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Entwurf

Raumfahrtproduktsicherung – Reparatur und Modifikation von Leiterplatten-Baugruppen für den Einsatz im Weltraum; Englische Fassung FprEN 16602-70-28:2013

Space product assurance –
Repair and modification of printed circuit board assemblies for space use;
English version FprEN 16602-70-28:2013

Assurance produit des projets spatiaux –
Réparation et modification des ensembles de circuits imprimés pour utilisation spatiale;
Version anglaise FprEN 16602-70-28:2013

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Nationales Vorwort

Dieses Dokument (FprEN 16602-70-28:2013) wurde vom Technischen Komitee CEN/CLC/TC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat vom DIN (Deutschland) gehalten wird.

Dieses Dokument ist derzeit zum einstufigen Annahmeverfahren vorgelegt.

Dieses Dokument wurde speziell zur Behandlung von Raumfahrtsystemen erarbeitet und hat daher Vorrang vor jeglicher Europäischer Norm, da es denselben Anwendungsbereich hat, jedoch über einen größeren Geltungsbereich (z. B. Luft- und Raumfahrt) verfügt.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-10-01 AA „Interoperabilität von Informations-, Kommunikations- und Navigationssystemen“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

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Nationaler Anhang NA
(informativ)

Begriffe

3 Begriffe und Abkürzungen

3.1 Begriffe aus anderen Normen

Für die Anwendung dieses Dokuments gelten die Begriffe nach ECSS-S-ST-00-01.

3.2 Für diese Norm spezifische Begriffe

3.2.1
Modifikation
Prozess des Modifizierens eines elektronischen Schaltkreises durch Hinzufügen oder Entfernen elektrischer Teile oder der Verdrahtung

3.2.2
Reparatur
Änderung an einem Bauelement mit allen zugehörigen Anschlüssen, einschließlich des Wiederbefestigens abgehobener Lötaugen oder Leiterbahnen oder jeglicher vergleichbarer Verfahren nach dieser Norm

ANMERKUNG 1 zum Begriff: Eine Änderung der Bauelemente zum Zwecke der Abstimmung, d. h. Auftrennen der Lötverbindungen und Ändern der Bauelementwerte, gilt nicht als Reparatur, Nacharbeit oder Modifikation.

ANMERKUNG 2 zum Begriff: Bei der Abstimmung werden Lötverbindungen mit der geringstmöglichen Menge an Lot erreicht, gerade ausreichend, um den Kontakt sicherzustellen.

3.2.3
Nacharbeit
Prozess des Nacharbeitens einer fehlerhaften Lötverbindung (ohne Änderung der Bauelemente) als Folge des Reparatur- oder Modifikationsprozesses oder zum Zwecke der Wiederherstellung der Ausführungsgüte von potentiell fehlerhaften Lötverbindungen

3.3 Abkürzungen

Für die Anwendung dieses Dokuments gelten die Abkürzungen in ECSS-S-ST-00-01 und die folgenden Abkürzungen:

Abkürzung	Bedeutung
PCB	Leiterplatte (en: printed circuit board)
PTFE	Polytetrafluorethylen (en: Polytetrafluoroethylene)
PTH	Durchkontaktierung/metallisiertes Loch (en: plated-through hole)
DIL	mit zwei Kontaktreihen/zweireihig (en: dual-in-line)

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EUROPEAN STANDARD — *Entwurf* — **FINAL DRAFT**

NORME EUROPÉENNE **FprEN 16602-70-28**

EUROPÄISCHE NORM

October 2013

ICS 49.140

English version

Space product assurance - Repair and modification of printed circuit board assemblies for space use

Assurance produit des projets spatiaux - Réparation et modification des ensembles de circuits imprimés pour utilisation spatiale

Raumfahrtproduktsicherung - Reparatur und Modifikation von Leiterplatten-Baugruppen für den Einsatz im Weltraum

This draft European Standard is submitted to CEN members for unique acceptance procedure. It has been drawn up by the Technical Committee CEN/CLC/TC 5.

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Foreword

This document (FprEN 16602-70-28:2013) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN (Germany).

This document (FprEN 16602-70-28:2013) originates from ECSS-Q-ST-70-28C.

This document is currently submitted to the Unique Acceptance Procedure.

This document has been developed to cover specifically space systems and will the-refore have precedence over any EN covering the same scope but with a wider do-main of applicability (e.g. : aerospace).

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1 Scope

The requirements and procedures for repair and modification 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.

This Standard does not address the potential need for rework resulting from a repair or modification and unassembled (bare) printed circuits boards.

This standard may be tailored for the specific characteristics and constraints of a space project, in conformance with ECSS-S-ST-00.

