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

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61514-2:2013. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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– withdrawn, or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. ~~Further reading of IEC 61069 is recommended.~~

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 ~~may~~ 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 ~~may~~ can be equipped with additional sensors and additional functionality supporting the main function.

The performance testing of an intelligent valve positioner ~~needs to be~~ is conducted with the positioner mounted on and connected to the actuator/valve assembly the positioner is used on. The specific characteristic parameters of ~~these combinations~~ the actuator/valve combination such as size, stroke, friction ~~(hysteresis)~~, type of packing, spring package and supply pressure for the pneumatic part~~, should be carefully chosen and reported, since the~~ has significant impact on the performance of a positioner ~~is greatly dependent on the used actuator~~.

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 ~~should be~~ are performed and the results ~~should be~~ reported in accordance with the relevant clauses of this document. In such cases, the test report ~~should~~ will state that it does not cover the full number of tests specified herein. Furthermore, the items omitted ~~should be~~ 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 ~~should~~ 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 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at http://www.electropedia.org)~~

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~~:1990~~, *Environmental testing - Part 2-1: Tests - Tests A: Cold*

IEC 60068-2-2~~:1974~~, *Environmental testing - Part 2-2: Tests - Test B: Dry heat*

IEC 60068-2-6~~:1995~~, *Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)*

IEC 60068-2-31~~:1969~~, *Environmental testing - Part 2-31: Tests - Test Ec: ~~Drop and topple~~ Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-78~~:2001~~, *Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state*

IEC 60079 (all parts), ~~*Electrical apparatus for explosive gas*~~ *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~~:1989~~, *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 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*~~

IEC 61010-1~~:2001~~, *Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements*

IEC 61032~~:1997~~, *Protection of persons and equipment by enclosures - Probes for verification*

~~IEC 61069 (all parts), *Industrial-process measurement and control – Evaluation of system properties for the purpose of system assessment*~~

~~IEC 61158 (all parts), *Digital data communications for measurement and control – Fieldbus for use in industrial control systems*~~

~~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 61298-4:2008, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 4: Evaluation report content*~~

IEC 61326-1:~~2005~~2020, *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements*

~~IEC/PAS 61499 (all parts), *Function blocks for industrial-process measurement and control systems*~~

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:~~2000~~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/TS 62098, *Evaluation methods for microprocessor-based instruments*~~

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

~~CISPR 11, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-311, 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:~~2000~~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 ~~reversal~~ a variation of the input variable does not produce any ~~noticeable~~ 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 ~~may~~ 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:

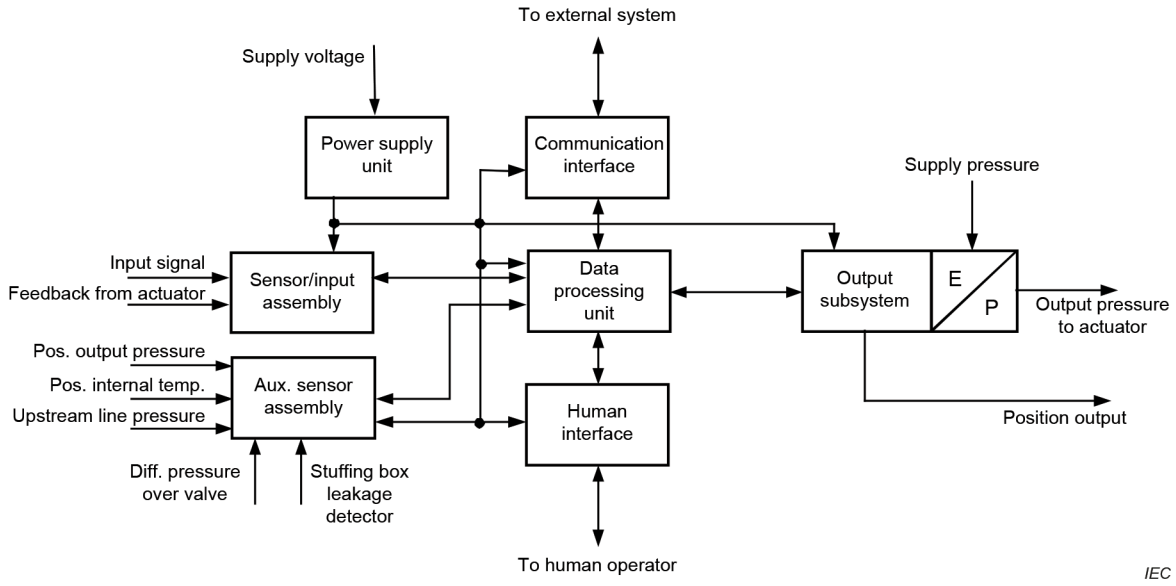

Figure 1 – Positioner model in extensive configuration

4.2.2 Power supply unit

Instruments that require a separate connection to an AC or DC supply voltage ~~may~~ 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 ~~may~~ can be distributed at physically different locations in the positioner. In instruments that receive a digital setpoint, the ~~current~~ input signal W as shown in Figure 4 does not exist. The feedback signal ~~is~~ can be generated by a mechanical linkage or a non-mechanical interface ~~(linkage)~~ between the positioner and the valve stem.

4.2.4 Auxiliary sensor assembly

The auxiliary sensor assembly is for the electronics part integrated with the main sensor input assembly. Many positioners are equipped with a pressure sensor in the pneumatic supply and output circuit and a temperature sensor inside the electronics housing. Their signals ~~may~~ can be used in the stem position control algorithm. For safeguarding and condition monitoring of the valve, a positioner ~~may~~ can be equipped with additional sensors. It ~~may~~ can also be equipped with circuits for digital inputs from switches.

