

# CONSOLIDATED VERSION

## VERSION CONSOLIDÉE



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

**Interruuteurs automatiques à courant différentiel résiduel avec dispositif de  
protection contre les surintensités incorporé pour usages domestiques et  
analogues (DD) –  
Partie 1: Règles générales**

This is a preview. Click here to purchase the full publication.



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2013 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 Varembé  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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.

#### Useful links:

IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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 It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

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

Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

### 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.

#### Liens utiles:

Recherche de publications CEI - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

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

Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électriques et électroniques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).

This is a preview. Click here to purchase the full publication.

# CONSOLIDATED VERSION

## VERSION CONSOLIDÉE



**Residual current operated circuit-breakers with integral overcurrent protection  
for household and similar uses (RCBOs) –**

**Part 1: General rules**

**Interrupteurs automatiques à courant différentiel résiduel avec dispositif de  
protection contre les surintensités incorporé pour usages domestiques et  
analogues (DD) –**

**Partie 1: Règles générales**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 29.120.50

ISBN 978-2-8322-1101-4

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

**Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

This is a preview. Click [here](#) to purchase the full publication.

# REDLINE VERSION

## VERSION REDLINE



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

**Interruuteurs automatiques à courant différentiel résiduel avec dispositif de  
protection contre les surintensités incorporé pour usages domestiques et  
analogues (DD) –  
Partie 1: Règles générales**

This is a preview. Click here to purchase the full publication.

## CONTENTS

FOREWORD .....	10
INTRODUCTION .....	12
1 Scope .....	13
2 Normative references .....	15
3 Terms and definitions .....	16
3.1 Definitions relating to currents flowing from live parts to earth .....	16
3.2 Definitions relating to the energization of a residual current circuit-breaker .....	16
3.3 Definitions relating to the operation and functions of residual current circuit-breakers .....	17
3.4 Definitions relating to values and ranges of energizing quantities .....	20
3.5 Definitions relating to values and ranges of influencing quantities .....	24
3.6 Definitions relating to terminals .....	24
3.7 Definitions relating to conditions of operation .....	26
3.8 Definitions relating to constructional elements .....	27
3.9 Definitions relating to tests .....	28
3.10 Definitions relating to insulation coordination .....	28
4 Classification .....	30
4.1 According to the method of operation .....	30
4.1.1 RCBO functionally independent of line voltage (see 3.3.8) .....	30
4.1.2 RCBO functionally dependent on line voltage (see 3.3.9) .....	30
4.2 According to the type of installation .....	31
4.3 According to the number of poles and current paths .....	31
4.4 According to the possibility of adjusting the residual operating current .....	31
4.5 According to resistance to unwanted tripping due to voltage surges .....	31
4.6 According to behaviour in presence of d.c. components .....	31
4.7 According to time-delay (in presence of a residual current) .....	31
4.8 According to the protection against external influences .....	31
4.9 According to the method of mounting .....	32
4.10 According to the method of connection .....	32
4.11 According to the instantaneous tripping current (see 3.4.18) .....	32
4.12 According to the $I^2t$ characteristic .....	32
4.13 According to the type of terminals .....	32
5 Characteristics of RCBOS .....	32
5.1 Summary of characteristics .....	32
5.2 Rated quantities and other characteristics .....	33
5.2.1 Rated voltage .....	33
5.2.2 Rated current ( $I_n$ ) .....	33
5.2.3 Rated residual operating current ( $I_{\Delta n}$ ) .....	34
5.2.4 Rated residual non-operating current ( $I_{\Delta no}$ ) .....	34
5.2.5 Rated frequency .....	34
5.2.6 Rated short-circuit capacity ( $I_{cn}$ ) .....	34
5.2.7 Rated residual making and breaking capacity ( $I_{\Delta m}$ ) .....	34
5.2.8 RCBO type S .....	34
5.2.9 Operating characteristics in case of residual currents with d.c. components .....	34
5.3 Standard and preferred values .....	34

