IEC 62739-3

Edition 1.0 2017-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Test method for erosion of wave soldering equipment using molten lead-free solder alloy –
Part 3: Selection guidance of erosion test methods

Méthode d'essai de l'érosion de l'équipement de brasage à la vague utilisant un alliage à braser sans plomb fondu –
Partie 3: Recommandations pour la sélection des méthodes d’essai d’érosion

IEC 62739-3:2017-01(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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

CDV	Report on voting
91/1368/CDV	91/1400/RVC

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 the parts in the IEC 62739 series, under the general title *Test method for erosion of wave soldering equipment using molten lead-free solder alloy*, 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- withdrawn,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.

TEST METHOD FOR EROSION OF WAVE SOLDERING EQUIPMENT USING MOLTEN LEAD-FREE SOLDER ALLOY –

Part 3: Selection guidance of erosion test methods

1 Scope

This part of IEC 62739 describes the selection methodology of an appropriate evaluating test method for the erosion of the metal materials without or with surface processing intended to be used for lead-free wave soldering equipment as a solder bath and other components which are in contact with the molten solder.

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 61190-1-3, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solder for electronic soldering applications*

IEC 62739-1:2013, *Test method for erosion of wave soldering equipment using molten lead-free solder alloy – Part 1: Erosion test method for metal materials without surface processing*

IEC 62739-2, *Test method for erosion of wave soldering equipment using molten lead-free solder alloy – Part 2: Erosion test method for metal materials with surface processing*

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
erosion
phenomenon where a base material is dissolved and made thinner by coming into contact with molten solder

[SOURCE: IEC 62739-1:2013, 3.1]

3.2
lead-free solder
alloy that does not contain more than 0,1 % mass fraction of lead (Pb) as its constituent and used for joining components to substrates or for coating surfaces

[SOURCE: IEC 60194:2015, 75.1904 modified – "mass fraction" is used instead of "weight" and "as its constituent" has been added]

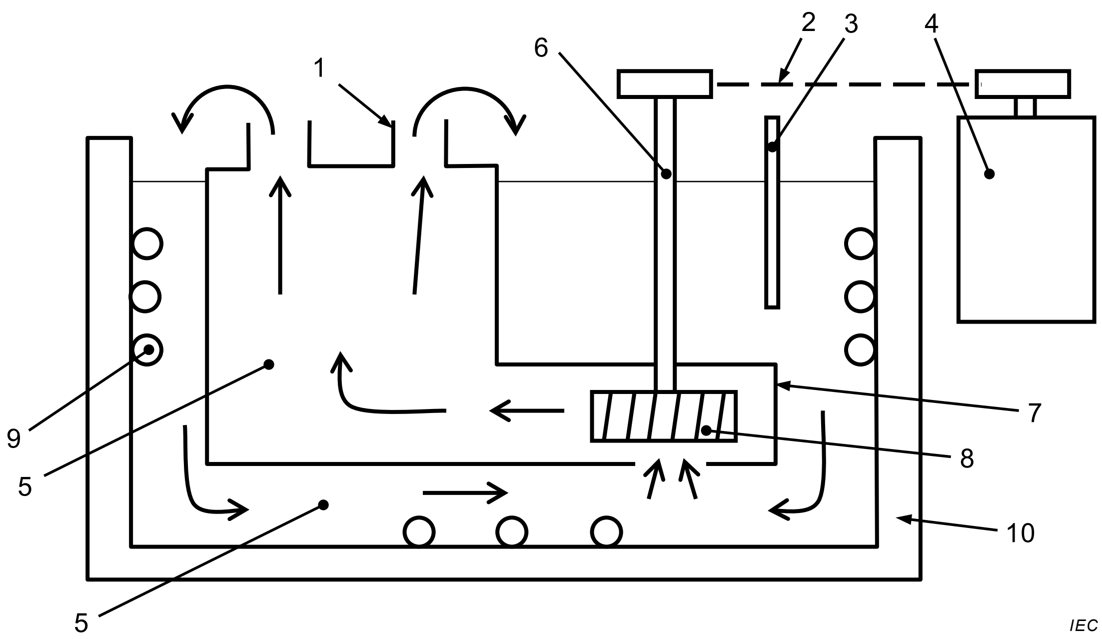
3.3
dross
oxide and other contaminants that form on the surface of molten solder

