

Australian/New Zealand Standard™

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

**Part 1: General rules
(IEC 61009-1, Ed. 3.2 (2013) MOD)**



AS/NZS 61009.1:2015

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-004, Electrical Accessories. It was approved on behalf of the Council of Standards Australia on 12 February 2015 and on behalf of the Council of Standards New Zealand on 10 February 2015.

This Standard was published on 23 March 2015.

The following are represented on Committee EL-004:

Australian Chamber of Commerce and Industry
Australian Industry Group
Consumer Electronics Suppliers Association
Consumers Federation of Australia
Electrical Compliance Testing Association
Electrical Regulatory Authorities Council
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This Standard was issued in draft form for comment as DR AS/NZS 61009.1:2014.

Australian/New Zealand Standard™

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

Part 1: General rules (IEC 61009-1, Ed. 3.2 (2013) MOD)

Originated in Australia as part of AS C111—1938.
Originated in New Zealand as AS/NZS 61009.1:1999.
Previous edition 2011.
Fourth edition 2015.

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-004, Electrical Accessories, to supersede AS/NZS 61009.1:2011, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)*, Part 1: *General rules (IEC 61009-1, Ed.3.0 (2010) MOD)*.

The objective of this Standard is to provide Australian and New Zealand electrical industries with requirements for residual current operated circuit-breakers with integral overcurrent protection functionally independent of, or functionally dependent on, line voltage for household and similar uses.

This Standard is an adoption with national modifications. It has been reproduced from IEC 61009-1, Ed. 3.2 (2013), *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)*, Part 1: *General rules*, which incorporates Amendment 1 (2012) and Amendment 2 (2013) and has been varied as indicated to take account of Australian/New Zealand conditions. The variations are specified in Appendix ZZ.

The variations described in Appendix ZZ form the Australian and New Zealand variations for the purposes of the CB scheme for recognition of testing to standards for safety of electrical equipment (the CB Scheme).

This Standard will exist in parallel with AS/NZS 3190, *Approval and test specification—Residual current devices (current-operated earth-leakage devices)*, and AS/NZS 3111, *Approval and test specification—Miniature overcurrent circuit-breakers*, and any revisions thereof. Both this Standard and AS/NZS 3190, in conjunction with AS/NZS 3111, are acceptable for RCBOs. PRCDs are acceptable only if they comply with AS/NZS 3190.

The essential safety requirements in AS/NZS 3820, *Essential safety requirements for electrical equipment*, that could be applicable to RCBOs are covered by this Standard.

This Standard is structured as follows:

- (a) Preface.
- (b) IEC 61009-1, Ed. 3.2 (2013) (unedited from the contents page to the final clause of the source document).
- (c) Appendix ZZ—(Australian/New Zealand) variations to the source document.

The variations listed in Appendix ZZ address issues including the following:

- (i) Verification of the correct operation in case of sudden appearance of residual currents at specified currents between $5 I_{\Delta n}$ and 500 A.
- (ii) Routine tests for overcurrent operation.
- (iii) Type 1 RCBO additional requirements.
- (iv) Add verification of the test device current.

As this Standard is reproduced from an International Standard, the following applies:

- (A) In the source text ‘this International Standard’ should read ‘this Australian/New Zealand Standard’.
- (B) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>		<i>Australian/New Zealand Standard</i>	
IEC		AS	
60060	High-voltage test techniques	1931	High-voltage test techniques
60060-1	Part 1: General definitions and test requirements	1931.1	Part 1: General definitions and test requirements
60060-2	Part 2: Measuring systems	1931.2	Part 2: Measuring systems
60068	Environmental testing	60068	Environmental testing
60068-3-4	Part 3-4: Supporting documentation and guidance—Damp heat tests	60068.3.4	Part 3.4: Supporting documentation and guidance—Damp heat tests
60417	Graphical symbols for use on equipment	60417	Graphical symbols for use on equipment
60417-1	Part 1: Overview and application	60417.1	Part 1: Overview and application
60529	Degrees of protection provided by enclosures (IP Code)	60529	Degrees of protection provided by enclosures (IP Code)
IEC		AS/NZS	
60695	Fire hazard testing	60695	Fire hazard testing
60695-2-10	Part 2-10: Glowing/hot-wire based test methods—Glow-wire apparatus and common test procedure	60695.2.10	Part 2.10: Glowing/hot wire based test methods—Glow-wire apparatus and common test procedure
60695-2-11	Part 2-11: Glowing/hot-wire based test methods—Glow-wire flammability test method for end-products	60695.2.11	Part 2.11: Glowing/hot-wire based test methods—Glow-wire flammability test method for end-products (IEC 6095-2-11:2000, MOD)
60898	Electrical accessories—Circuit-breakers for overcurrent protection for household and similar installations	60898	Electrical accessories—Circuit-breakers for overcurrent protection for household and similar installations
60898-1	Part 1: Circuit-breakers for a.c. operation	60898.1	Part 1: Circuit-breakers for a.c. operation (IEC 61009-1, Ed.3.0 (2010) MOD)
CISPR		AS/NZS CISPR	
14	Electromagnetic compatibility—Requirements for household appliances, electric tools and similar apparatus	14	Electromagnetic compatibility—Requirements for household appliances, electric tools and similar apparatus
14-1	Part 1: Emission	14.1	Part 1: Emission

Only normative references that have been adopted as Australian or Australian/New Zealand Standards have been listed.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annex to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

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INTRODUCTION

This part includes definitions, requirements and tests covering all types of RCBOs. For applicability to a specific type, this part applies in conjunction with the relevant part, as follows:

Part 2-1: Applicability of the general rules to RCBOs functionally independent of line voltage.

Part 2-2: Applicability of the general rules to RCBOs functionally dependent on line voltage.

AUSTRALIAN/NEW ZEALAND STANDARD

Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)**Part 1:****General rules (IEC 61009-1, Ed. 3.2 (2013) MOD)****1 Scope**

This International Standard applies to residual current operated circuit-breakers with integral overcurrent protection functionally independent of, or functionally dependent on, line voltage for household and similar uses (hereafter referred to as RCBOs), for rated voltages not exceeding 440 V a.c. with rated frequencies of 50 Hz, 60 Hz or 50/60 Hz and rated currents not exceeding 125 A and rated short-circuit capacities not exceeding 25 000 A for operation at 50 Hz or 60 Hz.

These devices are intended to protect people against indirect contact, the exposed conductive parts of the installation being connected to an appropriate earth electrode and to protect against overcurrents the wiring installations of buildings and similar applications. They may be used to provide protection against fire hazards due to a persistent earth fault current, without the operation of the overcurrent protective device.

RCBOs having a rated residual operating current not exceeding 30 mA are also used as a means for additional protection in the case of failure of the protective means against electric shock.

This standard applies to devices performing simultaneously the function of detection of the residual current, of comparison of the value of this current with the residual operating value and of opening of the protected circuit when the residual current exceeds this value, and also of performing the function of making, carrying and breaking overcurrents under specified conditions.

NOTE 1 The content of the present standard related to operation under residual current conditions is based on IEC 61008-1. The content of the present standard related to protection against overcurrents is based on IEC 60898-1.

NOTE 2 RCBOs are essentially intended to be operated by uninstructed persons and designed not to require maintenance. They may be submitted for certification purposes.

NOTE 3 Installation and application rules of RCBOs are given in the IEC 60364 series.

They are intended for use in an environment with pollution degree 2.

NOTE 4 For more severe overvoltage conditions, circuit-breakers complying with other standards (e.g. IEC 60947-2) should be used.

NOTE 5 For environments with higher pollution degrees, enclosures giving the appropriate degree of protection should be used.

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

RCBOs of type S are considered to be sufficiently proof against unwanted tripping even if the surge voltage causes a flashover and a follow-on current occurs.

NOTE 6 Surge arresters installed downstream of the general type of RCBOs and connected in common mode may cause unwanted tripping.

RCBOs are suitable for isolation.

RCBOs complying with this standard, with the exception of those with an uninterrupted neutral, are suitable for use in IT systems.

Special precautions (e.g. lightning arresters) may be necessary when excessive overvoltages are likely to occur on the supply side (for example in the case of supply through overhead lines) (see IEC 60364-4-44).

NOTE 7 For RCBOs having a degree of protection higher than IP20 special constructions may be required.

This standard also applies to RCBOs obtained by the assembly of an adaptable residual current device with a circuit-breaker. The mechanical assembly shall be effected in the factory by the manufacturer, or on site, in which case the requirements of Annex G shall apply. It also applies to RCBOs having more than one rated current, provided that the means for changing from one discrete rating to another is not accessible in normal service and that the rating cannot be changed without the use of a tool.

