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TECHNICAL REPORT

Residual current devices (RCDs) associated with additional function(s)

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ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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RESIDUAL CURRENT DEVICES (RCDs) ASSOCIATED WITH ADDITIONAL FUNCTION(S)

FOREWORD

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IEC TR 62710, which is a Technical Report, has been prepared by subcommittee 23E: Circuit-breakers and similar equipment for household use, of IEC technical committee 23: Electrical accessories.

The text of this standard is based on the following documents:

Enquiry draft	Report on voting
23E/875/DTR	23E/900/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

In this Technical Report, the following print types are used:

– compliance statements: *in italic type*

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This Technical Report (TR) introduces information allowing manufacturers to introduce additional function(s) associated with Residual current devices (RCD). This TR is also relevant for technical committees in charge of drafting an International Standard for additional function(s); for this purpose, requirements and tests have been introduced. It would also be of benefit to laboratories having difficulties in testing RCDs associated with an additional function. This TR does not cover the additional function(s) itself (this is the purpose of an International Standard covering the additional function(s)), nor the RCD function and characteristics (this is the purpose of an RCD International Standard). It is limited to checking that the additional function(s) do not impair any function of the RCD in case there is no International Standard for the additional function(s) for household and similar uses. Where there is a relevant International Standard for household and similar uses for the additional function(s), then it is used. This means that the assembly of the RCD plus the additional function(s) behave correctly according to the referred standards.

This Technical Report is drafted according to the following basic principles:

– In order not to restrict innovation, it is drafted independently of the additional function(s) and is thus applicable whatever the additional function(s) are.

  NOTE It is not possible to list all possible existing and future additional function(s); some examples are given within the definitions.

– The verification is only limited to the assembly and association of an RCD with one or several additional function(s), being integrated or not.

– The verification aims to show that the assembly of one or several additional function(s) declared suitable to a specific protective device is safe and does not impair the basic characteristics of the RCD.

– Responsibility for the assembly means that the additional function(s) and the RCD are intended to be from the same manufacturer or to be affixed with the same trademark. As a consequence, it is intended that the manufacturer or trademark owner declare with which protective devices the additional function(s) can be associated.

RESIDUAL CURRENT DEVICES (RCDs) ASSOCIATED WITH ADDITIONAL FUNCTION(S)

1 Scope

This Technical Report (TR) provides information concerning the possible use of:

– dedicated additional function(s) declared by a manufacturer as suitable for an assembly with declared RCDs complying with IEC standards for household and similar uses;

– specific RCDs complying with IEC standards for household and similar uses having integrated additional function(s).

NOTE 1 The term RCD is a generic term applied to a family of products which open automatically in response to a residual current at or exceeding the RCD's rated residual operating current $I_{\Delta n}$. This generic term is often applied to the following:

– RCCB: Residual current operated circuit-breaker without integral overcurrent protection;

– RCBO: Residual current operated circuit-breaker with integral overcurrent protection;

– SRCD: Residual current device with or without overcurrent protection for socket-outlets;

– PRCD: Portable residual current device without integral overcurrent protection.

This TR identifies the applicable testing procedure to determine the effect on the normal functioning of specific RCD(s) declared suitable with one or more additional function(s) integrated into or added to or assembled with this specific RCD.

This TR may also be used to draft additional requirements to standards for additional function(s) intended to be combined with RCDs for household and similar applications.

This TR provides a procedure based on an assessment in order to identify the necessary testing to demonstrate compliance with the appropriate requirements. If the assessment of the additional function integrated in the RCDs concludes that the additional function does not impair the RCD, no additional test is required by this TR.

Where more than one additional function(s) can be simultaneously associated with one or several RCD(s), the possible combinations is checked by considering the most severe ones.

This TR does not apply:

– to additional functions covered by a standard which explicitly addresses the combination with RCDs for household and similar applications;

NOTE 2 Example of an additional device with independent product standard is auxiliary contacts according to IEC 62019.

– to additional function(s) associated with RCDs for connection purposes;

NOTE 3 Examples of additional function(s) for connection purposes are connection devices between RCBOs and a circuit breakers.

– to locking devices.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TR 60755, *General requirements for residual current operated protective devices*

IEC 60898 (all parts), *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations*

IEC 61008 (all parts), *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)*

IEC 61009 (all parts), *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)*

IEC 62423, *Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60755, IEC 60898, IEC 61008, IEC 61009 and IEC 62423, as well as the following apply.

3.1
additional function
feature, action, capability, or the like integrated or assembled with a declared RCD, and not required by the basic product standard

Note 1 to entry: The additional function(s) can have a mechanical and/or electrical interface with one or more parts of the RCD.

Note 2 to entry: Examples of additional function(s) are: automatic reclosing devices, protection against too high or too low voltage, remote-controlled mechanism, remote-controlled tripping, telemonitoring, undervoltage release, shunt release, residual current indicator, lifetime monitoring, installation monitoring, thermal monitoring, self monitoring and test, data communication, smoke detector as well as any combinations of these devices, etc.

3.1.1
integrated additional function
additional function completely built into the RCD

3.1.2
non integrated additional function
external additional function such as a module which can subsequently be built-in on site or can be added on by the manufacturer

Note 1 to entry: The additional function(s) may influence the RCD via interfaces.

Note 2 to entry: After assembly of the external additional function(s) with the RCD, the device becomes a constructional unit.

3.2
RCD
residual current device
mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions

Note 1 to entry: RCDs are covered by an applicable RCD product standard and are used as a protective device against electric shock.

[SOURCE: IEC 60050-442:1998, 442-05-02, modified – The note has been modified.]

3.3
impair
impact on the operating characteristics of an RCD that results in the lack of compliance with the applicable RCD requirements

3.4
impairment
any effect caused by an additional function that takes the operating characteristics outside the limits specified in the relevant RCD product standard

3.5
exploratory testing
analysis and/or relevant testing performed on the assembly of

- an additional function and a RCD declared to be assembled with the additional function(s) according to the manufacturer instructions, or
- a RCD with integrated additional function(s),

with the objective of determining whether the additional function(s) impair the correct operation of the RCD.

