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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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 11: Effectiveness of residual current monitors (RCMs) type A and type B in TT, TN and IT systems

Sécurité électrique dans les réseaux de distribution basse tension de 1 000 V c.a. et 1 500 V c.c. – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection –
Partie 11: Efficacité des contrôleurs d'isolement à courant différentiel résiduel (RCM) de type A et de type B dans les réseaux TT, TN et IT

IEC 61557-11:2009

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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 –

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

FDIS	Report on voting
85/338/FDIS	85/343/RVD

Full information on the voting for the approval of this standard 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.

This part is to be used in conjunction with IEC 61557-1:2007, Part 1: *General requirements*.

A list of all parts of the IEC 61557 series, published under the general title *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,* can be found on the IEC website.

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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 11: Effectiveness of residual current monitors (RCMs) type A and type B in TT, TN and IT systems

1 Scope

This part of IEC 61557 specifies the requirements for testing equipment applied to the testing of the effectiveness of residual current monitors (RCMs) of type A and type B, which are already installed in distribution systems.

This test equipment can be used in any kind of network like a TN, TT or IT system. The test equipment may also be used for testing directionally discriminating RCMs in IT-Systems.

2 Normative references

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

IEC/TR 60755:2008, *General requirements for residual current operated protective devices*

IEC 61010-1:2001, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61326-2-2, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-2: Particular requirements – Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems*

IEC 61557-1, *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 1: General requirements*

IEC 61557-6, *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 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61557-1, IEC 61557-6 and the following apply.

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

[IEC 62020, definition 3.3.1]

3.2
earth fault current
I_e
current flowing to earth due to an insulation fault

[IEC 62020, definition 3.1.1]

3.3
test current
I_T
test current superimposed by the test equipment for testing the effectiveness of the RCM

3.4
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)

[IEC 62020, definition 3.2.3]

3.5
rated residual operating current
$I_{\Delta N}$
value of residual current assigned by the manufacturer which causes the RCM to operate under specified conditions

[IEC 62020, definitions 3.2.4 and 3.4.1 combined]

3.6
residual operating current
$I_{\Delta o}$
value of residual current which causes the RCM to operate under specified conditions

[IEC 62020, definition 3.2.4]

3.7
residual non-operating current
$I_{\Delta no}$
value of residual current at which and below which the RCM does not operate under specified conditions

[IEC 62020, definition 3.2.5]

3.8
actuating time
t_a
time taken for a 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

[IEC 62020, definition 3.3.12]

3.9
residual current monitor (RCM) type A
RCM for which monitoring is ensured for residual sinusoidal alternating currents and residual pulsating direct currents, whether suddenly applied or slowly rising

[IEC 62020, definition 3.3.8, modified]

3.10
residual current monitor (RCM) type B
RCM for which monitoring is ensured for residual sinusoidal alternating currents, with residual pulsating direct currents and smooth residual direct currents independent of polarity, whether suddenly applied or slowly rising

[IEC/TR 60755, definition 5.2.9.3, modified]

4 Requirements

The following requirements as well as those given in IEC 61557-1 shall apply.

4.1 Operating test

The testing equipment shall be capable of verifying that the residual operating current of a RCM type A tested with an a.c. test current is lower or equal to the value of the rated residual operating current.

Testing of RCMs type A shall be conducted with a suddenly applied calibrated a.c. current at zero crossing.

The tests shall be carried out with a sinusoidal, or mains-derived quasi sinusoidal, test current.

If the test equipment is capable of producing half-wave test currents, testing of residual current monitors (RCMs) type A may be carried out alternatively with half-wave test currents and/or a.c. current with superimposed ±6 mA d.c. according to IEC 62020.

In case of pulsed d.c. current, the test equipment shall be capable of testing in both polarities.

When testing RCMs of type B with a d.c. test current, it shall be verified that the residual operating current is lower or equal to 2 times the value of the rated residual operating current.

Testing of RCMs type B shall be conducted separately with a suddenly applied, calibrated a.c. current and a continuously rising smooth direct current.

The steepness of the continuous rate of rising shall not be higher than $2 \times I_{\Delta N}$ / 5 s.

If the continuous rate of rising is simulated by a stepwise or linearly increasing test current, the increase shall not be higher than $2 \times I_{\Delta N}$ / 30 (see Figures 1 to 3).

