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INTERNATIONAL STANDARD

colour inside

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

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LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

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FOREWORD

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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- withdrawn, or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.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

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

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_o 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.

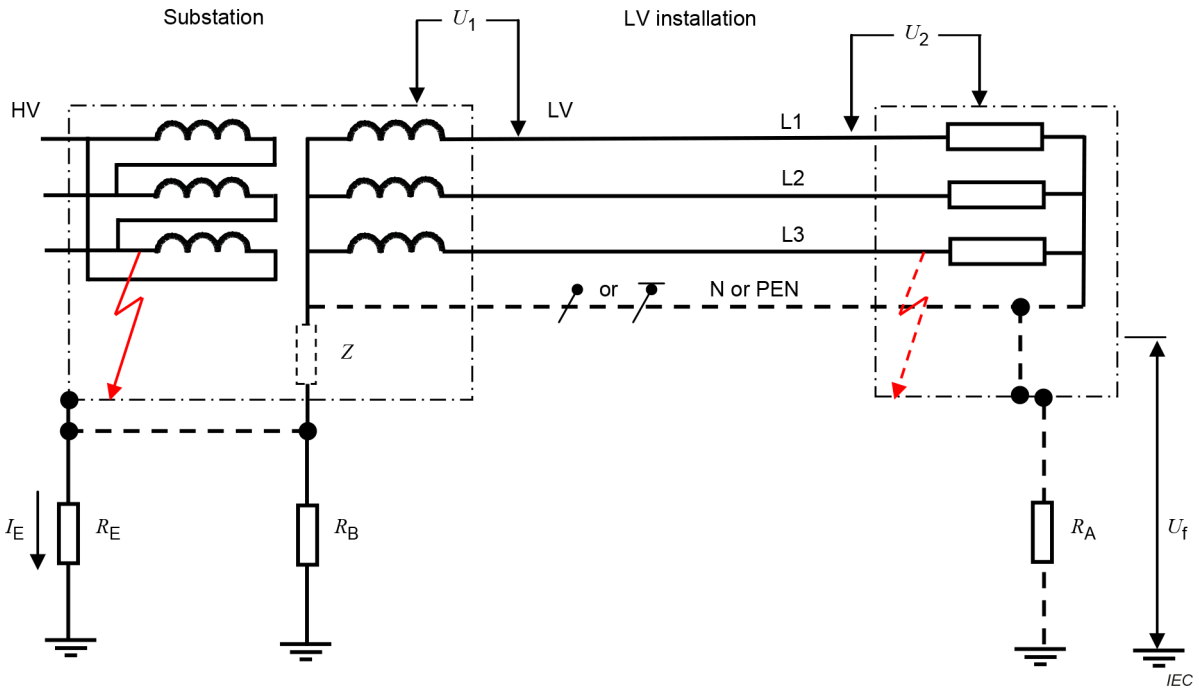

Figure 1 – Representative schematic diagram for possible connections to earth in substation and LV-installation and occurring overvoltages in case of faults

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.