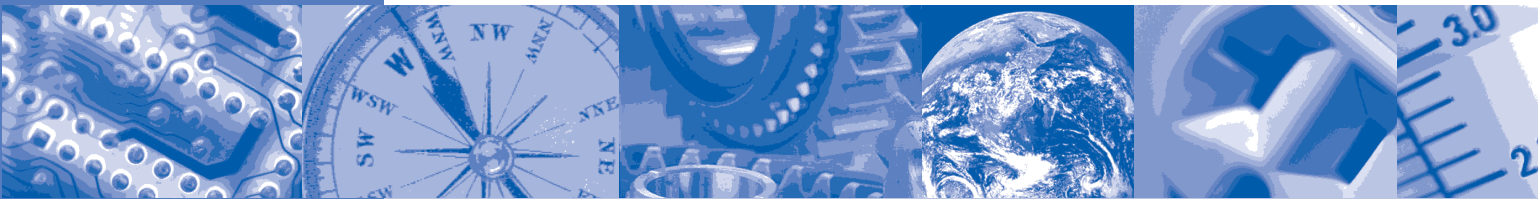


ISA-S75.13-1996



Method of Evaluating the Performance of Positioners with Analog Input Signals and Pneumatic Output



Approved 26 February 1996

ISA-S75.13 — Method of Evaluating the Performance of Positioners with Analog Input Signals and Pneumatic Output

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Preface

This preface, as well as all footnotes and annexes, is included for informational purposes and is not part of ISA-S75.13.

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The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards, recommended practices, and technical reports. The Department is further aware of the benefits to USA users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI and acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide*, which has been published by the Institute of Electrical and Electronics Engineers as ANSI/IEEE Std. 268-1992, and future revisions will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards, recommended practices, and technical reports that ISA develops.

This standard was originated by the Scientific Apparatus Makers Association (SAMA), within their Process Measurement and Control (PMC) Section. It was designated PMC TC 31b.1b dated 1977. SAMA turned the UNAPPROVED draft over to the ISA for refinement and processing, to lead to an American National Standard.

The ISA Standards and Practices Board approved the formation of a new Subcommittee, SP75.13, to work on this and other standards dealing with valve positioner performance. A committee was formed from former members of the SAMA Committee and members of the ISA Standards Committee on control valves.

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1 Scope

This standard specifies tests designed to determine the performance of positioners with analog input signals and pneumatic output. The method of evaluation described in this standard specifies the use of an actuator of the user's or manufacturer's choice. The positioner may be single-acting or double-acting.

2 Purpose

The methods of evaluation given in this standard are intended for use by manufacturers of valve positioners to determine the performance of their products and by users or independent testing establishments to verify performance.

Test conditions in this standard, such as the range of ambient temperatures, power supply, etc., relate to conditions that commonly arise in use. Consequently, the values specified shall be used where no other values are specified by the manufacturer or user. If other values are used, they must be stated. It is recognized that the manufacturer's specifications and instructions for installation and operation must be considered during all tests.

Tests specified in this standard are not necessarily sufficient for instruments specifically designed for unusually arduous conditions. Conversely, a reduced series of tests may serve adequately for instruments designed to perform within a more limited range of conditions.

The evaluating body should maintain the closest communication with the user and the manufacturer. Note shall be taken of the manufacturer's specifications for the instrument when the test program is being decided, and manufacturers should be invited to comment both on the test program and upon the results pertaining to their instrument.

3 Definitions

This standard introduces no new terms requiring definition. Terms used are defined in the following ANSI/ISA Standards:

ANSI/ISA-S26-1975, *Dynamic Response Testing of Process Control Instrumentation*

ANSI/ISA-S51.1-1995, *Process Instrumentation Terminology*

ANSI/ISA-S75.05-1983, *Control Valve Terminology*

4 Testing procedures

4.1 Introduction

4.1.1 When relating performance characteristics (such as values of accuracy) to values of other terms (such as conformity, hysteresis, dead band, and repeatability), equivalent units must be used.

4.1.2 The accuracy rating of the reference measuring means that relates to the characteristics being tested shall preferably be no greater than one-tenth of the tolerance allowed on the test specimen, but in no case greater than one-third of the allowed tolerance.

EXAMPLE: Dead band

Test specimen:	allowed dead band of 0.2 percent of range
Measuring means:	preferred dead band of 0.02 percent of range
Measuring means:	allowed dead band of 0.06 percent of range

When the accuracy rating of the reference measuring means is one-tenth or less than that of the device under test, the accuracy rating of the reference measuring means may be ignored. When the accuracy rating of the reference measuring means is one-third or less, but greater than one-tenth of that of the device under test, the accuracy rating of the reference measuring means shall be stated in the test report.

4.1.3 The positioner under test and the associated test equipment shall be allowed to stabilize under steady-state operating conditions. All testing shall be performed under these conditions. Those operating conditions that influence the test shall be observed and recorded. When the performance characteristic being determined requires reference operating conditions, the conditions of the test shall be maintained at reference operating conditions.

4.1.4 The number of test points to determine the desired performance characteristic of a device should be distributed over the range. They should include points at or near (within 10 percent) the lower- and upper-range values. There should not be fewer than five points, and preferably more. The number and location of these test points should be consistent with the degree of precision desired and the characteristics being evaluated.

4.1.5 Prior to recording these observations, the device under test shall be exercised by at least three full-range traverses in each direction.

4.1.6 At each point being observed, the input shall be held steady until the device under test becomes stabilized at its apparent final value.

4.1.7 Tapping or vibrating the device under test is not allowed unless the performance characteristic under study requires such action.

4.2 Test unit

4.2.1 For testing, the positioner should be fitted to any commercially available actuator for which it is intended. Test results should include a description of the actuator used, and the description shall include the following:

- a) Supply pressure
- b) Actuator pressure range
- c) Travel
- d) Nominal effective area
- e) Type (single- or double-acting)
- f) Volume at 0 percent and 100 percent travel (on both sides of double-acting actuator)
- g) Friction force (see 4.2.2)

4.2.2 The positioner/actuator assembly shall be mounted on a valve or test rig that is designed to permit the implementation of tests with minimum friction (unless otherwise specified). Friction force may be measured by determining the force required to initiate travel when the actuator pressure is constant. This value shall be recorded.

4.2.3 The positioner shall be calibrated in accordance with the manufacturer's instructions to permit a specified input signal range to produce 100 percent travel.

4.2.4 Any mechanical stops should be adjusted so that they do not interfere with the measurements.

4.2.5 Where the gain of the positioner can be altered, it should be set at the manufacturer's recommended setting or the maximum value that permits stable positioning action of the positioner/actuator assembly. This value shall be recorded.

4.2.6 All tests shall be conducted with the device in its normal mounting position, unless otherwise specified.

4.2.7 All tests shall be conducted with the supply pressure adjusted at the value recommended by the manufacturer, unless otherwise specified.

4.2.8 Positioners fitted with cams shall be tested with input/travel characteristics that are linear. Tests on positioners with other than linear input/travel characteristics may be performed as required.

4.2.9 All tests shall be conducted with positioner covers in place.

4.3 Environmental test conditions

4.3.1 Recommended range of ambient conditions for test measurements*

The recommended ranges of ambient conditions for test measurements are as follows:

Temperature:	15°C to 35°C (59°F to 95°F)
Relative humidity:	48% to 75%
Atmospheric pressure:	86 kPa to 106 kPa (12.47 psi to 15.37 psi)
Electromagnetic field:	Value to be stated, if relevant

*If ambient conditions are not within these ranges, actual values must be stated.

The maximum rate of temperature change during any test shall be 1°C (1.8°F) in 10 minutes (min).

4.3.2 Standard reference atmosphere

The standard reference atmosphere is as follows:

Temperature:	20°C (68°F)
Relative humidity:	65 %
Atmospheric pressure:	101.3 kPa (14.7 psi)

This standard reference atmosphere is that atmosphere to which values measured under any other atmospheric conditions are corrected by calculation. It is recognized that in many cases a correction factor for humidity is not possible. In such cases, the standard reference atmosphere applies to temperature and pressure corrections only. This standard reference atmosphere is equivalent to the normal reference operating conditions usually identified by the manufacturer.

