INTERNATIONAL STANDARD

IEC 60034-1

Edition 10.2
1999-08

Edition 10:1996 consolidated with amendments 1:1997 and 2:1999

Rotating electrical machines –

Part 1: Rating and performance

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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INTRODUCTION

In 1991, TC2 decided to edit IEC 60034-1 to group the requirements in a more logical order. The result is edition 10 which now takes precedence over edition 9.

There is no difference between the technical requirements of edition 10 and of edition 9 (including amendment number 1) and it is intended that in the short term any further amendments will be introduced simultaneously in edition 9 and edition 10.

Edition 9 will be withdrawn within two years. This will allow time for the updating of any other standards which refer to specific clauses of IEC 60034-1 and for users of the standard to make such changes as they judge necessary in their own documentation.

To facilitate these processes, cross-references (both ways) are listed in annex B.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

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

This consolidated version of IEC 60034-1 is based on the tenth edition (1996) [documents 2/933/FDIS and 2/969/RVD], its amendment 1 (1997) [documents 2/956/FDIS and 2/984/RVD] and amendment 2 (1999) [documents 2/1031+1055+1056/FDIS and 2/1058+1070+1071/RVD].

It bears the edition number 10.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A and B are for information only.

ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

Section 1: General

1.1 Scope

This standard 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 in so far as they are compatible.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60034. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60027-1:1992, *Letter symbols to be used in electrical technology – Part 1: General*

IEC 60027-4:1985, *Letter symbols to be used in electrical technology – Part 4: Symbols for quantities to be used for rotating electrical machines*

IEC 60034-2:1972, *Rotating electrical machines – Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)*

IEC 60034-3:1988, *Rotating electrical machines – Part 3: Specific requirements for turbine-type synchronous machines*

IEC 60034-5:1991, *Rotating electrical machines – Part 5: Classification of degrees of protection provided by enclosures of rotating electrical machines (IP code)*

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

IEC 60034-12:1980, *Rotating electrical machines – Part 12: Starting performance of single-speed three-phase cage induction motors for voltages up to and including 660 V*

IEC 60034-15:1995, *Rotating electrical machines – Part 15: Impulse voltage withstand levels of rotating a.c. machines with form-wound stator coils*

IEC 60034-17:1992, *Rotating electrical machines – Part 17: Guide for the application of cage induction motors when fed from converters*

IEC 60038:1983, *IEC standard voltages*

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

IEC 60060, *High-voltage test techniques*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60072, *Dimensions and output series for rotating electrical machines*

IEC 60085:1984, *Thermal evaluation and classification of electrical insulation*

IEC 60204-1:1992, *Electrical equipment of industrial machines – Part 1: General requirements*

IEC 60279:1969, *Measurement of the winding resistance of an a.c. machine during operation at alternating voltage*

IEC 60364-4-41:1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*

IEC 60445:1988, *Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

IEC 60449:1973, *Voltage bands for electrical installations of buildings*

IEC 60971:1989, *Semiconductor convertors. Identification code for convertor connections*

IEC 61293:1994, *Marking of electrical equipment with ratings related to electrical supply – Safety requirements*

CISPR 11:1990, *Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment*

CISPR 14:1993, *Limits and methods of measurement radio disturbance characteristics of electrical motor-operated and thermal appliances for household and similar purposes, electric tools and electric apparatus*

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

ISO 497:1973, *Guide to the choice of series of preferred numbers and series containing more rounded values of preferred numbers*

Section 2: Definitions

For the purpose of this International Standard, the definitions in IEC 60050(411) and the following definitions apply.

For definitions, other than those in 2.17 to 2.22, concerning cooling and coolants, reference should be made to IEC 60034-6.

For the purpose of this standard, the term 'agreement' means 'agreement between the manufacturer and purchaser'.

2.1
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.

2.2
rating
the set of rated values and operating conditions [IEV 411-51-24]

2.3
rated output
the value of the output included in the rating

2.4
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]

2.5
no-load (operation)
the state of a machine rotating with zero output power (but under otherwise normal operating conditions) [IEV 411-51-02, modified]

2.6
full load
the load which causes a machine to operate at its rating [IEV 411-51-10]

2.7
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.

2.8
rest and de-energized
the complete absence of all movement and of all electrical supply or mechanical drive [IEV 411-51-03]

2.9
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]

2.10
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]

2.11
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]

2.12
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]

2.13
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]

2.14
pull-up torque (of an a.c. motor)
the smallest value of the 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.

2.15
breakdown torque (of an a.c. motor)
the maximum value of the 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 those asynchronous motors of which the torque continually decreases with increase in speed.

2.16
pull-out torque (of a synchronous motor)
the maximum torque which the synchronous motor develops at operating temperature and at synchronous speed with rated voltage, frequency and field current

2.17
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]

2.18
coolant
a medium, liquid or gas, by means of which heat is transferred [IEV 411-44-02]

2.19
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]

2.20
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]

2.21
direct cooled (inner cooled) winding[1)]
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]

2.22
indirect cooled winding[1)]
any winding other than a direct cooled winding [IEV 411-44-09]

2.23
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

2.24
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

2.25
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.

[1)] In all cases when ‘indirect’ or ‘direct’ is not stated, an indirect cooled winding is implied.

2.26
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

2.27
encapsulated winding
a winding which is completely enclosed or sealed by moulded insulation [IEV 411-39-06]

2.28
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:

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

2.29
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.

Section 3: Duty

3.1 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 3.2, written after the value of the load.

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