ECSS-Q-70-28A
21 June 2002

Space product assurance

Repair and modification of printed circuit board assemblies for space use

ECSS Secretariat
ESA-ESTEC
Requirements & Standards Division
Noordwijk, The Netherlands

Published by: ESA Publications Division
ESTEC, P.O. Box 299,
2200 AG Noordwijk,
The Netherlands

ISSN: 1028-396X

Price: € 20

Printed in The Netherlands

Foreword

This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, national space agencies and European industry associations for the purpose of developing and maintaining common standards.

Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work.

This Standard has been prepared by the Product Assurance Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board.

(This page is intentionally left blank)

Contents

Foreword **3**

1 Scope **11**

2 Normative references **13**

3 Terms, definitions and abbreviated terms **15**

3.1 Terms and definitions 15
3.2 Abbreviated terms 15

4 Basic requirements **17**

4.1 General 17
4.2 Repairs 17
4.3 Modifications 18
4.4 Rework 18
4.5 Other requirements 18

5 Preparatory conditions **21**

5.1 Hazard, health and safety precautions 21
5.2 Materials 21
5.3 Facilities 21

6 Removal of conformal coating 23

6.1 Introduction 23
6.2 Requirements 23
6.3 Tools and materials required 23
6.4 Procedure 23
6.5 Acceptance criteria 24
6.6 Methods for the removal of conformal coating 24

7 Solder joint removal and unclinching 27

7.1 Introduction 27
7.2 Conformal coating 27
7.3 Tools and materials required 27
7.4 Procedure 27
7.5 Acceptance criteria 27
7.6 Methods for solder joint removal and unclinching 28

8 Repair of damaged gold-plated areas 31

8.1 Introduction 31
8.2 Requirements 31
8.3 Tools and materials required 31
8.4 Procedure 31
8.5 Acceptance criteria 32
8.6 Methods for the repair of damaged gold-plated areas 32

9 Repair of damaged conductor tracks 33

9.1 Introduction 33
9.2 Requirements 33
9.3 Tools and materials required 33
9.4 Procedure 33
9.5 Acceptance criteria 34
9.6 Method for the repair of damaged conductor tracks 34

10 Repair of lifted conductors 35

10.1 Introduction 35
10.2 Requirements 36
10.3 Tools and materials required 36
10.4 Procedure 36

10.5 Acceptance criteria 36
10.6 Methods for repair of lifted conductors 36

11 Repair of lifted terminal areas (pads) 39

11.1 Introduction 39
11.2 Requirements 40
11.3 Tools and materials required 40
11.4 Procedure 40
11.5 Acceptance criteria 40
11.6 Method for the repair of lifted terminal areas (pads) 40

12 Terminal post replacement 43

12.1 Introduction 43
12.2 Requirements 43
12.3 Tools and materials required 43
12.4 Procedure 43
12.5 Acceptance criteria 43
12.6 Method for the replacement of terminal post 44

13 Wire-to-wire joints 47

13.1 Introduction 47
13.2 Requirements 47
13.3 Tools and materials required 47
13.4 Procedure 47
13.5 Acceptance criteria 47
13.6 Method for wire-to-wire joining 48

14 Addition of components 49

14.1 Introduction 49
14.2 Requirements 49
14.3 Tools and materials required 50
14.4 Procedure 50
14.5 Acceptance criteria 50
14.6 Methods for addition of components 50

15 Removal and replacement of axial and multi-lead components. 59

15.1 Introduction 59
15.2 Requirements 59
15.3 Tools and materials required 59
15.4 Procedure 59
15.5 Acceptance criteria 59
15.6 Methods for removal and replacement of axial and multi-lead components 60

16 Removal and replacement of flat-pack components. 63

16.1 Introduction 63
16.2 Requirements 63
16.3 Tools and materials required 63
16.4 Procedure 63
16.5 Acceptance criteria 63
16.6 Method for the removal and replacement of flat-pack components 64

17 Modification of component connections 65

17.1 Introduction 65
17.2 Requirements 65
17.3 Tools and materials required 66
17.4 Procedure 66
17.5 Acceptance criteria 66
17.6 Methods for modification of component connections 66

18 Cutting of internal track of a multi-layer printed circuit board. . . 77

18.1 Introduction 77
18.2 Requirements 77
18.3 Tools and materials required 77
18.4 Procedure 77
18.5 Acceptance criteria 77
18.6 Method for cutting the internal track of a multi-layer printed circuit board . 77

19 Quality assurance 79

19.1 General 79
19.2 Data 79
19.3 Nonconformance 79

19.4 Calibration 79
19.5 Traceability 79
19.6 Operator and inspector training and certification 80

Figures

Figure 1: Removal of coating by thermal parting device 25
Figure 2: Continuous vacuum solder extraction on stud lead 28
Figure 3: Pulse-type solder sucker in use 29
Figure 4: Lifting individual leads with hot jet 29
Figure 5: Cross-sectional view of wicking method 30
Figure 6: Hot unclinching with thermal parting device 30
Figure 7: Lifted conductors 35
Figure 8: Repair using epoxy under conductor 37
Figure 9: Repair using epoxy over conductor 37
Figure 10: Lifted terminal area 39
Figure 11: Terminal areas without track 39
Figure 12: Terminal areas with track attached 40
Figure 13: Terminal post replacement 45
Figure 14: Use of approved type support clamp/heat sink 48
Figure 15: Additional components mounted on reverse (non-component) side of board 51
Figure 16: Additional components mounted on component side of board 52
Figure 17: "Piggyback" mounting of one component on top of another 53
Figure 18: Mounting and wiring of additional axially-leaded components mounted (on reverse side or on component side of board) using staking compound . . 55
Figure 19: Upside down mounting and wiring of additional side-brazed DIL component (on reverse side or on component side of board) using staking compound . . 55
Figure 20: Mounting of additional non-axially leaded components, e.g. capacitors, with wire connecting top or bottom sides of the circuit board using staking compound (on reverse side or on component side of board) 56
Figure 21: Mounting of additional component (on component side of board) with wire connections on reverse side of board using staking compound 56
Figure 22: Mounting of additional component (on reverse side of board) across extended leads of adjacent components 57
Figure 23: Mounting of additional component by linking to a "pigtailed" lead of an adjacent component 57
Figure 24: Mounting of additional component by linking to lead of an adjacent transistor (or other large component) 58
Figure 25: Removal of multi-lead components, clipping of component leads 60
Figure 26: Removal of multi-lead components, removal of remaining component leads 61
Figure 27: Removal of flat-pack components 64
Figure 28: Soldering of a wrap-around connection to an extended component lead . . 67
Figure 29: Soldering of component lead to a stud lead mounted into an existing hole . 67

Figure 30: Mounting a dual-in-line package with or without a wire link soldered onto a cropped lead (cropped lead without connection and cropped lead with connection led through hole and onto board) 69
Figure 31: Mounting a dual-in-line package with or without a wire link soldered onto a cropped lead (wire link passing away from board) 70
Figure 32: Mounting a connector with a wire link soldered onto a cropped lead 71
Figure 33: Addition of a wire link into a plated through hole occupied by a flat-section lead (wire link entering from the reverse side of the board) 72
Figure 34: Addition of a wire link into a plated through hole occupied by a flat-section lead (wire link entering from the component side of the board) 72
Figure 35: Addition of a wire link on top of a flat-pack lead 73
Figure 36: Isolation of a component lead 74
Figure 37: Addition of a wire link onto metallized cap of chips directly glued on PCB . . . 75
Figure 38: Addition of a wire link onto terminal pad of soldered chips 76
Figure 39: Cutting of internal track of a multi-layer circuit board 78

Tables

Table 1: Recommended wire diameters for given conductor widths 34

1

Scope

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

This Standard 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 or modification process. Unassembled (bare) printed circuit boards are not covered by this Standard.

(This page is intentionally left blank)

2

Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

ECSS-P-001	Glossary of terms
ECSS-Q-20	Space product assurance — Quality assurance
ECSS-Q-20-09	Space product assurance — Nonconformance control system
ECSS-Q-70	Space product assurance — Materials, mechanical parts and processes
ECSS-Q-70-08	Space product assurance — Manual soldering of high-reliability electrical connections
ECSS-Q-70-10	Space product assurance — Qualification of printed circuit boards
ECSS-Q-70-11	Space product assurance — Procurement of printed circuit boards
ECSS-Q-70-38 [1)]	Space product assurance — High-reliability soldering for surface-mount and mixed technology printed circuit boards

1) To be published.

(This page is intentionally left blank)

3

Terms, definitions and abbreviated terms

3.1 Terms and definitions

The following term and definition is specific to this Standard in the sense that it is complementary or additional to those contained in ECSS-P-001.

modification
process of modifying an electronic circuit by means of the addition or removal of electrical parts or wiring

3.2 Abbreviated terms

For the purposes of this Standard the abbreviated terms given in ECSS-P-001 apply.

(This page is intentionally left blank)

4

Basic requirements

4.1 General

a. All soldering operations shall be performed in accordance with ECSS-Q-70-08 or ECSS-Q-70-38 and it should be noted that many of the accessories and work aids detailed in this Standard are contained within purpose-built equipment.

b. 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 that is a good representation of the circuitry which shall be repaired or modified is desirable although not a requirement.

c. The appropriate repair or modification procedures are detailed in clauses 6 to 19 of this Standard.

d. Repairs and modifications made within the constraints of this Standard shall require formal approval or authorization from the local project PA/QA representative using nonconformance review board (NRB) procedures (ECSS-Q-20-09), after completion of a verification programme.

e. Components that are later submitted to failure analysis procedures shall be removed from assemblies and handled with great care.

f. If problems arise when performing repairs and modifications within the constraints of this Standard or if methods are proposed which are outside the constraints of this Standard, then details should be supplied to the final customer's product assurance division so that the accrued information can be reviewed when an update of this Standard is undertaken.

4.2 Repairs

4.2.1 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 Standard.

Changing of components for tuning, i.e. de-soldering and changing component value, is not considered a repair, rework or modification operation.

NOTE During tuning, solder jointing is achieved with a minimum of solder, just enough to ensure contact.

4.2.2 Number of repairs

a. The total number of repairs (involving soldering or epoxy adhesives) to any one printed circuit board assembly shall be limited to six.

b. When a printed circuit board assembly supports more than 120 passive chip components, the total number of repairs shall be limited to 5 % of the passive chip components.

NOTE 1 Repairing of passive chip components is not considered as critical as other components of the PCB and hence the larger number of repairs allowed.

NOTE 2 A repair of one component or connector can involve operations on one or more of its leads.

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

d. Repairs involving epoxy adhesives shall not exceed four to any one area of 25 cm^2.

4.3 Modifications

4.3.1 Modification criteria

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

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

c. The addition of one component shall count as one modification.

4.3.2 Number of modifications

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

4.4 Rework

4.4.1 Rework criteria

The reworking of defective solder joints (without component changing) as a consequence of the repair or modification process is not considered to be a repair and is permissible. All aspects of the reworked joint shall conform to the soldering requirements.

4.4.2 Number of reworks

Up to a maximum of three reworks on any one joint are allowed.

4.5 Other requirements

a. It can 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 besides the ones that receive chip components shall not be subjected to more than one de-soldering operation (i.e. only one component replacement is permitted). For chip components, three replacements may be used.

d. Repair or modification methods not detailed in this Standard, or in excess of criteria given in subclauses 4.2.2, 4.3.2 and 4.4.2, shall be the subject of an NRB in accordance with the relevant project procedure and this shall involve final customer participation.

e. Warped boards, with or without components, shall not be straightened.

(This page is intentionally left blank)

5

Preparatory conditions

5.1 Hazard, health and safety precautions

Particular attention shall be paid to health and safety precautions. Moreover, hazards to personnel, equipment or materials shall be controlled and minimized.

5.2 Materials

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

b. Solders, flux and cleaning solvents shall be as specified in ECSS-Q-70-08.

5.3 Facilities

All facilities and tools shall meet the requirements of ECSS-Q-70-08.

(This page is intentionally left blank)

6

Removal of conformal coating

6.1 Introduction

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

a. the solder on the area to be repaired is freely accessible;

b. the re-soldered joint is not contaminated.

6.2 Requirements

a. Soldering irons shall not be used for coating removal. The high operating temperatures 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 shall be taken when using the thermal parting tip to avoid the melting of any adjacent solder joints and circuitry.

d. Solvents tend to expand the coating media and attack coatings on electronic components in areas remote from direct solvent application. For these reasons, the time for solvent application shall be as short a possible but not exceeding 15 minutes.

6.3 Tools and materials required

- Suitable cutting instrument,
- thermal parting device complete with tips,
- brushes,
- approved solvent and
- pencil-type vacuum cleaner.

6.4 Procedure

Method 6.6.1 shall be used for polyurethane- and silicone-type coatings and method 6.6.2 shall be used for epoxy-type coatings.

6.5 Acceptance criteria

a. The solder on the area to be repaired shall be freely accessible.

b. In addition, none of the following shall occur:

- melting of adjacent solder joints or circuitry;
- blistering, measling or charring of coating;
- blistering, delamination, measling or charring of laminated base material;
- cuts, scratches or other damage to printed wiring.

6.6 Methods for the removal of conformal coating

6.6.1 Method for the removal of polyurethane and silicone-type coating

a. Carefully cut through the conformal coating that 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, see ECSS-Q-70-08A subclause 6.3.1, before removal of solder joints; apply minimum quantity of solvent and prevent solvent ingress beneath the exposed edges of the conformal coating.

6.6.2 Method for the 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 shall be regulated to a point where it will effectively "break down" the coating without scorching or charring (refer to Figure 1).

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. Preclip the leads of the component to be removed. This makes it possible later to remove the component body separately from leads and solder joints. The pencil-type vacuum cleaner and a bristle brush shall 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 or 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 clause 7.

