

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) -
Part 2-2: RCBOs according to classification 4.1.2, 4.1.3, 4.1.4, 4.1.5 and 4.1.6**

**Interrupteurs automatiques à courant différentiel résiduel avec dispositif de protection contre les surintensités incorporé pour usages domestiques et analogues (DD) -
Partie 2-2: DD conformes à la classification en 4.1.2, 4.1.3, 4.1.4, 4.1.5 et 4.1.6**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RESIDUAL CURRENT OPERATED CIRCUIT-BREAKERS
WITH INTEGRAL OVERCURRENT PROTECTION
FOR HOUSEHOLD AND SIMILAR USES (RCBOs) –****Part 2-2: RCBOs according to classification
4.1.2, 4.1.3, 4.1.4, 4.1.5 and 4.1.6**

FOREWORD

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IEC 61009-2-2 has been prepared by subcommittee 23E: Circuit-breakers and similar equipment for household use, of IEC technical committee 23: Electrical accessories. It is an International Standard.

This second edition cancels and replaces the first edition published in 1991. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) harmonization of all clauses between the IEC 61008, IEC 61009 and IEC 60755 series using blocks and modules approach;

- b) harmonization of all tables and figures between the IEC 61008, IEC 61009 and IEC 60755 series;
- c) terms and definitions are now referred to IEC 62873-2;
- d) modification of 4.1 for classification according to supply conditions;
- e) modification of Clause 6 for markings of RCBOs with a functional earth (FE);
- f) specific tests for operating characteristics of RCBO according to classifications 4.1.2, 4.1.3, 4.1.4, 4.1.5 and 4.1.6;
- g) specific test conditions for dielectric properties (9.7), temperature-rise (9.8), electrical and mechanical endurance (9.10), short-circuit tests (9.11), verification of trip-free (9.15), behaviour in the event of loss of the supply voltage (9.17), surge current tests (9.19), reliability (9.20), ageing (9.21) and temporary overvoltage TOV (9.24);
- h) additional tests for RCBOs with a terminal connected to the FE: Connecting capacity of FE terminal (9.200); Limitation of standing current in the FE (9.201).

The text of this International Standard is based on the following documents:

Draft	Report on voting
23E/1372/FDIS	23E/1390/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This International Standard is to be used in conjunction with IEC 61009-1:2024.

Where this document states "addition", "deletion" or "replacement", the corresponding requirement, test specification or explanatory material in IEC 61009-1:2024 is adapted accordingly.

Where this document defines a new subclause, this subclause number starts at 200 (for example an additional definition in this part would read 3.200).

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61009 series, published under the general title *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

RESIDUAL CURRENT OPERATED CIRCUIT-BREAKERS WITH INTEGRAL OVERCURRENT PROTECTION FOR HOUSEHOLD AND SIMILAR USES (RCBOs) –

Part 2-2: RCBOs according to classification 4.1.2, 4.1.3, 4.1.4, 4.1.5 and 4.1.6

1 Scope

IEC 61009-1:2024, Clause 1 is applicable except for the first paragraph, which is replaced by the first paragraph below, and the last paragraph, which is replaced by the second paragraph and note below:

This document applies to residual current operated circuit-breakers, with integral overcurrent protection, for household and similar uses (hereafter referred to as RCBOs), classified according to IEC 61009-1:2024, 4.1.2, 4.1.3, 4.1.4, 4.1.5 and 4.1.6. RCBOs according to this document are intended for voltages not exceeding 440 V AC with frequencies of 50 Hz, 60 Hz or 50/60 Hz and currents not exceeding 125 A and rated short-circuit capacities not exceeding 25 000 A for operation at 50 Hz or 60 Hz.

This document applies in conjunction with IEC 61009-1:2024. It specifies requirements, tests and test sequences to verify compliance and is used for certification purposes.

