IEC 60947-8

Edition 1.2 2011-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Low-voltage switchgear and controlgear –
Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines

Appareillage à basse tension –
Partie 8: Unités de commande pour la protection thermique incorporée (CTP) aux machines électriques tournantes

IEC 60947-8:2003+A1:2006+A2:2011

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 60947-8

Edition 1.2 2011-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Low-voltage switchgear and controlgear – Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines

Appareillage à basse tension – Partie 8: Unités de commande pour la protection thermique incorporée (CTP) aux machines électriques tournantes

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.130.20

ISBN 978-2-88912-722-1

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines

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.
2) The formal decisions or agreements of 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 IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60947-8 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This consolidated version of IEC 60947-8 consists of the first edition (2003) [documents 17B/1276/FDIS and 17B/1282/RVD], its amendment 1 (2006) [documents 17B/1477/FDIS and 17B/1504/RVD] and its amendment 2 (2011) [documents 17B/1732/FDIS and 17B/1739/RVD].

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 1.2.

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

This standard shall be used in conjunction with IEC 60947-1: General rules.

The provisions of the general rules dealt with in IEC 60947-1 are applicable to this standard, where specifically called for. Clauses and subclauses, tables, figures and annexes of the general rules thus applicable are identified by reference to IEC 60947-1 (e.g. 1.2.3 of IEC 60947-1, Table 4 of IEC 60947-1 or Annex A of IEC 60947-1, etc.).

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site 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.

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 publication using a colour printer.

INTRODUCTION

Thermal protection systems which are based on the principle of monitoring the temperature of the protected parts constitute a simple and effective means of protecting rotating electrical machines against excessive temperature rises, including those caused by faults in the cooling system, or excessively high ambient temperature, whereas systems of protection based only on monitoring the current absorbed may not ensure this type of protection.

Since the operating temperature and response times of thermal protection systems are fixed in advance, they may not be adjusted in relation to the conditions of use of the machine and they may not be completely effective for all fault conditions or improper use of the machine.

A thermal protection system in accordance with this standard may consist of a characteristic change thermal detector which has an associated control unit to convert a point on the characteristic of the detector to a switching function. A very large number of thermal protection systems are in use and, in all cases, the machine manufacturer will fit the detectors in the machine. The machine manufacturer will either supply the control unit with the machine or specify particulars of the control unit to be used.

It is also customary for the control units to be considered as part of the control system and not necessarily supplied with the machine. For this reason it is considered necessary to have an interchangeable system, where the characteristics of association between the detector and the control unit are specified. This particular system is not considered superior in any way to other systems complying with the requirements of this standard, but in some fields the practice is likely to be that this interchangeable system will be used, as indicated by the designation “Mark A”.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines

1 Scope

This part of IEC 60947 specifies rules for control units, which perform the switching functions in response to the thermal detectors incorporated in rotating electrical machines according to IEC 60034-11, and the industrial application.

It specifies rules for that type of system comprising a positive temperature coefficient (PTC) thermistor detector having particular characteristics, and its associated control unit.

The PT100 detectors are covered by IEC 60751, where the resistor values are given according to the temperatures of the detector.

The present rules lay down the characteristics of association of this particular positive temperature coefficient thermistor detector and its associated control unit (designated “Mark A detector” and “Mark A control unit”), when they are used in thermal protection systems.

NOTE It is not possible to specify all the requirements for the operating characteristics of a control unit, as they are dependent on some aspects of the thermal detectors. Some aspects of the requirements of the thermal protector system can only be specified when account is taken of the characteristics of the rotating machine to be protected and the method of installation of the detector within the machine.

For these reasons, for each characteristic it is necessary to specify who is responsible for stating the required values and who is responsible for compliance with the requirement and for carrying out any confirmatory test.

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 60034-11:2004, *Rotating electrical machines – Part 11: Thermal protection*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 60417:2002, *Graphical symbols for use on equipment*

IEC 60738-1:1998, *Thermistors – Directly heated positive step-function temperature coefficient – Part 1: Generic specification*

IEC 60751:1983, *Industrial platinum resistance thermometer sensors*
Amendment 1 (1986)
Amendment 2 (1995)

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test*
Amendment 1 (2007)
Amendment 2 (2010)

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*
Amendment 1 (2010)

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*
Corrigendum 1 (2009)

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low-frequency immunity tests*
Amendment 1 (2009)

CISPR 11:2009, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
Amendment 1 (2010)

CISPR 22:2008, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, relevant definitions of IEC 60947-1, together with the following definitions, apply.

