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**Raumfahrtproduktsicherung –
Hochzuverlässiges Löten von Oberflächen-Befestigungen und gemischte
Technologien;
Englische Fassung EN 16602-70-38:2019**

Space product assurance –
High-reliability soldering for surface-mount and mixed technology;
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Assurance produit spatiale –
Soudure haute fiabilité pour technologies à montage de surface et mixte;
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Nationales Vorwort

Dieses Dokument (EN 16602-70-38:2019) wurde vom Technischen Komitee CEN/CLC/JTC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat vom DIN (Deutschland) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-06-02 AA „Interoperabilität von Informations-, Kommunikations- und Navigationssystemen“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

Dieses Dokument (EN 16602-70-38:2019) basiert auf ECSS-Q-ST-70-38C Rev.1.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung von EN 16602-70-38:2019.

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

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

Die Benummerung der folgenden Begriffe und Abkürzungen ist identisch mit der Benummerung in der englischen Fassung.

3.1 Begriffe aus anderen Normen

- a) Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-S-ST-00-01.
- b) Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-Q-ST-60, besonders die folgenden Begriffe:
 - 1) handelsübliche Komponente
- c) Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-Q-ST-70-28, besonders die folgenden Begriffe:
 - 1) Reparatur
 - 2) Nacharbeit

3.2 Für diese Norm spezifische Begriffe

3.2.1

Zulassungsbehörde

Einrichtung, die auf der Grundlage der Bewertung der Prüfergebnisse das Verifizierungsprogramm überprüft und annimmt sowie die endgültige Zulassung erteilt

3.2.2

Verkleben

Auftragen eines Klebstoffs unter ein SMD-Gehäuse für mechanische oder thermische Anwendung, ohne dass die Klebestelle sichtbar ist

3.2.3

Koplanarität

maximaler Abstand zwischen dem am niedrigsten und dem am höchsten gelegenen Anschluss, wenn sich das Bauelement auf einer ebenen Oberfläche befindet

3.2.4

Kollektivbaugruppe

Satz von Bauelementen, die in einem Arbeitsgang auf die Leiterplatte gelötet wurden

3.2.5

kritischer Bereich

Bereich in der Lötstelle, in dem das Vorhandensein von Rissen und deren Ausmaß zur Annahme oder Rückweisung führt

3.2.6

Bauelement

Gehäuse, Komponente oder Teil

3.2.7

dynamische Wellenlötanlage

System zum Wellenlöten, bestehend aus Stationen zum Fluxen, zum Vorheizen und zum Löten mithilfe eines Transportbands

3.2.8

Luftstrecke

Abstand zwischen elektrisch unterschiedlichen Leitern bei der Montage auf den äußeren Schichten einer Leiterplatte

Anmerkung 1 zum Begriff: Der Abstand zwischen Leitern hängt von der Auslegungsspannung und den Wechselspannungs- bzw. Gleichspannungs-Spitzenwerten ab. Jede Nichteinhaltung der mindestens erforderlichen Luftstrecke infolge einer Nichtkonformität ist ein Fehlerzustand.

3.2.9

Wiederaufbereitung

Vorbereitungsmaßnahmen an einem Bauelement vor der Montage

Anmerkung 1 zum Begriff: Nachverzinnen, Goldentfernung, Bleiformung sind Beispiele für die Wiederaufbereitung.

3.2.10

Spülen (Auswaschen)

Grundmetall oder Metallisierung, teilweise oder vollständig während eines Lötvorgangs in geschmolzenem Weichlot gelöst

3.2.11

Selektivgalvanisieren

Zinn/Blei-beschichtete Lötkontakte, verbunden mit goldbeschichteten Kupferleiterbahnen

Anmerkung 1 zum Begriff: Dies steht in der Regel in Zusammenhang mit HF-Schaltungen.

3.2.12

empfindliche Geräte

Gerät, das anfällig für Risse in der Lötstelle ist, die 75 % der Annahmekriterien überschreiten, oder das eine Nichtkonformität außerhalb der Grenzen des Bauteilherstellers aufweist

Anmerkung 1 zum Begriff: Eine Auflistung der ESA über empfindliche Geräte findet sich zu Informationszwecken auf der ESCIES-Website, siehe www.escies.org.

Anmerkung 2 zum Begriff: Jedes Unternehmen führt seine eigene Liste der empfindlichen Geräte im PID.

3.2.13

Lotperlen (Lotkugeln)

mehrere Perlen aus Weichlot, die nicht mit der Lötstelle verschmolzen und um die Lötstelle herum verteilt sind, in der Regel durch die Rückstände des Flussmittels anhaftend

Anmerkung 1 zum Begriff: Kann durch nicht ordnungsgemäßes Vorheizen oder durch mangelhafte Lotqualität verursacht werden.

3.2.14

Aufschichten

Aufragung eines Klebstoffs an den Enden eines SMD-Gehäuses für mechanische Zwecke, wobei die Klebestelle teilweise sichtbar ist

3.2.15**Lotüberstand**

Dicke des Weichlots zwischen der Unterseite des Bauelement-Anschlusses und der Oberseite des Leiterplattenkontakts

3.2.16**Prüfmuster**

mit oberflächenmontierten Bauteilen verbundener Träger, der einem Verifizierungsprogramm unterzogen wird

3.2.17**Grabstein-Effekt**

Chip-Bauelement, das einen seiner beiden Anschlusskontakte anhebt, wodurch der Chip aufrecht wie ein Grabstein steht

Anmerkung 1 zum Begriff: Üblicherweise hervorgerufen durch:

- mangelhafte Auslegung, bei der der eine Kontakt die Rückfließtemperatur des Lötmetalls vor dem anderen Kontakt erreicht;
- unterschiedliche Mengen an Lötpaste an jedem Kontakt;
- unterschiedliche Lötbarkeit eines Kontakts oder eines Anschlusses im Hinblick auf den anderen.

