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Fire detection and alarm systems —

Part 10: Point-type flame detectors

Systèmes de détection et d'alarme d'incendie —

Partie 10: Détecteurs de flammes ponctuels

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Contents

Page

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 7240-10 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and fire alarm systems*.

ISO 7240 consists of the following parts, under the general title *Fire detection and alarm systems*:

— *Part 1: General and definitions*

— *Part 2: Control and indicating equipment*

— *Part 4: Power supply equipment*

— *Part 5: Point-type heat detectors*

— *Part 6: Carbon monoxide fire detectors using electro-chemical cells*

— *Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

— *Part 8: Carbon monoxide fire detectors using an electro-chemical cell in combination with a heat sensor*

— *Part 9: Test fires for fire detectors* [Technical Specification]

— *Part 10: Point-type flame detectors*

— *Part 11: Manual call points*

— *Part 12: Line type smoke detectors using a transmitted light beam*

— *Part 13: Compatibility assessment of system components*

— *Part 14: Guidelines for drafting codes of practice for design, installation and use of fire detection and fire alarm systems in and around buildings* [Technical Report]

— *Part 15: Point type fire detectors using scattered light, transmitted light or ionization sensors in combination with a heat sensor*

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— *Part 16: Sound system control and indication equipment*

— *Part 19: Design, installation, commissioning and service of sound systems for emergency purposes*

— *Part 21: Routing equipment*

— *Part 22: Smoke detection equipment for ducts*

The following parts are under preparation:

— *Part 26* dealing with oil mist detectors

— *Part 27* dealing with carbon fire detectors using optical or ionization smoke sensors, electrochemical cell carbon monoxide sensors and heat sensors

— *Part 28* dealing with fire protection control equipment

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Introduction

This part of ISO 7240 is based on a European Standard EN 54-10, prepared by the European Committee for Standardization CEN/TC 72 "*Fire detection and fire alarm systems*", together with ISO/DIS 19292, prepared by Technical Committee ISO/TC 8, *Ships and marine technology,* Subcommittee SC 1, *Lifesaving and fire protection.*

A fire detection and fire alarm system is required to function satisfactorily, not only in the event of a fire, but also during and after exposure to conditions likely to be met in practice, such as corrosion, vibration, direct impact, indirect shock and electromagnetic interference. Some tests specified are intended to assess the performance of the fire detectors under such conditions.

The performance of flame detectors is assessed from results obtained in specific tests. This part of ISO 7240 is not intended to place any other restrictions on the design and construction of such flame detectors.

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Fire detection and alarm systems —

Part 10: Point-type flame detectors

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1 Scope

This part of ISO 7240 specifies requirements, test methods and performance criteria for point-type, resettable flame detectors that operate using radiation from a flame for use in fire detection systems installed in buildings. Additional requirements for flame detectors for use in marine applications are specified in Annex A.

This part of ISO 7240 does not cover flame detectors working on different principles from those described in this document (although this part of ISO 7240 can be used as guidance in assessing such products).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 209-1, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition*

ISO 7240-1, *Fire detection and alarm systems — Part 1: General and definitions*

IEC 60064, *Tungsten filament lamps for domestic and similar general lighting purposes — Performance requirements*

IEC 60068-1, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing — Part 2: Tests. Tests A: Cold*

IEC 60068-2-2, *Environmental testing — Part 2: Tests: Tests B: Dry heat*

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

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

IEC 60068-2-30, *Environmental testing — Part 2: Tests. Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*

IEC 60068-2-42, *Environmental testing — Part 2: Tests. Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-52, *Environmental testing — Part 2: Tests — Test Kb: Salt mist, cyclic (sodium, chloride solution)*

IEC 60068-2-78, *Environmental testing — Part 2-78 — Tests — Test Cab: Damp heat, steady state*

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IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test*

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

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

IEC 61000-4-6:2006, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields*

EN 50130-4, *Alarm systems — Part 4: Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder and social alarm systems*

3 Terms and definitions

For the purposes of this document, the terms, definitions and symbols given in ISO 7240-1 and the following apply.

3.1
detector classification
classification of flame detectors to indicate their relative sensitivity to fire

NOTE Class 1 indicates the highest sensitivity and Class 3 the lowest sensitivity acceptable within this part of ISO 7240, except Class 4 where the sensitivity is nominated by the manufacturer.

3.2
infrared (IR) detector
flame detector responding only to radiation having wavelengths greater than 850 nm

3.3
multiband detector
flame detector having two or more sensing elements, each responding to radiation in a distinct wavelength range and each of whose outputs may contribute to the alarm decision

NOTE The alarm decision may be based on any arithmetic or logical combination of the individual signals.

3.4
response point
distance, D, measured in accordance with 5.1.5, at which the individual flame detector under test gives an alarm signal

3.5
sensitivity
measure of the ability of a flame detector to detect fires

NOTE Sensitivity is not necessarily directly related to the response point.

3.6
sensitivity adjustment
any adjustment of the detector or of the alarm criteria within the supply and monitoring equipment that leads to a change in sensitivity

See 5.1.2.

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3.7
ultra-violet (UV) detector
flame detector responding only to radiation having wavelengths less than 300 nm

4 General requirements

4.1 Compliance

In order to comply with this part of ISO 7240, the detector shall meet the requirements of this clause, which shall be verified by visual inspection or engineering assessment, shall be tested as described in Clause 5 and shall meet the requirements of the tests.

4.2 Classification

Detectors shall conform to one or more of the following classifications: class 1, class 2, class 3 or class 4 according to the requirements of the tests specified in 5.5.

Detectors suitable for use in marine environments shall conform to the additional requirements specified in Annex A.

4.3 Individual alarm indication

Each detector shall be provided with an integral red visual indicator, by which the individual detector that released an alarm can be identified, until the alarm condition is reset. Where other conditions of the detector are visually indicated, they shall be clearly distinguishable from the alarm indication, except when the detector is switched into a service mode. For detachable detector, the indicator may be integral with the base or the detector head.

The visual indicator shall be visible from a distance of 6 m in an ambient light intensity up to 500 lx at an angle of up to

a) 5° from the axis of the detector in any direction, and

b) 45° from the axis of the detector in at least one direction.

4.4 Connection of ancillary devices

The detector may provide for connections to ancillary devices (remote indicators, control relays, etc.), but open- or short-circuit failures of these connections shall not prevent the correct operation of the detector.

4.5 Monitoring of detachable detectors

For detachable detectors, a means shall be provided for a remote monitoring system (e.g. the control and indicating equipment) to detect the removal of the head from the base, in order to give a fault signal.

4.6 Manufacturer's adjustments

It shall not be possible to change the manufacturer's settings except by special means (e.g. the use of a special code or tool) or by breaking or removing a seal.

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4.7 On-site sensitivity adjustment

If there is provision for on-site sensitivity adjustment of the detector, then

a) for all settings at which the manufacturer claims compliance, the detector shall comply with the requirements of this part of ISO 7240 and shall achieve a classification corresponding to that marked on the detector for that setting;

b) for each setting in a), access to the adjustment means shall only be possible by the use of a code or special tool or by removing the detector from its base or mounting;

c) any setting or settings at which the manufacturer does not claim compliance with this part of ISO 7240 shall only be accessible by the use of a code or special tool, and it shall be clearly marked on the detector or in the associated data that if these setting or settings are used, the detector does not comply with this part of ISO 7240.

NOTE These adjustments can be carried out at the detector or at the control and indicating equipment.

4.8 Marking

Each detector shall be clearly marked with, or supplied with, the following information:

a) number of this part of ISO 7240 (i.e. ISO 7240-10);

b) name or trademark of the manufacturer or supplier;

c) model designation (type or number);

d) classification of the detector, e.g. class 1 and, where the detector is classified as class 4, the distance as determined by 5.5.2.3;

e) where the detector complies with the marine application requirements as specified in Annex A, the word “marine”, the symbol “M” or similar indication;

f) some mark(s) or code(s), (e.g. a serial number or batch code) by which the manufacturer can identify, at least, the date or batch and place of manufacture and the version number(s) of any software contained within the detector;

g) wiring terminal designations;

h) angle of reception as determined in 5.4;

i) operating wavelength band(s) e.g. UV, IR.

