INTERNATIONAL STANDARD

IEC 60770-2

Second edition
2003-01

Transmitters for use in industrial-process control systems –

Part 2: Methods for inspection and routine testing

Transmetteurs utilisés dans les systèmes de conduite des processus industriels –

Partie 2: Méthodes pour l'inspection et les essais individuels de série

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

TRANSMITTERS FOR USE IN INDUSTRIAL-PROCESS CONTROL SYSTEMS –

Part 2: Methods for inspection and routine testing

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 60770-2 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 published in 1989 and constitutes a technical revision.

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

FDIS	Report on voting
65B/468/FDIS	65B/477/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.

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

A bilingual edition may be issued at a later date.

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

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

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 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 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 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 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

At the time of the publication the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on these normative documents are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050-351:1998, *International Electrotechnical Vocabulary – Part 351: Automatic Control*

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 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: Test 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 62098:2000, *Evaluation methods for microprocessor-based instruments*

3 Terms and definitions

The main terms used for measuring the physical quantities are those used in IEC 60050-351 and IEC 61298. For the purpose of this standard the following terms apply:

3.1

acceptance test
a test to prove 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 (e.g. temperature, flow rate, speed, signal, etc.)

3.3

signal
physical variable, one or more parameters of which carry information about one or more variables, which the signal represents

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

3.9

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

3.10

influence quantity
test 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

The tests listed in 5.4 and 5.5 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.

5.1 Test conditions

5.1.1 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.

5.1.2 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.

5.1.3 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 cm³ rigid container.

5.2 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.

5.3 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.

5.4 Tests under reference conditions

5.4.1 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.

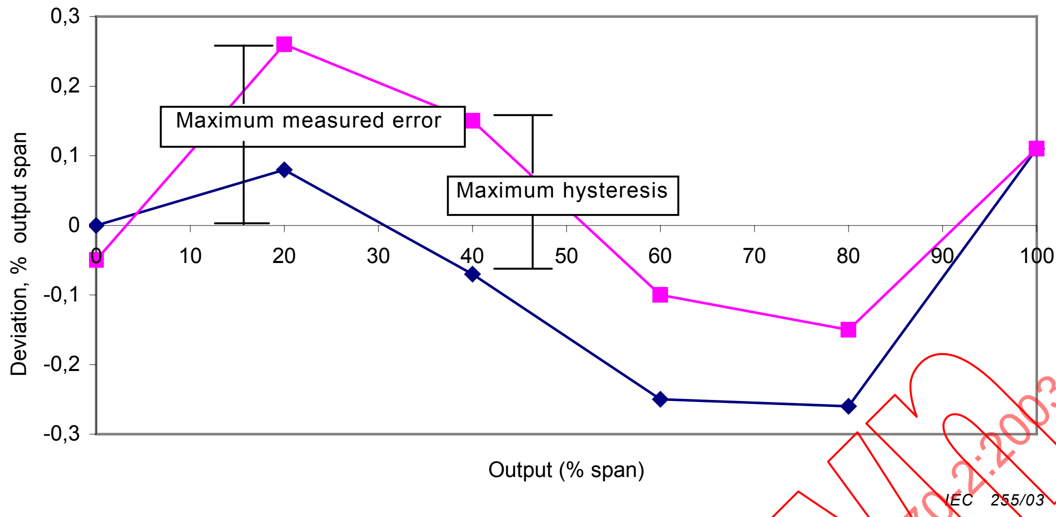

Figure 1 – Typical measured error plot

5.4.2 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.

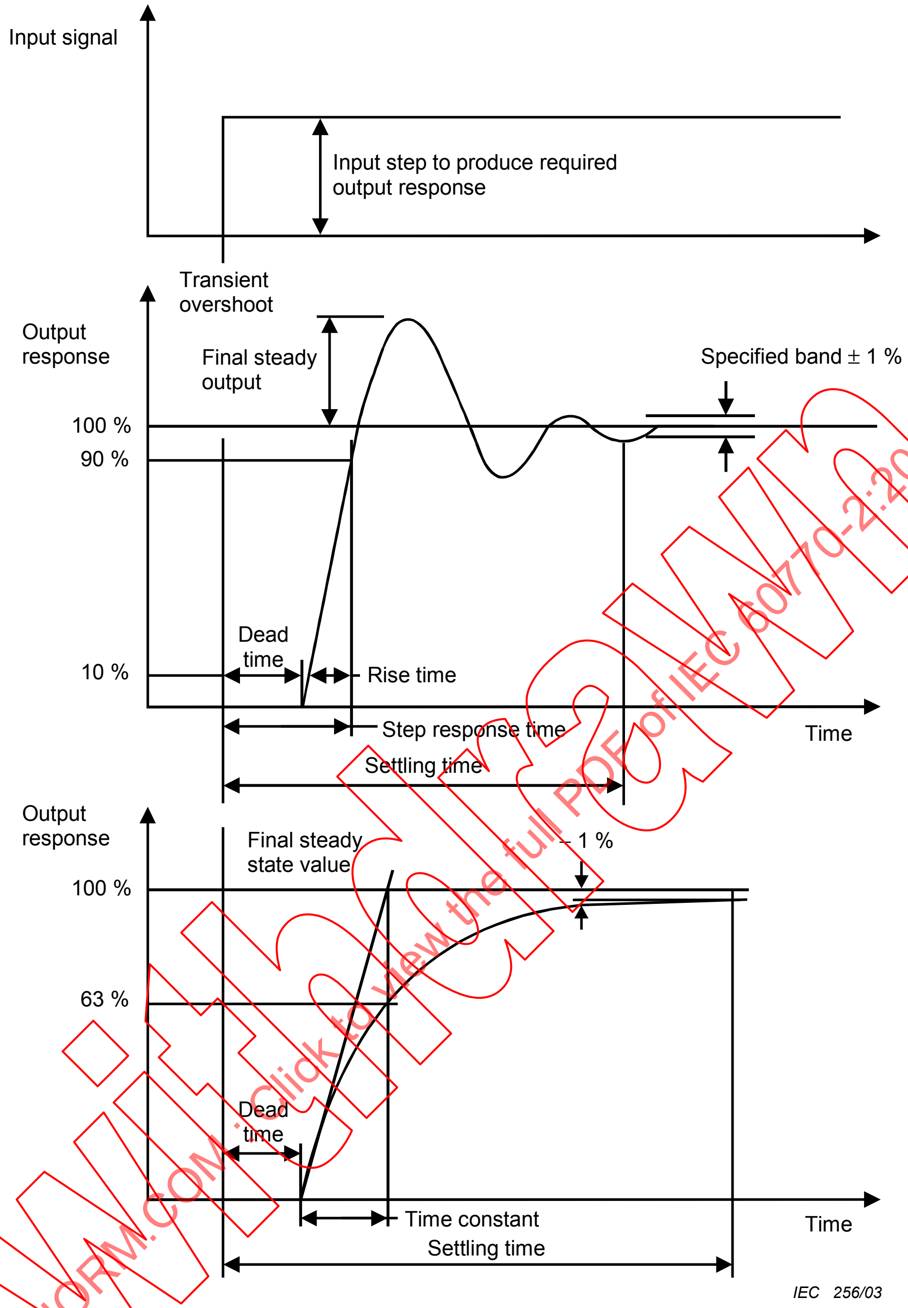

Figure 2 – Two examples of responses to a step input

5.5 Effects of influence quantities

Input signals: the tests described, in 5.5.1, 5.5.2, 5.5.3 and5.5.4, 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).