

Specification for data quality metrics for industrial measurement and control systems

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Committees responsible for this British Standard

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- ABB Automation Ltd.
- Alstom Controls Ltd.
- Department of Trade and Industry
- Engineering Equipment and Material Users Association
- Fisher-Rosemount Ltd.
- Foxboro Great Britain Ltd.
- Health and Safety Executive
- Measurement Technology Ltd.
- Phoenix Contact Ltd.
- Rockwell Automation Ltd.
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Foreword

This British Standard was prepared by Technical Committee AMT/7, Monitoring and control aspects of AMT. The preparation of the initial draft of this standard was funded by the UK Department of Trade and Industry under the BSI-DTI Consultancy Drafting Scheme.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 23 and a back cover.

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Introduction

Intelligent field devices and instruments are increasingly able to provide data quality information with their output measurements and statements about device current and future performance capability. Data quality metrics associated with measurement data and device status are independent of the communication network which transfers the data between component devices and interested agents.

This British Standard has been developed following a study of intelligent flowmeters²⁾ which was commissioned by the UK Department of Trade and Industry in 1997.

The survey collected views of UK users and suppliers of intelligent flowmeters during the second half of 1997 and shared them with a Technology Advisory Panel which reviewed and commented on the results. The participants and responders included twenty-four users of industrial instrumentation (including contractors), together with all the main suppliers of flowmeters.

The central themes of the work were:

- the status and impact of fieldbuses in UK industrial flow measurement;
- the status and impact on UK industry of intelligent flow instruments;
- to report on the implications of these technologies and make recommendations on their use for UK industry;
- to identify the business benefits and competitive advantages attainable from data quality metrics used with intelligent instruments.

Both users and suppliers identified the need for a generic approach to maintenance support and data quality reporting for intelligent instruments, particularly those using a digital communication network such as a fieldbus.

In response to this work, the study technical review panel and plenary meeting recommended that BSI prepare standards on data quality metrics for UK industry.

The validation concepts on which this British Standard is based have been verified and demonstrated by the Sensor Validation Research Group at the University of Oxford Department of Engineering Science, and by the IAM-Pilot³⁾ project at ENEL in Italy.

1 Scope

This British Standard specifies data quality metrics and status indications for use with intelligent instrumentation. This British Standard is intended to help industry gain operational benefits from a consistent and open approach to the use of data quality metrics for measurements and device status information. The data quality metrics in this specification have been classified by reference to the agents they primarily support, e.g. control agents, maintenance agents and management agents. These agents may be real persons or the system packages which implement the user applications.

A common approach is specified to support the implementation of function blocks using measurements accompanied by data quality attributes.

Although this specification assumes that a communication network such as fieldbus is used to transfer data within the measurement channel, the definitions of data quality metrics and status values are not related to any underlying communication protocol.

Designer specific status values are not defined in this specification. It is recommended that these details are specified and available as accessible data in the device specific information.

Data quality values can be used by control and maintenance agents to automate control adjustments and maintenance planning for the improvement of plant and process operation and efficiency. Examples of this are given in Annex A.

²⁾ *The impact of fieldbus and sensor fusion on flow measurement 1998*. Sira Ltd., South Hill, Chislehurst, Kent BR7 5EH.

³⁾ Esprit project 23525 IAM-Pilot, *Intelligent actuation and measurements — Pilot*. European Commission, Brussels.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this British Standard. For this dated reference, subsequent amendments to, or revisions of, any of this publication does not apply.

PD 6461-3:1995, *Vocabulary of metrology — Part 3: Guide to the expression of uncertainty in measurement*.

NOTE 1 This document is also known as the *Guide to the expression of uncertainty in measurement* (GUM), ISO/IEC, 1995.

NOTE 2 The relationship between PD 6431-3 and BS 7986 is explained in Annex B.

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1

agent

consumer of measurement data and/or the originator of command data that is transferred through a channel

3.2

BLIND

MVstatus during which the VMV is based on historical data

NOTE 1 BLIND indicates that based on internal diagnostic data, the instrument logic concludes that the raw measurement value is not representative of the process variable and sufficient evidence exists to assert that the problem is permanent.

