BRITISH STANDARD

BS EN 60947-8:2003 +A2:2012

Low-voltage switchgear and controlgear —

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

ICS 29.130.20

BSI British Standards

National foreword

This British Standard is the UK implementation of EN 60947-8:2003+A2:2012. It is identical to IEC 60947-8:2003, incorporating amendments 1:2006 and 2:2011. It supersedes BS EN 60947-8:2003, which will be withdrawn on 22 June 2014.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated in the text by [A1] 〈A1〉.

The UK participation in its preparation was entrusted by Technical Committee PEL/17, Switchgear, controlgear and HV/LV co-ordination, to Subcommittee PEL/17/2, Low voltage switchgear and controlgear.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Amendments/corrigenda issued since publication

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English version

Low-voltage switchgear and controlgear
Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines
(IEC 60947-8:2003)

Appareillage à basse tension
Partie 8: Unités de commande pour la protection thermique incorporée (CTP) aux machines électriques tournantes
(CEI 60947-8:2003)

Niederspannungsschaltgeräte
Teil 8: Auslösegeräte für den eingebauten thermischen Schutz (PTC) von rotierenden elektrischen Maschinen
(IEC 60947-8:2003)

This European Standard was approved by CENELEC on 2003-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC
European Committee for Electrotechnical Standardization
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Foreword

The text of document 17B/1276/FDIS, future edition 1 of IEC 60947-8, prepared by SC 17B, Low-voltage switchgear and controlgear, of IEC TC 17, Switchgear and controlgear, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60947-8 on 2003-07-01.

This Part 8 shall be used in conjunction with EN 60947-1. The provisions of the general rules dealt with in EN 60947-1 are applicable to this standard, where specifically called for. Clauses and subclauses, tables, figures and annexes 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.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2004-04-01

– latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2006-07-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes A, B and ZA are normative and annex C is informative.
Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60947-8:2003 was approved by CENELEC as a European Standard without any modification.

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Foreword to amendment A1

The text of document 17B/1477/FDIS, future amendment 1 to IEC 60947-8:2003, prepared by SC 17B, Low-voltage switchgear and controlgear, of IEC TC 17, Switchgear and controlgear, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60947-8:2003 on 2006-10-01.

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– latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2009-10-01

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Endorsement notice

The text of amendment 1:2006 to the International Standard IEC 60947-8:2003 was approved by CENELEC as an amendment to the European Standard without any modification.

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Foreword to amendment A2

The text of document 17B/1732/FDIS, future edition 1 of IEC 60947-8:2003/A2, prepared by SC 17B, "Low-voltage switchgear and controlgear", of IEC TC 17, "Switchgear and controlgear" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60947-8:2003/A2:2012.

The following dates are fixed:

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC)

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

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Endorsement notice

The text of the International Standard IEC 60947-8:2003/A2:2011 was approved by CENELEC as a European Standard without any modification.

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CONTENTS

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.

〚A1〛 IEC 60034-11:2004, *Rotating electrical machines – Part 11: Thermal protection*

〚A2〛 IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold* 〈A2〉

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* 〈A1〉

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

〚A1〛 IEC 60417:2002, *Graphical symbols for use on equipment* 〈A1〉

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)

〖A2〗 IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules* 〈A2〉

〖A1〗 IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices* 〈A1〉

〖A2〗 IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test* 〈A2〉

〖A1〗 IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test* 〈A1〉
〖A2〗 Amendment 1 (2007)
Amendment 2 (2010) 〈A2〉

〖A2〗 IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*
Amendment 1 (2010) 〈A2〉

〖A2〗 IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*
Corrigendum 1 (2009) 〈A2〉

〖A2〗 IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields* 〈A2〉

IEC 61000-4-8:〖A2〗 2009 〈A2〉, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:〖A2〗 2004 〈A2〉, *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*
〖A2〗 Amendment 1 (2009) 〈A2〉

〖A2〗 CISPR 11:2009, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
Amendment 1 (2010) 〈A2〉

CISPR 22:〖A2〗 2008 〈A2〉, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 [A1] Terms, definitions, symbols and abbreviations [A1]

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

[A1] 3.1 Terms and definitions

[A1]

〖A1〗 3.1.1 〈A1〗
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

〖A1〗 3.1.2 〈A1〗
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

〖A1〗 3.1.3 〈A1〗
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

〖A1〗 3.1.4 〈A1〗
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.

〖A1〗 3.1.5 〈A1〗
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.

〖A1〗 3.1.6 〈A1〗
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

〖A1〗 3.1.7 〈A1〗
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

〈A1〉 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) 〈A1〉

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.

c) The control unit shall switch on, or be able to be reset, when the resistance of the thermistor detector circuit falls from 1 650 Ω to 750 Ω.

d) When a resistance of 4 000 Ω is connected between each pair of terminals intended for the connection of a thermistor detector circuit, and when the control unit operates at its rated voltage, the voltage per pair of terminals shall not exceed 7,5 V (direct or alternating peak voltage).

e) There shall be no significant modification in the operation of the control unit when the capacitance of the detector circuit is not greater than 0,2 μF.

〖A1〗 5.2.7 Short-circuit detection within the sensor circuit

Thermal detectors have a low resistance and therefore a special measure is necessary to recognize a reduction of the resistance to nearly zero by a short-circuit. For safety applications, or to increase the lifetime of a rotating electrical machine, it is useful to establish a short-circuit detection system within the sensor circuit. The safety of the thermal protection, in particular, is increased by such a short-circuit detection.

Such a short-circuit detection only identifies a short-circuit but it does not automatically cover a defined action. All following actions depend on the configuration of the control unit and the manufacturers application. 〖/A1〗

5.3 Rated electrical values of protection systems

5.3.1 Rated electrical values of switching devices (i.e. control units and switching type thermal detectors)

The rated electrical values of the switching devices of control units and switching type thermal detectors shall be declared by the control unit manufacturer in accordance with 5.3.2 to 5.3.4, as appropriate.

