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**Electrical and pneumatic analogue chart recorders for use in industrial-process systems –
Part 1: Methods for performance evaluation**

**Enregistreurs analogiques électriques et pneumatiques sur papier diagramme,
utilisés dans les systèmes de commande des processus industriels –
Partie 1: Méthodes d'évaluation des performances**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL AND PNEUMATIC ANALOGUE CHART RECORDERS
FOR USE IN INDUSTRIAL-PROCESS SYSTEMS –****Part 1: Methods for performance evaluation**

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International Standard IEC 60873-1 has been prepared by subcommittee 65B: Devices, of IEC technical committee 65: Industrial-process measurement and control.

This first edition of IEC 60873-1 cancels and replaces IEC 60873 (1986) and constitutes a technical revision.

The main changes with respect to the previous edition concern the updating of methods for inspection and routine testing of devices, and recorder testing requirements now comply with IEC 61298.

This bilingual version (2012-12) corresponds to the monolingual English version, published in 2003-10.

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

FDIS	Report on voting
65B/494/FDIS	65B/511/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 standard is to be used in conjunction with IEC 61298.

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 2009. 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- withdrawn;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 60873 are intended for use by manufacturers to determine the performance of their products and by users or independent testing establishments to verify manufacturers' 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 no other values are specified by the manufacturer.

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 should 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 programmes and the results.

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ELECTRICAL AND PNEUMATIC ANALOGUE CHART RECORDERS FOR USE IN INDUSTRIAL-PROCESS SYSTEMS –

Part 1: Methods for performance evaluation

1 Scope and object

This part of Some tests should not apply to all instruments and additional tests may be required for certain types of recorders.

The object of this standard is to

When a full evaluation in accordance with this standard is not required, those tests which are IEC 60873 provides methods for determining the performance of all electrical and pneumatic analogue chart recorders operating from a standardized signal which may be used in process control. It is intended that continuous and dotted-line traces, multiple-pen and multiple-channel instruments should be covered.

specify uniform methods of test for the evaluation of the performance of electrical and pneumatic analogue chart recorders operating from a standardized signal which may be used in process control.

required should be performed and the results reported in accordance with those parts of the standard which are relevant. It should be made clear in such a report that the evaluation reported is not a full evaluation and the parts omitted should be indicated.

2 Normative references

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

IEC 61187:1993, *Electric and electronic measuring equipment – Documentation*

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 evaluation performance – Part 2: Tests under reference conditions*

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

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

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 and IEC 61298-3 together with the following additional definitions, apply.

3.1

friction effect

in the case of continuous line recorders, effect which friction of the marking device on the chart may have on the record even though the chart is moving slowly

3.2

measuring range

region between the limits within which a quantity is measured, or received, expressed by stating the lower and upper range values (for example, 0 Pa, 20 Pa).

NOTE Instruments may be supplied with manual or automatic means of adjusting the range. As used in this standard, the term "range" and the definitions below apply to the characteristics of the instruments for a specified setting of the adjustment means.

The zero value of the measured variable is "elevated" if it is greater than the lowest range value and "suppressed" if it is less than the lowest range value

3.3

output

position of the marking device of a recorder.

If an indicator is directly connected to the marking device, the indicated value is tested as a second output (see 10.4 for remarks on parallax)

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3.4

recorder

instrument which records, with a pen or other marking device, the instantaneous, effective or average value of the signal

3.5

recorder, multiple-pen

recorder for more than one input signal providing an individual pen or other marking device for each input signal

3.6

recorder, multiple-channel

recorder for more than one input signal which successively connects its internal measuring circuit(s) to different input signals, thereby recording the values of the input signals in sequence

3.7

record

trace marked on the instrument chart in response to an input signal

3.8

time per point

time interval between two immediately successive readings of a multiple-channel recorder, generally of signals in different external measuring circuits

3.9

zero adjustment

means provided in an instrument to cause a parallel shift in the input-output relationship

4 General testing procedures

General requirements for measurement procedure will be found in Clause 7 of IEC 61298-1. Other specific procedures can be found below.

