IEC 61557-1

Edition 3.0 2019-07
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 1: General requirements

IEC 61557-1:2019-07 RLV(en)

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

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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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 1: General requirements

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.
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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 61557-1 has been prepared by 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 third edition includes the following significant technical changes with respect to the previous edition:

a) terms aligned with IEC 60050;
b) measurement of uncertainty revised according to the equations in 4.2 of ISO/IEC Guide 98-3:2008 (GUM);
c) updated references for safety and EMC requirements;
d) updated references for marking and operating instructions;
e) updated references for testing safety and EMC;
f) Annex A contains an explanation of GUM;
g) Annex B addresses environmental aspects.

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

FDIS	Report on voting
85/689/FDIS	85/692/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.

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.

INTRODUCTION

IEC 60364-6~~:2006,~~ stipulates standardized conditions for the initial test of power installations in TN, TT or IT ~~(IEC 60364)~~ systems for continuous monitoring and for testing these installations after modifications. In addition to general references for the ~~execution~~ performance of the tests, IEC 60364-6 contains requirements that have to be verified by measurements. Only in a few instances, for example when measuring the insulation resistance, ~~the standard contains~~ does IEC 60364-6 contain details of the characteristics of the measuring device to be used. Circuits which are given as examples in IEC 60364-6, and referred to within the text of that document, are generally not suitable for practical use.

The tests are carried out in installations where hazardous voltages can occur and where careless use or a defect in the equipment can easily cause an accident. Therefore, the technician has to rely on measuring devices which ensure~~, apart from simplification of the measurements,~~ safe test methods, in addition to simplifying the measurements.

The application of the general safety regulations for electrical and electronic measuring devices (IEC 61010-1) for testing the protective measures is not sufficient in itself. The ~~execution~~ performance of measurements in the installation can cause hazards not only to the technician, but also to third persons, depending on the measuring method~~, also to third persons~~ used.

Likewise, reliable and comparable results of measurement with measuring devices from different manufacturers are an important precondition in order to obtain an objective ~~judgement~~ assessment about the installation, for example when the installation is handed over for periodic tests, for continuous insulation monitoring or in the case of performance warranty.

The IEC 61557 series has been established with the aim of stipulating common principles for measuring and monitoring equipment for testing electrical safety and measuring performances in systems with nominal voltages up to 1 000 V AC and 1 500 V DC which correspond to the above-mentioned characteristics.

For that reason, the following common ~~specifications~~ requirements have been stipulated in ~~Part 1 and other individual parts of the series of standards~~ IEC 61557-1 (other parts of IEC 61557 can specify additional requirements or deviations):

– protection against extraneous voltages;
– class II protection (except insulation monitoring devices and insulation fault location systems);
– ~~specifications~~ requirements and safety precautions against hazardous touch voltages at the measuring device;
– ~~specifications~~ requirements for the ~~judgement~~ assessment of connection configurations with respect to wiring errors in the tested equipment;
– special mechanical requirements;
– measuring methods;
– measured quantity;
– specification of the maximum operating uncertainty;
– ~~specifications~~ requirements for testing the influencing quantity and the calculation of the ~~operational~~ operating uncertainty;
– uncertainties of the measuring device at the thresholds specified in the respective standards;
– specification of the nature of type and routine tests and the required conditions for testing.

Contrary to the usual convention, terms and definitions that occur more than once in another part of the series are listed in IEC 61557-1:2019, Clause 3. Only terms and definitions specific to the respective part of IEC 61557 are listed in Clause 3 of that part.

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

1 Scope

This part of IEC 61557 specifies the general requirements ~~for~~ applicable to measuring and monitoring equipment for testing the electrical safety in low-voltage distribution systems with nominal voltages up to 1 000 V AC and 1 500 V DC.

When measuring equipment or measuring installations involve measurement tasks of various measuring equipment covered by this series of standards, then the part of this series relevant to each of the measurement tasks is applicable.

NOTE The term "measuring equipment" will hereafter be used to designate "testing, measuring and monitoring equipment".

Other parts of IEC 61557 can specify additional requirements or deviations.

This document does not cover functional safety or cybersecurity.

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 60038:~~1983~~ [1)] 2009, *IEC standard voltages*
~~Amendment 1: 1994~~
~~Amendment 2: 1997~~

~~IEC 60364-6:2006, *Electrical installations of buildings – Part 6: Verification*~~

~~IEC 60664-1, *Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests*~~

IEC 60529: ~~2001~~1989, *Degrees of protection provided by enclosures (IP code)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013[2]

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[3]

~~1) There exists a consolidated edition (6.2), which includes IEC 60038:1983 and its Amendments 1 (1994) and 2 (1997).~~

2 A consolidated version of this publication exists, comprising IEC 60529:1989, IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013.

IEC 61010-031, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held and hand-manipulated assemblies for electrical test and measurement*

IEC 61010-2-030:2017, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: ~~Special~~ Particular requirements for equipment having testing ~~and~~ or measuring circuits*~~4)~~

IEC 61010-2-032, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement*

IEC 61010-2-034:2017, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-034: Particular requirements for measurement equipment for insulation resistance and test equipment for electric strength*

IEC 61326-1:2012, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

~~IEC 61326-2-2:2005, *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 61326-2-4:2006, *Electrical equipment for measurement, control and laboratory use, - EMC requirements - Part 2: Particular requirements – Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9*~~

~~IEC 61557-2, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 2: Insulation resistance*~~

~~IEC 61557-3, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 3: Loop impedance*~~

~~IEC 61557-4, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 4: Resistance of earth connection and equipotential bonding*~~

~~IEC 61557-5, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 5: Resistance to earth*~~

~~IEC 61557-6, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 6: Residual current devices (RCD) in TT and TN systems*~~

~~IEC 61557-7, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 7: Phase sequence*~~

3 A consolidated version of this publication exists, comprising IEC 61010-1:2010 and IEC 61010-1:2010/AMD 1:2016.

~~4) To be published.~~

IEC 61557-8:2014, *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 8: Insulation monitoring devices for IT systems*

IEC 61557-9:2014, *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 9: Equipment for insulation fault location in IT systems*

~~IEC 61557-10, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 10: Combined measuring equipment for testing, measuring or monitoring of protective measures*~~

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
nominal system voltage ~~of the distribution system~~
U_n
value of the voltage by which the distribution system ~~or equipment~~ is designated and to which certain ~~operating~~ characteristics are ~~referred~~ assigned

~~[IEC 60038, Clause 1, modified]~~

~~**3.2**~~
~~**operating voltage in a system**~~
~~the value of the voltage under normal conditions, at a given instant and a given point of the system~~

~~[IEV 601-01-22, modified]~~

3.2
voltage against earth
U_o
<in distribution systems with an earthed neutral point> voltage between a phase conductor and the earthed neutral point

3.3
voltage against earth
U_o
<in all other distribution systems> voltage present between the remaining phase conductors and earth when one of the phase conductors is ~~shorted~~ short-circuited to earth

3.4
fault voltage
U_f
~~voltage appearing under fault conditions between exposed conductive parts (and/or extraneous conductive parts) and earth~~
voltage between a given point of fault and reference earth resulting from an insulation fault

[SOURCE: IEC 60050-826:2004, 826-11-02, modified – The symbol has been added.]

3.5
~~(~~effective~~)~~ touch voltage
U_t
voltage between conductive parts when touched simultaneously by a person or an animal

Note 1 to entry: The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the animal in electric contact with these conductive parts.

~~[IEV 826-11-05]~~

[SOURCE: IEC 60050-195:1998, 195-05-11, modified – The symbol has been added.]

3.6
conventional touch voltage limit
U_L
maximum value of the touch voltage which is permitted to be maintained indefinitely in specified conditions of external influences and is usually equal to 50 V AC, RMS or 120 V ripple free DC

~~[IEV 826-02-04, modified]~~

[SOURCE: IEC 60050-826:2004, 826-11-04, modified – "prospective" has been omitted from the term and from the definition and values for the limit have been added to the definition; the symbol has been added.]

~~**3.7**~~
~~**rated range of voltages**~~
~~voltage range for which the measuring and monitoring equipment is intended to be used and for which it has been designed~~

3.7
supply voltage
voltage that is used to power the measurement equipment

Note 1 to entry: If a supply voltage is specified, for instance in the supply contract, then it is called "declared supply voltage".

3.8
rated supply voltage
U_S
value of the supply voltage at a point where the measuring equipment does or can accept electric energy as a supply

3.9
output voltage
U_a
voltage across the measuring equipment terminals where this equipment does or can output electric energy

3.10
open-circuit voltage
U_q
voltage present across unloaded terminals on the measuring equipment

~~**3.11**~~
~~**rated voltage of measuring equipment**~~
~~U_{ME}~~
~~voltage for which the measuring equipment is intended to be used and the value of which is marked on the equipment~~

3.11
rated voltage
U_N
voltage value assigned by a manufacturer or other entity for a specified operating condition of the measuring equipment

Note 1 to entry: The value for the rated voltage of low-voltage equipment is generally assigned from the list of nominal voltages in IEC 60038:2009, Tables 1 and 6.

Note 2 to entry: Equipment may have more than one rated voltage value or may have a rated voltage range.

[SOURCE: IEC 60050-614:2016, 614-03-09, modified – The domain <of equipment> and Note 1 have been omitted; the symbol has been added; the term specifically adapted for measuring equipment.]

3.12
extraneous voltage
external voltage to which the measuring equipment can be subjected ~~by external influences~~ during measurement. ~~This is not required for the operation of the measuring equipment, but can interfere with its operation~~

3.13
rated current
I_N
~~current of the measuring equipment under rated conditions~~
current assigned by the manufacturer for the specified operating condition of the measuring equipment

Note 1 to entry: The specified operating condition is a value (or values) within the rated operating conditions that are designated by the manufacturer.

[SOURCE: IEC 60050-442:1998, 442-01-02, modified – "for accessories" has been deleted from the term and Note 1 has been added; the definition has been adapted for application to measuring equipment.]

3.14
short-circuit current
~~I_k~~
~~current flowing across the short-circuited terminals of the measuring equipment~~
over-current resulting from a short circuit due to a fault on the terminals or within the measuring equipment

~~3.16~~
~~earth~~
~~the conductive mass of the earth whose electric potential at any point is conventionally taken as equal to zero~~

~~[IEV 826-04-01]~~

~~3.17~~
~~earth electrode~~
~~a conductive part or group of conductive parts in intimate contact with and providing an electrical connection with earth~~

~~[IEV 826-04-02]~~

~~**3.18**~~
~~**total earthing resistance**~~
~~R_A~~
~~the resistance between the main earthing terminal and the earth~~

~~[IEV 826-04-03]~~

~~**3.19**~~
~~**percentage fiducial uncertainty**~~
~~(absolute) uncertainty of measuring equipment expressed as a percentage of the fiducial value (see 3.26)~~

3.16
uncertainty of measurement
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

Note 1 to entry: This term is used in the "uncertainty" approach.

