IEC TS 60034-27-5

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TECHNICAL SPECIFICATION

colour inside

Rotating electrical machines –
Part 27-5: Off-line measurement of partial discharge inception voltage on winding insulation under repetitive impulse voltage

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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ROTATING ELECTRICAL MACHINES –

Part 27-5: Off-line measurement of partial discharge inception voltage on winding insulation under repetitive impulse voltage

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 60034-27-5, which is a Technical Specification, has been prepared by IEC technical committee 2: Rotating machinery.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
2/1955/DTS	2/1962A/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

NOTE A table of cross-references of all IEC TC 2 publications can be found on the IEC TC 2 dashboard on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The recent development of power electronics technology has led to various power drive systems (PDS) of variable-speed rotating electrical machines. The new influences of PDS on rotating machines are introduced in IEC TS 60034-25 [1][1]. This document points out that electrical insulation of machine winding is exposed to numerous voltage impulses due to the repetitive fast switching of power devices in PDS. The severity of the impulses depends on ratings of converter and machines, converter topology, length of cable between machine and converter, filtering equipment and so on.

IEC 60034-18-41 [2], published in 2014, is the first International Standard which describes design qualification and type tests for Type I (partial discharge free) insulation systems used in converter-fed rotating electrical machines. In this document, both tests require partial discharge (PD) tests with power frequency voltage or impulse excitation. As for PD measurements with impulse excitation, IEC 60034-18-41 cites IEC TS 61934, which provides a technical explanation and several PD measuring methods, in general. For practical test guidance specific to winding insulation of rotating machines, this document was prepared as an off-line measurement of PD inception and extinction voltages during repetitive impulse condition, RPDIV and RPDEV.

[1] Numbers in square brackets refer to the Bibliography

ROTATING ELECTRICAL MACHINES –

Part 27-5: Off-line measurement of partial discharge inception voltage on winding insulation under repetitive impulse voltage

1 Scope

This document provides an off-line measurement method of the partial discharge inception and extinction voltage on winding insulation under repetitive impulse voltage. This document is relevant to rotating machines supplied by a voltage source converter.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-27-1, *Rotating electrical machines – Part 27-1: Off-line partial discharge measurements on the winding insulation*

IEC TS 61934:2011, *Electrical insulating materials and systems – Electrical measurement of partial discharges (PD) under short rise time and repetitive voltage impulses*

IEC TS 62478, *High voltage test techniques – Measurement of partial discharges by electromagnetic and acoustic methods*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in IEC 60034-27-1, IEC TS 61934, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
partial discharge
PD
localized electrical discharge that only partially bridges the insulation between conductors and which can or cannot occur adjacent to a conductor

3.2
repetitive partial discharge inception voltage
RPDIV
minimum peak-to-peak impulse voltage at which more than five PD pulses occur on ten voltage impulses of the same peak-to-peak values when the impulse voltage applied to the test object is increased with step-by-step method

Note 1 to entry: This is a mean value for the specified test time and a test arrangement where the voltage applied to the test object is increased with the step-by-step method. Details are mentioned in 5.5.

3.3
repetitive partial discharge extinction voltage
RPDEV
maximum peak-to-peak impulse voltage at which fewer than five PD pulses occur on ten voltage impulses of the same peak-to-peak values when the voltage applied to the test object is decreased with step-by-step method from a higher value at which such discharges are observed

Note 1 to entry: This is a mean value for the specified test time and a test arrangement where the voltage applied to the test object is decreased with the step-by-step method. Details are mentioned in 5.5.

3.4
unipolar impulse
voltage impulse, the polarity of which is either positive or negative

Note 1 to entry: Details are mentioned in 4.2.

3.5
bipolar impulse
voltage impulse, the polarity of which changes alternately from positive to negative or vice versa

3.6
peak-to-peak impulse voltage
$U_{pk/pk}$
maximum numerical value of voltage reached from the lowest value impulse

Note 1 to entry: The definition of peak-to-peak voltage is clarified in Clause 4.

Note 2 to entry: $U_{pk/pk}$ is used for the entire waveform of the impulse including distorted impulses.