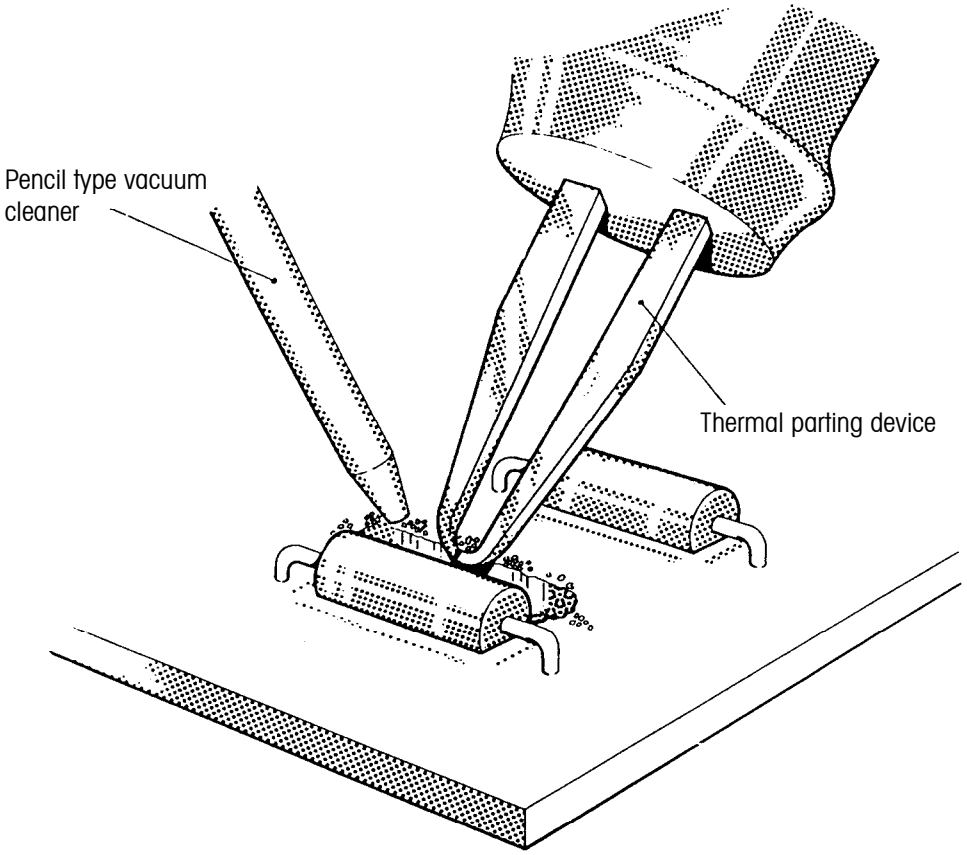

Figure 1: Removal of coating by thermal parting device

(This page is intentionally left blank)

7

Solder joint removal and unclinching

7.1 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 subclauses describe a number of removal methods which can be used according to the facilities and the specific conditions.

7.2 Conformal coating

Before this task is performed, any conformal coating that has been applied to the circuit shall be removed in accordance with the procedure set out in clause 6.

7.3 Tools and materials required

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

7.4 Procedure

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

- Method 7.6.1: Solder extraction with continuous vacuum
- Method 7.6.2: Solder extraction using sucker
- Method 7.6.3: Hot jet extraction
- Method 7.6.4: Use of wicking braid
- Method 7.6.5: Unclinching of leads.

7.5 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 or pad track;
   - delamination of the base laminate;
   - cuts, scratches or other damage to printed wiring or solder joint or pad.

7.6 Methods for solder joint removal and unclinching

7.6.1 Method for 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 2.

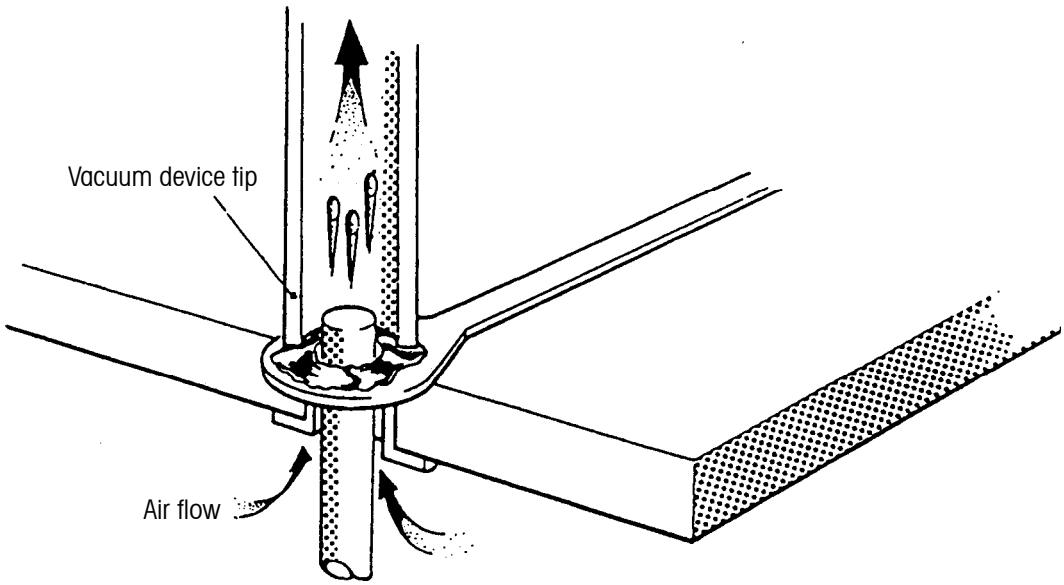

Figure 2: Continuous vacuum solder extraction on stud lead

7.6.2 Method for 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 shall be performed with two different devices simultaneously, i.e. soldering iron and sucker tip (refer to Figure 3). This method finds only limited use.

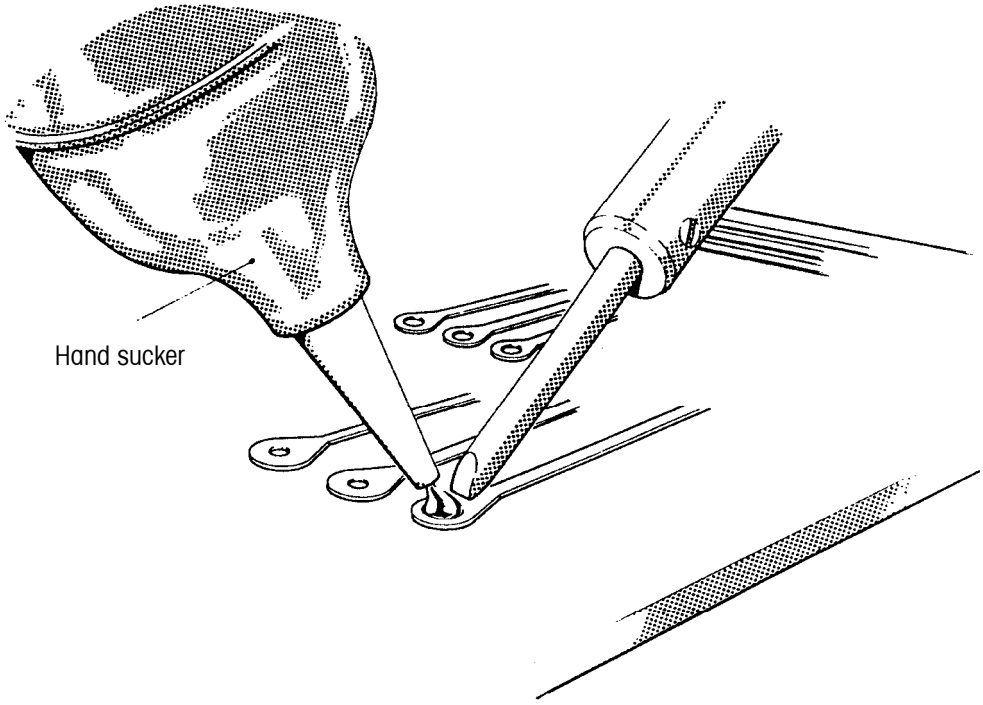

Figure 3: Pulse-type solder sucker in use

7.6.3 Method for hot jet extraction

This method relies on a thin jet of heated air (200 °C to 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 (refer to Figure 4). This method finds only limited use.

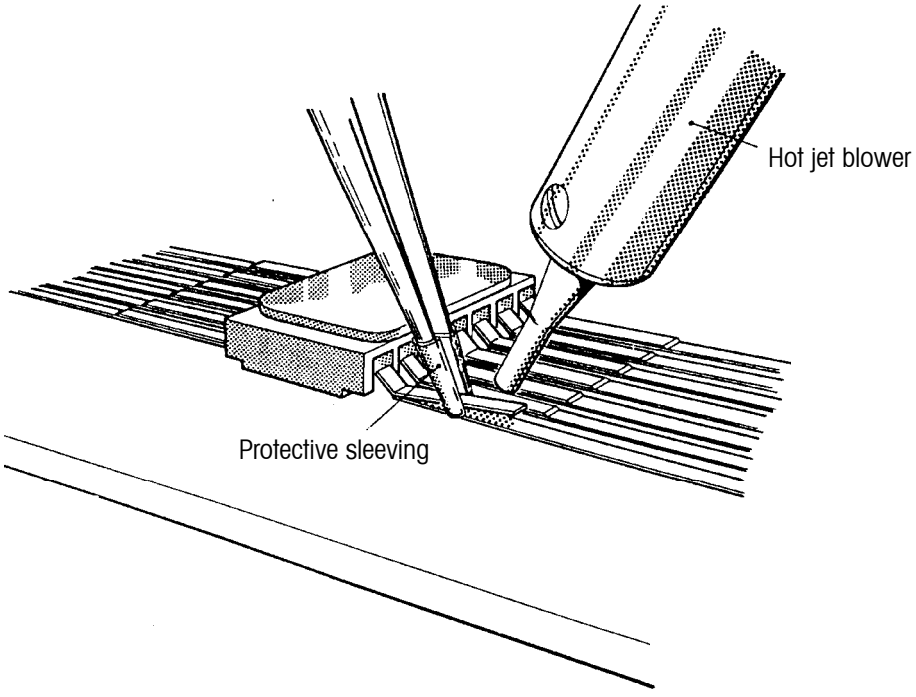

Figure 4: Lifting individual leads with hot jet

7.6.4 Method for the use of wicking braid

This method (refer to Figure 5) 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.

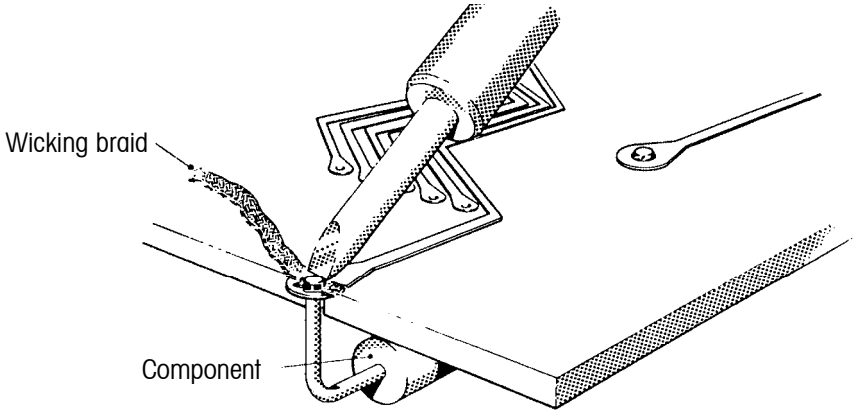

Figure 5: Cross-sectional view of wicking method

7.6.5 Method for unclinching of leads

a. Initial solder removal: first use method 7.6.1 (Vacuum) or method 7.6.4 (Wicking) to remove at least the surface solder from around the clinched lead and terminal area. This permits 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 shall 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 6, is designed to prevent damage to the terminal area. In lieu of the thermal parting device, tweezers or pliers may be used, provided that no contact is made with the terminal area.

c. Final solder removal: once the clinched leads are straightened, one may proceed to remove the solder joints by method 7.6.1, treating them as if they were originally unclinched leads.

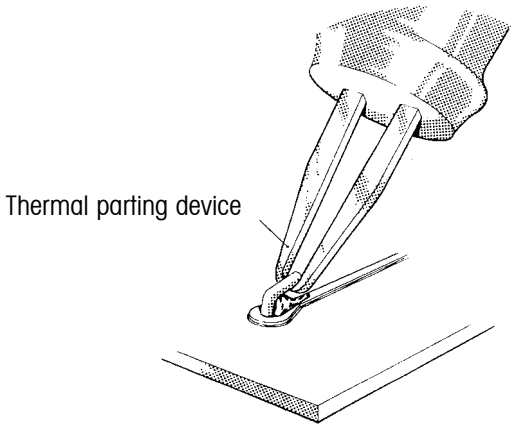

Figure 6: Hot unclinching with thermal parting device

8

Repair of damaged gold-plated areas

8.1 Introduction

Gold-plating can be damaged as a result of:

a. solder splatter on gold plating;

b. uneven scratched plating.

8.2 Requirements

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.

8.3 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 and
- approved solvent.

8.4 Procedure

Method 8.6.1 shall be used for removal of solder splatter on gold plating. Method 8.6.2 shall be used for repair of insufficient or scratched gold plating.

8.5 Acceptance criteria

8.5.1 Method 8.6.1

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.

8.5.2 Method 8.6.2

After repair, the soldered joints shall be inspected in accordance with the accept/reject criteria of ECSS-Q-70-08. Particularly detailed inspection shall be made of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material.

8.6 Methods for the repair of damaged gold-plated areas

8.6.1 Method for the removal of solder splatter on gold plating

a. Remove solder by vacuuming or by wicking with a flux impregnated wire (refer to method 7.6.4). 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.

8.6.2 Method for the repair of insufficient or scratched gold plating

The repair procedure is identical to the “Repair of damaged conductor tracks” detailed in clause 9, except that the gold plating shall be removed before soldering in accordance with ECSS-Q-70-08.

9

Repair of damaged conductor tracks

9.1 Introduction

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

a. complete break;

b. scratches or nicks that reduce the current-carrying capacity of the conductor to levels below standard requirement.

9.2 Requirements

The damage, in whatever form (refer to 9.1 above), shall not involve a length of track in excess of five times the conductor width.

9.3 Tools and materials required

- Soldering iron and solder
- Tweezers
- Epoxy resin
- Approved solvent
- Fibre eraser
- Cleaning tissue
- Selection of tinned copper or silver wire in accordance with Table 1.
  The recommended wire diameters for given conductor widths are listed in Table 1. Values stated are for conductor tracks having a thickness $> 30\ \mu$m. The maximum wire diameter shall not be greater than two thirds of the width of the conductor.

9.4 Procedure

Method 9.6 shall be used.

9.5 Acceptance criteria

After repair, the soldered joints shall be inspected in accordance with the accept or reject criteria of ECSS-Q-70-08. Particularly detailed inspection shall be made of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material.