For detachable detectors, the detector head shall be marked with at least a), b), c), d), e) and f), and the base shall be marked with at least b), c) (i.e. its own model designation) and g).

Where any marking on the device uses symbols or abbreviations not in common use, these shall be explained in the data supplied with the device.

The marking shall be visible during installation of the detector and shall be accessible during maintenance.

The markings shall not be placed on screws or other easily removable parts.

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4.9 Data

Detectors shall either be supplied with sufficient technical, installation and maintenance data to enable their correct installation and operation or, if all of these data are not supplied with each detector, reference to the appropriate data sheet shall be given on, or with, each detector.

To enable correct operation of the detectors, these data should describe the requirements for the correct processing of the signals from the detector. This may be in the form of a full technical specification of these signals, a reference to the appropriate signalling protocol or a reference to suitable types of control and indicating equipment, etc.

Installation and maintenance data shall include reference to an *in situ* test method to ensure that detectors operate correctly when installed.

NOTE Additional information can be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this part of ISO 7240.

4.10 Requirements for software-controlled detectors

4.10.1 General

The requirements of 4.10.2, 4.10.3 and 4.10.4 shall be met for detectors that rely on software control in order to fulfil the requirements of this part of ISO 7240.

4.10.2 Software documentation

4.10.2.1 The manufacturer shall submit documentation which gives an overview of the software design. This documentation shall be in sufficient detail for the design to be inspected for compliance with this part of ISO 7240 and shall include at least the following:

a) functional description of the main program flow (e.g. as a flow diagram or structogram), including

   1) a brief description of the modules and the functions that they perform,

   2) the way in which the modules interact,

   3) the overall hierarchy of the program,

   4) the way in which the software interacts with the hardware of the detector,

   5) the way in which the modules are called, including any interrupt processing;

b) description of those areas of memory used for the various purposes (e.g. the program, site-specific data and running data);

c) designation by which the software and its version can be uniquely identified.

4.10.2.2 The manufacturer shall have available detailed design documentation, but which is provided to the testing authority only when required by that authority. It shall comprise at least the following:

a) overview of the whole system configuration, including all software and hardware components;

b) description of each module of the program, containing at least

   1) the name of the module,

   2) a description of the tasks performed,

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3) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data;

c) full source code listings, as hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized;

d) details of any software tools used in the design and implementation phase (CASE-Tools, Compilers, etc.).

4.10.3 Software design

In order to ensure the reliability of the detector, the following requirements for software design apply.

a) The software shall have a modular structure.

b) The design of the interfaces for manually and automatically generated data shall not permit invalid data to cause error in the program operation.

c) The software shall be designed to avoid the occurrence of deadlock of the program flow.

4.10.4 Storage of programs and data

The program necessary to comply with this part of ISO 7240 and any preset data, such as manufacturer's settings, shall be held in non-volatile memory. Writing to areas of memory containing this program and data shall be possible only by the use of some special tool or code and shall not be possible during normal operation of the detector.

Site-specific data shall be held in memory which retains data for at least two weeks without external power to the detector, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.

5 Tests

5.1 General

5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, carry out the testing after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as specified in IEC 60068-1 as follows.

— temperature: (15 to 35) °C

— relative humidity: (25 to 75) %

— air pressure: (86 to 106) kPa

The temperature and humidity shall be substantially constant for each environmental test where the standard atmospheric conditions are applied.

5.1.2 Operating conditions for tests

If a test method requires a specimen to be operational, then connect the specimen to suitable supply and monitoring equipment having the characteristics required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range. If a test

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procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices [e.g. through wiring to an end-of-line device for collective (conventional) detectors] to allow a fault signal to be recognized.

Unless otherwise specified in the test method, detectors having adjustable sensitivity shall be set to their highest sensitivity for the conditioning.

The details of the supply and monitoring equipment and the alarm criteria used shall be given in the test report (see Clause 6).

5.1.3 Mounting arrangements

The specimen shall be mounted by its normal means of attachment in accordance with the manufacturer's instructions. If these instructions describe more than one method of mounting, then the method considered to be most unfavourable shall be chosen for each test.

5.1.4 Tolerances

Unless otherwise stated, the tolerances for the environmental test parameters shall be as given in the basic reference standards for the test (e.g. the relevant part of IEC 60068).

If a specific tolerance or deviation limit is not specified in a requirement or test procedure, then a tolerance of ± 5 % shall be applied.

5.1.5 Determination of response point

5.1.5.1 Principle

The response point shall be measured by exposing the detector to the radiation from a suitable flame source and determining the greatest distance at which the detector reliably produces an alarm condition within 30 s of being exposed to the radiation from the flame.

5.1.5.2 Test apparatus

The test apparatus shall be as described in Annex B.

The design and construction of the apparatus and the surfaces surrounding the test area shall be such that no significant radiation from the source reaches the detector apart from that which has passed through the aperture. (This means for example that there shall be no reflection of radiation from the walls or other parts of the apparatus and no spurious radiation from hot flue gases or hot surfaces around the burner.)

Throughout this test method, the detector shall be aligned relative to its optical axis and the distances relative to the plane of the detector sensing elements shall be measured. If the detector does not have a well-defined optical axis, then the manufacturer shall nominate an optical axis for the purposes of this test method. The position of this axis relative to an easily identifiable plane on the detector shall be noted in the test report (see Clause 6).

Similarly, if the detector sensing elements do not lie in a well-defined plane, then the manufacturer shall nominate a plane for the purposes of this test method. The position of this plane relative to an easily identifiable plane on the detector shall be noted in the test report (see Clause 6).

5.1.5.3 Initial determination

A suitable area for the aperture shall be determined experimentally before the commencement of the test program such that the response point of one detector, chosen at random from the specimens submitted for test, lies within the range 1 300 mm to 1 700 mm. The size and shape of the aperture used shall be recorded and shall be kept constant throughout the test program. For detectors having adjustable sensitivity and whose adjustment range covers more than one sensitivity class, the appropriate aperture size for each sensitivity class of detector shall be determined.

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5.1.5.4 Source stability

After determining a suitable aperture size and before any determination of response points, the irradiance on the optical axis of the source shall be measured using the radiometer in accordance with Clause B.5. This measurement shall be carried out with no modulation of the source and with the aperture unobstructed. The measured value of irradiance shall be recorded and used as a reference throughout the test program to verify that the source radiance has not varied by more than 5 %.

5.1.6 Test procedure

Connect the specimen to its supply and indicating equipment and allow it to stabilize for a period of 15 min or for a time specified by the manufacturer. During this stabilization period, shield the specimen using the shutter in accordance with Clause B.3 from all sources of radiation which can affect the determination of the response point.

Before commencing any measurement of the response point, allow the burner to reach a stable working condition.

Vary the distance of the specimen from the source and expose the detector to the source at each distance for 30 s using the shutter. The response point, D, is the greatest distance, measured between the aperture and the plane of the specimen sensing element(s), at which the detector reliably produces an alarm response within each 30 s exposure. If the detector response is known to be dependent on previous exposure to radiation, then allow sufficient time before each exposure to ensure that previous exposures do not substantially affect the measurement of the response point.

For detectors having stochastic response behaviour, each value of D shall be the mean value of at least six repetitions of each measurement. Continue repetitions until an additional value changes the average value of D by less than 5 %.

5.1.7 Reduced functional tests

Where the test procedure calls for a reduced functional test, the detector shall be exposed to a source of radiation that is sufficient to cause an alarm response from the detector. The nature of the source used and the duration of the exposure shall be appropriate to the product in question.

