

Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals

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Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

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National foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee and is the English language version of EN 60688:1992 *Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals*, including amendments A1:1999 and A2:2001, published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived by CENELEC from IEC 60688:1992, including amendments 1:1997 and 2:2001 published by the International Electrotechnical Commission (IEC).

This British Standard supersedes BS 6253-1:1982 and BS 6253-2:1989 which were withdrawn on 15 January 1993 in accordance with the CENELEC Internal Regulations.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by tags **[C]** **[C]**. Where a common modification has been introduced by amendment, the tags carry the number of the amendment. For example, the common modifications introduced by CENELEC amendment A1 are indicated by **[C1]** **[C1]**.

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From 1 January, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

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Summary of pages

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Descriptors: Measuring transducers, electrical measuring transducers, a.c. electrical quantities, conversion to analog signals, conversion to digital signals

English version

Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals

(includes amendments A1:1999 and A2:2001)
(IEC 60688:1992 + A1:1997 + A2:2001, modified)

Transducteurs électriques de mesure
convertissant les grandeurs électriques
alternatives en signaux analogiques ou
numériques
(inclut les amendements A1:1999 et A2:2001)
(CEI 60688:1992 + A1:1997 + A2:2001, modifié)

Meßumformer für die Umwandlung von
Wechselstromgrößen in analoge oder digitale
Signale
(enthält Änderungen A1:1999 und A2:2001)
(IEC 60688:1992 + A1:1997 + A2:2001,
modifiziert)

This European Standard was approved by CENELEC on 1992-03-24. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document IEC 85(C.O.)17, as prepared by IEC/TC 85, was submitted to the IEC-CENELEC parallel vote in June 1991.

The reference document was approved by CENELEC as EN 60688 on 24 March 1992.

The following dates were fixed:

- latest date of publication (dop) 1993-01-15 of an identical national standard
- latest date of withdrawal (dow) 1993-01-15 of conflicting national standards

For products which have complied with the relevant national standard before 1993-01-15, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1998-01-15.

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative.

Foreword to amendment A1

The text of amendment 1:1997 to the International Standard IEC 60688:1992, prepared by IEC TC 85, Measuring equipment for electrical and electromagnetic quantities, together with common modifications prepared by Reporting Secretariat SR 85, was submitted to the formal vote and was approved by CENELEC as amendment A1 to EN 60688:1992 on 1999-04-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-04-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2002-10-01

Foreword to amendment A2

The text of document 85/217/FDIS, future amendment 2 to IEC 60688:1992, prepared by IEC TC 85, Measuring equipment for electrical and electromagnetic quantities, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A2 to EN 60688:1992 on 2001-09-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2002-06-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2004-09-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard, Annex ZA is normative and given Annex A is informative.

Annex ZA has been added by CENELEC.

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Introduction

The **class index** system of classification used in this standard is based upon IEC 60051: *Direct acting indicating analogue electrical measuring instruments and their accessories*. Under this system, the permitted variations of the **output signal** due to varying **influence quantities** — ambient temperature, voltage, frequency, etc., — are implicit in the classification.

For those unfamiliar with the **class index** system, a word of warning is necessary. If, for example, a **transducer** is classified as Class 1, it does not follow that the **error** under practical conditions of use will be within 1 % of the actual value of the output or 1 % of the full output value. It means that the **error** should not exceed 1 % of the **fiducial value under closely specified conditions**. If the **influence quantities** are varied between the limits specified by the **nominal ranges** of use, a variation of amount comparable with the value of the **class index** may be incurred for each **influence quantity**.

The permissible **error** of a **transducer** under working conditions is the sum of the permissible **intrinsic error** and of the permissible variations due to each of the **influence quantities**. However, the actual **error** is likely to be much smaller because not all of the **influence quantities** are likely to be simultaneously at their most unfavourable values and some of the variations may cancel one another. It is important that these facts be taken into consideration when specifying **transducers** for a particular purpose.

Furthermore, some of the terms used in this standard are different from those used in IEC 60051 due to the fundamental differences between indicating instruments and measuring **transducers**.

All statements of performance are related to the output which is governed by two basic terms:

- “the **nominal value**”, which may have a positive or a negative sign or both,
- “the **span**”, which is the range of values of the **output signal** from maximum positive to maximum negative, if appropriate.

