

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Residual current devices with or without overcurrent protection for
socket-outlets for household and similar uses**

**Dispositifs à courant différentiel résiduel avec ou sans protection contre les
surintensités pour les socles de prises de courant destinés à des installations
domestiques et analogues**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2011 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00



IEC 62640

Edition 1.0 2011-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Residual current devices with or without overcurrent protection for
socket-outlets for household and similar uses**

**Dispositifs à courant différentiel résiduel avec ou sans protection contre les
surintensités pour les socles de prises de courant destinés à des installations
domestiques et analogues**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

XF

ICS 29.120.50

ISBN 978-2-88912-325-4

CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	12
2 Normative references	13
3 Terms and definitions	14
3.1 Definitions relating to currents flowing from live parts to earth	14
3.2 Definitions relating to the energization of a residual current device	15
3.3 Definitions relating to the operation and functions of the residual current device	15
3.4 Definitions relating to values and ranges of energizing quantities	17
3.5 Definitions relating to values and ranges of influencing quantities	19
3.6 Definitions relating to conditions of operation	20
3.7 Definitions relating to tests	21
3.8 Definitions relating to residual current devices in general	21
4 Classification.....	21
4.1 Classification according to behaviour resulting from failure of the line voltage	22
4.1.1 SRCD not opening automatically in case of failure of the line voltage	22
4.1.2 SRCD opening automatically in case of failure of the line voltage	22
4.2 Classification according to the design.....	22
4.2.1 SRCD consisting of an RCD incorporated in (a) fixed socket-outlet(s)	22
4.2.2 SRCD consisting of an RCD intended to be associated with fixed socket-outlets within the same mounting box or within two adjacent compatible boxes.....	22
4.2.3 SRCD consisting of an RCD incorporated in a connection unit intended to protect only one piece of fixed electrical equipment (e.g. hand dryer, water cooler, etc.) immediately adjacent to the SRCD	22
4.3 Classification according to behaviour in presence of d.c. components	22
4.4 Classification according to the provision for earthing	22
4.5 Classification according to the design of the cover plate.....	22
4.6 Classification according to the method of mounting	22
4.7 Classification according to the environmental conditions	23
4.7.1 Classification according to the degree of protection against ingress of solid foreign objects	23
4.7.2 Classification according to the degree of protection against harmful ingress of water	23
4.7.3 Classification according to the range of ambient air temperature	23
4.8 Classification according to the type of terminals	23
4.9 Classification according to overcurrent protection.....	23
5 Characteristics of SRCDs	23
5.1 Summary of characteristics	23
5.2 Characteristics common to all socket-outlet residual current devices	24
5.2.1 Rated current (I_n)	24
5.2.2 Rated residual operating current ($I_{\Delta n}$)	24
5.2.3 Rated residual non-operating current ($I_{\Delta no}$)	24
5.2.4 Rated voltage (U_n).....	24
5.2.5 Rated frequency	24
5.2.6 Rated residual making and breaking capacity ($I_{\Delta m}$).....	24

5.2.7	Operating characteristics in case of residual current.....	24
5.3	Characteristics specific to SRCDs with overcurrent protection (see 4.9)	25
5.3.1	SRCDs classified according to 4.9 a), 4.9 b) and 4.9 c) 1)	25
5.3.2	Rated short-circuit capacity (I_{cn}) for SRCD classified according to 4.9 c) 2)	26
5.4	Preferred or standard values	26
5.4.1	Preferred values of rated voltage (U_n)	26
5.4.2	Standard values of rated current (I_n).....	26
5.4.3	Standard values of rated residual operating current ($I_{\Delta n}$)	26
5.4.4	Standard value of rated residual non-operating current ($I_{\Delta no}$)	26
5.4.5	Standard values of rated frequency	26
5.4.6	Standard values of the rated making and breaking capacity (I_m).....	26
5.4.7	Standard values of the rated residual making and breaking capacity ($I_{\Delta m}$)	27
5.4.8	Standard values of the rated conditional short-circuit current (I_{nc})	27
5.4.9	Standard values of the rated conditional residual short-circuit current ($I_{\Delta c}$)	27
5.4.10	Standard values of the rated short-circuit capacity (I_{cn})	27
5.4.11	Standard values of break time	27
5.5	Standard ranges of overcurrent instantaneous tripping for SRCDs to 4.9 c) 2).....	28
6	Marking and other product information.....	28
6.1	General.....	28
6.2	Additional marking for screwless terminals	30
6.3	Additional marking for SRCDs with an FE connection	30
7	Standard conditions for operation in service and for installation.....	30
8	Requirements for construction and operation.....	31
8.1	General.....	31
8.2	Information and marking	31
8.3	Mechanical and electrical design	31
8.3.1	Mechanism	31
8.3.2	Clearance and creepage distances	32
8.3.3	Standing current in the FE	34
8.3.4	Screws, current-carrying parts and connections.....	34
8.3.5	Terminals	35
8.4	Operating characteristics.....	35
8.4.1	Operation in response to the type of residual current.....	35
8.4.2	Operation in response to the presence of a residual current equal to or greater than $I_{\Delta n}$	36
8.5	Behaviour of SRCDs with feed through terminals in case of miswiring	36
8.6	Test device.....	36
8.7	Temperature rise	36
8.8	Resistance to humidity	37
8.9	Dielectric properties	37
8.10	EMC compliance and unwanted tripping	37
8.10.1	EMC	37
8.10.2	Resistance against unwanted tripping due to current surges caused by impulse voltages for SRCDs of $I_{\Delta n} \geq 0,010$ A	37
8.11	Behaviour of SRCDs in case of overcurrent conditions	37
8.11.1	For all SRCDs	37

8.11.2	Behaviour of SRCDs classified according to 4.9 c) in case of overcurrent conditions	38
8.11.3	Standard time-(over)current zone for SRCD according to 4.9 c) 1) and 4.9 c) 2).....	38
8.12	Resistance of the insulation against impulse voltages	39
8.13	Mechanical and electrical endurance	39
8.14	Resistance to mechanical shock.....	39
8.15	Reliability	39
8.16	Protection against electric shock and degree of protection IP of the SRCD.....	39
8.16.1	Inaccessibility of live parts.....	40
8.16.2	Accessible knobs, operating means etc.	40
8.16.3	Accessible parts of SRCDs	40
8.16.4	Degree of protection IP of the SRCD.....	41
8.17	Resistance to heat	41
8.18	Resistance to abnormal heat and to fire	41
8.19	Behaviour of SRCDs within ambient temperature range.....	41
8.20	Resistance to temporary overvoltages	41
9	Tests	42
9.1	General	42
9.1.1	Test conditions	42
9.1.2	Characteristics of SRCDs	42
9.2	Marking and test of indelibility of marking	43
9.3	Verification of the trip-free mechanism	43
9.3.1	General test conditions	43
9.3.2	Test procedure	44
9.4	Test for the verification of electronic circuits	44
9.5	Requirements for capacitors and specific resistors and inductors	45
9.5.1	Capacitors	45
9.5.2	Resistors and inductors	45
9.6	Test of reliability of screws, current-carrying parts and connections	47
9.7	Screwed and screwless terminals.....	47
9.7.1	Screwed terminals for external copper conductors	47
9.7.2	Screwless terminals for external copper conductors	53
9.8	Verification of the operating characteristics of type AC and type A SRCDs	59
9.8.1	Test circuit	59
9.8.2	Verification of behaviour in the case of supply voltage failure	60
9.8.3	Off-load tests with residual sinusoidal alternating currents at the reference temperature of $(20 \pm 5) ^\circ\text{C}$	60
9.8.4	Verification of the correct operation with load at the reference temperature	61
9.8.5	Verification of the correct operation at the temperature limits with and without load	61
9.8.6	Additional tests for SRCDs fitted with an FE	62
9.8.7	Verification of correct operation of type A SRCDs with residual currents having a d.c. component	63
9.9	Verification of behaviour of SRCDs classified according to 4.2.1 b) in the case of miswiring.....	64
9.10	Verification of the test device	64
9.10.1	Verification of the simulated residual current	64
9.10.2	Verification of the operation of the test device	64

9.11	Verification of the limit of temperature rise	65
9.11.1	Test conditions	65
9.11.2	Ambient air temperature	65
9.11.3	Test procedure	66
9.11.4	Measurement of the temperature rise of different parts	66
9.12	Resistance to humidity	66
9.12.1	Preparation of the SRCD for test	66
9.12.2	Test conditions	66
9.12.3	Test procedure	66
9.12.4	Condition of the SRCD after the test	67
9.13	Test of dielectric properties	67
9.13.1	Insulation resistance of the main circuit	67
9.13.2	Dielectric strength of the main circuit	67
9.13.3	Capability of withstanding high d.c. voltages due to insulation measurements	68
9.14	EMC compliance and unwanted tripping	68
9.14.1	Electromagnetic compatibility (EMC)	68
9.14.2	Verification of resistance against unwanted tripping due to surge currents to earth resulting from impulse voltages for SRCDs of $I_{\Delta n} \geq 0,010$ A (ring wave test)	69
9.15	Verification of the behaviour of the SRCD under overcurrent conditions	69
9.15.1	List of the overcurrent tests	69
9.15.2	Short-circuit tests	70
9.15.3	Verification of the making and breaking capacity of the socket-outlet of the SRCD, classified according to 4.2.1	76
9.16	Verification of clearances of the SRCD with the impulse withstand voltage test	77
9.17	Mechanical and electrical endurance	78
9.17.1	Normal operation of socket-outlets of the SRCD	78
9.17.2	Test of the RCD part of the SRCD	78
9.18	Resistance to mechanical shock	80
9.18.1	General	80
9.18.2	Impact test apparatus	80
9.18.3	Surface type SRCD	83
9.18.4	Screwed glands	84
9.18.5	Shuttered SRCDs	84
9.19	Reliability	84
9.19.1	Climatic test	85
9.19.2	Test with temperature of 40 °C	86
9.20	Protection against electric shock and degree of protection IP of the SRCD	87
9.20.1	Protection against electric shock	87
9.20.2	Degree of protection IP of the SRCD	88
9.21	Resistance to heat	88
9.21.1	General	88
9.21.2	Conditioning	88
9.21.3	External parts of SRCDs	88
9.21.4	External Insulating parts	89
9.22	Resistance to abnormal heat and to fire – Glow-wire test	89
9.23	SRCDs with overcurrent protection	90

