

# Methods of evaluating the performance of electrical and pneumatic analogue chart recorders for use in industrial-process control systems

The European Standard EN 60873:1993 has the status of a  
British Standard

UDC 681.5:621.39-5

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# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Industrial-process Measurement and Control Standards Committee (PCL/-) to Technical Committee PCL/1 upon which the following bodies were represented:

- British Coal
- British Gas Corporation
- British Pressure Gauge Manufacturers' Association
- Department of Energy (Gas and Oil Measurement Branch)
- Department of Trade and Industry (National Weights and Measures Laboratory)
- Energy Industries Council
- Engineering Equipment and Materials Users' Association
- GAMBICA (BEAMA Ltd.)
- Health and Safety Executive
- Institution of Gas Engineers

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Department of Trade and Industry (National Engineering Laboratory)
- Electricity Supply Industry in England and Wales
- Sira Limited

This British Standard, having been prepared under the direction of the Industrial-process Measurement and Control Standards Committee, was published under the authority of the Board of BSI and comes into effect on 30 January 1987

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First published March 1971  
First revision January 1987

The following BSI references relate to the work on this standard:  
Committee reference PCL/1  
Draft for comment 78/26389 DC

ISBN 0 580 15750 4

## Amendments issued since publication

| Amd. No. | Date of issue | Comments                              |
|----------|---------------|---------------------------------------|
| 6189     | February 1989 |                                       |
| 7870     | July 1993     | Indicated by a sideline in the margin |
|          |               |                                       |
|          |               |                                       |

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# National foreword

This British Standard has been prepared under the direction of the Industrial-process Measurement and Control Standards Committee. It implements Harmonization Document HD 504 S1, published by the European Committee for Electrotechnical Standardization (CENELEC), which consists of IEC Publication 873:1986 “*Methods of evaluating the performance of electrical and pneumatic analogue chart recorders for use in industrial-process control systems*”, published by the International Electrotechnical Commission (IEC), with CENELEC common modifications. This British Standard supersedes BS 4671:1971 which is withdrawn.

In 1993 the European Committee for Electrotechnical Standardization (CENELEC) accepted IEC 873:1986 as European Standard EN 60873:1993. As a consequence of implementing the European Standard this British Standard is renumbered as BS EN 60873 and any reference to BS 4671 should be read as a reference to BS EN 60873. EN 60873 supersedes HD 504 S1.

**Terminology and conventions.** The text of the International Standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards.

## Cross-references

| International Standard | Corresponding British Standard                                                                                        |
|------------------------|-----------------------------------------------------------------------------------------------------------------------|
| IEC 68                 | BS 2011 <i>Basic environmental testing procedures</i>                                                                 |
| IEC 68-2-1:1974        | Part 2.1A:1977 <i>Tests A. Cold</i><br>(Identical)                                                                    |
| IEC 68-2-2:1974        | Part 2.1B:1977 <i>Test B. Dry heat</i><br>(Identical)                                                                 |
| IEC 68-2-3:1969        | Part 2.1Ca:1977 <i>Test Ca. Damp heat, steady state</i><br>(Identical)                                                |
| IEC 68-2-6:1982        | Part 2.1Fc:1983 <i>Test Fc. Vibration (sinusoidal)</i><br>(Identical)                                                 |
| IEC 68-2-14:1984       | Part 2.1N:1985 <i>Test N. Change of temperature</i><br>(Identical)                                                    |
| IEC 68-2-31:1969       | Part 2.1Ec:1977 <i>Test Ec. Drop and topple, primarily for equipment-type specimens</i><br>(Identical)                |
| IEC 278:1968           | BS 4308:1979 <i>Specification for documentation to be supplied with electronic measuring apparatus</i><br>(Identical) |
| IEC 348:1978           | BS 4743:1979 <i>Specification for safety requirements for electronic measuring apparatus</i><br>(Identical)           |
| IEC 381                | BS 5863 <i>Analogue signals for process control systems</i>                                                           |
| IEC 381-1:1982         | Part 1:1984 <i>Specification for direct current signals</i><br>(Identical)                                            |
| IEC 381-2:1978         | Part 2:1980 <i>Specification for direct voltage signals</i><br>(Identical)                                            |

| International Standard | Corresponding British Standard                                                                                                                                                                                                                               |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IEC 414:1973           | BS 5458:1977 <i>Specification for safety requirements for indicating and recording electrical measuring instruments and their accessories</i><br>(Identical)<br>BS 5967 <i>Operating conditions for industrial-process measurement and control equipment</i> |
| IEC 654-3:1983         | Part 3:1984 <i>Methods for assessing degrees of immunity of systems or parts of systems when subjected to mechanical influences</i><br>(Identical)<br>BS 6667 <i>Electromagnetic compatibility for industrial-process measurement and control equipment</i>  |
| IEC 801-3:1984         | Part 3:1985 <i>Method of evaluating susceptibility to radiated electromagnetic energy</i><br>(Identical)                                                                                                                                                     |

The Technical Committee has reviewed the provisions of IEC 50(351), referred to in clause 3, IEC 160, referred to in clause 5 and IEC 484, referred to in 12.5, and has decided that they are acceptable for use in conjunction with this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

### Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the EN title page, pages 2 to 28, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.



