IEC 61191-1

Edition 3.0 2018-09
REDLINE VERSION

INTERNATIONAL STANDARD

colour
inside

Printed board assemblies –
Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies

IEC 61191-1:2018-09 RLV(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2018 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IECNORM.COM : Click to view the full PDF of IEC 61194-1:2018 RLV

IEC 61191-1

Edition 3.0 2018-09
REDLINE VERSION

INTERNATIONAL STANDARD

colour
inside

Printed board assemblies –
Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.190; 31.240

ISBN 978-2-8322-6051-7

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD ... 7
1 Scope ... 9
2 Normative references ... 9
3 Terms and definitions ... 10
4 General requirements ... 11
  4.1 Order of precedence ... 11
    4.1.1 General remark ... 11
    4.1.2 Conflict ... 11
    4.1.3 Conformance documentation ... 12
  4.2 Interpretation of requirements ... 12
  4.3 Classification ... 12
  4.4 Defects and process indicators ... 13
  4.5 Process control requirements ... 13
  4.6 Requirements flowdown ... 13
  4.7 Physical designs ... 13
    ~~Design requirements ...~~
    4.7.1 New designs ... 13
    4.7.2 Existing designs ... 13
  4.8 Visual aids ... 14
  4.9 Proficiency of personnel ... 14
    4.9.1 Design proficiency ... 14
    4.9.2 Manufacturing proficiency ... 14
  4.10 Electrostatic discharge (ESD) ... 14
  4.11 Facilities ... 14
    4.11.1 General ... 14
    4.11.2 Environmental controls ... 14
    4.11.3 Temperature and humidity ... 15
    4.11.4 Lighting ... 15
    4.11.5 Field conditions ... 15
    4.11.6 Clean rooms ... 15
  4.12 Assembly tools and equipment ... 15
    4.12.1 General ... 15
    4.12.2 Process control ... 15
5 Requirements of materials ... 15
  5.1 Overview ... 15
  5.2 Solder ... 16
  5.3 Flux ... 16
  5.4 Solder paste ... 16
  5.5 Preform solder ... 16
  5.6 Adhesives ... 16
  5.7 Cleaning agents ... 16
    5.7.1 General ... 16
    5.7.2 Cleaning agents selection ... 17
  5.8 Polymeric coatings ... 17
    ~~General ...~~
    5.8.1 Solder resists and localized maskants ... 17

5.8.2 Conformal coating and encapsulants 17
5.8.3 Spacers (permanent and temporary)....17
5.9 Chemical strippers 17
5.10 Cleaning Agents....17
5.11 Heat shrinkable soldering devices 17
6 Components and printed board requirements 18
6.1 General....18
6.2 Solderability....18
6.2.1 Parts solderability 18
6.2.2 Reconditioning 18
6.2.3 Solderability testing of ceramic boards 18
6.3 Solderability maintenance 18
6.3.1 General 18
6.3.2 Preconditioning 18
6.3.3 Gold embrittlement of solder joints 19
6.3.4 Tinning of non-solderable parts 19
6.4 Solder purity maintenance 19
6.5 Lead preparation 20
6.5.1 General 20
6.5.2 Lead forming....20
6.5.3 Lead-forming limits....21
7 Assembly process requirements....21
7.1 Overview....21
7.2 Cleanliness 21
7.3 Part markings and reference designations 21
7.4 Solder connection contours 21
7.5 Moisture traps 21
7.6 Thermal dissipation 21
8 Assembly soldering requirements....22
8.1 General....22
8.1.1 Soldering process 22
8.1.2 Machine maintenance 22
8.1.3 Handling of parts....22
8.1.4 Preheating 22
8.1.5 Carriers 22
8.1.6 Hold down of surface mount leads 22
8.1.7 Heat application 22
8.1.8 Cooling 23
8.2 Reflow soldering 23
8.2.1 Requirements 23
8.2.2 Process development for reflow soldering....23
8.2.3 Flux application....23
8.2.4 Solder application 23
8.3 Manual/hand soldering 24
8.3.1 Non-reflow manual soldering 26
8.3.2 Reflow manual soldering 26
~~Mechanized immersion soldering (non-reflow)....~~
~~General ....~~
~~Process development for mechanized immersion soldering ....~~

~~Drying/degassing~~
~~Holding fixtures and materials~~
~~Flux application~~
~~Solder bath~~
9 Cleanliness and residue requirements 27
9.1 General 27
~~Equipment and material compatibility~~
~~Pre-soldering cleaning~~
~~Post-soldering cleaning~~
~~General~~
~~Ultrasonic cleaning~~
~~Cleanliness verification~~
~~General~~
~~Visual inspection~~
~~Testing~~
~~Cleanliness criteria~~
~~General~~
~~Particulate matter~~
~~Flux residues and other ionic or organic contaminants~~
~~Cleaning option~~
~~Test for cleanliness~~
~~Rosin residues on cleaned board assemblies~~
~~Ionic residues (instrument method)~~
~~Ionic residues (manual method)~~
~~Surface insulation resistance (SIR)~~
~~Other contamination~~
9.2 Qualified cleaning/manufacturing process 30
9.2.1 General 30
9.2.2 Cleaning designator 31
9.2.3 Upper specification limit 31
9.3 Visual requirements 31
9.4 Correlation of ionic testers 32
9.5 Non-ionic residues 32
9.6 SIR testing 32
10 Assembly requirements 27
10.1 General 32
10.2 Acceptance requirements 32
10.2.1 Process control 32
10.2.2 Corrective action limits 33
10.2.3 Control limit determination 33
10.3 General assembly requirements 33
10.3.1 Assembly integrity 33
10.3.2 Assembly damage 33
10.3.3 Markings 34
10.3.4 Flatness (bow and twist) 34
10.3.5 Solder connection 34
10.3.6 Interfacial connections 36
11 Coating and encapsulation 36
11.1 Conformal coating 36

11.1.1 Coating instructions 36
11.1.2 Application 36
11.1.3 Performance requirements 37
11.1.4 Rework of conformal coating 38
11.1.5 Conformal coating inspection 38
11.2 Encapsulation 38
11.2.1 Encapsulation instructions 38
11.2.2 Application 38
11.2.3 Performance requirements 39
11.2.4 Rework of encapsulant material 39
11.2.5 Encapsulant inspection 39
12 Rework and repair 39
~~General ....~~
12.1 Rework of unsatisfactorily soldered electrical and electronic assemblies 39
12.2 Repair 40
12.3 Post rework/repair cleaning 40
13 Product quality assurance 41
13.1 System requirements 41
13.2 Inspection methodology 41
13.2.1 Verification inspection 41
13.2.2 Visual inspection 41
13.2.3 Sampling inspection 42
13.3 Process control 42
13.3.1 System details 42
13.3.2 Defect reduction 42
13.3.3 Variance reduction 43
14 Other requirements 43
14.1 Health and safety 43
14.2 Special manufacturing requirements 43
14.2.1 Manufacture of devices incorporating magnetic windings 43
14.2.2 High-frequency applications 43
14.2.3 High-voltage or high-power applications 43
14.3 Guidance on requirement flowdown 43
15 Ordering data 44
Annex A (normative) Requirements for soldering tools and equipment 45
A.1 Requirements for tools and equipment 45
A.2 Abrasives 45
A.3 Benchtop and hand-soldering systems 45
A.4 Soldering iron holders 46
A.5 Wiping pads 46
A.6 Soldering guns 46
A.7 Solder pots 46
A.8 Process control 46
~~Annex (normative) Qualification of fluxes ....~~
Annex B (normative) Quality assessment 48
B.1 Process control (PC) 48
B.2 Reduction of quality conformance testing 48
B.3 Audit plan 49

Bibliography 50

Figure 1 – Solder contact angle..35
Figure 2 – Solder wetting of plated through-holes without leads 35
Figure 3 – Coating conditions..37

Table 1 – Solder contamination limits; maximum contaminant limit (percentage by weight) 19
Table 2 – Designation of surfaces to be cleaned...25
Table 3 – Residue testing for process control 25
Table 4 – Maximum acceptable rosin flux residues 26
Table 5 – Electrical and electronic assembly defects 34
Table 6 – Magnification requirements..35

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRINTED BOARD ASSEMBLIES –

Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61191-1 has been prepared by IEC technical committee 91: Electronics assembly technology.

This third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the requirements have been updated to be compliant with the acceptance criteria in IPC-A-610F;
b) the term "assembly drawing" has been changed to "assembly documentation" throughout;
c) references to IEC standards have been corrected;
d) Clause 9 was completely rewritten;
e) Annex B was removed because there are already procedures for circuit board assemblies.

The text of this International Standard is based on the following documents:

CDV	Report on voting
91/1481/CDV	91/1510/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 61191 series, published under the general title *Printed board assemblies*, can be found in the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

PRINTED BOARD ASSEMBLIES –

Part 1: Generic specification –
Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies

1 Scope

This part of IEC 61191 prescribes requirements for materials, methods and verification criteria for producing quality soldered interconnections and assemblies using surface mount and related assembly technologies. This part of IEC 61191 also includes recommendations for good manufacturing processes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IEC 60721-3-1, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities –~~ Section 1:~~ Storage*

~~IEC 61188-1-1, *Printed boards and printed board assemblies – Design and use – Part 1-1: Generic requirements – Flatness considerations for electronic assemblies*~~

IEC 61189-1, *Test methods for electrical materials, interconnection structures and assemblies – Part 1: General test methods and methodology*

IEC 61189-3, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 3: Test methods for interconnection structures (printed boards)*

IEC 61190-1-1, *Attachment materials for electronic assembly – Part 1-1: Requirements for soldering fluxes for high-quality interconnections in electronics assembly*

~~IEC 61190-1-2, *Attachment materials for electronic assembly – Part 1-2: Requirements for soldering pastes for high-quality interconnects in electronics assembly*~~

IEC 61190-1-3, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications*

IEC 61191-2, *Printed board assemblies – Part 2: Sectional specification – Requirements for surface mount soldered assemblies*

IEC 61191-3, *Printed board assemblies – Part 3: Sectional specification – Requirements for through-hole mount soldered assemblies*

IEC 61191-4, *Printed board assemblies – Part 4: Sectional specification – Requirements for terminal soldered assemblies*

IEC 61249-8-8, *Materials for interconnection structures – Part 8: Sectional specification set for non-conductive films and coatings – Section 8: Temporary polymer coatings*

IEC 61340-5-1, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

IEC/TR 61340-5-2, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*

IEC 61760-2, *Surface mounting technology – Part 2: Transportation and storage conditions of surface mounting devices (SMD) – Application guide*

ISO 9001:2008, *Quality management systems – Requirements*

IPC-A-610~~E:2010~~, *Acceptability of Electronic Assemblies*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
bow
deviation from flatness of a board characterized by a roughly cylindrical or spherical curvature so that, if the product is rectangular, its four corners are in the same plane

3.2
manufacturer
assembler
individual or company responsible for the procurement of materials and components, as well as all assembly process and verification operations necessary to ensure full compliance of assemblies with this document

3.3
objective evidence
documentation agreed to between the user and the manufacturer

Note 1 to entry: The documentation can be in the form of a hard copy, computer data, computer algorithms, video or other media.

3.4
process indicator
detectable anomaly, other than a defect, that is reflective of material, equipment, personnel, process and/or workmanship variation

3.5
proficiency
capability to perform tasks in accordance with the requirements and verification procedures detailed in this document

3.6
shadowing
phenomenon where parts create a shadow of leads, lands, or other parts, which obstruct heating at reflow soldering or spreading solder at flow soldering

3.7
supplier
individual or company responsible for assuring, to the manufacturer (assembler), full compliance of components and base materials with the requirements and verification procedures of this document

Note 1 to entry: Components include electronic, electromechanical, mechanical components, printed boards, etc.

Note 2 to entry: Base materials include solder, flux, cleaning agents, etc.

3.8
twist
deviation of a rectangular sheet, panel or printed board that occurs parallel to a diagonal across its surface, so that one of the corners of the sheet is not in the plane that contains the other three corners

3.9
user
procuring authority
individual, company or agency responsible for the procurement of electrical/electronic hardware, and having the authority to define the class of equipment and any variation or restrictions to the requirements of this document

EXAMPLE The originator/custodian of the contract detailing these requirements.

4 General requirements

4.1 Order of precedence

4.1.1 General remark

In the event of a conflict between the text of this standard and the applicable standard cited herein, the text of this document shall take precedence. However, nothing in this document supersedes applicable laws and regulations.

4.1.2 Conflict

In the event of conflict between the requirements of this document and the applicable assembly ~~drawing(s)~~ documentation, the applicable user approved assembly ~~drawing(s)~~ documentation shall govern. In the event of conflict between the requirements of this document and assembly ~~drawing(s)~~ documentation that has not been approved, the differences shall be referred to the designated user activity for approval. Upon such approval, the provisions shall be documented (by official revision notice or equivalent) on the assembly ~~drawings~~ documentation, which shall then govern.

4.1.3 Conformance documentation

Where this document requires documentary evidence to support conformance claims, each record shall be retained and be available for inspection for a minimum of two years from the date of the recorded occurrence (see ISO 9001).

4.2 Interpretation of requirements

The introduction of product classification according to the levels and their end use (see 4.3) permits the user to differentiate the performance requirements. When the user elects to specify compliance with the mandatory requirements of this document, the following conditions apply:

- unless otherwise specified by the user, the word "shall" signifies that the requirements are mandatory,
- deviations from any "shall" requirement requires written acceptance by the user, for example via assembly ~~drawing~~ documentation, specification or contract provision. The word “should” is used to indicate a recommendation or guidance statement. The word “may” indicates an optional situation. Both “should” and “may” express non-mandatory situations. “Will” is used to express a declaration of purpose.

4.3 Classification

This document recognizes that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product levels have been established to reflect differences in producibility, functional performance requirements, and verification (inspection/test) frequency.

It should be recognized that there may be overlaps of equipment between levels. The user (see 3.5) of the assemblies is responsible for determining the level to which the product belongs. The contract shall specify the level required and indicate any exceptions or additional requirements to the parameters, where appropriate.

Level A: General electronics products

Includes consumer products, some computer and computer peripherals, and hardware suitable for applications where the major requirement is function of the completed assembly.

Level B: Dedicated service electronics products

Includes communications equipment, sophisticated business machines, and instruments where high performance and extended life is required, and for which uninterrupted service is desired but not mandatory. Typically, the end-use environment would not cause failures.

Level C: High-performance electronics products

Includes all equipment where continued performance or performance-on-demand is mandatory. Equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment shall function when required, such as life support systems and other critical systems.

IPC-A-610 shall be used as workmanship standard.

NOTE Level A corresponds to class 1 in IPC-A-610

Level B corresponds to class 2 in IPC-A-610

Level C corresponds to class 3 in IPC-A-610

4.4 Defects and process indicators

Table 5 lists the defects that are unacceptable and require attention (for example, rework, repair~~, etc.~~). The manufacturer is responsible for identifying other areas of risk and treating those additional concerns as additions to Table 5. Such items should be documented on the assembly ~~drawing~~ documentation. Other than the unacceptable defects listed in Table 5, anomalies and variances from "shall" requirements are considered as process indicators, and shall be monitored when their occurrence is observed. The disposition of process indicators is not required.

Workmanship requirements shall ~~be consistent with IPC-A-610E, and~~ match the defined level of classification ~~identified in~~ according to 4.3.

IPC-A-610 shall be used as workmanship standard.

4.5 Process control requirements

This document requires the use of process control methodologies in the planning implementation and evaluation of the manufacturing processes used to produce soldered electrical and electronic assemblies. The philosophy, implementation strategies, tools and techniques may be applied in different sequences depending on the specific company, operation, or variable under consideration, to relate process control and capability to end-product requirements. The manufacturer, subject to agreement by the user, may be exempt from performing specific quality conformance evaluations and inspections, detailed in this document, provided objective evidence of a comprehensive and current continuous improvement plan is available (see 13.3).

4.6 Requirements flowdown

The applicable requirements of this document shall be imposed by each manufacturer or supplier on all applicable subcontracts and purchase orders. The manufacturer or supplier shall not impose or allow any variation from these requirements on subcontracts or purchase orders other than those that have been approved by the user.

Unless otherwise specified, the requirements of this document are not imposed on the procurement of off-the-shelf (catalogue) assemblies or subassemblies (see 14.3). However, the manufacturer of these items may comply as deemed appropriate.

4.7 Physical designs

~~4.7.1 Design requirements~~

~~Some structural and layout design requirements are given in the following subclauses.~~

4.7.1 New designs

The printed board layout and mechanical and thermal structure of the electrical/electronic assembly should, where relevant, be based on an appropriate design standard (for example IEC 61188-5-1) or as approved by the user. When a manufacturer has objective evidence that a revised layout will produce good end product quality that fulfills the requirements of this document, the user and manufacturer should agree on the changes, and the layout should be modified appropriately.

4.7.2 Existing designs

The requirements of this document should not constitute the sole cause for redesign of a currently approved design. However, when existing electronic or electrical designs undergo changes that have an impact on hardware configuration, the design of the latter shall be reviewed and user-approved changes made that allow for maximum practical compliance. Any manufacturer-proposed design changes shall be approved by the user; however, even though the proposed changes result in compliance with this document and the manufacture of quality end products, the user is under no obligation to accept the proposed redesign.

4.8 Visual aids

Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this document. The written requirements take precedence.

4.9 Proficiency of personnel

4.9.1 Design proficiency

The design facility shall have documentation which demonstrates that formal design training for all technical workforce personnel has been accomplished. Training shall be given irrespective of whether such personnel have direct responsibility for product electronic/electrical design (see ISO 9001).

4.9.2 Manufacturing proficiency

Prior to commencing work, all instructors, operators and inspection personnel shall be proficient in the tasks to be performed. Objective evidence of that proficiency shall be maintained and be available for review. Objective evidence shall include records of training for the applicable job functions being performed, testing to the requirements of this document, and results of periodic reviews of proficiency (see ISO 9001 and IPC-A-610~~E~~).

4.10 Electrostatic discharge (ESD)

The ESD control programme shall be in accordance with IEC 61340-5-1 and IEC/TR 61340-5-2. Documented procedures, electrostatic discharge control for the protection of ESD sensitive electrical and electronic parts, components, assemblies and equipment shall be maintained during, but not limited to:

a) receipt and test of incoming items;
b) board, component and parts storage and kitting;
c) manufacturing and rework;
d) inspection and test cycles;
e) storage and shipping of completed product;
f) transport and installation.

Procedures for analysis of failures arising from ESD shall be documented and be available for review by an authorized inspectorate.

4.11 Facilities

4.11.1 General

Cleanliness and ambient environments in all work areas shall be maintained at levels that prevent contamination or deterioration of soldering tools, materials and surfaces to be soldered. Eating, drinking and use of tobacco products or illegal drugs shall be prohibited in the work area.

4.11.2 Environmental controls

The soldering facility should be enclosed, temperature and humidity controlled, and maintained at a positive pressure.

4.11.3 Temperature and humidity

When relative humidity decreases to a level of 30 % or lower, the manufacturer shall verify that electrostatic discharge control is adequate, and that sufficient moisture is present for flux performance and solder paste applications. For operator comfort and solderability maintenance, the temperature should be maintained between 18 °C and 30 °C and the relative humidity should not exceed 70 %. For process control, the need for more restrictive temperature and humidity limits should be evaluated.

4.11.4 Lighting

Illumination at the working surface of manual soldering and inspection stations shall be 1 000 lm/m^2 minimum.

4.11.5 Field conditions

In field operations, where the controlled environment conditions required by this document cannot be achieved effectively, special precautions shall be taken to maximize the quality of solder connections and minimize the effects of the uncontrolled environment on the operation being performed on the hardware.

4.11.6 Clean rooms

The assembly of electronics may necessitate the use of clean rooms to ensure compliance with the end production performance requirements of this document. If required, the class of clean room shall be agreed upon between the user and the manufacturer.

4.12 Assembly tools and equipment

4.12.1 General

The manufacturer is responsible for the selection and maintenance of tools and equipment used in the preparation and soldering of components and/or conductors. Tools used shall be selected and maintained so that no damage results from their use. Tools and equipment should be clean prior to use and be kept clean and free of dirt, grease, flux, oil and other foreign matter during use. Soldering irons, equipment, and systems shall be chosen and employed to provide temperature control and isolation from electrical overstress EOS or ESD (see 4.10).

4.12.2 Process control

If suitable process controls are not in place to ensure compliance with 4.12 and the intent of Annex A, the relevant detailed requirements of Annex A shall be mandatory. Assembly tools and equipment shall be used in accordance with a documented process that is available for user review. Assembly tools and equipment shall demonstrate process parameters as described in the process documentation.

5 Requirements of materials

5.1 Overview

Materials used in the soldering processes stipulated in this document shall be as specified hereinafter. Since the materials and processes specified ~~may~~ can be incompatible in some combinations, the manufacturer shall be responsible for selecting the combination of materials and processes that will produce acceptable products.

5.2 Solder

Solder alloys conforming to IEC 61190-1-3 shall be used. Any alloy that provides the service life, performance, reliability or regulatory requirements of the product may be used if all other conditions of this document are met and agreed upon by user and manufacturer.

5.3 Flux

Flux shall be tested and classified in accordance with IEC 61190-1-1 or equivalent, into one of the following three types:

L = low or no flux/flux residue activity;
M = moderate flux/flux residue activity;
H = high flux/flux residue activity.

Types L or M flux shall be used for assembly soldering. For applications where the flux residue will not be removed (no-clean), the use of an L flux meeting the requirements of 9.6.9 without cleaning (C00) is recommended (see 9.6.3.2).

Inorganic acid fluxes and type H fluxes may be used for tinning of terminals, solid wire and sealed components. Inorganic acid fluxes may not be used for assembly soldering. Type H fluxes may be used for soldering of terminals, solid wire and sealed components when performed as part of an integrated fluxing, soldering, cleaning and cleanliness test system and either of the following conditions is met:

a) usage is approved by the user;
b) data demonstrating compliance with the testing requirements of Annex B is available for review.

When type H flux is used, cleaning is mandatory.

When liquid flux is used in conjunction with other fluxes, it shall be chemically compatible with the other fluxes and materials with which it will be used. The flux of cored solder shall be in accordance with this subclause. The percentage of flux in cored solder is optional.

5.4 Solder paste

Solder paste, solder powder and flux constituents shall meet the requirements of 5.2 and 5.3 and should be evaluated in accordance with IEC 61190-1-2 to meet the assembly process requirements.

5.5 Preform solder

Preform solder shall meet all applicable requirements in 5.2 and 5.3.

5.6 Adhesives

Adhesive materials used for attachment of ~~other than surface mounted~~ components shall be suitable for the application and compatible with the assembly.

5.7 Cleaning agents

5.7.1 General

Cleaning agents used for the removal of grease, oil, wax, dirt, flux and other debris shall be selected for their ability to remove flux residue, other residues and particulate contaminants. The cleaning agents should not have aggressive chemicals and shall not degrade the materials or the parts being cleaned. The cleaning process shall permit the assembly to meet the cleaning requirements of ~~9.6~~ 9.3.

5.7.2 Cleaning agents selection

Cleaning agents and mixtures of cleaning agents shall conform to all appropriate specifications and references. Mixtures of cleaning agents may be used provided they are suitably stabilized or inhibited.

The use of chlorinated solvents is not permitted. Water, water/alcohol or terpenes are to be considered as first choice for cleaning applications. Any cleaning solvent shall comply with applicable health, safety and environmental regulations.

5.8 Polymeric coatings

~~5.8.1 General~~

~~The detailed requirements for polymeric materials are defined in the following subclauses.~~

5.8.1 Solder resists and localized maskants

Polymer solder resist coatings and temporary maskants in accordance with IEC 61249-8-8 shall be of a material that:

a) does not degrade solderability or the substrate material or printed wiring;
b) precludes solder flow to the masked area;
c) is compatible, if left in place, with printed board base material, conductive material, the intended fluxes, adhesive and subsequently applied conformal coatings;
d) can, if temporary, be readily removed without post-removal residual contamination harmful to the integrity of the printed board conformal coating, or assembly.

5.8.2 Conformal coating and encapsulants

Conformal coating requirements for assemblies, including the type of coating (i.e. the material), shall be as specified on the approved assembly ~~drawing~~ documentation. If edge coating is specified on the assembly ~~drawing~~ documentation, it shall conform to 11.1.2.7. Encapsulants shall be suitable for the application and shall be compatible with the assembly.

5.8.3 Spacers (permanent and temporary)

Materials used as mechanical stand-offs shall withstand soldering processes and should permit inspection of the solder joints (see 13.2.2.3). This requirement includes spacers that should withstand temperatures generated due to self-heating of components. Location, configuration and material shall be specified in the appropriate documentation.

5.9 Chemical strippers

Chemical solutions, pastes and creams used to strip solid wires shall not cause degradation to the wire.

5.10 Cleaning Agents

The cleaning agents should not have aggressive chemicals and shall not degrade the materials or the parts being cleaned. In addition, wires shall be neutralized and cleaned of contaminants in accordance with the suppliers' recommended instructions, and shall be solderable in accordance with 6.2.

5.11 Heat shrinkable soldering devices

Heat shrinkable soldering devices shall be self-sealing and shall encapsulate the solder connection. Braided shield terminations shall be in accordance with detailed manufacturers' work instructions that have been prepared to reflect the requirements documented on an approved assembly ~~drawing~~ documentation. ~~These self-sealing devices are exempt from the cleaning requirements of 9.4.~~

6 Components and printed board requirements

6.1 General

Electronic/mechanical components and printed boards shall conform to the requirements of the procurement document; ensuring conformance shall be the responsibility of the assembly manufacturer. Components and printed boards selected for assembly shall be compatible with all materials and processes used to manufacture the assembly.

NOTE For further information, see IEC 62326-1, IEC 62326-4, IEC 62326-4-1 and IEC/PAS 62326-7-1.

6.2 Solderability

6.2.1 Parts solderability

Solderability of parts shall be the responsibility of the supplier and shall meet the requirements specified and agreed to by the manufacturer. Electronic/mechanical components and wires shall meet solderability requirements when tested in accordance with IEC 60068-2-20, IEC 60068-2-58 or equivalent; printed boards shall meet the requirements when tested in accordance with IEC 61189-3 or equivalent.

Prior to acceptance of parts for storage or use, the manufacturer shall ensure that the parts to be soldered have been solderability tested in accordance with a sampling plan and conform to the requirements of the applicable solderability specification. The user should specify the required solderability specification. Storage conditions shall comply with class 1K2 of IEC 60721-3-1 and IEC 61760-2.

6.2.2 Reconditioning

When tinning and inspection is performed as part of the assembly process, that tinning operation can be used in lieu of solderability testing (see 6.3).

6.2.3 Solderability testing of ceramic boards

Metallic elements of ceramic printed boards shall be tested for solderability as specified in IEC 61189-3, or by using an equivalent method.

6.3 Solderability maintenance

6.3.1 General

The manufacturer shall ensure that all components, leads, wiring, terminals, and printed boards which have met the requirements of 6.2 are solderable at the start of hand and/or machine soldering operations. The manufacturer shall establish procedures to minimize solderability degradation.

