SLOVENSKI STANDARD
oSIST prEN IEC 60034-15:2024

01-september-2024

Električni rotacijski stroji - 15. del: Nivoji vzdržljivosti na impulzno napetost oblikovno navitih statorskih tuljav pri rotacijskih izmeničnih strojih

Rotating electrical machines - Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines

Drehende elektrische Maschinen - Teil 15: Steh-Stoßspannungspegel von Formspulen im Ständer drehender Wechselstrommaschinen

Machines électriques tournantes - Partie 15: Niveaux de tenue au choc électrique des bobines de stator préformées des machines tournantes à courant alternatif

Ta slovenski standard je istoveten z: **prEN IEC 60034-15:2024**

ICS:

29.160.01	Rotacijski stroji na splošno	Rotating machinery in general

oSIST prEN IEC 60034-15:2024 **en,fr,de**

2/2199/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:	
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DATE OF CIRCULATION: **2024-07-26**	CLOSING DATE FOR VOTING: **2024-10-18**
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IEC TC 2 : ROTATING MACHINERY	
SECRETARIAT: United Kingdom	SECRETARY: Mr Charles Whitlock
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

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TITLE:

Rotating electrical machines - Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines

PROPOSED STABILITY DATE: 2027

NOTE FROM TC/SC OFFICERS:

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ROTATING ELECTRICAL MACHINES –

Part 15: Impulse voltage withstand levels of stator coils for rotating AC machines

FOREWORD

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International Standard IEC 60034-15 has been prepared by IEC technical committee 2: Rotating machinery.

This fourth edition cancels and replaces the third edition published in 2009 and constitutes a technical revision. The principal technical changes are as follows.

- Harmonize the standard test levels with IEEE Std 522.
- Introduce an enhanced surge impulse voltage withstand level.
- Introduce the option to test up to the point of electrical breakdown.
- Improve the evaluation of the recorded impulses in case of oscillations and overshoot.
- Indicate that converter fed machines are excluded from the scope.
- Provide guidance on the execution of impulse tests.

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

FDIS	Report on voting
2/xxxx/FDIS	2/xxxx/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 on the IEC TC 2 dashboard on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

IEC 60071-1 specifies general requirements for the phase to earth insulation, phase-to-phase and the longitudinal insulation of equipment in three phase a.c. systems and states that each apparatus committee is responsible for specifying the insulation levels and test procedures for its equipment, taking into consideration the recommendations of IEC 60071-1.

The object of IEC 60034-15 is to specify these requirements for rotating electrical machines Experience has shown that the values given in this standard meet the insulation requirements for the essential stresses in service. An explanation of the principles adopted in preparing these requirements is given in Annex A. This standard is neither intended for soft-start machines nor for electronic converter fed machines.

ROTATING ELECTRICAL MACHINES –

Part 15: Impulse voltage withstand levels of stator coils for rotating AC machines

1 Scope

This part of IEC 60034 relates to AC machines incorporating form-wound stator coils that are intended to be connected to a standard grid supply. It specifies the test procedures and voltages to be applied to sample coils, as well as routine tests performed on coils mounted in the stator core.

The stator windings and coils for converter-fed machines are excluded from the scope of this standard.

This IS is not intended for use on complete windings since it is difficult to determine when the turn insulation has failed due to the test.

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 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and requirements*

IEC 60071-1:2019, *Insulation co-ordination – Part 1: Definitions, principles, and rules*

3 Terms and definitions

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

3.1
sample test
test carried out on (sample) coils in new condition which adequately represent the configuration of the finished item to be used in the machine for the purpose of evaluating the manufacturing procedures and processes incorporated in the insulation system

3.2
routine test
test carried out on coils during manufacture

3.3
form-wound stator coil
coil that is preformed to shape, insulated, and substantially completed before insertion into the stator

3.4
impulse voltage
intentionally applied aperiodic transient voltage, which usually rises rapidly to a peak value and then falls more slowly to zero (Figure 1)

