TB 43-0127

TECHNICAL BULLETIN

MAINTENANCE AND REPAIR OF

PRINTED CIRCUIT BOARDS

AND PRINTED WIRING ASSEMBLIES

HEADQUARTERS, DEPARTMENT OF THE ARMY

7 OCTOBER 1983

TECHNICAL BULLETIN

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Washington, DC, 7 October 1983

MAINTENANCE AND REPAIR OF PRINTED CIRCUIT BOARDS AND PRINTED WIRING ASSEMBLIES

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help Improve this bulletin. If you find any mistakes or if you know of a way to improve the procedure please let us know. Mail your letter, DA Form 7028 (Recommended Changes to Publications and Blank Forms) or DA Form 2028 2 located In the back of this bulletin direct to Commander US Army Communications Electronics-Command and Fort Monmouth ATTN: DRSEL-ME-MP, Fort Monmouth New Jersey 07703. A reply will be furnished to you.

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WARNINGS

- While using the abrasion tools at high/low speeds, damage to the eyes may occur. Use protective eye covering when using the abrasion tools to repair Printed Circuit Boards.

- Vapors from solvents and epoxies may contain toxic gasses which are a health hazard. When using these materials during the repair of a Printed Circuit Board, provide adequate ventilation.

- For Artificial Respiration, refer to FM 21-11.

- Ethyl and isopropyl alcohol are flammable. Use extreme care and adequate ventilation to prevent a fire while using these materials.

HOW TO USE THIS TECHNICAL BULLETIN

- You must familiarize yourself with the entire maintenance procedure before beginning the task
- This technical bulletin covers the maintenance and repair of Printed Wiring Assemblies (PWAs) and Printed Circuit Boards (PCBs). PWA and PCB will be used throughout this bulletin
- This technical bulletin has been prepared in a descending number order from chapters, sections, and paragraphs.
- Special attention should be paid to the cautions relating to electrostatic discharge.
- Additional maintenance Information can be found in Appendix A.

CHAPTER 1

INTRODUCTION

1-1. Scope. This Technical Bulletin provides maintenance and repair procedures to be used as guidelines in the repair of Printed Wiring Assemblies (PWA) and Printed Circuit Boards (PCB) repair. Organizational and direct support maintenance is considered generally not applicable, but their maintenance functions are provided in paragraph 1-8.

1-2. General. In the planning and/or performance of detailed repair procedures refer to this publication and the following:

a. Specific Depot Maintenance Work Requirements (DMWR)
b. Maintenance Allocation Chart
c. MIL STD 1460(mu) procedure for soldering of electrical connections and printed wiring assemblies.
d. Reference documents in Appendix A

1-3. Acceptable Workmanship. Following the repair procedures detailed in this bulletin will result in a high quality repaired product. Illustrations are presented which show both acceptable and unacceptable workmanship in order to illustrate specific soldering tolerances (chapter 8)

1-4. Terms and Definitions. Appendix B provides a list of terms and definitions referred to in this bulletin. Throughout this bulletin the terms illustrated in figures 1-1 thru 1-4 will be used consistently in referring to PWA/PCBs. For additional terms and definitions refer to MIL-S-1313.

1-5. Recommended Repair Sequence. The recommended repair sequence, typically, is as follows: (With close attention paid to ESD sensitivity)

a. Receiving Inspection visual defects
b. Fault Isolation
c. Removal of Coatings
d. Component Removal
e. Repair of Damages
f. Component Installation
g. Cleaning
h. Testing
i. Recoating
j. Final Electrical Acceptance
k. Packing, Packaging, Preservation, Marking, and Shipping

1-6. Training

a. Maintenance personnel performing conventional troubleshooting must be trained on the specific equipment containing the assembly. They must be qualified to use the required test equipment. In addition, the Automatic Test Equipment (ATE) operator must receive special ATE training.

b. Physical repairs or component replacement shall be performed by personnel certified in soldering rework, and repair techniques.

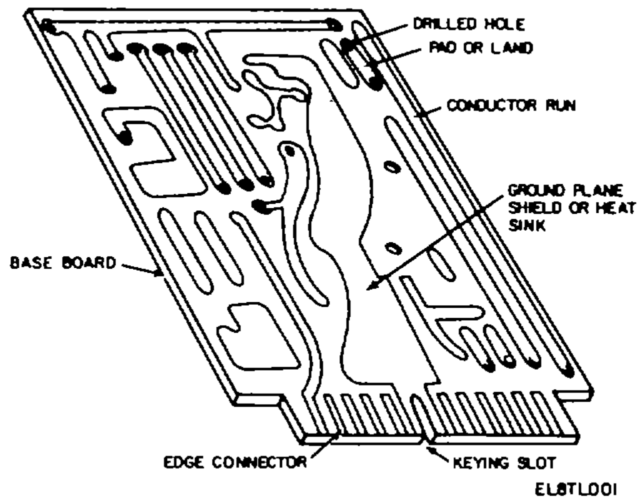


Figure 1-1. Printed Circuit Board Nomenclature

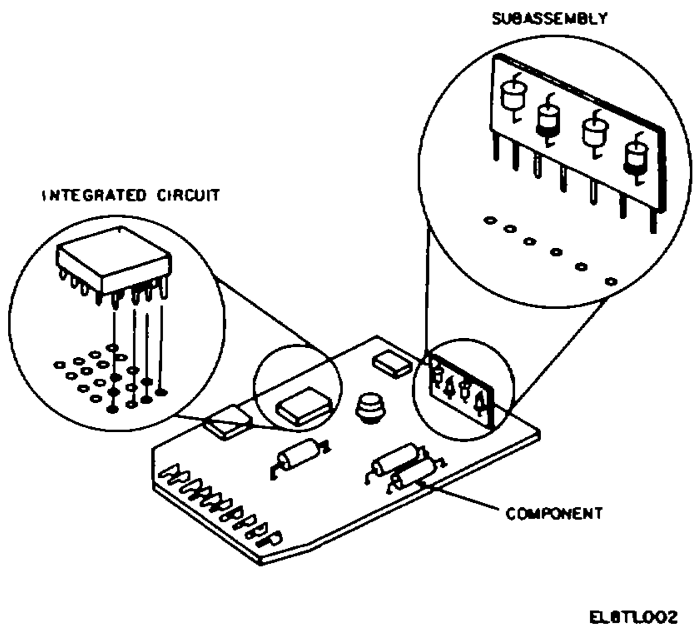


Figure 1-2. Printed Wiring Assembly Nomenclature

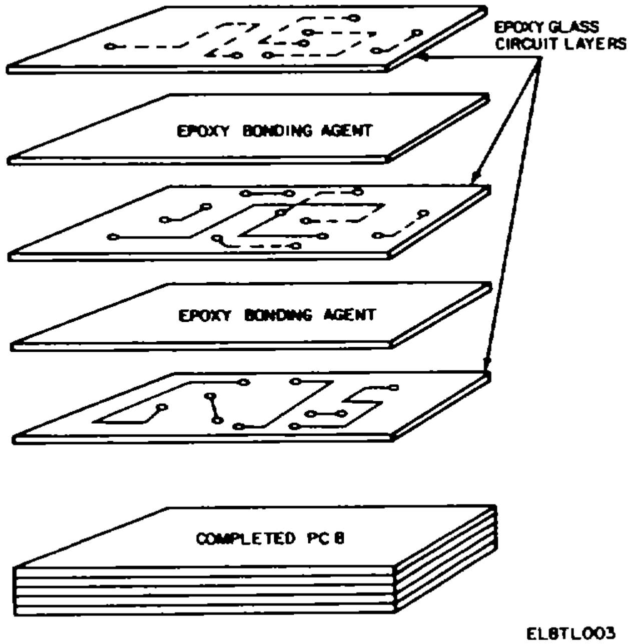


Figure 1-3. Typical Multilayer Printed Circuit Board

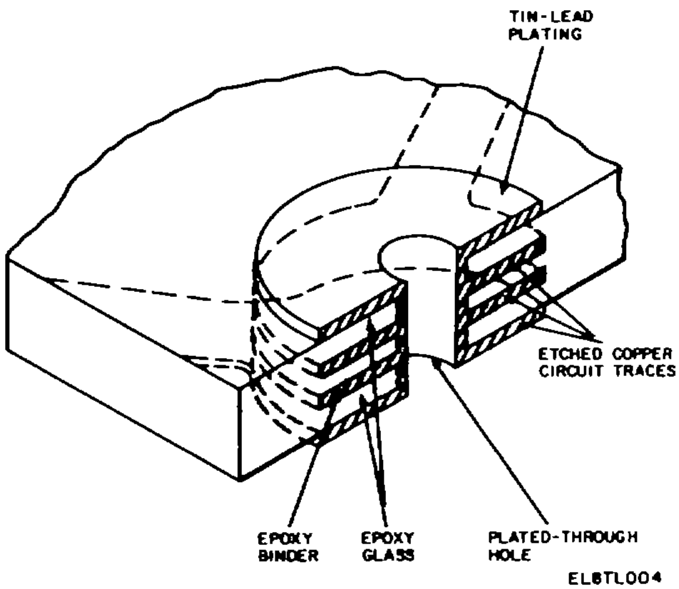


Figure 1-4. Cross Section of Multilayer Board

c. Appendix A contains a list of documents that provide additional information regarding PWA/PCB construction, repair, testing, and training.

1-7. Organizational and Direct Support Maintenance

a. Maintenance and repair of PWA/PCBs is normally not applicable to the organizational and direct support levels of maintenance for the following reasons

(1) Technical complexity
(2) Need for special tools, equipment, and materials
(3) Need for special test equipment
(4) Need for skilled training in fault isolation
(5) Need for skilled training in fault rectification
(6) Replacement components are not authorized at these levels

b. At the organizational and direct support level of maintenance and repair it is sometimes necessary to replace the PWA/PCB if authorized by the specific equipment technical manual. In this case, follow the instructions carefully as outlined in the technical manual to remove and replace the defective PWA/PCB.

c. Defective PWA/PCBs shall be packaged for shipment to the General Support facility with extreme care in order to avoid both physical damage and damage to electrosensitive components (i.e., MOS, JFET, and other small junction devices). Refer to the appropriate system maintenance manual for packaging instructions and/or Chapter 13 of this bulletin. If the PWA/PCB cannot be repaired at a general support facility, refer to the next higher echelon of maintenance.

CHAPTER 2

ELECTROSTATIC DISCHARGE PROTECTION

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB shall be marked "ESD Sensitive" at incoming inspection.

2-1. General. This chapter provides the overall requirements for the protection of PWA/PCBs from damage due to electrostatic discharge during all stages of their handling. The general trend in the development of electronic products has been toward miniaturization of circuit components (smaller parts). As the components become smaller they also become more sensitive to damage by static interference. Other trends in technology have been toward greater complexity, increased packaging density and, hence, thinner dielectrics (air space) between active elements, resulting in parts becoming even more sensitive to ESD

2-2. Implementation. To provide ESD protection, all work areas involved in the receiving, inspection, testing, repair, packaging and handling of PWA/PCBs will implement the requirements of this bulletin. The prevention of static discharges is accomplished when the work surfaces and the personnel have the background potential. ESD protection will be observed from receiving, inspection, and throughout the cycle, including the packaging for final shipment to the field or storage. In addition, all repair personnel who handle ESD sensitive devices will be certified by attending ESD training and will be recertified periodically. Repair facilities shall develop and maintain written ESD procedures applicable to their respective programs or activities in accordance with TB 43-8127, DOD STD 1686, DOD HDBK-263, and MIL-STD-454G (Requirement #1)

2-3. Static Ground Work Station. Some of the materials used in constructing a static ground work station are as follows:

a. Wrist strap. This strap is worn on the wrist of the repairperson end is commercially available in Velostat rubber form with "built in" 200K resistance (6098M, 3M Company or equivalent). The function of this strap is to rapidly dissipate personnel static charges safely to ground and equalize personnel static levels with that of the work surfaces (fig. 2-1**A**).

b. ESD Protective Mats. Work bench surfaces shall be covered with ESD protective mats and grounded as follows

(1) Procure commercially available steel screws and 2.5 cm diameter steel flat washers.

(2) Position the ESD protective mat on the workbench. (Commercially available velostat number 1705-M, 1/16 inch thick or equivalent.)

(3) Connect one terminal of the resistive ground cable between a screw head (steel bolt preferred) and a metal washer.

(4) Screw this assembly through ESD protective mat.

(5) Connect the terminal on the opposite end of the resistive ground cable to the permanent ground (fig. 2-1**B**).

(6) Connect the swivel connector between a screw head and washer.

(7) Screw this assembly through ESD protective mat.

(8) Attach the ESD protective mat to the workbench surface with enough screws and washers for security.

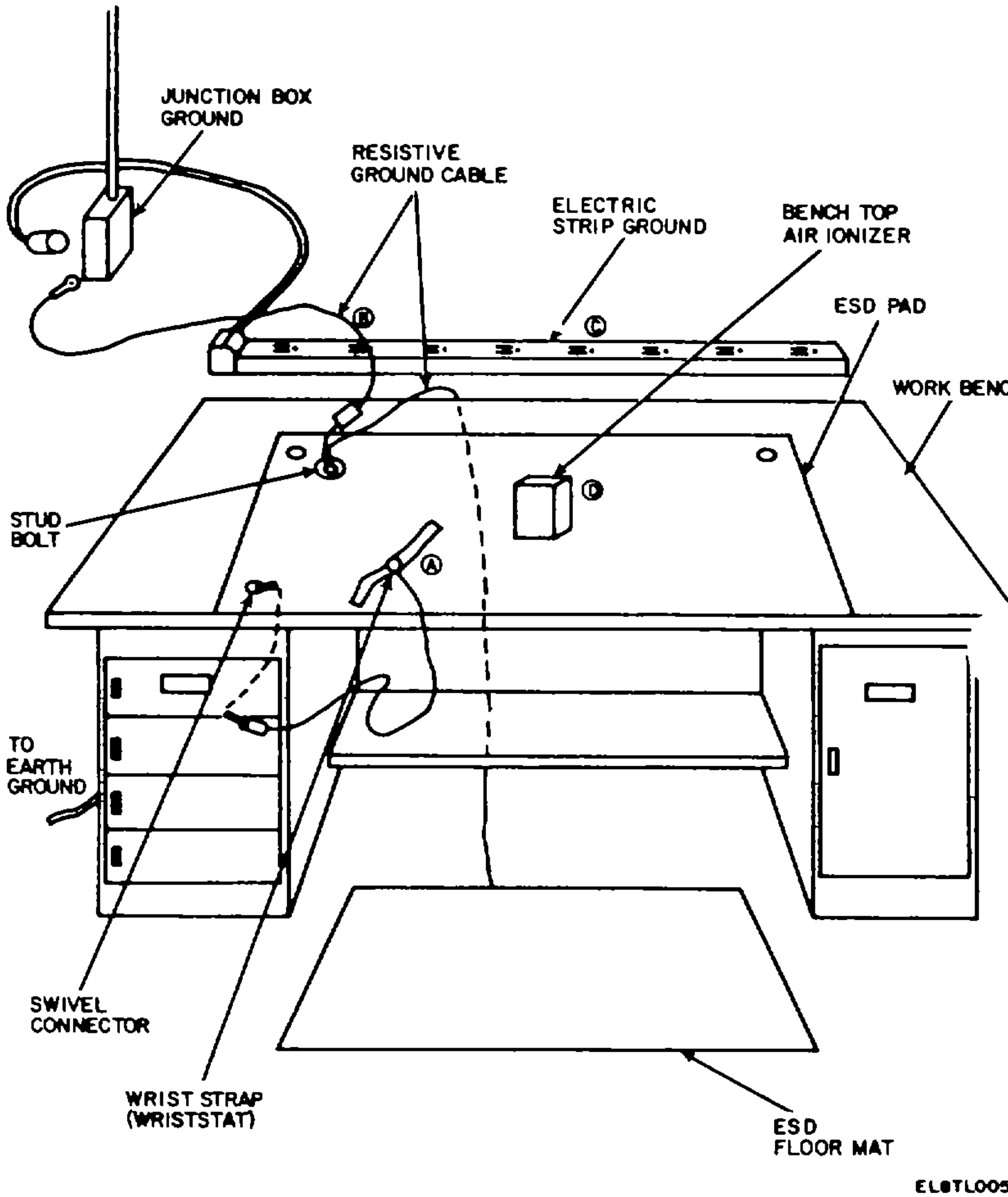


Figure 2-1. Electrostatic Discharge Work Station

NOTE

When the ESD protective table mat is 3M 8210 material, the steel bolt, or screw, and the swivel connector, must make contact with the middle layer of material which is the conductor. This is to ensure that the steel bolt and swivel connector are at the same electrical level

c. Electrical Strip Ground. Convenience outlets for use with metal cased portable tools and equipment should have provisions for automatically grounding the metal frame when the plug is mated with the receptacle. The plug grounding pin should make contact first and break contact last (fig. 2-1**C**).

d. Standard Work Bench. Work bench surfaces will be connected to ground through a permanent ground cable. The resistive ground cable is to be located at or near the point of contact with the workbench top and the resistance must be high enough to limit any leakage current to 5 milliamperes or less (fig. 2-1**D**).

e. Protective Floor Mats. ESD protected grounded floor mats shall be used where personnel mobility is required. Conductive shoes, shoe covers, or heel grounders will be used to discharge personnel when conductive floor mats are used. In addition, grounded conductive work stools are required.

2-4. Shunting Bars, Clips, Conductive Foams. When ESD items are removed from static ground work stations, the terminals will be shorted together using metal shunting bars, metal clips, or non corrosive conductive foams. For parts with metal cases, the shunt should also contact the case.

2-5. Ionizers. Placement of air ionizers should be in accordance with the manufacturer's recommendation or as determined through experience. Ionizers should be turned on for at least 2 to 3 minutes to allow charges in the area to be neutralized (fig. 2-1**D**).

2-6. Electrical Equipment, Tools, Soldering Irons. Ground all electrical repair tools used on the static work station surface. Check the insulated handles of hand tools for static generation and periodically treat them with an antistat, if required (para 2-8).

2-7. Electrostatic Detectors. Commonly used ESD detectors are the electrostatic field meters which are battery operated and portable. Detectors can be used for monitoring the size of electrostatic charges existing on materials, objects or people. For measurement of pulses with fast rise and decay times, use a high speed storage oscilloscope or a gun type ESD detector.

2-8. Antistats. These are chemical agents which, when applied to surfaces of insulative materials, will reduce their ability to generate static. Some antistats are good cleaners and can be mixed with water to clean surfaces such as floors and bench tops. Antistats should not be applied to PWA/PCB surfaces since they can increase conductivity or possibly effect solderability. Their effectiveness should be periodically checked by rubbing the surface with a material such as common polyethylene and monitoring the charge and its decay time with an electrostatic detector. It is also suggested that repair personnel should not wear silk, nylon, or rayon undergarments. Such clothing can generate large static charges.

2-9. Personnel Apparel. Personnel handling ESD sensitive items should wear long-sleeved protective smocks. Some work situations could require additional protection, such as the use of aprons made of ESD protective materials. Smocks, gloves, or finger cots of common plastic, rubber, or nylon are not to be used in protected areas. Protective apparel should be frequently checked, especially after cleaning, for ESD voltage by scanning personnel with an electrostatic detector.

2-10. Relative Humidity. Substantial electrostatic voltage levels can accumulate with a decrease in relative humidity. Relative humidity between 40 percent and 60 percent in ESD protected areas is desirable. When relative humidity drops to 30 percent or less, handling operations involving ESD sensitive components and assemblies will be curtailed and the appropriate maintenance engineering function notified.

2-11. Temperature Chambers. Caution should be used in cooling chambers with CO^2 since the evaporation of CO^2 can generate high static charges. Parts tested in temperature chambers should be placed in ESD protective tote boxes or trays on grounded metal racks within the chamber. Temperature chambers will be equipped with grounded baffles to dissipate charges In circulated air.

CHAPTER 3

RECEIVING INSPECTION

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB shall be marked "ESD Sensitive" at incoming inspection.

3-1. General. This chapter contains the essential information required to perform the General Support (GS) and/or Depot Level receiving inspection on defective PWA/PCBs as received from the field activity.

3-2. Responsibilities. The receiving inspection station has three primary responsibilities:

a. Check all tags and forms attached to the received assembly, and determine the reason for removal from service

b. Examine the assembly for any indication of physical damage to the components or PWA/PCB (chap 5).

c. Route an undamaged PWA/PCB to the test station and the damaged PWA/PCB to the repair station (fig. 3-1).

3-3. Repair VS Throw Away. All attempts will be made to repair the defective assembly without regards when directed by the field activities. This will be determined in an emergency or when a limited number of PWA/PCBs are available. However, the following criteria should be used to evaluate the normal flow of defective PWA/PCBs.

a. Manufacturer's most recent replacement cost, versus cost to repair.

b. Availability/Lead times for replacements.

c Actual repair costs including parts, labor, Inspection, test, handling and administrative costs.

(1) Diagnostics by the ATE operator will determine replacement parts required.

(2) Costs for repair parts will be determined by supply personnel.

Careful evaluation of the above criteria by General Support and Depot level management personnel will be necessary to arrive at a correct throw away/repair decision. All final decisions regarding maintenance repair versus throw-away shall be governed by the assigned Source, Maintenance, and Recoverability (SMR) codes for the particular PWA/PCB.

3-4. Receiving Inspection Flow Chart. The typical operational sequence In which a PWA/PCB is processed through the receiving inspection station is shown in figure 3-1 and described In the following paragraphs. For more specific flow information, refer to the detailed SOP's written specifically for each repair facility.

3-5. Tags and Forms. Proper identification of the PWA/PCB Assembly is made at the receiving stage; new tags/and or forms are prepared in accordance with TM 38-750. These tags must remain with the assembly as it proceeds through each stage. Figure 3-2 shows a typical "Process Move Tag" which records the work sequence, operation foreperson, and inspectors sign off section. The "Process Move Tag" becomes a necessary record of the major events occurring to a PWA/PCB Assembly during repair.

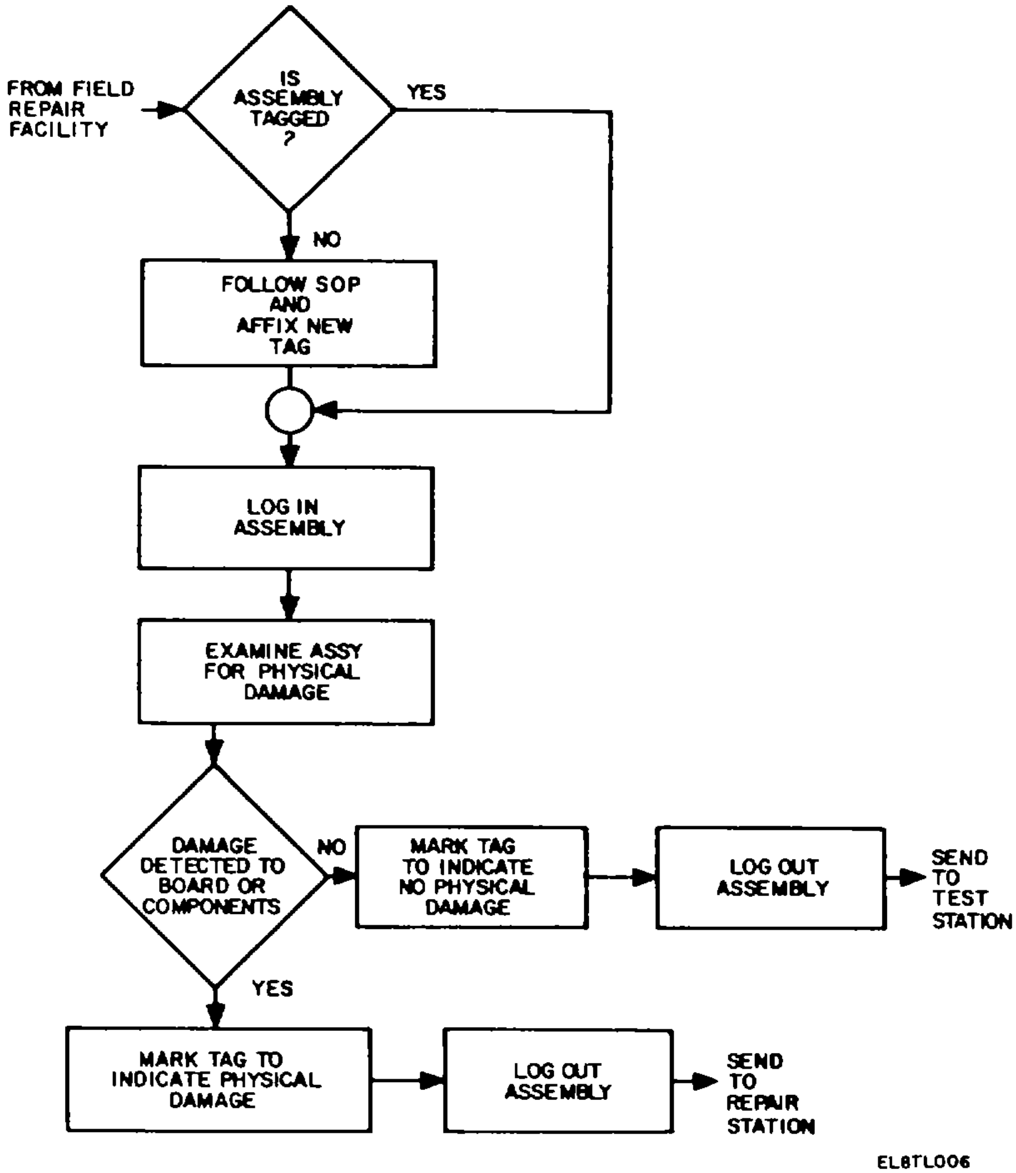
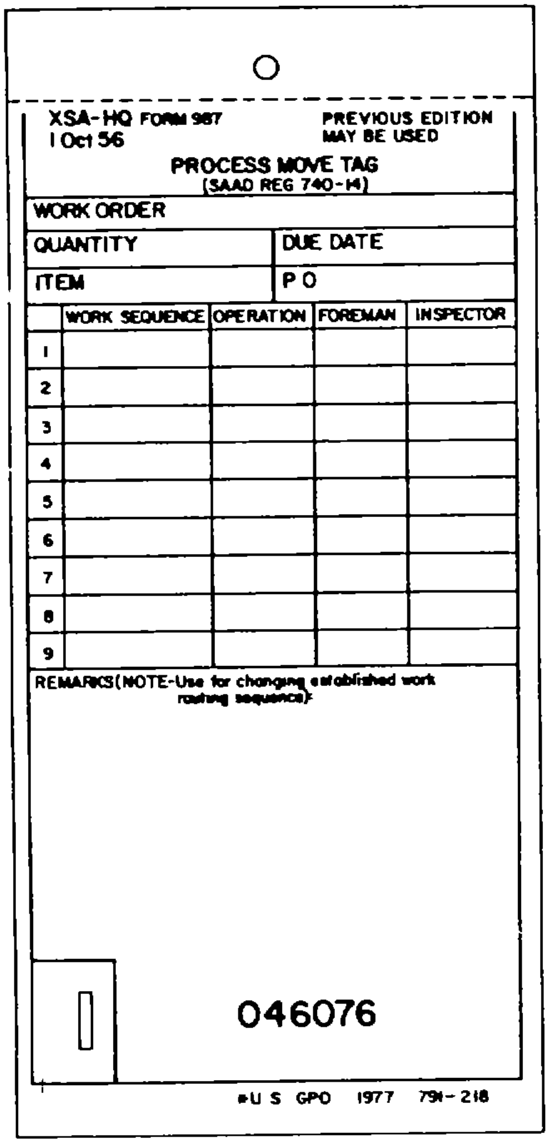


Figure 3-1. Receiving Inspection Flow Chart



XSA-HQ FORM 987
1 Oct 56

PREVIOUS EDITION MAY BE USED

PROCESS MOVE TAG
(SAAD REG 740-14)

WORK ORDER	
QUANTITY	DUE DATE
ITEM	P O

	WORK SEQUENCE	OPERATION	FOREMAN	INSPECTOR
1				
2				
3				
4				
5				
6				
7				
8				
9				

REMARKS(NOTE-Use for changing established work routing sequence):

046076

*U S GPO 1977 791-218

NOTE

WHATEVER SYSTEM PWA/ PCB is part of (P O) MUST BE ENTERED REPAIRPERSON MUST KNOW APPLICABLE TECHNICAL MANUAL IN ORDER TO REQUEST REPAIR PARTS BY NSN

EL8TL007

Figure 3-2. Process Move Tag

3-6. Routing. All decisions regarding routing will be determined by the appropriate SMR Damages to the PWA/PCBs beyond the scope of the General Support Facility will be sent to the proper facility for disposition. If no physical damage to the board is noted during visual inspection, the assembly is routed to the test station. If component damage is noted, the assembly is routed to the repair station

3-7. Special Handling. Process Move Tags will be noted in the remarks section it any special handling of the assembly is required during subsequent routing to test station, repair station, or shipment to Depot. Special consideration and marking should be given to Electro-Static Discharge (ESD) protection (chap 2).