[SOURCE: IEC 60194:2015, 75.0410]

4 General remarks

Figure 1 shows a schematic example of wave soldering equipment showing a solder bath and auxiliaries which are subjected to evaluation. Table 1 shows the location of the erosion in the field, and an example of the problems. The tests specified in IEC 62739-1 and IEC 62739-2 are intended to provide an appropriate maintenance inspection cycle and replacement period of a solder bath and other metal components, by assessing the anti-erosion capability of material and other metal components, including surface processing, subjected to solder baths.

Except for the duration, test conditions such as molten solder temperature and rotation speed, specified in IEC 62739-1 and IEC 6273-2, are predetermined. Thus, the erosion occurrence durations vary depending upon the type of metal and the surface processing employed. For this reason, an adequate test duration needs to be pre-set so as to clearly identify the non-erosion which is used as the baseline of the erosion depth by the focal depth method and which is also used to discriminate the type of metal and surface processing employed by erosion depth on the specimen.



Key

1	Jet stream nozzle	6	Impeller shaft
2	Drive belt	7	Molten solder pump
3	Temperature sensor	8	Impeller
4	Motor	9	Heater
5	Molten solder	10	Solder bath

Molten solder flow directions are indicated by an arrow.

Figure 1 – Schematic example of wave soldering equipment

Table 1 – Location of erosion in the field and examples of problems

Location of erosion in the field	Example of problems
Solder bath inner wall	Hole, molten solder leaking
Impeller shaft	Thinning, impeller shaft breaking
Molten solder pump components such as impeller	Soldering defects due to molten solder jet stream disturbance
Jet stream nozzle	Soldering defects due to molten solder jet stream disturbance
Temperature sensor tube	Hole, unintentional molten solder temperature, insulation failure
Throw-in heater	Hole insulation failure, electricity leak

5 Selection of the appropriate erosion test method

5.1 Correlation between test methods and stresses induced in the field

Table 2 shows the correlation between test methods and stresses induced in the field, indicating the applicable material.

Table 2 – Correlation between test methods and stresses induced in the field

Test method (Applicable standard)	Accelerated stress conditions	Applicable material	Stress induced in the field
Rotation test at 350 °C [a] (IEC 62739-1)	High temperature (350 °C) Molten lead-free solder flow Flux application	Metal material without surface processing	Assuming encroach due to solid metal fusion by high temperature molten lead-free solder. Assuming encroach due to chemical erosion by flux.
Rotation test at 450 °C [b] (IEC 62739-2)	High temperature (450 °C) Molten lead-free solder flow	Metal material with surface processing	Assuming encroach due to solid metal fusion by high temperature molten lead-free solder.
Rotation test at 450 °C with 2 mm bending [c] (IEC 62739-2)	High temperature (450 °C) Molten lead-free solder flow Bent stress (2 mm)	Metal material with surface processing	Assuming encroach due to solid metal fusion by high temperature molten lead-free solder. Assuming encroach acceleration by bending stress on the metal surface with surface processing.

[a] This test method is conducted at a suitable temperature for metal material without surface processing to produce appropriate erosion depth measurements. However, a sufficient test duration for each metal material shall be predefined. For metal material with surface processing, erosion occurrence duration becomes too long. Thus, this test method is not applicable for metal material with surface processing.

[b] This test method is conducted at a suitable temperature for metal material with surface processing to enable an appropriate erosion depth measurement. However, a sufficient test duration for each surface processing shall be predefined. For metal material without surface processing, erosion progresses so fast that a non-erosion area which is used for the baseline of the erosion depth cannot be obtained. Thus, this test method is not applicable for metal material without surface processing.

