IEEE STANDARDS ASSOCIATION

IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part I: Introduction

IEEE Power and Energy Society

Sponsored by the
Surge Protective Devices Committee

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

IEEE Std C62.92.1™-2016
(Revision of IEEE Std C62.92.1-2000)

IEEE Std C62.92.1™-2016
(Revision of IEEE Std C62.92.1-2000)

IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part I: Introduction

Sponsor

Surge Protective Devices Committee
of the
IEEE Power and Energy Society

Approved 7 December 2016

IEEE-SA Standards Board

Abstract: The application of neutral grounding to three-phase electrical utility systems is described in this guide. It is Part 1 of the IEEE C62.92 series of guides for neutral grounding. This guide presents basic considerations of the selection of neutral grounding parameters that will provide for the control of overvoltage and ground-fault current on all parts of three-phase electrical utility systems rated greater than 1000 V.

Keywords: classes of grounding, effectively grounding, IEEE C62.92.1™, means of grounding, neutral grounding, undergrounded systems

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

PDF: ISBN 978-1-5044-3735-6 STD22421
Print: ISBN 978-1-5044-3736-3 STDPD22421

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 Notices and Disclaimers Concerning IEEE Standards Documents." They can also be obtained on request from IEEE or viewed at http://standards.ieee.org/IPR/disclaimers.html.

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. IEEE Standards are documents developed through scientific, academic, and industry-based technical working groups. Volunteers in IEEE working groups 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 Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers and users 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.

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.

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 US 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.

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 10 years. When a document is more than 10 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 Xplore at http://ieeexplore.ieee.org/ 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

Introduction

This introduction is not part of IEEE Std C62.92.1–2016, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part I: Introduction.

This document is the first part of a five-part series of guides on the subject of electric utility system neutral grounding practices and serves as an introduction. When the series was first approved and published, it replaced IEEE Std 143™-1954, IEEE Guide for Ground-Fault Neutralizers, Grounding of Synchronous Generator Systems, and Neutral Grounding of Transmission Systems.

Each of the remaining four parts addresses a specific part of the utility system to serve as a guide for neutral grounding. The five parts are as follows:

a) IEEE Std C62.92.1™, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part I: Introduction[1]

b) IEEE Std C62.92.2™, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part II: Grounding of Synchronous Generator Systems

c) IEEE Std C62.92.3™, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part III: Generator Auxiliary Systems

d) IEEE Std C62.92.4™, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part IV: Distribution

e) IEEE Std C62.92.5™, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part V: Transmission and Subtransmission Systems

This series of guides is intended for application to three-phase electrical utility systems. They provide definitions and considerations that are general to all types of neutral grounding for electrical utility systems, as well as basic considerations of the selection of neutral grounding parameters that will provide for the control of overvoltage and ground-fault current on all parts of three-phase electrical utility systems. They are not intended to be used with the grounding, for example, of industrial systems, which are covered in other guides and standards. These guides and standards should be referenced, when appropriate, to gain a full picture of other grounding practices.

This document has been revised to address comments received as part of the most recent re-affirmation ballot. The most significant changes were to correct an error in one of the equations in the caption beneath Figure 1 in 6.3 and to correct an omission in the drawing itself. Equation A.2 and Equation A.3 were changed to correct arithmetic errors. Most of the other comments received during that re-affirmation ballot were editorial in nature and have been addressed. Other changes include the update of reference material publish dates that may have changed or been updated.

It is impossible to give recognition to all those who have contributed to the technology and practices of grounding of power systems, because work involving the preparation of this guide has been in progress for more than 30 years. However, the assistance of members, past and present, of the Neutral Grounding Devices Subcommittee of the Surge Protective Devices Committee, and other similar groups with comparable purposes, should be acknowledged.

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

Participants

At the time this IEEE guide was completed, the Neutral Grounding Devices Working Group had the following membership:

Steven Whisenant, *Chair*
Michael Champagne, *Vice Chair*

Robert Allison
Michael Comber
Thomas Field
Steven Hensley
Joseph L. Koepfinger
Chris Kulig
Iuda Morar
Caryn Riley
Thomas Rozek
Keith Stump
Ed Taylor
Arnie Vitols
Reigh Walling
James Wilson
Chad Withers
Jonathan Woodworth
Benjamin York

