

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Environmental testing –  
Part 2-82: Tests – Test XW<sub>1</sub>: Whisker test methods for electronic and electric  
components**

**Essais d'environnement –  
Partie 2-82: Essais – Essai XW<sub>1</sub>: Méthodes de vérification des trichites pour les  
composants électroniques et électriques**



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INTERNATIONAL  
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ENVIRONMENTAL TESTING –**

**Part 2-82: Tests – Test XW<sub>1</sub>: Whisker test methods  
for electronic and electric components**

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International Standard IEC 60068-2-82 has been prepared by IEC technical committee 91: Electronics assembly technology.

This bilingual version, published in 2008-04, corresponds to the English version.

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

FDIS	Report on voting
91/651/FDIS	91/685/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.

The French version of this standard has not been voted upon.

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

A list of all parts in the IEC 60068 series, under the general title *Environmental testing*, can be found on the IEC website.

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

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- withdrawn,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

The contents of the corrigendum of December 2009 have been included in this copy.

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## ENVIRONMENTAL TESTING –

### Part 2-82: Tests – Test XW<sub>1</sub>: Whisker test methods for electronic and electric components

#### 1 Scope

This part of IEC 60068 specifies whisker tests for electric or electronic components representing the finished stage, with tin or tin-alloy finish. However, the standard does not specify tests for whiskers that may grow as a result of external mechanical stress.

This test method is employed by a relevant specification (international component or application specification) with transfer of the test severities to be applied and with defined acceptance criteria.

Where tests described in this standard are considered for other components, e.g. mechanical parts as used in electrical or electronic equipment, it should be ensured that the material system and whisker growth mechanisms are comparable.

#### 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 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-20:1979, *Environmental testing – Part 2-20: Tests – Test T: Soldering*

IEC 60068-2-58:2004, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 61192-3:2002, *Workmanship requirements for soldered electronic assemblies – Part 3: Through-hole mount assemblies*

IEC 61760-1:2006, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

#### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-1, as well as the following, apply.

##### 3.1

##### **whisker**

metallic protrusion which spontaneously grows during storage or use



NOTE 1 Whiskers typically do not require any electrical field for their growth and may not be mixed with products of electrochemical migration. Typical signs of whiskers include:

- striations in growth direction;
- typically no branching;
- typically constant diameters.

Exceptions are known, but rare and may require detailed investigation.

For the purposes of this standard, whiskers are considered if

- they have an aspect ratio (length/width) greater than 2,
- they have a length of 10 µm or more.

NOTE 2 For the purposes of this standard, whiskers have the following characteristics:

- they can be kinked, bent, or twisted; they usually have a uniform cross-sectional shape;
- they may have rings around the circumference of the column.

NOTE 3 Whiskers are not to be confused with dendrites which are fern-like growths on the surface of a material which can be formed as a result of electro-migration of an ionic species or produced during solidification.

### 3.2

#### material system

termination consists of the following elements:

- a) base material;
- b) underlayer, if any, located under the final plating;
- c) final tin or tin alloy plating.

NOTE There may be additional layers between the base material and the underlayer. The penultimate layer is the used bulk material or the deposited layer underneath the final tin or tin alloy plating of the component.

## 4 Test equipment

The test equipment shall comprise the following elements:

### 4.1 Desiccator

The desiccator shall be capable of providing the conditions of temperature and humidity specified in 6.1.

### 4.2 Humidity chamber

The humidity chamber shall meet all the requirements of IEC 60068-2-78 and be capable of providing the conditions specified in 6.2.

### 4.3 Thermal cycling chamber

The thermal cycling chamber shall meet all the requirements of IEC 60068-2-14, test Na and be capable of providing the conditions specified in 6.3.

### 4.4 Optical microscope

An optical stereo-microscope with a magnification of at least 50 times and an appropriate illumination, capable of detecting whiskers with a length of 10 µm.

If used for measurement, the microscope shall be equipped with a scale or electronic detection system capable for length measurement with an accuracy of at least ±5 µm.

### 4.5 Scanning electron microscope

A scanning electron microscope (SEM) capable of investigating the surface of the specimen, preferably equipped with a handling system capable to tilt and rotate the specimen.

#### 4.6 Fixing jig

The fixture jig shall be capable of setting samples in any of the test chambers specified in 4.1, 4.2 and 4.3 without affecting compliance with the specified requirements.

The jig should also be attachable to the optical microscope or be appropriately small in size so that it can be inserted in the SEM sample chamber.

### 5 Preparation for test

#### 5.1 General

The samples shall represent finished products as supplied to the market.

NOTE Guidance on suitable sample sizes is provided in Annex C.

#### 5.2 Selection of test methods

Choose the appropriate test method according to the type of final plating, underlayer and base material of the specimen according to Table 6.

