IEC 60749-20-1

Edition 2.0 2019-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices – Mechanical and climatic test methods –
Part 20-1: Handling, packing, labelling and shipping of surface-mount devices sensitive to the combined effect of moisture and soldering heat

Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques –
Partie 20-1: Manipulation, emballage, étiquetage et transport des composants pour montage en surface sensibles à l'effet combiné de l'humidité et de la chaleur de brasage

IEC 60749-20-1:2019-06(en-fr)

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 corrigendum or an amendment might have been published.

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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries 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.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,…). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

IEC 60749-20-1

Edition 2.0 2019-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices – Mechanical and climatic test methods – Part 20-1: Handling, packing, labelling and shipping of surface-mount devices sensitive to the combined effect of moisture and soldering heat

Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques – Partie 20-1: Manipulation, emballage, étiquetage et transport des composants pour montage en surface sensibles à l'effet combiné de l'humidité et de la chaleur de brasage

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 31.080.01

ISBN 978-2-8322-7043-1

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 20-1: Handling, packing, labelling and shipping of surface-mount devices sensitive to the combined effect of moisture and soldering heat

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.

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 second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

a) updates to subclauses to better align the test method with IPC/JEDEC J-STD-033C, including new sections on aqueous cleaning and dry pack precautions;

b) addition of two annexes on colorimetric testing of HIC (humidity indicator card) and derivation of bake tables.

The text of this standard is based on the following documents:

FDIS	Report on voting
47/2565/FDIS	47/2579/RVD

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

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

A list of all parts in the IEC 60749 series, published under the general title *Semiconductor devices – Mechanical and climatic test methods,* can be found on the IEC website.

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

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

INTRODUCTION

The advent of surface-mount devices (SMDs) introduced a new class of quality and reliability concerns regarding package damage "cracks and delamination" from the solder reflow process. This document describes the standardized levels of floor life exposure for moisture/reflow-sensitive SMDs along with the handling, packing and shipping requirements necessary to avoid moisture/reflow-related failures. IEC 60749-20 defines the classification procedure and Annex A of this document defines the labelling requirements.

Moisture from atmospheric humidity enters permeable packaging materials by diffusion. Assembly processes used to solder SMDs to printed circuit boards (PCBs) expose the entire package body to temperatures higher than 200 °C. During solder reflow, the combination of rapid moisture expansion, materials mismatch, and material interface degradation can result in package cracking and/or delamination of critical interfaces within the package.

Typical solder reflow processes of concern for all devices are infrared (IR), convection/IR, convection, vapour phase reflow (VPR), hot air rework tools, and wave solder, including full immersion.

Non-semiconductor devices can exhibit additional process sensitivities beyond moisture sensitivity such as thermal sensitivity, flux sensitivity, or cleaning process sensitivity.

SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 20-1: Handling, packing, labelling and shipping of surface-mount devices sensitive to the combined effect of moisture and soldering heat

1 Scope

This part of IEC 60749 applies to all devices subjected to bulk solder reflow processes during PCB assembly, including plastic encapsulated packages, process sensitive devices, and other moisture-sensitive devices made with moisture-permeable materials (epoxies, silicones, etc.) that are exposed to the ambient air.

The purpose of this document is to provide SMD manufacturers and users with standardized methods for handling, packing, shipping, and use of moisture/reflow sensitive SMDs that have been classified to the levels defined in IEC 60749-20. These methods are provided to avoid damage from moisture absorption and exposure to solder reflow temperatures that can result in yield and reliability degradation. By using these procedures, safe and damage-free reflow can be achieved, with the dry packing process, providing a minimum shelf life capability in sealed dry-bags from the seal date.

