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Date: 21 November 2023

Origin: International

Latest date for receipt of comments: 10 January 2024

Project No. 2023/02823

Responsible committee: PEL/2 Rotating electrical machinery

Interested committees:

Title: BS EN IEC 60034-1 Rotating electrical machines

Part 1: Rating and performance

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

PROJECT NUMBER: IEC 60034-1 ED15	
DATE OF CIRCULATION: 2023-11-17	CLOSING DATE FOR COMMENTS: 2024-02-09
SUPERSEDES DOCUMENTS: 2/2167/RR	

IEC TC 2 : ROTATING MACHINERY	
SECRETARIAT: United Kingdom	SECRETARY: Mr Charles Whitlock
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 9, TC 18	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (See [AC/22/2007](#) or [NEW GUIDANCE DOC](#)).

TITLE:

Rotating electrical machines – Part 1: Rating and performance

NOTE FROM TC/SC OFFICERS:

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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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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	Note with respect to machines with integrated EMC-active components added
2	Normative references updated
4.x	References to IEC TS 60034-25 converted into notes
5.1	Reference to IEC TS 60034-25 converted into note
6.6	Clarification of requirements
7.2.1	Reference to IEC TS 60034-25 converted into note
7.5	Clarification of requirements
7.6	Reference to IEC TS 60034-25 converted into note
8.1	Clarification of references
Table 11	Updated values for thermal class 200 (N)
8.10.3	Clarification of requirements
10.2	Clarification of term 'digital form'
11.1	Reference to protective earth test added
13.3	Clarification of requirements after consultation with ACEC
13.5	Clarification of requirements after consultation with ACEC

The text of this International Standard is based on the following documents:

Draft	Report on voting
2/xxx/FDIS	2/xxx/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document 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 rotating electrical machines for rail and road vehicles, which are covered by the IEC 60349 series of standards.

NOTE Machines with integrated EMC-active components such as a variable frequency converter are considered being a power drive system (see the IEC 61800 series of standards). In such cases, this standard applies to the motor component of the power drive system only.

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 60034-18-1:2022, *Rotating electrical machines - Part 18-1: Functional evaluation of insulation systems - General guidelines*

IEC 60034-18-21:2012, *Functional evaluation of insulation systems - Test procedures for wire-wound windings - Thermal evaluation and classification*

- 46 IEC 60034-18-31:2012, *Functional evaluation of insulation systems - Test procedures for form-*
47 *wound windings - Thermal evaluation and classification of insulation systems used in machines*
48 *up to and including 50 MVA and 15 kV*
- 49 IEC 60034-18-32: 2022, *Functional evaluation of insulation systems - Test procedures for form-*
50 *wound windings - Electrical evaluation of insulation systems used in machines up to and*
51 *including 50 MVA and 15 kV*
- 52 IEC 60034-18-34:2012, *Functional evaluation of insulation systems - Test procedures for form-*
53 *wound windings - Evaluation of thermomechanical endurance of insulation systems*
- 54 IEC 60034-18-41:2014, *Rotating electrical machines – Part 18-41: Partial discharge free*
55 *electrical insulation systems (Type I) used in rotating electrical machines fed from voltage*
56 *converters – Qualification and quality control tests*
57 IEC 60034-18-41:2014/AMD1:2019
- 58 IEC 60034-18-42:2017, *Rotating electrical machines – Part 18-42: Partial discharge resistant*
59 *electrical insulation systems (Type II) used in rotating electrical machines fed from voltage*
60 *converters – Qualification tests*
61 IEC 60034-18-42:2017/AMD1:2020
- 62 IEC 60034-19:2014, *Rotating electrical machines – Part 19: Specific test methods for d.c.*
63 *machines on conventional and rectifier-fed supplies*
- 64 IEC 60034-27-4:2018, *Rotating electrical machines – Part 27-4: Measurement of insulation*
65 *resistance and polarization index of winding insulation of rotating electrical machines*
- 66 IEC 60034-29:2008, *Rotating electrical machines – Part 29: Equivalent loading and*
67 *superposition techniques – Indirect testing to determine temperature rise*
- 68 IEC 60034-30-1:2014, *Rotating electrical machines – Part 30-1: Efficiency classes of line*
69 *operated AC motors (IE-code)*
- 70 IEC 60034-30-3:2023, *Efficiency classes of high voltage AC motors (IE code)*
- 71 IEC 60034-33:2022 *Rotating electrical machines – Part 33: Specific technical requirements for*
72 *hydro generators*
- 73 IEC 60050-411:1996, *International Electrotechnical Vocabulary (IEV) – Part 411: Rotating*
74 *machinery*
75 IEC 60050-411:1996/AMD1:2007
76 IEC 60050-411:1996/AMD2:2021
- 77 IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test*
78 *requirements*
- 79 IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*
- 80 IEC 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General*
81 *requirements*
- 82 IEC 60204-11:2018, *Safety of machinery – Electrical equipment of machines – Part 11:*
83 *Requirements for equipment for voltages above 1 000 V AC or 1 500 V DC and not exceeding*
84 *36 kV*
- 85 IEC 60335-1:2020, *Household and similar electrical appliances – Safety – Part 1: General*
86 *requirements*
- 87 IEC 60364 (all parts), *Low-voltage electrical installations*
- 88 IEC 60417:2002, *Graphical symbols for use on equipment – 12-month subscription to regularly*
89 *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*