3.2.18**Unterfüllung**

eingeschlossene Materialansammlung zwischen einem Bauelement und dem Träger

3.3 Abkürzungen

Für die Anwendung dieser Norm gelten die Abkürzungen nach ECSS-S-ST-00-01 und die folgenden Abkürzungen:

Abkürzung Bedeutung

AAD	Bauelemente in Flächenarray-Bauweise	(en: area array device)
BGA	Kugelanordnung	(en: ball grid array)
CBGA	Keramik-Kugelanordnung	(en: ceramic ball grid array)
CCGA	Keramik-Säulenanordnung	(en: ceramic column grid array)
CGA	Säulenanordnung	(en: column grid array)
CLCC	Keramik-Chipträger mit Anschlussdrähten	(en: ceramic leaded chip carrier)
CTE	Wärmeausdehnungskoeffizient	(en: coefficient of thermal expansion)
DPAK	Dioden-Gehäuse	(en: diode package)
DRD	Definition der Dokumentanforderungen	(en: document requirement definition)
FM	Flugmodell oder Flug-Hardware	(en: flight model or flight hardware)
FP	Flatpack-Gehäuse	(en: flat pack package)
JEDEC	US-amerikanische Organisation zur Standardisierung von Halbleitern	(en: Joint Electron Device Engineering Council)
LCCC	Keramik-Chipträger ohne Anschlussdrähte	(en: leadless ceramic chip carrier)

Abkürzung Bedeutung

MELF	Metallelektrode flächengebunden ANMERKUNG Auch bekannt als MiniMelf oder MicroMelf.	(en: metal electrode face bonded)
MIP	vorgeschriebener Prüfpunkt	(en: mandatory inspection point)
PCB	Leiterplatte	(en: printed circuit board)
PLCC	Plastik-Chipträger mit Anschlussdrähten	(en: plastic leaded chip carrier)
PID	Prozessidentifikations-Dokument	(en: process identification document)
QFN	quadratisches Flachgehäuse ohne Anschlussdrähte	(en: quad flat pack no leads)
QFP	quadratisches Flachgehäuse	(en: quad flat pack)
r.m.s.	Effektivwert	(en: root-mean-square)
SIR	Oberflächenisolationswiderstand	(en: surface insulation resistance)
SMD	oberflächenmontiertes Bauteil	(en: surface mounted device)
SMT	Oberflächenmontagetechnik	(en: surface-mount technology)
SO	kleine Bauform	(en: small outline)
SOD	Gerät kleiner Bauform	(en: small outline device)
SOT	Transistor kleiner Bauform	(en: small outline transistor)
SOP	Gehäuse kleiner Bauform	(en: small outline package)
TO	Transistorbauform	(en: transistor outline)
TSOP	dünnes Gehäuse kleiner Bauform	(en: thin small outline package)

English version

Space product assurance - High-reliability soldering for surface-mount and mixed technology

Assurance produit des projets spatiaux - Soudure
haute fiabilité pour technologies à montage de surface
et mixte

Raumfahrtproduktsicherung - Hochzuverlässiges
Löten von Oberflächen-Befestigungen und gemischte
Technologien

This European Standard was approved by CEN on 5 October 2018.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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European Foreword

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This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2019, and conflicting national standards shall be withdrawn at the latest by October 2019.

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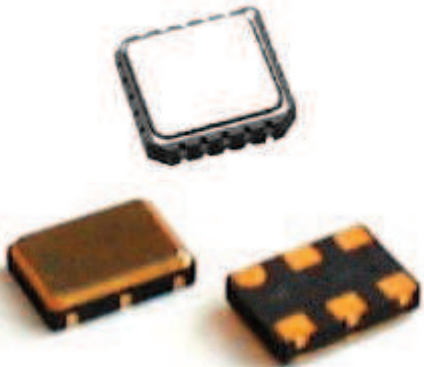
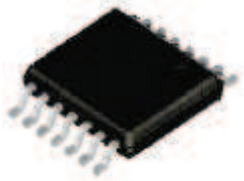
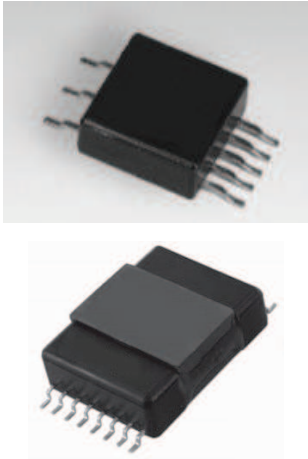
This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

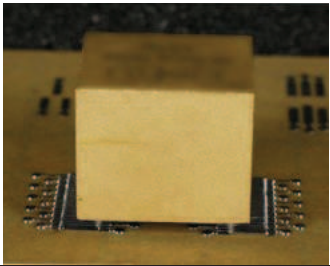
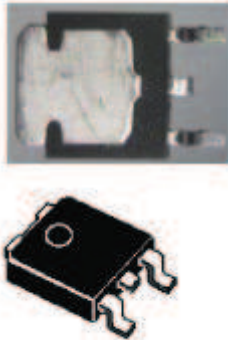
According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This Standard prescribes requirements for electrical connections of leadless and leaded surface mounted devices (SMD) on spacecraft and associated equipment, utilising a range of substrate assemblies and employing solder as the interconnection media. The principal types of SMDs can be gathered in the following families:

Rectangular and square end-capped or end-metallized device with rectangular body, leadless chip (see 11.5.2) e.g. end capped chip resistors and end capped chip capacitors.	
Cylindrical and square end-capped devices with cylindrical body, leadless chip (see 11.5.4) e.g. MELF for cylindrical end capped or e.g. D-5A for square end capped	
Bottom terminated chip device (see 11.5.3) This type of device has metallised terminations on the bottom side only. e.g. inductors and SMD0.5, SMD1, SMD2, SMD0.2, SMD0.22 e.g. Quad Flat Pack No lead (QFN)	

<p>Castellated chip carrier device (see 11.5.5)</p> <p>The main device of this type is leadless ceramic chip carrier (LCCC).</p> <p>e.g. LCC6</p>	
<p>Flat pack and gull-wing leaded device with round, rectangular, ribbon leads (see 11.5.6)</p> <p>e.g. small-outline transistor (SOT), small-outline package (SO), flat pack and quad flat pack (QFP) and SMD connectors with stress-relief.</p> <p>This family also comprises devices for through-hole mounting that have been reconfigured to surface mounting.</p>	
<p>Moulded magnetics (see 11.5.13)</p> <p>e.g. 1553 interface transformers or specific transformers</p>	
<p>“J” leaded device (see 11.5.7)</p> <p>e.g. ceramic leaded chip carriers (CLCC) and plastic leaded chip carriers (PLCC).</p>	

