



SLOVENSKI STANDARD

oSIST IEC 60034-1:2023

01-maj-2023

Električni rotacijski stroji - 1. del: Nazivni podatki in preskus lastnosti

Rotating electrical machines - Part 1: Rating and performance

Machines électriques tournantes - Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement

Ta slovenski standard je istoveten z: **IEC 60034-1:2022**

ICS:

29.160.01	Rotacijski stroji na splošno	Rotating machinery in general
-----------	------------------------------	-------------------------------

oSIST IEC 60034-1:2023

en,fr



IEC 60034-1

Edition 14.0 2022-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Rotating electrical machines –
Part 1: Rating and performance**

Machines électriques tournantes –

Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement

<https://standards.iteh.ai/catalog/standards/sist/3d0b19d7-12da-411b-a56b-ee6db6d5b13f/osist-iec-60034-1-2023>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.160.01

ISBN 978-2-8322-1076-8

Warning! Make sure that you obtained this publication from an authorized distributor.

Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

FOREWORD	7
1 Scope	10
2 Normative references	10
3 Terms and definitions	12
4 Duty	17
4.1 Declaration of duty	17
4.2 Duty types	18
4.2.1 Duty type S1 – Continuous running duty	18
4.2.2 Duty type S2 – Short-time duty	19
4.2.3 Duty type S3 – Intermittent periodic duty	20
4.2.4 Duty type S4 – Intermittent periodic duty with starting	21
4.2.5 Duty type S5 – Intermittent periodic duty with electric braking	22
4.2.6 Duty type S6 – Continuous operation periodic duty	24
4.2.7 Duty type S7 – Continuous operation periodic duty with electric braking	25
4.2.8 Duty type S8 – Continuous operation periodic duty with related load/speed changes	26
4.2.9 Duty type S9 – Duty with non-periodic load and speed variations	27
4.2.10 Duty type S10 – Duty with discrete constant loads and speeds	28
5 Rating	31
5.1 Assignment of rating	31
5.2 Classes of rating	31
5.2.1 Rating for continuous running duty	31
5.2.2 Rating for short-time duty	31
5.2.3 Rating for periodic duty	31
5.2.4 Rating for non-periodic duty	31
5.2.5 Rating for duty with discrete constant loads and speeds	32
5.2.6 Rating for equivalent loading	32
5.3 Selection of a class of rating	32
5.4 Allocation of outputs to class of rating	32
5.5 Rated output	33
5.5.1 DC generators	33
5.5.2 AC generators	33
5.5.3 Motors	33
5.5.4 Synchronous compensators	33
5.6 Rated voltage	33
5.6.1 DC generators	33
5.6.2 AC generators	33
5.6.3 AC motors	33
5.7 Preferred combinations of voltages and outputs	33
5.8 Machines with more than one rating	34
6 Site conditions	34
6.1 General	34
6.2 Altitude	34
6.3 Maximum ambient air temperature	34
6.4 Minimum ambient air temperature	34
6.5 Water coolant temperature	35

6.6	Standstill, storage and transport	35
6.7	Purity of hydrogen coolant	35
7	Electrical operating conditions	35
7.1	Electrical supply.....	35
7.2	Form and symmetry of voltages and currents	36
7.2.1	AC motors	36
7.2.2	AC generators	37
7.2.3	Synchronous machines.....	37
7.2.4	DC motors supplied from static power converters	38
7.3	Voltage during starting of AC motors.....	39
7.4	Voltage and frequency variations during operation.....	39
7.5	Three-phase AC machines operating on unearthed systems	41
7.6	Voltage (peak and gradient) withstand levels	42
8	Thermal performance and tests	42
8.1	Thermal class	42
8.2	Reference coolant.....	42
8.3	Conditions for thermal tests	43
8.3.1	Electrical supply	43
8.3.2	Temperature of machine before test	43
8.3.3	Temperature of coolant.....	44
8.3.4	Measurement of coolant temperature during test	44
8.4	Temperature rise of a part of a machine.....	44
8.5	Methods of measurement of temperature	45
8.5.1	General	45
8.5.2	Resistance method	45
8.5.3	Embedded temperature detector (ETD) method	45
8.5.4	Thermometer method.....	45
8.6	Determination of winding temperature	45
8.6.1	Choice of method	45
8.6.2	Determination by resistance method	46
8.6.3	Determination by ETD method.....	48
8.6.4	Determination by thermometer method	48
8.7	Duration of thermal tests	48
8.7.1	Rating for continuous running duty	48
8.7.2	Rating for short-time duty	49
8.7.3	Rating for periodic duty.....	49
8.7.4	Ratings for non-periodic duty and for duty with discrete constant loads	49
8.8	Determination of the thermal equivalent time constant for machines of duty type S9.....	49
8.9	Measurement of bearing temperature.....	49
8.10	Limits of temperature and of temperature rise	50
8.10.1	General	50
8.10.2	Indirect cooled windings	50
8.10.3	Direct cooled windings.....	54
8.10.4	Adjustments to take account of hydrogen purity on test	55
8.10.5	Permanently short-circuited windings, magnetic cores and all structural components (other than bearings) whether or not in contact with insulation.....	55
8.10.6	Commutators and sliprings, open or enclosed and their brushes and brushgear	55

