IEC 61249-2-31

Edition 1.0 2009-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Materials for printed boards and other interconnecting structures – Part 2-31: Reinforced base materials, clad and unclad – Halogenated modified or unmodified resin system, woven E-glass laminate sheets of defined relative permittivity (equal to or less than 4,1 at 1 GHz) and flammability (vertical burning test), copper-clad

Matériaux pour circuits imprimés et autres structures d'interconnexion – Partie 2-31: Matériaux de base renforcés, plaqués et non plaqués – Feuilles stratifiées en tissu de verre de type E, en résine isolante halogénée modifiée ou non, de permittivité relative (inférieure ou égale à 4,1 à 1 GHz) et d'inflammabilité définies (essai de combustion verticale), plaquées cuivre

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INTERNATIONAL
ELECTROTECHNICAL
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COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX S

ICS 31.180

ISBN 978-2-88910-453-6

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

FDIS	Report on voting
91/827/FDIS	91/842/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.

The list of all the parts in 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 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

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1 Scope

This part of IEC 61249 specifies requirements for properties of modified epoxide woven E-glass laminate sheet of a thickness of 0,05 mm up to 3,2 mm, of defined flammability (vertical burning test), copper-clad. The glass transition temperature is defined to be 150 °C minimum. The relative permittivity is equal to or less than 4,1 and the dissipation factor is equal to or less than 0,012 0 at 1 GHz.

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

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 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 61249-5-1:1995, *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)*

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

ISO 11014-1, *Safety data sheet for chemical products – Part 1: Content and order of sections*

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

3 Materials and construction

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

3.1 Resin system

The resin system is modified multifunctional epoxide, or modified epoxide, with halogenated woven E-glass laminate with a glass transition temperature of 150 °C minimum.

Contrast agents may be added to assist processing such as Automated Optical Inspection (AOI).

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The resin system should be modified to satisfy the electrical properties requirement of Clause 5.

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

3.2 Metal foil

The metal foil is made of copper as specified in IEC 61249-5-1, copper foil (for the manufacture of copper-clad materials). The preferred foils are electro-deposited copper of defined ductility.

3.3 Reinforcement

The reinforcement of the laminate shall be woven E-glass fabric (for the manufacture of prepreg and copper clad materials). A woven E-glass fabric exhibiting lower relative permittivity may be utilized.

4 Internal marking

Not specified.

5 Electrical properties

The electrical property requirements are given in Table 1.

Table 1 – Electrical properties

Property	Test method IEC 61189-2	Requirement
Resistance of foil	2E12	As specified in IEC 61249-5-1
Surface resistance after damp heat while in the humidity chamber (optional)	2E03	≥10 000 MΩ
Surface resistance after damp heat and recovery	2E03	≥50 000 MΩ
Volume resistivity after damp heat while in the humidity chamber (optional)	2E04	≥5 000 MΩm
Volume resistivity after damp heat and recovery	2E04	≥10 000 MΩm
Relative permittivity after damp heat and recovery (1 MHz)	2E10	≤4,5
Dissipation factor after damp heat and recovery (1MHz)	2E10	≤0,015
Relative permittivity at high frequency (1 GHz)	2E10	≤4,1
Dissipation factor at high frequency (1 GHz)	2E10	≤0,017
Electric strength (only for material thickness less than 0,5 mm)	2E11	≥30 kV/mm
Arc resistance	2E14	≥60 s

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Property	Test method IEC 61189-2	Requirement
Dielectric breakdown (only for material thicknesses ≥0,5 mm)	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

The copper-clad face shall be substantially free from defects that may have an impact on the fitness of the material 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.

6.1.1 Indentations (pits and dents)

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

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

The total point count for any 300 mm × 300 mm area laminate 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.

6.1.2 Wrinkles

There shall be no wrinkles in the copper surface.

6.1.3 Scratches

Scratches deeper than 20 % of the nominal thickness of the foil thickness are not allowed.

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.

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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.

6.1.4 Raised areas

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

Raised areas caused by blisters or inclusions are not allowed.

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

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

6.1.5 Surface waviness

When examined in accordance with test method 2M12 of IEC 61189-2, the surface waviness in both the machine and cross machine direction shall not exceed 7 µm.

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 allowed. The gloss of the unclad face shall be that given by the press plate or release foil used. Variations of gloss due to the impact of pressure of gases released during the curing are allowed.

6.3 Laminate thickness

The laminate thickness may be ordered to include or exclude the copper foil contribution as specified in the purchase order. As a general rule, laminates less than 0,8 mm are measured excluding copper, and laminates greater or equal to 0,8 mm are measured including copper. 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 given in Table 2. The fine tolerance shall apply unless another tolerance is ordered.

