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Fire detection and fire alarm systems —

Part 17: Short-circuit isolators

Systèmes de détection d'incendie et d'alarme —

Partie 17: Isolateurs de court-circuit

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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 7240-17 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

ISO 7240 consists of the following parts, under the general title *Fire detection and fire 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 optical 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*

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

— *Part 17: Short-circuit isolators*

— *Part 18: Input/output devices*

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

— *Part 20: Aspirating smoke detectors*

— *Part 21: Routing equipment*

— *Part 22: Smoke-detection equipment for ducts*

— *Part 24: Sound-system loudspeakers*

— *Part 25: Components using radio transmission paths*

— *Part 27: Point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor*

— *Part 28: Fire protection control equipment*

A Part 3, dealing with audible alarm devices and a Part 23, dealing with visual alarm devices, are in preparation.

Introduction

This part of ISO 7240 is based on a European standard EN 54-17, prepared by the European Committee for Standardization CEN/TC 72 *“Fire detection and fire alarm systems”*.

The purpose of short-circuit isolators is to limit the consequences of low-parallel-resistance faults between the lines of a transmission path of a fire detection and alarm system. This is normally achieved by connecting the transmission path in a loop configuration, separating sections of the loop with short-circuit isolators and introducing a means of detecting the presence of a fault, if its consequences (e.g. reduction in the line voltage) jeopardizes the correct operation of components on the transmission path. The faulty section of the loop can then be switched out, between a pair of short-circuit isolators, allowing the rest of the loop to continue to function correctly.

It is recognized that it is not possible for this part of ISO 7240 to specify all of the requirements for the function of a short-circuit isolator in a system. The requirements for the functioning of a short-circuit isolator are dependent on the system operation, the other components associated with the transmission path (e.g. the control and indicating equipment and detectors) and the transmission path parameters (e.g. line impedance and line loads) and it is necessary that they be verified in a system test.

However, this part of ISO 7240 includes the following:

— a requirement for the manufacturer to provide all of the specifications for the short-circuit isolator required by system designers to use the device correctly, in accordance with the system requirements;

NOTE It is the responsibility of the system designer to ensure that only those short-circuit isolators having the necessary performance are chosen to meet the system design requirements.

— tests to verify that the short-circuit isolator functions in accordance with the manufacturer's specifications; and

— tests to verify the performance of the short-circuit isolator in environmental and electromagnetic compatibility (EMC) conditions.

Due to the many different concepts that can be used for the operation of short-circuit isolators, it is not possible to define a precise functional test procedure applicable to all types. Instead, this part of ISO 7240 requires that a functional test procedure be developed to verify the manufacturer's specification and lists the most important points that it is necessary to verify. To assist in developing such test procedures, some example procedures are given in Annex A.

With respect to the foregoing, it is important that, in addition to meeting the requirements of this part of ISO 7240, short-circuit isolators are shown to operate correctly within the types of systems with which they are intended for use.

Fire detection and fire alarm systems —

Part 17:
Short-circuit isolators

1 Scope

This part of ISO 7240 specifies requirements, test methods and performance criteria for short-circuit isolators, for use in fire detection and alarm systems for buildings; see ISO 7240-1.

Means of isolation or protection incorporated within control and indicating equipment in ISO 7240-1:2005, Figure 1, item B, are not covered by this part of ISO 7240.

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, *Aluminium and aluminium alloys — Chemical composition*

ISO 7240-1:2005, *Fire detection and alarm systems — Part 1: General and definitions*

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

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

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

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

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

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

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

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

EN 50130-4:1995, *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
closed condition
condition of the short-circuit isolator that allows the normal signals and supply currents to pass through the short-circuit isolator, i.e. the correct condition for the short-circuit isolator when there is no short circuit

3.2
open condition
condition of the short-circuit isolator that prevents the passage of short-circuit currents through the short-circuit isolator, i.e. the correct condition for the short-circuit isolator when it is protecting part of a circuit from the effects of a short circuit

3.3
short-circuit isolator
device, which may be connected into a transmission path of a fire detection and fire alarm system, to limit the consequences of low-parallel-resistance faults between the lines of this transmission path

NOTE A short-circuit isolating device may be a physically separate device or it may be incorporated into another device apart from the control and indicating equipment, e.g. integrated into a smoke detector or detector base.

3.4
type A
device assessed for performance at (55 ± 2) °C

3.5
type B
device assessed for performance at (70 ± 2) °C

4 Requirements

4.1 Compliance

In order to comply with this part of ISO 7240, the short-circuit isolator shall meet the requirements of Clause 4, 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. However, for short-circuit isolating devices that are integrated into other devices already covered by an existing part of ISO 7240, the environmental conditioning shall be performed in accordance with that part of ISO 7240.

4.2 Integral status indication

If the short-circuit isolator incorporates an integral visual indication of its status, then this indication shall not be red.

4.3 Connection of ancillary devices

Where the short-circuit isolator provides for connections to ancillary devices (e.g. remote indicators), open- or short-circuit failures of these connections shall not prevent the correct operation of the short-circuit isolator.

4.4 Monitoring of detachable short-circuit isolators

If a short-circuit isolating device is detachable (i.e. it is attached to a mounting base), then a means shall be provided for a remote monitoring system (e.g. the control and indicating equipment) to detect the removal of the device from the base, in order to give a fault signal.

4.5 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.

4.6 On-site adjustments

If there is provision for on-site adjustment of the short-circuit isolator, then for each setting the short-circuit isolator shall comply with the requirements of this part of ISO 7240. Access to the means of adjustment shall be possible only by the use of a code or special tool.

4.7 Marking

Each short-circuit isolator shall be clearly marked with the following information:

a) number of this part of ISO 7240 (i.e. ISO 7240-17);

b) name or trademark of the manufacturer or supplier;

c) model designation (type or number);

d) type A or type B as appropriate or the maximum operating temperature;

e) wiring terminal designations;

f) some mark(s) or code(s) (e.g. 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 short-circuit isolator.

For detachable short-circuit isolators, the detachable part shall be marked with a), b), c), d) and f), and the base shall be marked with, at least c) (i.e. its own model designation) and e).

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 short-circuit isolator and shall be accessible during maintenance.