5.3.2 Rated voltages of a control unit

The rated voltages of a control unit are the rated insulation voltage (U_i) and the rated operational voltage (U_e) as defined in 4.3.1.2 and 4.3.1.1 of IEC 60947-1.

5.3.3 Rated currents of a control unit

The rated currents of a control unit are the conventional free air thermal current (I_{th}) and the rated operational current (I_e) as defined in 4.3.2.1 and 4.3.2.3 of IEC 60947-1.

NOTE A control unit may be assigned a number of combinations of rated operational voltage and rated operational current.

5.3.4 Rated making and breaking capacities of a control unit

For a control unit or a switching type thermal detector to which an utilization category is assigned, the utilization category shall be declared according to 4.4 of IEC 60947-5-1 and it is unnecessary to specify rated making and breaking capacities, since these values depend directly on the utilization category and on the rated operational voltages and currents.

5.4 Rated electrical values of characteristic variation thermal detectors

5.4.1 General

The rated electrical values of characteristic variation thermal detectors shall be declared by the manufacturer.

5.4.2 Rated insulation voltage

The rated insulation voltage (U_i) is the value of voltage to which the dielectric tests are referred.

5.4.3 Rated operational voltage of the detector

For a detector for which the operation is dependent on the applied voltage, the rated operational voltage (U_e) is the value of voltage by which the detector is designated and which may be applied to the detector.

NOTE For detectors used with alternating current, the rated operational voltage is the peak value of the voltage, indicated by $\hat{U}_e$.

5.5 Rated voltage of the detector circuit of the control unit

The rated voltage of the detector circuit (U_r) intended to be used with characteristic variation thermal detectors having a defined rated operational voltage shall be declared by the manufacturer of the control unit.

The voltage U_r is the maximum value of voltage which appears between each pair of terminals intended for the connection of a detector circuit when a resistance, determined as below, is connected between these terminals and when the control unit is supplied at its rated voltage.

The resistance to be used corresponds to the value of the characteristic curve when the control unit is switched off and takes into account the number of detectors in the circuit. This may be a maximum or minimum value depending upon the shape of the characteristic curve.

NOTE If the circuit is an a.c. circuit, the rated voltage is the peak value of voltage, indicated by $\hat{U}_r$.

6 Product information

6.1 Nature of information

The following information shall be given by the manufacturer:

Identification

a) manufacturer's name or trade mark;

b) type designation or serial number;

〈A2〉 c) 60947-8

The Mark A control units shall be additionally marked "Mark A control unit". 〈A2〉

Characteristics, basic rated values and utilization

d) rated control supply voltage (U_s);

e) rated frequency of control supply voltage;

f) rated operational voltage (U_e) of the control unit;

g) rated operational current (I_e) of the control unit;

h) utilization category, or making and breaking capacities;

i) a circuit diagram which specifies the terminal marking and the connections of the detectors, the control unit and the supply;

j) rated insulation voltage (U_i) of the control circuit;

k) type of thermal detectors with which the control unit is to be used and, if applicable, the rated voltage (U_r) of the detector circuit;

l) IP code in case of an enclosed equipment;

m) the equipment class according to the EMC emission levels and the specific requirements necessary to maintain compliance;

n) the immunity levels attained and the specific requirements necessary to maintain compliance;

o) rated impulse withstand voltage U_{imp};

p) rated operating temperature.

6.2 Marking

Subclause 5.2 of IEC 60947-1 applies with the following additions.

Data under d) to p) above shall, preferably, be marked on the equipment or in the manufacturer's published literature.

Data under c) and l) above shall, preferably, be marked on the equipment.

6.3 Instructions for installation, operation and maintenance

Subclause 5.3 of IEC 60947-1 applies with the following addition.

Information shall be provided by the manufacturer to advise the user on the measures to be taken with regard to the equipment in connection with the requirements for EMC.

7 Normal service, mounting and transport conditions

Clause 6 of IEC 60947-1 applies.

8 Constructional and performance requirements

8.1 Constructional requirements

8.1.1 General

Subclause 7.1 of IEC 60947-1 applies with the following additions.

Connection devices (e.g. terminals), when fitted, shall be able to accept single strand conductors from 0,5 mm^2 to 1,5 mm^2, and shall be sufficient in number to permit the connection of the thermal detector circuit(s).

Terminals for connection to a single thermal detector circuit shall be marked T1 and T2.

Terminals for connection to several thermal detector circuits shall be marked 1T1 and 1T2, 2T1 and 2T2, etc.

Terminals intended to be at frame or earth potential shall be marked with the appropriate symbol as specified in IEC 60417.

The installation shall be made in accordance with the manufacturer's instructions, including permissible shock and vibration levels and limitations on mounting positions.

8.1.2 Materials

8.1.2.1 General materials requirements

Subclause 7.1.2.1 of IEC 60947-1:2007 applies.

8.1.2.2 Glow wire testing

Subclause 7.1.2.2 of IEC 60947-1:2007 applies with the following addition.

When tests on the equipment or on sections taken from the equipment are used, parts of insulating materials necessary to retain current-carrying parts in position shall conform to the glow-wire tests of 8.2.1.1.1 of IEC 60947-1:2007 at a test temperature of 850 °C.

8.1.2.3 Test based on flammability category

Subclause 7.1.2.3 of IEC 60947-1:2007 applies.

8.1.3 Current-carrying parts and their connections

Subclause 7.1.3 of IEC 60947-1:2007 applies.

8.1.4 Clearances and creepage distances

Subclause 7.1.4 of IEC 60947-1:2007 applies.

8.2 Performance requirements

8.2.1 Normal conditions of service

Control units shall operate satisfactorily under all the conditions of Clause 7 and the following conditions when used with the appropriate detectors:

– supply voltage between 85 % and 110 % of the rated control supply voltage (U_s);

– frequency of the supply voltage (for a.c. units) 50 Hz or 60 Hz;

– clean air and a relative humidity not exceeding 50 % at a maximum of 40 °C.