5.1.8 Provision for tests

The following shall be provided for testing compliance with this part of ISO 7240:

a) for detachable detectors, eight heads and eight bases; for non-detachable detectors, eight specimens

b) the data required in 4.9.

The specimens submitted shall be deemed representative of the manufacturer's normal production with regard to their construction and calibration. This implies that the mean response point of the eight specimens found in the reproducibility test (5.2) should also represent the production mean and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

5.1.9 Test schedule

The detectors shall be tested according to the test schedule given in Table 1. After the reproducibility test, the four specimens having the largest value of response point (at the highest sensitivity setting) shall be numbered 1 to 4 and the remainder shall be numbered 5 to 8.

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Table 1 — Test schedule

Test	Subclause	Specimen number(s)
Reproducibility	5.2	all specimens
Repeatability	5.3	1
Directional dependence	5.4	1
Fire sensitivity	5.5	all specimens
Dazzling (operational)	5.6	1
Dry heat (operational)	5.7	2
Cold (operational)	5.8	2
Damp heat, cyclic (operational)	5.9	6
Damp heat, steady state (endurance)	5.10	6
Sulphur dioxide SO_2 corrosion (endurance)	5.11	5
Shock (operational)	5.12	8
Impact (operational)	5.13	7
Vibration, sinusoidal (operational)	5.14	4
Vibration, sinusoidal (endurance)	5.15	4
Variation in supply parameters (operational)	5.16	1
Electromagnetic compatibility (EMC) immunity tests (operational)	5.17	
Electrostatic discharge		1 [a]
Radiated electromagnetic fields		3 [a]
Conducted disturbance induced by electromagnetic fields		3 [a]
Fast transient bursts		3 [a]
Slow high-energy voltage surges		2 [a]

[a] In the interest of test economy, it is permitted to use the same specimen for more than one EMC test. In that case, intermediate functional test(s) on the specimen(s) used for more than one test can be deleted and the full functional test conducted at the end of the sequence of tests. However, it should be noted that in the event of a failure, it might not be possible to identify which test exposure caused the failure.

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5.1.10 Test report

The test results shall be reported in accordance with Clause 6.

5.2 Reproducibility

5.2.1 Object of test

To show that the sensitivity of the specimen does not vary unduly from specimen to specimen and to establish response point data for comparison with the response points measured after the environmental tests.

5.2.2 Test procedure

Measure the response point of each of the test specimens as specified in 5.1.6 and record each value of D. For detectors having adjustable sensitivity and whose range of adjustment covers more than one sensitivity class, repeat the measurement for each marked class.

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Calculate the mean of these response points, which shall be designated $\bar{D}$.

For each class setting, designate the maximum response point as D_{max}, the lowest response point as D_{min}, and the mean as $\bar{D}$.

5.2.3 Requirements

For each class setting, the ratio $D_{max} : \bar{D}$ shall not be greater than 1,15 and the ratio $\bar{D} : D_{min}$ shall not be greater than 1,22.

5.3 Repeatability

5.3.1 Object of test

To show that the specimen has a stable behaviour with respect to its response point even after a number of alarm conditions.

5.3.2 Test procedure

Measure the response point of the specimen to be tested six times as specified in 5.1.6.

Designate the maximum response point as D_{max}, the minimum value as D_{min}.

5.3.3 Requirements

The ratio of the response points $D_{max} : D_{min}$ shall not be greater than 1,14.

5.4 Directional dependence

5.4.1 Object of test

To show that the sensitivity of the specimen is not unduly dependent on the direction of the radiation incident on the specimen.

5.4.2 Test procedure

Mount the specimen on the optical bench with its optical axis coincident with the source optical axis as shown in Figure 1. Rotate the specimen through an angle, α, about an axis normal to the optical axis and passing through the point of intersection of the optical axis and the plane of the sensing element(s). Measure the response value of the specimen for

$$\alpha = 15°, 30°, \ldots, \alpha_{max}$$

where α_{max} is the maximum half-angle of reception specified for that detector type by the manufacturer.

With the angle, α, set to α_{max}, rotate the specimen about its optical axis through an angle, β, and measure the response point a further seven times for

$$\beta = 45°, 90°, 135°, 180°, 225°, 270°, 315°$$

Designate the maximum value of response value at any angle in this test and that measured for the same specimen in the reproducibility test as D_{max}, the minimum value as D_{min}.

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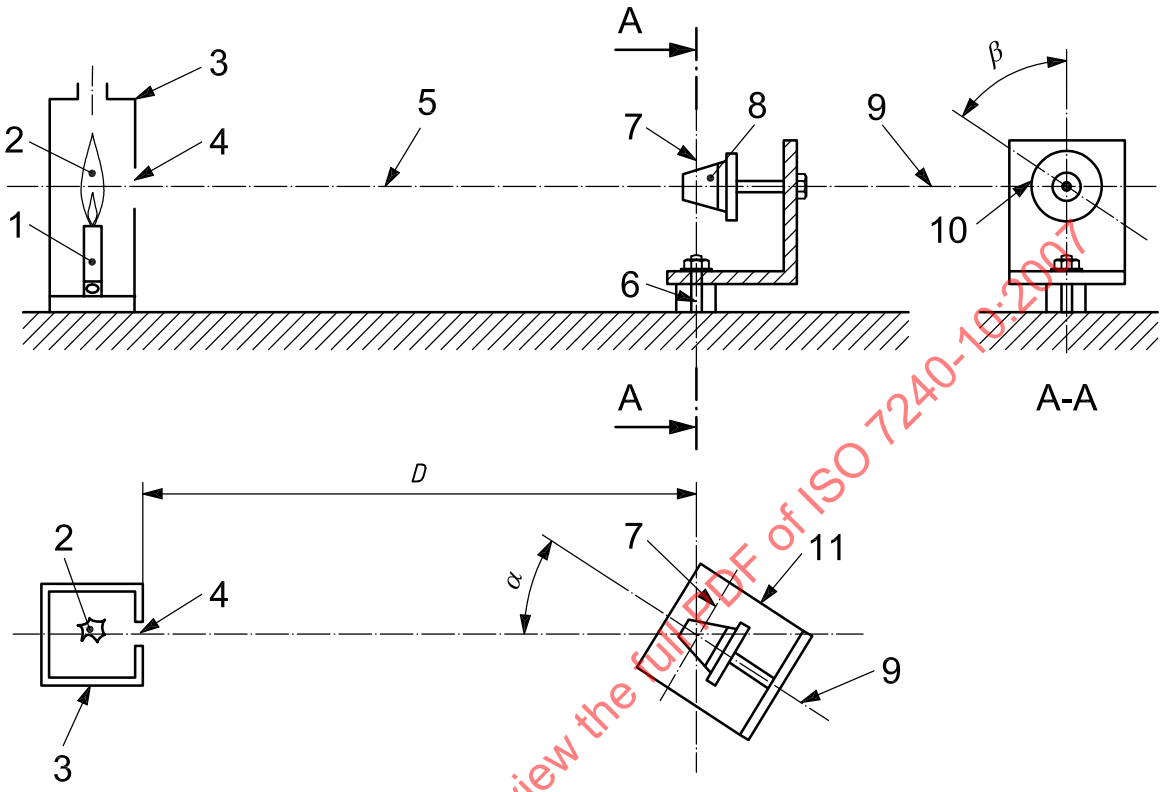
5.4.3 Requirements

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,41.



Key

1 methane gas burner
2 flame
3 burner housing
4 aperture
5 optical axis
6 vertical rotating axis
7 plane of sensing element(s)
8 detector
9 horizontal rotating axis
10 reference point
11 detector support
D response point

Figure 1 — Measurement of directional dependence

5.5 Fire sensitivity

5.5.1 Object of test

To show that the specimen has adequate sensitivity to fire as required for general application in fire detection systems for buildings, and to determine the sensitivity class or sensitivity classes appropriate for the detector.

