IEC 61189-5-1

Edition 1.0 2016-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Test methods for electrical materials, printed boards and other interconnection structures and assemblies –
Part 5-1: General test methods for materials and assemblies – Guidance for printed board assemblies

Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles –
Partie 5-1: Méthodes d'essai générales pour les matériaux et les assemblages – Lignes directrices pour les assemblages de cartes à circuit imprimé

IEC 61189-5-1:2016-07(en-fr)

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

Part 5-1: General test methods for materials and assemblies – Guidance for printed board assemblies

FOREWORD

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International Standard IEC 61189-5-1 has been prepared by IEC technical committee 91: Electronics assembly technology.

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

CDV	Report on voting
91/1273/CDV	91/1354/RVC

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.

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 website 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- withdrawn,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 printed boards and printed board assemblies, as well as related materials or component robustness, 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 technical committees (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 printed board assemblies as well as materials used in the manufacture of electronic assemblies. The methods are self-contained, with sufficient detail and description so as to achieve uniformity and reproducibility in the procedures and test methodologies.

It was decided by TC 91 that the contents of IEC 61189-5 and IEC 61189-6 be merged into a series of documents in the following way:

IEC 61189-5-1, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-1: General test methods for materials and assemblies – Guidance for printed board assemblies*

IEC 61189-5-2:2015, *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*

IEC 61189-5-3:2015, *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*

IEC 61189-5-4:2015, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-4: General test methods for materials and assemblies – Solder alloys and fluxed and non-fluxed solid wire for printed board assemblies*

IEC 61189-5-501:—, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-501: General test methods for materials and assemblies – Surface insulation resistance (SIR) testing of solder fluxes*[1]

IEC 61189-5-502:—, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-502: General test methods for materials and assemblies – SIR testing of assemblies* [1]

IEC 61189-5-503:—, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-503: General test methods for materials and assemblies – Conductive Anodic Filaments (CAF) testing of circuit* boards [1]

IEC 61189-5-504:—, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-504: General test methods for materials and assemblies – Process ionic contamination testing* [1]

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1 Under consideration.

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 including process control tests for the assembly process

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. This 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.

A list of all test methods included in the above-mentioned documents, is given in Annex A. This annex will be reissued whenever new tests are introduced.

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

Part 5-1: General test methods for materials and assemblies – Guidance 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 contains the types of content of the IEC 61189-5 series, as well as guidance documents and handbooks for printed board assemblies.

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.

There are no normative references in this document.

3 Accuracy, precision and resolution

3.1 General

Measurement 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 shall meet the requirements of ISO 9001 or equivalent (see Bibliography).

The calibration shall be conducted by an agency having accreditation to a national or international measurement standards 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. An 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.

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

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 to 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 µm

u) Ionic contamination: ± 10 %

4 Catalogue of approved test methods

This standard provides specific test methods in complete detail to permit implementation with minimal cross-referencing to other specific procedures. The use of generic conditioning exposures is accomplished in the methods by reference, for example, to those described in IEC 61189-1 and IEC 60068-1, and, when applicable, is a mandatory part of the test method standard.

Each method has its own title, number and revision status to accommodate updating and improving the methods as industry requirements change or demand new methodology. The methods are organized in test method groups and individual tests.

5 List of contents of the IEC 61189-5 series

The types of content of existing and planned standards in the IEC 61189-5 series is described in Annex A.

NOTE The details of the standards "under consideration" are not yet available.

Annex A
(informative)

Tests

Table A.1 gives a summary of the existing tests and of the tests under development.

Table A.1 – General test methods for materials and assemblies

IEC standard	Designation	Test
IEC 61189-5-2	C: Chemical test methods	
	5-2C01	Corrosion, flux
	5-2C02	Determination of acid value of liquid soldering flux potentiometric and visual titration methods
	5-2C03	Acid number of rosin
	5-2C04	Determination of halides in fluxes, silver chromate method
	5-2C05	Solids content, flux
	5-2C06	Quantitative determination of halide content in fluxes (chloride and bromide)
	5-2C07	Qualitative analysis of fluorides and fluxes by spot test
	5-2C08	Quantitative determination of fluoride concentration in fluxes
	5-2C09	Specific gravity
	5-2C10	Flux induced corrosion (copper mirror method)
	X: Miscellaneous test methods	
	5-2X01	Liquid flux activity, wetting balance method
	5-2X02	Spread test, liquid or extracted solder flux, solder paste and extracted cored wires or preforms
	5-2X03	Flux residues – Tackiness after drying
IEC 61189-5-3	X: Miscellaneous test methods	
	5-3X01	Paste flux viscosity – T-Bar spindle method
	5-3X02	Spread test, extracted solder flux, paste flux and solder paste
	5-3X03	Solder paste viscosity – T-Bar spin spindle method (applicable for 300 Pa•s to 1 600 Pa•s)
	5-3X04	Solder paste viscosity – T-Bar spindle method (applicable to 300 Pa•s)
	5-3X05	Solder paste viscosity – Spiral pump method (applicable for 300 Pa•s to 1 600 Pa•s)
	5-3X06	Solder paste viscosity – Spiral pump method (applicable to 300 Pa•s)
	5-3X07	Solder paste – Slump test
	5-3X08	Solder paste – Solder ball test
	5-3X09	Solder paste – Tack test
	5-3X10	Solder paste – Wetting test
	5-3X11	Determination of solder powder particle size distribution – Screen method for types
	5-3X12	Solder powder particle size distribution – Measuring microscope method
	5-3X13	Solder powder particle size distribution – Optical image analyser method
	5-3X14	Solder powder particle size distribution – Measuring laser diffraction method
	5-3X15	Determination of maximum solder powder particle size
	5-3X16	Solder paste metal content by weight