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

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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
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Международная Электротехническая Комиссия



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

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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.

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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 specific 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.

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²IEEE 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.