IEC 61189-5-2

Edition 1.0 2015-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-2: General test methods for materials and assemblies – Soldering flux for printed board assemblies

Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles – Partie 5-2: Méthodes d'essai générales pour les matériaux et les assemblages – Flux de brasage pour les assemblages de cartes imprimées

IEC 61189-5-2:2015-01(en-fr)

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FOREWORD

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International Standard IEC 61189-5-2 has been prepared by IEC technical committee 91: Electronics assembly technology.

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

FDIS	Report on voting
91/1210/FDIS	91/1223/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.

This International Standard is used in conjunction with IEC 61189-1:1997, IEC 61189-2:2006, IEC 61189-3:2007.

A list of all parts in the IEC 61189 series, published under the general title *Test methods for electrical materials, printed boards and other interconnection structures and assemblies*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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.

INTRODUCTION

IEC 61189 relates to test methods for materials or component robustness for printed board assemblies, irrespective of their method of manufacture.

The standard is divided into separate parts, covering information for the designer and the test methodology engineer or technician. Each part has a specific focus; methods are grouped according to their application and numbered sequentially as they are developed and released.

In some instances test methods developed by other TCs (for example, TC 104) have been reproduced from existing IEC standards in order to provide the reader with a comprehensive set of test methods. When this situation occurs, it will be noted on the specific test method; if the test method is reproduced with minor revisions, those paragraphs that are different are identified.

This part of IEC 61189 contains test methods for evaluating robustness of materials or component for printed board assemblies. The methods are self-contained, with sufficient detail and description so as to achieve uniformity and reproducibility in the procedures and test methodologies.

The tests shown in this standard are grouped according to the following principles:

P: preparation/conditioning methods
V: visual test methods
D: dimensional test methods
C: chemical test methods
M: mechanical test methods
E: electrical test methods
N: environmental test methods
X: miscellaneous test methods

To facilitate reference to the tests, to retain consistency of presentation, and to provide for future expansion, each test is identified by a number (assigned sequentially) added to the prefix (group code) letter showing the group to which the test method belongs.

The test method numbers have no significance with respect to an eventual test sequence; that responsibility rests with the relevant specification that calls for the method being performed. The relevant specification, in most instances, also describes pass/fail criteria.

The letter and number combinations are for reference purposes to be used by the relevant specification. Thus "5-2C01" represents the first chemical test method described in IEC 61189-5-2.

In short, in this example, 5-2 is the number of the part of IEC 61189, C is the group of methods, and 01 is the test number.

TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARDS AND OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –

Part 5-2: General test methods for materials and assemblies – Soldering flux for printed board assemblies

1 Scope

This part of IEC 61189 is a catalogue of test methods representing methodologies and procedures that can be applied to test printed board assemblies.

This part of IEC 61189 focuses on test methods for soldering flux based on the existing IEC 61189-5 and IEC 61189-6. In addition, it includes test methods of soldering flux for lead free soldering.

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 61189-5, *Test methods for electrical materials, interconnection structures and assemblies – Part 5: Test methods for printed board assemblies*

IEC 61189-6, *Test methods for electrical materials, interconnection structures and assemblies – Part 6: Test methods for materials used in manufacturing electronic assemblies*

IEC 61190-1-1, *Attachment materials for electronic assembly – Part 1-1: Requirements for soldering fluxes for high-quality interconnections in electronics assembly*

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*

ISO 9455 (all parts), *Soft soldering fluxes – Test methods*

ISO 9455-1, *Soft soldering fluxes – Test methods – Part 1: Determination of non-volatile matter, gravimetric method*

ISO 9455-2, *Soft soldering fluxes –Test methods – Part 2: Determination of non-volatile matter, ebulliometric method*

3 Accuracy, precision and resolution

3.1 General

Errors and uncertainties are inherent in all measurement processes. The information given below enables valid estimates of the amount of error and uncertainty to be taken into account.

Test data serve a number of purposes which include

– monitoring of a process;
– enhancing of confidence in quality conformance;
– arbitration between customer and supplier.

In any of these circumstances, it is essential that confidence can be placed upon the test data in terms of

– accuracy: calibration of the test instruments and/or system;
– precision: the repeatability and uncertainty of the measurement;
– resolution: the suitability of the test instrument and/or system.

3.2 Accuracy

The regime by which routine calibration of the test equipment is undertaken shall be clearly stated in the quality documentation of the supplier or agency conducting the test and should meet the requirements of ISO 9001.

The calibration shall be conducted by an agency having accreditation to a national or international measurement standard institute. There should be an uninterrupted chain of calibration to a national or international standard.

Where calibration to a national or international standard is not possible, round-robin techniques may be used and documented to enhance confidence in measurement accuracy.

The calibration interval shall normally be one year. Equipment consistently found to be outside acceptable limits of accuracy shall be subject to shortened calibration intervals. Equipment consistently found to be well within acceptable limits may be subject to relaxed calibration intervals.

