

INTERNATIONAL STANDARD

GROUP SAFETY PUBLICATION

**General safety requirements for residual current operated protected devices –
Part 1: Residual current operated protective devices for DC systems**

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IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**GENERAL SAFETY REQUIREMENTS FOR RESIDUAL
CURRENT OPERATED PROTECTED DEVICES –****Part 1: Residual current operated protective devices for DC systems**

FOREWORD

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IEC 60755-1 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 document is intended to be used in conjunction with IEC 60755.

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

Draft	Report on voting
23E/1273/FDIS	23E/1299/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 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/standardsdev/publications.

A list of all parts in the IEC 60755 series, published under the general title *General safety requirements for residual current operated protected devices*, can be found on the IEC website.

This International Standard is to be used in conjunction with IEC 60755:2017.

The following differing practices of a less permanent nature exist in the countries indicated below:

- IEC 60755:2017, IEC 60755:2017, 5.3.1.12: 1 000 A, 2 000 A, 2 500 A, 7 500 A and 9 000 A are also considered preferred values (Korea and Japan);
- IEC 60755:2017, IEC 60755:2017, 8.1.1: multiple settings are not allowed (Australia, Germany, Denmark, the UK and Switzerland);
- IEC 60755:2017, IEC 60755:2017, 8.1.2: the colours red and green are not used for contact position indication (US).

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,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Residual current devices are used for protection against electric shocks.

In IEC 60364 (all parts), residual current devices are used for automatic disconnection of supply in case of fault (see Clause 411 of IEC 60364-4-41:2005+AMD1:2017) and residual current devices with rated residual operating current not exceeding 30 mA are used as additional protection (see Clause 415 of IEC 60364-4-41:2005+AMD1:2017). The IEC has developed a set of standards for residual current operated protective devices intended to be used in AC systems.

DC systems are used for applications such as photovoltaic installations, data and telecom centres and electric vehicle charging systems. In addition, standards for plugs and socket-outlets for ICT equipment installed in data centres and telecom centres have been published.

Residual current devices for DC systems are used to provide fault protection and/or additional protection (according to IEC 60364-4-41:2005 and IEC 60364-4-41:2005/AMD1:2017).

This document defines the operating characteristics for residual current operated protective devices for DC systems. Details of how they should be installed to provide the desired level of protection are specified in the various parts of the IEC 60364 series. The operating characteristics given in this document are based on the information contained in IEC 60479 (all parts).

This document has been prepared as a Group Safety Publication by subcommittee 23E in accordance with its Group Safety Function for residual current devices. It is intended for use by technical committees in the preparation of standards for residual current unit, function or devices when it is intended to provide protective measures according to IEC 60364 (all parts). It is not intended for use as a stand-alone document, for example, for certification.

This document is intended for use in conjunction with IEC 60755. Where a particular subclause of IEC 60755 is not mentioned in this Part 1, that subclause applies as far as is reasonable. Where this Part 1 states "addition", "deletion" or "replacement", the corresponding requirement, test specification or explanatory material in IEC 60755 should be adapted accordingly.

GENERAL SAFETY REQUIREMENTS FOR RESIDUAL CURRENT OPERATED PROTECTED DEVICES –

Part 1: Residual current operated protective devices for DC systems

Replacement of Clause 1 of IEC 60755:2017 by:

1 Scope

This document gives requirements, recommendations and information for the drafting of standards for residual current operated protective devices, intended to be used in DC systems, hereafter referred to as DC-RCDs.

NOTE 1 When referring to IEC 60755, "RCD" shall be understood as "DC-RCD".

This document is primarily intended to be used as a reference for drafting product safety standards for:

- DC-RCD intended for general use;
- DC-RCD specifically intended to be incorporated in a specific item of equipment;
- DC-RCD embedded in an equipment.

This document is applicable for standards covering devices:

- which detect a residual current,
- compare it to a reference value, and
- open the contacts when the residual current exceeds this reference value.

Any association of devices, each one of them performing separately one or two of the above-mentioned functions but acting together in order to accomplish all three functions, is also covered by this document.

DC-RCDs are intended to provide fault protection, the exposed conductive parts of the installation being connected to a protective conductor, in accordance with IEC 60364-4-41:2005 and IEC 60364-4-41:2005/AMD1/2017.

DC-RCDs having a rated residual operating direct current not exceeding 80 mA and having a rated voltage not exceeding 220 V DC for single-pole or 440 V DC for two-pole are also used as a provision for additional protection, according to IEC 60364-4-41.

NOTE 2 Further requirements for higher voltages are under consideration.

NOTE 3 The value of 80 mA was the result of a calculation based on the content of clause 6 of IEC 60479-1:2018 and 5.3.4 of IEC 60479-2:2019.

NOTE 4 In Austria the value of 80 mA is considered as provisional until a broader and more solid set of data than the actual basis of the IEC 60479 series is available for DC.

In accordance with IEC 60364-4-42, residual current devices with a rated residual operating current not exceeding 300 mA can also be used to provide protection against fire hazards due to insulation faults.

DC-RCDs are suitable for isolation. They are suitable for use in TN, TT, and, under specific conditions, IT systems.

