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Test methods for electrical materials, printed boards and other interconnection structures and assemblies - Part 2: Test methods for materials for interconnection structures

Test methods for electrical materials, printed boards and other interconnection structures and assemblies -- Part 2: Test methods for materials for interconnection structures

Prüfverfahren für Elektromaterialien, Leiterplatten und andere Verbindungsstrukturen und Baugruppen -- Teil 2: Prüfverfahren für Materialien für Verbindungsstrukturen

Méthodes d'essais pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles -- Partie 2: Méthodes d'essai des matériaux pour structures d'interconnexion

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Test methods for electrical materials, printed boards and other interconnection structures and assemblies — Part 2: Test methods for materials for interconnection structures

(includes amendment A1:2000)
(IEC 61189-2:1997 + A1:2000)

Méthodes d'essais pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et les ensembles —
Partie 2: Méthodes d'essai des matériaux pour structures d'interconnexion
(inclut l'amendement A1:2000)
(CEI 61189-2:1997 + A1:2000)

Prüfverfahren für Elektromaterialien, Leiterplatten und andere Verbindungsstrukturen und Baugruppen —
Teil 2: Prüfverfahren für Materialien für Verbindungsstrukturen
(enthält Änderung A1:2000)
(IEC 61189-2:1997 + A1:2000)

This European Standard was approved by CENELEC on 1997-03-11. Amendment A1 was approved by CENELEC on 2000-02-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 52/636/FDIS, future edition 1 of IEC 61189-2, prepared by IEC TC 52, Printed circuits, in cooperation with IEC TC 91, Surface mounting technology, and IEC TC 50, Environmental testing, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61189-2 on 1997-03-11.

The following dates were fixed:

— latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop) 1998-01-01
— latest date by which the national standards conflicting with the EN have to be withdrawn	(dow) 1998-01-01

This part 2 of EN 61189 is to be used in conjunction with the other parts of EN 61189 and with the EN 60068 series.

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, Annex ZA is normative and Annex A and Annex B are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61189-2:1997 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of document 52/832/FDIS, future amendment 1 to IEC 61189-2:1997, prepared by IEC TC 52, Printed circuits, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment Al to EN 61189-2:1997 on 2000-02-01.

The following dates were fixed:

— latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement	(dop) 2000-11-01
— latest date by which the national standards conflicting with the amendment have to be withdrawn	(dow) 2003-02-01

Annexes designated "normative" are part of the body of the standard. In this standard, annex ZA is normative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of amendment 1:2000 to the International Standard IEC 61189-2:1997 was approved by CENELEC as an amendment to the European Standard without any modification.

Contents

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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 materials used to produce interconnection structures (printed boards) and 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.

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 "2D01" represents the first dimensional test method described in this publication.

In short, for this example, 2 is the part of IEC standard (61189-2), D is the group of methods, and 01 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.

1 Scope and object

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 normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61189. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61189 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

IEC 60068-2-2:1974, *Environmental testing — Part 2: Tests — Tests B: Dry heat.*

IEC 60249-1:1982, *Base materials for printed circuits — Part 1: Test methods.*

IEC 60249-3-1:1981, *Base materials for printed circuits — Part 3: Special materials used in connection with printed circuits — Specification No. 1: Prepreg for use as bonding sheet material in the fabrication of multilayer printed boards.*

IEC 60326-3:1991, *Printed boards — Part 3: Design and use of printed boards.*

IEC 60707:1981, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.*

ISO 3274:1996, *Geometrical Products Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments.*

ANSI/UL-94:1996, *Standard for tests for flammability of plastic materials for parts in devices and appliances.*

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.

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.

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

where

U_r is random uncertainty;

n is the sample size;

t is the percentage point of the "t" distribution (from **3.5**), statistical tables;

σ is the standard deviation (σ_{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 operator's 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.

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 µm
u)	Ionic contamination:	±10 %

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

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

5.1 Test 2P01: Dry heat (under consideration)

5.2 Test 2P02: Solder float stress (under consideration)

6 V: Visual test methods

7 D: Dimensional test methods

7.1 Test 2D01: Thickness of base materials and rigid boards

7.1.1 *Object*

This test method covers the procedure for the determination of the thickness of base materials, clad or unclad.

7.1.2 *Test specimens*

Standard sheet sizes of metal-clad or unclad base materials.

Standard panel sizes of metal-clad or unclad base materials.

7.1.3 *Test apparatus and material*

A suitable micrometer having a resolution of 0,01 mm or better shall be used.