9.23.1	Verification of the operating characteristic under overcurrent conditions	90
9.23.2	Short-circuit tests for SRCDs according to 4.9 c) 2)	91
9.23.3	Condition of the SRCD after tests	92
9.24	Verification of ageing of electronic components	92
9.25	Verification of the behaviour of the SRCD under temporary overvoltage conditions	93
9.26	Verification of the limiting value of FE/PE standing current	94
9.26.1	Verification of the limiting value of FE/PE standing current when the neutral is connected	94
9.26.2	Verification of the limiting value of FE/PE standing current when the neutral is not connected	94
Annex A (normative)	Test sequence and number of samples to be submitted for certification purposes	120
Annex B (normative)	Determination of clearances and creepage distances	125
Annex C (informative)	Approximate relationship between cross-sectional area in mm ² and AWG sizes	127
Annex D (normative)	Routine tests	128
Annex E (informative)	Methods of determination of short-circuit power-factor	129
Bibliography		131
Figure 1	– Standard test finger	95
Figure 2	– General test circuit	96
Figure 3	– Minimum creepage distances and clearances as a function of peak value of voltage	97
Figure 4	– Minimum creepage distances and clearances as a function of peak value of operating voltage	98
Figure 5	– Pillar terminals	99
Figure 6	– Screw terminals and stud terminals	100
Figure 7	– Saddle terminals	101
Figure 8	– Mantle terminals	101
Figure 9	– Arrangement for checking damage to conductors	102
Figure 10	– Information for deflection test	103
Figure 11	– Example of a test circuit with current and voltage derived from separate sources	104
Figure 12	– Test cycle for low temperature test	104
Figure 13	– Measurement of the standing FE/PE current	105
Figure 14	– Test circuit for the verification of the correct operation of SRCDs, in the case of residual pulsating direct currents	106
Figure 15	– Test circuit for the verification of the correct operation of SRCDs, in the case of residual pulsating direct currents superimposed by a smooth direct current	107
Figure 16	– Damped oscillator current wave 0,5 µs/100 kHz	108
Figure 17	– Example of test circuit for the verification of resistance against unwanted tripping due to surge currents to earth resulting from impulse voltages for SRCDs	108
Figure 18	– Test circuit for the verification of the rated making and breaking capacity and of the coordination	109
Figure 19	– Test apparatus for the verification of the minimum I^2t and I_p values to be withstood by the SRCD (9.15.2.1 a))	110

Figure 20 – Gauge for checking non-accessibility of live parts	111
Figure 21 – Impact-test apparatus	112
Figure 22 – Details of the striking element	113
Figure 23 – Mounting support for specimens.....	114
Figure 24 – Mounting block for flush-type SRCDs	114
Figure 25 – Reliability test cycle	115
Figure 26 – Ball-pressure test apparatus	116
Figure 27 – Sketches and table showing the application of the blows.....	117
Figure 28 – Diagrammatic representation of 9.22.....	118
Figure 29 – Test circuit for the verification of TOV withstand (9.25)	119
Figures B.1 to B.10 – Illustrations of the application of creepage distances	126
 Table 1 – Standard values of maximum break time of SRCDs for a.c. residual current.....	27
Table 2 – Standard values of maximum break time of SRCDs for pulsating d.c. residual current.....	28
Table 3 – Ranges of overcurrent instantaneous tripping.....	28
Table 4 – Position of marking.....	29
Table 5 – Values of influencing quantities	31
Table 6 – Minimum clearances and creepage distances.....	33
Table 7 – Tripping current limits.....	35
Table 8 – Temperature-rise values.....	37
Table 9 – Time-(over)load operating characteristics.....	38
Table 10 – Instantaneous operating characteristics.....	38
Table 11 – Withstand values and duration of temporary overvoltages	41
Table 12 – Test copper conductors corresponding to the rated currents.....	42
Table 13 – List of type tests	43
Table 14 – Maximum permissible temperatures under abnormal conditions	46
Table 15 – Screw thread diameters and applied torques	47
Table 16 – Relationship between rated current and connectable nominal cross-sectional areas of copper conductors	48
Table 17 – Values for flexing under mechanical load test for copper conductors	50
Table 18 – Values for pull test for screw-type terminals	50
Table 19 – Composition of conductors	51
Table 20 – Tightening torques for the verification of the mechanical strength of screw-type terminals	52
Table 21 – Relationship between rated current and connectable cross-sectional areas of copper conductors for screwless terminals.....	54
Table 22 – Value for pull test for screwless-type terminals.....	56
Table 23 – Values for flexing under mechanical load test for copper conductors	56
Table 24 – Test current for the verification of electrical and thermal stresses in normal use for screwless terminals.....	57
Table 25 – Nominal cross-sectional areas of rigid copper conductors for deflection test of screwless terminals	59
Table 26 – Deflection test forces.....	59
Table 27 – Tripping current ranges for SRCDs in case of pulsating d.c. current.....	

Table 28 – Tests to be applied for EMC	69
Table 29 – Tests to verify the behaviour of SRCs under overcurrent conditions	70
Table 30 – Power factor ranges of the test circuit	72
Table 31 – Test voltage for verification of impulse withstand voltage between poles	77
Table 32 – Test voltage for verification of impulse withstand voltage with the metal support	78
Table 33 – Cross-sectional area for test conductors.....	79
Table 34 – Height of fall for impact tests	82
Table 35 – Torque test values for glands	84
Table A.1 – Test sequences.....	121
Table A.2 – Number of samples for full test procedure	123
Table A.3 – Number of samples for simplified test procedure	124

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RESIDUAL CURRENT DEVICES WITH OR WITHOUT OVERCURRENT
PROTECTION FOR SOCKET-OUTLETS FOR
HOUSEHOLD AND SIMILAR USES**

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.

International Standard IEC 62640 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 standard is based on the following documents:

FDIS	Report on voting
23E/706/FDIS	23E/713/RVD

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

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

In this standard, the following print types are used:

- Requirements proper: in roman type.
- *Test specifications: in italic type.*
- Explanatory matter: in smaller roman type.

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

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

INTRODUCTION

IEC series 61008 and IEC 61009 are applicable to residual current devices having one to four poles used in any part of an electrical installation. These devices may be installed either at the origin of a whole installation or upstream of one or several circuits of a fixed installation or upstream of a circuit powering one or more socket-outlets, or be integrated in the same enclosure as a socket-outlet.

Such residual current devices are able to provide fault protection (protection against indirect contact), additional protection (protection against direct contact) if the rated residual current is equal to or less than 30 mA and protection against fire hazard due to a persistent earth leakage current without the operation of the overcurrent protection. Equipment meeting the requirements of the series IEC 61008 or IEC 61009 ensure isolation, withstand high levels of electromagnetic disturbances for household and similar applications and allow safe use of an electrical installation.

Although the series IEC 61008 and IEC 61009 may be applicable to “residual current devices integrated in socket-outlets” it is acknowledged that due to the specific use and location of a socket-outlet, at the boundary of the fixed installation and immediately upstream of electrical equipment powered through a plug inserted into the socket-outlet, these devices require different features.

The residual current device at socket-outlet level is normally intended to be installed by skilled or instructed persons. It can be operated several times per day. The isolation function is not necessary since pulling out the plug from the socket-outlet is recognized as providing effective isolation. The absence of permanently connected long conductors downstream of the RCD, together with a limited number of powered appliances, justifies reduced EMC levels. Residual current devices covered by this standard are intended for additional protection in case of direct contact only. These particular features having been considered, it was recognized that a dedicated standard for socket-outlet residual current devices (SRCDs) was necessary.

RESIDUAL CURRENT DEVICES WITH OR WITHOUT OVERCURRENT PROTECTION FOR SOCKET-OUTLETS FOR HOUSEHOLD AND SIMILAR USES

1 Scope

This International Standard applies to residual current-operated devices (RCD) incorporated in, or specifically intended for use with two pole socket-outlets, with or without earthing contact for household and similar uses (SRCD: socket-outlet residual current devices). SRCDs, according to this standard, are intended to be used in single phase systems such as phase to neutral or phase to phase or phase to earthed middle conductor.

SRCDs are only intended to provide additional protection downstream of the SRCD. SRCDs are intended for use in circuits where the fault protection (indirect contact protection) is already assured upstream of the SRCD.

NOTE 1 For example, fault protection (indirect contact protection) can be covered as follows:

- in TT systems, by upstream RCBOs or RCCBs according to IEC 61008-1 and IEC 61009-1;
- in a TN system, an overcurrent protective device can be used upstream.

NOTE 2 In the United States, there is no requirement for providing indirect contact protection upstream of an SRCD.

NOTE 3 In Switzerland these devices are not allowed for protective measures according to the national installation rules.

SRCDs are neither intended to provide an isolation function nor intended to be used in IT systems.

NOTE 4 For SRCDs intended to provide isolation or fault protection, or to be used in IT systems, IEC 61008-1 or IEC 61009-1 should be used, as applicable, in conjunction with IEC 60884-1.

NOTE 5 Requirements and testing for SRCDs intended to be used in IT systems are under consideration.

SRCDs are not used in distribution boards. They are not intended for the protection of a complete distribution circuit or a complete final circuit. These products are intended to be installed

- in boxes in compliance with IEC 60670-1,
- or in cable trunking systems in compliance with the IEC 61084 series,
- or in power track systems in compliance with the IEC 61534 series,
- or in boxes according to one of the above standards adjacent to socket-outlet boxes.

They are not intended to be used in enclosures or distribution boards in conformity with IEC 60670-24, IEC 61439-1 or IEC 60439-3.

RCDs for household and similar use not covered by the scope of this standard are covered by IEC 61008-1 or IEC 61009-1. SRCDs energized from batteries, or a circuit other than the one powering the loads, are not covered by this standard.

The residual current device incorporates the functions of detection of the residual current, of comparison of the value of this current with the residual operating value and of opening the protected circuit when the residual current exceeds this value.

The maximum rated residual operating current is 30 mA.

The maximum rated current is 16 A for devices with a rated voltage not exceeding 250 V a.c. or 20 A for devices with a rated voltage not exceeding 130 V a.c.

NOTE 6 In Australia and New Zealand, the maximum rated current for devices with a rated voltage not exceeding 250 V a.c. is 20 A.

NOTE 7 In Korea, the maximum rated current for devices with a rated voltage not exceeding 250 V a.c. is 32 A.

This International Standard applies to SRCDs incorporating overload or overcurrent protection.

This standard also applies to a connection unit incorporating a residual current device intended to protect only one piece of fixed electrical equipment immediately adjacent to the connection unit (e.g. hand dryer, water cooler, etc).

NOTE 8 SRCDs are designed to be operated by uninstructed persons and not to require maintenance.

The requirements of this standard apply for normal conditions of temperature and environment. Additional requirements may be necessary for devices used in locations having more severe environmental conditions.

The socket-outlet part of an SRCD is covered by IEC 60884-1 or the national requirements of the country where the SRCD is placed on the market.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60065:2001, *Audio, video and similar electronic apparatus – Safety requirements*
Amendment 1 (2005)
Amendment 2 (2010)

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

IEC 60068-3-4:2001, *Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests*

IEC 60384-14, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

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

IEC 60664-3:2003, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60670-1:2002, *Boxes and enclosures for electrical accessories for household and similar fixed electrical installations – Part 1: General requirements*

IEC 60695-2-10:2000, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60884-1:2002, *Plugs and socket-outlets for household and similar purposes – Part 1: General requirements*

NOTE In the United Kingdom, IEC 60884-1 is not indispensable and is not applicable to SRCDs or plug and socket systems.

IEC 61008-1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules*

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

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61084-1:1991, *Cable trunking and ducting systems for electrical installations – Part 1: General requirements*

IEC 61534-1:2003, *Powertrack systems – Part 1: General requirements*

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

Amendment 1 (2004)

Amendment 2 (2005)

CISPR 14-1, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in various parts of IEC 60050, as well as the following, apply.

