

# INTERNATIONAL STANDARD



**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**

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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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**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

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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- withdrawn,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.

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## 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.

~~The solder reflow processes of concern are convection, convection/IR, infrared (IR), vapour phase (VPR) and hot air rework tools. The use of assembly processes that immerse the component body in molten solder are not recommended for most SMDs.~~

~~This first edition of IEC 60749-20-1 is based principally on IPC/JEDEC J-STD-033<sup>1</sup> and the permission to use this standard is gratefully acknowledged. It is also based on contributing documents from various national committees.~~

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.

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<sup>1</sup>—Refer to Bibliography.

## 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 ~~non-hermetic SMD packages which are subjected to reflow solder processes and~~ 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, ~~and moisture-sensitivity level etc.~~

### 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 on which a moisture sensitive chemical is applied in such a way that it will make a significant, perceptible change in colour (hue), typically from blue (dry) to pink (wet) when the indicated relative humidity is exceeded~~

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**

~~bag designed to restrict the transmission of water vapour and used to pack moisture-sensitive devices~~

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 <sup>a</sup> label	Caution label
A1 or B1	Optional	Optional	Optional	Not required	Not required if classified at 220 °C to 225 °C
					Required <sup>b</sup> 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

<sup>a</sup> MSID = moisture-sensitive identification label.

<sup>b</sup> 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, etc.) 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).

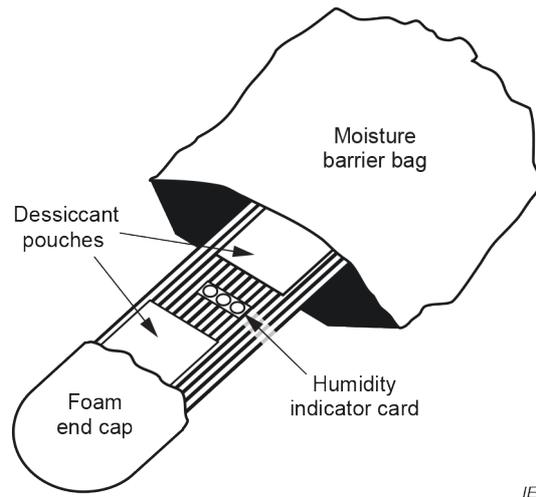
### 5.2.5 Excess time between bake and bag

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  $\leq 0,03 \text{ g/m}^2$  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 ~~must~~ shall be known.

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

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

where

$U$  = amount of desiccant in UNITS;

$M$  = shelf life desired in months;

$WVTR$  = water vapour transmission rate in  $\text{g/m}^2$  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.

$$U = 8 \times A \tag{2}$$

where

$U$  = amount of desiccant in UNITS;

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

~~NOTE—If trays, tubes, reels, foam end caps, etc., are placed in the bag without baking, additional desiccant will be required to absorb the moisture contained in these materials.~~

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.

No moisture-absorbing material (e.g. trays, tubes, reels, foam end caps) should be placed in the dry bag without baking. Any such material that is included increases the amount of desiccant needed to meet the calculated shelf life (see 7.4.2) by an amount based on the moisture content of the material. This can be determined by weighing a representative quantity of material known to be at equilibrium with the manufacturing environment, baking to a new constant weight, and subtracting the final from the initial weight. Additional UNIT(s) of desiccant, based on 10 % RH at 25 °C, should be added to absorb the amount of water, in grams, egressed from the packing materials (dunnage) after baking.

### 5.3.2.3 Desiccant handling and storage

Desiccant capacity decreases rapidly when exposed to 30 °C/60 % RH. Therefore, the desiccant should remain in the manufacturer's container or stored in a dry cabinet at < 5 % RH until use. When dry packing, the desiccant shall be removed from the storage container just prior to placing it into the MBB and sealing the MBB.

### 5.3.2.4 Humidity indicator card (HIC)

The HIC shall comply with relevant national standards governing chemically impregnated humidity indicator cards. For level A2, the HIC shall have a sensitivity value of 30 % RH, which may be indicated by colour dots with sensitivity values of 20 % RH, 30 % RH, 40 % RH. For SMDs classified from Levels B2a through to B5a, as a minimum, the HIC shall have 3 colour dots with sensitivity values of 5 % RH, 10 % RH, 60 % RH. The spots shall indicate the humidity with a significant and perceptible change in colour (hue) as indicated in Table 2. Hue shall be tested using the test method in Annex C. The colours shall be described in writing on the card. HIC reuse is not allowed if the 60 % spot has changed colour. Reuse is not allowed, owing to loss of accuracy of the 5 % and 10 % spot chemistry, if the 60 % spot has changed colour. It is not required to reuse the same HIC from the MBB if the MBB is to be resealed; a fresh HIC may be used.

Examples of HIC are shown in Figures 2a) and 2b).

### 5.3.2.5 HIC paper

White blotting paper made from fibrous, cellulosic material, with a minimum basis weight of, 255 g/m<sup>2</sup> shall be used for HICs.

### 5.3.2.6 Visual defects

HICs shall be free from defects including missing spots, tears, improperly located spots, and indicating colour overrunning the black circles.

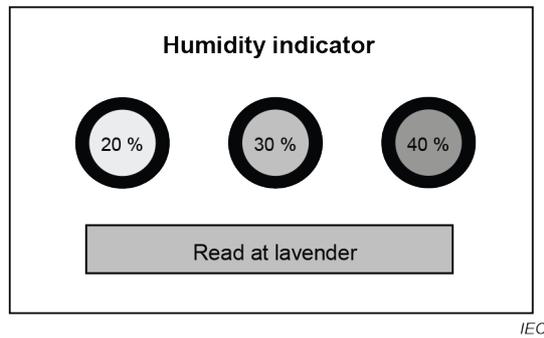
### 5.3.2.7 Preservation

HICs shall be stored in accordance with the manufacturer's recommendation prior to insertion in the MBB. At a minimum, the 10 % spot shall indicate dry when the cards are removed from the original container.

**Table 2 –Typical HIC spot compliance**

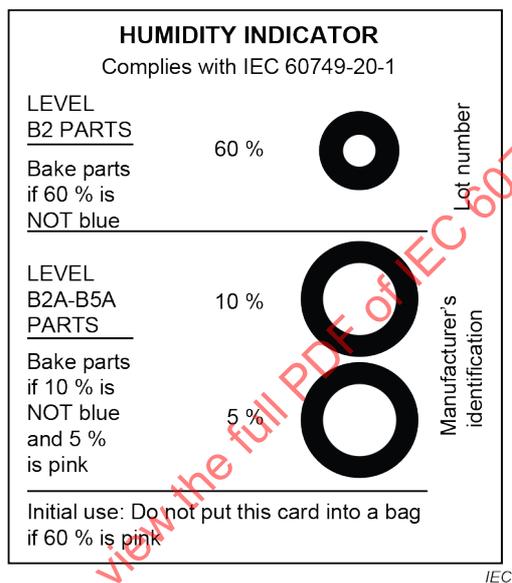
	Indication at 2 % RH environment	Indication at 5 % RH environment	Indication at 10 % RH environment	Indication at 55 % RH environment	Indication at 60 % RH environment	Indication at 65 % RH environment
5 % spot	Blue (dry)	Lavender (spot value) change $\leq 7$ % hue	Pink (wet)	Pink (wet)	Pink (wet)	Pink (wet)
10 % spot	Blue (dry)	Blue (dry)	Lavender (spot value) change $\leq 10$ % hue	Pink (wet)	Pink (wet)	Pink (wet)
60 % spot	Blue (dry)	Blue (dry)	Blue (dry)	Blue (dry)	Lavender (spot value) change $\leq 10$ % hue	Pink (wet)
NOTE Other colour schemes can be used.						

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Below 30 % RH can be confirmed by comparison of a colour (lavender).

**a) Example of humidity indicator card for level A2**



**b) Example of humidity indicator card for levels B2a to B5a**

**Figure 2 – Example humidity indicator cards**

**5.3.3 Labels**

**5.3.3.1 Labels – Moisture sensitive identification**

Labels relevant to the dry pack process are the moisture-sensitive identification (MSID) label and the caution label as specified in Annex A (see Figures A.2 to A.5). The MSID label shall be affixed to the lowest-level shipping container that contains the MBB. The caution label shall be affixed to the outside surface of the MBB. The caution label includes fields for the moisture classification level in accordance with IEC 60749-20; the peak package body temperature allowed during reflow soldering (the classification temperature); the floor life; and the bag seal date. If the calculated shelf life is greater than 12 months, item # 1 of the caution label shall be changed accordingly.

**5.3.3.2 Labels – Level B6 requirements**

Level B6 parts not shipped in MBBs shall have both an MSID label and the appropriate caution label affixed to the lowest level shipping container.

**5.3.3.3 Labels – Level A1 and B1 requirements**

Level A1 and B1 parts classified for other than from 220 °C to 225 °C maximum reflow temperature shall have a caution label with the maximum reflow temperature specified. The

caution label shall be affixed to the MBB (if used) or to the lowest-level shipping container. The caution label will not be required if a bar code label includes the level A1 or B1 classification and maximum reflow temperature information in human readable form. Level A1 and B1 parts classified at from 220 °C to 225 °C maximum reflow temperature do not require any moisture-related labels.

#### 5.3.4 Moisture barrier bag sealing

The bag shall be heat sealed so as not to damage or cause delamination of the MBB.

#### 5.3.5 Dry pack precautions

##### 5.3.5.1 HIC placement

The HIC may be placed anywhere in the MBB, but shall not be placed under a desiccant pouch.

##### 5.3.5.2 HIC reuse

HIC cards where the 10 % spot indicates wet shall not be used/reused if the bag will be opened and the HIC card inspected within 48 h.

HIC with 60 % RH indicated shall be discarded if the 60 % spot has indicated wet. HICs that have been exposed to 60 % or greater RH will no longer be accurate.

##### 5.3.5.3 Moisture barrier bag sealing

In actual practice, air evacuation is not required. Light air evacuation is to be used to reduce the packaging bulk and enhance carton packing. Full evacuation shall not be used as it will impede desiccant and HIC performance and possibly lead to MBB puncture.

#### 5.3.6 Shelf life

The calculated shelf life for dry packed SMDs shall be a minimum of 12 months from the bag seal date, when stored in a non-condensing atmospheric environment of <40 °C/90 % RH. If the calculated shelf life is greater than 12 months, item # 1 of the caution label is changed accordingly (see Figures A.4 and A.5).

## 6 Drying

### 6.1 Drying options

Component drying options for various moisture sensitivity levels and ambient humidity exposures of ~~≤60 % RH~~ are given in Tables 3, 4, 5 and 6. Drying using an allowable option resets the floor life clock. If dried and sealed in an MBB with fresh desiccant, the shelf life is reset. Tables 3, 4, 5 and 6 give reference conditions for drying SMDs. Tables 3 and 4 give conditions for re-bake of SMDs at a user site after the floor life has expired or other conditions have occurred to indicate excess moisture exposure. Table 5 gives conditions for bake prior to dry pack at a supplier and/or distributor and allows for a maximum total of 24 h MET. Table 6 summarizes conditions for resetting or pausing the floor-life clock at the user site in accordance with 6.2.1. The supplier shall formally communicate to the distributor the maximum time that the product may be left unsealed (at the distributor) before re-baking is required.

NOTE If the baking process is interrupted for greater than 15 minutes, the total time of the interruption is added to the bake time.

**Table 3 – Reference conditions for drying mounted or unmounted SMDs  
(user bake: floor life begins counting at time = 0 after bake) – Level 2**

**Level A2**

SMD body thickness	Level A2	Bake at 125 °C		Bake at 90 °C ≤5 % HR		Bake at 40 °C ≤5 % HR	
		Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/70 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/70 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/70 % RH
≤1,4 mm		9 h	7 h	33	23 h	13 days	9 days
≤2,0 mm		27 h	17 h	4 days	2 days	37 days	23 days
≤4,5 mm		48 h	48 h	10 days	8 days	79 days	67 days
BGA package >17 mm x 17 mm or any stacked die package (See Note 2)		96 h	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level

**Levels B2a to B5a**

SMD body thickness	Level	Bake at 125 °C		Bake at 90 °C ≤5 % HR		Bake at 40 °C ≤5 % HR	
		Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/60 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/60 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/60 % RH
≤1,4 mm	B2a	7 h	5 h	23 h	13 h	9 days	7 days
	B3	9 h	7 h	33 h	23 h	13 days	9 days
	B4	11 h	7 h	37 h	23 h	15 days	9 days
	B5	12 h	7 h	41 h	24 h	17 days	10 days
	B5a	16 h	10 h	54 h	24 h	22 days	10 days
≤2,0 mm	B2a	21 h	16 h	3 days	2 days	29 days	22 days
	B3	27 h	17 h	4 days	2 days	37 days	23 days
	B4	34 h	20 h	5 days	3 days	47 days	28 days
	B5	40 h	25 h	6 days	4 days	57 days	35 days
	B5a	48 h	40 h	8 days	6 days	79 days	56 days
≤4,5 mm	B2a	48 h	48 h	10 days	7 days	79 days	67 days
	B3	48 h	48 h	10 days	8 days	79 days	67 days
	B4	48 h	48 h	10 days	10 days	79 days	67 days
	B5	48 h	48 h	10 days	10 days	79 days	67 days
	B5a	48 h	48 h	10 days	10 days	79 days	67 days
BGA package >17 mm x 17 mm or any stacked die package (See Note 2)	2-6	96 h	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level

NOTE 1—Tables 2(a) and 2(b) are based on worst-case moulded lead frame SMDs. Users may reduce the actual bake time if technically justified (e.g., absorption/desorption data, etc.). In most cases it is applicable to other non-hermetic SMDs.

NOTE 2—BGA packages >17 mm x 17 mm, that do not have internal planes that block the moisture diffusion path in the substrate, may use bake times based on the thickness/moisture level portion of the table.

SMD body thickness	Level A2	Bake at 125 °C $+10_0$ °C		Bake at 90 °C $+8_0$ °C ≤ 5 % HR		Bake at 40 °C $+5_0$ °C ≤ 5 % HR	
		Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/70 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/70 % RH	Saturated at 30 °C/85 % RH	At limit of floor life + 72 h at 30 °C/70 % RH
≤ 1,4 mm		9 h	7 h	33 h	23 h	13 days	9 days
≤ 2,0 mm		27 h	17 h	4 days	2 days	37 days	23 days
≤ 4,5 mm		48 h	48 h	10 days	8 days	79 days	67 days
BGA package >17 mm x 17 mm or any stacked die package (See Note 2)		96 h	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level

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**Table 4 – Reference conditions for drying mounted or unmounted SMDs (user bake: floor life begins counting at time = 0 after bake) – Levels B2, B2a to B5a**

SMD body thickness	Level	Bake at 125 °C $+10_0$ °C		Bake at 90 °C $+8_0$ °C ≤ 5 % RH		Bake at 40 °C $+5_0$ °C ≤ 5 % RH	
		Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/60 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/60 % RH	Saturated at 30 °C/85 % RH	At limit of floor life + 72 h at 30 °C/60 % RH
≤ 1,4 mm	B2a	7 h	5 h	23 h	13 h	9 days	7 days
	B3	9 h	7 h	33 h	23 h	13 days	9 days
	B4	11 h	7 h	37 h	23 h	15 days	9 days
	B5	12 h	7 h	41 h	24 h	17 days	10 days
	B5a	16 h	10 h	54 h	24 h	22 days	10 days
≤ 2,0 mm	B2a	21 h	16 h	3 days	2 days	29 days	22 days
	B3	27 h	17 h	4 days	2 days	37 days	23 days
	B4	34 h	20 h	5 days	3 days	47 days	28 days
	B5	40 h	25 h	6 days	4 days	57 days	35 days
	B5a	48 h	40 h	8 days	6 days	79 days	56 days
≤ 4,5 mm	B2a	48 h	48 h	10 days	7 days	79 days	67 days
	B3	48 h	48 h	10 days	8 days	79 days	67 days
	B4	48 h	48 h	10 days	10 days	79 days	67 days
	B5	48 h	48 h	10 days	10 days	79 days	67 days
	B5a	48 h	48 h	10 days	10 days	79 days	67 days
BGA package > 17 mm × 17 mm or any stacked die package (See Note 2)	B2-B6	96 h	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level

Tables 3 and 4 are based on worst case moulded lead frame SMDs. Users may reduce the actual bake time if technically justified (e.g. absorption/desorption data). In most cases, it is applicable to other non-hermetic SMDs. If parts have been exposed to > 60 % RH, consideration shall be given to the need to increase the bake time by tracking desorption data to ensure parts are dry.

BGA packages > 17 mm × 17 mm, that do not have internal planes that block the moisture diffusion path in the substrate, may use bake times based on the thickness/moisture level portion of the table.

If baking of packages > 4,5 mm is required, see Annex D.

**Table 5 – Default baking times used prior to dry-pack that were exposed to conditions  $\leq 60\%$  RH (supplier bake: MET = 24 h)**

SMD body thickness	Level	Bake at 125 °C	Bake at 150 °C
$\leq 1,4$ mm	B2a	8 h	4 h
	B3	16 h	8 h
	B4	21 h	10 h
	B5	24 h	12 h
	B5a	28 h	14 h
$\leq 2,0$ mm	B2a	23 h	11 h
	B3	43 h	21 h
	B4	48 h	24 h
	B5	48 h	24 h
	B5a	48 h	24 h
$\leq 4,5$ mm	B2a	48 h	24 h
	B3	48 h	24 h
	B4	48 h	24 h
	B5	48 h	24 h
	B5a	48 h	24 h

~~NOTE – The bake times specified are based on worst case conditions and are conditions for a supplier and/or distributor. Oxidation may occur. Suppliers may reduce the actual bake time if technically justified (e.g., absorption/ desorption data, etc.).~~

If baking of packages  $> 4,5$  mm is required, see Annex D.

The bake times specified are conservative for packages without blocking planes or stacked die. For a stacked die or BGA package with internal planes that impede moisture diffusion the actual bake time may be longer than that required in this table if packages have had extended exposure to factory ambient before bake. Also, the actual bake time may be reduced if technically justified. The increase or decrease in bake time is determined using the procedure in IEC 60749-39 (i.e.  $< 0,002\%$  weight loss between successive readouts) or in accordance with critical interface concentration calculations.

