

INTERNATIONAL STANDARD

IEC 60664-1

Edition 1.2
2002-06

Edition 1:1992 consolidated with amendments 1:2000 and 2:2002

Insulation coordination for equipment within low-voltage systems –

Part 1: Principles, requirements and tests

iteh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 60664-1:1992](https://standards.iteh.ai/standards/iec/011bf3-f3f-4ed5-b821-09441deb6982/iec-60664-1-1992)

<https://standards.iteh.ai/standards/iec/011bf3-f3f-4ed5-b821-09441deb6982/iec-60664-1-1992>

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*



Reference number
IEC 60664-1:1992+A1:2000+A2:2002(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site** (www.iec.ch)

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/online_news/justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch
Tel: +41 22 919 02 11
Fax: +41 22 919 03 00

<https://standards.iteh.ai/catalog/standards-iec/1161b3-f13f-4ed5-b821-09441deb6982/iec-60664-1-1992>

INTERNATIONAL STANDARD

IEC 60664-1

Edition 1.2
2002-06

Edition 1:1992 consolidated with amendments 1:2000 and 2:2002

Insulation coordination for equipment within low-voltage systems –

Part 1: Principles, requirements and tests

iTek Standards
(<https://standards.iteh.ai>)
Document Preview

IEC 60664-1:1992

<https://standards.iteh.ai/document/standards/iec/0117bfb3-ff3f-4ed5-b821-09441deb6982/iec-60664-1-1992>

© IEC 2002 Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

CT

For price, see current catalogue

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	11
SECTION 1: GENERAL AND DEFINITIONS	
1.1 Scope.....	13
1.2 Normative references.....	13
1.3 Definitions.....	17
SECTION 2: BASIS FOR INSULATION COORDINATION	
2.1 Basic principles.....	27
2.2 Voltages and voltage ratings.....	31
2.3 Frequency.....	39
2.4 Time under voltage stress.....	39
2.5 Pollution.....	39
2.6 Information supplied with the equipment.....	41
2.7 Insulating material.....	41
SECTION 3: REQUIREMENTS AND DIMENSIONING RULES	
3.1 Dimensioning of clearances.....	45
3.2 Dimensioning of creepage distances.....	53
3.3 Requirements for design of solid insulation.....	63
SECTION 4: TESTS AND MEASUREMENTS	
4.1 Tests.....	73
4.2 Measurement of creepage distances and clearances.....	95
Annex A (informative) Basic data on withstand characteristics of clearances.....	103
Annex B (informative) Nominal voltages of supply systems for different modes of overvoltage control.....	113
Annex C (informative) Partial discharge test methods.....	117
Annex D (informative) Additional information on partial discharge test methods.....	127
Annex E (informative) Comparison of creepage distances specified in table 4 and clearances in table A.1.....	133
Figure 3 – Recurring peak voltage.....	37
Figure 2 – Test voltages.....	93
Figure A.1 – Withstand voltage at 2 000 m above sea level.....	107
Figure A.2 – Experimental data measured at approximately sea level and their low limits for inhomogeneous field.....	109
Figure A.3 – Experimental data measured at approximately sea level and their low limits for homogeneous field.....	111
Figure C.1 – Earthed test specimen.....	117
Figure C.2 – Unearthed test specimen.....	117

Figure C.3 – Calibration for earthed test specimen.....	123
Figure C.4 – Calibration for unearthed test specimen.....	125
Figure D.1 – Partial discharge test circuits.....	127
Figure E.1 – Comparison of creepage distances specified in table 4 and clearances in table A.1	133
Table 1 – Rated impulse voltage for equipment energized directly from the low-voltage mains	35
Table 2 – Clearances to withstand transient overvoltages	47
Table 7 – Clearances to withstand steady-state voltages, temporary overvoltages or recurring peak voltages	49
Table 7a – Dimensioning of clearances to withstand steady-state voltages, temporary overvoltages or recurring peak voltages.....	49
Table 7b – Additional information concerning the dimensioning of clearances to avoid partial discharge	49
Table 3a – Single-phase three or two-wire a.c. or d.c. systems.....	57
Table 3b – Three-phase four or three-wire a.c. systems.....	59
Table 4 – Creepage distances to avoid failure due to tracking.....	61
Table 5 – Test voltages for verifying clearances at sea level.....	75
Table 8 – Altitude correction factors.....	79
Table 6 – Severities for conditioning of solid insulation.....	87
Tableau A.1 – Withstand voltages in kilovolts for an altitude of 2 000 m above sea level	103
Table A.2 – Altitude correction factors	105
Table B.1 – Inherent control or equivalent protective control.....	113
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	115
Examples 1 to 11	96 to 100