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

4.8 Data

Short-circuit isolators 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 isolator, reference to the appropriate data sheet shall be given on, or with, each short-circuit isolator.

To enable correct operation of the short-circuit isolators, these data should describe the requirements for the correct processing of the signals from the short-circuit isolator. 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.

At least the following data are required to conduct the tests specified in this part of ISO 7240:

a) maximum line voltage, V_{max};

b) minimum line voltage, V_{min}, i.e. without a short circuit or partial short circuit fault;

c) maximum rated continuous current with the switch closed, $I_{C\ max}$;

d) maximum rated switching current (e.g. under short circuit conditions), $I_{S\ max}$;

e) maximum leakage current, $I_{L\ max}$, with the switch open (isolated state);

f) maximum series impedance with the switch closed, $Z_{C\ max}$;

g) ranges of parameters for each stimulus that the manufacturer claims will cause the short-circuit isolator to change from the closed to the open condition;

h) ranges of parameters for each stimulus that the manufacturer claims will cause the short-circuit isolator to change from the open to the closed condition;

i) whether the device is type A or type B.

NOTE Additional information can be required, depending on the product design and function, to demonstrate conformity with the requirements of this part of ISO 7240.

4.9 Additional requirements for software controlled short-circuit isolators

4.9.1 General

For short-circuit isolators that rely on software control in order to fulfil the requirements of this part of ISO 7240, the requirements of 4.9.2, 4.9.3 and 4.9.4 shall be met.

4.9.2 Software documentation

4.9.2.1 The manufacturer shall submit documentation that gives an overview of the software design. This documentation shall be in sufficient detail for inspection of the design 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

- a brief description of the modules and the functions that they perform,
- the way in which the modules interact,
- the overall hierarchy of the program,
- the way in which the software interacts with the hardware of the short-circuit isolator,
- 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.

4.9.2.2 The manufacturer shall prepare and maintain detailed design documentation. This shall be available for inspection in a manner that respects the manufacturer's rights for confidentiality. It shall comprise at least the following:

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

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

- the name of the part,
- a description of the tasks performed,
- 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 to recognize the program flow;

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

This detailed design documentation may be reviewed at the manufacturer's premises.

4.9.3 Software design

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

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

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

4.9.4 Storage of programs and data

The program necessary to comply with this part of ISO 7240 and any preset data, such as the 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 device.

Site-specific data shall be held in memory that retains data for at least two weeks without external power to the device, 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 that a specimen be operational, then the specimen shall be connected to suitable supply and monitoring equipment with characteristics as 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. The short-circuit isolator shall be set to the closed condition and the supply and monitoring equipment shall be able to detect if the isolator changes to the open condition.

The details of the supply and monitoring equipment 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 requirement or test procedure does not specify a tolerance or deviation limits, then deviation limits of $\pm$ 5 % shall be applied.

5.1.5 Functional test

5.1.5.1 Object

To confirm the correct operation of the short-circuit isolators, in accordance with the manufacturer's specification, and to verify their stability after and, where required, during the environmental and EMC tests.

5.1.5.2 Test procedure

Verify that the short-circuit isolator operates within the manufacturer's specification. Verify at least the following for both the input to and output from specimen:

a) each stimulus that the manufacturer claims will cause the short-circuit isolator to change from the closed to the open condition;

b) that the short-circuit isolator can switch the maximum specified switching current, $I_{\mathrm{S\ max}}$;

c) the open-condition (isolation) leakage current, I_{L}, when there is a direct short circuit on one side of the isolator;

d) each stimulus that the manufacturer claims will cause the short-circuit isolator to change from the open to the closed condition;

e) the closed-condition resistance, Z_{C}, at the maximum rated continuous current, $I_{\mathrm{C\ max}}$, or, if Z_{C} cannot be measured at $I_{\mathrm{C\ max}}$ because the isolator changes to the open condition before a current of $I_{\mathrm{C\ max}}$ is reached, then it shall be measured just before the isolator changes to the open condition;

f) the response to a direct short-circuit applied to one side of the isolator.

Examples of functional tests are given in Annex A.

5.1.6 Provision for tests

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

a) fourteen specimens, which are required to conduct the tests as indicated in the test schedule (see 5.1.7) and which shall be numbered 1 to 14 arbitrarily;

b) the data required in 4.8 and 4.9.

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

5.1.7 Test schedule

The specimens shall be tested according to the following test schedule (see Table 1).

Table 1 — Test schedule

Test	Reference	Specimen number(s)
Reproducibility	5.2	All specimens
Variation in supply voltage	5.3	1
Dry heat (operational)	5.4	2
Cold (operational)	5.5	3
Damp heat, cyclic (operational)	5.6	4
Damp heat, steady state (endurance)	5.7	5
Sulfur dioxide (SO_2) corrosion (endurance)	5.8	6
Shock (operational)	5.9	7
Impact (operational)	5.10	8
Vibration, sinusoidal (operational)	5.11	9
Vibration, sinusoidal (endurance)	5.12	9
Electrostatic discharge (operational)	5.13	10[a]
Radiated electromagnetic fields (operational)	5.13	11[a]
Conducted disturbances induced by electromagnetic fields (operational)	5.13	12[a]
Fast-transient bursts (operational)	5.13	13[a]
Slow, high-energy voltage surge (operational)	5.13	14[a]

[a] In the interests of test economy, it is permitted to use the same specimen for more than one EMC test. In this case, intermediate functional test(s) on the specimen(s) used for more than one test may be deleted, and the 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; see EN 50130-4:1995, Clause 4.

5.2 Reproducibility

5.2.1 Object

To show that each specimen meets the manufacturer's specifications.

5.2.2 Test procedure

Conduct the functional test described in 5.1.5 on each specimen.

5.2.3 Requirements

Each specimen shall function correctly within the manufacturer's specification.

5.3 Variation in supply voltage

5.3.1 Object

To show that the specimen meets the manufacturer's specifications for the specified range of supply voltage.

5.3.2 Test procedure

Conduct the functional test specified in 5.1.5 at the upper and the lower limits of the supply voltage range specified by the manufacturer.