**Table 6 – Resetting or pausing the ‘floor life’ clock at user site**

Moisture sensitivity level	Exposure time at temp./humidity	Floor life	Desiccator time at relative humidity	Bake	Reset shelf life
B2a, B3, B4, B5, B5a	Anytime $\leq 40$ °C/85 % RH	reset	N/A	Table 4	Dry pack after bake
B2a, B3, B4, B5, B5a	$>$ floor life $\leq 30$ °C/60 % RH	reset	N/A	Table 4	Dry pack after bake
B2a, B3	$> 12$ h $\leq 30$ °C/60 % RH	reset	N/A	Table 4	Dry pack after bake
B2a, B3	$\leq 12$ h $\leq 30$ °C/60 % RH	reset	5 x exposure time $\leq 10$ % RH	N/A	N/A
B4, B5, B5a	$> 8$ h $\leq 30$ °C/60 % RH	reset	N/A	Table 4	Dry pack after bake
B4, B5, B5a	$\leq 8$ h $\leq 30$ °C/60 % RH	reset	10 x exposure time $\leq 5$ % RH	N/A	N/A
B2a, B3	Cumulative time $<$ floor life $\leq 30$ °C/60 % RH	pause	any time $\leq 10$ % RH	N/a	N/A

## 6.2 Post exposure to factory ambient

### 6.2.1 Floor life clock

Placing SMDs, which have been exposed to factory ambient conditions for greater than 1 h, in a dry cabinet or dry pack does not necessarily stop/pause the floor life clock. However, if the conditions of 6.2.3 are met, the floor life clock can be stopped or reset (see Table 6).

### 6.2.2 Any duration exposure

Moisture sensitive SMDs which have been exposed only to ambient conditions of  $\leq 60\%$  RH for any length of time may be adequately dried by high or low temperature baking in accordance with Tables 3 and 4 for rebake prior to reflow, or Table 5 for drying prior to dry pack.

### 6.2.3 Short duration exposure

#### 6.2.3.1 General considerations for short duration exposure

Previously dry SMDs, which have been exposed only to ambient conditions not exceeding  $30\text{ }^{\circ}\text{C}/60\%$  RH, may be adequately dried by room temperature desiccation using a dry pack or a dry cabinet. ~~If dry pack is used and the total desiccant exposure is not greater than 30 min, the original desiccant may be reused.~~

#### 6.2.3.2 Moisture sensitivity levels B2, B2a and B3

For moisture sensitivity levels B2, B2a and B3 with floor life exposure not greater than 12 h at  $30\text{ }^{\circ}\text{C}/60\%$  RH, a minimum desiccating period of  $5\times$  the exposure time is required to dry the SMDs enough to reset the floor life clock (see Table 6). This can be accomplished by dry pack in accordance with 5.3 or a dry cabinet that is capable of maintaining not greater than  $10\%$  RH.

**NOTE** For components classed as moisture-sensitive levels B2, B2a or B3, that are exposed for any time less than their stated floor life, dry packing or placing the components in a dry cabinet that maintains not greater than  $10\%$  RH, will stop/pause the floor life clock. However, the cumulative floor life should meet the conditions in Table 7 and/or Table E.2. This does not apply to level B4.

#### 6.2.3.3 Moisture sensitivity levels B4, B5 and B5a

For moisture sensitivity levels B4, B5 and B5a with floor life exposure not greater than 8 h at  $30\text{ }^{\circ}\text{C}/60\%$  RH, a minimum desiccating period of  $10\times$  the exposure time is required to dry the SMDs enough to reset the floor life clock (see Table 6). This can be accomplished by dry pack in accordance with 5.3 or a dry cabinet that is capable of maintaining not greater than  $5\%$  RH.

Once the floor life clock has been reset, refer to 7.4 for safe storage conditions.

## 6.3 General considerations for baking

### 6.3.1 High-temperature carriers

Unless otherwise indicated by the manufacturer, SMDs shipped in high-temperature carriers (e.g. high-temperature trays) can be baked in the carriers at  $125\text{ }^{\circ}\text{C}$ .

### 6.3.2 Low-temperature carriers

SMDs shipped in low-temperature carriers (e.g. tubes, low-temperature trays, tape and reel) may not be baked in the carriers at any temperature higher than  $40\text{ }^{\circ}\text{C}$ . If a higher bake

temperature is required, SMDs shall be removed from the low-temperature carriers to thermally safe carriers, baked, and returned to the low-temperature carriers.

NOTE 1 Manual handling ~~may~~ can increase the risk of mechanical and/or ESD damage.

NOTE 2 If SMDs are placed in dry bags with unbaked carriers, refer to 5.3.2.2.

### 6.3.3 Paper and plastic container items

Paper and plastic container items such as cardboard boxes, bubble pack, and plastic wrap, ~~etc.~~, shall be removed from around the carriers prior to baking. Rubber bands around tubes and plastic tray ties shall also be removed prior to the high-temperature (125 °C) bake.

### 6.3.4 Bakeout times

Bakeout times start when all SMDs reach the specified temperature.

### 6.3.5 ESD protection

Proper ESD handling precautions should be observed, in accordance with relevant national standards for ESD-sensitive items. This is particularly critical if SMDs are manually handled by vacuum pencils under low-humidity conditions, e.g. in a dry environment, after baking, ~~etc.~~

### 6.3.6 Reuse of carriers

The appropriate materials specification should be consulted before reusing carriers.

### 6.3.7 Solderability limitations

#### 6.3.7.1 Oxidation risk

Baking SMDs can cause oxidation and/or intermetallic growth of the terminations, which, if excessive, can result in solderability problems during board assembly. The temperature and time for baking SMDs are therefore limited by solderability considerations. Unless otherwise indicated by the supplier, the cumulative bake time at a temperature greater than 90 °C and up to 125 °C shall not exceed 96 h. If the bake temperature is not greater than 90 °C, there is no limit on bake time. Bake temperatures higher than 125 °C are not allowed without consulting the supplier.

#### 6.3.7.2 Carrier out-gassing risk

Care should be taken to ensure that out-gassing of materials from the component carriers does not occur to any significant extent, such that solderability might be affected.

## 7 Use

### 7.1 Floor life clock start

Upon opening the MBB, the floor life clock starts. If an MBB is opened and the ~~SMDs will not be used within the specified floor life~~ ambient conditions are other than 30 °C/60 % RH, the procedures in ~~Clause 6~~ Annex E should be followed.

### 7.2 Incoming bag inspection

#### 7.2.1 Upon receipt

Dry packed SMDs should be inspected for a bag seal date located on the caution or bar code label to determine remaining shelf life. The bags should be inspected to verify there are no holes, gouges, tears, punctures or openings of any kind that would expose either the contents or an inner layer of a multilayer bag. If openings are found, and the humidity indicator card

(HIC) indicates maximum humidity has been exceeded, then the parts should be baked for 48 h at 125 °C or using the saturated bake times of Tables 3 and 4.

**7.2.2 Component inspection**

Intact bags may be opened for component inspection by cutting at the top of the bag near the seal. If the bags are opened under factory ambient conditions, see 6.2.3.

**7.3 Floor life**

The floor life of SMDs given in Table 7 will be modified by environmental conditions other than those stated in the table. Refer to Annex E to determine maximum allowable time before rebake would be necessary. If partial lots are used, the remaining SMDs shall be resealed or placed in safe storage within 1 h of bag opening (see 7.4). If one-hour exposure is exceeded, refer to 6.2.

**Table 7 – Moisture classification level and floor life**

Level	Floor life (out of bag) at factory ambient
A1 or B1	Unlimited at ≤30 °C/85 % RH
B2	1 year at ≤30 °C/60 % RH
B2a	4 weeks at ≤30 °C/60 % RH
A2	168 h at ≤30 °C/70 % RH
B3	168 h at ≤30 °C/60 % RH
B4	72 h at ≤30 °C/60 % RH
B5	48 h at ≤30 °C/60 % RH
B5a	24 h at ≤30 °C/60 % RH
B6	Mandatory bake before use. After bake, shall be reflowed within the time limit specified on the label.

**7.4 Safe storage**

**7.4.1 Safe storage categories**

"Safe storage" means dry SMDs held in a controlled humidity condition such that the floor life clock remains at zero. Acceptable safe storage conditions for SMDs classified as level B2 to B5a are listed below (in 7.4.2 to 7.4.4).

**7.4.2 Dry pack**

Dry packed SMDs in intact MBBs, stored in accordance with 5.3, shall have a calculated shelf life of at least 12 months from the bag seal date shown on the caution or bar code label.

**7.4.3 Shelf life**

The minimum calculated shelf life is 12 months from bag seal date. If the actual shelf life has exceeded 12 months, but less than 2 years, from the bag seal date and the humidity indicator card (HIC) (7.6.2) indicates that baking is not required, then it is safe to reflow the components as per the original MSL rating. Although unanticipated, factors other than moisture sensitivity could affect the total shelf life of components.

NOTE An HIC that has been continuously sealed in the MBB is typically accurate for at least 2 years.

#### 7.4.4 Dry atmosphere cabinet

##### 7.4.4.1 Dry cabinet capability

These are storage cabinets that maintain low humidity by purging with dry air or nitrogen at  $25\text{ °C} \pm 5\text{ °C}$ . The cabinets ~~must~~ shall be capable of recovering to their stated humidity rating within 1 h from routine excursions such as door opening/closing.

##### 7.4.4.2 Dry cabinet at 10 % RH

SMDs not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 10 % RH. These dry cabinets should not be considered as MBBs. The storage of SMDs in these dry cabinets should be limited to a maximum time in accordance with Tables E.1 and E.2. If the time limit is exceeded, they should be baked in accordance with Table 5 to restore the floor life.

##### 7.4.4.3 Dry cabinet at 5 % RH

SMDs not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 5 % RH. Storage in these dry cabinets may be considered equivalent to storage in a MBB with unlimited shelf life.

##### 7.4.4.4 Dry cabinet at 30 %RH

SMDs of class A2 not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 30 % RH. Storage in these dry cabinets may be considered equivalent to storage in an MBB with unlimited shelf life.

#### 7.5 Reflow

##### 7.5.1 Reflow categories

Reflow includes single and multi-pass assembly reflow and single component attach/removal for rework.

##### 7.5.2 Opened MBB

After a dry pack (MBB) has been opened, all SMDs within that bag ~~must~~ shall complete all solder reflow processing, including rework, prior to the stated floor life, resealed in the MBB, or stored in a dry atmosphere cabinet in accordance with 6.2. If the floor life or factory ambient conditions are exceeded, refer to 7.6.3.

##### 7.5.3 Reflow temperature extremes

During reflow, the component body temperature shall not exceed the rated value, stated on the caution label. The body temperature during reflow directly influences component reliability.

**NOTE 1** The component body temperature can be very different from the lead or solder ball temperature, particularly in IR and IR/convection processes, and should be checked separately.

**NOTE 2** Some hot air attach processes can require heating the component body to very high temperatures. If that temperature exceeds the classification temperature, moisture precautions and/or time-temperature limitations beyond the scope of this specification can be required. The supplier should be consulted.

##### 7.5.4 Additional thermal profile parameters

During reflow, the additional thermal profile parameters stated in IEC 60749-30 should not be exceeded. Although the body temperature during reflow is the most critical parameter, other

profile parameters such as the total exposure time to hot temperatures, and the heating rates, ~~may~~ can also influence component reliability.

### 7.5.5 Multiple reflow passes

If more than one reflow pass is used, care shall be taken to ensure that no moisture-sensitive SMDs, mounted or unmounted, have exceeded their floor life prior to the final pass. If any component on the board has exceeded its floor life, the board needs to be baked prior to the next reflow. Annex B should be referenced for the baking of populated boards.

**NOTE 1** The floor life clock is not reset by any reflow or rework process.

**NOTE 2** For cavity packages in which water can be entrapped, water cleaning processes after the first reflow can be an additional source of moisture. This can present an additional risk, which should be evaluated.

### 7.5.6 Maximum reflow passes

A maximum of three reflow passes is allowed per component. If more than three are required for any reason, the supplier shall be consulted (see IEC 60749-20).

## 7.6 Drying indicators

### 7.6.1 Drying requirements

These are events and conditions that require component drying prior to reflow or continued safe storage.

### 7.6.2 Excess humidity in the dry pack

#### 7.6.2.1 Humidity indicator cards

Excess humidity in the dry pack is noted by the humidity indicator card (HIC). It can occur due to misprocessing (e.g. missing or inadequate desiccant), mishandling (e.g. tears or rips in the MBB), or improper storage.

The HIC should be read immediately upon removal from the MBB. For best accuracy, the HIC should be read at  $23\text{ °C} \pm 5\text{ °C}$ . The following conditions apply regardless of the storage time, i.e. whether or not the shelf life has been exceeded.

**NOTE** Witness cards can be available from the HIC manufacturer if needed to confirm the wet/dry colours.

#### 7.6.2.2 HIC indication 1

For SMDs of class A2, if the HIC indicates that humidity inside MBB does not exceed 30 % RH, the parts are still adequately dry.

For SMDs of classes B2a to B5a, if the 10 % RH dot is blue, the parts are still adequately dry. The desiccant shall be replaced by active desiccant if the bag is going to be resealed.

#### 7.6.2.3 HIC indication 2

For SMDs of class A2, if the HIC indicates that there is a possibility of the humidity inside MBB exceeding 30 % RH, the SMDs have been exposed to an excessive level of moisture, and drying shall be done in accordance with Clause 6.

For SMDs of classes B2a to B5a, if the 5 % RH dot is pink and the 10 % RH dot is not blue, the SMDs have been exposed to an excessive level of moisture, and drying shall be done in accordance with Clause 6.

#### 7.6.2.4 HIC indication 3

If the 5 %, 10 %, and 60 % RH spots indicate wet, class A2 parts have been exposed to an excessive level of moisture, and drying shall be done in accordance with Clause 6.

#### 7.6.3 Floor life or ambient temperature/humidity exceeded

If the floor life or ambient temperature/humidity conditions given in Table 7 have been exceeded, SMDs shall be dried ~~per~~ in accordance with Clause 6 prior to reflow or safe storage. If the factory ambient temperature and/or humidity conditions given in Table 7 cannot be met, the component floor life shall be derated to compensate. Floor life derating is discussed in Annex E.

#### 7.6.4 Level B6 SMDs

SMDs classified as level B6 shall be dried by baking, then reflowed within the time limit specified on the label.

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## Annex A (normative)

### Symbol and labels for moisture-sensitive devices

#### A.1 Object

The purpose of Annex A is to provide a distinctive symbol and labels to be used to identify those devices that require special packing and handling precautions.

#### A.2 Symbol and labels

##### A.2.1 "Moisture-sensitive" symbol

This symbol (see Figure A.1) indicates that devices are moisture sensitive to level A2 or to a level from B2 to B6 and it appears on all moisture-sensitive caution labels (see Figure A.4).



Figure A.1 – Moisture-sensitive symbol (example)

##### A.2.2 Moisture-sensitive identification (MSID) label

This label should be on the lowest-level shipping container to indicate that moisture-sensitive devices are in the container. This label is recommended to be a minimum of 20 mm in diameter. See Figure A.2.

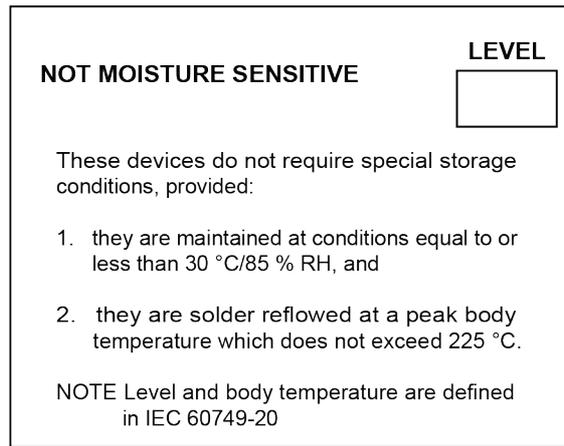


Figure A.2 – MSID label (example)

##### A.2.3 Moisture-sensitive caution labels

###### A.2.3.1 Level A1 or B1

This label is required only if the classification temperature is  $> 225\text{ }^{\circ}\text{C}$  and shall be placed on the lowest-level shipping container to indicate classification temperature and to identify the devices as "NOT MOISTURE SENSITIVE". See Figure A.3.



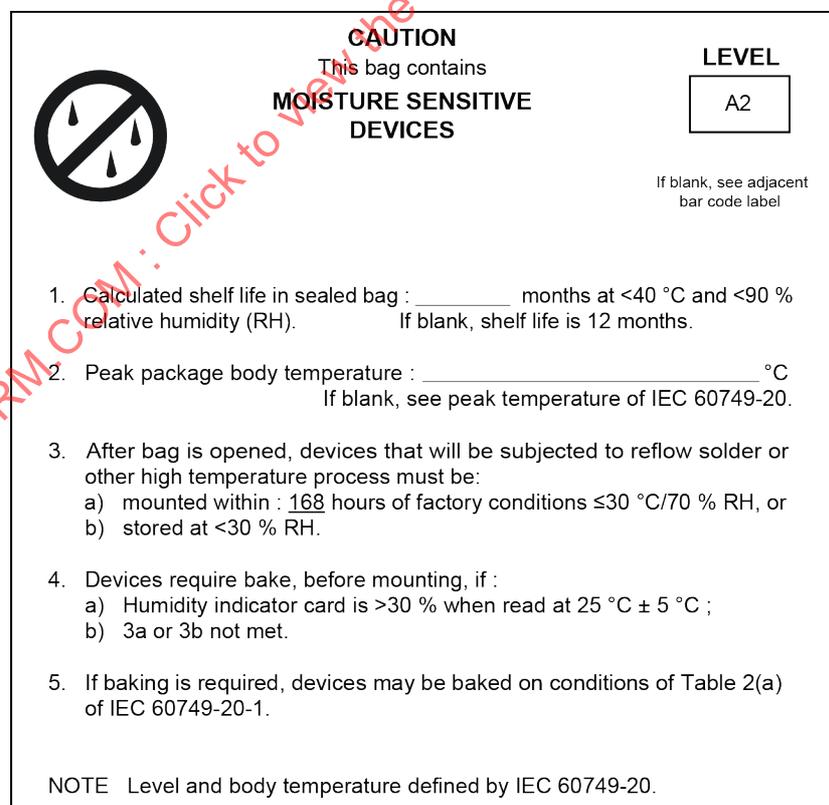
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**Figure A.3 – Information label for level A1 or B1 (example)**

**A.2.3.2 Level A2**

The moisture-sensitive caution label may be used for level A2 as defined by IEC 60749-20. See Figure A.4. This label is required on the moisture barrier bag and will provide the following information:

- the calculated shelf life in the sealed bag;
- the peak SMD body temperature (top surface) used for device classification as defined by IEC 60749-20;
- the floor life of the device at 30 °C/70 % RH as defined by IEC 60749-20.