NOTE Devices according to this document are not permitted in: DE.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 61009-1:2024, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

IEC 61543:2022, *Residual current-operated protective devices (RCDs) for household and similar use – Electromagnetic compatibility*

IEC 62873-2, *Residual current operated circuit-breakers for household and similar use – Part 2: Residual current devices (RCDs) – Vocabulary*

IEC 62873-3-1, *Residual current operated circuit-breakers for household and similar use – Part 3-1: Particular requirements for devices with screwless-type terminals for external copper conductors*

IEC 62873-3-2, *Residual current operated circuit-breakers for household and similar use – Part 3-2: Particular requirements for devices with flat quick-connect terminations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62873-2, in IEC 61009-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.200

limiting impedance value

R_x

maximum impedance value from the FE to the supply source for which protection is ensured when the RCBO classified in accordance with 4.1.3 is supplied from any one phase only and FE

4 Classification

IEC 61009-1:2024, Clause 4 applies with the following modifications (deletion of 4.1.1):

4.1 According to the supply conditions

4.1.2 RCBO with 2 or 4 current paths operating correctly on the occurrence of residual current within the voltage range of 1,1 U_e and 85 V

The RCBO does not open automatically in the event of loss of supply.

NOTE In China, the lower limit value of 50 V (line to neutral) is required (for RCBOs with $I_{\Delta n} \leq 30$ mA) instead of 85 V.

4.1.3 RCBO according to 4.1.2 fitted with a functional earth (FE) and able to continue to provide protection when supplied from just one phase and FE

4.1.3.1 Does not open automatically in the event of loss of supply and continues to provide residual current protection in the case of supply from just one phase and FE.

4.1.3.2 Does not open automatically in the event of loss of one or more phases and provides protection by opening automatically if supplied from just one phase and FE.

4.1.4 RCBO with 3 current paths operating correctly on the occurrence of residual current within the voltage range of 1,1 U_e and 0,7 U_e

The RCBO does not open automatically in the case of loss of supply.

These devices are not intended to be supplied from single phase circuits.

4.1.5 RCBO operating correctly on the occurrence of residual current within the voltage range 1,1 U_e and U_x

The device opens automatically, with or without delay, in the event of a supply voltage drop to a value less than U_x .

4.1.6 RCBO according to 4.1.5, however reclosing automatically after restoration of the supply voltage

5 Characteristics of RCBOs

IEC 61009-1:2024, Clause 5 applies with the following modifications.

5.1 Summary of characteristics

IEC 61009-1:2024, 5.1 applies with the following addition:

- minimum operating voltage U_x (see 5.2.1.200);
- rated value R_x (see 5.3.200).

5.2 Rated quantities and other characteristics

Add the following subclause:

5.2.1.200 Minimum operating voltage (U_x)

The minimum operating voltage, where applicable, as declared by the manufacturer for RCBOs.

5.3 Standard and preferred values

Add the following subclause:

5.3.200 Rated values for R_x

The standard value for R_x is 2 Ω for:

- single-pole RCBOs with two current paths; or
- three-pole with four current paths; or
- RCBO rated 120 V or 120/240 V

NOTE These devices are intended to be used in TN-systems only.

For other RCBOs the standard R_x value shall be 6 k Ω unless a lower value is declared by the manufacturer.

6 Marking and other product information

IEC 61009-1:2024, Clause 6 applies with the following additions.

6.200 Marking of RCBOs classified according to 4.1.3

This Subclause 6.200 applies to RCBOs classified according to 4.1.3.

RCBOs shall be marked with the rated value R_x in Ω , for values other than those specified in 5.3.200 (e.g. $R_x = 5\,000\,\Omega$).

This information may be marked on the side or on the back of the device and shall be visible only before the device is installed.

The following additional information is required in the manufacturer's instructions:

- This device will provide protection in installations where the earth loop impedance does not exceed the R_x value.

The FE-wire or terminal shall be identified by the marking "FE".

In addition, if a terminal is used, the marking of the maximum rated connecting capability (e.g. "max. 2,5 mm²") shall be visible close to the terminal.