CHAPTER 4

INSPECTION EQUIPMENT

NOTE

Before any procedures are started, it must be determined it printed circuit board needs protection from electrical discharge. If so, the PCB shell be marked "ESD Sensitive" at incoming inspection.

4-1. GENERAL. Precise physical inspection of complex PWA/PCB Assemblies requires special equipment and tools developed specifically for close visual examination of potential defects. Listed below is a minimum of such specialized equipment.

a. Optical Lighting System. The lighting system provides dual balanced, low glare lighting and a distortion free magnifier for thorough inspection of an assembly (fig. 4-1). P/N 7007-0006 - Pace POL-12 or equivalent.

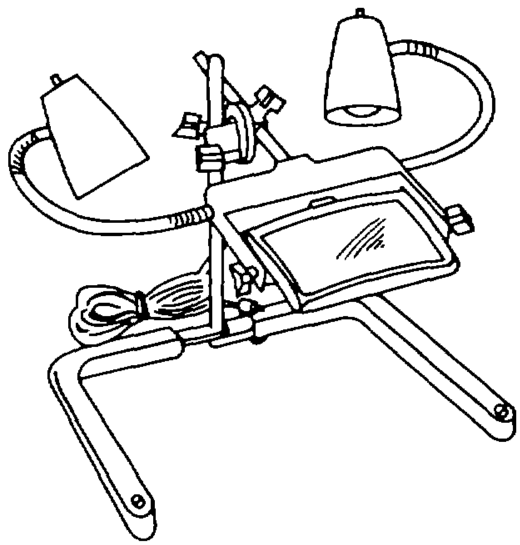


Figure 4-1. Optical Lighting System

b. Work Handling System. The work handling system provides a means of clamping, and at 360°, a PWA/PCB for precise Inspection (fig. 4-2). NSN 5999-01-115-6973 - PIN 7015-0009 or equivalent.

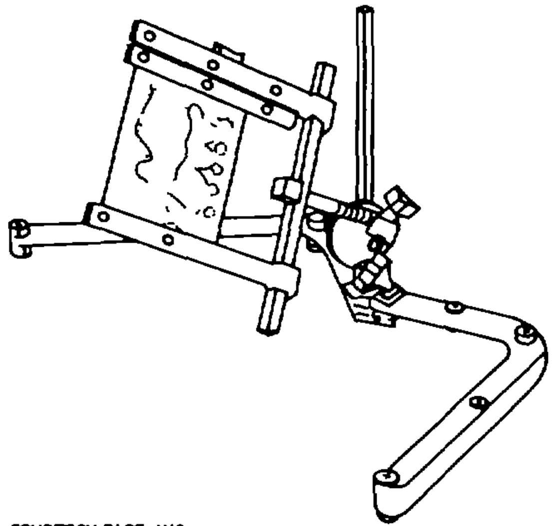


Figure 4-2. Work Handling System

c Black Light. The black light inspection lamp shines a blue/black light down on the circuit board. It discloses common flaws such as voids in plating, hairline cracks in etching, uneven conformal coating, and solder mask and flux residue. These flaws show up as white areas.

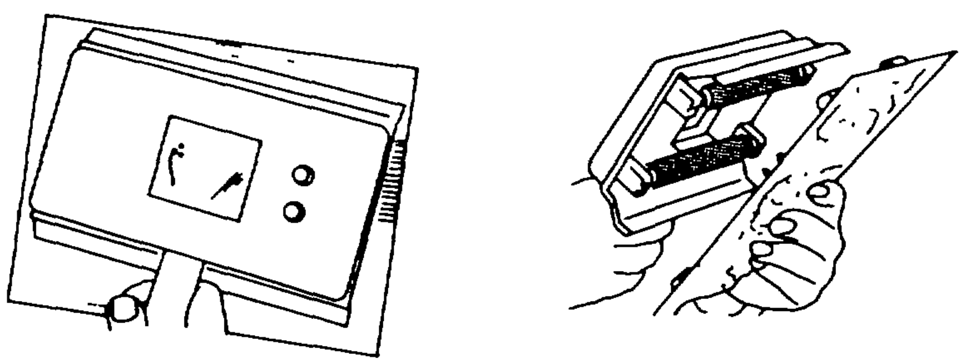


Figure 4-3. Black Light Inspection

d. Vacuum Cleaning/Handling System. This system provides a means for cleaning dust and grit from difficult to reach areas. NSN 4940-00-492-4739 - PACE 7014-0001 or equivalent.

e. Dental Mirror (45° angle). Dental mirror permits inspection of components and printed circuits in crowded areas (fig. 4-4). Pace 1106-0012

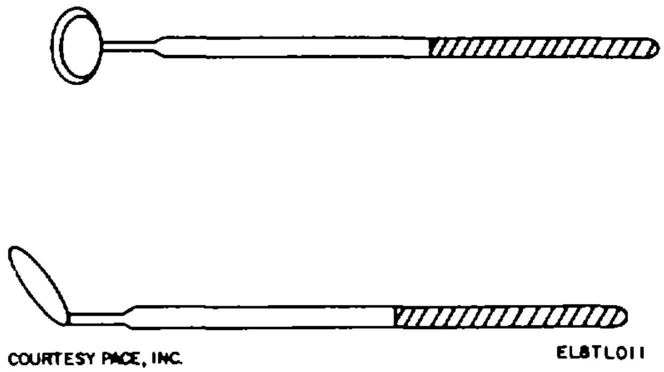


Figure 4-4. Dental Mirror (45° Angle)

4-2. SPECIALIZED EQUIPMENT. Along with the Multilayer Printed Circuit Boards (MPCBs) comes the need for more sophisticated inspection equipment. The Stereo Zoom Microscope is one of these. It provides a means to examine plated through holes, micro-miniature components for defects, and faulty welds (fig. 4-5). This model is Bausch & Lomb P/N 31-33-33

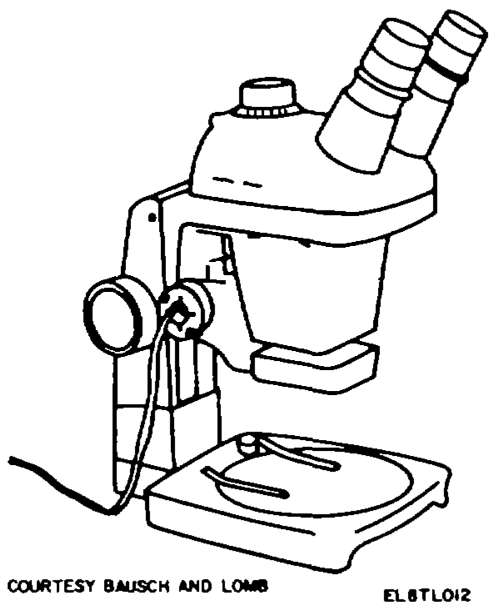


Figure 4-5. Stereo Zoom Microscope

CHAPTER 5

INSPECTION PROCEDURES

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB shall be marked "ESD Sensitive" at Incoming inspection.

5-1. General. This chapter provides a description of the visual defects observable on a PWA/PCB Assembly which causes an internal failure. These defects are divided into three groups shipping damages, environmental damage, and damages resulting from repairs.

5-2. Shipping Damages. After unpacking the PWA/PCB and storing the packing material, the receiving inspection section will Inspect the assembly for possible shipping damages (fig. 5-1). Some of the common shipping damages are listed below:

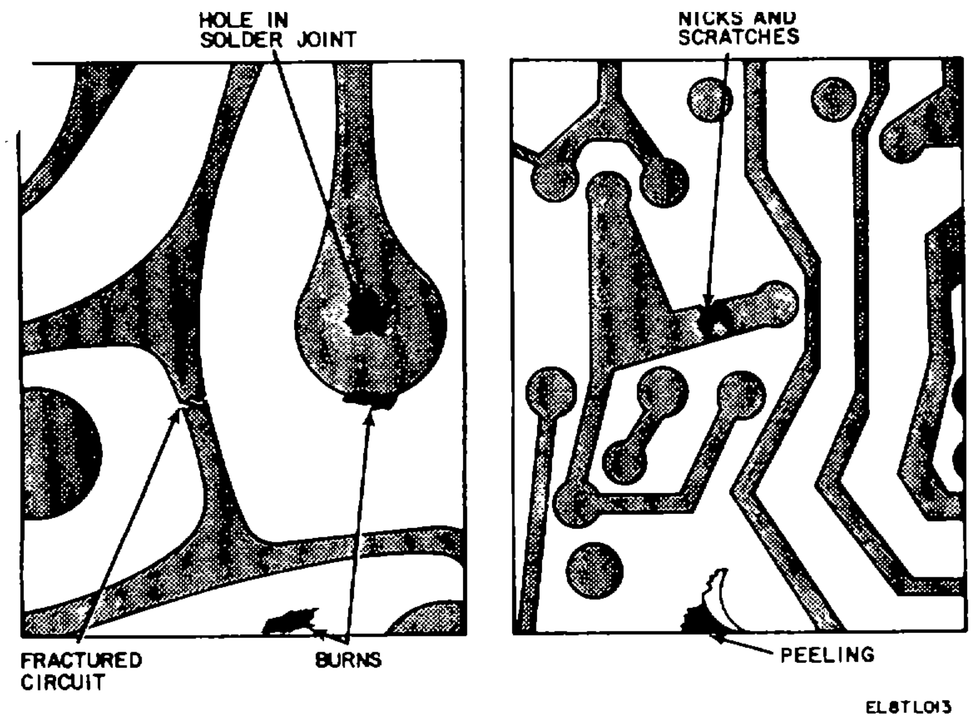


Figure 5-1. Shipping Damages

a. Cracked or bent printed circuit board
b. Broken wires or circuitry
c. Cracked, broken, or dented components
d. Scratches, dents, or peeling of the board
e. Cracked solder joints or connections
f. Burned, blistered, or scorched areas

5-3. Environmental Damages. The conformal coating protects the PWA/PCB from corrosion, moisture, salt air, fungus, vibration, and high temperatures. An uncoated PWA/PCB subject to environmental stress will result in any of the following conditions:

a. Corrosion - an oxidation or chemical reaction occurring on a metallic surface. It can appear as pitting, as eroding of the metal, or as a white or colored residue. All metallic surfaces such as lead wires, solder joints, metal tracks, metallic components, and the equipment housing should be inspected.

b. Dendritic Growth - an electrolytic transfer of metal from one conductor to another. The dendrite appears as a stalk with branches resembling a tree. The spaces between conductor tracts should be inspected for this phenomenon (TB 750-12, fig. 10-5).

c. Whisker Growth - single crystal growths resembling fine wire. Most frequently these growths appear on boards or components which have been electroplated with tin (fig. 5-2).

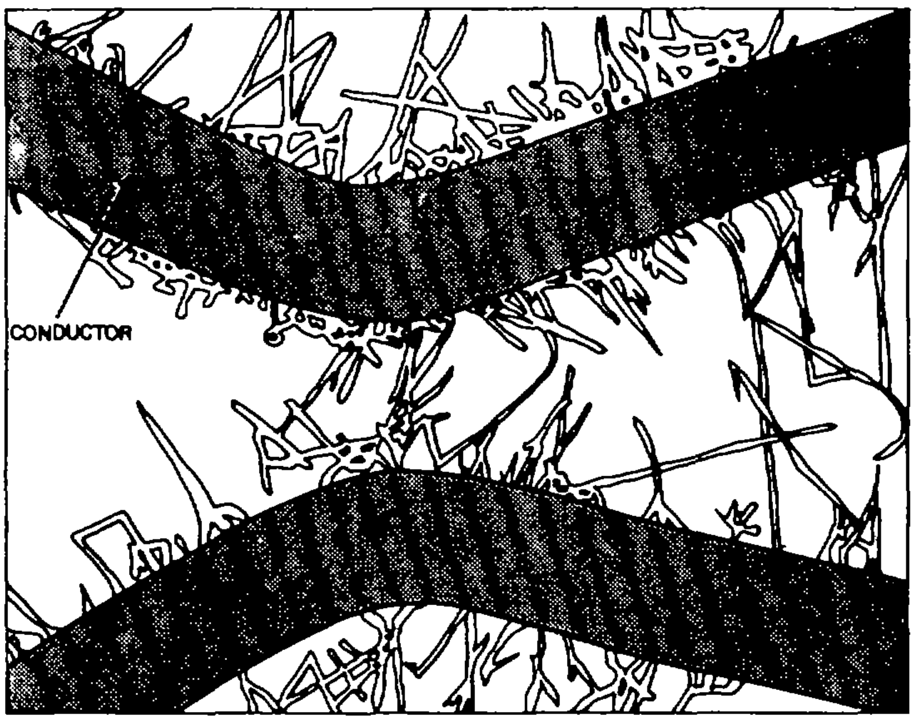


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Figure 5-2. Magnified Illustration of Whisker Growth

d. Conductive Contaminant Growth - bridging of circuits by conductive salts. It appears as a colored line between two conductor tracts (TB 750-12, fig. 10-7).

e. Laminate Degradation - white spots or discoloration in the board material itself (TB 750-12, fig. 9-18).

f. Reversion (Hydrolytic Stability) - tackiness or softening of the bonding or plastic type materials, i.e, cable potting material.

5-4. Repair Damages. All repaired PWA/PCBs will be inspected for conformance to the guidelines described fully in chapter 11. Workmanship will be of the highest quality and will comply with the requirements of this publication.

5-5. Visual Inspection. All PWA/PCBs will be visually inspected for conformance to the acceptance criteria using the following procedures:

a. Place PWA/PCB in the work handling system and rotate to various positions for inspection (fig. 4-2).

b. Remove all dust and grit with the vacuum cleaning system (fig. 9-4) Refer to specific DMWR for proper cleaning solvents if additional cleaning is required.

c. Place PWA/PCB under the optical lighting system magnifier and inspect as follows (fig. 4-1).

(1) Conduct visual inspection by slowly scanning assembly from left to right covering a 2 inch width.

(2) Repeat visual scan for each of the three potential defects in paragraphs 5-2, 5-3, and 5-4.

(3) Concentrate on one series of detects at a time to isolate and identify potential failures.

d. Record all abnormal conditions or discrepancies on the Process Move Tag (para 3-5).

CHAPTER 6

TEST PROCEDURES

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB shall be marked "ESD Sensitive" at incoming inspection.

6-1. General. This chapter describes the responsibilities of the test station in the General Support/Depot facility. Included is a brief description of the procedures for testing and troubleshooting PWA/PCBs.

6-2. Test Station. The test is responsible for:

a. Identifying defects as received

b. Verifying performance criteria after repair of PWA/PCBs

6-3. Test Station Operational Sequence. The PWA/PCB is processed through the test station as shown on the Flow Diagram (fig. 6-1). The PWA/PCB is received from either the receiving inspection or the final inspection station. The following sequence will be observed:

a. Log assembly into test station.

b. Check attached tags for an Identification of the problem.

c. Performance test the PWA/PCB using the specified DMWR test program.

(1) Include manual testing for environmental, mechanical, and electrical defects by sampling.

(2) Perform wire pulling, infrared, individual testing of suspected components, thermal shock, vibration and X-ray tests

(3) Refer to MIL HDBK-175 (Microelectronic Device Data Handbook) for detailed test procedures.

d. If required, perform diagnostic testing to fault isolate the detective circuit or component(s).

(1) Update the attached tags to identify the fault and log out to the repair station.

(2) If assembly passes the performance verification test, after repair, make entries on Process Move Tags and attach a copy of the printout.

(3) Log out the assembly to the final Inspection station.

6-4. Test Equipment. The test station will include standard bench test equipment. Consult all available handbooks, technical manuals, and DMWRs to obtain the needed information from the test equipment. When available, automatic test equipment will be used to gain a thorough and accurate testing

6-5. Types of Tests

a. Bare Board Tests. Starting at a specific junction of circuitry the test inspects each circuit or pad for openings and shorts.

b. Loaded Board Tests. Testing of loaded PC boards can be described by the following categories:

(1) *Continuity Tests*. It has been estimated that 50 to 60 percent of the defects on assembled PC boards are due to solder splashes, bad solder connections, and missing or improperly inserted components. Continuity testing checks for these defects.

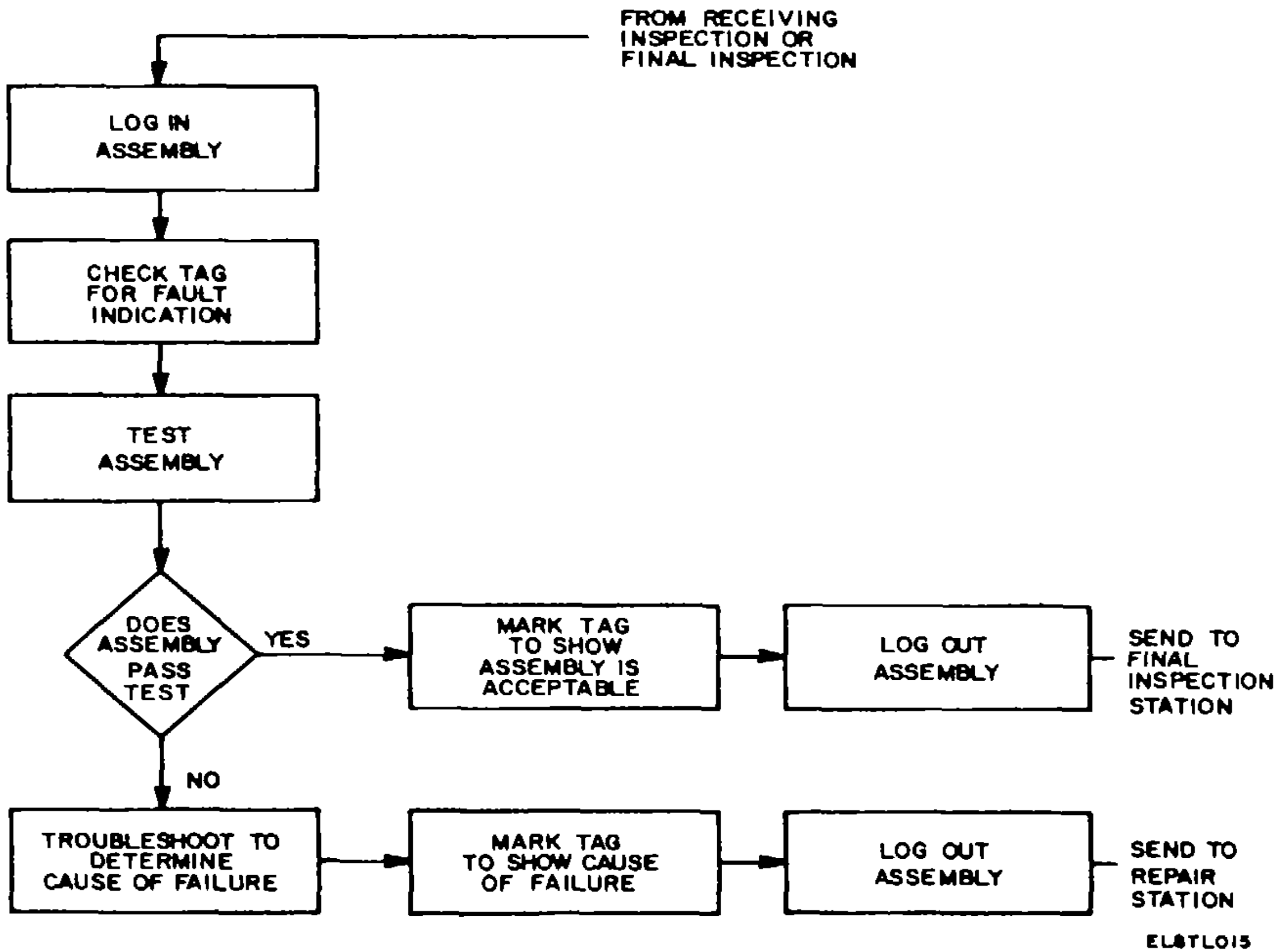


Figure 6-1. Test Function Flow Chart

(2) *In-Circuit Tests*. In-circuit testing measures the value or checks the static operation of component on the board without regard for the function of the overall circuit. Studies indicate that these testers will typically identity 95 percent or more of the printed circuit assemblies that would fail in systems operations.

(3) *Functional Tests*. Functional testing, also called go/no go assembly testing, checks the performance of the PC assembly as a whole. The tester applies typical inputs to the circuit under active operating conditions and checks the outputs against circuit requirements. Inputs and outputs are made through the board edge connector. Functional testing of good assemblies is very fast, and fewer than 2 percent of the "functionally tested good" boards fail in system operations. The tester uses a guided probe to check "tested bad" boards on a circuit pad, on a point to point basis.

CHAPTER 7

CONFORMAL COATING REMOVAL AND RECOATING TECHNIQUES

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB shall be marked "ESD Sensitive" at incoming inspection.

7-1. General. Prior to removal of coating or recoating of the PWA/PCB, the repair facility will identify the type and method of coating that was originally applied by the manufacturer. Coating Identification Information is contained in the appropriate Comsec Inter-Service Depot Overhaul Standards, (CIDOS). Refer to table 7-1 for conformal coating characteristics and table 7-2 for conformal coating removal methods.

7-2. Conformal Coating Methods. PWA/PCBs are coated by several basic methods, which are defined as follows:

a. Coating - A process of applying a relatively thin protective layer which covers the surface of the PWA/PCB and is sometimes called a conformal coating.

b. Impregnation - A process used for sealing porous materials, securing coil windings and other parts. Impregnation is accomplished by spraying, dipping or vacuum processing with very thin liquids.

c. Encapsulation - The process of coating the surface of an object with a viscous material to form a continuous thick protective layer which usually conforms to the shape of the object.

d. Potting - The process of filling a container with a material which hardens and prevents shifting of the component. The component(s) and its container are molded into one assembly which is protected from moisture and dirt.

e. Embedding - This process is similar to potting except that the container is a temporary mold which is removed after the material sets. This method is used to keep the component from shifting by partially embedding it. It is not sealed by the conformal coating (para 7-5).