6.3.2 Preconditioning

Component leads, terminations, and terminals may be preconditioned (e.g. hot solder dipped) to provide solderability maintenance.

6.3.3 Gold embrittlement of solder joints

6.3.3.1 General

To minimize the impact of embrittlement of solder from gold-plated items (e.g. component leads, printed board lands), the total volume of gold in any solder joint shall not exceed 1,4 % of the volume (i.e., 3 % by weight) of solder present.

If there is documented objective evidence, available for review, that there are no gold-related solder embrittlement issues, or other metallic-surface finish solder-joint integrity problems associated with the soldering process being used, the following requirements may be eliminated.

6.3.3.2 Gold on component ~~and piecepart~~ lead~~s~~ terminations

The manufacturer shall demonstrate compliance with the presoldering requirement:

a) all gold-plated leads/terminations and terminals have either been pre-tinned or the gold has been otherwise removed from surfaces to be soldered, and/or

b) the quantity of any residual gold present prior to soldering will not cause the limits given in 6.3.3 to be exceeded.

6.3.3.3 Tinning of leads/terminations

Tinning of leads/terminations shall not adversely affect the components. A double-tinning process or dynamic solder wave should be used for effective gold removal.

The gold-removal process may be eliminated for components to be soldered using dip, wave, or drag soldering processes provided that:

a) sufficient gold thickness exists to meet the solderability requirements in 6.2;

b) sufficient time, temperature and solder volume exist during the soldering process to enable the requirements of 6.3.3 to be met.

6.3.3.4 Gold on printed board lands

The volume of gold deposited on any printed board land intended for soldering components or terminals shall not cause the limits given in 6.3.3 to be violated.

6.3.4 Tinning of non-solderable parts

Component leads, terminations and printed boards not meeting the designated solderability requirements shall be reworked by hot solder dip tinning or other suitable methods prior to soldering. The reworked parts shall conform to the requirements of 6.2, except for steam ageing. Tinned areas of wires shall not conceal the wire strand(s) with solder. Wicking of solder under wire insulation shall be minimized. When required, heat sinks shall be applied to leads of heat-sensitive parts during the tinning operation.

6.4 Solder purity maintenance

Solder used for preconditioning gold removal, tinning of parts, and machine soldering shall be analyzed, replaced or replenished at a frequency to ensure compliance with the limits specified in Table 1. The frequency of analysis should be determined on the basis of historical data or monthly analyses. If contamination exceeds the limits of Table 1, intervals between the analyses, replacement or replenishment shall be shortened. Records containing the results of all analyses and solder bath usage (for example, total time in use, amount of replacement solder required, or area throughput) shall be maintained for each process system (see 4.1.3).

Table 1 – Solder contamination limits; maximum contaminant limit (percentage by weight)

Contaminant	~~Preconditioning (lead/wire tinning)~~ Preconditioning maximum contaminant weight percentage limit SnPb alloys	~~Assembly soldering (pot, wave, etc.)~~ Assembly Maximum Contaminant Weight Percentage Limit SnPb alloys	Preconditioning and assembly maximum contaminant weight percentage limit SACXXX lead-free alloys
Copper	0,750 [a]	0,300	Note[b]
Gold	0,500	0,200	0,200
Cadmium	0,010	0,005	0,005
Zinc	0,008	0,005	0,005
Aluminum	0,008	0,006	0,006
Antimony	0,500	0,500	0,200
Iron	0,020	0,020	0,020
Arsenic	0,030	0,030	0,030
Bismuth ~~[b]~~	0,250	0,250	0,250
Silver ~~[a]~~	0,750	0,100	4,000
Nickel	0,020	0,010	0,050
Palladium	0,004	0,004	0,004
Lead	~~0,100~~ N/A	~~0,100~~ N/A	0,100

The tin content of the solder bath shall be within ±~~1,5~~ 1 % of nominal for the solder specified and tested at the same frequency as tested for copper/gold contamination. The balance of bath shall be lead or the items listed above.

The total of copper, gold, cadmium, zinc and aluminum contaminants shall not exceed 0,4 % for assembly soldering.

NOTE When these metals are compositions of the solder alloy applied to the process, these are not considered to be contaminants.

~~[a] Not applicable for Sn62Pb36Ag2; limits to be 1,75 % to 2,25 %.~~

~~[b] Not applicable for processes using Sn60Pb38Bi2 (alloy 19/ISO 9453) for attachment.~~

~~[c]~~[a] When tinning fine-pitch leaded devices, the copper ratio should not exceed 0,300 %.

[b] A maximum copper limit of 1,1 % may be specified as agreed between the user and the supplier. Printed circuit assemblies that are characterized as thick and thermally demanding may potentially have plated through-hole fill and/or solder joint defects due to the impact of copper on solder flow characteristics.

6.5 Lead preparation

6.5.1 General

The detailed requirements for lead forming and preparation are described in the following subclauses.

6.5.2 Lead forming

The lead forming process shall not damage connections internal to components. The preferred methods of lead forming given in the manufacturer's specification shall be used. In addition, component bodies, leads and lead seals shall not be degraded below the basic component specification requirements.

6.5.3 Lead-forming limits

Whether leads are formed manually or by machine or die, components shall not be mounted if the component lead has unwanted nicks or deformation in diameter or width exceeding 10 % of the lead.

Exposed core metal is acceptable if the defect does not affect more than 5 % of the solderable surface area of the lead. Occurrence of exposed basis metal in the formed area of the lead shall be treated as a process indicator.

7 Assembly process requirements

7.1 Overview

Subclauses 7.2 to 7.6 deal with the requirements for the mounting of terminals, mechanical and electronic components, and wires to printed boards or other packaging and interconnecting structures. On assemblies using mixed component mounting technology, through-hole components should be mounted on one side of the printed board. Surface-mounted components may be mounted on either or both sides of the assembly.

When design restrictions mandate mounting components incapable of withstanding soldering temperatures incident to a particular process, such components shall be mounted and soldered to the assembly as a separate operation. In an assembly sequence where certain components are mounted and soldered followed by additional mounting and soldering, the appropriate steps shall be taken regarding cleaning of flux residues. If applicable, assemblies shall be cleaned after each soldering operation so that subsequent placement and soldering operations are not impaired by contamination (see Clause 9).

7.2 Cleanliness

The cleanliness of terminals, component leads, conductors, and printed wiring surfaces shall be sufficient to ensure solderability and compatibility with subsequent processes. Cleaning shall not damage the components, component leads, conductors or markings.

7.3 Part markings and reference designations

Part markings and reference designations shall be legible and components shall be mounted in such a manner that markings are visible.

7.4 Solder connection contours

Designs that utilize special solder connection contours as a part of a coefficient of thermal expansion (CTE) mismatch compensation system shall be identified on the approved assembly ~~drawing~~ documentation. The mounting technique shall be capable of performing with a solder connection that meets the requirements of 10.3.

7.5 Moisture traps

Within the constraints imposed by component and part design, parts and components shall be mounted to preclude the formation of moisture traps.

7.6 Thermal dissipation

When heat dissipation is required by the assembly, the material compatibility requirements of Clause 5 shall be followed.

8 Assembly soldering requirements

8.1 General

~~The detailed requirements for manual and machine soldering processes are defined in the following subclauses.~~

8.1.1 Soldering process

Soldering processes, as specified herein, shall not result in damage to the components or assemblies.

8.1.2 Machine maintenance

Machines used in the soldering process shall be maintained to assure capability and efficiency commensurate with design parameters established by the original equipment manufacturer.

Maintenance procedures and schedules shall be documented in order to provide reproducible processing.

8.1.3 Handling of parts

Parts shall be handled in a manner to preclude damage to terminations and to avoid the need for subsequent lead straightening operations. Once parts are mounted on printed boards, the assembly prior to soldering shall be handled, transported (for example by hand or conveyor) and processed in a manner to preclude movement that would detrimentally affect the formation of acceptable solder connections. After soldering operations have been performed, the assembly shall be sufficiently cooled so that the solder is solidified prior to further handling to prevent hot cracking of the solder.

8.1.4 Preheating

Assemblies should be preheated to minimize the presence of volatile solvents prior to soldering, to reduce the temperature differences across the board, to reduce thermal shock to boards and components, to improve solder flow, and to reduce the molten solder dwell time. The preheat temperature exposure shall not degrade printed boards, components, or soldering performance.

8.1.5 Carriers

Carriers used for the transport of printed boards through the assembly line shall be of such material, design, and configuration that they will not impair solderability or cause board, part or component degradation or electrostatic damage (ESD) to components.

8.1.6 Hold down of surface mount leads

Short, stiff or thick surface-mounted device leads shall not be held down under stress (for example by probes) during solder solidification so that the resulting initial stresses decrease reliability. The resistance reflow system (e.g. parallel gap, shorted bar, thermal transfer) should not deflect the leads more than twice the lead thickness. For short or thick leads, the deflection should be less than twice the lead thickness.

8.1.7 Heat application

The elements to be soldered shall be sufficiently heated to cause complete melting of the solder and wetting of the surface being soldered.

8.1.8 Cooling

The connection shall not be subjected to detrimental movement or detrimental stress at any time during the solidification of the solder. Controlled cooling may be used with documented processes.

8.2 Reflow soldering

8.2.1 Requirements

The detailed requirements for reflow soldering operations are defined subclauses 8.2.2 to 8.2.4. Methods for reflowing solder for attachment of surface-mounted devices include, but are not limited to, infrared, vapour phase, convection (hot air/gas), laser, thermode (hot bar) or conduction. These should provide:

a) the capability to apply controlled pre-heat to printed wiring assemblies;

b) the thermal capacity to raise and maintain the soldering temperatures for the range of component thermal masses and solder joint sizes to within ±5 °C of their selected temperature profile, throughout the span of the required continuous soldering production run;

c) within the constraints of thermal shock limitation requirements, to heat rapidly the surfaces to be joined and to cool them thereafter;

d) to minimize the effects of shadowing and colour on individual component-heating rates.

8.2.2 Process development for reflow soldering

Manufacturers shall establish and maintain a reflow soldering process that is repeatable within limits defined for the process equipment. A reflow soldering process instruction shall also be developed and maintained. The manufacturer shall perform the reflow soldering operations in accordance with these process instructions. The process shall include, as a minimum, a reproducible time/temperature envelope including the drying/degassing operation (when required), preheating operation (when required), solder reflow operation, and a cooling operation. These steps may be part of an integral or in-line system or may be accomplished by a series of separate operations. If the temperature/time profile is adjusted for a different printed wiring assembly, or another assembly variation, the setting to be used shall be documented.

8.2.3 Flux application

Flux, when used, shall be applied prior to formation of the final solder connection. Flux may be a constituent of the solder paste or preform solder. Any flux meeting the requirements of 5.3 may be used provided that

a) the flux or combination of fluxes does not damage parts,

b) the subsequent cleaning processes (if required) shall be sufficient to comply with the cleanliness requirements in Clause 9 and not be detrimental to the product.

8.2.4 Solder application

8.2.4.1 Workmanship

Enough solder shall be applied to components or boards or both to ensure that sufficient quantity is in place during reflow to meet the ~~end point~~ workmanship requirements.

8.2.4.2 Solder paste application

Methods for applying solder paste on surface-mount land pattern areas include, but are not limited to, screen or stencil printing, dispensing, or pin transfer. Solder paste shall be handled ~~by~~ in accordance with the material supplier's recommendation ~~for~~ to ensure proper performance. Re-use or mixing of solder paste exposed for excessive periods (for example 1 h to 24 h depending on the material) with fresh paste should be avoided.

8.2.4.3 Solid solder deposition (SSD)

Surface-mount land patterns can be coated with a defined amount of solder during the printed board's manufacturing process.

Different methods of solder application are permissible, for example:

a) plating of SnPb; it shall not be applied to lead-free soldering;

b) screen or stencil printing of solder paste followed by a reflow solder process. This process can be used with or without a flattening operation of the reflowed solder pads;

c) application of molten solder;

d) application of solder particles in an adherent flux (solid solder deposit technology).

The characteristics of the solid solder deposit on land patterns are the following:

e) the applied solder has a plated or molten intermetallic bond to the surface mounting device (SMD) land pattern;

f) the applied thickness of the solder is sufficient for a reliable reflow solder joint;

g) the solder is applied with sufficient precision to the SMD land pattern;

h) the flatness of deposited solder shall be suitable for the applicable component, for example fine-pitch devices require better flatness than most other components.

The amount of the solder shall be specified.

~~8.4 Mechanized immersion soldering (non-reflow)~~

~~8.4.1 General~~

~~The detailed requirements for immersion non-reflow machine soldering are defined in the following subclauses. These soldering systems should provide:~~

~~a) the capability to apply flux to all points requiring flux;~~

~~b) the capability to apply controlled pre-heat to printed board assemblies;~~

~~c) the thermal capacity to maintain the soldering temperature at the assembly surface to within ±5 °C of the selected temperature, throughout the span of the required continuous soldering production run;~~

~~d) within the constraints of thermal shock limitation requirements, to heat the surfaces to be joined in a controlled manner, and to cool them thereafter;~~

~~e) sufficient mechanical energy to minimize shadowing effects and to assist wetting in the nooks and crannies between closely packed surface mount components.~~

~~8.4.2 Process development for mechanized immersion soldering~~

~~The manufacturer shall maintain operating procedures describing the soldering process and the proper operation of the automatic soldering machine and associated equipment. For the soldering machine, these procedures, as a minimum, shall define the preheat temperature, solder temperature, rate of travel, frequency of temperature verification measurements, frequency and method of flux analysis (mandatory for low-solids fluxes), and frequency of solder bath analysis. If any of the above-mentioned characteristics are adjusted for a different printed wiring assembly, drawing number, or other positive identification element, the setting to be utilized shall be identified.~~

~~8.4.3 Drying/degassing~~

~~Prior to soldering, the assembly may be baked to reduce detrimental moisture and other volatiles.~~

~~8.4.4 Holding fixtures and materials~~

~~Devices, materials or techniques used to retain parts and components to the printed board through preheat, fluxing, soldering, and cooling stages shall not contaminate, damage or degrade printed boards or components. The devices, materials or techniques shall be adequate to maintain component positioning, and shall permit solder flow through plated through-holes and/or on to terminal areas.~~

~~8.4.5 Flux application~~

~~The flux used shall form a coating on the surface to be soldered. The flux or method of application should not damage or reduce reliability of components. The flux shall be thinned with material recommended by the flux supplier as necessary to meet the requirements of the flux application. The flux shall be dried sufficiently before soldering to prevent solder spatter.~~

~~8.4.6 Solder bath~~

~~8.4.6.1 Solder bath temperature~~

~~The solder bath using the solder compositions defined in 5.2 should be maintained at a temperature recommended by the supplier of the solder. However, the temperature shall not exceed the resistance to soldering heat of the components mounted. For alloys other than those cited in 5.2, other temperature ranges may be required. For all alloys, the nominal temperature should have a tolerance of ±5 °C. This tolerance shall not put the bath temperature outside the established limits.~~

~~The temperature and time of contact between the assembly and the solder shall be dependent upon such factors as preheating, thickness of the board, number and size of contacts or conductors, and the type of parts. The period of exposure of any printed board to a solder bath shall be limited to a duration which will not cause damage to the board or components mounted thereon.~~

~~8.4.6.2 Solder bath maintenance~~

~~Solder bath purity in machine soldering of printed board assemblies shall be maintained in accordance with 6.4 and the following procedures:~~

~~a) dross shall be removed from the solder bath in a manner which assures that dross does not contact the items being soldered. Automatic or manual methods for dross removal are acceptable;~~

~~b) soldering oils may be intermixed with the molten solder and carried to the surface of the solder wave or applied to the surface of the solder wave or solder bath. The oil level should be controlled to preclude intermix of oil in solidified solder joints;~~

~~c) solder in soldering machines shall be analyzed on a regular basis in accordance with 6.4.~~

8.3 Manual/hand soldering

~~8.5.1 Requirements~~

~~The detailed requirements for manual/hand soldering are defined in the following subclauses.~~

8.3.1 Non-reflow manual soldering

8.3.1.1 Flux application

If used, liquid flux shall be applied to the surfaces to be joined, prior to the application of heat. The use of excess flux should be avoided. When cored solder is used, it shall be placed in a position that allows the flux to flow and cover the connection elements as the solder melts. When an external liquid flux is used in conjunction with flux cored solders, the fluxes shall be compatible.

8.3.1.2 Solder application

A well-tinned tip (see 4.12) shall be applied to the joint and the solder introduced at the junction of the tip and the connection for maximum heat transfer. After applying heat and achieving heat transfer, the solder should be applied to the joint and not the soldering iron tip. Solder is supplied to a surface of the joint that ~~left from~~ is located to the left of the heating position. The method of application should be such that no solder ~~deposits~~ is deposited on the body of component. The solder and the soldering iron tip shall be quickly pulled apart from the joint metal. Solder shall only be applied to one side of a plated through-hole. The temperature of the soldering tip shall not exceed the specific working temperature. The application of heat should be within the restricted temperature and time specified. Heat may be applied to both sides of the plated through-hole. Some hand-soldering applications may require preheating to prevent damage to components.

8.3.1.3 Heat sinks

When hand soldering is being carried out close to the body of heat-sensitive devices, a heat sink should be used between the soldering iron tip and the component body as necessary to restrict heat flow into the component.

8.3.1.4 Solder wicking

Limited solder wicking during soldering of wire is permissible. Solder wicking shall not extend to a portion of the wire that is required to remain flexible.

8.3.2 Reflow manual soldering

8.3.2.1 Solder applications

Enough solder shall be applied to components, or boards, or both to ensure that sufficient quantity is in place during reflow to meet the end product requirements. Methods for solder application include dispensing or pin transfer of solder paste, or use of solder wire or preforms. Land patterns to which solder is applied shall be clean prior to solder application reflow methods.

8.3.2.2 Reflow methods

Manufacturers shall establish a reflow soldering process that is repeatable within the limits defined for the hand soldering reflow equipment (for example hot air or gas, infrared). The reflow process instructions shall be developed and maintained and shall be performed in accordance with these process instructions.

The process shall include as a minimum a reproducible time/temperature envelope that includes the drying/degassing operation (when required). Reflow methods include hot air/gas guns, solder irons, or hot bar (thermode) or laser operations.

8.3.2.3 Shielding

When manual reflow soldering is performed, appropriate shielding should be provided so that adjacent components (next to the parts being joined) are not damaged or that the solder joints of adjacent components are not reflowed again.

9 Cleanliness and residue requirements

9.1 General

When the ~~post soldering~~ cleanliness designator (see 9.2.2) specifies cleaning option C-0 (no surface to be cleaned), the soldered assembly shall meet the visual inspection requirements of 9.3 except that evidence of flux residue is permitted.

If cleaning is required ~~(as in 9.6)~~ during and after processing, parts, subassemblies, and final assemblies shall be cleaned within a time frame that permits appropriate removal of contaminants, especially flux residue.

All items cleaned shall be cleaned in a manner that will prevent detrimental thermal shock and intrusion of cleaning media into components that are not totally sealed. The assembly cleaning shall be capable of meeting the cleanliness requirements as specified herein.

The cleaning media and equipment shall be selected for their ability to remove the contaminations and shall not degrade the materials, markings or parts being cleaned.

~~9.2 Equipment and material compatibility~~

~~The cleaning media and equipment shall be selected for their ability to remove both ionic and non-ionic contamination, and shall not degrade the materials, markings, or parts being cleaned. Analysis and documentation demonstrating compliance with these requirements shall be available for review.~~

~~9.3 Pre-soldering cleaning~~

~~The cleanliness of terminals, component leads, conductors, and printed wiring surfaces shall be sufficient to ensure solderability. Cleaning shall not damage or reduce the reliability of the components, component leads, or conductors. For post-soldering cleaning option C-0 (no surfaces to be cleaned), cleanliness shall be sufficient to ensure compliance with the final assembly cleanliness requirements.~~

~~9.4 Post-soldering cleaning~~

~~9.4.1 General~~

~~When cleaning is required, flux residue shall be removed as soon as possible, preferably within 15 min, but no longer than 1 h after soldering. Some fluxes or processes may require more immediate action to facilitate adequate removal. Mechanical means such as agitation, spraying, brushing, etc., or vapour degreasing and other methods of application may be used in conjunction with the cleaning medium. The time between soldering and completion of cleaning may be extended for hand soldering operations provided interim cleaning is performed and complete cleaning is performed prior to the end of the production shift.~~

~~Terminations internal to self-sealing devices (e.g. heat shrinkable solder devices) shall be exempt from the cleaning requirements of this standard when the device encapsulates the solder connection.~~

~~9.4.2 Ultrasonic cleaning~~

~~Ultrasonic cleaning is permissible~~

~~a) on bare boards or assemblies, provided only terminals or connectors without internal electronics are present, or~~

~~b) on electronic assemblies with electrical components, provided the contractor has documentation available for review showing that the use of ultrasonics does not damage the mechanical or electrical performance of the product or components being cleaned.~~

~~9.5 Cleanliness verification~~

~~9.5.1 General~~

~~Assemblies shall meet the requirements of 9.6 for cleanliness. The following methods are to be used to assess the amount of remaining particulate or foreign matter, as well as flux residues and other ionic organic contaminants.~~

~~9.5.2 Visual inspection~~

~~When made as part of a documented process control and product improvement system, visual inspection shall be based on a statistical sample (see 13.2.3). Otherwise, 100 % visual inspection shall be used to assess the presence of foreign particulate matter as required in 9.6.2, or flux and other ionic or inorganic residues as required in 9.6.3.~~

~~9.5.3 Testing~~

~~Periodic testing of cleanliness of the assembly after final cleaning (e.g. the cleaning prior to conformal coating, encapsulation, or incorporation into the next higher assembly) shall be conducted on a random sample basis (see 13.2.3) to ensure the adequacy of the cleaning process(es), as required in 9.6.5.~~

~~If any assembly fails, the entire lot shall be recleaned and a random sample of this lot, and each lot cleaned since performing the last acceptable cleanliness test, shall be tested. The frequency of testing shall be a minimum of once each 8 h shift, unless the process control system data supports a change in frequency.~~

~~9.6 Cleanliness criteria~~

~~9.6.1 General~~

~~Cleaning of assemblies shall be performed as necessary to remove~~

~~a) particulate foreign matter as required in 9.6.2, and~~

~~b) flux residues and other ionic or organic contaminants as required in 9.6.3.~~

~~9.6.2 Particulate matter~~

~~Assemblies shall be free of dirt, lint, solder splash, dross, etc. Solder balls shall be neither loose nor degrade electrical performance characteristics. Inspection for particulate matter shall be consistent with inspection methodology defined in 13.2.2.2.~~

~~Solder balls shall not reduce the minimum design electrical spacing by more than 50 %, and shall be fixed to the board surface. Additionally, not more than 5 solder balls per 600 mm^2 shall occur.~~

~~9.6.3 Flux residues and other ionic or organic contaminants~~

~~9.6.3.1 General~~

~~The user and manufacturer shall agree to the cleaning requirements and the appropriate tests for cleanliness. In addition, the visual requirements for cleanliness shall be agreed to and specified.~~

~~It is the responsibility of the user to specify cleanliness. The user may wish to use the cleanliness designator that establishes the cleaning option and test for cleanliness in accordance with 9.6.3.2. In the absence of a specified cleanliness designator, the designator C-22 as described in the following subclauses should apply. In addition, the visual requirements for cleanliness (as in 9.6.3.3) shall be specified.~~

~~9.6.3.2 Post-soldering cleanliness designator~~

~~Where the user specifies a cleanliness designator, it shall be in the following form:~~

~~Cleanliness designator~~	~~Cleaning option~~	~~Test for cleanliness~~
~~C~~	~~9.6.4~~	~~9.6.5~~

~~A two digit (minimum) code describes the cleanliness requirements for all assemblies covered under this standard. This code begins with the letter C then a dash followed by two or more digits. The first digit represents the cleaning option described in 9.6.4 and the second and following digits indicate the requirements for cleanliness testing described in 9.6.5. (If all five cleanliness tests are required, the cleanliness designator will have a total of six digits.)~~

~~9.6.3.3 Visual requirements~~

~~Surfaces cleaned should be inspected without magnification and shall be free of visual evidence of flux residue or other contaminants. Surfaces not cleaned may have evidence of flux residues.~~

~~9.6.4 Cleaning option~~

~~The first digit of the cleanliness designator defines the cleaning option. One of the following digits is used to define the surfaces of the assembly that are to be cleaned:~~

~~0 = No surfaces to be cleaned.~~

~~1 = One side (wave solder source side) of assembly to be cleaned.~~

~~2 = Both sides of assembly to be cleaned.~~

~~9.6.5 Test for cleanliness~~

~~The second and following digits of the cleanliness designator define the requirements for cleanliness testing. The following digits may be used in any combination (not including zero):~~

~~0 = No test for cleanliness required.~~

~~1 = Test for rosin residues required (see 9.6.6).~~

~~2 = Test for ionic residues required (see 9.6.7and/or 9.6.8).~~

~~3 = Test for surface insulation resistance (see 9.6.9).~~

~~4 = Test for other surface organic contaminants (see 9.6.10).~~

~~5 = Other tests as deemed by user/manufacturer agreement.~~

~~9.6.6 Rosin residues on cleaned board assemblies~~

~~If rosin-based fluxes are used, assemblies shall be cleaned and tested in accordance with the following.~~

~~Assemblies that have been cleaned shall be tested in accordance with IEC 61189-1 and IEC 61189-3 (see Annex B), and shall comply with the following requirements for the maximum allowable level of rosin flux residues:~~

~~Level A: assemblies less than 200 µg /cm^2~~

~~Level B: assemblies less than 100 µg /cm^2~~

~~Level C: assemblies less than 40 µg /cm²~~

~~9.6.7 Ionic residues (instrument method)~~

~~Assemblies shall be tested in accordance with IEC 61189-1 and IEC 61189-3 (ionizable detection of surface contaminants (dynamic method), or ionizable detection of surface contaminants (static method), see Annex B) and shall contain less than 1,56 µg/cm² NaCl equivalent ionic or ionizable flux residue. Other methods may be used when the sensitivity of the alternative method is shown to be equal to or better than the above methods with respect to detecting ionizable surface contamination.~~

~~In comparing the sensitivity between methods, the solvent used to extract the residue, the method used to present the solvent to the assembly, and the method of detecting the residue should all be considered.~~

~~9.6.8 Ionic residues (manual method)~~

~~Assemblies shall be tested in accordance with IEC 61189-1 and IEC 61189-3 (resistivity of solvent extract, see Annex B). The surface contamination shall be less then 1,56 µg/cm² sodium chloride (NaCl) equivalent ionic or ionizable flux residue. Other acceptance values may be specified by the user for equivalent tests.~~

~~9.6.9 Surface insulation resistance (SIR)~~

~~Test specimens processed in exactly the same manner as the assemblies being produced shall be tested for the effect of the contamination on the electrical insulation resistance of printed boards under high temperature and humidity in accordance with IEC 61189-1 and IEC 61189-3 (see Annex B) using the test conditions of IEC 61189-1. The test specimens shall have a minimum resistance of 100 MΩ after soldering and/or after soldering and cleaning, depending on the flux classification. The user and manufacturer may agree upon other test specimens, test conditions, and SIR requirements.~~

~~9.6.10 Other contamination~~

~~Assemblies tested in accordance with IEC 61189-1 and IEC 61189-3 (see Annex B, surface organic contaminant detection test (in-house method)) shall not exceed the maximum acceptance level established by mutual agreement between user and manufacturer.~~

9.2 Qualified cleaning/manufacturing process

9.2.1 General

Unless otherwise specified by the user, the manufacturer shall qualify soldering and/or cleaning processes that result in acceptable levels of flux and other residues. Objective evidence shall be available for review. See J-STD-001 Appendix C for examples of objective evidence.

