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INTERNATIONAL STANDARD

Reference conditions and procedures for testing industrial and process measurement transmitters -
Part 1: General procedures for all types of transmitters

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Reference conditions and procedures for testing industrial and process measurement transmitters - Part 1: General procedures for all types of transmitters

FOREWORD

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IEC 62828-1 has been prepared by subcommittee 65B: Measurement and control devices, of IEC Technical Committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This second edition cancels and replaces the first edition published in 2017. This edition constitutes a technical revision.

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

a) informative Annexes E, F, G and H have been removed;
b) a new informative Annex G “Example of signal current for a 4 mA to 20 mA PMT” has been introduced (it has been moved from IEC 62828-2:2017 to this document);

c) the definitions of warm-up time, settling time and output signal have been moved from IEC 62828-4:2020 to this document;

d) The definitions of “inaccuracy” and “accuracy” have been reworked;

e) The clause regarding test report has been reworked.

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

Draft	Report on voting
65B/1306/FDIS	65B/1320/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 ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, 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 62828 series, published under the general title *Reference conditions and procedures for testing industrial and process measurement transmitters*, 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,
– withdrawn, or
– revised.

INTRODUCTION

Most of the current IEC standards on industrial and process measurement transmitters are rather old and were developed having in mind devices based on analogue technologies. Today's digital industrial and process measurement transmitters are quite different from those analogue transmitters: they include more functions and newer interfaces, both towards the computing section (mostly digital electronic) and towards the measuring section (mostly mechanical). Even if some standards dealing with digital process measurement transmitters already exist, they are not sufficient, since some aspects of the performance are not covered by appropriate test methods.

In addition, existing IEC test standards for industrial and process measurement transmitters are spread over many documents, so that for manufacturers and users it is difficult, impractical and time-consuming to identify and select all the standards to be applied to a device measuring a specific process quantity (pressure, temperature, flow, level, etc.).

To help manufacturers and users, it was decided to review, complete and reorganize the relevant IEC standards and to create a more suitable, effective and comprehensive standard series that provides in a systematic way all the necessary specifications and tests required for different industrial and process measurement transmitters.

To solve the issues mentioned above and to provide an added value for the stakeholders, the new standard series on industrial and process measurement transmitters covers the following main aspects:

– applicable normative references;
– specific terms and definitions;
– typical configurations and architectures for the various types of industrial and process measurement transmitters;
– hardware and software aspects;
– interfaces (to the process, to the operator, to the other measurement and control devices);
– physical, mechanical and electrical requirements and relevant tests; clear definition of the test categories: type tests, acceptance tests and routine tests;
– performance (its specification, tests and verification);
– environmental protection, hazardous areas application, functional safety, etc.;
– structure of the product documentation.

To cover in a systematic way all the topics to be addressed, the standard series is organized in several parts. At the moment of the publication of this document, the IEC 62828 consists of the following parts:

– *Part 1: General procedures for all types of transmitters;*
– *Part 2: Specific procedures for pressure transmitters;*
– *Part 3: Specific procedures for temperature transmitters;*
– *Part 4: Specific procedures for level transmitters;*
– *Part 5: Specific procedures for flow transmitters.*

1 Scope

This Part of IEC 62828 establishes a general framework for defining reference conditions and test procedures applicable for assessing the measurement performances of all types of industrial and process measurement transmitters (PMTs) used in measuring and control systems for industrial process and machinery.

For the purpose of this document, an analogue PMT is a process measurement transmitter with only analogue current and/or voltage output(s), irrespective the technology adopted and the complexity of the circuitry. All the other process measurement transmitters, with digital output(s) only or with hybrid analogue and digital output(s), are considered to be digital PMTs.

This document constitutes a common reference for the other parts of the IEC 62828 series.

Specific test procedures and additional requirements for given types of PMTs (pressure, temperature, level, flow, etc.) are covered by other parts of this series.

Sensing devices according to the IEC 60947 series are excluded from the scope of this document.

NOTE 1 In industrial and process applications, to indicate the process measurement transmitters, it is common also to use the terms "industrial transmitters", or "process transmitters".

NOTE 2 For better clarity, when the complete definition "industrial and process measurement transmitter" makes the sentence too long in this document, the short term "transmitter", or PMT, is used instead.

