

INTERNATIONAL STANDARD



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

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CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
440 Protection against voltage disturbances and electromagnetic disturbances.....	8
440.1 Scope	8
440.2 Normative references.....	8
440.3 Terms, definitions and symbols	9
440.3.1 Terms and definitions	9
440.3.2 Symbols	11
441 Void.....	12
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	12
442.1 Field of application.....	12
442.1.1 General	12
442.1.2 General requirements	12
442.2 Overvoltages in LV-systems during a high-voltage earth fault	12
442.2.1 General	12
442.2.2 Magnitude and duration of power-frequency fault voltage	14
442.2.3 Magnitude and duration of power-frequency stress voltages	15
442.2.4 Requirements for calculation of limits	16
442.3 Power-frequency stress voltage in case of loss of the neutral conductor in a TN and TT system	16
442.4 Power-frequency stress voltage in the event of an earth fault in an IT system with distributed neutral.....	16
442.5 Power-frequency stress voltage in the event of a short-circuit between a line conductor and the neutral conductor	17
443 Protection against transient overvoltages of atmospheric origin or due to switching.....	17
443.1 General.....	17
443.2 Void	18
443.3 Void	18
443.4 Overvoltage control.....	18
443.5 Risk assessment method	18
443.6 Classification of rated impulse voltages (overvoltage categories).....	20
443.6.1 Purpose of classification of rated impulse voltages (overvoltage categories)	20
443.6.2 Rated impulse voltages of equipment and overvoltage categories.....	21
444 Measures against electromagnetic influences	22
444.1 General.....	22
444.2 Void	23
444.3 Void	23
444.4 Mitigation of electromagnetic interference (EMI)	23
444.4.1 General	23
444.4.2 Sources of EMI	23
444.4.3 Measures to reduce EMI	23
444.4.4 TN-system	25
444.4.5 TT system.....	28
444.4.6 IT system.....	29
444.4.7 Multiple-source supply	30

444.4.8	Transfer of supply	33
444.4.9	Services entering a building	36
444.4.10	Separate buildings	37
444.4.11	Inside buildings	37
444.4.12	Protective devices	39
444.4.13	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	39
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	50
Annex A (informative)	Examples of calculated risk level CRL for the use of SPDs	51
A.1	Example 1 – Building in rural environment	51
A.2	Example 2 – Building in rural environment powered in HV	51
A.3	Example 3 – Building in urban environment powered by overhead lines	52
A.4	Example 4 – Building in urban environment powered by underground cables	52
Annex B (informative)	Guidance on overvoltage control by SPDs applied to overhead lines	53
Annex C (informative)	List of notes concerning certain countries	54
Bibliography		56
Figure 1	– Representative schematic diagram for possible connections to earth in substation and LV-installation and occurring overvoltages in case of faults	13
Figure 2	– Tolerable fault voltage due to an earth-fault in the HV system	15
Figure 3	– Illustration of an installation showing the lengths to consider	20
Figure 4	– By-pass conductor for screen reinforcement to provide a common equipotential bonding system	24
Figure 5	– Example of a substitute or by-pass equipotential bonding conductor in a TT-system	25
Figure 6	– 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 7	– 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 8 – TN-C-S system within an existing building installation	28
Figure 9 – TT system within a building installation	29
Figure 10 – IT system within a building installation	30
Figure 11 – TN multiple-source power supply with a non-suitable multiple connection between PEN and earth	31
Figure 12 – TN multiple-source power supplies to an installation with connection to earth of the star points at one and the same point.....	32
Figure 13 – TT multiple-source power supplies to an installation with connection to earth of the star points at one and the same point.....	33
Figure 14 – Three-phase alternative power supply with a 4-pole switch	34
Figure 15 – Neutral current flow in a three-phase alternative power supply with an unsuitable 3-pole switch.....	35
Figure 16 – Single-phase alternative power supply with 2-pole switch.....	36
Figure 17 – Armoured cables and metal pipes entering the buildings (examples)	37
Figure 18 – Illustration of measures in an existing building	38
Figure 19 – Interconnected earth electrodes	39
Figure 20 – Examples of protective conductors in star network	40
Figure 21 – Example of multiple meshed bonding star network	41
Figure 22 – Example of a common meshed bonding star network	42
Figure 23 – Example of equipotential bonding networks in structures without lightning protection systems.....	43
Figure 24 – Example of cable separation distance	46
Figure 25 – Cable arrangements in metal cable trays.....	48
Figure 26 – Continuity of metallic system components	48
Figure 27 – Location of cables inside metallic construction elements	49
Figure 28 – Connection of metallic sections	49
Table 1 – Power-frequency stress voltages and power-frequency fault voltage in low-voltage system.....	14
Table 2 – Permissible power-frequency stress voltage	16
Table 3 – Calculation of f_{env}	19
Table 4 – Required rated impulse voltage of equipment U_W	22
Table 5 – Summary of minimum separation distances where the specification 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**

