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INTERNATIONAL STANDARD

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BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution

Coordination de l'isolement des matériels dans les systèmes (réseaux) à basse tension – Partie 3: Utilisation de revêtement, d'empotage ou de moulage pour la protection contre la pollution

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSULATION COORDINATION FOR EQUIPMENT WITHIN LOW-VOLTAGE SYSTEMS –

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This consolidated version of IEC 60664-3 consists of the second edition (2003) [documents 109/24/FDIS and 109/31/RVD], its amendment 1 (2010) [documents 109/79/FDIS and 109/81/RVD] and its corrigendum of November 2010. It bears the edition number 2.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 60664-3 has been prepared by IEC technical committee 109: Insulation coordination for low-voltage equipment.

It has the status of a basic safety publication in accordance with IEC Guide 104.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The major changes made during the revision of IEC 60664-3 were the following:

- Part 3 has been exactly aligned with Part 1 (including amendments 1 and 2). It has been made clear that Part 3 can only be used as a whole document together with Part 1 of IEC 60664.
- The scope of Part 3 has been greatly extended including now also potting and moulding and similar procedures providing protection against pollution. The standard also applies to all kinds of coated printed boards including the surface of inner-layers of multi-layer boards, substrates and similar protected assemblies. The distances through an inner layer of multi-layer boards however are covered by the requirements for solid insulation in Part 1.
- The difference between the two types of protection has been clarified. Type 1 (formerly type A) protection leads to a reduction of the pollution degree present beyond the protection to pollution degree 1. Type 2 (formerly type B) protection introduces protection systems which can be considered similar to solid insulation. Consequently the dimensioning and test requirements have been aligned more correctly.
- The area of application has been extended including now functional, basic, supplementary and reinforced insulation.
- Type 1 and type 2 protection now can both be used under the conditions of pollution degree 3 (formerly only type B).
- Not only type 2 protection but also type 1 protection requires that between two conductive parts 100 % of the distance across the spacing shall be covered by the protection.
- For type 2 protection minimum distances have been introduced. In any case the spacings shall not be lower than the minimum value of 10 µm.
- Also the new Part 5 of IEC 60664 is referred to.
- The tests follow much more closely the different requirements for type 1 and type 2 protection. The protected assembly shall withstand the electrical tests for solid insulation in 4.1.2 of IEC 60664-1. For type 1 protection, the partial discharge test is not applicable. For type 2 protection, the partial discharge test is required. The required partial discharge extinction voltage and the test method are specified in 4.1.2.4 of IEC 60664-1.
- The requirements for the test specimen have been aligned with the extended scope.
- The tests for the “adhesion of coating” and the “scratch resistance test” have been updated.

IEC 60664 consists of the following parts under the general title *Insulation coordination for equipment within low-voltage systems*:

Part 1: Principles, requirements and tests

Part 2: Application guide

Part 3: Use of coating, potting or moulding for protection against pollution

Part 4: Consideration of high-frequency voltage stress

Part 5: A comprehensive method for determining clearances and creepage distances equal to or less than 2 mm

The committee has decided that the contents of the base publication and its amendments 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.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

This part of IEC 60664 details the conditions in which the reduction of clearance and creepage distances can apply to rigid assemblies such as printed boards or terminals of components. Protection against pollution can be achieved by any kind of encapsulation such as coating, potting or moulding. The protection may be applied to one or both sides of the assembly. This standard specifies the insulating properties of the protecting material.

Between any two unprotected conductive parts, the clearance and creepage distance requirements of IEC 60664-1 or IEC 60664-5 apply.

This standard refers only to permanent protection. It does not cover assemblies after repair.

Technical committees need to consider the influence on the protection of overheated conductors and components, especially under fault conditions, and to decide if any additional requirements are necessary.

Safe performance of assemblies is dependent upon a precise and controlled manufacturing process for the application of the protective system. Requirements for quality control, e.g. by sampling tests, should be considered by technical committees.

INSULATION COORDINATION FOR EQUIPMENT WITHIN LOW-VOLTAGE SYSTEMS –

Part 3: Use of coating, potting or moulding for protection against pollution

1 Scope

This part of IEC 60664 applies to assemblies protected against pollution by the use of coating, potting or moulding, thus allowing a reduction of clearance and creepage distances as described in Part 1 or Part 5.

NOTE 1 When reference is made to Part 1 or Part 5, IEC 60664-1 or IEC 60664-5 are meant.

This standard describes the requirements and test procedures for two methods of protection:

– type 1 protection improves the microenvironment of the parts under the protection;

– type 2 protection is considered to be similar to solid insulation.

This standard also applies to all kinds of protected printed boards, including the surface of inner layers of multi-layer boards, substrates and similarly protected assemblies. In the case of multi-layer printed boards, the distances through an inner layer are covered by the requirements for solid insulation in Part 1.