A record of the calibration and maintenance history shall be maintained for each instrument. These records should state the uncertainty of the calibration technique (in ± % deviation) in order that uncertainties of measurement can be aggregated and determined.

A procedure shall be implemented to resolve any situation where an instrument is found to be outside calibration limits.

3.3 Precision

The uncertainty budget of any measurement technique is made up of both systematic and random uncertainties. All estimates shall be based upon a single confidence level, the minimum being 95 %.

Systematic uncertainties are usually the predominant contributor and will include all uncertainties not subject to random fluctuation. These include

– calibration uncertainties;
– errors due to the use of an instrument under conditions which differ from those under which it was calibrated;
– errors in the graduation of a scale of an analogue meter (scale shape error).

Random uncertainties result from numerous sources but can be deduced from repeated measurement of a standard item. Therefore, it is not necessary to isolate the individual contributions. These may include

– random fluctuations such as those due to the variation of an influence parameter. Typically, changes in atmospheric conditions reduce the repeatability of a measurement;

– uncertainty in discrimination, such as setting a pointer to a fiducial mark or interpolating between graduations on an analogue scale.

Aggregation of uncertainties: Geometric addition (root-sum-square) of uncertainties may be used in most cases. Interpolation error is normally added separately and may be accepted as being 20 % of the difference between the finest graduations of the scale of the instrument.

$$U_{\mathrm{t}} = \pm\sqrt{(U_{\mathrm{s}}^2 + U_{\mathrm{r}}^2)} + U_{\mathrm{i}}$$

where

U_{t} is the total uncertainty;

U_{s} is the systematic uncertainty;

U_{r} is the random uncertainty;

U_{i} is the interpolation error.

Determination of random uncertainties: Random uncertainty can be determined by repeated measurement of a parameter and subsequent statistical manipulation of the measured data. The technique assumes that the data exhibits a normal (Gaussian) distribution.

$$U_{\mathrm{r}} = \frac{t \times \sigma}{\sqrt{n}}$$

where

U_{r} is the random uncertainty;

n is the sample size;

t is the percentage point of the t distribution as shown in Table 1;

σ is the standard deviation (σ_{n-1}).

3.4 Resolution

It is paramount that the test equipment used is capable of sufficient resolution. Measurement systems used should be capable of resolving 10 % (or better) of the test limit tolerance.

It is accepted that some technologies will place a physical limitation upon resolution (for example, optical resolution).

3.5 Report

In addition to requirements detailed in the test specification, the report shall detail

a) the test method used;

b) the identity of the sample(s);

c) the test instrumentation;

d) the specified limit(s);

e) an estimate of measurement uncertainty and resultant working limit(s) for the test;

f) the detailed test results;

g) the test date and operators' signature.

3.6 Student's *t* distribution

Table 1 gives values of the factor t for 95 % and 99 % confidence levels, as a function of the number of measurements.

Table 1 – Student's *t* distribution

Sample size	*t* value 95 %	*t* value 99 %		Sample size	*t* value 95 %	*t* value 99 %
2	12,7	63,7		14	2,16	3,01
3	4,3	9,92		15	2,14	2,98
4	3,18	5,84		16	2,13	2,95
5	2,78	4,6		17	2,12	2,92
6	2,57	4,03		18	2,11	2,9
7	2,45	3,71		19	2,1	2,88
8	2,36	3,5		20	2,09	2,86
9	2,31	3,36		21	2,08	2,83
10	2,26	3,25		22	2,075	2,82
11	2,23	3,17		23	2,07	2,81
12	2,2	3,11		24	2,065	2,8
13	2,18	3,05		25	2,06	2,79

3.7 Suggested uncertainty limits

The following target uncertainties are suggested:

a) Voltage < 1 kV: ± 1,5 %

b) Voltage > 1 kV: ± 2,5 %

c) Current < 20 A: ± 1,5 %

d) Current > 20 A: ± 2,5 %

Resistance

e) Earth and continuity: ± 10 %

f) Insulation: ± 10 %

g) Frequency: ± 0,2 %

Time

h) Interval < 60 s: ± 1 s

i) Interval > 60 s: ± 2 %

j) Mass < 10 g: ± 0,5 %

k) Mass 10 g – 100 g: ± 1 %

l) Mass > 100 g: ± 2 %

m) Force: ± 2 %

n) Dimension < 25 mm: ± 0,5 %

o) Dimension > 25 mm: ± 0,1 mm

p) Temperature < 100 °C: ± 1,5 %

q) Temperature > 100 °C: ± 3,5 %

r) Humidity 30 % to 75 % RH: ± 5 % RH

Plating thicknesses

s) Backscatter method: ± 10 %

t) Microsection: ± 2 μm

u) Ionic contamination: ± 10 %

4 C: Chemical test methods

4.1 Test 5-2C01: Corrosion, flux

4.1.1 Object

This test method is designed to determine the corrosive properties of flux residues under extreme environmental conditions. A pellet of solder is melted in contact with the test flux on a sheet metal test piece. The solder is then exposed to prescribed conditions of humidity and the resulting corrosion, if any, is assessed visually.