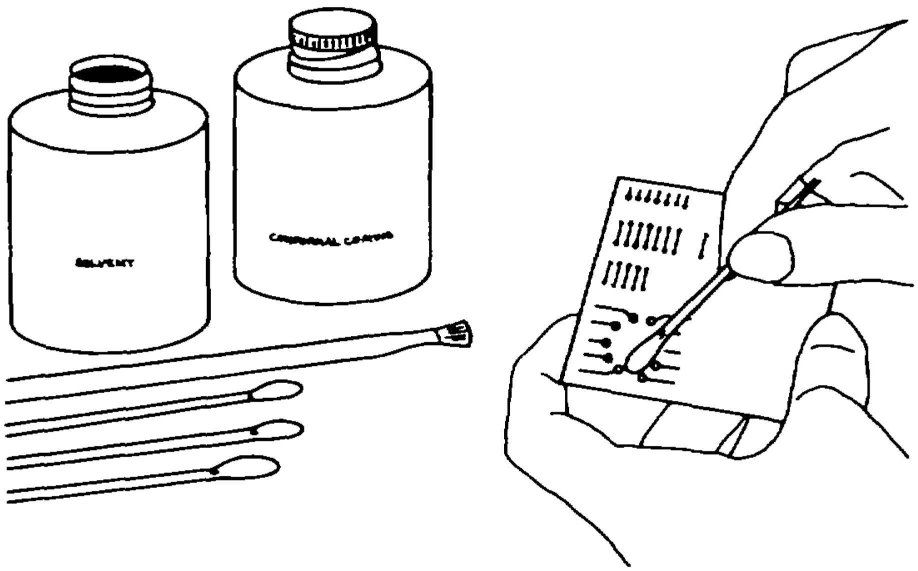
7-3. Coating Removal Methods. Once the coating has been identified by the appropriate CIDO, the exact removal method can be employed. Conformal coating must be removed from the connections to be unsoldered. This must be done because the coating creates a heat barrier when heated and may result in solder joint contamination. It is easier to restore the board to a serviceable condition if all the unwanted coating is removed at the beginning of a replacement procedure. In most instances, only a spot removal of the coating is necessary to suit the required repair action. There may be a few cases where removal of all of a specific type of coating, by solvent means, can be performed on a production basis as easily as spot removal. The removal method to be used is based on the general type of coating, the condition of the coating, and the nature of the components and the PWA/PCB. Coating removal methods (not necessarily in order), are as follows: solvent, stripping, thermal parting, mechanical abrasion, and the Hot Jet method.

WARNING

Don't use chloride base solvents. Provide adequate ventilation and avoid inhalation of solvents and epoxies vapors. They may contain toxic gasses. Ethyl and isopropyl alcohol are flammable.

a. Solvent Method. Xylene or trichlorethane may be used to spot remove soluble type coatings. The primary concern in using the solvent method is the determination of hazards to the components and the PWA/PCB by short term immersion or the entrapment of solvents. If removing RTV (silicon rubber), pre soak in freon TF to soften and expand the material which permits a stripping procedure. Dry the assembly by forced air or by the surrounding air. The solvent method procedure is as follows:

(1) Complete removal of soluble coating.
- (a) Fill several containers with mild solvent.
- (b) Immerse and brush entire PWA/PCB in the first container (high contamination).
- (c) Progress to the last container (fresh solvent) as you repeat (b) above.
- (d) Or, place PWA/PCB under a continuous flow of fresh mild solvent as you brush the assembly.



COURTESY PACE, INC.

ELBTL016

Figure 7-1. Coating Removal

(2) Spot removal of soluble coating (fig. 7-1).
- (a) Dip end of cotton-tipped applicator in the solvent.
- (b) Apply to coating around solder components and connections.
- (c) Swab the local area with fresh solvent until the coating is dissolved.
- (d) Repeat several times because the solvent evaporates fast.
- (e) Carefully use the wood end of the applicator or a bristle brush to dislodge the conformal coating.
- (f) Scrape off the exposed solder connection and brush away the residue (fig. 7-2).

WARNING

While using the abrasion tools at high/low speeds, damage to the eyes may occur. Use protective eye covering when using the abrasion tools to repair PWA/PCBs.

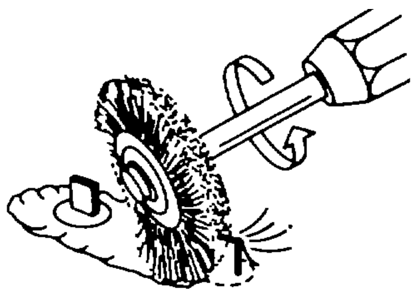


Figure 7-2. Abrasive Conformal Coating Removal

b. Stripping Method. (Usable only in special instances.)
- (1) Presoak RTV (silicon rubber) in freon TF (para 7-3(a)).
- (2) Slit the RTV and peel off.

c. Thermal Parting Method. Various shaped temperature controlled tips are used to soften the thick coatings which releases the bonds between the components and the PWA/PCBs. This method neither burns nor chars the PWA/PCB or the coating The thermal parting method procedure is as follows:
- (1) Select the proper thermal parting tip for the work piece.
- (2) Set the thermal parting tip temperature as described in the PRC 350C bench top repair center operating instructions.
- (3) Apply the thermal parting tip to the coating with a light pressure.
  - (a) Polyurethane coating will soften and epoxy coating will granulate.
  - (b) Regulate tip temperature to effectively break down coating without scorching.
- (4) Gradually reduce the coating thickness around component body without contacting the board surface. Remove as much coating as possible away from the component leads to allow easy removal of the leads.
- (5) Use low pressure (12 PSI) or a bristle brush to remove waste material which will allow good visual access and prevent accidental damage to the PWA/PCB.

(6) Clip the leads of faulty components to permit the removal of the component body separately from the leads and solder joints.
(7) Heat the component body with the thermal parting unit or a small soldering iron to weaken the bond beneath the components.
(8) Lift the component body free from the PWA/PCB (fig. 7-3).
(9) Remove the remaining coating material by additional thermal porting or by the miniature machining abrasive method.
(10) Heat the solder joints and remove the remaining leads.

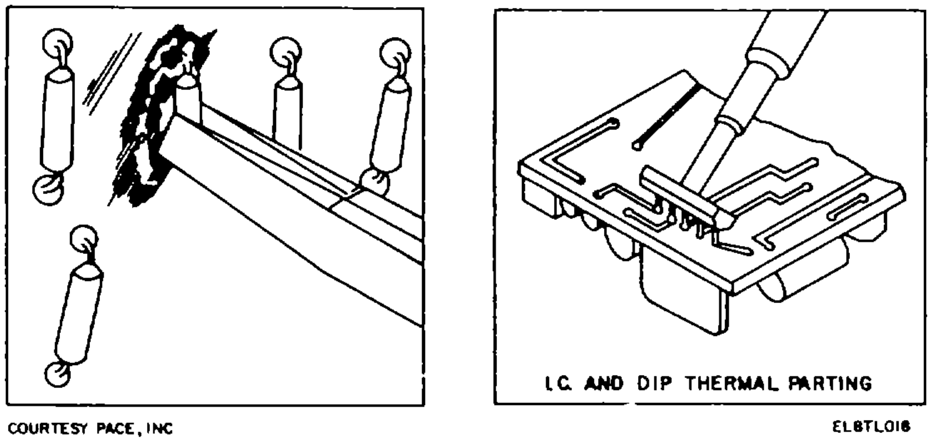


Figure 7-3. Component Removal

d. Mechanical Abrasive Method. The powered mechanical abrasive coating removal method permits consistent and precise removal of coatings without mechanical damage or dangerous healing. Use a powered miniature machining system (PACE model PM 166) which will permit fingertip control while providing low revolutions per minute at a high torque to facilitate the handling of gumming type coatings (test with pin). A wide variety of rotary abrasive materials cutting tools ball mills, twist drills, and rotary brushes, to suit the various coating types and configurations, are required. The mechanical abrasive method procedure is as follows:

(1) Thick Coating Removal. The thick coating is reduced by abrasion. The remaining thin coating is removed as stated in paragraph 7-3d(2). The procedure for thick coating removal is as follows:

(a) Route out thick coatings with proper size ball mill (fig. 7-5).

CAUTION

To prevent inadvertent damage to the base material of the PWA/PCB periodically remove the waste coatings by brushing or low pressure air (12 PSI) to allow visual inspection of the work surface.

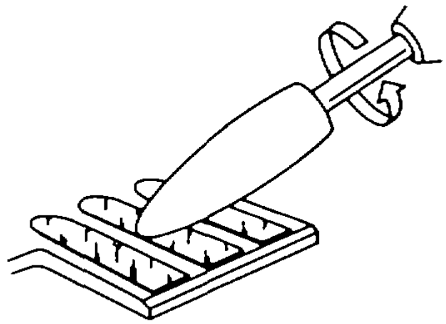


Figure 7-4. Precision Abrading of Thin Coating

NOTE

The design of a ball mill is such that its most efficient cutting area is on the side of the ball rather than at the end.

(b) When the coating has been reduced to a thin condition use the abrasive (fig. 7-2) or hot jet mode (fig. 7-6) for thin coating removal.

(2) Thin Coating Removal A rubberized abrasive and grit are used to remove thin/hard coatings from flat surfaces. This is not recommended for thin/soft coatings because the abrasive will load with coating material and become ineffective. A rotary bristle brush is used to remove thin/soft coatings and for working on irregular surfaces (fig. 7-2). Use a circular motion to minimize healing and damage to underlying materials. The procedure for thin coating removal is as follows:

(a) Select the appropriate rotating abrasive.
(b) Begin with a coarse abrasive to remove bulk of the coating and change to a finer abrasive or bristle brush to clean the loose coating around the component.
(c) Apply rotating abrasive to coating at various pressures to test the rate of coating removal.
(d) Remove the coating by applying the rotating abrasive at the most effective pressure (fig. 7-4).
(e) Clean area with ethyl alcohol to remove any remaining contaminants. The solder extraction can now be determined.

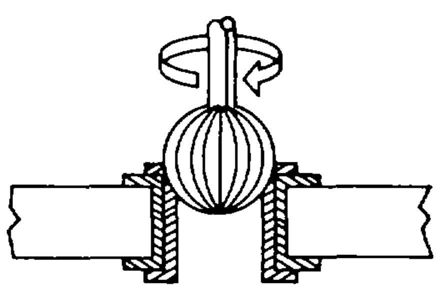


Figure 7-5. High-Torque, Low RPM Drilling and Milling

e. Hot Jet Method. The hot let method uses a controlled let of temperature regulated air to either soften or break down the coating (table 7-1). By controlling the gas temperature flow rates and let shape the hot jet can be applied without damage to almost any workpiece configuration on both the circuit and component sides of the PWA/PCB. Since there is no direct physical contact with the workpiece surfaces, direct observation of the heating action is possible while handling extremely delicate work. The hot jet method procedure is as follows:

(1) Set up hot let for minimum sized jet as outlined in the PRC-350C operating instructions.
(2) Adjust flow rate and temperature to suit specific coating removal without scorching or charring coating.
(3) Apply jet to work area (fig. 7-6).
(4) Remove softened coating with a soft, nonmarring edged tool (i. e. teflon, nylon, or orange wood).
(5) Remove coating around leads solder joints and component bodies.
(6) Use appropriate solder extraction method after coating is removed (para 8-7).

(a) Set up hot jet per the PACE operating instructions to provide minimum sized jet. Adjust flow rate and temperature to suit specific coating removal application.

(b) Apply jet to work area (fig. 7-6). With the aid of a relatively soft, nonmarring edged tool (i. e., teflon, nylon, or orange wood) use light pressure to remove softened or overcured coating. All coating around individual leads, solder joints, and component bodies can be removed in this manner. Never set the hot jet to heating levels that will cause scorching or charring of the coating material.

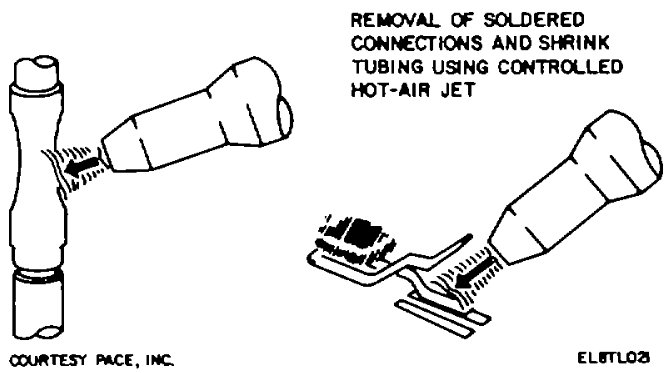


Figure 7-6. Hot-Air Jet Mode

7-4. Guidelines for Cleaning PWA/PCBs Prior to Conformal Coating. The following cleaning procedures do not address specific assemblies and will require slight modifications as outlined by the producing facility. Prior to recoating the PWA/PCB, remove all dirt, foreign matter, corrosion products, oil fingerprints, flux residues, and other contaminants.

a. Cleaning Solvents. The following solvents are recommended for removal of residues and polar/nonpolar contaminants.

(1) Isopropyl alcohol (TT-1-735, Grade A)
(2) Alcohol SDA-30 (O-E-760, Grade III)
(3) Trichlorotrifluoroethane (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. Cleaning Procedure:

(1) Clean affected area with a typewriter eraser and a cleaning/polishing pad if there is damage due to heat or contain corrosion products.

(2) Scrub affected area with a clean nylon brush moistened with the producing facility recommended cleaning solvent.

(3) Rinse or flush area with clean isopropyl alcohol.

(4) Wipe clean immediately with Kimwipes, to prevent a residue from air drying (avoid finger prints).

(5) Remove rework residue with a denial chisel.

(6) Remove adhesive residue with Kimwipes or equal and isopropyl alcohol.

(7) Repeal the process until assembly is cleaned.

(8) Alter cleaning dry in an oven with low press filtered gaseous nitrogen 10 + 3PSI or allow assembly to air-dry.

NOTE

Oven temperature is determined by the reference component specification manuals.

7-5. Recoating. The conformal coating must be replaced after the repair of the PWA/PCB.

a. Material Selection. The same generic type of coating or a suitable substitute should be used in recoating a PWA/PCB as was originally found on it to assure compatibility. Refer to table 7-2 for conformal coating characteristics. A detailed description is found in MIL-I 46058C. The general types of coating materials include:

(1) Varnish

(2) Epoxy resin

(3) Polyurethane resin

(4) Acrylic lacquer

(5) Silicone resin

(6) Silicone rubber (RTV)

(7) Parylene

b. Reasons for Coating. Coatings are used for protective and functional reasons and must conform to MIL-l-46058C. These reasons include considerations of humidity, fungus, mechanical shock and vibration, electrical insulation, mechanical penetration and abrasion heal sinking and bonding. To meet a specific usage, coating material selected by the manufacturer may require the following characteristics:

(1) Good thermal conductivity to carry heal away from the components.

(2) Low shrinkage factors during application and cure to prevent the coating from applying strains or stresses to the components leads or seals.

(3) Resilience, hardness and strength to properly support and protect the components to meet their loading conditions.

(4) Low moisture absorption.

(5) Inorganic materials to prevent fungus growth.

(6) Electrical insulation qualities.

c. Coating Application. The required thickness and uniformity determines the method of applying the coating. Application methods include brush on, spray on, dipping, and spread or pour on. Dipping and pouring of coatings will result in relatively thick coatings. Spraying and brushing will usually result in thin coatings. To assure the continuity of a coating used for electrical insulation or moisture protection over a given surface MIL-I-46058 requires a tracer in the coating material so that ultra-violet light detection will indicate any break or gap in surface coverage.

d. Coating Guide Lines for Component Areas. The following guidelines must be observed during the recoating process:

(1) The coating fills the space between the board and the component (optimum 5 mils).
(2) The fillet must be 100% on all sides of each component.
(3) Bubbles between leads must have a smaller diameter than the space between leads.
    (a) Larger diameters are acceptable if closed.
    (b) Pierce and fill if holes are open.
(4) Overcoat minute bubbles connecting leads or pads.
(5) Apply conformal coating to bottom of all communication holes to seal off moisture to component side.
(6) Minimize webbing between the underside of the leads and the surface of the board.
(7) Avoid encapsulating the lead bend area.
(8) Store PWA/PCB in a new clean zip lock polyurethane bag after the recoating process.

Table 7-1. Physical Characteristics Associated with Generic Types of Conformal Coatings

CONFORMAL COATING	HARD	MEDIUME HARD	SOFT	HEAT REACTION	SURFACE BOND VERY STRONG	SURFACE BOND STRONG	SURFACE BOND MEDIUM	SURFACE BOND LIGHT	SOLVENT REACTION	SMOOTH SURFACE	LUMPY SURFACE	NONPOROUS SURFACE	GLOSSY SURFACE	SEMIGLOSSY SURFACE	DULL SURFACE	RUBBERY SURFACE	BRITTLE	CHIPS OFF	PEELS AND FLAKES	STRETCHES	SCRATCH AND DENT BEND AND TEAR
EPOXY	X			X	X					X		X	X	X			X	X			
ACRYLIC LACQUERS		X		X		X			X	X		X	X				X	X	X		
POLYURETHANES	X	X	X	X			X			X		X	X						X	X	X
VARNISH	X	X		X		X			X		X			X			X		X		
RTV			X		X	X	X	X		X					X	X				X	X
PARYLENE	X				X					X		X			X				X		X

NOTE

Identifiable characteristics are relative and not absolute i. e., graduations from Hard to Soft can exist for many coating materials: variations from Transparent to Opaque may exist In the same coating, etc.

COLOR OF COATINGS

NOTE

Color variations by addition of tracer dyes (ultraviolet indicators, etc.) and filters can provide a wide variety of coloration in the same coating material.

Acrylic Lacquer	Clear - may have dye tracers.
Epoxy Resin	Clear - Amber may be opaque by dyeing and fillers.
Varnish	Amber - brown
Silicone Varnish	Clear - may have dye tracers.
Poly-U	Clear - may have dye tracers.
RTV	Translucent to Opaque - may also be colored.
Parylene	Clear

Table 7-2. Conformal Coating Removal Methods

Material	Thermal Parting	Mechanical Abrasion	Solvent	Stripping	Hot Jet
Acrylic Lacquer			X		
Polyurethane	X	X			X
Epoxy Resin	X	X			X
Silicone Rubber (RTV)		**X		X	
Varnish	X	*X			X
Silicone Varnish			X		
Parylene	X	X			

*Hard type only
**Freon TF to soften and expand

CHAPTER 8

DESOLDERING AND SOLDERING TECHNIQUES

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB will be marked “ESD sensitive” at incoming inspection.

8-1. General. This chapter provides the basic techniques to be used in performing solder repairs of PWA/PCBs. The primary purpose of solder is to join two or more metals with a metallic bond. This bond is achieved by the molten solder dissolving a small amount of the metals to be joined at the point of contact. A continuous metal bond is thus formed which is a partial alloy of the solder and the metals involved.

8-2. Solder. The solder used in electronic assemblies is essentially an alloy of lead and tin. The combination of 63 percent tin and 37 percent lead is eutectic and referred to as SN63. SN63 and SN60 are the most common alloys of solder used throughout the electronics Industry. For more information refer to Federal Specification QQ-S-571 Solder; Tin Alloy; Tin-Lead Ally and Lead Alloys. This specification contains the form and content of solders used by the military.

8-3. Flux. Oxides form on the surface of heated metals and create films which prevent proper soldering. Flux is used to remove these oxides and to prevent the formation of new oxides during the soldering operation. There are a variety of fluxes available but the only fluxes allowed in electronic work are either the pure gum resins or the resins combined with mild activators to accelerate the resin’s fluxing capability. Acid flux should never be used because of its corrosive properties (MIL-F-14256-Flux, Soldering, Liquid (Resin Base) and Federal Specification QQ-S-571.)

8-4. Cored Solder. A common form of solder and flux is the flux core type which is available in various solder alloys, sizes, and percentages of flux. When using flux core solder do not apply the solder directly to the tip because the flux will evaporate before it can do its job of removing the oxides from the work (fig. 8-1).

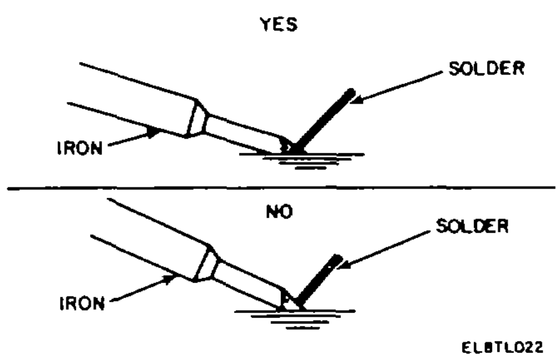


Figure 8-1. Cored Solder Use

8-5. Materials. It is the responsibility of the repair facility to select those materials and processes that will produce an acceptable high quality product. Except when otherwise specified on detailed drawings, the materials used in soldering operations will conform to the following requirements.

a. Solder. Use an SN60 or SN63 solder, optional form, conforming to Federal Specification QQ-S-571.

b. Flux. Use resin based fluxes conforming to Federal Specification QQ-S-571 and MIL-F-14256. Type RA (Activated Resin) flux can be used only on PWA/PCBs without stranded wires (cables that are twisted together).

c. Cleaning Solvents. Use solvents for cleaning of joints and repaired areas that are compatible with the materials in the parts to be cleaned. Refer to the specific maintenance/repair manual for the proper cleaning solvent to prevent additional damage to the PWA/PCB. In addition, proper ESD protective measures will be taken by the use of spray cleaners (para 2-8) which are identified on the container as static free (refer to DOD-STD-2000-1 for a complete list of cleaning solvents and their specifications).

NOTE

Curtail the repair operation when the humidity is 30 percent or less. Restart repair operation after maintenance engineering increase the humidity above 30 percent (chapter 2).

8-6. Solder Repair Facility. The area set aside for soldering should conform to DOD-STD-2000-1 (chap. 4).

a. Temperature. Ideally, the temperature in the areas of solder repair will be maintained at 75°F plus or minus 9°F (24°C plus or minus 5°C) with the humidity not greater than 65 percent.

b. Cleanliness. The solder repair work areas will be located in that part of the repair facility which is relatively free from other manufacturing operations which produce airborne dust dirt or contaminants. Any evidence of visible accumulation of contaminants on work station benches, tools, components, or equipment will be a cause for corrective action.

c. Vapors. Toxic or volatile vapors will be exhausted in accordance with the specific facility operating procedures and the Office of Safety and Health Administration (OSHA) requirements. Special care should be given to venting trichloroethane vapors during the cleaning operations.

8-7. Desoldering Techniques.

a. Solder Extraction Device (fig. 9-5). The solder extraction device is a coaxial, in-line instrument with the general configuration of a small soldering iron. It consists of a hollow tip, heating element, transfer tube, and collecting chamber located within the handle which collects and solidifies the waste solder and clipped leads. The unit is operated by a power source that provides controlled vacuum/pressure and electrical supply.

(1) Vacuum Mode (fig. 9-5). In the vacuum mode, the heated tip is applied to the solder joint. When a melt is noted the vacuum is activated causing the solder and any clipped leads to be withdrawn from the joint and deposited into the chamber.

(2) Pressure Mode (fig. 9-5). In the pressure mode the tip can transfer heat to a clipped lead for melting the solder without contacting the delicate pad on the lower side. Air pressure is forced down the hole to break up the liquid solder.

(3) Hot Air Jet Mode (fig. 9-5). The hot air let mode uses a controlled flow of heated air which melts the solder joint without physical damage to the circuitry. This permits the reflow of very delicate joints while minimizing the possibilities of mechanical damage.

b. Wicking Desoldering System (fig. 8-2). In addition to the hot air and vacuum method of desoldering the wicking method can also be used on large components but is not normally used on PCBs/PWAs. Desoldering by wicking is accomplished as follows:

(1) Connect a thermal shunt between heat-sensitive parts and the connection to be desoldered.
(2) Strip approximately 1 inch of insulation from the end of the stranded or braided wire.
(3) Dip stripped end of wire in liquid flux.

CAUTION

Apply heat for a maximum of 5 seconds with a minimum cooling off period of 30 seconds between heat applications.

(4) Place stranded wire or braid on solder connections and heat with soldering tip.
(5) Molten solder from the connection will adhere to the wire or braid. Simultaneously remove soldering tip and wire or braid when sufficient solder is removed from the connection (fig. 8-2).

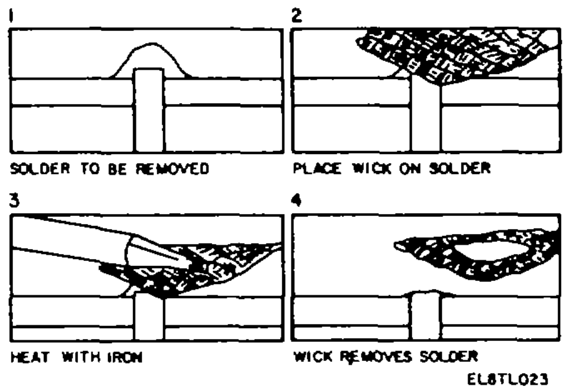


Figure 8-2. Wicking Desoldering System

c. Lap Solder Joint Removal. A lap reflow solder joint (fig. 8-3) is a technique used on flat pack I.C.'s and any other component that is mounted flat on the board and not mounted through a hole (TB SIG 222, chap. 5).

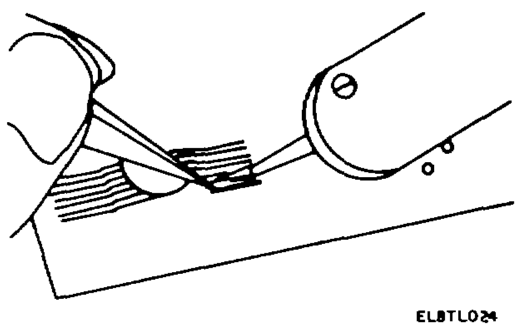


Figure 8-3. Lap Solder Joint Removal

8-8. Soldering Techniques. The following general techniques, as outlined in MIL-STD-454E and MIL-S-45743 will be practiced when performing high-reliability soldering:

a. *Cleaning*. Clean repair area and remove oxidation and dirt with solvent or an eraser.
b. *Flux Application*. Apply flux core solder or external flux to the area to be soldered.
c. *Heal Application*. Choose proper size iron, tip, and temperature selling to suit the mass being soldered.
d. *Solder Application*. *Apply solder to form a solder bond. Use a heat sink if needed*.
e. *Cleaning*. Clean assembly and remove all flux and residues using an approved solvent.