NOTE 1 Objective evidence can be provided by Surface-Insulation (SIR) testing of electronic assemblies following applicable standards or IPC-9202.

NOTE 2 Process ionic contamination test (PICT) data (or resistivity of solvent extract (ROSE) test data) can be used as a process control tool, but such test data alone cannot be used for prediction of assembly reliability under high-temperature/high-humidity environments.

Process ionic contamination test (PICT) data (or resistivity of solvent extract (ROSE) test data) using the historical acceptance value of 1,56 µg/cm^2 NaCl equivalence with no other objective evidence shall not be considered as acceptable objective evidence.

Unless otherwise specified by design, or by the user, the acceptability of the residue condition shall be determined at the point of the manufacturing process just prior to the application of conformal coating, or on the final assembly if conformal coating is not applied. Rework processes shall be included in the process qualification.

9.2.2 Cleaning designator

Unless otherwise specified by the user or the design authority, the manufacturer should specify a cleanliness designator that establishes the cleaning requirements and the process control tests for residues. The cleanliness designator is a 2-digit (minimum) code which describes the cleanliness requirements for all assemblies covered under this document. This code begins with letter C and then a dash followed by two or more digits.

The first digit represents the cleaning option in accordance with Table 2

Table 2 – Designation of surfaces to be cleaned

0	No surfaces are to be cleaned
1	One side (solder source side) is to be cleaned
2	Both sides of the assembly are to be cleaned

The second and following digits indicate the requirements for process control of residues in accordance with Table 3

Table 3 – Residue testing for process control

0	No test required
1	Test for rosin residues required
2	Test for ionic residues required
3	Test for surface insulation resistance as agreed between the user and the manufacturer
4	Test for surface organic contaminants as agreed between the user and the manufacturer
5	Other testing as agreed between the user and the manufacturer

In the absence of a specific cleaning designator, the designator C-22 shall apply. A cleaning designator of C-00 defines a so-called "no clean" process with no testing of residues.

9.2.3 Upper specification limit

When a manufacturing process has been defined and qualified in accordance with 9.2 and when ionic residue testing is required, ionic process specification limits shall be determined as follows.

An upper specification limit (USL), based on test data or historical data for the process, shall be established. Any other USL shall be agreed between the user and the manufacturer.

If a USL based on test data is to be used, the manufacturer shall determine a statistically based sampling plan for measuring ionic residues using resistivity of solvent extract (ROSE) testing or other methods as agreed between the user and the manufacturer.

9.3 Visual requirements

Assemblies shall be free of dirt, lint, solder splash, dross, etc. Solder balls shall not reduce the minimum design electrical spacing and shall be fixed to the board surface. Solder balls shall not degrade electrical performance characteristics.

Surfaces cleaned should be inspected without magnification and shall be free of visual evidence of flux residues or other contaminants. Surfaces not cleaned may have evidence of flux residues.

9.4 Correlation of ionic testers

If more than one ionic tester is used for judging product residue levels for the same product, a correlation study between the ionic testers shall be performed.

9.5 Non-ionic residues

All other residue requirements shall be agreed between the user and the manufacturer. The agreement should include the test method, the test parameters and the pass-fail criteria.

When rosin flux residue testing is required, assemblies shall be tested in accordance with IEC 61189-1 and IEC 61189-3 (see Annex B of this document) and shall comply with the requirements in Table 4 for the maximum allowable level of rosin flux residues.

Table 4 – Maximum acceptable rosin flux residues

Level A	200 µg/cm^2
Level B	100 µg/cm^2
Level C	40 µg/cm^2

When surface organic contamination testing is required, the test shall be performed in accordance with applicable standards and IEC 61189-3 (see Annex B of this document) and shall not exceed the maximum acceptance level agreed between the user and the manufacturer.

9.6 SIR testing

When surface insulation resistance testing (SIR) is required, test specimens processed in exactly the same manner as the assemblies being produced shall be tested for the effect of the contamination on the electrical insulation resistance of printed boards under high temperature and humidity in accordance with IEC 61189-5-502 and IEC 61189-3 (see Annex B) or another documented method agreed between user and manufacturer that determines test specimen, test conditions and pass-fail criteria and is available for review.

NOTE 1 IEC 61189-5-502 under preparation.

10 Assembly requirements

10.1 General

Boards, components and processes described and specified in Clauses 4 to 9 provide for soldered interconnections that are better than the minimum acceptance requirements of this clause. Processes and their controls should be capable of producing a product meeting or exceeding the acceptance criteria for a level C product. However, soldered connections shall meet the product level (A, B or C) acceptance requirements specified by user.

10.2 Acceptance requirements

10.2.1 Process control

The manufacturer shall either:

a) have a process control plan in accordance with 13.3; or

b) perform 100 % visual inspection to the requirements of 10.3. If defects and process indicators exceed the corrective action limits specified in 10.2.2 for their respective level of opportunities (10.2.3), the manufacturer shall initiate corrective action to reduce their occurrence. For corrective action calculations, no more than one defect characteristic (see Table 2) or process indicator shall be attributed to a particular interconnection site (for example lead-to-land, via, lead-in-hole).

If the limits specified in this document are met, it is likely that the reliability of the joint has a high possibility of meeting the assembly expectations. However, the user has the responsibility for determining true reliability requirements based on design and end product usage.

10.2.2 Corrective action limits

Corrective action shall be initiated if

a) defects listed in Table 2 exceed 0,3 % of the possibilities for their occurrence, and if
b) process indicators (see 4.4) exceed 3,0 % of the total opportunities for their occurrence.
c) As a minimum, the following general process indicator occurrences shall be monitored:
   1) markings (10.3.3);
   2) voids and blow holes (10.3.5);
   3) lead outline visibility (10.3.5);
   4) via interfacial connection wetting (10.3.6);
   5) other process indicators defined in the sectional specifications; and
   6) solder quantity.

10.2.3 Control limit determination

The total number of interconnection sites shall be used as the measure to which the percentage of defects or process indicators is applied. These calculations consider each surface mount termination, each through-hole termination, and each terminal termination as a single opportunity for determining the total number of opportunities for a given printed board assembly.

10.3 General assembly requirements

10.3.1 Assembly integrity

All products shall meet the requirements of the assembly ~~drawing~~ documentation. The electrical and mechanical integrity and the reliability of all components and assemblies shall be retained after exposure to all processes employed during manufacture and assembly (for example handling, fixing, soldering and cleaning).

10.3.2 Assembly damage

10.3.2.1 Assembly requirements

Assembly damage to electronic and mechanical devices shall not exceed the requirements given in the present document and in IEC 61191-2, IEC 61191-3, IEC 61191-4.

Printed boards shall show no evidence of burning, blistering, or delamination as referenced in IEC 62326-1. Laminate scratches shall be treated as weave exposure.

10.3.2.2 Unacceptable assembly defects

The following defects can be found in printed wiring assemblies: measles, crazing, blistering, delamination, weave exposure, haloing, edge delamination, and lifted lands or conductors.

The following conditions are causes for rejection:

a) assemblies exhibiting measling or crazing defects affecting their functionality;

b) blistering or delamination that make bridges between plated through-holes or between subsurface conductors, or which extend under surface conductors or over/under subsurface conductors.

10.3.3 Markings

Markings shall not be deliberately altered, obliterated or removed by the manufacturer unless required by the assembly~~ drawing~~ documentation. Additional markings (such as labels added during the manufacturing process) should not obscure the original supplier's markings. Where a loss of marking of the component partoccurs, it shall be recorded as a process indicator to track and determine if a supplier has a potential marking problem, and determine the degree of corrective action (for example new materials, new processes, remarking~~, etc.~~).

10.3.4 Flatness (bow and twist)

Bow and twist after soldering~~ shall~~ should not exceed~~ 0,5 % or 1,5 mm for level C surface mount; 0,75 % or 2,0 mm for level B surface mount; 1,0 % or 2,5 mm for level A surface mount;~~ 0,75 % for surface-mount and 1,5 %~~ or 2,5 mm~~ for through-hole (all levels) printed board applications. Mixed assemblies (SMT (surface mount technology), THT (through hole technology), etc.) shall meet the requirements for surface mount assemblies (see IEC 61191-2 and IEC 61189-3~~, IEC 61188-1-1~~).

10.3.5 Solder connection

10.3.5.1 Solder wetting angle

The acceptable solder connection shall indicate evidence of wetting and adherence when the solder blends with the soldered surface, forming a contact angle of 90° or less, except when the quantity of solder results in a contour that extends over the edge of the land (see Figure 1). The solder joints should have a generally smooth appearance.

~~A lead-free solder alloy composition will typically produce an appearance of surface roughness (grainy or dull) and greater wetting contact angles. These solder joints are acceptable.~~

If lead-free solder joints show a slightly rough (grainy or dull) appearance or greater wetting angles, these solder joints are still acceptable if all other criteria are fulfilled.

A smooth transition from land to connection surface or component lead shall be evident. A line of demarcation or transition zone where applied solder blends with solder coating, solder plate, or other surface material is acceptable, provided that wetting is evident. In the case of fused solder coatings, presence of the applied solder above the rim of the hole is not required if the hole wall and component lead exhibit good wetting (see Figure 2). Marks or scratches on the solder joint shall not degrade the integrity of the connection.

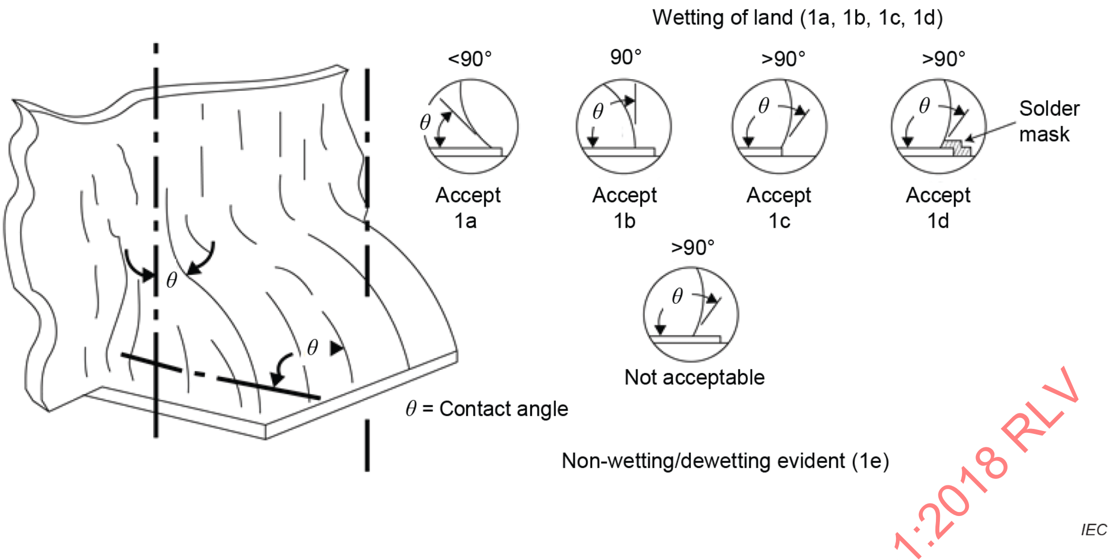

Figure 1 – Solder contact angle

10.3.5.2 Defects

The following conditions are unacceptable and shall be considered defects (see 12.1):

a) fractured or disturbed solder connections;

b) cold solder connection;

c) greater than 5 % of the solder connection (except vias) exhibiting dewet or nonwet characteristics;

d) excess solder that contacts the component body, except SO and SOT packages;

e) gold embrittlement due to insufficient gold removal (see 6.3.3); and

f) voiding by which the solder volume of the joint is decreased below the allowable minimum value.

NOTE SO and SOT packages are plastic small outline packages which can be wave soldered

10.3.5.3 Process indicators

The following conditions are acceptable, but shall be considered as process indicators and shall be documented and available for review:

a) voids and the blow holes where wetting is evident, and which do not reduce solder volume below the allowable minimum;

b) outline or lead not visible in solder joint because of excess solder.

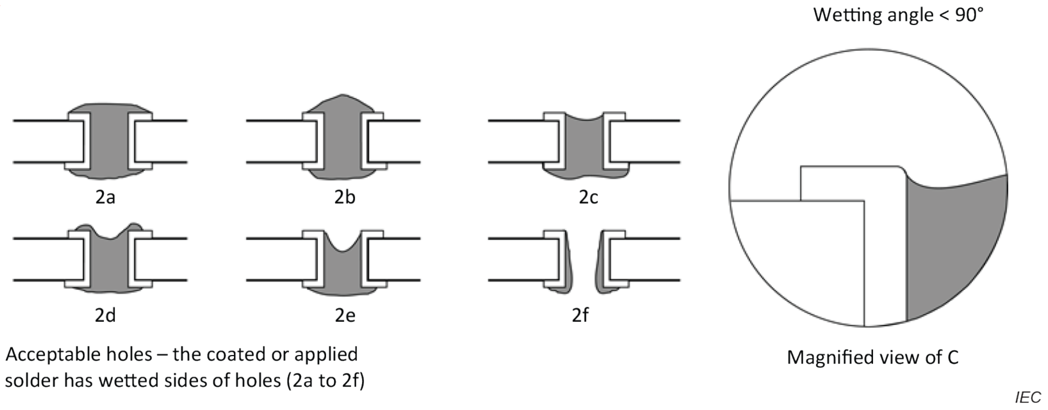

Figure 2 – Solder wetting of plated through-holes without leads

10.3.6 Interfacial connections

Unsupported holes with leads or plated through-holes, not subjected to mass soldering and used for interfacial connections need not be filled with solder. Plated through-holes not exposed to solder because of permanent or temporary maskants and used for interfacial connections need not be filled with solder. Plated through-holes without leads, including vias, after exposure to wave, dip, or drag solder processing shall meet the acceptability requirements of Figure 2. Failure to meet this requirement shall be treated as a process indicator in accordance with Clause 13. Wetting of the top-side lands by applied solder is acceptable, but not required (see Figures 2c, 2e and 2f). Plated through-hole damage due to copper dissolution is a defect (see Table 2)

11 Coating and encapsulation

~~11.1 Detail requirements~~

~~The detail requirements for coating and encapsulation procedures are defined in the following subclauses.~~

11.1 Conformal coating

11.1.1 Coating instructions

The material specification and supplier's instructions, as applicable, shall be followed. When curing conditions (temperature, time, IR intensity, etc.) vary from the supplier's recommended instructions, the alternate conditions shall be documented and available for review. The material shall be used within the time period specified (both shelf life and pot life), or used within the time period indicated by a documented system that the manufacturer (assembler) has established to mark and control age-dated material.

11.1.2 Application

11.1.2.1 Application details

A coating shall be continuous in all areas designated for coverage on the assembly ~~drawing~~ documentation. The coating fillets should be kept to a minimum. Conformal coating material shall not contain aggressive solvents. Conformal coating or method of application of conformal coating shall not damage or reduce the reliability of components. When used, masking materials shall have no harmful or degrading effect on the printed boards and shall be removable without leaving a contaminant residue. Dimensioning specified for masked areas shall not be decreased in length, width, or diameter by more than 0,8 mm by the application of conformal coating.

11.1.2.2 Adjustable components

The adjustable portion of adjustable components, as well as electrical and mechanical mating surfaces such as probe points, screw threads, bearing surfaces (for example card guides) shall be left uncoated as specified on the assembly ~~drawing~~ documentation.

11.1.2.3 Conformal coating on connectors

Mating connector surfaces of printed wiring assemblies shall not be conformal coated. The conformal coating specified on the assembly ~~drawing~~ documentation shall, however, provide a seal around the perimeter of all connector/board interface areas. Press-fit pins and connectors installed after conformal coating is applied shall be exempt from the seal requirement.

11.1.2.4 Conformal coating on brackets

The mating (contact) surface of brackets or other mounting devices shall not be coated with conformal coating unless specifically required by the assembly ~~drawing~~ documentation. However, the perimeter of the junction between these devices and the board and all attaching hardware shall be coated.

11.1.2.5 Conformal coating on flexible leads

Components that are electrically connected to the assembly by flexible leads (e.g. gull wing) shall as a minimum have the junction of the leads with the components and the assembly coated.

11.1.2.6 Perimeter coating

Unless otherwise specified on the approved assembly ~~drawing~~ documentation, the outer perimeter of assemblies shall not be increased in total thickness by more than 1,0 mm as a result of conformal coating. The outer perimeter is defined as the area on each side of the board at a distance of not more than 6,0 mm inwards from the outer edge (see Figure 3).

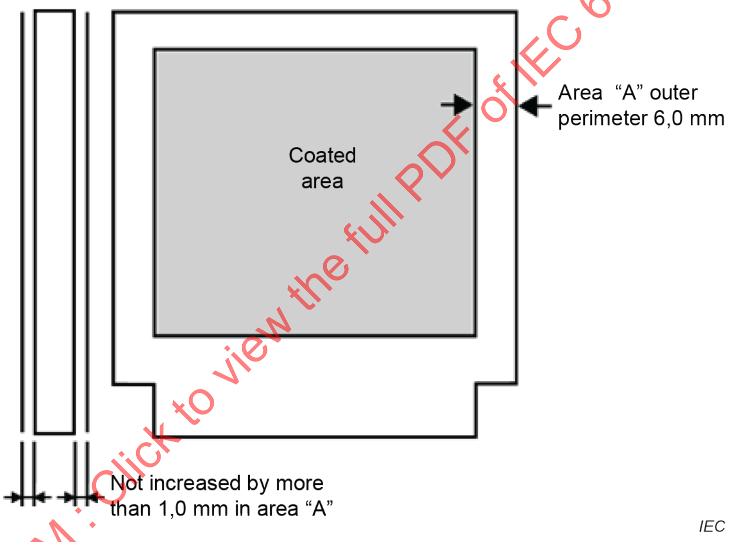

Figure 3 – Coating conditions

11.1.2.7 Edge coating

Unless otherwise specified on the approved assembly ~~drawing~~ documentation, the dimensions of the assemblies shall not be increased in length or width by more than 0,8 mm on each edge, giving a total of 1,5 mm by application of conformal coating.

11.1.3 Performance requirements

~~11.2.3.1 Coating requirements~~

~~The detailed requirements for applied coatings are defined in the following subclauses.~~

11.1.3.1 Thickness

The thickness of the conformal coating shall be as follows for the type specified:

a) types ER (epoxy), UR (urethane) and AR (acrylic): 0,03 mm to 0,13 mm;
b) type SR (silicone): 0,05 mm to 0,21 mm;
c) type XY (paraxylene): 0,01 mm to 0,05 mm;

d) type FC (fluoropolymer) ~ 0,01 µm

The thickness shall be measured on a flat, unencumbered, cured surface of the printed wiring assembly, or on a coupon which has been processed with the assembly. Coupons may be of the same type of material as the printed board or may be of a non-porous material such as metal or glass. As an alternative, a wet film thickness measurement may be used to establish the coating thickness, provided there is documentation that correlates the wet and dry film thicknesses.

11.1.3.2 Coating coverage

Conformal coating shall be of the type specified on the assembly ~~drawing~~ documentation, and shall:

a) be completely cured and homogeneous,

b) cover only those areas specified on the assembly ~~drawing~~ documentation,

c) be free of blisters or breaks which affect the assembly operations or sealing properties of the conformal coating,

d) be free of voids, bubbles, or foreign material which expose component conductors, printed wiring conductors (including ground planes) or other conductors, and/or violate design electrical spacing; and

e) contain no measling, peeling or wrinkle (non-adherent areas).

11.1.4 Rework of conformal coating

Procedures that describe the removal and replacement of conformal coating shall be documented and available for review.

11.1.5 Conformal coating inspection

Visual inspection of conformal coating may be performed without magnification. Inspection for conformal coating coverage may be performed under an ultraviolet (UV) light source when using conformal coating material containing a UV tracer. Magnification from 2× to 4× may be used for refereeing purposes.

11.2 Encapsulation

11.2.1 Encapsulation instructions

The material specification and the supplier's instructions, as applicable, shall be followed. The material shall be used within the time period specified (both shelf life and pot life) or used within the time period indicated by a documented system the manufacturer has established to mark and control age-dated material.

11.2.2 Application

11.2.2.1 Quality details

The encapsulant materials shall be continuous in all areas designated for coverage on the assembly ~~drawing~~ documentation. When used, masking material shall have no deleterious effect on the printed boards and shall be removable without contaminant residue.

11.2.2.2 Encapsulant-free surfaces

All portions of the assembly not designated to receive encapsulant material shall be free of any encapsulant material.

11.2.3 Performance requirements

The applied encapsulant shall be completely cured, homogeneous, and cover only those areas specified on the assembly ~~drawing~~ documentation.

The encapsulant shall be free of bubbles, blisters or breaks that affect the printed wiring assembly operation or sealing properties of the encapsulant material. There shall be no visible cracks, crazes, mealing, peeling and/or wrinkles in the encapsulant material.

11.2.4 Rework of encapsulant material

Procedures that describe the removal and replacement of encapsulant material shall be documented and available for review (i.e., within the manufacturers' ISO 9001 documentation or equivalent written procedures).

11.2.5 Encapsulant inspection

Visual inspection of encapsulation may be performed with magnification.

12 Rework and repair

~~12.1 General~~

~~The detailed requirements for rework and repair are defined in the following subclauses.~~

12.1 Rework of unsatisfactorily soldered electrical and electronic assemblies

Rework of unsatisfactory electrical and electronic assemblies consists of addressing the defects listed in Table 5 and the non-conforming characteristics shown in the defect tables of the relevant sectional specification (i.e. IEC 61191-2, IEC 61191-3, IEC 61191-4) as appropriate.

Rework of unsatisfactory solder connections and other defects shall not be performed until the discrepancies have been documented. Documentation requirements shall be defined in the process control plan and may be on a sampling or audit basis. This data shall be used to provide an indication as to the possible causes and to determine if corrective action, in accordance with 10.2~~, 10.2.2 and 10.2.3~~, is required. When rework is performed, each reworked and/or reflowed connection shall be inspected to the requirements of 10.3.5 in accordance with 13.2.

Table 5 – Electrical and electronic assembly defects

Defect No.	Defect description	Requirement subclause	Remarks
01	Violations of the assembly ~~drawing~~ documentation requirements a) missing component b) wrong component c) reversed component	4.1.2	
02	Damage to components beyond procurement specification or the relevant sectional specification allowance a) component damage (cracks) b) moisture cracking (pop-corning)	IEC 61191-2 IEC 61191-3 IEC 61191-4	
03	Damage to the assembly or printed board a) measling or crazing that affects functionality b) blisters/delamination that bridges between PTHs/conductors c) excessive departure from flatness	10.3.2 ~~10.3.2.2~~ 10.3.4	
04	Plated-through hole interconnections with and without leads a) non-wetted hole or lead b) unsatisfactory hole fill c) fractured solder joint d) cold or disturbed solder connection	10.3.5 ~~10.3.5.2~~ 10.3.6	
05	Violation of minimum design electrical spacing a) conductive part body or wire movement/misalignment b) solder balling c) solder bridging d) solder spikes e) solder webs/skins	~~IEC 61191-2~~ ~~9.6.2~~ ~~IEC 61191-2~~ ~~IEC 61191-2~~ ~~IEC 61191-2~~ IEC 61191-2 6.3.1	
06	Improper solder connections (lead, termination or land) a) dewetting or non-wetting b) solder leaching c) insufficient solder d) solder wicking e) insufficient reflow f) incomplete joint (open circuit) g) excessive solder h) excessive solder voids i) adhesive encroachment j) gold embrittlement	10.3.5.3 10.3.5.2	
07	Damaged marking on the board a) altered marking b) obliterated marking	10.3.3	
08	Failure to comply with stated cleaning or cleanliness testing	~~9.6~~ ~~9.6.3.2~~ 9.3. 9.5	
09	Failure to comply with conformal coating requirements	~~11.2.3.3~~ 11.1.3.2	
10	Copper dissolution	10.3.6	

12.2 Repair

Repairs are changes to an unacceptable end product to make it acceptable in accordance with the original functional requirements. The repair method shall be determined by agreement between the manufacturer and the user.

12.3 Post rework/repair cleaning

After rework or repair, assemblies shall be cleaned as necessary by a process meeting the requirements of subclauses 9.3 and 9.5.

13 Product quality assurance

13.1 System requirements

General requirements for the establishment and maintenance of an effective quality assurance programme incorporating process control systems (see 4.5) are given in the following subclauses.

13.2 Inspection methodology

13.2.1 Verification inspection

Verification inspection shall consist of the following:

a) surveillance of the operation to determine that practices, methods, procedures and a written inspection plan are being properly applied;

b) inspection to measure the quality of the product.

13.2.2 Visual inspection

13.2.2.1 Visual sampling

Inspection prior to soldering (for example between component placement and soldering) or in between other process steps (for example solder paste application and component placement) should only take place on a sampling basis when analyzing the assembly process to identify solder joint defect causes. After soldering, the assembly shall be evaluated in accordance with the established process control plan (see 13.3) or by 100 % visual inspection (see 10.2).

13.2.2.2 Magnification aids and lighting

The tolerance for magnification aid is 15 % of the selected magnification power (i.e. +15 % or a range of 30 % centred at the selected magnification power). Magnification aids and lighting (see 4.11.4) used for inspection shall be commensurate with the size of the item being processed. The magnification used to inspect solder connections shall be based on the minimum width of the land used for the device being inspected. Magnification aids should be in accordance with Table 6.

Table 6 – Magnification requirements

Land widths and land diameters mm	Inspection	Referee
>1,0	~~2×~~ 1,5× to 3×	4×
>0,5 to ≤1,0	~~4×~~ 3× to 7,5×	10×
≥0,25 to ≤0,5	7,5× to 10×	20×
<0,25	20×	40×

Referee conditions shall only be used to verify a product rejected at the inspection magnification. For assemblies with mixed land widths, the greater magnification may be used for the entire assembly.

13.2.2.3 Partially visible or hidden solder connections

Partially visible or hidden solder connections are acceptable provided that the following conditions are met:

a) the visible portion, if any, of the connection on either side of the PTH solder connection (or the visible portion of the SMD connection) is acceptable;

b) the design does not restrict solder flow to any connection element on the primary side (for example pin in hole component) of the assembly;

c) process controls are maintained in a manner assuring repeatability of assembly techniques.

13.2.3 Sampling inspection

Use of sample-based inspection shall be predicated on meeting one of the following:

a) when done as part of a documented process control system as in 13.3; or

b) as part of the user-approved product assurance programme.

