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Low-voltage surge protective devices -- Part 12: Surge protective devices connected to low-voltage power distribution systems - Selection and application principles

Überspannungsschutzgeräte für Niederspannung - Teil 12: Überspannungsschutzgeräte für den Einsatz in Niederspannungsanlagen - Auswahl und Anwendungsgrundsätze

Parafoudres basse tension - Partie 12: Parafoudres connectés aux réseaux de distribution basse tension - Principes de choix et d'application

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English version

Low-voltage surge protective devices - Part 12: Surge protective devices connected to low-voltage power distribution systems - Selection and application principles

(IEC 61643-12:2008, modified)

Parafoudres basse tension -
Partie 12: Parafoudres connectés
aux réseaux de distribution basse tension -
Principes de choix et d'application
(CEI 61643-12:2008, modifiée)

Überspannungsschutzgeräte
für Niederspannung -
Teil 12: Überspannungsschutzgeräte
für den Einsatz
in Niederspannungsanlagen -
Auswahl und Anwendungsgrundsätze
(IEC 61643-12:2008, modifiziert)

This Technical Specification was approved by CENELEC on 2009-10-30.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

This Technical Specification consists of the text of the International Standard IEC 61643-12:2008 prepared by SC 37A, Low-voltage surge protective devices, of IEC TC 37, Surge arresters, together with the common modifications prepared by the Technical Committee CENELEC TC 37A, Low voltage surge protective devices.

The text of the draft was circulated for voting in accordance with the Internal Regulations, Part 2, Subclause 11.3.3.3 and was accepted by CENELEC as CLC/TS 61643-12 on 2009-10-30.

This Technical Specification supersedes CLC/TS 61643-12:2006.

The following date was fixed:

– latest date by which the existence of the CLC/TS has to be announced at national level (doa) 2010-04-30

This Technical Specification is to be used in conjunction with EN 61643-11:2002.

Contents

Figures

Tables

0 Introduction

0.1 General

This Technical Specification is to be used with EN 61643-11:2002.

Surge protective devices (SPDs) are used to protect, under specified conditions, electrical systems and equipment against various overvoltages and impulse currents, such as lightning and switching surges.

SPDs shall be selected in accordance with their environmental conditions and the acceptable failure rate of the equipment and the SPDs.

This Technical Specification provides information :

- to the user about characteristics useful for the selection of an SPD.
- to evaluate, with reference to EN 62305-1 to EN 62305-4 and HD 384/60364 series, the need for using SPDs in low-voltage systems.
- on selection and co-ordination of SPDs, while taking into account the entire environment in which they are applied. Some examples are: equipment to be protected and system characteristics, insulation levels, overvoltages, method of installation, location of SPDs, co-ordination of SPDs, failure mode of SPDs and equipment failure consequences.
- and provides guidance to perform a risk analysis.

The HD 384/60364 series of harmonised documents provides direct information for contractors on the installation of SPDs.

For the purpose of having a usable and complete working document, parts from existing documents have been duplicated where necessary. Such parts are explicitly mentioned in the text and attention is drawn to the reader that these parts may change in future.

0.2 Keys to understanding the structure of this Technical Specification

The list below summarizes the structure of this Technical Specification and provides a summary of the information covered in each clause and annex. The main clauses provide basic information on the factors used for SPD selection. Readers who wish to obtain more detail on the information provided in Clauses 4 to 7 should refer to the relevant annexes.

Clause 1 describes the scope of this Technical Specification.

Clause 2 lists the normative references where additional information may be found.

Clause 3 provides definitions useful for the comprehension of this Technical Specification.

Clause 4 addresses the parameters of systems and equipment relevant to SPDs. In addition to the stresses created by lightning, those created by the network itself as temporary overvoltages and switching surges are described.

Clause 5 lists the electrical parameters used in the selection of an SPD and gives some explanation regarding these parameters. These are related to the data given in EN 61643-11.

Clause 6 is the core of this Technical Specification. It relates the stresses coming from the network (as discussed in Clause 4) to the characteristics of the SPD (as discussed in Clause 5). It outlines how the protection given by SPDs may be affected by its installation. The different steps for the selection of an SPD are presented including the problems of co-ordination when more than one SPD is used in an installation (details about co-ordination may be found in Annex F).

Clause 7 is an introduction to the risk analysis (considerations of when the use of SPDs is beneficial).

Clause 8 deals with co-ordination between signalling and power lines (under consideration).

