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MILITARY SPECIFICATION

SOLDERING, MANUAL TYPE, HIGH RELIABILITY, ELECTRICAL AND ELECTRONIC EQUIPMENT

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

1. SCOPE

1.1 Scope. This specification covers soldering, high reliability electrical and electronic connections with manual soldering apparatus as applicable to guided missile and certain aerospace equipment requiring extraordinary control of soldering environment and techniques. Is not applicable to general soldering requirements.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or requests for proposal form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

QQ-S-571	Solder, Tin Alloy, Tin-Lead Alloy and Lead Alloy

Military

MIL-F-14256	Flux, Soldering, Liquid (Rosin Base)
MIL-P-28809	Printed Wiring Assemblies
MIL-P-46843	Printed Wiring Assemblies

STANDARDS

Military

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts

FSC THJM

MIL-STD-429	Printed-Wiring and Printed Circuits Terms and Definitions

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions may be obtained from the procuring activity or as directed by the Contractor Officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein.

IPC-S-801 (Dec 1970)	Edge Dip Solderability Test for Printed Wiring Boards

(Application for copies should be addressed to the Institute of Printed Circuits, 1717 Howard Street, Evanston, IL 60202.)

2.3 Conflict of documents. In case of conflict between any requirement specified herein, and any contained in the engineering documentation (including other specifications or standards referenced therein) the requirements of the engineering documentation shall prevail.

3. REQUIREMENTS

3.1 Applicability. The requirements of this specification are applicable to high reliability soldering using manual solder techniques.

3.2 Materials. Except when otherwise specified on detailed drawings, the materials utilized in soldering operations shall conform to the following requirements. It is possible that the materials and processes specified may in some combinations be incompatible. It is the responsibility of the manufacturer to select those materials and processes that will produce acceptable high quality products.

3.2.1 Solder. An Sn60 or Sn63 solder, form optional, conforming to QQ-S-571, shall be used.

3.2.2 Flux. Rosin based fluxes conforming to QQ-S-571 and MIL-F-14256 shall be utilized. Type RA flux may be used only on printed board assemblies without stranded wires.

3.2.3 Cleaning solvents. Solvents to be used for the removal of process contaminants and residues from parts and solder joints shall be compatible with the materials in the parts being cleaned.

3.3 Facilities, equipment and tools.

3.3.1 The soldering facility.

3.3.1.1 Temperature and humidity. The temperature shall be maintained at 75°F plus or minus 9°F (24°C plus or minus 5°C) and the relative humidity shall not exceed 65 percent. Where low humidity (30% or lower) is encountered, grounding or other precautions shall be taken to prevent degradation of components which are sensitive to static electrical charges.

3.3.1.2 Control of airborne contaminants. Manufacturing operations or other activities which produce airborne contaminants shall not be permitted in the room containing the soldering area. Positive pressure shall be maintained in the soldering room, relative to adjacent rooms where such contaminants are produced, unless the rooms are separated by two doors with a minimum of 10 lineal feet of dead air space between them. Evidence of visible accumulation of contaminants on work benches, tools, components, etc., shall be cause for corrective action.

3.3.1.3 Vapors. Toxic or volatile vapors shall be exhausted in accordance with OSHA requirements.

3.3.1.4 Work station maintenance. Work areas and tools shall be maintained in a clean and orderly condition. All dirt, grease, flux, solder spatter, chips, and other contaminating foreign material shall be promptly removed. Eating, smoking and drinking at the soldering work station shall not be permitted, and precautions shall be taken to preclude contamination by products of such activities from the station.

3.3.1.5 Work station lighting. Working surface lighting of soldering stations shall be 100 foot-candles minimum (1077 lm/m^2).

3.3.2 Tools and equipment.

3.3.2.1 Cutting and forming conductors and component leads. Cutting tools (pliers, dies, and roller-type cutters) shall cut squarely without burrs, excessive ridges or sharp points. They shall be maintained to assure consistent clean, smooth cuts.

3.3.2.2 Bending tools. Bending tools used for wire or lead bending may be automatic or hand implements and may be of any type which will not cut, nick, or in any way damage solid or stranded wires, leads, integral insulation or any other insulation added prior to the bending operations. Bending tools shall not impart stress to the component bodies or seals.

3.3.2.3 Clinching tools. Clinching tools or clinching devices shall be of such design and used so that no damage will occur to the printed wiring conductors, components or printed wiring board during the clinching operations.

3.3.2.4 Insulation strippers.

3.3.2.4.1 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 adequate to preclude damage to the wire or insulation not stripped from the wire.

3.3.2.4.2 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. 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, will be maintained to assure consistently sharp and even cuts without damage to the wires or unstripped insulation.

3.3.2.4.3 Chemical strippers. Chemical solutions, pastes, and creams used to strip hookup and magnet wires shall be suitable for removal of the insulation (enamel, varnish, polyvinyl, etc.) to be stripped and shall be limited to those that: (1) cause no degradation of the base metal of the wire; and (2) allow wires or conductors to be neutralized and cleaned of both ionic and non-ionic contaminants.

3.3.2.4.4 Thermal solder stripping and tinning. If applicable, thermal solder 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.

3.3.2.4.5 Soldering irons and resistance soldering equipment. 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 electrode shall heat the joint area rapidly and maintain proper soldering temperature at the joint throughout the soldering operation. Soldering equipment shall not produce detrimental magnetic fields or introduce electrical energy detrimental to items soldered. Three-wire cords and positive tip grounding to prevent potential greater than 2 millivolts shall be used when voltage sensitive components are

soldered. The soldering iron tips or resistance soldering apparatus shall be sized to the operations involved. Soldering tips shall be made of commercially pure copper, tellurium copper, or lead copper and shall be plated/coated with another metal that prevents solution of the copper tip in molten solder. The soldering iron shall attain a temperature no more than 10°F (5.6°C) above the control temperature when in an idling or standby condition. Soldering irons shall be provided with holders.

3.3.2.6 Soldering iron holder. Holders shall be of a type which supports the iron body without tip contact to any part of the structure and shall protect personnel from burns.

3.3.2.7 Soldering tools. Tools shall be of a type that will not cut, nick, or in any way damage leads.

3.3.2.8 Thermal shunts. Thermal shunts or heat sinks (see Figure 1) shall preferably be made of copper for good heat conductivity and shall be of such size and shape that gives adequate thermal protection and minimum mechanical interference to the parts during the soldering operations.

3.3.2.9 Anti-wicking tools. Anti-wicking tools shall be of a type marked with conductor gage sizes (see Figure 2).

3.3.2.10 Holding tools. Tools, fixtures, and materials used to hold or restrain wires and components shall be of a type which will not damage or deform the wies, leads, wire insulation, or components. If toothed clips are utilized (see Figure 3), the jaws of the clips shall be plastic covered.

3.3.2.11 Wiping pad. Cellulose sponge pads for wipe-cleaning the soldering tip shall be fine texture, low sulphur, synthetic sponge, and shall be kept clean and moistened with water.

3.4 General soldering requirements.

3.4.1 In-process handling and storage. The printed board assemblies, components and assemblies shall be protected from contamination and damage during handling, assembly, and storage operations. Soldered subassemblies and assemblies shall, subsequent to cleaning operations and prior to any encapsulation processing, be handled to preclude contamination.

NOTE: Printed board assemblies should be handled only by their edges or with lint-free gloves that are also free of oils, solvent residue, soil, or other contaminants that could be transferred to the assemblies.

3.4.2 Tinning of untinned soldering tips. The soldering iron shall be heated and when the soldering tip reaches the lowest temperature required to melt solder, solder shall be applied to the tip. The hot tinned tip shall be cleaned by wiping it lightly on a wiping pad (see 3.3.2.11). A bright, thin but continuous tinnned surface shall be maintained on the soldering tip working surface to insure proper heat transfer and to avoid transfer of impurities to the solder connection.

3.4.3 Solderability. All surfaces to be soldered that do not conform to the requirements of MIL-STD-202, Test Method 208, and all printed wiring circuits that do not conform to IPC-S-801 shall be retinned or replated to provide solderability conforming to MIL-STD-202 or IPC-S-801 requirements as applicable. To prevent gold embrittlement, those areas of gold plated parts, (including solder cups and other hollow cylindrical terminals) to be soldered shall be subjected to a double tinning operation or the gold removed and a single tinning operation performed. More active fluxes than those specified in 3.2.2 may be used, provided all ionic and non-ionic contaminants are removed within one hour from the time that the item was retinned.

3.4.4 Preparation of conductors and terminals.

3.4.4.1 Insulation clearance. Insulation clearance shall be maintained per Table I. For purposes of this requirement, insulation clearance is that gap between the insulation and the edge of the terminal (see Figure 29).

TABLE I

Wire (AWG Size)	Clearance Min	Clearance Max
Smaller than #20	Visible Clearance	.060 (1.5mm)
#20 thru #10	1/32 (0.8mm)	2X diameter of insulation
#8 thru #2	1/32 (0.8mm)	3/8" (9.5mm)
#1 and larger	1/32 (0.8mm)	1/2" (12.7mm)
Coaxial and Special Wires	Per Engineering Drawing	

3.4.4.2 Insulation removal. Insulation shall be stripped utilizing any stripper compatible with 3.3.2.4. Thermal stripping is preferred for jacketed wires of size AWG 22 and smaller. Chemical or thermal insulation stripping is preferred for coated wire such as magnet wire. Chemically stripped wires shall be cleaned of ionic and non-ionic contaminants within one hour after stripping. Thermal insulation stripping and conductor tinning shall be performed under closely controlled time/temperature relationships in compliance with the wire manufacturers recommendations.

3.4.4.3 Conductor and insulation damage. The conductor shall not be scraped, ringed, nicked, cut, scored or otherwise reduced in size after stripping. The insulation shall not be burnt, charred, scorched, frayed, split or unevenly trimmed (see Figure 29) nor shall it be compressed, pinched or otherwise reduced in thickness. Slight discoloration due to thermal or chemical stripping and minor depresssions caused by mechanical strippers shall not be cause for rejection.

3.4.4.4 Conductor splicing. The splicing of conductors is prohibited except as specified by the drawings.

3.4.4.5 Stress relief.

3.4.4.5.1 Stranded and solid hook-up wire. Wiring terminated at a solder connection shall be formed with a slight loop or gradual bend sufficient to relieve tension on the wire.

3.4.4.5.2 Component leads and jumper wires. Leads/wires to be terminated and soldered to any of the various types of terminals or to printed board assemblies shall be mounted such that there is a curve or bend sufficient to allow relief from axial tension caused by thermal expansion/contraction (see Figures 4 and 34).

3.4.4.6 Cutting conductors. Conductor wire should be cut to length before soldering. Wire ends shall not extend beyond the solder joint (see Figures 5, 36, 37, and 43).

3.4.4.7 Cleaning conductors and terminals. Conductor surfaces to be soldered shall be clean. Cleaning techniques that impair solderability shall not be used. Cleanliness shall be sufficient to insure solderability.

3.4.4.8 Pretinning. Stranded conductors shall be pretinned on all portions of the wire coming in contact with the solder area. The solder shall penetrate to the inner strands of the stranded wire. Solder shall not conceal the contour of the individual outer strands nor shall solder extend under the insulation (as indicated by visual inspection without distortion of the strands) except as allowed by the procuring activity (see Figure 6). If flat packs leads are tinned to meet the requirements of 3.4.3, the tinning shall not (except when removing gold) extend beyond the second radius of the lead (see Figure 34).

3.4.4.9 Terminal assembly. Unless stated otherwise by engineering drawing or specifications, swaged and rolled terminals shall be assembled as depicted in Figure 17B.

3.4.5 Mechanical connection procedure.

3.4.5.1 Sorting and dressing lead wires to terminals. Lead wires shall be sorted and dressed to terminals as follows:

(1) Lead wires to be terminated shall be sorted by color code or other method of identification and dressed in their proper positions.

(2) Care shall be taken to assure that all leads are placed in a manner to prevent shorting or damage to insulation.

(3) Placing lead wires adjacent to sharp edges or corners shall be avoided.

(4) The insulation on lead wires shall not be crushed or damaged.

(5) Lead wires may be wrapped clockwise or counterclockwise around terminal from the side to which the lead is dressed, but must not interfere with the wrapping of other leads to the terminal.

3.4.5.2 General. Mechanical attachment of leads and lead wires to terminals, and printed board assemblies shall be in accordance with the following:

(1) Lead wrapping and lead clinching shall be accomplished utilizing tools as specified in 3.3.2. Leads shall be preformed to the final configuration (except for the final crimp, where required). Lead forming shall not damage the lead due to nicking, or deformation exceeding 5 percent of the wire diamater.

(2) Insulation clearance shall be maintained as stated in paragraph 3.4.4.1.

(3) Insofar as practicable, holding tools as specified in paragraph 3.3.2.10 shall be utilized to facilitate maintaining lead dress and to minimize the possibility of positioned leads shifting before the attachment is firmly established.

(4) Where necessary, positioned leads may be tack-soldered to assure maintenance of established positioning.

(5) Component lead bend radius shall be not less than one conductor diameter. (See Figure 4)

3.4.5.3 Turret terminals. The wire shall be maintained in contact with the shank of the terminal for the full curvature of the wrap (180-270 degrees) and the flange of the terminal (see Figure 7A). Where three or more terminals in a row require a continuous jumper, a solid buss may be wrapped 360 degrees and continued from terminal to terminal provided the wraps on the first and last terminals of the series conform to the 180° - 270° requirement (see Figure 7B). The number of lead attachments shall be maintained such that: (1) all wraps are parallel with the flange surface; (2) there is no overlapping of wraps and wires; (3) spacing between wires and between wire and terminal board and headers, is a minimum consistent with the diameter of the insulated wire. (See Figures 8 and 9).

3.4.5.4 Fork or bifurcated terminals. The order of preferred terminations are as follows:

3.4.5.4.1 Side route connections. The wire or component lead shall be dressed through the slot and wrapped to either post of the terminal (see Figures 10 and 11). The wire or lead shall be maintained in contact with the terminal post for the full curvature of the wrap (180-270 degrees) and the terminal base surface. The number of attachments shall be maintained such that: (1) there is no overlapping of wraps and wires; (2) spacing between wires and between wire and terminal board, printed board assembly is a minimum consistent with the diameter of the insulated wire; and (3) the wraps are dressed in alternate directions (see Figure 11).

3.4.5.4.2 Bottom route connection. The wire shall be inserted to the terminal base and wrapped to either post (see Figure 12). The wire shall be maintained in contact with the terminal post for the full curvature of the wrap (180-270 degrees). 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.

3.4.5.4.3 Top route connection. The stripped wire shall be positioned such that it extends the full length of the terminal forks. When the ratio of slot size to wire size is greater than 2:1, the wire may be doubled back as shown in Figure 13 to help hold the wire in position.

3.4.5.5 Hook or perforated terminals.

3.4.5.5.1 Hook terminals. Wires shall be mechanically attached as follows:

(1) Attach leads to either the top or the side and wrap securely around the terminal maintaining a finished wrap of 180-270 degrees.

(2) Maintain the correct insulation clearance.

(3) Connections shall be made at least 1/16-inch (1.6 mm) from the insulated base of the terminal where practical.

NOTE: Leads may approach the terminal from any angle.

3.4.5.5.2 Perforated terminals. Wires shall be mechanically attached as follows:

(1) The bared wire shall be wrapped maintaining a 180-270 degree wrap. (See Figure 15)

(2) Wraps to floating type terminals (tube sockets for example) shall have slack to allow for movement of the floating terminals. Where the use of a mechanical wrap is impractical, such as a large wire connecting to a small size terminal, insert the wire through the opening and solder without attempting a mechanical wrap.

(3) If wires are to be attached to a group of terminals, such as tube sockets, transformers or relays, the wires shall be neatly arranged around the terminals in such manner that they do not cross one another. Jumpers may cross the space between terminals, providing they do not interfere with the socket alignment holes.

(4) When leads enter terminals from different directions, enough slack must be left to allow movement of floating terminals; the same precaution must be observed with bare wire jumpers.