4.1.2 Test specimen

At least 0,035 g of flux solids, 1 g solder paste, 1 g wire, or 1 g preform with an equivalent amount of solids. Flux solids are defined as the residue from the solid content, flux test described in this 4.1. All solvent shall have been evaporated from the specimen in a chemical fume hood.

4.1.3 Apparatus and reagents

The following apparatus and reagents are needed:

a) solder pot;

b) humidity chamber capable of achieving (40 ± 1) °C and (93 ± 2) % relative humidity;

c) air-circulating drying oven;

d) microscope having minimum 20×;

e) chemicals: All chemicals shall be reagent grade (highly pure, without contamination) and water shall be distilled or deionized: ammonium persulphate; sulphuric acid, % volume (v/v), degreasing agent; acetone, or petroleum ether;

f) analytical balance capable of weighing 0,001 g;

g) copper sheet of a thickness of (0,50 ± 0,05) mm and a purity of 99 %.

4.1.4 Procedures

4.1.4.1 Chemicals

a) Ammonium persulphate (25 % m/v in 0,5 % v/v sulphuric acid). Dissolve 250 g of ammonium persulphate in water and add cautiously 5 ml of sulphuric acid (density 1,84 g/cm^3). Mix, cool, dilute to 1 litre and mix. This solution should be freshly prepared.

b) Sulphuric acid (5 % v/v). To 400 ml of water cautiously add 50 ml of sulphuric acid (density 1,84 g/cm^3). Mix, cool, dilute to 1 l and mix.

4.1.4.2 Test panel preparation

a) Cut a piece of 50 mm × 50 mm from the copper sheet for each test.

b) Form a circular depression in the centre of each test panel 3 mm deep by forcing a steel ball of a diameter of 20 mm into a hole of a diameter of 25 mm to form a cup.

c) Bend one corner of each test panel up to facilitate subsequent handling with tongs.

4.1.4.3 Preconditioning test panels

Immediately before performing the test, precondition as follows using clean tongs for handling.

a) Degrease with a suitable neutral organic solvent such as acetone or petroleum ether.

b) Immerse in 5 % sulphuric acid (by volume) at (65 ± 5) °C for 1 min to remove the tarnish film.

c) Immerse in a solution of 25 % m/v ammonium persulphate (0,5 % v/v sulphuric acid) at (23 ± 2) °C for 1 min to etch the surface uniformly.

d) Wash in running tap water for a maximum of 5 s.

e) Immerse in 5 % sulfuric acid (by volume) at (23 ± 2) °C for 1 min.

f) Wash for 5 s in running tap water, then rinse thoroughly in deionized water.

g) Rinse with acetone.

h) Allow to dry in clean air.

i) Use the test piece as soon as possible or store up to 1 h in a closed container.

4.1.4.4 Preparation of test solder

a) Weigh (1,00 ± 0,05) g specimen of solder for each test and place in the centre of depression of each test panel.

b) Degrease solder specimen with a suitable neutral organic solvent such as acetone or petroleum ether.

c) Solder may be in the form of pellets or by forming tight spirals of solder wire.

4.1.4.5 Test

a) Heat solder pot so that solder bath stabilizes at (235 ± 5) °C in the case of Sn63Pb37 and Sn60Pb40 alloy, or at (255 ± 3) °C for Sn96,5Ag3Cu0,5, or at 35±3 °C higher than the liquidus temperature of any other solder alloy as agreed between the user and the supplier. For solder alloys except Sn63Pb37 and Sn60Pb40, the temperature of the solder pot may be approximately 40 °C higher than the liquid temperature of each alloy.

b) Liquid flux, place 0,035 g of flux solids into the depression in the test panel. Add solder sample.

c) Solder paste, cored wire or cored preform, place 1 g of solder paste, flux-cored wire or cored-preform into the depression in the test panel.

d) Using tongs, lower each test panel onto the surface of the molten solder.

e) Allow the test panel to remain in contact until the solder specimen in the depression of the test panel melts. Maintain this condition for (5 ± 1) s.

f) Carefully examine the test panel at 20× magnification for subsequent comparison after humidity exposure. Record observations, especially any discoloration.

g) Preheat test panel to (40 ± 1) °C for (30 ± 2) min.

h) Preset humidity chamber to (40 ± 1) °C and (93 ± 2) % relative humidity.

i) Suspend each test panel vertically (and separately) in the humidity chamber.

j) Expose panels to the above environment for 72 h (3 days). M (moderately active) and H (highly active) flux may be tested in the cleaned, as well as uncleaned, condition.

4.1.4.6 Evaluation

Carefully examine test panels prior to placing them in the environmental chamber. Note any discoloration.

After the appropriate exposure period, remove test panels from humidity chamber, examine at 20× magnification and compare with observations noted prior to exposure.

Corrosion is described as follows.

– Excrescences at the interfaces of the flux residue and copper boundary or the residues or discontinuities in the residues.

– Discrete white or coloured spots in the flux residues.