3.7
impulse rise time
t_r
time for the voltage to rise from 10 % to 90 % of its final value

3.8
impulse decay time
t_d
time interval between the instants at which the instantaneous values of a triangular impulse decrease from a specified upper value to a specified lower value

3.9
impulse fall time
t_f
time for the voltage of a rectangular impulse to fall from 90 % to 10 % of its initial value

3.10
impulse width
t_w
interval of time between the first and last instants at which the instantaneous value of a single impulse reaches a specified fraction of its impulse magnitude or a specified threshold

3.11
time between two successive impulses
t_{pp}
time between two successive impulses with the same waveform – in a considered set of pulses, for example, for one period

3.12
impulse voltage repetition rate
f_r
average of the inverse of the time between two successive impulses t_{pp}

3.13
train of impulse
sequence of repetitive impulse voltages with the same waveform parameters, including peak-to-peak impulse voltage, rise time, decay time, impulse width, fall time, polarity and time interval between impulses

Note 1 to entry: Details are mentioned in 4.3.

3.14
step-by-step method
SBS method
method of impulse voltage application of trains of repetitive impulse with step-by-step increase and decrease of peak values

Note 1 to entry: Details are mentioned in 4.4.

3.15
U_s
starting applied voltage $U_{pk/pk}$ during step-by-step method

Note 1 to entry: See Figure 16 and Figure 17.

3.16
U_m
maximum applied voltage $U_{pk/pk}$ during step-by-step method

Note 1 to entry: See Figure 16 and Figure 17.

3.17
ΔU
increase or decrease voltage $U_{pk/pk}$ during step-by-step method

Note 1 to entry: See Figure 16 and Figure 17.

3.18
N_p
number of impulses in a train during step-by-step method

Note 1 to entry: See Figure 16.

3.19
t_{ss}
rest time between two trains of impulses with voltage step ΔU during step-by-step method

Note 1 to entry: See Figure 16.

3.20
k
ratio of $U_{pk/pk}$ value of distorted waveform to original $U_{pk/pk}$ at open terminal of an impulse generator

3.21
conditioning
pre-application of conditioning voltage before PD test for stable measurement condition

3.22
ringing
transient oscillation of impulse voltage that is influenced by the circuit impedance

3.23
noise
electric noise caused by thermal white noise from PD detection circuit or impulse generator which may lower PD detection sensitivity

3.24
disturbance
electric and electromagnetic transient impulse from impulse generator or adjacent electric devices which may disturb PD pulse waveform observation

3.25
motorette
special test model used for the evaluation of the electrical insulation systems of random-wound windings

3.26
formette
special test model used for the evaluation of the electrical insulation systems for form-wound windings

3.27
parallel winding
special test winding in which the turn/turn insulation is simulated by at least two electrically isolated conductors wound in parallel, one of which is grounded and the other is energized

4 Repetitive impulse voltages for PD measurement

4.1 General

This document describes RPDIV and RPDEV as repetitive partial discharge inception and extinction voltage of test objects under repetitive impulse voltage. They were first defined in IEC TS 61934 and are redefined in this document. Both RPDIV and RPDEV have two features compared with the conventional PDIV and PDEV under sinusoidal voltage defined in IEC 60034-27-1. The first feature is the clear definition of repetitive impulse voltage with distortion and the second one is 50 % PD occurrence probability.

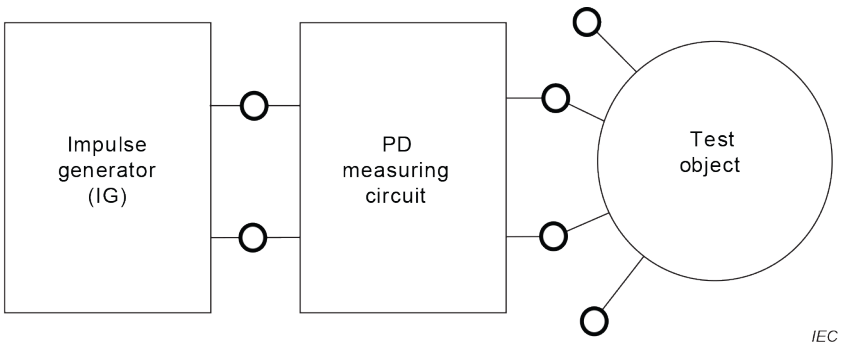

Figure 1 – Block representation of measurement circuit for RPDIV and RPDEV

Figure 1 shows a representative scheme of a measurement circuit for RPDIV and RPDEV as a block diagram. Repetitive impulse voltage from an impulse generator (IG) are mentioned in detail in this Clause 4. PD measuring methods are mentioned in Clause 5. Subclause 6.1 describes test objects of both model samples and complete windings. A four-terminal test object