13.3 Process control

13.3.1 System details

Process control shall be a documented system, available for review, that meets the intent of ISO 9001, IEC 61193-3, or user-approved system. The primary goal of process control is to continually reduce variation in the processes, products, or services to provide product or processes meeting or exceeding customer requirements. The process control system shall include the following elements as a minimum:

a) training shall be provided to personnel with assigned responsibilities in the development, implementation, and use of process control and statistical methods that are commensurate with their responsibilities;

b) quantitative methodologies and evidence shall be maintained to demonstrate that the process is capable and in control;

c) improvement strategies to define initial process control limits and methodologies leading to a reduction in the occurrence of process indicators in order to achieve continuous process improvement;

d) criteria for switching to sample-based inspection shall be defined. When processes exceed control limits, or demonstrate an adverse trend or run, the criteria for reversion to higher levels of inspection (up to 100 %) shall also be defined;

e) when defect(s) are identified in the lot sample, the entire lot shall be 100 % inspected for the occurrence(s) of the defect(s) observed;

f) a system shall be put in place to initiate corrective action for the occurrence of process indicators, out-of-control process(es), and/or discrepant assemblies;

g) a documented audit plan is defined to monitor process characteristics and/or output at a prescribed frequency.

Objective evidence of process control may be in the form of control charts or other tools and techniques of statistical process control derived from application of process parameter and/or product parameter data. This data can be acquired from sources such as inspection, non-destructive evaluation, machine operation data, or periodic testing of production samples. For attribute data, the key is understanding and controlling parameters in the process that influence the response in question and establishing controls at that point. Attribute data, measured in parts of 10^{-6} nonconforming product, can generally be correlated to a process capability index (Cpk) generated using variable data (see Annex B).

Available resources (e.g. ISO 9001, IEC 61193-1~~, etc.~~) should be used in establishing the process control plan and defining the characteristics and criteria.

13.3.2 Defect reduction

Continuous process improvement techniques shall be implemented to reduce the occurrence of defects and process indicators. When processes vary beyond established process control limits, corrective action shall be taken to prevent recurrence. When corrective action is ineffective within 30 days of implementation, the problem shall be referred to plant management for resolution.

13.3.3 Variance reduction

All variances from the requirements of this document shall be minimized with the goal of elimination (where economically practical) through process corrective action. Failure to implement process corrective action and/or the use of continually ineffective corrective action shall be grounds for disapproval of the process and associated documentation.

14 Other requirements

14.1 Health and safety

The use of some materials referenced in this document can be hazardous. In such cases, a risk assembly shall be undertaken prior to the use of any hazardous material. All safety precautions shall be taken as outlined in the data provided with the material. Adequate ventilation shall be provided in all areas where solder chemicals are used or fumes are generated. To provide for the personnel's safety, areas, equipment and procedures shall meet all applicable occupational (workplace), safety and health regulations.

14.2 Special manufacturing requirements

14.2.1 Manufacture of devices incorporating magnetic windings

This document is limited in its applicability to the manufacturing processes associated with the mounting of internal electronic elements and the soldering of the internal connections of transformers, motors, and similar devices. Unless a user has a specific need for the controls provided by this document, it shall not be imposed relative to the manufacture of the internal elements of these devices. The external interconnect points (i.e. terminals, pins, etc.) shall meet the solderability requirements of this document.

14.2.2 High-frequency applications

High-frequency applications (for example radiowaves and microwaves) may require part spacings, mounting systems, and assembly designs that vary from the requirements stated herein. When high-frequency design requirements prevent compliance with the design and part-mounting requirements contained herein, manufacturers may use alternative designs.

14.2.3 High-voltage or high-power applications

High-power applications, such as high-voltage power supplies, may require part spacings, mounting systems, and assembly designs that vary from the requirements stated herein. When high-voltage design requirements prevent compliance with the design and part-mounting requirements contained herein, manufacturers may use alternative designs.

14.3 Guidance on requirement flowdown

Manufacturers are responsible for delivering fully compliant hardware according to the requirements of this document and the applicable assembly ~~drawing~~ documentation. Where a part is adequately defined by a basic part specification, then the requirements of this document should be imposed on the manufacture of that part only when absolutely necessary to meet end-item requirements. When it is unclear where flowdown should stop, it is the responsibility of the manufacturer to work with the user to determine this point.

15 Ordering data

Procurement documents should follow the requirements with the inclusion of the following referenced items:

a) the title, number and date of this document;

b) whether or not to conduct preproduction testing;

c) the quantity of preproduction samples required, if any;

d) the disposition of preproduction samples, when applicable;

e) the specific type of evaluation to be used and the requirements for the quality control system;

f) the detailed requirements for operator certification, if any;

g) level of product (see 4.3);

h) cleanliness designator, cleaning option, cleanliness test (see 9.2); and

i) ESD packaging requirements.

Annex A
(normative)

Requirements for soldering tools and equipment

A.1 Requirements for tools and equipment

The following requirements for tools and equipment shall be imposed if process controls are not sufficiently in place to ensure compliance with 4.12.

A.2 Abrasives

Knives, emery cloth, sandpaper, sandblasting, braid, steel wool, and other abrasives shall not be used on surfaces to be soldered.

A.3 Benchtop and hand-soldering systems

The selection criteria of benchtop and hand-soldering systems shall include the following:

a) soldering systems shall be selected for their capacity to heat the connection area rapidly and maintain sufficient soldering temperature range at the connection throughout the soldering operation;

b) temperature-controlled soldering ~~equipment~~ systems at rest shall be controlled within ±5 °C of the idle tip temperature. Constant output (steady output) tools in compliance with items a), d), e) and f) may also be used;

c) operator-selected or rated temperatures of soldering systems at idle/standby shall be within ±15 °C of actual measured tip temperature;

d) resistance between the tip of soldering systems and the workstation common point ground shall not exceed 5 Ω. The heated element and tips shall be measured when at their normal operating temperature. ~~Current-limited~~ General soldering ~~equipment~~ systems ~~manufactured to CECC 100015~~ shall have internal tip-to-ground resistance of 1 Ω to 5 Ω ~~inclusive~~. If required, current-limited soldering systems with internal tip-to-ground resistance of ≥1 MΩ may be used;

e) tip-to-ground voltage leakage shall not exceed 2 mV RMS (Z_{in} = 100 kΩ);

f) tip transient voltages generated by the soldering ~~equipment~~ systems shall not exceed 2 V peak
(Z_{in} ≥100 kΩ);

g) tool holders shall be of a type appropriate for the hand piece or tool used. The holder shall not apply excessive physical stress or heat-sinking to heating elements, and shall protect the personnel from burns;

h) sponges for cleaning of soldering irons tips and reflow soldering tool surfaces shall be manufactured from materials which are not detrimental to solderability or which could contaminate the soldering tool surfaces;

i) soldering guns with the transformer incorporated into the hand piece shall not be used;

j) solder pots shall maintain the solder temperature within ±5°C of the selected temperature. Solder pots shall be grounded. Resistance between the molten solder and the workstation common point ground shall not exceed 5 Ω;

k) soldering systems shall be used separately to avoid nonconformity, mixing or contamination of soldering tips by various solders.

The appropriate requirements of this clause shall also apply to non-conventional benchtop soldering equipment including equipment that uses conductive, convective, parallel gap resistance, shorted bar resistance, hot gas, infrared, laser-powered devices, or thermal transfer soldering techniques.

Tools used shall be maintained so that no detrimental damage results from their use, and they shall be kept clean and free of dirt, grease, flux, oil or other foreign matter during use. The heat source shall not cause damage to the printed board or components.

A.4 Soldering iron holders

Soldering iron holders shall be of a type appropriate for the soldering iron used. The holder shall leave the soldering iron heating element and tip unsupported without applying excessive physical stress or heat sinking, and it shall protect the personnel from burns.

A.5 Wiping pads

Sponges and pads for wipe cleaning of soldering iron tips and reflow soldering tool surfaces shall be kept free of contaminants that are detrimental to solderability or that would contaminate the soldering tool surfaces.

A.6 Soldering guns

Soldering guns with the transformer incorporated into the hand piece shall not be used.

A.7 Solder pots

Solder pots shall maintain the solder temperature within ±5 °C of the selected temperature. Solder pots shall be grounded.

A.8 Process control

Documented process controls shall be in place to ensure compliance with Annex B. All equipment shall be operated in accordance with the manufacturers' recommendations and calibrated, where necessary, to maintain manufacturers' specifications. Process control documents shall be available to production workers and for user review. Equipment grounding, protection and temperature control testing should be performed when qualifying equipment for purchase, inspection of new or repaired equipment, and when indicated as part of the process-control programme.

~~Annex B~~
~~(normative)~~

~~Qualification of fluxes~~

~~Testing shall be done as follows:~~

~~a) a minimum of 24 assemblies representative of the assemblies being soldered and incorporating a surface insulation resistance (SIR) test pattern as described in IEC 61189-1 and IEC 61189-3 shall be tested in accordance with 9.6.9;~~

~~b) the assemblies shall be fabricated using the proposed solder flux, soldering process and cleaning system. The conformal coating selected for the design shall be applied and cured in accordance with production requirements. If a manufacturer employs multiple conformal coatings, a sample set of at least 24 printed wiring assemblies shall be tested for each coating to be used. If a manufacturer will use the flux on uncoated assemblies, a sample set of at least 24 uncoated assemblies shall be tested;~~

~~c) these assemblies shall be tested in accordance with 9.6.3.3 and comply with the requirements of 9.6.9.~~

Annex B
(normative)

Quality assessment

B.1 Process control (PC)

Process control (PC), when coupled with statistical analysis (SPC), uses systematic mathematical techniques to analyze a process or its outputs. The purpose of these analyses is to take appropriate actions to achieve and maintain a state of statistical control, and to assess and improve process capability. The primary goal of PC is to reduce variation in processes, products or services continually. This is in order to provide a product meeting or exceeding real or implied customer requirements.

Implementation of PC or SPC shall be in accordance with ISO 9001 or a user-approved documented system.

Depending on the progress made in implementing PC on a particular product, an individual supplier may demonstrate compliance to the specification with any of the following:

a) quality conformance evaluations;

b) end-product control and capability as defined in the PC plan;

c) in-process control and capability correlated to customer requirements as defined in the process control plan; and

d) process-parameter control and capability correlated to customer requirements as defined in the PC plan.

An individual supplier may choose to use a combination of the four assurance techniques listed above to prove compliance. For example, a documented control plan ~~may~~ can indicate that a product with 15 characteristics ~~may~~ can meet the specifications ~~by~~ of quality conformance evaluations ~~on~~ for two characteristics, in-process product evaluations ~~on~~ for five characteristics, and process parameter control ~~on~~ for five characteristics. The remaining three characteristics meet the specification ~~by~~ through a combination of in-process control and quality conformance evaluations.

Evidence of compliance to the specification at the level of PC implementation claimed in the control plan is auditable by the customer or by an appointed third party.

Requirements are dynamic in nature and are based on what is accepted in the worldwide market. Requirements may be stated as the reduction of variation around a target value, as opposed to just meeting the specification, drawing, etc.

B.2 Reduction of quality conformance testing

The primary goal of process control is not the reduction of quality conformance testing. The primary goal of process control is to continually reduce variation in processes, product and services. This is in order to provide products meeting or exceeding real or implied customer requirements. However, as a result of the understanding and the control of highly capable process and product parameters, quality conformance testing may be reduced to an audit function in an orderly fashion in accordance with the following:

a) a documented PC plan according to the requirements of ISO 9001 or a user-approved plan is in place and up to date;

b) the process or processes that affect the characteristic have been identified, have been included in the control plan, and have been documented as being in a state of statistical control. Product characteristics resulting from this plan have demonstrated a capability above a minimum specified value. For variables data, this capability is often defined as a Cpk above 1,33. (For attribute data, the key is understanding and controlling parameters in the process that influence the response in question and establishing controls at that point.) The criteria for reduced testing then becomes a stable process whose critical correlated parameters exhibit a state of statistical control, and which produce an acceptable level of nonconforming products as agreed to between the supplier and the customer. For example, attribute data resulting in a nonconformance ratio of 33×10^{-6} would approximate a Cpk of 1,33 for variables data;

c) a corrective action discipline is in place for discoveries of, and reaction to, out-of-control and discrepant points;

d) the measurement system used has been validated in accordance with the implementation plan, and correlated to the criticality of the measurement requirements. A desirable minimum for variable data is a 4 to 1 gauge for repeatability and reproducibility;

e) a documented audit plan is defined to monitor process output. The plan sets out corrective action in the event that an audit discovers a discrepancy;

f) current quality evaluation techniques have not exhibited any nonconformance for a period of time or for a number of lots, as agreed to between the customer and the supplier.

B.3 Audit plan

The audit plan should be designed to confirm that the PC plan is being implemented correctly and to confirm that implementation of the plan achieves continuing improvement. The audit plan that is put in place after replacement of quality conformance testing shall include provisions for action to be taken when out-of-specification conditions are found.

The action plan shall include the following items:

a) a complete description of the problem;
b) a complete description of the root cause for the failure;
c) a containment and short-term corrective action to preclude continuing production or shipment of nonconforming products;
d) a description of the planned long-term corrective action that will eliminate future recurrence of non-conformance.

Demonstrating capability with attribute data requires a great deal of data, particularly as the process improves into the defective level measured in parts of 10^{-6}. Process capability (Cp) and Cpk statistics generally are used to describe variable characteristics and, without transformations, do not lend themselves to attribute data.

Bibliography

IEC and ISO references

~~IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*~~

~~IEC 60068-2-58:2004, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*~~

IEC 61188-5-1~~:2002~~, *Printed boards and printed board assemblies – Design and use – Part 5-1: Attachment (land/joint) considerations – Generic requirements*

IEC 61188-5-2~~:2003~~, *Printed boards and printed board assemblies – Design and use of printed boards and printed board assemblies – Part 5-2: Attachment (land/joint) considerations – Discrete components*

IEC 61188-5-3~~:2007~~, *Printed boards and printed board assemblies – Design and use – Part 5-3: Attachment (land/joint) considerations – Components with gull-wing leads on two sides*

IEC 61188-5-4~~:2007~~, *Printed boards and printed board assemblies – Design and use – Part 5-4: – Attachment (land/joint) considerations – Components with J leads on two sides*

IEC 61188-5-5~~:2007~~, *Printed boards and printed board assemblies – Design and use – Part 5-5: – Attachment (land/joint) considerations – Components with gull-wing leads on four sides*

IEC 61188-5-6~~:2003~~, *Printed boards and printed board assemblies – Design and use – Part 5-6: Attachment (land/joint) considerations – Chip carriers with J leads on four sides*

IEC 61188-7~~:2009~~, *Printed boards and printed board assemblies – Design and use – Part 7: Electronic component zero orientation for CAD library construction*

IEC 61189-2~~:2006~~, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 2: Test methods for materials for interconnection structures*

IEC 61189-5-502, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-502: General test methods for materials and assemblies – SIR testing of assemblies*[1]

IEC 61190-1-2~~:2007~~, *Attachment materials for electronic assembly – Part 1-2: Requirements for soldering pastes for high-quality interconnects in electronics assembly*

IEC 61193-1~~:2001~~, *Quality assessment systems – Part 1: Registration and analysis of defects on printed board assemblies*

IEC 61193-3, *Quality assessment systems – Part 3: Selection and use of sampling plans for printed boards and laminate end-products and in-process auditing*

IEC 62326-1~~:2002~~, *Printed boards – Part 1: Generic specification*

---

[1] Under preparation.

IEC 62326-4~~:1996~~, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification*

~~IEC 62326-4-1:1996, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification – Section 1: Capability detail specification – Performance levels A, B and C*~~

IEC/PAS 62326-7-1~~:2007~~, *Performance guide for single- and double-sided flexible printed wiring boards*

~~ISO 9001:2008, *Quality management systems – Requirements*~~

Other references

IPC-TM-650, *Test Methods Manual*

2.3.25	*Detection and measurement of ionizable surface contaminants by resistivity of solvent extract*
2.3.25.1	*Ionic Cleanliness Testing of Bare PWBs*
2.3.27	*Cleanliness test – residual rosin*
2.3.38	*Surface organic contamination detection test*
2.4.22	*Bow and twist (percentage)*
2.6.3.3	*Surface insulation resistance, fluxes*

~~IPC-PC-90~~ IPC-9191, *General Requirements for Implementation of Statistical Process Control*

IPC-9202, *Material and Process Characterization/Qualification Test Protocol for Assessing Electrochemical Performance*

IPC-OI-645, *Standard for Visual Optical Inspection Aids*

IPC-SM-817, *General Requirements for Dielectric Surface Mounting Adhesives*

J-STD-001, *Requirements for Soldered Electrical and Electronic Assemblies*

J-STD-002, *Solderability Tests for Component Leads, Terminals, Lugs Terminals and Wires*

J-STD-003, *Solderability Tests for Printed Boards*

J-STD-004, *Requirements for Soldering Fluxes*

J-STD-005, *General Requirements and Test Methods for Electronic Grade Solder Paste*

J-STD-006, *General Requirements and Test Methods for Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Solder Applications*

~~J-STD-020, *General Requirements and Test Methods for Handling Moisture Sensitive Components*~~

J-STD-020, *Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices*

J-STD-033, *Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices*

IEC 61191-1

Edition 3.0 2018-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Printed board assemblies –
Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies

Ensembles de cartes imprimées –
Partie 1: Spécification générique – Exigences relatives aux ensembles électriques et électroniques brasés utilisant les techniques de montage en surface et associées

IEC 61191-1:2018-09(en-fr)

CONTENTS

FOREWORD 6

1 Scope 8

2 Normative references 8

3 Terms and definitions 9

4 General requirements 10

- 4.1 Order of precedence 10
  - 4.1.1 General remark 10
  - 4.1.2 Conflict 10
  - 4.1.3 Conformance documentation 10
- 4.2 Interpretation of requirements 11
- 4.3 Classification 11
- 4.4 Defects and process indicators 11
- 4.5 Process control requirements 12
- 4.6 Requirements flowdown 12
- 4.7 Physical designs 12
  - 4.7.1 New designs 12
  - 4.7.2 Existing designs 12
- 4.8 Visual aids 12
- 4.9 Proficiency of personnel 13
  - 4.9.1 Design proficiency 13
  - 4.9.2 Manufacturing proficiency 13
- 4.10 Electrostatic discharge (ESD) 13
- 4.11 Facilities 13
  - 4.11.1 General 13
  - 4.11.2 Environmental controls 13
  - 4.11.3 Temperature and humidity 13
  - 4.11.4 Lighting 14
  - 4.11.5 Field conditions 14
  - 4.11.6 Clean rooms 14
- 4.12 Assembly tools and equipment 14
  - 4.12.1 General 14
  - 4.12.2 Process control 14

5 Requirements of materials 14

- 5.1 Overview 14
- 5.2 Solder 14
- 5.3 Flux 14
- 5.4 Solder paste 15
- 5.5 Preform solder 15
- 5.6 Adhesives 15
- 5.7 Cleaning agents 15
  - 5.7.1 General 15
  - 5.7.2 Cleaning agents selection 15
- 5.8 Polymeric coatings 16
  - 5.8.1 Solder resists and localized maskants 16
  - 5.8.2 Conformal coating and encapsulants 16
  - 5.8.3 Spacers (permanent and temporary) 16

5.9 Chemical strippers 16
5.10 Cleaning Agents 16
5.11 Heat shrinkable soldering devices 16
6 Components and printed board requirements 16
6.1 General 16
6.2 Solderability 17
6.2.1 Parts solderability 17
6.2.2 Reconditioning 17
6.2.3 Solderability testing of ceramic boards 17
6.3 Solderability maintenance 17
6.3.1 General 17
6.3.2 Preconditioning 17
6.3.3 Gold embrittlement of solder joints 17
6.3.4 Tinning of non-solderable parts 18
6.4 Solder purity maintenance 18
6.5 Lead preparation 19
6.5.1 General 19
6.5.2 Lead forming 19
6.5.3 Lead-forming limits 19
7 Assembly process requirements 20
7.1 Overview 20
7.2 Cleanliness 20
7.3 Part markings and reference designations 20
7.4 Solder connection contours 20
7.5 Moisture traps 20
7.6 Thermal dissipation 20
8 Assembly soldering requirements 20
8.1 General 20
8.1.1 Soldering process 20
8.1.2 Machine maintenance 21
8.1.3 Handling of parts 21
8.1.4 Preheating 21
8.1.5 Carriers 21
8.1.6 Hold down of surface mount leads 21
8.1.7 Heat application 21
8.1.8 Cooling 21
8.2 Reflow soldering 21
8.2.1 Requirements 21
8.2.2 Process development for reflow soldering 22
8.2.3 Flux application 22
8.2.4 Solder application 22
8.3 Manual/hand soldering 23
8.3.1 Non-reflow manual soldering 23
8.3.2 Reflow manual soldering 23
9 Cleanliness and residue requirements 24
9.1 General 24
9.2 Qualified cleaning/manufacturing process 24
9.2.1 General 24

9.2.2 Cleaning designator 25
9.2.3 Upper specification limit 25
9.3 Visual requirements 25
9.4 Correlation of ionic testers....26
9.5 Non-ionic residues 26
9.6 SIR testing 26
10 Assembly requirements....26
10.1 General....26
10.2 Acceptance requirements 26
10.2.1 Process control 26
10.2.2 Corrective action limits 27
10.2.3 Control limit determination....27
10.3 General assembly requirements 27
10.3.1 Assembly integrity 27
10.3.2 Assembly damage....27
10.3.3 Markings....28
10.3.4 Flatness (bow and twist)....28
10.3.5 Solder connection 28
10.3.6 Interfacial connections 30
11 Coating and encapsulation....30
11.1 Conformal coating 30
11.1.1 Coating instructions 30
11.1.2 Application....30
11.1.3 Performance requirements 31
11.1.4 Rework of conformal coating 32
11.1.5 Conformal coating inspection 32
11.2 Encapsulation 32
11.2.1 Encapsulation instructions....32
11.2.2 Application....32
11.2.3 Performance requirements 33
11.2.4 Rework of encapsulant material....33
11.2.5 Encapsulant inspection 33
12 Rework and repair 33
12.1 Rework of unsatisfactorily soldered electrical and electronic assemblies 33
12.2 Repair....34
12.3 Post rework/repair cleaning 34
13 Product quality assurance....35
13.1 System requirements....35
13.2 Inspection methodology....35
13.2.1 Verification inspection 35
13.2.2 Visual inspection....35
13.2.3 Sampling inspection 36
13.3 Process control 36
13.3.1 System details 36
13.3.2 Defect reduction....36
13.3.3 Variance reduction 37
14 Other requirements....37
14.1 Health and safety....37

14.2 Special manufacturing requirements 37
14.2.1 Manufacture of devices incorporating magnetic windings 37
14.2.2 High-frequency applications 37
14.2.3 High-voltage or high-power applications 37
14.3 Guidance on requirement flowdown 37
15 Ordering data 37
Annex A (normative) Requirements for soldering tools and equipment 39
A.1 Requirements for tools and equipment 39
A.2 Abrasives 39
A.3 Benchtop and hand-soldering systems 39
A.4 Soldering iron holders 40
A.5 Wiping pads 40
A.6 Soldering guns 40
A.7 Solder pots 40
A.8 Process control 40
Annex B (normative) Quality assessment 41
B.1 Process control (PC) 41
B.2 Reduction of quality conformance testing 41
B.3 Audit plan 42
Bibliography 43

Figure 1 – Solder contact angle 29
Figure 2 – Solder wetting of plated through-holes without leads 30
Figure 3 – Coating conditions 31

Table 1 – Solder contamination limits; maximum contaminant limit (percentage by weight) 19
Table 2 – Designation of surfaces to be cleaned 25
Table 3 – Residue testing for process control 25
Table 4 – Maximum acceptable rosin flux residues 26
Table 5 – Electrical and electronic assembly defects 34
Table 6 – Magnification requirements 35

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

PRINTED BOARD ASSEMBLIES –

Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IECNORM.COM : Click to view the full PDF of IEC 61191-1:2018 RLV

International Standard IEC 61191-1 has been prepared by IEC technical committee 91: Electronics assembly technology.

This third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the requirements have been updated to be compliant with the acceptance criteria in IPC-A-610F;

b) the term "assembly drawing" has been changed to "assembly documentation" throughout;

c) references to IEC standards have been corrected;

d) Clause 9 was completely rewritten;

e) Annex B was removed because there are already procedures for circuit board assemblies.

The text of this International Standard is based on the following documents:

CDV	Report on voting
91/1481/CDV	91/1510/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 61191 series, published under the general title *Printed board assemblies*, can be found in the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

PRINTED BOARD ASSEMBLIES –

Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies

1 Scope

This part of IEC 61191 prescribes requirements for materials, methods and verification criteria for producing quality soldered interconnections and assemblies using surface mount and related assembly technologies. This part of IEC 61191 also includes recommendations for good manufacturing processes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IEC 60721-3-1, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Storage*

IEC 61189-1, *Test methods for electrical materials, interconnection structures and assemblies – Part 1: General test methods and methodology*

IEC 61189-3, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 3: Test methods for interconnection structures (printed boards)*

IEC 61190-1-1, *Attachment materials for electronic assembly – Part 1-1: Requirements for soldering fluxes for high-quality interconnections in electronics assembly*

IEC 61190-1-3, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications*

IEC 61191-2, *Printed board assemblies – Part 2: Sectional specification – Requirements for surface mount soldered assemblies*

IEC 61191-3, *Printed board assemblies – Part 3: Sectional specification – Requirements for through-hole mount soldered assemblies*

IEC 61191-4, *Printed board assemblies – Part 4: Sectional specification – Requirements for terminal soldered assemblies*

IEC 61249-8-8, *Materials for interconnection structures – Part 8: Sectional specification set for non-conductive films and coatings – Section 8: Temporary polymer coatings*

IEC 61340-5-1, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

IEC/TR 61340-5-2, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*

IEC 61760-2, *Surface mounting technology – Part 2: Transportation and storage conditions of surface mounting devices (SMD) – Application guide*

ISO 9001:2008, *Quality management systems – Requirements*

IPC-A-610*, Acceptability of Electronic Assemblies*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
bow
deviation from flatness of a board characterized by a roughly cylindrical or spherical curvature so that, if the product is rectangular, its four corners are in the same plane

3.2
manufacturer
assembler
individual or company responsible for the procurement of materials and components, as well as all assembly process and verification operations necessary to ensure full compliance of assemblies with this document

3.3
objective evidence
documentation agreed to between the user and the manufacturer

Note 1 to entry: The documentation can be in the form of a hard copy, computer data, computer algorithms, video or other media.

3.4
process indicator
detectable anomaly, other than a defect, that is reflective of material, equipment, personnel, process and/or workmanship variation

3.5
proficiency
capability to perform tasks in accordance with the requirements and verification procedures detailed in this document

3.6
shadowing
phenomenon where parts create a shadow of leads, lands, or other parts, which obstruct heating at reflow soldering or spreading solder at flow soldering

3.7
supplier
individual or company responsible for assuring, to the manufacturer (assembler), full compliance of components and base materials with the requirements and verification procedures of this document

Note 1 to entry: Components include electronic, electromechanical, mechanical components, printed boards, etc.

