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The repair and modification of printed-circuit board assemblies for space use

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ABSTRACT

The repair and modification procedures detailed in this specification are designed to maintain the rigorous standards set by ESA for the manufacture and assembly of space-quality printed-circuit boards.

DOCUMENT CHANGE RECORD

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF METHODS

LIST OF FIGURES

SECTION 1: SCOPE

The repair and modification procedures detailed in this specification are designed to maintain the rigorous standards set by ESA for the manufacture and assembly of space-quality printed-circuit boards.

SECTION 2: GENERAL

2.1 INTRODUCTION

(a) This specification is confined to the repair and modification of single-sided, double-sided and multi-layer printed-circuit board assemblies. However, rework may be necessary on defective solder joints as a consequence of the repair/modification process. Unassembled (bare) printed circuit boards are not covered by this specification. Furthermore, it should be noted that the straightening of warped boards is not allowed.

(b) All soldering operations shall be performed in accordance with ESA PSS-01-708 and it should be noted that many of the accessories/work aids detailed in this specification are contained within purpose-built equipment.

(c) The repair and modification of printed circuit board assemblies demands the highest levels of skill and operators shall be trained and certified accordingly. Training on hardware which is a good representation of the circuitry which has to be repaired/modified is desirable although not a requirement.

(d) The appropriate repair/modification procedures are detailed in Chapters 4 to 16 of this specification.

(e) Repairs and modification made within the constraints of this document shall require formal approval/authorisation from the local project PA/QA representative using Material Review Board (MRB) procedures.

(f) Components that will be later submitted to failure analysis procedures shall be removed from assemblies and handled with great care.

(g) If problems arise when performing repairs and modifications within the constraints of this document or if methods are proposed which are outside the constraints of this document, then it is desirable that details are supplied to the Product Assurance Division of ESA so that the accrued information can be reviewed when an update of this document is undertaken.

2.2 REPAIRS

2.2.1 Repair criteria

Repairs shall be permitted when it is necessary to restore the functional capability of a printed circuit assembly that has been damaged during assembly or during testing.

A repair consists of changing a component with all its associated connections, including the fixing down of a lifted pad or track or any similar procedure described in this document.

2.2.2 Limited repair

Limited repair may be necessary in the interest of economy or schedule. Such a repair shall not degrade the quality of the product and shall not prevent the printed-circuit board from complying with all relevant project specification requirements and shall be authorised by MRB procedure only.

2.2.3 Number of repairs

The total number of repairs (involving soldering and/or epoxy adhesives) to any one printed circuit board assembly shall be limited to six (6). A repair of one component or connector may involve operations on one or more of its leads.

Repairs involving soldering operations shall not exceed three (3) to any one area of 25 cm^2.

Repairs involving epoxy adhesives shall not exceed two (2) to any one area of 25 $cm.^2$

2.3 MODIFICATIONS

2.3.1 Modification criteria

The modification of a printed circuit assembly shall be limited to the revision of interconnecting features by interrupting conductors and/or adding components as well as wire connections.

The revision of connections to one component or connector shall count as one modification.

The addition of one component shall count as one modification.

2.3.2 Number of modifications

The total number of such modifications on any one printed circuit shall not exceed two (2) to any one area of 25 cm^2.

2.4 REWORK

2.4.1 Rework criteria

The reworking of defective solder joints as a consequence of the repair/modification process is not considered to be a repair and is permissible. All aspects of the reworked joint shall comply with the soldering requirements.

2.4.2 Number of reworks

Up to a maximum of three (3) reworks on any one joint is allowed.

2.5 OTHER CONSTRAINTS

(a) It may be necessary for components to be removed and replaced because of malfunction or mechanical damage or because of damage to the conductor track in the vicinity of the component. For space use, components so removed shall not be re-used but shall be replaced by new equivalent components.

(b) Removal of components shall take place only if the mounting density is such that the integrity of other components in the vicinity can be ensured.

(c) Each printed circuit termination area shall not be subjected to more than one desoldering operation (i.e. only one component replacement is permitted).

(d) Repair or modification methods not detailed in this document, or in excess of criteria given in paragraphs 2.2.3, 2.3.2 and 2.4.2, will be the subject of a Material Review Board (MRB) in accordance with the relevant project procedure and this shall involve ESA participation.

(e) The straightening of warped boards, with or without components, is not permissible.

2.6 RELATED DOCUMENTS

Some or all of the contents of the documents listed below are directly related to this specification. The applicability of these documents is defined in the contract.

ESA PSS-01-20	Quality Assurance of ESA Spacecraft and Associated Equipment
ESA PSS-01-70	Material and Process Selection and Quality Control for ESA Spacecraft and Associated Equipment
ESA PSS-01-708	The Manual Soldering of High-reliability Electrical Connections
ESA PSS-01-710	The Qualification and Procurement of Two-sided Printed Circuit Boards (gold-plated or tin-lead finish)

2.7 DEFINITIONS

The definitions listed in ESA PSS-01-708 shall apply.

SECTION 3: PREPARATORY CONDITIONS

3.1 HAZARD/SAFETY PRECAUTIONS

Particular attention shall be paid to health and safety precautions. Moreover, unavoidable hazards to personnel, equipment or materials shall be controlled and minimised; the relevant nationally/locally approved hazard control instructions shall be used to achieve such controls.

3.2 MATERIALS

All materials used for repairs and which are forming part of the end product shall be suitable for their intended space application.

Solders, flux and cleaning solvents shall be as specified in ESA PSS-01-708.

3.3 FACILITIES

All facilities and tools shall meet the requirements of ESA PSS-01-708.

SECTION 4: REMOVAL OF CONFORMAL COATING

4.1 INTRODUCTION

Before the disassembly of components from printed-circuit assemblies, any conformal coating must be removed to ensure that:

(a) solder on the area to be repaired is freely accessible

(b) the re-soldered joint is not contaminated.

4.2 CONSTRAINTS

(a) Soldering irons must not be used for coating removal. The high operating temperatures will cause charring of the coatings and possible delamination in the base laminate.

(b) The tool used to cut around the area to be repaired shall not be sharp enough to damage the printed wiring assembly.

(c) Care must be taken when using the thermal parting tip to avoid the melting of any adjacent solder joints and circuitry.

(d) Solvents may tend to expand the coating media and attack coatings on electronic components in areas remote from direct solvent application. For these reasons, the maximum time for solvent application shall be limited to 15 minutes.

4.3 TOOLS AND MATERIALS REQUIRED

- suitable cutting instrument
- thermal parting device complete with tips
- brushes
- approved solvent
- pencil-type vacuum cleaner

4.4 PROCEDURE

Method 4-1 shall be used for polyurethane and silicone-type coatings and Method 4-2 shall be used for epoxy-type coatings. The methods are detailed at the end of this chapter.

4.5 ACCEPTANCE CRITERIA

(a) Solder on the area to be repaired shall be freely accessible.

(b) In addition, none of the following conditions shall prevail:
- melting of adjacent solder joints or circuitry
- blistering, measling and charring of coating
- blistering, delamination, measling and charring of laminated base material
- cuts, scratches or other damage to printed wiring

METHOD 4-1 REMOVAL OF POLYURETHANE AND SILICONE-TYPE COATING

(a) Carefully cut through the conformal coating which envelopes the component to be replaced, using a suitable cutting instrument.

(b) Peel away the cut area and, while doing so, apply the vacuum cleaner to the area to remove any small loose particles of conformal coating.

(c) Thoroughly clean the exposed area with an approved solvent before removal of solder joints; apply minimum quantity of solvent and prevent solvent ingressing beneath the exposed edges of the conformal coating.

METHOD 4-2 REMOVAL OF EPOXY-TYPE COATING

(a) Select an appropriate thermal parting tip to suit the workpiece configuration. Set the nominal tip temperature, using the manufacturer's recommended procedure.

(b) Apply the thermal parting tip to the coating, using a light pressure. The tip temperature should be regulated to a point where it will effectively 'break down' the coating without scorching or charring (refer to Figure 4.1).

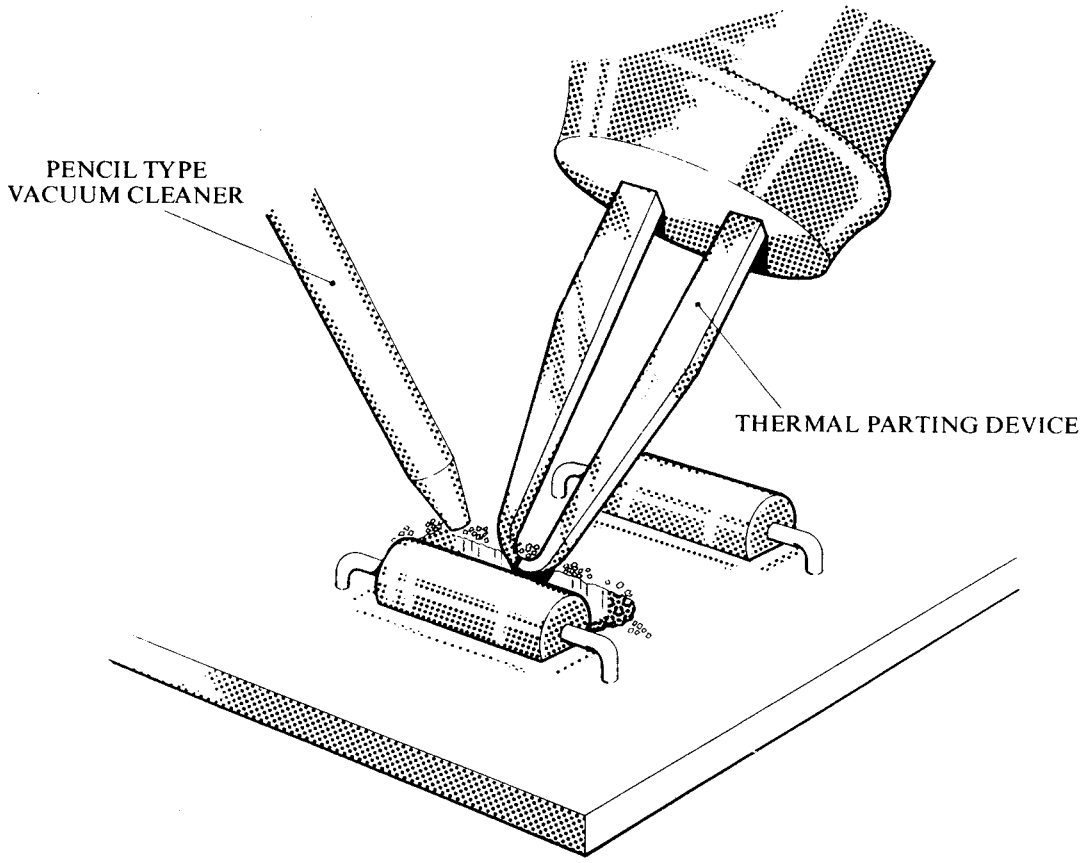


Figure 4.1 - Removal of coating by thermal parting device

(c) Gradually reduce the coating thickness around the component body without contacting the board surface. Remove as much coating as possible from around component leads to allow easy removal of the leads. Pre-clip leads of component to be removed. This will make it possible later to remove the component body separately from leads and solder joints. The pencil-type vacuum cleaner and a bristle brush should be used to remove waste material during the parting process to allow good visual access and prevent inadvertent damage to the board and particulate contamination.

(d) When sufficient coating has been removed, leaving only a small bonded joint between component and board, heat the component body with the thermal parting unit or small soldering iron to weaken the bond at the component/epoxy interface and lift the component free of the circuit board.

(e) The remaining coating material shall now be removed by additional thermal parting. The remaining leads and solder joints shall then be removed by an appropriate solder extraction means as described in Chapter 5.

SECTION 5: SOLDER JOINT REMOVAL AND UNCLINCHING

5.1 INTRODUCTION

A basic requirement for the repair of an electronic circuit is the removal of the solder joint retaining the component in position. There are various methods of achieving this and avoiding thermal and mechanical damage during component replacement.

The following paragraphs describe a number of removal methods which can be used according to the facilities and the specific conditions.

5.2 CONSTRAINTS

Before this task is performed, any conformal coating which has been applied to the circuit must be removed in accordance with the procedure set out in Chapter 4.

5.3 TOOLS AND MATERIALS REQUIRED

- soldering iron or hot jet blower (as applicable)
- solder sucker: continuous vacuum device, hand, wicking wire (as applicable)
- thermal parting device, tweezers, pliers (as applicable)

5.4 PROCEDURE

Solder removal shall be accomplished by one or more of the following methods:

METHOD 5-1 Solder extraction with continuous vacuum

METHOD 5-2 Solder extraction using sucker

METHOD 5-3 Hot jet extraction

METHOD 5-4 Use of wicking braid

METHOD 5-5 Unclinching of leads

METHODS 5-1 to 5-5 are detailed at the end of this chapter

5.5 ACCEPTANCE CRITERIA

(a) There shall be no residual solder present on the solder joint treated.

(b) In addition, none of the following shall occur:
- melting of adjacent solder joints or circuitry
- lifting of the solder joint/pad track
- delamination of the base laminate
- cuts, scratches or other damage to printed wiring/solder joint/pad.

METHOD 5-1 SOLDER EXTRACTION WITH CONTINUOUS VACUUM

The best results are obtained when a vacuum pump is used. The solder can then be withdrawn from the joint either directly through the tip of the soldering iron or through a separate vacuum device attached to the soldering iron. The heated tip of the iron is applied to the soldered joint and, when a melt is noted, the vacuum is activated, e.g. by means of a foot switch, causing the solder to be withdrawn from the joint and deposited into a collecting chamber.

With appropriate handling, this method will largely avoid the overheating problem. The correct positioning of the vacuum device tip is shown in Figure 5.1.

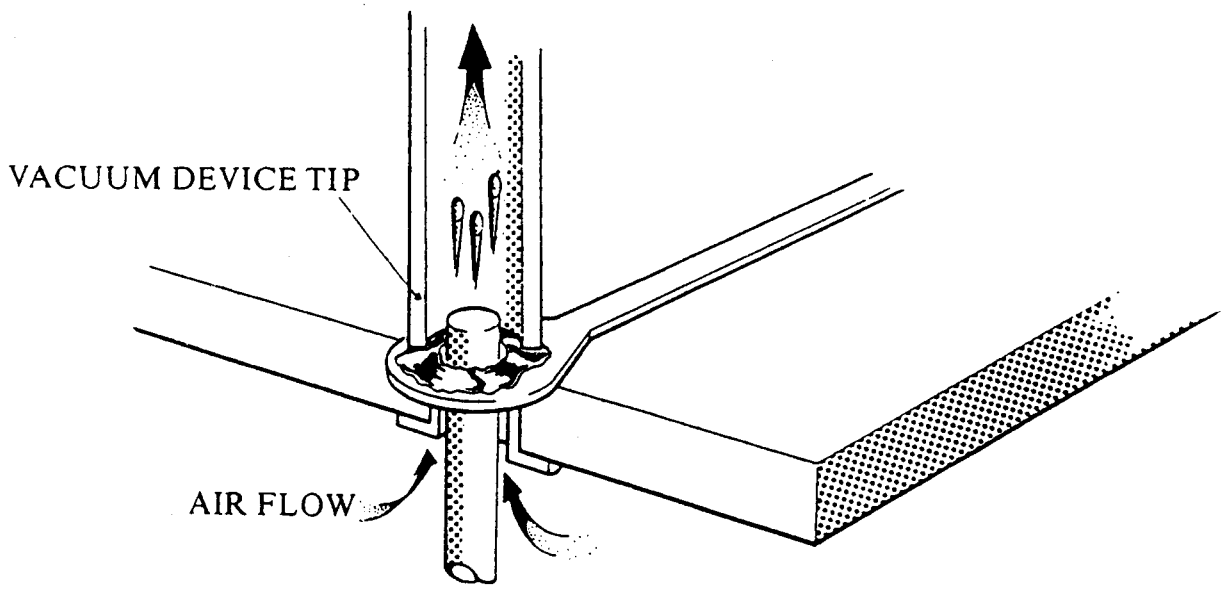


Figure 5.1 - Continuous vacuum solder extraction on stud lead

METHOD 5-2 SOLDER EXTRACTION USING SUCKER

This is a method in which the molten solder is removed by means of a sucker tip. There are several variations of this technique, but all of them have the disadvantage that the vacuum is applied only in short pulses and the procedure may have to be repeated several times. In addition, the work must be performed with two different devices simultaneously, i.e. soldering iron and sucker tip (refer to Figure 5.2). This method will find only limited use.