3.1 Definitions relating to currents flowing from live parts to earth

3.1.1

earth fault current

current flowing to earth due to an insulation fault

3.1.2

earth leakage current

current flowing from the live parts of the installation to earth in the absence of an insulation fault

3.1.3

pulsating direct current

current of pulsating wave form which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0,006 A d.c. during one single interval of time, expressed in angular measure, of at least 150°

3.1.4

current delay angle

α

time, expressed in angular measure, by which the starting instant of the current conduction is delayed by phase control

3.1.5**smooth direct current**

direct current which is ripple free

NOTE A current is considered to be ripple free when the coefficient of ripple is below 10 %.

3.2 Definitions relating to the energization of a residual current device**3.2.1****residual current** I_{Δ}

vector sum of the instantaneous values of the current flowing in the main circuit of the RCD expressed as r.m.s. value

3.2.2**residual operating current** $I_{\Delta n}$

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

3.2.3**residual non-operating current** $I_{\Delta no}$

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

3.3 Definitions relating to the operation and functions of the residual current device**3.3.1****residual current device****RCD**

mechanical switching device or association of devices designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions

3.3.2**detection**

function consisting in sensing the presence of a residual current

3.3.3**evaluation**

function consisting in giving to the RCD the possibility to operate when the detected residual current exceeds a specified reference value

3.3.4**interruption**

function consisting in automatically bringing the main contacts of the RCD from the closed position into the open position, thereby interrupting the current(s) flowing through them

3.3.5**switching device**

device designed to make or to break the current in one or more electric circuits

[IEC 60050-442:1998, 442-01-46]

3.3.6

trip-free mechanism of a RCD

moving contacts of which return to and remain in the open position when the opening operation is initiated after the initiation of the closing operation, even if the closing command is maintained

NOTE To ensure proper breaking of the current which may have been established, it may be necessary that the contacts momentarily reach the closed position.

[IEC 60050-441:2000, 441-16-31, modified)

3.3.7

SRCD without integral overcurrent protection

SRCD not designed to perform the functions of protection against overloads and/or short-circuits

3.3.8

SRCD with integral overcurrent protection

SRCD designed to perform the functions of protection against overloads and/or short-circuits

3.3.9

residual current unit

device performing simultaneously the functions of detection of the residual current and of comparison of the value of this current with the residual operating value, and incorporating the means of operating the tripping mechanism of a circuit-breaker with which it is designed to be assembled

3.3.10

break time of a RCD

time which elapses between the instant the residual operating current is attained and the instant of arc extinction in all poles

3.3.11

limiting non-actuating time

maximum time during which the residual operating current can be applied to the RCD without causing it to operate

3.3.12

time-delay RCD

RCD specially designed to attain a predetermined value of limiting non-actuating time, corresponding to a given value of residual current

3.3.13

test device

device incorporated in the RCD simulating the residual current conditions for the operation of the SRCD under specified conditions

3.3.14

functional earth

FE

wire or terminal intended to be connected to the PE so as to ensure a supply to the SRCD when the SRCD is supplied from just one phase and thereby to enable the SRCD to operate under this condition

3.3.15

limiting impedance value

R_e

maximum impedance value from the FE to the supply source for which protection is ensured when the SRCD is supplied just from any one phase and FE

3.3.16**loss of supply**

loss of one or more active conductors

3.3.17**fuse**

switching device that, by the melting of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when it exceeds a given value for a sufficient time

NOTE The fuse comprises all the parts that form the complete device.

[IEC 60050-441:2000, 441-18-01, modified]

3.3.18**pole**

that part of an SRCD associated exclusively with one electrically separated conducting path of its main circuit, provided with contacts intended to connect and disconnect the main circuit itself, and excluding those portions which provide a means for mounting and operating the poles together

3.4 Definitions relating to values and ranges of energizing quantities**3.4.1****limiting value of the non-operating over-current in the case of a single-phase load**

maximum value of a single-phase overcurrent which, in the absence of a residual current, can flow through an SRCD (whatever the number of poles) without causing it to operate

NOTE 1 In the case of overcurrent in the main circuit, unwanted tripping may occur in the absence of residual current, due to asymmetry existing in the detecting device itself.

NOTE 2 In the case of SRCD with integral overcurrent protection, the limiting value of the non-operating current may be determined by the overcurrent protection means.

3.4.2**residual short-circuit withstand current**

maximum value of the residual current for which the operation of the RCD part is assured under specified conditions and above which that device may undergo irreversible alterations

3.4.3**limiting thermal value of the short-time current**

highest value of current (r.m.s.) which the device is capable of carrying for a specified short period and under specified conditions without undergoing, by heating effect, permanent deterioration of its characteristics

3.4.4**prospective current**

current that would flow in the circuit if each main current path of the SRCD and of the overcurrent protective device, if any, were replaced by a conductor of negligible impedance

NOTE The prospective current may be qualified in the same manner as an actual current, for example: prospective breaking current, prospective peak current, prospective residual current, etc.

[IEC 60050-442:1998, 442-01-47, modified]

3.4.5**making capacity**

value of the a.c. component of a prospective current that an SRCD is capable of making at a stated voltage under prescribed conditions of use and behaviour

[IEC 60050-442:1998, 442-01-48, modified]

3.4.6**breaking capacity**

value of the a.c. component of a prospective current that an SRCD is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[IEC 60050-442:1998, 442-01-49, modified]

3.4.7**residual making and breaking capacity**

$I_{\Delta m}$

value of the a.c. component of a residual prospective current which an SRCD can make, carry for its opening time and break under specified conditions of use and behaviour

[IEC 60050-442:1998, 442-05-27, modified]

3.4.8**conditional short-circuit current**

I_{nc}

value of the a.c. component of a prospective current, which an SRCD without integral short-circuit protection, but protected by a suitable short-circuit protective device (hereafter referred to as SCPD) in series, can withstand under specified conditions of use and behaviour

[IEC 60050-442:1998, 442-05-28, modified]

3.4.9**conditional residual short-circuit current**

$I_{\Delta c}$

value of the a.c. component of a residual prospective current which the RCD part without integral short-circuit protection, but protected by a suitable SCPD in series, can withstand under specified conditions of use and behaviour

[IEC 60050-442:1998, 442-05-22, modified]

3.4.10**Joule integral**

$I^2 t$

integral of the square of the current, over a given time interval (t_0 , t_1):

$$I^2 t = \int_{t_0}^{t_1} i^2 dt$$

[IEC 60050-441:2000, 441-18-23, modified]

3.4.11**recovery voltage**

voltage which appears across the supply terminals of the SRCD after the breaking of the current

NOTE This voltage may be considered as comprising two successive intervals of time, one during which a transient voltage exists, followed by a second one during which power-frequency voltage alone exists.

[IEC 60050-442:1998, 442-01-05, modified]

3.4.12**transient recovery voltage**

recovery voltage during the time in which it has a significant transient character

NOTE 1 The transient voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit and of the SRCD. It includes the voltage shift of the neutral of a polyphase circuit.

NOTE 2 The transient recovery voltage in three-phase circuits is, unless otherwise stated, that across the first pole to clear, because this voltage is generally higher than that which appears across each of the other two poles.

[IEC 60050-441:2000, 441-17-26, modified]

3.4.13

power-frequency recovery voltage

recovery voltage after the transient voltage phenomena have subsided

[IEC 60050-441:2000, 442-17-27]

3.4.14

overcurrent

current exceeding the rated current

3.4.15

overload current

overcurrent occurring in an electrically undamaged circuit

NOTE An overload current may cause damage if sustained for a sufficient time.

3.4.16

temporary overvoltage

overvoltage at power frequency of relatively long duration

3.4.17

short-circuit current

overcurrent resulting from a fault of negligible impedance between points intended to be at different potentials in normal service

NOTE A short-circuit current may result from a fault or from an incorrect connection.

3.5 Definitions relating to values and ranges of influencing quantities

3.5.1

influencing quantity

quantity likely to modify the specified operation of an SRCD

3.5.2

reference value of an influencing quantity

value of an influencing quantity to which the manufacturer's stated characteristics are referred

3.5.3

reference conditions of influencing quantities

collectively, reference values of all influencing quantities

3.5.4

range of an influencing quantity

range of values of an influencing quantity which permits the SRCD to operate under specified conditions, the other influencing conditions having their reference values

3.5.5

extreme range of an influencing quantity

range of values of an influencing quantity within which the SRCD suffers only spontaneously reversible changes, although not necessarily complying with all the requirements of this standard

3.5.6

ambient air temperature

temperature, determined under prescribed conditions, of the air surrounding the SRCD

NOTE For an enclosed SRCD, it is the air outside the enclosure.

[IEC 60050-441:2000, 441-11-13, modified]

3.6 Definitions relating to conditions of operation

3.6.1

operation

transfer of the moving contact(s) from the open position to the closed position or vice versa

NOTE If a distinction is necessary, an operation in the electrical sense (e.g. make or break) is referred to as a switching operation, and an operation in the mechanical sense (e.g. close or open) is referred to as a mechanical operation.

3.6.2

closing operation

operation by which the SRCD is brought from the open position to the closed position

3.6.3

opening operation

operation by which the SRCD is brought from the closed position to the open position

[IEC 60050-441:2000, 441-16-09, modified]

3.6.4

operating cycle

succession of operations from one position to another and back to the first position

[IEC 60050-441:2000, 441-16-02, modified]

3.6.5

operation sequence

succession of specified operations with specified time intervals

[IEC 60050-441:2000, 441-16-03]

3.6.6

clearance

shortest distance in air between two conductive parts

NOTE For the purpose of determining a clearance to accessible parts, the accessible surface of an insulating enclosure is considered conductive as if it was covered by a metal foil wherever it can be touched by hand or by the standard test finger according to IEC 60529.

[IEC 60050-441:2000, 441-17-31, modified]

3.6.7

creepage distance

shortest distance along the surface of an insulating material between two conductive parts

NOTE For the purpose of determining a creepage distance to accessible parts, the accessible surface of the insulating enclosure is considered conductive as if it was covered by a metal foil wherever it can be touched by a hand or a standard test finger according to IEC 60529.

[IEC 60050-471:2007, 471-01-04, modified]

3.7 Definitions relating to tests

3.7.1

type test

test of one or more devices made to a certain design to show that the design meets certain requirements

[IEC 60050-426:2008, 426-05-01, modified]

3.7.2

routine test

test to which each individual device is subjected during and/or after manufacture to ascertain whether it complies with certain criteria

[IEC 60050-411:1996, 411-53-02, modified]

3.8 Definitions relating to residual current devices in general

3.8.1

short-circuit protective device**SCPD**

device, specified by the manufacturer, to be installed in the circuit in series with the SRCD in order to protect it against short-circuit currents only

3.8.2

supply terminals

terminals upstream of the RCD part

3.8.3

load terminals

terminals downstream of the RCD part

3.8.4

feed through

means provided on the SRCD for the connection of one or more additional socket-outlets, protected by the RCD part

3.8.5

instructed person

person adequately advised or supervised by skilled persons to enable him or her to avoid dangers and prevent risks which electricity may create.

