IEEE STANDARDS ASSOCIATION

IEEE Standard for Common Requirements for Testing of AC Capacitive Current Switching Devices over 1000 V

IEEE Power and Energy Society

Sponsored by the
Switchgear Committee

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

IEEE Std C37.100.2™-2018

IEEE Standard for Common Requirements for Testing of AC Capacitive Current Switching Devices over 1000 V

Sponsor

Switchgear Committee
of the
IEEE Power and Energy Society

Approved 8 March 2018

IEEE-SA Standards Board

Abstract: Common requirements for testing of AC capacitive current switching devices with nominal system voltage above 1000 V are provided in this standard.

Keywords: back-to-back switching, bank charging, C0, C1, C2, cable charging, capacitive current switching, capacitor switching, design test, IEEE C37.100.2™, line charging, preconditioning, restrike, single-phase testing, synthetic test, three-phase testing, unit test

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

PDF: ISBN 978-1-5044-4864-2 STD23109
Print: ISBN 978-1-5044-4865-9 STDPD23109

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 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.

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. A current 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 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 IEEE standard was completed, the PC37.100.2 Working Group had the following membership:

Neil McCord, *Chair*
John C. Webb, *Vice Chair*
Donald Swing, *Secretary*

Roy Alexander
Edwin Almeida
Anne Bosma
Antone Bonner
Frank DeCesaro
Edgar Dullni
Sergio Flores
Harold Hirz
Peter Meyer
Tom Mulcahy
Brian Roberts
R. Kirkland Smith
James van de Ligt

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

Roy Alexander
Chris Ambrose
Roy Ayers
Thomas Barnes
George Becker
W. J. (Bill) Bergman
Jean-Marc Biasse
Wallace Binder
Antone Bonner
Anne Bosma
Jeffrey Brogdon
Ted Burse
Eldridge Byron
Paul Cardinal
Stephen Cary
Chih Chow
Lucas Collette
Michael Crawford
Gary Donner
Denis Dufournet
Edgar Dullni
Jerry Earl
Douglas J. Edwards
Cliff Erven
Sergio Flores
Marcel Fortin
Frank Gerlach
David Gilmer
Mietek Glinkowski
Daniel Graves
John Harder
John Harley
Helmut Heiermeier
Jeffrey Helzer
Victor Hermosillo
James Houston
Todd Irwin
Richard Jackson
Song Jin
Laszlo Kadar
Jeffrey Kester
Yuri Khersonsky
James Kinney
Joseph L. Koepfinger
Peter Kovari
Jim Kulchisky
Chung Yiu Lam
Benjamin Lanz
Hua Liu
R. Long
Frank Mayle
Omar Mazzoni
Neil McCord
Peter Meyer
Sujeet Mishra
Thomas Mulcahy
Daniel Mulkey
Michael Newman
Joe Nims
T. W. Olsen
Lorraine Padden
Jim Phillips
Iulian Profir
Reynaldo Ramos
Sarma Santosh Reddy
Carl Reigart
Anthony Ricciuti
Brian Roberts
Michael Roberts
Timothy Robirds
Charles Rogers
Thomas Rozek
Bartien Sayogo
Nikunj Shah
Hamid Sharifnia
Devki Sharma
Michael Skidmore
Jeremy Smith
Jerry Smith
R. Kirkland Smith
James Stage
Tom Stefanski
Michael Swearingen
Donald Swing
Marcelo Valdes
James van de Ligt
Roger Verdolin
John Vergis
Mark Waldron
John C. Webb
Jan Weisker
Kenneth White
Terry Woodyard
Richard York
Jian Yu

When the IEEE-SA Standards Board approved this standard on 8 March 2018, it had the following membership:

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

Ted Burse	Xiaohui Liu	Robby Robson
Guido R. Hiertz	Kevin Lu	Dorothy Stanley
Christel Hunter	Daleep Mohla	Mehmet Ulema
Joseph L. Koepfinger*	Andrew Myles	Phil Wennblom
Thomas Koshy	Paul Nikolich	Philip Winston
Hung Ling	Ronald C. Petersen	Howard Wolfman
Dong Liu	Annette D. Reilly	Jingyi Zhou

*Member Emeritus

Introduction

This introduction is not part of IEEE Std C37.100.2-2018, IEEE Standard for Common Requirements for Testing of AC Capacitive Current Switching Devices over 1000 V.