<p>Area array devices (AAD) (see 11.5.8)</p> <p>The interconnections between solder footprints on the devices and solder footprints on the PCB consist entirely of solder.</p> <p>The devices have either solder balls (Ball Grid Array - BGA) or solder columns (Column Grid Array - CGA) applied to the solder footprints on the devices prior to mounting on a PCB (normally done by the device manufacturer). The solder balls on the BGAs can consist of either eutectic solder or high temperature solder (5 - 10 % Sn) whereas the solder columns on the CGAs always consist of high temperature solder. Although BGAs are usually presented as a device family, there exist a large number of BGA devices with wide-ranging properties. The vast majority of BGA devices are non hermetic.</p>	
<p>Devices with ribbon terminals without stress relief (flat lug leads) (see 11.5.9)</p> <p>This package has flat leads extending from the sides</p>	
<p>Device with Inward formed L-shaped leads (see 11.5.10)</p> <p>e.g. moulded tantalum chip capacitors.</p>	
<p>Stacked modules devices with leads protruding vertically from bottom (see 11.5.11)</p>	
<p>Leaded device with plane termination (see 11.5.12)</p> <p>e.g. Diode PAcKage (DPAK or TO252)</p>	 DPAK

1

Scope

This Standard defines the technical requirements and quality assurance provisions for the manufacture and verification of high-reliability electronic circuits based on surface mounted device (SMD) and mixed technology.

The Standard defines acceptance and rejection criteria for high-reliability manufacture of surface-mount and mixed-technology circuit assemblies intended to withstand normal terrestrial conditions and the vibrational g-loads and environment imposed by space flight.

The proper tools, correct materials, design and workmanship are covered by this document. Workmanship standards are included to permit discrimination between proper and improper work.

The assembly of leaded devices to through-hole terminations and general soldering principles are covered in ECSS-Q-ST-70-08.

Requirements related to printed circuit boards are contained in ECSS-Q-ST-70-10, ECSS-Q-ST-70-11 and ECSS-Q-ST-70-12. The mounting and supporting of devices, terminals and conductors prescribed herein applies to assemblies at PCB level designed to continuously operate over the mission within the temperature limits of -55 °C to +85 °C.

For temperatures outside this normal range, special design, verification and qualification testing is performed to ensure the necessary environmental survival capability.

Special thermal heat sinks are applied to devices having high thermal dissipation (e.g. junction temperatures of 110 °C, power transistors) in order to ensure that solder joints do not exceed 85 °C.

Verification of SMD assembly processes is made on test vehicles (surface mount verification samples). Temperature cycling ensures the operational lifetime for spacecraft. However, mechanical testing only indicates SMD reliability as it is unlikely that the test vehicle represents every flight configuration.

This Standard does not cover the qualification and acceptance of the EQM and FM equipment with surface-mount and mixed-technology.

The qualification and acceptance tests of equipment manufactured in accordance with this Standard are covered by ECSS-E-ST-10-03.

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

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 16601-00-01	ECSS-S-ST-00-01	ECSS system — Glossary of terms
EN 16601-40	ECSS-M-ST-40	Space project management — Configuration and information management
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 16602-60	ECSS-Q-ST-60	Space product assurance — Electrical, electronic and electromechanical (EEE) components
EN 16602-60-05	ECSS-Q-ST-60-05	Space product assurance — Generic requirements for hybrids
EN 16602-60-13	ECSS-Q-ST-60-13	Space product assurance - Commercial electrical, electronic and electromechanical (EEE) components
EN 16602-70	ECSS-Q-ST-70	Space product assurance — Materials, mechanical parts and processes
EN 16602-70-01	ECSS-Q-ST-70-01	Space product assurance — Cleanliness and contamination control
EN 16602-70-02	ECSS-Q-ST-70-02	Space product assurance — Thermal vacuum outgassing test for the screening of space materials
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 16602-70-11	ECSS-Q-ST-70-11	Space product assurance — Procurement of printed circuit boards

EN reference	Reference in text	Title
EN 16602-70-12	ECSS-Q-ST-70-12	Space product assurance — Design rules for printed circuit boards
EN 16602-70-28	ECSS-Q-ST-70-28	Space product assurance — Repair and modification of printed circuit board assemblies for space use.
EN 16602-70-71	ECSS-Q-ST-70-71	Space product assurance — Materials processes and their data selection
	MIL-STD-883 Method 2009	Test Method Standard, Microcircuits
	IPC-TM-650: 2.6.3.3 Issue 2004	Test methods manual. Surface Insulation Resistance, Fluxes

Terms, definitions and abbreviated terms

3.1 Terms from other standards

- a. For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply.
- b. For the purpose of this Standard, the terms and definitions from ECSS-Q-ST-60 apply, in particular for the following term(s):
 1. commercial component
- c. For the purpose of this Standard, the terms and definitions from ECSS-Q-ST-70-28 apply, in particular for the following term(s):
 1. repair
 2. rework

3.2 Terms specific to the present standard

3.2.1 approval authority

entity that reviews and accepts the verification programme, evaluating the test results and grants the final approval

3.2.2 bonding

application process of adhesive under a SMD package for mechanical or thermal purpose where adhesive joint is not visible

3.2.3 co-planarity

maximum distance between lowest and highest termination when device rests on flat surface

3.2.4 collective assembled devices

set of components that are soldered to PCB in one operation

3.2.5 critical zone

area in the solder joint in which the existence and magnitude of cracks is subject to acceptance or rejection

3.2.6 device

package, component or part

3.2.7 dynamic wave soldering machine

system that achieves wave soldering and which consists of stations for fluxing, preheating, and soldering by means of a conveyer

3.2.8 electrical clearance

spacing between non-common electrical conductors on external layers of a printed circuit board assembly

NOTE The distance between conductors depends on the design voltage and DC or AC peaks. Any violation of minimum electrical clearance as a result of a nonconformance is a defect condition.

3.2.9 reprocessing

preparatory operation done on a device prior to assembly

NOTE Retinning, degolding, lead forming are examples of reprocessing.