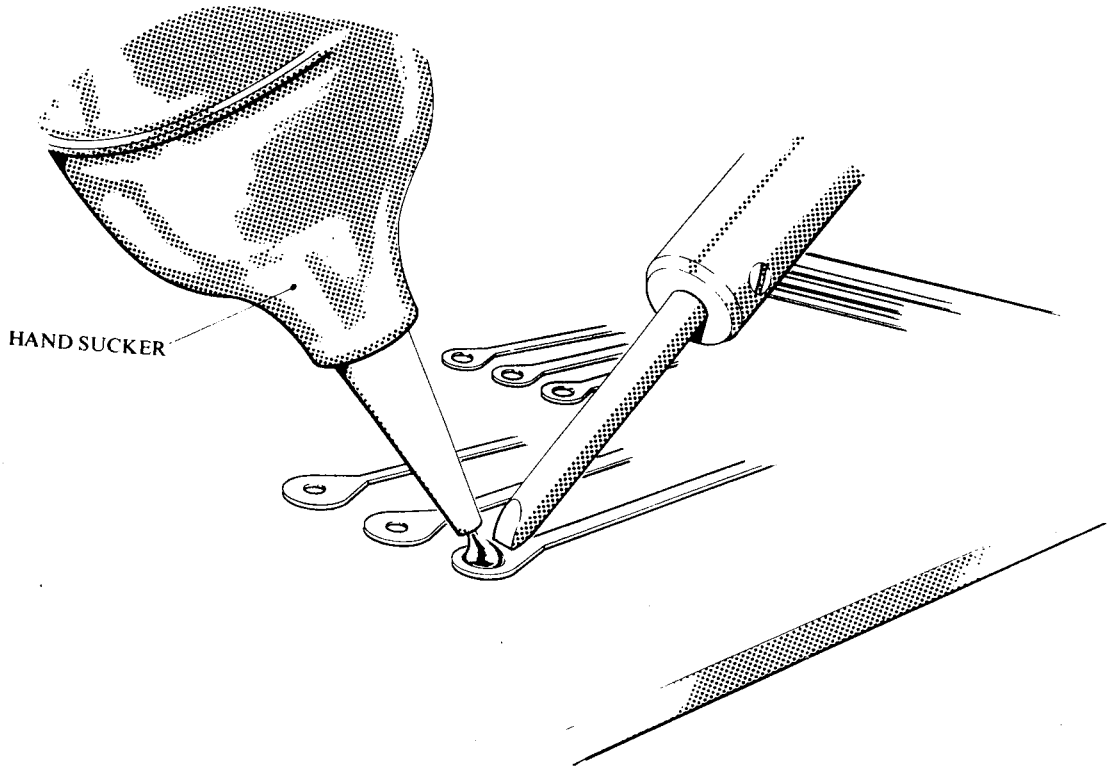


Figure 5.2 - Pulse-type solder sucker in use

METHOD 5-3 HOT JET EXTRACTION

This method relies on a thin jet of heated air (200- 300 °C) to melt the defective solder joint. It is particularly well suited to circuits in flat packages. Owing to the controlled dimensions of the jet, one can unsolder connecting wires individually without affecting the other joints. The molten solder is then wicked off or vacuumed away. This method, shown in Figure 5.3, will find limited use.

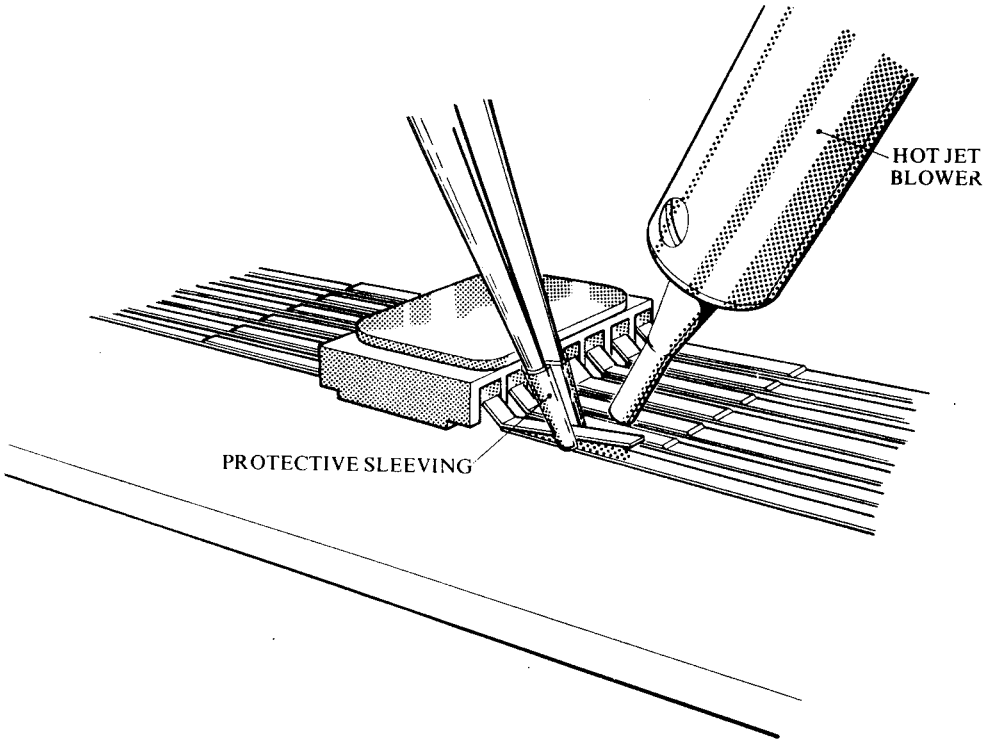


Figure 5.3 - Lifting individual leads with hot jet

METHOD 5-4 USE OF WICKING BRAID

This method (refer to Figure 5.4) incorporates braiding saturated with flux or stranded wire heated in contact with the solder joint. Capillary action causes the molten solder to be drawn into the wick. This method works well on large surface joints and can be applied to through-hole solder joints or, with more difficulty, to the solder between a clinched lead and a terminal area. As the amount of wicked-out solder increases, the capillary action becomes less effective. Thus, joints containing a large amount of solder often require the repeated application of heat, creating a danger of overheating.

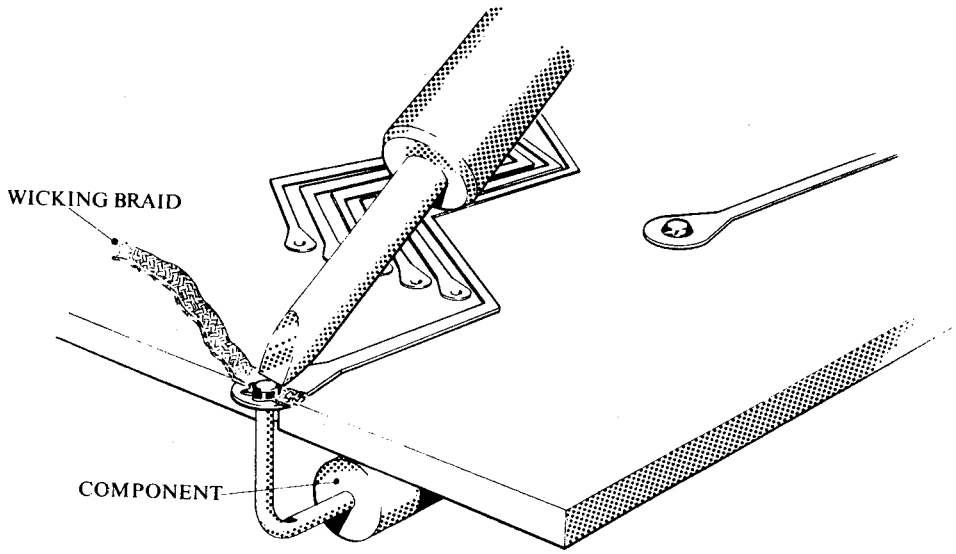


Figure 5.4 - Cross-sectional view of wicking method

METHOD 5-5 UNCLINCHING OF LEADS

(a) Initial solder removal. First use Method 5-1 or Method 5-4 to remove at least the surface solder from around the clinched lead and terminal area. This will permit observation of the true circumstances of the clinched lead contact to the terminal area and the extent of the remaining solder joint between them. The actual unclinching action will be based on these observed conditions.

(b) After solder removal from the clinched area, the joint is allowed to cool down for a few seconds and the wire is carefully lifted with a thin plastic rod or similar device. The method, shown in Figure 5.5, is designed to prevent damage to the terminal area. In lieu of the thermal parting device, tweezers or pliers may be used, provided no contact is made with the terminal area.

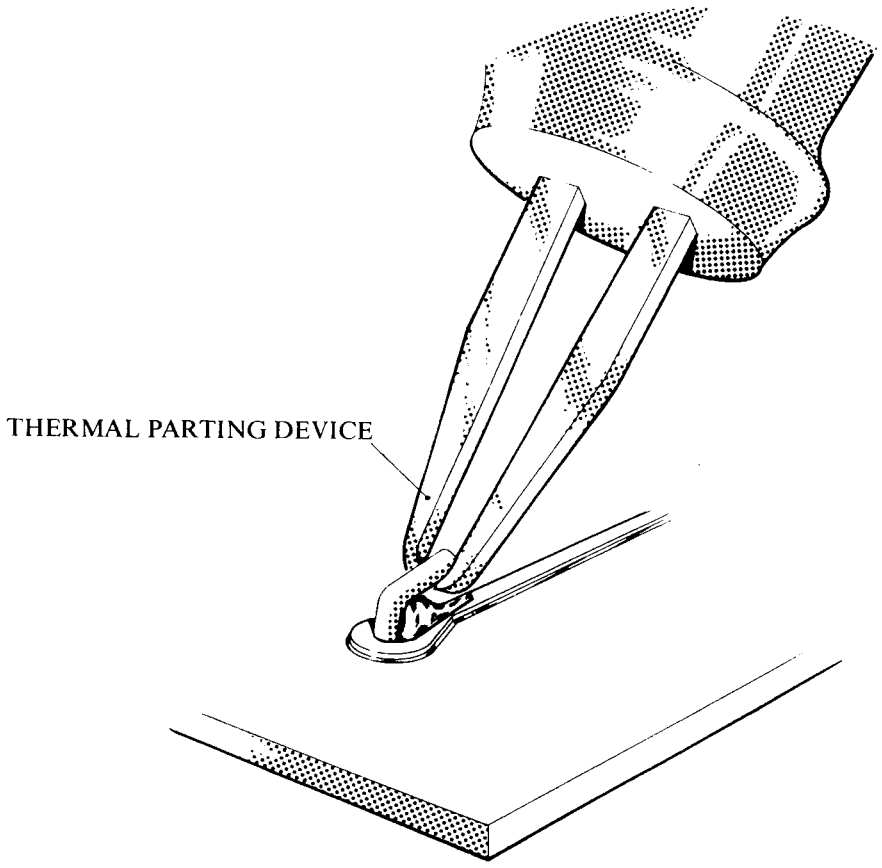


Figure 5.5 - Hot unclinching with thermal parting device

(c) Final solder removal. Once the clinched leads are straightened, one may proceed to remove the solder joints by Method 5-1, treating them as if they were originally unclinched leads.

SECTION 6: REPAIR OF DAMAGED GOLD-PLATED AREAS

6.1 INTRODUCTION

Gold-plating can be damaged as a result of:

(a) solder splatter on gold plating (see Method 6-1)

(b) uneven scratched plating (see Method 6-2)

6.2 CONSTRAINTS

(a) Scratches shall only be repaired if the current-carrying capacity requirement of the conductor is not met.

(b) Flaking, blistered or otherwise defective plating is not considered repairable and a board with such defects shall be rejected.

6.3 TOOLS AND MATERIALS REQUIRED

- soldering iron
- solder sucker, wicking wire, pencil-type vacuum cleaner
- safety glasses (or similar protecting device)
- rubber gloves
- glass fibre eraser
- cleaning tissue
- approved solvent

6.4 PROCEDURE

Method 6-1 shall be used for removal of solder splatter on gold plating. Method 6-2 shall be used for repair of insufficient or scratched gold plating. The methods are detailed at the end of this chapter.

6.5 ACCEPTANCE CRITERIA

6.5.1 Method 6-1

There shall be no residual solder present on the gold plating or damage to the plating. Colour changes on the conductor surface resulting from gold-tin alloying are permitted.

6.5.2 Method 6-2

After repair, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. Particularly detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material.

METHOD 6-1 REMOVAL OF SOLDER SPLATTER ON GOLD PLATING

(a) Remove solder by vacuuming or by wicking with a flux-impregnated wire (refer to Method 5-4). Apply heat just long enough for melting and removal of the solder.

(b) Remove remaining solder with a glass fibre eraser, or similar, employing vacuum cleaner.

(c) Clean repair area with solvent mixture.

METHOD 6-2 REPAIR OF INSUFFICIENT OR SCRATCHED GOLD PLATING

The repair procedure is identical to the "Repair of damaged conductor tracks" detailed in Chapter 7 except that the gold plating shall be removed before soldering in accordance with ESA PSS-01-708.

SECTION 7: REPAIR OF DAMAGED CONDUCTOR TRACKS

7.1 INTRODUCTION

The damage to the conductor may be in one of the following forms:

(a) complete break

(b) scratches or nicks which reduce the current -carrying capacity of the conductor to levels below specification requirement.

7.2 CONSTRAINTS

The damage, in whatever form (refer to Section 7.1), shall not involve a length of track in excess of five times the conductor width.

7.3 TOOLS AND MATERIALS REQUIRED

- soldering iron and solder
- tweezers
- epoxy resin
- approved solvent
- fibre eraser
- cleaning tissue
- selection of tinned copper wire in accordance with Table 7.1.

NOTE: The recommended wire diameters for given conductor widths are listed in Table 7.1. Values stated are for conductor tracks having a thickness ≥ 30 µm. The maximum wire diameter shall not be greater than two thirds (2/3) the width of the conductor.

TABLE 7.1

CONDUCTOR WIDTH (mm)	WIRE DIA (mm) MINIMUM	AWG
0.30	0.16	34
0.40	0.20	32
0.50	0.23	31
0.80	0.28	29
1.60	0.40	26
3.20	0.56	23

7.4 PROCEDURE

Method 7-1 shall be used. This is detailed at the end of this chapter.

7.5 ACCEPTANCE CRITERIA

After repair, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. Particularly detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material.

METHOD 7-1 REPAIR OF DAMAGED CONDUCTOR TRACKS

(a) Clean both sides of break in conductor, at least 3 mm on each side, with a fibre eraser and then with an approved solvent.

(b) Cut a piece of applicable gauge tinned copper wire at least 6 mm longer than the break.

(c) Hold wire with a pair of tweezers on centre line of conductor and solder in place.

(d) Clean area with approved solvent.

(e) Flow a small amount of epoxy resin over the entire repair and cure.

SECTION 8: REPAIR OF LIFTED CONDUCTORS

8.1 INTRODUCTION

This procedure is applicable where a portion of the conductor has lifted from the substrate but not broken (refer to Figure 8.1).

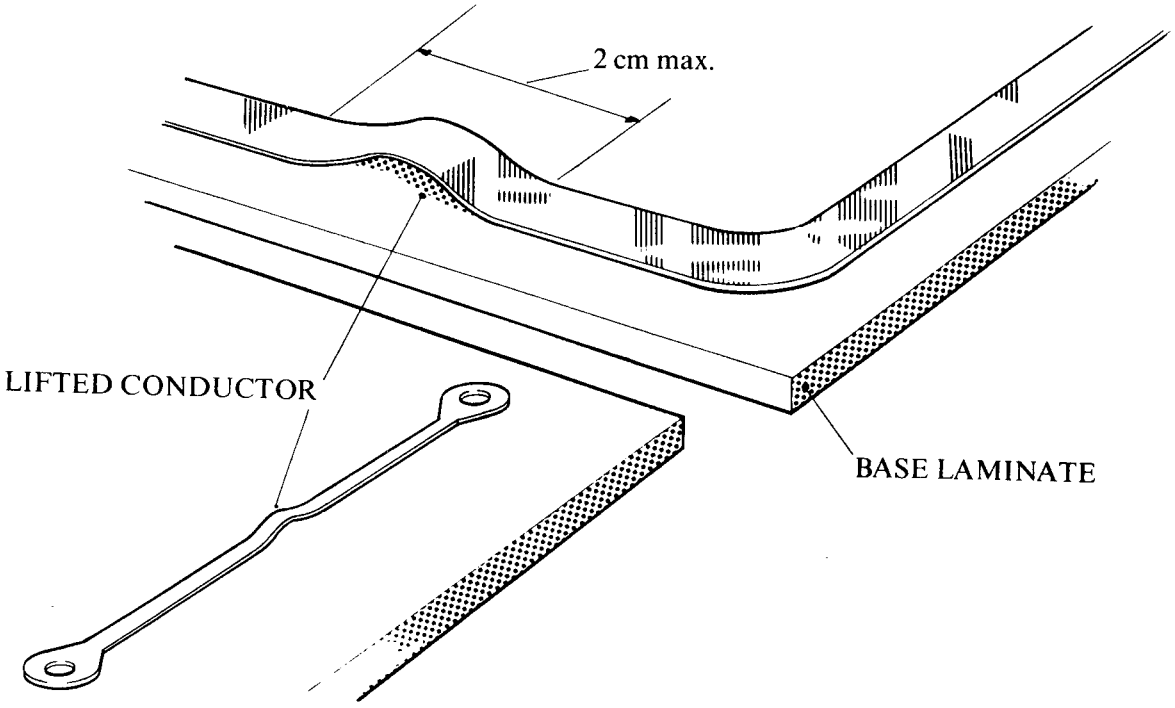


Figure 8.1 - Lifted conductors

8.2 CONSTRAINTS

The length of the lifted conductor to be repaired shall not exceed one-half the length of conductor between two terminal areas or 2 cm, whichever is the smaller.

The number of repairs per printed circuit board assembly shall not exceed the requirements detailed in Paragraph 2.2.3.

8.3 TOOLS AND MATERIALS REQUIRED

- approved solvent
- space-approved epoxy adhesive (compatible with base epoxy)
- plastic toothpicks
- strip of thin PTFE sheet
- small weights

8.4 PROCEDURE

Any components and/or solder that may interfere with the repair shall be removed from the damaged conductor as described in Sections 5 and 13 before proceeding.

Either Method 8-1 or 8-2 shall be used. These methods are detailed at the end of this chapter.

8.5 ACCEPTANCE CRITERIA

(a) The lifted conductor track shall be firmly secured to the base laminate by the epoxy as defined in Methods 8-1 and 8-2. Moreover, the epoxy shall be fully cured and shall not cover areas which require subsequent soldering.

(b) Where components have been removed and subsequently replaced, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. Particularly detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material and/or components.

METHOD 8-1 USE OF EPOXY UNDER CONDUCTOR
(Refer to Figure 8.2)

(a) Clean underside of lifted conductor and surrounding area with isopropyl alcohol.

(b) Remove all particles which prevent the lifted conductor from making intimate contact with the surface of the substrate.

(c) Using a hot air lance, gently blow the adhesive under the entire length of lifted conductor. Ensure the epoxy does not come into contact with surfaces required subsequently for soldering.

(d) Press conductor into contact with substrate by the application of small weights; the interface between the weights and track shall be covered with a thin piece of PTFE. Cure according to the space-qualified method.

(e) Do not handle repaired units until the epoxy has cured.