NOTE 2 The VMV is projected from past history and uncertainty increases at a rate consistent with past history and any limits configured into the device.

3.3

BLURRED

MVstatus where the data channel reports real measurement data but a known problem exists for which compensation has been applied, with the reported measurement being the best estimate of the true instantaneous process value, the uncertainty having been increased accordingly

3.4

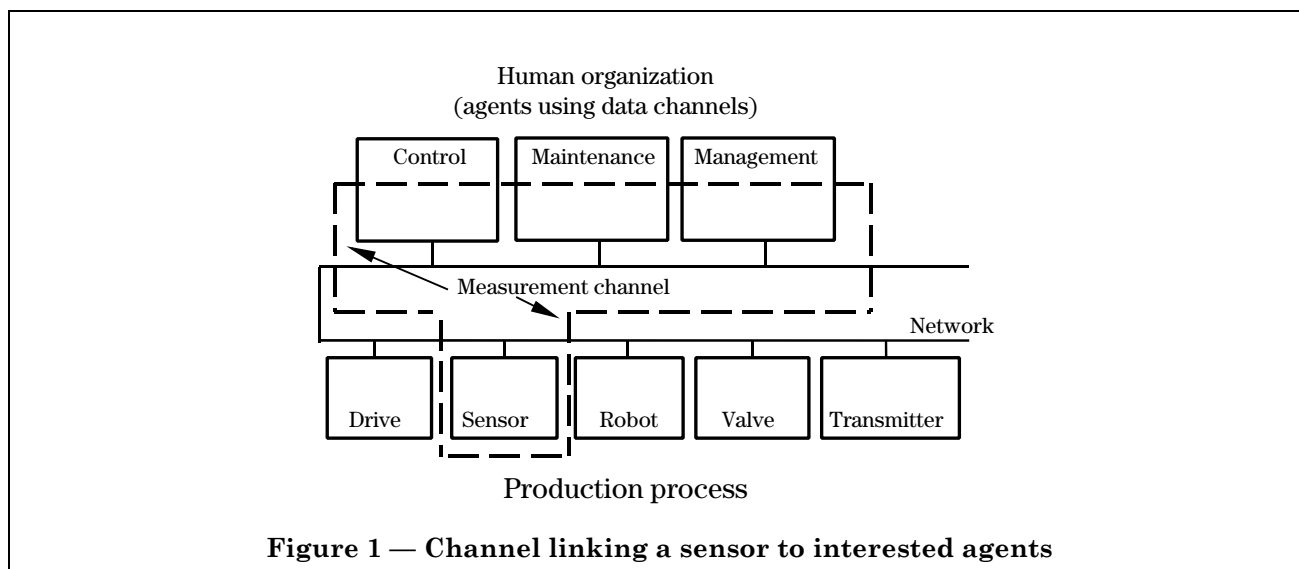
channel

complete sequence of related entities involved in the transfer and manipulation of data moving between a sensor or actuator and an agent

NOTE 1 Practical examples of channels include:

- a) flow measurement channel comprising an orifice plate, DP cell, totalizer, communication network or fieldbus and function blocks linked to maintenance agents;
- b) a flow output channel including control agents linked to split-range function blocks, communication network, valve positioner and valve.

NOTE 2 Figure 1 illustrates an example channel.



3.5

CLEAR

MVstatus where the measurement is valid, on-line and within nominal data sheet specification values

3.6

COMMON MODE FAULT

faults that occur throughout a set of measurement channels where they share common elements

NOTE An example of this could be where a shared process connection breaks or becomes blocked and affects all measurements using the connection.

3.7

CRITICAL MAINTENANCE

device status where the designer believes, based on local diagnostics, that a critical condition exists which could damage the plant or the environment

NOTE An example of this could be the leakage of process fluids from a perforated diaphragm.

