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INTERNATIONAL STANDARD

colour inside

Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures –
Part 11: Effectiveness of residual current monitors (RCM) ~~type A and type B~~ in TT, TN and IT systems

IEC 61557-11:2020-06 RLV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V AC AND 1 500 V DC – EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES –

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

FOREWORD

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International Standard IEC 61557-11 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) document title modified to include all types of RCM;
b) terms aligned with IEC 60050;
c) addition of requirements for testing new types of RCM;
d) moving of requirements for RCM Type B from former Annex A to main body text;
e) alignment of the structure with that of the whole IEC 61557 series.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
85/720/FDIS	85/722/RVD

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

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

This International Standard is to be used in conjunction with IEC 61557-1:2019.

A list of all parts in the IEC 61557 series, published under the general title *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures*, can be found on the IEC website.

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

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- withdrawn,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

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ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V AC AND 1 500 V DC – EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES –

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

1 Scope

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

This test equipment can be used in any kind of network, such as a TN, TT or IT system. The test equipment~~ may~~ can also be used for testing directionally discriminating residual current monitors (RCM) in IT systems.

It is not the purpose of this document to verify the residual current monitors (RCM) according to their product standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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~~2010, *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 61557-1:2019, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – 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 AC and 1 500 V DC – 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)*~~

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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.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
earth fault current
~~I_e~~
current flowing to earth due to an insulation fault

[SOURCE: ~~IEC 62020, definition 3.1.1~~ IEC 60050-442:1998, 442-01-23]

3.2
test current
I_T
~~test~~ current superimposed by the test equipment for testing the effectiveness of the RCM

3.3
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)~~

~~[IEC 62020, definition 3.2.3]~~

RMS value of the vector sum of the currents flowing through the main circuit of the residual current device due to an insulation fault

[SOURCE: IEC 60050-442:2019, 442-05-19, modified – The wording "instantaneous values" has been deleted from the definition and "due to an insulation fault" has been added.]

3.4
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]~~

value of residual operating current assigned to the RCM by the manufacturer at which the RCM operates under specified conditions

3.5
residual operating current
$I_{\Delta o}$
value of residual current which causes the residual current monitoring device to operate under specified conditions

~~[IEC 62020, definition 3.2.4]~~

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[SOURCE: IEC 60050-442:2019, 442-05-20, modified: "residual current device" has been replaced with "residual current monitoring device" and symbol "$I_{\Delta n}$" has been replaced with "$I_{\Delta o}$".]

3.6
residual non-operating current
~~$I_{\Delta no}$~~
value of residual current at and below which the RCM does not operate under specified conditions

~~[IEC 62020, definition 3.2.5]~~

[SOURCE: IEC 60050-442:2019, 442-05-21, modified – "residual current device" has been replaced with "RCM" and the symbol has been omitted.]

3.7
actuating time
t_a
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

[SOURCE: ~~IEC 62020, definition 3.3.12~~ IEC 62020-1:2020, 3.1.6, modified – The symbol has been added.]

3.8
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

[SOURCE: ~~IEC 62020, definition 3.3.1~~ IEC 62020-1:2020, 3.1.1]

3.9
RCM Type A
type of RCM for which monitoring is ensured for residual sinusoidal alternating currents and residual pulsating direct currents, whether suddenly applied or slowly rising

[SOURCE: ~~IEC 62020, definition 3.3.8~~ IEC 62020-1:2020, 5.2.6.2, modified – The words "initiating an alarm" have been replaced with "monitoring".]

3.10
RCM Type B
type of 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

Note 1 to entry: RCM Type B are described in IEC 62020-1:2020, 5.2.6.4.

~~[IEC/TR 60755, definition 5.2.9.3, modified]~~

3.11
directionally discriminating RCM
type of RCM having the ability to discriminate between supply side and load side residual currents of the monitored lines, as declared by the manufacturer

Note 1 to entry: Directionally discriminating RCM are described in IEC 62020-1.

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[SOURCE: IEC 62020-1:2020, 3.1.10]

4 Requirements

4.1 General

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

In addition to the requirements of IEC 61557-1:2019, Clause 4, the requirements of Clause 4 of this document shall apply.

