

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Parafoudres à basse tension –
Partie 12: Parafoudres connectés aux réseaux à basse tension –
Principes de choix et de mise en œuvre**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or for further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Parafoudres à basse tension –
Partie 12: Parafoudres connectés aux réseaux à basse tension –
Principes de choix et de mise en œuvre**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.240.10

ISBN 978-2-8322-7914-4

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	10
INTRODUCTION.....	12
0.1 General.....	12
0.2 Keys to understanding the structure of this document	12
1 Scope.....	14
2 Normative references	14
3 Terms, definitions and abbreviated terms	15
3.1 Terms and definitions.....	15
3.2 List of abbreviated terms and acronyms used in this document	28
4 Need for protection.....	29
5 Low-voltage power systems and equipment to be protected.....	30
5.1 General.....	30
5.2 Low-voltage power systems	30
5.2.1 General	30
5.2.2 Lightning overvoltages and surge currents.....	30
5.2.3 Switching overvoltages	31
5.2.4 Temporary overvoltages U_{TOV}	32
5.3 Characteristics of the equipment to be protected.....	33
6 Surge protective devices	33
6.1 Basic functions of SPDs.....	33
6.2 Additional requirements	34
6.3 Classification of SPDs.....	34
6.3.1 SPD: classification.....	34
6.3.2 Typical design and topologies.....	35
6.4 Characteristics of SPDs	36
6.4.1 Service conditions as described in IEC 61643-11	36
6.4.2 List of parameters for SPD selection.....	37
6.5 Additional information on characteristics of SPDs	38
6.5.1 Information related to power-frequency voltages.....	38
6.5.2 Information related to surge currents	39
6.5.3 Information related to voltage protection level provided by SPDs.....	40
6.5.4 Information related to the SPD's status at its end of life.....	42
6.5.5 I_{SCCR} : Short-circuit current rating and I_{fi} : Follow current interrupt rating.....	43
6.5.6 I_L : Rated load current and ΔU : Voltage drop (for two-port SPDs or one-port SPDs with separate input and output terminals).....	43
6.5.7 Information related to change of characteristics of SPDs	44
7 Application of SPDs in low-voltage power systems	44
7.1.1 General	44
7.1.2 Consideration regarding location of the SPD depending on the classes of test.....	46
7.1.3 SPD modes of protection and installation.....	46
7.1.4 Need for additional protection.....	48
7.2 Selection of SPD characteristics	55
7.2.1 General	55
7.2.2 Selection of U_C , U_T , I_n , I_{imp} , I_{max} , I_{SCCR} , I_{fi} and U_{oc} of the SPD.....	56

7.2.3	Protective distance	62
7.2.4	Expected lifetime	62
7.2.5	Interaction between SPDs and other devices	62
7.2.6	Choice of the voltage protection level U_p	63
7.2.7	Coordination between the chosen SPD and other SPDs	63
7.3	Characteristics of auxiliary devices	66
7.3.1	Disconnecting devices	66
7.3.2	Surge and event counters	66
7.3.3	Status indicator	67
Annex A (informative) Typical information required before selecting an SPD and explanation of testing procedures		68
A.1	Typical Information required before selecting an SPD	68
A.1.1	System data	68
A.1.2	SPD application considerations	68
A.1.3	Characteristics of SPD	69
A.1.4	Additional equipment and fittings	69
A.2	Explanation of testing procedures used in IEC 61643-11	70
A.2.1	General Principles	70
A.2.2	Test sequences and tests description	70
Annex B (informative) Examples of relationship between U_c and nominal system voltage and example of relationship between U_p and U_c for Metal oxide varistors (MOV)		78
B.1	Relationship between U_c and the nominal voltage of the system	78
B.2	Relationship between U_p and U_c for Metal oxide varistors (MOV)	78
Annex C (informative) Environment – Surge voltages in LV systems		80
C.1	General	80
C.2	Lightning overvoltages	80
C.2.1	General	80
C.2.2	Surges transferred from MV to the LV system	81
C.2.3	Overvoltages caused by direct flashes to LV distribution systems	81
C.2.4	Induced overvoltages on LV distribution systems	82
C.2.5	Overvoltages caused by flashes to a Lightning Protection System or to a structure in its vicinity	82
C.3	Switching overvoltages	83
C.3.1	General	83
C.3.2	General description	84
C.3.3	Circuit-breaker and switch operations	84
C.3.4	Fuse operations (current-limiting fuses)	85
Annex D (informative) Partial lightning current calculations		87
Annex E (informative) TOV in the low-voltage system due to faults between high-voltage system and earth		90
E.1	General	90
E.2	References	91
E.3	Symbols	91
E.4	Overvoltages in LV-systems during a high-voltage earth fault	91
E.5	Example of a TT-system – Calculation of the possible temporary overvoltages	93
E.5.1	Possible stresses on equipment in low-voltage installations due to earth faults in a high-voltage system	93
E.5.2	Characteristics of the high-voltage system	94

