

INTERNATIONAL STANDARD

IEC 60770-3

First edition
2006-04

Transmitters for use in industrial-process control systems –

Part 3: Methods for performance evaluation of intelligent transmitters

© IEC 2006 — Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

XA

For price, see current catalogue

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope and object.....	7
2 Normative references.....	7
3 Terms and definitions	8
4 Design review	10
4.1 General	10
4.2 Transmitter analysis	10
4.3 Aspects to be reviewed.....	14
4.4 Documentary information	20
5 Performance testing.....	21
5.1 General	21
5.2 Instrument considerations.....	21
5.3 Measurement considerations	23
5.4 Test facilities	24
5.5 Transmitter under test (testing precautions).....	25
5.6 Reference conditions for performance tests	26
5.7 Test procedures for tests under reference conditions	27
5.8 Test Procedures for determination of the effects of influence quantities.....	30
6 Other considerations.....	40
6.1 Safety.....	40
6.2 Degree of protection provided by enclosures	40
6.3 Electromagnetic emission	40
6.4 Variants.....	41
7 Evaluation report	41
Annex A informative Dependability testing	42
Annex B informative Throughput testing	49
Annex C informative Function block testing	53
Figure 1 – Intelligent transmitter model.....	11
Figure 2 – Basic test set-up.....	24
Figure 3 – Examples of step responses of electrical outputs of transmitters	29
Figure A.1 – Example schematic of a transmitter	43
Figure A.2 – Test tool for low impedance circuits and shared circuits	44
Figure A.3 – Matrix for reporting fault behaviour	46
Figure A.4 – Ranking of various types of failure modes.....	47
Figure B.1 – Transmitter in stand-alone configuration	49
Figure B.2 – Transmitter as a participant in a fieldbus installation	49

Table 1 – Checklist for mapping functionality	14
Table 2 – Checklist for mapping configurability	15
Table 3 – Checklist for mapping hardware-configuration	16
Table 4 – Checklist for mapping adjustment and tuning procedures	16
Table 5 – Checklist for mapping operability.....	17
Table 6 – Checklist for mapping dependability	18
Table 7 – Checklist for mapping manufacturer’s support.....	19
Table 8 – Reporting format for design review.....	19
Table 9 – Checklist on available documentation.....	20
Table 10 – Listing of functions of single variable transmitter	22
Table 11 – Listing of functions of composite variable transmitter	23
Table 12 – Reference environmental and operational test conditions	26
Table 13 – procedures for tests under reference conditions	27
Table 14 – Methods for testing immunity to sensor disturbances	33
Table 15 – Methods for testing immunity to wiring disturbances	34
Table 16 – Methods for testing the immunity to disturbances of the power utilities.....	36
Table 17 – Methods for testing the immunity to environmental disturbances	38
Table 18 – Methods for testing the immunity to degradation in time.....	40

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**TRANSMITTERS FOR USE IN INDUSTRIAL-PROCESS
CONTROL SYSTEMS –**

**Part 3: Methods for performance evaluation
of intelligent transmitters**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The International Standard IEC 60770-3 has been prepared by subcommittee 65B, Devices, of IEC technical committee 65: Industrial-process measurement and control.

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

FDIS	Report on voting
65B/580/FDIS	65B/587/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.

IEC 60770 consists of the following parts, under the general title *Transmitters for use in industrial-process control systems*:

Part 1: Methods for performance evaluation

Part 2: Methods for inspection and routine testing

Part 3: Methods for performance evaluation of intelligent transmitters

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

A bilingual version of this standard may be issued at a later date.

INTRODUCTION

New transmitters for use in industrial process control systems are now equipped with micro-processors which utilise digital data processing and communication methods, auxiliary sensors and artificial intelligence. This makes them more complex than conventional analogue transmitters and gives them considerable added value.