4.2 Functions

4.2.1 Operating test

The testing equipment shall be capable of verifying that the residual operating current of an RCM Type A tested with an AC test current is less than or equal to the value of the rated residual operating current.

Testing of an RCM Type A shall be conducted with a calibrated AC current suddenly applied at a 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 an RCM Type A may be carried out alternatively with half-wave test currents and/or AC current with superimposed ±6 mA DC~~ according to IEC 62020~~.

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

When testing an RCM Type B with a DC test current, it shall be verified that the residual operating current is less than or equal to 2 times the value of the rated residual operating current.

Testing of an RCM Type B shall be conducted separately with a suddenly applied, calibrated AC current and a~~ continuously rising~~ linearly increasing smooth direct current.

The~~ steepness~~ slope of the~~ continuous rate of rising~~ linear increase shall not be greater than 2 times $I_{\Delta n}$ / 5 s.

If~~ the continuous rate of rising~~ the slope of the linear increase is simulated by a stepwise or linearly increasing test current; the increase shall not be greater than 2 times $I_{\Delta n}$ / 30 (see Figure 1 to Figure 3).

In both cases, the starting current shall be less than 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 % of the rated residual operating current $I_{\Delta n}$.

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.

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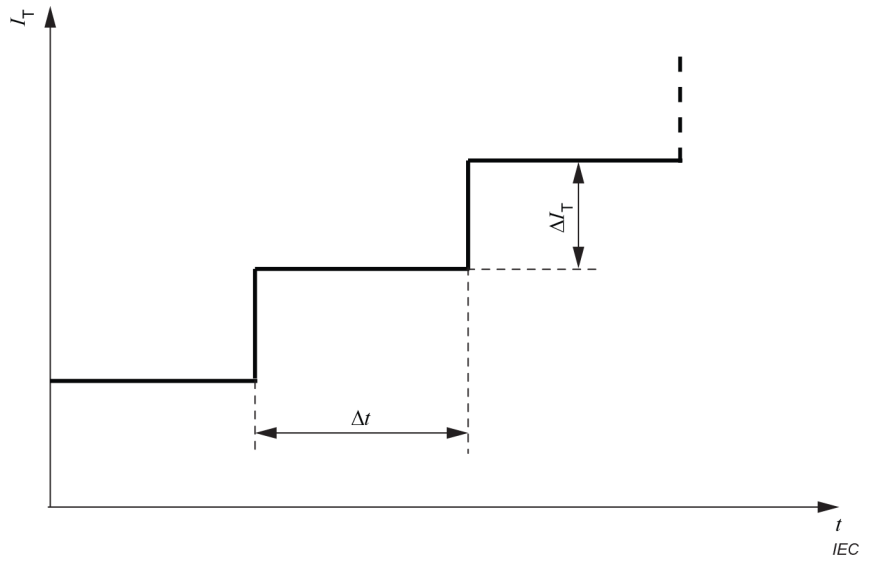

Figure 1 – Maximum step size of increasing smooth direct test current (I_T)