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5.5.2 Test procedure

5.5.2.1 Principle of test

The test consists of exposing the detectors to the radiation from two types of test fire at known distances, d, to determine if the detectors are capable of producing an alarm signal within 30 s. The distance shall be chosen in accordance with the manufacturers specification for the intended class or classes of the detector (see 5.5.3.).

5.5.2.2 Mounting of specimens

Mount the eight specimens on a support, with their optical axes in the horizontal plane and at a height of 1,5 m $\pm$ 0,2 m. The horizontal angle of incidence, I_H, as defined in Figure 2, shall be not greater than 5°.

Connect each specimen to its supply and monitoring equipment, as specified in 5.1.2, and allow it to stabilize in its quiescent condition for at least 15 min before the start of each test fire or for a period specified by the manufacturer.

Ensure the area is free of radiation sources and draughts that can affect the response of the detectors to the test fire.

5.5.2.3 Test fires

5.5.2.3.1 If the manufacturer specifies class 1, perform the procedure specified in 5.5.2.3.5 to 5.5.2.3.11 with the distance between the fire and the detectors of 25 m from the plane of the detector sensing elements.

5.5.2.3.2 If the manufacturer specifies class 2, perform the procedure specified in 5.5.2.3.5 to 5.5.2.3.11 with the distance between the fire and the detectors of 17 m from the plane of the detector sensing elements.

5.5.2.3.3 If the manufacturer specifies class 3, perform the procedure specified in 5.5.2.3.5 to 5.5.2.3.11 with the distance between the fire and the detectors of 12 m from the plane of the detector sensing elements.

5.5.2.3.4 If the manufacturer specifies class 4, perform the procedure specified in 5.5.2.3.5 to 5.5.2.3.11 with the distance between the fire and the detectors specified by the manufacturer from the plane of the detector sensing elements.

5.5.2.3.5 Place the fire tray containing *n*-heptane in accordance with Annex C.

5.5.2.3.6 Shield the specimen from the fire tray.

5.5.2.3.7 Ignite the fuel and allow it to burn for at least 1 min.

5.5.2.3.8 Remove the shutter and allow the detectors to be exposed to the radiation from the fire for a period of 30 s. At the end of the 30 s period, shield the detectors from the fire radiation.

5.5.2.3.9 Record the status of each detector during the test.

5.5.2.3.10 If all eight specimens are in the alarm condition, then the detector shall be deemed to respond to the test fire. If one or more of the specimens has failed to respond, then the detector is deemed to have failed the test.

5.5.2.3.11 Repeat the procedure specified in 5.5.2.3.5 to 5.5.2.3.10 using the methylated spirit fire, in accordance with Annex D.

5.5.2.3.12 For detectors having adjustable sensitivity, repeat the above tests for the extreme sensitivity settings. If the range of adjustment covers more than one sensitivity class, conduct the tests for settings corresponding to each of the marked classes [see 4.7 a)].

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5.5.3 Classification

The detector shall be classified according to the greatest distance at which all eight specimens respond to each fire type within the 30 s exposure. The classes shall be as follows:

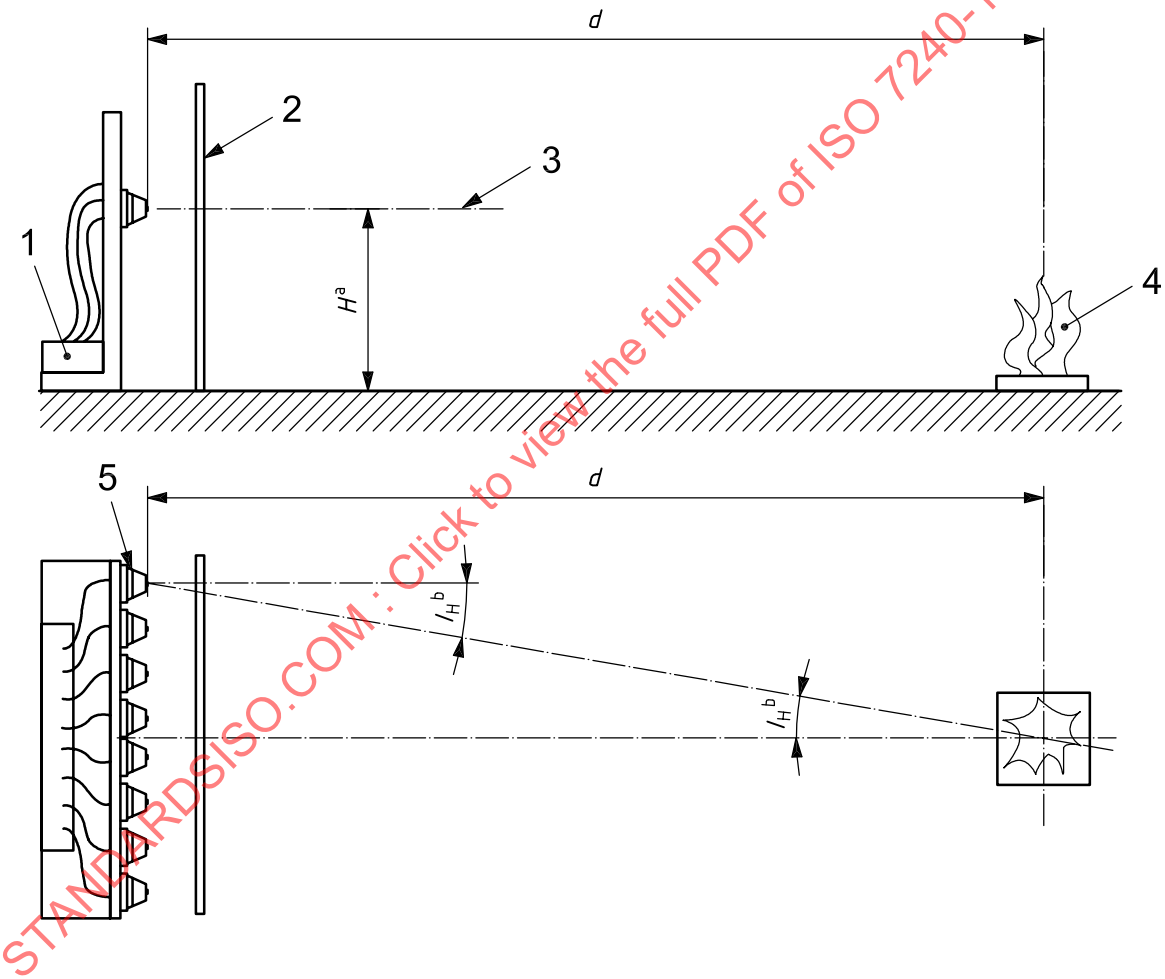
— class 1 if all specimens respond to both fire types at a distance of 25 m;

— class 2 if all specimens respond to both fire types at a distance of 17 m;

— class 3 if all specimens respond to both fire types at a distance of 12 m;

— class 4 if all specimens respond to both fire types at a distance nominated by the manufacturer.

At each tested setting for which the manufacturer claims compliance with this part of ISO 7240, the detector response shall be classified as class 1, 2, 3 or 4.



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Key

1 supply and monitoring equipment
2 screen to be removed during test
3 horizontal optical axis of detectors
4 test fire
5 detectors

a $H = (1{,}5 \pm 0{,}2)$ m
b $I_H = 0° \pm 5°$

Figure 2 — Fire sensitivity test

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5.5.4 Requirements

The detector shall attain classification 1, 2, 3 or 4 (see 5.5.3).

For detectors having adjustable sensitivity, and for which the adjustment covers more than one sensitivity class, the sensitivity class determined at each setting shall correspond to that marked on the detector.

5.6 Dazzling (operational)

5.6.1 Object of test

To show that the sensitivity of the specimen is not unduly influenced by the close proximity of artificial light sources.

5.6.2 Test procedure and apparatus

5.6.2.1 Reference

Use the test apparatus and perform the procedure described in Annex E and 5.6.2.2 to 5.6.2.6.