E.6	Temporary power-frequency overvoltages depending on different LV-systems and different kinds of earthing configurations	94
E.6.1	General	94
E.6.2	Conclusion – Worst case SPDs stress current for SPDs HV-TOV behaviour.	96
E.6.3	Conclusion – Worst case test source for SPDs HV-TOV behaviour, if the SPD is connected to ground between N-PE and / or L-PE:.....	96
E.6.4	Examples of different LV-systems and their possible earthing configurations.....	97
E.7	Values of the temporary overvoltages for the US TN C system.....	101
E.8	Values of temporary overvoltages used in IEC 61643-11 with explanations.....	103
E.8.1	General	103
E.8.2	Values of temporary overvoltages for US systems	106
E.8.3	Values of temporary overvoltages for Japanese systems	109
Annex F (informative)	Coordination rules and principles.....	114
F.1	General.....	114
F.2	Energy coordination.....	114
F.2.1	General	114
F.2.2	Analytical studies: simple case of the coordination of two metal oxide varistors (MOV) based SPDs	114
F.2.3	Analytical study: case of coordination between a gas-based SPD and a Metal oxide varistors (MOV) based SPD	118
F.2.4	Analytical study: general coordination of two SPDs.....	120
F.2.5	Let-through energy (LTE) method	121
F.3	Coordination tests: energy and voltage protection coordination.....	123
F.3.1	Introduction	123
F.3.2	Coordination criteria	124
F.3.3	Coordination techniques	124
F.3.4	Test protocol	124
Annex G (informative)	Examples of application	128
G.1	Domestic application.....	128
G.2	Industrial application.....	130
G.3	Presence of a lightning protection system	134
G.4	Wind Turbines	135
G.4.1	General	135
G.4.2	Transient overvoltages in the DFIG converter circuit.....	135
G.4.3	Transmission effect of the transient voltage due to a long cable	136
G.4.4	Voltage coordination between SPD and equipment in wind turbine systems	137
G.4.5	Possible solutions for the case described in CLC/TR 50539-22.....	139
Annex H (informative)	Risk assessment method and examples of application	140
H.1	General.....	140
H.2	Simplified method proposed for low voltage risk assessment as described in IEC 60364-4-44	140
H.2.1	Overvoltage control	140
H.2.2	Simplified risk assessment method	140
H.2.3	Example 1 – Building in rural environment.....	142
H.2.4	Example 2 – Building in rural environment powered by HV	142
H.2.5	Example 3 – Building in urban environment	143
H.2.6	Example 4 – Building in urban environment powered by HV.....	143

