

This is a preview - click here to buy the full publication



IEC TS 63053

Edition 1.0 2017-06

TECHNICAL SPECIFICATION

**General requirements for residual current operated protective devices
for DC systems**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.120.50

ISBN 978-2-8322-4526-2

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	9
3 Terms and definitions	10
4 Classification.....	11
4.1 According to the type of installation	11
4.2 According to the possibility of adjusting the residual operating current.....	11
4.3 According to time-delay (in presence of a residual current).....	11
4.4 According to the protection against external influences.....	12
4.5 According to the method of mounting.....	12
4.6 According to the method of connection	12
4.7 According to the type of terminals.....	12
4.8 According to the number of poles and current paths.....	12
4.9 According to the instantaneous tripping current.....	13
4.10 According to the I^2t characteristics.....	13
4.11 According to overcurrent protection.....	13
4.12 According to the method of construction	13
4.13 According to the range of ambient air temperature	13
4.14 According to the time constant.....	13
4.15 According to the current direction through the poles.....	13
5 Characteristics of residual current devices.....	14
5.1 Summary of characteristics.....	14
5.2 Rated quantities and other characteristics.....	14
5.2.1 Rated voltages	14
5.2.2 Rated direct current (I_n)	14
5.2.3 Rated making and breaking capacity (I_m).....	14
5.2.4 Rated residual operating direct current ($I_{\Delta n}$)	15
5.2.5 Rated residual non-operating direct current ($I_{\Delta no}$).....	15
5.2.6 Rated residual direct making and breaking capacity ($I_{\Delta m}$).....	15
5.2.7 Rated conditional direct short-circuit current (I_{nc}).....	15
5.2.8 Rated conditional residual direct short-circuit current ($I_{\Delta c}$).....	15
5.2.9 Time-delay DC-RCD	15
5.2.10 Operating characteristics	15
5.3 Standard and preferred values.....	15
5.3.1 Preferred values of rated operational voltage (U_e).....	15
5.3.2 Preferred values of rated current (I_n).....	16
5.3.3 Standard values of rated residual operating direct current ($I_{\Delta n}$).....	16
5.3.4 Standard value of residual non-operating direct current ($I_{\Delta no}$).....	16
5.3.5 Standard values of rated impulse withstand voltage (U_{imp}).....	16
5.3.6 Standard values of operating time	17
5.3.7 Minimum value of the rated making and breaking capacity (I_m).....	18
5.3.8 Minimum value of the rated residual direct making and breaking capacity ($I_{\Delta m}$).....	18
5.4 Coordination with short-circuit protective devices (SCPDs).....	18
5.4.1 General	18
5.4.2 Preferred values of the rated conditional direct short-circuit current (I_{nc}).....	18

5.4.3	Preferred values of the rated conditional residual direct short-circuit current ($I_{\Delta C}$)	18
6	Marking and other product information.....	19
7	Conditions for operation in service and for installation	20
7.1	Preferred ranges of application, reference values of influencing quantities/factors and associated test tolerances	20
7.2	Conditions of installation	21
7.3	Pollution degree.....	21
8	Requirements for construction and operation.....	21
8.1	Mechanical design	21
8.1.1	General	21
8.1.2	Mechanism	22
8.1.3	Clearance and creepage distances	23
8.1.4	Screws, current-carrying parts and connections.....	23
8.1.5	Terminals for external conductors	24
8.2	Protection against electric shock.....	24
8.3	Dielectric properties and isolating capability.....	24
8.4	Temperature-rise	24
8.5	Operating characteristics	25
8.5.1	General	25
8.5.2	Operation in response to a residual current equal to and greater than $I_{\Delta n}$	25
8.5.3	Operation in response time in presence of a residual current equal to and greater than $I_{\Delta n}$	25
8.6	Mechanical and electrical endurance	25
8.7	Performance at short-circuit currents	25
8.8	Resistance to mechanical shock and impact	26
8.9	Resistance to heat.....	26
8.10	Resistance to abnormal heat and to fire	26
8.11	Test device	26
8.12	Requirements for DC-RCDs in case of loss of supply.....	26
8.13	Behaviour of DC-RCDs in case of overcurrent in the main circuit	27
8.14	Behaviour of DC-RCDs in the case of current surges caused by impulse voltages.....	27
8.15	Void.....	27
8.16	Reliability.....	27
8.17	Electromagnetic compatibility (EMC).....	27
8.18	Resistance to temporary overvoltages (TOVs)	27
8.19	Performance of DC-RCDs at inrush currents.....	28
9	Preparation of test clauses for DC-RCDs product standard.....	28
9.1	General.....	28
9.1.1	General test conditions	28
9.1.2	Test clauses not specified in this document.....	28
9.2	Operating characteristics	29
9.2.1	General requirements for operating characteristics tests.....	29
9.2.2	Steady increase of residual current.....	29
9.2.3	Closing on a residual current	29
9.2.4	Sudden appearance of residual current	29
9.2.5	Residual current higher than $3 I_{\Delta n}$	29