4.1 Selection of ranges for test

Where there are switched ranges (or dial settings), for example, gain, the tests shall be repeated to cover all ranges. Where the DUT is supplied calibrated for use, the first set of tests shall be carried out without adjustment.

- a) The recorder shall be put into operation according to the manufacturer's instructions; in particular, those relating to the preliminary adjustments.

NOTE The chart and ink supplied by the manufacturer for the recorders should be used for all tests.

- b) Unless otherwise stated, where the span is adjustable other than to take up manufacturing tolerances, the tests should be carried out with the span adjustment set approximately at the manufacturer's stated minimum and maximum and at an intermediate value.
- c) Unless otherwise stated, where the zero adjustment is adjustable other than to take up manufacturing tolerances, such as devices equipped with means for suppression or elevation of zero, the tests should be carried out with the elevation/suppression adjustment set for its minimal effect, then at its extreme values.

If the extent of adjustment is more than twice the maximum span, tests should also be carried out with the adjustment set approximately at the arithmetic mean of the two extreme values of elevation and/or suppression (see also 4.1.1.2 of IEC 61298-2).

NOTE Testing of an instrument with provision for substantial adjustment of both span and zero in accordance with 4.1b) and 4.1c) may require an impractically large number of tests. Preliminary tests should be conducted to determine the effect of changing span and zero adjustments on the characteristic being measured so that redundant tests can be eliminated from the test programme in cases where the characteristic can be inferred reliably from fewer tests. For example, hysteresis and dead band may not be significantly affected by selection of the lower and upper range value if the span is held constant and may often be calculated for different spans from measurements at a single-span setting. In any case, the report should clearly indicate relevant values of the measured parameters for each setting of the adjustments so that the values of measured error, hysteresis, dead band, etc., are all referenced to the same adjustment of the recorder.

4.2 Zero and span adjustment

Zero and span should be adjusted to make the actual characteristic conform closely to ideal values at the upper and lower range limits before carrying out each test specified in this standard. When this is done, the fact shall be stated in the evaluation report.

4.3 Information to be reported

Unless otherwise agreed, the test results shall be expressed as percentages of output span.

When performance characteristics are specified, they shall be tabulated beside the actual test results.

The limit of error of the measuring systems used for the test shall be stated in the test report and should be smaller than, or equal to, one-quarter of the stated limit of error of the instrument tested.

4.4 Other procedures

- a) An adequate time, as specified by the manufacturer, shall be allowed after switching on the power supply in order to allow temperature within the instrument to stabilize. In the absence of a manufacturer's specification, a period of at least 30 min should be allowed.

- b) In performing tests on a multiple-channel recording instrument, the measured quantity shall be applied to the instrument under test and to a reference instrument and shall be varied so that the required value is shown on the reference instrument. The determination of deviations shall be carried out by using first one of the channels and then, successively, the other channels. Input values should generally be selected in such a way that the recorded values are produced on different points on the chart to provide best discrimination between the recorded values. (In the case of certain tests such as checking zero and span, this is not possible.)

For these types of instruments, it is generally more convenient to adjust the input to obtain the true output values and then record the value of the input.

- c) Errors shall be determined as departure from the input/output relationship specified by the manufacturer where the manufacturer's settings before delivery are used. In other cases, reference must also be made to the adjustments and settings put in by the tester.

5 Conditions during tests

5.1 Environmental

The environmental test conditions shall be in accordance with 6.1 of IEC 61298-1, which also discusses how to deal with small variations from the standard conditions. These conditions apply to all the tests that are dealt with in this standard, except when otherwise stated.

5.2 Supplies

5.2.1 Reference values for power supplies

Reference values are those specified by the manufacturer.

5.2.2 Tolerances

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The tolerances shall be those given in 6.2.2 of IEC 61298-1 unless closer tolerances are agreed between user and manufacturer. These are as follows.

Electrical supply

Rated voltage:	±1 %
Rated frequency:	±1 %
Harmonic distortion (a.c. supply):	less than 5 %
Ripple (d.c. supply):	less than 0,1 %

Pneumatic power supply

Rated pressure:	±1 %
Supply air temperature:	ambient temperature ± 2 °C
Supply air humidity:	dew-point at least 10 °C below recorder body temperature

Oil and dust free

NOTE An oil content not greater than 1×10^{-6} by weight and absence of dust particles greater than 3 µm is considered to be an "oil- and dust-free" supply.

