IEEE SA
STANDARDS ASSOCIATION

IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part V: Transmission Systems and Subtransmission Systems

IEEE STANDARDS

IEEE Power and Energy Society

Developed by the
Surge Protective Devices Committee

IEEE Std C62.92.5™-2020
(Revision of IEEE Std C62.92.5-2009)

IEEE

IEEE Std C62.92.5™-2020
(Revision of IEEE Std C62.92.5-2009)

IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part V: Transmission Systems and Subtransmission Systems

Developed by

Surge Protective Devices Committee
of the
IEEE Power and Energy Society

Approved 24 September 2020

IEEE SA Standards Board

Abstract: Basic factors and general considerations in selecting the class and means of neutral grounding for a particular ac transmission or subtransmission system are covered in this guide. An apparatus to be used to achieve the desired grounding is suggested, and methods for specifying the grounding devices are given. Transformer tertiary systems, equipment-neutral grounding, and the effects of series compensation on grounding are discussed.

Keywords: electrical utility systems, equipment neutral grounding, grounding, IEEE C62.92.5™, neutral grounding, series compensation, subtransmission systems, transformer tertiary systems, transmission systems

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

Copyright © 2020 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 23 December 2020. 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 978-1-5044-7056-8 STD24413
Print: ISBN 978-1-5044-7065-0 STDPD24413

IEEE prohibits discrimination, harassment, and bullying.
For more information, visit https://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.

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE Standards documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page (https://standards.ieee.org/ipr/disclaimers.html), appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning IEEE Standards Documents."

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

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through an accredited consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed by volunteers with scientific, academic, and industry-based expertise in technical working groups. Volunteers are not necessarily members of IEEE or IEEE SA, 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 makes no warranties or representations concerning its standards, and expressly disclaims all warranties, express or implied, concerning this standard, including but not limited to the warranties of merchantability, fitness for a particular purpose and non-infringement. In addition, IEEE does not warrant or represent that the use of the material contained in its standards is free from patent infringement. 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: THE NEED TO PROCURE 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 is the approved IEEE standard.

Copyright © 2020 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, nor 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 the presenter's views should be considered the personal views of that individual rather than the formal position of IEEE, IEEE SA, the Standards Committee, or the Working Group.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE or IEEE SA. However, **IEEE does not provide interpretations, 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 evaluating comments or in revisions to an IEEE standard is welcome to join the relevant IEEE working group. You can indicate interest in a working group using the Interests tab in the Manage Profile and Interests area of the IEEE SA myProject system. An IEEE Account is needed to access the application.

Comments on standards should be submitted using the Contact Us form.

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 constitute 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.

Data privacy

Users of IEEE Standards documents should evaluate the standards for considerations of data privacy and data ownership in the context of assessing and using the standards in compliance with applicable laws and regulations.

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.

Copyright © 2020 IEEE. All rights reserved.

Photocopies

Subject to payment of the appropriate licensing fees, 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; https://www.copyright.com/. 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 IEEE Xplore or contact IEEE. For more information about the IEEE SA or IEEE's standards development process, visit the IEEE SA Website.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE SA Website. Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Details section. Errata are also available in IEEE Xplore. Users are encouraged to periodically check for errata.

Patents

IEEE Standards are developed in compliance with the IEEE SA Patent Policy.

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 https://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 © 2020 IEEE. All rights reserved.

IMPORTANT NOTICE

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. IEEE Standards development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. 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.

Copyright © 2020 IEEE. All rights reserved.

Participants

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

Steven G. Whisenant, *Chair*
Michael K. Champagne, *Vice Chair*

Robert Allison
Thomas Field
Christine Goldsworthy
Steven Hensley
Chris Kulig
Joseph L. Koepfinger
Iuda Morar
Craig Polinski
Andrew Steffen
Keith Stump
James Taylor
Reigh Walling
Jon Woodworth
Jim Wilson
Chad Withers
Ben York