8-9. Additional Information. For more detailed information about temperatures and soldering techniques refer to TB SIG 222 Solder and Soldering.

CHAPTER 9

REPAIR EQUIPMENT AND TOOLS

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB will be marked "ESD sensitive" at incoming inspection.

9-1. General. Repairing of complex PWA/PCBs requires special equipment and tools. A typical PACE repair station, which handles a variety of repairs. Is shown in figure 9-4 (PACE Model PRC-350C w/PPS 20A aux power source). A brief description of a typical PACE Model PRC-350C repair station components are described below:

a. Power Source (fig. 9-1). This equipment provides the source of heating, vacuum and air pressure. Repair facilities should specify that these power sources be "spike-free" (no voltage transients), "static-free" (no build-up of electro-static charges) and should not produce Radio Frequency Interference (RFI). Any of the above undesirable characteristics could cause damage to the PWA/PCB or interfere with repair operations (NSN - not assigned - PACE Model PPS-200C, w/ZPS PN 7008-0079)

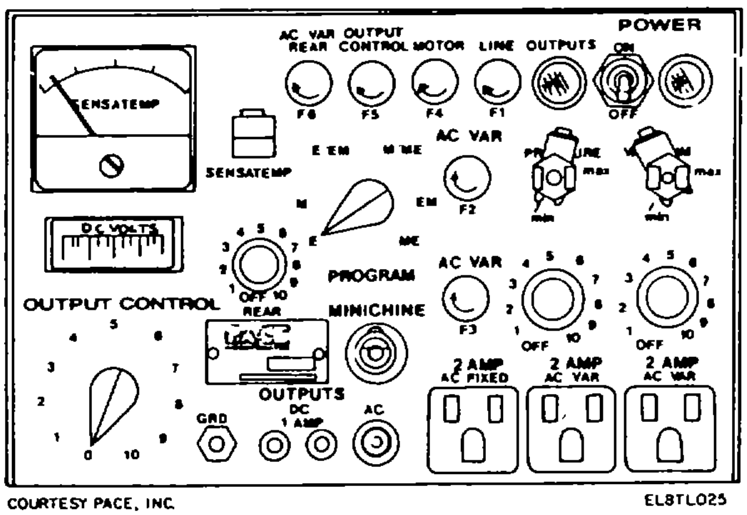


Figure 9-1. Power Source

b. Auxiliary Power Sources (fig. 9-4). This power source is compatible for use with the PRC-350C system. It has a means for patching into the PPS-200C power source so that it can be programmed into the PRC-350C s operational sequences. This power source can provide power to the fused eyeletting system, heavy duty heating unit, tweezer, and heavy duty clamps (PACE Model PPS-20A).

c. Work Handing Unit. See chapter 4 for a description of the Work Handling System. (NSN 5999-01-035-5375, PACE Model WP-6, PN 7015-0009)

d. Optical Lighting System. This system provides both proper lighting and magnification and is mounted to the WP-6 work handling unit (para 4-1(a)). (PACE Model POL-12, PN 7007-0006)

e. Fused Eyeletting Unit (fig. 9-4). This unit permits the installation of highly reliable fused eyelets and funnelets for a broad range of hot fusing or cold setting conditions. (PACE Model PF-25A)

f. Black Light (fig. 4-3). The black light inspection lamp shines a blue/black light down on the circuit board. It discloses common flaws such as voids in plating, hairline cracks in etching uneven conformal coating and solder mask and flux residue. These flaws show up as white areas.

g. Stereo Zoom Microscope. Paragraph 4-2 gives a description of the stereo zoom microscope (fig. 4-5, typical).

h Vacuum Cleaning/Handling System. This system provides a means for cleaning dust and grit from hard to reach areas (NSN 494-00-492-4739, PACE Model VT-100, PN 7014-0001)

i. Parallel Gap Welder (fig. 9-2). This welder is used to repair a multilayer printed circuit board or breaks on the inner or outer conductors of a double sided board (UNITEK, Model C5)

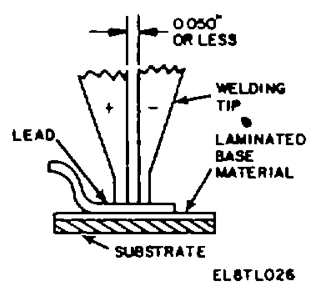


Figure 9-2. Parallel Gap Weld

j. Handtools. There are various common handtools required such as, pliers, wirecutter, tweezers, etc.

k. Special Tools. The special tools include dental inspection mirrors (fig. 4-4), and a pro vise cutting tool (fig. 9-3) to probe, cut, slice, drill, or lift components. (PACE PN 7016-0003)

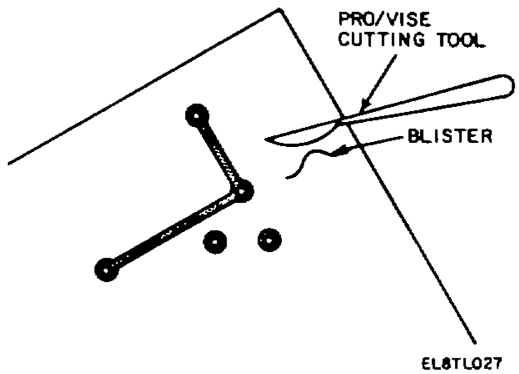


Figure 9-3. Blister Repair

l. Component-Forming Tool (fig. 9-4). This tool is used to measure hole-to-hole spacing and forms component leads for mounting. (PACE P/N 6016-0003)

m. Desoldering System (fig. 9-5). This solder extraction system provides controlled temperature, vacuum pressure or hot air jet for solder removal. (PACE Model SX25V (spike free) provides ESD protection.)

n. Accessories. All the needed accessories for repair are included in the PRC-350C Bench-top Repair Center.

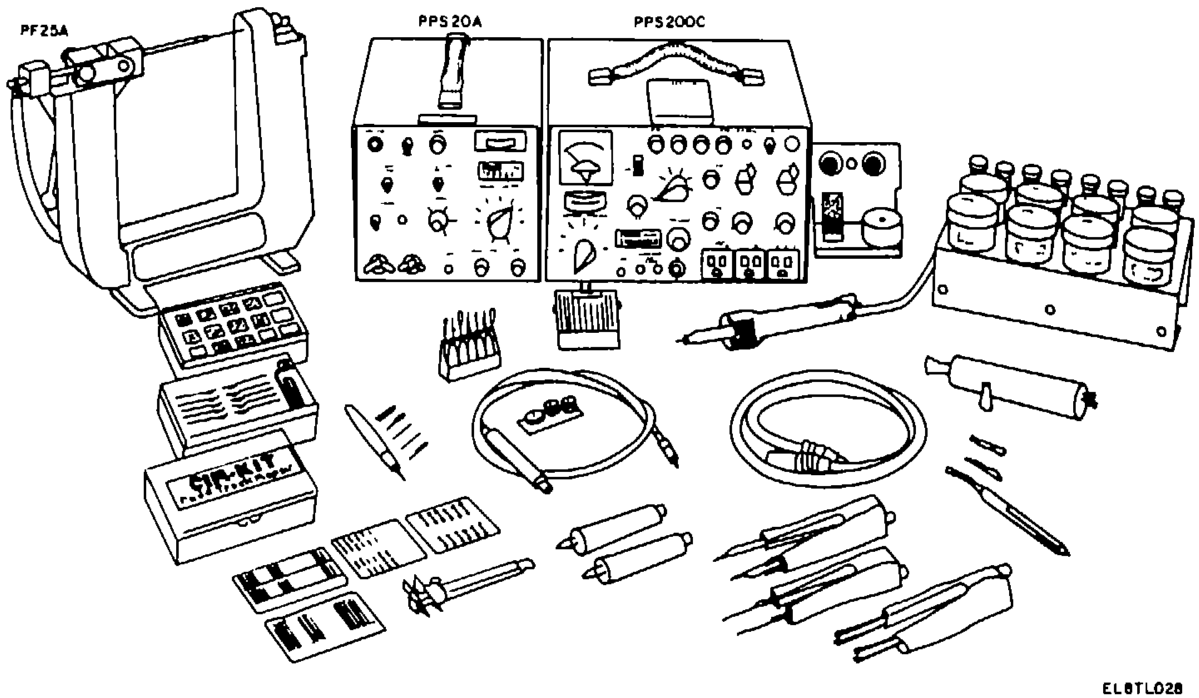


Figure 9-4. Bench Top Repair

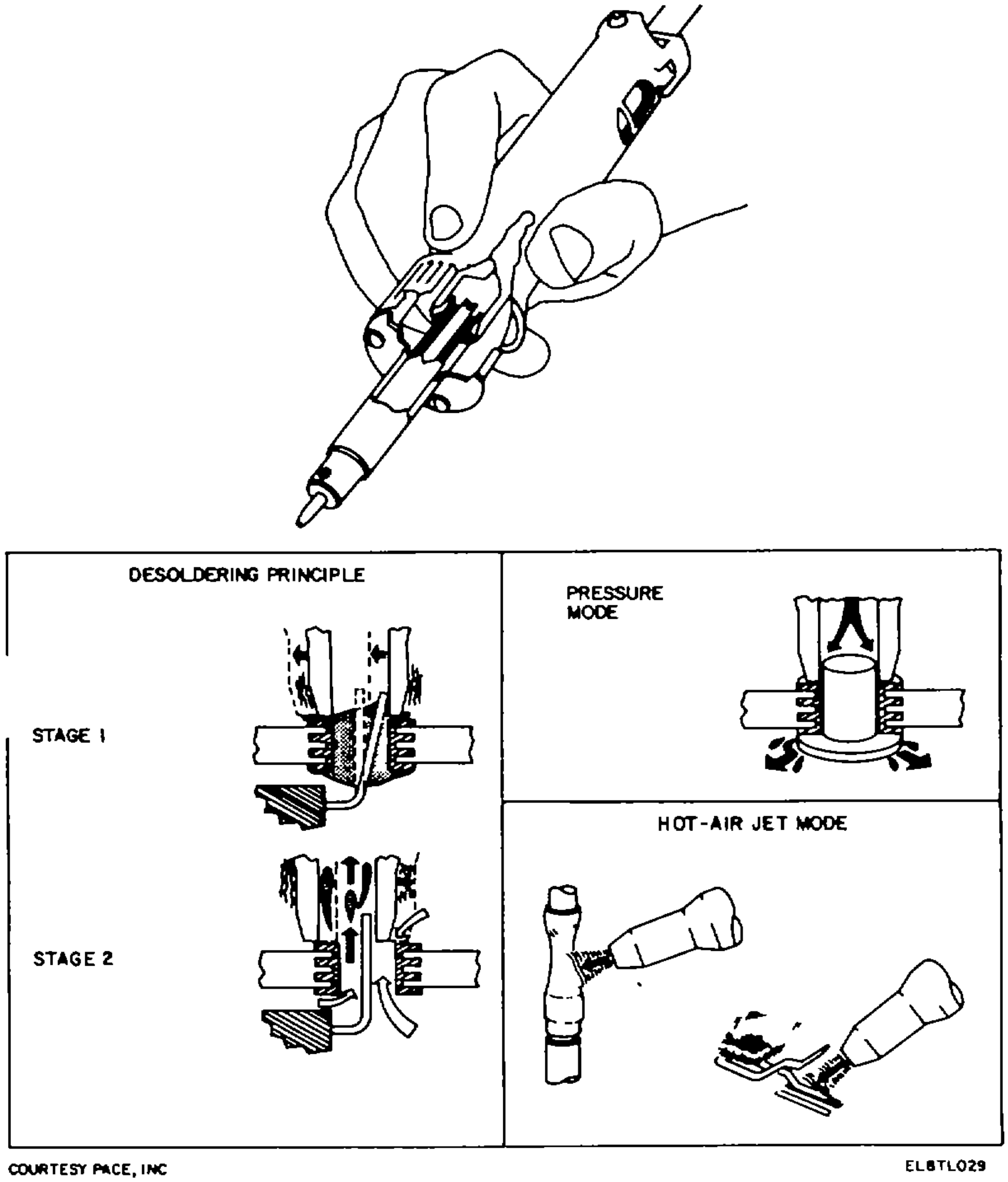


Figure 9-5. Desoldering System

CHAPTER 10

COMPONENT ORIENTATION AND INSTALLATION

NOTE

Before any procedures are started it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB will be marked "ESD sensitive" at incoming inspection.

10-1. General. Component orientation and installation procedures are necessary to assure a high order of reliability in the repair of PWA/PCBs. It is necessary for the new component to duplicate the polarity of the old component.

10-2. Diodes. Semiconductors must be installed with the correct polarity in order to function. If the polarity is reversed, the diode could be damaged as well as associated components and circuitry. The polarity of semiconductors is usually shown by colored dots, bands, caps, letters, and + and - signs(fig. 10-1).

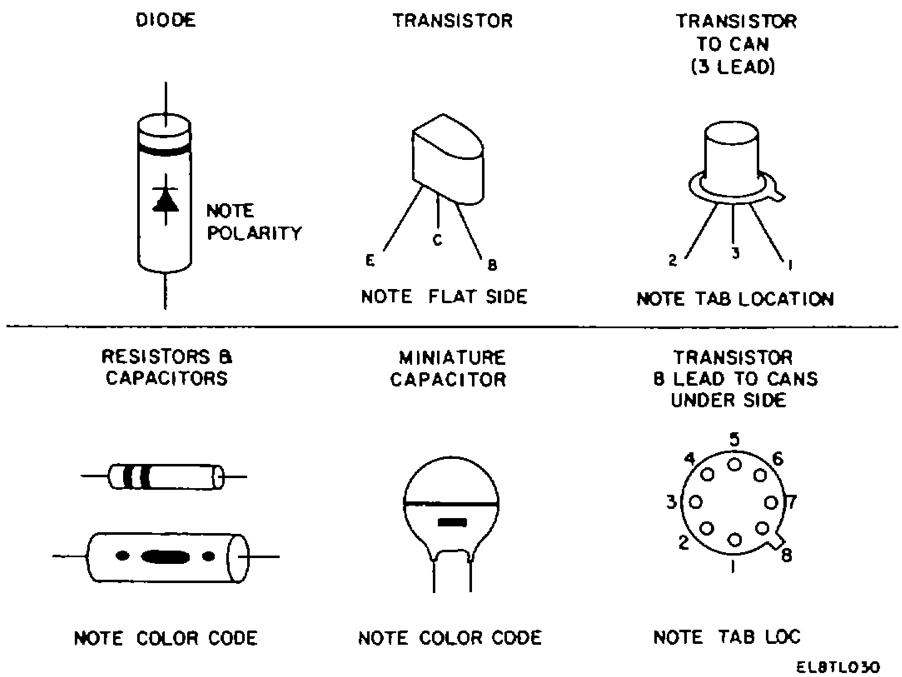


Figure 10-1. Component Orientation

10-3. Resistors and Capacitors. Resistor orientation is not critical. The polarity or capacitors should be verified prior to installation. Body colors, bands of color, and dots of color provide information for determining the values of resistors and capacitors (fig. 10-1).

10-4. TO Cans. TO Cans are round metal cylinders in varied sizes with 3, 4, 6, 8, 10, 12, or more, leads originating in the sealed base. An indexing lab is provided for orienting the package. Looking at the base of a can the number one lead is the first lead past the tab in a clockwise direction (fig. 10-1).

10-5. Dual-In-Line Packages (DIPs). These components are rectangular, integrated circuit components with leads usually mounted through the board. Dimensions and numbers of leads vary. Index or orientation markings appear in the center of one short side of the component body, while lead numbers appear on top of the component and are read in a counterclockwise direction (fig. 10-2(A)).

10-6. Flat Pack. Flat Pack integrated circuit packages commonly contain 8, 10, 12, 14, or more leads. Standard center-to-center lead spacing is 0.050 inch. Unlike DIPs or TO Cans, most flat packs are not mounted through the board, but are planar mounted to form lap solder joints. The index point may appear on the corner of the first lead or centered between the number 1 lead and the top of the component. The leads are numbered counterclockwise from the index point (fig. 10-2(B)).

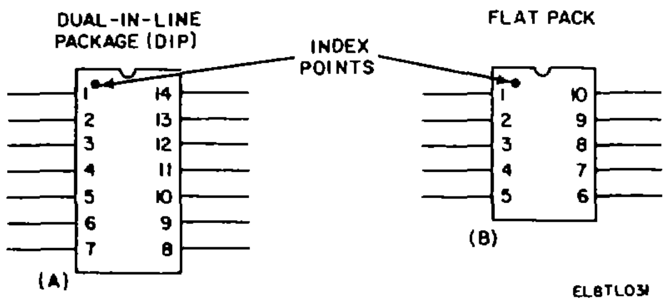


Figure 10-2. Component Orientation

10-7. Component Installation. Components will be positioned so that their major axes are roughly parallel with or perpendicular to each other and to the edges of the printed wiring board upon which they are mounted. Identification labels and markings should be visible and components oriented in the same direction as other similar components on the PWA/PCB. If placement is restricted by adjacent objects, components will be installed offset from and parallel to a theoretical line connecting their termination points. When placement is thus restricted leads will be formed in any convenient shape consistent with the lead-bending and termination requirements of figures 10-9 through 10-17. Components will seat squarely on the board surface within the requirements of figures 10-3, 10-4 and 10-5. These illustrations show a typical installation of axial-leaded components. There are other installations which are equally acceptable, providing they conform to the basic principles shown.

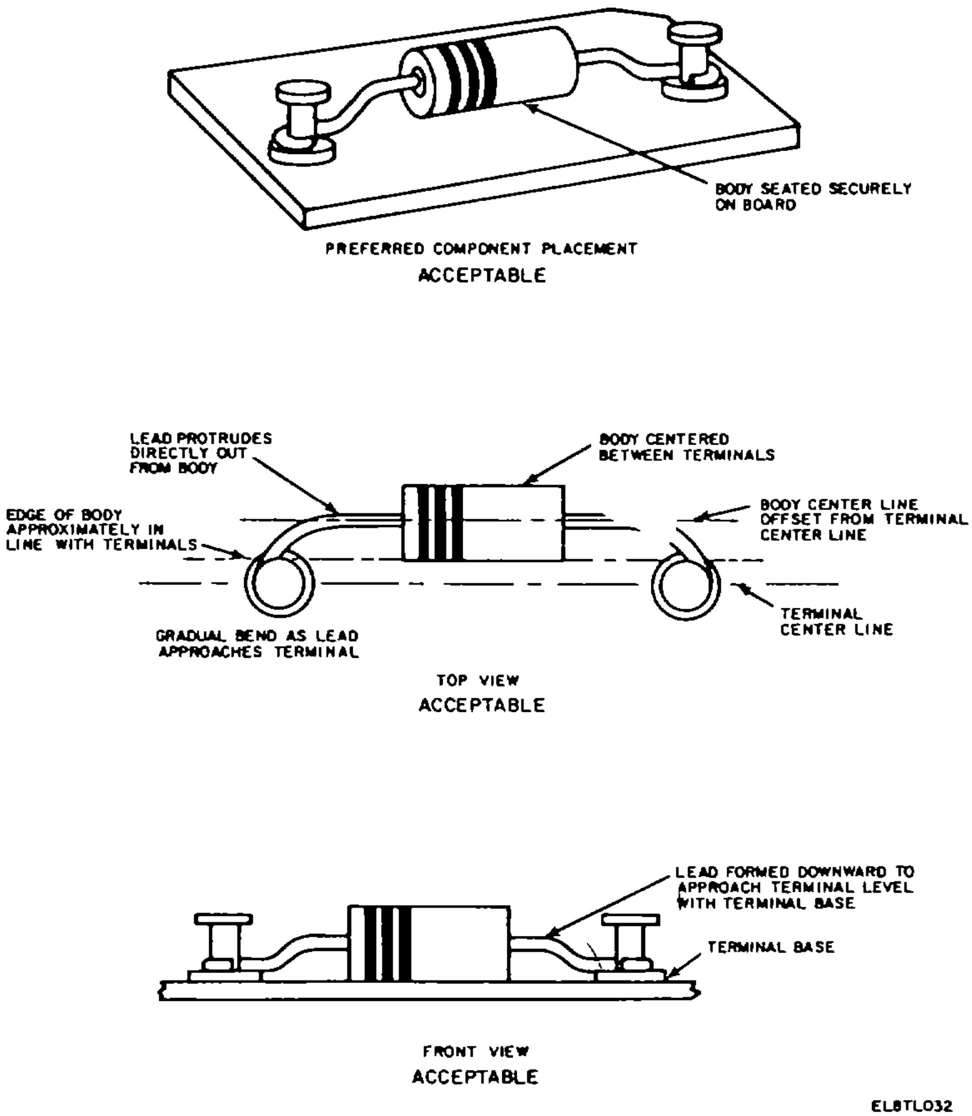
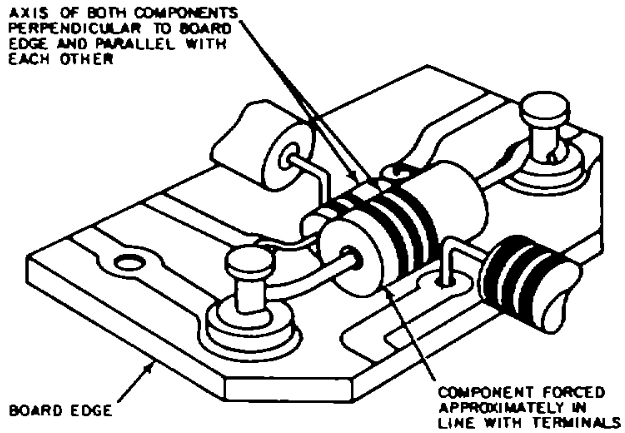
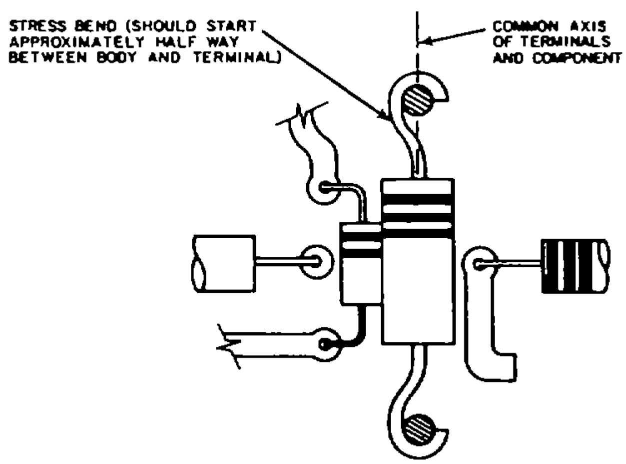


Figure 10-3. Component Installation



ACCEPTABLE



TOP VIEW

ACCEPTABLE

EL8TL033

Figure 10-4. Component Installation

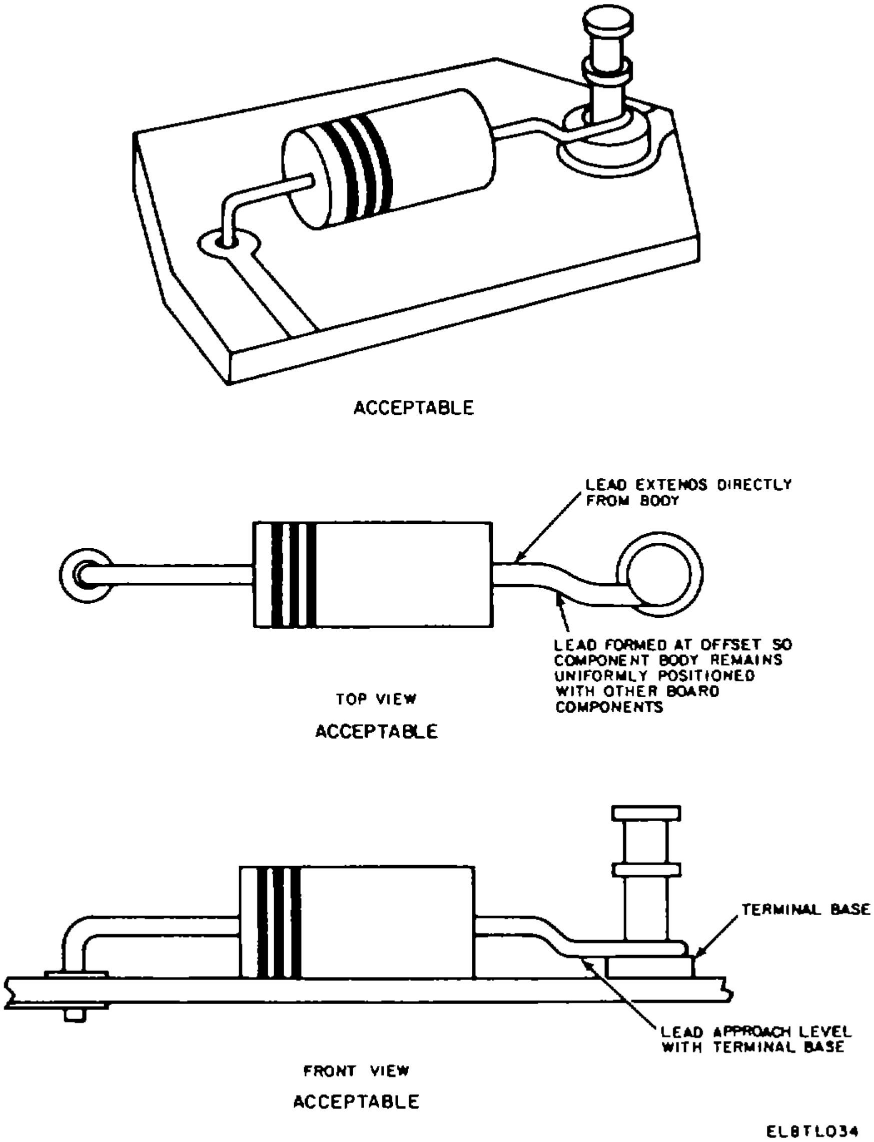


Figure 10-5. Component Installation

10-8. Component Lead Forming. Lead forming or bending is accomplished using either a component forming tool or pliers with nonserrated jaws. Pliers with serrated jaws may be used if the jaws are first covered with heal shrink tubing or similar material, to prevent damage to component leads. If the component tool is used, it is first adjusted to span the distance between the two holes (fig. 10-6). The component body is then placed between the forming posts and the leads are firmly bent as desired without stressing the point of entrance to the component. The lead bend will then fit the desired hole spacing.

