

INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

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

(standards.iteh.ai)

**Coordination de l'isolement des matériels dans les systèmes (réseaux)
à basse tension –**

Partie 1: Principes, exigences et essais



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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

CONTENTS

1	Scope and object.....	7
2	Normative references	7
3	Terms and definitions	9
4	Basis for insulation coordination	14
4.1	General	14
4.2	Insulation coordination with regard to voltage	14
4.2.1	General	14
4.2.2	Insulation coordination with regard to long-term a.c. or d.c. voltages	15
4.2.3	Insulation coordination with regard to transient overvoltage	15
4.2.4	Insulation coordination with regard to recurring peak voltage	15
4.2.5	Insulation coordination with regard to temporary overvoltage	15
4.2.6	Insulation coordination with regard to environmental conditions	16
4.3	Voltages and voltage ratings	16
4.3.1	General	16
4.3.2	Determination of voltage for long-term stresses	16
4.3.3	Determination of rated impulse voltage	17
4.3.4	Determination of recurring peak voltage	19
4.3.5	Determination of temporary overvoltage	19
4.4	Frequency	20
4.5	Time under voltage stress	20
4.6	Pollution	20
4.6.1	General	20
4.6.2	Degrees of pollution in the micro-environment	21
4.6.3	Conditions of conductive pollution	21
4.7	Information supplied with the equipment	21
4.8	Insulating material	21
4.8.1	Comparative tracking index (CTI)	21
4.8.2	Electric strength characteristics	22
4.8.3	Thermal characteristics	22
4.8.4	Mechanical and chemical characteristics	22
5	Requirements and dimensioning rules	23
5.1	Dimensioning of clearances	23
5.1.1	General	23
5.1.2	Dimensioning criteria	23
5.1.3	Electric field conditions	24
5.1.4	Altitude	24
5.1.5	Dimensioning of clearances of functional insulation	24
5.1.6	Dimensioning of clearances of basic, supplementary and reinforced insulation	24
5.1.7	Isolating distances	25
5.2	Dimensioning of creepage distances	25
5.2.1	General	25
5.2.2	Influencing factors	25
5.2.3	Dimensioning of creepage distances of functional insulation	27
5.2.4	Dimensioning of creepage distances of basic, supplementary and reinforced insulation	27
5.2.5	Reduction of creepage distances with the use of a rib (ribs)	27

5.3	Requirements for design of solid insulation	28
5.3.1	General	28
5.3.2	Stresses	28
5.3.3	Requirements	30
6	Tests and measurements	32
6.1	Tests	32
6.1.1	General	32
6.1.2	Test for verification of clearances	33
6.1.3	Tests for the verification of solid insulation	36
6.1.4	Performing dielectric tests on complete equipment	41
6.1.5	Other tests	42
6.1.6	Measurement accuracy of test parameters	42
6.2	Measurement of creepage distances and clearances.....	43
Annex A (informative) Basic data on withstand characteristics of clearances		48
Annex B (informative) Nominal voltages of supply systems for different modes of overvoltage control		53
Annex C (normative) Partial discharge test methods		55
Annex D (informative) Additional information on partial discharge test methods		60
Annex E (informative) Comparison of creepage distances specified in Table F.4 and clearances in Table A.1		63
Annex F (normative) Tables..... (standards.iteh.ai)		64
Bibliography..... https://standards.iteh.ai/catalog/standards/sis/3a5e98cd-fda8-4900-aeb9-46908d3a36d8/iec-60664-1-2007		73
Figure 1 – Recurring peak voltage		19
Figure 2 – Determination of the width (W) and height (H) of a rib		28
Figure 3 – Test voltages		40
Figure A.1 – Withstand voltage at 2 000 m above sea level		50
Figure A.2 – Experimental data measured at approximately sea level and their low limits for inhomogeneous field.....		51
Figure A.3 – Experimental data measured at approximately sea level and their low limits for homogeneous field		52
Figure C.1 – Earthed test specimen		55
Figure C.2 – Unearthed test specimen		55
Figure C.3 – Calibration for earthed test specimen		58
Figure C.4 – Calibration for unearthed test specimen.....		58
Figure D.1 – Partial discharge test circuits		60

Figure E.1 – Comparison of creepage distances specified in Table F.4 and clearances in Table A.1 63

Table A.1 – Withstand voltages in kilovolts for an altitude of 2 000 m above sea level 48