DC-RCDs are resistant to unwanted tripping including the case where surge voltages (as a result of switching transients or induced by lightning) cause loading currents in the installation without occurrence of flashover.

This group safety publication is primarily intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51. It is not intended for use by manufacturers or certification bodies.

One of the responsibilities of a technical committee is, wherever applicable, to make use of group safety publications in the preparation of its publications. The requirements, test methods or test conditions of this group safety publication will not apply unless specifically referred to or included in the relevant publications.

2 Normative references

Clause 2 of IEC 60755:2017 is applicable except as follows:

Addition:

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

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

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

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

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

IEC 61000-4-16, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz*

IEC 61000-4-17, *Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on d.c. input power port immunity test*

IEC 61000-4-29, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*

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

3 Terms and definitions

Clause 3 of IEC 60755:2017 is applicable except as follows:

Addition:

3.101

residual operating direct current

value of residual direct current which causes the DC residual current device to operate under specified conditions

[SOURCE: IEC 60050-442:2019, 442-05-72]

3.102

residual non-operating direct current

value of residual direct current at and below which the DC residual current device does not operate under specified conditions

[SOURCE: IEC 60050-442:2019, 442-05-73]

3.103

residual direct current making and breaking capacity

value of a residual prospective direct current which a DC residual current device can make, carry for its opening time and break under specified conditions of use and behaviour

[SOURCE: IEC 60050-442:2019, 442-05-74, modified]

3.104

conditional direct short-circuit current

value of a prospective direct current, which a DC residual current device without integral short-circuit protection, but protected by a short-circuit protective device in series, can withstand under specified conditions of use and behaviour

[SOURCE: IEC 60050-442:2019, 442-05-75]

3.105

conditional residual direct short-circuit current

value of a residual direct prospective current, which a DC residual current device without integral short-circuit protection, but protected by a short-circuit protective device in series, can withstand under specified conditions of use and behaviour

[SOURCE: IEC 60050-442:2019, 442-05-76, modified]

3.106

mid-point

common point between two symmetrical circuit elements the opposite ends of which are electrically connected to different line conductors of the same circuit

[SOURCE: IEC 60050-195:1998, 195-02-04]

3.107

M-pole

part of a DC-RCD associated exclusively with one electrically separated conducting path intended to connect and to disconnect the mid-point

3.108

time constant

rise time $T = L/R$ (ms) of a prospective direct current to reach a value of 0,632 times the maximum peak current

3.109**rated direct making and breaking capacity** I_m

value of a prospective direct current, which a DC residual current device is capable of making and breaking at a stated voltage under specified conditions of use and behaviour

4 Classification

Clause 4 of IEC 60755:2017 is applicable except as follows:

Deletion of Subclause 4.4.

4.10 According to the number of poles and current paths

Subclause 4.10 of IEC 60755:2017 is applicable except as follows:

Replacement of notes to 4.10.1 and 4.10.3:

NOTE In this case, the M-path does not contain any switching contact.

Deletion of 4.10.5 and 4.10.6.

4.15 According to the intended use

Deletion in note 1:

e.g. IEC 61008-1

Addition:

4.101 According to the current direction through the poles**4.101.1 Polarised DC-RCD****4.101.2 Non-polarised DC-RCD****5 Characteristics of residual current devices****5.1 Summary of characteristics**

Subclause 5.1 of IEC 60755:2017 is applicable except as follows:

Deletion of the third dash.

Replacement of the fourth, fifth, sixth and seventh dashes:

- rated direct making and breaking capacity I_m (see 5.2.4);
- rated residual operating direct current $I_{\Delta n}$ (see 5.2.5);
- rated residual non-operating direct current $I_{\Delta no}$ (see 5.2.6);
- rated residual direct making and breaking capacity $I_{\Delta m}$ (see 5.2.7);

Replacement of the ninth, tenth and eleventh dashes:

- operating characteristics (see 5.2.10)
- rated conditional short-circuit direct current I_{nc} (see 5.2.8);

- rated conditional residual short-circuit direct current $I_{\Delta c}$ (see 5.2.9);

Wherever in IEC 60755, it is referred to

- rated making and breaking capacity I_m
- rated residual operating current $I_{\Delta n}$
- rated residual non-operating current $I_{\Delta no}$
- rated residual making and breaking capacity $I_{\Delta m}$
- rated conditional short-circuit current I_{nc}
- rated conditional residual short-circuit current $I_{\Delta c}$

It should be read as:

- rated direct making and breaking capacity I_m ;
- rated residual operating direct current $I_{\Delta n}$;
- rated residual non-operating direct current $I_{\Delta no}$;
- rated residual direct making and breaking capacity $I_{\Delta m}$;
- rated conditional short-circuit direct current I_{nc} ;
- rated conditional residual short-circuit direct current $I_{\Delta c}$;

5.2 Rated quantities and other characteristics

Subclause 5.2 of IEC 60755:2017 is applicable except as follows:

Deletion of 5.2.3.

