

IEEE Standard for Performance Characteristics and Dimensions for High Current Power Transformer Bushings with Rated Continuous Current in Excess of 5000 A in Bus Enclosures

IEEE Power and Energy Society

Sponsored by the
Transformers Committee

IEEE Standard for Performance Characteristics and Dimensions for High Current Power Transformer Bushings with Rated Continuous Current in Excess of 5000 A in Bus Enclosures

Sponsor

Transformers Committee
of the
IEEE Power and Energy Society

Approved 7 May 2018

IEEE-SA Standards Board

Abstract: The electrical, dimensional, and related special requirements for high current rating power transformer bushings within bus enclosures that have rated continuous current in excess of 5000 A are addressed in this standard. Bushings covered by this standard are intended for use as components of liquid-filled transformers, including but not limited to Generator Step-Up (GSU) Transformers.

Keywords: basic impulse insulation levels (BILs), bushings, cantilever test, capacitance, creepage distance, generator step-up (GSU) transformers, isolated-phase bus, line-to-ground voltage, metal-enclosed bus, nominal system voltage, power transformer bushings, power factor

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

Copyright © 2018 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 6 June 2018. 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 978-1-5044-4893-2 STD23128
Print: ISBN 978-1-5044-4894-9 STDPD23128

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.

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

Participants

At the time this draft standard was completed, the Bushing—Standardization of GSU Bushings Working Group had the following membership:

Scott Digby, *Chair*
John D. Brafa, *Vice Chair*
Richard von Gemmingen, *Secretary*

Omar Ahmed	Wayne Johnson	Kirk Robbins
Jeffrey Benach	Randall Kyle	Devki Sharma
James Campbell	Mario Locarno	Fabian Stacy
Florian Costa	Kumar Mani	Craig Stiegemeier
Keith Ellis	Shankar Nambi	David Stockton
Eduardo Garcia	Anthony Natale	Ajith Varghese
David Geibel	Leslie Recksiedler	Yves Vermette
John Graham	Sebastien Riopel	Eric Weatherbee
Eric Humphrey		William Whitehead
Jose Izquierdo		Shibao Zhang

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

Stephen Antosz	Daniel Huenger	Alvaro Portillo
Peter Balma	Richard Jackson	Farnoosh Rahmatian
Barry Beaster	John John	Sebastien Riopel
W.J. (Bill) Bergman	Gael Kennedy	Richard Rohr
Thomas Blackburn	Sheldon Kennedy	Rodrigo Ronchi
W Boettger	James Kinney	Thomas Rozek
J. Brafa	Axel Kraemer	Daniel Sauer
Demetrio Bucaneg Jr.	Jim Kulchisky	Mathieu Sauzay
Ted Burse	John Lackey	Bartien Sayogo
Paul Cardinal	Chung-Yiu Lam	Nikunj Shah
Juan Castellanos	Aleksandr Levin	Devki Sharma
John Crouse	Weijun Li	Hyeong Sim
Willaim Darovny	Thomas Lundquist	Richard Simonelli
Scott Digby	Richard Marek	Jerry Smith
Gary Donner	J. Dennis Marlow	Ronald Stahara
Joseph Foldi	Hugo Marroquin	James Van De Ligt
David Geibel	William McBride	Jason Varnell
David Gilmer	John McClelland	Roger Verdolin
Jalal Gohari	Andrew McNulty	John Vergis
Edwin Goodwin	Joseph Melanson	Yves Vermette
James Graham	Daniel Mulkey	David Wallach
Randall Groves	K.R.M. Nair	Joe Watson
John Harley	Michael Newman	Eric Weatherbee
Roger Hayes	Lorraine Padden	Kenneth White
Werner Hoelzl	Bansi Patel	Jennifer Yu
Jill Holmes	Poorvi Patel	Jian Yu
Philip Hopkinson	Christopher Petrola	Shibao Zhang

When the IEEE-SA Standards Board approved this standard on 7 May 2018, it had the following membership:

Jean-Phillipe Faure, *Chair*
Gary Hoffman, *Vice Chair*
John D. Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Ted Burse
Guido R. Hiertz
Christel Hunter
Joseph L. Koepfinger*
Thomas Koshy
Hung Ling
Dong Liu

Xiaohui Liu
Kevin Lu
Daleep Mohla
Andrew Myles
Paul Nikolich
Ronald C. Petersen
Annette D. Reilly

Robby Robson
Dorothy Stanley
Mehmet Ulema
Phil Wennblom
Philip Winston
Howard Wolfman
Jingyi Zhou

*Member Emeritus

Introduction

This introduction is not part of IEEE Std C57.19.04-2018, Standard for Performance Characteristics and Dimensions for High Current Power Transformer Bushings with Rated Continuous Current in Excess of 5000 A Located in Bus Enclosures.

IEEE Std C57.19.00™ and IEEE Std C57.19.01™ define the dimensions and performance characteristics of outdoor apparatus bushings, which are intended for use in an environment where the upper end of the bushing is subject to ambient, free air. Such bushings may not have a satisfactory life expectancy if the upper end is in a metal enclosure and the upper terminal is connected to bus designed to perform as described in IEEE Std C37.23™.

In the power generation industry, bushings located on the low voltage side of generator step-up transformers are commonly subject to an environment that is hotter than the usual service conditions defined in IEEE Std C57.19.00. For such an application, bushings can be directly connected to metal-enclosed bus, which allows a temperature rise much higher than the temperature rise described in IEEE Std C57.19.00 temperature rise design test, and are continuously loaded to levels which subject the bushings to more than 5000 A. This new standard, IEEE Std C57.19.04™, has been created because low-voltage bushings of generator step-up transformers have remained dimensionally undefined with undocumented performance expectations for a very long time.

Misapplying bushings that comply with the performance requirements of IEEE Std C57.19.00 and IEEE Std C57.19.01 in an environment typical of how the low voltage bushings of a generator step-up transformer would reside often leads to overheating, insulation breakdown, overpressure, gasket damage, rapid breakdown of insulation, and premature end-of-life.

Users which specify their high current bushings residing in metal enclosed bus duct (i.e., isophase or non-segmented bus duct, air terminal chamber), should adhere to IEEE Std C57.19.04 to improve long-term and robust performance, as well as mechanical interchangeability over the life of their asset.

Contents

1. Overview.....	10
1.1 Scope.....	10
2. Normative References.....	10
3. Rated continuous current.....	11
3.1 Thermal basis of rating.....	11
3.2 Requirement for thermal testing.....	11
3.3 Temperature rise test.....	11
4. General Requirements.....	13
5. Detailed Requirements.....	13
6. Non-Capacitance Graded Bushings.....	20
Annex A (informative) Bibliography.....	22