IEC 60730-2-9

Edition 4.2 2020-04
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

colour inside

Automatic electrical controls –
Part 2-9: Particular requirements for temperature sensing controls

IEC 60730-2-9:2015-05+AMD1:2018-01+AMD2:2020-04 CSV(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 97.120

ISBN 978-2-8322-8156-7

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IEC 60730-2-9

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REDLINE VERSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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AUTOMATIC ELECTRICAL CONTROLS –

Part 2-9: Particular requirements for temperature sensing controls

FOREWORD

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This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 60730-2-9 edition 4.2 contains the fourth edition (2015-05) [documents 72/990/FDIS and 72/998/RVD], its amendment 1 (2018-01) [documents 72/1112A/FDIS and 72/1118/RVD] and its amendment 2 (2020-04) [documents 72/1225/FDIS and 72/1236/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 60730-2-9 has been prepared by technical committee TC 72: Automatic electrical controls.

This fourth edition constitutes a technical revision.

This edition includes alignment with the text of 60730-1 fifth edition and the following significant technical changes with respect to the previous edition:

a) modification of heating-freezing tests in Clause 12;
b) alignment of the EMC requirements in H.26 to those in other part 2 standards;
c) addition of requirements in Clause H.27 to cover class B and C control functions of temperature sensing controls;

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

This Part 2-9 is intended to be used in conjunction with IEC 60730-1. It was established on the basis of the fifth edition (2013) of that publication. Consideration may be given to future editions of, or amendments to, IEC 60730-1.

This Part 2-9 supplements or modifies the corresponding clauses in IEC 60730-1 so as to convert that publication into the IEC standard: Particular requirements for temperature sensing controls.

Where this Part 2-9 states "addition", "modification", or "replacement", the relevant requirement, test specification or explanatory matter in part 1 should be adapted accordingly.

Where no change is necessary, this part 2 indicates that the relevant clause or subclause applies.

In the development of a fully international standard, it has been necessary to take into consideration the differing requirements resulting from practical experience in various parts of the world and to recognize the variation in national electrical systems and wiring rules.

The “in some countries” notes regarding differing national practices are contained in the following subclauses:

4.1.101	17.8.4.101	Annex AA
7.2, Table 1	17.16.101	Clause CC.2
11.4.101	17.16.102	DD.9.2
11.101	17.16.105	EE.3.6
12.101.3	18.102.3	
13.2	23.101	

In this publication:

1) The following print types are used:
   – Requirements proper: in roman type;
   – *Test specifications: in italic type;*
   – Notes; in small roman type;
   – Words defined in Clause 2: **bold**.
2) Subclauses, notes, tables and figures which are additional to those in part 1 are numbered starting from 101, additional annexes are lettered AA, BB, etc.

A list of all parts of the IEC 60730 series, published under the title *Automatic electrical controls* can be found on the IEC website.

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.

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AUTOMATIC ELECTRICAL CONTROLS –

Part 2-9: Particular requirements for temperature sensing controls

1 Scope and normative references

This clause of Part 1 is applicable except as follows:

1.1 Scope

Replacement:

This part of IEC 60730 applies to automatic electrical temperature **sensing controls** for use in, on or in association with equipment, including **electrical controls** for heating, air-conditioning and similar applications. The equipment may use electricity, gas, oil, solid fuel, solar thermal energy, etc., or a combination thereof.

NOTE Throughout this standard, the word "equipment" includes "appliance" and "control system".

This standard is applicable to automatic electrical temperature **sensing controls** forming part of a building automation **control system** within the scope of ISO 16484.

This standard also applies to automatic electrical temperature **sensing controls** for equipment that may be used by the public, such as equipment intended to be used in shops, offices, hospitals, farms and commercial and industrial applications.

This standard does not apply to automatic electrical temperature **sensing controls** intended exclusively for industrial process applications, unless explicitly mentioned in the relevant equipment standard.

1.1.1

Replacement:

This standard applies to the inherent safety, to the **operating values**, **operating times**, and **operating sequences** where such are associated with equipment safety, and to the testing of automatic electrical temperature **sensing control** devices used in, or in association with, equipment.

NOTE Examples of such **controls** include **boiler thermostats**, **fan controls**, **temperature limiters** and **thermal cut-outs**.

This standard is also applicable to the functional safety of low complexity safety-related temperature **sensing controls** and **systems**.

1.1.2

Addition:

This standard also applies to the electrical safety of temperature sensing controls with non-electrical outputs such as refrigerant flow and gas **controls**.

1.1.3 Not applicable.

1.1.4

Replacement:

This standard applies to **manual controls** when such are electrically and/or mechanically integral with automatic temperature **sensing controls**.

NOTE Requirements for manual switches not forming part of an **automatic control** are contained in IEC 61058-1.

1.1.5

Replacement:

This standard applies to a.c. or d.c. powered temperature **sensing controls** with a rated voltage not exceeding 690 V a.c. or 600 V d.c.

1.1.6

Replacement:

This standard does not take into account the **response value** of an **automatic action** of a temperature **sensing control**, if such a **response value** is dependent upon the method of mounting it in the equipment. Where a **response value** is of significant purpose for the protection of the **user**, or surroundings, the value defined in the appropriate equipment standard or as determined by the manufacturer shall apply.

1.1.7

Replacement:

This standard applies also to temperature **sensing controls** incorporating **electronic devices**, requirements for which are contained in Annex H and to temperature **sensing controls** using **NTC thermistors** or **PTC thermistors**, requirements for which are contained in Annex J.

Additional subclause:

1.1.101 This standard applies to **single operation devices** as defined in this standard.

1.1 Normative references

Addition:

IEC 60216-1:2013, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60691, *Thermal links – Requirements and application guide*

IEC 60730-2-4, *Automatic electrical controls for household and similar use – Part 2-4: Particular requirements for thermal motor protectors for motor-compressors of hermetic and semi-hermetic type*

2 Terms and definitions

This clause of Part 1 is applicable except as follows:

2.2 Definitions of types of control according to purpose

2.2.19
operating control

Add, to the definition, the following note:

Note 1 to entry: In general, a **thermostat** is an **operating control**.

2.2.20
protective control

Add, to the definition, the following note:

Note 1 to entry: In general, a **thermal cut-out** is a **protective control**.

Additional definitions:

2.2.101
single-operation device
SOD
control having a temperature **sensing element** which is intended to operate only once and then requires complete replacement

2.2.101.1
bimetallic single-operation device
single operation device (**SOD**) having a bimetallic temperature **sensing element**

Note 1 to entry: A **bimetallic single operation device** (**SOD**) does not reset above a declared temperature (see 11.4.103).

Note 2 to entry: Requirements for thermal links (which are not allowed to reset) are contained in IEC 60691.

2.2.101.2
non-bimetallic single-operation device
single operation device (**SOD**) having a temperature **sensing element** which is part of a combination action **control**, the **operation** of which cannot be separated from other functions of the **control** and having a non-bimetallic thermal element that operates only once and then requires complete or partial replacement

Note 1 to entry: When such parts can be tested separately, they are considered to be thermal links within the scope of IEC 60691.

Note 2 to entry: The ageing period and thermal response of the device is dependent on the intended use of the device. As a result, the nature of the testing applicable to the device is representative of the application conditions for which the **protective control** is intended (see 7.2).

Note 3 to entry: **Non-bimetallic SODs** provide the equivalent of **micro-disconnection**.

2.2.101.2.1
rated functioning temperature
T_r
temperature of the **sensing element** of a **non-bimetallic SOD** which causes it to change the state of conductivity of the **control** when measured under specified conditions as declared by the manufacturer

2.2.102
room thermostat
independently mounted or incorporated **thermostat** intended to control the temperature of habitable space

2.2.103
fan control
automatic temperature **sensing control** intended to control the **operation** of a fan or blower

2.2.104
boiler thermostat
thermostat intended to control boiler/liquid temperature

2.2.105
modulating thermostat
thermostat which controls the temperature between two limits by continuously controlling the input to the load

2.2.106
voltage maintained thermal cut-out
thermal cut-out which is maintained in its operated condition by the voltage which appears across it in that condition

2.2.107
agricultural thermostat
thermostat intended for use in agricultural confinement buildings

2.3 Definitions relating to the function of controls

2.3.14 *Additional definition:*

2.3.14.101
time factor
transient response of temperature **sensing controls** by defined change of the **activating quantity**

2.5 Definitions of types of control according to construction

Additional definitions:

2.5.101
push-and-turn actuation
two-step actuation accomplished by first pushing, then rotating the **actuating member** of the control

2.5.102
pull-and-turn actuation
two-step actuation accomplished by first pulling, then rotating the **actuating member** of the control

3 General requirements

This clause of Part 1 is applicable.

4 General notes on tests

4.1 Conditions of test

This clause of Part 1 is applicable except as follows:

4.1 Conditions of test

Additional subclauses:

4.1.101 For the purposes of the tests of this standard and unless otherwise indicated, ambient temperature excursions beyond T_{max} during abnormal **operation** as a precursor to the **operation** of a manual reset **thermal cut-out** or a **bimetallic SOD** are ignored.

NOTE In Canada and the USA, the preceding applies only to **bimetallic SODs**.

4.1.102 For manual reset **thermal cut-outs** and **bimetallic SODs** which have an **operating value** above T_{max}, the temperature at the **sensing element** is raised, as necessary, to achieve any cycling required during the tests.

4.2 amples required

4.2.1 *Addition:*

Six samples of **bimetallic SODs** are used for the test of Clause 15 and a further six for the test of Clause 17.

5 Rating

This clause of Part 1 is applicable.

6 Classification

This clause of Part 1 is applicable except as follows:

6.4 According to features of automatic action

6.4.3 *Additional subclauses:*

6.4.3.101 – for sensing actions, no increase in the **operating value** as a result of any leakage from the **sensing element**, or from parts connecting the **sensing element** to the **switch head** (type 2.N);

6.4.3.102 – an action which operates after a declared thermal cycling test as specified in 17.101 (type 2.P);

NOTE In general, **thermal cut-outs** for specific applications, such as pressurized water heating systems, may be classified as having Type 2.P action.

6.4.3.103 – an action which is initiated only after a **push-and-turn actuation** or **pull-and-turn actuation** and in which only rotation is required to return the **actuating member** to the **OFF position** or rest position (type 1.X or 2.X);

6.4.3.104 – an action which is initiated only after a **push-and-turn actuation** or **pull-and-turn actuation** (type 1.Z or 2.Z);

6.4.3.105 – an action which cannot be reset under electrically loaded conditions (type 1.AK or 2.AK);

6.4.3.106 – an action which operates after declared agricultural environmental exposures (type 1.AM or 2.AM).

6.7 According to ambient temperature limits of the switch head

Additional subclauses:

6.7.101 **Controls** for use in or on cooking appliances.

6.7.102 **Controls** for use in or on ovens of the self-cleaning type.

6.7.103 **Controls** for use in or on food-handling appliances.

6.7.104 The **non-bimetallic SODs** are limited for use in appliances for heating or employing liquids or steam. It is not suitable for instantaneous water heaters and storage water heaters.

6.8.3 *Modification:*

Replace the first paragraph by:

For an **in-line cord control**, a free standing control, an **independently mounted control** or a **control** integrated or incorporated in an assembly utilizing a non-electrical energy source:

6.15 According to construction

Additional subclause:

6.15.101 – **controls** having parts containing liquid metal.

7 Information

This clause of Part 1 is applicable except as follows:

7.2 Methods of providing information

Table 1 – Required information and methods of providing information

Addition:

	Information	Clause or subclause	Method
101	Maximum **sensing element** temperature (other than relevant to requirement 105) [101]	6.7 6.15 14.101	X
102	**Time factor** with or without sheath	2.3.14.101 11.101 BB.1.2	X
103	**SOD** reset temperature (either –35 °C or 0 °C)	2.2.101 11.4.103 17.15.2.3	X
104	Number of cycles for **bimetallic SOD** with 0 °C reset	17.15.1.3.1	X
105	Maximum **sensing element** temperature for the test of 17.16.107 (T_e)	6.7.102 17.16.107	D
106	**Controls** having parts containing liquid metal [102]	6.15.101 11.1.101 18.102	D
107	Tensile yield strength	11.1.101	X
108	Minimum current for the purpose of the test of 23.101 [103]	23.101	D
109	$T_{max.1}$ is the maximum ambient temperature in which the **control** may remain continuously in the operated condition so that Table 13 temperatures are not exceeded [105]	14.4.3.1	D
110	Time period t_1 is the maximum time during which the ambient temperature can be higher than $T_{max.1}$ after the **control** has operated [105]	14.4.3.1	D
111	Temperature limit above which automatic reset of a manual reset thermal cut-out or a **voltage maintained thermal cut-out** shall not occur (not higher than –20 °C)	2.2.106 11.4.106 17.16.104.1 17.16.108	X
112	For type 2.P **controls**, the method of test	17.101	X
113	The click rate *N* or switching **operations** per minute for the purposes of testing to CISPR 14-1	23	X
114	**Rated functioning temperature** (T_f)	2.2.101.2.1 17.15.2	C
115	Ageing temperature for **non-bimetallic SOD** [106]	17.15.2.2 17.15.2.3	D
116	Rate of rise of temperature for testing **non-bimetallic SOD** [107]	17.15.2.2 17.15.2.3	D
117	**Agricultural thermostat**	2.2.107 6.4.3.106 11.4.107 11.6.3.101 Annex DD	D

Additional footnotes:

101 This declaration applies only to temperature **sensing controls** containing liquid metal. For temperature **sensing controls** used in or on self-cleaning ovens, this declaration is the temperature for the cooking **operation**.

102 In China, the use of liquid metal in or on cooking or food -handling equipment is not allowed.

~~In Germany, **controls** using liquid metal are allowed only with a special marking on the control. Documentation (D) shall contain a clear warning of the actual danger that may occur. The following symbol shall be used for marking the control: ⚠ !~~

In Canada, ~~the use~~ parts of controls containing mercury is not allowed.

103 When no minimum is declared, the test value is 15 mA.

105 Consideration should be given to the provision of information by the **equipment manufacturer** relating to the minimum time that the appliance has to be disconnected from the supply to allow a **voltage maintained thermal cut-out** to reset.

106 Determined by the **control manufacturer** based on the opening temperature of the **thermal-cut-out**.

107 Determined by the **control manufacturer** referring to the actual maximum rate of rise probable in the projected end-use equipment.

8 Protection against electric shock

This clause of Part 1 is applicable.

9 Provision for protective earthing

This clause of Part 1 is applicable.

10 Terminals and terminations

This clause of Part 1 is applicable.

11 Constructional requirements

This clause of Part 1 is applicable except as follows:

11.1 Materials

Additional subclauses:

11.1.101 Parts containing liquid metal

For **controls** declared under Table 1, requirement 106, parts that contain mercury (Hg), and parts of any **control** that contain sodium (Na), potassium (K), or both, shall be constructed of metal that has a tensile yield strength at least four times the circumferential (hoop) or other stress on the parts at a temperature 1,2 times the **maximum temperature** of the **sensing element** (T_e).

Compliance is checked by inspection of the manufacturer's declaration and by the test of 18.102.

11.1.102 Material for non-bimetallic SODs

Insulating material used in **non-bimetallic SODs** as defined in this standard shall comply with the requirements of IEC 60216-1:2013 and be suitable for the application.

11.3 Actuation and operation

11.3.9 Pull-cord actuated control

Addition:

NOTE 101 Note 2 is not applicable to **controls** classified as type 1.X or 2.X or type 1.Z or 2.Z.

11.4 Actions

11.4.3 Type 2 action

Additional subclauses:

11.4.3.101 Capacitors shall not be connected across the contacts of a **thermal cut-out**.

11.4.3.102 Constructions requiring a soldering **operation** to reset **thermal cut-outs** are not permitted.

11.4.11 Type 1.H or 2.H action

Additional subclauses:

11.4.11.101 For this test, the reset mechanism of the **control** will be held in the reset position for the duration of the test from 11.4.11.102 to 11.4.11.104. The verification of the automatic non-resetting above –35 °C will be carried out by 11.4.11.105 to 11.4.11.106. For **SOD**, the verification of the automatic non-resetting above either +0 °C or –35 °C will be carried out by 11.4.11.105 to 11.4.11.106, as declared in item 103 of Table 1.

11.4.11.102 *With the reset mechanism held in the reset position at room temperature, continuity across contacts is observed by a low-energy circuit, 0,05 A maximum.*

11.4.11.103 *The **control**'s **sensing element** is then installed in an air circulating chamber or an oil bath and the **control**'s **switch head** is installed as in 14.5.1. When the whole **control** is declared as the **sensing element**, the whole **control** is placed in an air-circulating chamber. The **control** or the **control**'s **sensing element** is adjusted for the maximum set point temperature. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or oil bath temperature is then raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.11.104 *After the **control** has operated and with the reset mechanism still held in the reset position, the temperature of the chamber or oil bath is then reduced to determine if the **control** automatically resets. Verification of contact closure is done by applying the method in 11.4.11.102.*

11.4.11.105 *The whole **control** or the **control**'s **sensing element** is then installed in an air circulating chamber or oil bath again and the **control**'s **switch head** (if applicable) is installed as in 14.5.1 with the reset mechanism in its normal condition. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the control under test. The chamber or coil bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.11.106 *After the **control** has operated, the temperature of the chamber is allowed to cool down to either +0 °C or –35 °C. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.12 Type 1.J or 2.J action

Additional subclauses:

11.4.12.101 *For this test, the reset mechanism of the **control** will be held in the reset position for the duration of the test from 11.4.12.102 to 11.4.12.104. The verification of the automatic non-resetting above –35 °C will be carried out by 11.4.12.105 to 11.4.12.106. For **SOD**, the verification of the automatic non-resetting above either +0 °C or –35 °C will be carried out by 11.4.12.105 to 11.4.12.106, as declared in item 103 of Table 1.*

11.4.12.102 *With the reset mechanism held in the reset position at room temperature, contact separation is observed by a low-energy circuit, 0,05 A maximum.*

11.4.12.103 *The **control**'s **sensing element** is then installed in an air circulating chamber or oil bath and the **control**'s **switch head** is installed as in 14.5.1. When the whole **control** is declared as the **sensing element**, the whole **control** is placed in an air-circulating chamber. The control or the **control**'s **sensing element** is adjusted for the maximum set point temperature. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or oil bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. **The** chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until 10 K over the operation temperature. Indication of contact separation is still observed by applying the method of 11.4.11.102.*

11.4.12.104 *After the **control** has operated and with the reset mechanism still held in the reset position, the temperature of the chamber or oil bath is then reduced to determine if the **control** automatically resets. Verification of contact closure is done by applying the method in 11.4.11.102.*

11.4.12.105 *The whole **control** or the **control**'s **sensing element** is then installed in an air circulating chamber or oil bath again and the **control**'s **switch head** (if applicable) is installed as in 14.5.1. with the reset mechanism in its normal condition. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or oil bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.12.106 *After the **control** has operated, the temperature of the chamber or oil bath is allowed to cool down to either +0 °C or –35 °C. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.13 Type 1.K or 2.K action

Additional subclauses:

11.4.13.101 A type 2.K action shall be so designed that in the event of a break in the **sensing element**, or in any other part between the **sensing element** and the **switch head**, the declared disconnection or interruption is provided before the sum of the declared **operating value** and **drift** is exceeded.

*Compliance is checked by breaking the **sensing element**. The breaking may be achieved by partly pre-cutting or filing through.*

*The temperature **sensing control** is heated to within 10 K of the operating temperature and the temperature then increased at a rate not to exceed 1 K/min. The contacts shall open before the sum of the declared **operating value** plus **drift** is exceeded.*

11.4.13.102 Type 2.K action may also be achieved by compliance with a), b) or c).

a) Two **sensing elements** operating independently from each other and actuating one switch head.

b) Bimetallic **sensing elements** with

   1) exposed elements attached with at least double spot welding of the bimetal at both of its ends, or

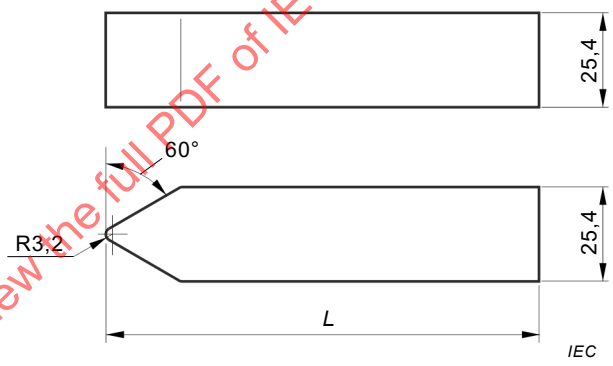
   2) elements so located or installed in a **control** of such construction that the bimetal is not likely to be physically damaged during installation and use.

c) If the loss of the fluid fill causes the contacts of the **control** to remain closed or leakage causes upward shift beyond the declared maximum operating temperature, the bulb and capillary of a temperature **sensing control** which is actuated by a change in the pressure of a fluid confined in the bulb and capillary shall conform to the following.

   There shall be no damage to the bulb or capillary to the extent which will permit escape of any of the fill when an impact **tool**, as illustrated in Figure 101, is dropped once from a height of 0,60 m so that the tapered end of the **tool** strikes the bulb or capillary in a perpendicular position. For this test, the capillary or the bulb shall be on a concrete surface.

   If the capillary is provided with a separate shroud or sleeve, it is to be left in place during the test described above.

Dimensions in millimetres



Material: Steel, CRS, Break all corners

L to be sized to obtain total mass of 0,454 kg

Figure 101 – Impact tool

Additional subclauses:

11.4.101 Type 2.N action

A type 2.N action shall be so designed that in the event of a leak in the **sensing element**, or in any other part between the **sensing element** and the **switch head**, the declared disconnection or interruption is provided before the sum of the declared **operating value** and **drift** is exceeded.

Compliance is checked by the following test:

*The **operating value** of a type 2.N **control** is measured under the conditions of Clause 15 of Part 1. If the **control** has means for **setting**, it is set to the highest value.*

*After this measurement, a hole is artificially produced in the **sensing element** and the measurement of the **operating value** is repeated.*

*No positive **drift** is allowed above the declared value.*

A separate shroud or sleeve may be employed for protection of the bulb and capillary to achieve conformance with Clause 18.

NOTE 1 The test can be replaced by theoretical computations of the physical mode of operation.

NOTE 2 In Canada and the USA, a type 2.N action is checked by item c) of 11.4.13.102.

11.4.102 Type 2.P action

A type 2.P action shall be so designed that it operates in its intended manner after a thermal cycling test.

Compliance is checked by the test of 17.101.

11.4.103 Bimetallic single-operation device

A **bimetallic single-operation device** shall be so designed that it does not reset above the reset value declared in Table 1, requirement 103.

Compliance is checked by the test of 17.15.

11.4.104 Type 1.X or 2.X

A type 1.X or 2.X action shall be so designed that a turn action can only be accomplished after the completion of a push-action or a pull-action. Only rotation shall be required to return the **actuating member** of the **control** to the **OFF position** or rest position.

Compliance is checked by the tests of 18.101.

11.4.105 Type 1.Z or 2.Z

A type 1.Z or 2.Z action shall be so designed that a turn action can only be accomplished after the completion of a push-action or a pull-action.

Compliance is checked by the tests of 18.101.

11.4.106 Voltage maintained thermal cut-out

A **voltage maintained thermal cut-out** shall be so designed that it does not reset above the reset value declared in Table1, requirement 111.

11.4.107 Type 1.AM or 2.AM

A type 1.AM or 2.AM action shall be so designed that it operates in its intended manner after the declared agricultural environmental exposures.

Compliance is checked by the tests of Annex DD.

11.6 Mounting of controls

11.6.3 Mounting of independently mounted controls

Additional subclause:

11.6.3.101 For **agricultural thermostats** declared in Table 1, requirement 117, the mounting method shall be such that the integrity of the protection by the enclosure is not compromised.

Additional subclause:

11.101 Time factor

If a **time factor** is declared, this shall be checked by one of the applicable determining methods as indicated in Annex BB. The determined value shall not exceed the rated values. See Table BB.1.

NOTE In Germany, for temperature **sensing controls** intended to control boiler water or flue gas temperature in heat generating systems, the maximum values of **time factor** given in Table BB.1 shall not be exceeded.

12 Moisture and dust resistance

This clause of Part 1 is applicable except as follows:

Additional subclauses:

12.101 Refrigeration controls

Controls which have the **switch head** and **sensing element** mounted in the evaporator of refrigeration or similar equipment, producing conditions of over temperature and of freezing and melting, shall maintain insulation integrity.

12.101.1 *Compliance is checked by the following tests.*

12.101.2 **Controls** which use a potting compound are given a softening test. Two samples are heated in a heating chamber at 15 K above the maximum declared operating temperature for 16 h with the potting surface in the most unfavourable position. The potting material shall not unduly soften or distort, crack or deteriorate.

12.101.3 *The two samples used for the softening tests and one untested sample (three total) are placed in water maintained between T_{max} (maximum declared **switch head** ambient temperature) and either (T_{max} +5) °C or 1,05 times T_{max}, whichever is greater for 2 h. The three samples are then immediately transferred to water at a temperature of below 5 °C for 2 h and then frozen in a small, flexible container at a temperature between T_{min} (minimum declared **switch head** ambient temperature) and (T_{min} –5) °C for 2 h. Ten heating-freezing cycles are required.*

NOTE In Canada and the USA, if the contact mechanism of defrost **controls** has the **creepage distances** and **clearances** required for refrigeration controllers, one cycle only of heating and freezing is required, otherwise ten cycles are required.

12.101.4 *The tested samples shall be left in water at room temperature overnight after each completed heating-freezing cycle.*

12.101.5 *After the last freezing test, the samples are thawed to approximately room temperature in water and the insulation resistance is measured from current-carrying parts to grounded parts and to the surface of potting and/or insulating material; the direct current voltmeter method is used. Insulation resistance shall be at least 50 000 Ω.*

12.101.6 *While the samples are still moist, a voltage equal to (2 × V_R) + 1 000 V is applied at rated frequency for 1 min between current-carrying parts and grounded parts and the surface of the potting and/or insulating material. No flashover or breakdown of insulation shall occur during the test.*

13 Electric strength and insulation resistance

This clause of Part 1 is applicable except as follows:

13.2 Electric strength

Additional note:

NOTE 101 In the USA, an independently mounted **room thermostat** for **operation** over 50 V, intended for direct control of electric space-heating equipment, shall withstand for 1 min without breakdown the application of alternating potential of 900 V between the line and load terminals. A piece of insulating material may be placed between the **thermostat** contacts during the test. There shall be no breakdown either through or across the insulating material supporting the contact and terminal assemblies. This **control** shall be the **control** that is designated as "SAMPLE 1" under the tests for compliance in 17.16.102.1 of this standard.

14 Heating

This clause of Part 1 is applicable except as follows:

14.4.3.1

Addition:

For a **voltage maintained thermal cut-out**, the heating test of 14.4.3.1 is completed, after which the temperature of the **sensing element** is raised until the contacts open. At this time, the ambient temperature surrounding the **sensing element** is reduced to $T_{max.1}$ in time period t_1, at a uniform rate. The test of 14.5.1 is then completed.

Additional subclause:

14.4.3.1.101 Where the whole **control** has been declared as the **sensing element** (see Table 1, requirement 47), the heating test, at the request of the manufacturer, need not be conducted until the successful completion of the tests in Clause 17.

