

Electrical accessories — Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) —

Part 1: General rules

The European Standard EN 61009-1:1994, with the incorporation of amendments A1:1995, A11:1995, A2:1998, A13:1998, A14:1998, A15:1998, A17:1998 and A19:2000 has the status of a British Standard

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Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

Austria	Italy
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Greece	Sweden
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National foreword

This British Standard has been prepared under the direction of the Electrotechnical Sector Board and is the English language version of EN 61009-1:1994, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) — Part 1: General rules*, including amendments A1:1995, A11:1995, A2:1998, A13:1998, A14:1998, A15:1998, A17:1998, A19:2000 and corrigenda September 1994, December 1997 and April 1998, published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived by CENELEC from IEC 61009-1:1991 including amendment 1:1995 and the text of a second amendment (see Note 1), published by the International Electrotechnical Commission (IEC).

NOTE 1 The second amendment to IEC 61009-1:1991 was submitted to the IEC-CENELEC parallel vote. While it was approved and published by CENELEC as amendment A2 to EN 61009-1:1994, IEC incorporated the text of the amendment into a new edition of IEC 61009-1.

NOTE 2 There is no amendment A12 to EN 61009-1.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a sideline in the margin. Parts of the original IEC text that have been modified by CENELEC have been quoted in National annex NA. The attention of UK users of this standard is drawn to the special national conditions itemized in Annex ZB.

The following print types are used in this standard:

requirement proper:	in roman type
test specifications:	<i>in italic type</i>
explanatory matter:	in smaller roman type

This British Standard is one of a series in which the other publications are as follows.

BS EN 61002-2-1:1995, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) — Part 2-1: Applicability of the general rules to RCBO's functionally independent of line voltage*.

BS IEC 1009-2-2:1991, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) — Part 2-2: Applicability of the general rules to RCBO's functionally dependent on line voltage*.

Cross references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index" or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 167 and a back cover.

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EN 61009-1	+ A2	+ A15
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Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) — Part 1: General rules

(Includes amendments A1:1995, A11:1995, A2:1998, A13:1998, A14:1998, A15:1998, A17:1998 and A19:2000)

Interruppteurs automatiques à courant différentiel résiduel avec protection contre les surintensités incorporée pour installations domestiques et analogues (DD)

Partie 1: Règles générales

(Inclut les amendements A1:1995, A11:1995, A2:1998, A13:1998, A14:1998, A15:1998, A17:1998 et A19:2000)

Fehlerstrom-Schuttschalter mit Überstromauslöser (RCBO's) für Hausinstallationen und für ähnliche Anwendungen

Teil 1: Allgemeine Anforderungen

(Enthält Änderungen A1:1995, A11:1995, A2:1998, A13:1998, A14:1998, A15:1998, A17:1998 und A19:2000)

This European Standard was approved by CENELEC on 1994-03-08. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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 61009-1:1991 together with common modifications prepared by Technical Committee CENELEC TC 23E, Circuit-breakers and similar equipment for household and similar uses, was submitted to the Unique Acceptance Procedure (UAP) for acceptance as a European Standard.

As the original document did not obtain a sufficient number of positive votes, a revised draft was prepared and submitted to a second vote. The new draft was approved by CENELEC as EN 61009-1 on 1994-03-08.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1996-07-01
- latest date of withdrawal of conflicting national standards (dow) 2000-07-01

Conformity of products with the requirements of this standard ensures conformity with the essential requirements of Directive 73/23/EEC (Low voltage Directive) and its amendment 93/68/EEC.

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given for information only. In this standard, Annex A, Annex B, Annex C, Annex D, Annex E, Annex F, Annex G, Annex ZA, Annex ZB and Annex ZD are normative and Annex IA, Annex IB, Annex IC and Annex ZC are informative.

Annex ZA (normative references), Annex ZB (special national conditions), Annex ZC (A-deviations) and Annex ZD (classification into energy limiting classes) have been added by CENELEC.

Subclauses, figures and tables added by CENELEC are numbered starting with Z1, Z2

Foreword to amendment A1

The text of document 23E/211/DIS, future amendment 1 to IEC 61009-1:1991, prepared by SC 23E, Circuit-breakers and similar equipment for household use, of IEC TC 23, Electrical accessories, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 61009-1:1994 on 1995-09-20.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-07-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2000-07-01

Foreword to amendment A11

This amendment was prepared by the Technical Committee CENELEC TC 23E, Circuit breakers and similar devices for household and similar applications.

Its aim is to add a type of RCBO able to operate at temperatures down to -25°C with unified requirements acceptable by all members of CENELEC.

The text of the draft was submitted to the formal vote and was approved by CENELEC as amendment A11 to EN 61009-1:1994 on 1995-07-04.

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- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2000-07-01

Foreword to amendment A2

The text of document 23E/246/FDIS, future amendment to IEC 61009-1:1991, prepared by SC 23E, Circuit-breakers and similar equipment for household use, of IEC TC 23, Electrical accessories, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A2 to EN 61009-1:1994 on 1996-10-01.

NOTE The text of this document was included in a new edition of IEC 61009-1; it is however published as a separate amendment by CENELEC.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-07-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2001-01-01

Foreword to amendment A13

This amendment was prepared by the Technical Committee CENELEC TC 23E, Circuit-breakers and similar devices for household and similar applications.

The text of the draft was submitted to the formal vote and was approved by CENELEC as amendment A13 to EN 61009-1:1994 on 1997-10-01.

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- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2001-01-01

Foreword to amendment A14

The text of document 23E/252/FDIS, intended to be published in a new (second) edition of IEC 61009-1, prepared by SC 23E, Circuit-breakers and similar equipment for household use, of IEC TC 23, Electrical accessories, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A14 to EN 61009-1:1994 on 1996-10-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-07-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2001-01-01

Foreword to amendment A15

This amendment was prepared by the Technical Committee CENELEC TC 23E, Circuit-breakers and similar devices for household and similar applications.

It comprises the text of two draft amendments, prAA and prAB, which were submitted to the Unique Acceptance Procedure and were approved together as amendment A15 to EN 61009-1:1994 on 1998-04-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-11-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2003-03-01

Foreword to amendment A17

At the request of the Irish electrotechnical committee, a draft for an amendment to EN 61009-1:1994 was submitted to the CENELEC members for acceptance in May 1998.

The text of the draft was accepted by CENELEC as amendment A17 to EN 61009-1:1994 on 1998-07-25.

The following dates were fixed:

- latest date by which the existence of the amendment has to be announced at national level (doa) 1998-10-25
- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-01-25

Foreword to amendment A19

At the request of the Swedish electrotechnical committee, a draft for an amendment to EN 61009-1:1994 was submitted to the CENELEC members for acceptance in December 1999.

The text of the draft was accepted by CENELEC as amendment A19 to EN 61009-1:1994 on 2000-02-13.

The following dates were fixed:

- latest date by which the existence of the amendment has to be announced at national level (doa) 2000-05-13
- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-08-13

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

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 RCBO's functionally independent of line voltage.

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

1 Scope

This International Standard applies to residual current operated circuit-breakers with integral overcurrent protection functionally independent of, or functionally dependent on, line voltage for household and similar uses (hereafter referred to as RCBO's), 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.

RCBO's 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.

NOTES

1 The content of the present standard related to the operation under residual current conditions is based on IEC 1008.

The content of the present standard related to protection against overcurrents is based on IEC 898.

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

3 Installation and application rules of RCBO's are given in IEC 364.

RCBO's 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.

RCBO's 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 4 – Surge arresters installed downstream of the general type of RCBO's and connected in common mode may cause unwanted tripping.

Note 5 – RCBO's within the scope of the present standard are considered as suitable for isolation (see 8.1.3, 9.7.2, 9.7.3, 9.10.3, 9.12.12.1, 9.12.12.2, 9.12.13.2).

Special precautions (e.g. lightning arresters) may be necessary when excessive over-voltages are likely to occur on the supply side (for example in the case of supply through overhead lines) (see IEC 364-4-443).

NOTE - For RCBO's having a degree of protection higher than IP20 special constructions may be required.

This standard also applies to RCBO's 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 RCBO's of the plug-in type.

Particular requirements are necessary for RCBO's 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 - For the time being, for RCBO's 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 884-1 may be used as far as applicable.

This standard does not apply to:

- RCBO's intended to protect motors,
- RCBO's the current setting of which is adjustable by means accessible to the user in normal service.
- RCBO's 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 RCBO's used in locations having severe environmental conditions.

RCBO's including batteries are not covered by this standard.

A guide for the coordination of RCBO's with fuses is given in annex F.

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

3.2.4 residual operating current: Value of residual current which causes the RCBO to operate under specified conditions.

3.2.5 residual non-operating current: Value of residual current at and below which the RCBO does not operate under specified conditions.

3.3 *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 RCBO's functionally independent of line voltage: RCBO's 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 RCBO's functionally dependent on line voltage: RCBO's 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.

3.3.16 *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.

3.4 Definitions relating to values and ranges of energizing quantities

3.4.1 rated value (IEV 151-04-03): A quantity value assigned, generally by the manufacturer, for a specific operating condition of a RCBO.

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 (IEV 441-17-26): The recovery voltage during the time in which it has a significant transient character.

NOTE - The transient voltage may be oscillatory or non-oscillatory, or a combination of these depending on the characteristics of the circuit and of the RCBO. It includes the voltage shift of the neutral of a poly-phase 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 over-current 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 IEV 441-17-39.

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

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

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

3.4.15 Coordination between overcurrent protective devices in series

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

NOTES

- 1 The selectivity-limit current is a limiting value of current:
 - below which, in the presence of two overcurrent protective devices in series, the protective device on the load side completes its breaking operation in time to prevent the other protective device from starting its operation (i.e. selectivity is ensured);
 - above which, in the presence of two overcurrent protective devices in series, the protective device on the load side may not complete its breaking operation in time to prevent the other protective device from starting its operation (i.e. selectivity is not ensured);
- 2 $I^2 t$ characteristics may be used instead of time-current characteristics.

3.4.15.2 take-over current (I_B): The current coordinate of the intersection between the maximum break time-current characteristics of two overcurrent protective devices.

NOTES

- 1 The take-over current is a limiting value of current above which, in the presence of two overcurrent protective devices in series, the protective device generally, but not necessarily, on the supply side, provides back-up operation for the other protective device.
- 2 $I^2 t$ characteristics may be used instead of time-current characteristics.

3.4.16 conventional non-tripping current (I_{nt}) (IEV 441-17-22): A specified value of current which the RCBO can carry for a specified time (conventional time) without operating.

3.4.17 conventional tripping current (I_t) (IEV 441-17-23): 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.

3.4.19 clearance (see annex B): The shortest distance in air between two conductive parts.

NOTE - For the purpose of determining a clearance to accessible parts, the accessible surface of an insulating enclosure 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 3.

3.4.20 creepage distance (see annex B): The 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 were covered by a metal foil wherever it can be touched by a hand or a standard test finger according to figure 3.

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 RCBO's 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 RCBO's 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 Sub-Committee 23F on terminals is completed.

3.6.1 terminal: A terminal is a conductive part of a RCBO, provided for reusable 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.

3.7 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

RCBO's 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 RCBO's according to the various applications but does not exclude the use of RCBO's of any classification for protection over and above that required by the relevant wiring rules.

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.
- NOTE - RCBO's 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 - The selection of the RCBO's of b) is subject to the conditions of 532.2.2.2 of IEC 364-5-53.

Table Z1 - Survey of the types of RCBO's 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 (1)	Indirect contact and additional (1)	Additional (1)	Additional (1) (2)
Service (3) continuity	Yes	Yes	No	Yes
NOTES 1. Additional protection, provided only for RCBO's with $I_{\Delta n} \leq 0,03 \text{ A}$. 2. Only devices integrated in one unit with a socket-outlet or designed exclusively for being associated locally with a socket-outlet in the same mounting box. 3. This information is given for guidance only.				

4.2 *Deleted.*

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

two-pole RCBO with one overcurrent protected pole;

two-pole RCBO with two overcurrent protected poles;

- three-pole RCBO with three overcurrent protected poles;
- 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*

- RCBO's with normal resistance to unwanted tripping (general type as in table 2);
- RCBO's with increased resistance to unwanted tripping (S type as in table 2).