3.6
residual current tripping circuit
any electrical part of the RCD allowing the RCD to trip due to residual fault current

3.7
operating means
part of a RCD which allows operation of the mechanism by manual means

EXAMPLE Rocker or rotary handle.

4 Classification according to the association of a RCD with additional function(s)

4.1 General

Additional functions are classified in the following way.

4.2 According to the type of construction

Additional functions are classified according to the type of construction:

a) RCDs with integrated additional function(s);
b) RCDs with non integrated additional function(s);

4.3 According to the interface between a RCD and additional function(s)

Additional functions are classified according to the type of interface:

a) interface via the operating means,
b) interface via the mechanism of the RCD,

EXAMPLE Latching mechanism, operating shaft.

c) interface via the circuit of the test device,
d) interface via the residual current tripping circuit,

EXAMPLE Summation current transformer with additional winding, tripping relay, protective circuit of the tripping relay or of the secondary circuit of the summation current transformer.

e) interface via the main circuit / main contacts / main terminals,

f) interface via a combination of more than one interface.

5 Characteristics

The characteristics of the RCD are given in the relevant RCD standard.

The characteristics of the additional function(s) are given in the relevant standard, if any.

6 Marking and other product information

6.1 Instructions and operation for RCDs with integrated additional function(s) according to 4.2 a)

Where the manufacturer has integrated the additional function(s) within the RCD, the RCD shall be marked with the symbol  (IEC 60417-6291) and the manufacturer shall provide adequate instructions and information in a leaflet or data sheet.

These instructions shall cover at least the following:

– detailed description and explanation about the use and objective of the additional function(s);
– derating factor(s), if any;
– instructions for wiring and installation of the RCD integrating the additional function(s) in normal use;
– instructions for correct use of the additional function(s).

6.2 Instructions and operation for a non integrated additional function according to 4.2 b)

Where the additional function is not integrated within the RCD, the manufacturer shall provide adequate instructions and information in a leaflet or data sheet. These instructions shall cover at least the following:

– detailed description and explanation about the use and objective of the additional function(s);
– reference to the type(s) and catalogue number(s), covering current and voltage ratings, etc. of the declared RCD;
– derating factor(s), if any;
– method of assembly with the declared RCD(s);
– instruction for wiring and installation for normal use;
– method for checking operation after assembly to verify the mechanical operation of the RCD by mechanical means and using the test device;
– instructions for correct use of the additional function(s).

The non-integrated additional function(s) and the RCD shall be from the same manufacturer or be affixed with the same trademark.

7 Standard conditions for operation in service and for installation

The additional function(s) associated with a RCD shall be capable of operating under the standard conditions for operation in service and for installation of the RCD standard with which it is declared to be associated (IEC 61008-1 or IEC 61009-1 or IEC 61540 or IEC 62335 or IEC 62423 or IEC 62640 as applicable).

Where an additional function is declared to be associated with several RCDs, the standard conditions of the most severe standard shall apply to the additional function.

8 Requirements for construction and operation

8.1 General

The additional function(s) assembled with a RCD shall be so designed and constructed that, in normal use, the performance is safe and reliable to the user and the environment.

For assessment of necessary tests, it shall be verified which requirements provided within the relevant RCD standard can be impaired by the additional function(s). The procedure for identifying the necessary testing is given in Clause 9.

Measurement of all operating levels, values or parameters of the RCD shall comply with the acceptance criteria of the relevant RCD product standard.

Annex A applies to the non-integrated additional function(s) unit designed for assembly on site.

The additional function(s) shall be designed so that:

a) the RCD shall not be prevented from manual switching ON or OFF by the additional function(s) under normal conditions;

   This condition is considered as fulfilled if the manual opening of the RCD is not possible without disabling the additional function(s) by means of manual operation

b) if the additional function is a reclosing device, it shall be provided with means to disable this function;

c) a fault or a failure affecting the normal use of the additional function(s) shall not result in a non-compliance of the basic requirements for the RCD function. If a fault or failure of an additional function will result in non-compliance of the requirements of the RCD function, the occurrence of a fault or failure of the additional function shall cause the RCD to switch OFF;

d) it shall not be possible to energize the circuit on the load side of the RCD by operating the additional function(s) when the RCD is manually switched OFF and connected as in normal use (the isolation function of the RCD shall not be impaired by the additional function(s)), unless the additional function is intended to reclose the RCD;

e) for additional function(s) according to 4.3 e), for example interface to the main contacts, which may create specific contacts positions, it shall not be possible to alter the isolation capability of the protective device, whatever the status of the additional function(s). In case of the latter the RCD or the additional function(s) shall have a provision to lock the RCD in the open position.

A deliberate residual current to earth shall not be used to trip the RCD. This requirement is considered satisfied if:

– no fault is introduced into the installation that causes the RCD to function as a disconnector;

– the protective conductor of the installation does not become live when the additional function is operated. A standing current in the PE up to the limit of 1 mA is accepted with a touch voltage limited not exceeding dangerous levels according to the IEC 60364 and IEC 60479 series;

The degree of protection of the additional function(s) associated with a RCD shall not be less than the degree of protection of the RCD(s) with which it is declared to be associated.

Compliance is checked by the testing procedure of Clause 9.

8.2 Mechanical requirements

The manufacturer shall declare the effect(s) of the additional function(s) on the basic RCD function.

The additional function(s) and the RCD shall readily fit together in the correct manner and the design shall be such that it prevents incorrect assembly.

Parts to be coupled with the tripping mechanism shall be securely fixed after mounting and shall not become loose.

Fixing means for assembly, if any, shall be captive except for terminal covers.

Compliance is checked by the testing procedure of Clause 9.

8.3 Electrical compatibility

Additional function(s) shall withstand the rated current and the prospective short circuit currents to which they may be subjected.