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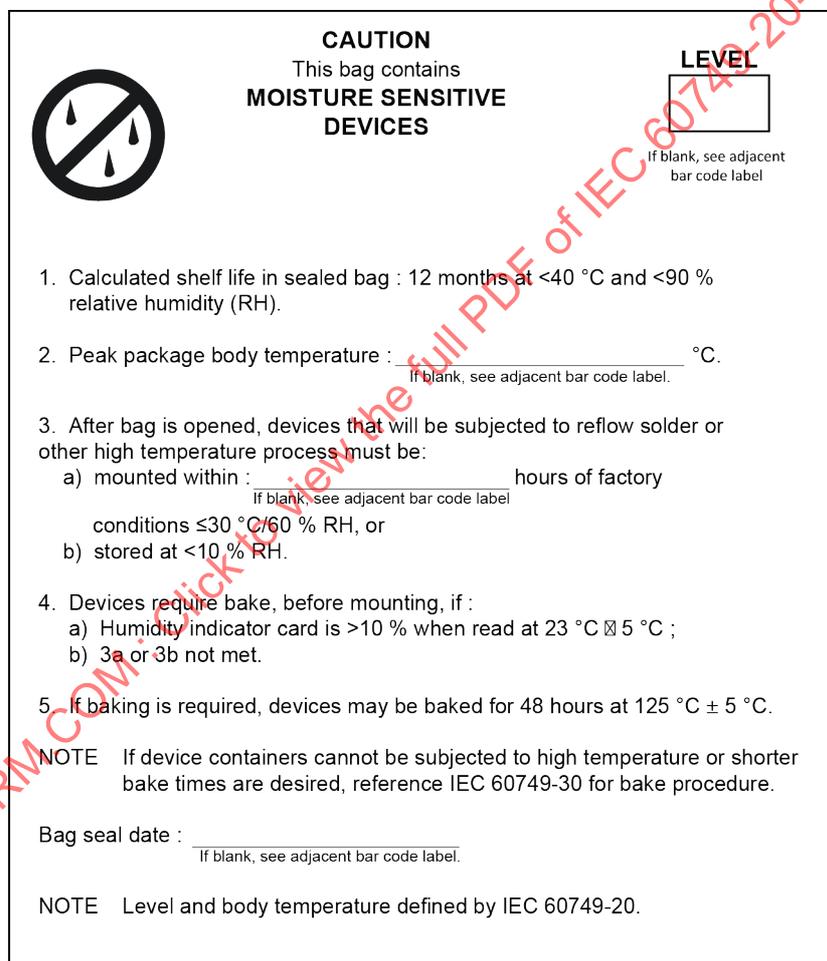
**Figure A.4 – Moisture-sensitive caution label for level A2 (example)**

**A.2.3.3 Levels B2 to B5a**

The moisture-sensitive caution label shall be used for levels B2, B2a, B3, B4, B5, and B5a as defined by IEC 60749-20. See Figure A.5. This label is required on the moisture barrier bag and will provide the following information:

- moisture classification level;
- the calculated shelf life in the sealed bag;
- the peak SMD body temperature (top surface) used for device classification as defined by IEC 60749-20;
- the floor life of the device at 30 °C/60 % RH as defined by IEC 60749-20;
- the bag seal date using “MMDDYY”, “YYWW” or equivalent format.

An acceptable alternative will be to provide the above information on the adjacent bar code label.



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**Figure A.5 – Moisture-sensitive caution label for levels B2-B5a (example)**

**A.2.3.4 Level B6**

Level B6 devices shall be identified as “EXTREMELY MOISTURE SENSITIVE”. See Figure A.6. This label is required on the moisture barrier bag and/or the lowest-level shipping container. The label shall specify the peak SMD body temperature at which the device was classified. If the required information is not provided on the caution label, then it **must** shall be on the adjacent bar code label.

Level B6, as defined by IEC 60749-20, does not require that devices be shipped in a moisture-barrier bag with desiccant, etc. (dry-pack), since these devices require baking by the end user before use. However, moisture-barrier bags have become a “symbol” for moisture-sensitive devices and, therefore, are recommended to be used with level B6 device shipments. It is also recommended that these bags be sealed even though desiccant and humidity indicator cards (HIC) may not be inside the bags.

	<b>CAUTION EXTREMELY MOISTURE SENSITIVE</b>	<b>LEVEL</b> <div style="border: 1px solid black; padding: 2px; display: inline-block;">B6</div>
	Peak package body temperature : _____ °C. <small>If blank, see adjacent bar code label.</small>	
1. Must be baked before mounting for 48 hours at 125 °C ± 5 °C in high temperature device containers.		
NOTE If device containers cannot be subjected to high temperature or if shorter bake times are desired, reference IEC 60749-30 for bake procedure.		
2. After baking devices must be mounted within 6 hours at factory conditions of ≤30 °C/60 % RH.		
NOTE Level and body temperature defined by IEC 60749-20.		

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**Figure A.6 – Moisture-sensitive caution label for level B6 (example)**

#### A.2.3.5 Label size

Labels are recommended to be a minimum of 75 mm by 75 mm square.

#### A.2.3.6 Label colours

The MSID and caution labels shall be contrasting colours. These labels shall be legible to normal vision at a distance of 1 m. Monochromatic reproduction in any colour that contrasts with the background may be used. Where the choice of colour is arbitrary, it is suggested that

- the MSID label background be blue (Pantone-~~#297C~~® 297 C<sup>2</sup>) with a black symbol and letters.
- the caution label background be white with a blue (Process Blue<sup>3</sup>) symbol and letters.

Wherever possible, the colour red should be avoided as red suggests a personal hazard.

<sup>2</sup> Pantone® 297 C is the trade name or trademark of a product supplied by Pantone. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

<sup>3</sup> Pantone® Process Blue C is the trade name or trademark of a product supplied by Pantone. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

## Annex B (informative)

### Board rework

#### B.1 Component removal, rework and remount

##### B.1.1 Removal precautions

If a component is to be removed from the board, it is recommended that localized heating is used and the maximum body temperatures of any surface mount component on the board do not exceed 200 °C. This method will minimize moisture related component damage. If any component temperature exceeds 200 °C, the board ~~must~~ shall be baked dry in accordance with B.2 prior to rework and/or component removal. Component temperatures shall be measured at the top centre of the SMD body. Any SMDs that have not exceeded their floor life can be exposed to a maximum body temperature as high as their specified maximum reflow temperature.

Socketed components should be removed prior to rework.

##### B.1.2 Removal for failure analysis

Failure to follow the requirements of B.1.1 may cause moisture/reflow damage that could hinder or completely prevent the determination of the original failure mechanism.

##### B.1.3 Removal and remount

Removal and reinstallation or replacement of a component should be conducted in accordance with national standards governing rework, repair and modification of printed boards and electronic assemblies. If a component is to be removed and reinstalled, it ~~may~~ can be necessary to first bake the printed wiring assembly to eliminate moisture from the component. The guidelines of Table 2 may be used in identifying an appropriate bake cycle. When identifying a bake cycle, the maximum exposure temperature and maximum rate of temperature change of components and materials on the subject printed wiring assembly shall be considered and an appropriate time-temperature profile (see national standards governing the rework of electronic assemblies) used. Replacement SMDs shall not have exceeded their specified floor life. Localized replacement reflow heating is recommended, so that the entire board is not re-subjected to reflow temperature profiles.

NOTE Temperatures on neighbouring SMDs above the melting point of the solder being used ~~may~~ can cause some solder joints to partially reflow, which ~~may~~ could result in a potential solder joint reliability concern.

#### B.2 Baking of populated boards

Some SMDs and board materials are not able to withstand long duration bakes at  $\geq 125$  °C. Examples of this are some FR-4 materials, which cannot withstand a 24 h bake at 125 °C, and some organic LEDs that have maximum temperatures of around 70 °C. Batteries and electrolytic capacitors are also temperature-sensitive. With component and board temperature restrictions in mind, choose a bake temperature from Table 2; then determine the appropriate bake duration based on the component to be removed.

**NOTE** For additional considerations, see national standards governing rework, repair and modification of printed boards and electronic assemblies.

## Annex C (normative)

### Test method for humidity indicator cards used with electronic component packaging

#### C.1 HIC testing method

To function properly, the spots shall show a visually perceptible colour change to indicate a change in the amount of humidity. This testing method uses a colorimeter to measure the colour (hue) of humidity indicating spots. The percentage of change in hue from one humidity value to another is then calculated.

#### C.2 Testing apparatus

The testing apparatus consists of:

- a chamber capable of maintaining atmosphere at a temperature of  $23\text{ °C} \pm 1\text{ °C}$  and a relative humidity from 2 % RH to ( $65\text{ %} \pm 1\text{ %}$ ) RH. The cards inside the chamber shall be observable from outside the chamber. Nominally, an acrylic box with a capacity of approximately 60 l, having facilities for access to the box interior while maintaining atmosphere is used. Humidity conditions can be achieved by placing combinations of molecular sieve desiccant, glycerin, and water inside the chamber;
- a colorimeter capable of measuring L, a\*, and b\* values (where L indicates lightness, a\* is the red/green coordinate, and b\* is the yellow/blue coordinate);
- an electronic hygrometer, with the minimum range of 1 % RH to 90 % RH.

#### C.3 Testing procedure

Place the sealed container of cards into the chamber. Set the chamber to the first humidity listed in Table 2. Open the container and suspend two cards inside the chamber so that the spots can be observed from outside the chamber. Allow the cards to condition for a minimum of 24 hours. All testing occurs inside the chamber, while the cards are exposed to the test humidity. Using a colorimeter, measure and record the L, a\*, and b\* values for each spot on the cards.

Set the chamber for the next humidity and continue in this manner until data has been collected for all conditions.

**Table C.1 – HIC spot compliance**

RH indicating spot	Hue value reading	
	Initial (dry)	Conditioned (spot value)
5 %	2 %	5 %
10 %	5 %	10 %
60 %	55 %	60 %

Printing in the indicating spot (coloured area) will affect the hue measurement, Spots without printing should be used

#### C.4 Data analysis

Using the  $a^*$  and  $b^*$  data, calculate the hue value,  $h_{ab}$  for each spot at each humidity condition in Table 2,

where:

If  $a^*$  and  $b^*$  are negative, then:

$$h_{ab} = \text{the absolute value of } \arctan(b^*/a^*)$$

If  $a^*$  and  $b^*$  are positive, or if  $a^*$  is positive and  $b^*$  is negative, then:

$$h_{ab} = 180 + \arctan(b^*/a^*)$$

If  $a^*$  is negative and  $b^*$  is positive, then:

$$h_{ab} = 360 + \arctan(b^*/a^*)$$

Calculate the percent change in hue value at the humidity values shown in Table 2. Accept cards that show a 10 % or greater change in hue value reading from initial dry to the conditioned spot value in accordance with Table C.1. Cards with spots that do not indicate dry or wet conditions, in accordance with Table 2, should be rejected.

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## Annex D (informative)

### Derivation of bake tables

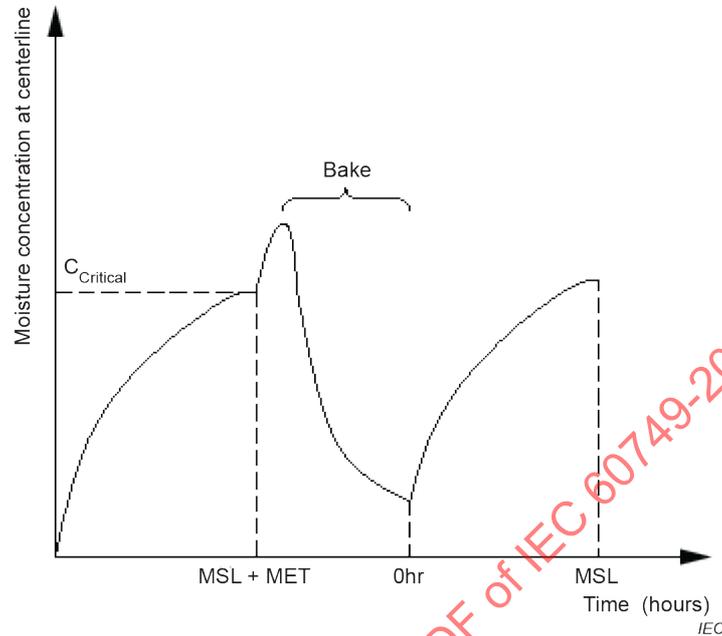


Figure D.1 –Typical moisture concentration over time

The derivation of the bake table process is illustrated graphically in Figure D.1.

Bake Tables 3, 4 and 5 were calculated using the following assumptions/approach:

a) Assume Fickian 1-D diffusion and Henry's Law apply:

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2} \quad (\text{Fick's law})$$

$C_{\text{Sat}}$  (at surface)  $\propto$  % RH in ambient atmosphere (Henry's Law)

Where  $C$  as a function of time ( $t$ ) is:

$$C(t) = C_{\text{Sat}} \left( 1 - \frac{4}{\pi} \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n}{(2n+1)} e^{-D(2n+1)^2 \pi^2 t / 4L^2} \right\} \right)$$

b) Diffusivity =  $6,2 \exp(-0,445 \text{ eV/kT}) \text{ mm}^2/\text{s}$ , (assumes slow diffusing mold compound)

- 1)  $D_{30 \text{ }^\circ\text{C}} = 2,48 \times 10^{-7} \text{ mm}^2/\text{s}$
- 2)  $D_{40 \text{ }^\circ\text{C}} = 4,27 \times 10^{-7} \text{ mm}^2/\text{s}$
- 3)  $D_{90 \text{ }^\circ\text{C}} = 4,13 \times 10^{-6} \text{ mm}^2/\text{s}$
- 4)  $D_{125 \text{ }^\circ\text{C}} = 1,44 \times 10^{-5} \text{ mm}^2/\text{s}$ .

c) Define:

- 1)  $L_{\text{centerline}}$  = critical thickness, e.g. thickness of package / 2
- 2)  $C_{\text{Critical}}$  = concentration at  $L_{\text{centerline}}$  for given MSL (based on 30 °C/60 % RH exposure + 24 h MET preconditioning)

- 3)  $C_{\text{Centerline}}$  = concentration at  $L_{\text{centerline}}$  for any exposure condition
- d) Impose following two exposure conditions:
  - 1) MSL + > 72 h exposure (assume saturated at 30 °C/85 % RH where  $C_{\text{Sat}} = 7,8 \text{ mg/cm}^3$ )
  - 2) MSL +  $\leq$  72 h exposure (assume ambient at 30 °C/60 % RH where  $C_{\text{Sat}} = 5,3 \text{ mg/cm}^3$ )
- e) Calculate minimum time at bake temperature for cases d)1) and d)2) where an additional MSL exposure will keep  $C_{\text{Centerline}} < C_{\text{Critical}}$ .

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## Annex E (informative)

### Derating due to factory environmental conditions

Factory floor life exposures for SMDs removed from the dry bags will be a function of the ambient environmental conditions. A safe, yet conservative, handling approach is to expose the SMDs only up to the maximum time limits for each moisture-sensitivity level as shown in Table 4. This approach, however, does not work if the factory humidity or temperature is greater than the testing conditions of 30 °C/60 % RH. A solution for addressing this problem is to derate the exposure times based on the knowledge of moisture diffusion in the component packaging materials (see IEC 60749-39). Recommended equivalent total floor life exposures can be estimated for a range of humidities and temperatures based on the nominal plastic thickness for each device. Tables E.1 and E.2 list equivalent derated floor lives for humidities ranging from 20 % RH to 90 % RH for four temperatures, 20 °C, 25 °C, 30 °C and 35 °C. These tables are applicable to SMDs moulded with novolac, biphenyl or multifunctional epoxy mould compounds. The following assumptions were used in calculating Tables E.1 and E.2:

- a) activation energy for diffusion = 0,35 eV (smallest known value);
- b) for  $\leq 70$  % RH (for level A2) or 60 % RH (for level B2a to B5a), use diffusivity =  $0,121 e^{-0,35eV/kT} \text{ mm}^2 \cdot \text{s}^{-1}$  (this uses smallest known diffusivity at 30 °C);
- c) for  $> 70$  % RH (for level A2) or 60 % RH (for level B2a to B5a), use diffusivity =  $1,320 e^{-0,35eV/kT} \text{ mm}^2 \cdot \text{s}^{-1}$  (this uses largest known diffusivity at 30 °C).

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**Table E.1 – Recommended equivalent total floor life (days) for level A2 at 20 °C, 25 °C, 30 °C and 35 °C for ICs with novolac, biphenyl and multifunctional epoxies (reflow at same temperature at which component was classified)**

Floor life after opening MBBs whose inner atmosphere is 30 % RH (The values in parentheses are floor life after opening MBBs whose inner atmosphere is 10 % RH)												
SMD type and body thickness	Moisture sensitivity level	Maximum percent relative humidity										Temperature °C
		5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	
Body thickness ≥3,1 mm including PQFPs >84 pins, PLCCs (square) All MQFPs or All BGAs ≥1 mm	Level A2	∞	∞	∞	∞	7 (62)	6 (43)	5 (34)	5 (29)	4 (5)	3 (4)	35
		∞	∞	∞	∞	9 (77)	8 (54)	7 (43)	7 (37)	5 (7)	4 (5)	30
		∞	∞	∞	∞	11 (97)	10 (67)	9 (54)	8 (46)	6 (8)	5 (7)	25
		∞	∞	∞	∞	14 (122)	12 (85)	11 (68)	11 (58)	8 (11)	6 (9)	20
Body 2,1 mm ≤ thickness <3,1 mm including PLCCs (rectangular) 18-32 pins SOICs (wide body) SOICs ≥ 20 pins, PQFPs ≤ 80 pins	Level A2	∞	∞	∞	∞	11 (34)	7 (22)	6 (17)	5 (14)	3 (3)	2 (2)	35
		∞	∞	∞	∞	14 (42)	9 (27)	7 (21)	7 (18)	3 (4)	2 (3)	30
		∞	∞	∞	∞	17 (52)	11 (34)	9 (27)	8 (22)	4 (5)	3 (4)	25
		∞	∞	∞	∞	22 (66)	14 (43)	12 (34)	11 (28)	6 (7)	4 (5)	20
Body thickness < 2,1 mm including SOICs <18 pins All TQFPs, TSOPs or all BGAs < 1 mm body thickness	Level A2	∞	∞	∞	∞	∞	∞	8 (11)	5 (7)	0,5 (1)	0,5 (0,5)	35
		∞	∞	∞	∞	∞	∞	10 (14)	7 (9)	1 (1)	0,5 (0,5)	30
		∞	∞	∞	∞	∞	∞	13 (17)	8 (12)	1 (1)	0,5 (1)	25
		∞	∞	∞	∞	∞	∞	17 (22)	11 (15)	1 (2)	1 (1)	20

NOTE ∞ represents indefinite exposure time allowed at conditions specified.



