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Industrial-process control systems – Instruments with analogue inputs and two- or multi-state outputs –
Part 1: Methods of evaluating performance

Systèmes de commande de processus industriels – Instruments avec entrées analogiques et sorties à deux ou plusieurs états –
Partie 1: Méthodes d'évaluation des performances

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL-PROCESS CONTROL SYSTEMS – INSTRUMENTS WITH ANALOGUE INPUTS AND TWO- OR MULTI-STATE OUTPUTS –

Part 1: Methods of evaluating performance

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International Standard IEC 61003-1 has been prepared by subcommittee 65B: Devices, of IEC technical committee 65: Industrial-process measurement and control.

This second edition cancels and replaces the first edition issued in 1991 and constitutes a technical revision. It takes into account the common standardized basis specified in the IEC 61298 series. Any test method or procedure specified and described herein is referred to the corresponding Clause of the IEC 61298 series. Any particular method or procedure not covered by the IEC 61298 series is developed and specified in this standard in accordance with the criteria stated in the IEC 61298 series, as far as they are applicable.

This bilingual version (2014-01) corresponds to the monolingual English version, published in 2004-01.

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

FDIS	Report on voting
65B/516/FDIS	65B/524/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.

The French version of this standard has not been voted upon.

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

The committee has decided that the contents of this publication will remain unchanged until 2012. At this date, the publication will be

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- withdrawn;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

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INTRODUCTION

The methods of evaluation specified in this part of IEC 61003 are intended for use by manufacturers to determine the performance of their products and by users, or independent testing establishments, to verify the manufacturer's performance specifications.

The test conditions in this standard, for example the range of ambient temperatures and power supply, represent those, which commonly arise in use. Consequently, the values specified herein shall be used where the manufacturer specifies no other values.

The tests specified in this standard are not necessarily sufficient for instruments specifically designed for unusually arduous duties. Conversely, a restricted series of tests may be suitable for instruments designed to perform within a more limited range of conditions.

It will be appreciated that the closest communication should be maintained between the evaluating body and the manufacturer. Note shall 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.

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INDUSTRIAL-PROCESS CONTROL SYSTEMS – INSTRUMENTS WITH ANALOGUE INPUTS AND TWO- OR MULTI-STATE OUTPUTS –

Part 1: Methods of evaluating performance

1 Scope

This part of IEC 61003 is applicable to pneumatic and electric industrial-process instruments using measured values that are continuous signals in accordance with IEC 60382, or IEC 60381-1. The other input value (i.e. the set point value) may be either a mechanical (position, force, etc.) or a standard signal.

It should be noted that tests specified herein may be applied to instruments which have other continuous measured values, provided that due allowance is made for such differences.

These instruments may be used as controllers or as switches for alarm and other similar purposes.

Instruments with feedback are not covered by this standard.

Electronic security issues may impact only a few products covered by this document. Consequently this document does not address such security issues.

This standard is intended to specify uniform testing methods for performance evaluation of industrial-process instruments with analogue measured values and two- or multi-state outputs.

Considerations other than the performances are listed in Clause 10.

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2 Normative references

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

IEC 60050-351:1998, *International Electrotechnical Vocabulary (IEV) – Part 351 Automatic control*

IEC 60381-1:1982, *Analogue signals for process control systems – Part 1: Direct current signals*

IEC 60382:1991, *Analogue pneumatic signals for process control systems*

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

IEC 61298-1:1995, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 1: General considerations*

IEC 61298-2:1995, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 2: Tests under reference conditions*

IEC 61298-3:1998, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 3: Tests for the effects of influence quantities*

IEC 61298-4:1995, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 4: Evaluation report content*

IEC 61326:2002, *Electrical equipment for measurement, control and laboratory use – EMC requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-351 and in IEC 61298-1, IEC 61298-2, IEC 61298-3, IEC 61298-4, together with the following definitions apply.

3.1
switching point x_1, x_2
measured value (with the input moving either upscale or downscale), at which the output (y) changes from one state to another

3.2
two-state instrument
action illustrated in Figure 1, where x is the value of the input variable and y is the value of the output signal.

The two-state instrument, having one pair of switching points x_1 and x_2 (x_2 greater than x_1) has the relationships:

$y = y_1$ for $x < x_1$

$y = y_2$ for $x > x_2$

For $x_1 < x < x_2$, y may be either y_1 or y_2.

It is y_1 if the last switching point crossed by x was x_1.

It is y_2 if the last switching point crossed by x was x_2.

3.3
multi-state instrument
a multi-state instrument (see Clause 7 and Figure 4) has n possible output values and n-1 pairs of switching points. Each pair of switching points may be investigated by the procedure given for the two-state instrument.

