IEEE STANDARDS ASSOCIATION

IEEE Guide for the Application of Surge-Protective Devices for Use on the Load Side of Service Equipment in Low-Voltage (1000 V or Less, 50 Hz or 60 Hz) AC Power Circuits

IEEE Power and Energy Society

Sponsored by the
Surge Protective Devices Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std C62.72™-2016
(Revision of
IEEE Std C62.72-2007)

IEEE Std C62.72™-2016
(Revision of
IEEE Std C62.72-2007)

IEEE Guide for the Application of Surge-Protective Devices for Use on the Load Side of Service Equipment in Low-Voltage (1000 V or Less, 50 Hz or 60 Hz) AC Power Circuits

Sponsor

Surge Protective Devices Committee
of the
IEEE Power and Energy Society

Approved 3 March 2016

IEEE-SA Standards Board

Abstract: Guidance is provided to specifiers, users and manufacturers of surge-protective devices (SPDs) about the application considerations of SPDs to power distribution systems and associated equipment. This guide applies to SPDs to be connected to the load side of the service equipment (and main over current protective device) of 50 Hz or 60 Hz ac power circuits rated 1000 V ac or less. Information on surge origins, effects of surges, number and magnitude of surge events, location categories, power distribution system (PDS) configurations, grounding and bonding, SPD specifications, SPD ratings, SPD characteristics, SPD lifetime, interactions of SPDs with a PDS, and SPD coordination considerations are provided in the guide.

Keywords: arrester, bonding, grounding, IEEE C62.72™, internally generated surges, lightning, SPD, surge-protective device coordination, surge-protective device, switching, transient, transient voltage surge suppressor

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2016 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 10 June 2016. Printed in the United States of America.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-1-5044-1990-1 STD20923
Print: ISBN 978-1-5044-1991-8 STDPD20923

IEEE prohibits discrimination, harassment, and bullying.
For more information, visit http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html.
No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Copyright © 2016 IEEE. All rights reserved.

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading "Important Notice" or "Important Notices and Disclaimers Concerning IEEE Standards Documents."

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association ("IEEE-SA") Standards Board. IEEE ("the Institute") develops its standards through a consensus development process, approved by the American National Standards Institute ("ANSI"), which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Copyright © 2016 IEEE. All rights reserved.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Copyright © 2016 IEEE. All rights reserved.

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE-SA Website at http://ieeexplore.ieee.org/Xplore/home.jsp or contact IEEE at the address listed previously. For more information about the IEEE-SA or IEEE's standards development process, visit the IEEE-SA Website at http://standards.ieee.org.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: http://standards.ieee.org/findstds/errata/index.html. Users are encouraged to check this URL for errata periodically.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at http://standards.ieee.org/about/sasb/patcom/patents.html. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Copyright © 2016 IEEE. All rights reserved.

Participants

At the time this IEEE guide was completed, the 3.6.6 Working Group had the following membership:

Ronald W. Hotchkiss, *Chair*
Andrea Haa, *Vice Chair*
Martin Guy, *Secretary*

Frank Basciano
Kenneth Brown
Dan Buchanan*
William Bush
Bryan Cole*
Vincent Crevenat
Joe DeGregoria
Douglas Dorr
Louis Farquhar
Ray Hill
Joseph L. Koepfinger
Steve Millard
James Moellmann
Carey Mossop
Richard Odenberg
Tom Phipps
Anthony Surtees
Jim Tiesi*
Matthew Wakeham
Mark Wingate

*Corresponding Member

The following members of the individual balloting committee voted on this guide. Balloters may have voted for approval, disapproval, or abstention.

Thomas Barnes
Frank Basciano
William Bloethe
Kenneth Brown
William Bush
Suresh Channarasappa
Bryan Cole
Gary Donner
Douglas Dorr
Randall Dotson
Cliff Erven
Louis Farquhar
Keith Flowers
James Funke
Doaa Galal
Frank Gerleve
Randall Groves
Thomas Gruzs
Jeffrey Helzer
Steven Hensley
Gary Heuston
Raymond Hill
Gary Hoffman
Ronald W. Hotchkiss
Song Jin
Laszlo Kadar
John Kay
Yuri Khersonsky
Morteza Khodaie
Chad Kiger
Joseph L. Koepfinger
Jim Kulchisky
Paneendra Kumar BL
Chung-Yiu Lam
Michael Lauxman
Paul Lindemulder
Albert Livshitz
Albert Martin
Michael Maytum
Omar Mazonni
T. David Mills
James Moellmann
Edrin Murzaku
Michael Newman
David Nichols
Joe Nims
Hans Wo Oertel
Lorraine Padden
Bansi Patel
Timothy Patel
Thomas Phipps
Julian Profir
Robert Resuali
Michael Roberts
Thomas Rozek
Bartien Sayogo
Robert Schuerger
Nikunj Shah
David Singleton
Jeremy Smith
K. Stump
Rick Syverson
David Tepen
Donald Turner
Eric Udren
John Vergis
Matthew Wakeham
S. Frank Waterer
Kenneth White
James Wilson
Mark Wingate
Shuhui Zhang

Copyright © 2016 IEEE. All rights reserved.

When the IEEE-SA Standards Board approved this guide on 3 March 2016, it had the following membership:

Jean-Philippe Faure, *Chair*
Ted Burse, *Vice Chair*
John Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Chuck Adams
Masayuki Ariyoshi
Stephen Dukes (TAB Rep.)
Jianbin Fan
Travis Griffith
Gary Hoffman
Ronald W. Hotchkiss
Michael Janezic
Joseph L. Koepfinger*
Hung Ling
Kevin Lu
Annette Reilly
Gary Robinson
Mehmet Ulema
Yingli Wen
Howard Wolfman
Don Wright
Yu Yuan
Daidi Zhong

*Member Emeritus

Copyright © 2016 IEEE. All rights reserved.