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]

3.12**locked-rotor torque**

minimum 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 rotor locked, 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 AC motor>**

minimum 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 AC 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]

3.28**rated form factor of direct current supplied to a DC motor armature from a static power converter**

ratio of the r.m.s. maximum permissible value of the current $I_{\text{rms,maxN}}$ to its average value I_{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**

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):

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

Note 1 to entry: For small values of current ripple, the ripple factor may be approximated by the following formula:

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

Note 2 to entry: The above formula may be used as an approximation if the resulting calculated value of q_i is equal to or less than 0,4.

The basis for determining this variation should be by oscillograph measurement (or a comparable device) and not by ammeter readings. A line should be drawn on the oscillogram through the consecutive peaks of the current wave. This line is the envelope of the current wave. The variation is the difference between the maximum ($I_{\max}$) and minimum ($I_{\min}$) ordinates of this envelope.

3.30

tolerance

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

3.31

type test

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

Note 1 to entry: 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.

[SOURCE: IEC 60050-411:1996, 411-53-01]

3.32

routine test

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

[SOURCE: IEC 60050-411:1996, 411-53-02]

3.33

runaway speed

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

Note 1 to entry: The motor can be also a turbine or an internal combustion engine.

Note 2 to entry: For motors, the maximum overspeed at loss of supply is meant that a motor might reach driven by the coupled equipment

[SOURCE: IEC 60050-411:1996, 411-17-23]

3.34

main insulation

basic insulation (see IEC 60664-1) of a rotating electrical machine

3.35

converter capable machine

electrical machine designed for direct online start and suitable for operation on a power electronic frequency converter without special filtering

Note 1 to entry: Such motors include but are not limited to IEC Design N, NE, H, or HE, or NEMA Design A, B, or C which may be subject to energy efficiency regulation in the EU, North America or other locations.

Note 2 to entry: The intent of the converter capable motor is to run within the thermal class of the insulation system; but as the harmonic content of the converter output voltage varies between different drive topologies, coordination with the manufacturer may be required by the end user.

Note 3 to entry: See IEC TS 60034-25 for performance variations of all characteristics such as efficiency and acoustic noise when operating a converter capable motor on a frequency converter.

3.36

converter duty machine

electrical machine designed specifically for operation fed by a power electronic frequency converter with a temperature rise within the specified insulation thermal class or thermal class.

Note 1 to entry: Such motors have no IEC Design or NEMA Design letter and may be exempted from energy efficiency regulation in the EU, North America and other locations.

3.37

shaft voltage

voltage of mainly supply frequency measured between the shaft ends of an electrical machine, which may occur due to magnetic asymmetries

325 Note 1 to entry: For more information on the root cause of the shaft voltage, see IEC TS 60034-24:2009, 5.5 and
326 Clause 6.

327 Note 2 to entry: The shaft voltage of (mainly) supply frequency should not be mixed-up with the HF shaft voltage
328 which can be caused in converter-fed machines by a high frequency (HF) common mode current impulse.

329 **4 Duty**

330 **4.1 Declaration of duty**

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

333 numerically, where the load does not vary or where it varies in a known manner;

334 as a time sequence graph of the variable quantities;

335 by selecting one of the duty types S1 to S10 that is no less onerous than the expected duty.

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

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

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

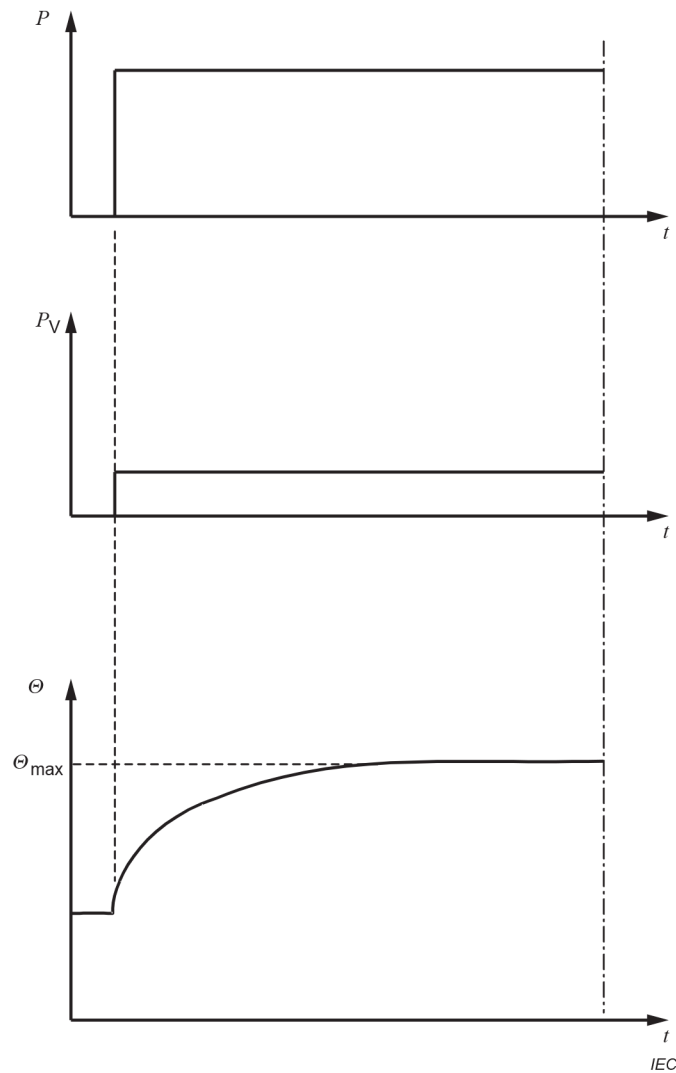
342 Where the purchaser does not declare a duty, the manufacturer shall assume that duty type S1
343 (continuous running duty) applies.

344 **4.2 Duty types**

345 **4.2.1 Duty type S1 – Continuous running duty**

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

348 The appropriate abbreviation is S1.



349

350 **Key**351 P load352 P_V electrical losses353 Θ temperature354 $\Theta_{\max}$ maximum temperature attained355 t time

356

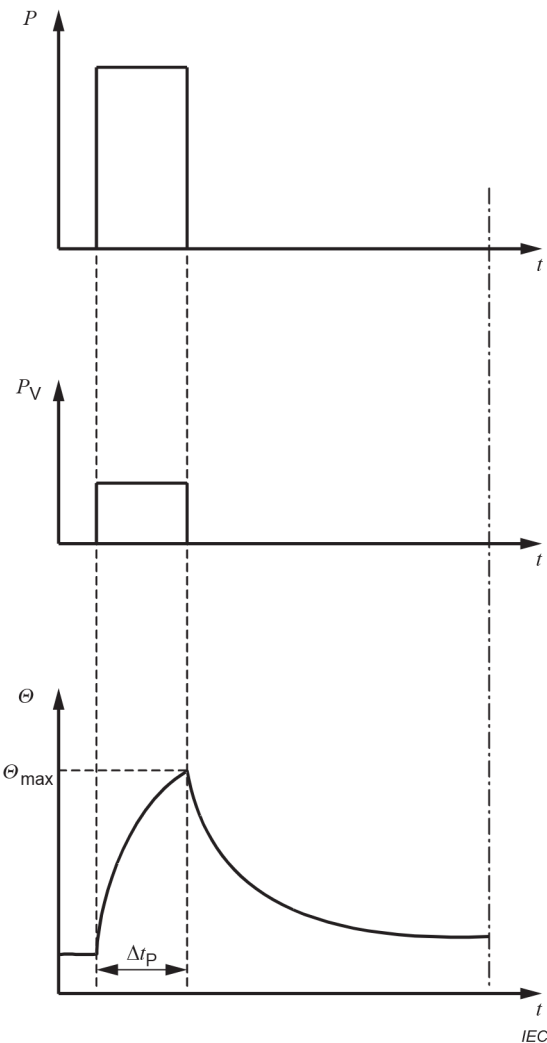
Figure 1 – Continuous running duty – Duty type S1

357 **4.2.2 Duty type S2 – Short-time duty**

358 Operation at constant load for a given time, less than that required to reach thermal equilibrium,
 359 followed by a time at rest and de-energized of sufficient duration to re-establish machine
 360 temperatures within 2 K of the coolant temperature, see Figure 2.