3.4
switching differential X_{sd}
difference between the switching point x_2 with the measured value moving upscale and the switching point x_1 with the measured value moving downscale

3.5
instrument with no switching differential
this is considered to be a special case where the switching differential approaches zero

3.6
mean switching point x_m
the mean of the values of upscale and downscale switching points

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3.7
switching range X_{sr}
in a multi-state instrument the range of measured values corresponding to the extreme switching points

3.8
set point w (reference input variable)
the point (value) at which it is desired that switching (at x_2 or x_1 as specified) should occur

4 General conditions for tests

For the purpose of this standard the general test conditions (e.g. environmental test conditions, supply conditions, load conditions, mounting position, externally induced vibrations, external mechanical constraints, delivery of the instrument) specified in IEC 61298-1, Clause 6 apply, together with the additional information below.

4.1 Documentary information

The manufacturer shall supply to the evaluating body information for installation, commissioning, operation, routine maintenance and repair of the instrument. A spare parts list, together with a recommendation of the spare parts to be held in stock, shall be supplied. The language of written information for installation should be the language of the local user.

All the relevant publications supplied by the manufacturer, automatically and on request, should be listed.

If they do not contain a clear description, with adequate diagrams, of the operation of the instrument, or if they do not contain an adequate spare parts and specifications list, the nature of the inadequacy should be noted.

Additionally, any certificates indicating the degree of intrinsic safety and flameproofing, etc. of electrically powered instruments should be listed. This information should give details of the certificate numbers and the degree of protection provided.

Procedures for installation, routine maintenance and adjustment, repairs and overhaul should be examined by the actual performance of the required operation. This should be performed in accordance with the manufacturer's instructions, so that an evaluation of the instructions can be carried out concurrently.

4.2 Safety

Electrically powered instruments should be examined to determine the degree to which their design protects them against accidental electric shock.

4.3 Installation

The instrument should be installed and set to work according to the manufacturer's instructions, taking account of the various applications which may be met in practice and which require different procedures.

The method of mounting specified by the manufacturer should be reported. Any restrictions on the use of the instrument caused by this method of mounting shall be noted with explanations.

Any other aspects that may seem relevant to the ease or difficulty of installation should be noted with explanations.

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4.4 Supply conditions

Tolerances on supply conditions for mains supplied equipment are given in 6.2.2 of IEC 61298-1. For instruments with self-contained power supplies (e.g. battery-powered) the tolerances are different and shall be agreed.

NOTE For pneumatic instrument care should be taken to ensure that pneumatic connections are leak tight.

5 General testing procedures and precautions

For the purpose of this standard, the general testing procedures and precautions, specified in Clause 7 of IEC 61298-1, shall be applied, together with the additional information below.

5.1 Checking of calibration made prior to delivery

The input-output characteristic that shall be checked (see 7.6 of IEC 61298-1) is the values of the switching points x_1 and x_2 found during the calibration (if any) made prior to delivery.

5.2 Set point

Except where otherwise specified, the set point shall be set to the midscale value or, where no scale is provided, to the middle of the effective range of adjustment.

5.3 Switching differential

Except where otherwise specified, if the switching differential X_{sd} is adjustable, it shall be set to the midscale value or, where no scale is provided, to the middle of the effective range of adjustment.

6 Test methods and procedures

For the purpose of this standard, the tests general methods and procedures – if any – specified in IEC 61298-2 and IEC 61298-3 apply, together with the additional information stated below.

6.1 Tests under reference conditions

Methods and procedures for each test are described in the last column of the following table.

In the others column are indicated:

– Clause N° and designation of test;

– Clause number of the reference where the general procedures are specified.

