IR-Camera Devices for Temperature Monitoring

Requirements and Test Methods

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VdS Guidelines for IR-camera Devices for Temperature Monitoring in Fire Protection Applications

IR-Camera Devices for Temperature Monitoring

Requirements and Test Methods

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In order to avoid impairing the understanding of the text, VdS Schadenverhütung uses the generic masculine throughout. This expressly does not imply any preference or other evaluation of the male, female or other sex.

Content

1 General

1.1 Scope

These guidelines specify requirements, test methods and performance characteristics for IR-camera devices for temperature monitoring in fire protection applications inside and outside buildings.

They serve as the basis for the issuing of a VdS-approval and, in addition to the compliance with the following requirements, require the implementation of continuous product surveillance.

IR-camera devices for temperature monitoring are not fire detectors for which European standards are available.

IR-camera devices for temperature monitoring in fire protection evaluate infrared radiation to monitor temperatures of objects and surfaces. IR-camera devices can measure the temperature of surfaces, detect the exceeding of one or more threshold values on a defined sensor area (number of pixels), and forward this message to superordinate/downstream systems.

IR-camera devices can detect temperature abnormalities in their monitoring area at an early stage and thus serve as a supplement to fire detection and alarm systems. They can also support on-site personnel in assessing and evaluating hazardous situations.

IR-camera devices consist of at least two components, as shown in Figure 1-1:

– the IR-camera
– the evaluation unit, which is used for the evaluation of signals from the IR-camera, as well as for the generation of alarm and fault signals, possibly for forwarding.

These components can be placed in one housing. If the IR-camera and the evaluation unit are placed in separate housings, additional requirements apply.

IR-camera devices can include the following optional components:

– Pan and tilt unit, which allows the IR-camera device to monitor a larger detection range
– Reference radiator of the applicant; this can be used e.g. for the internal verification of the temperature measurement
– Interface, which enables the signal transmission of alarm and fault signals to the building management system or to a CIE

Use of additional components, such as an enhanced visualization and control unit, is possible. The function-relevant hardware components of the IR-camera device must meet the requirements specified in these guidelines.

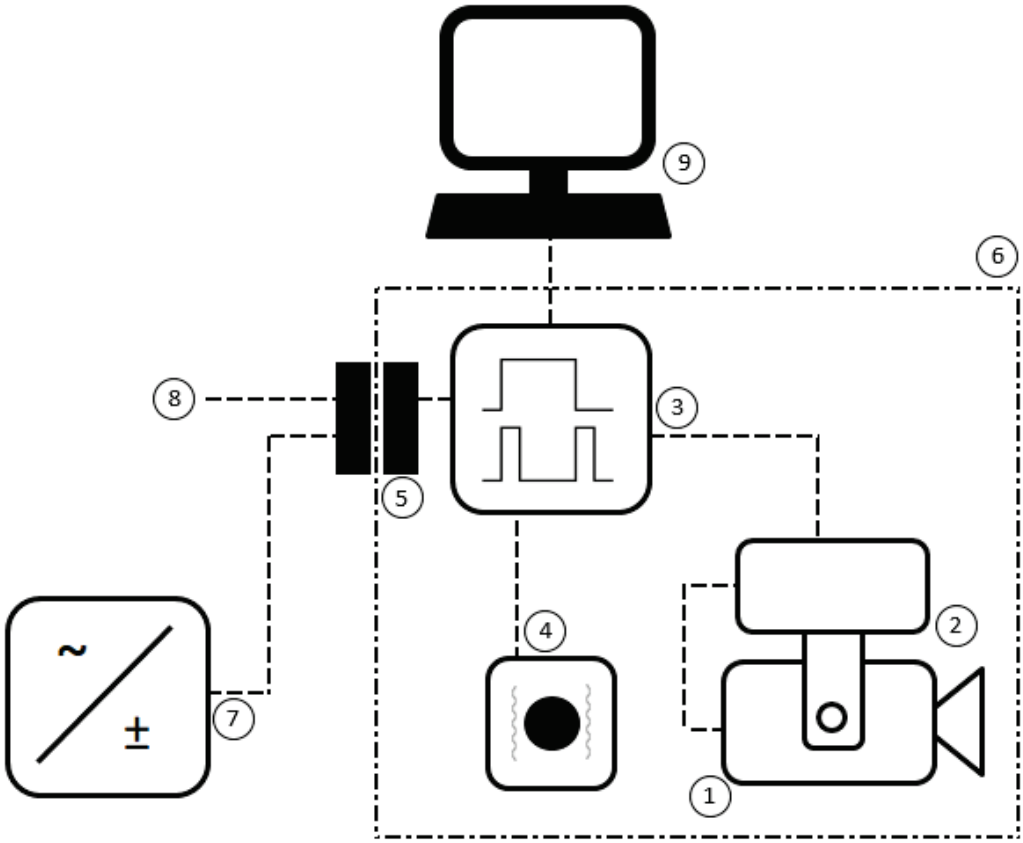

Figure 1-1: General design of an IR-camera device

1. IR-camera
2. Pan and tilt unit
3. Evaluation unit
4. Reference radiator
5. Interface
6. IR-camera device
7. Power supply
8. BMS or CIE
9. Enhanced visualization and control unit

1.2 Validity

These guidelines are valid from 01.02.2022.

Note: This is a translation of the German guidelines. If there are any discrepancies, the German version shall be binding.

2 Normative References

These guidelines contain dated and undated references to other publications. The normative references are cited at the appropriate places in the clauses, the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to these guidelines only when announced by a change of these guidelines. For undated references the latest edition of the publication referred to applies.

