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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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 3: Loop impedance

IEC 61557-3:2019-07 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 3: Loop impedance

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International Standard IEC 61557-3 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

This third edition cancels and replaces the second edition published in 2007. This edition constitutes a technical revision.

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

a) addition of equirements as regards the measurement category;

b) addition of new requirements for operating instructions;

c) 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
85/687/FDIS	85/694/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- withdrawn,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
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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 3: Loop impedance

1 Scope

This part of IEC 61557 specifies the requirements applicable to equipment for measuring the loop impedance between a ~~phase~~ line conductor and protective conductor ~~or~~; between a ~~phase~~ line conductor and neutral; or between two ~~phase~~ line conductors by using the voltage drop when the circuit under test is loaded.

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 61010-1:~~2001~~2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
IEC 61010-1:2010/AMD1:2016[1]

IEC 61010-2-030:2017, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits*

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61557-1 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
loading ~~**method**~~
method of ~~loading~~ applying a load to a circuit within a distribution system to cause a voltage drop

[1] A consolidated version of this publication exists, comprising IEC 61010-1:2010 and IEC 61010-1:2010/AMD1:2016.

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3.2
loading equipment
~~equipment causing a voltage drop in a circuit~~
part of the measuring equipment to load the circuit being tested

3.3
test current
~~current that causes a voltage drop in a circuit~~
electric current controlled by the measuring device to cause a voltage drop in a circuit being tested

3.4
system phase angle
angle between loop impedance and loop resistance of the distribution system

3.5
loop impedance
~~Z_s~~ Z_L
sum of the impedances in a current loop comprising the impedance of the source of the current~~,~~ and the impedance of the ~~phase~~ line conductor (e.g. protective conductor, earth electrode and earth) from the point of measurement to the other terminal of the source of the current

4 Requirements

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

4.1 General

~~The maximum percentage operating uncertainty within the measuring range to be marked or stated shall not exceed ±30 % with the measured value as the fiducial value, as determined in accordance with Table 1.~~

~~The operating uncertainty applies to the rated operating conditions in IEC 61557-1 and the following:~~

- ~~circuit to be tested without load;~~
- ~~system voltage between 85 % and 110 % of the nominal voltage of the distribution system for which the equipment has been designed;~~
- ~~system frequency between 99 % and 101 % of the nominal frequency of the distribution system for which the equipment has been designed;~~
- ~~system voltage and frequency kept constant during the measurement;~~
- ~~circuit loaded by loading equipment.~~

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

Equipment intended to be used on the distribution system shall, at the minimum, be rated measurement category III according to IEC 61010-2-030.

Equipment intended to be used on socket outlets only can be rated for measurement category II according to IEC 61010-2-030.

4.2 Measurement of loop impedance

For measurements in close proximity to the transformer of the distribution system, equipment with a specified loop impedance measuring function (influence quantity for system phase angle

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at a minimum of 30°) shall be used or a specified additional operating uncertainty shall be taken into account by the user.

~~NOTE~~ In applications where the measurement of loop resistance is carried out in close proximity to the sourcing transformer (e.g. < 50 m) the system phase angle may be ~~more~~ greater than 18° (e.g. up to 30°) and therefore the inductive part of the internal impedance of the transformer may not be negligible.

When the loading by loading equipment causes transients on the distribution system, the operating uncertainty shall not be exceeded as a result of the transient.

Equipment with specified influence quantity $E_{6.1}$ of system phase angle of approximately 18° shall be marked with the warning symbol according to IEC 61010-1:2010, Table 1, symbol 14, adjacent to the loop function marking or a warning shall be given on the display.

4.3 External resistance

When external resistances are included in the calibration as a zero offset, this shall be indicated on the measuring instrument.

This offset shall remain included in the calibration as long as it is indicated on the measuring instrument regardless of any changes in range or function.

4.4 Fault voltage exceeding U_L

~~Avoidance of the presence of a fault voltage resulting from the measurement exceeding 50 V at the point of measurement on the circuit under test shall be ensured. This can be achieved by an automatic disconnection when fault voltages with a value >50 V in accordance with Figure 1 of IEC 61010-1 occur.~~

Fault voltages as a result of a measurement that exceed U_L at the point of test shall be avoided. This can be achieved by automatic disconnection in accordance with IEC 61010-1:2010/AMD1:2016, Figure 2.

4.5 Overvoltage

The measuring equipment shall not be damaged nor shall the user be exposed to danger when the measuring equipment is connected to 120 % of the nominal voltage of the distribution system for which the measuring equipment has been designed. Protective devices of the test equipment shall not be activated.

The user shall not be exposed to danger and the equipment shall not be damaged when the measuring equipment is accidentally connected to a voltage having a value of 173 % of its rated voltage to earth according to IEC 61010-2-030 for 1 min. Protective devices of the test equipment ~~may~~ can be activated.

If the measuring equipment indicates the value of the voltage at its measuring terminals, it shall also indicate if the system voltage exists and if the live conductor is exchanged with the protective conductor.

5 Marking and operating instructions

5.1 Marking

In addition to ~~the marking in accordance with~~ IEC 61557-1:2019, 5.1 and 5.2, the following information shall be provided on the measuring equipment.