Supplementary requirements may be necessary for RCBOs of the plug-in type.

Particular requirements are necessary for RCBOs incorporated in or intended only for association with plugs and socket-outlets or with appliance couplers for household and similar general purposes and if intended to be used at frequencies other than 50 Hz or 60 Hz.

For RCBOs incorporated in, or intended only for association with socket-outlets, the requirements of this standard may be used, as far as applicable, in conjunction with the requirements of IEC 60884-1 or the national requirements of the country where the product is placed on the market.

NOTE 8 Residual current-operated protective devices (RCDs) incorporated in, or intended only for association with socket-outlets, can either meet IEC 62640 or this standard.

NOTE 9 In DK, plugs and socket-outlets shall be in accordance with the requirements of the heavy current regulations section 107.

NOTE 10 In the UK, the plug part associated with an RCBO shall comply with BS 1363-1 and the socket-outlet(s) associated with an RCBO shall comply with BS 1363-2. In the UK, the plug part and the socket-outlet(s) associated with an RCBO need not comply with any IEC 60884-1 requirements.

This standard does not apply to:

- RCBOs intended to protect motors;
- RCBOs the current setting of which is adjustable by means accessible to the user in normal service.

The requirements of this standard apply for normal environmental conditions (see 7.1). Additional requirements may be necessary for RCBOs used in locations having severe environmental conditions.

RCBOs including batteries are not covered by this standard.

A guide for the coordination of RCBOs with fuses is given in Annex F.

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 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2:1994, *High-voltage test techniques – Part 2: Measuring systems*

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

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

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60228:2004, *Conductors of insulated cables*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

IEC 60364-5-52:2001, *Electrical installations of buildings – Part 5-52: Selection and erection of electrical equipment – Wiring systems¹*

IEC 60364-5-53:2001, *Low-voltage electrical installations – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*

IEC 60417, *Graphical symbols for use on equipment*

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

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

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

IEC 60695-2-10, *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 60898-1:2002, *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

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

Amendment 1:2004

Amendment 2:2005

CISPR 14-1:2009, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

¹ A third edition is currently in preparation.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

Where the terms "voltage" or "current" are used, they imply r.m.s. values, unless otherwise specified.

NOTE 1 Reference to IEC definitions is also made when the terms "device" or "mechanical switching device" are replaced by the term "RCBO".

NOTE 2 For a glossary of symbols see Annex IB.

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 current conduction is delayed by phase control

3.2 Definitions relating to the energization of a residual current circuit-breaker

3.2.1

energizing quantity

electrical excitation quantity which, alone or in combination with other such quantities, shall be applied to an RCBO to enable it to accomplish its function under specified conditions

3.2.2

energizing input-quantity

energizing quantity by which the RCBO is activated when it is applied under specified conditions

NOTE These conditions may involve, for example, the energizing of certain auxiliary elements.

3.2.3

residual current

I_{Δ}

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

3.2.4

residual operating current

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

3.2.5**residual non-operating current**

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

3.2.6**residual current ($I_{\Delta t}$) of an RCBO**

value of residual current which is the lower limit of the overcurrent instantaneous tripping range according to type B, C or D (see footnote c of Table 2)

3.3 Definitions relating to the operation and functions of residual current circuit-breakers**3.3.1****switching device**

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

[IEV 441-14-01:1984]

3.3.2**mechanical switching device**

switching device designed to close and open one or more electric circuits by means of separable contacts

[IEV 441-14-02: 1984, modified]

3.3.3**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. The fuse comprises all the parts that form the complete device

[IEV 441-18-01:1984, modified]

3.3.4**circuit-breaker**

mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and (automatically) breaking currents under specified abnormal conditions such as those of short-circuit

[IEV 441-14-20:1984, modified]

3.3.5**residual current operated circuit-breaker**

mechanical switching device 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

3.3.6**residual current operated circuit-breaker without integral overcurrent protection****RCCB**

residual current operated circuit-breaker not designed to perform the functions of protection against overloads and/or short-circuits

3.3.7**residual current operated circuit-breaker with integral overcurrent protection****RCBO**

residual current operated circuit-breaker designed to perform the functions of protection against overloads and/or short-circuits

3.3.8**RCBOs functionally independent of line voltage**

RCBOs for which the functions of detection, evaluation and interruption do not depend on the line voltage

NOTE These devices are defined in 2.3.2 of IEC/TR 60755:1983 as residual current devices without auxiliary source.

3.3.9**RCBOs functionally dependent on line voltage**

RCBOs for which the functions of detection, evaluation or interruption depend on the line voltage

NOTE 1 This definition covers partially the definition of residual current devices with auxiliary source of 2.3.3 of IEC 60755:1983.

NOTE 2 It is understood that the line voltage is applied to the RCBO, for detection, evaluation or interruption.

3.3.10**break time of an RCBO**

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

3.3.11**limiting non-actuating time**

maximum delay during which a value of residual current higher than the residual non-operating current can be applied to the RCBO without causing it to operate

3.3.12**time-delay RCBO**

RCBO specially designed to attain a pre-determined value of limiting non-actuating time, corresponding to a given value of residual current

3.3.13**closed position**

position in which the predetermined continuity of the main circuit of the RCBO is secured

[IEV 441-16-22]

3.3.14**open position**

position in which the predetermined clearance between open contacts in the main circuit of the RCBO is secured

[IEV 441-16-23]

3.3.15**pole**

that part of an RCBO 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

3.3.15.1**overcurrent protected pole**

pole provided with an overcurrent release, hereafter referred to as protected pole

3.3.15.2**overcurrent unprotected pole**

pole without an overcurrent release, but otherwise generally capable of the same performance as a protected pole of the same RCBO, hereafter referred to as unprotected pole

NOTE 1 To ensure this requirement, the unprotected pole may be of the same construction as the protected pole(s), or of a particular construction.

NOTE 2 If the short-circuit capacity of the unprotected pole is different from that of the protected pole(s), this should be indicated by the manufacturer.

3.3.15.3**switched neutral pole**

pole only intended to switch the neutral and not intended to have a short-circuit capacity

3.3.16**uninterrupted neutral**

current path, not interrupted and not protected against overcurrents, intended to be connected to the neutral conductor of the installation

3.3.17**main circuit (of an RCBO)**

all the conductive parts of an RCBO included in the current paths (see 4.3)

3.3.18**control circuit (of an RCBO)**

circuit (other than a path of the main circuit) intended for the closing operation or the opening operation, or both, of the RCBO

NOTE The circuits intended for the test device are included in this definition.

3.3.19**auxiliary circuit (of an RCBO)**

all the conductive parts of an RCBO which are intended to be included in a circuit other than the main circuit and the control circuit of the RCBO

[IEV 441-15-04]

3.3.20**RCBO type AC**

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

3.3.21**RCBO type A**

RCBO for which tripping is ensured for residual sinusoidal alternating currents and residual pulsating direct currents, whether suddenly applied or slowly rising

3.3.22**test device**

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

3.4 Definitions relating to values and ranges of energizing quantities**3.4.1****rated value**

quantity value assigned by the manufacturer, for a specific operating condition of an RCBO

3.4.2**overcurrent**

any current exceeding the rated current

3.4.2.1**overload current**

overcurrent occurring in an electrically undamaged circuit

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

3.4.2.2**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.

3.4.3**prospective current**

current that would flow in the circuit, if each main current path of the RCBO 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.

3.4.4**prospective peak current**

peak value of a prospective current during the transient period following initiation

NOTE The definition assumes that the current is made by an ideal RCBO, i.e. with instantaneous transition from infinite to zero impedance. For circuits where the current can follow several different paths, for example polyphase circuits, it further assumes that the current is established simultaneously in all poles, even if the current only in one pole is considered.

3.4.5**maximum prospective peak current (of an a.c. circuit)**

prospective peak current, when the initiation of the current takes place at the instant which leads to the highest possible value

NOTE For a multipole circuit-breaker in a polyphase circuit, the maximum prospective peak current refers to a single pole only.

3.4.6**short-circuit (making and breaking) capacity**

alternating component of the prospective current, expressed by its r.m.s. value, which the RCBO is designed to make, to carry for its opening time and to break under specified conditions

3.4.6.1**ultimate short-circuit breaking capacity**

breaking capacity for which the prescribed conditions according to a specified test sequence do not include the capability of the RCBO to carry 0,85 times its non-tripping current for the conventional time

3.4.6.2**service short-circuit breaking capacity**

breaking capacity for which the prescribed conditions according to a specified test sequence include the capability of the RCBO to carry 0,85 times its non-tripping current for the conventional time

3.4.7**breaking current**

current in a pole of an RCBO at the instant of initiation of the arc during a breaking process

[IEV 441-17-07:1984, modified]

NOTE For a.c., reference is made to the r.m.s. value.

