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**Transmitters for use in industrial-process control systems –
Part 3: Methods for performance evaluation of intelligent transmitters**
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**Transmetteurs utilisés dans les systèmes de commande des processus
industriels –**
<https://standards.iteh.ai/catalog/standards/sist/5ff7d0d1-3fb-4768-b171->
Partie 3: Méthodes d'évaluation des performances des transmetteurs intelligents



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**TRANSMITTERS FOR USE IN INDUSTRIAL-PROCESS
CONTROL SYSTEMS –****Part 3: Methods for performance evaluation
of intelligent transmitters**

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The International Standard IEC 60770-3 has been prepared by subcommittee 65B: Measurement and control devices, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 2006. This edition constitutes a technical revision.

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

- a) Introduction.
- b) Terms and definitions: all definitions already present in IEC 60050 and in IEC 61298 have been deleted.
- c) All parts: added concept of wireless transmitters.

The text of this standard is based on the following documents:

FDIS	Report on voting
65B/917/FDIS	65B/930/RVD

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

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

A list of all parts in the IEC 60770, published under the general title *Transmitters for use in industrial-process control systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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INTRODUCTION

New transmitters for use in industrial process control systems are now equipped with micro-processors which utilise digital data processing and communication methods, auxiliary sensors and artificial intelligence. This makes them more complex than conventional analogue transmitters and gives them considerable added value.

An intelligent transmitter is an instrument that uses digital data processing and communication methods for performing its functions and for safeguarding and communicating data and information on its operation. It may be equipped with additional sensors and functionality which support the main function of the intelligent transmitter. The variety of added functionality can for instance enhance accuracy and rangeability, self-test capabilities, and alarm and condition monitoring. Therefore accuracy-related performance testing, although still a major tool for evaluation, is no longer sufficient to show the flexibility, capability and other features with respect to engineering, installation, maintainability, reliability and operability.

Because of the complexity of intelligent transmitters, a close collaboration should be maintained between the evaluating body and the manufacturer during the evaluation. Note should be taken of the manufacturer's specifications for the instrument, when the test programme is being decided, and the manufacturer should be invited to comment on both the test programme and the results. His comments on the results should be included in any report produced by the testing organisation.

This part of IEC 60770 addresses, in its main body, structured and mandatory methods for a design review and performance testing of intelligent transmitters. Intelligent transmitters will, in many cases, also have the capacity to be integrated into digital communication (bus) systems, where they have to co-operate with a variety of devices. In this case, dependability, (inter)operability and real-time behaviour are important issues. The testing of these aspects depends largely on the internal structure and organisation of the intelligent transmitter and the architecture and size of the bus system. The Annexes A, B and C give a non-mandatory methodology and framework for designing specific evaluation procedures for dependability and throughput testing and function block testing in a specific case.

When a full evaluation, in accordance with this part of IEC 60770, is not required or possible, those tests which are required, should be performed and the results reported in accordance with the relevant parts of this standard. In such cases, the test report should state that it does not cover the full number of tests specified herein. Furthermore, the items omitted should be mentioned, in order to give the reader of the report a clear overview.

The structure of this part of IEC 60770 largely follows the framework of IEC 62098. For performance testing, the IEC 61298 series should also be consulted. A number of tests described there are still valid for intelligent transmitters. Further reading of the IEC 61069 series is recommended, as some notions in this part of IEC 60770 are based on concepts brought forward therein.

TRANSMITTERS FOR USE IN INDUSTRIAL-PROCESS CONTROL SYSTEMS –

Part 3: Methods for performance evaluation of intelligent transmitters

1 Scope

This part of IEC 60770 specifies the following methods.

- Methods for
 - assessment of the functionality of intelligent transmitters;
 - testing the operational behaviour, as well as the static and dynamic performance of an intelligent transmitter.
- Methodologies for
 - determining the reliability and diagnostic features used to detect malfunctions;
 - determining the communication capabilities of the intelligent transmitters in a communication network.

