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INTERNATIONAL STANDARD

Test methods for electrical materials, printed boards and other interconnection structures and assemblies –
Part 3: Test methods for interconnection structures (printed boards)

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

Part 3: Test methods for interconnection structures (printed boards)

FOREWORD

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International Standard IEC 61189-3 has been prepared by IEC technical committee 91: Electronics assembly technology.

This second edition cancels and replaces the first edition, published in 1997, its amendment 1 (1999) and constitutes a technical revision.

The document 91/698/FDIS, circulated to the National Committees as Amendment 2, led to the publication of the new edition.

The major technical changes with regard to the previous edition concern the addition of 25 new tests, as follows:

– 6 V: Visual test methods: 3V01, 3V02 and 3V03;

– 7 D: Dimensional test methods: 3D03;

– 8 C: Chemical test methods: 3C02, 3C13 and 3C14;

– 9 M: Mechanical test methods: 3M01, 3M03, 3M04, 3M07 and 3M09;

– 10 E: Electrical test methods: 3E03, 3E04, 3E05, 3E11, 3E12, 3E13, 3E16, 3E17 and 3E18;

– 11 N: Environmental test methods: 3N03, 3N07 and 3N12;

– 12 X: Miscellaneous test methods: 3X01

This edition also includes the deletion of Annex B: Conversion table, as the referred documents were disbanded in 2005 and do not officially exist. Should any one wish to consult such information, they should refer to the first edition of IEC 61189-3 (1997).

The text of this standard is based on the first edition, its Amendment 1 and the following documents:

FDIS	Report on voting
91/698/FDIS	91/727/RVD

Full information on the voting for the approval of this amendment 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 the parts in the IEC 61189 series, under the general title *Test methods for electrical materials, printed boards and other interconnection structures and assemblies,* can be found on the IEC website.

NOTE Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

This standard should be used in conjunction with the following parts:

Part 1: General test methods and methodology

Part 2: Test methods for materials for interconnection structures

Part 3: Test methods for electronic components assembling characteristics

Part 5: Test methods printed board assemblies and also the following standard

Part 6: Test methods for materials used in manufacturing electronic assemblies

IEC 60068 (all parts), Environmental testing

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result 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.

A bilingual version of this publication may be issued at a later date.

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 TCs (e.g. TC 50) 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 printed boards and other forms of interconnection structures. 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 "3D02" represents the second dimensional test method described in this publication.

In short, for this example, 3 is the part of IEC standard (61189-3), D is the group of methods, and 02 is the test number.

A list of all test methods included in this standard, as well as those under consideration is given in Annex B. This annex will be reissued whenever new tests are introduced.

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

Part 3: Test methods for interconnection structures (printed boards)

1 Scope

This part of IEC 61189 is a catalogue of test methods representing methodologies and procedures that can be applied to test materials used for manufacturing interconnection structures (printed boards) and assemblies.

2 Normative references

The following referenced documents are indispensable for the application 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 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60068-1: 1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-20: 1979, *Environmental testing – Part 2: Tests – Test T: Soldering*
Amendment 2 (1987)

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests –Test Cab: Damp heat, steady state*

IEC 60169–15, *Radio-frequency connectors – Part 15: RF coaxial connectors with inner diameter of outer conductor 4,13 mm (0,163 in) with screw coupling – Characteristic impedance 50 ohms (Type SMA)*

IEC 60454-1:1992, *Specifications for pressure-sensitive adhesive tapes for electrical purposes – Part 1: General requirements*

IEC 60454-3-1:1998, *Pressure-sensitive adhesive tapes for electrical purposes – Part 3: Specifications for individual materials – Sheet 1: PVC film tapes with pressure-sensitive adhesive*

IEC 60584-1, *Thermocouples – Part 1: reference tables*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 61188-1-2:1998, *Printed boards and printed board assemblies – Design and use – Part 1-2: Generic requirements – Controlled impedance*