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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

EN reference	Reference in text	Title
EN 16001-00-01	ECSS-S-ST-00-01	ECSS system — Glossary of terms
EN 16602-10-09	ECSS-Q-ST-10-09	Space product assurance — Nonconformance control system
EN 16602-20	ECSS-Q-ST-20	Space product assurance — Quality assurance
EN 16602-70	ECSS-Q-ST-70	Space product assurance — Materials, mechanical parts and processes
EN 16602-70-08	ECSS-Q-ST-70-08	Space product assurance — Manual soldering of high- reliability electrical connections
EN 16602-70-10	ECSS-Q-ST-70-10	Space product assurance — Qualification of printed circuit boards
EN 16602-70-38	ECSS-Q-ST-70-38	Space product assurance — High-reliability soldering for surface-mount and mixed technology

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3 Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply.

3.2 Terms specific to the present standard

3.2.1 modification

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

3.2.2 repair

change of 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

NOTE 1 Changing of components for tuning, i.e. de-soldering and changing component value is not considered a repair, rework or modification operation.

NOTE 2 During tuning, solder jointing is achieved with a minimum of solder, just enough to ensure contact.

3.2.3 rework

process of reworking of a defective solder joint (without component changing) as a consequence of the repair or modification process or for restoring good workmanship of potentially defective solder joints

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3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
PCB	printed circuit board
PTFE	Polytetrafluoroethylene
PTH	plated-through hole
DIL	dual-in-line

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4 Requirements

4.1 Basic requirements

4.1.1 Hazard, health and safety precautions

a. The supplier shall define and implement procedures to control hazards to personnel, equipment or materials.

4.1.2 Materials

a. All materials used for repairs and which form part of the end product shall meet the specification for the end product.

b. Solders, flux and cleaning solvents shall be as specified in ECSS-Q-ST-70-08, clauses 6.1, 6.2 and 6.3.

4.1.3 Facilities

a. All facilities and tools for repair and modification of printed circuit board assemblies for space use shall be in conformance with ECSS-Q-ST-70-08.

4.1.4 General

a. All processes, as described from clauses 4.2 to 4.19, shall conform with the ECSS-Q-ST-70 requirements

b. The supplier shall perform all soldering operations in conformance with clauses 7, 8, 9, 10 and 11 of ECSS-Q-ST-70-08 or clauses 8, 9, 10, 11 and 12 of ECSS-Q-ST-70-38.

NOTE Many of the accessories and work aids detailed in this Standard are contained within purpose-built equipment.

c. The supplier shall apply the repair or modification procedures as detailed in clauses 4.6 to 4.18.

NOTE the verification of the supplier repair and modification processes for each type of devise is specified in accordance with clause 14.1 of ECSS-Q-ST-70-38 and clause 13.1 of ECSS-Q-ST-70-08.

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d. For repairs and modifications, the supplier shall ask for formal approval or authorization from the project PA/QA representative using NCR and NRB procedures as specified in ECSS-Q-ST-10-09

e. The supplier shall remove components that are submitted to failure analysis procedures from assemblies and handle them in such a way that their state and conditions are not altered for the analysis procedures.

f. When the proposed repair method, tools or procedure are not covered by this Standard, the supplier shall detail the repair procedure in the relevant NCR and treat in conformance with ECSS-Q-ST-10-09.

4.2 Repairs

4.2.1 Repair criteria

a. The supplier shall carry out repairs only when it is necessary to restore the functional or performance capability of a printed circuit assembly that has been damaged during assembly or during testing.

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 not exceed six.

b. When a printed circuit board assembly supports more than 120 passive chip components, the total number of repairs shall not exceed 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 the revision of interconnecting features by interrupting conductors or adding components as well as wire connections.

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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

a. 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

a. All aspects of the reworked solder joint shall conform to ECSS-ST-Q-70-38 or ECSS-ST-Q-70-08,

4.4.2 Number of reworks

a. The total number of such reworks on any one joint shall not exceed three.

4.5 Other requirements

a. The supplier shall not reuse components removed because of malfunction or mechanical damage or because of damage to the conductor track in the vicinity of the component but replace them by new identical or equivalent components.

b. The supplier shall remove components only if the mounting density is such that the integrity of other components in the vicinity can be ensured.

c. The supplier shall not carry out more than one de-soldering operation on a printed circuit termination besides the ones that receive chip components.

d. For chip components, the number of replacements in one location shall not exceed three.

e. For repair or modification methods not detailed in this Standard, or in excess of criteria given in clauses 4.2.2, 4.3.2 and 4.4.2, the supplier shall apply the following procedure:

   1. Document deviation as NCR.

   2. Involve final customer in NRB.

f. The supplier shall not straighten warped boards, with or without components.

