SLOVENSKI STANDARD
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Space product assurance - Verification and approval of automatic machine wave soldering

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Luft- und Raumfahrt - Raumfahrtproduktsicherung - Verifikation und Zulassung von Maschinenschwalllötverfahren

Assurance produits des projets spatiaux - Validation et approbation du brasage automatique a la vague

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25.160.50	Trdo in mehko lotanje	Brazing and soldering
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Space product assurance - Verification and approval of automatic machine wave soldering

Assurance produits des projets spatiaux - Validation et approbation du brasage automatique à la vague

This European Standard was approved by CEN on 27 June 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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 member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 14612:2003) has been prepared by Technical Committee CEN/TC CST02 "Space product assurance — Verification and approval of automatic machine wave soldering", the secretariat of which is held by CMC.

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of an identical text or by endorsement, at the latest by February 2004, and conflicting national standards shall be withdrawn at the latest by February 2004.

It is based on a previous version[1)] prepared by the ECSS Product Assurance Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board. The European Cooperation for Space Standardization (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 allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this Standard takes into account the existing ISO 9000 family of documents.

Annex A is normative. Annex B is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1) ECSS-Q-70-07A.

Introduction

Wave soldering is regarded as a critical process that will find limited application during the assembly of components on to printed circuit boards (PCBs) intended for spacecraft. The preferred procedure is by manual soldering to the requirements of ECSS-Q-70-08. Generally the small number of identically designed circuits does not warrant the setting up of unique machine parameters for each individual layout.

1 Scope

This specification defines the basic requirements for the verification and approval of automatic machine wave soldering for use in spacecraft hardware. The process requirements for wave soldering of double-sided and multilayer boards are also defined.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 13701:2001, *Space systems — Glossary of terms.*

ECSS-Q-70-08, *Space product assurance - The manual soldering of high-reliability electrical connections.*

ECSS-Q-70-10, *Space product assurance - Qualification of printed circuit boards.*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13701:2001 and the following apply.

3.1.1
ionisable contaminant
process residues such as flux activators, fingerprints, etching and plating salts, that exist as ions and when dissolved, increase electrical conductivity

3.1.2
machine oil
liquid compounds formulated for use as oil in wave-soldering equipment

NOTE They serve primarily to provide a barrier between the atmosphere and molten solder, thereby reducing the oxidation (drossing) of the solder. Certain oils also reduce the surface tension of molten solder, thereby enhancing the wetting characteristics of the solder

3.1.3
measling
condition existing in the base laminate of a printed circuit board in the form of discrete white spots or “crosses” below the surface of the base laminate, reflecting a separation of fibres in the glass cloth at the weave intersection

3.1.4
wave soldering
process wherein printed circuit boards are brought in contact with a gently overflowing wave of liquid solder which is circulated by a pump in an appropriately designed solder pot reservoir

NOTE The prime functions of the molten wave are to serve as a heat source and heat-transfer medium and to supply solder to the joint area.

3.1.5
wave-soldering equipment
systems that achieve wave soldering and which consist of stations for fluxing, preheating, and soldering by means of a conveyer

NOTE Cleaning is usually offered as an option. Normally, additional cleaning is necessary in order to meet cleanliness standards.

3.2 Abbreviated terms

The following abbreviated terms are defined and used with this standard.

Abbreviation	Meaning
PCB	Printed Circuit Board
PID	Process Identification Document

4 General

4.1 Introduction

When wave soldering is identified as a suitable alternative to manual soldering for use in the customer's projects, it will be essential to follow the steps outlined in this document before the final customer's approval is granted. The sequence of main events is shown in Figure 1. Each step shall be fully completed and the details recorded, so that a dossier is compiled for each manufacturer's assembly line. All dossiers are kept updated by the final customer and serve as a reference for the final customer's Project Engineers.

A general qualification is not granted for wave soldering. Wave soldering lines that were previously verified (see also clause 5) may be also approved for use on named projects, but this shall depend entirely on the specific project requirements. Project process approval shall be obtained, as for all materials and critical processes, see ECSS-Q-70.

4.2 Design

Designers of printed circuit boards shall be familiar with design parameters that are necessary for the wave-soldering process. Circuit tracks that are spaced close together should be oriented in line with the pass direction to avoid solder bridging. Large heat sink areas should be avoided; these will include ground planes and large leads closely connected to massive metal parts.

4.3 Rework

Space-quality requirements of solder joints (see ECSS-Q-70-08) shall be met without more than 5 % rework on each wave soldered circuit.

