

# INTERNATIONAL STANDARD

**IEC**  
**60746-1**

Second edition  
2003-01

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## Expression of performance of electrochemical analyzers –

### Part 1: General

*Expression des qualités de fonctionnement  
des analyseurs électrochimiques –*

*Partie 1:  
Généralités*

[IEC 60746-1:2003](#)

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**EXPRESSION OF PERFORMANCE OF  
ELECTROCHEMICAL ANALYZERS –**
**Part 1: General**

## 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.
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- 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 60746-1 has been prepared by subcommittee 65D: Analysing equipment, of IEC technical committee 65: Industrial-process measurement and control.

This second edition cancels and replaces the first edition published in 1982 and constitutes a technical revision.

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

FDIS	Report on voting
65D/89A/FDIS	65D/93/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.

For this second edition, the text has been changed to reflect revision and introduction of International Standards since 1982. An Informative Annex A has been introduced.

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

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

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- withdrawn;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

## INTRODUCTION

This standard specifies the statements which manufacturers should make to describe analyzers so that users may compare the performance characteristics of any analyzer to their requirements. It includes the terminology and definitions of the terms to be used in such statements. It describes the tests that are applicable to all types of electrochemical analyzers, which may be used to determine these performance characteristics by either the manufacturer or the user.

This standard is applicable to electrochemical analyzers used for the determination of certain properties of (generally aqueous) solutions such as pH value, electrical conductivity, dissolved oxygen content, the concentration of specified ions and redox potential. Other standards in this series describe those aspects that are particular to specific types of analyzer, for example IEC 60746-2. It is in accordance with the general principles set out in IEC 60359 and takes into account documents specifying methods for evaluating performance, IEC 60770 and IEC 61298.

This standard is applicable to analyzers specified for installation in any location and to analyzers having either flow-through or immersible type sensors. It is applicable to the complete analyzer when supplied by one manufacturer as an integral unit comprised of all mechanical, electrical and electronic portions. It also applies to sensor units alone and electronic units alone when supplied separately or by different manufacturers. For the purposes of this standard, any regulator for mains-supplied power or any non-mains power supply, provided with the analyzer or specified by the manufacturer, is considered part of the analyzer whether it is integral with the analyzer or housed separately.

It does not apply to accessories used in conjunction with the analyzers, such as chart recorders or data acquisition systems. However, when multiple analyzers are combined and sold with a single electronic unit for measurements of several properties in parallel, that read-out unit is considered to be part of the analyzer. Similarly, e.m.f.-to-current or e.m.f.-to-pressure converters that are not an integral part of the analyzer are not included.

Safety requirements are dealt with in IEC 61010.

Standard ranges of analogue d.c. current and pneumatic signals used in process control systems are dealt within IEC 60381-1, and IEC 60382.

Specifications for values of influence quantities for the testing of performance characteristics can be found in IEC 60654-1 and methods of testing in IEC 60068.

Requirements for documentation to be supplied with instruments are dealt with in some National Standards and also IEC 61187.

General principles concerning quantities, units and symbols are dealt with in ISO 1000. See also ISO 31, Parts 0 to 13.

# EXPRESSION OF PERFORMANCE OF ELECTROCHEMICAL ANALYZERS –

## Part 1: General

### 1 Scope

This standard is intended:

- to specify the terminology and definitions of terms related to the performance characteristics of electrochemical analyzers used for the continuous determination of certain aspects of (generally aqueous) solutions;
- to specify uniform methods to be used in making statements on the performance characteristics of such analyzers;
- to specify general test procedures to determine and verify the performance characteristics of electrochemical analyzers, taking into account the differences of approach in IEC documents specifying test methods (IEC 60359, IEC 60770, IEC 61298);
- to provide basic documents to support the application of standards of quality assurance: ISO 9001, ISO 9002 and ISO 9003.

### 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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60359:2001, *Electrical and electronic measurement equipment – Expression of performance*

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

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

IEC 60654-1, *Industrial-process measurement and control equipment – Operating conditions – Part 1: Climatic conditions*

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

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

ISO 9001, *Quality management systems – Requirements*

ISO 9002, *Quality systems – Model for quality assurance in production, installation and servicing*

ISO 9003, *Quality systems – Model for quality assurance in final inspection and test*

### 3 Terms and definitions

For the purposes of this standard, the following definitions apply. These definitions are based on those in IEC 60359. Additional definitions from IEC 60770 are included for performance characteristics appropriate to electrochemical analyzers. The definitions have, in some cases, been clarified and directed towards relevance to electrochemical analyzers. The reconciliation of the quantities used to define performance characteristics in this document with those referred to in IEC 60359, IEC 60770 and IEC 61298 is discussed in clause 4.

#### 3.1

##### **electrochemical analyzer**

measuring instrument that provides an indication of a specific property of a medium by use of a sensor which responds to ions from electrolytes (or ions generated from reactions with non-electrolytes) in that medium

NOTE The analyzer may comprise of separate parts, see below.

