BS EN 62739-1:2013

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN 62739-1:2013. It is identical to IEC 62739-1:2013.

BSI, as a member of CENELEC, is obliged to publish EN 62739-1:2013 as a British Standard. However, attention is drawn to the fact that the UK committee has voted against its approval as a European Standard.

The UK committee advises that it is current European practice for suppliers of lead-free wave soldering equipment to perform the relevant tests to demonstrate fitness of purpose.

The UK participation in its preparation was entrusted to Technical Committee EPL/501, Electronic assembly technology & Printed Electronics.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EUROPEAN STANDARD

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English version

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 62739-1:2013)

Méthode d'essai de l'érosion de l'équipement de brasage à la vague utilisant un alliage à braser sans plomb fondu -
Partie 1: Méthode d'essai d'érosion des matériaux métalliques sans traitement de surface
(CEI 62739-1:2013)

Verfahren zur Erosionsprüfung für Wellenlötausrüstungen bei Verwendung von geschmolzener, bleifreier Lotlegierung -
Teil 1: Erosionsprüfverfahren für metallische Werkstoffe ohne Oberflächenbehandlung
(IEC 62739-1:2013)

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Foreword

The text of document 91/1092/FDIS, future edition 1 of IEC 62739-1, prepared by IEC TC 91 "Electronics assembly technology" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62739-1:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-04-23
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-07-23

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The text of the International Standard IEC 62739-1:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60194:2006 NOTE Harmonized as EN 60194:2006.

Annex ZA
(normative)
Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 61190-1-3		Attachment materials for electronic assembly - Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications	EN 61190-1-3	

CONTENTS

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

1 Scope

This part of the IEC 62739 series provides an evaluating test method for the erosion of the metallic materials without 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 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*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
erosion
phenomenon where a base material is dissolved and made thinner by coming into contact with molten solder

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

[SOURCE: IEC 60194:2006, 75.1904 modified — "mass fraction" is used instead of "weight"]

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

[SOURCE: IEC 60194:2006, 75.0410]

4 Test

4.1 Overview

The specimen is mounted to the rotation block of the test equipment which is driven by the motor (may include gear unit) then immersed into molten lead-free solder and rotated to simulate solder flow in the wave soldering equipment. The erosion depth is measured after the block is rotated for a designated period of time.

4.2 Test equipment

4.2.1 Test equipment description

Test equipment shall include equipment that realises the test conditions specified in 4.3.

Component materials of the test equipment which come in contact with molten solder shall be erosion resistant or processed to be erosion resistant.

Details of the specifications of the equipment are given in Annex A.

4.2.2 Configuration example of test equipment

An example of the configuration of the test equipment is shown in Figure 1.

The test equipment consists of a pot unit, rotation unit, and control unit.

a) The pot unit consists of a heater to melt the lead-free solder alloy and a pot in which a specimen can rotate.
b) The rotation unit consists of a motor which rotates the specimen and a rotation block to which the specimen is attached.
c) The control unit has functions to control the heater, using a temperature sensor, control mechanism and motor rotation.

Since dross spreads during the test, it is preferable for the test equipment to have a ventilatory function with an exhaust air duct.

Other test equipment can be used if its configuration and functions meet the above requirements.