#### 5.3 Storage conditions prior to testing

The specimen shall be kept for at least 2 h in the standard atmospheric conditions defined in IEC 60068-1, 5.3.1 prior to any preconditioning or test.

#### 5.4 Handling of the specimen

It is recommended to hold the specimen with a fixture jig as specified in 4.6 to prevent them from being contaminated unexpectedly. The fixture jig shall not contact the metallic surfaces of the specimen to be tested. The sample shall be handled carefully to prevent the grown whiskers from falling away unexpectedly. Broken whiskers shall be recorded, see 7.4.

Where there is a possibility of grown whiskers to drop down, an appropriate fixture jig design shall be considered in advance of the test. Conductive sputter coating typically used to aid SEM inspection, such as C, Pt, or Au, shall not be deposited on the specimen.

#### 5.5 Preconditioning by heat treatment

##### 5.5.1 Soldering simulation prior to ambient and damp heat test (see 6.1 and 6.2)

###### a) Components intended for soldering

Before soldering simulation, the specimen of material descriptions case 1.1, case 3 or case 4 shall have been stored under room temperature for more than 30 days after the last manufacturing process, e.g. as indicated by the date code of the product.

Unless otherwise specified by the relevant specification, the components shall be submitted to a soldering simulation according to Table 1 without the use of solder and without contact to any metal surface.

**Table 1 – Methods of preconditioning – Soldering simulation**

Component type	Soldering simulation	
	First half of the sample	Second half of the sample
SMD	Reflow heat treatment according to Table 3 (Group 3) of 8.1.2.1, IEC 60068-2-58	None
Other	Bath with inert liquid <sup>1</sup> according to test Ta, method 1 of IEC 60068-2-20 Dipping depth: max. 4 mm.	None

<sup>1</sup> e.g. Perfluoropolyether PFPE.

After preconditioning the test shall be started within 168 h.

Conditions of thermal preconditioning shall be recorded.

b) Components not intended for soldering

No thermal preconditioning shall be applied.

### 5.5.2 Soldering simulation prior to temperature cycling test (see 6.3)

a) Components intended for soldering

Before soldering, the specimen of material descriptions case 1.1, case 3 or case 4 shall have been stored under room temperature for more than 30 days after the last manufacturing process, e.g. as indicated by the date code of the product.

Unless otherwise specified by the relevant specification, the components may be assembled onto printed circuit boards. The circuit board material shall be epoxide woven glass with a thickness of  $(1,6 \pm 0,2)$  mm. The assembly process shall be according to Table 2.

**Table 2 – Methods of preconditioning – Soldering**

Component type	Soldering
SMD	Hot air convection reflow soldering with SnAgCu solder <sup>1</sup> , low activity flux, according to Table 3 (Group 3) of 8.1.2.1, IEC 60068-2-58
Other	Wave soldering by use of a soldering profile according to 6.1 of IEC 61760-1, using SnAgCu solder

<sup>1</sup> Apply 50 % of the solder paste volume recommended for typical production. This requirement shall ensure that after soldering a part of the terminal surface is not covered by solder and remains for inspection.

After this preconditioning the test shall be started within 168 h.

The soldering conditions shall be recorded.

b) Components not intended for soldering

Unless otherwise described by the relevant specification, the components are tested in unassembled stage.

### 5.6 Specimen preparation by leads forming

In cases where components are subjected to mechanical stress after delivery, e.g. the forming of leads, a representative pre-conditioning is required. Unless otherwise specified by the relevant specification, each specimen shall be bent 90° to the consistent inner bending radius specified as the minimum radius in Table 1, of IEC 61192-3.

## 6 Test conditions

### 6.1 Ambient test

Unless otherwise specified by the relevant specification, apply the conditions according to Table 3 and in accordance with the severity selected from Table 6:

**Table 3 – Severities of the ambient test**

Severity	Temperature °C	Relative humidity %
A	30 ± 2	60 ± 3
B	25 ± 10	50 ± 25

Test duration: 4 000 h.

### 6.2 Damp heat test

Unless otherwise specified by the relevant specification, use the humidity chamber specified in IEC 60068-2-78 and apply the conditions stated below:

- temperature: (55 ± 3) °C
- relative humidity: (85 ± 5) %
- test duration: 2 000 h.

Apply heating, cooling, moistening, and dehumidifying in the test in a way that dew does not condensate on the specimens.

### 6.3 Temperature cycling test

Unless otherwise specified by the relevant specification, apply the procedures specified in IEC 60068-2-14, test Na with the conditions stated below:

For the lower temperature and upper temperature, one severity according to Table 4 shall be used.

**Table 4 – Severities of the temperature cycling test – Temperature**

Severity (First character)	Lower temperature °C	Upper temperature °C
K	–40 ± 5	85 ± 2
L	–55 ± 5	85 ± 2
M	–40 ± 5	125 ± 2
N	–55 ± 5	125 ± 2

NOTE Neither the sequence of listed severities nor the range between lower and upper temperature impose a specific degree of severity, see Annex H.

