



BSI Standards Publication

Materials for printed boards and other interconnecting structures

Part 2-43: Reinforced base materials clad and unclad — Non-halogenated epoxide cellulose paper/woven E-glass reinforced laminate sheets of defined flammability (vertical burning test), copper-clad for lead-free assembly

National foreword

This British Standard is the UK implementation of EN 61249-2-43:2016. It is identical to IEC 61249-2-43:2016.

The UK participation in its preparation was entrusted to Technical Committee EPL/501, Electronic Assembly Technology.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Date	Text affected
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English Version

**Materials for printed boards and other interconnecting structures -
Part 2-43: Reinforced base materials clad and unclad -
Non-halogenated epoxide cellulose paper/woven E-glass
reinforced laminate sheets of defined flammability (vertical burning
test), copper-clad for lead-free assembly
(IEC 61249-2-43:2016)**

Matériaux pour circuits imprimés et autres structures
d'interconnexion - Partie 2-43: Matériaux de base renforcés,
plaqués et non plaqués - Feuilles stratifiées renforcées en
verre de type E tissé/papier cellulose époxyde non
halogéné, plaquées cuivre, d'inflammabilité définie (essai
de combustion verticale) pour les assemblages sans plomb
(IEC 61249-2-43:2016)

Materialien für Leiterplatten und andere
Verbindungsstrukturen - Teil 2-43: Kaschierte und
unkaschierte verstärkte Basismaterialien - Kupferkaschierte
mit Zellulose-Papier im Kernbereich und E-Glasgewebe in
den Außenlagen verstärkte Laminattafeln auf der Basis von
halogenfreiem Epoxidharz mit definierter Brennbarkeit
(Brennprüfung mit vertikaler Prüflingslage) für bleifreie
Bestückungstechnik
(IEC 61249-2-43:2016)

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

European foreword

The text of document 91/1350/FDIS, future edition 1 of IEC 61249-2-43, prepared by IEC/TC 91 "Electronics assembly technology" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61249-2-43:2016.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2017-03-16
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2019-06-16

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

ISO 9000	NOTE	Harmonized as EN ISO 9000.
ISO 14001	NOTE	Harmonized as EN ISO 14001.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61189-2	2006	Test methods for electrical materials, printed boards and other interconnection structures and assemblies - Part 2: Test methods for materials for interconnection structures	EN 61189-2	2006
IEC 61249-5-1	-	Materials for interconnection structures - Part 5: Sectional specification set for conductive foils and films with or without coatings - Section 1: Copper foils (for the manufacture of copper-clad base materials)	EN 61249-5-1	-
IEC/PAS 61249-6-3	-	Specification for finished fabric woven from "E" glass for printed boards	-	-
ISO 11014	-	Safety data sheet for chemical products - Content and order of sections	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MATERIALS FOR PRINTED BOARDS
AND OTHER INTERCONNECTING STRUCTURES –**
**Part 2-43: Reinforced base materials clad and unclad –
Non-halogenated epoxide cellulose paper/woven E-glass
reinforced laminate sheets of defined flammability
(vertical burning test), copper-clad for lead-free assembly**

FOREWORD

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International Standard IEC 61249-2-43 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
91/1350/FDIS	91/1363/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.

A list of all parts of the IEC 61249 series, under the general title *Materials for printed boards and other interconnecting structures*, 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.

MATERIALS FOR PRINTED BOARDS AND OTHER INTERCONNECTING STRUCTURES –

Part 2-43: Reinforced base materials clad and unclad – Non-halogenated epoxide cellulose paper/woven E-glass reinforced laminate sheets of defined flammability (vertical burning test), copper-clad for lead-free assembly

1 Scope

This part of IEC 61249 gives requirements for properties of non-halogenated epoxide cellulose paper reinforced core/woven E-glass reinforced surface laminate sheets of defined flammability (vertical burning test), copper-clad for lead-free assembly in thicknesses of 0,60 mm up to 1,70 mm. The flammability rating is achieved through the use of non-halogenated fire retardants reacted as part of the epoxide polymeric structure. The glass transition temperature is defined to be 100 °C minimum.