Table 1: Recommended wire diameters for given conductor widths

Conductor width (mm)	Wire diameter (mm) minimum	AWG
0,30	0,16	34
0,40	0,20	32
0,50	0,25	30
0,80	0,32	28
1,60	0,40	26
3,20	0,51	24

9.6 Method for the repair of damaged conductor tracks

a. Clean both sides of break in conductor, to at least three times the track width on each side, with a fibre eraser and then with an approved solvent.

b. Cut a piece of applicable gauge tinned copper or silver wire to at least six times the track width.

c. Hold the 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. Alternative coatings according to disposition by NRB may be used.

10

Repair of lifted conductors

10.1 Introduction

This procedure is applicable where a portion of the conductor has lifted from the substrate but not broken (refer to Figure 7).

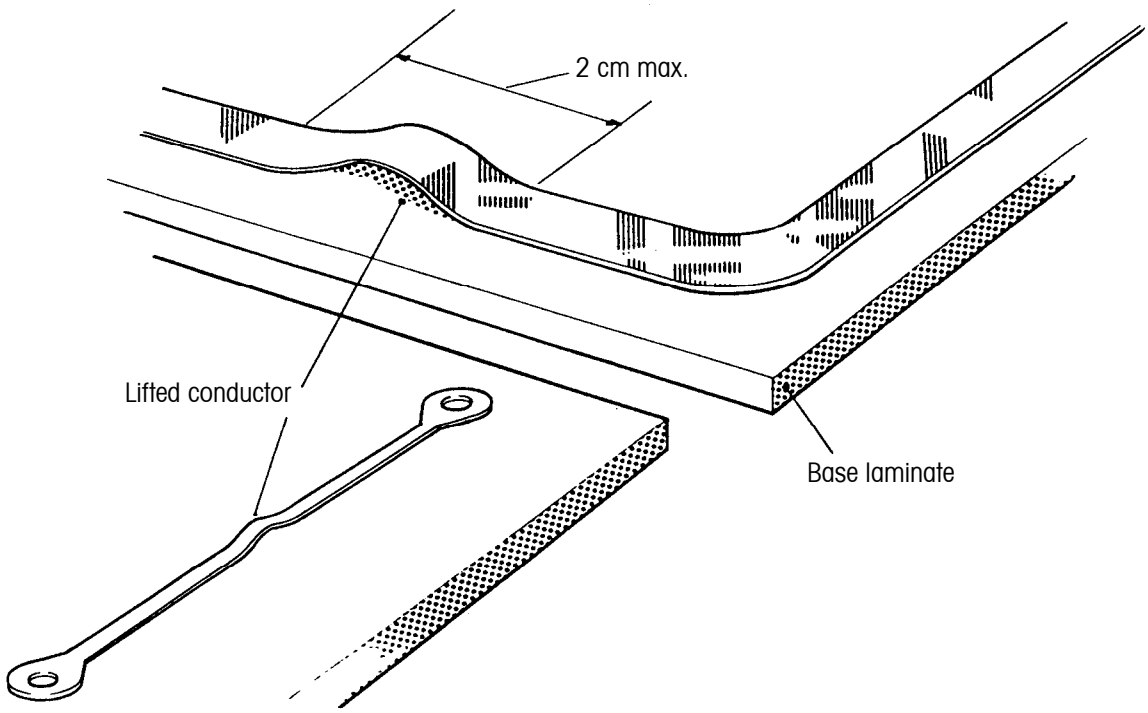

Figure 7: Lifted conductors

10.2 Requirements

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

b. The number of repairs per printed circuit board assembly shall not exceed the requirements detailed in subclause 4.2.2.

10.3 Tools and materials required

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

10.4 Procedure

Any components or solder that may interfere with the repair shall be removed from the damaged conductor as described in clauses 7 and 15 before proceeding.

Either method 10.6.1 or 10.6.2 shall be used.

10.5 Acceptance criteria

a. The lifted conductor track shall be firmly secured to the base laminate by the epoxy as defined in methods 10.6.1 and 10.6.2. Moreover, the epoxy shall be fully cured and shall not cover areas that 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 ECSS-Q-70-08. 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 or components.

10.6 Methods for repair of lifted conductors

10.6.1 Method for the use of epoxy under conductor

(Refer to Figure 8)

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

b. Remove all particles that 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.

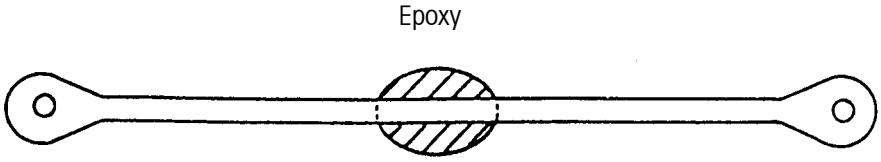

Figure 8: Repair using epoxy under conductor

10.6.2 Method for the use of epoxy over conductor

(Refer to Figure 9)

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.

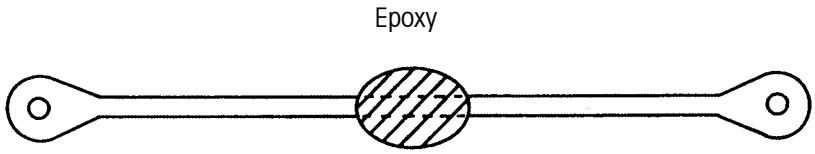

Figure 9: Repair using epoxy over conductor

(This page is intentionally left blank)

11

Repair of lifted terminal areas (pads)

11.1 Introduction

This procedure is applicable to:

a. any terminal area that has been separated, loosened or lifted or which is otherwise no longer bonded to the base material, as shown in Figure 10;

b. any terminal area that has been damaged by tearing, cutting, or other mechanical means in excess of established acceptance limits (refer to Figures 11 and 12);

c. terminal areas designed to accommodate clinched leads.

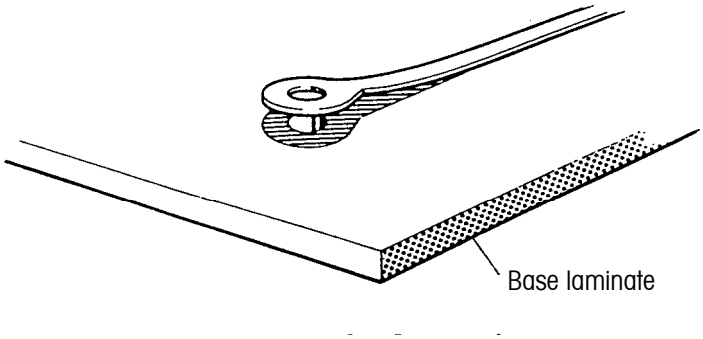

Figure 10: Lifted terminal area

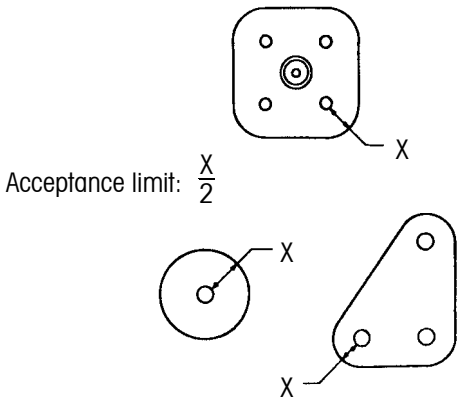

Figure 11: Terminal areas without track

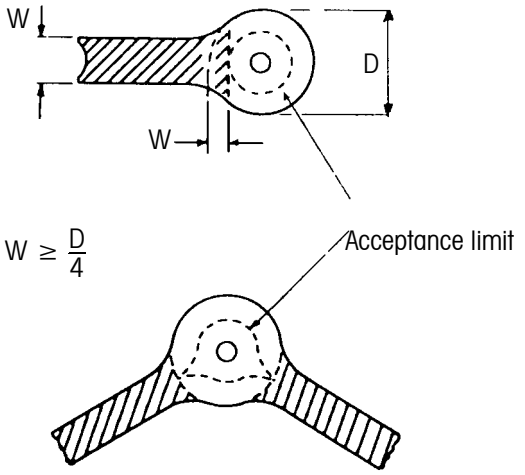

Figure 12: Terminal areas with track attached

11.2 Requirements

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

b. The unshaded areas in Figures 11 and 12 are terminal or land areas to be inspected. In these areas, the amount of disbonded material shall 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 180^0 of the periphery.

c. For plated through holes only: When the repair is completed, a clinched lead-through is to be inserted in the plated through hole. This may be a separate wire link or the component lead.

11.3 Tools and materials required

- Solder remover (vacuum type),
- oven (if thermal curing epoxy is used),
- soldering iron,
- plastic or wooden toothpicks (for lifting terminal area whilst cleaning),
- isopropyl alcohol solvent and
- epoxy resin compatible with base.

11.4 Procedure

Method 11.6 shall be used.

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

11.5 Acceptance criteria

The acceptance criteria shall be as stated in subclause 10.5 and as shown in Figures 11 and 12.

11.6 Method for the 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. Solder side of terminal area shall 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.

(This page is intentionally left blank)

12

Terminal post replacement

12.1 Introduction

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

12.2 Requirements

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

12.3 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.

12.4 Procedure

Method 12.6 shall be used.

12.5 Acceptance criteria

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

b. Where components have been removed and subsequently replaced, the soldered joints shall be inspected in accordance with the accept or reject criteria of ECSS-Q-70-08. In particular, detailed inspection shall be made of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material or components.

12.6 Method for the replacement of terminal post

a. Remove the conformal coating from the area surrounding the damaged post (see clause 6).

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 clause 15.

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 13).

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 13).

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 shall 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.

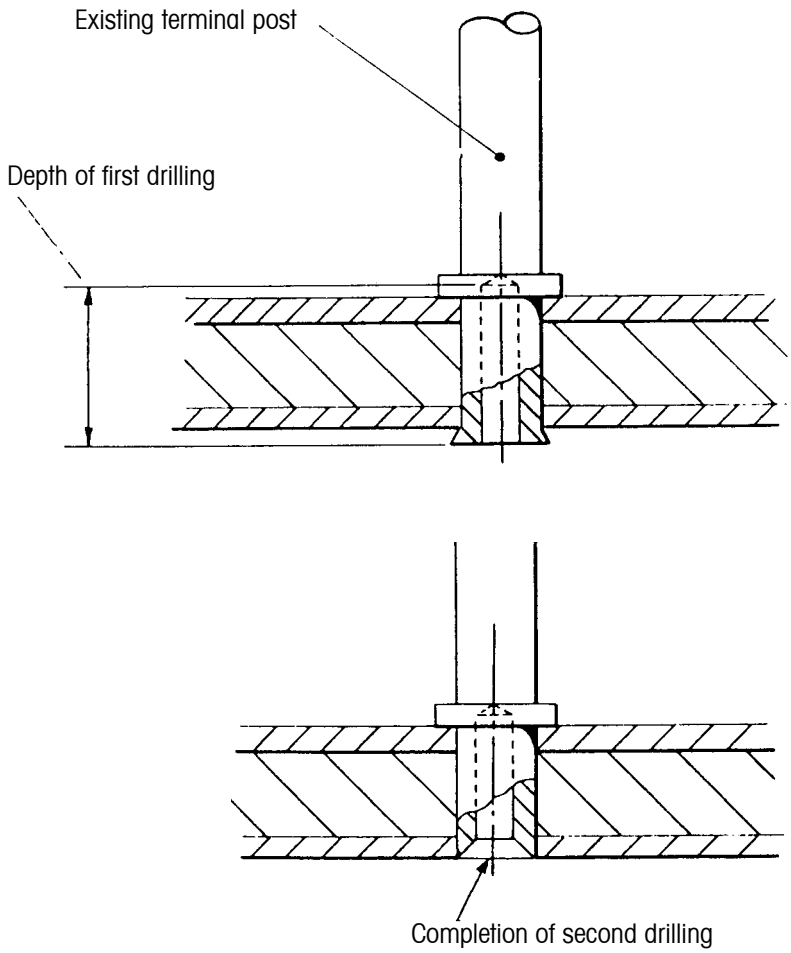

Figure 13: Terminal post replacement

(This page is intentionally left blank)

13

Wire-to-wire joints

13.1 Introduction

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

13.2 Requirements

a. Repair shall be undertaken 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 shall 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.

13.3 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 and
- cotton gloves or finger cots.

13.4 Procedure

Method 13.6 shall be used.

13.5 Acceptance criteria

The joint shall be inspected as stated in method 13.6 i. Furthermore, there shall be no visual damage to adjacent conductor tracks, base laminate or components.

13.6 Method for wire-to-wire joining

a. Cut wires to the correct length.

b. Remove wire insulation as detailed in ECSS-Q-70-08. The insulation clearance shall be as prescribed in ECSS-Q-70-08.

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 ECSS-Q-70-08.

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 14).

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 ECSS-Q-70-08 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 clauses 14 and 17, 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.

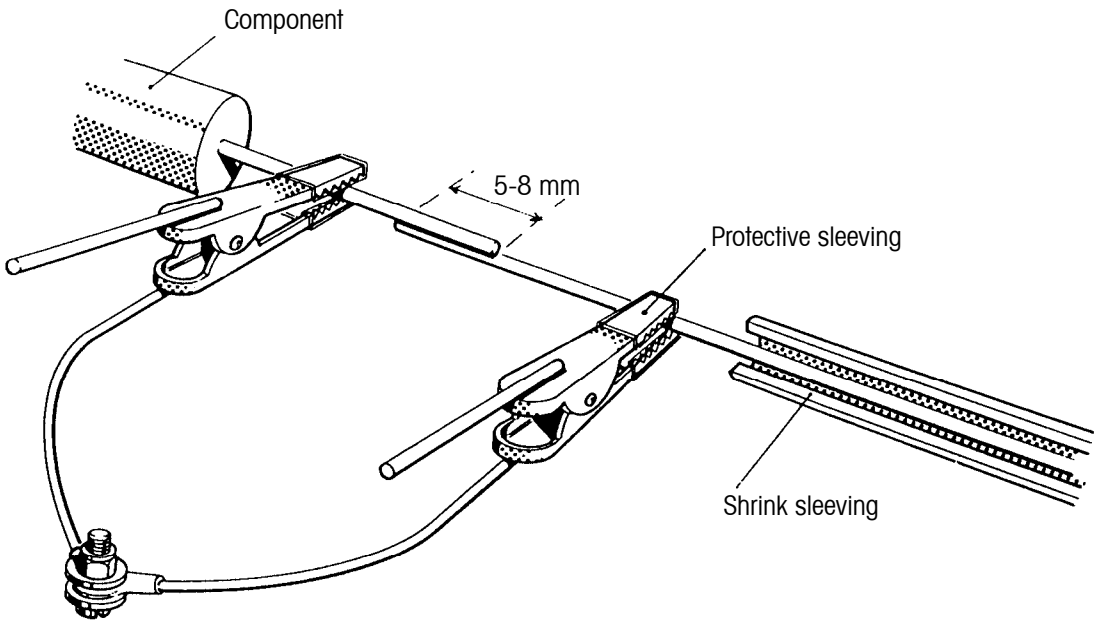

Figure 14: Use of approved type support clamp/heat sink

14

Addition of components

14.1 Introduction

Additional components can 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 14.6.1 Additional components mounted on reverse (non-component) side of board

Method 14.6.2 Additional components mounted on component side of board

Method 14.6.3 Additional components mounted on terminal posts, including "piggyback" mounting

Method 14.6.4 Additional components mounted (on reverse side or on component side of board) using staking compound

Method 14.6.5 Additional components mounted (on reverse side or on component side of board) to leads of adjacent components.

