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IEC 60034-18-41

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Rotating electrical machines –
Part 18-41: Partial discharge free electrical insulation systems (Type I) used in rotating electrical machines fed from voltage converters – Qualification and quality control tests

Machines électriques tournantes –
Partie 18-41: Systèmes d'isolation électrique sans décharge partielle (Type I) utilisés dans des machines électriques tournantes alimentées par des convertisseurs de tension – Essais de qualification et de contrôle qualité

IEC 60034-18-41:2014-03(en-fr)

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IEC 60034-18-41 cancels and replaces IEC/TS 60034-18-41 (2006).

The text of this standard is based on the following documents:

FDIS	Report on voting
2/1728/FDIS	2/1738/RVD

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

This publication 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 in the IEC TC 2 dashboard on the IEC website.

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

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- withdrawn,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

INTRODUCTION

The approval of electrical insulation systems for use in rotating electrical machines driven from voltage converters is set out in two IEC documents. They divide the systems into those which are not expected to experience partial discharge activity within specified conditions in their service lives (Type I) and those which are expected to withstand partial discharge activity in any part of the insulation system throughout their service lives (Type II). For both Type I and Type II insulation systems, the drive system integrator (the person responsible for co-ordinating the electrical performance of the entire drive system) shall inform the machine manufacturer what voltage will appear at the machine terminals in service. The machine manufacturer will then decide upon the severity of the tests appropriate for qualifying the insulation system. The severity is based on the impulse rise time, the peak to peak voltage and, in the case of Type II systems, the impulse repetition rate. After installation of the converter/machine system, it is recommended that the drive system integrator measures the phase/phase and phase/ground voltages between the machine terminals and ground to check for compliance.

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The Type I systems are dealt with in this standard. They are generally used in rotating machines rated at 700 V r.m.s. or less and tend to have random wound windings. The procedures described here are directed at:

– Qualification of the insulation system.
– Type and routine testing of the complete windings of service machines.

Before undertaking any testing, the machine manufacturer shall decide upon the level of severity that the system will be required to withstand. The severity is based on how large the voltage overshoot and how short the impulse rise time will be at the machine terminals. The machine designer then makes a choice from a table in which the range of expected overshoot voltage is divided into bands. Testing is performed at the extreme value of each band. A default value of 0,3 μs is attributed to the impulse rise time. Other values of impulse rise time or voltage overshoot are dealt with as special cases.

In qualification testing, the insulation system is used to construct various representative test objects. These are subjected to the range of tests described in IEC 60034-18-21 or IEC 60034-18-31 with the addition of a high frequency voltage test and a partial discharge test. For the latter, it may be necessary to use impulse test equipment, as described in IEC/TS 61934. If the test object is partial discharge free under the specified test conditions at the end of the sequence of testing, the insulation system is qualified for the severity band that has been selected.

Type and optional routine tests are performed on complete windings to demonstrate that they are partial discharge free under sinewave or impulse voltage conditions (as appropriate) for the band of severity that the manufacturer has chosen. An impulse voltage insulation class is then assigned to the machine. A mechanism is described for dealing with special cases.

IEC/TS 60034-18-42

The tests for qualification and acceptance of electrical insulation systems chosen for Type II rotating electrical machines are described in this technical specification. These insulation systems are generally used in rotating machines and tend to have form-wound coils, mostly rated above 700 V r.m.s. The qualification procedure is completely different from that used for Type I insulation systems and involves destructive ageing of insulated test objects under accelerated conditions. The rotating machine manufacturer requires a life curve for the insulation system that can be interpreted to provide an estimate of life under the service conditions with converter drive. Great importance is attached to the qualification of any stress grading system that is used and testing here should be performed under repetitive impulse conditions. If the insulation system can be shown to provide an acceptable life under the

appropriate ageing conditions, it is qualified for use. Acceptance testing is performed on coils made using this insulation system when subjected to a voltage endurance test.

ROTATING ELECTRICAL MACHINES –

Part 18-41: Partial discharge free electrical insulation systems (Type I) used in rotating electrical machines fed from voltage converters – Qualification and quality control tests

1 Scope

This part of IEC 60034 defines criteria for assessing the insulation system of stator/rotor windings which are subjected to voltage-source pulse-width-modulation (PWM) drives. It applies to stator/rotor windings of single or polyphase AC machines with insulation systems for converter operation.

