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BS EN 60749-20:2009

BSI Standards Publication

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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National foreword

This British Standard is the UK implementation of EN 60749-20:2009. It is identical to IEC 60749-20:2008. It supersedes BS EN 60749-20:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/47, Semiconductors.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Amendments issued since publication

Amd. No.	Date	Text affected

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EUROPEAN STANDARD

NORME EUROPÉENNE

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EN 60749-20

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English version

Semiconductor devices - Mechanical and climatic test methods - Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat (IEC 60749-20:2008)

Dispositifs à semiconducteurs -
Méthodes d'essais mécaniques
et climatiques -
Partie 20: Résistance
des CMS à boîtiers plastique
à l'effet combiné de l'humidité
et de la chaleur de brasage
(CEI 60749-20:2008)

Halbleiterbauelemente -
Mechanische und klimatische
Prüfverfahren -
Teil 20: Beständigkeit kunststoffverkappter
oberflächenmontierbarer Bauelemente
(SMD) gegenüber der kombinierten
Beanspruchung von Feuchte
und Lötwärme
(IEC 60749-20:2008)

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Foreword

The text of document 47/1989/FDIS, future edition 2 of IEC 60749-20, prepared by IEC TC 47, Semiconductor devices, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60749-20 on 2009-09-01.

This European Standard supersedes EN 60749-20:2003.

The main changes are as follows:

– to reconcile certain classifications of EN 60749-20 and those of IPC/JEDEC J-STD-020C;

– reference EN 60749-35 instead of Annex A of EN 60749-20:2003;

– update for lead-free solder;

– correct certain errors in EN 60749-20:2003.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2010-06-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2012-09-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60749-20:2008 was approved by CENELEC as a European Standard without any modification.

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
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	EN 60068-2-20	2008
IEC 60749-3	- [1)]	Semiconductor devices - Mechanical and climatic test methods - Part 3: External visual examination	EN 60749-3	2002 [2)]
IEC 60749-35	- [1)]	Semiconductor devices - Mechanical and climatic test methods - Part 35: Acoustic microscopy for plastic encapsulated electronic components	EN 60749-35	2006 [2)]

[1)] Undated reference.

[2)] Valid edition at date of issue.

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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 referenced documents are indispensable for the application 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*

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

3 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.

4 Test apparatus and materials

4.1 Humidity chamber

The humidity chamber shall provide an environment complying with the temperature and relative humidity defined in 5.3.

4.2 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 5.4.2 and 5.4.3. 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.

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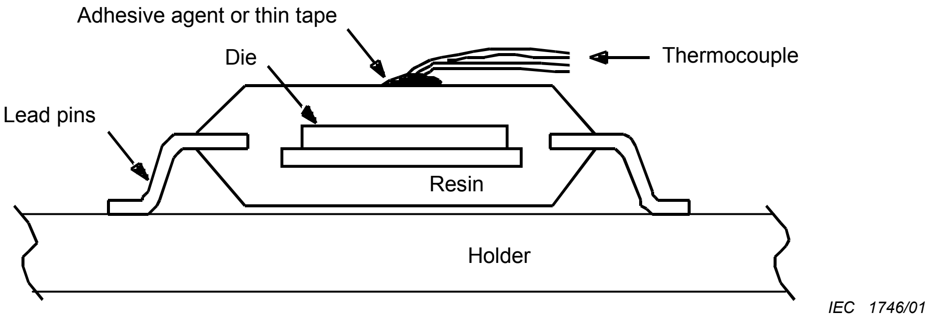

NOTE The adhesive agent or thin tape should have good thermal conductivity.

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

4.3 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.

4.4 Wave-soldering apparatus

The wave-soldering apparatus shall comply with conditions given in 5.4.4. Molten solder shall usually be flowed.

4.5 Solvent for vapour-phase reflow soldering

Perfluorocarbon (perfluoroisobutylene) shall be used.

4.6 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.

4.7 Solder

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

5 Procedure

5.1 Initial measurements

5.1.1 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 40×.

5.1.2 Electrical measurement

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

5.1.3 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.