3.4.8**applied voltage**

voltage which exists across the terminals of a pole of an RCBO just before the making of the current

[IEV 441-17-24:1984]

NOTE This definition refers to a single-pole RCBO. For a multipole RCBO, the applied voltage is the voltage across the supply terminals of the RCBO.

3.4.9**recovery voltage**

voltage which appears across the terminals of a pole of an RCBO after the breaking of the current

[IEV 441-17-25:1984]

NOTE 1 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.

NOTE 2 This definition refers to a single-pole RCBO. For a multipole RCBO, the recovery voltage is the voltage across the supply terminals of the RCBO.

3.4.9.1**transient recovery voltage**

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

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

[IEV 441-17-26:1984, modified]

3.4.9.2**power-frequency recovery voltage**

recovery voltage after the transient voltage phenomena have subsided

[IEV 441-17-27:1984]

3.4.10**opening time**

time measured from the instant at which, the RCBO being in the closed position, the current in the main circuit reaches the operating value of the overcurrent release to the instant when the arcing contacts have separated in all poles

NOTE The opening time is commonly referred to as tripping time, although, strictly speaking, tripping time applies to the time between the instant of initiation of the opening time and the instant at which the opening command becomes irreversible.

3.4.11**Definitions relating to arcing time****3.4.11.1****arcing time of a pole**

interval of time between the instant of initiation of the arc in a pole and the instant of final arc extinction in that pole

[IEV 441-17-37, modified]

3.4.11.2

arcing time of a multipole RCBO

interval of time between the instant of first initiation of the arc and the instant of final arc extinction in all poles

[IEV 441-17-38]

3.4.12

break time (in case of overcurrent)

interval of time between the beginning of the opening time of an RCBO and the end of the arcing time, in case of overcurrent

[IEV 441-17-39:1984, modified]

3.4.13

I^2t (Joule integral)

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

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

[IEV 441-18-23:1984]

3.4.14

I^2t characteristic of an RCBO

curve giving the maximum value of I^2t as a function of the prospective current under stated conditions of operation

3.4.15

Coordination between overcurrent protective devices in series

3.4.15.1

selectivity-limit current

I_s

current coordinate of the intersection between the maximum break-time current characteristic of the protective device on the load side and the pre-arcing (for fuses) or tripping (for circuit-breakers) time-current characteristic of the other protective device

NOTE 1 The selectivity-limit current is a limiting value of current:

- below which, in the presence of two overcurrent protective devices in series, the protective device on the load side completes its breaking operation in time to prevent the other protective device from starting its operation (i.e. selectivity is ensured);
- above which, in the presence of two overcurrent protective devices in series, the protective device on the load side may not complete its breaking operation in time to prevent the other protective device from starting its operation (i.e. selectivity is not ensured).

NOTE 2 I^2t characteristics may be used instead of time-current characteristics.

3.4.15.2

take-over current

I_B

current coordinate of the intersection between the maximum break time-current characteristics of two overcurrent protective devices

NOTE 1 The take-over current is a limiting value of current above which, in the presence of two overcurrent protective devices in series, the protective device generally, but not necessarily, on the supply side, provides back-up operation for the other protective device.

NOTE 2 I^2t characteristics may be used instead of time-current characteristics.

3.4.16**conventional non-tripping current** I_{nt}

specified value of current which the RCBO can carry for a specified time (conventional time) without operating

[IEV 441-17-22 :1984]

3.4.17**conventional tripping current** I_t

specified value of current which causes the RCBO to operate within a specified time (conventional time)

3.4.18**instantaneous tripping current**

minimum value of current which causes the circuit-breaker to operate automatically without intentional time-delay

3.4.19**non-operating overcurrents in the main circuit**

NOTE In the case of overcurrent in the main circuit, in the absence of residual current, operation of the detecting device may occur as a consequence of asymmetry existing in the detecting device itself.

3.4.19.1**limiting value of overcurrent in case of a load through an RCBO with two current paths**

maximum value of overcurrent of a load which, in the absence of any fault to frame or to earth, and in the absence of an earth leakage current, can flow through an RCBO with two current paths without causing it to operate

3.4.19.2**limiting value of overcurrent in case of a single phase load through a three-pole or four-pole RCBO**

maximum value of a single phase overcurrent which, in the absence of any fault to frame or to earth, and in the absence of an earth leakage current, can flow through a three-pole or a four-pole RCBO without causing it to operate

3.4.20**residual making and breaking capacity**

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

3.4.21**limiting values (U_x and U_y) of the line voltage for RCBOs functionally dependent on line voltage****3.4.21.1** U_x

minimum value of the line voltage at which an RCBO functionally dependent on line voltage still operates under specified conditions in case of decreasing line voltage (see 9.17.1)

3.4.21.2 U_y

minimum value of the line voltage below which an RCBO functionally dependent on line voltage opens automatically in the absence of any residual current (see 9.17.2)

3.5 Definitions relating to values and ranges of influencing quantities

3.5.1

influencing quantity

any quantity likely to modify the specified operation of an RCBO

3.5.2

reference value of an influencing quantity

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

3.5.3

reference conditions of influencing quantities

collectively, the reference values of all influencing quantities

3.5.4

range of an influencing quantity

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

3.5.5

extreme range of an influencing quantity

range of values of an influencing quantity within which the RCBO suffers only spontaneously reversible changes, although not necessarily complying with any requirements

3.5.6

ambient air temperature

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

NOTE For RCBOs installed inside an enclosure, it is the temperature of the air outside the enclosure.

[IEV 441-11-13]

3.5.7

reference ambient air temperature

ambient air temperature on which the time-overcurrent characteristics are based

3.6 Definitions relating to terminals

3.6.1

terminal

conductive part of an RCBO, provided for re-usable electrical connection to external circuits

3.6.2

screw-type terminal

terminal for the connection and subsequent disconnection of one conductor or the interconnection of two or more conductors capable of being dismantled, the connections being made, directly or indirectly, by means of screws or nuts of any kind

3.6.3

pillar terminal

screw-type terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw(s)

NOTE 1 The clamping pressure may be applied directly by the shank of the screw or by an intermediate clamping element to which pressure is applied by the shank of the screw.

NOTE 2 Examples of pillar terminals are shown in Figure IC.1 of Annex IC.

3.6.4**screw terminal**

screw-type terminal in which the conductor is clamped under the head of the screw. The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, a clamping plate or an anti-spread device

NOTE Examples of screw terminals are shown in Figure IC.2a of Annex IC.

3.6.5**stud terminal**

screw-type terminal in which the conductor is clamped under a nut

NOTE 1 The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, a clamping plate or an anti-spread device.

NOTE 2 Examples of stud terminals are shown in Figure IC.2b.

3.6.6**saddle terminal**

screw-type terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

NOTE Examples of saddle terminals are shown in Figure IC.3.

3.6.7**lug terminal**

screw terminal or a stud terminal, designed for clamping a cable lug or a bar by means of a screw or nut

NOTE Examples of lug terminals are shown in Figure IC.4.

3.6.8**screwless terminal**

connecting terminal for the connection and subsequent disconnection of one conductor or the dismantlable interconnection of two or more conductors capable of being dismantled, the connection being made, directly or indirectly, by means of springs, wedges, eccentrics or cones, etc., without special preparation of the conductor other than removal of insulation

3.6.9**tapping screw**

screw manufactured from a material having high resistance to deformation, when applied by rotary insertion to a hole in a material having less resistance to deformation than the screw

NOTE The screw is made with a tapered thread, the taper being applied to the core diameter of the thread at the end section of the screw. The thread produced by application of the screw is formed securely only after sufficient revolutions have been made to exceed the number of threads on the tapered section.

3.6.10**thread forming tapping screw**

tapping screw having an uninterrupted thread

NOTE 1 It is not a function of this thread to remove material from the hole.

NOTE 2 An example of a thread forming tapping screw is shown in Figure 1.

3.6.11**thread cutting tapping screw**

tapping screw having an interrupted thread

NOTE 1 It is a function of this thread to remove material from the hole.

NOTE 2 An example of a thread cutting tapping screw is shown in Figure 2.

