

# FINAL VERSION

# VERSION FINALE



**Low-voltage electrical installations –  
Part 4-44: Protection for safety – Protection against voltage disturbances and  
electromagnetic disturbances**

**Installations électriques à basse tension –  
Partie 4-44: Protection pour assurer la sécurité – Protection contre les  
perturbations de tension et les perturbations électromagnétiques**

## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
440.1 Scope.....	8
440.2 Normative references.....	8
441 (Vacant) .....	10
442 Protection of low-voltage installations against temporary overvoltages due to earth faults in the high-voltage system and due to faults in the low-voltage system .....	10
442.1 Field of application.....	10
442.1.1 General requirements .....	10
442.1.2 Symbols .....	10
442.2 Overvoltages in LV-systems during a high-voltage earth fault .....	11
442.2.1 Magnitude and duration of power-frequency fault voltage .....	13
442.2.2 Magnitude and duration of power-frequency stress voltage .....	14
442.2.3 Requirements for calculation of limits.....	15
442.3 Power-frequency stress voltage in case of loss of the neutral conductor in a TN and TT system.....	15
442.4 Power-frequency stress voltage in the event of an earth fault in an IT system with distributed neutral .....	15
442.5 Power-frequency stress voltage in the event of a short-circuit between a line conductor and the neutral conductor.....	16
443 Protection against transient overvoltages of atmospheric origin or due to switching .....	16
443.1 General .....	16
443.2 Void.....	17
443.3 Terms and definitions.....	17
443.4 Overvoltage control.....	17
443.5 Risk assessment method .....	18
443.6 Classification of rated impulse voltages (overvoltage categories).....	19
443.6.1 Purpose of classification of rated impulse voltages (overvoltage categories).....	19
443.6.2 Rated impulse voltages of equipment and overvoltage categories .....	20
444 Measures against electromagnetic influences.....	21
444.1 General.....	21
444.2 (void).....	22
444.3 Definitions .....	22
444.4 Mitigation of electromagnetic interference (EMI).....	23
444.4.1 Sources of EMI.....	23
444.4.2 Measures to reduce EMI .....	23
444.4.3 TN-system.....	25
444.4.4 TT system .....	29
444.4.5 IT system .....	30
444.4.6 Multiple-source supply .....	31
444.4.7 Transfer of supply.....	34
444.4.8 Services entering a building .....	36
444.4.9 Separate buildings.....	37
444.4.10 Inside buildings .....	37
444.4.11 Protective devices .....	39
444.4.12 Signal cables.....	39

444.5	Earthing and equipotential bonding.....	39
444.5.1	Interconnection of earth electrodes .....	39
444.5.2	Interconnection of incoming networks and earthing arrangements .....	40
444.5.3	Different structures for the network of equipotential conductors and earthing conductors .....	40
444.5.4	Equipotential bonding networks in buildings with several floors.....	42
444.5.5	Functional earthing conductor .....	43
444.5.6	Commercial or industrial buildings containing significant amounts of information technology equipment.....	44
444.5.7	Earthing arrangements and equipotential bonding of information technology installations for functional purposes.....	44
444.6	Segregation of circuits .....	45
444.6.1	General .....	45
444.6.2	Design requirements.....	45
444.6.3	Conditions for zero segregation .....	46
444.7	Cable management systems .....	47
444.7.1	General .....	47
444.7.2	Design guidelines .....	47
444.7.3	Installation guidelines .....	48
445	Protection against undervoltage .....	49
445.1	General requirements .....	49
Annex A (informative)	Examples of calculated risk level $C_{PL}$ for the use of SPDs .....	51
Annex B (informative)	Guidance on overvoltage control by SPDs applied to overhead lines.....	53
Annex C (informative)	List of notes concerning certain countries.....	54
Figure 44.A1	– Representative schematic search for possible connections to earth in substation and LV-installation and occurrence of overvoltages in case of faults .....	12
Figure 44.A2	– Tolerable fault voltage due to an earth-fault in the HV system .....	14
Figure 443.1	– Illustration of an installation showing the lengths to consider .....	19
Figure 44.R1	– By-pass conductor or screen reinforcement to provide a common equipotential bonding system .....	24
Figure 44.R2	– Example of a substitute or by-pass equipotential bonding conductor in a TT-system.....	25
Figure 44.R3A	– Avoidance of neutral conductor currents in a bonded structure by using the TN-S system from the origin of the public supply up to and including the final circuit within a building .....	26
Figure 44.R3B	– Avoidance of neutral conductor currents in a bonded structure by using a TN-S system downstream of a consumer's private supply transformer .....	27
Figure 44.R4	– TN-C-S system within an existing building installation .....	28
Figure 44.R5	– TT system within a building installation .....	29
Figure 44.R6	– IT system within a building installation .....	30
Figure 44.R7A	– TN multiple-source power supply with a non-suitable multiple connection between PEN and earth .....	31
Figure 44.R7B	– TN multiple source power supplies to an installation with connection to earth of the star points at one and the same point .....	32
Figure 44.R8	– TT multiple-source power supplies to an installation with connection to earth of the star points at one and the same point .....	33
Figure 44.R9A	– Three-phase alternative power supply with a 4-pole switch .....	34