Replacement in 5.2.4, 5.2.7, 5.2.8 and 5.2.9:

"RMS value of the AC component" by "value of the prospective direct current"

Replacement of 5.2.10:

5.2.10 Operating characteristics

DC-RCD ensures tripping for residual smooth direct currents, whether suddenly applied or slowly rising, independent of polarity.

Addition:

5.2.101 Time-delay DC-RCD

Time-delay DC-RCD which complies with the relevant part of Table 108 if applicable.

5.3 Standard and preferred values

Clause 5.3 of IEC 60755:2017 is applicable except as follows:

Addition:

All rated values shall be read as DC values.

Replacement of 5.3.1 by:

5.3.1 Values of rated operational voltage (U_e)

The values of rated operational voltage shall be defined in the relevant product standard. Examples are given in Table 100.

Replacement of 5.3.3 by:

5.3.3 Standard values of rated residual operating direct current ($I_{\Delta n}$)

Standard values of rated residual operating direct current are:

0,02 A – 0,08 A – 0,3 A – 0,6 A – 1 A – 2 A – 3 A – 5 A – 10 A – 20 A – 30 A

NOTE 1 The value of 80 mA was the result of a calculation based on the content of 5.3.4 of IEC TS 60479-2:2017.

NOTE 2 In Austria the value of 80 mA is considered as provisional until a broader and more solid set of data than the actual basis of the IEC 60479 series is available for DC.

5.3.4 Standard value of residual non-operating current ($I_{\Delta no}$)

Subclause 5.3.4 of IEC 60755:2017 is applicable except as follows:

Removal of the note.

Removal of 5.3.5.

5.3.7 Standard values of operating time

Replacement of 5.3.7.1:

5.3.7.1 Standard values of maximum break time for non-time delay DC-RCDs

Standard values of maximum break time for non time-delay type DC-RCDs are given in Table 104.

5.3.7.2 Standard values of actuating and non-actuating times for time-delay type residual current devices

Subclause 5.3.7.2 of IEC 60755:2017 is applicable except as follows:

Replacement of fourth paragraph:

Time-delay type DC-RCDs are permitted only for $I_{\Delta n}$ higher than 0,08 A.

Replacement of fifth paragraph:

Standard values of actuating and non-actuating times for time-delay type DC-RCDs are given in Table 108.

5.3.9 Standard minimum value of non-operating overcurrent in case of a single phase load through a three- or four-pole or four-current-paths RCD

Replacement of 5.3.9:

5.3.9 Standard minimum value of non-operating overcurrent in case of a single phase load through a three-pole DC-RCD or a DC-RCD with three current paths

The standard minimum value of non-operating overcurrent in case of a single-phase load through a three-pole DC-RCD or a DC-RCD with three-current-paths shall be defined in the relevant product standard.

NOTE For DC-RCDs with integral overcurrent protection, this minimum value can be lower, depending on the characteristics of the overcurrent protection.

5.3.10 Minimum value of the rated making and breaking capacity (I_m)

Subclause 5.3.10 of IEC 60755:2017 is applicable except as follows:

Deletion of third paragraph.

5.3.11 Minimum value of the rated residual making and breaking capacity ($I_{\Delta m}$)

Subclause 5.3.11 of IEC 60755:2017 is applicable except as follows:

Deletion of third paragraph.

6 Marking and other product information

6.1 Information and marking for DC-RCDs according to 4.15.1

Subclause 6.1 of IEC 60755:2017 is applicable except as follows:

Replacement of first paragraph:

The information given in column 2 of Table 102 shall be provided. The position of marking shall be specified in the relevant product standard (e.g. visible after installation, on the product, in the leaflet or manufacturer's catalogue).

Deletion of last paragraph.

6.2 Information and marking for RCDs according to 4.15.2 and 4.15.3

Subclause 6.2 of IEC 60755:2017 is applicable except as follows:

Replacement of Table 3 by Table 103.

7 Conditions for operation in service and for installation

7.1 Preferred ranges of application, reference values of influencing quantities/factors and the associated test tolerances

Subclause 7.1 of IEC 60755:2017 is applicable except as follows:

Replacement of Table 1 by Table 101.

8 Requirements for construction and operation

8.1.2 Mechanism

Subclause 8.1.2 of IEC 60755:2017 is applicable except as follows:

Replacement of first paragraph:

The moving contacts of all poles of multipole DC-RCDs shall be coupled so that all poles, except the mid-point M-pole, if any, make and break substantially together, whether operated manually or automatically.

Replacement of second paragraph:

The mid-point M-pole of three-pole DC-RCDs shall not close after and shall not open before the other poles.

Replacement of second dash of ninth paragraph:

– a separate indicator.

If a separate indicator is used to indicate the position of the main contacts, this shall show the colour red for the closed position and the colour green for the open position.

8.1.3 Clearance and creepage distances

Subclause 8.1.3 IEC 60755:2017 is applicable except as follows:

Replacement of second paragraph:

The clearances and creepage distances for insulation and for isolation shall be in accordance with IEC 60664-1.

8.5 Operating characteristics**8.5.2 Operation in response to the type of residual current***Replacement of 8.5.2:*

The tripping characteristic of DC-RCDs shall ensure adequate protection against residual current without premature operation.