9	Other performance and tests	57
9.1	Routine tests	57
9.2	Withstand voltage test	58
9.3	Occasional excess current	62
9.3.1	General	62
9.3.2	Generators	62
9.3.3	Motors (except commutator motors and permanent magnet motors)	62
9.3.4	Commutator machines	62
9.4	Momentary excess torque for motors	62
9.4.1	Polyphase induction motors and DC motors	62
9.4.2	Polyphase synchronous motors	63
9.4.3	Other motors	63
9.5	Pull-up torque and locked-rotor torque for cage induction motors with direct online starting	63
9.6	Safe operating speed of cage induction motors	63
9.7	Overspeed	64
9.8	Short-circuit current for synchronous machines	65
9.9	Short-circuit withstand test for synchronous machines	65
9.10	Commutation test for commutator machines	66
9.11	Total harmonic distortion (<i>THD</i>) for synchronous machines	66
9.11.1	General	66
9.11.2	Limits	66
9.11.3	Tests	66
9.12	Protective earth test	66
9.13	Measurement of insulation resistance and polarization index of winding insulation	67
9.14	Shaft-voltage test	68
10	Information requirements	68
10.1	General	68
10.2	Product documentation	68
10.3	Rating plate	68
10.4	Information content	69
10.4.1	General	69
10.4.2	Minimum information requirements	69
10.4.3	All AC machines	70
10.4.4	All DC machines	70
10.4.5	Machines over 5 kW (or 5 kVA) rated output	70
10.4.6	Optional information	70
11	Miscellaneous requirements	71
11.1	Protective earthing of machines	71
11.2	Shaft-end key(s)	72
12	Tolerances	72
12.1	General	72
12.2	Tolerances on values of quantities	73
13	Electromagnetic compatibility (EMC)	74
13.1	General	74
13.2	Immunity	75
13.2.1	Machines not incorporating electronic circuits	75
13.2.2	Machines incorporating electronic circuits	75

13.3	Emission	75
13.4	Immunity tests	75
13.5	Emission measurements	75
14	Application requirements	75
Annex A (informative) Guidance for the application of duty type S10 and for establishing the value of relative thermal life expectancy TL		77
Annex B (informative) Electromagnetic compatibility (EMC) limits		78
Bibliography		79
Figure 1	– Continuous running duty – Duty type S1	19
Figure 2	– Short-time duty – Duty type S2	20
Figure 3	– Intermittent periodic duty – Duty type S3	21
Figure 4	– Intermittent periodic duty with starting – Duty type S4	22
Figure 5	– Intermittent periodic duty with electric braking – Duty type S5	23
Figure 6	– Continuous operation periodic duty – Duty type S6	24
Figure 7	– Continuous operation periodic duty with electric braking – Duty type S7	25
Figure 8	– Continuous operation periodic duty with related load/speed changes – Duty type S8	27
Figure 9	– Duty with non-periodic load and speed variations – Duty type S9	28
Figure 10	– Duty with discrete constant loads – Duty type S10	30
Figure 11	– Voltage and frequency limits for motors and for generators except generators or synchronous compensators within the scope of IEC 60034-3 and hydro generators within the scope of IEC 60034-33	41
Figure 12	– Worst case increase in temperature rise ($\Delta\theta$) and recommended reduction of output power (ΔP) of motors as a function of the combined change of voltage and frequency $ \Delta\theta $ (indicative guideline to users of motors and generators only)	41
Figure 13	– Factor K for determining $R_{PE,M}$	67
Table 1	– Preferred voltage ratings	34
Table 2	– Unbalanced operating conditions for synchronous machines	38
Table 3	– CCC symbol designation	39
Table 4	– Primary functions of machines	40
Table 5	– Reference coolant (see also Table 11)	43
Table 6	– Time interval	47
Table 7	– Measuring points	49
Table 8	– Limits of temperature rise of windings indirectly cooled by air	51
Table 9	– Limits of temperature rise of windings indirectly cooled by hydrogen	52
Table 10	– Adjustments to limits of temperature rise at the operating site of indirect cooled windings to take account of non-reference operating conditions and ratings	53
Table 11	– Assumed maximum ambient temperature	54
Table 12	– Adjusted limits of temperature rise at the test site ($\Delta\theta_T$) for windings indirectly cooled by air to take account of test site operating conditions	55
Table 13	– Limits of temperature of directly cooled windings and their coolants	56
Table 14	– Adjustments to limits of temperature at the operating site for windings directly cooled by air or hydrogen to take account of non-reference operating conditions and ratings	56