Additional subclauses:

14.101 The following is applicable to **controls** classified under 6.7.101 to 6.7.103 inclusive.

14.101.1 As a means of complying with Note i) of Table 13, if the temperature of insulating parts exceeds that permitted in Table 13, then the test of 17.16.101 may be conducted after the conditioning of 14.102 and 14.102.1.

14.102 A previously untested sample of the **control** is conditioned for 1 000 h in an oven maintained at a temperature between 1,02 T_1 + 20 K and 1,05 times that temperature, where T_1 is the maximum measured temperature on the insulating part during the test of Clause 14. The **control** shall not be energized during this test.

14.102.1 If the elevated temperature is localized, such as at or near a terminal, the 1 000 h conditioning is conducted with the control between T_{max} and T_{max} + 5 % for normal conditions, but with the contacts closed and non-cycling. If necessary, the contacts may be forced closed to provide the most arduous temperature conditions. A bimetal heater across

the mains is energized at 1,1 times rated voltage. A series bimetal heater shall conduct at 1,1 times rated current.

15 Manufacturing deviation and drift

This clause of Part 1 is applicable except as follows:

15.1 *Addition:*

The values of **manufacturing deviation** and **drift** shall be according to Annex AA unless otherwise declared by the manufacturer.

NOTE 101 The note is not applicable.

15.4 *Addition:*

*Alternatively, the declared **manufacturing deviation** and **drift** may be expressed separately as a tolerance value to the declared **operating value**.*

15.5.3 *Additional subclauses:*

15.5.3.101 ***Controls** intended for **setting by the user** shall be set at the maximum operating temperature unless otherwise declared by the manufacturer.*

15.5.3.102 ***Controls** utilizing a bimetallic or similar sensing mechanism or that portion of a **control** intended to be exposed to a controlled ambient shall be placed in a circulating air oven to determine the **operating value**.*

15.5.3.103 *For bimetallic and similar type **controls**, the temperature shall be determined by mounting a 0,25 mm thermocouple wire to the sensing portion of an identical **control** not electrically connected and mounted adjacent to the **control** under test in a circulating air oven.*

15.5.3.104 *For fluid expansion type **controls**, a maximum 0,25 mm thermocouple shall be attached to the sensing portion, using a suitable adhesive.*

15.5.3.105 *For fluid expansion or contraction type **controls**, the complete **control** or, if so intended in use, the bulb portion, or that length of a sensing portion of a **control** declared by the manufacturer as being a minimum sensing dimension shall be placed in either a circulating air oven or a liquid bath.*

15.5.3.106 *The temperature of the oven or bath may be rapidly increased to 10 K below or decreased to 10 K above the expected operating temperature of the **control** until conditions of equilibrium have been achieved. The rate of temperature change shall then be reduced to a maximum of 0,5 K/min or to the declared rate of change, whichever is the lowest.*

15.5.3.107 *The **operation** of the **control** shall be sensed by a suitable device with a sensing current not exceeding 0,05 A.*

The circuit voltage may be any convenient value that will give reliable indication of the function being monitored.

15.5.3.108 *The **operating value** of the **control** shall be recorded.*

15.5.3.109 *For **SODs**, after the contacts have operated, satisfactory disconnection is determined by subjecting each **SOD** to the voltage specified in Table 12, with no prior humidity treatment.*

15.5.4 and **15.5.5** Not applicable.

15.5.6

Addition:

*Alternatively, the **manufacturing deviation** shall be according to Annex AA.*

16 Environmental stress

This clause of Part 1 is applicable except as follows:

Addition:

This clause is not applicable for **bimetallic SOD**.

17 Endurance

This clause of Part 1 is applicable except as follows:

17.3.1 *Addition:*

– for temperature **sensing controls** in which the whole **control** is declared as the **sensing element** and for which the minimum operating temperature declared in Table 1, requirement 48, is less than 0 °C, the test of 17.8 is carried out on a further set of three samples at the minimum declared operating temperature with a tolerance of +5 K, –0 K, the number of cycles being 5 % of the number declared in Table 1, requirement 27.

17.8.4 *Additional subclause:*

17.8.4.101 *The number of automatic and manual cycles for independently mounted and **in-line cord control**s shall be as indicated in Clause CC.1, unless a higher number is declared by the manufacturer.*

NOTE In Canada and the USA, the number of cycles is as indicated in Clause CC.2.

17.15 *This subclause of Part 1 is replaced as follows:*

17.15 Single operation devices

17.15.1 Bimetallic single operation devices

Bimetallic single operation devices shall be subjected to the following tests:

17.15.1.1 *After the appropriate tests of Clause 15, the same six samples shall be maintained at –35 °C or 0 °C as declared in Table 1, requirement 103, for 7 h. The devices shall not reset during this period, which is determined by the test of 15.5.3.109.*

17.15.1.2 *Six untested **bimetallic single operation devices** are conditioned for 720 h at a temperature which is the lower of either:*

– *90 % of the declared **operating value** ±1 K,*

– *or (7 ± 1) K below the declared **operating value**.*

17.15.1.2.1 *During this conditioning, the **bimetallic single operation device** (**SOD**) shall not operate. **Operation** of the **bimetallic single operation device** (**SOD**) shall be detected as indicated in 15.5.3.107.*

17.15.1.2.2 *The appropriate tests of Clause 15 shall be repeated on the six samples subjected to the conditioning of 17.15.1.2 and the temperature measured shall be within the declared deviation limits.*

17.15.1.3 *For **bimetallic single operation devices** with a declared reset temperature of –35 °C, six untested samples shall be subjected to an over-voltage (or overload in Canada and the USA) test for one cycle under the electrical conditions of Table 14 or Table 15, as appropriate.*

The test of 15.5.3.109 shall be repeated.

17.15.1.3.1 *For **bimetallic single operation devices** with a declared reset temperature of 0 °C, one sample shall be subjected to an over-voltage (or overload in Canada and the USA) test of 50 cycles under the electrical conditions of Table 14 or Table 15, as appropriate.*

The sample is then subjected to the number of cycles declared in Table 1, requirement 104, at rated current and voltage.

*The purpose of the tests of 17.15.1.3.1 is to evaluate the device under unintended **operation** caused by exposure to temperatures below 0 °C. In order to achieve cycling, it is suggested that the test be conducted in a test chamber which permits decrease of the ambient temperature to the declared reset value and increase of the ambient temperature to the normal **operating value**.*

After the test of 17.15.1.3.1, the appropriate tests of Clause 15 shall be repeated and the temperature measured shall be within the declared deviation limits.

17.15.2 Non-bimetallic SODs

17.15.2.1 ***Non-bimetallic SODs** are subject to the following tests:*

*For a **non-bimetallic SOD**, automatic temperature sensing functions except those for the non-bimetallic part of the **control**, such as **thermostat**, **temperature limiter** and/or the **thermal-cut-out**, shall comply with 17.16.101, 17.16.103 and 17.16.104 respectively.*

These tests are conducted on separate samples.

17.15.2.2 *Six untested samples are then to be mounted in a suitable apparatus and the thermal **sensing elements** are conditioned for an ageing period equal to either 750 h or the result of the specified number of cycles declared by the end product application divided by 4 (calculation value is the number of hours), whichever is greater, at the temperature declared in Table 1, requirement 115, – 5 K. No **operation** of the **SODs** shall occur during this ageing period. **Operation** of the device shall be detected as indicated in 15.5.3.107.*

17.15.2.3 *At the end of the ageing period, the samples are removed from the apparatus. The appropriate tests of Clause 15 shall be repeated on six untested samples and the six samples subjected to the conditioning of 17.15.2.2 and the temperatures measured shall be within the declared deviation limits, with the electrical conditions of the test V_{Rmax} and I_{Rmax}.*

*For **non-bimetallic SODs** where the **sensing element** has a declared reset temperature, the **SODs** shall be held at the temperature declared in Table 1 and the test will continue for 7 h. The device shall not reset during this period as indicated in 15.5.3.109.*

All samples shall then be subjected to the test of Clause 13, carried out at the temperature limits declared in Table 1, requirement 36.

*The apparatus used for the tests of 17.15.2.2 and 17.15.2.3 should be constructed so that heat can be applied to the thermal **sensing element** of the **SOD** whilst taking care that other parts of the **control** are protected from exposure to temperatures in excess of their intended use.*

17.16 Test for particular purpose controls

Additional subclauses:

17.16.101 Thermostats

- *17.1 to 17.5 inclusive are applicable.*
- *17.6 is applicable to actions classified as type 1.M or type 2.M, the value of "X" being (5 ± 1) K or ±5 % of the original **activating quantity**, whichever is greater.*
- *17.7 is applicable.*
- *17.8 is applicable.*
- *17.9 is applicable, but only to slow-make, slow-break **automatic actions**.*
- *17.9.3.1 is not applicable.*
- *17.10 to 17.13 inclusive are applicable, but only to those **thermostats** which have a **manual action** (including an **actuating means** providing **setting by the user**).*
- *17.14 is applicable for all temperature **sensing controls**. In addition to the criteria stated in 17.14, temperature **sensing controls** specified under 14.4.3.1.101 shall comply with the requirements of Clause 14.*
- *17.15 is not applicable.*

NOTE In Canada and the USA only, the requirements of 17.16.102 are applicable.

17.16.102 Independently mounted **room thermostats** for **operation** above 50 V which include a resistance load rating and which are intended for direct control of electric space-heating equipment shall meet the requirements of 17.16.102.1 to 17.16.102.3 inclusive for USA.

NOTE For Canada, such **controls** above 30 V shall meet the requirements of 17.16.102.4 and 17.16.102.5.

17.16.102.1 Two samples of a **room thermostat** intended for direct control of electric space-heating equipment (designated "SAMPLE 1" and "SAMPLE 2") shall be subjected to an over-current test consisting of making and breaking for 50 cycles of **operation**, at a rate of 6 cycles/min, a value of current described in Table 15.

17.16.102.2 SAMPLE 1 (see 13.2) and SAMPLE 2 shall be subjected to an endurance test consisting of 6 000 cycles at the rate of not more than one cycle/min and at 110 % of both the rated current and rated voltage. The "on" time shall be (50 ± 20) % and **operation** is to be by thermal means. There shall be no electrical or mechanical **failure** of either **thermostat**, and there shall be no undue burning or pitting of the contacts of SAMPLE 1 (see 17.3).

17.16.102.3 The **thermostat** designated SAMPLE 2 shall be subjected to an additional 30 000 cycles under the conditions described in 17.4, except that rated voltage and current shall be used. The test may be discontinued if the **thermostat** becomes inoperative due to the contacts not opening or closing. There shall be no indication of a fire or shock hazard.

17.16.102.4 The test is conducted on one sample, at 120 % of rated voltage and current, making and breaking for 50 cycles. The sample subjected to above test is further tested for 30 000 cycle endurance test, at rated voltage and current as described in Clause 17.

17.16.102.5 The test shall successfully complete the required number of cycles as intended without causing any hazard, and comply with dielectric strength in 13.2.

17.16.103 Temperature limiters

– *17.1 to 17.5 inclusive are applicable.*

– *17.6 is applicable to actions classified as type 1.M or type 2.M, the value of "X" being (5 ± 1) K, or ±5 % of the original **activating quantity**, whichever is greater.*

– *17.7 and 17.8 are applicable, except that, where necessary, the reset **operation**, if required, is obtained by **actuation**. This **actuation** shall be as specified in 17.4 for accelerated speed, as soon as permitted by the mechanism, or as declared by the manufacturer in Table 1, requirement 37.*

– *17.9 is applicable, but only to **temperature limiters** with slow-make, slow-break **automatic actions**, the same conditions for manual reset as specified above for 17.7 and 17.8 being used.*

– *17.9.3.1 is not applicable.*

– *17.10 to 17.13 inclusive do not apply to the normal reset **manual action**, which is tested during the automatic tests of 17.7 to 17.9 inclusive. If the **temperature limiter** has other **manual actions** which are not tested during the automatic tests, then these subclauses are applicable.*

– *17.14 is applicable for all temperature **sensing controls**. In addition to the criteria stated in 17.14, temperature **sensing controls** specified under 14.4.3.1.101 shall comply with the requirements of Clause 14.*

– *17.15 is not applicable.*

17.16.104 Thermal cut-outs

– *17.1 to 17.5 inclusive are applicable.*

– *17.6 is applicable to actions classified as type 2.M, the value of "X" being (5 ± 1) K, or ±5 % of the original **activating quantity**, whichever is greater.*

– *17.7 and 17.8 are applicable, except that, where necessary, the reset **operation**, if required, is obtained by **actuation**.*

– *This **actuation** shall be as specified in 17.4 for accelerated speed, as soon as permitted by the mechanism, or as declared by the manufacturer in Table 1, requirement 37.*

– *17.9 is applicable, but only to **thermal cut-outs** with slow-make, slow-break **automatic actions**, the same conditions for manual reset as specified above for 17.7 and 17.8 being used.*

– *17.9.3.1 is not applicable.*

– *17.10 to 17.13 inclusive do not apply to the normal reset **manual action**, which is tested during the automatic tests of 17.7 to 17.9 inclusive. If the **thermal cut-out** has other **manual actions** which are not tested during the automatic tests, then these subclauses are applicable.*

– *17.14 is applicable for all **controls**. In addition to the criteria stated in 17.14, **controls** specified under 14.4.3.1.101, shall comply with the requirements of Clause 14.*

– *17.15 is not applicable.*

17.16.104.1 For **voltage maintained thermal cut-outs**, the test of 17.16.108 is applicable.

17.16.105 In Canada and the USA, if a **control** has two or more electrical ratings (for example, inductive and resistive or different currents at different voltages), it may be tested for not less than 25 % of its declared endurance (if equal to or greater than 30 000 cycles) at each rating, but the total number of cycles on any one sample is not to be more than its declared endurance.

However, at least one sample shall be tested for a total number of cycles equal to its declared endurance.

17.16.106 Evaluation of materials

The following tests are conducted as indicated in 14.101.1.

*The **control** is subjected to the tests of 17.7 for 50 **operations** and 17.8 for 1 000 **operations**. The tests of 17.7 and 17.8 are conducted at an ambient temperature of (20 ± 5) °C.*

*After these tests, the **control** shall comply with 17.5.*

17.16.107 Over-temperature test of sensing element

*For **controls** declared under Table 1, requirement 105, the **sensing element** portion of a previously untested sample is exposed to 250 thermal cycles.*

The test ambient temperature is varied between 40 °C and T_e at the maximum rate of temperature change declared in Table 1, requirement 37. The extremes of temperature are maintained for 30 min.

*After the test, the **control** shall comply with 17.14.*

17.16.108 Voltage maintained thermal cut-out

Six untested **voltage maintained thermal cut-outs** are conditioned for 7 h at a temperature of –20 °C (or lower, if declared).

During and at the conclusion of the conditioning, none of the six samples shall have operated.

Operation of the **voltage maintained thermal cut-outs** shall be detected as indicated in 15.5.3.107.

These requirements apply to a **voltage maintained thermal cut-out** in the operated condition with the voltage across it.

Additional subclauses:

17.101 Type 2.P cycling test

Temperature **sensing controls** of type 2.P action shall be tested as follows:

17.101.1 Following the appropriate tests of 17.16 and the evaluation of 17.14, the **control** is subjected to a thermal cycling test of 50 000 cycles at a temperature maintained between 50 % and 90 % of the switch-off temperature recorded in 17.14. During this test, the **switch head** is maintained at (20 ± 5) °C.

The manufacturer shall declare whether the method of 17.101.2 or 17.101.3 is to be used.

The test shall be carried out in accordance with the manufacturer's declaration in Table 1, requirement 112.

17.101.2 Two-bath method

The two baths are filled with synthetic oil, water or air (two chambers). The first bath is maintained at a temperature equal to 90 % of the switch-off temperature (°C) recorded

in 17.14. The second bath is maintained at a temperature equal to 50 % of the switch-off temperature recorded in 17.14.

If a medium different from that used in Annex BB is selected for this test, then an appropriate conversion factor shall be applied to the **time factor** indicated in the following paragraph.

*The temperature **sensing element** (see 2.8.1 and Table 1, requirement 47) is immersed in the first bath for a period of time equal to at least five times the **time factor**. The temperature **sensing element** is then immersed in the second bath for the same period of time.*

*The transfer between baths is carried out as quickly as possible but care should be taken to avoid mechanical stress to the temperature **sensing element**.*

17.101.3 Temperature change method

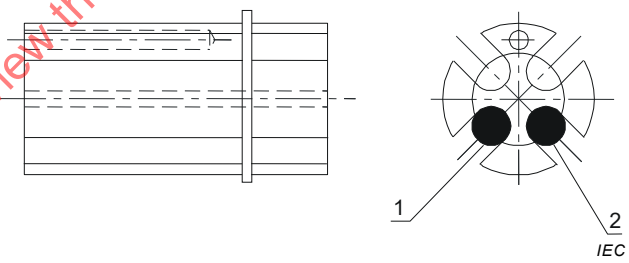
This method is based on a continuously water-cooled oil-filled bath (synthetic oil).

An aluminium cylinder (see Figure 102) is immersed in this bath. The cylinder contains the temperature **sensing element** under test and a temperature **sensing element** to control temperature cycling between 50 % and 90 % of the switch-off temperature (°C) recorded in 17.14.

The aluminium cylinder is wrapped with a resistance wire to heat the temperature **sensing element**. To eliminate the difficulties resulting from the difference between the **time factor** of the temperature **sensing element** under test and the temperature **sensing element** which is controlling the test temperature range, the temperature **sensing element** of a second identical test sample is used.

The two membrane positions of the second sample, calculated at 50 % and 90 % of the switch-off temperature (°C) are measured by a position sensor and used to switch the current through the resistance wire (heat) on and off.

Unless otherwise declared by the manufacturer in Table 1, requirement 37, the rate of change of temperature rise/fall shall be (35 ± 10) K/min.



Key

1	temperature **sensing element**
2	temperature **sensing element** to control the temperature cycle between 0,5 and 0,9 times the switch-off temperature

Figure 102 – Aluminium cylinder for temperature change method

17.101.4 After this test, for **controls** other than **bimetallic SODs**, an additional 20 cycles are carried out by increasing the temperature from (20 ± 5) °C to 1,1 times the switch-off temperature.

During this test, any manual reset mechanism shall not be reset. The other conditions of 17.101.1 are unchanged.

NOTE The purpose of this test is to stress the operating mechanism (for example, membrane, bellows, etc.).

17.101.5 *After thoroughly degreasing the **switch head**, the operating temperature(s) is re-checked under the conditions of Clause 15 and the measured value(s) shall still be within the declared limits of deviation and **drift**.*

18 Mechanical strength

This clause of Part 1 is applicable except as follows:

Additional subclauses:

18.101 Push-and-turn or pull-and-turn actuation

18.101.1 Controls with actions classified as type 1.X or 2.X or type 1.Z or 2.Z shall be subjected to the tests of 18.101.2 and 18.101.3.

*One new sample is used for the tests. After these tests, the **control** shall comply with the requirements of 18.1.5.*

18.101.2

Controls with actions classified as type 1.X or 2.X or type 1.Z or 2.Z shall be subjected to the following tests.

– The axial force required to push or pull the **actuating member** shall be not less than 10 N.

– An axial push or pull force of 140 N applied to the **actuating member** shall not affect compliance with 18.1.5.

– For a **control** intended for use with a knob having a grip diameter or length of 50 mm or less, the means preventing rotation of the shaft prior to the push or pull **actuation** shall withstand, without damage, or effect on **control** function, a torque of 4 Nm.

– Alternatively, if the means preventing rotation of the shaft is defeated when a torque of at least 2 Nm is applied, the effect shall be such that either

  • the means is not damaged, but overridden to close the contacts, in which case subsequent **actuation** at a torque less than 2 Nm shall require both push-and-turn or pull-and-turn to operate the contacts, or

  • no **operation** of the contacts occurs nor can be made to occur.

– The torque required to reset the **control** to the initial contact condition, if necessary after the application of the push or pull, shall not be greater than 0,5 Nm.

– A torque of 6 Nm is applied to the **setting** means. Any breakage or damage to the means preventing rotation of the shaft shall not result in **failure** to comply with the requirements of Clauses 8, 13 and 20.

– For **controls** intended for use with a knob having a grip diameter or length greater than 50 mm, the values of torque are increased proportionally.

18.101.3 **Controls** with actions classified as type 1.X or 2.X or type 1.Z or 2.Z shall be actuated for the declared number of manual cycles.

After this test, the **control** shall comply with the requirements of 18.101.2. For the case in which the means preventing rotation is not damaged but is overridden to operate the contacts, the first 1/6th of the declared manual cycles shall be performed without first pushing or pulling the **actuating member**.

18.102 Parts containing liquid metal

18.102.1 Parts of all **controls** containing sodium (Na), potassium (K), or both, and parts of **controls** classified under 6.7.101 to 6.7.103 inclusive that contain mercury (Hg) shall withstand for 1 min, without leakage or rupture, a hydraulic pressure equal to five times the maximum internal pressure achieved during **operation**.

18.102.1.1 The method of test and the number of samples required shall be agreed between the manufacturer and the test authority.

It may be necessary for the manufacturer to provide special samples for the purpose of this test (for example, without mercury). Any suitable fluid may be used in lieu of the liquid metal, provided that the test fluid and test method exert the intended stress on all fluid-containing parts.

18.102.1.2 *After the test of 18.102.1, the hydraulic pressure is to be increased until rupture occurs. The rupture shall occur at the bellows or diaphragm or other part that is within the* ***switch head*** *or* ***control*** *enclosure.*

18.102.2 *The* ***control*** *shall not leak or rupture when heated to 1,2 times the* ***maximum temperature*** *of the* ***sensing element****.*

A separate sample is used for this test.

18.102.3 *Additionally, when the bellows or diaphragm of a separate sample is deliberately punctured with a sharp, pointed metal rod, the following shall occur:*

– *sodium, potassium, or mercury shall be contained in the* ***switch head*** *or* ***control*** *enclosure.*

NOTE In Canada and the USA, mercury is allowed to escape from the **switch head** or **control** enclosure, in which case the **control** shall be declared as requiring evaluation in the appliance to determine if mercury enters an oven or food-handling compartment, contacts food-handling equipment, or the like.

18.102.4 *The acceptability of the location of the rupture shall be evaluated in the appliance.*

19 Threaded parts and connections

This clause of Part 1 is applicable.

20 Creepage distances, clearances and distances through solid insulation

This clause of Part 1 is applicable.

21 Resistance to heat, fire and tracking

This clause of Part 1 is applicable.

22 Resistance to corrosion

This clause of Part 1 is applicable.

23 Electromagnetic compatibility (EMC) requirements – Emission

This clause of Part 1 is applicable except as follows:

Additional subclauses:

23.101 Thermostats shall be so constructed that they do not generate radio interference for a time period exceeding 20 ms.

NOTE In Canada and the USA, this test is not applicable.

Compliance is checked by the test of 23.101.1 and 23.101.2.

23.101.1 Test conditions

Three previously untested samples are subjected to the test.

The electrical and thermal conditions are as specified in 17.2 and 17.3, except as follows.

– The test is conducted at the lowest declared voltage and lowest declared current (Table 1, requirement 108).

– The rates of temperature change are α_1 and β_1. If these have not been declared, the following are used:

  1 K/15 min for **sensing elements** in gases;

  1 K/min for **sensing elements** in other media.

– For **controls** declared for use with inductive loads, the power factor is 0,2. For **controls** declared for use with purely resistive loads, the power factor is 1,0.

23.101.2 Test procedure

The **control** is subjected to five cycles of **operation** with the contacts opening and five cycles of **operation** with the contacts closing.

The duration of radio interference is measured by an oscilloscope connected to the **control** so as to measure the voltage drop across the contacts.

NOTE For the purpose of this test, radio interference is any observed fluctuation of voltage across the contacts which is superimposed upon the supply waveform as a result of contact **operation**.

24 Components

This clause of Part 1 is applicable.

25 Normal operation

This clause of Part 1 is applicable.

26 Electromagnetic compatibility (EMC) requirements – Immunity

This clause of Part 1 is applicable.

27 Abnormal operation

This clause of Part 1 is applicable.

28 Guidance on the use of electronic disconnection

This clause of Part 1 is applicable.

Annexes

The annexes of Part 1 are applicable except as follows:

Annex G
(normative)

Heat and fire resistance tests

This annex of Part 1 is applicable except as follows:

G.5.1 Ball pressure test 1

Replace the first line and first dashed item as follows:

*Where the whole control has been declared as the **sensing element**, the temperature in the heating oven is the highest of:*

– *20 K ± 2 K in excess of the **maximum temperature** measured during the tests of Clause 14, or Clause 17.14, if the heating test of Clause 14 is not conducted,*

G.5.2 Ball pressure test 2

Replace the first line as follows:

*Where the whole **control** has been declared as the **sensing element**, the ball pressure test is carried out as described in G.5.1 except that the temperature in the heating oven shall be T_b ± 2 °C where T_b is equal to the higher of:*

Replace the fourth dashed item as follows:

– *20 K in excess of the **maximum temperature** recorded during the heating test of Clause 14, or 17.14, if the heating test of Clause 14 is not conducted,*

Annex H
(normative)

Requirements for electronic controls

Replacement:

This annex of Part 1 is applicable except as follows:

H.2 Terms and definitions

Additional definitions:

H.2.101.1
permanent operation
continuous monitoring of the protective function during the **operation** of the appliance or system for longer than 24 h

Note 1 to entry: 24 h is considered the typical time interval between a first and a second **fault**.

H.2.101.2
non-permanent operation
continuous monitoring of the protective function during the **operation** of the appliance or system for less than 24 h

Note 1 to entry: 24 h is considered the typical time interval between a first and a second **fault**.

H.6 Classification

H.6.18 According to classes of control functions

H.6.18.2 *Addition:*

NOTE 101 In general, **thermal cut-outs** perform **class B control functions** or **class C control functions**.

H.6.18.3 *Addition:*

NOTE 101 In general, **thermal cut-outs** used on closed water heater systems perform **class C control functions**.

H.7 Information

Additional requirements to Table 1:

Information		Clause or subclause	Method
58a	See footnote c of Table H.101	H.26.2.104	X
109	The output condition of **thermal cut-outs**, type 2 **thermostats** and type 2 **temperature limiters** after **operation**[104]	H.26.2.103 H.26.2.106	
118	Conditions of test when requested by the manufacturer for integrated and incorporated **electronic controls**.	H.23.1.2	X
119	Frequency of the **defined state** test function	H.27.1.2.2.2 H.27.1.2.3.2 H.27.1.2.3.3	X
120	The **control** is for **permanent operation** or **non-permanent operation**	H.2.101.1 H.2.101.2 H.27.1.2.2.2 H.27.1.2.3.2	X
Additional note: [104] For example, conducting or non-conducting, as applicable.			

H.11 Constructional requirements

H.11.12 Controls using software

H.11.12.2.6 *Replace the second paragraph by the following:*

NOTE The values declared in Table 1, requirement 71 may be given in the applicable appliance standard.

H.11.12.2.7 *Addition, at the end of this subclause:*

NOTE 101 The values declared in Table 1, requirement 72 may be given in the applicable appliance standard.

H.23 Electromagnetic compatibility (EMC) requirements – Emission

H.23.1.2 Radio frequency emission

Addition:

Integrated controls and **incorporated controls** are not subjected to the tests of H.23.1.2, as the results of these tests are influenced by the incorporation of the control into the equipment and the use of measures to control emissions used therein. They may, however, be carried out under declared conditions if so requested by the manufacturer.