(5) Extreme care shall be used when connecting leads to transformer terminals, because these terminals will normally not withstand the wrapping force applied to other terminal types.

3.4.5.6 Feed-through terminals. The terminating end of a wire inserted through a feed-through terminal shall be hooked over the lip of the terminal not less than 1/16 inch (1.6 mm) (see Figures 16 and 17A). Not less than 1/16 inch (1.6 mm) of the connection hook shall be soldered tangent to the terminal.

3.4.5.7 Printed board terminations. Unless otherwise specified the following procedures shall be used in assembly of components on printed boards and preparing terminations for soldered connections:

a. Components shall be assembled to the board with the component body on the side opposite that which bears the circuitry to be soldered unless the board is specifically designed for the component to be mounted on the circuit side.

NOTE: For this requirement, double-sided boards containing only redundant pads on the side opposite the printed wiring or printed circuits shall be considered as single-sided boards.

b. Component leads and other conductors terminated directly at the PW board terminal pad shall extend through the board a minimum of 1/2 the largest pad dimension (usually the largest pad dimension is the diameter when the pad is round), and a maximum of the largest pad dimension after clinching. Unless otherwise specified, the lead bend direction shall be along the conductor pattern, parallel to the board and in contact with the printed wiring. Normal springback after being completely clinched is permissible. Leads shall not extend beyond the terminal pad or printed wiring pattern. Leads shall point as nearly in opposite directions as the wiring pattern permits for mechanical retention prior to and during the soldering operation. On circular components with three or more leads, radial orientation of lead pointing shall be used where the wiring pattern permits. When automatic insertion of components is authorized in the drawing, contract, or purchase order, direction of the clinch is optional. (See applicable sketches in MIL-P-46843).

c. When component lead wire diameter, length, or composition prevent bending, or when specified on the engineering drawing, the lead shall be treated as an unclinched pin.

d. When leads cannot be clinched per above, they shall extend through the printed board a minimum of 0.030 inch (0.8 mm) and a maximum of 0.060 inch (1.5 mm). See Figure 27.

e. Printed board assembly terminal areas which are designated for installation of terminals shall not be gold plated and shall be tinned. A V-type (funnel) swage shall be used on printed circuits, where the swaged end of terminal terminates in a terminal area or pattern (see Figure 17B). A roll-type swage shall be used only where the swaged end terminates directly to the base material of the printed wiring (see Figure 17B). After swaging, the terminal shall be free from circumferential splits or cracks, but may have a maximum of three radial splits or cracks provided the splits or cracks do not extend beyond the rolled or swaged area of the terminal. Radial splits or cracks shall be a minimum of 90 degrees apart.

3.4.5.8 Ribbon lead geometry. Ribbon leads shall be preformed to fit the pads. (Figures 33 through 35). Care shall be exercised to minimize the skewing of leads in relation to the terminal areas, and to assure that the leads are not damaged during the tinning and solder operations. After soldering, the lead knee on flat packs shall not rise vertically more than half the distance from the point the lead penetrates the component body to the top of the component or .063 inch (1.60 mm) whichever is less. The lead knee of components such as diodes and capacitors with flat leads shall have a maximum rise of .063 inch (1.60 mm). The end of the lead may curl or tilt no more than one lead thickness measured from the bottom of the lead to the top of the pad. (See Figure 33)

3.5 Soldering the connection.

3.5.1 Flux application. Flux shall be utilized for all soldered electrical connections. When liquid flux is used, it shall be applied sparingly but in sufficient quantities to assure effective fluxing action. When cored fluxes are used, liquid fluxes shall not be added except during rework or touch up.

3.5.2 Heat application. Apply the soldering iron tip to the connection in such a manner that the soldering temperature will be reached in the minimum time by the surfaces to be soldered. Care shall be taken to assure that printed circuits, adjacent components, insulation, and parts that will be adversely affected by heat are not degraded. Thermal shunts conforming to 3.3.2.8 may be used to prevent damage to parts being soldered and shall be used with all heat-sensitive components.

3.5.3 Solder application. For soldering connections other than cup terminals which necessitate a special technique, see below, solder shall be applied at the junction of the soldering iron tip and the elements to be joined and the iron tip shall be moved with the molten solder to maintain a solder bridge. (See Figures 18 and 37 thru 41) Solder shall cover the conductor and a concave fillet shall be formed between the lower half of the conductor and the other elements (terminal, flange, printed wiring terminal area) of the solder connection. The contour of the conductor (component lead, jumper wire) and the strands of stranded wire shall not be obscured by solder (Figure 19). Visible wicking under the insulation shall not be present (strands shall not be distorted to check wicking) except as allowed by the procuring activity. When excessive wicking is suspected, a stiffness greater than normal two diameters from the trimmed end of the insulation will be cause for rejection. Exposed copper ends on the conductors shall be completely covered with solder. Precautions shall be taken to prevent relative movement in the soldered joint during solidification. Forced cooling of the solder prior to solidification is prohibited.

3.5.3.1 Soldering solder cup and other hollow cylindrical terminals. Position the terminal at an angle with the open side of the cupt toward the solderer. Place the soldering iron to the base of the terminal (Figure 20) and maintain until the flow temperature of solder is attained. Slowly prefill the cup with sufficient solder to assure that the total of the prefill solder and the pretinned conductor is sufficient to fill the cup without overflow when the conductor is inserted. While maintaining the cup at soldering temperature, the conductor wire shall be positioned within the cup cavity. The conductor wire shall be pushed into the terminal as the soldering iron tip is simultaneously slid to the terminal base (see Figure 21). The wire shall be bottomed in the cavity before the soldering tip is removed. After solder solidification, the solder shall form a fillet extending from the conductor to the tip and rim of the solder cup (see Figure 23A). Any excess solder shall be removed from the terminal to the extent that any solder on the external surface of the terminal is in the form of a thin film only (see Figure 23).

3.5.3.2 Plated-through holes. Solder shall be applied to plated-through holes used for interfacial and interlayer connection utilizing the procedure detailed below. Additionally, solder shall be flowed only from one side of the circuit board to assure that all plating within the hole is supported with solder. Solder coverage and fill are illustrated in Figures 25 and 27.

3.5.3.2.1 Plated-through holes with a continuous solder plug. The solder in the hole may be depressed (on both sides of the board) up to 25 percent of the board thickness including the pads on both sides of the board, but evidence of good wetting shall be present. See Figure 25.

3.5.3.2.2 Plated-through holes with feed-through wire. The holes shall show evidence of good wetting and sufficient solder on both sides of the printed circuit board. Nominal spring back of clinched wire is allowable. See Figure 26.

3.5.3.2.3 Plated-through holes with leads. Plated-through holes with component lead may have the solder depressed on the component side of the board; however, the total depression shall not exceed 25 percent of the hole depth, including the pads, with good wetting completely around the hole. See Figure 27.

3.6 Operations following soldering.

3.6.1 Cleaning the soldered connection. After the solder has completely solidified, all residual flux and soils shall be removed (within 1 hour) using solvents or combinations of solvents which will remove polar and nonpolar contaminants. After final cleaning, finished assemblies shall not be contaminated by handling or environments.

3.6.2 Cleaning solder joints other than those on printed board assemblies. Soldered assemblies that cannot be transported or conveniently handled due to size and configuration (connector-assembled cables, interconnecting harness wiring to terminal strips, and other chassis and rack components) shall be thoroughly cleaned by flushing and rinsing using spray system or suitable brushes and cleaning solvents. Drying shall be accomplished with clean dry air or clean dry nitrogen. Other techniques may be used with prior approval of the procuring activity.

3.6.3 Resistivity of solvent extract. When uncoated printed board assemblies are tested as specified in 4.3.2, the resistivity shall be not less than 2,000,000 ohm-centimeter.

3.6.4 Insulation sleeving or tubing. Either flexible or heat-shrinkable tubing, when required on the detail drawings, shall be fitted over the solder connections only after residual flux has been removed.

3.7 Unsoldering.

3.7.1 Removing the conductor wire. Solder joints shall be allowed to cool to room temperature prior to reworking unless a heat sink is used to dissipate the additional heat. A well-tinned soldering iron tip shall be used to melt solder connections when conductor wires are removed from component terminals. Wires may be removed from tubular or pin-type materials with resistance-soldering apparatus.

3.7.2 Removing the solder. Solder should be removed from terminals and solder cups either by using mechanical vacuum devices or by wicking with a stranded conductor or shielding braid and flux. In wicking with stranded conductor or shielding braid and flux, place the wire on the solder connection and place the hot soldering iron tip on the wire. The iron tip and the wire shall be removed simultaneously as soon as the desired amount of solder has wicked into the stranded wire (see Figure 24). Remove all residual flux and contaminants.

3.7.3 Optional methods of removing solder. This specification does not preclude other methods of removing solder which are equally reliable. The contractor or agency proposing to use another method shall have it approved by the procuring activity prior to the initiation of any fabrication.

3.7.4 Surfaces of printed boards with connections unsoldered. Unsoldering operations shall be accomplished in such time and manner that the printed board material or components are not degraded or damaged.

3.8 Reworked connections. all reworked soldered connections shall meet original soldering requirements.

3.9 Qualification of soldering operators and soldering inspectors.

3.9.1 Qualification of solder personnel will be by certificate of training. Certification shall be traceable to the Government agency responsible for Standards of Workmanship for each service (i.e., Air Force, Army, and Navy). For Department of the Army Personnel, Frankford Arsenal,

Philadelphia, PA., Quality Assurance Directorate, Standards of Workmanship School, is the designated agency. Other services and industry may use this facility upon application.

3.9.2 Certification of soldering operators and inspectors. Unless otherwise specified (see 6.2), certification records of the operators/inspectors training, qualification and ability to meet the requirements of this specification shall be made available to the procuring activity.

3.9.3 Recertification. Certified status of a soldering operator or a soldering inspector may be maintained by successfully completing re-examination tests every twelve months or by a continuing record of satisfactory workmanship as witnessed by government inspectors.

3.10 Workmanship. The workmanship, utilized in accomplishment of the processes specified herein, shall be of a level of quality adequate to assure that the processed products shall meet the performance requirements of the applicable product drawings and specifications, relative to these processes. The solder connections shall have a smooth, bright appearance with metallic luster and shall not have a chalky, gritty, or irregular surface, nor exhibit points (peaks), pits, scars, fractures, trapped flux, foreign materials, or have holes which expose base metal (where the bottom is not visible, exposed base metal will be assumed). The connections shall be completely covered by solder to the extent that no base metal is visible, including the copper ends of cut wire or leads. Solder beads shall not project from terminals, nor shall solder spatter exist on adjacent components or surfaces.

NOTE: The visual standards provided as figures herein are intended as aids in determining acceptability of processed products. It is expected that strict adherence to the specified requirements should result in a general quality of workmanship equal to the upper illustrations. The center illustrations represent minimum acceptable standards which are undesirable as a general condition but are acceptable. The bottom illustration represents unacceptable conditions. Corrective action should be taken when general quality of workmanship is not in accordance with the upper illustration.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, or purchase order the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order the supplier may use his own or any other facilities suitable for the performance of the inspection

requirements specified herein unless disapproved by the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that suppliers and services conform to prescribed requirements.

4.2 Quality conformance inspection.

4.2.1 One hundred percent inspection. Each soldered connection and its associated wiring or leads shall be visually inspected to determine conformance to the requirements specified herein. Table II provides a list of defects with reference to the applicable requirements. Any defect shall be cause for rejection.

4.2.2 Sampling Inspection. Sampling for cleanliness of uncoated printed board assemblies, utilizing the resistivity of solvent extract method, shall be in accordance with the applicable provisions of MIL-P-46843 or MIL-P-28809.

4.2.3 Process inspection. Surveillance shall be conducted on a continuous basis to assure that the requirements for tools, materials, handling, equipment, facilities, and processes specified herein are strictly adhered to. Any noncompliance shall be grounds for rejection of the material processed.

TABLE II

LISTS OF DEFECTS

CHARACTERISTIC	REQUIREMENT	FIGURE(S)	DEFECT
Workmanship	3.10	5, 23, 47, 50 and 51	Solder spatter and beads
Workmanship	3.10	28, 36, and 40	Cold solder joint
Workmanship	3.10	5 and 36	Rosin Joint
Insulation Clearance	3.4.4.1	29, 36 & 37	Incorrect insulation clearance
Insulation Integrity	3.4.4.3	29, 36 & 37	Damaged insulation
Conductor Integrity	3.4.4.3	39	Damaged conductor
Wicking (solder joint)	3.5.3	37 & 40	Excessive wicking
Wicking (pretinning)	3.4.4.8		Excessive wicking
Stress Relief	3.4.4.5	4, 44 & 49	Wire or component lead in tension
Heat Application	3.5.2		Charring or blistering of components or insulation
Mechanical Connections	3.4.5		Multiple termination exceeding requirement
Mechanical Connections	3.4.5	37	Wires or leads not in contact with terminal for prescribed length
Mechanical Connections	3.4.5		Overlapping of wires or leads
Mechanical Connections	3.4.5		Inadequate spacing between wires or leads or between wire/leads and terminal board or header
Workmanship	3.10	5, 23 & 50	Solder Points (peaks)
Workmanship	3.10	41 and 46	Pits, scars, or holes

TABLE II (Cont'd)

CHARACTERISTIC	REQUIREMENT	FIGURE(S)	DEFECTS
Solder Application	3.5.3	19, 36, 40 & 46	Excessive Solder
Workmanship	3.10		Fractured (Cracked) solder connection
Cleanliness of Connection	3.6, 3.10	41 and 45	Unclean connection
Workmanship	3.10	41 and 42	Dewetting
Solder Application	3.5.3	39, 42 & 43	Insufficient solder
Solder Application	3.5.3	42	Conductor base metal visible
Lead Clinch	3.4.5.7b	41	Clinched lead extending outside of pad or trace
Ribbon Lead Geometry	3.4.5.8	57, 31 & 32	Ribbon leads extending outside of pad or trace
Lead Clinch	3.4.5.7b	26	Incorrect length of clinch
Conductor Integrity	3.4.4.4		Unauthorized splice
Plated through holes	3.5.3.2	56, 25 & 27	Inadequate solder plug
Plated through holes	3.5.3.2.2	26	Inadequate wetting
Mechanical connection	3.4.5	38	Flared or birdcaged wire
Solder Application	3.5.3	48	Disturbed solder connection
Solder Application	3.5.3.1	23	Solder runs

4.3 Inspection methods.

4.3.1 Visual inspection. Visual inspection shall be performed utilizing a minimum of 4X magnification. Lighting shall equal or exceed the requirement of 3.3.1.5. A clear, incandescent light should be used for detection of uncovered copper. When solder connections are suspected as defective, magnification commensurate with the size of the connection shall be used to aid the visual inspection. As a guideline, magnification for visual inspection of connections in microminiature, miniature, and standard assemblies may be limited to 70X, 30X, and 10X respectively.

4.3.2 Cleanliness test. The resistivity of solvent extract method for cleanliness testing of uncoated printed wiring assemblies shall be in accordance with the applicable provisions of MIL-P-46843 or MIL-P-28809.

4.4 Inspection standard. Figures 1 through 58, and any additional provisions provided or approved by the procuring activity, shall be utilized, as aids, in determining compliance with the requirements of this specification.

4.5 Qualification and certification . Prior to performance of the requirements of this specification all soldering personnel qualification and certification shall be verified to be in accordance with 3.9.

5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6. NOTES

6.1 Intended use. It is intended that the soldering procedures covered by this specification are to be utilized for the soldering of highly reliable electrical connections in critical electrical and electronic equipment of military weapon system. This specification outlines the basic soldering procedures and process requirements which are to be employed. It also graphically illustrates the accept/reject criteria for soldered connections. It is recognized that soldering connections exist other than those dealt with herein, and it is intended that these connections shall be handled under the general provisions of this specification.

6.2 Ordering data. Ordering data shall include the following:

a. Title, number and date of this specification.

b. If certification of operators is not required (see 3.9 and 4.5).