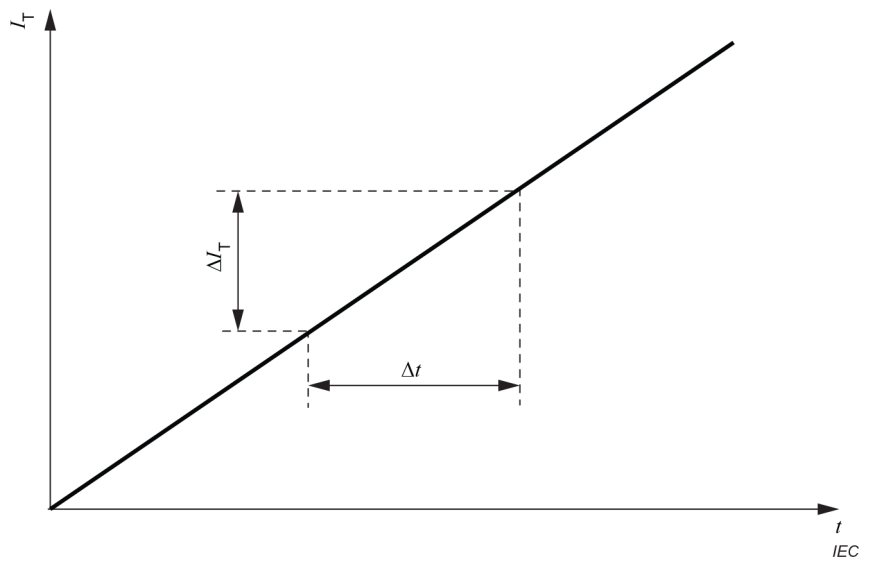

Figure 2 – Maximum gradient of linearly increasing smooth direct test current (I_T)

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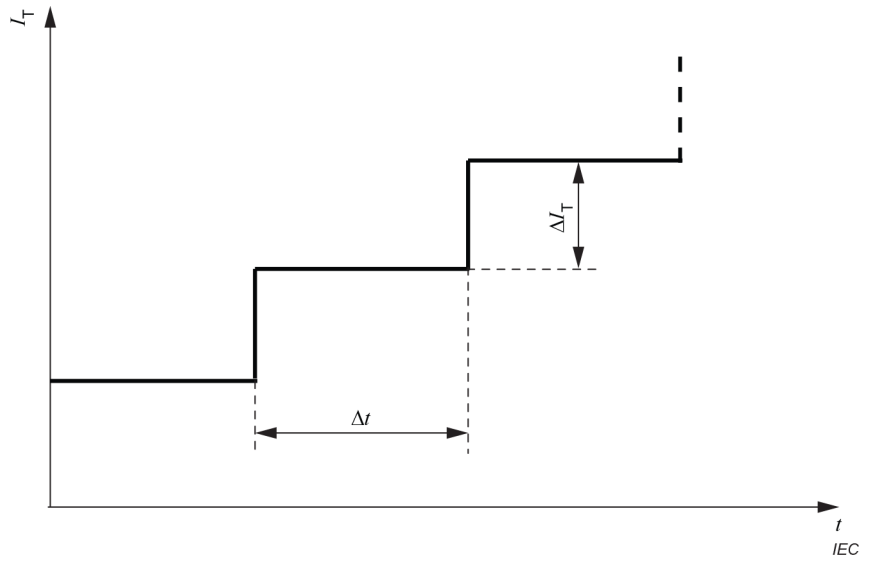

Figure 3 – Example for linearly increasing smooth direct test current (I_T): $I_{\Delta n}$ = 30 mA

Key (for Figure 1 to Figure 3)

t time

$I_{\Delta n}$ rated residual operating current

I_T smooth direct test current

ΔI_T slope of the linear increasing test current or steps of stepwise rising test current

Δt time for one step for linearly increasing test current or time for steepness of continuous rising test current

A slow continuous or stepwise increase of the DC test current is required to prevent the AC sensitive part of the RCM Type B from operating during the DC test.

Example for ΔI_T = 2 mA: ≥ 167 ms

Example for ΔI_T = 0,5 mA: ≥ 42 ms

NOTE 1 Existing leakage currents downstream can influence the verification.

NOTE 2 The actual rise time depends on the system capacitance and the resistive load of the test equipment.

NOTE 3 Smooth DC test current refers to direct current with AC ripple up to 10 % (peak to peak).

4.2.2 Non-operating test

When a test at 50 % or less of the rated residual operating current is used 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.

4.2.3 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 AC test current.

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

NOTE The general function of RCMs is not to disconnect 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~~ can only be tested via the visual or additional electrical detection of this signal.

According to IEC 62020-1, the ~~response~~ actuating time of the RCM 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.