5.6.2.2 State of the specimen during conditioning

Mount the specimen on the optical bench as described in 5.1.3 and connect it to its supply and indicating equipment as specified in 5.1.2.

5.6.2.3 Conditioning

Condition the specimen in a darkened room for 1 h and then perform the following procedure.

a) Switch the lamp ON for 1 s and then OFF for 1 s. Repeat 20 times.

b) Switch the lamp ON for 2 h.

5.6.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.6.2.5 Final measurement (light source on)

Immediately after the continuous exposure [see 5.6.2.3 b)], and with the light source still ON, determine the response point in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.6.2.6 Final measurement (light source off)

Immediately after the completion of the measurement in 5.6.2.5 switch the light source OFF and allow the specimen to recover for 5 min. At the end of the recovery period, determine the response point in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

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5.6.3 Requirements

No alarm or fault signals shall be given during the exposures a) and b) of 5.6.2.3.

The ratio of the response point values D_{max} : D_{min} determined in 5.6.2.5 shall not be greater than 1,26.

The ratio of the response point values D_{max} : D_{min} determined in 5.6.2.6 shall not be greater than 1,14.

5.7 Dry heat (operational)

5.7.1 Object of test

To demonstrate the ability of the specimen to function correctly at high ambient temperatures appropriate to the anticipated service environment.

5.7.2 Test procedure and apparatus

5.7.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Ba or Bb, and by 5.7.2.2 to 5.7.2.4.

5.7.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

5.7.2.3 Conditioning

Apply the following conditioning:

— temperature: Starting at an initial air temperature of (23 ± 5) °C, increase the air temperature to (55 ± 2) °C;

— duration: Maintain the temperature for 16 h.

NOTE Test Bb specifies rates of change of temperature of $\leqslant$ 1 °C/min for the transitions to and from the conditioning temperature.

5.7.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals. During the last 30 min of the conditioning, subject the specimen to the reduced functional test in accordance with 5.1.7.

5.7.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.7.3 Requirements

No alarm or fault signals shall be given during the transition to the conditioning temperature or during the conditioning.

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The specimen shall give an alarm signal in response to the reduced function test.

The ratio point values D_{max} : D_{min} shall be not greater than 1,26.

5.8 Cold (operational)

5.8.1 Object of test

To demonstrate the ability of the specimen to function correctly at low ambient temperatures appropriate to the anticipated service temperature.

5.8.2 Test procedure

5.8.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1, Test Ab, and by 5.8.2.2 to 5.8.2.4.

5.8.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

5.8.2.3 Conditioning

Apply the following conditioning:

— temperature: (−10 ± 3) °C;

— duration: 16 h.

NOTE Test Ab specifies rates of change of temperature of ⩽ 1 °C/min for the transitions to and from the conditioning temperature.

5.8.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals. During the last 30 min of the conditioning, subject the specimen to the reduced functional test in accordance with 5.1.7.

5.8.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.8.3 Requirements

No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

The specimen shall give an alarm signal in response to the reduced functional test.

The ratio D_{max} : D_{min} shall be not greater than 1,26.

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5.9 Damp heat, cyclic (operational)

5.9.1 Object of test

To demonstrate the ability of the specimen to function in an environment with high relative humidity where condensation on the equipment can occur.

5.9.2 Test procedure

5.9.2.1 Reference

Use the test apparatus and procedures as specified in IEC 60068-2-30 using the Variant 1 test cycle and controlled recovery conditions and in 5.9.2.2 to 5.9.2.4.

5.9.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

NOTE Any self-test feature intended to monitor the transmission of the detector window can be disabled during this test.

5.9.2.3 Conditioning

The following severity of conditioning shall be applied:

— temperature: (40 ± 2) °C;

— number of cycles: 2.

5.9.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

During the last 30 min of the high-temperature phase of the last cycle, subject the specimen to the reduced functional test described in 5.1.7.

5.9.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.9.3 Requirements

No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

The specimen shall give an alarm signal in response to the reduced functional test.

The ratio D_{max} : D_{min} shall be not greater than 1,26.

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5.10 Damp heat, steady state (endurance)

5.10.1 Object of test

To demonstrate the ability of the specimen to withstand the long-term effects of humidity in the service environment (e.g. changes in electrical properties of materials, chemical reactions involving moisture, galvanic corrosion).

5.10.2 Test procedure

5.10.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab, and in 5.10.2.2 to 5.10.2.4.

5.10.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3. Do not supply it with power during the conditioning.

5.10.2.3 Conditioning

Apply the following conditioning:

— temperature: (40 ± 2) °C;

— relative humidity: (93 ± 3) %;

— duration: 21 d.

5.10.2.4 Final measurements

After a recovery period of between 1 h and 2 h in standard atmospheric conditions, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.10.3 Requirements

No fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen.

The ratio D_{max} : D_{min} shall be not greater than 1,26.

5.11 Sulfur dioxide (SO_2) corrosion (endurance)

5.11.1 Object of test

To demonstrate the ability of the specimen to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

5.11.2 Test procedure

5.11.2.1 Reference

Use the test apparatus and procedure as generally specified in IEC 60068-2-42, Test Kc, but carry out the conditioning as specified in 5.11.2.3.

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5.11.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3. Do not supply it with power during the conditioning, but equip it with untinned copper wires of the appropriate diameter, connected to a sufficient number of terminals to allow the final measurement to be made without making further connections to the specimen.

5.11.2.3 Conditioning

Apply the following conditioning:

— temperature: (25 ± 2) °C;

— relative humidity: (93 ± 3) %;

— SO_2 concentration: (25 ± 5) µl/l;

— duration: 21 d.

5.11.2.4 Final measurements

Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C and ⩽ 50 % RH, followed by a recovery period of at least 1 h at the standard atmospheric conditions. After this, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.11.3 Requirements

No fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen.

The ratio $D_{max} : D_{min}$ shall be not greater than 1,26.

5.12 Shock (operational)

5.12.1 Object of test

To demonstrate the immunity of the specimen to mechanical shocks that are likely to occur, albeit infrequently, in the anticipated service environment.

5.12.2 Test procedure and apparatus

5.12.2.1 General

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-27, Test Ea, but carry out the conditioning as specified in 5.12.2.3.

5.12.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 to a rigid fixture and connect it to its supply and monitoring equipment as specified in 5.1.2.

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5.12.2.3 Conditioning

For specimens with a mass $\leqslant$ 4,75 kg, apply the following conditioning:

— shock pulse type: half sine;

— pulse duration: 6 ms;

— peak acceleration: $10(100 - 20M)$ m/s^2 (where M is the mass of the specimen in kilograms);

— number of directions: six;

— pulses per direction: three.

Do not test specimens with a mass $>$ 4,75 kg.

5.12.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any alarm or fault signals.

5.12.2.5 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.12.3 Requirements

No alarm or fault signals shall be given during the conditioning period or the additional 2 min.

The ratio D_{max} : D_{min} shall be not greater than 1,26.

5.13 Impact (operational)

5.13.1 Object of test

To demonstrate the immunity of the specimen to mechanical impacts upon its surface, which it may sustain in the normal service environment, and which it can reasonably be expected to withstand.

5.13.2 Test procedure

5.13.2.1 Apparatus

Use the test apparatus specified in Annex F.

5.13.2.2 State of the specimen during conditioning

Mount the specimen rigidly to the apparatus by its normal mounting means and position it so that it is struck by the upper half of the impact face when the hammer is in the vertical position (i.e. when the hammerhead is moving horizontally). Choose the azimuthal direction and the position of impact relative to the specimen as that most likely to impair the normal functioning of the specimen. Connect the specimen to its supply and monitoring equipment as specified in 5.1.2.

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5.13.2.3 Conditioning

Use the following test parameters during the conditioning:

— impact energy: (1,9 ± 0,1) J;

— hammer velocity: (1,5 ± 0,13) m/s;

— number of impacts: one.

5.13.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any alarm or fault signals.

