

# INTERNATIONAL STANDARD



**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**

Document Preview

IEC 61557-3:2019

<https://standards.iteh.ai/catalog/standards/iec/5a26c1d8-272e-47d6-a0a8-a188abd73115/iec-61557-3-2019>



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2019 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

**About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

**About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

**IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)**

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

**IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

**IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

**Electropedia - [www.electropedia.org](http://www.electropedia.org)**

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

**IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)**

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

[IEC 61557-3:2019](https://standards.iteh.ai/catalog/standards/iec/5a26c1d8-272e-47d6-a0a8-a188abd73115/iec-61557-3-2019)

<https://standards.iteh.ai/catalog/standards/iec/5a26c1d8-272e-47d6-a0a8-a188abd73115/iec-61557-3-2019>



IEC 61557-3

Edition 3.0 2019-07  
REDLINE VERSION

# INTERNATIONAL STANDARD



**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**

Document Preview

[IEC 61557-3:2019](https://standards.iteh.ai/catalog/standards/iec/5a26c1d8-272e-47d6-a0a8-a188abd73115/iec-61557-3-2019)

<https://standards.iteh.ai/catalog/standards/iec/5a26c1d8-272e-47d6-a0a8-a188abd73115/iec-61557-3-2019>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 17.220.20; 29.080.01; 29.240.01

ISBN 978-2-8322-7233-6

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Normative references.....	5
3 Terms and definitions.....	5
4 Requirements.....	6
4.1 General.....	6
4.2 Measurement of loop impedance.....	6
4.3 External resistance.....	7
4.4 Fault voltage exceeding $U_L$ .....	7
4.5 Overvoltage.....	7
5 Marking and operating instructions.....	7
5.1 Marking.....	7
5.2 Operating instructions.....	8
6 Tests.....	8
6.1 General.....	8
6.2 Operating uncertainty.....	8
6.3 External resistance.....	10
6.4 Fault voltage.....	10
6.5 Overvoltage.....	10
Bibliography.....	11
Table 1 – Calculation of operating uncertainty.....	9

[IEC 61557-3:2019](https://standards.iteh.ai/)

<https://standards.iteh.ai/catalog/standards/iec/5a26c1d8-272e-47d6-a0a8-a188abd73115/iec-61557-3-2019>

## 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**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

**This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**

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 requirements 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
- amended.

**IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

# 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 61010-1:2004:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*  
IEC 61010-1:2010/AMD1:2016<sup>1</sup>

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

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

### 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  $\pm 30\%$  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



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:

- 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  $\rightarrow$  greater than  $18^\circ$ ;
- 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  $>18^\circ$ .~~

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 ~~4.4~~ 6.2 is not exceeded;
- range of loop impedance (magnitude and angle) within which the operating uncertainty stated in ~~4.4~~ 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.

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	$A$	<del>Part 3, Subclause 6.1</del> IEC 61557-3:2019, 6.2	R
Position (on equipment using mechanical displays)	Reference position ±90° approximately	$E_1$	<del>Part 1, Subclause 4.2</del> IEC 61557-1:2019, 6.2.2	R
Supply voltage	At the limits stated by the manufacturer	$E_2$	<del>Part 1, Subclauses 4.2, 4.3</del> IEC 61557-1:2019, 6.2.4	R
Temperature	0 °C and 35 °C (± 2°)	$E_3$	<del>Part 1, Subclause 4.2</del> IEC 61557-1:2019, 6.2.3	T
Phase angle	At a phase angle 0° to 18° approximately	$E_6$	<del>Part 3, Subclause 4.1</del> 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	$E_{6.1}^a$	<del>Part 3, Subclause 4.1</del> 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	$E_{6.2}^a$	<del>Part 3, Subclause 4.1</del> IEC 61557-3:2019, 6.2	T
System frequency	<del>99 % to 101 %</del> 95 % to 105 % of the nominal frequency	$E_7$	<del>Part 3, Subclause 4.1</del> IEC 61557-3:2019, 6.2	T
System voltage	85 % to 110 % of the nominal voltage	$E_8$	<del>Part 3, Subclause 4.1</del> IEC 61557-3:2019, 6.2	T
Harmonics	5 % of 3 <sup>rd</sup> harmonic at 0° phase angle 6 % of 5 <sup>th</sup> harmonic at 180° phase angle 5 % of 7 <sup>th</sup> harmonic at 0° phase angle (percentage of the fundamental of nominal voltage of distribution system)	$E_9$	<del>Part 3, Subclause 4.1</del> IEC 61557-3:2019, 6.2	T