3.8.6

connection unit

device associated with the fixed wiring of an installation to which a single piece of equipment can be directly connected

4 Classification

The SRCDs are classified in the following ways:

NOTE 1 The correct use of SRCDs corresponding to the classifications of this clause is subject to installation rules (e.g. according to the IEC 60364 series).

NOTE 2 SRCDs may be fitted with an FE connection which enables the device to operate when supplied from one phase only.

NOTE 3 In the United States, detection of the earthing of the load neutral is required.

4.1 Classification according to behaviour resulting from failure of the line voltage

4.1.1 SRCD not opening automatically in case of failure of the line voltage

NOTE In Germany, the classification of 4.1.1 is different.

4.1.2 SRCD opening automatically in case of failure of the line voltage

- a) not re-closing automatically when the line voltage is restored;
- b) re-closing automatically when the line voltage is restored.

4.2 Classification according to the design

4.2.1 SRCD consisting of an RCD incorporated in (a) fixed socket-outlet(s)

- a) SRCDs without feed through;
- b) SRCDs with feed through.

4.2.2 SRCD consisting of an RCD intended to be associated with fixed socket-outlets within the same mounting box or within two adjacent compatible boxes

NOTE 1 Adjacent means two boxes which are next to or contiguous with each other.

- a) SRCDs with dedicated means for the connection of the socket-outlet (e.g. flying leads);

NOTE 2 In Denmark and in the United Kingdom, SRCDs with flying leads are not accepted in fixed installations.

- b) SRCDs with load terminals.

4.2.3 SRCD consisting of an RCD incorporated in a connection unit intended to protect only one piece of fixed electrical equipment (e.g. hand dryer, water cooler, etc.) immediately adjacent to the SRCD

4.3 Classification according to behaviour in presence of d.c. components

- a) SRCDs of type AC;
- b) SRCDs of type A.

4.4 Classification according to the provision for earthing

- a) SRCD with provision for earthing (PE terminal)
- b) SRCD without provision for earthing

An SRCD without provision for earthing cannot provide any FE terminal.

NOTE In the United Kingdom and in Germany, SRCDs without provision for earthing are forbidden.

4.5 Classification according to the design of the cover plate

- a) Design A – SRCDs where the cover or cover-plate can be removed without displacement of the conductors;
- b) Design B – fixed SRCDs where the cover or cover-plate cannot be removed without displacement of the conductors.

NOTE If a fixed SRCD has a base (main part) which cannot be separated from the cover or cover-plate, and requires a supplementary plate to meet this standard which can be removed for redecorating the wall without displacement of the conductors, it is considered to be of design A, provided the supplementary plate meets the requirements specified for covers and cover-plates.

4.6 Classification according to the method of mounting

- a) surface type SRCD;
- b) flush-type SRCD;
- c) semi-flush type SRCD;
- d) panel-type SRCD (switch-board and distribution board excluded);

- e) floor recessed-type SRCD.

4.7 Classification according to the environmental conditions

4.7.1 Classification according to the degree of protection against ingress of solid foreign objects

- a) IP2X: SRCD protected against access to hazardous parts with a finger and against harmful effects due to ingress of solid foreign objects of 12,5 mm diameter and greater;
- b) IP4X: SRCD protected against access to hazardous parts with a wire and against harmful effects due to ingress of solid foreign objects of 1,0 mm diameter and greater;
- c) IP5X: SRCD protected against access to hazardous parts with a wire and dust protected.

4.7.2 Classification according to the degree of protection against harmful ingress of water

- a) ordinary SRCDs, i.e. with degree of protection IPX0 or IPX1, when mounted on a vertical surface for normal use;

NOTE For the purpose of this standard, the term "ordinary" applies only to the degree of protection against harmful ingress of water.

- b) IPX4: SRCDs protected against splashing water;
- c) IPX5: SRCDs protected against water jets.

4.7.3 Classification according to the range of ambient air temperature

- a) SRCDs intended for use between -5°C and $+40^{\circ}\text{C}$;
- b) SRCDs intended for use between -25°C and $+40^{\circ}\text{C}$.

4.8 Classification according to the type of terminals

- a) SRCDs with screw type terminals;
- b) SRCDs with screwless terminals for rigid conductors only;
- c) SRCDs with screwless terminals for rigid and flexible conductors.

4.9 Classification according to overcurrent protection

- a) SRCD without integral overcurrent protection;
- b) SRCD with overcurrent protection independent of the RCD opening means (e.g. a fused device or a fused plug and socket system);
- c) SRCD with overcurrent protection integral with the RCD opening means:
 - 1) two-pole SRCD with one or two overload protected pole(s);
 - 2) two-pole SRCD with one or two overcurrent protected pole(s):
 - B-type SRCD;
 - C-type SRCD.

5 Characteristics of SRCDs

5.1 Summary of characteristics

The characteristics of an SRCD shall be stated in the following terms, as applicable:

- a) type of design and method of mounting (4.5 and 4.6);
- b) rated current I_n (5.2.1);
- c) operating characteristics in case of residual currents with d.c. components (5.2.7);
- d) rated residual operating current $I_{\Delta n}$ (5.2.2);
- e) rated residual non-operating current $I_{\Delta no}$ if different from the preferred value (5.2.3);

- f) rated voltage U_n (5.2.4);
- g) rated frequency (5.2.5);
- h) rated making and breaking capacity I_m (5.3.1.4);
- i) rated residual making and breaking capacity $I_{\Delta m}$ (5.2.6);
- j) overcurrent protection:
 - 1) Classified according 4.9 a), 4.9 b) and 4.9 c) 1):
 - i) rated conditional short-circuit current I_{nc} (5.3.1.2);
 - ii) rated conditional residual short-circuit current $I_{\Delta c}$ (5.3.1.3);
 - iii) overload characteristic 4.9 c) 1).
 - 2) Classified according to 4.9 c) 2):
 - i) rated short-circuit capacity I_{cn} (5.3.2);
 - ii) instantaneous tripping type B or C.

5.2 Characteristics common to all socket-outlet residual current devices

5.2.1 Rated current (I_n)

The value of current assigned to the SRCD by the manufacturer, which the device can carry in uninterrupted duty.

5.2.2 Rated residual operating current ($I_{\Delta n}$)

The value of residual operating current (3.2.2), assigned to the SRCD by the manufacturer, at which the device shall operate under specified conditions.

NOTE $I_{\Delta n}$ is expressed by the r.m.s. value of the alternating current at rated frequency.

5.2.3 Rated residual non-operating current ($I_{\Delta no}$)

Maximum value of residual non-operating current (3.2.3), assigned to the SRCD by the manufacturer, at which the device does not operate under specified conditions.

5.2.4 Rated voltage (U_n)

The r.m.s. value of voltage, assigned to the SRCD by the manufacturer, to which the performance of the device is referred (particularly the short-circuit performance).

5.2.5 Rated frequency

Value of frequency assigned to the SRCD by the manufacturer at which the device operates correctly under specified conditions.

5.2.6 Rated residual making and breaking capacity ($I_{\Delta m}$)

The r.m.s. value of residual prospective current (3.4.7 and 3.4.9) which an SRCD can make, carry for its opening time and break under specified conditions without undergoing alterations impairing its functions.

5.2.7 Operating characteristics in case of residual current

5.2.7.1 SRCD type AC

SRCD for which tripping is ensured for residual sinusoidal alternating currents, whether suddenly applied or slowly rising.

5.2.7.2 SRCD type A

SRCD for which tripping is ensured for

- residual sinusoidal alternating currents,
- residual pulsating direct currents,
- residual pulsating direct currents superimposed on a smooth direct current of 0,006 A,

with or without phase-angle control, independent of polarity, whether suddenly applied or slowly rising.

5.3 Characteristics specific to SRCDs with overcurrent protection (see 4.9)

5.3.1 SRCDs classified according to 4.9 a), 4.9 b) and 4.9 c) 1)

5.3.1.1 Coordination with short-circuit protective devices

The association of a short-circuit protective device with an SRCD is intended to ensure adequate protection to the device from the effects of short-circuit currents.

The manufacturer of the SRCD shall specify the following characteristics of the short-circuit protective device:

- maximum let-through I^2t ;
- maximum value of let-through peak current I_p .

Any short-circuit protective device, complying with the relevant IEC standard and having the above characteristic values lower than those specified by the manufacturer of the SRCD, may be used for protection of the device, provided the short-circuit protective device does not interfere with normal service.

NOTE In the United Kingdom, the short-circuit protective device must comply with BS 1362

5.3.1.2 Rated conditional short-circuit current (I_{nc})

The r.m.s. value of the prospective current assigned by the manufacturer, which an SRCD, protected by a short-circuit protective device, can withstand under specified conditions without undergoing alterations impairing its functions.

NOTE For the rated conditional short-circuit current assigned to an SRCD coordinated with a given short-circuit protective device, it is intended that such an association is able to withstand any short-circuit current up to the assigned value.

5.3.1.3 Rated conditional residual short-circuit current ($I_{\Delta c}$)

Value of residual prospective current assigned by the manufacturer, which an SRCD, protected by a short-circuit protective device, can withstand under specified conditions without undergoing alterations impairing its functions.

NOTE For the rated conditional residual short-circuit current assigned to an SRCD in coordination with a given short-circuit protective device, it is assumed that such an association is able to withstand any residual short-circuit current up to the assigned value.

5.3.1.4 Rated making and breaking capacity (I_m)

The r.m.s. value of prospective current (3.4.4) which an SRCD can make, carry for its opening time and break under specified conditions without undergoing alterations impairing its functions.

5.3.2 Rated short-circuit capacity (I_{cn}) for SRCD classified according to 4.9 c) 2)

The rated short-circuit capacity of an SRCD is the value of the ultimate short-circuit breaking capacity assigned to the SRCD by the manufacturer.

5.4 Preferred or standard values

5.4.1 Preferred values of rated voltage (U_n)

The preferred values of rated voltage according to IEC 60038 are as follows:

110 V – 120 V – 230 V.

5.4.2 Standard values of rated current (I_n)

The standard values of rated current for rated voltages up to 130 V are as follows:

6 A – 10 A – 13 A – 16 A – 20 A.

The standard values of rated current for rated voltages up to 250 V are:

6 A – 10 A – 13 A – 16 A.

NOTE 1 In Korea, 32 A is also considered as a standard value.

NOTE 2 In Australia, New Zealand and the United States, 15 A is also considered as a standard value.

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

The standard values of rated residual operating current are as follows:

0,006 A – 0,01 A – 0,03 A.

NOTE In Korea and Japan, 0,015 A is also considered as a standard value.

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

The standard value of rated residual non-operating current is $0,5 I_{\Delta n}$.

NOTE The value of $0,5 I_{\Delta n}$ refers to alternating residual currents of power frequency only.

5.4.5 Standard values of rated frequency

The standard values of rated frequency are as follows:

50 Hz, 60 Hz or 50/60 Hz.

5.4.6 Standard values of the rated making and breaking capacity (I_m)

The standard value of the rated making and breaking capacity is as follows:

250 A.

The power factor associated with this value is given in Table 30.

