

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**

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**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 COMMISSION

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International Standard IEC 61249-2-31 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 |
|-------------|------------------|
| 91/827/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 laminated 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.

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2 Normative references (standards.iteh.ai)

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 laminated with a glass transition temperature of 150 °C minimum.

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

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 | Requirement |
|---|-------------|---------------------------------------|
| Resistance of foil | 2E12 | As specified in IEC 61249-5-1 |
| Surface resistance after damp heat while in the humidity chamber (optional) | 2E03 | $\geq 10\,000\text{ M}\Omega$ |
| Surface resistance after damp heat and recovery | 2E03 | $\geq 50\,000\text{ M}\Omega$ |
| Volume resistivity after damp heat while in the humidity chamber (optional) | 2E04 | $\geq 5\,000\text{ M}\Omega\text{m}$ |
| Volume resistivity after damp heat and recovery | 2E04 | $\geq 10\,000\text{ M}\Omega\text{m}$ |
| Relative permittivity after damp heat and recovery (1 MHz) | 2E10 | $\leq 4,5$ |
| Dissipation factor after damp heat and recovery (1MHz) | 2E10 | $\leq 0,015$ |
| Relative permittivity at high frequency (1 GHz) | 2E10 | $\leq 4,1$ |
| Dissipation factor at high frequency (1 GHz) | 2E10 | $\leq 0,017$ |
| Electric strength (only for material thickness less than 0,5 mm) | 2E11 | $\geq 30\text{ kV/mm}$ |
| Arc resistance | 2E14 | $\geq 60\text{ s}$ |

| Property | Test method IEC 61189-2 | Requirement |
|--|----------------------------|----------------------------|
| Dielectric breakdown (only for material thicknesses $\geq 0,5$ mm) | 2E15 | ≥ 40 kV |
| Surface resistance at 125 °C | 2E07 | $\geq 1\ 000$ M Ω |
| Volume resistivity at 125 °C | 2E07 | $\geq 1\ 000$ M Ω m |

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 \times 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 μ m 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.

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

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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 |

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 2M01 of 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/m²) and double-sided, copper-clad laminates with maximum foil thickness difference of 70 μm (610 g/m²).

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.

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.

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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 |