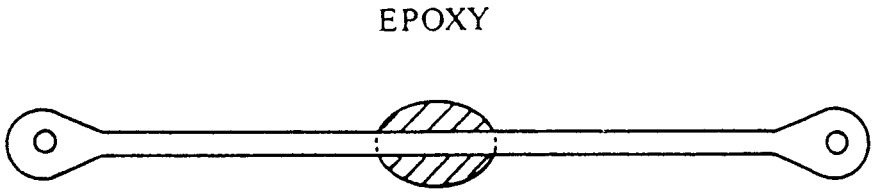


Figure 8.2 - Repair using epoxy under conductor

METHOD 8-2 USE OF EPOXY OVER CONDUCTOR
(Refer to Figure 8.3)

(a) Clean the upper face of the lifted conductor and surrounding area with isopropyl alcohol.

(b) Apply epoxy to the surface of the lifted conductor and to its surroundings to a distance of at least 3 mm in all directions from the damaged area.

(c) Cure according to the space-qualified method.

(d) Do not handle repaired units until the epoxy has cured.

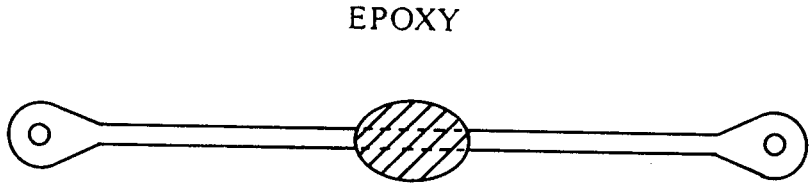


Figure 8.3 - Repair using epoxy over conductor

SECTION 9: REPAIR OF LIFTED TERMINAL AREAS (PADS)

9.1 INTRODUCTION

This procedure is applicable to:

(a) Any terminal area which has been separated, loosened or lifted or which is otherwise no longer bonded to the base material, as shown in Figure 9.1.

(b) Any terminal area which has been damaged by tearing, cutting, or other mechanical means in excess of established acceptance limits (refer to Figures 9.2 and 9.3).

(c) Terminal areas designed to accommodate clinched leads.

9.2 CONSTRAINTS

(a) Circuitry spacing must not be reduced by the repair to less than the minimum acceptable standard.

(b) The unshaded areas in Figures 9.2 and 9.3 are terminal or land areas to be inspected. In these areas, the amount of disbonded material must not extend for more than one half the distance from the edge of the terminal area to the nearest edge of the hole (annular ring) over not more than 180 °C of the periphery.

(c) When the repair is completed, a clinched lead-through is to be inserted in the hole. This may be a separate wire link or the component lead.

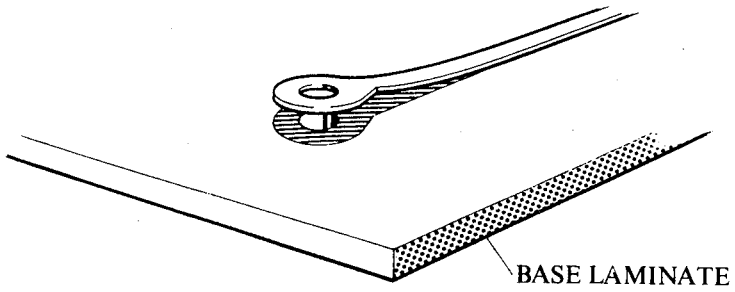


Figure 9.1-Lifted terminal area

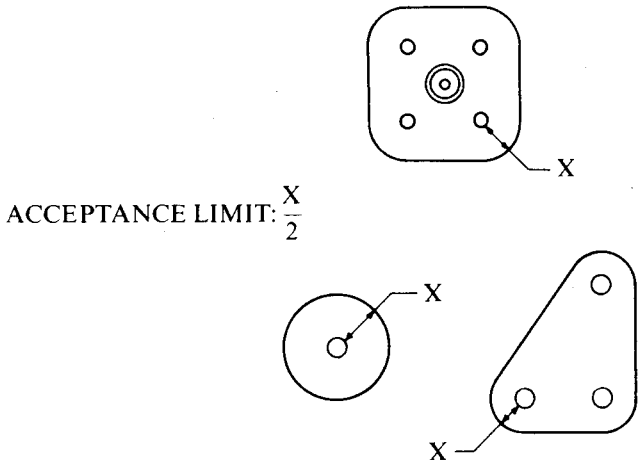


Figure 9.2-Terminal areas without track

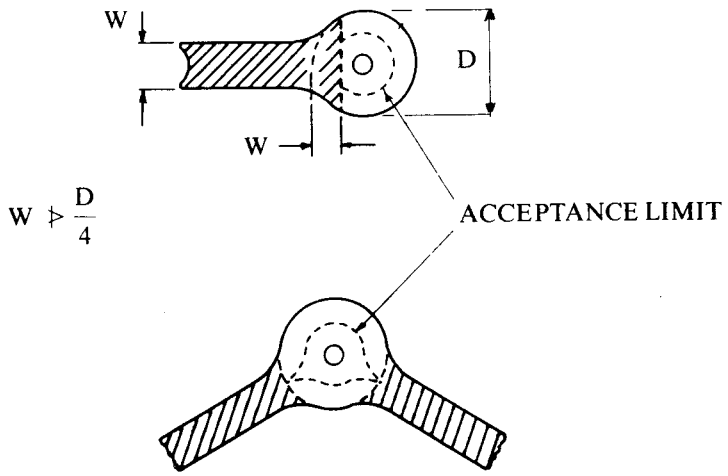


Figure 9.3 - Terminal areas with track attached

9.3 TOOLS AND MATERIALS REQUIRED

- solder remover (vacuum type)
- oven (if thermal curing epoxy used)
- soldering iron
- plastic toothpicks (for lifting terminal whilst cleaning)
- isopropyl alcohol solvent
- epoxy resin compatible with base

9.4 PROCEDURE

Method 9-1 shall be used. This is detailed at the end of this chapter.

Before starting, components and solder which impinge on the repair area shall be removed in accordance with the methods described in this document.

9.5 ACCEPTANCE CRITERIA

The acceptance criteria shall be as stated in Section 8.5 and as shown in Figures 9.2 and 9.3.

METHOD 9-1 REPAIR OF LIFTED TERMINAL AREAS (PADS)

(a) Clean all dirt, fingerprints, flux residue and foreign matter from under and around pad with isopropyl alcohol or other approved solvent.

(b) Insert space-approved epoxy adhesive under the copper with a camel-hair brush, syringe or other suitable applicator.

(c) CAUTION: Solder side of terminal area must be free of contamination.

(d) Press terminal area down with a clamp or suitable weight unit set.

(e) Air cure or bake to manufacturer's instructions before attempting further work. The surface build-up of adhesive shall be smooth and neat in appearance.

SECTION 10: TERMINAL POST REPLACEMENT

10.1 INTRODUCTION

Terminal posts shall be replaced when they have become damaged. Straightening operations will cause doubt as to their integrity and shall not be attempted.

10.2 CONSTRAINTS

Terminal-post replacement is applicable when it is considered that the operation can be carried out without damage to adjacent conductor track/base laminate/components.

10.3 TOOLS AND MATERIALS REQUIRED

- replacement terminal posts
- side cutters
- soldering iron
- approved solder
- approved solvent
- appropriate drill bits
- suitable support jigs
- pliers
- pencil vacuum cleaner

10.4 PROCEDURE

Method 10-1 shall be used. This is detailed at the end of this chapter.

10.5 ACCEPTANCE CRITERIA

(a) The terminal installation shall be in accordance with manufacturer's procedure. Furthermore, no damage to adjacent conductor tracks/base laminate or components shall be observed.

(b) Where components have been removed and subsequently replaced, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. In particular, detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material and/or components.

METHOD 10-1 TERMINAL POST REPLACEMENT

(a) Remove the conformal coating from the area surrounding the damaged post (see Chapter 4).

(b) Remove the component connected to the terminal post by cutting the component leads. Remove the section of component lead remaining at the non-damaged side of the component using the method described in Chapter 13.

(c) Turn the printed circuit assembly over and support it on suitable jigging so that the subsequent drilling operation does not cause flexing of the assembly.

(d) Select a drill bit that is approximately 80% of the post diameter and drill into the post to a depth that just exceeds the thickness of the epoxy board (refer to Figure 10.1).

(e) With a drill bit the exact size of the terminal post, slowly drill into the post until the swaged section has been removed (refer to Figure 10.1).

(f) Remove the solder from the base of the post.

(g) Take the post between the jaws of a pair of pliers and, with a slight rocking motion, pull the post from the printed circuit assembly. Heat must be applied if the terminal post is installed in a plated-through hole.

(h) Clean the surrounding area with approved solvent and pencil vacuum cleaner.

(i) Fit replacement terminal post in accordance with normal manufacturing procedure.

(j) Clean with approved solvent.

(k) Inspect joint for correctness of swage and soldering.

(l) Fit new component.

(m) Re-apply conformal coating to the area.

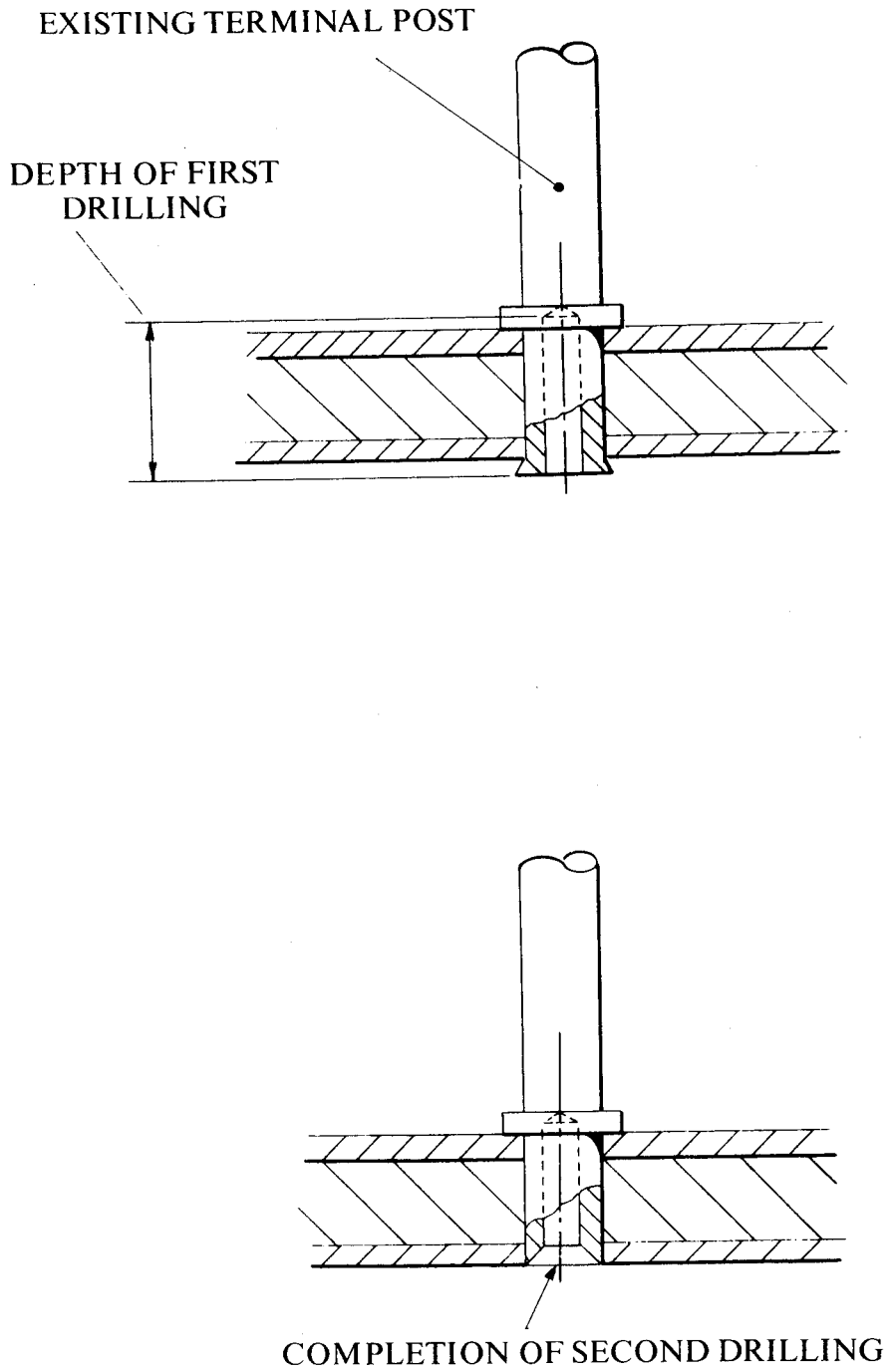


Figure 10.1 - Terminal post replacement

SECTION 11. WIRE-TO-WIRE JOINTS

INTRODUCTION

Wire-to-wire joints are used for wires which are broken or require lengthening for modification purposes.

CONSTRAINTS

(a) Repair should be undertaken only when considerations of time, cost and use make it impossible to install new wires.

(b) If the wire is shaped to by-pass a component, then the wire must have additional fixing at each bend.

(c) During the process care shall be taken to avoid the ingress of flux between conductor and insulating sleeve.

11.3 TOOLS AND MATERIALS REQUIRED

- side cutters
- soldering iron, solder and flux
- heating means (infrared or hot air)
- approved solvent
- wire stripper
- heat shunt
- heat shrink sleeving (transparent, approved type)
- approved insulated wire
- wire clamping device
- cotton gloves or finger cots

11.4 PROCEDURE

Method 11-1 shall be used. This is detailed at the end of this chapter.

11.5 ACCEPTANCE CRITERIA

The joint shall be inspected as stated in Method 11- 1 (i). Furthermore, no damage to adjacent conductor tracks, base laminate or components shall be observed.

METHOD 11-1 WIRE-TO-WIRE JOINING

(a) Cut wires to the correct length.

(b) Remove wire insulation as detailed in ESA PSS- 01-708. The insulation clearance shall be as prescribed in ESA PSS-01-708.

(c) If disturbed, the lay of a stranded conductor shall be restored. Do not use bare fingers to achieve this.

(d) Pre-tin the wires in accordance with ESA PSS-01- 708.

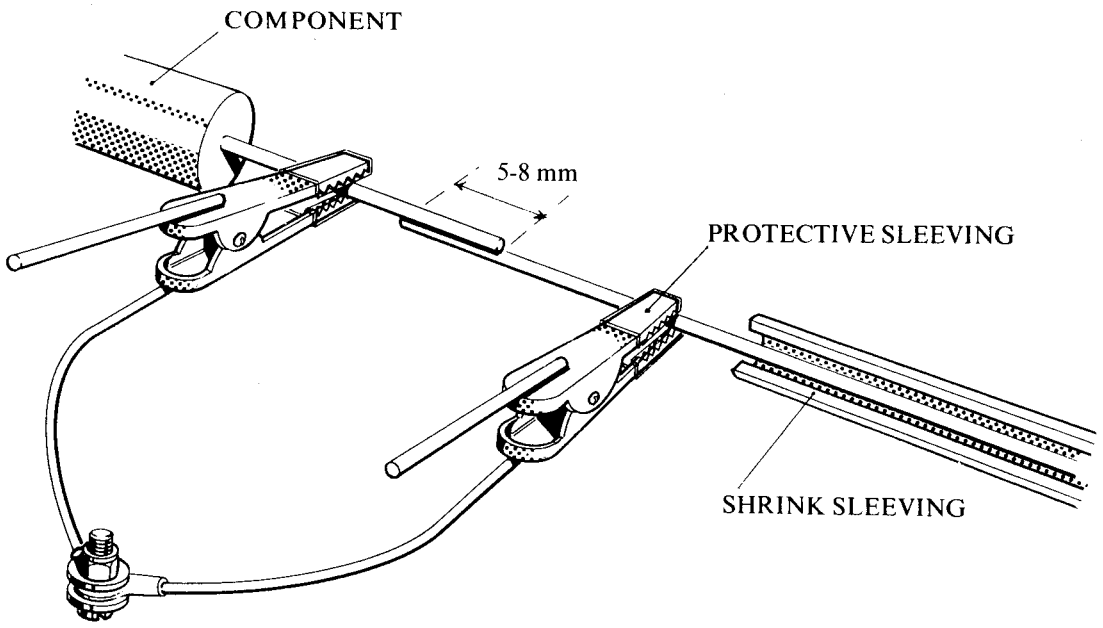


Figure 11.1 - Use of approved type support clamp/heat sink

(e) Place heat-shrink sleeving over the wire insulation in readiness for sliding over the joined wire.

(f) If necessary, position wires into joined configuration and maintain position with clamping device (refer to Figure 11.1).

(g) Solder wires together (using heat shunt on each lead) to form a lap-type joint. A low contact angle between the solder and wires is required and the contour of the individual conductor wires shall be visible.

(h) Clean area with approved solvent to remove flux.

(i) Inspect joint. The workmanship standards of ESA PSS-01-708 shall apply.

(j) Position shrink sleeve over joint and shrink to size in accordance with manufacturer's instructions. At no time shall the shrink temperature be allowed to exceed the melting point of the solder.

NOTE: For the configurations described in Chapters 12 and 15, a wrap-around joint can be used for component lead extension.

(k) Position the extended wire on the board and bond to the board using a suitable space-approved adhesive. If the lead is longer than 2.5 cm, it shall be bonded along its length at intervals of not more than 2.5 cm. The first spot bond of the extension wire shall not be more than 1.5 cm from the component-to-wire soldered joint.

SECTION 12: ADDITION OF COMPONENTS

12.1 INTRODUCTION

Additional components may be required on a printed circuit assembly for the following reasons:

(a) An oversight in design

(b) Subsequent testing of the manufactured assembly indicates a need for modification

(c) A change in the design requirement.

Methods to be used are:

METHOD 12-1	Additional components mounted on reverse (non-component) side of board
METHOD 12-2	Additional components mounted on component side of board
METHOD 12-3	Additional components mounted on terminal posts, including 'piggyback' mounting
METHOD 12-4	Additional components mounted (on reverse side or on component side of board) using staking compound
METHOD 12-5	Additional components mounted (on reverse side or on component side of board) to leads of adjacent components.