14.2 Requirements

a. Components shall be added only if such addition does not invalidate the physical dimension requirements of ECSS-Q-70-10. Method 14.6.1, method 14.6.4 (reverse side mounting) and method 14.6.5 (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 14.6.3 shall be used only if there is sufficient metallic land, as defined in ECSS-Q-70-10, to allow for both soldering and swaging of the terminal post.

b. The addition of a component may necessitate the extension of component leads; such leads should be extended for an equal distance on each side of the component by means of the lap joint method defined in clause 13 or the wraparound method of subclause 9.3 "Turret and straight pin terminals" of ECSS-Q-70-08A. 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 to the procedures in this clause 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 clause 7.

14.3 Tools and materials required

- 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 and
- pencil type vacuum cleaner

14.4 Procedure

Select from methods 14.6.1 to 14.6.5. They can be chosen for single-sided or double-sided boards. The appropriate method (method 14.6.1 or method 14.6.2) shall be chosen for addition of components to double-sided boards depending on the configuration required.

14.5 Acceptance criteria

After repair, the soldered joints shall be inspected in accordance with the accept or reject criteria of ECSS-Q-70-08. In particular, detailed inspection shall be made of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material or components.

14.6 Methods for addition of components

14.6.1 Method for 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 clause 6.

c. If the new component lead traverses conductors, assemble insulating sleeving to the section of lead that will not be soldered (refer to Figure 15).

d. Form the component lead as shown in Figure 15. 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 ECSS-Q-70-08.

e. Component lead diameter (or width) shall not be greater than two thirds track width.

f. Solder into position.

g. Remove protective paper.

h. Clean soldered area with approved solvent.

i. Inspect to the requirements of ECSS-Q-70-08.

j. Re-apply conformal coating and cure according to standard requirement.

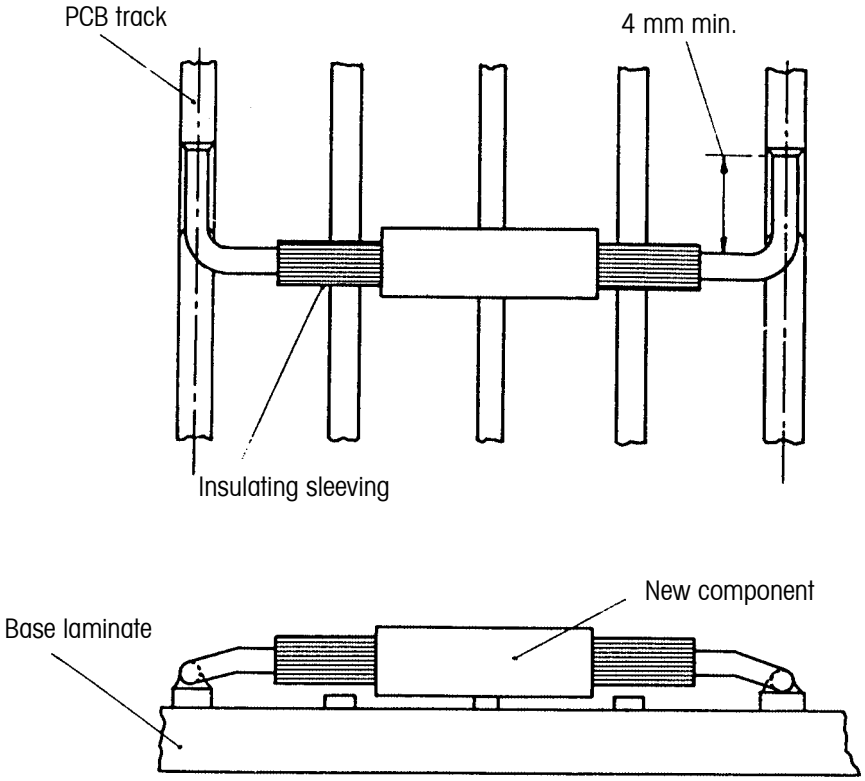

Figure 15: Additional components mounted on reverse (non-component) side of board

14.6.2 Method for 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 clause 6.

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, “d”, plus 0,25 mm 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 16. Components may also be mounted in parallel with existing tracks to avoid additional bending of leads. The stress relief and bend radius requirements of ECSS-Q-70-08 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 16).

f. Component lead diameter (or width) shall not be greater than two thirds track width.

g. Clean soldered area with approved solvent.

h. Inspect to the requirements of ECSS-Q-70-08.

i. Re-apply conformal coating and cure according to standard requirement.

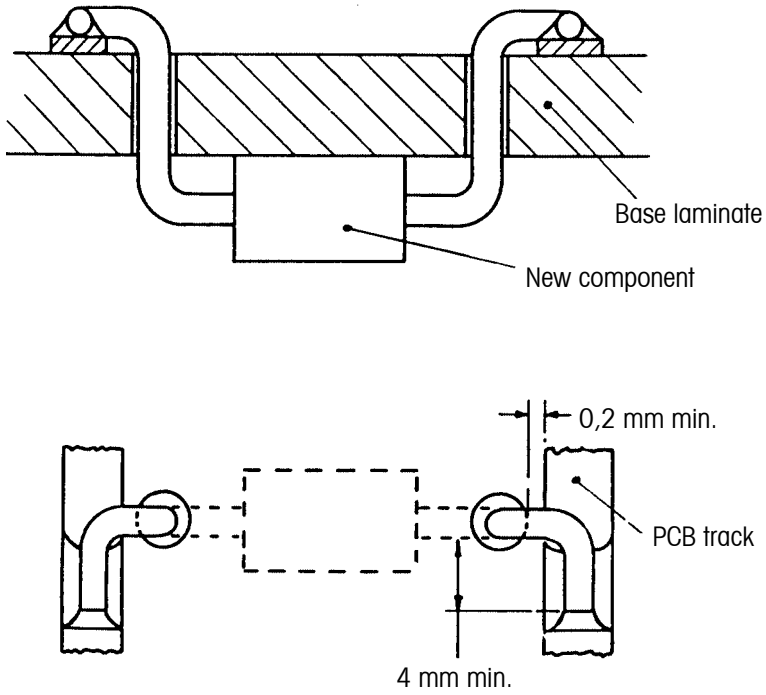

Figure 16: Additional components mounted on component side of board

14.6.3 Method for additional components mounted on terminal posts, including "piggyback" mounting

This method shall be used only if there is enough metallic land to permit drilling of 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.

b. Carefully remove any conformal coating from the area to be worked. Use the method described in clause 6.

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 ECSS-Q-70-08 shall apply.

f. If it is necessary to attach the leads of the component to the non-component side of the board, method 14.6.2 step c shall be used.

   Components should be mounted 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 17.

g. For a "piggyback" configuration, apply an approved staking compound to join component bodies together and the lower component to the board.

h. Re-apply conformal coating and cure according to standard requirement.

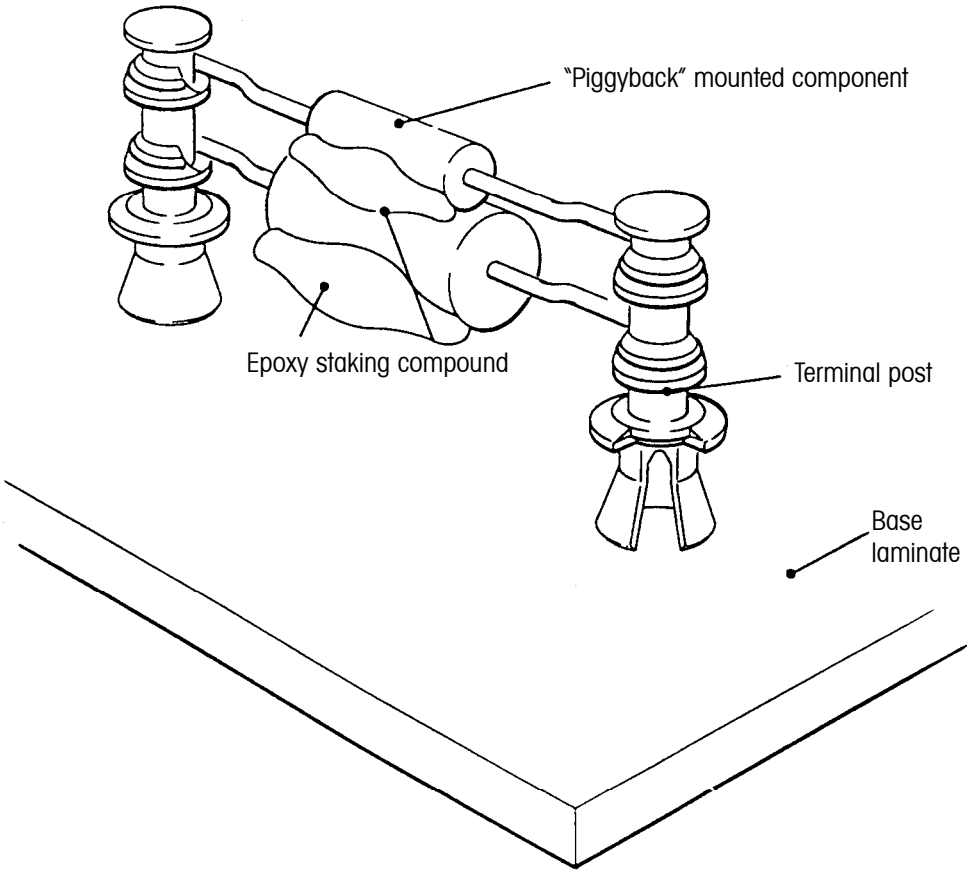

Figure 17: "Piggyback" mounting of one component on top of another

14.6.4 Method for 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 18, 19, 20 and 21).

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 clause 6.

c. For the configuration shown in Figure 21 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 mm 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 18, 19, 20 and 21. Cure according to standard requirements.

If a DIL package is mounted upside down, leads shall be de-golded and pre-tinned in accordance with ECSS-Q-70-08. Part coding shall be re-marked onto the underside to preserve identification.

The stress relief and bend radius requirements of ECSS-Q-70-08 shall apply.

e. Strip, pre-tin (with use of a heat sink 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 shall 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 subclause 9.3 "Turret and straight pin terminals" of ECSS-Q-70-08A (refer to Figures 18, 19, 20 and 21).

g. For some component types, a heat sink shall be used to prevent reflow of low melting point soldered connections within the component body.

h. Clean soldered area with approved solvent.

i. Inspect to the requirements of ECSS-Q-70-08.

j. Position wire extensions on board and bond to the board as defined in clause 13.

k. Re-apply conformal coating and cure according to standard requirements.

14.6.5 Method for additional components mounted (on reverse side or on component side of board) to leads of adjacent components

Several configurations may be used (refer to Figures 22, 23 and 24).

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 clause 6.

c. For the configurations shown in Figures 22 and 23, remove existing components in the adjacent positions (to which connections of the additional component are required). Use the method described in clause 15. Replace with new components which have either leads extended in the "Z" direction (refer to Figure 22) or a formed "pigtail" lead (refer to Figure 23).

d. Form the leads of the additional component. The stress relief and bend radius requirements of ECSS-Q-70-08 shall apply. For the configuration shown in Figure 24, 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 subclause 9.3 "Turret and straight pin terminals" of ECSS-Q-70-08A.

f. Clean soldered area with approved solvent.

g. Inspect to the requirements of ECSS-Q-70-08.

h. For the configurations shown in Figures 23 and 24, bond components to the board.

i. Re-apply conformal coating and cure according to standard requirements.

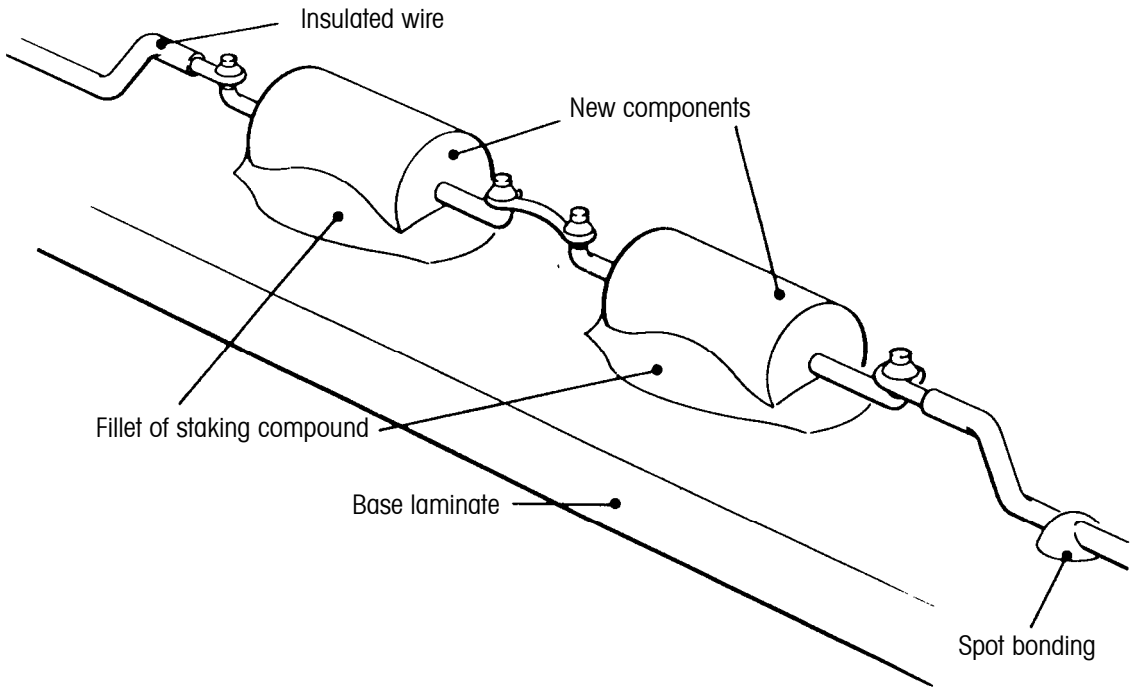

Figure 18: Mounting and wiring of additional axially-leaded components mounted (on reverse side or on component side of board) using staking compound