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

This third edition cancels and replaces the second edition published in 2007, Amendment 1:2015 and Amendment 2:2018. This edition constitutes a technical revision.

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

- a) the structure of the document has been updated in accordance with the ISO/IEC Directives, Part 2:2021: the terms, definitions and symbols have been regrouped under a new Subclause 440.3, the tables and figures have been renumbered;

- b) Clause 443 has been amended to better introduce the DC SPD and to improve some of the wording.

The text of this International Standard is based on the following documents:

Draft	Report on voting
64/2696/FDIS	64/2737/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

This part 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 transient overvoltages of atmospheric origin or due to switching |
| Clause 444 | Measures against electromagnetic influences |
| Clause 445 | Protection against undervoltage |

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LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

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

440 Protection against voltage disturbances and electromagnetic disturbances

440.1 Scope

This part of IEC 60364 provides requirements for the safety of electrical installations in the event of voltage disturbances and electromagnetic disturbances generated for different specified reasons.

The requirements of this document 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 can be conducted into or between electrical installations via these supply systems.

440.2 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 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

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

IEC 60364-5-53:2019, *Low-voltage electrical installations – Part 5-53: Selection and erection of electrical equipment – Devices for protection for safety, isolation, switching, control and monitoring*

IEC 60364-5-53:2019/AMD1:2020

IEC 60364-5-53:2019/AMD2:2024

IEC 60364-5-54:2011, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*
IEC 60364-5-54:2011/AMD1:2021

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

IEC 61196-7, *Coaxial communication cables – Part 7: Sectional specification for cables for BCT cabling in accordance with ISO/IEC 11801-4 – Indoor drop cables for systems operating at 5 MHz – 6 000 MHz*

IEC 61936-1, *Power installations exceeding 1 kV AC and 1,5 kV DC – Part 1: AC*

IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

ISO/IEC 14763-2:2019, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

ISO/IEC TR 29106, *Information technology – Generic cabling – Introduction to the MICE environmental classification*

440.3 Terms, definitions and symbols

440.3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60364-1 and the following apply.

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

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

440.3.1.1 urban environment

area with a high density of buildings or densely populated communities with tall buildings

EXAMPLE Town centre.

440.3.1.2 suburban environment

area with a medium density of buildings

EXAMPLE Town outskirts.

440.3.1.3 rural environment

area with a low density of buildings

EXAMPLE The countryside.

440.3.1.4 surge protective device SPD

device that contains at least one non-linear component that is intended to limit surge voltages and divert surge currents

Note 1 to entry: An SPD is a complete assembly, having appropriate connecting means.

[SOURCE: IEC 61643-11:2011, 3.1.1]

440.3.1.5 calculated risk level CRL

calculated value of risk used to evaluate the need for transient overvoltage protection

440.3.1.6
rated impulse voltage U_W

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

[SOURCE: IEC 60664-1:2020, 3.1.19, modified – In the term, "withstand" has been deleted and the symbol U_{imp} has been replaced with U_W .]

440.3.1.7
bonding network
BN

set of interconnected conductive structures that provides an "electromagnetic shield" for electronic systems at frequencies from direct current (DC) to low radio frequency (RF)

Note 1 to entry: The term "electromagnetic shield" denotes any structure used to divert, block or impede the passage of electromagnetic energy. In general, a BN does not need to be connected to earth but BN considered in this standard are connected to earth.

440.3.1.8
bonding ring conductor
BRC

earthing bus conductor in the form of a closed ring

Note 1 to entry: Normally the bonding ring conductor, as part of the bonding network, has multiple connections to the CBN that improves its performance.

