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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**

**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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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 second edition cancels and replaces the first edition published in 2002 and constitutes a technical revision. The main changes are as follows:

- to reconcile certain classifications of IEC 60749-20 and those of IPC/JEDEC J-STD-020C;
- reference IEC 60749-35 instead of Annex A of IEC 60749-20, Edition 1;
- update for lead-free solder;
- correct certain errors in the original Edition 1.

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

FDIS	Report on voting
47/1989/FDIS	47/2003/RVD

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

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

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

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

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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*

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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.

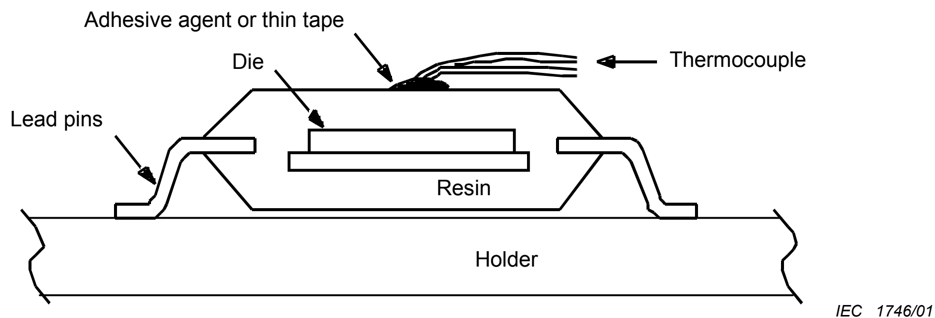
4 Test apparatus and materials

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.



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.

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4.4 Wave-soldering apparatus

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

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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

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

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

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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 %.

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			

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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			

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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).

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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.

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.

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Table 4 – SnPb eutectic process – Classification reflow temperatures

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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

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 mm^3		
			<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

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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.

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.

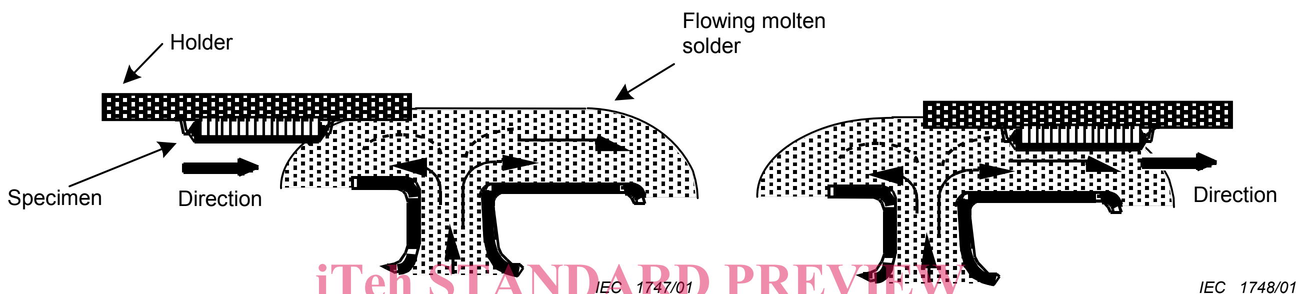

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Figure 2a – Start of immersion Figure 2b – End of immersion

IEC 60749-20:2008
https://standards.iteh.ai/catalog/standards/sist/...-8685-c90fc861acbb/iec-60749-20-2008

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.