7.1.4 *Procedure*

a) General conditions

— Test specimens shall be placed between the two faces of the micrometer, so that the whole face of the pressure-foot will fall within the area of the material. The pressure-foot shall be lowered gently, slowly and with great care onto the test specimen so that all punching effect is avoided.

— No stress shall be imposed by hand on the instrument or the material when a reading is being taken. The reading shall be taken as soon as the pointer has ceased to move. It is necessary to take care in avoiding parallax errors and vibrations which may significantly affect the results.

b) Method 1

— This procedure is intended for the thickness measurement of the sheets of metal-clad; or unclad base materials.

— The specimen shall be held vertically or horizontally.

— Thickness to the nearest 0,01 mm at two points 25 mm or more inside each edge, at eight points, and additionally at two points in the middle parts, so that a total of 10 points, shall be measured as shown in Figure 13.

— The measurement shall be made twice at each point and the mean value shall be determined as the thickness of each point.

— For automatic thickness inspection, continuous measuring shall be performed in three measuring tracks parallel to the longitudinal axis of the sheet, two at least 25 mm from the longitudinal edges and the third near the midline.

c) Method 2

— This procedure is intended for the thickness measurement of panels of metal-clad or unclad base materials. The thickness of the specimens held vertically or horizontally shall be measured at the places which are agreed between the interested parties.

7.1.5 *Report*

The report shall include:

a) the test method number and revision;

b) the date of the test;

c) the identification of the material tested;

d) a statement certifying that the test was carried out for as-received metal-clad or unclad base materials;

e) the thicknesses measured and the nominal thickness with its tolerance;

f) any deviation from this test method;

g) the name of the person conducting the test.

7.1.6 *Additional information*

The use of a micrometer with a damping device, or controlled rate of movement of the pressure-foot, is advantageous.

8 C: Chemical test methods

8.1 Test 2C01: Resistance to sodium hydroxide of base materials

8.1.1 *Object*

The purpose of this test method is to provide a procedure for determining the alkaline resistance of base materials by exposure to a sodium hydroxide solution.

8.1.2 *Test specimens*

a) Specimens shall be taken from the panel or sheet in such a way that they are at least 25 mm from the edge of the sheet.

b) Specimens shall be prepared from a sample of metal-clad base material from which the metal has been completely removed by any appropriate method reflecting usual practice.

c) Specimen size is (50 ± 2) mm in both length and width, and shall be cut out using a fine saw to give the edges a smooth finish.

d) A minimum of three specimens shall be used.

8.1.3 *Test apparatus and materials*

The following test apparatus and materials shall be used:

a) an appropriate alkaline-proof container which contains an analytical grade sodium hydroxide solution maintained at a temperature of (40 ± 2) °C at a concentration by weight of (3 ± 0,2) %. In order to ensure that the concentration remains within the tolerance, the solution must be prepared daily. The number of specimens tested per litre of solution shall not be more than 50;

b) a rack to hold specimens upright in the container. The design of the rack shall allow maximum exposure of the specimen surfaces to the solution;

c) a clean dry gauze, cloth or paper to wipe off the water from the specimen surfaces;

d) a fine blade saw for the sample preparation.

8.1.4 *Procedure*

Place the specimens in the rack then in the sodium hydroxide solution for 3 min ± 20 s.

Take the rack out of the sodium hydroxide solution and quickly rinse the specimens under running water for a minimum of 5 min.

Wipe the water from the specimen surfaces completely with a clean dry gauze, cloth or paper.

Immediately make a visual check for colour change, swelling, blistering and/or delamination.

8.1.5 Report

The report shall include:

a) the test number and revision index;

b) the testing date;

c) the identification of the material tested;

d) the changes in surface appearance, if any;

e) any deviation from this test method.

8.1.6 *Additional information*

Sodium hydroxide is a powerful alkaline chemical. It shall be handled with care, avoiding eye and skin contact by wearing protective glasses and chemically resistant gloves.

8.2 Test 2C02: Gel time of epoxy based prepreg materials

8.2.1 *Object*

The purpose of this test method is to provide a means for determining the gel time of epoxide resin impregnated reinforcement cured to the B-stage used in the manufacturing of laminate and printed boards.

8.2.2 *Test specimens*

A number of pieces approximately 100 mm square or another convenient size, in order to yield approximately 1 g of dry resin, shall be cut from areas uniformly distributed across the width of the sheet or roll, but excluding the area within 25 mm of each edge or selvedge.