5.2 Drying

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

5.3 Moisture soak

5.3.1 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). If baking the specimen before soldering is detailed in the relevant specification, the specimen shall be baked instead of being subject to moisture soak.

5.3.2 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.				

5.3.3 Moisture soak for dry-packed SMDs

5.3.3.1 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 %.

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5.3.3.2 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 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 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 packed into a moisture-proof bag with IC trays and desiccants within a few weeks of drying. They may 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.

5.3.3.3 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.

5.4 Soldering heat

5.4.1 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 5.4.2 to 5.4.4 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.

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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 be detailed in the relevant specification.

5.4.2 Method of heating by infrared convection or convection reflow soldering

5.4.2.1 Preparation

The specimen shall be put on the holder.

5.4.2.2 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.

5.4.2.3 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 Tables 4 and 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 follow the values as indicated in the profile given in Figure A.9, Figure A.10 or Table A.2.

Table 4 – SnPb eutectic process – Classification reflow temperatures

Package thickness mm	**Method**	**Time within 5 °C of specified classification temperature** s	**Temperature for volume** mm^3		
			<350 °C	**350 – 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

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Table 5 – Pb-free process – Classification reflow temperatures

Package thickness mm	**Method**	**Time within 5°C of the specified classification temperature** s	**Temperature for volume** mm³		
			<350 °C	**350 – 2 000** °C	**>2 000** °C
<1,6	Method A	10	260	260	260
		20			
	Method B	30			
1,6 – 2.5	Method A	10	260	250	245
		20			
	Method B	30			
>2,5	Method A	10	250	245	245
		20			
	Method B	30			

5.4.3 Method of heating by vapour-phase reflow soldering

5.4.3.1 Preparation

The specimen shall be put on the holder.

5.4.3.2 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.

5.4.3.3 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

5.4.4 Method of heating by wave-soldering

5.4.4.1 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.

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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 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).

5.4.4.2 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.

5.4.4.3 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.

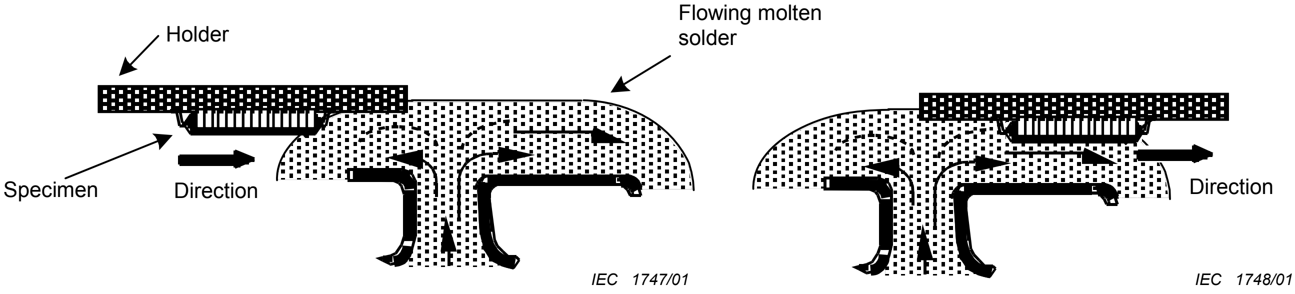

Figure 2a – Start of immersion **Figure 2b – End of immersion**

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

5.4.4.4 Cleaning

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

5.5 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.

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5.6 Final measurements

5.6.1 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 40×.

5.6.2 Electrical measurement

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

5.6.3 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.