6.3 Cleaning solvents. The following solvents have been found suitable for the removal of polar and nonpolar contaminants and residues from parts, assemblies, and solder connections per requirements of Section 3.6.1 of this specification.

a. Chemicals

(1) Isopropyl Alcohol (TT-I-735, Grade A)

(2) Alcohol SDA-30 (O-E-760, Grade III)

(3) Trichlorotrifluoethane (MIL-C-81302, Type II)

(4) I-I-I Trichloroethane (O-T-620)

(5) Perchloroethylene (O-T-236)

(6) Reagent Water (ASTM D-1193, Grade IV)

b. Solutions

(1) 35 percent weight, Isopropyl Alcohol (TT-I-735, Grade A)
65 percent weight, Trichlorotrifluoroethane (MIL-C-81302, Type II)

(2) 15 percent weight, Isopropyl Alcohol (TT-I-735, Grade A)
85 percent weight, Trichlorotrifluoroethane (MIL-C-81302, Type II)

(3) 35 percent weight, Alcohol SDA-30 (O-E-760, Class A, Grade III)
65 percent weight, Trichlorotrifluoroethane (MIL-C-81320, Type II)

(4) 14.6 percent weight, Isopropanol (TT-I-735, 2 Propanol, Grade A)
85.4 percent weight, Tetrachlorodifluoroethane (CCL_2F-CCL_2F)

(5) 28.4 percent weight, Isopropanol (TT-I-735, 2 Propanol, Grade A)
71.6 percent weight, Tetrachlorodifluoroethane (CCL_2F-CCL_2F)

(6) 4 percent weight, Ethyl Alcohol SDA-30 (O-E-760, Class A, Grade III)
96 percent weight, Trichlorotrifluoroethane (MIL-C-81302, Type II)

Note: Due to the many manufacturing processes and materials used to clean printed/wiring circuit assemblies after soldering, it is the responsibility of the producing facility to determine the suitability of the solvents selected for the cleaning processes.

SAFETY NOTE: Many cleaning fluids should be used with caution and in well-ventilated rooms.

6.4 Solvent control. Solvent control can be accomplished by:

a. Periodic removal of soil-saturated solvent.

b. Monitoring of solvent for acid production.

6.5 Terms and definitions. Definitions applicable to this specification shall comply with MIL-STD-429 and the following:

Cold Solder Joint	Unacceptable solder joint due to poor wetting and insufficient heat in making the solder joint.
Disturbed Solder Joint	Unsatisfactory connection resulting from relative motion between the wire and the terminal during solidifcation of the solder.
Double Tinned	The tinning process repeated. This is one technique to remove gold plating from leads of components.
Excessive Solder Connections	A connection unsatisfactory because the contour of the elements of the connection are completely obscured or one with solder overflowed beyond the confines of the connection area.
Ionic	An electrically conductive material which often is corrosive.
Nicked	Cuts in the individual strands of wire or in a solid conductor. Usually results from improper application of tools.
Polar	Chemical bond with electrostatic attraction between oppositely charged particles.
Ringed	Deformation of a solid lead or conductor around the circumference usually resulting from worn or incorrect forming tools.
Rosin Solder Connections	Unsatisfactory connection which contains trapped flux.

Scored	Marks, incisions, or notchings on the individual conductor strands or a solid conductor that has reduced its diameter.
Scratch	A scratch is a relatively long and narrow furrow or groove, usually shallow, on a surface caused by marking or rasping the surface with something pointed or sharp.
Sharp Edges	Point protrusions or thin solder sections which may pierce conformal coating causing material damage or personal injury.
Terminal	A tie point device used for making electrical connections. Five basic types of terminals are: bifurcated, hook, perforated or pierced, solder cup and turret.
Thermal Shunt	A device (also referred to as a heat sink) which has good heat dissipation characteristics used to conduct heat away from an object.
Work Station	The solder work station is an identified area used for manual soldering. The area within 10 feet (3.05 M) of the actual soldering bench shall be considered a part of the work station.

Custodian:
Army - MI
Navy - AS
Air Force - 11

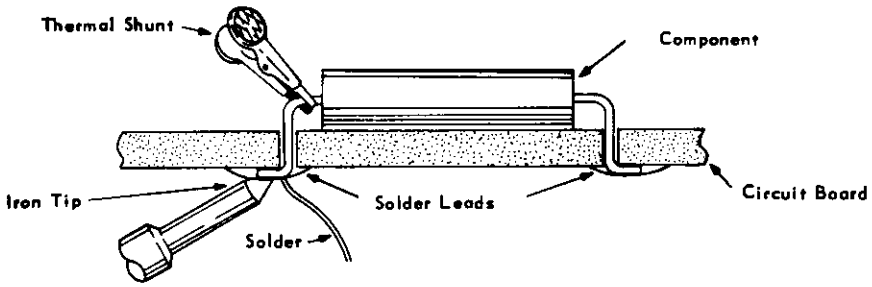
Review Interest:
Army - MR, PA, MU, EL
Navy - OS
Air Force - 99

User Interest:
Army - AV, WC, PA, SC

Civilian Agencies
NASA - MSFC
DSA - FSS

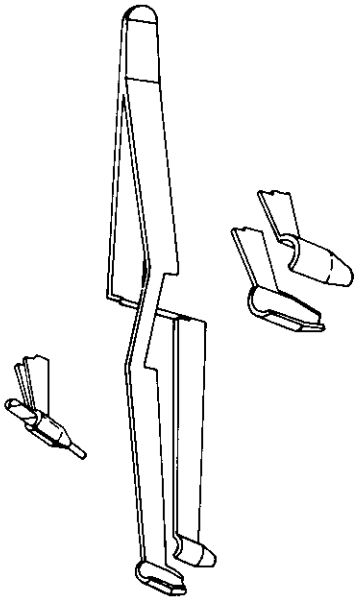
Preparing Activity:
Army - MI

Project No. THJM-0068



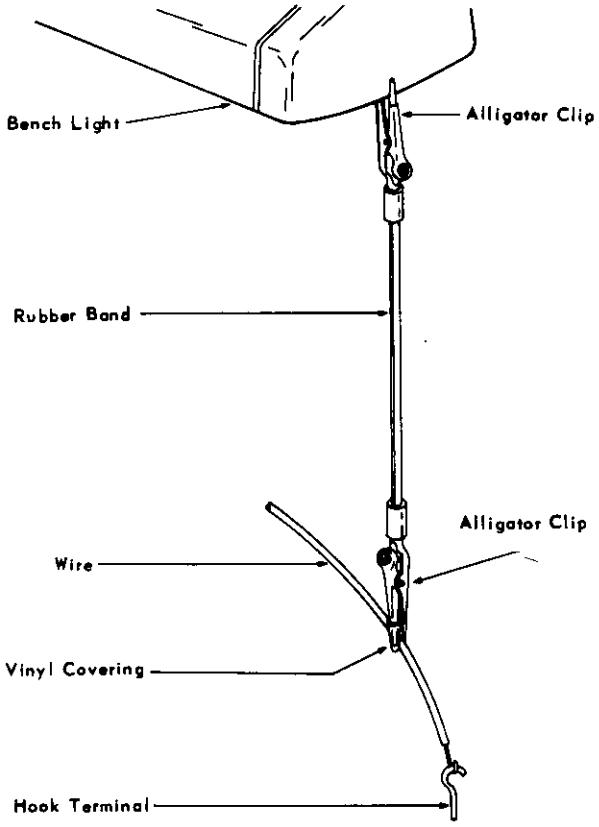
See 3.3.2.8 and 3.5.2

FIGURE 1. THERMAL SHUNT



See 3.3.2.9

FIGURE 2. ANTI-WICKING TOOL



See 3.3.2.10

FIGURE 3. LEAD HOLDING TOOL

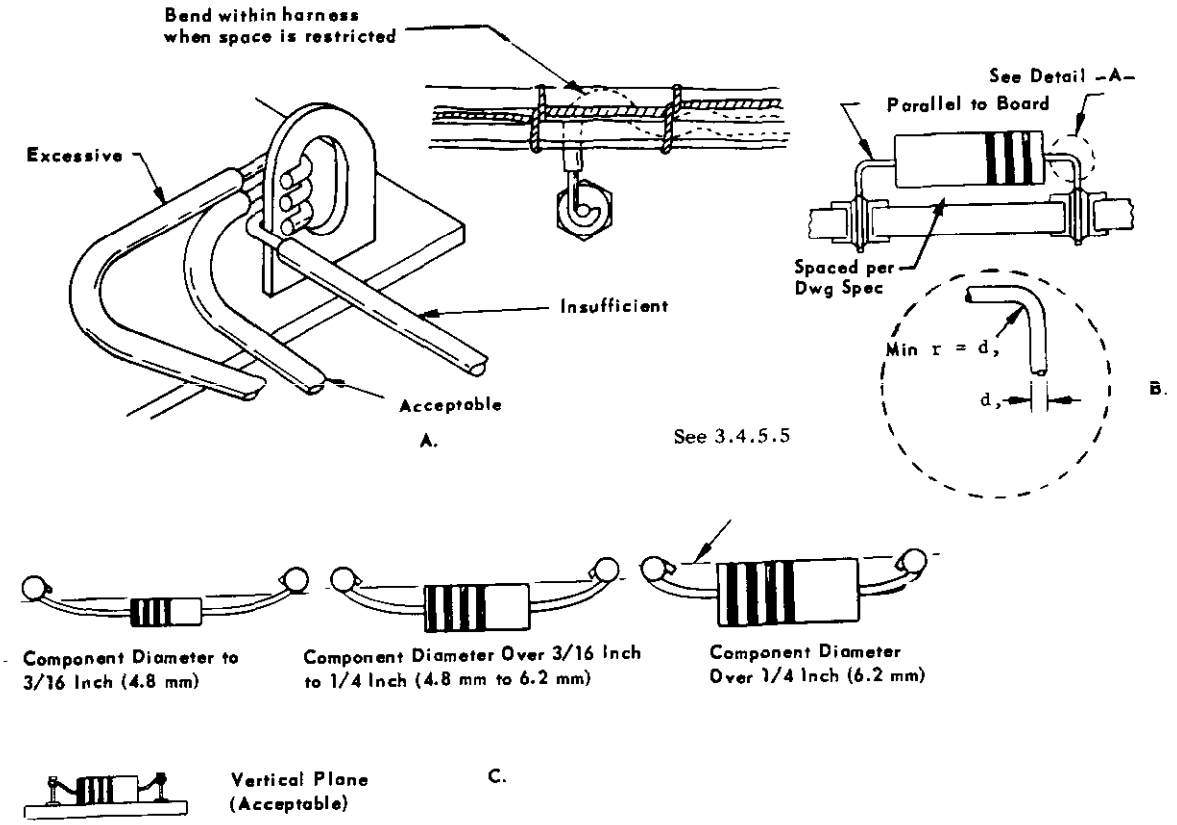


FIGURE 4. STRESS RELIEF

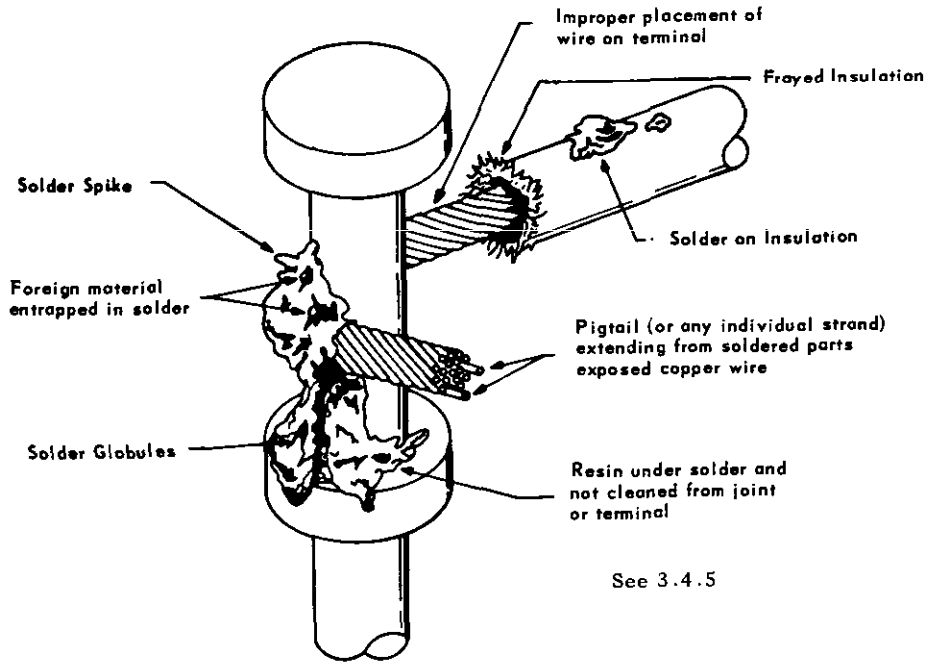


FIGURE 5. POOR WORKMANSHIP –

Any one or more of the conditions shown constitutes poor workmanship and is unacceptable

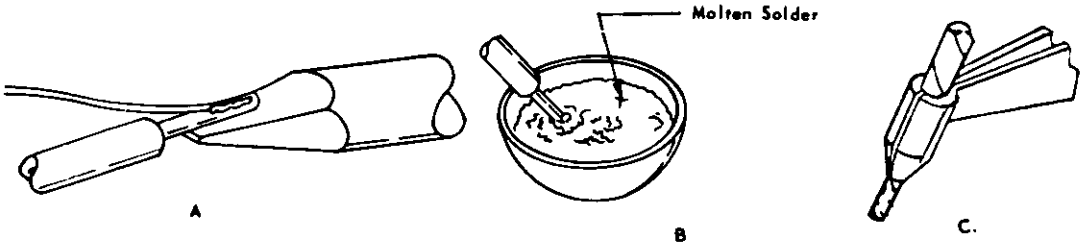
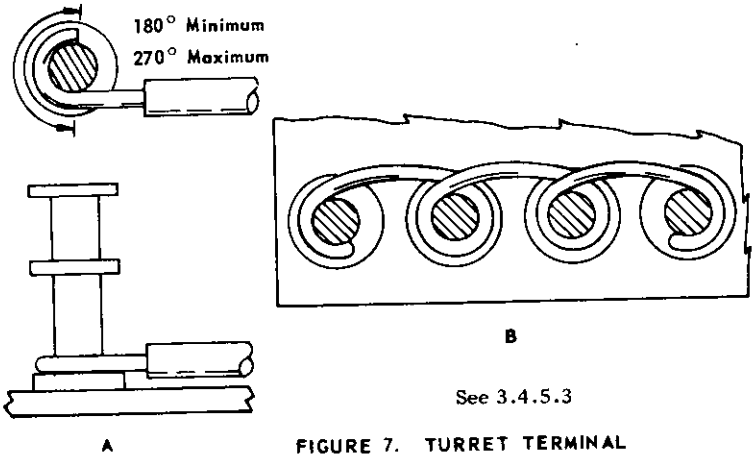
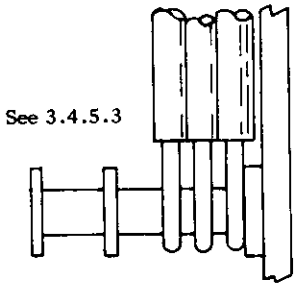


FIGURE 6. SUGGESTED METHODS FOR TINNING (WIRE) See 3.4.4.8



See 3.4.5.3

FIGURE 7. TURRET TERMINAL



See 3.4.5.3

FIGURE 8. MULTIPLE CONNECTION

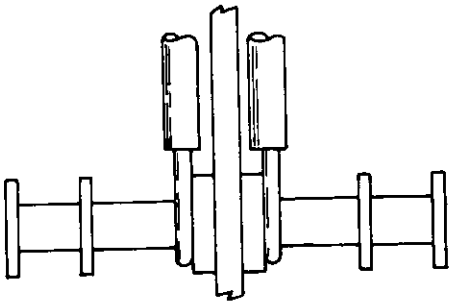
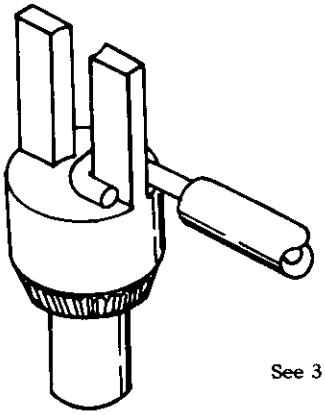