NOTE 1 For d.c. units, ripple and form factor should be agreed between the manufacturer and the user.

NOTE 2 Devices intended to be used under conditions of service which are outside the above limits should be the subject of an agreement between the manufacturer and the user.

8.2.2 Abnormal conditions of service

The control unit shall be able to withstand without damage the conditions produced when it is supplied at its rated voltage and also:

– when a short-circuit link is placed across each pair of thermal detector circuit terminals;

– when each pair of thermal detector circuit terminals is open-circuited.

This shall be verified by the test specified in 9.3.3.2.

8.2.3 Dielectric properties

Subclause 7.2.3 of IEC 60947-1 applies.

Unless otherwise specified by the manufacturer, the power frequency dielectric tests for the thermal detector circuit of the control unit shall be based on a rated insulation voltage of 690 V.

8.2.4 Temperature rise

Auxiliary circuits of an equipment including auxiliary switches shall be capable of carrying their conventional thermal current without the temperature rise exceeding the limits specified in Tables 2 and 3 of IEC 60947-1, when tested in accordance with 9.3.3.3.

8.2.5 Conditional short-circuit current

The switching element shall withstand the stresses resulting from short-circuit currents under the conditions specified in 9.3.4.

NOTE The requirements are derived from IEC 60947-5-1. A direct reference to this standard is considered as not sufficient.

8.2.6 Making and breaking capacities for control and auxiliary circuits

The utilization category shall be declared as AC-15 and DC-13 as defined in Annex A of IEC 60947-1 and verified by tests in 9.3.3.5.

8.2.7 Requirements for equipment with protective separation

Annex N of IEC 60947-1 applies.

8.2.8 Operating temperature variation

The operating temperatures of the thermal detector (TNF or TFS as applicable) before and after the tests to verify the rated making and breaking capacities of the switching component under normal and abnormal conditions of use shall meet the requirements according to the requirements of 5.2.3, unless otherwise agreed between the machine manufacturer and the manufacturer of the detector and/or the control unit.

This shall be verified by the test specified in 9.3.3.6.

8.2.9 〚A2〛 Environmental testing

Clause B.2 applies. 〚/A2〛

8.2.10 Shock and vibration

〚A1〛 8.2.10.1 Shock

The control unit shall be tested in accordance with IEC 60068-2-27 with the following parameters.

Three positive and negative shocks shall be applied in each direction along three mutually perpendicular axes, with the device energized and de-energized.

Pulse shape: half-sine

Peak acceleration: 100 m/s^2

Duration of the pulse: 11 ms

8.2.10.2 Vibration

The control unit shall be tested in accordance with IEC 60068-2-6 with the parameters of Table 2, with the device energized and de-energized.

Table 2 – Vibration test parameters

Frequency range	Displacement	Acceleration
$2\ ^{+3}_{-0}$ to 13,2 Hz	±1mm	
13,2 Hz to 100 Hz		±0,7 g

8.2.11 Requirements for short-circuit detection within the sensor circuit

When the control unit operates under 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 tests specified in 9.3.3.12.

a) The control unit shall be switched on, or be able to be reset, when the resistance of the detector circuit is between X Ω and 750 Ω.

b) The control unit shall switch off as the resistance falls, before it reaches 10 Ω.

c) The control unit shall switch on, or be able to be reset, when the resistance of the detector circuit is increased, before it reaches X Ω.

d) There shall be no significant modification in the operation of the control unit when the capacitance of the detector circuit is not greater than 0,2 μF.

The value X shall be provided by the manufacturer of the control unit.

NOTE The resistance value of the PTC may be as low as 20 Ω. 〈A1〉

8.3 Electromagnetic compatibility (EMC)

8.3.1 General

Subclause 7.3.1 of IEC 60947-1 applies.

8.3.2 Immunity

8.3.2.1 Equipment not incorporating electronic circuits

Subclause 7.3.2.1 of IEC 60947-1 applies.

8.3.2.2 Equipment incorporating electronic circuits

Subclause 7.3.2.2 of IEC 60947-1 applies with the following addition.

For the appropriate tests to verify the compliance with these requirements, see 9.4.2.2.

〈A2〉 Performance criteria are based on the acceptance criteria given in Table 24 of IEC 60947-1:2007 and are changed as follows:

Performance criterion A:
On line “Operation of power and control circuits”,
replace:
“No unwanted operation”
by:
“During the tests, the output state of the switching element shall not change.”

Performance criterion B:
On line “Operation of power and control circuits”,
replace:
“Temporary degradation or loss of performance which is self-recoverable”
by:
“During the tests, the output state of the switching element shall not change for more than 1 ms for d.c. devices or one half-wave of supply frequency for a.c. devices.”

Performance criterion C:
On line “Operation of power and control circuits”,
replace:
“Temporary degradation or loss of performance which requires operator intervention or system reset.”
by:
“Temporary degradation or loss of performance which is self recoverable or requires system reset.”

The performance criteria shall be performance criterion A in general, except as follows:

- for electrostatic discharges, for fast transient/burst, for surges and for voltage dips “0 % during 0,5 cycle and 0 % during 1 cycle”, performance criterion B shall be fulfilled;

- for voltage dips “70 % during 25/30 cycles” and for short time interruptions, performance criterion C shall be fulfilled. 〈A2〉

Equipment utilizing electronic circuits, in which all components are passive (for example diodes, resistors, varistors, capacitors, surge suppressors, inductors), is not required to be tested.

8.3.3 Emission

8.3.3.1 Equipment not incorporating electronic circuits

Subclause 7.3.3.1 of IEC 60947-1 applies.

8.3.3.2 Equipment incorporating electronic circuits

8.3.3.2.1 General

If the equipment is only verified for environment A, the following warning shall be given to the user (for example in the instruction manual) stipulating that the use of this equipment in environment B may cause radio interference in which case the user may be required to employ additional mitigation methods.

NOTICE
This product has been designed for environment A. The use of this product in environment B may cause unwanted electromagnetic disturbances in which case the user may be required to take adequate mitigation measures.