Some property requirements may have several classes of performance. The class desired should be specified on the purchase order, otherwise the default class of material will be supplied.

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 61189-2:2006, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 2: Test methods for materials for interconnection structures*

IEC 61249-5-1, *Materials for interconnection structures – Part 5: Sectional specification set for conductive foils and films with and without coatings – Section 1: Copper foils (for the manufacture of copper-clad base materials)*

IEC PAS 61249-6-3, *Specification for finished fabric woven from "E" glass for printed boards*

ISO 11014, *Safety data sheet for chemical products – Content and order of sections*

3 Materials and construction

3.1 General

The sheet consists of an insulating base with metal-foil bonded to one side or both.

3.2 Resin system

Non-halogen epoxide, filled or unfilled, resulting in a laminate with a glass transition temperature of 100 °C minimum. The maximum total halogens contained in the resin plus reinforcement matrix is $1,5 \times 10^{-3}$ parts (1 500 ppm) with a maximum chlorine of 9×10^{-4} parts (900 ppm) parts and maximum bromine being 9×10^{-4} parts (900 ppm).

Contrast agents may be added to enhance processing such as automated optical inspection (AOI).

Its flame resistance is defined in terms of the flammability requirements of 7.3.

3.3 Metal foil

Copper as specified in IEC 61249-5-1. The preferred foils are electrodeposited of defined ductility.

3.4 Reinforcement

Woven E-glass as specified in IEC PAS 61249-6-3, woven E-glass fabric (for the manufacture of prepreg and copper clad material) as the surface sheet on each side of a core reinforcement comprised of cellulose paper.

4 Internal marking

Not specified.

5 Electrical properties

The electrical property requirements are shown in Table 1.

Table 1 – Electrical properties

Property	Test method IEC 61189-2	Requirements
Surface resistance after damp heat while in the humidity chamber	2E04	$\geq 3\,000\text{ M}\Omega$
Surface resistance after damp heat and recovery (optional)	2E03	$\geq 30\,000\text{ M}\Omega$
Volume resistivity after damp heat while in the humidity chamber	2E04	$\geq 1\,000\text{ M}\Omega\text{m}$
Volume resistivity after damp heat and recovery (optional)	2E04	$\geq 5\,000\text{ M}\Omega\text{m}$
Relative permittivity after damp heat and recovery (1 MHz)	2E10	$\leq 5,4$
Dissipation factor after damp heat and recovery (1 MHz)	2E10	$\leq 0,045$
Arc resistance	2E14	$\geq 60\text{ s}$
Dielectric breakdown	2E15	$\geq 40\text{ kV}$
Surface resistance at 125 °C	2E07	$\geq 1\,000\text{ M}\Omega$
Volume resistivity at 125 °C	2E07	$\geq 1\,000\text{ M}\Omega\text{m}$

6 Non-electrical properties of the copper-clad laminate

6.1 Appearance of the copper-clad sheet

6.1.1 General

The copper-clad face shall be substantially free from defects that may have an impact on the material's fitness for use for the intended purpose.

For the following specific defects, the requirements given shall apply when inspection is made in accordance with IEC 61189-2, method 2M18.

6.1.2 Indentations (pits and dents)

The size of an indentation, usually the length, shall be determined and given a point value to be used as measure of the quality as indicated in Table 2.

Table 2 – Size and indentations

Size mm	Point value for each indentation
0,13 to 0,25	1
0,26 to 0,50	2
0,51 to 0,75	4
0,76 to 1,00	7
Over 1,00	30

The total point count for any 300 mm × 300 mm area shall be calculated to determine the class of the material.

- Class A 29 maximum
- Class B 17 maximum
- Class C 5 maximum
- Class D 0
- Class X To be agreed upon by user and supplier

The required class of material shall be specified in the purchase order. Class A applies unless otherwise specified.