3.7 Definitions relating to conditions of operation

3.7.1

operation

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

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

3.7.2

closing operation

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

[IEV 441-16-08:1984]

3.7.3

opening operation

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

[IEV 441-16-09:1984]

3.7.4

dependent manual operation

operation solely by means of directly applied manual energy, such that the speed and force of the operation are dependent on the action of the operator

[IEV 441-16-13]

3.7.5

independent manual operation

stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator

IEV 441-16-16]

3.7.6

trip-free RCBO

an RCBO, the moving contacts of which return to and remain in the open position when the (automatic) 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.

[IEV 441-16-31]

3.7.7

operating cycle

succession of operations from one position to another and back to the first position through all other positions, if any

[IEV 441-16-02]

3.7.8

sequence of operations

succession of specified operations with specified time intervals

3.7.9**uninterrupted duty**

duty in which the main contacts of an RCBO remain closed whilst carrying a steady current without interruption for long periods (which could be weeks, months, or even years)

3.8 Definitions relating to constructional elements**3.8.1****main contact**

contact included in the main circuit of an RCBO, intended to carry, in the closed position, the current of the main circuit

[IEV 441-15-07:1984]

3.8.2**arcing contact**

contact on which the arc is intended to be initiated

NOTE An arcing contact may serve as a main contact. It may also be a separate contact so designed that it opens after and closes before another contact which it is intended to protect from damage.

3.8.3**control contact**

contact included in a control circuit of an RCBO and mechanically operated by the RCBO

[IEV 441-15-09]

3.8.4**auxiliary contact**

contact included in an auxiliary circuit and mechanically operated by the RCBO (e.g. for indicating the position of the contacts)

[IEV 441-15-10:1984, modified]

3.8.5**release**

device, mechanically connected to (or integrated into) an RCBO which releases the holding means and permits the automatic opening of the RCBO

[IEV 441-15-17, modified]

NOTE In the IEV definition, reference to closing is also made.

3.8.6**overcurrent release**

release which permits an RCBO to open with or without time-delay when the current in the release exceeds a predetermined value

NOTE In some cases, this value may depend upon the rate of rise of current.

[IEV 441-16-33:1984]

3.8.7**inverse time-delay overcurrent release**

overcurrent release which operates after a time-delay inversely dependent upon the value of the overcurrent

NOTE Such a release may be designed so that the time-delay approaches a definite minimum for high values of overcurrent.

[IEV 441-16-35:1984]

3.8.8**direct overcurrent release**

overcurrent release directly energized by the current in the main circuit of an RCBO

[IEV 441-16-36:1984]

3.8.9**overload release**

overcurrent release intended for protection against overloads

[IEV 441-16-38:1984]

3.8.10**conductive part**

part which is capable of conducting current, although it may not necessarily be used for carrying service current

[IEV 441-11-09:1984]

3.8.11**exposed conductive part**

conductive part which can be readily touched and which normally is not live, but which may become live under fault conditions

[IEV 441-11-10:1984]

3.9 Definitions relating to tests**3.9.1****type test**

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

3.9.2**routine test**

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

3.10 Definitions relating to insulation coordination**3.10.1****insulation coordination**

mutual correlation of insulation characteristics of electrical equipment taking into account the expected micro-environment and other influencing stresses

[IEC 60664-1:2007, definition 3.1]

3.10.2**working voltage**

highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

NOTE 1 Transients are disregarded.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

[IEC 60664-1:2007, definition 3.5]

3.10.3**overvoltage**

any voltage having a peak value exceeding the corresponding peak value of maximum steady-state voltage at normal operating conditions

[IEC 60664-1:2007, definition 3.7]

3.10.4**impulse withstand voltage**

highest peak value of impulse voltage of prescribed form and polarity, which does not cause breakdown of the insulation under specific conditions

[IEC 60664-1:2007, definition 3.8.1]

3.10.5**overvoltage category**

numeral defining a transient overvoltage condition

[IEC 60664-1:2007, definition 3.10]

3.10.6**macro-environment**

environment of the room or other location, in which the equipment is installed or used

[IEC 60664-1:2007, definition 3.12.1]

3.10.7**micro-environment**

immediate environment of the insulation which particularly influences the dimensioning of the creepage distances

[IEC 60664-1:2007, definition 3.12.2]

3.10.8**pollution**

any addition of foreign matter, solid, liquid or gaseous that can result in a reduction of electric strength or surface resistivity of the insulation

[IEC 60664-1:2007, definition 3.11]

3.10.9**pollution degree**

numeral characterizing the expected pollution of the micro-environment

[IEC 60664-1:2007, definition 3.13]

NOTE The pollution degree to which equipment is exposed may be different from that of the macro-environment where the equipment is located because of protection offered by means such as an enclosure or internal heating to prevent absorption or condensation of moisture.

3.10.10**isolation (isolating function)**

function intended to cut off the supply from the whole installation or a discrete section of it by separating it from every source of electrical energy for reasons of safety

[IEC 60947-1:2007, definition 2.1.19, modified]

3.10.11**isolating distance**

clearance between open contacts, meeting the safety requirements specified for isolation purposes

[IEV 441-17-35:1984, modified]

3.10.12

clearance

shortest distance in air between two conductive parts along a string stretched the shortest way between these conductive parts

[IEV 441-17-31, modified]

NOTE 1 For the purpose of determining a clearance to accessible parts, the accessible surface of an insulating enclosure should be 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 Figure 3.

NOTE 2 See also Annex B.

3.10.13

creepage distance

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

[IEV 604-03-61:1987, modified]

NOTE 1 For the purpose of determining a creepage distance to accessible parts, the accessible surface of an insulating enclosure should be 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 Figure 3.

NOTE 2 See also Annex B.

4 Classification

RCBOs are classified in the following 12 ways:

4.1 According to the method of operation

NOTE The selection of the various types is made according to the requirements of IEC 60364-5-53.

4.1.1 RCBO functionally independent of line voltage (see 3.3.8)

4.1.2 RCBO functionally dependent on line voltage (see 3.3.9)

4.1.2.1 Opening automatically in case of failure of the line voltage, without or with delay (see 8.12):

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

4.1.2.2 Not opening automatically in case of failure of the line voltage:

- a) able to trip in case of a hazardous situation (e.g. due to an earth fault), arising on failure of the line voltage (requirements under consideration);
- b) not able to trip in case of a hazardous situation (e.g. due to an earth fault), arising on failure of line voltage.

NOTE The selection of the RCBOs in b) is subject to the conditions of 531.2.2.2 of IEC 60364-5-53:2001.

4.2 According to the type of installation

- RCBO for fixed installation and fixed wiring;
- RCBO for mobile installation and corded connection (of the device itself to the supply).

4.3 According to the number of poles and current paths

- single-pole RCBO with one overcurrent protected pole and uninterrupted neutral (see 3.3.16) (two current paths);
- two-pole RCBO with one overcurrent protected pole;
- two-pole RCBO with two overcurrent protected poles;
- three-pole RCBO with three overcurrent protected poles;
- three-pole RCBO with three overcurrent protected poles and uninterrupted neutral (four current paths);
- four-pole RCBO with three overcurrent protected poles;
- four-pole RCBO with four overcurrent protected poles.

NOTE The pole which is not an overcurrent protected pole (see 3.3.15.1) may be:

- "unprotected" (see 3.3.15.2), or
- "switched neutral" (see 3.3.15.3).

4.4 According to the possibility of adjusting the residual operating current

- RCBO with a single value of rated residual operating current;
- RCBO with multiple settings of residual operating current by fixed steps (see 5.2.3).

4.5 According to resistance to unwanted tripping due to voltage surges

- RCBOs with normal resistance to unwanted tripping (general type as in Table 2, and Table 3 if applicable);
- RCBOs with increased resistance to unwanted tripping (S type as in Table 2, and Table 3 if applicable).

4.6 According to behaviour in presence of d.c. components

- RCBOs of type AC;
- RCBOs of type A.

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

- RCBO without time-delay: type for general use;
- RCBO with time-delay: type S for selectivity.

4.8 According to the protection against external influences

- enclosed-type RCBO (not requiring an appropriate enclosure);
- unenclosed-type RCBO (for use with an appropriate enclosure).

4.9 According to the method of mounting

- surface-type RCBO;
- flush-type RCBO;
- panel board type RCBO, also referred to as distribution board type.

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

4.10 According to the method of connection

- RCBOs, the electrical connections which are not associated with the mechanical mounting;
- RCBOs, the electrical connections which are associated with the mechanical mounting.

NOTE Examples of this type are:

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

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

4.11 According to the instantaneous tripping current (see 3.4.18)

- B-type RCBO;
- C-type RCBO;
- D-type RCBO.

