# IEC 62828-5

Edition 1.0 2020-08

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

**Reference conditions and procedures for testing industrial and process measurement transmitters –
Part 5: Specific procedures for flow transmitters**

**Conditions de référence et procédures pour l'essai des transmetteurs de mesure industriels et de processus –
Partie 5: Procédures spécifiques pour les transmetteurs de débit**



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## FOREWORD

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The IEC 62828 series cancels and replaces the IEC 60770 series and proposes revisions for the IEC 61298 series.

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

| FDIS | Report on voting |
|---|---|
| 65B/1179/FDIS | 65B/1181/RVD |

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

This International Standard is to be used in conjunction with IEC 62828-1:2017.

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 "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- withdrawn,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

Most of the current IEC standards on industrial 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) and towards the measuring section (mostly mechanical). Even if some standards dealing with digital transmitters already exist, they are not sufficient, since some aspects of the performance are not covered by appropriate test methods.

In addition, the existing IEC test standards for industrial and process measurement transmitters are spread over many documents, so that for manufacturers and users it was 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, level, flow, etc.).

To help the manufacturers and users, it was decided to review, complete and reorganize the existing IEC standards on the industrial and process measurement transmitters and to create a more suitable, effective and comprehensive standard series that provides, in a systematic way, all the needed specifications and tests for the 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 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;
- performances (their specification, tests and verification);
- environmental protection, hazardous areas application, functional safety, etc.;
- structure of the technical documentation.

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

- IEC 62828-1: *General procedures for all types of transmitters*
- IEC 62828-2: *Specific procedures for pressure transmitters*
- IEC 62828-3: *Specific procedures for temperature transmitters*
- IEC 62828-4: *Specific procedures for level transmitters*
- IEC 62828-5: *Specific procedures for flow transmitters*

In preparing the IEC 62828 series (all parts), many test procedures were taken, with the necessary improvements, from the IEC 61298 series. Because the IEC 61298 series is currently applicable to all process measurement and control devices, when the IEC 62828 series is completed, the IEC 61298 series will be revised to harmonize it with the IEC 62828 series, taking out from its scope the industrial and process measurement transmitters. During the time when the scope of the IEC 61298 series is being updated, the new IEC 62828 series takes precedence for industrial and process measurement transmitters.

When the IEC 62828 series is published, the IEC 60770 series will be withdrawn.

# REFERENCE CONDITIONS AND PROCEDURES FOR TESTING INDUSTRIAL AND PROCESS MEASUREMENT TRANSMITTERS –

## Part 5: Specific procedures for flow transmitters

## 1 Scope

This part of IEC 62828 establishes specific procedures for testing flow transmitters used in measuring and control systems for industrial process and for machinery control systems. For general test procedures, reference is to be made to IEC 62828-1:2017, applicable to all types of industrial and process measurement transmitters.

This document – together with IEC 62828-1:2017 – is the reference standard for testing every type of flow transmitter, not only for liquids but also for gases and for steam.

In this document, "industrial flow transmitters" consistently covers all types of flow transmitters used in measuring and control systems for industrial process and for machinery.

## 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 62828-1:2017, *Reference conditions and procedures for testing industrial and process measurement transmitters – Part 1: General procedures for all types of transmitters*



IEC 61987-12, *Industrial-process measurement and control – Data structures and elements in process equipment catalogues – Part 12: Lists of properties (LOPs) for flow measuring equipment for electronic data exchange*

ISO 4185, *Measurement of liquid flow in closed conduits – Weighing method*

ISO 17025, *General requirements for the competence of testing and calibration laboratories*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62828-1 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

### 3.1 Terms related to the flow transmitters

**3.1.1**
**adjustment**
properties characterizing the means provided for the adjustment of a device

[SOURCE: Identifier ABC081 in the IEC common data dictionary]

**3.1.2**
**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: 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: Often, the first step alone in the above definition is perceived as being calibration.