12.2 CONSTRAINTS

(a) Components shall be added only if such addition does not invalidate the physical dimension requirements of ESA PSS-01-710.

Method 12-1, Method 12-4 (reverse side mounting) and Method 12-5 (reverse side mounting) shall be employed only if the packaging enables the component to be mounted on the underside of the assembly and this does not cause other problems.

Method 12-3 shall be used only if there is sufficient metallic land, as defined in ESA PSS-01-710, to allow for both soldering and swaging of the terminal post.

(b) The addition of a component may necessitate the extension of component leads; it is preferable that such leads be extended for an equal distance on each side of the component by means of the lap joint method defined in Chapter 11 or the wrap-around method of Paragraph 7.9 "Connection without Terminals" of ESA PSS-01-708. The wires shall be covered with space-approved insulation. The lead extension shall be limited to avoid subsequent vibration problems. The first spot bond of the extension wire shall not be more than 15 mm from the component-to-wire soldered joint.

(c) Where reference is made in these procedures to the removal of the remaining portion of lead on the non-component side of the board, this shall include the removal of any clinched portion in accordance with Chapter 5.

12.3 TOOLS AND MATERIALS REQU.RED

- soldering iron
- approved solder
- side cutters
- heat shunt
- wire stripper
- approval solvent and cleaning brushes
- approved epoxy paste staking compound
- approved thixotropic polyurethane staking compound
- terminal pins
- wire insulation
- approved insulated wire
- lint-free paper
- pencil type vacuum cleaner

12.4 PROCEDURE

Select from Methods 12-1 to 12-5 which are detailed at the end of this chapter. They can be chosen for single-sided or double-sided boards. The appropriate method (Method 12-1 or Method 12-2) shall be chosen for addition of components to double-sided boards depending on the configuration required.

12.5 ACCEPTANCE CRITERIA

After repair, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. In particular, detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material and/or components.

METHOD 12-1 ADDITIONAL COMPONENTS MOUNTED ON REVERSE (NON-COMPONENT) SIDE OF BOARD

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Carefully remove any conformal coating from the area to be worked. Use the method described in Chapter 4.

(c) If the new component lead traverses conductors, assemble insulating sleeving to the section of lead that will not be soldered (refer to Figure 12.1).

(d) Form the component lead as shown in Figure 12.1.
The section of lead to be soldered shall be formed so that it follows the centre-line of the conductor track. Forming shall observe the stress-relief requirements of ESA PSS-01-708.

NOTE: Component lead diameter (or width) shall not be greater than two thirds (2/3) track width.

(e) Solder into position.

(f) Remove protective paper.

(g) Clean soldered area with approved solvent.

(h) Inspect to the requirements of ESA PSS-01-708.

(i) Re-apply conformal coating and cure according to specification requirement.

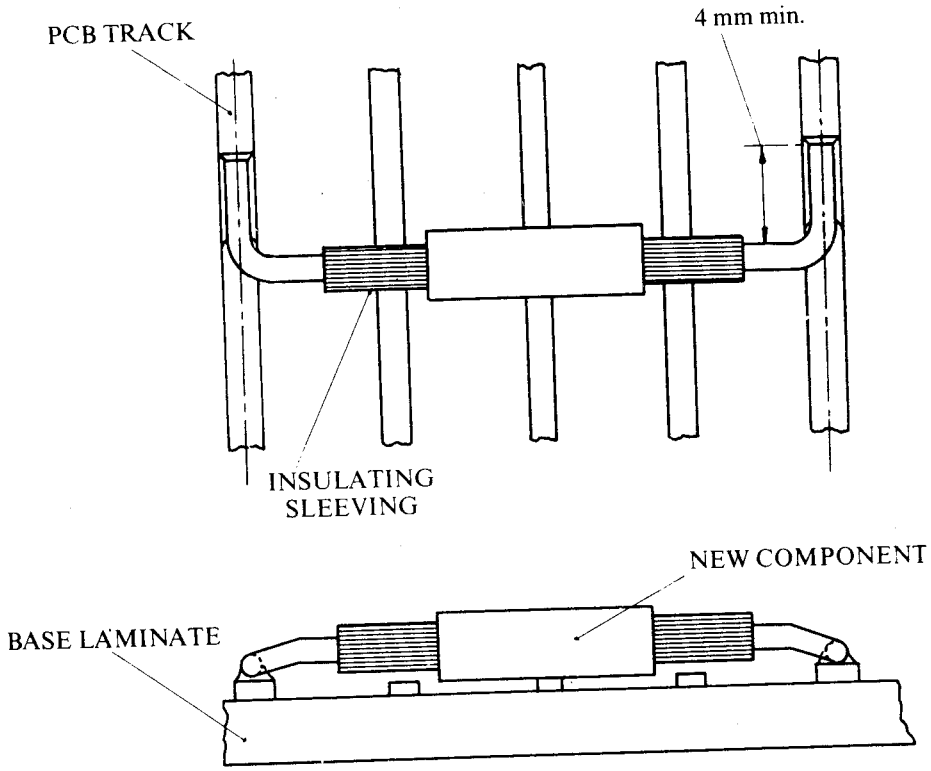


Figure 12.1 - Additional components mounted on reverse (non-component) side of board

METHOD 12-2 ADDITIONAL COMPONENTS MOUNTED ON COMPONENT SIDE OF BOARD

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Carefully remove any conformal coating from the area to be worked. Use the method described in Chapter 4.

(c) Drill holes in the printed circuit assembly adjacent to the conductor tracks to which the component is to be joined. (During this operation the vacuum cleaner shall be used to remove swarf). The size of hole shall be component lead diameter, W, plus 0.25 to 0.50 mm. The position of the hole shall be such that the edge of the hole is a minimum of 0.2 mm from the edge of the conductor.

(d) Form the component leads and assemble the component to the board as shown in Figure 12.2. Components may also be mounted in parallel with existing tracks to avoid additional bending of leads. The stress relief and bend radius requirements of ESA PSS-01-708 shall apply.

(e) Place the section of the component lead to be soldered along the centre line of the conductor and solder into this position (refer to Figure 12.2).

NOTE: Component lead diameter (or width) shall not be greater than two thirds (2/3) track width.

(f) Clean soldered area with approved solvent.

(g) Inspect to the requirements of ESA PSS-01-708.

(h) Re-apply conformal coating and cure according to specification requirement.

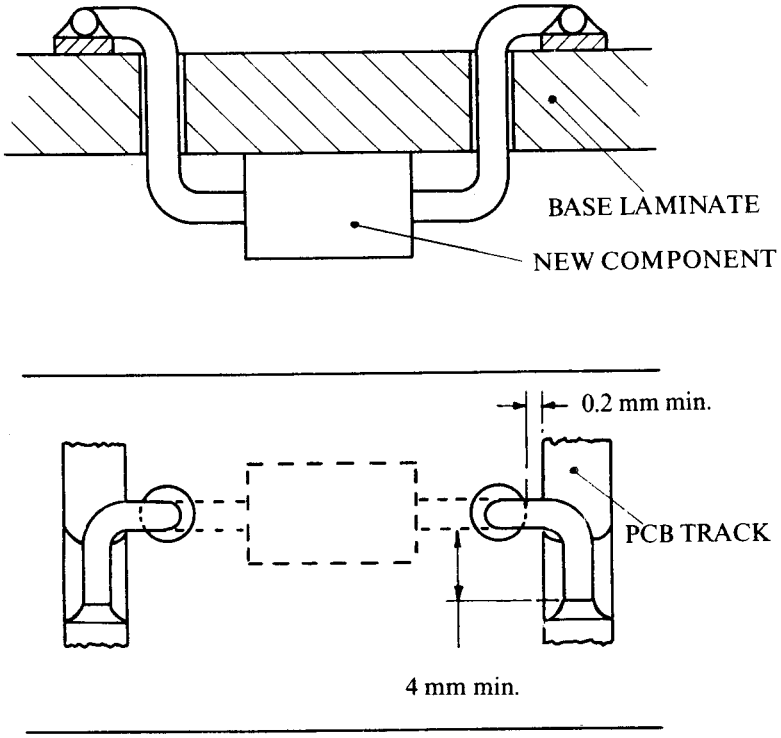


Figure 12.2 - Additional components mounted on component side of board

METHOD 12-3 ADDITIONAL COMPONENTS MOUNTED ON TERMINAL POSTS, INCLUDING 'PIGGY BACK' MOUNTING

This method shall be used only if there is enough metallic land to permit drilling the appropriate size terminal post hole and subsequent soldering.

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked. Use the method described in Chapter 4.

(b) Carefully remove any conformal coating from the area to be worked. Use the method described in Chapter 4.

(c) Drill the terminal post holes into suitable land areas of the conductor track. During this operation the vacuum cleaner shall be used.

(d) Mount and solder the terminal posts in their respective holes.

(e) Solder the component to the terminal posts. The constraints of ESA PSS-01-708 shall apply.

NOTE: If it is necessary to attach the leads of the component to the non-component side of the board, Method 12-2, Paragraph (c) shall be used.

It is preferable to mount components parallel to each other with one side of each component lying on the pcb. However, it is also permissible to mount one component on top of another ('piggyback' mounting). If this is required, solder the second component to the terminal posts as shown in Figure 12.3.

(f) For a 'piggyback' configuration, apply an approved staking compound to join component bodies together and the lower component to the board.

(g) Re-apply conformal coating and cure according to specification requirement.

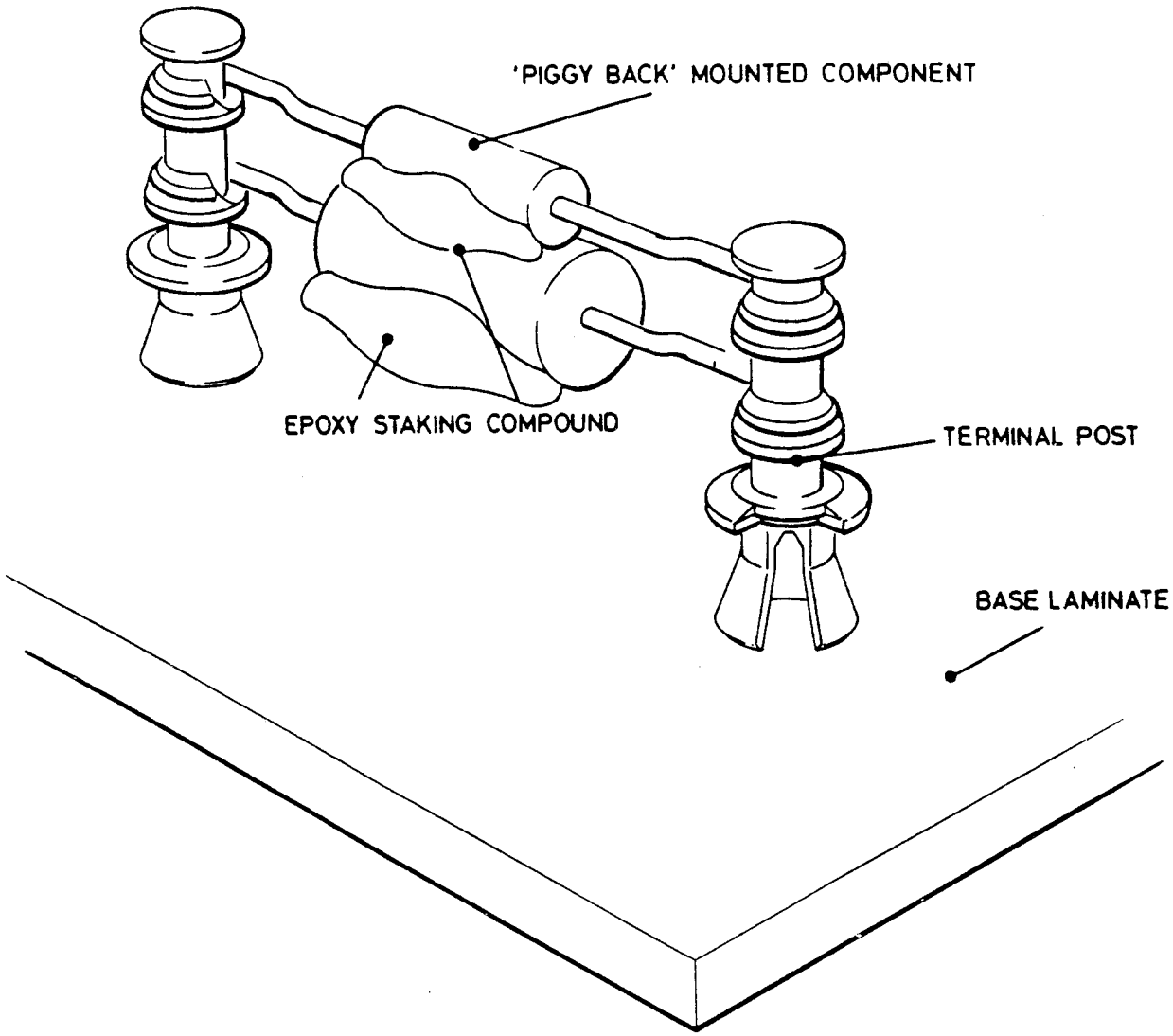


Figure 12.3 - 'Piggyback' mounting of one component on top of another

METHOD 12-4 ADDITIONAL COMPONENTS MOUNTED (ON REVERSE SIDE OR ON COMPONENT SIDE OF BOARD) USING STAKING COMPOUND

This method can be used for the addition of axially and non-axially leaded components and dual-in-line (DIL) packages. The bonding of components avoids subsequent vibration problems. Several configurations are permissible (refer to Figures 12.4 (a), (b), (c) and (d)).

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Carefully remove any conformal coating from the area to be worked. Use the method described in Chapter 4.

(c) For the configuration shown in Figure 12.4 (d) only, drill holes in the double-sided printed circuit board at the position where the component is to be mounted. (During this operation the vacuum cleaner shall be used to remove swarf). The size of hole shall be component lead diameter, 'd', plus 0.25 to 0.50 mm.

NOTE: This procedure can be applied to multi-layer boards, if controls are applied to ensure that internal conductors are not damaged.

(d) Form the component leads. Bond the component to the board with epoxy paste or thixotropic polyurethane staking compound as illustrated in Figures 12.4 (a) or (b) or (c) or (d). Cure according to specification requirements.

If a DIL package is to be mounted upside down, leads shall be de-golded and pre-tinned in accordance with ESA PSS- 01-708. Part coding shall be re-marked onto the underside to preserve identification.

The stress relief and bend radius requirements of ESA PSS-01-708 shall apply.

(e) Strip, pre-tin (with use of a heatsink to prevent wicking) and form space-approved insulated wire for component lead extension.

For connecting top/bottom sides of double-sided or multi-layer printed circuit boards, insulated wire can be passed through unused plated through holes. Holes must not be drilled or solder-wicked to enable the wire to be inserted. (AWG 30, silver plated, stranded, insulated wire fits adequately in a plated through hole of diameter 0.75 mm).

(f) Solder wires to component leads using a wrap- around connection as per Paragraph 7.9 "Connection without Terminals" of ESA PSS-01-708 (refer to Figures 12.4 (a), (b), (c) and (d)).

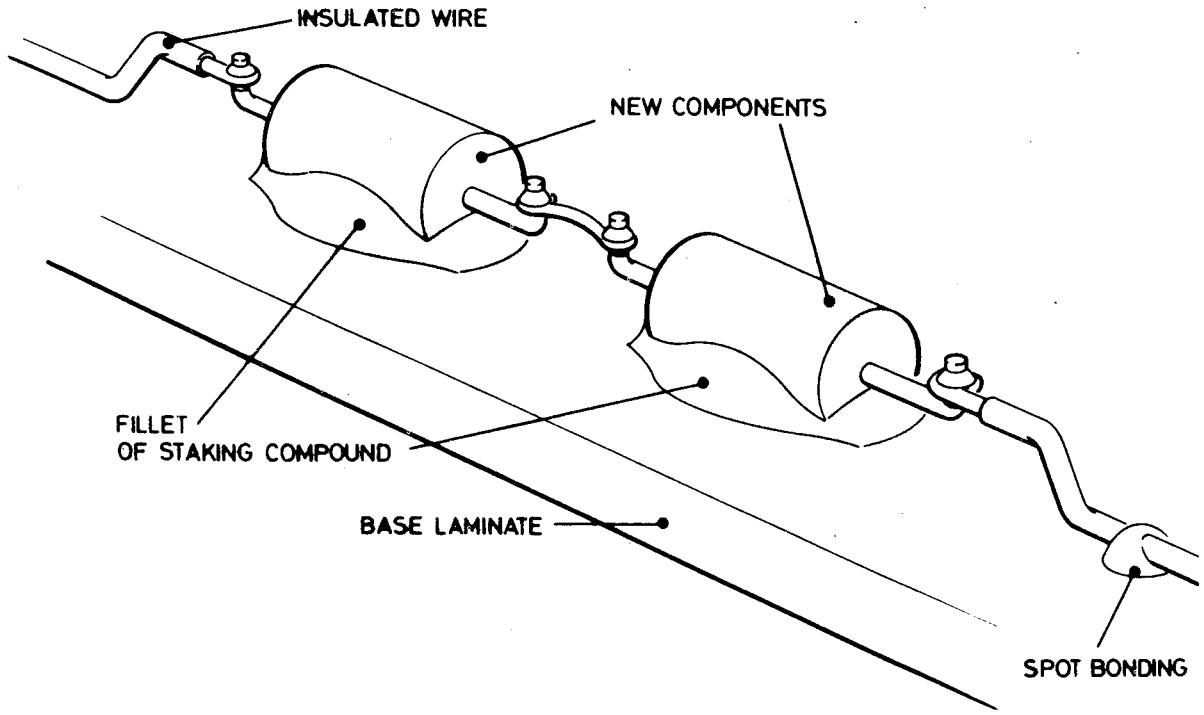
NOTE: For some component types, a heatsink must be used to prevent reflow of low melting point soldered connections within the component body.

(g) Clean soldered area with approved solvent.