Annex A gives examples of various SPD technologies.

Annex B deals with explanations of testing procedures used in EN 61643-11.

Annex C deals with the calculation of the sharing of lightning current between different earthing systems.

Annex D provides specific examples on the use of this Technical Specification.

Annex E provides specific examples of the use of the risk analysis.

Annex F deals with consideration when Type 1 SPDs are to be applied.

Annex G discusses differences between immunity level and insulation withstand of equipments.

Annex H provides practical examples of SPD installation as used in some countries.

Annex I deals with surge withstand of fuses.

Annex J provides SPD coordination tests principles.

Annex K provides simple calculation of I_{imp} for Type 1 SPDs in case of a building protected by a LPS.

1 Scope

This Technical Specification describes the principles for selection, operation, location and co-ordination of SPDs to be connected to 50 Hz to 60 Hz a.c. power circuits and equipment rated up to 1 000 V r.m.s..

NOTE 1 This Technical Specification deals only with SPDs and not with SPDs components integrated inside equipment.

NOTE 2 Additional requirements may be necessary for special applications such as electrical traction, etc.

NOTE 3 It should be remembered that IEC 60364 series and EN 62305-4 are also applicable.

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.

HD 384/60364 series, *Electrical installations of buildings/Low-voltage electrical installations* (IEC 60364 series, mod.)

HD 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock* (IEC 60364-4-41, mod.)

HD 60364-4-443:2006, *Electrical installations of buildings – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances – Clause 443: Protection against overvoltages of atmospheric origin or due to switching* (IEC 60364-4-44:2001/A1:2003, mod.)

HD 60364-5-534:2008, *Low-voltage electrical installations – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control – Clause 534: Devices for protection against overvoltages* (IEC 60364-5-53:2001/A1:2002 (Clause 534), mod.)

EN 60529, *Degrees of protection provided by enclosures (IP Code)* (IEC 60529)

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

EN 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test* (IEC 61000-4-5)

EN 61008-1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's) – Part 1: General rules* (IEC 61008-1, mod.)

EN 61009-1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) – Part 1: General rules* (IEC 61009-1, mod.)

EN 61643-11:2002 + A11:2007, *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and tests* (IEC 61643-1:1998, mod. + corrigendum Dec. 1998, mod.)

EN 62305-1:2006, *Protection against lightning – Part 1: General principles* (IEC 62305-1:2006)

EN 62305-2, *Protection against lightning – Part 2: Risk management* (IEC 62305-2)

EN 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard* (IEC 62305-3, mod.)

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE These definitions are for the most part reproduced from EN 61643-11 (the definition number being indicated within square brackets). Where necessary a note has been added for better understanding regarding application of SPDs.

3.1
surge protective device
SPD
device that is intended to limit transient overvoltages and divert surge currents. It contains at least one non-linear component

[EN 61643-11:2002, Definition 3.1]

3.2
continuous operating current
I_c
current flowing through each mode of protection of the SPD when energized at the maximum continuous operating voltage (U_c) for each mode

3.3
maximum continuous operating voltage
U_c
maximum r.m.s. voltage which may be continuously applied to the SPD's mode of protection. This is equal to the rated voltage

[EN 61643-11:2002, Definition 3.11]

3.4
voltage protection level
U_p
parameter that characterizes the performance of the SPD in limiting the voltage across its terminals, which is selected from a list of preferred values. This value is greater than the highest value of the measured limiting voltages

[EN 61643-11:2002, Definition 3.15]

3.5
measured limiting voltage
maximum magnitude of voltage that is measured across the terminals of the SPD during the application of impulses of specified waveshape and amplitude

[EN 61643-11:2002, Definition 3.16]

3.6
residual voltage
U_{res}
peak value of voltage that appears between the terminals of an SPD due to the passage of discharge current

[EN 61643-11:2002, Definition 3.17]

3.7
temporary overvoltage test value
U_T
test voltage applied for a specific duration, to the SPD to simulate the stress under TOV conditions

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.18, by adding the following note.

NOTE 2 It is a characteristic declared by the manufacturer that gives information about the behaviour of the SPD when stressed with voltages U_T above U_c for a given specific duration t_T (this behaviour may either be no change in the performance after application of the temporary overvoltage or a defined failure without hazard for either personnel, equipment or facility).