		Floor life											
SMD type and body thickness	Moisture sensitivity level	Maximum percent relative humidity										Temperature °C	
		5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %		
Body thickness < 2,1 mm including SOICs < 18 pins All TQFPs, TSOPs or all BGAs < 1 mm body thickness	Level B2a	∞	∞	∞	∞	∞	∞	∞	17	1	0,5	0,5	35
		∞	∞	∞	∞	∞	∞	∞	28	1	1	1	30
		∞	∞	∞	∞	∞	∞	∞	∞	2	1	1	25
		∞	∞	∞	∞	∞	∞	∞	∞	2	2	1	20
	Level B3	∞	∞	∞	∞	∞	∞	8	5	1	0,5	0,5	35
		∞	∞	∞	∞	∞	∞	11	7	1	1	1	30
		∞	∞	∞	∞	∞	∞	14	10	2	1	1	25
		∞	∞	∞	∞	∞	∞	20	13	2	2	1	20
	Level B4	∞	∞	∞	7	4	3	2	1	0,5	0,5	35	
		∞	∞	∞	9	5	4	3	1	1	1	30	
		∞	∞	∞	12	7	5	4	2	1	1	25	
		∞	∞	∞	17	9	7	6	2	2	1	20	
	Level B5	∞	∞	7	3	2	2	1	1	0,5	0,5	35	
		∞	∞	13	5	3	2	2	1	1	1	30	
		∞	∞	18	6	4	3	3	2	1	1	25	
		∞	∞	26	8	6	5	4	2	2	1	20	
	Level B5a	∞	7	2	1	1	1	1	1	0,5	0,5	35	
		∞	10	3	2	1	1	1	1	1	0,5	30	
		∞	13	5	3	2	2	2	1	1	1	25	
		∞	18	6	4	3	2	2	2	2	1	20	

NOTE ∞ represents indefinite exposure time allowed at conditions specified.

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# 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**

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## 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**

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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.

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## 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.

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## 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 <sup>a</sup> label	Caution label
A1 or B1	Optional	Optional	Optional	Not required	Not required if classified at 220 °C to 225 °C
					Required <sup>b</sup> 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

<sup>a</sup> MSID = moisture-sensitive identification label.

<sup>b</sup> 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).

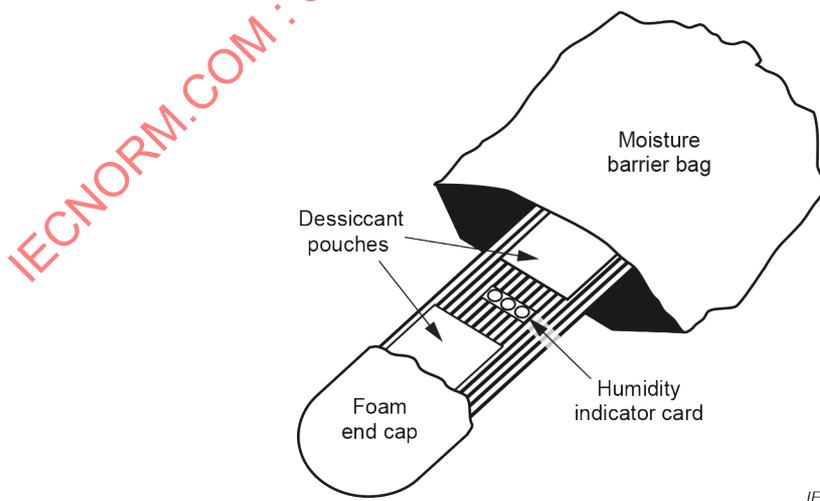
**5.2.5 Excess time between bake and bag**

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  $\leq 0,03 \text{ g/m}^2$  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.

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

where

- $U$  = amount of desiccant in UNITS;
- $M$  = shelf life desired in months;
- $WVTR$  = water vapour transmission rate in  $\text{g/m}^2$  in 24 h;
- $A$  = total surface area of the MBB in  $\text{m}^2$ ;
- $D$  = 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.

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

where

- $U$  = amount of desiccant in UNITS;
- $A$  = total surface area of the MBB in  $\text{m}^2$ .

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.

No moisture-absorbing material (e.g. trays, tubes, reels, foam end caps) should be placed in the dry bag without baking. Any such material that is included increases the amount of desiccant needed to meet the calculated shelf life (see 7.4.2) by an amount based on the moisture content of the material. This can be determined by weighing a representative quantity of material known to be at equilibrium with the manufacturing environment, baking to a new constant weight, and subtracting the final from the initial weight. Additional UNIT(s) of desiccant, based on 10 % RH at 25 °C, should be added to absorb the amount of water, in grams, egressed from the packing materials (dunnage) after baking.

#### **5.3.2.3 Desiccant handling and storage**

Desiccant capacity decreases rapidly when exposed to 30 °C/60 % RH. Therefore, the desiccant should remain in the manufacturer's container or stored in a dry cabinet at < 5 % RH until use. When dry packing, the desiccant shall be removed from the storage container just prior to placing it into the MBB and sealing the MBB.

#### **5.3.2.4 Humidity indicator card (HIC)**

The HIC shall comply with relevant national standards governing chemically impregnated humidity indicator cards. For level A2, the HIC shall have a sensitivity value of 30 % RH, which may be indicated by colour dots with sensitivity values of 20 % RH, 30 % RH, 40 % RH. For SMDs classified from Levels B2a through to B5a, as a minimum, the HIC shall have 3 colour dots with sensitivity values of 5 % RH, 10 % RH, 60 % RH. The spots shall indicate the humidity with a significant and perceptible change in colour (hue) as indicated in Table 2. Hue shall be tested using the test method in Annex C. The colours shall be described in writing on the card. HIC reuse is not allowed if the 60 % spot has changed colour. Reuse is not allowed, owing to loss of accuracy of the 5 % and 10 % spot chemistry, if the 60 % spot has changed colour. It is not required to reuse the same HIC from the MBB if the MBB is to be resealed; a fresh HIC may be used.

Examples of HIC are shown in Figures 2a) and 2b).

#### **5.3.2.5 HIC paper**

White blotting paper made from fibrous, cellulosic material, with a minimum basis weight of, 255 g/m<sup>2</sup> shall be used for HICs.

#### **5.3.2.6 Visual defects**

HICs shall be free from defects including missing spots, tears, improperly located spots, and indicating colour overrunning the black circles.

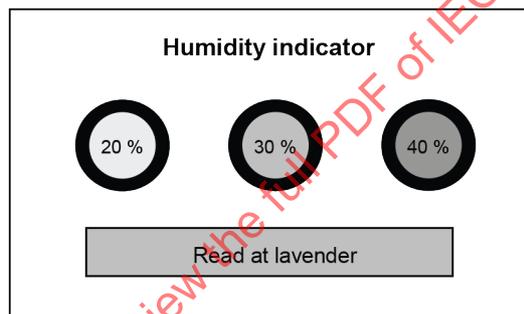
#### **5.3.2.7 Preservation**

HICs shall be stored in accordance with the manufacturer's recommendation prior to insertion in the MBB. At a minimum, the 10 % spot shall indicate dry when the cards are removed from the original container.

**Table 2 –Typical HIC spot compliance**

	Indication at 2 % RH environment	Indication at 5 % RH environment	Indication at 10 % RH environment	Indication at 55 % RH environment	Indication at 60 % RH environment	Indication at 65 % RH environment
5 % spot	Blue (dry)	Lavender (spot value) change ≤7 % hue	Pink (wet)	Pink (wet)	Pink (wet)	Pink (wet)
10 % spot	Blue (dry)	Blue (dry)	Lavender (spot value) change ≤10 % hue	Pink (wet)	Pink (wet)	Pink (wet)
60 % spot	Blue (dry)	Blue (dry)	Blue (dry)	Blue (dry)	Lavender (spot value) change ≤10 % hue	Pink (wet)

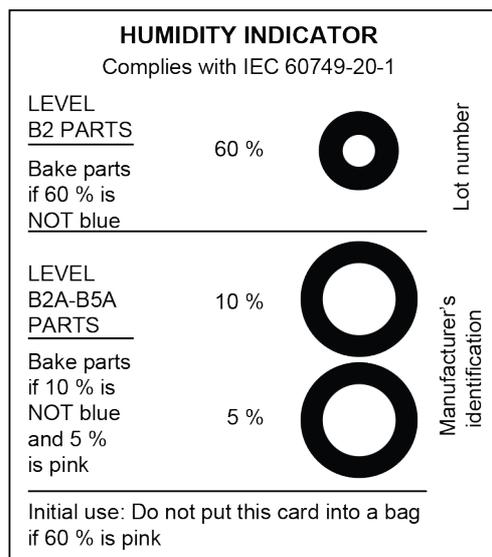
NOTE Other colour schemes can be used.



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Below 30 % RH can be confirmed by comparison of a colour (lavender).

**a) Example of humidity indicator card for level A2**



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**b) Example of humidity indicator card for levels B2a to B5a**

**Figure 2 – Example humidity indicator cards**

### 5.3.3 Labels

#### 5.3.3.1 Labels – Moisture sensitive identification

Labels relevant to the dry pack process are the moisture-sensitive identification (MSID) label and the caution label as specified in Annex A (see Figures A.2 to A.5). The MSID label shall be affixed to the lowest-level shipping container that contains the MBB. The caution label shall be affixed to the outside surface of the MBB. The caution label includes fields for the moisture classification level in accordance with IEC 60749-20; the peak package body temperature allowed during reflow soldering (the classification temperature); the floor life; and the bag seal date. If the calculated shelf life is greater than 12 months, item # 1 of the caution label shall be changed accordingly.

#### 5.3.3.2 Labels – Level B6 requirements

Level B6 parts not shipped in MBBs shall have both an MSID label and the appropriate caution label affixed to the lowest level shipping container.

#### 5.3.3.3 Labels – Level A1 and B1 requirements

Level A1 and B1 parts classified for other than from 220 °C to 225 °C maximum reflow temperature shall have a caution label with the maximum reflow temperature specified. The caution label shall be affixed to the MBB (if used) or to the lowest-level shipping container. The caution label will not be required if a bar code label includes the level A1 or B1 classification and maximum reflow temperature information in human readable form. Level A1 and B1 parts classified at from 220 °C to 225 °C maximum reflow temperature do not require any moisture-related labels.

### 5.3.4 Moisture barrier bag sealing

The bag shall be heat sealed so as not to damage or cause delamination of the MBB.

### 5.3.5 Dry pack precautions

#### 5.3.5.1 HIC placement

The HIC may be placed anywhere in the MBB, but shall not be placed under a desiccant pouch.

#### 5.3.5.2 HIC reuse

HIC cards where the 10 % spot indicates wet shall not be used/reused if the bag will be opened and the HIC card inspected within 48 h.

HIC with 60 % RH indicated shall be discarded if the 60 % spot has indicated wet. HICs that have been exposed to 60 % or greater RH will no longer be accurate.

#### 5.3.5.3 Moisture barrier bag sealing

In actual practice, air evacuation is not required. Light air evacuation is to be used to reduce the packaging bulk and enhance carton packing. Full evacuation shall not be used as it will impede desiccant and HIC performance and possibly lead to MBB puncture.

### 5.3.6 Shelf life

The calculated shelf life for dry packed SMDs shall be a minimum of 12 months from the bag seal date, when stored in a non-condensing atmospheric environment of <40 °C/90 % RH. If the calculated shelf life is greater than 12 months, item # 1 of the caution label is changed accordingly (see Figures A.4 and A.5).

## 6 Drying

### 6.1 Drying options

Component drying options for various moisture sensitivity levels and ambient humidity exposures are given in Tables 3, 4, 5 and 6. Drying using an allowable option resets the floor life clock. If dried and sealed in an MBB with fresh desiccant, the shelf life is reset. Tables 3, 4, 5 and 6 give reference conditions for drying SMDs. Tables 3 and 4 give conditions for re-bake of SMDs at a user site after the floor life has expired or other conditions have occurred to indicate excess moisture exposure. Table 5 gives conditions for bake prior to dry pack at a supplier and/or distributor and allows for a maximum total of 24 h MET. Table 6 summarizes conditions for resetting or pausing the floor-life clock at the user site in accordance with 6.2.1. The supplier shall formally communicate to the distributor the maximum time that the product may be left unsealed (at the distributor) before re-baking is required.

NOTE If the baking process is interrupted for greater than 15 minutes, the total time of the interruption is added to the bake time.

**Table 3 – Reference conditions for drying mounted or unmounted SMDs  
(user bake: floor life begins counting at time = 0 after bake) – Level 2**

SMD body thickness	Level A2	Bake at 125 °C $+10_0$ °C		Bake at 90 °C $+8_0$ °C ≤ 5 % HR		Bake at 40 °C $+5_0$ °C ≤ 5 % HR	
		Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/70 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/70 % RH	Saturated at 30 °C/85 % RH	At limit of floor life + 72 h at 30 °C/70 % RH
≤ 1,4 mm		9 h	7 h	33 h	23 h	13 days	9 days
≤ 2,0 mm		27 h	17 h	4 days	2 days	37 days	23 days
≤ 4,5 mm		48 h	48 h	10 days	8 days	79 days	67 days
BGA package >17 mm x 17 mm or any stacked die package (See Note 2)		96 h	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level

**Table 4 – Reference conditions for drying mounted or unmounted SMDs (user bake: floor life begins counting at time = 0 after bake) – Levels B2, B2a to B5a**

SMD body thickness	Level	Bake at 125 °C $+10_0$ °C		Bake at 90 °C $+8_0$ °C ≤ 5 % RH		Bake at 40 °C $+5_0$ °C ≤ 5 % RH	
		Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/60 % RH	Saturated at 30 °C/85 %RH	At limit of floor life + 72 h at 30 °C/60 % RH	Saturated at 30 °C/85 % RH	At limit of floor life + 72 h at 30 °C/60 % RH
≤ 1,4 mm	B2a	7 h	5 h	23 h	13 h	9 days	7 days
	B3	9 h	7 h	33 h	23 h	13 days	9 days
	B4	11 h	7 h	37 h	23 h	15 days	9 days
	B5	12 h	7 h	41 h	24 h	17 days	10 days
	B5a	16 h	10 h	54 h	24 h	22 days	10 days
≤ 2,0 mm	B2a	21 h	16 h	3 days	2 days	29 days	22 days
	B3	27 h	17 h	4 days	2 days	37 days	23 days
	B4	34 h	20 h	5 days	3 days	47 days	28 days
	B5	40 h	25 h	6 days	4 days	57 days	35 days
	B5a	48 h	40 h	8 days	6 days	79 days	56 days
≤ 4,5 mm	B2a	48 h	48 h	10 days	7 days	79 days	67 days
	B3	48 h	48 h	10 days	8 days	79 days	67 days
	B4	48 h	48 h	10 days	10 days	79 days	67 days
	B5	48 h	48 h	10 days	10 days	79 days	67 days
	B5a	48 h	48 h	10 days	10 days	79 days	67 days
BGA package > 17 mm × 17 mm or any stacked die package (See Note 2)	B2-B6	96 h	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level

Tables 3 and 4 are based on worst case moulded lead frame SMDs. Users may reduce the actual bake time if technically justified (e.g. absorption/desorption data). In most cases, it is applicable to other non-hermetic SMDs. If parts have been exposed to > 60 % RH, consideration shall be given to the need to increase the bake time by tracking desorption data to ensure parts are dry.

BGA packages > 17 mm x 17 mm, that do not have internal planes that block the moisture diffusion path in the substrate, may use bake times based on the thickness/moisture level portion of the table.

If baking of packages > 4,5 mm is required, see Annex D.

**Table 5 – Default baking times used prior to dry-pack that were exposed to conditions  $\leq 60$  % RH (supplier bake: MET = 24 h)**

SMD body thickness	Level	Bake at 125 °C	Bake at 150 °C
$\leq 1,4$ mm	B2a	8 h	4 h
	B3	16 h	8 h
	B4	21 h	10 h
	B5	24 h	12 h
	B5a	28 h	14 h
$\leq 2,0$ mm	B2a	23 h	11 h
	B3	43 h	21 h
	B4	48 h	24 h
	B5	48 h	24 h
	B5a	48 h	24 h
$\leq 4,5$ mm	B2a	48 h	24 h
	B3	48 h	24 h
	B4	48 h	24 h
	B5	48 h	24 h
	B5a	48 h	24 h

If baking of packages  $> 4,5$  mm is required, see Annex D.

The bake times specified are conservative for packages without blocking planes or stacked die. For a stacked die or BGA package with internal planes that impede moisture diffusion the actual bake time may be longer than that required in this table if packages have had extended exposure to factory ambient before bake. Also, the actual bake time may be reduced if technically justified. The increase or decrease in bake time is determined using the procedure in IEC 60749-39 (i.e.  $< 0,002$  % weight loss between successive readouts) or in accordance with critical interface concentration calculations.

**Table 6 – Resetting or pausing the ‘floor life’ clock at user site**

Moisture sensitivity level	Exposure time at temp./humidity	Floor life	Desiccator time at relative humidity	Bake	Reset shelf life
B2a, B3, B4, B5, B5a	Anytime $\leq 40$ °C/85 % RH	reset	N/A	Table 4	Dry pack after bake
B2a, B3, B4, B5, B5a	$>$ floor life $\leq 30$ °C/60 % RH	reset	N/A	Table 4	Dry pack after bake
B2a, B3	$> 12$ h $\leq 30$ °C/60 % RH	reset	N/A	Table 4	Dry pack after bake
B2a, B3	$\leq 12$ h $\leq 30$ °C/60 % RH	reset	5 x exposure time $\leq 10$ % RH	N/A	N/A
B4, B5, B5a	$> 8$ h $\leq 30$ °C/60 % RH	reset	N/A	Table 4	Dry pack after bake
B4, B5, B5a	$\leq 8$ h $\leq 30$ °C/60 % RH	reset	10 x exposure time $\leq 5$ % RH	N/A	N/A
B2a, B3	Cumulative time $<$ floor life $\leq 30$ °C/60 % RH	pause	any time $\leq 10$ % RH	N/a	N/A

## 6.2 Post exposure to factory ambient

### 6.2.1 Floor life clock

Placing SMDs, which have been exposed to factory ambient conditions for greater than 1 h, in a dry cabinet or dry pack does not necessarily stop/pause the floor life clock. However, if the conditions of 6.2.3 are met, the floor life clock can be stopped or reset (see Table 6).

### 6.2.2 Any duration exposure

Moisture sensitive SMDs which have been exposed only to ambient conditions of  $\leq 60\%$  RH for any length of time may be adequately dried by high or low temperature baking in accordance with Tables 3 and 4 for rebake prior to reflow, or Table 5 for drying prior to dry pack.

### 6.2.3 Short duration exposure

#### 6.2.3.1 General considerations for short duration exposure

Previously dry SMDs, which have been exposed only to ambient conditions not exceeding  $30\text{ }^{\circ}\text{C}/60\%$  RH, may be adequately dried by room temperature desiccation using a dry pack or a dry cabinet.

#### 6.2.3.2 Moisture sensitivity levels B2, B2a and B3

For moisture sensitivity levels B2, B2a and B3 with floor life exposure not greater than 12 h at  $30\text{ }^{\circ}\text{C}/60\%$  RH, a minimum desiccating period of  $5\times$  the exposure time is required to dry the SMDs enough to reset the floor life clock (see Table 6). This can be accomplished by dry pack in accordance with 5.3 or a dry cabinet that is capable of maintaining not greater than  $10\%$  RH.

For components classed as moisture-sensitive levels B2, B2a or B3, that are exposed for any time less than their stated floor life, dry packing or placing the components in a dry cabinet that maintains not greater than  $10\%$  RH, will stop/pause the floor life clock. However, the cumulative floor life should meet the conditions in Table 7 and/or Table E.2. This does not apply to level B4.

