ICS 29.240, 29.240.01, 29.240.10

SLOVENSKÁ TECHNICKÁ NORMA

Október 2019

STN	**Nízkonapäťové prepäťové ochranné prístroje Časť 31: Požiadavky a skúšobné metódy pre prepäťové ochranné prístroje (SPD) vo fotovoltických inštaláciách**	**STN EN 61643-31** 34 1393

Low-voltage surge protective devices - Part 31: Requirements and test methods for SPDs for photovoltaic installations

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 09/19

Obsahuje: EN 61643-31:2019, IEC 61643-31:2018

Oznámením tejto normy sa od 03.05.2022 ruší
STN EN 50539-11 (34 1395) z novembra 2013

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61643-31

May 2019

ICS 29.240; 29.240.10 Supersedes EN 50539-11:2013

English Version

Low-voltage surge protective devices - Part 31: Requirements and test methods for SPDs for photovoltaic installations (IEC 61643-31:2018 , modified)

Parafoudres basse tension - Partie 31: Parafoudres pour usage spécifique y compris en courant continu - Exigences et méthodes d'essai des parafoudres pour installations photovoltaïques (IEC 61643-31:2018 , modifiée)

Überspannungsschutzgeräte für Niederspannung - Teil 31: Anforderungen und Prüfungen für Überspannungsschutzgeräte in Photovoltaik-Installationen (IEC 61643-31:2018 , modifiziert)

This European Standard was approved by CENELEC on 2018-02-14. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 61643-31:2019 E

European foreword

The text of document 37A/306/FDIS, future edition 1 of IEC 61643-31, prepared by SC 37A: “Low-voltage surge protective devices”, of IEC/TC 37: “Surge arresters” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61643-31:2019.

A draft amendment, which covers common modifications to IEC 61643-31, was prepared by CLC/TC 37A "Low-voltage surge protective devices" and approved by CENELEC.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2019-11-03
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2022-05-03

EN 61643-31:2019 supersedes EN 50539-11:2013.

Clauses, subclauses, notes, tables, figures and annexes which are additional to those in IEC 61643-31:2019 are prefixed “Z”.

EN 61643-31:2019 includes the following significant technical changes with respect to EN 50539-11:2013: It includes also guidance for verification of conformity for products already tested according EN 50539-11:2013.

The main changes with respect of EN 50539-11:2013 are the complete restructuring and improvement of the test procedures and test sequences.

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

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

Endorsement notice

The text of the International Standard IEC 61643:2018 was approved by CENELEC as a European Standard with agreed common modifications.

COMMON MODIFICATIONS

Modify as follows:

Through the complete document: *Replace all IEC 61643 references by EN 61643*

Replace all IEC references by EN when relevant standard is listed in either the Normative reference or in the Bibliography sections.

Foreword *Add to the Foreword the following:*

This standard covers the principle elements and objectives for electrical equipment designed for use within certain voltage limits (LVD - 2014/35/EU) and for electromagnetic compatibility (EMCD - 2014/30/EU).

Introduction *Delete the last sentence in the Introduction.*

Scope *Modify the 5th paragraph to read:*

SPDs with separate input and output terminal(s) that contain specific series impedance between these terminal(s) (so called two-port SPDs according to EN 61643-11) are not covered. As test class III in EN 61643-11 was primarily developed to cover two-port SPDs, SPDs tested according to this test class are not intended to be used in PV-systems.

3.1.19 *Add the following note:*

NOTE EN 62475 provides the current impulse definitions of front time, time to half values and waveshape.

5.3 *Replace 5.3 by the following*:

Types 1 and 2 SPDs- Class I and II tests

Information required for class I and class II tests is given in Table Z1.

Table Z1 – Tests of types 1 and 2 SPDs

Type of SPD	Tests	Required information
Type 1	Class I	I_{imp}
Type 2	Class II	I_n

6.5 *Add new requirement:*

6.5.4 Vibration and shock

Information on vibration and shock tests for transportation and special applications can be found in Annex ZB of EN 61643-11.