NOTE In the examples given in Annex A, this means replacing V_{nom} by V_{max} and V_{min}.

5.3.3 Requirements

The specimen shall function correctly within the manufacturer's specification.

5.4 Dry heat (operational)

5.4.1 Object

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

5.4.2 Test procedure

5.4.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-2, Test B, and with 5.4.2.2 to 5.4.2.5.

5.4.2.2 State of the specimen during conditioning

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

5.4.2.3 Conditioning

Apply the following conditioning:

— temperature: (55 ± 2) °C for type A or (70 ± 2) °C for type B;

— duration: 16 h.

5.4.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any change from the closed condition.

During the last hour of the conditioning period, conduct the functional test as described in 5.1.5.

5.4.2.5 Final measurements

After a recovery period of at least 1 h at the standard laboratory conditions, conduct the functional test as described in 5.1.5.

5.4.3 Requirements

The specimen shall remain in the closed condition during the conditioning period except when required to change during the functional test.

The specimen shall function correctly within the manufacturer's specification during both of the functional tests.

5.5 Cold (operational)

5.5.1 Object

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

5.5.2 Test procedure

5.5.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-1, Test A, and with 5.5.2.2 to 5.5.2.5.

5.5.2.2 State of the specimen during conditioning

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

5.5.2.3 Conditioning

Apply the following conditioning:

— temperature: (−10 ± 3) °C;

— duration: 16 h.

5.5.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any change from the closed condition.

During the last hour of the conditioning period, conduct the functional test as specified in 5.1.5.

5.5.2.5 Final measurements

After a recovery period of at least 1 h at the standard laboratory conditions, conduct the functional test as specified in 5.1.5.

5.5.3 Requirements

The specimen shall remain in the closed condition during the conditioning period except when required to change during the functional test.

The specimen shall function correctly within the manufacturer's specification during both of the functional tests.

5.6 Damp heat, cyclic (operational)

5.6.1 Object

To demonstrate the ability of the specimen to function correctly at high relative humidity (with condensation), which can occur for short periods in the anticipated service environment.

5.6.2 Test procedure

5.6.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-30, Test Db, using the variant 1 test cycle and controlled recovery conditions, and with 5.6.2.2 to 5.6.2.5.

5.6.2.2 State of the specimen during conditioning

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

5.6.2.3 Conditioning

Apply the following conditioning:

- lower temperature: (25 ± 3) °C at > 95 % RH;
- upper temperature: (40 ± 5) °C;
- relative humidity at upper temperature: (93 ± 3) %;
- number of cycles: two.

5.6.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any change from the closed condition.

5.6.2.5 Final measurements

After a recovery period of at least 1 h at the standard laboratory conditions, conduct the functional test as described in 5.1.5.

5.6.3 Requirements

The specimen shall remain in the closed condition during the conditioning period.

The specimen shall function correctly within the manufacturer's specification during the functional test.

5.7 Damp heat, steady state (endurance)

5.7.1 Object

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 or galvanic corrosion.

5.7.2 Test procedure

5.7.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-78, Test Cab, and with 5.7.2.2 to 5.7.2.4.

5.7.2.2 State of the specimen during conditioning

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

5.7.2.3 Conditioning

Apply the following conditioning:

— temperature: (40 ± 2) °C;

— relative humidity: (93 ± 3) %;

— duration: 21 d.

5.7.2.4 Final measurements

After a recovery period of at least 1 h at the standard laboratory conditions, conduct the functional test as described in 5.1.5.

5.7.3 Requirements

The specimen shall function correctly within the manufacturer's specification during the functional test.

5.8 Sulfur dioxide (SO_2) corrosion (endurance)

5.8.1 Object

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

5.8.2 Test procedure

5.8.2.1 General

Use the test apparatus and procedure in accordance with IEC 60068-2-42, except for the relative humidity of the test atmosphere, which shall be maintained (93 ± 3) % instead of (75 ± 5) %, and with 5.8.2.2 to 5.8.2.4.

5.8.2.2 State of the specimen during conditioning

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 taking the final measurement without making further connections to the specimen.

5.8.2.3 Conditioning

Apply the following conditioning:

- temperature: (25 ± 2) °C;
- relative humidity: (93 ± 3) %;
- SO_2 concentration: (25 ± 5) µl/l;
- duration: 21 d.

5.8.2.4 Final measurements

Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, ⩽ 50 % RH, followed by a recovery period of at least 1 h at the standard laboratory conditions.

After the recovery period, conduct the functional test as specified in 5.1.5.

5.8.3 Requirements

The specimen shall function correctly within the manufacturer's specification during the functional test.

5.9 Shock (operational)

5.9.1 Object

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

5.9.2 Test procedure

5.9.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-27, Test Ea, except that the conditioning shall be as specified in 5.9.2.3, and with 5.9.2.2 to 5.9.2.5.

5.9.2.2 State of the specimen during conditioning

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

5.9.2.3 Conditioning

For specimens with a mass < 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, expressed in kilograms);
- number of directions: six;
- pulses per direction: three.

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

5.9.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any change from the closed condition.

5.9.2.5 Final measurements

After the conditioning and the further 2 min, conduct the functional test as specified in 5.1.5.

5.9.3 Requirements

The specimen shall remain in the closed condition during the conditioning period and the additional 2 min.

The specimen shall function correctly within the manufacturer's specification during the functional test.

5.10 Impact (operational)

5.10.1 Object

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

5.10.2 Test procedure

5.10.2.1 Apparatus

Use the test apparatus and perform the procedure in accordance with Annex B and 5.10.2.2 to 5.10.2.5.

5.10.2.2 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.

5.10.2.3 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.

5.10.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any change from the closed condition.

5.10.2.5 Final measurements

After the conditioning and the further 2 min, conduct the functional test as specified in 5.1.5.

5.10.3 Requirements

The specimen shall remain in the closed condition during the conditioning period and the additional 2 min.

The specimen shall function correctly within the manufacturer's specification during the functional test.

5.11 Vibration, sinusoidal (operational)

5.11.1 Object

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

5.11.2 Test procedure

5.11.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-6, Test Fc, and with 5.11.2.2 to 5.11.2.5.