#### 6.2.3.3 Moisture sensitivity levels B4, B5 and B5a

For moisture sensitivity levels B4, B5 and B5a with floor life exposure not greater than 8 h at  $30\text{ }^{\circ}\text{C}/60\%$  RH, a minimum desiccating period of  $10\times$  the exposure time is required to dry the SMDs enough to reset the floor life clock (see Table 6). This can be accomplished by dry pack in accordance with 5.3 or a dry cabinet that is capable of maintaining not greater than  $5\%$  RH.

Once the floor life clock has been reset, refer to 7.4 for safe storage conditions.

## 6.3 General considerations for baking

### 6.3.1 High-temperature carriers

Unless otherwise indicated by the manufacturer, SMDs shipped in high-temperature carriers (e.g. high-temperature trays) can be baked in the carriers at  $125\text{ }^{\circ}\text{C}$ .

### 6.3.2 Low-temperature carriers

SMDs shipped in low-temperature carriers (e.g. tubes, low-temperature trays, tape and reel) may not be baked in the carriers at any temperature higher than  $40\text{ }^{\circ}\text{C}$ . If a higher bake temperature is required, SMDs shall be removed from the low-temperature carriers to thermally safe carriers, baked, and returned to the low-temperature carriers.

NOTE 1 Manual handling can increase the risk of mechanical and/or ESD damage.

NOTE 2 If SMDs are placed in dry bags with unbaked carriers, refer to 5.3.2.2.

### **6.3.3 Paper and plastic container items**

Paper and plastic container items such as cardboard boxes, bubble pack, and plastic wrap shall be removed from around the carriers prior to baking. Rubber bands around tubes and plastic tray ties shall also be removed prior to the high-temperature (125 °C) bake.

### **6.3.4 Bakeout times**

Bakeout times start when all SMDs reach the specified temperature.

### **6.3.5 ESD protection**

Proper ESD handling precautions should be observed, in accordance with relevant national standards for ESD-sensitive items. This is particularly critical if SMDs are manually handled by vacuum pencils under low-humidity conditions, e.g. in a dry environment, after baking.

### **6.3.6 Reuse of carriers**

The appropriate materials specification should be consulted before reusing carriers.

### **6.3.7 Solderability limitations**

#### **6.3.7.1 Oxidation risk**

Baking SMDs can cause oxidation and/or intermetallic growth of the terminations, which, if excessive, can result in solderability problems during board assembly. The temperature and time for baking SMDs are therefore limited by solderability considerations. Unless otherwise indicated by the supplier, the cumulative bake time at a temperature greater than 90 °C and up to 125 °C shall not exceed 96 h. If the bake temperature is not greater than 90 °C, there is no limit on bake time. Bake temperatures higher than 125 °C are not allowed without consulting the supplier.

#### **6.3.7.2 Carrier out-gassing risk**

Care should be taken to ensure that out-gassing of materials from the component carriers does not occur to any significant extent, such that solderability might be affected.

## **7 Use**

### **7.1 Floor life clock start**

Upon opening the MBB, the floor life clock starts. If an MBB is opened and the ambient conditions are other than 30 °C/60 % RH, the procedures in Annex E should be followed.

### **7.2 Incoming bag inspection**

#### **7.2.1 Upon receipt**

Dry packed SMDs should be inspected for a bag seal date located on the caution or bar code label to determine remaining shelf life. The bags should be inspected to verify there are no holes, gouges, tears, punctures or openings of any kind that would expose either the contents or an inner layer of a multilayer bag. If openings are found, and the humidity indicator card (HIC) indicates maximum humidity has been exceeded, then the parts should be baked for 48 h at 125 °C or using the saturated bake times of Tables 3 and 4.

### 7.2.2 Component inspection

Intact bags may be opened for component inspection by cutting at the top of the bag near the seal. If the bags are opened under factory ambient conditions, see 6.2.3.

### 7.3 Floor life

The floor life of SMDs given in Table 7 will be modified by environmental conditions other than those stated in the table. Refer to Annex E to determine maximum allowable time before rebake would be necessary. If partial lots are used, the remaining SMDs shall be resealed or placed in safe storage within 1 h of bag opening (see 7.4). If one-hour exposure is exceeded, refer to 6.2.

**Table 7 – Moisture classification level and floor life**

Level	Floor life (out of bag) at factory ambient
A1 or B1	Unlimited at ≤30 °C/85 % RH
B2	1 year at ≤30 °C/60 % RH
B2a	4 weeks at ≤30 °C/60 % RH
A2	168 h at ≤30 °C/70 % RH
B3	168 h at ≤30 °C/60 % RH
B4	72 h at ≤30 °C/60 % RH
B5	48 h at ≤30 °C/60 % RH
B5a	24 h at ≤30 °C/60 % RH
B6	Mandatory bake before use. After bake, shall be reflowed within the time limit specified on the label.

### 7.4 Safe storage

#### 7.4.1 Safe storage categories

"Safe storage" means dry SMDs held in a controlled humidity condition such that the floor life clock remains at zero. Acceptable safe storage conditions for SMDs classified as level B2 to B5a are listed below (in 7.4.2 to 7.4.4).

#### 7.4.2 Dry pack

Dry packed SMDs in intact MBBs, stored in accordance with 5.3, shall have a calculated shelf life of at least 12 months from the bag seal date shown on the caution or bar code label.

#### 7.4.3 Shelf life

The minimum calculated shelf life is 12 months from bag seal date. If the actual shelf life has exceeded 12 months, but less than 2 years, from the bag seal date and the humidity indicator card (HIC) (7.6.2) indicates that baking is not required, then it is safe to reflow the components as per the original MSL rating. Although unanticipated, factors other than moisture sensitivity could affect the total shelf life of components.

NOTE An HIC that has been continuously sealed in the MBB is typically accurate for at least 2 years.

#### 7.4.4 Dry atmosphere cabinet

##### 7.4.4.1 Dry cabinet capability

These are storage cabinets that maintain low humidity by purging with dry air or nitrogen at 25 °C ± 5 °C. The cabinets shall be capable of recovering to their stated humidity rating within 1 h from routine excursions such as door opening/closing.

#### **7.4.4.2 Dry cabinet at 10 % RH**

SMDs not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 10 % RH. These dry cabinets should not be considered as MBBs. The storage of SMDs in these dry cabinets should be limited to a maximum time in accordance with Tables E.1 and E.2. If the time limit is exceeded, they should be baked in accordance with Table 5 to restore the floor life.

#### **7.4.4.3 Dry cabinet at 5 % RH**

SMDs not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 5 % RH. Storage in these dry cabinets may be considered equivalent to storage in a MBB with unlimited shelf life.

#### **7.4.4.4 Dry cabinet at 30 %RH**

SMDs of class A2 not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 30 % RH. Storage in these dry cabinets may be considered equivalent to storage in an MBB with unlimited shelf life.

### **7.5 Reflow**

#### **7.5.1 Reflow categories**

Reflow includes single and multi-pass assembly reflow and single component attach/removal for rework.

#### **7.5.2 Opened MBB**

After a dry pack (MBB) has been opened, all SMDs within that bag shall complete all solder reflow processing, including rework, prior to the stated floor life, resealed in the MBB, or stored in a dry atmosphere cabinet in accordance with 6.2. If the floor life or factory ambient conditions are exceeded, refer to 7.6.3.

#### **7.5.3 Reflow temperature extremes**

During reflow, the component body temperature shall not exceed the rated value, stated on the caution label. The body temperature during reflow directly influences component reliability.

The component body temperature can be very different from the lead or solder ball temperature, particularly in IR and IR/convection processes, and should be checked separately.

Some hot air attach processes can require heating the component body to very high temperatures. If that temperature exceeds the classification temperature, moisture precautions and/or time-temperature limitations beyond the scope of this specification can be required. The supplier should be consulted.

#### **7.5.4 Additional thermal profile parameters**

During reflow, the additional thermal profile parameters stated in IEC 60749-30 should not be exceeded. Although the body temperature during reflow is the most critical parameter, other profile parameters such as the total exposure time to hot temperatures, and the heating rates, can also influence component reliability.

#### **7.5.5 Multiple reflow passes**

If more than one reflow pass is used, care shall be taken to ensure that no moisture-sensitive SMDs, mounted or unmounted, have exceeded their floor life prior to the final pass. If any

component on the board has exceeded its floor life, the board needs to be baked prior to the next reflow. Annex B should be referenced for the baking of populated boards.

NOTE The floor life clock is not reset by any reflow or rework process.

For cavity packages in which water can be entrapped, water cleaning processes after the first reflow can be an additional source of moisture. This can present an additional risk, which should be evaluated.

### 7.5.6 Maximum reflow passes

A maximum of three reflow passes is allowed per component. If more than three are required for any reason, the supplier shall be consulted (see IEC 60749-20).

## 7.6 Drying indicators

### 7.6.1 Drying requirements

These are events and conditions that require component drying prior to reflow or continued safe storage.

### 7.6.2 Excess humidity in the dry pack

#### 7.6.2.1 Humidity indicator cards

Excess humidity in the dry pack is noted by the humidity indicator card (HIC). It can occur due to misprocessing (e.g. missing or inadequate desiccant), mishandling (e.g. tears or rips in the MBB), or improper storage.

The HIC should be read immediately upon removal from the MBB. For best accuracy, the HIC should be read at  $23\text{ °C} \pm 5\text{ °C}$ . The following conditions apply regardless of the storage time, i.e. whether or not the shelf life has been exceeded.

NOTE Witness cards can be available from the HIC manufacturer if needed to confirm the wet/dry colours.

#### 7.6.2.2 HIC indication 1

For SMDs of class A2, if the HIC indicates that humidity inside MBB does not exceed 30 % RH, the parts are still adequately dry.

For SMDs of classes B2a to B5a, if the 10 % RH dot is blue, the parts are still adequately dry. The desiccant shall be replaced by active desiccant if the bag is going to be resealed.

#### 7.6.2.3 HIC indication 2

For SMDs of class A2, if the HIC indicates that there is a possibility of the humidity inside MBB exceeding 30 % RH, the SMDs have been exposed to an excessive level of moisture, and drying shall be done in accordance with Clause 6.

For SMDs of classes B2a to B5a, if the 5 % RH dot is pink and the 10 % RH dot is not blue, the SMDs have been exposed to an excessive level of moisture, and drying shall be done in accordance with Clause 6.

#### 7.6.2.4 HIC indication 3

If the 5 %, 10 %, and 60 % RH spots indicate wet, class A2 parts have been exposed to an excessive level of moisture, and drying shall be done in accordance with Clause 6.

### 7.6.3 Floor life or ambient temperature/humidity exceeded

If the floor life or ambient temperature/humidity conditions given in Table 7 have been exceeded, SMDs shall be dried in accordance with Clause 6 prior to reflow or safe storage. If the factory ambient temperature and/or humidity conditions given in Table 7 cannot be met, the component floor life shall be derated to compensate. Floor life derating is discussed in Annex E.

### 7.6.4 Level B6 SMDs

SMDs classified as level B6 shall be dried by baking, then reflowed within the time limit specified on the label.

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## Annex A (normative)

### Symbol and labels for moisture-sensitive devices

#### A.1 Object

The purpose of Annex A is to provide a distinctive symbol and labels to be used to identify those devices that require special packing and handling precautions.

#### A.2 Symbol and labels

##### A.2.1 "Moisture-sensitive" symbol

This symbol (see Figure A.1) indicates that devices are moisture sensitive to level A2 or to a level from B2 to B6 and it appears on all moisture-sensitive caution labels (see Figure A.4).



Figure A.1 – Moisture-sensitive symbol (example)

##### A.2.2 Moisture-sensitive identification (MSID) label

This label should be on the lowest-level shipping container to indicate that moisture-sensitive devices are in the container. This label is recommended to be a minimum of 20 mm in diameter. See Figure A.2.



Figure A.2 – MSID label (example)

##### A.2.3 Moisture-sensitive caution labels

###### A.2.3.1 Level A1 or B1

This label is required only if the classification temperature is  $> 225\text{ }^{\circ}\text{C}$  and shall be placed on the lowest-level shipping container to indicate classification temperature and to identify the devices as "NOT MOISTURE SENSITIVE". See Figure A.3.

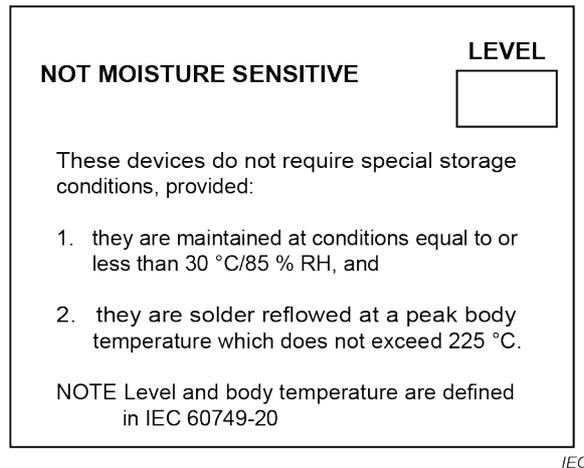


Figure A.3 – Information label for level A1 or B1 (example)

#### A.2.3.2 Level A2

The moisture-sensitive caution label may be used for level A2 as defined by IEC 60749-20. See Figure A.4. This label is required on the moisture barrier bag and will provide the following information:

- the calculated shelf life in the sealed bag;
- the peak SMD body temperature (top surface) used for device classification as defined by IEC 60749-20;
- the floor life of the device at 30 °C/70 % RH as defined by IEC 60749-20.

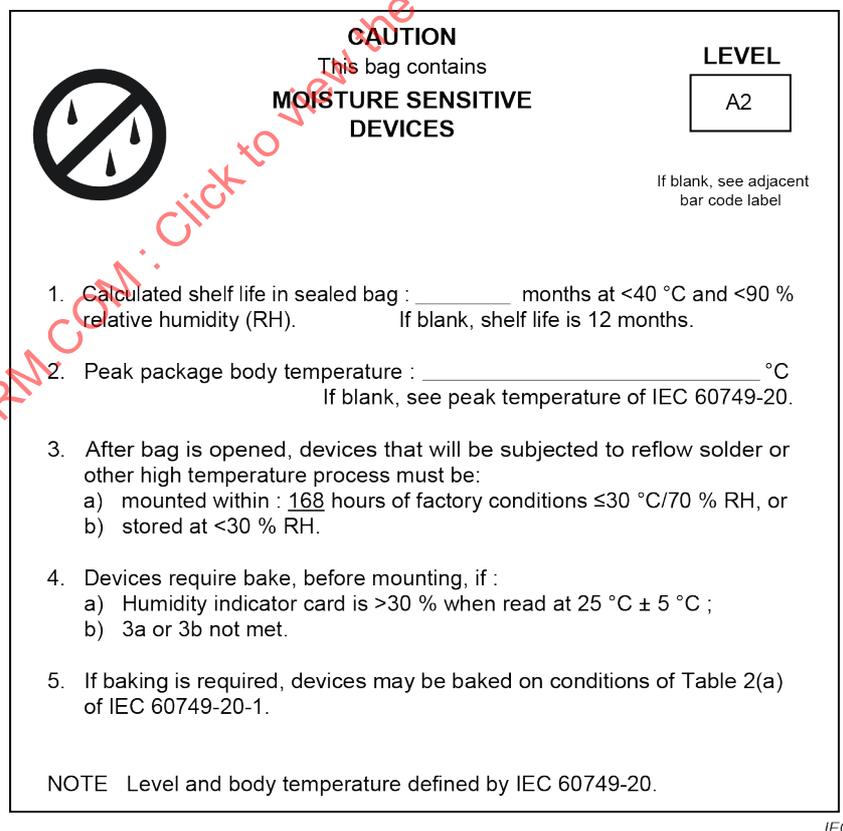


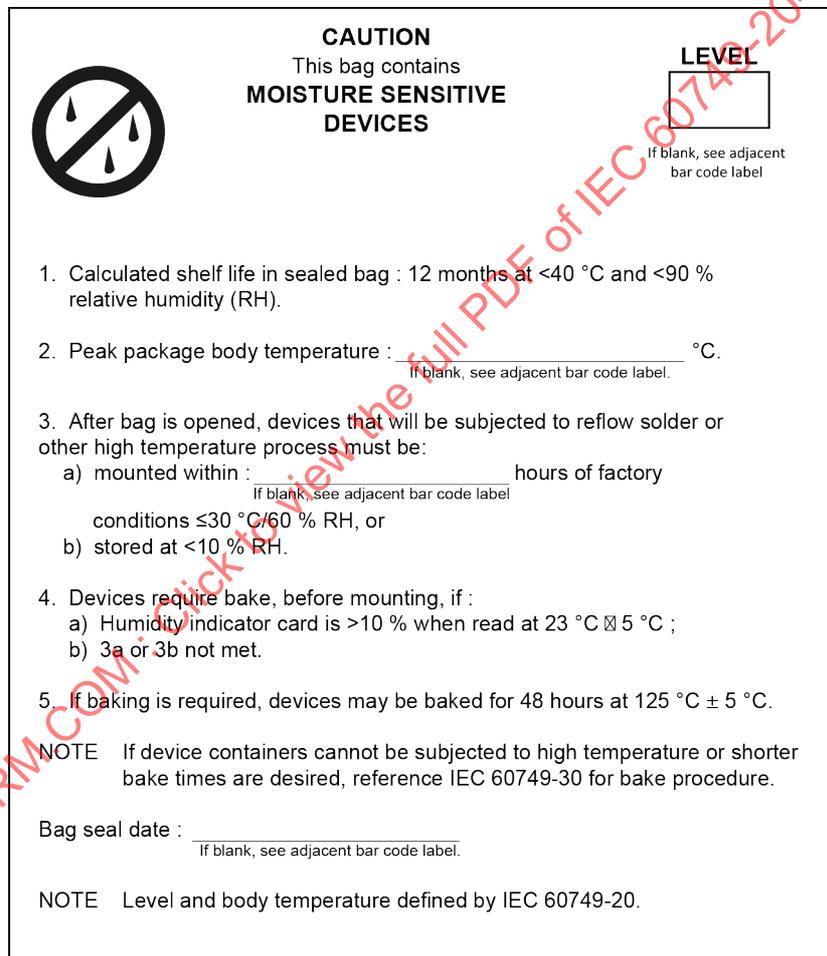
Figure A.4 – Moisture-sensitive caution label for level A2 (example)

**A.2.3.3 Levels B2 to B5a**

The moisture-sensitive caution label shall be used for levels B2, B2a, B3, B4, B5, and B5a as defined by IEC 60749-20. See Figure A.5. This label is required on the moisture barrier bag and will provide the following information:

- moisture classification level;
- the calculated shelf life in the sealed bag;
- the peak SMD body temperature (top surface) used for device classification as defined by IEC 60749-20;
- the floor life of the device at 30 °C/60 % RH as defined by IEC 60749-20;
- the bag seal date using “MMDDYY”, “YYWW” or equivalent format.

An acceptable alternative will be to provide the above information on the adjacent bar code label.

