Madalpingelised elektripaigaldised. Osa 4-442: Kaitseviisid. Madalpingepaigaldiste kaitse kõrgepingevõrkude maaühenduste tagajärjel ja madalpingevõrkude rikete tagajärjel tekkivate ajutiste liigpingete eest

Low-voltage electrical installations - Part 4-442: Protection for safety - 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

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EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-HD 60364-4-442:2012 sisaldab Euroopa standardi HD 60364-4-442:2012+AC:2012 ingliskeelset teksti.	This Estonian standard EVS-HD 60364-4-442:2012 consists of the English text of the European standard HD 60364-4-442:2012+AC:2012.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 13.01.2012.	Date of Availability of the European standard is 13.01.2012.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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Low-voltage electrical installations - Part 4-442: Protection for safety - 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

(IEC 60364-4-44:2007 (CLAUSE 442), modified)

Installations électriques à basse tension - Partie 4-442: Protection pour assurer la sécurité - Protection des installations électriques à basse tension contre les surtensions temporaires dues à des défauts à la terre dans le réseau haute tension et dues à des défauts dans le réseau basse tension (CEI 60364-4-44:2007 (CLAUSE 442), modifiée)

Errichten von Niederspannungsanlagen - Teil 4-442: Schutzmaßnahmen - Schutz von Niederspannungsanlagen bei vorübergehenden Überspannungen infolge von Erdschlüssen im Hochspannungssystem und infolge von Fehlern im Niederspannungssystem (IEC 60364-4-44:2007 (CLAUSE 442), modifiziert)

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. HD 60364-4-442:2012 E

Foreword

This document (HD 60364-4-442:2012) consists of the text of IEC 60364-4-44:2007 prepared by IEC/TC 64, "Electrical installations and protection against electric shock", together with the common modifications prepared by CLC/TC 64 "Electrical installations and protection against electric shock".

The following dates are fixed:

– latest date by which the HD has to be implemented at national level by publication of a harmonized national standard or by endorsement	(dop)	2012-12-07
– latest date by which the national standards conflicting with the HD have to be withdrawn	(dow)	2014-12-07

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

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Endorsement notice

The text of the International Standard IEC 60364-4-44:2007 was approved by CENELEC as a Harmonization document with common modifications.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60364-5-51:2005	NOTE	Harmonized as HD 60364-5-51:2009 (modified).
IEC 61000-2 series	NOTE	Harmonized in EN 61000-2 series (not modified).
IEC 61000-5 series	NOTE	Harmonized in EN 61000-5 series (not modified).
IEC 61386 series	NOTE	Harmonized in EN 61386 series (not modified).
IEC 61663-1	NOTE	Harmonized as EN 61663-1.
IEC 62020:1998	NOTE	Harmonized as EN 62020:1998 (not modified).

COMMON MODIFICATIONS

Title:

Replace the title of HD 60364-4-442 as follows:

Low-voltage electrical installations - Part 4-442: Protection for safety - 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

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

In the footnote**) **delete** “second paragraph”.

442.2.1 Magnitude and duration of power-frequency fault voltage

Replace 442.2.1 and its contents as follows:

442.2.1 Power-frequency fault voltage

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 a dangerous level, see HD 60364-4-41.

In a TN system where R_E and R_B are connected together (see Table 44.A1), their connection to a L.V. global earthing system as described in EN 50522:2010, 3.4.19 can then be considered to be a safety measure against dangerous fault voltages.

NOTE 1 A global earthing system is an earthing system created by the interconnection of local earthing systems that ensures, by the proximity of these earthing systems, that there are no dangerous touch voltages.

Such systems cause the division of the earth fault current in a way that results in a reduction of the earth potential rise at the local earthing system. Such a system could be said to form a quasi equipotential surface.

In installations outside a global earthing system, the PEN conductor shall be earthed additionally at least one more time.

