

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

Part 1: General rules

ICS 29.120.50

National foreword

This British Standard is the UK implementation of EN 61009-1:2004+A14:2012, incorporating corrigenda July 2006, November 2012 and amendments A11:2008, A12:2009, A13:2009 and A14:2012. It is derived from IEC 61009-1:1996, incorporating amendment 1:2002 and corrigendum May 2003. It supersedes BS EN 61009-1:2004, which will be withdrawn on 2 January 2015.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Changes introduced by CENELEC corrigendum July 2006 are indicated by **AC1** **AC1**.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated by tags **C** **C**.

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A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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English version

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

Interrupteurs automatiques
à courant différentiel résiduel
avec protection contre les surintensités
incorporée pour installations domestiques
et analogues (DD)
Partie 1: Règles générales

Fehlerstrom-/Differenzstrom-
Schutzschalter mit eingebautem
Überstromschutz (RCBOs)
für Hausinstallationen und
für ähnliche Anwendungen
Teil 1: Allgemeine Anforderungen

This European Standard was approved by CENELEC on 2004-03-16. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 61009-1:1996 and its amendment 1:2002, prepared by SC 23E, Circuit-breakers and similar equipment for household use, of IEC TC 23, Electrical accessories, together with common modifications prepared by the Technical Committee CENELEC TC 23E, Circuit breakers and similar devices for household and similar applications, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 61009-1 on 2004-03-16.

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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2009-04-01

This European Standard was prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directives. See Annex ZZ..

Annexes, clauses, subclauses, figures and tables that are additional to those in IEC 61009-1 are prefixed with the letter Z.

Foreword to amendment A11

This amendment to the European Standard EN 61009-1:2004 was prepared by the Technical Committee CENELEC TC 23E, Circuit breakers and similar devices for household and similar applications.

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Foreword to amendment A12

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Foreword to amendment A14

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document have to be withdrawn (dow) 2015-01-02

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RESIDUAL CURRENT OPERATED CIRCUIT-BREAKERS WITH INTEGRAL OVERCURRENT PROTECTION FOR HOUSEHOLD AND SIMILAR USES (RCBOs)

Part 1: General rules

INTRODUCTION

This part includes definitions, requirements and tests covering all types of RCBOs. For applicability to a specific type this part shall apply 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.

1 Scope and object

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., rated currents not exceeding 125 A for fixed installation 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.

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

NOTE 1 For environment with higher pollution degree, enclosures giving the appropriate degree of protection should be used.

RCBOs within the scope of the present standard are suitable for isolation.

Devices to this standard, are suitable for use in IT systems provided that the requirements of HD 384.4.473 are complied with.

NOTE 2 The content of the present standard related to the operation under residual current conditions is based on EN 61008. The content of the present standard related to protection against overcurrents is based on EN 60898.

NOTE 3 RCBOs are essentially intended to be operated by uninstructed persons and designed not to require maintenance. They may be submitted for certification purposes.

NOTE 4 Installation and application rules of RCBOs are given in HD 384.

NOTE 5 Recommendations for the dimensional coordination between enclosures and RCBOs for mounting on rail according to EN 60715 or equivalent means are given in CENELEC Report R023-001. 

Ⓒ 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 the S type 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 For more severe overvoltage conditions, RCBOs complying with other standards (e.g. EN 60947-2) should be used.

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 HD 384.4.443).

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.

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

Particular requirements are necessary for RCBOs integrated in one unit with a socket-outlet or designed exclusively for being associated locally with a socket-outlet in the same mounting box.

NOTE 8 Until a specific EN for SRCDs is prepared and approved, for RCBOs integrated in one unit with a socket-outlet or designed exclusively for being associated locally with a socket-outlet in the same mounting box the requirements of this standard in conjunction with those of IEC 60884-1 may be used as far as applicable.

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,
- RCBOs having more than one rated current.

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 co-ordination under short-circuit conditions between a RCBO and another short-circuit protective device (SCPDs) is given in Annex F.

This standard contains all requirements necessary to ensure compliance with the operational characteristics required for these devices by type tests.

It also contains the details relative to test requirements and methods of testing necessary to ensure reproducibility of test results.

This standard states:

- a) the characteristics of RCBOs;
- b) the conditions with which RCBOs shall comply, with reference to:
 - 1) their operation and behaviour in normal service,
 - 2) their operation and behaviour in case of overload,
 - 3) their operation and behaviour in case of short-circuits up to their rated short-circuit capacity,
 - 4) their operation under residual current conditions,
 - 5) EMC,
 - 6) their dielectric properties;
- c) the tests intended for confirming that these conditions have been met and the methods to be adopted for the tests;
- d) the data to be marked on the devices; Ⓒ

- Ⓒ e) the test sequences to be carried out and the number of samples to be submitted for certification purposes (see Annex A);
- f) the co-ordination under short-circuit conditions with another short-circuit protective device (SCPD) associated in the same circuit (see Annex F);
- g) the routine tests to be carried out on each RCBO to reveal unacceptable variations in material or manufacture, likely to affect safety (see Annex D). Ⓒ

2 Normative references

Ⓒ NOTE Normative references to international publications are listed in Annex ZA (normative). Ⓒ

3 Definitions

For the purpose of this standard, the following definitions apply.

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

NOTES

- 1 For glossary of symbols see annex IB.
- 2 Reference to IEV definitions is also made when the terms "device" or "mechanical switching device" are replaced by the term "RCBO".

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 (IEV 101-04-34) 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 :** The 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:** An electrical excitation quantity which, alone or in combination with other such quantities, shall be applied to a 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.

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.

A1 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 note c of Table 2) **A1**

3.3 Definitions relating to the operation and functions of residual current circuit-breakers

3.3.1 switching device (IEV 441-14-01): A device designed to make or break the current in one or more electric circuits.

3.3.2 mechanical switching device (IEV 441-14-02): A switching device designed to close and open one or more electric circuits by means of separable contacts.

3.3.3 fuse (IEV 441-18-01): A 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.

3.3.4 circuit-breaker (IEV 441-14-20): A 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.

3.3.5 residual current operated circuit-breaker: A mechanical switching device designed for making, carrying and breaking 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): A 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): A 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 755 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.

NOTES

1 This definition covers partially the definition of residual current devices with auxiliary source of 2.3.3 of IEC 755.

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

3.3.10 break time of a RCBO: The 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 (IEV 441-16-22): The position in which the predetermined continuity of the main circuit of the RCBO is secured.

3.3.14 open position (IEV 441-16-23): The position in which the predetermined clearance between open contacts in the main circuit of the RCBO is secured.

3.3.15 pole: That part of a 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: A pole provided with an overcurrent release, hereafter referred to as protected pole.