Two test conditions, method A and method B, are specified in the soldering heat test of IEC 60749-20. For method A, moisture soak conditions are specified on the assumption that moisture content inside the moisture barrier bag is less than 30 % RH. For method B, moisture soaking conditions are specified on the assumption that manufacturer's exposure time (MET) does not exceed 24 h and the moisture content inside the moisture barrier bag is less than 10 % RH. In an actual handling environment, SMDs tested by method A are permitted to absorb moisture up to 30 % RH, and SMDs tested by method B are permitted to absorb moisture up to 10 % RH. This document specifies the handling conditions for SMDs subjected to the above test conditions.

NOTE Hermetic SMD packages are not moisture sensitive and do not require moisture precautionary handling.

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 60749-20, *Semiconductor devices – Mechanical and climatic test methods – Part 20: Resistance of plastic-encapsulated SMDs to the combined effect of moisture and soldering heat*

IEC 60749-30, *Semiconductor devices – Mechanical and climatic test methods – Part 30: Preconditioning of non-hermetic surface mount devices prior to reliability testing*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
active desiccant
desiccant that is either fresh (new) or has been baked according to the manufacturer's recommendations to renew it to original specifications

3.2
bar code label
label that gives information in a code consisting of parallel bars and spaces, each of various specific widths

Note 1 to entry: For the purposes of this document, the bar code label is on the lowest level shipping container and includes information that describes the product, e.g. part number, quantity, lot information, supplier identification, moisture-sensitivity level.

3.3
mass reflow
reflow of a number of components with simultaneous attachment by an infrared (IR), convection/IR, convection, or vapour phase reflow (VPR) process

3.4
carrier
container that directly holds components such as a tray, tube, or tape and reel

3.5
desiccant
absorbent material used to maintain a low relative humidity

3.6
floor life
allowable time period for a moisture-sensitive device, after removal from a moisture barrier bag, dry storage or dry bake and before the solder reflow process

3.7
humidity indicator card
HIC
card printed with a moisture-sensitive chemical (cobalt bromide) that changes from blue to pink in the presence of water vapour

Note 1 to entry: The HIC is packed inside the moisture-barrier bag, along with a desiccant, to aid in determining the level of moisture to which the moisture-sensitive devices have been subjected.

Note 2 to entry: This note applies to the French language only.

3.8
manufacturer's exposure time
MET
maximum time after bake that the component manufacturer requires to process components prior to bag seal, and that also includes the maximum time allowed at the distributor for having the bag open to split out smaller shipments

Note 1 to entry: This note applies to the French language only.

3.9
moisture barrier bag
MBB
storage bag manufactured with a flexible laminated vapour barrier film that restricts the transmission of water vapour

Note 1 to entry: This note applies to the French language only.

3.10
rework
removal of a component for scrap, reuse, or failure analysis; replacement of an attached component; or heating and repositioning of a previously attached component

3.11
shelf-life
maximum storage period for a dry-packed moisture-sensitive device in an unopened moisture barrier bag (MBB) to avoid exceeding the specified interior bag ambient humidity

3.12
surface-mount device
SMD
plastic-encapsulated surface-mount devices made with moisture-permeable materials

Note 1 to entry: For the purposes of this document, the term "SMD" is limited as indicated in the above definition.

3.13
solder reflow
solder attachment process in which previously applied solder or solder paste is melted to attach a component to the printed circuit board

3.14
water vapour transmission rate
WVTR
measure of the permeability of plastic film or metallized plastic film material to moisture

4 General applicability and reliability considerations

4.1 Assembly processes

4.1.1 Mass reflow

This document applies to mass solder reflow assembly by convection, convection/IR, infrared (IR), and vapour phase (VPR), processes. It does not apply to mass solder reflow processes that immerse the component bodies in molten solder (e.g. wave soldering bottom mounted components). Such processes are not allowed for many SMDs and are not covered by the component qualifications standards used as a basis for this document.

4.1.2 Localized heating

This document also applies to moisture-sensitive SMDs that are removed or attached singly by local ambient heating, i.e. "hot air rework". See Annex B.

4.1.3 Socketed components

This document does not apply to SMDs that are socketed and not exposed to solder reflow temperatures. Such SMDs are not at risk and do not require moisture precautionary handling.