3.8

DAZZLED

transient MVstatus during which the VMV is based on historical data whilst the fault condition is assessed

NOTE 1 DAZZLED indicates that based on internal diagnostic data, the instrument logic concludes that the raw measurement value is not representative of the process variable, but needs more data to determine if the problem is permanent.

NOTE 2 The VMV is projected from past history and the uncertainty increases at a rate consistent with past history and any limits configured into the device.

NOTE 3 This status may be reported during a test procedure of limited duration which prevents measurement function (intrusive test).

3.9

data quality metrics

defined set of quality attributes added to measurement values to assist their interpretation by interested agents

3.10

DEVICE-ON-TEST

device status where the device is undergoing an intrusive test or re-calibration action during which normal functions may be disturbed or inhibited

NOTE This status may be self-initiated or externally requested.

3.11

device status

parameter issued by a device indicating the device's current level of urgency for maintenance support

NOTE Device status is a designer's best estimate of the health of the device, intended to assist maintenance agents. Device status is suitable for any device or group of related devices and indicates one of the following four categories of action:

- a) device is OK so do nothing;
- b) designer suggests maintenance is needed when convenient;
- c) designer suggests maintenance is needed now;
- d) designer suggests possible danger to the environment, urgent response required.

3.12

fieldbus

digital communication system designed for use between sensors, controllers and actuators in automation applications

3.13

function block

software functional unit comprising an individual, named copy of a data structure and associated operations specified by a corresponding function block type

3.14

function block status

FB status

parameter issued by a function block indicating the block designer's best estimate of an overall maintenance status for the group of devices and related equipment that contributes to the function block output

3.15

HIGH PRIORITY MAINTENANCE

device status where the designer believes, based on local diagnostics, that a major fault or incipient problem has been detected

NOTE Examples of this are where the main measurement is BLIND or the device is expected to become faulty within X_2 hours, where X_2 is configurable.

3.16

intelligent actuation and measurement

IAM

combined use of instrument functions and communication services to support the control, maintenance and the technical management of industrial automation

3.17

intelligent instrument

device where embedded computing capability is included as part of a measurement, control or actuation device

3.18

intrusive testing

test procedure that causes measurement disturbances which are not related to process values

3.19

loss-of-variable condition

condition when the measured value is believed to be unrepresentative of the actual process value

3.20**LOW PRIORITY MAINTENANCE**

device status where the designer believes, based on local diagnostics, that a minor fault or incipient problem has been detected

NOTE Examples of this are:

- a) where the re-calibration time has passed and the main measurement is BLURRED;
- b) in a multi-measurement device where the main measurement is CLEAR and one or more of the secondary measurements is BLURRED or BLIND;
- c) where the device is expected to become faulty within X_1 hours, where X_1 is configurable.

3.21**measured value**

MV

value measured by an instrument at a particular instant in time

3.22**MVstatus**

parameter indicating how the associated measurement has been generated

NOTE The specified values of measurement status assume the VMV and its associated VU are the data channel best estimate of the true values, including compensation, as available, for any detected local problems.

3.23**NOMINAL**

device status where the designer believes maintenance is not needed

3.24**non-intrusive testing**

test that does not disturb the measurement value

3.25**OFFLINE**

MVstatus where the instrument does not have to give a valid output

NOTE VMV and VU are normally zero during this status.

3.26**REPLACED**

MVstatus where the VMV and VU have been entered from an external agent such as an operator or higher level modelling program

3.27**SECURE (COMMON)**

MVstatus where the VMV is derived from multiple estimates of the same measurement, at least two of which are CLEAR but which are susceptible to common mode faults

3.28**SECURE (DIVERSE)**

MVstatus where the VMV is derived from multiple estimates of the same measurement, at least two of which are CLEAR and are not susceptible to common mode faults

NOTE SECURE DIVERSE is most appropriate for the output of a function block which combines data from independent instruments using different measurement technologies. It is not anticipated that single measurement instruments will provide this status as common elements exist, such as power supply and processing units, even where multiple transducers and process connections are present.