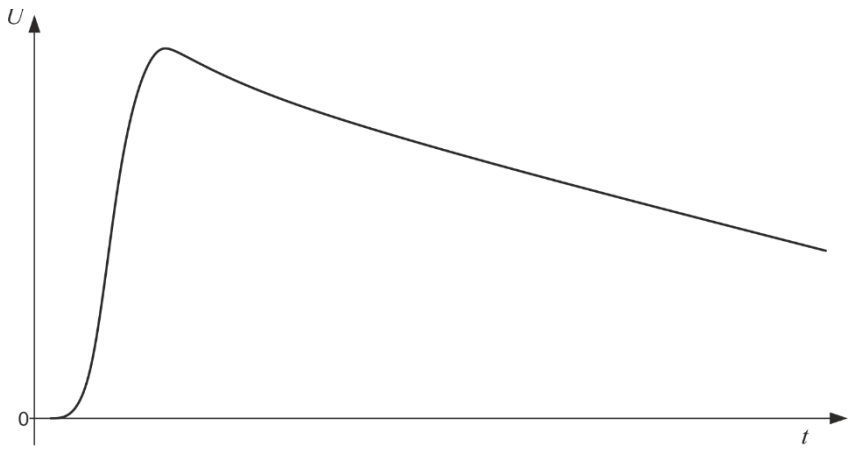

Figure 1 – Impulse voltage curve

3.5
lightning impulse voltage
impulse voltage with a front time T_1 less than 20 μs (see Figure 2)

3.6
full lightning impulse voltage
lightning impulse voltage, which is not interrupted by a disruptive discharge

3.7
overshoot
increase of amplitude of an impulse voltage due to a damped oscillation at the peak caused by the circuit

Note 1 to entry: Such oscillations (frequency range usually 0,1 MHz to 2 MHz) are caused by circuit inductance and sometimes cannot be avoided in large circuits or for inductive test objects.

3.8
front time
T_1
virtual parameter for the impulse voltage to rise from 0 % to 100 % and defined as 1,67 times the interval T between the instants when the impulse is 30 % and 90 % of the peak value of the voltage curve (point A and B, Figure 2)

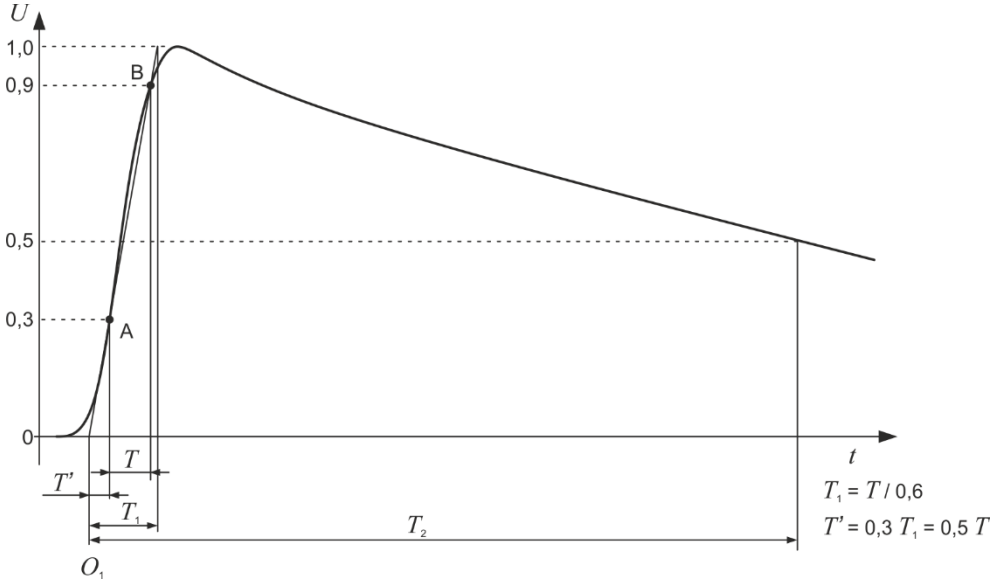

Figure 2 – Full impulse voltage time parameters

Note 1 to entry: This front time definition is applicable to both the standard lightning impulse as well as to the steep front impulse as described in this standard.

Note 2 to entry: In this standard exclusively the term “front time” is used. This quantity should not be confused with the term “rise time” that is used in other documents, but usually defined as being the time between the 10 % and 90 % value of the pulse final magnitude.