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

- RCBO's of type AC;
- RCBO's of type A.

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

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

4.8 *According to the protection against external influences*

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

4.9 *According to the method of mounting*

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

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

4.10 *According to the method of connection*

- RCBO's the connections of which are not associated with the mechanical mounting;
- RCBO's the connections of which are associated with the mechanical mounting, for example:
 - plug-in type;
 - bolt-on type.

NOTE - 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.

4.11 According to the instantaneous tripping current (see 3.4.18)

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

4.12 According to the I^2t characteristic

In addition to the manufacturer providing the I^2t characteristic (see 5.1) RCBO's may be classified according to their I^2t characteristic.

RCBO's of B-type and C-type, having rated current up to and including 32 A and having rated short-circuit breaking capacity of 3 000 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, in accordance with annex ZD.

4.13 According to the range of ambient air temperature

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

5 Characteristics of RCBO's**5.1 Summary of characteristics**

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

- 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 coordination 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);
- ranges of ambient air temperature (see 5.3.10).

For RCBO's 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_o)

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.

5.2.2 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.

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.

|| The conditions are those specified in 9.12.11.2 and 9.12.11.4d).

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.

5.2.10 Insulation coordination including clearances and creepage distances

Under consideration.

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

5.3 Standard and preferred values

5.3.1 Preferred values of rated voltage (U_n)

Preferred values of rated voltage are as follows:

RCBO	Circuit supplying the RCBO	Rated voltage
Two-pole with one or two overcurrent protected poles	single phase, phase to neutral, phase to phase	230 V
	single phase, phase to phase	400 V
Three-pole with three overcurrent protected poles	three-phase three-wire	400 V
Four-pole with three or four overcurrent protected poles	three-phase four-wire	400 V

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

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

Standard values of rated residual operating current are

- 0,01 - 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

Standard values of rated frequency are: 50 Hz and 60 Hz.

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

5.3.6.1 Standard values up to and including 10 000 A

The 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 rated residual making and breaking capacity

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

(*) Only for RCBO's 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 Deleted

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 RCBO's are given in table 2.

Table 2 — Standard values of break time and non-actuating time for operation under residual current conditions

Type	I_n	$I_{\Delta n}$	Standard value of break time and non-actuating time at a residual current equal to:					
			$I_{\Delta n}$	$2I_{\Delta n}$	$5I_{\Delta n}^*$	$I_{\Delta t}^{**}$	500 A or $10 I_n^{***}$	
General	Any value	Any value	0,3	0,15	0,04	0,04**	0,04	Maximum break times
S	≥ 25	$> 0,03$	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

* For RCBO's of the general type incorporated in or intended only for association with plugs and socket outlets, and for RCBO's of the general type with $I_{\Delta n} \leq 30$ mA, 0,25 A may be used as an alternative to $5 I_{\Delta n}$.

** This test is made with a current $I_{\Delta t}$ which is the lower limit of the overcurrent instantaneous tripping range according to type B, C or D, as applicable (see Table 3).

*** Discrimination between instantaneous tripping and residual tripping cannot be ensured.

**** 500 A or $10 I_n$, whichever is the greater. The verifications of the break times at these values are only made during the tests of 9.12.11.2.

For type A RCBO's 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 RCBO's with $I_{\Delta n} > 0,01$ A and by the factor 2 for RCBO's 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 $20 I_n$

5.3.10 Standard ranges of ambient air temperature

The standard ranges of ambient air temperature are:

- -5 °C to $+40\text{ °C}$;
- -25 °C to $+40\text{ °C}$.

6 Marking and other product information

6.1 Standard marking

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

- a) manufacturer's name or trade mark;
- b) type designation, catalogue number or serial number;
- c) rated voltage(s) with the symbol $\sim$;
- d) rated current without symbol "A", preceded by the symbol of overcurrent instantaneous tripping (B, C or D), for example B 16;
- e) rated frequency, if the RCBO is designed for a frequency other than 50 Hz;
- f) rated residual operating current ($I_{\Delta n}$) in A or mA;
- g) *deleted*
- h) rated short-circuit capacity, in amperes in rectangle without symbol A;
- j) reference calibration temperature, if different from 30 °C ;
- k) the degree of protection (only if different from IP 20);
- l) the position of use (symbol according to IEC 51), if necessary;
- m) rated residual making and breaking capacity ($I_{\Delta m}$), if different from rated short-circuit capacity (I_{cn});
- n) the symbol S (S in a square) for type S devices;
- o) symbol of the method of operation according to table Z1 of 4.1, if the RCBO is functionally dependent on the line voltage;

q) operating means of the test device, by the letter T;

r) wiring diagram unless the correct mode of connection is evident;

s) operating characteristic in presence of residual currents with d.c. components

- RCBO's of type AC with the symbol 
- RCBO's of type A with the symbol. 

t) Energy limiting class in a square in accordance with annex ZD, if applied. I_{cn} and the energy limiting class when apply shall be both on the device and combined together.

u) the symbol of use at ambient air temperatures between -25 °C and $+40\text{ °C}$  (the value -25 included in the snowflake symbol according to figure 0027 of ISO 7000), if relevant. RCBO's according to 4.Z1.2 shall be marked with the symbol  (snowflake enclosing -25).

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

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

If the degree of protection IP is marked on the device itself, all parts shall comply with the relevant IP requirements (EN 60529). The IP indications in the catalogue or instruction sheets may take into account various methods of installation (e.g. additional covers, terminal covers, enclosures..).

For RCBO's 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. Provisionally the use of national indications only is allowed. These indications shall be readily visible when the RCBO is installed.

For RCBO's 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 417-5019 a)).

NOTE - The symbol  (IEC 417-5017a)), previously recommended, shall be progressively superseded by the preferred symbol IEC 417-5019 a), given above.

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

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

Specifications on appropriate recommendations to the user to regularly operate the test device are under consideration.

6.2 Additional marking

Additional marking to other standards (European or International Standards or other) is 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 6.1.

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.

6.3 Guidance table for marking

See next page.

6.3 Guidance table for marking

6	Marking and other product information Each RCBO shall be marked in a durable manner with all or, for small apparatus, part of the following data: The minimum requirements are indicated by the symbol "X"	Marking shall be on the RCBO itself			Marking in the catalogue
		Marking visible when the device is installed in case of small devices, where the space available does not allow all the data to be marked.	Marking allowed on the side or on the back of the device, visible before the device is installed.	Alternatively the 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		Remaining information to be given in the manufacturer's catalogues if not marked on the device
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 only for one frequency (see 5.3.5);				X
f)	rated residual operating current ($I_{\Delta n}$) in A or in mA	X			
h)	rated short circuit capacity, in amperes in a rectangle without symbol "A"		X(*)		X
j)	reference calibration temperature, if different from 30°C				X
k)	the degree of protection (only if different from IP20);				
l)	the position of use (symbol according to IEC 51), if necessary;		X		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)	indication that the RCBO is functionally dependent on line voltage, if applicable ;		X	X	
q)	operating means of the test device, by the letter T;	X			
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 - RCBOs of type AC with the symbol  - RCBOs of type A with the symbol  Energy limiting class (e.g. 3) in a square in accordance with Annex ZD if applied	X	X(*)		
t)	RCBOs according to 4.21.2 shall be marked with the symbol  (snowflake enclosing -25)		X		
	Indication of the terminal for the neutral with "N"				
	Additional marking of performance to other standards		X		

*) I_{cn} and the energy limiting class, if applied, shall be on the device and combined together.

NOTE: Specifications on appropriate recommendations to the user to regularly operate the test device are under consideration.

7 Standard conditions for operation in service and for installation

7.1 Standard conditions

RCBO's 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 (See note 2) -25 °C to +40 °C (See note 2)	20 °C	±5 °C
Altitude	Not exceeding 2 000 m		
Relative humidity maximum value at 40 °C	50% (See note 3)		
External magnetic field	Not exceeding 5 times the earth's magnetic field in any direction	Earth's magnetic field	(See note 4)
Position	As stated by the manufac- turer 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 tolerances given apply unless otherwise specified in the relevant test. 7) Extreme limits of -20 °C and 60 °C, for RCBO's for use in the range of -5 °C to +40 °C and of -35 °C and 60 °C, for RCBO's 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.			