Table 2 – Nominal thickness and tolerance of metal-clad laminates

Nominal thickness excluding metal foil, (material intended for multilayer boards) mm	Nominal thickness including metal foil (material intended for single or double sided boards) mm	Tolerance requirement ± mm		
		Coarse	Fine	Extra fine
≥0,05 ≤0,10		0,03	0,02	0,01
>0,10 ≤0,15		0,04	0,03	0,02
>0,15 ≤0,30		0,05	0,04	0,03
>0,30 ≤0,50		0,08	0,05	0,04
>0,50 ≤0,80		0,09	0,06	0,05
>0,80 ≤1,00	≥0,80 ≤1,00	0,13	0,09	0,07
>1,00 ≤1,30	>1,00 ≤1,30	0,17	0,11	0,08
	>1,30 ≤1,70	0,20	0,13	0,10
	>1,70 ≤2,10	0,23	0,15	0,12
	>2,10 ≤2,60	0,25	0,18	0,15
	>2,60 ≤3,20	0,30	0,20	0,15

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The thickness and tolerances are not applicable 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 2M01of IEC 61189-2, the bow and twist shall not exceed the values given in Table 3.

Table 3 – Bow and twist

Property	Test method IEC 61189-2	Nominal thickness mm	Panel dimension longest side mm	Requirement %	
				Copper foil on one side	Copper foil on both sides
Bow and twist	2M01	≥0,8 ≤1,3	≤350	≤2,0	≤1,5
			>350 ≤500	≤1,8	≤1,3
			>500	≤1,5	≤1,0
		>1,3 <1,7	≤350	≤1,5	≤1,0
			>350 ≤500	≤1,3	≤0,8
			>500	≤1,0	≤0,5
		≥1,7 ≤3,2	≤350	≤1,0	≤0,5
			>350 ≤500	≤0,8	≤0,4
			>500	≤0,5	≤0,3

NOTE 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 are subject to agreement between purchaser and supplier.

6.5 Properties related to the copper foil bond

Pull-off and peel strength requirements are given in Table 4. These requirements apply to copper foil with a normal profile depth. In the case of low or very low profile copper foil, the requirements shall be at least 50 % of that given in Table 4 as a minimum.

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Table 4 – Pull-off and peel strength

Property	Test method IEC 61189-2	Requirement			
		Thickness of the copper foil			
		≤12 µm (≤101 g/m^2)	18 µm (152 g/m^2)	35 µm (305 g/m^2)	≥70 µm (≥610 g/m^2)
Peel strength as received	2M14	≥0,60 N/mm	≥0,70 N/mm	≥0,80 N/mm	≥0,90 N/mm
		No blistering nor delamination			
Peel strength after heat shock of 20 s	2M14	≥0,60 N/mm	≥0,70 N/mm	≥0,80 N/mm	≥0,90 N/mm
		No blistering nor delamination			
Blistering after 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

Punching is not applicable. The laminate shall, in accordance with the manufacturer's recommendations, be capable of being sheared or drilled. Delamination at the edges due to the shearing process is permissible provided 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.

6.7 Dimensional stability

The dimensional stability requirements are given in Table 5. When specimens are tested in accordance with IEC 61189-2 2X02 the observed tolerance shall be as specified in Table 5. The nominal dimensional stability value shall be as agreed upon between user and vendor. The tolerance range agreed upon between user and supplier shall be class A unless otherwise specified on the purchase order.

The choice of the glass fabrics 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.

Table 5 – Dimensional stability

Property	Test method IEC 61189-2	Class	Requirement ppm
Dimensional stability	2X02	A	±500
		B	±300
		C	±100
		X	As agreed upon between user and supplier

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6.8 Sheet sizes

6.8.1 Typical sheet sizes

Sheet size is a subject of agreement between user 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 $^{+20}_{0}$ 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 specification given by the purchaser.

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 given in Table 6. Tolerances indicated as normal shall be in effect unless otherwise specified by in the specification given by the purchaser.

Table 6 – Size tolerances for cut panel

Panel size mm	Tolerance requirement ± mm	
	Normal	Close
≤300	2,0	0,5
>300 ≤600	2,0	0,8
>600	2,0	1,6
NOTE 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 specification given by the purchaser, the following requirements for rectangularity shall apply as given in Table 7. Tolerance indicated as normal shall be in effect unless otherwise specified in the purchasing specification.

Table 7 – Rectangularity of cut panel

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

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