It describes qualification tests and quality control (type and routine) tests on representative samples or on completed machines which verify fitness for operation with voltage source converters.

This standard does not apply to:

– rotating machines which are only started by converters;
– rotating electrical machines with rated voltage ≤ 300 V r.m.s.;
– rotor windings of rotating electrical machines operating at ≤ 200 V (peak).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-18-1:2010, *Rotating electrical machines – Part 18-1: Functional evaluation of insulation systems – General guidelines*

IEC 60034-18-21, *Rotating electrical machines – Part 18-21: Functional evaluation of insulation systems – Test procedures for wire-wound windings – Thermal evaluation and classification*

IEC 60034-18-31, *Rotating electrical machines – Part 18-31: Functional evaluation of insulation systems – Test procedures for form-wound windings – Thermal evaluation and classification of insulation systems used in rotating machines*

IEC/TS 60034-18-42, *Rotating electrical machines – Part 18-42: Qualification and acceptance tests for partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters*[1]

IEC/TS 60034-25:2007, *Rotating electrical machines – Part 25: Guidance for the design and performance of a.c. motors specifically designed for converter supply*

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1 This TS is in the process of being transformed into an IS.

IEC/TS 60034-27, *Rotating electrical machines – Part 27: Off-line partial discharge measurements on the stator winding insulation of rotating electrical machines*

IEC 60172, *Test procedure for the determination of the temperature index of enamelled winding wires*

IEC 60664-1, *Insulation co-ordination for equipment within low voltage systems – Part 1: Principles, requirements and tests*

IEC/TS 61800-8, *Adjustable speed electrical power drive systems – Part 8: Specification of voltage on the power interface*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
partial discharge
PD
electric discharge that only partially bridges the insulation between electrical conductors

Note 1 to entry: It may occur inside the insulation or adjacent to an electrical conductor.

3.2
partial discharge inception voltage
PDIV
lowest voltage at which partial discharges are initiated in the test arrangement when the voltage applied to the test object is gradually increased from a lower value at which no such discharges are observed

Note 1 to entry: With sinusoidal applied voltage, the PDIV is defined as the r.m.s. value of the voltage. With impulse voltages, the PDIV is defined as the peak to peak voltage.

3.3
partial discharge extinction voltage
PDEV
voltage at which partial discharges are extinguished in the test arrangement when the voltage applied to the test object is gradually decreased from a higher value at which such discharges are observed

Note 1 to entry: With sinusoidal applied voltage, the PDEV is defined as the r.m.s. value of the voltage. With impulse voltages, the PDEV is defined as the peak to peak voltage.

3.4
peak (impulse) voltage
U_p
maximum numerical value of voltage reached during a unipolar voltage impulse (e.g. U_p in Figure 1)

Note 1 to entry: For bi-polar voltage impulses, it is half the peak to peak voltage (see Figure 2).

Note 2 to entry: The definition of peak to peak voltage is clarified in Clause 4.

3.5
steady state impulse voltage magnitude
U_a
final magnitude of the voltage impulse (see Figure 1)

3.6
voltage overshoot
U_b
magnitude of the peak voltage in excess of the steady state impulse voltage (see Figure 1)

3.7
peak to peak impulse voltage
$U'_{pk/pk}$
peak to peak voltage at the impulse repetition rate (see Figure 2)

3.8
peak to peak voltage
$U_{pk/pk}$
peak to peak voltage at the fundamental frequency (see Figure 2)

3.9
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 polarity

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 gradually increased from a value at which no partial discharges can be detected.

3.10
unipolar impulse
voltage impulse, the polarity of which is either positive or negative

Note 1 to entry: The term impulse is used to describe the transient stressing voltage applied to the test object and the term pulse is used to describe the partial discharge signal.