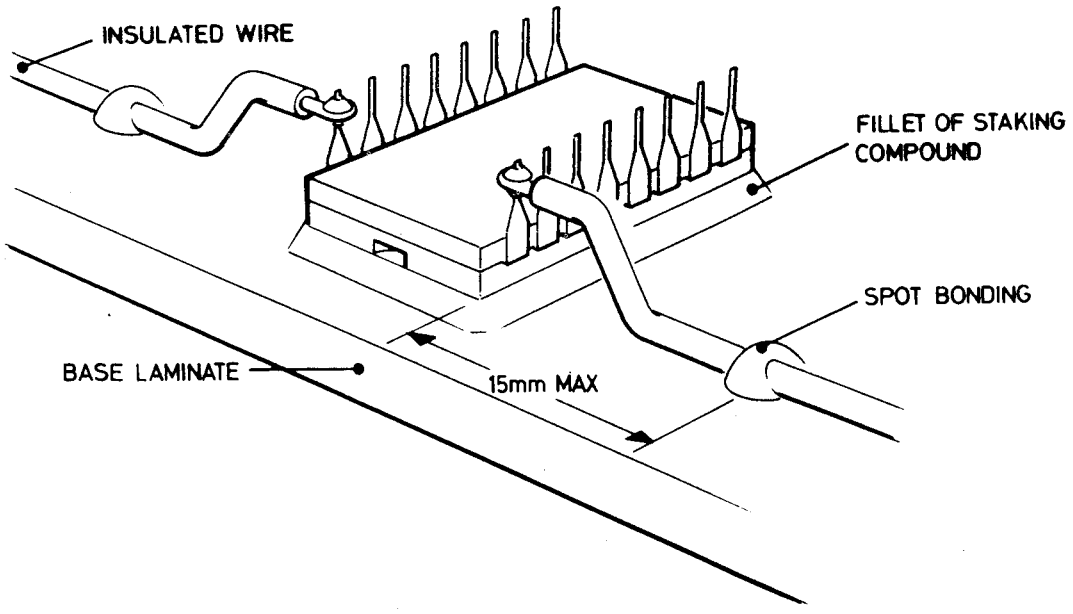
(h) Inspect to the requirements of ESA PSS-01-708.

(i) Position wire extensions on board and bond to the board as defined in Chapter 11.

(j) Re-apply conformal coating and cure according to specification requirements.

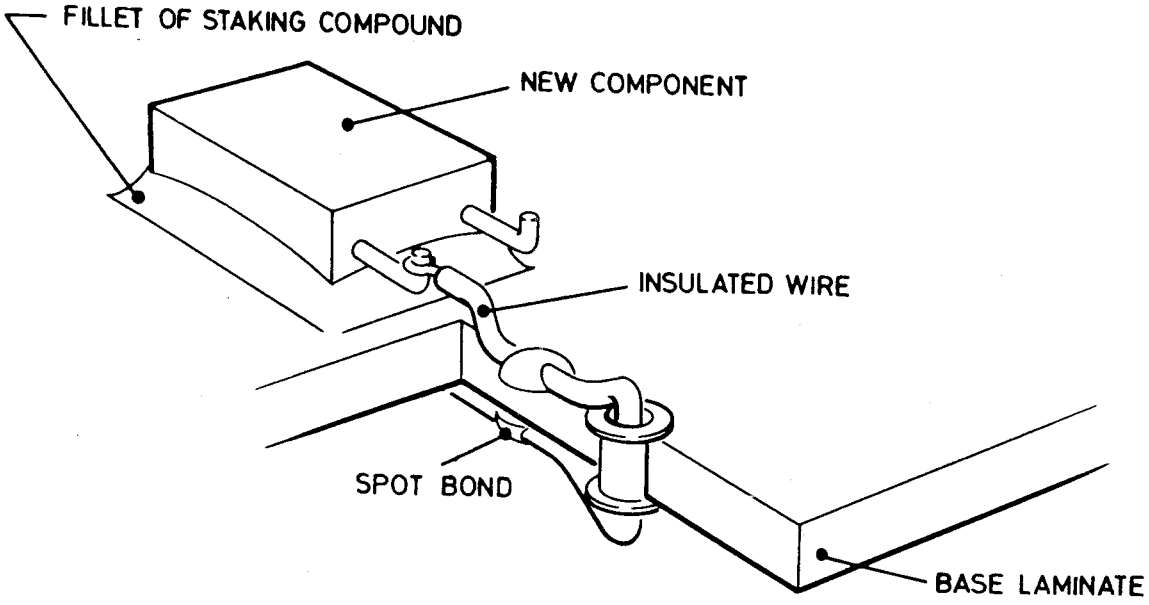


(a) Mounting and wiring of axially-leaded components

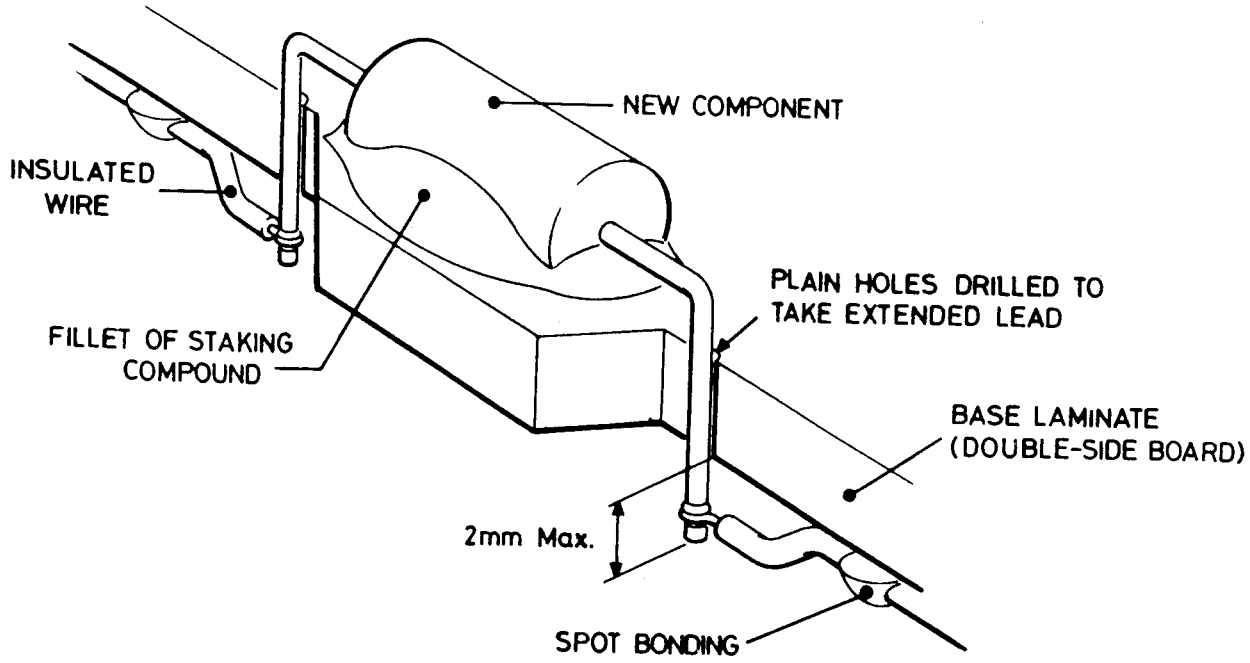


(b) Upside down mounting and wiring of side-brazed DIL component

Figure 12.4 - Additional components mounted (on reverse side or on component side of board) using staking compound



(c) Mounting of non-axially leaded components, e.g. capacitors, with wire connecting top/bottom sides of the circuit board



(d) Mounting of component (on component side of board) with wire connections on reverse side of board

Figure 12.4 - Additional components mounted (on reverse side or on component side of board) using staking compound

METHOD 12-5 ADDITIONAL COMPONENTS MOUNTED (ON REVERSE SIDE OR ON COMPONENT SIDE OF BOARD) TO LEADS OF ADJACENT COMPONENTS

Several configurations are permissible (refer to Figures 12.5 (a), (b) and (c)).

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Carefully remove any conformal coating from the area to be worked. Use the method described in Chapter 4.

(c) For the configurations shown in Figures 12.5 (a) and (b),remove existing components in the adjacent positions (to which connections of the additional component are required). Use the method described in Chapter 13. Replace with new components which have either leads extended in the Z - direction (refer to Figure 12.5 (a)) or a formed pig-tail lead (refer to Figure 12.5 (b)).

(d) Form the leads of the additional component. The stress relief and bend radius requirements of ESA PSS-01-708 shall apply. For the configuration shown in Figure 12.5 (c), assemble insulating sleeving to the section of lead that will not be soldered if lead passes above a conductor.

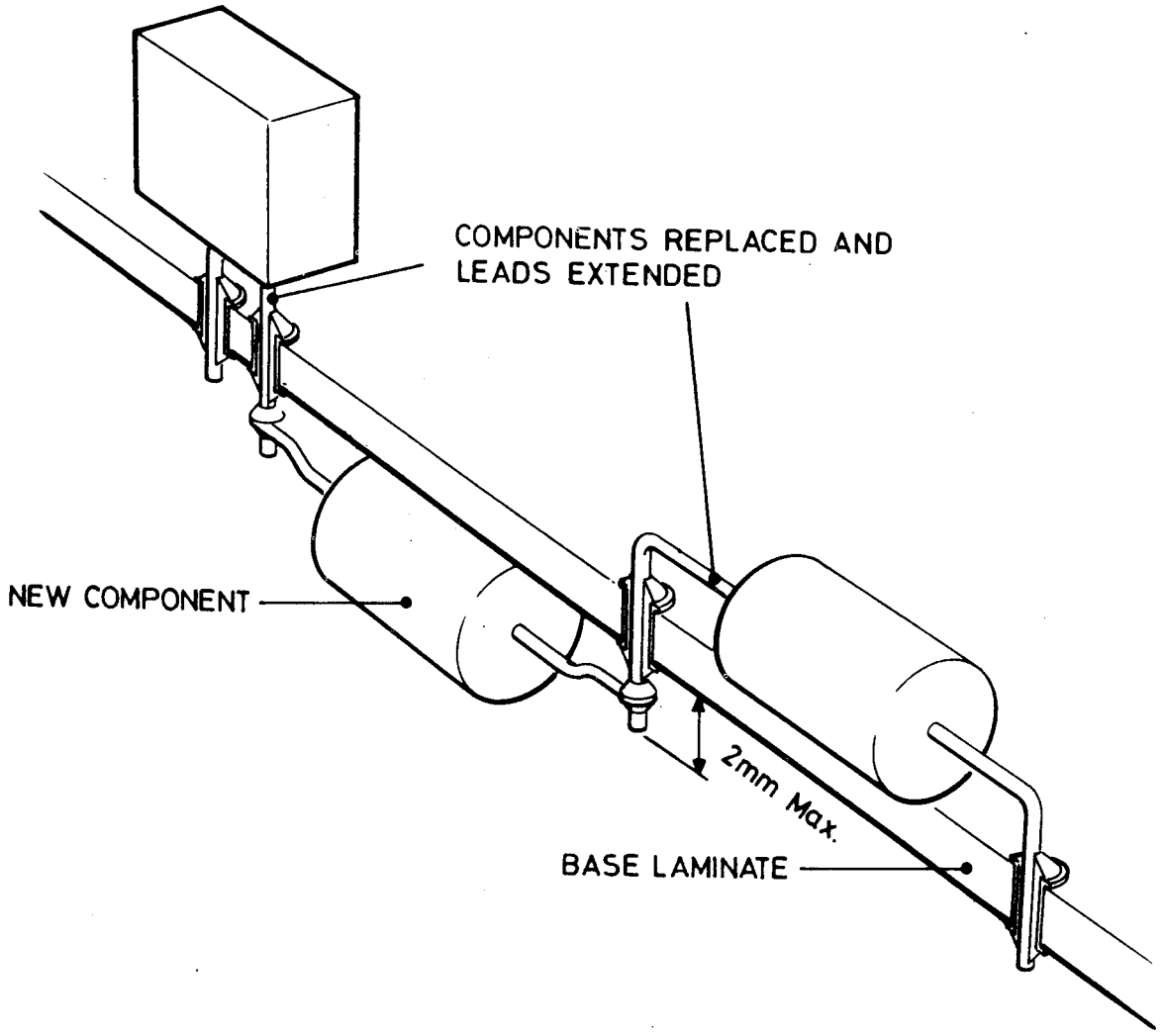
(e) Solder leads onto the leads of adjacent components using a wrap-around connection as per Paragraph 7.9 "Connection without Terminals" of ESA PSS-01-708.

(f) Clean soldered area with approved solvent.

(g) Inspect to the requirements of ESA PSS-01-708.

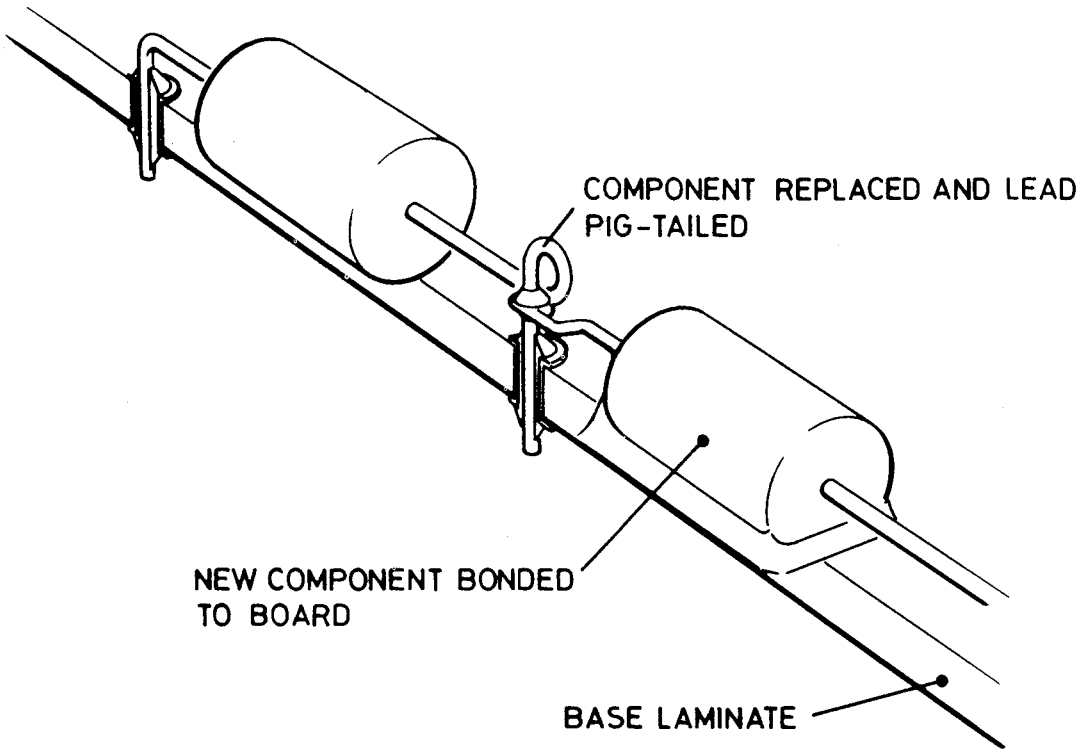
(h) For the configurations shown in Figures 12.5(b) and (c), bond components to the board.

(i) Re-apply conformal coating and cure according to specification requirements.



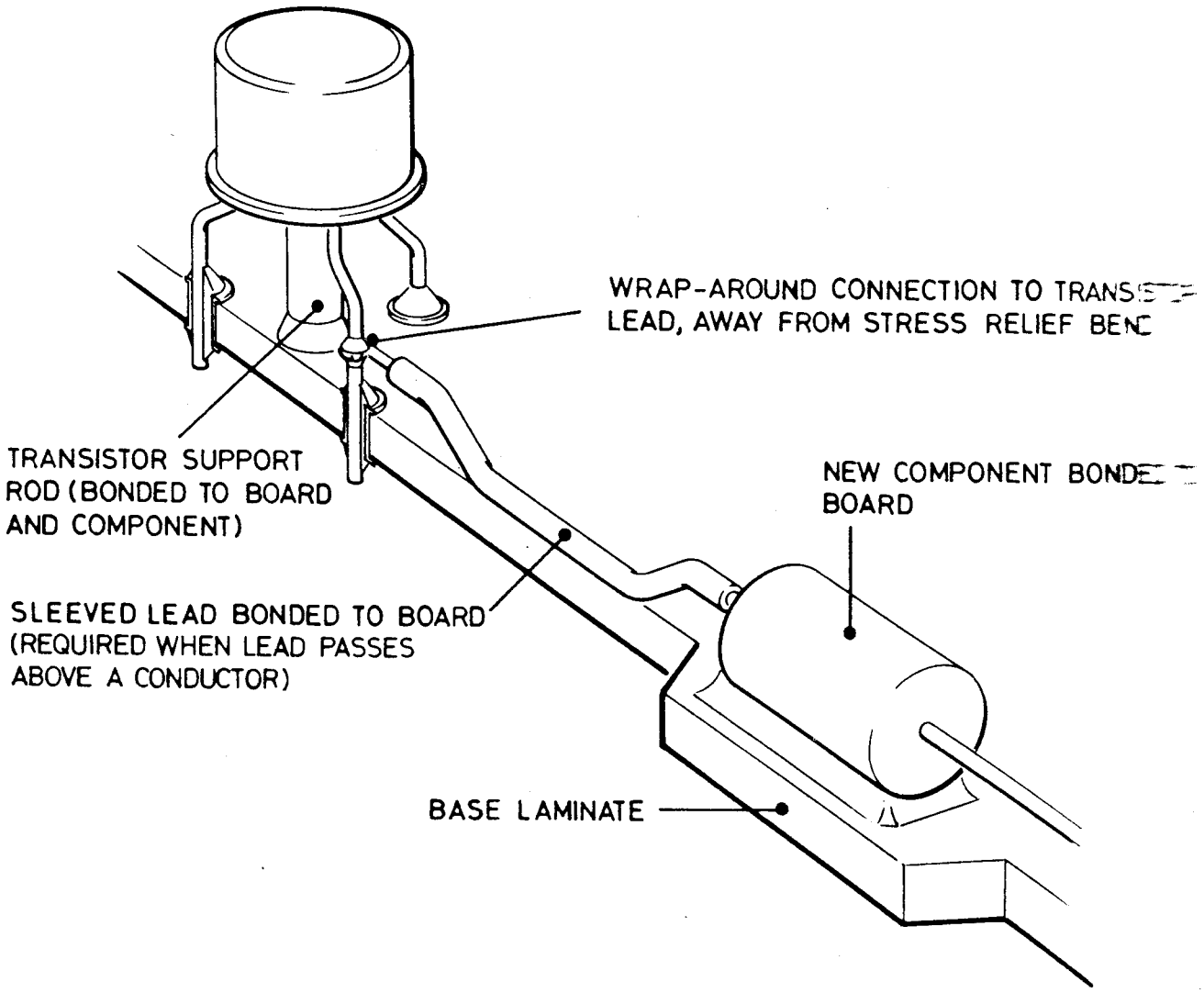
(a) Mounting of component (on reverse side of board) across extended leads of adjacent components

Figure 12.5 - Additional components mounted (on reverse side or on component side of board) to leads of adjacent components



(b) Mounting of component by linking to a pig-tailed lead of an adjacent component

Figure 12.5 - Additional components mounted (on reverse side or on component side of board) to leads of adjacent components



(c) Mounting of component by linking to lead of an adjacent transistor (or other large component)

Figure 12.5 - Additional components mounted (on reverse side or on component side of board) to leads of adjacent components

SECTION 13: REMOVAL AND REPLACEMENT OF AXIAL AND MULTI-LEAD COMPONENTS

13.1 INTRODUCTION

This procedure is applicable to components having axial or multi-lead configurations.