3.2.10 scavenging (leaching)

basis metal or metallization partly or wholly dissolved in melted solder during a soldering operation

3.2.11 selective plating

tin-lead plated solder footprints connected to gold plated copper tracks

NOTE It is usually related to RF circuits.

3.2.12 sensitive devices

device prone to have cracks in solder joint exceeding 75 % of acceptance criteria or showing nonconformance outside the component manufacturer limit

NOTE 1 ESA list of sensitive devices is published on ESCIES for information, see www.escies.org.

NOTE 2 Each company maintains its own list of sensitive devices in the PID.

3.2.13 solder balling (solder balls)

numerous spheres of solder having not melted in with the joint form and being scattered around the joint area normally attached by flux residues

NOTE Can be caused by incorrect preheating or poor quality solder.

3.2.14 stacking

application process of adhesive at extremities of a SMD package for mechanical purpose where adhesive joint is partially visible

3.2.15 solder stand-off

thickness of solder between the underside of the device termination and the surface of the PCB footprint

3.2.16 test vehicle

substrate assembled with Surface Mounted Devices subjected to a verification programme

3.2.17 tombstoning

chip devices lifting off one of their two terminal footprints causing the chip to stand up like a tombstone

NOTE Normally caused by:

- bad design where one footprint reaches solder reflow temperature before the other;
- different quantities of solder paste on each footprint;
- different solderability of one footprint or one termination with respect to the other.

3.2.18 underfill

encapsulant material deposited between a device and substrate

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
AAD	area array device
BGA	ball grid array
CBGA	ceramic ball grid array
CCGA	ceramic column grid array
CGA	column grid array
CLCC	ceramic leaded chip carrier
CTE	coefficient of thermal expansion
DPAK	diode package
DRD	document requirement definition
FM	flight model or flight hardware
FP	flat pack package
JEDEC	Joint Electron Device Engineering Council
LCCC	leadless ceramic chip carrier
MELF	metal electrode face bonded
	NOTE: Also known as minimelf or micromelf
MIP	mandatory inspection point
PCB	printed circuit board
PLCC	plastic leaded chip carrier

Abbreviation	Meaning
PID	process identification document
QFN	quad flat pack no leads
QFP	quad flat pack
r.m.s.	root-mean-square
SIR	surface insulation resistance
SMD	surface mounted device
SMT	surface-mount technology
SO	small outline
SOD	small outline device
SOT	small outline transistor
SOP	small outline package
TO	transistor outline
TSOP	thin small outline package

3.4 Nomenclature

3.4.1 Formal verbs

The following nomenclature apply throughout this document:

- a. The word “shall” is used in this document to express requirements. All the requirements are expressed with the word “shall”.
- b. The word “should” is used in this document to express recommendations. All the recommendations are expressed with the word “should”.

NOTE It is expected that, during tailoring, all the recommendations in this standard are either converted into requirements or tailored out.

- c. The words “may” and “need not” are used in this document to express positive and negative permissions respectively. All the positive permissions are expressed with the word “may”. All the negative permissions are expressed with the words “need not”.
- d. The word “can” is used in this document to express capabilities or possibilities, and therefore, if not accompanied by one of the previous words, it implies descriptive text.

NOTE In ECSS “may” and “can” have a complete different meaning: “may” is normative (permission) and “can” is descriptive.

- e. The present and past tense are used in this document to express statement of fact, and therefore they imply descriptive text.

Principles of reliable soldered connections

The following are the general principles to ensure reliable soldered connections:

- Reliable soldered connections are the result of proper design, control of tools, materials, processes and work environments, and workmanship performed in accordance to verified and approved procedures, inspection control and precautions.
- The basic design concepts to ensure reliable connections and to avoid solder joint failure are as follows:
 - Stress relief is an inherent part of the design, which reduces detrimental thermal and mechanical stresses on the solder connections.
 - Where adequate stress relief is not possible materials are so selected that the mismatch of thermal expansion coefficients is a minimum at the constraint points in the device mounting configuration.
- The assembled substrates are designed to allow easy inspection.
- Since only the outer row of solder joints to area array packages can be visually inspected, inner rows are inspected using X-ray techniques. To facilitate X-ray inspection of the solder joints to BGAs, the solder footprints can have a teardrop design.
- Circuit designs for area array devices, (e.g. BGA, CGA) have clearance around the perimeter of these packages to ensure that reflow nozzles can perform rework or repair operations (see ECSS-Q-ST-70-28). The clearance depends on the equipment used for reworking and the height of adjacent components.

NOTE Unpopulated areas on the underside of the substrate assist indirect heating for removal of these packages.
- Soldering to gold using tin-lead alloy can cause failure.

Process identification document (PID)

5.1 General

5.1.1 Purpose

The purpose of the PID is to ensure that a precise reference is established for the assembly processes approved in accordance with this Standard.

The PID provides a standard reference against which any anomalies occurring after the approval can be examined and resolved.

5.1.2 Document preparation

- a. The supplier shall prepare the PID in conformance with DRD from Annex F.
- b. The supplier shall provide a draft PID prior to any start of verification to the Approval Authority.
- c. The first issue of the PID shall fully comply to this standard.
- d. For supplier, already approved on the basis of reliable tests results which supported the approval of any deviation finally recorded in the PID, then the PID may supersede the corresponding requirements from this standard.

5.1.3 <<deleted>>

- a. <<deleted>>
- b. <<deleted>>

5.1.4 Approval

- a. The PID shall be submitted to the Approval Authority for approval.

NOTE The approval can be achieved by PID signature or minutes of meeting being signed by the Approval Authority.

- b. <<deleted>>

5.1.5 SMT contact person

- a. The supplier shall appoint a contact person for SMT topics.

5.2 <<deleted>>

- a. <<deleted>>
- b. <<deleted>>
- c. <<deleted>>
- d. <<deleted>>
- e. <<deleted>>

5.3 Process identification document updating

- a. The PID shall be managed in accordance with ECSS-M-ST-40.
- b. A PID shall represent the current verified manufacturing processes and production controls.
- c. Any proposed change to the PID shall be agreed by the Approval Authority.
- d. <<deleted>>
- e. The supplier shall initiate a review of the PID, the SMT summary table and the relevant applicable documents at least every two years for agreement by the Approval Authority.