361 The appropriate abbreviation is S2, followed by an indication of the duration of the duty.

362 Example: S2 60 min.



- 363
- 364 **Key**
- 365 P load
- 366 P_V electrical losses
- 367 Θ temperature
- 368 $\Theta_{\max}$ maximum temperature attained
- 369 t time
- 370 Δt_P operation time at constant load,
- 371 e. g. $\Delta t_P = 60$ min for S2 60 min

372

Figure 2 – Short-time duty – Duty type S2

373

4.2.3 Duty type S3 – Intermittent periodic duty

374

NOTE 1 Periodic duty implies that thermal equilibrium is not reached during the time on load.

375

NOTE 2 For duty cycles with a time of one load cycle T_C other than 10 min, see 5.2.3.

376

A sequence of identical duty cycles, each including a time of operation at constant load and a

377

time at rest and de-energized, see Figure 3. In this duty, the cycle is such that the starting

378

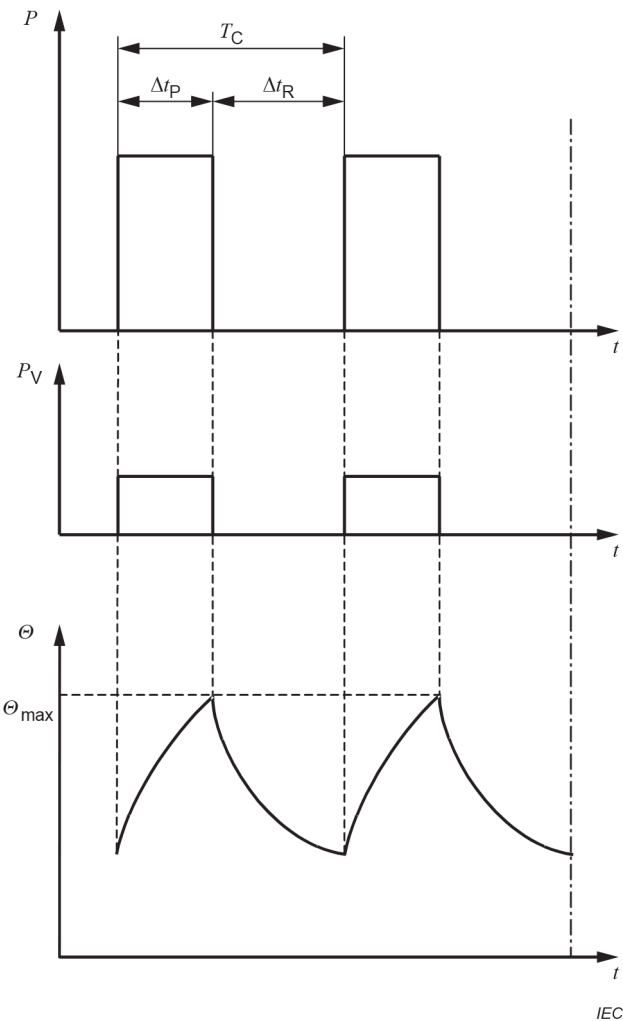
current does not significantly affect the temperature rise.

379

The appropriate abbreviation is S3, followed by the cyclic duration factor.

380

Example: S3 25 %.