Note 2 to entry: Base materials include solder, flux, cleaning agents, etc.

3.8
twist
deviation of a rectangular sheet, panel or printed board that occurs parallel to a diagonal across its surface, so that one of the corners of the sheet is not in the plane that contains the other three corners

3.9
user
procuring authority
individual, company or agency responsible for the procurement of electrical/electronic hardware, and having the authority to define the class of equipment and any variation or restrictions to the requirements of this document

EXAMPLE The originator/custodian of the contract detailing these requirements.

4 General requirements

4.1 Order of precedence

4.1.1 General remark

In the event of a conflict between the text of this standard and the applicable standard cited herein, the text of this document shall take precedence. However, nothing in this document supersedes applicable laws and regulations.

4.1.2 Conflict

In the event of conflict between the requirements of this document and the applicable assembly documentation, the applicable user approved assembly documentation shall govern. In the event of conflict between the requirements of this document and assembly documentation that has not been approved, the differences shall be referred to the designated user activity for approval. Upon such approval, the provisions shall be documented (by official revision notice or equivalent) on the assembly documentation, which shall then govern.

4.1.3 Conformance documentation

Where this document requires documentary evidence to support conformance claims, each record shall be retained and be available for inspection for a minimum of two years from the date of the recorded occurrence (see ISO 9001).

4.2 Interpretation of requirements

The introduction of product classification according to the levels and their end use (see 4.3) permits the user to differentiate the performance requirements. When the user elects to specify compliance with the mandatory requirements of this document, the following conditions apply:

- unless otherwise specified by the user, the word "shall" signifies that the requirements are mandatory,
- deviations from any "shall" requirement requires written acceptance by the user, for example via assembly documentation, specification or contract provision. The word “should” is used to indicate a recommendation or guidance statement. The word “may” indicates an optional situation. Both “should” and “may” express non-mandatory situations. “Will” is used to express a declaration of purpose.

4.3 Classification

This document recognizes that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product levels have been established to reflect differences in producibility, functional performance requirements, and verification (inspection/test) frequency.

It should be recognized that there may be overlaps of equipment between levels. The user (see 3.5) of the assemblies is responsible for determining the level to which the product belongs. The contract shall specify the level required and indicate any exceptions or additional requirements to the parameters, where appropriate.

Level A: General electronics products

Includes consumer products, some computer and computer peripherals, and hardware suitable for applications where the major requirement is function of the completed assembly.

Level B: Dedicated service electronics products

Includes communications equipment, sophisticated business machines, and instruments where high performance and extended life is required, and for which uninterrupted service is desired but not mandatory. Typically, the end-use environment would not cause failures.

Level C: High-performance electronics products

Includes all equipment where continued performance or performance-on-demand is mandatory. Equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment shall function when required, such as life support systems and other critical systems.

IPC-A-610 shall be used as workmanship standard.

NOTE Level A corresponds to class 1 in IPC-A-610

Level B corresponds to class 2 in IPC-A-610

Level C corresponds to class 3 in IPC-A-610

4.4 Defects and process indicators

Table 5 lists the defects that are unacceptable and require attention (for example, rework, repair). The manufacturer is responsible for identifying other areas of risk and treating those additional concerns as additions to Table 5. Such items should be documented on the assembly documentation. Other than the unacceptable defects listed in Table 5, anomalies and variances from "shall" requirements are considered as process indicators, and shall be monitored when their occurrence is observed. The disposition of process indicators is not required.

Workmanship requirements shall match the defined level of classification according to 4.3.

IPC-A-610 shall be used as workmanship standard.

4.5 Process control requirements

This document requires the use of process control methodologies in the planning implementation and evaluation of the manufacturing processes used to produce soldered electrical and electronic assemblies. The philosophy, implementation strategies, tools and techniques may be applied in different sequences depending on the specific company, operation, or variable under consideration, to relate process control and capability to end-product requirements. The manufacturer, subject to agreement by the user, may be exempt from performing specific quality conformance evaluations and inspections, detailed in this document, provided objective evidence of a comprehensive and current continuous improvement plan is available (see 13.3).

4.6 Requirements flowdown

The applicable requirements of this document shall be imposed by each manufacturer or supplier on all applicable subcontracts and purchase orders. The manufacturer or supplier shall not impose or allow any variation from these requirements on subcontracts or purchase orders other than those that have been approved by the user.

Unless otherwise specified, the requirements of this document are not imposed on the procurement of off-the-shelf (catalogue) assemblies or subassemblies (see 14.3). However, the manufacturer of these items may comply as deemed appropriate.

4.7 Physical designs

4.7.1 New designs

The printed board layout and mechanical and thermal structure of the electrical/electronic assembly should, where relevant, be based on an appropriate design standard (for example IEC 61188-5-1) or as approved by the user. When a manufacturer has objective evidence that a revised layout will produce good end product quality that fulfills the requirements of this document, the user and manufacturer should agree on the changes, and the layout should be modified appropriately.

4.7.2 Existing designs

The requirements of this document should not constitute the sole cause for redesign of a currently approved design. However, when existing electronic or electrical designs undergo changes that have an impact on hardware configuration, the design of the latter shall be reviewed and user-approved changes made that allow for maximum practical compliance. Any manufacturer-proposed design changes shall be approved by the user; however, even though the proposed changes result in compliance with this document and the manufacture of quality end products, the user is under no obligation to accept the proposed redesign.

4.8 Visual aids

Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this document. The written requirements take precedence.

4.9 Proficiency of personnel

4.9.1 Design proficiency

The design facility shall have documentation which demonstrates that formal design training for all technical workforce personnel has been accomplished. Training shall be given irrespective of whether such personnel have direct responsibility for product electronic/electrical design (see ISO 9001).

4.9.2 Manufacturing proficiency

Prior to commencing work, all instructors, operators and inspection personnel shall be proficient in the tasks to be performed. Objective evidence of that proficiency shall be maintained and be available for review. Objective evidence shall include records of training for the applicable job functions being performed, testing to the requirements of this document, and results of periodic reviews of proficiency (see ISO 9001 and IPC-A-610).

4.10 Electrostatic discharge (ESD)

The ESD control programme shall be in accordance with IEC 61340-5-1 and IEC/TR 61340-5-2. Documented procedures, electrostatic discharge control for the protection of ESD sensitive electrical and electronic parts, components, assemblies and equipment shall be maintained during, but not limited to:

a) receipt and test of incoming items;

b) board, component and parts storage and kitting;

c) manufacturing and rework;

d) inspection and test cycles;

e) storage and shipping of completed product;

f) transport and installation.

Procedures for analysis of failures arising from ESD shall be documented and be available for review by an authorized inspectorate.

4.11 Facilities

4.11.1 General

Cleanliness and ambient environments in all work areas shall be maintained at levels that prevent contamination or deterioration of soldering tools, materials and surfaces to be soldered. Eating, drinking and use of tobacco products or illegal drugs shall be prohibited in the work area.

4.11.2 Environmental controls

The soldering facility should be enclosed, temperature and humidity controlled, and maintained at a positive pressure.

4.11.3 Temperature and humidity

When relative humidity decreases to a level of 30 % or lower, the manufacturer shall verify that electrostatic discharge control is adequate, and that sufficient moisture is present for flux performance and solder paste applications. For operator comfort and solderability maintenance, the temperature should be maintained between 18 °C and 30 °C and the relative humidity should not exceed 70 %. For process control, the need for more restrictive temperature and humidity limits should be evaluated.

4.11.4 Lighting

Illumination at the working surface of manual soldering and inspection stations shall be 1 000 lm/m^2 minimum.

4.11.5 Field conditions

In field operations, where the controlled environment conditions required by this document cannot be achieved effectively, special precautions shall be taken to maximize the quality of solder connections and minimize the effects of the uncontrolled environment on the operation being performed on the hardware.

4.11.6 Clean rooms

The assembly of electronics may necessitate the use of clean rooms to ensure compliance with the end production performance requirements of this document. If required, the class of clean room shall be agreed upon between the user and the manufacturer.

4.12 Assembly tools and equipment

4.12.1 General

The manufacturer is responsible for the selection and maintenance of tools and equipment used in the preparation and soldering of components and/or conductors. Tools used shall be selected and maintained so that no damage results from their use. Tools and equipment should be clean prior to use and be kept clean and free of dirt, grease, flux, oil and other foreign matter during use. Soldering irons, equipment, and systems shall be chosen and employed to provide temperature control and isolation from electrical overstress EOS or ESD (see 4.10).

4.12.2 Process control

If suitable process controls are not in place to ensure compliance with 4.12 and the intent of Annex A, the relevant detailed requirements of Annex A shall be mandatory. Assembly tools and equipment shall be used in accordance with a documented process that is available for user review. Assembly tools and equipment shall demonstrate process parameters as described in the process documentation.

5 Requirements of materials

5.1 Overview

Materials used in the soldering processes stipulated in this document shall be as specified hereinafter. Since the materials and processes specified can be incompatible in some combinations, the manufacturer shall be responsible for selecting the combination of materials and processes that will produce acceptable products.

5.2 Solder

Solder alloys conforming to IEC 61190-1-3 shall be used. Any alloy that provides the service life, performance, reliability or regulatory requirements of the product may be used if all other conditions of this document are met and agreed upon by user and manufacturer.

5.3 Flux

Flux shall be tested and classified in accordance with IEC 61190-1-1 or equivalent, into one of the following three types:

L = low or no flux/flux residue activity;

M = moderate flux/flux residue activity;

H = high flux/flux residue activity.

Types L or M flux shall be used for assembly soldering. For applications where the flux residue will not be removed (no-clean), the use of an L flux meeting the requirements of 9.6.9 without cleaning (C00) is recommended (see 9.6.3.2).

Inorganic acid fluxes and type H fluxes may be used for tinning of terminals, solid wire and sealed components. Inorganic acid fluxes may not be used for assembly soldering. Type H fluxes may be used for soldering of terminals, solid wire and sealed components when performed as part of an integrated fluxing, soldering, cleaning and cleanliness test system and either of the following conditions is met:

a) usage is approved by the user;
b) data demonstrating compliance with the testing requirements of Annex B is available for review.

When type H flux is used, cleaning is mandatory.

When liquid flux is used in conjunction with other fluxes, it shall be chemically compatible with the other fluxes and materials with which it will be used. The flux of cored solder shall be in accordance with this subclause. The percentage of flux in cored solder is optional.

5.4 Solder paste

Solder paste, solder powder and flux constituents shall meet the requirements of 5.2 and 5.3 and should be evaluated in accordance with IEC 61190-1-2 to meet the assembly process requirements.

5.5 Preform solder

Preform solder shall meet all applicable requirements in 5.2 and 5.3.

5.6 Adhesives

Adhesive materials used for attachment of components shall be suitable for the application and compatible with the assembly.

5.7 Cleaning agents

5.7.1 General

Cleaning agents used for the removal of grease, oil, wax, dirt, flux and other debris shall be selected for their ability to remove flux residue, other residues and particulate contaminants. The cleaning agents should not have aggressive chemicals and shall not degrade the materials or the parts being cleaned. The cleaning process shall permit the assembly to meet the cleaning requirements of 9.3.

5.7.2 Cleaning agents selection

Cleaning agents and mixtures of cleaning agents shall conform to all appropriate specifications and references. Mixtures of cleaning agents may be used provided they are suitably stabilized or inhibited.

The use of chlorinated solvents is not permitted. Water, water/alcohol or terpenes are to be considered as first choice for cleaning applications. Any cleaning solvent shall comply with applicable health, safety and environmental regulations.

5.8 Polymeric coatings

5.8.1 Solder resists and localized maskants

Polymer solder resist coatings and temporary maskants in accordance with IEC 61249-8-8 shall be of a material that:

a) does not degrade solderability or the substrate material or printed wiring;
b) precludes solder flow to the masked area;
c) is compatible, if left in place, with printed board base material, conductive material, the intended fluxes, adhesive and subsequently applied conformal coatings;
d) can, if temporary, be readily removed without post-removal residual contamination harmful to the integrity of the printed board conformal coating, or assembly.

5.8.2 Conformal coating and encapsulants

Conformal coating requirements for assemblies, including the type of coating (i.e. the material), shall be as specified on the approved assembly documentation. If edge coating is specified on the assembly documentation, it shall conform to 11.1.2.7. Encapsulants shall be suitable for the application and shall be compatible with the assembly.

5.8.3 Spacers (permanent and temporary)

Materials used as mechanical stand-offs shall withstand soldering processes and should permit inspection of the solder joints (see 13.2.2.3). This requirement includes spacers that should withstand temperatures generated due to self-heating of components. Location, configuration and material shall be specified in the appropriate documentation.

5.9 Chemical strippers

Chemical solutions, pastes and creams used to strip solid wires shall not cause degradation to the wire.

5.10 Cleaning Agents

The cleaning agents should not have aggressive chemicals and shall not degrade the materials or the parts being cleaned. In addition, wires shall be neutralized and cleaned of contaminants in accordance with the suppliers' recommended instructions, and shall be solderable in accordance with 6.2.

5.11 Heat shrinkable soldering devices

Heat shrinkable soldering devices shall be self-sealing and shall encapsulate the solder connection. Braided shield terminations shall be in accordance with detailed manufacturers' work instructions that have been prepared to reflect the requirements documented on an approved assembly documentation.

6 Components and printed board requirements

6.1 General

Electronic/mechanical components and printed boards shall conform to the requirements of the procurement document; ensuring conformance shall be the responsibility of the assembly manufacturer. Components and printed boards selected for assembly shall be compatible with all materials and processes used to manufacture the assembly.

NOTE For further information, see IEC 62326-1, IEC 62326-4, IEC 62326-4-1 and IEC/PAS 62326-7-1.

6.2 Solderability

6.2.1 Parts solderability

Solderability of parts shall be the responsibility of the supplier and shall meet the requirements specified and agreed to by the manufacturer. Electronic/mechanical components and wires shall meet solderability requirements when tested in accordance with IEC 60068-2-20, IEC 60068-2-58 or equivalent; printed boards shall meet the requirements when tested in accordance with IEC 61189-3 or equivalent.

Prior to acceptance of parts for storage or use, the manufacturer shall ensure that the parts to be soldered have been solderability tested in accordance with a sampling plan and conform to the requirements of the applicable solderability specification. The user should specify the required solderability specification. Storage conditions shall comply with class 1K2 of IEC 60721-3-1 and IEC 61760-2.

6.2.2 Reconditioning

When tinning and inspection is performed as part of the assembly process, that tinning operation can be used in lieu of solderability testing (see 6.3).

6.2.3 Solderability testing of ceramic boards

Metallic elements of ceramic printed boards shall be tested for solderability as specified in IEC 61189-3, or by using an equivalent method.

6.3 Solderability maintenance

6.3.1 General

The manufacturer shall ensure that all components, leads, wiring, terminals, and printed boards which have met the requirements of 6.2 are solderable at the start of hand and/or machine soldering operations. The manufacturer shall establish procedures to minimize solderability degradation.

6.3.2 Preconditioning

Component leads, terminations, and terminals may be preconditioned (e.g. hot solder dipped) to provide solderability maintenance.

6.3.3 Gold embrittlement of solder joints

6.3.3.1 General

To minimize the impact of embrittlement of solder from gold-plated items (e.g. component leads, printed board lands), the total volume of gold in any solder joint shall not exceed 1,4 % of the volume (i.e., 3 % by weight) of solder present.

If there is documented objective evidence, available for review, that there are no gold-related solder embrittlement issues, or other metallic-surface finish solder-joint integrity problems associated with the soldering process being used, the following requirements may be eliminated.

6.3.3.2 Gold on component lead terminations

The manufacturer shall demonstrate compliance with the presoldering requirement:

a) all gold-plated leads/terminations and terminals have either been pre-tinned or the gold has been otherwise removed from surfaces to be soldered, and/or

b) the quantity of any residual gold present prior to soldering will not cause the limits given in 6.3.3 to be exceeded.

6.3.3.3 Tinning of leads/terminations

Tinning of leads/terminations shall not adversely affect the components. A double-tinning process or dynamic solder wave should be used for effective gold removal.

The gold-removal process may be eliminated for components to be soldered using dip, wave, or drag soldering processes provided that:

a) sufficient gold thickness exists to meet the solderability requirements in 6.2;
b) sufficient time, temperature and solder volume exist during the soldering process to enable the requirements of 6.3.3 to be met.

6.3.3.4 Gold on printed board lands

The volume of gold deposited on any printed board land intended for soldering components or terminals shall not cause the limits given in 6.3.3 to be violated.

6.3.4 Tinning of non-solderable parts

Component leads, terminations and printed boards not meeting the designated solderability requirements shall be reworked by hot solder dip tinning or other suitable methods prior to soldering. The reworked parts shall conform to the requirements of 6.2, except for steam ageing. Tinned areas of wires shall not conceal the wire strand(s) with solder. Wicking of solder under wire insulation shall be minimized. When required, heat sinks shall be applied to leads of heat-sensitive parts during the tinning operation.

6.4 Solder purity maintenance

Solder used for preconditioning gold removal, tinning of parts, and machine soldering shall be analyzed, replaced or replenished at a frequency to ensure compliance with the limits specified in Table 1. The frequency of analysis should be determined on the basis of historical data or monthly analyses. If contamination exceeds the limits of Table 1, intervals between the analyses, replacement or replenishment shall be shortened. Records containing the results of all analyses and solder bath usage (for example, total time in use, amount of replacement solder required, or area throughput) shall be maintained for each process system (see 4.1.3).

Table 1 – Solder contamination limits; maximum contaminant limit (percentage by weight)

Contaminant	Preconditioning maximum contaminant weight percentage limit SnPb alloys	Assembly Maximum Contaminant Weight Percentage Limit SnPb alloys	Preconditioning and assembly maximum contaminant weight percentage limit SACXXX lead-free alloys
Copper	0,750[a]	0,300	Note[b]
Gold	0,500	0,200	0,200
Cadmium	0,010	0,005	0,005
Zinc	0,008	0,005	0,005
Aluminum	0,008	0,006	0,006
Antimony	0,500	0,500	0,200
Iron	0,020	0,020	0,020
Arsenic	0,030	0,030	0,030
Bismuth	0,250	0,250	0,250
Silver	0,750	0,100	4,000
Nickel	0,020	0,010	0,050
Palladium	0,004	0,004	0,004
Lead	N/A	N/A	0,100

The tin content of the solder bath shall be within ±1 % of nominal for the solder specified and tested at the same frequency as tested for copper/gold contamination. The balance of bath shall be lead or the items listed above.

The total of copper, gold, cadmium, zinc and aluminum contaminants shall not exceed 0,4 % for assembly soldering.

NOTE When these metals are compositions of the solder alloy applied to the process, these are not considered to be contaminants.

[a] When tinning fine-pitch leaded devices, the copper ratio should not exceed 0,300 %.

[b] A maximum copper limit of 1,1 % may be specified as agreed between the user and the supplier. Printed circuit assemblies that are characterized as thick and thermally demanding may potentially have plated through-hole fill and/or solder joint defects due to the impact of copper on solder flow characteristics.

6.5 Lead preparation

6.5.1 General

The detailed requirements for lead forming and preparation are described in the following subclauses.

6.5.2 Lead forming

The lead forming process shall not damage connections internal to components. The preferred methods of lead forming given in the manufacturer's specification shall be used. In addition, component bodies, leads and lead seals shall not be degraded below the basic component specification requirements.

6.5.3 Lead-forming limits

Whether leads are formed manually or by machine or die, components shall not be mounted if the component lead has unwanted nicks or deformation in diameter or width exceeding 10 % of the lead.

Exposed core metal is acceptable if the defect does not affect more than 5 % of the solderable surface area of the lead. Occurrence of exposed basis metal in the formed area of the lead shall be treated as a process indicator.

7 Assembly process requirements

7.1 Overview

Subclauses 7.2 to 7.6 deal with the requirements for the mounting of terminals, mechanical and electronic components, and wires to printed boards or other packaging and interconnecting structures. On assemblies using mixed component mounting technology, through-hole components should be mounted on one side of the printed board. Surface-mounted components may be mounted on either or both sides of the assembly.

When design restrictions mandate mounting components incapable of withstanding soldering temperatures incident to a particular process, such components shall be mounted and soldered to the assembly as a separate operation. In an assembly sequence where certain components are mounted and soldered followed by additional mounting and soldering, the appropriate steps shall be taken regarding cleaning of flux residues. If applicable, assemblies shall be cleaned after each soldering operation so that subsequent placement and soldering operations are not impaired by contamination (see Clause 9).

7.2 Cleanliness

The cleanliness of terminals, component leads, conductors, and printed wiring surfaces shall be sufficient to ensure solderability and compatibility with subsequent processes. Cleaning shall not damage the components, component leads, conductors or markings.

7.3 Part markings and reference designations

Part markings and reference designations shall be legible and components shall be mounted in such a manner that markings are visible.

7.4 Solder connection contours

Designs that utilize special solder connection contours as a part of a coefficient of thermal expansion (CTE) mismatch compensation system shall be identified on the approved assembly documentation. The mounting technique shall be capable of performing with a solder connection that meets the requirements of 10.3.

7.5 Moisture traps

Within the constraints imposed by component and part design, parts and components shall be mounted to preclude the formation of moisture traps.

7.6 Thermal dissipation

When heat dissipation is required by the assembly, the material compatibility requirements of Clause 5 shall be followed.

8 Assembly soldering requirements

8.1 General

8.1.1 Soldering process

Soldering processes, as specified herein, shall not result in damage to the components or assemblies.

8.1.2 Machine maintenance

Machines used in the soldering process shall be maintained to assure capability and efficiency commensurate with design parameters established by the original equipment manufacturer.

Maintenance procedures and schedules shall be documented in order to provide reproducible processing.

8.1.3 Handling of parts

Parts shall be handled in a manner to preclude damage to terminations and to avoid the need for subsequent lead straightening operations. Once parts are mounted on printed boards, the assembly prior to soldering shall be handled, transported (for example by hand or conveyor) and processed in a manner to preclude movement that would detrimentally affect the formation of acceptable solder connections. After soldering operations have been performed, the assembly shall be sufficiently cooled so that the solder is solidified prior to further handling to prevent hot cracking of the solder.

8.1.4 Preheating

Assemblies should be preheated to minimize the presence of volatile solvents prior to soldering, to reduce the temperature differences across the board, to reduce thermal shock to boards and components, to improve solder flow, and to reduce the molten solder dwell time. The preheat temperature exposure shall not degrade printed boards, components, or soldering performance.

8.1.5 Carriers

Carriers used for the transport of printed boards through the assembly line shall be of such material, design, and configuration that they will not impair solderability or cause board, part or component degradation or electrostatic damage (ESD) to components.

8.1.6 Hold down of surface mount leads

Short, stiff or thick surface-mounted device leads shall not be held down under stress (for example by probes) during solder solidification so that the resulting initial stresses decrease reliability. The resistance reflow system (e.g. parallel gap, shorted bar, thermal transfer) should not deflect the leads more than twice the lead thickness. For short or thick leads, the deflection should be less than twice the lead thickness.

8.1.7 Heat application

The elements to be soldered shall be sufficiently heated to cause complete melting of the solder and wetting of the surface being soldered.

8.1.8 Cooling

The connection shall not be subjected to detrimental movement or detrimental stress at any time during the solidification of the solder. Controlled cooling may be used with documented processes.

8.2 Reflow soldering

8.2.1 Requirements

The detailed requirements for reflow soldering operations are defined subclauses 8.2.2 to 8.2.4. Methods for reflowing solder for attachment of surface-mounted devices include, but are not limited to, infrared, vapour phase, convection (hot air/gas), laser, thermode (hot bar) or conduction. These should provide:

a) the capability to apply controlled pre-heat to printed wiring assemblies;

b) the thermal capacity to raise and maintain the soldering temperatures for the range of component thermal masses and solder joint sizes to within ±5 °C of their selected temperature profile, throughout the span of the required continuous soldering production run;

c) within the constraints of thermal shock limitation requirements, to heat rapidly the surfaces to be joined and to cool them thereafter;

d) to minimize the effects of shadowing and colour on individual component-heating rates.

8.2.2 Process development for reflow soldering

Manufacturers shall establish and maintain a reflow soldering process that is repeatable within limits defined for the process equipment. A reflow soldering process instruction shall also be developed and maintained. The manufacturer shall perform the reflow soldering operations in accordance with these process instructions. The process shall include, as a minimum, a reproducible time/temperature envelope including the drying/degassing operation (when required), preheating operation (when required), solder reflow operation, and a cooling operation. These steps may be part of an integral or in-line system or may be accomplished by a series of separate operations. If the temperature/time profile is adjusted for a different printed wiring assembly, or another assembly variation, the setting to be used shall be documented.

8.2.3 Flux application

Flux, when used, shall be applied prior to formation of the final solder connection. Flux may be a constituent of the solder paste or preform solder. Any flux meeting the requirements of 5.3 may be used provided that

a) the flux or combination of fluxes does not damage parts,

b) the subsequent cleaning processes (if required) shall be sufficient to comply with the cleanliness requirements in Clause 9 and not be detrimental to the product.

8.2.4 Solder application

8.2.4.1 Workmanship

Enough solder shall be applied to components or boards or both to ensure that sufficient quantity is in place during reflow to meet the workmanship requirements.

8.2.4.2 Solder paste application

Methods for applying solder paste on surface-mount land pattern areas include, but are not limited to, screen or stencil printing, dispensing, or pin transfer. Solder paste shall be handled in accordance with the material supplier's recommendation to ensure proper performance. Re-use or mixing of solder paste exposed for excessive periods (for example 1 h to 24 h depending on the material) with fresh paste should be avoided.

8.2.4.3 Solid solder deposition (SSD)

Surface-mount land patterns can be coated with a defined amount of solder during the printed board's manufacturing process.

Different methods of solder application are permissible, for example:

a) plating of SnPb; it shall not be applied to lead-free soldering;

b) screen or stencil printing of solder paste followed by a reflow solder process. This process can be used with or without a flattening operation of the reflowed solder pads;

c) application of molten solder;

d) application of solder particles in an adherent flux (solid solder deposit technology).

The characteristics of the solid solder deposit on land patterns are the following:

e) the applied solder has a plated or molten intermetallic bond to the surface mounting device (SMD) land pattern;
f) the applied thickness of the solder is sufficient for a reliable reflow solder joint;
g) the solder is applied with sufficient precision to the SMD land pattern;
h) the flatness of deposited solder shall be suitable for the applicable component, for example fine-pitch devices require better flatness than most other components.

The amount of the solder shall be specified.

8.3 Manual/hand soldering

8.3.1 Non-reflow manual soldering

8.3.1.1 Flux application

If used, liquid flux shall be applied to the surfaces to be joined, prior to the application of heat. The use of excess flux should be avoided. When cored solder is used, it shall be placed in a position that allows the flux to flow and cover the connection elements as the solder melts. When an external liquid flux is used in conjunction with flux cored solders, the fluxes shall be compatible.