4.1.4 Point-to-point soldering

This document does not apply to SMDs in which only the leads are heated to reflow the solder, e.g. hand-soldering, hot bar attach of gull-wing leads, and through hole by wave soldering. The heat absorbed by the SMD body from such operations is typically much lower than that for mass surface mount reflow or hot air rework, and moisture precautionary measures are typically not needed.

4.1.5 Aqueous cleaning

For non-cavity SMDs, typical short-term aqueous cleaning processes will not impact the floor life (internal moisture content). Special consideration should be given to non-hermetic cavity packages.

4.2 Reliability

The methods set forth in this specification ensure that an adequate SMD reliability can be achieved during and after the PCB assembly operation, when the SMDs are evaluated and verified by IEC 60749-20 and/or by IEC 60749-30, together with environmental reliability testing.

This specification does not address or ensure solder joint reliability of attached components.

5 Dry packing

5.1 Requirements

Dry packing requirements for the various moisture sensitivity levels are shown in Table 1. The levels are determined in accordance with IEC 60749-20 and/or IEC 60749-30, together with reliability testing. As a minimum, all materials used in dry packing should conform to relevant national packaging material standards for ESD-sensitive items.

Table 1 – Dry packing requirements

Level	Dry before bag	MBB	Desiccant	MSID[a] label	Caution label
A1 or B1	Optional	Optional	Optional	Not required	Not required if classified at 220 °C to 225 °C
					Required[b] if classified at other than 220 °C to 225 °C
A2 or B2	Optional	Required	Required	Required	Required
B2a-B5a	Required	Required	Required	Required	Required
B6	Optional	Optional	Optional	Required	Required

[a] MSID = moisture-sensitive identification label.

[b] A "Caution" label is not required if level and reflow temperature are given, in human readable form, on the barcode label attached to the lowest level shipping container.

5.2 Drying of SMDs and carrier materials before being sealed in MBBs

5.2.1 Drying requirements – level A2

Packing of the SMDs classified as Level A2 into MBBs shall be carried out within one week under the environmental condition below 30 °C/60 % RH after moulding, burn-in, or bake.

MET is not specified for Level A2 SMDs.

MBBs may be opened for a short period of time (less than 1 h) and re-closed provided that the HIC indicates a humidity of less than 30 % RH and provided that the desiccant is replaced with fresh desiccant. When the MBB is next opened, as long as the HIC indicates below 30 % RH, the duration time of the previous MBB's opening may be disregarded. Thus, if the HIC indicates below 30 % RH when MBB is opened, the floor life is not dependent on the duration time of the MBB's opening, and is 168 h at 30 °C/70 % RH.

5.2.2 Drying requirements – levels B2a to B5a

SMDs classified from Levels B2a through to B5a shall be dried (see Clause 6) prior to being sealed in MBBs. The period between drying and sealing shall not exceed the MET less the time allowed for distributors to open the bags and repack parts. If the supplier's actual MET is more than the default 24 h, then the actual time shall be used. If the distributor practice is to repack the MBBs with active desiccant, then this time does not need to be subtracted from the MET.

5.2.3 Drying requirements – carrier materials

The materials from which carriers (such as trays, tubes, reels) are made can affect the moisture level when placed in the MBB. Therefore, the effect of these materials shall be compensated for by baking or, if required, adding additional desiccant in the MBB to ensure the shelf life of the SMDs (see 6.3).

5.2.4 Drying requirements – other

Suppliers may use the drying effect of normal in-line processes such as post-mould cure, marking cure, and burn-in to reduce the bake time. An equivalency evaluation is recommended to ensure that high-temperature processing maintains moisture weight gain to an acceptable level. The total weight gain for the SMD at the time it is sealed in the MBB shall not exceed the moisture gain of that SMD starting dry and then being exposed to 30 °C/60 % RH for MET h (less the time for distributors).