3.1 Terms and definitions

3.1.1
built-in thermal protection
protection of certain parts (called protected parts) of a rotating electrical machine against excessive temperatures resulting from certain conditions of thermal overload, achieved by means of a thermal protection system, the whole or part of which is a thermally sensitive device incorporated within the machine

3.1.2
thermal protection system
system intended to ensure the thermal protection of a rotating electrical machine by means of a built-in thermal detector together with a control unit

3.1.3
thermal detector
electrical insulated device (component), sensitive to temperature only, which will initiate a switching function in the control system when its temperature reaches a predetermined level

3.1.4
switching type thermal detector
thermal detector which causes a direct operation of a switching element

NOTE The combination of the thermal detector and the switching element is rated as a unit and mounted in the rotating electrical machine.

3.1.5
control system
system to translate a particular point on the characteristic of a thermal detector to a switching function on the supply to the rotating electrical machine

NOTE The system is capable of being reset (either manually or automatically) when the temperature falls to the reset value.

3.1.6
protected part
part of a rotating electrical machine, the temperature of which is limited to a predetermined value by the action of the thermal protection system

3.1.7
thermal overload with slow variation
slow temperature rise above the normal operating temperature

NOTE 1 The variation of the temperature of the protected part is sufficiently slow for the temperature of the thermal detector to follow without appreciable delay.

NOTE 2 A thermal overload with slow variation may be caused, for instance, by:

- defects in ventilation or in the ventilation system, for example partial blocking of the ventilation ducts, excessive dust, dirt on the windings or on the cooling ribs of the frame;
- an excessive rise in the ambient temperature or in the temperature of the cooling medium;
- gradually increasing mechanical overload;
- prolonged voltage drop or over-voltage in the machine supply;
- excessive duty in a machine.

3.1.8
thermal overload with rapid variation
rapid rise of temperature above the normal operating temperature

NOTE 1 The variation of the temperature of the protected part may be too rapid for the temperature of the thermal detector to follow without delay. This may result in a significant temperature difference between the thermal detector and the protected part.

NOTE 2 A thermal overload with rapid variation may be caused, for instance, by stalling the machine or in certain circumstances, by phase failure or by starting under abnormal conditions (inertia too high, voltage too low, load torque abnormally high).

3.1.9
thermally critical part of a machine
part of a machine in which the temperature most rapidly reaches its dangerous value

NOTE A part of a machine which is thermally critical in the case of thermal overload with slow variation may not be so for a thermal overload with rapid variation.

3.1.10
thermal protection with detector
form of protection where the part of the machine in which the thermal detector(s) is (are) incorporated is the thermally critical part

3.1.11
maximum temperature after tripping
maximum value of the temperature which is reached by the protected part of the machine during the period which follows tripping by the thermal protection system, for thermal overload with rapid variation

3.1.12
category of thermal protection
indication of the permissible temperature levels on the windings of a machine when subjected to the thermal overload

3.1.13
characteristic variation thermal detector
thermal detector which has a characteristic the variation of which, related to the temperature, is able to initiate a switching function in the control system for one temperature fixed in advance during manufacture or by initial adjustment of the control unit

NOTE For example, a resistor detector, thermocouple detector, negative temperature coefficient thermistor detector, positive temperature coefficient thermistor detector.

3.1.14
abrupt characteristic change thermal detector
thermal detector which has a characteristic, the abrupt change of which for one temperature fixed in advance during manufacture is able to initiate a switching operation in the control system

3.1.15
control unit
device which converts into a switching function the variation of the characteristic of a thermal detector

NOTE The control unit may be part of other devices or systems.

3.1.16
control circuit
circuit controlling the switching device which makes and breaks the power supply

3.1.17
detector operating temperature (TNF)
detector temperature at which detector switching occurs during an increase of temperature, or at which the variation of the characteristic related to the temperature is such as to cause operation of the associated control unit

3.1.18
system operating temperature (TFS)
detector temperature at which, during an increase of temperature, the detector and control unit together cause the operation of the control unit

3.1.19
reset temperature
detector temperature at which, during a decrease of temperature, detector switching occurs or at which the variation of the characteristic related to the temperature is such that in conjunction with the control unit it permits the resetting of the control unit

3.1.20
electrically separated contact elements
contact elements belonging to the same control unit, but adequately insulated from each other so that they can be connected into electrically separated circuits

3.1.21
PTC thermistor detector
abrupt characteristic change thermal detector made by a PTC thermistor, having on part of its resistance-temperature characteristic, known as the PTC part, a considerable increase in its electrical resistance with negligible power dissipation as soon as its temperature exceeds a given value

3.1.22
mark A detector
PTC thermistor detector having the particular characteristics described in Annex A

3.1.23
mark A control unit

control unit having the particular characteristics specified in this standard and intended for operation in conjunction with a mark A detector

3.1.24

control unit with short-circuit detection within the thermal detector circuit

control unit capable of detecting short-circuited thermal detector circuits

3.1.25
control unit with dynamic wire break detection
control unit capable of indicating wire breaks within the thermal detector circuits

3.2 Symbols and abbreviations

EMC	Electromagnetic compatibility
I_e	Rated operational current (5.3.3)
I_{th}	Conventional free air thermal current (5.3.3)
PTC	Positive temperature coefficient
Q	Amplification factor (9.3.3.13.3)
TFS	System operating temperature (3.1.18)
TNF	Detector operating temperature (3.1.17)
U_e	Rated operational voltage (5.3.2)
U_i	Rated insulation voltage (5.3.2)
U_{imp}	Rated impulse withstand voltage (6.1)
U_r	Rated voltage of the detector circuit (6.1)
U_s	Rated control supply voltage (6.1)

4 Classification

Under consideration.