NOTE Deficient wave-soldered connections are caused most frequently by the movement of component leads during solidification, the presence of solder alloy within stress relief bends and the entrapment of machine oils and solder fluxes within the solder fillet. Rework of any nature is costly. It involves not only the risk of irreparable lifted pads and measling, but also the possibility of heat damage to sensitive components.

A solder-joint-discrepancy log, such as that given in annex B, shall be maintained as an aid to process control, optimisation of parameters and repeatability.

5 Request for verification of process

5.1 General

Verification tests shall be conducted to establish confidence in the reliability of all automatic machine soldering production lines.

Each application for verification shall contain a brief description of the facility, details of past experience and the name of the spacecraft project concerned; the application shall be signed by the person responsible for space-component-assembly processes and addressed to the relevant final customer's Materials and Processes engineer responsible for that project.

5.2 Documentation

The following documents shall also be forwarded with the application for evaluation:

a) company organigram related to wave-soldering production and control personnel (including names and functions of all key personnel involved);

b) list of materials such as solder, flux, solvents, PCBs and equipment (including types and names of supplier) used for wave soldering;

c) production flow chart, showing quality assurance inspection points;

d) list of process specifications, including reference numbers of relevant in-house documents. The general process requirements shall include those listed in annex A;

e) detailed report concerning optimisation of wave-soldering process parameters (i.e. preheat temperature, temperature of solder, conveyer speed, temperature - time profile, control of dross, cleaning procedure);

f) outline of company test capabilities (e.g. thermal cycling chambers, metallography, chemical analysis, failure analysis).

5.3 Samples

The application shall be accompanied by three samples of wave-solder assembled boards whose complexity is typical of that found in spacecraft and which meet space-quality workmanship standards. They shall have been cleaned, but not conformally coated. These items are hereinafter referred to as technology samples.

6 Technology samples

6.1 Configuration

The technology samples shall consist of PCBs procured from a space-approved manufacturing line, which shall be assembled with components to a documented procedure as detailed in annex A. A listing of these procedures shall form part of the line's Process Identification Document (PID). Except for the actual machine soldering procedure, the full component assembly requirements of ECSS-Q-70-08 shall apply. The assembled board shall be free of flux residues and other contaminants.

6.2 Accompanying data

A description of the components, materials and processes utilised, together with the cleanliness test report, shall accompany the technology samples.

The cleanliness tests shall be made by the contractor using a method the same as, or equivalent to, requirements of ECSS-Q-70-08.

6.3 Examination

The technology samples shall be assessed by the final customer or by a recognized test house. Visual and metallographic inspections are required. After examination, the completed report shall be sent to the supplier.

7 Line audit

Provided the technology samples are found acceptable, the final customer shall audit the wave-soldering and related facilities at a time when the equipment is in operation. The audit shall also include a further on-site review of the documentation listed in subclauses 5.2 and 6.2. Compliance with the process requirements of annex A shall be evaluated.

The final customer shall supply the manufacturer with a copy of the audit report.

8 Verification

8.1 Planning, management and finance

After the successful completion of the line audit, the supplier shall furnish the final customer with an evaluation programme and flow chart for approval. The evaluation programme shall be performed by the supplier's quality laboratories under the supervision of a product assurance engineer, or by one or more independent test houses. Each test house shall require the final customer's approval prior to commencement of the programme. The entire evaluation programme shall be financed by the supplier and can be monitored by the final customer at various stages during testing.

8.2 Description of samples

The programme shall be designed to contain the following:

a) Five PCBs from each production line assembled according to the wave-soldering procedure of annex A. Each board shall have an identical layout (i.e. dimensions, number of layers, type of components).

b) The layout and component density (i.e. number of components per unit board area) shall be similar to that envisaged for spacecraft circuits.

c) The variety of component packages mounted on each board shall be restricted to those envisaged for spacecraft circuits. There shall be at least three of each type per board. Particular attention shall be given to heat-sensitive components. Only component types utilized during this programme shall be regarded as process approved.

Note Owing to the high cost of some components, the final customer can agree to the use of non-functional, or commercial-quality components but they shall be of the same lead material and finish (viz. solderability) as the hi-rel components required for flight.

d) Each component type shall be tabulated, together with details concerning:

- component lead material and finish;
- lead diameter-to-hole diameter ratio.

8.3 Initial tests

a) The following initial tests shall be performed on each of the five assembled PCBs: