

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/159e7346-bd07-4d93-9bae-26cac329a304/iec-60034-1-2010>



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

FOREWORD

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

This twelfth edition cancels and replaces the eleventh edition published in 2004. It constitutes a technical revision.

Major changes were not introduced in this edition. The corrections, clarifications and improvements include:

Clause or subclause	Change
6.5	Clarification of water coolant temperature
8.10.2	Minor change to Table 12
10.2	Recognition of IE code, of open circuit voltage of synchronous machines excited by permanent magnets and of maximum operation speed of machines specifically designed for converter supply
12	Clarification of the term 'tolerances'

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

FDIS	Report on voting
2/1579/FDIS	2/1587/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.

A list of all parts of the IEC 60034 series, published under the general title *Rotating electrical machines*, can be found on the IEC website.

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 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- withdrawn,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.

ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

1 Scope

This part of IEC 60034 is applicable to all rotating electrical machines except those covered by other IEC standards, for example, IEC 60349 [10]¹⁾.

Machines within the scope of this standard may also be subject to superseding, modifying or additional requirements in other publications, for example, IEC 60079 [8] and IEC 60092 [9].

NOTE If particular clauses of this standard 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 referenced documents are indispensable for the application 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, *Letter symbols to be used in electrical technology – Part 1: General*

IEC 60027-4, *Letter symbols to be used in electrical technology – Part 4: Rotating electrical 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, *Rotating electrical machines – Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines*

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

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

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

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

IEC 60034-17, *Rotating electrical machines – Part 17: Cage induction motors when fed from converters – Application guide*

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

1) Figures in square brackets refer to the Bibliography.

IEC 60034-30, *Rotating electrical machines – Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code)*

IEC 60038, *IEC standard voltages*

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

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

IEC 60072 (all parts), *Dimensions and output series for rotating electrical machines*

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

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

IEC 60204-11, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*

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

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

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

IEC 60971, *Semiconductor convertors. Identification code for convertor connections²⁾*

IEC 61293, *Marking of electrical equipment with ratings related to electrical supply – Safety requirements*

CISPR 11, *Industrial, scientific and medical equipment – Radiofrequency disturbance characteristics – Limits and methods of measurement*

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, some of which are repeated here for convenience, and the following terms and definitions apply.

NOTE 1 For definitions concerning cooling and coolants, other than those in 3.17 to 3.22, reference should be made to IEC 60034-6 [1].

²⁾ IEC 60971 was withdrawn (and not replaced) in 2004.

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

3.1

rated value

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

[IEV 411-51-23]

NOTE The rated voltage or voltage range is the rated voltage or voltage range between lines at the terminals.

3.2

rating

the set of rated values and operating conditions

[IEV 411-51-24]

3.3

rated output

the value of the output included in the rating

3.4

load

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

[IEV 411-51-01]

3.5

no-load (operation)

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

[IEV 411-51-02, modified]

3.6

full load

the load which causes a machine to operate at its rating

[IEV 411-51-10]

3.7

full load value

a quantity value for a machine operating at full load

[IEV 411-51-11]

NOTE This concept applies to power, torque, current, speed, etc.

3.8

de-energized and rest

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

[IEV 411-51-03]

3.9

duty

the 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

[IEV 411-51-06]

**3.10
duty type**

a 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

[IEV 411-51-13]

**3.11
cyclic duration factor**

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

[IEV 411-51-09]

**3.12
locked-rotor torque**

the smallest measured torque the motor develops at its shaft and with the rotor locked, over all its angular positions, at rated voltage and frequency

[IEV 411-48-06]

**3.13
locked-rotor current**

the greatest steady-state r.m.s. current taken from the line with the motor held at rest, over all angular positions of its rotor, at rated voltage and frequency

[IEV 411-48-16]

**3.14
pull-up torque (of an a.c. motor)**

the smallest steady-state asynchronous torque which the motor develops between zero speed and the speed which corresponds to the breakdown torque, when the motor is supplied at the rated voltage and frequency

This definition does not apply to those asynchronous motors of which the torque continually decreases with increase in speed.

NOTE In addition to the steady-state asynchronous torques, harmonic synchronous torques, which are a function of rotor load angle, will be present at specific speeds.

At such speeds, the accelerating torque may be negative for some rotor load angles.

Experience and calculation show this to be an unstable operating condition and therefore harmonic synchronous torques do not prevent motor acceleration and are excluded from this definition.

**3.15
breakdown torque (of an a.c. motor)**

the maximum steady-state asynchronous torque which the motor develops without an abrupt drop in speed, when the motor is supplied at the rated voltage and frequency

This definition does not apply to motors with torques that continually decrease with increase in speed.