6.1.3 Wrinkles

There shall be no wrinkles in the copper surface.

The inspection area shall exclude a 13 mm border from the edge of the panel or sheet.

6.1.4 Scratches

Scratches deeper than 10 µm or 20 % of the nominal thickness of the foil thickness, whichever is lower, are not permitted.

Scratches with a depth less than 5 % of the nominal thickness of the foil shall not be counted unless this depth is 10 µm or more.

Scratches with a depth between 5 % and 20 % of the nominal thickness of the foil are permitted to a total length of 100 mm for a 300 mm × 300 mm area.

The inspection area shall exclude a 13 mm border from the edge of the panel or sheet.

6.1.5 Raised areas

Raised areas are usually impressions in the press plates used during manufacture but may also be caused by blisters or inclusions of foreign particles under the foil.

Raised areas caused by blisters or inclusions are not permitted.

Raised areas being impressions of defects in press plates are permitted to the following extent:

- Class A and X material maximum height 15 μm and maximum length 15 mm;
- Class B and C material maximum height 8 μm and maximum length 15 mm;
- Class D material maximum height 5 μm and maximum length 15 mm.

6.1.6 Surface waviness

Under consideration.

6.2 Appearance of the unclad face

The unclad face of a single side clad sheet shall have the natural appearance resulting from the curing process. Small irregularities in colour are permitted. The gloss of the unclad face shall be that given by the press plate, release film, or release foil used. Variations of gloss due to the impact of pressure of gases released during the curing are permitted.

6.3 Laminate thickness

If the copper-clad laminate is tested in accordance with test method 2D01 of IEC 61189-2, the thickness shall not depart from the nominal thickness by more than the appropriate value shown in Table 3. The fine tolerances shall apply unless the other tolerances are ordered.

Table 3 – Nominal thickness and tolerance of metal-clad laminate

Property	Test method IEC 61189-2	Nominal thickness <i>including metal foil</i> mm	Tolerance requirement \pm mm		
			Coarse	Fine	Extra fine
Thickness	2D01	$\geq 0,60 < 0,80$	0,08	0,06	0,05
		$\geq 0,80 < 1,00$	0,17	0,10	0,08
		$\geq 1,00 \leq 1,70$	0,19	0,13	0,08

The thickness and tolerances do not apply to the outer 25 mm of the trimmed master sheet or the outer 13 mm of the cut-to-size panel as manufactured and delivered by the supplier. At no point shall the thickness vary from the nominal thickness by a value greater than 125 % of the specified tolerance.

6.4 Bow and twist

When the copper-clad laminate is tested in accordance with test method 2M01 of IEC 61189-2, the bow and twist shall not exceed the values given in Table 4.

Table 4 – Bow and twist requirements

Property	Test method IEC 61189-2	Nominal thickness mm	Panel dimension longest side mm	Requirements %	
				Copper foil on one side	Copper foil on both sides
Bow and twist	2M01	$\geq 0,6 \leq 1,3$	≤ 350	$\leq 3,0$	$\leq 2,5$
			$> 350 \leq 500$	$\leq 2,8$	$\leq 2,3$
			> 500	$\leq 2,5$	$\leq 2,0$
		$> 1,3 < 1,7$	≤ 350	$\leq 2,5$	$\leq 2,0$
			$> 350 \leq 500$	$\leq 2,3$	$\leq 1,8$
			> 500	$\leq 2,0$	$\leq 1,5$

The requirements for bow and twist apply only to one sided copper-clad laminates with maximum foil thickness of 105 μm (915 g/m^2) and double sided copper-clad laminates with maximum foil thickness difference of 70 μm (610 g/m^2).

Requirements for laminates with copper foil configurations beyond these limits should be subject to agreement between purchaser and supplier.

6.5 Properties related to the copper foil bond

Pull-off and peel strength requirements are shown in Table 5. These requirements apply to copper foil with a normal profile depth.