An intelligent transmitter is an instrument that uses digital data processing and communication methods for performing its functions and for safeguarding and communicating data and information on its operation. It may be equipped with additional sensors and functionality which support the main function of the intelligent transmitter. The variety of added functionality can for instance enhance accuracy and rangeability, self-test capabilities, and alarm and condition monitoring. Therefore accuracy-related performance testing, although still a major tool for evaluation, is no longer sufficient to show the flexibility, capability and other features with respect to engineering, installation, maintainability, reliability and operability.

Because of the complexity of intelligent transmitters, a close collaboration should be maintained between the evaluating body and the manufacturer during the evaluation. 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 programme and the results. His comments on the results should be included in any report produced by the testing organisation.

This part of IEC 60770 addresses, in its main body, structured and mandatory methods for a design review and performance testing of intelligent transmitters. Intelligent transmitters will, in many cases, also have the capacity to be integrated into digital communication (bus) systems, where they have to co-operate with a variety of devices. In this case, dependability, (inter)operability and real-time behaviour are important issues. The testing of these aspects depends largely on the internal structure and organisation of the intelligent transmitter and the architecture and size of the bus system. The Annexes A, B and C give a non-mandatory methodology and framework for designing specific evaluation procedures for dependability and throughput testing and function block testing in a specific case.

When a full evaluation, in accordance with this part of IEC 60770, is not required or possible, those tests which are required, should be performed and the results reported in accordance with the relevant parts of this standard. In such cases, the test report should state that it does not cover the full number of tests specified herein. Furthermore, the items omitted should be mentioned, in order to give the reader of the report a clear overview.

The structure of this part of IEC 60770 largely follows the framework of IEC 62098. For performance testing, the IEC 61298 series should also be consulted. A number of tests described there are still valid for intelligent transmitters. Further reading of the IEC 61069 series is recommended, as some notions in this part of IEC 60770 are based on concepts brought forward therein.

TRANSMITTERS FOR USE IN INDUSTRIAL-PROCESS CONTROL SYSTEMS –

Part 3: Methods for performance evaluation of intelligent transmitters

1 Scope and object

This part of IEC 60770 specifies the following methods.

- Methods for
 - reviewing the functionality and the degree of intelligence in intelligent transmitters;
 - testing the operational behaviour, as well as the static and dynamic performance of an intelligent transmitter.
- Methodologies for
 - determining the reliability and diagnostic features used to detect malfunctions;
 - determining the communication capabilities of the intelligent transmitters in a communication network.

The methods and methodologies are applicable to intelligent transmitters, which convert one or more physical, chemical or electrical quantities into digital signals for use in a communication network or into analogue electrical signals (as specified in the IEC 60381 series).

The methods and methodologies listed in this part of IEC 60770 are intended for use by:

- manufacturers to determine the performance of their products and
- users or independent testing laboratories to verify equipment performance specifications.

Manufacturers of intelligent transmitters are urged to apply this part of IEC 60770 at an early stage of development.

This standard is intended to provide guidance for designing evaluations of intelligent transmitters by providing:

- a checklist for reviewing the hardware and software design in a structured way;
- test methods for measuring and qualifying the performance, dependability and operability under various environmental and operational conditions;
- methods for reporting the data obtained.

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 (IEV) – 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 60068-2-1, *Environmental testing – Part 2: Tests. Tests A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2: Tests B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-31, *Environmental testing. Part 2: Tests. Test Ec: Drop and topple, primarily for equipment-type specimens*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60079 (all parts), *Electrical apparatus for explosive gas atmospheres*

IEC 60381(all parts), *Analogue signals for process control systems*

IEC 60529:1989, *Degree of protection provided by enclosures (IP Code)*
Amendment 1 (1999)

IEC 60654 (all parts), *Operating conditions for industrial-process measurement and control equipment*

IEC 60721-3 (all parts), *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities*

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

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

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61158 (all parts), *Digital data communications for measurement and control – Fieldbus for use in industrial control systems*

IEC 61298 (all parts), *Process measurement and control devices – General methods and procedures for evaluating performance*

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

IEC 61499 (all parts), *Function blocks*

IEC 61804 (all parts), *Function blocks (FB) for process control*

CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*