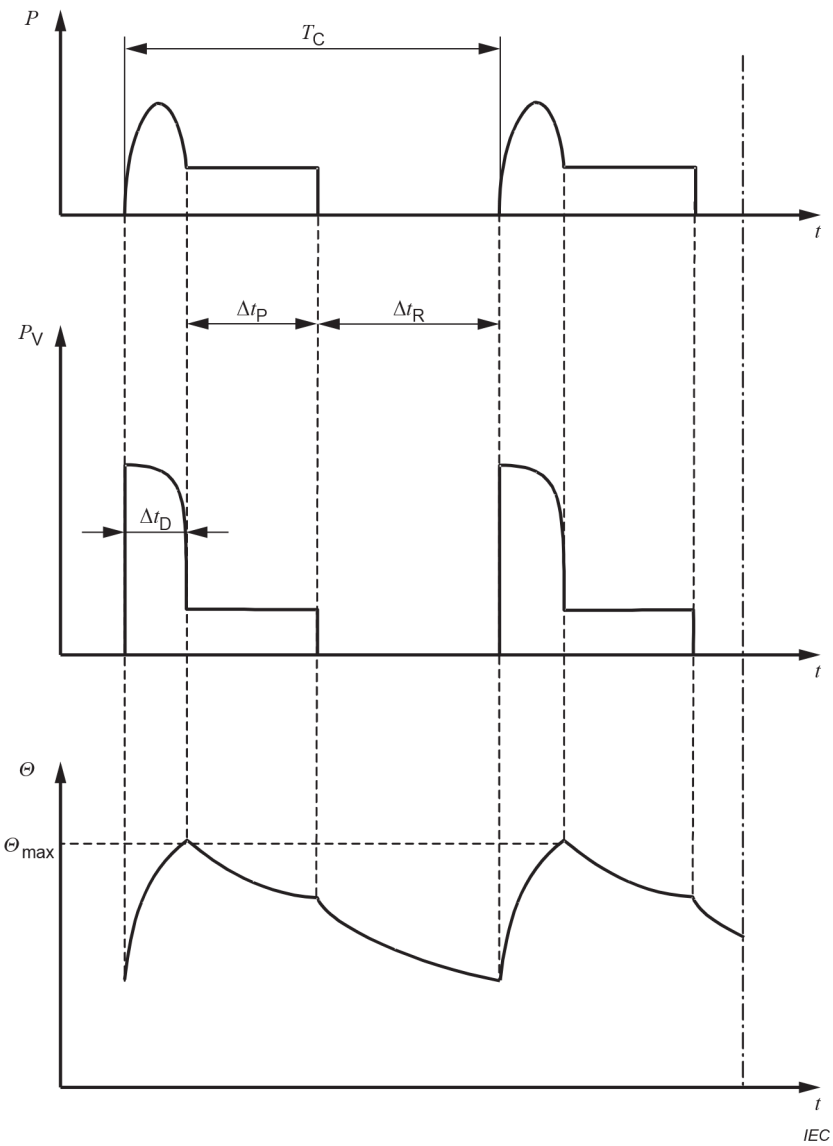


- Key**
- P load
 - P_V electrical losses
 - Θ temperature
 - $\Theta_{\max}$ maximum temperature attained
 - t time
 - T_C time of one load cycle
 - Δt_P operation time at constant load
 - Δt_R time at rest and de-energized
 - Cyclic duration factor = $\Delta t_P / T_C$

Figure 3 – Intermittent periodic duty – Duty type S3

4.2.4 Duty type S4 – Intermittent periodic duty with starting

- NOTE 1 Periodic duty implies that thermal equilibrium is not reached during the time on load.
- NOTE 2 For duty cycles with a time of one load cycle T_C other than 10 min, see 5.2.3.
- A sequence of identical duty cycles, each cycle including a significant starting time, a time of operation at constant load and a time at rest and de-energized, see Figure 4.
- The appropriate abbreviation is S4, followed by the cyclic duration factor, the moment of inertia of the motor (J_M) and the moment of inertia of the load (J_{ext}), both referred to the motor shaft.
- Example: S4 25 % $J_M = 0,15 \text{ kg} \times \text{m}^2$ $J_{\text{ext}} = 0,7 \text{ kg} \times \text{m}^2$.