NOTE 2 Examples of substrates are hybrid integrated circuits and thick-film technology.

This standard refers only to permanent protection. It does not cover assemblies that are subjected to mechanical adjustment or repair.

The principles of this standard are applicable to functional, basic, supplementary and reinforced insulation.

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 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*~~
~~Amendment 1 (1993)~~
~~Amendment 2 (1994)~~

~~IEC 60068-2-2:1974, *Basic environmental testing procedures – Part 2: Tests – Tests B: Dry heat*~~
~~Amendment 1 (1993)~~
~~Amendment 2 (1994)~~

~~IEC 60068-2-14:1984, *Basic environmental testing procedures – Part 2: Tests – Test N: Change of temperature*~~
~~Amendment 1 (1986)~~

~~IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*~~

~~IEC 60249-1:1982, *Base materials for printed circuits – Part 1: Test methods*~~
~~Amendment 4 (1993)~~

~~IEC 60249-2 (all parts), *Base materials for printed circuit – Part 2: Specifications*~~

~~IEC 60326-2:1990, *Printed boards – Part 2: Test methods*~~
~~Amendment 1 (1992)~~

~~IEC 60454-3-1:1998, *Pressure-sensitive adhesive tapes for electrical purposes – Part 3: Specifications for individual materials – Sheet 1: PVC film tapes with pressure-sensitive adhesive*~~

~~IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*~~
~~Amendment 1 (2000)~~
~~Amendment 2 (2002)~~

~~IEC 60664-5: –, *Insulation coordination for equipment within low-voltage systems – Part 5: A comprehensive method for determining clearance and creepage distances equal to or less than 2 mm*~~

~~IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*~~

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60326-2:1990, *Printed boards – Part 2: Test methods*
Amendment 1 (1992)

IEC 60454-3-1:1998, *Pressure-sensitive adhesive tapes for electrical purposes – Part 3: Specifications for individual materials – Sheet 1: PVC film tapes with pressure-sensitive adhesive*
Amendment 1 (2001)

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-5:2007, *Insulation coordination for equipment within low-voltage systems – Part 5: Comprehensive method for determining clearances and creepage distances equal to or less than 2 mm*

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 61189-3:2007, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 3: Test methods for interconnection structures (printed boards)*

IEC 61249-2 (all Parts 2) *Materials for printed boards and other interconnecting structures – Reinforced base materials, clad and unclad*

IEC Guide 104:2004, *The preparation of safety publications and the use of basic safety publications and group safety publications*

3 Definitions

For the purposes of this document, the definitions given in IEC 60664-1 as well as the following definitions apply.

3.1
base material
insulating material upon which a conductive pattern may be formed

NOTE The base material may be rigid or flexible, or both. It may be a dielectric or an insulated metal sheet.

(IEC 60194, definition 40.1334)

3.2
printed board
general term for completely processed printed circuit and printed wiring configurations

NOTE This includes single-sided, double-sided and multilayer boards with rigid, flexible, and rigid-flex base materials

(IEC 60194, definition 60.1485)

3.3
conductor
single conductive path in a conductive pattern

(IEC 60194, definition 22.0251)

3.4
protection
any kind of measure which reduces the influence of the environment

3.5
coating
insulating material such as varnish or dry film laid on the surface of the assembly

NOTE Coating and base material of a printed board form an insulating system that may have properties similar to solid insulation.

3.6
solid insulation
solid insulating material interposed between two conductive parts

NOTE In the case of a printed board with a coating, solid insulation consists of the board itself as well as the coating. In other cases, solid insulation consists of the encapsulating material.

3.7
spacing
any combination of clearances, creepage distances and insulation distances through insulation

4 Design requirements

4.1 Principles

Dimensioning of spacings between conductors depends on the type of protection used.

When type 1 protection is used, dimensioning of clearances and creepage distances shall follow the requirements of Part 1 or Part 5. If the requirements of this standard are met, pollution degree 1 applies under the protection.

When type 2 protection is used, spacings between conductive parts shall meet the requirements and tests for solid insulation of Part 1 and their dimensions shall not be less than the minimum clearances specified in Part 1 or Part 5 for homogeneous field conditions.

4.2 Application range regarding environment

The design requirements are applicable in all microenvironments.

Stresses such as temperature, chemical, mechanical ~~or~~ those listed in ~~3.3.2.3~~ 5.3.2.4 of Part 1 shall be taken into account when the protective material is selected.

Absorption of humidity by the protective material shall not impair the insulation properties of the parts being protected.

NOTE Absorption of humidity can be checked by an insulation resistance measurement under humid conditions.