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4.6 Removal of conformal coating

4.6.1 Requirements

a. The supplier shall not use soldering irons for coating removal.

NOTE The high operating temperatures cause charring of the coatings and possible delamination in the base laminate.

b. It shall be verified that no damage occurs to the printed wiring assembly by cutting around the area to be repaired.

c. When using the thermal parting tip it shall be assured that any adjacent solder joints and circuitry does not melt.

d. The time for solvent application shall not exceed 15 minutes.

NOTE The time of solvent application is kept as short as possible. The reason is that solvents tend to expand the coating media and attack coatings on electronic components in areas remote from direct solvent application.

4.6.2 Procedure

a. The supplier should use method A.3.1 for polyurethane- and silicone-type coatings.

b. The supplier should use method A.3.2 for epoxy-type coatings.

4.6.3 Acceptance criteria

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

b. None of the following shall occur:

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

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4.7 Solder joint removal and unclinching

4.7.1 Procedure

a. Depending on the kind of solder joint, the supplier should use one or more of the methods described in B.3.1, B.3.2, B.3.3, B.3.4 and B.3.5.

NOTE To select the appropriate method refer to the method descriptions.

b. Prior to commencing, the supplier should remove any conformal coating that has been applied to the circuit in conformance with the procedure set out in Annex A.

4.7.2 Acceptance criteria

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

b. None of the following shall occur:

1. melting of adjacent solder joints or circuitry;
2. lifting of the solder joint or pad track;
3. delamination of the base laminate;
4. damage to printed wiring or solder joint or pad.

NOTE Damages such as cuts, scratches.

4.8 Repair of damaged gold-plated areas

4.8.1 Requirements

a. The supplier shall repair scratches only if the current-carrying capacity requirement of the conductor is not met.

b. The supplier shall reject boards with defective plating other than in requirements 4.8.1a.

NOTE Defect plating might be flaking or blistering.

4.8.2 Procedure

a. The supplier should use method C.3.1 for removal of solder splatter on gold plating.

b. For repair of insufficient or scratched gold plating the supplier should apply the following procedure:

1. remove gold plating before soldering in conformance with clauses 7.2.4 of ECSS-ST-Q-70-08;
2. perform method D.3.

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4.8.3 Acceptance criteria

4.8.3.1 Removal of solder splatter on gold plating

a. There shall be no residual solder present on the gold plating or damage to the plating.

NOTE Colour changes on the conductor surface resulting from gold-tin alloying are permitted.

4.8.3.2 Repair of insufficient or scratched gold plating

a. After repair, the supplier shall inspect the soldered joints in conformance with the accept/reject criteria of clause 12 in ECSS-ST-Q-70-08.

NOTE For example: Inspection of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material is one of the required inspections.

4.9 Repair of damaged conductor tracks

4.9.1 Requirements

a. The damage shall not involve a length of track in excess of five times the conductor width.

4.9.2 Procedure

a. For conductor tracks having a thickness > 30 µm, the selection of tinned copper or silver wire shall be in conformance with Table 4-1.

b. The maximum wire diameter shall not be greater than two thirds of the width of the conductor.

Table 4-1: 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

c. The supplier should use method D.3.

d. The supplier should use alternative coatings in method D.3 only according to disposition by NRB.

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4.9.3 Acceptance criteria

a. After repair, the supplier shall inspect the soldered joints in conformance with the accept/reject criteria of clause 12 in ECSS-Q-ST-70-08.

NOTE For example: Inspection of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material is one of the required inspections.

4.10 Repair of lifted conductors

4.10.1 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 and 2 cm, whichever is the smallest.

b. The number of repairs per printed circuit board assembly shall conform with the requirements detailed in clause 4.2.2.

4.10.2 Procedure

a. Depending on their applicability, the supplier should use either method E.3.1 or E.3.2.

b. Before applying method E.3.1 or E.3.2, the supplier shall remove any components or solder that can interfere with the repair of the damaged conductor as described in clauses 4.7 and 4.15 before proceeding.

4.10.3 Acceptance criteria

a. The lifted conductor track shall be secured to the base laminate by the epoxy

b. The epoxy shall be fully cured.

c. The epoxy shall not cover areas that require subsequent soldering.

d. Where components have been removed and subsequently replaced, the supplier shall inspect the soldered joints in conformance with the accept/reject criteria of clause 12 in ECSS-Q-ST-70-08.

NOTE For example: Inspection of the pad or track area to ensure that no lifting has occurred and that no damage has been sustained by the base material is one of the required inspections.

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