NOTE Severities for this test are given by two characters, e.g. KQ for –40 °C / 85 °C / 1 000 cycles. Reference to only one severity parameter can be made by using an “x” for the unspecified parameter, e.g. Kx for –40 °C / 85 °C.

Apply a minimum dwell time of 20 min for both the low and high test temperature. The transfer time between the extremes shall be less than 30 s.

For the number of test cycles, apply the conditions according to Table 5 and in accordance with the severity selected from Table 6.

**Table 5 – Severities of the temperature cycling test – Cycles**

Severity (Second character)	Number of cycles
P	2 000
Q	1 000

NOTE Severities for this test are given by two characters, e.g. KQ for  $-40\text{ }^{\circ}\text{C} / 85\text{ }^{\circ}\text{C} / 1\ 000$  cycles. Reference to only one severity parameter can be made by using an "x" for the unspecified parameter, e.g. xQ for 1 000 cycles.

## 7 Test schedule

### 7.1 Procedure for test method selection

Unless otherwise specified by the relevant specification, test methods shall be selected according to the type of plating, underlayer and base material of the component. Apply the decision matrix of Table 6 for the selection of the appropriate test methods.

**Table 6 – Suitability of test methods for different plating situations**

Case	Material description Base material, underlayer and plating	Test method and severity		
		Ambient test	Damp heat test	Temperature cycling test
		6.1	6.2	6.3
1	Base material is an alloy of only iron (Fe) and nickel (Ni) without underlayer, or underlayer is an alloy of only iron and nickel. Plating is tin (Sn) or any tin alloy, except those alloys defined in case 1.1.	NO	YES	YES Severity xP
1.1	Base material is an alloy of only iron (Fe) and nickel (Ni) without underlayer, or underlayer is alloy of only iron and nickel. Plating is a tin (Sn) alloy containing copper (Cu) or zinc (Zn) or both.	YES Severity A	YES	YES Severity xP
2	Any base material except those covered in case 1.0 or 1.1. Underlayer is nickel (Ni) or silver (Ag).	YES Severity B	YES	YES Severity xQ
3	Base material is copper (Cu) or copper alloy, no underlayer. Plating is tin (Sn) or any tin alloy.	YES Severity A	YES	YES Severity xQ
3.1	Base material is copper (Cu) or copper alloy without underlayer, or underlayer is copper or copper alloy. Plating is tin (Sn), with established inter-metallic Sn Cu compound layer (see condition A below).	YES Severity B	YES	YES Severity xQ
4	Base material or underlayer is none of the materials specified in cases 1 through 3 above.	YES Severity A	YES	YES Severity xP

Special conditions:

- A) The presence of a grown inter-metallic Sn Cu compound layer with a minimum thickness of  $0,5\ \mu\text{m}$  is presumed
- if the tin plating is deposited in a molten tin bath with a temperature of at least  $250\text{ }^{\circ}\text{C}$  and a corresponding retention period of at least  $0,5\ \text{s}$ , or
  - if the tin plating has been fused within 24 h after electroplating with a temperature of at least  $250\text{ }^{\circ}\text{C}$  and a corresponding retention period of at least  $0,5\ \text{s}$ , or

- if the tin plating has been annealed within 24 h after electroplating with a temperature of at least 150 °C for a retention period of at least 1 h.

## 7.2 Initial measurement

Inspect the appearance of specimen prepared according to Clause 5 before performing the test selected according to Table 6. Measure and record the maximum length of whiskers found on the specimen.

If a more detailed assessment is desired, unless otherwise specified by the relevant specification, whiskers shall be counted using a SEM in a square field of 250 µm × 250 µm at the densest part on the sample.

## 7.3 Test

After the initial measurement, apply the test methods recommended by the decision matrix of Table 6.

## 7.4 Recovery

At any intermediate test point, or after completion of the test, the specimen shall be stored in the standard atmospheric conditions defined in IEC 60068-1, 5.3.1 for at least 2 h. The specimen shall be handled carefully in order to prevent any whisker from falling off the surface.

In the event of whiskers falling off, record such event and continue succeeding steps.

## 7.5 Intermediate or final assessment

Perform any intermediate or the final assessment as described in 7.2.

## 8 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

Information to be given:	Subclause
a) Description of the fixing jig	4.6
b) Requirements for preparation of specimen	
– thermal preconditioning	5.4, 5.5
– lead forming	5.6
c) Severities and tolerances for ambient test	6.1
– temperature	
– humidity	
– duration	
d) Severities and tolerances for damp test	6.2
– temperature	
– humidity	
– duration	
e) Severities and tolerances for temperature cycling test	6.3
– lower and upper temperature	
– dwell time	
– transition time	