6

Preparatory conditions

6.1 Calibration

- a. The supplier shall maintain records of tool calibration and verification.
- b. Requirements from clause 5.1 from ECSS-Q-ST-70-08 shall apply for "Calibration".

6.2 Facility cleanliness

- a. Requirements from clause 5.2 from ECSS-Q-ST-70-08 shall apply for "Facility cleanliness".

6.3 Environmental conditions

- a. Requirements from clause 5.3 from ECSS-Q-ST-70-08 shall apply for "Environmental conditions".

6.4 Precautions against static charges

- a. Requirements from clause 5.5 from ECSS-Q-ST-70-08 shall apply for "Precautions against static charges".

6.5 Lighting requirements

- a. Requirements from clause 5.4 from ECSS-Q-ST-70-08 shall apply for "Lighting requirements".

6.6 Equipment and tools

6.6.1 Brushes

- a. Requirements from clause 5.6.2 from ECSS-Q-ST-70-08 shall apply for "Brushes".

6.6.2 Cutters and Pliers

- a. Requirements from clause 5.6.3 from ECSS-Q-ST-70-08, shall apply for "Cutters and Pliers".

6.6.3 Bending tools

- a. Requirements from clause 5.6.4 from ECSS-Q-ST-70-08 shall apply for "Bending tools".

6.6.4 Clinching tools

- a. Requirements from clause 5.6.5 from ECSS-Q-ST-70-08 shall apply for "Clinching tools".

6.6.5 Insulation strippers

- a. Requirements from clause 5.6.6 from ECSS-Q-ST-70-08 shall apply for "Insulation strippers".

6.6.6 Soldering tools

- a. Requirements from clause 5.6.8 from ECSS-Q-ST-70-08 shall apply for "Soldering tools".

6.6.7 Soldering irons and resistance soldering equipment

- a. Requirements from clause 5.6.7 from ECSS-Q-ST-70-08 shall apply for "Soldering irons and resistance soldering equipment".
- b. For surface mounted devices, the soldering tip shall not exceed 340 °C.

NOTE Based on the device manufacturer's recommendations, solder iron can be substituted by applying, for instance, hot air in order to avoid thermal shock.

6.6.8 <<deleted>>

- a. <<deleted>>

6.6.9 Solder baths for degolding and pretinning

- a. Requirements from clause 7.2.3.2.2 from ECSS-Q-ST-70-08 shall apply for "Solder baths" for degolding and pretinning.

6.7 Soldering machines and equipment

6.7.1 General

- a. Machines and equipment used to solder surface mount devices shall either be a type incorporating dynamic single or dual solder wave, or be of the solder reflow type.
- b. The soldering machine shall be grounded in order to avoid electrostatic discharge.
- c. The supplier shall ensure that the soldering conditions do not exceed the values given by the individual device data sheets

NOTE Examples of soldering conditions include.
maximum temperature to avoid internal
melting, removal of marking ink, degradation
of encapsulating plastic.

- d. Temperature and time profiles for assembly shall be identified by the supplier and approved by the Approval Authority.
- e. The supplier shall identify changes and implement a verification programme in compliance with the requirements from clause 14.13.
- f. The supplier shall demonstrate the reproducibility of their reflow processes.

6.7.2 Dynamic wave-solder machines

- a. Dynamic soldering machines shall be of automatic type and of a design offering the following:
 - 1. Controllable preheating to drive off volatile solvents and to avoid thermal shock damage to the PCB and device packages.
 - 2. The capacity to maintain the solder temperature at the printed circuit board assembly to within 5 °C of the established bath temperature throughout the duration of any continuous soldering run when measured 3,0 mm below the surface of the wave.
 - 3. A wave system that limits shadowing and allows solder fillet formation.
 - 4. Carriers made from a material that cannot contaminate, degrade or damage the printed circuit board or substrate nor transmit vibrations or shock stress from the conveyors to a degree permitting physical, functional or electrostatic damage to devices, board or substrate during transport through preheating, soldering and cooling stages.
 - 5. An extraction system, either integral or separate, conforming to the requirements of clauses 6.2a and 6.3a.

6.7.3 Condensation (vapour phase) reflow machines

- a. Condensation reflow machines shall conform to the following requirements:
 - 1. Not transmit a movement or vibration into the assemblies being soldered that result in misalignment of devices or disturbed solder joints.
 - 2. Be capable of preheating an assembly with solder paste to the temperature recommended by the solder paste manufacturer prior to soldering.
 - 3. Use a reflow fluid whose boiling point is a minimum of 12 °C above the melting point of the solder being used.
 - 4. Maintain the preselected temperature to within ± 5 °C in the reflow zone during soldering.
 - 5. Include an extraction system that conforms to requirements 6.2a and 6.3a.

6.7.4 Hot gas reflow machines

- a. Hot gas reflow machines shall conform to the following requirements:
 - 1. Does not transmit movement or vibration to the assemblies being soldered which result in misalignment of devices or disturbed solder joints.
 - 2. Preheats an assembly with solder paste to the temperature recommended by the solder paste manufacturer prior to soldering.
 - 3. <<deleted>>
 - 4. Prevents the reflow of adjacent devices.
 - 5. Maintains the preselected reflow temperature within ± 5 °C as measured at the substrate surface.

6.7.5 <<deleted>>

- a. <<deleted>>

6.7.6 Convection and radiation reflow systems

- a. Convection and radiation reflow machines shall be of design such that the system meets the following requirements:
 - 1. Provides a controlled temperature profile and does not transmit movement or vibration into the assembly being soldered.
 - 2. Preheats an assembly with solder paste to the temperature recommended by the solder paste manufacturer prior to soldering.
 - 3. Heats the area of the assembly to be soldered using focused or unfocussed energy, to a preselected temperature that is a

minimum of 12 °C above the melting point of the solder being used as measured at laminate or substrate surface.

4. Maintains the preselected temperature to within ± 5 °C in the reflow zone during soldering.

6.7.7 Other equipment for reflow soldering

- a. Other solder reflow systems may be approved for use by the Approval Authority, if compliance with clauses 6.7.1 to 6.7.6 is demonstrated.