4.2.5 Human interface

A positioner can be classified as intelligent only when data produced by the positioner can be communicated to the external world. The human interface is an important tool for communication. It consists of integral means at the instrument for reading out data (local display) and provisions for entering and requesting data (local pushbuttons). It ~~may~~ can appear that some instruments are not equipped with a human interface. In these cases, access is provided via the data communication interface and an external device (handheld terminal or PC).

4.2.6 Communication interface

Positioner intelligence is further supported by the communication interface, which connects the positioner to external systems. Through the interface and a fieldbus, data transfer (setpoint, configuration and process data) takes place between the positioner and the external system. There are also hybrid instruments, which require an analogue input for control data where the data communication interface is integrated in the input circuit and has no separate point of connection for the fieldbus. The digital information is superimposed on the analogue input current. There ~~may be~~ are instruments which do not have a communication interface. Then configuration and read-out of data take place via the local human interface.

4.2.7 Data processing unit

The data processing unit provides the instrument with a number of functions that ~~may~~ can vary considerably from make to make. The functions that can be implemented include:

– control function;
– configuration;
– calibration;
– tuning;
– valve condition monitoring (valve diagnostics);
– external process control function;
– self-testing;
– trending and data storage;
– cyber-security.

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

4.2.8 Output subsystem

In the single acting version, the output subsystem converts the digital information via an electro-pneumatic converter (E/P) into the pneumatic signal for controlling the actuator.

In the double acting version, the output subsystem is equipped with two oppositely operating E/P converters. In balanced (steady) position, the converters provide pressures that, apart from the friction force to the valve stem, are equal. The relation between the balance pressure and the supply pressure determines the stiffness of a double acting system.

With respect to the pneumatic unit, the following two designs are, among others, commonly used:

– analogue techniques of conventional E/P converters as shown in Figure 2;
– electronically controlled two-state pilot valves as shown in Figure 3.

Moreover, the output subsystem can also be provided with isolated analogue signal outputs proportional to one (or more) of the measured or calculated data and/or one or more configurable output relays for alarm purposes. Such outputs usually require a separate power supply.

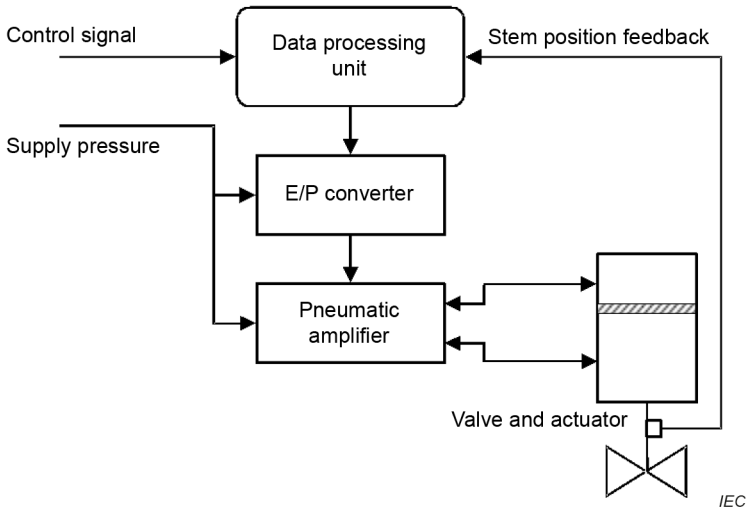

Figure 2 – Basic design for positioners with analogue outputs

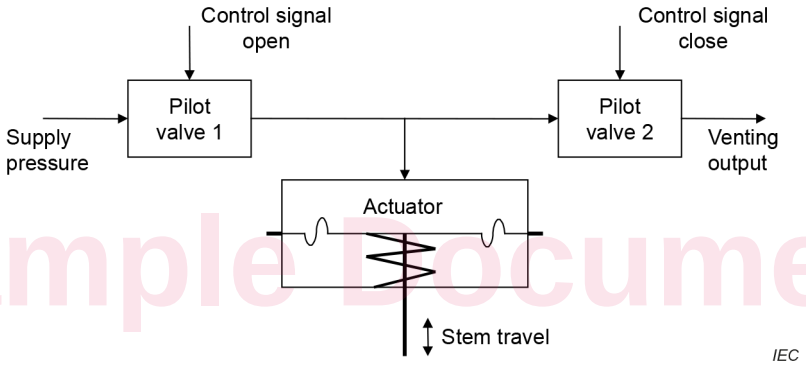

Figure 3 – Basic design for positioners with pulsed output

4.2.9 External functionality

Through the data communication interface ~~and the fieldbus~~, the instrument communicates with PCs, handheld devices and DCS systems. In many cases, a part of the functionality of the positioner ~~may~~ can reside in these external devices. This ~~may~~ can include the following functions:

– (remote) configuration tool;
– data storage (configuration, position trend, valve condition);
– parts of the calibration and stem tuning procedure;
– automated valve condition monitoring and alarming;
– cyber-security.

In an evaluation, the external functionality (if present) shall be considered as well.

4.3 Aspects of functionality and capabilities to be reviewed

~~4.3.1 Checklist~~

The following Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7 shall serve as a checklist for the determination of the functions and capabilities implemented in the positioner under consideration. ~~An example of the reporting format can be found in 4.4.~~