Introduction

This introduction is not part of IEEE Std C62.72-2016, IEEE Guide for the Application of Surge-Protective Devices for Use on the Load Side of the Service Equipment in Low-Voltage (1000 V or Less, 50 Hz or 60 Hz) AC Power Circuits.

One purpose of this guide is to provide specifiers, users, and manufacturers of surge-protective devices (SPDs) with an understanding of numerous application considerations to be evaluated before SPDs are installed in low-voltage ac power circuits. Given this understanding, specifiers, users and manufacturers can exercise due diligence in applying SPDs, take steps to prevent their misapplications, and act to either prevent or mitigate adverse effects that SPDs may have on a power distribution system (PDS) in an effort to improve the effectiveness and benefit of applying SPDs to the PDS.

The growth of interest in and use of low-voltage power SPDs parallels the increasing number of installations with sensitive, sophisticated, and expensive electronic equipment and components that can be exposed and susceptible to surge voltages. It must be recognized that SPDs are not designed to correct every type of power system disturbance. However, SPDs can be extremely effective at mitigating the impact of transient overvoltages or surges. The functionality of any SPD is directly related to the specific location where it is connected to a low-voltage PDS and the methods used to make the required electrical connections to the PDS. SPDs installed at various locations in the low-voltage PDS, as well as in specific equipment, can interact with each other, with protective relaying systems, and with other components of the PDS. Due to the complex nature of surges and the numerous environments where surges are generated and SPDs exist, the application of SPDs has yet to become an exact science.

This guide is one document in the IEEE C62™ group of standards that deals with power systems surges and surge protection. Other IEEE C62 documents describe performance characteristics of SPDs, recommend standard test protocols for verifying performance, and provide guidance on the interaction between power systems disturbances and SPDs. This application guide is the sister document to IEEE Std C62.62™[1], IEEE Standard Test Specifications for Surge-Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low-Voltage (1000 V and Less) AC Power Circuits. The guide was limited in scope to the load side of the service equipment to harmonize with IEEE Std C62.62 and to prevent conflict with another project, PC62.44™, which covers the application of SPDs on the line side of the service equipment.

As part of the ongoing improvement and life cycle of this guide, the following topics and changes were specific work areas focused on by the working group:

— Discussion of internally generated surges due to normal and abnormal system operations

— Expanded explanation of short-circuit current ratings of SPDs including fault current and load-side short circuit interruption capability

— The grounding (earthing) and bonding clause of the guide underwent a major revision while emphasizing the discussion around SPD applications

— Discussion of the surge tests described in IEEE Std C62.62 and how they impact the application of SPDs

— Revisions to the clauses regarding SPD surge current, nominal discharge current ratings and the use of these ratings for specifying SPDs

— Additional guidance on the maximum continuous operating voltage rating

[1] Information on references can be found in Clause 2.

Copyright © 2016 IEEE. All rights reserved.

- A clause further dispelling the use of response time as a useful characteristic on an SPD
- A direct statement that energy ratings (Joule ratings) should not be used when characterizing SPDs
- Guidance on the load-side surge withstand capability of two-port SPDs
- An explanation of the UL SPD Types nomenclature from (UL 1449 [B72][2])
- Explanation of SPD enclosure ratings and application considerations
- Application considerations regarding SPD disconnectors
- SPD safety and regulatory considerations
- Expanded discussion of SPD modes of protection
- Discussion of overvoltage failures of SPDs and TOVs
- Extensive additions to the clauses on SPD coordination considerations
- Surge waveforms and durations, ring waves, combination wave generator surges
- SPD conductor connection length
- Distance between SPDs
- Comparison and coordination of SPD terminologies
- SPD maximum continuous operating voltage coordination
- Surge current rating/nominal discharge current rating coordination
- Aging of SPDs
- Coordination of SPDs to the grounding (earthing) and bonding system
- Integral installation of SPDs within electrical distribution and end-use equipment
- SPDs used in conjunction with lightning protection systems
- SPD installation in hazardous locations
- SPD documentation

Suggestions for improvements to this guide are welcome. They should be sent to the Secretary, IEEE Standards Board, The Institute of Electrical and Electronic Engineers, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA.

[2] The numbers in brackets correspond to those of the bibliography in Annex A.

Copyright © 2016 IEEE. All rights reserved.

Contents

Copyright © 2016 IEEE. All rights reserved.

Copyright © 2016 IEEE. All rights reserved.

Copyright © 2016 IEEE. All rights reserved.

IEEE Guide for the Application of Surge-Protective Devices for Use on the Load Side of Service Equipment in Low-Voltage (1000 V or Less, 50 Hz or 60 Hz) AC Power Circuits

IMPORTANT NOTICE: IEEE Standards documents are not intended to ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

This IEEE document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notice" or "Important Notices and Disclaimers Concerning IEEE Documents." They can also be obtained on request from IEEE or viewed at http://standards.ieee.org/IPR/disclaimers.html.

1. Overview

1.1 Scope

This guide covers the application of surge-protective devices (SPDs) for installation on the load side of the service equipment for 50 Hz or 60 Hz, ac power circuits rated 1000 V rms or less.

1.2 Purpose

The purpose of this guide is to provide users, specifiers, installers and manufacturers with guidance on the use, selection, application and installation of SPDs for installation on the load side of the service equipment for 50 Hz or 60 Hz, ac power circuits rated 1000 V rms or less.

Copyright © 2016 IEEE. All rights reserved.