Note 2 to entry: The parameter can be, for example, a standard deviation (or a given multiple of it), or a half-width of an interval having a stated level of confidence. Various ways of obtaining uncertainty are defined in the GUM.

Note 3 to entry: Uncertainty of measurement comprises, in general, many components. Some of these components can be evaluated from the statistical distribution of the results of a series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from the assumed probability distributions based on experience or other information.

[SOURCE: IEC 60050-311:2001, 311-01-02]

3.17
operating uncertainty
calculated uncertainty taking into account the intrinsic uncertainty and defined influence quantities to mirror the worst case situation

3.18
fiducial uncertainty
uncertainty of measuring equipment expressed as a percentage of the fiducial value

3.19
fiducial value
clearly specified value to which reference is made in order to define the fiducial uncertainty

~~[IEV 311-01-16, modified]~~

Note 1 to entry: This value can be, for example, the upper limit of the measuring range, the scale length or any other value which is clearly stated.

[SOURCE: IEC 60050-311:2001, 311-01-16, modified – "error" has been replaced by "uncertainty"; Note 1 has been omitted.]

~~**3.21**~~
~~**operating instrumental uncertainty**~~
~~instrumental uncertainty under the rated operating conditions~~

~~[IEC 60359, definition 3.2.11]~~

~~NOTE The operating uncertainty will have an extreme value (without regard to sign) at some combination of values of influence quantities within their operating ranges.~~

3.20
percentage operating uncertainty
operating uncertainty of measuring equipment expressed as a percentage of the fiducial value

3.21
intrinsic uncertainty
uncertainty of a measuring instrument or supply instrument when used under reference conditions

Note 1 to entry: The uncertainty caused by friction is part of the intrinsic uncertainty.

~~[IEC 60359, definition 3.2.10]~~

[SOURCE: IEC 60050-311:2001, 311-03-09, modified – "or supply instrument" has been added to the definition; the Note has been deleted and Note 1 has been added.]

3.22
performance
characteristics defining the ability of a measuring instrument to achieve the intended functions

[SOURCE: IEC 60050-311:2001, 311-06-11]

~~**3.23**~~
~~**performance characteristic**~~
~~one of the quantities (described by values, tolerances, ranges) assigned to an equipment in order to define its performance~~

~~NOTE Depending on its application, one and the same quantity may be referred to in this standard as a "performance characteristic" and as a "measured or supplied quantity" and also may act as an "influence quantity".~~

~~In addition, the term "performance characteristic" includes quotients of quantities, such as voltage per unit of length.~~

3.23
influence quantity
~~quantity which is not the subject of the measurement and whose change affects the realationship between the indication and the result of the measurement~~

~~[IEC 60359, definition 3.1.14]~~

~~NOTE An influence quantity may be external or internal with reference to the equipment. When the value of one of the influence quantities changes within its measuring range, it may affect the uncertainty due to another. The measured quantity or a parameter of it may itself act as an influence quantity. For example, for a voltmeter the value of the measured voltage may produce an additional uncertainty due to non-linearity or its frequency may also cause an additional uncertainty.~~

quantity which is not the subject of the measurement and whose change affects the result of the measurement

Note 1 to entry: This term is used in the "uncertainty" approach.

Note 2 to entry: Influence quantities can originate from the measured system, the measuring equipment or the environment.

Note 3 to entry: As the calibration diagram depends on the influence quantities, in order to assign the result of a measurement it is necessary to know whether the relevant influence quantities lie within the specified range.

Note 4 to entry: An influence quantity may be external or internal with reference to the equipment. When the value of one of the influence quantities changes within its measuring range, it may affect the uncertainty due to another quantity. The measured quantity, or a parameter of it, may itself act as an influence quantity. For example, for a voltmeter, the value of the measured voltage may produce an additional uncertainty due to non-linearity or its frequency may also cause an additional uncertainty.

[SOURCE: IEC 60050-311:2001, 311-06-01, modified – "the relationship between the indication and" has been deleted from the definition; Note 4 has been added.]

3.24
variation
<due to an influence quantity> difference between the indicated values for the same value of the measurand of an indicating measuring instrument, or the values of a material measure, when an influence quantity assumes, successively, two different values

~~[IEC 60359, definition 3.3.5]~~

[SOURCE: IEC 60050-311:2001, 311-07-03]

3.25
reference conditions
~~appropriate~~ set of specified values and/or ranges of values of influence quantities under which the ~~smallest permissible~~ uncertainties ~~of~~, or limits of error, admissible for a measuring instrument are specified

~~[IEC 60359, definition 3.3.10]~~

[SOURCE: IEC 60050-311:2001, 311-06-02, modified – "are the smallest" has been replaced with "are specified".]

3.26
operating condition
characteristic which may affect performance of a component, device or equipment

Note 1 to entry: Examples of operating conditions are ambient conditions, characteristics of the power supply, duty cycle or duty type.

[SOURCE: IEC 60050-151:2001, 151-16-01]

3.27
rated operating conditions
~~set of conditions that must be fulfilled during the measurement in order that a calibration diagram may be valid~~
specified set of conditions which may affect the performance of a measuring device and under which the operating uncertainty is maintained

~~[IEC 60359, definition 3.3.13]~~

3.28
~~rated~~ **measuring voltage**
U_m
voltage present at the measuring terminals during the measurement

3.29
uncertainty of measuring equipment
uncertainty of the result of a direct measurement of a measurand having negligible intrinsic uncertainty

Note 1 to entry: Unless explicitly stated otherwise, the measuring equipment uncertainty is expressed as an interval with coverage factor 2.

Note 2 to entry: In single-reading direct measurements of measurands having low intrinsic uncertainty with respect to the measuring equipment uncertainty, the uncertainty of the measurement coincides, by definition, with the measuring equipment uncertainty. Otherwise the measuring equipment uncertainty is to be treated as a component of category B in evaluating the uncertainty of the measurement on the basis of the model connecting the several direct measurements involved.

Note 3 to entry: The measuring equipment uncertainty automatically includes, by definition, the effects due to the quantization of the reading values (minimum evaluable fraction of the scale interval in analogic outputs, unit of the last stable digit in digital outputs).

Note 4 to entry: For material measures, the measuring equipment uncertainty is the uncertainty that should be associated to the value of the quantity reproduced by the material measure in order to ensure the compatibility of the results of its measurements.

~~**3.28**~~
~~**specified operating range**~~
~~range of values of a single influence quantity which forms a part of the rated operating conditions (see 3.31)~~

~~**3.29**~~
~~**effect of the supply voltage**~~
~~effect influencing the functioning of measuring equipment, and consequently the measured value produced by it~~

~~**3.30**~~
~~**effects of the distribution system voltage**~~
~~effect influencing the operation and, consequently, the measured value produced by it~~

4 Requirements

4.1 General requirements

Measuring equipment, when used for a designated purpose, shall not endanger persons, livestock or property. Furthermore, measuring equipment with additional functions not forming part of the application of the IEC 61557 series shall also not endanger persons, livestock or property.

~~Measuring equipment shall comply with IEC 61010-1 provided nothing to the contrary is specified hereafter.~~

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

4.2 Influence quantities – Operating uncertainty (B), percentage operating uncertainty (B [%])

The operating uncertainty shall be calculated by means of Equation 1:

$$B = \pm\left(|A| + 1{,}15 \times \sqrt{\sum_{i=1}^{N} E_i^2}\right)$$

$$B = \pm\sqrt{A^2 + \frac{4}{3}\sum\nolimits_i E_i^{\,2}} \qquad (1)$$

where

A is the intrinsic uncertainty;

E_i is the variation;

i is the consecutive number of the variations.

~~N is the number of influencing factors.~~

The percentage operating uncertainty shall be calculated by means of Equation 2:

$$B[\%] = \pm\frac{B}{F} \times 100\,\% \qquad (2)$$

where

F is the fiducial value.

The influencing variations used for calculating the operating uncertainty are denoted as follows:

- variation due to changing the position E_1
- variation due to changing the supply voltage E_2
- variation due to changing the temperature E_3
- variation due to interference voltages E_4
- variation due to earth electrode resistance E_5
- variation due to changing the phase angle of impedance of circuit under test E_6
  - variation due to system phase angle 0° to 18° (use as applicable) $E_{6.1}$
  - variation due to system phase angle 0° to 30° (use as applicable) $E_{6.2}$
- variation due to changing the system frequency E_7
- variation due to changing the system voltage E_8
- variation due to system harmonics E_9
- variation due to system DC quantities E_{10}
- variation due to external low-frequency magnetic fields E_{11}
- variation due to load current E_{12}
- variation due to touch current caused by common mode voltage E_{13}
- variation due to frequency E_{14}
- variation due to repeatability E_{15}

The permissible percentage operating uncertainties are stated in other parts of IEC 61557.

~~NOTE~~ Only one of the influence quantities is varied when calculating the operating uncertainty, whilst the remaining influence quantities are kept under reference conditions. The larger of the respective values of the variation (positive and negative variation) is inserted into the equation for the calculation of the operating uncertainty.

~~Not all influence quantities are relevant to measuring equipment covered by Parts 2 to 8 of IEC 61557.~~

~~Variations measured during type tests can be used in certain cases for calculating the operating uncertainty in routine tests. Details for this are specified in the relevant parts of the IEC 61557 series.~~

4.3 Rated operating conditions

~~The stated operating uncertainties shall apply under the following rated operating conditions:~~

The following rated operating conditions shall apply, except for insulation monitoring devices (IMD) in accordance with IEC 61557-8 and for insulation fault location systems (IFLS) in accordance with IEC 61557-9:

- temperature range from 0 °C to 35 °C;
- a position of ±90° from the reference position for portable measuring equipment;
- 85 % to 110 % of the nominal supply voltage for supply from the distribution systems (if applicable). The values in IEC 60038 shall be ~~used~~ applied for a supply from the distribution system;
- the charge condition in accordance with 4.4 shall apply to the battery or batteries/ accumulators for measuring equipment with a supply from batteries/accumulators;

– the range of revolutions per minute stated by the manufacturer for measuring equipment with a supply from a hand-driven generator;

– frequency of the supply voltage ± ~~1~~ 5 % (if applicable).

NOTE Additional rated operating conditions are stated in other parts of the IEC 61557 series.