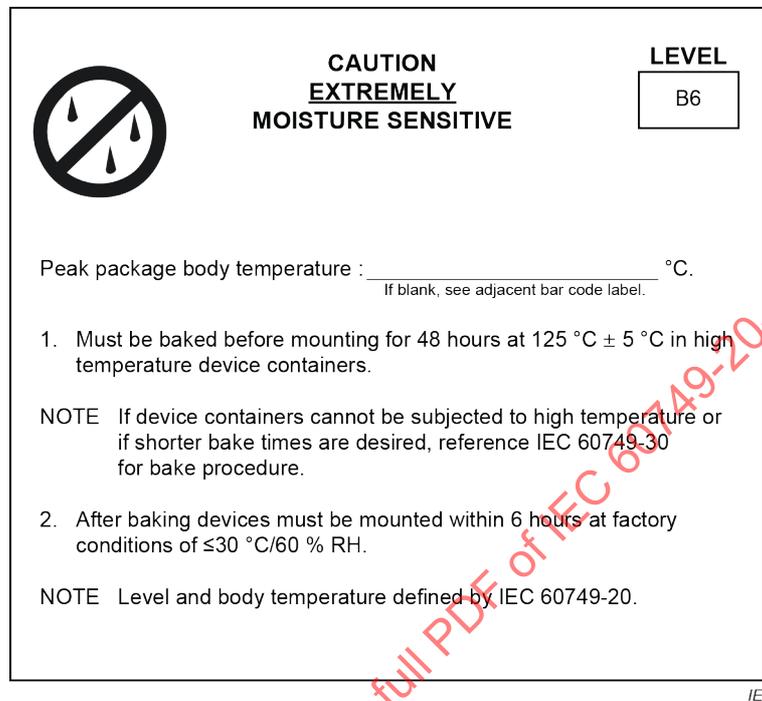


**Figure A.5 – Moisture-sensitive caution label for levels B2-B5a (example)**

**A.2.3.4 Level B6**

Level B6 devices shall be identified as “EXTREMELY MOISTURE SENSITIVE”. See Figure A.6. This label is required on the moisture barrier bag and/or the lowest-level shipping container. The label shall specify the peak SMD body temperature at which the device was classified. If the required information is not provided on the caution label, then it shall be on the adjacent bar code label.

Level B6, as defined by IEC 60749-20, does not require that devices be shipped in a moisture-barrier bag with desiccant, etc. (dry-pack), since these devices require baking by the end user before use. However, moisture-barrier bags have become a “symbol” for moisture-sensitive devices and, therefore, are recommended to be used with level B6 device shipments. It is also recommended that these bags be sealed even though desiccant and humidity indicator cards (HIC) may not be inside the bags.



**Figure A.6 – Moisture-sensitive caution label for level B6 (example)**

#### **A.2.3.5 Label size**

Labels are recommended to be a minimum of 75 mm by 75 mm square.

#### **A.2.3.6 Label colours**

The MSID and caution labels shall be contrasting colours. These labels shall be legible to normal vision at a distance of 1 m. Monochromatic reproduction in any colour that contrasts with the background may be used. Where the choice of colour is arbitrary, it is suggested that

- the MSID label background be blue (Pantone® 297 C1) with a black symbol and letters;
- the caution label background be white with a blue (Process Blue<sup>2</sup>) symbol and letters.

Wherever possible, the colour red should be avoided as red suggests a personal hazard.

<sup>1</sup> Pantone® 297 C is the trade name or trademark of a product supplied by Pantone. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

<sup>2</sup> Pantone® Process Blue C is the trade name or trademark of a product supplied by Pantone. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

## **Annex B** (informative)

### **Board rework**

#### **B.1 Component removal, rework and remount**

##### **B.1.1 Removal precautions**

If a component is to be removed from the board, it is recommended that localized heating is used and the maximum body temperatures of any surface mount component on the board do not exceed 200 °C. This method will minimize moisture related component damage. If any component temperature exceeds 200 °C, the board shall be baked dry in accordance with B.2 prior to rework and/or component removal. Component temperatures shall be measured at the top centre of the SMD body. Any SMDs that have not exceeded their floor life can be exposed to a maximum body temperature as high as their specified maximum reflow temperature.

Socketed components should be removed prior to rework.

##### **B.1.2 Removal for failure analysis**

Failure to follow the requirements of B.1.1 may cause moisture/reflow damage that could hinder or completely prevent the determination of the original failure mechanism.

##### **B.1.3 Removal and remount**

Removal and reinstallation or replacement of a component should be conducted in accordance with national standards governing rework, repair and modification of printed boards and electronic assemblies. If a component is to be removed and reinstalled, it can be necessary to first bake the printed wiring assembly to eliminate moisture from the component. The guidelines of Table 2 may be used in identifying an appropriate bake cycle. When identifying a bake cycle, the maximum exposure temperature and maximum rate of temperature change of components and materials on the subject printed wiring assembly shall be considered and an appropriate time-temperature profile (see national standards governing the rework of electronic assemblies) used. Replacement SMDs shall not have exceeded their specified floor life. Localized replacement reflow heating is recommended, so that the entire board is not re-subjected to reflow temperature profiles.

NOTE Temperatures on neighbouring SMDs above the melting point of the solder being used can cause some solder joints to partially reflow, which could result in a potential solder joint reliability concern.

#### **B.2 Baking of populated boards**

Some SMDs and board materials are not able to withstand long duration bakes at  $\geq 125$  °C. Examples of this are some FR-4 materials, which cannot withstand a 24 h bake at 125 °C, and some organic LEDs that have maximum temperatures of around 70 °C. Batteries and electrolytic capacitors are also temperature-sensitive. With component and board temperature restrictions in mind, choose a bake temperature from Table 2; then determine the appropriate bake duration based on the component to be removed.

For additional considerations, see national standards governing rework, repair and modification of printed boards and electronic assemblies.

## Annex C (normative)

### Test method for humidity indicator cards used with electronic component packaging

#### C.1 HIC testing method

To function properly, the spots shall show a visually perceptible colour change to indicate a change in the amount of humidity. This testing method uses a colorimeter to measure the colour (hue) of humidity indicating spots. The percentage of change in hue from one humidity value to another is then calculated.

#### C.2 Testing apparatus

The testing apparatus consists of:

- a chamber capable of maintaining atmosphere at a temperature of  $23\text{ °C} \pm 1\text{ °C}$  and a relative humidity from 2 % RH to ( $65\% \pm 1\%$ ) RH. The cards inside the chamber shall be observable from outside the chamber. Nominally, an acrylic box with a capacity of approximately 60 l, having facilities for access to the box interior while maintaining atmosphere is used. Humidity conditions can be achieved by placing combinations of molecular sieve desiccant, glycerin, and water inside the chamber;
- a colorimeter capable of measuring L, a\*, and b\* values (where L indicates lightness, a\* is the red/green coordinate, and b\* is the yellow/blue coordinate);
- an electronic hygrometer, with the minimum range of 1 % RH to 90 % RH.

#### C.3 Testing procedure

Place the sealed container of cards into the chamber. Set the chamber to the first humidity listed in Table 2. Open the container and suspend two cards inside the chamber so that the spots can be observed from outside the chamber. Allow the cards to condition for a minimum of 24 hours. All testing occurs inside the chamber, while the cards are exposed to the test humidity. Using a colorimeter, measure and record the L, a\*, and b\* values for each spot on the cards.

Set the chamber for the next humidity and continue in this manner until data has been collected for all conditions.

**Table C.1 – HIC spot compliance**

RH indicating spot	Hue value reading	
	Initial (dry)	Conditioned (spot value)
5 %	2 %	5 %
10 %	5 %	10 %
60 %	55 %	60 %

Printing in the indicating spot (coloured area) will affect the hue measurement, Spots without printing should be used

#### C.4 Data analysis

Using the  $a^*$  and  $b^*$  data, calculate the hue value,  $h_{ab}$  for each spot at each humidity condition in Table 2,

where:

If  $a^*$  and  $b^*$  are negative, then:

$$h_{ab} = \text{the absolute value of } \arctan(b^*/a^*)$$

If  $a^*$  and  $b^*$  are positive, or if  $a^*$  is positive and  $b^*$  is negative, then:

$$h_{ab} = 180 + \arctan(b^*/a^*)$$

If  $a^*$  is negative and  $b^*$  is positive, then:

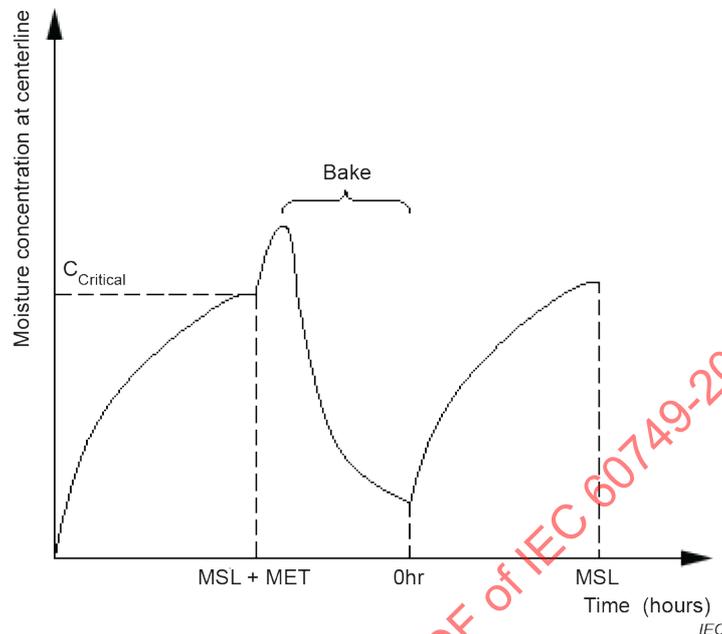
$$h_{ab} = 360 + \arctan(b^*/a^*)$$

Calculate the percent change in hue value at the humidity values shown in Table 2. Accept cards that show a 10 % or greater change in hue value reading from initial dry to the conditioned spot value in accordance with Table C.1. Cards with spots that do not indicate dry or wet conditions, in accordance with Table 2, should be rejected.

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## Annex D (informative)

### Derivation of bake tables



**Figure D.1 –Typical moisture concentration over time**

The derivation of the bake table process is illustrated graphically in Figure D.1.

Bake Tables 3, 4 and 5 were calculated using the following assumptions/approach:

a) Assume Fickian 1-D diffusion and Henry's Law apply:

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2} \quad (\text{Fick's law})$$

$C_{\text{Sat}}$  (at surface)  $\propto$  % RH in ambient atmosphere (Henry's Law)

Where  $C$  as a function of time ( $t$ ) is:

$$C(t) = C_{\text{Sat}} \left( 1 - \frac{4}{\pi} \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n}{(2n+1)} e^{-D(2n+1)^2 \pi^2 t / 4L^2} \right\} \right)$$

b) Diffusivity =  $6,2 \exp(-0,445 \text{ eV}/kT)$  mm<sup>2</sup>/s, (assumes slow diffusing mold compound)

- 1)  $D_{30 \text{ °C}} = 2,48 \times 10^{-7}$  mm<sup>2</sup>/s
- 2)  $D_{40 \text{ °C}} = 4,27 \times 10^{-7}$  mm<sup>2</sup>/s
- 3)  $D_{90 \text{ °C}} = 4,13 \times 10^{-6}$  mm<sup>2</sup>/s
- 4)  $D_{125 \text{ °C}} = 1,44 \times 10^{-5}$  mm<sup>2</sup>/s.

c) Define:

- 1)  $L_{\text{centerline}}$  = critical thickness, e.g. thickness of package / 2
- 2)  $C_{\text{Critical}}$  = concentration at  $L_{\text{centerline}}$  for given MSL (based on 30 °C/60 % RH exposure + 24 h MET preconditioning)

- 3)  $C_{\text{Centerline}}$  = concentration at  $L_{\text{centerline}}$  for any exposure condition
- d) Impose following two exposure conditions:
  - 1) MSL + > 72 h exposure (assume saturated at 30 °C/85 % RH where  $C_{\text{Sat}} = 7,8 \text{ mg/cm}^3$ )
  - 2) MSL +  $\leq$  72 h exposure (assume ambient at 30 °C/60 % RH where  $C_{\text{Sat}} = 5,3 \text{ mg/cm}^3$ )
- e) Calculate minimum time at bake temperature for cases d)1) and d)2) where an additional MSL exposure will keep  $C_{\text{Centerline}} < C_{\text{Critical}}$ .

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## Annex E (informative)

### Derating due to factory environmental conditions

Factory floor life exposures for SMDs removed from the dry bags will be a function of the ambient environmental conditions. A safe, yet conservative, handling approach is to expose the SMDs only up to the maximum time limits for each moisture-sensitivity level as shown in Table 4. This approach, however, does not work if the factory humidity or temperature is greater than the testing conditions of 30 °C/60 % RH. A solution for addressing this problem is to derate the exposure times based on the knowledge of moisture diffusion in the component packaging materials (see IEC 60749-39). Recommended equivalent total floor life exposures can be estimated for a range of humidities and temperatures based on the nominal plastic thickness for each device. Tables E.1 and E.2 list equivalent derated floor lives for humidities ranging from 20 % RH to 90 % RH for four temperatures, 20 °C, 25 °C, 30 °C and 35 °C. These tables are applicable to SMDs moulded with novolac, biphenyl or multifunctional epoxy mould compounds. The following assumptions were used in calculating Tables E.1 and E.2:

- a) activation energy for diffusion = 0,35 eV (smallest known value);
- b) for  $\leq 70$  % RH (for level A2) or 60 % RH (for level B2a to B5a), use diffusivity =  $0,121 e^{-0,35eV/kT} \text{ mm}^2 \cdot \text{s}^{-1}$  (this uses smallest known diffusivity at 30 °C);
- c) for  $> 70$  % RH (for level A2) or 60 % RH (for level B2a to B5a), use diffusivity =  $1,320 e^{-0,35eV/kT} \text{ mm}^2 \cdot \text{s}^{-1}$  (this uses largest known diffusivity at 30 °C).

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**Table E.1 – Recommended equivalent total floor life (days) for level A2 at 20 °C, 25 °C, 30 °C and 35 °C for ICs with novolac, biphenyl and multifunctional epoxies (reflow at same temperature at which component was classified)**

Floor life after opening MBBs whose inner atmosphere is 30 % RH (The values in parentheses are floor life after opening MBBs whose inner atmosphere is 10 % RH)												
SMD type and body thickness	Moisture sensitivity level	Maximum percent relative humidity										Temperature °C
		5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	
Body thickness ≥3,1 mm including PQFPs >84 pins, PLCCs (square) All MQFPs or All BGAs ≥1 mm	Level A2	∞	∞	∞	∞	7	6	5	5	4	3	35
		(62)	(43)	(34)	(29)	(5)	(4)	30				
		∞	∞	∞	∞	9	8	7	7	5	4	25
		(77)	(54)	(43)	(37)	(7)	(5)	20				
Body 2,1 mm ≤ thickness <3,1 mm including PLCCs (rectangular) 18-32 pins SOICs (wide body) SOICs ≥ 20 pins, PQFPs ≤ 80 pins	Level A2	∞	∞	∞	∞	11	10	9	8	6	5	35
		(97)	(67)	(54)	(46)	(8)	(7)	30				
		∞	∞	∞	∞	14	12	11	11	8	6	25
		(122)	(85)	(68)	(58)	(11)	(9)	20				
Body thickness < 2,1 mm including SOICs <18 pins All TQFPs, TSOPs or all BGAs < 1 mm body thickness	Level A2	∞	∞	∞	∞	11	7	6	5	3	2	35
		(34)	(22)	(17)	(14)	(3)	(2)	30				
		∞	∞	∞	∞	14	9	7	7	3	2	25
		(42)	(27)	(21)	(18)	(4)	(3)	20				
Body thickness < 2,1 mm including SOICs <18 pins All TQFPs, TSOPs or all BGAs < 1 mm body thickness	Level A2	∞	∞	∞	∞	17	11	9	8	4	3	35
		(52)	(34)	(27)	(22)	(5)	(4)	30				
		∞	∞	∞	∞	22	14	12	11	6	4	25
		(66)	(43)	(34)	(28)	(7)	(5)	20				
Body thickness < 2,1 mm including SOICs <18 pins All TQFPs, TSOPs or all BGAs < 1 mm body thickness	Level A2	∞	∞	∞	∞	∞	∞	8	5	0,5	0,5	35
		(11)	(7)	(1)	(0,5)	30						
		∞	∞	∞	∞	∞	∞	10	7	1	0,5	25
		(14)	(9)	(1)	(0,5)	20						
Body thickness < 2,1 mm including SOICs <18 pins All TQFPs, TSOPs or all BGAs < 1 mm body thickness	Level A2	∞	∞	∞	∞	∞	∞	13	8	1	0,5	35
		(17)	(12)	(1)	(1)	30						
		∞	∞	∞	∞	∞	∞	17	11	1	1	25
		(22)	(15)	(2)	(1)	20						

NOTE ∞ represents indefinite exposure time allowed at conditions specified.



		Floor life											
SMD type and body thickness	Moisture sensitivity level	Maximum percent relative humidity										Temperature °C	
		5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %		
Body thickness < 2,1 mm including SOICs < 18 pins All TQFPs, TSOPs or all BGAs < 1 mm body thickness	Level B2a	∞	∞	∞	∞	∞	∞	∞	17	1	0,5	0,5	35
		∞	∞	∞	∞	∞	∞	∞	28	1	1	1	30
		∞	∞	∞	∞	∞	∞	∞	∞	2	1	1	25
		∞	∞	∞	∞	∞	∞	∞	∞	2	2	1	20
	Level B3	∞	∞	∞	∞	∞	∞	8	5	1	0,5	0,5	35
		∞	∞	∞	∞	∞	∞	11	7	1	1	1	30
		∞	∞	∞	∞	∞	∞	14	10	2	1	1	25
		∞	∞	∞	∞	∞	∞	20	13	2	2	1	20
	Level B4	∞	∞	∞	7	4	3	2	1	0,5	0,5	35	
		∞	∞	∞	9	5	4	3	1	1	1	30	
		∞	∞	∞	12	7	5	4	2	1	1	25	
		∞	∞	∞	17	9	7	6	2	2	1	20	
	Level B5	∞	∞	7	3	2	2	1	1	0,5	0,5	35	
		∞	∞	13	5	3	2	2	1	1	1	30	
		∞	∞	18	6	4	3	3	2	1	1	25	
		∞	∞	26	8	6	5	4	2	2	1	20	
	Level B5a	∞	7	2	1	1	1	1	1	0,5	0,5	35	
		∞	10	3	2	1	1	1	1	1	0,5	30	
		∞	13	5	3	2	2	2	1	1	1	25	
		∞	18	6	4	3	2	2	2	2	1	20	

NOTE ∞ represents indefinite exposure time allowed at conditions specified.

