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INTERNATIONAL STANDARD

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

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

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

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SEMICONDUCTOR DEVICES –
MECHANICAL AND CLIMATIC TEST METHODS –

Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat

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International Standard IEC 60749-20 has been prepared by IEC technical committee 47: Semiconductor devices.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

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

a) incorporation of a technical corrigendum to IEC 60749-20:2008 (second edition);
b) inclusion of new Clause 3;
c) inclusion of explanatory notes.

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

FDIS	Report on voting
47/2634/FDIS	47/2646/RVD

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

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

A list of all parts 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,
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SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat

1 Scope

This part of IEC 60749 provides a means of assessing the resistance to soldering heat of semiconductors packaged as plastic encapsulated surface mount devices (SMDs). This test is destructive.

2 Normative references

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

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

IEC 60749-3, *Semiconductor devices – Mechanical and climatic test methods – Part 3: External visual ~~inspection~~ examination*

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

IEC 60749-35, *Semiconductor devices – Mechanical and climatic test methods – Part 35: Acoustic microscopy for plastic encapsulated electronic components*

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
acoustic tomography
determination of the physical qualities of a known substance by measuring how long it takes sound to travel through it

3.2
classification reflow temperature
T_{C}
maximum body temperature for which the component moisture sensitivity level (MSL) is verified by the component manufacturer and as noted on the caution and/or bar code label

3.3
crack
separation within a bulk material

Note 1 to entry: See also delamination (3.5).

3.4
dead-bug orientation
orientation of a package with the terminals facing upwards

3.5
delamination
interfacial separation between two materials intended to be bonded

Note 1 to entry: See also crack (3.3).

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

Note 1 to entry: For the purposes of this document "'unlimited" floor life only refers to moisture/reflow related failures and does not take into consideration other failure mechanisms or shelf life issues due to long term storage.

3.7
live-bug orientation
orientation of a package when resting on its terminals

3.8
moisture sensitivity level
MSL
rating indicating a component's susceptibility to damage due to absorbed moisture when subjected to reflow soldering

3.9
soak
exposure of a component for a specified time at a specified temperature and humidity

4 General description

Package cracking and electrical failure in plastic encapsulated SMDs can result when soldering heat raises the vapour pressure of moisture which has been absorbed into SMDs during storage. These problems are assessed. In this test method, SMDs are evaluated for heat resistance after being soaked in an environment which simulates moisture being absorbed while under storage in a warehouse or dry pack. Moisture sensitivity level (MSL) ratings generated by this document are utilized to determine the soak conditions for preconditioning in accordance with IEC 60749-30.

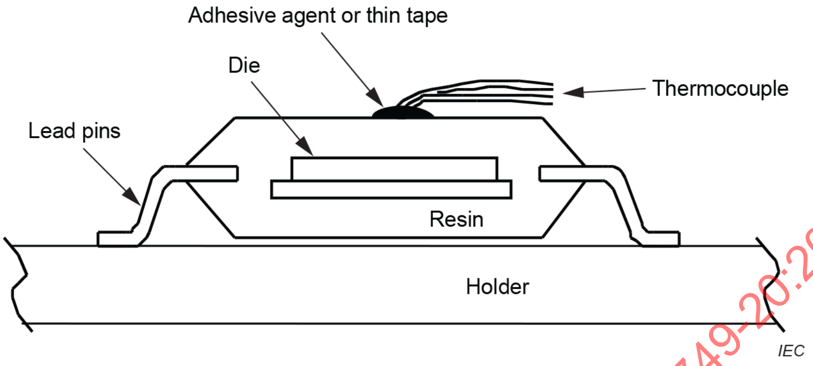
5 Test apparatus and materials

5.1 Humidity chamber

The humidity chamber shall provide an environment complying with the temperature and relative humidity defined in 6.3.

5.2 Reflow soldering apparatus

The infrared convection, the convection and the vapour-phase reflow soldering apparatus shall provide temperature profiles complying with the conditions of soldering heat defined in 6.4.2 and 6.4.3. The settings of the reflow soldering apparatus shall be adjusted by temperature profiling of the top surface of the specimen while it is undergoing the soldering heat process, measured as shown in Figure 1.



~~NOTE~~ The adhesive agent or thin tape should have good thermal conductivity.

Figure 1 – Method of measuring the temperature profile of a specimen

5.3 Holder

Unless otherwise detailed in the relevant specification, any board material, such as epoxy fibreglass or polyimide, may be used for the holder. The specimen shall be placed on the holder by the usual means and in a position as shown in Figure 1. If the position of the specimen, as shown in Figure 1, necessitates changing the shape of terminations and results in subsequent electrical measurement anomalies, a position that avoids changing the shape of terminations may be chosen, and this shall be specified in the relevant specification.

5.4 Wave-soldering apparatus

The wave-soldering apparatus shall comply with conditions given in 6.4.4. Molten solder shall usually be flowed.

5.5 Solvent for vapour-phase reflow soldering

Perfluorocarbon (perfluoroisobutylene) shall be used.

5.6 Flux

Unless otherwise detailed in the relevant specification, the flux shall consist of 25 % by weight of colophony in 75 % by weight of isopropyl alcohol, both as specified in Annex B of IEC 60068-2-20:2008.

5.7 Solder

A solder of the composition as specified in Table 1 of IEC 60068-2-20:2008 shall be used.

6 Procedure

6.1 Initial measurements

6.1.1 Visual inspection

Visual inspection, as specified in IEC 60749-3, shall be performed before the test. Special attention shall be paid to external cracks and swelling, which will be looked for under a magnification of 40X.

6.1.2 Electrical measurement

Electrical testing shall be performed as required by the relevant specification.

6.1.3 Internal inspection by acoustic tomography

Unless otherwise detailed in the relevant specification, internal cracks and delamination in the specimen shall be inspected by acoustic tomography in accordance with IEC 60749-35.

6.2 Drying

Unless otherwise detailed in the relevant specification, the specimen shall be baked at 125 °C ± 5 °C for at least 24 h.

NOTE 1 This time/temperature is modified if desorption data on the particular device under test shows that a different condition is required to obtain a "dry" package when starting in the wet condition for 85 °C/85 % RH.

NOTE 2 If a bake test is interrupted for more than 15 min, then the total time of the interruption is excluded from the bake time. The interruption time is taken into account (if no greater than 1 h) then re-incorporated to ensure a minimum of 24 h. For instance, if the interruption was 45 min, then the total bake test time would be 24 h and 45 min. If greater than 1 h the bake is restarted for a full 24 h.

6.3 Moisture soak

6.3.1 General

Unless otherwise detailed in the relevant specification, moisture soak conditions shall be selected on the basis of the packing method of the specimen (see A.1.1, Annex A). If baking the specimen before soldering is detailed in the relevant specification, the specimen shall be baked instead of being subjected to moisture soak.

6.3.2 Conditions for non-dry-packed SMDs

The moisture soak condition shall be selected from Table 1, in accordance with the permissible limit of actual storage (see A.1.2.1).

Table 1 – Moisture soak conditions for non-dry-packed SMDs

Condition	Temperature °C	Relative humidity %	Duration time h	Permissible limit on actual storage
A1 or B1	85 ± 2	85 ± 5	168 ± 24	< 30 °C, 85 % RH
RH: relative humidity				
NOTE Conditions A1 and B1 indicate moisture soak for non-dry-packed SMDs under either method A or B.				

6.3.3 Moisture soak for dry-packed SMDs

6.3.3.1 General

Moisture soak conditions for dry-packed SMDs may be used as specified in method A, Table 2, or method B, Table 3. Moisture soak conditioning for dry-packed SMDs consists of two stages. The first stage of conditioning is intended to simulate moisturizing SMDs before opening the dry pack/dry cabinet. The second stage of conditioning is to simulate moisturizing SMDs during storage after opening the dry pack for soldering (floor life). Moisture soak conditioning for dry-packed SMDs shall be selected from method A or B. Method A shall be used when the relative humidity in the dry pack or dry cabinet is specified by the manufacturer as being between 10 % and 30 %. Method B shall be used when the relative humidity in the dry pack or dry cabinet is specified by the manufacturer as being below 10 %.

6.3.3.2 Method A

Unless otherwise detailed in the relevant specification, the first stage conditioning of A2, as shown in Table 2, shall be performed. Subsequently, the second stage conditioning of A2, as shown in Table 2, shall be performed within 4 h of finishing the first stage of conditioning (see A.1.2.2).

The relative humidity of the first stage conditioning ~~must~~ shall be the same as the upper limit of the relative humidity inside the moisture barrier bag. The relative humidity of the second stage conditioning ~~must~~ shall be the same as the conditions of floor life.

Where required in the relevant specification, test conditions other than those of the moisture barrier bag and floor life conditions may be specified in the moisture soak conditions of Table 2.

Table 2 – Moisture soak conditions for dry-packed SMDs (method A)

Condition	Moisture soak conditions	Permissible storage conditions in the dry pack and the dry cabinet	Condition of floor life
A2 first-stage conditioning	(85 ± 2) °C, (30 ± 5) % RH, $168\ ^{24}_{-0}$ h	< 30 °C, 30 % RH, 1 year	–
A2 second-stage conditioning	(30 ± 2) °C, (70 ± 5) % RH, $168\ ^{24}_{-0}$ h	–	< 30 °C, 70 % RH, 168 h
RH: Relative humidity			

NOTE 1 The first stage of conditioning represents storage conditions in the dry pack and the dry cabinet, as well as increasing relative humidity in the dry pack, by repacking the SMDs at the distributor's facility and the user's inspection facility. When condition A2 is applied, the SMDs ~~should be~~ are packed into a moisture-proof bag with IC trays and desiccants within a few weeks of drying. They ~~may~~ can then be subjected to multiple temporary openings of the moisture-proof bag (for several hours at a time). Repack and inspection of SMDs are possible while the humidity indicator in the dry pack indicates less than 30 % RH since SMDs will recover the initial condition of absorbed moisture within a few days of repacking. In this case, the moisture content measurement of SMDs (see Clause A.2) is not needed as a moisture control of the dry pack. A check of the moisture indicator is sufficient for moisture control.

NOTE 2 When moisture soak of the first-stage conditioning does not result in saturation, the soak time is extended to 336 h, because SMDs in a dry pack or dry cabinet will become saturated with moisture during long-term storage. When moisture soak of the first stage of conditioning reaches saturation, the soak time is shortened.

6.3.3.3 Method B

The condition of moisture soak conditioning shall be selected from Table 3 in accordance with the condition of the floor life detailed in the relevant specification (see A.1.2.3).

Table 3 – Moisture soak conditions for dry-packed SMDs (method B)

Condition	Moisture soak conditions	Total conditions from baking to dry packing and temporary opening of the dry pack	Condition of floor life
B2	(85 ± 2) °C, (60 ± 5) % RH, 168^{+24}_{-24} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 1 year
B2a	(30 ± 2) °C, (60 ± 5) % RH, 696^{+24}_{-24} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 4 weeks
B3	(30 ± 2) °C, (60 ± 5) % RH, 192^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 168 h
B4	(30 ± 2) °C, (60 ± 5) % RH, 96^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 72 h
B5	(30 ± 2) °C, (60 ± 5) % RH, 72^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 48 h
B5a	(30 ± 2) °C, (60 ± 5) % RH, 48^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 24 h
B6	(30 ± 2) °C, (60 ± 5) % RH, 6^{+24}_{-0} h		< 30 °C, 60 % RH, 6 h
RH: relative humidity			

NOTE ~~1~~ Moisture soak conditions from B2 to B6 consist of the first-stage conditioning (30 °C, 60 % RH, 24 h) and the second-stage conditioning (floor life).

~~NOTE 2~~ Contents in the dry pack of SMDs, IC trays and other materials, should be fully dried just before packing into the moisture-proof bag and the desiccant should be completely dry. This is because moist materials and degraded desiccants give off water vapour, causing the relative humidity in the dry pack to exceed 10 %. The relative humidity in the dry pack should be verified by the humidity indicator and the moisture content measurement of the SMDs, as shown in Clause A.2.

~~NOTE 3~~ Storage of SMDs in a dry cabinet instead of a dry pack is not recommended because very low relative humidity cannot be obtained in a dry cabinet.

~~NOTE 4~~ The individual conditions of method B should cover total storage condition from baking the SMDs to soldering them, and this should include the duration time of room storage from baking the SMDs to packing them into the dry pack, temporary opening of the dry pack and the floor life.

6.4 Soldering heat

6.4.1 General

Unless otherwise detailed in the relevant specification, the specimen shall be subjected to soldering heat within 4 h of finishing the moisture soak or baking. The method and condition of soldering heat shall be selected from 6.4.2 to 6.4.4 according to the relevant specification. Whichever method is chosen, the soldering heat cycles shall be a minimum of one and a maximum of three. Unless otherwise detailed in the relevant specification, one cycle of soldering heat shall be used. If more than one cycle is selected, the specimen shall be cooled down to below 50 °C before the second, and subsequent, soldering heat.

NOTE If the specimen is not affected by moisture soak and drying, which takes place during room storage of over 4 h, a storage time exceeding 4 h following the completion of moisture soak or the baking ~~may~~ can be detailed in the relevant specification.

6.4.2 Method of heating by infrared convection or convection reflow soldering

6.4.2.1 Preparation

The specimen shall be put on the holder.

6.4.2.2 Preheating

Unless otherwise specified in the relevant specification, the specimen shall be preheated at a temperature conditions range shown in A.3.1 for 60 s to 120 s in the reflow soldering apparatus.

6.4.2.3 Solder heating

Following preheating, the temperature of the specimen shall be raised to peak temperature and then lowered to room temperature. The heating condition shall be selected from Table 4 or Table 5 in accordance with the relevant specification depending on the actual soldering conditions. Tolerances of temperature and time are shown in A.3.1.

NOTE 1 In Table 4 and Table 5, the conditions of method A are applied for actual soldering on condition of short temperature profile, and the conditions of method B are applied for actual soldering on condition of long temperature profile.

NOTE 2 Following preheating, the temperature of the specimen ~~should~~ will follow the values as indicated in the profile given in Figure A.9, Figure A.10 or Table A.2.

NOTE 3 Package ''volume'' excludes external terminals (e.g., balls, bumps, lands, leads) and/or non-integral heat sinks. Package volume includes the external dimensions of the package body, regardless of whether it has a cavity or is a passive package style.

NOTE 4 At the discretion of the device manufacturer, but not the board assembler/user, the maximum peak package body temperature (T_p) can exceed the values specified in Table 4 or Table 5. The use of a higher T_p does not change the classification temperature (T_c).

NOTE 5 The maximum component temperature reached during reflow depends on package thickness and volume. The use of convection reflow processes reduces the thermal gradients between packages. However, thermal gradients due to differences in thermal mass of SMD packages can still exist.

NOTE 6 Moisture sensitivity levels of components intended for use in a Pb-free assembly process are evaluated using the Pb-free classification temperatures and profiles defined in Table 4 and Table 5, whether or not the process is Pb-free.

Table 4 – SnPb eutectic process – Classification reflow temperatures (T_c)

Package thickness mm	Method	Time within 5 °C of specified classification temperature s	Temperature for volume mm³		
			< 350 °C	350 to 2 000 °C	~~≥~~ < 2 000 °C
< 2,5	Method A	10	240	240	225
	Method B	20	240	225	225
≥ 2,5	Method A	10	240	240	225
	Method B	20	225	225	225

Table 5 – Pb-free process – Classification reflow temperatures (T_c)

Package thickness mm	Method	Time within 5 °C of specified classification temperature s	Temperature for volume mm^3		
			<350 °C	350 to 2 000 °C	> 2 000 °C
< 1,6	Method A	10	260	260	260
		20			
	Method B	30			
1,6 to 2,5	Method A	10	260	250	245
		20			
	Method B	30			
> 2,5	Method A	10	250	245	245
		20			
	Method B	30			

6.4.3 Method of heating by vapour-phase reflow soldering

6.4.3.1 Preparation

The specimen shall be put on the holder.

6.4.3.2 Preheating

Unless otherwise specified in the relevant specification, the specimen shall be preheated at a temperature from 100 °C to 160 °C for 1 min to 2 min in the vapour-phase soldering apparatus.

6.4.3.3 Solder heating

The temperature of the specimen shall be raised after preheating. When the temperature of the specimen has reached 215 °C ± 5 °C, it shall be maintained for 40 s ± 4 s as shown in Table 6 (refer to A.3.2).

Table 6 – Heating condition for vapour-phase soldering

Condition	Temperature °C	Time s
II-A	215 ± 5	40 ± 4

6.4.4 Method of heating by wave-soldering

6.4.4.1 Preparation

The bottom surface of the specimen shall be fixed to the holder by an adhesive agent specified in the relevant specification. Unless otherwise detailed in the relevant specification, flux shall not be applied to the specimen and holder.