6.8 Ancillary equipment

6.8.1 General

- a. Equipment shall not generate, induce or transmit electrostatic charges to devices being placed.
- b. The supplier shall demonstrate the reproducibility of their SMT processes.

6.8.2 Solder deposition equipment

- a. Equipment used to deposit solder pastes shall be of a screening, stencilling, dispensing, roller coating, dotting or jet printing type.
- b. Equipment shall apply pastes of a viscosity and quantity such that the positioned device is retained on the board before and during soldering operations, ensuring self-centring and solder fillet formation.
- c. Equipment used to apply solder preforms shall ensure alignment of the preform with the land or device lead and termination.

6.8.3 Automatic device placement equipment

- a. Automatic or computer controlled equipment used for device placement shall be of the coordinate-driven pick-and-place type or of the robotic type.
- b. The placement equipment used shall be of a type that:
 1. prevents device or board damages
 2. indexes devices with respect to the circuit
 3. aligns the device leads or castellations with the board terminal areas.

6.8.4 <<deleted>>

- a. <<deleted>>

6.8.5 Cleanliness testing equipment

- a. Requirements from clause 11.3.1 from ECSS-Q-ST-70-08 shall apply for "Cleanliness testing".

6.8.6 Magnification aids

- a. Clause 13.1 shall apply.

6.8.7 X-ray inspection equipment

- a. The maximum dose during X-Rays inspection shall be less than 5 % of the eligible dose of the most sensitive component according to its specification.
- b. X-ray equipment shall be calibrated in order to evaluate the total dose received by the devices during the inspection.

NOTE In order to minimize the dose given to the device, it is good practice to:

- Record the total dose received.
- Use off-line image analysis as much as possible.
- Use filters, optimizing the direction of the X-ray beam and masking sensitive areas.

- c. The resolution of the X-ray equipment shall be able to detect solder balls having a diameter of 0,03 mm.
- d. The sensitivity shall be demonstrated by means of actual 0,03 mm diameter solder balls, stuck to adhesive tape, attached to the multilayer board assembly being inspected.

NOTE <<deleted>>

6.8.8 Metallographic equipment

- a. The metallographic equipment shall enable cross-sectioning and polishing of the moulded solder interconnections.

7

Material selection

7.1 General

- a. Material selection shall be performed in accordance with ECSS-Q-ST-70-71 and ECSS-Q-ST-70.

7.2 Solder

7.2.1 Form

- a. Solder paste, ribbon, wire and preforms shall be used provided that the alloy and flux meet the requirements in clause 7.2.2.
- b. Alloy for use in solder baths shall be supplied as ingots (without flux) and be compliant with requirements from clause 7.2.2.

7.2.2 Composition

- a. The solder alloy shall have a composition specified in Table 7-1.

NOTE 1 Use EN 61190-1-3 for solder and EN 61190-1-1 for flux, EN 61190-1-2 for solder paste.

NOTE 2 The solder alloy used depends upon the application. See Annex E.2 for Guide for choice of solder type.

7.2.3 Solder paste

- a. <<deleted>>
- b. The metal purity shall be as specified in Table 7-1.

Table 7-1: Chemical composition of spacecraft solders

ESA designation	Sn min % - max %	Pb max %	In min % – max %	Sb max %	Ag min % – max %	Bi max %	Cu max %	Fe max %	Zn max %	Al max %	As max %	Cd max %	Other max %
63 tin solder	62,5-63,5	remainder	-	0,05	-	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08
62 tin silver loaded	61,5-62,5	remainder	-	0,05	1,8-2,2	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08
60 tin solder	59,5-61,5	remainder	-	0,05	-	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08
96 tin solder	remain	0,10	-	0,05	3,5-4,0	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08
75 indium lead	max 0,25	remainder	74,0-76,0	0,05	-	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08
70 indium lead	0,00-0,10	remainder	69,3-70,7	0,05	-	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08
50 indium lead	0,00-0,10	remainder	49,5-50,5	0,05	-	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08
10 tin lead	9,0-10,5	remainder	-	0,05	-	0,10	0,05	0,02	0,001	0,001	0,03	0,002	0,08

7.2.4 Maintenance of paste purity

- a. When purchased premixed or mixed in house, the purity of solder paste shall be maintained.
- b. Manufacturers' instructions shall be applied for the handling and storage of containers of solder paste purchased premixed.
- c. Refrigerated solder paste shall reach room temperature before opening the container.
- d. Neither paste purchased premixed nor paste mixed in-house shall be used if the use-by date or shelf life recommended by the manufacturer of the paste or paste constituents has expired.
- e. When the solder paste's shelf life has expired it shall not be used unless:
 - 1. relifing is performed
 - 2. tests that include visual inspection and viscosity measurements (according to the manufacturer's recommendations) are passed successfully.
- f. When relifing is performed, and the material passes the specified tests, the new shelf life shall be half the initial shelf life.
- g. Tools used for removing solder paste from the container shall not contaminate the paste dispensed or that remaining within.

7.3 Flux

7.3.1 Rosin based flux

- a. Requirements from clause 6.3.1 from ECSS-Q-ST-70-08 shall apply for "Rosin based flux".

7.3.2 Corrosive acid flux

- a. Requirements from clause 6.3.2 from ECSS-Q-ST-70-08 shall apply for "INH1 Corrosive acid flux".

7.3.3 Flux controls for wave-soldering equipment

- a. A controlled method shall be established and implemented for wave-soldering machines such that the flux is not contaminated with remaining residues from previous non-space works.

7.4 Solvents

- a. Requirements from clause 6.4 from ECSS-Q-ST-70-08 shall apply for "Solvents".

7.5 Flexible insulation materials

- a. Requirements from clause 6.5 from ECSS-Q-ST-70-08 shall apply for "Flexible insulation materials".

7.6 Terminals

- a. Requirements from clause 6.6 from ECSS-Q-ST-70-08 shall apply for "Terminals".

7.7 Wires

- a. Requirements from clause 6.7 from ECSS-Q-ST-70-08 shall apply for "Wires".