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSULATION COORDINATION FOR EQUIPMENT WITHIN LOW-VOLTAGE SYSTEMS –

Part 1: Principles, requirements and tests

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

This part of International Standard IEC 60664 has been prepared by Sub-Committee 28A: Insulation coordination for low-voltage equipment, of IEC Technical Committee 28: Insulation coordination.

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

This consolidated version of IEC 60664-1 is based on the first edition (1992) [documents 28A(CO)28+29+32+33 and 28A(CO)31+34+35+36], its amendment 1 (2000) [documents 28A/141/FDIS and 28A/146/RVD] and its amendment 2 (2002) [documents 109/3A/FDIS and 109/7/RVD].

It bears the edition number 1.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A to E are for information only.

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

Part 1: 1992, Principles, requirements and tests.

Part 2-1: 1997, Application guide – Dimensioning procedure worksheets and dimensioning examples

Part 3: 1992, Use of coatings to achieve insulation coordination of printed board assemblies.

Part 4: 1997, Consideration of high-frequency voltage stress

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2006. At this date, the publication will be

- reconfirmed,
- withdrawn;
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of November 2002 have been included in this copy.

WITHDRAWN

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 60664-1:1992](https://standards.iteh.ai/standards/iec/011bf3-f3f-4ed5-b821-09441deb6982/iec-60664-1-1992)

<https://standards.iteh.ai/standards/iec/011bf3-f3f-4ed5-b821-09441deb6982/iec-60664-1-1992>

INTRODUCTION

This part of IEC 60664 is a revision of the 1st edition of IEC 60664 (including 60664A and amendment 1) which was published in 1980 as a report having the status of a basic safety publication following IEC Guide 104. It is now published as a standard. It is now numbered as part 1 (covering principles, requirements and tests) in the new layout of the IEC 60664 series in which some further parts are foreseen as follows:

- IEC 60664-2 will cover concise requirements for clearances, creepage distances and solid insulation.
- IEC 60664-3 will cover use of coatings to achieve insulation coordination of printed board assemblies.
- IEC 60664-4 will be in the form of an application guide covering:
 - 1) Dimensioning procedure worksheet and dimensioning examples.
 - 2) Interface requirements and transient overvoltage control means.
 - 3) Explanations to the pollution degrees.
 - 4) Dielectric testing.

This part has been revised to

- provide for distinguishing insulation coordination for:
 - low-voltage mains;
 - other installation systems;
 - internal circuits of equipment;
- indicate that controlled overvoltage conditions can either inherently exist in a system or be achieved by means of overvoltage attenuating means;
- emphasize that the overvoltage categories have a probabilistic implication rather than the meaning of physical attenuation of the transient overvoltage downstream in the installation;
- spell out clearly the remaining duties of specialized Technical Committees;
- take into account IEC 60364-4-41, IEC 60364-4-42 and 60364-4-443;
- incorporate requirements for solid insulation.

INSULATION COORDINATION FOR EQUIPMENT WITHIN LOW-VOLTAGE SYSTEMS –

Part 1: Principles, requirements and tests

SECTION 1: GENERAL AND DEFINITIONS

1.1 Scope

1.1.1 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 part do not apply where ionized gases occur. Special requirements for such situations may be specified at the discretion of the relevant Technical Committee.

This part does not deal with distances

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

NOTE 1 Extension of the scope up to 1 MHz is under consideration.

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

NOTE 3 Requirements for altitudes exceeding 2 000 m can be derived from table A.2 of annex A.

1.1.2 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.