~~NOTE 1~~ If flux is applied, vaporization of solvent in the flux could affect the temperature rise of the specimen. Flux should not, therefore, be applied to the body of the specimen and should only be applied to lead pins as sparingly as possible.

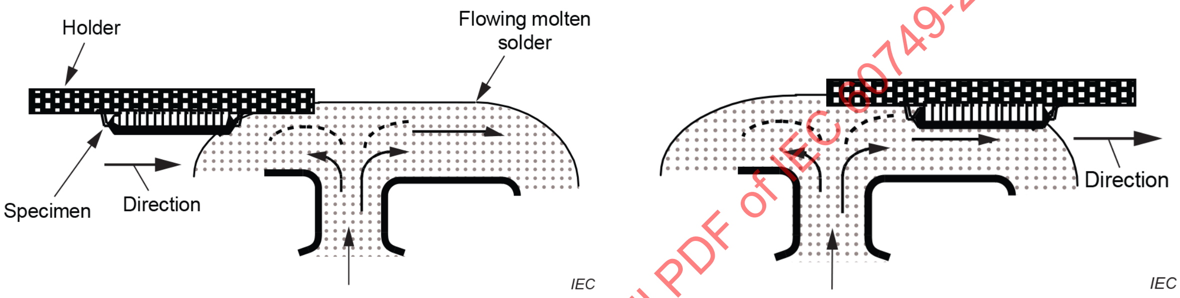
~~NOTE 2~~ Where SMDs have a stand-off (height between the bottom of the SMD body and the bottom of the lead pin) of less than 0,5 mm (except lower thermal resistance SMDs with a heat sink and whose body thickness exceeds 2,0 mm), they should be tested by the soldering heat of methods A and B. SMDs whose body thickness exceeds 3,0 mm are tested by soldering heat by condition ~~I~~ B. Wave-soldering of conditions III-A and III-B should be omitted because methods A and B are more severe than conditions III-A and III-B for these SMDs (refer to A.3.3).

6.4.4.2 Preheating

Unless otherwise detailed in the relevant specification, the specimen shall be preheated at a temperature of 80 °C to 140 °C for 30 s to 60 s in the soldering apparatus.

6.4.4.3 Solder heating

Following preheating, the specimen and the holder shall be immersed into flowing molten solder, as shown in Figure 2. The immersion condition shall be selected from Table 7.



a) **Start of immersion** b) **End of immersion**

Figure 2 – Heating by wave-soldering

Table 7 – Immersion conditions for wave-soldering

Condition	Temperature of solder °C	Immersing time s	Actual soldering method
III-A	260 ± 5	5 ± 1	Single-wave
III-B	260 ± 5	10 ± 1	Double-wave

6.4.4.4 Cleaning

If the flux is applied, it shall be removed by a cleaning method detailed in the relevant specification.

6.5 Recovery

If recovery is detailed in the relevant specification, the specimen shall be stored under standard atmospheric conditions for the time given in the specification.

~~NOTE~~ Wave-soldering is not commonly available to the semiconductor manufacturer. Where the manufacturer does not have access to such equipment, the method should be specified only by agreement between the manufacturer and the customer.

6.6 Final measurements

6.6.1 Visual inspection

Visual inspection, as specified in IEC 60749-3, shall be performed after the test. Special attention shall be paid to external cracks and swelling which will be looked for under a magnification of 40X.

6.6.2 Electrical measurement

Electrical testing shall be performed as required by the relevant specification.

NOTE Lead oxidation or other mechanisms caused by baking can affect the electrical testing of the devices.

6.6.3 Internal inspection by acoustic tomography

Unless otherwise specified in the relevant specification, internal cracks and delamination in the specimen shall be inspected by acoustic tomography in accordance with IEC 60749-35.

7 Information to be given in the relevant specification

		Clause/subclause
a)	Material of holder	5.3
b)	Position of specimen on the holder	5.3
c)	Composition of flux	5.6
d)	Number of test specimens	6
e)	Item and failure criteria for initial measurement	6.1
f)	Preconditioning	6.2
g)	Method of moisture soak	6.3
h)	Conditions of drying	6.2
i)	Baking conditions instead of the moisture soak	6.3
j)	Method of moisture soak for dry packed SMDs	6.3.3
k)	Period between the stages of moisture soak conditioning	6.3.3.2
l)	Conditions of first-stage and second-stage conditioning and whether another condition is needed	6.3.3.2
m)	Soak time of the first-stage conditioning if 168 h of soak time is insufficient	6.3.3.2
n)	Moisture soak conditions for SMDs stored in completely dried dry pack	6.3.3.3
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p)	Period between finish of moisture soak and soldering heat	6.4.1
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s)	Preheat conditions for infrared convection and convection reflow soldering	6.4.2.2
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x)	Cleaning method for flux	6.4.4.4
y)	Recovery conditions	6.5
z)	Item and failure criteria for final measurement	6.6

Annex A
(informative)

Details and description of test method on resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat

A.1 Description of moisture soak

A.1.1 Guidance for moisture soak

Method A and method B of moisture soak of 6.3 are intended to be used for dry-packed SMDs, whereas the conditions in Table 1 are intended for use with non-dry-packed SMDs which have been stored under room conditions.

Where package cracking is generated by soldering heat after the moisture soak of the conditions found in Table 1, it is recommended that devices be dry-packed or stored in a dry atmosphere.

If the cracking is generated by solder heating after the moisture soak of method A and method B, it is recommended that SMDs be pre-baked before being soldered on to the PCBs.

A.1.2 Considerations on which the condition of moisture soak is based

A.1.2.1 General description of moisture soak

The presence of moisture in SMDs is caused by diffusion of water vapour into the resin. The moisture content of the resin needs to be examined, since package cracking during soldering emanates from near the die pad or the die. Examples of characteristics for moisture soak at 85 °C, 85 % relative humidity, are shown in Figure A.1. In the case where the resin thickness from the bottom surface of the package to the die pad is 1 mm, Figure A.1 indicates that over 168 h are needed for saturation to take place.

Moisture soak characteristics, such as that of the resin in Figure A.3, show a slow moisture soak speed which is nevertheless considered significant. Figure A.1 and Figure A.4 to Figure A.8 represent moisture soak characteristics of the resin.

Saturation is needed for soldering heat tests in order to simulate long-time storage of, for example, one year which occurs when SMDs are dry-packed or warehoused. The diffusion speed of water vapour into resin depends only on temperature. Given the resin thickness as defined in Figure A.2, saturating moisture time at 85 °C depends on the resin thickness as shown in Figure A.3. It would appear that, for a normal SMD whose resin thickness is from 0,5 mm to 1,0 mm, 168 h of moisture soak time are required.

The saturated moisture content of resin depends on temperature and relative humidity as shown in Figure A.4. The relative humidity required for moisture soak can be determined from Figure A.4 (for example, so that the content of moisture at 85 °C can be made to correspond with the content of moisture at 30 °C, the actual storage temperature). Conditions of moisture soak for soldering heat tests are derived from Figure A.4 as shown in Table A.1.

Figure A.5 shows the moisture content in resin at the first interface (top surface of die or bottom surface of die pad) under conditions of moisture soak and real storage conditions.

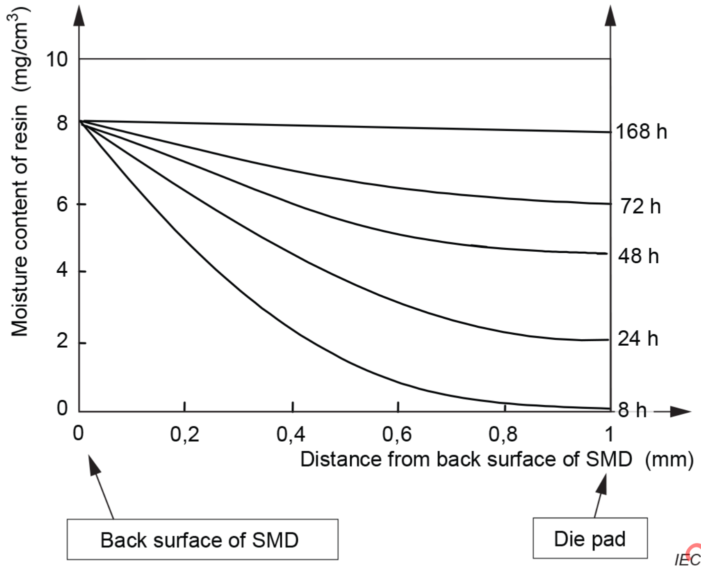
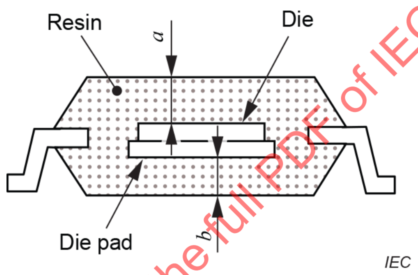


Figure A.1 – Process of moisture diffusion at 85 °C, 85 % RH



NOTE "*a*" or "*b*": the thicker of the two is defined as the resin thickness and the top surface of the die or the bottom surface of the die pad is defined as the first interface.

Figure A.2 – Definition of resin thickness and the first interface

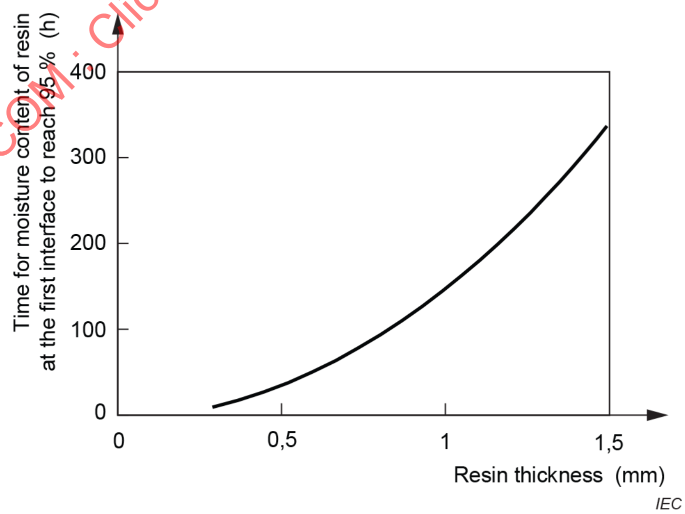


Figure A.3 – Moisture soak time to saturation at 85 °C as a function of resin thickness

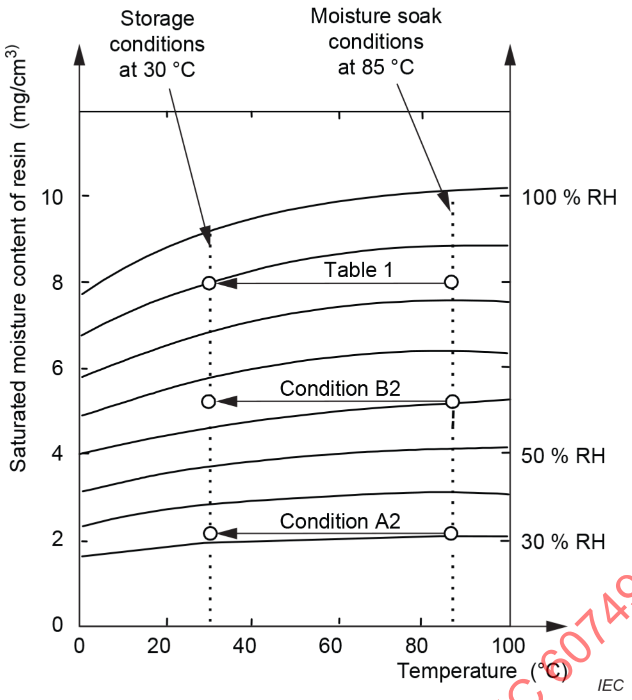


Figure A.4 – Temperature dependence of saturated moisture content of resin

Table A.1 – Comparison of actual storage conditions and equivalent moisture soak conditions before soldering heat

Condition	Actual conditions of storage	Relative humidity for moisture soak at 85 °C %
A2	30 °C max., 30 % RH max.	30 ± 5
Table 1	30 °C max., 85 % RH max.	85 ± 5
B2	30 °C max., 60 % RH max.	60 ± 5

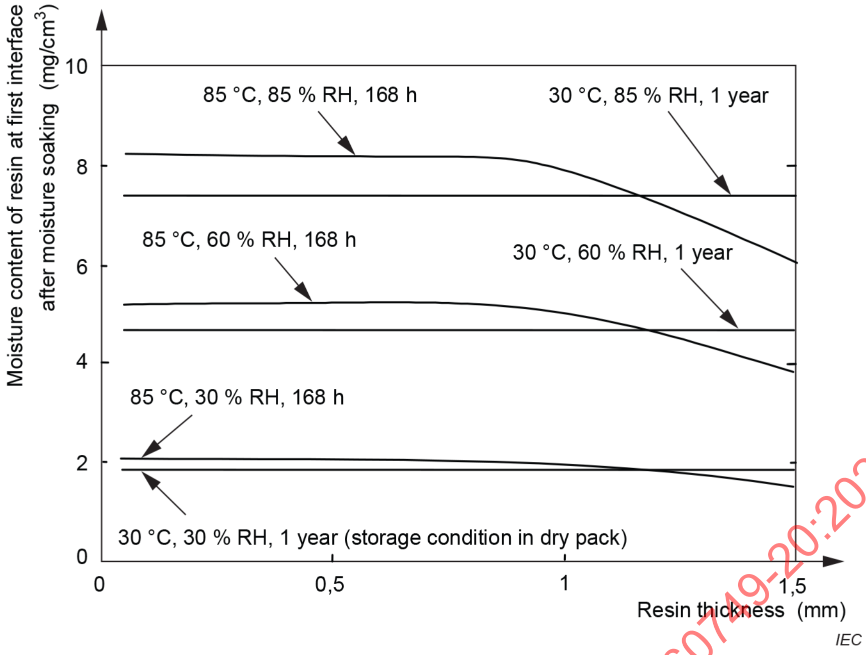


Figure A.5 – Dependence of moisture content of resin at the first interface on resin thickness under various soak conditions

A.1.2.2 Moisture soak conditioning – Method A

Method A of moisture soak given in 6.3.3.2 is based on conditions where SMDs are stored in a dry pack or dry cabinet for a long time, under permissible conditions of 30 °C, 30 % RH, for one year, and where the packing/cabinet can be opened temporarily any number of times for a few hours at a time, provided the humidity indicator indicates below 30 % RH.

Figure A.6 shows that the first-stage conditioning ~~A3~~ A2 and the second-stage conditioning A2 completely represent a floor life of 30 °C, 70 % RH, 168 h after opening the dry pack, even though the dry pack is degraded into a condition of 30 % RH.

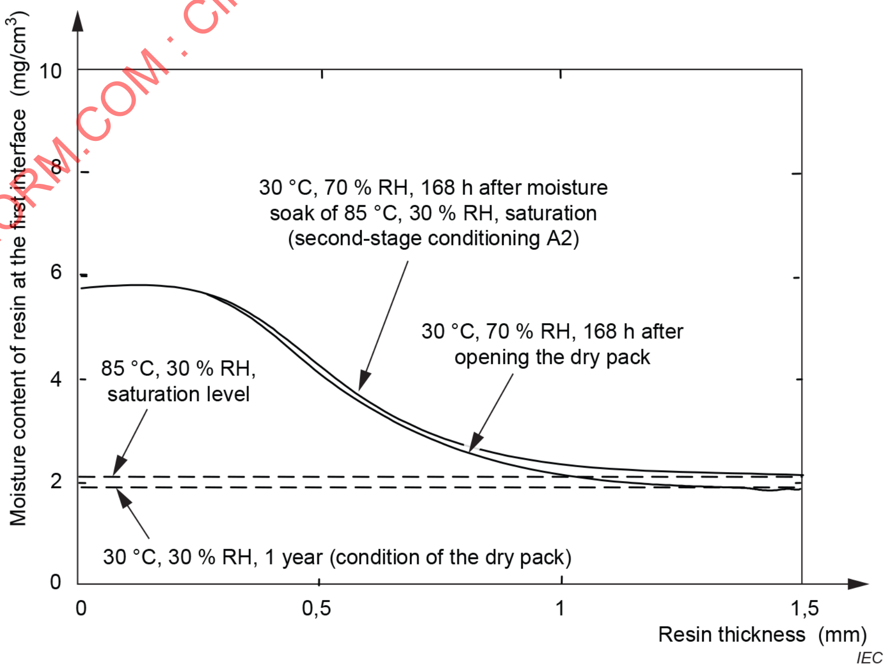


Figure A.6 – Dependence of moisture content of resin at the first interface on resin thickness related to method A of moisture soak

A.1.2.3 Moisture soak conditioning – Method B

Method B of moisture soak given in 6.3.3.3 is based on conditions where SMDs, IC trays and other materials have been completely baked immediately before dry packing, and the volume of the dried desiccant added to the enclosure bag ensures absorption of moisture diffused through the enclosure bag. Integrity of the dry pack is verified through

a) use of *in situ* moisture control indicators of a sensitivity that will alert for loss of enclosure bag integrity; and

b) determination of SMD moisture content as shown in Clause A.2. Environmental exposure time includes the time from SMD bake to dry pack, the time the dry pack may be temporarily opened at the distributor's facility, and the package floor life.