4.12 According to the I^2t characteristic

In addition to the I^2t characteristic to be provided by the manufacturer in accordance with Clause 5, RCBOs may be classified according to their I^2t characteristic.

4.13 According to the type of terminals

- RCBOs with screw-type terminals for external copper conductors;
- RCBOs with screwless type terminals for external copper conductors;

NOTE 1 The requirements for RCBOs equipped with these types of terminals are given in Annex J.

- RCBOs with flat quick-connect terminals for external copper conductors;

NOTE 2 The requirements for RCBOs equipped with these types of terminals are given in Annex K.

- RCBOs with screw-type terminals for external aluminium conductors.

NOTE 3 The requirements for RCBOs equipped with this type of terminal are given in Annex L.

5 Characteristics of RCBOs

5.1 Summary of characteristics

The characteristics of an RCBO shall be stated in the following terms:

- type of installation (see 4.2);
- number of poles and current paths (see 4.3);
- rated current I_n (see 5.2.2);
- rated residual operating current $I_{\Delta n}$ (see 5.2.3);
- rated residual non-operating current $I_{\Delta no}$ (see 5.2.4);
- rated voltage U_n (see 5.2.1);
- rated frequency (see 5.2.5);
- rated short-circuit capacity I_{cn} (see 5.2.6);
- rated residual making and breaking capacity $I_{\Delta m}$ (see 5.2.7);
- time-delay, if applicable (see 5.2.8);
- operating characteristics in case of residual currents with d.c. components (see 5.2.9);
- method of mounting (see 4.9);
- method of connection (see 4.10);
- range of instantaneous tripping overcurrent (see 4.11);

- I^2t classification (see 4.12);
- degree of protection (see IEC 60529).

For RCBOs functionally dependent on line voltage:

- behaviour of the RCBO in case of failure of line voltage (see 4.1.2).

5.2 Rated quantities and other characteristics

5.2.1 Rated voltage

5.2.1.1 Rated operational voltage (U_e)

The rated operational voltage (hereafter referred to as "rated voltage") of an RCBO is the value of voltage, assigned by the manufacturer, to which its performance is referred.

NOTE The same RCBO may be assigned a number of rated voltages and associated rated short-circuit capacities.

5.2.1.2 Rated insulation voltage (U_i)

The rated insulation voltage of an RCBO is the value of voltage, assigned by the manufacturer, to which dielectric test voltages and creepage distances are referred.

Unless otherwise stated, the rated insulation voltage is the value of the maximum rated voltage of the RCBO. In no case shall the maximum rated voltage exceed the rated insulation voltage.

5.2.1.3 Rated impulse withstand voltage (U_{imp})

The rated impulse withstand voltage of an RCBO shall be equal to or higher than the standard values of rated impulse withstand voltage given in Table 5.

5.2.2 Rated current (I_n)

A current assigned by the manufacturer as the current which the RCBO can carry in uninterrupted duty (see 3.7.9), at a specified reference ambient air temperature.

The standard reference ambient air temperature is 30 °C. If a different reference ambient air temperature for the RCBO is used, the effect on the overload protection of cables shall be taken into account, since this is also based on a reference ambient air temperature of 30 °C, according to installation rules (see Clause 523 of IEC 60364-5-52:2001).

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

The value of residual operating current (see 3.2.4), assigned to the RCBO by the manufacturer, at which the RCBO shall operate under specified conditions.

For an RCBO having multiple settings of residual operating current, the highest setting is used to designate it.

RCBOs with continuously adjustable settings are not allowed.

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

The value of residual non-operating current (3.2.5), assigned to the RCBO by the manufacturer, at which the RCBO does not operate under specified conditions.

5.2.5 Rated frequency

The rated frequency of an RCBO is the power frequency for which the RCBO is designed and to which the values of the other characteristics correspond.

NOTE The same RCBO may be assigned a number of rated frequencies.

5.2.6 Rated short-circuit capacity (I_{cn})

The rated short-circuit capacity of an RCBO is the value of the ultimate short-circuit breaking capacity (see 3.4.6.1) assigned to that RCBO by the manufacturer.

NOTE An RCBO having a given rated short-circuit capacity I_{cn} has a corresponding service short-circuit capacity (I_{cs}) (see Table 22).

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

The r.m.s. value of the a.c. component of residual prospective current (3.2.3 and 3.4.3), assigned by the manufacturer, which an RCBO can make, carry and break under specified conditions.

The conditions are those specified in 9.12.13.

5.2.8 RCBO type S

A time-delay RCBO (see 3.3.12) which complies with the relevant part of Table 2 and Table 3 if applicable.

5.2.9 Operating characteristics in case of residual currents with d.c. components

5.2.9.1 RCBO type AC

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

5.2.9.2 RCBO type A

An RCBO for which tripping is ensured for residual sinusoidal alternating currents and residual pulsating direct currents, whether suddenly applied or slowly rising.

5.3 Standard and preferred values

5.3.1 Preferred values of rated voltage (U_n)

Preferred values of rated voltage are as follows:

RCBOs	Circuit supplying the RCBOs	Rated voltage of RCBOs for use in systems 230 V or 230/400 V or 400 V V	Rated voltage of RCBOs for use in systems 120/240 V or 240 V V
Single pole (with two current paths)	Single-phase (phase to earthed middle conductor or phase to neutral)	230	120
Two-pole	Single phase (phase to neutral or phase to phase or phase to earthed middle conductor)	230	120
	Single phase (phase to phase)	400	240
	Single phase (phase to phase, 3-wire)		120/240
	Three phase (4-wire) (230/400 V-system phase to neutral or 230 V-system phase to phase)	230	

Three-pole (with three or four current path)	Three phase (3-wire or 4-wire) (400 V or 230/400 V or 240 V-system)	400	240
Four-pole	Three phase (4-wire) (230/400 V-system)	400	

NOTE 1 In IEC 60038 the network voltage value of 230/400 V has been standardized. This value should progressively supersede the values of 220/380V and 240/415 V.

NOTE 2 Wherever in this standard there is a reference to 230 V or 400 V, they may be read as 220 V or 240 V, 380 V or 415 V, respectively.

NOTE 3 Wherever in this standard there is a reference to 120 V or 120/240 V or 240 V, they may be read as 100 V or 100/200 V or 200 V, respectively.

NOTE 4 Wherever in this standard there is a reference to 240 V three phases, it may be read as 100 V or 120/208 V.

NOTE In Japan phase to neutral conductor and phase to earthed conductor (grounded conductor) is thought differently because single phase 2-wire system supplied from 2-wire system source do not have neutral point.

5.3.2 Preferred values of rated current (I_n)

Preferred values of rated current are:

6 – 8 – 10 – 13 – 16 – 20 – 25 – 32 – 40 – 50 – 63 – 80 – 100 – 125 A.

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

Standard values of rated residual operating current are:

0,006 – 0,01 – 0,03 – 0,1 – 0,3 – 0,5 A.

NOTE In KR and Japan, the values of 0,015 A, 0,2 A and 1 A are also considered as standard values.

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

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

NOTE For residual pulsating direct currents, residual non-operating currents depend on the current delay angle α (see 3.1.4).

5.3.5 Standard values of rated frequency

Preferred values of rated frequency are: 50 Hz, 60 Hz and 50/60 Hz.

5.3.6 Values of rated short-circuit capacity

5.3.6.1 Standard values up to and including 10 000 A

Standard values of rated short-circuit capacities up to and including 10 000 A are given in Table 1.

Table 1 – Standard values of rated short-circuit capacity

1 500 A
3 000 A
4 500 A
6 000 A
10 000 A

NOTE The values of 1 000 A, 2 000 A, 2 500 A, 7 500 A and 9 000 A are also considered as standard in some countries.

The corresponding ranges of power factor are given in 9.12.5.

5.3.6.2 Values above 10 000 A up to and including 25 000 A

For values above 10 000 A up to and including 25 000 A preferred values are 15 000 A and 20 000 A.

The corresponding range of power factor is given in 9.12.5.

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

The minimum value of the rated residual making and breaking capacity ($I_{\Delta m}$) is $10 I_n$ or 500 A, whichever is the greater.

The associated power factors are specified in Table 21.

