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IEEE Guide for Technology of Unified Power Flow Controller Using Modular Multilevel Converter

Part 3: Thyristor Bypass Switch

IEEE Power and Energy Society

Developed by the
Transmission and Distribution Committee

IEEE Std 2.45.3™-2020

IEEE

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Abstract: An approach to preparing a specification for the thyristor bypass switch (TBS) of a unified power flow controller (UPFC) using modular multilevel converter (MMC) technology is documented by this guide. The intention of this guide is to serve as a base specification to allow users to modify or develop specific clauses to meet a particular application.

Keywords: fast bypass system, function requirements, IEEE 2745.3™, performance requirements, system composition, test, thyristor bypass switch

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Introduction

This introduction is not part of IEEE Std 2745.3-2020, IEEE Guide for Technology of Unified Power Flow Controller Using Modular Multilevel Converter—Part 3: Thyristor Bypass Switch.

As the most flexible, powerful, and comprehensive flexible ac transmission system (FACTS) device, the unified power flow controller (UPFC) can realize the bidirectional control of power flow, flexibly control voltage and reactive power, and improve the steady and dynamic stability of power grids. From the 1990s to 2004, three UPFC projects were put into operation: Inez substation of AEP, Kangjin substation of Korean Electric Power Corporation (KEPCO), and Marcy substation of New York Power Authority (NYPA), all of which utilized gate turn-off thyristor (GTO) devices and three-level converter technology. With the increasing development of power electronics equipment and technology, modular multilevel converter (MMC) technology with insulate-gate bipolar transistor (IGBT) devices has been successfully applied to UPFC projects such as at the Tiebei substation of State Grid Corporation of China (SGCC), Yunzaobang substation of SGCC, and Mudu substation of SGCC. Compared to GTO devices and three-level converter technology, the MMC technology is superior in expandable structure, low output waveform deviation, easy control of capacitor voltage, and desirable fault tolerance of sub-modules. Therefore, the MMC technology is the development trend of UPFCs in the future. With the decreasing cost of converters, more MMC-UPFC projects may be put into commercial operation to satisfy the requirements of power flow control and system stability.

A series of documents, named the IEEE 2745™ series, is being developed to provide guides for technology for UPFCs using MMC technology. This guide, IEEE Std 2745.3, is the third part of the IEEE 2745 series and focuses on the thyristor bypass switch (TBS).

The purpose of this guide is to specify the technical requirements for TBSs of UPFC projects, including technical guidelines and references for testing methods for the TBS so that utilities, integrators, manufacturers, and other interested entities can benefit from this guide. This guide specifies the function of the fast bypass equipment of the UPFC and the structure, layout, performance, control, protection, and reliability assessment of the TBS. This guide aims to provide the knowledge base, experience, and opportunities for greater utilization of TBSs.

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IEEE Guide for Technology of Unified Power Flow Controller Using Modular Multilevel Converter

Part 3: Thyristor Bypass Switch

1. Overview

1.1 Scope

This guide specifies the technical requirements for the thyristor bypass switch (TBS) used in a unified power flow controller (UPFC), including TBS structure, layout, function, performance, control, protection, monitoring, and communication interface technology. This guide also specifies testing methods that can be used as references and guidelines for design, function and performance inspection, testing, and acceptance of equipment.

1.2 Purpose

The purpose of this guide is to specify technical requirements for TBSs of UPFC projects, including technical guidelines and references for testing methods for the TBS.

1.3 Application

The guide should be considered as a general-purpose resource and does not include all details needed for a specific application. Likewise, because TBSs are typically designed to address a specific UPFC application, not every part of this guide may be applicable. The user of this guide should evaluate how, and to what extent, each clause applies to the development of a TBS specification.

1.4 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[1,2]

[1]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.
[2]The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is used only in statements of fact.