BS EN 60770-2:2010

Transmitters for use in industrial-process control systems

Part 2: Methods for inspection and routine testing

National foreword

This British Standard is the UK implementation of EN 60770-2:2010. It is identical to IEC 60770-2:2010. It supersedes BS EN 60770-2:2003, which will be withdrawn on 1 December 2013.

The UK participation in its preparation was entrusted by Technical Committee GEL/65, Measurement and control, to Subcommittee GEL/65/2, Elements of systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Transmitters for use in industrial-process control systems - Part 2: Methods for inspection and routine testing
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Transmetteurs utilisés dans les systèmes de conduite des processus industriels - Partie 2: Méthodes pour l'inspection et les essais individuels de série
(CEI 60770-2:2010)

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(IEC 60770-2:2010)

CENELEC

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Foreword

The text of document 65B/760/FDIS, future edition 3 of IEC 60770-2, prepared by SC 65B, Devices & process analysis, of IEC TC 65, Industrial-process measurement, control and automation, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60770-2 on 2010-12-01.

This European Standard supersedes EN 60770-2:2003.

The significant technical change with respect to EN 60770-2:2003 is as follows:

– the sequence in content has been reordered in Clause 5.

This standard should be read in conjunction with EN 61298-1, EN 61298-2, EN 61298-3 and EN 61298-4.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-09-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-12-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60770-2:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61326-1:2005 NOTE Harmonized as EN 61326-1:2006 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-300	-	International Electrotechnical Vocabulary - Electrical and electronic measurements and measuring instruments - Part 311: General terms relating to measurements - Part 312: General terms relating to electrical measurements - Part 313: Types of electrical measuring instruments - Part 314: Specific terms according to the type of instrument	-	-
IEC 60381-1	1982	Analogue signals for process control systems - Part 1: Direct current signals	HD 452.1 S1	1984
IEC 60382	1991	Analogue pneumatic signal for process control systems	EN 60382	1993
IEC 60410	1973	Sampling plans and procedures for inspection by attributes	-	-
IEC 60770-1	1999	Transmitters for use in industrial-process control systems - Part 1: Methods for performance evaluation	EN 60770-1	1999
IEC 60770-3	2006	Transmitters for use in industrial-process control systems - Part 3: Methods for performance evaluation of intelligent transmitters	EN 60770-3	2006
IEC 61298-1	2008	Process measurement and control devices - General methods and procedures for evaluating performance - Part 1: General considerations	EN 61298-1	2008
IEC 61298-2	2008	Process measurement and control devices - General methods and procedures for evaluating performance - Part 2: Tests under reference conditions	EN 61298-2	2008
IEC 61298-3	2008	Process measurement and control devices - General methods and procedures for evaluating performance - Part 3: Tests for the effects of influence quantitites	EN 61298-3	2008

Publication	Year	Title	EN/HD	Year
IEC 61298-4	2008	Process measurement and control devices - General methods and procedures for evaluating performance - Part 4: Evaluation report content	EN 61298-4	2008
IEC/TS 62098	2000	Evaluation methods for microprocessor-based instruments	-	-

CONTENTS

INTRODUCTION

The methods of inspection and routine testing specified in this standard are intended for use in acceptance tests or after repair to verify the fulfilment of the performance specifications as established by the user. The methods given in this standard are primarily intended for the testing of conventional analogue transmitters. For setting up test procedures for microprocessor-based instruments IEC 60770-3 and IEC/TS 62098 should be consulted.

TRANSMITTERS FOR USE IN INDUSTRIAL-PROCESS CONTROL SYSTEMS –

Part 2: Methods for inspection and routine testing

1 Scope and object

This part of IEC 60770 is applicable to transmitters, which have either a standard analogue electric current output signal or a standard pneumatic output analogue signal in accordance with IEC 60381-1 or IEC 60382. The tests detailed herein may be applied to transmitters which have other output signals, provided that due allowance is made for such differences.

For the method of inspection and routine testing of the intelligent transmitters see IEC 60770-3.