H.26 Electromagnetic compatibility (EMC) requirements – Immunity

H.26.2 *Additional subclauses:*

H.26.2.101 After each test, one or more of the following criteria shall apply, as permitted in Table H.101.

H.26.2.102 The **control** shall remain in its current condition and thereafter shall continue to operate as declared within the limits verified in Clause 15, if applicable.

H.26.2.103 The **control** shall assume the condition declared in Table 1, requirement 109 and thereafter shall operate as in H.26.2.102.

H.26.2.104 The **control** shall assume the condition declared in Table 1, requirement 109, such that it cannot be reset automatically or manually. The output waveform shall be sinusoidal or as declared in Table 1, requirement 53 for normal **operation**.

H.26.2.105 The **control** shall remain in the condition declared in Table 1, requirement 109. A non-self-resetting **control** shall be such that it can only reset manually. After the temperature which caused cut-out to occur is removed, it shall operate as in H.26.2.102 or shall remain in the declared condition as in H.26.2.104.

H.26.2.106 The **control** may return to its initial state and thereafter shall operate as in H.26.2.102.

If a control is in the condition declared in Table 1, requirement 109, it may reset but shall resume the declared condition again if the temperature which caused it to operate is still present.

H.26.2.107 The output and functions shall be as declared in Table 1, requirement 58a or requirement 58b and the **control** shall comply with the requirement of 17.5.

Table H.101 – Compliance criteria

Applicable Clause H.26 tests	**Compliance criteria permitted**					
Thermal cut-outs, type 2 **thermostats** and type 2 **temperature limiters**	H.26.2.102	H.26.2.103	H.26.2.104	H.26.2.105	H.26.2.106	H.26.2.107[c]
H.26.4 to H.26.14 inclusive	[b]	[b]	[b]	[a]	[a]	[x]
Other temperature **sensing controls**	H.26.2.102	H.26.2.103	H.26.2.104	H.26.2.105	H.26.2.106	H.26.2.107[c]
H.26.8, H.26.9	[x]				[x]	[x]

[x] = Permitted for other than **thermal cut-outs**

[a] = Permitted when the disturbance is applied after **operation**

[b] = Permitted when the disturbance is applied before **operation**

[c] = This compliance criterion is permitted only for **integrated controls** or **incorporated controls**, since the acceptability of the output must be judged in the appliance.

H.26.5 Voltage dips, voltage interruptions and voltage variations in the power supply network

H.26.5.2 Voltage variation test

H.26.5.2.2 Test procedure

Replacement of last paragraph:

The **control** is subjected to each of the specified voltage test cycles three times with 10 s intervals between each test cycle. For a **control** declared under Table 1, requirement 109, each test cycle is performed three times when the control is in the declared condition and three times when it is not.

H.26.8 Surge immunity test

H.26.8.3 Test procedure

Additional subclause:

H.26.8.3.101 For **controls** declared under Table 1, requirement 109, the tests are performed when the **control** is in the declared condition and when it is not.

H.26.9 Electrical fast transient/burst immunity test

H.26.9.3 Test procedure

Additional subclause:

H.26.9.3.101 The **control** is subjected to five tests. For **controls** declared under Table 1, requirement 109, the tests are performed when the **control** is in the declared condition and when it is not.

H.26.10 Ring wave immunity test

H.26.10.5 Test procedure

Additional subclause:

H.26.10.5.101 For **controls** declared under Table 1, requirement 109, the tests are performed when the **control** is in the declared condition and when it is not.

H.26.12 Radio-frequency electromagnetic field immunity

H.26.12.2 Immunity to conducted disturbances

H.26.12.2.2 Test procedure

Additional subclause:

H.26.12.2.2.101 For **controls** declared under Table 1, requirement 109, sweeping is performed when the **control** is in the declared condition and when it is not.

H.26.12.3 Immunity to radiated disturbances

H.26.12.3.2 Test procedure

Additional subclause:

H.26.12.3.2.101 For **controls** declared under Table 1, requirement 109, sweeping is performed when the **control** is in the declared condition and when it is not.

H.26.13 Test of influence of supply frequency variations

H.26.13.3 Test procedure

Additional subclause:

H.26.13.3.101 For **controls** declared under Table 1, requirement 109, the test shall be performed when the **control** is in the declared condition and when it is not.

H.26.14 Power frequency magnetic field immunity test

H.26.14.3 Test procedure

Additional subclause:

H.26.14.3.101 For **controls** declared under Table 1, requirement 109, the test shall be performed when the **control** is in the declared condition and when it is not.

H.26.15 Evaluation of compliance

H.26.15.2

Addition:

See Table H.101 for compliance criteria.

H.26.15.4

Addition:

See Table H.101 for compliance criteria.

H.27 Abnormal operation

This clause of Part 1 is applicable except as follows:

H.27.1.1.2 *Replace the first line by:*

The **control** shall be operated under the following conditions. In addition, **controls** declared under Table 1, requirement 109 shall be tested when the **control** is in the declared condition and when it is not.

H.27.1.1.3

This clause of Part 1 is applicable except item c).

H.27.1.2.2 Class B control function

This clause of Part 1 is applicable except as follows:

H.27.1.2.2.2 First fault

Replace item b) as follows:

b) the **control** shall react within the **fault reaction time** (see Table 1, requirement 91) by proceeding to the **defined state** provided that a subsequent restart under the same **fault** conditions results in the **system** returning to the same **defined state** condition;

Replace item c) as follows:

c) for **systems** with **non-permanent operation**, the **control** shall continue to operate as intended, the **fault** shall be detected during the next start-up sequence. The compliance criteria shall be a) or b);

NOTE Requirements for **systems** with **permanent operation** are under consideration.

Replace item d) as follows:

d) the **control** shall continue to operate as intended.

Replace the last two paragraphs as follows:

The **fault reaction time** shall be declared by the manufacturer (see Table 1, requirement 91).

For **permanent operation** as declared by the manufacturer (see Table 1, requirement 120), item c) is under consideration.

For the **control** function where a mechanical actuator is part of the **defined state** a test up to but not including the switching contacts is sufficient. If the test of the **defined state** fails, the **control** shall initiate the **safety shut-down**. Frequency of test is as declared by the manufacturer (see Table 1, requirement 119). Internal **faults** of the components of the checking circuits are not considered.

H.27.1.2.2.3 Fault introduced during defined state

Not applicable.

H.27.1.2.3 Class C control function

This clause of Part 1 is applicable except as follows:

H.27.1.2.3.2 First fault

Replace item b) as follows:

b) the **control** reacting within the **fault reaction time** (see Table 1, requirement 91) by proceeding to **defined state** provided that subsequent reset from the lock-out condition under the same **fault** condition results in the **system** returning to the **defined state** condition;

Replace item c) as follows:

c) for **systems** with **non-permanent operation**, the **control** shall continue to operate as intended, the **fault** shall be detected during the next start-up sequence. The compliance criteria shall be a) or b).

NOTE 101 Requirements for **systems** with **permanent operation** are under consideration.

Replace item d) as follows:

d) The **control** shall continue to operate as intended.

Replace the last sentence with the following:

The **fault reaction time** shall be declared by the manufacturer (see Table 1, requirement 91).

For **permanent operation** as declared by the manufacturer (see Table 1, requirement 120), item c) is under consideration.

For the **control** function where a mechanical actuator is part of the **defined state** a test up to but not including the switching contacts is sufficient. If the test of the **defined state** fails, the **control** shall initiate the **safety shut-down**. Frequency of test is as declared by the manufacturer (see Table 1, requirement 119). Internal **faults** of the components of the checking circuits are not considered.

H.27.1.2.3.3 Second fault

Replace second sentence and items a) and b) with the following:

During assessment, for **systems** with **non-permanent operation**, the second **fault** shall only be considered to occur when a start-up sequence has been performed after the first **fault**. For **systems** with **permanent operation**, the second **fault** occurs 24 h after the first **fault**.

Replace the last two sentences with the following:

The **fault reaction time**, as well as the applicability of H.27.1.2.3.2 c), shall be as declared by the manufacturer.

For the **control** function where a mechanical actuator is part of the **defined state** a test up to but not including the switching contacts is sufficient. If the test of the **defined state** fails, the **control** shall initiate the **safety shut-down**. Frequency of test is as declared by the manufacturer (see Table 1, requirement 119). Internal **faults** of the components of the checking circuits are not considered.

H.27.1.2.4 Faults during defined state

Under consideration.

Annex J
(normative)

Requirements for thermistor elements and controls using thermistors

This annex of Part 1 is applicable except as follows:

J.4 General notes on tests

J.4.3.5 According to purpose

Additional subclause:

J.4.3.5.101 For the purpose of declaring the number of endurance cycles in Table 1, requirement 64, **thermistors** are evaluated for the function performed in the **control**.

NOTE For example, the same number of cycles would be declared in requirement 64 as in requirement 27 for a **thermistor** used as the **sensing element** of a **control** with **type 2 action** in which one cycle of **control operation** occurs with each cycle of **thermistor operation**, or vice versa.

J.7 Information

Addition to Table 1:

Add to requirement 64 a reference to J.4.3.5.101.

Additional annexes:

Annex AA
(informative)

Maximum manufacturing deviation and drift [a, b]

NOTE In Canada and the USA, Annex AA is normative.

		Maximum allowable deviation from declared operating value		Maximum allowable drift from initial measured value	
Type of control	**Temperature range** °C	**% of declared operating value**	***K***	**% of declared operating value**	***K***
Storage water heater **thermostat**	≤77 [e]	–	3	–	6
	>77	–	4	–	6
Storage water heater thermal cut-out	Any	–	3	5	6
Thermal cut-outs for duct heaters, warm air furnaces and boilers	<150	–	8	5	–
	≥150	5	–	5	–
Thermal cut-outs for electric base-board heaters	Any	–	8	+2 [d]	–
Appliance **thermal cut-outs** other than the above [c]	<150	–	6	6	6
	150 ≤ *t* ≤ 204	4	–	5	–
	>204	5	–	5	–

[a] Where both the per cent and *K* variations are indicated, the greater value may be used.

[b] When the per cent of the declared **operating value** is used, the following values are to be added to the maximum deviation or **drift** calculated using the table.

– For 5 %: 0,9 *K*

– For 4 %: 0,7 *K*

– For 2 %: 0,4 *K*

[c] For appliance **thermal cut-outs**, the downward **drift** may be 20 % of the declared **operating value** plus 4 *K*. The acceptability of this **drift** must be determined in the application, taking into account such conditions as the possibility of user tampering, overlapping performance with a **thermostat** and other similar conditions that might result in a fire, shock or casualty hazard.

[d] The downward **drift** is not limited for **thermal cut-outs** for electric baseboard heaters.

[e] **Controls** for household use have a manufacturer **setting** ≤60 °C. Deviation and **drift** are checked at 60 °C or at the maximum **set point**.

Annex BB
(informative)

Time factor

BB.0 General

The **time factor** shall be determined by one of the following methods:

– sudden temperature change (Clause BB.2);

– linear rise of temperature (Clause BB.3).

NOTE Normally, the **time factor** can be described by an exponential function of first order.

In the case of exponential functions of higher order, the dead time has to be taken into consideration.

BB.1 The characteristics and switching points for the determination of the **time factor** *T* shall be checked in a steady state.

BB.1.1 The **time factor** is determined by means of an appropriate test device (for example, the two-bath or gradient method) for gaseous or liquid activating media. Should the test medium not correspond to the working medium, the respective conversion factors shall be specified.

BB.1.2 The **time factor** shall be measured with or without sheath or bulb well as declared by the manufacturer.

BB.1.3 The velocity of the test medium shall be:

0,2 m/s to 0,3 m/s for fluids;

1,0 m/s to 1,5 m/s for air.

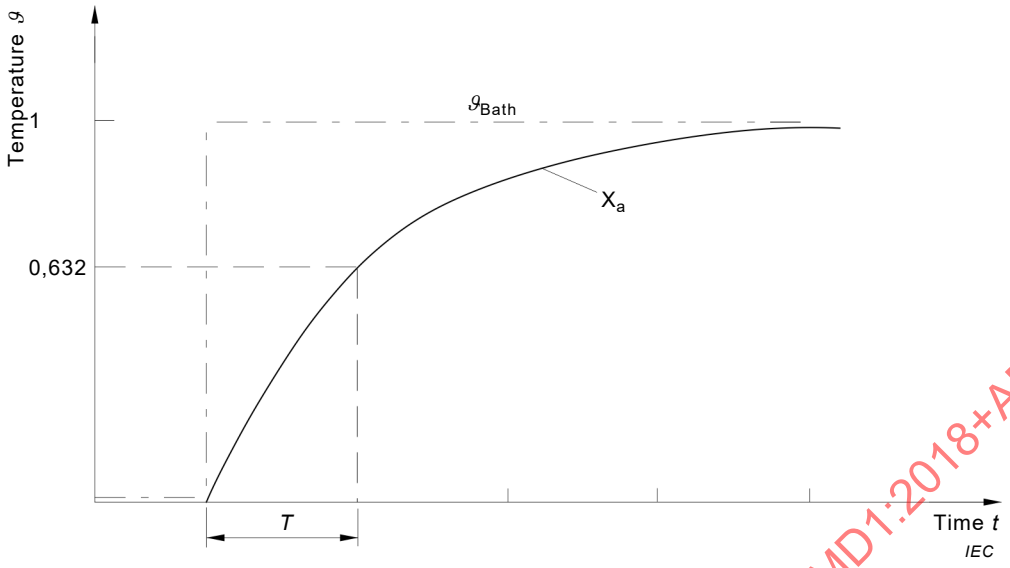
BB.2 Two-bath method

The temperature sensor is subjected to a sudden temperature rise after a steady-state temperature has been reached. The time at which a value of the output signal is reached which is equal to 63,2 % of the sudden temperature rise is determined as **time factor** *T* (see Figure BB.1).

In case of **thermostats** of the continuous type, the **time factor** shall be determined by this method alone.

BB.3 Gradient method

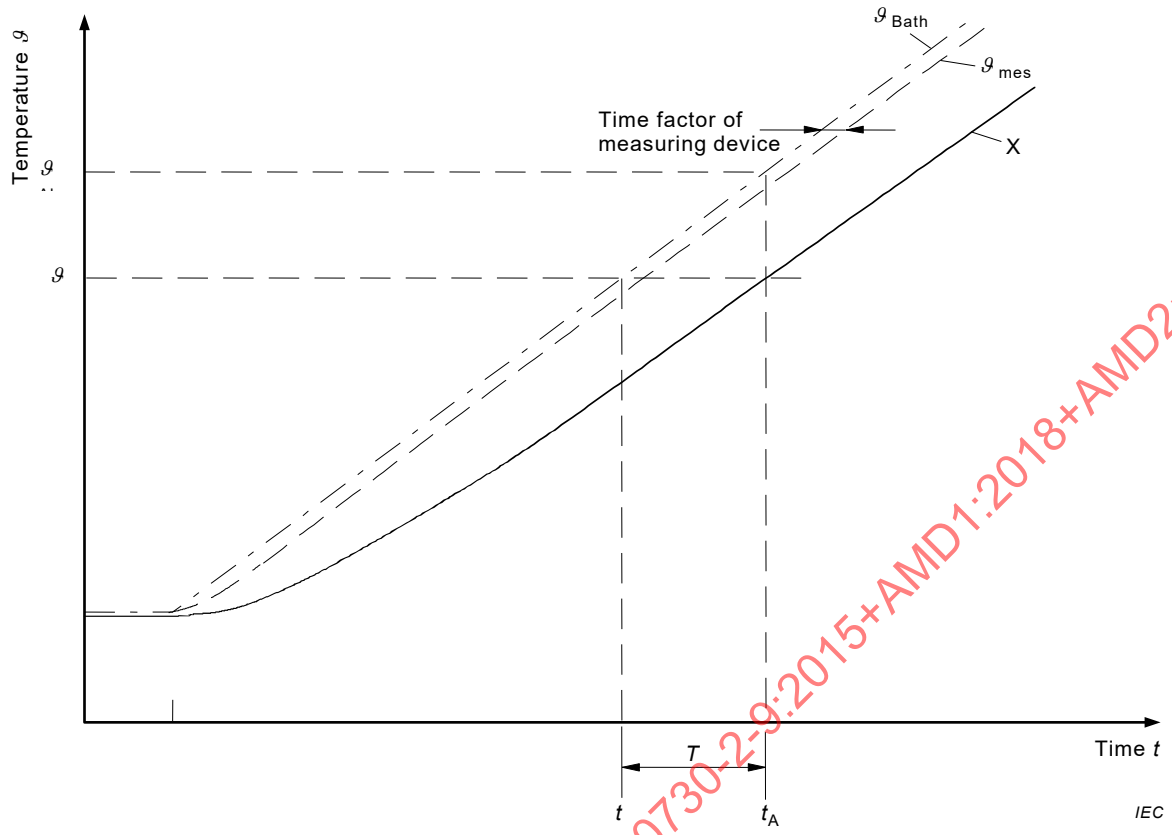
The temperature sensor is subjected to a bath temperature which rises at constant gradient. **Time factor** *T* is determined as a time delay at which the sensor temperature runs approximately parallel to the temperature of the bath. This occurs when a period of +5 *T* has elapsed since the beginning of the rise in temperature. The **time factor** of the measuring device shall be taken into account here (see Figure BB.2).



Components

ϑ_{Bath}	Test-bath temperature
X_a	Sample output signal
T	Time factor

Figure BB.1 – Determination of time factor in the case of a sudden temperature change



Components

ϑ_{Bath}	Test-bath temperature	ϑ_G	Set limit value
ϑ_{mes}	Bath temperature measured	t_{Ab}	Time of switch-off
X_a	Sample output signal	t_o	Time when $\vartheta_{Bath} = \vartheta_G$
ϑ_{Ab}	Switch-off temperature	T	$t_{Ab} - t_o$ (time factor)

Calculation of switch-off temperature ϑ_{Ab} under test conditions when T and A are known.

$$\vartheta_{Ab}\,^{1)} = T \times A + \vartheta_G$$

where A is the test-bath temperature gradient.

Figure BB.2 – Determination of time factor in the case of a linear rise of test-bath temperature

Table BB.1 – Method to determine and verify time factor values (see 11.101)

	Mode of working	Time factor T with working fluid at the sensing device s		
		Water	Air	Oil
Boiler thermostat and boiler **temperature limiters**	Continuous	130	120	–
Boiler thermostat, boiler **temperature limiters** and boiler **thermal cut-outs**	Two-point behaviour	45	120	60
Flue gas **temperature limiters**	Two-point behaviour	–	45	–

1) When a period of approximately 5 T has elapsed since the beginning of the rise in temperature.

Annex CC
(informative)

Number of cycles

CC.1 Number of cycles for independently mounted and in-line cord controls

Temperature sensing controls	Automatic action	Manual action
Thermostats	6 000	600
Room thermostats	100 000	600
Self-resetting **thermal cut-outs**	1 000	
Non-self-resetting **thermal cut-outs**	300	
Other **manual actions**		300

CC.2 Minimum number of cycles for independently mounted and in-line cord controls (Canada and the USA)

Temperature sensing controls	Automatic action		Manual action		Slow make and slow break [a]			
	With current	Without current	With current	Without current	First	Max. cycles per min	Last	Max. cycles per min
Self-resetting **thermal cut-outs**	100 000				75 000	6	25 000	1 b
Non-self-resetting **thermal cut-outs**	1 000*	5 000	1 000**	5 000	1 000	1 b	5 000	c
Self-resetting **temperature limiters**	6 000				6 000	1 b	–	–
	30 000 d				24 000 d	6 d	6 000 d	1 d
Non-self-resetting **temperature limiters**	6 000*		6 000**		6 000	1 b	–	–
	6 000				6 000	1 b	–	–
Thermostats	30 000 d				24 000 d	6 d	6 000 d	1 d
Other **manual action**			6 000		1 000	6	5 000	1 b
Room thermostats for other than **SELV**	30 000					6	–	–

* Break only.

** Make only.

[a] Magnetic, manual and motor-operated switches or the like, and switches that snap with lost motion and do not creep, may be tested at the rate of six cycles per minute.

[b] For all **controls**, the test is to be conducted with (50 ± 20) % “ON” time. A temperature operated **control** is to be so tested, using a slow rate of change.

[c] When no current is used, the switch may be operated at any convenient speed.

[d] For air-conditioning and refrigeration applications.

Annex DD
(normative)

Controls for use in agricultural confinement buildings

DD.1 Object

The object of Annex DD is to provide a standard test method for determining the ability of a temperature **sensing control** to withstand specified severities of chemical compounds associated with use in **agricultural confinement building** environments. The requirements of this annex are intended to be in addition to the requirements of this standard. Twelve new samples, unless the test of DD.7.8.2 is required, in which case thirteen, are used for the tests of this annex.

Controls declared and intended for use in **agricultural confinement buildings** are not intended for use in potentially explosive atmospheres within the scope of IEC 60079 series.

DD.2 Terms and definitions

DD.2.1
agricultural confinement building
farm structure characterised by being heated and/or cooled by artificial means, where accumulation of animal food and waste may result in concentrations of corrosive compounds not normally found in freely ventilated farm buildings (e.g. barns) and periodically disinfected prior to subsequent similar use

DD.3 Test apparatus

Test chambers and sample shelves are of materials known to withstand the corrosive effects of the test medium so as not to introduce additional by-products of corrosion.

DD.4 Severities

Severities are specified in Clause DD.7.

DD.5 Pre-conditioning

Annex DD does not prescribe any requirement for pre-conditioning. However, **controls** provided with openings for the entrance of wiring, fittings and/or cords of the type intended during installation shall be provided and used during testing. The resultant opening for wires or the cut end of cords, if any, shall be sealed to prevent entrance of the test medium into the control. Other openings, if any, are not modified.

DD.6 Initial measurements

Annex DD does not prescribe any requirement for initial measurements.

DD.7 Testing

DD.7.1 General

For the following tests, if any of the samples exposed for 10 days do not meet the requirements of DD.9.2, the 30 day test may be discontinued to conserve time and test chamber utilization.

DD.7.2 Moist carbon dioxide – sulfur dioxide – air mixture

Two samples are placed in the test chamber, one exposed for 10 days and the other for 30 days. An amount of carbon dioxide equivalent to 1 % of the volume of the test chamber

and an equal amount of sulfur dioxide is to be introduced into the test chamber each working day. Prior to the introduction of gas each day, the gas-air mixture from the previous day is purged. The test is run continuously, with the introduction of gas accomplished at least 8 times during the 10 day exposure and 22 times during the 30 day exposure.

A quantity of 10 ml of water per 0,003 m^3 of chamber volume is maintained at the bottom of the chamber for humidity.

The temperature of the test chamber is maintained at (35 ± 2) °C.

DD.7.3 Moist hydrogen sulfide – air mixture

Two samples are placed in the test chamber, one exposed for 10 days and the other for 30 days. An amount of hydrogen sulfide equivalent to 1 % of the volume of the test chamber is to be introduced into the test chamber each working day. Prior to the introduction of gas each day, the gas-air mixture from the previous day is purged. The test is run continuously, with the introduction of gas accomplished at least 8 times during the 10 day exposure and 22 times during the 30 day exposure.

A quantity of 10 ml of water per 0,003 m^3 of chamber volume is maintained at the bottom of the chamber for humidity.

The temperature of the test chamber is maintained at (25 ± 5) °C.

DD.7.4 Moist ammonia – air mixture

Two samples are placed in the test chamber, one exposed for 10 days and the other for 30 days. An ammonium hydroxide-water solution is placed in the bottom of the chamber. The solution is of a concentration which produces a 1 % by volume ammonia vapour above the solution, the remaining vapour being composed of air and water. The solution is not replaced or replenished during the test.

The temperature of the test chamber is maintained at (35 ± 2) °C.

DD.7.5 Urea – water vapour

Two samples are placed in the test chamber, one exposed for 10 days and the other for 30 days. A saturated urea-water solution (excess crystals in 10 ml of water per 0,003 m^3 of chamber volume) is placed in the bottom of the chamber. The solution is not replaced or replenished during the test.

The temperature of the test chamber is maintained at (35 ± 2) °C.

DD.7.6 Warm humid air

Two samples are placed in the test chamber, one exposed for 10 days and the other for 30 days. The humidity of the test chamber is maintained at (98 ± 2) % relative humidity.

The temperature of the test chamber is maintained at (60 ± 1) °C.

DD.7.7 Disinfectant – germicide – water mixture exposure

One sample is exposed to 1 300 cycles of intermittent spraying and drying of disinfectant-germicide-water mixture. The spray-dry cycle consists of 10 min spray followed by 50 min of no spray.

The temperature of the test chamber is maintained at (35 ± 2) °C.

NOTE The dairy disinfectant-germicide is mixed at a concentration of 7,8 ml disinfectant-germicide per litre of water. The disinfectant-germicide is composed of 15 % dimethyl ammonium chloride compounds and 85 % inert ingredients.

DD.7.8 Dust exposure

DD.7.8.1 Dust penetration

One sample shall be exposed to the dust test in IEC 60529 for first characteristic numeral 5. Enclosures may be deemed either category 1 or category 2.

DD.7.8.2 Dust heating, abnormal

For **controls** incorporating heat-producing devices (e.g. transformer, relay, electronic switching device), one sample is mounted and electrically connected as intended in a test chamber. Wheat and corn dust passed through a 0,075 mm mesh width screen is blown into the top of the chamber and allowed to fall vertically onto the sample until the blanket on top of the sample stabilizes. The blower is deenergized.

The test chamber temperature is then raised to T_{max} or 40 °C, whichever is greater, and the sample energized at V_r and I_r until chamber temperature stabilizes.

DD.8 Recovery

Samples tested in accordance with DD.7.2 through DD.7.8.1, inclusive, are rinsed with water and allowed to dry at room temperature.

DD.9 Evaluation

DD.9.1 General

Gaskets and other materials intended to seal the enclosure shall not have deteriorated excessively.

External adjustments and other mechanisms, if any, shall remain operable. Compliance is checked by **actuation** and inspection.

Samples of the **control** shall complete each of the six corrosive exposure tests without undue corrosion which may affect integrity of the enclosure so as to impair its function within the meaning of this standard. Compliance is checked by inspection.

DD.9.2 For the tests of DD.7.2 through DD.7.7, each sample shall meet the requirements of Clause 8, 17.5 and Clause 20 after the overvoltage test of 17.1.3.1 conducted at room temperature.

NOTE In Canada and the USA, the overvoltage test is replaced by an overload test.

DD.9.3 For the test of DD.7.8.1, dust shall not have entered the enclosure.

Compliance is checked by inspection.

DD.9.4 For the test of DD.7.8.2, the temperatures specified in Clause 14 shall not be exceeded by more than 15 K.

Annex EE
(informative)

Guide to the application of temperature sensing controls within the scope of IEC 60730-2-9

EE.1 General

EE.1.1 Annex EE applies to automatic temperature **sensing controls** for use in, on or in association with equipment for household and similar use, including **electrical controls** for heating, air-conditioning and similar applications.

The purpose of Annex EE is to provide guidelines for the selection of temperature **sensing controls** by the user based on the particular application. It is also intended for technical committees to give guidance on the use of the various classifications of IEC 60730-2-9.