440.3.1.9
common equipotential bonding system
common bonding network
CBN

equipotential bonding system providing both protective-equipotential-bonding and functional-equipotential-bonding

[SOURCE: IEC 60050-195:2021, 195-02-25]

440.3.1.10
equipotential bonding

set of electric connections intended to achieve equipotentiality between conductive parts

[SOURCE: IEC 60050-195:2021, 195-01-10]

440.3.1.11
earth-electrode network
ground-electrode network (US)

part of an earthing arrangement comprising only the earth electrodes and their interconnections

[SOURCE: IEC 60050-195:2021, 195-02-21]

440.3.1.12
meshed bonding network
MESH-BN

bonding network in which all associated equipment frames, racks and cabinets and usually the DC power return conductor, are bonded together as well as at multiple points to the CBN and may have the form of a mesh

Note 1 to entry: The MESH-BN augments the CBN.

440.3.1.13**by-pass equipotential bonding conductor
parallel earthing conductor
PEC**

earthing conductor connected in parallel with the screens of signal or data cables in order to limit the current flowing through the screens

440.3.2 Symbols

In this document, the following symbols are used (see Figure 1).

I_E	part of the earth fault current in the high-voltage system that flows through the earthing arrangement of the transformer substation
R_E	resistance of the earthing arrangement of the transformer substation
R_A	resistance of the earthing arrangement of the exposed-conductive-parts of the equipment of the low-voltage installation
R_B	resistance of the earthing arrangement of the low-voltage system neutral, for low-voltage systems in which the earthing arrangements of the transformer substation and of the low-voltage system neutral are electrically independent
U_0	in TN- and TT-systems: nominal AC RMS line voltage to earth in IT-systems: nominal AC voltage between line conductor and neutral conductor or mid-point conductor, as appropriate
U_f	power-frequency fault voltage that appears in the low-voltage system between exposed-conductive-parts and earth for the duration of the fault
U_1	power-frequency stress voltage between the line conductor and the exposed-conductive-parts of the low-voltage equipment of the transformer substation during the fault
U_2	power-frequency stress voltage between the line conductor and the exposed-conductive-parts of the low-voltage equipment of the low-voltage installation during the fault

NOTE 1 The power-frequency stress voltage (U_1 and U_2) is the voltage that appears across the insulation of low-voltage equipment and across surge protective devices connected to the low-voltage system.

The following additional symbols are used in respect of IT-systems in which the exposed-conductive-parts of the equipment of the low-voltage installation are connected to an earthing arrangement that is electrically independent of the earthing arrangement of the transformer substation.

I_h	fault current that flows through the earthing arrangement of the exposed-conductive-parts of the equipment of the low-voltage installation during a period when there is a high-voltage fault and a first fault in the low-voltage installation (see Table 1).
I_d	fault current that flows through the earthing arrangement of the exposed-conductive-parts of the low-voltage installation during the first fault in a low-voltage system (see Table 1).
Z	impedance (e.g. IMD internal impedance, artificial neutral impedance) between the low-voltage system and an earthing arrangement.

NOTE 2 An earthing arrangement can be considered electrically independent of another earthing arrangement if a rise of potential with respect to earth in one earthing arrangement does not cause an unacceptable rise of potential with respect to earth in the other earthing arrangement. See IEC 61936-1.

441 Void

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

442.1 Field of application

442.1.1 General

This Clause 442 provides requirements for the safety of low-voltage installation in the event of

- a fault between the high-voltage system and earth in the transformer substation that supplies the low-voltage installation,
- a loss of the supply neutral in the low-voltage system,
- a short-circuit between a line conductor and neutral,
- an accidental earthing of a line conductor of a low-voltage IT-system.

The requirements for the earthing arrangement at the transformer substation are given in IEC 61936-1.

442.1.2 General requirements

As Clause 442 covers faults between a high-voltage line and the earth in the HV/LV substation, it gives rules for the designer and installer of the substation. It is necessary to have the following information concerning the high-voltage system:

- quality of the system earthing;
- maximum level of earth fault current;
- resistance of the earthing arrangement.