Figure A.7 shows the calculated relation between method B conditions and long-term storage at elevated moisture conditions. This calculated figure indicates that conditions B3 to B6 demonstrate potential correlation problems for thick SMDs where the moisture content of the storage environment is greater than 10 %.

In SMDs with interface to package exterior thickness greater than 1 mm, conditions B3 to B6 are no more severe than 30 °C, 10 % RH, for one-year storage. Therefore, if a 10 % RH saturation condition at the interface is deemed to have a significant effect on the reflow performance, thick SMDs assessed with method B conditions shall be stored in conditions lower than 10 % RH.

Figure A.8 provides an example of how the calculated interface moisture content of condition B-tested products may not adequately replicate the calculated interface moisture content for the most used environments at greater than 10 % moisture content.

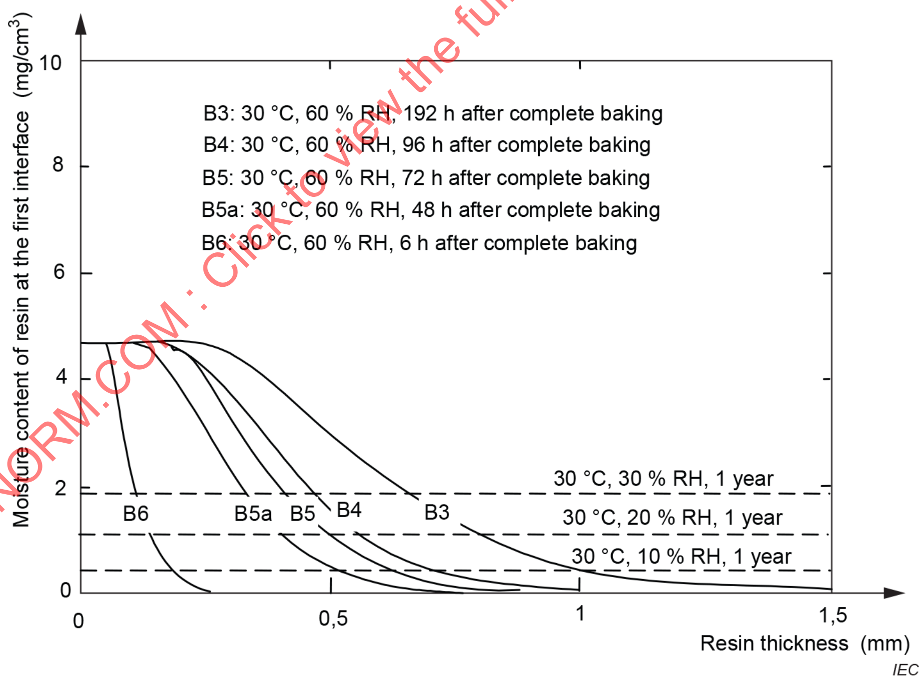


Figure A.7 – Dependence of the moisture content of resin at the first interface on resin thickness related to method B of moisture soak

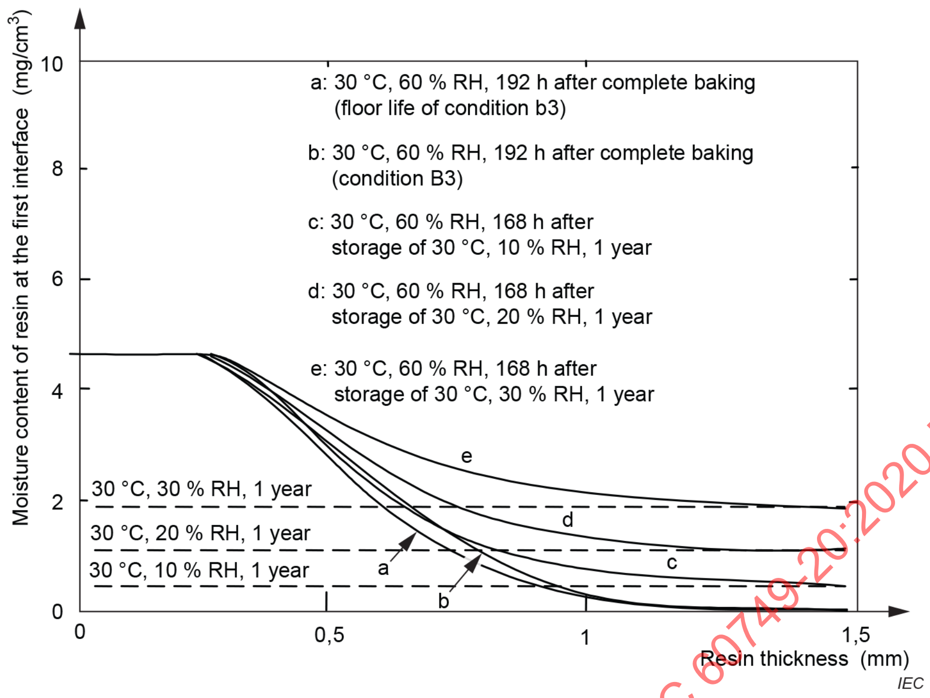


Figure A.8 – Dependence of moisture content of resin at the first interface on resin thickness related to condition B2 of method B of moisture soak

A.2 Procedure for moisture content measurement

The moisture content of a device (MCD) is often used to provide an indication of moisture content in SMDs. Measurement of the MCD shall, however, be used carefully for the following reasons:

– when the moisture soak does not result in saturation, the moisture content of the resin at the first interface will not be representative, since moisture distribution in SMDs ~~may~~ can be variable. For example, the surface of the SMD ~~may~~ can contain a high level of moisture whereas the inner part of the device is dry, and vice versa;

– though the moisture content of resin is equal, according to the ratio of resin in the device, the MCD varies.

A procedure for measuring the moisture content of a device is described as follows:

- the device is weighed with an accuracy of 0,1 mg per device (x);
- as permitted by the absolute maximum rating of storage temperature in the relevant specification, the device is dried for 24 h at 150 °C or 48 h at 125 °C;
- the device is allowed to cool down to room temperature for 30 min ± 10 min;
- the device is re-weighed (y);
- the moisture content of the device (MCD) is calculated using the following formula:

$$\text{MCD} = 100\left(\frac{x-y}{y}\right)\ \%$$

A.3 Soldering heat methods

A.3.1 Temperature profile of infrared convection and convection reflow soldering

A.3.1.1 Method A time-temperature profiles

Solder heating temperature profiles, whose soldering time is shorter than that of method B, specified in 6.4.2, shall be performed according to the temperature profile shown in Figure A.9 and Figure A.10 (where T_p, the peak package body temperature, is the highest temperature that an individual package body reaches during moisture sensitivity level testing and t_p is the time for the temperature taken between T_p and T_p − 5 °C).

In actual soldering, in order to obtain good soldering, the temperature of the solder joint needs to be controlled. On the other hand, since the heating damage to the semiconductor is dependent on the temperature of the body of the semiconductor, it ~~needs~~ is necessary to control ~~of~~ the body temperature for the soldering heat test.

Since a large semiconductor has a large heat capacity, the temperature of the body during actual soldering does not rise easily, and since a small semiconductor has a small heat capacity, there is a tendency for the temperature to rise easily. Therefore, as shown in Table 4 or Table 5, it is necessary to change the temperature conditions with the size of the body of the semiconductor.

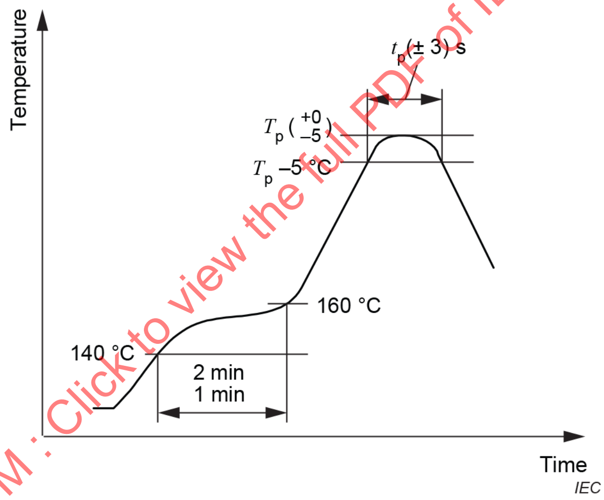


Figure A.9 – Temperature profile of infrared convection and convection reflow soldering for Sn-Pb eutectic assembly

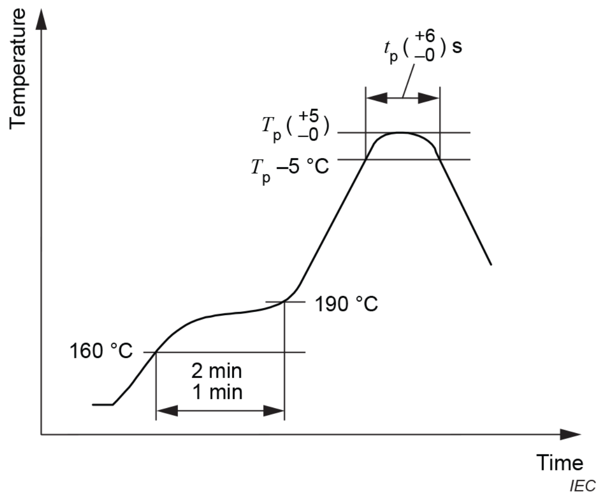


Figure A.10 – Temperature profile of infrared convection and convection reflow soldering for lead-free assembly

A.3.1.2 Method B time-temperature profiles

Table A.2 – Classification profiles

Profile feature	Sn-Pb eutectic assembly	Pb-free assembly
Ramp-up rate (T_{smax} to T_p)	3 °C s^{-1} max.	3 °C s^{-1} max.
Preheat Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	 100 °C 150 °C 60 s to 120 s	 150 °C 200 °C 60 to 120 s
Time maintained above: Temperature (T_L) Time (t_L)	 183 °C 60 s to 150 s	 217 °C 60 s to 150 s
Peak package body temperature (T_p)	For users T_p ~~must~~ shall not exceed the classification temperature in Table 4. For suppliers T_p ~~must~~ shall equal or exceed the classification temperature in Table 4.	For users T_p ~~must~~ shall not exceed the classification temperature in Table 5. For suppliers T_p ~~must~~ shall equal or exceed the classification temperature in Table 5.
Time (t_p) [a] within 5 °C of the specified classification temperature (T_c), see Figure A.11	20 s [a]	30 s [a]
Ramp-down rate (T_p to T_{smax})	6 °C s^{-1} max.	6 °C s^{-1} max.
Time 25 °C to peak temperature	6 min max.	8 min max.

~~NOTE 1~~ Temperature min (T_{smin}) is the temperature at the start of preheat. Temperature max (T_{smax}) is the temperature at the end of preheat before ramp. t_s is the time taken to heat from T_{smin} to T_{smax}.

~~NOTE 2 Live-bug (orientation) is a term used to describe the orientation of the package when resting on its terminals. Dead-bug (orientation) is a term used to describe the orientation of the package with the terminals facing up.~~

~~NOTE 3~~ All temperatures refer to the centre of the package, measured on the package body surface that is facing up during assembly reflow, for example live-bug. If parts are reflowed in other than the normal live-bug assembly reflow orientation, i.e. dead-bug, T_p should be within ±2 °C of the live-bug T_p and still meet the T_c requirements, otherwise the profile should be adjusted to achieve the latter.

~~NOTE 4~~ Reflow profiles in this document are for classification/preconditioning and are not meant to specify board assembly profiles. Actual board assembly profiles should be developed based on specific process needs and

board designs and should not exceed the parameters in this table. For example, if T_c is 260 °C and time t_p is 30 s, this means the following for the supplier and the user: For a supplier: the peak temperature should be at least 260 °C. The time above 255 °C should be at least 30 s. For a user: the peak temperature should not exceed 260 °C. The time above 255 °C should not exceed 30 s. ~~NOTE 5~~ All components in the test load should meet the classification profile requirements.
[a] Tolerance for t_p is defined as a supplier minimum and a user maximum.

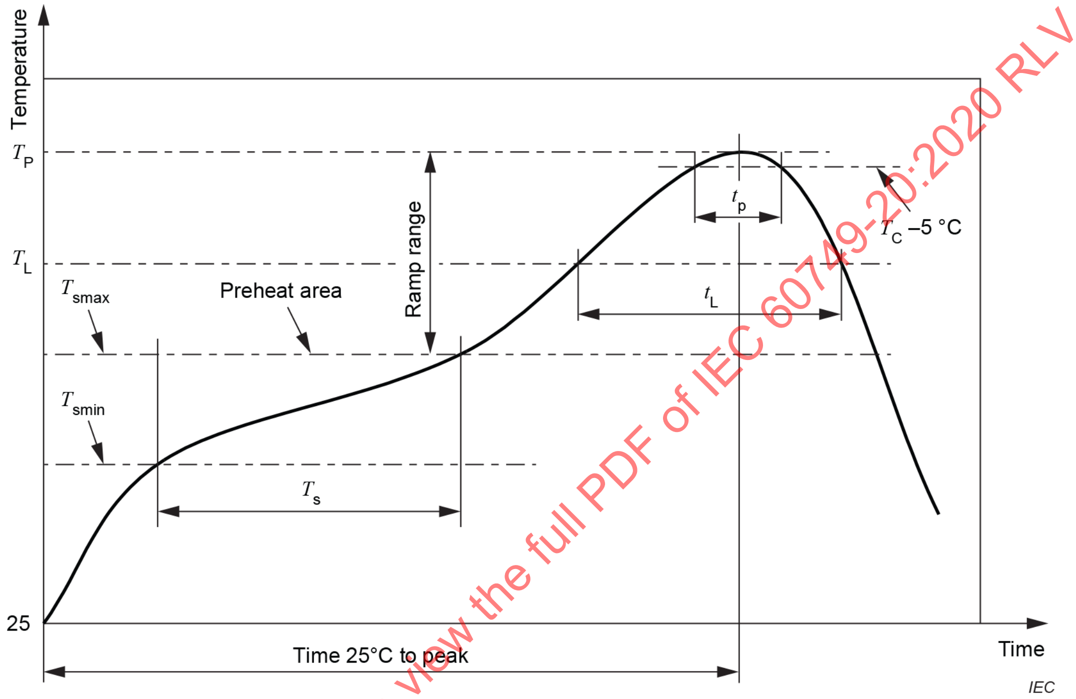


Figure A.11 – Classification profile

A.3.2 Temperature profile of vapour-phase soldering

Solder heating using the vapour-phase soldering specified in 6.4.3 shall be performed according to the temperature profile shown in Figure A.12.

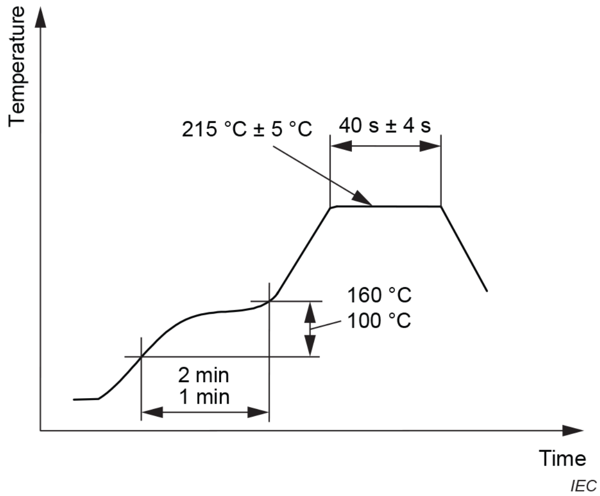


Figure A.12 – Temperature profile of vapour-phase soldering (condition II-A)

A.3.3 Heating method by wave-soldering

The method of immersion into a solder bath as shown in Figure A.13 does not correspond exactly with real wave soldering criteria because the molten solder does not enter the gap between the PCB and the SMD's body during real wave-soldering. Consequently, the temperature of the SMD during real wave-soldering is lower than that during the immersion method into a solder bath. When the immersion method is performed for ICs and LSIs having a large heat capacity, the device's body temperature becomes higher than that resulting from the wave-soldering method, by between 10 °C and 80 °C. When SMDs are large, such as quad flat packages (QFPs) and quad flat J-leaded packages (QFJs), the differential could be between 50 °C and 80 °C. Consequently, the wave-soldering method as shown in Figure 2 shall be performed for the soldering heat test. Package cracking is generated by rapid temperature rise at the first interface during solder heating.

