

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Materials for printed boards and other interconnecting structures –  
Part 2-44: Reinforced base materials clad and unclad – Non-halogenated epoxide  
non-woven/woven E-glass reinforced laminate sheets of defined flammability  
(vertical burning test), copper-clad for lead-free assembly**

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**Matériaux pour circuits imprimés et autres structures d'interconnexion –  
Partie 2-44: Matériaux de base renforcés, plaqués et non plaqués – Feuilles  
stratifiées renforcées en verre de type E tissé/non-tissé époxyde non halogéné,  
plaquées cuivre, d'inflammabilité définie (essai de combustion verticale) pour  
les assemblages sans plomb**



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Part 2-44: Reinforced base materials clad and unclad – Non-halogenated epoxide  
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MATERIALS FOR PRINTED BOARDS  
AND OTHER INTERCONNECTING STRUCTURES –**

**Part 2-44: Reinforced base materials clad and unclad –  
Non-halogenated epoxide non-woven/woven E-glass reinforced  
laminate sheets of defined flammability (vertical burning test),  
copper-clad for lead-free assembly**

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International Standard IEC 61249-2-44 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
91/1351/FDIS	91/1364/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.

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## MATERIALS FOR PRINTED BOARDS AND OTHER INTERCONNECTING STRUCTURES –

### Part 2-44: Reinforced base materials clad and unclad – Non-halogenated epoxide non-woven/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 non-woven 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 105 °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.

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#### 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-halogenated epoxide, filled or unfilled, resulting in a laminate with a glass transition temperature of 105 °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  $9 \times 10^{-4}$  parts (900 ppm) and maximum bromine being  $9 \times 10^{-4}$  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, copper foil (for the manufacture of copper-clad materials). 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 non-woven E-glass mat.

## 4 Internal marking

Not specified.

## 5 Electrical properties

The electrical property requirements are shown in Table 1.

Table 1 – Electrical properties

Property	Test method	Requirements
Surface resistance after damp heat while in the humidity chamber	2E04	≥5 000 MΩ
Surface resistance after damp heat and recovery (optional)	2E03	≥40 000 MΩ
Volume resistivity after damp heat while in the humidity chamber	2E04	≥5 000 MΩm
Volume resistivity after damp heat and recovery (optional)	2E04	≥10 000 MΩm
Relative permittivity after damp heat and recovery (1 MHz)	2E10	≤5,4
Dissipation factor after damp heat and recovery (1 MHz)	2E10	≤0,040
Arc resistance	2E14	≥60 s
Dielectric breakdown	2E15	≥40 kV
Surface resistance at 125 °C	2E07	≥1 000 MΩ
Volume resistivity at 125 °C	2E07	≥1 000 MΩm

## 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 of 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

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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  $\mu\text{m}$  and maximum length 15 mm;
- Class B and C material maximum height 8  $\mu\text{m}$  and maximum length 15 mm;
- Class D material maximum height 5  $\mu\text{m}$  and maximum length 15 mm.

### 6.1.6 Surface waviness

Under consideration.

## 6.2 Appearance of the unclad face

The unclad face of 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 including metal foil mm IEC 61249-2-44:2016	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 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	≥0,6 ≤1,3	≤350	≤2,5	≤2,0
			>350 ≤500	≤2,3	≤1,8
		>1,3 <1,7	>500	≤2,0	≤1,5
			≤350	≤2,0	≤1,5
		>350 ≤500	≤1,8	≤1,3	
		>500	≤1,5	≤1,0	

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

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	Requirement		
Pull-off strength	2M05	≥25 N		
		Thickness of the copper foil		
		18 µm (152 g/m <sup>2</sup> )	≥35 µm (305 g/m <sup>2</sup> )	≥70 µm (610 g/m <sup>2</sup> )
Peel strength after heat shock 288 °C, 20 s	2M14	≥1,0 N/mm	≥1,2 N/mm	≥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	≥1,0 N/mm	≥1,4 N/mm	≥1,6 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 125 °C (optional)	2M17	≥0,7 N/mm	≥0,9 N/mm	≥1,1 N/mm
Blistering after 288 °C, 20 s heat shock	2C05	No blistering nor delamination		

NOTE 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. Drilled holes shall be capable of being through-plated with no interference from any exudations into the hole.

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

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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 be in effect 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;
- 1 020 mm × 1 220 mm;
- 1 070 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.