EN 54-1 : 2011 Fire detection and fire alarm systems – Part 1: Introduction

EN 60068-2-1 : 2007 Environmental testing - Part 2-1: Tests – Test A: Cold

EN 60068-2-2 : 2007 Environmental testing - Part 2-2: Tests – Test B: Dry heat

EN 60068-2-6 : 2008 Environmental testing - Part 2-6: Tests – Test Fc: Vibration (sinusoidal)

EN 60068-2-27 : 2009 Environmental testing - Part 2-27: Tests – Test Ea and guidance: Shock

EN 60068-2-30 : 2005 Environmental testing - Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)

EN 60068-2-42 : 2003 Environmental testing - Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections

EN 60068-2-75 : 2014 Environmental testing - Part 2-75: Tests – Test Eh: Hammer tests

EN 60068-2-78 : 2013 Environmental testing - Part 2-78: Tests – Test Cab: Damp heat, steady state

EN 50130-4 : 2015-04 Alarm systems – Part 4: Electromagnetic compatibility

VdS 2344en Procedure for the testing, approval and certification of products and systems for fire protection and security technologies

VdS 2841en Performance of product surveillances – Procedures for testing, approval and evaluation of conformity of equipment, components and systems for fire protection and security technologies

VdS 2203en : 2001-03 Rules for fire prevention and security technology – Software – Requirements and test methods

VdS 3189en VdS-Guidelines for IR-camera devices for temperature monitoring in fire detection – Planning and installation

3 Terms and Abbreviations

3.1 Terms

For the application of this document, the terms according to VdS 3189, according to DIN EN 54-1 and the following terms apply.

Alarm threshold: Temperature at which an IR-camera device generates an alarm

Alarm threshold range: Temperature range in which the alarm threshold can be set

Detection range: The area of a building or site that is monitored by an IR-camera including an existing pan and tilt unit

Capture area: The capture area is the image section, which the camera captures without panning and tilting

Functional element: Part of an IR-camera device that ensures the function of the IR-camera device in addition to the evaluation unit and the IR-camera (e.g. a connection box)

Cooling air: This is used to protect certain parts and/or components of the IR-camera device from overheating

Measuring distance: Distance between IR-camera and measured object

Purge air: It is used to keep the optics free of impurities (e.g. dirt, dust)

3.2 Abbreviations

CIE Control and indicating equipment

EMC Electromagnetic compatibility

BMT Building Management technology

IR Infrared

IRC Infrared-camera device

PTU Pan and tilt unit

$\mathbf{T_A}$ Set alarm threshold

$\mathbf{T_{Amin}}$ Response value at minimum alarm threshold

$\mathbf{T_{Amax}}$ Response value at maximum alarm threshold

$\mathbf{T_R}$ measured temperature of the reference radiator

$\mathbf{T_{ref}}$ specified reference temperature (of the reference radiator)

$\mathbf{T_{RO}}$ measured temperature of the reference radiator at maximum supply voltage

$\mathbf{T_{RU}}$ measured temperature of the reference radiator at minimum supply voltage

$\mathbf{T_{rex}}$ Response value from the reproducibility

$\mathbf{T_{stat}}$ Static response temperature

$\mathbf{T_{Vmax}}$ Response value at maximum supply voltage

$\mathbf{T_{Vmin}}$ Response value at minimum supply voltage

4 Environmental classes

A categorization into the different environmental classes I to III must be carried out for each component (IR-camera, evaluation unit, if applicable pan and tilt unit and/or functional elements) in order to reflect the various possible service environments of the components of an IRC.

The IR-camera and an optional pan and tilt unit must be categorized in environmental class II or III, the evaluation unit must be categorized either in environmental class I, II or III.

Note: Environmental class I includes equipment that is likely to be installed inside commercial/industrial buildings, but for which the avoidance of extreme environmental conditions

can be considered in the selection of the installation location. Environmental class II includes equipment that is likely to be installed inside commercial/industrial buildings in all areas. Environmental class III includes equipment that is expected to be installed outdoors.

5 Requirements

5.1 General

In order to comply with these guidelines, the function-relevant components of IR-camera devices for temperature monitoring shall fulfil the requirements of this clause, which shall be verified by technical assessment or shall be tested as described in section 6. The IR-camera device shall meet the corresponding requirements.

5.2 Software

The software contained in the IRC must comply with the software requirements according to the guidelines VdS 2203. Especially sections 4.11 and 4.13 of VdS 2203 must be applied.

5.3 Technical documentation

The applicant shall provide technical documentation (e.g. user documentation) which clearly and unmistakably describes and allows the proper use, installation, correct operation as well as the maintenance of the IRC.

All operating parameters (e.g. supply voltage range, power consumption etc.) shall be clearly stated. Furthermore, the IRC shall be clearly described with the help of suitable technical documentation (drawings, parts lists etc. see VdS 2344, Annex B).

The documentation enclosed shall include at least the following information:

– definition of the field of application, including the limitations of use and, if applicable, a proof of function and effectiveness
– ambient conditions allowed
– environmental class
– Minimum and maximum distances between IR-camera and the surfaces and objects to be monitored
– capture area of an IR-camera
– detection range (if a PTU is used)
– information on temperature measuring ranges, alarm thresholds and other criteria for the corresponding application
– components of the IR-camera device
– information on the design of interfaces

5.4 Marking

All components of an IRC must be marked with product marking as follows:

– Name or trademark of the manufacturer
– Model designation
– Marking or code enabling the manufacturer to identify at least the date or batch and place of manufacture
– The version number of the software used shall be at least readable via interface
– Environmental class (I, II or III)

The marking shall be visible during installation and shall be accessible during maintenance. Markings shall not be placed on screws or other easily removable parts.

Note: If there are different components in one housing, it is sufficient if the common housing is labelled with the product marking.

5.5 Displays

The IR-camera device can have a built-in red optical indicator that can be used to indicate the general alarm condition until reset. If other conditions can be visually indicated, they shall be clearly distinguishable from the alarm indication.

5.6 Connection of ancillary devices

If the IRC has connections for ancillary devices (e.g. display units, parallel displays, control relays), interruptions or short-circuits of these connections must not impair the proper functioning of the IRC.

5.7 On-site adjustment of response value

Where provision is made for on-site adjustment of the response behaviour of the IR-camera device, access to the means of adjustment for each setting shall be possible only by the use of a special code or tool.

