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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Systèmes de commande des processus industriels –
Partie 2: Méthodes d'évaluation des performances des positionneurs de vanne intelligents à sorties pneumatiques montés sur un ensemble actionneur/vanne

IEC 61514-2:2013

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INDUSTRIAL PROCESS CONTROL SYSTEMS –

Part 2: Methods of evaluating the performance of intelligent valve positioners with pneumatic outputs mounted on an actuator valve assembly

FOREWORD

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International Standard IEC 61514-2 has been prepared by subcommittee 65B: Measurement and control devices, of IEC technical committee 65: Industrial-process measurement, control and automation.

This part of IEC 61514 is to be used in conjunction with IEC 61514:2000.

This second edition cancels and replaces the first edition published in 2004. This edition constitutes a technical revision.

The significant changes with respect to the previous edition are as follows:

– The standard has been optimized for usability.
– The test procedures have been reviewed regarding applicability for use in test facilities. Impractical test procedures were removed or modified.

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

FDIS	Report on voting
65B/868/FDIS	65B/872/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 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 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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 standard 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.

INDUSTRIAL PROCESS CONTROL SYSTEMS –

Part 2: Methods of evaluating the performance of intelligent valve positioners with pneumatic outputs mounted on an actuator valve assembly

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 be applied to positioners which receive standard analogue electrical input signals (as specified in IEC 60381) and/or digital signals via a data communication link 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 be equipped with additional sensors and additional functionality supporting the main function.

The performance testing of an intelligent valve positioner needs to be conducted with the positioner mounted on and connected to the actuator/valve assembly the positioner is to be used on. The specific characteristic parameters of these combinations 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 performance of a positioner is greatly dependent on the used actuator.

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

This standard 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 standard, is not required or possible, the tests which are required should be performed and the results should be 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, to give the reader of the report a clear overview.

The standard is also applicable for non-intelligent microprocessor-based valve positioners without means for bi-directional communication. In that case an evaluation should be reduced to a limited programme of performance testing and a short 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 60068-2-1:1990, *Environmental testing – Part 2: Tests. Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B: Dry heat*

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

IEC 60068-2-31:1969, *Environmental testing – Part 2: Tests. Test Ec: Drop and topple, 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 atmospheres*

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, *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, *Electrical equipment for measurement, control and laboratory use – EMC requirements*

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

IEC 61514:2000, *Industrial-process control systems – Methods of evaluating the performance of valve positioners with pneumatic outputs*

IEC/TS 62098, *Evaluation methods for microprocessor-based instruments*

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 61514:2000 and IEC 60050-351, as well as the following apply.

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 standard, only positioners with pneumatic output signals are considered, as defined in 3.1 of IEC 61514:2000. 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.

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

Note 1 to entry: The stem 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 within which reversal of the input variable does not produce any noticeable change in the output variable

3.10
operating mode
selected method of operation of the positioner

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

Note 1 to entry: The input variable may 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 blockscheme 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:

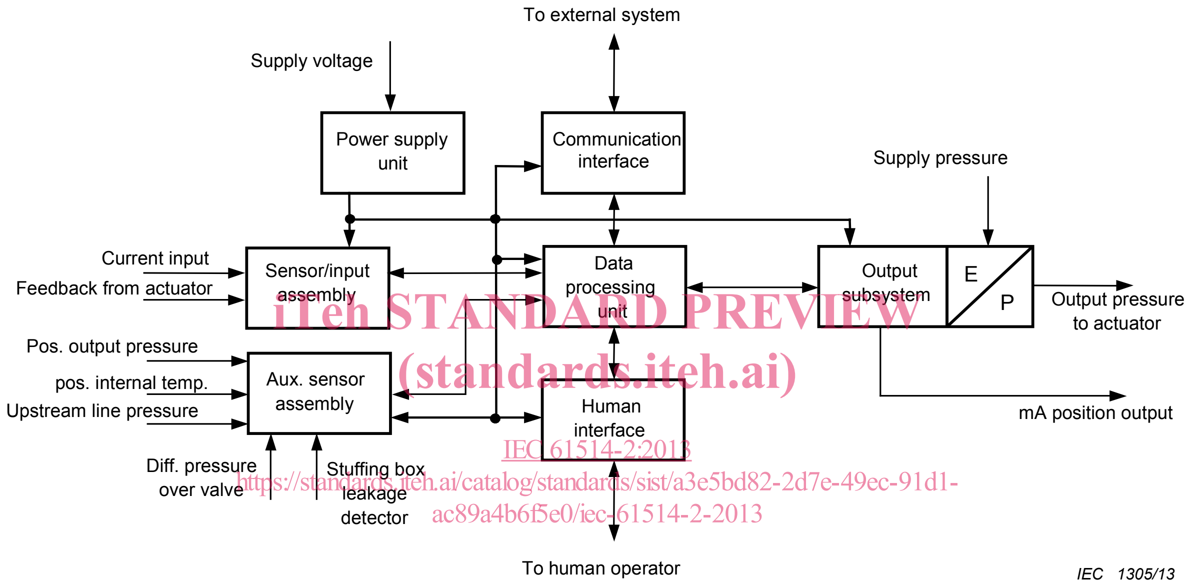

Figure 1 – Positioner model in extensive configuration

4.2.2 Power supply unit

Instruments that require a separate connection to an a.c. or d.c. supply voltage may 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 (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 be distributed at physically different locations in the positioner. In instruments that receive a digital setpoint, the current input as shown in Figure 4 does not exist. The feedback signal is generated by a 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 output circuit and a temperature sensor inside the electronics housing. Their signals may be used in the stem position control algorithm. For safeguarding and condition monitoring of the valve a positioner may be equipped with additional sensors. It may 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 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 instruments which do not have a communication interface. Then configuration and read-out of data take place via the human interface.

4.2.7 Data processing unit

The data processing unit provides the instrument with a number of functions that may 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;
– part of the functionality may 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.

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.

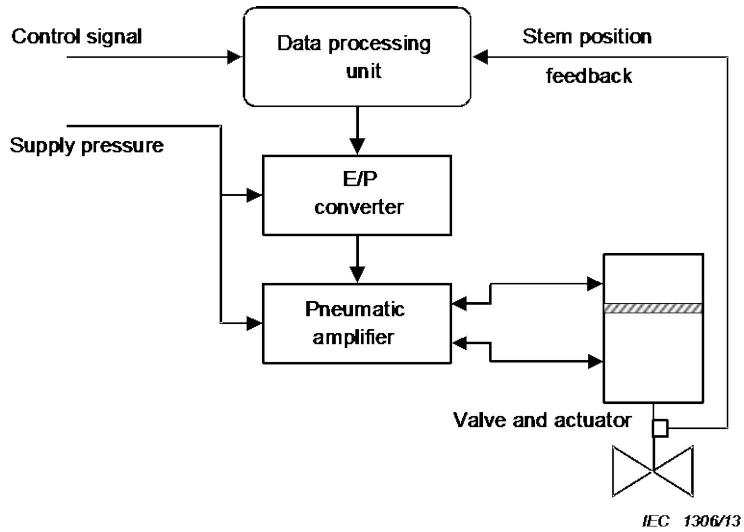

Figure 2 – Basic design for positioners with analogue outputs

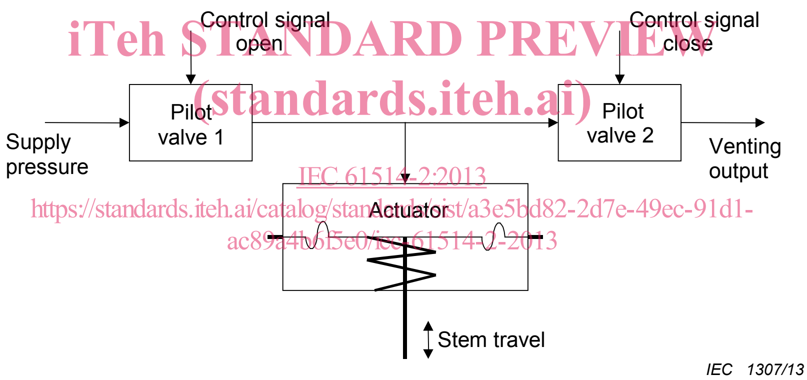

Figure 3 – Basic design for positioners with pulsed output

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 reside in these devices. This may 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.

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 Tables 1 through 5 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.