13.2 CONSTRAINTS

(a) Extreme caution is required when dealing with circuit boards having plated-through holes as the connecting surfaces easily rupture. Very small lands are also hazardous as they will loosen if the temperature of the base material is too high or excessive force is exerted during removal of the leads.

(b) Where reference is made in these procedures to the removal portion of lead on the non-component side of the board, this shall include the removal of any clinched portion in accordance with the method described in Chapter 5.

13.3 TOOLS AND MATERIALS REQUIRED

- side-cutting pliers and/or diamond saw
- soldering iron
- long-nose pliers
- approved solvent

13.4 PROCEDURE

Select from Methods 13-1 and 13-2 which are detailed at the end of this chapter.

13.5 ACCEPTANCE CRITERIA

After repair, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. In particular, detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material and/or components.

METHOD 13-1 REMOVAL OF COMPONENTS WITH AXIAL LEADS (DESTRUCTIVE REMOVAL)

(a) Cut the vertical section of the component leads just above the solder fillet and parallel to the surface of the board. Ensure that burrs are not formed.

(b) Remove the remaining portion of the lead on the other side of the board using either a soldering iron with wick or vacuum extractor, then gently pull the lead with long-nose pliers when the solder is molten.

(c) Remove excess solder with a vacuum extractor or solder remover.

(d) Clean up the area of the joint with an approved cleaning agent.

(e) Fit new component and solder it in place in accordance with ESA PSS-01-708.

METHOD 13-2 REMOVAL OF MULTI-LEAD COMPONENTS (DESTRUCTIVE REMOVAL)

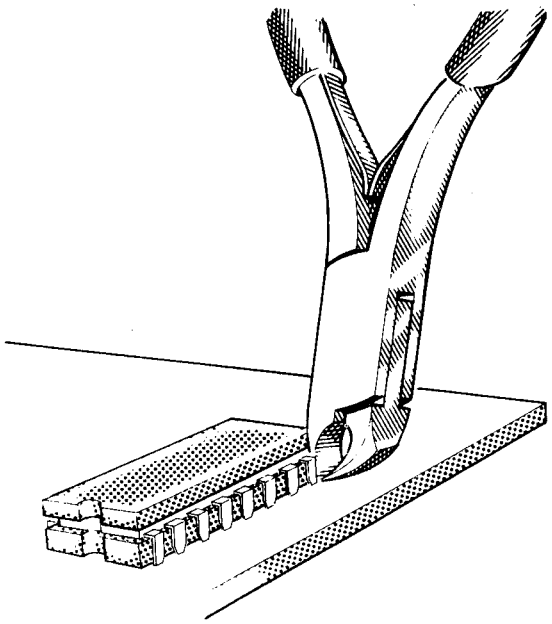
(a) Cut component leads using diamond saw or sidecutting pliers (refer to Figure 13.1)

(b) Unsolder and remove the remaining portion of the leads on the other side of the board, whilst gently pulling with long-nose pliers when the solder is molten.

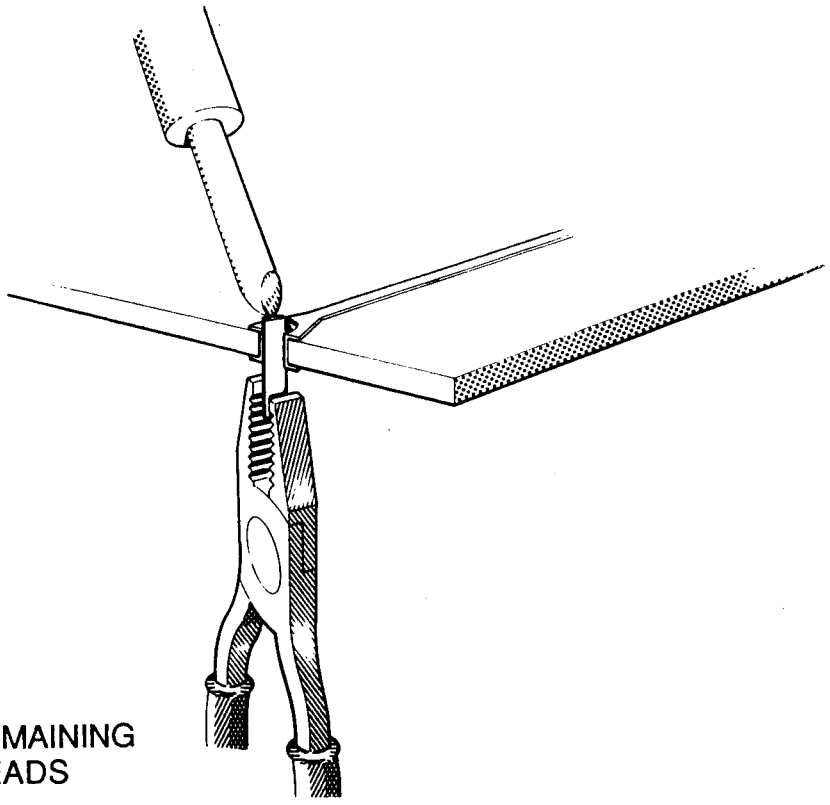
(c) Remove excess solder with a vacuum extractor or by the wicking method.

(d) Clean the area of the joint with an approved cleaning agent.

(e) Fit new component and solder in place in accordance with ESA PSS-01-708.



CLIPPING OF COMPONENT LEADS



REMOVAL OF REMAINING
COMPONENT LEADS

Figure 13.1 - Removal of multi-lead components

SECTION 14: REMOVAL AND REPLACEMENT OF FLAT-PACK COMPONENTS

14.1 INTRODUCTION

This procedure is applicable to components in flat-pack configuration mounted on the printed-circuit board, on the same plane as the conductive pattern by means of lap-soldered joints.

14.2 CONSTRAINTS

Extreme caution is required in order to avoid damage to the board/conductor tracks by scratching or overheating etc.

14.3 TOOLS AND MATERIALS REQUIRED

- soldering iron, heat controlled
- solder
- wicking braid
- strip Kapton or Teflon sheet (approx. 6 cm long)
- lead-bending fixture for flat-pack circuits
- approved solvent and cleaning tissue.

14.4 PROCEDURE

Method 14-1 shall be used. This is detailed at the end of this chapter.

14.5 ACCEPTANCE CRITERIA

After repair, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. In particular, detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material and/or components.

METHOD 14-1 REMOVAL AND REPLACEMENT OF FLAT-PACK COMPONENTS

(a) Apply heat to the soldered joint, simultaneously lifting the leads by sliding a piece of thin Kapton sheet progressively from the non-soldered section of the lead towards the soldered section (refer to Figure 14.1).

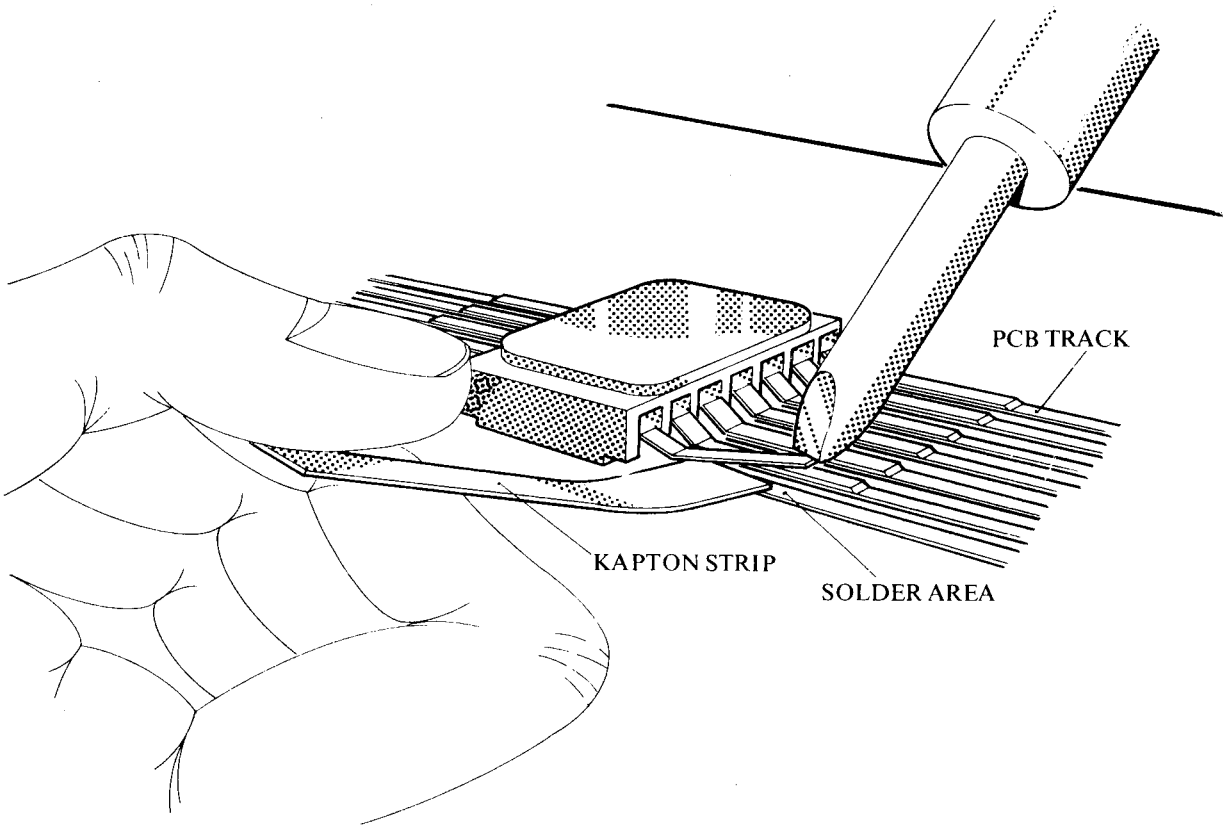


Figure 14.1 - Removal of flat-pack components

(b) Clean solder area using an approved cleaning solvent.

(c) Inspect surface of joint for raised areas of track and overheated solder.

NOTE: Raised surfaces shall be repaired in accordance with the method described in Section 8.1 and overheated solder shall be removed by wicking and the solder area re-tinned.

(d) Position new component, tack it to the board for stability if required and solder in place using a heat-controlled soldering iron. If package density allows, a reflow machine with a single lead tip (peg-tip) may be used.

SECTION 15: MODIFICATION OF COMPONENT CONNECTIONS

15.1 INTRODUCTION

Modification of the connections from components to the printed circuit board may be required for the same reasons as those given in Section 12.1.

Methods to be used are:

METHOD 15-1	Soldering of a wrap-around connection to an extended component lead
METHOD 15-2	Soldering of component lead to a stud lead mounted into an existing hole
METHOD 15-3	Mounting a dual-in-line (DIL) package with or without a wire link soldered onto a cropped lead
METHOD 15-4	Mounting a connector with or without a wire link soldered onto a cropped lead
METHOD 15-5	Addition of a wire link into a plated through hole occupied by a flat- section lead
METHOD 15-6	Addition of a wire link on top of a flat-pack lead
METHOD 15-7	Isolation of a component lead

15.2 CONSTRAINTS

The criteria of Section 2.3 shall apply.

For modification of DIL package connections, no more than one third (1/3) of the leads per side shall be cropped (refer to Method 15-3) or insulated (refer to Method 15-7). For example, no more than two (2) leads shall be cropped or insulated on each side of a 14 lead DIL package.

15.3 TOOLS AND MATERIALS REQUIRED

- soldering iron
- approved solder
- side cutters
- approved solvent and cleaning brushes
- lint-free paper
- pencil type vacuum cleaner
- approved epoxy paste staking compound
- approved insulated wire
- plain copper wire
- teflon sleeve tubing
- hand-held drill
- scalpel blade
- long-nose pliers

15.4 PROCEDURE

Select from Methods 15-1 to 15-7 which are detailed at the end of this chapter.

15.5 ACCEPTANCE CRITERIA

After modification and where components have been removed and subsequently replaced, the soldered joints shall be inspected in accordance with the accept/reject criteria of ESA PSS-01-708. In particular, detailed inspection shall be made of the pad/track area to ensure that no lifting has occurred and that no damage has been sustained by the base material and/or components.

METHOD 15-1 SOLDERING OF A WRAP-AROUND CONNECTION TO AN EXTENDED COMPONENT LEAD

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Carefully remove any conformal coating from the area to be worked. Use the method described in Chapter 4.

(c) Remove existing component in the location at which a wrap around connection is required. Use the method described in Chapter 13. Replace with a new component with lead extended in the Z - direction (refer to Figure 15.1).

(d) Strip, pre-tin (with use of a heatsink to prevent wicking) and form space-approved insulated wire for wrap-around connection to extended lead.

(e) Solder wire to extended component lead using a wrap-around connection as per Paragraph 7.9 "Connection without Terminals" of ESA PSS-01-708.

(f) Clean soldered area with approved solvent.

(g) Inspect to the requirements of ESA PSS-01-708.

(h) Position wire connection on board and bond to the board as defined in Chapter 11.

(i) Re-apply conformal coating and cure according to specification requirements.

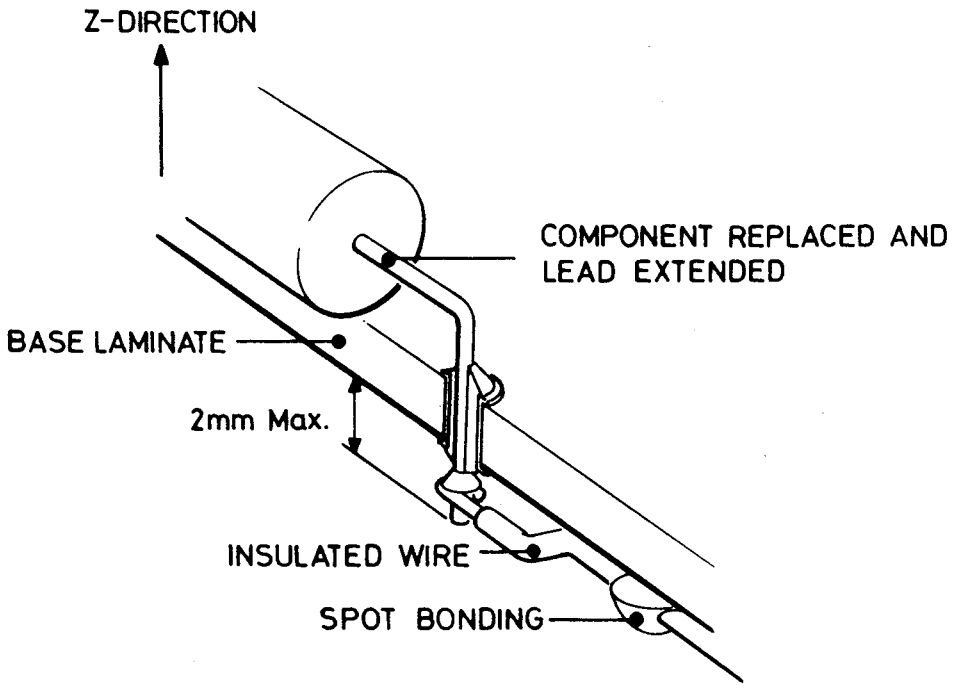


Figure 15.1 - Soldering of a wrap-around connection to an extended component lead

METHOD 15-2 SOLDERING OF COMPONENT LEAD TO A STUD LEAD MOUNTED INTO AN EXISTING HOLE

This method shall be used to enable a component to be mounted when the leads are of a larger diameter than that of existing plated through holes in the printed circuit board.

(a) Pre-tin and solder a suitable diameter plain copper wire into the plated through hole.

(b) Mount component by attaching component lead to stud lead using a wrap-around connection as per Paragraph 7.9 "Connection without Terminals" of ESA PSS-01-708 (refer to Figure 15.2).

(c) Clean soldered area with approved solvent.

(d) Inspect to the requirements of ESA PSS-01-708.

