IEC 60364-4-44

Edition 2.0 2007-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

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

FOREWORD

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

This second edition of IEC 60364-4-44 cancels and replaces the first edition published in 2001, amendment 1 (2003) and amendment 2 (2006).

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

The text of this standard is based on the first edition, its Amendment 1, Amendment 2 and the following documents:

FDIS	Report on voting
64/1600/FDIS	64/1609/RVD

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 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 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

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- withdrawn,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

The contents of the corrigenda of May 2010 and October 2011 have been included in this copy.

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 disturbances 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 60038:1983, *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 60364-5-54:2002, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective bonding conductors* [1]

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*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

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1 A third edition is currently in preparation.

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61558-2-1, *Safety of power transformers, power supplies, reactors and similar products – Part 2-1: Particular requirements for tests for separating transformers and power supplies incorporating separating transformers for general applications*

IEC 61558-2-4, *Safety of power transformers, power supply units and similar – Part 2-4: Particular requirements for isolating transformers for general use*

IEC 61558-2-6, *Safety of power transformers, power supply units and similar – Part 2-6: Particular requirements for safety isolating transformers for general use*

IEC 61558-2-15, *Safety of power transformers, power supply units and similar – Part 2-15: Particular requirements for isolating transformers for the supply of medical locations*

IEC 61643 (all parts), *Low-voltage surge protective devices*

IEC 61936-1, *Power installations exceeding 1 kV a.c. – Part 1: Common rules*

IEC 62305-1, *Protection against lightning – Part 1: General principles*

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

IEC 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

441 (Vacant)

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

The rules of this clause provide 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.

442.1.1 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 consider four situations as proposed in 442.1, which generally cause the most severe temporary overvoltages such as defined in IEC 60050-604:

– 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).

442.1.2 Symbols

In Clause 442 the following symbols are used (see Figure 44.A1):

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 a.c. r.m.s. line voltage to earth

in IT-systems: nominal a.c. 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 44.A1).

I_d fault current, in accordance with 411.6.2, 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 44.A1).

Z impedance (e.g. IMD internal impedance, artificial neutral impedance) between the low-voltage system and an earthing arrangement.

NOTE 2 An earthing arrangement may 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.

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

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 44.A1 provides the relevant methods of calculation for the different types of overvoltages.

NOTE 1 Table 44.A1 deals with IT systems with a neutral point only. For IT systems with no neutral point, the formulae should be adjusted accordingly.