3.8
temporary overvoltage of the network
U_{TOV}
power frequency overvoltage occurring on the network at a given location, of relatively long duration. TOVs may be caused by faults inside the LV system ($U_{TOV,LV}$) or inside the HV system ($U_{TOV,HV}$)

NOTE Temporary overvoltages, typically lasting up to several seconds, usually originate from switching operations or faults (for example, sudden load rejection, single-phase faults, etc.) and/or from non-linearity (ferroresonance effects, harmonics, etc.).

3.9
nominal discharge current
I_n
crest value of the current through the SPD having a current waveshape of 8/20. This is used for the classification of the SPD for class II test and also for preconditioning of the SPD for class I and II tests

[EN 61643-11:2002, Definition 3.8]

3.10
impulse current
I_{imp}
it is defined by three parameters, a current peak value I_{peak}, a charge Q and a specific energy W/R. Tested in accordance with the test sequence of the operating duty test. This is used for the classification of the SPD for class I test

[EN 61643-11:2002, Definition 3.9]

3.11
thermal runaway
operational condition when the sustained power dissipation of an SPD exceeds the thermal dissipation capability of the housing and connections, leading to a cumulative increase in the temperature of the internal elements culminating in failure

[EN 61643-11:2002, Definition 3.25]

3.12
thermal stability
an SPD is thermally stable if after the operating duty test causing temperature rise, the temperature of the SPD decreases with time when the SPD is energized at specified maximum continuous operating voltage and at specified ambient temperature conditions

[EN 61643-11:2002, Definition 3.26]

3.13
SPD disconnector
device (internal and/or external) required for disconnecting an SPD from the power system

NOTE This disconnecting device is not required to have isolating capability. It is to prevent a persistent fault on the system and is used to give indication of the SPD failure.

There may be more than one disconnector function for example, an overcurrent protection function and a thermal protection function. These functions may be integrated into one unit or performed in separate units.

[EN 61643-11:2002, Definition 3.29]

3.14
short-circuit withstand
maximum prospective short-circuit current that the SPD is able to withstand

[EN 61643-11:2002, Definition 3.28]

3.15
one-port SPD
SPD connected in shunt with the circuit to be protected. A one-port device may have separate input and output terminals without a specified series impedance between these terminals

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.2, by adding the following note.

NOTE 2 Annex A shows some typical one-port SPDs and the generic drawing for a one-port SPD. A one-port SPD may be connected in shunt, Figure A.1 a), or in line with the power supply. In the first case the load current is not flowing through the SPD. In the second case, the load current is flowing through the SPD and the temperature rise under load current and the associated maximum admissible load current may be determined as for a two-port SPD. Figure A.3 shows the response of various types of one-port SPD to an 8/20 impulse applied via a combination wave generator.

3.16
two-port SPD
SPD with two sets of terminals, input and output. A specific series impedance is inserted between these terminals

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.3, by adding the following note.

NOTE 2 The measured limiting voltage may be higher at the input terminals than at the output terminals. Therefore, equipment to be protected shall be connected to the output terminals. Figure A.2 shows typical two-port SPDs. Figure A.3 shows the response of a two-port SPD to an 8/20 impulse applied via a combination wave generator.

3.17
voltage switching type SPD

SPD that has a high impedance when no surge is present, but can have a sudden change in impedance to a low value in response to a voltage surge. Common examples of components used as voltage-switching devices are spark-gaps, gas discharge tubes (GDT), thyristors (silicon-controlled rectifiers) and triacs. These SPDs are sometimes called "crowbar type"

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.4, by adding the following note.

NOTE 2 A voltage-switching device has a discontinuous U versus I characteristic. Figure 3c shows the response of a typical voltage switching SPD to an impulse applied via a combination wave generator.

3.18
voltage limiting type SPD
SPD that has a high impedance when no surge is present, but will reduce it continuously with increased surge current and voltage. Common examples of components used as non-linear devices are: varistors and suppressor diodes. These SPDs are sometimes called "clamping type"

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.5, by adding the following note.

NOTE 2 A voltage-limiting device has a continuous U versus I characteristic. Figure 3b shows the response of a typical voltage-limiting SPD to an impulse applied via a combination wave generator.

3.19
combination type SPD
SPD that incorporates both voltage switching type components and voltage limiting type components may exhibit voltage-switching, voltage-limiting, or both voltage-switching and voltage-limiting behaviour depending upon the characteristics of the applied voltage

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.6, by adding the following note.