8.3.1.2 Solder application

A well-tinned tip (see 4.12) shall be applied to the joint and the solder introduced at the junction of the tip and the connection for maximum heat transfer. After applying heat and achieving heat transfer, the solder should be applied to the joint and not the soldering iron tip. Solder is supplied to a surface of the joint that is located to the left of the heating position. The method of application should be such that no solder is deposited on the body of component. The solder and the soldering iron tip shall be quickly pulled apart from the joint metal. Solder shall only be applied to one side of a plated through-hole. The temperature of the soldering tip shall not exceed the specific working temperature. The application of heat should be within the restricted temperature and time specified. Heat may be applied to both sides of the plated through-hole. Some hand-soldering applications may require preheating to prevent damage to components.

8.3.1.3 Heat sinks

When hand soldering is being carried out close to the body of heat-sensitive devices, a heat sink should be used between the soldering iron tip and the component body as necessary to restrict heat flow into the component.

8.3.1.4 Solder wicking

Limited solder wicking during soldering of wire is permissible. Solder wicking shall not extend to a portion of the wire that is required to remain flexible.

8.3.2 Reflow manual soldering

8.3.2.1 Solder applications

Enough solder shall be applied to components, or boards, or both to ensure that sufficient quantity is in place during reflow to meet the end product requirements. Methods for solder application include dispensing or pin transfer of solder paste, or use of solder wire or preforms. Land patterns to which solder is applied shall be clean prior to solder application reflow methods.

8.3.2.2 Reflow methods

Manufacturers shall establish a reflow soldering process that is repeatable within the limits defined for the hand soldering reflow equipment (for example hot air or gas, infrared). The reflow process instructions shall be developed and maintained and shall be performed in accordance with these process instructions.

The process shall include as a minimum a reproducible time/temperature envelope that includes the drying/degassing operation (when required). Reflow methods include hot air/gas guns, solder irons, or hot bar (thermode) or laser operations.

8.3.2.3 Shielding

When manual reflow soldering is performed, appropriate shielding should be provided so that adjacent components (next to the parts being joined) are not damaged or that the solder joints of adjacent components are not reflowed again.

9 Cleanliness and residue requirements

9.1 General

When the cleanliness designator (see 9.2.2) specifies cleaning option C-0 (no surface to be cleaned), the soldered assembly shall meet the visual inspection requirements of 9.3 except that evidence of flux residue is permitted.

If cleaning is required during and after processing, parts, subassemblies, and final assemblies shall be cleaned within a time frame that permits appropriate removal of contaminants, especially flux residue.

All items cleaned shall be cleaned in a manner that will prevent detrimental thermal shock and intrusion of cleaning media into components that are not totally sealed. The assembly cleaning shall be capable of meeting the cleanliness requirements as specified herein.

The cleaning media and equipment shall be selected for their ability to remove the contaminations and shall not degrade the materials, markings or parts being cleaned.

9.2 Qualified cleaning/manufacturing process

9.2.1 General

Unless otherwise specified by the user, the manufacturer shall qualify soldering and/or cleaning processes that result in acceptable levels of flux and other residues. Objective evidence shall be available for review. See J-STD-001 Appendix C for examples of objective evidence.

NOTE 1 Objective evidence can be provided by Surface-Insulation (SIR) testing of electronic assemblies following applicable standards or IPC-9202.

NOTE 2 Process ionic contamination test (PICT) data (or resistivity of solvent extract (ROSE) test data) can be used as a process control tool, but such test data alone cannot be used for prediction of assembly reliability under high-temperature/high-humidity environments.

Process ionic contamination test (PICT) data (or resistivity of solvent extract (ROSE) test data) using the historical acceptance value of 1,56 µg/cm^2 NaCl equivalence with no other objective evidence shall not be considered as acceptable objective evidence.

Unless otherwise specified by design, or by the user, the acceptability of the residue condition shall be determined at the point of the manufacturing process just prior to the application of conformal coating, or on the final assembly if conformal coating is not applied. Rework processes shall be included in the process qualification.

9.2.2 Cleaning designator

Unless otherwise specified by the user or the design authority, the manufacturer should specify a cleanliness designator that establishes the cleaning requirements and the process control tests for residues. The cleanliness designator is a 2-digit (minimum) code which describes the cleanliness requirements for all assemblies covered under this document. This code begins with letter C and then a dash followed by two or more digits.

The first digit represents the cleaning option in accordance with Table 2

Table 2 – Designation of surfaces to be cleaned

0	No surfaces are to be cleaned
1	One side (solder source side) is to be cleaned
2	Both sides of the assembly are to be cleaned

The second and following digits indicate the requirements for process control of residues in accordance with Table 3

Table 3 – Residue testing for process control

0	No test required
1	Test for rosin residues required
2	Test for ionic residues required
3	Test for surface insulation resistance as agreed between the user and the manufacturer
4	Test for surface organic contaminants as agreed between the user and the manufacturer
5	Other testing as agreed between the user and the manufacturer

In the absence of a specific cleaning designator, the designator C-22 shall apply. A cleaning designator of C-00 defines a so-called "no clean" process with no testing of residues.

9.2.3 Upper specification limit

When a manufacturing process has been defined and qualified in accordance with 9.2 and when ionic residue testing is required, ionic process specification limits shall be determined as follows.

An upper specification limit (USL), based on test data or historical data for the process, shall be established. Any other USL shall be agreed between the user and the manufacturer.

If a USL based on test data is to be used, the manufacturer shall determine a statistically based sampling plan for measuring ionic residues using resistivity of solvent extract (ROSE) testing or other methods as agreed between the user and the manufacturer.

9.3 Visual requirements

Assemblies shall be free of dirt, lint, solder splash, dross, etc. Solder balls shall not reduce the minimum design electrical spacing and shall be fixed to the board surface. Solder balls shall not degrade electrical performance characteristics.

Surfaces cleaned should be inspected without magnification and shall be free of visual evidence of flux residues or other contaminants. Surfaces not cleaned may have evidence of flux residues.

9.4 Correlation of ionic testers

If more than one ionic tester is used for judging product residue levels for the same product, a correlation study between the ionic testers shall be performed.

9.5 Non-ionic residues

All other residue requirements shall be agreed between the user and the manufacturer. The agreement should include the test method, the test parameters and the pass-fail criteria.

When rosin flux residue testing is required, assemblies shall be tested in accordance with IEC 61189-1 and IEC 61189-3 (see Annex B of this document) and shall comply with the requirements in Table 4 for the maximum allowable level of rosin flux residues.

Table 4 – Maximum acceptable rosin flux residues

Level A	200 µg/cm^2
Level B	100 µg/cm^2
Level C	40 µg/cm^2

When surface organic contamination testing is required, the test shall be performed in accordance with applicable standards and IEC 61189-3 (see Annex B of this document) and shall not exceed the maximum acceptance level agreed between the user and the manufacturer.

9.6 SIR testing

When surface insulation resistance testing (SIR) is required, test specimens processed in exactly the same manner as the assemblies being produced shall be tested for the effect of the contamination on the electrical insulation resistance of printed boards under high temperature and humidity in accordance with IEC 61189-5-502 and IEC 61189-3 (see Annex B) or another documented method agreed between user and manufacturer that determines test specimen, test conditions and pass-fail criteria and is available for review.

NOTE 1 IEC 61189-5-502 under preparation.

10 Assembly requirements

10.1 General

Boards, components and processes described and specified in Clauses 4 to 9 provide for soldered interconnections that are better than the minimum acceptance requirements of this clause. Processes and their controls should be capable of producing a product meeting or exceeding the acceptance criteria for a level C product. However, soldered connections shall meet the product level (A, B or C) acceptance requirements specified by user.

10.2 Acceptance requirements

10.2.1 Process control

The manufacturer shall either:

a) have a process control plan in accordance with 13.3; or

b) perform 100 % visual inspection to the requirements of 10.3. If defects and process indicators exceed the corrective action limits specified in 10.2.2 for their respective level of opportunities (10.2.3), the manufacturer shall initiate corrective action to reduce their occurrence. For corrective action calculations, no more than one defect characteristic (see Table 2) or process indicator shall be attributed to a particular interconnection site (for example lead-to-land, via, lead-in-hole).

If the limits specified in this document are met, it is likely that the reliability of the joint has a high possibility of meeting the assembly expectations. However, the user has the responsibility for determining true reliability requirements based on design and end product usage.

10.2.2 Corrective action limits

Corrective action shall be initiated if

a) defects listed in Table 2 exceed 0,3 % of the possibilities for their occurrence, and if
b) process indicators (see 4.4) exceed 3,0 % of the total opportunities for their occurrence.
c) As a minimum, the following general process indicator occurrences shall be monitored:
    1) markings (10.3.3);
    2) voids and blow holes (10.3.5);
    3) lead outline visibility (10.3.5);
    4) via interfacial connection wetting (10.3.6);
    5) other process indicators defined in the sectional specifications; and
    6) solder quantity.

10.2.3 Control limit determination

The total number of interconnection sites shall be used as the measure to which the percentage of defects or process indicators is applied. These calculations consider each surface mount termination, each through-hole termination, and each terminal termination as a single opportunity for determining the total number of opportunities for a given printed board assembly.

10.3 General assembly requirements

10.3.1 Assembly integrity

All products shall meet the requirements of the assembly documentation. The electrical and mechanical integrity and the reliability of all components and assemblies shall be retained after exposure to all processes employed during manufacture and assembly (for example handling, fixing, soldering and cleaning).

10.3.2 Assembly damage

10.3.2.1 Assembly requirements

Assembly damage to electronic and mechanical devices shall not exceed the requirements given in the present document and in IEC 61191-2, IEC 61191-3, IEC 61191-4.

Printed boards shall show no evidence of burning, blistering, or delamination as referenced in IEC 62326-1. Laminate scratches shall be treated as weave exposure.

10.3.2.2 Unacceptable assembly defects

The following defects can be found in printed wiring assemblies: measles, crazing, blistering, delamination, weave exposure, haloing, edge delamination, and lifted lands or conductors.

The following conditions are causes for rejection:

a) assemblies exhibiting measling or crazing defects affecting their functionality;

b) blistering or delamination that make bridges between plated through-holes or between subsurface conductors, or which extend under surface conductors or over/under subsurface conductors.

10.3.3 Markings

Markings shall not be deliberately altered, obliterated or removed by the manufacturer unless required by the assembly documentation. Additional markings (such as labels added during the manufacturing process) should not obscure the original supplier's markings. Where a loss of marking of the component part occurs, it shall be recorded as a process indicator to track and determine if a supplier has a potential marking problem, and determine the degree of corrective action (for example new materials, new processes, remarking).

10.3.4 Flatness (bow and twist)

Bow and twist after soldering should not exceed 0,75 % for surface-mount, and 1,5 % for through-hole (all levels) printed board applications. Mixed assemblies (SMT (surface mount technology), THT (through hole technology), etc.) shall meet the requirements for surface mount assemblies (see IEC 61191-2 and IEC 61189-3).

10.3.5 Solder connection

10.3.5.1 Solder wetting angle

The acceptable solder connection shall indicate evidence of wetting and adherence when the solder blends with the soldered surface, forming a contact angle of 90° or less, except when the quantity of solder results in a contour that extends over the edge of the land (see Figure 1). The solder joints should have a generally smooth appearance.

If lead-free solder joints show a slightly rough (grainy or dull) appearance or greater wetting angles, these solder joints are still acceptable if all other criteria are fulfilled.

A smooth transition from land to connection surface or component lead shall be evident. A line of demarcation or transition zone where applied solder blends with solder coating, solder plate, or other surface material is acceptable, provided that wetting is evident. In the case of fused solder coatings, presence of the applied solder above the rim of the hole is not required if the hole wall and component lead exhibit good wetting (see Figure 2). Marks or scratches on the solder joint shall not degrade the integrity of the connection.

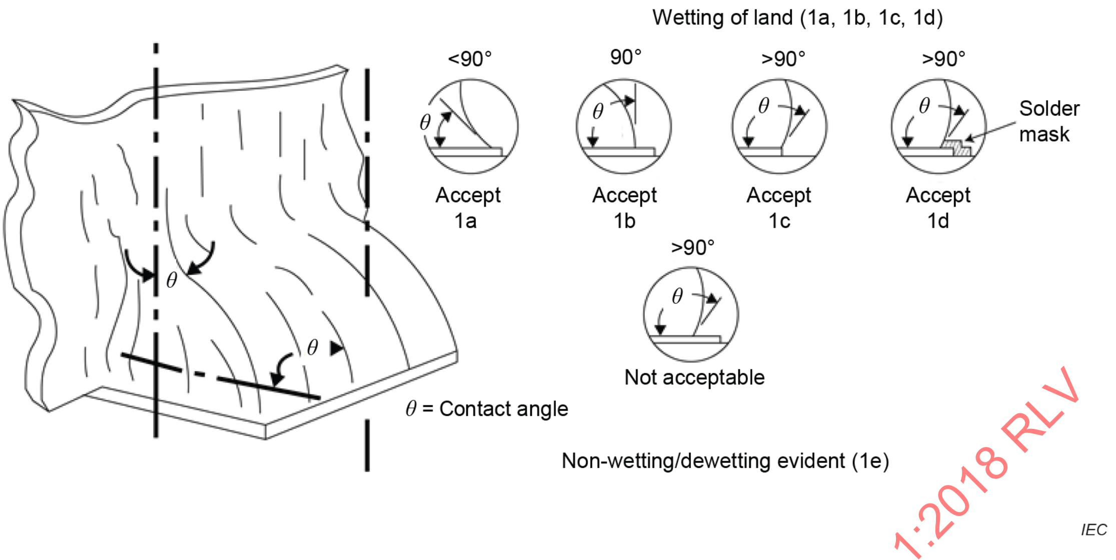

Figure 1 – Solder contact angle

10.3.5.2 Defects

The following conditions are unacceptable and shall be considered defects (see 12.1):

a) fractured or disturbed solder connections;

b) cold solder connection;

c) greater than 5 % of the solder connection (except vias) exhibiting dewet or nonwet characteristics;

d) excess solder that contacts the component body, except SO and SOT packages;

e) gold embrittlement due to insufficient gold removal (see 6.3.3); and

f) voiding by which the solder volume of the joint is decreased below the allowable minimum value.

NOTE SO and SOT packages are plastic small outline packages which can be wave soldered

10.3.5.3 Process indicators

The following conditions are acceptable, but shall be considered as process indicators and shall be documented and available for review:

a) voids and the blow holes where wetting is evident, and which do not reduce solder volume below the allowable minimum;

b) outline or lead not visible in solder joint because of excess solder.

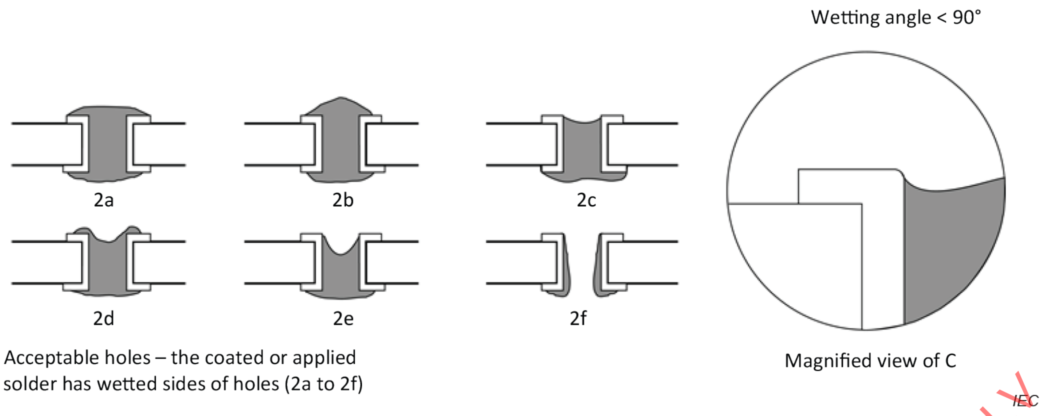

Figure 2 – Solder wetting of plated through-holes without leads

10.3.6 Interfacial connections

Unsupported holes with leads or plated through-holes, not subjected to mass soldering and used for interfacial connections need not be filled with solder. Plated through-holes not exposed to solder because of permanent or temporary maskants and used for interfacial connections need not be filled with solder. Plated through-holes without leads, including vias, after exposure to wave, dip, or drag solder processing shall meet the acceptability requirements of Figure 2. Failure to meet this requirement shall be treated as a process indicator in accordance with Clause 13. Wetting of the top-side lands by applied solder is acceptable, but not required (see Figures 2c, 2e and 2f). Plated through-hole damage due to copper dissolution is a defect (see Table 2)

11 Coating and encapsulation

11.1 Conformal coating

11.1.1 Coating instructions

The material specification and supplier's instructions, as applicable, shall be followed. When curing conditions (temperature, time, IR intensity, etc.) vary from the supplier's recommended instructions, the alternate conditions shall be documented and available for review. The material shall be used within the time period specified (both shelf life and pot life), or used within the time period indicated by a documented system that the manufacturer (assembler) has established to mark and control age-dated material.

11.1.2 Application

11.1.2.1 Application details

A coating shall be continuous in all areas designated for coverage on the assembly documentation. The coating fillets should be kept to a minimum. Conformal coating material shall not contain aggressive solvents. Conformal coating or method of application of conformal coating shall not damage or reduce the reliability of components. When used, masking materials shall have no harmful or degrading effect on the printed boards and shall be removable without leaving a contaminant residue. Dimensioning specified for masked areas shall not be decreased in length, width, or diameter by more than 0,8 mm by the application of conformal coating.

11.1.2.2 Adjustable components

The adjustable portion of adjustable components, as well as electrical and mechanical mating surfaces such as probe points, screw threads, bearing surfaces (for example card guides) shall be left uncoated as specified on the assembly documentation.

11.1.2.3 Conformal coating on connectors

Mating connector surfaces of printed wiring assemblies shall not be conformal coated. The conformal coating specified on the assembly documentation shall, however, provide a seal around the perimeter of all connector/board interface areas. Press-fit pins and connectors installed after conformal coating is applied shall be exempt from the seal requirement.

11.1.2.4 Conformal coating on brackets

The mating (contact) surface of brackets or other mounting devices shall not be coated with conformal coating unless specifically required by the assembly documentation. However, the perimeter of the junction between these devices and the board and all attaching hardware shall be coated.

11.1.2.5 Conformal coating on flexible leads

Components that are electrically connected to the assembly by flexible leads (e.g. gull wing) shall as a minimum have the junction of the leads with the components and the assembly coated.

11.1.2.6 Perimeter coating

Unless otherwise specified on the approved assembly documentation, the outer perimeter of assemblies shall not be increased in total thickness by more than 1,0 mm as a result of conformal coating. The outer perimeter is defined as the area on each side of the board at a distance of not more than 6,0 mm inwards from the outer edge (see Figure 3).

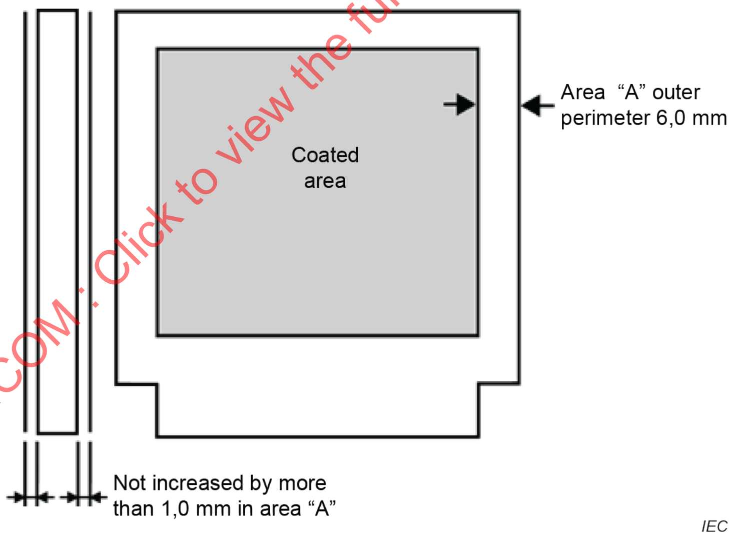

Figure 3 – Coating conditions

11.1.2.7 Edge coating

Unless otherwise specified on the approved assembly documentation, the dimensions of the assemblies shall not be increased in length or width by more than 0,8 mm on each edge, giving a total of 1,5 mm by application of conformal coating.

11.1.3 Performance requirements

11.1.3.1 Thickness

The thickness of the conformal coating shall be as follows for the type specified:

a) types ER (epoxy), UR (urethane) and AR (acrylic):	0,03 mm to 0,13 mm;
b) type SR (silicone):	0,05 mm to 0,21 mm;
c) type XY (paraxylene):	0,01 mm to 0,05 mm;
d) type FC (fluoropolymer)	~ 0,01 µm

The thickness shall be measured on a flat, unencumbered, cured surface of the printed wiring assembly, or on a coupon which has been processed with the assembly. Coupons may be of the same type of material as the printed board or may be of a non-porous material such as metal or glass. As an alternative, a wet film thickness measurement may be used to establish the coating thickness, provided there is documentation that correlates the wet and dry film thicknesses.

11.1.3.2 Coating coverage

Conformal coating shall be of the type specified on the assembly documentation, and shall:

a) be completely cured and homogeneous,
b) cover only those areas specified on the assembly documentation,
c) be free of blisters or breaks which affect the assembly operations or sealing properties of the conformal coating,
d) be free of voids, bubbles, or foreign material which expose component conductors, printed wiring conductors (including ground planes) or other conductors, and/or violate design electrical spacing; and
e) contain no measling, peeling or wrinkle (non-adherent areas).

11.1.4 Rework of conformal coating

Procedures that describe the removal and replacement of conformal coating shall be documented and available for review.

11.1.5 Conformal coating inspection

Visual inspection of conformal coating may be performed without magnification. Inspection for conformal coating coverage may be performed under an ultraviolet (UV) light source when using conformal coating material containing a UV tracer. Magnification from 2× to 4× may be used for refereeing purposes.

11.2 Encapsulation

11.2.1 Encapsulation instructions

The material specification and the supplier's instructions, as applicable, shall be followed. The material shall be used within the time period specified (both shelf life and pot life) or used within the time period indicated by a documented system the manufacturer has established to mark and control age-dated material.

11.2.2 Application

11.2.2.1 Quality details

The encapsulant materials shall be continuous in all areas designated for coverage on the assembly documentation. When used, masking material shall have no deleterious effect on the printed boards and shall be removable without contaminant residue.

11.2.2.2 Encapsulant-free surfaces

All portions of the assembly not designated to receive encapsulant material shall be free of any encapsulant material.

11.2.3 Performance requirements

The applied encapsulant shall be completely cured, homogeneous, and cover only those areas specified on the assembly documentation.

The encapsulant shall be free of bubbles, blisters or breaks that affect the printed wiring assembly operation or sealing properties of the encapsulant material. There shall be no visible cracks, crazes, mealing, peeling and/or wrinkles in the encapsulant material.

11.2.4 Rework of encapsulant material

Procedures that describe the removal and replacement of encapsulant material shall be documented and available for review (i.e., within the manufacturers' ISO 9001 documentation or equivalent written procedures).

11.2.5 Encapsulant inspection

Visual inspection of encapsulation may be performed with magnification.

12 Rework and repair

12.1 Rework of unsatisfactorily soldered electrical and electronic assemblies

Rework of unsatisfactory electrical and electronic assemblies consists of addressing the defects listed in Table 5 and the non-conforming characteristics shown in the defect tables of the relevant sectional specification (i.e. IEC 61191-2, IEC 61191-3, IEC 61191-4) as appropriate.

Rework of unsatisfactory solder connections and other defects shall not be performed until the discrepancies have been documented. Documentation requirements shall be defined in the process control plan and may be on a sampling or audit basis. This data shall be used to provide an indication as to the possible causes and to determine if corrective action, in accordance with 10.2, is required. When rework is performed, each reworked and/or reflowed connection shall be inspected to the requirements of 10.3.5 in accordance with 13.2.

Table 5 – Electrical and electronic assembly defects

Defect No.	Defect description	Requirement subclause	Remarks
01	Violations of the assembly documentation requirements a) missing component b) wrong component c) reversed component	4.1.2	
02	Damage to components beyond procurement specification or the relevant sectional specification allowance a) component damage (cracks) b) moisture cracking (pop-corning)	IEC 61191-2 IEC 61191-3 IEC 61191-4	
03	Damage to the assembly or printed board a) measling or crazing that affects functionality b) blisters/delamination that bridges between PTHs/conductors c) excessive departure from flatness	10.3.2 10.3.4	
04	Plated-through hole interconnections with and without leads a) non-wetted hole or lead b) unsatisfactory hole fill c) fractured solder joint d) cold or disturbed solder connection	10.3.5 10.3.6	
05	Violation of minimum design electrical spacing a) conductive part body or wire movement/misalignment b) solder balling c) solder bridging d) solder spikes e) solder webs/skins	IEC 61191-2 6.3.1	
06	Improper solder connections (lead, termination or land) a) dewetting or non-wetting b) solder leaching c) insufficient solder d) solder wicking e) insufficient reflow f) incomplete joint (open circuit) g) excessive solder h) excessive solder voids i) adhesive encroachment j) gold embrittlement	10.3.5.3 10.3.5.2	
07	Damaged marking on the board a) altered marking b) obliterated marking	10.3.3	
08	Failure to comply with stated cleaning or cleanliness testing	9.3 9.5	
09	Failure to comply with conformal coating requirements	11.1.3.2	
10	Copper dissolution	10.3.6	

12.2 Repair

Repairs are changes to an unacceptable end product to make it acceptable in accordance with the original functional requirements. The repair method shall be determined by agreement between the manufacturer and the user.

12.3 Post rework/repair cleaning

After rework or repair, assemblies shall be cleaned as necessary by a process meeting the requirements of subclauses 9.3 and 9.5.

13 Product quality assurance

13.1 System requirements

General requirements for the establishment and maintenance of an effective quality assurance programme incorporating process control systems (see 4.5) are given in the following subclauses.

13.2 Inspection methodology

13.2.1 Verification inspection

Verification inspection shall consist of the following:

a) surveillance of the operation to determine that practices, methods, procedures and a written inspection plan are being properly applied;

b) inspection to measure the quality of the product.

13.2.2 Visual inspection

13.2.2.1 Visual sampling

Inspection prior to soldering (for example between component placement and soldering) or in between other process steps (for example solder paste application and component placement) should only take place on a sampling basis when analyzing the assembly process to identify solder joint defect causes. After soldering, the assembly shall be evaluated in accordance with the established process control plan (see 13.3) or by 100 % visual inspection (see 10.2).

13.2.2.2 Magnification aids and lighting

The tolerance for magnification aid is 15 % of the selected magnification power (i.e. +15 % or a range of 30 % centred at the selected magnification power). Magnification aids and lighting (see 4.11.4) used for inspection shall be commensurate with the size of the item being processed. The magnification used to inspect solder connections shall be based on the minimum width of the land used for the device being inspected. Magnification aids should be in accordance with Table 6.

Table 6 – Magnification requirements

Land widths and land diameters mm	**Inspection**	**Referee**
>1,0	1,5× to 3×	4×
>0,5 to ≤1,0	3× to 7,5×	10×
≥0,25 to ≤0,5	7,5× to 10×	20×
<0,25	20×	40×

Referee conditions shall only be used to verify a product rejected at the inspection magnification. For assemblies with mixed land widths, the greater magnification may be used for the entire assembly.

