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TECHNICAL SPECIFICATION

General requirements for residual current operated protective devices for DC systems

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CONTENTS

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GENERAL REQUIREMENTS FOR RESIDUAL CURRENT OPERATED PROTECTIVE DEVICES FOR DC SYSTEMS

FOREWORD

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- 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- withdrawn,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 date 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*

3 Terms and definitions

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

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

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

3.1
residual operating direct current
value of residual direct current which causes the DC-RCD to operate under specified conditions

[SOURCE: IEC 60050-442:1998, 442-05-20, modified – Adapted to DC-RCDs.]

3.2
residual non-operating direct current
value of residual direct current at and below which the DC-RCD does not operate under specified conditions

[SOURCE: IEC 60050-442:1998, 442-05-21, modified – Adapted to DC-RCDs.]

3.3
residual direct making and breaking capacity
value of a residual prospective direct current which a DC-RCD can make, carry for its opening time and break under specified conditions of use and behaviour

[SOURCE: IEC 60050-442:1998, 442-05-27, modified – Adapted to DC-RCDs.]

3.4
conditional direct short-circuit current
value of a prospective direct current, which a DC-RCD without integral short-circuit protection, but protected by a short-circuit protective device in series, can withstand under specified conditions of use and behaviour

3.5
conditional residual direct short-circuit current
value of a residual direct prospective current, which a DC-RCD without integral short-circuit protection, but protected by a SCPD in series, can withstand under specified conditions of use and behaviour

[SOURCE: IEC 60050-442;1998, 442-05-22, modified – Adapted to DC-RCDs.]

3.6
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]

3.7
M-pole
part of a DC-RCD associated exclusively with one electrically separated conducting path intended to connect and to disconnect the mid-point

3.8
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

4 Classification

4.1 According to the type of installation

4.1.1 DC-RCD for fixed installation and fixed wiring.

4.1.2 Portable DC-RCD with corded connection.

4.2 According to the possibility of adjusting the residual operating current

4.2.1 DC-RCD with a single value of rated residual operating current.

4.2.2 DC-RCD with multiple settings of residual operating current by fixed steps.

4.3 According to time-delay (in presence of a residual current)

4.3.1 DC-RCD without time-delay: for general use, with normal resistance to unwanted tripping.

4.3.2 DC-RCD with time-delay: for selectivity, with increased resistance to unwanted tripping.

4.4 According to the protection against external influences

4.4.1 Enclosed-type DC-RCD (not requiring an appropriate enclosure).

4.4.2 Unenclosed-type DC-RCD (for use with an appropriate enclosure).

4.5 According to the method of mounting

4.5.1 Surface-type DC-RCD.

4.5.2 Flush-type DC-RCD.

4.5.3 Panel board type DC-RCD, also referred to as distribution board type.

NOTE These types can be intended to be mounted on rails.

4.6 According to the method of connection

4.6.1 DC-RCD, the electrical connections of which are not associated with the mechanical mounting.

4.6.2 DC-RCD, the electrical connections of which are associated with the mechanical mounting.

NOTE 1 Specific requirements for this classification are under consideration.

NOTE 2 Examples of this type are:

– plug-in type;
– bolt-on type;
– screw-in type.

Some DC-RCDs can be of the plug-in type or bolt-on type on the line side only, the load terminals being usually suitable for wiring connection.

4.7 According to the type of terminals

4.7.1 DC-RCD with screw-type terminals for external copper conductors.

4.7.2 DC-RCD with screwless type terminals for external copper conductors.

NOTE 1 The requirements for DC-RCDs equipped with these types of terminals are given in IEC 62873-3-1.

4.7.3 DC-RCD with flat quick-connect terminals for external copper conductors.

NOTE 2 The requirements for DC-RCDs equipped with these types of terminals are given in IEC 62873-3-2.

4.7.4 DC-RCD with screw-type terminals for external aluminium conductors.

NOTE 3 The requirements for DC-RCDs equipped with these types of terminals are given in IEC 62873-3-3.

4.8 According to the number of poles and current paths

4.8.1 Single-pole DC-RCD with two current paths.

4.8.2 Two-pole DC-RCD.

4.8.3 Two-pole DC-RCD with three current paths.

4.8.4 Three-pole DC-RCD.

4.9 According to the instantaneous tripping current

This classification applies to the residual current function combined with the circuit-breaker and is defined in the relevant product standard.

4.10 According to the I^2t characteristics

This classification applies to the residual current function combined with the circuit-breaker and is defined in the relevant product standard.

4.11 According to overcurrent protection

4.11.1 Residual current devices without integral overcurrent protection.

4.11.2 Residual current devices with integral overcurrent protection.

4.11.3 Residual current devices with integral overload protection only.

4.11.4 Residual current devices with integral short-circuit protection only.

4.12 According to the method of construction

4.12.1 DC-RCD completely assembled by the manufacturer as one device (standalone DC-RCD)

4.12.2 DC-RCD comprised of a circuit-breaker and r.c. unit to be assembled on site

4.12.3 Any association of devices acting together in order to accomplish the three main functions of a DC-RCD – detection of a residual current, comparison to a reference value and opening the contacts or poles when the residual current exceeds this reference value.

NOTE The current sensing means and/or the processing device can be mounted separately from the current breaking device.

4.13 According to the range of ambient air temperature

4.13.1 Residual current devices intended for use between –5 °C and +40 °C.

4.13.2 Residual current devices intended for use between –25 °C and +40 °C.

4.13.3 Residual current devices intended for use in more severe conditions.

4.14 According to the time constant

4.14.1 Residual current devices suitable for DC circuits with a time constant of $T \leq 4$ ms.

4.14.2 Residual current devices suitable for DC circuits with a time constant of $T \leq 15$ ms.

NOTE It is assumed that short-circuit currents of 1 500 A are not exceeded in installations in which, due to the loads connected, time constants in normal service up to 15 ms can occur. Where higher short-circuit currents can occur, the time constant of $T = 4$ ms is considered sufficient.

4.15 According to the current direction through the poles

4.15.1 Polarised DC-RCD.

4.15.2 Non-polarised DC-RCD.