Figure 44.R9B – Neutral current flow in a three-phase alternative power supply with an unsuitable 3-pole switch .....	35
Figure 44.R9C – Single-phase alternative power supply with 2-pole switch.....	36
Figure 44.R10 – Armoured cables and metal pipes entering the buildings (examples) .....	37
Figure 44.R11 – Illustration of measures in an existing building .....	38
Figure 44.R12 – Interconnected earth electrodes .....	39
Figure 44.R13 – Examples of protective conductors in star network .....	40
Figure 44.R14 – Example of multiple meshed bonding star network .....	41
Figure 44.R15 – Example of a common meshed bonding star network .....	42
Figure 44.R16 – Example of equipotential bonding networks in structures without lightning protection systems .....	43
Figure 44.R17 – Example of cable separation distance .....	46
Figure 44.R19 – Cable arrangements in metal cable-trays .....	48
Figure 44.R20 – Continuity of metallic system components.....	48
Figure 44.R21 – Location of cables inside metallic construction elements.....	49
Figure 44.R22 – Connection of metallic sections.....	49
Bibliography .....	56
Table 44.A1 – Power-frequency stress voltages and power-frequency fault voltage in low-voltage system.....	13
Table 44.A2 – Permissible power-frequency stress voltage .....	15
Table 443.1 – Calculation of $f_{ENV}$ .....	18
Table 443.2 – Required rated impulse voltage of equipment $U_W$ .....	21
Table 444.1 – Summary of minimum separation distances where the specification and/or intended application of the information and communication technology cable is not available .....	46

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

### LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

#### Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances

### 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.
- 2) The formal decisions or agreements of 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

#### DISCLAIMER

This Consolidated version is not an official IEC Standard and has been prepared for user convenience. Only the current versions of the standard and its amendment(s) are to be considered the official documents.

This Consolidated version of IEC 60364-4-44 bears the edition number 2.2. It consists of the second edition (2007-08) [documents 64/1600/FDIS and 64/1609/RVD] and its corrigenda 1 (2010-05) and 2 (2011-10), its amendment 1 (2015-09) [documents 64/2032/FDIS and 64/2073/RVD] and its corrigendum (2016-08), and its amendment 2 (2018-01) [documents 65C/684/FDIS and 65C/691/RVD]. The technical content is identical to the base edition and its amendments.

**This Final version does not show where the technical content is modified by amendments 1 and 2. A separate Redline version with all changes highlighted is available in this publication.**

International Standard IEC 60364-4-44 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

The document 64/1600/FDIS, circulated to the National Committees as Amendment 3, led to the publication of the new edition.

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

A list of all the parts in the IEC 60364 series, under the general title *Low-voltage electrical installations*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The reader's attention is drawn to the fact that Annex C lists all of the "in-come-country" clauses on differing practices of a less permanent nature relating to the subject of this standard.

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 document using a colour printer.**

## INTRODUCTION

Part 4-44 of IEC 60364 covers the protection of electrical installations and measures against voltage disturbances and electromagnetic disturbances.

The requirements are arranged into four clauses as follows:

- Clause 442 Protection of low-voltage installations against temporary overvoltages due to earth faults in the high-voltage system and due to faults in the low-voltage system
- Clause 443 Protection against overvoltages of atmospheric origin or due to switching
- Clause 444 Measures against electromagnetic influences
- Clause 445 Protection against undervoltage

## LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

### Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances

#### 440.1 Scope

The rules of this Part of IEC 60364 are intended to provide requirements for the safety of electrical installations in the event of voltage disturbances and electromagnetic disturbance generated for different specified reasons.

The rules of this part are not intended to apply to systems for distribution of energy to the public, or power generation and transmission for such systems (see the scope of IEC 60364-1) although such disturbances may be conducted into or between electrical installations via these supply systems.

#### 440.2 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 60038:2009, *IEC standard voltages*

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

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-4-41:2005, *Electrical installations of buildings – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-5-52, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-53:2001, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*

IEC 60364-5-53:2001/AMD1:2002

IEC 60364-5-53:2001/AMD2:2015

IEC 60364-5-54:2002, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective bonding conductors*<sup>1</sup>

IEC 60479-1:2005, *Effects of current on human beings and livestock – Part 1: General aspects*

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

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61000-2-5:1995, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 5: Classification of electromagnetic environments – Basic EMC publication*

<sup>1</sup> A third edition is currently in preparation.