In both cases the starting current shall be below $0{,}2 \times I_{\Delta N}$.

The operating uncertainty of the increasing test current I_T shall not exceed ±10 % of the rated residual operating current $I_{\Delta N}$.

The operating uncertainty of the calibrated test current I_T shall not exceed 0 % to +10 %.

The test period shall be adapted to the set actuating time of the RCM and it shall be possible to extend the test period up to 10 s.

4.2 Non-operating test

When a test at 50 % or less of the rated residual operating current to test the reliability of the RCM is included, the minimum test period shall be 10 s. The alarm shall not be activated.

When a non-operating test at 50 % or less of the rated residual operating current is included, the operating uncertainty of the calibrated test current shall not exceed 0 % to –10 % of the specified non-operating test current.

NOTE Existing leakage currents downstream can influence the verification.

4.3 Test of actuating time

If the set actuating time of the RCM is being tested with the test equipment, the setting of the test period on the test device shall have a resolution of minimum 0,5 s ranging up to 10 s. The setting uncertainty shall not exceed 0 % to –10 % of the set value. The test shall solely be performed with calibrated a.c. test current.

Other methods for the acquisition of the actuating time via optical recognition or interfacing are permissible.

NOTE The general function of RCMs is not the disconnecting of the power supply when a residual current above the value of the rated residual operating current occurs. The RCM indicates the increase of the residual current above the residual operating current with a signalling device, for example a lamp, buzzer, contact relay or interface-signal. Thus the response time may only be tested via the visual or additional electrical detection of this signal.

According to IEC 62020 the response time of RCMs may only amount to a maximum of 10 s. The response time shall be specified by the manufacturer or shall be adjustable on the device.

If the RCM is being used for the purpose of disconnection, the tests covered by IEC 61557-6 shall apply.

4.4 Operating conditions

The operating uncertainty applies according to the test conditions specified in IEC 61557-1 and additionally

– the protective conductor is free of extraneous voltage,

– the system voltage remains constant during tests,

– the circuit behind the RCM is free of leakage currents,

– sinusoidal half-wave or full-wave current with rated frequency, respectively smooth direct current (see 4.1),

– the a.c. test current I_T shall be switched on at a zero crossing,

– the test period shall be 10 s for the maximum test current for which the test equipment is designed,

– the time limit may be omitted when testing with current higher than 500 mA,

– the resistance of the probes is within the limits stated by the manufacturer.

4.5 Prevention of danger by fault voltages exceeding 50 V a.c. or 120 V d.c. in the monitored system during measurement

This can be achieved by the following:

– automatic disconnection in accordance with IEC 61010-1:2001, Figure 1, if the residual voltage is above 50 V a.c. or 120 V d.c.;

– application of test current I_T, gradually or permanently adjustable, where the test starts a maximum current of a.c. 3,5 mA or 15 mA d.c. in accordance with IEC 61010-1:2001, 6.3.2 b), including parallel test circuits, is permitted. The possibility to change the test current I_T

without generating a dangerous residual voltage shall be clearly identifiable, for instance on a voltmeter.

In special locations the touch voltage limit is 25 V a.c or 60 V d.c.

The operating uncertainty for the detection of the fault voltage shall not exceed 0 % to –20 % of the limit.

4.6 Prevention of danger caused by overvoltages when the system is connected

If the system is connected to 120 % of the nominal voltage of the system for which the test equipment is designed, neither the operator shall be harmed nor the device be damaged. Protective devices shall not be activated. If the device is intended to be used in IT systems, the nominal voltage of the test equipment is the phase to phase voltage.

If the test equipment is accidentally connected to 173 % of the nominal voltage in TN or TT systems for which the test equipment is designed for the duration of 1 min, neither the operator shall be harmed nor the device be damaged. In this case, protective devices may be activated.

4.7 Electromagnetic compatibility (EMC)

The electromagnetic compatibility shall be in accordance with IEC 61326-2-2.

5 Marking and operating instructions

5.1 Markings

In addition to the marking in accordance with IEC 61557-1, the following information shall be provided on the measuring equipment.

Rated residual operating current or rated residual operating currents of the RCM for which the test equipment has been designed for an actuating time of 10 s.