The methods and methodologies are applicable to intelligent transmitters, which convert one or more physical, chemical or electrical quantities into digital signals for use in a communication network (as specified in the IEC 61158 series or others) or into analogue electrical signals (as specified in the IEC 60381 series).

The methods and methodologies listed in this part of IEC 60770 are intended for use by:

- manufacturers to determine the performance of their products, and
- users or independent testing laboratories to verify equipment performance specifications.

Manufacturers of intelligent transmitters are urged to apply this part of IEC 60770 at an early stage of development.

This standard is intended to provide guidance for designing evaluations of intelligent transmitters by providing:

- a checklist for reviewing the hardware and software design in a structured way;
- test methods for measuring and qualifying the performance, dependability and operability under various environmental and operational conditions;
- methods for reporting the data obtained.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

IEC 60381 (all parts), *Analogue signals for process control systems*

IEC 60529, *Degree of protection provided by enclosures (IP Code)*

IEC 60721-3 (all parts), *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities*

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

IEC 61032, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

IEC 61298 (all parts), *Process measurement and control devices – General methods and procedures for evaluating performance*

IEC 61298-1:2008, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 1: General considerations*

IEC 61298-2:2008, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 2: Tests under reference conditions*

IEC 61298-3:2008, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 3: Tests for the effects of influence quantities*

IEC 61298-4, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 4: Evaluation report content*

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

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

IEC 61499 (all parts), *Function blocks*

IEC 61804 (all parts), *Function blocks (FB) for process control*

CISPR 11, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-300, in the IEC 61298 series and the following apply.

3.1

intelligent transmitter

transmitter provided with means for bi-directional communication with external systems and human operators for sending measurement and status information and receiving and processing external commands

3.2

single variable transmitter

transmitter that measures one single physical quantity

3.3 multivariable transmitter

transmitter that measures two or more identical or different physical quantities

3.4 adjustment

set of operations carried out on a measuring instrument in order that it provides given indications corresponding to given values of the measurand

Note 1 to entry: When the instrument is made to give a null indication corresponding to a null value of the measurand, the set of operations is called zero adjustment.

Note 2 to entry: Many manufacturers use the term calibration for adjustment of zero, span and linearity or conformity.

3.5 tuning

process of adjusting the various instrument parameters, required for obtaining a stable and optimal measurement

Note 1 to entry: This can range from "trial and error" to an automatic proprietary procedure provided by the manufacturer.

3.6 configuring

process of implementing the functionality required for a certain application

3.7 configurability

extent to which an intelligent transmitter can be provided with functions to control various applications

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3.8 set-up

process of configuring, calibrating and tuning a transmitter for optimal measurement

3.9 operating mode

selected method of operation of a transmitter

4 Design assessment

4.1 General

The design review is meant to identify and make explicit, in a structured way, the functionality and capabilities of the intelligent transmitter under consideration. As stated in the introduction, intelligent transmitters appear in a great variety of designs. A design review is the necessary tool for showing the details of:

- the physical structure,
- the functional structure.

Subclause 4.2 guides the evaluator through the process of describing the physical structure of intelligent transmitters by identifying the hardware modules and the inputs and outputs to the operational and environmental domains. Thereafter, the functional structure can be described, using the checklist of 4.3. The checklist gives a framework of the relevant issues, which need to be addressed by the evaluator, mainly through adequate qualitative and quantitative experiments.

4.2 Transmitter analysis

4.2.1 General

Two different types of transmitters can be identified:

- **Single variable transmitter.** The measured value (output) represents one single physical quantity measured by one type of sensor.
- **Multivariable transmitter.** This type of transmitters appears in two versions:
 - An instrument providing a variety of measured values (outputs), each of which is related to a measurement of one distinct input quantity with a specific sensor.
 - An instrument providing derived measured values resulting from the measurement of more than one quantity through more than one type of sensor and processed through a distinct algorithm (e.g. flow computer, mechanical power meter). In many cases, the individual measured variables are also available to the user.