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 60068-2-1, *Environmental testing - Part 2-1: Tests - Test A: Cold*

IEC 60068-2-2, *Environmental testing - Part 2-2: Tests - Test B: Dry heat*

IEC 60068-2-6, *Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock*

IEC 60068-2-78, *Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state*

IEC 60654-1, *Industrial-process measurement and control equipment - Operating conditions - Part 1: Climatic conditions*

IEC 60654-3, *Operating conditions for industrial-process measurement and control equipment - Part 3: Mechanical influences*

IEC 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements*

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

IEC 61499 (all parts), *Function blocks*

IEC 61804 (all parts), *Devices and integration in enterprise systems - Function blocks (FB) for process control and electronic device description language (EDDL)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1.1 Terms related to accuracy

3.1.1.1
accuracy
<of a measuring instrument> quality which characterizes the ability of a measuring instrument to provide an indicated value close to a true value of the measurand

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

Note 2 to entry: Accuracy is all the better when the indicated value is closer to the corresponding true value.

[SOURCE: IEC 60050-311:2001, 311-06-08]

3.1.1.2
conformity
ability of a measuring instrument to provide an indication having a specified characteristic curve which can be linear, logarithmic, parabolic, etc.

3.1.1.3
dead band
dead zone
finite range of values within which a variation of the input variable does not produce any measurable change in the output variable

Note 1 to entry: When this type of characteristic is intentional, it is sometimes called neutral zone.

Note 2 to entry: This entry was numbered 351-24-14 in IEC 60050-351:2006.

Note 3 to entry: This value is usually insignificant for the actual instruments.

[SOURCE: IEC 60050-351:2013, 351-45-15, modified – Note 3 has been added.]

3.1.1.4
error
discrepancy between a computed, observed or measured value or condition, and the true, specified or theoretically correct value or condition

Note 1 to entry: An error within a system can be caused by failure of one or more of its components, or by activation of a systematic fault.

[SOURCE: IEC 60050-192:2024, 192-03-02]

3.1.1.5
hysteresis
phenomenon represented by a characteristic curve which has a branch, called ascending branch, for increasing values of the input variable, and a different branch, called descending branch, for decreasing values of the input variable

Note 1 to entry: The CDD code of this entry for Electronic Data Exchange is ABB661 and the hysteresis is defined as the difference between consecutive upscale and downscale outputs for any single test cycle at the same input test point.

[SOURCE: IEC 60050-351:2013, 351-45-16, modified – The note to entry has been added.]

3.1.1.6
inaccuracy
maximum positive and negative deviation from the specified characteristic curve observed in testing a device under specified conditions and by a specified procedure

Note 1 to entry: The term “accuracy” is defined in IEC 60050-300:2001, 311-06-08.

3.1.1.7
linearity
ability of a measuring instrument to provide an indication having a linear relationship with a defined quantity other than an influence quantity

Note 1 to entry: The method of expression of lack of linearity is different for different kinds of instrument and is established in each particular instance.

[SOURCE: IEC 60050-311:2001, 311-06-05]

3.1.1.8
long-term drift
drift in output monitored for 30 days at 90 % of span

[SOURCE: IEC 61987-1:2024, 3.23]

3.1.1.9
long-term stability
drift of zero output signal in percent of full scale after a given period of normal operating conditions

Note 1 to entry: The long-term stability can be evaluated over a different period of time, e.g. 6 months, 1, 2 or 5 years.

Note 2 to entry: Depending on the type of PMT, the drift can be referred to an upper range limit (e.g. digital pressure PMTs), a fixed value (e.g. certain level PMTs), a full scale (e.g. some analogue PMTs), etc.

[SOURCE: IEC 61987 #ABB551 in the IEC common data dictionary, modified – Notes 1 and 2 to entry have been added.]

3.1.1.10
measured error
largest positive or negative value of errors of the average upscale or downscale values at each point of measurement

3.1.1.11
measuring range
range defined by two values of the measurand, or quantity to be supplied, within which the limits of uncertainty of the measuring instrument are specified

Note 1 to entry: An instrument can have several measuring ranges.