5.8 Reproducibility

The response values of the IRC's T_{rex} must not deviate more than 5 K from the set alarm threshold T_A. The difference between the response values of several IRC's must not exceed 5 K.

Note: The set alarm threshold can only be verified by testing at temperatures above 60°C.

5.9 Functional test of the pan and tilt unit (PTU) (option with requirements)

The pan and tilt units of the IRC's must function according to the manufacturer's specifications.

5.10 Capture area of the IR-camera

In the boundary areas of the capture areas of the IR-camera specified by the applicant, the deviation between the response value and T_A shall be ≤ 5 K.

5.11 Response behaviour at maximum and minimum distance

The parameters specified by the applicant (such as the transmission factor) in order to detect a measurement object at the specified distance shall be verified and complied with.

No manual changes to the settings on the IR-camera device shall be made during the test.

The following requirements apply for the maximum and minimum distance to the measurement object:

– The IRC shall change to the alarm state at a temperature of T_A + 6 K (± 1 K).
– The IRC must not change to the alarm state at a temperature of T_A - 7 K (± 1 K).

5.12 Static response temperature

The value of the static response temperature T_{stat} of the IRC must not deviate more than 5 K from T_A.

5.13 Alarm threshold range

Within the alarm threshold range of the IRC, the response values must not deviate from T_A by more than 5 K.

5.14 Variation in supply parameters (operational)

Within the defined range(s) of supply parameters, the response values must not deviate from T_A by more than 5 K.

The other components of the IRC, e.g. the pan and tilt unit, shall also function as intended within the specified limits as stated by the applicant.

5.15 Dry heat (operational)

After exposure to high ambient temperatures, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

The test sample shall not generate any alarm or fault signals during the test in accordance with clause 6.15.

During operation, an alarm signal shall be generated during the reduced functional test. If a PTU is included, it shall function as specified by the applicant during and after the exposure.

5.16 Dry heat (endurance)

After long-term exposure to high ambient temperatures, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

During the test according to clause 6.16, no alarm or fault signal shall be generated after the recovery phase when the test sample is energized.

If a PTU is included, it shall function as specified by the applicant after the exposure.

5.17 Cold (operational)

After exposure to low ambient temperatures, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

During the test according to clause 6.17, the specimen shall not emit alarm or fault signals during the entire exposure.

During operation, an alarm signal shall be generated during the reduced functional test. If a PTU is included, it shall function as specified by the applicant during and after the exposure.

5.18 Damp heat, cyclic (operational)

After exposure to high relative humidity and short-term condensation, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

During the test according to clause 6.18, the specimen shall not generate alarm or fault signals during the entire exposure.

During operation, an alarm signal shall be generated during the reduced functional test. If a PTU is included, it shall function as specified by the applicant during and after the exposure.

5.19 Damp heat, cyclic (endurance)

After the long-term exposure to high relative humidity and short-term condensation, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

In the test according to clause 6.19, no alarm or fault signal shall be generated after the recovery phase when the specimen is energized.

If a PTU is included, it shall function after exposure as specified by the applicant.

5.20 Damp heat, steady state (endurance)

After long-term exposure to permanently high humidity levels, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

In the test according to clause 6.20, no alarm or fault signal shall be generated after the recovery phase when the specimen is energized.

If a PTU is included, it shall function after exposure as specified by the applicant.

5.21 Damp heat, steady state (operational)

After exposure to high humidity levels (without condensation), the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

When tested in accordance with clause 6.21, the test specimen shall not generate any alarm or fault signals during the entire exposure.

During operation, an alarm signal shall be generated during the reduced functional test. If a PTU is included, it shall function as specified by the applicant during and after the exposure.

5.22 Sulphur dioxide (SO_2) corrosion (endurance)

After corrosive exposure to sulphur dioxide as an atmospheric contaminant, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

In the test according to clause 6.22, no alarm or fault signal shall be generated after the recovery phase when the specimen is energized.

If a PTU is included, it shall function after exposure as specified by the applicant.

5.23 Shock (operational)

After exposure to mechanical shocks, as may occur under normal operating conditions, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

In the test according to clause 6.23, no alarm signal shall be generated during exposure. A temporary fault signal may be generated during the exposure, which shall automatically be reset after the exposure has ended.

After the test, the device must function properly again within 3 minutes and the fault signal (if present) must no longer be present.

If a PTU is included, it shall function after exposure as specified by the applicant.

Note: The test according to clause 6.23 is to be carried out only with specimens of a mass ≤ 4.75 kg.

5.24 Impact (operational)

After exposure to mechanical impact, as may occur under normal operating conditions, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

When tested in accordance with clause 6.24, the specimen shall not generate any alarm or fault signals during the exposure period and for a further 2 minutes.

If a PTU is included, it shall function after exposure as specified by the applicant.

5.25 Vibration, sinusoidal (operational)

After exposure to vibrations such as may occur under normal operating conditions, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

During the test according to clause 6.25, no alarm or fault signal and/or failure of the device shall occur during exposure.

If a PTU is included, it shall function after exposure as specified by the applicant. A temporary fault signal may appear on the specimen during the exposure, which is automatically reset after the exposure has ended.

After exposure, the specimen must function properly again within 3 minutes and the fault signal (if present) must no longer be present.

5.26 Vibration, sinusoidal (endurance)

After long-term exposure to vibrations as may occur under normal operating conditions, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

In the test according to clause 6.26, no alarm or fault signal shall be generated after the recovery phase when the test sample is energized.

If a PTU is included, it shall function after exposure as specified by the applicant.

5.27 Electromagnetic compatibility (EMC) immunity tests (operational)

After exposure to electromagnetic disturbances such as may occur in the normal operating environment, the response value of the IRC shall not deviate by more than 5 K from the response value T_{rex} determined in the reproducibility test according to clause 6.8.

For each of the tests according to clause 6.27 a) to g) the compliance criteria specified in EN 50130-4 shall be applied.