6 Information to be given in the relevant specification

		Subclause
a)	Material of holder	4.3
b)	Position of specimen on the holder	4.3
c)	Composition of flux	4.6
d)	Number of test specimens	5
e)	Item and failure criteria for initial measurement	5.1
f)	Preconditioning	5.2
g)	Method of moisture soak	5.3
h)	Conditions of drying	5.2
i)	Baking conditions instead of the moisture soak	5.3
j)	Method of moisture soak for dry packed SMDs	5.3.3
k)	Period between the stages of moisture soak conditioning	5.3.3.2
l)	Conditions of first-stage and second-stage conditioning and whether another condition is needed	5.3.3.2
m)	Soak time of the first-stage conditioning if 168 h of soak time is insufficient	5.3.3.2
n)	Moisture soak conditions for SMDs stored in completely dried dry pack	5.3.3.3
o)	Moisture soak conditions for non-dry-packed SMDs	5.3.2
p)	Period between finish of moisture soak and soldering heat	5.4.1
q)	Method and condition of soldering heat	5.4.1
r)	Number of cycles of soldering heat	5.4.1
s)	Preheat conditions for infrared convection and convection reflow soldering	5.4.2.2
t)	Heating conditions for infrared convection and convection reflow soldering	5.4.3.3
u)	Preheat conditions for vapour-phase reflow soldering	5.4.3.2
v)	Adhesion method	5.4.4.1
w)	Preheat conditions for wave-soldering	5.4.4.2

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x) Cleaning method for flux	5.4.4.4
y) Recovery conditions	5.5
z) Item and failure criteria for final measurement	5.6

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Annex A
(informative)

Details and descriptions 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 5.3 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 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 Figures A.4 to 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.

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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.

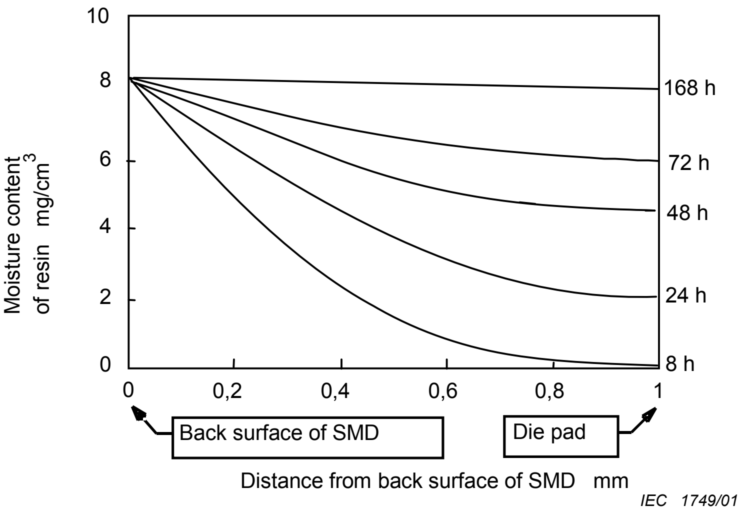
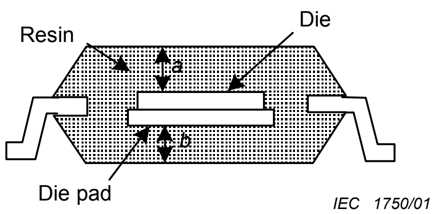


Figure A.1 – Process of moisture diffusion at 85 °C, 85 % RH



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

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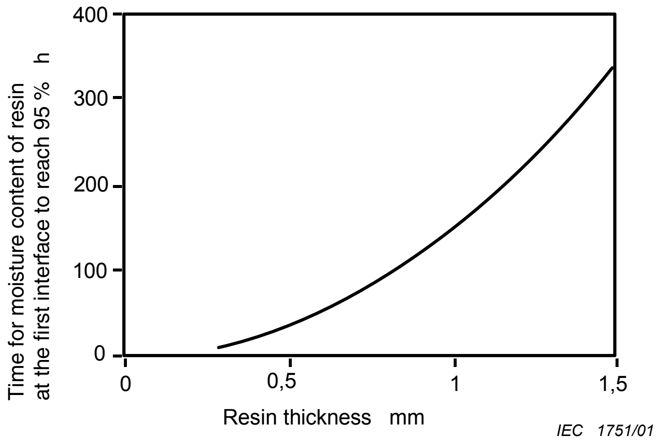

Figure A.3 – Moisture soak time to saturation at 85 °C as a function of resin thickness