[SOURCE: IEC 60050-311:2001, 311-03-12]

3.1.1.12
non-conformity
deviation from ideal behavior for devices that have a non-linear input/output relationship (which can be linear, logarithmic, parabolic, etc.), determined from the curve plotted using the overall average of corresponding upscale and downscale errors

Note 1 to entry: Non-conformity can be calculated and expressed in one of three ways:

– independent: curve positioned so as to minimize the maximum deviation;

– terminal-based: curve positioned so as to coincide with the actual characteristic curve at the upper and lower range-values;

– zero-based: curve positioned so as to coincide with the actual characteristic curve at the lower range-value.

Note 2 to entry: The corresponding properties are to be found in the CDD.

[SOURCE: IEC 61987-13:2016, 3.3.6, modified – Specifications have been added in parentheses.]

3.1.1.13
non-linearity
deviation from ideal behavior for devices that have a linear input/out relationship, determined from the curve plotted using the overall average of corresponding upscale and downscale errors

Note 1 to entry: Non-linearity can be calculated and expressed in one of three ways:

– independent: line positioned so as to minimize the maximum deviation;

– terminal-based: line positioned so as to coincide with the actual characteristic curve at the upper and lower range-values;

– zero-based: line positioned so as to coincide with the actual characteristic curve at the lower range-value.

Note 2 to entry: The corresponding properties are to be found in the CDD.

[SOURCE: IEC 61987-13:2016, 3.3.7]

3.1.1.14
overrange
input signal larger than an instrument is designed to accept or measure

Note 1 to entry: That part of the proportional range where the analogue output signal represents a process value above the configured measuring range.

Note 2 to entry: The output signal can be not calibrated in overrange state.

3.1.1.15
overshoot
for a step response, the maximum transient deviation from the final steady-state value of the output variable, expressed as a percentage of the difference between the final and the initial steady-state values

[SOURCE: IEC 61987 #ABD684 in the IEC common data dictionary]

3.1.1.16
repeatability
closeness of agreement between the results of successive measurements of the same measurand, carried out under the same conditions of measurement, i.e.:

– by the same measurement procedure,
– by the same observer,
– with the same measuring instruments, used under the same conditions,
– in the same laboratory,
– at relatively short intervals of time.

Note 1 to entry: The concept of "measurement procedure" is defined in VIM 2.5.

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

3.1.1.17
signal
physical variable quantity, one or more parameters of which carry information about one or more variable quantities

Note 1 to entry: These parameters are designed "information parameters".

Note 2 to entry: This entry was numbered 351-21-51 in IEC 60050-351:2006.

[SOURCE: IEC 60050-351:2013, 351-41-17]

3.1.1.18
span
algebraic difference between the values of the upper and lower limits of the measuring range

Note 1 to entry: The limits shall not be considered as physical limits regarding the capabilities of the device, but rather as the upper and lower values defined for the relevant application.

[SOURCE: IEC 61987 #ABB785 in the IEC common data dictionary ("other variables" removed)].

3.1.1.19
span error
difference between the actual span and the ideal span, expressed as percentage of ideal span

[SOURCE: IEC 61987 # ABB655 in the IEC common data dictionary].

3.1.1.20
stability
ability of a measuring instrument to keep its performance characteristics unchanged during a specified time interval, all other conditions being the same

[SOURCE: IEC 60050-311:2001, 311-06-12]

3.1.1.21
warm-up time
duration between the instant when the power supply is energized and the instant when the instrument can be used, as specified by the manufacturer

[SOURCE: IEC 61987 #ABB026 in the IEC common data dictionary]

3.1.1.22
settling time
time interval between the step change of an input signal and the instant when the resulting variation of the output signal does not deviate more than 1 % from its steady state value

[SOURCE: IEC 61987 #ABA999 in the IEC common data dictionary]

3.1.1.23
output signal
analogue or digital representation of the measurand produced by a transmitter

Note 1 to entry: A transmitter is a transducer with standardized output, see IEC 60050-351-2013, 351-56-29.

[SOURCE: IEC 60050-314:2001, 314-04-06, modified: “transducer” has been replaced by “transmitter”.]