NOTE 2 Figure A.3 shows the response of various typical combination type SPDs to a combination wave impulse.

3.20
modes of protection
SPD protective components may be connected line to line or line to earth or line to neutral or neutral to earth and combination thereof. These paths are referred to as modes of protection

[EN 61643-11:2002, Definition 3.7]

3.21
follow current
I_f
current supplied by the electrical power system and flowing through the SPD after a discharge current impulse. The follow current is significantly different from the continuous operating current (I_c)

[EN 61643-11:2002, Definition 3.13]

3.22
maximum discharge current for class II test
(I_{max})
crest value of a current through the SPD having an 8/20 waveshape and magnitude in accordance with the test sequence of the class II operating duty test. I_{max} is greater than I_n

[EN 61643-11:2002, Definition 3.10]

3.23
degradation
change of original performance parameters as a result of exposure of the SPD to surge, service or unfavourable environment

NOTE 1 Adapted from 3.27 of EN 61643-11 by adding the following note.

NOTE 2 Degradation is a measure of the ability of an SPD to withstand the conditions for which it is designed throughout its service life. Two type tests are applied to provide confidence with respect to degradation. The first one is the operating duty test and the second is the ageing test. However, these two tests may be combined.

The operating duty test is conducted by applying a specified number of defined current waveshapes to the SPD. Permitted changes in the SPD characteristics are given in EN 61643-11.

The ageing test is carried out at a specified temperature with a voltage of specified magnitude and duration applied to the SPD. Permitted changes in the SPD characteristics are given in this Technical Specification (this test is under consideration).

This can be used to determine the SPD prospective installed life which should also consider the following:

– replacement policy;
– location and accessibility;

– acceptable failure rate;
– operating practices.

3.24
residual current device
RCD
mechanical switching device or association of devices intended to cause the opening of the contacts when the residual or unbalanced current attains a given value under specified conditions

[EN 61643-11:2002, Definition 3.37]

3.25
nominal voltage of the system phase to earth
U_n
voltage by which a system or equipment is designated and to which certain operating characteristics are referred (for example, 230/400 V).

Under normal system conditions, the voltage at the supply terminals may differ from the nominal voltage as determined by the tolerances of the supply systems. In this Technical Specification a tolerance of ± 10 % is used

3.26
line to neutral voltage of the system
U_o
line to neutral voltage (r.m.s. value of the a.c. voltage) of the system, derived from the nominal system voltage (the voltage by which the system is designated)

[EN 61643-11:2002, Definition 3.46]

3.27
rated load current (I_L)
maximum continuous rated r.m.s. current that can be supplied to a load connected to the protected output of an SPD

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.14, by adding the following note.

NOTE 2 This is only relevant to SPD(s) having separate input and output terminals.

3.28
overcurrent protection
overcurrent device (e.g. circuit breaker or fuse), which could be part of the electrical installation located externally up-stream of the SPD

[EN 61643-11:2002, Definition 3.36]

3.29
maximum continuous operating voltage of the power system at the SPD location
U_{cs}
maximum r.m.s. voltage to which the SPD may be permanently subjected at the point of application of the SPD

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.49, by adding the following notes

NOTE 2 This takes into account only voltage regulation and/or voltage drop or increase. It is also called actual maximum system voltage (see Figure 6) and is directly linked to U_0

NOTE 3 This voltage does not take into account harmonics, faults, TOVs or transient conditions.

3.30
sparkover voltage of a voltage-switching SPD

maximum voltage value before disruptive discharge between the electrodes of the gap of a SPD

NOTE 1 Adapted from EN 61643-11:2002, Definition 3.38, by adding the following note.

NOTE 2 A voltage-switching SPD may be based on components other than gaps (for example, silicon-based components).

3.31
lightning protection system
LPS
complete system used to protect a structure and its contents against the effects of lightning

3.32
multiservice SPD
surge protective device providing protection for two or more services such as power, telecommunication and signalling in a single enclosure in which a reference bond is provided between services during surge conditions

3.33
residual current
I_{PE}
current flowing through the PE terminal, when the SPD is energized at the maximum continuous operating voltage (U_c) when connected in accordance with the manufacturer instructions

[EN 61643-11:2002, Definition 3.42]

3.34
prospective short-circuit current of a power supply
I_p
current which would flow at a given location in a circuit if it were short-circuited at that location by a link of negligible impedance

[EN 61643-11:2002, Definition 3.40]