7.4.4.2.2 *Replace:*

in less than 60 s when PV_4 with I_{SCPV} or DC_3 with 2,7 times I_{SCPV} is applied. During the tests when DC_3 with 2,7 times I_{SCPV} is applied, the fuse for detection shall not operate;

in less than 5 min when DC_3 with a prospective short-circuit current of equal to I_{SCPV} is applied.

by:

in less than 20 s when PV_4 with I_{SCPV} or DC_3 with 2,7 times I_{SCPV} is applied. During the tests when DC_3 with 2,7 times I_{SCPV} is applied, the fuse for detection shall not operate;

in less than 1 min when DC_3 with a prospective short-circuit current of equal to I_{SCPV} is applied.

7.4.4.3.2 *Replace:*

In less than 60 s during the test when PV_4 with a prospective short-circuit current of I_{SCPV} is applied;

by:

In less than 20 s during the test when PV_4 with a prospective short-circuit current of I_{SCPV} is applied;

Annex ZA *Add Annex ZA (See annexes)*

Annex ZB *Add Annex ZB (See annexes)*

Annex ZZ *Add Annex ZZ (See annexes)*

Bibliography *Modify Bibliography (See Annexes)*

Add the following annexes:

Annex ZA
(informative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60060-1	2010	High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	2010
IEC 60112	2003	Method for the determination of the proof and the comparative tracking indices of solid insulating materials	EN 60112	2003
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529	1991
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 61000	series	Electromagnetic compatibility (EMC)	EN 61000	series
IEC 61000-6-1	2005	Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments	EN 61000-6-1	2007
IEC 61000-6-3	2006	Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments	EN 61000-6-3	2007
IEC 60068-2-78	2012	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	2013
IEC 61180-1	1992	High-voltage test techniques for low-voltage equipment - Part 1: Definitions, test and procedure requirements	EN 61180-1	1994
IEC 60364-5-51	-	Electrical installation of buildings – Part 5-51: Selection and erection of electrical equipment; Common rules	HD 60364-5-51	2009

IEC 61643-11	2011	Low-voltage surge protective devices –Part 11: Surge protective devices connected to low-voltage power systems –Requirements and test methods	EN 61643-11 + A11	2012 2018
IEC 62475	-	High-current test techniques - Definitions and requirements for test currents and measuring systems	EN 62475	2010

Annex ZB
(normative)

Reduced test procedure

This annex addresses the number of samples to be submitted and test sequence to be applied for verification of conformity for products already tested according EN 50539-11:2013.

The simplified test procedure according to Table ZB.1 may then be applied for verification of conformity.

For new products complete type tests and samples according to Clause 7 are required.

Table ZB.1 - Simplified test procedure for SPDs already complying with EN 50539-11

Test sequence	Test description	Subclause	Testing required
1	Identification and marking	6.1.1 / 6.1.2 / 7.2	Yes[a]
	Mounting	6.3.1	No
	Terminals and connections	6.3.2 / 6.3.3	No
	Testing for protection against direct contact	6.2.1	Yes[b]
	Environment, IP code	6.4	No
	Residual current	6.2.2 / 7.4.1	No
	Continuous current	6.2.8 / 7.4.6	Yes
	Operating duty test	6.2.4 / 7.4.2	No
	Operating duty test for test classes I and II	7.2.3.2 / 7.4.2.3 / 7.4.2.4	No
	Additional duty test for test class I	7.4.2.5	No
	Thermal stability	6.2.5.3 / 7.4.3.2	Yes
	Air clearances and creepage distances	6.6.3.4 / 7.5.1	No
	Ball pressure test	6.4	No
	Resistance to abnormal heat and fire	6.4	No
	Tracking resistance	6.4	No
2	Voltage Protection level	6.2.3	No
3	Insulation resistance	6.2.6	No
	Dielectric withstand	6.2.7 / 7.4.5	No
3a	**See below - only if applicable**		
	Mechanical strength	6.3.5	No
	Temperature withstand	6.2.5 / 7.4.3.1	No
3b	**See below - only if applicable**		
4	Heat resistance	6.4	No
5[c]	SPD failure mode test	6.2.5.4 / 7.4.4	Yes[d]
6	Live test under damp heat	7.6.1	No
7	Total discharge current test for multipole SPDs	6.2.9	No
Additional tests for one-port-SPDs with separate input / output terminals			
3b	Rated load current	6.5.1 / 7.7.1.1	No
Additional tests for outdoor use SPDs			
8	Environmental tests for outdoor SPDs	6.5.2 / 7.7.2	No
Additional tests for SPDs with separate isolated circuits			
3a	Isolation between separate circuits	6.5.3 / 7.4.5	No

[a] This is related to 6.1.1 only.