Neither an alarm nor a fault signal shall be generated during exposure.

If a PTU is included, it shall function after exposure as specified by the applicant.

5.28 Test of the reference radiator (option with requirements)

If a reference radiator is used, it must maintain the specified reference temperature even if the supply parameters fluctuate.

Note: The reference radiator must not be used for adjusting the parameters and/or setting the parameters of the IRC during operation.

5.28.1 Compliance with the reference temperature

The difference between the temperature of the reference radiator T_R measured according to clause 6.28.1 and the specified reference temperature T_{ref} shall not exceed 5 K.

5.28.2 Variation of supply parameters

The difference between the temperatures T_{RO} and T_{RU} of the reference radiator measured according to clause 6.28.2 and the specified reference temperature T_{ref} shall not exceed 5 K.

5.29 Automatic functional test of the IR-camera device

The function of the IRC must be monitored within 24 hours. A deviation in the function of the IRC of more than 10 K shall be transmitted within 1 h as a fault.

The applicant shall provide means to cause a deviation of the measured temperature of more than 10 K at the IRC.

5.30 Fault monitoring

The following faults must result in a fault signal within 100 seconds:

a) A wire breakage or short circuit in a transmission path

b) Failure of the available purge air/cooling air, if this is required for operation and evaluation

c) Failure of the pan and tilt unit, if present

The IRC must have an output for forwarding the fault signal. The transmission must also take place if the IRC is no longer supplied with power.

5.31 System fault

A system fault in software-controlled IRC is a fault in accordance with VdS 2203 paragraph 4.11.1 and 4.13.1. In the event of a system fault, the system fault must be forwarded via the fault output within 3 minutes at the latest.

5.32 Reduced sensitivity (option with requirements)

If the IRC has means to reduce the sensitivity in the presence of operators, the following requirements apply.

1) There must be at least one input on the IRC that can receive signals to activate or deactivate about the reduction of the sensitivity. There must be at least one output that transmits the information about the reduction of the sensitivity.
2) The IRC may automatically activate or deactivate the sensitivity reduction by means of a timer device. Access to the timer device shall only be possible by using a special code or tool.

Note: Reducing the sensitivity can be achieved, for example, by increasing the required area of the hotspot that causes the alarm to be triggered.

5.33 Coincidence detection (option with requirements)

If the IRC has a coincidence detection option, the following requirement apply:

After receiving an initial alarm from an IR-camera, the IR-camera device shall be prevented from entering the alarm state until an alarm confirmation signal is received from another IR-camera in the same monitoring area.

6 Tests

6.1 General

6.1.1 Atmospheric conditions for tests

Unless otherwise specified in a test procedure, all tests shall be carried out after the specimens have adjusted to the following standard atmospheric conditions in accordance with EN 60068-1:

a) temperature: (15 to 35) °C;
b) relative humidity: (25 to 75) %;
c) barometric pressure: (86 to 106) kPa.

If variations in these parameters have a significant effect on the measurements, such variations should be minimized during a series of measurements to be considered as one test for one specimen.

6.1.2 Operating conditions for tests

If a test method requires the specimen to be “operational”, the specimen shall be connected to suitable supply and monitoring equipment. The characteristics of this equipment shall be consistent with the applicant´s technical data.

Unless otherwise specified the supply parameters shall be set within the manufacturer´s specified range(s) and shall remain constant throughout the tests. Generally, the value chosen shall be the nominal value or the mean value of the specified range.

If a test method requires the specimen to be monitored to detect alarm or fault signals, connections shall be made to any necessary ancillary devices.

Details of the supply and monitoring equipment used and the alarm condition criteria used shall be included in the test report.

The settings of further parameters (e.g. emissivity, transmittance) are to be made accordingly for the respective test.

6.1.3 Mounting arrangements

The specimens shall be mounted using their 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 the most unfavourable shall be selected and documented for each test.

6.1.4 Reduced functional test

The specimen is to be mounted according to clause 6.1.2 and connected to its supply and monitoring equipment. The reference radiator is to be heated to a temperature 10 K above the alarm threshold set on the specimen. The reference radiator is then positioned in the capture area of the specimen. It is verified whether an alarm signal is generated. Afterwards, the reference radiator is removed from the IRC's capture area and the IRC is returned to the quiescent condition.

If a PTU is used its function must be evaluated by visual inspection.

6.1.5 Measurement of the response value

The IR-camera shall be set up on a rigid base at a distance of at least 1 m from a calibration radiation emitter. Unless otherwise specified by the applicant, the specimen shall be connected to its supply and monitoring equipment.

The IRC’s alarm threshold is set to a temperature specified by the applicant within the specified alarm threshold range.

The calibration radiation emitter is set to a temperature at least 10 K below the alarm threshold. The IR-camera is aligned with the calibration source and stabilized for a period of at least 15 minutes. The temperature of the calibration radiation emitter is then increased at a rate of rise of 3 K/min ± 0.4 K until a temperature of 10 K above the alarm threshold is reached.

The temperature of the radiation source at the time of the alarm condition is recorded as the response value.

6.1.6 Provision for tests

The following shall be provided for testing compliance with these guidelines:

a) A minimum of three IR-camera devices

b) The data/documents specified in VdS 2344

The specimens submitted shall be representative of the manufacturer's normal production with regard to their construction and calibration.

This means that the mean response value related to the set response temperature of the three specimens determined in the reproducibility test should also represent the production mean, and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

6.1.7 Test schedule

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Table 6-1: Test schedule

6.2 Software

The test methods of VdS 2203 shall be applied.

6.3 Technical documentation

The technical documentation shall be examined by visual inspection for compliance with the requirements according to clause 5.3.

6.4 Marking

The marking shall be inspected for completeness and compliance with the requirements according to clause 5.4.

6.5 Displays

The displays shall be visually inspected for compliance with the requirements of clause 5.5.