8.3.3.2.2 Limits for high-frequency emissions

Equipment incorporating electronic circuits (such as switched mode power supply, circuits incorporating microprocessors with high-frequency clocks) may generate continuous electromagnetic disturbances.

Emissions shall not exceed the limits specified in CISPR 11 for Group 1, Class A.

Products equipped with a telecom port, as defined in CISPR 22, shall comply with the requirements of CISPR 22, for Class A, relative to this particular port.

These tests are only required when the control and/or auxiliary circuits contain components with fundamental switching frequencies greater than 9 kHz.

8.3.3.2.3 Limits for low-frequency emissions

Subclause 7.3.3.2.2 of IEC 60947-1 applies.

9 Tests

9.1 Kinds of tests

9.1.1 General

Subclause 8.1.1 of IEC 60947-1 applies.

9.1.2 Type tests

Type tests are intended to verify compliance of the design of control units with this standard.

They comprise the following verifications:

a) dielectric properties (see 9.3.3.4);

b) operational performance (see 9.3.3.1 and 9.3.3.2);

c) making and breaking capacities (see 9.3.3.5);

d) temperature rise limits (see 9.3.3.3);

e) constructional requirements (see 9.2);

f) short-circuit behaviour (see 9.3.4);

g) EMC (see 9.4).

9.1.3 Routine tests

Subclause 8.1.3 of IEC 60947-1 applies where sampling tests are not made instead.

9.1.4 Sampling tests

Sampling tests for control units comprise dielectric tests.

Subclause 8.1.4 of IEC 60947-1 applies with the following additions.

A manufacturer may use sampling tests instead of routine tests at his own discretion, if engineering and statistical analysis show that routine tests (on each product) are not required.

Sampling shall meet or exceed the following requirements as specified in IEC 60410 (see Table II-A – Single sampling plans for normal inspection):

– sampling based on AQL ≤ 1

– acceptance number Ac = 0 (no defect accepted)

– rejection number Re = 1 (if one defect, the entire lot shall be tested)

Sampling shall be made at regular intervals for each specific lot.

Alternative statistical methods that ensure compliance with the above IEC 60410 requirements can be used, e.g. statistical methods controlling continuous manufacturing or process control with capability index.

9.2 Compliance with constructional requirements

Subclause 8.2 of IEC 60947-1 applies with additional requirements of 8.1.

9.3 Compliance with performance requirements

9.3.1 Test sequences

〈A1〉 9.3.1.1 General

Each test sequence shall be carried out on one sample in a clean and new condition.

It is sufficient to test only one equipment in case of a range of equipment.

More than one test sequence or all test sequences may be conducted on one sample at the request of the manufacturer. However, the tests shall be conducted in the sequence given for each sample.

For control units with auxiliary contacts fulfilling the requirements of IEC 60947-5-1, 9.3.1.3 of the present standard applies.

9.3.1.2 Self-standing control units

The type and sequence of tests to be performed on representative samples are as follows:

a) **Test sequence 1**
   - test no. 1 – temperature rise (see 9.3.3.3)
   - test no. 2 – dielectric properties (see 9.3.3.4)

b) **Test sequence 2**
   - test no. 1 – performance test under normal conditions (see 9.3.3.1)
   - test no. 2 – making and breaking capacity under normal conditions (see 9.3.3.5.2)
   - test no. 3 – dielectric properties (see 9.3.3.4)
   - test no. 4 – verification of the operating temperature variation (see 9.3.3.6)

   NOTE 1 In cases where test sequences 2 and 3 are combined, test nos. 3 and 4 may be carried out only once, at the end of sequence 3.

c) **Test sequence 3**
   - test no. 1 – performance test under abnormal conditions (see 9.3.3.2)
   - test no. 2 – making and breaking capacity under abnormal conditions (see 9.3.3.5.3)
   - test no. 3 – dielectric properties (see 9.3.3.4)
   - test no. 4 – verification of the operating temperature variation (see 9.3.3.6)

   NOTE 2 In cases where test sequences 2 and 3 are combined, test nos. 3 and 4 may be carried out only once, at the end of sequence 3.

d) **Test sequence 4**
   - test no. 1 – performance under conditional short-circuit current (see 9.3.4)
   - test no. 2 – dielectric properties (see 9.3.3.4) 〈A1〉

〈A1〉 e) **Test sequence 5**
   - test no. 1 – verification of switch on and switch off of Mark A control units (see 9.3.3.10)
   - test no. 2 – verification of the rated voltage of the detector circuit of the control unit (see 9.3.3.11)
   - test no. 3 – verification of the short-circuit detection in sensor circuits, where applicable (see 9.3.3.12)

f) **Test sequence 6**
   - test no. 1 – EMC tests (see 9.4)

9.3.1.3 Control units within other devices

The type and sequence of tests to be performed on representative samples of devices already type-tested according to their own standard, for example softstarters, overload relays, etc, and including a thermal protection function shall be as follows:

a) **Test sequence 5**
   - test no. 1 – verification of switch on and switch off of Mark A control units (see 9.3.3.10)
   - test no. 2 – verification of the rated voltage of the detector circuit of the control unit (see 9.3.3.11)
   - test no. 3 – verification of the short-circuit detection in sensor circuits, where applicable (see 9.3.3.12)

b) **Test sequence 6**
   - test no. 1 – EMC tests (see 9.4) 〈A1〉

9.3.2 General test conditions

Subclause 8.3.2 of IEC 60947-1 applies.

9.3.3 Performance

9.3.3.1 Verification of performance with respect to normal conditions of service of control units

Control units shall be tested to verify their performance according to the requirements given in 8.2.1.

Control units shall be tested by the control unit manufacturer to verify the declared detector characteristics, as defined in 5.2.6.

9.3.3.2 Verification of performance with respect to abnormal conditions of service of control units

The tests shall be carried out by the control unit manufacturer.