Table 5 – Pull-off and peel strength requirements

Property	Test method IEC 61189-2	Requirements		
Pull-off strength	2M05	≥ 30 N		
		Thickness of the copper foil		
		18 μm (152 g/m^2)	≥ 35 μm (305 g/m^2)	≥ 70 μm (610 g/m^2)
Peel strength after heat shock 288 °C, 20 s	2M14	$\geq 1,0$ N/mm	$\geq 1,2$ N/mm	$\geq 1,6$ N/mm
		No blistering nor delamination		
Peel strength after dry heat 125 °C	2M15	Under consideration	Under consideration	Under consideration
		No blistering nor delamination		
Peel strength after exposure to solvent vapour. Solvents as agreed upon between purchaser and supplier	2M06	$\geq 1,0$ N/mm	$\geq 1,2$ N/mm	$\geq 1,4$ N/mm
		No blistering nor delamination		
Peel strength after simulated plating	2M16	Under consideration	Under consideration	Under consideration
		No blistering nor delamination		
Peel strength at high temperature Temperature 100 °C (optional)	2M17	Not specified	Not specified	Not specified
Blistering after 288 °C, 20 s heat shock	2C05	No blistering nor delamination		

In case of difficulty due to breakage of the foil or reading range of the force measuring device, the measurement of peel strength at high temperature may be carried out using conductor widths of more than 3 mm.

6.6 Punching and machining

The laminate shall, in accordance with the manufacturer's recommendations, be capable of being punched, sheared or drilled. Delamination at the edges due to the shearing process is permissible, provided that the depth of delamination is not larger than the thickness of the base material. Delamination at the edges of drilled holes due to the drilling process is not permissible.

A suitable test method for evaluating punching is 2M19 of IEC 61189-2. Requirements for punching force and pull-out force are matters for agreement between user and supplier.

6.7 Dimensional stability

When specimens are tested in accordance with IEC 61189-2, 2X02, the observed tolerance shall be as specified in Table 6. The nominal dimensional stability value shall be as agreed upon between user and vendor. The tolerance range around the agreed upon nominal range shall be range B unless otherwise specified on the purchase order.

Table 6 – Dimensional stability

Property	Test method IEC 61189-2	Class	Requirement μm/m
Dimensional stability	2X02	A	±600
		B	±400
		C	±200
		X	As agreed upon between user and supplier

The choice of the glass fabrics and cellulose papers in the construction of the laminate has a significant impact on dimensional stability. Examples of typical constructions used in printed board applications can be found in Annex B. Annex B is not a construction requirement table but is presented for engineering information only.

Class A performance shall apply unless otherwise noted on the purchase order.

6.8 Sheet sizes

6.8.1 Typical sheet sizes

Sheet sizes are matters of agreement between purchaser and supplier. However, the recommended sizes are listed below:

- 915 mm × 1 220 mm;
- 1 065 mm × 1 155 mm;
- 1 065 mm × 1 280 mm;
- 1 000 mm × 1 000 mm;
- 1 000 mm × 1 200 mm.

6.8.2 Tolerances for sheet sizes

The size of sheet delivered by the supplier shall not deviate more than $\begin{matrix} +25 \\ -0 \end{matrix}$ mm from the ordered size.

6.9 Cut panels

6.9.1 Cut panel sizes

Cut panel sizes shall be, when delivered, in accordance with the purchaser's specification.

6.9.2 Size tolerances for cut panels

For panels cut to size according to the purchaser's specification, the following tolerances for length and width shall apply as shown in Table 7. Tolerances indicated as normal shall be in effect unless otherwise specified by in the purchasing specification.

Table 7 – Size tolerances for cut panels

Panel size mm	Tolerance requirement ± mm	
	Normal	Close
≤300	2,0	0,5
>300 ≤ 600	2,0	0,8
>600	2,0	1,6

The specified tolerances include all deviations caused by cutting the panels.

6.9.3 Rectangularity of cut panels

For panels cut to size according to the purchaser's specification, the following requirements for rectangularity shall apply as shown in Table 8. Tolerance indicated as normal shall be in effect unless otherwise specified in the purchasing specification.