6.6 Connection of ancillary devices

For the interruption of ancillary devices` connections, the following steps are carried out in sequence:

1) A specimen is connected to its supply and monitoring equipment according to the applicant's instructions.
2) The connection of an ancillary device is interrupted with equipment provided by the applicant.
3) For 3 minutes, it is verified that there is no alarm or fault message.
4) The IRC is subjected to a reduced functional test according to clause 6.1.4 and it is checked whether an alarm signal is generated.
5) Steps 2) to 4) are repeated with each additional connection of an ancillary device.

For the short circuit, the following steps are carried out in sequence:

1) A specimen is connected to its supply and monitoring equipment according to the applicant's instructions.
2) The connection of an ancillary device is short-circuited with equipment provided by the applicant.
3) For 3 minutes, it is verified that there is no alarm or fault message.
4) The IRC is subjected to a reduced functional test according to clause 6.1.4 and it is checked whether an alarm signal is generated.
5) Steps 2) to 4) are repeated with each additional connection of an ancillary device.

6.7 On-site adjustment of response value

A review of the documentation provided, in conjunction with the appropriate operation of the IR-camera device, shall be conducted to assess whether it is not possible to change the applicant's settings other than by special means (e.g. a special code or tool, or by breaking or removing a seal).

6.8 Reproducibility

The response value of the individual test samples shall be determined according to clause 6.1.5.

The maximum response value shall be designated $T_{rex,max}$ and the minimum response value $T_{rex,min}$. Compliance with the requirement according to clause 5.8 is checked.

6.9 Functional test of the pan and tilt unit (PTU) (option with requirements)

Each PTU shall be set up with the IR-camera on a rigid base. Unless otherwise specified by the applicant, the specimen shall be connected to its supply and monitoring equipment and adjusted to the ambient conditions for a period of at least 15 minutes.

The function of the pan and tilt unit shall be tested as specified by the applicant.

6.10 Capture area of IR-camera

The IR-camera shall be aligned so that the radiation source (calibration radiation emitter) is located on the edge of the capture area of the IR-camera as specified by the applicant.

The response values in the four corners of the capture area (see Figure 6-1) are measured and recorded according to the procedure described in clause 6.1.5.

It is verified whether:

– $|T_1 - T_A| \leq 5$ K,
– $|T_2 - T_A| \leq 5$ K,
– $|T_3 - T_A| \leq 5$ K and
– $|T_4 - T_A| \leq 5$ K

is given.

Note: An optionally available pan/tilt unit must be deactivated for the test.

Figure 6-1: Capture area of the IR-camera

6.11 Response behaviour at maximum and minimum distance

The following steps are carried out in sequence:

1) A 30 cm x 30 cm radiation source is homogeneously heated up to the temperature T_A + 6 K (± 1 K).
2) The radiation source is then brought into the capture area of the IR-camera at the maximum distance l_{max} specified by the applicant.
3) It is checked whether the change to the alarm state occurs.
4) Step 1) is repeated.
5) The radiation source is brought into the capture area of the IR-camera at the minimum distance l_{min} specified by the applicant.
6) Step 3) is repeated.
7) A 30 cm x 30 cm radiation source is homogeneously heated up to the temperature T_A - 7 K (± 1 K).
8) Step 2) is repeated.
9) It is checked whether no change to the alarm state occurs.
10) Step 7) is repeated.
11) Step 5) and step 9) are repeated.

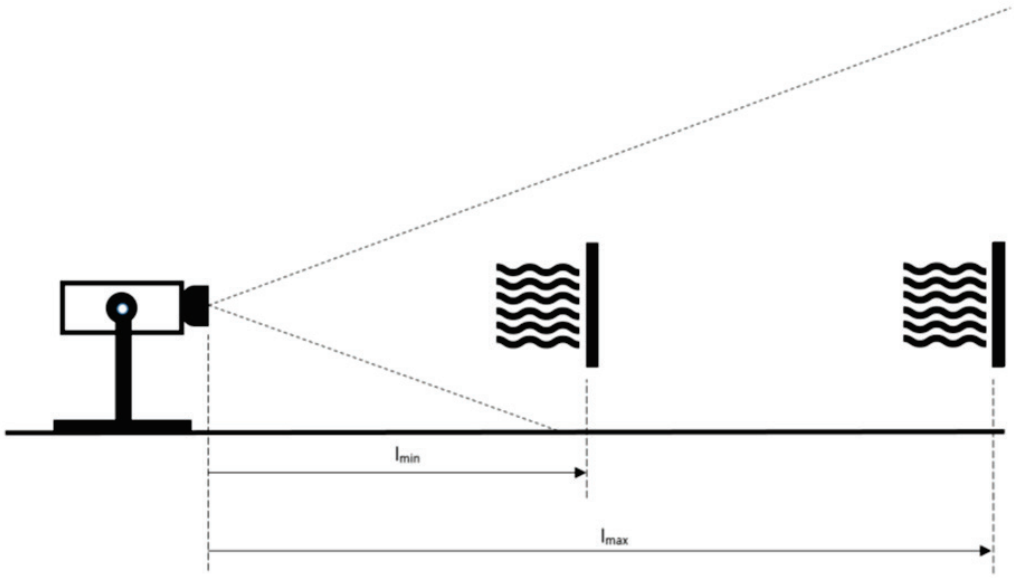

Figure 6-2: Test setup for the response behaviour at maximum and minimum distance

With the agreement of the applicant, this test may be carried out outside the atmospheric conditions according to clause 6.1.1.

If different distance ranges can be monitored with different settings, this test must be carried out for the range with the absolute maximum distance and the range with the absolute minimum distance.

6.12 Static response temperature

The IR-camera shall be set up on a rigid base at a distance of at least 1 m from a radiation source. Unless otherwise specified by the applicant, the test sample shall be connected to its supply and monitoring equipment.

The alarm threshold of the IRC shall be set to a temperature specified by the applicant within the specified alarm threshold range.