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## COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**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**

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Cette deuxième édition annule et remplace la première édition parue en 2009. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) mises à jour de certains paragraphes pour mieux aligner la méthode d'essai avec le document IPC/JEDEC J-STD-033C, comprenant de nouvelles sections sur le nettoyage aqueux et les précautions applicables aux emballages avec dessiccant;
- b) ajout de deux annexes sur les essais colorimétriques des cartes indicatrices d'humidité (HIC) et la détermination des tableaux d'étuvage.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
47/2565/FDIS	47/2579/RVD

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 60749, publiées sous le titre général *Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques*, peut être consultée sur le site web de l'IEC.

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## INTRODUCTION

L'arrivée des composants pour montage en surface (CMS) a introduit une nouvelle classe de qualité mais suscite des préoccupations dans le domaine de la fiabilité quant aux dommages subis par les boîtiers, comme les "fissures et les délaminages" causés par le procédé de brasage par refusion. Le présent document décrit les niveaux normalisés d'exposition à un environnement non protégé pour les CMS sensibles à l'humidité/la refusion ainsi que les exigences de manipulation, d'emballage et de transport nécessaires pour éviter les défaillances liées à l'humidité/la refusion. L'IEC 60749-20 définit la procédure de classification et l'Annexe A du présent document définit les exigences d'étiquetage.

L'humidité d'origine atmosphérique pénètre par diffusion dans les matériaux d'emballage perméables. Les procédés d'assemblage utilisés pour souder les CMS sur les cartes des circuits imprimés (PCB, Printed Circuit Board) exposent l'ensemble du corps du boîtier à des températures supérieures à 200 °C. Au cours du brasage par refusion, la combinaison de l'expansion rapide de l'humidité, du défaut d'adaptation des matériaux et de la dégradation des interfaces des matériaux peut entraîner des fissures du boîtier et/ou des délaminages des interfaces critiques à l'intérieur de celui-ci.

Les procédés de brasage par refusion typiquement concernés sont les procédés par infrarouge (IR), par convection/IR, par convection, en phase vapeur (VPR), les outils de reprise utilisant l'air chaud et le brasage à la vague, comprenant une immersion totale.

Les dispositifs sans semi-conducteurs peuvent présenter des sensibilités supplémentaires à certains procédés, autres que la sensibilité à l'humidité, telles que la sensibilité thermique, la sensibilité au flux ou la sensibilité aux procédés de nettoyage.

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## 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

#### 1 Domaine d'application

La présente partie de l'IEC 60749 s'applique à tous les dispositifs soumis à des procédés de brasage par refusion en masse lors de l'assemblage de la PCB, comprenant les boîtiers plastiques, les dispositifs sensibles aux procédés et les autres dispositifs sensibles à l'humidité fabriqués dans des matériaux perméables à l'humidité (époxydes, silicones, etc.), qui sont exposés à l'air ambiant.

L'objet du présent document est de fournir aux fabricants et aux utilisateurs de CMS des méthodes normalisées pour la manipulation, l'emballage, le transport et l'utilisation des CMS sensibles à l'humidité/la refusion qui sont classés selon les niveaux définis dans l'IEC 60749-20. Ces méthodes sont fournies pour éviter les dommages provoqués par l'absorption d'humidité et l'exposition aux températures de brasage par refusion pouvant donner lieu à une dégradation de rendement et de fiabilité. L'utilisation de ces procédures permet une refusion sûre et ne causant pas de dommages, avec le procédé d'emballage avec dessiccant, ce qui permet une durée minimale de stockage dans des sachets scellés avec dessiccant à compter de la date de scellement.

Deux conditions d'essai, à savoir la méthode A et la méthode B, sont spécifiées dans l'essai à la chaleur de brasage de l'IEC 60749-20. Pour la méthode A, les conditions d'absorption d'humidité sont spécifiées en partant de l'hypothèse selon laquelle la teneur en humidité à l'intérieur du sachet étanche à l'humidité est inférieure à un taux d'humidité relative (HR) de 30 %. Pour la méthode B, les conditions d'absorption d'humidité sont spécifiées en partant de l'hypothèse selon laquelle le temps d'exposition du fabricant (MET) ne dépasse pas 24 h et la teneur en humidité à l'intérieur du sachet étanche à l'humidité est inférieure à 10 % d'HR. Dans un environnement de manipulation réel, il est admis que les CMS soumis à essai via la méthode A absorbent jusqu'à 30 % d'HR et que ceux soumis à essai via la méthode B absorbent jusqu'à 10 % d'HR. Le présent document spécifie les conditions de manipulation des CMS soumis aux conditions d'essai décrites ci-dessus.

NOTE Les boîtiers hermétiques de CMS ne sont pas sensibles à l'humidité et n'exigent pas la prise de précautions particulières contre l'humidité.

#### 2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils 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 60749-20, *Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques – Partie 20: Résistance des CMS à boîtier plastique à l'effet combiné de l'humidité et de la chaleur de brasage*

IEC 60749-30, *Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques – Partie 30: Préconditionnement des composants pour montage en surface non hermétiques avant les essais de fiabilité*

### 3 Termes et définitions

Pour les besoins du présent document, les termes et définitions 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

##### **dessiccant actif**

dessiccant qui est frais (neuf) ou qui a subi un étuvage selon les recommandations du fabricant pour le renouveler et retrouver ses spécifications d'origine

#### 3.2

##### **étiquette à code-barres**

étiquette fournissant des informations sous la forme d'un code constitué de barres et d'espaces parallèles de différentes largeurs

Note 1 à l'article: Dans le cadre du présent document, l'étiquette à code-barres est placée sur le conteneur d'expédition du niveau le plus bas et comprend des informations qui décrivent le produit, par exemple référence, quantité, informations de lot, identification du fournisseur, niveau de sensibilité à l'humidité.

#### 3.3

##### **refusion en masse**

refusion d'un certain nombre de composants avec fixation simultanée par un procédé de refusion à infrarouge (IR), par convection/IR, par convection ou en phase vapeur (VPR)

#### 3.4

##### **support**

conteneur qui maintient directement les composants, par exemple un plateau, un tube, ou une bande et une bobine

#### 3.5

##### **dessiccant**

matériau absorbant utilisé pour maintenir un faible taux d'humidité relative

#### 3.6

##### **temps de stockage en environnement non protégé**

laps de temps admissible qui s'écoule entre le moment où un dispositif sensible à l'humidité est retiré d'un sachet étanche à l'humidité, sort d'un stockage à sec ou d'un étuvage de séchage et le moment où il subit un procédé de brasage par refusion

#### 3.7

##### **carte indicatrice d'humidité**

##### **HIC**

carte imprimée avec un produit chimique sensible à l'humidité (bromure de cobalt) qui passe du bleu au rose en présence de vapeur d'eau

Note 1 à l'article: La HIC est placée à l'intérieur du sachet étanche à l'humidité, avec un dessiccant, pour permettre de déterminer le niveau d'humidité auquel ont été soumis les dispositifs sensibles à l'humidité.

Note 2 à l'article: Le terme abrégé "HIC" est dérivé du terme anglais développé correspondant "humidity indicator card".

### **3.8 temps d'exposition du fabricant MET**

temps maximal après étuvage exigé par le fabricant de composants pour traiter les composants avant de sceller le sachet; ce laps de temps inclut également le délai maximal autorisé pendant lequel le distributeur peut laisser le sachet ouvert pour constituer des lots d'expédition de plus petite taille

Note 1 à l'article: Le terme abrégé "MET" est dérivé du terme anglais développé correspondant "manufacturer's exposure time".

### **3.9 sachet étanche à l'humidité MBB**

sachet de stockage comportant un film antivapeur plastifié souple qui limite la transmission de la vapeur d'eau

Note 1 à l'article: Le terme abrégé "MBB" est dérivée du terme anglais développé correspondant "moisture barrier bag".

### **3.10 reprise**

retrait d'un composant en vue d'une mise au rebut, d'une réutilisation ou d'une analyse des défaillances; remplacement d'un composant fixé ou chauffage et repositionnement d'un composant précédemment fixé

### **3.11 durée limite de stockage**

durée de stockage maximale pour un composant sensible à l'humidité, sous emballage avec dessiccant dans un sachet non ouvert, étanche à l'humidité (MBB), afin d'éviter de dépasser la valeur de l'humidité ambiante intérieure spécifiée du sachet

### **3.12 composant pour montage en surface CMS**

dispositifs pour montage en surface sous boîtiers en plastique réalisés dans des matériaux perméables à l'humidité

Note 1 à l'article: Pour les besoins du présent document, le terme "CMS" est limité aux configurations données dans la définition.

### **3.13 brasage par refusion**

procédé de fixation par brasage dans lequel une brasure ou une pâte à braser précédemment appliquée est fondue pour fixer un composant sur la carte de circuit imprimé

### **3.14 taux de transmission de vapeur d'eau TTVE**

mesure de la perméabilité à l'humidité d'un matériau en film plastique ou en film plastique métallisé

## **4 Considérations générales d'applicabilité et de fiabilité**

### **4.1 Procédés d'assemblage**

#### **4.1.1 Refusion en masse**

Le présent document s'applique à l'assemblage par brasage par refusion en masse utilisant les procédés par convection, par convection/IR, à infrarouge (IR) et en phase vapeur (VPR). Il ne s'applique pas aux procédés de brasage par refusion en masse qui immergent les corps

des composants dans une brasure fondue (par exemple, composants montés sur face inférieure par brasage à la vague). De tels procédés ne sont pas autorisés pour de nombreux CMS et ne sont pas couverts par les normes de qualification de composants utilisées comme base pour le présent document.

#### **4.1.2 Chauffage localisé**

Le présent document s'applique également aux CMS sensibles à l'humidité qui sont retirés ou fixés individuellement par un chauffage ambiant local, c'est-à-dire une "reprise à l'air chaud". Voir l'Annexe B.

#### **4.1.3 Composants sur support**

Le présent document ne s'applique pas aux CMS sur support qui ne sont pas exposés à des températures de brasage par refusion. De tels CMS ne courent pas de risques et n'exigent donc pas de précautions particulières contre l'humidité.

#### **4.1.4 Brasage point-par-point**

Le présent document ne s'applique pas aux CMS dans lesquels seuls les fils sont chauffés pour faire refondre la brasure, par exemple brasage à la main, fixation par élément chauffant de sorties en aile de mouette et trous traversants par brasage à la vague. La chaleur absorbée par le corps des CMS à la suite de telles opérations est généralement bien plus faible que pour la refusion en masse pour montage en surface ou pour la reprise à l'air chaud, et des mesures préventives contre l'humidité ne sont généralement pas nécessaires.

#### **4.1.5 Nettoyage aqueux**

Pour les CMS n'ayant pas de cavité interne, les procédés typiques de nettoyage aqueux de courte durée n'ont pas d'impact sur le temps de stockage en environnement non protégé (teneur interne en humidité). Il convient d'accorder une attention particulière aux boîtiers à cavité non hermétiques.

### **4.2 Fiabilité**

Les méthodes énoncées dans la présente spécification garantissent qu'une fiabilité appropriée du CMS peut être obtenue pendant et après l'opération d'assemblage de la PCB, lorsque les CMS sont évalués et vérifiés selon l'IEC 60749-20 et/ou l'IEC 60749-30, ainsi que par des essais de fiabilité d'environnement.

La présente spécification ne traite pas la question de la fiabilité des joints brasés des composants fixés et ne donne aucune assurance dans ce domaine.

## **5 Emballage avec dessiccant**

### **5.1 Exigences**

Les exigences relatives aux emballages avec dessiccant pour les différents niveaux de sensibilité à l'humidité sont indiquées dans le Tableau 1. Les niveaux sont déterminés conformément à l'IEC 60749-20 et/ou à l'IEC 60749-30, ainsi qu'à l'aide des essais de fiabilité. Au minimum, il convient que tous les matériaux utilisés dans l'emballage avec dessiccant soient conformes aux normes nationales applicables aux matériaux d'emballage pour éléments sensibles aux décharges électrostatiques (DES).

**Tableau 1 – Exigences relatives aux emballages avec dessiccant**

Niveau	Sec avant le sachet	MBB	Dessiccant	Etiquette MSID <sup>a</sup>	Etiquette d'avertissement
A1 ou B1	Facultatif	Facultatif	Facultatif	Non exigée	Non exigée si classé entre 220 °C et 225 °C
					Exigée <sup>b</sup> si classé à une valeur hors de la plage de 220 °C à 225 °C
A2 ou B2	Facultatif	Exigé	Exigé	Exigée	Exigée
B2a-B5a	Exigé	Exigé	Exigé	Exigée	Exigée
B6	Facultatif	Facultatif	Facultatif	Exigée	Exigée

<sup>a</sup> MSID = Identification de la sensibilité à l'humidité (Moisture-Sensitive IDentification)

<sup>b</sup> Aucune étiquette d'"avertissement" n'est exigée si le niveau et la température de refusion sont donnés sous une forme lisible par une personne, sur l'étiquette à code-barres fixée sur le conteneur d'expédition du niveau le plus bas.

## 5.2 Séchage des CMS et des matériaux supports avant d'être scellés dans des sachets étanches à l'humidité

### 5.2.1 Exigences de séchage – Niveau A2

L'emballage dans des MBB des CMS classés en niveau A2 doit être réalisé sous une semaine dans des conditions d'environnement inférieures à 30 °C et 60 % d'humidité relative après moulage, vieillissement artificiel à chaud ou étuvage.

Le MET n'est pas spécifié pour les CMS de niveau A2.

Les MBB peuvent être ouverts pendant un court laps de temps (moins d'1 h) puis refermés, sous réserve que la HIC indique une humidité relative inférieure à 30 % et que le dessiccant soit remplacé par un dessiccant neuf. Lorsque le MBB est de nouveau ouvert, il est admis de ne pas tenir compte de sa durée d'ouverture précédente tant que la HIC indique une humidité relative inférieure à 30 %. Ainsi, si la HIC indique une humidité relative inférieure à 30 % lorsque le MBB est ouvert, le temps de stockage en environnement non protégé ne dépend pas de la durée pendant laquelle le MBB reste ouvert et elle est de 168 h à 30 °C et 70 % d'HR.

### 5.2.2 Exigences de séchage – Niveaux B2a à B5a

Les CMS classés des niveaux B2a à B5a doivent être séchés (voir l'Article 6) avant d'être scellés dans les MBB. Le laps de temps qui s'écoule entre le séchage et le scellement ne doit pas dépasser le temps d'exposition du fabricant (MET), déduction faite du temps laissé aux distributeurs pour ouvrir les sachets et réemballer les pièces. Si le MET réel du fournisseur est supérieur aux 24 h par défaut, alors le temps réel doit être utilisé. Si le distributeur réemballe les MBB avec du dessiccant actif, alors le temps nécessaire à cette opération n'a pas à être déduit du MET.

### 5.2.3 Exigences de séchage – Matériaux supports

Les matériaux utilisés pour la fabrication des supports (tels que plateaux, tubes, bobines) peuvent affecter le niveau d'humidité lorsqu'ils sont placés dans les MBB. De ce fait, l'effet de ces matériaux doit être compensé par un étuvage ou, si cela est exigé, par l'ajout de dessiccant supplémentaire dans le MBB pour assurer la durée limite de stockage des CMS (voir 6.3).

### 5.2.4 Exigences de séchage – Autres

Les fournisseurs peuvent utiliser l'effet de séchage des procédés à la chaîne normaux, tels que le traitement après moulage, le traitement de marquage et le vieillissement artificiel à chaud pour réduire le temps d'étuvage. Une évaluation d'équivalence est recommandée pour s'assurer que le traitement à haute température maintient le gain de masse en humidité à un niveau acceptable. Le gain de masse total pour un CMS au moment où il est scellé dans le MBB ne doit pas dépasser le gain d'humidité de ce CMS lorsqu'il est sec au départ puis exposé à 30 °C/60 % d'HR pendant le MET donné en heures (moins le temps accordé aux distributeurs).

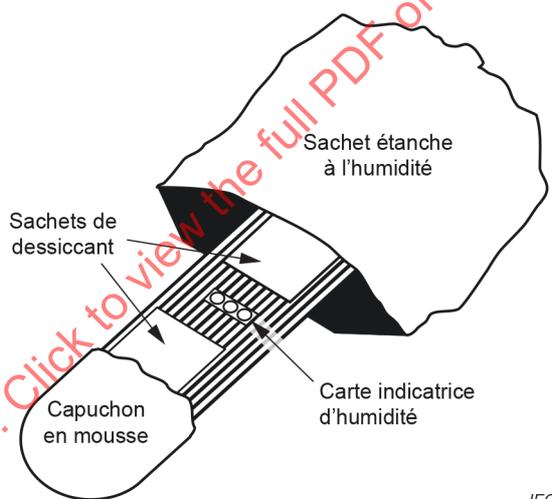
### 5.2.5 Temps excessif entre l'étuvage et l'ensachage

Si le délai autorisé entre l'étuvage et l'ensachage est dépassé, les CMS doivent être reséchés conformément à l'Article 6.

## 5.3 Emballage avec dessiccant

### 5.3.1 Description

Un emballage avec dessiccant consiste à placer un matériau dessiccant et une HIC avec les CMS et leurs supports à l'intérieur d'un sachet étanche à l'humidité (MBB) qui est ensuite scellé. Une configuration représentative d'un emballage avec dessiccant est donnée à la Figure 1.



**Figure 1 – Configuration typique d'emballage avec dessiccant pour les CMS sensibles à l'humidité dans des tubes d'expédition**

### 5.3.2 Matériaux

#### 5.3.2.1 Sachet étanche à l'humidité (MBB)

Le sachet étanche à l'humidité doit satisfaire à toutes les exigences des normes nationales applicables concernant la souplesse, la protection contre les DES, la résistance mécanique et la résistance à la perforation. Les sachets doivent être thermoscellables. Le taux de transmission de vapeur d'eau (TTVE) doit être de  $\leq 0,03 \text{ g/m}^2$  en 24 h à 40 °C après les essais de flexion, conformément aux normes nationales applicables qui régissent la durabilité à la flexion des matériaux des barrières souples. Le TTVE est mesuré en utilisant les normes nationales applicables régissant le taux de transmission de vapeur d'eau à travers un film ou une feuille plastique au moyen d'un capteur à infrarouge à modulation.

### 5.3.2.2 Dessiccant

Le matériau dessiccant doit être conforme aux normes nationales applicables régissant les dessiccants activés utilisés pour la déshumidification statique des sachets d'emballage. Le dessiccant doit être exempt de poussières, non corrosif et absorbant à des niveaux spécifiés dans la norme. Le dessiccant doit être emballé dans des sachets perméables à l'humidité. La quantité de dessiccant utilisée, par sachet étanche à l'humidité, doit être fondée sur la surface du sachet et le TTVE pour maintenir une humidité relative intérieure dans le MBB qui soit inférieure à 30 % à 25 °C, pour les CMS de classe A2, et inférieure à 10 % à 25 °C pour les CMS des niveaux B2a à B5a.