The following colours are not allowed for the FE-wire:

- green, yellow, blue and green-and-yellow.

The manufacturer's instruction shall state that the FE shall be connected directly to the PE and looping in the FE terminal is not allowed.

Compliance is verified by inspection.

6.201 Marking of RCBOs classified according to 4.1.5 and 4.1.6

For RCBOs classified according to 4.1.5 and 4.1.6 and opening with a delay in the event of failure of the line voltage, the manufacturer shall state in its product information the range of such delay.

Compliance is verified by inspection.

7 Standard conditions for operation in service and for installation

IEC 61009-1:2024, Clause 7 applies.

8 Requirements for construction and operation

IEC 61009-1:2024, Clause 8 applies with the following modifications.

8.1.2 Mechanism

IEC 61009-1:2024, 8.1.2 applies with the following addition:

In the case of RCBOs classified according to 4.1.6, the operating means shall remain in the ON position following automatic opening of the contacts; when the line voltage is re-established, the contacts shall reclose automatically unless in the meantime the operating means has been placed in the OFF position. For this type of RCBO, the operating means shall not be used as a means for indicating the closed and open positions.

8.1.3 Clearances, creepage distances and solid insulation

IEC 61009-1:2024, 8.1.3.1 applies with the following addition:

For RCBOs classified according to 4.1.3 of IEC 61009-1:2024, Table 20 applies with the following additional requirement:

In the evaluation of the minimum required clearances and creepage distances, the FE is considered as a live part. In the case of RCBOs provided with flying leads, the measurements are carried out with the RCBO installed as in normal use.

8.1.5 Terminals for external conductors

IEC 61009-1:2024, 8.1.5 applies with the following addition for RCBOs classified according to 4.1.3.

8.1.5.200 Additional requirements for FE terminal or FE-wire

This Subclause 8.1.5.200 applies to RCBOs classified according to 4.1.3.

The rated connecting capacity of the FE terminal shall not exceed 2,5 mm² and it shall not be possible to connect a wire greater than 2,5 mm².

The RCBO FE-wire shall have a cross-section of at least 0,75 mm².

Compliance is checked by the tests of 9.200, inspection and measurement.

8.1.5.201 Screwless or flat quick-connect terminal for FE

This Subclause 8.1.5.201 applies to RCBOs classified according to 4.1.3.

It shall not be possible to connect a wire with a cross-sectional area greater than 2,5 mm² to an FE terminal.

- If the FE terminal is of a screwless type, it shall be for one conductor only and shall comply with IEC 62873-3-1;
- If the FE terminal is of a flat quick-connect terminations type, it shall be limited to one wire and shall comply with IEC 62873-3-2.

8.12 Requirements for RCBOs in the event of loss of supply

RCBOs shall operate according to their classification in the event of loss of supply (see Table 33).

For RCBOs classified according to 4.1.5 and 4.1.6, U_x shall not be greater than 0,85 U_e (or, if relevant, 0,85 times the minimum value of the range of rated voltages).

RCBOs classified according to 4.1.6 shall not reclose automatically after opening due to a residual current.

Compliance is checked by the test of 9.17.

8.17 Resistance to temporary overvoltages (TOV)

IEC 61009-1:2024, 8.17 applies with the following addition:

For RCBOs classified according to 4.1.3, the following additional requirements regarding the resistance to temporary overvoltages (TOV) apply:

Withstand values of alternating overvoltage levels and duration are given in Table 201.

Compliance with the above requirement is checked by the test of 9.24.200.

8.200 Standing current in the FE under normal conditions

This Subclause 8.200 applies to RCBOs classified according to 4.1.3.

The standing current from the FE through the protective conductor shall not exceed 1 mA under normal supply conditions.

Compliance is checked by the test of 9.201.2.

8.201 Standing current in the FE in the case of RCBO supplied from just one phase and FE

This Subclause 8.201 applies to RCBOs classified according to 4.1.3.