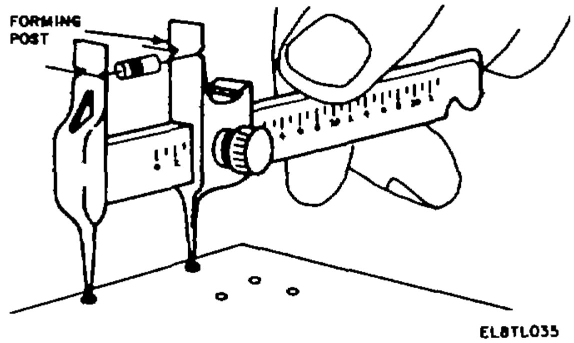


Figure 10-6. Lead Spacing and Bending

a. Minimum Lead Bend Radius. The minimum bend radius for component leads will be equal to the lead diameter (fig. 10-7).

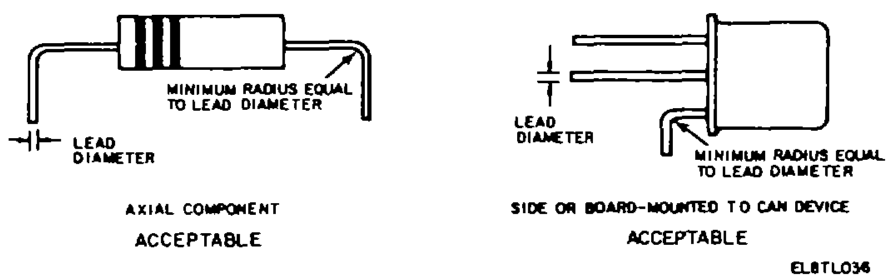


Figure 10-7. Minimum Lead Bend Radius

b. Minimum Distance, Lead Bend from Component Body. The minimum distance from a component body, seal, or lead weld, to the start of a lead bend, will be equal to twice the lead diameter (fig. 10-8).

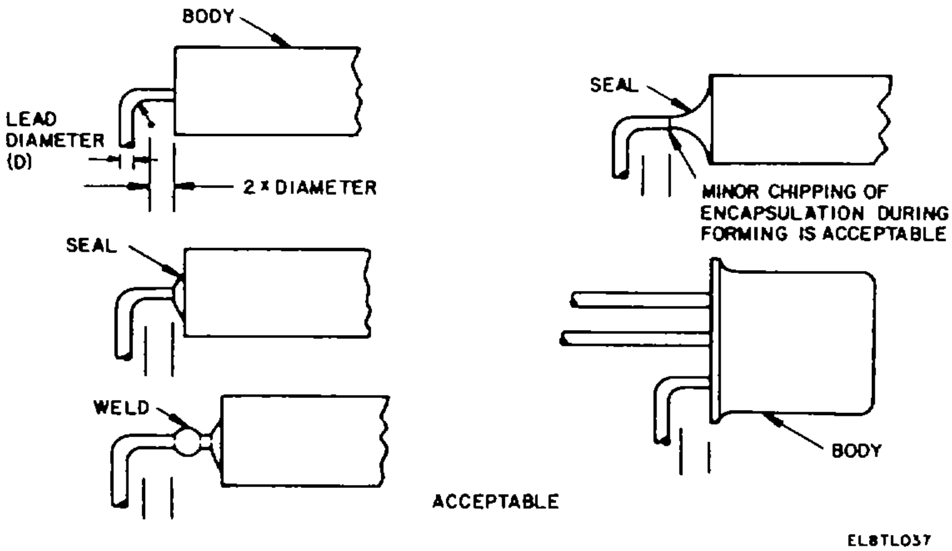


Figure 10-8. Minimum Distance, Lead Bend from Component Body

c. Angle of Lead Form. Leads will be formed approximately 90° from their major axis so that a free fit in the hole terminations is assured (fig. 10-9).

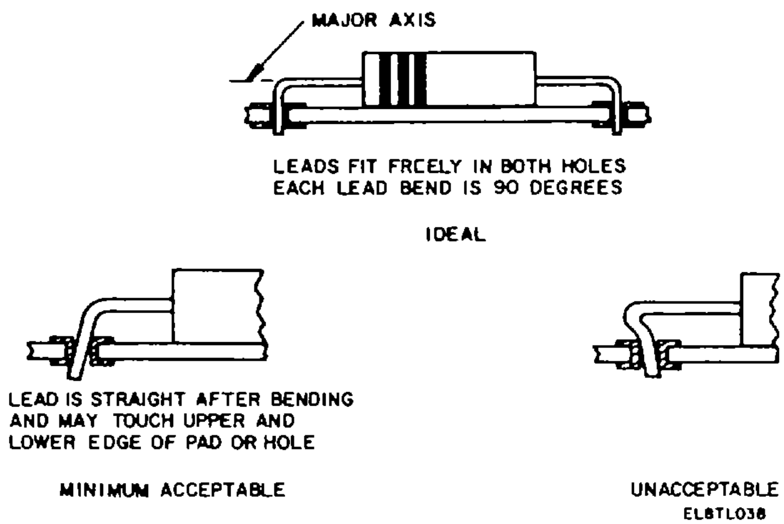


Figure 10-9. Angle of Lead Form

d. Lead Dress. Axial components will be positioned between hole terminations so that leads emerge in a direction approximately coaxial with the body axis to prevent stress at the component body to lead seal. The component bodies will be in maximum contact with the board surface. Components which will be conformal coated or spot bonded may be displaced a maximum of 1/32 inch form the board surface (fig. 10-10).

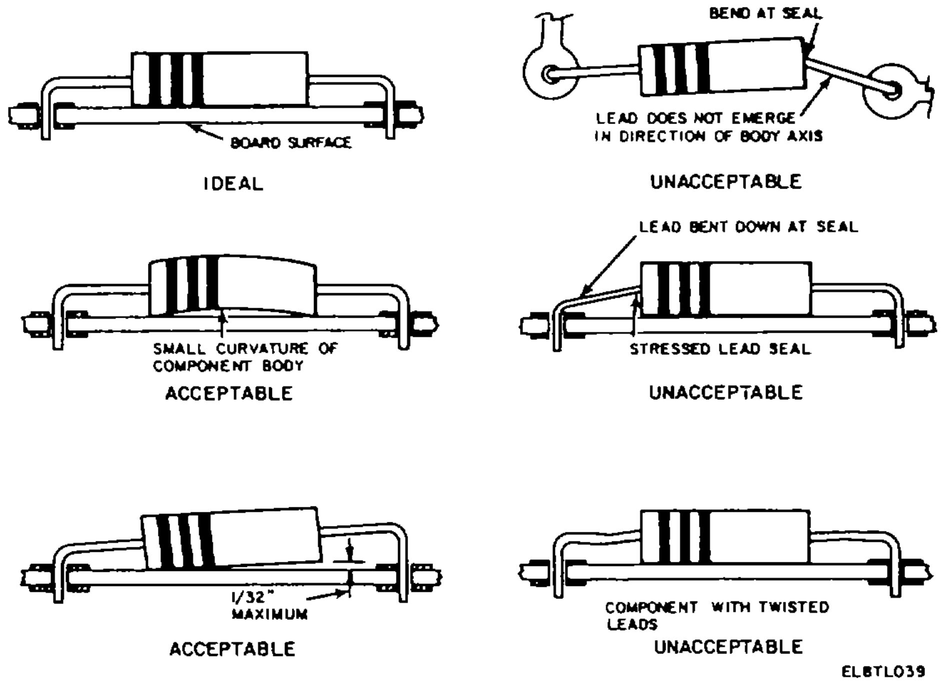


Figure 10-10. Lead Dress

e. Stressed Leads. Lead clinching will not disturb lead dress which has met the requirements of figure 10-14 and will not stress the lead seal (fig. 10-11).

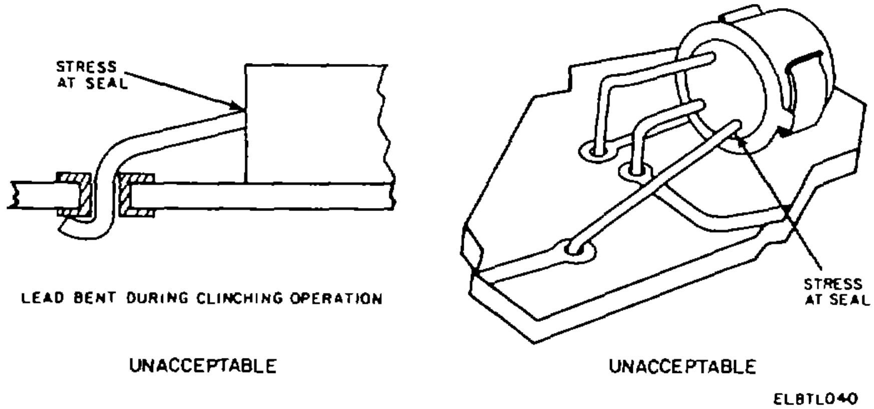


Figure 10-11. Stressed Leads

f. TO Cans - Side and Inverse Mounting. TO Cans may be mounted on their sides or upside down using the following criteria (fig. 10-12).

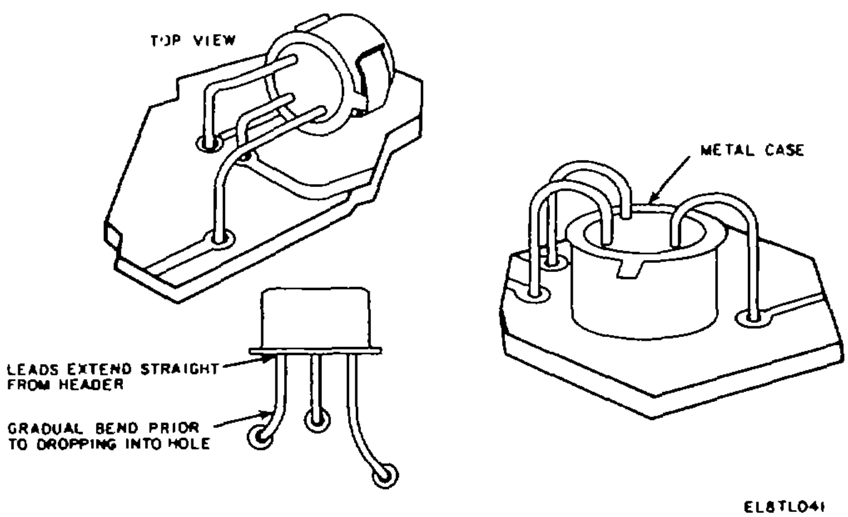


Figure 10-12. Side and Inverse Mounting of TO Cans

g. Component Placement. Components will be positioned on the board so that lead lengths are normally within 1/16 inch above the board. However, the lead lengths may be different if an interference occurs with adjacent components (fig. 10-13).

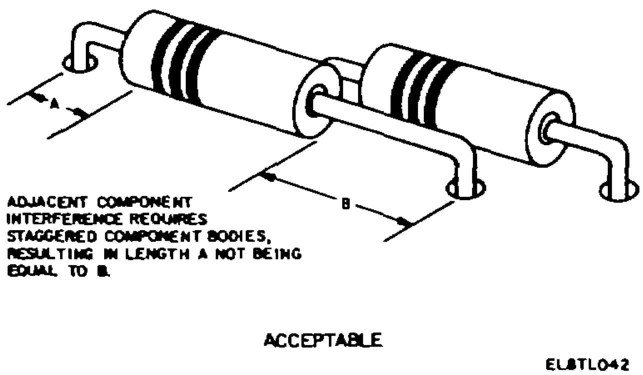


Figure 10-13. Component Placement

h. Lead Protrusion and Clinching. The distance by which leads may protrude through holes in printed wiring boards and lead clinching (where required) will be governed by figure 10-15, 10-16, and 10-17.

(1) Lead Protrusion. Unclinched (straight) component leads on printed wiring boards will protrude one to two times the lead diameter (fig. 10-14).

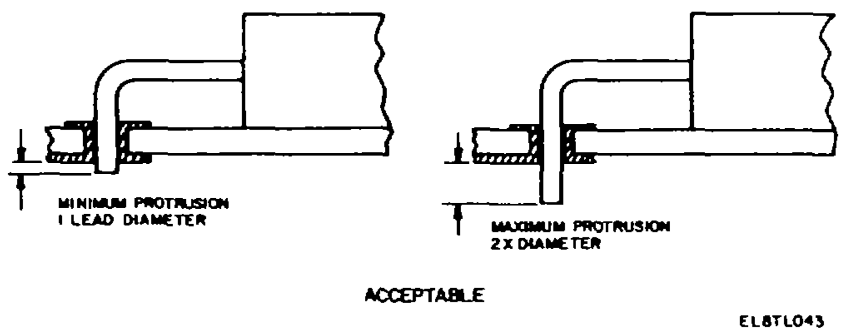


Figure 10-14. Unclinched Lead Protrusion

(2) Lead Clinch Distance. When lead clinching is required, component leads on single and double sided boards will be securely clinched in the direction of the printed wiring which is connected to the pad Lead clinching is unacceptable when there is an isolated pad on the lead termination side of the board (fig 10-15).

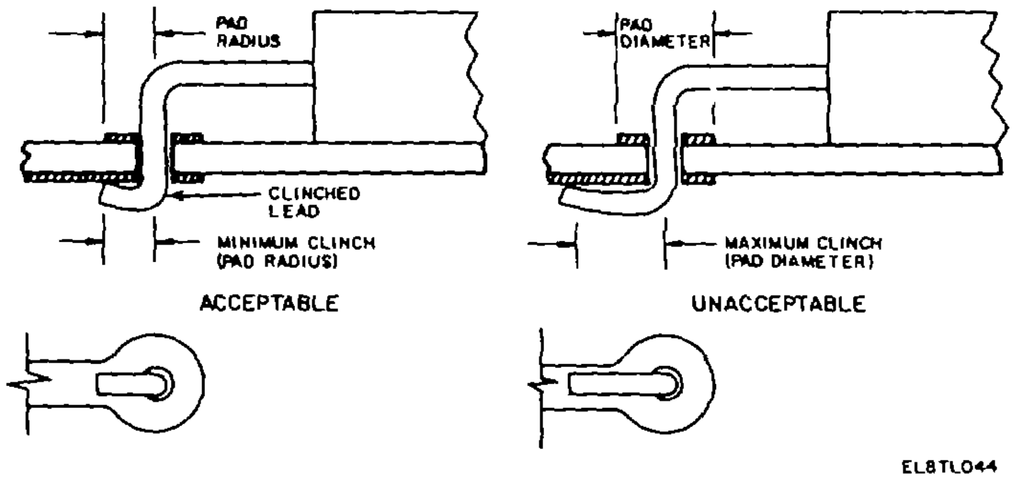


Figure 10-15. Lead Clinch Distance.

(3) Clinched Lead Gap Criteria. Lead clinching will be accomplished without damaging the pad or the printed wiring Natural spring back *of* a lead away from the pad or printed wiring is acceptable A gap between the lead end and the pad or printed wiring is acceptable when *1t* is *evident* that further clinching would endanger the integrity of the pad or printed wiring (fig. 10-16).

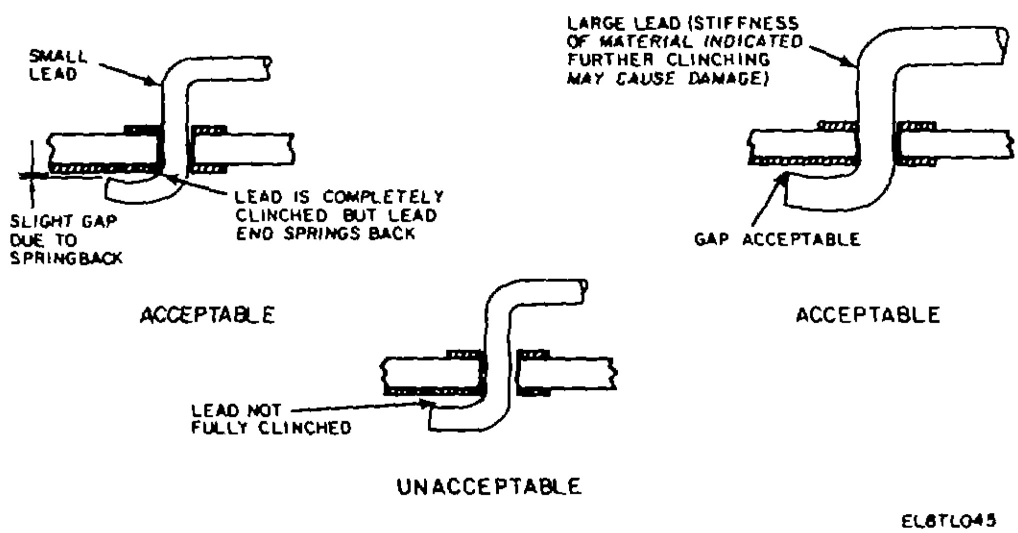


Figure 10-16. Clinched Lead Gap Criteria

(4) Lead Clinching Pad Connected to Printed Wiring. When lead clinching is required the leads will be clinched in the direction of the printed wiring prior 10 soldering (fig. 10-17).

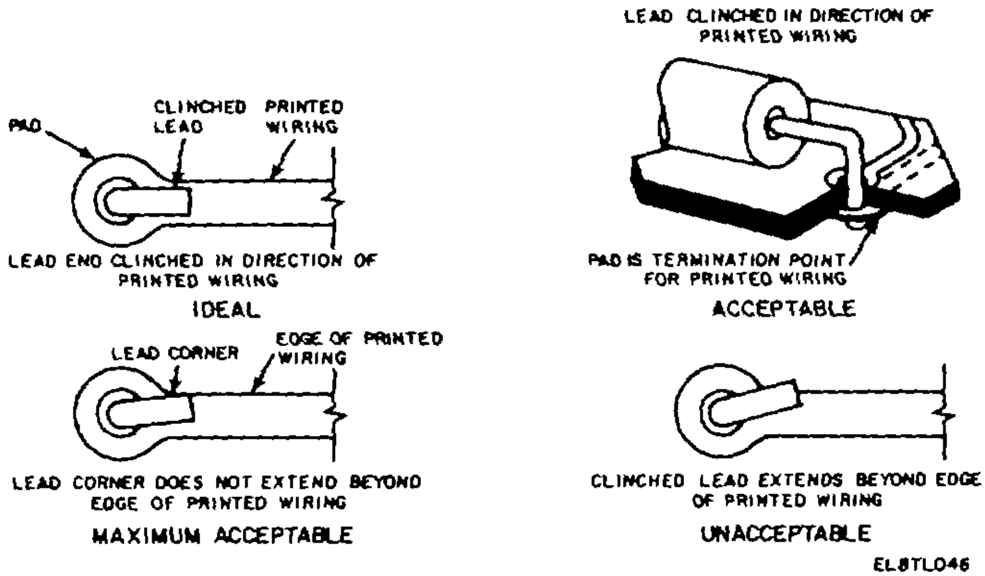


Figure 10-17. Lead Clinching, Pad Connection Board

i. Flat pack and Dual in Line Pack (DIP) ICs.

(1) Flat Pack They are planar mounted on the surface of the board to form lap solder joint connections. The specification for round leads will be observed with these additions.

(a) The leads will contain two distinct bends at an approximate angle of 45° (fig. 10-18(B)).

(b) The leads will contact the solder pad from the second bend to the lead tip (fig. 10-19).

(c) The contact area will not overhang *the* edge of the solder pad (fig. 10-20).

(d) The contact area o1 the lead wilt be of one hall The length of The solder pad (fig. 10-20).

(2) Dual in Line Packs (DIPs). They are mounted through The surface of The board and soldered in place (fig. 10-18(A)). The specification for round leads will be observed with these additions*:*

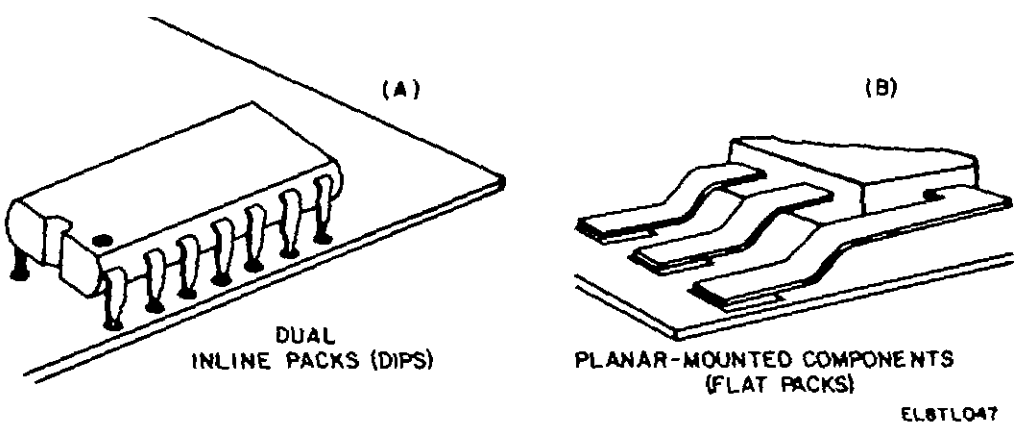


Figure 10-18. Typical Planer Mounted IC

(a) Form the leads by pressing both rows of leads down onto a flat surface with enough pressure to obtain the correct angle (fig. 10-21(A)). Another method is the use of o. DIP clip that holds the leads inward for installation.

(b) Clinch the two leads on opposite corners to hold the IC in place.

(c) Apply Iron tip to one side of the joint touching the lead and pad area while applying solder to the opposite side (fig. 10-21(B)).

(d) Apply iron until solder pool flows into hole to produce a smooth concave fillet (fig. 10-21(C)).

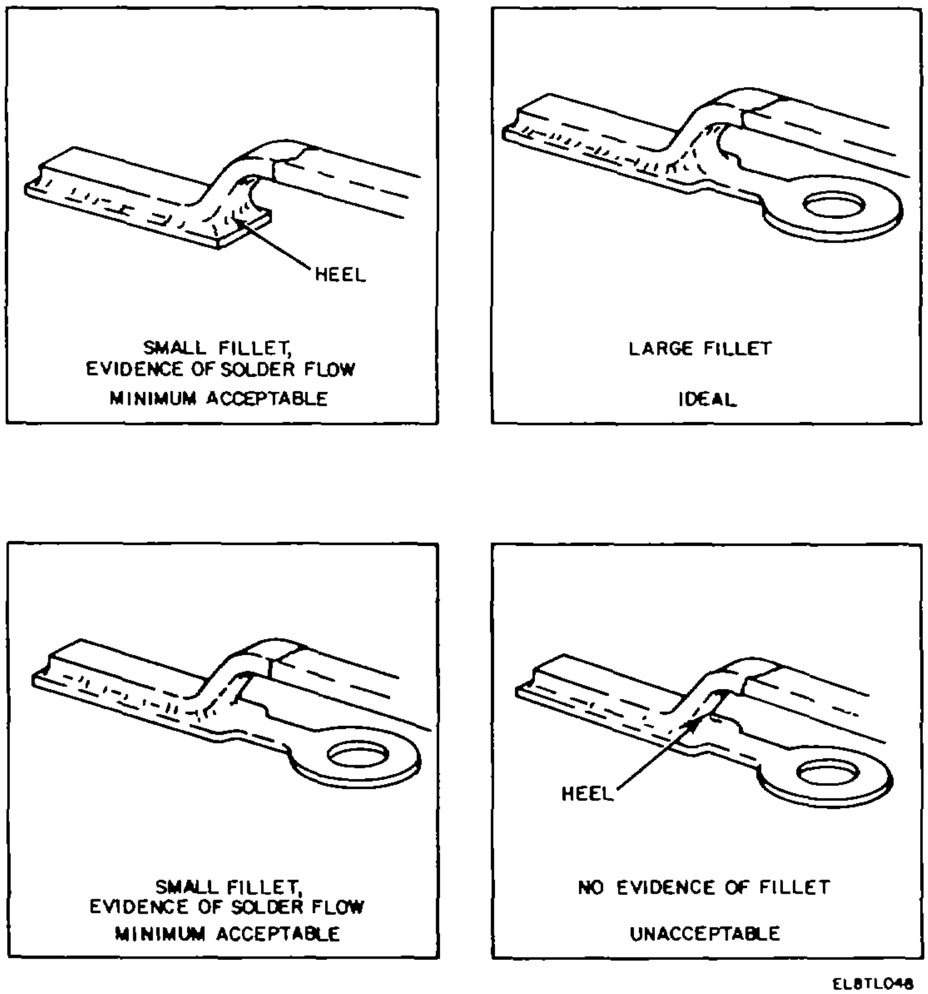


Figure 10-19. Typical Flat Pack Lead Installation

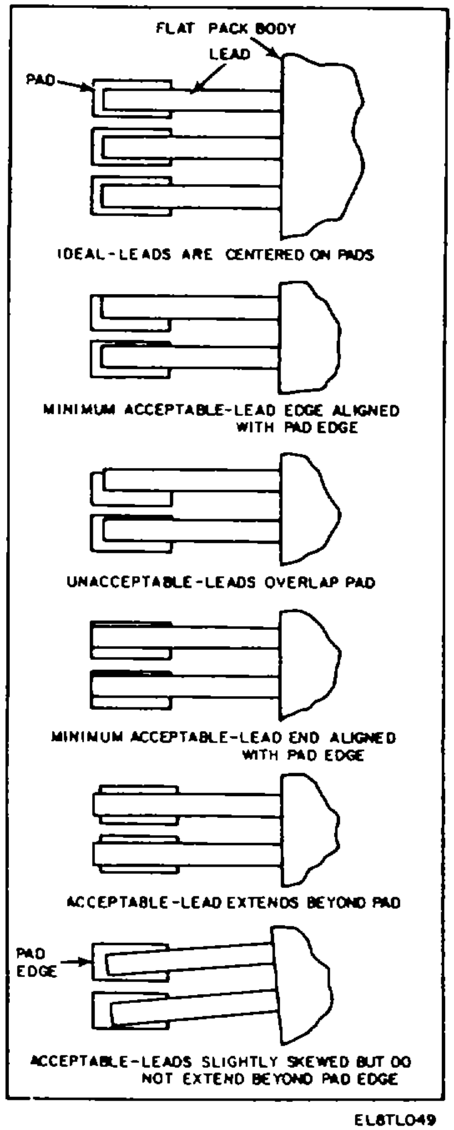


Figure 10-20. Typical Flat Pack Lead Positioning

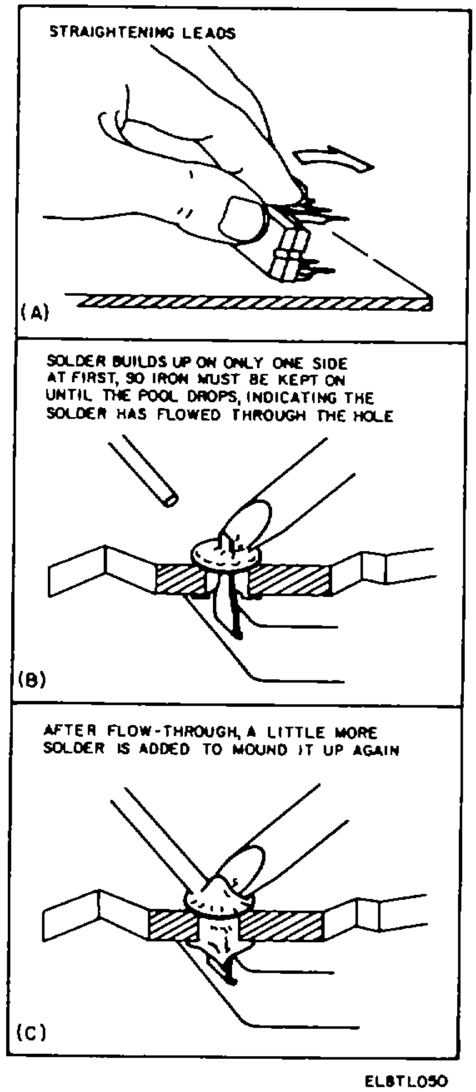


Figure 10-21. DIP Mounting and Soldering

CHAPTER 11

PRINTED WIRING ASSEMBLY AND PRINTED CIRCUIT BOARD REPAIR

NOTE

Before any procedures are started it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB will be marked "ESD sensitive" at incoming inspection.