8.2.3 *Test apparatus and material*

The following test apparatus and materials shall be used:

a) heating plate capable of maintaining a temperature of (170 ± 0,5) °C;

b) timer, capable of determining time within ±1 s;

c) wooden stick, pointed, approximately 3 mm in diameter;

d) a measure of capacity for 0,3 g to 0,4 g resin powder;

e) sieve, 50 mesh per inch.

8.2.4 *Procedure*

Detach the dry resin from the prepreg (B-stage) by folding or crushing. Remove any glass fibre present by sieving. Alternatively, in the case of materials too soft to detach dry resin by crushing, the resin required may be obtained by pressing the folded stack of material in contact with the heating plate and squeezing out the melted resin.

Remove any glass fibre present by sieving.

Adjust the heating plate or equivalent to 170 °C and allow to stabilize at that temperature.

Using the measure of capacity a quantity of 0,3 g to 0,4 g resin powder shall be taken.

Pour the measured dry resin in the form of a small cone on one spot of the heating plate and start the timer immediately. If the alternative method given above is used, the timer shall be started at that moment when the folded stack is brought in contact with the heating plate.

Stir the resin, using a wooden stick approximately 3 mm in diameter, holding the stick as near vertical as possible and mixing the centre as well as the edges of the melted resin. While stirring, the diameter of the pool of melting resin shall not exceed 25 mm.

At the approach of the gel point the resin becomes tacky and forms strings when pulling the stick out. The gel point is reached when it no longer forms strings when pulling the stick out, and is no longer tacky but still elastic. At this point, the timer is stopped and the elapsed time measured in seconds is taken as the gel time. When used as a reference, three separate measurements shall be carried out and the average recorded as gel time.

8.2.5 *Report*

The report shall include:

a) the test method number and revision index;

b) the testing date;

c) the identification of the material tested;

d) the gel time in seconds (average);

e) any deviation from this test method.

8.2.6 *Additional information*

The determination of gel time may also be carried out using a sample of the resin contained in a rotational viscometer, in which case more information about the flow characteristics of the resin may be obtained. If this method is used, the viscosity value corresponding to the gel point shall be defined by determination of the correlation with the test described above.

8.3 Test 2C03: Resin content of prepreg materials by treated weight

8.3.1 *Object*

The purpose of this test method is to provide a means for measuring the resin content of resin impregnated reinforcement cured to the B-stage, only if the weight of uncoated reinforcement is known. This method is applicable to both organic and inorganic reinforcements.

8.3.2 *Test specimens*

a) Specimens shall be taken from the roll or sheet in such a way that they are at least 25 mm from the edge.

b) Four specimens (100 ± 0,2) mm °(100 ± 0,2) mm shall be taken at equal spacing across the web for rolls or from different areas of sheeted material.

8.3.3 *Test apparatus and materials*

The following test apparatus and materials shall be used:

a) analytical balance with a 0,001 g or better resolution;

b) desiccator (stabilization chamber) capable of maintaining 25 % relative humidity (RH) or less at room temperature.

8.3.4 *Procedure*

8.3.4.1 *Determination of weight of reinforcement*

The weight of 1 dm^2 reinforcement may be determined by one of the two methods described below:

8.3.4.1.1 *Method 1*

Determine the weight of the reinforcement from the actual length, width and weight of roll of reinforcement material:

$$W_B = 10 \times \frac{W_R}{L \times D} \quad (1)$$

where

W_B is the weight of 1 dm^2 reinforcement (g);
W_R is the roll weight (kg);
L is the roll length (m);
D is the roll width (m).

8.3.4.1.2 *Method 2*

Determine the weight from median statistical or typical reinforcement weight in grams per metre:

$$W_B = 0{,}01\ W \quad (2)$$

where

W_B is the weight of 1 dm^2 reinforcement (g);
W is the weight of 1 m^2 (g).

8.3.4.2 *Determination of total weight of prepreg*

Determine actual reinforcement weight at the beginning of the roll, using the same measurement technique as described in this method.

All the above methods consider any finishes applied to the reinforcement as part of the reinforcement.

The specimen shall be desiccated unless the prepreg material is tested within 10 min of manufacture to prevent the absorption of moisture.

Determine and record the total weight of the four specimens to the nearest 0,001 g.

8.3.4.3 *Resin content*

The resin content shall be calculated as follows:

$$C_R = \left(1 - \frac{W_B}{W_T}\right) \times 100 \quad (3)$$

where

C_R is the resin content (%);
W_B is the weight of the reinforcement (g/dm^2);
W_T is the weight of the treated prepreg (g/dm^2).