Table A.2 – Altitude correction factors 49

Table B.1 – Inherent control or equivalent protective control 53

Table B.2 – Cases where protective control is necessary and control is provided by surge arresters having a ratio of clamping voltage to rated voltage not smaller than that specified by IEC 60099-1 54

Table F.1 – Rated impulse voltage for equipment energized directly from the low-voltage mains 64

Table F.2 – Clearances to withstand transient overvoltages 65

Table F.3a – Single-phase three or two-wire a.c. or d.c. systems 66

Table F.3b – Three-phase four or three-wire a.c. systems 67

Table F.4 – Creepage distances to avoid failure due to tracking 68

Table F.5 – Test voltages for verifying clearances at different altitudes 70

Table F.6 – Severities for conditioning of solid insulation 70

Table F.7 – Clearances to withstand steady-state voltages, temporary overvoltages or recurring peak voltages 71

Table F.7a – Dimensioning of clearances to withstand steady-state voltages, temporary overvoltages or recurring peak voltages 71

Table F.7b – Additional information concerning the dimensioning of clearances to avoid partial discharge 71

Table F.8 – Altitude correction factors IEC 60664-1:2007
<https://standards.iteh.ai/catalog/standards/sist/3a5e98cd-fda8-4900-aeb9-46908d3a36d8/iec-60664-1-2007> 72

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WITHIN LOW-VOLTAGE SYSTEMS –****Part 1: Principles, requirements and tests****FOREWORD**

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

This second edition cancels and replaces the first edition, published in 1992, amendments 1 (2000) and 2 (2002) and a corrigendum (2002).

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

In addition to a number of editorial improvements, the following main changes have been made with respect to the previous edition:

- Amendment of Japanese mains conditions with regard to the rated impulse voltages, the rationalized voltages and the nominal voltages of supply systems for different modes of overvoltage control
- Amendment of dimensioning of clearances smaller than 0,01 mm

- Alignment of the table and the corresponding formula regarding test voltages for verifying clearances at different altitudes
- Amendment of interpolation of the creepage distance values for functional insulation
- Amendment of creepage distance dimensioning taking into account ribs
- Revision of the former Clause 4 "Tests and measurements" (now Clause 6) to achieve a more detailed description of the tests and their purpose, the test equipment and possible alternatives
- Change of Annex C "Partial discharge test methods" from a former technical report, Type 2 (now called TS), to a normative Annex C.

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

CDV	Report on voting
109/58/CDV	109/62/RVC

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 in the IEC 60664 series, 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 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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- withdrawn;
- replaced by a revised edition, or
- amended.

INSULATION COORDINATION FOR EQUIPMENT WITHIN LOW-VOLTAGE SYSTEMS –

Part 1: Principles, requirements and tests

1 Scope and object

This part of IEC 60664 deals with insulation coordination for equipment within low-voltage systems. It applies to equipment for use up to 2 000 m above sea level having a rated voltage up to a.c. 1 000 V with rated frequencies up to 30 kHz, or a rated voltage up to d.c. 1 500 V.

It specifies the requirements for clearances, creepage distances and solid insulation for equipment based upon their performance criteria. It includes methods of electric testing with respect to insulation coordination.

The minimum clearances specified in this standard do not apply where ionized gases occur. Special requirements for such situations may be specified at the discretion of the relevant technical committee.

This standard does not deal with distances

- through liquid insulation,
- through gases other than air,
- through compressed air.

NOTE 1 Insulation coordination for equipment within low-voltage systems with rated frequencies above 30 kHz is given in IEC 60664-4.

NOTE 2 Higher voltages may exist in internal circuits of the equipment.

NOTE 3 Guidance for dimensioning for altitudes exceeding 2 000 m is given in Table A.2.

The object of this basic safety standard is to guide technical committees responsible for different equipment in order to rationalize their requirements so that insulation coordination is achieved.

It provides the information necessary to give guidance to technical committees when specifying clearances in air, creepage distances and solid insulation for equipment.

Care should be taken to see that manufacturers and technical committees are responsible for application of the requirements, as specified in this basic safety publication, or make reference to it, where necessary, in standards for equipment within their scope.

In the case of missing specified values for clearances, creepage distances and requirements for solid insulation in the relevant product standards, or even missing standards, this standard is applicable.