FIGURE 9. DOUBLE-ENDED TERMINAL See 3.4.5.3



See 3.4.5.4

FIGURE 10. BIFURCATED TERMINAL

SIDE ROUTE SINGLE CONNECTION

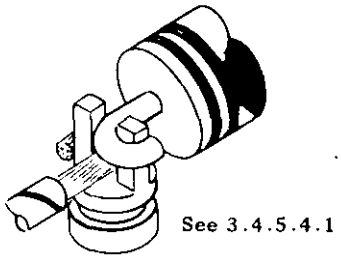


FIGURE 11 BIFURCATED TERMINAL MULTIPLE SIDE ROUTE CONNECTIONS

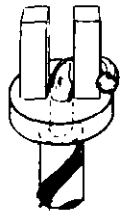


FIGURE 12. BIFURCATED TERMINAL BOTTOM ROUTE CONNECTION

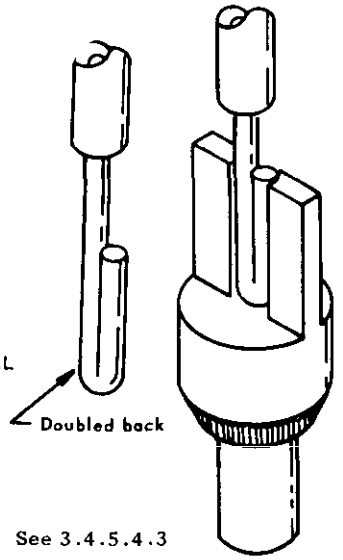


FIGURE 13. BIFURCATED TERMINAL TOP ROUTE CONNECTION

(Not for Naval Air Service Production)

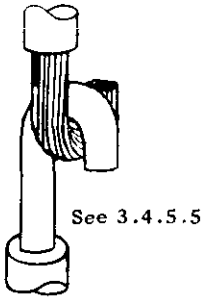
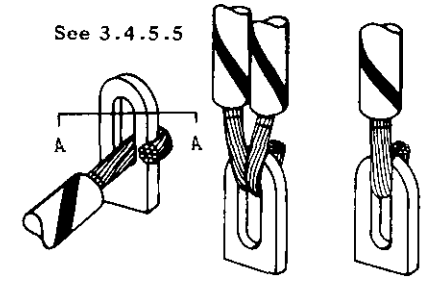


FIGURE 14. HOOK TERMINAL



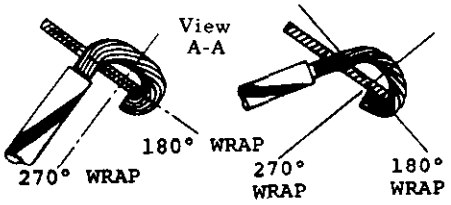


FIGURE 15. EYELET TERMINAL

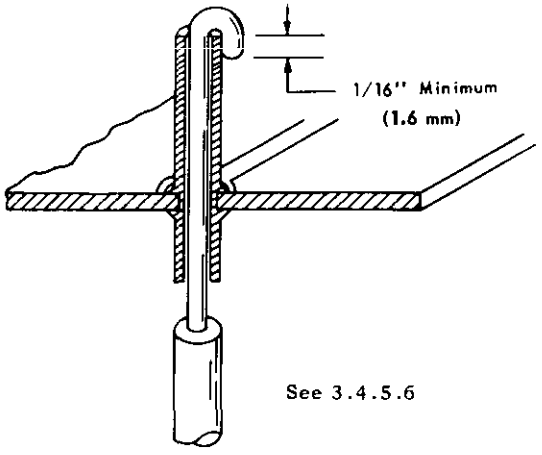


FIGURE 16. FEEDTHRU TERMINAL TOP TERMINATION

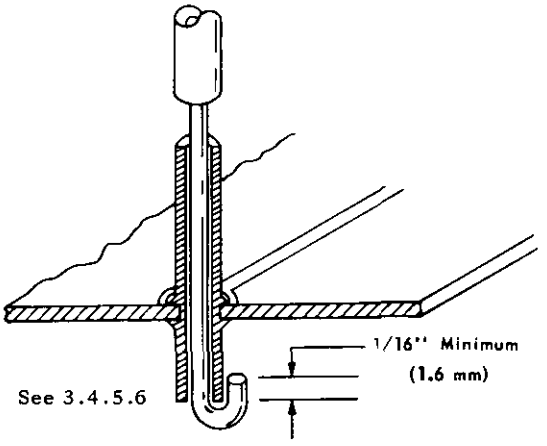
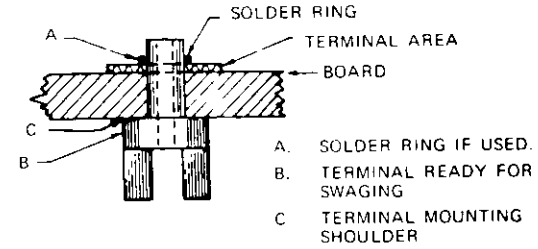
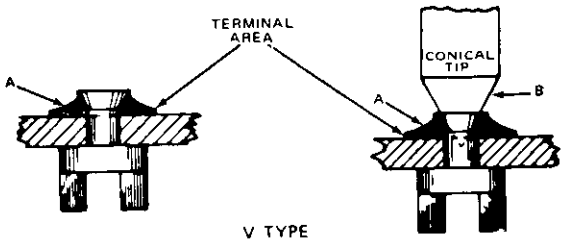


FIGURE 17. A FEEDTHRU TERMINAL BOTTOM TERMINATION

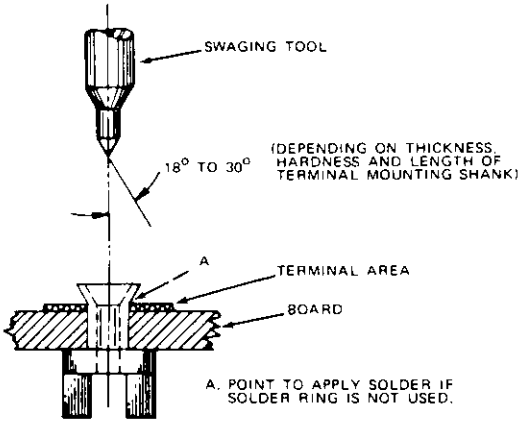


TERMINAL BEFORE SWAGING

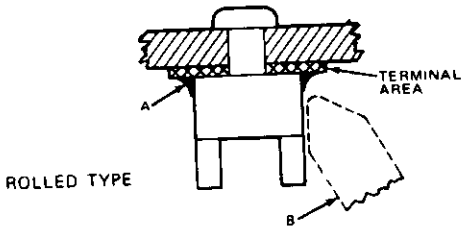
Soldering swaged terminals.



V TYPE

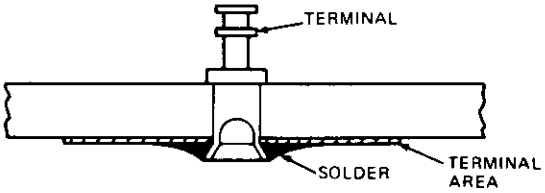


Typical "V" type swaging tool and swaged terminal.

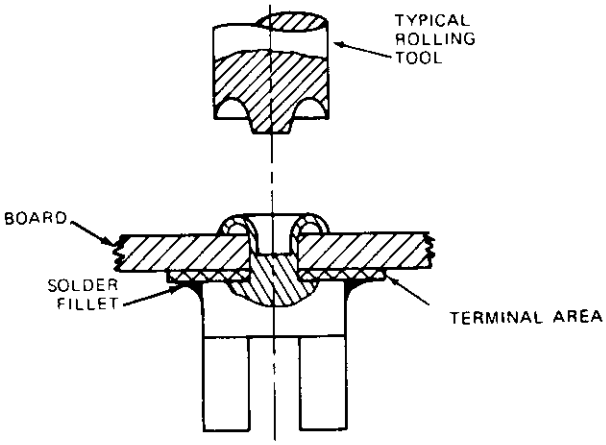


ROLLED TYPE

A COMPLETED JOINT
B. SOLDERING IRON TIP



TURRET TERMINAL INSTALLATION



ROLLED BIFURCATED TERMINAL INSTALLATION

See 3.4.5.7

FIGURE 17B. TERMINAL INSTALLATION

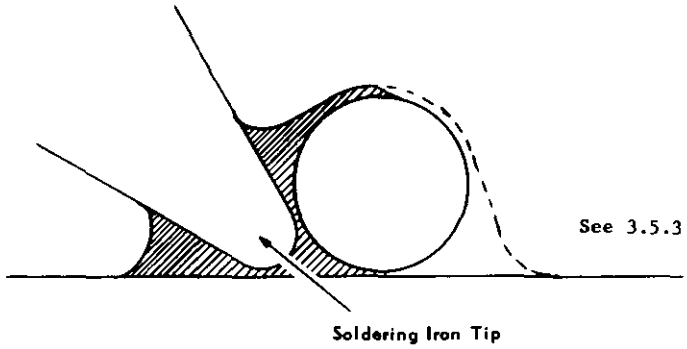
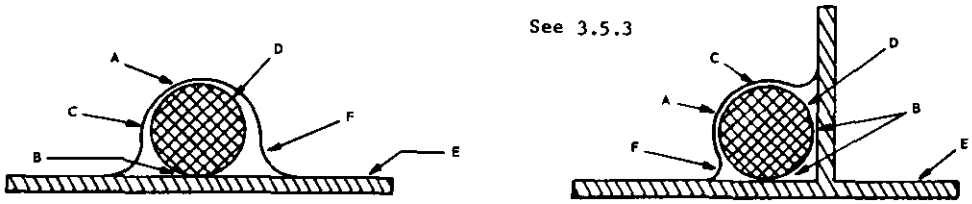


FIGURE 18. POSITIONING SOLDERING IRON



A. A minimum amount of solder shall cover the top of the conductor.

B. Wire, solder and terminal must be completely fused at this point and wire must be adjacent to terminal.

C. Entire mass consisting of terminal, wire and solder must be free of all foreign substances.

D. Conductor wire (copper).

E. Terminal or printed circuit (PC) pad.

F. Smooth solder contour and proper filleting action indicating required flowing and wetting action.

FIGURE 19. ENLARGED CROSS SECTIONS OF PROPER SOLDER CONNECTIONS

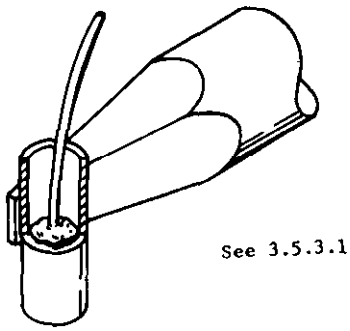


FIGURE 20. FILLING HOLE WITH SOLDER

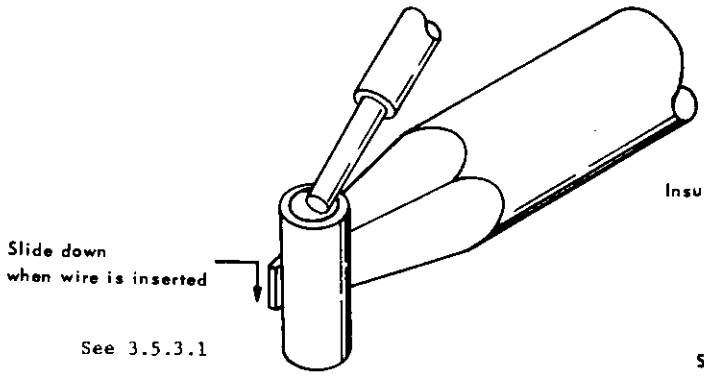


FIGURE 21. INSERTING THE WIRE

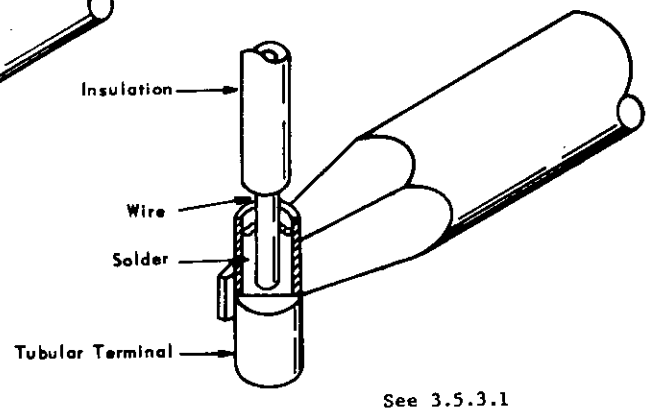
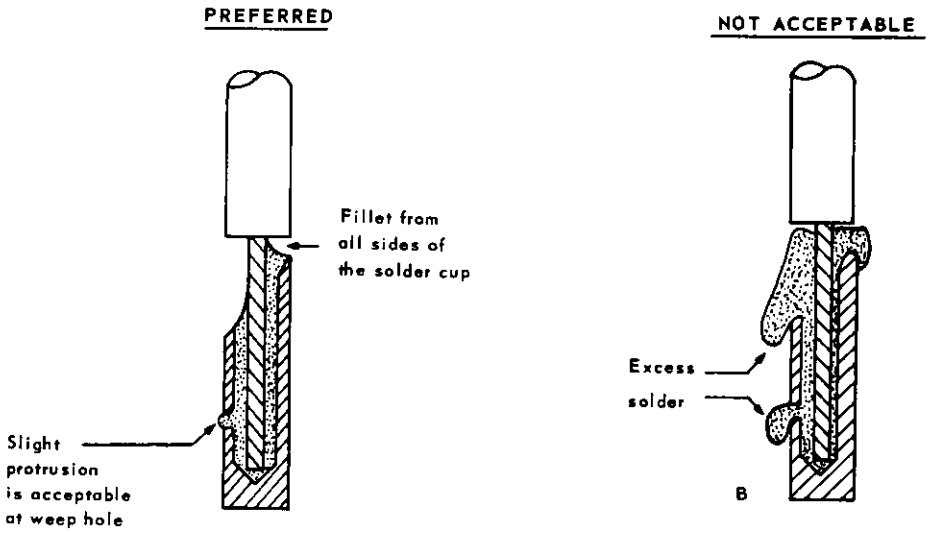


FIGURE 22. WIRE INSERTED IN HOLE



A NOTE: Any solder on the outside surface of the solder cup shall be in the form of a thin film only.