5.13.2.5 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.13.3 Requirements

No alarm or fault signals shall be given during the conditioning period or the additional 2 min.

The impact shall not detach the flame detector from its base or the base from the mounting.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

5.14 Vibration, sinusoidal (operational)

5.14.1 Object of test

To demonstrate the immunity of the specimen to vibration at levels considered appropriate to the normal service environment.

5.14.2 Test procedure

5.14.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.14.2.2 to 5.14.2.5.

5.14.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2. Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

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5.14.2.3 Conditioning

Apply the following conditioning:

— frequency range: (2 to 10) Hz;

— displacement: 1,24 mm;

— frequency range: (10 to 150) Hz;

— acceleration amplitude: 5 m/s^2 ($\approx$ 0,5 g_n);

— number of axes: three;

— sweep rate: 1 octave/min;

— number of sweep cycles: 1 /axis.

The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. It is necessary to make only one final measurement.

5.14.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.14.2.5 Final measurements

After the conditioning, visually inspect the specimen for mechanical damage both internally and externally. Then measure the response point as specified in 5.1.5.

NOTE The final measurements are normally made after the vibration endurance test and it is necessary to make them here only if the operational test is conducted in isolation.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.14.3 Requirements

No alarm or fault signals shall be given during the conditioning. No mechanical damage either internally nor externally shall result.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

5.15 Vibration, sinusoidal (endurance)

5.15.1 Object of test

To demonstrate the ability of the specimen to withstand the long-term effects of vibration at levels appropriate to the shipping, installation and service environment.

5.15.2 Test procedure

5.15.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.15.2.2 to 5.15.2.4.

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5.15.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.3, but do not supply it with power during conditioning. Apply the vibration in each of three mutually perpendicular axes in turn and so that one of the three axes is perpendicular to the normal mounting axis of the specimen.

5.15.2.3 Conditioning

Apply the following conditioning:

— frequency range: (10 to 150) Hz;

— acceleration amplitude: 10 m/s^2 (≈1,0 g_n);

— number of axes: three;

— sweep rate: 1 octave/min;

— number of sweep cycles: 20 /axis.

NOTE The vibration operational and endurance tests can be combined such that the specimen is subjected to the operational test conditioning followed by the endurance-test conditioning in one axis before changing to the next axis. It is necessary to make only one final measurement.

5.15.2.4 Final measurements

After the conditioning, measure the response point of the specimen as specified in 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.15.3 Requirements

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

5.16 Variation of supply parameters (operational)

5.16.1 Object of test

To show that, within the specified range(s) of the supply parameters (e.g. voltage), the response point of the detector is not unduly dependent on those parameters.

5.16.2 Test procedure

Measure the response point of the specimen as specified in 5.1.5, at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

NOTE For collective (conventional) detectors, the supply parameter is the dc voltage applied to the detector. For other types of detector (e.g. analogue addressable), it can be necessary to consider signal levels and timing.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

5.16.3 Requirements

The ratio D_{max} : D_{min} shall be not greater than 1,26.

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5.17 Electromagnetic compatibility (EMC) immunity tests (operational)

5.17.1 The following EMC immunity tests shall be carried out as specified in EN 50130-4:

a) electrostatic discharge;

NOTE For ultraviolet (UV) detectors that respond to the radiation from the spark, the time between discharges can be increased up to a maximum of 30 s.

b) radiated electromagnetic fields;

c) conducted disturbances induced by electromagnetic fields;

d) fast transient bursts;

e) slow high-energy voltage surges.

5.17.2 For these tests, the criteria for compliance as specified in EN 50130-4 and the following shall apply.

a) The functional test, called for in the initial and final measurements, shall be as follows.

   — Measure the response point as specified in 5.1.5.

   — Designate the greater of the response point measured in this test and that measured for the same specimen in the reproducibility test D_{max}, and the lesser as D_{min}.

b) The required operating condition shall be as specified in 5.1.2.

c) The specimen shall be mounted in accordance with 5.1.3.

d) The acceptance criteria for the functional test after the conditioning shall be that the ratio $D_{max} : D_{min}$ shall be not greater than 1,26.

6 Test report

The test report shall contain as a minimum the following information:

a) identification of the alarm tested;

b) reference to this part of ISO 7240;

c) results of the test: the individual response points and the minimum, maximum and arithmetic mean values where appropriate;

d) detector classification;

e) conditioning period and the conditioning atmosphere;

f) temperature and the relative humidity in the test room throughout the test;

g) details of the supply and monitoring equipment and the alarm criteria;

h) details of any deviation from this part of ISO 7240 or from the International Standards to which reference is made;

i) details of any operations regarded as optional.

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Annex A
(normative)

Marine test requirements

A.1 General

Flame detectors classified for marine applications shall comply with the additional tests specified in Table A.1; it is not necessary that they comply with the tests specified in Table A.2.

Table A.1 — Additional tests for marine applications

Test	Clause	Specimen number(s)
Dry heat (operational)	A.2	2
Cold (operational)	A.3	2
Damp heat	A.4	6
Salt mist	A.5	5
Vibration, sinusoidal (operational)	A.6	4
High voltage	A.7	7
Variation in supply parameters	A.8	1
Electrical power-supply failure	A.9	3
Insulation resistance [a]	A.10	2, 6
Electrostatic discharge immunity	A.11	1
Radiated radio-frequency immunity	A.12	3
Conducted low-frequency immunity	A.13	3
Conducted high-frequency immunity	A.14	3
Burst/fast response transient immunity	A.15	3
Surge immunity	A.16	8
[a] Measurements shall be performed before and after the relevant environmental tests		

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Table A.2 — Non-required tests

Test	Clause
Dry heat (operational)	5.7
Cold (operational)	5.8
Damp heat, cyclic (operational)	5.9
Damp heat, steady state (endurance)	5.10
Sulphur dioxide SO_2 corrosion (endurance)	5.11
Shock (operational)	5.12
Impact (operational)	5.13
Vibration, sinusoidal (operational)	5.14
Vibration, sinusoidal (endurance)	5.15
Variation in supply parameters	5.16
Electromagnetic compatibility (EMC), immunity tests (operational)	5.17
Liquid (methylated spirit) fire (TF6)	Annex D

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A.2 Dry heat (operational)

A.2.1 Object of test

To demonstrate the ability of the specimen to function correctly at high ambient temperatures appropriate to the anticipated service environment.

A.2.2 Test procedure and apparatus

A.2.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Bb, and by A.2.3.2 to A.2.3.4.

A.2.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

A.2.2.3 Conditioning

Apply the following conditioning:

— temperature: Starting at an initial air temperature of (23 ± 5) °C, increase the air temperature to (70 ± 2) °C;

— duration: Maintain the temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of $\leqslant 1$ °C/min for the transitions to and from the conditioning temperature.

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A.2.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals. During the last 30 min of the conditioning, subject the specimen to the reduced functional test in accordance with 5.1.7.

A.2.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.2.3 Requirements

No alarm or fault signals shall be given during the transition to the conditioning temperature or during the conditioning.

The specimen shall give an alarm signal in response to the reduced function test.

The ratio point values $D_{max} : D_{min}$ shall be not greater than 1,26.

A.3 Cold (operational)

A.3.1 Object of test

To demonstrate the ability of the specimen to function correctly at low ambient temperatures appropriate to the anticipated service temperature.

A.3.2 Test procedure

A.3.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1, Test Ab, and by A.3.2.2 to A.3.2.4.

A.3.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

A.3.2.3 Conditioning

Apply the following conditioning:

— temperature: (5 ± 3) °C;

— duration: 2 h.

For detectors intended for installation on open decks or exposure to the outside weather, apply the following conditioning.

— temperature: (– 25 ± 3) °C;

— duration: 2 h.

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NOTE Test Ab specifies rates of change of temperature of $\leqslant$ 1 °C/min for the transitions to and from the conditioning temperature.