Table 8 – Rectangularity of cut panels

Property	Test method IEC 61189-2	Requirement mm/m	
		Normal	Close
Rectangularity of cut panels	2M23	≤3	≤2

7 Non-electrical properties of the base material after complete removal of the copper foil

7.1 Appearance of the dielectric base material

The etched specimens shall be inspected to verify that no surface or subsurface imperfections of the dielectric material exceed those shown below. The panels shall be inspected using an optical aid apparatus which provides a minimum magnification of 4×.

Referee inspection shall be conducted at 10× magnification. Lighting conditions of inspection shall be appropriate to the material under inspection or as agreed upon between user and supplier.

Surface and subsurface imperfections (such as weave texture, resin starvation, voids, foreign inclusions) shall be acceptable provided that the imperfections meet the following:

- the reinforcement fibres are not cut or exposed;
- the foreign inclusions are not conductive;
- metallic inclusions are not acceptable;

- the imperfections do not propagate as a result of thermal stress;
- the foreign inclusions are translucent;
- opaque foreign fibres are less than 15 mm in length and average no more than 1,0 per 300 mm × 300 mm area;
- opaque foreign inclusions other than fibres shall not exceed 0,50 mm. Opaque foreign inclusions less than 0,15 mm shall not be counted. Opaque foreign inclusions between 0,50 mm and 0,15 mm shall average no more than two spots per 300 mm × 300 mm area;
- voids (sealed voids or surface voids) have a longest dimension less than 0,075 mm and there shall not be more than three voids in a 3,5 mm diameter circle.

7.2 Flexural strength

When the laminate is tested in accordance with test method 2M20 of IEC 61189-2, the flexural strength shall be as shown in Table 9.

Table 9 – Flexural strength requirements

Property	Test method IEC 61189-2	Requirements
Flexural strength Length direction Cross direction (applicable to sheets ≥0,80 mm to 1,70 mm in thickness)	2M20	≥200 N/mm ² ≥150 N/mm ²
Flexural strength at elevated temperature Length direction (applicable to sheets ≥0,80 mm to 1,70 mm in thickness)		Not specified

7.3 Flammability

When the laminate is tested in accordance with test method 2C06 of IEC 61189-2 the flammability shall be as shown in Table 10.

The performance labelled FV-0 shall be in effect unless otherwise noted on the purchase order.

Table 10 – Flammability requirements

Property	Test method IEC 61189-2	Requirements	
		Designation	
		FV-0	FV-1
Flammability	2C06		
Flaming combustion time after each application of the flame for each test specimen		≤10 s	≤30 s
Total flaming combustion time for the 10 flame applications for each set of five specimens		≤50 s	≤250 s
Glowing combustion time after the second removal of the test flame		≤30 s	≤60 s
Flaming or glowing combustion up to the holding clamp		None	None
Dripping flaming particles that ignite the tissue paper		None	None

7.4 Water absorption

When the laminate is tested in accordance with test method 2N02 of IEC 61189-2, the maximum water absorption shall be as shown in Table 11.

Table 11 – Water absorption requirements

Property	Test method IEC 61189-2	Thickness mm	Requirements %
Water absorption	2N02	$\geq 0,60 \leq 1,70$	$\leq 0,50$

7.5 Measling

When the laminate is tested in accordance with test method 2N01 of IEC 61189-2, the measle requirements shall be as shown in Table 12.

Table 12 – Measling requirements

Property	Test method IEC 61189-2	Requirements
Measling	2N01 ^{a, b}	No measling on three specimens. If one out of three specimens fails, the test has to be repeated. No measling on three specimens of the second test is permitted. No blistering or delamination on any of the three specimens is permitted.
^a Under consideration. ^b The following test conditions shall be demanded: The dwell time at 2 atm (202,65 kPa) in a pressure vessel shall be 60 min and the condition of heat shock after cooking shall be 274 °C, 20 s.		