See 3.5.3.1

FIGURE 23. WIRE INSERTED IN TUBULAR TERMINAL WITH WEEP HOLE

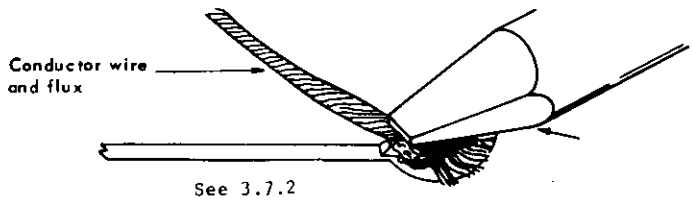
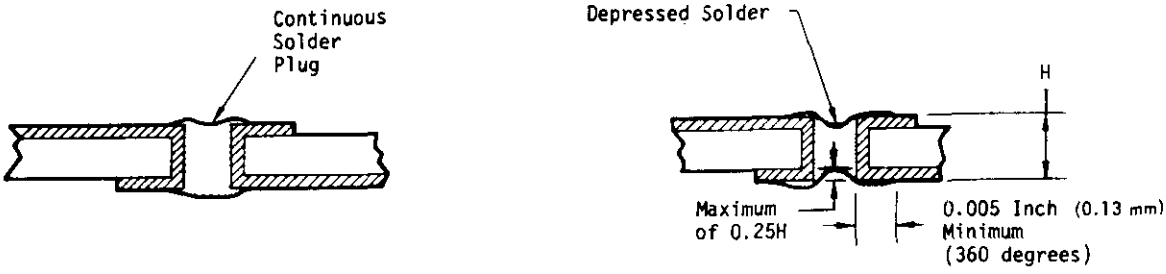


FIGURE 24. 'WICKING' OPERATION

PLATED-THROUGH HOLES WITH CONTINUOUS SOLDER PLUG



ACCEPTABLE

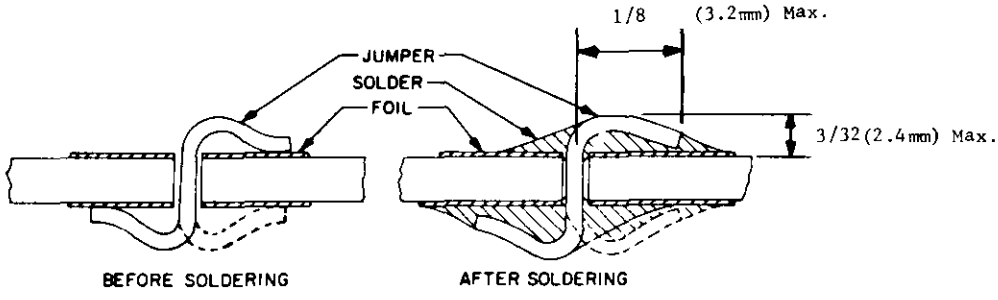
PLATED-THROUGH HOLE IS COMPLETELY FILLED WITH SOLDER.

MINIMUM ACCEPTABLE

SLIGHT DEPRESSION BOTH SIDES, BUT NEITHER EXCEEDS 25% OF THE BOARD THICKNESS, OTHERWISE COMPLETELY FILLED WITH SOLDER.

See 3.5.3.2.1

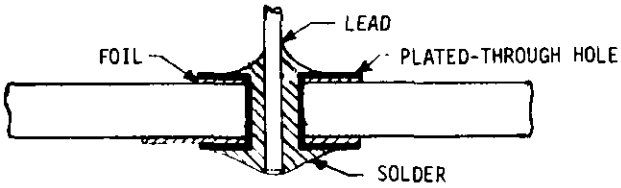
FIGURE 25



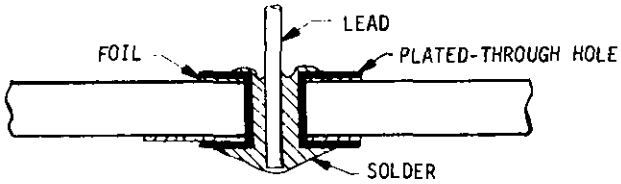
FEED-THROUGH WIRES
PLATED-THROUGH HOLES OR
NON-PLATED THROUGH HOLES

See 3.5.3.2.2

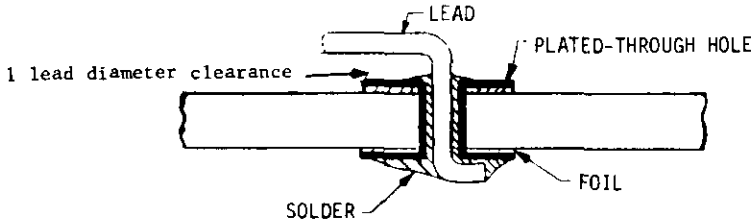
FIGURE 26



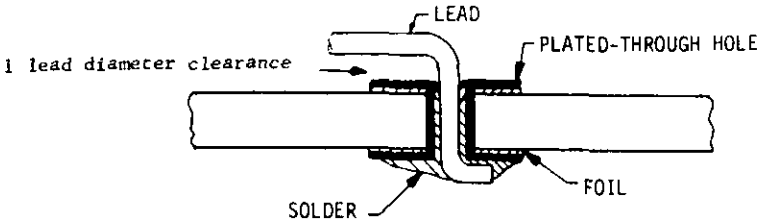
ACCEPTABLE



MINIMUM ACCEPTABLE



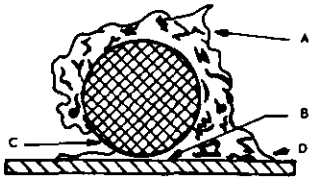
ACCEPTABLE



See 3.5.3.2.3

MINIMUM ACCEPTABLE

FIGURE 27 — LEAD CONFIGURATION — PLATED-THROUGH HOLES



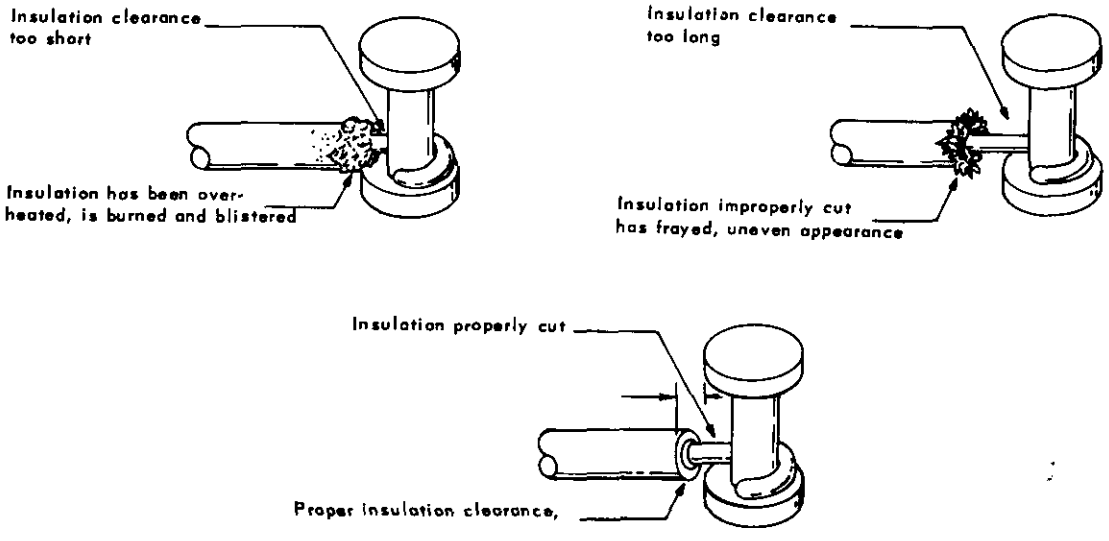
A. Solder has a chalky appearance, lacks metallic luster, generally presents a rough, piled-up appearance.

B. Solder has not bonded terminal and wire together.

C. Solder coverage not complete.

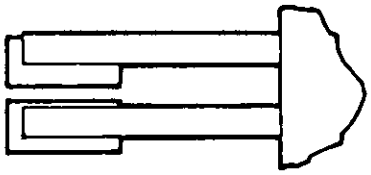
D. Improper filleting indicating insufficient flowing and wetting action.

FIGURE 28 - COLD OR UNDER-HEATED SOLDER JOINT

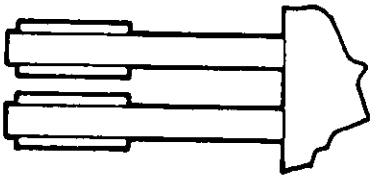


See 3.4.4

FIGURE 29 - EXAMPLES OF INSULATION TRIM



UNACCEPTABLE - Lead Overlaps Pad

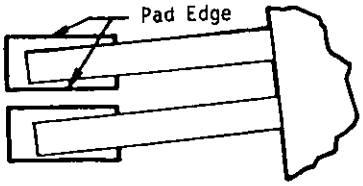


UNACCEPTABLE - Lead Extends Beyond Pad

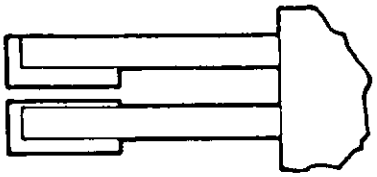
See 3.4.5.8

FLAT LEAD JOINT CONFIGURATION

FIGURE 31



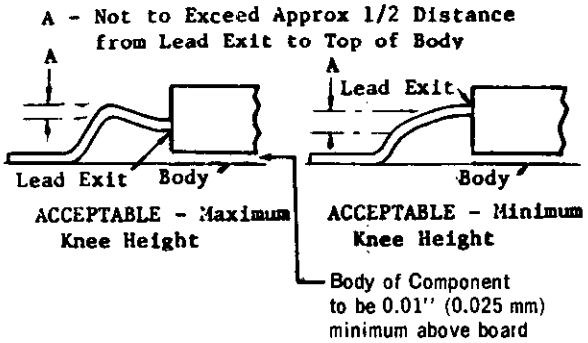
ACCEPTABLE - Leads Slightly Skewed But Do Not Extend Beyond Pad Edge

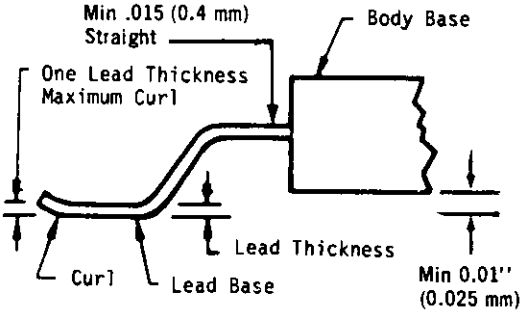


MINIMUM ACCEPTABLE - Lead Edge Coincident with Pad Edge

See 3.4.5.8

FIGURE 32



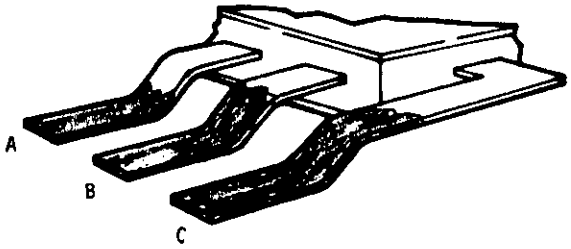


MAXIMUM ACCEPTABLE TOE RISE

See 3.4.5.8

FLAT LEAD JOINT CONFIGURATION

FIGURE 33

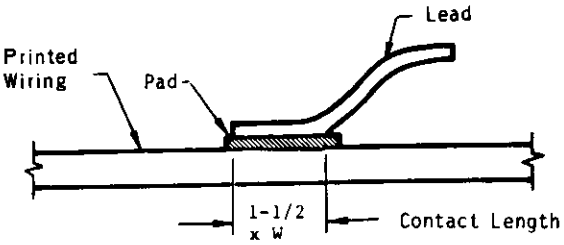


See 3.4.4.8

LEAD TINNING

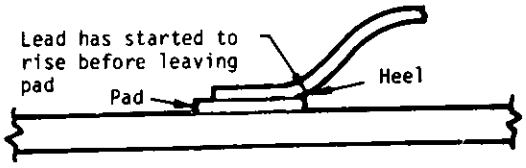
A - Acceptable: Extends past first radius
B - Minimum Acceptable: Tinning extends to second radius
C - Reject: Solder extends past second radius
D - All leads are formed to prevent stress after soldering

FIGURE 34 - LEAD TINNING AND LEAD FORM

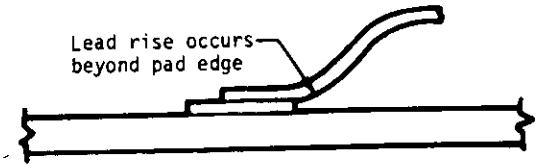


ACCEPTABLE

The heel of a formed lead must begin to rise before reaching the edge of the pad.



MINIMUM ACCEPTABLE

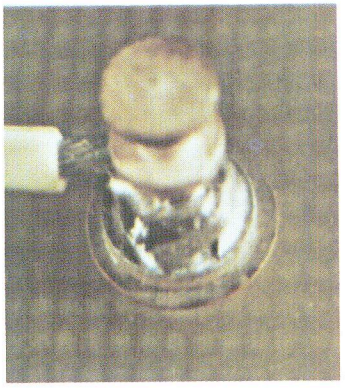


UNACCEPTABLE

Heel Overhang See 3.4.5.8

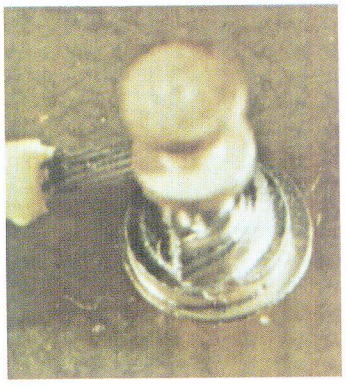
FIGURE 35 - FLAT LEAD CONFIGURATION

INSULATION DAMAGE



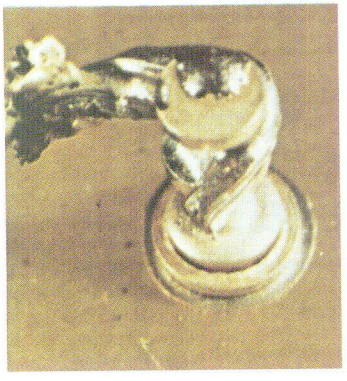
ACCEPTABLE

1. INSULATION IS UNMARKED.
2. EXPOSED BARE WIRE IS HELD TO A MINIMUM.
3. TRIM IS NEAT AND EVEN.



MINIMUM ACCEPTABLE

1. MINOR SCORCH MARKS ON INSULATION.
2. TRIM IS SLIGHTLY IRREGULAR.
3. EXPOSED WIRE IS WITHIN TOLERANCE WITH NO SIGN OF WICKING.

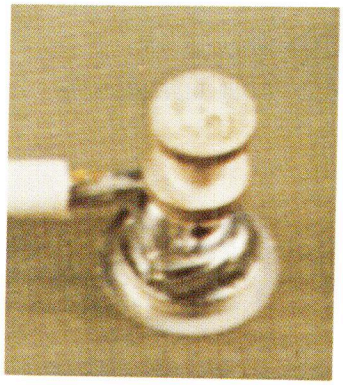


REJECT

1. INSULATION HAS BEEN BURNED.
2. EXCESS HEAT AND SOLDER HAS CAUSED EXCESSIVE WICKING.
3. VERY BAD CONNECTION - EXCESS HEAT
   (a) EXCESS SOLDER (LEAD NOT DISCERNIBLE)
   (b) COLD SOLDER
   (c) ROSIN ENTRAPMENT
   (d) LEAD NOT TERMINATED AT BASE OF TERMINAL

FIGURE 36

INSULATION DAMAGE

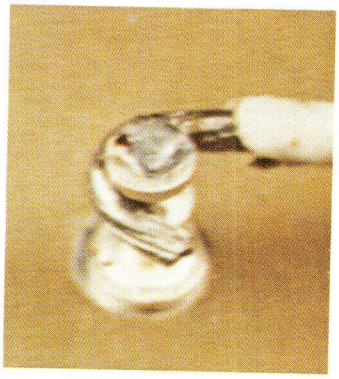


ACCEPTABLE

1. INSULATION IS CLEAN AND UNDAMAGED.
2. TRIM IS NEAT AND EVEN.

MINIMUM ACCEPTABLE

1. SLIGHT SCORCH MARKS ON INSULATION.
2. INSULATION IS CLOSE TO JOINT BUT IS NOT EMBEDDED IN SOLDER (CLEAN STRANDS VISIBLE BETWEEN INSULATION AND JOINT.
3. MAXIMUM SOLDER BUT CONTOUR OF CONDUCTOR IS VISIBLE.