DC-RCDs shall operate in response to a steady increase of smooth direct residual current within specified limits of the non-operating current and the operating current in accordance with Table 113.

8.5.3 Operation in presence of a residual current equal to and greater than $I_{\Delta n}$ **8.5.3.1 DC-RCDs without time-delay**

Subclause 8.5.3.1 of IEC 60755:2017 is applicable except as follows:

Replacement of second paragraph:

The operation of DC-RCDs to a suddenly applied residual current shall be in accordance with Table 104 and whatever the polarity, if any.

8.5.3.2 DC-RCDs with time-delay

Subclause 8.5.3.2 of IEC 60755:2017 is applicable except as follows:

Replacement of paragraph:

The operation and non-operation of DC-RCDs to a suddenly applied residual current shall be in accordance with Table 108 and whatever the polarity, if any.

8.5.4 Additional requirements for RCDs according to 4.15.2 and 4.15.3

Replacement of 8.5.4:

8.5.4 Additional requirements for DC-RCDs according to 4.15.2 and 4.15.3

The operating characteristics of the DC residual current device incorporated or embedded in an equipment shall not be impaired by the equipment according to the relevant product standard of the equipment (where the DC residual current device is incorporated or embedded).

The relevant product standard shall contain a compliance clause by inspection and/or tests according to these requirements.

8.10 Resistance to abnormal heat and to fire

Replacement at the end of first paragraph: "of this document" by "of the relevant product standard".

8.11 Test device

Subclause 8.11 of IEC 60755:2017 is applicable except as follows:

Deletion of "(e.g. SRCD, PRCD)" from sixth paragraph.

8.12 Requirements for DC-RCDs in case of loss of supply

Subclause 8.12 of IEC 60755:2017 is applicable except as follows:

Replacement of first paragraph:

The minimum operational voltage of DC-RCDs shall not exceed 90 V.

DC-RCDs classified according to 4.10.3 or 4.10.4 shall operate also in case of loss of one supply conductor, line or mid-point M.

8.17 Electromagnetic compatibility (EMC)

Subclause 8.17 of IEC 60755:2017 is applicable, additionally:

Addition after first paragraph:

The operating characteristics shall not be affected by high frequency ripple. This requirement is verified with tests 9.9.101 for ripple immunity.

8.18 Resistance to temporary overvoltages (TOV)

Subclause 8.18 of IEC 60755:2017 is applicable except as follows:

Replacement of first paragraph:

DC-RCDs shall adequately withstand temporary overvoltages due to various phenomena.

Replacement of second paragraph:

Withstand values of overvoltage and duration are given in Table 130, $U_{(L \text{ to } M)}$ being the nominal value between L+ or L- to mid-point M.

9 Tests

9.1 General

9.1.1 General test conditions

Subclause 9.1.1 of IEC 60755:2017 is applicable except as follows:

Replacement of Table 1 by Table 101.

Addition at the end of 9.1.1:

For DC-RCDs classified according to 4.101.2, and for switching tests only, two samples shall be tested with supply connected in one direction and one sample with connections in the opposite direction in respect of current flow.

Unless otherwise specified, DC test voltages and currents shall have a ripple of $\omega \leq 5\%$ or have the minimum instantaneous value no lower than the required test value -5% and shall have no maximum instantaneous value higher than $+10\%$ of the required test value.

9.2 Operating characteristics

9.2.1 General requirements for operating characteristics tests

Subclause 9.2.1 of IEC 60755:2017 is applicable except as follows:

Replacement of third paragraph:

The test procedure for the DC-RCD shall include tests based on the requirements of 9.2.101 as applicable. Each test shall be made with smooth DC residual current on one pole only, taken at random, with at least two measurements; the polarity of the smooth DC current is changed after each measurement.

Removal of fifth and sixth paragraphs.

Addition:

All tests are performed at $1,1 U_n$ and at the minimum operating voltage (90V), with no load, unless otherwise specified.

Subclauses 9.2.2 to 9.2.5 are not applicable.

Addition:

9.2.101 Test of DC-RCDs

9.2.101.1 General

The test procedure for DC-RCDs shall contain at least tests according to the requirements of 9.2.101.2 to 9.2.101.8, as applicable.

9.2.101.2 Steady increase of residual current

Correct operation of the DC-RCD shall be tested where the DC-RCD being in the closed position, a 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, and the tripping current shall be measured. The measured values shall be situated between $I_{\Delta no}$ and $I_{\Delta n}$.

9.2.101.3 Closing on a residual current

Correct operation of the DC-RCD shall be tested with the circuit being calibrated at the rated value of the operating residual current, the DC-RCD being in open position, and the DC-RCD is suddenly closed on the circuit. The measurements of the break time shall not exceed the value of Table 104 or Table 108, according to the type of DC-RCD.

9.2.101.4 Sudden appearance of residual current

Correct operation of the DC-RCD shall be tested with the circuit being calibrated at each value of residual current of Table 104 or Table 108 as applicable, the DC-RCD being in closed position, and the residual current is suddenly established. The measurements of the break time shall not exceed the value of Table 104 or Table 108, according to the type of DC-RCD.