Table 15 – Adjusted limits of temperature at the test site θ_T for windings directly cooled by air to take account of test site operating conditions	57
Table 16 – Minimum routine tests for machines assembled and tested in the factory of the manufacturer.....	58
Table 17 – Withstand voltage tests	60
Table 18 – Test voltage factors for machines with an assigned Impulse Voltage Insulation Class (IVIC) according to IEC 60034-18-41 and IEC 60034-18-42.....	61
Table 19 – Maximum safe operating speed (min^{-1}) of three-phase single-speed cage induction motors for voltages up to and including 1 000 V	64
Table 20 – Overspeeds	65
Table 21 – Cross-sectional areas of earthing conductors	72
Table 22 – Schedule of tolerances on values of quantities	73
Table B.1 – Electromagnetic emission limits per CISPR 11 Class B Group 1.....	78
Table B.2 – Electromagnetic emission limits per CISPR 11 Class A Group 1.....	78

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST IEC 60034-1:2023](https://standards.iteh.ai/catalog/standards/sist/3d0b19d7-12da-411b-a56b-ee6db6d5b13f/osist-iec-60034-1-2023)

<https://standards.iteh.ai/catalog/standards/sist/3d0b19d7-12da-411b-a56b-ee6db6d5b13f/osist-iec-60034-1-2023>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60034-1 has been prepared by IEC technical committee 2: Rotating machinery. It is an International Standard.

This fourteenth edition cancels and replaces the thirteenth edition published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

Clause or subclause	Change
1	Clarification of the scope
2	General use of dated references
3.29	Clarification on identification of maximum and minimum current
3.34	Definition of main insulation
3.35	Definition of converter capable machine
3.36	Definition of converter duty machine
3.37	Definition of shaft voltage
4.2	Explanation for using duty types S9 and S10 for converter duty machines
5.6.3	New subclause for clarification of the terms range of rated voltages and voltage variations
6.2	Requirement to consider reduced arcing distance in machine design for altitudes >1 000 m
7.1	Clarification on bus transfer or fast reclosing Clarification on the capability to withstand impulse voltages
7.3	New subclause on voltage deviation during starting
7.4	Extended variation of supply frequency Note added on design for operation with extended voltage and frequency Recommended derating added for high variations of voltage and frequency
7.6	Clarification that enamelled wires are no bare living material
8.3.1	Clarification on electrical supply during thermal tests added
9.1	Changes in Table 16, especially inclusion of PM and reluctance synchronous machines
9.2	Requirement on test equipment for withstand voltage test added Test voltage for variable speed AC machines added Clarification to withstand voltage test for machines after stock holding
9.5	Extended to requirements on minimum locked rotor torque
9.10	Note added on criteria for commutation test
9.11.3	Clarification added that synchronous motors do not need a THD test
9.12	New subclause on protective earth test
9.13	New subclause on measurement of insulation resistance and polarization index
9.14	New subclause on shaft-voltage measurement
10.	Clause has been rearranged completely Clarification on unit symbol for speed added
11.1	Clarification on protective earth test after installation added
12.1	Clarification on the tolerances due to the accuracy of the test equipment Note on measurement uncertainty added
12.2	Change in the tolerance on efficiency Clarification on the tolerance on locked-rotor current New tolerance on sound pressure level
14	Improved title of clause

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

1 Scope

This part of IEC 60034 is applicable to all rotating electrical machines, except rotating electrical machines for rail and road vehicles, which are covered by the IEC 60349 series of standards.

Machines within the scope of this document may also be subject to superseding, modifying or additional requirements in other standards, for example, IEC 60079 and IEC 60092.

NOTE If particular clauses of this document are modified to meet special applications, for example machines subject to radioactivity or machines for aerospace, all other clauses apply insofar as they are compatible.

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 60027-1:1992, *Letters symbols to be used in electrical technology – Part 1: General*
IEC 60027-1:1992/AMD1:1997
IEC 60027-1:1992/AMD2:2005

IEC 60027-4:2006, *Letter symbols to be used in electrical technology – Part 4: Rotating electric machines*

IEC 60034-2 (all parts), *Rotating electrical machines – Part 2: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

IEC 60034-3:2020, *Rotating electrical machines – Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines and for synchronous compensators*

IEC 60034-5:2020, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60034-6:1991, *Rotating electrical machines – Part 6: Methods of cooling (IC code)*

IEC 60034-8:2007, *Rotating electrical machines – Part 8: Terminal markings and direction of rotation*
IEC 60034-8:2007/AMD1:2014