11-1. General. This chapter provides the repair instructions required for general support personnel to perform shop repairs to common PWA/PCBs and Multilayer Boards.

11-2. Repair Section Responsibilities. General support repair section will repair defective modules by replacing the defective PWA/PCB(s) when authorized by the maintenance manual. If the extent of the repair cannot be accomplished in the general support repair section the defective assembly will be sent to the depot for repair/disposition. The operational sequence through the repair section is shown by the flow chart in figure 11-1.

11-3. Repair Sequence. As shown in figure 11-1 the repair section may receive an assembly from the receiving inspection section the final inspection section or the lest section. The PWA/PCB is first logged into the repair section and the process move lags are checked to identify the discrepancy. The repairs are made and the attached lags are then marked to indicate the work accomplished. The PWA/PCB is then logged out to the final inspection section for electrical and mechanical acceptance.

11-4. Damaged Conductor Repair Procedure for Single Layer Boards

a. Solid Wire. All breaks in wire conductors must be repaired so that no reduction in cross section thickness will result Table 11-1 provides equivalent conductor widths and solid wire diameters. It is assumed that the broken conductor is of the 2-ounce type which provides a margin of safety in selecting the equivalent wire diameter. Proceed as follows.

(1) Measure the conductor width and select the equivalent or next larger diameter solid wire.

Table 11-1. Proper Wire Selection

CONDUCTOR WIDTH (2-oz.)	EQUIVALENT SOLID WIRE DIAMETER
0.010	#34(0.006)
0.015	#32(0.008)
0.020	#31(0.009)
0.031	#29(0.011)
0.062	#26(0.016)
0.125	#23(0.023)

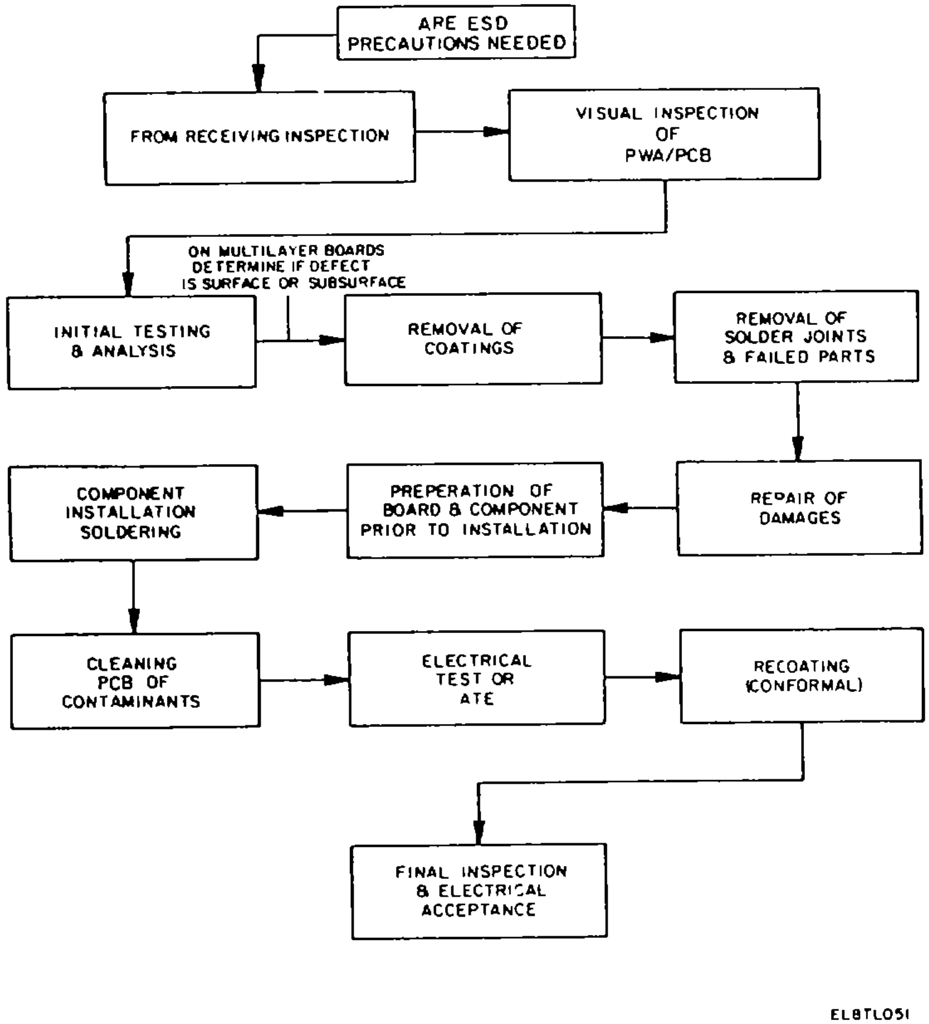


Figure 11-1. Repair Sequence Flow Chart

(2) Follow the foil repair procedure in (b) below.

b. Foil Repair Procedure.

(1) Choose a matching foil, copper, aluminum, wrought copper, or gold ribbon (fig. 11-2).
(2) Measure the conductor width and select the proper size for repair.
(3) Cut foil length 1/4 inch longer than the break.
(4) Prepare surface to be repaired by solvent or abrasion (chapter 7).
(5) Lap reflow solder along the center of the conductor (para 8-7).
(6) Inject epoxy filler under repair foil with a hypodermic needle.
(7) Clean residue from the repair area.
(8) Recoat the solder joint with conformal coating (chapter 7).

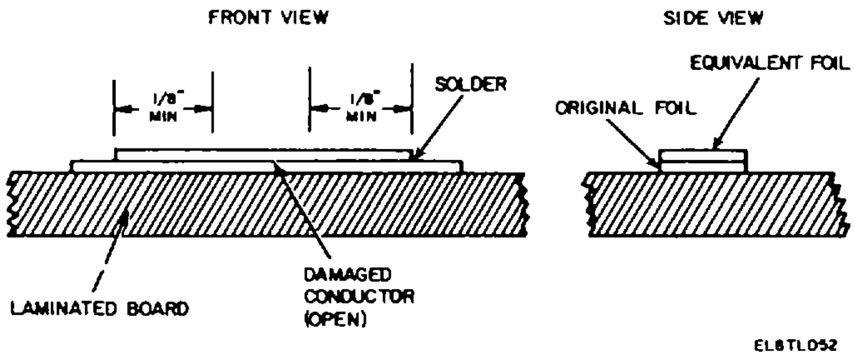


Figure 11-2. Foil Repair

11-5. Eyelet Repair for Single Layer Boards

a. Hole Preparation. All holes to be tilted with an eyelet will be drilled using miniature machining techniques, with ball mills or by using small linger held drills. The ball mills or drills should be the same size as the existing hole. Drilling is not permitted on multilayer PWA/PCBs because of the possible damage to other layers. There are three methods of hole preparation before installing eyelets.

(1) Using the existing hole.
   (a) Remove solder from plated through hole by extraction.
   (b) Select proper size eyelet (para 11-5b).
   (c) Set eyelet in hole (para 11-5f).

(2) Make a new hole.
   (a) Use a denial explorer or round, tapered toothpick to determine size of eyelet.
   (b) Use ball mill diameter to match eyelet.
   (c) Examine both sides of board and determine that no damage will result from the eyelet installation.
   (d) Drill from the pad(s) side at a right angle to avoid delaminating the pad(s).

NOTE

Drill from pad side if hole is unsupported and has a pad on one side. Drill through part way from both sides if there are pads on both sides or if the hole is plated through.

(e) Clean residue from area.
(f) Select proper size eyelet. (para 11-5b).
(g) Set eyelet in hole (para 11-5f).
(3) Opening up existing hole:

NOTE

Because the remaining pad area will be reduce (fig. 11-3) cleaning must be performed carefully and pretinning should be avoided to prevent delamination.

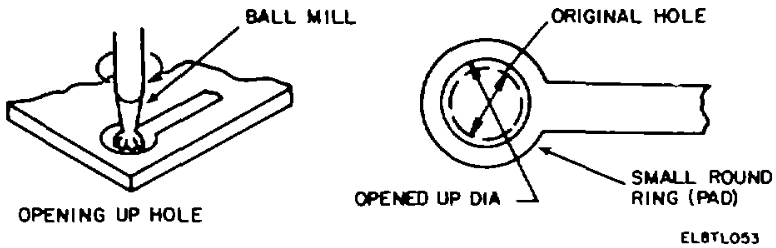


Figure 11-3. Ball Mill Principle

(a) Select drill bit the same size as the original hole (para 11-5a(2)(b)).
(b) Use an awl or center punch to make a starting indent to prevent the ball mill from skidding on the conductor (fig. 11-3).
(c) Mill the barrel of the eyelet out of the hole without enlarging the hole size.
(d) Heal each flange with a soldering iron and remove the flanges from the board.
(e) Clean residue from area.
(f) Select proper eyelet (para 11-5b).
(g) Set eyelet in hole (para 11-5f)

b. Eyelet Selection. Use table 11-2 to select an eyelet with the proper inside diameter for component leads.

(1) Allow 0.04 to 0.028 inch clearance between the lead diameter and the inside diameter of the eyelet for proper soldering.
(2) Use the smallest outside diameter which will allow the entry of a replacement eyelet without any force.

Table 11-2. Eyelet and Funnel Flange Selection

COMPONENT	LEAD DIAMETER MILLIMETERS
Carbon Resistors	25
	31
	40
	45
Wire Wound Resistors	20
	31
	40
TO Cans	16-19
Capacitors	25-45
Glass Diodes	20
DIP Packages	18-24

c. *Flange Diameter Selection (fig. 11-4).*

(1) Select an eyelet head flange with a diameter that fits the PWA/PCB pad.
(2) Use a funnel flange if the eyelet flange is greater than the PWA/PCB pad.
(3) Select minimum OD to permit entry of the eyelet or tunnel flange into basic board hole without forcing.

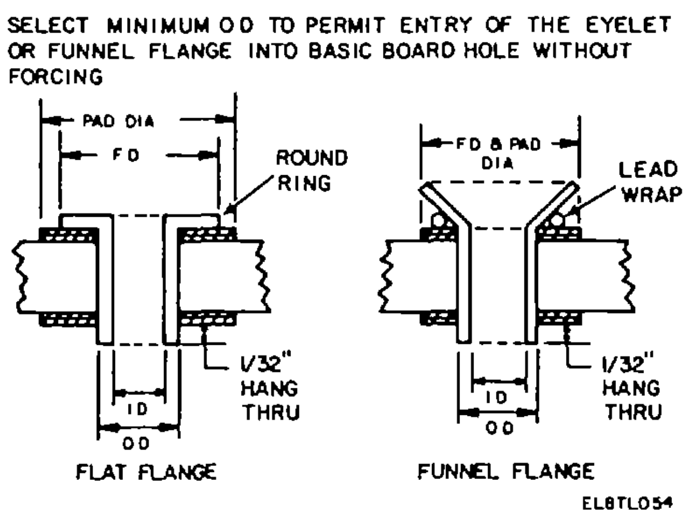


Figure 11-4. Flange Criteria

d. Eyelet Barrel Length Selection (fig. 11-5). The eyelet barrel length is based on the thickness of the PWA/PCB.

(1) Select an eyelet barrel length that hangs 1/32 inch through the bottom of the board before setting.
(2) Select a length that will result in a flat set or petal formation.

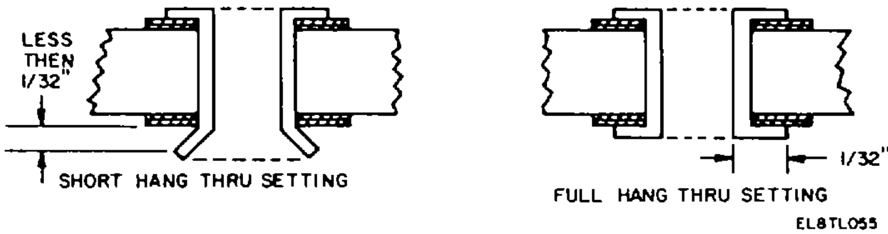


Figure 11-5. Eyelet Barrel Length Selection

e. Flange Type Selection. The scored barrel type funnel provides the most reliable termination.

(1) Select a flat set or fused flat flange eyelet for repairs, when possible.
(2) Select a scored barrel type eyelet for a star or petal setting.
(3) Select the funnel flange for repairs which cannot use the flat set or fused flat flange.
(4) Select the funnel flange if hand soldering of the eyelet to the circuit conductor will be used.

f. Setting the Eyelet. Figure 11-6 shows various tools to manually set the eyelets. After the hole has been repaired and the correct eyelet is selected, set the eyelets as follows using dies in the circuit (PACE PN6993-0077):

(1) Brace the head of the eyelet against a flat solid surface i.e., a jewelers anvil.
(2) Flare the end of the eyelet to an approximate 45° angle using an adjustable spring-loaded automatic center punch (fig. 11-6).
(3) Set the flared end by tapping with a flat pin punch using a soft-faced hammer.
(4) Check the setting by inserting the sharp end of a typewriter eraser into the eyelet and twisting.
(5) Proper setting won't allow the eyelet to turn in the hole. Reset if the eyelet turns in the hole.

11-6. Multilayer PWA/PCB Repair. The repairs should only be accomplished by personnel that are highly trained in the state of the art repair techniques. Use only standard repair procedures and practice good workmanship. The following two rules will be followed.

a. Avoid excessive heat. The following defects result from excessive heat.

(1) Plated-through holes damaged.
(2) Board scorched or burned.
(3) Electrical resistance of the epoxy is lowered.
(4) Holes are contaminated by the flowing of epoxy bindermaterial.

NOTE

Do not apply heat to the same pad immediately if you failed the first try. Allow the connection to cool before second attempt. When replacing multilayer components avoid working immediately on adjacent pads. Do not rush your repair work

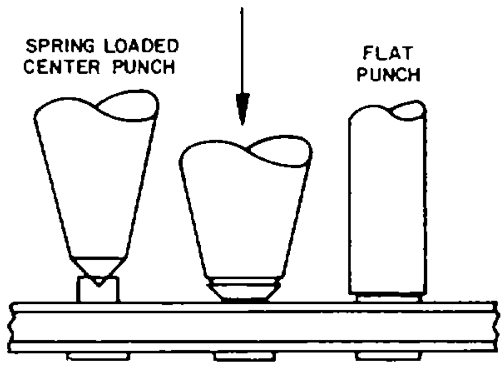


Figure 11-6. Setting the Eyelet

b. Use care in removing conformal coatings
   (1) Remove all traces of conformal coating from leads and terminal areas (pads).
   (2) Use the appropriate removal method (chap 7) to match the type of coating on the PWA/PCB.

11-7. Delamination Repair Procedures for Multilayer PWA/PCB

a. Materials required.
   (1) Epoxy, epon 815, shell
   (2) Catalyst, TETA (epoxy)
b. Tools required.
   (1) Syringes, 5cc
   (2) Needle hypodermic *#22*
   (3) Mixing container, small
   (4) Stirrer
   (5) Pin vise
   (6) Drill #69(.029 dia.)
   (7) Oven (150°F)
   (8) Balance (scale)
c. Repair equipment preparation.

NOTE

Temperature of oven should be determined by the component specification manuals.

(1) Preheat PWA/PCB in a 125°F oven for fifteen minutes.
(2) Prepare a mixture of 10 grams of 815 epoxy and 1.3 grams of TETA catalyst.
(3) Drill two .029 diameter holes through the top of the PCB layer at opposite ends of the delamination area. This will gain access to the delamination area.

(4) Modify the #22 hypodermic needle as described below:
   (a) Grind off tapered tip to a squared-off tip.
   (b) Connect modified lip to the syringe.
(5) Fill syringe 1/4 full with the epoxy mixture.
(6) Insert tip of needle into the delaminated area through the predrilled hole.
(7) Gently inject the epoxy until the delamination is no longer visible.
(8) Place in a vacuum chamber (29" high) for 3-5 minutes to aid in the hard to fill areas.
(9) Remove excess epoxy from PCB(s) surface and allow to cure for 6 hours at room temperature.
(10) Place into an oven (125°F) for 2 hours to accelerate the curing process.

11-8. Conductor Repair Procedures for Multilayer Boards. Use the parallel gap welding technique to repair defective printed circuit conductors on double-sided and multilayer boards (fig. 9-2). This method can be used to repair breaks on both inner and outer layers. Refer to figure 11-7 and follow the procedure below:

a. Locale break and chisel or mill away base until enough conductor is exposed to perform a weld (0.1 inch of conductor on each side of the break).
b. Clean conductor to a shiny color for a proper weld.
c. Select a gold ribbon the same width as the conductor being repaired (preferred material).
d. Position gold ribbon over the break.
e. Apply a spot weld on each side of break with a parallel gap welder.
   (1) Control the interelectrode spacing for consistent results.
   (2) Vary the spacing according to the materials and the bond to be produced.
   (3) Fit the electrodes tight against the work for good electrical and thermal conductivity.
   (4) Use a spacing at least 1-1/2 times the thickness of the upper material (fig. 9-2).

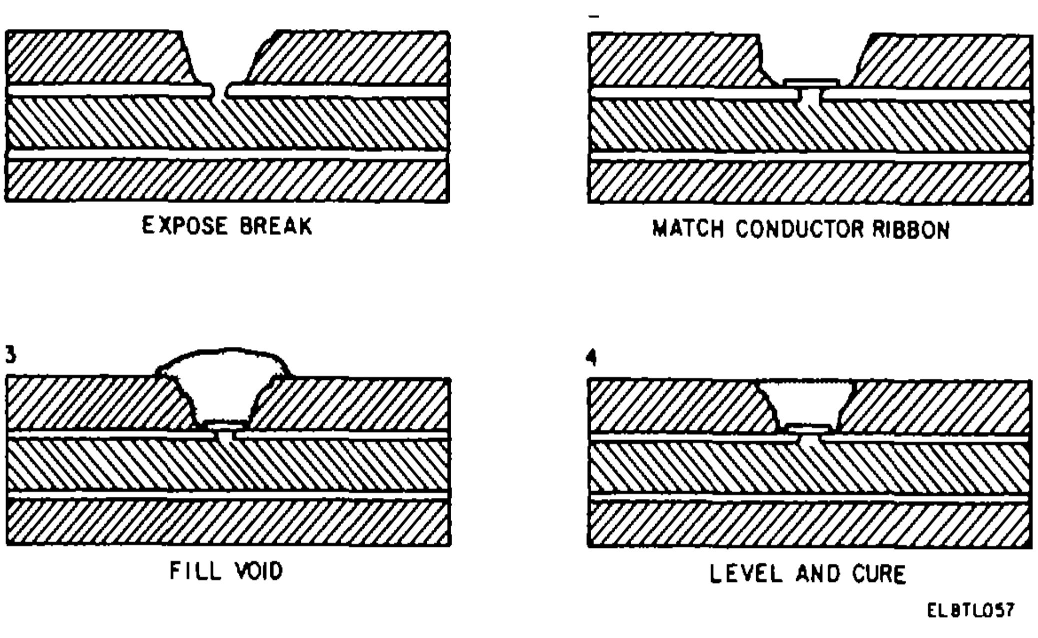


Figure 11-7. Damaged Conductor (Trace) Repair

f. Fill the void with a compatible epoxy mixture and allow to cure after the welding is completed.
g. Level the cured epoxy mixture with a chisel or mill to match the surface finish of the printed circuit board.

11-9. Hole Repair on Non-Plated Through Holes. Repair can he made on damaged misplaced or over sized mounting holes

a. In addition to the tools in figure 9-4, the following materials are needed.
   (1) Isopropyl alcohol
   (2) Perchlorethylene (O-T-236)
   (3) Epoxy material compatible with base laminate
   (4) Fiberglass #128

WARNING

Provide adequate ventilation. Vapors from solvents and epoxies may contain toxic gases. Ethyl and isopropyl alcohol are flammable.

b. The repair procedure is as follows
   (1) Clean repair area with a stiff bristled brush dampened in perchloroethylene and rinse with isopropyl alcohol.
   (2) Select the proper bonding materials (resin and catalyst) and mix as recommended by manufacturer.
   (3) Add fiberglass #128 and stir until all fibers are wet.
   (4) Apply wet fibers to the hole.

NOTE

Avoid plugging adjacent holes not meant for repair.

   (5) Cure as recommended by the manufacturer.
   (6) Abrade the area flush.
   (7) Redrill the hole per specification.

11-10. Blister Repair in the Circuit Area. Blisters between the layers of a multilayer circuit board are usually founded alter DIP or wave soldering. Repair only electrically functional boards with mechanical damage.

a. In addition to the tools and materials shown in figure 9-4 the following materials are needed.
   (1) Oven
   (2) Epoxy material (compatible with base laminate)
   (3) isopropyl alcohol
   (4) Microscope
b. The procedure is as follows.
   (1) Clean board thoroughly with alcohol and compressed air from the PPS200C power source (para 4-1c)
   (2) Puncture two small holes into each blister with a dental pick. Locate the holes opposite each other around the outside of the blister.

NOTE

Temperature of oven should De determined by the component specification manuals

(3) Place board in oven (see note).
(4) Apply epoxy material with a hypodermic needle (table 7-2) over one of the openings of each blister while the board is warm
(5) Observe that the epoxy is drawn into the blister and fills the void.
(6) Place board in oven (see note).
(7) Remove from oven and perform electrical test covering all interconnections around and in the work area (chap 6).

11-11. Blister Repair in a Non Circuit Area. The tools and materials are the same as in paragraph 11-10. The procedure is as follows:

a. Remove all surface contamination around blistered area with alcohol and compressed air.
b. Remove blister with a pro/vise cutting tool (fig. 9-3).
c. Remove loose material with alcohol.
d. Air dry for 10 minutes.
e. Fill with epoxy.
f. Air cure or place in oven (para 11-10 note).
g. Abrade flush with board and clean with alcohol.

11-12. Selective Plating Repairs. Plating prevents oxidation of the base material and aids in solderability. Swab plating of the edge connectors is controlled by a high speed localized electroplating on a small area of the circuit pattern without the use of a submerging tank. The edge connectors are normally coated with a rhodium overplate of 0.00003 inches of a gold overplate of 0.00005 inches. The procedure is as follows:

a. Determine the plating requirements.
b. Select the plating materials.
c. Select a plating until (MIL-P-80249A).
d. Plate connectors as described in the Plating Equipment Handbook.

CHAPTER 12

QUALITY CONTROL ACCEPTANCE CRITERIA

NOTE

Before any procedures are started, it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB wilt be marked “ESD sensitive" at incoming inspection.

12-1. General. This chapter provides a description of the quality control acceptance criteria for PWA/PCBs during final inspection. All PWA/PCBs will be visually inspected for conformance to Military Standards and Specifications. The workmanship will be of the highest quality and will comply with there requirements of this publication.