Figure A.14 shows the relationship between the thickness of the SMD's body and the peak temperature at the first interface under each type of solder heating. In SMDs having a stand-off (the height between the bottom of the SMD's body and the bottom of the lead pin) of less than 0,5 mm (excluding lower thermal resistance SMDs having a heat sink), if the body thickness of the SMD exceeds 2,0 mm and solder heating by methods A and B is used, the wave-soldering method can be omitted. Similarly, when the thickness exceeds 3,0 mm and solder heating by methods A and B is used, the wave-soldering method can also be omitted. For SMDs having a stand-off exceeding 0,5 mm (see Figure A.15) or having a heat sink, wave-soldering cannot be omitted because their body temperature will be higher than that shown in Figure A.14.

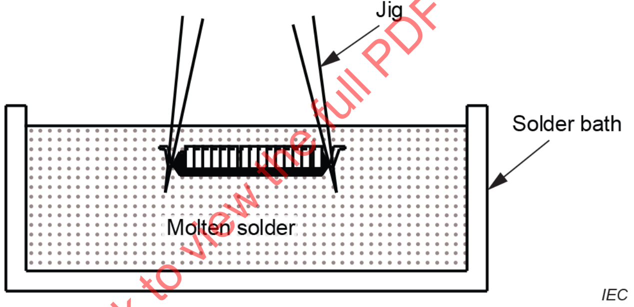


Figure A.13 – Immersion method into solder bath

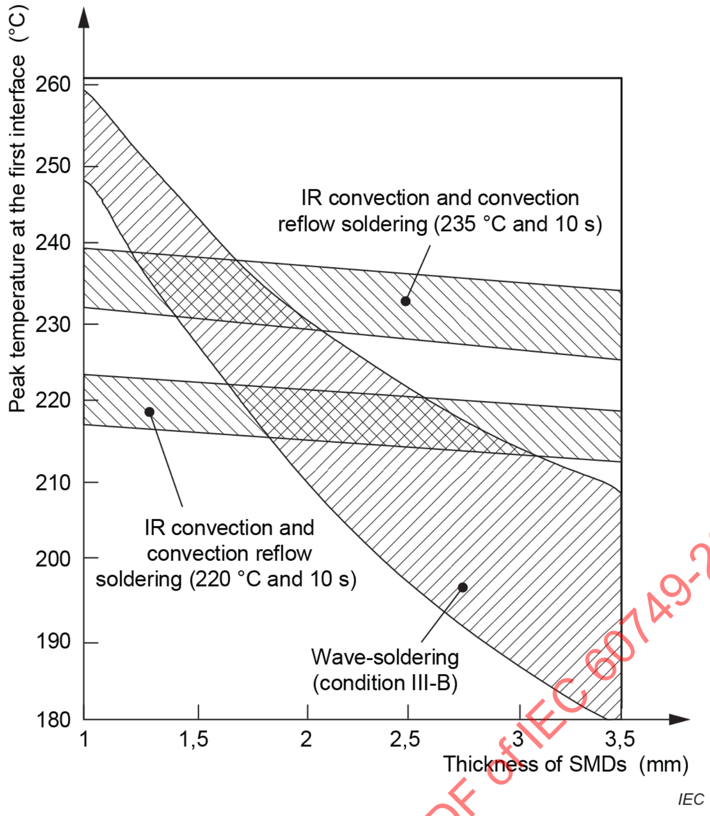
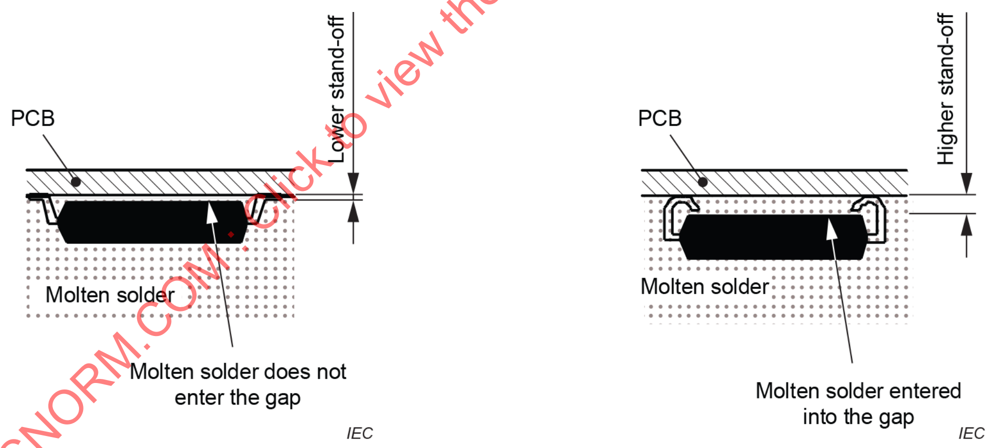


Figure A.14 – Relation between the infrared convection reflow soldering and wave-soldering



a) Lower **b) Higher**

NOTE The reason for the differential of the SMD temperature depends on the height of the stand-off.

Figure A.15 – Temperature in the body of the SMD during wave-soldering

IEC 60749-20

Edition 3.0 2020-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

**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 60749-20:2020-08(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –
MECHANICAL AND CLIMATIC TEST METHODS –

Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat

FOREWORD

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International Standard IEC 60749-20 has been prepared by IEC technical committee 47: Semiconductor devices.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

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

a) incorporation of a technical corrigendum to IEC 60749-20:2008 (second edition);
b) inclusion of new Clause 3;
c) inclusion of explanatory notes.

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

FDIS	Report on voting
47/2634/FDIS	47/2646/RVD

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

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

A list of all parts 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat

1 Scope

This part of IEC 60749 provides a means of assessing the resistance to soldering heat of semiconductors packaged as plastic encapsulated surface mount devices (SMDs). This test is destructive.

2 Normative references

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

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

IEC 60749-3, *Semiconductor devices – Mechanical and climatic test methods – Part 3: External visual examination*

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

IEC 60749-35, *Semiconductor devices – Mechanical and climatic test methods – Part 35: Acoustic microscopy for plastic encapsulated electronic components*

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
acoustic tomography
determination of the physical qualities of a known substance by measuring how long it takes sound to travel through it

3.2
classification reflow temperature
T_c
maximum body temperature for which the component moisture sensitivity level (MSL) is verified by the component manufacturer and as noted on the caution and/or bar code label

3.3
crack
separation within a bulk material

Note 1 to entry: See also delamination (3.5).

3.4
dead-bug orientation
orientation of a package with the terminals facing upwards

3.5
delamination
interfacial separation between two materials intended to be bonded

Note 1 to entry: See also crack (3.3).

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

Note 1 to entry: For the purposes of this document "'unlimited" floor life only refers to moisture/reflow related failures and does not take into consideration other failure mechanisms or shelf life issues due to long term storage.

3.7
live-bug orientation
orientation of a package when resting on its terminals

3.8
moisture sensitivity level
MSL
rating indicating a component's susceptibility to damage due to absorbed moisture when subjected to reflow soldering

3.9
soak
exposure of a component for a specified time at a specified temperature and humidity

4 General description

Package cracking and electrical failure in plastic encapsulated SMDs can result when soldering heat raises the vapour pressure of moisture which has been absorbed into SMDs during storage. These problems are assessed. In this test method, SMDs are evaluated for heat resistance after being soaked in an environment which simulates moisture being absorbed while under storage in a warehouse or dry pack. Moisture sensitivity level (MSL) ratings generated by this document are utilized to determine the soak conditions for preconditioning in accordance with IEC 60749-30.

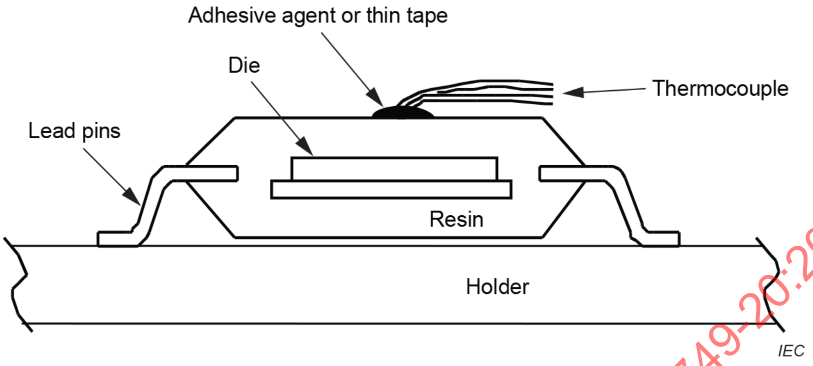
5 Test apparatus and materials

5.1 Humidity chamber

The humidity chamber shall provide an environment complying with the temperature and relative humidity defined in 6.3.

5.2 Reflow soldering apparatus

The infrared convection, the convection and the vapour-phase reflow soldering apparatus shall provide temperature profiles complying with the conditions of soldering heat defined in 6.4.2 and 6.4.3. The settings of the reflow soldering apparatus shall be adjusted by temperature profiling of the top surface of the specimen while it is undergoing the soldering heat process, measured as shown in Figure 1.



The adhesive agent or thin tape should have good thermal conductivity.

Figure 1 – Method of measuring the temperature profile of a specimen

5.3 Holder

Unless otherwise detailed in the relevant specification, any board material, such as epoxy fibreglass or polyimide, may be used for the holder. The specimen shall be placed on the holder by the usual means and in a position as shown in Figure 1. If the position of the specimen, as shown in Figure 1, necessitates changing the shape of terminations and results in subsequent electrical measurement anomalies, a position that avoids changing the shape of terminations may be chosen, and this shall be specified in the relevant specification.

5.4 Wave-soldering apparatus

The wave-soldering apparatus shall comply with conditions given in 6.4.4. Molten solder shall usually be flowed.

5.5 Solvent for vapour-phase reflow soldering

Perfluorocarbon (perfluoroisobutylene) shall be used.

5.6 Flux

Unless otherwise detailed in the relevant specification, the flux shall consist of 25 % by weight of colophony in 75 % by weight of isopropyl alcohol, both as specified in Annex B of IEC 60068-2-20:2008.

5.7 Solder

A solder of the composition as specified in Table 1 of IEC 60068-2-20:2008 shall be used.

6 Procedure

6.1 Initial measurements

6.1.1 Visual inspection

Visual inspection, as specified in IEC 60749-3, shall be performed before the test. Special attention shall be paid to external cracks and swelling, which will be looked for under a magnification of 40X.

6.1.2 Electrical measurement

Electrical testing shall be performed as required by the relevant specification.

6.1.3 Internal inspection by acoustic tomography

Unless otherwise detailed in the relevant specification, internal cracks and delamination in the specimen shall be inspected by acoustic tomography in accordance with IEC 60749-35.

6.2 Drying

Unless otherwise detailed in the relevant specification, the specimen shall be baked at 125 °C ± 5 °C for at least 24 h.

NOTE 1 This time/temperature is modified if desorption data on the particular device under test shows that a different condition is required to obtain a "dry" package when starting in the wet condition for 85 °C/85 % RH.

NOTE 2 If a bake test is interrupted for more than 15 min, then the total time of the interruption is excluded from the bake time. The interruption time is taken into account (if no greater than 1 h) then re-incorporated to ensure a minimum of 24 h. For instance, if the interruption was 45 min, then the total bake test time would be 24 h and 45 min. If greater than 1 h the bake is restarted for a full 24 h.

6.3 Moisture soak

6.3.1 General

Unless otherwise detailed in the relevant specification, moisture soak conditions shall be selected on the basis of the packing method of the specimen (see A.1.1, Annex A). If baking the specimen before soldering is detailed in the relevant specification, the specimen shall be baked instead of being subjected to moisture soak.

6.3.2 Conditions for non-dry-packed SMDs

The moisture soak condition shall be selected from Table 1, in accordance with the permissible limit of actual storage (see A.1.2.1).

Table 1 – Moisture soak conditions for non-dry-packed SMDs

Condition	Temperature °C	Relative humidity %	Duration time h	Permissible limit on actual storage
A1 or B1	85 ± 2	85 ± 5	168 ± 24	< 30 °C, 85 % RH

RH: relative humidity

NOTE Conditions A1 and B1 indicate moisture soak for non-dry-packed SMDs under either method A or B.

6.3.3 Moisture soak for dry-packed SMDs

6.3.3.1 General

Moisture soak conditions for dry-packed SMDs may be used as specified in method A, Table 2, or method B, Table 3. Moisture soak conditioning for dry-packed SMDs consists of two stages. The first stage of conditioning is intended to simulate moisturizing SMDs before opening the dry pack/dry cabinet. The second stage of conditioning is to simulate moisturizing SMDs during storage after opening the dry pack for soldering (floor life). Moisture soak conditioning for dry-packed SMDs shall be selected from method A or B. Method A shall be used when the relative humidity in the dry pack or dry cabinet is specified by the manufacturer as being between 10 % and 30 %. Method B shall be used when the relative humidity in the dry pack or dry cabinet is specified by the manufacturer as being below 10 %.

6.3.3.2 Method A

Unless otherwise detailed in the relevant specification, the first stage conditioning of A2, as shown in Table 2, shall be performed. Subsequently, the second stage conditioning of A2, as shown in Table 2, shall be performed within 4 h of finishing the first stage of conditioning (see A.1.2.2).

The relative humidity of the first stage conditioning shall be the same as the upper limit of the relative humidity inside the moisture barrier bag. The relative humidity of the second stage conditioning shall be the same as the conditions of floor life.

Where required in the relevant specification, test conditions other than those of the moisture barrier bag and floor life conditions may be specified in the moisture soak conditions of Table 2.

Table 2 – Moisture soak conditions for dry-packed SMDs (method A)

Condition	Moisture soak conditions	Permissible storage conditions in the dry pack and the dry cabinet	Condition of floor life
A2 first-stage conditioning	(85 ± 2) °C, (30 ± 5) % RH, $168\,^{24}_{-0}$ h	< 30 °C, 30 % RH, 1 year	–
A2 second-stage conditioning	(30 ± 2) °C, (70 ± 5) % RH, $168\,^{24}_{-0}$ h	–	< 30 °C, 70 % RH, 168 h
RH: Relative humidity			

NOTE 1 The first stage of conditioning represents storage conditions in the dry pack and the dry cabinet, as well as increasing relative humidity in the dry pack, by repacking the SMDs at the distributor's facility and the user's inspection facility. When condition A2 is applied, the SMDs are packed into a moisture-proof bag with IC trays and desiccants within a few weeks of drying. They can then be subjected to multiple temporary openings of the moisture-proof bag (for several hours at a time). Repack and inspection of SMDs are possible while the humidity indicator in the dry pack indicates less than 30 % RH since SMDs will recover the initial condition of absorbed moisture within a few days of repacking. In this case, the moisture content measurement of SMDs (see Clause A.2) is not needed as a moisture control of the dry pack. A check of the moisture indicator is sufficient for moisture control.

NOTE 2 When moisture soak of the first-stage conditioning does not result in saturation, the soak time is extended to 336 h, because SMDs in a dry pack or dry cabinet will become saturated with moisture during long-term storage. When moisture soak of the first stage of conditioning reaches saturation, the soak time is shortened.

6.3.3.3 Method B

The condition of moisture soak conditioning shall be selected from Table 3 in accordance with the condition of the floor life detailed in the relevant specification (see A.1.2.3).

Table 3 – Moisture soak conditions for dry-packed SMDs (method B)

Condition	Moisture soak conditions	Total conditions from baking to dry packing and temporary opening of the dry pack	Condition of floor life
B2	(85 ± 2) °C, (60 ± 5) % RH, 168^{+24}_{-24} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 1 year
B2a	(30 ± 2) °C, (60 ± 5) % RH, 696^{+24}_{-24} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 4 weeks
B3	(30 ± 2) °C, (60 ± 5) % RH, 192^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 168 h
B4	(30 ± 2) °C, (60 ± 5) % RH, 96^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 72 h
B5	(30 ± 2) °C, (60 ± 5) % RH, 72^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 48 h
B5a	(30 ± 2) °C, (60 ± 5) % RH, 48^{+24}_{-0} h	< 30 °C, 60 % RH, 24 h	< 30 °C, 60 % RH, 24 h
B6	(30 ± 2) °C, (60 ± 5) % RH, 6^{+24}_{-0} h		< 30 °C, 60 % RH, 6 h
RH: relative humidity			

NOTE Moisture soak conditions from B2 to B6 consist of the first-stage conditioning (30 °C, 60 % RH, 24 h) and the second-stage conditioning (floor life).