UDC 681.5:621.39-5

Descriptors: Industrial-process control systems, analogue recorders, electrical recorders, pneumatic recorders, chart recorders, methods of evaluating the performance of recorders

English version

# Methods of evaluating the performance of electrical and pneumatic analogue chart recorders for use in industrial-process control systems

(IEC 873:1986, modified)

Méthodes d'évaluation des performances des enregistreurs analogiques électriques et pneumatiques sur papier diagramme, utilisés dans les systèmes de conduite des processus industriels  
(CEI 873:1986, modifiée)

Methoden der Beurteilung des Betriebsverhaltens von analogen elektrischen und pneumatischen Streifenschreibern in Systemen der industriellen Prozeßtechnik  
(IEC 873:1986, modifiziert)

This European Standard was approved by CENELEC on 1993-03-09. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

## CENELEC

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

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## Foreword

At the request of CENELEC Reporting Secretariat SR 65B, HD 504 S1:1988 (IEC 873:1986, modified) was submitted to the CENELEC voting procedure for conversion into a European Standard.

The text of the International Standard together with the common modifications accepted for HD 504 S1:1988 was approved by CENELEC as EN 60873 on 9 March 1993.

The following dates were fixed:

- latest date of publication of  
an identical national  
standard (dop) 1994-03-01
- latest date of withdrawal of  
conflicting national  
standards (dow) —

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative.

## Introduction

The methods of evaluation specified in this standard 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 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 programmes and the results.

## 1 Scope

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

## 2 Object

This standard is intended to 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.

When a full evaluation in accordance with this standard is not required, those tests which are required shall be performed and the results reported in accordance with those parts of the standard which are relevant.

## 3 Definitions

For the purpose of this standard, the definitions below shall apply until final definitions of these terms are published in a new edition of IEC Publication 50(351): International Electrotechnical Vocabulary (IEV), Chapter 351: Automatic Control.

### 3.1

#### conformity

the conformity of a curve consists in the closeness by which it approximates to a specified curve (e.g., linear, logarithmic, parabolic, cubic, square root, etc.)

NOTE 1 It is usually measured in terms of non-conformity and expressed as conformity, for example, the maximum deviation between an average curve and a specified curve. The average curve is determined after making two or more full-range traverses in each direction. The value of conformity is referred to the output span unless otherwise stated.

NOTE 2 As a performance specification, conformity may be expressed as independent conformity, terminal-based conformity or zero-based conformity.

NOTE 3 Linearity is a specific, frequently encountered case of conformity where the specified curve is a straight line.

### 3.2

#### conformity, independent

the maximum deviation of the actual characteristic (average of upscale and downscale readings) from a specified curve, so positioned as to minimize the maximum deviation

### 3.3

#### conformity, terminal-based

the maximum deviation of the actual characteristic (average of upscale and downscale readings) from a specified curve coinciding with the actual characteristic at upper and lower range-values

**3.4****conformity, zero-based**

the maximum deviation of the actual characteristic (average of upscale and downscale readings) from a specified curve so positioned as to coincide with the actual characteristic at the lower range-value and to minimize the maximum deviation

**3.5****dead band**

the largest change in input that can be effected without causing a detectable change in output

**3.6****friction effect**

in the case of continuous line recorders, it is the effect which friction of the marking device on the chart may have on the record

**3.7****hysteresis**

that property of an element evidenced by the dependence of the value of the output, for a given excursion of the input, upon the history of prior excursions and the direction of the current traverse (see Figure B.2, page 26, and Table B.I, page 25)

NOTE This is a common usage definition which includes hysteresis error and dead band. That portion of the difference which is dependent on the history of prior excursion is hysteresis error, while that portion due to dead band may be determined by a conventional dead-band test.

**3.8****hysteresis error**

that portion of hysteresis due to energy absorption in the elements of a measuring instrument. Unless otherwise specified, it should be determined by subtracting the effect of the dead band from the maximum measured separation between upscale and downscale readings of the measured variable during a full-range traverse

**3.9****range**

the range is the region between the limits within which a quantity is measured, or received, expressed by stating the lower and upper range-values. 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.

**3.10****elevated-zero range**

a range in which the zero value of the measured variable is greater than the lower range-value.

Example:  $-10\text{ }^{\circ}\text{C}$ ,  $+30\text{ }^{\circ}\text{C}$

**3.11****lower range-value**

the lowest value of the measured variable that a device is adjusted to measure

**3.12****upper range-value**

the highest value of the measured variable that a device is adjusted to measure

**3.13****span**

the algebraic difference between the upper and lower range-values. Example: 16 mA when the range is 4 mA, 20 mA

**3.14****suppressed-zero range**

a range in which the zero value of the measured variable is less than the lower range-value.

Example:  $200\text{ }^{\circ}\text{C}$ ,  $500\text{ }^{\circ}\text{C}$

**3.15****over-range**

the extent by which any value of the input signal exceeds its upper range-value or goes below its lower range-value

**3.16****output**

the 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 Sub-clause 12.4 for remarks on parallax

**3.17****repeatability**

the closeness of agreement among a number of consecutive measurements of the output for the same value of the input under the same operating conditions, approaching from the same direction, for full-range traverses

**3.18****recorder**

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

**3.19****recorder, multiple-pen**

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

**3.20****recorder, multiple-channel**

a 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

**3.21****record**

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

**3.22****time per point**

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

**3.23****zero adjustment**

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

**4 General testing procedures****4.1 Selection of ranges for test**

**4.1.1** 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.

**4.1.2** 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.

**4.1.3** 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.