4.3 Requirements for the types of protection

Protection is achieved in the following ways:

– type 1 protection improves the microenvironment of the parts under the protection. The clearance and creepage distance requirements of Part 1 or Part 5 for pollution degree 1 apply under the protection. Between two conductive parts, it is a requirement that one or both conductive parts, together with all the spacings between them, are covered by the protection;

– type 2 protection is considered to be similar to solid insulation. Under the protection, the requirements for solid insulation specified in Part 1 are applicable and the spacings shall be not less than those specified in Table 1. The requirements for clearances and creepage distances in Part 1 or Part 5 do not apply. Between two conductive parts, it is a requirement that both conductive parts, together with all the spacings between them, are covered by the protection so that no airgap exists between the protective material, the conductive parts and the printed board.

Clearance and creepage distance requirements according to Part 1 or Part 5 apply to all unprotected parts of the equipment.

4.4 Dimensioning procedures

For type 1 protection, the dimensioning requirements of ~~3.1~~ 5.1 and ~~3.2~~ 5.2 of Part 1 or Part 5 apply.

For type 2 protection, the spacing between the conductors before the protection is applied shall not be less than the values as specified in Table 1. These values apply to basic insulation, supplementary insulation as well as reinforced insulation. These values may also be applied to functional insulation.

NOTE In case of multi-layer boards, the spacing between the conductors at the surface of inner layers is dimensioned as specified for type 1 protection or type 2 protection depending on the result of the tests on the protection.

Table 1 – Minimum spacings for type 2 protection

Maximum peak value of any voltage [a] kV	Minimum spacings mm
≤0,33	0,01
>0,33 and ≤0,4	0,02
>0,4 and ≤0,5	0,04
>0,5 and ≤0,6	0,06
>0,6 and ≤0,8	0,1
>0,8 and ≤1,0	0,15
>1,0 and ≤1,2	0,2
>1,2 and ≤1,5	0,3
>1,5 and ≤2,0	0,45
>2,0 and ≤2,5	0,6
>2,5 and ≤3,0	0,8
>3,0 and ≤4,0	1,2
>4,0 and ≤5,0	1,5
>5,0 and ≤6,0	2
>6,0 and ≤8,0	3
>8,0 and ≤10	3,5
>10 and ≤12	4,5
>12 and ≤15	5,5
>15 and ≤20	8
>20 and ≤25	10
>25 and ≤30	12,5
>30 and ≤40	17
>40 and ≤50	22
>50 and ≤60	27
>60 and ≤80	35
>80 and ≤100	45

[a] Transient overvoltages are disregarded since they are unlikely to degrade the protected assembly.

Compliance is checked by measurement of the spacing before applying the protection.

5 Tests

5.1 General

The suitability of protection is evaluated by carrying out all the tests described in 5.8 after the conditioning described in 5.7.

NOTE The suitability of protection is evaluated after the scratch resistance test described in 5.5, the visual examination described in 5.6 and the subsequent conditioning described in 5.7.

Six specimens are used unless otherwise specified by technical committees. In addition, technical committees may specify the additional tests of 5.9, each of which is carried out on a separate new specimen.

These tests are designed for type testing. Technical committees should consider if any of the tests shall be specified for routine or sampling tests.

The sequence of tests is shown in Annex A.

No failure of any specimen under test is permitted.

Annex B lists the decisions required to be taken by technical committees when referring to this standard.

5.2 Specimens for testing coatings

Test specimens may be

– test specimens according to Annex C, which specifically applies for printed wiring boards. The specimen used for testing shall have the same minimum distances as those from production;
– specimens from production;
– any printed board, as long as the test specimens are representative of those from production.

5.3 Specimens for testing mouldings and potting

Production specimens shall be used, or they shall be representative of those from production.

5.4 Preparation of test specimens

Printed boards shall be cleaned and coated using the normal procedure of the manufacturer. The soldering procedure is carried out but without components being in place. Moulded and potted specimens shall be tested without further preparation.

5.5 Scratch resistance test

~~Scratches shall be made across five pairs of conducting parts and the intervening separations at points where the separations will be subject to the maximum potential gradient during the tests.~~

NOTE In some cases, scratch resistance test cannot be applied to assemblies protected against pollution by the use of potting or moulding. In such cases, considerations for any alternatively or additional tests may be necessary

Scratches shall be made across five pairs of conducting parts and the intervening separations at points where the insulation will be subject to the maximum electric field strength between conductors.

Protective layers shall be scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip shall be rounded and polished, with a radius of 0,25 mm ± 0,02 mm. The pin shall be loaded so that the force exerted along its axis is 10 N ± 0,5 N. The scratches shall be made by drawing the pin along the surface in a plane perpendicular to the conductor edges of the protective layer at a speed of approximately 20 mm/s as shown in Figure 1. Five scratches shall be made at least 5 mm apart and at least 5 mm from the edges.