For certain types of transmitters, where the sensor is an integral part, other specific IEC or ISO standards may need to be consulted (e.g. for chemical analyzers, flow-meters, etc.)

This standard is intended to provide technical methods for inspection and routine testing of transmitters, for instance, for acceptance tests or after repair. For a full evaluation, IEC 60770-1 and/or IEC 60770-3, respectively for analogue or intelligent transmitters shall be used.

Quantitative criteria for acceptable performance should be established by agreement between manufacturer and user.

By agreement the tests need not be carried out by an accredited laboratory.

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 60050-300, *International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

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

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

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 60770-1:1999, *Transmitters for use in industrial-process control systems – Part 1: Methods for performance evaluation*

IEC 60770-3:2006, *Transmitters for use in industrial-process control systems – Part 3: Methods for performance evaluation of intelligent transmitters*

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 evaluation 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/TS 62098:2000, *Evaluation methods for microprocessor-based instruments*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-300, in the IEC 61298 series and the following apply.

3.1
acceptance test
test proving to the user that the device complies with the performance specifications as they appear in the contract

3.2
variable
quantity or condition whose value is subject to change and can usually be measured

EXAMPLE temperature, flow rate, speed, signal, etc.

3.3
signal
physical variable of which one or more parameters carry information about one or more variables represented by the signal

3.4
range
region of the values between the lower and upper limits of the quantity under consideration

3.5
span
algebraic difference between the upper and lower limit values of a given range

3.6
test procedure
statement of the tests to be carried out and the conditions for each test, agreed between the manufacturer, the test laboratory and the purchaser/user before the evaluation starts

3.7
maximum measured error
largest positive or negative value of error of the upscale or downscale value of each point of measurement

3.8
hysteresis
greatest difference between the upscale and downscale output readings at one point

3.9
step response
time response of a transmitter produced by a stepwise variation of one of the input variables

3.10
influence quantity
parameter chosen to represent one aspect of the environment under which a device may operate

4 Sampling for test

If, by agreement between user and manufacturer, tests are to be performed only on samples, it is recommended that a sampling method such as that presented in IEC 60410 be selected. When sampling is used, transmitters to be tested may be chosen by the user.

5 Performance tests

5.1 General

The tests listed in 5.5 and 5.6 shall be performed. Under certain circumstances, the user may not require every test to be carried out. The sequence of the tests shall be such that the results of a test are not affected by a previous test, provided proper pre-conditioning has been performed.

5.2 Test conditions

5.2.1 Ambient conditions

– Temperature	from 15 °C to 25 °C
– Relative humidity	from 45 % to 75 %
– Atmospheric pressure	from 86 kPa to 106 kPa
– Electromagnetic field	value to be stated if relevant

The maximum rate of change of ambient temperature permissible during any test shall be 1 °C in 10 min, but not more than 3 °C per hour.

5.2.2 Supply conditions

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 supply:

– rated pressure	±3 %
– supply air temperature	ambient temperature ±2 °C

– supply air humidity	dew-point at least 10 °C below device body temperature
– oil and dust content	oil: less than 1×10^{-6} by weight dust: absence of particles greater than 3 μm

5.2.3 Load conditions

Electrical instrumentation:

– voltage output signals: the minimum load value specified by the manufacturer
– current output signals: the maximum load value specified by the manufacturer

Pneumatic instrumentation:

– a rigid tube 8 m long and 4 mm internal diameter connected to a 20 cm^3 rigid container.

5.3 Preconditioning

For preconditioning with power applied to the transmitter, sufficient time (not less than 30 min) should be allowed to ensure stabilization of the operating temperature of the transmitter.

5.4 Adjustments

The routine tests shall be carried out (as an acceptance test or after repair) with the adjustments for lower range value, span and damping determined by the user in consultation with the manufacturer.

5.5 Tests under reference conditions

5.5.1 Measured error and hysteresis

The input-output characteristic under reference conditions shall be measured in one measurement cycle, traversing the full range in each direction. For this, at least five points of measurement should be evenly distributed over the range; they should include points at or near (within 10 % of span) the 0 % and 100 % values of the span.