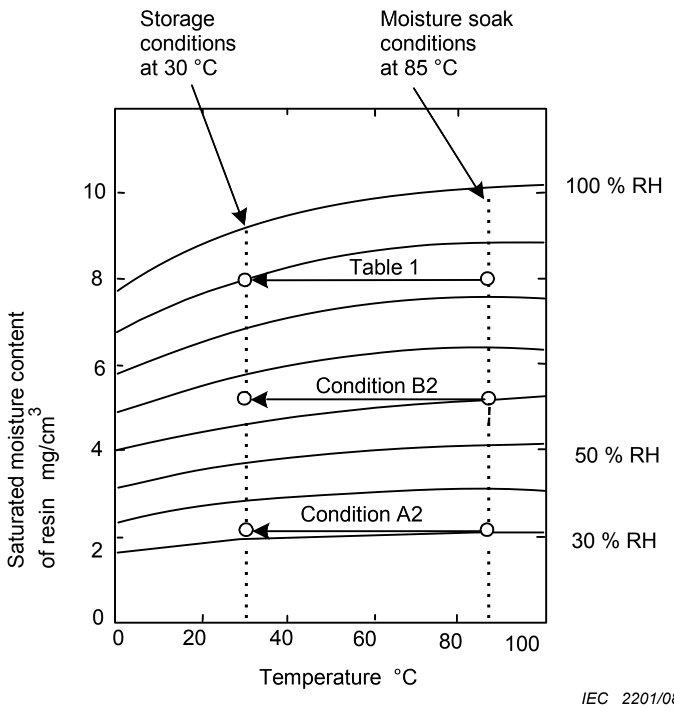

Figure A.4 – Temperature dependence of saturated moisture content of resin

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

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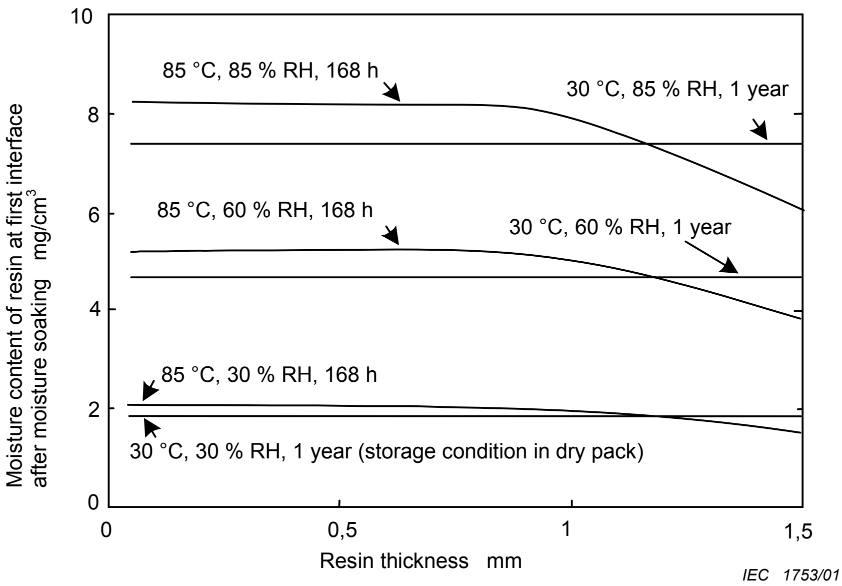

Figure A.5 – Dependence of moisture content of resin at the first interface on resin thickness under various soak conditions

A.1.2.2 Moisture soak conditioning – Method A

Method A of moisture soak given in item 5.3.3.2 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 and the second-stage conditioning A2 completely represents 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.