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

Prevention of danger due to fault voltages exceeding U_L within the system under test shall be ensured during the use of the test equipment. This can be achieved as follows:

– automatic disconnection in accordance with IEC 61010-1:~~2001~~2010, Figure 1, if the residual voltage is above 50 V AC or 120 V DC;
– application of test current I_T, gradually or permanently adjustable, where the test starts with a maximum current of 3,5 mA AC or 15 mA DC in accordance with IEC 61010-1:~~2001~~2010, 6.3.2 b), including parallel test circuits, is permitted. The possibility to change the test current I_T without generating a dangerous ~~residual~~ fault voltage shall be clearly identifiable, for instance on a voltmeter;
– in special locations, the touch voltage limit is 25 V AC or 60 V DC;
– the operating uncertainty for the detection of the fault voltage shall not exceed 0 % to −20 % of the limit.

4.4 ~~Prevention of danger caused by overvoltages when the system is connected~~ Overvoltage

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~~ line-to-line 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 requirements of IEC 61557-1:2019, 5.1, 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.

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NOTE Other rated residual operating currents for ~~lower~~ a shorter duration of the actuating times ~~may~~ can be marked in addition.

The maximum voltage to earth and the rated measuring category shall be marked.

5.2 Operating instructions

5.2.1 General

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

In addition to the requirements of IEC 61557-1:2019, 5.3, the operating instructions shall include the information and warnings set out in 5.2.2 and 5.2.3.

5.2.2 Information

a) Information about special test configurations to avoid unintended tripping of residual current devices (RCD) ~~(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.

5.2.3 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 AC or 60 V DC.

6 Tests

6.1 General

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

In addition to IEC 61557-1:2019, Clause 6, the following tests shall be performed.

Tests shall be carried out with rated residual operating currents, in addition to 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~~ observed.

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NOTE

$$R_{\text{Amax}} = \frac{U_{\text{L}}}{I_{\Delta\text{n}}} I_{\Delta\text{o}}$$

$$R_{\text{Amax}} = \frac{U_{\text{L}}}{I_{\text{T}}}$$

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 ($R_{\text{A}} = R_{\text{Amax}}$);

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

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

6.2 Operating uncertainty

The operating uncertainty applies in accordance with the test conditions specified in IEC 61557-1:2019 and, in addition, the following requirements apply:

~~– 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 voltage on the protective conductor relative to earth or N shall be less than 1 Vrms;

– the system voltage remains stable within ±1 V during the measurement;

– the circuit following the residual current protective device carries a negligible leakage current;

– sinusoidal half-wave current with rated frequency, or sinusoidal full-wave current with rated frequency, or smooth direct current (see 4.2);

– the AC 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 greater than 500 mA;

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

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.~~

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~~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 IEC 61557	Type of test
Intrinsic uncertainty	Reference conditions	A	IEC 61557-11:2020, 6.2	R
Position	Reference position ±90°	E_1	IEC 61557-1:2019, 4.2	R
Supply voltage	At the limits stated by the manufacturer	E_2	IEC 61557-1:2019, 4.2, 4.3	R
Temperature	0 °C and 35 °C	E_3	IEC 61557-1:2019, 4.2	T
Resistance of the probes	Within the limits stated by the manufacturer	E_5	IEC 61557-11:2020, 4.4	T
System voltage	85 % to 110 % of the nominal voltage	E_8	IEC 61557-11:2020, 4.4~~, 4.5~~	T
Operating uncertainty	$B = \pm\sqrt{A^2 + \frac{4}{3}\sum_i E_i^2}$		IEC 61557-11:2020, 4.1 IEC 61557-11:2020, 4.2 IEC 61557-11:2020, 4.3 IEC 61557-11:2020, ~~4.5~~ 6.2	R

A = intrinsic uncertainty

~~E_n~~ E_i = variations

R = routine test

T = type test

F = fiducial value

$$B\,[\%] = \pm\frac{B}{F} \times 100\ \%$$

6.3 Test of protection against high fault voltages

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

Compliance with 4.3 shall be tested in all ranges.

6.4 Test of overvoltage

The permissible overvoltage in accordance with the requirements of 4.4 shall be tested (type test).