5.11.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as described in 5.1.3 and connect it to its supply and monitoring equipment as described 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 its normal mounting plane.

5.11.2.3 Conditioning

Apply the following conditioning:

- frequency range: (10 to 150) Hz;
- acceleration amplitude: 5 m/s^2 (≈ 0,5 g_n);
- number of axes: three;
- sweep rate: one octave/min;
- number of sweep cycles: two /axis.

The vibration (operational) and vibration (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.

5.11.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any change from the closed condition.

5.11.2.5 Final measurements

After the conditioning, conduct the functional test as described in 5.1.5.

NOTE If the vibration operational and endurance tests are combined, the final measurements are made after the vibration endurance test and it is necessary to make them only if the operational test is conducted in isolation.

5.11.3 Requirements

The specimen shall remain in the closed condition during the conditioning period.

If the final measurement, as specified in 5.11.2.5, has been conducted, the specimen shall function correctly within the manufacturer's specification during the functional test.

5.12 Vibration, sinusoidal (endurance)

5.12.1 Object

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

5.12.2 Test procedure

5.12.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-6, Test Fc, and with 5.12.2.2 to 5.12.2.4.

5.12.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as described in 5.1.3. Apply the vibration in each of three mutually perpendicular axes, in turn, and so that one of the three axes is perpendicular to its normal mounting plane of the specimen.

Do not supply the specimen with power during conditioning.

5.12.2.3 Conditioning

Apply the following conditioning:

- frequency range: (10 to 150) Hz;
- acceleration amplitude: 10 m/s^2 ($\approx$1,0 g_n);
- number of axes: three;
- sweep rate: one octave/min;
- number of sweep cycles: 20 /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.

5.12.2.4 Final measurements

After the conditioning, conduct the functional test as described in 5.1.5.

5.12.3 Requirements

The specimen shall function correctly within the manufacturer's specification during the functional test.

5.13 Electromagnetic compatibility (EMC), immunity tests (operational)

5.13.1 Object

To demonstrate the immunity of the specimen to electromagnetic interference.

5.13.2 Test procedure

5.13.2.1 General

The test apparatus and procedure shall be as described in EN 50130-4, and as described below.

5.13.2.2 State of the specimen(s) during conditioning

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

5.13.2.3 Conditioning

Conduct the following EMC immunity tests in accordance with 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 voltage surges.

5.13.2.4 Measurements during conditioning

Monitor the specimen for any change of state or faulty operation.

5.13.2.5 Final measurements

After a recovery period of at least 1 h at the standard laboratory conditions, conduct the functional test as described in 5.1.5.

5.13.3 Requirements

The specimen shall remain in the closed condition without any faulty operation during conditioning.

The specimen shall function correctly within the manufacturer's specification during the functional test.

6 Test report

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

a) identification of the specimen tested;

b) reference to this part of ISO 7240 (i.e. ISO 7240-17:2009);

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

d) conditioning period and the conditioning atmosphere;

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

f) details of the supply and monitoring equipment;

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

h) details of any operations regarded as optional.

Annex A
(informative)

Examples for the functional test procedure

A.1 Introduction

This annex provides some examples of functional test procedures for some hypothetical short-circuit isolators. For these examples, the following simplistic and not necessarily practical types of isolators are described:

a) simple “autonomous” voltage-sensing isolator;

b) simple “autonomous” current-sensing isolator;

c) simple “controllable” isolator that can be instructed to open and close by the control and indicating equipment and that opens if the voltage falls so low that the control and indicating equipment cannot command the device.

For each example, a typical block diagram and list of the parameters that it is necessary to specify and verify is given. Examples of test circuits and test procedures for making the necessary tests and measurements are then given.

A.2 Example 1 — Simple “autonomous” voltage sensing isolator

A.2.1 Block diagram

Figure A.1 shows the block diagram of a simple “autonomous” voltage-sensing isolator.

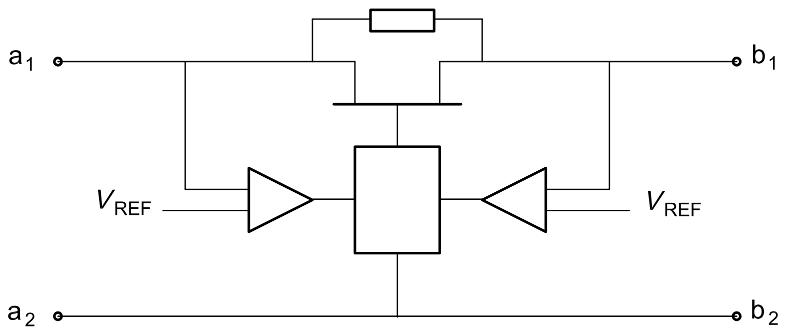


Figure A.1 — Typical block diagram for simple “autonomous” voltage-sensing isolator

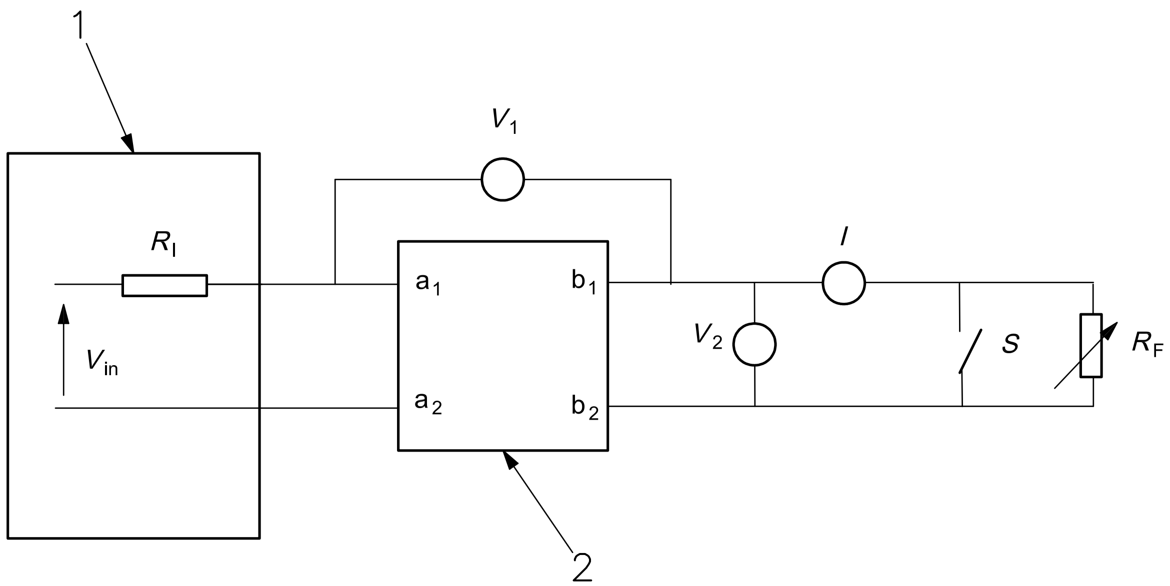
A.2.2 Parameter specifications

Parameter specifications are identified as follows:

V_{max}	maximum line voltage;
V_{nom}	nominal line voltage;
V_{min}	minimum line voltage;
$V_{SO\ max}$	maximum voltage at which the device isolates, i.e. switches from close to open;
$V_{SO\ min}$	minimum voltage at which the device isolates, i.e. switches from close to open;
$V_{SC\ max}$	maximum voltage at which the device reconnects, i.e. switches from open to close;
$V_{SC\ min}$	minimum voltage at which the device reconnects, i.e. switches from open to close;
$I_{C\ max}$	maximum rated continuous current with the switch closed;
$I_{S\ max}$	maximum rated switching current, e.g. under short circuit conditions;
$I_{L\ max}$	maximum leakage current with the switch open, isolated state;
$Z_{C\ max}$	maximum series impedance with the switch closed.

A.2.3 Test circuit

Figure A.2 shows the test circuit for simple “autonomous” voltage-sensing isolator.



Key

1 power supply

2 short-circuit isolator

Figure A.2 — Test circuit for simple “autonomous” voltage-sensing isolator

A.2.4 Test procedure

A.2.4.1 Connect the specimen to a test circuit as shown above with switch S open and R_F set to infinity, i.e. an open circuit.

A.2.4.2 Set V_{in} to the nominal line voltage, unless otherwise stated in a test procedure, and set the effective internal resistance of the supply, R_I, to limit the short-circuit current to $I_{S max}$, i.e. $R_I = V_{in}/I_{S max}$.

A.2.4.3 Apply an instantaneous short circuit by closing switch S. Measure the current, I, and record this as the leakage current, I_L. Check that $I_L \leqslant I_{L max}$.

A.2.4.4 Open switch S and monitor V_2 to check that the device reconnects.

A.2.4.5 Reduce R_F until $I = I_{C max}$. Then measure V_1 and I and hence calculate the effective switch impedance Z_C. Check that $Z_C \leqslant Z_{C max}$.

A.2.4.6 Increase R_F to infinity, i.e. an open circuit, and adjust R_I to $(V_{in} - V_{SO min})/I_{C max}$.

A.2.4.7 Reduce R_F and measure the voltage, V_2, at the moment that the device isolates (i.e. the switch opens) and record this voltage as V_{SO}. Check that $V_{SO max} \geqslant V_{SO} \geqslant V_{SO min}$.

A.2.4.8 Continue to reduce R_F to zero and then measure the current, I, and record this as the leakage current, I_L. Check that $I_L \leqslant I_{L max}$.

A.2.4.9 Increase R_F and measure the voltage, V_2, at the moment that the device reconnects (i.e. the switch closes) and record this voltage as V_{SC}. Check that $V_{SC max} \geqslant V_{SC} \geqslant V_{SC min}$. Then measure V_1 and I and hence calculate the effective switch impedance, Z_C. Check that $Z_C \leqslant Z_{C max}$.

A.2.4.10 Repeat steps A.2.4.1 to A.2.4.9 with the specimen from the other side (i.e. exchange connections a_1 and a_2 with b_1 and b_2).

NOTE It can be necessary to attach a recording device, e.g. a chart recorder, to measure V_2 in order to correctly determine the values of V_{SO} and V_{SC}.

A.3 Example 2 — Simple "autonomous" current-sensing isolator

A.3.1 Block diagram

Figure A.3 shows the block diagram of a simple "autonomous" current-sensing isolator.

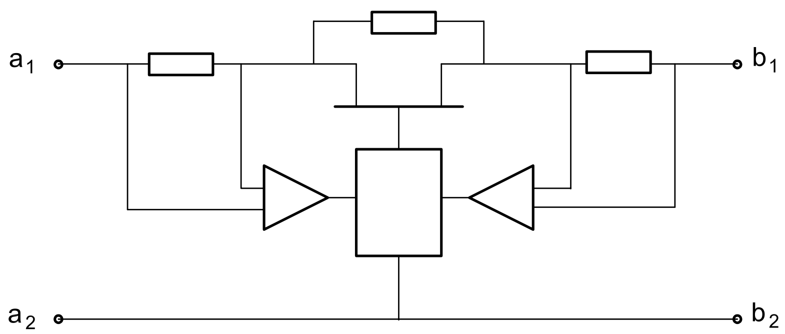


Figure A.3 — Typical block diagram for simple "autonomous" current-sensing isolator

A.3.2 Parameter specifications

Parameter specifications are identified as follows:

V_{max} maximum line voltage;

V_{nom} nominal line voltage;

V_{min} minimum line voltage;

$I_{SO\ max}$ maximum current at which the device isolates, i.e. switches from close to open;

$I_{SO\ min}$ minimum current at which the device isolates, i.e. switches from close to open;

$I_{SC\ max}$ maximum current at which the device reconnects, i.e. switches from open to close;

$I_{SC\ min}$ minimum current at which the device reconnects, i.e. switches from open to close;