[SOURCE: ISO/IEC Guide 99:2007, 2.39]

**3.1.3**
**fluid**
general category for gases, steams and liquids, which are substances that continuously deform under the action of shear stress and at rest cannot withstand shear stress

**3.1.4**
**maximum flow rate**
corresponds to maximum measurand regarding flow rate $Q_{max}$, and this $Q_{max}$ can be also the maximum working flow



**3.1.5**
**minimum flow rate**
corresponds to minimum measurand regarding flow rate $Q_{min}$, and this $Q_{min}$ can be the minimum working flow

**3.1.6**
**nominal range**
range of indications obtainable with a particular setting of the controls of a measuring instrument

Note 1 to entry: The nominal range is normally stated in terms of its lower and upper limits. Where the lower limit is zero, the nominal range is commonly stated solely in terms of its upper limit.

[SOURCE: IEC 60050-311:2001, 311-03-14]

**3.1.7**
**pressure loss**
static pressure difference between the inlet and the outlet of a flow meter or flow meter package (consisting of flow meter, inlet/outlet pipe sections and flow straightener or any other flow conditioning device), to be given as function of flow rate and viscosity

**3.1.8**
**Reynolds number**
dimensionless quantity characterizing the flow of a fluid in a given configuration characterized by a specified length $l$, defined by $Re = \rho v l / \eta = v l / \gamma$, where the fluid is described by its mass density $\rho$, velocity $v$, dynamic viscosity $\eta$, and kinematic viscosity $\gamma$

[SOURCE: IEC 60050-113:2011, 113-03-36, modified – In the definition, "quantity of dimension 1" replaced by "dimensionless".]

**3.1.9**
**zero and span adjustment**
means provided for adjusting the zero and span

[SOURCE: IEC 61987, ABA896 modified]

**3.1.10**
**viscosity**
for a fluid with laminar flow in x-direction, thus for which $v_y = v_z = 0$ and $v_x = v_x(z) \geq 0$, where $x$, $y$, $z$ are Cartesian coordinates, scalar quantity characterizing internal friction

Note 1 to entry: The coherent SI unit of dynamic viscosity is pascal second, Pa·s.

[SOURCE: IEC 60050-113:2011, 113-03-34, modified – The end of the definition has been omitted.]

**3.1.11**
**voltage fluctuation**
series of voltage changes or a continuous variation of the RMS or peak value of the voltage

[SOURCE: IEC 60050-161:1990, 161-08-05, modified – The note has been omitted.]

## 3.2 Terms related to the flow velocity

**3.2.1**

**assigned flow velocity range**
properties characterizing a range configured at the factory for flow velocity

[SOURCE: IEC 61987, ABD493]



**3.2.2**
**maximum flow velocity**
highest flow velocity for which a device is or must be designed to operate within its specified limits

[SOURCE: IEC 61987, ABF560]

**3.2.3**
**span for flow velocity**
difference between the upper and lower range of flow velocity to which a flow velocity measurement instrument is adjusted.

[SOURCE: IEC 61987, ABD435]

**3.2.4**
**line-pack effect**
uncertainty contribution due to the compressibility and the time delay at flowing pressure and temperature in pipelines

Note 1 to entry: A pipeline, particularly in the oil and gas industry is used to transport natural gas over long distances and can also be used to store that gas before and during transportation. Noteworthy, the compressibility of the gas allows the storing of gas in pipelines to be performed temporarily. This technique is called "line packing", i.e. a method used for providing short-term gas storage in which natural gas is compressed in transmission lines, providing additional amounts of gas to meet limited peak demand.

### 3.3 Reference to the IEC common data dictionary (CDD)

The IEC common data dictionary (CDD) contains a classification of measuring devices with lists of properties for the device types most often met in practice. These properties can be used to describe the performance of a device, the effect of any quantities influencing its performance as well as the reference standards against which it was tested with test results.

Each property has a unique identifier, e.g. ABB551, which is quoted in this document as appropriate. By entering the appropriate properties in the LOPs, it is possible to exchange test results electronically between interested parties. The CDD is to be found at the following address: http://std.iec.ch/cdd/iec61987/cdddev.nsf.

The various measuring devices are to be found in the domain "Process automation (IEC 61987 series)"; ABA000 – Equipment for industrial-process automation; ABV000 – Characterization; ABA001 – Measuring Instruments. The device characterization is also to be found in IEC 61987-11.

## 4 General description of the device

### 4.1 General

As flow transmitters have many kinds of classified types and various features, more detailed type and feature information of flow transmitters can be found in IEC 61987-12 (see flow Process Measurement Transmitter (PMT)). Table D.1 in Annex D is a summary of the flow PMT described in IEC 61987-12.