Additional function(s) intended to be connected in series with a RCD shall withstand the rated current of the RCD and the same short circuit currents as the RCD.

Terminals for additional function(s) not intended to carry the rated current of the RCD shall be suitably rated for the range of conductors specified in the manufacturer's instruction for the additional function(s).

Compliance is checked by the testing procedure of Clause 9.

8.4 Protection against electric shock

Protection against electric shock shall not be impaired when the additional function is integrated in or assembled with the RCD and mounted and wired in accordance with manufacturer's instructions.

Live parts of the additional function(s) assembled in the RCD shall not be accessible in normal use and all requirements applicable to the RCD part before assembly are applicable to the whole product, including the additional function(s) and the RCD, after assembly or incorporation.

NOTE A part is considered to be "accessible" if it can be touched by the standard test finger.

Once assembled, no parts shall be likely to come loose without intentional action by a user or technician.

Compliance is checked by the testing procedure of Clause 9.

8.5 Dielectric properties, isolating capability and insulation coordination

The overvoltage category of an additional function associated with a RCD shall not be less than the overvoltage category of the RCD(s) with which it is declared to be associated.

The additional function(s) shall not impair the dielectric properties and the isolation capability of the RCD with which it is associated or in which it is incorporated. This condition is considered as fulfilled if the manual opening of the RCD is not possible without disabling the additional function(s) by means of a manual operation.

Compliance is checked by the testing procedure of Clause 9.

8.6 Clearances and creepage distances

The clearances and creepage distances of an additional function associated with a RCD according to classification 4.2 or 4.3 shall not be less than the required clearances and creepage distances of the RCD(s) with which it is declared to be associated.

Compliance is checked by the testing procedure of Clause 9.

8.7 Screws, current-carrying parts and connections

Connections of the additional function(s), whether electrical or mechanical, shall withstand the mechanical stresses occurring to the declared associated RCD(s) in normal use. In case of an additional function able to be assembled with several RCDs, the requirements of the most severe RCD standard shall apply.

Compliance is checked by the testing procedure of Clause 9.

8.8 Terminals for external conductors

The RCD terminals for external conductors, once assembled with the additional function(s), shall be such that the conductors may be connected in the same conditions and with the same requirements as the declared associated RCD(s).

Compliance is checked by the testing procedure of Clause 9.

8.9 Temperature rise

The temperature rise of a RCD with an additional function shall not exceed the values specified in the standard for the RCD when measured according to the conditions specified in the RCD standard while taking into account the limits of this TR.

The RCD shall not suffer damage impairing its functions and its safe use when assembled or incorporated with an additional function.

Compliance is checked by the testing procedure of Clause 9.

8.10 Mechanical and electrical endurance

RCDs' mechanical and electrical endurance shall not be impaired by the additional function(s) and shall be capable of performing the required number of mechanical and electrical operations specified within the relevant standard.

Where the mechanism and/or the poles are used for reasons other than closing/opening the RCD poles for safety reasons, a more severe testing procedure can be considered, for example a higher number of operations than that specified in the applicable RCD standard.

NOTE The electrical or mechanical endurance of RCDs might be severely impaired if additional function(s) of any type would use RCDs for reasons or functions different than those for which the RCD was designed.

Additional function(s) having a lower electrical or mechanical endurance may be used. The test of the combination is then performed with that lower number of operations.

Compliance is checked by the testing procedure of Clause 9.

8.11 Performance at short-circuit currents

RCDs' performance during short-circuit currents shall not be impaired by the additional function(s) and the RCDs shall be able to perform the 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 as specified in the relevant standard.

Compliance is checked by the testing procedure of Clause 9.

8.12 Resistance to mechanical shock and impact

RCDs' resistance to mechanical shock and impact shall not be impaired by the additional function(s) and shall show adequate mechanical behaviour so as to withstand the stresses imposed during installation and use as specified in the relevant standard.

Compliance is checked by the testing procedure of Clause 9.

8.13 Resistance to heat, to abnormal temperature and to fire

The resistance to heat of the RCD, to abnormal temperature and to fire shall not be impaired by the additional function(s) and shall show adequate resistance as specified in the relevant standard.

Compliance is checked by the testing procedure of Clause 9.

8.14 Test device

The RCD test device shall not be impaired by the additional function(s) and shall show adequate performance according to the relevant standard.

The additional function(s) cannot replace the test device.

Any button of an integrated additional function (classified according to 4.2) shall be separated from the RCD test button and clearly identified, the use of the letter T not being allowed.

Compliance is checked by the testing procedure of Clause 9.

8.15 Behaviour of RCDs in the case of overcurrents in the main circuit

Integration or assembly of an additional function with a RCD shall not impair the normal operation of the RCD under specified conditions of overcurrent.

Compliance is checked by the testing procedure of Clause 9.

8.16 Behaviour of RCDs in the case of current surges caused by impulse voltages

The ability of RCDs to withstand current surges to earth due to the loading of the capacitances of the installation and the current surges to earth due to flashover in the installation, as required within the relevant RCD standard, shall not be impaired by the additional function(s).

Compliance is checked by the testing procedure of Clause 9.

8.17 Behaviour of RCDs in the case of sinusoidal residual currents and in case of residual currents comprising a d.c. component

The ability of RCDs to perform in the presence of sinusoidal residual fault currents and in case of residual fault currents comprising a d.c. component in accordance with their classification, as required in the relevant RCD standard, shall not be impaired by the additional function(s).

Compliance is checked by the testing procedure of Clause 9.

8.18 Reliability

The ability of RCDs to operate reliably even after long service, taking into account the ageing of their components as required in the relevant RCD standard, shall not be impaired by the additional function(s).

Compliance is checked by the testing procedure of Clause 9.

8.19 Electromagnetic compatibility (EMC)

The compliance of RCDs with the EMC requirements of the relevant RCD standard shall not be impaired by the additional function(s).

Compliance is checked by the testing procedure of Clause 9.