5.3.8 Limiting values of break time and non-actuating time for RCBO of type AC and A

5.3.8.1 Limiting values of break time and non-actuating time for alternating residual currents (r.m.s. values) for type AC and A

Table 2 – Limiting values of break time and non-actuating time for alternating residual currents (r.m.s. values) for type AC and A RCBO

Limiting values of break time and non-actuating time (s) for type AC and A RCBOs in event of alternating residual currents (r.m.s. values) equal to									
Type	I_n A	$I_{\Delta n}$ A	$I_{\Delta n}$	$2 I_{\Delta n}$	$5 I_{\Delta n}$	$5 I_{\Delta n}$ or 0,25 A ^a	5 A – 200 A, 500 A ^b	$I_{\Delta t}$ ^c	
General	Any	<0,03	0,3	0,15		0,04	0,04	0,04	Maximum break times
		0,03	0,3	0,15		0,04	0,04	0,04	
		>0,03	0,3	0,15	0,04		0,04	0,04	
S	≥25	>0,03	0,5	0,2	0,15		0,15	0,15	Minimum non-actuating times
		>0,03	0,13	0,06	0,05		0,04	0,04	

^a Value to be decided by the manufacturer for this test.

^b The tests are only made during the verification of the correct operation as mentioned in 9.9.12 d) but in any case values exceeding the lower limit of the overcurrent instantaneous tripping range are not tested.

^c The test is made with a current $I_{\Delta t}$ equal to the lower limit of the overcurrent instantaneous tripping range according to type B, C or D, as applicable. For the tests of 9.9.1.3 and 9.9.1.4 b), the current $I_{\Delta t}$ is established so that the vector sum $I_{\Delta t} + I_n$ is equal to the lower limit of the overcurrent instantaneous tripping range, according to type B, C or D, as applicable.

NOTE In the US, 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

$$T = 125 \left(\frac{10}{V} \right)^{1.43}$$

for low resistance faults.

5.3.8.2 Maximum values of break time for half-wave residual currents (r.m.s. values) for type A

Table 3 – Maximum values of break time for half-wave residual currents (r.m.s. values) for type A RCBO

			Maximum values of break time and non-actuating time (s) for type A RCBOs in the event of half-wave pulsating residual currents (r.m.s. values) equal to							
Type	I_n A	$I_{\Delta n}$ A	$1,4 I_{\Delta n}$	$2 I_{\Delta n}$	$2,8 I_{\Delta n}$	$4 I_{\Delta n}$	$7 I_{\Delta n}$	0,35 A	0,5 A	350 A ^a
General	Any	<0,03		0,3		0,15			0,04	0,04
		0,03	0,3		0,15			0,04		0,04
		>0,03	0,3		0,15		0,04			0,04
S	≥25	>0,03	0,5		0,2		0,15			0,15

^a This value shall be limited to the lower limit of the overcurrent instantaneous tripping ranges according to type B, C or D, as applicable.

5.3.9 Standard ranges of overcurrent instantaneous tripping

Standard ranges of overcurrent instantaneous tripping are given in Table 4.

Table 4 – 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 $10 I_n$
D	Above $10 I_n$ up to and including $20 I_n$ ^a

^a For special cases values up to $50 I_n$ may also be used.

5.3.10 Standard values of rated impulse withstand voltage (U_{imp})

Table 5 gives the standard values of rated impulse withstand voltages as a function of the nominal voltage of the installation.

Table 5 – Rated impulse withstand voltage as a function of the nominal voltage of the installation

Rated impulse withstand voltage U_{imp} kV	Nominal voltage of the installation	
	Three-phase systems V	Single-phase system with mid-point earthed V
2,5 ^a		120/240 ^b
4 ^a	230/400	120/240, 240 ^c
NOTE 1 For test voltages to check the insulation, see Table 19.		
NOTE 2 For test voltages to check the isolation distance across open contacts, see Table 28.		
^a The values 3 kV and 5 kV, respectively are used for verifying the isolating distances across open contacts at the altitude of 2 000 m (see Tables 7 and 28). ^b For installation practice in Japan. ^c For installation practice in North American countries.		

6 Marking and other product information

Each RCBO shall be marked in a durable manner with all or, for small apparatus, part of the following data:

- manufacturer's name or trade mark;
- type designation, catalogue number or serial number;
- rated voltage(s);
- rated current without symbol "A", preceded by the symbol of overcurrent instantaneous tripping (B, C or D), for example B 16;
- rated frequency; RCBOs with more than one rated frequency (e.g. 50/60 Hz) shall be marked accordingly;
- rated residual operating current;
- settings of residual operating current for RCBOs with multiple residual operating currents;
- rated short-circuit capacity, in amperes;
- reference calibration temperature, if different from 30 °C;
- the degree of protection (only if different from IP 20);
- the position of use, if necessary;
- rated residual making and breaking capacity, if different from rated short-circuit capacity;
- the symbol  (S in a square) for type S devices;
- indication that the RCBO is functionally dependent on line voltage, if applicable (under consideration);
- operating means of the test device, by the letter T;
- wiring diagram;
- operating characteristic in presence of residual currents with d.c. components

– RCBOs of type AC with the symbol  (IEC 60417-5032-2002-10)

– RCBOs of type A with the symbol. 

- for type D RCBOs: the maximum instantaneous tripping current, if higher than 20 I_n (see Table 4).

The marking shall be on the RCBO itself or on a nameplate or nameplates attached to the RCBO and shall be located so that it is legible when the RCBO is installed.

The suitability for isolation, which is provided by all RCBOs of this standard, may be indicated by the symbol  on the device. When affixed, this marking may be included in a wiring diagram, where it may be combined with symbols of other functions.

NOTE 1 In Australia, this marking on the circuit-breaker is mandatory but is not required to be visible after installation.

When the symbol is used on its own (i.e. not in a wiring diagram), combination with symbols of other functions is not allowed.

If a degree of protection higher than IP20 is marked on the device, it shall comply with it, whichever the method of installation. If the higher degree of protection is obtained only by a specific method of installation and/or with the use of specific accessories (e.g. terminal covers, enclosures, etc.), this shall be specified in the manufacturer's literature.

If, for small devices, the space available does not allow all the above data to be marked, at least the information under d), f), n), p) and r) (only for type A) shall be marked and visible when the device is installed. The information under a), b), c), h), l), r) (only for type AC) and s) may be marked on the side or on the back of the device and be visible only before the device is installed. The information under q) may be on the inside of any cover which has to be removed in order to connect the supply wires. Any remaining information not marked shall be given in the manufacturer's catalogues.

For RCBOs other than those operated by means of push-button, 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 indications only is allowed. These indications shall be readily visible when the RCBO is installed.

For RCBOs operated by means of two push-buttons, the push-button designed for the opening operation only shall be red and/or be marked with the symbol "O".

RED shall not be used for any other push-button of the RCBO.

If a push-button is used for closing the contacts and is evidently identified as such, its depressed position is sufficient to indicate the closed position.

If a single push-button is used for closing and opening the contacts and is identified as such, the button remaining in its depressed position is sufficient to indicate the closed position. On the other hand, if the button does not remain depressed, an additional means indicating the position of the contacts shall be provided.

If it is necessary to distinguish between the supply and the load terminals, they shall be clearly marked (e.g. by "line" and "load" placed near the corresponding terminals or by arrows indicating the direction of power flow).

Terminals exclusively intended for the connection of the neutral conductor shall be indicated by the letter N.

Terminals intended for the protective conductor, if any, shall be indicated by the symbol



(IEC 60417-5019-2006-08).

NOTE 2 The symbol  (IEC 60417-5017-2006-08), previously recommended, shall be progressively superseded by the preferred symbol IEC 60417-5019, given above.

Marking shall be indelible, easily legible and not be placed on screws, washers or other removable parts.

Compliance is checked by inspection and by the test of 9.3.

For universal terminals (for rigid-solid, rigid-stranded and flexible conductors):

- no marking.

For non-universal terminals:

- terminals declared for rigid-solid conductors only shall be marked by the letters "s" or "sol";
- terminals declared for rigid (solid and stranded) conductors only shall be marked by the letter "r".

The markings should appear on the RCBO or, if the space available is not sufficient, on the smallest package unit or in technical information.

7 Standard conditions for operation in service and for installation

7.1 Standard conditions

RCBOs complying with this standard shall be capable of operating under the standard conditions shown in Table 6.