4.3.3 Environmental envelope for reference measurements

When correction factors to adjust parameters sensitive to the atmospheric condition to their standard reference atmosphere values are unknown, and measurements under the recommended range of ambient atmospheric conditions are unsatisfactory, repeated measurements under closely controlled atmospheric conditions may be conducted.

For the purpose of this standard, the following atmospheric conditions are given for reference measurements:

	<u>Nominal Value</u>	<u>Tolerance</u>
Temperature:	20°C (68°F)	± 2°C (± 3.6°F)
Relative humidity:	65 %	± 5 %
Atmospheric pressure:	86 kPa (12.47 psi) to 106 kPa (15.37 psi)	

4.4 Supply conditions

4.4.1 Reference values

Reference values are the values specified by the manufacturer.

4.4.2 Tolerances

Electrical supply

Rated voltage:	± 1 %
Rated frequency:	± 1 %
Harmonic distortion:	less than 1 % (ac supply)
Ripple:	less than 0.1 % (dc supply)

Pneumatic supply

Rated pressure:	± 1 % (during static test conditions)
Supply temperature:	ambient temperature of ± 2°C (± 3.6°F)
Supply dewpoint:	dewpoint at least 10°C (50°F) below positioner body temperature
Oil- and dust-free:	per ISA-S7.3-1975 (R1981)

5 Static behavior

5.1 Measurement (calibration) cycle

Maintain test conditions and precondition the test unit as indicated in [Section 4](#). Observe and record positioner feedback travel for each desired input value for one full-range traverse in each direction, starting near the mid-range value. The final input must be approached from the same direction as the initial input. Apply the input in such a way that neither input nor travel overshoot occurs.

5.2 Calibration curve

For the purpose of the following test procedures, the calibration curve will be prepared as a "deviation plot." Determine the difference between each observed measured travel and its corresponding ideal travel. This difference is the deviation and may be expressed as a percentage of ideal travel span. The deviation is plotted versus input or ideal travel. [Figure 1](#) illustrates the plot of the percentage of deviation versus the percentage of input. A positive deviation denotes that the observed travel is greater than the ideal travel.