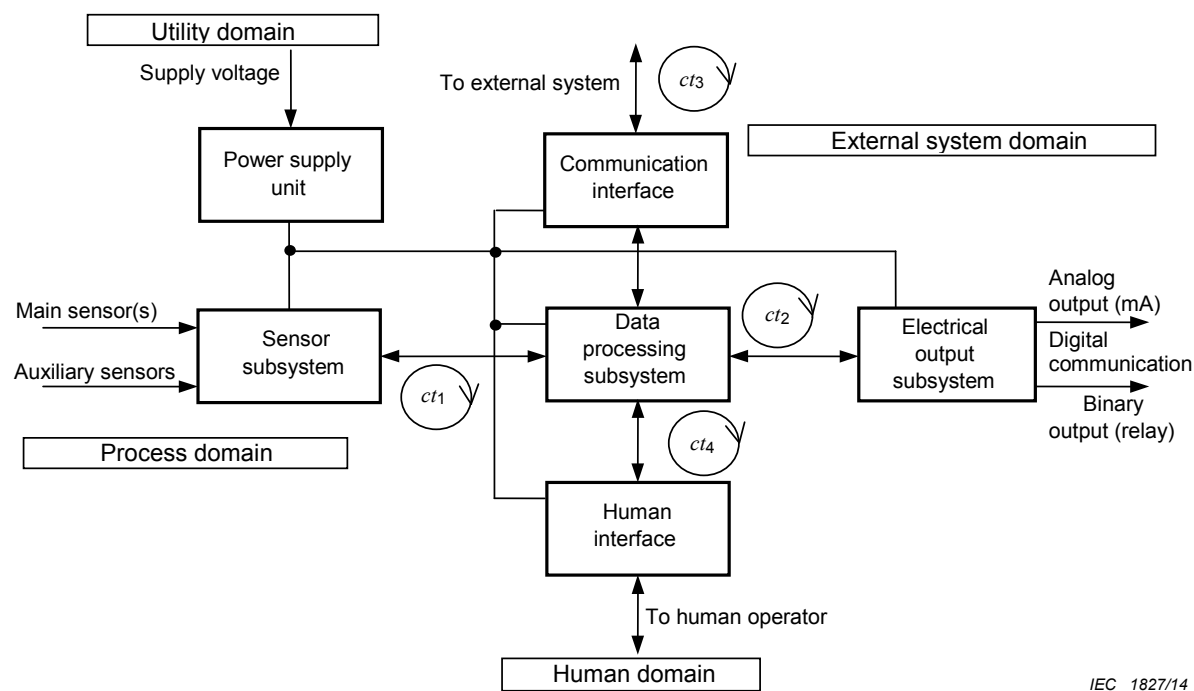
Each type of intelligent transmitter may be equipped with independent auxiliary sensors and auxiliary (mainly digital) outputs, which are not involved in the primary measurement process.

The generic transmitter model of Figure 1 gives a maximum configuration and is a tool for setting up a block scheme and concise description of the transmitter to be evaluated. It is also important for defining the functions to be considered in the performance tests (see Clause 5).

Functionally, a transmitter is an information transformer. Data enters and then exits the instrument through the various (external) domains given in Figure 1, following distinct data flow paths. The following paths can be defined, but are not always resident in a specific transmitter under consideration:

- Sensors (process domain) to external systems (remote data processing systems).
- Sensors (process domain) to operator displays (human domain).
- Sensors (process domain) to external systems (electrical outputs).
- Operator commands through local keyboard (human domain) to data processing subsystem, consequently affecting the above-mentioned data flows to external systems (remote data processing systems and electrical outputs).
- Remote commands (from external remote data processing systems) to the instrument's data processing subsystem, consequently affecting the above-mentioned data flows to external systems (electrical outputs) and local operator displays (human domain).

A block scheme and description shall be included in the evaluation report and may be enhanced with photographs or drawings of important details.