#### 3.2

##### **sensor**

that part of the electrochemical analyzer (which may be a separate unit) which is in contact with the medium in which the property is to be measured

NOTE In general an electrical output related to that property of the sample which is to be measured is derived from this part of the analyzer. Examples of electrochemical sensors are: pH, ion-sensitive and redox potentiometric cells, dissolved oxygen cells, conductance cells.

#### 3.3

##### **electronic unit**

device converting the electrical signal from the sensor to a defined, scaled, output signal

#### 3.4

##### **simulator**

device which provides well-defined electrical properties similar to a specific type of sensor

NOTE It may therefore be used to determine the performance characteristics of the electronic unit alone. It must exhibit uncertainties that are negligible in comparison with the specifications of performance characteristics to be determined.

#### 3.5

##### **calibration solution**

solution of known value of the property being measured, used for periodic calibration and for various performance tests.

NOTE 1 The value should be expressed in SI units compatible with ISO 31.

NOTE 2 For the purposes of this Standard, the value of this solution represents the conventional true value (see 3.8) against which the indicated value is compared.

NOTE 3 The values of calibration solutions should be traceable to reference material according to international or national standards, or agreed upon by the manufacturer and the user, and the uncertainty of the conventional true values shall be stated.

#### 3.6

##### **test solution**

solution of approximately known value of the property being measured, which is stable in value over an extended period of time

#### 3.7

##### **true value**

value of a quantity which is defined with no uncertainty.

NOTE The true value of a quantity is an ideal concept and, in general, cannot be known exactly.



**3.8****conventional true value**

value approximating to the true value of a quantity such that, for the purpose for which that value is used, the difference between the two will be regarded as negligible

NOTE 1 Since the “true value” cannot be known exactly, for the sake of simplicity and where no ambiguity exists, the term “true value” may be used where the term “conventional true value” is meant.

NOTE 2 See 3.1.13 of IEC 60359.

**3.9****performance characteristic**

one of the quantities assigned to an apparatus in order to define its performance by values, tolerances, ranges, etc.

**3.10****influence quantity**

any quantity, which is not the subject of the measurement but which influences the indication of the measuring equipment

NOTE Influence quantities may interact in their effect on the measuring equipment.

**3.11****variation**

difference between the values indicated by an analyzer for the same value of the property being measured when a single influence quantity assumes successively two different values

**3.12****rated value**

value assigned to a performance characteristic of the analyzer by the manufacturer

NOTE See 3.3.8 of IEC 60359.

**3.13****range**

domain between the upper and lower limits of the quantity under consideration

NOTE 1 The term “range” is usually used with a modifier. It may apply to a performance characteristic or an influence quantity, etc. For example, the Rated Measuring Range is the set of values of the property to be measured, corresponding to the Output Signal Range of the analyzer (for example 4 mA - 20 mA, etc).

NOTE 2 See 3.3.2 of IE 60359.

**3.14****span**

difference between the upper and lower limits of the rated measuring range

**3.15****performance**

quality with which the intended functions of the equipment are accomplished

**3.16****reference conditions**

appropriate set of influence quantities, with reference values with their tolerances and reference ranges, with respect to which intrinsic uncertainty is specified

**3.17****reference value**

specified value of one of a set of reference conditions

NOTE A tolerance may be specified for a reference value.

**3.18****reference range**

specified range of values of one of a set of reference conditions

### 3.19

#### **specified operating range**

range of values of a single influence quantity which forms part of the rated operating conditions

### 3.20

#### **specified measuring range**

set of values of the property to be measured for which the uncertainty of the analyzer is intended to lie within specified limits

NOTE 1 An instrument can have several specified measuring ranges.

NOTE 2 The specified measuring range can be smaller than the range of values which can be indicated, for example, on the scale.

NOTE 3 This term used to be known as "effective range".

### 3.21

#### **rated operating conditions**

set of operating ranges for influence quantities and associated ranges of performance characteristics within which the variations of an analyzer are specified by the manufacturer

### 3.22

#### **limit conditions of operation**

extreme conditions which an operating instrument can withstand without resulting in damage or degradation of performance when it is afterwards operated under rated operating conditions

### 3.23

#### **storage and transport conditions**

extreme conditions which a non-operating instrument can withstand without resulting in damage or degradation of performance when it is afterwards operated under rated operating conditions

### 3.24

#### **uncertainty (of measurement)**

dispersion of values that may be attributed to the measured quantity

NOTE See 3.1.4 of IEC 60359.

### 3.25

#### **intrinsic uncertainty**

uncertainty when used under reference conditions (see 3.16)

NOTE See 3.1.10, 3.1.11, 3.1.12 of IEC 60359.

### 3.26

#### **operating uncertainty**

uncertainty when used under rated operating conditions (see 3.21)

NOTE See also 3.2.11 of IEC 60359.

### 3.27

#### **relative uncertainty**

ratio of the uncertainty to the conventional true value (when expressed in the same units)

NOTE See 3.3.4 of IEC 60359.

### 3.28

#### **interference uncertainty**

uncertainty caused by substances other than those affecting the measured property being present in the sample