3.3.15.2 overcurrent unprotected pole: A 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.

NOTES

- 1 To ensure this requirement, the unprotected pole may be of the same construction as the protected pole(s), or of a particular construction.
- 2 If the short-circuit capacity of the unprotected pole is different from that of the protected pole(s), this shall be indicated by the manufacturer.

3.3.15.3 switched neutral pole: A pole only intended to switch the neutral and not intended to have a short-circuit capacity.

☐ Text deleted ☐

3.3.17 main circuit (of a RCBO): All the conductive parts of a RCBO included in the ☐ poles ☐ (see 4.3).

3.3.18 control circuit (of a RCBO): A 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 a RCBO) (IEV 441-15-04): All the conductive parts of a RCBO which are intended to be included in a circuit other than the main circuit and the control circuit of the RCBO.

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.

[C] 3.3.Z1

plug-in RCBO RCBO having one or more plug-in terminals (see 3.6.Z1) and designed for use with appropriate means for the plug-in connection. **[C]**

3.4 Definitions relating to values and ranges of energizing quantities

[A1] 3.4.1

rated values

quantity value assigned by the manufacturer, for a specific operating condition of a RCBO.
[IEV 151-04-03, modified] **[A1]**

3.4.2 overcurrent: Any current exceeding the rated current

3.4.2.1 overload current: An 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: An 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: The 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: The 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, that is 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): The 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: The 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: A 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: A 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 (IEV 441-17-07): The current in a pole of a RCBO at the instant of initiation of the arc during a breaking process.

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

3.4.8 applied voltage (IEV 441-17-24): The voltage which exists across the terminals of a pole of a RCBO just before the making of the current.

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 (IEV 441-17-25): The voltage which appears across the terminals of a pole of a RCBO after the breaking of the current.

NOTES

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.

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

 Text deleted 

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.

3.4.9.2 power-frequency recovery voltage (IEV 441-17-27): The recovery voltage after the transient voltage phenomena have subsided.

3.4.10 opening time: The 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 Arcing time

3.4.11.1 arcing time of a pole (IEV 441-17-37): The interval of time between the instant of initiation of the arc in a pole and the instant of final arc extinction in that pole.

3.4.11.2 arcing time of a multipole RCBO (IEV 441-17-38): The interval of time between the instant of first initiation of the arc and the instant of final arc extinction in all poles.

3.4.12 break time (in case of overcurrent): The interval of time between the beginning of the opening time of a RCBO and the end of the arcing time, in case of overcurrent.

NOTE – This definition is based on IEC 441-17-39.

3.4.13 I^2t (Joule integral) (IEV 441-18-23): The integral of the square of the current over a given time interval (t_0 , t_1):

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

3.4.14 I^2t characteristic of a RCBO: A curve giving the maximum value of I^2t as a function of the prospective current under stated conditions of operation.

3.4.15 Co-ordination between overcurrent protective devices in series

3.4.15.1

overcurrent protective co-ordination of overcurrent protective devices

co-ordination of two or more overcurrent protective devices in series to ensure overcurrent discrimination (selectivity) and/or back-up protection

(2.5.22 of EN 60947-1)

3.4.15.2

overcurrent discrimination

co-ordination of the operating characteristics of two or more overcurrent protective devices in series such that, on the incidence of overcurrents within stated limits, the device intended to operate within these limits does so, while the other(s) does (do) not

(IEV 441-17-15)

3.4.15.3

back-up protection

overcurrent co-ordination of two overcurrent protective devices in series, where the protective device, generally but not necessarily on the supply side, effects the overcurrent protection with or without the assistance of the other protective device and prevents excessive stress on the latter

(2.5.24 of EN 60947-1)

3.4.15.4

total discrimination (total selectivity)

overcurrent discrimination where, in the presence of two overcurrent protective devices in series, the protective device on the load side effects the protection without causing the other protective device to operate

(2.17.2 of EN 60947-2)

3.4.15.5

partial discrimination (partial selectivity)

overcurrent discrimination where, in the presence of two overcurrent protective devices in series, the protective device on the load side effects the protection up to a given level of overcurrent, without causing the other protective device to operate

(2.17.3 of EN 60947-2)

3.4.15.6

selectivity limit current (I_s)

the current co-ordinate of the intersection between the total time-current characteristic of the protective device on the load side and the pre-arcing (for fuses), or tripping (for RCBOs) time-current characteristic of the other protective device

AC1 The selectivity limit current (see Figure D.1 of EN 60898-1) is a limiting value of current **AC1**

- 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)

(2.17.4 of EN 60947-2)

3.4.15.7

take-over current (I_B)

current co-ordinate of the intersection between the time-current characteristics of two overcurrent protective devices

NOTE The take-over current is the current co-ordinate of the intersection between the maximum break-time / current characteristics of two overcurrent protective devices in series.

(2.5.25 of EN 60947-1 and 2.17.6 of EN 60947-2) **AC1**

3.4.15.8

conditional short-circuit current (of a circuit or a switching device)

prospective current that a circuit or a switching device, protected by a specified short-circuit protective device, can satisfactorily withstand for the total operating time of that device under specified conditions of use and behaviour

NOTE 1 For the purpose of this standard, the short-circuit protective device is generally a RCBO or a fuse.

NOTE 2 This definition differs from IEC 441-17-20 by broadening the concept of current limiting device into a short-circuit protective device, the function of which is not only to limit the current.

(2.5.29 of EN 60947-1)

3.4.15.9

rated conditional short-circuit current I_{nc}

value of prospective current, stated by the manufacturer, which the equipment, protected by a short-circuit protective device specified by the manufacturer, can withstand satisfactorily for the operating time of this device under the test conditions in the relevant product standard

(4.3.6.4 of EN 60947-1).

3.Z1 Definitions related to insulation co-ordination

3.Z1.1

insulation co-ordination

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

(1.3.1 of IEC 60664-1)

3.Z1.2

working voltage

the 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

(1.3.5 of IEC 60664-1)

NOTE 1 Transients are disregarded.

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

3.Z1.3

overvoltage

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

(1.3.7 of IEC 60664-1)

3.Z1.4

impulse withstand voltage

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

(1.3.8.1 of IEC 60664-1)

3.Z1.5

overvoltage category

a numeral defining a transient overvoltage condition

(1.3.10 of IEC 60664-1)

3.Z1.6

macro-environment

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

3.Z1.7

micro-environment

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

(1.3.12.2 of IEC 60664-1)

3.Z1.8

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

(1.3.11 of IEC 60664-1)

3.Z1.9

pollution degree

a numeral characterising the expected pollution of the micro-environment

(1.3.13 of IEC 60664-1)

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.Z1.10

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

(3.6.10 of EN 60898-1)

3.Z1.11

isolating distance

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

(3.6.11 of EN 60898-1)

3.Z1.12

clearance (see Annex B)

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

(IEV 441-17-31)

NOTE For the purpose of determining a clearance to accessible parts, the accessible surface of an insulating enclosure shall 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 9.