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

Saleman Alibhay
Curtis Ashton
Sinan Balban
Thomas Barnes
Michael Basler
Philip Beaumont
W.J.(Bill) Bergman
Wallace Binder
Thomas Blair
Kenneth Bow
Gustavo Brunello
Demetrio Bucaneg Jr.
William Bush
William Byrd
Paul Cardinal
Michael K. Champagne
Arvind Chaudhary
Michael Chirico
Robert Christman
Stephen Conrad
Randall Crellin
David Crotty
Davide De Luca
Gary Donner
Jorge Fernandez Daher
Dominick Fontana
Rostyslaw Fostiak
Carl Fredericks
Waymon Goch
Jalal Gohari
Edwin Goodwin
Stephen Grier
J.Travis Griffith
Randall Groves
Said Hachichi
John Harley
Jeffrey Helzer
Steven Hensley
Werner Hoelzl
Robert Hoerauf
Philip Hopkinson
James Houston
Richard Jackson
John John
Peter Kelly
Gael Kennedy
Sheldon Kennedy
Yuri Khersonsky
James Kinney
Hermann Koch
Boris Kogan
Jusuf Krvavac
Chung-Yiu Lam
Wei-Jen Lee
Lawrenc Long
Thomas Lundquist
Reginaldo Maniego
Lee Matthews
Michael Maytum
Omar Mazzoni
William McBride
Remo Mugwyler
R. Murphy
Dennis Neitzel
Michael Newman
Joe Nims
Lorraine Padden
Sergio Panetta
Bansi Patel
Christopher Petrola
Prasad Pmsvvsv
Eric Rasmussen
Lakshman Raut
Timothy Robirds
Charles Rogers
Rodrigo Ronchi
Ryandi Ryandi
Steven Sano
Sergio Santos
Bartien Sayogo
Carl Schuetz
Kenneth Sedziol
Robert Seitz
Devki Sharma
Hyeong Sim
Veselin Skendzic
Jerry Smith
Gary Smullin
Thomas Starai
Andrew Steffen
Gary Stoedter
Keith Stump
Ganesh Subramanian
James Taylor
David Tepen
Michael Thompson
Robert Thompson
James Timperley
Demetrios Tziouvaras
Nijam Uddin
James Van De Ligt
Gerald Vaughn
John Vergis
David Wallace
Reigh Walling
Daniel Ward
Steven G. Whisenant
Kenneth White
James Wilson
Jon Woodworth
Gaetano Zizzo

Copyright © 2020 IEEE. All rights reserved.

When the IEEE-SA Standards Board approved this guide on 24 September 2020, it had the following membership:

Gary Hoffman, *Chair*
Jon Walter Rosdahl, *Vice Chair*
John Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Ted Burse
Doug Edwards
J.Travis Griffith
Grace Gu
Guido R. Hiertz
Joseph L. Koepfinger*
David J. Law
Howard Li
Dong Liu
Kevin Lu
Paul Nikolich
Damir Novosel
Dorothy Stanley
Mehmet Ulema
Lei Wang
Sha Wei
Philip B. Winston
Daidi Zhong
Jingyi Zhou

*Member Emeritus

Copyright © 2020 IEEE. All rights reserved.

Introduction

This introduction is not part of IEEE Std C62.92.5-2020, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part V: Transmission Systems and Subtransmission Systems.

This guide is a part of a series of standards on neutral grounding in electrical utility systems. 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. In this series of documents, individual considerations and practices have been given to the grounding of synchronous generator systems, generator-station auxiliary systems, and distribution systems.

IEEE Std 143-1954 is a revision of AIEE No. 954, October 1954, which was a compilation of the following three AIEE Transaction papers:

— AIEE Committee Guide Report, "Application of Ground-Fault Neutralizers," *AIEE Transactions (Power Apparatus and Systems)*, vol. 72, pt. III, pp. 183–190, April 1953.

— AIEE Committee Report, "Application Guide for the Grounding of Synchronous Generator Systems," *AIEE Transactions (Power Apparatus and Systems)*, vol. 72, pt. III, pp. 517–530, June 1953.

— AIEE Committee Report, "Application Guide on Methods of Neutral Grounding of Transmission Systems," *AIEE Transactions (Power Apparatus and Systems)*, vol. 72, pt. III, pp. 663–668, August, 1953.

The contents of Parts I–V of the revision of IEEE Std 143-1954 are based on the foregoing documents, but are amplified and updated with new material from the IEEE tutorial course "Surge Protection in Power Systems" (79EH0144–6-PWR) and other sources. Part VI of this series addresses current-regulated power sources.

In Part I through Part V of this series, emphasis is placed on power system grounding practices rather than the grounding, for example, of industrial systems, which is 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 revision of this Part V contains no major changes, but is an editorial update and technical clarification as required by IEEE-SA. It incorporates both technical and editorial comments received during the balloting process that have made it more valuable to the reader.

It is impossible to give recognition to all those who have contributed to the technology and practices of grounding of power systems, since work involving the preparation of this guide has been in progress for more than 80 years. However, the assistance of both past and present members of the Neutral Grounding Devices Subcommittee of the Surge-Protective Devices Committee, and other similar groups with comparable purposes, should be acknowledged.

Copyright © 2020 IEEE. All rights reserved.

Contents

Copyright © 2020 IEEE. All rights reserved.

IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems—Part V: Transmission Systems and Subtransmission Systems

1. Overview

1.1 Scope

The scope of this document is to provide the basic factors and general considerations in selecting the class and means of neutral grounding for a particular ac transmission or subtransmission system, and the suggested method and apparatus to be used to achieve the desired grounding. Definitions of grounding terms used in this part of the guide can be found in IEEE Std C62.92.1™.[1]

1.2 Purpose

The purpose of this document is to provide the user with insight on the basic factors and general considerations in selecting the class and means of neutral grounding for a particular ac transmission or subtransmission system. An apparatus to achieve the desired grounding is suggested, and methods for specifying the grounding devices are given.

1.3 Word Usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals is *required to*).[2,3]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals is *recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals is *permitted to*).

[1]Information on references can be found in Clause 2.
[2]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.
[3]The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

Copyright © 2020 IEEE. All rights reserved.