7.8 Printed circuit substrates

- a. Printed Circuit Boards shall be designed in conformance with the requirements of clause 14 of ECSS-Q-ST-70-12.
- b. Printed Circuit Boards shall be made of materials and manufactured in conformance with the requirements of clause 9 of ECSS-Q-ST-70-10.
- c. Printed Circuit Boards shall be procured in conformance with the requirements of clauses 5 and 6 of ECSS-Q-ST-70-11.

7.8.1 <<deleted>>

- a. <<deleted>>
- b. <<deleted>>
- c. <<deleted>>

Table 7-2: <<deleted>>

7.8.2 <<deleted>>

- a. <<deleted>>

7.8.3 <<deleted>>

- a. <<deleted>>

7.8.4 <<deleted>>

- a. <<deleted>>

7.8.5 <<deleted>>

- a. <<deleted>>

7.8.6 <<deleted>>

- a. <<deleted>>

7.9 Devices**7.9.1 General**

- a. Devices and their finishes shall be selected from those approved in conformance with requirements from clauses 4, 5 and 6 of ECSS-Q-ST-60, for “manufacturer and component evaluation” and “Procurement control”.

- b. <<deleted>>

- c. Solder may be applied to the terminations by hot dipping or by electroplating from a solution.

NOTE Devices with terminations finished by electroplating can impact the device wetting.

- d. <<deleted>>

- e. The incoming inspection of each device batch shall include the verification by test of the termination composition, to avoid assembly of pure tin finish, in accordance with requirement 4.3.7b from ECSS-Q-ST-60.

- f. Pure tin finish with more than 97 % purity shall not be used.

NOTE This is due to the possibility of whisker growth and transformation to grey tin powder at low temperatures.

- g. <<deleted>>

- h. <<deleted>>

- i. Devices shall be capable of withstanding cleaning processes currently used in space projects.

- j. Parts with silver palladium finish shall not be used.

- k. Reprocessing shall not damage the device.

NOTE Reprocessing of ceramic chip capacitors is advised to be avoided due to potential crack formation.

- l. If devices initially designed for insertion-mount application are used for surface mounting, they shall be of a type that can be surface-mount adapted.

- m. The adaptation specified in the requirement 7.9.1l shall not functionally or physically degrade the device or the substrate to which the adapted device is to be attached.
- n. Connectors shall be of a configuration incorporating either male or female quick-disconnect contacts and stress relief provision for the soldered connection of each individual contact when such connections are completed.
- o. Type II chip ceramic capacitors shall not be reworked.

7.9.2 <<deleted>>

- a. <<deleted>>
- b. <<deleted>>
- c. <<deleted>>

7.9.3 Moisture sensitive devices

- a. Moisture sensitive devices shall be stored and handled in conformance with the device manufacturer's recommendations. .

NOTE Many types of plastic encapsulated devices, particularly some plastic BGAs, are moisture sensitive.

- b. When moisture sensitive devices are used, bakeout shall be performed in accordance with clause 8.5b.

7.9.4 <<deleted>>

- a. <<deleted, modified and moved to 7.9.1l>>
- b. <<deleted, modified and moved to 7.9.1m>>
- c. <<deleted>>
- d. <<deleted>>
- e. <<deleted and moved to 7.9.1n>>

7.10 Adhesives, encapsulants and conformal coatings

- a. Adhesives shall be dispensable, non-stringing, and have a reproducible dot profile after application.
- b. Adhesives, encapsulants and conformal coating shall be non-corrosive to devices and substrates.
- c. The uncured strength shall be capable of holding devices during handling prior to curing.
- d. Adhesives, encapsulants and conformal coatings shall conform to the outgassing requirements of ECSS-Q-ST-70-02.

- e. Adhesives, encapsulants and conformal coatings shall have no adverse effects upon materials used on the substrate, or devices attached thereon.

NOTE The effects of some conformal coatings on the reliability of mounted SMDs are described in ESA SP-1173.

- f. Adhesives, encapsulants and conformal coatings shall be selected based on their thermal conductivity and dielectric properties.

NOTE Some thermally conductive adhesives used to dissipate Joule heating are listed in ESA STM-265 "Evaluation of Thermally Conductive Adhesives as Stacking Compounds during the Assembly of Spacecraft Electronics".

- g. The capability of the adhesives to meet their requirements shall be demonstrated by means of a verification programme in conformance with clause 14.

NOTE <<deleted>>

- h. Stress relief of device leads shall not be negated by the encapsulants or conformal coatings.

NOTE 1 This is particularly important at low service temperatures.

NOTE 2 The coefficient of expansion, glass transition temperature and modulus of adhesives used under devices for thermal reasons, for achieving stand-off heights or mechanical support during vibration, can be considered to ensure that the additional stress put on the solder joints does not degrade the solder joint reliability.

- i. Adhesive shall not be in contact with terminal of component.
- j. Bonding shall not be performed on fused tin lead unless the tin lead surface is limited to < 25 % by area of the bonding surface and demonstrated by verification as specified in clause 14.
- k. Spread of bonding material onto surrounding areas shall not be accepted unless it does not reduce the volume of the initial bonding joint.
- l. Bonding material shall not be in contact to surrounding devices.
- m. Bonding with epoxy adhesive directly to glass bodied devices shall not be used.

NOTE It is good practice to use a sleeve between glass and the epoxy adhesive.

Preparation for soldering

8.1 Preparation of devices and terminals

8.1.1 Preparation of wires and terminals

- a. Requirements from clause 7.2 from ECSS-Q-ST-70-08, clause "Preparation of conductors, terminals and solder cups" shall apply.

8.1.2 Preparation of surfaces to be soldered

- a. Requirements from clause 7.2.2 from ECSS-Q-ST-70-08, clause "Surfaces to be soldered" shall apply.

8.1.3 Degolding and pretinning of conductors

- a. Requirements from clauses 7.2.3 and 7.2.4 from ECSS-Q-ST-70-08 shall apply for "Degolding and pretinning of conductors".

8.1.4 Alloying of pure tin finish

- a. <<deleted>>
- b. Pure tin device terminations shall be pretinned with full tin lead solder coverage.
- c. Pure tin device terminations shall be in compliance with requirements from clauses 7.2.4 and 7.2.6 of ECSS-Q-ST-70-08 and requirement 8.1a from ECSS-Q-ST-60-13.