The abnormal conditions of service specified in 8.2.2 shall be applied, after which the control unit shall be capable of successfully undergoing the test for verification of the making and breaking capacities under abnormal conditions of use, specified in 9.3.3.5.3.

9.3.3.3 Temperature rise

Subclause 8.3.3.3 of IEC 60947-1 applies with the following addition.

All switching elements of the control unit shall be tested. All switching elements that may be simultaneously closed shall be tested together. However, switching elements forming an integral part of an actuating system in such a manner that the elements cannot remain in the closed position are exempt from this test.

NOTE Several temperature rise tests may be necessary if the control circuit device has several positions in which switching elements are in their closed position.

The minimum length of each temporary connection, from terminal to terminal, shall be 1 m.

9.3.3.4 Verification of dielectric properties

Subclause 8.3.3.4 of IEC 60947-1 applies with additional requirements of 8.2.3.

9.3.3.5 Verification of the rated making and breaking capacities

9.3.3.5.1 General

Tests for the verification of the switching capacity shall be performed on the devices which ensure the switching function in the thermal protection system, i.e. control units.

The switching capacity tests are intended to verify that the control unit is capable of making and breaking an operational current at a given operational voltage under normal and abnormal conditions of use specified for its utilization category. The operating temperature (TNF or TFS) is checked before and after these tests to check compliance with the requirements of 8.2.8.

9.3.3.5.2 Making and breaking capacities of switching elements under normal conditions

Subclause 8.3.3.5.2 of IEC 60947-5-1 applies.

9.3.3.5.3 Making and breaking capacities of switching elements under abnormal conditions

Subclause 8.3.3.5.3 of IEC 60947-5-1 applies.

9.3.3.6 Verification of the operating temperature variation

This test shall be carried out after the detector, or the control unit with its detector connected, has been checked for its ability to withstand the making and breaking tests under normal and abnormal conditions of use specified in 9.3.3.5 followed by the dielectric withstand test specified in 9.3.3.4.

If the components satisfactorily complete these tests, the operating temperature shall be checked in a similar manner to the check before the switching performance tests, i.e. either TNF as in IEC 60738-1 or TFS as 9.3.3.7.

The final operating temperature so measured shall be compared with the initial values, and the difference shall not exceed the limits given in 9.3.3.8.

9.3.3.7 Verification of rated system operating temperature (TFS)

The tests for the verification of system operating temperature shall be made on control systems with a declared value of system operating temperature, as specified in 5.2.3. The tests shall be made either by the detector manufacturer or by the manufacturer of the control unit, as agreed between the two manufacturers. The system to be tested consists of a detector, or detectors, connected to a control unit which has previously been set, if this is necessary. The control system that is tested shall be representative of the system supplied for service.

The control unit shall be supplied at the normal specified conditions and the output signal circuit shall be monitored in such a manner that the current flowing across the switching device of the control unit is equal to the rated operational current.

The detector shall be tested by one of the methods specified in IEC 60738-1 and the temperature shall be raised until the control unit operates the signal circuit. The temperature as measured by the thermocouple shall be taken as the value of TFS and shall comply with the requirements of 5.2.3.

9.3.3.8 Verification of reset temperature

A test for verification of the declared reset temperature shall be carried out either by the detector manufacturer or by the manufacturer of the control unit, as agreed between the two manufacturers.

For a detector with a declared value of TNF, the reset temperature test shall be carried out as specified in IEC 60738-1 except that the temperature shall be allowed to fall at a rate not exceeding 0,5 K/min until the detector reaches its operating point.

For a control system with a declared value of TFS, the reset temperature test shall be carried out as specified in 9.3.3.7 except that the temperature shall be allowed to fall at a rate not exceeding 0,5 K/min until the control unit operates the signal circuit.

The value of the reset temperature shall comply with the value including its tolerances declared in accordance with 5.2.5.

9.3.3.9 Tests for equipment with protective separation

Annex N of IEC 60947-1 applies.

9.3.3.10 Verification of switch on and switch off of Mark A control units

Operation of the control unit switch on and switch off, for the values of resistance specified in 5.2.6, shall be verified as follows.

The control unit shall be energized under the most unfavourable combinations of the normal conditions of service specified in 8.2.1.

When a variable resistance is inserted between each pair of terminals intended for the connection of the thermistor detectors, the following conditions shall be met:

a) For any resistance value of 750 Ω or less, the control unit shall be switched on, or be able to be reset. Compliance with this condition shall be checked by testing with a variable resistance set to this value. In case of doubt, this check shall also be carried out at a lower value of resistance.

b) When the resistance value is increased (at a uniform rate of approximately 250 Ω/s), the control unit shall switch off when the resistance value is in the range of 1 650 Ω to 4 000 Ω.

c) The control unit shall be left in tripped condition for 1 min; after which the resistance value shall be lowered at a uniform rate of no more than 250 Ω/s; the control unit shall switch on, or be able to be reset, when the resistance value is in the range of 1 650 Ω to 750 Ω.

The test specified under items b) and c) shall be repeated after a capacitor having a value of 0,2 μF has been connected across the terminals intended for the connection of the detectors; the resistance value at which the control unit switches off shall not differ by more than 5 % from the value reached during the preceding test.

9.3.3.11 Verification of the rated voltage of the detector circuit of the control unit

Control units shall be tested by the control unit manufacturer to verify the declared rated voltage of the detector circuit, as defined in 5.5.

A1 9.3.3.12 Verification of the short-circuit detection within the sensor circuit

Operation of the control unit switch on and switch off, for the values of resistance specified in 8.2.11 shall be verified as follows.

The control unit shall be energized under the most unfavourable combinations of the normal conditions of service specified in 8.2.1.

