



BSI Standards Publication

Instrument transformers

Part 21: Uncertainty evaluation in the accuracy test of instrument transformers

National foreword

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Instrument transformers - Part 21: Uncertainty evaluation in the accuracy test of instrument transformers

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This document is published as an IEC/IEEE Dual Logo standard.

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Draft	Report on voting
38/829/FDIS	38/835/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications/.

A list of all parts in the IEC 61869 series, published under the general title *Instrument transformers*, can be found on the IEC website.

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Accuracy is a crucial feature of instrument transformers (ITs) in most cases and applications: its assessment is required since a very long time by the relevant International Standards, which also establish the conventional accuracy requirements in terms of accuracy classes limits.

This document aims at a) providing information on the main sources of uncertainties arising in the setup used to test the accuracy of ITs and that must be taken into account in the evaluation of measurement uncertainty; b) defining the procedures to be implemented for testing the accuracy of ITs, depending on the type of IT (i.e. either with an analogue or a digital secondary signal) and assessing the conformity to the requirements reported in the product standards (conformity assessment); c) defining the procedure for evaluating the uncertainty contributions in testing the accuracy of ITs.

1 Scope

This part of IEC 61869 provides the requirements, the methods and the guidelines to be applied on the evaluation of uncertainty in testing the accuracy of instrument transformers (IT) with an analogue or a digital secondary signal for measuring, protection and control purposes, with rated frequencies from 15 Hz to 400 Hz.

This document covers the uncertainty evaluation in testing the accuracy of IT (including on-site testing of accuracy) independently of the technology used (either inductive or non-inductive).

This document reports on how to take into account the sources of uncertainty in the setups for accuracy and how to combine their effects in order to evaluate the uncertainty in the test results. Metrological traceability to the International System of Units (SI) will always be assumed for both reference devices and devices under test.

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 61869 (all parts), *Instrument transformers*

IEC 61869-9, *Instrument transformers - Part 9: Digital interface for instrument transformers*

IEC 61869-99:2022, *Instrument transformers - Part 99: Glossary*

IEEE C57.13-2016, *IEEE Standard Requirements for Instrument Transformers*

JCGM 100:2008 or ISO/IEC Guide 98-3:2008, *Evaluation of measurement data - Guide to the expression of uncertainty in measurement (GUM)*

3 Terms, definitions, abbreviated terms and symbols

For the purposes of this document, the terms and definitions given in IEC 61869-99 and the following apply.

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

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEEE Standards Dictionary Online: available at: <https://dictionary.ieee.org>

3.1 General definitions

3.1.1

measurement

process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity

Note 1 to entry: Measurement does not apply to nominal properties.

Note 2 to entry: Measurement implies comparison of quantities or counting of entities.

Note 3 to entry: Measurement presupposes a description of the quantity commensurate with the intended use of a measurement result, a measurement procedure, and a calibrated measuring system operating according to the specified measurement procedure, including the measurement conditions.

[SOURCE: JCGM 200:2012, 2.1]

3.1.2

measurand

quantity intended to be measured

Note 1 to entry: The measurement, including the measuring system and the conditions under which the measurement is carried out, might change the phenomenon, body, or substance such that the quantity being measured may differ from the measurand as defined. In this case, adequate correction is necessary.

[SOURCE: JCGM 200:2012, 2.3, modified – Notes 1, 2 and 4 to entry have been omitted, along with the examples.]

3.1.3

measurement method

generic description of a logical organization of operations used in a measurement

Note 1 to entry: Measurement methods may be qualified in various ways such as:

- substitution measurement method,
- differential measurement method, and
- null measurement method.

[SOURCE: JCGM 200:2012, 2.5, modified – The admitted term "method of measurement" has been omitted, as well as the last two dashed list items in the note.]

3.1.4

measurement procedure

detailed description of a measurement according to one or more measurement principles and to a given measurement method, based on a measurement model and including any calculation to obtain a measurement result

Note 1 to entry: A measurement procedure is usually documented in sufficient detail to enable an operator to perform a measurement.

Note 2 to entry: A measurement procedure can include a statement concerning a target measurement uncertainty.

[SOURCE: JCGM 200:2012, 2.6, modified – Note 3 to entry has been omitted.]

3.1.5

measurement result

set of quantity values being attributed to a measurand together with any other available relevant information

Note 1 to entry: A measurement result is generally expressed as a single measured quantity value and a measurement uncertainty.

[SOURCE: JCGM 200:2012, 2.9, modified – The admitted term "result of measurement" has been omitted, along with Notes 1 and 3 to entry and the second sentence of Note 2 to entry.]

3.1.6**measurement uncertainty**

non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

Note 1 to entry: Measurement uncertainty comprises, in general, many components. Some of these may be evaluated by Type A evaluation of measurement uncertainty from the statistical distribution of the quantity values from series of measurements and can be characterized by standard deviations. The other components, which may be evaluated by Type B evaluation of measurement uncertainty, can also be characterized by standard deviations, evaluated from probability density functions based on experience or other information.

[SOURCE: JCGM 200:2012, 2.26, modified – Synonyms have been omitted, along with Notes 1, 2 and 4 to entry.]