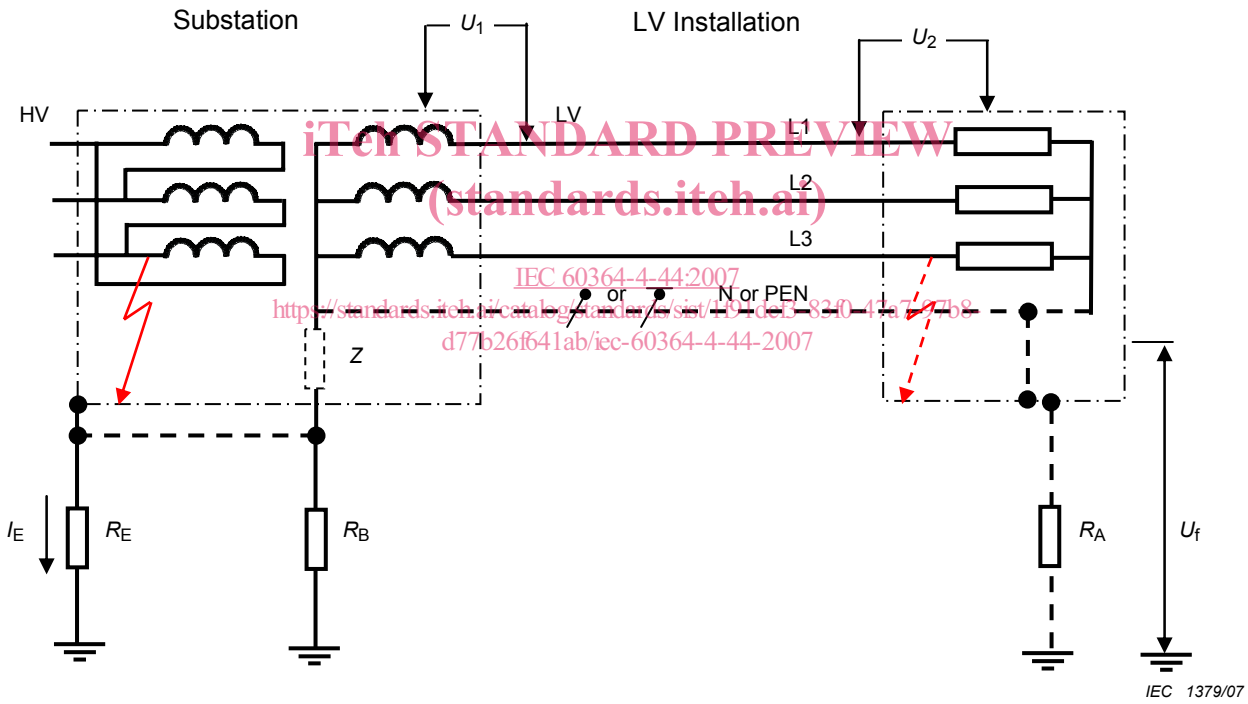

Figure 44.A1 – Representative schematic sketch for possible connections to earth in substation and LV-installation and occurring overvoltages in case of faults

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

Table 44.A1 – Power-frequency stress voltages and power-frequency fault voltage in low-voltage system

Types of system earthing	Types of earth connections	U_1	U_2	U_f
TT	R_E and R_B connected	U_o *)	$R_E \times I_E + U_o$	0 *)
	R_E and R_B separated	$R_E \times I_E + U_o$	U_o *)	0 *)
TN	R_E and R_B connected	U_o *)	U_o *)	$R_E \times I_E$ **)
	R_E and R_B separated	$R_E \times I_E + U_o$	U_o *)	0 *)
IT	R_E and Z connected R_E and R_A separated	U_o *)	$R_E \times I_E + U_o$	0 *)
		$U_o \times \sqrt{3}$	$R_E \times I_E + U_o \times \sqrt{3}$	$R_A \times I_h$
	R_E and Z connected R_E and R_A interconnected	U_o *)	U_o *)	$R_E \times I_E$
		$U_o \times \sqrt{3}$	$U_o \times \sqrt{3}$	$R_E \times I_E$
	R_E and Z separated R_E and R_A separated	$R_E \times I_E + U_o$	U_o *)	0 *)
		$R_E \times I_E + U_o \times \sqrt{3}$	$U_o \times \sqrt{3}$	$R_A \times I_d$

*) No consideration needs to be given.

**) See 442.2.1 second paragraph.

With existing earth fault in the installation.

NOTE 3 The requirements for U_1 and U_2 are derived from design criteria for insulation of low-voltage equipment with regard to temporary power-frequency overvoltage (see also Table 44.A2).

NOTE 4 In a system whose neutral is connected to the earthing arrangement of the transformer substation, such temporary power-frequency overvoltage is also to be expected across insulation which is not in an earthed enclosure when the equipment is outside a building.

NOTE 5 In TT- and TN-systems the statement “connected” and “separated” refers to the electrical connection between R_E and R_B. For IT-systems it refers to the electrical connection between R_E and Z and the connection between R_E and R_A.

442.2.1 Magnitude and duration of power-frequency fault voltage

The magnitude and the duration of the fault voltage U_f (as calculated in Table 44.A1) which appears in the LV installation between exposed-conductive-parts and earth, shall not exceed the values given for U_f by the curve of Figure 44.A2 for the duration of the fault.

Normally, the PEN conductor of the low-voltage system is connected to earth at more than one point. In this case, the total resistance is reduced. For these multiple grounded PEN conductors, U_f can be calculated as:

$$U_f = 0{,}5\, R_E \times I_E$$

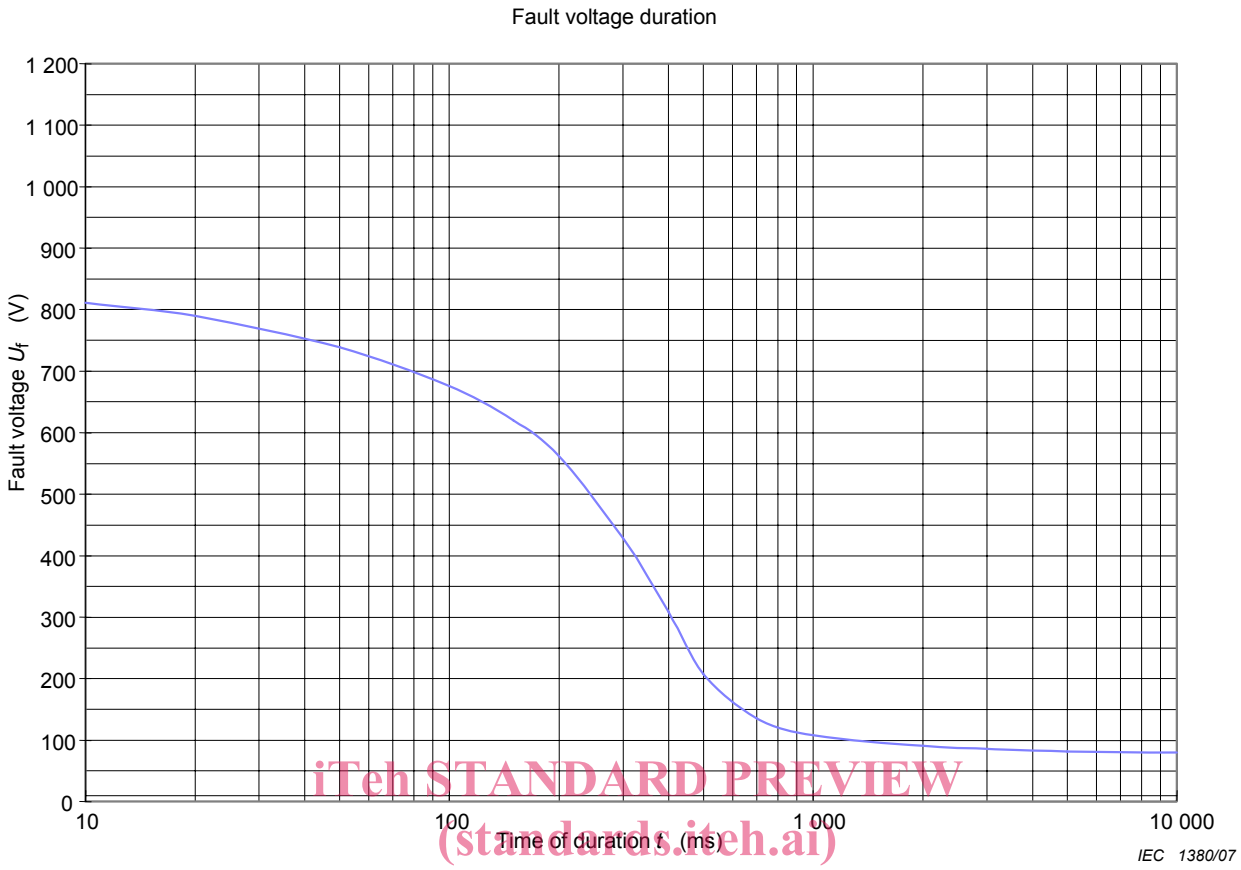

Figure 44.A2 – Tolerable fault voltage due to an earth-fault in the HV system

NOTE The curve shown in Figure 44.A2 is taken from IEC 61936-1. On the basis of probabilistic and statistical evidence this curve represents a low level of risk for the simple worst case where the low voltage system neutral conductor is earthed only at the transformer substation earthing arrangements. Guidance is provided in IEC 61936-1 concerning other situations.

442.2.2 Magnitude and duration of power-frequency stress voltages

The magnitude and the duration of the power-frequency stress voltage (U_1 and U_2) as calculated in Table 44.A1 of the low-voltage equipment in the low-voltage installation due to an earth fault in the high-voltage system shall not exceed the requirements given in Table 44.A2.

Table 44.A2 – Permissible power-frequency stress voltage

Duration of the earth fault in the high-voltage system	**Permissible power-frequency stress voltage on equipment in low-voltage installations**
t	U
>5 s	U_o + 250 V
≤5 s	U_o + 1 200 V
In systems without a neutral conductor, U_o shall be the line-to-line voltage.	
NOTE 1 The first line of the table relates to high-voltage systems having long disconnection times, for example, isolated neutral and resonant earthed high-voltage systems. The second line relates to high-voltage systems having short disconnection times, for example low-impedance earthed high-voltage systems. Both lines together are relevant design criteria for insulation of low-voltage equipment with regard to temporary power frequency overvoltage, see IEC 60664-1. NOTE 2 In a system whose neutral is connected to the earthing arrangement of the transformer substation, such temporary power-frequency overvoltage is also to be expected across insulation which is not in an earthed enclosure when the equipment is outside a building.	