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

William Ackerman
Saleman Alibhay
John Anthony
Thomas Barnes
G. Bartok
Frank Basciano
David Beach
Barry Beaster
Philip Beaumont
Robert Beavers
W.J. (Bill) Bergman
Steven Bezner
Wallace Binder
William Bloethe
Jeffrey Bragg
Chris Brooks
Andrew Brown
Gustavo Brunello
Zeeky Bukhala
William Byrd
Thomas Callsen
Paul Cardinal
Michael Champagne
Robert Christman
Michael Comber
Stephen Conrad
Randall Crellin
Matthew Davis
Gary Donner
Michael Dood
Randall Dotson
Cliff Erven
Keith Flowers
Rostyslaw Fostiak
Dale Fredrickson
Fredric Friend
Frank Gerleve
David Gilmer
Jalal Gohari
Christine Goldsworthy
Edwin Goodwin
Stephen Grier
Randall Groves
Ajit Gwal
Said Hachichi
Paul Hamer
Dennis Hansen
Jeffrey Helzer
Steven Hensley
Lee Herron
Werner Hoelzl
Robert Hoerauf
Jill Holmes
Philip Hopkinson
Ronald Hotchkiss
James Houston
Richard Jackson
Alan Jensen
Gerald Johnson
Gael Kennedy
Sheldon Kennedy
Yuri Khersonsky
Gary Kobet
Hermann Koch
Joseph L. Koepfinger
Boris Kogan
Jim Kulchisky
Chung-Yiu Lam
Thomas La Rose
Michael Lauxman
John Leach
Paul Lindemulder
Albert Livshitz
Thomas Lundquist
Reginaldo Maniego
Albert Martin
Lee Matthews
Michael Maytum
John McAlhaney Jr.
William McBride
Thomas McCarthy
John McClelland
Jeffery Mizener
Daleep Mohla
Daniel Mulkey
Jerry Murphy
R. Murphy
Ryan Musgrove
K. R. M. Nair
Arun Narang
Arthur Neubauer
Michael Newman
Joe Nims
Gary Nissen
James O'Brien
Hans-Wo Oertel
Tim Olson
Carl Orde
Thomas Overman
Bansi Patel
S. Patel
Subhash Patel
Brian Penny
Alvaro Portillo
Reynaldo Ramos
Leslie Recksiedler
Keith Reese
Michael Roberts
Timothy Robirds
Charles Rogers
Jesse Rorabaugh
Joseph Rostron
Thomas Rozek
Daniel Sabin
Bartien Sayogo
Dennis Schlender
Robert Schuerger

Carl Schuetz
Kenneth Sedziol
Robert Seitz
Nikunj Shah
Devki Sharma
Hyeong Sim
David Singleton
Jerry Smith
Andrew Steffen
Keith Stump
C. Tailor
David Tepen
James Thompson
Michael Thompson
Wayne Timm
John Toth
Remi Tremblay
Demetrios Tziouvaras
Joe Uchiyama
Gerald Vaughn
John Vergis
Jane Verner
Ilia Voloh
Reigh Walling
Lanyi Wang
Daniel Ward
Lee Welch
Yingli Wen
Steven Whisenant
Kenneth White
James Wilson
Terry Woodyard
Dean Yager
Richard Young
Jian Yu
Luis Zambrano
David Zech
Peter Zhao

When the IEEE-SA Standards Board approved this guide on 7 December 2016, it had the following membership:

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

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

*Member Emeritus

Contents

IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part I: Introduction

1. Overview

1.1 Scope

This guide is intended for application to three-phase electrical utility systems and is Part I of the IEEE Std C62.92 series. This part provides definitions and considerations that are general to all types of neutral grounding for electrical utility systems. Goals of system grounding, means of grounding, and classes of grounding are addressed in this part.

1.2 Purpose

This guide presents basic considerations of the selection of neutral grounding parameters that will provide for the control of overvoltage and ground-fault current on all parts of three-phase electrical utility systems.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

Accredited Standards Committee C2-2017, National Electrical Safety Code® (NESC®).[2]

IEEE Std 80™, IEEE Guide for Safety in AC Substation Grounding.[3,4]

IEEE Std 142™, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book ™).[5]

[2]National Electrical Safety Code and NESC are both registered trademarks and service marks of the Institute of Electrical and Electronics Engineers, Inc. and is available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).
[3]The IEEE standards or products referred to in this clause are trademarks of The Institute of Electrical and Electronics Engineers, Inc.
[4]This publication is available from The Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://standards.ieee.org/).
[5]*IEEE Green Book* is a registered trademark of the Institute of Electrical and Electronics Engineers, Inc.