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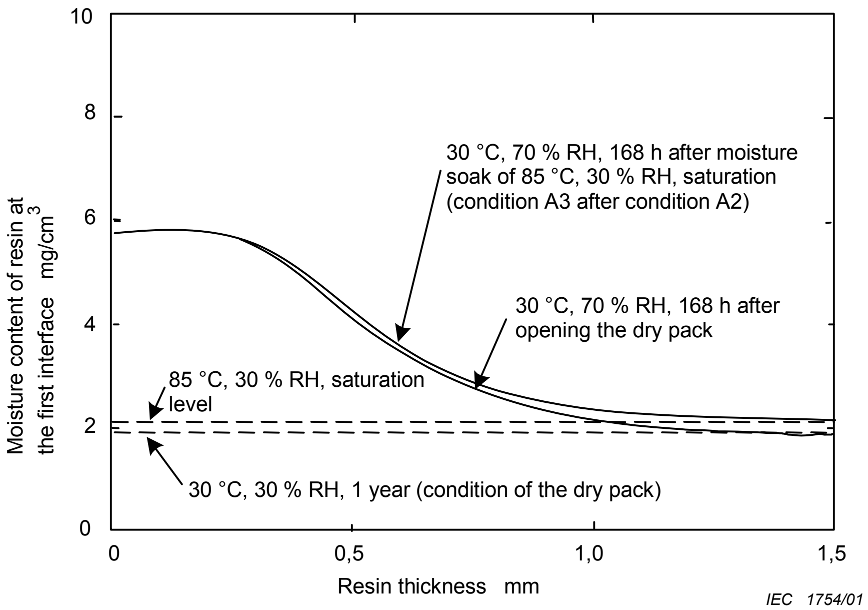

Figure A.6 – Dependence of moisture content of resin at the first interface on resin thickness related to method A of moisture soak

A.1.2.3 Moisture soak conditioning – Method B

Method B of moisture soak given in 5.3.3.3 is based on conditions where SMDs, IC trays and other materials have been completely baked immediately before dry packing and the volume of 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.

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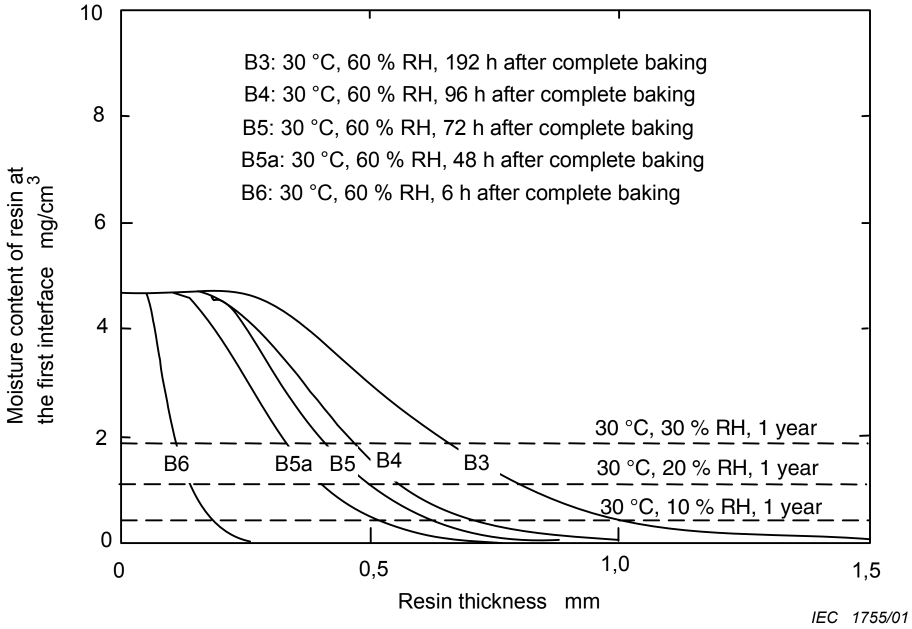

Figure A.7 – Dependence of the moisture content of resin at the first interface on resin thickness related to method B of moisture soak