When the RCBO is supplied from just one phase and FE as for single phase conditions, the standing current in the FE shall not exceed 2 mA.

Compliance is checked by the test of 9.201.3.

9 Tests

IEC 61009-1:2024, Clause 9 applies with the following modifications.

9.1 General

IEC 61009-1:2024, 9.1 applies with the following addition:

Replace the third paragraph with:

The test sequences and the number of samples to be submitted are stated in Annex A.

9.7 Test of dielectric properties

IEC 61009-1:2024, 9.7 applies with the following modifications.

9.7.2 Insulation resistance of the main circuit

IEC 61009-1:2024, 9.7.2 applies with the following additions:

Add, at the end of 9.7.2 b), the following:

For RCBOs classified according to 4.1.3, for the purpose of this test, the FE is considered as a pole and the electronic circuit between poles and FE shall be disconnected.

For RCBOs classified according to 4.1.5 and 4.1.6 not remaining in the closed position, each pole is bridged by an external connection;

Add, at the end of 9.7.2 c), the following:

For RCBOs classified according to 4.1.3, for the purpose of this test, the FE is connected to all poles.

For RCBOs classified according to 4.1.5 and 4.1.6 not remaining in the closed position, each pole is bridged by an external connection;

9.7.6 Capability of control circuits connected to the main circuit to withstand high DC voltages due to insulation measurements

For RCBOs classified according to 4.1.3, the text of IEC 61009-1:2024, 9.7.6 is replaced by the following:

The test is carried out on the RCBO fixed on a metal support, in the closed position, with all control circuits connected as in service.

A DC voltage source is used with the following characteristics:

- open voltage: $600\text{ V }^{+25}_0\text{ V}$
- maximum ripple: 5 %
- short-circuit current: $12\text{ mA }^{+2}_0\text{ mA}$

This test voltage is applied for 1 min, in turn between each pole and the other poles connected together to the frame. For the purpose of this test the FE is considered as part of the frame.

After this treatment, under the conditions of 9.9.1.2.3, the RCBO shall trip with a test current of $I_{\Delta n}$. Only one test is carried out, the break time and shall comply with IEC 61009-1:2024, Table 11.

Moreover, the RCBO shall be capable of performing satisfactorily the tests specified in 9.9.1.5.1 or 9.9.1.5.2 as applicable with only one measurement.

9.7.7.2 Verification of clearances with the impulse withstand voltage

IEC 61009-1:2024, 9.7.7.2 applies with the following additions:

Add, after the fifth paragraph (before list item a)), the following:

For RCBOs classified according to 4.1.5 and 4.1.6, not remaining in the closed position, each pole is bridged by an external connection;

For the tests according to 9.7.7.2 b) the following applies:

For RCBOs classified according to 4.1.3, the test of 9.7.7.2 b) is carried out by applying the impulse voltage between:

- the metal support connected together with the terminal(s) intended for the protective conductor(s), or FE, and
- the phase pole(s) and neutral pole (or path) connected together.

9.8 Test of temperature-rise

IEC 61009-1:2024, 9.8 applies with the following modifications.

9.8.2 Test procedure

IEC 61009-1:2024, 9.8.2 applies with the following addition:

The test is performed at any convenient voltage, the electronic components being supplied at the rated voltage.

Special samples, permitting to supply the electronic components at the rated voltage may be prepared by the manufacturer for this test.

NOTE Figure 22 gives an example of a test circuit for supplying RCBOs including electronic components with rated voltage, but at reduced energy consumption of the complete test arrangement.

9.9 Verification of the operating characteristics

9.9.1 Verification of the operating characteristics under residual current conditions

9.9.1.1 Test circuit and test procedure

The RCBO is installed as for normal use.

The test circuit shall be of negligible inductance. For tests according to 9.9.1.2, the test circuit shall correspond to Figure 28. For tests according to 9.9.1.3, the test circuit shall correspond to Figure 29 or Figure 30, as applicable.