Contents in the dry pack of SMDs, IC trays and other materials, should be fully dried just before packing into the moisture-proof bag and the desiccant should be completely dry. This is because moist materials and degraded desiccants give off water vapour, causing the relative humidity in the dry pack to exceed 10 %. The relative humidity in the dry pack should be verified by the humidity indicator and the moisture content measurement of the SMDs, as shown in Clause A.2.

Storage of SMDs in a dry cabinet instead of a dry pack is not recommended because very low relative humidity cannot be obtained in a dry cabinet.

The individual conditions of method B should cover total storage condition from baking the SMDs to soldering them, and this should include the duration time of room storage from baking the SMDs to packing them into the dry pack, temporary opening of the dry pack and the floor life.

6.4 Soldering heat

6.4.1 General

Unless otherwise detailed in the relevant specification, the specimen shall be subjected to soldering heat within 4 h of finishing the moisture soak or baking. The method and condition of soldering heat shall be selected from 6.4.2 to 6.4.4 according to the relevant specification. Whichever method is chosen, the soldering heat cycles shall be a minimum of one and a maximum of three. Unless otherwise detailed in the relevant specification, one cycle of soldering heat shall be used. If more than one cycle is selected, the specimen shall be cooled down to below 50 °C before the second, and subsequent, soldering heat.

NOTE If the specimen is not affected by moisture soak and drying, which takes place during room storage of over 4 h, a storage time exceeding 4 h following the completion of moisture soak or the baking can be detailed in the relevant specification.

6.4.2 Method of heating by infrared convection or convection reflow soldering

6.4.2.1 Preparation

The specimen shall be put on the holder.

6.4.2.2 Preheating

Unless otherwise specified in the relevant specification, the specimen shall be preheated at a temperature conditions range shown in A.3.1 for 60 s to 120 s in the reflow soldering apparatus.

6.4.2.3 Solder heating

Following preheating, the temperature of the specimen shall be raised to peak temperature and then lowered to room temperature. The heating condition shall be selected from Table 4 or Table 5 in accordance with the relevant specification depending on the actual soldering conditions. Tolerances of temperature and time are shown in A.3.1.

NOTE 1 In Table 4 and Table 5, the conditions of method A are applied for actual soldering on condition of short temperature profile, and the conditions of method B are applied for actual soldering on condition of long temperature profile.

NOTE 2 Following preheating, the temperature of the specimen will follow the values as indicated in the profile given in Figure A.9, Figure A.10 or Table A.2.

NOTE 3 Package ''volume'' excludes external terminals (e.g., balls, bumps, lands, leads) and/or non-integral heat sinks. Package volume includes the external dimensions of the package body, regardless of whether it has a cavity or is a passive package style.

NOTE 4 At the discretion of the device manufacturer, but not the board assembler/user, the maximum peak package body temperature (T_p) can exceed the values specified in Table 4 or Table 5. The use of a higher T_p does not change the classification temperature (T_c).

NOTE 5 The maximum component temperature reached during reflow depends on package thickness and volume. The use of convection reflow processes reduces the thermal gradients between packages. However, thermal gradients due to differences in thermal mass of SMD packages can still exist.

NOTE 6 Moisture sensitivity levels of components intended for use in a Pb-free assembly process are evaluated using the Pb-free classification temperatures and profiles defined in Table 4 and Table 5, whether or not the process is Pb-free.

Table 4 – SnPb eutectic process – Classification reflow temperatures (T_c)

Package thickness mm	Method	Time within 5 °C of specified classification temperature s	Temperature for volume mm³ < 350 °C	 350 to 2 000 °C	 < 2 000 °C
< 2,5	Method A	10	240	240	225
	Method B	20	240	225	225
≥ 2,5	Method A	10	240	240	225
	Method B	20	225	225	225

Table 5 – Pb-free process – Classification reflow temperatures (T_c)

Package thickness mm	Method	Time within 5 °C of specified classification temperature s	Temperature for volume mm³		
			<350 °C	350 to 2 000 °C	> 2 000 °C
< 1,6	Method A	10	260	260	260
		20			
	Method B	30			
1,6 to 2,5	Method A	10	260	250	245
		20			
	Method B	30			
> 2,5	Method A	10	250	245	245
		20			
	Method B	30			

6.4.3 Method of heating by vapour-phase reflow soldering

6.4.3.1 Preparation

The specimen shall be put on the holder.

6.4.3.2 Preheating

Unless otherwise specified in the relevant specification, the specimen shall be preheated at a temperature from 100 °C to 160 °C for 1 min to 2 min in the vapour-phase soldering apparatus.

6.4.3.3 Solder heating

The temperature of the specimen shall be raised after preheating. When the temperature of the specimen has reached 215 °C ± 5 °C, it shall be maintained for 40 s ± 4 s as shown in Table 6 (refer to A.3.2).

Table 6 – Heating condition for vapour-phase soldering

Condition	Temperature °C	Time s
II-A	215 ± 5	40 ± 4

6.4.4 Method of heating by wave-soldering

6.4.4.1 Preparation

The bottom surface of the specimen shall be fixed to the holder by an adhesive agent specified in the relevant specification. Unless otherwise detailed in the relevant specification, flux shall not be applied to the specimen and holder.

If flux is applied, vaporization of solvent in the flux could affect the temperature rise of the specimen. Flux should not, therefore, be applied to the body of the specimen and should only be applied to lead pins as sparingly as possible.

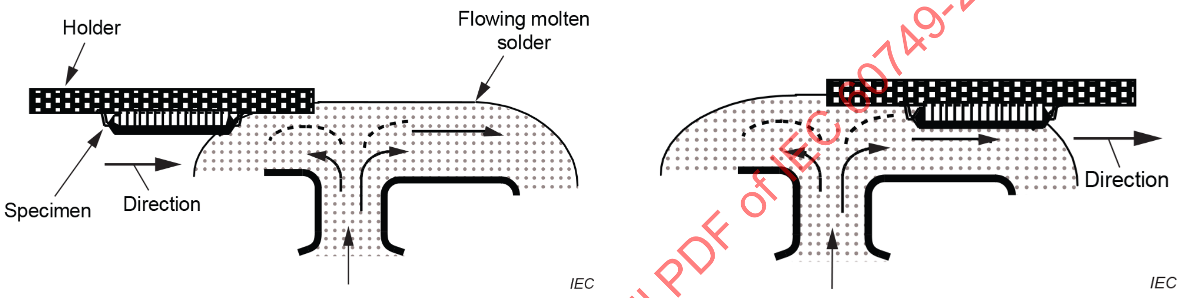
Where SMDs have a stand-off (height between the bottom of the SMD body and the bottom of the lead pin) of less than 0,5 mm (except lower thermal resistance SMDs with a heat sink and whose body thickness exceeds 2,0 mm), they should be tested by the soldering heat of methods A and B. SMDs whose body thickness exceeds 3,0 mm are tested by soldering heat by condition B. Wave-soldering of conditions III-A and III-B should be omitted because methods A and B are more severe than conditions III-A and III-B for these SMDs (refer to A.3.3).

6.4.4.2 Preheating

Unless otherwise detailed in the relevant specification, the specimen shall be preheated at a temperature of 80 °C to 140 °C for 30 s to 60 s in the soldering apparatus.

6.4.4.3 Solder heating

Following preheating, the specimen and the holder shall be immersed into flowing molten solder, as shown in Figure 2. The immersion condition shall be selected from Table 7.



a) Start of immersion **b) End of immersion**

Figure 2 – Heating by wave-soldering

Table 7 – Immersion conditions for wave-soldering

Condition	Temperature of solder °C	Immersing time s	Actual soldering method
III-A	260 ± 5	5 ± 1	Single-wave
III-B	260 ± 5	10 ± 1	Double-wave

6.4.4.4 Cleaning

If the flux is applied, it shall be removed by a cleaning method detailed in the relevant specification.

6.5 Recovery

If recovery is detailed in the relevant specification, the specimen shall be stored under standard atmospheric conditions for the time given in the specification.

Wave-soldering is not commonly available to the semiconductor manufacturer. Where the manufacturer does not have access to such equipment, the method should be specified only by agreement between the manufacturer and the customer.

6.6 Final measurements

6.6.1 Visual inspection

Visual inspection, as specified in IEC 60749-3, shall be performed after the test. Special attention shall be paid to external cracks and swelling which will be looked for under a magnification of 40X.

6.6.2 Electrical measurement

Electrical testing shall be performed as required by the relevant specification.

NOTE Lead oxidation or other mechanisms caused by baking can affect the electrical testing of the devices.

6.6.3 Internal inspection by acoustic tomography

Unless otherwise specified in the relevant specification, internal cracks and delamination in the specimen shall be inspected by acoustic tomography in accordance with IEC 60749-35.

7 Information to be given in the relevant specification

		Clause/subclause
a)	Material of holder	5.3
b)	Position of specimen on the holder	5.3
c)	Composition of flux	5.6
d)	Number of test specimens	6
e)	Item and failure criteria for initial measurement	6.1
f)	Preconditioning	6.2
g)	Method of moisture soak	6.3
h)	Conditions of drying	6.2
i)	Baking conditions instead of the moisture soak	6.3
j)	Method of moisture soak for dry packed SMDs	6.3.3
k)	Period between the stages of moisture soak conditioning	6.3.3.2
l)	Conditions of first-stage and second-stage conditioning and whether another condition is needed	6.3.3.2
m)	Soak time of the first-stage conditioning if 168 h of soak time is insufficient	6.3.3.2
n)	Moisture soak conditions for SMDs stored in completely dried dry pack	6.3.3.3
o)	Moisture soak conditions for non-dry-packed SMDs	6.3.2
p)	Period between finish of moisture soak and soldering heat	6.4.1
q)	Method and condition of soldering heat	6.4.1
r)	Number of cycles of soldering heat	6.4.1
s)	Preheat conditions for infrared convection and convection reflow soldering	6.4.2.2
t)	Heating conditions for infrared convection and convection reflow soldering	6.4.3.3
u)	Preheat conditions for vapour-phase reflow soldering	6.4.3.2
v)	Adhesion method	6.4.4.1
w)	Preheat conditions for wave-soldering	6.4.4.2

		Clause/subclause
x)	Cleaning method for flux	6.4.4.4
y)	Recovery conditions	6.5
z)	Item and failure criteria for final measurement	6.6

Annex A
(informative)

Details and description of test method on resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat

A.1 Description of moisture soak

A.1.1 Guidance for moisture soak

Method A and method B of moisture soak of 6.3 are intended to be used for dry-packed SMDs, whereas the conditions in Table 1 are intended for use with non-dry-packed SMDs which have been stored under room conditions.

Where package cracking is generated by soldering heat after the moisture soak of the conditions found in Table 1, it is recommended that devices be dry-packed or stored in a dry atmosphere.

If the cracking is generated by solder heating after the moisture soak of method A and method B, it is recommended that SMDs be pre-baked before being soldered on to the PCBs.

A.1.2 Considerations on which the condition of moisture soak is based

A.1.2.1 General description of moisture soak

The presence of moisture in SMDs is caused by diffusion of water vapour into the resin. The moisture content of the resin needs to be examined, since package cracking during soldering emanates from near the die pad or the die. Examples of characteristics for moisture soak at 85 °C, 85 % relative humidity, are shown in Figure A.1. In the case where the resin thickness from the bottom surface of the package to the die pad is 1 mm, Figure A.1 indicates that over 168 h are needed for saturation to take place.

Moisture soak characteristics, such as that of the resin in Figure A.3, show a slow moisture soak speed which is nevertheless considered significant. Figure A.1 and Figure A.4 to Figure A.8 represent moisture soak characteristics of the resin.

Saturation is needed for soldering heat tests in order to simulate long-time storage of, for example, one year which occurs when SMDs are dry-packed or warehoused. The diffusion speed of water vapour into resin depends only on temperature. Given the resin thickness as defined in Figure A.2, saturating moisture time at 85 °C depends on the resin thickness as shown in Figure A.3. It would appear that, for a normal SMD whose resin thickness is from 0,5 mm to 1,0 mm, 168 h of moisture soak time are required.

The saturated moisture content of resin depends on temperature and relative humidity as shown in Figure A.4. The relative humidity required for moisture soak can be determined from Figure A.4 (for example, so that the content of moisture at 85 °C can be made to correspond with the content of moisture at 30 °C, the actual storage temperature). Conditions of moisture soak for soldering heat tests are derived from Figure A.4 as shown in Table A.1.

Figure A.5 shows the moisture content in resin at the first interface (top surface of die or bottom surface of die pad) under conditions of moisture soak and real storage conditions.

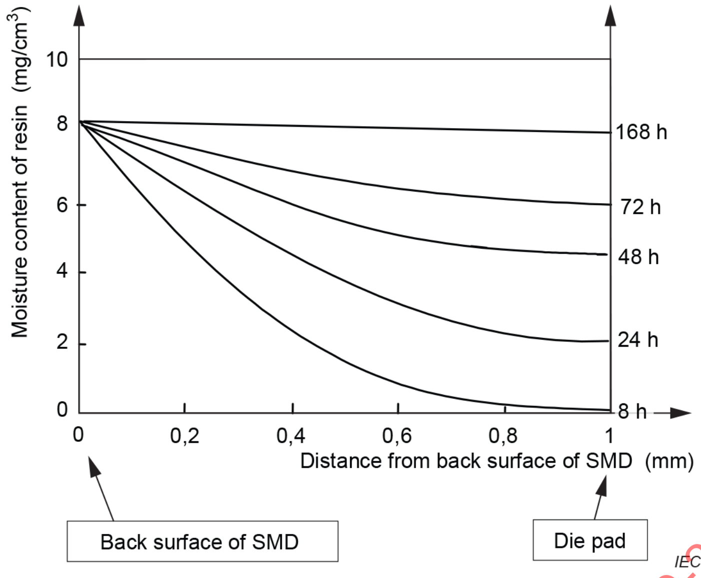
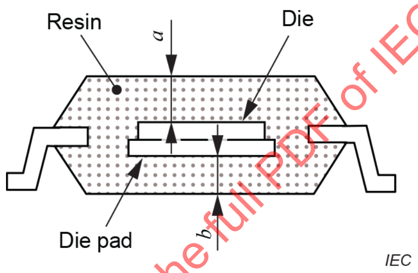


Figure A.1 – Process of moisture diffusion at 85 °C, 85 % RH



NOTE "*a*" or "*b*": the thicker of the two is defined as the resin thickness and the top surface of the die or the bottom surface of the die pad is defined as the first interface.