[c] This test method is suitable for metal material with surface processing when the rotation test at 450 °C takes too long and additional acceleration is required. However, a sufficient test duration for each surface processing shall be predefined. For metal material without surface processing, erosion progresses so fast that a non-erosion area which is used for the baseline of the erosion depth cannot be obtained. Thus, this test method is not applicable for metal material without surface processing.

5.2 Recommended test method by materials

Table 3 shows an appropriate test method depending on the material used with respect to solder baths and auxiliaries.

Table 3 – Applicable test method depending on the materials

Metal materials and surface processing		Applicable acceleration test method		
Metal material	**Surface processing**	**Rotation test at 350 °C**	**Rotation test at 450 °C**	**Rotation test at 450 °C with 2 mm bending**
SUS304	None	A	B	B
SUS316	None	A	B	B
Titan	None	A	B	B
Cast iron	None	A	B	B
SUS304, SUS316	Surface diffusion type	B	A	A
SUS304, SUS316	Coating type	B	A	A

“A” denotes recommended. “B” denotes not applicable.

Surface processing is classified as surface diffusion type which is forming a surface process layer by diffusing nitrogen (for example) into material and coating type which is forming a coating layer on the surface of the mater material. Examples of each type are given below.

a) Surface diffusion type: nitrogen supersaturated solid solution diffusion treatment, diffusion penetration nitriding, gas nitriding, nitrocarburizing, plasma nitriding

b) Coating type: fine ceramic coating by chemical densified process, CrN coating by a Physical Vapor Deposition (PVD) method, and alumina coating by thermal spray.

NOTE The erosion mechanism of the test is explained in Annex C.

6 Common items for each test method

6.1 Specimen preparation

The specimens shall be prepared as indicated below.

a) Basically, specimen shaping shall be carried out by punching, using a press machine. However, for high hardness materials such as titan and cast iron which are not suitable for punching, shaving shall be used.

b) Specimen edge burrs, etc., which are produced during specimen shaping and may cause erosion, shall be removed by chamfering and such;

c) if necessary, surface processing shall be done after processes a) and b).

d) Care shall be taken to handle the specimen after fabrication, so as not to contaminate the specimen by oil, or other contaminants, since this could affect the test result.

6.2 Solder alloy

Unless otherwise specified, Sn96,5Ag3Cu,5 solder alloy specified in IEC 61190-1-3 shall be used. If Sn purity is too high, erosion occurs after a short time and inaccurate results may be the consequence.

6.3 Accelerated stress conditions

6.3.1 Test temperature

The test temperature is specified as 350 °C ± 3 °C in IEC 62739-1 and 450 °C ± 3 °C in IEC 62739-2. These test temperatures are determined so as to clearly identify the non-erosion area which is used for the baseline of the erosion depth by the focal depth method and to differentiate metal material and surface processing employed by erosion the depth on the specimen. A sufficient test duration for metal material shall be pre-set, suitable for each metal material and surface processing (see Annex A).

NOTE The thermal acceleration factor for erosion is explained in Annex D.

6.3.2 Rotation speed

The speed difference between molten solder alloy and the specimen by rotating the specimen is assuming the molten solder flow speed in the wave soldering equipment. A rotation speed of 100 r/min ± 3 r/min is specified for all test methods. If the rotation speed is slower than the specified value, then the molten solder flow speed is lower than the speed in the actual production process. Thus, this condition is not recognized as an acceleration factor of the molten solder flow speed in the actual production process. If the rotation speed is higher than the specified value, then the molten solder begins to rotate and the relative speed difference between the molten solder and the specimen becomes minimal. This condition is also not recognized as an acceleration factor of the molten solder flow speed in the actual production process.

NOTE An example of a test result is shown in Figure A.3.