3.11
bipolar impulse
voltage impulse, the polarity of which changes alternately from positive to negative or vice versa

3.12
impulse voltage repetition rate
f
inverse of the average time between two successive impulses of the same polarity, whether unipolar or bipolar

3.13
impulse rise time
t_r
time for the voltage to rise from 10 % to 90 % of its final value (see Figure 1)

3.14
electrical insulation system
insulating structure containing one or more electrical insulating materials together with associated conducting parts employed in an electrotechnical device

3.15
formette
special test model used for the evaluation of the electrical insulation systems for form-wound windings

3.16
motorette
special test model used for the evaluation of the electrical insulation systems of random-wound windings

3.17
(electric) stress
electric field in volts/mm

3.18
rated voltage
U_N
voltage assigned by the manufacturer for a specified power frequency operating condition of a machine and indicated on its rating plate

3.19
impulse voltage insulation class
IVIC
safe peak to peak voltage assigned by the manufacturer in relation to the rated voltage for a specified converter-driven machine and indicated in its documentation and on its rating plate

3.20
fundamental frequency
first frequency, in the spectrum obtained from a Fourier transform of a periodic time function, to which all the frequencies of the spectrum are referred.

Note 1 to entry: For the purposes of this standard, the fundamental frequency of the machine terminal voltage is the one defining the speed of the converter fed machine.

3.21
impulse duration
impulse width
interval of time between the first and last instants at which the instantaneous value of an impulse reaches a specified fraction of its impulse magnitude or a specified threshold.

3.22
jump voltage
U_j
change in voltage at the terminals of the machine occurring at the start of each impulse when fed from a converter (see Figure 3)

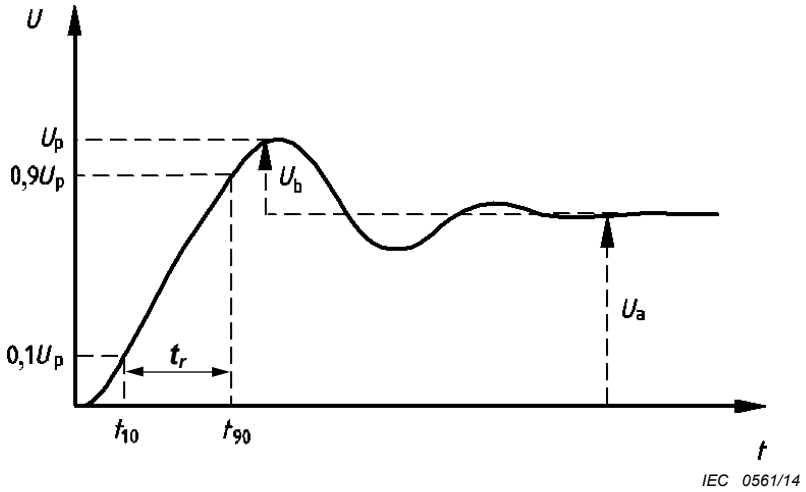
3.23
DC bus voltage
U_{dc}
voltage of the intermediate circuit of the voltage converter (dc-link-circuit)

Note 1 to entry: For a two level converter U_{dc} is equal to U_a in Figure 1.

Note 2 to entry: For a multilevel converter, U_{dc} is equal to ½ Upk/pk minus the overshoot in Figure 2.

3.24
overshoot factor
ratio of the voltage appearing at the machine terminals and the voltage at the converter for each converter level

3.25
power drive system
complete drive module and rotating machine together with the connecting cable if necessary



Key

U voltage
t time

Figure 1 – Voltage impulse waveshape parameters

4 Machine terminal voltages arising from converter operation

Modern converter output voltage rise times may be in the 0,05 µs – 2,0 µs range due to power semiconductor switching characteristics. The voltage appearing at the terminals of a converter driven machine may be calculated using IEC/TS 61800-8 and depends upon several characteristics of the power drive system, such as,

a) operating line voltage of the converter;
b) architecture and control regime of the converter;
c) filters between the converter and machine;
d) length and type of cable between them;
e) design of the machine winding;
f) design and configuration of the installation.

In order to apply this Standard to the qualification and testing of the insulation system of a winding, it is necessary to specify the required parameters of the voltage appearing at the machine terminals (Clause 7).

The amplitude and rise time of the voltage at the machine terminals depend upon the grounding system, various design aspects of the cable, the machine surge impedance and the presence of any filters that increase the impulse rise time. Common ranges of characteristics of converter impulses at the machine terminals are given in Table 1.