REJECT

1. INSULATION HAS BEEN BURNED.
2. EVIDENCE OF WICKING.
3. LEAD NOT WRAPPED A MINIMUM OF 180°.

FIGURE 37

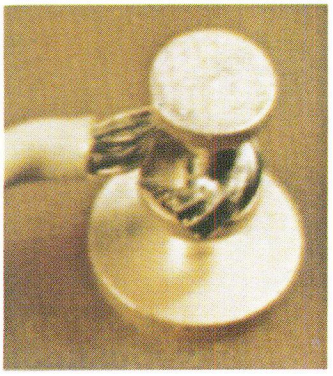
STRANDED CONDUCTORS

ACCEPTABLE

1. JOINT IS UNDER NO TENSION.
2. ORIGINAL LAY OR TWIST OF THE WIRE HAS BEEN MAINTAINED.

MINIMUM ACCEPTABLE

1. DIAMETER OF LOOP IS SUFFICIENT TO AVOID TENSION ON JOINT.
2. ORIGINAL LAY OR TWIST OF THE WIRE HAS BEEN MAINTAINED.

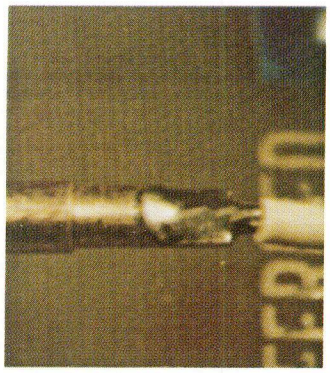


REJECT

1. WIRE HAS BEEN BENT IN A SHARP RIGHT ANGLE BEND CAUSING STRANDS TO KINK.
2. STRANDS HAVE BEEN FLARED ON TERMINAL.
3. LEAD NOT TERMINATED AT BASE OF TERMINAL.

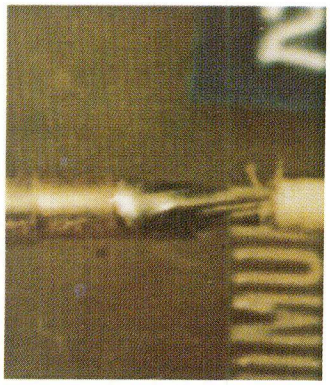
FIGURE 38

CONNECTOR CUPS



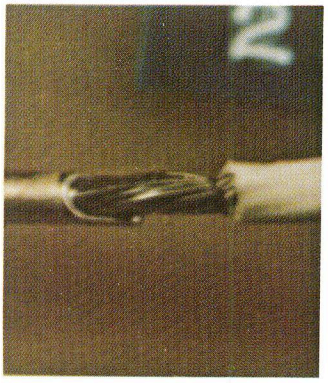
ACCEPTABLE

1. CONDUCTOR IS CORRECT SIZE FOR CUP APPLICATION.
2. SOLDER COMPLETELY FILLS THE CUP AND FOLLOWS THE CONTOUR OF THE CUP ENTRY SLOT.



MINIMUM ACCEPTABLE

1. CONDUCTOR IS MAXIMUM SIZE FOR CUP APPLICATION.
2. ALL STRANDS ARE WITHIN CUP AND FULLY SEATED.
3. MAXIMUM SOLDER; HOWEVER, THERE IS NO EVIDENCE OF WICKING, NOR DOES THE SOLDER EXTEND BEYOND CUP DIAMETER.

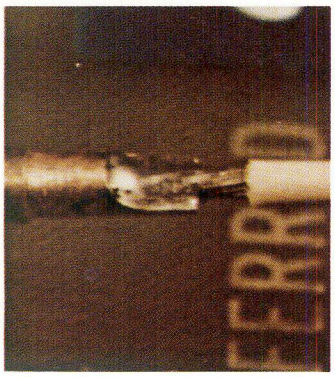


REJECT

1. CONDUCTOR IS TOO BIG FOR CUP APPLICATION.
2. CONNECTION CONTAINS LOOSE STRANDS AND HAVE BEEN CUT TO REDUCE SIZE OF CONDUCTOR TO FIT CUP.
3. INSUFFICIENT SOLDER
4. CUT STRANDS

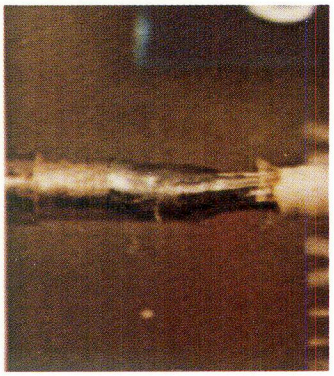
FIGURE 39

CONNECTOR CUPS



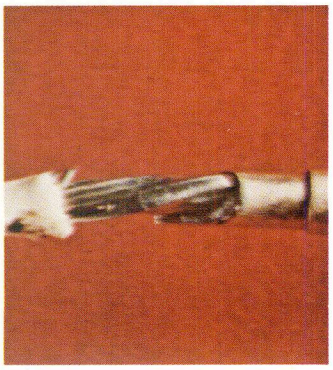
ACCEPTABLE

1. ONLY SUFFICIENT SOLDER HAS BEEN USED TO FILL THE CUP.
2. CONDUCTOR SHOWS NO SIGN OF WICKING, INDIVIDUAL STRANDS ARE VISIBLE.



MINIMUM ACCEPTABLE

1. CUP HAS BEEN "SPOT TINNED" AS A RESULT OF THE SOLDERING IRON APPLICATION.
2. MAXIMUM AMOUNT OF SOLDER HAS BEEN USED BUT DOES NOT PROJECT BEYOND CUP DIAMETER.
3. NO EVIDENCE OF EXCESSIVE "WICKING".



REJECT

1. COLD SOLDER.
2. EXCESS SOLDER EXTENDS BEYOND CUP DIAMETER.
3. WICKING IS EVIDENT BY SOLDER EXTENDING TO AND UNDER INSULATION.
4. CONDUCTOR IS NOT SEATED IN CUP. SOLDER IS NOT BONDED TO CONDUCTOR AND CUP.

FIGURE 40

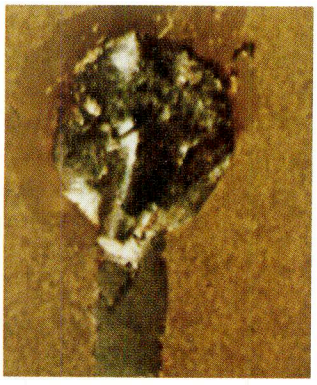
SOLDER COVERAGE - PRINTED CIRCUIT

ACCEPTABLE

1. LEAD AND PAD ARE WELL WETTED.
2. CONTOUR OF LEAD IS CLEARLY DEFINED.
3. SOLDER HAS A SMOOTH, SHINY APPEARANCE.

MINIMUM ACCEPTABLE

1. SMALL IMPERFECTIONS IN SURFACE.
2. SMOOTH, METALLIC APPEARANCE.
3. MAXIMUM SOLDER BUT LEAD IS DISCERNIBLE.

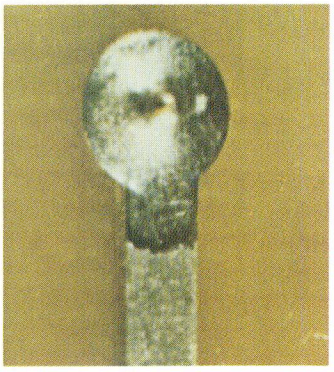


REJECT

1. EVIDENCE OF CONTAMINATION. LEAD IS NOT SOLDERED.
2. PIN HOLE ADJACENT TO LEAD.
3. PAD HAS DEWETTED UNDER LEAD.
4. LEAD NOT ALIGNED WITH CONDUCTOR.

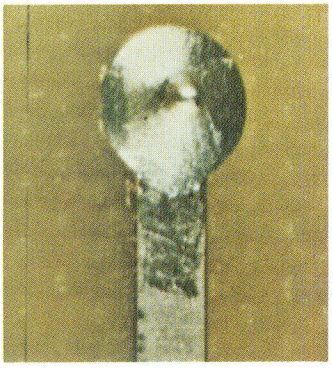
FIGURE 41

SOLDER COVERAGE - CONNECTOR PINS



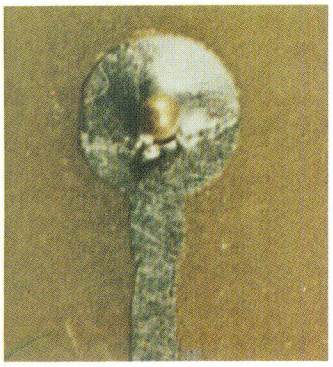
ACCEPTABLE

1. NO SURFACE IMPERFECTIONS.
2. CONCAVE SHAPE, BRIGHT SOLDER.
3. GOOD WETTING OF PIN AND PAD.
4. PIN CONTOUR IS WELL DEFINED.



MINIMUM ACCEPTABLE

1. MINOR SURFACE IMPERFECTIONS.
2. VISIBLE LINE OF DEMARCATION BETWEEN SOLDER AND PIN. HOWEVER, SOLDER FLOW IS NOT BROKEN. PIN IS COMPLETELY TINNED.
3. MAXIMUM SOLDER BUT PIN CONTOUR IS DISCERNIBLE.

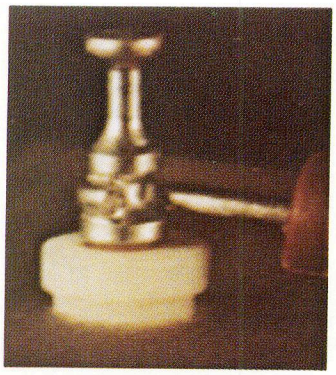


REJECT

1. EVIDENCE OF DEWETTING, SOLDER DOES NOT COVER PAD, BASE METAL SHOWING.
2. SOLDER INCOMPLETE ON TIP OF PIN. EVIDENCE OF CONTAMINATION INDICATED BY FAILURE OF PIN TO TIN. NOTE DEFINITE BREAK BETWEEN PIN AND SOLDER FILLETS.
3. GOLD NOT REMOVED.

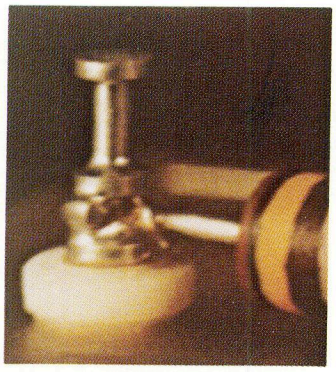
FIGURE 42

TURRET TERMINALS - TEFLON MOUNTED



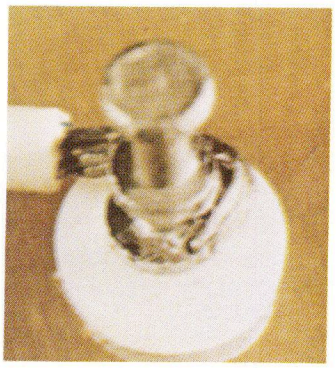
ACCEPTABLE

1. MINIMUM WRAP.
2. ONLY SUFFICIENT SOLDER USED TO MAKE CONNECTION.
3. LEAD AND TERMINAL ARE WELL WETTED AND SOLDER HAS FEATHERED OUT TO PRODUCE A SMOOTH, BRIGHT JOINT.
4. TEFLON IS FIRMLY SEATED.



MINIMUM ACCEPTABLE

1. HOOK OF LEAD SLIGHTLY AWAY FROM TERMINAL.
2. JOINT IS WELL WETTED AND LEAD IS WELL DEFINED.

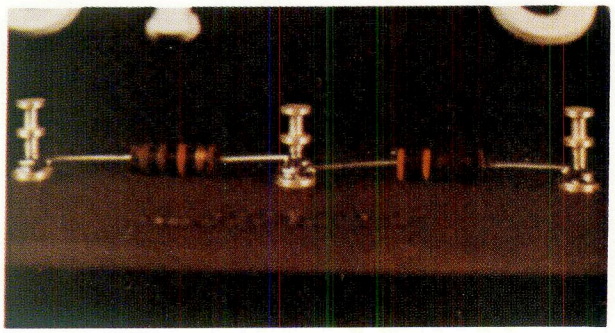


REJECT

1. HOLE BETWEEN LEAD AND BOTTOM TURRET. INSUFFICIENT SOLDER DID NOT WET JOINT PROPERLY.
2. EXCESS WRAP. EXTENDS BEYOND TURRET DIAMETER.

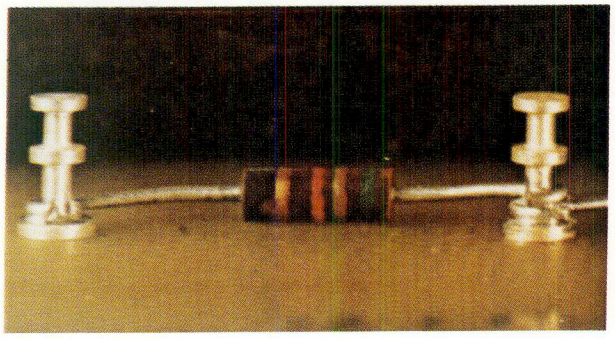
FIGURE 43

COMPONENTS



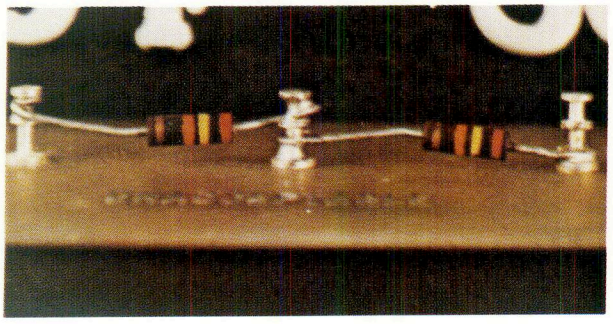
ACCEPTABLE

1. COMPONENT CENTERED BETWEEN TERMINALS AND SEATED FLUSH ON BOARDS.
2. LEADS ARE NOT UNDER TENSION - NOTE OFFSET FROM TERMINAL CENTERLINE (1/16 INCH).
3. LEAD BEND HAS BEEN MADE AT LEAST 1/8 INCH FROM COMPONENT BODY TO PROTECT COMPONENT AND LEAD WELD.



MINIMUM ACCEPTABLE

1. COMPONENT LEAD FORM A SLIGHT LOOP TO OFFSET COMPONENT BODY FROM TERMINAL CENTERLINE.



REJECT

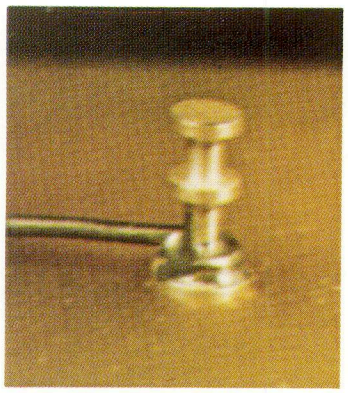
1. COMPONENT NOT FLUSH WITH BOARD.
2. LEAD BENT AT COMPONENT BODY.
3. VERY POOR QUALITY THROUGHOUT INSTALLATION.

FIGURE 44

COMPONENTS

ACCEPTABLE

1. COMPONENT LEAD IS CLEAN AND WELL TINNED.
2. SOLDER IS NEAT AND BRIGHT AND COMPLETELY COVERS THE WIRE.



MINIMUM ACCEPTABLE

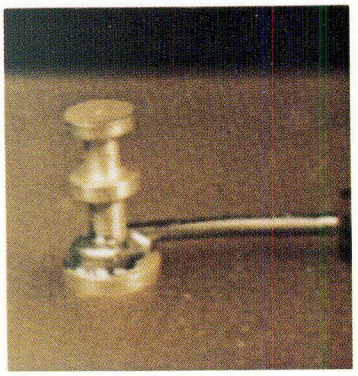
1. SLIGHT "DIMPLE", NOT ADJACENT TO LEAD OR TERMINAL POST.
2. SOLDER IS MAXIMUM BUT LEAD IS WELL DEFINED.

REJECT

1. SOLDER HAS NOT WET TERMINAL.
2. HOLE ADJACENT TO TERMINAL.
3. COMPONENT LEAD SHOWS EVIDENCE OF CONTAMINATION - SOLDER HAS NOT WET LEAD.
4. LEAD HAS EXCESS WRAP - EXTENDS BEYOND THE TURRET DIAMETER.