3.Z1.13

creepage distance (see Annex B)

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

NOTE For the purpose of determining a creepage distance to accessible parts, the accessible surface of an insulating enclosure shall 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 9. 

3.4.16 conventional non-tripping current (I_{nt})

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

(IEV 441-17-22)

3.4.17 conventional tripping current (I_t)

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

3.4.18 instantaneous tripping current

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

 Text deleted 

3.4.21 Non-operating overcurrents in the main circuit

The definitions of limiting values of non-operating overcurrents are given in 3.4.21.1 and 3.4.21.2.

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.

3.4.21.1 limiting value of overcurrent in case of a load through a 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 a RCBO with two current paths without causing it to operate.

3.4.21.2 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.

3.4.22 residual making and breaking capacity: Value of the a.c. component of a residual prospective current which a RCBO can make, carry for its opening time and break under specified conditions of use and behaviour.

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

3.4.23.1 U_x : Minimum value of the line voltage at which a RCBO functionally dependent on line voltage still operates under specified conditions in case of decreasing line voltage (see 9.17.1).

3.4.23.2 U_y : Minimum value of the line voltage below which a RCBO functionally dependent on line voltage opens automatically in the absence of any residual current.

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 a RCBO.

3.5.2 reference value of an influencing quantity: The 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: The 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: The 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 (IEV 441-11-13): The 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.

3.5.7 reference ambient air temperature: The ambient air temperature on which the time-overcurrent characteristics are based.

3.6 Definitions relating to terminals

NOTE – These definitions may be modified when the work of Subcommittee 23F on terminals is completed.

3.6.1 terminal: A terminal is a conductive part of a RCBO, provided for re-usable electrical connection to external circuits.

3.6.2 screw-type terminal: A 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: A 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). The clamping pressure may be applied directly by the shank of the screw or through an intermediate clamping element to which pressure is applied by the shank of the screw.

NOTE – Examples of pillar terminals are shown in figure IC.1 of annex IC.

3.6.4 screw terminal: A 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.2 of annex IC.

3.6.5 stud terminal: A screw-type terminal in which the conductor is clamped under a nut.

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 – Examples of stud terminals are shown in figure IC.2 of annex IC.

3.6.6 saddle terminal: A 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 of annex IC.

3.6.7 lug terminal: A 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 of annex IC.

3.6.8 screwless terminal: A 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: A 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.

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: A tapping screw having an uninterrupted thread; it is not a function of this thread to remove material from the hole.

NOTE – An example of a thread forming tapping screw is shown in figure 1.

3.6.11 thread cutting tapping screw: A tapping screw having an interrupted thread; it is a function of this thread to remove material from the hole.

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

3.6.Z1

plug-in terminal

terminal the electrical connection and disconnection of which can be effected without displacing the conductors of the corresponding circuit. The connection is effected without the use of a tool and is provided by the resilience of the fixed and/or moving parts and/or by springs 

3.7 Conditions of operation

3.7.1 operation: The 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 (IEV 441-16-08): An operation by which the RCBO is brought from the open position to the closed position.

3.7.3 opening operation (IEV 441-16-09): An operation by which the RCBO is brought from the closed position to the open position.

3.7.4 dependent manual operation (IEV 441-16-13): An 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.

3.7.5 independent manual operation (IEV 441-16-16): A 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.

3.7.6 trip-free RCBO (IEV 441-16-31): A 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.

3.7.7 operating cycle (IEV 441-16-02): A succession of operations from one position to another and back to the first position through all other positions, if any.

3.7.8 sequence of operations: A succession of specified operations with specified time intervals.

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

3.8 *Constructional elements*

3.8.1 main contact (IEV 441-15-07): A contact included in the main circuit of a RCBO, intended to carry, in the closed position, the current of the main circuit.

3.8.2 arcing contact: A 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 (IEV 441-15-09): A contact included in a control circuit of a RCBO and mechanically operated by the RCBO.

3.8.4 auxiliary contact (IEV 441-15-10): A contact included in an auxiliary circuit and mechanically operated by the RCBO (e.g. for indicating the position of the contacts).

3.8.5 release (IEV 441-15-17): A device, mechanically connected to (or integrated into) a RCBO which releases the holding means and permits the automatic opening of the RCBO.

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

3.8.6 overcurrent release (IEV 441-16-33): A release which permits a 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.

3.8.7 inverse time-delay overcurrent release (IEV 441-16-35): An 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.

3.8.8 direct overcurrent release (IEV 441-16-36): An overcurrent release directly energized by the current in the main circuit of a RCBO.

3.8.9 overload release (IEV 441-16-38): An overcurrent release intended for protection against overloads.

3.8.10 conductive part (IEV 441-11-09): A part which is capable of conducting current, although it may not necessarily be used for carrying service current.

3.8.11 exposed conductive part (IEV 441-11-10): A conductive part which can be readily touched and which normally is not live, but which may become live under fault conditions.

3.9 Tests

3.9.1 **type test** (IEV 151-04-15): A test of one or more devices made to a certain design to show that the design meets certain requirements.

3.9.2 **routine tests** (IEV 151-04-16): A test to which each individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria.

4 Classification

RCBOs are classified:

4.1 According to the method of operation

☐ The selection of the various types is made according to HD 384 and non-conflicting national wiring rules. Table Z1 lists the types of RCBOs according to the various applications but does not exclude the use of RCBOs of any classification for protection over and above that required by the relevant wiring rules.

Table Z1 – Survey of the types of RCBOs according to their method of operation

Classification	4.1.1	4.1.2.2a)	4.1.2.1b)	4.1.2.2b)
Marking of use	Without	E1	E2	E3
Protection	Indirect contact and additional protection ^a	Indirect contact and additional protection ^a	Additional protection ^a	Additional protection ^{a b}
Service continuity ^c	Yes	Yes	No	Yes
^a Additional protection, provided only for RCBOs with $I_{\Delta n} \leq 0,03 \text{ A}$. ^b Only devices integrated in one unit with a socket-outlet or designed exclusively for being associated locally with a socket outlet in a same mounting box. ^c This information is given for guidance only.				

☐

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) ☐ Deleted ☐

b) Not reclosing automatically when the line voltage is restored.

