

# INTERNATIONAL STANDARD

# IEC 60034-1

Eleventh edition  
2004-04

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## Rotating electrical machines –

### Part 1: Rating and performance

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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 IEC technical committee 2: Rotating machinery.

This eleventh edition cancels and replaces the tenth edition published in 1996, its amendments 1 (1997) and 2 (1999). It constitutes a technical revision.

The major changes introduced in this edition are:

Clause or subclause	Change
7.2.2	New requirements for a.c. generators to supply non-linear circuits
8	Major changes to Tables 4, 7 and 9
9.1	New requirements for routine tests
9.2	Table 16 Test voltage of auxiliaries
9.11	Total harmonic distortion for synchronous machines
11.1	Protective earthing of machines
12.1	Table 20 Tolerance on efficiency
13	Electromagnetic compatibility

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

FDIS	Report on voting
2/1278/FDIS	2/1294/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.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

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- withdrawn;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

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# 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.

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

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: Symbols for quantities to be used for rotating electrical machines*

IEC 60034-2, *Rotating electrical machines – Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)*

IEC 60034-3, *Rotating electrical machines – Part 3: Specific requirements for turbine-type synchronous machines*

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

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

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 rotating a.c. machines with form-wound stator coils*

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 – Functional evaluation of insulating systems*

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 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 60279, *Measurement of the winding resistance of an a.c. machine during operation at alternating voltage*

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 of terminations of certain designated conductors, including general rules for an alphanumeric system*

IEC 60971, *Semiconductor convertors. Identification code for convertor connections*

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

<https://standards.iteh.ai/en/standards/iec/000/00aca-62aa-4879-ad55-7234b2662acc/iec-60034-1-2004>

IEC 61986, *Rotating electrical machines – Equivalent loading and super-position techniques – Indirect testing to determine temperature rise*

IEC 62114, *Electrical insulation systems – Thermal classification*

CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

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

CISPR 16, *Specification for radio disturbance and immunity measuring apparatus and methods*

### 3 Terms and definitions

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

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

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 (inner cooled) winding<sup>1</sup>**

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]

**3.22****indirect cooled winding<sup>1</sup>**

any winding other than a direct cooled winding

[IEV 411-44-09]

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<sup>1)</sup> In all cases when 'indirect' or 'direct' is not stated, an indirect cooled winding is implied.

**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  $I_{\text{rms,maxN}}$  to its average value  $I_{\text{avN}}$  (mean value integrated over one period) at rated conditions:

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

**3.29****current ripple factor**

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

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

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

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

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.