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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Rotating electrical machines –
Part 11: Thermal protection

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FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60034-11 has been prepared by IEC technical committee 2: Rotating machinery.

This third edition cancels and replaces the second edition, published in 2004. This edition constitutes a technical revision.

The main changes with respect to the previous edition are

- the additional specification of winding temperature limits for temperature class 200 (N),
- the increased limits of maximum winding temperatures for overloads with rapid variation,
- the clarification that the motor winding may be permanently damaged after it has been exposed to temperatures according to Table 2,
- a clarification of scope,
- a clarification of the definition of indirect thermal protection,
- a clarifying note in Clause 6,
- the conversion of note 3 in Clause 6 into normal text including changes in wording,
- the incorporation of note 3 in Clause 5 into Clause 2,
- a clarification on the test methods for larger motors in 8.3.

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

FDIS	Report on voting
2/2011/FDIS	2/2019/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in 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 "http://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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Thermal protection systems are based on the principle of protecting or monitoring the vulnerable machine parts against excessive temperatures. This requires the selection of the appropriate thermal protection device to suit both the type of protection required and the machine component to be protected. This document does not detail the protection methods available or specify the protection method to be used for particular applications, but instead it specifies the temperature of the protected parts that should not be exceeded if a fault or machine abuse occurs.

The requirements are not intended to guarantee a "normal" machine life for all conditions of use, but rather to avoid both failure and accelerated premature thermal ageing of the winding insulation. The requirements result from a compromise, since the level of protection should neither be set so low that it causes nuisance tripping nor so high that it allows continuous working at temperatures that will seriously affect the life of the winding insulation.

Normal insulation life can only be ensured by correct motor application and maintenance. Frequent operation at above the normal temperature limits, see IEC 60034-1, which cannot be prevented by built-in thermal protection without risking nuisance tripping may lead to a noticeable reduction in machine life. ~~It should be noted that~~ The life of the winding insulation is approximately halved for every 8 K to 10 K increase in the continuous operating temperature.

The requirement to incorporate thermal protection in a machine is a matter for agreement. The application of this document ~~should be~~ is a matter of agreement between the user and the machine manufacturer.

ROTATING ELECTRICAL MACHINES –

Part 11: Thermal protection

1 Scope

This part of IEC 60034 specifies requirements relating to the use of thermal protectors and thermal detectors incorporated into the stator windings or placed in other suitable positions in induction machines in order to protect them against serious damage due to thermal overloads. ~~It applies to machines manufactured in accordance with IEC 60034-12 with the voltage limits specified in IEC 60034-12. The protection of bearings and other mechanical parts is not included.~~ It applies to single-speed three-phase 50 Hz or 60 Hz cage induction motors in accordance with IEC 60034-1 and IEC 60034-12 that:

- have a rated voltage up to 1 000 V;
- are intended for direct-on-line or star-delta starting.

Not included are:

- direct protection of the rotor winding; the methods of protection only protect rotor windings indirectly; for large motors (particularly 2 pole motors) and for motors starting large inertia loads, special attention is given to rotor heating both when starting and especially after a "trip" has occurred;
- the protection of bearings and other mechanical parts;
- the protection methods to be used for particular applications.

NOTE 1 Although temperature values given in this document are higher than those specified in IEC 60034-1, they are not in conflict.

NOTE 2 Additional requirements may apply to particular motor types, such as those used in household appliances, or for motors used in explosive atmospheres.

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 60034-1:~~2004~~2017, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-12:~~2002~~2016, *Rotating electrical machines – Part 12: Starting performance of single-speed three-phase cage induction motors*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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
thermal protection
protection of windings of a machine against excessive temperature resulting from conditions of overload or loss of cooling

3.2
thermal protection system
system for the protection of a machine winding against excessive temperature resulting from conditions of overload or loss of cooling by means of either thermal protector(s) or thermal detector(s)

3.3
thermal detector
electrically insulated device that is only sensitive to temperature, capable of initiating a switching function in a protection system when its temperature reaches a predetermined level

3.4
thermal protector
electrically insulated device that is sensitive to the temperature of the machine winding which carries machine current, capable of directly switching off the machine when its temperature reaches a predetermined level

Note 1 to entry: Some thermal protectors are sensitive to both temperature and current, the combination of which activates the direct switching off of the machine.

3.5
thermal overload with slow variation
overload condition or loss of cooling that produces a rise of temperature that is sufficiently slow that the temperature of the thermal protector or detector follows it without appreciable delay

3.6
thermal overload with rapid variation
overload condition or loss of cooling that produces a rise of temperature that is too rapid for the temperature of the thermal protector or detector to follow without appreciable delay resulting in a significant temperature difference between the thermal device and the part to be protected

3.7
maximum temperature after tripping
maximum value of the temperature that is reached by the protected part of the machine during the period which follows tripping by the thermal protection system

3.8
direct thermal protection
form of protection where the part of the machine in which the thermal detector(s) or thermal protector(s) are incorporated is the part for which protection is being provided

3.9
indirect thermal protection
form of protection where the part of the machine in which the thermal detector(s) or thermal protector(s) are incorporated (e.g. the stator winding) is not the part for which protection is being provided (e.g. the rotor winding)

4 Thermal protection limits

Machines shall be capable of operating at rated output and at all operating conditions according to IEC 60034-1 without activation of the thermal protection device. The thermal protection device shall limit the winding temperature in accordance with Clause 5 or Clause 6.

5 Protection against thermal overloads with slow variation

When subjected to an overload or other misuse condition causing overheating with slow variation, the protection system shall operate to prevent the temperature of the machine winding from exceeding the values in Table 1.

