

IEEE Guide for Field Testing of Relaying Current Transformers

IEEE Power and Energy Society

Sponsored by the
Power System Relaying and Control Committee

IEEE Guide for Field Testing of Relaying Current Transformers

Sponsor

Power System Relaying and Control Committee
of the
IEEE Power and Energy Society

Approved 6 December 2017

IEEE-SA Standards Board

Abstract: Field test methods described in this guide assure that current transformers are connected properly, are of marked ratio and polarity, and are in a condition to perform as designed both initially and after having been in service for a period of time.

Keywords: current transformers, excitation, field testing, IEEE C57.13.1™, insulation, polarity, ratio, relaying

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 31 October 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.

National Electrical Safety Code and NESC are registered trademarks and service marks of the Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-1-5044-4591-7 STD22940
Print: ISBN 978-1-5044-4592-4 STDPD22940

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 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 guide was completed, the IEEE Guide for Field Testing of Relaying Current Transformers Working Group had the following membership:

Bruce A. Magruder, *Chair*

Will Knappek, *Vice Chair*

Rene Aguilar
Lee Bigham
Jeff Burnworth
Fred Friend

Jay Gosalia
Gordie Halt
John Herron
Heather Malson

Anthony Newman
Michael Stojak
Jason Strebe
Joe Uchiyama

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

Ali AlAwazi
Thomas Barnes
Jeffrey Barsch
Philip Beaumont
Martin Best
Arthur Bigham
Wallace Binder
Demetrio Bucaneg Jr.
Jeffrey Burnworth
William Byrd
Paul Cardinal
Michael Chirico
Stephen Conrad
Ratan Das
Alla Deronja
Gary Donner
Michael Dood
Donald Dunn
Dale Fredrickson
Fredric Friend
Jean-Sebastien Gagnon
Rafael Garcia
Mietek Glinkowski
Jalal Gohari
Stephen Grier

Randall Groves
Roger Hedding
Werner Hoelzl
Jerry Hohn
Richard Jackson
John John
Gerald Johnson
Laszlo Kadar
James Kinney
William Knappek
Boris Kogan
Jim Kulchisky
Chung-Yiu Lam
Bruce Mackie
Bruce A. Magruder
Omar Mazzoni
William McBride
Brian Mugalian
Jerry Murphy
R. Murphy
Arthur Neubauer
Michael Newman
Lorraine Padden
Bansi Patel

Bruce Pickett
Jeffrey Pond
Iulian Profir
Farnoosh Rahmatian
Charles Rogers
Steven Sano
Bartien Sayogo
Thomas Schossig
Hyeong Sim
Jeremy Smith
Jerry Smith
Wayne Stec
Gary Stoedter
Michael Thompson
Francois Trichon
Demetrios Tziouvaras
James Van De Ligt
Benton Vandiver
John Vergis
Ilia Voloh
John Wang
Lisa Ward
Philip Winston
Jian Yu
Xi Zhu

When the IEEE-SA Standards Board approved this guide on 6 December 2017, it had the following membership:

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

Chuck Adams
Masayuki Ariyoshi
Ted Burse
Stephen Dukes
Doug Edwards
J. Travis Griffith
Michael Janezic

Thomas Koshy
Joseph L. Koepfinger*
Kevin Lu
Daleep Mohla
Damir Novosel
Ronald C. Petersen
Annette D. Reilly

Robby Robson
Dorothy Stanley
Adrian Stephens
Mehmet Ulema
Phil Wennblom
Howard Wolfman
Yu Yuan

*Member Emeritus

Introduction

This introduction is not part of IEEE Std C57.13.1-2017, IEEE Guide for Field Testing of Relaying Current Transformers.

This project revises the previous guide to keep it current with technological changes in instrument transformers and test equipment.

In the application of protective relays, a widely used input quantity is current. A multiplicity of different protective relays either utilize current directly, combine it with other currents as in differential schemes, or combine it with voltage to make impedance or power measurements. The source of relay input current is from current transformers, which may be located on the bushings of power circuit breakers and power transformers, on the bus bars of metal clad switchgear, or installed as separate items of equipment located as required.

This guide should be used in conjunction with other references, such as IEEE Std C57.13™, IEEE Standard Requirements for Instrument Transformers;¹ IEC 60044-8, Instrument Transformers—Electrical Current Transducers [B2]; and *Handbook for Electricity Metering*, EEI Publication No. 93-02-03 [B1].²

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

²Numbers in brackets correspond to those of the bibliography in [Annex D](#).

Contents

1. Overview.....	11
1.1 Scope.....	11
1.2 Purpose.....	11
2. Normative references	11
3. Definitions.....	12
4. Consideration of American National Standards Institute (ANSI) accuracy classes.....	12
5. Precautions in field testing current transformers (CTs).....	12
5.1 Demagnetizing CTs	13
5.2 Greater primary winding turns.....	13
6. Types of tests and measurements.....	13
6.1 Ratio test.....	13
6.2 Polarity test.....	13
6.3 Insulation resistance test.....	14
6.4 Resistance measurement.....	14
6.5 Excitation test.....	14
6.6 Admittance test.....	14
6.7 Burden test.....	14
7. AC sources for primary current injection tests.....	14
8. Ratio tests.....	14
8.1 Voltage method.....	15
8.2 Out-of-service current method	15
8.3 In-service current manual method	17
8.4 In-service current automated method	17
9. Polarity test.....	17
9.1 DC voltage test	17
9.2 AC voltage test—oscilloscope.....	18
9.3 Current method.....	19
9.4 Phase angle method	19
10. Insulation resistance tests.....	21
11. Winding and lead resistance (internal resistance).....	22
12. Excitation test.....	23
12.1 Safety.....	23
12.2 Type of test	23
12.3 How to interpret the test results	24
13. Admittance test.....	28
14. Burden tests.....	28
15. Burden measurements	29
16. Specialized situations.....	29
16.1 CT in a closed-delta transformer connection	29
16.2 Generator CTs.....	30
16.3 Inter-core coupling check	30

Annex A (informative) Wiring integrity, test switches, and test equipment	33
Annex B (informative) Excitation voltage measurement considerations	36
Annex C (informative) Optical current sensor systems	41
Annex D (informative) Bibliography	44

IEEE Guide for Field Testing of Relaying Current Transformers

1. Overview

1.1 Scope

The scope of this guide is to describe field test methods that assure current transformers (CTs) are connected properly, are of marked ratio and polarity, and are in a condition to perform as designed both initially and after being in service for a period of time.

[Annex A](#) describes wiring integrity checks, the use of test jacks, current-shortening switches, and relay test equipment.

[Annex B](#) illustrates excitation voltage measurement differences between rms responding voltmeters (commonly used under field conditions) and average responding voltmeters (commonly used in laboratory tests) and also discusses the effect of the source impedance.

[Annex C](#) describes the characteristics, and other pertinent information, of optical current sensor systems used with protective relaying. It provides an overview of the components used in an optical sensor system, discusses the differences from conventional CTs, and provides testing information.

[Annex D](#) is the bibliography for this guide.

1.2 Purpose

The purpose of the guide is to provide information on the current technology for field testing of instrument transformers and to more closely coordinate the information with the other industry standards, for example, the National Electrical Safety Code® (NESC®) (Accredited Standards Committee C2).³

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, National Electrical Safety Code® (NESC®).⁴

³Information on references can be found in [Clause 2](#).

⁴The NESC is available from the Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).