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Clause and Designation	Reference	Test methods and procedures description
6.1.1 Switching accuracy related factors	IEC 61298-2 4.1.7	The input measured value x shall be varied slowly at least five times in each direction through its entire range. By observation of the output, the values of points x_1 and x_2 and their average shall be determined. For each cycle, the switching differential ($x_1 - x_2$) shall be noted.
6.1.1.1 Inaccuracy of switching points	IEC 61298-2 4.1.7.1	Switching point inaccuracy is determined by selecting the greatest positive and negative deviations of any measured value of x_1 and x_2, of any cycle, from the set point w for increasing and decreasing inputs and reporting this in percent of nominal span of measured value.
6.1.1.2 Non-repeatability of switching points	IEC 61298-2 4.1.7.6	Non-repeatability shall be computed observing the maximum difference, in percent of nominal span of measured value, among all x_1 values and among all x_2 values. The maximum value, from either the x_1 maximum difference or the x_2 maximum difference, is reported as non-repeatability.
6.1.1.3 Inaccuracy of switching differential	IEC 61298-2 4.1.7.1	The switching differential X_{sd} is calculated by subtracting the average value of x_1 from the average value of x_2 (see 6.1.1). Switching differential inaccuracy is determined by selecting the greatest positive and negative deviations of any measured value of the switching differentials – calculated in each of the five cycles – from the X_{sd} value and reporting this in percent of the nominal span of measured value.
6.1.1.4 Non-repeatability of switching differential	IEC 61298-2 4.1.7.6	Non-repeatability shall be computed calculating the differences, in percent of the nominal span of measured value, among all switching differential values noted in 6.1.1. The maximum of those values is reported as non-repeatability of switching differential.
6.1.2 Mean switching point		Mean switching point x_m is calculated as the mean of the average values of x_1 and x_2 (see 6.1.1).
6.1.3 Set point		For the adjustment of set point value w, four cases shall be considered: 1. a) w is an adjustable and directly measurable value; b) w is adjustable at the instrument and an adjusting scale for w is provided; 2. w is adjustable at the instrument, but there is no adjusting scale; 3. w is a pre-selected fixed value.

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Clause and Designation	Reference	Test methods and procedures description
6.1.3.1 Set point adjustable and measurable or indicated	IEC 61298-2 4.1.7.1 and 4.1.7.6	Determine values of x_1, x_2 and X_{sd}, and their accuracy-related factors, in accordance with the test procedures in subclause 6.1.1, at least for values of w of 10 %, 50 % and 90 %, the 50 % value being taken last. Determine values of x_m, in accordance with the test procedures in 6.1.2. The inaccuracy of set point setting is determined by selecting the greatest positive and negative deviations of any measured value of x_m from the ideal set-point value for each cycle and for each set-point and reporting this in percent of the nominal span of measured value.
6.1.3.2 Set point adjustable but not indicated	IEC 61298-2 4.1.7.1 and 4.1.7.6	Determine values of x_1, x_2 and X_{sd}, and their accuracy-related factors, in accordance with the test procedures in 6.1.1 and 6.1.2, and values of x_m, in accordance with the test procedures in 6.1.2. Make this test, for at least three values of w, approximately evenly spaced over the effective range of adjustment, the approximately mid value being taken last. No determination of x_m-w is possible in this case.
6.1.3.3 Set point not adjustable	IEC 61298-2 4.1.7.1 and 4.1.7.6	Determine values of x_1, x_2 and X_{sd}, and their accuracy-related factors, in accordance with the test procedures in 6.1.1 and 6.1.2, and values of x_m, in accordance with the test procedures in 6.1.2. The inaccuracy of set point setting is determined by selecting the greatest positive and negative deviations of any measured value of x_m from the value of w declared by the manufacturer and reporting that in percent of the nominal span of measured value. NOTE For two-state instruments with non-symmetrically adjustable switching differential (e.g. instruments where x_1 or x_2 instead of x_m is intended to be equal to w) the value of $x_1 - w$ or $x_2 - w$ instead of x_m-w should be taken into account.

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6.2 Tests for the effects of influence quantities

Methods and procedures for each test are described in the last column of the following table.

In the others column are indicated:

– Clause N° and designation of test;
– Clause number of the reference where the general procedures are specified.

Clause and Designation	Reference	Test methods and procedures description
6.2.1 Ambient temperature	IEC 61298-3 Clause 5	The change in switching points shall be determined at each test temperature specified in 5.2 of IEC 61298-3. For example: +20 °C (reference), +40 °C, +55 °C, +20 °C, 0 °C, –20 °C, +20 °C. After the first cycle, a second temperature cycle, identical to the first, shall be performed without readjustment of the instrument. For instruments with a pneumatic output the air supply temperature shall be the same as the instrument temperature.
6.2.2 Humidity	IEC 61298-3 Clause 6	The test shall be performed for electrical instruments only. This test shall be performed according to the methods and procedures stated in Clause 6 of IEC 61298-3, together with what is stated below. After the stabilisation at the reference relative humidity and temperature, a set of reference measurements shall be taken. The power supply to the instrument shall be switched off and the relative humidity shall be increased as specified in Clause 6 of IEC 61298-3. The instrument shall be switched on for the final 4 h of the period in stable conditions and the change in switching points shall be measured immediately after this period. As specified in Clause 6 of IEC 61298-3, the relative humidity shall be reduced to the original reference value and, after stabilisation, the effect of this test on the switching points shall be determined. After this test, a visual inspection shall be conducted to check for effects of flashover, accumulation of condensation, deterioration of components.

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