☐ RCBOs of type 4.1.2.1b) shall comply with the relevant requirements of 8.12. ☐

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 (☐ additional requirements are 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 deleted ☐

4.2 Deleted

4.3 *According to the number of poles and current paths*

 Text deleted

- two-pole RCBO with one overcurrent protected pole;
- two-pole RCBO with two overcurrent protected poles;
- three-pole RCBO with three overcurrent protected poles;
- 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 Deleted

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);
- RCBOs with increased resistance to unwanted tripping (S type as in table 2).

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 methods of connection*

4.10.1 *According to the fixation system:*

- RCBO's, the electrical connections of which are not associated with the mechanical mounting;
- RCBO's, the electrical connections of which are associated with the mechanical mounting.

NOTE Examples of this type are:

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

Some RCBO's 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. 

4.10.2 According to the type of terminals:

- RCBO's with screw-type terminals for external copper conductors;
- RCBO's with screwless type terminals for external copper conductors;

NOTE 1 The requirements for RCBO's equipped with this type of terminals are given in Annex ZE.

- RCBO's with flat quick-connect terminals for external copper conductors;

NOTE 2 The requirements for RCBO's equipped with this type of terminals are given in Annex ZF. C11

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

C RCBOs of B-type and C-type, having rated current up to and including 40 A and having short-circuit breaking capacity of 3 000 A, 4 500 A, 6 000 A and 10 000 A, may be classified according to the limits within which their I^2t characteristics lie, measured according to 9.12.6 (see Annex ZD).

4.21 According to the range of ambient air temperature

- RCBOs for use at ambient air temperatures between $-5\text{ }^{\circ}\text{C}$ and $+40\text{ }^{\circ}\text{C}$;
- RCBOs for use at ambient air temperatures between $-25\text{ }^{\circ}\text{C}$ and $+40\text{ }^{\circ}\text{C}$. C

5 Characteristics of RCBOs

5.1 Summary of characteristics

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

C Text deleted C

- 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 (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);
- insulation co-ordination including clearances and creepage distances (see 5.2.10);
- 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 529).

C – ranges of ambient air temperature (see 5.3.Z1) C

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 a 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 a 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.Z1 **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 5.3.Z2. ⓘ

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 section 523 of IEC 364).

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.

ⓘ Note deleted ⓘ

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

NOTE – A RCBO having a given rated short-circuit capacity I_{cn} has a corresponding service short-circuit capacity (I_{cs}) (see table 18).

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 a RCBO can make, carry and break under specified conditions.

AC1 The conditions are those specified in 9.12.11.4 d). AC1

5.2.8 RCBO type S

A time-delay RCBO (see 3.3.12) which complies with the relevant part of table 2.

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

5.2.9.1 RCBO type AC

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

5.2.9.2 RCBO type A

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

C Text deleted C

5.2.10 Insulation co-ordination including clearances and creepage distances

Under consideration.

NOTE – For the time being, clearances and creepage distances are given in 8.1.3.

5.3 C Standard and standard values

5.3.1 Standard values of rated voltage (U_n)

Standard values of rated voltage are as follows: C

C17	RCBO	Rated voltage of RCBOs for use in systems 230 V, 230 V/400 V, 400V
	Two-pole	230 V 400 V
	Three-pole	400 V
	Four-pole	400 V

C18

NOTES

1 In IEC 38 the voltage values of 230 V and 400 V have been standardized. These values should progressively replace the values of 220 V and 240 V, and of 380 V and 415 V respectively.

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.

5.3.2 Preferred values of rated current (I_n)

Preferred values of rated current are:

6 – 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:

0,01 – 0,03 – 0,1 – 0,3 – 0,5 A.

NOTE – In some countries 1 A is also considered as a standard value.

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 Values of rated frequency

The preferred value of rated frequency is 50 Hz.

5.3.6 Values of rated short-circuit capacity (I_{cn}) and of rated residual making and breaking capacity ($I_{\Delta m}$)

NOTE 1 For test voltages to check the insulation, see 9.20

NOTE 2 For test voltages to check isolation distance across open contacts, see Table Z2.

5.3.6.1 Standard values up to and including 10 000 A

Standard values of rated short-circuit capacity and of rated residual making and breaking capacity are given in Table 1. The values of I_{cn} and $I_{\Delta m}$ may be different on the same product.

Table 1 - Standard values of rated short-circuit capacity and of the rated residual making and breaking capacity

1 500 A (*)
3 000 A
4 500 A
6 000 A
10 000 A

(*) Only for RCBOs integrated in one unit with a socket outlet or designed exclusively for being associated locally with a socket outlet in the same mounting box.

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 C Text deleted C

5.3.8 Standard values of break time and non-actuating time for operation under residual current conditions

The standard values of maximum break time (3.3.10) and non-actuating time (see 3.3.11) for type AC RCBOs are given in table 2.

A1 **Table 2 – Standard values of break time and non-operating time for operating under residual current conditions**

Type	I_n A	$I_{\Delta n}$ A	Standard values of break time and non-operating time at a residual current (I_{Δ}) equal to: s					
			$I_{\Delta n}$	$2 I_{\Delta n}$	$5 I_{\Delta n}$ ^a	5 A, 10 A, ^b 20 A, 50 A, 100 A, 200 A, 500 A ^e	$I_{\Delta t}$ ^c	
General	Any value	Any value	0,3	0,15	0,04	0,04	0,04	Maximum break times
S	$\Delta 25$	>0,030	0,5	0,2	0,15	0,15	0,15	Maximum break times
			0,13	0,06	0,05	–	0,04	Minimum non-actuating times (no tripping)

^a For RCBOs of the general type with $I_{\Delta n} \leq 0,030$ A, 0,25 A may be used as an alternative to $5 I_{\Delta n}$.

^b The tests at C11 5 A, 10 A, 20 A, 50 A, 100 A and 200 A C11 and are only performed during the verification of the correct operation according to 9.9.1.2 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.

C11 ^e The verification of the break times at 500 A is only made for the test of 9.9.1.2.c, but in any case the test is not done for values exceeding the lower limit of the overcurrent instantaneous tripping range. C11

The verification of the break times at 500 A is only made for the test of 9.9.1.2-c, but in any case the test is not done for values

For type A RCBOs the maximum break times stated in table 2 shall also be valid, the current values (i.e. $I_{\Delta n}$, $2 I_{\Delta n}$, $5 I_{\Delta n}$, 0,25 A and 500 A), however, being increased, for the test of 9.21.1, by the factor 1,4 for RCBOs with $I_{\Delta n} > 0,01$ A and by the factor 2 for RCBOs with $I_{\Delta n} \leq 0,01$ A.

5.3.9 Standard ranges of overcurrent instantaneous tripping

Standard ranges of overcurrent instantaneous tripping are given in table 3.