When a variable resistance is inserted between each pair of terminals intended for the connection of the thermistor detectors, the following conditions shall be met.

a) The variable resistance shall be increased up to the value where the control unit is able to switch on or to be reset. This value shall be equal to or less than X Ω.

b) The control unit shall switch off when the variable resistance is reduced, before it reaches 10 Ω.

c) The control unit shall be left in tripped position for 1 min, after which the control unit shall switch on, or be able to be reset, when the resistance is increased to a value within the range 10 Ω to X Ω.

d) The tests specified under items b) and c) shall be repeated after a capacitor having a value of 0,2 μF has been connected across the terminals intended for the connection of detectors; the resistance value at which the control unit switches off, shall not differ by more than 10 % from the value reached during the preceding test.

The value X shall be provided by the manufacturer of the control unit. A1

[A1] 9.3.3.13 Verification of the shock and vibration requirements

9.3.3.13.1 General

A control unit shall be tested according to the requirements of 8.2.10.

9.3.3.13.2 Shock

After the shock test, the operating characteristics, according to the product standard, shall not have been changed. There shall be no mechanical damage.

9.3.3.13.3 Vibration

The control units shall be tested in accordance with IEC 60068-2-6 with the following test parameters:

- duration in case of no resonance condition: 90 min at 30 Hz;
- duration at each resonance frequency at which Q (amplification factor) is ≥ 2 is recorded: 90 min;
- during the vibration test, operational conditions shall be demonstrated (see 9.3.3.1);
- tests shall be carried out in three mutually perpendicular axes;
- if sweep test is chosen, in the case where several resonance frequencies are detected close to each other, the duration of test shall be 120 min.

Results to be obtained: during the vibration test, an unintended opening or closing of the contacts for more than 3 ms is not accepted, unless the manufacturer states longer values in its documents or catalogue. If for any reason, the opening or closing time is longer than 3 ms, the manufacturer shall state these other values in its instruction documents.

NOTE An unintended opening and closing time of more than 3 ms (bouncing) may cause problems in some applications (e.g. PLC-monitoring with high speed inputs), therefore adequate measures may be necessary. [A1]

9.3.4 Performance under conditional short-circuit current

9.3.4.1 General conditions for short-circuit tests

Subclause 8.3.4.1 of IEC 60947-5-1 applies.

9.3.4.2 Test procedure

Subclause 8.3.4.2 of IEC 60947-5-1 applies.

9.3.4.3 Test circuit and test quantities

Subclause 8.3.4.3 of IEC 60947-5-1 applies.

9.3.4.4 Condition of the switching element after the test

Subclause 8.3.4.4 of IEC 60947-5-1 applies.

9.4 EMC tests

9.4.1 General

Emission and immunity tests are type tests and shall be carried out under representative conditions, both operational and environmental, using the manufacturer's instructions for installation.

The tests shall be carried out in accordance with the reference EMC standard.

9.4.2 Immunity

9.4.2.1 Equipment not incorporating electronic circuits

No tests are necessary.

9.4.2.2 Equipment incorporating electronic circuits

Tests shall be made according to the values given in Table 1.

Table 1 – Tests for EMC – Immunity

Type of test	Test level required
Electrostatic discharge immunity test IEC 61000-4-2	8 kV / air discharge or 4 kV / contact discharge
Radiated radio-frequency electromagnetic field immunity test 80 MHz to 1 GHz IEC 61000-4-3	10 V/m [d]
Radiated radio-frequency electromagnetic field immunity test 1 GHz to 2 GHz IEC 61000-4-3	3 V/m
Radiated radio-frequency electromagnetic field immunity test 2 GHz to 2,7 GHz IEC 61000-4-3	1 V/m
Electrical fast transient/burst immunity test IEC 61000-4-4	2 kV on power ports [a] 1 kV on signal ports [b]
1,2/50 µs – 8/20 µs surge immunity test IEC 61000-4-5 [c]	2 kV (line to earth) 1 kV (line to line)
Conducted radio-frequency immunity test (150 kHz to 80 MHz) IEC 61000-4-6	10 V
Power-frequency magnetic field immunity test IEC 61000-4-8 [f]	30 A/m
Voltage dips immunity test IEC 61000-4-11	Class 2 [g, h] 0 % during 0,5 cycle and 0 % during 1 cycle 70 % during 25/30 cycles
Voltage interruptions immunity test IEC 61000-4-11	Class 2 [g, h] 0 % during 250/300 cycles
Immunity to harmonics in the supply IEC 61000-4-13	No requirements [e]

[a] Power port: the point at which a conductor or cable carrying the primary electrical power needed for the operation of an equipment or associated equipment is connected.

[b] Signal port: the point at which a conductor or cable carrying information for transferring data or signals is connected to the equipment.

[c] Not applicable for ports with a rated voltage of 24 V d.c. or less.

[d] Except for the ITU broadcast frequency bands 87 MHz to 108 MHz, 174 MHz to 230 MHz and 470 MHz to 790 MHz, where the level shall be 3 V/m.

[e] Future requirements are under study.

[f] Applicable only to equipment containing devices sensitive to power frequency magnetic fields.

[g] The given percentage means percentage of the rated operational voltage, e.g. 0 % means 0 V.

[h] The value in front of the slash mark (/) is for 50 Hz and the value behind is for 60 Hz tests.

9.4.3 Emission

9.4.3.1 Equipment not incorporating electronic circuits

No tests are necessary.

9.4.3.2 Equipment incorporating electronic circuits

This test shall be performed according to CISPR 11, Group 1, Class A and 8.3.3.2.

9.5 Routine and sampling tests

9.5.1 General

Routine tests are tests to which each individual control unit is subjected, during or after manufacture, to verify that it complies with the stated requirements.

Routine or sampling tests shall be carried out under the same, or equivalent conditions to those specified for type tests. However, the limits of operation may be verified at the prevailing ambient air temperature, but a correction may be necessary to allow the normal ambient conditions.

9.5.2 Operating tests on control units

Tests shall be made by the control unit manufacturer to ensure the correct operation of the control unit, at certain limits of input signal from the detector circuit. These limits of input signal shall be such as to ensure the operation of the detector plus control unit within the operating temperature limits specified in 9.3.3.6; these limits of signal input shall be agreed between the control unit manufacturer and the detector manufacturer.

The tests may be made at any convenient voltage.