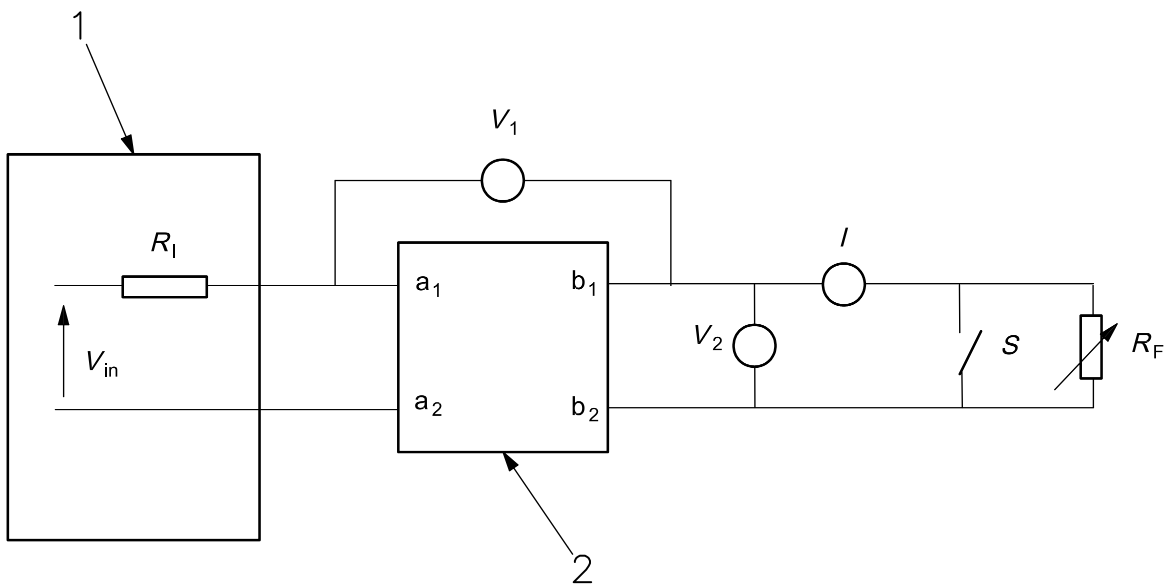
$I_{S\ max}$ maximum rated switching current, e.g. under short circuit conditions;

$I_{L\ max}$ maximum leakage current with the switch open, isolated state;

$Z_{C\ max}$ maximum series impedance with the switch closed.

A.3.3 Test circuit

Figure A.4 shows the test circuit for simple “autonomous” current-sensing isolator.



Key

1 power supply

2 short-circuit isolator

Figure A.4 — Test circuit for simple “autonomous” current-sensing isolator

A.3.4 Test procedure

A.3.4.1 Connect the specimen to a test circuit as shown above with switch S open and R_F set to infinity, i.e. an open circuit.

A.3.4.2 Set V_{in} to the nominal line voltage, unless otherwise stated in a test procedure, and set the effective internal resistance of the supply, R_I, to limit the short-circuit current to $I_{S\ max}$, i.e. $R_I = V_{in}/I_{S\ max}$.

A.3.4.3 Apply an instantaneous short circuit by closing switch S. Measure the current, I, and record this as the leakage current, I_L. Check that $I_L \leqslant I_{L\ max}$.

A.3.4.4 Open switch S and monitor V_2 to check that the device reconnects.

A.3.4.5 Reduce R_F and measure the current, I, at the moment that the device isolates, i.e. the switch opens, and record this current as I_{SO}. Check that $I_{SO\ max} \geqslant I_{SO} \geqslant I_{SO\ min}$.

A.3.4.6 Continue to reduce R_F to zero and then measure the current, I, and record this as the leakage current, I_L. Check that $I_L \leqslant I_{L\ max}$.

A.3.4.7 Increase R_F and measure the current, I, at the moment that the device reconnects, i.e. the switch closes, and record this current as I_{SC}. Check that $I_{SC\ max} \geqslant I_{SC} \geqslant I_{SC\ min}$. Then measure V_1 and I and hence calculate the effective switch impedance Z_C. Check that $Z_C \leqslant Z_{C\ max}$.

A.3.4.8 Repeat steps A.3.4.1 to A.3.4.7 with the specimen from the other side, i.e. exchange connections a_1 and a_2 with b_1 and b_2).

NOTE It can be necessary to attach a recording device, e.g. a chart recorder, to measure I in order to correctly determine the values of I_{SO} and I_{SC}.

A.4 Example 3 — Simple controllable isolator

A.4.1 General

A.4.2 Block diagram

Figure A.5 shows the block diagram of a simple “controllable” isolator.

A simple “controllable” isolator can be instructed to open and close by the control and indicating equipment; it will open if the voltage falls so low that the control and indicating equipment cannot command the device.

