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Industrial process control systems - Methods of evaluating the performance of valve positioners with pneumatic outputs -
Part 2: Test Methods for intelligent positioners mounted on an actuator valve assembly

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Industrial process control systems - Methods of evaluating the performance of valve positioners with pneumatic outputs - Part 2: Test Methods for intelligent positioners mounted on an actuator valve assembly

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IEC 61514-2 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 third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

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

a) in 5.5.2, the standard for the measurements of influence quantities has been changed to IEC 62828-1:2026;
b) all references to IEC 61514 have been updated to IEC 61514:2026;

c) the aspect of cyber-security has been added in 4.2.7 and 4.2.9.

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

Draft	Report on voting
65B/1315/FDIS	65B/1332/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.

This document is to be used in conjunction with IEC 61514:2026.

A list of all parts of the IEC 61514 series, published under the general title *Industrial process control systems*, 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– withdrawn, or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

New instruments for process control and measurement including valve positioners are mainly equipped with microprocessors, thereby utilising digital data processing and communication methods and/or artificial intelligence, making them more complex and giving them a considerable added value.

Modern intelligent valve positioners are no longer only controlling the valve position, but they are in many cases also equipped with various facilities for self-testing, actuator/valve condition monitoring and alarming. The variety of added functionalities is large. They can no longer be compared with the single function "cam-type" positioners. Therefore, accuracy related performance testing, although still very important, is no longer sufficient to demonstrate their flexibility, capabilities and other features with respect to engineering, installation, maintainability, reliability and operability.

In this document, the evaluation considers performance testing and a design review of both hardware and software. The layout of this document follows to some extent the framework of IEC TS 62098. A number of performance tests described in IEC 61514 are still valid for intelligent valve positioners.

1 Scope

This part of IEC 61514 specifies design reviews and tests intended to measure and determine the static and dynamic performance, the degree of intelligence and the communication capabilities of single-acting or double-acting intelligent valve positioners. The tests can be applied to positioners which receive standard analogue electrical input signals (as specified in IEC 60381-1 or IEC 60381-2) and/or digital signals via a data communication link (for example Fieldbus) and have a pneumatic output. An intelligent valve positioner as defined in Clause 3 is an instrument that uses for performing its functions digital techniques for data processing, decision-making and bi-directional communication. It can be equipped with additional sensors and additional functionality supporting the main function.

The performance testing of an intelligent valve positioner is conducted with the positioner mounted on and connected to the actuator/valve assembly the positioner is used on. The specific characteristic parameters of the actuator/valve combination such as size, stroke, friction, type of packing, spring package and supply pressure for the pneumatic part has significant impact on the performance of a positioner.

The methods of evaluation given in this document are intended for testing laboratories to verify equipment performance specifications. The manufacturers of intelligent positioners are urged to apply this document at an early stage of development.

This document is intended to provide guidance for designing evaluations of intelligent valve positioners by providing:

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

When a full evaluation, in accordance with this document, is not required or possible, the tests which are required are performed and the results reported in accordance with the relevant clauses of this document. In such cases, the test report will state that it does not cover the full number of tests specified herein. Furthermore, the items omitted are mentioned, to give the reader of the report a clear overview.

This document is also applicable for non-intelligent microprocessor-based valve positioners without means for bi-directional communication. In that case an evaluation will be reduced to a limited programme of performance testing and a review of the construction.

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 60050-300, *International electrotechnical vocabulary (IEV) - International Electrotechnical Vocabulary Electrical and electronic measurements and measuring instruments - Part 311: General terms relating to measurements - Part 312: General terms relating to electrical measurements - Part 313: Types of electrical measuring instruments - Part 314: Specific terms according to the type of instrument*

IEC 60050-351, *International electrotechnical vocabulary (IEV) - Part 351: Control technology*

IEC 60068-2-1, *Environmental testing - Part 2-1: Tests - Tests 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 60068-2-31, *Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens*

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

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60381-1, *Analogue signals for process control systems - Part 1: Direct current signals*

IEC 60381-2, *Analogue signals for process control systems - Part 2: Direct voltage signals*

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

IEC 60534-1, *Industrial-process control valves - Part 1: Control valve terminology and general considerations*

IEC 60654 (all parts), *Operating conditions for industrial-process measurement and control equipment*

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 61326-1:2020, *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61511 (all parts), *Functional safety - Safety instrumented systems for the process industry sector*

IEC 61514:2026, *Industrial-process control systems - Methods of evaluating the performance of valve positioners with pneumatic outputs*

IEC 62061, *Safety of machinery - Functional safety of safety-related control systems*

IEC 62828-1:2026, *Reference conditions and procedures for testing industrial and process measurement transmitters - Part 1: General procedures for all types of transmitters*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-311, IEC 60050-351 and IEC 61514 as well as 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

3.1
intelligent valve positioner
position controller based on microprocessor technology, and utilising digital techniques for data processing, decision-making and bi-directional communication

Note 1 to entry: It may be equipped with additional sensors and additional functionality supporting the main function.

Note 2 to entry: In this document, only positioners with pneumatic output signals are considered, as defined in 3.1 of IEC 61514:2026. The input signal may be an electric current or voltage, or a digital signal via a fieldbus.

Note 3 to entry: For non-intelligent microprocessor-based position controllers without bi-directional communication, an evaluation is reduced to a limited amount of performance testing and an abridged design review of the construction.

3.2
configuring
process of implementing the functionality required for a certain application

3.3
configurability
extent to which an intelligent positioner can be provided with functions to control various applications

3.4
calibration
process of adjusting the range of travel to the required value for acquiring a defined input-to-travel characteristic

Note 1 to entry: The adjusted travel can either be from stop to stop or to a value in between as defined by the valve manufacturer.

Note 2 to entry: Instruments may exist that are provided with an automatic procedure for travel range adjustment, which may then be addressed with the term auto-calibration.

Note 3 to entry: The calibration process describes the adjustment of a positioner to a given actuator/valve assembly and is not comparable with the definition given in IEC 60050-311:2001, 311-01-09.

3.5
tuning
process of adjusting the various control parameters for a certain application

Note 1 to entry: The stem position tuning procedure can range from "trial and error" to an automatic proprietary procedure provided by the manufacturer and often addressed as auto-tuning.

3.6
set-up
process of configuring, calibrating and tuning a positioner for optimal controlling of a specific actuator/valve assembly

3.7
travel cut-off
point close to the extreme end (low or high) of the characteristic curve at which the positioner forces the valve to the corresponding mechanical stop (fully closed or fully open)

3.8
stroke time
time required to travel between two different positions under a defined set of conditions

3.9
dead band
finite range of values of the input variable within which a variation of the input variable does not produce any measurable change in the output variable

[SOURCE: IEC 60050-351:2013, 351-45-15, modified – Notes 1 and 2 to entry have been removed.]

3.10
operating mode
selected method of operation of the positioner

Note 1 to entry: The above definition is different from the definition given in IEC 60050-351:2013, 351-55-01.

3.11
setpoint
input variable, which sets the desired value of the controlled variable (travel)

Note 1 to entry: The input variable can originate from an analogue source (mA or voltage) or from a digital source (fieldbus) or local keyboard.

3.12
balance pressure

average of the pressures on the opposite chambers of a double acting actuator in steady state condition

Note 1 to entry: The balance pressure shall be expressed as a percentage of the positioner supply pressure to evaluate the stiffness of the double acting system.

4 Design review

4.1 General

The observations of Clause 4 shall be based on open literature (manuals, instruction leaflets, etc.) provided to a user on delivery of the instruments and whatever the manufacturer is willing to disclose. They shall not contain confidential information.

The design review is meant to identify and make explicit the functionality and capabilities of the intelligent valve positioner under consideration in a structured way. As intelligent positioners appear in a great variety of designs a review has to show in a structured way the details of

– their physical structure;
– their functional structure.

Subclause 4.2 guides the evaluator in the process of describing the physical structure of intelligent positioners through identifying the hardware modules and the I/Os to the operational and environmental domains.

Thereafter the functional structure is described using the checklist of 4.3. The checklist gives a structured framework of the relevant issues, which have to be addressed by the evaluator through adequate qualitative and quantitative experiments.

4.2 Positioner identification

4.2.1 Overview

The structured identification process, based on the following considerations, leads to a block scheme and a concise description of the positioner under test, which shall be included in the evaluation report. It may be enhanced with photographs or drawings of important details.

The instrument, schematically shown in Figure 1, can have the following main physical modules and provisions for connection to the external world:

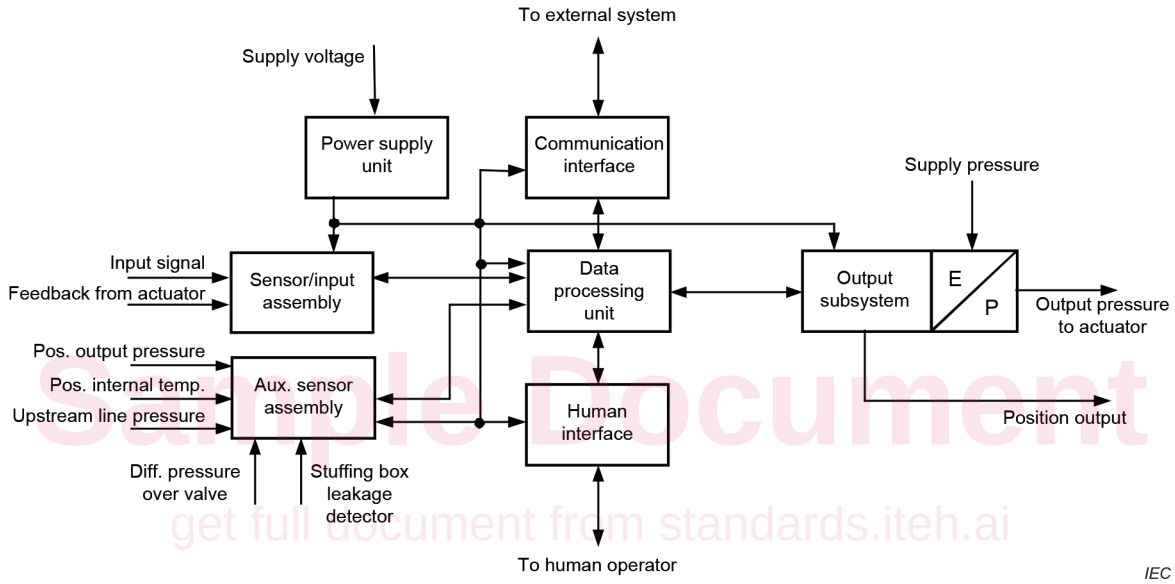

Figure 1 – Positioner model in extensive configuration

4.2.2 Power supply unit

Instruments that require a separate connection to an AC or DC supply voltage can exist. However, the majority of instruments are "loop powered" which means that they receive power either through the current input for instruments that need an analogue signal (mA) setpoint, or through the fieldbus when the setpoint is a digital signal.

4.2.3 Sensor/input assembly

The main sensor/input assembly is that part of the positioner to which the analogue setpoint is connected and which also receives the feedback signal from the actuator/valve assembly (stem movement). It supports the primary function of the positioner. Parts of the assembly can be distributed at physically different locations in the positioner. In instruments that receive a digital setpoint, the input signal W as shown in Figure 4 does not exist. The feedback signal can be generated by a mechanical linkage or a non-mechanical interface between the positioner and the valve stem.