12-2. Repair Defects Acceptance Criteria. Repair soldering should have the appearance of being bright/shiny, smooth and neat. The solder should feather out to a thin edge to indicate proper flowing and wetness and show no evidence of overheating or underheating. Visual inspection can also determine whether or not the minimum amount of flux and solder was used during the repair. Loose flakes of resin will be removed from the solder connection prior to recoating. The following criteria will be used for the visual inspection of the PWA/PCBs:

a. Solder connections will appear to have complete fillets of the proper shape cover the exposed connection properly, and not bridge between other circuits (MIL-S-45743E, fig. 41).

b. All excess flux will be removed from the PWA/PCB solder connections by scraping, alcohol, or compressed air.

c. All conductors will show proper welting with no electrical interference, such as points (icicles), sharp edges, wrinkles, or mechanical interference (MIL-S-45743E, fig. 28).

d. Components, subassemblies, markings or platings will not show damage due to repair.

e. Terminals. The solder acceptance criteria for terminals is shown in MIL-S-45743E, figures 43 through 46 and figures 52 ,53, and 54.

(1) *Turret Terminal.* The bend to attach a wire or lead to a turret will be from 180° to 360°. The wires or leads will be attached to the base of the lower guide slot or to the top shoulder of the upper guide slot. The wire will be in contact for the full curvature of the wrap. The side route shall be used on all solid-post, turret terminals. Insulation clearance should be referenced from the base or top shoulder as applicable (MIL-S-45743E, fig. 7, 8, and 9).

(2) *Bifurcated Terminals.* The bend to attach a wire to a bifurcated terminal will be from 180° to 360°. These terminals will have leads or wires terminated as follows:

(a) *Terminal Fill (MIL-S-45743E fig. 10 through 13 and fig. 54).* On the bottom and top-route a maximum of two conductors will be used for each route. On the side-route, all conductors or wires will be confined within the lower 80 percent of the terminal. A maximum of three conductors is permitted.

(b) *Bottom route wires.* These wires will terminate with a double 90° bend (180° total) and be soldered to the terminal shoulder. The insulation clearance will be measured from the point of entry into the terminal (MIL-S-45743E, fig. 12).

(c) *Side-route wires (MIL-S-457143E, fig. 10).* These wires will enter the mounting slot at a right angle and terminate with a double 90° bend (180° total). When more than one wire is connected, the direction of the bends will be alternated (MIL-S-45743E, fig. 11). The first wire will be soldered to the base and the terminal post. Additions will be soldered as close as possible to the preceding wire. The insulation on these wires will be a uniform distance from the terminal posts. The insulation clearance will be referenced from the base.

(d) Top-route wires. A large diameter wire which fills the bifurcated gap will be inserted without a bend and will require only fillets for retention. A smaller wire will be bent into a "U" shape. Insulation clearance will be measured from the point of entry into the terminal (MIL-S-45743E, fig. 13).

(3) Hook, Perforated/Pierced Terminals. The bend in the wires or leads attached to these terminals will be from 180° to 360°.

(a) Hook terminal. The wire shall enter the hook with a double 90° bend (180° total) (MIL-S-45743E, fig. 14).

(b) Pierced terminals (eyelets). The wire must pass through the eye and be wrapped around a single terminal (MIL-S-45743E, fig. 15).

(c) Multiple or threaded terminal wiring (strapping). The termination terminal will be wrapped as indicated in (b) above (eyelets). The wire will pass through the eye and should contact two nonadjacent surfaces of each intermediate terminal. *(*TB 750-12, fig. 9-14).

(4) Conductor end Hollow Cylindrical Terminal Connections. Tinned wires or leads will not be bent or formed. All conductor will bottom when termination is in a solder cup insulation clearance will be referenced from the point of entry into the cup (MIL-S-45743E, fig. 22). All solder will be removed from the outside of the cup except for a smooth film which will not extend beyond the base of the terminal. All stranded wire will be completely contained within the cup (MIL-S-45743E, fig. 23).

(5) *Tubular Hollow Terminal.* The end of the wire will be visible in the bottom of the terminal and will not protrude more than 0.050-inch (TB 750-12, fig. 9-15). Solder will be exposed only at the end of terminal (TB 750-12, fig. 9-16).

f. Lap Reflow Soldered Joints.

(1) *Soldered Joint Requirements.* A flat pack solder point will have a bright, shiny, smooth fillet at the heel of the lead, and have good wetting (fig. 11-2). The solder will cover the lead from the heel to the toe. The quality of the solder joint is determined by the following

(a) Fillet formation.
(b) Lead position.
(c) Amount of solder.
(d) Surface preparation.
(e) Soldering time and temperature.

(2) Acceptance Criteria. The strength of the solder Joint is directly related to the lead location and the fillet formation. The acceptance of the solder joint can be determined by using the criteria illustrated in MIL-S-45743E, fig. 31 through 35, fig. 48, fig. 49, and fig. 57

g. Eyelet or Funnelet Connections. Printed circuit pads, from which component leads may be removed frequently, will be reinforced with eyelets or funnelets. Components connected or soldered to a PWA/PCB containing eyelets or funnelets must be checked for the following:

(1) Leads will fit the hole spacing without straining seals at component body.
(2) Leads will be inserted through the eyelets with the components mounted flat against the board.
(3) Leads will extend through the eyelet a minimum of 0.030 to 0.050-inch from the end of the eyelet. (TB 750-12, fig. 17)

h. Unclinched Leads. Unclinched straight leads of mounted components will extend 0 030 through 0.050-inch above the solder pad (fig. 12-1). A lead is clinched to stabilize components mounted on a PWA/PCB.

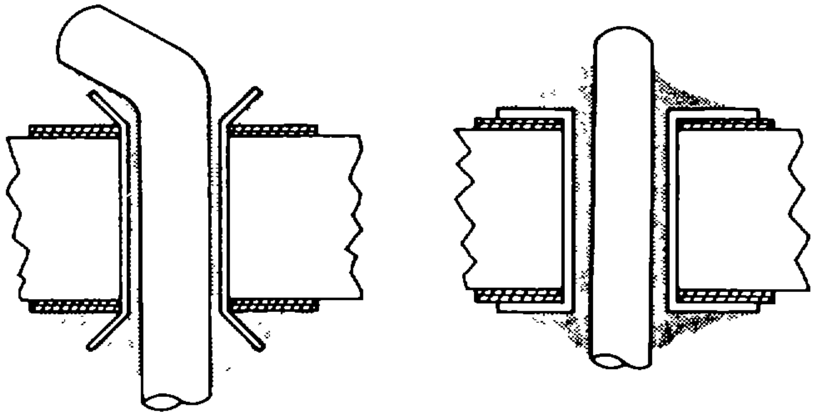


Figure 12-1. Lead Termination

i. *Component Lead Forming.* All leads will be formed to provide proper spacing and bend *radii.* The minimum distance from the component and seal to the beginning of the bend will be a minimum of 1/16 inch from the weld. The lead forming will be done with a device that provides the proper lead spacing and lead radii without straining the seals (TB 750-12, fig. 2-18).

j. *Component Mounting.* Components will be mounted parallel and in contact with the board for more direct support (based on engineer design, some components may be intentionally mounted off the board). Leads or conductors will terminate directly al the circuit pads or thru hole terminations. If required, clinched leads will not extend beyond the pad area and will be clinched in the direction of the runs (MIL-570-1460 (MU), fig. 38 and 39). In addition, component connections and mounting will meet the following criteria:

(1) Components are centered between termination holes or terminals within 1/16-inch variation.
(2) Components' replacement should be mounted in the same position as the original placement.
(3) Components should be mounted flush with the board leaving clearance between components.
(4) Sleeving is extended 1/8 inch beyond both ends of the component. The sleeving will be free of cuts splits and burns.
(5) Components are positioned so that the coating will not be abraded.
(6) Stress relief loops are provided on leads as required (fig. 12-2).

k. *Measling.* Measling looks as if the coating has been worn away and the weave *of* the PCB base material shows through. The acceptance criteria is as follows:

(1) The total of all areas affected by measling will not exceed 3 percent of the total area of the PCB.
(2) Any connecting measles or measles that totally bridge adjacent plated-thru or leadwire holes is not acceptable.
(3) Individual measles may be up to .031 inch in any direction.
(4) Measling between a functional conductor and an adjacent hole is acceptable if the area free of measles is at least 50 percent of the distance between adjacent conductors. The measle free space will be the total space measured on both sides or between measles.

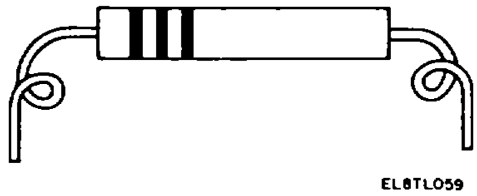


Figure 12-2. Stress Relief Loops

(5) Measling between two adjacent conductors is acceptable if:
(a) The board is conformally coated.
(b) The measle lies below the surface o*f* the base laminate (no weave exposure).
(c) The area free of measles is at least 50 percent of the distance between adjacent conductors.
(6) Measling between nonfunctional areas (such as a rivet) and a functional area (such as a conductor) is acceptable if the above criteria is maintained.
(7) Haloing around holes or slots will not exceed .031 inch violate minimum spacing requirements, or extend from the hole to the edge of the board.
(8) Repair or modification of PCB will not cause propagation of measling beyond the limits specified herein.

I. *Coatings.* Common guidelines in determining the acceptance criteria for PWA/PCB coating are as follows:
(1) All printed wiring solder joints and electrical components will be completely covered width conformal coatings and there should be no evidence of bubbles or coating on the connector.
(2) Unsoldered terminals, contact bars, and other electrical contacts that may require change or adjustment will not be coated.
(3) Coated surface should be 1 to 5 mils thick. Build up of greater thickness around components or in clefts and fissures is permissible. Occasional small bubbles are accept table when the coating is not impaired mechanically or electrically and if there is no danger of contamination, moisture entrapment or moisture penetration.
(4) Bubbles between leads having a smaller diameter than the space between leads are acceptable if closed. If not closed, they may be pierced and filled.
(5) Minute bubbles connecting leads or pads are not acceptable and must be overcoated.
(6) All component holes must have conformal coating in the bottom to seal off moisture to the component side (chap 7).
(T) Webbing between the underside of the leads and the surface of the board is acceptable.
(8) The fillet will not encapsulate the lead bend area.
(9) Ultraviolet light (black light) is necessary to detect discontinuities, bubbles, and bare spots in conformal coatings by a highlighted area.
(10) Coating that is brushed on will be limited to the repair area

m. *Soldermask Wrinkling.* Wrinkling is defined as the condition resulting from the formation of ridges, creases, or furrows in soldermask bonded to tin-lead plating which occurs after melting and resolidification of the tin-lead. This phenomenon occurs as the board is wave soldered. The tin-lead plating will reach its melting temperature and become molten under the soldermask coating. As the tin-lead resolidifies unevenly, the soldermask retains adhesion, causing the mask surface to appear wrinkled.

(1) Wrinkling Acceptance Criteria.

(a) Wrinkling of the soldermask film over areas of reflowed tin-lead plating is acceptable if there is no evidence of breaking, lifting, or degradation of the film.

(b) Solder flux, oils, or other contaminates underwrinkled areas of soldermask (covering on PCB to protect from solder) are not acceptable.

(c) Wrinkling of the soldermask is not acceptable on boards prior to wave soldering.

(d) The wrinkled soldermask must retain adhesion to the reflowed plating. Adhesion is determined by applying a piece of Federal Specification L-T-90 tape 1/2" X 2" to the masked board and rapidly removing the tape manually. Inspection of the tape should show no traces of soldermask. Examination of the coating should show no separation or fracturing of the coating from the plating or laminate.

(2) *Blister Definition*. Blisters result from entrapped air within the soldermask material rising to the surface either during curing or wave soldering operations. Blisters tend to take the shape of small circular bubbles. In some cases, they pop, forming small surface cavities.

(3) *Blister Acceptance Criteria.*

(a) The blisters show no evidence of pin holes and their dimensions do not exceed 0.010 inches in any direction when viewed at 30X magnification.

(b) A blister or series of blisters must not interconnect continuously across circuit paths.

(c) The blisters contain no solder flux, oils or other contaminates under blistered areas paths of soldermask.

12-3. Cause for Rejection. Evidence of any defects, including the following, will be cause for rejection:

a. Charring or burning in conductor or eyelet areas.
b. Solder splattering.
c. Pits, sears, or holes which would degrade the solder joint.
d. Insufficient or excess solder.
e. Loose leads or wires.
f. Resin solder joint.
g. Fractures.
h. Cut, nicked, scratched, or scraped leads, conductors, or circuitry.
i. Dirty solder connections, i.e., lint, residue, flux, solder, and dirt.
j. Pads connected by plated through holes, showing evidence of failure to wet. (MIL-S-45743E, fig. 28).
k. Crystallized connections.
l. Evidence of overheating.
m. Evidence of underheating.
n. Evidence of excess flux.
o. Presence of resin flux.
p. Excess wetting.
q. Cold solder joint. (MIL-S-45743E, fig. 28).
r. Evidence of excess wrinkling.
s. Conformal coating covering electrical contacts (chap 7).

CHAPTER 13

FINAL INSPECTION

NOTE

Before any procedures are started. it must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB will be marked ESD sensitive at incoming inspection.

13-1. General. This chapter provides instructions for the final *inspection* station of the General Support and Depot facility after repair has been completed. The final inspection station is responsible for assuring high quality workmanship as well as performance characteristics. The operational sequence in which a repaired assembly is processed through final *inspection* is shown typically on the flow diagram (fig. 13-1) and described below

13-2. Tags and Forms. Upon receipt from the repair or test station the PWA/PCB is logged in, and all the attached lags and forms are checked for completion and proper annotation. If any required entry is in complete, the responsible station is contacted to update the documents.

13-3. Quality inspection. The lags and forms are checked to determine the work performed on the assembly by the repair station. The repaired area is visually inspected with a properly lighted magnifier and under ultraviolet (black) light (fig. 4-3) for signs of poor soldering, improper conformal coating, and incorrect component installation (chap .12). If the repaired assembly does not pass visual inspection, the tags are marked to indicate the defect, and the assembly is returned to the repair station. If the repair is deemed satisfactory, the assembly is then tested to verify the performance criteria. If the final test reveals improper performance, fault isolation is accomplished to locate the faulty component(s) by automatic test equipment. The tags are then marked to indicate the defect, and the assembly and test printout are returned to the repair station. If the assembly passes all operational tests the inspector visually inspects the item for probe marks, physical damage, loose or missing hardware and overall appearance. When all quality requirements are met, as outlined in chapter 12, the attached tags and forms are marked to indicate final acceptance.

a. Performance Verification Test. Verify functional performance of repaired assembly as follows:

(1) Perform complete testing of the repaired assembly in accordance with the information provided in chapter 6.

(2) Check Test printout to verity that the repaired assembly meets all the performance criteria (If problem cannot be isolated send to the next level of repair).

(3) Mark tags and forms to indicate the reason(s) for rejection, if performance is improper, and return the assembly to the repair station.

4) Proceed with the overall inspection for appearance and uniformity If the repaired assembly meets all the performance criteria.

b. Final Overall inspection. Perform final overall inspection of repaired assembly as follows:

(1) Place PWA/PCB in work handling systems (para 4-1b).

(2) Inspect overall assembly for probe marks, scratched conformal coating, physical damage, oxidation of connector strips, loose or missing hardware, and general appearance (chap. 12), with the aid of the optical lighting system (para 4-1b).

(3) Mark tags of any defects that are defected and return the assembly to the repair station for repair.

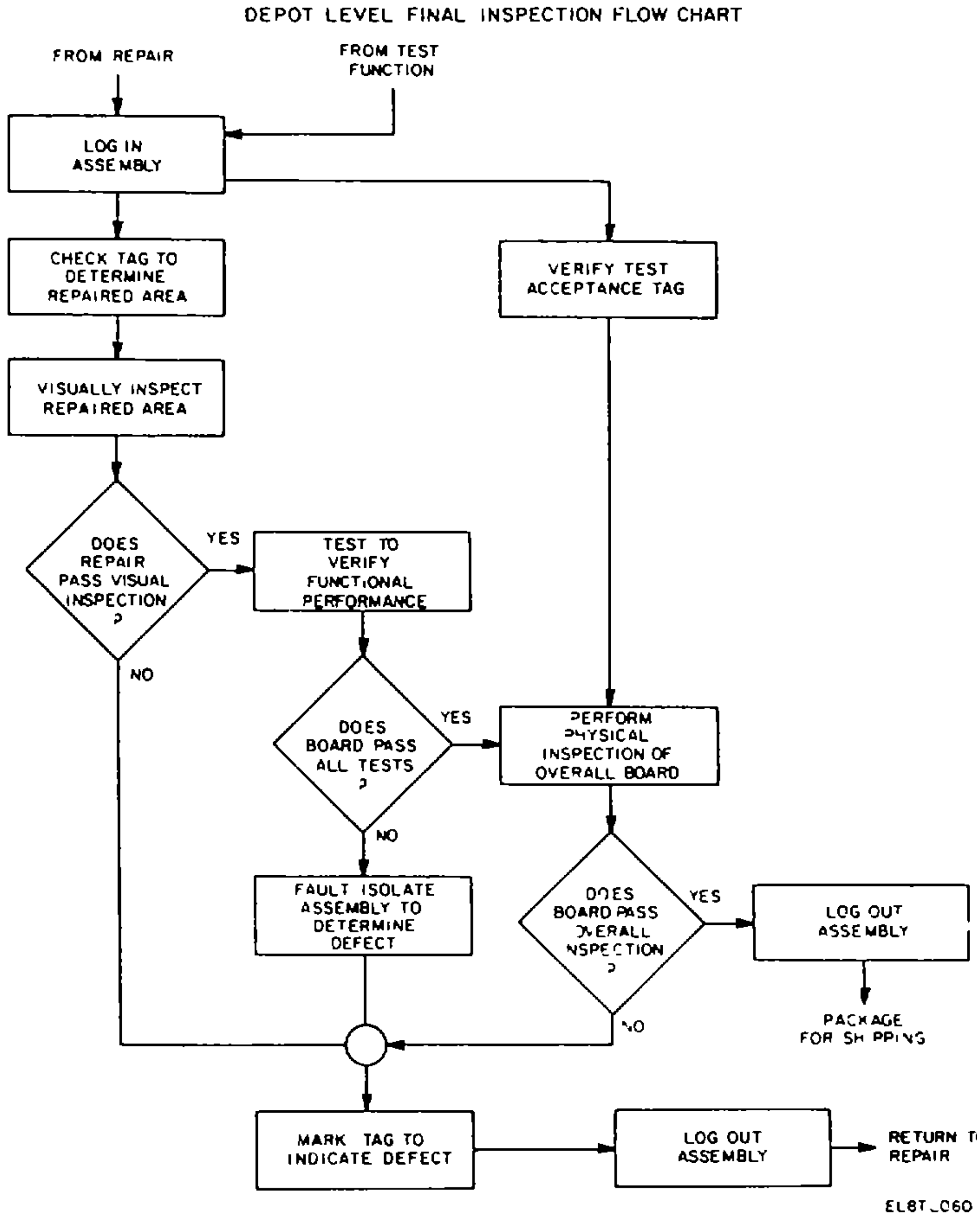


Figure 13-1. Depot Level Final inspection Flow Chart

(4) Mark the attached tags and forms to indicate final acceptance if the assembly passes all of the above inspections.
(5) Log out assembly and package for shipping in accordance with instructions provided in chapter 12.
(6) Check and perform any required ESD protection before shipment.

CHAPTER 14

PACKAGING AND SHIPPING

NOTE

Before any procedures are started, It must be determined if printed circuit board needs protection from electrical discharge. If so, the PCB will be marked "ESD sensitive" at incoming inspection.

14-1. General. This chapter contains the necessary general information required for proper shipment and storage of repaired PWA/PCBs.

14-2. Preservation. All required PWA/PCBs will be protected from humidity damage during shipping or storage by including desiccant dehydrators (Military Specification MIL-D-9394, or equivalent) in the shipping case. In addition, PWA/PCBs which have been determined to be sensitive to electrostatic discharge will be initially wrapped in bubble pack material or open cell plastic foam such as MIL-P-81997 and PPC-C-1842 Type III Style A.

14-3. Packing and Unpacking. Repaired PWA/PCBs will be packaged for shipping in accordance with the specification requirements provided on manufacturer's Packaging Data Sheets (PDS). The PDS provides specific packaging information as material requirements, material dimensions, and marking data for each assembly. Refer to the specific Depot Maintenance Work Requirement (DMWR) for any special packing instructions, such as dessicators or anti-static discharge protection bags. A typical procedure for packing and unpacking PWA/PCBs and modules is illustrated in figures 14-1 and 14-2 and described below:

a. *PWA/PCBs (fig. 14-1).*

(1) Remove and retain Process Move Tags and other forms from the PWA/PCB.
(2) Place PWA/PCB into proper plastic bag (antistatic, if required), insert dessicator, and seal open end with pressure sensitive tape.
(3) Wrap assembly into water-resistant cushioning material, and seal all edges with pressure-sensitive tape.
(4) Place wrapped assembly into polystyrene container and secure ends with pressure-sensitive tape. Ensure that it extends a minimum of two inches onto top and bottom of the container.
(5) Place container into opaque packaging bag and seal open end with pressure-sensitive tape.
(6) Place opaque bag into shipping container and seal all joints and seams with pressure-sensitive tape.

b. *Modules (fig. 14-2).*

(1) Remove and retain required Process Move Tags and forms.
(2) Place module into polystyrene barrier, wrap and seal edges with pressure-sensitive tape.
(3) Place unicellular polyethylene foam blocking material around wrapped module.
(4) Place assembly into water resistant fiberboard container and seal with pressure-sensitive tape.

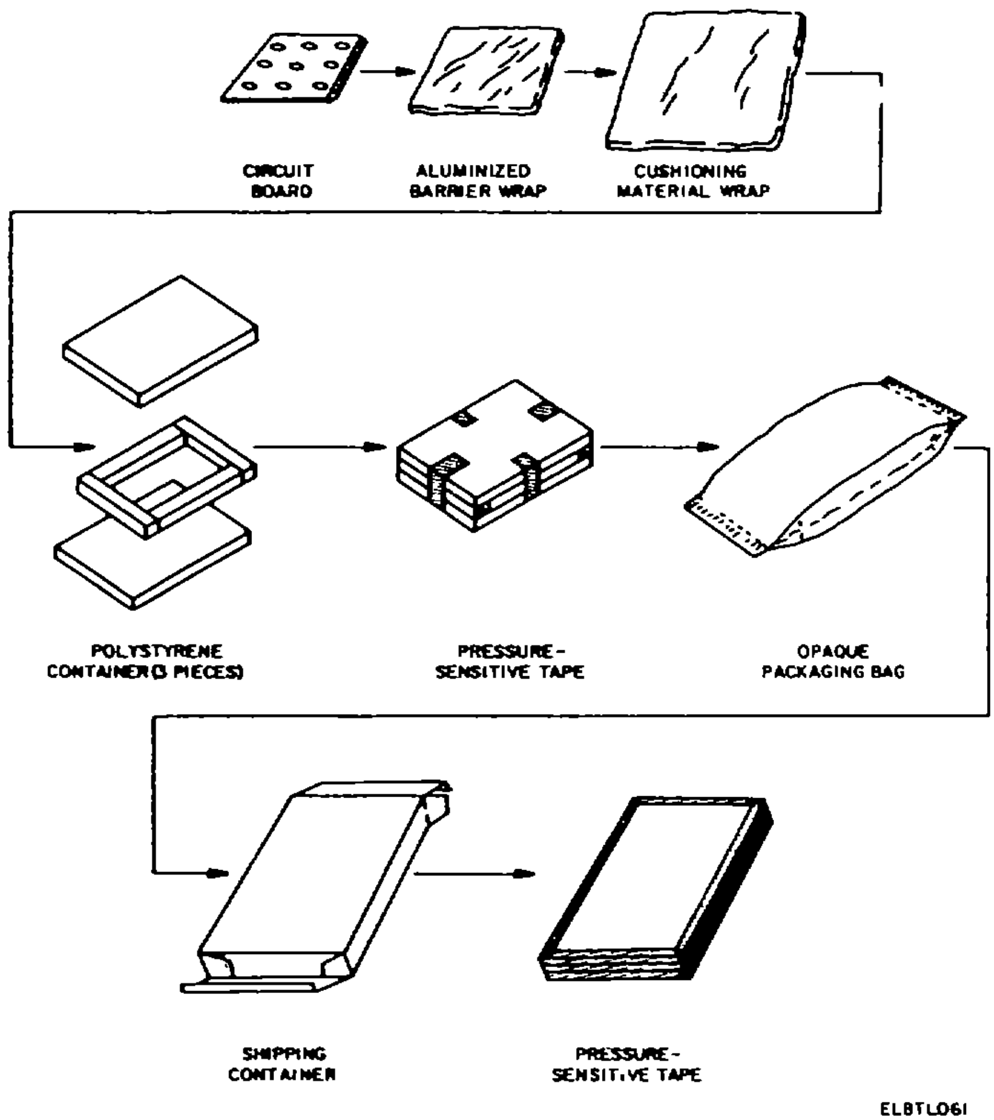


Figure 14-1. Circuit Board Packaging Diagram

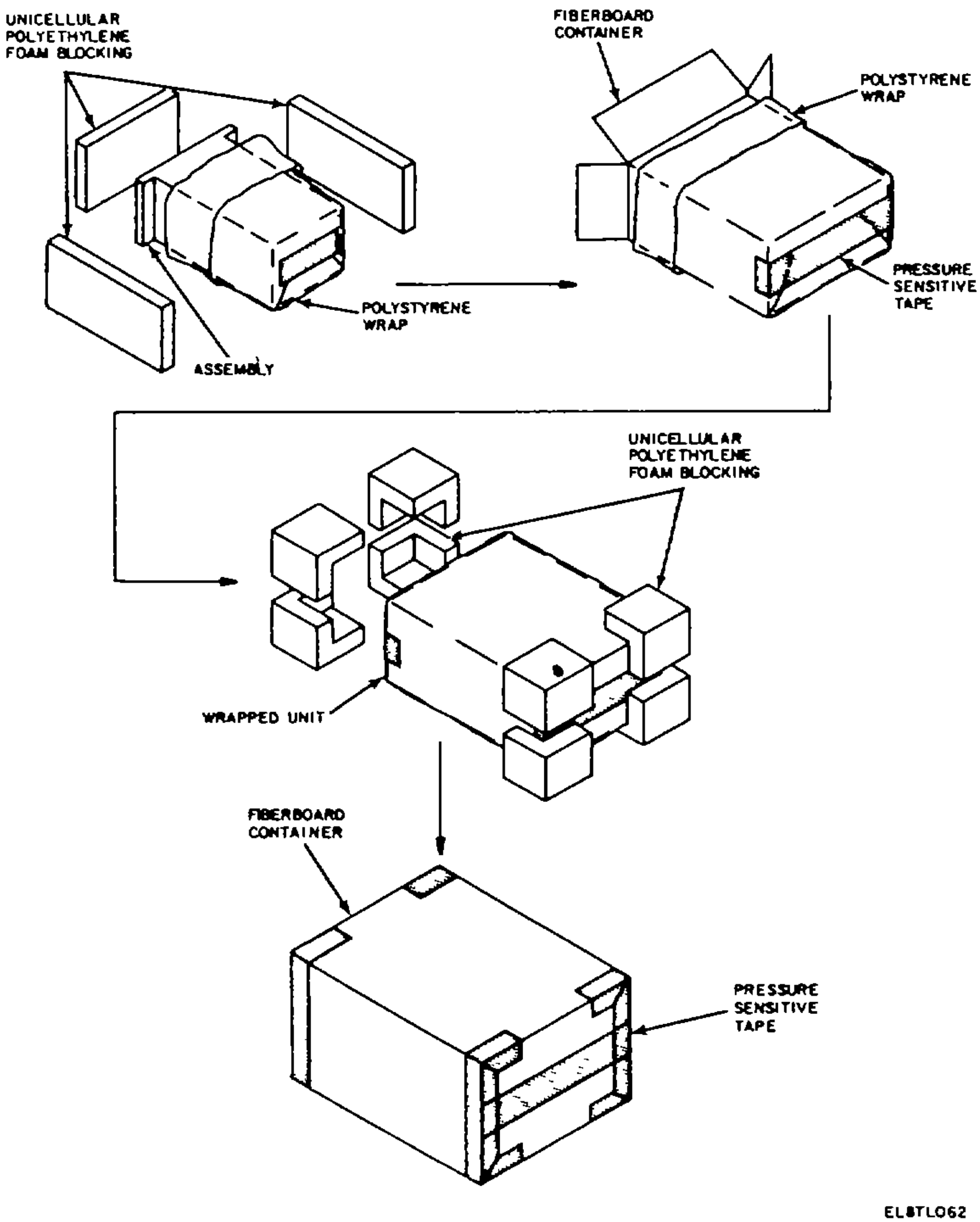


Figure 14-2. Assembly Packaging Diagram

c. *Marking and Shipping.*

(1) Prepare shipping documents in accordance with Standard Operating instructions.
(2) Attach to shopping container.
(3) Determine final destination of the assembly using the information annotated on the tags and forms.
(4) Mark "ESD Sensitive", if applicable.

