



IEEE Trial-Use Recommended Practice for Pulse-Type Partial Discharge Measurements on Individual Stator Coils and Bars

IEEE Power and Energy Society

Developed by the
Electric Machinery Committee

IEEE Std 2465™-2023

STANDARDS

IEEE Trial-Use Recommended Practice for Pulse-Type Partial Discharge Measurements on Individual Stator Coils and Bars

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Electric Machinery Committee
of the
IEEE Power and Energy Society

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IEEE SA Standards Board

Abstract: Pulse-type partial discharge test methods for individual form-wound stator coils and bars that are equipped with PD suppression coatings and energized with a sinusoidal voltage source are described in this recommended practice. A uniform procedure for measurements in terms of apparent charge at frequencies below 1 MHz and for measurements in millivolts at higher frequencies, up to 300 MHz is also provided in this recommended practice. This document does not provide pass/fail criteria, but it does describe the measurement circuit, the simulated slot, external factors affecting the measurements, the recommended method for calibration or normalization, appropriate test voltage levels, the need for and parameters of conditioning, and it provides guidelines for interpretation of test results.

Keywords: ac electric machine windings, electrical insulation, form-wound bars, form-wound coils, groundwall, IEEE 2465™, partial discharge

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Introduction

This introduction is not part of IEEE Std 2465-2023, IEEE Trial-Use Recommended Practice for Pulse-Type Partial Discharge Measurements on Individual Stator Coils and Bars.

When IEEE Std 1434™, IEEE Guide for the Measurement of Partial Discharges in AC Electric Machinery, was last revised in 2014, it was agreed that a separate document would be developed as a recommended practice for individual stator coils and bars.

Note that the photographs in this recommended practice are in color. If this document is to be printed, consider printing in color for the full benefits of the details in the photos.

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IEEE Trial-Use Recommended Practice for Pulse-Type Partial Discharge Measurements on Individual Stator Coils and Bars

1. Overview

1.1 Scope

This document describes pulse-type partial discharge (PD) test methods for individual form-wound stator coils and bars that are equipped with PD suppression coatings and energized using a sinusoidal voltage source. It includes a procedure for measurement in terms of apparent charge at frequencies below 1 MHz. It also includes a procedure for measurements in millivolts at higher frequencies up to 300 MHz. This document does not provide pass/fail criteria.

1.2 Purpose

The purposes of this recommended practice are as follows:

- a) To provide a uniform procedure for pulse-type PD measurements on the groundwall insulation system of individual form-wound stator coils and bars in order to obtain consistent results
- b) To describe the measurement circuits
- c) To describe the simulated slot and external factors affecting the measurements
- d) To recommend a method for calibration or normalization
- e) To recommend appropriate test voltage levels
- f) To determine the need and parameters for conditioning
- g) To provide guidelines for the interpretation of test results

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*).^{6,7}

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*).

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.

ASTM D1868-20, Standard Test Method for Detection and Measurement of Partial Discharge (Corona) Pulses in Evaluation of Insulation Systems.⁸

IEC 60270, High-voltage test techniques—Partial discharge measurements.⁹

IEEE Std 4™-2013, IEEE Standard Techniques for High Voltage Testing.^{10,11}

IEEE Std 510-1983™ (withdrawn), IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing.¹²

IEEE Std 1434™-2014, IEEE Guide for the Measurement of Partial Discharges in AC Electric Machinery.

IEEE Std 1553™, IEEE Standard for Voltage-Endurance Testing of Form-Wound Coils and Bars used in Hydroelectric Generators.

IEEE Std 1799™, IEEE Recommended Practice for Quality Control Testing of External Discharges on Stator Coils, Bars, and Windings.

⁶The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

⁷The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

⁸ASTM publications are available from the American Society for Testing and Materials (<https://www.astm.org/>).

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¹²IEEE Std 510-1983 has been withdrawn; however, copies can be obtained from The Institute of Electrical and Electronics Engineers (<https://standards.ieee.org/>).

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.¹³ Other terms related to partial discharge (PD) measurements are defined in ASTM D1868-20.

apparent charge: The apparent charge (Q) of a PD pulse is that charge which, if injected within a very short time between the terminals of the test object in a specified circuit, would give the same reading on the measuring instrument as the PD current pulse itself. The apparent charge is usually expressed in picocoulombs (pC).

bandwidth: The range of frequencies within which performance, with respect to some characteristic, falls within specific limits.

continuous partial discharges (PDs): Discharges that recur at regular intervals, for example, on approximately every cycle of an alternating voltage.

corona (air): A luminous discharge due to ionization of the air surrounding a conductor or insulated conductor caused by a voltage gradient exceeding a certain critical value.

high frequency (HF): 3 MHz to 30 MHz.

ionization: The process by which electrons are lost from or transferred to neutral molecules or atoms to form positively or negatively charged particles.

largest repeatedly occurring PD magnitude Q_{IEC} : The magnitude recorded by a measuring system which has the pulse train response in accordance with 4.3.3 of IEC 60270:2015.

largest repeatedly occurring partial discharge (PD) magnitude Q_m : Largest magnitude associated with a PD pulse repetition rate of a specified number of pulses per second, which can be directly inferred from a pulse magnitude distribution or phase resolved distribution. A recommended pulse repetition rate for Q_m is 10 pulses per second.

low frequency (LF): According to IEC 60270, for wide-band partial discharge (PD) measurements the recommended values for the significant frequency parameters f_1 , f_2 and Δf are:

$$30 \text{ kHz} \leq f_1 \leq 100 \text{ kHz}$$

$$f_2 \leq 1 \text{ MHz}$$

$$100 \text{ kHz} \leq \Delta f \leq 900 \text{ kHz}$$

where f_2 and f_1 are the upper and lower limit frequencies. The bandwidth is $\Delta f = f_2 - f_1$.

noise: Unwanted disturbances superimposed on a useful signal that tend to obscure the signal's information content.

normalization capacitor: A capacitor through which charge is injected into a partial discharge (PD) measuring circuit for the purpose of normalizing the measurement.

¹³IEEE Standards Dictionary Online is available at: <http://dictionary.ieee.org>. An IEEE account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.