H.2.7	Example 5 – electric vehicle supply equipment	143
H.2.8	Example 6 – Chemical facility	144
H.3	Factors to be considered during risk assessment	146
H.3.1	Environmental	146
H.3.2	Equipment and facilities	147
H.3.3	Economics and service interruption	148
H.3.4	Safety	148
H.3.5	Cost of protection	149
Annex I (informative)	System stresses	150
I.1	Lightning overvoltages and currents [5.2.2]	150
I.1.1	Aspects of the power distribution system that affect the need for an SPD	150
I.1.2	Sharing of surge current within a structure	150
I.2	Switching overvoltages [5.2.2]	151
I.3	Temporary overvoltages U_{TOV} [5.2.3]	151
Annex J (informative)	Application of SPDs	153
J.1	Location and protection given by SPDs [7.1]	153
J.1.1	Possible modes of protection and installation [7.1.5]	153
J.1.2	Influence of the oscillation phenomena on the protective distance [7.2.3]	161
J.1.3	Protection zone concept [7.2.3.5]	162
J.2	Selection of SPDs	164
J.2.1	Selection of U_C [7.3.1]	164
J.2.2	Coordination problems [7.3.6.2]	165
J.2.3	Practical cases [7.2.6.3]	167
J.3	Simple calculation of I_{imp} for a class I SPD in case of a building protected by a LPS	167
Annex K (informative)	Immunity vs. rated impulse voltage withstand	172
Annex L (informative)	Examples of SPD installation in power distribution boards in some countries	178
Annex M (informative)	Coordination when equipment has both signaling and power terminals	183
Annex N (informative)	Short circuit backup protection and surge withstand	190
N.1	General	190
N.2	Information single shot 8/20 and 10/350 fuses withstand	190
N.3	Fuse Influencing factors (reduction) for preconditioning and operating duty test	191
N.4	Operating duty withstand of fuses based on experimental data and confirmed by calculations based on the parameters and limits specified by the IEC 60269 series	191
N.5	Behaviour of external disconnector technologies	193
N.6	Additional requirement and test values for SPD external disconnectors used in some countries	193
Annex O (informative)	Practical methods for testing system level immunity under lightning discharge conditions	197
O.1	General	197
O.2	SPD discharge current test under normal service conditions	197
O.3	Induction test due to lightning currents	197
O.4	Recommended test classification of system level immunity test (following IEC 61000-4-5)	197
Annex P (informative)	Guide for testing SPDs containing multiple components	199

P.1	General.....	199
P.2	Example of a multiple spark gaps in series with ohmic/capacitive trigger control	199
P.3	Example of 2 spark gaps in series with capacitive trigger control and with a parallel connected series connection of GDT + MOV(s)	200
P.4	Example of a 3-electrode GDT with parallel MOV bypass/trigger control	200
P.5	Example of a 4-electrode gap with GDT + MOV trigger control.....	201
P.6	Example of a Spark Gap in parallel with a series-connected GDT and MOV.....	202
P.7	Example of a 3-electrode gap with trigger transformer	202
Annex Q (informative) Exceptions in the USA related to Class I tested SPDs.....		204
Bibliography.....		205
Figure 1	– Examples of one-port SPDs	19
Figure 2	– Examples of two-port SPDs.....	20
Figure 3	– Output voltage response of one-port and two-port SPDs to a combination wave generator impulse.....	21
Figure 4	– Examples of components and combinations of components	36
Figure 5	– Typical curve of U_{res} versus I for Metal oxide varistors (MOV).....	41
Figure 6	– Typical curve for a spark gap	42
Figure 7	– Flowchart for SPD application	45
Figure 8	– Example of connection Type 1 (CT1).....	47
Figure 9	– Example of connection Type 2 (CT2).....	47
Figure 10	– Influence of SPD connecting lead lengths	51
Figure 11	– Possible installation scheme with intermediate earth bar when lead length exceed 50 cm	52
Figure 12	– Example of the need for additional SPDs when connected leads are less than 50 cm long.....	54
Figure 13	– Flow chart for the selection of an SPD.....	55
Figure 14	– U_T and U_{TOV}	57
Figure 15	– SPD and external disconnector arrangement for continuity of supply.....	60
Figure 16	– SPD and external disconnector arrangement for continuity of protection.	60
Figure 17	– Selectivity between OCPD and disconnector in case of short-circuit.....	61
Figure 18	– Typical use of two SPDs – Electrical drawing	64
Figure A.1	– Test set-up for operating duty test	71
Figure A.2	– Test timing diagram for first 15 impulses.....	72
Figure A.3	– Test timing diagram for additional 5 impulses	72
Figure B.1	– Simple calculation of the sum of partial lightning currents into the power distribution system.....	87
Figure E.1	– Representative schematic for possible connections to earth in substations and LV-installations and resulting overvoltages in case of faults	92
Figure E.2	– Example of a TT-system with combined earthing of the transformer substation R_E with LV –midpoint earthing (earthed neutral) R_B	93
Figure E.3	– TN system (IEC 60364-4-44:2007, Figure 44B).....	97
Figure E.4	– TT system (IEC 60364-4-44:2007, Figure 44C).....	98
Figure E.5	– IT system, example a (IEC 60364-4-44:2007, Figure 44D).....	99
Figure E.6	– IT system, example b (IEC 60364-4-44:2007, Figure 44F)	100