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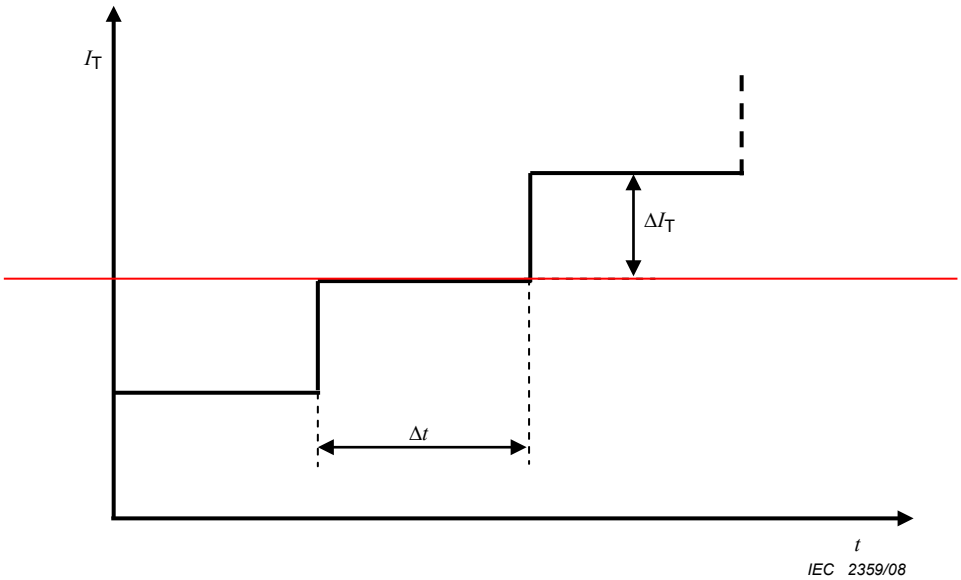


~~$\Delta I_T \leq 2\ I_{\Delta N} / 30$ $\Delta I_T / \Delta t \leq 2\ I_{\Delta N} / 5$ s~~

~~**Key** (for Figures 1 to 3)~~

~~t time~~

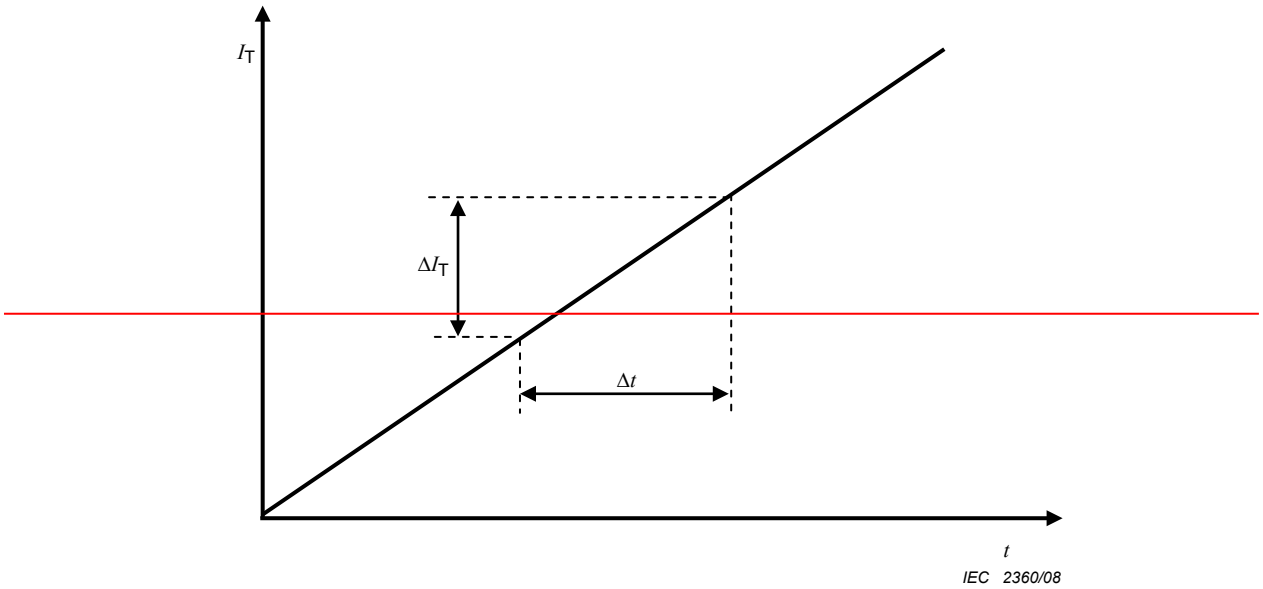
~~$I_{\Delta N}$ rated residual operating current~~