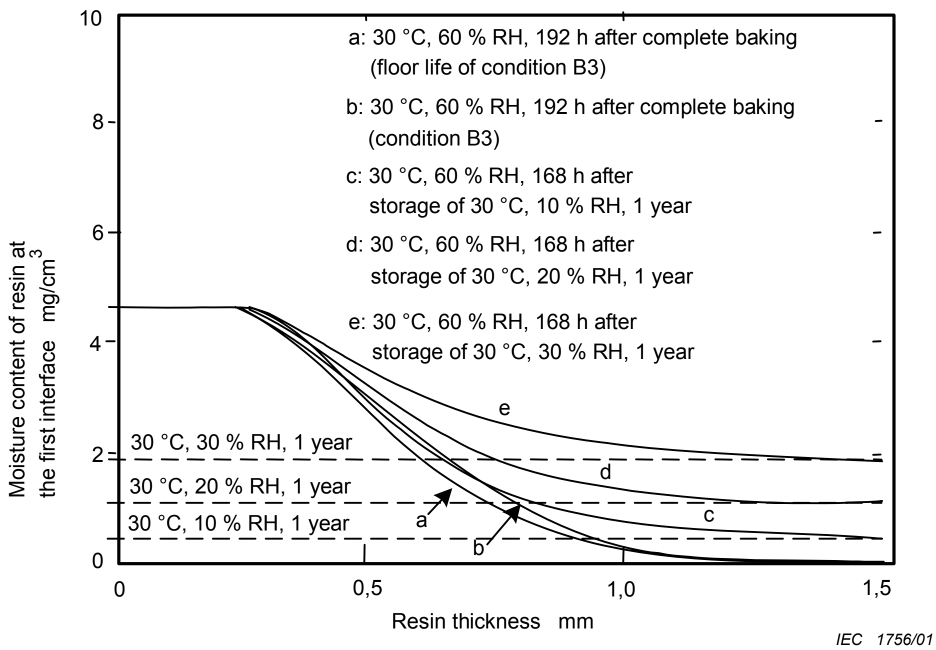

Figure A.8 – Dependence of moisture content of resin at the first interface on resin thickness related to condition B2 of method B of moisture soak

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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 be variable. For example, the surface of the SMD may 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 equation:

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

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 5.4.2, 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 solder joint needs to be controlled. On the other hand, since the heating damage to semiconductor is dependent on the temperature of body of semiconductor, it needs control of body temperature for the soldering heat test.

Since a large semiconductor has a large heat capacity, temperature of 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 temperature conditions with the size of the body of the semiconductor.

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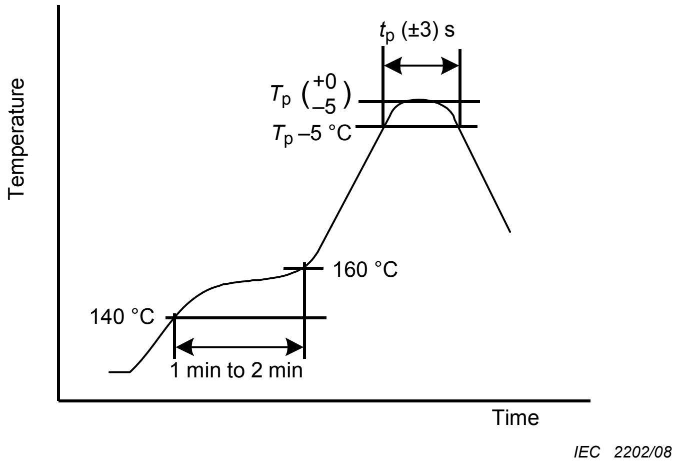

Figure A.9 – Temperature profile of infrared convection and convection reflow soldering for Sn-Pb eutectic assembly

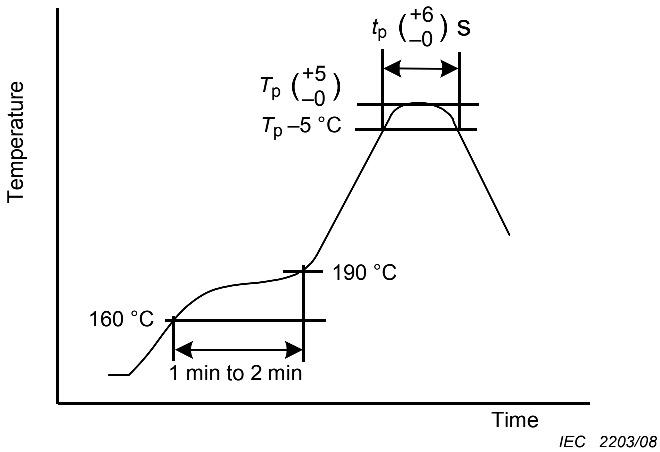

Figure A.10 – Temperature profile of infrared convection and convection reflow soldering for lead-free assembly