Examples of the rise in temperature as a function of time are shown in Figure 1 and Figure 2.

Table 1 – Maximum winding temperatures for overloads with slow variation

Thermal class	130(B)	155(F)	180(H)	200(N)
Maximum insulated winding temperature °C	145	170	195	215

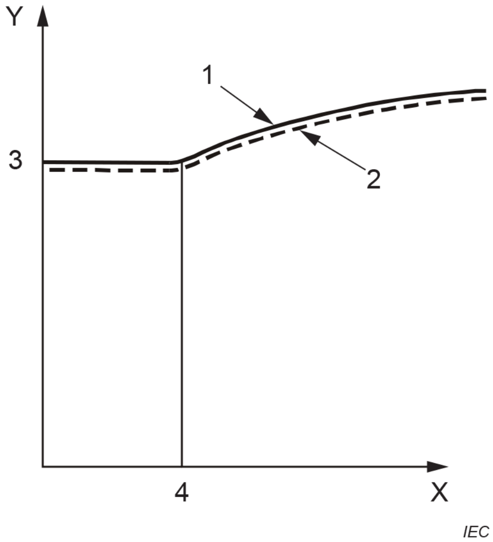
The winding temperature shall be determined by the resistance method in accordance with the requirements of 8.6.2 of IEC 60034-1:2017.

NOTE 1 The limit values in Table 1 exceed the thermal classification and thus will reduce the lifetime of the motor~~, if the motor is operated over a longer period of time with these values~~.

NOTE 2 The maximum temperature limits are based on experience. Some of the ways in which a thermal overload with slow variation may be caused are:

- Defects in ventilation or the ventilation system due to excessive dust in the ventilation ducts, or dirt on windings or frame cooling ribs, etc.
- An excessive rise in ambient temperature or the temperature of the cooling medium.
- Gradual increasing mechanical overload.
- Prolonged voltage drop, over-voltage or unbalance in the machine supply.
- Excessive duty on a motor rated for intermittent duty.
- Frequency deviations.

~~NOTE 3 The maximum temperature limits are based on experience taking into account factors such as ambient temperature, variations in supply voltage and normal requirements for starting motors.~~



Key

1 is the winding temperature in the vicinity of the thermal protector or detector

2 is the temperature of the thermal protector or detector

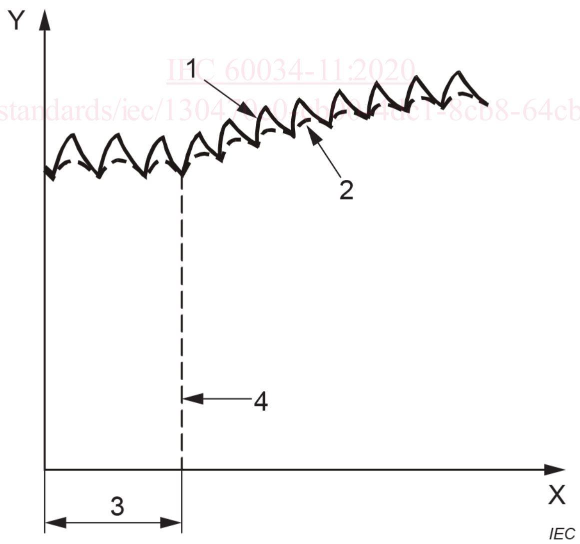
3 is the temperature when operating at normal duty

4 is the time at the beginning of the thermal overload

X axis is time

Y axis is temperature

Figure 1 – Example of thermal overload with slow variation and direct thermal protection



Key

1 is the winding temperature in the vicinity of the thermal detector or protector

2 is the temperature of the thermal detector or protector

3 is the interval with normal cycling frequency

4 is the time at the beginning of the thermal overload

X axis is time

Y axis is temperature

Figure 2 – Example of thermal overload with slow variation in the case of too intensive intermittent periodic duty with starting (duty S4) and direct thermal protection

6 Protection against thermal overloads with rapid variation

When a thermal overload with rapid variation is applied to the machine, the thermal protection system shall operate to prevent the temperature of the machine winding from exceeding the values given in Table 2.

A current overload relay does not normally provide protection against repeated rapid overload variations and the use of a thermal protection device should be considered

Examples of the rise in temperature as a function of time are shown in Figure 3 and Figure 4.

Table 2 – Maximum winding temperatures for overloads with rapid variation

Thermal class	130(B)	155(F)	180(H)	200(N)
Maximum insulated winding temperature °C	225	~~240~~ 250	~~260~~ 275	295

The winding temperature shall be determined by direct measurements such as thermocouples in accordance with the requirements of 8.5.3 of IEC 60034-1:2017.

It is understood that the motor winding may be permanently damaged and may not be able to operate after it has been exposed to temperatures according to Table 2.

NOTE 1 Some of the ways in which a thermal overload with rapid variation may be caused are:

- Stalling the motor.
- Phase failure.
- Starting under abnormal conditions, for example, inertia too great, voltage too low, load torque abnormally high;
- Sudden and significant increase in load.
- Starting repeatedly during a short time.

NOTE 2 The maximum temperature limits are based on experience, taking into account factors such as ambient temperature, variations in supply voltage and normal requirements for starting motors.

~~NOTE 3~~ The temperatures in Table 2 ~~should~~ shall not be confused with the operating temperatures of the winding's thermal protector or thermal detector ~~operating temperatures~~ which have to be significantly below these values. The thermal protector shall be installed at a place where the highest temperatures are expected according to the application and the motor cooling system.