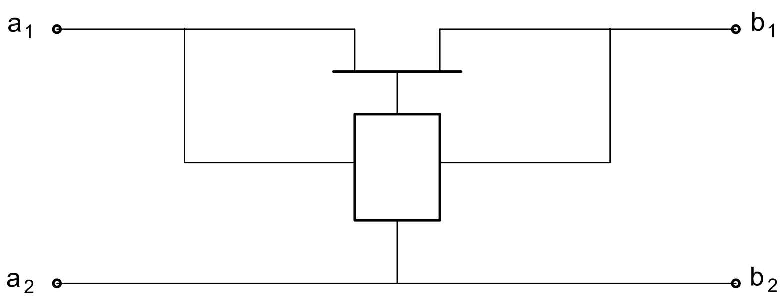


Figure A.5 — Typical block diagram for simple “controllable” isolator

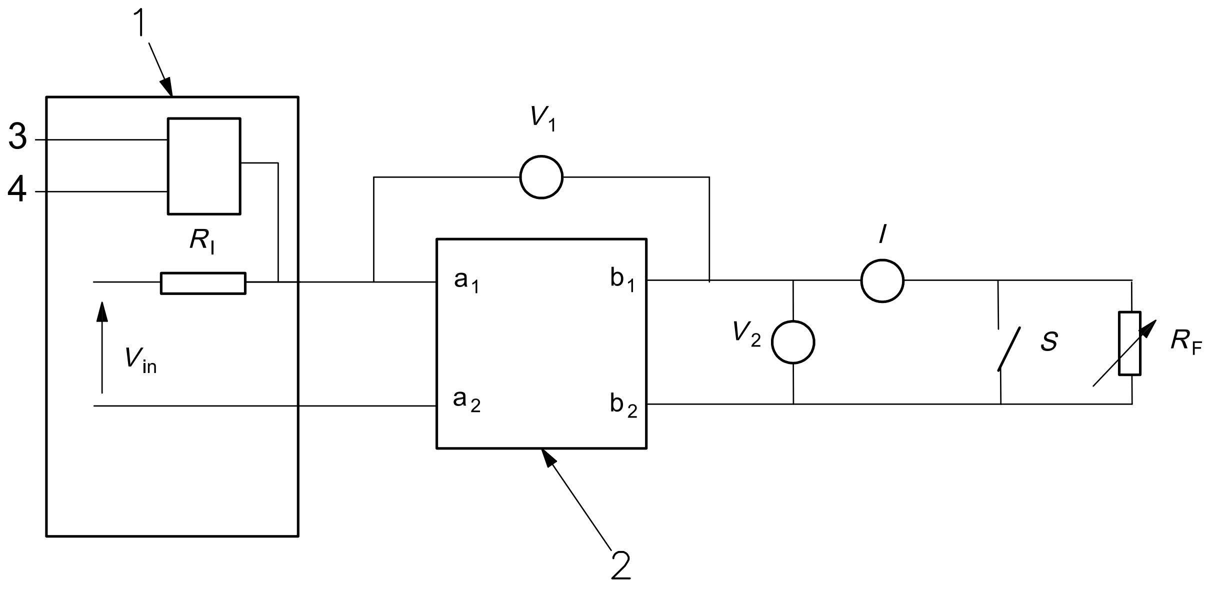
A.4.3 Parameter specifications

Parameter specifications are identified as follows:

Isolate command	command that causes the device to switch from close to open;
Reconnect command	command that causes the device to switch from open to close;
V_{max}	maximum line voltage;
V_{nom}	nominal line voltage;
V_{min}	minimum line voltage;
$V_{SO\ max}$	maximum voltage at which the device isolates, i.e. switches from close to open;
$V_{SO\ min}$	minimum voltage at which the device isolates, i.e. switches from close to open;
$I_{C\ max}$	maximum rated continuous current with the switch closed;
$I_{S\ max}$	maximum rated switching current, e.g. under short circuit conditions;
$I_{L\ max}$	maximum leakage current with the switch open, isolated state;
$Z_{C\ max}$	maximum series impedance with the switch closed.

A.4.4 Test circuit

Figure A.6 shows the test circuit for simple “controllable” isolator.



Key

1 power supply and control equipment

2 short-circuit isolator

3 isolate command input

4 reconnect command input

NOTE It can be necessary for the manufacturer to provide suitable power supply and control equipment.

Figure A.6 — Test circuit for simple “controllable” isolator

A.4.5 Test procedure

A.4.5.1 Connect the specimen to a test circuit as shown above with switch S open and R_F set to infinity, i.e. an open circuit.

A.4.5.2 Set V_{in} to the nominal line voltage, unless otherwise stated in a test procedure, and set the effective internal resistance of the supply, R_I, to limit the short-circuit current to $I_{S\ max}$, i.e. $R_I = V_{in}/I_{S\ max}$. Operate the isolate and reconnect commands and monitor V_2 to check that the device isolates and reconnects.

A.4.5.3 Apply an instantaneous short circuit by closing switch S. Measure the current, I, and record this as the leakage current, I_L. Check that $I_L \leqslant I_{L\ max}$.

A.4.5.4 Open switch S, operate the reconnect command and monitor V_2 to check that the device reconnects.

A.4.5.5 Reduce R_F until $I = I_{C\ max}$. Then measure V_1 and I and hence calculate the effective switch impedance, Z_C. Check that $Z_C \leqslant Z_{C\ max}$. Operate the isolate and reconnect commands and monitor V_2 to check that the device isolates and reconnects.

A.4.5.6 Increase R_F to infinity, i.e. an open circuit, and adjust R_I to $(V_{in} - V_{SO\ min})/I_{C\ max}$.

A.4.5.7 Reduce R_F and measure the voltage, V_2, at the moment that the device isolates, i.e. the switch opens, and record this voltage as V_{SO}. Check that $V_{SO\ max} \geqslant V_{SO} \geqslant V_{SO\ min}$.

A.4.5.8 Continue to reduce R_F to zero and then measure the current I and record this as the leakage current I_L. Check that $I_L \leqslant I_{L\ max}$.

A.4.5.9 Increase R_F until the reconnect command can be correctly applied and apply the reconnect command. Then measure V_1 and I and hence calculate the effective switch impedance, Z_C. Check that $Z_C \leqslant Z_{C\ max}$.

A.4.5.10 Repeat steps A.4.5.1 to A.4.5.9 with the specimen from the other side, i.e. exchange connections a_1 and a_2 with b_1 and b_2.

NOTE It can be necessary to attach a recording device, e.g. a chart recorder, to measure V_2 in order to correctly determine the value of V_{SO}.

Annex B
(informative)

Apparatus for impact test

The impact test apparatus (see Figure B.1) consists essentially of a swinging hammer comprised of a rectangular section head (striker) with a chamfered impact face, mounted on a tubular steel shaft. The hammer is fixed into a steel boss, which runs on ball bearings on a fixed steel shaft mounted in a rigid steel frame, so that the hammer can rotate freely about the axis of the fixed shaft. The design of the rigid frame is such as to allow complete rotation of the hammer assembly when the specimen is not present.

The striker, with overall dimensions of 76 mm (width) × 50 mm (depth) × 94 mm (length), is manufactured from aluminium alloy (Al Cu4SiMg as specified in ISO 209), which has been solution- and precipitation-treated. It has a plane-impact face chamfered at (60 ± 1)° to the long axis of the head. The tubular steel shaft has an outside diameter of (25 ± 0,1) mm with a wall thickness of (1,6 ± 0,1) mm.

The striker is mounted on the shaft so that its long axis is at a radial distance of 305 mm from the axis of rotation of the assembly, the two axes being mutually perpendicular. The central boss is 102 mm in outside diameter and 200 mm long, and is mounted coaxially on the fixed steel pivot shaft, which is approximately 25 mm in diameter; however, the precise diameter of the shaft depends on the bearings used.