**3.16
pull-out torque (of a synchronous motor)**

the maximum torque which the synchronous motor develops at synchronous speed with rated voltage, frequency and field current

**3.17
cooling**

a procedure by means of which heat resulting from losses occurring in a machine is given up to a primary coolant, which may be continuously replaced or may itself be cooled by a secondary coolant in a heat exchanger

[IEV 411-44-01]

**3.18
coolant**

a medium, liquid or gas, by means of which heat is transferred

[IEV 411-44-02]

**3.19
primary coolant**

a medium, liquid or gas, which, being at a lower temperature than a part of a machine and in contact with it, removes heat from that part

[IEV 411-44-03]

**3.20
secondary coolant**

a medium, liquid or gas, which, being at a lower temperature than the primary coolant, removes the heat given up by this primary coolant by means of a heat exchanger or through the external surface of the machine

[IEV 411-44-04]

**3.21
direct cooled winding
inner cooled winding**

a winding mainly cooled by coolant flowing in direct contact with the cooled part through hollow conductors, tubes, ducts or channels which, regardless of their orientation, form an integral part of the winding inside the main insulation

[IEV 411-44-08]

NOTE In all cases when 'indirect' or 'direct' is not stated, an indirect cooled winding is implied.

**3.22
indirect cooled winding**

any winding other than a direct cooled winding

NOTE In all cases when 'indirect' or 'direct' is not stated, an indirect cooled winding is implied.

[IEV 411-44-09]

**3.23
supplementary insulation**

an independent insulation applied in addition to the main insulation in order to ensure protection against electric shock in the event of failure of the main insulation

**3.24
moment of inertia**

the sum (integral) of the products of the mass elements of a body and the squares of their distances (radii) from a given axis

3.25

thermal equilibrium

the state reached when the temperature rises of the several parts of the machine do not vary by more than a gradient of 2 K per hour

[IEV 411-51-08]

NOTE Thermal equilibrium may be determined from the time-temperature rise plot when the straight lines between points at the beginning and end of two successive reasonable intervals each have a gradient of less than 2 K per hour.

3.26

thermal equivalent time constant

the time constant, replacing several individual time constants, which determines approximately the temperature course in a winding after a step-wise current change

3.27

encapsulated winding

a winding which is completely enclosed or sealed by moulded insulation

[IEV 411-39-06]

3.28

rated form factor of direct current supplied to a d.c. motor armature from a static power converter

the ratio of the r.m.s. maximum permissible value of the current $I_{rms,maxN}$ to its average value I_{avN} (mean value integrated over one period) at rated conditions:

$$k_{fN} = \frac{I_{rms,maxN}}{I_{avN}}$$

3.29

current ripple factor

the ratio of the difference between the maximum value I_{max} and the minimum value I_{min} of an undulating current to two times the average value I_{av} (mean value integrated over one period):

$$q_i = \frac{I_{max} - I_{min}}{2 \times I_{av}}$$

NOTE For small values of current ripple, the ripple factor may be approximated by the following expression:

$$q_i = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$$

The above expression may be used as an approximation if the resulting calculated value of q_i is equal to or less than 0,4.

3.30

tolerance

the permitted deviation between the declared value of a quantity and the measured value

3.31

type test

a test of one or more machines made to a certain design to show that the design meets certain specifications

[IEV 411-53-01]

NOTE The type test may also be considered valid if it is made on a machine which has minor deviations of rating or other characteristics. These deviations should be subject to agreement.

3.32

routine test

a test to which each individual machine is subjected during or after manufacture to ascertain whether it complies with certain criteria

[IEV 411-53-02]

3.33

runaway speed

the maximum speed attained by the engine/generator set after removal of the full load of the generator if the speed regulator does not function

[IEV 811-17-23]

NOTE For motors, the maximum overspeed at loss of supply is meant that a motor might reach driven by the coupled equipment

4 Duty

4.1 Declaration of duty

It is the responsibility of the purchaser to declare the duty. The purchaser may describe the duty by one of the following:

- a) numerically, where the load does not vary or where it varies in a known manner;
- b) as a time sequence graph of the variable quantities;
- c) by selecting one of the duty types S1 to S10 that is no less onerous than the expected duty.

The duty type shall be designated by the appropriate abbreviation, specified in 4.2, written after the value of the load.

An expression for the cyclic duration factor is given in the relevant duty type figure.

The purchaser normally cannot provide values for the moment of inertia of the motor (J_M) or the relative thermal life expectancy (TL), see Annex A. These values are provided by the manufacturer.

Where the purchaser does not declare a duty, the manufacturer shall assume that duty type S1 (continuous running duty) applies.

4.2 Duty types

4.2.1 Duty type S1 – Continuous running duty

Operation at a constant load maintained for sufficient time to allow the machine to reach thermal equilibrium, see Figure 1.

The appropriate abbreviation is S1.