

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

FOREWORD

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

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

This third edition cancels and replaces the second edition published in 2003 and Amendment 1:2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) information added concerning interpolation;
- b) provided scratch test is only for type 2 **protection**;

- c) renumbered the scratch test to follow the visual examination test, since it makes more sense there;
- d) separated the tables under what is now called Annex A, to make them clearer.

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

FDIS	Report on voting
109/153/FDIS	109/154/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.

In this standard, the following types are used:

- Terms used throughout this standard which have been defined in Clause 3: **bold type**

A list of all parts in the IEC 60664 series, published under the general title *Insulation coordination for equipment within low-voltage systems*, 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 website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,
- replaced by a revised edition, or [IEC 60664-3:2016](https://standards.iteh.ai/catalog/standards/sist/686bfb7b-3a69-4701-af60-82a2928d242f/iec-60664-3-2016)
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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 apply.

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

Technical committees should consider the influence on the **protection** of overheating **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.

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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 IEC 60664-1.

This document 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 document 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 IEC 60664-1.

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

This document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Environmental testing – Part 2-1: Tests – Test A: Cold*

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

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

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

IEC 60326-2:1990, *Printed boards – Part 2: Test methods*

IEC 60454-3-1:1998/AMD1:2001, *Pressure-sensitive adhesive tapes for electrical purposes – Part 3: Specifications for individual materials – Sheet 1: PVC film tapes with pressure – sensitive adhesive*

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

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), *Materials for printed boards and other interconnecting structures – Reinforced base materials, clad and unclad*

IEC Guide 104:2010, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

base material

insulating material upon which a conductive pattern may be formed

Note 1 to entry: The **base material** may be rigid or flexible, or both. It may be a dielectric or an insulated metal sheet.

[SOURCE: IEC 60050-541:1990, 541-02-01]

3.2

printed board

base material cut to size containing all required holes and bearing at least one conductive pattern.

Printed boards are typically subdivided according to

- their structure (e.g., single- and double-sided, multilayers)
- the nature of the **base material** (e.g., rigid, flexible)

[SOURCE: IEC 60050-541:1990, 541-01-03]

3.3

conductor (of a printed board) single conductive path in a conductive pattern

[SOURCE: IEC 60050-541:1990, 541-01-20]

3.4 protection

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 1 to entry: **Coating** and **base material** of a **printed board** form an insulating system that may have properties similar to **solid insulation**

[SOURCE: IEC 60050-212:2010, 212-11-61].

3.6 solid insulation

solid insulating material, or a combination of solid insulating materials, placed between two conductive parts or between a conductive part and a body part

EXAMPLE 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.

[SOURCE: IEC 60050-903:2013, 903-04-14]

3.7 spacing

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

[SOURCE: IEC 60050-471:2007, 471-01-20]
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4 Design requirements

4.1 Principles

The 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 IEC 60664-1. 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 IEC 60664-1 and their dimensions shall not be less than the minimum clearances specified in IEC 60664-1 for homogeneous field conditions.

4.2 Application range with regards to the environment

The design requirements are applicable in all microenvironments.

Stresses such as temperature, chemical or mechanical stresses, or those listed in 5.3.2.4 of IEC 60664-1:2007 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 IEC 60664-1 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 IEC 60664-1 are applicable and the **spacings** shall be not less than those specified in Table 1. The requirements for clearances and creepage distances in IEC 60664-1 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 air gap exists between the protective material, the conductive parts and the **printed board**.

Clearance and creepage distance requirements according to IEC 60664-1 apply to all unprotected parts of the equipment.

4.4 Dimensioning procedures

For type 1 **protection**, the dimensioning requirements of 5.1 and 5.2 of IEC 60664-1:2007 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.

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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

Maximum peak value of any voltage ^{a)} kV	Minimum spacings mm
> 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.

The suitability of **protection** is evaluated after the visual examination test described in 5.5, the scratch-resistance test 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; or
- 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 the components being in place. Moulded and potted specimens shall be tested without further preparation.

5.5 Visual examination

The specimens shall be visually examined according to test 3V02 in 6.2 of IEC 61189-3:2007.

The specimens shall show no

- blistering,
- swelling,
- separation from the **base material**,
- cracks,
- voids,
- areas with adjacent unprotected conductive parts, with the exception of lands,
- electromigration (following electromigration conditioning),

following the test sequence criteria given in the tables within Annex A.

5.6 Scratch-resistance test

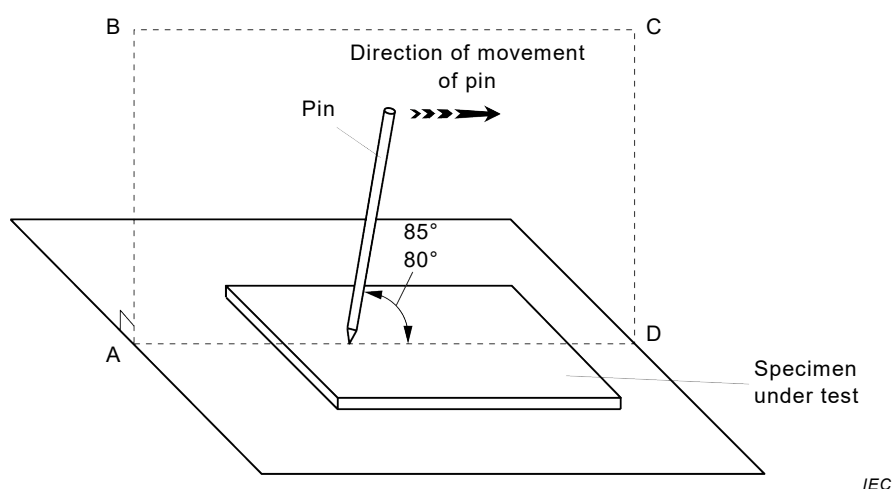
IEC 60664-3:2016

The scratch-resistance test is only carried out for type 2 **protection**. Prior to the sequence of tests for type 2 **protection**, the test samples shall be subjected to the scratch-resistance test.

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



NOTE The pin is in the plane ABCD which is perpendicular to the specimen under test.

Figure 1 – Scratch-resistance test for protecting layers

5.7 Conditioning of the test specimens

5.7.1 General

The conditioning methods are suitable for the majority of applications. For particular applications, a modification of the parameters specified for the conditioning may be appropriate and should be considered by technical committees.

NOTE The climatic sequence from 5.7.2 to 5.7.5 is intended to simulate ageing.

5.7.2 Cold conditioning

The cold conditioning (simulation of storage and transportation) is carried out according to test Ab of IEC 60068-2-1. The severities shall be specified by the technical committees and selected from the following temperatures:

- -10 °C
- -25 °C
- -40 °C
- -65 °C

The duration of the test is 96 h.

5.7.3 Dry-heat conditioning

The dry-heat conditioning is carried out according to test Bb of IEC 60068-2-2. However, the conditioning time and conditioning temperature corresponds to the composition of the **printed board** and the working surface temperature shown in Table 2. Interpolation of Table 2's maximum working surface temperatures and corresponding conditioning temperature values is allowed.