8.20 Operating characteristics

8.20.1 Operating characteristics of the RCD

The additional function(s) shall not impair the operating characteristics of the declared RCD(s).

Compliance is checked by the testing procedure of Clause 9.

8.20.2 Influence of the additional function(s) on the performance of the RCD with different conditions of supply voltage

The switching status of the RCD shall not be changed unintentionally by the additional function(s) independent from the status of the supply voltage. For that purpose a mechanical or electrical locking device may be used.

The following cases shall be considered.

Case 1: The RCD is in the ON position and the supply voltage is available as for normal use. After the RCD is manually switched OFF, the RCD shall not be switched ON again due to an action of the additional function(s) unless switching ON of the RCD is the purpose of the additional function(s), for example automatic reclosing device.

Case 2: The RCD is in the ON position and the supply voltage is available as for normal use. After tripping of the RCD due to a residual current, the RCD shall not switch ON again due to the additional function(s) unless switching ON of the RCD is the purpose of the additional function(s), for example automatic reclosing device. In case of the latter and to have the possibility to avoid an automatic reclosing, the RCD or the additional function(s) shall have a provision to lock the OFF position.

Case 3: Supply voltage on the RCD is not available. The additional function(s) has a separate supply voltage. After the RCD is manually switched OFF, the RCD shall not be switched ON again due to an action of the additional function(s).

Case 4: The RCD is in the ON position and the supply voltage is not available. When the supply voltage is switched ON, for example after a supply failure, the RCD shall not be switched OFF unintentionally.

Case 5: The RCD is switched OFF by the manual operating means and the supply voltage is not available. When the supply voltage is switched ON, for example after a supply failure, the RCD shall not close unintentionally.

Case 6: The supply voltage is available as for normal use and the RCD is in the ON position. When the supply voltage is switched OFF, the additional function shall not switch OFF the RCD unless it is the purpose of the additional function(s), for example undervoltage release. This requirement does not apply to RCDs according to classification 4.1.2 of IEC 61008-1:2010 and 61009-1:2010.

Case 7: The supply voltage is available as for normal use and the RCD is in the OFF position. When the supply voltage is switched OFF, the RCD shall not be switched ON again due to an action of the additional function(s).

Compliance for these different cases is checked by the tests of Clause 9.

9 Tests

9.1 General

The declared RCD associated with the declared additional function(s) is considered as a single product during testing and evaluation. This new single product is referred to as “equipment under test” in this clause.

After assembly or incorporation the new product can be either in the same box or enclosure or in several boxes or enclosures.

In cases where different additional functions are designed to be integrated or built-in at the same time into or onto a RCD, not only the single additional function(s), but also all possible combinations shall be evaluated to determine the most severe case.

An analysis of documentation on how to use the additional function(s) (for example, how to enable and disable it or how to reach the isolating condition of the installation) is made in order to check:

– compatibility of the standard conditions of operation in service: temperature, humidity, vibration, etc. (see Clause 7);
– the general conditions for assembling or incorporating a declared RCD with an additional function (see 8.1 and 8.2);
– standard electrical compatibility for operation in service: voltage, current, frequency, etc. (see 8.3);
– design and measures regarding the protection against electric shock (see 8.4) and insulation coordination (see 8.5): overvoltage category, pollution degree, IP, etc.

This first analysis can also include exploratory testing (see 3.5).

Three different cases shall be considered (see 9.2 to 9.4).

9.2 The additional function is integrated within the RCD according to 4.2 a)

The following testing procedure shall be performed.

a) The “equipment under test” (RCD integrating the additional function(s)) is mounted and wired according to the manufacturer’s instructions as in normal use when the additional function is in use.
b) If the RCD has not been previously tested according to the relevant standard, the testing procedure of the relevant standard applicable to the RCD is then applied alone to the “equipment under test” (at this stage the additional function is disregarded and may be not activated).

c) The testing procedure of the relevant standard applicable to the additional function(s), if any, is then applied alone (at this stage, the RCD function may be disregarded) to the “equipment under test “.

d) Afterwards, a testing procedure based on the relevant standard applicable to the RCD and to the impairment assessment of 9.5.3 shall be applied to the “equipment under test” with the additional function(s) activated, unless the standard covering the additional function(s) explicitly addresses the combination with RCDs for household and similar applications.

9.3 The additional function is not integrated within a declared RCD according to 4.2b) whose compliance to the relevant RCD standard is not yet tested

The following testing procedure shall be performed.

a) The RCD is assembled to the additional function(s) according to the manufacturer’s instructions and then the RCD and its assembled function are mounted and wired according to the manufacturer’s instructions as in normal use when the additional function is in use.

b) The testing procedure of the relevant standard applicable to the RCD is then applied alone to the “equipment under test” (at this stage the additional function is disregarded and may be not activated).

c) The testing procedure of the relevant standard applicable to the additional function(s), if any, is then applied alone (at this stage, the RCD function may be disregarded) to the “equipment under test”.

d) Afterwards, a testing procedure according to the relevant standard applicable to the RCD shall be applied either completely or partially to the “equipment under test” with the additional function(s) activated, unless the standard covering the additional function(s) explicitly addresses the combination with RCDs for household and similar applications. Tests can be disregarded where it is obvious that the additional function has no influence on a given requirement or on a given operational characteristic of the standard of the RCD. The minimum necessary testing to be applied is identified in 9.5.

9.4 The additional function is not integrated within a declared RCD according to 4.3 whose compliance to the relevant RCD standard is already tested

The following testing procedure shall be performed.

a) The RCD is assembled to the additional function(s) according to the manufacturer’s instructions and then the RCD and its assembled function are mounted and wired as in normal use when the additional function is in use.

b) The testing procedure of the relevant standard applicable to the additional function(s), if any, is then applied alone (at this stage, the RCD function may be disregarded) to the “equipment under test “;

c) Afterwards, a testing procedure according to the relevant standard applicable to the RCD shall be applied either completely or partially to the “equipment under test” with the additional function(s) activated, unless the standard covering the additional function(s) explicitly addresses the combination with RCDs for household and similar applications. Tests can be disregarded where it is obvious that the additional function has no influence on a given requirement or on a given operational characteristic of the standard of the RCD. The minimum necessary testing to be applied is identified in 9.5.