7.6 Glass transition temperature and cure factor

The requirements for glass transition temperature and cure factor are found in Table 13.

Table 13 – Glass transition temperature and cure factor requirements

Property	Test method IEC 61189-2	Requirements
Glass transition temperature	2M10 or 2M11	≥ 100 °C
Cure factor	2M03	$\geq 0,92$

7.7 Decomposition temperature

The requirements for decomposition temperature are found in Table 14.

Table 14 – Decomposition temperature requirements

Property	Test method IEC 61189-2	Requirements
Decomposition temperature (5 % weight loss from 50 °C)	2MXX ^a	≥ 300 °C
^a Under consideration.		

7.8 Time to delamination (TMA)

The requirements for time to delamination are found in Table 15. The specimen shall not have copper foil on any layer.

Table 15 – Time to delamination requirements

Property		Test method IEC 61189-2	Requirements
Time to delamination	T260 (at 260 °C)	2M25	≥1 min
	T288 (at 288 °C)		N/A

8 Quality assurance

8.1 Quality system

The supplier shall operate a quality system, ISO 9000 or similar, to support quality conformance inspection.

The supplier shall operate a management system for environmental control, ISO 14001 or similar, to support environmental considerations.

8.2 Responsibility for inspection

The supplier is responsible for all the inspections of the manufactured material. The purchaser or an appointed third party may audit this inspection.

8.3 Qualification inspection

Laminates furnished under this standard shall be qualified. Qualification testing shall be performed to demonstrate the manufacturer's ability to meet the requirements of this specification sheet. Qualification testing shall be conducted at a laboratory in compliance with IEC laboratory requirements. A list of the normal qualification tests can be found in Annex C. The manufacturer shall retain on file the data which supports that the materials meet this standard and shall be readily available for review upon request.

8.4 Quality conformance inspection

The supplier shall operate a quality plan to assure product conformance to this standard. Such a quality plan, when appropriate, should utilize statistical methods rather than lot-by-lot inspection. It is the responsibility of the supplier based on the quality plan to determine the frequency of test to assure conforming products. In the absence of a quality plan or supporting data, the testing regime shall be as outlined in Annex C.

A combination of the following techniques may be used to show compliance with the requirements which can be used to reduce the frequency of testing. The data supporting the reduction of testing frequency shall be available for review upon request.

- In process parameter control
- In process inspection
- Periodic final inspection
- Final lot inspection

8.5 Certificate of conformance

The supplier shall, on request from the purchaser, issue a certificate of conformance to this standard in electronic or paper format.

8.6 Safety data sheet

A safety data sheet in accordance with ISO 11014 shall be available for products manufactured and delivered in compliance with this standard.

9 Packaging and marking

If not otherwise specified in the purchase order, laminate sheets shall be marked with the manufacturer's designation and lot number. Marking shall remain legible during normal handling but be readily removable prior to use of the material.

Cut-to-size panels shall be identified by marking on the package.

Laminates comprised of asymmetric copper configurations shall be marked on the side of heaviest copper weight.

Sheets and panels shall be packaged in a manner which will provide adequate protection against corrosion, deterioration and physical damage during shipment and storage.

Packages shall be marked in a manner to clearly identify the contents.

10 Ordering information

Orders shall include the following details:

- a) reference to this standard;
- b) type of material (see Clause 1 and 7.3);
- c) size, thickness and copper cladding;
- d) class of indentations (see 6.1.2);
- e) class of raised areas (see 6.1.5);
- f) class of thickness tolerance (see 6.3);
- g) class of dimensional stability (see 6.7);
- h) class of panel size tolerance (see 6.9.2);
- i) class of flammability (see 7.3); and
- j) request for certification, if applicable (see 8.5).

Annex A (informative)

Engineering information

A.1 General

Information in this annex does not detail material property requirements. The information is intended as a guideline for design and engineering purposes. Users of this standard are encouraged to supply information to be included in the annex.

Materials according to this standard show the properties and data as listed in Clause A.2 to Clause A.7.

