

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Low-voltage surge protective devices –
Part 22: Surge protective devices connected to tele-communications and
signalling networks – Selection and application principles**

**Parafoudres basse tension –
Partie 22: Parafoudres connectés aux réseaux de signaux et de
télécommunications – Principes de choix et d'application**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2015 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
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

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 also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

More than 60 000 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.

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

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

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.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

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 aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

Plus de 60 000 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.

Service Clients - webstore.iec.ch/csc

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

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Low-voltage surge protective devices –
Part 22: Surge protective devices connected to tele-communications and
signalling networks – Selection and application principles**

**Parafoudres basse tension –
Partie 22: Parafoudres connectés aux réseaux de signaux et de
télécommunications – Principes de choix et d'application**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.240.01; 29.240.10

ISBN 978-2-8322-2750-3

**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.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references.....	9
3 Terms, definitions and abbreviations	9
3.1 Terms and definitions	10
3.2 Abbreviations	10
4 Description of technologies	10
4.1 General.....	11
4.2 Voltage-limiting components.....	10
4.2.1 General	10
4.2.2 Clamping components.....	11
4.2.3 Switching components.....	11
4.3 Current-limiting components	11
4.3.1 General	11
4.3.2 Current-interrupting components	11
4.3.3 Current-reducing components.....	11
4.3.4 Current-diverting components.....	11
5 Parameters for selection of SPDs and appropriate tests from IEC 61643-21.....	12
5.1 General.....	12
5.2 Normal service conditions	12
5.2.1 General	12
5.2.2 Air pressure and altitude	12
5.2.3 Ambient temperature.....	12
5.2.4 Relative humidity	12
5.2.5 Abnormal service conditions.....	12
5.3 SPD parameters that may affect normal system operation.....	12
6 Risk management.....	13
6.1 General.....	13
6.2 Risk analysis.....	14
6.3 Risk identification.....	14
6.4 Risk treatment.....	14
7 Application of SPDs.....	16
7.1 General.....	16
7.2 Coupling mechanisms	16
7.3 Application, selection and installation of surge protective devices (SPDs).....	18
7.3.1 Application requirements for SPDs	18
7.3.2 SPD installation cabling considerations	22
7.3.3 Comparison between SPD classification of IEC 61643-11 and IEC 61643-21.....	25
8 Multiservice surge protective devices	25
9 Coordination of SPDs/ITE	28
Annex A (informative) Voltage-limiting components	29
A.1 Clamping components	29
A.1.1 General	29
A.1.2 Metal oxide varistor (MOV).....	29

A.1.3	Silicon semi-conductors	29
A.2	Switching components.....	31
A.2.1	General	31
A.2.2	Gas discharge tube (GDT).....	31
A.2.3	Air gaps	31
A.2.4	Thyristor surge suppressor (TSS) – Fixed voltage types (self-gating)	32
A.2.5	Thyristor surge suppressor (TSS) – Gated types	32
Annex B (informative)	Current-limiting components.....	33
B.1	General.....	33
B.2	Non-resetting current limiters	33
B.2.1	General	33
B.2.2	Series current-interrupting components	33
B.2.3	Shunt current-diverting limiters.....	34
B.3	Self-resetting current limiters.....	36
B.3.1	General	36
B.3.2	Series current-reducing components.....	36
B.3.3	Shunt current-diverting components	38
Annex C (informative)	Risk management.....	39
C.1	Risk due to lightning discharges	39
C.1.1	Risk assessment.....	39
C.1.2	Risk analysis.....	39
C.1.3	Risk treatment	41
C.2	Risk due to power line faults.....	42
C.2.1	General	42
C.2.2	AC power systems	42
C.2.3	DC power systems	42
Annex D (informative)	Transmission characteristics related to IT systems	44
D.1	General.....	44
D.2	Telecommunications systems.....	44
D.3	Signalling, measurement and control systems.....	45
D.4	Cable TV systems	45
Annex E (informative)	Coordination of SPDs/ITE	46
E.1	General.....	46
E.2	Determination of U_{IN} and I_{IN}	46
E.3	Determine the output protective voltage and current waveforms for SPD1	47
E.4	Compare SPD1 and SPD2 values.....	47
E.5	Necessity of verification of the coordination by testing	48
Annex F (informative)	Protection of Ethernet systems	49
F.1	Power over Ethernet (PoE).....	49
F.2	Withstand capabilities and SPD coordination	50
F.3	Common mode to differential mode surge conversion by switching devices	50
F.3.1	General	50
F.3.2	Differential mode voltage reduction by inter-wire protection.....	51
F.3.3	Differential mode voltage reduction by single switching element.....	52
Annex G (informative)	EMC impact of SPDs	54
G.1	General.....	54
G.2	Electromagnetic immunity.....	54
G.3	Electromagnetic emission.....	54