IEC 1827/14

Key

ct cycle time

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Figure 1 – Intelligent transmitter model

For an intelligent transmitter, the main physical modules and provisions for connection to external systems and human operators are defined in 4.2.2 to 4.2.9.

4.2.2 Data processing subsystem

The data processing subsystem is the heart of an intelligent transmitter. Its main function is to provide and process the measured quantity(ies) for further real-time use by the human and communication interfaces and/or at the electrical output subsystem. Many transmitters measure one quantity by means of one (main) sensor, but derived measured values such as heat or mass flow and mechanical power require more sensors.

Besides the main measurement function, a transmitter may be equipped with a number of additional functions that can vary considerably from make to make. Amongst the additional functions that may be resident in a transmitter are:

- configuration;
- adjustment and tuning;
- self-testing, diagnostics, condition monitoring;
- external process control function;
- trending and data storage.

Part of the functionality may be located in external devices that are temporarily or continuously connected to the communication interface (e.g. configuring, trending).

4.2.3 Sensor subsystem

The sensor subsystem converts the physical or chemical quantity(ies) to be measured into electrical signals that are conditioned and digitised for use by the data processing unit. The subsystem may also be equipped with electrical circuits for sensing binary signals (e.g. change

measurement range on an external command), or auxiliary sensors of a different type (e.g. auxiliary for compensation or internal diagnostics and condition monitoring purposes).

The sensor and sensor subsystem may be integrated with the other modules in one enclosure. The sensor can also be located remotely (e.g. densitometer, thermocouple transmitter). Certain transmitters (e.g. thermocouple and resistance thermometer detector (RTD)) utilise standardised (third party) sensors that provide an electric signal. In such a case, it may be agreed to perform the evaluation with an acceptable simulator instead of the application of the actual quantity.

Depending on the measurement principle used, the sensor may not require auxiliary (external) power (e.g. thermocouples) or it may require auxiliary power (e.g. strain gauges) or a specifically characterised power source (e.g. electromagnetic and Coriolis flowmeters).

Sensors are, in general, incorporated in the process installations and in many cases, they may also be in direct contact with the process medium. As such, medium properties, medium conditions and installation conditions may adversely influence them. As a remote unit, the sensor may also be subjected to more severe environmental conditions than the other subsystems. Moreover, it shall also be considered whether it is necessary to apply combined environmental and process conditions during an evaluation.

As part of the design review, a list of the types of sensors that are provided and their measuring ranges shall be compiled.

4.2.4 Human interface

The human interface is an important tool for direct interaction and communication with the human operator. It consists of integral means at the instrument for reading out data (local display) and provisions for entering and requesting data (local pushbuttons). Instruments may be provided that are not equipped with a human interface. Access to the database is then provided via the communication interface and the external system or a handheld terminal.

A list of the measurement data that can be shown on the display and the refresh rates, as well as the status data that can either automatically or on request be made available to the operator shall be tabulated. In addition, a summary of the functions and facilities for access and data presentation shall be made.

4.2.5 Communication interface

Transmitter intelligence is supported by the communication interface, which connects the instrument to external systems. Through the interface (wired or wireless), measurement and control data are transferred and access is also provided to the instrument's configuration data. In the case of hybrid (SMART) instruments, the digital signal is superimposed on an analogue current signal and it is made available at the electrical output subsystem. There may be instruments which do not have a communication interface. Then configuration and read-out of data may take place via the human interface

A list of the measurement data that can be transferred to a host and the refresh rates should be compiled. A summary of the status data that can either automatically or on request be transferred to the host shall also be listed. The functions and facilities for access and data presentation shall also be indicated.

4.2.6 Electrical output subsystem

Instruments suitable for connection to a fieldbus (or wireless) need not necessarily be provided with an electrical output subsystem.

The electrical output subsystem primarily converts digital information provided by the data processing subsystem into one or more analogue electrical signals. It may also be equipped