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 60038:1983, *IEC standard voltages*

IEC 60050(151):2001, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 60050(212):1990, *International Electrotechnical Vocabulary – Chapter 212: Insulating solids, liquids and gases*

IEC 60050(604):1987, *International Electrotechnical Vocabulary (IEV) – Chapter 604: Generation, transmission and distribution of electricity – Operation*
Amendment 1 (1998)

IEC 60050(826):2004, *International Electrotechnical Vocabulary (IEV) – Part 826: Electrical installations*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

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

IEC 60085:2004, *Electrical insulation – Thermal classification*

IEC 60099-1:1991, *Surge arresters – Part 1: Non-linear resistor type gapped surge arresters for a.c. systems*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60216, (all parts) *Electrical insulating materials – Properties for thermal endurance*

IEC 60243-1:1998, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60270:2000, *High-voltage test techniques – Partial discharge measurements*

IEC 60364-4-44:2001, *Electrical installations of buildings – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
Amendment 1 (2003)

IEC 60664-4:2005, *Insulation coordination for equipment within low-voltage systems – Part 4: Consideration of high-frequency voltage stress*

IEC 60664-5, *Insulation coordination for equipment within low-voltage systems – Part 5: A comprehensive method for determining clearances and creepage distances equal to or less than 2 mm¹*

IEC 61140:2001, *Protection against electric shock – Common aspects for installation and equipment*
Amendment 1 (2004)

IEC 61180-1:1992, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements*

¹ A second edition of IEC 60664-5 will be published shortly.

IEC 61180-2:1994, *High-voltage test techniques for low-voltage equipment – Part 2: Test equipment*

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

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1

insulation coordination

mutual correlation of insulation characteristics of electrical equipment taking into account the expected micro-environment and other influencing stresses

NOTE Expected voltage stresses are characterized in terms of the characteristics defined in 3.5 to 3.7.

3.2

clearance

shortest distance in air between two conductive parts

3.3

creepage distance

shortest distance along the surface of a solid insulating material between two conductive parts

(IEV 151-15-50)

3.4

solid insulation

solid insulating material interposed between two conductive parts

3.5

working voltage

highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

NOTE 1 Transients are disregarded.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

3.6

recurring peak voltage

U_{rp}

maximum peak value of periodic excursions of the voltage waveform resulting from distortions of an a.c. voltage or from a.c. components superimposed on a d.c. voltage

NOTE Random overvoltages, for example due to occasional switching, are not considered to be recurring peak voltages.

3.7

overvoltage

any voltage having a peak value exceeding the corresponding peak value of maximum steady-state voltage at normal operating conditions

3.7.1

temporary overvoltage

overvoltage at power frequency of relatively long duration

3.7.2

transient overvoltage

short duration overvoltage of a few milliseconds or less, oscillatory or non-oscillatory, usually highly damped

(IEV 604-03-13)

3.7.3

switching overvoltage

transient overvoltage at any point of the system due to specific switching operation or fault

3.7.4

lightning overvoltage

transient overvoltage at any point of the system due to a specific lightning discharge

3.7.5

functional overvoltage

deliberately imposed overvoltage necessary for the function of a device

3.8

withstand voltage

voltage to be applied to a specimen under prescribed test conditions which does not cause breakdown and/or flashover of a satisfactory specimen

(IEV 212-01-31)

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3.8.1

impulse withstand voltage

highest peak value of impulse voltage of prescribed form and polarity which does not cause breakdown of insulation under specified conditions

<https://standards.iteh.ai/catalog/standards/sist/3a5e98cd-fda8-4900-acb9-46908d3a36d8/iec-60664-1-2007>

3.8.2

r.m.s. withstand voltage

highest r.m.s. value of a voltage which does not cause breakdown of insulation under specified conditions

3.8.3

recurring peak withstand voltage

highest peak value of a recurring voltage which does not cause breakdown of insulation under specified conditions

3.8.4

temporary withstand overvoltage

highest r.m.s. value of a temporary overvoltage which does not cause breakdown of insulation under specified conditions

3.9

rated voltage

value of voltage assigned by the manufacturer, to a component, device or equipment and to which operation and performance characteristics are referred

NOTE Equipment may have more than one rated voltage value or may have a rated voltage range.

3.9.1

rated insulation voltage

r.m.s. withstand voltage value assigned by the manufacturer to the equipment or to a part of it, characterizing the specified (long-term) withstand capability of its insulation

NOTE The rated insulation voltage is not necessarily equal to the rated voltage of equipment which is primarily

related to functional performance.