NOTE For instruments with a non-linear input-output relationship (e.g. square law), the test points should be chosen so as to obtain output values equally distributed over the output span.

Measurement procedure:

Initially, an input signal equal to the lower range value is generated and the value of the corresponding input and output signal is noted. Then the input signal is slowly increased to reach, without overshoot, the first test point. After an adequate stabilization period, the value of the corresponding input and output signal is noted.

The operation is repeated for all the predetermined values up to 100 % of the input span. After measurement at this point, the input signal is slowly brought down, without overshoot, to the test value directly below 100 % of input span, and then to all other values in turn down to 0 % of input span, thus closing the measurement cycle.

The difference between the output signal values obtained at the test points for each upscale and downscale traverse and the corresponding ideal values are recorded as the measured errors. The errors generally shall be expressed as percent of the ideal output span. All the error values thus obtained shall be shown in a tabular form (see Table 1) and presented graphically (see Figure 1).

Table 1 – Typical measured errors

Output (% of span)	0	20	40	60	80	100
Measured error up		0,09	−0,04	−0,23	−0,22	0,10
Measured error down	−0,06	0,26	0,17	−0,08	−0,13	
Maximum measured error	−0,06	**0,26**	0,17	−0,23	−0,22	0,10
Hysteresis		0,17	**0,21**	0,15	0,09	

From Table 1, the maximum measured error found is 0,26 % and the maximum hysteresis is 0,21 %. The data from Table 1 are plotted in Figure 1.

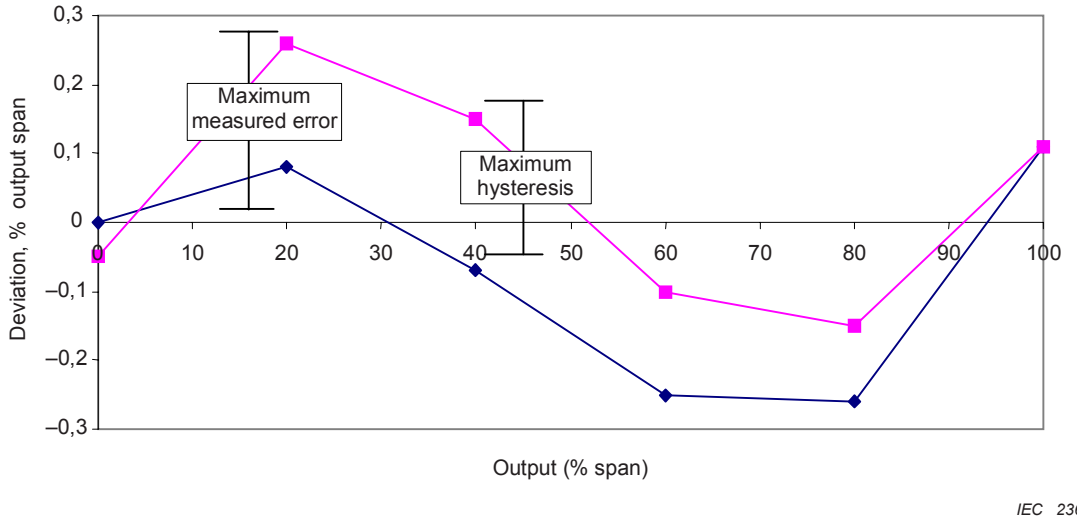

Figure 1 – Typical measured error plot

5.5.2 Step response

Output loading:

Electrical transmitters: Values specified by the manufacturer or a 0,1 μF capacitor in parallel with the reference load resistance.

Pneumatic transmitters: An 8 m length of 4 mm internal diameter rigid pipe connected to a 20 cm^3 rigid container.

Measurement procedure:

Two steps corresponding to 80 % of output span, preferably from 10 % to 90 %, then from 90 % to 10 % shall be applied.

The settling time, the time for the output to reach and remain within 1 % of the span of its steady state value shall be reported for each step. The amount of dead time, rise time, time constant and overshoot (in percentage of span), if any, shall also be reported. Figure 2 illustrates the definitions of the times and gives examples of responses to a positive step input.