The IR-camera is aligned with the radiation source. The radiation source is heated up to a starting temperature of 50 °C. Then its temperature is increased at a rate of rise of 3 K/min ± 0.4 K until a temperature of T_A - 8 K is reached.

Subsequently, the temperature increase is continued at a rate of rise of ≤ 0.2 K/min. The temperature of the radiation source at the time of the alarm state is recorded as the static response temperature T_{stat}. It is checked whether $|T_{stat} - T_A| \leq 5$ K.

6.13 Alarm threshold range

The following steps are carried out with each test sample in turn:

1) The alarm threshold of the IRC is set to the lower limit value of the specified alarm threshold range declared by the applicant.
2) The response value T_{Amin} is determined according to clause 6.1.5.
3) It is determined whether $|T_{Amin} - T_A| \leq 5$ K.
4) The alarm threshold of the IRC is set to the upper limit value of the specified alarm threshold range declared by the applicant.
5) The response value T_{Amax} is determined according to clause 6.1.5.
6) It is determined whether $|T_{Amax} - T_A| \leq 5$ K.

6.14 Variation in supply parameters (operational)

The following steps are carried out in sequence:

1) The IRC is supplied with the upper limit value of the range of the supply voltage specified by the applicant.
2) The response value T_{Vmax} is determined according to clause 6.1.5.
3) It is checked whether $|T_{Vmax} – T_A| \leq 5$ K.
4) If a PTU is used its function is tested according to the applicant’s specifications.
5) The IRC is supplied with the lower limit value of the range of the supply voltage specified by the applicant.
6) The response value T_{Vmin} is determined according to clause 6.1.5.
7) It is checked whether $|T_{Vmin} – T_A| \leq 5$ K.
8) Step 4) is repeated.

6.15 Dry heat (operational)

The test procedure and the test equipment are in accordance with tests Bb according to EN 60068-2-2 and the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions and connected to its supply and monitoring equipment.

The specimen is then subjected to the conditioning in accordance with Table 6-2.

Environmental class	Temperature [°C]	Duration [h]
I	40 ± 2	16
II	55 ± 2	16
III	70 ± 2	16

Table 6-2: Conditions for dry heat (operational) test for IRC

The specimen is monitored during conditioning to detect any alarm or fault signals.

During the last hour of conditioning, the IRC is subjected to a reduced functional test according to clause 6.1.4.

After a recovery period of at least 1 h under standard laboratory conditions, the function of the PTU is tested (if applicable). The response value of the specimen is determined according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements of clause 5.15 is verified.

6.16 Dry heat (endurance)

The test procedure and the test equipment are in accordance with test Bb according to EN 60068-2-2 and the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions. The specimen must not be supplied with power during conditioning.

The specimen is then subjected to the conditioning in accordance with Table 6-3.

Environmental class	Temperature [°C]	Duration [days]
I	No test	
II	No test	
III	70 ± 2	21

Table 6-3: Conditions for dry heat (endurance) test for IRC

After a recovery period of at least 1 h under standard laboratory conditions, the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.16 is verified.

6.17 Cold (operational)

The test procedure and the test equipment comply with test Ab according to EN 60068-2-1 and the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions and connected to its supply and monitoring equipment.

The specimen is then subjected to the conditioning in accordance with Table 6-4:

Environmental class	Temperature [°C]	Duration [h]
I	-5 ± 3	16
II	-10 ± 3	16
III	-25 ± 3	16

Table 6-4: Conditions for cold (operational) test for IRC

The specimen is monitored during conditioning to detect any alarm or fault signals.

During the last hour of conditioning, the specimen is subjected to a reduced functional test according to clause 6.1.4.

After a recovery period of at least 1 h under standard laboratory conditions, the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test is designated T_{max}, whereas the lower response value is designated T_{min}.

Compliance with the requirements according to clause 5.17 is verified.

6.18 Damp heat, cyclic (operational)

The test procedure and the test equipment comply with EN 60068-2-30 applying the test cycle variant 2 and controlled recovery conditions as well as with the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions and connected to its supply and monitoring equipment.

The specimen is then subjected to the conditioning in accordance with Table 6-5:

Environmental class	Lower Temperature [°C]	Upper Temperature [°C]	Relative humidity [%]		Number of cycles
			At lower Temperature	At upper Temperature	
I	No test				
II	25 ± 2	40 ± 2	≥ 95	93 ± 3	2
III	25 ± 2	55 ± 2	≥ 95	93 ± 3	2

Table 6-5: Conditions for damp heat, cyclic (operational) test for IRC

The specimen is monitored during conditioning to detect any alarm or fault signals.

During the last hour of the high temperature in the last cycle, the specimen is subjected to a reduced functional test according to clause 6.1.4.

After a recovery period of at least 1 h under standard laboratory conditions, the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.18 is verified.

6.19 Damp heat, cyclic (endurance)

The test procedure and the test equipment comply with EN 60068-2-30 applying the test cycle variant 2 and controlled recovery conditions as well as with the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions. The specimen must not be supplied with power during conditioning.

The specimen is then subjected to the conditioning in accordance with Table 6-6:

Environmental class	Lower Temperature [°C]	Upper Temperature [°C]	Relative humidity [%]		Number of cycles
			At lower Temperature	At upper Temperature	
I	No test				
II	No test				
III	25 ± 2	55 ± 2	≥ 95	93 ± 3	6

Table 6-6: Conditions for damp heat, cyclic (endurance) test for IRC

Note: The rates for the temperature rises should be selected so that condensation should occur on the surface of the specimens.

After a recovery period of at least 1 h under standard laboratory conditions, the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.19 is verified.

6.20 Damp heat, steady state (endurance)

The test procedure and the test equipment comply with test Cab according to EN 60068-2-78 and the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions. The specimen must not be supplied with power during conditioning.