The following Subclauses 442.2, 442.3, 442.4 and 442.5 consider four situations as proposed in 442.1, which generally cause the most severe temporary overvoltages such as defined in IEC 60050-614:

- fault between the high-voltage system(s) and earth (see 442.2);
- loss of the neutral in a low-voltage system (see 442.3);
- accidental earthing of a low-voltage IT system (see 442.4);
- short-circuit in the low-voltage installation (see 442.5).

442.2 Overvoltages in LV-systems during a high-voltage earth fault

442.2.1 General

In case of a fault to earth on the HV-side of the substation, the following types of overvoltage may affect the LV-installation:

- power-frequency fault voltage (U_f);
- power-frequency stress voltages (U_1 and U_2).

Table 1 provides the relevant methods of calculation for the different types of overvoltages.

Table 1 deals with IT systems with a neutral point only. For IT systems with no neutral point, the formulae should be adjusted accordingly.

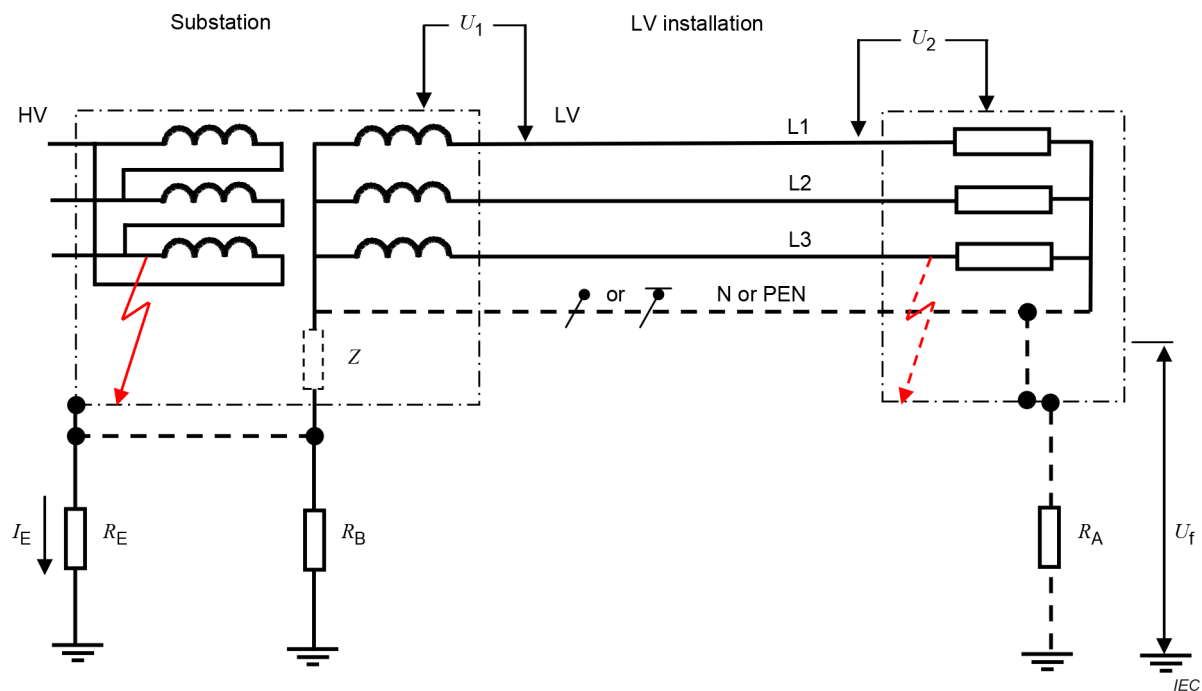


Figure 1 – Representative schematic diagram for possible connections to earth in substation and LV-installation and occurring overvoltages in case of faults

Where high- and low-voltage earthing systems exist in proximity to each other, two practices are presently used:

- interconnection of all high-voltage (R_E) and low-voltage (R_B) earthing systems;
- separation of high-voltage (R_E) from low-voltage (R_B) earthing systems.

The general method used is interconnection. The high- and low-voltage earthing systems shall be interconnected if the low-voltage system is totally confined within the area covered by the high-voltage earthing system (see IEC 61936-1).

NOTE 1 Details of the different types of system earthing (TN, TT, IT) are shown in IEC 60364-1.