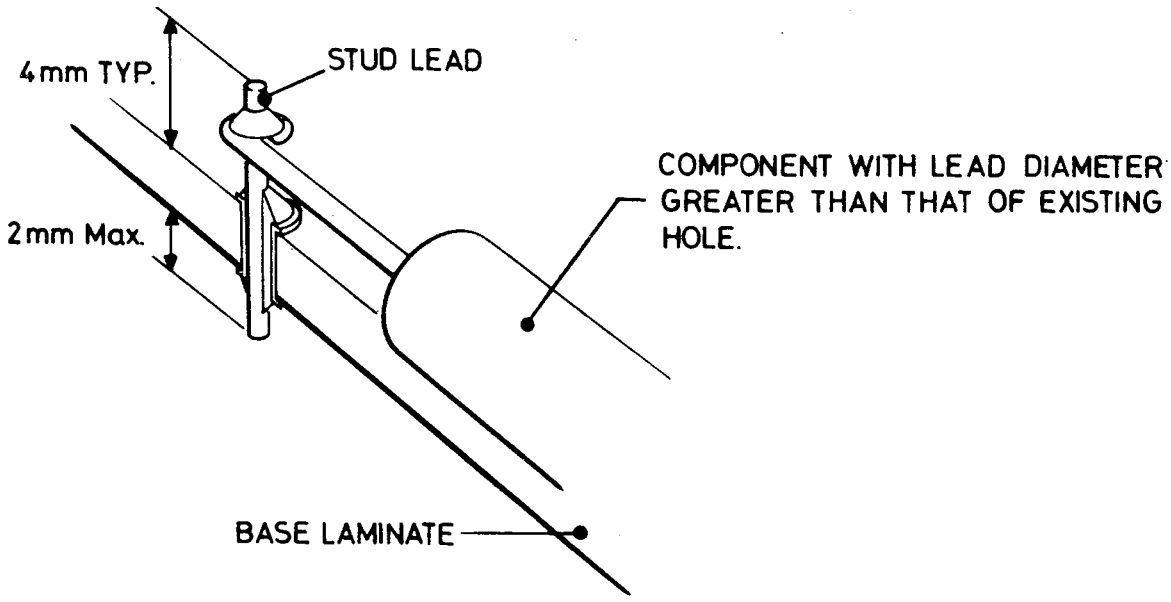


Figure 15.2 - Soldering of component lead to a stud lead mounted into an existing hole

METHOD 15-3 MOUNTING A DUAL-IN-LINE (DIL) PACKAGE WITH OR WITHOUT A WIRE LINK SOLDERED ONTO A CROPPED LEAD

The method shall be used only if it is necessary to crop no more than one third (1/3) of the leads per side of a DIL package.

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Remove the existing DIL package. Use the method described in Chapter 13.

(c) As required, crop leads of a replacement component in line with the bottom of the component body as shown in Figure 15.3. (The component may be of either a J-lead or a side-brazed lead configuration).

(d) De-gold and pre-tin the leads in two operations. If connection of cropped leads to the board is required, the cropped leads must be de-golded and pre-tinned by hand. For cropped side-brazed leads, the entire lead shoulder shall be de-golded and pre-tinned (but this does not necessarily include the gold-plating on the braze fillet).

(e) Solder the replacement component into position. If no connection of cropped leads to the board is required, proceed to step (h).

(f) Strip, pre-tin (with use of a heatsink to prevent wicking) and form space-approved insulated wire for connection of cropped leads to board.

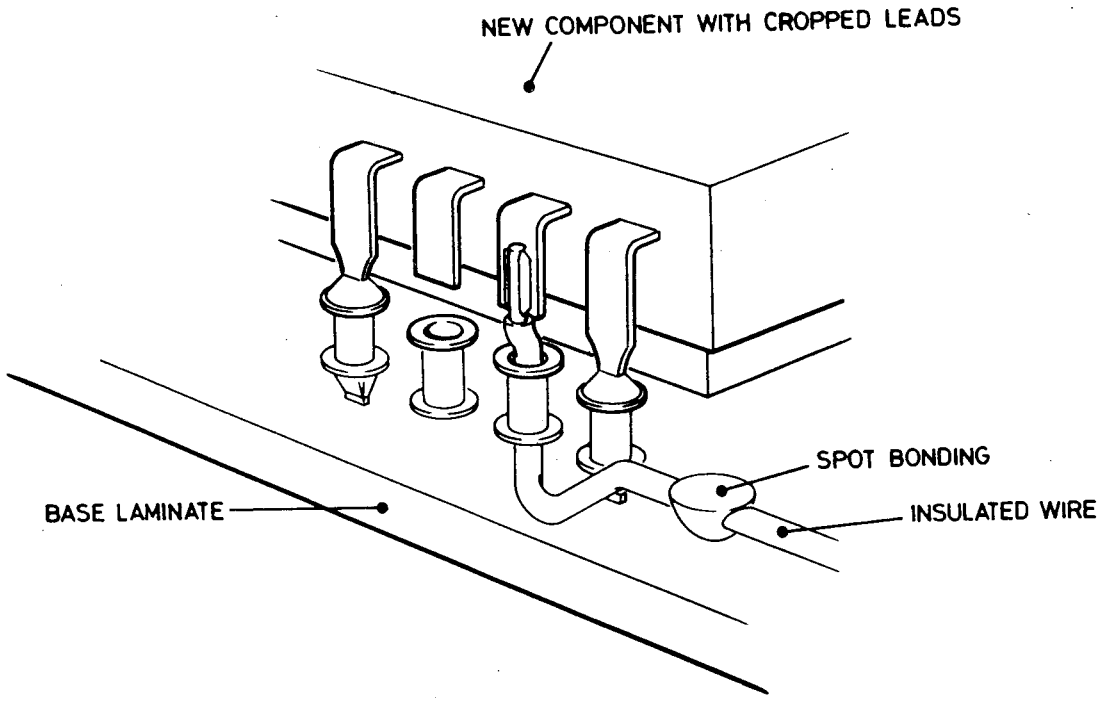
(g) Solder wires to cropped leads to form a lap joint. Wires may be led down onto the board or may pass away from the board (refer to Figures 15.3 (a) and (b)). Length of the lap joint must be three times (3x) the stripped wire diameter. For cropped J-leads, soldering shall be for 3 seconds (maximum) at a tip temperature of 250 °C ± 5 °C and for cropped side-brazed leads, soldering shall be for 3 seconds (maximum) at a tip temperature of 295 °C ± 5 °C.

(h) Clean soldered area with approved solvent.

(i) Inspect to the requirements of ESA PSS-01-708.

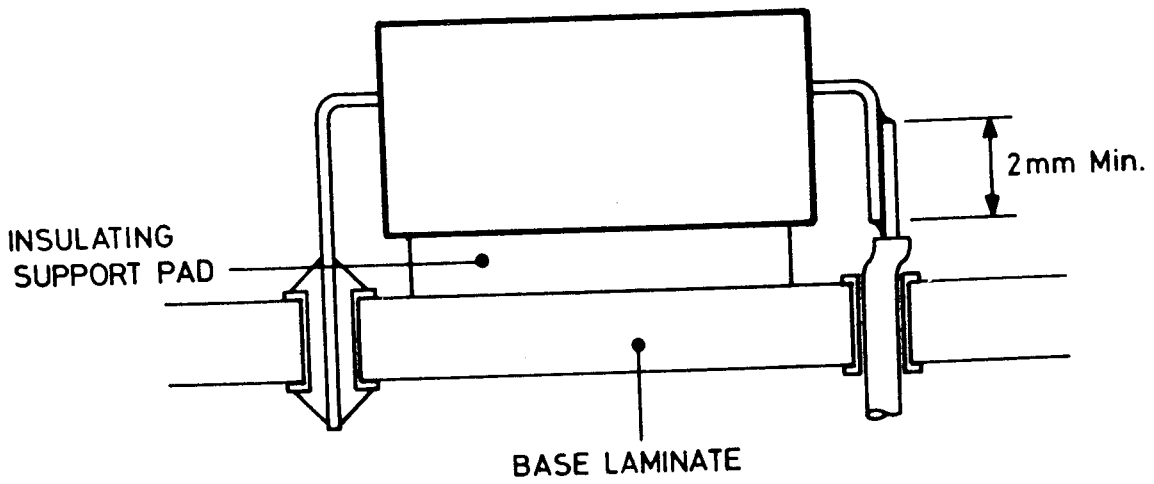
(j) Position wire connections on board and bond to the board as defined in Chapter 11.

(k) Re-apply conformal coating and cure according to specification requirement.



SIDE VIEW

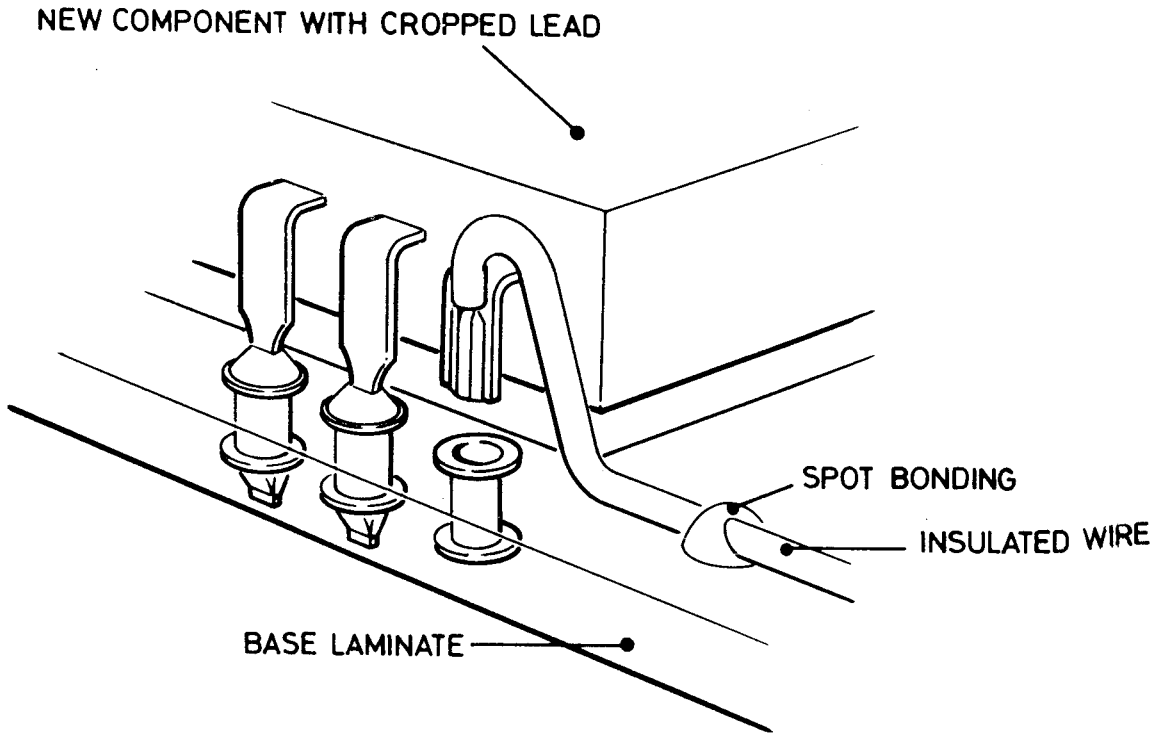
Showing one cropped lead without connection and one cropped lead with wire connection



CROSS SECTION

(a) Cropped lead without connection and cropped lead with connection led through hole and onto board

Figure 15.3 - Mounting a dual-in-line package with or without a wire link soldered onto a cropped lead



(b) Wire link passing away from board

Figure 15.3 - Mounting a dual-in-line package with or without a wire link soldered onto a cropped lead

METHOD 15-4 MOUNTING A CONNECTOR WITH OR WITHOUT A WIRE LINK SOLDERED ONTO A CROPPED LEAD

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Remove the existing connector from the board. Use the method described in Chapter 13.

(c) As required, crop leads of a replacement connector as shown in Figure 15.4.

(d) De-gold and pre-tin connector leads, including cropped leads, if connection of cropped leads to the board is required.

(e) Solder the replacement connector into position. If no connection of cropped leads to the board is required, proceed to step (h).

(f) Strip, pre-tin (with use of a heatsink to prevent wicking) and form space-approved insulated wire for connection of cropped leads to board.

(g) Solder wires to cropped leads using a wrap-around connection as per Paragraph 7.9 "Connection without Terminals" of ESA PSS-01-708.

(h) Clean soldered area with approved solvent.

(i) Inspect to the requirements of ESA PSS-01-708.

(j) Position wire connections on board and bond to the board as defined in Chapter 11.

(k) Re-apply conformal coating and cure according to specification requirements.

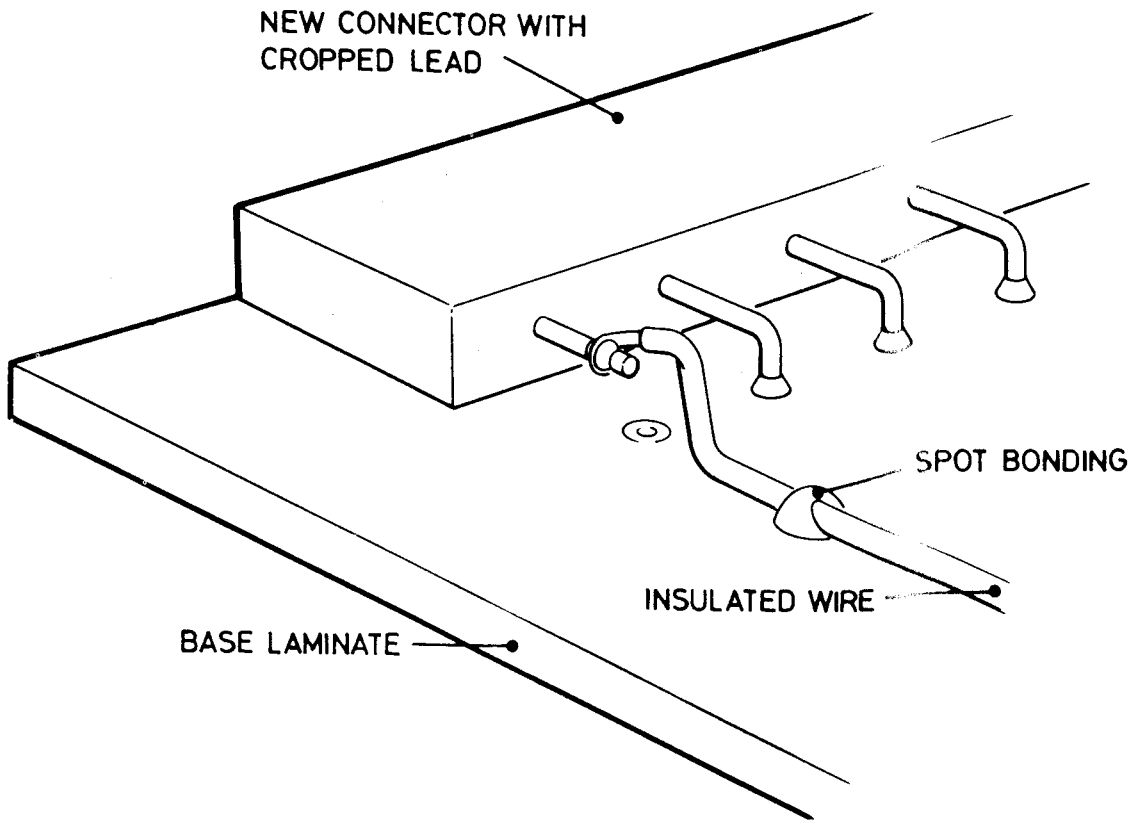


Figure 15.4 - Mounting a connector with a wire link soldered onto a cropped lead

METHOD 15-5 ADDITION OF A WIRE LINK INTO A PLATED THROUGH HOLE OCCUPIED BY A FLAT-SECTION LEAD

This method can be used only if the plated through hole is occupied by a flat-section lead, for example a DIL package lead. Volume limitations prevent the insertion of a wire link into a hole occupied by a round-section lead.

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Remove conformal coating from the area surrounding the plated through hole requiring addition of a wire link. Use the method described in Chapter 4.

(c) De-solder the lead occupying the hole. Use the method described in Chapter 5.

(d) Strip, pre-tin (with use of a heatsink to prevent wicking) and form space-approved insulated AWG 30 wire for making a link into the plated through hole.

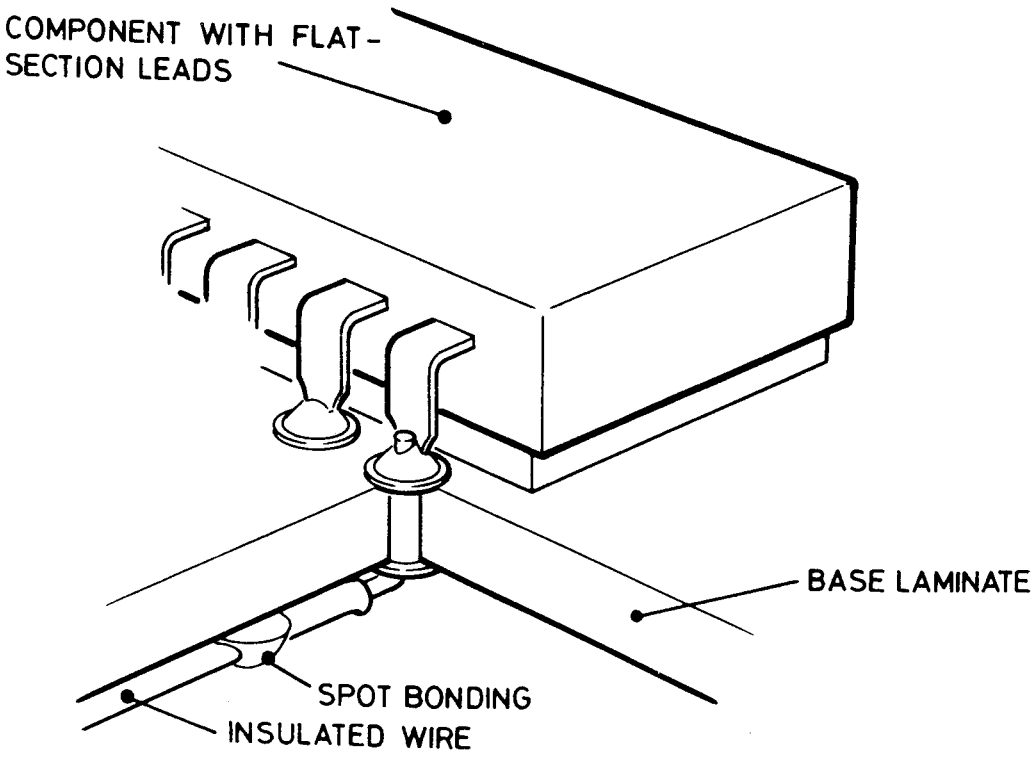
(e) Insert wire into plated through hole to lie alongside the existing component lead. The wire may enter from either the reverse side of the board (refer to Figure 15.5 (a)) or from the component side of the board (refer to Figure 15.5 (b)). Solder wire/component lead into place. (Figures 15.5 (a) and (b) illustrate the solder fillet which must be achieved).