3.9
virtual origin
O_1
instant preceding that corresponding to point A, of the voltage curve (see Figure 2) by a time 0,3 T_1

3.10
time to half-value
T_2
virtual parameter defined as the time interval between the virtual origin, O1, and the instant when the voltage curve has decreased to half the peak voltage value (see Figure 2)

3.11
standard lightning impulse (SLI)
lightning impulse with a front time of 1,2 μs ± 0,36 μs, a time-to-half-value of 50 μs ± 10 μs and a voltage value of the impulse voltage U_p with a tolerance of ± 3 % as specified in IEC 60060-1

3.12
steep-front impulse (SFI)
lightning impulse with a front time of 0,2 μs ± 0,1 μs and a voltage value of the impulse voltage U'_p with a tolerance of ± 3 %

3.13
slot simulation / slot model
a rigid, metal fixture to mimic the actual stator slot with at least the same length as the stator core and the same width as the slots in the stator core

Note 1 to entry: The slot simulation is not necessarily built up from sheets of electrical core sheet material.

4 Impulse voltage withstand levels

4.1 General

Impulse voltage withstand levels are defined to test the insulation between the conductors and the earthed outside surface of the coil as well as to test the insulation that is stressed when a voltage is applied across both terminals of the coil. As the steep-front voltage of the pulses proceeds through the coil windings, turn by turn they stress the interturn insulation between the strands as well as the main insulation of the coil. Based on experience of laboratory tests, it is assumed that when a steep-front voltage impulse across the terminals of a single coil is applied with a voltage level that is around 70 % of the standard lightning withstand voltage for the main insulation, the actual situation for the entry (first) coil of a complete stator winding is approximated. Since there does not exist a simple general method to determine the actual voltage stress in a winding of a certain design (see Annex A for further explanation), no distinct test levels for the individual interturn insulation itself are given in this standard.

While performing impulse tests, overshoot and /or oscillations can occur. See Annex E for information on dealing with this situation.

4.2 Impulse withstand levels

The impulse withstand levels for a specific rated voltage shall be calculated in accordance with the following formulae.

For the standard lightning impulse (SLI) withstand level between the conductors and the earthed outside surface of the main wall insulation:

$$U_P = 5\,\frac{\sqrt{2}}{\sqrt{3}}\,U_N \text{ with a minimum of 8 kV} \qquad (1)$$

For the steep-front impulse (SFI) withstand level across the terminals of the coil with one terminal connected to the earth:

$$U'_{\mathrm{P}} = 3,5\,\frac{\sqrt{2}}{\sqrt{3}}\,U_{\mathrm{N}} \text{ with a minimum of 5,6 kV} \qquad (2)$$

With the SFI, the outside surface of the main wall insulation should preferably be directly connected to earth.

Table 1 gives the impulse voltage withstand levels for some common rated voltages rounded to one decimal.

Without any particular indication a stator winding is considered to be able to withstand the levels defined in this standard category. These levels are considered as those not being surpassed by the voltage excursions occurring in a direct-on-line application of a stator winding on a normal grid.

NOTE This level is in line with the level as defined in IEEE Std 522

Table 1 – Standard impulse voltage withstand levels for sample coils used in AC rotating machines

Rated voltage (RMS value)	Rated SLI voltage withstand level (see NOTE 1)	Rated SFI voltage withstand level (see NOTE 2)
U_{N}	U_{P}	U'_{P}
kV	kV	kV
2,3	9,4	6,6
3	12,2	8,6
3,3	13,5	9,4
4	16,3	11,4
6	24,5	17,1
6,6	26,9	18,9
10	40,8	28,6
11	44,9	31,4
13,2	53,9	37,7
13,8	56,3	39,4
15	61,2	42,9
18	73,5	51,4
22	89,8	62,9

NOTE 1 The levels in Column 2 are based on a standard lightning impulse (SLI) having a voltage value of the impulse voltage U_{P} with a tolerance of ± 3 %.

NOTE 2 The levels in Column 3 are based on a steep-front lightning impulse (SFI) having a front time of (0,2 ± 0,1) μs and a voltage value of the impulse voltage U'_{P} with a tolerance of ± 3 %.

4.3 Enhanced impulse withstand levels

A user can request for an enhanced impulse withstand level, for instance, when special operation conditions occur (such as very frequent switching or aborted starts), a specific grid layout is present (for instance feeding by overhead lines) or other special circumstances are present. This might lead to an enhanced winding insulation design to be implemented.

In this case an enhanced impulse voltage withstand capability is specified where the standard levels as found in the previous clause are increased by a default value of 15 kV (for the SLI) and 11 kV (for the SFI). The resulting test voltage shall be limited to twice the standard voltage values as defined in Clause 4.2. Formulae (3) and (4) give the calculation of the levels to be applied. Application of these test levels are subject on the explicit agreement between user and manufacturer. Upon agreement a deviation from the default increase is allowed.