NOTE 2 The existence of a global earthing system may be determined by sample measurements or calculation for typical systems. Typical examples of global earthing systems are in city centres; urban or industrial areas with distributed low- and high-voltage earthing.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
-	-	Earthing of power installations exceeding 1 Kv a.c.	EN 50522	2010
IEC 60038 (mod)	1983	Nominal voltages for low-voltage public electricity supply systems	HD 472 S1 + corr. February + A1	1989 2002 1995
IEC 60050-604	1987	International Electrotechnical Vocabulary (IEV) - 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	HD 60364-1	-
IEC 60364-4-41 (mod)	2005	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock	HD 60364-4-41 + corr. July	2007 2007
IEC 60364-5-54 (mod)	2002	Electrical installations of buildings - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements, protective conductors and protective bonding conductors	HD 60364-5-54	2007
IEC/TS 60479-1	2005	Effects of current on human beings and livestock - Part 1: General aspects	-	-
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 60950-1	-	Information technology equipment - Safety - Part 1: General requirements	EN 60950-1	-

Publication	Year	Title	EN/HD	Year
IEC/TS 61000-2-5	1995	Electromagnetic compatibility (EMC) - Part 2-5: Environment - 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	EN 61000-6-1	2007 [1)]
IEC 61000-6-2	-	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments	EN 61000-6-2 + corr. September	2005 [1)] 2005
IEC 61000-6-3	-	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	EN 61000-6-3	2007 [1)]
IEC 61000-6-4	-	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments	EN 61000-6-4	-
IEC 61558-2-1	-	Safety of power transformers, power supplies, reactors and similar products - Part 2-1: Particular requirements and tests for separating transformers and power supplies incorporating separating transformers for general applications	EN 61558-2-1	-
IEC 61558-2-4	-	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V - Part 2-4: Particular requirements and tests for isolating transformers and power supply units incorporating isolating transformers	EN 61558-2-4	-
IEC 61558-2-6	-	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V - Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers	EN 61558-2-6	-

1) Dated reference in accordance with CLC Guide 25.

Publication	Year	Title	EN/HD	Year
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	EN 61558-2-15	-
IEC 61643	series	Low-voltage surge protective devices	EN 61643/ CLC/TS 61643	series
IEC 61936-1	-	Power installations exceeding 1 kV a.c. - Part 1: Common rules	EN 61936-1	-
IEC 62305-1	-	Protection against lightning - Part 1: General principles	EN 62305-1	-
IEC 62305-3	-	Protection against lightning - Part 3: Physical damage to structures and life hazard	EN 62305-3	-
IEC 62305-4	-	Protection against lightning - Part 4: Electrical and electronic systems within structures	EN 62305-4	-

Annex ZB
(normative)

Special national conditions

Special national condition: National characteristic or practice that cannot be changed even over a long period, e.g. climatic conditions, electrical earthing conditions.

NOTE If it affects harmonization, it forms part of the Harmonization Document.

For the countries in which the relevant special national conditions apply these provisions are normative, for other countries they are informative.

Clause	Special national condition
442.2 **Table 44.A1**	**Italy** In Italy the permissible power-frequency stress voltage on equipment in low-voltage installations in case of a duration of the earth fault in the high-voltage system ≤ 5 s is U_o + 500 V.

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.