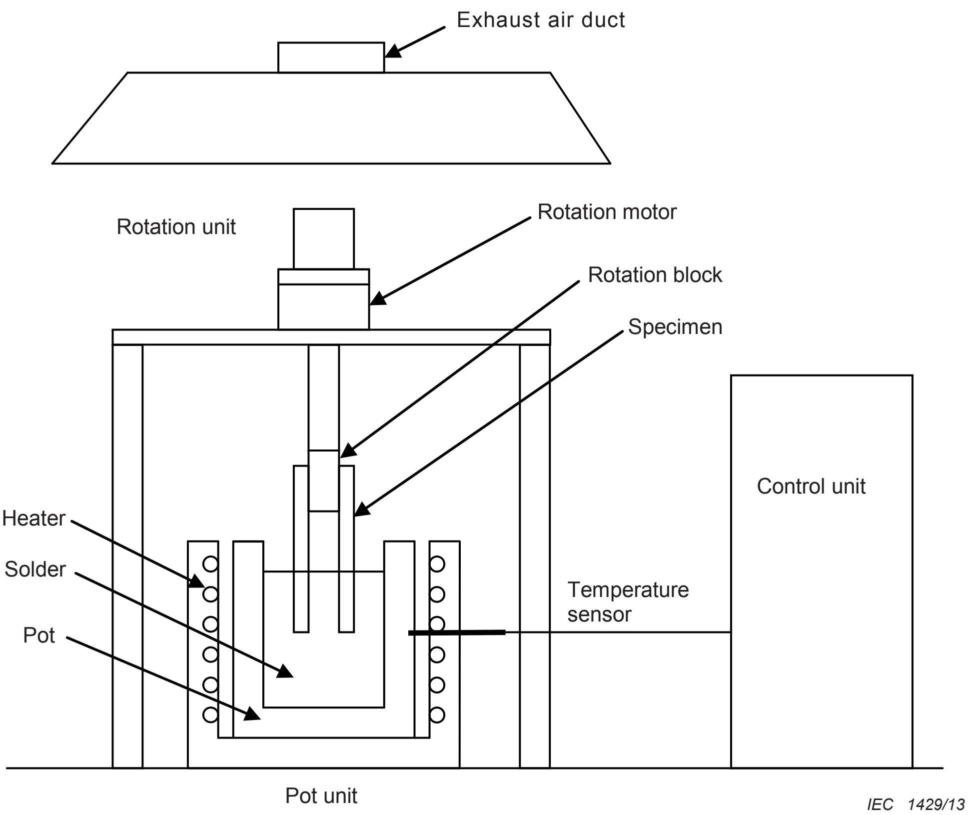


Figure 1 – Configuration example of test equipment

4.3 Specimen

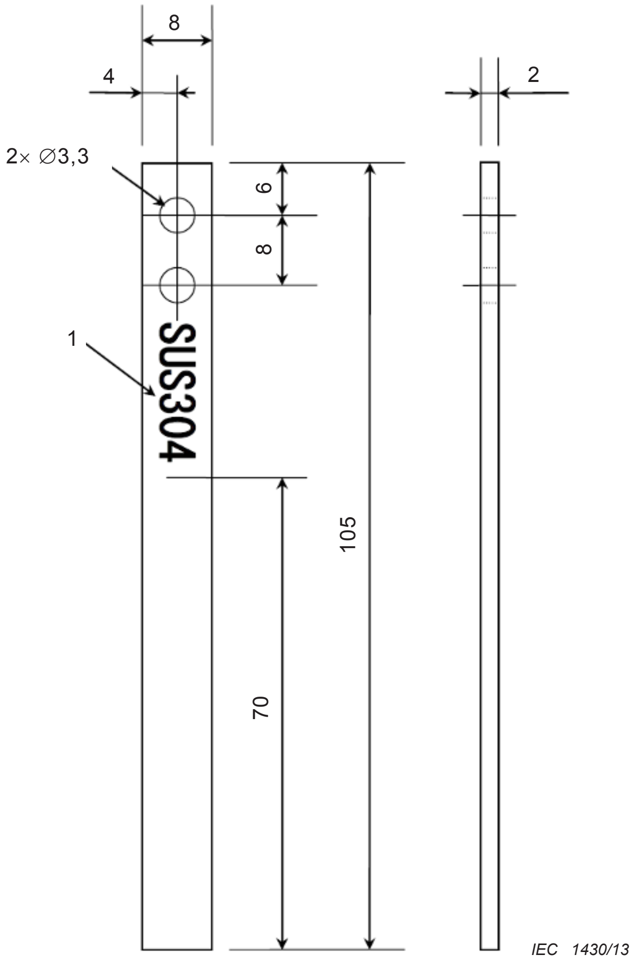
A specimen of the following material and shape is used.

a) The material of the specimen shall be the same as that of the solder bath and its components which come into contact with the molten solder.

b) The shape of specimen and the indication of the material designation shall be as shown in Figure 2. The indication of the material designation shall be engraved.

c) The surfaces of the specimen to be evaluated shall be the surface with material indication (face A) and its backside (face B), and from the lower edge to 50 mm above it.