9.5 Testing procedure

9.5.1 General

An impairment assessment shall be carried out by the manufacturer of the equipment under test to determine if the assembly of an additional function with a declared RCD can impair the basic RCD protection offered by the RCD function with regard to the relevant RCD standard.

Tests can be disregarded where it is obvious that the additional function has no influence on a given requirement or on a given operational characteristic of the standard of the RCD.

The list of tests given in Table 1 is considered, line by line, during the impairment assessment (see 9.5.2 and 9.5.3). Some additional testing might be considered, if justified, during the evaluation for RCDs. A final list of tests is then made to perform the tests (see 9.5.3.2).

A RCD is basically a protective device opening in case of emergency situation. During the impairment assessment, particular attention shall be paid to assess if the additional function(s) could cause the RCD opening at an abnormal rate or lead to abnormal ageing or reducing the endurance of the RCD.

Where a combination of more than one interface allows the operation of the RCD mechanism, several columns of Table 1 shall be applicable.

Table 1 – List of basic tests to be considered, according to the interface between RCDs and additional function(s), during the assessment

Test sequence		Example: Test according to IEC 61009-1:2010[f]	Additional tests with interface according to classification for testing					Test (or inspection)
			4.3 a)	4.3 b)	4.3 c)	4.3 d)	4.3 e)	
A		6	X	X	X	X	X	Marking
		8.1.1						General
		8.1.2	X	X				Mechanism
		9.3	X	X	X	X	X	Indelibility of marking
		8.1.3	X	X	X	X	X	Clearance and creepage distances (external parts only)
		8.1.6						Non-interchangeability
		9.11		X				Trip-free mechanism
		9.4	X[c]	X[c]	X[c]	X[c]	X[c]	Reliability of screws, current-carrying parts and connections
		9.5	X[c]	X[c]	X[c]	X[c]	X[c]	Reliability of terminals for external conductors
		9.6	X[c]	X[c]	X[c]	X[c]	X[c]	Protection against electric shock
		9.14	X	X	X	X	X	Resistance to heat
		8.1.3	X	X	X	X	X	Clearances and creepage distances (internal parts)
		9.15	X	X	X	X	X	Resistance to abnormal heat and to fire
B		9.7	X	X	X	X	X	Dielectric properties
		9.8	X	X	X	X	X	Temperature rise
		9.20	X	X	X	X	X	Resistance of insulation against impulse voltages
		9.22.2	X	X	X	X	X	Reliability at 40 °C
		9.23	X	X	X	X	X	Reliability of electronic components
C		9.10	X[b]	X				Mechanical and electrical endurance
	C_1	9.12.11.2.1 (and 9.12.12)	X[a]	X[a]		X[a]	X[a]	Performance at reduced short-circuit currents (Verification of the RCBO after short-circuit tests)
	C_2	9.12.11.2.2 (and 9.12.12)	X[a]	X[a]		X[a]	X[a]	Short-circuit test for verifying the suitability of RCBOs for use in IT systems (Verification of the RCBO after short-circuit tests)
D_0		9.9.1	X	X	X	X	X	Operating characteristics under residual operating conditions

Test sequence	Example: Test according to IEC 61009-1:2010[f]	Additional tests with interface according to classification for testing					Test (or inspection)
		4.3 a)	4.3 b)	4.3 c)	4.3 d)	4.3 e)	
D_1	9.17						Behaviour in the case of failure of the line voltage
	10.3	X[d]	X[d]	X[d]	X[d]	X[d]	Verification of the influence of the additional function(s) on the performance of the RCD in case of different states of supply voltage
	9.19				X	X	Behaviour in case of surge currents
	9.21				X	X	DC components
	9.12.13	X[a]	X[a]		X[a]	X[a]	Performance at $I_{\Delta m}$
	9.16			X			Test device
E_0	9.9.2	X	X				Overcurrent operating characteristics
	9.18	X	X				Limiting value of overcurrent in case of a single-phase load through a 3-pole or 4-pole RCBO
E_1	9.13	X	X	X	X	X	Resistance to mechanical shock and impact
	9.12.11.3 (and 9.12.12)	X[a]	X[a]		X[a]	X[a]	Short-circuit performance at 1 500 A
F_0	9.12.11.4 b) (and 9.12.12)	X[a]	X[a]		X[a]	X[a]	Performance at service short-circuit capacity
F_1	9.12.11.4 c) (and 9.12.12.2)	X[a]	X[a]		X[a]	X[a]	Performance at rated short-circuit capacity
G	9.22.1	X	X	X	X	X	Reliability (climatic tests)
H[g]	IEC 61543 Table 4, T1.1	X[e]	X[e]	X	X	X	Harmonics, interharmonics
	IEC 61543 Table 4, T1.2	X[e]	X[e]	X	X	X	Signalling voltage
	IEC 61543 Table 5, T2.3	X[e]	X[e]	X	X	X	Conducted unidirectional transients of the ms and μs time scale
I	IEC 61543 Table 5, T2.1	X[e]	X[e]	X	X	X	Conducted sine-wave voltages or currents
	IEC 61543 Table 5, T2.5	X[e]	X[e]	X	X	X	Radiated high-frequency phenomena
	IEC 61543 Table 5, T2.2	X[e]	X[e]	X	X	X	Fast transients (burst)
J	IEC 61543 Table 5, T2.6	X[e]	X[e]	X	X	X	Conducted common mode disturbances in the frequency range
	IEC 61543 Table 6, T3.1	X[e]	X[e]	X	X	X	Lower than 150 kHz