EE.1.2 Overview

All temperature **sensing controls** tested in accordance with IEC 60730-2-9 are tested to determine inherent constructional safety and safe **operation**. Safety is checked in the areas of protection against electric shock, heating, electric strength, provision for earthing, mechanical strength, endurance and abnormal use, etc. as appropriate.

Also included are requirements for **electronic controls**, including those incorporating **complex electronics** and software.

Controls classified as type 2 are also ~~checked~~ assessed to provide a degree of confidence in terms of their operating temperature. Tests are made to determine that the spread of operating temperature in the new condition is within the manufacturer's declared value, and also to determine that drift of operating temperature is within the manufacturer's declared value after the specified ~~endurance~~ tests.

NOTE A temperature **sensing control** can be classified for more than one purpose, depending upon the application.

EE.2 Selection of temperature sensing controls within the scope of IEC 60730-2-9

Suitable **controls** for a specific application are selected based on the classifications and declarations recorded in the relevant test report under Clauses 6 and 7 of the standard. Such classifications and declarations applicable to all **automatic controls** are contained in IEC 60730-1. Amendments and additions to Part 1 are given in the relevant Part 2, that is IEC 60730-2-9 for temperature **sensing controls**.

The IEC 60730 series of standards should be regarded as a catalogue of characteristics from which the manufacturer will have specified a set, applicable to his particular control, and the types of application for which he believes it suitable.

It is therefore the responsibility of the user of the control, be it an OEM (Original **Equipment Manufacturer**) or **installer**, to select the control which is suitable for their intended application. Also, equipment product standards should specify minimum requirements for control applications. It is not sufficient to specify simply that a **control** shall comply with IEC 60730, or IEC 60730-2-9, but rather particular declarations of relevant types and characteristics should be selected.

EE.3 Classifications common to temperature sensing controls

EE.3.1 Nature of supply

Indicates the type of supply voltage for which the **control** is suitable, a.c. only, d.c. only or a.c. and d.c. There is also the provision for specific types of supply or multiple supplies.

EE.3.2 Type of load

Indicates the type of load, that is,

– resistive only;
– resistive or inductive or a combination of both, for which the inductive element covers loads with a power factor not less than 0,6;
– specific load;
– current less than 20 mA;
– specific motor load;
– pilot load.

Controls for resistive circuits may be used for an inductive load, provided that the power factor is not less than 0,8, and the inductive load does not exceed 60 % of the current rating for the resistive load. Such circuits may also be used for other reactive loads provided that the reactive current does not exceed 5 % of the rated resistive current, and that the load is not greater than 10 VA.

An example of a resistive plus inductive load is a circuit in a fan-heater which incorporates both a heating element and a motor.

Circuits intended for inductive loads only may either be classified under EE.3.2 by declaring that the resistive load is equal to the inductive load, or may be classified as for a declared specific load.

Examples of specific loads are circuits for tungsten filament or fluorescent lamp loads, highly inductive loads with a power factor of less than 0,6, capacitive loads, and contacts intended to be operated off load.

Examples of circuits of less than 20 mA are circuits for neon indicators and other signal lamps.

EE.3.3 Types of temperature sensing controls according to their purpose

~~A temperature **sensing control** may be classified for more than one purpose.~~

EE.3.3.1 Thermostat

Cycling temperature **sensing control**, which is intended to keep a temperature between two particular values under normal operating conditions of the controlled equipment and which may have provision for **setting by the user**. A **thermostat** is therefore also classified as an ~~operational~~ **operating** control with at least type 1 action (electromechanical) or at least Class A control function (electronic control). A typical usage of **thermostats** is to control the normal running temperature of a room heater or hot plate.

Thermostats are defined in IEC 60335-1 as follows:

thermostat
temperature-sensing device, the operating temperature of which may be either fixed or adjustable and which during normal **operation** keeps the temperature of the controlled part between certain limits by automatically opening and closing a circuit

EE.3.3.2 Temperature limiter

Temperature **sensing control** which is intended to keep a temperature below or above one particular value during normal operating conditions of the controlled equipment and which may have provision for **setting by the user**. A **temperature limiter** is therefore also classified as an ~~operational~~ **operating control** with Class A control functions. Under certain applications, a **temperature limiter** may be classified as an **operating control** with Class B control functions. A typical usage of a **temperature limiter** with Class A function is to switch off a kettle on boiling.

A **temperature limiter** may be of the automatic or of the manual reset type. It does not make the reverse **operation** during the normal duty cycle of the appliance.

Temperature limiters are defined in IEC 60335-1 as follows:

temperature limiter
temperature-sensing device, the operating temperature of which may be either fixed or adjustable and which during normal **operation** operates by opening or closing a circuit when the temperature of the controlled part reaches a predetermined value

NOTE 1 A **temperature limiter** does not make the reverse **operation** during the normal duty cycle of the appliance. It can require manual resetting.

NOTE 2 **A temperature limiter** control is used to limit the temperature of part of the appliance/equipment during normal **operation** of the appliance. The differential between the operating and remake temperature of a **temperature limiter** is large.

NOTE 3 An electromechanical **temperature limiter** can be either a type 1 or type 2 control depending on the application.

NOTE 4 An electronic **temperature limiter** is classified as an **operating control** with Class A control functions. Under certain applications, a **temperature limiter** may be classified as an **operating control** with Class B control functions.

EE.3.3.3 Thermal cut-out

Temperature **sensing control** intended to keep a temperature below or above one particular value during abnormal operating conditions of the controlled equipment and which has no provision for **setting by the user**. A **thermal cut-out** is therefore also classified as a protective control with a type 2 action (electromechanical) or at least Class B control function (electronic control). Under certain applications, an electronic **thermal cut-out** may be classified as a protective control with Class C control functions, for example, water heaters. Typical usage of **thermal cut-outs** is to provide overheating protection of a room heater, hot plate or water heater.

A **thermal cut-out** may be of the automatic or manual reset type.

~~Normally, a thermal cut-out will provide a **type 2 action**.~~

Thermal cut-outs are defined in IEC 60335-1 as follows:

a) **thermal cut-out**
device which during abnormal **operation** limits the temperature of the controlled part by automatically opening the circuit, or by reducing the current, and is constructed so that its setting cannot be altered by the user

NOTE 1 A **thermal cut-out** control does not operate during normal **operation** of the appliance. It is used to regulate or limit the temperature of part of the appliance/equipment in fault conditions.

NOTE 2 When a **thermal cut-out** is built-in or on a motor, and is specifically intended to protect the motor against overheating due to running overload and failure to start and carries the motor current and is sensitive to motor temperature and current, it is a **thermal motor protector**. **Thermal motor protectors** are covered by IEC 60730-2-22.

b) **self-resetting thermal cut-out**
thermal cut-out that automatically restores the current after the relevant part of the appliance has cooled down sufficiently

NOTE 1 A **self-resetting thermal cut-out** control does not operate during normal **operation** of the appliance. It is used to regulate the temperature of part of the appliance/equipment in fault conditions.

NOTE 2 A **self-resetting thermal cut-out** is normally a type 2 control depending on the application and a declaration of number of cycles is between 300 and 10 000 (depending upon the end product application).

c) **non-self-resetting thermal cut-out**
thermal cut-out that requires a manual **operation** for resetting, or replacement of a part, in order to restore the current

NOTE 1 Manual **operation** includes disconnection of the appliance from the supply mains.

NOTE 2 A **non-self- resetting thermal cut-out** control does not operate during normal **operation** of the appliance. It is used to limit the temperature of part of the appliance/equipment in fault conditions and can disconnect the appliance from the supply mains.

NOTE 3 A **non-self- resetting thermal cut-out** control is usually a type 2 control that provides either micro-disconnection or full-disconnection. A declaration of the number of cycles of **operation** would be at least 30 cycles.

The following **thermal cut-out** is not specifically defined in IEC 60335 but can be used in appliances:

voltage maintained thermal cut-out
thermal cut-out which is maintained in its operated condition by the voltage which appears across it in that condition

NOTE 1 **A voltage maintained thermal cut-out** control can only be reset if the appliance is disconnected from the electrical supply.

NOTE 2 A **voltage maintained thermal cut-out** control does not operate during normal **operation** of the appliance. It is used to limit the temperature of part of the appliance/equipment in fault conditions and can disconnect the appliance from the supply mains.

NOTE 3 A **voltage maintained thermal cut-out** control is a type 2 control. A declaration of the number of cycles of **operation** would be at least 1 000 cycles.

EE.3.3.3.1 Motor protector

Automatic control that is specifically intended to protect the windings of an electric motor from overheating.

EE.3.3.3.2 Thermal motor protector

Automatic control, built-in or on a motor, that is specifically intended to protect the motor against overheating due to running overload and failure to start. The control carries the motor current and is sensitive to motor temperature and current.

NOTE 1 These are covered by IEC 60730-2-22.

NOTE 2 If it is not built-in or on a motor, does not carry the motor current, is not sensitive to motor temperature and current, it is a **thermal cut-out**, which is covered by IEC 60730-2-9.

EE.3.3.4 ~~Bimetallic~~ Single operation device (SOD)

EE.3.3.4.1 Bimetallic

Control having a bimetallic temperature **sensing element**, which is intended to operate only once, and then requires complete replacement. A **single operation device** ~~(SOD)~~ is therefore also classified as a **protective control** with type 2 action (electromechanical). Typical usage of single **operation** devices is to provide overheating protection of an electric kettle or water heater.

A bimetallic single **operation** device ~~(**SOD**)~~ does not reset above a declared temperature.

EE.3.3.4.2 Non-bimetallic

A **non-bimetallic single operation device** ~~(**SOD**)~~ denotes a control having a non-bimetallic sensing device, the **operation** of which cannot be separated from other functions of the control, and which operates only once and then requires complete replacement. Such a device is classified as a protective control.

If such parts can be tested separately, then they are identified as thermal links, which are not within the scope of IEC 60730-2-9 and are covered by IEC 60691.

Typical usage of single **operation** devices is to provide overheating protection of an electric kettle or water heater.

EE.3.3.5 Protective controls

These are defined in IEC 60335-1 as follows:

protective device
device, the **operation** of which prevents a hazardous situation under abnormal **operation** conditions

NOTE 1 The aim of a **protective device** is to reduce the risk of a hazard by restoring the appliance to a fail-safe under abnormal conditions of the end product. Based on the application, the protective device could be automatically or manually resettable. Examples of a temperature protective device are **single operation devices** (**SOD**), **thermal links** and **thermal cut-outs**.

NOTE 2 An electromechanical **protective device** control is a type 2 control. A declaration of the number of cycles of **operation** would be 1 cycle.

NOTE 3 An electronic **protective device** is classified as a control with Class B or C control functions (depending upon the application).

EE.3.4 Features of automatic action

EE.3.4.1 Controls are classified either as type 1 or type 2

A **type 1** control is tested fully to determine inherent safety, but is not tested to determine operating temperature consistency, either in the new condition, or after the specified ~~endurance~~ tests. Type 1 controls are therefore intended to be used in applications where the controlled temperature is not critical, in terms of performance or safety of the controlled equipment.

A **type 2** control is tested for inherent safety and for consistency of operating temperature, both in new condition, to check that the operating temperature is within the manufacturers' declared manufacturing tolerance (**manufacturing deviation**), and also for the change in operating temperature (drift) after the specified ~~endurance (**drift**)~~ tests.

It should be noted that both **manufacturing deviation** and **drift** are declared by the manufacturer of the control. A **user** of the **control** should therefore ensure that a **control** is chosen which is suitable and meets the requirements of the application, allowing for the declared **manufacturing deviation** and **drift**.

Type 1 actions and **type 2 actions** are further classified according to one or more of the following constructional or operational features as outlined in EE.3.4.2 and EE.3.4.3.

These further classifications are only applicable if the relevant declarations have been made and any appropriate tests completed.

An action providing more than one feature may be classified by a combination of the appropriate letters, for example, type 1.C.L. or type 2.A.E.

A **manual action** is not classified according to EE.3.4.1.

EE.3.4.2 Constructional features

The following constructional features can be declared. The incorporation of these features into the design of a **control** will depend on the intended final use of the control, its application within an equipment, or the type of equipment in which it is incorporated.

– A **trip-free** mechanism which cannot even momentarily be reclosed against the **fault** (type 1.D or 2.D, see 6.4.3.4).

  This type of mechanism may be required by some equipment standards, where even a very short reclosure of the contacts while the equipment is in a **fault** condition could result in an escalation of the **fault** condition. An example is where such reclosure could result in the **operation** of a safety valve allowing steam to escape.

– A **trip-free** mechanism in which the contacts cannot be prevented from opening or maintained closed against a continuation of the **fault** (type 1.E or 2.E, see 6.4.3.5).

  An example is a current-**sensing control** which has to be reclosed or can be reclosed momentarily to detect that the excess current **fault** still exists. A mechanism of this type would be acceptable in applications where a very short reclosure would not seriously affect the **fault** conditions in the controlled equipment, for example an electric room heater.

– An action which can only be reset by the use of a **tool** (type 1.F or 2.F, see 6.4.3.6).

  This type of action is necessary when, for example, **servicing** by a skilled person is necessary after a particular type of **fault**.

– An action which is not intended to be reset under electrically loaded conditions (type 1.G or 2.G, see 6.4.3.7).

  This type of action might be used to allow a lower contact specification, or where an equipment needs to be restarted from an ‘off’ state.

– A **trip-free** mechanism in which the contacts cannot be prevented from opening and which may automatically be reset to the "closed" position after normal **operation** conditions have been restored if the reset means is held in the "reset" position (type 1.H or 2.H, see 6.4.3.8).

– A **trip-free** mechanism in which the contacts cannot be prevented from opening and the **control** is not permitted to function as an automatic reset device if the reset means is held in the "reset" or "on" position (type 1.J or 2.J, see 6.4.3.9).

EE.3.4.3 Operational features

The following operational features can be declared. The incorporation of these features into the design of a **control** will depend on the intended final use of the control, its application within an equipment, or the type of equipment in which it is incorporated.

– For sensing actions, no increase in the **operating value** as the result of a breakage in the **sensing element**, or in parts connecting the **sensing element** to the **switch head** (type 1.K or 2.K, see 6.4.3.10).

  This type of design can be used to prevent excessive temperature/pressure conditions after breakage of a temperature **sensing element**, for example in a pressurised water heater.

– An action so designed that in the case of **failure** of the electrical supply, it performs its intended function independently of any external auxiliary energy source or electrical supply (type 1.L or 2.L, see 6.4.3.11).

– An action which operates after a declared ageing period (type 1.M or 2.M, see 6.4.3.12).

This type of action may be required for a **protective control** which spends the majority of its life at a normal working temperature, and is then required to operate without fail, when an equipment **fault** condition is sensed, e.g. self-cleaning ovens.

EE.3.5 Control pollution situation

The **control** is classified according to the degree of protection provided by its enclosure against harmful ingress of water and solid objects (dust). These classifications are in accordance with IEC 60529 and are known as IP ratings. A **control** rated as IP00 has no enclosure and therefore relies on the protection afforded by the equipment in which it is installed for protection against the ingress of water and dust.

A **control** intended for use in a particular environment may be used for a different environment if the appropriate provisions, if any, are made in the equipment.

EE.3.6 Method of connection

Control with at least one terminal intended for the connection of **fixed wiring**.

NOTE In Canada and the USA, **flying leads** are allowed.

Control with at least one terminal intended for the connection of a flexible cord.

Fixed wiring and flexible cords are defined as **external conductors**.

A **control** may be classified for both the above types of terminal.

Control without any terminals intended for the connection of an **external conductor**.

This type of **control** is intended for the connection of only integrated or **internal conductors**.

External conductor is a conductor, a part of which is external to an **in-line cord control**, an **independently mounted control** or to an equipment in or on which a **control** is mounted.

Internal conductor is a conductor which is neither an **external conductor**, nor an **integrated conductor**. This includes conductors external to a **control** but within an equipment.

Integrated conductor is a conductor inside a control, or is used to permanently interconnect terminals or **terminations** of a control.

EE.3.7 Ambient temperature limits of the switch head

The **switch head** is defined as all parts of the **control** other than the temperature **sensing element**. If by construction it is impossible to distinguish between the **switch head** and the temperature **sensing element**, then the whole **control** is considered to be the **sensing element**.

If no declaration of ambient temperature is made, the ambient temperatures are assumed to be between the minimum value (T_{min}) of 0 °C, and a maximum value (T_{max}) of 55 °C. Other values may be declared, but no less than a maximum value (T_{max}) of 30 °C or a minimum value (T_{min}) of 0 °C.

Preferred values of T_{max} are 30 °C, 55 °C, 70 °C, 85 °C, 105 °C, 125 °C, 150 °C. Preferred values of T_{min} are 0 °C, –10 °C, –20 °C, –30 °C, and –40 °C.

Values differing from these preferred values are allowed.

EE.3.8 Protection against electric shock

This classification covers the method of providing protection against electric shock, that is the combination of earthing, and/or insulation or extra low voltage, used to provide the necessary protection.

There are five types of protection, known as class 0, class 0I, class I, class II and class III. The definitions for these classes are detailed in 2.7.2 to 2.7.6 of IEC 60730-1.

This classification differs for the following various types of control.

An **integrated control** is not classified but takes the classification of the equipment with which it is integrated.

An **incorporated control** is classified for use in an equipment of class 0I, class 0, class I, class II or class III.

An **in-line cord control**, a freestanding control, or an **independently mounted control** is classified as class 0I, class 0, class I, class II or class III.

EE.3.9 Circuit disconnection or interruption

Contact separation is classified according to one of the following types:

– full-disconnection;
– **micro-disconnection**;
– **micro-interruption**;
– **all-pole disconnection**;
– **electronic disconnection**, see Clause H.28.

Some **equipment** standards may require full-disconnection, others may permit either full-disconnection or **micro-disconnection**; some may only require **micro-interruption**.

Different actions of a **control** may provide different circuit disconnections or interruptions.

– **Full disconnection** A contact separation in all supply poles other than earth, which provide the equivalent of **basic insulation** between the supply mains and those parts intended to be disconnected.

  This type of disconnection is intended for situations where electrical isolation is required. In some equipment standards, a physical contact gap of 3 mm is required for situations where the disconnected part can be touched during **servicing**, etc.

– **Micro-disconnection** Provides adequate contact separation in at least one pole so as to provide functional security.

  Micro-disconnection denotes that for non-**sensing controls** the function controlled by the disconnection is secure, and for **sensing controls** is secure between the limits of **activating quantity** declared in Table 1, requirement 36.

  This type of disconnection is not intended to provide electrical isolation, and flashover may occur during transient over voltage conditions.

  Where the number of poles on the **control** is equal to the number of supply poles of the equipment to which it is connected, full-disconnection provides **all-pole disconnection**.

– **Micro-interruption** Interruption of a circuit by contact separation, by a cycling action or a non-cycling action, and which does not provide full-disconnection or **micro-disconnection**.

  This type of interruption would normally be applicable, for example, to a **thermostat** without a marked **OFF position**.

– **All-pole disconnection** For single-phase a.c. appliances and for d.c. appliances, disconnection of both supply conductors by a single switching action or, for appliances to be connected to more than two supply conductors, disconnection of all supply conductors, except the earthed (grounded) conductor, by a single switching action.

  The protective earthing conductor is not considered to be a supply conductor.

  All pole disconnection may provide either full-disconnection or **micro-disconnection**.

– **Electronic disconnection** A non-cycling disconnection by an **electronic device** of a circuit for functional disconnection and which provides a disconnection other than by means of an air gap by satisfying certain electrical requirements in at least one pole.

  Electronic disconnection is similar to **micro-disconnection** in application, but may not be suitable for some types of application, where conduction of one half cycle of the supply waveform while in the “OFF” condition could result in a hazard.

EE.3.10 Number of cycles of actuation (M) of each manual action

Preferred values are:

– 100 000 cycles;
– 30 000 cycles;
– 10 000 cycles;
– 6 000 cycles;
– 3 000 cycles [2];
– 300 cycles [3];
– 30 cycles [3].

EE.3.11 Number of automatic cycles (A) of each automatic action

Preferred values are:

– 300 000 cycles;
– 200 000 cycles;
– 100 000 cycles;
– 30 000 cycles;
– 20 000 cycles;
– 10 000 cycles;
– 6 000 cycles;
– 3 000 cycles [3];
– 1 000 cycles [3] [4];
– 300 cycles [5] [5];
– 30 cycles [4] [6];

_____

[2] Applicable only to actions of **controls** for specific equipment and applications such as voltage-tap **controls**, summer/winter **controls** for water heaters and where permitted by the appropriate equipment standard.

For **controls** with more than one **manual action**, a different value may be declared for each. If a **control** has more than one intended "OFF" position, then a cycle of **actuation** shall be regarded as a movement from one "OFF" position to the next "OFF" position.

[3] Not applicable to thermostats or to other fast cycling actions.

[4] Applicable only to manual reset.

[5] Applicable only to actions which require the replacement of a part after each **operation**.

[6] Can only be reset during **manufacturer servicing**.

– 1 cycle [5)].

For **controls** having more than one **automatic action**, a different value may be declared for each.

EE.3.12 Temperature limits of the mounting surface of the control

Controls may be classified as:

– **control** suitable for mounting on a surface which is not more than 20 K above the ambient temperature classified in 6.7;

– **control** suitable for mounting on a surface which is more than 20 K above the ambient temperature classified in 6.7.

An example of such a **control** is one mounted on a compressor unit in a refrigerator, where the mounting surface may be 150 °C, although the **sensing element** is at a temperature of –10 °C, and the ambient temperature is only 30 °C.

EE.3.13 Value of proof tracking index (PTI) for the insulation material used

Values for PTI are:

– material of material group IIIb with a PTI of 100 and up to but excluding 175;

– material of material group IIIa with a PTI of 175 and up to but excluding 400;

– material of material group II with a PTI of 400 and up to but excluding 600;

– material of material group I with a PTI of 600 and over.

EE.3.14 Period of electrical stress across insulating parts supporting live parts and between live parts and earthed metal

Electrical stress across the insulated parts is classified according to the following:

– short period;

– long period.

Long periods of electrical stress are considered to exist if the **control** is used in equipment for continuous use; and also for the supply side of a **control** in any other equipment unlikely to be disconnected from the supply by the removal of a plug or by the **operation** of a **control** providing **full disconnection**.

At the present time, this classification is not used and no tests are specified.

EE.3.15 Construction

Construction is classified according to the following types:

– **integrated control**;

– **incorporated control**;

– **in-line cord control**;

– **free-standing control**;

– **independently mounted control** for:

  • surface mounting;

  • flush mounting;

  • panel mounting.

EE.3.16 Ageing requirements of the equipment in which the control is intended to be used

Preferred values are:

– 60 000 h;
– 30 000 h;
– 10 000 h;
– 3 000 h;
– 300 h;
– 15 h.

Controls which operate during the heating or endurance tests of the equipment standard are not classified according to EE.3.16.

EE.3.17 Definitions of type of control according to construction

electronic control
a control which incorporates at least one electronic device

EE.3.18 Definitions relating to classes of control functions

For the evaluation of protective measures for fault tolerance and avoidance of hazards, it is necessary to classify control functions with regard to their fault behaviour.

At the classification of control functions, their integration into the complete safety concept of the appliance shall be taken into account.

NOTE A control function consists of the entire loop beginning with the sensing means through the processing circuitry (hardware and software if used) and including the actuator drive.

For the purpose of evaluating the design of a control function, present requirements recognise three distinct classes:

a) **class A control function**
control functions which are not intended to be relied upon for the safety of the application

NOTE 1 Examples are: room **thermostats**, temperature control.

b) **class B control function**
control functions which are intended to prevent an unsafe state of the appliance

NOTE 1 Failure of the control function will not lead directly to a hazardous situation.

NOTE 2 Examples are: thermal limiter, pressure limiter.

c) **class C control function**
control functions which are intended to prevent special hazards such as explosion or whose failure could directly cause a hazard in the appliance

NOTE 1 Examples include **thermal cut-outs** for closed water systems (without vent protection).

EE.4 Specific types of temperature sensing control

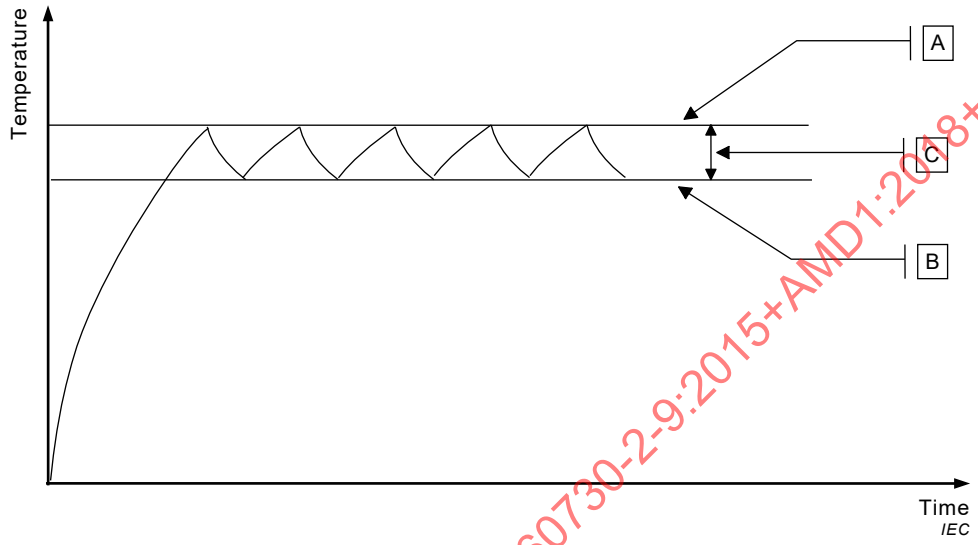
A detailed guide to the application of the various types of temperature **sensing controls** is given below.

EE.4.1 Thermostats

EE.4.1.1 Function

As defined, a **thermostat** is intended to operate automatically to keep the temperature of the controlled medium, air, water, oil, solid material or surface, between an upper and lower temperature, the difference being called the differential.

The type of controlled output is shown graphically in Figure EE.1.



Key

A upper temperature

B lower temperature

C differential

Figure EE.1 – Thermostat

A **thermostat** can either be fixed **setting** or can have an **actuating member** for **setting** of the controlled temperature by the end **user**. For **thermostats** intended for integration or incorporation into equipment, means may also be provided for initial **setting by the equipment manufacturer** or **setting by the installer**.

A **thermostat** is intended to operate during the normal **operation** of equipment, and the number of **operations** specified in 6.10 and 6.11 should be selected to cover the expected number of **operations** during the estimated life of the equipment. This is primarily to determine its safe **operation** during the life of the equipment, and for type 2 **controls**, to provide confidence that the operating temperature will be maintained within specified limits.

The **failure** of a **thermostat** to operate due to, for example, welded contacts, is normally protected against in equipment by provision of a thermal cut out, or a **single operation device**.

