

# IEEE Guide for the Application of Protective Relaying for Phase-Shifting Transformers

IEEE Power and Energy Society

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Power System Relaying and Control Committee

# IEEE Guide for the Application of Protective Relaying for Phase-Shifting Transformers

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

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**Abstract:** Protection methods for different types of phase shifting transformers (PST) are provided in this guide, and the interaction between protection and operating conditions of PSTs is discussed. Models representing PSTs to determine short circuit currents for relaying functions are presented. Sizing and location issues of protection current transformers employed in the protection of PSTs are included. Examples of appropriate relay applications and settings are provided.

**Keywords:** advance phase angle, application of multifunction relays for transformer protection, CT saturation, current transformers, differential protection, dual-core design, IEEE C37.245™, overcurrent protection, phase-shifting transformer, power transfer, protection of transformers, retard phase angle, series transformer, single-core design

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## Introduction

This introduction is not part of IEEE Std C37.245™-2018, IEEE Guide for the Application of Protective Relaying for Phase-Shifting Transformers.

Phase shifting transformers (PSTs) are applied on the electric power system but typically represent only a small portion of a utility's overall transformer fleet. As such many protection engineers have limited familiarity with PSTs and the considerations behind properly applying relay protection to them. The variety of PST designs and configurations further complicates the process for new engineers to familiarize themselves with PST protection schemes.

This document provides application guidelines for selecting and engineering protection schemes for a variety of commonly applied types of PSTs.

The guide provides a background on the theory and application of PSTs, as well as an overview of common types of both single-core and two-core PSTs. PST overload mitigation techniques, equivalent MVA calculations for use in estimating inrush currents, and PST fault modeling methods and considerations are also discussed. Considerations for current transformer (CT) and voltage transformer (VT) location and ratings are provided.

The guide provides a detailed discussion on PST protection schemes, focusing on the microprocessor based protective schemes for both single-core and two-core PST designs.

Setting calculation examples are provided in [Annex A](#) and [Annex B](#).

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# IEEE Guide for the Application of Protective Relaying for Phase-Shifting Transformers

## 1. Overview

### 1.1 Scope

This guide provides protection methods for different types of phase shifting transformers (PSTs) and discusses the interaction between protection and operating conditions of PSTs. Models representing PSTs to determine short circuit currents for relaying functions are presented. Sizing and location issues of protection current transformers employed in the protection of PSTs are included. This guide provides examples of appropriate relay applications and settings.

### 1.2 Purpose

The purpose of this guide is to provide protection engineers with information that helps them to properly apply relays and other devices to protect phase-shifting transformers.

## 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.

IEEE Std C37.91™, IEEE Guide for Protecting Power Transformers.<sup>1,2</sup>

## 3. Acronyms and abbreviations

ARS	advance-retard-switch
AT	ampere-turns
ATB	ampere-turns balance
CCVT	capacitance coupled voltage transformer
CT	current transformer
EMTP	electromagnetic transient program

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