CHAPTER 15

NEW TECHNOLOGY

NOTE

Before any procedures are started, it must be determined printed circuit board needs protection from electrical discharge. If so, the PCB will be marked "ESD sensitive" at in coming inspection.

15-1. General. This chapter is a brief description of new discoveries, materials, improved processes, new repair equipment, tools or any other technical information that may be of value to the Repair Technicians. Primarily, it is intended to provide advance indications of things to come from the State-of the-Art.

15-2. Flexible Circuits. Flexible circuits/cables are designed to provide efficient and practical methods for making connections and utilizing space. The etched circuit is composed of flat copper conductors enclosed in insulating materials. The conductor to insulation bonding provides a barrier against moisture and gases, and is very durable. The product may be bent, coiled, twisted, and formed to follow the various outlines of multiple systems. Assemblies may be hinged, pulled-out and flexed for maintenance or inspection even when still in operation. Flex circuitry/cables provide high reliability with less distortion or noise than conventional wiring. In addition, various methods can be used for final assembly, such as, welding and soldering. Figure 15-1 is a sample of a flexible circuit.

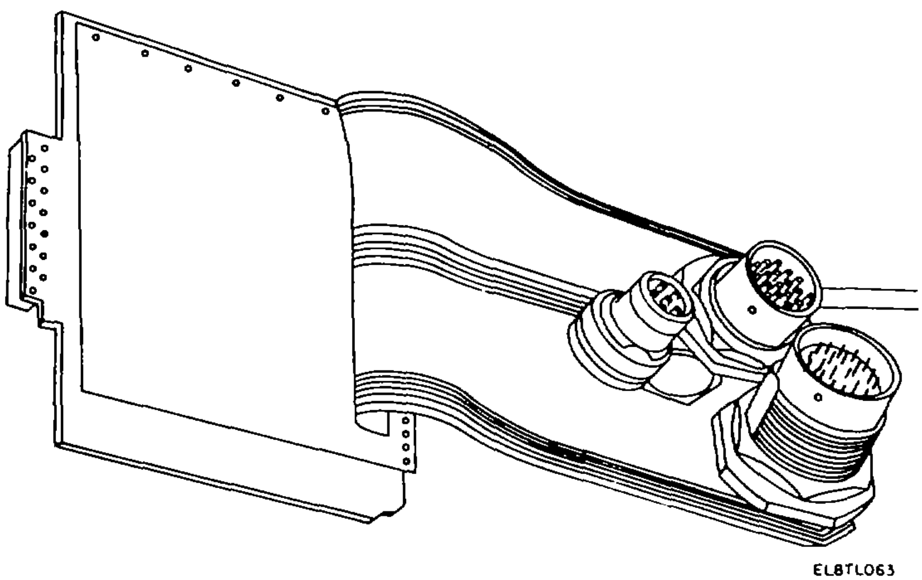


Figure 15-1. Flexible Circuit

15-3. Multiwire Technology. A multiwire PWA/PCB is a computer tape controlled series of conductor wires laid down on an adhesive coated double sided printed circuit board. The two sides of the board are used for voltage and ground plane applications. The voltage and ground planes are etched to both sides providing a semicured base for laying in the conductor wires. The circuit is formed by using a pressure head, that imbeds the conductor wires in the adhesive. Holes are then drilled in the board followed by the plating of these holes. Multiwire PWA/PCBs can be hand, wave, or dip soldered using conventional soldering techniques. Multiwire printed circuit boards are recommended for high frequency applications.

15-4. Additive Plating Technology. Additive plating may be defined in this manner. Additive plating s a process whereby printed circuit boards are manufactured by selective depositing of a conductor material on an unclad base material (no conductor material anyplace on the base material). The circuit is developed by applying a background negative-image resist pattern, which leaves conductor areas and holes to be plated through, exposed for metal deposit Additive plating is an economy oriented process.

15-5. Leadless Components. A new trend in the manufacture of PCBs is to use so-called "LEADLESS COMPONENTS". These are passive components such as resistors or capacitors which are made on semiconductor substrate material and are greatly reduced in size. They do have axial leads, however, and or removed and replaced in a similar manner to flat pack ICs (para 8-7c). Use of leadless components can reduce a multilayer board to a single layer and reduce its size by as much as one-third.

15-6. Automatic Tailing Equipment (ATE). Within the past 20 years, PWA/PCBs have replaced hand wiring and soldering. Along with these advances came quality control problems which created the need for a faster and a higher percentage of testing. High density and multilayer boards can be 100 percent tested after repair, and 100 percent fault isolated when received for repair.

15-7. Testing. A manufacturer of assemblies for example, who purchases all of his PWA/PCBs from suppliers should not have to do any bare board testing. But not all suppliers have a total process control relationship with the supplier so it is best to treat the incoming boards as any other purchased component part. This treatment would include sampling inspection as a minimum; 100 percent inspection or test as a preference. Automatic testing is virtually mandatory for large quantities of complex boards with plated through-holes or large multilayer boards.

15-8. Decisions. All PWA/PCBs are ultimately 100 percent tested. This reduces the cost of repairs to a minimum. The cost of finding and replacing a defective component or repairing a circuit trace buried six layers into a twenty layer board can range from $30.00 to $300.00. So the cost effectiveness of Automatic Test Equipment can be justified.

15-9. Field Tested ATE.

a. Bendix; Test Systems Divisions #3209070
b. Hewlett-Packard Company #3060A
c. Teradyne incorporated #N221, L200, L621

15-10. Electrical Repair Facility (ERF). The ERF Van that the Army is using to do emergency and on-site repairs will revolutionize the current system. The saving in time will result in the saving of money. Reference DEP 11-5410-217-14, Appendix C for a list of end items for reorder (fig. 15-2).

15-11. Automatic Test Equipment (EQUATE). The Equate Van was designed to work side by side with the repair van. It will fault isolate equipment before it goes to repair (ERF) and then test after repairs are done (fig. 15-3).

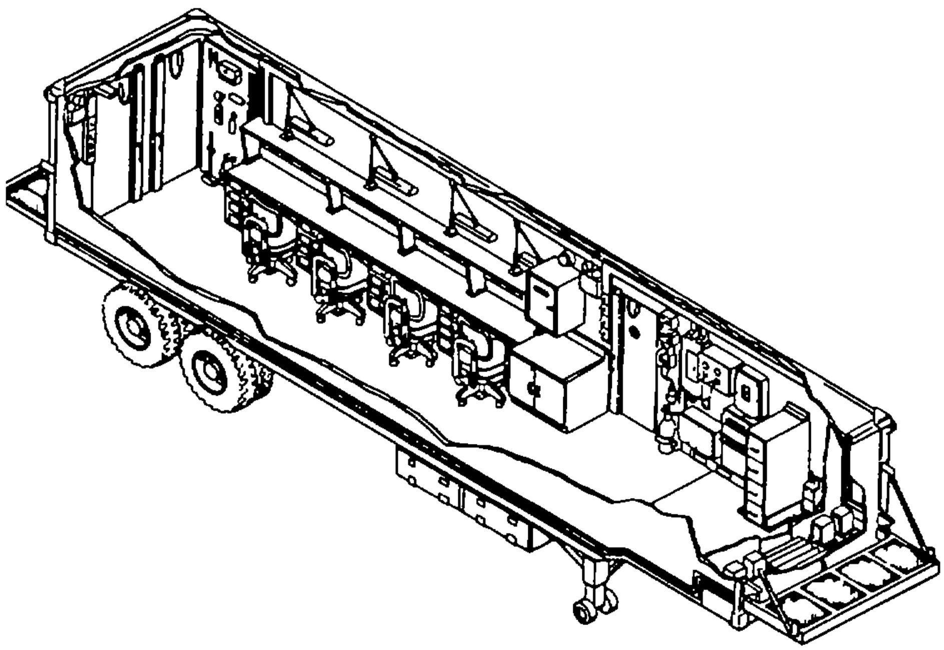


Figure 15-2. Electrical Repair Van

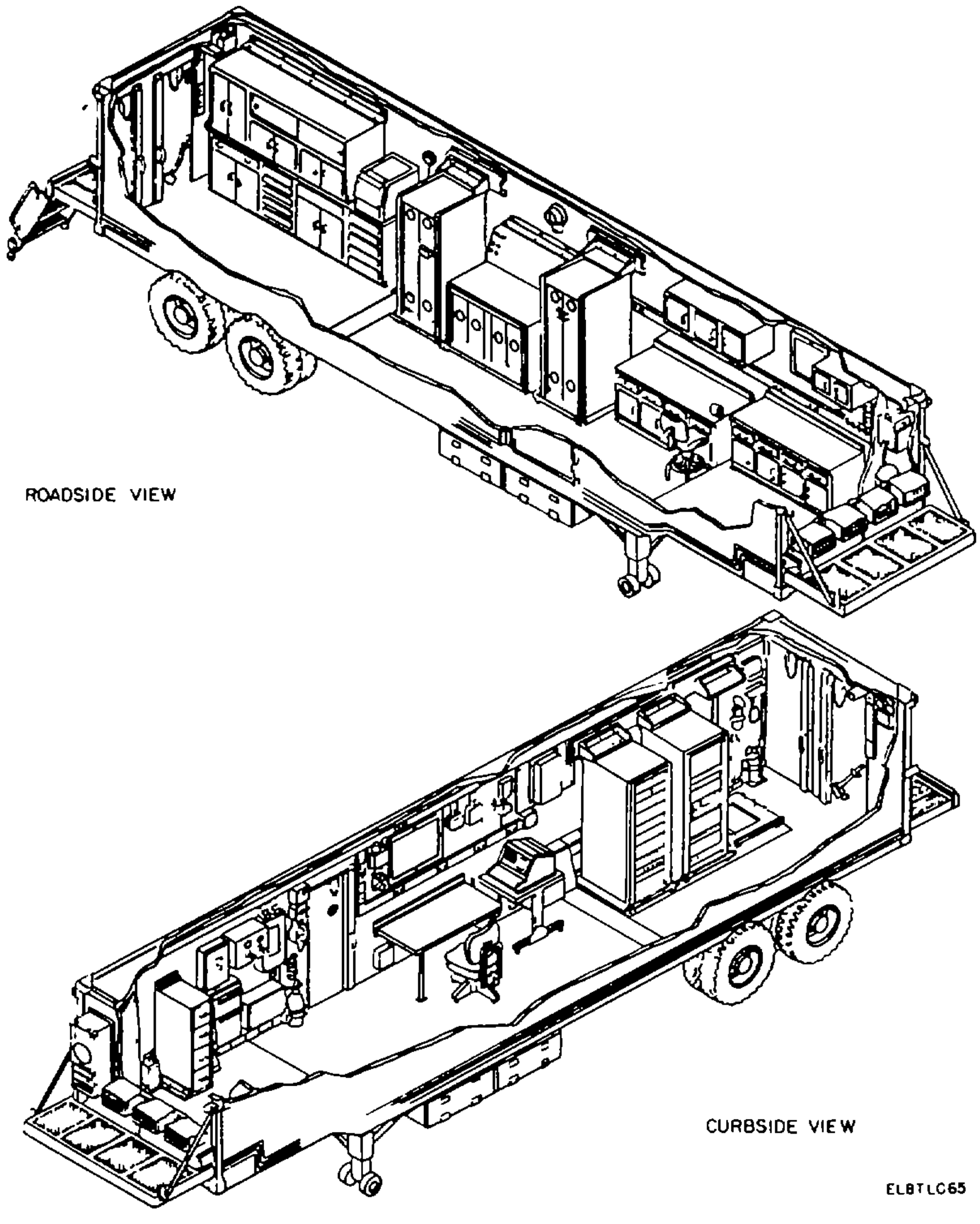


Figure 15-3. Automatic Test Van

APPENDIX A

REFERENCE DOCUMENTS

A-1. Scope. This appendix lists all technical bulletins, Military Standards, Military Specifications and miscellaneous documents referenced In this Bulletin.

A-2. Technical Bulletins

MIL-STD-1569	Requirements for the Repair and Modification of Printed Wiring Assemblies
TB-750-12	Repair Procedures and Inspection Standards *for* Communications Security Equipment Printed Wiring Assemblies
TB-SIG-222	Solder and Soldering

A-3. Military Specifications and Standards

MIL-B-117	Bag Interior Packaging
MIL-C-81302	Cleaning Compound Solvent Trichlorotrifluoroethane
MIL-D-3464	Desiccants Activated (In Bags) for Static Dehumidification and Packaging
MIL-D-9394	Dehydrator Desiccant, Hd-186-asq
MIL-F-14256	Flux., Soldering Liquid (Rosin Base)
MIL-HDBK-175	Microelectronic Device Data Handbook
MIL-I-46058C	Insulating Compound, Electrical (for coating Printed Wiring Assemblies)
MIL-P-116	Methods *of* Preservation and Storage
MIL-P-28809	Printed Wiring Assemblies
MIL-P-50884	Printed Wiring Flexible, General Specification for
MIL-P-81728	Plating, tin Lead (Electro deposited)
MIL-P-81997	Pouches, Cushioned, Flexible Electrostatic Free Reclosable, Transparent
MIL-S-45743	Soldering Manual Type, High Reliability Electrical and Electronic Equipment
MIL-STD-454G (Requirement #1)	Standard General Requirements for Electronic Equipment
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-275	Printed Wiring for Electronic Equipment

APPENDIX A - Continued

MIL-STD-429	Printed Wiring and Printed Circuits Terms and Definitions
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-1313	Microelectronics Terms and Definitions
MIL-STD-1569	Requirements for the Repair and Modification of Printed Wiring Assemblies
MIL-STD-46056	Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)
MIL-STD-46844	Solder Bath Soldering of Printed Wiring Assemblies, Automatic Machine Type
MIL-STD-54680	Soldering of Metallic Ribbon Lead Materials to Solder Coated Conductors, Process for Reflow
MIL-T-81533	Trichloroethane 1, 1, 1 (Methyl Chloroform) Inhibited, Vapor Degreasing

A-4. Miscellaneous Documents

AA-HBK-010/2M VOL's I, II, III	(2M) Electronic Repair Program
AMCR-702-7	Depot Processing Control and Soldering (Electrical Connections)
AR 700-58	Packaging Improvements Reporting
AR 7501	Army Material Maintenance Concept and Policies
DOD-HDBK-263	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, and Assemblies and Equipment (Excluding Electrically Initialed Explosive Devices) (Metric)
DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric)
NASA Handbook NHB 5300.4	Requirements for Soldered Electrical Connections
NAVSEA TEOOO	Miniature/Microminiature
O-E-760	Ethyl Alcohol (Ethanol) Denatured Alcohol and Proprietary Solvents
O-T-236	Tetrachloroethylene (Perchloroethylene) Technical Grade
PPP-C-843	Cushioning Material. Cellusic
PPP-T-76	Tape Pressure Sensitive Adhesive Paper (for Carton Sealing)
QQ-S-571	Solder Tin Alloy; Tin Lead Alloy; and Lead Alloys
TT-I-735	Isopropyl Alcohol

APPENDIX B

COPYRIGHT INFORMATION

The following illustrations are reprinted with the permission of PACE, Inc.:

Figure 4-1	Figure 7-4
Figure 4-2	Figure 7-5
Figure 4-3	Figure 7-6
Figure 7-1	Figure 9-1
Figure 7-2	Figure 9-4
Figure 7-3	Figure 9-5

GLOSSARY

Section 1. ABBREVIATIONS

(Not Applicable)

Section 2. DEFINITIONS OF UNUSUAL TERMS

Bifurcated (split)	A terminal containing a slot or split in which wires or leads are placed before soldering
Black Lite Lamp	Inspection device picks up nick, and scratches on leads and cold solder joints as well as, coverage of coating material.
Certification	The act of verifying that required training has been completed and specified proficiency has, been demonstrated.
Cold Solder Connection	Unsatisfactory connection resulting from non wetting and showing an abrupt rise of the solder from the surface being soldered.
Components	Axial (Along an axis) resistors capacitors etc. Radial: (Leads radiate out from center of one surface) transistors diodes and some capacitors I.C.'s integrated circuits (Dips) dual in-line packages.
Conductive Soldering	A method of soldering which employs a hot soldering iron for transfer of heat to the soldering area.
Conformal Coating	An electrical insulating compound applied to individual components or entire board to protect in shipping and wave soldering. Can be spot removed, for repair, with solvent or hot air jet.
Diagnostics	Troubleshooting through testing means, to determine the actual cause and effect of failure.
Discrete Circuit	Fabricated from separate components individually manufactured.
Discrete Components	Fabricated prior to insertion.
Disturbed Solder Joint	The solder has a dull porous and crystalline appearing surface. It may also, under magnification reveal many cracks, or fractures. Movement of the parts during the critical plastic phase just before solidification will cause this type of defect.
Double Tinned	The tinning process repeated. This is one technique to remove gold plating from leads of components.
Dross	Impurities in solder, i.e., oxides of tin and lead.

GLOSSARY - Continued

Epoxy Potting Compound	A nonconductive organic plastic used for encapsulation of components and/or wires.
Electrostatic Discharge Protection (ESD)	Antistatic protection and ion generating units to keep static-free conditions at the bench. Includes mats, rocks, bins, gloves, boots, wrist bands, etc.
Eutectic Alloy	As applied to solder the composition of metals that changes rapidly from a solid to a liquid state without an intermediary plastic stage.
Eyelet	A tubular metal part having one flanged end with the other end being upset during installation.
Excessive Solder	The contour of the component lead or wire being joined is completely obscured; the solder has overflowed beyond the confines of the area being soldered. Excessive solder could contribute to wicking.
Fault Rectification	A physical repair action to reestablish the equipment's organic function and reliability.
Fault Signature	A computer program for fault isolating a particular PCB. If a program is not available, hand probing of each component and subassembly is necessary.
Fillet	A blending or rounding of intersecting conductors or leads which eliminate sharp corners. Also, buildup of solder around a component lead, etc.
Flux	A material used to promote the joining of metals in soldering.
Heal Rate Recognition	The ability to relate temperature levels and rate of heating by observing the rate at which solder melts.
Heat Sink	A device with jaws of conductive material, e.g., copper or aluminum, which clamps on a lead to protect the component from the heat of soldering.
Insufficient Solder	The component or wire leads show exposed lead or copper material and absence of a solder fillet between the terminal and leads being soldered.
Integrated Circuit	A microcircuit consisting of interconnected elements inseparably associated on or within a continuous substrate to perform an electronic circuit function.
Ionic	An electrically conductive material which often is corrosive.
Lazer Drilling	Method used to repair 10-20 layer boards, when buried traces are fractured.
Lead Wire	A length of wire, usually more than 1 inch in length used to interconnect terminal points.
Mechanical Wrap	The securing of a wire or the lead of a component around a terminal prior to the soldering operation.

GLOSSARY - Continued

Module	A complete subassembly of a larger system combined into a single package.
Nicked	Cuts in the individual strands of wire or in a solid conductor. Usually results from improper application of tools.
Nitrogen Fogging	Cleaning technique; a fog wave that eliminates impurities at wave soldering (oxides).
Overheated Solder Joint	The solder has a chalky, dull, or crystalline appearance and shows evidence of coarse grain porosity or pitting. An overheated solder joint is caused by excessive heat being applied during the initial soldering operation or from repeated efforts to repair a joint that will not flow or wet properly.
Polar	Chemical bond with electrostatic attraction between oppositely charged particles.
Preferred Solder Joint	The solder is smooth ,bright and feathered out to a thin edge, indicating proper flow and wetting action. No bare lead material is exposed within the solder joint, and there are no sharp protrusions or evidence of contamination (embedded foreign matter). The contour of the component lead wire is visible.
Perforated or Pierced Terminal	A terminal containing a hole through which leads or wires are placed before soldering.
Reflow Soldering	Components are inserted on top of board, not through holes. This procedure is used with Planer mounted "Flat Paks" and a Lap Flow tool designed for this purpose.
Remanufacture	To manufacture into a new product, i.e., tomatoes into sauce.
Resistance Soldering	A method of soldering in which a current is passed through and heats the soldering area by contact with two electrodes.
Rosin Solder Connections	Unsatisfactory connection which contains trapped flux.
Scored	Marks, incisions, or notching 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.
Solder Extracting Systems	1. Three step desoldering (heat collecting vacuum tube, solidfier of collected waste) 2. Wicking method stranded (braided) copper wire soaked with flux draws heated solder onto cord. 3. Solder sucker method; bulb syringe with teflon tip or plunger apparatus.

GLOSSARY - Continued

Soldered Joints	The connection of similar or dissimilar metals by applying molten solder with no fusion of the base metals.
Solder Splatter	Unwanted fragments of solder.
Stress Loop	The forming of a slight curve in the leads of components to avoid stress between terminations.
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.
Thermal Stress Testing	To insure adhesion of laminants.
Transpad	Used for spacing. Raises component off the Board; also acts as a heat sink.
Ultra-Sonic Soldering	Used with aluminum solder. Because of aluminum’s hardness, ultra-sonic vibration is necessary to dissipate oxides.
Work Station	The solder work station is an identified area used for manual soldering. The area within 10 feet (3.05 meters) of the actual soldering bench shall be considered part of the work station.

By Order of the Secretary of the Army

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Chief of Staff

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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'EIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

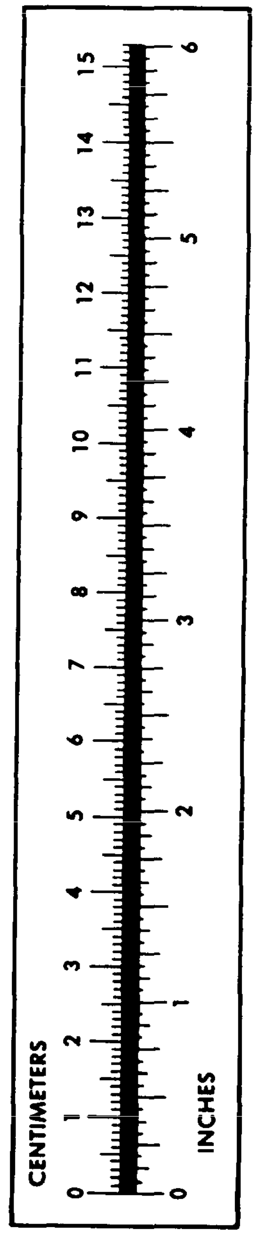
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
'ers	Gallons	0.264
.ms	Ounces	0.035
.ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
'ometers per Liter	Miles per Gallon	2.354
›meters per Hour	Miles per Hour	0.621



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