5.2.5 Excess time between bake and bag

If the allowable time between bake and bag is exceeded, the SMDs shall be redried in accordance with Clause 6.

5.3 Dry pack

5.3.1 Description

A dry pack consists of desiccant material and a humidity indicator card (HIC) sealed with the SMDs and their carriers inside a moisture barrier bag (MBB). A representative dry pack configuration is shown in Figure 1.

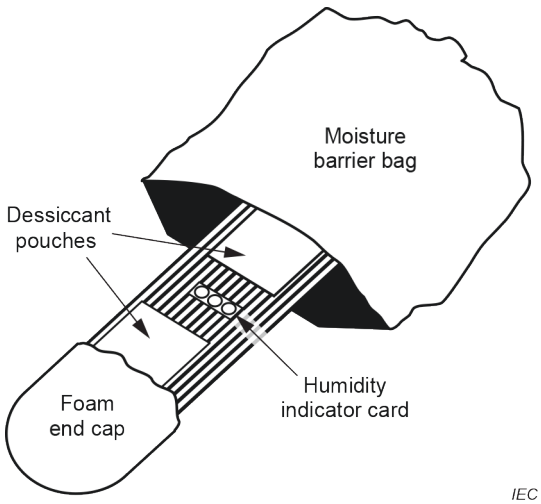

Figure 1 – Typical dry pack configuration for moisture-sensitive SMDs in shipping tubes

5.3.2 Materials

5.3.2.1 Moisture barrier bag (MBB)

The moisture barrier bag shall meet relevant national standard requirements for flexibility, ESD protection, mechanical strength, and puncture resistance. The bags shall be heat-sealable. The water vapour transmission rate (WVTR) shall be ≤ 0,03 g/m^2 in 24 h at 40 °C after flex testing in accordance with relevant national standards governing flex durability of flexible barrier materials. The WVTR is measured using relevant national standards governing water vapour transmission rate through plastic film and sheeting using a modulated infrared sensor.

5.3.2.2 Desiccant

The desiccant material shall comply with relevant national standards governing activated desiccants used for the static dehumidification of packaging bags. Desiccant shall be dustless, non-corrosive, and absorbent to amounts specified in the standard. The desiccant shall be packaged in moisture-permeable bags. The amount of desiccant used, per moisture barrier bag, shall be based on the bag surface area and WVTR in order to maintain an interior relative humidity in the MBB of less than 30 % at 25 °C for SMD classification A2 and less than 10 % at 25 °C for SMDs classified from Levels B2a to B5a.

For comparison between various desiccant types, certain specifications adopted the "UNIT" as the basic unit of measure of quantity for desiccant material. A UNIT of desiccant is defined as the amount that will absorb a minimum of 2,85 g of water vapour at 20 % RH and 25 °C. To meet the dry pack requirements of this document, the amount of water vapour that a UNIT of desiccant can absorb at 10 % RH and 25 °C shall be known.

When the desiccant capacity at 10 % RH and 25 °C is known, the following equation should be used.

$$U = (0{,}003 \times M \times WVTR \times A)/D \qquad (1)$$

where

U = amount of desiccant in UNITS;

M = shelf life desired in months;

$WVTR$ = water vapour transmission rate in g/m^2 in 24 h;

A = total surface area of the MBB in m^2;

D = amount of water in grams, that a UNIT of desiccant will absorb at 10 % RH and 25 °C.

When the desiccant capacity at 10 % RH and 25 °C is not known, the quantity needed can be estimated using the following simplified equation.

$$U = 8 \times A \qquad (2)$$

where

U = amount of desiccant in UNITS;

A = total surface area of the MBB in m^2.

If it is desired to minimize the amount of desiccant used for dry-packing level 2 components, a value of D based on the amount of water in grams that a UNIT of desiccant will absorb at 60 % RH and 25 °C should be used in the formula. This value can be obtained from the desiccant manufacturer. When this option is used, it can be verified that, when the component was classified in accordance with IEC 60749-20, it has achieved full saturation during moisture soak.