The specimen is then subjected to the conditioning in accordance with Table 6-7:

Environmental class	Temperature [°C]	Relative Humidity [%]	Duration [days]
I, II and III	40 ± 2	93 ± 3	21

Table 6-7: Conditions for damp heat, steady state (endurance) test for IRC

After a recovery period of at least 1 h under standard laboratory conditions, the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.20 is verified.

6.21 Damp heat, steady state (operational)

The test procedure and the test equipment comply with test Cab according to EN 60068-2-78 and the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions and connected to its supply and monitoring equipment.

The specimen is then subjected to the conditioning in accordance with Table 6-8:

Environmental class	Temperature [°C]	Relative Humidity [%]	Duration [days]
I, II and III	40 ± 2	93 ± 3	4

Table 6-8: Conditions for damp heat, steady state (operational) test for IRC

The specimen is monitored during conditioning to detect any alarm or fault signals.

During the last hour of conditioning, the specimen is subjected to a reduced functional test according to clause 6.1.4.

After a recovery period of at least 1 h under standard laboratory conditions, the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.21 is verified.

6.22 Sulphur dioxide (SO_2) corrosion (endurance)

The test procedure and the test equipment in principal comply with test Kc according to EN 60068-2-42 and the following requirements.

The specimen is mounted in its normal operating position according to the manufacturer's instructions. The specimen must not be supplied with power during conditioning.

Non-tinned copper wires of suitable diameter are connected to the corresponding terminals so as to allow final measuring without having to establish other connections to the specimen.

The specimen is then subjected to the conditioning in accordance with Table 6-9:

Environmental class	Temperature [°C]	Relative humidity [%]	Sulphur dioxide content [µl/l]	Duration [days]
I	No test			
II and III	25 ± 2	93 ± 3	(25 ± 5)	21

Table 6-9: Conditions for sulphur dioxide (SO_2) corrosion (endurance) test for IRC

Immediately upon conditioning, the specimen is dried at (40 ± 2) °C and a relative air humidity below 50 % for 16 h followed by a recovery period of at least 1 h under standard laboratory conditions.

Afterwards the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.22 is verified.

6.23 Shock (operational)

The test procedure and the test equipment comply with test Ea according to EN 60068-2-27 and the following requirements.

The specimen is mounted in its usual operating position to a rigid fixture and connected to its supply and monitoring equipment.

The specimen is then subjected to the conditioning in accordance with Table 6-10.

Environmental class	Pulse type	Pulse duration [ms]	Max. acceleration related to the specimen mass M (kg) [m/s²]	Number of shock directions	Number of pulses per direction
I	No test				
II and III	Half sine	6	1000 - (200 x M)	6 (2 per axis)	3

Table 6-10: Conditions for shock (operational) test for IRC

The specimen is monitored during conditioning to detect any alarm or fault signals.

Afterwards the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.23 is verified.

6.24 Impact (operational)

The test procedure and the test equipment comply with EN 60068-2-75 and the following requirements.

The specimen is mounted in its usual operating position to a rigid fixture and connected to its supply and monitoring equipment.

The specimen is then subjected to the conditioning in accordance with Table 6-11.

Environmental class	Impact energy [J]	Number of impacts per point
I, II and III	0.5 ± 0.04	3

Table 6-11: Conditions for impact (operational) test for IRC

The impacts are applied to all accessible surfaces of the specimen. Three blows are applied to each of these surfaces at one or more points for which damage to or impairment of operation by the test object is considered possible.

It should be ensured that the results of a series of three impacts are not detrimental to the following series of impacts. In case of doubt three further blows must be made on a new specimen at the same position.

The specimen is monitored during conditioning and two further minutes to detect any alarm or fault signals. After conditioning and a duration of 2 minutes the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.24 is verified.

6.25 Vibration, sinusoidal (operational)

The test procedure and the test equipment comply with EN 60068-2-6 and the following requirements.

The specimen is mounted in its usual operating position to a rigid fixture and connected to its supply and monitoring equipment.

The specimen is then subjected to the conditioning in accordance with Table 6-12.

Environ-mental class	Frequency range [Hz]	Acceleration amplitude [m/s²]{g_n}	Number of axes	Sweep rate [Octaves/min]	Number of sweep cycles per axis
I	10 - 150	1.0 {≈ 0.1}	3	1	1
II and III	10 - 150	5.0 {≈ 0.5}	3	1	1

Table 6-12: Conditions for vibration, sinusoidal (operational) test for IRC

Vibrations are to be induced successively along three axes, which are perpendicular to one another. The specimen shall be mounted so that one of the three axes is perpendicular to its standard mounting level.

The specimen is monitored during conditioning to detect any alarm or fault signals.

Afterwards the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.25 is verified.

6.26 Vibration, sinusoidal (endurance)

The test procedure and the test equipment comply with EN 60068-2-6 and the following requirements.

The specimen is mounted in its usual operating position to a rigid fixture position. The specimen must not be supplied with power during conditioning.

The specimen is then subjected to the conditioning in accordance with Table 6-13.

Environ-mental class	Frequency range [Hz]	Acceleration amplitude [m/s²]{g_n}	Number of axes	Sweep rate [octaves/min]	Number of sweep cycles per axis
I	10 - 150	5.0 {≈ 0.5}	3	1	20
II and III	10 - 150	10.0 {≈ 0.5}	3	1	20

Table 6-13: Conditions for vibration, sinusoidal (endurance) test for IRC

Vibrations are to be induced successively along three axes, which are perpendicular to one another. The specimen shall be mounted so that one of the three axes is perpendicular to its standard mounting level.

Afterwards the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.26 is verified.

6.27 Electromagnetic compatibility (EMC) immunity tests (operational)

The following EMC immunity tests are performed according to EN 50130-4:

a) Electrostatic discharge

b) Radiated electromagnetic fields

c) Conducted disturbances induced by electromagnetic fields

d) Fast transient bursts

e) Slow high-energy surge voltages

f) Mains supply voltage variations[1)] — if the IRC incorporates a mains supply

g) Mains supply voltage dips and short interruptions — if the IRC incorporates a mains supply

[1)] The test for mains supply voltage variations can be combined with the test for variations in supply parameters.