Dimensions in millimetres



Key

1 Laser engraved mark

Figure 2 – Shape of the specimen

4.4 Test conditions

Test materials and test conditions are shown in Table 1.

Table 1 – Test conditions

Composition of test solder alloy	Sn96,5Ag3Cu,5 specified in IEC 61190-1-3 shall be used if not otherwise specified in individual standards.
Test flux	Rosin flux with halide content of 0,2 % mass fraction shall be used. Materials specified in Annex B of IEC 60068-2-20:2008, shall be used.
Solder temperature (at measurement position)	350 °C ± 3 °C (the temperature is measured at a depth of 35 mm to 40 mm from the solder surface and at a distance of 20 mm to 30 mm from the specimen.).
Rotation speed of specimen	100 r/min ± 3 r/min
Rotation radius of specimen	6 mm to 8 mm (from the centre of the rotation block to the outer edge of the specimen)
Dipping depth of specimen	65 mm to 70 mm (from molten solder surface to the lower edge of the specimen)
Test duration	A suitable test time needs to be set up in advance[a].
Frequency of removal of dross	A minimum of once every 16 h
[a] Erosion generating time is different by specimen materials. The proper test duration at which the erosion depth difference by material can be distinguished while the uneroded area which is used as the base of the erosion depth measurement clearly remains, should be set up before performing the test. In case of stainless steel (SUS316, SUS304 grade), 192 h correspond to it.	

4.5 Test method

4.5.1 Test procedure

The test is conducted following the steps outlined below.

a) Clean the surface of the specimen with gauze or a paper towel.

b) Dip the cleaned specimen in a cleansing solution of, for example, ethanol for several seconds and wipe the surface of the specimen with a new gauze or paper towel.

c) Repeat steps a) and b) twice.

d) Dip the cleaned specimen for several seconds in the test flux specified in 4.3 within 1 h of completing step c).

e) After dipping the specimen, remove it from the test flux. Apply a paper towel to the bottom of the specimen to remove excess flux from the specimen.

f) Suspend the specimen in the air for 5 min to10 min to dry it.

g) The erosion test needs to be commenced within 1 h of completing step c). Therefore, after being cleaned as per step e) and dipped in the test flux and dried as in step f), the specimen shall be attached again to the rotation block with face B touching the block, without contacting the molten solder.

h) Remove the dross floating on the molten solder in the pot following the dross removal procedure specified in 4.5.2. Dip the specimen attached to the rotation block into the molten solder maintained at the specified temperature. The specimen should be dipped in the molten solder to the depth specified in 4.4 and rotated by the rotation motor at the rotation speed specified in 4.4. After the rotation is complete, commence measuring the elapsed time of the test.

i) Remove the specimen from the molten solder within 2 h after the test duration reaches to a specified value, and wipe off the solder completely from the specimen with a waste cloth.

j) The dross floating on the molten solder in the pot is removed at the frequency specified in 4.4.

k) After the test duration specified in 4.4 passes, measure the depth of the erosion by the method specified in Clause 5.

l) Do not remove the specimen from the molten solder until the elapsed time of the test reaches the rated value, which includes the time for removing the dross and the equipment down time during the nights.

4.5.2 Dross removal procedure

The dross floating on the molten solder in the pot is removed following the steps outlined below.

a) Stop the rotation motor and use an appropriate jig (like a stainless steel ladle with many holes) to remove the dross floating on the molten solder in the pot. Put the dross in a sealed container.

b) Check the volume of the molten solder in the pot (to ensure the dipping depth as specified in 4.4 is maintained). If the volume does not meet the specified requirements, supply additional solder accordingly.

c) Dip the specimen into the molten solder, which is now free from dross, to the depth specified in 4.4. Continue the test specified in 4.5.1.

5 Method of erosion depth measurement (focal depth method with optical microscope)

5.1 General

After the test, the depth of the erosion of the specimen is measured following the steps outlined below.