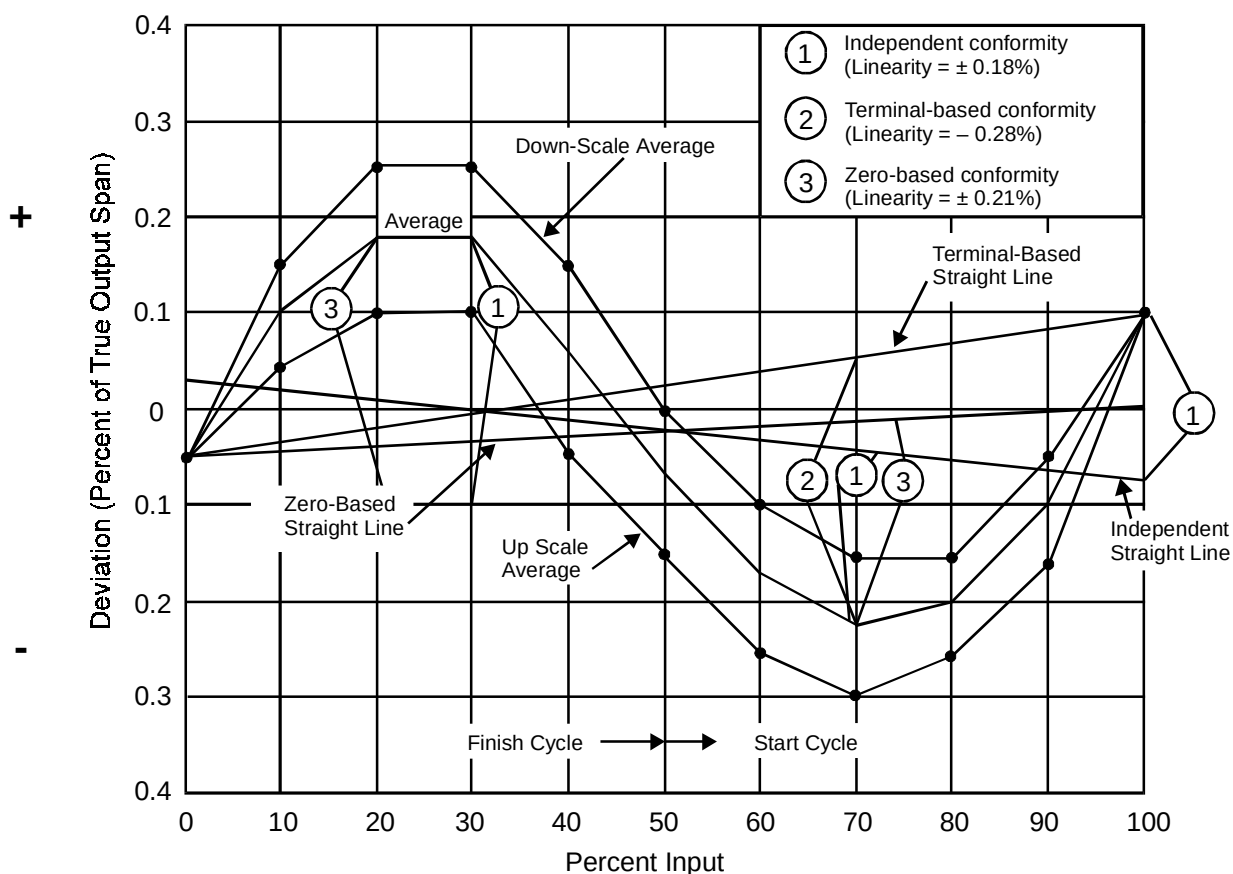


Figure 1 — Calibration curve (of data from Table 1)

Table 1 — Calibration report

Input	Error										Average Error
	Up Actual	Down Actual	Up Actual	Down Actual	Up Actual	Down Actual	Up Actual	Up Average	Down Average	Up Average	
Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
0		−0.04		−0.05		−0.06			−0.05		−0.05
10		+0.14	+0.04	+0.15	+0.05	+0.16	+0.06		+0.15	+0.05	+0.10
20		+0.23	+0.08	+0.26	+0.09	+0.26	+0.13		+0.25	+0.10	+0.175
30		+0.24	+0.09	+0.25	+0.10	+0.26	+0.11		+0.25	+0.10	+0.175
40		+0.13	−0.07	−0.15	−0.04	+0.17	−0.04		+0.15	−0.05	−0.05
50	−0.18	−0.02	−0.16	+0.01	−0.13	+0.01	−0.13	−0.15	0	−0.15	−0.075
60	−0.27	−0.12	−0.25	−0.10	−0.23	−0.08		−0.25	−0.10		−0.175
70	−0.32	−0.17	−0.30	−0.16	−0.28	−0.12		−0.30	−0.15		−0.225
80	−0.27	−0.17	−0.26	−0.15	−0.22	−0.13		−0.25	−0.15		−0.20
90	−0.16	−0.06	−0.15	−0.05	−0.14	−0.04		−0.15	−0.05		−0.10
100	+0.09		+0.11		+0.10			+0.10			+0.10

Measured Accuracy = +0.26 percent
 = −0.32 percent
 Hysteresis plus Dead Band = +0.22 percent
 Repeatability = 0.05 percent

NOTE — Accuracy of reference measuring means was not considered in the determination of the average error.

5.2.1 Accuracy, measured

Measured accuracy may be determined from the deviation values (see Table 1) of a number of calibration cycles. It is the greatest positive and negative deviation of the recorded values (from both an up-scale and a down-scale travel traverse) from the reference or zero deviation line. Measured accuracy may be expressed as a range from a plus to a minus percentage of ideal span.

EXAMPLE: The measured accuracy is +0.26 percent to −0.32 percent of travel span.

5.2.2 Dead band

Maintain test conditions and precondition the test device as indicated in Section 4 and proceed as follows:

- Slowly vary (increase or decrease) the input to the device being tested until a detectable travel change is observed.
- Observe the input value and record.
- Slowly vary the input in the opposite direction (decrease or increase) until a detectable travel change is observed.