Marking is permitted on the display for any of the following:

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– range of the resistance of the loop impedance or of the calculated short-circuit current respectively within which compliance with the uncertainty limits in accordance with 4.2 is maintained;

– nominal system voltage for which the equipment is rated;

– rated system frequency for which the equipment is rated;

– maximum system phase angle ~~of~~ for which the ~~loading~~ equipment is designed when this angle is ~~>~~ greater than 18°;

– rated voltage to earth and measurement category.

5.2 Operating instructions

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

~~Data relating to the loading equipment if the phase angle is >18°.~~

In addition to IEC 61557-1:2019, 5.3, the following information shall be provided in the operating instructions for the measuring equipment:

– an explanation of the influence of the system phase angle on measurement accuracy;

– ~~Value~~ the amplitude and waveform of test current and duration of loading;

– range of system voltages within which the operating uncertainty stated in ~~4.1~~ 6.2 is not exceeded;

– range of loop impedance (magnitude and angle) within which the operating uncertainty stated in ~~4.1~~ 6.2 is not exceeded;

– ~~Note~~ information on possible measurement uncertainties, for example due to preloading the circuit under test;

– data relating to the effect of system voltage variations and other effects from the system such as measuring in close proximity to the transformer of the distribution system. A specific user correction shall be stated, unless the instrument has a fully specified loop impedance measuring function.

6 Tests

6.1 General

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

6.2 Operating uncertainty

The operating uncertainty shall be determined under the rated operating conditions of IEC 61557-1 and in addition the following shall apply:

– the electrical distribution system on which a loop impedance test is performed shall be under constant load condition, except for load changes provoked by the test instrument;

– measurement shall be carried out without changing existing loads within the electrical distribution system under test;

– system voltage shall be between 85 % and 110 % of the nominal voltage of the distribution system for which the equipment has been designed;

– system frequency shall be between 99 % and 101 % of the nominal frequency of the distribution system for which the equipment has been designed;

– system voltage and frequency shall not change during the measurement by more than 0,5 %;

– measured circuit shall be loaded with loading equipment.

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

– nominal system voltage;
– nominal system frequency;
– reference temperature 23 °C ± 2 °C;
– reference position in accordance with the manufacturer's statement;
– nominal distribution system supply or battery voltage respectively;
– difference between the phase angle of the loading equipment and the loop impedance of the circuit under test ≤ 5°.
– the maximum percentage operating uncertainty within the measuring range to be marked or stated shall not exceed ±30 % with the measured value as the fiducial value, as determined in accordance with Table 1.

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

Table 1 – Calculation of operating uncertainty

Intrinsic uncertainty or influence quantity	Reference conditions or specified operating range	Designation code	Requirements or tests in accordance with relevant parts of IEC 61557	Type of test
Intrinsic uncertainty	Reference conditions	A	~~Part 3, Subclause 6.1~~ IEC 61557-3:2019, 6.2	R
Position (on equipment using mechanical displays)	Reference position ±90° approximately	E_1	~~Part 1, Subclause 4.2~~ IEC 61557-1:2019, 6.2.2	R
Supply voltage	At the limits stated by the manufacturer	E_2	~~Part 1, Subclauses 4.2, 4.3~~ IEC 61557-1:2019, 6.2.4	R
Temperature	0 °C and 35 °C (± 2°)	E_3	~~Part 1, Subclause 4.2~~ IEC 61557-1:2019, 6.2.3	T
Phase angle	At a phase angle 0° to 18° approximately	E_6	~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	T
System phase angle	At a system phase angle 0° to 18° at the bottom of the measurement range	$E_{6.1}$ [a]	~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	T
System phase angle	At a system phase angle 0° to 30° at the bottom of the measurement range	$E_{6.2}$ [a]	~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	T
System frequency	~~99 % to 101 %~~ 95 % to 105 % of the nominal frequency	E_7	~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	T
System voltage	85 % to 110 % of the nominal voltage	E_8	~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	T
Harmonics	5 % of 3rd harmonic at 0° phase angle 6 % of 5th harmonic at 180° phase angle 5 % of 7th harmonic at 0° phase angle (percentage of the fundamental of nominal voltage of distribution system)	E_9	~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	T

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Intrinsic uncertainty or influence quantity	Reference conditions or specified operating range	Designation code	Requirements or tests in accordance with relevant parts of IEC 61557	Type of test
DC quantity	Add additional DC quantities of 0,5 % of the nominal voltage of distribution system in both polarities. It is recommended that manufacturers include E_{10} into the calculation of operating uncertainty according to this table.	E_{10} [b]	~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	T
Operating uncertainty	$B = \pm\sqrt{A^2 + \frac{4}{3}\sum_i E_i^2}$		~~Part 3, Subclause 4.1~~ IEC 61557-3:2019, 6.2	R

Key

A = intrinsic uncertainty

~~E_n~~ E_i = variations

R = routine test

T = type test

F = fiducial value

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

[a] Use $E_{6.1}$ or $E_{6.2}$ as applicable.

[b] Influence quantity E_{10} takes into account possible voltage drops caused by DC leakage currents according to IEC 61800-5-2 on the PE or PEN conductor.

6.3 External resistance

Compliance with the requirements in accordance with 4.3 shall be tested (type test).

6.4 Fault voltage

Compliance with the requirements in accordance with 4.4 shall be tested (routine test).

6.5 Overvoltage

The permissible ~~overload~~ overvoltage in accordance with the requirements of 4.5 ~~and 4.6~~ shall be tested (type test).

~~**6.5** Compliance with the tests in this clause shall be recorded.~~

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