5.3.1	Preferred values of rated voltage ( $U_n$ ) .....	34
5.3.2	Preferred values of rated current ( $I_n$ ) .....	35
5.3.3	Standard values of rated residual operating current ( $I_{\Delta n}$ ) .....	35
5.3.4	Standard value of residual non-operating current ( $I_{\Delta no}$ ) .....	35
5.3.5	Standard values of rated frequency .....	35
5.3.6	Values of rated short-circuit capacity .....	36
5.3.7	Minimum value of the rated residual making and breaking capacity ( $I_{\Delta m}$ ) .....	36
5.3.8	Limiting values of break time and non-actuating time for RCBO of type AC and A .....	36
5.3.9	Standard ranges of overcurrent instantaneous tripping .....	37
5.3.10	Standard values of rated impulse withstand voltage ( $U_{imp}$ ) .....	38
6	Marking and other product information.....	38
7	Standard conditions for operation in service and for installation.....	40
7.1	Standard conditions.....	40
7.2	Conditions of installation .....	41
7.3	Pollution degree .....	41
8	Requirements for construction and operation.....	41
8.1	Mechanical design.....	41
8.1.1	General .....	41
8.1.2	Mechanism .....	42
8.1.3	Clearances and creepage distances (see also Annex B).....	43
8.1.4	Screws, current-carrying parts and connections.....	46
8.1.5	Terminals for external conductors .....	47
8.1.6	Non-interchangeability .....	50
8.2	Protection against electric shock .....	50
8.3	Dielectric properties and isolating capability .....	51
8.4	Temperature-rise .....	51
8.4.1	Temperature-rise limits .....	51
8.4.2	Ambient air temperature .....	52
8.5	Operating characteristics.....	52
8.5.1	Under residual current conditions .....	52
8.5.2	Under overcurrent conditions .....	52
8.6	Mechanical and electrical endurance .....	54
8.7	Performance at short-circuit currents .....	54
8.8	Resistance to mechanical shock and impact .....	54
8.9	Resistance to heat .....	54
8.10	Resistance to abnormal heat and to fire .....	54
8.11	Test device.....	54
8.12	Requirements for RCBOs functionally dependent on line voltage .....	55
8.13	<del>Behaviour of RCBOs in case of a single-phase overcurrent through a three-pole or four-pole RCBOVoid</del> .....	55
8.14	Behaviour of RCBOs in case of current surges caused by impulse voltages .....	55
8.15	Behaviour of RCBOs in case of earth fault currents comprising a d.c. component .....	55
8.16	Reliability .....	56
8.17	Electromagnetic compatibility (EMC) .....	56

9	Tests .....	56
9.1	General .....	56
9.2	Test conditions .....	57
9.3	Test of indelibility of marking .....	58
9.4	Test of reliability of screws, current-carrying parts and connections .....	58
9.5	Test of reliability of <b>screw-type</b> terminals for external <b>copper</b> conductors .....	59
9.6	Verification of protection against electric shock .....	62
9.7	Test of dielectric properties .....	62
9.7.1	Resistance to humidity .....	62
9.7.2	Insulation resistance of the main circuit .....	63
9.7.3	Dielectric strength of the main circuit .....	64
9.7.4	Insulation resistance and dielectric strength of auxiliary circuits .....	64
9.7.5	Secondary circuit of detection transformers .....	65
9.7.6	Capability of control circuits connected to the main circuit withstanding high d.c. voltages due to insulation measurements .....	65
9.7.7	Verification of impulse withstand voltages (across clearances and across solid insulation) and of leakage current across open contacts .....	66
9.8	Test of temperature-rise .....	71
9.8.1	Ambient air temperature .....	71
9.8.2	Test procedure .....	71
9.8.3	Measurement of the temperature of parts .....	71
9.8.4	Temperature-rise of a part .....	71
9.9	Verification of the operating characteristic .....	72
9.9.1	Verification of the operating characteristics under residual current conditions .....	72
9.9.2	Verification of the operating characteristic under overcurrent conditions .....	75
9.10	Verification of mechanical and electrical endurance .....	76
9.10.1	General test conditions .....	76
9.10.2	Test procedure .....	77
9.10.3	Condition of the RCBO after test .....	77
9.11	Verification of the trip-free mechanism .....	78
9.11.1	General test conditions .....	78
9.11.2	Test procedure .....	78
9.12	Short-circuit tests .....	78
9.12.1	General conditions for test .....	78
9.12.2	Test circuit for short-circuit performance .....	79
9.12.3	Values of test quantities .....	80
9.12.4	Tolerances on test quantities .....	80
9.12.5	Power factor of the test circuit .....	81
9.12.6	Measurement and verification of $I^2t$ and of the peak current ( $I_p$ ) .....	81
9.12.7	Calibration of the test circuit .....	81
9.12.8	Interpretation of records .....	82
9.12.9	Condition of the RCBO for test .....	82
9.12.10	Behaviour of the RCBO during short-circuit tests .....	83
9.12.11	Test procedure .....	83
9.12.12	Verification of the RCBO after short-circuit test .....	87
9.12.13	Verification of the rated residual making and breaking capacity ( $I_{\Delta m}$ ) .....	88