4.4 Battery ~~check~~ test facility

Measuring equipment with power supplied from dry or rechargeable battery cells shall ~~check~~ test and indicate that the state of charge of these batteries will permit measurement within the specification. This may be done automatically as part of the measurement cycle or as a separate function. ~~The battery should be loaded at least as heavily as during a measurement.~~ Where the battery test is a separate function, the test load shall be of the same level as the one appearing during a measurement.

~~**4.4 Terminals**~~

~~The terminals shall be designed so that the probe assembly can be connected to the measuring equipment reliably and accidental touching of any live parts is impossible.~~

~~In this instance, the protective conductor shall be treated as a live part, with the exception of measuring devices covered in IEC 61557-8.~~

~~**4.5 Class of protection**~~

~~Measuring equipment shall be designed with double or reinforced insulation (protection class II), with the exception of measuring devices covered in IEC 61557-8 and IEC 61557-9.~~

~~**4.6 Class of pollution**~~

~~Measuring equipment shall be designed for at least pollution class 2 in accordance with IEC 61010-1.~~

~~**4.7 Overvoltage category**~~

~~Measuring equipment covered by IEC 61557-8 and IEC 61557-9 shall be designed for at least overvoltage category III according to IEC 60664-1.~~

~~**4.8 Measuring category**~~

~~Measuring equipment covered by IEC 61557-3, IEC 61557-5, IEC 61557-6, IEC 61557-7 and IEC 61557-10 shall be designed for at least measuring category III according IEC 61010-2-030. Measuring equipment covered by IEC 61557-2, IEC 61557-4, IEC 61557-5 (battery powered) and IEC 61557-4 shall be designed for at least measuring category II.~~

4.5 Safety

Measuring and monitoring equipment shall be in accordance with IEC 61010-1, IEC 61010-2-030, IEC 61010-031, IEC 61010-2-034 and, if applicable, IEC 61010-2-032, and with the following additional requirements.

Overvoltage categories and/or measurement categories are specified in the relevant parts of IEC 61557.

Handheld measuring equipment shall fulfil the requirements for double or reinforced insulation.

The conductive parts of the terminals shall not be accessible and hazardous in connected, partially connected or unconnected conditions.

The protective conductor if used for measuring purposes shall be treated as a live part, except where a different requirement is specified in other parts of IEC 61557.

The terminals shall be designed so that the probe assembly can be connected to the measuring equipment reliably.

4.6 Electromagnetic compatibility

~~Measuring equipment covered by IEC 61557-2, IEC 61557-3, IEC 61557-4, IEC 61557-5, IEC 61557-6, IEC 61557-7 and IEC 61557-10 shall be designed according to IEC 61326-2-2.~~

~~Measuring equipment covered by IEC 61557-8 and IEC 61557-9 shall be designed according to IEC 61326-2-4.~~

4.6.1 Immunity

For immunity requirements, IEC 61326-1:2012, Table 2 shall apply. For testing, see 6.5.

4.6.2 Emission

For emissions, either class A or class B limits in accordance with IEC 61326-1:2012, 7.2 shall apply.

4.7 ~~Vibration test~~ Mechanical strength against vibration

In addition to the mechanical resistance tests in accordance with IEC 61010-1, measuring equipment shall successfully pass the following vibration conditions (type test):

– direction: three mutually perpendicular axes;
– amplitude: 1 mm;
– frequency: 25 Hz;
– duration: 20 min.

5 Marking and operating instructions

5.1 General

Marking and operating instructions shall comply with IEC 61010-1, IEC 61010-2-032, IEC 61010-2-030 and, in addition, these instructions shall comply with the requirements ~~unless otherwise~~ specified in ~~other~~ the relevant parts of IEC 61557.

5.2 Marking

The measuring equipment shall carry the following marking ~~which shall be clearly readable and indelible~~:

– type of equipment;

~~– Units of the measured quantity.~~

~~– Ranges of measurement.~~

– type and current rating of the fuse in the case of exchangeable fuses;
– type of battery/accumulator and polarity of connection in the battery compartment;
– nominal system voltage ~~of the distribution system~~ and, if applicable, the symbol for double insulation in accordance with IEC 61010-1:2010, Table 1, symbol 11 ~~for measuring equipment with distribution system power supply~~;
– manufacturer's name or registered trade mark;

– model number, name or other means to identify the equipment (inside or outside);

– reference to the operating instructions ~~with the symbol~~  in accordance with IEC 61010-1:2010, Table 1, symbol 14.

Units of the measured quantities and ranges of measurement shall be stated on the enclosure or on the display.

5.3 Operating instructions

5.3.1 Performance requirements

The operating uncertainty, the intrinsic uncertainty and the variations E_1 to ~~E_{10}~~ E_{15} shall be provided in the operating instructions (with the exception of measuring devices covered by IEC 61557-8 and IEC 61557-9).

5.3.2 Other information

The operating instructions shall ~~comprise~~ contain the following details:

– connection diagrams;

– instructions for measurements;

– brief description of the principle of measurement;

– diagrams or tables showing the maximum permissible indicated values taking into consideration the tolerances stated by the manufacturer (if necessary);

– type of battery/rechargeable cells;

– information on the charging current, charging voltage and duration of charging for rechargeable cells;

– operational lifetime/runtime of the battery/rechargeable cells or the possible number of measurements;

– type of IP protection according to IEC 60529;

– any necessary special guidance notes.

6 Tests

6.1 General

Measuring equipment shall be tested in accordance with ~~IEC 61010-2-030 and IEC 61326-2-2 unless otherwise specified in the following subclauses or in other parts of IEC 61557 series~~ the safety standards IEC 61010-1, IEC 61010-2-030, IEC 61010-031, IEC 61010-2-034 and, if applicable, IEC 61010-2-032, and the EMC standards of IEC 61326 (all relevant parts).

All tests shall be carried out under reference conditions unless otherwise specified. The reference conditions are stated in the ~~various~~ relevant parts of IEC 61557 ~~series~~.

Tolerances are added in the relevant parts of IEC 61557.

6.2 Operating uncertainty

6.2.1 General

The operating uncertainty shall be determined according to 6.2.2 to 6.2.4.

6.2.2 Influence of changing position

The variation E_1 due to changing the position in accordance with 4.2 and 4.3, if applicable, shall be determined for positions +90° or −90° from the reference position stated by the manufacturer (routine test).

6.2.3 Influence of temperature

~~The variation E_3 due to changing the temperature in accordance with 4.2 shall be determined under the following rated operating conditions:~~

~~– at 0 °C and 35 °C after reaching a state of equilibrium (type test).~~

The variation E_3 shall be determined from the reference temperature at 0 °C and 35 °C after the device has reached a state of equilibrium (type test).

6.2.4 Influence of the supply voltage

The variation E_2 due to changing the supply voltage shall be determined under the following rated operating conditions (routine test):

– limits in accordance with 4.3 for measuring equipment supplied from distribution systems;
– limits in accordance with 4.4 and 6.3 for measuring equipment supplied from a battery/accumulator;
– limits in accordance with 4.3 for measuring equipment supplied by a hand-driven generator.

6.3 Battery ~~check~~ test facility

The lower and upper limits for the battery voltage to which the battery ~~check~~ test facility in accordance with 4.4 is set, shall be determined by means of an external voltage source. These values shall be used during the test in accordance with 6.2.4 as limits for variation E_2 by changing the supply voltage (routine test).

6.4 Safety tests

Compliance with 4.5 shall be tested (type test).

6.5 EMC tests

For the electromagnetic radio frequency field (RF) and conducted RF the following requirements apply:

– the auxiliary circuits of the measuring equipment shall be energised with the rated voltage;
– the measuring equipment shall be tested in its operating conditions.

~~**6.5 Protection class**~~

~~Compliance with double or reinforced insulation (protection class II) in accordance with 4.5 shall be checked, with the exception of measuring devices covered by IEC 61557-8 and IEC 61557-9 *(type test)*.~~

~~**6.6 Terminals**~~

~~Terminals in accordance with 4.4 shall be checked for protection against accidental contact with live parts *(type test)*.~~

6.6 Mechanical requirements

The test shall be ~~executed~~ performed in accordance with 4.7 (type test).

The tests are deemed to have been passed successfully when no parts have become loose or bent and the connecting leads are not damaged. After the process, the measuring equipment shall comply with the requirements ~~with respect to operating uncertainty in accordance with 4.1 *(type test)*~~ for intrinsic uncertainty of the equipment (type test), if applicable.

6.7 Marking and operating instructions

~~The marking and the operating instructions in accordance with Clause 5 of Parts 1 to 10 of the IEC 61557 series shall be checked by visual inspection *(type test, except correct marking as routine test).*~~

The marking and the operating instructions shall be confirmed by visual inspection (type test).

The marking shall be inspected during type test and routine test.

6.8 Records

Compliance with the tests in Clause 6 shall be recorded.

Annex A
(informative)

Explanation of the application of GUM in series IEC 61557

A.1 Overview

The operating uncertainty is a predictive parameter characterizing the expanded uncertainty of the results generated by the measuring device under defined operational conditions.

The operating uncertainty forms an upper limit of the expanded uncertainty which can be expected if the device is operated within the defined operational conditions.

The operating uncertainty might be used to characterize results generated by the device if the device is used within defined operational conditions.

When possible and convenient, the uncertainty may be expressed in the relative form or in the fiducial form. The relative uncertainty is the ratio U/V of the absolute uncertainty U to the measure value V, and the fiducial uncertainty is the ratio U/V_{f} of the absolute uncertainty U to a conventionally chosen value V_{f}.

The principles of the GUM (ISO/IEC Guide 98-3:2008) are used to calculate the operating uncertainty.

A.2 Basic model of evaluation of results under operational conditions

A.2.1 General

The basic model for the evaluation of the results under operational conditions is:

$$Y_{\mathrm{oper}} = Y_{\mathrm{ref}} + \sum_i \delta E_i$$

The result under reference conditions Y_{ref} is the result which could be generated under reference (calibration) conditions. The uncertainty $u(Y_{\mathrm{ref}})$ is evaluated during calibration.

The deviations δE_i are derived from the operational conditions. Usually the expectation value of the δE_i is zero and some limits are known.

A.2.2 Standard uncertainty of a result

The standard uncertainty of a result under operational conditions $u(Y_{\mathrm{oper}})$ can be calculated using uncertainty propagation. The sensitivity of all input quantities is equal to 1.

$$u\left(Y_{\mathrm{oper}}\right) = \sqrt{u\left(Y_{\mathrm{ref}}\right)^2 + \sum_i u\left(\delta E_i\right)^2}$$

The standard uncertainty under reference conditions is equal to the expanded uncertainty evaluated during calibration divided by the coverage factor:

$$u\left(Y_{\mathrm{ref}}\right) = \frac{U_{\mathrm{cal}}\left(Y\right)}{k_{\mathrm{cal}}}$$

A.2.3 Expanded uncertainty

The expanded uncertainty of the calibration $U_{cal}(Y)$ and the coverage factor k_{cal} (usually equal to 2) are stated in the calibration certificate.