9.5.3 Dielectric tests

The metal foil shall not be applied. The tests shall be conducted on dry and clean control units.

Verification of dielectric withstand may be performed before final assembly of the device (that is, before connecting sensitive devices such as filter capacitors).

1) **Impulse withstand voltage**

   Subclause 8.3.3.4.2, item 1), of IEC 60947-1 applies.

2) **Power-frequency withstand voltage**

   Subclause 8.3.3.4.2, item 2), of IEC 60947-1 applies.

3) **Combined impulse voltage and power-frequency withstand voltage**

   The tests of items 1) and 2) above may be replaced by a single power-frequency withstand test where the peak value of the sinusoidal wave corresponds to the value stated in items 1) or 2), whichever is higher.

NOTE It is important that care should be taken when carrying out dielectric tests on control units containing semiconductor devices to ensure that such devices are not damaged during the tests.

9.5.4 Routine verification of switch on and switch off of Mark A control units

For Mark A control units, the following additional test shall be carried out by the control unit manufacturer.

The test shall be carried out under the conditions of 9.5.1, except that the control unit shall be at room temperature and shall be energized with the rated control supply voltage. The test may be carried out at the two limiting values of resistance, 750 Ω and 4 000 Ω, i.e. without continuous variation of resistance.

Annex A
(normative)

Thermal detectors used in thermal protection systems

A.1 Characteristics of association of Mark A detectors

In order to ensure that the operating temperatures (TFS and reset) of the detectors associated with their control units are in accordance with this standard, the detectors shall comply with the following requirements.

Resistance-temperature characteristics of Mark A detectors

The resistance of each detector, taken individually, shall meet the following conditions for the temperatures indicated, referred to the rated operating temperature (TNF). Compliance shall be verified by the test specified in A.2 (see Figure A.1).

a) ≤550 Ω at a temperature of TNF – 5 K, for all the values of the measuring voltage less than or equal to 2,5 V (direct voltage);

b) ≥1 330 Ω at a temperature of TNF + 5 K, for all the values of the measuring voltage less than or equal to 2,5 V (direct voltage);

c) ≥4 000 Ω at a temperature of TNF + 15 K, for all the values of the measuring voltage less than or equal to 7,5 V (direct voltage);

d) ≤250 Ω at any temperature lying between –20 °C and TNF – 20 K, for all the values of the measuring voltage less than or equal to 2,5 V (direct voltage).

The preferred installation is three detectors connected in series. When provision is made for connecting more than three detectors, the maximum resistance value of each detector shall be such that the total resistance of the circuit of detectors connected in series does not exceed 750 Ω, at any temperature lying between –20 °C and TNF – 20 K.

NOTE 1 The exact resistance values in the range –20 °C to TNF – 20 K are not important, but it should be noted that the lowest values of the resistance of detectors in a serviceable operating condition are generally more than 20 Ω.

NOTE 2 In the case of temperatures below –20 °C, the resistance value may be greater than 250 Ω.

NOTE 3 The resistance values above, and consequently the operating tolerances, are valid for values of applied voltage less than or equal to 2,5 V except at the point TNF + 15 K for which the applied voltage may reach 7,5 V. If these values of applied voltage are exceeded then the performance of the detector together with its control unit may not meet the normal operating tolerances.

A.2 Verification of interchangeability characteristics

A.2.1 Type tests on Mark A detectors

The appropriate tests shall be carried out by the detector manufacturer, together with the following test.

Verification of the resistance-temperature characteristic

The detector resistance-temperature characteristic shall be verified under suitable conditions, by the measurement of its resistance for the five points of temperature defined in Clause A.1 (–20 °C, TNF – 20 K, TNF – 5 K, TNF + 5 K , TNF + 15 K).

The voltage applied to the detector shall be a direct voltage of 2,5 V except for the point at TNF + 15 K where the applied voltage shall be 7,5 V.

The measured resistance shall be in accordance with the requirements of Clause A.1.

A.2.2 Routine tests on Mark A detectors

Routine tests shall be carried out as specified in 9.5.