Table 6 – Standard conditions for operation in service

Influencing quantity	Standard range of application	Reference value	Test tolerances (see note 6)
Ambient temperature (see notes 1 and 7)	-5 °C to +40 °C (see note 2)	20 °C	± 5 °C
Altitude	Not exceeding 2 000 m		
Relative humidity maximum value at 40°C	50 % (see note 3)		
External magnetic field	Not exceeding 5 times the earth's magnetic field in any direction	Earth's magnetic field	(see note 4)
Position	As stated by the manufacturer with a tolerance of 2° in any direction (see note 5)	As stated by the manufacturer	2° in any direction
Frequency	Reference value ± 5 % (see note 6)	Rated value	± 2 %
Sinusoidal wave distortion	Not exceeding 5 %	Zero	5 %
NOTE 1 The maximum value of the mean daily temperature is +35 °C. NOTE 2 Values outside the range are admissible where more severe climatic conditions prevail, subject to agreement between manufacturer and user. NOTE 3 Higher relative humidities are admitted at lower temperatures (for example 90 % at 20 °C). NOTE 4 When an RCBO is installed in proximity to a strong magnetic field, supplementary requirements may be necessary. NOTE 5 The device should be fixed in such a way that it does not cause deformation liable to impair its functions. NOTE 6 The tolerance given apply unless otherwise specified in the relevant test. NOTE 7 Extreme limits of -20 °C and +60 °C are admissible during storage and transportation, and should be taken into account in the design of the device.			

7.2 Conditions of installation

RCBOs shall be installed in accordance with the manufacturer's instructions.

7.3 Pollution degree

RCBOs complying with this standard are intended for environment with pollution degree 2, i.e. normally, only non-conductive pollution occurs; occasionally, however, a temporary conductivity caused by condensation may be expected.

8 Requirements for construction and operation

8.1 Mechanical design

8.1.1 General

RCBOs shall be designed and constructed so that, in normal use, their use is safe and without danger to the user or to the environment.

The residual current detection and the residual current release shall be located between the incoming and outgoing terminals of the RCBO.

It shall not be possible to alter the operating characteristics of the RCBO by means of external interventions other than those specifically intended for changing the setting of the residual operating current.

Changing from one setting to another shall not be possible without a tool. It shall not be possible to disable or inhibit the RCBO function by any means.

NOTE In Australia, Germany, Denmark, Italy, the UK and Switzerland, multiple settings are not allowed.

In case of an RCBO having multiple settings of residual operating current, the rating refers to the highest setting.

8.1.2 Mechanism

The moving contacts of all poles of multipole RCBOs shall be mechanically coupled so that all poles, except the switched neutral, if any, make and break substantially together, whether operated manually or automatically.

The switched neutral pole (see 3.3.15.3) of four-pole RCBOs shall not close after and shall not open before the other poles.

Compliance is checked by inspection and by manual tests, using any appropriate means (example: indicator lights, oscilloscope, etc.).

If a pole having an appropriate short-circuit making and breaking capacity is used as a neutral pole and the RCBO has an independent manual operation (see 3.7.5), then all poles, including the neutral pole, may operate substantially together.

RCBOs shall have a trip-free mechanism.

It shall be possible to switch the RCBO on and off by hand. For plug-in RCBOs without an operating handle, this requirement is not considered to be met by the fact that the RCBO can be removed from its base.

RCBOs shall be so constructed that the moving contacts can come to rest only in the closed position (see 3.3.13) or in the open position (see 3.3.14), even when the operating means is released in an intermediate position.

RCBOs shall provide in the open position (see 3.3.14) an isolation distance in accordance with the requirements necessary to satisfy the isolating function (see 8.3).

Indication of the position of the main contacts shall be provided by one or both of the following means:

- the position of the actuator (this being preferred); or
- a separate mechanical indicator.

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

NOTE 1 In the US, the colours red and green are not used for contact position indication.

The means of indication of the contact position shall be reliable.

Compliance is checked by inspection and by the tests of 9.9.2.2.

RCBOs shall be designed so that the actuator, front plate or cover can only be correctly fitted in a manner which ensures correct indication of the contact position.

Compliance is checked by inspection and by the tests of 9.12.12.1 and 9.12.12.2.

When means are provided or specified by the manufacturer to lock the operating means in the open position, locking in that position shall only be possible when the main contacts are in the open position.

NOTE 2 Locking of the operating means in the closed position is permitted for particular applications.

Compliance is checked by inspection, taking into account the instructions of the manufacturer.

Where 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, in which case it shall be necessary to reset the RCBO manually before reclosing is possible.

In the case of RCBOs functionally dependent on line voltage reclosing automatically (see 4.1.2.1 a)) when the line voltage is restored after failure of line voltage, the operating means shall remain in the ON position following automatic opening of the contacts; when the line voltage is re-established, the contacts shall reclose automatically unless in the meantime the operating means has been placed in the OFF position.

NOTE 3 For this type of RCBO, the operating means cannot be used as a means for indicating the closed and open positions.

When an indicator light is used, this shall be lit when the RCBO is in the closed position and be of bright colour. The indicator light shall not be the only means to indicate the closed position.

The action of the mechanism shall not be influenced by the position of enclosures or covers and shall be independent of any removable part.

A cover sealed in position by the manufacturer is considered to be a non-removable part.

If the cover is used as a guiding means for push-buttons, it shall not be possible to remove the buttons from the outside of the RCBO.

Operating means shall be securely fixed on their shafts and it shall not be possible to remove them without the aid of a tool.

Operating means directly fixed to covers are allowed. If the operating means has an "up-down" movement, when the RCBO is mounted as in normal use, the contacts shall be closed by the up movement.

NOTE 4 Provisionally in certain countries top to bottom closing movement is allowed.

Compliance with the above requirements is checked by inspection, by manual test and, for the trip-free mechanism, by the test of 9.11.

8.1.3 Clearances and creepage distances (see also Annex B)

The minimum required clearances and creepage distances are given in Table 7 which is based on the RCBO being designed for operating in an environment with pollution degree 2.

Compliance for item 1 in Table 7 is checked by measurement and by the test of 9.7.7.4.1 and 9.7.7.4.2. The test is carried out with samples not submitted to the humidity treatment described in 9.7.1.

The clearances of items 2 and 4 (except accessible surface after installation, see Note 1) may be reduced provided that the measured clearances are not shorter than the minimum allowed in IEC 60664-1 for homogenous field conditions.

NOTE 1 Accessible surface after installation means any surface accessible by the user when the RCD is installed according to the manufacturer's instructions. The test finger can be applied to determine whether a surface is accessible or not.

In this case, after the humidity treatment described in 9.7.1, compliance for item 2 and 4 and arrangements of 9.7.2 items b), c), d) and e) is checked in the following order:

- Tests according to 9.7.2 to 9.7.6 as applicable;
- Test according to 9.7.7.2 is applied with test voltages given in Table 19 with test arrangements of 9.7.2 items b), c), d), e).

If measurement does not show any reduced clearance, test 9.7.7.2 is not applied.

Compliance for item 3 in Table 7 is checked by measurement.

NOTE 2 All measurements required in 8.1.3 are carried out in Test sequence A on one sample and the tests 9.7.7.2 are carried out before 9.7.1 on three samples of Test sequence B.

Parts of PCBs connected to the live parts protected against pollution by the use of a type 2 protection according to IEC 60664-3 are exempt from this verification.

The insulating materials are classified into material groups on the basis of their comparative tracking index (CTI) according to 4.8.1 of IEC 60664-1:2007.

NOTE 3 Information on the requirements for design of solid insulation and appropriate testing is provided in IEC 60664-1:2007, 5.3 and 6.1.3.

NOTE 4 For clearances on printed wiring material, the following Note 3 in Table F.2 in 60664-1:2007 can be used: "For printed wiring material, the values for pollution degree 1 apply except that the value should not be less than 0,04 mm, as specified in Table F.4." For creepage distances on printed wiring material, distances in Table F.4 in 60664-1:2007 can be used if protected with a coating meeting IEC 60664-3 requirements and tests.

NOTE 5 The dimensioning of clearances and creepage distances for spacings equal to or less than 2 mm for printed wiring board may be optimised under certain conditions in case of use of IEC 60664-5. Only humidity levels HL 2 and HL3 are considered.