[b] This is related to SPDs having a U_{CPV} equal to or below 120 V only.

[c] For this test sequence more than one set of samples may be needed.

[d] This is related to combination SPDs only (no additional test for other types of SPDs).

Annex ZZ

(informative)

Relationship between this European standard and the safety objectives of Directive 2014/35/EU [2014 OJ L96] aimed to be covered

This European standard has been prepared under a Commission's standardisation request relating to harmonised standards in the field of the Low Voltage Directive, M/511, to provide one voluntary means of conforming to safety objectives of Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits [2014 OJ L96].

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZZ.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding safety objectives of that Directive, and associated EFTA regulations.

Table ZZ.1 – Correspondence between this European standard and Annex I of Directive 2014/35/EU [2014 OJ L96]

Safety objectives of Directive 2014/35/EU	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
(1)(a)	Clauses 6.1, 6.3.1 Clause 7.3	
(1)(b)	Clause 6.1	
(1)(c)	Clauses 1, 2, 3, 4, 5 and refer to 2a) to 2d) below and 3a) to 3c) below	
(2)(a)	Clause 5.5, 6.2.1, 6.2.2 Clause 7.1, 7.2, 7.4.1, 7.2.1 table 5 and table 4 pass criteria c, e, h, l, j, and clause 8	
(2)(b)	Clauses 6.5.1, 6.2.5.3, 6.2.5, 6.2.4, 6.5.1 Clauses 7.1, 7.2, 7.4.2, 7.4.3.2, 7.4.3, 7.4.4, 7.7.1, 8	
(2) (c)	Clauses 6.4.3.1, 6.4.3.2 Clause 8	
(2)(d)	Clauses 6.3.4, 6.2.6, 6.2.7, 6.5.2 Clauses 7.1, 7.2, 7.5.1, 7.5.2, 7.4.5, 7.7.2, 8	
(3)(a)	Clause 6.3.5 Clause 7.1, 7.2, 8	

(3)(b)	Clauses 6.4.2, 6.4.1, 6.5.2 Clauses 7.1, 7.2, 7.6.1, 7.6.2, 7.7.2, 8 Clause 8.5.2, 8.5.3, 8.3.5.1	
(3)(c)	Clauses 6.2.5 Clauses 7.1, 7.2, 7.4.3, 7.4.4, 8	

WARNING 1: Presumption of conformity stays valid only as long as a reference to this European standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2: Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

Bibliography

For the following references,

Replace:

IEC 60950:1991, Information technology equipment-Safety

by:

EN 60950-1, Information technology equipment – Safety – Part 1: General requirements (IEC 60950-1)

Replace:

ISO 4892-2, Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps

ISO 4892-1, Plastics - Methods of exposure to laboratory light sources - Part 1: General guidance

ISO 4628-3, Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 3: Assessment of degree of rusting

by:

EN ISO 4892-2, Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps (ISO 4892-2)

EN ISO 4892-1:2000, Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance (ISO 4892-1)

EN ISO 4628-3, Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting (ISO 4628-3)

Add the following references:

EN 50521:2008, Connectors for photovoltaic systems - Safety requirements and tests

EN 60068-2-11:1999, Environmental testing – Part 2: Tests – Test Ka: Salt mist (IEC 60068-2-11:1981)

EN 60068-2-14:2009, Environmental testing – Part 2-14: Tests - Test N: Change of temperature (IEC 60068-2-14:2009)

EN 60068-2-30:2005, Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle) (IEC 60068-2-30:2005)

EN 60099-4:2004, Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems (IEC 60099-4:2004, mod.)

EN 60112:2003, Method for the determination of the proof and the comparative tracking indices of solid insulating materials (IEC 60112:2003)

EN 60228: 2005, Conductors of insulated cables (IEC 60228: 2004)

EN 60947-1:2007, Low voltage switchgear and controlgear – Part 1: General rules (IEC 60947-1:2007)

EN 60947-5-1:2004, Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices (IEC 60947-5-1:2003)

EN 60999-1:2000, Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included) (IEC 60999-1:1999)

EN 60695-2-11:2001 [1)], Fire hazard testing – Part 2-11: Glowing/hot wire based test methods – Glow-wire flammability test method for end-product (IEC 60695-2-11:2000)

EN 62305 (all parts), Protection against lightning (IEC 62305 (all parts))

HD 21 (all parts), Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V (IEC 60227 (all parts), mod.)