Annex H (informative) Definition of internal port (Source: ITU-T K.44)	55
Annex I (informative) Maintenance of SPDs for Information Technology	56
I.1 General requirements	56
I.2 Maintenance responsibilities	56
I.3 Maintenance of SPDs	56
I.3.1 General	56
I.3.2 Visual inspection	57
I.3.3 Complete inspection	57
I.3.4 Examining periods	57
Annex J (informative) Earth potential rise (EPR)	59
J.1 General	59
J.2 Causes of EPR	59
J.3 Influence of soil resistivity	59
J.4 Fibre optics	59
Annex K (informative) References and examples of risk management based on IEC 62305-2	60
Bibliography	61
Figure 1 – SPD installation in telecommunications and signalling networks	15
Figure 2 – Measurement and Control network (MCR)	15
Figure 3 – Coupling mechanisms	17
Figure 4 – Example of a configuration of the lightning protection concept	19
Figure 5 – Example of a configuration according to the zones (Figure 4)	20
Figure 6 – Example of protection measures against common-mode voltages and differential mode voltages of the data (f) and supply voltage input (g) of an ITE	21
Figure 7 – Influence of voltages U_{L1} and U_{L2} on protection level U_P caused by inductance of the leads	22
Figure 8 – Removal of the voltages U_{L1} and U_{L2} from the protector unit by connecting leads to a common point	23
Figure 9 – Necessary installation conditions of a three, five or multi-terminal SPD with an ITE for minimizing the interference influences on the protection level	24
Figure 10 – Individual SPDs	26
Figure 11 – MSPD with E connection option	26
Figure 12 – MSPD with transient bonding SPCs to PE terminals	27
Figure 13 – Combination of two SPDs	28
Figure A.1 – Behaviour of clamping components	29
Figure A.2 – Behaviour of switching components	31
Figure B.1 – Behaviour of current interrupting components	33
Figure B.2 – Behaviour of current-diverting component	34
Figure B.3 – Thermally operated (heat coil) three-terminal shunt current limiter	35
Figure B.4 – Behaviour of current-reducing components (thermally operated type)	36
Figure B.5 – Thermally operated (PTC thermistor) two-terminal series current limiting component	37
Figure B.6 – Two-terminal series electronic current limiting component	38
Figure B.7 – Electronic (gated bidirectional thyristor) three-terminal shunt current limiting component	38
Figure C.1 – Risk evaluation procedure	41

Figure E.1 – Coordination verification process.....	47
Figure F.1 – PoE powering modes.....	49
Figure F.2 – Common mode to differential mode surge conversion by asynchronous SPD operation	50
Figure F.3 – Differential surge generated by asynchronous SPD operation on a longitudinal surge	51
Figure F.4 – SPD circuit with inter-wire protection to limit the differential surge	51
Figure F.5 – Differential surge voltage limited by inter-wire protection	52
Figure F.6 – SPD using a single switching element and a steering diode bridge	52
Figure F.7 – Differential surge voltage reduced by single switching element and steering diode bridge	53
Table 1 – Responsibility for managing the protective measures.....	14
Table 2 – Coupling mechanisms.....	18
Table 3 – Selection aid for rating SPDs for the use in (zone) interfaces according to IEC 62305-1	20
Table 4 – Relationship between SPD classification of IEC 61643-21 and IEC 61643-11.....	25
Table 5 – Relationship between LPZ and the requested test categories of MSPDs	27
Table C.1 – AC overhead power systems	42
Table C.2 – AC underground electric cables	42
Table C.3 – DC overhead power systems	43
Table C.4 – DC underground electric cables.....	43
Table D.1 – Transmission characteristics for telecommunication systems in access networks.....	44
Table D.2 – Transmission characteristics of IT systems in customer premises.....	45
Table D.3 – Transmission characteristics of cable TV systems.....	45
Table F.1 – Comparison of Type 1 (PoE) and Type 2 PoE+) powering values.....	49
Table I.1 – Maximum period between inspections of lightning protective measures covered by IEC 62305-3.....	57
Table I.2 – Maximum period between inspections of lightning protective measures covered by ITU-T K.69 [18]	58