1 Scope

This International Standard applies to **transducers** with electrical inputs and outputs for making measurements of a.c. electrical quantities. The **output signal** may be in the form of an analogue direct current or in digital form. In this instance, that part of the **transducer** utilized for communication purposes will need to be compatible with the external system.

This standard applies to measuring **transducers** used for converting alternating electrical quantities such as:

- current
- voltage
- active power
- reactive power
- power factor
- phase angle
- frequency

to an **output signal**.

Within the **measuring range**, the **output signal** is a function of the measurand. An **auxiliary supply** may be needed.

This standard applies:

- a) if the nominal frequency of the input(s) lies between 5 Hz and 1 500 Hz;
- b) if a measuring **transducer** is part of a system for the measurement of a non-electrical quantity, this standard may be applied to the **electrical measuring transducer**, if it otherwise falls within the scope of this standard;
- c) to **transducers** for use in a variety of applications such as telemetry and process control and in one of a number of defined environments.

This International Standard is intended:

- to specify the terminology and definitions relating to **transducers** whose main application is in electrical power engineering, especially for the purposes of process control and telemetry systems;
- to unify the test methods used in evaluating **transducer** performance;
- to specify **accuracy** limits and output values for **transducers**.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard 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 (301, 302, 303):1983, *International Electrotechnical Vocabulary (IEV). Chapter 301: General terms on measurements in electricity. Chapter 302: Electrical measuring instruments. Chapter 303: Electronic measuring instruments.*

^[A2] IEC 60051-1:1997, *Direct acting indicating analogue electrical measuring instruments and their accessories — Part 1: Definitions and general requirements common to all parts.* ^[A2]

IEC 60068-2-3:1985, *Environmental testing — Part 2: Tests — Test Ca: Damp heat, steady state.*

IEC 60255-4:1976, *Electrical relays — Part 4: Single input energizing quantity measuring relays with dependent specified time.*

^[A1] Text deleted ^[A1]

IEC 60521:1988, *Class 0,5, 1 and 2 alternating-current watt-hour meters.*

^[A2] IEC 61000-4, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques.* ^[A2]

^[A2] IEC 61010-1:2001, *Safety requirements for electrical equipment for measurement, control and laboratory use — Part 1: General requirements.* ^[A2]

NOTE Refer to Annex A for the list of informative references.

3 Definitions

For the purpose of this International Standard the following definitions apply:

3.1 General terms

3.1.1

electrical measuring transducer (hereinafter designated “**transducer**”)

a device for converting an a.c. measurand to a direct current, a direct voltage or a digital signal for measurement purposes

3.1.2

auxiliary supply

an a.c. or d.c. electrical supply, other than the measurand, which is necessary for the correct operation of the **transducer**

3.1.3

auxiliary circuit

a circuit which is usually energized by the **auxiliary supply**

NOTE The **auxiliary circuit** is sometimes energized by one of the input quantities.

3.1.4

transducer with offset zero (live zero)

a **transducer** which gives a predetermined **output signal** other than zero when the measurand is zero

3.1.5**transducer with suppressed zero**

a **transducer** for which zero **output signal** corresponds to a measurand greater than zero

3.1.6**distortion factor**

the ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the non-sinusoidal quantity

3.1.7**output load** (for analogue signals only)

the total resistance of the circuits and apparatus connected externally across the output terminals of the **transducer**

3.1.8**ripple content (of an analogue output signal)**

$\overline{A_2}$ with steady state input conditions, the ratio of the peak-to-peak value of the fluctuating component of an analogue output signal, expressed in percentage, to the fiducial value $\overline{A_2}$

3.1.9**output signal**

an analogue or digital representation of the measurand

3.1.10**output power**

the power at the **transducer** output terminals

3.1.11**output current (voltage)** (for analogue signals only)

the current (voltage) produced by the **transducer** which is an analogue function of the measurand

3.1.12**reversible output current (voltage)** (for analogue signals only)

an **output current** (voltage) which reverses polarity in response to a change of sign or direction of the measurand

3.1.13**measuring element of a transducer**

a unit or module of a **transducer** which converts the measurand, or part of the measurand, into a corresponding signal

3.1.14**single element transducer**

a **transducer** having one measuring element

3.1.15**multi-element transducer**

a **transducer** having two or more measuring elements. The signals from the individual elements are combined to produce an **output signal** corresponding to the measurand

3.1.16**multi-section transducer**

a **transducer** having two or more independent measuring circuits for one or more functions

3.1.17**response time**

the time from the instant of application of a specified change of the measurand until the **output signal** reaches and remains at its final steady value or within a specified band centred on this value

3.1.18**compliance voltage (accuracy limiting output voltage)**

for **variable output load transducers** having a current output, the value of the voltage appearing across the output terminals up to which the **transducer** complies with the requirements of this standard

3.1.19

(output) series mode interference voltage

an unwanted alternating voltage appearing in series between the output terminals and the load

3.1.20

(output) common mode interference voltage

an unwanted alternating voltage which exists between each of the output terminals and a reference point

3.1.21

storage conditions

the conditions, defined by means of the ranges of the influence quantities, such as temperature or any other special condition, within which the **transducer** may be stored (non-operating) without damage

3.1.22

stability

the ability of a **transducer** to keep its performance characteristics unchanged during a specified time, all influence quantities remaining within their specified ranges

3.1.22.1

short-term stability

the **stability** over a period of 24 h

3.1.22.2

long-term stability

the **stability** over a period of one year

3.1.23

usage group

a group of **transducers** capable of operating under a specified set of environmental conditions

3.2 Description of transducers according to the measurand

3.2.1

voltage transducer

a **transducer** used for the measurement of a.c. voltage

3.2.2

current transducer

a **transducer** used for the measurement of a.c. current

3.2.3

active power (watt) transducer

a **transducer** used for the measurement of active electrical power

3.2.4

reactive power (var) transducer

a **transducer** used for the measurement of reactive electrical power

3.2.5

frequency transducer

a **transducer** used for the measurement of the frequency of an a.c. electrical quantity

3.2.6

phase angle transducer

a **transducer** for the measurement of the phase angle between two a.c. electrical quantities having the same frequency

3.2.7

power factor transducer

a **transducer** used for the measurement of the power factor of an a.c. circuit

3.3 Description of transducers according to their output load

3.3.1

fixed output load transducer

a **transducer** which complies with this standard only when the **output load** is at its **nominal value**, within specified limits

3.3.2

variable output load transducer

a **transducer** which complies with this standard when the **output load** has any value within a given range

3.4 Nominal values

3.4.1

nominal value

a value, or one of the values, indicating the intended use of a **transducer**

NOTE The lower and upper **nominal values** of the measurand are those which correspond to the lower and upper **nominal values** of the **output signal**.

3.4.2

output span (hereinafter designated “**span**”)

the algebraic difference between the upper and lower **nominal values** of the **output signal**

3.4.3

fiducial value

a value to which reference is made in order to specify the **accuracy** of a **transducer**

the **fiducial value** is the **span**, except for **transducers** having a reversible and symmetrical **output signal** when the **fiducial value** may be half the **span** if specified by the manufacturer

3.4.4

circuit insulation voltage (nominal circuit voltage)

the highest circuit voltage to earth on which a circuit of a **transducer** may be used and which determines its voltage test

3.4.5

nominal power factor

the factor by which it is necessary to multiply the product of the nominal voltage and nominal current to obtain the nominal power

$$\text{Nominal power factor} = \frac{\text{nominal power}}{\text{nominal voltage} \times \text{nominal current}}$$

when the current and voltage are sinusoidal quantities, the **nominal power factor** is $\cos \varphi$, φ being the phase difference between the current and the voltage. For **reactive power transducers**, the **nominal power factor** is $\sin \varphi$

3.4.6

maximum permissible values of input current and voltage

values of current and voltage assigned by the manufacturer as those which the **transducer** will withstand indefinitely without damage

3.4.7

limiting value of the output (current or voltage) signal

the upper limit of **output (current or voltage) signal** which cannot, by design, be exceeded under any conditions

3.4.8

measuring range

A_2 the range defined by two values of the measurand within which the performance complies with the requirements of this standard (see 2.4.3 of IEC 60051-1) A_2