### 4.2 Differential pressure flowmeters

All flowmeters that use differential pressure to calculate flow rate, i.e. Venturi tubes, Venturi nozzles, orifice plates, nozzles, pitot tubes. These meters constrict the flow in the pipe by using some form of primary element.



The relationship between measured differential pressure and flow rate is a function of:

– tap location,
– primary element design,
– up-stream and down-stream piping, and
– discharge coefficient, which minimizes effects of actual flow rate against theoretically calculated flow rate.

The output of the flowmeters is the flow velocity, which is proportional to the square root of the differential pressure divided by the fluid density.

### 4.3 Velocity flowmeters

All flowmeters where the velocity of the fluid inside the meter is the basis for the calculation of flow, i.e. turbine, electromagnetic, vortex, ultrasonic, variable area meter.

The output of the flowmeters is proportional to the flow velocity and the pipe cross section. The relationship between the change of velocity and flow rate is approximately linear.

### 4.4 Volumetric flowmeters

All flowmeters where the output corresponds directly to a certain volume of fluid passing through the inside of the meter, i.e. positive displacement meter.

The output of the flowmeters is proportional to the displaced volume.

### 4.5 Mass flowmeters

This includes all flowmeters where the output corresponds directly to a certain mass of fluid passing through the inside of the meter, i.e. Coriolis mass flowmeters, thermal mass flowmeters.

## 5 Reference test conditions and service conditions

The corresponding clause of IEC 62828-1:2017 applies in full, both for reference test conditions and for service conditions.

## 6 Test procedures

### 6.1 General

Clause 6 of IEC 62828-1:2017 applies, with the following additional requirements, applicable to any fluids: liquid, gas and steam.

There are several methods used for flow calibration and testing: comparison against a reference meter is one of them. For more accurate measurements, primary methods such as gravimetric, or pressure-based or volume-based references shall be preferred.

Table A.1 in Annex A summarizes all the tests for different measurement principles at the reference and service conditions.



Annex B and Annex C describe the methods and the requirements for the calibration and verification of flow transmitters and for preparing a test report.



Acceptance tests are typically defined and agreed specifically between the manufacturer and the user in accordance with Annex E. Nevertheless, all tests in this document can also be used as the basis for any acceptance tests.

### 6.2 Tests at standard and operating reference test conditions

#### 6.2.1 General requirements

For the majority of the tests on every type of flow transmitters, the corresponding clause of IEC 62828-1:2017 applies, in particular see:

– Annex B in IEC 62828-1:2017 for the summary of the tests at the standard reference conditions, and
– Annex C in IEC 62828-1:2017 for the summary of the tests at the operating reference conditions.

All tests shall be carried out under the installation conditions (straight sections of piping upstream and downstream of the flow transmitter, flow conditioners, etc.) stipulated by the supplier of the type of flow transmitter to be tested.

During the tests, corrections shall be made for temperature and pressure differences between the flow transmitter under test and the reference standard; otherwise, these differences have to be taken into account in the uncertainty calculations.

The temperature and pressure measurements have to be performed at a representative position on the flow transmitter under test and on the reference standard meter.

After settling or plumbing the reference flow transmitter and the testing flow transmitter to the prescribed portion on the facility, the measurand is flowed in the plumbing or the pipe fittings.

When the measurand is a liquid, the facility needs an air bleeding capability at the high point in the line to release trapped vapors to fill the measurand in the plumbing or the pipe fittings. Prior to testing, confirm the status of the plumbing or the pipe fittings for additional potential sources that can introduce error, such as vibration or leakage. If the status requires amending, it shall address these matters. Depending on the measuring principle, further properties of the test fluid (e.g. density, viscosity, conductivity) that can have a significant influence on the flow transmitter behaviour shall be considered in the test procedures.

If not stated otherwise in the uncertainty examination document of the test bench, the stability requirements of Table 1 shall be respected.