Test sequence	Example: Test according to IEC 61009-1:2010[f]	Additional tests with interface according to classification for testing					Test (or inspection)
		4.3 a)	4.3 b)	4.3 c)	4.3 d)	4.3 e)	
[a] CO operation as far as possible performed with the additional function(s).							
[b] If applicable, the manual operation is replaced by the additional function(s); operating cycles according to manufacturer's declaration.							
[c] For additional terminals.							
[d] In case of voltage-dependent additional function(s).							
[e] Only if the additional function is integrated into the RCD.							
[f] The clauses or subclauses of relevant product standard according to the type of RCD shall be used (IEC 61009-1:2010, IEC 61009-1:2010/AMD 1:2012 and IEC 61009-1:2010/AMD 2:2013).							
[g] For devices containing a continuously operating oscillator, the test of CISPR 14-1 shall be carried out on the samples prior to the tests of this sequence.							
NOTE The first two columns are for information regarding the content of the required tests in the last column.							

9.5.2 Impairment identification

If considered necessary, an exploratory testing (aiming to check, to investigate, to look for and to assess possible impairments of the RCD protective function) can be applied when the additional function is activated.

The following impairment may be considered.

– Impairment with regard to the mechanical consequences: Any type of mechanical impairment shall be considered such as direct or indirect mechanical coupling, possible vibration, consequences of any mechanical shocks or impact, mechanical corrosion, abnormal mechanical use affecting the endurance, the trip free mechanism or the tripping time, etc.

– Impairment with regard to tripping time: Any type of foreseeable impairment that could impair directly or indirectly the minimum and maximum tripping time of a RCD.

– Impairment with regard to magnetic influences: Any type of foreseeable magnetic impairment shall be considered such as magnetic influence on the toroid and/or any magnetic saturation, magnetic influence on the mechanism or on electronic components, etc.

– Impairment with regard to the electrical consequences: Any type of foreseeable electrical impairment shall be considered such as direct or indirect electrical coupling, electrical endurance, performances at short circuit currents, surge currents, overcurrents and overvoltages, etc.

– Impairment with regard to EMC consequences: Any type of foreseeable EMC impairment shall be considered such as conducted common mode disturbances in the frequency range, harmonics, interharmonics, signalling voltage, conducted transients, conducted sine-wave voltages or currents, radiated high-frequency phenomena, fast transients (burst), electrostatic discharges, etc.

– Impairment with regard to temperature rise: Any type of foreseeable heat or temperature impairment shall be considered such as additional heat as a consequence of the assembly of the additional function(s), abnormal heat able to impair the resistance to heat and fire, etc.

– Foreseeable impairment with regard to any type of communication between the additional function(s) and the RCD such as radio communication, infrared communication or optical communication, magnetic communication, electrical analogical or digital communication (switches, bus, etc.), etc.

NOTE It may happen that some additional impairment would be detected during the exploratory testing.

9.5.3 Impairment assessment

9.5.3.1 General

After impairment identification (see 9.5.2), impairment assessment shall be carried out by the manufacturer. It is guided by each line of Table 1 and by the following:

– the documentation provided with the RCD and the additional function(s) which allows an understanding of the use and influence of the additional function(s);

– the information and general requirements mentioned in Clause 8;

– the test report, if any, of the declared RCDs which have already been tested for another purpose (e.g. certification);

– the results of the possible exploratory test;

– any other information such as reports on accidents or reports on unsafe or bad functioning.

NOTE 1 In estimating the impairment, both normal condition as well as single fault condition have to be taken into account.

The impairment assessment is carried out by the manufacturer for each relevant situation highlighted during the impairment identification (see 9.5.2) by determining the elements of risk associated with a particular situation or technical process taking into account the following elements:

a) The severity of harm or abnormal functioning of the RCD which can be:
   1) negligible (the safety or basic RCD functioning is not impaired), or
   2) slight (normally reversible or not seriously impairing the normal RCD operation), or
   3) serious (normally irreversible or seriously impairing the normal RCD operation).

   NOTE 2 A negligible harm or abnormal functioning may concern a parameter not directly or immediately impairing safety and whose occurrence is slow to occur e.g. indelibility of marking.

   NOTE 3 Examples of serious harm or abnormal function are any harm able to lead to ventricular fibrillation in case of electric shock or leading to a longer tripping time than the normal tripping time or impairing isolation, insulation, possible abnormal temperature or fire. Any other risk whose estimation would impair any other characteristic or performance differing by more than ± 5 % of the normal characteristic or performance is considered serious.

b) The probability of occurrence of that harm or abnormal functioning, which is a function of the following.
   1) Exposure to a hazardous situation or abnormal functioning and how quickly the hazardous situation leads to harm or to impairment of the normal RCD operation: suddenly, fast, slow.
      i) Tolerable exposure: The exposure to the hazardous situation is seldom and obvious for the user, who is aware of it, and slowly occurring so does not affect safety.
      ii) Non tolerable exposure: The exposure to the hazardous situation is either frequent or permanent or not obvious for the user, who may not be aware of it, or can occur quickly or suddenly, or may affect safety.
   2) The occurrence of the hazardous event or abnormal functioning.
      i) Tolerable occurrence.
      ii) Non tolerable occurrence. It cannot be considered negligible that the occurrence of the hazardous situation happens when the RCD needs to trip for safety reasons (e.g. someone in contact with live parts of the installation downstream of the RCD) and the RCD is prevented from tripping.
   3) The technical possibilities to avoid the harm or the abnormal functioning, for example particular requirements for use and installation.

NOTE 4 Accident data can be available to indicate the probability and severity of injury associated with the use of the additional function(s).

9.5.3.2 List of tests to be applied

After impairment assessment the manufacturer shall determine which tests from Table 1 should be applied by the laboratory to the “equipment under test” or whether safety has been achieved.

It is therefore the responsibility of the manufacturer to carry out the whole assessment and to propose the list of tests to be applied by the laboratory. The laboratory is allowed to produce comments on the assessment and on the list of tests. These comments are part of the documentation.