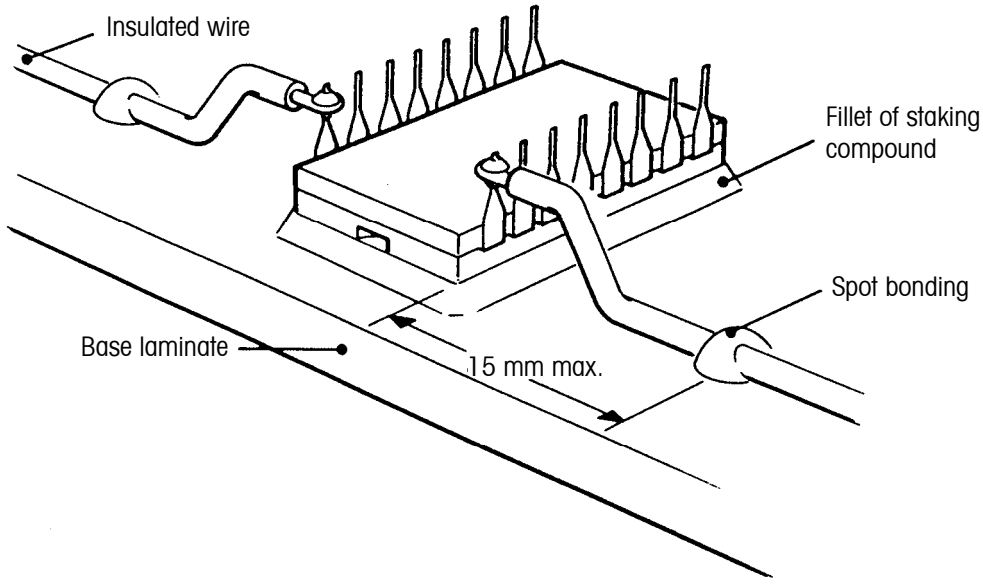

Figure 19: Upside down mounting and wiring of additional side-brazed DIL component (on reverse side or on component side of board) using staking compound

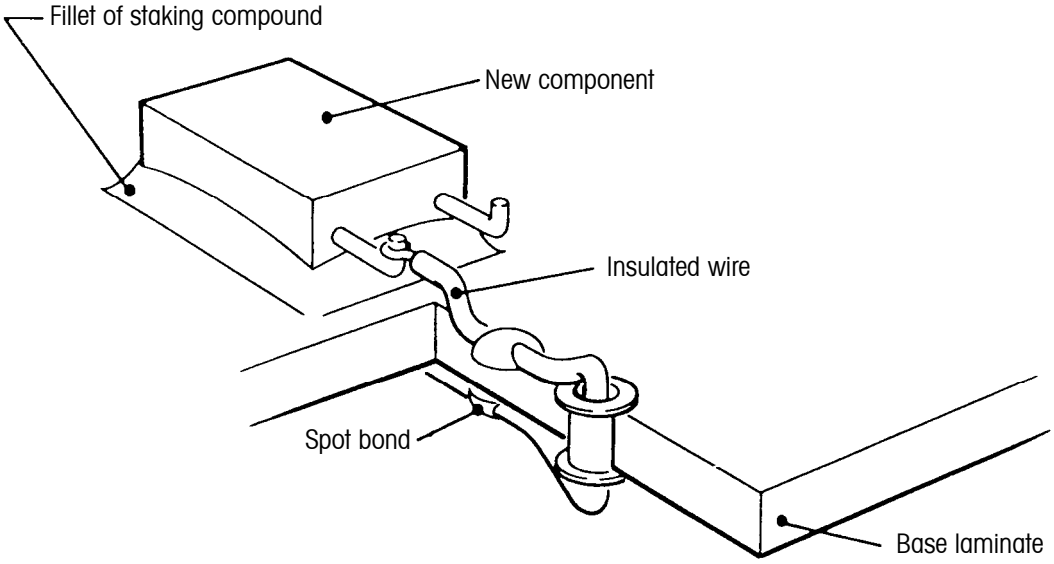

Figure 20: Mounting of additional non-axially leaded components, e.g. capacitors, with wire connecting top or bottom sides of the circuit board using staking compound (on reverse side or on component side of board)

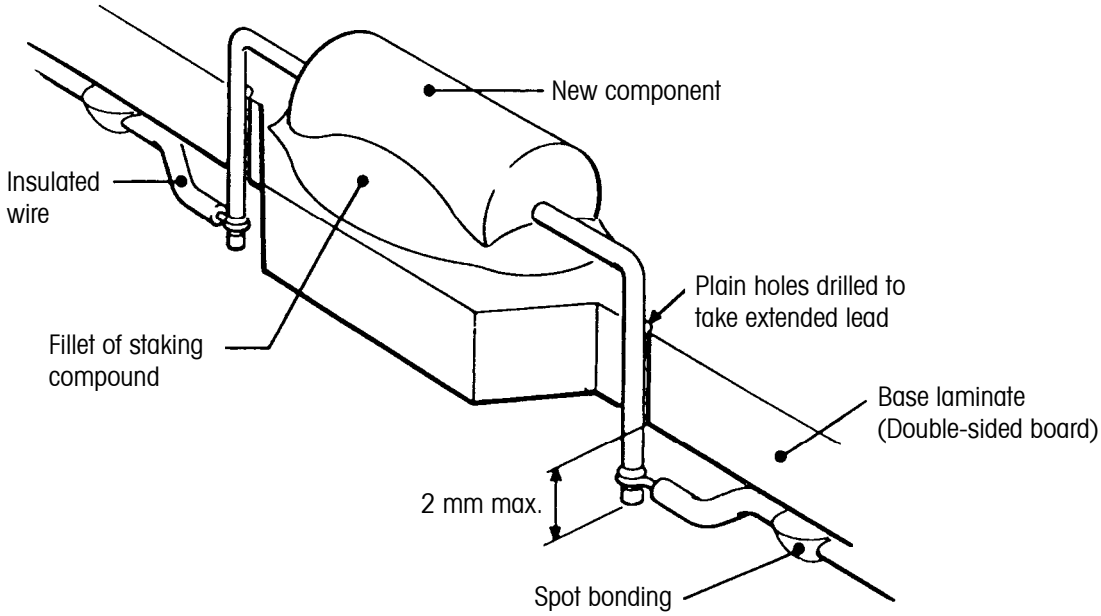

Figure 21: Mounting of additional component (on component side of board) with wire connections on reverse side of board using staking compound

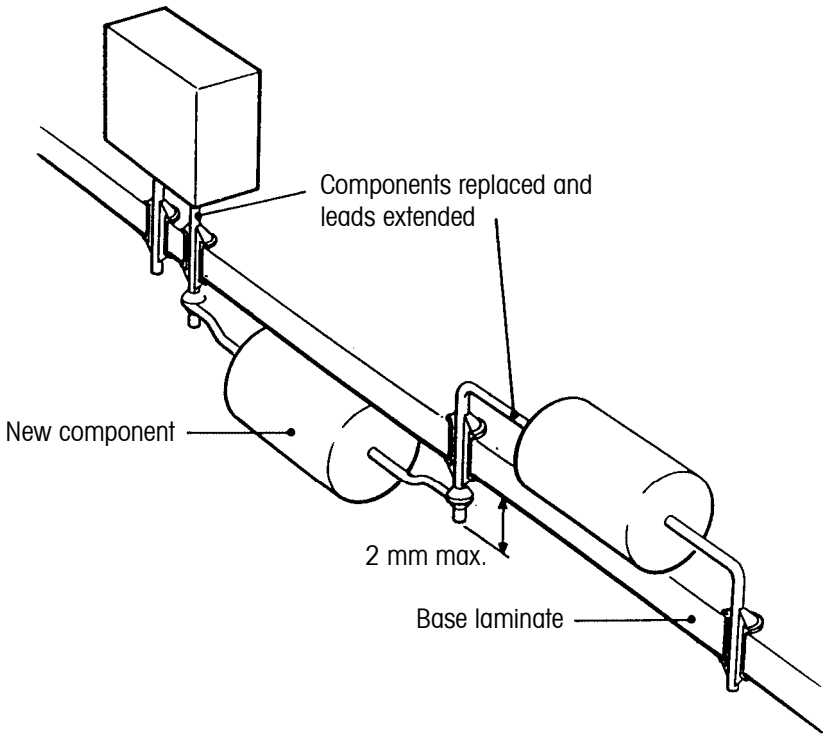

Figure 22: Mounting of additional component (on reverse side of board) across extended leads of adjacent components

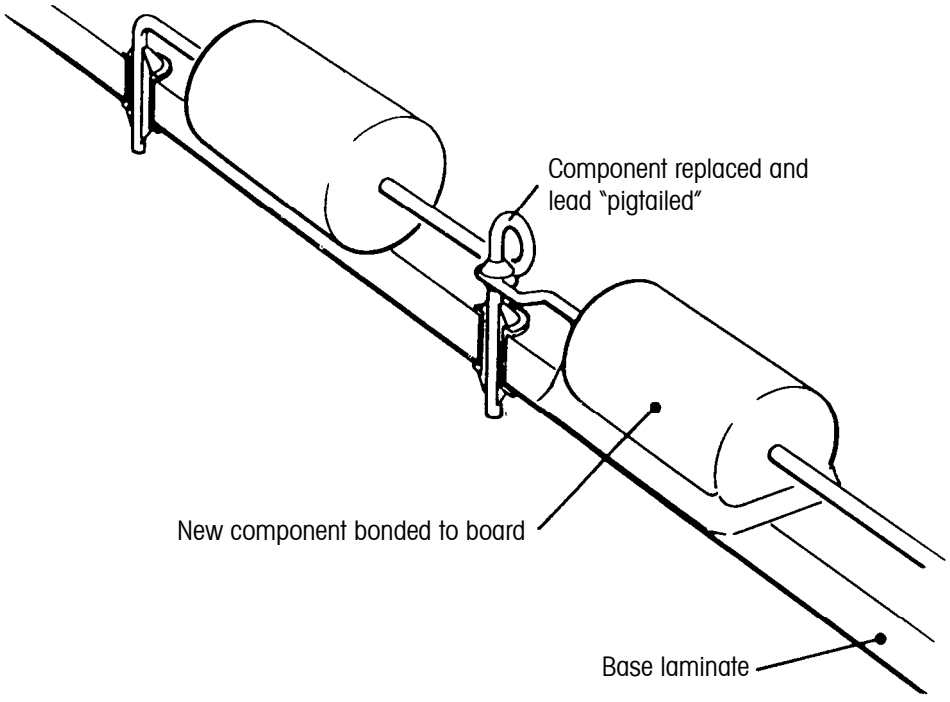

Figure 23: Mounting of additional component by linking to a "pigtailed" lead of an adjacent component

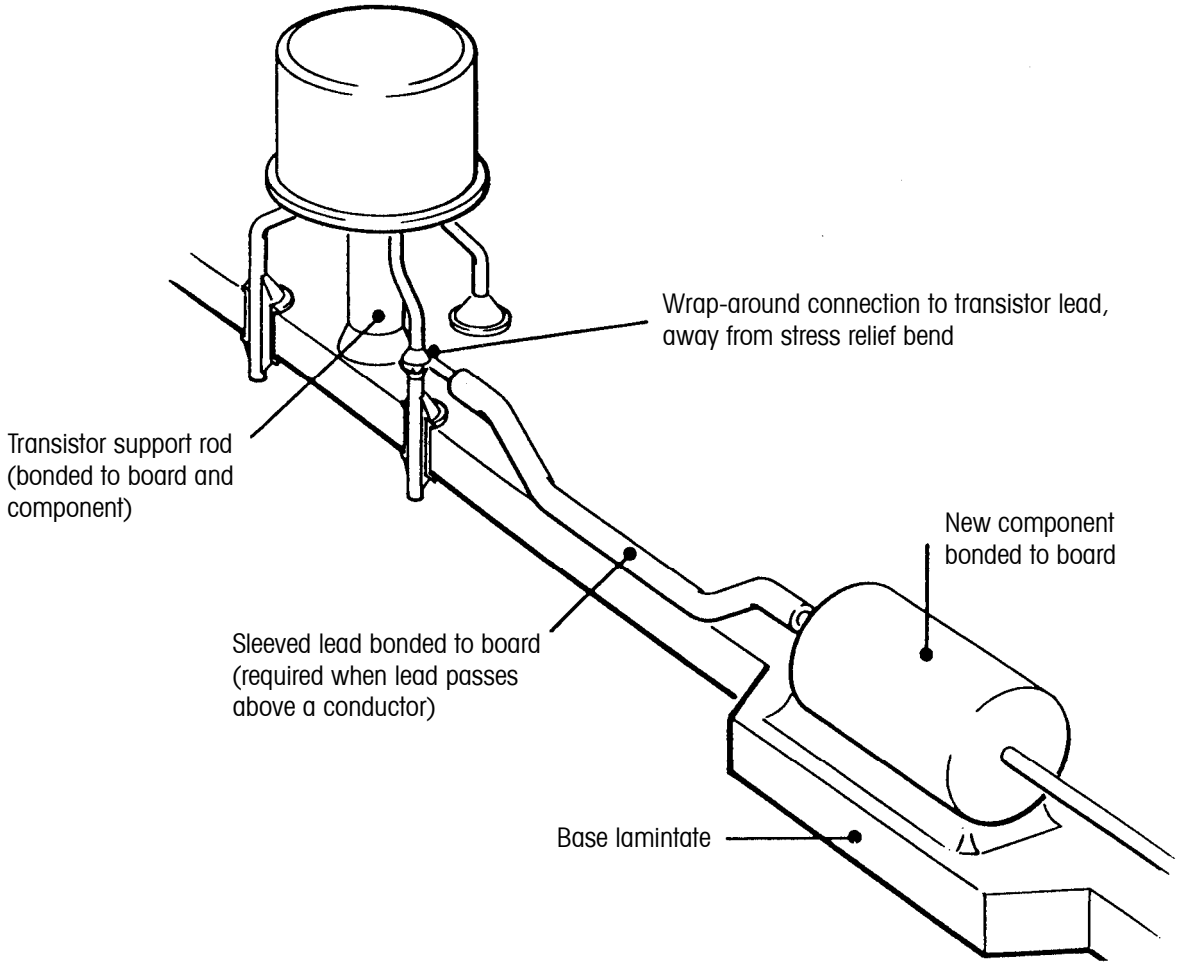

Figure 24: Mounting of additional component by linking to lead of an adjacent transistor (or other large component)

15

Removal and replacement of axial and multi-lead components

15.1 Introduction

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

15.2 Requirements

a. Extreme caution shall be exercised when dealing with circuit boards having plated-through holes as the connecting surfaces rupture easily. Very small lands are also hazardous as they 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 clause 7.