Table 3 – Ranges of overcurrent instantaneous tripping

Type	Range
B	above $3 I_n$ up to and including $5 I_n$
C	above $5 I_n$ up to and including $10 I_n$
D	above $10 I_n$ up to and including C 20 I_n C

5.3.Z1 Standard ranges of ambient air temperature

The standard ranges of ambient air temperature are:

- -5 °C to +40 °C
- -25 °C to +40 °C

5.3.Z2 Standard values of rated impulse withstand voltage (U_{imp})

Standard value of the rated impulse voltage (U_{imp}) is 4 kV.

NOTE For test voltages to check the isolation distance across open contacts, see Table Z2. 

6.Z1 Standard marking

Each RCBO shall be marked in a durable manner according to the following Table Z3.

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.

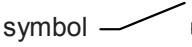
If it is necessary to distinguish between the supply and the load terminals, they shall be clearly marked (e.g. by "line" and "load" placed near the corresponding terminals or by arrows indicating the direction of power flow).

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

Terminals intended for the protective conductor, if any, shall be indicated by the symbol  (IEC 60417-5019 a)).

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

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 

C11 The suitability for isolation, which is provided by all RCBOs of this standard, maybe 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, (e.g. overload protection, or other symbols of IEC TC 3). When the symbol is used on its own (i.e. not in a wiring diagram), combination with symbols of other functions is not allowed.

The base for plug-in RCBOs shall be marked with the following:

- rated current or maximum rated current;
- trade mark.

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.

6.Z2 Additional marking

Additional marking to other standards (EN or IEC or other) or additional requirements are allowed under the following conditions:

- the RCBO shall comply with all the requirements of the additional standard;
- the relevant standard to which the additional marking refers shall be indicated adjacent to this marking and shall be clearly differentiated or separated from the standard marking according to 6.Z1.

Compliance is checked by inspection and by carrying out all the test sequences required by the relevant standard. Equivalent or less severe test sequences need not be repeated.

C11

C11 Subclause deleted **C11**



Table Z3 – Requirements for marking

	Each RCBO shall be marked in a durable manner with all or, for small apparatus, part of the following data: The minimum requirements are indicated by the symbol "X"	Marking on the RCBO itself			Product information in the catalogue
		If, for small devices the space available does not allow all the data to be marked, at least the following information shall be marked and visible when the device is installed.	The following information may be marked on the side or on the back of the device and be visible only before the device is installed.	Alternatively the following information may be on the inside of any cover which has to be removed in order to connect the supply wires.	
a)	the manufacturer's name or trademark;		X		
b)	type designation, catalogue number or serial number;		X		
c)	rated voltage(s) with the symbol ~;		X		
d)	rated current without symbol "A", preceded by the symbol of overcurrent instantaneous tripping (B, C or D), for example B16;	X			
e)	rated frequency, if the RCBO is designed for frequencies other than 50 Hz (see 5.3.5);		X		
f)	rated residual operating current ($I_{\Delta n}$) in A or in mA;	X			
g)	deleted;				
h)	rated short circuit capacity, in amperes in a rectangle without symbol "A";		X (*)		
j)	reference calibration temperature, if different from 30 °C;				X
k)	the degree of protection (only if different from IP20);				X
l)	the position of use (symbol according to IEC 60051), if necessary;		X		
m)	rated residual making and breaking capacity ($I_{\Delta m}$), if different from rated short-circuit capacity (I_{cn});				X
n)	the symbol S (S in a square) for type S devices;	X			
o)	symbol of the method of operation according to Table Z1 of 4.1 if the RCBO is functionally dependent on the line voltage;		X	X	



	Each RCBO shall be marked in a durable manner with all or, for small apparatus, part of the following data: The minimum requirements are indicated by the symbol "X"	Marking on the RCBO itself			Product information in the catalogue
		If, for small devices the space available does not allow all the data to be marked, at least the following information shall be marked and visible when the device is installed.	The following information may be marked on the side or on the back of the device and be visible only before the device is installed.	Alternatively the following information may be on the inside of any cover which has to be removed in order to connect the supply wires.	
q)	operating means of the test device, by the letter T ^b ;	X			Any remaining information not marked shall be given in the catalogues .
r)	wiring diagram unless the correct mode of operation is evident;		X	X	
s)	operating characteristic in presence of residual currents with d.c. components		X		
	- RCBOs of type AC with the symbol  - RCBOs of type A with the symbol 	X			
t)	energy limiting class (e.g. 3) in a square in accordance with Annex ZD if applied;		X ^a		
u)	RCBOs according to 4.Z1 shall be marked with the symbol  (the value -25 included in the snowflake symbol according to Figure 0027 of ISO 7000) if relevant;		X		
v)	indication of the terminal for the neutral with "N";		X		
w)	additional marking of performance to other standards or additional requirements according to 6.Z2.		X		
^a I _{cn} and the energy limiting class shall be on the device and combined together. It is recommended to advise the user to test the device regularly.					



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 4.

Table 4 – 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 [C] –25 °C to +40 °C ²⁾ [C]	20 °C	± 5 °C
Altitude	[C] Not exceeding 2 000 m ³⁾ [C]		
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 %

1) The maximum value of the mean daily temperature is +35 °C.

2) Values outside the range are admissible where more severe climatic conditions prevail, subject to agreement between manufacturer and user.

3) Higher relative humidities are admitted at lower temperatures (for example 90 % at 20 °C).

4) When a RCBO is installed in proximity of a strong magnetic field, supplementary requirements may be necessary.

5) The device shall be fixed without causing deformation liable to impair its functions.

6) The tolerance given apply unless otherwise specified in the relevant test.

7) [C] Extreme limits of –20 °C and 60 °C, for RCBOs for use in the range of –5 °C to +40 °C and of –35 °C and 60 °C, for RCBOs for use in the range of –25 °C to +40 °C, are admissible during storage and transportation. These conditions should be taken into account in the design of the device.

8) For installations at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and of the cooling effect of the air. RCBOs intended to be so used shall be designed specially or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement [C]

7.2 Conditions of installation

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

[C] 7.21 Pollution degree

RCBOs to 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 [C]

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.

In case of a 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 so mechanically coupled that all poles, except the switched neutral, if any, make and break substantially together, whether operated manually or automatically, even if an overload occurs on one protected pole only.

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

Compliance is checked by inspection and by manual test, using any appropriate means (e.g. 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 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 open and closed 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 (ON) and the colour green for the open - position (OFF).

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

Compliance is checked by inspection and by the tests of 9.9.2.2a) ☐

⌚ 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 Locking of the operating means in the ON position is permitted for particular applications.

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

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 be provided with means for indicating their closed and open positions, which shall be easily discernible from the front of the RCBO when fitted with its cover(s) or cover-plate(s), if any (see clause 6).