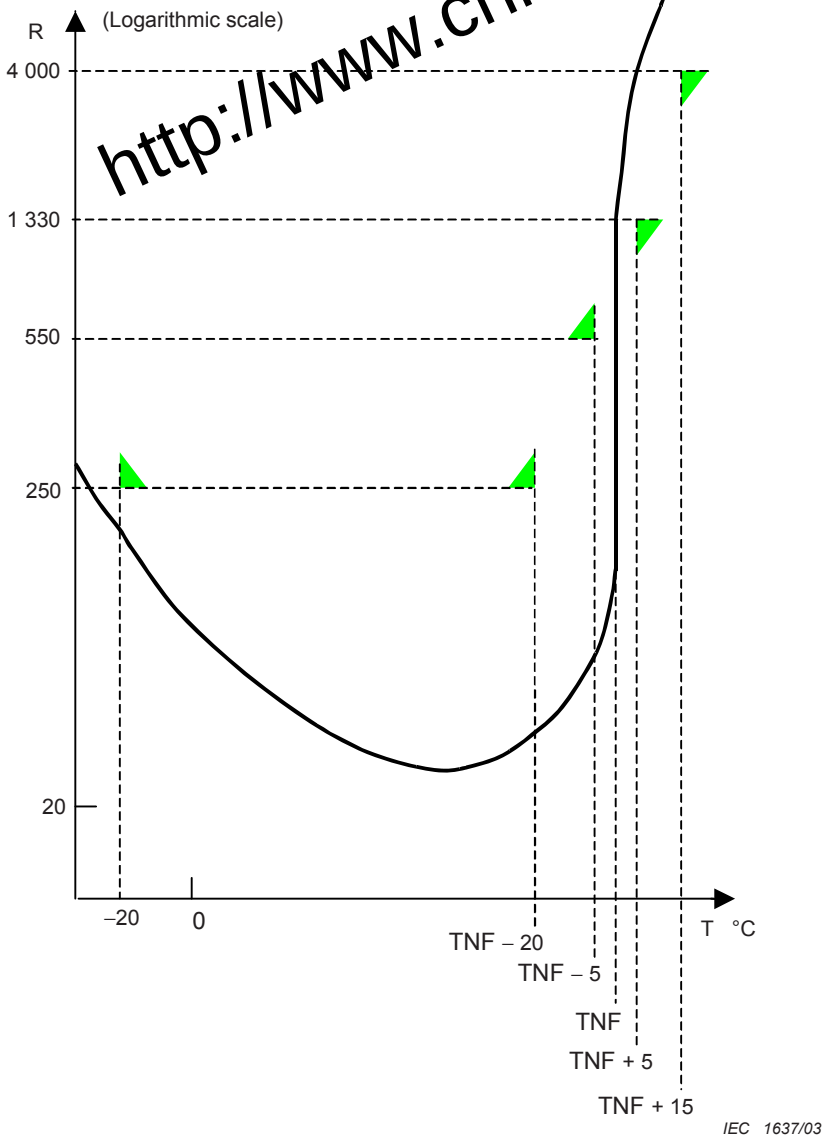

Figure A.1 – Characteristic curve of a typical Mark A detector

Annex B
(normative)

Special tests

[A1] B.1 Dynamic wire break detection

Under consideration. [A1]

B.2 [A2] Special tests – Damp heat, salt mist, vibration and shock

For these special tests, Annex Q of IEC 60947-1:2007 applies with the following additions.

Where Table Q.1 of IEC 60947-1:2007 calls for verification of operational capability, this shall be made by carrying out the “Verification of switch on and switch off of Mark A control units”.

The test is done while a variable resistance is inserted between each pair of terminals intended for the connection of the thermistor detectors. The following conditions a) to c) shall be met.

a) For any resistance value of 750 Ω or less, the control unit shall be switched on, or shall be able to be reset. Compliance with this condition shall be checked by testing with a variable resistance set to this value. In case of doubt, this check shall also be carried out at a lower value of resistance.

b) When the resistance value is increased (at a uniform rate of approximately 250 Ω/s), the control unit shall switch off when the resistance value is in the range of 1650 Ω to 4000 Ω.

c) The control unit shall be left in tripped condition for 1 min; after which the resistance value shall be lowered at a uniform rate of no more than 250 Ω/s; the control unit shall switch on, or shall be able to be reset, when the resistance value is in the range of 1650 Ω to 750 Ω.

The vibration tests shall be done on the equipment in the ‘ON’ and ‘OFF’ positions.

The control unit shall not trip during the test. To check the auxiliary contacts, tests can be done under any current / voltage value.

The shock test on the equipment shall be done in the ‘OFF’ position.

For the dry heat test Bd, damp heat test and low temperature test Ab or Ad as appropriate according to IEC 60068-2-1, the equipment shall not trip during the conditioning period. Functional tests from a) to c) shall be done.

Functional test for dry heat and low temperature tests shall be done during the last hour at the test temperature.

For low temperature tests, the equipment shall not be energized during conditioning and testing, except for functional tests.

For dry heat tests, the equipment shall be energized during conditioning and testing and for functional tests.

With the agreement of the manufacturer, the duration of the recovery periods may be reduced.

After the salt mist test the product may be washed where agreed by the manufacturer [A2]

〖A1〗 *Annex C deleted* 〖A1〗

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60034-11	2004	Rotating electrical machines - Part 11: Thermal protection	EN 60034-11	2004
IEC 60068-2-1	-	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-6 + corr. March	1995 1995	Environmental testing - Part 2: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6[1)]	1995
IEC 60068-2-27	1987	Basic environmental testing procedures - Part 2: Tests - Test Ea and guidance: Shock	EN 60068-2-27[2)]	1993
IEC 60410	1973	Sampling plans and procedures for inspection by attributes	-	-
IEC 60738-1	1998	Thermistors - Directly heated positive step-function temperature coefficient - Part 1: Generic specification	EN 60738-1[3)]	1999
IEC 60751 + A1 + A2	1983 1986 1995	Industrial platinum resistance thermometer sensors	EN 60751[4) 5)] - + A2	1995 - 1995
IEC 60947-1	2007	Low-voltage switchgear and controlgear - Part 1: General rules	EN 60947-1	2007
IEC 60947-5-1	2003	Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices	EN 60947-5-1 + corr. July	2004 2005
IEC 61000-4-2	2008	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	2009
IEC 61000-4-3 + A1 + A2	2006 2007 2010	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3 + A1 + A2	2006 2008 2010

[1)] EN 60068-2-6 is superseded by EN 60068-2-6:2008, which is based on IEC 60068-2-6:2007.

[2)] EN 60068-2-27 is superseded by EN 60068-2-27:2009, which is based on IEC 60068-2-27:2008.

[3)] EN 60738-1 is superseded by EN 60738-1:2006, which is based on IEC 60738-1:2006.

[4)] EN 60751 includes A1 to IEC 60751.

[5)] EN 60751 is superseded by EN 60751:2008, which is based on IEC 60751:2008.

Publication	Year	Title	EN/HD	Year
IEC 61000-4-4 + A1	2004 2010	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4 + A1	2004 2010
IEC 61000-4-5 + corr. October	2005 2009	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	2006
IEC 61000-4-6	2008	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	2009
IEC 61000-4-8	2009	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	EN 61000-4-8	2010
IEC 61000-4-11	2004	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	EN 61000-4-11	2004
IEC 61000-4-13 + A1	2002 2009	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	EN 61000-4-13 + A1	2002 2009
IEC 60417	Data-base	Graphical symbols for use on equipment	-	-
CISPR 11 (mod) + A1	2009 2010	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement	EN 55011 + A1	2009 2010
CISPR 22 (mod)	2008	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	EN 55022	2010

Annex ZZ
(informative)

Coverage of Essential Requirements of EU Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Article 1 of Annex I of the Directive 2004/108/EC.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directives concerned.

WARNING - Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

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