~~I_T smooth direct test current~~

~~ΔI_T steepness of continuous rising test current or steps of stepwise rising test current~~

~~Δt time for one step for stepwise rising test current or time for steepness of continuous rising test current~~

~~**Figure 1 – Maximum steepness of stepwise rising smooth direct test current (I_T)**~~



~~$\Delta I_T / \Delta t \leq 2\ I_{\Delta N} / 5$ s~~

~~**Figure 2 – Maximum increase of linearly increasing smooth direct test current (I_T)**~~

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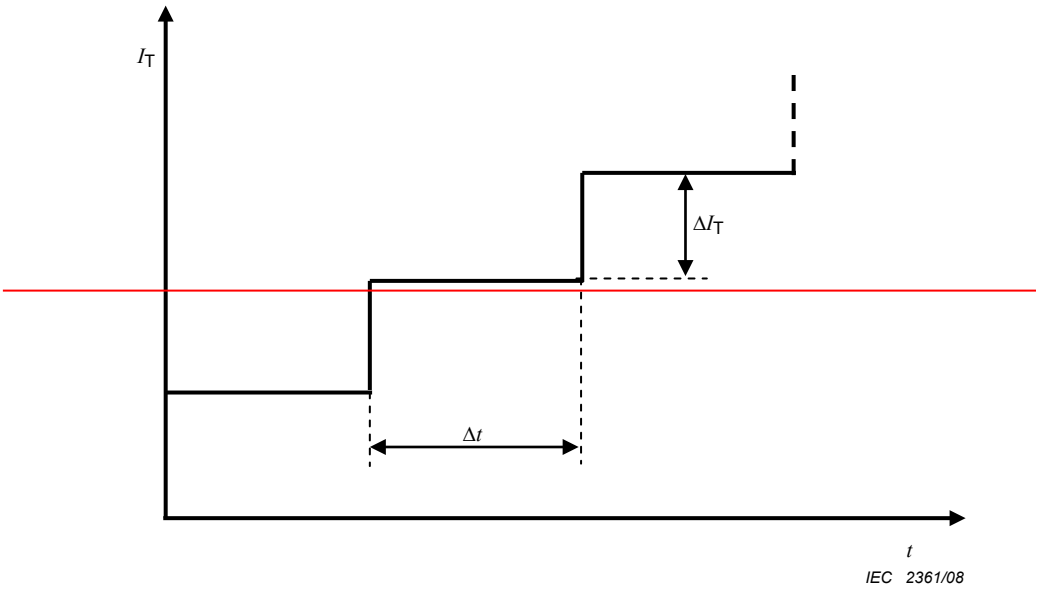

~~$\Delta I_T \leq 2 \times 30$ mA / 30 ≤ 2 mA~~

~~Example for ΔI_T = 2 mA: $\Delta t \geq$ (2 mA × 5 s) / (2 × 30 mA) ≥ 167 ms~~
~~Example for ΔI_T = 0,5 mA: $\Delta t \geq$ (0,5 mA × 5 s) / (2 × 30 mA) ≥ 42 ms~~

~~NOTE 1 Existing leakage currents downstream may influence the verification.~~

~~NOTE 2 The actual rise time depends on the system capacitance and the resistive load of the test equipment.~~

~~NOTE 3 Smooth d.c. test current refers to direct current with a.c. ripple up to 10 % (peak to peak).~~

~~NOTE 4 A slow continuous or stepwise increase of the d.c. test current is required to prevent the a.c. sensitive part of the RCM type B from operating during the d.c. test.~~

~~Figure 3 – Example for linearly increasing smooth direct test current (I_T): $I_{\Delta N}$ = 30 mA~~

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