IEC 60034-12:2016, *Rotating electrical machines – Part 12: Starting performance of single-speed three-phase cage induction motors*

IEC 60034-15:2009, *Rotating electrical machines – Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines*

IEC 60034-18 (all parts), *Rotating electrical machines – Part 18: Functional evaluation of insulation systems*

IEC 60034-18-41:2014, *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*
IEC 60034-18-41:2014/AMD1:2019

IEC 60034-18-42:2017, *Rotating electrical machines – Part 18-42: Partial discharge resistant electrical insulation systems (Type II) used in rotating electrical machines fed from voltage converters – Qualification tests*
IEC 60034-18-42:2017/AMD1:2020

IEC 60034-19:2014, *Rotating electrical machines – Part 19: Specific test methods for d.c. machines on conventional and rectifier-fed supplies*

IEC TS 60034-25:2014, *Rotating electrical machines – Part 25: AC electrical machines used in power drive systems – Application guide*

IEC 60034-27-4, *Rotating electrical machines – Part 27-4: Measurement of insulation resistance and polarization index of winding insulation of rotating electrical machines*

IEC 60034-29:2008, *Rotating electrical machines – Part 29: Equivalent loading and superposition techniques – Indirect testing to determine temperature rise*

IEC 60034-30-1:2014, *Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE-code)*

IEC TS 60034-30-2, *Rotating electrical machines – Part 30-2: Efficiency classes of variable speed AC motors (IE-code)*

IEC 60034-33: *Rotating electrical machines – Part 33: Specific technical requirements for hydro generators*

IEC 60050-411:1996, *International Electrotechnical Vocabulary (IEV) – Part 411: Rotating machinery*

IEC 60050-411:1996/AMD1:2007

IEC 60050-411:1996/AMD2:2021

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

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

IEC 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60204-11:2018, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for equipment for voltages above 1 000 V AC or 1 500 V DC and not exceeding 36 kV*

IEC 60335-1:2020, *Household and similar electrical appliances – Safety – Part 1: General requirements*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60417, *Graphical symbols for use on equipment – 12-month subscription to regularly updated online database comprising all graphical symbols published in IEC 60417*

IEC 60445:2017, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 61148:2011, *Terminal markings for valve device stacks and assemblies and for power conversion equipment*

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

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR 11:2015/AMD1:2016

CISPR 11:2015/AMD2:2019

CISPR 14 (all parts), *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus*

CISPR 16 (all parts), *Specification for radio disturbance and immunity measuring apparatus and methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions in IEC 60050-411, and the following apply.

NOTE 1 For definitions concerning cooling and coolants, other than those in 3.17 to 3.22, see IEC 60034-6.

NOTE 2 For the purposes of this document, the term 'agreement' means 'agreement between the manufacturer and purchaser'.

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

rated value

quantity value assigned, generally by a manufacturer, for a specified operating condition of a machine

Note 1 to entry: The rated voltage or voltage range is the rated voltage or voltage range between lines at the terminals.

[SOURCE: IEC 60050-411:1996, 411-51-23]

3.2

rating

set of rated values and operating conditions

[SOURCE: IEC 60050-411:1996, 411-51-24]

3.3

rated output

value of the output included in the rating

3.4 load

all the values of the, *in case of a generator*, electrical and, *in case of a motor*, mechanical quantities that signify the demand made on a rotating machine by an electrical circuit or a mechanism at a given instant

[SOURCE: IEC 60050-411:1996, 411-51-01, modified: modification indicated in italics.]

3.5 no-load (operation)

state of a machine rotating with zero output power (*but under otherwise normal operating conditions*)

[SOURCE: IEC 60050-411:1996, 411-51-02, modified: modification indicated in italics.]

3.6 full load

load which causes a machine to operate at its rating

[SOURCE: IEC 60050-411:1996, 411-51-10]

3.7 full load value

quantity value for a machine operating at full load

Note 1 to entry: This concept applies to power, torque, current, speed, etc.

[SOURCE: IEC 60050-411:1996, 411-51-11]

3.8 rest and de-energized

complete absence of all movement and of all electrical supply or mechanical drive

[SOURCE: IEC 60050-411:1996, 411-51-03]

3.9 duty

statement of the load(s) to which the machine is subjected, including, if applicable, starting, electric braking, no-load and rest and de-energized periods, and including their durations and sequence in time

[SOURCE: IEC 60050-411:1996, 411-51-06]

3.10 duty type

continuous, short-time or periodic duty, comprising one or more loads remaining constant for the duration specified, or a non-periodic duty in which generally load and speed vary within the permissible operating range

[SOURCE: IEC 60050-411:1996, 411-51-13]

3.11 cyclic duration factor

ratio between the period of loading, including starting and electric braking, and the duration of the duty cycle, expressed as a percentage

[SOURCE: IEC 60050-411:1996, 411-51-09]