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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 - 120 s	 150 °C 200 °C 60-120 s
Time maintained above: Temperature (T_L) Time (t_L)	 183 °C 60 s - 150 s	 217 °C 60 s - 150 s
Peak package body temperature (T_p)	For users T_p must not exceed the classification temperature in Table 4. For suppliers T_p must equal or exceed the classification temperature in Table 4.	For users T_p must not exceed the classification temperature in Table 5. For suppliers T_p must 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, e.g. 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.

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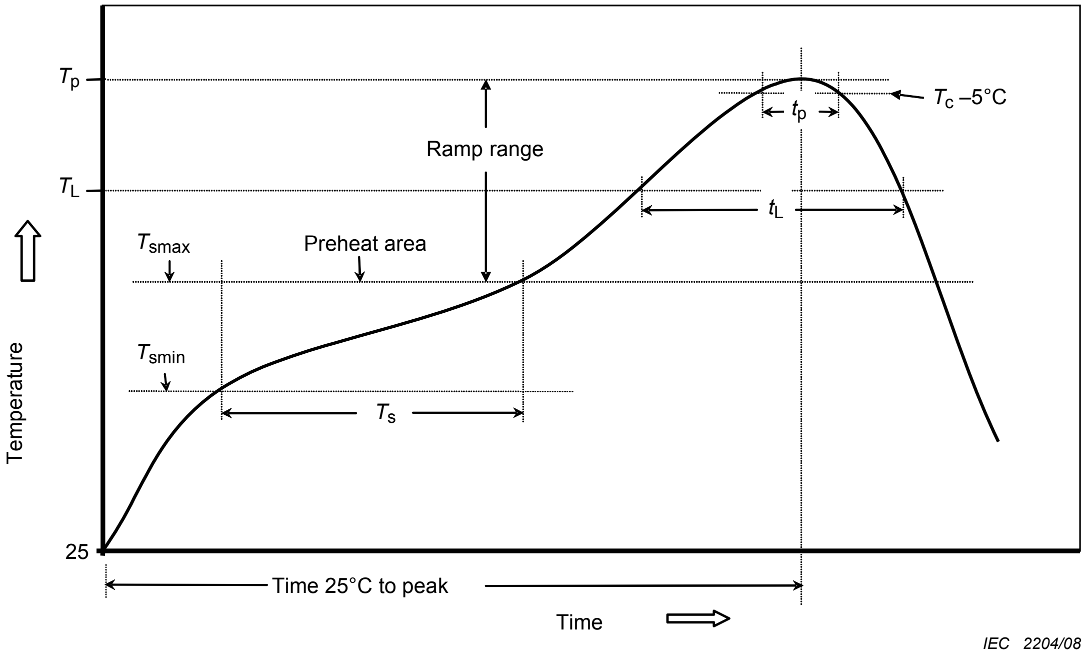

Figure A.11 – Classification profile

A.3.2 Temperature profile of vapour-phase soldering

Solder heating using the vapour-phase soldering specified in 5.4.3 shall be performed according to the temperature profile shown in Figure A.12.

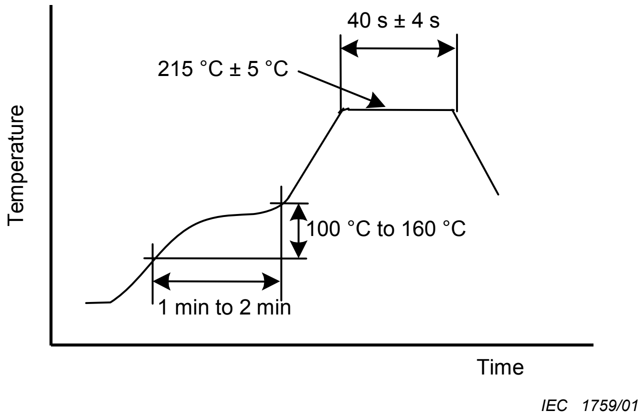

Figure A.12 – Temperature profile of vapour-phase soldering (condition II-A)

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 QFP and QFJ, the differential could be between 50 °C and 80 °C. Consequently, the wave-soldering

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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.