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.

⌚ *Text deleted* ⌚

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 deleted* ⌚

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

The minimum required clearances and creepage distances are given in Table 5 which is based on the RCBO being designed for operating in an environment with pollution degree 2. However, the clearances of item 2, 4 and 5 may be reduced provided that the tests at rated impulse voltage are withstood.

The insulating materials are classified into Material Groups on the basis of their comparative tracking index (CTI) according to 2.7.1.1 and 2.7.1.3 of IEC 60664-1 and measured according to IEC 60112. ⌚

Table 5 – Minimum clearances for U_{imp} 4 kV and creepage distances

	Minimum clearances mm	Minimum creepage distances ^{e), f)}											
		Group IIIa ^{h)} (175V ≤ CTI < 400 V) ^{d)}				Group II (400V ≤ CTI < 600V) ^{d)}				Group I (600V ≤ CTI) ^{d)}			
	Rated voltage V	Working voltage ^{e)} V											
Description	230 V/400 V 230 V 400 V	>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)}	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) j)}	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)}	8,0		3,0	6,0	8,0		3,0	6,0	8,0		3,0	6,0	8,0
		Rated voltage V											
		230 - 400				230 - 400				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	3,0	4,0				3,0				3,0			
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 as 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. 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 V ≤ CTI < 175 V) the values for material group IIIa multiplied by 1,6 apply. i) For working voltages up to and including 25 V reference may be made to IEC 60664-1. j) This applies also to clearance and creepage distances between live parts of different polarity of the RCBO and equipments mounted close to it.													
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.													

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 – 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 a RCBO.

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

NOTE – 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 of:

- 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.

NOTE – New requirements and appropriate tests for determining the resistance to corrosion are under consideration. These requirements should permit other materials to be used if suitably coated.

The requirements of this subclause do not apply to contacts, magnetic circuits, heater elements, bimetals, shunts, parts of electronic devices nor 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.

 Text deleted 

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 RCBO's included in the standard, or by the tests of Annex ZE or ZF, as relevant for the type of connection.* 

8.1.5.2 RCBOs shall be provided with terminals which shall allow the connection of copper conductors having nominal cross-sectional areas as shown in table 6.

 NOTE – Examples of possible designs of screw-type terminals are given in Annex 1C. 

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

Rated current A		Range of nominal cross-section to be clamped * mm ²	
Greater than	Up to and including	Rigid (solid or stranded) conductor	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	24 to 50	25 to 35

* 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.

 Note deleted 

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.

8.1.3 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 a 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.

8.1.Z1 Mechanical mounting of plug-in type RCBOs

The mechanical mounting of plug-in type RCBOs shall be reliable and have adequate stability.

8.1.Z1.1 Plug-in type RCBOs, the holding in position of which does not depend solely on their plug-in connection(s)

Compliance of the mechanical mounting is checked by the relevant tests of 9.13.

8.1.Z1.2 Plug-in type RCBOs, the holding in position of which depends solely on their plug-in connection(s)

Compliance of the mechanical mounting is checked by the relevant tests of 9.13. 

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 wired as in normal conditions of use, shall either be of insulating material, or be lined throughout with insulating material, unless the live parts are within an internal enclosure of insulating material.

Linings shall be fixed in such a way that they are not likely to be lost during installation of the RCBOs. They shall have adequate thickness and mechanical strength and shall provide adequate protection at places where sharp edges occur.

Inlet openings for cables or conduits shall either be of insulating material or be provided with bushings or similar devices of insulating material. Such devices shall be reliably fixed and shall have adequate mechanical strength.

For plug-in RCBOs external parts other than screws or other means for fixing covers, which are accessible for normal use, shall be of insulating material.

Metallic operating means shall be insulated from live parts and their conductive parts which otherwise would be "exposed conductive parts" shall be covered by insulating material, with the exception of means for coupling insulated operating means of several poles.

Metal parts of the mechanism shall not be accessible. In addition, they shall be insulated from accessible metal parts, from metal frames supporting the base of flush-type RCBOs, from screws or other means for fixing the base to its support and from metal plates used as support.

It shall be possible to replace plug-in RCBOs easily without touching live parts.

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

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

8.3 Dielectric properties and isolating capability

RCBOs shall have adequate dielectric properties and shall ensure isolation.

Control circuits connected to the main circuit shall not be damaged by high d.c. voltage due to insulating measurements which are carried out after RCBOs are installed.

8.3.Z1 Dielectric strength at power frequency

RCBOs shall have adequate dielectric properties at power frequency.

Compliance is checked by the tests of 9.7.1, 9.7.2, 9.7.3 and 9.7.4 (if applicable).

Moreover, after the endurance tests of 9.10 and after the short-circuit tests of 9.12, the RCBOs shall withstand the test of 9.7.3 but at the reduced test voltage specified in 9.10.3 and 9.12.12.2 respectively and without the previous humidity treatment of 9.7.1.

8.3.Z2 Isolating capability

RCBOs shall be suitable for isolation.

Compliance is checked by the verification of compliance with the minimum clearances and creepage distances of item 1 of Table 5 of 8.1.3 and by the tests of 9.7.Z1.1 and 9.7.Z1.2. 

8.3.Z3 Dielectric strength at rated impulse withstand voltage (U_{imp})

RCBOs shall adequately withstand impulse voltages.

Compliance is checked by the tests of 9.20. 

8.4 Temperature-rise

8.4.1 Temperature-rise limits

The temperature-rises of the parts of a RCBO specified in table 7, measured under the conditions specified in 9.8.2, shall not exceed the limiting values stated in that table.

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

Table 7 – Temperature-rise values

Parts a) b)	Temperature-rise K
Terminals for external connections c)	65
External parts liable to be touched during manual operation of the RCBO, including operating means of insulating material and metallic means for coupling insulated operating means of several poles	40
External metallic parts of operating means	25
Other external parts, including that face of the RCBO in direct contact with the mounting surface	60
a) No value is specified for the contact, since the design of most RCBOs is such that a direct measurement of the temperature of those parts cannot be made without the risk of causing alterations or displacement of parts likely to affect the reproducibility of the tests. The test of reliability (se 9.22) is considered to be sufficient for checking indirectly the behaviour of the contacts with respect to undue temperature-rises in service. b) No value is specified for parts other than those listed, but no damage shall be caused to adjacent parts of insulating materials, and the operation of the RCBO shall not be impaired. c) For plug-in type RCBOs the terminals of the base on which they are installed.	

8.4.2 Ambient air temperature

The temperature-rise limits given in table 7 are applicable only if the ambient air temperature remains between the limits given in table 4.