EE.4.1.2 Examples of operation

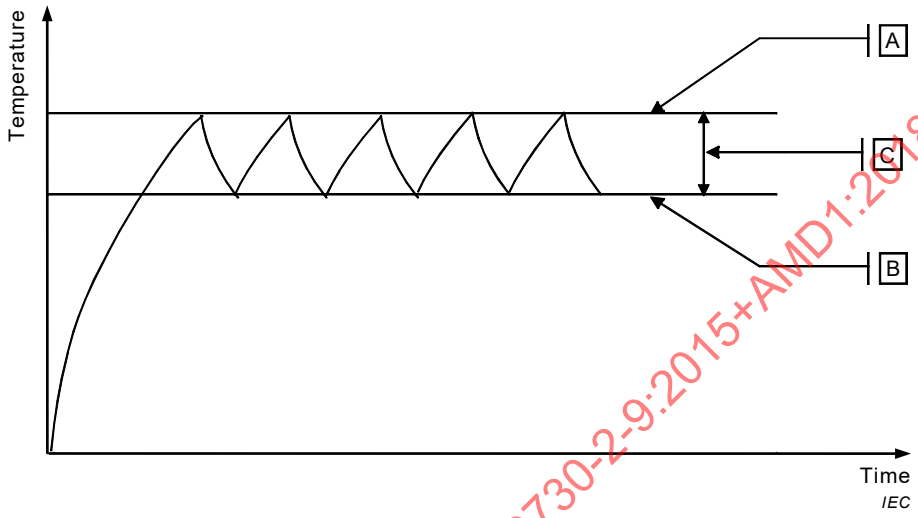
Refer to Table EE.1.

EE.4.2 Temperature limiter

EE.4.2.1 Function

As defined, a **temperature limiter** is intended to operate to keep the temperature of the controlled medium, air, water, oil, solid material or surface, above or below the set temperature.

The type of controlled output is shown graphically in Figures EE.2 and EE.3.



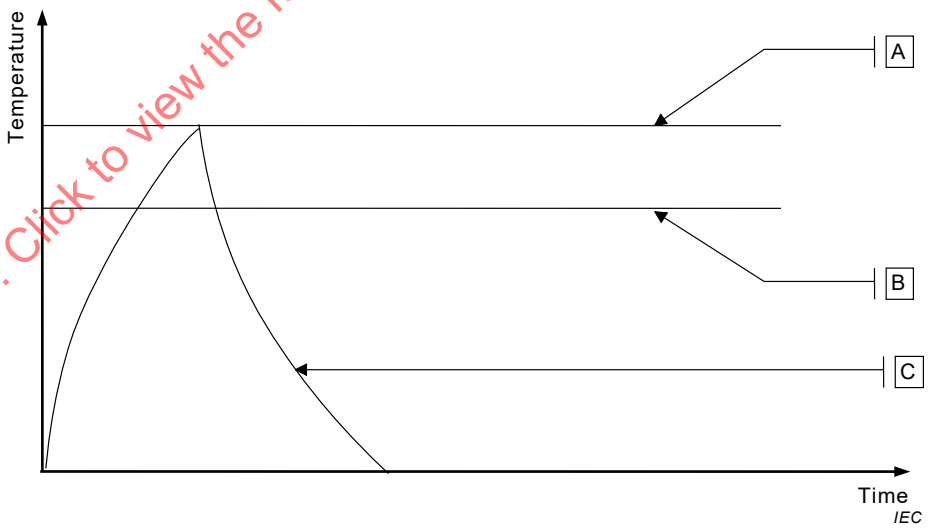
Key

A upper temperature

B lower temperature

C differential (usually much larger than a **thermostat**)

Figure EE.2 – Self-resetting temperature limiter



Key

A set temperature

B reset temperature

C requires manual reset

Figure EE.3 – Non-self-resetting temperature limiter

A **temperature limiter** can either be fixed **setting** or can have an **actuating member** for setting of the temperature by the end **user**. For **temperature limiters** intended for integration or incorporation into equipment, means may also be provided for initial **setting by the equipment manufacturer** or **setting by the installer**.

A **temperature limiter** is intended to operate during the normal **operation** of an equipment and the number of **operations** specified in 6.10 and 6.11 should be selected to cover the expected number of **operations** during the estimated life of the equipment. This is primarily to determine its safe **operation** during the life of the equipment, and for type 2 **controls**, to provide confidence that the operating temperature will be maintained within specified limits.

The **failure** of a **temperature limiter** to operate due to, for example, welded contacts, is normally protected against in an equipment by provision of a thermal cut out, or **single operation device**.

The construction of an automatic reset **temperature limiter** can be identical to a **thermostat**, differing only in the manner in which it has been tested, although frequently it will have a larger differential between the upper and lower operating temperature.

EE.4.2.2 Examples of operation

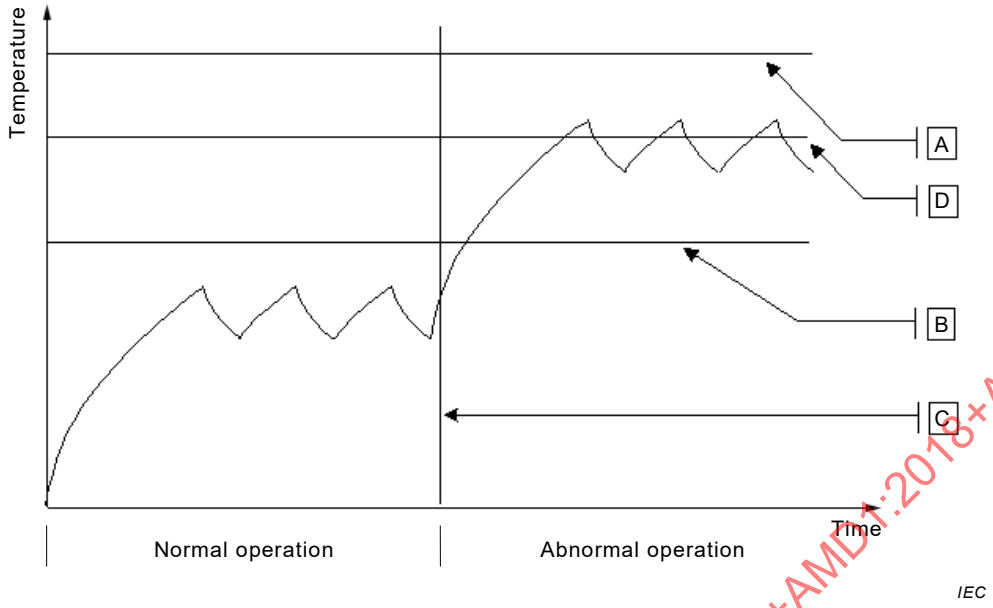
Refer to Table EE.1.

EE.4.3 Thermal cut-out

EE.4.3.1 Function

As defined, a **thermal cut-out** is intended to keep the temperature of the controlled medium, air, water, oil, solid material or surface, above or below the set temperature, during abnormal **operation** of an equipment.

The type of controlled output is shown graphically in Figures EE.4 and EE.5.



Key

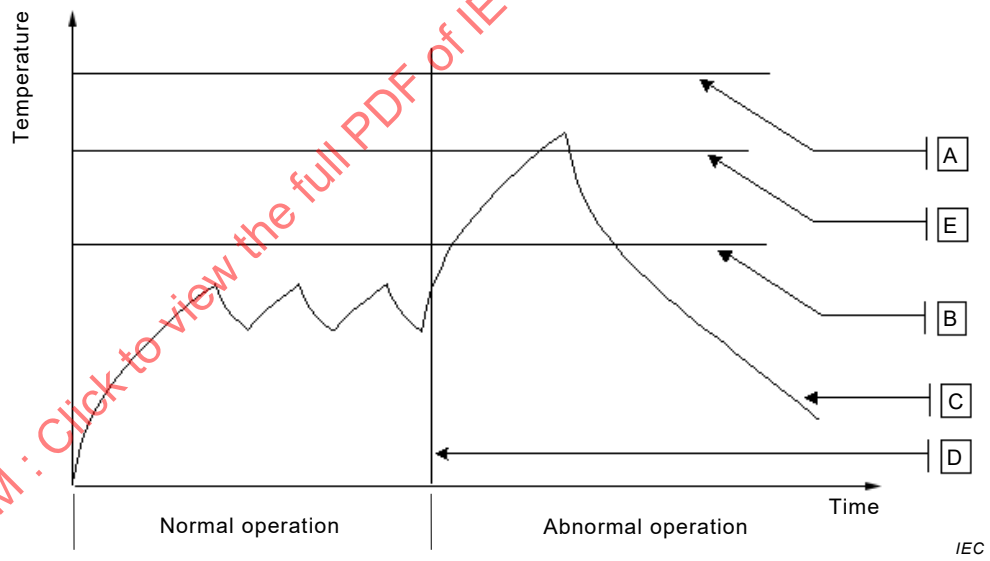
A hazard temperature

B **maximum temperature** during **normal use**

C **fault** condition

D **thermal cut-out** temperature

Figure EE.4 – Self-resetting thermal cut-out



Key

A hazard temperature

B **maximum temperature** during **normal use**

C requires manual reset

D fault condition

E **thermal cut-out** temperature

Figure EE.5 – Manual reset thermal cut-out

A **thermal cut-out** can be either automatic or manual reset, and does not incorporate an **actuating member** for **setting** of the controlled temperature by the end **user**. For thermal cut

outs intended for integration or incorporation into an equipment, means may also be provided for initial **setting by the equipment manufacturer** or **setting by the installer**.

A **thermal cut-out** is intended to operate only during abnormal **operation** of an equipment, and the number of **operations** specified in 6.10 and 6.11 is dependent on the type and usage pattern of the equipment. Equipment standards normally specify the number of **operations** required for **protective controls**, such as **thermal cut-outs**.

Thermal cut-outs will normally be classified as type 2 **controls**, but this is dependent on customer requirements, and/or the requirements specified in the relevant equipment standard.

The number of **operations** specified is therefore normally to determine its safe **operation** during the life of the equipment, and to provide confidence that the operating temperature will be maintained within specified limits.

The **operation** of a thermal cut out is usually the final **protective control** against a hazard or **fault** condition within equipment.

The construction of **thermal cut-outs** can be identical to **thermostats** or **temperature limiters**, differing only in the manner in which they have been tested.

EE.4.3.2 Examples of operation

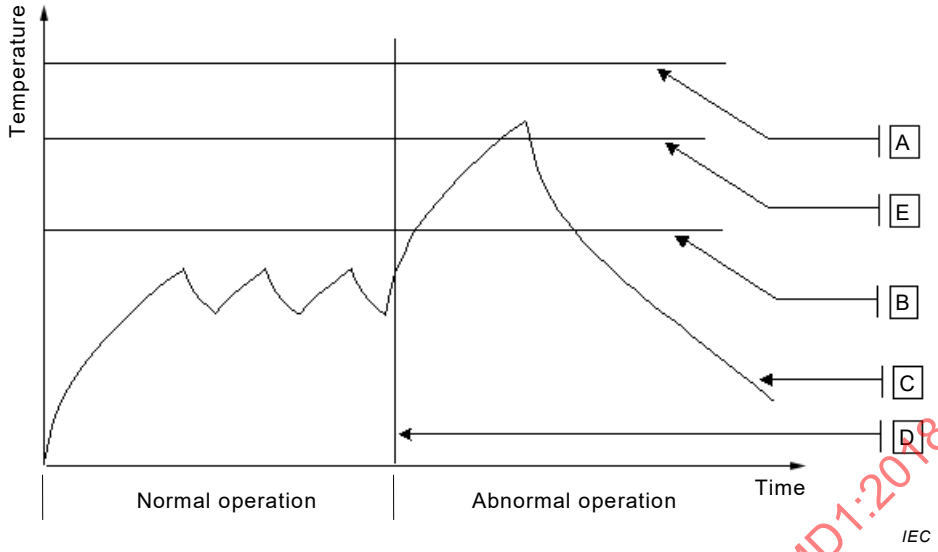
Refer to Table EE.1.

EE.4.4 Single operation device

EE.4.4.1 Application

As defined, a **single operation device** (**SOD**) is intended to keep the temperature of the controlled medium, air, water, oil, solid material or surface, below the set temperature, during abnormal **operation** of equipment.

The type of controlled output is shown graphically in Figure EE.6.



Key

A hazard temperature

B **maximum temperature** during **normal use**

C requires replacement of the **control** or part

D **fault** condition

E **single operation device** (**SOD**) cut out temperature

Figure EE.6 – Single operation device

A **single operation device** (**SOD**) has no means of temperature **setting** after manufacture and is intended to be non-resettable, i.e. a thermal fuse, requiring complete replacement of the **control** or a part of the **control**.

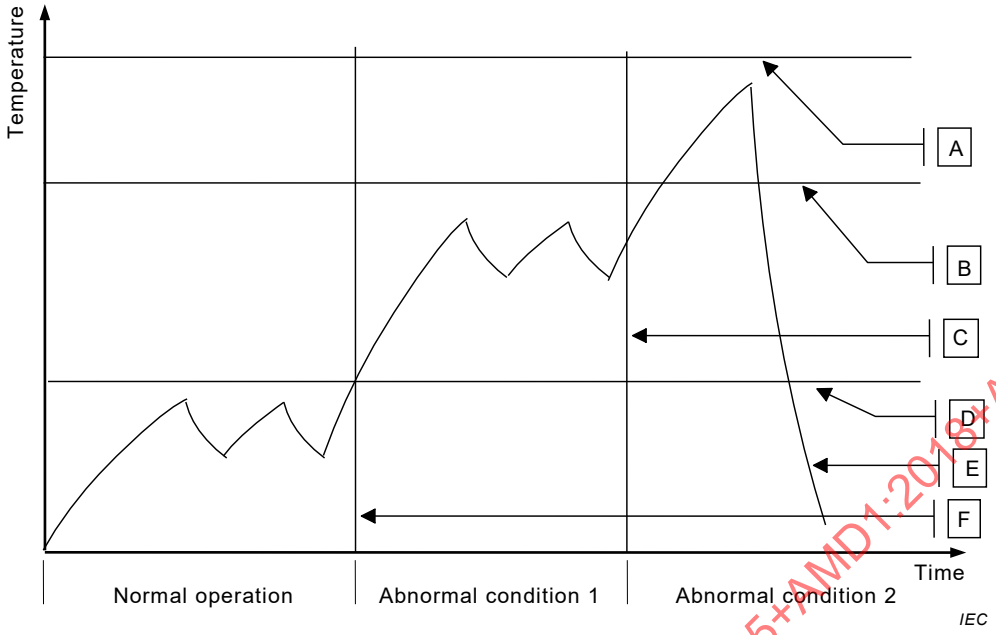
Bimetallic types do however exist which can be reset with specialist equipment.

EE.4.4.2 Examples of operation

Refer to Table EE.1.

Single operation devices are sometimes used in a three-stage **control system**, comprising a **thermostat**, a thermal cut out and a **single operation device**.

Such a **system** is shown graphically in Figure EE.7.



Key

A final hazard temperature (abnormal condition 2)

B interim hazard temperature (abnormal condition 1)

C **failure** of **thermal cut-out**, or abnormal condition to which the **thermal cut-out** is not responsive

D **maximum temperature** during **normal use**

E requires replacement of **control** or part

F **fault** condition

Figure EE.7 – Three-stage control system

EE.4.4.3 Examples of application

Refer to Table EE.1.

Table EE.1 – Typical examples of the classification of temperature sensing controls in accordance with IEC 60730-2-9

Classification	Declaration/Action																	
	Type 1	Type 2	A	B	C	D	E	F	G	H	J	K	L	M	N	P	X	Z
Control application																		
Thermostat in room heaters		X [a]		X									X					
	X				X													
Manual reset **thermal cut-out** in room heaters (small)		X		X		X		X		X		X	X	X		X		
Thermal cut-out for electric kettles		X		X				X										
Temperature limiter in electric kettles	X		X	X														
Auto reset **thermal cut-out** in space heaters (dwelling)		X		X														
Manual reset **thermal cut-out** in space heaters		X		X		X			X									
Thermal cut-out for refrigerator compressor **control** (for **thermal motor protector**, refer to IEC 60730-2-4)		X			X													
Thermal cut-out for room heaters		X			X													
Thermal cut-out for hair dryers		X			X													
Thermal cut-out for transformers		X			X													
Thermal cut-out for fans		X			X													

[a] In general, thermostats provide type 1 action but depending on the application, it is possible for a thermostat to provide type 2 action where the efficacy of the output is desired.

Declaration/ Actions	Control applications												
	TRH	MTC RH	TC EK	TL EK	ART CSH	MTC SH	TC RC	TC RH	TC HD	TCT	TCF	TC WH	TC SP
Type 1	X			X									
Type 2		X	X		X	X	X	X	X	X	X	X	X
A				X									
B		X	X		X	X	X	X	X	X	X	X	X
C	X			X									
Y												X	X
D		X				X							
E													
F		X	X										
G						X							
H		X											
J													
K		X											
L	X	X											
M		X											
N													
P		X											
X													
Z													
AK													
AM													
Class A control function[c]	x			X									
Class B control function[c]		X	X		X	X	X	X	X	X	X	X[a]	X
Class C control function[c]												X[b]	
Electronic circuit faults with regard to functional safety		FF	FF		FF	FF	FF	FF	FF	FF	FF	SF[b] FF[a]	FF

Control application codes:	
Control application	**Code**
Thermostat in room heaters	TRH
Manual reset **thermal cut-out** in room heaters (small)	MTCRH
Thermal cut-out for electric kettles	TCEK
Temperature limiter in electric kettles	TLEK
Auto reset **thermal cut-out** in space heaters (dwelling)	ARTCSH
Manual reset **thermal cut-out** in space heaters	MTCSH
Thermal cut-out for refrigerator compressor control (for thermal motor protector, refer to IEC 60730-2-22)	TCRC
Thermal cut-out for room heaters	TCRH
Thermal cut-out for hair dryers	TCHD
Thermal cut-out for transformers	TCT
Thermal cut-out for fans	TCF
Thermal cut-out for water heaters	TCWH
Thermal cut-out for spa applications	TCSP
[a] First fault applies to non-closed water heater applications [b] First and second fault applies to closed water heater applications. [c] Control functions generally apply to electronic controls.	
Component fault code:	
Component fault	**Code**
First fault	FF
First and second fault	SF

EE.5 Examples of controls used with domestic appliances

EE.5.1 General usage of controls in appliances

See Figure EE.8 for a typical representation of controls evaluated to IEC 60730-2-9 used in appliances.

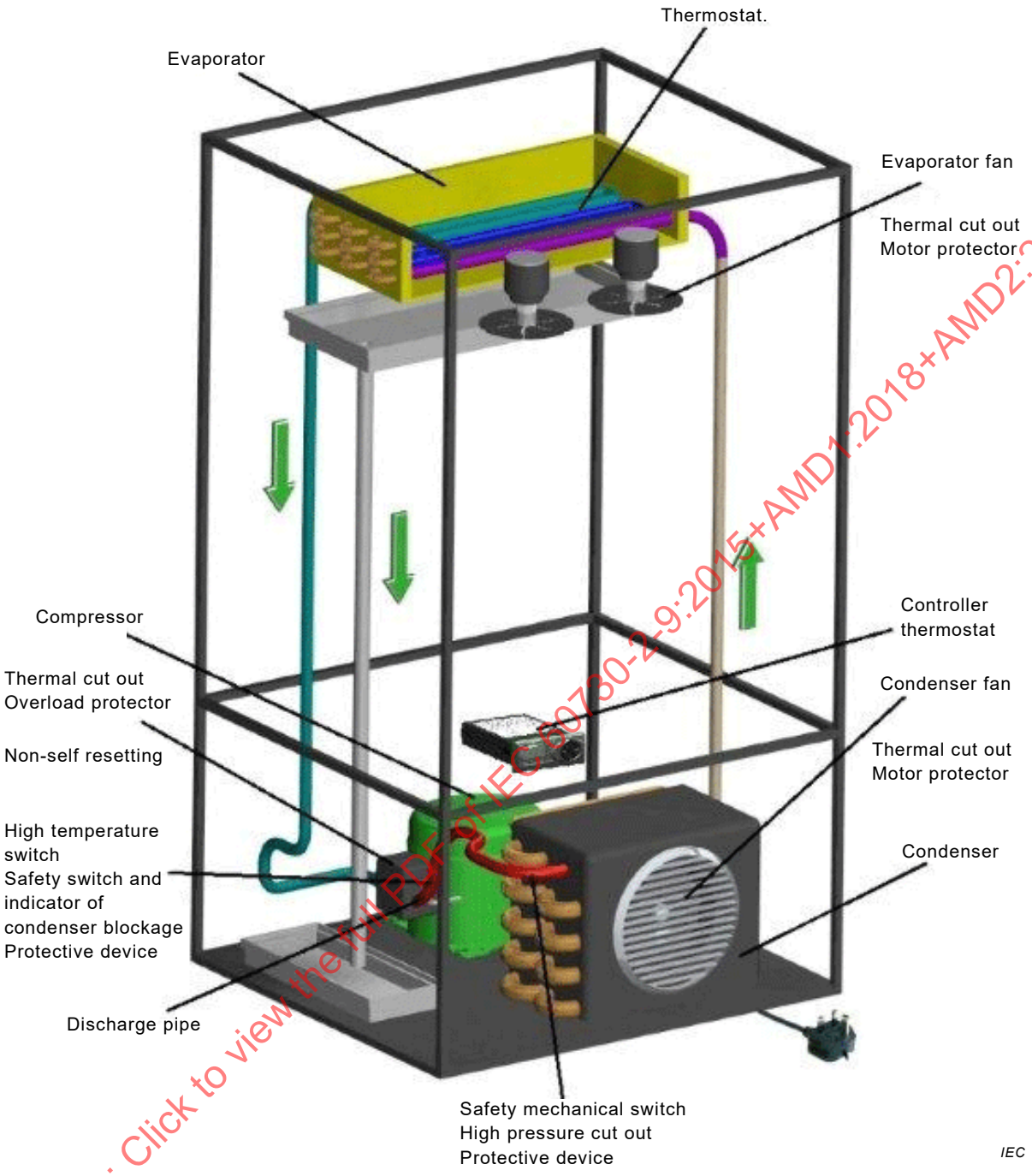


Figure EE.8 – Schematic diagram showing usage of various controls approved to IEC 60730-2-9

EE.5.2 Examples of which device is expected to operate during the tests of Clauses 11 and 19 of IEC 60335 (all parts)

Table EE.2 provides examples of applications where the controls are expected to operate during the tests of Clauses 11 and 19 of IEC 60335 (all parts)

Table EE.2 – Examples of controls expected to operate during Clauses 11 and 19 of IEC 60335 (all parts)

Iron IEC 60335-2-3	**Thermostat** operates (cycles) during the test of normal **operation** tests of Clause 11. **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19
Washing machine IEC 60335-2-7	**Thermostat** operates / cycles during the test of normal **operation** tests of Clause 11. **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19
Toaster IEC 60335-2-9	**Temperature limiter** / **thermostat** operate during the test of normal **operation** tests of Clause 11. **Thermal cut-out** / **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19
Kettle IEC 60335-2-15	**Temperature limiter** / **thermostat** operate during the test of normal **operation** tests of Clause 11. **Thermal cut-out** / **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19
Electric blanket IEC 60335-2-17	**Temperature limiter** / **thermostat** operate during the test of normal **operation** tests of Clause 11. **Thermal cut-out** / **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19
Skin or hair care IEC 60335-2-23	**Temperature limiter** / **thermostat** operate during the test of normal **operation** tests of Clause 11. **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19
Battery chargers IEC 60335-2-29	**Temperature limiter** / **thermostat** operate during the test of normal **operation** tests of Clause 11. **Thermal cut-out** / **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19
Panel heater IEC 60335-2-30	**Thermostat** operates during the test of normal **operation** tests of Clause 11. **Thermal cut-out** / **SOD** / thermal fuse / current fuse operate during the abnormal **operation** tests of Clause 19

Table EE.3 provides a correlation between the various part 2 standards of IEC 60335 to the type of action and functionality of various controls used in the particular products.

Table EE.3 – Guidance on the common usage of types of control

Product	Standard	Temperature limiter	Thermostat	Thermal cut-out (auto reset)	Voltage maintained Thermal cut-out	Thermal cut-out (manual reset)	SOD	Further classification of type of action
Minimum type of control action specified	-	Type 1	Type 1	Type 2	Type 2	Type 2	Type 2	-
Minimum class of control function required for equivalent electronic control		Class A	Class A	Class B	Class B	Class B	Class B	
Appliances	IEC 60335-1	Operating	Operating	Clause 19 (See Note)	Clause 19 (See Note)	Clause 19 (See Note)	Clause 19 (See Note)	
Vacuum cleaners	IEC 60335-2-2			Clause 19 (See Note)	Clause 19 (See Note)	Clause 19 (See Note)	Clause 19 (See Note)	-
Electric irons	IEC 60335-2-3		Operating		Clause 19 (See Note)	Clause 19 (See Note)	Clause 19 (See Note)	-
Spin extractors	IEC 60335-2-4			Clause 19 (See Note)	Clause 19 (See Note)	Clause 19 (See Note)	Clause 19 (See Note)	
Dishwashers	IEC 60335-2-5		Operating	Clause 19			Clause 19	
Stationary cooking ranges	IEC 60335-2-6	Operating	Operating	Clause 19		Clause 19	Clause 19	
Washing machines	IEC 60335-2-7		Operating	Clause 19		Clause 19	Clause 19	
Shavers	IEC 60335-2-8						Clause 19	
Grills and toasters	IEC 60335-2-9	Operating	Operating	Clause 19		Clause 19	Clause 19	
Tumble dryers	IEC 60335-2-11		Operating	Clause 19		Clause 19	Clause 19	
Deep fat fryers	IEC 60335-2-13		Operating	Clause 19		X	X	
Kitchen machines	IEC 60335-2-14		Operating	Clause 19		X	X	

Product	Standard	Temperature limiter	Thermostat	Thermal cut-out (auto reset)	Voltage maintained Thermal cut-out	Thermal cut-out (manual reset)	SOD	Further classification of type of action
Minimum type of control action specified	-	Type 1	Type 1	Type 2	Type 2	Type 2	Type 2	-
Minimum class of control function required for equivalent electronic control		Class A	Class A	Class B	Class B	Class B	Class B	
Appliances for heating liquids **TCEK** **TLEK**	IEC 60335-2-15	Operating	Operating	Subclause 19.4			Clause 19	
Food waste disposers	IEC 60335-2-16					Clause 19	Clause 19	
Electric blankets	IEC 60335-2-17	Operating	Operating			Clause 19	Clause 19	
Storage water heaters	IEC 60335-2-21		Operating			Clause 19 Class C	Clause 19	
Appliances for skin or hair care	IEC 60335-2-23	Operating	Operating				Clause 19	
Refrigerating appliances	IEC 60335-2-24		Operating	Clause 19		Clause 19	Clause 19	
Microwave ovens	IEC 60335-2-25			Clause 19			Clause 19	
Battery chargers	IEC 60335-2-29	Operating	Operating	Clause 19		Clause 19	Clause 19	
Room heaters **TRH** **MTCRH**	IEC 60335-2-30		Operating	Clause 19	Clause 19	Clause 19	Clause 19	
Motor compressors	IEC 60335-2-34			Clause 19			X	
Instantaneous water heaters	IEC 60335-2-35		Clause 19	Clause 19		Clause 19	Clause 19	
Pumps	IEC 60335-2-41			Clause 19		Clause 19	Clause 19	

Product	Standard	Temperature limiter	Thermostat	Thermal cut-out (auto reset)	Voltage maintained Thermal cut-out	Thermal cut-out (manual reset)	SOD	Further classification of type of action
Minimum type of control action specified	-	Type 1	Type 1	Type 2	Type 2	Type 2	Type 2	-
Minimum class of control function required for equivalent electronic control		Class A	Class A	Class B	Class B	Class B	Class B	
Thermal storage heaters	IEC 60335-2-61		Clause 19	Clause 19		Clause 19	Clause 19	
Fixed immersion heaters	IEC 60335-2-73		Clause 19			Clause 19	Clause 19	
Vending machines	IEC 60335-2-75		Operating	Clause 19		Clause 19	Clause 19	
Ventilating fans	IEC 60335-2-80			Clause 19			Clause 19	
Commercial refrigerating appliance	IEC 60335-2-89		Operating	Clause 19		Clause 19	Clause 19	
NOTE Clause numbers refer to when the control is required to operate during the tests of IEC 60335 (all parts). In some applications, a thermal fuse, current fuse or intentionally weak part is also used as an equivalent method of protection.								