5.2 Preparation of the specimen

The specimen is prepared following the steps outlined below.

a) After the test has been conducted for the test duration specified in 4.4, continue dipping the specimen in the molten solder until the rotation stops. Remove the specimen from the solder when the rotation stops.

b) Remove the specimen by picking it up from the molten solder and detaching it from the rotation block.

c) Dip each specimen again into the molten solder, heat it, and remove it from the solder. Wipe the surface of the specimen to be evaluated immediately with a cotton cloth to remove the solder.

If the solder has not been removed completely, repeat step c) until all solder has been removed.

5.3 Measurement equipment

The measurement equipment shall consist of an optical microscope, digital micrometre, CCD camera, and TV monitor and be able to measure focal depth. An example of the measurement equipment is shown in Figure 3.

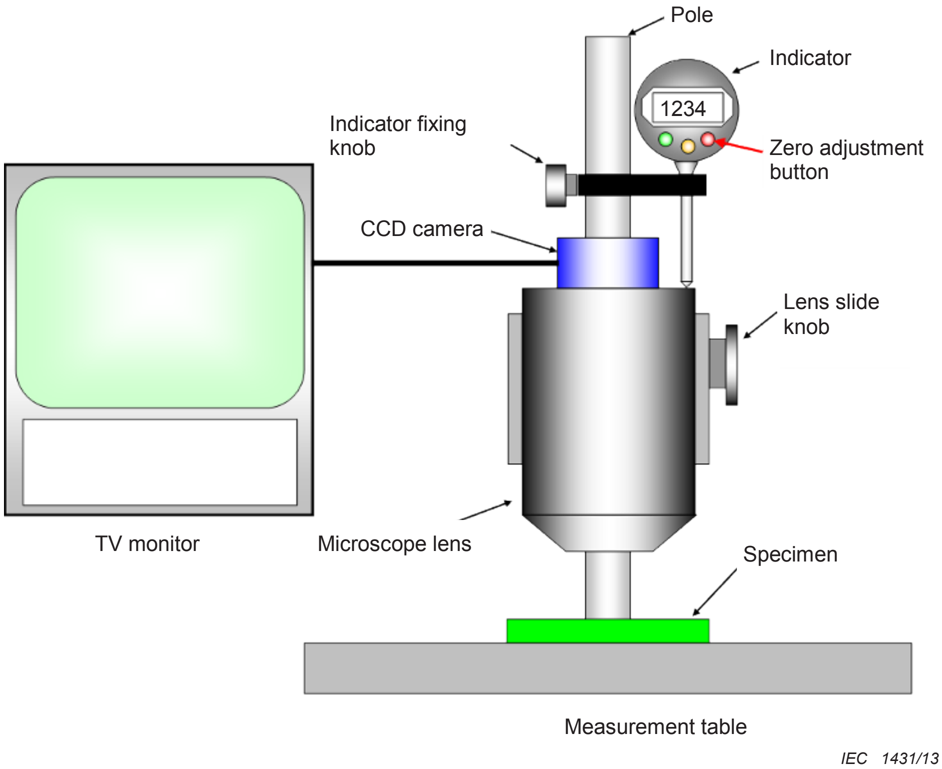


Figure 3 – Example of measurement equipment configuration for the focal depth method using an optical microscope

5.4 Measurement procedure

The specimen is measured following the steps outlined below.

a) Prepare the measurement equipment specified in 5.2. (If the equipment includes no CCD camera, specimens shall be observed using normal or corrected vision.)

b) Visually observe faces A and B specified in 4.3 to find the seemingly deepest erosion area in advance (more than 3 areas on each face).

c) Place the specimen on the measurement equipment and find the deepest erosion area by multiplying the magnification of the microscope to its maximum setting. (The magnification ratio is preferably 200 or higher.)

d) After identifying the deepest erosion area, focus the microscope's lens on an uneroded area within the view angle by rotating the lens slide knob.

e) Press the zero setting button of the digital indicator to reset the indicated value to zero.

f) Then, rotate the lens slide knob of the microscope to focus on the deepest erosion area.

g) Read and record the value indicated on the digital indicator.

h) It is preferable to take a photograph of the erosion area if possible.

i) The position where the erosion seems to be the deepest is measured at three places or more on each face and the maximum value is adopted as erosion depth. To exclude the influence of the erosion generated by dross, the evaluation area is limited to 50 mm from the lower edge of the specimen. It is premised that the specified dipping depth is 65 mm to 70 mm.