The value of I_m shall be equal to or greater than the value of $I_{\Delta m}$.

5.4.7 Standard values of the rated residual making and breaking capacity ($I_{\Delta m}$)

The standard value of the rated residual making and breaking capacity is as follows:

250 A.

The power factor associated with this value is given in Table 30.

5.4.8 Standard values of the rated conditional short-circuit current (I_{nc})

The standard values of the rated conditional short-circuit current I_{nc} are as follows:

1 500 A – 3 000 A.

The power factors associated with these values are given in Table 30.

NOTE In Korea, 2 500 A is considered as a standard value.

5.4.9 Standard values of the rated conditional residual short-circuit current ($I_{\Delta c}$)

The standard values of the rated conditional residual short-circuit current $I_{\Delta c}$ are as follows:

1 500 A – 3 000 A.

The power factors associated with these values are given in Table 30.

NOTE In Korea, 2 500 A is considered as a standard value.

5.4.10 Standard values of the rated short-circuit capacity (I_{cn})

The standard values of the rated short-circuit capacity I_{cn} are as follows:

1 500 A – 3 000 A.

The power factors associated with these values are given in Table 30.

NOTE In Korea, 2 500 A is considered as a standard value.

5.4.11 Standard values of break time

5.4.11.1 Standard values of maximum break time for a.c. residual current

Table 1 – Standard values of maximum break time of SRCDs for a.c. residual current

$I_{\Delta n}$ A	Standard values of maximum break time at s			
	$I_{\Delta n}$	$2 I_{\Delta n}$	$5 I_{\Delta n}^a$	250 A
Any value	0,3	0,15	0,04	0,04
^a 0,25 A may be used as an alternative to $5 I_{\Delta n}$. (The revision of this value is under consideration.)				

NOTE In the United States, where the tripping times are specifically related to current, the following formulas apply $T = \left(\frac{20}{I}\right)^{1,43}$ for high-resistance faults and $T = 1,25 \left(\frac{10}{V}\right)^{1,43}$ for low resistance faults.

5.4.11.2 Standard values of maximum break time for pulsating d.c.

Table 2 – Standard values of maximum break time of SRCDs for pulsating d.c. residual current

$I_{\Delta n}$ A	Standard values of maximum break time at						
	s						
	$1,4 I_{\Delta n}$	$2 I_{\Delta n}$	$2,8 I_{\Delta n}$	$4 I_{\Delta n}$	$7 I_{\Delta n}^a$	$10 I_{\Delta n}^b$	175 A
$\leq 0,010$		0,3		0,15		0,04	0,04
$> 0,010$	0,3		0,15		0,04		0,04
NOTE Alternative standard values of maximum break time of SRCDs for pulsating d.c. residual current, for use in bi-phase systems with 120 V middle point, are under consideration.							
^a For SRCD with $I_{\Delta n} = 0,030$ A, the value 0,35 A may be used instead of $7 I_{\Delta n}$.							
^b For SRCD with $I_{\Delta n} \leq 0,010$ A, the value 0,5 A may be used instead of $10 I_{\Delta n}$.							

5.5 Standard ranges of overcurrent instantaneous tripping for SRCDs to 4.9 c) 2)

The standard ranges of overcurrent instantaneous tripping are given in Table 3.

Table 3 – Ranges of overcurrent instantaneous tripping

Type	Range
B	Above $3 I_n$ up to and including $5 I_n$
C	Above $5 I_n$ up to and including $10 I_n$

6 Marking and other product information

6.1 General

The following information, as shown in Table 4, shall be provided.

Table 4 – Position of marking

	Marking or information item	Position of the marking or information		
		Visible on product when installed	On the product	In a leaflet
A	Manufacturer's name or trade mark		X	
B	Type designation or serial number		X	
C	Rated voltage(s)		X	
D	Rated frequency(s) (if different from 50 Hz or 60 Hz)		X	
E1	Rated current for SRCDs according to 4.9 a) and b)		X ^a	
E2	Rated current for SRCDs according to 4.9 c) 1) and 4.9 c) 2)	X ^b		
F1	Symbol  for type A		X	
F2	Symbol  for type AC		X	
G	Rated residual operating current (in A or mA)	X		
H	Rated residual non-operating current if different from the preferred value			X
I	Rated short-circuit breaking and making capacity (as applicable)			X
J	Rated conditional short-circuit current, if applicable, and in this case, characteristics for the associated short-circuit protective device, according to 5.3.1			X
K	Degree of protection (if different from IP20)	X		
L	Position for use, if applicable			X
M	Range of operating temperature, if classified according to 4.7.3 b) 		X	
N	Identification of the test device by the letter "T" or the word "Test"	X		
O	Means shall be provided to distinguish between the open and closed states of the device. For SRCDs other than those operated by means of push-buttons, the open position shall be indicated by the symbol "O" and the closed position by the symbol "I" (a short straight line). Additional national symbols are allowed for this indication. Provisionally, the use of national symbols as the only indication of the positions is allowed. These indications shall be readily visible when the SRCD is in normal use. For SRCDs operated by means of two push-buttons, the push-button intended for the opening operation only shall be RED and/or be marked with the symbol "O". In this case, the separate test button shall not be red but shall be marked with the letter "T" or the word "Test". If the test button is the only means for the opening operation, it remains marked "T" or "Test", in which case the colour red may be used. RED shall not be used for any other push-button of the SRCD. If a push-button is used for closing the contact and is clearly identified as such, its depressed position is sufficient to indicate the closed position	X		
P	The FE-wire or terminal shall be identified by the marking "FE"		X	X
Q	For devices with load terminals, the supply and the load terminals shall be clearly marked (e.g. by "supply" and "load" placed near the corresponding terminals or by arrows indicating the direction of power flow). For devices with feed-through means, the supply and feed-through means shall be clearly marked (e.g. "supply" and "feed through")		X	
R	Terminals specifically intended for the connection of the neutral shall be indicated by the symbol N		X	
S	Information on the integral overcurrent protective device, if applicable			X
T	Information on coordination with upstream protective device, if applicable			X
U	All relevant information for the correct assembly, if any, installation and use of the product shall be provided			X
V	Rated short-circuit capacity in amperes (I_{sc}) (as applicable)		X	
NOTE 1 In the United States, the information given in items G and K do not need to be visible.				
NOTE 2 In United Kingdom, the information given in item B is not used.				
^a Shall not be visible on the product when installed as in normal use.				
^b For SRCDs according to 4.9 c) 1) the rated current of the overload protection is indicated with the symbol "A", for example 6A, and for SRCDs according to 4.9 c) 2) the rated current is indicated without the symbol "A" and preceded by the symbol of the overcurrent instantaneous tripping (B or C), for example B16.				

6.2 Additional marking for screwless terminals

SRCDs with screwless terminals shall be marked with the following:

- an appropriate marking indicating the length of insulation to be removed before the insertion of the conductor into the screwless terminal;
- an indication of the suitability to accept rigid conductors only, for those SRCDs having this restriction.

The additional markings shall be put on the SRCD or on the packaging or given in an instruction sheet which accompanies the SRCD.

6.3 Additional marking for SRCDs with an FE connection

The following additional information for all SRCDs with an FE connection is required in the manufacturer's instructions:

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

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

The following colours are not permitted for the FE wire: green, yellow, blue and green-and-yellow.

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

Compliance is verified by inspection.

7 Standard conditions for operation in service and for installation

The preferred ranges of application and the reference values of influencing quantities/factors and their associated test tolerances, are given in Table 5.

Table 5 – Values of influencing quantities

Influencing quantity	Preferred ranges of application	Reference value	Test tolerance
Ambient air temperature	–5 °C to +40 °C –25 °C to +40 °C (see ^a , ^b et ^e)	–	As permitted by the test
Altitude	Not exceeding 2 000 m	–	–
Relative humidity: maximum value at 40 °C	50 % ^c)	–	–
External magnetic field	Not exceeding five times the earth's magnetic field in any direction	Earth's magnetic field	^d
Position	As stated by the manufacturer, with a tolerance of 5° in any direction ^d	As stated by the manufacturer	2° in any direction
Frequency	Reference value ±5 %	Rated frequency as stated by the manufacturer	±2 %
Sinusoidal wave distortion	Not exceeding 5 %	Zero	5 %
Pollution degree	2	-	-
^a The maximum value of the mean daily temperature is +35 °C or in accordance to the national standards for the socket-outlet part where the product is placed on the market. ^b Values outside the ranges may be required where more severe climatic conditions prevail. ^c Higher relative humidities are admitted at lower temperature (e.g. 90 % at 20 °C). ^d The device shall be fixed without causing deformation liable to impair its functions. ^e For SRCDs with an operating range –5 °C to +40 °C, the extreme limits of –20 °C and +60 °C are admissible during storage and transportation, for SRCDs with an operating range –25 °C to +40 °C, the extreme limits are –35 °C and +60 °C. These limits shall be taken into account in the design of the SRCDs.			

8 Requirements for construction and operation

8.1 General

SRCDs intended for compliance with this standard shall be in accordance with the scope and the relevant classifications.

Compliance is checked by visual inspection and tests as relevant.

8.2 Information and marking

Marking on the SRCD shall be indelible and easily legible.

Labels intended to provide permanent information shall not be easily removed from the device.

Compliance is checked by visual inspection and by the test of 9.2.

8.3 Mechanical and electrical design

8.3.1 Mechanism

The RCD part of the SRCD shall have 2 poles.

The moving contacts of all poles of RCDs shall be mechanically coupled in such a way that all poles make and break substantially together, whether operated manually or automatically.

Means shall be provided to distinguish between the open and closed states of the contacts.

The mechanism shall be trip-free and constructed so that the moving contacts can come to rest only in the closed position or in the open position, even when the operating means is manually released in an intermediate position.

When the operating means is used to indicate the position of the contacts, the operating means, when released, shall automatically take up the position corresponding to that of the moving contacts; in this case, the operating means shall have two distinct rest positions corresponding to the position of the contacts but, for automatic opening, a third distinct position of the operating means may be provided.

If symbols are used, they shall be “ I ” and “ O ” to indicate the closed and open positions, respectively.

If colours are used, red shall indicate the closed position and green the open position.

Alternative national symbols may be used with or without the above symbols.

The earthing circuit PE within the SRCD, if any, shall be continuous and shall not be affected by the operation of the SRCD.

Compliance is checked by visual inspection and the tests of 9.3.

8.3.2 Clearance and creepage distances

The minimum required clearances and creepage distances are given in Table 6 which is based on the SRCD being designed for operating in an environment with pollution degree 2.

However, the clearances 1, 2, 3 and 4 may be reduced provided that the tests 9.13.2 are complied with.

NOTE The insulating materials are classified into material groups on the basis of their comparative tracking index (CTI) according to 2.7.1.1 and 2.7.1.3 of IEC 60664-1:2007 and measured according to IEC 60112.

Parts of printed boards with type 2 coating according to IEC 60664-3 are exempt from this verification.