9.2.6	Tests with load	29
9.2.7	Tests at the temperature limits.....	29
9.2.8	Additional test for delay type RCDs	30
9.3	Tests of electrical endurance	30
9.4	Tests of behaviour of the DC-RCD under short-circuit conditions	30
9.4.1	General	30
9.4.2	Short-circuit tests	30
9.4.3	Behaviour of the DC-RCD during and after the tests	32
9.5	Test of the trip-free mechanism.....	33
9.6	Verification of the operation of the test device.....	33
9.7	Test of behaviour of DC-RCDs in case of current surges caused by impulse voltages	33
9.7.1	Current surge test for all DC-RCDs (0,5 μ s/100 kHz ring wave test).....	33
9.7.2	Verification of behaviour with surge currents (8/20 μ s surge current test)	33
9.8	Tests of reliability.....	34
9.8.1	Climatic test.....	34
9.8.2	Test with temperature of 40 °C	34
9.9	Verification of ageing of electronic components	35
9.10	Tests of electromagnetic compatibility (EMC).....	35
9.10.1	General	35
9.10.2	General requirements	36
9.10.3	Specific requirements on ripple immunity.....	38
9.10.4	Verification of behaviour during inrush currents	38
Annex A (informative)	Recommended diagram for short-circuit tests.....	42
Bibliography	45
Figure 1	– Damped oscillator current wave 0,5 μ s/100 kHz	39
Figure 2	– Examples of installation	40
Figure 3	– Downstream circuit for simulating inrush currents.....	41
Figure 4	– Example of test circuit for verification of ageing of electronic components.....	41
Figure A.1	– Diagram for all the short-circuit tests.....	43
Figure A.2	– Detail of impedance Z or Z_1	44
Table 1	– Preferred values of rated operational voltage (U_e).....	16
Table 2	– Standard values of maximum break time for non-time-delay DC-RCDs	17
Table 3	– Standard values of break time and non-actuating time for time-delay DC-RCDs.....	17
Table 4	– Marking for DC-RCDs.....	19
Table 5	– Values of influencing quantities	21
Table 6	– Tripping current limits.....	25
Table 7	– Withstand values and duration of temporary overvoltages	27
Table 8	– List of electromagnetic phenomena covered by IEC 61543.....	37

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GENERAL REQUIREMENTS FOR RESIDUAL CURRENT OPERATED PROTECTIVE DEVICES FOR DC SYSTEMS

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 63053, which is a technical specification, has been prepared by subcommittee 23E: Circuit-breakers and similar equipment for household use, of IEC technical committee 23: Electrical accessories.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
23E/1006/DTS	23E/1021/RVDTS

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

In this standard, the following print types are used:

– *conformity statements: in italic type*

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

In AC systems, residual current devices are used to provide protection against the risk of 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) and residual current devices with rated residual operating current not exceeding 30 mA are used as additional protection (see 415 of IEC 60364-4-41:2005). IEC SC 23E 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 centres 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 centre have been published. Therefore, a reference document for residual current devices intended to be used in DC supply systems is necessary.

Residual current devices for DC systems may be used to provide fault protection (automatic disconnection of supply according to Clause 411 of IEC 60364-4-41:2005); they may also be used to provide protection against direct contact. They provide protection against electric shock downstream of the device in DC networks.

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) and the requirements in IEC 60364-4-41.

This document is intended for use by technical committees in the preparation of standards for residual current devices. It is not intended to be used as a stand-alone document, for example, for certification.

GENERAL REQUIREMENTS FOR RESIDUAL CURRENT OPERATED PROTECTIVE DEVICES FOR DC SYSTEMS

1 Scope

This document provides general minimum requirements, recommendations and information for the drafting and testing procedures of standards for residual current operated protective devices, intended to be used in DC systems having a rated voltage not exceeding 400 V DC and a rated current not exceeding 125 A, hereafter referred to as DC-RCDs.

NOTE 1 This document can also be used as a guide for DC-RCDs with voltages up to 1 500 V DC.

This document is primarily intended to be used as a reference for drafting product safety standard for DC-RCDs.

This document cannot be used alone but is intended for use by technical committees in the preparation of standards for products similar to those mentioned in the scope of this standard.

This document applies to a device

- which detects a residual current,
- compares it to a reference value, and
- opens the contacts or poles 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.

NOTE 2 RCMs (residual current monitor according to IEC 62020) whose purpose is to monitor an electrical installation and not to provide protection are not covered by this document and cannot be considered similar or equivalent to DC-RCDs.

DC-RCDs are intended to provide fault protection, the exposed conductive parts of the installation being connected to an appropriate earth electrode, in accordance with IEC 60364-4-41.

DC-RCDs having a rated residual operating direct current not exceeding 80 mA are also used as a provision for additional protection in case of failure of the protective means against electric shock.

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 a persistent earth fault current.

DC-RCDs are suitable for isolation. They are suitable for all supply systems, with the exception of single-pole DC-RCDs with two current paths which are not suitable for use in IT systems.

DC-RCDs of the general type 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.

NOTE 3 Installation and application rules of RCDs are given in IEC 60364 (all parts).

NOTE 4 Surge protective devices installed downstream of DC-RCDs and connected in common mode can cause unwanted tripping.

The requirements of this document apply for normal environmental conditions (see 7.1). Additional requirements can apply for RCDs type DC used in locations having severe environmental conditions.

NOTE 5 For DC-RCDs having a degree of protection higher than IP 20 special constructions can be applicable.

DC-RCDs which include batteries are not covered by this document.

Specific additional requirements for RCDs incorporated or embedded in equipment are covered in IEC TR 60755. Those specific additional requirements are also applicable for DC-RCDs.

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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2, *High-voltage test techniques – Part 2: Measuring systems*

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

IEC 60068-3-4, *Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60417, *Graphical symbols for use on equipment* (available at <http://www.graphical-symbols.info/equipment>)

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

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 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61543:1995, *Residual current-operated protective devices (RCDs) for household and similar use – Electromagnetic compatibility*

IEC 61543:1995/AMD1:2004

IEC 61543:1995/AMD2:2005

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