The scope of this document is limited to testing switching devices for capacitive current switching capability only. For other testing requirements, refer to the relevant apparatus standards.

This capacitive current switching test standard is a document combining the requirements of IEEE Std C37.09a™-2005 [B7] with IEEE Std C37.66™-2005 [B11] and IEEE Std 1247™-2005 [B3]. IEEE Std C37.09a-2005 was selected as the base document because it had been harmonized by a joint IEEE/IEC task force that developed a revised approach to capacitive current switching standardization. IEC has published this task force's work as part of IEC's circuit breaker standard, designated IEC 62271-100. Please note that since IEEE Std C37.016™-2006 [B9] refers to IEEE Std 1247-2005 [B3] for all of the capacitive current switching tests it specifies, consideration of IEEE Std 1247-2005 [B3] covers the requirements of IEEE Std C37.016-2006 [B9].

The term circuit-breaker from IEEE Std C37.09a [B7] has been replaced with the term capacitive current switching device for this document.

These standards represent two basic methods for determining capacitive current switching performance. The method to prove performance per IEEE Std C37.09a [B7] is based on focusing on the performance at minimum arcing time and then demonstrating the rest of the interrupting window. IEEE Std C37.66 [B11] and IEEE Std 1247 [B3] are testing performance and endurance through a large number of test operations up to 1200 operations. To reconcile the different methods a subclause, 4.9, was added to this standard allowing the 1200 random operation method to be used to achieve a capacitive current switching rating. For example, a C2 rating can be achieved either by 1200 single-phase operations with a maximum of two restrikes as specified in IEEE Std C37.66 [B11] or 16 single-phase operations (targeted to minimum arcing time) with no restrikes as specified in IEEE Std C37.09a [B7].

The three classes of capacitive current switching test restrike performance are retained from IEEE Std C37.09a—very low probability of restrike (Class C2), low probability of restrike (Class C1), and unspecified probability of restrike (Class C0).

IEEE Std C37.09a [B7] is based on an assumption of "simultaneity". IEEE Std 1247-2005 [B3] had a detailed scheme in Table 4. The working group has simplified this table to two values. If the non-simultaneity is between 0 and 90 electrical degrees, then the voltage factor (k_c) is 1.4. If the non-simultaneity is greater than or equal to 90 electrical degrees, then the voltage factor (k_c) is 2.1.

Contents

IEEE Standard for Common Requirements for Testing of AC Capacitive Current Switching Devices over 1000 V

1. Overview

1.1 Scope

This standard provides common requirements for testing of ac capacitive current switching devices over 1000 V.

1.2 Usage of terms

Each of the various U.S. and international standards use different terminology for operating a switch. For this standard, the following terminology is used. “Making” applies to closing the contacts with voltage applied and “breaking” applies to operations that interrupt current. The term “switching” refers to the act of making then breaking. The terms “opening” and “closing” refer to the mechanical action (i.e., without current in the main current path or voltage present). Many existing standards and definitions use opening and closing to describe actions both with and without current flow and rely upon the context of the usage to inform the reader whether or not current is made or interrupted. When referring to other documents and definitions the contextual nature of these works should be understood; it is not the purpose of this document to change the meaning of these other documents. For example, the *IEEE Standards Dictionary Online* uses the word “opening” rather than “breaking” in the definitions of reignition and restrike. The context, in particular the words “resumption of current” indicates to the reader that “breaking,” as used in this document, is the activity under discussion.

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.