UL 60034-1 (IEC 60034-1:2017)

STANDARD FOR SAFETY

Rotating Electrical Machines – Part 1: Rating and Performance

UL Standard for Safety for Rotating Electrical Machines – Part 1: Rating and Performance, UL 60034-1 (IEC 60034-1:2017)

Second Edition, Dated September 18, 2018

Summary of Topics

This is the Second Edition of the Standard for Rotating Electrical Machines – Part 1: Rating and Performance, UL 60034-1, which is a UL-only identical adoption of IEC 60034-1: 2017 Ed. 13

The new requirements are substantially in accordance with Proposal(s) on this subject dated July 20, 2018.

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UL 60034-1 (IEC 60034-1:2017)

Standard for Rotating Electrical Machines – Part 1: Rating and Performance

First Edition – July, 2016

Second Edition

September 18, 2018

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 60034-1 as an American National Standard (ANSI) occurred on September 11, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The IEC Foreword is also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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Bibliography

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Preface (UL)

This UL Standard is based on IEC Publication 60034-1: 13th edition, Rotating electrical machines – Part 1: Rating and performance. IEC publication 60034-1 is copyrighted by the IEC.

This is the UL Standard for Safety for Rotating Electrical Machines – Part 1: Rating and Performance. This UL Part 1 is to be used in conjunction with the appropriate UL Part 2, UL 60034-2-1, which contains clauses to supplement or modify the corresponding clauses in the Part 1, to provide relevant requirements for each type of product.

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Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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.

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

This thirteenth edition cancels and replaces the twelfth edition published in 2010. It constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

Clause or subclause	Change
3.25	Shorter time to thermal equilibrium
5.5.2	Note on P-Q capability diagram for synchronous generators
6.4	Clarification added that other conditions can be agreed on
6.6	Clarification added that standstill is explicitly included; note added
7.1	Clarification on bus transfer or fast reclosing
	Capability to withstand impulse voltages in case of machines connected to a U converter
7.2.4	New Table 3 for identification code
7.3	Table 4 corrected to reflect current scope of IEC 60034-3
7.5	Voltage withstand level for machines connected to a converter
8.3.4	Measurement of ambient air temperature in case of open machines
8.6.3.4	Notes on ETD in the end windings of high voltage machines and on ETD use to monitor strand blockage in case of directly liquid cooled windings
8.10	Clarification on temperature limit
	Clarification on temperature difference between method R and method ETD
	Clarification that temperature limit acc. to method R must always be kept
	Note on measured temperature limits between methods R and ETD
	Table 8 and Table 11 extended incorporating thermal class 200 (N)
	Line 4c) of Table 8 restricted to field windings of DC machines
	Temperature limits in Table 8 changed according to 2/1737/DC and the comments received on this document
	Physically correct formula in Table 10, item 1b
9.1	Clarification on machines that are subject to routine testing
9.2	Separate withstand voltage testing of phases
	Clarification on frequency and time instant for withstand voltage test
	Note on leakage current during withstand voltage test
	Note referring to IEC 60027
10.2	Information on IVIC on rating plate or in documentation
	Clarification added to item f
	IC code and design letter for locked-rotor apparent power on rating plate
11.1	Clarification on cross-sectional area of earthing conductor for generators
	Note on grounding for small machines added
12.2	Tolerance on field current of synchronous machines added
	Tolerance on power factor applies also for PM synchronous machines operated directly at the lines
	Contradiction between tolerances on efficiency and on losses clarified
13.1	Changed as proposed by ACEC
	Note for large generators added
13.3	Changed as proposed by ACEC
13.5	Changed as proposed by ACEC
Annex B	DC power supply added

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

FDIS	Report on voting
2/1857/FDIS	2/1863/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 stability date indicated on the IEC website 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.

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, *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 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, *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 60034-6, *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 60034-12:2016, *Rotating electrical machines – Part 12: Starting performance of singlespeed 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 60034-18 (all parts), *Rotating electrical machines – Part 18: Functional evaluation of insulation systems*

IEC 60034-18-41, *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 TS 60034-25, *Rotating electrical machines – Part 25: AC electrical machines used in power drive systems – Application guide*

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

IEC 60034-30-1, *Rotating electrical machines – Part 30-1: Efficiency classes of line operated A.C. 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 60335-1:2010, *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, conductor terminations and conductors*

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

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

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 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
de-energized and rest
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]

3.12
locked-rotor torque
smallest measured torque the motor develops at its shaft and with the rotor locked, over all its angular positions, at rated voltage and frequency

[SOURCE: IEC 60050-411:1996, 411-48-06]

3.13
locked-rotor current
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

[SOURCE: IEC 60050-411:1996, 411-48-16]

3.14
pull-up torque <of an a.c. motor>
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

Note 1 to entry: This definition does not apply to those asynchronous motors of which the torque continually decreases with increase in speed.

Note 2 to entry: 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>
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

Note 1 to entry: 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>
maximum torque which the synchronous motor develops at synchronous speed with rated voltage, frequency and field current

3.17
cooling
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

[SOURCE: IEC 60050-411:1996, 411-44-01]

3.18
coolant
medium, liquid or gas, by means of which heat is transferred

[SOURCE: IEC 60050-411:1996, 411-44-02]

3.19
primary coolant
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

[SOURCE: IEC 60050-411:1996, 411-44-03]

3.20
secondary coolant
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

[SOURCE: IEC 60050-411:1996, 411-44-04]

3.21
direct cooled winding
inner cooled winding
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

Note 1 to entry: In all cases when 'indirect' or 'direct' is not stated, an indirect cooled winding is implied.

[SOURCE: IEC 60050-411:1996, 411-44-08]

3.22
indirect cooled winding
any winding other than a direct cooled winding

Note 1 to entry: In all cases when 'indirect' or 'direct' is not stated, an indirect cooled winding is implied.

[SOURCE: IEC 60050-411:1996, 411-44-09]

3.23
supplementary insulation
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
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
state reached when the temperature rises of the several parts of the machine do not vary by more than a gradient of *1 K per half hour*

Note 1 to entry: 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 intervals of half hour each have a gradient of 1 K or less per half hour or 2 K or less per hour.

[SOURCE: IEC 60050-411:1996, 411-51-08, modified: modification indicated in italics]

3.26
thermal equivalent time constant
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
winding which is completely enclosed or sealed by moulded insulation

[SOURCE: IEC 60050-411:1996, 411-39-06]