NOTE If there is difficulty in generating or recording an accurate input step, due to the physical characteristics or range of the input variable, the dynamics required for this test should be agreed between the manufacturer and the user. Where there is no concern about the step response, this test may be omitted.

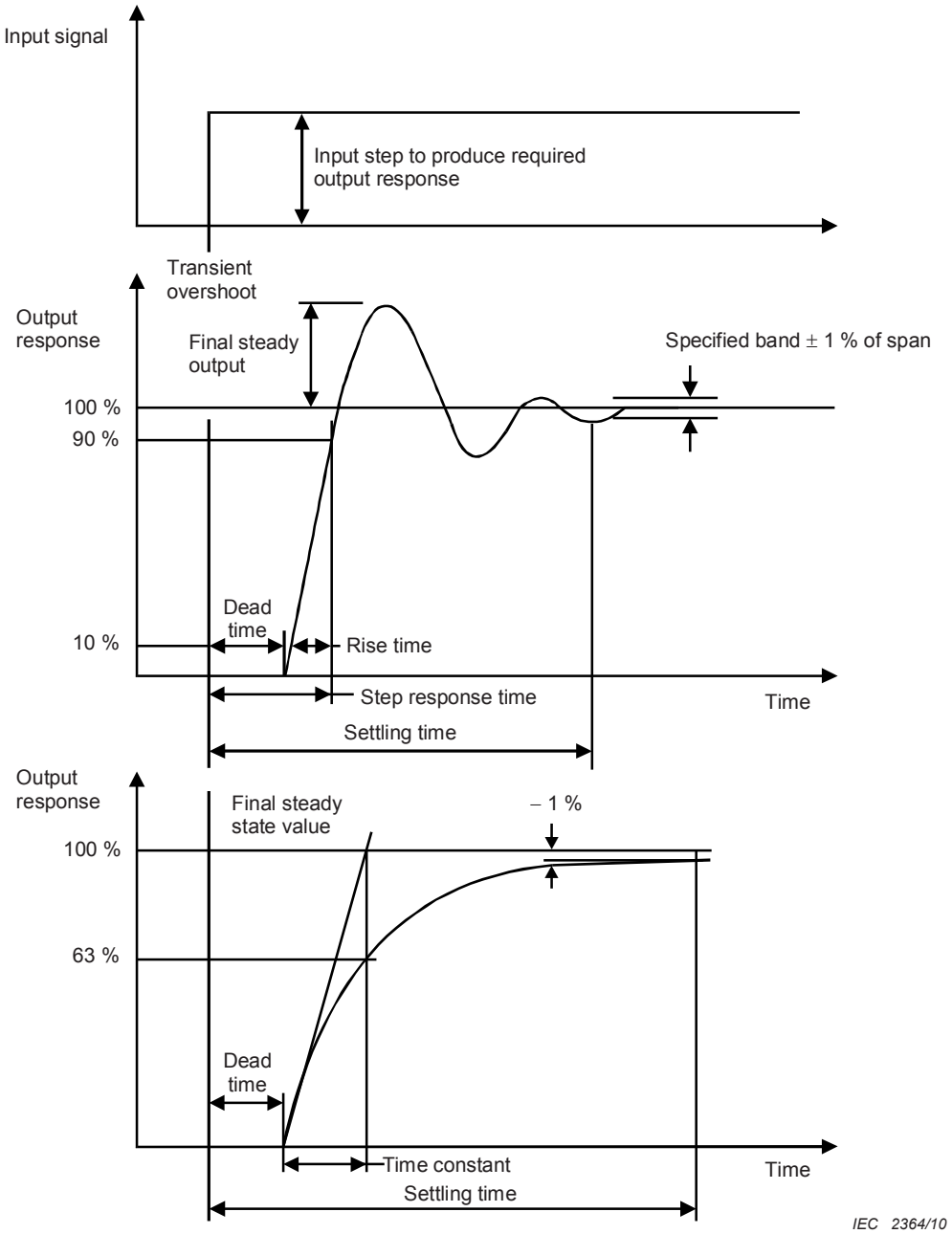

Figure 2 – Two examples of responses to a step input

5.6 Effects of influence quantities

5.6.1 Input signals and output load

Input signals: the tests described in 5.6.2, 5.6.3, 5.6.4 and 5.6.5 shall each be conducted with input signals of 0 % and 100 % of span if the transmitter output is able to go at least 2 % below its lower range value and at least 2 % above its upper range value. Otherwise, suitable input signals such as 5 % and 95 % of span shall be substituted.