1.2 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 Guide 104:1984, *Guide to the drafting of safety publications, and the role of committees with safety pilot functions and safety group functions*

IEC 60038:1983, *IEC standard voltages*

IEC 60050(151):1978, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

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

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

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 60068-2-3:1969, *Environmental testing – Part 2: Tests, Test Ca: Damp heat, steady state*

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

IEC 60085:1984, *Thermal evaluation and classification of electrical insulation*

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

IEC 60112:1979, *Method for determining the comparative and the proof-tracking indices of solid insulating materials under moist conditions*

IEC 60216, *Guide for the determination of thermal endurance properties of electrical insulating materials*

IEC 60243-1:1988, *Methods of test for electric strength of solid insulating materials – Part 1: Tests at power frequencies*

IEC 60335-1:1991, *Safety of household and similar electrical appliances – Part 1: General requirements*

IEC 60364-4-41:1982, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*

IEC 60364-4-442:1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 44: Protection against overvoltages – Section 442: Protection of low-voltage installations against faults between high-voltage systems and earth*

IEC 60364-4-443:1990, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 44: Protection against overvoltages – Section 443: Protection against overvoltages of atmospheric origin or due to switching*

IEC 60364-5-537:1981, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 53: Switchgear and controlgear – Section 537: Devices for isolation and switching. Amendment No. 1 (1989)*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60536:1976, *Classification of electrical and electronic equipment with regard to protection against electric shock*

IEC 60664-4:1997, *Insulation coordination for equipment within low-voltage systems – Part 4: Considerations of high-frequency voltage stress*

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* ¹⁾

IEC 60669-1:1981, *Switches for household and similar fixed electrical installations – Part 1: General requirements*

IEC 60730-1:1990, *Automatic electrical controls for electrical household appliances – Part 1: General requirements*

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

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

1.3 Definitions

For the purpose of this part of IEC 60664, the following definitions apply.

1.3.1

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 1.3.5 to 1.3.7.

1.3.2

clearance

shortest distance in air between two conductive parts

1.3.3

creepage distance

shortest distance along the surface of the insulating material between two conductive parts (IEV 151-03-37)

1.3.4

solid insulation

solid insulating material interposed between two conductive parts

1.3.5

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.

1.3.6

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.

¹⁾ To be published.

1.3.7

overvoltage

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

1.3.7.1

temporary overvoltage

overvoltage at power frequency of relatively long duration

1.3.7.2

transient overvoltage

short duration overvoltage of a few milliseconds or less, oscillatory or non-oscillatory, usually highly damped (IEV 604-03-13)

1.3.7.2.1

switching overvoltage

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

1.3.7.2.2

lightning overvoltage

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

1.3.7.3

functional overvoltage

deliberately imposed overvoltage necessary for the function of a device

1.3.8 Withstand voltages

1.3.8.1

impulse withstand voltage

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

1.3.8.2

r.m.s. withstand voltage

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

1.3.8.3

recurring peak withstand voltage

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

1.3.8.4

temporary withstand overvoltage

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

1.3.9

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.

1.3.9.1

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.

1.3.9.2

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

1.3.9.3

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

1.3.9.4

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

1.3.10

overvoltage category

numeral defining a transient overvoltage condition

NOTE Overvoltage categories I, II, III and IV are used, see 2.2.2.1.

1.3.11

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

1.3.12 Environment

1.3.12.1

macro-environment

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

1.3.12.2

micro-environment

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

1.3.13

pollution degree

numeral characterizing the expected pollution of the micro-environment

NOTE Pollution degrees 1, 2, 3 and 4 are used, see 2.5.1.

1.3.14

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.

1.3.15**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 × 1 m.

1.3.16**controlled overvoltage condition**

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

1.3.17 Insulations**1.3.17.1****functional insulation**

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

1.3.17.2**basic insulation**

insulation applied to live parts to provide basic protection against electric shock

NOTE Basic insulation does not necessarily include insulation used exclusively for functional purposes (2-1 of IEC 60536).

1.3.17.3**supplementary insulation**

independent insulation applied in addition to basic insulation, in order to provide protection against electric shock in the event of a failure of basic insulation (2.2 of IEC 60536)

1.3.17.4**double insulation**

insulation comprising both basic insulation and supplementary insulation (2.3 of IEC 60536)

1.3.17.5**reinforced insulation**

single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant IEC standard (2.4 of IEC 60536)

NOTE A single insulation system does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as basic or supplementary insulation.

1.3.18**partial discharge (PD)**

electric discharge that partially bridges the insulation

1.3.18.1**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 annex D, D.2) under test.