For the deviations δE_i, usually only some limits symmetric to zero are known. According to GUM, limits can be converted to a standard uncertainty with the use of a rectangular distribution:

$$u(\delta E_i) = \frac{e_i}{\sqrt{3}}$$

The e_i is the half width of the limits characterizing the deviation δE_i.

The operating uncertainty is equal to the standard uncertainty under operational conditions multiplied by the operating coverage factor:

$$U(Y_{oper}) = k_{oper} \times u(Y_{oper})$$

The operating coverage factor k_{oper} is fixed to 2,0.

This is equivalent to the half width of coverage interval with a coverage probability of 95,45 % under the assumption that the results are distributed normally.

A.2.4 Relative operating uncertainty

The relative operating uncertainty as a percentage can be calculated using a fiducial value Y_f.

$$W(Y_{oper}) = \frac{U(Y_{oper})}{Y_f} \times 100\,\%$$

The operating uncertainty and the relative operating uncertainty as a percentage can be written as symmetric interval limits using plus and minus signs.

A.2.5 Calibration uncertainty

For practical calculations, the calibration uncertainty $U_{cal}(Y)$ may be replaced by A, and e_i, by E_i. The resulting equation is:

$$U(Y_{oper}) = \sqrt{A^2 + \frac{4}{3}\sum_i E_i^2} \le |A| + 1{,}5 \times \sqrt{\sum_i E_i^2}$$

under the assumption that the coverage factor k_{cal} stated in the calibration certificate is equal to the operating coverage factor k_{oper} = 2,0.

Therefore the following equation may be used as an upper bound for the operating coverage interval:

$$B = \pm\left[\left|A\right| + 1{,}15 \times \sqrt{\sum_i E_i^{\,2}}\right]$$

A.3 Operating uncertainty calculations as basis for 4.1

A.3.1 Standard uncertainty

The basis for this model is the addition of faults.

Uncertainty in respect to GUM (ISO/IEC Guide 98-1:2009, measuring method B) for any statistical distribution:

$$u = \sqrt{a^2 + \sum_i e_i^{\,2}}$$

where

a is the expected intrinsic operating uncertainty for example by calibration certificates;

e_i e_i = is the expected operating uncertainty by influencing factors for example through temperature;

u is the standard uncertainty of the result of a measurement expressed as a standard deviation.

A.3.2 Operating uncertainty in accordance with 4.1

The basis for this model of calculation is the expanded uncertainty according to GUM (ISO/IEC Guide 98-3:2008, 6.2).

Determination of the operating uncertainty for the IEC 61557 series with stipulation of the defined statistical distributions based on empirical values:

– $B = \pm\, k \times u$ with $k = 2$ for coverage probability of 95,45 %;

– $a = \dfrac{A}{2}$ standard distribution for the intrinsic uncertainty;

– $e_i = \dfrac{E_i}{\sqrt{3}}$ rectangular distribution for the operating uncertainty through influence factors in the operation;

– $B = \pm\sqrt{A^2 + \frac{4}{3}\sum_i E_i^2}$ uncertainty for coverage probability of 95,45 % according to GUM, (ISO/IEC Guide 98-3:2008, 7.22).

Annex B
(informative)

Environmental aspects

B.1 Overview

Every product has an effect on the environment, which may occur at any or all stages of its life cycle – raw-material acquisition, manufacture, distribution, use, maintenance, re-use and end-of-life. These effects may range from slight to significant; they may be short term or long term, and they may occur at the local, national, regional or global level (or a combination thereof).

The widespread use of electrical and electronic products has drawn increased awareness to their environmental impacts. As a result, legislation, as well as market-driven requirements for environmentally conscious design, is emerging.

The continuous introduction of new products and materials can make evaluation increasingly complex, since additional data will need to be gathered to assess the life-cycle impacts of such new products and materials. The gathered data is used as a basis for improvement of the products with respect to environmental impacts. Life-cycle assessment (LCA) and environmentally conscious design (ECD) principles provide instruments that may be useful in this respect.

The application of LCA to an ECD process allows the reduction of adverse environmental impacts of a product throughout its entire life cycle. This can involve balancing the environmental aspects of the product with other factors, such as its intended use, performance, cost, safety, marketability, and quality and choosing methods to meet legal and regulatory requirements in an environmentally conscious way. In striving for this goal, multiple benefits can be achieved for the organization, its customers and other stakeholders. The consideration of environmental aspects particularly in the very early stage of the product design process can contribute to cost reduction and to better marketability. Environmentally conscious design is not a separate design activity; rather it is an integral part of the existing design process. The design in this context includes the activities associated with the processes of product planning, development and decision making as well as the creation of policies within the organization.

ECD is intended to be used by all those involved in the design and development of electrical and electronic products. This includes all parties in the supply chain regardless of organization type, size, location and complexity. It is applicable for all types of products, new as well as modified. Sector-specific documents may be developed to address needs not covered in this document. The use of this annex as a base reference is encouraged so as to ensure consistency throughout the electrotechnical sector.

This annex provides a set of guidelines to establish the material declaration and the end-of-life information in the general framework of the information that shall be shared according to IEC 62430.

B.2 Guidelines to establish a material declaration and end-of-life information

B.2.1 General

Manufacturers are increasingly requested to provide a material declaration and end-of-life information in accordance with regulations or in the form of labels, or they are asked directly by their customers to communicate and declare information about the material composition of their products. The main intended uses of this information are to:

– enable assessment of product compliance with substance-restriction requirements;
– improve product end-of-life by facilitating integration in the appropriate recycling processes.

Providing the material declaration is at the discretion of the manufacturer.

NOTE Since IEC 62474 is intended to establish requirements for material declarations, standardize protocols, and facilitate transfer and processing of data, it is possible that its application throughout the supply chain will make the compilation of material declarations of products easier.

B.2.2 Guidelines for material declaration

The material declaration should be made in accordance with IEC 62474 and contain the two following sections as a minimum.

– Base data requirements:
  • product family name;
  • product identification: commercial references covered by the declaration;
  • total product mass;
  • mass and type of batteries, if integrated;
  • mass of packaging.
– Material class information:
  • distribution of the product mass according to the 15 generic material classes as defined in the IEC 62474 database.

NOTE Examples of material declarations are given in IEC 62474.

Single-material declarations can be made for a family of products only when the composition is the same for all the products thereof.

B.2.3 Guidelines for end-of-life (EoL)

Different regulations (for waste electrical and electronic equipment, batteries, packaging), incentives on circular economy or customers require or push the design of products that are easily recyclable.

If required, the end-of-life information (EoLI) should be prepared in accordance with IEC TR 62635 and should contain the following as a minimum:

– manufacturer identification;
– product identification;
– potential hazard identification;
– selective treatment;
– sketches, drawings or pictures to identify and locate parts and materials listed.

B.2.4 Example of a material declaration and end-of-life information

B.2.4.1 Manufacturer identification

Address: xxxxxxxxxxxxxxxxxx

Website: xxxxxxxxxxxxxxxxxx

B.2.4.2 Product identification

Range: multifunction meter xxxxxx

Commercial references: xxxxxx, xxxxx, xxxxxx, etc.

B.2.4.3 Purpose of the document

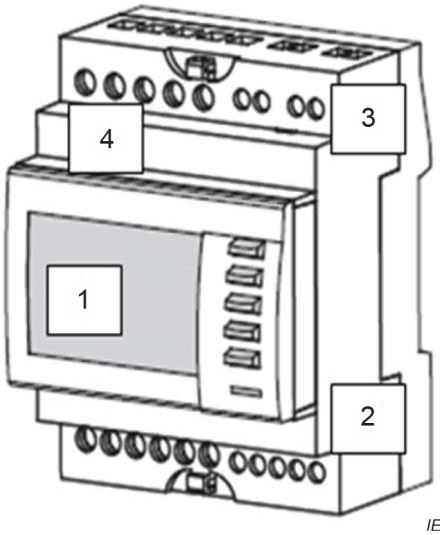
This declaration is intended to provide basic information on the product material content (see Table B.1) and end-of-life information.

Table B.1 – Material content according to IEC 62474 material classes

Metals, weight (%)		Plastics, weight (%)		Others, weight (%)	
Stainless steel	< 1	Polyvinyl chloride	< 1	Ceramics and glass	7,5
Other ferrous alloys, non-stainless steel	5	Other thermoplastics	60	Other organic materials	< 1
Aluminium and its alloys	< 1				
Copper and its alloys	15				
Magnesium and its alloys	< 1				
Nickel and its alloys	< 1				
Zinc and its alloys	1,5				
Precious metals	< 1				
Other non-ferrous metals and alloys	< 1				
Total product mass: 400 g					
Mass of packaging: 100 g					

B.2.4.4 End-of-life information

A list of components and materials that can be subjected to selective treatment may be requested according to local/national regulations; for measuring equipment, such components may be as in the example in Figure B.1.



Key

1 LCD screen

2 Printed circuit boards (inside the module)

3 Lithium cell (inside the module)

4 Plastics with brominated flame retardants

Figure B.1 – Components listed for EoL of a product

Decommissioning and disassembly should be performed by qualified personnel.

Bibliography

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IEC 61326 (all parts), *Electrical equipment for measurement, control and laboratory use – EMC requirements*

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IEC 62430, *Environmentally conscious design for electrical and electronic products*

IEC 62474, *Material declaration for products of and for the electrotechnical industry*

IEC TR 62635, *Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment*

ISO/IEC Guide 98-1:2009, *Uncertainty of measurement – Part 1: Introduction to the expression of uncertainty in measurement*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

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IEC 61557-1

Edition 3.0 2019-07

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 1: General requirements

Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V c.a. et 1 500 V c.c. – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection
Partie 1: Exigences générales

IEC 61557-1:2019-07(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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 1: General requirements

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.
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International Standard IEC 61557-1 has been prepared by 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 third edition includes the following significant technical changes with respect to the previous edition:

a) terms aligned with IEC 60050;
b) measurement of uncertainty revised according to the equations in 4.2 of ISO/IEC Guide 98-3:2008 (GUM);
c) updated references for safety and EMC requirements;

d) updated references for marking and operating instructions;

e) updated references for testing safety and EMC;

f) Annex A contains an explanation of GUM;

g) Annex B addresses environmental aspects.

