

Electrical accessories — Residual current monitors for household and similar uses (RCMs)

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ICS 29.120.50

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English version

Electrical accessories
Residual current monitors for household
and similar uses (RCMs)
(IEC 62020:1998)

Petit appareillage électrique
Contrôleurs d'isolement à courant
différentiel résiduel (RCM) pour usages
domestiques et analogues
(CEI 62020:1998)

Elektrisches Installationsmaterial
Differenzstrom-Überwachungsgeräte
für Hausinstallationen und ähnliche
Verwendungen (RCMs)
(IEC 62020:1998)

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CENELEC

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

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Foreword

The text of document 23E/337/FDIS, future edition 1 of IEC 62020, 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 EN 62020 on 1998-10-01.

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Annexes designated “normative” are part of the body of the standard.

In this standard, Annex ZA is normative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62020:1998 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of document 23E/531/FDIS, future amendment 1 to IEC 62020:1998, was 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 62020:1998 on 2005-03-01.

A draft amendment, aiming to improve subclause 8.18.1 of EN 62020:1998, prepared by the Technical Committee CENELEC TC 23E, Circuit breakers and similar devices for household and similar applications, was submitted to the Unique Acceptance Procedure and was approved by CENELEC on 2005-03-01 for inclusion into amendments A1 to EN 62020:1998.

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- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2008-03-01

Annex ZB has been added by CENELEC.

Endorsement notice

The text of amendment 1:2003 to the International Standard IEC 62020:1998 was approved by CENELEC as an amendment to the European Standard with agreed common modifications.

Contents

	Page
Foreword	2
Introduction	7
1 Scope	7
2 Normative references	7
3 Definitions	8
3.1 Definitions relating to currents flowing from live parts to earth	8
3.2 Definitions relating to the energization of an RCM	9
3.3 Definitions relating to the operation and to the functions of residual current monitors	9
3.4 Definitions relating to values and ranges of energizing quantities	10
3.5 Definitions relating to values and ranges of influencing quantities	11
3.6 Definitions relating to terminals	12
3.7 Conditions of operation	13
3.8 Test	13
4 Classification	13
4.1 According to the method of operation	13
4.2 According to the type of installation	13
4.3 According to the number of current paths	13
4.4 According to the ability to adjust the residual operating current	14
4.5 According to the possibility of adjusting the time-delay	14
4.6 According to the protection against external influences	14
4.7 According to the method of mounting	14
4.8 According to the method of connection	14
4.9 According to the type of connection of the load conductors	14
4.10 According to fault indicating means	14
4.11 According to ability to directionally discriminate between supply side and load side residual currents	14
5 Characteristics of RCMs	15
5.1 Summary of characteristics	15
5.2 Rated quantities and other characteristics	15
5.3 Standard and preferred values	16
5.4 Coordination with short-circuit protective devices (SCPDs) (only valid for RCMs classified according to 4.9.2)	17
6 Marking and other product information	18
7 Standard conditions for operation in service and for installation	20
7.1 Standard conditions	20
7.2 Conditions of installation	20
8 Requirements for construction and operation	20
8.1 Mechanical design	20
8.2 Protection against electric shock	24
8.3 Dielectric properties	24
8.4 Temperature rise	24
8.5 Operating characteristic	24
8.6 Directional discrimination	25
8.7 Operational endurance	25
8.8 Performance at short-circuit currents	25
8.9 Resistance to mechanical impact	25
8.10 Resistance to heat	25
8.11 Resistance to abnormal heat and to fire	25

	Page
8.12 Test device	26
8.13 Correct operation of RCMs within the supply voltage range	26
8.14 Behaviour of RCMs in case of overcurrents in the main circuit	26
8.15 Resistance of RCMs to unwanted tripping due to current surges caused by impulse voltages	26
8.16 Behaviour of RCMs in case of earth fault currents comprising d.c. components	26
8.17 Reliability	26
8.18 Electromagnetic compatibility (Based on IEC 61543)	26
8.19 Connection of an external current transformer (CT)	28
9 Tests	29
9.1 General	29
9.2 Test conditions	30
9.3 Test of indelibility of marking	30
9.4 Test of reliability of screws, current-carrying parts and connections	30
9.5 Test of reliability of terminals for external conductors	31
9.6 Verification of protection against electric shock	32
9.7 Test of dielectric properties	33
9.8 Test of temperature rise	35
9.9 Verification of the operating characteristics	36
9.10 Verification of operational endurance	38
9.11 Verification of short-circuit withstand capability	39
9.12 Verification of resistance to mechanical impact	43
9.13 Test of resistance to heat	45
9.14 Test of resistance to abnormal heat and to fire	46
9.15 Verification of the operation of the test device at the limits of rated voltage	46
9.16 Verification of limiting values of the non-operating current under overcurrent conditions	47
9.17 Verification of resistance against unwanted operation due to current surges caused by impulse voltages	48
9.18 Verification of resistance of the insulation against impulse voltages	48
9.19 Verification of the correct operation at residual currents with d.c. components	49
9.20 Verification of reliability	50
9.21 Verification of ageing of electronic components	51
9.22 Verification of EMC requirements	52
9.23 Response of the RCM to temporary overvoltages on the LV-side, due to fault conditions on the HV-side	52
Annex A (normative) Test sequence and number of samples to be submitted for verification of conformity to the standard	72
Annex B (normative) Determination of clearances and creepage distances	75
Annex ZA (normative) Normative references to international publications with their corresponding European publications	77
Figure 1 — Standard test finger (9.6)	53
Figure 2a— Test circuit for the verification of the operating characteristics for RCMs for use in TN and TT-systems	54
Figure 2b — Test circuit for the verification of directional discrimination in IT systems for RCMs classified according to 4.11	55
Figure 3 — Test circuit for the verification of the correct operation of RCMs in the case of residual pulsating direct currents	56
Figure 4 — Test circuit for the verification of the correct operation of RCMs in the case of residual pulsating direct currents superimposed by smooth direct current of 0,006 A	56

	Page
Figure 5 — Test circuit for the verification of the co-ordination with a SCPD of a RCM with two current paths (9.11)	57
Figure 6 — Test circuit for the verification of the co-ordination with a SCPD of a RCM with three current paths in a three phase circuit (9.11)	58
Figure 7 — Test circuit for the verification of the co-ordination with a SCPD of a RCM with four current paths on a three-phase circuit with neutral (9.11)	59
Figure 8 — Test apparatus for the verification of the minimum I^2t and I_p values to be withstood by the RCM [9.11.2.1a]	60
Figure 9 — Mechanical impact test apparatus (9.12.1)	61
Figure 10 — Striking element for pendulum impact test apparatus (9.12.2)	62
Figure 11 — Mounting support for sample for mechanical impact test (9.12.1)	62
Figure 12 — Example of mounting an unenclosed RCM for mechanical impact test (9.12.1)	63
Figure 13 — Example of mounting of panel mounting type RCM for the mechanical impact test (9.12.1)	64
Figure 14 — Application of force for mechanical test of rail-mounted RCM (9.12.2)	65
Figure 15 — Ball-pressure test apparatus (9.13.2)	65
Figure 16 — Test circuit for the verification of the limiting value of overcurrent in the case of single-phase load through a three-phase RCM (9.16.2)	66
Figure 17 — Current ring wave 0,5 μ s/100 kHz	67
Figure 18 — Test circuit for the ring-wave test at RCMs	67
Figure 19 — Stabilizing period for reliability test (9.20.1.3)	68
Figure 20 — Reliability test cycle (9.20.1.3)	69
Figure 21 — Example for test circuit for verification of ageing of electronic components (9.21)	70
Figure 22a — RCMs without monitored lines connected	71
Figure 22b — RCMs with monitored lines connected	71
Figure B.1 — Illustrations of the application of creepage distances	76
Figure B.2 — Illustrations of the application of creepage distances	76
Figure B.3 — Illustrations of the application of creepage distances	76
Figure B.4 — Illustrations of the application of creepage distances	76
Figure B.5 — Illustrations of the application of creepage distances	76
Figure B.6 — Illustrations of the application of creepage distances	76
Figure B.7 — Illustrations of the application of creepage distances	77
Figure B.8 — Illustrations of the application of creepage distances	77
Figure B.9 — Illustrations of the application of creepage distances	77
Figure B.10 — Illustrations of the application of creepage distances	77
Table 1 — Standard conditions for operation in service	19
Table 2 — Clearances and creepage distances	21
Table 3 — Connectable cross-sections of copper conductors for screw-type terminals	23
Table 4 — Temperature-rise values	25
Table Z.1 — Low frequency immunity test conditions	27
Table 15 — EMC Tests	28
Table 5 — List of type tests depending on RCM classification	29
Table 6 — Test copper conductors corresponding to the rated currents	29
Table 7 — Screw thread diameters and applied torques	31
Table 8 — Pulling forces	32
Table 9 — Conductor dimensions	32

	Page
Table 16 — Summary of the tests contained in 9.7.2 , 9.7.3 and 9.7.4	35
Table 11 — Silver wire diameter as a function of rated current and short-circuit currents	41
Table 12 — Minimum values of I^2t and I_p	42
Table 13 — Power factors for short-circuit tests	42
Table 14 — Acutating current ranges	49
Table A.1 — Test sequences	72
Table A.2 — Number of samples submitted to tests	73
Table A.3 — Tests with reduced number of samples	74

Introduction

The purpose of a residual current monitor (hereinafter referred to as RCM) is to monitor an electrical installation or circuit for the presence of an unbalanced earth fault current and to indicate, by means of an alarm, the presence of such a residual current when it exceeds a predetermined level.

An RCM may be used in conjunction with protective devices (see IEC 60364-4).

Installation and application rules are given in IEC 60364.

1 Scope

This International Standard applies to residual current monitors having rated voltages not exceeding 440 V a.c. and rated currents not exceeding 125 A for household and similar purposes.

These devices are intended to monitor the residual current of the installation and to give a warning if the residual current between a live part and an exposed conductive part or earth exceeds a predetermined level.

A1) RCMs covered by this standard are not intended to be used as protective devices. **A1**

RCMs detect residual alternating currents and residual pulsating direct currents whether suddenly applied or slowly rising (see 8.16).

This standard applies to monitors performing simultaneously the functions of detection of the residual current, of comparison of the value of this current with the residual operating current of the device and of providing the prescribed warning signal(s) when the residual current exceeds this value.

RCMs having internal batteries are not covered by this standard.

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

This standard does not cover Insulation Monitoring Devices (IMDs) which are covered by the scope of IEC 61557-8.

NOTE An RCM is distinguished from an IMD in that it is passive in its monitoring function and only responds to an unbalanced fault current in the installation being monitored. An IMD is active in its monitoring and measuring functions in that it can measure the balanced and unbalanced insulation resistance or impedance in the installation (see IEC 61557-8).

2 Normative references

The following normative documents contain requirements which, through reference in this text, form an integral part of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and product committees using this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60038:1983, *IEC standard voltages*.

IEC 60050-101:1998, *International Electrotechnical Vocabulary (IEV) — Part 101: Mathematics*.

IEC 60050(151):1978, *International Electrotechnical Vocabulary (IEV) — Chapter 151: Electrical and magnetic devices*.

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) — Chapter 441: Switchgear, controlgear and fuses*.

IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*.

IEC 60068-2-28:1990, *Environmental testing — Part 2: Tests — Guidance for damp heat tests*.

IEC 60068-2-30:1980, *Environmental testing — Part 2: Tests — Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*.

IEC 60364-4-443:1995, *Electrical installations of buildings — Part 4: Protection for safety — Chapter 44: Protection against overvoltages — Section 443: Protection against overvoltages of atmospheric origin or due to switching*.

IEC 60364-5-53:1994, *Electrical installations of buildings — Part 5: Selection and erection of electrical equipment — Chapter 53: Switchgear and controlgear*.

IEC 60417-2:1998, *Graphical symbols for use on equipment — Part 2: Symbol originals*.

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*.

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*.

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

IEC 60695-2-1/0:1994, *Fire hazard testing — Part 2: Test methods — Section 1/sheet 0: Glow-wire test methods — General*.

IEC 60755:1983, *General requirements for residual current operated protective devices*.

IEC 61008-1:1996, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) — Part 1: General rules*.

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

IEC 61557-8:1997, *Electrical safety in low-voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing, measuring or monitoring of protective measures — Part 8: Insulation monitoring devices for IT systems*.

ISO/IEC Guide 2:1991, *General terms and their definitions concerning standardization and related activities*.

 CISPR 14-1:2002, *Electromagnetic compatibility — Requirements for household appliances, electric tools and similar apparatus — Part 1: Emission* .

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.

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 101-14-31) which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0,006 A d.c. during one single interval of time, expressed in angular measure, of at least 150°

3.1.4

current delay angle α

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

3.2 Definitions relating to the energization of an RCM

3.2.1

energizing quantity

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

3.2.2

energizing input-quantity

energizing quantity by which the RCM is activated when it is applied under specified conditions these conditions may involve, for example, the energizing of certain auxiliary elements

3.2.3

residual current (I_{Δ})

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

3.2.4

residual operating current

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

3.2.5

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

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

3.3 Definitions relating to the operation and to the functions of residual current monitors

3.3.1

residual current monitor (RCM)

device or association of devices which monitors the residual current in an electrical installation, and which activates an alarm when the residual current exceeds the operating value of the device

3.3.2

RCMs functionally independent of line voltage

RCMs for which the functions of detection, evaluation and actuation do not depend on the line voltage

3.3.3

RCMs functionally dependent on line voltage

RCMs for which the functions of detection, evaluation or actuation depend on the line voltage

NOTE It is understood that the line voltage is applied to RCMs for detection, evaluation or actuation.

3.3.4

limiting non-actuating time

maximum delay during which a value of residual current higher than the residual I_{Δ} operating I_{Δ} current can be applied to the RCM without causing it to operate

3.3.5

time-delay RCM

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

3.3.6

main circuit (of a RCM)

all the conductive parts of a RCM included in the current paths (see 4.3)

3.3.7

control and auxiliary circuit (of a RCM)

all the conductive parts of a RCM intended to be included in a circuit other than the main circuit of the RCM

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

3.3.8**RCM type A**

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

3.3.9**test device**

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

3.3.10**alarm state**

alarm state indicates that the residual current in the installation monitored has exceeded the preset level of the RCM

3.3.11**non-alarm state**

non-alarm state indicates that the residual current in the installation monitored is less than the preset level of the RCM

3.3.12**actuating time**

time taken for an RCM to change from the non-alarm state to the alarm state in response to the sudden appearance of a residual current which exceeds the preset level

** 3.3.13****functional earth connection (FE)**

electrical connection between RCM and earth which is provided to ensure:

- a reference point for RCMs having a discriminating function (see 4.11) and/or
- continued operation in the event of loss of supply neutral.

3.3.14 maximum actuating time ($T_{\max}$)

the maximum actuating time for residual currents greater than or equal to $I_{\Delta n}$ for RCMs with adjustable time delay

3.3.15 minimum non-actuating time ($T_{\min}$)

the minimum non-actuating time for residual currents greater than or equal to $I_{\Delta n}$ for RCMs with adjustable time delay ****

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

quantity value assigned by the manufacturer for a specific operating condition of a RCM

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

definitions of limiting values of non-operating overcurrents are given in 3.4.2.1 and 3.4.2.2

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.

3.4.2.1**limiting value of overcurrent in case of a load through a RCM 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 RCM with two current paths without causing it to operate

3.4.2.2**limiting value of overcurrent in case of a single-phase load through a RCM**

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 RCM without causing it to switch to the alarm state

3.4.3**residual short-circuit withstand current**

maximum value of the residual current for which the operation of the RCM is ensured under specified conditions and above which the device may undergo irreversible alterations

3.4.4**prospective current**

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

3.4.5**conditional short-circuit current**

value of the a.c. component of a prospective current, which a RCM protected by a suitable short-circuit protective device (hereafter referred to as SCPD) in series can withstand under specified conditions of use and behaviour

3.4.6**conditional residual short-circuit current**

value of the a.c. component of a residual prospective current which a RCM protected by a suitable SCPD in series, can withstand under specified conditions of use and behaviour

3.4.7 **I^2t (Joule integral)**

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

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

3.5 Definitions relating to values and ranges of influencing quantities**3.5.1****influencing quantity**

any quantity likely to modify the specified operation of a RCM

3.5.2**reference value of an influencing quantity**

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

3.5.3**reference conditions of influencing quantities**

collectively, the reference values of all influencing quantities

3.5.4**range of an influencing quantity**

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

3.5.5**extreme range of an influencing quantity**

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

3.5.6**ambient air temperature**

temperature, determined under prescribed conditions of the air surrounding the RCM (for an enclosed RCM it is the air outside the enclosure)

3.6 Definitions relating to terminals**3.6.1****terminal**

conductive part of a device, provided for reusable electrical connection to external circuits

NOTE For examples of designs of terminals, see informative Annex IC in IEC 61008-1.

3.6.2**screw-type terminal**

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

3.6.3**pillar terminal**

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

3.6.4**screw terminal**

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

3.6.5**stud terminal**

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

3.6.6**saddle terminal**

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

3.6.7**lug terminal**

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

3.6.8**screwless terminal**

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

3.6.9**tapping screw**

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

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

3.6.11**thread cutting screw**

tapping screw having an interrupted thread; it is a function of this thread to remove material from the hole

3.7 Conditions of operation**3.7.1****operation**

alteration of the state of the RCM from the non-alarm state to the alarm state or vice versa

3.7.2**clearance** (see Annex B)

shortest distance in air between two conductive parts

NOTE For the purpose of determining a clearance to accessible parts, the accessible surface of insulating enclosure shall be considered conductive as if it was covered by a metal foil wherever it can be touched by hand or by the standard test finger according to Figure 1.

3.7.3**creepage distance** (see Annex B)

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

NOTE For the purpose of determining a creepage distance to accessible parts, the accessible surface of insulating enclosure shall be considered conductive as if it was covered by a metal foil wherever it can be touched by hand or by a standard test finger according to Figure 1.

3.8 Test**3.8.1****type test**

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

3.8.2**routine tests**

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

4 Classification

RCMs are classified:

4.1 According to the method of operation

4.1.1 RCM functionally dependent on line voltage

4.1.2 RCM functionally dependent on an energy source other than line voltage

4.2 According to the type of installation

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

4.3 According to the number of current paths

- two current paths RCM;
- three current paths RCM;
- four current paths RCM.

4.4 According to the ability to adjust the residual operating current

- RCM with a non-adjustable residual operating current;

NOTE Some RCMs with non-adjustable residual operating current may include a pre-warning level.

- RCM with adjustable residual operating current.

4.5 According to the possibility of adjusting the time-delay

- RCM without adjustable time-delay;
- RCM with adjustable time-delay.

4.6 According to the protection against external influences

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

4.7 According to the method of mounting

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

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

4.8 According to the method of connection

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

NOTE Some RCMs 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.

4.9 According to the type of connection of the load conductors

A1 4.9.1 *RCM to which the monitored line is not directly connected*

See Figure 22a.

4.9.2 *RCM to which the monitored line is directly connected*

See Figure 22b. **A1**

4.10 According to fault indicating means

- visual, non-resettable during fault condition (minimum requirement);
- visual and audible; the audible means may be disabled by the user during fault condition;
- visual, with relay output; the relay may be disabled by the user during fault condition;
- visual, with other output signal.

4.11 According to ability to directionally discriminate between supply side and load side residual currents

- directionally discriminating (applicable in IT systems);
- directionally non-discriminating.

5 Characteristics of RCMs

5.1 Summary of characteristics

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

- type of installation (see 4.2);
- number of current paths (see 4.3);
- rated current I_n (see 5.2.2);
- rated residual operating current $I_{\Delta n}$ (see 5.2.3);
- rated residual non-operating current $I_{\Delta no}$ (see 5.2.4);
- rated voltage U_n (see 5.2.1);
- rated frequency (see 5.2.5);
- time-delay, if applicable;
- operating characteristics in case of residual currents with d.c. components (see 5.2.6);
- insulation coordination including clearances and creepage distances (see 5.2.7);
- degree of protection (see IEC 60529);
- rated conditional short-circuit current I_{nc} (only for RCMs according to 4.9.2);
- rated conditional residual short-circuit current $I_{\Delta c}$ (only for RCMs according to 4.9.2);
- behaviour of the RCM in case of failure of the line voltage (see 4.1.1);
- behaviour of the RCM in case of failure of the energy source other than the 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 U_n) of a RCM is the value of voltage, assigned by the manufacturer, to which its performance is referred.

NOTE The same RCM may be assigned a number of rated voltages.

5.2.1.2 Rated insulation voltage (U_i)

The rated insulation voltage of a RCM 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 RCM. In no case shall the maximum rated voltage exceed the rated insulation voltage.

5.2.2 Rated current (I_n)

The value of current, assigned to the RCM by the manufacturer, which the RCM can carry in uninterrupted duty. A1 Text deleted A1

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

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

NOTE For a RCM having multiple settings of residual operating current the highest setting is used to designate it.

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

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

5.2.5 Rated frequency

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

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

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

Actuation is ensured by RCM for residual sinusoidal alternating currents and residual pulsating direct currents, whether suddenly applied or slowly rising.

NOTE This operating characteristic corresponds to type A of IEC 61008-1.

5.2.7 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)

The voltages 230 V and 400 V are standardized according to IEC 60038. These values shall progressively replace the values 220 V and 240 V, 380 V and 415 V, respectively.

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

For single-phase three-wire systems the standardized voltages are 120/240 V.

5.3.2 Preferred values of rated current (I_n)

Preferred values of rated current are (only for RCMs according to 4.9.2)

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

NOTE For RCMs according to 4.9.1 the rated current is limited by the physical size of the current transformer, external or internal to the RCM itself.

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

A1 Preferred **A1** values of rated residual operating current are

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

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

A1 Note deleted **A1**

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

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

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

5.3.5 Standard minimum value of non-operating overcurrent in case of a multiphase balanced load through a multipath RCM (see 3.4.2.1)

The standard minimum value of the non-operating current in case of a multiphase balanced load through a multipath RCM is 6 I_n .

5.3.6 Standard minimum value of the non-operating overcurrent through a RCM (see 3.4.2.2)

The standard minimum value of the non-operating overcurrent through a RCM is 6 I_n .

This clause does not apply to RCMs classified according to 4.9.1. The minimum value of the non-operating overcurrent through a RCM classified according to 4.9.1 shall be taken into account to declare the rated current (see note to 5.3.2). For this purpose RCMs according to 4.9.1 with adjustable residual operating current shall be set at the lowest value appropriate to each current transformer.

5.3.7 Preferred values of rated frequency

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

If another value is used, the rated frequency shall be marked on the device and the tests carried out at this frequency.

5.3.8 Standard and preferred values of the rated conditional short-circuit current (I_{nc}) (only applicable to RCMs classified according to 4.9.2)

5.3.8.1 Values up to and including 10 000 A

Up to and including 10 000 A the values of the rated conditional short-circuit current I_{nc} are standard. They are:

3 000 – 4 500 – 6 000 – 10 000 A.

The associated power factors are specified in Table 13.

5.3.8.2 Values above 10 000 A

For values above 10 000 A up to and including 25 000 A a preferred value is 20 000 A.

The associated power factors are specified in Table 13.

Values above 25 000 A are not considered in this standard.

5.3.9 Maximum actuating time (T_{max})

The actuating time for residual currents equal to or greater than $I_{\Delta n}$ shall not exceed 10 s.

A1 5.3.10 Minimum non-actuating time (T_{min})

For RCMs with minimum non-actuating time according to 3.3.15, this time shall be declared by the manufacturer. **A1**

5.4 Coordination with short-circuit protective devices (SCPDs) (only valid for RCMs classified according to 4.9.2)

5.4.1 General

RCMs shall be protected against short-circuits by means of circuit-breakers or fuses complying with their relevant standards according to the installation rules of IEC 60364.

Coordination between RCMs and the SCPD shall be verified under the general conditions of 9.11.2.1, by means of the tests described in 9.11.2.2 which are designed to verify that there is an adequate protection of the RCMs against short-circuit currents up to the conditional short-circuit current I_{nc} and up to the conditional residual short-circuit current $I_{\Delta c}$.

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

The r.m.s. value of prospective current, assigned by the manufacturer, which a RCM, protected by a SCPD, can withstand under specified conditions without undergoing alterations impairing its functions.

The conditions are those specified in 9.11.2.2 a).

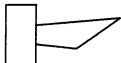
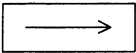
5.4.3 Rated conditional residual short-circuit current ($I_{\Delta c}$)

The value of residual prospective current, assigned by the manufacturer, which a RCM, protected by a SCPD, can withstand under specified conditions without undergoing alterations impairing its functions.

The conditions are those specified in 9.11.2.2 b).

6 Marking and other product information

A1 Each RCM and external devices of RCMs, if applicable, shall be marked in a durable manner with the following data: **A1**

- a) the manufacturer's name or trade mark;
- b) type designation, catalogue number or serial number;
- c) rated voltage(s);
- d) rated frequency, if the RCM is designed for frequencies other than 50 Hz and/or 60 Hz (see **5.3.7**);
- e) rated current;
- f) rated residual operating current;
- g) settings of residual operating current in case of RCMs with multiple residual operating current settings;
- h) the degree of protection (only if different from IP20);
- j) the position of use (symbol according to IEC 60051), if necessary;
- k) operating means of the test device, by the letter T;
- l) wiring diagram;
- m) operating characteristic in presence of residual currents with d.c. components with the symbol: 
- n) disabling means for the audible signal, by the symbol: 
- o) installation instructions, including identification of current transformer(s) which may be used with the RCM;
- p) directionally discriminating RCM by the symbol: 
- A1** q) the maximum actuating time (see **5.3.9**);
- r) the minimum non-actuating time (see **5.3.10**);
- s) the FE-terminal shall be marked "FE".

If, for small devices, the space available does not allow all the above data to be marked, at least the information under e), f), k) and, as applicable, o) and p) shall be marked and visible when the device is installed. The remaining information shall be given in the manufacturer's catalogues. **A1**

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

Table 1 — Standard conditions for operation in service

Influencing quantity	Standard range of application	Reference value	Test tolerances ^f
Ambient temperature ^{ag}	– 5 °C to + 40 °C ^b	20 °C	± 5 °C
Altitude	Not exceeding 2 000 m		
Relative humidity maximum value at 40 °C	50 % ^c		
External magnetic field	Not exceeding 5 times the earth's magnetic field in any direction	Earth's magnetic field	^d
Position	As stated by the manufacturer, with a tolerance of 2° in any direction ^e	As stated by the manufacturer	2° in any direction
Frequency	Reference value ± 5 %	Rated value	± 2 %
Sinusoidal wave distortion	Not exceeding 5 %	Zero	5 %

^a The maximum value of the mean daily temperature is + 35 °C.

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

^c Higher relative humidities are admitted at lower temperature (for example 90 % at 20 °C).

^d When a RCM is installed in proximity of a strong magnetic field, supplementary requirements may be necessary.

^e The device shall be fixed without causing deformation liable to impair its functions.

^f The tolerances given apply unless otherwise specified in the relevant test.

^g Extreme limits of – 20 °C and + 60 °C are admissible during storage and transportation, and should be taken into account in the design of the device.

Additional components, e.g. separate warning units, shall be marked according to a), b), c), d) and n) (if applicable).

If, for small devices, the space available does not allow all the above data to be marked, at least the information under e), f), k) and n) shall be marked and visible when the device is installed. The information under a), b), c), j), l) and p) 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 l) 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 catalogue.

The manufacturer shall give the reference of one or more suitable SCPDs in his catalogues and in a sheet accompanying each RCM classified under 4.9.2.

Red shall not be used for the test button nor for the resetting means, if any, of the RCM.

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 on the RCM for connecting the current transformer shall be clearly identified.

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

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



[IEC 60417-2-5019 a)].

NOTE The symbol  [IEC 60417-2-5017 a)], previously recommended, shall be progressively superseded by the preferred symbol IEC 60417-2-5019 a), given above.

The 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.

7 Standard conditions for operation in service and for installation

7.1 Standard conditions

RCMs complying with this standard shall be capable of operating under the standard conditions shown in Table 1.

7.2 Conditions of installation

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

8 Requirements for construction and operation

8.1 Mechanical design

8.1.1 General

A RCM may provide for remote indication of the fault condition.

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

Where RCMs are fitted with an internal current transformer (CT), but have the capability of selecting an optional external CT, all relevant tests shall be carried out using the internal CT. The proper function of the external CT shall, however, be confirmed by testing it once according to 9.9.4.

8.1.2 Features

A1 The RCM shall be provided with a visual "Power on" indicator which shall neither be red, yellow nor blue. **A1**

The RCM shall be provided with means for indicating a fault condition when the residual current exceeds the preset operating value, the primary indicating means being visual. The visual indicating means shall be an integral part of the RCM and shall be easily discernible from the front of the RCM when installed as for normal use. This visual indicating means shall not be coloured green. It shall not be possible to override the visual alarm whilst the fault is present.

NOTE A visual alarm may also be part of a remote alarm unit, where it shall be clearly visible when installed.

Where an audible alarm is provided in addition, the audible signal shall be easily perceptible by persons with normal hearing and may have adjustable sound level. It is permissible to switch off the audible alarm whilst the fault is present.

The audible alarm, if any, shall be automatically self-resetting on removal of the fault. In the event of a subsequent fault following removal of the first fault, the audible alarm shall be reactivated.

RCMs may be fitted with a resetting means to manually reset the RCM to the non-alarm state after removal of the fault. RCMs not fitted with a resetting means shall reset automatically after removal of the fault.

Where means are provided for adjustment of the residual operating current or of the delay time, such adjustment shall only be possible by the use of a tool.

Compliance with the above paragraphs is checked by inspection during the tests according to 9.9.

A1 8.1.3 Clearances and creepage distances (see also Annex B)

Clearance and creepage distances applicable to the RCM and its external components, e.g. current transformers etc., with the exception of printed circuit boards, shall comply with the requirements of Table 2 when the RCM is mounted as for normal use.

The above requirements shall also apply to active conductors (phases and neutral) connected directly to the printed circuit board.

Creepage distances applicable to printed circuit boards of the RCM shall comply with the requirements of Table 4 of IEC 60664-1, "Creepage distances to avoid failure due to tracking", Pollution degree 2, Material group III.

Table 4 of IEC 60664-1 includes requirements for uncoated printed circuit boards. IEC 60664-3 provides for reduced clearance and creepage distances for printed circuit boards using a protective coating, potting or moulding. Such printed circuit boards may therefore be verified for compliance in accordance with IEC 60664-3 instead of Table 4 or IEC 60664-1. **A1**

Table 2 — Clearances and creepage distances

Description	Distance mm
<i>Clearances^a</i>	
— between live parts of different polarity ^{bc}	3
— between live parts and	
• metal resetting means	3
• metal test button	3
• screws or other means for fixing covers which have to be removed when mounting the RCM	3
• the surface on which the base is mounted ^d	6 (3)
• screws or other means for fixing the RCM ^d	6 (3)
• metal covers or boxes ^d	6 (3)
• other accessible metal parts ^e	3
• metal frames supporting flush-type RCMs	3
<i>Creepage distances^a</i>	
— between live parts of different polarity ^{bc}	
• for RCMs having a rated voltage not exceeding 250 V	3
• for other RCMs	4
— between live parts and	
• metal resetting means	3
• metal test button	3
• screws or other means for fixing covers which have to be removed when mounting the RCM	3
• screws or other means for fixing the RCMs ^d	6 (3)
• accessible metal parts ^e	3
^a Clearances and creepage distances of the secondary circuit and between the primary windings of the RCM transformer are not considered. ^b Care should be taken for providing adequate spacing between live parts of different polarity of RCMs of the plug-in type mounted close to one another. Values are under consideration. ^c In some countries greater distances between terminals are used in accordance with national practices. ^d If clearances and creepage distances between live parts of the device and the metallic screen or the surface on which the RCM is mounted are dependent on the design of the RCM only, so that they cannot be reduced when the RCM is mounted in the most unfavourable position (even in a metallic enclosure), the values in brackets are sufficient. ^e 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 RCM during installation shall not be of the thread-cutting type.

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

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

NOTE 2 Screwed connections are considered as checked by the tests of 9.8, 9.11, 9.12, 9.13 and 9.21.

8.1.4.2 For screws in engagement with a thread of insulating material and which are operated when mounting the RCM 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 with respect to the stability of the dimensions.

8.1.4.4 Current-carrying parts including parts intended for protective conductors, if any, shall be of

- copper;
- an alloy containing at least 58 % copper for parts worked cold, or at least 50 % copper for other parts;
- other metal or suitably coated metal, no less resistant to corrosion than copper and having mechanical properties no less suitable.

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

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

8.1.5 Terminals for external conductors

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

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 RCMs according to classification **4.9.2** shall be provided with terminals which shall allow the connection of copper conductors having nominal cross-sectional areas as shown in Table 3.

NOTE For conductors of signalling circuits smaller cross-sections and smaller terminals are permitted.

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.

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 wires of the conductor, use of cable lugs, formation of eyelets, etc., but not the reshaping of the conductor before its introduction into the terminal or the twisting of a flexible conductor to consolidate the end.

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.

Table 3 — Connectable cross-sections of copper conductors for screw-type terminals

Rated current A		Range of nominal cross-section to be clamped ^a mm ²	
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	24 to 35

NOTE For correspondence between ISO and AWG cross-sections see Annex ID of IEC 61008-1.

^a 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.

8.1.5.6 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 9.5.2.

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 a tool.

Compliance is checked by manual test.

In general, common designs of terminals provide sufficient resilience to comply with this requirement; for some 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.