9.2.101.5 Residual current higher than $3 I_{\Delta n}$

Correct operation of the DC-RCD, according to 9.2.101.4, shall be tested for values of residual current higher than $3 I_{\Delta n}$ and lower than the rated residual direct making and breaking capacity ($I_{\Delta m}$). The values of residual current for these tests shall be specified in the relevant DC-RCD standard.

9.2.101.6 Tests with load

Correct operation of the DC-RCD shall be tested, according to 9.2.101.3 and 9.2.101.4, the DC-RCD being loaded with the rated current.

9.2.101.7 Tests at the temperature limits

Correct operation of the DC-RCD, according to 9.2.101.4, shall be tested at the minimum ambient temperature, with no load, and then at the maximum ambient temperature, the DC-RCD being loaded at the rated current.

9.2.101.8 Additional test for delay type DC-RCDs

Correct operation of delay type DC-RCDs shall be tested according to Table 108: the DC-RCD being in the closed position, the residual current is suddenly established for periods corresponding to the relevant minimum non-actuating times. The DC-RCD shall not trip during these tests.

9.2.101.9 Additional test for DC-RCDs classified according 4.10.3 or 4.10.4

The tests shall be performed according to 9.2.101.3 and 9.2.101.4, with the DC-RCD

- first being supplied between the mid-point terminal and L+ terminal only,
- second being supplied between the mid-point terminal and L- terminal only and
- third being supplied between the L+ terminal and L- terminal only.

9.3 Tests of electrical endurance

Subclause 9.3 of IEC 60755:2017 is applicable except as follows:

Replacement of second dash in first paragraph:

- time constant of 2 ms

Addition of third dash

- Test procedure in respect of number of poles and polarity

9.4 Tests of behaviour of the DC-RCD under short-circuit conditions

9.4.1 General

Subclause 9.4.1 of IEC 60755:2017 is applicable except as follows:

Replacement of second paragraph:

The test procedure for the DC-RCD shall include tests based on requirements of 9.4.2a), 9.4.2b), 9.4.2c), 9.4.2d), 9.4.2e), 9.4.2f), 9.4.2g), as applicable. After the tests, the DC-RCD shall be tested according to the test procedure of 9.4.3.

Replacement of third paragraph:

For residual current devices with integral overcurrent protection, tests 9.4.2a), 9.4.2c), 9.4.2d), 9.4.2e), 9.4.2f), 9.4.2g) need not be introduced in the test procedure. These tests and the consequent verification are to be replaced by specific short-circuit tests based on the applicable standard for circuit-breakers IEC 60947-2, IEC 60898-2 or IEC 60898-3

Replacement of fourth paragraph:

The test procedure of the product standard shall specify the following items, as applicable:

- test circuit;
- the coordination tests 9.4.2c), 9.4.2d) and 9.4.2e) shall be performed with an SCPD as declared by the manufacturer;
- time constant of 5 ms;

NOTE For short-circuit current above 10 kA, Technical Committees can select higher values of time constant

- power recovery voltage;
- tolerances on test quantities: current, time constant, voltage.

9.4.2 Short-circuit tests

Subclause 9.4.2 of IEC 60755:2017 is applicable except as follows:

Addition after second paragraph in point c):

During the test either both the DC residual current device and the SCPD or the SCPD only may operate. However, if only the DC residual current device opens, the test is also considered as satisfactory.

Addition after second paragraph in point d):

During the test either both the DC residual current device and the SCPD or the SCPD only may operate. However, if only the DC residual current device opens, the test is also considered as satisfactory.

Replacement of first paragraph in point e):

This test is intended to check that in the case of line L+ or L- to earth short-circuits with currents up to the value of the rated conditional residual short-circuit current $I_{\Delta c}$, the DC-RCD is able to withstand the corresponding stresses.

Addition after second paragraph in point e):

During the test either both the DC residual current device and the SCPD or the SCPD only may operate. However, if only the DC residual current device opens, the test is also considered as satisfactory.

Replacement of first dash in point f):

- at a voltage 105 % of the rated L+ to Mid point voltage;

Addition:

a) Verification of small DC currents

The DC-RCD condition and method of installation shall be as specified in 9.4.1. The tests shall be made at the maximum operational voltage assigned by the manufacturer to the DC-RCD. The test circuit shall have a time constant of 2 ms.

The DC-RCD is closed three times for each of the test currents listed below. During the test, the operating means are operated as in normal use. If the DC-RCD does not open, it will be opened manually.

Test currents: 1 A, 2 A, 4 A, 8 A, 16 A, 32 A, 63 A, 150 A.

The time interval between the individual operating cycles CO shall be at least 10 s, and the closing time shall not exceed 2 s. The time interval between the tests for different currents shall be at least 2 min.

During the test, the time required for the arc to be extinguished shall not exceed 1 s.

Furthermore, the test according to 9.4.2 g) is performed on each pole of a two-pole or three-pole DC-RCD at a test voltage of 105 % of the rated L+ to M-point voltage.