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

FDIS	Report on voting
85/689/FDIS	85/692/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.

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.

INTRODUCTION

IEC 60364-6 stipulates standardized conditions for the initial test of power installations in TN, TT or IT systems for continuous monitoring and for testing these installations after modifications. In addition to general references for the performance of the tests, IEC 60364-6 contains requirements that have to be verified by measurements. Only in a few instances, for example when measuring the insulation resistance, does IEC 60364-6 contain details of the characteristics of the measuring device to be used. Circuits which are given as examples in IEC 60364-6, and referred to within the text of that document, are generally not suitable for practical use.

The tests are carried out in installations where hazardous voltages can occur and where careless use or a defect in the equipment can easily cause an accident. Therefore, the technician has to rely on measuring devices which ensure safe test methods, in addition to simplifying the measurements.

The application of the general safety regulations for electrical and electronic measuring devices (IEC 61010-1) for testing the protective measures is not sufficient in itself. The performance of measurements in the installation can cause hazards not only to the technician, but also to third persons, depending on the measuring method used.

Likewise, reliable and comparable results of measurement with measuring devices from different manufacturers are an important precondition in order to obtain an objective assessment about the installation, for example when the installation is handed over for periodic tests, for continuous insulation monitoring or in the case of performance warranty.

The IEC 61557 series has been established with the aim of stipulating common principles for measuring and monitoring equipment for testing electrical safety and measuring performances in systems with nominal voltages up to 1 000 V AC and 1 500 V DC which correspond to the above-mentioned characteristics.

For that reason, the following common requirements have been stipulated in IEC 61557-1 (other parts of IEC 61557 can specify additional requirements or deviations):

– protection against extraneous voltages;
– class II protection (except insulation monitoring devices and insulation fault location systems);
– requirements and safety precautions against hazardous touch voltages at the measuring device;
– requirements for the assessment of connection configurations with respect to wiring errors in the tested equipment;
– special mechanical requirements;
– measuring methods;
– measured quantity;
– specification of the maximum operating uncertainty;
– requirements for testing the influencing quantity and the calculation of the operating uncertainty;
– uncertainties of the measuring device at the thresholds specified in the respective standards;
– specification of the nature of type and routine tests and the required conditions for testing.

Contrary to the usual convention, terms and definitions that occur more than once in another part of the series are listed in IEC 61557-1:2019, Clause 3. Only terms and definitions specific to the respective part of IEC 61557 are listed in Clause 3 of that part.

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

1 Scope

This part of IEC 61557 specifies the general requirements applicable to measuring and monitoring equipment for testing the electrical safety in low-voltage distribution systems with nominal voltages up to 1 000 V AC and 1 500 V DC.

When measuring equipment or measuring installations involve measurement tasks of various measuring equipment covered by this series of standards, then the part of this series relevant to each of the measurement tasks is applicable.

NOTE The term "measuring equipment" will hereafter be used to designate "testing, measuring and monitoring equipment".

Other parts of IEC 61557 can specify additional requirements or deviations.

This document does not cover functional safety or cybersecurity.

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 60038:2009, *IEC standard voltages*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013[1]

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements*
IEC 61010-1:2010/AMD1:2016[2]

IEC 61010-031, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held and hand-manipulated assemblies for electrical test and measurement*

[1] A consolidated version of this publication exists, comprising IEC 60529:1989, IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013.

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

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 61010-2-032, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement*

IEC 61010-2-034:2017, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-034: Particular requirements for measurement equipment for insulation resistance and test equipment for electric strength*

IEC 61326-1:2012, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61557-8:2014, *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 8: Insulation monitoring devices for IT systems*

IEC 61557-9:2014, *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 9: Equipment for insulation fault location in IT systems*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
nominal system voltage
U_n
value of the voltage by which the distribution system is designated and to which certain characteristics are assigned

3.2
voltage against earth
U_o
<in distribution systems with an earthed neutral point> voltage between a phase conductor and the earthed neutral point

3.3
voltage against earth
U_o
<in all other distribution systems> voltage present between the remaining phase conductors and earth when one of the phase conductors is short-circuited to earth

3.4
fault voltage
U_f
voltage between a given point of fault and reference earth resulting from an insulation fault

[SOURCE: IEC 60050-826:2004, 826-11-02, modified – The symbol has been added.]

3.5
effective touch voltage
U_t
voltage between conductive parts when touched simultaneously by a person or an animal

Note 1 to entry: The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the animal in electric contact with these conductive parts.

[SOURCE: IEC 60050-195:1998, 195-05-11, modified – The symbol has been added.]

3.6
conventional touch voltage limit
U_L
maximum value of the touch voltage which is permitted to be maintained indefinitely in specified conditions of external influences and is usually equal to 50 V AC, RMS or 120 V ripple free DC

[SOURCE: IEC 60050-826:2004, 826-11-04, modified – "prospective" has been omitted from the term and from the definition and values for the limit have been added to the definition; the symbol has been added.]

3.7
supply voltage
voltage that is used to power the measurement equipment

Note 1 to entry: If a supply voltage is specified, for instance in the supply contract, then it is called "declared supply voltage".

3.8
rated supply voltage
U_S
value of the supply voltage at a point where the measuring equipment does or can accept electric energy as a supply

3.9
output voltage
U_a
voltage across the measuring equipment terminals where this equipment does or can output electric energy

3.10
open-circuit voltage
U_q
voltage present across unloaded terminals on the measuring equipment

3.11
rated voltage
U_N
voltage value assigned by a manufacturer or other entity for a specified operating condition of the measuring equipment

Note 1 to entry: The value for the rated voltage of low-voltage equipment is generally assigned from the list of nominal voltages in IEC 60038:2009, Tables 1 and 6.

Note 2 to entry: Equipment may have more than one rated voltage value or may have a rated voltage range.

[SOURCE: IEC 60050-614:2016, 614-03-09, modified – The domain <of equipment> and Note 1 have been omitted; the symbol has been added; the term specifically adapted for measuring equipment.]

3.12
extraneous voltage
external voltage to which the measuring equipment can be subjected during measurement

3.13
rated current
I_N
current assigned by the manufacturer for the specified operating condition of the measuring equipment

Note 1 to entry: The specified operating condition is a value (or values) within the rated operating conditions that are designated by the manufacturer.

[SOURCE: IEC 60050-442:1998, 442-01-02, modified – "for accessories" has been deleted from the term and Note 1 has been added; the definition has been adapted for application to measuring equipment.]

3.14
short-circuit current
over-current resulting from a short circuit due to a fault on the terminals or within the measuring equipment

3.15
rated frequency
f_N
frequency for which the measuring equipment is intended to be used and for which it has been designed

3.16
uncertainty of measurement
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

Note 1 to entry: This term is used in the "uncertainty" approach.

Note 2 to entry: The parameter can be, for example, a standard deviation (or a given multiple of it), or a half-width of an interval having a stated level of confidence. Various ways of obtaining uncertainty are defined in the GUM.

Note 3 to entry: Uncertainty of measurement comprises, in general, many components. Some of these components can be evaluated from the statistical distribution of the results of a series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from the assumed probability distributions based on experience or other information.

[SOURCE: IEC 60050-311:2001, 311-01-02]

3.17
operating uncertainty
calculated uncertainty taking into account the intrinsic uncertainty and defined influence quantities to mirror the worst case situation

3.18
fiducial uncertainty
uncertainty of measuring equipment expressed as a percentage of the fiducial value

3.19
fiducial value
clearly specified value to which reference is made in order to define the fiducial uncertainty

Note 1 to entry: This value can be, for example, the upper limit of the measuring range, the scale length or any other value which is clearly stated.

[SOURCE: IEC 60050-311:2001, 311-01-16, modified – "error" has been replaced by "uncertainty"; Note 1 has been omitted.]

3.20
percentage operating uncertainty
operating uncertainty of measuring equipment expressed as a percentage of the fiducial value

3.21
intrinsic uncertainty
uncertainty of a measuring instrument or supply instrument when used under reference conditions

Note 1 to entry: The uncertainty caused by friction is part of the intrinsic uncertainty.

[SOURCE: IEC 60050-311:2001, 311-03-09, modified – "or supply instrument" has been added to the definition; the Note has been deleted and Note 1 has been added.]

3.22
performance
characteristics defining the ability of a measuring instrument to achieve the intended functions

[SOURCE: IEC 60050-311:2001, 311-06-11]

3.23
influence quantity
quantity which is not the subject of the measurement and whose change affects the result of the measurement

Note 1 to entry: This term is used in the "uncertainty" approach.

Note 2 to entry: Influence quantities can originate from the measured system, the measuring equipment or the environment.

Note 3 to entry: As the calibration diagram depends on the influence quantities, in order to assign the result of a measurement it is necessary to know whether the relevant influence quantities lie within the specified range.

Note 4 to entry: An influence quantity may be external or internal with reference to the equipment. When the value of one of the influence quantities changes within its measuring range, it may affect the uncertainty due to another quantity. The measured quantity, or a parameter of it, may itself act as an influence quantity. For example, for a voltmeter, the value of the measured voltage may produce an additional uncertainty due to non-linearity or its frequency may also cause an additional uncertainty.

[SOURCE: IEC 60050-311:2001, 311-06-01, modified – "the relationship between the indication and" has been deleted from the definition; Note 4 has been added.]

3.24
variation
<due to an influence quantity> difference between the indicated values for the same value of the measurand of an indicating measuring instrument, or the values of a material measure, when an influence quantity assumes, successively, two different values

[SOURCE: IEC 60050-311:2001, 311-07-03]

3.25
reference conditions
set of specified values and/or ranges of values of influence quantities under which the uncertainties, or limits of error, admissible for a measuring instrument are specified

[SOURCE: IEC 60050-311:2001, 311-06-02, modified – "are the smallest" has been replaced with "are specified".]

3.26
operating condition
characteristic which may affect performance of a component, device or equipment

Note 1 to entry: Examples of operating conditions are ambient conditions, characteristics of the power supply, duty cycle or duty type.

[SOURCE: IEC 60050-151:2001, 151-16-01]

3.27
rated operating conditions
specified set of conditions which may affect the performance of a measuring device and under which the operating uncertainty is maintained

3.28
measuring voltage
U_m
voltage present at the measuring terminals during the measurement

3.29
uncertainty of measuring equipment
uncertainty of the result of a direct measurement of a measurand having negligible intrinsic uncertainty

Note 1 to entry: Unless explicitly stated otherwise, the measuring equipment uncertainty is expressed as an interval with coverage factor 2.