9.13	Verification of resistance to mechanical shock and impact .....	89
9.13.1	Mechanical shock .....	89
9.13.2	Mechanical impact .....	89
9.14	Test of resistance to heat .....	92
9.15	Test of resistance to abnormal heat and to fire .....	93
9.16	Verification of the operation of the test device at the limits of rated voltage .....	94
9.17	Verification of the behaviour of RCBOs functionally dependent on line voltage, classified under 4.1.2.1, in case of failure of the line voltage .....	94
9.17.1	Determination of the limiting value of the line voltage ( $U_x$ ) .....	94
9.17.2	Verification of the automatic opening in case of failure of the line voltage .....	95
9.17.3	Verification of the correct operation, in presence of a residual current, for RCBOs opening with delay in case of failure of the line voltage .....	95
9.17.4	Verification of correct operation of RCBOs with three or four current paths, in presence of a residual current, the neutral and one line terminal only being energized .....	95
9.17.5	Verification of the reclosing function of automatically reclosing RCBOs .....	95
9.18	<del>Verification of the limiting value of overcurrent in case of a single-phase load through a three-pole or four-pole RCBO</del> Void .....	95
9.19	Verification of behaviour of RCBOs in case of current surges caused by impulse voltages .....	96
9.19.1	Current surge test for all RCBOs (0,5 µs/100 kHz ring wave test) .....	96
9.19.2	Verification of behaviour at surge currents up to 3 000 A (8/20 µs surge current test) .....	96
9.20	<del>Verification of resistance of the insulation against an impulse voltage</del> Void .....	97
9.21	<del>Verification of correct operation of residual currents with d.c. components</del> Void .....	98
9.21.1	<del>Type A residual current devices</del> .....	98
9.22	Verification of reliability .....	99
9.22.1	Climatic test .....	99
9.22.2	Test with temperature of 40 °C .....	101
9.23	Verification of ageing of electronic components .....	101
9.24	Electromagnetic compatibility (EMC) .....	102
9.24.1	Tests covered by the present standard .....	102
9.24.2	Tests to be carried out according to IEC 61543 .....	102
9.25	Test of resistance to rusting .....	102
Annex A (normative)	Test sequence and number of samples to be submitted for certification purposes .....	131
Annex B (normative)	Determination of clearances and creepage distances .....	138
Annex C (normative)	Arrangement for the detection of the emission of ionized gases during short-circuit tests .....	145
Annex D (normative)	Routine tests .....	148
Annex E (normative)	Special requirements for auxiliary circuits for safety extra-low voltage .....	149
Annex F (normative)	Coordination between RCBOs and separate fuses associated in the same circuit .....	150
Annex G (normative)	Additional requirements and tests for RCBOs consisting of a circuit-breaker and a residual current unit designed for assembly on site .....	151

Annex H (informative) Void .....	155
Annex IA (informative) Methods for determination of short-circuit power-factor .....	156
Annex IB (informative) Glossary of symbols.....	158
Annex IC (informative) Examples of terminals.....	159
Annex ID (informative) Correspondence between ISO and AWG copper conductors .....	162
Annex IE (informative) Follow-up testing programme for RCBOs .....	163
<b>Annex J (normative) Particular requirements for RCBOs with screwless type terminals for external copper conductors .....</b>	<b>167</b>
Annex K (normative) Particular requirements for RCBOs with flat quick-connect terminations.....	175
<b>Annex L (normative) Specific requirements for RCBOs with screw-type terminals for external untreated aluminium conductors and with aluminium screw-type terminals for use with copper or with aluminium conductors .....</b>	<b>182</b>
Bibliography .....	192
Figure 1 – Thread-forming tapping screw (3.6.10).....	103
Figure 2 – Thread-cutting tapping screw (3.6.11).....	103
Figure 3 – Jointed test finger (9.6) .....	104
Figure 4 – Test circuit for the verification of – operating characteristics (9.9.1) – trip-free mechanism (9.11) – behaviour in case of failure of line voltage (9.17.3 and 9.17.4) for RCBOs functionally dependent on line voltage.....	105
Figure 5 – Test circuit for the verification of the correct operation of RCBOs, in the case of residual pulsating direct currents.....	106
Figure 6 – Test circuit for the verification of the correct operation in case of residual pulsating direct currents in presence of a standing smooth direct current of 0,006 A.....	107
<b>Figure 7 – Test circuit for the verification of the suitability of an RCBO for use in IT systems (9.12.11.2.2) .....</b>	<b>109</b>
Figure 7 – Typical diagram for all short-circuit tests except for 9.12.11.2.2 .....	110
<b>Figure 8 – Test circuit for the verification of the rated short-circuit capacity of a single- pole RCBO with two current paths (9.12) .....</b>	<b>111</b>
Figure 8 – Typical diagram for short-circuit tests according to 9.12.11.2.2 .....	112
<b>Figure 9 – Test circuit for the verification of the rated short-circuit capacity of a two- pole RCBO, in case of a single phase circuit (9.12) .....</b>	<b>113</b>
Figure 9 – Detail of impedances Z, Z <sub>1</sub> and Z <sub>2</sub> .....	113
<b>Figure 10 – Test circuit for the verification of the rated short-circuit capacity of a three- pole RCBO on a three phase circuit (9.12) –Void .....</b>	<b>114</b>
<b>Figure 11 – Test circuit for the verification of the rated short-circuit capacity of a three- pole RCBO with four current paths on a three phase circuit with neutral (9.12) –Void .....</b>	<b>115</b>
<b>Figure 12 – Test circuit for the verification of the rated short-circuit capacity of a four- pole RCBO on a three phase circuit with neutral (9.12) –Void .....</b>	<b>116</b>
Figure 13 – Example of calibration record for short-circuit test .....	117
Figure 14 – Mechanical shock test apparatus (9.13.1) .....	118
Figure 15 – Mechanical impact test apparatus (9.13.2.1) .....	119
Figure 16 – Striking element for pendulum impact test apparatus (9.13.2.1) .....	120
Figure 17 – Mounting support for sample for mechanical impact test (9.13.2.1) .....	121