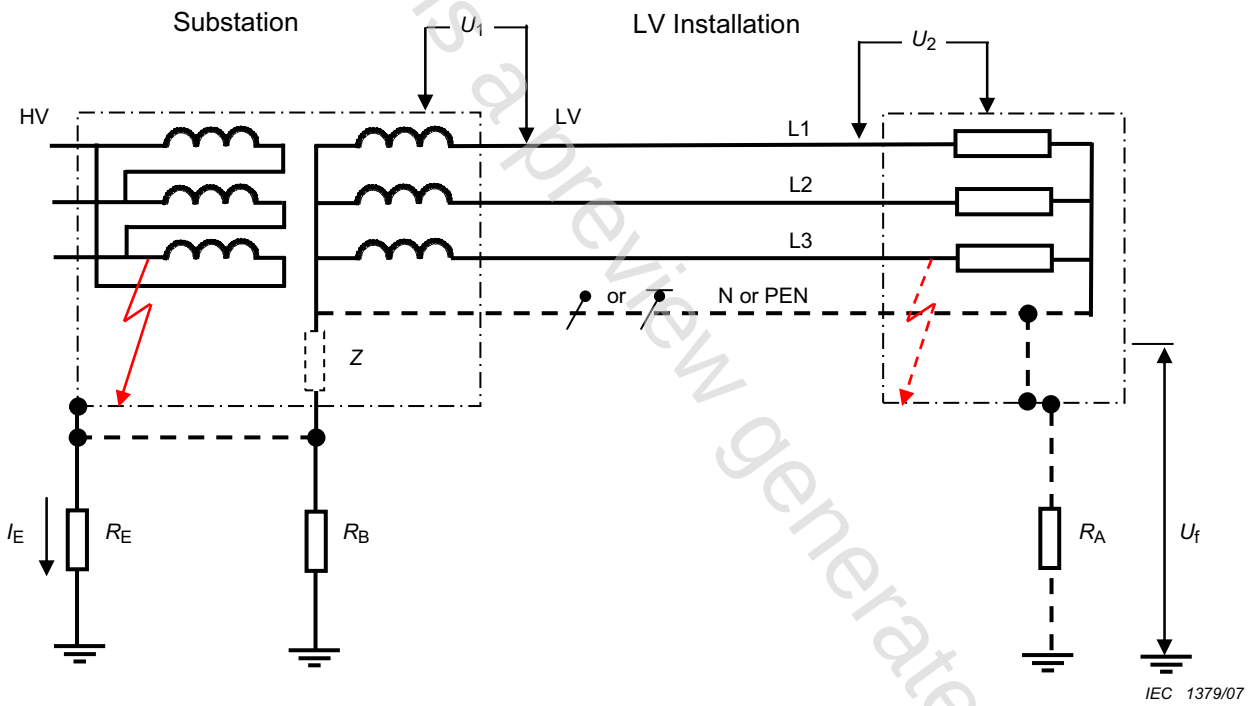

Figure 44.A1 – Representative schematic sketch for possible connections to earth in substation and LV-installation and occurring overvoltages in case of faults

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:

$$U_f = 0{,}5\, R_F \times I_F$$

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.	

442.2.3 Requirements for calculation of limits

Where required by Table 44.A1, the permissible power-frequency stress voltage shall not exceed the value given in Table 44.A2.

Where required by Table 44.A1, the permissible power-frequency fault voltage shall not exceed the value given in Figure 44.A2.

The requirements of 442.2.1 and 442.2.2 are deemed to be fulfilled for installations receiving a supply at low-voltage from a public electricity distribution system.

To fulfil the above requirements, coordination between the HV-system operator and the LV-system installer is necessary. Compliance with the above requirements mainly falls into the responsibility of the substation installer/owner/operator who needs also to fulfil requirements provided by IEC 61936-1. Therefore the calculation for U_1, U_2 and U_f is normally not necessary for the LV system installer.

Possible measures to fulfil the above requirements are e.g.

- separation of earthing arrangement between HV and LV;
- change of LV system earthing;
- reduction of earth resistance R_E.

442.3 Power-frequency stress voltage in case of loss of the neutral conductor in a TN and TT system

Consideration shall be given to the fact that, if the neutral conductor in a multi-phase system is interrupted, basic, double and reinforced insulation as well as components rated for the voltage between line and neutral conductors can be temporarily stressed with the line-to-line voltage. The stress voltage can reach up to $U = \sqrt{3}\ U_o$.

442.4 Power-frequency stress voltage in the event of an earth fault in an IT system with distributed neutral

Consideration shall be given to the fact that, if a line conductor of an IT system is earthed accidentally, insulation or components rated for the voltage between line and neutral conductors can be temporarily stressed with the line-to-line voltage. The stress voltage can reach up to $U = \sqrt{3}\ U_o$.

442.5 Power-frequency stress voltage in the event of a short-circuit between a line conductor and the neutral conductor

Consideration shall be given to the fact that if a short-circuit occurs in the low-voltage installation between a phase conductor and the neutral conductor, the voltage between the other line conductors and the neutral conductor can reach the value of 1,45 x U_o for a time up to 5 s.