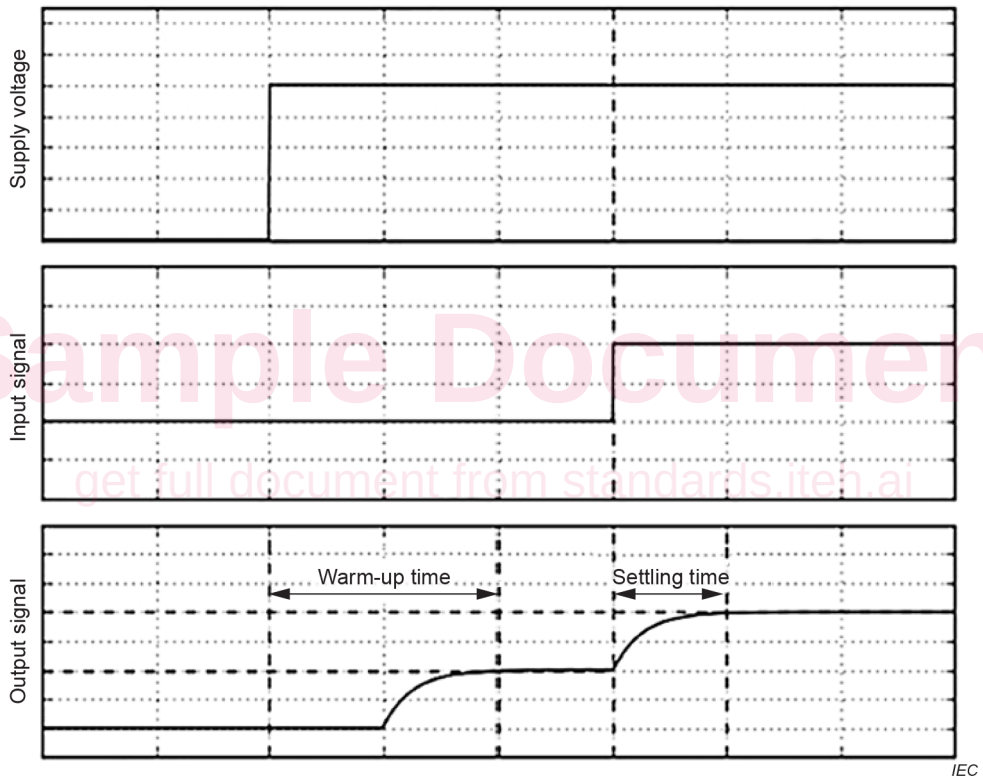

Figure 1 – Principle diagram illustrating the definitions of warm-up time, settling time and output signal

3.1.1.24
start-up drift
drift in output monitored after a defined period of time following power on

3.1.1.25
step response time
duration between the instant when the measurand (or quantity supplied) is subjected to a specified abrupt change and the instant when the indication (or quantity supplied) reaches, and remains within specified limits of, its final steady-state value

Note 1 to entry: This definition is the one conventionally used for measuring instruments. Other definitions exist.

Note 2 to entry: The dead time of the transmitter response is included in the step response time (see Figure 5 and Figure 6).

[SOURCE: IEC 60050-311:2001, 311-06-04, modified – Note 2 has been added.]

3.1.1.26
true value
value consistent with the definition of a given particular quantity

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

Note 2 to entry: This is a value that would be obtained by a perfect measurement.

Note 3 to entry: True values are by nature indeterminate.

Note 4 to entry: The indefinite article "a", rather than the definite article "the", is used in conjunction with "true value" because there can be many values consistent with the definition of a given particular quantity.

[SOURCE: IEC 60050-311:2001, 311-01-04]

3.1.1.27
conventional true value (of a quantity)
value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose

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

Note 2 to entry: The "conventional true value" is sometimes called "assigned value", "best estimate of the value", "conventional value" or "reference value". The term "reference value", in this sense, should not be confused with "reference value" in the sense used in 311-07-01.

Note 3 to entry: Frequently, a large number of results of measurement of a quantity are used to establish a conventional true value.

Note 4 to entry: Traditional definitions, based on the true value approach, treated the conventional true value as a value approximating to a true value of the quantity such that the difference could be neglected for the purposes for which that value was used.

[SOURCE: IEC 60050-311:2001, 311-01-06]

3.1.1.28
variable quantity
variable
physical quantity the value of which is subject to change and can usually be measured

Note 1 to entry: The term "variable" alone is frequently used to circumvent the lengthy but correct designation "variable quantity".

[SOURCE: IEC 60050-351:2013, 351-41-01]

3.1.1.29
zero offset
deviation of the actual zero output from the specified zero output

Note 1 to entry: For example, the specified output of a 4-20 mA PMT is 4 mA.