Bibliography

The Bibliography of Part 1 is applicable except as follows:

Addition:

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60335-2-2, *Household and similar electrical appliances – Safety – Part 2-2: Particular requirements for vacuum cleaners and water-suction cleaning appliances*

IEC 60335-2-3, *Household and similar electrical appliances – Safety – Part 2-3: Particular requirements for electric irons*

IEC 60335-2-4, *Household and similar electrical appliances – Safety – Part 2-4: Particular requirements for spin extractors*

IEC 60335-2-5, *Household and similar electrical appliances – Safety – Part 2-5: Particular requirements for dishwashers*

IEC 60335-2-6, *Household and similar electrical appliances – Safety – Part 2-6: Particular requirements for stationary cooking ranges, hobs, ovens and similar appliances*

IEC 60335-2-7, *Household and similar electrical appliances – Safety – Part 2-7: Particular requirements for washing machines*

IEC 60335-2-8, *Household and similar electrical appliances – Safety – Part 2-8: Particular requirements for shavers, hair clippers and similar appliances*

IEC 60335-2-9, *Household and similar electrical appliances – Safety – Part 2-9: Particular requirements for grills, toasters and similar portable cooking appliances*

IEC 60335-2-11, *Household and similar electrical appliances – Safety – Part 2-11:Particular requirements for tumble dryers*

IEC 60335-2-13, *Household and similar electrical appliances – Safety – Part 2-13: Particular requirements for deep fat fryers, frying pans and similarappliances*

IEC 60335-2-14, *Household and similar electrical appliances – Safety – Part 2-14: Particular requirements for kitchen machines*

IEC 60335-2-15, *Household and similar electrical appliances – Safety – Part 2-15: Particular requirements for appliances for heating liquids*

IEC 60335-2-16, *Household and similar electrical appliances – Safety – Part 2-16: Particular requirements for food waste disposers*

IEC 60335-2-17, *Household and similar electrical appliances – Safety – Part 2-17: Particular requirements for blankets, pads, clothing and similar flexible heating appliances*

IEC 60335-2-21, *Household and similar electrical appliances – Safety – Part 2-21: Particular requirements for storage water heaters*

IEC 60335-2-23, *Household and similar electrical appliances – Safety – Part 2-23: Particular requirements for appliances for skin or hair care*

IEC 60335-2-24, *Household and similar electrical appliances – Safety – Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice makers*

IEC 60335-2-25, *Household and similar electrical appliances – Safety – Part 2-25: Particular requirements for microwave ovens, including combinationmicrowave ovens*

IEC 60335-2-29, *Household and similar electrical appliances – Safety – Part 2-29: Particular requirements for battery chargers*

IEC 60335-2-30, *Household and similar electrical appliances – Safety – Part 2-30: Particular requirements for room heaters*

IEC 60335-2-34, *Household and similar electrical appliances – Safety – Part 2-34: Particular requirements for motor-compressors*

IEC 60335-2-35, *Household and similar electrical appliances – Safety – Part 2-35: Particular requirements for instantaneous water heaters*

IEC 60335-2-41, *Household and similar electrical appliances – Safety – Part 2-41: Particular requirements for pumps*

IEC 60335-2-61, *Household and similar electrical appliances – Safety – Part 2-61: Particular requirements for thermal storage room heaters*

IEC 60335-2-73, *Household and similar electrical appliances – Safety – Part 2-73: Particular requirements for fixed immersion heaters*

IEC 60335-2-75, *Household and similar electrical appliances – Safety – Part 2-75: Particular requirements for commercial dispensing appliances and vending machines*

IEC 60335-2-80, *Household and similar electrical appliances – Safety – Part 2-80: Particular requirements for fans*

IEC 60335-2-89, *Household and similar electrical appliances – Safety – Part 2-89: Particular requirements for commercial refrigerating appliances withan incorporated or remote refrigerant unit or compressor*

IEC 60730-2-22, *Automatic electrical controls – Part 2-22: Particular requirements for thermal motor protectors*

ISO 22967, *Forced draught gas burners*

ISO 22968, *Forced draught oil burners*

ISO 23550 (all parts), *Safety and control devices for gas burners and gas-burning appliances*

IEC 60730-2-9

Edition 4.2 2020-04
CONSOLIDATED VERSION

FINAL VERSION

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Automatic electrical controls –
Part 2-9: Particular requirements for temperature sensing controls

IEC 60730-2-9:2015-05+AMD1:2018-01+AMD2:2020-04 CSV(en)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

AUTOMATIC ELECTRICAL CONTROLS –

Part 2-9: Particular requirements for temperature sensing controls

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 60730-2-9 edition 4.2 contains the fourth edition (2015-05) [documents 72/990/FDIS and 72/998/RVD], its amendment 1 (2018-01) [documents 72/1112A/FDIS and 72/1118/RVD] and its amendment 2 (2020-04) [documents 72/1225/FDIS and 72/1236/RVD].

This Final version does not show where the technical content is modified by amendments 1 and 2. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 60730-2-9 has been prepared by technical committee TC 72: Automatic electrical controls.

This fourth edition constitutes a technical revision.

This edition includes alignment with the text of 60730-1 fifth edition and the following significant technical changes with respect to the previous edition:

a) modification of heating-freezing tests in Clause 12;
b) alignment of the EMC requirements in H.26 to those in other part 2 standards;
c) addition of requirements in Clause H.27 to cover class B and C control functions of temperature sensing controls;

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

This Part 2-9 is intended to be used in conjunction with IEC 60730-1. It was established on the basis of the fifth edition (2013) of that publication. Consideration may be given to future editions of, or amendments to, IEC 60730-1.

This Part 2-9 supplements or modifies the corresponding clauses in IEC 60730-1 so as to convert that publication into the IEC standard: Particular requirements for temperature sensing controls.

Where this Part 2-9 states "addition", "modification", or "replacement", the relevant requirement, test specification or explanatory matter in part 1 should be adapted accordingly.

Where no change is necessary, this part 2 indicates that the relevant clause or subclause applies.

In the development of a fully international standard, it has been necessary to take into consideration the differing requirements resulting from practical experience in various parts of the world and to recognize the variation in national electrical systems and wiring rules.

The “in some countries” notes regarding differing national practices are contained in the following subclauses:

4.1.101	17.8.4.101	Annex AA
7.2, Table 1	17.16.101	Clause CC.2
11.4.101	17.16.102	DD.9.2
11.101	17.16.105	EE.3.6
12.101.3	18.102.3	
13.2	23.101	

In this publication:

1) The following print types are used:
   – Requirements proper: in roman type;
   – *Test specifications: in italic type;*
   – Notes; in small roman type;
   – Words defined in Clause 2: **bold**.
2) Subclauses, notes, tables and figures which are additional to those in part 1 are numbered starting from 101, additional annexes are lettered AA, BB, etc.

A list of all parts of the IEC 60730 series, published under the title *Automatic electrical controls* can be found on the IEC website.

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.

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AUTOMATIC ELECTRICAL CONTROLS –

Part 2-9: Particular requirements for temperature sensing controls

1 Scope and normative references

This clause of Part 1 is applicable except as follows:

1.1 Scope

Replacement:

This part of IEC 60730 applies to automatic electrical temperature **sensing controls** for use in, on or in association with equipment, including **electrical controls** for heating, air-conditioning and similar applications. The equipment may use electricity, gas, oil, solid fuel, solar thermal energy, etc., or a combination thereof.

NOTE Throughout this standard, the word "equipment" includes "appliance" and "control system".

This standard is applicable to automatic electrical temperature **sensing controls** forming part of a building automation **control system** within the scope of ISO 16484.

This standard also applies to automatic electrical temperature **sensing controls** for equipment that may be used by the public, such as equipment intended to be used in shops, offices, hospitals, farms and commercial and industrial applications.

This standard does not apply to automatic electrical temperature **sensing controls** intended exclusively for industrial process applications, unless explicitly mentioned in the relevant equipment standard.

1.1.1

Replacement:

This standard applies to the inherent safety, to the **operating values**, **operating times**, and **operating sequences** where such are associated with equipment safety, and to the testing of automatic electrical temperature **sensing control** devices used in, or in association with, equipment.

NOTE Examples of such **controls** include **boiler thermostats**, **fan controls**, **temperature limiters** and **thermal cut-outs**.

This standard is also applicable to the functional safety of low complexity safety-related temperature **sensing controls** and **systems**.

1.1.2

Addition:

This standard also applies to the electrical safety of temperature sensing controls with non-electrical outputs such as refrigerant flow and gas **controls**.

1.1.3 Not applicable.

1.1.4

Replacement:

This standard applies to **manual controls** when such are electrically and/or mechanically integral with automatic temperature **sensing controls**.

NOTE Requirements for manual switches not forming part of an **automatic control** are contained in IEC 61058-1.

1.1.5

Replacement:

This standard applies to a.c. or d.c. powered temperature **sensing controls** with a rated voltage not exceeding 690 V a.c. or 600 V d.c.

1.1.6

Replacement:

This standard does not take into account the **response value** of an **automatic action** of a temperature **sensing control**, if such a **response value** is dependent upon the method of mounting it in the equipment. Where a **response value** is of significant purpose for the protection of the **user**, or surroundings, the value defined in the appropriate equipment standard or as determined by the manufacturer shall apply.

1.1.7

Replacement:

This standard applies also to temperature **sensing controls** incorporating **electronic devices**, requirements for which are contained in Annex H and to temperature **sensing controls** using **NTC thermistors** or **PTC thermistors**, requirements for which are contained in Annex J.

Additional subclause:

1.1.101 This standard applies to **single operation devices** as defined in this standard.

1.1 Normative references

Addition:

IEC 60216-1:2013, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60691, *Thermal links – Requirements and application guide*

IEC 60730-2-4, *Automatic electrical controls for household and similar use – Part 2-4: Particular requirements for thermal motor protectors for motor-compressors of hermetic and semi-hermetic type*

2 Terms and definitions

This clause of Part 1 is applicable except as follows:

2.2 Definitions of types of control according to purpose

2.2.19
operating control

Add, to the definition, the following note:

Note 1 to entry: In general, a **thermostat** is an **operating control**.

2.2.20
protective control

Add, to the definition, the following note:

Note 1 to entry: In general, a **thermal cut-out** is a **protective control**.

Additional definitions:

2.2.101
single-operation device
SOD
control having a temperature **sensing element** which is intended to operate only once and then requires complete replacement

2.2.101.1
bimetallic single-operation device
single operation device (**SOD**) having a bimetallic temperature **sensing element**

Note 1 to entry: A **bimetallic single operation device** (**SOD**) does not reset above a declared temperature (see 11.4.103).

Note 2 to entry: Requirements for thermal links (which are not allowed to reset) are contained in IEC 60691.

2.2.101.2
non-bimetallic single-operation device
single operation device (**SOD**) having a temperature **sensing element** which is part of a combination action **control**, the **operation** of which cannot be separated from other functions of the **control** and having a non-bimetallic thermal element that operates only once and then requires complete or partial replacement

Note 1 to entry: When such parts can be tested separately, they are considered to be thermal links within the scope of IEC 60691.

Note 2 to entry: The ageing period and thermal response of the device is dependent on the intended use of the device. As a result, the nature of the testing applicable to the device is representative of the application conditions for which the **protective control** is intended (see 7.2).

Note 3 to entry: **Non-bimetallic SODs** provide the equivalent of **micro-disconnection**.

2.2.101.2.1
rated functioning temperature
T_r
temperature of the **sensing element** of a **non-bimetallic SOD** which causes it to change the state of conductivity of the **control** when measured under specified conditions as declared by the manufacturer

2.2.102
room thermostat
independently mounted or incorporated **thermostat** intended to control the temperature of habitable space

2.2.103
fan control
automatic temperature **sensing control** intended to control the **operation** of a fan or blower

2.2.104
boiler thermostat
thermostat intended to control boiler/liquid temperature

2.2.105
modulating thermostat
thermostat which controls the temperature between two limits by continuously controlling the input to the load

2.2.106
voltage maintained thermal cut-out
thermal cut-out which is maintained in its operated condition by the voltage which appears across it in that condition

2.2.107
agricultural thermostat
thermostat intended for use in agricultural confinement buildings

2.3 Definitions relating to the function of controls

2.3.14 *Additional definition:*

2.3.14.101
time factor
transient response of temperature **sensing controls** by defined change of the **activating quantity**

2.5 Definitions of types of control according to construction

Additional definitions:

2.5.101
push-and-turn actuation
two-step actuation accomplished by first pushing, then rotating the **actuating member** of the control

2.5.102
pull-and-turn actuation
two-step actuation accomplished by first pulling, then rotating the **actuating member** of the control

3 General requirements

This clause of Part 1 is applicable.

4 General notes on tests

4.1 Conditions of test

This clause of Part 1 is applicable except as follows:

4.1 Conditions of test

Additional subclauses:

4.1.101 For the purposes of the tests of this standard and unless otherwise indicated, ambient temperature excursions beyond T_{max} during abnormal **operation** as a precursor to the **operation** of a manual reset **thermal cut-out** or a **bimetallic SOD** are ignored.

NOTE In Canada and the USA, the preceding applies only to **bimetallic SODs**.

4.1.102 For manual reset **thermal cut-outs** and **bimetallic SODs** which have an **operating value** above T_{max}, the temperature at the **sensing element** is raised, as necessary, to achieve any cycling required during the tests.

4.2 amples required

4.2.1 *Addition:*

Six samples of **bimetallic SODs** are used for the test of Clause 15 and a further six for the test of Clause 17.

5 Rating

This clause of Part 1 is applicable.

6 Classification

This clause of Part 1 is applicable except as follows:

6.4 According to features of automatic action

6.4.3 *Additional subclauses:*

6.4.3.101 – for sensing actions, no increase in the **operating value** as a result of any leakage from the **sensing element**, or from parts connecting the **sensing element** to the **switch head** (type 2.N);

6.4.3.102 – an action which operates after a declared thermal cycling test as specified in 17.101 (type 2.P);

NOTE In general, **thermal cut-outs** for specific applications, such as pressurized water heating systems, may be classified as having Type 2.P action.

6.4.3.103 – an action which is initiated only after a **push-and-turn actuation** or **pull-and-turn actuation** and in which only rotation is required to return the **actuating member** to the **OFF position** or rest position (type 1.X or 2.X);

6.4.3.104 – an action which is initiated only after a **push-and-turn actuation** or **pull-and-turn actuation** (type 1.Z or 2.Z);

6.4.3.105 – an action which cannot be reset under electrically loaded conditions (type 1.AK or 2.AK);

6.4.3.106 – an action which operates after declared agricultural environmental exposures (type 1.AM or 2.AM).

6.7 According to ambient temperature limits of the switch head

Additional subclauses:

6.7.101 **Controls** for use in or on cooking appliances.

6.7.102 **Controls** for use in or on ovens of the self-cleaning type.

6.7.103 **Controls** for use in or on food-handling appliances.

6.7.104 The **non-bimetallic SODs** are limited for use in appliances for heating or employing liquids or steam. It is not suitable for instantaneous water heaters and storage water heaters.

6.8.3 *Modification:*

Replace the first paragraph by:

For an **in-line cord control**, a free standing control, an **independently mounted control** or a **control** integrated or incorporated in an assembly utilizing a non-electrical energy source:

6.15 According to construction

Additional subclause:

6.15.101 – **controls** having parts containing liquid metal.

7 Information

This clause of Part 1 is applicable except as follows:

7.2 Methods of providing information

Table 1 – Required information and methods of providing information

Addition:

	Information	Clause or subclause	Method
101	Maximum **sensing element** temperature (other than relevant to requirement 105) [101]	6.7 6.15 14.101	X
102	**Time factor** with or without sheath	2.3.14.101 11.101 BB.1.2	X
103	**SOD** reset temperature (either –35 °C or 0 °C)	2.2.101 11.4.103 17.15.2.3	X
104	Number of cycles for **bimetallic SOD** with 0 °C reset	17.15.1.3.1	X
105	Maximum **sensing element** temperature for the test of 17.16.107 (T_e)	6.7.102 17.16.107	D
106	**Controls** having parts containing liquid metal [102]	6.15.101 11.1.101 18.102	D
107	Tensile yield strength	11.1.101	X
108	Minimum current for the purpose of the test of 23.101 [103]	23.101	D
109	$T_{max.1}$ is the maximum ambient temperature in which the **control** may remain continuously in the operated condition so that Table 13 temperatures are not exceeded [105]	14.4.3.1	D
110	Time period t_1 is the maximum time during which the ambient temperature can be higher than $T_{max.1}$ after the **control** has operated [105]	14.4.3.1	D
111	Temperature limit above which automatic reset of a manual reset thermal cut-out or a **voltage maintained thermal cut-out** shall not occur (not higher than –20 °C)	2.2.106 11.4.106 17.16.104.1 17.16.108	X
112	For type 2.P **controls**, the method of test	17.101	X
113	The click rate *N* or switching **operations** per minute for the purposes of testing to CISPR 14-1	23	X
114	**Rated functioning temperature** (T_f)	2.2.101.2.1 17.15.2	C
115	Ageing temperature for **non-bimetallic SOD** [106]	17.15.2.2 17.15.2.3	D
116	Rate of rise of temperature for testing **non-bimetallic SOD** [107]	17.15.2.2 17.15.2.3	D
117	**Agricultural thermostat**	2.2.107 6.4.3.106 11.4.107 11.6.3.101 Annex DD	D

Additional footnotes:

101 This declaration applies only to temperature **sensing controls** containing liquid metal. For temperature **sensing controls** used in or on self-cleaning ovens, this declaration is the temperature for the cooking **operation**.

102 In China, the use of liquid metal in or on cooking or food handling equipment is not allowed.

In Canada, parts of controls containing mercury is not allowed.

103 When no minimum is declared, the test value is 15 mA.

105 Consideration should be given to the provision of information by the **equipment manufacturer** relating to the minimum time that the appliance has to be disconnected from the supply to allow a **voltage maintained thermal cut-out** to reset.

106 Determined by the **control manufacturer** based on the opening temperature of the **thermal-cut-out**.

107 Determined by the **control manufacturer** referring to the actual maximum rate of rise probable in the projected end-use equipment.

8 Protection against electric shock

This clause of Part 1 is applicable.

9 Provision for protective earthing

This clause of Part 1 is applicable.

10 Terminals and terminations

This clause of Part 1 is applicable.

11 Constructional requirements

This clause of Part 1 is applicable except as follows:

11.1 Materials

Additional subclauses:

11.1.101 Parts containing liquid metal

For **controls** declared under Table 1, requirement 106, parts that contain mercury (Hg), and parts of any **control** that contain sodium (Na), potassium (K), or both, shall be constructed of metal that has a tensile yield strength at least four times the circumferential (hoop) or other stress on the parts at a temperature 1,2 times the **maximum temperature** of the **sensing element** (T_e).

Compliance is checked by inspection of the manufacturer's declaration and by the test of 18.102.

11.1.102 Material for non-bimetallic SODs

Insulating material used in **non-bimetallic SODs** as defined in this standard shall comply with the requirements of IEC 60216-1:2013 and be suitable for the application.

11.3 Actuation and operation

11.3.9 Pull-cord actuated control

Addition:

NOTE 101 Note 2 is not applicable to **controls** classified as type 1.X or 2.X or type 1.Z or 2.Z.

11.4 Actions

11.4.3 Type 2 action

Additional subclauses:

11.4.3.101 Capacitors shall not be connected across the contacts of a **thermal cut-out**.

11.4.3.102 Constructions requiring a soldering **operation** to reset **thermal cut-outs** are not permitted.

11.4.11 Type 1.H or 2.H action

Additional subclauses:

11.4.11.101 For this test, the reset mechanism of the **control** will be held in the reset position for the duration of the test from 11.4.11.102 to 11.4.11.104. The verification of the automatic non-resetting above –35 °C will be carried out by 11.4.11.105 to 11.4.11.106. For **SOD**, the verification of the automatic non-resetting above either +0 °C or –35 °C will be carried out by 11.4.11.105 to 11.4.11.106, as declared in item 103 of Table 1.

11.4.11.102 *With the reset mechanism held in the reset position at room temperature, continuity across contacts is observed by a low-energy circuit, 0,05 A maximum.*

11.4.11.103 *The **control**'s **sensing element** is then installed in an air circulating chamber or an oil bath and the **control**'s **switch head** is installed as in 14.5.1. When the whole **control** is declared as the **sensing element**, the whole **control** is placed in an air-circulating chamber. The **control** or the **control**'s **sensing element** is adjusted for the maximum set point temperature. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or oil bath temperature is then raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.11.104 *After the **control** has operated and with the reset mechanism still held in the reset position, the temperature of the chamber or oil bath is then reduced to determine if the **control** automatically resets. Verification of contact closure is done by applying the method in 11.4.11.102.*

11.4.11.105 *The whole **control** or the **control**'s **sensing element** is then installed in an air circulating chamber or oil bath again and the **control**'s **switch head** (if applicable) is installed as in 14.5.1 with the reset mechanism in its normal condition. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the control under test. The chamber or coil bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.11.106 *After the **control** has operated, the temperature of the chamber is allowed to cool down to either +0 °C or –35 °C. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.12 Type 1.J or 2.J action

Additional subclauses:

11.4.12.101 *For this test, the reset mechanism of the **control** will be held in the reset position for the duration of the test from 11.4.12.102 to 11.4.12.104. The verification of the automatic non-resetting above –35 °C will be carried out by 11.4.12.105 to 11.4.12.106. For **SOD**, the verification of the automatic non-resetting above either +0 °C or –35 °C will be carried out by 11.4.12.105 to 11.4.12.106, as declared in item 103 of Table 1.*

11.4.12.102 *With the reset mechanism held in the reset position at room temperature, contact separation is observed by a low-energy circuit, 0,05 A maximum.*

11.4.12.103 *The **control**'s **sensing element** is then installed in an air circulating chamber or oil bath and the **control**'s **switch head** is installed as in 14.5.1. When the whole **control** is declared as the **sensing element**, the whole **control** is placed in an air-circulating chamber. The control or the **control**'s **sensing element** is adjusted for the maximum set point temperature. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or oil bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. **The** chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until 10 K over the operation temperature. Indication of contact separation is still observed by applying the method of 11.4.11.102.*

11.4.12.104 *After the **control** has operated and with the reset mechanism still held in the reset position, the temperature of the chamber or oil bath is then reduced to determine if the **control** automatically resets. Verification of contact closure is done by applying the method in 11.4.11.102.*

11.4.12.105 *The whole **control** or the **control**'s **sensing element** is then installed in an air circulating chamber or oil bath again and the **control**'s **switch head** (if applicable) is installed as in 14.5.1. with the reset mechanism in its normal condition. The chamber or oil bath temperature shall be determined by positioning a thermocouple wire adjacent to the **control** under test. The chamber or oil bath temperature is raised from room temperature and held at approximately 10 K below the set point until temperatures stabilize. The chamber or oil bath temperature is then raised at a rate of not more than 0,5 K per minute until the contact operates. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.12.106 *After the **control** has operated, the temperature of the chamber or oil bath is allowed to cool down to either +0 °C or –35 °C. Indication of contact separation is observed by applying the method of 11.4.11.102.*

11.4.13 Type 1.K or 2.K action

Additional subclauses:

11.4.13.101 A type 2.K action shall be so designed that in the event of a break in the **sensing element**, or in any other part between the **sensing element** and the **switch head**, the declared disconnection or interruption is provided before the sum of the declared **operating value** and **drift** is exceeded.

*Compliance is checked by breaking the **sensing element**. The breaking may be achieved by partly pre-cutting or filing through.*

*The temperature **sensing control** is heated to within 10 K of the operating temperature and the temperature then increased at a rate not to exceed 1 K/min. The contacts shall open before the sum of the declared **operating value** plus **drift** is exceeded.*

11.4.13.102 Type 2.K action may also be achieved by compliance with a), b) or c).

a) Two **sensing elements** operating independently from each other and actuating one switch head.

b) Bimetallic **sensing elements** with

   1) exposed elements attached with at least double spot welding of the bimetal at both of its ends, or

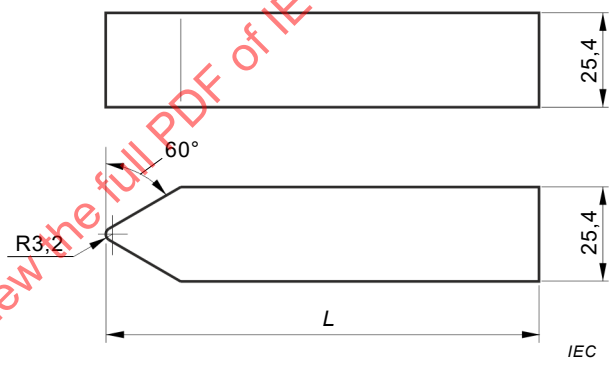
   2) elements so located or installed in a **control** of such construction that the bimetal is not likely to be physically damaged during installation and use.

c) If the loss of the fluid fill causes the contacts of the **control** to remain closed or leakage causes upward shift beyond the declared maximum operating temperature, the bulb and capillary of a temperature **sensing control** which is actuated by a change in the pressure of a fluid confined in the bulb and capillary shall conform to the following.

   There shall be no damage to the bulb or capillary to the extent which will permit escape of any of the fill when an impact **tool**, as illustrated in Figure 101, is dropped once from a height of 0,60 m so that the tapered end of the **tool** strikes the bulb or capillary in a perpendicular position. For this test, the capillary or the bulb shall be on a concrete surface.

   If the capillary is provided with a separate shroud or sleeve, it is to be left in place during the test described above.

Dimensions in millimetres



Material: Steel, CRS, Break all corners

L to be sized to obtain total mass of 0,454 kg

Figure 101 – Impact tool

Additional subclauses:

11.4.101 Type 2.N action

A type 2.N action shall be so designed that in the event of a leak in the **sensing element**, or in any other part between the **sensing element** and the **switch head**, the declared disconnection or interruption is provided before the sum of the declared **operating value** and **drift** is exceeded.

Compliance is checked by the following test:

*The **operating value** of a type 2.N **control** is measured under the conditions of Clause 15 of Part 1. If the **control** has means for **setting**, it is set to the highest value.*

*After this measurement, a hole is artificially produced in the **sensing element** and the measurement of the **operating value** is repeated.*

*No positive **drift** is allowed above the declared value.*

A separate shroud or sleeve may be employed for protection of the bulb and capillary to achieve conformance with Clause 18.

NOTE 1 The test can be replaced by theoretical computations of the physical mode of operation.

NOTE 2 In Canada and the USA, a type 2.N action is checked by item c) of 11.4.13.102.