Table 7 – Minimum clearances and creepage distances

	Minimum clearances mm			Minimum creepage distances ^{e, f} mm											
				Group IIIa ^h (175 V ≤ CTI < 400 V) ^d				Group II (400 V ≤ CTI < 600 V) ^d				Group I (600 V ≤ CTI) ^d			
	Rated voltage V			Working voltage ^e V											
	<i>U_{imp}</i>														
	2,5 kV	4 kV	4 kV												
Description	120/240 120	120/240 240	230/400 230 400	>25 ≤50 ⁱ	120	250	400	>25 ≤50 ⁱ	120	250	400	>25 ≤50 ⁱ	120	250	400
1. Between live parts which are separated when the main contacts are in the open position ^a	2,0	4,0	4,0	1,2	2,0	4,0	4,0	0,9	2,0	4,0	4,0	0,6	2,0	4,0	4,0
2. Between live parts of different polarity ^a	1,5	3,0	3,0	1,2	1,5	3,0	4,0	0,9	1,5	3,0	3,0	0,6	1,5	3,0	3,0
3. Between circuits supplied from different sources, one of which being PELV or SELV ^g	3,0	6,0	8,0		3,0	6,0	8,0		3,0	6,0	8,0		3,0	6,0	8,0
				Rated voltage V											
				120 / 240	230 / 400	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 RCBO - surface on which the RCBO is mounted ^b - screws or other means for fixing the RCBO ^b - metal covers or boxes ^b - other accessible metal parts ^c - metal frames supporting flush-type RCBOs	1,5	3,0	3,0	1,5	4,0	1,5	3,0	1,5	3,0	1,5	3,0				
NOTE 1 The values given for 400 V are also valid for 440 V.															
NOTE 2 The parts of the neutral path, if any, are considered to be live parts.															
NOTE 3 Care should be taken to provide adequate clearances and creepage distances between live parts of different polarity of RCBOs, e.g. of the plug-in type mounted close to one another. If the clearance and creepage distances requirements are not fulfilled to all the surfaces adjacent to the RCD, appropriate information will be provided for installation purposes.															

- a For auxiliary and control contacts the values are given in the relevant standard.
- 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 RCBO is mounted are not dependent on the design of the RCBO only, so that they can be reduced when the RCBO 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 for normal use. The foil is pushed into corners, grooves, etc., by means of a straight unjointed test finger according to 9.6 (see Figure 3).
- d See IEC 60112.
- e Interpolation is allowed in determining creepage distances corresponding to voltage values intermediate to those listed as working voltage. When interpolating, linear interpolation shall be used and values shall be rounded to the same number of digits as the values picked up from the tables. For determination of creepage distances, see Annex B.
- f Creepage distances cannot be less than the associated clearances.
- g To cover all different voltages including ELV in an auxiliary contact.
- h For material group IIb ($100 \text{ V} \leq \text{CTI} < 175 \text{ V}$) 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.

8.1.4 Screws, current-carrying parts and connections

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

Screws operated when mounting the RCBO during installation shall not be of the thread-cutting type.

NOTE 1 Screws (or nuts) which are operated when mounting the RCBO include screws for fixing covers or cover-plates, but not connecting means for screwed conduits and for fixing the base of an RCBO.

Compliance is checked by inspection and by the test of 9.4.

NOTE 2 Screwed connections are considered as checked by the tests of 9.8, 9.12, 9.13, 9.14 and 9.23.

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

Compliance is checked by inspection and by manual test.

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 the part to be fixed, by a recess in the female thread or by the use of a screw with the leading thread removed.

8.1.4.3 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 no 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.

8.1.4.4 Current-carrying parts including parts intended for protective conductors, if any, shall be made of a metal having, under the conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use.

Examples of suitable materials are given below:

- copper;
- an alloy containing at least 58 % copper for parts worked cold, or at least 50 % copper for other parts;

- other metal or suitably coated metal, no less resistant to corrosion than copper and having mechanical properties no less suitable.

In case of using ferrous alloys or suitably coated ferrous alloys, compliance to resistance to corrosion is checked by a test of resistance to rusting (see 9.25).

The requirements of this subclause do not apply to contacts, magnetic circuits, heater elements, bimetals, shunts, parts of electronic devices or to screws, nuts, washers, clamping plates, similar parts of terminals and parts of the test circuit.

8.1.5 Terminals for external conductors

8.1.5.1 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.

Connection arrangements intended for busbar connection are admissible, provided they are not used for the connection of cables.

Such arrangements may be either of the plug-in or of the bolt-on type.

The terminals shall be readily accessible under the intended conditions of use.

Compliance is checked by inspection, by the tests of 9.5 for screw-type terminals, by specific tests for plug-in or bolt-on RCBOs included in the standard, or by the tests of Annexes J, K or L, as relevant for the type of connection.

8.1.5.2 RCBOs shall be provided with:

- either terminals which shall allow the connection of copper conductors having nominal cross-sectional areas as shown in Table 8;

NOTE Examples of possible designs of screw-type terminals are given in Annex IC.

- or terminals for external untreated aluminium conductors and with aluminium screw-type terminals for use with copper or with aluminium conductors according to Annex L.

Compliance is checked by inspection, by measurement and by fitting, in turn, one conductor of the smallest and one of the largest cross-sectional area as specified.

Table 8 – Connectable cross-sections of copper conductors for screw-type terminals

Rated current ^{a)} A		Range of nominal cross-section to be clamped ^{b)} mm ²	
Greater than	Up to and including	Rigid (solid or stranded ^{c)}) conductors	Flexible conductors
–	13	1 to 2,5	1 to 2,5
13	16	1 to 4	1 to 4
16	25	1,5 to 6	1,5 to 6
25	32	2,5 to 10	2,5 to 6
32	50	4 to 16	4 to 10
50	80	10 to 25	10 to 16
80	100	16 to 35	16 to 25
100	125	25 to 50	25 to 35

NOTE Information on AWG is given in Annex ID.

a) A range of RCBOs having the same fundamental design and having the same design and construction of terminals, the terminals are fitted with copper conductors of the smallest cross-section for the minimum rated current and largest cross-section for the maximum rated current, as specified, solid and stranded, as applicable.

b) It is required that, for current ratings up to and including 50 A, terminals be designed to clamp solid conductors as well as rigid stranded conductors. Nevertheless, it is permitted that terminals for conductors having cross-sections from 1 mm² up to 6 mm² be designed to clamp solid conductors only.

c) Rigid stranded conductors shall be used for conductors having cross-sections from 1,5 mm² up to 50 mm² and shall be in compliance with class 2 of IEC 60228, related to stranded conductors for single-core.

8.1.5.3 The means for clamping the conductors in the terminals shall not serve to fix any other component, although they may hold the terminals in place or prevent them from turning.

Compliance is checked by inspection and by the tests of 9.5.

8.1.5.4 Terminals for rated currents up to and including 32 A shall allow the conductors to be connected without special preparation.

Compliance is checked by inspection.

NOTE The term "special preparation" covers soldering of wire 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.

8.1.5.5 Terminals 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.

Compliance is checked by inspection and by the tests of 9.4 and 9.5.1.

8.1.5.6 Terminals shall be so designed that they clamp the conductor without undue damage to the conductor.

Compliance is checked by inspection and by the test of 9.5.2.

8.1.5.7 Terminals shall be so designed that they clamp the conductor reliably and between metal surfaces.

Compliance is checked by inspection and by the tests of 9.4 and 9.5.1.

8.1.5.8 Terminals shall be so designed or positioned that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.

This requirement does not apply to lug terminals.

Compliance is checked by the test of 9.5.3.

8.1.5.9 Terminals shall be so fixed or located that, when the clamping screws or nuts are tightened or loosened, their fixings do not work loose.

These requirements do not imply that the terminals shall be so designed that their rotation or displacement is prevented, but any movement shall be sufficiently limited so as to prevent non-compliance with the requirements of this standard.

The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that

- the sealing compound or resin is not subject to stress during normal use,
- the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this standard.

Compliance is checked by inspection, by measurement and by the test of 9.4.

8.1.5.10 Clamping screws or nuts of terminals intended for the connection of protective conductors shall be adequately secured against accidental loosening and it shall not be possible to unclamp them without the use of a tool.

Compliance is checked by manual test.

In general, the designs of terminals of which examples are shown in Annex IC provide sufficient resilience to comply with this requirement; for other designs special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.

8.1.5.11 Screws and nuts of terminals intended for the connection of external conductors shall be in engagement with a metal thread and the screws shall not be of the tapping screw type.

8.1.6 Non-interchangeability

For RCBOs intended to be mounted on bases forming a unit therewith (plug-in type or screw-in type) it shall not be possible, without the aid of a tool, to replace an RCBO when mounted and wired as for normal use by another RCBO of the same make having a higher rated current.

Compliance is checked by inspection.

NOTE The expression "as for normal use" implies that the RCBO is mounted according to the manufacturer's instructions.

8.2 Protection against electric shock

RCBOs shall be so designed that, when they are mounted and wired as for normal use, live parts are not accessible.

NOTE The term "normal use" implies that RCBOs be installed according to the manufacturer's instructions.

A part is considered to be "accessible" if it can be touched by the standard test finger (see 9.6).

For RCBOs other than those of the plug-in type, external parts, other than screws or other means for fixing covers and labels, which are accessible when the RCBOs are mounted and