A.3.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals. During the last 30 min of the conditioning, subject the specimen to the reduced functional test in accordance with 5.1.7.

A.3.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions measure the response point of the specimen in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.3.3 Requirements

No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

The specimen shall give an alarm signal in response to the reduced functional test.

The ratio D_{max} : D_{min} shall be not greater than 1,26.

A.4 Damp heat

A.4.1 Object of test

To demonstrate the ability of the specimen to function in an environment with high relative humidity where condensation on the equipment can occur.

A.4.2 Test procedure

A.4.2.1 Reference

Use the test apparatus and procedures as specified in IEC 60068-2-30, Test Db, and in A.4.2.2 to A.4.2.4.

A.4.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3.

During the first 12 h of the conditioning, connect the specimen to supply and monitoring equipment as specified in 5.1.2.

During the second 12 h of conditioning, do not supply the specimen with power.

NOTE Any self-test feature intended to monitor the transmission of the detector window can be disabled during this test.

A.4.2.3 Conditioning

The following severity of conditioning shall be applied:

— temperature: (55 ± 2) °C;

— relative humidity: (95 ± 5) %;

— duration: 24 h.

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A.4.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

During the first 2 h of conditioning, subject the specimen to the reduced functional test described in 5.1.7.

During the last 2 h of conditioning, subject the specimen to the reduced functional test described in 5.1.7.

A.4.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.4.3 Requirements

No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

The specimen shall give an alarm signal in response to the reduced functional test.

The ratio $D_{max} : D_{min}$ shall be not greater than 1,26.

A.5 Salt mist

A.5.1 Object of test

To demonstrate the ability of the specimen to withstand the corrosive effects of salt mist.

A.5.2 Test procedure

A.5.2.1 Reference

Use the test apparatus and procedure as generally specified in IEC 60068-2-52, Test Kb, but carry out the conditioning as specified in A.5.2.3.

A.5.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3. Do not supply it with power during the conditioning.

A.5.2.3 Conditioning

Apply the following conditioning:

— NaCl spray solution: 2 h;

— standing time after spray: 7 d;

— number of cycles: four.

A.5.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

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During the 7th day of each cycle, measure the response point as specified in 5.1.5.

A.5.2.5 Final measurements

Immediately after the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and during conditioning, and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.5.3 Requirements

No fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen.

The ratio $D_{max} : D_{min}$ shall be not greater than 1,26.

A.6 Vibration, sinusoidal (operational)

A.6.1 Object of test

To demonstrate the immunity of the specimen to vibration at levels considered appropriate to the normal marine service environment.

A.6.2 Test procedure

A.6.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in A.6.2.2 to A.6.2.5.

A.6.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2. Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

A.6.2.3 Conditioning

Apply the conditioning specified in Table A.3.

Table A.3 — Vibration test

Frequency	Amplitude	Acceleration
(+ 3/– 0) Hz – 13,2 Hz	± 1,0 mm	—
13,2 Hz – 100 Hz	—	± 0,7 g

If resonance points do not exist, apply the vibration of acceleration ± 0,7 g at 30 Hz for 90 min.

Where resonance points are found, either repeat the test with necessary provisions to avoid resonance or apply the vibration, using the same amplitude or acceleration of resonance point, at the resonance frequency for 90 min.

For equipment intended for installation in severe vibration conditions such as diesel engines or air compressors, the vibration level specified in Table A.4 shall be applied.

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Table A.4 — Severe vibration test

Frequency	Amplitude	Acceleration
(+ 3/– 0) Hz – 25 Hz	± 1,6 mm	—
13,2 Hz – 100 Hz	—	± 4,0 g

A.6.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

Monitor the specimen during the conditioning period for resonance points, at which the amplification factor is $\geqslant$ Q2.

A.6.2.5 Final measurements

After the conditioning, visually inspect the specimen for mechanical damage both internally and externally. Then measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.6.3 Requirements

No alarm or fault signals shall be given during the conditioning. No mechanical damage either internally nor externally shall result.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

A.7 High voltage

A.7.1 Object of test

To demonstrate the immunity of the specimen to high voltage surges that can occur in a marine service environment.

A.7.2 Test procedure

A.7.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

A.7.2.2 Conditioning

Apply alternating current voltages specified in Table A.5 at a frequency of 50 Hz or 60 Hz between current-carrying parts and earth for 1 min.

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Table A.5 — Test voltages

Rated voltage V_r V	Test voltage V
$V_r \leqslant 65$	$2V_r + 500$
$65 < V_r \leqslant 250$	1 500
$250 < V_r \leqslant 500$	2 000
$500 < V_r \leqslant 690$	2 500

For equipment containing circuits in which electronic apparatus is used and the application of the test voltage is not desirable, the circuits may be removed before applying the test voltages.

A.7.2.3 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.7.3 Requirements

No alarm or fault signals shall be given during the conditioning.

The ratio of the response points $D_{max} : D_{min}$ shall not be greater than 1,26.

A.8 Variation in supply parameters

A.8.1 Object of test

To show that, within the specified range(s) of the supply parameters (e.g. voltage), the response point of the specimen is not unduly dependent on those parameters.

A.8.2 Test procedure

A.8.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

A.8.2.2 Conditioning

Apply the supply variation parameters as specified in Table A.6.

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Table A.6 — Electrical supply variation parameters

Parameter	Variation from rated value %	
	Voltage	Frequency
Permanent a.c.		
Combination 1	+ 6	+ 5
Combination 2	+ 6	– 5
Combination 3	– 10	+ 5
Combination 4	– 10	– 5
Temporary a.c.		
Combination 5	+ 20 for 1,5 s	+ 10 for 5 s
Combination 6	– 20 for 1,5 s	– 10 for 5 s
d.c.		—
For equipment not related to a battery	Tolerance (continuous) ± 10 Cyclic variation 5 Ripple 10	
For equipment related to a battery	– 25, + 30 for equipment connected to a battery during charging – 25, + 20 for equipment not connected to a battery during charging	

A.8.2.3 Measurements during conditioning

Measure the response point of the specimen as specified in 5.1.5 at the limits specified in Table A.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

In the case of tests “Combination 5” and “Combination 6”, measurement of the response point may be omitted.

A.8.3 Requirements

No alarm or fault signals shall be given during the conditioning.

The ratio of the response points $D_{max} : D_{min}$ shall not be greater than 1,26.

A.9 Electrical power-supply failure

A.9.1 Object of test

To demonstrate the ability of the specimen to operate normally following an interruption to the power supply.

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A.9.2 Test procedure

A.9.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

A.9.2.2 Conditioning

Disconnect the power supply to the specimen for a period of 30 s three times over 5 min.

A.9.2.3 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.9.3 Requirements

No abnormality shall be observed after the power supply equipment is reconnected to the specimen. The equipment shall operate satisfactorily. The ratio of the response points $D_{max} : D_{min}$ shall not be greater than 1,26.

A.10 Insulation resistance

A.10.1 Object of test

To demonstrate the integrity of the electrical insulation of the specimen.

A.10.2 Test procedure

A.10.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 but do not supply it with power during conditioning.

A.10.2.2 Conditioning

Apply the voltages specified in Table A.7 to current carrying parts and between current-carrying parts and earth.

Table A.7 — Test voltages

Rated voltage V_r V	Test voltage V
$V_r \leqslant 65$	V_r and not less than 24
$V_r > 65$	500

For the equipment containing circuits in which electronic apparatus are used and the application of the test voltage is not desirable, apply the test voltage after removing the circuits.

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A.10.2.3 Final measurements

Measure the insulation resistance between current carrying parts and between current-carrying parts and earth.

A.10.3 Requirements

The insulation resistance shall be not less than the value specified in Table A.8.

Table A.8 — Insulation resistance

Rated voltage V_r V	Insulation before environmental test MΩ	Insulation after environmental test MΩ
$V_r \leqslant 65$	10	1
$V_r > 65$	100	10

A.11 Electrostatic discharge immunity

A.11.1 Object of test

To demonstrate the immunity of the specimen to the effects of electrostatic discharge.