The specimen is connected to its supply and monitoring equipment and monitored for changes of state during conditioning.

Afterwards the function of the PTU is tested (if applicable) and the response value of the specimen is measured according to clause 6.1.5.

The higher response value measured for this specimen during this test and during the reproducibility test shall be designated T_{max}, whereas the lower response value shall be designated T_{min}.

Compliance with the requirements according to clause 5.27 is verified.

6.28 Test of the reference radiator (option with requirements)

6.28.1 Compliance with the reference temperature

The applicant’s reference radiator shall be mounted on a rigid base at a distance of at least 1 m from the IR-camera (VdS).

Unless otherwise specified by the applicant, the applicant’s reference radiator must be connected to its supply and monitoring equipment and adapted to the ambient conditions for a period of at least 15 minutes.

The IR-camera (VdS) must be aligned with the applicant’s reference radiator and the temperature of the reference radiator T_R must be measured.

Compliance with the requirements according to clause 5.28.1 is verified.

6.28.2 Variation in supply parameters

The following steps are carried out in sequence:

1) The applicant's reference radiator is set up on a rigid base at a distance of at least 1 m from the IR-camera (VdS). Unless otherwise specified by the applicant, the applicant's

reference radiator is connected to its supply and monitoring equipment and adapted to the ambient conditions for a period of at least 15 minutes.

2) The reference radiator is supplied with the upper limit of the range of the supply voltage as specified by the applicant.

3) The IR-camera (VdS) is aligned with the applicant's reference radiator, then the temperature of the reference radiator (T_{RO}) is measured.

4) It is checked whether $|T_{RO} – T_{ref}| \leq 5$ K.

5) The reference radiator is supplied with the lower limit of the range of the supply voltage specified by the applicant.

6) The IR-camera (VdS) is aligned with the applicant's reference radiator, then the temperature of the reference radiator (T_{RU}) is measured.

7) It is checked whether $|T_{RU} – T_{ref}| \leq 5$ K.

6.29 Automatic functional test of the IR-camera device

The IRC is mounted on a rigid base.

The specimen is connected to its supply and monitoring equipment for 48 hours and is operational. Then a deviation of the measured temperature of more than 10 K is caused with the means provided. It is checked whether a fault signal is transmitted after 25 hours.

6.30 Fault monitoring

6.30.1 Wire breakage and short circuit

The tests are to be carried out separately and consecutively for each wired transmission path. The quiescent state shall be assumed. The transmission path is influenced in such a way that a complete physical interruption is caused.

The transmission path is interrupted with means provided by the applicant. After 100 seconds, it is checked whether the transmission of the fault signal has taken place.

The interruption of the transmission path is removed and the IRC is returned to the quiescent state.

The transmission path is then affected in such a way that a single complete physical short-circuit is induced in each individual pair of wires.

The transmission path is short-circuited with means provided by the applicant. After 100 s, it is checked whether the transmission of the fault signal has occurred.

The short-circuit is removed and the IRC is returned to the quiescent state.

6.30.2 Failure of the purge air/cooling air

The purge air/cooling air is interrupted. After 100 s, it is checked whether the transmission of a fault signal has occurred.

6.30.3 Failure of the pan and tilt unit

A failure of the pan and tilt unit is caused. After 100 s, it is checked whether the transmission of a fault signal has occurred.

6.31 System fault

The test methods of VdS 2203 are applied.

A system fault is caused with means provided by the applicant. After 3 minutes, it is checked whether the transmission of the fault signal has occurred.

6.32 Reduced sensitivity (option with requirements)

The following steps are carried out in sequence:

1) A signal is applied to the input of the IRC, which leads to the activation of the reduction of sensitivity. It is checked whether the sensitivity has been reduced and the output for transmitting the information about the reduced sensitivity is activated.
2) a) The IRC's time switching device is set to an activation time. After the activation time, it is checked whether the automatic activation of the reduction of sensitivity has been carried out and the output for the transmission of the information about the reduced sensitivity is activated.

   b) The IRC's time switching device is set to a deactivation time. After the deactivation time, it is checked whether the automatic deactivation of the reduction of sensitivity has been carried out and the output for the transmission of information about the reduced sensitivity is deactivated.

6.33 Coincidence detection (option with requirements)

The following steps are carried out in succession with IR-camera devices with a maximum of two IR-cameras:

1) The two IR-cameras of the IRC are set to coincidence detection.
2) A radiation source with a temperature T_A + 6 K (± 1 K) is introduced into the capture area of one IR-camera.
3) It is checked whether the change of the IR-camera device into the alarm state does not occur.
4) A radiation source with a temperature T_A + 6 K (± 1 K) is placed in the capture area of the other IR-camera.
5) It is checked whether the IR-camera device changes to the alarm state.
6) The radiation source(s) is/are removed from the capture areas of the two IR-cameras and the IR-camera device is set to the quiescent state as specified by the applicant.

The following steps are carried out in succession with IR-camera devices with three or more IR-cameras:

1) Any two IR-cameras of the IR-camera device are set to coincidence detection.
2) A radiation source with a temperature T_A + 6 K (± 1 K) is introduced into the capture area of one IR-camera that is not set to coincidence detection.
3) It is checked whether the IR-camera device changes to the alarm state.
4) The radiation source is removed from the capture area of the IR-camera.
5) The IR-camera device is set to the quiescent state as specified by the applicant.
6) A radiation source with a temperature T_A + 6 K (± 1 K) is introduced into the capture area of an IR-camera that is set to coincidence detection.

7) It is checked whether the change of the IR-camera device into the alarm state does not occur.

8) A radiation source with a temperature T_A + 6 K (± 1 K) is introduced into the capture area of the other IR-camera that is set to coincidence detection.

9) Step 3) is repeated.

10) The radiation source(s) is/are removed from the capture areas of the two IR-cameras and the IR-camera device is set to the quiescent state as specified by the applicant.