Output load: electrical transmitters should be connected to maximum rated output load (for current output).

5.6.2 Power supply variations

Using each chosen input signal, the user shall measure and report the change of output in percentages of span at the following variations in power supply or at the manufacturer's stated limits, whichever is smaller:

Voltage variation: +10 % to –15 % of nominal a.c. voltage and +20 % to –15 % for nominal d.c. voltage (IEC 61298-3) (for 2-wire transmitters the load has also to be taken in account).

Pneumatic supply pressure variation: +10 % to –15 % of nominal pressure (IEC 61298-3).

5.6.3 Ambient temperatures

The user shall measure and report at 0 % and 100 % input signal the change in observed output signal. This shall be carried out at each of the following ambient temperatures:

a) 20 °C (reference);

b) maximum operating temperature specified by the manufacturer;

c) 20 °C;

d) minimum operating temperature specified by the manufacturer;

e) 20 °C;

The tolerance for each test temperature should be ±2 °C and the rate of change of ambient temperature should be less than 1 °C per minute.

Before measuring the influence effect, sufficient time (usually 3 h) shall be allowed for stabilization of the temperature of all parts of the transmitter.

Output changes shall be reported as percentages of output span.

NOTE This test may be omitted only where there is no concern about ambient temperature effects.

5.6.4 Over-range

Before this test, measurements of the output shall be performed at 0 % and 100 % input values. The input shall then be increased to the maximum over-range value specified by the manufacturer. After the over-range value has been applied for 1 min, the input shall be reduced to the nominal lower range value. After a further 5 min have elapsed, using the same input levels as before, determine the changes in observed output values.

Differential pressure transmitters are to be tested for over-range effects in both directions. They shall be tested as described above, first over-ranging the positive chamber and then over-ranging the negative chamber. The changes in output, determined after over-ranging in each direction, shall be reported.

Output changes shall be reported as percentages of output span.

5.6.5 Static line pressure

This test shall be carried out on transmitters which in normal operation are subjected to line pressure.

Before this test, measurements of the output shall be performed at 0 % and 100 % input values. The pressure shall be changed from atmospheric to the full working pressure of the instrument. For some applications, this test may also be required to be performed at pressures below atmospheric pressure. Using the same input levels as before, the changes in observed output values shall be measured.

NOTE Measuring the static pressure influence with inputs other than zero differential pressure is very difficult to realise for differential pressure transmitters. If this should be required, a separate agreement between manufacturer and user is recommended.

Output changes shall be reported as percentages of output span.

6 Test report and documentation

A complete test report of the evaluation shall be prepared after the completion of the tests. The test report shall have the following generic lay-out:

- Title page with
  - abridged name and type/model number of the instrument;
  - name of the manufacturer;
  - name and address of the laboratory;
  - names and signatures of evaluator and his next principal (report authorizer);
  - identification code of the report and date of issue.
- Introduction with
  - aim of the tests;
  - name and address of the manufacturer;
  - model, type, serial number and date of manufacture (or final assembly) of the instrument;
  - short description of the instrument, type and number of sensors, measuring range, recording method, measurement intervals, memory size in terms of number of messages, supply and energy consumption;
  - period and year in which tests are performed;
  - test methods used and test methods omitted or varied.
- Conclusions and test results with
  - summary with conclusions with respect to the applicability based on the test results and other qualitative findings;
  - table in which all test results are conveniently arranged.

All the original documentation related to the measurements made during the tests shall be stored by the user for at least two years after the report is issued.

Bibliography

IEC 60381-2:1978, *Analogue signals for process control systems – Part 2: Direct voltage signals*

IEC 61326 -1:2005, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

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