7.2 Conditions of installation

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

8 Requirements for construction and operation

8.1 Mechanical design

8.1.1 General

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 RCBO's shall be so mechanically coupled that all poles except the switched neutral, if any, make and break substantially together, whether operated manually or automatically.

A switched neutral pole (see 3.3.15.3) shall open after and close before the other pole(s).

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.

RCBO's shall have a trip-free mechanism.

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

RCBO's 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.

RCBO's 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.

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.

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

8.1.3 Clearances and creepage distances (see annex B)

Clearances and creepage distances shall be not less than the values shown in table 5, when the RCBO is mounted as for normal use.

NOTE - A revision of the values of table 5 is under consideration.

Table 5 - Clearances and creepage distances

Description	Distance mm
Clearances ^{a)}	
1. Between live parts which are separated when the RCBO is in the open position ^{b)}	3
2. Between live parts of different polarity ^{c)}	3
3. Between live parts and	
- metal operating means	3
- screws or other means for fixing covers which have to be removed when mounting the RCBO	3
- the surface on which the base is mounted ^{e)}	6 (3)
- screws or other means for fixing the RCBO ^{e)}	6 (3)
- metal covers or boxes ^{e)}	6 (3)
- other accessible metal parts ^{f)}	3
- metal frames supporting flush-type RCBO's	3
4. Between metal parts of the mechanism and	
- accessible metal parts ^{f)}	3
- screws or other means for fixing the RCBO	3
- metal frames supporting flush-type RCBO's	3
Creepage distances ^{a)}	
1. Between live parts which are separated when the RCBO is in the open position ^{b)}	3
2. Between live parts of different polarity ^{c)}	
- for RCBO's having a rated voltage not exceeding 250 V	3
- for other RCBO's	4
3. Between live parts and	
- metal operating means	3
- screws or other means for fixing covers which have to be removed when mounting the RCBO	3
- screws or other means for fixing the RCBO ^{e)}	6 (3)
- accessible metal parts ^{f)}	3
a) Clearances and creepage distances of the secondary circuit and between the primary windings of the RCBO transformer are not considered. b) Not applicable to auxiliary and control contacts. c) Care should be taken for providing adequate spacing between live parts of different polarity of RCBO's of the plug-in type mounted close to one another. Values are under consideration. d) Deleted e) 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 dependent on the design of the RCBO only, so that they cannot be reduced when the RCBO is mounted in the most unfavourable position (even in a metallic enclosure), the values in brackets are sufficient. f) 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 jointed test finger according to 9.6.	

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, part 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.

In this standard, screw-type terminals for external copper conductors only are considered.

NOTE - Requirements for flat quick-connect terminations, screwless terminals and terminals for the connection of aluminium conductors are under consideration.

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 and by the tests of 9.5.

8.1.5.2 RCBO's 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 terminals are given in annex IC.

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 * mm²	
Greater than	Up to and including	Rigid (solid or stranded) conductors	Flexible conductors
—	13	1 to 2,5	1 to 2,5
13	16	1 to 4	1 to 4
16	25	1,5 to 6	1,5 to 6
25	32	2,5 to 10	2,5 to 6
32	50	4 to 16	4 to 10
50	80	10 to 25	10 to 16
80	100	16 to 35	16 to 25
100	125	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.			

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

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

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

Compliance is checked by inspection.

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

8.1.5.5 Terminals shall have adequate mechanical strength.

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

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

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

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

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

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

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

This requirement does not apply to lug terminals.

Compliance is checked by the test of 9.5.3.

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

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

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

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

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

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

Compliance is checked by manual test.

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

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

8.1.6 Non-interchangeability

For RCBO's 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.

8.2 Protection against electric shock

RCBO's 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 RCBO's 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 RCBO's 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 RCBO's 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 RCBO's. 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 RCBO's 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 RCBO's, 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 RCBO's 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

RCBB's shall have adequate dielectric properties.

Control circuits connected to the main circuit shall not be damaged by high d.c. voltages due to insulation measurements which are normally carried out after RCBO's are installed.