11.4.102 Type 2.P action

A type 2.P action shall be so designed that it operates in its intended manner after a thermal cycling test.

Compliance is checked by the test of 17.101.

11.4.103 Bimetallic single-operation device

A **bimetallic single-operation device** shall be so designed that it does not reset above the reset value declared in Table 1, requirement 103.

Compliance is checked by the test of 17.15.

11.4.104 Type 1.X or 2.X

A type 1.X or 2.X action shall be so designed that a turn action can only be accomplished after the completion of a push-action or a pull-action. Only rotation shall be required to return the **actuating member** of the **control** to the **OFF position** or rest position.

Compliance is checked by the tests of 18.101.

11.4.105 Type 1.Z or 2.Z

A type 1.Z or 2.Z action shall be so designed that a turn action can only be accomplished after the completion of a push-action or a pull-action.

Compliance is checked by the tests of 18.101.

11.4.106 Voltage maintained thermal cut-out

A **voltage maintained thermal cut-out** shall be so designed that it does not reset above the reset value declared in Table1, requirement 111.

11.4.107 Type 1.AM or 2.AM

A type 1.AM or 2.AM action shall be so designed that it operates in its intended manner after the declared agricultural environmental exposures.

Compliance is checked by the tests of Annex DD.

11.6 Mounting of controls

11.6.3 Mounting of independently mounted controls

Additional subclause:

11.6.3.101 For **agricultural thermostats** declared in Table 1, requirement 117, the mounting method shall be such that the integrity of the protection by the enclosure is not compromised.

Additional subclause:

11.101 Time factor

If a **time factor** is declared, this shall be checked by one of the applicable determining methods as indicated in Annex BB. The determined value shall not exceed the rated values. See Table BB.1.

NOTE In Germany, for temperature **sensing controls** intended to control boiler water or flue gas temperature in heat generating systems, the maximum values of **time factor** given in Table BB.1 shall not be exceeded.

12 Moisture and dust resistance

This clause of Part 1 is applicable except as follows:

Additional subclauses:

12.101 Refrigeration controls

Controls which have the **switch head** and **sensing element** mounted in the evaporator of refrigeration or similar equipment, producing conditions of over temperature and of freezing and melting, shall maintain insulation integrity.

12.101.1 *Compliance is checked by the following tests.*

12.101.2 **Controls** which use a potting compound are given a softening test. Two samples are heated in a heating chamber at 15 K above the maximum declared operating temperature for 16 h with the potting surface in the most unfavourable position. The potting material shall not unduly soften or distort, crack or deteriorate.

12.101.3 *The two samples used for the softening tests and one untested sample (three total) are placed in water maintained between T_{max} (maximum declared **switch head** ambient temperature) and either (T_{max} +5) °C or 1,05 times T_{max}, whichever is greater for 2 h. The three samples are then immediately transferred to water at a temperature of below 5 °C for 2 h and then frozen in a small, flexible container at a temperature between T_{min} (minimum declared **switch head** ambient temperature) and (T_{min} –5) °C for 2 h. Ten heating-freezing cycles are required.*

NOTE In Canada and the USA, if the contact mechanism of defrost **controls** has the **creepage distances** and **clearances** required for refrigeration controllers, one cycle only of heating and freezing is required, otherwise ten cycles are required.

12.101.4 *The tested samples shall be left in water at room temperature overnight after each completed heating-freezing cycle.*

12.101.5 *After the last freezing test, the samples are thawed to approximately room temperature in water and the insulation resistance is measured from current-carrying parts to grounded parts and to the surface of potting and/or insulating material; the direct current voltmeter method is used. Insulation resistance shall be at least 50 000 Ω.*

12.101.6 *While the samples are still moist, a voltage equal to (2 × V_R) + 1 000 V is applied at rated frequency for 1 min between current-carrying parts and grounded parts and the surface of the potting and/or insulating material. No flashover or breakdown of insulation shall occur during the test.*

13 Electric strength and insulation resistance

This clause of Part 1 is applicable except as follows:

13.2 Electric strength

Additional note:

NOTE 101 In the USA, an independently mounted **room thermostat** for **operation** over 50 V, intended for direct control of electric space-heating equipment, shall withstand for 1 min without breakdown the application of alternating potential of 900 V between the line and load terminals. A piece of insulating material may be placed between the **thermostat** contacts during the test. There shall be no breakdown either through or across the insulating material supporting the contact and terminal assemblies. This **control** shall be the **control** that is designated as "SAMPLE 1" under the tests for compliance in 17.16.102.1 of this standard.

14 Heating

This clause of Part 1 is applicable except as follows:

14.4.3.1

Addition:

For a **voltage maintained thermal cut-out**, the heating test of 14.4.3.1 is completed, after which the temperature of the **sensing element** is raised until the contacts open. At this time, the ambient temperature surrounding the **sensing element** is reduced to $T_{max.1}$ in time period t_1, at a uniform rate. The test of 14.5.1 is then completed.

Additional subclause:

14.4.3.1.101 Where the whole **control** has been declared as the **sensing element** (see Table 1, requirement 47), the heating test, at the request of the manufacturer, need not be conducted until the successful completion of the tests in Clause 17.

Additional subclauses:

14.101 The following is applicable to **controls** classified under 6.7.101 to 6.7.103 inclusive.

14.101.1 As a means of complying with Note i) of Table 13, if the temperature of insulating parts exceeds that permitted in Table 13, then the test of 17.16.101 may be conducted after the conditioning of 14.102 and 14.102.1.

14.102 A previously untested sample of the **control** is conditioned for 1 000 h in an oven maintained at a temperature between 1,02 T_1 + 20 K and 1,05 times that temperature, where T_1 is the maximum measured temperature on the insulating part during the test of Clause 14. The **control** shall not be energized during this test.

14.102.1 If the elevated temperature is localized, such as at or near a terminal, the 1 000 h conditioning is conducted with the control between T_{max} and T_{max} + 5 % for normal conditions, but with the contacts closed and non-cycling. If necessary, the contacts may be forced closed to provide the most arduous temperature conditions. A bimetal heater across

the mains is energized at 1,1 times rated voltage. A series bimetal heater shall conduct at 1,1 times rated current.

15 Manufacturing deviation and drift

This clause of Part 1 is applicable except as follows:

15.1 *Addition:*

The values of **manufacturing deviation** and **drift** shall be according to Annex AA unless otherwise declared by the manufacturer.

NOTE 101 The note is not applicable.

15.4 *Addition:*

*Alternatively, the declared **manufacturing deviation** and **drift** may be expressed separately as a tolerance value to the declared **operating value**.*

15.5.3 *Additional subclauses:*

15.5.3.101 ***Controls** intended for **setting by the user** shall be set at the maximum operating temperature unless otherwise declared by the manufacturer.*

15.5.3.102 ***Controls** utilizing a bimetallic or similar sensing mechanism or that portion of a **control** intended to be exposed to a controlled ambient shall be placed in a circulating air oven to determine the **operating value**.*

15.5.3.103 *For bimetallic and similar type **controls**, the temperature shall be determined by mounting a 0,25 mm thermocouple wire to the sensing portion of an identical **control** not electrically connected and mounted adjacent to the **control** under test in a circulating air oven.*

15.5.3.104 *For fluid expansion type **controls**, a maximum 0,25 mm thermocouple shall be attached to the sensing portion, using a suitable adhesive.*

15.5.3.105 *For fluid expansion or contraction type **controls**, the complete **control** or, if so intended in use, the bulb portion, or that length of a sensing portion of a **control** declared by the manufacturer as being a minimum sensing dimension shall be placed in either a circulating air oven or a liquid bath.*

15.5.3.106 *The temperature of the oven or bath may be rapidly increased to 10 K below or decreased to 10 K above the expected operating temperature of the **control** until conditions of equilibrium have been achieved. The rate of temperature change shall then be reduced to a maximum of 0,5 K/min or to the declared rate of change, whichever is the lowest.*

15.5.3.107 *The **operation** of the **control** shall be sensed by a suitable device with a sensing current not exceeding 0,05 A.*

The circuit voltage may be any convenient value that will give reliable indication of the function being monitored.

15.5.3.108 *The **operating value** of the **control** shall be recorded.*

15.5.3.109 *For **SODs**, after the contacts have operated, satisfactory disconnection is determined by subjecting each **SOD** to the voltage specified in Table 12, with no prior humidity treatment.*

15.5.4 and **15.5.5** Not applicable.

15.5.6

Addition:

*Alternatively, the **manufacturing deviation** shall be according to Annex AA.*

16 Environmental stress

This clause of Part 1 is applicable except as follows:

Addition:

This clause is not applicable for **bimetallic SOD**.

17 Endurance

This clause of Part 1 is applicable except as follows:

17.3.1 *Addition:*

– for temperature **sensing controls** in which the whole **control** is declared as the **sensing element** and for which the minimum operating temperature declared in Table 1, requirement 48, is less than 0 °C, the test of 17.8 is carried out on a further set of three samples at the minimum declared operating temperature with a tolerance of +5 K, –0 K, the number of cycles being 5 % of the number declared in Table 1, requirement 27.

17.8.4 *Additional subclause:*

17.8.4.101 *The number of automatic and manual cycles for independently mounted and **in-line cord control**s shall be as indicated in Clause CC.1, unless a higher number is declared by the manufacturer.*

NOTE In Canada and the USA, the number of cycles is as indicated in Clause CC.2.

17.15 *This subclause of Part 1 is replaced as follows:*

17.15 Single operation devices

17.15.1 Bimetallic single operation devices

Bimetallic single operation devices shall be subjected to the following tests:

17.15.1.1 *After the appropriate tests of Clause 15, the same six samples shall be maintained at –35 °C or 0 °C as declared in Table 1, requirement 103, for 7 h. The devices shall not reset during this period, which is determined by the test of 15.5.3.109.*

17.15.1.2 *Six untested **bimetallic single operation devices** are conditioned for 720 h at a temperature which is the lower of either:*

– *90 % of the declared **operating value** ±1 K,*

– *or (7 ± 1) K below the declared **operating value**.*

17.15.1.2.1 *During this conditioning, the **bimetallic single operation device** (**SOD**) shall not operate. **Operation** of the **bimetallic single operation device** (**SOD**) shall be detected as indicated in 15.5.3.107.*

17.15.1.2.2 *The appropriate tests of Clause 15 shall be repeated on the six samples subjected to the conditioning of 17.15.1.2 and the temperature measured shall be within the declared deviation limits.*

17.15.1.3 *For **bimetallic single operation devices** with a declared reset temperature of –35 °C, six untested samples shall be subjected to an over-voltage (or overload in Canada and the USA) test for one cycle under the electrical conditions of Table 14 or Table 15, as appropriate.*

The test of 15.5.3.109 shall be repeated.

17.15.1.3.1 *For **bimetallic single operation devices** with a declared reset temperature of 0 °C, one sample shall be subjected to an over-voltage (or overload in Canada and the USA) test of 50 cycles under the electrical conditions of Table 14 or Table 15, as appropriate.*

The sample is then subjected to the number of cycles declared in Table 1, requirement 104, at rated current and voltage.

*The purpose of the tests of 17.15.1.3.1 is to evaluate the device under unintended **operation** caused by exposure to temperatures below 0 °C. In order to achieve cycling, it is suggested that the test be conducted in a test chamber which permits decrease of the ambient temperature to the declared reset value and increase of the ambient temperature to the normal **operating value**.*

After the test of 17.15.1.3.1, the appropriate tests of Clause 15 shall be repeated and the temperature measured shall be within the declared deviation limits.

17.15.2 Non-bimetallic SODs

17.15.2.1 ***Non-bimetallic SODs** are subject to the following tests:*

*For a **non-bimetallic SOD**, automatic temperature sensing functions except those for the non-bimetallic part of the **control**, such as **thermostat**, **temperature limiter** and/or the **thermal-cut-out**, shall comply with 17.16.101, 17.16.103 and 17.16.104 respectively.*

These tests are conducted on separate samples.

17.15.2.2 *Six untested samples are then to be mounted in a suitable apparatus and the thermal **sensing elements** are conditioned for an ageing period equal to either 750 h or the result of the specified number of cycles declared by the end product application divided by 4 (calculation value is the number of hours), whichever is greater, at the temperature declared in Table 1, requirement 115, – 5 K. No **operation** of the **SODs** shall occur during this ageing period. **Operation** of the device shall be detected as indicated in 15.5.3.107.*

17.15.2.3 *At the end of the ageing period, the samples are removed from the apparatus. The appropriate tests of Clause 15 shall be repeated on six untested samples and the six samples subjected to the conditioning of 17.15.2.2 and the temperatures measured shall be within the declared deviation limits, with the electrical conditions of the test V_{Rmax} and I_{Rmax}.*

*For **non-bimetallic SODs** where the **sensing element** has a declared reset temperature, the **SODs** shall be held at the temperature declared in Table 1 and the test will continue for 7 h. The device shall not reset during this period as indicated in 15.5.3.109.*

All samples shall then be subjected to the test of Clause 13, carried out at the temperature limits declared in Table 1, requirement 36.

*The apparatus used for the tests of 17.15.2.2 and 17.15.2.3 should be constructed so that heat can be applied to the thermal **sensing element** of the **SOD** whilst taking care that other parts of the **control** are protected from exposure to temperatures in excess of their intended use.*

17.16 Test for particular purpose controls

Additional subclauses:

17.16.101 Thermostats

- *17.1 to 17.5 inclusive are applicable.*
- *17.6 is applicable to actions classified as type 1.M or type 2.M, the value of "X" being (5 ± 1) K or ±5 % of the original **activating quantity**, whichever is greater.*
- *17.7 is applicable.*
- *17.8 is applicable.*
- *17.9 is applicable, but only to slow-make, slow-break **automatic actions**.*
- *17.9.3.1 is not applicable.*
- *17.10 to 17.13 inclusive are applicable, but only to those **thermostats** which have a **manual action** (including an **actuating means** providing **setting by the user**).*
- *17.14 is applicable for all temperature **sensing controls**. In addition to the criteria stated in 17.14, temperature **sensing controls** specified under 14.4.3.1.101 shall comply with the requirements of Clause 14.*
- *17.15 is not applicable.*

NOTE In Canada and the USA only, the requirements of 17.16.102 are applicable.

17.16.102 Independently mounted **room thermostats** for **operation** above 50 V which include a resistance load rating and which are intended for direct control of electric space-heating equipment shall meet the requirements of 17.16.102.1 to 17.16.102.3 inclusive for USA.

NOTE For Canada, such **controls** above 30 V shall meet the requirements of 17.16.102.4 and 17.16.102.5.

17.16.102.1 Two samples of a **room thermostat** intended for direct control of electric space-heating equipment (designated "SAMPLE 1" and "SAMPLE 2") shall be subjected to an over-current test consisting of making and breaking for 50 cycles of **operation**, at a rate of 6 cycles/min, a value of current described in Table 15.

17.16.102.2 SAMPLE 1 (see 13.2) and SAMPLE 2 shall be subjected to an endurance test consisting of 6 000 cycles at the rate of not more than one cycle/min and at 110 % of both the rated current and rated voltage. The "on" time shall be (50 ± 20) % and **operation** is to be by thermal means. There shall be no electrical or mechanical **failure** of either **thermostat**, and there shall be no undue burning or pitting of the contacts of SAMPLE 1 (see 17.3).

17.16.102.3 The **thermostat** designated SAMPLE 2 shall be subjected to an additional 30 000 cycles under the conditions described in 17.4, except that rated voltage and current shall be used. The test may be discontinued if the **thermostat** becomes inoperative due to the contacts not opening or closing. There shall be no indication of a fire or shock hazard.

17.16.102.4 The test is conducted on one sample, at 120 % of rated voltage and current, making and breaking for 50 cycles. The sample subjected to above test is further tested for 30 000 cycle endurance test, at rated voltage and current as described in Clause 17.

17.16.102.5 The test shall successfully complete the required number of cycles as intended without causing any hazard, and comply with dielectric strength in 13.2.

17.16.103 Temperature limiters

– *17.1 to 17.5 inclusive are applicable.*

– *17.6 is applicable to actions classified as type 1.M or type 2.M, the value of "X" being (5 ± 1) K, or ±5 % of the original **activating quantity**, whichever is greater.*

– *17.7 and 17.8 are applicable, except that, where necessary, the reset **operation**, if required, is obtained by **actuation**. This **actuation** shall be as specified in 17.4 for accelerated speed, as soon as permitted by the mechanism, or as declared by the manufacturer in Table 1, requirement 37.*

– *17.9 is applicable, but only to **temperature limiters** with slow-make, slow-break **automatic actions**, the same conditions for manual reset as specified above for 17.7 and 17.8 being used.*

– *17.9.3.1 is not applicable.*

– *17.10 to 17.13 inclusive do not apply to the normal reset **manual action**, which is tested during the automatic tests of 17.7 to 17.9 inclusive. If the **temperature limiter** has other **manual actions** which are not tested during the automatic tests, then these subclauses are applicable.*

– *17.14 is applicable for all temperature **sensing controls**. In addition to the criteria stated in 17.14, temperature **sensing controls** specified under 14.4.3.1.101 shall comply with the requirements of Clause 14.*

– *17.15 is not applicable.*

17.16.104 Thermal cut-outs

– *17.1 to 17.5 inclusive are applicable.*

– *17.6 is applicable to actions classified as type 2.M, the value of "X" being (5 ± 1) K, or ±5 % of the original **activating quantity**, whichever is greater.*

– *17.7 and 17.8 are applicable, except that, where necessary, the reset **operation**, if required, is obtained by **actuation**.*

– *This **actuation** shall be as specified in 17.4 for accelerated speed, as soon as permitted by the mechanism, or as declared by the manufacturer in Table 1, requirement 37.*

– *17.9 is applicable, but only to **thermal cut-outs** with slow-make, slow-break **automatic actions**, the same conditions for manual reset as specified above for 17.7 and 17.8 being used.*

– *17.9.3.1 is not applicable.*

– *17.10 to 17.13 inclusive do not apply to the normal reset **manual action**, which is tested during the automatic tests of 17.7 to 17.9 inclusive. If the **thermal cut-out** has other **manual actions** which are not tested during the automatic tests, then these subclauses are applicable.*

– *17.14 is applicable for all **controls**. In addition to the criteria stated in 17.14, **controls** specified under 14.4.3.1.101, shall comply with the requirements of Clause 14.*

– *17.15 is not applicable.*

17.16.104.1 For **voltage maintained thermal cut-outs**, the test of 17.16.108 is applicable.

17.16.105 In Canada and the USA, if a **control** has two or more electrical ratings (for example, inductive and resistive or different currents at different voltages), it may be tested for not less than 25 % of its declared endurance (if equal to or greater than 30 000 cycles) at each rating, but the total number of cycles on any one sample is not to be more than its declared endurance.

However, at least one sample shall be tested for a total number of cycles equal to its declared endurance.

17.16.106 Evaluation of materials

The following tests are conducted as indicated in 14.101.1.

*The **control** is subjected to the tests of 17.7 for 50 **operations** and 17.8 for 1 000 **operations**. The tests of 17.7 and 17.8 are conducted at an ambient temperature of (20 ± 5) °C.*

*After these tests, the **control** shall comply with 17.5.*

17.16.107 Over-temperature test of sensing element

*For **controls** declared under Table 1, requirement 105, the **sensing element** portion of a previously untested sample is exposed to 250 thermal cycles.*

The test ambient temperature is varied between 40 °C and T_e at the maximum rate of temperature change declared in Table 1, requirement 37. The extremes of temperature are maintained for 30 min.

*After the test, the **control** shall comply with 17.14.*

17.16.108 Voltage maintained thermal cut-out

Six untested **voltage maintained thermal cut-outs** are conditioned for 7 h at a temperature of –20 °C (or lower, if declared).

During and at the conclusion of the conditioning, none of the six samples shall have operated.

Operation of the **voltage maintained thermal cut-outs** shall be detected as indicated in 15.5.3.107.

These requirements apply to a **voltage maintained thermal cut-out** in the operated condition with the voltage across it.

Additional subclauses:

17.101 Type 2.P cycling test

Temperature **sensing controls** of type 2.P action shall be tested as follows:

17.101.1 Following the appropriate tests of 17.16 and the evaluation of 17.14, the **control** is subjected to a thermal cycling test of 50 000 cycles at a temperature maintained between 50 % and 90 % of the switch-off temperature recorded in 17.14. During this test, the **switch head** is maintained at (20 ± 5) °C.

The manufacturer shall declare whether the method of 17.101.2 or 17.101.3 is to be used.

The test shall be carried out in accordance with the manufacturer's declaration in Table 1, requirement 112.

17.101.2 Two-bath method

The two baths are filled with synthetic oil, water or air (two chambers). The first bath is maintained at a temperature equal to 90 % of the switch-off temperature (°C) recorded

in 17.14. The second bath is maintained at a temperature equal to 50 % of the switch-off temperature recorded in 17.14.

If a medium different from that used in Annex BB is selected for this test, then an appropriate conversion factor shall be applied to the **time factor** indicated in the following paragraph.

*The temperature **sensing element** (see 2.8.1 and Table 1, requirement 47) is immersed in the first bath for a period of time equal to at least five times the **time factor**. The temperature **sensing element** is then immersed in the second bath for the same period of time.*

*The transfer between baths is carried out as quickly as possible but care should be taken to avoid mechanical stress to the temperature **sensing element**.*

17.101.3 Temperature change method

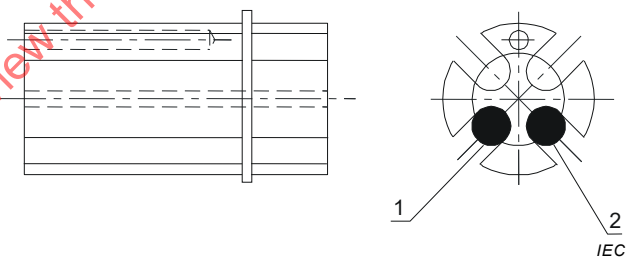
This method is based on a continuously water-cooled oil-filled bath (synthetic oil).

An aluminium cylinder (see Figure 102) is immersed in this bath. The cylinder contains the temperature **sensing element** under test and a temperature **sensing element** to control temperature cycling between 50 % and 90 % of the switch-off temperature (°C) recorded in 17.14.

The aluminium cylinder is wrapped with a resistance wire to heat the temperature **sensing element**. To eliminate the difficulties resulting from the difference between the **time factor** of the temperature **sensing element** under test and the temperature **sensing element** which is controlling the test temperature range, the temperature **sensing element** of a second identical test sample is used.

The two membrane positions of the second sample, calculated at 50 % and 90 % of the switch-off temperature (°C) are measured by a position sensor and used to switch the current through the resistance wire (heat) on and off.

Unless otherwise declared by the manufacturer in Table 1, requirement 37, the rate of change of temperature rise/fall shall be (35 ± 10) K/min.



Key

1	temperature **sensing element**
2	temperature **sensing element** to control the temperature cycle between 0,5 and 0,9 times the switch-off temperature

Figure 102 – Aluminium cylinder for temperature change method

17.101.4 After this test, for **controls** other than **bimetallic SODs**, an additional 20 cycles are carried out by increasing the temperature from (20 ± 5) °C to 1,1 times the switch-off temperature.

During this test, any manual reset mechanism shall not be reset. The other conditions of 17.101.1 are unchanged.

NOTE The purpose of this test is to stress the operating mechanism (for example, membrane, bellows, etc.).

17.101.5 *After thoroughly degreasing the **switch head**, the operating temperature(s) is re-checked under the conditions of Clause 15 and the measured value(s) shall still be within the declared limits of deviation and **drift**.*

18 Mechanical strength

This clause of Part 1 is applicable except as follows:

Additional subclauses:

18.101 Push-and-turn or pull-and-turn actuation

18.101.1 Controls with actions classified as type 1.X or 2.X or type 1.Z or 2.Z shall be subjected to the tests of 18.101.2 and 18.101.3.

*One new sample is used for the tests. After these tests, the **control** shall comply with the requirements of 18.1.5.*

18.101.2

Controls with actions classified as type 1.X or 2.X or type 1.Z or 2.Z shall be subjected to the following tests.

– The axial force required to push or pull the **actuating member** shall be not less than 10 N.

– An axial push or pull force of 140 N applied to the **actuating member** shall not affect compliance with 18.1.5.

– For a **control** intended for use with a knob having a grip diameter or length of 50 mm or less, the means preventing rotation of the shaft prior to the push or pull **actuation** shall withstand, without damage, or effect on **control** function, a torque of 4 Nm.

– Alternatively, if the means preventing rotation of the shaft is defeated when a torque of at least 2 Nm is applied, the effect shall be such that either

  • the means is not damaged, but overridden to close the contacts, in which case subsequent **actuation** at a torque less than 2 Nm shall require both push-and-turn or pull-and-turn to operate the contacts, or

  • no **operation** of the contacts occurs nor can be made to occur.

– The torque required to reset the **control** to the initial contact condition, if necessary after the application of the push or pull, shall not be greater than 0,5 Nm.

– A torque of 6 Nm is applied to the **setting** means. Any breakage or damage to the means preventing rotation of the shaft shall not result in **failure** to comply with the requirements of Clauses 8, 13 and 20.

– For **controls** intended for use with a knob having a grip diameter or length greater than 50 mm, the values of torque are increased proportionally.

18.101.3 **Controls** with actions classified as type 1.X or 2.X or type 1.Z or 2.Z shall be actuated for the declared number of manual cycles.

After this test, the **control** shall comply with the requirements of 18.101.2. For the case in which the means preventing rotation is not damaged but is overridden to operate the contacts, the first 1/6th of the declared manual cycles shall be performed without first pushing or pulling the **actuating member**.

18.102 Parts containing liquid metal

18.102.1 Parts of all **controls** containing sodium (Na), potassium (K), or both, and parts of **controls** classified under 6.7.101 to 6.7.103 inclusive that contain mercury (Hg) shall withstand for 1 min, without leakage or rupture, a hydraulic pressure equal to five times the maximum internal pressure achieved during **operation**.

18.102.1.1 The method of test and the number of samples required shall be agreed between the manufacturer and the test authority.

It may be necessary for the manufacturer to provide special samples for the purpose of this test (for example, without mercury). Any suitable fluid may be used in lieu of the liquid metal, provided that the test fluid and test method exert the intended stress on all fluid-containing parts.

18.102.1.2 *After the test of 18.102.1, the hydraulic pressure is to be increased until rupture occurs. The rupture shall occur at the bellows or diaphragm or other part that is within the* ***switch head*** *or* ***control*** *enclosure.*

18.102.2 *The* ***control*** *shall not leak or rupture when heated to 1,2 times the* ***maximum temperature*** *of the* ***sensing element****.*

A separate sample is used for this test.

18.102.3 *Additionally, when the bellows or diaphragm of a separate sample is deliberately punctured with a sharp, pointed metal rod, the following shall occur:*

– *sodium, potassium, or mercury shall be contained in the* ***switch head*** *or* ***control*** *enclosure.*

NOTE In Canada and the USA, mercury is allowed to escape from the **switch head** or **control** enclosure, in which case the **control** shall be declared as requiring evaluation in the appliance to determine if mercury enters an oven or food-handling compartment, contacts food-handling equipment, or the like.

18.102.4 *The acceptability of the location of the rupture shall be evaluated in the appliance.*

19 Threaded parts and connections

This clause of Part 1 is applicable.

20 Creepage distances, clearances and distances through solid insulation

This clause of Part 1 is applicable.