(f) Clean soldered area with approved solvent.

(g) Inspect to the requirements of ESA PSS-01-708.

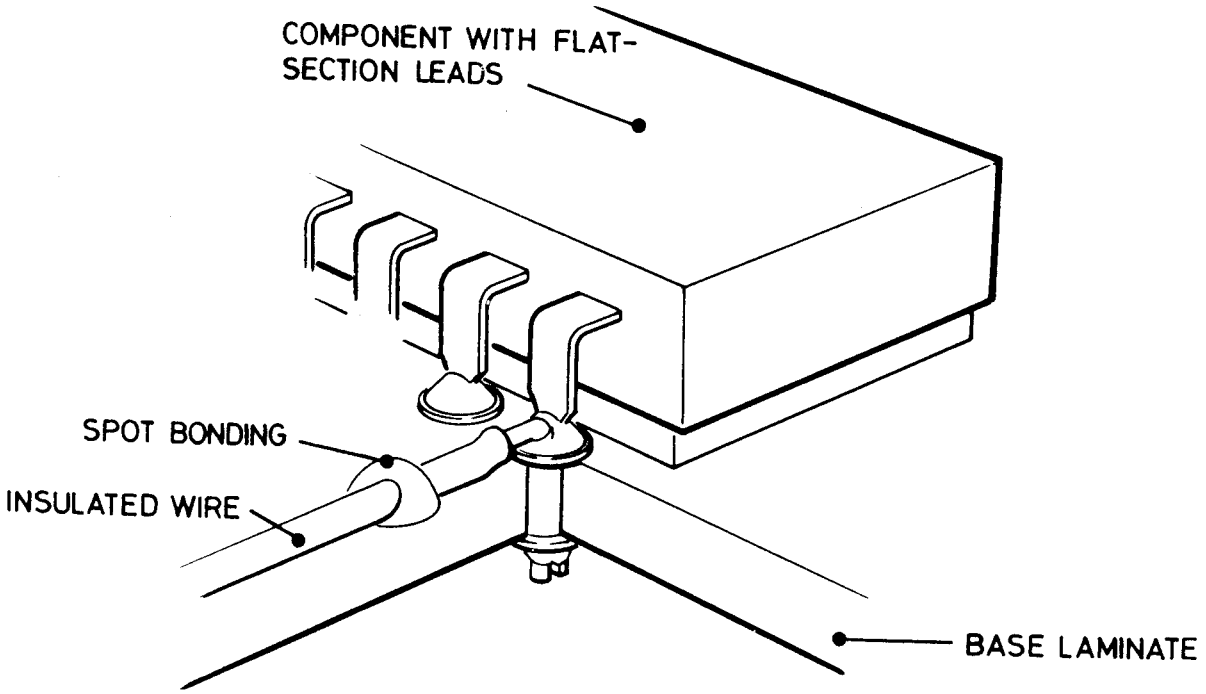
(h) Position wire link on board and bond to the board as defined in Chapter 11.

(i) Re-apply conformal coating and cure according to specification requirements.



(a) Wire link entering from the reverse side of the board

Figure 15.5 - Addition of a wire link into a plated thrcugh hole occupied by a flat-section lead



(b) Wire link entering from the component side of the board

Figure 15.5 - Addition of a wire link into a plated through hole occupied by a flat-section lead

METHOD 15-6 ADDITION OF A WIRE LINK ON TOP OF A FLAT-PACK LEAD

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Remove conformal coating from the area surrounding the flatpack lead requiring addition of a wire link. Use the method described in Chapter 4.

(c) Strip, pre-tin (with use of a heatsink to prevent wicking) and form space-approved insulated wire for making a link on top of the flat-pack lead.

(d) Place the section of the wire to be soldered along the centre line of the lead and solder into this position (refer to Figure 15.6 and, for the solder fillet appropriate for a lap joint, Figures 12.1 and 12.2).

NOTE: Wire diameter shall be not greater than two thirds (2/3) lead width.

(e) Clean soldered area with approved solvent.

(f) Inspect to the requirements of ESA PSS-01-708.

(g) Position wire link on board and bond to the board as defined in Chapter 11.

(h) Re-apply conformal coating and cure according to specification requirements.

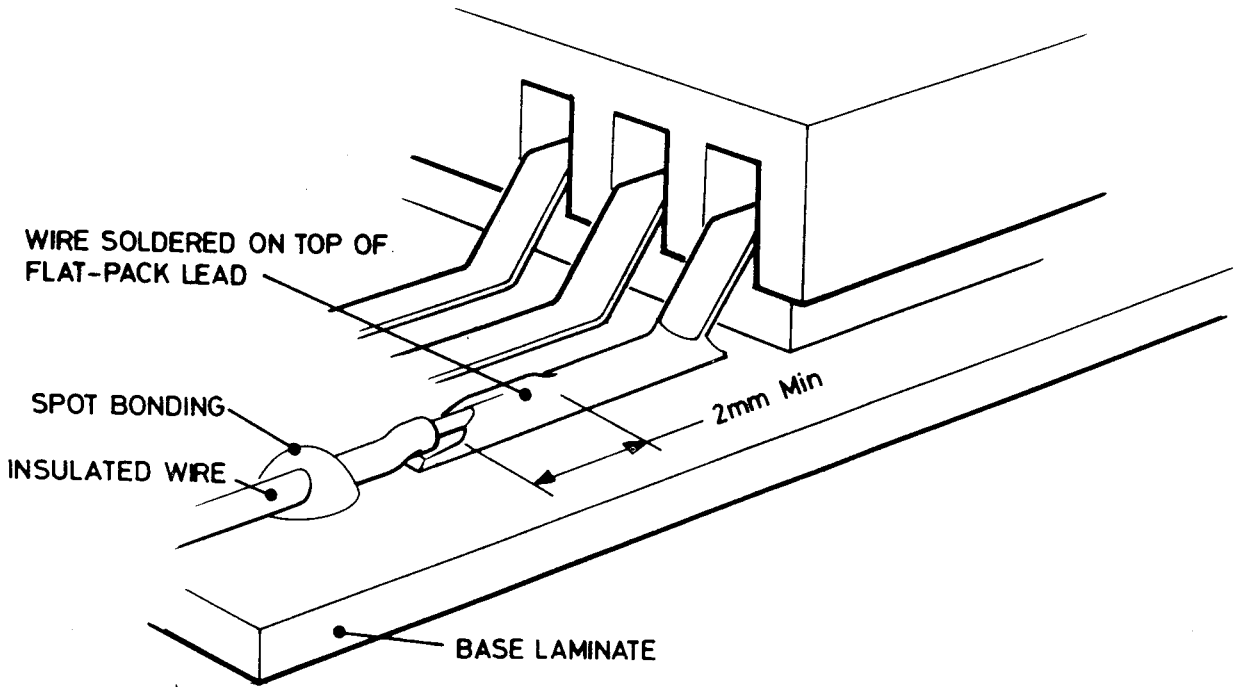


Figure 15.6 - Addition of a wire link on top of a flat-pack lead

METHOD 15-7 ISOLATION OF A COMPONENT LEAD

This method shall be used if it is required to isolate a component lead from its plated through hole connection on either double-sided or multilayer printed circuit boards.

This method shall be used only if it is required to isolate no more than one third (1/3) of the leads per side of a DIL package.

This "drilling-isolation" method is critical. Operator training is essential and drilling tools must be sharp.

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Remove the existing component. Use the method described in Chapter 13.

(c) Where isolation is required, drill out plated through holes, using a hand-held drill. The drill shall be held vertically with respect to the board. For example, a 1.1 mm diameter drill can be used for a 0.75 mm diameter hole.

(d) Remove pads on both sides of the board using a new scalpel blade. Take care that no glass fibres within the board are cut.

(e) Drill out further. For example, after using a 1.1 mm diameter drill (refer to step (c)), use a 1.3 mm diameter hand-held drill. The vacuum cleaner shall be used to remove swarf from the drilling operations.

(f) Insert lengths of Teflon sleeve tubing into drilled out holes (for the example above, use tubing of 0.5 mm internal bore diameter). The tube shall isolate the lead between component body and soldering spot in such a way that a minimum distance of 0.5 mm is achieved (refer to Figure 15.7).

NOTE: Although Figure 15.7 illustrates an isolated lead of a DIL package, Method 15-7 can also be used if it is required to isolate a lead of a metal can package.

(g) Insert new component with appropriate leads passing through the isolated holes. Solder remaining leads.

(h) When required, attach stripped, pre-tinned and formed insulated wire to the isolated lead using a wrap-around connection as per Paragraph 7.9 "Connection without Terminals" of ESA PSS-01-708.

(i) Clean soldered area with approved solvent.

(j) Inspect to the requirements of ESA PSS-01-708.

(k) Spot bond component and wire connections using epoxy staking compound and cure according to specification requirements.

(l) Re-apply conformal coating and cure according to specification requirements.

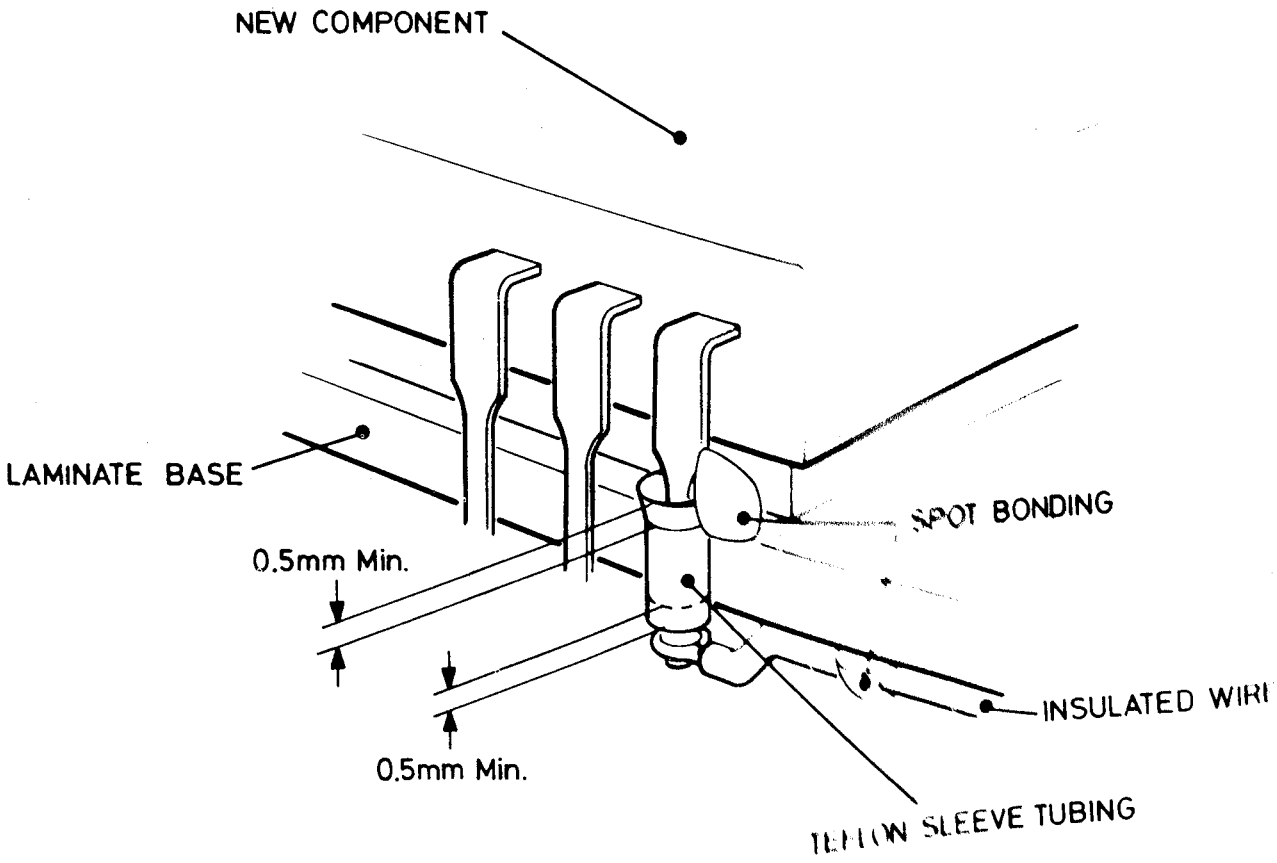


Figure 15.7 - Isolation of a component lead

SECTION 16: CUTTING OF INTERNAL TRACK OF A MULTILAYER PRINTED CIRCUIT BOARD

16.1 INTRODUCTION

This procedure can be used when it is necessary to interrupt an internal connection of a multi-layer printed circuit board.

16.2 CONSTRAINTS

Extreme caution is required in order to avoid damage to tracks in the vicinity of that requiring modification.

16.3 TOOLS AND MATERIALS REQUIRED

- lint-free paper
- approved solvent and cleaning brushes
- pencil type vacuum cleaner
- approved pcb repair facility (work station), including a milling attachment
- approved epoxy compound

16.4 PROCEDURE

Method 16-1 shall be used. This is detailed at the end of this chapter.

16.5 ACCEPTANCE CRITERIA

The re-worked area shall be inspected and there shall be no damage to adjacent conductor tracks, plated through holes, components and base laminate.

METHOD 16-1 CUTTING OF INTERNAL TRACK OF A MULTI-LAYER CIRCUIT BOARD

(a) Using lint-free paper, mask as much as possible of the circuitry surrounding the area to be worked.

(b) Carefully remove any conformal coating from the area to be worked. Use the method described in Chapter 4.

(c) Mill through successive layers of the board progressively (to ensure clear visibility of layer separation and to avoid the presence of shorts caused by burrs) until there is clear visibility of the internal track to be cut (refer to Figure 16.1). The vacuum cleaner shall be used to remove swarf from the milling operation.

(d) Cut the track and check that the resistance is greater than 2 kohm.

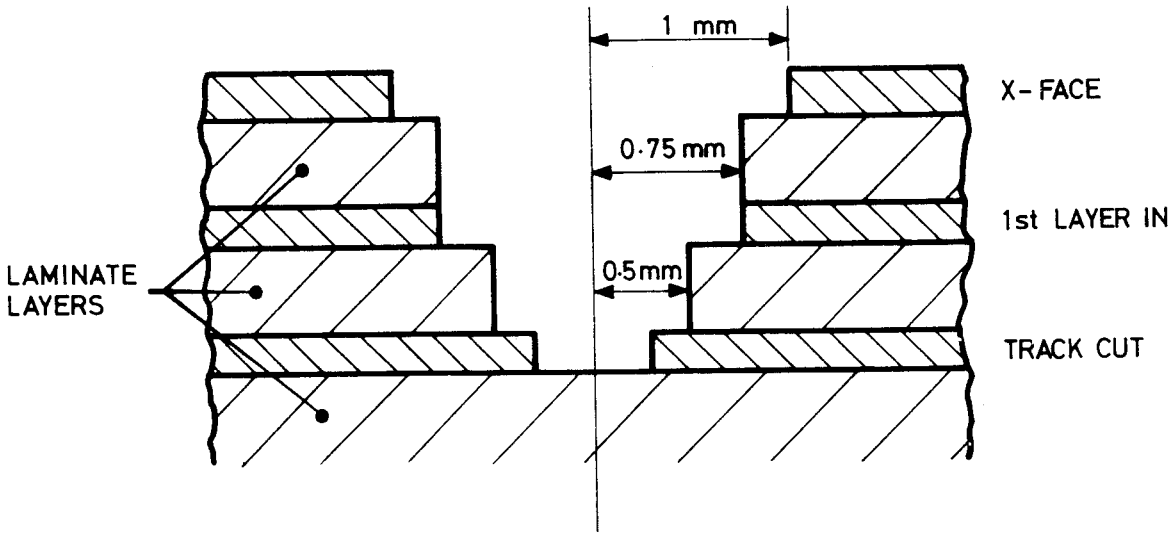
NOTE: Ensure there will be no damage to mounted parts during electrical monitoring.

(e) Remove protective paper.

(f) Clean milled area with approved solvent.

(g) Fill hole with epoxy compound and cure to specification requirements.

(h) Re-apply conformal coating and cure to specification requirements.



Dimensions are for guidance only

Figure 16.1 - Cutting of internal track of a multi-layer circuit board

SECTION 17: QUALITY ASSURANCE

The quality assurance requirements are defined in ESA PSS-01-20. However, particular attention shall be paid to the following points:

17.1 DATA

The logbooks shall contain, as a minimum, the following:

(a) copy of final inspection documentation;

(b) index of limited-life articles and their use times;

(c) non-conformance reports and corrective actions;

(d) copy of the inspection and test results with reference to the relevant procedure.

17.2 NON-CONFORMANCE

Any non-conformance which is observed in respect to the process shall be treated in accordance with the quality assurance requirements.

17.3 CALIBRATION

Each standard and piece of measuring equipment shall be calibrated. Any suspected or actual equipment failure shall be notified to ESA so that previous results may be examined to ascertain whether or not re-inspection/re-testing is needed.

17.4 TRACEABILITY

Traceability shall be maintained from incoming inspection to final test, including details of test equipment, serial numbers and personnel employed in performing the task.

17.5 OPERATOR AND INSPECTOR TRAINING AND CERTIFICATION

All operators and inspectors employed in repair/modification procedures shall be trained and certified as detailed in ESA PSS-01-708 and shall have undergone a further training programme to ensure proficiency in the repair methods detailed herein.