   If maximum erosion depth estimation is needed, the extreme value statistical analysis in Annex B should be used.

6 Items to be recorded in test report

In the test report, each of the following items shall be included even if the descriptions in Table 1 are satisfied:

a) date and time of the measurement;

b) test and measuring equipment manufacturer and equipment number;

c) specimen:

   1) material and number;

   2) thermal refining;

   3) processing conducted (e.g. cutting, grinding);

   4) surface condition;

d) solder material;

e) test conditions:

   1) temperature of molten solder;

   2) rotation speed;

f) presence/absence of erosion, depth of erosion;

g) condition of erosion (details of the erosion’s condition; photographs that indicate the location of the erosion).

Annex A
(normative)

Specifications of test equipment & measurement equipment

A.1 Overview

This annex provides specifications of the test equipment mentioned in 4.2.and measurement equipment mentioned in 5.3.

A.2 Characteristics of the test equipment

A.2.1 General

The test equipment of this standard shall consist of a pot unit, rotation unit, and control unit, each of which has the following characteristics.

A.2.2 Pot unit

a) The pot should be large enough to contain more than 5 kg of solder so that the specimen can rotate inside of it and not to block the rotation of the specimen specified in 4.4.
b) The pot should be deep enough to dip the specimen to the specified depth.
c) If a steel pot is used, the pot surface should be processed to prevent erosion. No particular specification is given to the surface processing.
d) The heater should be capable of melting the solder and heating the molten solder up to 400 °C.
e) If the heater needs to be dipped in the molten solder, the heater surface should be processed to prevent erosion.

A.2.3 Rotation unit

a) The rotation unit has a motor that rotates the specimen.
b) The shaft of the rotation motor is provided with a rotation block to hold the specimen.
c) The specimen attached to the rotation block rotates in the solder at the depth specified in 4.4.

A.2.4 Control unit

a) The control unit has a temperature sensor and uses a temperature adjuster to control the heater. The unit is capable of maintaining the temperature of the molten solder at 350 °C ± 3 °C.
b) If the temperature sensor needs to be dipped in the molten solder to the depth specified in 4.4, it is preferable that the sensor is surface processed.
c) The motor shall be controlled at a rotation speed of 100 r/min ± 3 r/min as specified in 4.4.
d) It is preferable that the elapsed time of the test specified in 4.4 can be automatically recorded.
e) For safety reasons, it is preferable that the equipment has an interlock or other functions to prevent overheating of the solder.

A.2.5 Ventilation

Since the specimen is rotated during the test, the dross and hot air would diffuse in the surrounding air. It is therefore preferable that the test equipment has an exhaust air duct for ventilation. The ventilation rate does not need to be specified if it does not affect the solder temperature.

A.3 Accuracy of the measurement equipment

A.3.1 General

The measurement equipment of this standard shall consist of an optical microscope, digital indicator, CCD camera, TV monitor, and possess the following measurement accuracy.

A.3.2 Measurement accuracy

Measurement accuracy = depth of field + accuracy of digital indicator

a) Example of 100 times: 382 + 30 = 412 μm or less.

b) Example of 300 times: 38 + 30 = 68 μm or less.

c) Example of 600 times: 17 + 30 = 47 μm or less.

Annex B
(informative)

Method of estimation of maximum erosion depth by extreme value statistical analysis

B.1 Overview

This annex describes a method of estimating the maximum erosion depth by extreme value statistical analysis mentioned in Clause 5 of this document.

B.2 Estimation method

B.2.1 Extreme value statistical analysis

Define N, measurement sections of the same condition on the specimen as shown in Figure B.1. The maximum erosion depth in each section is measured experimentally and the most probable maximum erosion depth of the specimen is estimated by using Gumbel **distribution.**

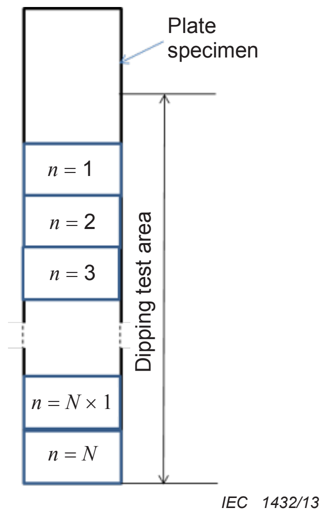


Figure B.1 – Example of section division of plate specimen

B.3 Estimation procedure

B.3.1 General

The measurement data is processed following the steps outlined below to conduct extreme value statistical analysis.