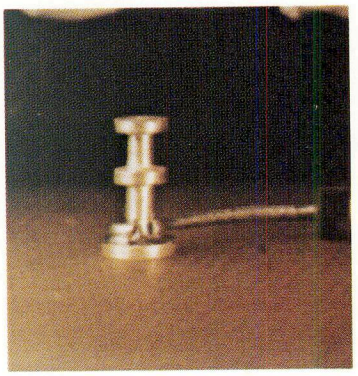
FIGURE 45

COMPONENTS



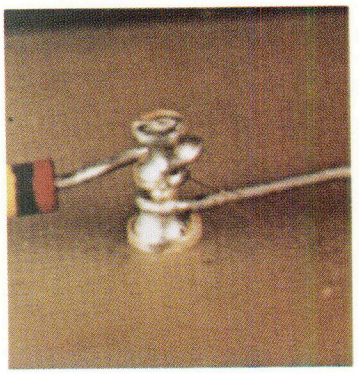
ACCEPTABLE

1. SOLDER IS SUFFICIENT TO COVER LEAD AND "FEATHER" OUT ON TERMINAL POST.
2. LEAD IS CLEAN WITH NO SURFACE MARKS.



MINIMUM ACCEPTABLE

1. SMALL, SMOOTH SURFACE MARK IN LEAD. HOWEVER, LEAD IS CLEAN AND WELL TINNED.
2. SOLDER FLOW IS GOOD.



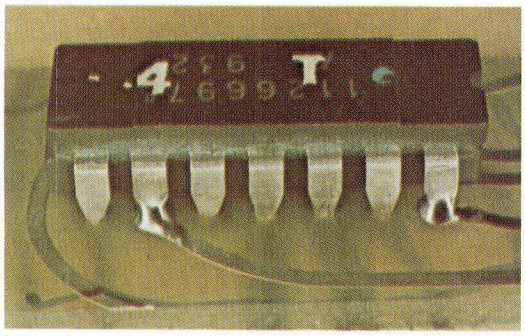
REJECT

1. EXCESS SOLDER, BOTTOM LEAD NOT DEFINED.
2. HOLE UNDER LEAD, EVIDENCE OF ROSIN ENTRAPMENT.
3. EXCESS WRAP: LEAD EXTENDS BEYOND TURRET DIAMETER.

FIGURE 46

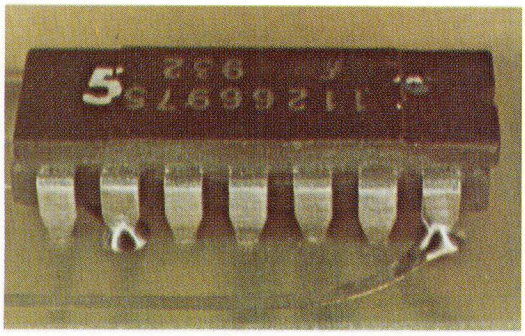
INTEGRATED CIRCUIT (DIP) COMPONENT SIDE OF BOARD

(LEADS ARE NOT GOLD PLATED)



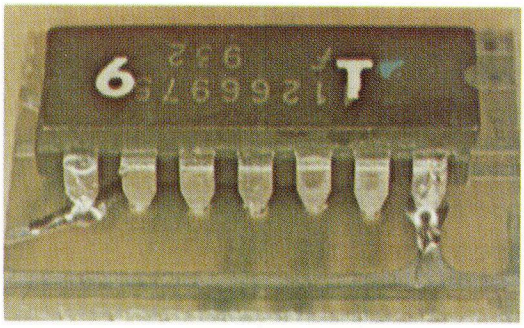
ACCEPTABLE

1. SOLDER IS SMOOTH BRIGHT AND SHINY.
2. GOOD WETTING OF SOLDER TO PAD AND LEAD.



MINIMUM ACCEPTABLE

1. SOLDER IS BRIGHT AND SHINY, BUT HAS MINOR HOLE.
2. MAXIMUM AMOUNT OF SOLDER USED.



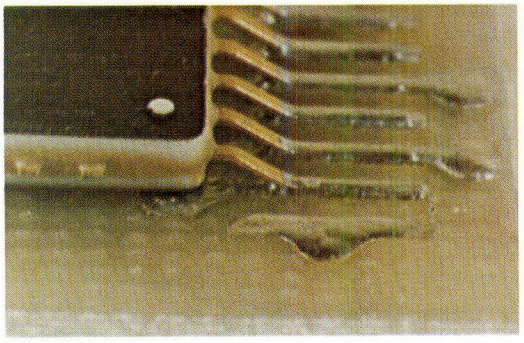
REJECT

1. SOLDER SPATTER UP BOTH LEADS TO BODY.
2. SOLDER PEAK ON SECOND LEAD FROM LEFT.
3. SOLDER SHOWS EVIDENCE OF DEWETTING.

FIGURE 47

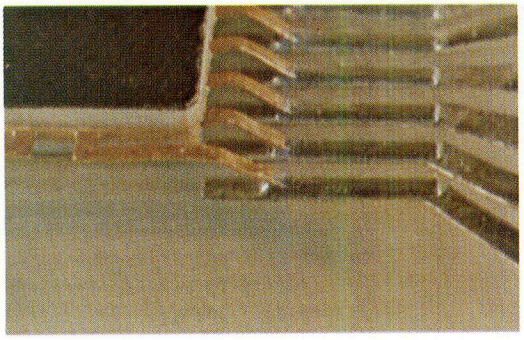
INTEGRATED CIRCUIT (FP) WITH FLAT LEADS

(LEADS ARE NOT GOLD PLATED)



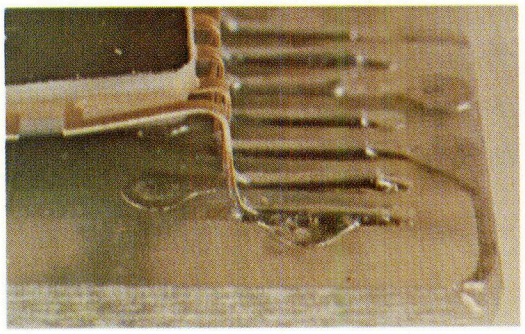
ACCEPTABLE

1. SOLDER FLOWED SMOOTHLY OVER ALL JOINTS.
2. ALL JOINTS ARE ALIGNED ON PADS EVENLY.
3. GOOD WETTING OF HEEL OF CONTACT TO PAD.
4. MINOR IRREGULARITIES IN JOINT SURFACES.



MINIMUM ACCEPTABLE

1. MINIMUM SOLDER BUT JOINTS SMOOTH, BRIGHT AND HAVE GOOD FILLETS ON SIDES AND HEELS.
2. MINIMUM SOLDER AT TOE OF TWO BOTTOM LEADS.
3. LEADS ARE COINCIDENT TO EDGE OF PAD.
4. MINOR DEFORMATION IN BOTTOM LEAD BETWEEN FIRST AND SECOND BEND.
5. MINOR KNEE RISE SECOND THRU FIFTH LEADS FROM BOTTOM DO NOT EXCEED 50% FROM LEAD ROOT TO TOP OF COMPONENT BODY.



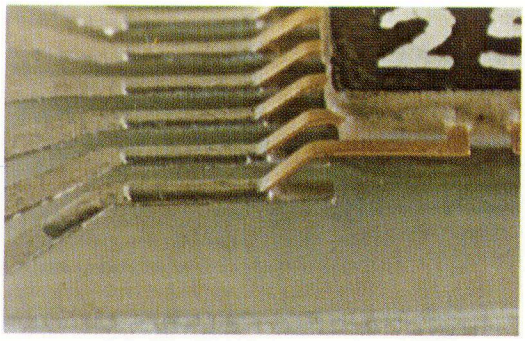
REJECT

1. DEWETTING AT HEEL OF SECOND LEAD FROM BOTTOM.
2. SECOND LEAD RAISED OFF PAD
3. FIRST LEAD IMPROPERLY FORMED, RISE EXCEEDS 50% OF THE DISTANCE FROM LEAD ROOT TO TOP OF COMPONENT BODY.
4. **DISTURBED SOLDER JOINT**

FIGURE 48

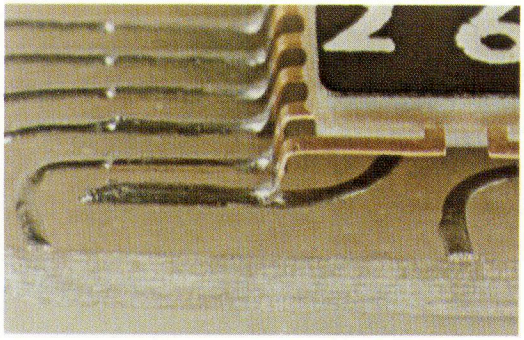
INTEGRATED CIRCUIT (FP) WITH FLAT LEADS

(LEADS ARE NOT GOLD PLATED)



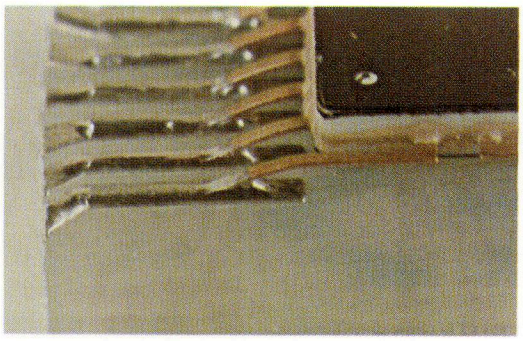
ACCEPTABLE

1. GOOD EVEN FILLETS, AND WETTING OF JOINTS.
2. PADS AND LEADS ARE EVENLY ALIGNED.
3. LEADS ARE UNIFORM, NO DEFORMATION.



MINIMUM ACCEPTABLE

1. GOOD WETTING ON ALL JOINT SURFACES.
2. SOLDER IS MAXIMUM BUT CONTOUR OF LEAD VISIBLE.
3. MINOR VOIDS IN SOLDER JOINTS.
4. LEADS ARE APPROACHING MAXIMUM ALLOWABLE BEND BUT NO LEADS ARE UNDER TENSION.
5. SURFACE IRREGULARITIES INDICATE MINIMUM TEMPERATURE BUT SURFACE IS STILL BRIGHT.

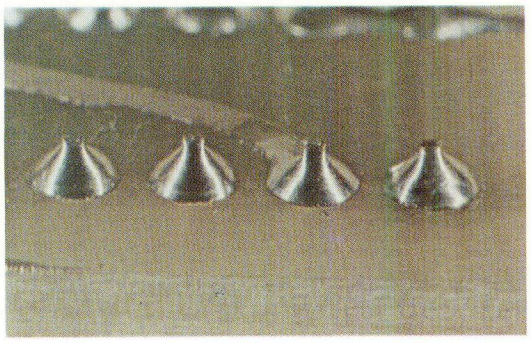


REJECT

1. EXCESSIVE SOLDER AT TOE
2. VOIDS AND HOLES IN SOLDER
3. HEEL OF CONTACT NOT WETTED, POSSIBLE CRACKS BETWEEN SOLDER AND PAD.
4. FOURTH LEAD FROM BOTTOM UNDER TENSION.

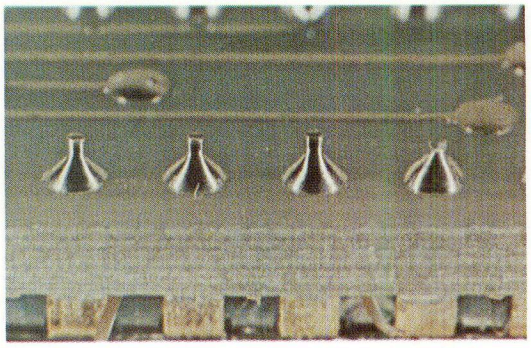
FIGURE 49

INTEGRATED CIRCUIT (DIP) PIN SIDE OF BOARD



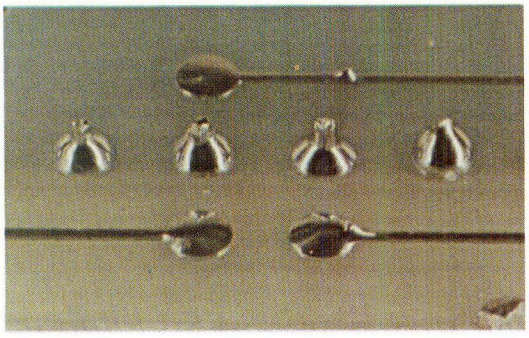
ACCEPTABLE

1. ALL LEADS ARE CUT SAME LENGTH.
2. NO SURFACE IMPERFECTIONS, SOLDER IS UNIFORM.
3. SOLDER IS SMOOTH, BRIGHT AND SHINY.
4. GOOD WETTING OF PIN AND PAD.



MINIMUM ACCEPTABLE

1. GOOD WETTING OF JOINTS, SURFACES ARE BRIGHT AND SHINY.
2. MAXIMUM AMOUNT OF SOLDER USED, FOURTH LEAD FROM LEFT.
3. THIRD LEAD FROM LEFT SLIGHTLY LONG.



REJECT

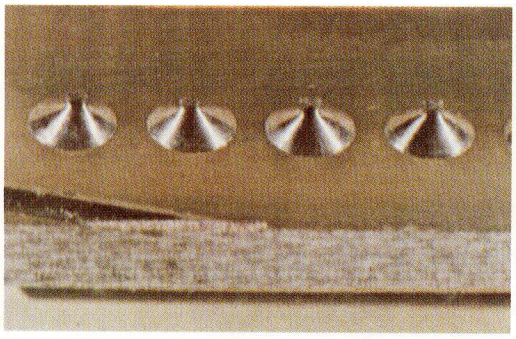
1. EVIDENCE OF DEWETTING, PIN NOT BONDED TO PAD.
2. EXCESSIVE SOLDER.
3. SOLDER PEAK ON CIRCUIT RUN ABOVE THIRD JOINT.
4. SOLDER SPATTER ADJACENT TO SECOND JOINT FROM LEFT.

NOTE

PLATED THROUGH HOLES ARE ACCEPTABLE.

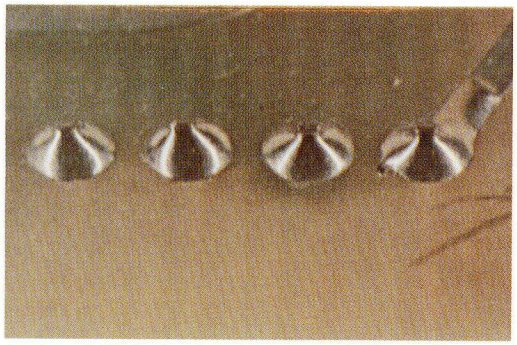
FIGURE 50

INTEGRATED CIRCUIT (DIP) PIN SIDE OF BOARD



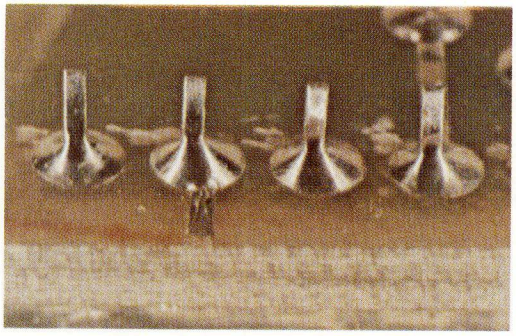
ACCEPTABLE

1. GOOD WETTING ON ALL LEADS
2. LEADS ARE EVENLY CUT
3. SOLDER IS SMOOTH, BRIGHT AND SHINY.



MINIMUM ACCEPTABLE

1. GOOD WETTING ON ALL LEADS.
2. SOLDER IS MAXIMUM, BUT LEADS STILL DEFINED.
3. SOLDER EXTENDS BEYOND ONE PAD, FOURTH LEAD FROM LEFT.