13.2.2.3 Partially visible or hidden solder connections

Partially visible or hidden solder connections are acceptable provided that the following conditions are met:

a) the visible portion, if any, of the connection on either side of the PTH solder connection (or the visible portion of the SMD connection) is acceptable;

b) the design does not restrict solder flow to any connection element on the primary side (for example pin in hole component) of the assembly;
c) process controls are maintained in a manner assuring repeatability of assembly techniques.

13.2.3 Sampling inspection

Use of sample-based inspection shall be predicated on meeting one of the following:

a) when done as part of a documented process control system as in 13.3; or
b) as part of the user-approved product assurance programme.

13.3 Process control

13.3.1 System details

Process control shall be a documented system, available for review, that meets the intent of ISO 9001, IEC 61193-3, or user-approved system. The primary goal of process control is to continually reduce variation in the processes, products, or services to provide product or processes meeting or exceeding customer requirements. The process control system shall include the following elements as a minimum:

a) training shall be provided to personnel with assigned responsibilities in the development, implementation, and use of process control and statistical methods that are commensurate with their responsibilities;
b) quantitative methodologies and evidence shall be maintained to demonstrate that the process is capable and in control;
c) improvement strategies to define initial process control limits and methodologies leading to a reduction in the occurrence of process indicators in order to achieve continuous process improvement;
d) criteria for switching to sample-based inspection shall be defined. When processes exceed control limits, or demonstrate an adverse trend or run, the criteria for reversion to higher levels of inspection (up to 100 %) shall also be defined;
e) when defect(s) are identified in the lot sample, the entire lot shall be 100 % inspected for the occurrence(s) of the defect(s) observed;
f) a system shall be put in place to initiate corrective action for the occurrence of process indicators, out-of-control process(es), and/or discrepant assemblies;
g) a documented audit plan is defined to monitor process characteristics and/or output at a prescribed frequency.

Objective evidence of process control may be in the form of control charts or other tools and techniques of statistical process control derived from application of process parameter and/or product parameter data. This data can be acquired from sources such as inspection, non-destructive evaluation, machine operation data, or periodic testing of production samples. For attribute data, the key is understanding and controlling parameters in the process that influence the response in question and establishing controls at that point. Attribute data, measured in parts of 10^{-6} nonconforming product, can generally be correlated to a process capability index (Cpk) generated using variable data (see Annex B).

Available resources (e.g. ISO 9001, IEC 61193-1) should be used in establishing the process control plan and defining the characteristics and criteria.

13.3.2 Defect reduction

Continuous process improvement techniques shall be implemented to reduce the occurrence of defects and process indicators. When processes vary beyond established process control limits, corrective action shall be taken to prevent recurrence. When corrective action is ineffective within 30 days of implementation, the problem shall be referred to plant management for resolution.

13.3.3 Variance reduction

All variances from the requirements of this document shall be minimized with the goal of elimination (where economically practical) through process corrective action. Failure to implement process corrective action and/or the use of continually ineffective corrective action shall be grounds for disapproval of the process and associated documentation.

14 Other requirements

14.1 Health and safety

The use of some materials referenced in this document can be hazardous. In such cases, a risk assembly shall be undertaken prior to the use of any hazardous material. All safety precautions shall be taken as outlined in the data provided with the material. Adequate ventilation shall be provided in all areas where solder chemicals are used or fumes are generated. To provide for the personnel's safety, areas, equipment and procedures shall meet all applicable occupational (workplace), safety and health regulations.

14.2 Special manufacturing requirements

14.2.1 Manufacture of devices incorporating magnetic windings

This document is limited in its applicability to the manufacturing processes associated with the mounting of internal electronic elements and the soldering of the internal connections of transformers, motors, and similar devices. Unless a user has a specific need for the controls provided by this document, it shall not be imposed relative to the manufacture of the internal elements of these devices. The external interconnect points (i.e. terminals, pins, etc.) shall meet the solderability requirements of this document.

14.2.2 High-frequency applications

High-frequency applications (for example radiowaves and microwaves) may require part spacings, mounting systems, and assembly designs that vary from the requirements stated herein. When high-frequency design requirements prevent compliance with the design and part-mounting requirements contained herein, manufacturers may use alternative designs.

14.2.3 High-voltage or high-power applications

High-power applications, such as high-voltage power supplies, may require part spacings, mounting systems, and assembly designs that vary from the requirements stated herein. When high-voltage design requirements prevent compliance with the design and part-mounting requirements contained herein, manufacturers may use alternative designs.

14.3 Guidance on requirement flowdown

Manufacturers are responsible for delivering fully compliant hardware according to the requirements of this document and the applicable assembly documentation. Where a part is adequately defined by a basic part specification, then the requirements of this document should be imposed on the manufacture of that part only when absolutely necessary to meet end-item requirements. When it is unclear where flowdown should stop, it is the responsibility of the manufacturer to work with the user to determine this point.

15 Ordering data

Procurement documents should follow the requirements with the inclusion of the following referenced items:

a) the title, number and date of this document;

b) whether or not to conduct preproduction testing;

c) the quantity of preproduction samples required, if any;
d) the disposition of preproduction samples, when applicable;
e) the specific type of evaluation to be used and the requirements for the quality control system;
f) the detailed requirements for operator certification, if any;
g) level of product (see 4.3);
h) cleanliness designator, cleaning option, cleanliness test (see 9.2); and
i) ESD packaging requirements.

Annex A
(normative)

Requirements for soldering tools and equipment

A.1 Requirements for tools and equipment

The following requirements for tools and equipment shall be imposed if process controls are not sufficiently in place to ensure compliance with 4.12.

A.2 Abrasives

Knives, emery cloth, sandpaper, sandblasting, braid, steel wool, and other abrasives shall not be used on surfaces to be soldered.

A.3 Benchtop and hand-soldering systems

The selection criteria of benchtop and hand-soldering systems shall include the following:

a) soldering systems shall be selected for their capacity to heat the connection area rapidly and maintain sufficient soldering temperature range at the connection throughout the soldering operation;

b) temperature-controlled soldering systems at rest shall be controlled within ±5 °C of the idle tip temperature. Constant output (steady output) tools in compliance with items a), d), e) and f) may also be used;

c) operator-selected or rated temperatures of soldering systems at idle/standby shall be within ±15 °C of actual measured tip temperature;

d) resistance between the tip of soldering systems and the workstation common point ground shall not exceed 5 Ω. The heated element and tips shall be measured when at their normal operating temperature.

   General soldering systems shall have internal tip-to-ground resistance of 1 Ω to 5 Ω.

   If required, current-limited soldering systems with internal tip-to-ground resistance of ≥1 MΩ may be used;

e) tip-to-ground voltage leakage shall not exceed 2 mV RMS (Z_{in} = 100 kΩ);

f) tip transient voltages generated by the soldering systems shall not exceed 2 V peak (Z_{in} ≥100 kΩ);

g) tool holders shall be of a type appropriate for the hand piece or tool used. The holder shall not apply excessive physical stress or heat-sinking to heating elements, and shall protect the personnel from burns;

h) sponges for cleaning of soldering irons tips and reflow soldering tool surfaces shall be manufactured from materials which are not detrimental to solderability or which could contaminate the soldering tool surfaces;

i) soldering guns with the transformer incorporated into the hand piece shall not be used;

j) solder pots shall maintain the solder temperature within ±5°C of the selected temperature. Solder pots shall be grounded. Resistance between the molten solder and the workstation common point ground shall not exceed 5 Ω;

k) soldering systems shall be used separately to avoid nonconformity, mixing or contamination of soldering tips by various solders.

The appropriate requirements of this clause shall also apply to non-conventional benchtop soldering equipment including equipment that uses conductive, convective, parallel gap resistance, shorted bar resistance, hot gas, infrared, laser-powered devices, or thermal transfer soldering techniques.

Tools used shall be maintained so that no detrimental damage results from their use, and they shall be kept clean and free of dirt, grease, flux, oil or other foreign matter during use. The heat source shall not cause damage to the printed board or components.

A.4 Soldering iron holders

Soldering iron holders shall be of a type appropriate for the soldering iron used. The holder shall leave the soldering iron heating element and tip unsupported without applying excessive physical stress or heat sinking, and it shall protect the personnel from burns.

A.5 Wiping pads

Sponges and pads for wipe cleaning of soldering iron tips and reflow soldering tool surfaces shall be kept free of contaminants that are detrimental to solderability or that would contaminate the soldering tool surfaces.

A.6 Soldering guns

Soldering guns with the transformer incorporated into the hand piece shall not be used.

A.7 Solder pots

Solder pots shall maintain the solder temperature within ±5 °C of the selected temperature. Solder pots shall be grounded.

A.8 Process control

Documented process controls shall be in place to ensure compliance with Annex B. All equipment shall be operated in accordance with the manufacturers' recommendations and calibrated, where necessary, to maintain manufacturers' specifications. Process control documents shall be available to production workers and for user review. Equipment grounding, protection and temperature control testing should be performed when qualifying equipment for purchase, inspection of new or repaired equipment, and when indicated as part of the process-control programme.

Annex B
(normative)

Quality assessment

B.1 Process control (PC)

Process control (PC), when coupled with statistical analysis (SPC), uses systematic mathematical techniques to analyze a process or its outputs. The purpose of these analyses is to take appropriate actions to achieve and maintain a state of statistical control, and to assess and improve process capability. The primary goal of PC is to reduce variation in processes, products or services continually. This is in order to provide a product meeting or exceeding real or implied customer requirements.

Implementation of PC or SPC shall be in accordance with ISO 9001 or a user-approved documented system.

Depending on the progress made in implementing PC on a particular product, an individual supplier may demonstrate compliance to the specification with any of the following:

a) quality conformance evaluations;
b) end-product control and capability as defined in the PC plan;
c) in-process control and capability correlated to customer requirements as defined in the process control plan; and
d) process-parameter control and capability correlated to customer requirements as defined in the PC plan.

An individual supplier may choose to use a combination of the four assurance techniques listed above to prove compliance. For example, a documented control plan can indicate that a product with 15 characteristics can meet the specifications of quality conformance evaluations for two characteristics, in-process product evaluations for five characteristics, and process parameter control for five characteristics. The remaining three characteristics meet the specification through a combination of in-process control and quality conformance evaluations.

Evidence of compliance to the specification at the level of PC implementation claimed in the control plan is auditable by the customer or by an appointed third party.

Requirements are dynamic in nature and are based on what is accepted in the worldwide market. Requirements may be stated as the reduction of variation around a target value, as opposed to just meeting the specification, drawing, etc.

B.2 Reduction of quality conformance testing

The primary goal of process control is not the reduction of quality conformance testing. The primary goal of process control is to continually reduce variation in processes, product and services. This is in order to provide products meeting or exceeding real or implied customer requirements. However, as a result of the understanding and the control of highly capable process and product parameters, quality conformance testing may be reduced to an audit function in an orderly fashion in accordance with the following:

a) a documented PC plan according to the requirements of ISO 9001 or a user-approved plan is in place and up to date;
b) the process or processes that affect the characteristic have been identified, have been included in the control plan, and have been documented as being in a state of statistical control. Product characteristics resulting from this plan have demonstrated a capability above a minimum specified value. For variables data, this capability is often defined as a

Cpk above 1,33. (For attribute data, the key is understanding and controlling parameters in the process that influence the response in question and establishing controls at that point.) The criteria for reduced testing then becomes a stable process whose critical correlated parameters exhibit a state of statistical control, and which produce an acceptable level of nonconforming products as agreed to between the supplier and the customer. For example, attribute data resulting in a nonconformance ratio of 33 × 10^{-6} would approximate a Cpk of 1,33 for variables data;

c) a corrective action discipline is in place for discoveries of, and reaction to, out-of-control and discrepant points;

d) the measurement system used has been validated in accordance with the implementation plan, and correlated to the criticality of the measurement requirements. A desirable minimum for variable data is a 4 to 1 gauge for repeatability and reproducibility;

e) a documented audit plan is defined to monitor process output. The plan sets out corrective action in the event that an audit discovers a discrepancy;

f) current quality evaluation techniques have not exhibited any nonconformance for a period of time or for a number of lots, as agreed to between the customer and the supplier.

B.3 Audit plan

The audit plan should be designed to confirm that the PC plan is being implemented correctly and to confirm that implementation of the plan achieves continuing improvement. The audit plan that is put in place after replacement of quality conformance testing shall include provisions for action to be taken when out-of-specification conditions are found.

The action plan shall include the following items:

a) a complete description of the problem;

b) a complete description of the root cause for the failure;

c) a containment and short-term corrective action to preclude continuing production or shipment of nonconforming products;

d) a description of the planned long-term corrective action that will eliminate future recurrence of non-conformance.

Demonstrating capability with attribute data requires a great deal of data, particularly as the process improves into the defective level measured in parts of 10^{-6}. Process capability (Cp) and Cpk statistics generally are used to describe variable characteristics and, without transformations, do not lend themselves to attribute data.

Bibliography

IEC and ISO references

IEC 61188-5-1, *Printed boards and printed board assemblies – Design and use – Part 5-1: Attachment (land/joint) considerations – Generic requirements*

IEC 61188-5-2, *Printed boards and printed board assemblies – Design and use of printed boards and printed board assemblies – Part 5-2: Attachment (land/joint) considerations – Discrete components*

IEC 61188-5-3, *Printed boards and printed board assemblies – Design and use – Part 5-3: Attachment (land/joint) considerations – Components with gull-wing leads on two sides*

IEC 61188-5-4, *Printed boards and printed board assemblies – Design and use – Part 5-4: – Attachment (land/joint) considerations – Components with J leads on two sides*

IEC 61188-5-5, *Printed boards and printed board assemblies – Design and use – Part 5-5: – Attachment (land/joint) considerations – Components with gull-wing leads on four sides*

IEC 61188-5-6, *Printed boards and printed board assemblies – Design and use – Part 5-6: Attachment (land/joint) considerations – Chip carriers with J leads on four sides*

IEC 61188-7, *Printed boards and printed board assemblies – Design and use – Part 7: Electronic component zero orientation for CAD library construction*

IEC 61189-2, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 2: Test methods for materials for interconnection structures*

IEC 61189-5-502, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-502: General test methods for materials and assemblies – SIR testing of assemblies*[1]

IEC 61190-1-2, *Attachment materials for electronic assembly – Part 1-2: Requirements for soldering pastes for high-quality interconnects in electronics assembly*

IEC 61193-1, *Quality assessment systems – Part 1: Registration and analysis of defects on printed board assemblies*

IEC 61193-3, *Quality assessment systems – Part 3: Selection and use of sampling plans for printed boards and laminate end-products and in-process auditing*

IEC 62326-1, *Printed boards – Part 1: Generic specification*

IEC 62326-4, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification*

IEC/PAS 62326-7-1, *Performance guide for single- and double-sided flexible printed wiring boards*

---

[1] Under preparation.

Other references

IPC-TM-650, *Test Methods Manual*

- 2.3.25 *Detection and measurement of ionizable surface contaminants by resistivity of solvent extract*
- 2.3.25.1 *Ionic Cleanliness Testing of Bare PWBs*
- 2.3.27 *Cleanliness test – residual rosin*
- 2.3.38 *Surface organic contamination detection test*
- 2.4.22 *Bow and twist (percentage)*
- 2.6.3.3 *Surface insulation resistance, fluxes*

IPC-9191, *General Requirements for Implementation of Statistical Process Control*

IPC-9202, *Material and Process Characterization/Qualification Test Protocol for Assessing Electrochemical Performance*

IPC-OI-645, *Standard for Visual Optical Inspection Aids*

IPC-SM-817, *General Requirements for Dielectric Surface Mounting Adhesives*

J-STD-001, *Requirements for Soldered Electrical and Electronic Assemblies*

J-STD-002, *Solderability Tests for Component Leads, Terminals, Lugs Terminals and Wires*

J-STD-003, *Solderability Tests for Printed Boards*

J-STD-004, *Requirements for Soldering Fluxes*

J-STD-005, *General Requirements and Test Methods for Electronic Grade Solder Paste*

J-STD-006, *General Requirements and Test Methods for Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Solder Applications*

J-STD-020, *Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices*

J-STD-033, *Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices*

SOMMAIRE

AVANT-PROPOS 50

1 Domaine d'application 52

2 Références normatives 52

3 Termes et définitions 53

4 Exigences générales 54

4.1 Ordre de priorité 54

4.1.1 Remarque générale 54

4.1.2 Contradiction 54

4.1.3 Documentation relative à la conformité 55

4.2 Interprétation des exigences 55

4.3 Classification 55

4.4 Défauts et indicateurs de processus 56

4.5 Exigences relatives au contrôle du processus 56

4.6 Transmission des exigences 56

4.7 Conceptions physiques 56

4.7.1 Conceptions nouvelles 56

4.7.2 Conceptions existantes 57

4.8 Aides visuelles 57

4.9 Compétence du personnel 57

4.9.1 Compétence au niveau de la conception 57

4.9.2 Compétence au niveau de la fabrication 57

4.10 Décharge électrostatique (ESD, ElectroStatic Discharge) 57

4.11 Installations 57

4.11.1 Généralités 57

4.11.2 Contrôles environnementaux 58

4.11.3 Température et humidité 58

4.11.4 Eclairage 58

4.11.5 Conditions sur le terrain 58

4.11.6 Salles blanches 58

4.12 Outils et matériel d'assemblage 58

4.12.1 Généralités 58

4.12.2 Contrôle de processus 58

5 Exigences relatives aux matériaux 59

5.1 Vue d'ensemble 59

5.2 Brasure 59

5.3 Flux 59

5.4 Pâte à braser 59

5.5 Préformes de brasage 59

5.6 Adhésifs 60

5.7 Agents nettoyants 60

5.7.1 Généralités 60

5.7.2 Choix des agents nettoyants 60

5.8 Revêtements en polymères 60

5.8.1 Epargnes de brasure et masques localisés 60

5.8.2 Revêtement enrobant et encapsulants 60

5.8.3 Ecarteurs (permanents et temporaires) 60

5.9 Dénudeurs chimiques 61
5.10 Agents nettoyants 61
5.11 Dispositifs de brasage rétractables à la chaleur 61
6 Exigences relatives aux composants et cartes imprimées 61
6.1 Généralités 61
6.2 Brasabilité....61
6.2.1 Brasabilité des pièces 61
6.2.2 Reconditionnement 61
6.2.3 Essai de brasabilité des circuits sur substrats céramiques 61
6.3 Maintien de la brasabilité....62
6.3.1 Généralités 62
6.3.2 Préconditionnement 62
6.3.3 Effritement de la dorure dans les joints brasés....62
6.3.4 Etamage des pièces non brasables 62
6.4 Maintien de la pureté de la brasure....63
6.5 Préparation des sorties 64
6.5.1 Généralités 64
6.5.2 Formation des sorties....64
6.5.3 Limites de formation des sorties 64
7 Exigences relatives au processus d’assemblage 64
7.1 Vue d’ensemble 64
7.2 Propreté....64
7.3 Marquages des pièces et désignations de référence 64
7.4 Contours des connexions de brasure....65
7.5 Pièges à humidité 65
7.6 Dissipation thermique....65
8 Exigences relatives au brasage d’un ensemble....65
8.1 Généralités 65
8.1.1 Processus de brasure 65
8.1.2 Entretien de la machine....65
8.1.3 Manipulation des pièces....65
8.1.4 Préchauffage 65
8.1.5 Supports....65
8.1.6 Maintien en position basse des sorties de montage en surface....66
8.1.7 Application de chaleur....66
8.1.8 Refroidissement....66
8.2 Brasage par refusion....66
8.2.1 Exigences....66
8.2.2 Développement du processus pour le brasage par refusion....66
8.2.3 Application du flux....67
8.2.4 Application de la brasure....67
8.3 Brasage manuel....68
8.3.1 Brasage manuel sans refusion 68
8.3.2 Brasage manuel par refusion....68
9 Exigences relatives à la propreté et aux résidus....69
9.1 Généralités 69
9.2 Processus de nettoyage/fabrication qualifié 69
9.2.1 Généralités....69

9.2.2 Désignateur de propreté 70
9.2.3 Limite supérieure de spécification 70
9.3 Exigences visuelles 70
9.4 Corrélation des appareils d'essais ioniques 71
9.5 Résidus non ioniques 71
9.6 Essai de résistance d'isolement de surface 71
10 Exigences relatives à l'ensemble 71
10.1 Généralités 71
10.2 Exigences relatives à l'acceptation 72
10.2.1 Contrôle de processus 72
10.2.2 Limites de l'action corrective 72
10.2.3 Détermination de la limite de contrôle 72
10.3 Exigences générales relatives à l'ensemble 72
10.3.1 Intégrité de l'ensemble 72
10.3.2 Détérioration de l'ensemble 73
10.3.3 Marquage 73
10.3.4 Planéité (courbure et vrillage) 73
10.3.5 Connexion brasée 73
10.3.6 Connexions d'interface 75
11 Revêtement et encapsulation 75
11.1 Revêtement enrobant 75
11.1.1 Instructions relatives au revêtement 75
11.1.2 Application 75
11.1.3 Exigences relatives aux performances 77
11.1.4 Retouche du revêtement enrobant 77
11.1.5 Examen du revêtement enrobant 77
11.2 Encapsulation 77
11.2.1 Instructions relatives à l'encapsulation 77
11.2.2 Application 78
11.2.3 Exigences relatives aux performances 78
11.2.4 Retouche du matériau encapsulant 78
11.2.5 Examen de l'encapsulant 78
12 Retouches et réparations 78
12.1 Retouche des ensembles électriques et électroniques brasés non satisfaisants 78
12.2 Réparations 79
12.3 Nettoyage après des retouches ou des réparations 79
13 Assurance de la qualité du produit 80
13.1 Exigences relatives au système 80
13.2 Méthodologie d'examen 80
13.2.1 Examen de vérification 80
13.2.2 Examen visuel 80
13.2.3 Examen par échantillonnage 81
13.3 Contrôle de processus 81
13.3.1 Détails relatifs au système 81
13.3.2 Réduction des défauts 82
13.3.3 Réduction de la variance 82
14 Autres exigences 82

14.1 Santé et sécurité 82
14.2 Exigences spéciales relatives à la fabrication 82
14.2.1 Fabrication de dispositifs comprenant des enroulements magnétiques 82
14.2.2 Applications à haute fréquence..82
14.2.3 Applications à haute tension et à puissance élevée..82
14.3 Recommandation sur la transmission des exigences..83
15 Données relatives aux commandes 83
Annex A (normative) Exigences relatives aux outils et au matériel de brasage 84
A.1 Exigences relatives aux outils et au matériel..84
A.2 Abrasifs 84
A.3 Appareils de table et autres systèmes de brasage manuel 84
A.4 Supports de fer à braser..85
A.5 Tampons de nettoyage 85
A.6 Pistolets à braser 85
A.7 Pots de brasage..85
A.8 Contrôle de processus..85
Annex B (normative) Evaluation de la qualité..86
B.1 Contrôle de processus..86
B.2 Réduction des essais de conformité de la qualité..86
B.3 Plan d'audit..87
Bibliographie 88

Figure 1 – Angle de contact de brasure 74
Figure 2 – Mouillage de brasure de trous traversants métallisés sans sorties 75
Figure 3 – Conditions de revêtement..76

Tableau 1 – Limites de contamination de la brasure; limite maximale de contamination (pourcentage en masse) 63
Tableau 2 – Désignation des surfaces à nettoyer..70
Tableau 3 – Essais sur les résidus pour le contrôle de processus 70
Tableau 4 – Niveau maximal autorisé de résidus de flux de résine..71
Tableau 5 – Défauts des ensembles électriques et électroniques..79
Tableau 6 – Exigences relatives au grossissement 80

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

____

ENSEMBLES DE CARTES IMPRIMÉES –

Partie 1: Spécification générique – Exigences relatives aux ensembles électriques et électroniques brasés utilisant les techniques de montage en surface et associées

AVANT-PROPOS

1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 61191-1 a été établie par le comité d'études 91 de l'IEC: Techniques d'assemblage des composants électroniques.

Cette troisième édition annule et remplace la deuxième édition parue en 2013. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) les exigences ont été mises à jour pour être conformes aux critères d'acceptation de l'IPC-A-610F;
b) le terme "dessin d'assemblage" a été remplacé partout par "document d'assemblage";
c) les références aux normes IEC ont été corrigées;

d) l’Article 9 a été entièrement réécrit;

e) l’Annexe B a été retirée car des procédures d’assemblages de cartes à circuits existent déjà.

Le texte de cette Norme internationale est issu des documents suivants:

CDV	Rapport de vote
91/1481/CDV	91/1510/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61191, publiées sous le titre général *Ensembles de cartes imprimées*, peut être consultée sur le site web de l’IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l’IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

ENSEMBLES DE CARTES IMPRIMÉES –

Partie 1: Spécification générique – Exigences relatives aux ensembles électriques et électroniques brasés utilisant les techniques de montage en surface et associées

1 Domaine d'application

La présente partie de l'IEC 61191 établit les exigences relatives aux matériaux, méthodes et critères de vérification utilisés dans le cadre de la production d'interconnexions et d'ensembles brasés de qualité faisant appel à la technique de montage en surface ainsi qu'à des techniques d'assemblage associées. La présente partie de l'IEC 61191 comprend également des recommandations concernant la qualité des processus de fabrication.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60068-2-20, *Essais d'environnement – Partie 2-20: Essais – Essai T: Méthodes d'essai de la brasabilité et de la résistance à la chaleur de brasage des dispositifs à broches*

IEC 60068-2-58, *Essais d'environnement – Partie 2-58: Essais – Essai Td: Méthodes d'essai de la soudabilité, de la résistance de la métallisation à la dissolution et de la résistance à la chaleur de brasage des composants pour montage en surface (CMS)*

IEC 60194, *Conception, fabrication et assemblage des cartes imprimées – Termes et définitions*

IEC 60721-3-1, *Classification des conditions d'environnement – Partie 3: Classification des groupements des agents d'environnement et de leurs sévérités – Stockage*

IEC 61189-1, *Méthodes d'essai pour les matériaux électriques, les structures d'interconnexion et les ensembles – Partie 1: Méthodes d'essai générales et méthodologie*

IEC 61189-3, *Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles – Partie 3: Méthodes d'essai des structures d'interconnexion (cartes imprimées)*

IEC 61190-1-1, *Matériaux de fixation pour les assemblages électroniques – Partie 1-1: Exigences relatives aux flux de brasage pour les interconnexions de haute qualité dans les assemblages de composants électroniques*

IEC 61190-1-3, *Matériaux de fixation pour les assemblages électroniques – Partie 1-3: Exigences relatives aux alliages à braser de catégorie électronique et brasure solide fluxée et non-fluxée pour les applications de brasage électronique*

IEC 61191-2, *Ensembles de cartes imprimées – Partie 2: Spécification intermédiaire – Exigences relatives à l'assemblage par brasage pour montage en surface*

IEC 61191-3, *Ensembles de cartes imprimées – Partie 3: Spécification intermédiaire – Exigences relatives à l'assemblage par brasage de trous traversants*

IEC 61191-4, *Ensembles de cartes imprimées – Partie 4: Spécification intermédiaire – Exigences relatives à l'assemblage de bornes par brasage*

IEC 61249-8-8, *Matériaux pour les structures d'interconnexion – Partie 8: Collection de spécifications intermédiaires pour les films et revêtements non conducteurs – Section 8: Revêtements amovibles de polymères*

IEC 61340-5-1, *Electrostatique – Partie 5-1: Protection des dispositifs électroniques contre les phénomènes électrostatiques – Exigences générales*

IEC/TR 61340-5-2, *Electrostatique – Partie 5-2: Protection des dispositifs électroniques contre les phénomènes électrostatiques – Guide d'utilisation*

IEC 61760-2, *Technique du montage en surface – Partie 2: Transport et stockage des composants pour montage en surface (CMS) – Guide d'application*

ISO 9001:2008, *Systèmes de management de la qualité – Exigences*

IPC-A-610*, Acceptabilité des assemblages électroniques*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 60194 ainsi que les suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
courbure
défaut de planéité d'une carte, caractérisé par une déformation grossièrement cylindrique ou sphérique telle que, si le produit est rectangulaire, ses quatre coins sont dans le même plan

3.2
fabricant
assembleur
individu ou société responsable de la fourniture de matériaux et composants, ainsi que de tous les procédés d'assemblage et des opérations de vérification nécessaires pour assurer la parfaite conformité des ensembles avec le présent document

3.3
preuve objective
documentation faisant l'objet d'un accord entre l'utilisateur et le fabricant

Note 1 à l'article: La documentation peut être sous forme de documents de papier, de données informatisées, d'algorithmes, d'images vidéo ou d'autres supports.