6.3.3 Bending stress to the specimen

If it takes too long during the rotation test at 450 °C, further acceleration is needed. During the rotation test at 450 °C with 2 mm bending specified in IEC 62739-2, the specimen is subjected to bending stress as additional acceleration. 1 mm bending stress is not enough to accelerate occurrence of erosion (see Clause A.2). Bending stress exceeding 2 mm gives permanent deformation of the specimen, thus the erosion depth measurement by the focal depth method becomes difficult.

6.4 Dross

6.4.1 Dross generation and removal interval

The higher the test temperature and the higher the rotation speed, the more dross is generated due to the promoted oxidation of molten solder. Compared to the amount of dross produced by the rotation test at 350 °C the rotation test at 450 °C, generates more dross. However, by removing dross every 16 h, both tests can be run without problems such as firing and overflowing.

To reduce dross, nitrogen gas atmosphere is advantageous. However, the equipment configuration such as oxygen partial pressure adjustment can be complicated. The test can be conducted with periodic dross removal as mentioned above, thus this is not recommended.

6.4.2 Dross removal method

Dross removal shall be carried out after the motor has been switched off, by using an appropriate tool (for example, a stainless steel ladle with many holes, as shown in Figure 2). The safety of the operator shall be ensured, by protective measures such as heat-resistant gloves, a face mask and dust-proof glasses to protect him/her from high temperatures and metal dust in the air. The removed dross should be put into sealable containers to minimize the splashing of metal dust from the removed dross.

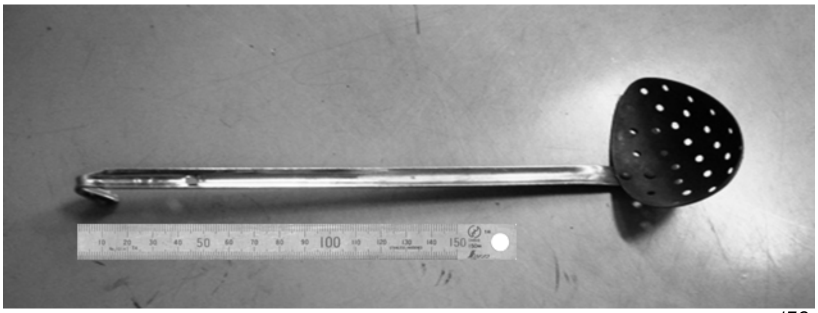


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Figure 2 – Example of dross removal tool

6.4.3 Molten solder volume after dross removal

After dross removal, to ensure that the specified dipping depth is met, check the volume of the molten solder in the solder pot. If the volume of the molten solder is short, solder alloy shall be added accordingly.

6.5 Erosion depth measurement method

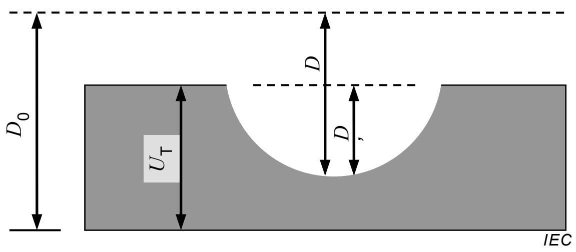
6.5.1 Post test treatment

If solder adheres, before the measurement, heat the specimen and wipe it off, or clean it using acid, for example, using diluted hydrochloric acid (5 %) for 10 min at 20 °C.

6.5.2 Local erosion depth

6.5.2.1 Erosion depth definition

A general definition of erosion depth for a crater like shape is defined as $D = (D_0 - U_T) + D'$ as shown in Figure 3.



