INTERNATIONAL STANDARD

IEC 62032

First edition
2005-03

IEEE C57.135™

Guide for the application, specification, and testing of phase-shifting transformers

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

The Institute of Electrical and Electronics Engineers, Inc, 3 Park Avenue, New York, NY 10016-5997, USA
Telephone: +1 732 562 3800 Telefax: +1 732 562 1571 E-mail: stds-info@ieee.org Web: www.standards.ieee.org

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDE FOR THE APPLICATION, SPECIFICATION, AND TESTING OF PHASE-SHIFTING TRANSFORMERS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC/IEEE 62032 has been processed through IEC Technical Committee 14: Power transformers.

The text of this standard is based on the following documents:

IEEE Std	FDIS	Report on voting
C57.135 (2001)	14/491/FDIS	14/494/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Attention is drawn to the fact that a certain number of graphical symbols used in this IEEE publication differ from the IEC graphical symbols laid down in IEC 60617.

Consequently, an Annex B has been created outlining the differences in the graphical symbols for diagrams between IEEE C57.135:2001 and IEC 60617. This annex is not exhaustive and only mentions the equivalences of the most important symbols used.

Once the IEC/IEEE publication has been revised, Annex B will be deleted and the graphical symbols will be put in line with IEC 60617.

The committee has decided that the contents of this publication will remain unchanged until 2006.

IEC/IEEE Dual Logo International Standards

This Dual Logo International Standard is the result of an agreement between the IEC and the Institute of Electrical and Electronics Engineers, Inc. (IEEE). The original IEEE Standard was submitted to the IEC for consideration under the agreement, and the resulting IEC/IEEE Dual Logo International Standard has been published in accordance with the ISO/IEC Directives.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

Use of an IEC/IEEE Dual Logo International Standard is wholly voluntary. The IEC and IEEE disclaim liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEC or IEEE Standard document.

The IEC and IEEE do not warrant or represent the accuracy or content of the material contained herein, and expressly disclaim any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEC/IEEE Dual Logo International Standards documents are supplied “AS IS”.

The existence of an IEC/IEEE Dual Logo International 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 IEC/IEEE Dual Logo International 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.

Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, 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 publishing and making this document available, the IEC and IEEE are not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Neither the IEC nor IEEE is undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEC/IEEE Dual Logo International Standards or IEEE Standards document, should rely upon the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations – Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received 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 interpretation requests except in those cases where the matter has previously received formal consideration.

Comments for revision of IEC/IEEE Dual Logo International Standards are welcome from any interested party, regardless of membership affiliation with the IEC or IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA and/or General Secretary, IEC, 3, rue de Varembé, PO Box 131, 1211 Geneva 20, Switzerland.

Authorization to photocopy portions of any individual standard for internal or personal use is granted by the Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, 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.

NOTE 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 with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

IEEE Guide for the Application, Specification, and Testing of Phase-Shifting Transformers

Sponsor

Transformers Committee
of the
IEEE Power Engineering Society

Approved 1 August 2002
American National Standards Institute

Approved 6 December 2001
IEEE-SA Standards Board

Abstract: Theory, application of phase-shifting transformers, and the difference of specification and testing to standard system transformers are described. Various types of phase-shifting transformers and how to select the optimal design to achieve required control of power flow are covered. An understanding of the terminology, types, construction, and testing specifical to phase-shifting transformers is provided.
Keywords: advance phase angle, dual-core design, main transformer, power transfer, phase-shifting transformer, retard phase angle, series transformer, single-core design, special tests

IEEE Introduction

This guide describes the application, specification, and testing of phase-shifting transformers. It is intended for the following:

— Organizations responsible for the application and specification of phase-shifting transformers for electric transmission systems to control power flow.

— Organizations responsible for testing phase-shifting transformers.

This guide is designed to help organizations

— Understand the various types of phase-shifting transformers and how to apply them to obtain required control of power flow.

— Prepare specifications for the purchase of phase-shifting transformers.

— Standardize tests and test methods for phase-shifting transformers.

This guide is intended to satisfy the following objectives:

— Promote consistency within organizations for the application and specification of phase-shifting transformers.

— Provide an understanding of the terminology, types, construction, and testing relating specifically to phase-shifting transformers.

— Promote the standardization of testing procedures for phase shifting transformers.

GUIDE FOR THE APPLICATION, SPECIFICATION, AND TESTING OF PHASE-SHIFTING TRANSFORMERS

1. Overview

1.1 Scope

This guide covers the application, specification, theory of operation, and factory and field testing of single-phase and three-phase oil-immersed phase-shifting transformers (PSTs).

This guide is limited to matters particular to PSTs and does not include matters relating to general requirements for power transformers covered in existing standards, recommended practices, or guides.

1.2 Purpose

The terminology, function, application, theory of operation and protection, and design of PSTs are not covered by existing transformer standards and guides. The purpose of this document is to provide guidance to those specifying, designing, and using PSTs.

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

NOTE The user's attention is drawn to the fact that the publications referenced below have no precise equivalent among publications issued by IEC. Normally, it is the practice of the IEC to include equivalent IEC standards for standards published by other organizations at the regional or national levels. However, following comments made by national committees on 14/491/FDIS, it has been determined that as no IEC publications exist that are exactly equivalent to IEEE standards, it would be misleading to provide references to similar IEC publications. This standard therefore includes references in this clause to IEEE standards only.

IEEE Std 693™-1997, IEEE Recommended Practices for Seismic Design of Substations.[1, 2]

IEEE Std 1313.1™-1996, IEEE Standard for Insulation Coordination—Definitions, Principles, and Rules.

IEEE Std C37.90.1™-2002, IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.

[1]The IEEE standards or products referred to in Clause 2 are trademarks owned by the Institute of Electrical and Electronics Engineers, Incorporated.

[2]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

IEEE Std C57.12.00™-2000, IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

IEEE Std C57.12.10™-1988, American National Standard for Transformers 230 kV and Below 833/958 through 8333/10 417 kVA, Single-Phase, and 750/862 through 60 000/80 000/100 000 kVA, Three-Phase without Load Tap Changing; and 3750/4687 Through 60 000/80 000/100 000 kVA with Load Tap Changing—Safety Requirements.

IEEE Std C57.12.70™-2000, IEEE Standard Terminal Markings and Connections for Distribution and Power Transformers.

IEEE Std C57.12.80™-2002, IEEE Standard Terminology for Power and Distribution Transformers.

IEEE Std C57.12.90™-1993, IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers, and IEEE Guide for Short Circuit Testing of Distribution and Power Transformers.

IEEE Std C57.19.00™-1991 (Reaff 1997), IEEE Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings.

IEEE Std C57.19.01™-1991 (Reaff 1997), IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings.

IEEE Std C57.19.100™-1995 (Reaff 1997), IEEE Guide for Application of Power Apparatus Bushings.

IEEE Std C57.91™-1995, IEEE Guide for Loading Mineral Oil Immersed Overhead and Pad-Mounted Distribution Transformers Rated 500 kVA and Less with 65 °C or 55 °C Average Winding Rise.

IEEE Std C57.93™-1995 (Reaff 2001), IEEE Guide for Installation of Liquid-Immersed Transformers.

IEEE Std C57.131™-1995, IEEE Standard Requirements for Load Tap Changers.