IEC 61189-1:1997, *Test methods for electrical materials, interconnection structures and assemblies – Part 1: General test methods and methodology*

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

IEC 61190-1-2, *Attachment materials for electronic assembly – Part 1-2: Requirements for*

solder pastes for high quality interconnections in electronic assembly

IEC 62326-4:1996, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification*

IEC 62326-4-1:1996, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification – Section 1: Capability Detail Specification – Performance levels A, B and C*

ISO 4046:1978, *Paper, board, pulp and related terms – Vocabulary (withdrawn)*[1]

ISO 9002:1994, *Quality systems – Model for quality assurance in production, installation and servicing (withdrawn)*

ISO 9453:2006, *Soft solder alloys – Chemical compositions and forms*

3 Accuracy, precision and resolution

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:

– to monitor a process;
– to enhance confidence in quality conformance;
– to arbitrate 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 instruments and/or system for the test.

3.1 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 4.11 of ISO 9002. 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.

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1 ISO 4046 has been withdrawn and replaced by ISO 4046: Parts 1 to 5.

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

3.2 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.

$$U_r = t\,\sigma/\sqrt{n}$$

where

U_r is random uncertainty

n is the sample size

t is the percentage point of the "t" distribution (from 3.5, statistic tables)

F is the standard deviation (F_{n-1})

3.3 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 (e.g. optical resolution)

3.4 Report

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

– the test method used;
– the identity of the sample(s);
– the test instrumentation;
– the specified limit(s);
– an estimate of measurement uncertainty, and resultant working limit(s) for the test;
– the detailed test results;
– the test date and operators’ signature.

3.5 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. It is sufficient to use 95 % limits, as in the case of the worked examples shown in Annex A.

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

3.6 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 to 75 % RH: ± 5 % RH

Plating thicknesses

s) Backscatter method: ± 10 %
t) Microsection: ± 2 ⌈m
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 IEC 61189-1 and IEC 60068 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 P: Preparation/conditioning test methods

6 V: Visual test methods

6.1 Test 3V01: Visual examination, 3× magnification

6.1.1 Object

This method describes the procedure for visual examination of materials and finished printed boards, where 3× magnification is required by the relevant sectional specification (SS) or customer detail specification (CDS).

6.1.2 Test specimen

Finished printed board(s), portion of finished printed board, or test coupon(s), as specified by the relevant sectional specification (SS) or customer detail specification (CDS).

6.1.3 Test apparatus and materials

The following test apparatus and materials shall be used:

a) Optical device capable of providing 3× magnification.

b) Referee optical device capable of providing 10× magnification.

6.1.4 Procedure

The following steps shall be taken:

a) The product shall be carefully examined, per the specified requirement, under 3× magnification device.

b) In the case of a questionable evaluation at 3×, a referee examination may be performed at 10×.

6.1.5 Report

The report shall include:

a) the test method number and revision;

b) the date of evaluation;

c) identification and description of specimen;

d) the magnification used for the examination;

e) the referee magnification examination, if applicable;

f) the results of evaluation, including requirement(s) failed, failure modes and degree of failure, in case of failure;

g) any deviation from this test method;

h) the name of the person that conducted the test.

6.1.6 Additional information

In addition to stated requirements, any other objective evidence of defective and/or substandard conditions should be noted, such as dirt, oil, corrosion, fingerprints, foreign matter, etc.

6.2 Test 3V02: Visual examination, 10× magnification

6.2.1 Object

This method describes the procedure for visual examination of materials and finished printed boards where 10× magnification is required by the relevant sectional specification (SS) or customer detail specification (CDS).

6.2.2 Test specimen

Finished printed board(s) or test coupon(s), as specified in the relevant specification.

6.2.3 Test apparatus and materials

The following test apparatus and materials shall be used:

a) Optical device capable of providing 10× magnification.

b) Referee optical device capable of providing 50× magnification.