Pour permettre une comparaison entre différents types de dessiccants, certaines spécifications ont adopté l'"UNITE" comme unité de mesure de base de quantité pour les matériaux dessiccants. Une UNITE de dessiccant est définie comme la quantité qui absorbe un minimum de 2,85 g de vapeur d'eau à 20 % d'HR et 25 °C. Pour satisfaire aux exigences du présent document relatives aux emballages avec dessiccant, la quantité de vapeur d'eau qu'une UNITE de dessiccant peut absorber à 10 % d'HR et 25 °C doit être connue.

Lorsque la capacité du dessiccant à 10 % d'HR et 25 °C est connue, il convient d'utiliser l'équation suivante.

$$U = (0,003 \times M \times TTVE \times A)/D \quad (1)$$

où:

- $U$  = quantité de dessiccant, exprimée en UNITES;
- $M$  = durée limite de stockage, exprimée en mois;
- $TTVE$  = taux de transmission de vapeur d'eau, exprimé en g/m<sup>2</sup> en 24 h;
- $A$  = surface totale du MBB, exprimée en m<sup>2</sup>;
- $D$  = quantité d'eau, exprimée en grammes, qu'une UNITE de dessiccant absorbe à 10 % d'HR et 25 °C.

Lorsque la capacité du dessiccant à 10 % d'HR et 25 °C n'est pas connue, la quantité nécessaire peut être estimée en utilisant la formule simplifiée suivante.

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

où:

- $U$  = quantité de dessiccant en UNITES;
- $A$  = surface totale du MBB, exprimée en m<sup>2</sup>.

Si le but est de réduire le plus possible la quantité de dessiccant utilisée pour les composants de niveau 2 des emballages avec dessiccant, il convient d'utiliser dans la formule une valeur  $D$ , basée sur la quantité d'eau en grammes qu'une UNITE de dessiccant absorbe à 60 % d'HR et 25 °C. Cette valeur peut être obtenue auprès du fabricant du dessiccant. Lorsque cette option est retenue, il peut être vérifié que le composant, s'il a été classifié conformément à l'IEC 60749-20, a atteint la saturation complète lors de l'absorption d'humidité.

Il convient de ne placer aucun matériau absorbant l'humidité (par exemple des plateaux, des tubes, des bobines, des capuchons en mousse) dans le sachet avec dessiccant sans étuvage. L'inclusion de tels matériaux augmente la quantité de dessiccant nécessaire à l'atteinte de la durée limite de stockage calculée (voir 7.4.2), dans des proportions basées sur la teneur en humidité du matériau. Cela peut être déterminé en pesant une quantité représentative de matériau, connu pour être à l'équilibre dans l'environnement de fabrication, en l'étuvant à une nouvelle masse constante et en soustrayant la masse finale de la masse initiale. Il convient d'ajouter une ou plusieurs UNITES de dessiccant, sur la base de 10 % d'HR à 25 °C, afin

d'absorber la quantité d'eau, en grammes, sortant des matériaux d'emballage (bois de calage) à l'issue de l'étuvage.

### 5.3.2.3 Manipulation et stockage du dessiccant

La capacité du dessiccant diminue rapidement lorsqu'elle est exposée à un environnement à 30 °C/60 % d'HR. Il convient par conséquent que le dessiccant soit conservé jusqu'à son utilisation dans le conteneur du fabricant, ou stocké dans une armoire sèche à une humidité relative inférieure à 5 %. Lors du conditionnement dans l'emballage avec dessiccant, le dessiccant doit être retiré du conteneur de stockage juste avant de le placer dans le MBB et de sceller celui-ci.

### 5.3.2.4 Carte indicatrice d'humidité (HIC)

La HIC doit être conforme aux normes nationales applicables régissant les cartes indicatrices d'humidité imprégnées chimiquement. Pour le niveau A2, la HIC doit avoir une valeur de sensibilité de 30 % d'HR, qui peut être indiquée par des points de couleur avec des valeurs de sensibilité de 20 % d'HR, de 30 % d'HR et de 40 % d'HR. Pour les CMS classés des niveaux B2a à B5a, au minimum, la HIC doit avoir 3 points de couleur avec des valeurs de sensibilité de 5 % d'HR, de 10 % d'HR et de 60 % d'HR. Les points doivent indiquer la teneur en humidité avec une variation significative et perceptible de couleur (teinte), comme indiqué dans le Tableau 2. La teinte doit être soumise à essai en utilisant la méthode d'essai de l'Annexe C. Les couleurs doivent être décrites par écrit sur la carte. La réutilisation d'une HIC n'est pas admise si le point correspondant à 60 % d'HR a changé de couleur. La réutilisation n'est pas admise en raison de la perte de précision des points à 5 % d'HR et 10 % d'HR, si le point à 60 % d'HR a changé de couleur. Il n'est pas exigé de réutiliser la même HIC dans un MBB si celui-ci est à sceller de nouveau; une HIC neuve peut être utilisée.

Des exemples de HIC sont représentés aux Figures 2a) et 2b).

### 5.3.2.5 Papier constitutif de la HIC

Du papier buvard blanc fabriqué à partir de matière cellulosique fibreuse, présentant un grammage de base minimal de 255 g/m<sup>2</sup>, doit être utilisé pour les HIC.

### 5.3.2.6 Défauts visuels

Les HIC doivent être exemptes de défauts, incluant des accrocs, des points de couleur manquants, ou disposés aux mauvais endroits, ou le débordement de la couleur de signalisation sur les cercles noirs.

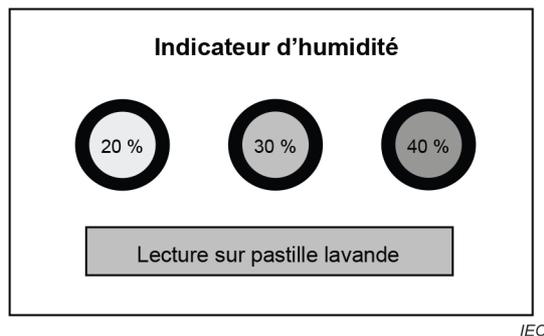
### 5.3.2.7 Conservation

Les HIC doivent être conservées conformément à la recommandation du fabricant, avant leur insertion dans le MBB. Au minimum, le point à 10 % d'HR doit indiquer l'absence d'humidité lorsque les cartes sont retirées du conteneur d'origine.

**Tableau 2 –Coloration typique des points de couleur d'une HIC**

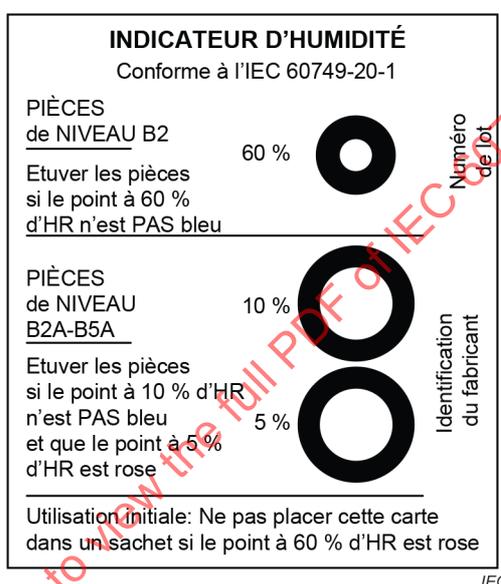
	Coloration dans un environnement à 2 % d'HR	Coloration dans un environnement à 5 % d'HR	Coloration dans un environnement à 10 % d'HR	Coloration dans un environnement à 55 % d'HR	Coloration dans un environnement à 60 % d'HR	Coloration dans un environnement à 65 % d'HR
Point à 5 % d'HR	Bleu (sec)	Lavande (valeur de référence du point)  Variation de teinte ≤7 %	Rose (humide)	Rose (humide)	Rose (humide)	Rose (humide)
Point à 10 % d'HR	Bleu (sec)	Bleu (sec)	Lavande (valeur de référence du point)  Variation de teinte ≤10 %	Rose (humide)	Rose (humide)	Rose (humide)
Point à 60 % d'HR	Bleu (sec)	Bleu (sec)	Bleu (sec)	Bleu (sec)	Lavande (valeur de référence du point)  Variation de teinte ≤10 %	Rose (humide)
NOTE D'autres codes de couleur peuvent être utilisés.						

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Les valeurs d'humidité relative inférieures à 30 % peuvent être confirmées par comparaison avec une couleur de référence (lavande).

a) Exemple de carte indicatrice d'humidité pour le niveau A2



b) Exemple de carte indicatrice d'humidité pour les niveaux B2a à B5a

Figure 2 – Exemples de carte indicatrice d'humidité

### 5.3.3 Étiquettes

#### 5.3.3.1 Étiquettes – Identification de la sensibilité à l'humidité

Les étiquettes applicables au procédé d'emballage avec dessiccant correspondent aux étiquettes d'identification de la sensibilité à l'humidité (MSID) et d'avertissement, comme spécifié dans l'Annexe A (voir les Figures A.2 à A.5). L'étiquette MSID doit être apposée sur le conteneur d'expédition du niveau le plus bas qui contient le MBB. L'étiquette d'avertissement doit être apposée sur la surface extérieure du MBB. L'étiquette d'avertissement comporte des champs pour le niveau de classification à l'humidité, conformément à l'IEC 60749-20; la température de crête autorisée pour le corps du boîtier, pendant le brasage par refusion (la température de classification); le temps de stockage en environnement non protégé et la date de scellement du sachet. Si la durée limite de stockage calculée est supérieure à 12 mois, l'élément n° 1 de l'étiquette d'avertissement doit être modifié en conséquence.

#### 5.3.3.2 Étiquettes – Exigences relatives au niveau B6

Les pièces de niveau B6 qui ne sont pas expédiées dans des MBB doivent comporter à la fois une étiquette MSID et une étiquette d'avertissement appropriée, apposée sur le conteneur d'expédition du niveau le plus bas.

### 5.3.3.3 Étiquettes – Exigences relatives aux niveaux A1 et B1

Les pièces de niveaux A1 et B1 classées pour des températures maximales de refusion autres que la plage de 220 °C à 225 °C doivent comporter une étiquette d'avertissement avec la température maximale de refusion spécifiée. L'étiquette d'avertissement doit être apposée sur le MBB (le cas échéant) ou sur le conteneur d'expédition du niveau le plus bas. L'étiquette d'avertissement n'est pas exigée si une étiquette à code-barres comprend la classification de niveau A1 ou B1 et la température maximale de refusion, sous une forme lisible par une personne. Les pièces de niveau A1 et B1 classées à des températures maximales de refusion comprises entre 220 °C et 225 °C n'exigent aucune étiquette relative à l'humidité.

### 5.3.4 Scellement du sachet étanche à l'humidité

Le sachet doit être thermoscellé de façon à ne pas endommager ou provoquer un délaminage du MBB.

### 5.3.5 Précautions relatives aux emballages avec dessiccant

#### 5.3.5.1 Disposition d'une HIC

La HIC peut être disposée n'importe où dans le MBB, mais ne doit pas être placée sous une poche de dessiccant.

#### 5.3.5.2 Réutilisation d'une HIC

Les cartes HIC dont la couleur du point à 10 % d'HR a changé pour révéler l'exposition à un environnement humide ne doivent pas être utilisées/réutilisées si le sachet est ouvert et que la carte HIC est inspectée dans un délai de 48 h.

Les cartes HIC disposant d'un point à 60 % d'HR doivent être mises au rebut si la couleur de ce point à 60 % d'HR a changé pour révéler l'exposition à un environnement humide. Les HIC ayant été exposées à une humidité relative supérieure ou égale à 60 % ne présentent plus une précision suffisante.

#### 5.3.5.3 Scellement du sachet étanche à l'humidité

L'évacuation de l'air n'est pas exigée dans la pratique réelle. Une légère évacuation de l'air est à appliquer afin de réduire l'encombrement et d'améliorer le conditionnement dans les cartons. Une évacuation totale de l'air, ou mise sous vide, ne doit pas être utilisée car elle altère les performances du dessiccant et de la HIC, et peut potentiellement entraîner une perforation du MBB.

### 5.3.6 Durée limite de stockage

La durée limite de stockage calculée pour des CMS sous emballage avec dessiccant doit être au moins de 12 mois à partir de la date de scellement du sachet, lorsqu'ils sont stockés dans un environnement atmosphérique sans condensation < 40 °C/90 % d'HR. Si la durée limite de stockage calculée est supérieure à 12 mois, l'élément n° 1 de l'étiquette d'avertissement est modifié en conséquence (voir Figures A.4 et A.5).

## 6 Séchage

### 6.1 Options de séchage

Les options de séchage des composants pour différents niveaux de sensibilité à l'humidité et des expositions à une humidité ambiante sont données dans les Tableaux 3, 4, 5 et 6. Le séchage, lorsqu'il utilise une option admissible, réinitialise le décompte du temps de stockage en environnement non protégé. En cas de séchage et de scellement dans un MBB avec du dessiccant neuf, la durée limite de stockage est réinitialisée. Les Tableaux 3, 4, 5 et 6 donnent les conditions de référence pour le séchage des CMS. Les Tableaux 3 et 4 donnent

des conditions pour un nouvel étuvage des CMS sur le site de l'utilisateur, après expiration du temps de stockage en environnement non protégé ou après apparition d'autres conditions indiquant une exposition excessive à l'humidité. Le Tableau 5 donne les conditions pour l'étuvage avant emballage avec dessiccant chez un fournisseur et/ou un distributeur, et prévoit un MET total maximal de 24 h. Le Tableau 6 synthétise les conditions de réinitialisation ou d'interruption du décompte du temps de stockage en environnement non protégé sur le site de l'utilisateur, conformément à 6.2.1. Le fournisseur doit communiquer de manière formelle au distributeur la durée maximale pendant laquelle le produit peut être laissé non scellé (chez le distributeur) avant qu'un nouvel étuvage soit exigé.

NOTE Si le procédé d'étuvage est interrompu pendant plus de 15 min, la durée totale de l'interruption est ajoutée au temps d'étuvage.

**Tableau 3 – Conditions de référence pour le séchage des CMS montés ou non montés (étuvage utilisateur: le décompte du temps de stockage en environnement non protégé démarre tout de suite après l'étuvage) – Niveau 2**

Épaisseur du corps du CMS	Niveau A2	Étuvage à 125 °C $+10_0$ °C		Étuvage à 90 °C $+8_0$ °C		Étuvage à 40 °C $+5_0$ °C	
		HR ≤ 5 %		HR ≤ 5 %		HR ≤ 5 %	
		Saturé à 30 °C/85 % d'HR	À la limite du temps de stockage en environnement non protégé + 72 h à 30 °C/70 % d'HR	Saturé à 30 °C/85 % d'HR	À la limite du temps de stockage en environnement non protégé + 72 h à 30 °C/70 % d'HR	Saturé à 30 °C/85 % d'HR	À la limite du temps de stockage en environnement non protégé + 72 h à 30 °C/70 % d'HR
≤ 1,4 mm		9 h	7 h	33 h	23 h	13 jours	9 jours
≤ 2,0 mm		27 h	17 h	4 jours	2 jours	37 jours	23 jours
≤ 4,5 mm		48 h	48 h	10 jours	8 jours	79 jours	67 jours
Boîtier BGA > 17 mm x 17 mm ou tout boîtier à puces empilées (voir Note 2)		96 h	Comme ci-dessus par épaisseur de boîtier et niveau d'humidité	Non applicable	Comme ci-dessus par épaisseur de boîtier et niveau d'humidité	Non applicable	Comme ci-dessus par épaisseur de boîtier et niveau d'humidité

**Tableau 4 – Conditions de référence pour le séchage des CMS montés ou non montés (étuvage utilisateur: le décompte du temps de stockage en environnement non protégé démarre tout de suite après l'étuvage) – Niveaux B2 et B2A à B5a**

Épaisseur du corps du CMS	Ni-veau	Étuvage à 125 °C $+10_0^{\circ}\text{C}$		Étuvage à 90 °C $+8_0^{\circ}\text{C}$		Étuvage à 40 °C $+5_0^{\circ}\text{C}$	
		HR ≤ 5 %		HR ≤ 5 %		HR ≤ 5 %	
		Saturé à 30 °C/85 % d'HR	À la limite du temps de stockage en environnement non protégé + 72 h à 30 °C/60 % d'HR	Saturé à 30 °C/85 % d'HR	À la limite du temps de stockage en environnement non protégé + 72 h à 30 °C/60 % d'HR	Saturé à 30 °C/85 % d'HR	À la limite du temps de stockage en environnement non protégé + 72 h à 30 °C/60 % d'HR
≤ 1,4 mm	B2a	7 h	5 h	23 h	13 h	9 jours	7 jours
	B3	9 h	7 h	33 h	23 h	13 jours	9 jours
	B4	11 h	7 h	37 h	23 h	15 jours	9 jours
	B5	12 h	7 h	41 h	24 h	17 jours	10 jours
	B5a	16 h	10 h	54 h	24 h	22 jours	10 jours
≤ 2,0 mm	B2a	21 h	16 h	3 jours	2 jours	29 jours	22 jours
	B3	27 h	17 h	4 jours	2 jours	37 jours	23 jours
	B4	34 h	20 h	5 jours	3 jours	47 jours	28 jours
	B5	40 h	25 h	6 jours	4 jours	57 jours	35 jours
	B5a	48 h	40 h	8 jours	6 jours	79 jours	56 jours
≤ 4,5 mm	B2a	48 h	48 h	10 jours	7 jours	79 jours	67 jours
	B3	48 h	48 h	10 jours	8 jours	79 jours	67 jours
	B4	48 h	48 h	10 jours	10 jours	79 jours	67 jours
	B5	48 h	48 h	10 jours	10 jours	79 jours	67 jours
	B5a	48 h	48 h	10 jours	10 jours	79 jours	67 jours
Boîtier BGA > 17 mm × 17 mm ou tout boîtier à puces empilées (voir Note 2)	B2-B6	96 h	Comme ci-dessus par épaisseur de boîtier et niveau d'humidité	Non applicable	Comme ci-dessus par épaisseur de boîtier et niveau d'humidité	Non applicable	Comme ci-dessus par épaisseur de boîtier et niveau d'humidité

Les Tableaux 3 et 4 sont fondés sur les CMS à grille de connexion moulée du cas le plus défavorable. Les utilisateurs peuvent réduire le temps réel d'étuvage si cela se justifie techniquement (par exemple données d'absorption/de désorption). Dans la plupart des cas, cela s'applique à d'autres CMS non hermétiques. Si des pièces ont été exposées à une humidité relative > 60 %, la nécessité d'améliorer le temps d'étuvage en effectuant un suivi des données de désorption, pour s'assurer que les pièces sont sèches, doit être prise en considération.

Les boîtiers BGA > 17 mm x 17 mm qui ne possèdent pas de plans internes bloquant le chemin de diffusion de l'humidité dans le substrat peuvent utiliser des temps d'étuvage fondés sur la partie épaisseur/niveau d'humidité du tableau.

Si l'étuvage de boîtiers > 4,5 mm est exigé, voir l'Annexe D.