Electronic circuits showing clearances or creepage distances, between active conductors (phase and neutral) and/or between active conductors and the earth circuit, shorter than what is required in Table 6 when the contacts are in the closed position, have to comply with test of 9.4

Compliance is checked by inspection and/or measurement and by the tests of 9.4 and 9.5 for electronic circuits, as applicable.

Table 6 – Minimum clearances and creepage distances

	Minimum clearances mm			Minimum creepage distances ^{),)} mm											
				Group IIIa ^h (1 75 V ≤ C _T I < 400 V)				Group II (400 V ≤ C _T I < 600 V)				Group I (600 V ≤ C _T I) ^d			
	Rated voltage V			Working voltage V ^{e)}											
Description :	120/240 120	120/240 240	230/400 230	>25 ≤50 ⁱ	120	250		>25 ≤50 ⁱ	120	250		>25 ≤50 ⁱ	120	250	
1 Between live parts which are separated when the main contacts are in the open position	2,0 ^a	3,0 ^a	3,0 ^a	1,2	1,5	3,0		0,9	1,5	3,0		0,6	1,5	3,0	
2 Between internal live parts of different polarity															
3 Between internal live parts and FE-terminal or FE-wire ^{j)}															
				Supply system rated voltage V											
				120 / 240		230 / 400		120 / 240		230 / 400		120 / 240		230 / 400	
4 Between live parts and – accessible surfaces of operating means – screws or other means for fixing covers which have to be removed when mounting the SRCD – surface on which the SRCD is mounted ^b – crews or other means for fixing the SRCD ^b – metal covers or boxes ^{b)} – other accessible metal parts ^c – metal frames supporting flush-type SRCD	1,5	3,0	3,0	1,5	4,0			1,5	3,0			1,5	3,0		
5 Between metal parts of the mechanism and: – accessible metal parts ^c – screws or other means for fixing the SRCD – metal frames supporting flush-type SRCD															
^a This value may be reduced to 1,2 mm minimum provided the tests of 9.13.2 are complied with.															
^b The values are doubled if clearances and creepage distances between live parts of the device and the metallic screen or the surface on which the SRCD is mounted are not dependent on the design of the SRCD only, so that they can be reduced when the SRCD is mounted in the most unfavourable condition.															
^c Including a metal foil in contact with the surfaces of insulating material which are accessible after installation as for normal use. The foil is pushed into corners, grooves, etc., by means of a straight un-jointed test finger.															
^d See IEC 60112.															
^e Interpolation is allowed in determining creepage distances corresponding to voltage values intermediate to those listed as working voltage. For determination of creepage distances, see Annex B.															
^f Creepage distances cannot be less than the associated clearances.															
^h For material group IIIb (CTI < 175 V) the values for material group IIIa multiplied by 1,6 apply.															
ⁱ For working voltages up to and including 25 V, reference may be made to IEC 60664-1.															
^j For the purposes of this requirement, the following applies: – the FE is treated as a PE, – the free end of a FE wire is not considered.															

8.3.3 Standing current in the FE

When neutral is connected, the value of the standing current in FE shall not exceed 0,5 mA.

When the neutral is not connected, the value of the standing current in the FE shall not exceed 2 mA.

Compliance is checked by the tests of 9.26.

8.3.4 Screws, current-carrying parts and connections

Electrical connections shall not be subject to undue ageing.

8.3.4.1 Connections, whether electrical or mechanical, shall withstand the mechanical stresses occurring in normal use.

Screws operated when connecting the SRCD shall not be of the thread-cutting type.

NOTE Screws (or nuts) which are operated when connecting the SRCD include screws for fixing covers or cover-plates, but not connecting means for screwed conduits and for fixing the base of an SRCD.

Compliance is checked by inspection and by the test of 9.6.

8.3.4.2 For screws in engagement with a thread of insulating material and which are operated when assembling the SRCD during installation, correct introduction of the screw into the screw hole or nut shall be ensured.

NOTE The requirement with regard to correct introduction is met if introduction of the screw in a slanting manner is prevented, for example, by guiding the screw by means of the part to be fixed using a recess in the female thread, or by the use of a screw with the leading thread removed.

Compliance is checked by inspection and by the manual test of 9.6.

8.3.4.3 Electrical connections shall be so designed that contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics not less suitable, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinkage or yielding of the insulating material.

Compliance is checked by inspection.

NOTE The suitability of the material is considered in respect of the stability of the dimensions.

8.3.4.4 Current-carrying parts including those of terminals (also earthing terminals) shall be of a metal having, under the conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use.

NOTE Examples of suitable metals, when used within the permissible temperature range and under normal conditions of chemical pollution, are as follows:

- copper;
- an alloy containing at least 58 % copper for parts from rolled sheet (in cold condition) or at least 50 % copper for other parts;
- stainless steel containing at least 13 % chromium and not more than 0,09 % carbon;
- other metal or suitably coated metal, not less suitable for their intended use.

The requirements of this subclause do not apply to contacts, magnetic circuits, heater elements, bimetals, shunts, parts of electronic devices, screws, nuts, washers, clamping plates nor to similar parts of terminals and parts of the test circuit.

Compliance is checked by inspection and, if necessary, by chemical analysis.

8.3.5 Terminals

8.3.5.1 Terminals for external conductors

Terminals for external conductors shall be such that the conductors may be connected so as to ensure that the necessary contact pressure is maintained permanently.

Compliance is checked by the test of 9.7.

8.3.5.2 Feed through terminals

Access to the feed through terminals shall only be available by the removal of a barrier.

Compliance is checked by inspection.

8.4 Operating characteristics

The operating characteristic of SRCDs shall take into account the classifications and the requirements of the following subclauses, as applicable.

Compliance of the following subclauses is checked by the tests of 9.8.

8.4.1 Operation in response to the type of residual current

8.4.1.1 Alternating residual current

All SRCDs shall operate in response to a steady increase of alternating residual current of rated frequency within the limits of the non-operating current $I_{\Delta n0}$ and the rated residual operating current $I_{\Delta n}$ in accordance with Table 7.

8.4.1.2 Pulsating d.c. residual current for type A

Type A SRCDs shall operate in response to a steady increase of pulsating direct residual current of rated frequency within specified limits of the non operating current and the operating current in accordance with Table 7.

Table 7 – Tripping current limits

Type	Current shape	Tripping current		
		Non-operating current (lower limit)	Operating current (upper limit)	
			$I_{\Delta n} < 30 \text{ mA}$	$I_{\Delta n} = 30 \text{ mA}$
AC and A	Sinusoidal alternative current	$0,5 I_{\Delta n}$	$I_{\Delta n}$	
A	Pulsating direct current			
	0°	$0,35 I_{\Delta n}$	$2 I_{\Delta n}$	$1,4 I_{\Delta n}$
	90°	$0,25 I_{\Delta n}$	$2 I_{\Delta n}$	$1,4 I_{\Delta n}$
	135°	$0,11 I_{\Delta n}$	$2 I_{\Delta n}$	$1,4 I_{\Delta n}$

The tripping limits apply independently of the polarity of the pulsating direct residual current.

8.4.1.3 Pulsating d.c. residual current in the presence of a standing smooth direct current of 0,006 A

Type A SRCDs shall operate in response to a steady increase of pulsating direct residual current of rated frequency within specified limits of the non-operating current and the

operating current in accordance with Table 7, also in the case of simultaneous presence of a smooth direct current of 0,006 A through any path of the SRCD.

The tripping limits of the pulsating direct current shall be kept even if the polarity of the pulsating direct residual current and the smooth direct current are the same.

8.4.2 Operation in response to the presence of a residual current equal to or greater than $I_{\Delta n}$

The operation of SRCDS to a suddenly applied residual current shall be in accordance with Tables 1 and 2, as applicable.

8.5 Behaviour of SRCDS with feed through terminals in case of miswiring

An SRCD classified according to 4.2.1 b) shall not permit the connection of the supply to the socket-outlet portion and/or the line terminals when a supply circuit is connected directly to the feed through terminals of the SRCD.

Compliance is checked by the tests of 9.9.

NOTE In Australia and New Zealand, 8.5 is not applicable.

8.6 Test device

The SRCD shall be provided with a test device, to simulate the passing through the detecting device of a residual current not exceeding $2,5 I_{\Delta n}$ at rated voltage, in order to allow a periodic testing of the ability of the SRCD to operate.

Compliance is checked by the tests of 9.10.

It shall not be possible to energize the circuit on the load side by operating the test device when the SRCD is in the open position and connected as in normal use.

Compliance is checked by inspection.

The protective conductor of the installation shall not become live when the test device is operated.

Compliance is checked by inspection.

8.7 Temperature rise

The temperature rises of the parts of an SRCD specified in Table 8, measured under the conditions specified in 9.11, shall not exceed the limiting values stated in that table.

The SRCD shall not suffer damage impairing its functions and its safe use.

Table 8 – Temperature-rise values

Parts ^{a, b}	Temperature rise K
SRCD terminals for external connections	60
External parts liable to be touched in normal service	40
Other external parts, including that face of the SRCD in direct contact with the mounting surface	60
^a No value is specified for the contacts, since the design of most SRCDS is such that a direct measurement of the temperature of those parts cannot be made without the risk of causing alterations or displacement of parts likely to affect the reproducibility of the tests. The test of 9.11 is considered to be sufficient for checking indirectly the behaviour of the contacts with respect to undue temperature rises in service.	
^b No value is specified for parts other than those listed, but no damage shall be caused to adjacent parts of insulating materials.	

Compliance is checked by the tests of 9.11.

8.8 Resistance to humidity

SRCDs shall have adequate mechanical properties to withstand humid conditions.

Compliance is checked by the tests of 9.12.

8.9 Dielectric properties

SRCDs shall have adequate dielectric properties.

Compliance is checked by the tests of 9.13.

8.10 EMC compliance and unwanted tripping

8.10.1 EMC

SRCDs shall comply with relevant EMC requirements.

Compliance is checked by the tests of 9.14.1.

8.10.2 Resistance against unwanted tripping due to current surges caused by impulse voltages for SRCDs of $I_{\Delta n} \geq 0,010$ A

SRCDs shall adequately withstand the current surges to earth due to the loading of capacitances in the load.

NOTE Such current surges may be attributable to load capacitance, surge protective devices (SPD) or flashover.

Compliance is checked by the tests of 9.14.2.

8.11 Behaviour of SRCDs in case of overcurrent conditions

8.11.1 For all SRCDs

SRCDs shall have adequate capability in cases of overload or short-circuit conditions.

Compliance is checked by the tests of 9.15 as applicable.

8.11.2 Behaviour of SRCDs classified according to 4.9 c) in case of overcurrent conditions

The operating characteristic of SRCDs, under overload and overcurrent conditions, shall comply with the requirements of 8.11.3 and 8.11.3.1.

8.11.3 Standard time-(over)current zone for SRCD according to 4.9 c) 1) and 4.9 c) 2)

The tripping characteristic of SRCDs to 4.9 c) 1) and 4.9 c) 2) shall ensure adequate protection against overload and overcurrent, without premature operation.

The zone of the time-current characteristic (tripping characteristic) of an SRCD is defined by the conditions and the values stated in Tables 9 and 10.