Figure E.7 – IT system, example c1 (IEC 60364-4-44:2007, Figure 44E).....	101
Figure E.8 – Temporary overvoltage resulting from a fault in the primary (4 wires MV-system – direct earthing) of the distribution transformer in a TN-system according to North American practice	102
Figure E.9 – Typical TOV max p.u. RMS-voltages (V) Table 2, IEEE 1159-2009	107
Figure E.10 – Example of share the ground of the single phase center-tap grounded 100 / 200 V system and three phase (Delta) corner grounded 200 V system	111
Figure E.11 – Typical power distribution networks of single phase center-tap grounded 100 / 200 V system in Japan	112
Figure E.12 – Typical power system configuration in Japan	113
Figure E.13 – TOV characteristic by faults in the high-voltage system in Japan	113
Figure F.1 – Two Metal oxide varistors (MOV) with the same nominal discharge current	115
Figure F.2 – Two Metal oxide varistors (MOV) with different nominal discharge current	117
Figure F.3 – Example of coordination of a gap-based SPD and a Metal oxide varistor (MOV) based SPD	120
Figure F.4 – LTE – Coordination method with standard pulse parameters	121
Figure F.5 – SPDs arrangement for the coordination test	126
Figure G.1 – Domestic installation	129
Figure G.2 – Industrial installation	132
Figure G.3 – Circuitry of industrial installation	133
Figure G.4 – Example for a LPS	135
Figure G.5 – Configuration of a DFIG wind turbine	136
Figure G.6 – PWM voltage between the generator and the converter at the rotor circuit	136
Figure G.7 – position of converter and generator	137
Figure G.8 – A converter tested in laboratory and its L-PE voltage waveform	138
Figure H.1 – Example of the individual sections of a power line	142
Figure H.2 – Example of electric vehicle supply equipment	144
Figure H.3 – Example of chemical facility	145
Figure J.1 – Installation of surge protective devices in TN-systems	154
Figure J.2 – Installation of surge protective devices in TT-systems (SPD downstream of the RCD)	156
Figure J.3 – Installation of surge protective devices in TT-systems (SPD upstream of the RCD)	157
Figure J.4 – Installation of surge protective devices in IT-systems without distributed neutral	158
Figure J.5 – Typical installation of SPD at the entrance of the installation in case of a TN-C-S system	159
Figure J.6 – General way of installing one-port SPDs	159
Figure J.7 – Examples of acceptable and unacceptable SPD installations regarding EMC aspects	160
Figure J.8 – Physical and electrical representations of a system where equipment being protected is separated from the SPD giving protection	161
Figure J.9 – Possible oscillation between a Metal oxide varistors (MOV) SPD and the equipment to be protected	161
Figure J.10 – Example of voltage doubling	162
Figure J.11 – Subdivision of a building into protection zones	163
Figure J.12 – Coordination of two Metal oxide varistors (MOV)	166

