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IEEE Recommended Practice for Thyristor Controlled Rectifiers for Traction Power Substation Applications

IEEE STANDARDS

IEEE Vehicular Technology Society

Developed by the
Rail Transit Vehicle Interface Standards Committee

IEEE Std 1653.5™-2020

IEEE

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Rail Transit Vehicle Interface Standards Committee
of the
IEEE Vehicular Technology Society

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IEEE SA Standards Board

Abstract: Design, manufacturing, and testing unique to the application of thyristor controlled power rectifiers for dc supplied transportation substation applications up to 1500 V dc nominal output is covered in this recommended practice. Both forward rectifier with power flow from ac to dc, and reversible rectifiers with bidirectional power flow are included; traction power substation rectifiers that are to be provided as part of a rectifier transformer unit or are provided separately are intended to be addressed. Application information and extensive definitions of related technical terms are included.

Keywords: commutating reactance, controlled rectifier, double-way, extra heavy traction, heavy traction, IEEE 1653.5™, light transition load, power rectifier, rectifier transformer unit, reversible rectifier, service rating, thyristor rectifier, traction power substation

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Introduction

This introduction is not part of IEEE Std 1653.5-2020, IEEE Recommended Practice for Thyristor Controlled Rectifiers for Traction Power Substation Applications.

The intention of this recommended practice is to provide up-to-date recommendations for thyristor controlled traction rectifiers. A controlled rectifier is an assembly that converts ac to dc, and is capable of regulating the output dc voltage as either a preset constant or to predetermined voltage-current characteristics.

Thyristor controlled rectifiers lend themselves to providing the option of regenerative braking energy recuperation at a small incremental cost of adding reverse bridge and upgrading control system. Consequently, this document deals with reversible thyristor controlled rectifiers also. The scope of this effort is limited to controlled traction power rectifiers providing power to dc-supplied transportation equipment found in trackside rail substations or other catenary uses. The practice of adding independent inverters to thyristor or diode rectifiers is out of scope of this document.

IEEE Std 1653.2™-2020, Standard for Uncontrolled Traction Power Rectifiers for Substation Applications up to 1500 Volts DC Nominal Output provides an up-to-date replacement for the rescinded NEMA Standards Publication RI 9, Silicon Rectifier Units for Transportation Power Supplies, and the rescinded ANSI Standard C34.2, Practices and Requirements for Semiconductor Power Rectifiers. Its scope was limited to uncontrolled (diode type) traction power rectifiers supplying power to dc-supplied transportation equipment.

IEEE Std 1653.5™-2020, Recommended Practice provides an up-to-date replacement for the rescinded NEMA Standards Publication RI 9, Silicon Rectifier Units for Transportation Power Supplies, and the rescinded ANSI Standard C34.2, Practices and Requirements for Semiconductor Power Rectifiers. Its scope is limited to controlled traction power rectifiers supplying power to dc-supplied transportation equipment.

Neither IEEE Std 1653.2-2020, nor ANSI C34.2 standards cover rectifiers with capacitive load and rectifier controller requirements; both are essential for controlled rectifiers used for traction. Consequently, these standards are not applicable to controlled rectifiers for traction power because many of their formulae (e.g., voltage regulation) and recommendations contradict those for controlled rectifiers with capacitive load. Furthermore, a substantial part of applying controlled rectifiers for traction relates to testing that is also very different from IEEE Std 1653.2-2020 and ANSI C34.2 recommendations, both for design and field testing.

The present art is to use phase control power thyristors (also called silicon-controlled rectifier or SCR) as the rectifying and control elements for traction power rectifiers. However, other semiconductor devices are available today that can also be used. Such devices as insulated gate bipolar transistors (IGBTs) are also being used for rectifier applications.

This recommended practice leaves open the possibilities that other devices and rectifying schemes may be developed in the future for use in voltage-controlled power substation rectifiers. For this recommended practice, emphasis is placed on existing industry applications that use thyristor controlled rectifiers.

Contents

IEEE Recommended Practice for Thyristor Controlled Rectifiers for Traction Power Substation Applications

1. Overview

1.1 Scope

This recommended practice covers the design, manufacturing, and testing, of controlled semiconductor power rectifiers for dc traction power systems.

1.2 Purpose

This recommended practice provides common terminology and standard design, manufacturing, and testing criteria specific to controlled rectifiers supplying power to traction power systems for use by manufacturers, specifiers, and users. Design architecture, calculation methods and limits, test methods, and acceptance criteria for controlled rectifiers shall be defined to allow for objective evaluation and acceptance of controlled rectifiers from different vendors.

1.3 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]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals is *recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals is *permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals is *able to*).

[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 only used in statements of fact.