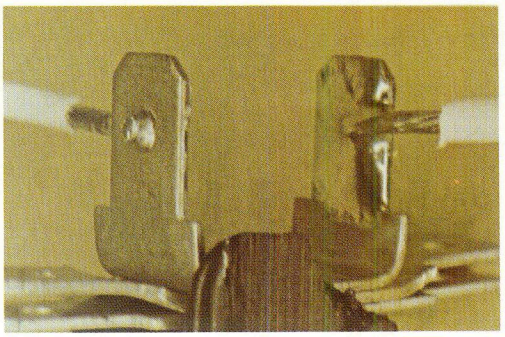


REJECT

1. PIN HOLE IN SOLDER.
2. INSUFFICIENT SOLDER USED ON ONE TERMINAL.
3. BASE METAL SHOWING ON LEAD.
4. LEADS CUT TOO LONG.
5. LEADS NOT PROPERLY CLEANED.
6. SOLDER SPATTER.

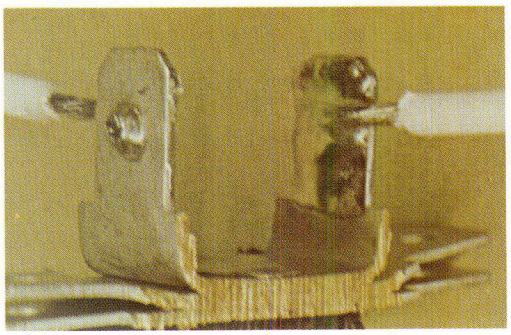
FIGURE 51

PIERCED TERMINALS



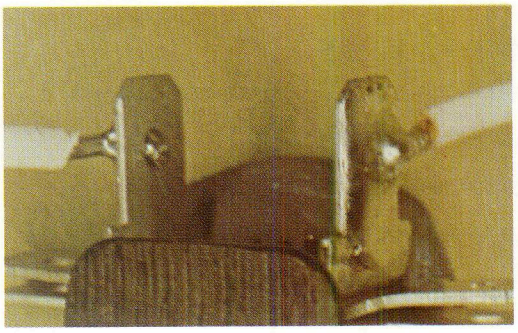
ACCEPTABLE

1. GOOD WETTING, SOLDER FEATHERS OUT TO SMOOTH EDGE.
2. MINIMUM AMOUNT OF INSULATION STRIPPED.
3. LEAD WIRE HAS GOOD WETTING TO TERMINAL.
4. SOLDER IS SMOOTH, BRIGHT, SHINY.
5. WIRE LEAD IS CLEARLY OUTLINED.



MINIMUM ACCEPTABLE

1. GOOD WETTING OF LEAD AND TERMINAL.
2. MAXIMUM AMOUNT OF INSULATION STRIPPED.
3. WIRE END IS MAXIMUM LENGTH
4. MAXIMUM AMOUNT OF SOLDER ON LEFT JOINT.

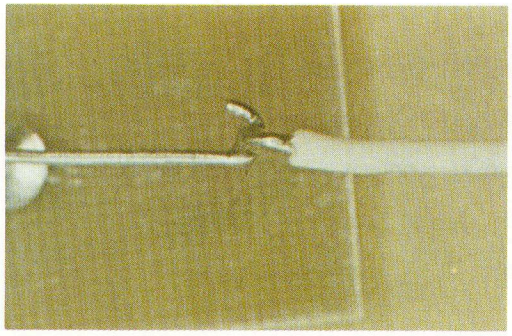


REJECT

1. EXCESSIVE SOLDER, STRANDS OBSCURED. FLUX AT BOTTOM OF RIGHT SOLDER JOINT.
2. CONTAMINATION ON WIRE (FLUX).
3. RAGGED INSULATION.
4. WIRE PROTRUDING THRU HOLE, SOLDER HAS NOT WET TERMINAL.

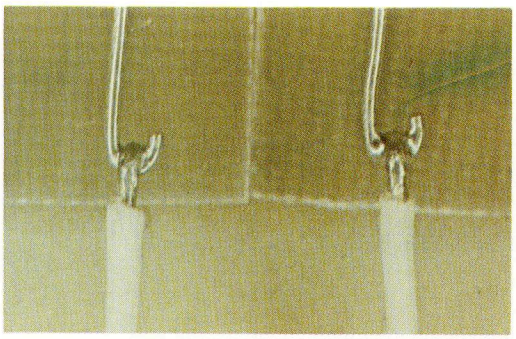
FIGURE 52

HOOKED TERMINALS



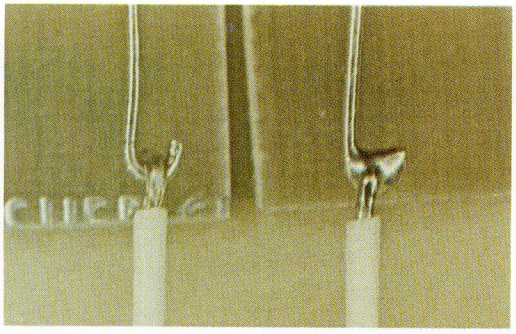
ACCEPTABLE

1. CORRECT AMOUNT OF SOLDER USED, WIRE IS CLEARLY DEFINED.
2. INSULATION CLEARANCE GOOD WITH NEAT INSULATION REMOVAL.



MINIMUM ACCEPTABLE

1. BOTH WIRES HAVE GOOD WETTING OF WIRE TO TERMINAL.
2. MAXIMUM AMOUNT OF SOLDER USED ON ONE TERMINAL.
3. MINIMUM AMOUNT OF SOLDER USED ON ONE TERMINAL.

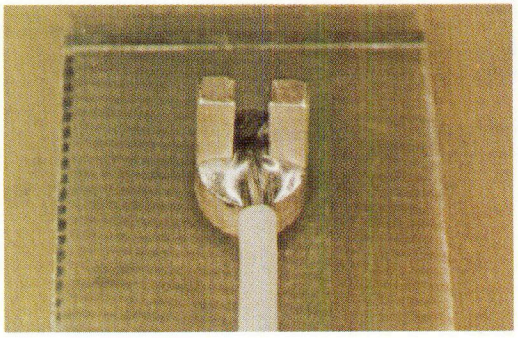


REJECT

1. EXCESSIVE SOLDER USED ON ONE TERMINAL.
2. INSUFFICIENT SOLDER USED ON ONE TERMINAL.
3. WIRE AND TERMINAL NOT PROPERLY WETTED, ALSO STRANDS ARE FLARED AT TERMINAL.
4. LEFT WIRE NOT WRAPPED 180° OVER HOOK.

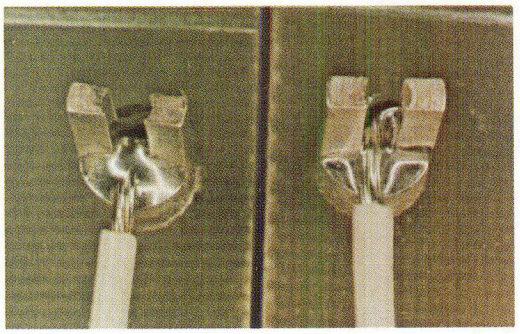
FIGURE 53

BIFURCATED TERMINALS



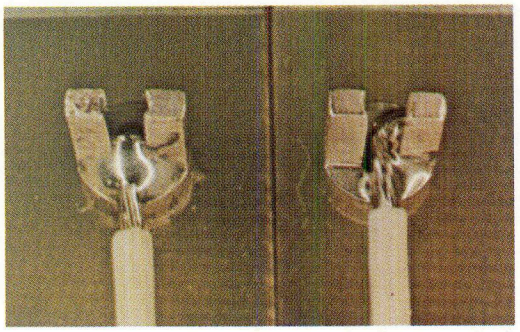
ACCEPTABLE

1. GOOD WETTING OF TERMINAL AND WIRE.
2. INSULATION TRIMMED NEATLY.
3. SOLDER IS SMOOTH, BRIGHT AND SHINY.



MINIMUM ACCEPTABLE

1. ONE TERMINAL HAS MAXIMUM SOLDER, THE OTHER MINIMUM SOLDER.
2. ONE TERMINAL HAS MAXIMUM INSULATION CLEARANCE, THE OTHER MINIMUM INSULATION CLEARANCE.
3. MINOR IMPERFECTIONS IN SOLDER.



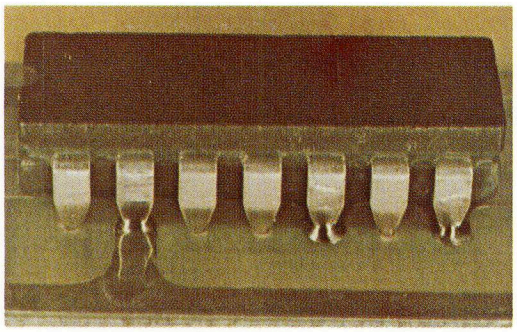
REJECT

1. ONE TERMINAL HAS EXCESSIVE SOLDER, THE OTHER HAS INSUFFICIENT SOLDER.
2. VOIDS IN SOLDER, TERMINAL IS DEWETTED.
3. HOLE IN SOLDER BESIDE WIRE.

FIGURE 54

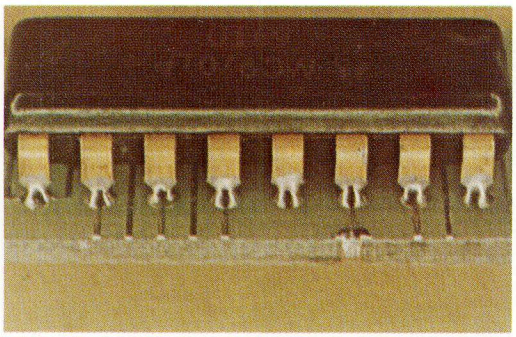
INTEGRATED CIRCUIT (DIP) COMPONENT SIDE OF BOARD

(LEADS ARE NOT GOLD PLATED)



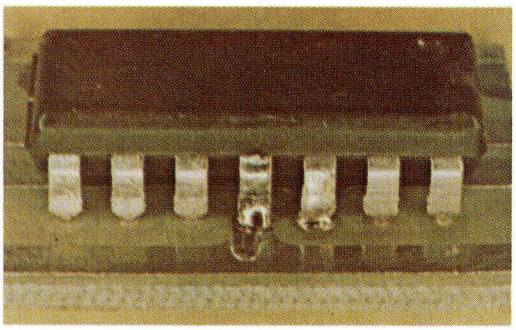
ACCEPTABLE

1. GOOD FILLET AROUND TERMINAL LEAD.
2. SOLDER IS BRIGHT AND SHINY.



MINIMUM ACCEPTABLE

1. MAXIMUM SOLDER USED.
2. MINOR SOLDER SPILLAGE ON TERMINAL LEAD.
3. GOOD WETTING ON ALL CONNECTIONS.

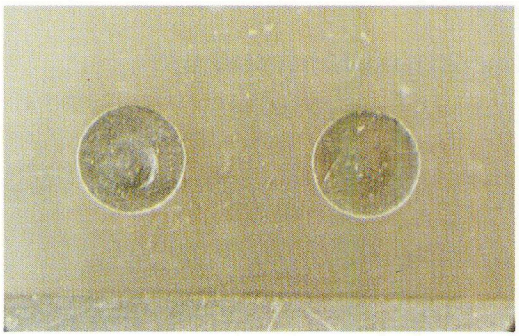


REJECT

1. EXCESSIVE SOLDER USED.
2. EVIDENCE OF CONTAMINATION IN SOLDER.
3. SOLDER NOT WETTED TO LEAD.
4. SOLDER PEAK ON LEAD.

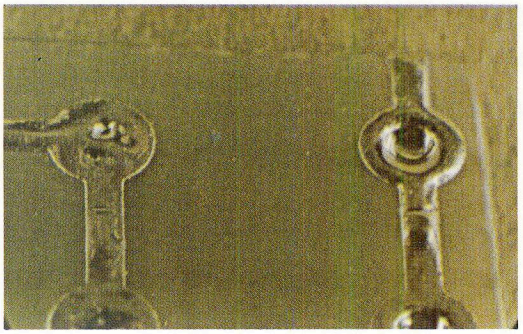
FIGURE 55

PLATED-THROUGH HOLES WITH SOLDER PLUG



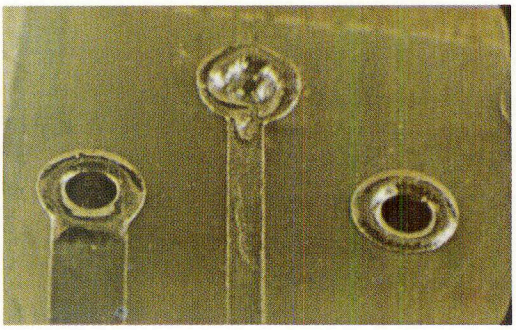
ACCEPTABLE

1. SOLDER IS EVEN, BRIGHT AND SMOOTH.
2. MINOR CONCAVITY.



MINIMUM ACCEPTABLE

1. SOLDER IS BRIGHT WITH GOOD WETTING AND FILLET.
2. PIN HOLE IN LEFT JOINT, BUT BOTTOM IS VISIBLE.
3. SECOND JOINT FROM LEFT (UPPER) HAS CONCAVITY BUT THIS IS LESS THAN 25% OF HOLE DEPTH.



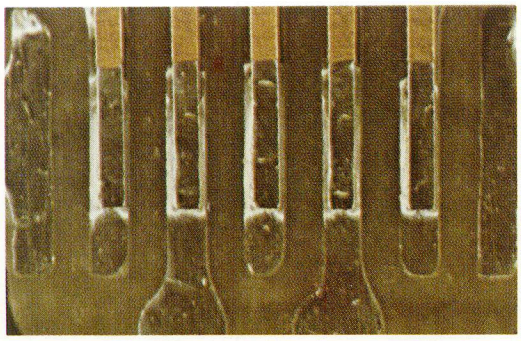
REJECT

1. TWO END HOLES SHOW EVIDENCE OF WETTING ONLY, NO SOLDER PLUG.
2. TOP HOLE HAS DEPRESSION EXCEEDING 25% OF HOLE DEPTH.

FIGURE 56

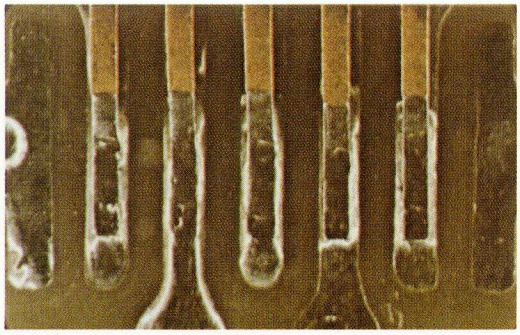
INTEGRATED CIRCUIT (FP) WITH FLAT LEADS

(LEADS ARE NOT GOLD PLATED)



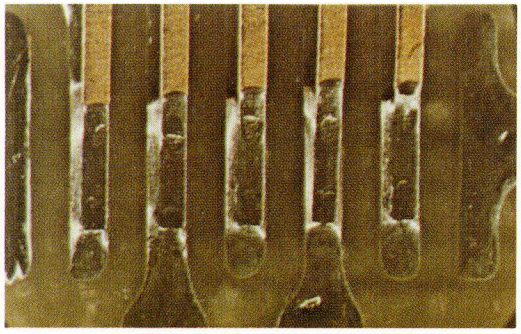
ACCEPTABLE

1. LEADS CENTERED EVENLY ON PADS.
2. GOOD FILLET AROUND AND AT END OF LEAD.
3. GOOD WETTING OF ALL JOINTS.
4. TOOL MARKS (ELECTRODES) ARE NOT GROUNDS FOR REJECTION.



MINIMUM ACCEPTABLE

1. JOINTS HAVE MAXIMUM SOLDER AT TOE, BUT IS BRIGHT AND HAS GOOD FILLETS.
2. TERMINAL LEADS ARE NEARING EDGE OF PAD.
3. SLIGHT VOIDS PRESENT, BUT NO BASE METAL SHOWING.
4. TOOL MARKS (ELECTRODES) ARE NOT GROUNDS FOR REJECTION.



REJECT

1. TERMINAL LEADS ARE MISALIGNED WITH PADS.
2. LEADS ARE SKEWED SLIGHTLY, BUT ARE OVERHANGING THE PAD AT HEEL.

FIGURE 57

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