B.3.2 Preparation of specimen

Use the specimen that has undergone the erosion test, and define erosion depth measurement sections on the specimen. The measurement sections shall be those which have undergone the test under the same conditions. Although the number of the sections is not necessarily specified as long as the obtained data give a linear curve on a probability paper, it is preferably eight or more.

B.3.3 Measurement of erosion depth

The measurement of the erosion depth is not explicitly specified herein. To obtain accurate data, however, it is preferable to perform acid pickling to remove the solder and X-ray CT scanning to measure the depth.

As for the measurement precision of the measurement equipment, the tolerance shall be ± 5 μm from actual erosion depth.

B.3.4 Data arranging method

Data arrangement is carried out following the steps outlined below.

a) Define a Gumbel distribution.

The Gumbel's maximum value distribution $F(x)$ is obtained by Equation (B.1).

$$F(x) = \exp[-\exp\{-(x-\lambda)/\alpha\}] \tag{B.1}$$

where x is the maximum erosion depth in the section;
λ is the position parameter;
α is the scale parameter.

b) Define y of Gumbel probability paper.

y is the standardization variable of the double exponential distribution (Gumbel distribution) and is given by Equation (B.2) if combined with Equation (B.1). In this case, y presents the vertical axis of the probability paper.

$$y = -\ln\{-\ln F(x)\} = (1/\alpha)\, x - (\lambda/\alpha) \tag{B.2}$$

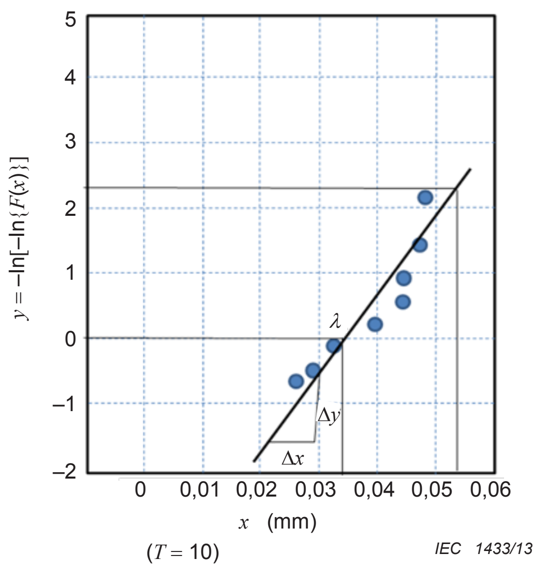
c) If plotted on a Gumbel probability paper (with the vertical axis y and the horizontal axis x), the data give a straight line as shown in Figure B.2. x is λ when $y = 0$. $1/\alpha$ is given by the slope of the line $\Delta y / \Delta x$.

d) How to obtain the maximum erosion depth.

The return period T is defined by dividing the total area by the area of the sample section. Here, the maximum value of x, x_{max}, can be obtained from Equation (B.3) as a function of T, λ, and α.

$$x_{max} \lambda + \alpha \ln\{-\ln(1-1/T)\} \approx \lambda + \alpha \ln T \tag{B.3}$$

The maximum erosion depth can be finally estimated following this procedure.



Key

y standardization variable

x erosion depth

F(*x*) cumulative distribution

Figure B.2 – Estimated maximum erosion depth for N = 8

Bibliography

IEC 60194:2006, *Printed board design, manufacture and assembly – Terms and definitions*

ISO 16143-1:2004, *Stainless steels for general purposes – Part 1: Flat products*

ISO 16143-2:2004, *Stainless steels for general purposes – Part 2: Semi-finished products, bars, rods and sections*

ISO 16143-3:2005, *Stainless steels for general purposes – Part 3: Wire*

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