Figure L.1 – A wiring diagram of an SPD connected on the load side of the main incoming isolator via a separate isolator (which could be included in the SPD enclosure)	178
Figure L.2 – SPD connected to the nearest available outgoing MCB to the incoming supply (TNS installation typically seen in the UK)	179
Figure L.3 – A single line-wiring diagram of an SPD connected in shunt on the first outgoing way of the distribution panel via a fuse (or MCB)	180
Figure L.4 – SPD connected to the nearest available circuit breaker on the incoming supply (US three phase 4W + G, TN-C-S installation)	181
Figure L.5 – SPD connected to the nearest available circuit breaker on the incoming supply (US single (split) phase 3W + G, 120/240 V system – typical for residential and small office applications).....	182
Figure M.1 – Example of a PC with modem in a US power and communication system.....	184
Figure M.2 – Schematic of circuit of Figure M.1 used for experimental test	185
Figure M.3 – voltage recorded across reference points for the PC/modem during a surge in the example (voltage and current vs. time in μ s).....	186
Figure M.4 – Typical TT system used for simulations	187
Figure M.5 – Voltage and current waveshapes measured during the application of a surge when a multi-service SPD was installed in the circuit of the structure shown in of Figure M.1	189
Figure N.1 – Schematic diagram for coordination of SPD internal and external disconnectors with MOV	195
Figure N.2 – Example of time-current characteristics of SPD disconnectors	196
Figure O.1 – Example of a circuit used to perform discharge current tests under normal service conditions	198
Figure O.2 – Example circuit of an induction test of a lightning currents	198
Figure P.1 – Example of multiple spark gaps in series with ohmic/capacitive trigger control	199
Figure P.2 – 2 spark gaps in series with capacitive trigger control	200
Figure P.3 – 3-electrode GDT with parallel MOV bypass/trigger control	201
Figure P.4 – 4-electrode spark gap with GDT + MOV trigger control	201
Figure P.5 – Spark Gap in parallel with series-connected GDT and MOV.....	202
Figure P.6 – 3-electrode spark gap with trigger transformer	203
Table 1 – Maximum TOV values based on IEC 60364-4-44:2007	33
Table 2 – Preferred values of I_{imp}	40
Table 3 – modes of protection for various LV systems	48
Table 4 – Minimum recommended U_C of the SPD for various power systems	56
Table B.1 – Relationship between U_C and nominal system voltage.....	78
Table B.2 – Example of values of U_p/U_C for Metal oxide varistors (MOV).....	79
Table E.1 – Permissible power-frequency stress voltages according to IEC 60364-4-44	92
Table E.2 – Power-frequency stress voltages and power-frequency fault voltage in low-voltage-systems during a high-voltage earth fault	95
Table E.3 – TOV test values for systems complying with IEC 60364 series	103
Table E.4 – Reference test voltage values for systems complying with IEC 60364 series.....	105
Table E.5 – TOV parameters for US systems	107
Table E.6 – UL TOV values used to test SPDs in US systems.....	108

Table E.7 – Nominal voltage and reference test voltage for Japanese system.....	109
Table E.8 – TOV test parameters for Japanese system.....	110
Table E.9 – The maximum value of TOV voltage at the difference earth fault points.....	111
Table E.10 – Earth electrode class and maximum value of earth resistance.....	112
Table F.1 –	123
Table F.2 –	123
Table F.3 –	123
Table F.4 – Test procedure for coordination.....	127
Table G.1 – Peak value of PWM voltage and du/dt at two terminals based on investigation in 2011 in China	137
Table G.2 – Example of characteristics of the generator alternator excitation circuit and associated SPD	138
Table G.3 – Comparison between the wind turbine system and low-voltage distribution system.....	139
Table H.1 – Calculation of CRL.....	141
Table H.2 – Simplified method	145
Table H.3 – IEC 62305-2 method	146
Table J.1 – Determination of the value of I_{imp}	169
Table J.2 – Determination of the value of I_{imp} for additional systems used in Japan.....	170
Table J.3 – number of conductors related to usual structure of power supply	171
Table J.4 – number of conductors related to additional systems used in Japan	171
Table K.1 – Typical rated impulse voltages (derived from IEC 60664-1).....	173
Table K.2 – Selection of immunity test levels depending on the installation conditions.....	176
Table K.3 – Immunity level for AC input	176
Table M.1 – Simulation results	187
Table N.1 – Examples of ratio between single shot withstand and full preconditioning/operating duty test	192
Table N.2 – Behaviour of external disconnecter technologies.....	193
Table N.3 – Examples of electrical ratings for SFD	194
Table N.4 – Examples of tripping current for SSD	194

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

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

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 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 61643-12 has been prepared by subcommittee 37A: Low-voltage surge protective devices, of IEC technical committee 37: Surge arresters.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

NOTE The following differing practice of a less permanent nature exists in the USA: In the USA, SPDs tested to Class I tests are not required. This exception applies to the entire document.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Scope: Deleted reference to 1 500 V dc
- b) Added or revised some definitions
- c) Added new clause 4 on Need for protection

- d) Added new information on disconnecting devices
- e) Revised Characteristics of SPD
- f) Revised List of parameters for SPD selection
- g) Added new information on Measured Limiting Voltage
- h) Added or revised some Annexes

The text of this International Standard is based on the following documents:

FDIS	Report on voting
37A/341/FDIS	37A/347/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61643 series, published under the general title *Low-voltage surge protective devices*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document 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

0.1 General

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 according to their environmental conditions and the acceptable failure rate of the equipment and the SPDs.