Unless otherwise specified in this document, the tests shall be carried out at $1,1 U_e$.

The FE, if any, is connected to the supply neutral, via the resistor R_X .

The instruments for the measurement of the residual current shall display (or allow to determine) the true RMS value.

Unless otherwise specified in this document, the tests are performed with no load at the ambient air temperature of $20\text{ °C} \pm 5\text{ °C}$.

The RCBO shall perform the tests of 9.9.1.2 and 9.9.1.3, as applicable. Each test is performed by applying the residual current to one pole only, taken at random, with five measurements, unless otherwise specified in this document.

For RCBOs having more than one rated frequency, the tests shall be carried out at the lowest and highest frequency, except for test in 9.9.1.2.5 where verification is performed at only one frequency.

For RCBOs having multiple settings of residual operating current, the tests shall be carried out for each setting.

9.9.1.2 Tests for all RCBOs

9.9.1.2.1 Verification of correct operation in the case of a steady increase of the residual current

The switches S_1 , S_2 , S_3 , S_4 and the RCBO being in the closed position, the residual current is steadily increased, starting from a value not higher than $0,2 I_{\Delta n}$, trying to attain the value of $I_{\Delta n}$ within 30 s. The test shall be performed five times, the tripping current being measured each time.

All five measured values shall be situated between $I_{\Delta no}$ and $I_{\Delta n}$.

For RCBOs where the load and line terminals are not marked, the test shall be performed by connecting the supply on one side of the poles for two samples and then on the other side of the poles for one sample.

9.9.1.2.2 Verification of correct operation on closing on a residual current

The test circuit being calibrated at the value of the rated residual operating current $I_{\Delta n}$ and the switches S_1 , S_2 , S_3 and S_4 being closed, the RCBO is closed to simulate service conditions as closely as possible. The break time is measured five times. No measurement shall exceed the limiting value specified for $I_{\Delta n}$ in IEC 61009-1:2024, Table 11, according to the type of RCBO.

9.9.1.2.3 Verification of correct operation in the case of sudden appearance of residual current

1) All types

The test circuit being successively calibrated at each of the values of residual current specified in IEC 61009-1:2024, Table 11, the switches S_2 , S_3 , S_4 and the RCBO being in the closed position, the test voltage is suddenly established by closing the switch S_1 .

The RCBO shall trip during each test.

Five measurements of the break time are made at each value of residual current.

No value shall exceed the relevant specified limiting value given in IEC 61009-1:2024, Table 11.

2) Additional test for type S

The test circuit being successively calibrated at each of the values of residual current specified in IEC 61009-1:2024, Table 11, the switches S_1 , S_3 , S_4 and the RCBO being in the closed position, the residual current is suddenly established by closing the switch S_2 for periods corresponding to the relevant minimum non-actuating times, with a tolerance of 0 to -5 %.

Each application of residual current shall be separated from the previous one by an interval of at least 1 min.

The RCBO shall not trip during any of the tests.

9.9.1.2.4 Verification of correct operation in the case of sudden appearance of residual currents between 5 $I_{\Delta n}$ and 500 A

The test circuit is calibrated successively to the following values of the residual current:

5 A, 10 A, 20 A, 50 A, 100 A and 200 A.

The switches S_1 , S_3 , S_4 and the RCBO being in the closed position, the residual current is suddenly established by closing the switch S_2 .

The RCBO shall trip during each test. The break time shall not exceed the times given in IEC 61009-1:2024, Table 11.

The test is carried out once for each value of residual current on one pole only, taken at random.

9.9.1.2.5 Verification of correct operation with load

The tests of 9.9.1.2.2 and 9.9.1.2.3 are repeated, the pole under test and one other pole of the RCBO being loaded with rated current at rated voltage. For 9.9.1.2.2, the device is open before the test.

For the test of 9.9.1.2.3, the switches S_1 , S_3 , S_4 and the RCBO are in closed position. The residual current is established by closing S_2 .