21 Resistance to heat, fire and tracking

This clause of Part 1 is applicable.

22 Resistance to corrosion

This clause of Part 1 is applicable.

23 Electromagnetic compatibility (EMC) requirements – Emission

This clause of Part 1 is applicable except as follows:

Additional subclauses:

23.101 Thermostats shall be so constructed that they do not generate radio interference for a time period exceeding 20 ms.

NOTE In Canada and the USA, this test is not applicable.

Compliance is checked by the test of 23.101.1 and 23.101.2.

23.101.1 Test conditions

Three previously untested samples are subjected to the test.

The electrical and thermal conditions are as specified in 17.2 and 17.3, except as follows.

– The test is conducted at the lowest declared voltage and lowest declared current (Table 1, requirement 108).

– The rates of temperature change are α_1 and β_1. If these have not been declared, the following are used:

  1 K/15 min for **sensing elements** in gases;

  1 K/min for **sensing elements** in other media.

– For **controls** declared for use with inductive loads, the power factor is 0,2. For **controls** declared for use with purely resistive loads, the power factor is 1,0.

23.101.2 Test procedure

The **control** is subjected to five cycles of **operation** with the contacts opening and five cycles of **operation** with the contacts closing.

The duration of radio interference is measured by an oscilloscope connected to the **control** so as to measure the voltage drop across the contacts.

NOTE For the purpose of this test, radio interference is any observed fluctuation of voltage across the contacts which is superimposed upon the supply waveform as a result of contact **operation**.

24 Components

This clause of Part 1 is applicable.

25 Normal operation

This clause of Part 1 is applicable.

26 Electromagnetic compatibility (EMC) requirements – Immunity

This clause of Part 1 is applicable.

27 Abnormal operation

This clause of Part 1 is applicable.

28 Guidance on the use of electronic disconnection

This clause of Part 1 is applicable.

Annexes

The annexes of Part 1 are applicable except as follows:

Annex G
(normative)

Heat and fire resistance tests

This annex of Part 1 is applicable except as follows:

G.5.1 Ball pressure test 1

Replace the first line and first dashed item as follows:

*Where the whole control has been declared as the **sensing element**, the temperature in the heating oven is the highest of:*

– *20 K ± 2 K in excess of the **maximum temperature** measured during the tests of Clause 14, or Clause 17.14, if the heating test of Clause 14 is not conducted,*

G.5.2 Ball pressure test 2

Replace the first line as follows:

*Where the whole **control** has been declared as the **sensing element**, the ball pressure test is carried out as described in G.5.1 except that the temperature in the heating oven shall be T_b ± 2 °C where T_b is equal to the higher of:*

Replace the fourth dashed item as follows:

– *20 K in excess of the **maximum temperature** recorded during the heating test of Clause 14, or 17.14, if the heating test of Clause 14 is not conducted,*

Annex H
(normative)

Requirements for electronic controls

Replacement:

This annex of Part 1 is applicable except as follows:

H.2 Terms and definitions

Additional definitions:

H.2.101.1
permanent operation
continuous monitoring of the protective function during the **operation** of the appliance or system for longer than 24 h

Note 1 to entry: 24 h is considered the typical time interval between a first and a second **fault**.

H.2.101.2
non-permanent operation
continuous monitoring of the protective function during the **operation** of the appliance or system for less than 24 h

Note 1 to entry: 24 h is considered the typical time interval between a first and a second **fault**.

H.6 Classification

H.6.18 According to classes of control functions

H.6.18.2 *Addition:*

NOTE 101 In general, **thermal cut-outs** perform **class B control functions** or **class C control functions**.

H.6.18.3 *Addition:*

NOTE 101 In general, **thermal cut-outs** used on closed water heater systems perform **class C control functions**.

H.7 Information

Additional requirements to Table 1:

Information		Clause or subclause	Method
58a	See footnote c of Table H.101	H.26.2.104	X
109	The output condition of **thermal cut-outs**, type 2 **thermostats** and type 2 **temperature limiters** after **operation**[104]	H.26.2.103 H.26.2.106	
118	Conditions of test when requested by the manufacturer for integrated and incorporated **electronic controls**.	H.23.1.2	X
119	Frequency of the **defined state** test function	H.27.1.2.2.2 H.27.1.2.3.2 H.27.1.2.3.3	X
120	The **control** is for **permanent operation** or **non-permanent operation**	H.2.101.1 H.2.101.2 H.27.1.2.2.2 H.27.1.2.3.2	X
Additional note: [104] For example, conducting or non-conducting, as applicable.			

H.11 Constructional requirements

H.11.12 Controls using software

H.11.12.2.6 *Replace the second paragraph by the following:*

NOTE The values declared in Table 1, requirement 71 may be given in the applicable appliance standard.

H.11.12.2.7 *Addition, at the end of this subclause:*

NOTE 101 The values declared in Table 1, requirement 72 may be given in the applicable appliance standard.

H.23 Electromagnetic compatibility (EMC) requirements – Emission

H.23.1.2 Radio frequency emission

Addition:

Integrated controls and **incorporated controls** are not subjected to the tests of H.23.1.2, as the results of these tests are influenced by the incorporation of the control into the equipment and the use of measures to control emissions used therein. They may, however, be carried out under declared conditions if so requested by the manufacturer.

H.26 Electromagnetic compatibility (EMC) requirements – Immunity

H.26.2 *Additional subclauses:*

H.26.2.101 After each test, one or more of the following criteria shall apply, as permitted in Table H.101.

H.26.2.102 The **control** shall remain in its current condition and thereafter shall continue to operate as declared within the limits verified in Clause 15, if applicable.

H.26.2.103 The **control** shall assume the condition declared in Table 1, requirement 109 and thereafter shall operate as in H.26.2.102.

H.26.2.104 The **control** shall assume the condition declared in Table 1, requirement 109, such that it cannot be reset automatically or manually. The output waveform shall be sinusoidal or as declared in Table 1, requirement 53 for normal **operation**.

H.26.2.105 The **control** shall remain in the condition declared in Table 1, requirement 109. A non-self-resetting **control** shall be such that it can only reset manually. After the temperature which caused cut-out to occur is removed, it shall operate as in H.26.2.102 or shall remain in the declared condition as in H.26.2.104.

H.26.2.106 The **control** may return to its initial state and thereafter shall operate as in H.26.2.102.

If a control is in the condition declared in Table 1, requirement 109, it may reset but shall resume the declared condition again if the temperature which caused it to operate is still present.

H.26.2.107 The output and functions shall be as declared in Table 1, requirement 58a or requirement 58b and the **control** shall comply with the requirement of 17.5.

Table H.101 – Compliance criteria

Applicable Clause H.26 tests	**Compliance criteria permitted**					
Thermal cut-outs, type 2 **thermostats** and type 2 **temperature limiters**	H.26.2.102	H.26.2.103	H.26.2.104	H.26.2.105	H.26.2.106	H.26.2.107[c]
H.26.4 to H.26.14 inclusive	[b]	[b]	[b]	[a]	[a]	[x]
Other temperature **sensing controls**	H.26.2.102	H.26.2.103	H.26.2.104	H.26.2.105	H.26.2.106	H.26.2.107[c]
H.26.8, H.26.9	[x]				[x]	[x]

[x] = Permitted for other than **thermal cut-outs**

[a] = Permitted when the disturbance is applied after **operation**

[b] = Permitted when the disturbance is applied before **operation**

[c] = This compliance criterion is permitted only for **integrated controls** or **incorporated controls**, since the acceptability of the output must be judged in the appliance.

H.26.5 Voltage dips, voltage interruptions and voltage variations in the power supply network

H.26.5.2 Voltage variation test

H.26.5.2.2 Test procedure

Replacement of last paragraph:

The **control** is subjected to each of the specified voltage test cycles three times with 10 s intervals between each test cycle. For a **control** declared under Table 1, requirement 109, each test cycle is performed three times when the control is in the declared condition and three times when it is not.

H.26.8 Surge immunity test

H.26.8.3 Test procedure

Additional subclause:

H.26.8.3.101 For **controls** declared under Table 1, requirement 109, the tests are performed when the **control** is in the declared condition and when it is not.

H.26.9 Electrical fast transient/burst immunity test

H.26.9.3 Test procedure

Additional subclause:

H.26.9.3.101 The **control** is subjected to five tests. For **controls** declared under Table 1, requirement 109, the tests are performed when the **control** is in the declared condition and when it is not.

H.26.10 Ring wave immunity test

H.26.10.5 Test procedure

Additional subclause:

H.26.10.5.101 For **controls** declared under Table 1, requirement 109, the tests are performed when the **control** is in the declared condition and when it is not.

H.26.12 Radio-frequency electromagnetic field immunity

H.26.12.2 Immunity to conducted disturbances

H.26.12.2.2 Test procedure

Additional subclause:

H.26.12.2.2.101 For **controls** declared under Table 1, requirement 109, sweeping is performed when the **control** is in the declared condition and when it is not.

H.26.12.3 Immunity to radiated disturbances

H.26.12.3.2 Test procedure

Additional subclause:

H.26.12.3.2.101 For **controls** declared under Table 1, requirement 109, sweeping is performed when the **control** is in the declared condition and when it is not.

H.26.13 Test of influence of supply frequency variations

H.26.13.3 Test procedure

Additional subclause:

H.26.13.3.101 For **controls** declared under Table 1, requirement 109, the test shall be performed when the **control** is in the declared condition and when it is not.

H.26.14 Power frequency magnetic field immunity test

H.26.14.3 Test procedure

Additional subclause:

H.26.14.3.101 For **controls** declared under Table 1, requirement 109, the test shall be performed when the **control** is in the declared condition and when it is not.

H.26.15 Evaluation of compliance

H.26.15.2

Addition:

See Table H.101 for compliance criteria.

H.26.15.4

Addition:

See Table H.101 for compliance criteria.

H.27 Abnormal operation

This clause of Part 1 is applicable except as follows:

H.27.1.1.2 *Replace the first line by:*

The **control** shall be operated under the following conditions. In addition, **controls** declared under Table 1, requirement 109 shall be tested when the **control** is in the declared condition and when it is not.

H.27.1.1.3

This clause of Part 1 is applicable except item c).

H.27.1.2.2 Class B control function

This clause of Part 1 is applicable except as follows:

H.27.1.2.2.2 First fault

Replace item b) as follows:

b) the **control** shall react within the **fault reaction time** (see Table 1, requirement 91) by proceeding to the **defined state** provided that a subsequent restart under the same **fault** conditions results in the **system** returning to the same **defined state** condition;

Replace item c) as follows:

c) for **systems** with **non-permanent operation**, the **control** shall continue to operate as intended, the **fault** shall be detected during the next start-up sequence. The compliance criteria shall be a) or b);

NOTE Requirements for **systems** with **permanent operation** are under consideration.

Replace item d) as follows:

d) the **control** shall continue to operate as intended.

Replace the last two paragraphs as follows:

The **fault reaction time** shall be declared by the manufacturer (see Table 1, requirement 91).

For **permanent operation** as declared by the manufacturer (see Table 1, requirement 120), item c) is under consideration.

For the **control** function where a mechanical actuator is part of the **defined state** a test up to but not including the switching contacts is sufficient. If the test of the **defined state** fails, the **control** shall initiate the **safety shut-down**. Frequency of test is as declared by the manufacturer (see Table 1, requirement 119). Internal **faults** of the components of the checking circuits are not considered.

H.27.1.2.2.3 Fault introduced during defined state

Not applicable.

H.27.1.2.3 Class C control function

This clause of Part 1 is applicable except as follows:

H.27.1.2.3.2 First fault

Replace item b) as follows:

b) the **control** reacting within the **fault reaction time** (see Table 1, requirement 91) by proceeding to **defined state** provided that subsequent reset from the lock-out condition under the same **fault** condition results in the **system** returning to the **defined state** condition;

Replace item c) as follows:

c) for **systems** with **non-permanent operation**, the **control** shall continue to operate as intended, the **fault** shall be detected during the next start-up sequence. The compliance criteria shall be a) or b).

NOTE 101 Requirements for **systems** with **permanent operation** are under consideration.

Replace item d) as follows:

d) The **control** shall continue to operate as intended.

Replace the last sentence with the following:

The **fault reaction time** shall be declared by the manufacturer (see Table 1, requirement 91).

For **permanent operation** as declared by the manufacturer (see Table 1, requirement 120), item c) is under consideration.

For the **control** function where a mechanical actuator is part of the **defined state** a test up to but not including the switching contacts is sufficient. If the test of the **defined state** fails, the **control** shall initiate the **safety shut-down**. Frequency of test is as declared by the manufacturer (see Table 1, requirement 119). Internal **faults** of the components of the checking circuits are not considered.

H.27.1.2.3.3 Second fault

Replace second sentence and items a) and b) with the following:

During assessment, for **systems** with **non-permanent operation**, the second **fault** shall only be considered to occur when a start-up sequence has been performed after the first **fault**. For **systems** with **permanent operation**, the second **fault** occurs 24 h after the first **fault**.

Replace the last two sentences with the following:

The **fault reaction time**, as well as the applicability of H.27.1.2.3.2 c), shall be as declared by the manufacturer.

For the **control** function where a mechanical actuator is part of the **defined state** a test up to but not including the switching contacts is sufficient. If the test of the **defined state** fails, the **control** shall initiate the **safety shut-down**. Frequency of test is as declared by the manufacturer (see Table 1, requirement 119). Internal **faults** of the components of the checking circuits are not considered.

H.27.1.2.4 Faults during defined state

Under consideration.

Annex J
(normative)

Requirements for thermistor elements and controls using thermistors

This annex of Part 1 is applicable except as follows:

J.4 General notes on tests

J.4.3.5 According to purpose

Additional subclause:

J.4.3.5.101 For the purpose of declaring the number of endurance cycles in Table 1, requirement 64, **thermistors** are evaluated for the function performed in the **control**.

NOTE For example, the same number of cycles would be declared in requirement 64 as in requirement 27 for a **thermistor** used as the **sensing element** of a **control** with **type 2 action** in which one cycle of **control operation** occurs with each cycle of **thermistor operation**, or vice versa.

J.7 Information

Addition to Table 1:

Add to requirement 64 a reference to J.4.3.5.101.

Additional annexes:

Annex AA
(informative)

Maximum manufacturing deviation and drift [a, b]

NOTE In Canada and the USA, Annex AA is normative.

		Maximum allowable deviation from declared operating value		Maximum allowable drift from initial measured value	
Type of control	**Temperature range** °C	**% of declared operating value**	***K***	**% of declared operating value**	***K***
Storage water heater **thermostat**	≤77 [e]	–	3	–	6
	>77	–	4	–	6
Storage water heater thermal cut-out	Any	–	3	5	6
Thermal cut-outs for duct heaters, warm air furnaces and boilers	<150	–	8	5	–
	≥150	5	–	5	–
Thermal cut-outs for electric base-board heaters	Any	–	8	+2 [d]	–
Appliance **thermal cut-outs** other than the above [c]	<150	–	6	6	6
	150 ≤ *t* ≤ 204	4	–	5	–
	>204	5	–	5	–

[a] Where both the per cent and *K* variations are indicated, the greater value may be used.

[b] When the per cent of the declared **operating value** is used, the following values are to be added to the maximum deviation or **drift** calculated using the table.

– For 5 %: 0,9 *K*

– For 4 %: 0,7 *K*

– For 2 %: 0,4 *K*

[c] For appliance **thermal cut-outs**, the downward **drift** may be 20 % of the declared **operating value** plus 4 *K*. The acceptability of this **drift** must be determined in the application, taking into account such conditions as the possibility of user tampering, overlapping performance with a **thermostat** and other similar conditions that might result in a fire, shock or casualty hazard.

[d] The downward **drift** is not limited for **thermal cut-outs** for electric baseboard heaters.

[e] **Controls** for household use have a manufacturer **setting** ≤60 °C. Deviation and **drift** are checked at 60 °C or at the maximum **set point**.

Annex BB
(informative)

Time factor

BB.0 General

The **time factor** shall be determined by one of the following methods:

– sudden temperature change (Clause BB.2);

– linear rise of temperature (Clause BB.3).

NOTE Normally, the **time factor** can be described by an exponential function of first order.

In the case of exponential functions of higher order, the dead time has to be taken into consideration.

BB.1 The characteristics and switching points for the determination of the **time factor** *T* shall be checked in a steady state.

BB.1.1 The **time factor** is determined by means of an appropriate test device (for example, the two-bath or gradient method) for gaseous or liquid activating media. Should the test medium not correspond to the working medium, the respective conversion factors shall be specified.

BB.1.2 The **time factor** shall be measured with or without sheath or bulb well as declared by the manufacturer.

BB.1.3 The velocity of the test medium shall be:

0,2 m/s to 0,3 m/s for fluids;

1,0 m/s to 1,5 m/s for air.

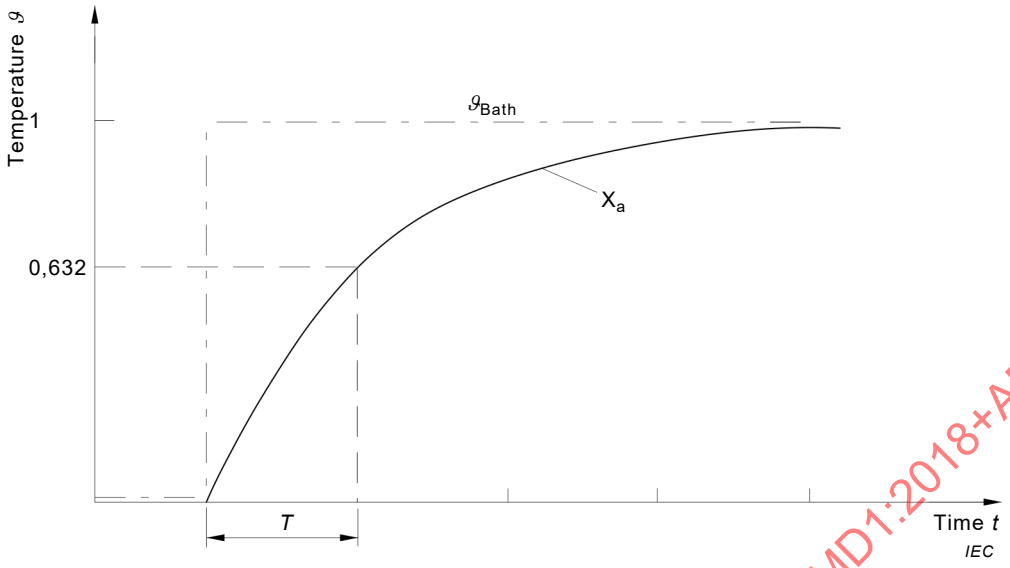
BB.2 Two-bath method

The temperature sensor is subjected to a sudden temperature rise after a steady-state temperature has been reached. The time at which a value of the output signal is reached which is equal to 63,2 % of the sudden temperature rise is determined as **time factor** *T* (see Figure BB.1).

In case of **thermostats** of the continuous type, the **time factor** shall be determined by this method alone.

BB.3 Gradient method

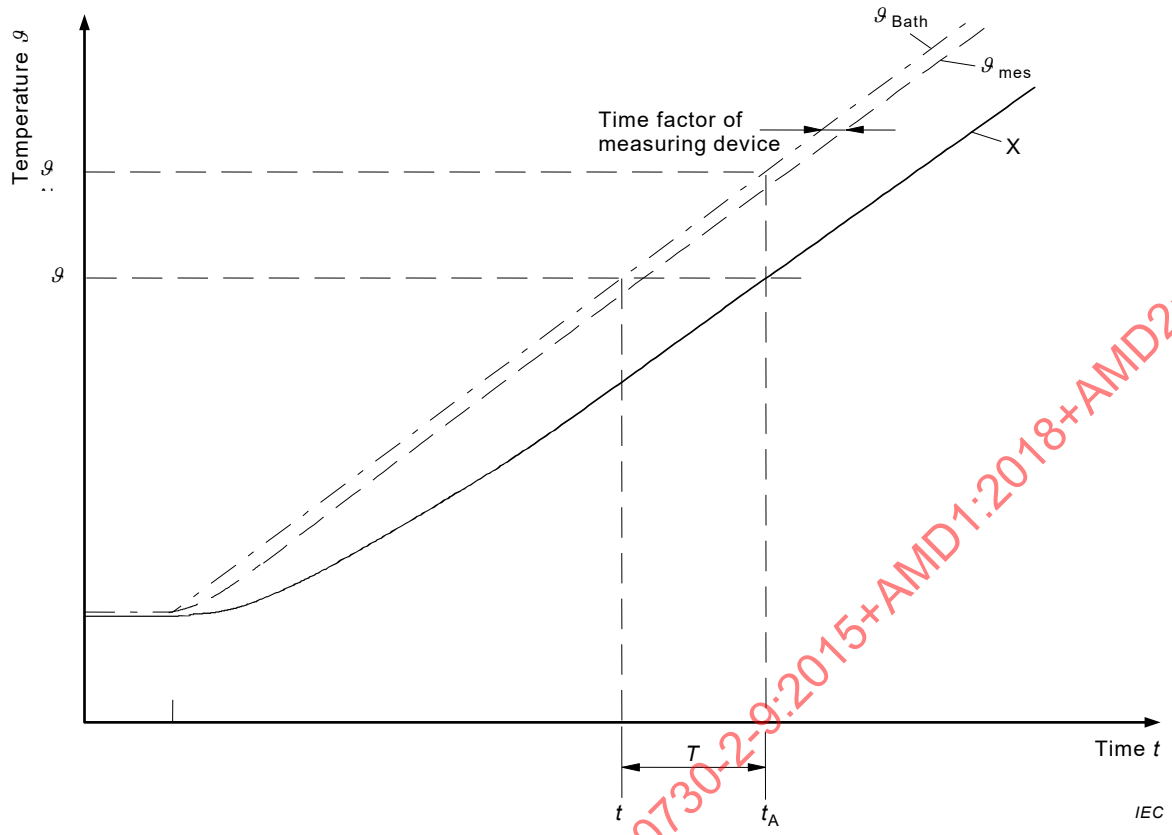
The temperature sensor is subjected to a bath temperature which rises at constant gradient. **Time factor** *T* is determined as a time delay at which the sensor temperature runs approximately parallel to the temperature of the bath. This occurs when a period of +5 *T* has elapsed since the beginning of the rise in temperature. The **time factor** of the measuring device shall be taken into account here (see Figure BB.2).



Components

ϑ_{Bath}	Test-bath temperature
X_a	Sample output signal
T	Time factor

Figure BB.1 – Determination of time factor in the case of a sudden temperature change



Components

ϑ_{Bath}	Test-bath temperature	ϑ_G	Set limit value
ϑ_{mes}	Bath temperature measured	t_{Ab}	Time of switch-off
X_a	Sample output signal	t_o	Time when $\vartheta_{Bath} = \vartheta_G$
ϑ_{Ab}	Switch-off temperature	T	$t_{Ab} - t_o$ (time factor)

Calculation of switch-off temperature ϑ_{Ab} under test conditions when T and A are known.

$$\vartheta_{Ab}\,^{1)} = T \times A + \vartheta_G$$

where A is the test-bath temperature gradient.

Figure BB.2 – Determination of time factor in the case of a linear rise of test-bath temperature

Table BB.1 – Method to determine and verify time factor values (see 11.101)

	Mode of working	Time factor T with working fluid at the sensing device s		
		Water	Air	Oil
Boiler thermostat and boiler **temperature limiters**	Continuous	130	120	–
Boiler thermostat, boiler **temperature limiters** and boiler **thermal cut-outs**	Two-point behaviour	45	120	60
Flue gas **temperature limiters**	Two-point behaviour	–	45	–

1) When a period of approximately 5 T has elapsed since the beginning of the rise in temperature.

Annex CC
(informative)

Number of cycles

CC.1 Number of cycles for independently mounted and in-line cord controls

Temperature sensing controls	Automatic action	Manual action
Thermostats	6 000	600
Room thermostats	100 000	600
Self-resetting **thermal cut-outs**	1 000	
Non-self-resetting **thermal cut-outs**	300	
Other **manual actions**		300

CC.2 Minimum number of cycles for independently mounted and in-line cord controls (Canada and the USA)

Temperature sensing controls	Automatic action		Manual action		Slow make and slow break [a]			
	With current	Without current	With current	Without current	First	Max. cycles per min	Last	Max. cycles per min
Self-resetting **thermal cut-outs**	100 000				75 000	6	25 000	1 b
Non-self-resetting **thermal cut-outs**	1 000*	5 000	1 000**	5 000	1 000	1 b	5 000	c
Self-resetting **temperature limiters**	6 000				6 000	1 b	–	–
	30 000 d				24 000 d	6 d	6 000 d	1 d
Non-self-resetting **temperature limiters**	6 000*		6 000**		6 000	1 b	–	–
	6 000				6 000	1 b	–	–
Thermostats	30 000 d				24 000 d	6 d	6 000 d	1 d
Other **manual action**			6 000		1 000	6	5 000	1 b
Room thermostats for other than **SELV**	30 000					6	–	–

* Break only.

** Make only.

[a] Magnetic, manual and motor-operated switches or the like, and switches that snap with lost motion and do not creep, may be tested at the rate of six cycles per minute.

[b] For all **controls**, the test is to be conducted with (50 ± 20) % “ON” time. A temperature operated **control** is to be so tested, using a slow rate of change.

[c] When no current is used, the switch may be operated at any convenient speed.

[d] For air-conditioning and refrigeration applications.

Annex DD
(normative)

Controls for use in agricultural confinement buildings

DD.1 Object

The object of Annex DD is to provide a standard test method for determining the ability of a temperature **sensing control** to withstand specified severities of chemical compounds associated with use in **agricultural confinement building** environments. The requirements of this annex are intended to be in addition to the requirements of this standard. Twelve new samples, unless the test of DD.7.8.2 is required, in which case thirteen, are used for the tests of this annex.

Controls declared and intended for use in **agricultural confinement buildings** are not intended for use in potentially explosive atmospheres within the scope of IEC 60079 series.

DD.2 Terms and definitions

DD.2.1
agricultural confinement building
farm structure characterised by being heated and/or cooled by artificial means, where accumulation of animal food and waste may result in concentrations of corrosive compounds not normally found in freely ventilated farm buildings (e.g. barns) and periodically disinfected prior to subsequent similar use

DD.3 Test apparatus

Test chambers and sample shelves are of materials known to withstand the corrosive effects of the test medium so as not to introduce additional by-products of corrosion.

DD.4 Severities

Severities are specified in Clause DD.7.

DD.5 Pre-conditioning

Annex DD does not prescribe any requirement for pre-conditioning. However, **controls** provided with openings for the entrance of wiring, fittings and/or cords of the type intended during installation shall be provided and used during testing. The resultant opening for wires or the cut end of cords, if any, shall be sealed to prevent entrance of the test medium into the control. Other openings, if any, are not modified.

DD.6 Initial measurements

Annex DD does not prescribe any requirement for initial measurements.

DD.7 Testing

DD.7.1 General

For the following tests, if any of the samples exposed for 10 days do not meet the requirements of DD.9.2, the 30 day test may be discontinued to conserve time and test chamber utilization.

DD.7.2 Moist carbon dioxide – sulfur dioxide – air mixture

Two samples are placed in the test chamber, one exposed for 10 days and the other for 30 days. An amount of carbon dioxide equivalent to 1 % of the volume of the test chamber