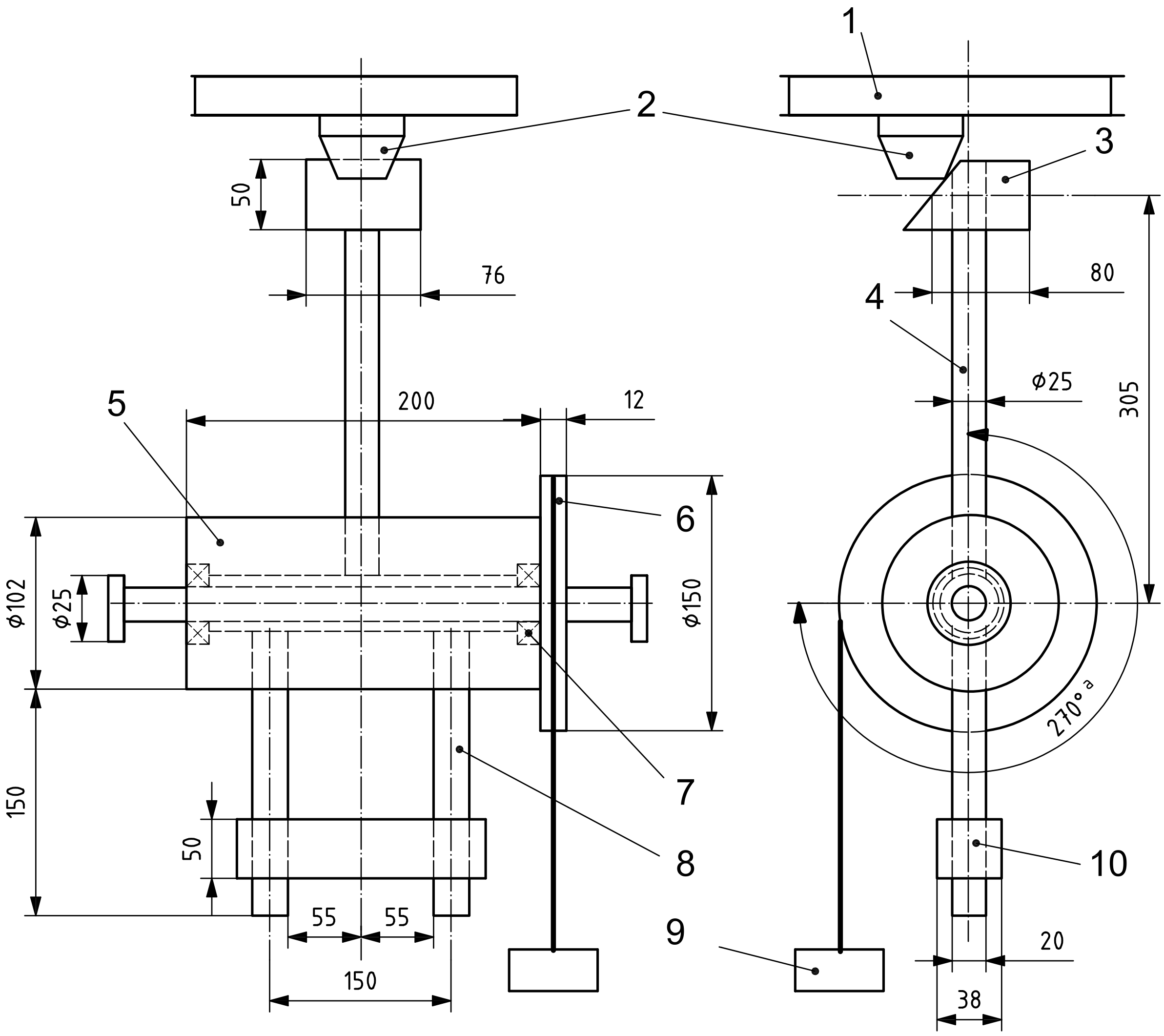
Diametrically opposite the hammer shaft are two steel counter-balance arms, each 20 mm in outside diameter and 185 mm long. These arms are screwed into the boss so that a length of 150 mm protrudes. A steel counter-balance weight is mounted on the arms so that its position can be adjusted to balance the mass of the striker and arms, as in Figure B.1. On the end of the central boss is mounted a 150 mm-diameter aluminium-alloy pulley, 12 mm wide, and around this is wound an inextensible cable, with one end fixed to the pulley. The other end of the cable supports the operating weight.

The rigid frame also supports the mounting board on which the specimen is mounted by its normal fixings. The mounting board is adjustable vertically so that the upper half of the impact face of the hammer can strike the specimen when the hammer is moving horizontally, as shown in Figure B.1.

To operate the apparatus, the position of the mounting board with the specimen is first adjusted as shown in Figure B.1 and the mounting board is then secured rigidly to the frame. The hammer assembly is then balanced carefully by adjustment of the counter-balance weight with the operating weight removed. The hammer arm is then drawn back to the horizontal position ready for release and the operating weight is reinstated. On release of the assembly, the operating weight will spin the hammer and arm through an angle of $3\pi/2$ rad to strike the specimen. The mass, expressed in kilograms, of the operating weight to produce the required impact energy of 1,9 J equals $0{,}388/(3\pi r)$ kg, where r is the effective radius of the pulley, expressed in metres. This equals approximately 0,55 kg for a pulley radius of 75 mm.

As this part of ISO 7240 requires a hammer velocity at impact of (1,5 ± 0,13) m/s, it is necessary to reduce the mass of the hammerhead by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0,79 kg is required to obtain the specified velocity, but it is necessary to determine this by trial and error.

Dimensions in millimetres



Key

1 mounting board
2 specimen
3 striker
4 striker shaft
5 boss
6 pulley
7 ball bearings
8 counter-balance arms
9 operating weight
10 counter-balance weight

a Angle of movement.

NOTE The dimensions shown are for guidance, apart from those relating to the hammerhead.

Figure B.1 — Impact apparatus

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[1] EN 54-17, *Fire detection and fire alarm systems — Part 17: Short-circuit isolators*

[2] ISO 9001:2000, *Quality management systems — Requirements*

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[4] IEC 60268-1:1985, *Sound system equipment — Part 1: General*

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