15.3 Tools and materials required

- Side-cutting pliers or diamond saw,
- soldering iron,
- long-nose pliers, and
- approved solvent.

15.4 Procedure

Select from methods 15.6.1 and 15.6.2.

15.5 Acceptance criteria

After repair, the soldered joints shall be inspected in accordance with the accept or reject criteria of ECSS-Q-70-08. In particular, detailed inspection shall be made of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material or components.

15.6 Methods for removal and replacement of axial and multi-lead components

15.6.1 Method for the 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 ECSS-Q-70-08.

15.6.2 Method for the removal of multi-lead components (destructive removal)

a. Cut component leads using diamond saw or side-cutting pliers (refer to Figures 25 and 26).

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 ECSS-Q-70-08.

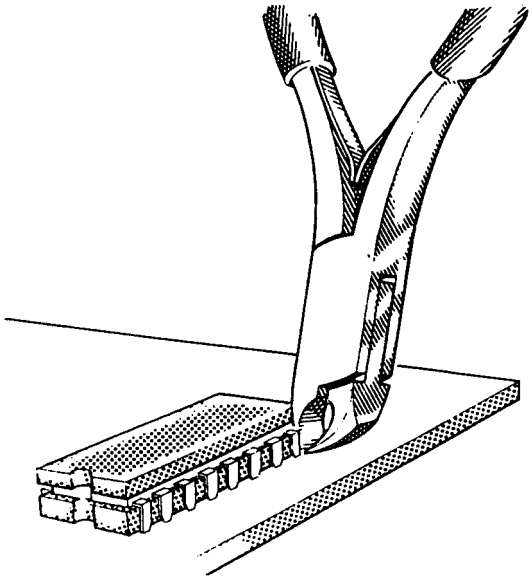

Figure 25: Removal of multi-lead components, clipping of component leads

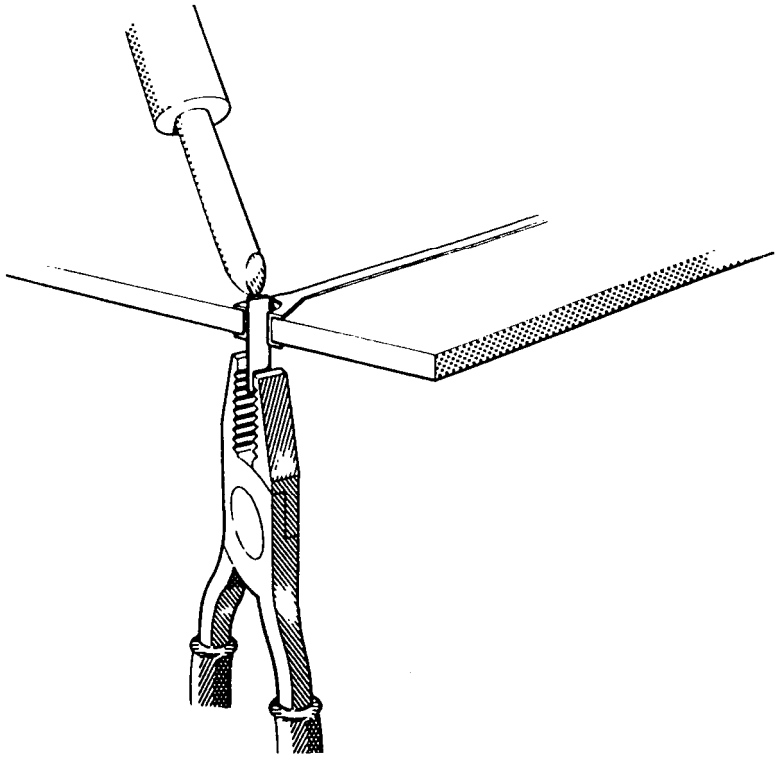

Figure 26: Removal of multi-lead components, removal of remaining component leads

(This page is intentionally left blank)

16

Removal and replacement of flat-pack components

16.1 Introduction

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

16.2 Requirements

Extreme caution shall be exercised in order to avoid damage to the board or conductor tracks by, for example, scratching or overheating.

Removal of larger flat-packs that have been bonded to the PCB for mechanical support of for thermal reasons shall be addressed as part of a NRB.

16.3 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, and
- approved solvent and cleaning tissue.

16.4 Procedure

Method 16.6 shall be used.

16.5 Acceptance criteria

After repair, the soldered joints shall be inspected in accordance with the accept or reject criteria of ECSS-Q-70-08. In particular, a detailed inspection shall be made of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material or components.

16.6 Method for the 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 27).

b. Remove adhesive bonding, if applicable, by suitable means as dispositioned by NRB.

c. Clean solder area using an approved cleaning solvent.

d. Inspect surface of joint for raised areas of track and overheated solder. Raised surfaces shall be repaired in accordance with the methods described in clause 10 and overheated solder shall be removed by wicking and the solder area re-tinned.

e. 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.

f. Apply new adhesive if required by component size.

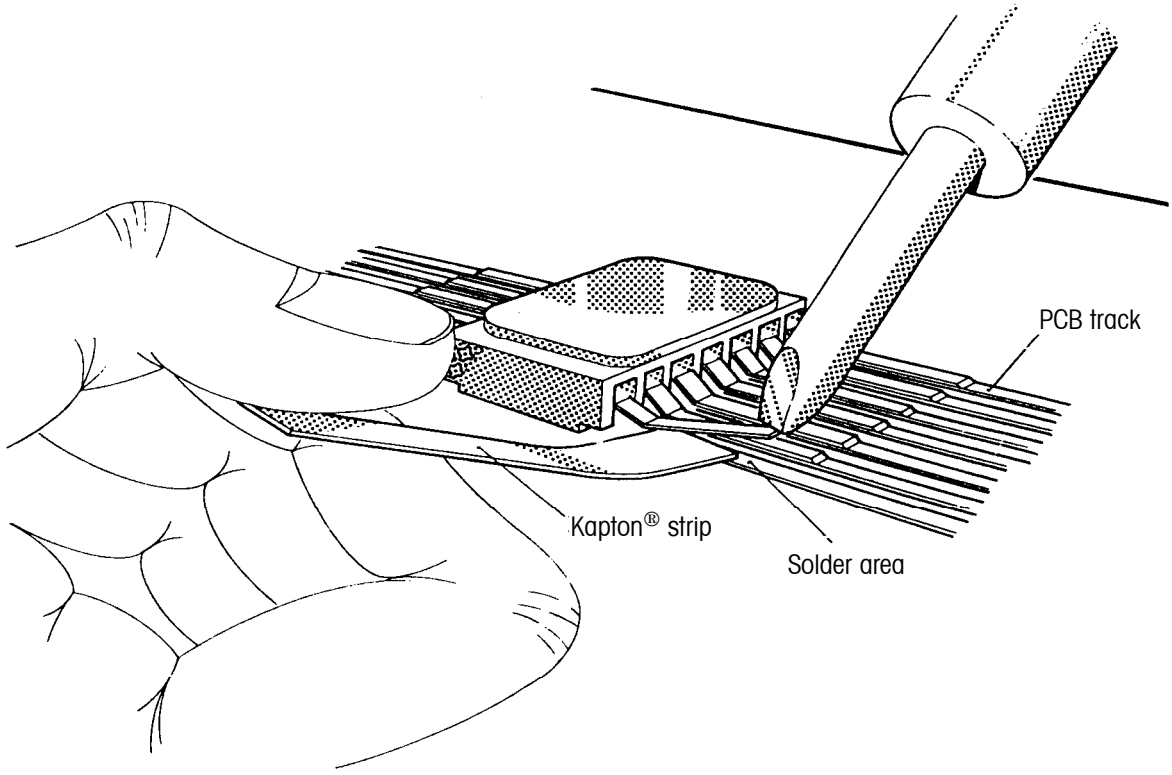

Figure 27: Removal of flat-pack components

17

Modification of component connections

17.1 Introduction

Modification of the connections from components to the printed circuit board can be required for the same reasons as those given in subclause 14.1.

Methods to be used are:

Method 17.6.1 Soldering of a wrap-around connection to an extended component lead,

Method 17.6.2 Soldering of component lead to a stud lead mounted into an existing hole,

Method 17.6.3 Mounting a dual-in-line (DIL) package with or without a wire link soldered onto a cropped lead,

Method 17.6.4 Mounting a connector with or without a wire link soldered onto a cropped lead,

Method 17.6.5 Addition of a wire link into a plated through hole occupied by a flat-section lead,

Method 17.6.6 Addition of a wire link on top of a flat-pack lead,

Method 17.6.7 Isolation of a component lead,

Method 17.6.8 Addition of a wire link onto soldered chips on a single-side piece of PCB with appropriate pads,

Method 17.6.9 Addition of a wire link onto metallized cap of chips directly glued on PCB,

Method 17.6.10 Addition of a wire link onto terminal pad of soldered chips.

17.2 Requirements

a. The criteria of subclause 4.3 shall apply.

b. For modification of DIL package connections, no more than one third of the leads per side shall be cropped (refer to method 17.6.3) or insulated (refer to method 17.6.7). For example, no more than two leads shall be cropped or insulated on each side of a 14-lead DIL package.

17.3 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, and
- long-nose pliers.

17.4 Procedure

Select from methods 17.6.1 to 17.6.10.

17.5 Acceptance criteria

After modification and where components have been removed and subsequently replaced, the soldered joints shall be inspected in accordance with the accept or reject criteria of ECSS-Q-70-08. In particular, detailed inspection shall be made of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material or components.

17.6 Methods for modification of component connections

17.6.1 Method for the 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 clause 6.

c. Remove existing component in the location at which a wrap around connection is required. Use the method described in clause 15. Replace with a new component with lead extended in the “Z”-direction (refer to Figure 28).

d. Strip, pre-tin (with use of a heat sink 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 subclause 9.3 “Turret and straight pin terminals” of ECSS-Q-70-08A.

f. Clean soldered area with approved solvent.

g. Inspect to the requirements of ECSS-Q-70-08.

h. Position wire connection on board and bond to the board as defined in clause 13.

i. Re-apply conformal coating and cure according to standard requirements.

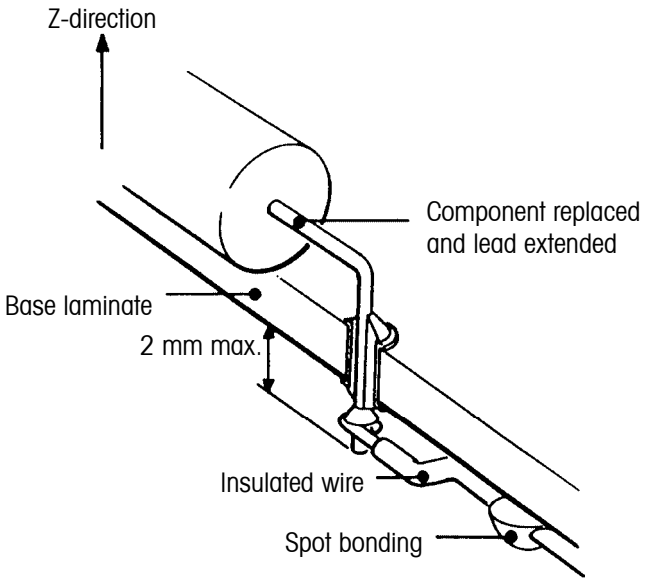

Figure 28: Soldering of a wrap-around connection to an extended component lead

17.6.2 Method for the 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 (refer to Figure 29) as per subclause 9.3 “Turret and straight pin terminals” of ECSS-Q-70-08A.

c. Clean soldered area with approved solvent.

d. Inspect to the requirements of ECSS-Q-70-08.

e. Ensure stress relief is provided in component lead.

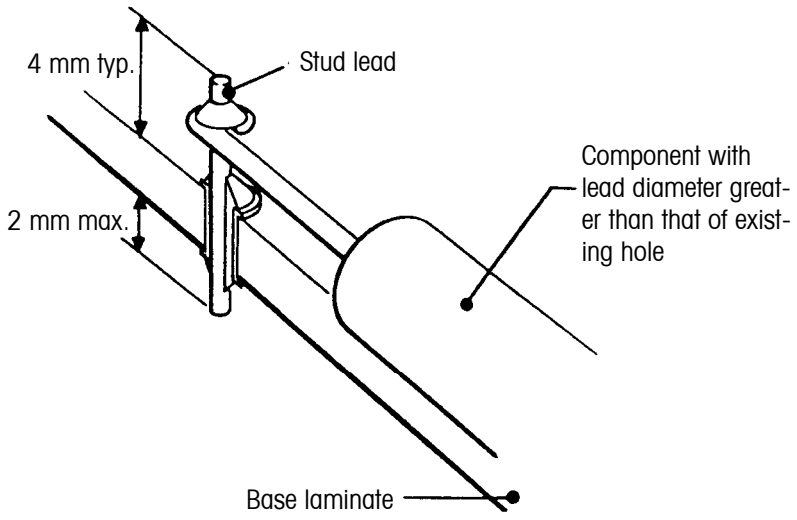

Figure 29: Soldering of component lead to a stud lead mounted into an existing hole

17.6.3 Method for 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 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 clause 15.

c. As required, crop leads of a replacement component in line with the bottom of the component body as shown in Figure 30. (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, then the cropped leads shall 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 heat sink 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 30 and 31). The length of the lap joint shall be three times the stripped wire diameter. For cropped “J”-leads, soldering shall be for 3 seconds (maximum) at a tip temperature of (250 $\pm$ 5) ^{o}C and for cropped “side-brazed” leads, soldering shall be for 3 seconds (maximum) at a tip temperature of (295 $\pm$ 5) ^{o}C.

h. Clean soldered area with approved solvent.

i. Inspect to the requirements of ECSS-Q-70-08. Position wire connections on board and bond to the board as defined in clause 13.

j. Re-apply conformal coating and cure according to the requirements in this standard.