This document provides information to the user about characteristics useful for the selection of an SPD.

This document provides information to evaluate the need for using SPDs in low-voltage systems, with reference to IEC 62305, Parts 1 to 4 and the IEC 60364 series. It also provides information on selection and coordination of SPDs, while taking into account the entire environment in which they are applied. Examples include: equipment to be protected and system characteristics, insulation levels, overvoltages, method of installation, location of SPDs, coordination of SPDs, end of life behaviour of SPDs and equipment failure consequences.

IEC 62305-2 provides a general method for evaluating the risk due to surges and lightning. IEC 60364-4-44 provides a simplified way of evaluating the risk posed to electrical installations.

Guidance on requirements for product insulation coordination is provided by IEC 60664 series. Requirements for safety (fire, overcurrent and electric shock) and installation are provided by IEC 60364 series.

The IEC 60364 series provide direct information for contractors on the installation of SPDs. IEC TR 62066 contains more information on the scientific background of surge protection.

0.2 Keys to understanding the structure of this document

The list below summarizes the structure of this document 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 document.

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

Clause 3 provides definitions useful for the understanding of this document.

Clause 4 is an introduction to the risk of surges (considerations of when the use of SPDs is beneficial).

Clause 5 addresses the parameters of systems and equipment important for SPD selection. In addition to the stresses created by lightning, those created by the network itself are described, namely temporary overvoltages and switching surges.

Clause 6 lists the electrical parameters for the selection of an SPD and provides explanations regarding these parameters. These are related to those given in IEC 61643-11.

Clause 7 is the core of this document. It relates the stresses coming from the network (as discussed in Clause 5) to the characteristics of the SPD (as discussed in Clause 6). It also outlines how the protection by SPDs may be affected by its installation. The different steps for the selection of an SPD are presented, including coordination when more than one SPD is used in an installation (details about SPD coordination may be found in Annex F).

Annex A deals with information given with inquiries and explains the testing procedures used in IEC 61643-11.

Annex B provides examples of the relationship between two important parameters of SPDs, U_c and U_p , in the specific case of Metal Oxide Varistors (MOV) and also examples of the relationship between U_c and the nominal voltage of the network.

Annex C supplements the information given in Clause 5 on surge voltages in low-voltage systems.

Annex D deals with the sharing of lightning current between different earthing systems used to determine the SPD rating in case of direct lightning current.

Annex E deals with temporary overvoltages due to faults in the high-voltage system.

Annex F supplements the information given in Clause 7 on coordination rules when more than one SPD is used in a system.

Annex G provides specific examples on the use of this document.

Annex H provides specific examples of the use of the risk analysis given in Clause 4.

Annex I supplements the information given in Clause 5 about system stresses.

Annex J supplements the information given in Clause 7 on the application of SPDs in various low-voltage systems criteria for selection of SPDs.

Annex K discusses differences between immunity level and insulation withstand of electrical equipment.

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

Annex M discusses problems of coordination with equipment having both signaling and power terminals.

Annex N provides information on withstand of fuses in surge conditions.

Annex O provides practical methods for testing system level immunity.

Annex P provides test application to SPDs with multiple components.

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

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

1 Scope

This part of IEC 61643 describes the principles for the selection, operation, location and coordination of SPDs to be connected to 50/60 Hz AC power circuits, and equipment rated up to 1 000 V RMS.

These devices contain at least one non-linear component and are intended to limit surge voltages and divert surge currents.

NOTE 1 Additional requirements for special applications are also applicable, if required.

NOTE 2 IEC 60364 and IEC 62305-4 are also applicable.

NOTE 3 This document deals only with SPDs and not with surge protection components (SPC) integrated inside equipment.

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 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

IEC 60364-5-53, *Low-voltage electrical installations – Part 5-53: Selection and erection of electrical equipment – Devices for protection for safety, isolation, switching, control and monitoring*

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

IEC 61643-32, *Low-voltage surge protective devices – Part 32: Surge protective devices connected to the d.c. side of photovoltaic installations – Selection and application principles*

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 62305-1:2010, *Protection against lightning – Part 1: General principles*

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