3.9.2

rated impulse voltage

impulse withstand voltage value assigned by the manufacturer to the equipment or to a part of it, characterizing the specified withstand capability of its insulation against transient overvoltages

3.9.3

rated recurring peak voltage

recurring peak withstand voltage value assigned by the manufacturer to the equipment or to a part of it, characterizing the specified withstand capability of its insulation against recurring peak voltages

3.9.4

rated temporary overvoltage

temporary withstand overvoltage value assigned by the manufacturer to the equipment, or to a part of it, characterizing the specified short-term withstand capability of its insulation against a.c. voltages

3.10

overvoltage category

numeral defining a transient overvoltage condition

NOTE 1 Overvoltage categories I, II, III and IV are used, see 4.3.3.2.

NOTE 2 The term 'overvoltage category' in this standard is synonymous with 'impulse withstand category' used in IEC 60364-4-44, Clause 443.

3.11

pollution

any addition of foreign matter, solid, liquid, or gaseous that can result in a reduction of electric strength or surface resistivity of the insulation

3.12

environment

surrounding which may affect performance of a device or system

NOTE Examples are pressure, temperature, humidity, pollution, radiation and vibration.

(IEV 151-16-03, modified)

3.12.1

macro-environment

environment of the room or other location in which the equipment is installed or used

3.12.2

micro-environment

immediate environment of the insulation which particularly influences the dimensioning of the creepage distances

3.13

pollution degree

numeral characterizing the expected pollution of the micro-environment

NOTE Pollution degrees 1, 2, 3 and 4 are established in 4.6.2.

3.14

homogeneous field

electric field which has an essentially constant voltage gradient between electrodes (uniform field), such as that between two spheres where the radius of each sphere is greater than the distance between them

NOTE The homogeneous field condition is referred to as case B.

3.15

inhomogeneous field

electric field which does not have an essentially constant voltage gradient between electrodes (non-uniform field)

NOTE The inhomogeneous field condition of a point-plane electrode configuration is the worst case with regard to voltage withstand capability and is referred to as case A. It is represented by a point electrode having a 30 μm radius and a plane of 1 m \times 1 m.

3.16

controlled overvoltage condition

condition within an electrical system wherein the expected transient overvoltages are limited to a defined level

3.17

insulation

that part of an electrotechnical product which separates the conducting parts at different electrical potentials

(IEV 212-01-05)

3.17.1

functional insulation

insulation between conductive parts which is necessary only for the proper functioning of the equipment

3.17.2

basic insulation

insulation of hazardous-live-parts which provides basic protection

NOTE The concept does not apply to insulation used exclusively for functional purposes.

(IEV 826-12-14)

3.17.3

supplementary insulation

independent insulation applied in addition to basic insulation for fault protection

(IEV 826-12-15)

3.17.4

double insulation

insulation comprising both basic insulation and supplementary insulation

(IEV 826-12-16)

3.17.5

reinforced insulation

insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

NOTE Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

(IEV 826-12-17)

3.18

partial discharge

PD

electric discharge that partially bridges the insulation

3.18.1 apparent charge

q

electric charge which can be measured at the terminals of the specimen under test

NOTE 1 The apparent charge is smaller than the partial discharge.

NOTE 2 The measurement of the apparent charge requires a short-circuit condition at the terminals of the specimen (see Clause D.2) under test.

3.18.2 specified discharge magnitude

magnitude of the apparent charge which is regarded as the limiting value according to the objective of this standard

NOTE The pulse with the maximum amplitude should be evaluated.

3.18.3 pulse repetition rate

average number of pulses per second with an apparent charge higher than the detection level

NOTE Within the scope of this standard it is not permitted to weigh discharge magnitudes according to the pulse repetition rate.

3.18.4 partial discharge inception voltage

U_i

lowest peak value of the test voltage at which the apparent charge becomes greater than the specified discharge magnitude when the test voltage is increased above a low value for which no discharge occurs

NOTE For a.c. tests the r.m.s. value may be used.

3.18.5 partial discharge extinction voltage

U_e

lowest peak value of the test voltage at which the apparent charge becomes less than the specified discharge magnitude when the test voltage is reduced below a high level where such discharges have occurred

NOTE For a.c. tests the r.m.s. value may be used.

3.18.6 partial discharge test voltage

U_t

peak value of the test voltage for the procedure of 6.1.3.5.3 where the apparent charge is less than the specified discharge magnitude

NOTE For a.c. tests the r.m.s. value may be used.

3.19 test

technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure

(13.1 of ISO/IEC Guide 2:1996) ^[1]²

NOTE A test is carried out to measure or classify a characteristic or a property of an item by applying to the item a set of environmental and operating conditions and/or requirements.

² References in square brackets refer to the bibliography.