9.4.3 Behaviour of the DC-RCD during and after the tests

Subclause 9.4.3 of IEC 60755:2017 is applicable except as follows:

Replacement of second paragraph:

After each of the tests applicable, carried out in accordance with 9.4.2a), 9.4.2b), 9.4.2c), 9.4.2d), 9.4.2e), 9.4.2f), 9.4.2g), the DC-RCD shall show no damage impairing its further use and shall be capable, without maintenance, of withstanding the following tests:

Replacement of third paragraph:

Under the test conditions of 9.2.101.4, the RCD shall trip with a test current of $1,25 I_{\Delta n}$. One test only is made on one pole taken at random, without measurement of break time.

9.7 Test of behaviour of DC-RCDs in case of current surges caused by impulse voltages

9.7.1 Current surge test for all DC-RCDs (0,5 µs/100 kHz ring wave test)

Replacement of 9.7.1:

Tests of ring wave are under consideration.

9.7.2 Verification of behaviour at surge currents (8/20 µs surge current test)

Replacement of 9.7.2:

Tests of 8/20 surges are under consideration.

Addition after 9.7.2:

9.7.101 Inrush currents

Test of inrush current is under consideration.

9.8 Tests of reliability

9.8.1 Climatic test

Subclause 9.8.1 of IEC 60755:2017 is applicable except as follows:

Replacement of fourth paragraph:

The upper temperature shall be $55\text{ °C} \pm 2\text{ °C}$ (variant 1 according to IEC 60068-2-30:2005) and the number of cycles shall be 28.

During the test, the DC-RCD shall be supplied with rated voltage.

Replacement of last paragraph:

Under the test conditions of 9.2.101.4, the RCD shall trip with a test current of $1,25 I_{\Delta n}$. One test only is made on one pole taken at random, without measurement of break time.

9.8.2 Test with temperature of 40 °C

Subclause 9.8.2 of IEC 60755:2017 is applicable except as follows:

Replacement of fourth paragraph:

The DC-RCD is loaded with a current equal to the rated current at any convenient voltage and is subjected, at a temperature of $40\text{ °C} \pm 2\text{ °C}$, to 28 cycles, each cycle comprising 21 h with current passing and 3 h without current. The current is interrupted by an auxiliary switch, the DC-RCD not being operated.

Deletion of fifth paragraph.

Replacement of last paragraph:

Under the test conditions of 9.2.101.4, the DC-RCD shall trip with a test current of $1,25 I_{\Delta n}$. One test only is made on one pole taken at random, without measurement of break time.

9.8.3 Verification of ageing of electronic components

Subclause 9.8.3 of IEC 60755:2017 is applicable except as follows:

Replacement of third paragraph:

For this test, it is allowed to provide the main current path with rated current at any convenient voltage, and to separately supply the electronics at 1,1 times the rated voltage, with samples prepared for this test.

Replacement of last paragraph:

Under the test conditions of 9.2.101.4, the RCD shall trip with a test current of $1,25 I_{\Delta n}$. One test only is made on one pole taken at random, without measurement of break time. An example of the test circuit for this verification is given in Figure 118.

9.9 Tests of electromagnetic compatibility (EMC)

9.9.2 Specific requirements for RCDs for household and similar uses

Replacement of 9.9.2:

9.9.101 Specific requirements for DC-RCDs for household and similar uses

9.9.101.1 General

For DC-RCDs for household and similar uses, technical committees shall introduce EMC tests covering electromagnetic emissions and electromagnetic immunity in compliance with 9.9.101.2 and 9.9.101.3 that contain the minimum test levels and generic performance criteria. Technical committees may select more severe test conditions according to the particular environment of their products

9.9.101.2 Electromagnetic emissions of DC-RCDs

DC-RCDs shall be submitted to emission tests. The requirements of CISPR 14-1:2020 apply.

9.9.101.3 Electromagnetic immunity of DC-RCDs

9.9.101.3.1 General

DC-RCDs shall be submitted to immunity tests, according to tests levels and performance criteria as defined in Table 145. Unless otherwise stated, the tests are made without load.

9.9.101.3.2 Voltage dips and voltage interruptions (T 1)

These tests are performed according to IEC 61000-4-29, the test levels and criteria are given in Table 146.

9.9.101.3.3 Conducted disturbances, induced by radio-frequency fields (T 3)

These tests are performed at 3 V according to IEC 61000-4-6 and according to the test conditions of 5.3.3 of IEC 61543:2022

9.9.101.3.4 Fast transient/burst (T 4)

These tests are performed at level 3 (2 kV peak) according to IEC 61000-4-4 and according to the test conditions for RCCBs and RCBOs of 5.3.4 of IEC 61543:2022

9.9.101.3.5 Surges (T 5a and T 5b)

These tests are performed according to IEC 61000-4-5 and according to the test conditions for RCCBs and RCBOs of subclause 5.3.5 of IEC 61543:2022, with the following test levels:

Test T 5a:

- Common mode 4 kV
- Differential mode 2 kV

Test T 5b:

- Common mode 2kV, 1kV, 0,5kV
- Differential mode 1kV, 0,5kV

9.9.101.3.6 Radiated, radio-frequency, electromagnetic field (T 6)

These tests are performed at 3 V/m according to IEC 61000-4-3 and according to the test conditions of 5.3.6 of IEC 61543:2022.