Note 2 to entry: In single-reading direct measurements of measurands having low intrinsic uncertainty with respect to the measuring equipment uncertainty, the uncertainty of the measurement coincides, by definition, with the measuring equipment uncertainty. Otherwise the measuring equipment uncertainty is to be treated as a component of category B in evaluating the uncertainty of the measurement on the basis of the model connecting the several direct measurements involved.

Note 3 to entry: The measuring equipment uncertainty automatically includes, by definition, the effects due to the quantization of the reading values (minimum evaluable fraction of the scale interval in analogic outputs, unit of the last stable digit in digital outputs).

Note 4 to entry: For material measures, the measuring equipment uncertainty is the uncertainty that should be associated to the value of the quantity reproduced by the material measure in order to ensure the compatibility of the results of its measurements.

4 Requirements

4.1 General requirements

Measuring equipment, when used for a designated purpose, shall not endanger persons, livestock or property. Furthermore, measuring equipment with additional functions not forming part of the application of the IEC 61557 series shall also not endanger persons, livestock or property.

4.2 Influence quantities – Operating uncertainty (B), percentage operating uncertainty (B [%])

The operating uncertainty shall be calculated by means of Equation 1:

$$B = \pm\sqrt{A^2 + \tfrac{4}{3}\Sigma_i E_i^2} \quad B = \pm\sqrt{A^2 + \frac{4}{3}\sum_i E_i^2} \tag{1}$$

where

A is the intrinsic uncertainty;

E_i is the variation;

i is the consecutive number of the variations.

The percentage operating uncertainty shall be calculated by means of Equation 2:

$$B[\%] = \pm\frac{B}{F} \times 100\,\% \tag{2}$$

where

F is the fiducial value.

The influencing variations used for calculating the operating uncertainty are denoted as follows:

– variation due to changing the position E_1
– variation due to changing the supply voltage E_2
– variation due to changing the temperature E_3
– variation due to interference voltages E_4
– variation due to earth electrode resistance E_5
– variation due to changing the phase angle of impedance of circuit under test E_6
  - variation due to system phase angle 0° to 18° (use as applicable) $E_{6.1}$
  - variation due to system phase angle 0° to 30° (use as applicable) $E_{6.2}$
– variation due to changing the system frequency E_7
– variation due to changing the system voltage E_8
– variation due to system harmonics E_9
– variation due to system DC quantities E_{10}
– variation due to external low-frequency magnetic fields E_{11}
– variation due to load current E_{12}
– variation due to touch current caused by common mode voltage E_{13}
– variation due to frequency E_{14}
– variation due to repeatability E_{15}

The permissible percentage operating uncertainties are stated in other parts of IEC 61557.

Only one of the influence quantities is varied when calculating the operating uncertainty, whilst the remaining influence quantities are kept under reference conditions. The larger of the respective values of the variation (positive and negative variation) is inserted into the equation for the calculation of the operating uncertainty.

4.3 Rated operating conditions

The following rated operating conditions shall apply, except for insulation monitoring devices (IMD) in accordance with IEC 61557-8 and for insulation fault location systems (IFLS) in accordance with IEC 61557-9:

– temperature range from 0 °C to 35 °C;

– a position of ±90° from the reference position for portable measuring equipment;

– 85 % to 110 % of the nominal supply voltage for supply from the distribution systems (if applicable). The values in IEC 60038 shall be applied for a supply from the distribution system;

– the charge condition in accordance with 4.4 shall apply to the battery or batteries/ accumulators for measuring equipment with a supply from batteries/accumulators;

– the range of revolutions per minute stated by the manufacturer for measuring equipment with a supply from a hand-driven generator;

– frequency of the supply voltage ±5 % (if applicable).

NOTE Additional rated operating conditions are stated in other parts of the IEC 61557 series.

4.4 Battery test facility

Measuring equipment with power supplied from dry or rechargeable battery cells shall test and indicate that the state of charge of these batteries will permit measurement within the specification. This may be done automatically as part of the measurement cycle or as a separate function. Where the battery test is a separate function, the test load shall be of the same level as the one appearing during a measurement.

4.5 Safety

Measuring and monitoring equipment shall be in accordance with IEC 61010-1, IEC 61010-2-030, IEC 61010-031, IEC 61010-2-034 and, if applicable, IEC 61010-2-032, and with the following additional requirements.

Overvoltage categories and/or measurement categories are specified in the relevant parts of IEC 61557.

Handheld measuring equipment shall fulfil the requirements for double or reinforced insulation.

The conductive parts of the terminals shall not be accessible and hazardous in connected, partially connected or unconnected conditions.

The protective conductor if used for measuring purposes shall be treated as a live part, except where a different requirement is specified in other parts of IEC 61557.

The terminals shall be designed so that the probe assembly can be connected to the measuring equipment reliably.

4.6 Electromagnetic compatibility

4.6.1 Immunity

For immunity requirements, IEC 61326-1:2012, Table 2 shall apply. For testing, see 6.5.

4.6.2 Emission

For emissions, either class A or class B limits in accordance with IEC 61326-1:2012, 7.2 shall apply.

4.7 Mechanical strength against vibration

In addition to the mechanical resistance tests in accordance with IEC 61010-1, measuring equipment shall successfully pass the following vibration conditions (type test):

– direction: three mutually perpendicular axes;
– amplitude: 1 mm;
– frequency: 25 Hz;
– duration: 20 min.

5 Marking and operating instructions

5.1 General

Marking and operating instructions shall comply with IEC 61010-1, IEC 61010-2-032, IEC 61010-2-030 and, in addition, these instructions shall comply with the requirements specified in the relevant parts of IEC 61557.

5.2 Marking

The measuring equipment shall carry the following marking:

– type of equipment;
– type and current rating of the fuse in the case of exchangeable fuses;
– type of battery/accumulator and polarity of connection in the battery compartment;
– nominal system voltage and, if applicable, the symbol for double insulation in accordance with IEC 61010-1:2010, Table 1, symbol 11;
– manufacturer's name or registered trade mark;
– model number, name or other means to identify the equipment (inside or outside);
– reference to the operating instructions in accordance with IEC 61010-1:2010, Table 1, symbol 14.

Units of the measured quantities and ranges of measurement shall be stated on the enclosure or on the display.

5.3 Operating instructions

5.3.1 Performance requirements

The operating uncertainty, the intrinsic uncertainty and the variations E_1 to E_{15} shall be provided in the operating instructions (with the exception of measuring devices covered by IEC 61557-8 and IEC 61557-9).

5.3.2 Other information

The operating instructions shall contain the following details:

– connection diagrams;
– instructions for measurements;
– brief description of the principle of measurement;
– diagrams or tables showing the maximum permissible indicated values taking into consideration the tolerances stated by the manufacturer (if necessary);
– type of battery/rechargeable cells;
– information on the charging current, charging voltage and duration of charging for rechargeable cells;

– operational lifetime/runtime of the battery/rechargeable cells or the possible number of measurements;
– type of IP protection according to IEC 60529;
– any necessary special guidance notes.

6 Tests

6.1 General

Measuring equipment shall be tested in accordance with the safety standards IEC 61010-1, IEC 61010-2-030, IEC 61010-031, IEC 61010-2-034 and, if applicable, IEC 61010-2-032, and the EMC standards of IEC 61326 (all relevant parts).

All tests shall be carried out under reference conditions unless otherwise specified. The reference conditions are stated in the relevant parts of IEC 61557.

Tolerances are added in the relevant parts of IEC 61557.

6.2 Operating uncertainty

6.2.1 General

The operating uncertainty shall be determined according to 6.2.2 to 6.2.4.

6.2.2 Influence of changing position

The variation E_1 due to changing the position in accordance with 4.2 and 4.3, if applicable, shall be determined for positions +90° or –90° from the reference position stated by the manufacturer (routine test).

6.2.3 Influence of temperature

The variation E_3 shall be determined from the reference temperature at 0 °C and 35 °C after the device has reached a state of equilibrium (type test).

6.2.4 Influence of the supply voltage

The variation E_2 due to changing the supply voltage shall be determined under the following rated operating conditions (routine test):

– limits in accordance with 4.3 for measuring equipment supplied from distribution systems;
– limits in accordance with 4.4 and 6.3 for measuring equipment supplied from a battery/accumulator;
– limits in accordance with 4.3 for measuring equipment supplied by a hand-driven generator.

6.3 Battery test facility

The lower and upper limits for the battery voltage to which the battery test facility in accordance with 4.4 is set, shall be determined by means of an external voltage source. These values shall be used during the test in accordance with 6.2.4 as limits for variation E_2 by changing the supply voltage (routine test).

6.4 Safety tests

Compliance with 4.5 shall be tested (type test).

6.5 EMC tests

For the electromagnetic radio frequency field (RF) and conducted RF the following requirements apply:

– the auxiliary circuits of the measuring equipment shall be energised with the rated voltage;
– the measuring equipment shall be tested in its operating conditions.

6.6 Mechanical requirements

The test shall be performed in accordance with 4.7 (type test).

The tests are deemed to have been passed successfully when no parts have become loose or bent and the connecting leads are not damaged. After the process, the measuring equipment shall comply with the requirements for intrinsic uncertainty of the equipment (type test), if applicable.

6.7 Marking and operating instructions

The marking and the operating instructions shall be confirmed by visual inspection (type test).

The marking shall be inspected during type test and routine test.

6.8 Records

Compliance with the tests in Clause 6 shall be recorded.

Annex A
(informative)

Explanation of the application of GUM in series IEC 61557

A.1 Overview

The operating uncertainty is a predictive parameter characterizing the expanded uncertainty of the results generated by the measuring device under defined operational conditions.

The operating uncertainty forms an upper limit of the expanded uncertainty which can be expected if the device is operated within the defined operational conditions.

The operating uncertainty might be used to characterize results generated by the device if the device is used within defined operational conditions.

When possible and convenient, the uncertainty may be expressed in the relative form or in the fiducial form. The relative uncertainty is the ratio U/V of the absolute uncertainty U to the measure value V, and the fiducial uncertainty is the ratio U/V_{f} of the absolute uncertainty U to a conventionally chosen value V_{f}.

The principles of the GUM (ISO/IEC Guide 98-3:2008) are used to calculate the operating uncertainty.

A.2 Basic model of evaluation of results under operational conditions

A.2.1 General

The basic model for the evaluation of the results under operational conditions is:

$$Y_{\mathrm{oper}} = Y_{\mathrm{ref}} + \sum_i \delta E_i$$

The result under reference conditions Y_{ref} is the result which could be generated under reference (calibration) conditions. The uncertainty $u(Y_{\mathrm{ref}})$ is evaluated during calibration.