3.1.7**Type A evaluation of measurement uncertainty**

evaluation of a component of measurement uncertainty by a statistical analysis of measured quantity values, obtained under defined measurement conditions

Note 1 to entry: For information about statistical analysis, see e.g. JCGM 100:2008 (GUM).

[SOURCE: JCGM 200:2012, 2.28, modified – Synonyms have been omitted, along with Notes 1 and 3 to entry, the reference to the GUM has been modified.]

3.1.8**Type B evaluation of measurement uncertainty**

evaluation of a component of measurement uncertainty determined by means other than a Type A evaluation of measurement uncertainty

EXAMPLES Evaluation based on information

- associated with authoritative published quantity values;
- associated with the quantity value of a certified reference material;
- obtained from a calibration certificate;
- about drift;
- obtained from the accuracy class of a verified measuring instrument;
- obtained from limits deduced through personal experience.

[SOURCE: JCGM 200:2012, 2.29, modified – Note 1 to entry has been omitted.]

3.1.9**standard measurement uncertainty**

standard uncertainty

u

measurement uncertainty expressed as a standard deviation

Note 1 to entry: The term "standard measurement uncertainty" is usually shortened as "standard uncertainty".

[SOURCE: JCGM 200:2012, 2.30, modified – Symbol has been added, a synonym has been omitted, Note 1 to entry added.]

3.1.10**combined standard measurement uncertainty**

combined standard uncertainty

u_c

standard measurement uncertainty that is obtained using the individual standard measurement uncertainties associated with the input quantities in a measurement model

Note 1 to entry: The term "standard measurement uncertainty" is usually shortened as "standard uncertainty".

[SOURCE: JCGM 200:2012, 2.31, modified – Symbol has been added, Note 1 to entry has been replaced.]

3.1.11**uncertainty budget**

statement of a measurement uncertainty, of the components of that measurement uncertainty, and of their calculation and combination

Note 1 to entry: An uncertainty budget should include the measurement model, estimates, and measurement uncertainties associated with the quantities in the measurement model, covariances, type of applied probability density functions, degrees of freedom, type of evaluation of measurement uncertainty, and any coverage factor.

[SOURCE: JCGM 200:2012, 2.33]

3.1.12**expanded measurement uncertainty**

expanded uncertainty

U

product of a combined standard measurement uncertainty and a factor larger than the number one

Note 1 to entry: The factor depends upon the type of probability distribution of the output quantity in a measurement model and on the selected coverage probability.

Note 2 to entry: Expanded measurement uncertainty is termed "overall uncertainty" in some documents (see also the GUM) and simply "uncertainty" in IEC documents.

Note 3 to entry: The expanded measurement uncertainty term is usually shortened in expanded uncertainty.

[SOURCE: JCGM 200:2012, 2.35, modified – Note 2 to entry regarding the term "factor" has been omitted, Note 3 to entry has been added.]

3.1.13**coverage interval**

interval containing the set of true quantity values of a measurand with a stated probability, based on the information available

Note 1 to entry: A coverage interval can be derived from an expanded measurement uncertainty (see JCGM 100:2008, 2.3.5).

[SOURCE: JCGM 200:2012, 2.36, modified – Notes 1 and 2 to entry have been omitted, the reference to the GUM has been modified.]

3.1.14**coverage probability**

probability that the set of true quantity values of a measurand is contained within a specified coverage interval

Note 1 to entry: The coverage probability is also termed "level of confidence" in the GUM.

[SOURCE: JCGM 200:2012, 2.37, modified – Note 1 to entry has been omitted.]

3.1.15**coverage factor**

k

number larger than one by which a combined standard measurement uncertainty is multiplied to obtain an expanded measurement uncertainty

[SOURCE: JCGM 200:2012, 2.38, modified – Note 1 to entry has been omitted and the symbol has been added.]

3.1.16**measurement model**

mathematical relation among all quantities known to be involved in a measurement

Note 1 to entry: A general form of a measurement model is the equation $h(Y, X_1, \dots, X_n) = 0$, where Y , the output quantity in the measurement model, is the measurand, the quantity value of which is to be inferred from information about input quantities in the measurement model $X_1, \dots, X_n$.

[SOURCE: JCGM 200:2012, 2.48, modified – Synonyms and Note 2 to entry have been omitted.]

3.1.17**calibration**

operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

Note 1 to entry: A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration", nor with verification of calibration.

Note 3 to entry: In the definition, the term "indication" for instrument transformers has to be understood as secondary signal value.

[SOURCE: JCGM 200:2012, 2.39, modified – Note 3 to entry has been omitted and a new Note 3 has been added.]

3.1.18**laboratory calibration**

calibration performed in the factory test laboratory or in an external calibration laboratory

Note 1 to entry: The laboratory calibration ensures defined environmental conditions and power source control.

3.1.19**accuracy**

quality which characterizes the ability of a measuring instrument to provide an indicated value close to a true value of the measurand

[SOURCE: IEC 60050-311:2001, 311-06-08, modified – Notes to entry have been omitted.]

3.1.20**accuracy test**

test in which the results of error measurement are compared with the accuracy class limits

3.1.21**metrological traceability**

property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty

[SOURCE: JCGM 200:2012, 2.41, modified – Notes to entry have been omitted.]