8.5 Operating characteristics

The operating characteristic of RCBOs, under residual current or overcurrent conditions, shall comply with the requirements of 9.9.

8.5.1 Under residual current conditions

The operating characteristic of RCBOs shall comply with the requirements of 9.9.1.

8.5.2 Under overcurrent conditions

RCBOs shall comply with the requirements of 8.5.2.1 and 8.5.2.3.

8.5.2.Z1 Effect of single phase loading of multi-pole RCBO on the tripping characteristic

Single phase loading of RCBO with more than 2 current paths shall not have a significant effect on the overcurrent tripping characteristic.

Compliance is checked by the tests of 9.9.2.Z1. 

8.5.2.1 Standard time-(over)current zone

The tripping characteristic of RCBOs shall ensure adequate protection against overcurrents, without premature operation.

The zone of the time-current characteristic (tripping characteristic) of a RCBO is defined by the conditions and the values stated in table 8.

This table refers to a RCBO mounted in accordance with the reference conditions (see 9.2) operating at the reference calibration temperature of 30 °C, with a tolerance of $^{+5}_0$ °C (see note of table 8).

Compliance is checked by the tests specified in 9.9.2.

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

In any case the variation of the test current of table 8 shall not exceed 1,2 % per K of calibration temperature variation.

If the RCBOs are marked for a calibration temperature different from 30 °C, they are tested for that different temperature.

NOTE – The manufacturer shall be prepared to give information on the variation of the tripping characteristic for calibration temperatures differing from the reference value.

Table 8 – Time-current operating characteristics

Test	Type	Test current	Initial condition	Limits of tripping or non-tripping time	Results to be obtained	Remarks
a	B, C, D	1,13 I_n	Cold *	$t \geq 1$ h (for $I_n \leq 63$ A) $t \geq 2$ h (for $I_n > 63$ A)	No tripping	
b	B, C, D	1,45 I_n	Immediately following test (a)	$t < 1$ h (for $I_n \leq 63$ A) $t < 2$ h (for $I_n > 63$ A)	Tripping	Current steadily increased within 5 s
c	B, C, D	2,55 I_n	Cold *	1 s < t < 60 s (for $I_n \leq 32$ A) 1 s < t < 120 s (for $I_n > 32$ A)	Tripping	
C d	B	3 I_n	Cold*)	0,1 < t < 45 s ($I_n \leq 32$ A) 0,1 < t < 90 s ($I_n > 32$ A)	Tripping	Current established by closing an auxiliary switch
	C	5 I_n		0,1 < t < 15 s ($I_n \leq 32$ A) 0,1 < t < 30 s ($I_n > 32$ A)		
	D	10 I_n		0,1 < t < 4 s ** ($I_n \leq 32$ A) 0,1 < t < 8 s ($I_n > 32$ A)		
e	B C D	5 I_n 10 I_n C 20 I_n C	Cold *	$t < 0,1$ s	Tripping	Current established by closing an auxiliary switch
* The term "cold" means without previous loading, at the reference calibration temperature. C ** For $I_n \leq 10$ A, $t < 8$ s is permitted. C						

8.5.2.2 Conventional quantities

a) Conventional time

The conventional time is 1 h for RCBOs of rated current up to and including 63 A, and 2 h for RCBOs of rated current above 63 A.

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

The conventional no-tripping overcurrent of a RCBO is 1,13 times its rated current.

c) Conventional tripping overcurrent (I_t)

The conventional tripping overcurrent of a RCBO is 1,45 times its rated current.

8.5.2.3 Overcurrent tripping characteristic

The overcurrent tripping characteristic of RCBOs shall be contained within the zone defined in 8.5.2.1.

NOTE – Conditions of temperature and mounting different from those specified in 9.2 (e.g. mounting in a special enclosure, grouping of several RCBOs in the same enclosure, etc.) may affect the tripping characteristic of RCBOs.

The manufacturer shall be prepared to give information on the variation of the tripping characteristic for ambient temperatures differing from the reference value, within the limits of 7.1.

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

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

Compliance is checked by the tests of 9.9.2.3.

8.6 Mechanical and electrical endurance

RCBOs shall be capable of performing an adequate number of mechanical and electrical operations.

Compliance is checked by the test of 9.10.

8.7 Performance at short-circuit currents

RCBOs shall be capable of performing a specified number of short-circuit operations during which they shall neither endanger the operator nor initiate a flashover between live conductive parts or between live conductive parts and earth.

Compliance is checked by the tests of 9.12.

8.8 Resistance to mechanical shock and impact

RCBOs shall have adequate mechanical behaviour so as to withstand the stresses imposed during installation and use.

Compliance is checked by the test of 9.13.

8.9 Resistance to heat

RCBOs shall be sufficiently resistant to heat.

Compliance is checked by the test of 9.14.

8.10 Resistance to abnormal heat and to fire

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

Compliance is checked by inspection and by the test of 9.15.

8.11 Test device

For RCCBs with rated residual current of 30 mA the ampere-turns produced when operating the test device of a RCCB, supplied at rated voltage or at the highest value of the voltage range, if applicable, shall not exceed 1,66 times the ampere-turns produced, when a residual current equal to $I_{\Delta n}$ is passed through one of the poles of the RCCB.

NOTE – The test device is intended to check the tripping function, not the value at which this function is effective with respect to the rated residual operating current and the break times.

C14 For RCBOs with rated residual current of 30 mA the ampere-turns produced when operating the test device of a RCBO, supplied at rated voltage or at the highest value of the voltage range, if applicable, shall not exceed 50 mA.

For RCBOs with rated residual currents other than 30 mA the ampere-turns produced when operating the test device of a RCBO, supplied at rated voltage or at the highest value of the voltage range, if applicable, shall not exceed 2,5 times the ampere-turns produced, when a residual current equal to $I_{\Delta n}$ is passed through one of the poles of the RCBO. **C14**

C Text deleted **C**

The test device shall comply with the test of 9.16.

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

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

The test device shall not be the sole means of performing the opening operation and is not intended to be used for this function.

8.12 Requirements for RCBOs functionally dependent on line voltage

RCBOs functionally dependent on line voltage shall operate correctly at any value of the line voltage between 0,85 and 1,1 times their rated voltage, for which purpose multipole RCBOs shall have all their **A1** current paths supplied from the **A1** phases and neutral, if any.

Compliance is checked by the test of 9.17 under the supplementary test conditions specified in 9.9.1.2.

According to their classification, RCBOs shall comply with the requirements given in table 9.

