IEC 61189-5-3

Edition 1.0 2015-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

**Test methods for electrical materials, printed boards and other interconnection structures and assemblies –
Part 5-3: General test methods for materials and assemblies – Soldering paste for printed board assemblies**

**Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles –
Partie 5-3: Méthodes d'essai générales pour les matériaux et les assemblages – Pâte de brasage pour les assemblages de cartes imprimées**

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

Part 5-3: General test methods for materials and assemblies – Soldering paste for printed board assemblies

FOREWORD

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9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61189-5-3 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
91/1211/FDIS	91/1224/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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 revision, those paragraphs that are different are identified.

This part of IEC 61189 contains test methods for evaluating robustness of materials or components 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 "5-3X01" represents the first chemical test method described in IEC 61189-5-3.

In short, in this example, 5-3 is the number of the part of IEC 61189, X 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 5-3: General test methods for materials and assemblies – Soldering paste 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 paste based on the existing IEC 61189-5 and IEC 61189-6. In addition, it includes test methods of soldering paste 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 61190-1-2:2014, *Attachment materials for electronic assembly – Part 1-2: Requirements for soldering pastes 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*

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.

$$U_t = \pm \sqrt{(U_s^2 + U_r^2)} + U_i$$

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.

$$U_r = \frac{t \times \sigma}{\sqrt{n}}$$

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 be 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 the 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 – 75) % RH: ± 5 % RH

Plating thicknesses

s) Backscatter method: ± 10 %

t) Microsection: ± 2 microns

u) Ionic contamination: ± 10 %

4 X: Miscellaneous test methods

4.1 Test 5-3X01: Paste flux viscosity – T-Bar spindle method

4.1.1 Object

This test method is designed to measure the viscosity of paste flux.

4.1.2 Test specimen

The test specimen shall contain enough paste flux to fill a container with a minimum diameter of 4 cm to a minimum depth of approximately 10 cm.

4.1.3 Apparatus and reagents

a) Viscometer with helipath stand and a T-C spindle (Brookfield RVTD[1] or equivalent).

b) Water bath capable of holding (25 ± 0,5) °C.

c) Stopwatch.

d) Spatula.

4.1.4 Procedure

4.1.4.1 Test

a) Place the container of paste flux in the water bath at (25 ± 0,5) °C.

b) When the medium has attained thermal equilibrium, place the container under the spindle so that it is at the centre of the surface.

c) Start the Brookfield at 5 r/min and start the helipath stand on descent.

d) Record the value 2 min after the spindle has cut into the top surface of the medium. Check that the spindle is not touching the bottom of the container.

e) Remove the spindle from the paste flux. Using the spatula, stir the flux vigorously for (15-20) s and re-measure the viscosity.

4.1.4.2 Expression of results

The viscosities are calculated from the values recorded after 2 min of medium penetration. Both stirred and unstirred results should be recorded.

4.1.5 Safety notes

Observe all appropriate precautions on material safety data sheets (MSDS) for chemicals involved in this test method.

4.2 Test 5-3X02: Spread test, extracted solder flux, paste flux and solder paste

4.2.1 Object

This test method gives an indication of activity of solder paste. The test method offers two methods.

Method A measures the solder spread area.

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1 Brookfied RVTD is the trade name of a product supplied by Brookfield Engineering Laboratories, Inc. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Method B measures the solder spread ratio.

4.2.2 Method A

4.2.2.1 Test specimen

a) For extracted solder flux, a minimum of 10 ml that is furnished in a clean glass container.

b) For paste flux and solder paste flux, 10 ml of the diluted material (35 %).

4.2.2.2 Apparatus and reagents

a) Five replicates of 0,25 mm thick 70/30 brass of a size of approximately 40 mm × 75 mm.

b) Degreased very fine steel wool (for example, #00).

c) Solder wire from Sn63Pb37A, or Sn96.5Ag3Cu0.5, or any other solder alloy wire agreed between the user and the supplier per IEC 61190-1-3 with a diameter of 1,5 mm.

d) A solder pot not less than 25 mm in depth containing at least 2 kg solder.

4.2.2.3 Test specimen preparation

a) Clean five brass coupons with steel wool.

b) Flatten the brass coupon by bending the opposite sides of the coupon. The two bends should be parallel to the curve of the metal coil in which the brass was provided in order to stiffen and flatten the test specimen.

c) Cut a 30 mm length of solid wire solder.

d) Wrap the cut length of solder around a 3 mm mandrel.

e) Cut the coil into individual rings to make a preform of the solder.

4.2.2.4 Test

a) Maintain the solder bath at (260 ± 3) °C for Sn60Pb40, or at (255 ± 3) °C for Sn96.5Ag3Cu0.5, or at (35 ± 3) °C higher than the liquidus temperature for any other solder alloy agreed between the user and the supplier .

b) Place the preformed solder on the centre of the test specimen.

c) Place one drop (0,05 ml) of flux on the centre of the preform of the test specimen.

d) Carefully place the coupon on the surface of the solder bath for 15 s.

e) Remove the coupon in a horizontal position and place on a flat surface allowing the adhered solder to solidify undisturbed.

f) Remove all flux residue with a suitable solvent.

4.2.2.5 Evaluation

Measure the solder spread area by comparing to circles (pre-drawn) with areas similar to those listed in Table 2. The mean of the spread of all five specimens tested shall be reported. Record the data and enter it in Table 12.

Table 2 is intended as an aid in defining areas in mm^2.

Table 2 – Typical spread areas defined in mm^2

Diameter mm	Area mm^2
10,00	78,54
10,70	90,00
11,28	100,00