Key

D True erosion depth

D_0 Specimen thickness before test

U_T Specimen thickness after test

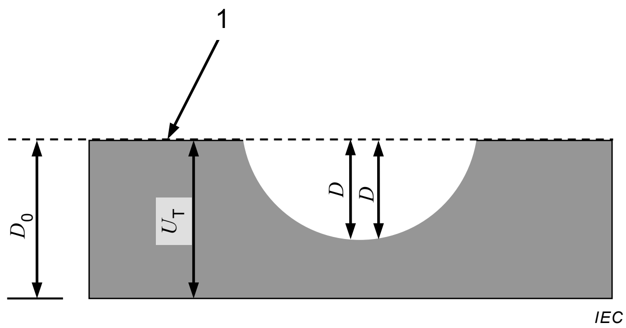
D' Calculated erosion depth

Figure 3 – Schematic general definition of erosion depth

6.5.2.2 Erosion depth measurement using the focal depth method

In the test methods specified in IEC 62739-1 and IEC 62739-2, the specimen is relatively small, and it is difficult to measure it, by using the depth gauge and thus the optical method is used. There are also various optical methods (see Annex B), among these, the focal depth method using an optical microscope. These microscopes are relatively inexpensive.

The erosion depth measurement using the focal depth method is based on the assumption that the specimen thickness after the test remains unchanged, and that a non-erosion area can be observed on the same observation screen. As shown in Figure 4, D_0 is equal to U_T and D is equal to D'.



Key

1 Base plane for erosion depth easement (0 position)

D True erosion depth

D_0 Specimen thickness before test

U_T Specimen thickness after test

D' Calculated erosion depth

Figure 4 – Schematic definition of erosion depth by focal depth method

6.5.2.3 Presentation of erosion depth by the focal depth method

If precise measurement is required, measure the specimen thickness before and after the test and calculate the erosion depth according to the definition of Figure 3. In case the specimen thickness remains same before and after the test, the measured value of D' may be used as erosion depth according to the definition of Figure 4. Figure 5 shows typical examples of local erosion.

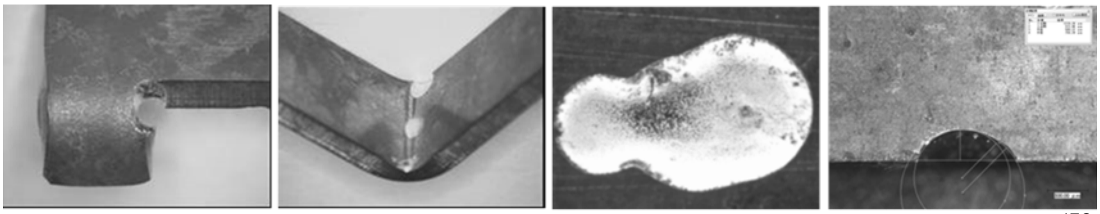
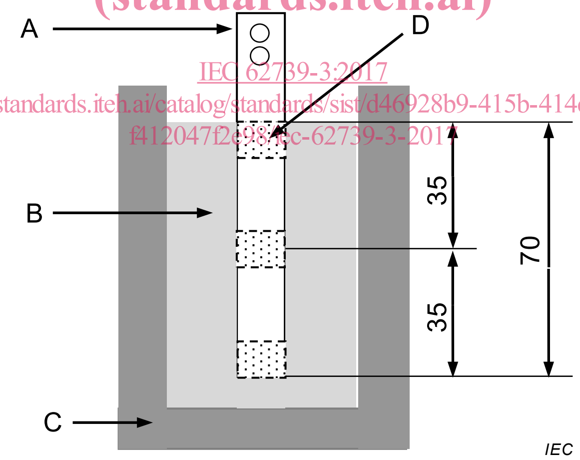


Figure 5 – Examples of local erosion

6.5.2.4 Evaluation region

The erosion state depends on the immersion position of the specimen into the solder pot. Thus 5 points for each 3 regions, as shown in Figure 6, shall be measured and statistically analysed. For comparative evaluation, the maximum (the deepest) value may be used as the representative value.

Dimensions in millimetres



Key

A Specimen

B Molten solder

C Solder pot

D Evaluation region (If erosion occurs other than in the designated region, such region may be added for evaluation.)

Figure 6 – Example of evaluation region

6.5.3 General (uniform) erosion depth

6.5.3.1 Presence of non-erosion area

In the case where any non-erosion area exists on the same observation screen as shown in Figure 7, the erosion depth can be measured by the focal depth method in 6.5.2.