

IEEE Standard for High-Potential Test Requirements for Excitation Systems for Synchronous Machines

IEEE Power and Energy Society

Sponsored by the
Energy Development and Power Generation Committee

IEEE Std 421.3™-2016

(Revision of
IEEE Std 421.3-1997)

IEEE Standard for High-Potential Test Requirements for Excitation Systems for Synchronous Machines

Sponsor

**Energy Development and Power Generation Committee
of the
IEEE Power and Energy Society**

Approved 5 February 2016

IEEE-SA Standards Board

Abstract: High-potential test voltages for excitation systems used with synchronous machines are established. Test voltages are established based on whether equipment is connected to the exciter power circuit or is electrically isolated from the exciter power circuit.

Keywords: dielectric testing, excitation systems, IEEE 421.3™, test voltages

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 30 March 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 978-1-5044-0815-8 STD20874
Print: ISBN 978-1-5044-0816-5 STDPD20874

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 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.

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. 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/xpl/standards.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

Participants

At the time this IEEE standard was completed, the ECS—High-Potential Test Requirements for Excitation Systems for Synchronous Machines Working Group had the following membership:

Richard Schaefer, *Chair*

G. Anderson	Joseph Hurley	William Pearson
David Apps	R. T. Jones	J. Robertson
Gene Asbury	Kiyong. Kim	I. Rowley
Matthias Baechle	V. Knakins	T. Sawatzlay
Michael Basler	Ruediger. Kutzner	A. W. Schneider, Jr.
M. Coultres	Om P. Malik	Uwe Seeger
Markus Egretzberger	Shawn McMullen	Paul Smulders
M. Faltas	R. Mousse	H. Su
Namal Fernando	R. Mutukutti	K. Sullivan
Alexander Glaninger-Katschnig	L. Nettleton	Jose Taborda
S. Guindon	Pierre Ouellette	David Thumser
Les Hajagos	Shawn Patterson	Eric Toft
Thomas Higgins		Eric Vaughn

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

Michael Basler	Joseph Hurley	Shawn Patterson
William Bloethe	Relu Ilie	Howard Penrose
Andrew Brown	Jim Kulchisky	Julian Profir
Gustavo Brunello	Andreas Kunkel	Richard Schaefer
Luis Coronado	Ruediger Kutzner	A. W. Schneider, Jr.
Matthew Davis	Benjamin Lanz	Uwe Seeger
Gary Donner	James Lau	Jeremy Smith
Markus Egretzberger	Albert Livshitz	Paul Smulders
Namal Fernando	Lawrence Long	Jose Taborda
Rostyslaw Fostiak	Om P. Malik	Robert Thornton-Jones
Frank Gerleve	Shawn McMullen	David Thumser
Alexander Glaninger-Katschnig	Antonio Mejia	James Timperley
Randall Groves	Rhonda Netzel	Eric Toft
James Gurney	Michael Newman	Eric Vaughn
Werner Hoelzl		John Vergis

When the IEEE-SA Standards Board approved this standard on 5 February 2016, it had the following membership:

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

Chuck Adams
Masayuki Ariyoshi
Ted Burse
Steven Dukes
Jianbin Fan
J. Travis Griffith
Gary Hoffman

Ronald W. Hotchkiss
Michael Janezic
Joseph L. Koepfinger*
Hung Ling
Kevin Lu
Annette D. Reilly

Gary Robinson
Mehmet Ulema
Yingli Wen
Howard Wolfman
Don Wright
Yu Yuan
Daidi Zhong

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 421.3™-2016, IEEE Standard for High-Potential Test Requirements for Excitation Systems for Synchronous Machines.

This standard defines high-potential test requirements for excitation systems for synchronous machines. IEEE Std 421.3™ establishes test voltages for the exciter output circuit and for all other circuits electrically isolated from the exciter output circuit. This standard was written to agree with existing standards as much as possible but expands the test voltages to account for stresses associated with high ceiling exciters.

Contents

1. Overview	1
1.1 Scope	1
1.2 Purpose	1
2. Normative references.....	2
3. Definitions	2
4. High-potential tests.....	2
4.1 General	2
4.2 Type of tests	3
5. Frequency and waveshape of test voltage	3
6. High-potential test considerations	3
7. Duration and application of test voltage	3
8. Measurement of test voltage.....	4
9. Test temperature	4
10. Standard test voltages	4
10.1 Exciter power circuit.....	4
10.2 All other circuits (electrically isolated from the exciter power circuit)	5
Annex A (informative) Background and technical considerations	6
Annex B (informative) Bibliography.....	8

IEEE Standard for High-Potential Test Requirements for Excitation Systems for Synchronous Machines

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 standard applies to high-potential testing of complete excitation systems and their components for synchronous machines. The components of the excitation system are described in IEEE Std 421.1TM [B2].¹ Auxiliary devices connected to either the input or output side of the rectifier bridge are exposed to similar excitation system stresses and are included in the requirements of this standard. Examples of such devices include temperature indicators, transducers, meters, field circuit breaker, discharge resistor, crowbar, etc. This standard does not cover the synchronous machine field winding.

1.2 Purpose

The purpose of this standard is to provide requirements and specific directions for the high-potential testing of complete excitation systems and their components using the most recent information manufacturers have made available.

¹ The numbers in brackets correspond to those of the bibliography in Annex B.