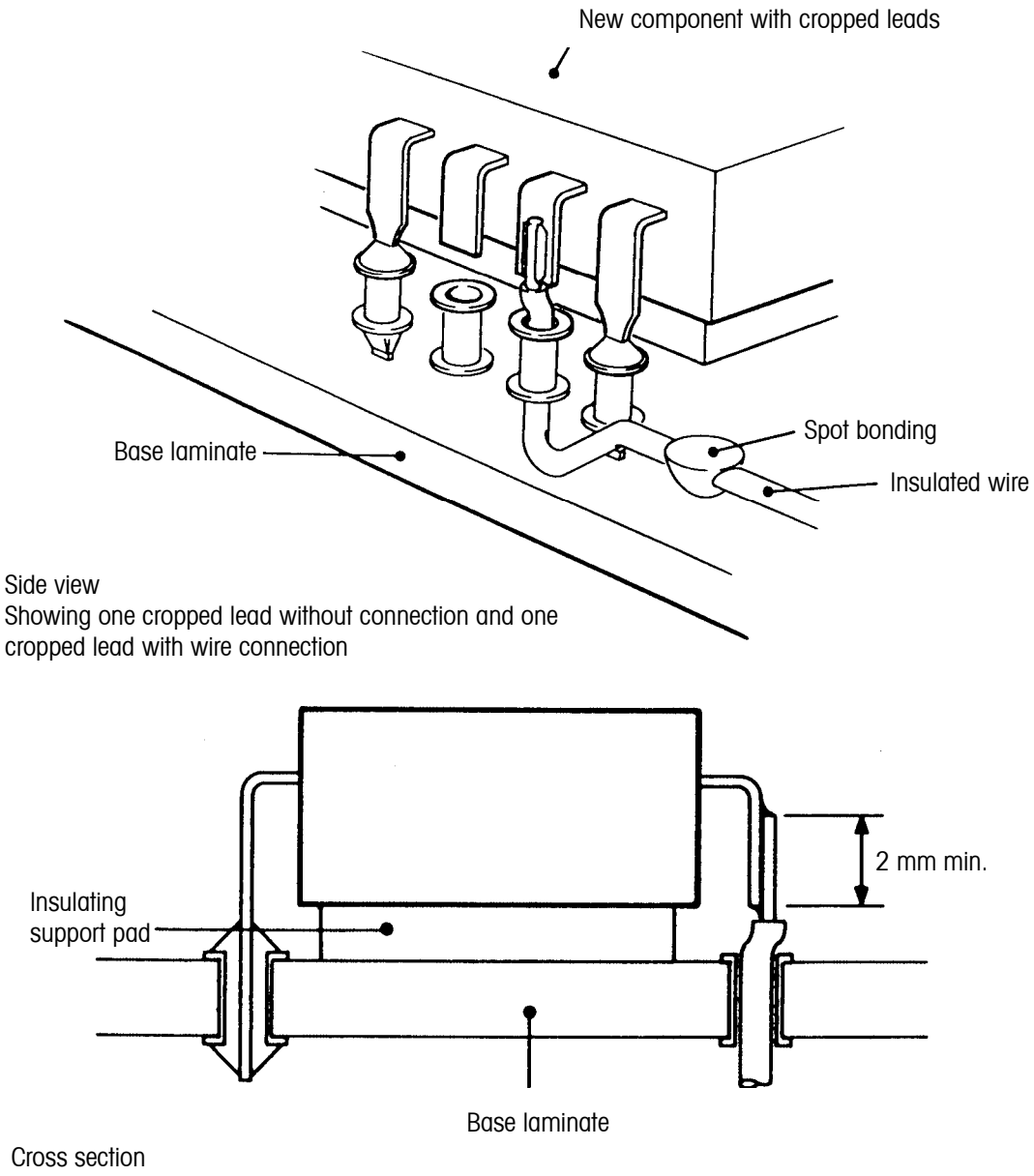

Figure 30: Mounting a dual-in-line package with or without a wire link soldered onto a cropped lead (cropped lead without connection and cropped lead with connection led through hole and onto board)

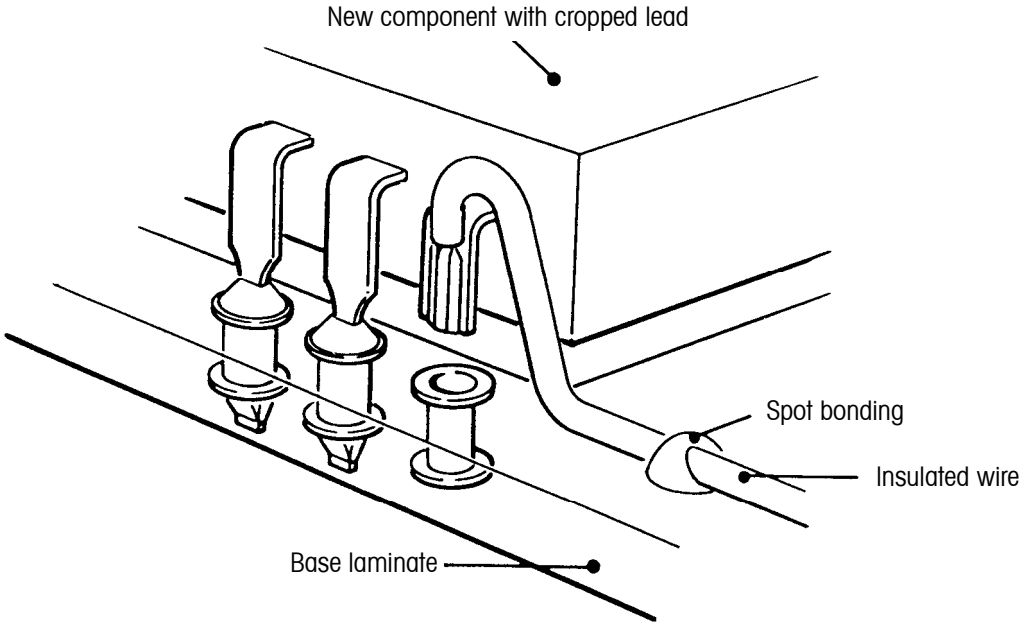

Figure 31: Mounting a dual-in-line package with or without a wire link soldered onto a cropped lead (wire link passing away from board)

17.6.4 Method for 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 clause 15.

c. As required, crop leads of a replacement connector as shown in Figure 32.

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 heat sink 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 sub-clause 9.3 “Turret and straight pin terminals” of ECSS-Q-70-08A.

h. Clean soldered area with approved solvent.

i. Inspect to the requirements of ECSS-Q-70-08.

j. Position wire connections on board and bond to the board as defined in clause 13.

k. Re-apply conformal coating and cure according to standard requirements.

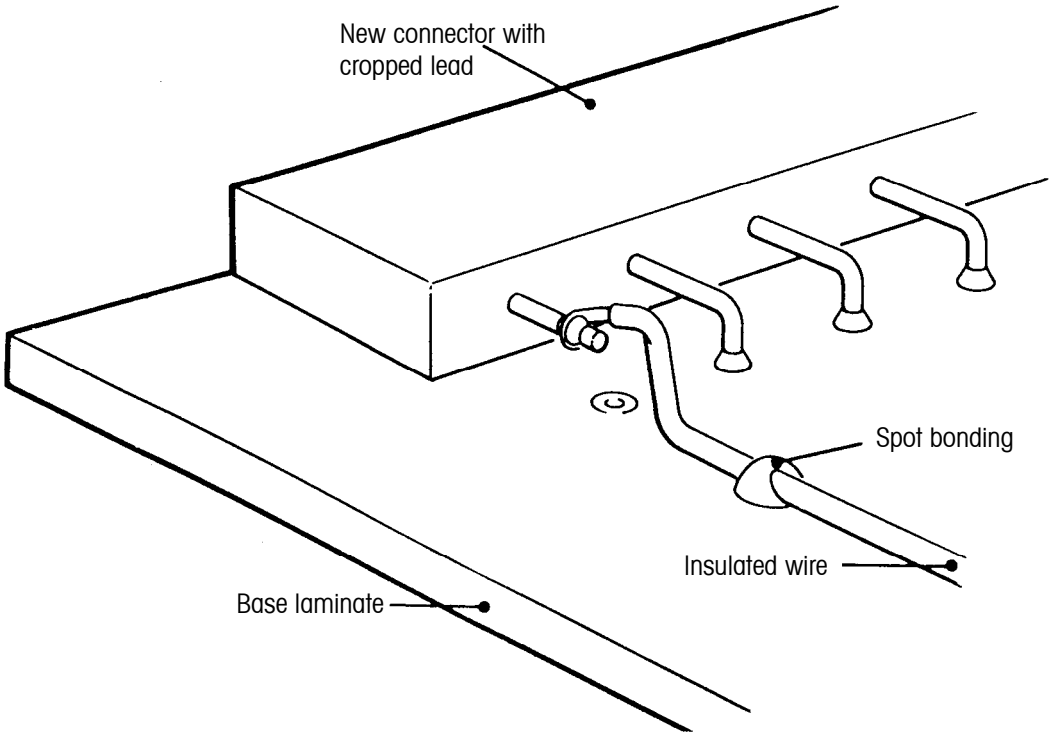

Figure 32: Mounting a connector with a wire link soldered onto a cropped lead

17.6.5 Method for the 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 clause 6.

c. De-solder the lead occupying the hole. Use the method described in clause 7.

d. Strip, pre-tin (with use of a heat sink 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 33) or from the component side of the board (refer to Figure 34). Solder wire or component lead into place. (Figures 33 and 34 illustrate the solder fillet which shall be achieved).

f. Clean soldered area with approved solvent.

g. Inspect to the requirements of ECSS-Q-70-08.

h. Position wire link on board and bond to the board as defined in clause 13.

i. Re-apply conformal coating and cure according to standard requirements.

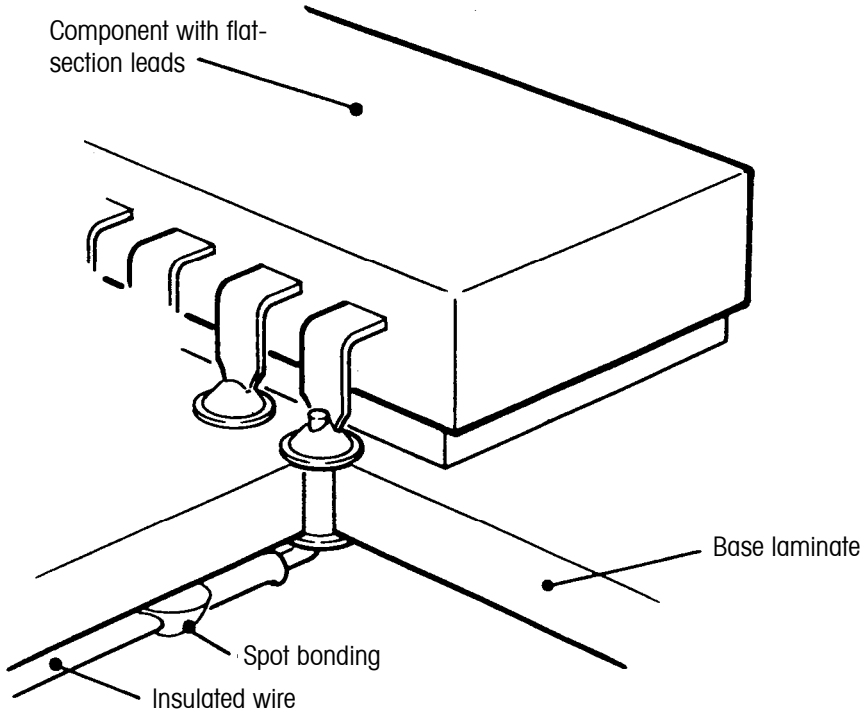

Figure 33: Addition of a wire link into a plated through hole occupied by a flat-section lead (wire link entering from the reverse side of the board)

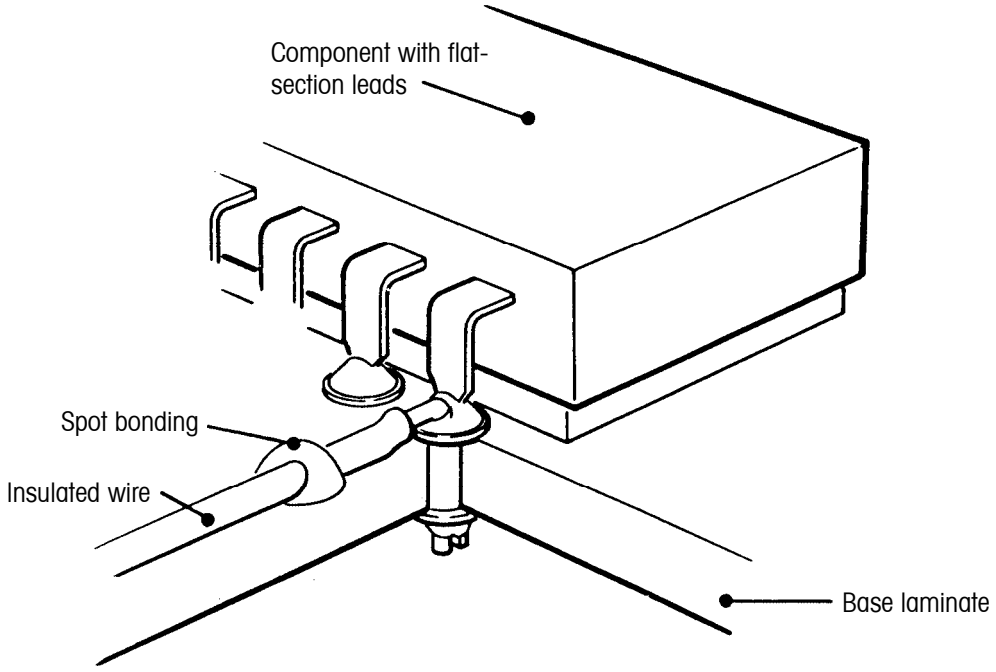

Figure 34: Addition of a wire link into a plated through hole occupied by a flat-section lead (wire link entering from the component side of the board)

17.6.6 Method for the 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 flat-pack lead requiring addition of a wire link. Use the method described in clause 6.

c. Strip, pre-tin (with use of a heat sink 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 35 and, for the solder fillet appropriate for a lap joint, Figures 15 and 16).
Wire diameter shall not be greater than two thirds lead width.

e. Clean soldered area with approved solvent.

f. Inspect to the requirements of ECSS-Q-70-08.

g. Position wire link on board and bond to the board as defined in clause 13.

h. Re-apply conformal coating and cure according to standard requirements.