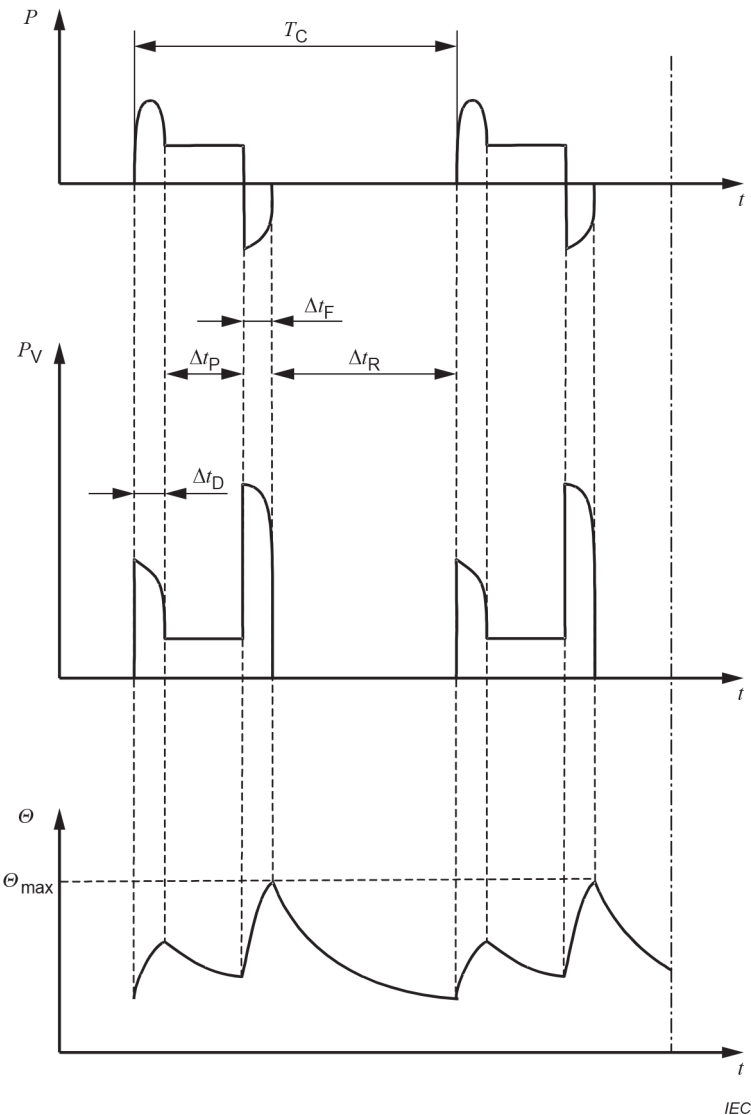
Key			
P	load	t	time
P_V	electrical losses	T_C	time of one load cycle
Θ	temperature	Δt_D	starting/accelerating time
$\Theta_{\max}$	maximum temperature attained	Δt_P	operation time at constant load
		Δt_R	time at rest and de-energized
Cyclic duration factor = $(\Delta t_D + \Delta t_P)/T_C$			

Figure 4 – Intermittent periodic duty with starting – Duty type S4

4.2.5 Duty type S5 – Intermittent periodic duty with electric braking

- NOTE 1 Periodic duty implies that thermal equilibrium is not reached during the time on load.
- NOTE 2 For duty cycles with a time of one load cycle T_C other than 10 min, see 5.2.3.
- A sequence of identical duty cycles, each cycle consisting of a starting time, a time of operation at constant load, a time of electric braking and a time at rest and de-energized, see Figure 5.
- The appropriate abbreviation is S5, followed by the cyclic duration factor, the moment of inertia of the motor (J_M) and the moment of inertia of the load (J_{ext}), both referred to the motor shaft.

412 Example: S5 25 % $J_M = 0,15 \text{ kg} \times \text{m}^2$ $J_{\text{ext}} = 0,7 \text{ kg} \times \text{m}^2$.



413

414 **Key**

P	load	T_C	time of one load cycle
P_V	electrical losses	Δt_D	starting/accelerating time
Θ	temperature	Δt_P	operation time at constant load
Θ_{max}	maximum temperature attained	Δt_F	time of electric braking
t	time	Δt_R	time at rest and de-energized

Cyclic duration factor = $(\Delta t_D + \Delta t_P + \Delta t_F)/T_C$

415

416 **Figure 5 – Intermittent periodic duty with electric braking – Duty type S5**

417 **4.2.6 Duty type S6 – Continuous operation periodic duty**

418 NOTE 1 Periodic duty implies that thermal equilibrium is not reached during the time on load.

419 NOTE 2 For duty cycles with a time of one load cycle T_C other than 10 min, see 5.2.3.

420 A sequence of identical duty cycles, each cycle consisting of a time of operation at constant
421 load and a time of operation at no-load. There is no time at rest and de-energized, see Figure 6.

422 The appropriate abbreviation is S6, followed by the cyclic duration factor.

423 Example: S6 40 %.