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –**Part 22: Surge protective devices connected to
telecommunications and signalling networks –
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 61643-22 has been prepared by subcommittee 37A: Low-voltage surge protective devices, of IEC technical committee 37: Surge arresters.

This second edition cancels and replaces the first edition published in 2004. This edition constitutes a technical revision.

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

- a) Update the use of multiservice SPDs (Article 8)
- b) Comparison between SPD classification of IEC 61643-11 and IEC 61643-21 (7.3.3)
- c) Consideration of new transmission systems as PoE (Annex F)
- d) EMC requirements of SPDs (Annex G)

e) Maintenance cycles of SPDs (Annex I)

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

FDIS	Report on voting
37A/273/FDIS	37A/277/RVD

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

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

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

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

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 International Standard is a guide for the application of SPDs to telecommunications and signalling lines and those SPDs which have telecom or signalling SPDs in the same enclosure with power line SPDs (so called multiservice SPDs). Definitions, requirements and test methods are given in IEC 61643-21. The decision to use SPDs is based on an analysis of the risks that are seen by the network or system under consideration. Because telecommunications and signalling systems may depend on long lengths of wire, either buried or aerial, the exposure to overvoltages from lightning, power line faults and power line/load switching, can be significant. If these lines are unprotected, the resultant risk to information technology equipment (ITE) can also be significant. Other factors that may influence the decision to use SPDs are local regulators and insurance stipulations. This standard provides indications for evaluating the need for SPDs, the selection, installation and dimensioning of SPDs and for achieving coordination between SPDs and between SPDs and ITE installed on telecommunication and signal lines.

Coordination of SPDs assures that a proper interaction between them, as well as between an SPD and the ITE to be protected will be realized. Coordination requires that the voltage protection level, U_p , and let-through current, I_p , of the initial SPD does not exceed the resistibility of subsequent SPDs or the ITE.

In general, the SPD closest to the source of the impinging surge diverts most of the surge; a downstream SPD will divert the remaining or residual surge. The coordination of SPDs in a system is affected by the operation of the SPDs and the equipment to be protected as well as the characteristics of the system to which the SPDs are connected.

The following variables should be reviewed when attempting to attain proper coordination:

- waveshape of the impinging surge (impulse or AC)
- ability of the equipment to withstand an overvoltage/overcurrent without damage;
- installation, e.g. distance between SPDs and between SPDs and ITE;
- SPD voltage-protection levels.

The performance of an SPD and its coordination with other SPDs can be affected by exposure to previous transients. This is especially true for transients which approach the limit of the capacity of the SPD. If there is considerable doubt concerning the number and severity of the surges handled by the SPDs under consideration, it is suggested that SPDs with higher capabilities be used.

One of the direct effects of poor coordination may be bypassing of the SPD closest to the surge source, with the result that the following SPD will be forced to handle the entire surge. This can result in damage to that SPD.

Lack of proper coordination can also lead to equipment damage and, in severe cases, may lead to a fire hazard.

There are several technologies used in the design of the SPDs covered in this standard. These are explained in the main text and also in informative Annexes A and B.

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 22: Surge protective devices connected to telecommunications and signalling networks – Selection and application principles

1 Scope

This part of IEC 61643 describes the principles for the selection, operation, location and coordination of SPDs connected to telecommunication and signalling networks with nominal system voltages up to 1 000 V r.m.s. a.c. and 1 500 V d.c.

This standard also addresses SPDs that incorporate protection for signalling lines and power lines in the same enclosure (so called multiservice SPDs).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61643-21:2012, *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*

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

IEC 61643-12, *Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power distribution systems – Selection and application principles*

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

IEC 62305-2:2010, *Protection against lightning – Part 2: Risk management*

IEC 62305-3:2010, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

IEC 62305-4:2010, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

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

3 Terms, definitions and abbreviations

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