5.3 Other

Input signals: spurious induced voltage or pressure fluctuation shall be minimized in order to have a negligible effect on the measurement.

Recorder position during the test shall be one of the normal operating positions specified by the manufacturer. Only one of any permitted positions shall be used throughout the tests.

6 Test procedures

The following tests are suitable for industrial-process recorders. In general, each applicable test should be conducted on a given recorder if a full evaluation report is planned. If a test has been omitted this should be stated, together with the reason.

For the purpose of this standard the procedures for tests under reference conditions (for example, accuracy-related factors, dynamic behaviour, etc.) specified in IEC 61298-2 apply, together with the additional information below.

6.1 Accuracy-related factors

6.1.1 General

Prior to recording observations, the recorder shall be exercised by three full-range traverses in each direction.

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

Tapping the instrument under test is not allowed. The instrument should be handled as specified by the manufacturer.

Deviations are determined for increasing and decreasing values of the measured quantity according to the following methods.

a) Continuous line recorder

The chart being driven, the input signal shall be applied to the recorder under test and to a reference instrument and progressively changed in such a way as to avoid overshoot until the required value is reached on the reference instrument. Friction effects are included in the limits of error.

b) Dotted-line recorder (single-channel)

The measured quantity shall be applied to the instrument under test and to a reference instrument and shall be varied so that the required value is shown on the reference instrument.

c) Dotted-line recorder (multiple-channel)

The measurement of errors shall be carried out in the same manner as for single-channel dotted-line recorders (see item b) of 6.1.1), by first using one of the channels and then, successively, the other channels.

For each determination using increasing values, all the unused channel(s) shall be energized so that the recorded point(s) correspond to the lower limit of the span.

6.1.2 Measurement cycle

Maintain test conditions and pre-condition the device under test as indicated in 6.1.1. Observe and record output values for each input value for at least three, but preferably five, full-range traverses in each direction.

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 output overshoot occurs.

6.1.3 Error tabulation

Determine the difference between each observed output value and its corresponding ideal output value. This difference is the error and shall be expressed as a percentage of output span. A positive error denotes that the observed output value is greater than the ideal output value.

Compute the following:

- a) average upscale error – the arithmetic mean of the errors at each test point for the upscale readings of each measurement cycle;
- b) average downscale error – the arithmetic mean of the errors at each test point for the downscale readings of each measurement cycle;
- c) average error – the arithmetic mean of all upscale and downscale readings at each test point.

Record error values, average upscale error values, average downscale error values, and average error values.

6.1.4 Error curve

Plot the following error curves versus percentage input:

- average upscale error;
- average downscale error;
- average error.

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6.2 Measured error

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This shall be determined as required in 4.1.7.2 of IEC 61298-2. Unless otherwise stated in the report, and, where it is not contrary to the manufacturer's adjustment instructions, the instrument shall be adjusted for minimum error at the lower and upper range values before the test.

6.3 Conformity (terminal-based), hysteresis and repeatability

These factors shall be determined directly from the error curve as required by 4.1.7 of IEC 61298-2.

6.4 Dead band

The procedure shall be exactly the same as in 4.2 of IEC 61298-2, taking into account the chart speed. Therefore, the chart speed should be sufficiently low for the pen movement not to be affected by the movement of the paper.

7 Effect of influence quantities

For the purpose of this standard, the test procedures specified in IEC 61298-3 apply. Unless otherwise stated, these effects shall be assessed by determining the change in the lower range value and the span due to the following changes in conditions of use taken individually. The other conditions of use remain constant at the reference values. Rates of change of influence quantities shall be sufficiently slow to ensure that no overshoot occurs at any location in the recorder under test.

NOTE 1 If necessary and agreed upon, measurement of output should be made at a sufficient number of input values to permit assessment of any significant effect of influence quantities on conformity, hysteresis, etc.

NOTE 2 Chart drive speed and chart paper may also be affected by influence quantities.