Table 9 applies to all SRCDs according to 4.9 c) 1) and 4.9 c) 2).

Table 10 applies in addition to Table 9 only for SRCDs according to 4.9 c) 2).

Table 9 refers to an SRCD mounted in accordance with the reference conditions (see 9.1) operating at the reference calibration temperature of 30 °C, with a tolerance of $^{+5}_0$ °C (see note of Table 9).

Compliance is checked by the tests specified in 9.23.1.

Checking is made at any convenient temperature, the results being referred to 30 °C through the information given by the manufacturer.

In any case the variation of the test current of Table 9 shall not exceed 1,2 % per K of calibration temperature variation.

Table 9 – Time-(over)load operating characteristics

Test	Type	Test current	Initial condition	Limits of tripping or non-tripping time	Results to be obtained	Remarks
a	All	$1,13 I_n$	Cold ^a	$t \leq 1 \text{ h}$	No tripping	
b	All	$1,45 I_n$	Immediately following test ^a	$t < 1 \text{ h}$	Tripping	Current steadily increased within 5 s
c	All	$2,55 I_n$	Cold ^a	$1 \text{ s} < t < 60 \text{ s}$	Tripping	

^a The term "cold" means without previous loading, at the reference calibration temperature.

Table 10 – Instantaneous operating characteristics

Test	Type	Test current	Initial condition	Limits of tripping or non-tripping time	Results to be obtained	Remarks
d	B, C	$3 I_n$ $5 I_n$	Cold ^a	$t \leq 0,1 \text{ s}$	No tripping	Current established by closing a switch
e	B, C	$5 I_n$ $10 I_n$	Cold ^a	$t < 0,1 \text{ s}$	Tripping	Current established by closing a switch

^a The term "cold" means without previous loading, at any convenient air temperature.

8.11.3.1 Conventional quantities

a) Conventional time:

The conventional time is 1 h.

b) Conventional non-tripping overcurrent (I_{nt}):

The conventional non-tripping overcurrent of an SRCD is 1,13 times its rated current.

c) Conventional tripping overcurrent (I_t):

The conventional tripping overcurrent of an SRCD is 1,45 times its rated current.

8.11.3.2 Tripping characteristic

The overload and instantaneous tripping characteristics of SRCDs shall be contained within the zone defined in 8.11.3.

8.11.3.3 Effect of the ambient air temperature on the overcurrent tripping characteristic

Ambient temperatures other than the reference temperature, within the limits of -5 °C and $+40\text{ °C}$, shall not unacceptably affect the overcurrent tripping characteristic of SRCDs.

Compliance is checked by the tests of 9.23.1.3.

8.12 Resistance of the insulation against impulse voltages

The insulation of an SRCD shall have adequate resistance to impulse voltages.

Compliance is checked by the tests of 9.16.

8.13 Mechanical and electrical endurance

SRCDs shall be capable of carrying out a specified number of closing and opening operations and making and breaking operations.

Compliance is checked by the tests of 9.17.

8.14 Resistance to mechanical shock

SRCDs shall be able to withstand the normal stresses imposed during installation and use.

Compliance is checked by the tests of 9.18.

8.15 Reliability

SRCDs shall provide protection throughout their intended service life, taking into account the ageing in likely working conditions.

Compliance is checked by the tests of 9.19 and 9.24.

8.16 Protection against electric shock and degree of protection IP of the SRCD

Lacquer and enamel are not considered to provide adequate insulation for the purpose of this subclause.

8.16.1 Inaccessibility of live parts

SRCDs shall be designed and constructed in such a way that when they are mounted and wired according to the manufacturer's instructions, live parts are not accessible, even after removal of parts which can be removed without the use of a tool.

A part is considered to be accessible if it can be touched by the standard test finger (see Figure 1).

Compliance is checked by inspection and by the tests of 9.20.1.

8.16.2 Accessible knobs, operating means etc.

Accessible parts, knobs, operating means, push-buttons, rockers and the like, shall be of insulating material, unless their accessible metal parts are separated from the metal parts of the mechanism by double insulation or reinforced insulation, or as an alternative, they are reliably connected to earth.

Compliance is checked by inspection.

8.16.3 Accessible parts of SRCDs

Accessible parts shall be made of insulating material with the exception of the following:

- a) small screws and the like which are isolated from live parts and which are used for fixing bases and covers or cover plates;
- b) actuating members complying with 8.16.2;
- c) the covers or cover plates of metal which comply with the requirements of 8.16.3.1 or 8.16.3.2;
- d) socket tubes intended to be connected to the PE and parts of the earthing circuit.

8.16.3.1 Covers or cover plates of metal not intended to be earthed shall be protected by additional insulation made by insulating linings or insulating barriers

The insulating linings or insulating barriers shall:

- a) either be fixed to covers or cover plates or the body of the switches in such a way that they cannot be removed without being permanently damaged;
- b) or are so designed that
 - i) they cannot be replaced in an incorrect position;
 - ii) if they are omitted, the accessories are rendered inoperable or manifestly incomplete;
 - iii) there is no risk of accidental contact between live parts and metal covers or cover plates, for example through their fixing screws, even if a conductor should come away from its terminal;
 - iv) precautions are taken in order to prevent creepage distances or clearances to become less than the values specified in Clause 23 of IEC 60884-1:2002.

Compliance is checked by inspection.

The above linings or barrier shall comply with the tests of Clauses 16 and 23 of IEC 60884-1:2002.

8.16.3.2 The earthing of metal covers or cover plates

The earthing of metal covers or cover plates is made while fixing the covers or cover plates and may be made without requiring the use of means other than the fixing means; the resulting connection shall be of low resistance.

NOTE Fixing screws or other means are allowed.

Compliance is checked by inspection and by the tests of 9.20.1.

8.16.4 Degree of protection IP of the SRCD

The minimum degree of protection of the SRCD shall be IP20.

Compliance of the SRCD with degree of protection greater than IP 20 is checked by the tests of 9.20.2.

8.17 Resistance to heat

SRCDs shall be sufficiently resistant to heat.

Compliance is checked by the tests of 9.21.

8.18 Resistance to abnormal heat and to fire

External parts of SRCDs made of insulating material shall not be liable to ignite and to spread fire if current-carrying parts in their vicinity, under fault or overload conditions, attain a high temperature. The resistance to abnormal heat and to fire of the other parts made of insulating material is considered as checked by the other tests of this standard.

Compliance is checked by the tests of 9.22.

8.19 Behaviour of SRCDs within ambient temperature range

SRCDs shall operate correctly between -5 °C and $+40\text{ °C}$.

SRCDs according to 4.7.3 b) shall operate correctly between -25 °C and $+40\text{ °C}$.

Compliance is checked by the tests of 9.8.5.

8.20 Resistance to temporary overvoltages

SRCDs shall adequately withstand temporary overvoltages due to various phenomena (such as a fault in the high-voltage network; break of neutral; short-circuit between line conductor and neutral conductor, etc.).

Values of alternating withstanding overvoltage levels and duration are given in Table 11.

Table 11 – Withstand values and duration of temporary overvoltages

Temporary overvoltages		
Occurrence	Voltage level	Duration
Between earth and all poles, including neutral, if any ^a	$1\,200\text{ V} + U_n$	5 s
Between earth and all poles, including neutral, if any ^a	$250\text{ V} + U_n$	1 h
Between the two poles	$\sqrt{3} \times U_n$	1 h
^a Only for SRCD with PE or FE terminal.		

Compliance of the above requirement is checked by the test of 9.25.

9 Tests

9.1 General

9.1.1 Test conditions

The SRCD is mounted individually according to manufacturer's instructions as for normal use (including the FE, if applicable, connected to PE via R_e), in free air, at an ambient temperature between 20 °C and 25 °C, unless otherwise specified, and is protected against undue external heating or cooling.

Unless otherwise specified, tests are carried at the rated frequency $\pm 5\%$.

SRCDs designed for installation in individual enclosures are tested in the smallest of such enclosures specified by the manufacturer.

SRCDs classified according to 4.2.2 shall be tested without associated fixed socket-outlet(s).

The socket-outlet part of the SRCDs classified according to 4.2.1 shall be tested, according to IEC 60884-1, but at the rated voltage of the RCD part.

In countries where IEC 60884-1 is not applicable, national requirements for socket-outlets apply.

Unless otherwise specified, the tests are carried out at 1,1 U_n as applicable.

Table 12 – Test copper conductors corresponding to the rated currents

Rated current I_n A	$I_n \leq 6$	$6 < I_n \leq 13$	$13 < I_n \leq 20$	$20 < I_n \leq 25$	$25 < I_n \leq 32$
S mm ²	1	1,5	2,5	4	6

NOTE 1 For AWG copper conductors, see Annex C.

NOTE 2 Values above 30 A are used in some country, e.g. Korea.

During the tests, no maintenance or dismantling of the samples is allowed.

For the tests of 9.4, 9.8, 9.11, 9.17 and 9.24, the SRCD is connected as follows:

- the connections are made by means of single-core, PVC-insulated copper cables in accordance with Table 12;
- the minimum length of each temporary connection from terminal to terminal is 1 m.

The tightening torques to be applied to the terminal screws are two-thirds of those specified in Table 20.

9.1.2 Characteristics of SRCDs

Characteristics of SRCDs are checked by means of type tests.

The type tests required by this standard are listed in Table 13.

Table 13 – List of type tests

Reference subclause	Requirement	Test subclause
8.1	General	
8.2	Information and marking	9.2
8.3	Mechanical and electrical design	9.3, 9.4, 9.5, 9.6, 9.7, 9.26
8.4	Operating characteristics	9.8
8.5	Behaviour of SRCDs with feed through terminals in case of miswiring	9.9
8.6	Test device	9.10
8.7	Temperature rise	9.11
8.8	Resistance to humidity	9.12
8.9	Dielectric properties	9.13
8.10	EMC compliance and unwanted tripping	9.14
8.11	Behaviour of SRCDs in case of overcurrent conditions	9.15, 9.23
8.12	Resistance of the insulation against impulse voltages	9.16
8.13	Mechanical and electrical endurance	9.17
8.14	Resistance to mechanical shock	9.18
8.15	Reliability	9.19, 9.24
8.16	Protection against electric shock	9.20
8.17	Resistance to heat	9.21
8.18	Resistance to abnormal heat and to fire	9.22
8.19	Behaviour of SRCD within ambient temperature range	9.8.5
8.20	Resistance to temporary overvoltage (TOV)	9.25

9.2 Marking and test of indelibility of marking

The marking shall comply with the requirement of Clause 6.

The test of indelibility of marking is made by rubbing the marking by hand for 15 s with a piece of cotton cloth soaked with water and again for 15 s with a piece of cotton cloth soaked with aliphatic solvent hexane (with a content of aromatics of maximum 0,1 % volume, a kauributanol value of 29, an initial boiling point of approximately 65 °C, a dry point of approximately 69 °C and a specific gravity of 0,68 g/cm³).

Marking made by impressing, moulding or engraving is not subjected to this test.

After this test, the marking shall be easily legible. The marking shall also remain easily legible after all the tests of this standard.

It shall not be easily possible to remove labels and they shall show no curling.