The deviations δE_i are derived from the operational conditions. Usually the expectation value of the δE_i is zero and some limits are known.

A.2.2 Standard uncertainty of a result

The standard uncertainty of a result under operational conditions $u(Y_{\mathrm{oper}})$ can be calculated using uncertainty propagation. The sensitivity of all input quantities is equal to 1.

$$u\left(Y_{\mathrm{oper}}\right) = \sqrt{u\left(Y_{\mathrm{ref}}\right)^2 + \sum_i u\left(\delta E_i\right)^2}$$

The standard uncertainty under reference conditions is equal to the expanded uncertainty evaluated during calibration divided by the coverage factor:

$$u\left(Y_{\mathrm{ref}}\right) = \frac{U_{\mathrm{cal}}\left(Y\right)}{k_{\mathrm{cal}}}$$

A.2.3 Expanded uncertainty

The expanded uncertainty of the calibration $U_{cal}(Y)$ and the coverage factor k_{cal} (usually equal to 2) are stated in the calibration certificate.

For the deviations δE_i, usually only some limits symmetric to zero are known. According to GUM, limits can be converted to a standard uncertainty with the use of a rectangular distribution:

$$u(\delta E_i) = \frac{e_i}{\sqrt{3}}$$

The e_i is the half width of the limits characterizing the deviation δE_i.

The operating uncertainty is equal to the standard uncertainty under operational conditions multiplied by the operating coverage factor:

$$U(Y_{oper}) = k_{oper} \times u(Y_{oper})$$

The operating coverage factor k_{oper} is fixed to 2,0.

This is equivalent to the half width of coverage interval with a coverage probability of 95,45 % under the assumption that the results are distributed normally.

A.2.4 Relative operating uncertainty

The relative operating uncertainty as a percentage can be calculated using a fiducial value Y_f.

$$W(Y_{oper}) = \frac{U(Y_{oper})}{Y_f} \times 100\,\%$$

The operating uncertainty and the relative operating uncertainty as a percentage can be written as symmetric interval limits using plus and minus signs.

A.2.5 Calibration uncertainty

For practical calculations, the calibration uncertainty $U_{cal}(Y)$ may be replaced by A, and e_i, by E_i. The resulting equation is:

$$U(Y_{oper}) = \sqrt{A^2 + \frac{4}{3}\sum_i E_i^2} \le |A| + 1{,}5 \times \sqrt{\sum_i E_i^2}$$

under the assumption that the coverage factor k_{cal} stated in the calibration certificate is equal to the operating coverage factor k_{oper} = 2,0.

Therefore the following equation may be used as an upper bound for the operating coverage interval:

$$B = \pm\left[\left|A\right| + 1{,}15 \times \sqrt{\sum_i E_i^{\,2}}\right]$$

A.3 Operating uncertainty calculations as basis for 4.1

A.3.1 Standard uncertainty

The basis for this model is the addition of faults.

Uncertainty in respect to GUM (ISO/IEC Guide 98-1:2009, measuring method B) for any statistical distribution:

$$u = \sqrt{a^2 + \sum_i e_i^{\,2}}$$

where

a is the expected intrinsic operating uncertainty for example by calibration certificates;

e_i e_i =is the expected operating uncertainty by influencing factors for example through temperature;

u is the standard uncertainty of the result of a measurement expressed as a standard deviation.

A.3.2 Operating uncertainty in accordance with 4.1

The basis for this model of calculation is the expanded uncertainty according to GUM (ISO/IEC Guide 98-3:2008, 6.2).

Determination of the operating uncertainty for the IEC 61557 series with stipulation of the defined statistical distributions based on empirical values:

– B = ± $k \times u$ with k = 2 for coverage probability of 95,45 %;

– $a = \frac{A}{2}\ a = \frac{A}{2}$ standard distribution for the intrinsic uncertainty;

– $e_i = \frac{E_i}{\sqrt{3}}\ e_i = \frac{E_i}{\sqrt{3}}$ rectangular distribution for the operating uncertainty through influence factors in the operation;

– $B = \pm\sqrt{A^2 + \frac{4}{3}\sum_i E_i^2}$ uncertainty for coverage probability of 95,45 % according to GUM, (ISO/IEC Guide 98-3:2008, 7.22).

Annex B
(informative)

Environmental aspects

B.1 Overview

Every product has an effect on the environment, which may occur at any or all stages of its life cycle – raw-material acquisition, manufacture, distribution, use, maintenance, re-use and end-of-life. These effects may range from slight to significant; they may be short term or long term, and they may occur at the local, national, regional or global level (or a combination thereof).

The widespread use of electrical and electronic products has drawn increased awareness to their environmental impacts. As a result, legislation, as well as market-driven requirements for environmentally conscious design, is emerging.

The continuous introduction of new products and materials can make evaluation increasingly complex, since additional data will need to be gathered to assess the life-cycle impacts of such new products and materials. The gathered data is used as a basis for improvement of the products with respect to environmental impacts. Life-cycle assessment (LCA) and environmentally conscious design (ECD) principles provide instruments that may be useful in this respect.

The application of LCA to an ECD process allows the reduction of adverse environmental impacts of a product throughout its entire life cycle. This can involve balancing the environmental aspects of the product with other factors, such as its intended use, performance, cost, safety, marketability, and quality and choosing methods to meet legal and regulatory requirements in an environmentally conscious way. In striving for this goal, multiple benefits can be achieved for the organization, its customers and other stakeholders. The consideration of environmental aspects particularly in the very early stage of the product design process can contribute to cost reduction and to better marketability. Environmentally conscious design is not a separate design activity; rather it is an integral part of the existing design process. The design in this context includes the activities associated with the processes of product planning, development and decision making as well as the creation of policies within the organization.

ECD is intended to be used by all those involved in the design and development of electrical and electronic products. This includes all parties in the supply chain regardless of organization type, size, location and complexity. It is applicable for all types of products, new as well as modified. Sector-specific documents may be developed to address needs not covered in this document. The use of this annex as a base reference is encouraged so as to ensure consistency throughout the electrotechnical sector.

This annex provides a set of guidelines to establish the material declaration and the end-of-life information in the general framework of the information that shall be shared according to IEC 62430.

B.2 Guidelines to establish a material declaration and end-of-life information

B.2.1 General

Manufacturers are increasingly requested to provide a material declaration and end-of-life information in accordance with regulations or in the form of labels, or they are asked directly by their customers to communicate and declare information about the material composition of their products. The main intended uses of this information are to:

– enable assessment of product compliance with substance-restriction requirements;
– improve product end-of-life by facilitating integration in the appropriate recycling processes.

Providing the material declaration is at the discretion of the manufacturer.

NOTE Since IEC 62474 is intended to establish requirements for material declarations, standardize protocols, and facilitate transfer and processing of data, it is possible that its application throughout the supply chain will make the compilation of material declarations of products easier.

B.2.2 Guidelines for material declaration

The material declaration should be made in accordance with IEC 62474 and contain the two following sections as a minimum.

– Base data requirements:
  • product family name;
  • product identification: commercial references covered by the declaration;
  • total product mass;
  • mass and type of batteries, if integrated;
  • mass of packaging.
– Material class information:
  • distribution of the product mass according to the 15 generic material classes as defined in the IEC 62474 database.

NOTE Examples of material declarations are given in IEC 62474.

Single-material declarations can be made for a family of products only when the composition is the same for all the products thereof.

B.2.3 Guidelines for end-of-life (EoL)

Different regulations (for waste electrical and electronic equipment, batteries, packaging), incentives on circular economy or customers require or push the design of products that are easily recyclable.

If required, the end-of-life information (EoLI) should be prepared in accordance with IEC TR 62635 and should contain the following as a minimum:

– manufacturer identification;
– product identification;
– potential hazard identification;
– selective treatment;
– sketches, drawings or pictures to identify and locate parts and materials listed.

B.2.4 Example of a material declaration and end-of-life information

B.2.4.1 Manufacturer identification

Address: xxxxxxxxxxxxxxxxxx

Website: xxxxxxxxxxxxxxxxxx

B.2.4.2 Product identification

Range: multifunction meter xxxxxx

Commercial references: xxxxxx, xxxxx, xxxxxx, etc.

B.2.4.3 Purpose of the document

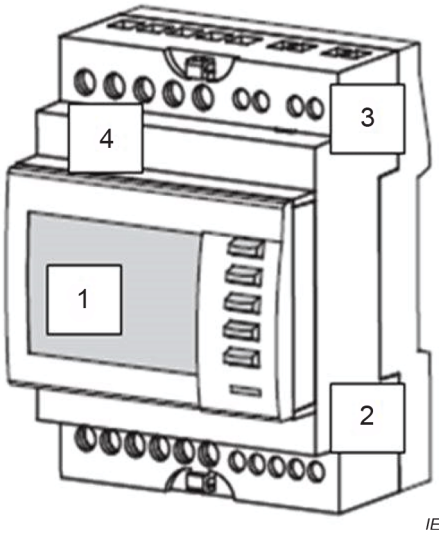
This declaration is intended to provide basic information on the product material content (see Table B.1) and end-of-life information.

Table B.1 – Material content according to IEC 62474 material classes

Metals, weight (%)		Plastics, weight (%)		Others, weight (%)	
Stainless steel	< 1	Polyvinyl chloride	< 1	Ceramics and glass	7,5
Other ferrous alloys, non-stainless steel	5	Other thermoplastics	60	Other organic materials	< 1
Aluminium and its alloys	< 1				
Copper and its alloys	15				
Magnesium and its alloys	< 1				
Nickel and its alloys	< 1				
Zinc and its alloys	1,5				
Precious metals	< 1				
Other non-ferrous metals and alloys	< 1				
Total product mass: 400 g					
Mass of packaging: 100 g					

B.2.4.4 End-of-life information

A list of components and materials that can be subjected to selective treatment may be requested according to local/national regulations; for measuring equipment, such components may be as in the example in Figure B.1.



Key

1 LCD screen

2 Printed circuit boards (inside the module)

3 Lithium cell (inside the module)

4 Plastics with brominated flame retardants

Figure B.1 – Components listed for EoL of a product

Decommissioning and disassembly should be performed by qualified personnel.