Figure A.2 – Definition of resin thickness and the first interface

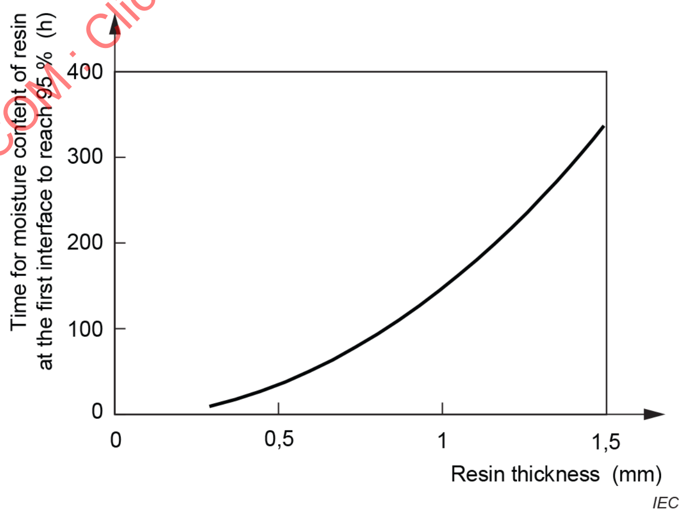


Figure A.3 – Moisture soak time to saturation at 85 °C as a function of resin thickness

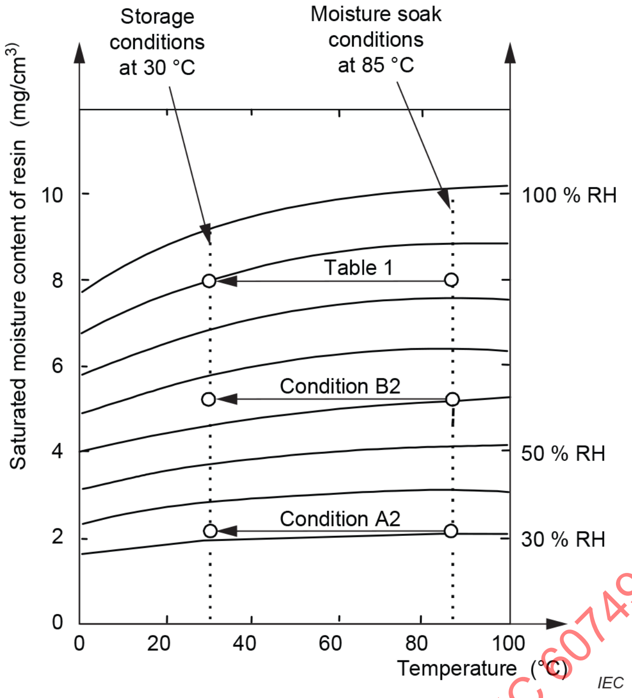


Figure A.4 – Temperature dependence of saturated moisture content of resin

Table A.1 – Comparison of actual storage conditions and equivalent moisture soak conditions before soldering heat

Condition	Actual conditions of storage	Relative humidity for moisture soak at 85 °C %
A2	30 °C max., 30 % RH max.	30 ± 5
Table 1	30 °C max., 85 % RH max.	85 ± 5
B2	30 °C max., 60 % RH max.	60 ± 5

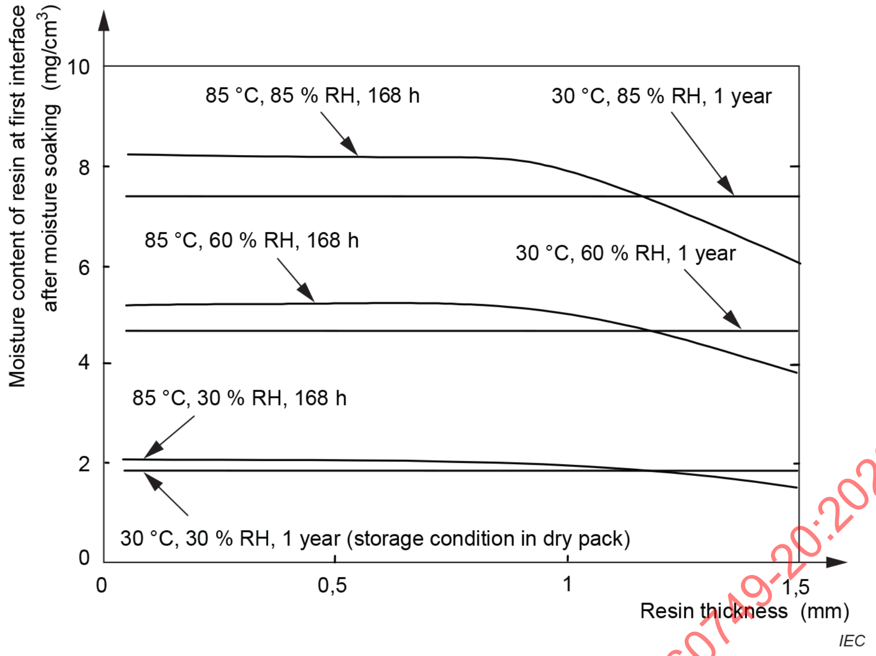


Figure A.5 – Dependence of moisture content of resin at the first interface on resin thickness under various soak conditions

A.1.2.2 Moisture soak conditioning – Method A

Method A of moisture soak given in 6.3.3.2 is based on conditions where SMDs are stored in a dry pack or dry cabinet for a long time, under permissible conditions of 30 °C, 30 % RH, for one year, and where the packing/cabinet can be opened temporarily any number of times for a few hours at a time, provided the humidity indicator indicates below 30 % RH.

Figure A.6 shows that the first-stage conditioning A2 and the second-stage conditioning A2 completely represent a floor life of 30 °C, 70 % RH, 168 h after opening the dry pack, even though the dry pack is degraded into a condition of 30 % RH.

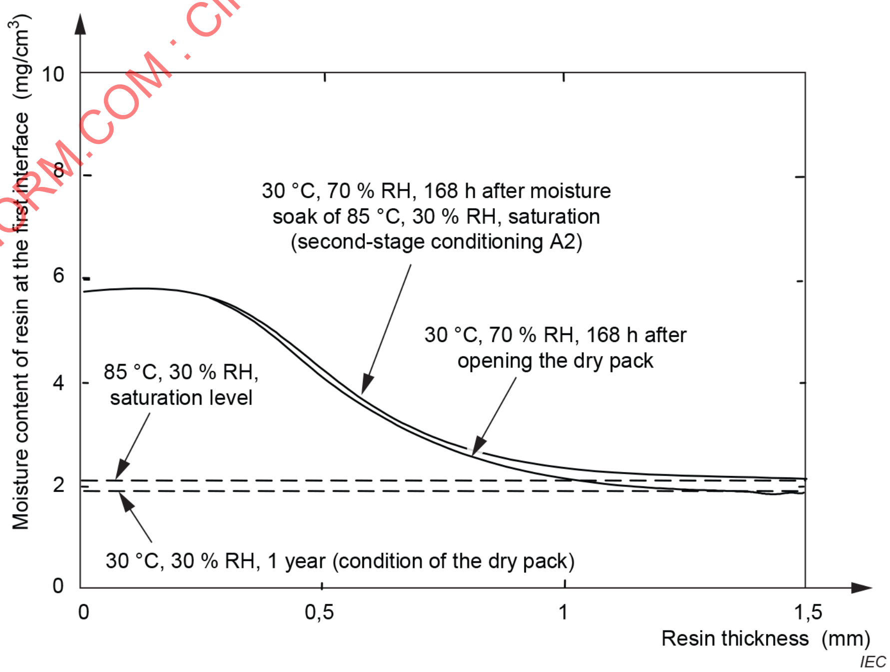


Figure A.6 – Dependence of moisture content of resin at the first interface on resin thickness related to method A of moisture soak

A.1.2.3 Moisture soak conditioning – Method B

Method B of moisture soak given in 6.3.3.3 is based on conditions where SMDs, IC trays and other materials have been completely baked immediately before dry packing, and the volume of the dried desiccant added to the enclosure bag ensures absorption of moisture diffused through the enclosure bag. Integrity of the dry pack is verified through

a) use of *in situ* moisture control indicators of a sensitivity that will alert for loss of enclosure bag integrity; and

b) determination of SMD moisture content as shown in Clause A.2. Environmental exposure time includes the time from SMD bake to dry pack, the time the dry pack may be temporarily opened at the distributor's facility, and the package floor life.

Figure A.7 shows the calculated relation between method B conditions and long-term storage at elevated moisture conditions. This calculated figure indicates that conditions B3 to B6 demonstrate potential correlation problems for thick SMDs where the moisture content of the storage environment is greater than 10 %.

In SMDs with interface to package exterior thickness greater than 1 mm, conditions B3 to B6 are no more severe than 30 °C, 10 % RH, for one-year storage. Therefore, if a 10 % RH saturation condition at the interface is deemed to have a significant effect on the reflow performance, thick SMDs assessed with method B conditions shall be stored in conditions lower than 10 % RH.

Figure A.8 provides an example of how the calculated interface moisture content of condition B-tested products may not adequately replicate the calculated interface moisture content for the most used environments at greater than 10 % moisture content.

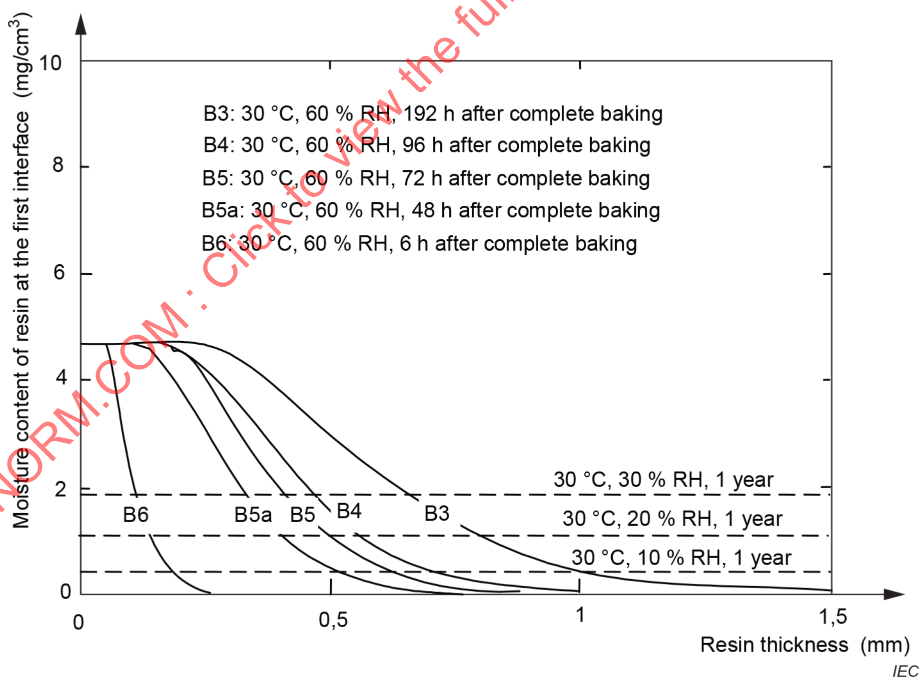


Figure A.7 – Dependence of the moisture content of resin at the first interface on resin thickness related to method B of moisture soak

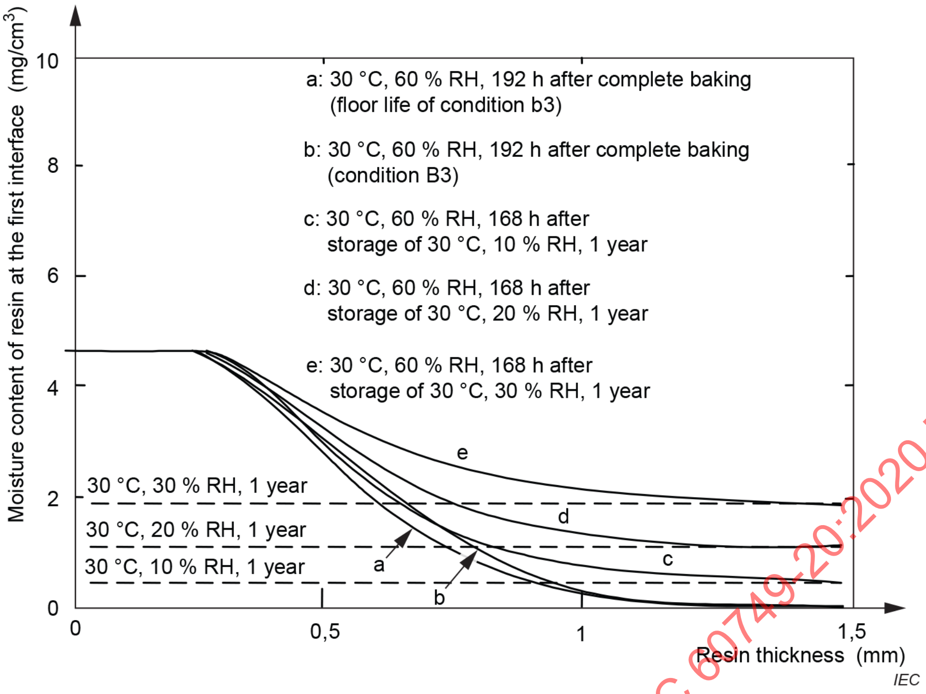


Figure A.8 – Dependence of moisture content of resin at the first interface on resin thickness related to condition B2 of method B of moisture soak

A.2 Procedure for moisture content measurement

The moisture content of a device (MCD) is often used to provide an indication of moisture content in SMDs. Measurement of the MCD shall, however, be used carefully for the following reasons:

– when the moisture soak does not result in saturation, the moisture content of the resin at the first interface will not be representative, since moisture distribution in SMDs can be variable. For example, the surface of the SMD can contain a high level of moisture whereas the inner part of the device is dry, and vice versa;

– though the moisture content of resin is equal, according to the ratio of resin in the device, the MCD varies.

A procedure for measuring the moisture content of a device is described as follows:

- the device is weighed with an accuracy of 0,1 mg per device (x);
- as permitted by the absolute maximum rating of storage temperature in the relevant specification, the device is dried for 24 h at 150 °C or 48 h at 125 °C;
- the device is allowed to cool down to room temperature for 30 min ± 10 min;
- the device is re-weighed (y);
- the moisture content of the device (MCD) is calculated using the following formula:

$$\text{MCD} = 100\left(\frac{x-y}{y}\right) \ \%$$

A.3 Soldering heat methods

A.3.1 Temperature profile of infrared convection and convection reflow soldering

A.3.1.1 Method A time-temperature profiles

Solder heating temperature profiles, whose soldering time is shorter than that of method B, specified in 6.4.2, shall be performed according to the temperature profile shown in Figure A.9 and Figure A.10 (where T_p, the peak package body temperature, is the highest temperature that an individual package body reaches during moisture sensitivity level testing and t_p is the time for the temperature taken between T_p and T_p − 5 °C).

In actual soldering, in order to obtain good soldering, the temperature of the solder joint needs to be controlled. On the other hand, since the heating damage to the semiconductor is dependent on the temperature of the body of the semiconductor, it is necessary to control the body temperature for the soldering heat test.

Since a large semiconductor has a large heat capacity, the temperature of the body during actual soldering does not rise easily, and since a small semiconductor has a small heat capacity, there is a tendency for the temperature to rise easily. Therefore, as shown in Table 4 or Table 5, it is necessary to change the temperature conditions with the size of the body of the semiconductor.

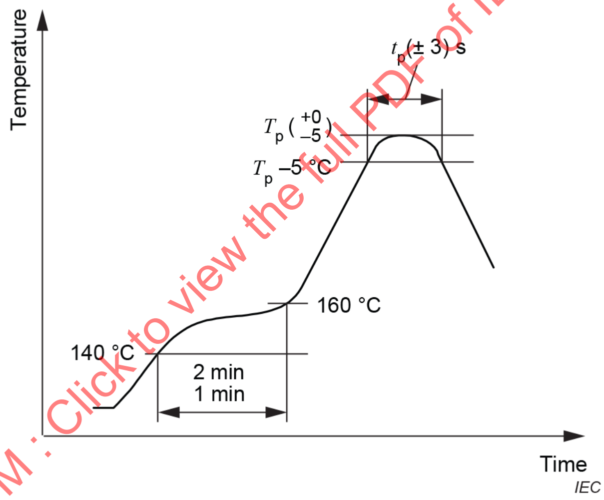


Figure A.9 – Temperature profile of infrared convection and convection reflow soldering for Sn-Pb eutectic assembly

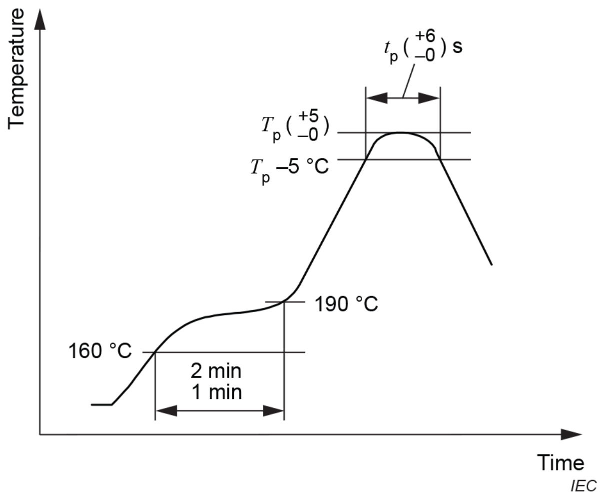


Figure A.10 – Temperature profile of infrared convection and convection reflow soldering for lead-free assembly

A.3.1.2 Method B time-temperature profiles

Table A.2 – Classification profiles

Profile feature	Sn-Pb eutectic assembly	Pb-free assembly
Ramp-up rate (T_{smax} to T_p)	3 °C s^{-1} max.	3 °C s^{-1} max.
Preheat Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	 100 °C 150 °C 60 s to 120 s	 150 °C 200 °C 60 to 120 s
Time maintained above: Temperature (T_L) Time (t_L)	 183 °C 60 s to 150 s	 217 °C 60 s to 150 s
Peak package body temperature (T_p)	For users T_p shall not exceed the classification temperature in Table 4. For suppliers T_p shall equal or exceed the classification temperature in Table 4.	For users T_p shall not exceed the classification temperature in Table 5. For suppliers T_p shall equal or exceed the classification temperature in Table 5.
Time (t_p) [a] within 5 °C of the specified classification temperature (T_c), see Figure A.11	20 s [a]	30 s [a]
Ramp-down rate (T_p to T_{smax})	6 °C s^{-1} max.	6 °C s^{-1} max.
Time 25 °C to peak temperature	6 min max.	8 min max.

Temperature min (T_{smin}) is the temperature at the start of preheat. Temperature max (T_{smax}) is the temperature at the end of preheat before ramp. t_s is the time taken to heat from T_{smin} to T_{smax}.