A.2 Chemical properties

- Resistance against chemicals
- Void

A.3 Electrical properties

- Comparative tracking index 175 V to 250 V
- Void

A.4 Flammability properties

- Needle flame test
- Oxygen index 45 %

A.5 Mechanical properties

- Compressive strength (flatwise) 400 N/mm²
- Compressive strength (edgewise) 240 N/mm²
- Hardness at room temperature 200 (Rockwell M)
- Modulus of elasticity, flexural (warp) 1,9 × 10⁴ (N/mm²)
- Modulus of elasticity, flexural (weft) 1,5 × 10⁴ (N/mm²)
- Modulus of elasticity, tensile (warp) 1,7 × 10⁴ (N/mm²)
- Modulus of elasticity, tensile (weft) 1,4 × 10⁴ (N/mm²)
- Poisson's ratio 0,12 to 0,16
- Shear strength 148 N/mm²
- Young's modulus 22 GPa

A.6 Physical properties

- Density 1,85 g/cm³
- Void

A.7 Thermal properties

- Coefficient of thermal expansion (<T_g) 60 × 10⁻⁶/ °C

- Coefficient of thermal expansion (>T_g) $400 \times 10^{-6}/\text{ }^{\circ}\text{C}$
- Specific heat capacity $1,25 \text{ kJ/kg }^{\circ}\text{C}$
- Thermal conductivity $0,3 \text{ W/m }^{\circ}\text{C}$
- UL temperature index (mechanical) $130 \text{ }^{\circ}\text{C}$
- UL temperature index (electrical) $130 \text{ }^{\circ}\text{C}$
- Maximum operating temperature (MOT) $130 \text{ }^{\circ}\text{C}$

Annex B
(informative)**Common laminate constructions**

Nominal thickness mm	Common construction
0,60 to 1,70	7 628/cellulose paper/7 628
NOTE E-glass 7 628 fiberglass cloth.	

Annex C (informative)

Guideline for qualification and conformance inspection

Users of this standard are encouraged to supply information to be included in Table C.1.

Table C.1 – Qualification and conformance inspection

Property	Test method IEC 61189-2	Qualification testing	Conformance testing	Conformance frequency
Peel strength after thermal shock	2M14	Yes	Yes	Lot
Peel strength at 100 °C	2M15	Yes	Yes	Quarterly
Peel strength after solvent vapour	2M06	Yes	Yes	Quarterly
Peel strength after simulated plating	2M16	Yes	No	
Pull off strength	2M05	Yes	No	
Dimensional stability	2X02	Yes	Yes	Monthly
Flexural strength	2M20	Yes	Yes	Annually
Flammability	2C06	Yes	Yes	Monthly
Thermal stress, unetched	2C05	Yes	Yes	Lot
Solderability	2MXX	Yes	No	
Glass transition temperature	2M10	Yes	Yes	Monthly
Cure factor	2M03	Yes	Yes	Monthly
Permittivity at 1 MHz, as received	2E10	Yes	Yes	Monthly
Decomposition temperature	2MXX	Yes	Yes	Annually
Time to delamination	2M25	Yes	Yes	Quarterly
Dissipation factor at 1 MHz, as received	2E10	Yes	Yes	Monthly
Surface resistance after damp heat/recovery	2E03	Yes	Yes	Annually
Volume resistance after damp heat/recovery	2E04	Yes	Yes	Annually
Arc resistance	2E14	Yes	Yes	Annually
Dielectric breakdown	2E15	Yes	Yes	Quarterly
Water absorption	2N02	Yes	Yes	Quarterly
Bow and twist	2M01	Yes	Yes	Lot
Surface waviness	2M12	Yes	No	
Appearance of the dielectric base material	See 7.1	Yes	Yes	Lot

Bibliography

IEC 60194:2015, *Printed board design, manufacture and assembly – Terms and definitions*

ISO 9000, *Quality management systems – Fundamentals and vocabulary*

ISO 14001, *Environmental management systems – Requirements with guidance for use*



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