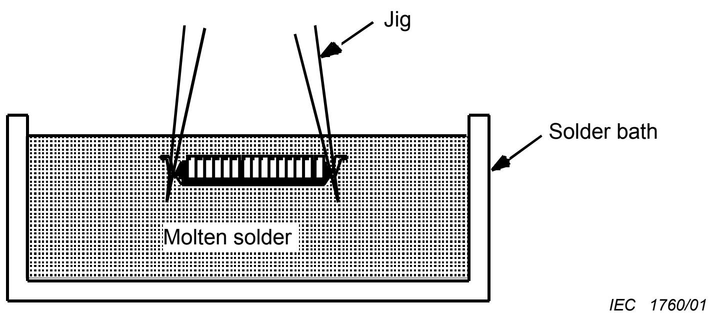

Figure A.13 – Immersion method into solder bath

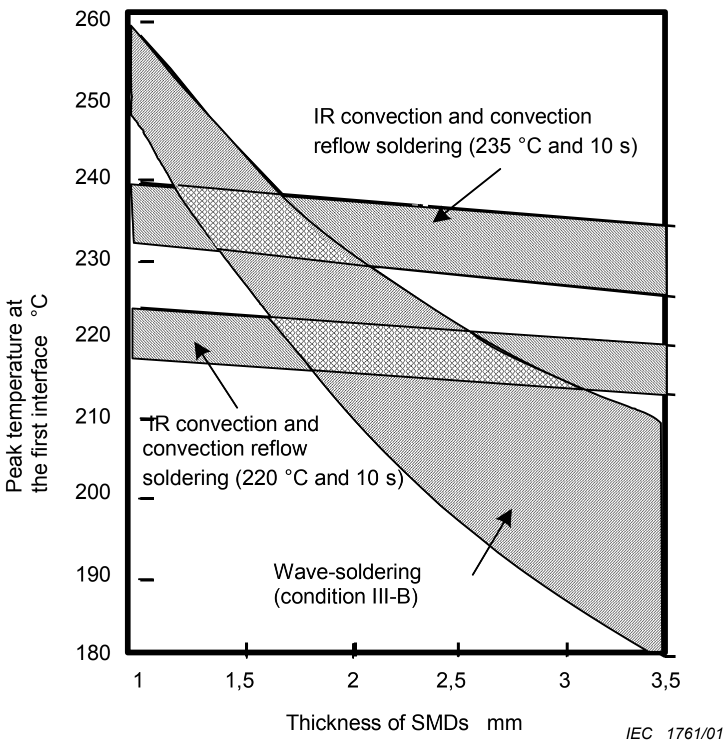

Figure A.14 – Relation between the infrared convection reflow soldering and wave-soldering

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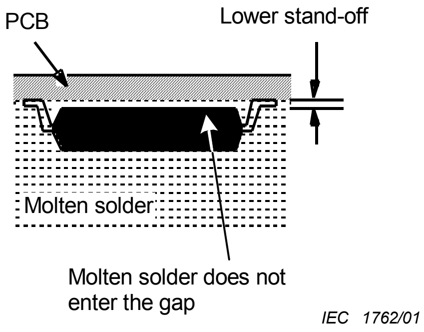

Figure A.15a – Lower

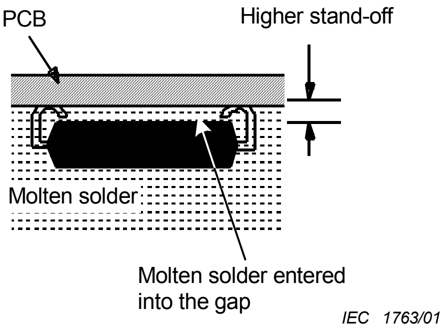

Figure A.15b – Higher

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

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