All temperatures refer to the centre of the package, measured on the package body surface that is facing up during assembly reflow, for example live-bug. If parts are reflowed in other than the normal live-bug assembly reflow orientation, i.e. dead-bug, T_p should be within ±2 °C of the live-bug T_p and still meet the T_c requirements, otherwise the profile should be adjusted to achieve the latter.

Reflow profiles in this document are for classification/preconditioning and are not meant to specify board assembly profiles. Actual board assembly profiles should be developed based on specific process needs and board designs and should not exceed the parameters in this table.

For example, if T_c is 260 °C and time t_p is 30 s, this means the following for the supplier and the user:

For a supplier: the peak temperature should be at least 260 °C. The time above 255 °C should be at least 30 s. For a user: the peak temperature should not exceed 260 °C. The time above 255 °C should not exceed 30 s. All components in the test load should meet the classification profile requirements.
[a] Tolerance for t_p is defined as a supplier minimum and a user maximum.

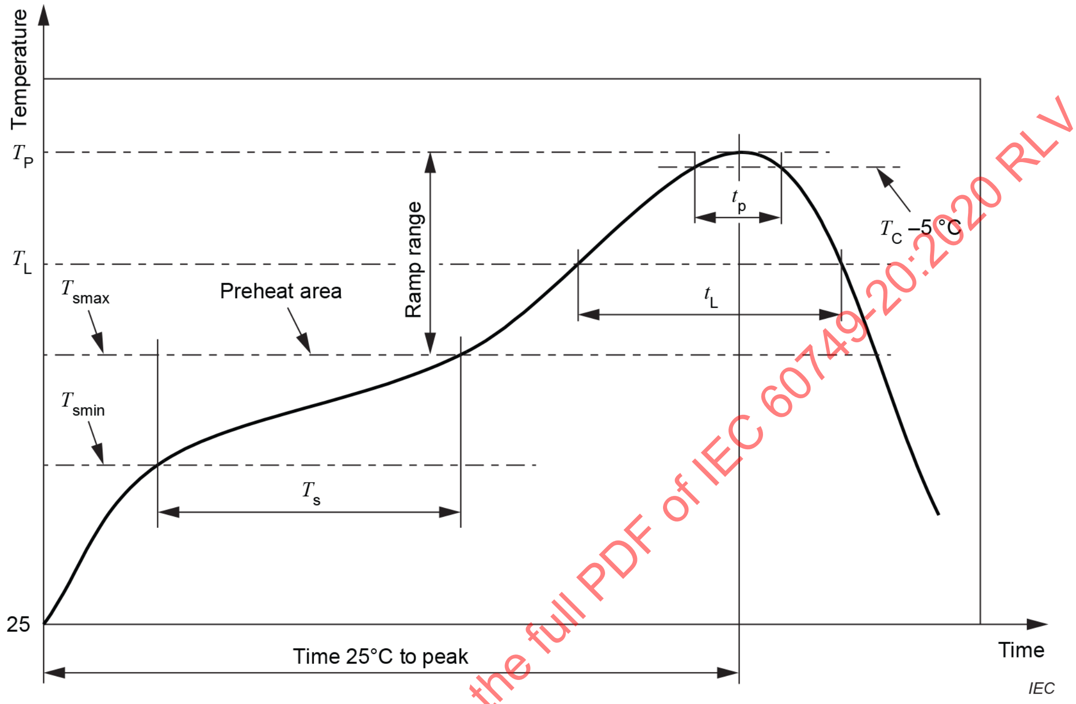


Figure A.11 – Classification profile

A.3.2 Temperature profile of vapour-phase soldering

Solder heating using the vapour-phase soldering specified in 6.4.3 shall be performed according to the temperature profile shown in Figure A.12.

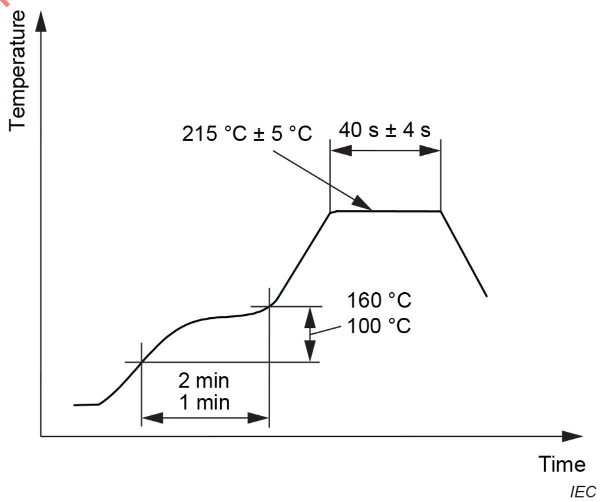


Figure A.12 – Temperature profile of vapour-phase soldering (condition II-A)

A.3.3 Heating method by wave-soldering

The method of immersion into a solder bath as shown in Figure A.13 does not correspond exactly with real wave soldering criteria because the molten solder does not enter the gap between the PCB and the SMD's body during real wave-soldering. Consequently, the temperature of the SMD during real wave-soldering is lower than that during the immersion method into a solder bath. When the immersion method is performed for ICs and LSIs having a large heat capacity, the device's body temperature becomes higher than that resulting from the wave-soldering method, by between 10 °C and 80 °C. When SMDs are large, such as quad flat packages (QFPs) and quad flat J-leaded packages (QFJs), the differential could be between 50 °C and 80 °C. Consequently, the wave-soldering method as shown in Figure 2 shall be performed for the soldering heat test. Package cracking is generated by rapid temperature rise at the first interface during solder heating.

Figure A.14 shows the relationship between the thickness of the SMD's body and the peak temperature at the first interface under each type of solder heating. In SMDs having a stand-off (the height between the bottom of the SMD's body and the bottom of the lead pin) of less than 0,5 mm (excluding lower thermal resistance SMDs having a heat sink), if the body thickness of the SMD exceeds 2,0 mm and solder heating by methods A and B is used, the wave-soldering method can be omitted. Similarly, when the thickness exceeds 3,0 mm and solder heating by methods A and B is used, the wave-soldering method can also be omitted. For SMDs having a stand-off exceeding 0,5 mm (see Figure A.15) or having a heat sink, wave-soldering cannot be omitted because their body temperature will be higher than that shown in Figure A.14.

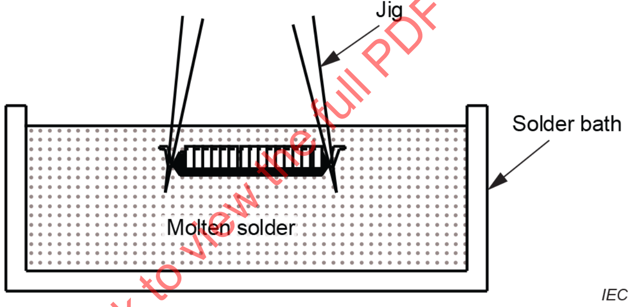


Figure A.13 – Immersion method into solder bath

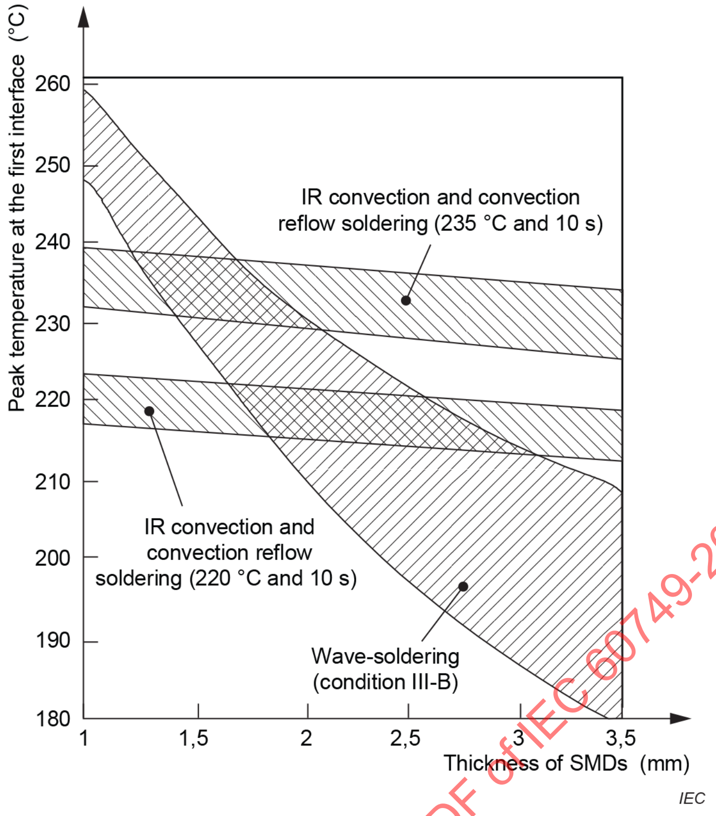
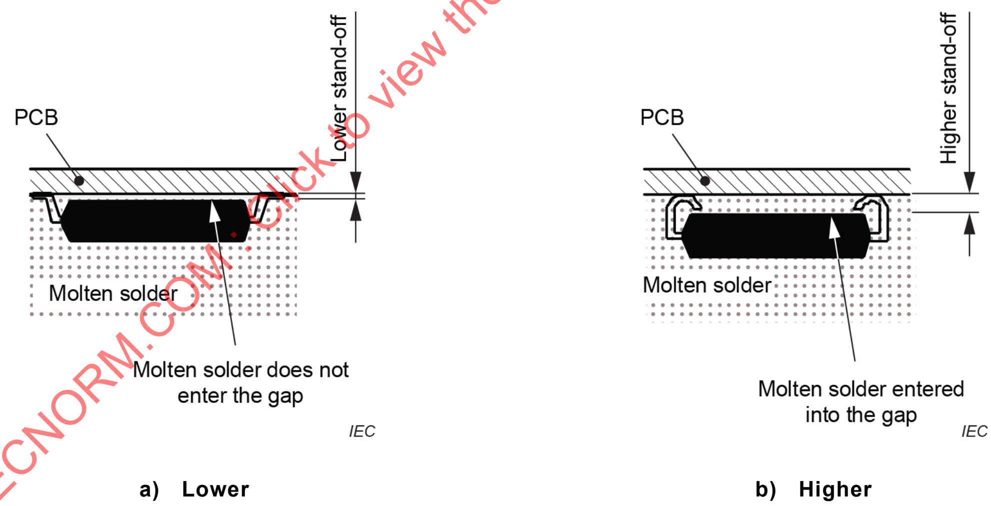


Figure A.14 – Relation between the infrared convection reflow soldering and wave-soldering



NOTE The reason for the differential of the SMD temperature depends on the height of the stand-off.

Figure A.15 – Temperature in the body of the SMD during wave-soldering

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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

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La Norme internationale IEC 60749-20 a été établie par le comité d'études 47 de l'IEC: Dispositifs à semiconducteurs.

Cette troisième édition annule et remplace la deuxième édition parue en 2008. Cette édition constitue une révision technique.

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

a) incorporation d'un corrigendum de l'IEC 60749-20:2008 (deuxième édition),

b) inclusion d'un nouvel Article 3,

c) inclusion de notes explicatives.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
47/2634/FDIS	47/2646/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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- amendé.

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

1 Domaine d'application

La présente partie de l'IEC 60749 fournit des moyens d'évaluer la résistance à la chaleur de brasage des semiconducteurs sous emballage comme les composants à boîtier plastique pour montage en surface (CMS). Cet essai est destructif.

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 60068-2-20:2008, *Essais d'environnement – Partie 2-20: Essais – Essai T: Méthodes d'essai de la brasabilité et de la résistance à la chaleur de brasage des dispositifs à broches*

IEC 60749-3, *Semiconductor devices - Mechanical and climatic test methods - Part 3: External visual examination*

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*

IEC 60749-35, *Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques – Partie 35: Microscopie acoustique pour composants électroniques à boîtier plastique*

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
tomographie acoustique
détermination des qualités physiques d'une substance connue en mesurant le temps que met le son pour la traverser

3.2
température de refusion dans la classification
T_c
température maximale du corps pour laquelle le niveau de sensibilité à l'humidité (NSH) du composant est vérifié par le fabricant de celui-ci et indiqué sur l'étiquette de mise en garde et/ou à code-barres

3.3
fissure
séparation dans un corps

Note 1 à l'article: Voir aussi déstratification (3.5).

3.4
orientation *dead-bug* (pattes en l'air)
orientation d'un boîtier dont les broches sont face dessus

3.5
déstratification
séparation interfaciale entre deux matériaux destinés à être collés

Note 1 à l'article: Voir aussi fissure (3.3).

3.6
environnement non protégé
période de temps autorisée après le retrait d'un sac étanche à l'humidité, l'entreposage à sec ou la cuisson au four à sec et avant le processus de refusion de brasure

Note 1 à l'article: Pour les besoins du présent document, un environnement non protégé "illimité" désigne uniquement les défaillances liées à l'humidité/refusion et ne tient pas compte des autres mécanismes de défaillance ou des problèmes de durée de conservation dus au stockage à long terme.

3.7
orientation *live-bug* (broches en bas)
orientation d'un boîtier reposant sur ses broches

3.8
niveau de sensibilité à l'humidité
NSH
valeur nominale indiquant la sensibilité d'un composant aux dommages causés par l'humidité absorbée lorsqu'il est soumis au brasage par refusion

3.9
absorption
exposition d'un composant pendant une durée déterminée à une température et une humidité spécifiées

4 Description générale

Des craquelures dans le boîtier et des défaillances électriques des CMS à boîtier plastique peuvent apparaître lorsque la chaleur de brasage augmente la pression de vapeur de l'humidité absorbée dans les CMS lors du stockage. Ces problèmes sont évalués. La présente méthode d'essai consiste à évaluer la résistance à la chaleur des CMS après les avoir plongés dans un milieu simulant l'humidité absorbée lors du stockage en magasin ou dans un emballage avec dessiccant. Les valeurs des niveaux de sensibilité à l'humidité (NSH) générées par le présent document sont utilisées pour déterminer les conditions d'absorption pour le préconditionnement conformément à l'IEC 60749-30.

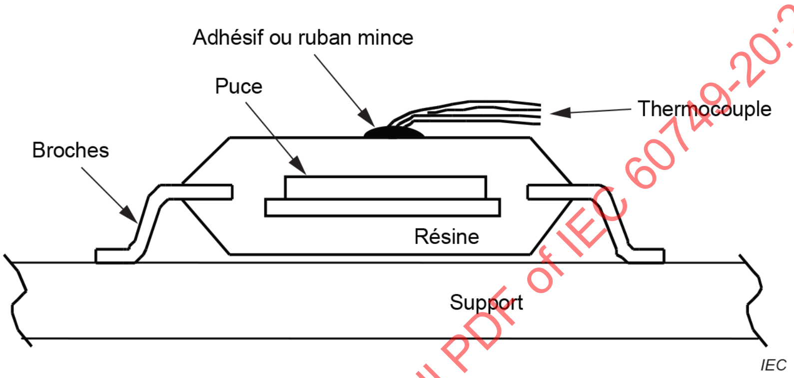
5 Appareillage d'essai et matériaux

5.1 Chambre d'humidité

La chambre d'humidité doit créer un environnement respectant la température et l'humidité relative définies en 6.3.

5.2 Appareillage de brasage par refusion

L'appareillage de brasage par refusion par convection infrarouge, par convection et en phase vapeur doit fournir des profils de température conformes aux conditions de chaleur de brasage définies en 6.4.2 et en 6.4.3. Les réglages de l'appareillage de brasage par refusion doivent être réalisés à l'aide des profils de températures de la surface supérieure de l'éprouvette, mesurées conformément à la Figure 1, pendant que l'éprouvette est soumise à la chaleur de brasage.



Il convient que l'adhésif ou le ruban mince possède une bonne conductivité thermique.

Figure 1 – Méthode de mesure du profil de température d'une éprouvette

5.3 Support

Sauf indication contraire dans la spécification applicable, on peut utiliser pour le support n'importe quel matériau de circuit tel que la fibre de verre époxyde ou polyimide. L'éprouvette doit être placée sur le support selon les méthodes habituelles et dans la position indiquée à la Figure 1. Si la mise en place de l'éprouvette, selon la Figure 1, nécessite le changement de forme des conducteurs et entraîne des anomalies dans les mesures électriques ultérieures, il est possible de choisir une méthode évitant de changer la forme des conducteurs et cette possibilité doit être mentionnée dans la spécification applicable.

5.4 Appareillage de brasage à la vague

L'appareillage de brasage à la vague doit être conforme aux conditions données en 6.4.4. Généralement, la brasure en fusion doit être agitée de façon à constituer une vague.

5.5 Solvant pour brasage par refusion en phase vapeur

Le perfluorocarbone (de l'isobutène perfluoré) doit être utilisé.