A.11.2 Test procedure

A.11.2.1 Reference

Perform the procedure as specified in Level 3 of IEC 61000-4-2.

A.11.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

A.11.2.3 Conditioning

Apply the following conditioning to current carrying parts and between current-carrying parts and earth:

— contact discharge: 6 kV;

— air discharge: 8 kV;

— interval between single discharges: 1 s;

— number of pulses: 10/polarity.

A.11.2.4 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

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A.11.3 Requirements

No alarm or fault signals shall be given during the conditioning. Degradation, loss of function or performance, which is self-recoverable is permissible, but no actual change in operating state or stored data shall occur.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

A.12 Radiated radio-frequency immunity

A.12.1 Object of test

To demonstrate the immunity of the specimen to radio-frequency interference.

A.12.2 Test procedure

A.12.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

A.12.2.2 Conditioning

Apply the following conditioning:

— frequency range: 80 MHz to 2 GHz;

— modulation: 80 % AM at 1 kHz;

— field strength: 10 V/m;

— frequency sweep rate: $\leqslant 1{,}5 \times 10^{-3}$ (or 1 %/3 s).

A.12.2.3 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.12.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

A.13 Conducted low-frequency immunity

A.13.1 Object of test

To demonstrate the immunity of the specimen to low-frequency interference.

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A.13.2 Test procedure

A.13.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

A.13.2.2 Conditioning

Apply the conditioning specified on Table A.9.

Table A.9 — Low-frequency immunity parameters

Test voltage	Frequency[a]	Frequency[b]
10 % of a.c. supply voltage	60 Hz to 900 Hz	50 Hz to 750 Hz
10 % of a.c. supply voltage	900 Hz to 6 kHz	750 Hz to 5 kHz
10 % of a.c. supply voltage	6 kHz to 12 kHz	5 kHz to 10 kHz
10 % of d.c. supply voltage and at least 3 V	50 Hz to 10 kHz	50 Hz to 10 kHz
Maximum power	2 W	2 W

[a] Where rated frequency of the equipment is 60 Hz.

[b] Where rated frequency of the equipment is 50 Hz.

A.13.2.3 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.13.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

A.14 Conducted high-frequency immunity

A.14.1 Object of test

To demonstrate the immunity of the specimen to high-frequency interference.

A.14.2 Test procedure

A.14.2.1 Reference

Perform the procedure as specified in Level 2 of IEC 61000-4-6.

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A.14.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

A.14.2.3 Conditioning

Apply the following conditioning:

— frequency range: 150 kHz to 80 MHz;

— modulation: 80 % amplitude modulatiaon at 1 kHz;

— amplitude: 3 V r.m.s.

A.14.2.4 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.14.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

A.15 Burst/fast transient immunity

A.15.1 Object of test

To demonstrate the immunity of the specimen to fast bursts of electrical interference.

A.15.2 Test procedure

A.15.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

A.15.2.2 Reference

Perform the procedure as specified in Level 3 of IEC 61000-4-4.

A.15.2.3 Conditioning

Apply the following conditioning:

— single pulse time: 5 ns (between 10 % and 90 % value);

— single pulse width: 50 ns (50 % value);

— amplitude for line on power supply port and earth: 2 kV;

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— amplitude for line on I/O data control and signal lines: 1 kV;

— pulse period: 300 ms;

— burst duration: 15 ms;

— duration: 5 min/polarity.

A.15.2.4 Final measurements

After the conditioning, measure the response point as specified in 5.1.5.

Designate the greater of the response points measured in this test and that measured for the same specimen in the reproducibility test as D_{max}, and the lesser as D_{min}.

A.15.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points D_{max} : D_{min} shall not be greater than 1,26.

A.16 Surge immunity

A.16.1 Object of test

To demonstrate the immunity of the specimen to electrical surges.

A.16.2 Test procedure

A.16.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

A.16.2.2 Reference

Perform the procedure as specified in Level 2 of IEC 61000-4-5.

A.16.2.3 Conditioning

Apply the following conditioning:

— pulse rise time: 1,2 µs (between 10 % and 90 % value);

— single pulse width: 50 µs (50 % value);

— amplitude between line and earth: 1 kV;

— amplitude between lines: 0,5 kV;

— repetition rate: $\geqslant$ 1 pulse/min;

— number of pulses: 5/polarity.

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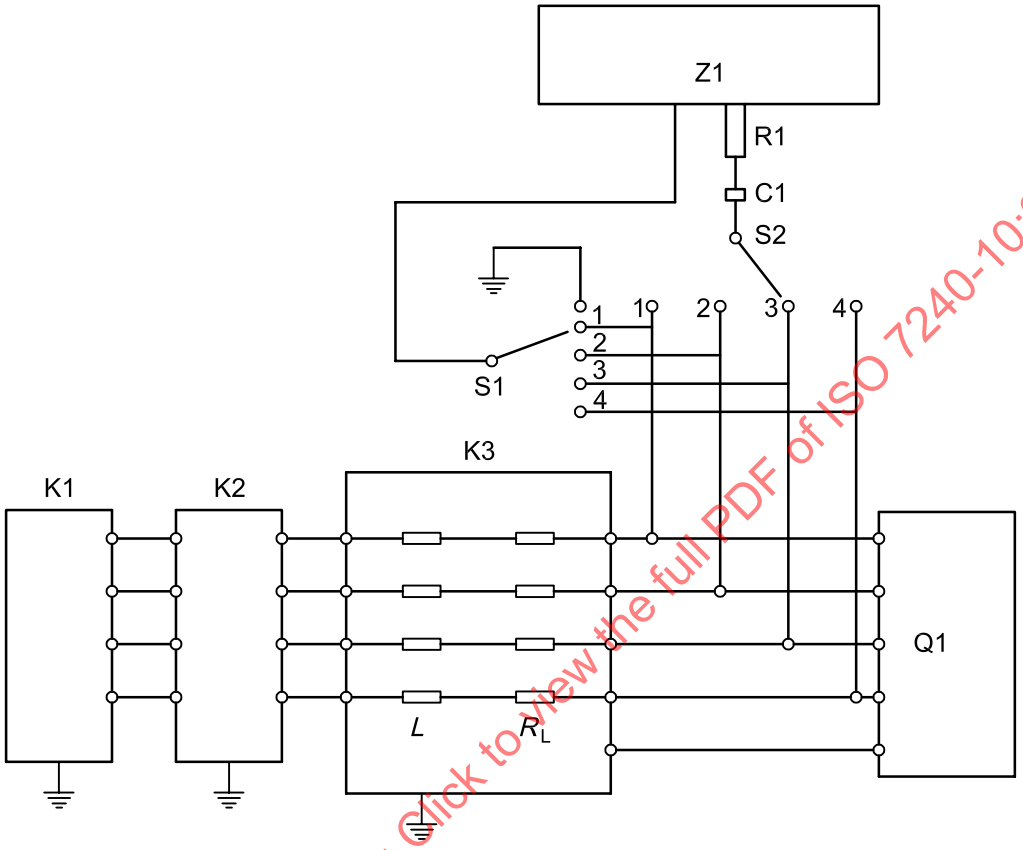
Where the power and signal lines are identical, the test procedure shall be in accordance with Figure A.1.

During the test, switch S1 to test positions 1 to 4, but not in the same position as S2.

During the test, switch S2 to test positions 1 to 4, but not in the same position as S1.



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Components

C1 capacitor with capacitance of 0,5 µF
K1 auxiliary equipment
K2 protection equipment
K3 decoupling network
L inductor *L* = 20 mH
Q1 equipment under test
R1 resistor with resistance of 40 Ω
R_L resistive part of inductor L
S1 switch line to earth: position 0
line to line: positions 1 – 4
S2 switch
Z1 combination wave generator

Figure A.1 — Example of surge immunity test circuit

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