Bibliography

IEC 60050-195, *International Electrotechnical Vocabulary (IEV) – Part 195: Earthing and protection against electric shock*

IEC 60050-311:2001, *International Electrotechnical Vocabulary (IEV) – Part 311: General terms relating to measurements*

IEC 60050-442:1998, *International Electrotechnical Vocabulary (IEV) – Part 442: Electrical accessories*

IEC 60050-614:2016, *International Electrotechnical Vocabulary (IEV) – Part 614: Generation, transmission and distribution of electricity – Operation*

IEC 60050-826:2004, *International Electrotechnical Vocabulary (IEV) – Part 826: Electrical installations*

IEC 60359, *Electrical and electronic measurement equipment – Expression of performance*

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-6, *Low voltage electrical installations – Part 6: Verification*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 61326 (all parts), *Electrical equipment for measurement, control and laboratory use – EMC requirements*

IEC 61326-2-4, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-4: Particular requirements – Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9*

IEC 62430, *Environmentally conscious design for electrical and electronic products*

IEC 62474, *Material declaration for products of and for the electrotechnical industry*

IEC TR 62635, *Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment*

ISO/IEC Guide 98-1:2009, *Uncertainty of measurement – Part 1: Introduction to the expression of uncertainty in measurement*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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SÉCURITÉ ÉLECTRIQUE DANS LES RÉSEAUX DE DISTRIBUTION BASSE TENSION AU PLUS ÉGALE À 1 000 V C.A. ET 1 500 V C.C. – DISPOSITIFS DE CONTRÔLE, DE MESURE OU DE SURVEILLANCE DE MESURES DE PROTECTION

Partie 1: Exigences générales

AVANT-PROPOS

1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
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9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 61557-1 a été établie par le comité d'études 85 de l'IEC: Equipement de mesure des grandeurs électriques et électromagnétiques.

Cette troisième édition annule et remplace la deuxième édition parue en 2007. Cette édition constitue une révision technique.

Cette troisième édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) alignement des termes sur ceux de l'IEC 60050;

b) mesure de l'incertitude revue conformément aux équations données en 4.2 du Guide ISO/IEC 98-3:2008 (GUM);

c) mise à jour des références aux exigences de sécurité et de CEM;

d) mise à jour des références au marquage et aux instructions de fonctionnement;

e) mise à jour des références aux essais de sécurité et de CEM;

f) l'Annexe A comporte une explication du GUM;

g) l'Annexe B porte sur les aspects environnementaux.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
85/689/FDIS	85/692/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61557, publiées sous le titre général *Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V c.a. et 1 500 V c.c. — Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

L'IEC 60364-6 stipule les conditions normalisées de l'essai initial des installations de distribution dans les réseaux TN, TT ou IT pour la surveillance permanente et pour les essais de ces installations après des modifications. Outre des indications générales relatives à la réalisation des essais, l'IEC 60364-6 contient des exigences qui doivent être vérifiées par des mesures. Dans certains cas seulement, par exemple lors de la mesure de la résistance d'isolement, l'IEC 60364-6 contient quelques indications précises concernant les caractéristiques de l'appareil de mesure à utiliser. Les circuits de mesure fournis comme exemples dans l'IEC 60364-6 et cités dans le texte de ce document ne sont généralement pas adaptés à un usage pratique.

Les essais sont effectués dans des installations où des tensions dangereuses peuvent être présentes et où une imprudence ou une panne peut facilement être à l'origine d'un accident. Le technicien doit donc utiliser des dispositifs de mesure qui non seulement simplifient les mesures, mais garantissent également des méthodes d'essai sûres.

L'application des exigences de sécurité générales relatives aux dispositifs de mesure électriques et électroniques (IEC 61010-1) n'est pas suffisante pour les essais des mesures de protection. Selon la méthode de mesure utilisée, la prise des mesures au sein de l'installation peut présenter des dangers pour le technicien et pour les tierces personnes.

De même, des résultats de mesure fiables et comparables avec des appareils de mesure de différents fabricants constituent une condition préalable importante pour une évaluation objective de l'installation, par exemple lors du transfert de l'installation pour essais périodiques, pour la surveillance permanente de l'isolation ou en cas de prestations de garantie.

La série IEC 61557 a été établie dans le but de développer des principes communs pour les dispositifs de mesure et de surveillance utilisés aux fins d'essai de la sécurité électrique et de mesure des performances dans des réseaux à des tensions nominales jusqu'à 1 000 V c.a. et 1 500 V c.c. correspondant aux caractéristiques susmentionnées.

Pour cette raison, les exigences communes suivantes ont été établies dans l'IEC 61557-1 (les autres parties de l'IEC 61557 peuvent spécifier des exigences supplémentaires ou des écarts):

– protection contre les tensions extérieures;
– protection de classe II (à l'exception des contrôleurs d'isolement et des dispositifs de localisation de défaut d'isolement);
– exigences et précautions de sécurité contre les tensions de contact dangereuses au niveau de l'appareil de mesure;
– exigences relatives à l'appréciation des configurations de branchement par rapport aux erreurs de câblage dans l'installation soumise à essai;
– exigences mécaniques particulières;
– méthodes de mesure;
– grandeur mesurée;
– spécification relative à l'incertitude de fonctionnement maximale;
– exigences relatives aux essais de la grandeur d'influence et au calcul de l'incertitude de fonctionnement;
– incertitudes de l'appareil de mesure aux seuils spécifiés dans les normes respectives;
– spécification relative à la nature des essais de type et des essais individuels de série et aux conditions exigées pour ces essais.

Contrairement à la convention habituelle, les termes et définitions utilisés plusieurs fois dans une autre partie de la série sont répertoriés à l'Article 3 de l'IEC 61557-1:2019. Seuls les termes et définitions propres à la partie concernée de l'IEC 61557 sont répertoriés à l'Article 3 de cette partie.

SECURITE ELECTRIQUE DANS LES RESEAUX DE DISTRIBUTION BASSE TENSION AU PLUS ÉGALE À 1 000 V C.A. ET 1 500 V C.C. – DISPOSITIFS DE CONTRÔLE, DE MESURE OU DE SURVEILLANCE DE MESURES DE PROTECTION

Partie 1: Exigences générales

1 Domaine d'application

La présente partie de l'IEC 61557 spécifie les exigences générales applicables aux dispositifs de mesure et de surveillance utilisés aux fins d'essai de la sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V c.a. et 1 500 V c.c.

Lorsque des appareils ou installations de mesure impliquent des mesures avec différents appareils couverts par la présente série de normes, la partie de cette série de normes qui est pertinente pour un type de mesure donné est applicable.

NOTE Le terme "appareil de mesure" est utilisé dans la suite du texte pour désigner un "dispositif de contrôle, de mesure et de surveillance".

Les autres parties de l'IEC 61557 peuvent spécifier des exigences supplémentaires ou des écarts.

La présente norme ne couvre pas la sécurité fonctionnelle ou la cybersécurité.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60038:2009, *Tensions normales de l'IEC*

IEC 60529:1989, *Degrés de protection procurés par les enveloppes (code IP)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013[1]

IEC 61010-1:2010, Règles *de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 1: Exigences générales*
IEC 61010-1:2010/AMD1:2016[2]

IEC 61010-031, *Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 031: Prescriptions de sécurité pour sondes équipées portatives et manipulées à la main pour mesurage et essais électriques*

[1] Il existe une version consolidée de cette publication, comprenant l'IEC 60529:1989, l'IEC 60529:1989/AMD1:1999 et l'IEC 60529:1989/AMD2:2013.

[2] Il existe une version consolidée de cette publication, comprenant l'IEC 61010-1:2010 et l'IEC 61010-1:2010/AMD1:2016.

IEC 61010-2-030:2017, *Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 2-030: Exigences particulières pour les appareils équipés de circuits d'essai ou de mesure*

IEC 61010-2-032, *Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 2-032: Exigences particulières pour les capteurs de courant, portatifs et manipulés à la main, de test et de mesure électriques*

IEC 61010-2-034:2017, *Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 2-034: Exigences particulières applicables aux appareils de mesure de la résistance d'isolement et aux appareils d'essai de rigidité diélectrique*

IEC 61326-1:2012, *Matériel électrique de mesure, de commande et de laboratoire – Exigences relatives à la CEM – Partie 1: Exigences générales*

IEC 61557-8:2014, *Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V c.a. et 1 500 V c.c. – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection – Partie 8: Contrôleur permanent d'isolement pour réseaux IT*

IEC 61557-9:2014, *Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V c.a. et 1 500 V c.c. – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection – Partie 9: Dispositifs de localisation de défauts d'isolement pour réseaux IT*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
tension de réseau nominale
U_n
valeur de la tension utilisée pour désigner le réseau de distribution et à laquelle certaines caractéristiques sont assignées

3.2
tension par rapport à la terre
U_o
<dans un réseau de distribution dont le point neutre est mis à la terre> tension d'un conducteur de phase par rapport au point neutre mis à la terre

3.3
tension par rapport à la terre
U_o
<dans les autres réseaux de distribution> tension qui apparaît entre la terre et les autres conducteurs de phase lorsque l'un des conducteurs de phase est mis en court-circuit avec la terre

3.4
tension de défaut
U_f
tension entre un point de défaut donné et la terre de référence, consécutivement à un défaut de l'isolation

[SOURCE: IEC 60050-826:2004, 826-11-02, modifié – Le symbole a été ajouté.]

3.5
tension de contact effective
U_t
tension entre des parties conductrices touchées simultanément par une personne ou un animal

Note 1 à l'article: La valeur de la tension de contact effective peut être sensiblement influencée par l'impédance de la personne ou de l'animal en contact électrique avec ces parties conductrices.

[SOURCE: IEC 60050-195:1998, 195-05-11, modifié – Le symbole a été ajouté.]

3.6
tension limite conventionnelle de contact
U_L
valeur maximale de la tension de contact qu'il est admis de pouvoir maintenir indéfiniment dans des conditions d'influences externes spécifiées, et qui est généralement égale à 50 V c.a. en courant efficace ou à 120 V c.c. en courant lissé

[SOURCE: IEC 60050-826:2004, 826-11-04, modifié – L'adjectif "présumée" a été supprimé du terme et de la définition et des valeurs limites ont été ajoutées à la définition; le symbole a été ajouté.]

3.7
tension d'alimentation
tension utilisée pour alimenter un appareil de mesure

Note 1 à l'article: Si une tension d'alimentation est spécifiée, par exemple dans le contrat de fourniture, elle est appelée "tension d'alimentation déclarée".

3.8
tension d'alimentation assignée
U_S
valeur de la tension d'alimentation de l'appareil de mesure à un point où il prend ou peut prendre l'énergie électrique nécessaire à son fonctionnement

3.9
tension de sortie
U_a
tension aux bornes de l'appareil de mesure à l'endroit où cet équipement délivre ou peut délivrer une énergie électrique

3.10
tension en circuit ouvert
U_q
tension aux bornes non chargées de l'appareil de mesure

3.11
tension assignée
U_N
valeur de la tension fixée par un fabricant, ou une autre entité, pour le fonctionnement spécifié de l'appareil de mesure