Any impairment assessment showing either a serious harm or possible abnormal functioning or showing a non tolerable exposure or a non tolerable occurrence of risk of harm or possible abnormal functioning shall lead to a test.

In case the additional function leads to a rate of use of the RCD higher than that normally accepted or leading to abnormal ageing or reducing the endurance of the RCD, the corresponding testing of the “equipment under test” may need to be adapted to these new conditions.

If necessary, the impairment assessment may lead to increase the severity or the parameters of the tests or to propose additional testing showing that the use of the additional function(s) does not impair the RCD at a non tolerable level.

NOTE For example, the 2 000 operating cycles frequently used for RCD’s mechanical endurance can be extended to a higher and more appropriate number if the use of the additional function(s) leads to a high number of openings during the life of the device(s).

Less severe tests compared to the relevant RCD standard may only be accepted for the additional function(s) alone, as long as the performance of the RCD is not impaired.

If justified, the manufacturer may conclude from the impairment assessment that some additional testing to those mentioned in Table 1 could be necessary. In this case the manufacturer will propose the necessary additional testing.

A final list of tests is then made available and forwarded to the laboratory together with the impairment assessment.

Acceptance criteria during testing:

– measurement of any tripping time and tripping current of the RCD shall be performed satisfactorily according to the acceptance criteria of the relevant RCD standard;
– if any measurement exceeds by more than ± 5 % the limit of the specified values, the device shall be derated and the derating factors shall be indicated in the technical documentation.

9.5.3.3 List of tests to be applied whatever would be the result of the impairment assessment

Subclause 9.5.3.3 does not apply to devices described in 9.2 if type tests according to the RCD standard were already performed with the integrated additional function activated.

The following tests shall be applied by the laboratory on each ”equipment under test” having the purpose of checking compliance of RCDs when the additional function is in use and activated.

NOTE It may happen that an additional function cannot be unused or deactivated. In this case the tests are not repeated.

The following tests shall be performed according to the test clauses of the relevant RCD standard.

1) Verification of the trip-free mechanism.
2) Verification of the correct operation in case of sudden appearance of residual currents. One measurement of the tripping time is made for each value of the residual current between $I_{\Delta n}$ and 500 A.
3) Verification of the correct operation when closing onto a residual current.
4) Verification of the operation of the test device at the limits of rated voltage.
5) In case of an RCBO, at least the test sequence F1 “Performance at rated short-circuit capacity” of IEC 61009-1 shall be performed.
6) Verification of resistance of the insulation of open contacts and basic insulation against an impulse voltage.

Acceptance criteria: the “equipment under test” shall perform satisfactorily the tests and fulfil the acceptance criteria of the relevant RCD standard.

9.5.4 Verification of the influence of the additional function(s) on the performance of the RCD at different states of supply voltage

The “equipment under test” is supplied as for normal use. The “equipment under test” is tested in the different cases, as applicable and given in 8.20.2, as follows.

a) Case 1: The test is performed by applying the rated voltage to the supply terminals of the equipment under test. The RCD is manually switched OFF and the additional function is in conventional operation according to the manufacturer’s instructions.

   The voltage is applied to the sample for approximately 5 min.

   The operating element of the RCD shall remain in an unchanged, switched OFF position and fulfil the isolation function by passing the test according to the relevant RCD standard.

   The switching ON of the RCD is allowed if it is the purpose of the additional function(s), for example automatic reclosing device.

b) Case 2: The test is performed by applying the rated voltage to the supply terminals of the equipment under test. The RCD is caused to trip by applying a current of 5 times the rated residual current. The additional function is in conventional operation according to the manufacturer’s instructions.

   The voltage is applied to the sample for approximately 5 min.

   The operating element of the RCD shall remain in an unchanged, switched OFF position and fulfil the isolation function by passing the test according to the relevant RCD standard.

   The switching ON of the RCD is allowed if it is the purpose of the additional function(s), for example automatic reclosing device.

c) Case 3: The test is performed by applying the external rated supply voltage of the additional function(s) of the equipment under test only. Where the power supply of the additional function(s) and the RCD part of the equipment under test come from the same power supply, this test can be omitted.

   The RCD is manually switched OFF and the equipment under test is in conventional operation according to the manufacturer’s instructions.

   The voltage is applied to the sample for approximately 5 min.

   The operating element of the RCD shall remain in an unchanged, switched OFF position and fulfil the isolation function by passing the test according to the relevant RCD standard.

d) Case 4: The equipment under test, consisting of a RCD in the switched ON position and additional function(s) in conventional operation according to the manufacturer’s

instructions, is connected to a power source able to deliver the nominal voltage but not yet activated.

After 2 min, the power source is activated.

The test is passed when the status of the RCD remains in an unchanged switched ON position after having switched ON the voltage. The status of the RCD is observed for at least 5 min.

e) Case 6: The test is performed by applying the rated voltage to the supply terminals of the equipment under test, consisting of a RCD in the switched ON position and additional function(s) in conventional operation according to the manufacturer's instructions.

The voltage applied to the equipment under test is switched OFF.

The test is passed when the status of the RCD remains in an unchanged switched ON position after having switched OFF the voltage. The status of the RCD is observed for at least 5 min.

The switching OFF of the RCD is allowed if it is the purpose of the additional function(s), for example undervoltage release

f) Cases 5 and 7: The test is performed by applying the rated voltage to the supply terminals of the equipment under test, consisting of a RCD in the switched OFF position and additional function(s) in conventional operation according to the manufacturer's instructions.

The voltage applied to the equipment under test is switched OFF and after approximately 30 s is switched ON again.

The test is passed when the status of the RCD remains in an unchanged, switched OFF position.