NOTE Other rated residual operating currents for lower actuating times may be marked in addition.

5.2 Operating instructions

The operating instructions shall state the following in addition to the statements given in IEC 61557-1.

5.2.1 Information

a) Information about special test configurations to avoid unintended tripping of RCDs (see Annex B);

b) information to avoid unintended influences on the operation of the system;

c) information for recalibration cycles and safety tests of the test equipment after repair and instructions for periodical tests.

5.2.2 Warnings

a) If the detecting circuit for the fault voltage has no probe and if a possible voltage between the protective conductor and earth influences the measurements, a warning shall be included.

b) Where the detecting circuit for the fault voltage uses the N-conductor as a probe, a warning shall be given to test the connection between the neutral point of the distribution system and earth before the test is started; a possible voltage between the N-conductor and earth may influence the measurements.

c) A warning that leakage currents in the circuit following the RCM may influence measurements and test results.

d) The earth electrode resistance of a detecting circuit for the fault voltage with a probe shall not exceed the value stated by the manufacturer.

e) A warning that the potential fields of other earthed installations may influence the determination of the fault voltage.

f) A warning that for special locations the touch voltage is limited to 25 V a.c or 60 V d.c.

6 Tests

6.1 General

The following tests in addition to those required according to IEC 61557-1 shall be executed.

Tests shall be carried out with rated residual operating currents, in addition with the values of the non-operating test currents I_T, if applicable.

The test circuit shall be adapted to test the function of the fault voltage detection circuit at the limits of the fault voltage for which the equipment is designed and in addition at the appropriate $R_A = R_{Amax}$ for each range.

The test circuit shall be adapted to each test method employed. The manufacturer's instructions shall be heeded.

NOTE $R_{Amax} = \frac{U_L}{I_{\Delta N}} \times I_{\Delta o}$ $R_{Amax} = \frac{U_L}{I_T}$

where

U_L is the conventional touch voltage limit;

I_T is the test current superimposed by the test circuit;

R_A is the total earthing resistance ($R_A = R_{Amax}$);

$I_{\Delta N}$ is the rated residual operating current;

$I_{\Delta o}$ is the residual operating current.

6.2 Operating uncertainty

The operating uncertainty shall be determined in accordance with Table 1. In this process, the intrinsic uncertainty shall be determined under the following reference conditions:

– nominal voltage of the rated range of the device,
– nominal frequency of the rated range of the device,
– reference temperature 23 °C ± 2 °C,
– reference position in accordance with the manufacturer's instructions,
– protective conductor free from extraneous voltages,
– 100 Ω resistance of the auxiliary earth electrode in a TT system.

The operating uncertainty thus evaluated shall not exceed the limits specified in 4.1 to 4.2.

a) Compliance with the permissible operating uncertainty when detecting the fault voltage shall be tested for measurements with and without a probe.

b) Compliance with the requirements in accordance with 4.5 shall be tested *(routine test)*.

c) The overload protection in accordance with 4.6 shall be tested *(type test)*.

d) Compliance with the tests in this clause shall be recorded.

Table 1 – Calculation of operating uncertainty

Intrinsic uncertainty or influence quantity	Reference conditions or specified operating range	Designation code	Requirements or test in accordance with the relevant parts of series IEC 61557	Type of test
Intrinsic uncertainty	Reference conditions	A	Part 11, 6.2	R
Position	Reference position ±90°	E_1	Part 1, 4.2	R
Supply voltage	At the limits stated by the manufacturer	E_2	Part 1, 4.2, 4.3	R
Temperature	0 °C and 35 °C	E_3	Part 1, 4.2	T
Resistance of the probes	Within the limits stated by the manufacturer	E_5	Part 11, 4.4	T
System voltage	85 % to 110 % of the nominal voltage	E_8	Part 11, 4.4, 4.5	T
Operating uncertainty	$B = \pm (\lvert A \rvert + 1{,}15\sqrt{E_1^2 + E_2^2 + E_3^2 + E_5^2 + E_8^2})$		Part 11, 4.1 Part 11, 4.2 Part 11, 4.3 Part 11, 4.5	R

A = intrinsic uncertainty

E_n = variations

R = routine test

T = type test

$$B(\%) = \pm \frac{B}{\text{fiducial value}} \times 100\,\%$$