9.3 Verification of the trip-free mechanism

9.3.1 General test conditions

The SRCD is connected and wired as in normal use.

It is tested in a substantially resistive circuit, the diagram of which is shown in Figure 2.

9.3.2 Test procedure

S_1 , S_4 and the SRCD being previously closed, a residual current equal to $1,5 I_{\Delta n}$ is passed by closing the switch S_2 , whilst the operating means being held in the closed position. The SRCD shall trip.

This test is then repeated by resetting and/or relatching the SRCD slowly over a period of approximately 1 s to a position where the residual current starts to flow. Tripping shall occur without further movement of the operating means.

Both tests are carried out three times, at least once on each pole intended to be connected to a phase.

NOTE If the SRCD is fitted with more than one operating means, the trip-free operation is verified for each operating means.

9.4 Test for the verification of electronic circuits

SRCDs shall not create fire and/or shock hazards under abnormal conditions likely to occur in service.

The conditions under which a component is used within an SRCD shall be in accordance with the operating characteristics marked on the component and/or given in the data provided by the manufacturer.

When SRCDs are exposed to abnormal conditions, no part shall reach temperatures likely to cause danger of fire to the surroundings of the SRCDs and no live parts shall become accessible.

Compliance is checked by subjecting the SRCDs to the heating test under fault conditions as follows:

Unless otherwise specified, the tests are made on SRCDs while they are mounted, connected as specified in 9.11.

Examination of the SRCD and its circuit diagram will show the fault conditions which shall be applied.

Generally, one separate sample is submitted for each fault condition to be tested.

Each of the following fault conditions a) to e) shall be applied in turn. Only one test is carried out for each of the following fault conditions.

- a) Short-circuit across clearances and creepage distances, if smaller than those given by curve A of Figure 3 with the following exception.

In the requirements for clearances and creepage distances between conductors (one of which may be connected to one pole of the supply mains), which are on a printed board, the values given by Figure 3 are replaced by the values calculated from the following formula:

$$\lg d = 0,78 \lg \frac{V}{300} \text{ with a minimum of } 0,2 \text{ mm}$$

where

d is the distance in millimetres;

V the peak value of the voltage in volts.

NOTE 1 These distances can be determined by reference to Figure 4.

NOTE 2 The above reduced values apply to the conductors themselves, but not to mounted components or associated soldered connections. A lacquer coating or the like on printed boards is ignored when calculating the distances.

Clearances and creepage distances, complying with the requirements of Table 6 and printed boards with type 2 coating complying with IEC 60664-3, are excluded from this test.

- b) Short-circuit across insulation consisting of lacquer or enamel coatings.
- c) Short-circuit or interruption of semiconductors.

NOTE 3 For integrated circuits and other semiconductor devices with more than two terminals, the number of tests implied make it impracticable to apply the open-circuiting and/or shorting of all combinations of terminals. In this case, it is permissible first to analyse in detail, by a desk study, all the possible mechanical, thermal and electrical faults which may develop in the SRCD due to the malfunction of the electronic device or other circuit components. Only the combinations corresponding to faults that, on the basis of this analysis, are considered to be likely to cause the non-compliance of the SRCD with the requirements of the last two paragraphs of this subclause are investigated by this method.

- d) Short-circuit of electrolytic capacitors.
- e) Short-circuit or disconnection of resistors, inductors or capacitors.

NOTE 4 Condition e) need not be applied if these components comply with the requirements of 9.5

The temperatures resulting from the fault conditions are measured for the parts mentioned in Table 14 after steady state has been reached or after 4 h (whichever is the shorter time) under each of the fault conditions a) to e).

These temperatures shall not exceed the values given in Table 14 during tests b) and c). They may exceed the values given in Table 14 during test a).

After the tests a) to e), the SRCDs may no longer be capable of meeting all their performance requirements, but they shall comply with the requirements of protection against electric shock according to 9.20.

9.5 Requirements for capacitors and specific resistors and inductors

These requirements concern capacitors and specific resistors and inductors used in electronic circuits connected between active conductors (phases and neutral) and/or between active conductors and the earth circuit when the contacts are in the closed position.

9.5.1 Capacitors

Capacitors shall comply with the requirements of IEC 60384-14.

The relevant type of capacitors are as follows.

- X_1 or X_2 when relating to interference;
- Y_1 or Y_2 when relating to shock hazard.

These capacitors shall be marked with their rated voltage in volts, their rated capacitance in microfarads and their reference temperature in degrees Celsius, or the manufacturer may provide data sheets.

9.5.2 Resistors and inductors

Resistors and inductors, whose short-circuiting or disconnection resulted in non-compliance with the requirements of 9.4, shall comply with the relevant safety requirements of IEC 60065.

Tests already carried out on resistors and inductors complying with IEC 60065 are not required to be repeated.

Table 14 – Maximum permissible temperatures under abnormal conditions

Parts of the SRCD	Maximum permissible temperature under specific abnormal conditions °C
Accessible parts Knobs, handles, accessible surfaces, enclosures, if:	
– metallic	100
– non-metallic ^a	100
	^b
Internal surfaces of insulating enclosures	135
Supply cords and wiring insulation with: ^{c, f}	
– polyvinyl chloride or synthetic rubber	135
– natural rubber	
Other insulations ^c :	
– thermoplastic materials ^d	^e
– non-impregnated paper	105
– non-impregnated cardboard	115
– impregnated cotton, silk, paper and textile	125
– laminates based on cellulose or textile, bonded with	
• phenol-formaldehyde, melamine-formaldehyde, phenol-furfural or polyester	145
• epoxy	185
– mouldings of	
• phenol-formaldehyde, or phenol-furfural, melamine and melamine phenolic compounds with	
– cellulose fillers	165
– mineral fillers	185
• thermosetting polyester with mineral fillers	185
• alkyd with mineral fillers	185
– composite materials of:	
• polyester with fibre glass reinforcement	185
• epoxy with fibre glass reinforcement	185
– silicone rubber	225
Parts of thermoplastic materials ^d acting as support or as a mechanical barrier	^e
Winding wires insulated with ^{c, f}	
• non-impregnated silk cotton, etc.	110
• impregnated silk cotton, etc.	135
• oleoresinous materials	170
• polyvinyl-formaldehyde or polyurethane resins	185
• polyester resins	190
• polyesterimide resins	215
Core laminations	As for the relevant windings
Terminals and parts which may come into contact with cable insulation when installed	135
NOTE The values in this table are taken from Table 3 of IEC 60065:2005.	
^a If this temperature is higher than that allowed by the class of the relevant insulating material, the nature of the material is the governing factor. ^b The admissible temperatures for the internal part of insulating enclosures are those indicated for the relevant insulating materials. ^c In this standard, the permissible temperatures are based on service experience in relation to the thermal stability of the materials. The materials quoted are examples. For materials for which higher temperature limits are claimed and for materials other than those listed, the maximum temperatures should not exceed those which have been proved to be satisfactory. ^d Natural rubber and synthetic rubbers are not considered as being thermoplastic materials. ^e Due to their variety, it is not possible to specify permissible temperatures for thermoplastic materials. While the matter is under consideration, the following method shall be used: a) a softening temperature of the material is determined on a separate specimen, under the conditions specified in ISO 306, modified as follows: – the depth of penetration is 0,1 mm; – the total thrust of 10 N is applied before the dial gauge is set to zero or its initial reading noted; b) the temperature limit to be considered is the softening temperature itself. ^f The possibility of raising the values for wires and cables insulated with heat-resistant polyvinyl chloride is under consideration.	

9.6 Test of reliability of screws, current-carrying parts and connections

Compliance with the requirements of 8.3.4 is checked by inspection and, for screws and nuts which are operated when connecting the SRCD, by the following test.

The screws or nuts are tightened and loosened

- 10 times for screws in engagement with a thread of insulating material,
- 5 times in all other cases.

Screws or nuts in engagement with a thread of insulating material are completely removed and re-inserted each time.

The test is made by means of a suitable test screwdriver or spanner applying a torque as shown in Table 15.

Screws and nuts shall not be tightened in jerks.

The test is made with rigid conductors, having the largest cross-sectional areas specified in Table 12. The conductor is moved each time the screw or nut is loosened.

Table 15 – Screw thread diameters and applied torques

Nominal diameter of thread mm		Torque Nm	
Greater than	Up to and including	I ^a	II ^b
–	2,8	0,2	0,4
2,8	3,0	0,25	0,5
3,0	3,2	0,3	0,6
3,2	3,6	0,4	0,8
3,6	4,1	0,7	1,2
4,1	4,7	0,8	1,8
4,7	5,3	0,8	2,0

^a Column I applies to screws without heads if the screw, when tightened, does not protrude from the hole, and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw.

^b Column II applies to other screws which are tightened by means of a screwdriver.

During the test, the screwed connections shall not work loose and there shall be no damage, such as breakage of screws or deterioration of the head slots, threads, washers or stirrups that will impair the further use of the SRCD.

Moreover, enclosures and covers shall not be damaged.

9.7 Screwed and screwless terminals

9.7.1 Screwed terminals for external copper conductors

9.7.1.1 SRCDs shall be provided with terminals which shall allow the proper connection of copper conductors having nominal cross-sectional areas as shown in Table 16.

Table 16 – Relationship between rated current and connectable nominal cross-sectional areas of copper conductors

Current and type of SRCD	Rigid (solid or stranded) copper conductors ^c		Flexible copper conductors	
	Nominal cross-sectional area mm ²	Diameter of the largest conductor mm	Nominal cross-sectional area mm ²	Diameter of the largest conductor mm
6 A	–	–	From 0,75 up to 1,5 inclusive	1,73
10 A 2P and 2P+ 	From 1 up to 2,5 inclusive ^a	2,13	–	–
13 A and 16 A 2P and 2P+ 	From 1,5 up to 2 × 2,5 inclusive ^b	2,13	–	–
20 A 2P and 2P+ 	From 1,5 up to 4 inclusive	2,72	–	–
32 A ^d 2P+ 	From 2,5 up to 10 inclusive	4,32	–	–
^a The terminal shall allow the connection of two 1,5 mm ² conductors having a diameter of 1,45 mm. ^b Some countries require the looping-in of three conductors of 2,5 mm ² , or two conductors of 4 mm ² . ^c The use of flexible conductors is permitted. ^d This value is for Korea.				

The conductor space shall be at least that specified in Figures 5, 6, 7 or 8.

Compliance is checked by inspection, by measurement and by fitting conductors of the smallest and largest nominal cross-sectional areas specified.

9.7.1.2 Terminals with screw clamping shall allow the conductor to be connected without special preparation.

Compliance is checked by inspection.

NOTE The term "special preparation" covers soldering of the wires of the conductor, use of cable lugs, formation of eyelets, etc., but not the reshaping of the conductor before its introduction into the terminal or the twisting of a flexible conductor to consolidate the end.

9.7.1.3 Terminals with screw clamping shall have adequate mechanical strength.

Screws and nuts for clamping the conductors shall have a metric ISO thread or a thread comparable in pitch and mechanical strength.

Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

Compliance is checked by inspection and by the tests of 9.7.1.6 and 9.7.1.8.