5.6 Flux

Sauf précision contraire dans la spécification applicable, le flux doit comprendre en masse 25 % de colophane et 75 % d'alcool isopropylique, selon les spécifications de l'Annexe B de l'IEC 60068-2-20:2008.

5.7 Brasure

Une brasure dont la composition est spécifiée dans le Tableau 1 de l'IEC 60068-2-20:2008 doit être utilisée.

6 Procédure

6.1 Mesures initiales

6.1.1 Examen visuel

L'examen visuel, comme spécifié dans l'IEC 60749-3, doit être réalisé avant l'essai. Il faut prêter une attention particulière aux fissures externes et aux gonflements à détecter sous un grossissement de 40X.

6.1.2 Mesure électrique

Les essais électriques doivent être effectués selon les exigences de la spécification applicable.

6.1.3 Contrôle interne par tomographie acoustique

Sauf précision contraire dans la spécification applicable, les fissures et déstratifications internes de l'éprouvette doivent être contrôlées par tomographie acoustique conformément à l'IEC 60749-35.

6.2 Séchage

Sauf précision contraire dans la spécification applicable, l'éprouvette doit être étuvée à 125 ± 5 °C pendant au moins 24 h.

NOTE 1 Ce temps/température est modifié si les données de désorption du dispositif particulier soumis à essai montrent qu'une condition différente est exigée pour obtenir un boîtier "sec" en démarrant en conditions humides à 85 °C/85 % HR.

NOTE 2 Si un essai d'étuvage est interrompu pendant plus de 15 min, la durée totale de l'interruption est exclue du temps d'étuvage. La durée d'interruption est prise en compte (si elle n'est pas supérieure à 1 h), puis réincorporée pour assurer un minimum de 24 h. Par exemple, si l'interruption est de 45 min, alors le temps total de l'essai d'étuvage est de 24 h et 45 min. Si elle est supérieure à 1 h, l'étuvage est relancé pendant 24 h.

6.3 Absorption d'humidité

6.3.1 Généralités

Sauf précision contraire dans la spécification applicable, les conditions d'absorption d'humidité doivent être choisies selon la méthode d'emballage de l'éprouvette (voir A.1.1, Annexe A). Si l'étuvage de l'éprouvette avant le brasage est précisé dans la spécification applicable, l'éprouvette doit être soumise à l'étuvage au lieu de l'absorption d'humidité.

6.3.2 Conditions relatives aux CMS sous emballage sans dessiccant

La condition d'absorption d'humidité doit être choisie dans le Tableau 1, selon la limite autorisée pour le stockage réel (voir A.1.2.1).

Tableau 1 – Conditions d'absorption d'humidité pour CMS sous emballage sans dessiccant

Condition	Température °C	Humidité relative %	Durée h	Limite autorisée pour le stockage réel
A1 ou B1	85 ± 2	85 ± 5	168 ± 24	< 30 °C, 85 % HR

HR: humidité relative

NOTE Les conditions A1 et B1 indiquent une absorption d'humidité pour les CMS sous emballage sans dessiccant selon la méthode A ou B.

6.3.3 Absorption d'humidité pour CMS sous emballage avec dessiccant

6.3.3.1 Généralités

Pour les CMS sous emballage avec dessiccant, les conditions d'absorption d'humidité spécifiées dans la méthode A, Tableau 2, ou la méthode B, Tableau 3, peuvent être utilisées. Pour les CMS sous emballage avec dessiccant, le conditionnement pour absorption d'humidité comprend deux phases. La première phase est destinée à simuler l'absorption d'humidité du CMS avant l'ouverture de l'emballage avec dessiccant ou de l'armoire sèche. La seconde phase de conditionnement vise à simuler l'absorption d'humidité du CMS au cours du stockage après l'ouverture de l'emballage avec dessiccant en vue du brasage (environnement non protégé). Le conditionnement pour absorption d'humidité pour les CMS sous emballage avec dessiccant doit être choisi à partir de la méthode A ou B. La méthode A doit être utilisée lorsque l'humidité relative dans l'emballage avec dessiccant ou dans l'armoire sèche est spécifiée par le fabricant comme se situant entre 10 % et 30 %. La méthode B doit être utilisée lorsque l'humidité relative dans l'emballage avec dessiccant ou dans l'armoire sèche est spécifiée par le fabricant comme étant inférieure à 10 %.

6.3.3.2 Méthode A

Sauf précision contraire dans la spécification applicable, le conditionnement de la première phase de A2 indiqué dans le Tableau 2 doit être exécuté. Ultérieurement, le conditionnement de la seconde phase de A2 indiqué dans le Tableau 2 doit être exécuté dans les 4 h qui suivent la fin de la première phase de conditionnement (voir A.1.2.2).

L'humidité relative du conditionnement de la première phase doit être la même que la limite supérieure de l'humidité relative à l'intérieur du sac étanche à l'humidité. L'humidité relative du conditionnement de la seconde phase doit être la même que dans les conditions d'un environnement non protégé.

Si la spécification correspondante l'exige, les conditions d'essai autres que celles du sac étanche à l'humidité et celles de l'environnement non protégé peuvent être spécifiées dans les conditions pour l'absorption d'humidité du Tableau 2.

Tableau 2 – Conditions d'absorption d'humidité pour CMS sous emballage avec dessiccant (méthode A)

Condition	Conditions d'absorption d'humidité	Conditions de stockage autorisées dans l'emballage avec dessiccant et dans l'armoire sèche	Conditions de stockage en environnement non protégé
Conditionnement de la première phase A2	(85 ± 2) °C, (30 ± 5) % HR, $168\ ^{24}_{-0}$ h	< 30 °C, 30 % HR, 1 an	–
Conditionnement de la seconde phase A2	(30 ± 2) °C, (70 ± 5) % HR, $168\ ^{24}_{-0}$ h	–	< 30 °C, 70 % HR, 168 h
HR: Humidité relative			

NOTE 1 La première phase de conditionnement représente les conditions de stockage dans l'emballage avec dessiccant et dans l'armoire sèche, ainsi que l'augmentation de l'humidité relative dans l'emballage avec dessiccant suite au réemballage des CMS chez le distributeur et lors du contrôle d'entrée de l'utilisateur. Lorsque la condition A2 est appliquée, les CMS sont emballés dans un sachet étanche à l'humidité avec des réglettes à circuits intégrés et des dessiccants dans les quelques semaines qui suivent le séchage. Ils peuvent alors être soumis à des ouvertures temporaires multiples du sachet étanche à l'humidité (pendant plusieurs heures chaque fois). Le réemballage et le contrôle des CMS sont possibles tant que l'indicateur d'humidité dans l'emballage avec dessiccant indique moins de 30 % d'humidité relative, étant donné que les CMS récupèrent l'état initial de l'humidité absorbée dans les quelques jours qui suivent le réemballage. Dans ce cas, la mesure de la teneur en humidité des CMS (voir A.2) n'est pas nécessaire en tant que contrôle d'humidité de l'emballage avec dessiccant. Une vérification de l'indicateur d'humidité est suffisante pour le contrôle d'humidité.

NOTE 2 Lorsque le conditionnement de la première phase pour absorption d'humidité n'aboutit pas à une saturation, le temps d'absorption est étendu à 336 h, car les CMS dans un emballage avec dessiccant ou une armoire sèche sont saturés par l'humidité accumulée au cours d'un stockage de longue durée. Le temps d'absorption d'humidité est réduit lorsque la saturation est atteinte lors de la première phase de conditionnement.

6.3.3.3 Méthode B

Le conditionnement pour absorption d'humidité doit être choisi dans le Tableau 3 selon les conditions de stockage en environnement non protégé précisées dans la spécification applicable (voir A.1.2.3).

Tableau 3 – Conditions d'absorption d'humidité pour CMS sous emballage avec dessiccant (méthode B)

Condition	Conditions d'absorption d'humidité	Conditions globales depuis l'étuvage jusqu'à l'emballage avec dessiccant et son ouverture temporaire	Conditions de stockage en environnement non protégé
B2	(85 ± 2) °C, (60 ± 5) % HR, $168\ ^{+24}_{-24}$ h	< 30 °C, 60 % HR, 24 h	< 30 °C, 60 % HR, 1 an
B2a	(30 ± 2) °C, (60 ± 5) % HR, $696\ ^{+24}_{-24}$ h	< 30 °C, 60 % HR, 24 h	< 30 °C, 60 % HR, 4 semaines
B3	(30 ± 2) °C, (60 ± 5) % HR, $192\ ^{+24}_{-0}$ h	< 30 °C, 60 % HR, 24 h	< 30 °C, 60 % HR, 168 h
B4	(30 ± 2) °C, (60 ± 5) % HR, $96\ ^{+24}_{-0}$ h	< 30 °C, 60 % HR, 24 h	< 30 °C, 60 % HR, 72 h
B5	(30 ± 2) °C, (60 ± 5) % HR, $72\ ^{+24}_{-0}$ h	< 30 °C, 60 % HR, 24 h	< 30 °C, 60 % HR, 48 h

Condition	Conditions d'absorption d'humidité	Conditions globales depuis l'étuvage jusqu'à l'emballage avec dessiccant et son ouverture temporaire	Conditions de stockage en environnement non protégé
B5a	(30 ± 2) °C, (60 ± 5) % HR, $48\ ^{+24}_{-0}$ h	< 30 °C, 60 % HR, 24 h	< 30 °C, 60 % HR, 24 h
B6	(30 ± 2) °C, (60 ± 5) % HR, $6\ ^{+24}_{-0}$ h		< 30 °C, 60 % HR, 6 h
HR: humidité relative			

NOTE Les conditions d'absorption d'humidité de B2 à B6 englobent les deux phases de conditionnement: la première phase (30 °C, 60 % HR, 24 h) et la deuxième phase en environnement non protégé.

Il convient que le contenu de l'emballage avec dessiccant des CMS, réglettes à circuits intégrés et autres matériaux, soit totalement séché juste avant l'emballage dans le sachet étanche à l'humidité et il convient que le dessiccant soit totalement sec. La raison en est que les matériaux humides et les dessiccants dégradés dégagent de la vapeur d'eau, provoquant une humidité relative dans l'emballage supérieure à 10 %. Il convient que l'humidité relative dans l'emballage avec dessiccant soit vérifiée par l'indicateur d'humidité et la mesure de la teneur en humidité des CMS, comme représenté en A.2.

Le stockage des CMS dans une armoire sèche au lieu d'un emballage avec dessiccant n'est pas recommandé, car il n'est pas possible d'obtenir une humidité relative très faible dans une armoire sèche.

Il convient que les conditions individuelles de la méthode B englobent l'ensemble des conditions de stockage depuis l'étuvage des CMS jusqu'à leur brasage. Il convient que ces conditions incluent la durée du stockage dans le local, depuis l'étuvage des CMS jusqu'à la mise en emballage avec dessiccant, l'ouverture temporaire de l'emballage avec dessiccant et le stockage en environnement non protégé.

6.4 Chaleur de brasage

6.4.1 Généralités

Sauf indication contraire dans la spécification applicable, l'éprouvette doit être soumise à la chaleur de brasage dans les 4 h qui suivent la fin de l'absorption d'humidité ou de l'étuvage. La méthode et les conditions relatives à la chaleur de brasage doivent être choisies de 6.4.2 à 6.4.4 selon la spécification applicable. Quelle que soit la méthode d'essai employée, le nombre de cycles de chaleur de brasage doit être compris entre un et trois. Sauf précision contraire dans la spécification applicable, il faut appliquer un cycle de chaleur de brasage. Si plus d'un cycle est choisi, l'éprouvette doit être refroidie jusqu'à une température inférieure à 50 °C avant chacun des autres cycles.

NOTE La spécification applicable peut stipuler un temps de stockage supérieur à 4 h après la fin de l'absorption d'humidité ou de l'étuvage, si l'absorption d'humidité et le séchage qui interviennent pendant un stockage dans le local de plus de 4 h n'affectent pas l'éprouvette.

6.4.2 Méthode de chauffage par brasage par refusion par convection infrarouge ou par convection

6.4.2.1 Préparation

L'éprouvette doit être placée sur le support.

6.4.2.2 Préchauffage

Sauf indication contraire dans la spécification applicable, l'éprouvette doit être préchauffée dans une gamme de conditions de températures figurant en A.3.1, pendant 60 s à 120 s dans l'appareillage de brasage par refusion.

6.4.2.3 Chauffage de la brasure

Après le préchauffage, la température de l'éprouvette doit être augmentée jusqu'à la température de crête et ensuite être diminuée pour atteindre la température ambiante. Les conditions de chauffage doivent être choisies dans le Tableau 4 ou le Tableau 5 selon la spécification applicable dépendant des conditions réelles de brasage. Les tolérances de température et de temps sont indiquées en A.3.1.

NOTE 1 Dans le Tableau 4 et le Tableau 5, les conditions de la méthode A sont appliquées pour le brasage réel en condition de profil court de température et les conditions de la méthode B sont appliquées pour le brasage réel en condition de profil long de température.

NOTE 2 A la suite du préchauffage, la température de l'éprouvette suit les valeurs indiquées à la Figure A.9, à la Figure A.10 ou dans le Tableau A.2 concernant les profils de températures.

NOTE 3 Le "volume" du boîtier exclut les broches externes (par exemple billes, bossages, plages d'accueil, broches) et/ou dissipateurs thermiques non intégrés. Le volume du boîtier inclut les dimensions extérieures du corps de boîtier, qu'il ait une cavité ou qu'il soit un boîtier passif.

NOTE 4 A la discrétion du fabricant du dispositif, mais pas de l'assembleur/utilisateur de la carte, la température de crête du corps de boîtier maximale (T_p) peut dépasser les valeurs spécifiées dans le Tableau 4 ou le Tableau 5. L'utilisation d'une T_p plus élevée ne modifie pas la température de classification (T_c).

NOTE 5 La température maximale des composants atteinte au cours de la refusion dépend de l'épaisseur et du volume du boîtier. L'utilisation de processus par refusion par convection réduit les gradients thermiques entre boîtiers. Cependant, les gradients thermiques dus aux différences de masse thermique des boîtiers CMS peuvent persister.

NOTE 6 Les niveaux de sensibilité à l'humidité des composants destinés à être utilisés à un processus d'assemblage sans plomb sont évalués à l'aide des températures et des profils de classification sans plomb définis dans le Tableau 4 et le Tableau 5, que le processus soit avec ou sans plomb.

Tableau 4 – Processus eutectique Sn-Pb – Températures de refusion dans la classification (T_c)

Epaisseur de boîtier mm	Méthode	Temps à 5 °C près de la température de la classification spécifiée s	Température pour le volume mm^3		
			< 350 °C	350 à 2 000 °C	< 2 000 °C
< 2,5	Méthode A	10	240	240	225
	Méthode B	20	240	225	225
≥ 2,5	Méthode A	10	240	240	225
	Méthode B	20	225	225	225

Tableau 5 – Processus sans Pb – Températures de refusion dans la classification (T_c)

Epaisseur de boîtier mm	Méthode	Temps à 5 °C près de la température de la classification spécifiée s	Température pour le volume mm^3		
			< 350 °C	350 à 2 000 °C	> 2 000 °C
< 1,6	Méthode A	10	260	260	260
		20			
	Méthode B	30			
1,6 à 2,5	Méthode A	10	260	250	245
		20			
	Méthode B	30			
> 2,5	Méthode A	10	250	245	245
		20			
	Méthode B	30			

6.4.3 Méthode de chauffage par brasage par refusion en phase vapeur

6.4.3.1 Préparation

L'éprouvette doit être placée sur le support.

6.4.3.2 Préchauffage

Sauf indication contraire dans la spécification applicable, l'éprouvette doit être préchauffée à une température comprise entre 100 °C et 160 °C pendant 1 min à 2 min dans l'appareillage de brasage en phase vapeur.

6.4.3.3 Chauffage de la brasure

La température de l'éprouvette doit être augmentée après le préchauffage. Lorsque la température de l'éprouvette a atteint (215 ± 5) °C, elle doit être maintenue pendant (40 ± 4) s, comme indiqué dans le Tableau 6 (se référer à A.3.2).

Tableau 6 – Condition de chauffage du brasage en phase vapeur

Condition	Température °C	Temps s
II-A	215 ± 5	40 ± 4

6.4.4 Méthode de chauffage par brasage à la vague

6.4.4.1 Préparation

La surface inférieure de l'éprouvette doit être fixée au support par un adhésif défini dans la spécification applicable. Sauf précision contraire dans la spécification applicable, il ne faut pas appliquer de flux à l'éprouvette ni au support.

Si du flux est appliqué, la vaporisation de solvant dans le flux peut affecter l'échauffement de l'éprouvette. De ce fait, il convient de ne pas appliquer le flux sur le corps de l'éprouvette, mais de l'appliquer uniquement sur les broches aussi modérément que possible.