**Table 1 – Stability requirements during the measurement**

| | For gases | For liquids |
|---|---|---|
| Stability of the instantaneous flow rate | ≤ 3 % | ≤ 3 % |
| Static medium pressure drift | ≤ 0,2 % within 100 s | ≤ 5 % within 100 s |
| Medium temperature range for inaccuracy test | 10 °C to 40 °C | 10 °C to 40 °C |
| Medium temperature drift during the measurement of single test flow rate | ≤ 0,2 K | ≤ 0,5 K |
| Medium temperature drift over the entire tests | ≤ 2 K | ≤ 5 K |
| NOTE Greater pressure variations are allowed if the line-pack effect (see 3.2.4) is corrected and the uncertainty examination of the test facility shows that the above-mentioned requirements have been fulfilled. | | |



If these conditions are not satisfied during the measurement of a test point, the measurement result is to be rejected and the measurement has to be repeated.



In addition, the specific tests of 6.2, 6.3, 6.4 and 6.5 apply to flow transmitters.

### 6.2.2 Requirements with different test fluids

#### 6.2.2.1 Test gases (applies to flow transmitters for gas only)

a) Required gases for type evaluation tests

All the tests may be performed with air or any other gas as specified by the manufacturer under the rated operating conditions stated in Clause 5. For the temperature tests, it is important that the gas be dry.

Flow transmitters intended to measure different gases are to be evaluated with the gases specified by the manufacturer.

b) Evaluation for the use of an alternative test gas during verification

When flow transmitters are to be verified (at initial or subsequent verification) with air, the type evaluation test as stated in 6.2.3.15 shall include air.

When flow transmitters are to be verified with a type of gas different from that at operating conditions, the type evaluation test as stated in 6.2.3.15 shall include such a type of gas.

In both cases mentioned, the maximum differences between the error curves of the intended test gas and the gas in-use are calculated and the need to use correction factors during the verification test is established as follows:

- If these differences stay within 1/3 of the measurement uncertainty of the stated inaccuracy, the initial or subsequent verification may be performed with the alternative gas.
- If these differences exceed 1/3 of the measurement uncertainty of the stated inaccuracy, the initial or subsequent verification may only be performed with the alternative gas if a correction for the differences is applied.

It shall be documented whether the initial or subsequent verification may be performed with air (or the other gas(-es)) and whether correction factors shall be applied.

#### 6.2.2.2 Test liquids (applies to flow transmitters for liquid only)

a) Required liquids for type test evaluations

All the tests may be performed with water or any other liquid as specified by the manufacturer under the rated operating conditions stated in Clause 5.

Flow transmitters intended to measure different liquids are to be tested with the liquids specified by the manufacturer.

As viscosity and density of the fluid can influence the flow transmitter performance, these values have to be monitored, directly or indirectly, during the tests and are to be documented.

When flow transmitters are to be verified with test liquids different from the specified liquid, the maximum differences between the meter characteristics with the intended test liquid and the liquid in-use are calculated and the need to use correction factors during verification test is established as follows:

- If these differences stay within 1/3 of the measurement uncertainty of the stated inaccuracy, the initial or subsequent verification may be performed with the alternative liquid.
- If these differences exceed 1/3 of the measurement uncertainty of the stated inaccuracy, the initial or subsequent verification may only be performed with the alternative liquid if a suitable correction for the differences is applied. This correction and its uncertainty have to be documented.



b) Complete filling of the measuring system

The flow transmitter and the pipework between the transmitter and the other components of the test bench shall be kept full of liquid during measurement and during shutdown periods.

c) Elimination of air or gases



Measuring systems shall incorporate a gas elimination device for the proper elimination of any air or undissolved gases which can be contained in the liquid before it enters the flow transmitter. Gas elimination devices shall be installed in accordance with the manufacturer's instructions.

In the case that neither air intake nor gas release will occur in the liquid upstream of the flow transmitter, a gas elimination device is not required.

d) Control and closing mechanisms

If there is a risk that the supply conditions can generate overload pressure or flow in the pipeline at the flow transmitter, a flow-limiting device should be provided. This device needs be installed downstream of the transmitter. Such a device shall allow the flow transmitter to be isolated from the test loop.

#### 6.2.2.3 Test steam (applies to flow transmitters for steam only)

As steam neither can be classified as a gas nor a liquid, to verify the specifications of a flow transmitter for steam applications, special test procedures are required.

There are three conditions of steam:

- wet steam;
- saturated steam;
- overheated steam.

Because there is a lack of test stands for steam, it is acceptable to perform tests with dry gas/water. In these cases, it is necessary to add uncertainty contributions to the measurement error. In particular, influences of temperature, pressure and steam humidity have to be considered.