9.9.101.3.7 Conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz (T 7)

These tests are performed at level 3 according to IEC 61000-4-16.

9.9.101.3.8 Electrostatic discharges (T 8)

These tests are performed at level 3 according to IEC 61000-4-2 and according to the test conditions of 5.3.8 of IEC 61543:2022.

9.9.101.3.9 Ripple immunity (T 9)

These tests are performed at level 3 according to IEC 61000-4-17.

9.9.101.3.10 Performance criteria for DC-RCDs

For safety reasons, some tests levels and test specifications have been chosen at levels higher than those required by the generic standard. The following performance criteria A, B and C apply.

A: During the test making reference to this performance criterion, the DC-RCD shall remain closed at a continuously applied residual current of $0,3 I_{\Delta n}$, and shall trip at $1,25 I_{\Delta n}$.

B: During the test making reference to this performance criterion, the DC-RCD shall not trip. After the test, compliance with 9.2.101.4 at $I_{\Delta n}$ only shall be checked in order to verify that the device operates as intended.

C: During the test making reference to these performance criteria, the DC-RCD may trip. After the test, with the sample in the closed position, compliance with 9.2.101.4 at $I_{\Delta n}$ only shall be checked.

Table 100 – Example for values of rated operational voltage (U_e)

DC-RCD	Supply system	DC voltage	
		Rated operational voltage	Examples of DC supply systems
Single-pole with two-current path	2 wires (L+ or L- to M)	200 V	Figure 200 a)
Two poles	2 wires or 3 wires (L+ to L-)	200 V	Figure 200 b)
		400 V	Figure 200 c)
Two-pole with three-current path	3 wires (L+ to L-)	400 V	Figure 200 d)
Three-pole	3 wires (L+ to L-)	400 V	Figure 200 e)

NOTE The two-wire arrangement refers to Figure 6 of IEC 60364-1:2005, the three-wire arrangement refers to Figure 7 of IEC 60364-1:2005.

Replacement of Table 1:

Table 101 – Values of influencing quantities

Influencing quantity	Preferred range of application	Reference value	Test tolerances ^f
Ambient air temperature ^g	- 5 °C to + 40 °C ^{a b} - 25 °C to + 40 °C ^{a b}	As stated by the relevant product standard	As permitted by the test requirements in the relevant product standard
Altitude	Not exceeding 2 000 m		
Relative humidity maximum value at 40 °C	50 % ^c		
External magnetic field	Not exceeding 5 times the earth's magnetic field in any direction	Earth's magnetic field	^d
Mounting orientation	As stated by the manufacturer, with a tolerance of 5 ° in any direction ^e	As stated by the manufacturer	2° in any direction
DC supply voltage	see 9.2.1 (where the ripple is defined)	Rated value	

^a The maximum value of the mean daily temperature is + 35 °C.

^b Values outside the range are admissible where more severe climatic conditions prevail, subject to agreement between manufacturer and user.

^c Higher relative humidities are admitted at lower temperatures (for example 90 % at 20 °C).

^d When a DC-RCD is installed in proximity to a strong magnetic field, supplementary requirements may be necessary.

^e The device shall be fixed in such a way that it does not cause deformation liable to impair its functions.

^f The tolerance given applies unless otherwise specified in the relevant test.

^g Extreme limits of -20 °C and +60 °C are admissible during storage and transportation, and should be taken into account in the design of the device.

Replacement of Table 2:

Table 102 – Marking for DC-RCDs according to 4.15.1

	Marking or Information item
A	The manufacturer's name or trade mark
B	Type designation, catalogue number or serial number
C	Rated voltage(s) followed by "DC", for example 400 V DC
D	Rated current followed by "DC", for example 40 A DC
E	Void
F	Rated residual operating direct current followed by "DC"
G	Settings of residual operating direct current for DC-RCDs with multiple residual operating currents
H	Rated making and breaking capacity or rated short-circuit capacity (in amperes) for DC-RCDs with overcurrent protection
I	Reference calibration temperature, if different from 30 °C, for DC-RCDs with overcurrent protection
J	Rated residual direct making and breaking capacity
K	The degree of protection (only if different from IP 20)
L	The position of use, if necessary
M	The symbol S (S in a square) for type S devices
N	Void
O	Operating means of the test device, by the letter "T"
P	Wiring diagram, see Figure 200 a) to e)
Q	Void
R	Void
S	Reference of the product standard, for example IEC 6xxxx
T	Void
U	Void
V	Rated time delay, if applicable
W	Rated conditional short-circuit direct current, if applicable, and in such a case characteristic for the associated short-circuit protective device, according to 5.4.1
X	Range of operating temperature
Y	Symbols I/O to distinguish between the open and closed states of the device
Z	Mark supply and load terminals (e.g. by "line" and "load") if it is necessary to distinguish between the supply and the load terminals
AA	Symbol M if terminals are specifically intended for the connection of the midpoint conductor
AB	Marking of polarity for devices according to classification 4.101.1

Replacement of Table 3:

Table 103 – Marking for DC-RCDs according to 4.15.2 and 4.15.3

	Marking or Information item
E	Void
G	Settings of residual operating current for DC-RCDs with multiple residual operating currents
J	Rated residual making and breaking capacity
M	The symbol S (S in a rectangle) for type S devices
O	Operating means of the test device, by the letter "T"
Q	Void
R	Void
V	Rated time-delay if applicable
W	Rated conditional short-circuit current if applicable, and in such a case characteristic for the associated short-circuit protective device, according to 5.2.8
	Means shall be provided to distinguish between the open and closed states of the device

Replacement of Table 4:

Table 104 – Standard values of maximum break time for non-time-delay DC-RCDs

Type	I_n (A)	$I_{\Delta n}$ (A)	Standard values of break time at a residual operating direct current equal to (s)			
			$I_{\Delta n}$	$2 I_{\Delta n}$	$3 I_{\Delta n}$	1, 2, 5, 10, 20, 50, 100 A
General	Any value	Any value	0,3 ^a	0,15 ^a	0,04 ^a	0,4 ^b
NOTE The maximum break time of this table is for $U_0 \leq 230$ V. In case of fault protection and higher voltages use the maximum disconnection times according to IEC 60364-4-41 Table 41.1						
^a For residual currents of 1 A and above, due to the arc extinction, the maximum break time shall not exceed 0,4 s.						
^b Due to the arc extinction, the overall disconnection time shall not exceed 0,4 s.						

NOTE In Austria the maximum break times provided in Table 104 and Table 108 are considered as provisional until a broader and more solid set of data than the actual basis of the IEC 60479 series is available for DC.

Deletion of Table 5, Table 6 and Table 7.

Replacement of Table 8:

Table 108 – Standard values of break time and non-actuating time for time-delay DC-RCDs

Rated time delay (s)		Standard values of break and non-actuating time at (s)			
		$I_{\Delta n}$	$2 I_{\Delta n}$	$3 I_{\Delta n}$	1, 2, 5, 10, 20, 50, 100 A
0,06	Maximum break time ^c	0,5 ^d	0,2 ^d	0,15 ^d	0,4 ^e
	Minimum non actuating time	b	0,06	b	b
Rated time delay	Maximum break time	b	b	a b	b
	Minimum non actuating time	b	rated delay	b	b
NOTE The standard break times required by this table are applicable for fault voltages up to 230 V to earth. For higher voltages use the maximum disconnection times according to IEC 60364-4-41, Table 41.1.					
^a To ensure fault protection, the maximum break time shall not exceed the values in IEC 60364-4-41. ^b Defined either by the relevant product standard or by the manufacturer. ^c For residual current devices with $I_{\Delta ndc} \leq 0,08$ A, the value for the maximum break time is given in Table 4. ^d For residual currents of 1 A and above, due to the arc extinction, the maximum break time shall not exceed 0,4 s. ^e Due to the arc extinction, the overall disconnection time shall not exceed 0,4 s.					

NOTE In Austria the maximum break times provided in Table 104 and Table 108 are considered as provisional until a broader and more solid set of data than the actual basis of the IEC 60479 series is available for DC.

Deletion of Table 9 and Table 10.

Replacement of Table 13:

Table 113 – Tripping current limits

Number of poles	Current shape	Tripping current	
		Lower limit	Upper limit
All classifications	Smooth DC	$0,5 I_{\Delta n}$	$I_{\Delta n}$

Deletion of Table 14, Table 15, Table 16, Table 17 and Table 18.

Replacement of Table 30:

Table 130 – Withstand values and duration of temporary overvoltages

TOV		
Occurrence	Voltage	Duration
Between mid-point M-pole and all other poles	$2 \times U_{(L \text{ to } M)}$	1 h

Deletion of Table 36.

Replacement of Table 45:

Table 145 – Immunity tests

Test reference	Electromagnetic phenomena	EMC standard	Test specification	Performance criteria
T 1	Voltage dips, short interruptions and voltage variations	IEC 61000-4-29	See 9.9.101.3.2	B or C
T 2	Power frequency magnetic fields	IEC 61000-4-8	See NOTE	
T 3	Conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6	See 9.9.101.3.3	A
T 4	Fast transient/burst	IEC 61000-4-4	See 9.9.101.3.4	B
T 5a	Surges	IEC 61000-4-5	See 9.9.101.3.5	C
T 5b	Surges	IEC 61000-4-5	See 9.9.101.3.5	B
T 6	Radiated, radio-frequency, electromagnetic field	IEC 61000-4-3	See 9.9.101.3.6	A
T 7	Conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz	Values derived from IEC 61000-4-16	See 9.9.101.3.7	A
T.8	Electrostatic discharges	IEC 61000-4-2	See 9.9.101.3.8	B
T.9	Ripple immunity	IEC 61000-4-17	See 9.9.101.3.9	A
NOTE This document contains a short-circuit test with a minimum of 500 A. This creates a magnetic field higher than the value of 3A/m given in IEC 61000-6-1.				

Addition:

Table 146 – Voltage dips and short interruptions levels

Test	Test level (% U_e)	Duration (s)	Criteria
Voltage dips	40 and 70	0,01 0,1	B
Short interruption	0	0,001 0,01	B
		1	C