3.4
indicateur de processus
anomalie détectable, différente d'un défaut, reflétant une variation au niveau du matériau, du matériel, du personnel, du processus et/ou de la fabrication

3.5
compétence
capacité à réaliser une tâche conformément aux exigences et procédures de vérification décrites dans le présent document

3.6
masquage
phénomène par lequel les pièces forment une ombre des sorties, pastilles ou autres parties qui obstruent le chauffage pour le brasage par refusion ou l'application de la brasure pour le brasage par fusion

3.7
fournisseur
individu ou société chargé(e) d'assurer au fabricant (assembleur) la parfaite conformité des composants et des matériaux de base aux exigences et aux procédures de vérification du présent document

Note 1 à l'article: Les composants comprennent les composants électroniques, électromécaniques ou mécaniques, les cartes imprimées, etc.

Note 2 à l'article: Les matériaux de base comprennent la brasure, le flux, les agents nettoyants, etc.

3.8
vrillage
déformation d'une plaque rectangulaire, panneau ou carte imprimée qui se produit parallèlement à une diagonale de sa surface, telle que l'un des coins de la plaque n'est pas dans le plan contenant les trois autres

3.9
utilisateur
autorité du fournisseur
individu, société ou agence responsable de la fourniture de matériel électrique/électronique, ayant la charge de définir la classe de matériel ainsi que toute variation ou restriction par rapport aux exigences du présent document

EXEMPLE L'initiateur ou la personne chargée du respect du contrat qui détaille ces exigences.

4 Exigences générales

4.1 Ordre de priorité

4.1.1 Remarque générale

En cas de contradiction entre le texte de la présente norme et les normes applicables qui y sont citées, le texte du présent document doit être prioritaire. Cependant, le présent document ne remplace en rien les lois et réglementations applicables.

4.1.2 Contradiction

En cas de contradiction entre les exigences du présent document et le document d'assemblage applicable, le document d'assemblage applicable approuvé par l'utilisateur doit s'appliquer. Dans le cas d'une contradiction entre les exigences du présent document et un document d'assemblage non approuvé, les différences doivent être signalées à l'utilisateur désigné pour approbation. Pour une telle approbation, les dispositions doivent être documentées (par une note de révision officielle ou un document équivalent) dans le document d'assemblage, qui doit alors s'appliquer.

4.1.3 Documentation relative à la conformité

Lorsque le présent document exige l’apport de preuves documentaires pour étayer des demandes de conformité, chaque rapport doit être conservé et disponible pour un éventuel examen pendant une durée minimale de deux ans à partir de la date de l’événement enregistré (voir ISO 9001).

4.2 Interprétation des exigences

L’introduction d’une classification des produits en fonction des niveaux et de leur utilisation finale (voir 4.3) permet à l’utilisateur de différencier les exigences de performance. Quand l’utilisateur déclare se conformer aux exigences obligatoires du présent document, les conditions suivantes s’appliquent:

- sauf spécification contraire par l’utilisateur, le verbe "doit" signifie que les exigences sont obligatoires;
- tout écart par rapport à une exigence obligatoire ("doit") exige l’acceptation écrite de l’utilisateur, par exemple au travers du document d’assemblage, de la spécification ou d’une disposition contractuelle. "Il convient" est utilisé pour indiquer une recommandation. Le verbe "peut" indique un choix facultatif. Ces derniers termes ("il convient" et "peut") expriment des situations non obligatoires. Il y a parfois également des déclarations d’intention (utilisation du futur).

4.3 Classification

Le présent document reconnaît que les ensembles électriques et électroniques sont soumis à des classifications correspondant à l’utilisation finale prévue pour l’article. Trois niveaux généraux relatifs au produit fini ont été établis afin de refléter les différences au niveau de la productibilité, des exigences de performances fonctionnelles et de la fréquence des vérifications (examen/essai).

Il convient d’admettre que des empiètements de matériels peuvent se produire entre différents niveaux. C’est à l’utilisateur (voir 3.5) des ensembles que revient la responsabilité de déterminer le niveau auquel le produit appartient. Le contrat doit spécifier le niveau exigé et indiquer toute exception ou exigence supplémentaire concernant les paramètres, le cas échéant.

Niveau A: Produits électroniques généraux

Comprend les produits de consommation, certains ordinateurs et périphériques ainsi que le matériel informatique approprié aux applications quand l’exigence principale dépend de l’ensemble achevé.

Niveau B: Produits électroniques spécialisés

Comprend du matériel de communication, des machines de bureau perfectionnées et des instruments pour lesquels de hautes performances et une durée de vie étendue sont exigées et un fonctionnement ininterrompu est souhaité sans que cela soit pour autant obligatoire. Généralement, l’environnement d’utilisation finale ne provoque pas de défaillance.

Niveau C: Produits électroniques à hautes performances

Comprend tous les matériels pour lesquels un fonctionnement continu ou sur demande est obligatoire. Aucun temps d’arrêt du matériel ne peut être toléré, il est possible que l’environnement d’utilisation finale soit exceptionnellement difficile et le matériel doit fonctionner lorsque cela est exigé, comme c’est le cas pour les systèmes d’aide à la vie et autres systèmes d’urgence.

L’IPC-A-610 doit être utilisée comme norme de qualité d’exécution.

NOTE Le niveau A correspond à la classe 1 dans l'IPC-A-610.

Le niveau B correspond à la classe 2 dans l'IPC-A-610.

Le niveau C correspond à la classe 3 dans l'IPC-A-610.

4.4 Défauts et indicateurs de processus

Le Tableau 5 énumère les défauts inacceptables et qui exigent une attention particulière (par exemple, retouches, réparations). Le fabricant est chargé d'identifier d'autres points à risque et de les considérer comme des additions au Tableau 5. Il convient de documenter ces points précis dans le document d'assemblage. Tout ce qui ne relève pas des défauts inacceptables énumérés dans le Tableau 5, des anomalies et des écarts par rapport aux exigences obligatoires ("doit") est considéré comme un indicateur de processus, et son évolution doit être contrôlée lorsque son apparition est observée. La disposition d'indicateurs de processus n'est pas exigée.

Les exigences relatives à la qualité d'exécution doivent correspondre au niveau de classification identifié en 4.3.

L'IPC-A-610 doit être utilisée comme norme de qualité d'exécution.

4.5 Exigences relatives au contrôle du processus

Le présent document exige l'utilisation de méthodes de contrôle du processus dans le cadre de la planification, de la mise en œuvre et de l'évaluation des processus de fabrication utilisés pour produire des ensembles électriques et électroniques montés par brasage. Afin d'établir la relation entre le contrôle de processus, la capacité et les exigences relatives au produit fini, la philosophie, les stratégies de mise en œuvre, les outils et les techniques peuvent être appliqués en séquences différentes en fonction de la société, de l'opération ou de la variable spécifique considérée. A condition que l'utilisateur donne son accord, le fabricant peut ne pas effectuer d'évaluations ni d'examens spécifiques de conformité de la qualité, tels qu'ils sont décrits dans le présent document, à condition de fournir la preuve objective qu'il existe un plan d'amélioration actuel complet et continu (voir 13.3).

4.6 Transmission des exigences

Les exigences applicables du présent document doivent être imposées par chaque fabricant ou fournisseur à tous les contrats de sous-traitance ou commandes applicables. Le fabricant ou le fournisseur ne doit imposer ou autoriser aucune variation par rapport à ces exigences sur les contrats de sous-traitance ou sur les commandes autres que celles approuvées par l'utilisateur.

Sauf spécification contraire, les exigences du présent document ne sont pas imposées à la fourniture d'ensembles ou sous-ensembles directement disponibles (sur catalogue) (voir 14.3). Cependant, le fabricant de ces articles peut s'y conformer selon les cas.

4.7 Conceptions physiques

4.7.1 Conceptions nouvelles

Il convient que la disposition de la carte imprimée ainsi que la structure mécanique et thermique de l'ensemble électrique/électronique répondent, le cas échéant, à une norme de conception appropriée (par exemple l'IEC 61188-5-1) ou à ce qui a été approuvé par l'utilisateur. Quand un fabricant a la preuve objective qu'une nouvelle disposition donnera un produit fini de bonne qualité qui satisfera aux exigences du présent document, il convient que l'utilisateur et le fabricant s'entendent sur les modifications et il convient que la disposition soit modifiée en conséquence.

4.7.2 Conceptions existantes

Il convient que les exigences du présent document ne constituent pas l'unique raison de transformer une conception actuelle approuvée. Cependant, lorsque des conceptions électroniques ou électriques existantes subissent des modifications ayant des répercussions sur la configuration du matériel, la conception de ce dernier doit être réexaminée et des modifications recevant l'approbation de l'utilisateur doivent être faites pour assurer une conformité pratique maximale. Toute proposition de modification de conception de la part du fabricant doit être approuvée par l'utilisateur; cependant, même lorsque les modifications proposées donnent des produits finis de bonne qualité conformes au présent document, l'utilisateur n'est pas dans l'obligation d'accepter les modifications proposées.

4.8 Aides visuelles

Les dessins et les illustrations sont représentés ici afin de faciliter l'interprétation des exigences écrites du présent document. Les exigences écrites sont prioritaires.

4.9 Compétence du personnel

4.9.1 Compétence au niveau de la conception

Le service de conception doit disposer de documents prouvant que l'ensemble du personnel technique a reçu une formation formelle à la conception. La formation doit être dispensée sans tenir compte de la responsabilité directe du personnel vis-à-vis de la conception électronique/électrique du produit (voir l'ISO 9001).

4.9.2 Compétence au niveau de la fabrication

Avant d'entreprendre le travail, tous les instructeurs, les opérateurs et le personnel en charge des examens doivent être compétents au niveau des tâches à réaliser. Une preuve objective de cette compétence doit être conservée et disponible pour être consultée. La preuve objective doit comprendre des attestations de formations inhérentes aux fonctions applicables réalisées, des essais de conformité aux exigences du présent document ainsi que les résultats des contrôles de compétence périodiques (voir l'ISO 9001 et l'IPC-A-610).

4.10 Décharge électrostatique (ESD, ElectroStatic Discharge)

Le programme de contrôle ESD doit être conforme à l'IEC 61340-5-1 et à l'IEC/TR 61340-5-2. Les procédures et leurs pièces justificatives, relatives au contrôle de décharge électrostatique pour la protection des pièces, composants, ensembles et matériels électriques et électroniques sensibles aux ESD doivent être conservées, entre autres, durant les phases suivantes:

a) la réception et l'essai des articles reçus;

b) le stockage et l'assemblage des cartes, composants et pièces;

c) la fabrication et les retouches;

d) l'examen et les cycles d'essai;

e) le stockage et l'expédition du produit fini;

f) le transport et l'installation.

Les procédures d'analyse des défaillances résultant d'une ESD doivent être documentées et être disponibles pour être consultées par un inspecteur mandaté.

4.11 Installations

4.11.1 Généralités

La propreté et les environnements ambiants dans toutes les zones de travail doivent être maintenus à des niveaux prévenant toute contamination ou détérioration des outils et des matériaux de brasage ainsi que des surfaces à braser. Il doit être interdit de manger, de boire et de consommer du tabac ou des drogues illicites sur le lieu de travail.

4.11.2 Contrôles environnementaux

Il convient de placer l'installation de brasage dans un espace clos, de réguler la température et l'humidité et de maintenir une pression positive.

4.11.3 Température et humidité

Quand l'humidité relative diminue pour atteindre 30 % ou moins, le fabricant doit vérifier que le contrôle de décharge électrostatique est adéquat et que le degré d'humidité est suffisant pour conserver les performances du flux et des applications de pâte à braser. Pour assurer le confort de l'opérateur et le maintien de la brasabilité, il convient de maintenir la température entre 18 °C et 30 °C et il convient de ne pas dépasser une humidité relative de 70 %. Pour le contrôle de processus, il convient d'évaluer la nécessité d'imposer des limites plus restrictives en ce qui concerne la température et l'humidité.

4.11.4 Eclairage

L'éclairage du plan de travail des postes de brasage manuel et des postes d'examen doit être de 1 000 $\mathrm{lm/m^2}$ au minimum.

4.11.5 Conditions sur le terrain

Pour les opérations sur le terrain, où il n'est pas possible de respecter les conditions d'environnement contrôlé exigées par le présent document, des précautions particulières doivent être prises afin d'optimiser la qualité des connexions brasées et de réduire le plus possible les effets de l'environnement non contrôlé pour l'opération réalisée sur le matériel.

4.11.6 Salles blanches

L'assemblage de composants électroniques peut nécessiter l'utilisation de salles blanches pour assurer la conformité aux exigences relatives à la qualité de fonctionnement de la production finale, figurant dans le présent document. Si cela est exigé, la classe de la salle blanche doit faire l'objet d'un accord entre l'utilisateur et le fabricant.

4.12 Outils et matériel d'assemblage

4.12.1 Généralités

Le fabricant est responsable du choix et de l'entretien des outils et du matériel utilisés lors de la préparation et du brasage de composants et/ou de conducteurs. Les outils utilisés doivent être choisis et entretenus de façon que leur utilisation ne provoque aucun dommage. Il convient de veiller à la propreté des outils et du matériel avant leur utilisation, de les maintenir propres et d'éliminer les traces de saleté, de graisse, de flux, d'huile et de tout autre corps étranger au cours de l'utilisation. Les fers à braser, le matériel et les systèmes de brasage doivent être choisis et utilisés de façon à assurer le contrôle de la température et l'isolation contre les surcharges électriques (EOS, Electrical OverStress) ou les ESD (voir 4.10).

4.12.2 Contrôle de processus

Si des contrôles de processus adaptés ne sont pas mis en place pour assurer la conformité à 4.12 et à l'objectif de l'Annexe A, les exigences applicables détaillées de l'Annexe A doivent s'appliquer obligatoirement. Les outils et le matériel d'assemblage doivent être utilisés conformément à un processus documenté disponible pour consultation par l'utilisateur. Les outils et le matériel d'assemblage doivent indiquer les paramètres du processus, tel que cela est décrit dans la documentation du processus.

5 Exigences relatives aux matériaux

5.1 Vue d'ensemble

Les matériaux utilisés pour les processus de brasage stipulés dans le présent document doivent être conformes à ce qui est spécifié ci-après. Les matériaux et les processus spécifiés pouvant ne pas être compatibles avec certaines combinaisons, le fabricant doit être responsable du choix de la combinaison de matériaux et de processus permettant d'obtenir des produits acceptables.

5.2 Brasure

Les alliages de brasure conformes à l'IEC 61190-1-3 doivent être utilisés. D'autres alliages assurant la durée de vie, la qualité de fonctionnement, la fiabilité ou la conformité aux exigences réglementaires exigées pour le produit peuvent être utilisés si toutes les autres conditions du présent document sont respectées et si l'utilisateur et le fabricant sont d'accord sur ce point.

5.3 Flux

Le flux doit être soumis à essai et il doit être classé conformément à l'IEC 61190-1-1 ou à une norme équivalente, parmi l'un des trois types suivants:

L = activité faible ou inexistante du flux/résidu de flux;

M = activité modérée du flux/résidu de flux;

H = activité importante du flux/résidu de flux.

Un flux de type L ou M doit être utilisé pour le brasage des ensembles. Dans le cas d'applications pour lesquelles le résidu de flux n'est pas retiré (pas nettoyé), il est recommandé d'utiliser un flux de type L satisfaisant aux exigences de 9.6.9 sans nettoyage (C00) (voir 9.6.3.2).

Des flux acides inorganiques et des flux de type H peuvent être utilisés pour l'étamage des bornes, des fils rigides et des composants scellés. Les flux acides inorganiques ne peuvent pas être utilisés pour le brasage des ensembles. Les flux de type H peuvent être utilisés pour le brasage des bornes, des fils rigides et des composants scellés s'ils s'intègrent à un système de fluxage, brasage, nettoyage et d'essai de propreté, et si l'une ou l'autre des conditions suivantes est respectée:

g) l'utilisation est approuvée par l'utilisateur;

h) des données démontrant la conformité aux exigences d'essai de l'Annexe B sont disponibles pour être consultées.

Quand le flux de type H est utilisé, le nettoyage est obligatoire.

Lorsqu'un flux liquide est utilisé conjointement avec d'autres flux, il doit être chimiquement compatible avec les autres flux et matériaux qui lui seront associés. Le flux d'une brasure à flux incorporé doit être conforme au présent paragraphe. Le pourcentage de flux dans une brasure à flux incorporé est facultatif.

5.4 Pâte à braser

Les composants de la pâte à braser, de la poudre à braser et du flux doivent satisfaire aux exigences de 5.2 et 5.3, et il convient de les évaluer conformément à l'IEC 61190-1-2, afin de satisfaire aux exigences relatives au processus d'assemblage.

5.5 Préformes de brasage

Les préformes de brasage doivent satisfaire à toutes les exigences applicables de 5.2 et 5.3.

5.6 Adhésifs

Les matériaux adhésifs utilisés pour la fixation de composants doivent être appropriés à l'utilisation et compatibles avec l'ensemble.

5.7 Agents nettoyants

5.7.1 Généralités

Les agents nettoyants utilisés pour enlever les traces de graisse, d'huile, de cire, de saleté, de flux et autres débris doivent être choisis pour leur aptitude à éliminer le résidu de flux ainsi que d'autres résidus et contaminants présents sous forme de particules. Il convient que les agents nettoyants ne contiennent pas de produits chimiques agressifs, et ils ne doivent pas dégrader les matériaux ou les pièces nettoyés. Le processus de nettoyage doit permettre à l'ensemble de satisfaire aux exigences de 9.3 relatives au nettoyage.

5.7.2 Choix des agents nettoyants

Les agents nettoyants et les mélanges d'agents nettoyants doivent se conformer à toutes les spécifications et références appropriées. Des mélanges d'agents nettoyants peuvent être utilisés à condition qu'ils soient convenablement stabilisés ou inhibés.

L'utilisation de solvants chlorés n'est pas autorisée. L'eau, le mélange hydroalcoolique ou les terpènes doivent constituer les principaux éléments à prendre en considération pour les applications de nettoyage. L'utilisation d'un quelconque solvant de nettoyage doit respecter les réglementations applicables en matière de santé et de sécurité, ainsi que les autres réglementations relatives à l'environnement.

5.8 Revêtements en polymères

5.8.1 Epargnes de brasure et masques localisés

Les revêtements d'épargne de brasure en polymères et les masques temporaires, conformément à l'IEC 61249-8-8, doivent être réalisés dans un matériau qui:

a) ne réduit pas la brasabilité et ne dégrade ni le substrat ni le câblage imprimé;

b) limite la vague de brasage à la zone masquée;

c) est compatible, s'il reste en place, avec le matériau de base de la carte imprimée, le matériau conducteur, les flux prévus, l'adhésif et les revêtements enrobants appliqués par la suite;

d) peut, s'il est temporaire, être facilement éliminé sans qu'il en résulte de contamination résiduelle préjudiciable à l'intégrité du revêtement enrobant de la carte imprimée ou de l'ensemble.

5.8.2 Revêtement enrobant et encapsulants

Les exigences relatives au revêtement enrobant pour les ensembles, y compris le type de revêtement (c'est-à-dire le matériau), doivent se conformer au document d'assemblage approuvé. Si le revêtement de bord est spécifié dans le document d'assemblage, il doit être conforme à 11.1.2.7. Les encapsulants doivent être appropriés à l'application et doivent être compatibles avec l'ensemble.

5.8.3 Ecarteurs (permanents et temporaires)

Les matériaux utilisés comme écarteurs mécaniques doivent résister aux processus de brasage, et il convient qu'ils permettent l'examen des joints de brasure (voir 13.2.2.3). Cette exigence comprend les écarteurs pour lesquels il convient qu'ils résistent à des températures produites par l'autoéchauffement des composants. L'emplacement, la configuration et le matériau doivent être spécifiés dans la documentation appropriée.

5.9 Dénudeurs chimiques

Les solutions chimiques, pâtes et crèmes utilisées pour dénuder des fils rigides ne doivent pas endommager le fil.

5.10 Agents nettoyants

Il convient que les agents nettoyants ne contiennent pas de produits chimiques agressifs, et ils ne doivent pas dégrader les matériaux ou les pièces nettoyés. En outre, les fils doivent être neutralisés et débarrassés des contaminants, conformément aux instructions préconisées par les fournisseurs, et doivent être brasables, conformément à 6.2.

5.11 Dispositifs de brasage rétractables à la chaleur

Les dispositifs de brasage rétractables à la chaleur doivent être auto-obturants et doivent encapsuler la connexion de brasure. Les sorties de blindage tressées doivent être conformes aux instructions de travail détaillées des fabricants, élaborées pour refléter les exigences documentées sur un document d'assemblage approuvé.

6 Exigences relatives aux composants et cartes imprimées

6.1 Généralités

Les composants électroniques/mécaniques et les cartes imprimées doivent être conformes aux exigences du document fournisseur; le fabricant de l'ensemble doit assurer la conformité. Les composants et cartes imprimées choisis pour l'ensemble doivent être compatibles avec tous les matériaux et processus utilisés pour fabriquer l'ensemble.

NOTE Pour de plus amples informations, consulter l'IEC 62326-1, l'IEC 62326-4, l'IEC 62326-4-1 et l'IEC/PAS 62326-7-1.

6.2 Brasabilité

6.2.1 Brasabilité des pièces

Le fournisseur doit être responsable de la brasabilité des pièces, qui doit satisfaire aux exigences spécifiées et approuvées par le fabricant. Les composants électroniques/mécaniques et les fils doivent satisfaire aux exigences relatives à la brasabilité s'ils sont soumis à essai conformément à l'IEC 60068-2-20, à l'IEC 60068-2-58 ou à une norme équivalente; les cartes imprimées doivent satisfaire aux exigences si elles sont soumises à essai conformément à l'IEC 61189-3 ou à une norme équivalente.

Avant l'acceptation de pièces en vue de leur stockage ou de leur utilisation, le fabricant doit s'assurer que les pièces à braser ont fait l'objet d'essais de brasabilité, conformément à un plan d'échantillonnage, et il doit assurer la conformité aux exigences de la spécification applicable relative à la brasabilité. Il convient que l'utilisateur précise la spécification relative à la brasabilité exigée. Les conditions de stockage doivent être conformes à la classe 1K2 de l'IEC 60721-3-1 et de l'IEC 61760-2.

6.2.2 Reconditionnement

Lorsque l'étamage et l'examen sont réalisés au cours du processus d'assemblage, cette opération d'étamage peut être utilisée pour remplacer l'essai de brasabilité (voir 6.3).

6.2.3 Essai de brasabilité des circuits sur substrats céramiques

Les éléments métalliques des circuits sur substrats céramiques doivent être soumis à un essai de brasabilité, tel que spécifié dans l'IEC 61189-3, ou en appliquant une méthode équivalente.

6.3 Maintien de la brasabilité

6.3.1 Généralités

Le fabricant doit assurer que tous les composants, sorties, câblages, bornes et cartes imprimées satisfaisant aux exigences de 6.2 sont brasables au début des opérations de brasage manuelles et/ou à la machine. Le fabricant doit établir des procédures permettant de réduire le plus possible la dégradation de la brasabilité.

6.3.2 Préconditionnement

Les sorties et les bornes des composants peuvent être préconditionnées (par exemple l'immersion dans la brasure chauffée) afin d'assurer le maintien de la brasabilité.

6.3.3 Effritement de la dorure dans les joints brasés

6.3.3.1 Généralités

Afin de réduire le plus possible l'impact de l'effritement de la brasure des parties dorées (par exemple les sorties de composants, les pastilles des cartes imprimées), le volume total d'or dans un joint ne doit pas dépasser 1,4 % du volume (c'est-à-dire 3 % en masse) de la brasure constituant le joint.

S'il existe une preuve objective documentée, disponible pour être consultée, de l'absence de problèmes d'effritement de la brasure au niveau de la dorure ou autres problèmes d'intégrité du joint de brasure quant à l'état de la surface métallique, associés au processus de brasage appliqué, les exigences suivantes peuvent être supprimées.

6.3.3.2 Dorure sur les sorties de composants

Le fabricant doit démontrer la conformité à l'exigence relative au prébrasage, c'est-à-dire:

a) que toutes les sorties et bornes dorées ont été pré-étamées ou que la dorure a été retirée des surfaces à braser; et/ou

b) que la quantité de dorure résiduelle avant la brasure ne provoquera pas le dépassement des limites fixées en 6.3.3.

6.3.3.3 Etamage des sorties

L'étamage des sorties ne doit pas détériorer les composants. Il convient d'utiliser un processus de double étamage ou une vague de brasage dynamique pour enlever la dorure de manière efficace.

Le processus de retrait de la dorure peut être éliminé pour les composants destinés à être fixés grâce à des processus de brasage par immersion, de brasage à la vague, ou à la traîne, à condition que:

a) l'épaisseur de la dorure soit suffisante pour satisfaire aux exigences de brasabilité de 6.2;

b) le temps, la température et le volume de brasure soient suffisants, au cours du processus de brasage, pour satisfaire aux exigences de 6.3.3.

6.3.3.4 Dorure sur une pastille de la carte imprimée

Le volume d'or déposé sur une quelconque pastille de la carte imprimée destinée au brasage de composants ou de bornes ne doit pas être la cause du non-respect des limites de 6.3.3.

6.3.4 Etamage des pièces non brasables

Les sorties et les bornes de composants et les cartes imprimées ne satisfaisant pas aux exigences de brasabilité désignées doivent être retouchées par le biais d'un étamage par