Table 9 – Requirements for RCBOs functionally dependent on line voltage

Classification of the device according to 4.1		Behaviour in case of failure of the line voltage
RCBOs opening automatically in case of failure of the line voltage (4.1.2.1)	Without delay	Opening without delay, according to the conditions stated in 9.17.2. a)
	With delay	Opening with delay, according to 9.17.2. b). Correct operation during the delay shall be verified according to 9.17.3.
RCBOs which do not open automatically in case of failure of the line voltage (4.1.2.2.)		No opening

C Specific requirements for RCBOs classified in 4.1.2.2a) are under consideration. **C**

8.13 Void

 8.14 *Behaviour of RCBOs in case of current surges caused by impulse voltages*

RCBOs shall adequately withstand the current surges to earth due to the loading of the capacitance of the installation and the current surges to earth due to flashover in the installation. RCBOs of the S-type shall additionally show adequate resistance against unwanted tripping in case of current surges to earth due to flashover in the installation.

Compliance is checked by the tests of 9.19. 

8.15 *Behaviour of RCBOs in case of earth fault currents comprising a d.c. component*

RCBOs shall adequately perform in presence of earth fault currents comprising a d.c. component in accordance with their classification.

Compliance is checked by the tests of 9.21.

8.16 *Reliability*

RCBOs shall operate reliably even after long service, taking into account the aging of their components.

Compliance is checked by the tests of 9.22 and 9.23.

 8.Z1 Behaviour of RCBOs at low ambient air temperatures

RCBOs for use in the range of –25 °C to +40 °C (see 4.Z1) shall operate reliably at low temperatures.

Compliance is checked by the tests of 9.Z1. 

 8.Z2 Electromagnetic compatibility (EMC)

RCBOs shall operate reliably even in presence of electromagnetic disturbances and shall comply with relevant EMC requirements.

Compliance is checked by the tests of 9.Z2. 

9 Tests

9.1 General

9.1.1 *The characteristics of RCBOs are checked by means of type tests.*

Type tests required by this standard are listed in table 10.

 NOTE To verify compliance of additional marking to 6.Z2, if any, tests are carried out according to the relevant standard. 

Table 10 – List of type tests

Test	Subclause
– Indelibility of marking	9.3
– Reliability of screws, current-carrying parts and connections	9.4
– Reliability of terminals for external conductors	9.5
– Protection against electric shock	9.6
– C Dielectric properties and isolating capability C	9.7
– Temperature-rise	9.8
– Operating characteristic	9.9
– Mechanical and electrical endurance	9.10
– Trip-free mechanism	9.11
– Short circuit *	9.12
– Resistance to mechanical shock and impact	9.13
– Resistance to heat	9.14
– Resistance to abnormal heat and to fire	9.15
– Operation of the test device at the limits of rated voltage	9.16
– Behaviour of RCBOs in case of failure of the line voltage for RCBOs classified according to 4.1.2.1.	9.17
– C₁₃ Text deleted C₁₃	
– Resistance against unwanted tripping due to current surges	9.19
– Resistance of the insulation against an impulse voltage	9.20
– Behaviour of RCBOs in case of an earth fault current comprising a d.c. component	9.21
– Reliability	9.22
– Ageing of electronic components	9.23
– C Behaviour at low ambient air temperatures of RCBOs classified for use in the range of -25 °C to +40 °C	9.21 C
* This comprises several tests.	

9.1.2 For certification purposes, type tests are carried out in test sequences

NOTE – The term "certification" denotes:

- either manufacturer's declaration of conformity;
- or third-party certification, for example by an independent certification body.

The test sequences and the number of samples to be submitted are stated in annex A.

Unless otherwise specified, each type test (or sequence of type tests) is made on RCBOs in a clean and new condition, the influencing quantities having their normal reference values (see table 4).

9.1.3 Routine tests to be carried out by the manufacturer on each device are given in annex D.

9.2 Test conditions

The RCBO is mounted individually according to manufacturer's instructions and in free air, at an ambient temperature between 20 °C and 25 °C, unless otherwise specified, and is protected against undue external heating or cooling.

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

NOTE – An individual enclosure is an enclosure designed to accept one device only.

Unless otherwise specified, the RCBO is wired with the appropriate cable of cross-section S specified in table 11 and is fixed on a dull black painted plywood board of about 20 mm thickness, the method of fixing being in compliance with the requirements relating to the indications of the manufacturer concerning mounting.

Table 11 – Test copper conductors corresponding to the rated currents

Rated current I_n A	$I_n \leq 6$	$6 < I_n \leq 13$	$13 < I_n \leq 20$	$20 < I_n \leq 25$	$25 < I_n \leq 32$	$32 < I_n \leq 50$	$50 < I_n \leq 63$	$63 < I_n \leq 80$	$80 < I_n \leq 100$	$100 < I_n \leq 125$
S mm ²	1	1,5	2,5	4	6	10	16	25	35	50

Ⓢ Note deleted Ⓢ

Where tolerances are not specified, type tests are carried out at values not less severe than those specified in this standard. Unless otherwise specified, tests are carried out at the rated frequency $\pm 5\%$.

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

For the tests of 9.8, 9.9, 9.10 and 9.23, the RCBO is connected as follows:

- the connections are made by means of single-core, PVC-insulated copper cables;
- the connections are in free air and spaced not less than the distance existing between the terminals;
- the length, with a tolerance of $^{+5}_0$ cm, of each temporary connection from terminal to terminal is
 - 1 m for cross-sections up to and including 10 mm²;
 - 2 m for cross-sections larger than 10 mm².

The tightening torques to be applied to the terminal screws are two-thirds of those specified in table 12.

9.3 Test of indelibility of marking

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

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

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

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

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

Compliance with the requirements of 8.1.4 is checked by inspection and, for screws and nuts which are operated when mounting and connecting the RCBO, by the following test.

The screws or nuts are tightened and loosened:

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

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

The test is made by means of a suitable test screwdriver or spanner applying a torque as shown in table 12.

The screws and nuts shall not be tightened in jerks.

The test is made with rigid conductors only, having the largest cross-sectional areas specified in table 6, solid or stranded, whichever is the more unfavourable. The conductor is moved each time the screw or nut is loosened.

Table 12 – Screw thread diameters and applied torques

Nominal diameter of thread mm		Torque Nm		
Greater than	Up to and including	I	II	III
–	2,8	0,2	0,4	0,4
2,8	3,0	0,25	0,5	0,5
3,0	3,2	0,3	0,6	0,6
3,2	3,6	0,4	0,8	0,8
3,6	4,1	0,7	1,2	1,2
4,1	4,7	0,8	1,8	1,8
4,7	5,3	0,8	2,0	2,0
5,3	6,0	1,2	2,5	3,0
6,0	8,0	2,5	3,5	6,0
8,0	10,0	–	4,0	10,0

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

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

Column III applies to screws and nuts which are tightened by means of a screwdriver.