5 Characteristics

5.1 General

The characteristics of a control unit shall be stated in the following terms, where such terms are applicable:

– type of equipment (see 5.2);
– rated electrical values of protection systems (see 5.3);
– rated electrical values of characteristic variation thermal detectors (see 5.4);
– rated voltage of the detector circuit of the control unit (see 5.5).

5.2 Type of equipment

5.2.1 Operating temperatures of protection systems

Each detector, or detector with control unit, shall have either a declared rated operating temperature in accordance with 5.2.2 (TNF), or a declared rated system operating temperature in accordance with 5.2.3 (TFS), or both. For example:

a) Switching type thermal detector: TNF shall be declared.

b) Abrupt characteristic change thermal detector: TNF shall be declared; TFS is not applicable.

c) Abrupt characteristic change thermal detector with its control unit: TFS shall be declared. In this case, the value of TFS may coincide with the value of TNF for the detector itself.

d) Characteristic variation thermal detector with its control unit: TFS shall be declared. In this case, the detector may not have a definable value of TNF.

5.2.2 Rated detector operating temperature

In the case of an abrupt characteristic change thermal detector, the value of the TNF shall be declared by the detector manufacturer.

It is recommended that the normal value of TNF, expressed in degrees Celsius, be selected from the series of numbers which are multiples of five.

It shall be the responsibility of the detector manufacturer to verify the detector operating temperature.

5.2.3 Rated system operating temperature

If the protection system of detector and the control unit are supplied through a single supplier then that supplier shall declare the value of the TFS.

In all other cases, the control unit manufacturer shall declare the value of the TFS.

The tolerance on the declared value of the TFS shall be ±6 K unless otherwise agreed between the manufacturers.

NOTE The tolerance is the sum of the tolerances of the detector and the control unit.

It shall be the responsibility of the manufacturer, or supplier who declares the value of the TFS, to ensure that this value is verified, but the test may be carried out by the detector manufacturer or the control unit manufacturer by agreement.

Routine tests shall be carried out by the control unit manufacturer to verify correct operation under normal operating conditions in accordance with 8.2.1.

5.2.4 Maximum permissible rated operating temperature for the system

The maximum permissible value of the TFS for a particular detector or a particular control unit shall be declared by the detector manufacturer or by the control unit manufacturer respectively.

NOTE For any particular device, the maximum value of the TFS will be dependent on the characteristics and the materials used in the manufacture of the detector, or by the limits on the characteristics of the detector which can be modified by the range of settings available with the control unit design.

5.2.5 Reset temperature

The reset temperature value and tolerances may be declared by the manufacturer of the detector or, in cases where this depends upon the combination of the detector and its control unit, by the control unit manufacturer.

It shall be the responsibility of the detector manufacturer or the control unit manufacturer, depending on which of them has declared the reset temperature, to ensure that this is verified in accordance with 9.3.3.8, but the test may be carried out by either manufacturer by agreement.

NOTE To restart the machine after the tripping of the control system, it is important for the machine winding and the thermal detector to cool sufficiently to permit normal machine acceleration without nuisance tripping, especially with a high inertia load. The temperature value for restarting depends on installation and service conditions. The control system may be designed in order to permit a selection of different temperature values.

For a manual restarting system, the maximum temperature shall be considered. For automatic restarting systems, the machine manufacturer should consider the minimum and maximum differential temperatures which result from choices of TNF or TFS and rest temperature with the declared tolerance values. Differential values which are too narrow may not permit sufficient cool-down for restarting without nuisance tripping. Differential temperatures that are too wide may result in an excessively long machine cooling down time or resetting may be prevented in high ambient temperatures.

5.2.6 Characteristics of Mark A control units

When the control unit operates under the normal conditions of service and the detector circuit is connected to the terminals of the control unit, the following conditions shall be met. Compliance shall be verified by the tests specified in 9.3.3.10.

a) The control unit shall switch on, or be able to be reset, when the resistance of the detector circuit is 750 Ω or less.

b) The control unit shall switch off when the resistance of the thermistor detector circuit is increased from 1 650 Ω to 4 000 Ω.