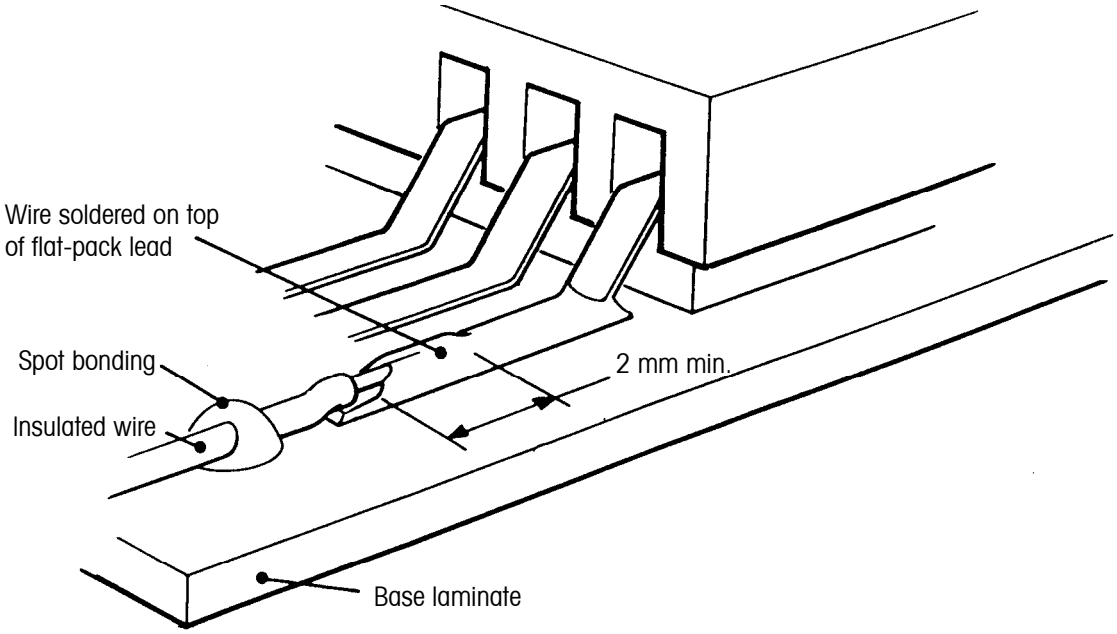

Figure 35: Addition of a wire link on top of a flat-pack lead

17.6.7 Method for the 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 multi-layer printed circuit boards.

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

This "drilling-isolation" method is critical. Operator training is essential and drilling tools shall 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 clause 15.

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 36).

NOTE Although Figure 36 illustrates an isolated lead of a DIL package, method 17.6.7 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 subclause 9.3 “Turret and straight pin terminals” of ECSS-Q-70-08A.

i. Clean soldered area with approved solvent.

j. Inspect to the requirements of ECSS-Q-70-08.

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

l. Re-apply conformal coating and cure according to standard requirements.

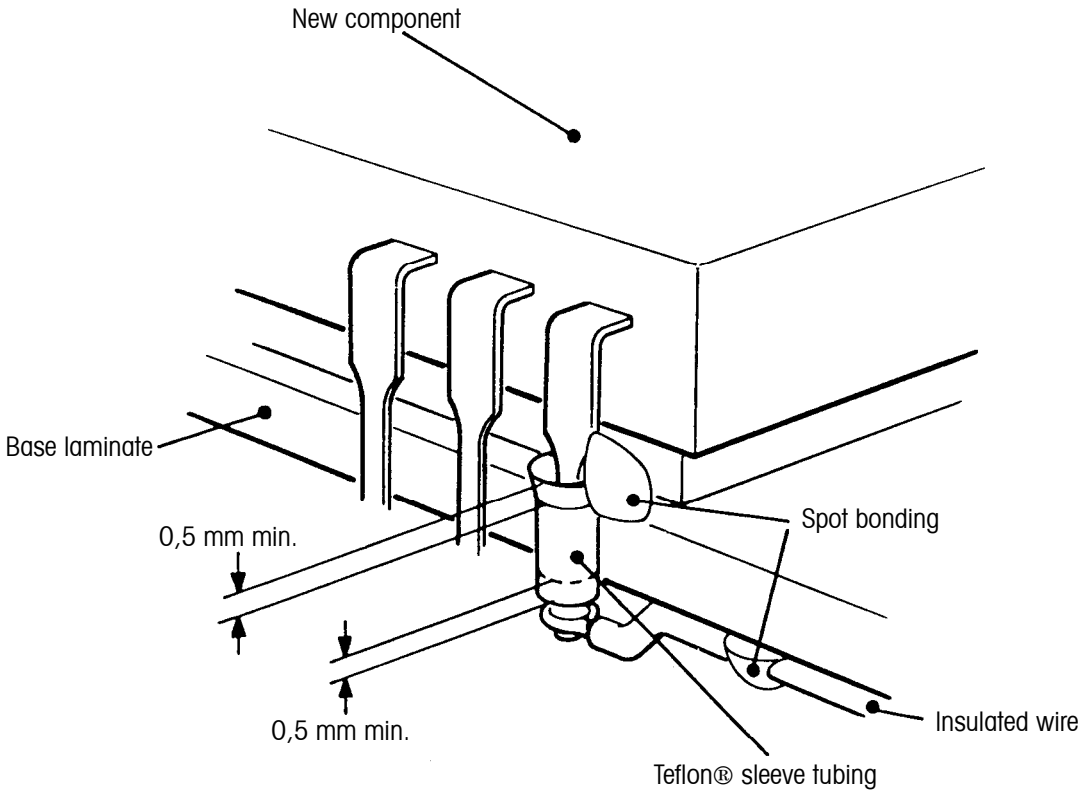

Figure 36: Isolation of a component lead

17.6.8 Method for the addition of a wire link onto soldered chips on a single side piece of PCB with appropriate pads

The number of pieces of PCB shall not exceed two to any one area of 25 cm^2. It is possible to glue a piece of PCB on tinned surface if this does not exceed 50 % of piece surface.

a. Glue with epoxy pieces of PCB on PCB board and cure.

b. Solder wire on appropriate pads on piece of PCB. Soldered length shall be greater than to 1,2 mm.

c. Clean soldered area with approved solvent.

d. Inspect joint to the requirements of ECSS-Q-70-08.

e. Position the extended wire on the board and bond to the board by using a suitable space-approved adhesive (epoxy spot). If the lead is longer than 3 cm, it shall be bonded along its length at intervals of not more than 3 cm. The first spot bond of the extension wire shall be just after the wire stress relief.

f. Re-apply conformal coating and cure according to the requirements in this Standard

17.6.9 Method for the addition of a wire link onto metallized cap of chips directly glued on PCB

The method shall be used only if the glued surface on PCB is not tinned.

a. Put an epoxy spot at the centre of component, suited with the size of package.

b. Bond the chip on PCB and cure.

c. Check that the epoxy spot does not extend onto metallized cap.

d. Solder silver wires or insulated wire (refer to Figure 37).

e. Clean soldered area with approved solvent.

f. Inspect joint to the requirements of ECSS-Q-70-08.

g. Position the extended wire on the board and bond to the board by using a suitable space-approved adhesive (epoxy spot). If the lead is longer than 3 cm, it shall be bonded along its length at intervals of not more than 3 cm. The first spot bond of the extension wire shall be just after the wire stress relief.

h. Re-apply conformal coating and cure according to the requirements in this Standard.

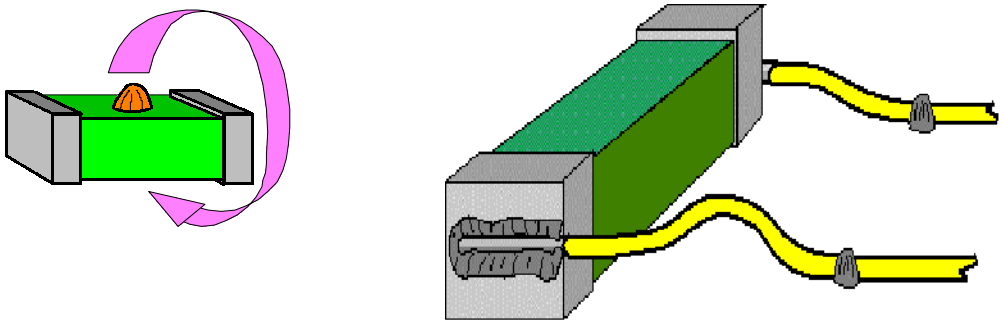

Figure 37: Addition of a wire link onto metallized cap of chips directly glued on PCB

17.6.10 Method for the addition of a wire link onto terminal pad of soldered chips

a. Flux the chip solder joint with brush.

b. Solder silver wires or insulated wires (refer to Figure 38). Soldered length shall be greater than 1,2 mm.

c. Clean soldered area with approved solvent.

d. Inspect joint to the requirements of ECSS-Q-70-08.

e. Position the extended wire on the board and bond to the board by using a suitable space-approved adhesive (epoxy spot). If the lead is longer than 3 cm, it shall be bonded along its length at intervals of not more than 3 cm. The first spot bond of the extension wire shall be just after the wire stress relief.

f. Re-apply conformal coating and cure according to the requirements in this Standard.

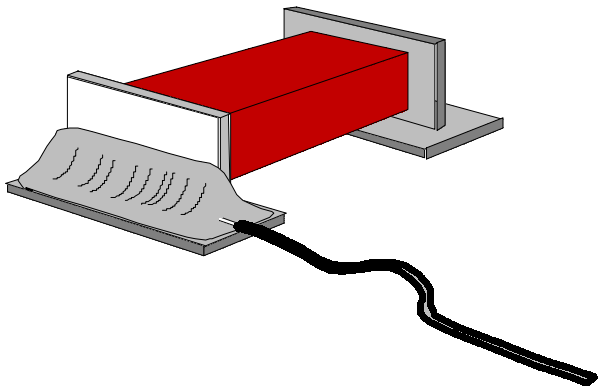

Figure 38: Addition of a wire link onto terminal pad of soldered chips

18

Cutting of internal track of a multi-layer printed circuit board

18.1 Introduction

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

18.2 Requirements

Extreme caution shall be exercised in order to avoid damage to tracks in the vicinity of that requiring modification.

18.3 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, and
- approved epoxy compound.

18.4 Procedure

Method 18.6 shall be used.

18.5 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.

18.6 Method for cutting the internal track of a multi-layer printed 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 clause 6.

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 39). 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 MΩ..
Ensure there is 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 standard requirements.

h. Re-apply conformal coating and cure to standard requirements.

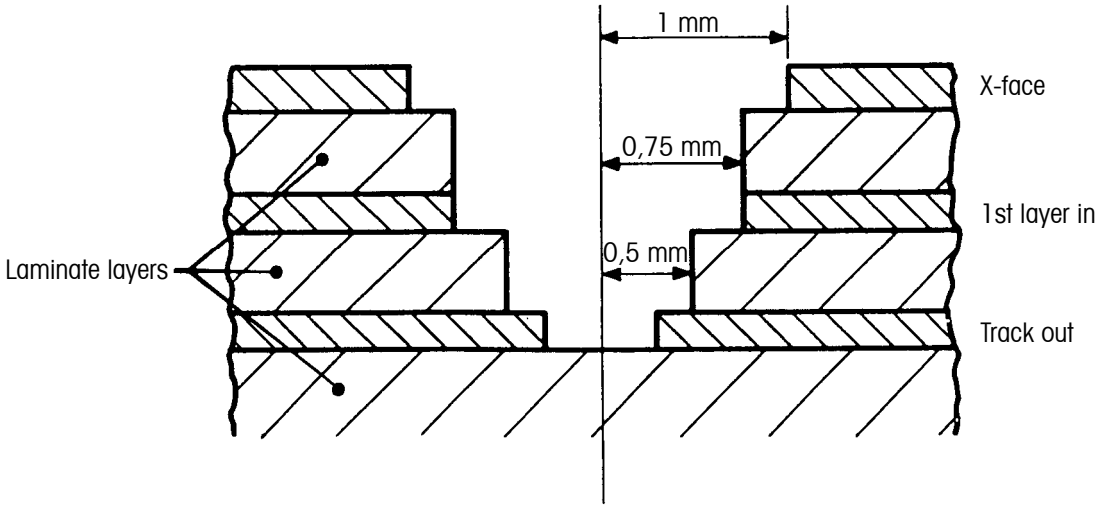

Figure 39: Cutting of internal track of a multi-layer circuit board

19

Quality assurance

19.1 General

The quality assurance requirements are defined in ECSS-Q-20.

19.2 Data

The quality records (e.g. logbooks) shall be retained for at least ten years or in accordance with project contract requirements, and contain as a minimum the following:

a. copy of final inspection documentation;

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

c. nonconformance reports and corrective actions;

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

19.3 Nonconformance

Any nonconformance that is observed in respect of the process shall be handled in accordance with the quality assurance requirements, see ECSS-Q-20-09.

19.4 Calibration

Each reference standard and piece of measuring equipment shall be calibrated. Any suspected or actual equipment failure shall be recorded as a project nonconformance report, so that previous results may be examined to ascertain whether or not re-inspection or retesting is required. The final customer shall be notified of the nonconformance details.

19.5 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.

Repair, modification or rework shall be recorded in the relevant documentation (e.g. manufacturing traveller, or manufacturing flow chart) of the printed circuit board assembly.

19.6 Operator and inspector training and certification

All operators and inspectors employed in repair or modification procedures shall be trained and certified as detailed in ECSS-Q-70-08 and shall have undergone a further training programme to ensure proficiency in the repair methods detailed herein.

ECSS Document Improvement Proposal

1. Document I.D.	2. Document date	3. Document title
ECSS-Q-70-28A	21 June 2002	Repair and modification of printed circuit board assemblies for space use

4. Recommended improvement (identify clauses, subclauses and include modified text or graphic, attach pages as necessary)

5. Reason for recommendation

6. Originator of recommendation

Name:	Organization:	
Address:	Phone: Fax: e-mail:	**7. Date of submission:**

8. Send to ECSS Secretariat

Name:	Address:	Phone: +31-71-565-3952
W. Kriedte ESA-TOS/QR	ESTEC, P.O. Box 299 2200 AG Noordwijk The Netherlands	Fax: +31-71-565-6839 e-mail: Werner.Kriedte@esa.int

Note: The originator of the submission should complete items 4, 5, 6 and 7.

An electronic version of this form is available in the ECSS website at: http://www.ecss.nl/
At the website, select “Standards” - “ECSS forms” - “ECSS Document Improvement Proposal”

(This page is intentionally left blank)