NOTE 1 Pure tin terminations can be dipped into liquid solder as described in ECSS-Q-ST-70-08, clause 7.2.6 in order to replace the tin with tin-lead alloy.

NOTE 2 Reprocessing of ceramic chip capacitors is not recommended due to potential crack formation.

- d. The reprocessing process shall be verified by micro sectioning and SEM/EDX with respect to alloying and full coverage.

8.2 Preparation of solder bit

- a. Requirements from clause 7.3 from ECSS-Q-ST-70-08 shall apply for "Preparation of solder bit".

8.3 Handling

- a. Requirements from clause 7.5 from ECSS-Q-ST-70-08 shall apply for "Handling".

8.4 Storage

- a. Requirements from clause 7.6 from ECSS-Q-ST-70-08 shall apply for "Storage".

8.5 Baking of PCBs and moisture sensitive devices

- a. <<deleted>>
- b. Baking of moisture sensitive devices shall be implemented before any reprocessing or assembly process in conformance with JEDEC classification.

NOTE This is to counteract the "popcorn" effect in soldering using oven or vapour phase reflow techniques.

- c. Baking times and temperatures, for moisture sensitive devices, shall be in compliance with manufacturer recommendations and baking times as specified in J-STD-033 and documented.

NOTE 1 Typical baking conditions are from 6 h to 24 h at 125 °C depending on the JEDEC classification, except for devices delivered in reels for which a lower temperature and longer time are used.

NOTE 2 It is good practice to store devices under nitrogen, dry air (20 % RH maximum) or partial vacuum.

- d. Baking of unpopulated PCBs should be made as a minimum of 8 hours at 120 °C.
- e. Baking of populated PCBs shall be performed when the PCB has been kept under clean room conditions for more than 72 hours.

NOTE Storage of PCBs in dry cabinet interrupts the accumulated baking time.

- f. Baking of populated PCB shall be made at a temperature which does not degrade the devices or assembly.

NOTE To limit the bake out operation, which can induce later failure, the PCB can be stored in dry environment after the baking.

Mounting of devices prior to soldering

9.1 General requirements

- a. Requirements from clause 8.1 from ECSS-Q-ST-70-08, "Mounting of components – General" shall apply.

9.2 Lead bending and cutting requirements

- a. Requirements from clause 8.2 from ECSS-Q-ST-70-08, clause "Lead bending requirements" shall apply.

9.3 Mounting of terminals to PCBs

- a. Requirements from clause 8.3 from ECSS-Q-ST-70-08 shall apply for "Mounting of terminals to PCBs".

9.4 Lead attachment to through holes

- a. Requirements from clause 8.4 from ECSS-Q-ST-70-08 shall apply for "Lead attachment to through holes".

9.5 Mounting of devices to terminals

- a. Requirements from clause 8.5 from ECSS-Q-ST-70-08 shall apply for "Mounting of components to terminals".

9.6 Mounting of through hole connectors to PCBs

- a. Requirements from clause 8.6 from ECSS-Q-ST-70-08 shall apply for "Mounting of through hole connectors to PCBs".

9.7 Surface mount requirements

9.7.1 General

- a. Devices to be mounted shall be designed for, and be capable of withstanding the soldering temperatures of the particular process being used for fabrication of the assembly.

NOTE Surface mounted devices can be mounted on either one side or both sides of a printed circuit assembly.

- b. <<deleted>>

- c. Devices incapable of withstanding machine soldering temperatures shall be hand soldered in a subsequent operation.

- d. Supplier shall ensure that degolding, pretinning, reprocessing and soldering conditions do not exceed the device suppliers mandated processing conditions.

NOTE 1 In case of non-compliant mounting procedure with a component manufacturer, a company can apply different soldering temperature compliant with clause 6 after successful verification tests as described in clause 14 and dedicated tests at component levels showing there is no degradation of these components.

NOTE 2 To mount component by hand soldering at very low temperature can degrade reliability of component and PCB by increasing the duration of soldering necessary to obtain an acceptable solder joint.

- e. Supplier shall ensure that degolding and pretinning has been performed such that the solder fillet is not in contact with the gold or AuSn intermetallic.
- f. Supplier shall ensure repeatability of the mounting when artificial standoff is adopted.

9.7.2 Stress relief

- a. When PCBs with high CTE compensation are employed, the supplier shall accommodate CTE mismatch by the mounting technology.

NOTE 1 Pure eutectic tin-lead solder or indium-lead solder provide better stress relief (due to their ductility) than those with additional elements, e.g. antimony, gold.

NOTE 2 Leadless devices with e.g. end-cap terminations, metallization, can have some stress relief (such as additional foil or wire

leads, possibly attached by welding or high melting point solder).

NOTE 3 A solder stand-off (see Figure 11-1, dimension "X") can assist stress relief; in this situation, the CTE mismatch strain is taken up by the ductile solder.

NOTE 4 <<deleted>>

9.7.3 Registration of devices and footprints

- a. Devices shall be mounted on their associated terminal footprints .
- b. The spacing between conductive elements shall not be reduced below the minimum electrical spacing specified in clause 7.3 of ECSS-Q-ST-70-12.

NOTE Some surface mounted devices that are not bonded to the PCB can self-align during the soldering process. It is the registration after soldering that is important.

9.7.4 Lead forming

- a. The leads of leaded surface mount devices shall be formed to their final configuration prior to mounting.
- b. Forming shall not degrade the solderability or cause loss of plating adhesion to the leads.
- c. Forming shall not cause mechanical damage to the leads or attachment seals.
- d. Leads of dual-in-line and gull-wing packages, flat-packs and other multileaded devices shall be dressed, mechanically re-aligned to ensure co-planarity providing that the lead to package connection is not subjected to plastic deformation.
- e. Formed leads shall not be re-bent.
- f. Lead forming shall be symmetrical.

9.7.5 Mounting devices in solder paste

- a. Both leaded and leadless surface mounted devices shall be mounted in solder paste prior to reflow soldering.

NOTE It is good practice to optimize the pick and place mounting force on the device lead, ball or column.

- b. The solder paste deposited on each solder land shall be visually inspected for registration and coverage by the operator prior to mounting the devices.

NOTE <<deleted>>