9.6 Documentation

Documentation on the impairment assessment shall demonstrate the procedure that has been followed by the manufacturer and the results that have been achieved by the laboratory. This documentation may include the following:

NOTE The laboratory can be either a manufacturer's laboratory or an independent laboratory (e.g. within the frame of conformity assessment).

a) The declared additional function(s) and RCD for which the assessment has been made;

b) The manufacturer's documentation;

c) The description of the exploratory testing if any (see 3.5);

d) The hazards identified (see 9.5.2) and the hazardous events considered during the assessment;

e) The results of the impairment assessment (see 9.5.3);

f) The list of tests proposed by the manufacturer and applied by the laboratory to the "equipment under test" (see 9.5.3.2) together with the comments made by the laboratory on the evaluation and identification, if any.

The test reports shall be made available and shall include rationale for tests not undertaken.

Annex A
(informative)

Additional requirements and tests for RCDs consisting of a RCD and a non integrated additional function unit designed for assembly on site

A.1 General

The main body of this Technical Report applies in all respects to devices covered by this annex, unless otherwise specified.

A.2 Scope

This annex applies to RCDs consisting of a RCD complying with the requirements of an applicable RCD standard and a non integrated additional function unit (complying with the appropriate requirements of an applicable standard, if any), designed for assembly on site, in accordance with the manufacturer's instructions.

A.3 Terms and definitions

Clause 3 of this Technical Report applies and in particular the definition for “non integrated additional function”.

A.4 Marking and other product information

A.4.1 Manufacturer's name or trademark

With reference to 6.2 of this Technical Report, the RCD declared compatible by the manufacturer and the non integrated additional function unit which it is to be assembled on site shall bear the same manufacturer's name or trademark.

A.4.2 Marking

A.4.2.1 Marking of the RCD

Marking of the RCD shall be in accordance with the applicable RCD standard.

A.4.2.2 Marking of the non integrated additional function unit to be assembled on site

The non integrated additional function unit to be assembled on site shall be marked with the following items:

– manufacturer's name or trademark;
– type designation, catalogue number or serial number;
– rated voltage(s);
– rated frequency, if useful; non integrated additional function unit with more than one rated frequency (e.g. 50/60 Hz) shall be marked accordingly;
– rated current, if any;
– degree of protection (only if different from IP 20);
– wiring diagram;
– maximum rated current of the RCD with which it may be assembled (e.g. 63 A max.);

– position of use, if necessary.

The following information shall be provided in the catalogue or data sheet:

– the RCD references which the manufacturer has declared to be compatible for assembling on site.

A.4.2.3 Marking of the assembled RCD and non integrated additional function unit

The following marking on the non integrated additional function unit to be assembled on site shall not be visible after assembly:

– maximum rated current of the RCD with which it may be assembled (e.g. 63 A max.).

Marking of the position of use, if applicable, shall remain visible after assembly.

A.4.3 Instructions for assembly and operation

The manufacturer shall provide adequate instructions with the non integrated additional function unit to be assembled on site.

These instructions shall cover at least the following:

– reference to the type(s) and catalogue number(s), covering current and voltage ratings, number of poles, etc. of the RCD with which the non integrated additional function unit is designed to be assembled;
– RCD derating factor(s), if any;
– method of assembly;
– need for checking operation after assembly to verify the mechanical operation;
– verification of the tripping operation by use of the RCD test button.

A.5 Constructional requirements

A.5.1 General

The design shall be such that it shall be possible to assemble the non integrated additional function unit on site.

Design may be such that the non integrated additional function unit may be disassembled on site in accordance with the manufacturer's instructions.

For devices declared not suitable for disassembling, the disassembly shall leave permanent visible damage.

Compliance is checked according to A.6.4.

A.5.2 Degree of protection

The degree of protection of the non integrated additional function unit to be assembled on site shall be no less than that of the RCD with which it is to be assembled.

A.5.3 Mechanical requirements

The RCD and the non-integrated additional function unit to be assembled on site shall fit together readily in the correct manner, and the design shall be such as to prevent an incorrect assembly.

Parts to be coupled with the tripping mechanism shall be securely fixed after mounting and shall not become loose.

Fixing means for assembly shall be captive.

NOTE Terminal covers, if any, are not covered by this requirement.

A.5.4 Electrical compatibility

It shall not be possible to assemble a RCD of a given rated short-circuit capacity with a non integrated additional function unit to be assembled on site so as to result in a lower short-circuit performance.

Compliance is checked by inspection and manual test.

A.6 Type tests and verifications

A.6.1 Tests on RCDs

The RCD shall comply with the type tests of the applicable RCD standard.

A.6.2 Tests on non integrated additional function unit to be assembled on site

The non integrated additional function unit being assembled with the RCD shall comply with the testing procedure applicable to the non integrated function if any.

A.6.3 Tests on assembled RCDs and non integrated additional function unit

The type test specified in Clause 9 is applicable.

A.6.4 Verification of marking and constructional requirements

Compliance with the requirements of A.4.1, A.4.2, A.4.3, A.5.1, A.5.2, A.5.3 and A.5.4 shall be checked by inspection and manual test, as applicable.

For devices declared suitable to be disassembled, compliance with the requirements of A.5.1 is checked by the following test.

The non-integrated additional function unit and the compatible RCD as declared by the manufacturer have to be assembled and disassembled five times. The non-integrated additional function unit to be assembled on site and the compatible RCD are then reassembled. After each assembly, the correct operation of the combination shall be verified by using the test button. The RCD shall trip each time.

Afterward, a tripping test with measurement of the tripping time is made in accordance to the applicable RCD standard.

Bibliography

IEC 61540, *Electrical accessories – Portable residual current devices without integral overcurrent protection for household and similar use (PRCDs)*

IEC 61543 (all parts), *Residual current-operated protective devices (RCDs) for household and similar uses – Electromagnetic compatibility*

IEC 62335, *Circuit breakers – Switched protective earth portable residual current devices for class I and battery powered vehicle applications*

IEC 62640, *Residual current devices with or without overcurrent protection for socket-outlets for household and similar uses*

IEC 60364, *Low-voltage electrical installations*

IEC 60479, *Effects of current on human beings and livestock*

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

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