HD 60364-4-443:2001, 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 60364-5-51:2009, Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment - Common rules (IEC 60364-5-51:2005, 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.)

IEC 60245 (all parts), Rubber insulated cables – Rated voltages up to and including 450/750 V

UTE C 61-740-51, Juin 2009, Parafoudres basse tension – Partie -51: Parafoudres connectés aux installations de générateurs photovoltaïques – Exigences et essays

EN 61643-32:2016, Low-voltage surge protective devices - Surge protective devices for specific use including d.c.- Part 32: Selection and application principles – SPDs connected to photovoltaic installations

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1) Superseded by EN 60695-2-11:2014 (IEC 60695-2-11:2014).

IEC 61643-31

Edition 1.0 2018-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Low-voltage surge protective devices – Part 31: Requirements and test methods for SPDs for photovoltaic installations

Parafoudres basse tension – Partie 31: Parafoudres pour usage spécifique y compris en courant continu – Exigences et méthodes d'essai des parafoudres pour installations photovoltaïques

IEC 61643-31:2018-01(en-fr)

IEC 61643-31

Edition 1.0 2018-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Low-voltage surge protective devices –
Part 31: Requirements and test methods for SPDs for photovoltaic installations

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 31: Requirements and test methods for SPDs for photovoltaic installations

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61643-31 has been prepared by subcommittee 37A: Low-voltage surge protective devices, of IEC technical committee 37: Surge arresters.

The text of this standard is based on the following documents:

FDIS	Report on voting
37A/306/FDIS	37A/310/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 parts of the IEC 61643 series can be found, under the general title *Low-voltage surge protective devices*, on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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 61643 addresses safety and performance tests for surge protective devices (SPDs) to be installed on the DC side of photovoltaic installations to protect against induced and direct lightning effects.

There are three classes of tests:

1) The Class I test is intended to simulate partial conducted lightning current impulses. SPDs subjected to Class I test methods are generally recommended for locations at points of high exposure, e.g., line entrances to buildings protected by lightning protection systems.
2) SPDs tested to Class II or Class III test methods are subjected to impulses of shorter duration.
3) SPDs are tested on a “black box” basis as far as possible.

Tests take into account that photovoltaic generators:

- behave like current generators,
- that their output current depends on the incident light intensity and temperature,
- that their short-circuit current is slightly higher than the operating output current,
- are connected in series and/or parallel combinations leading to a great variety of voltages, currents and powers from a few hundreds of W (in residential installations) to several MW (photovoltaic fields).

The specific electrical parameters of PV installations on the DC side require specific test requirements for SPDs.

IEC 61643-32 addresses the selection and application principles of SPDs in practical situations for PV application (work in progress).

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 31: Requirements and test methods for SPDs for photovoltaic installations

1 Scope

This part of IEC 61643 is applicable to Surge Protective Devices (SPDs), intended for surge protection against indirect and direct effects of lightning or other transient overvoltages. These devices are designed to be connected to the DC side of photovoltaic installations rated up to 1 500 V DC.

These devices contain at least one non-linear component and are intended to limit surge voltages and divert surge currents. Performance characteristics, safety requirements, standard methods for testing and ratings are established.

SPDs complying with this standard are exclusively dedicated to be installed on the DC side of photovoltaic generators and the DC side of inverters.

SPDs for PV systems with energy storage (e.g. batteries, capacitor banks) are not covered.

SPDs with separate input and output terminals that contain specific series impedance between these terminal(s) (so called two-port SPDs according to IEC 61643-11:2011) are not covered.

SPDs compliant with this standard are designed to be permanently connected where connection and disconnection of fixed SPDs can only be done using a tool. This standard does not apply to portable SPDs

NOTE 1 In general SPDs for PV applications do not contain a specific series impedance between the input/output terminals due to power efficiency considerations.

NOTE 2 Wherever reference is made to the electric power system or the power system within this document, this refers to the DC side of the photovoltaic installation.

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 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

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

IEC 61180-1, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements*

IEC 61643-11:2011, *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods*

IEC 62475:2010, *High-current test techniques – Definitions and requirements for test currents and measuring systems*