Compliance is checked by the tests of 9.7 and 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 contacts, since the design of most RCBO's 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 (see 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 RCBO's 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 RCBO's, 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 RCBO's shall comply with the requirements of 9.9.1.

8.5.2 Under overcurrent conditions

RCBO's shall comply with the requirements of 8.5.2.1 and 8.5.2.3.

8.5.2.1 Standard time-(over)current zone

The tripping characteristic of RCBO's shall ensure adequate protection against over-currents, 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 RCBO's 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 (*)	$t \geq 1 \text{ h}$ (for $I_n \leq 63 \text{ A}$) $t \geq 2 \text{ h}$ (for $I_n > 63 \text{ A}$)	No tripping	
b	B, C, D	$1,45 I_n$	Immediately following test (a)	$t < 1 \text{ h}$ (for $I_n \leq 63 \text{ A}$) $t < 2 \text{ h}$ (for $I_n > 63 \text{ A}$)	Tripping	Current steadily increased within 5 s
c	B, C, D	$2,55 I_n$	Cold (*)	$1 \text{ s} < t < 60 \text{ s}$ (for $I_n \leq 32 \text{ A}$) $1 \text{ s} < t < 120 \text{ s}$ (for $I_n > 32 \text{ A}$)	Tripping	
d	B C D	$\frac{3}{5} I_n$ $\frac{5}{10} I_n$	Cold (*)	$t \geq 0,1 \text{ s}$	No tripping	Current established by closing an auxiliary switch
e	B C D	$\frac{5}{10} I_n$ $\frac{10}{50} I_n$	Cold (*)	$t < 0,1 \text{ s}$	Tripping	Current established by closing an auxiliary switch
* The term "cold" means without previous loading, at the reference calibration temperature.						

8.5.2.2 Conventional quantities

a) Conventional time

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

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

The conventional non-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 RCBO's 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 RCBO's in the same enclosure, etc.) may affect the tripping characteristic of RCBO's.

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 $-5\text{ }^{\circ}\text{C}$ and $+40\text{ }^{\circ}\text{C}$, shall not unacceptably affect the overcurrent tripping characteristic of RCBO's.

Compliance is checked by the tests of 9.9.2.3.

8.6 Mechanical and electrical endurance

RCBO's 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

RCBO's 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

RCBO's 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

RCBO's 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 RCBO's 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

RCBO's shall be provided with a test device to simulate the passing through the detecting device of a residual current in order to allow a periodic testing of the ability of the residual current device to operate.

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.

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.

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 RCBO's functionally dependent on line voltage

RCBO's 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 RCBO's shall be connected to the respective 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, RCBO's shall comply with the requirements given in table 9.

1 Specific requirements are under consideration for RCBO's classified in 4.1.2. 2a).

Table 9 - Requirements for RCBO's functionally dependent on line voltage

Classification of the device according to 4.1		Behaviour in case of failure of the line voltage
RCBO's 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
RCBO's which do not open automatically in case of failure of the line voltage (4.1.2.2)		No opening

8.13 *Behaviour of RCBO's in case of a single-phase overcurrent through a three-pole or four-pole RCBO*

Three-pole and four-pole RCBO's shall not operate with single-phase overcurrent having a value equal to the lower limit of the overcurrent instantaneous tripping range according to type B, C or D, as applicable.

Compliance is checked by the test of 9.18.

8.14 *Resistance of RCBO's to unwanted tripping due to current surges caused by impulse voltages*

RCBO's shall adequately withstand the current surges to earth due to the loading of the capacitances of the installation. RCBO's with increased resistance to unwanted tripping (S type as in table 2) shall additionally withstand the current surges to earth due to flashover in the installation.

Compliance is checked by the tests of 9.19.

8.15 *Behaviour of RCBO's in case of earth fault currents comprising a d.c. component*

RCBO's 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*

RCBO's shall operate reliably even after long service, taking into account the ageing of their components.

Compliance is checked by the tests of 9.22 and 9.23.

8.17 *Behaviour of RCBO's at low ambient air temperatures*

RCBO's for use in the range of $-25\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$ (see 4.13) shall operate reliably at low temperatures.

Compliance is checked by the tests of 9.24.

