IEC 60688

Edition 3.0 2012-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals

Transducteurs électriques de mesure convertissant les grandeurs électriques alternatives ou continues en signaux analogiques ou numériques

IEC 60688:2012

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL MEASURING TRANSDUCERS FOR CONVERTING A.C. AND D.C. ELECTRICAL QUANTITIES TO ANALOGUE OR DIGITAL SIGNALS

FOREWORD

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International Standard 60688 has been prepared by IEC Technical Committee 85: Measuring equipment for electrical and electromagnetic quantities.

This third edition cancels and replaces the second edition published in 1992 and its Amendment 1 (1997) and Amendment 2 (2001). It constitutes a technical revision

This edition includes the following significant technical changes with respect to the previous edition:

– extending the scope to DC quantities;
– extending the scope to harmonics, total harmonic distortion and apparent power;
– adaptation of the requirements for digital transducers;
– updating normative references;
– updating safety requirements with the IEC 61010 series;
– updating EMC requirements with IEC 61326-1.

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

FDIS	Report on voting
85/421/FDIS	85/436/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.

In this standard, the following print types are used:

– requirements and definitions: in roman type;

– NOTES: in smaller roman type;

– *compliance: in italic type.*

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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.

The contents of the corrigendum of December 2013 have been included in this copy.

INTRODUCTION

New transducers can now be equipped with micro-processors that utilize digital data processing, communication methods and auxiliary sensors. This makes them more complex than conventional analogue transducers and gives them considerable added value.

The class index system of classification used in this standard is based upon the IEC 60051 series: *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 mean 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.

ELECTRICAL MEASURING TRANSDUCERS FOR CONVERTING A.C. AND D.C. ELECTRICAL QUANTITIES TO ANALOGUE OR DIGITAL SIGNALS

1 Scope

This International Standard applies to transducers with electrical inputs and outputs for making measurements of a.c. or d.c. electrical quantities. The output signal may be in the form of an analogue direct current, an analogue direct voltage or in digital form. In this case, 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 electrical quantities such as the following:

– current,
– voltage,
– active power,
– reactive power,
– power factor,
– phase angle,
– frequency,
– harmonics or total harmonic distortion,
– apparent power

to an output signal.

This standard is not applicable for:

– instrument transformers that comply with IEC 60044 series;
– transmitters for use in industrial process applications that comply with the IEC 60770 series;
– performance measuring and monitoring devices (PMD) that comply with IEC 61557-12.

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 0 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 industry;
– to unify the test methods used in evaluating transducer performance;

– to specify accuracy limits and output values for transducers.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60051-1:1997, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

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

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60255-151, *Measuring relays and protection equipment – Part 151: Functional requirements for over/under current protection*

IEC 61010 (all parts), *Safety requirements for electrical equipment for measurement, control and laboratory use*

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

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 30 Special requirements for testing and measuring circuits*

IEC 61326 (all parts), *Electrical equipment for measurement, control and laboratory use – EMC requirements*

IEC 61326-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61557-12, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 12: Performance measuring and monitoring devices (PMD)*

IEC 60417, *Graphical symbols for use on equipment*

NOTE Please refer to the Bibliography for the list of informative references.

3 Terms and definitions

For the purpose of this document the following terms and definitions apply:

3.1 General terms

3.1.1
electrical measuring transducer
transducer
device for converting an a.c or d.c.. measurand to a direct current, a direct voltage or a digital signal for measurement purposes

3.1.2
analogue transducer
device for converting an a.c or d.c.. measurand to a direct current, direct voltage for measurement purposes

3.1.3
digital transducer
device for converting an a.c or d.c.. measurand to a digital signal for measurement purposes

3.1.4
auxiliary supply
a.c. or d.c. electrical supply, other than the measurand, which is necessary for the correct operation of the transducer

3.1.5
auxiliary circuit
circuit which is usually energized by the auxiliary supply.

Note 1 to entry: The auxiliary circuit is sometimes energized by one of the input quantities.

3.1.6
transducer with offset zero
transducer that gives a predetermined output signal other than zero when the measurand is zero

3.1.7
transducer with suppressed zero
transducer for which zero output signal corresponds to a measurand greater than zero

3.1.8
total distortion factor
ratio of the r.m.s. value of the total distortion content to the the r.m.s. value of an alternating quantity

Note 1 to entry: The total distortion factor depends on the choice of the fundamental component. If it is not clear from the context which one is used, an indication should be given.

3.1.9
output load
for analogue signals, the total resistance of the circuits and apparatus connected externally across the output terminals of the transducer

3.1.10
ripple content of an analogue output signal
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

3.1.11
output signal
an analogue or digital representation of the measurand

3.1.12
output power
power at the transducer output terminals

3.1.13
output current
output voltage
for analogue signals, the current (voltage) produced by the transducer which is an analogue function of the measurand

3.1.14
reversible output current
reversible output voltage
for analogue signals, the output current (voltage) that reverses polarity in response to a change of sign or direction of the measurand

3.1.15
measuring element of a transducer
unit or module of a transducer that converts the measurand, or part of the measurand, into a corresponding signal

3.1.16
single element transducer
transducer having one measuring element

3.1.17
multi-element transducer
transducer having two or more measuring elements, the signals from the individual elements being combined to produce an output signal corresponding to the measurand

3.1.18
combined transducer
transducer having two or more measuring circuits for one or more functions

3.1.19
response time
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 interval centred on this value

3.1.20
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

3.1.21
output series mode interference voltage
unwanted alternating voltage appearing in series between the output terminals and the load

3.1.22
output common mode interference voltage
unwanted alternating voltage that exists between each of the output terminals and a reference point

3.1.23
storage conditions
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

3.1.24
stability
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
stability over a period of 24 h

3.1.22.2
long-term stability
stability over a period of one year

3.1.23
usage group
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
transducer used for the measurement of a.c. or d.c. voltage

3.2.2
current transducer
transducer used for the measurement of a.c. or d.c. current

3.2.3
apparent power transducer
transducer that is used for the measurement of the apparent power

3.2.4
active power transducer
transducer used for the measurement of active electrical power

3.2.5
reactive power transducer
transducer used for the measurement of reactive electrical power

3.2.6
frequency transducer
transducer used for the measurement of the frequency of an a.c. electrical quantity

3.2.7
phase angle transducer
transducer for the measurement of the phase angle between two a.c. electrical quantities having the same frequency

3.2.8
power factor transducer
transducer used for the measurement of the power factor of an a.c. circuit

3.2.9
harmonics transducer
transducer that is used for the measurement of the harmonics or the total harmonic distortion of an a.c. circuit

3.3 Description of transducers according to their output load

3.3.1
fixed output load transducer
transducer that complies with this standard only when the output load is at its nominal value, within specified limits

3.3.2
variable output load transducer
transducer that complies with this standard when the output load has any value within a given range

3.4 Nominal values

3.4.1
nominal value
value, or one of the values, indicating the intended use of a transducer

Note 1 to entry: 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
span
algebraic difference between the upper and lower nominal values of the output signal

3.4.3
fiducial value
value to which reference is made in order to specify the accuracy of a transducer

Note 1 to entry: 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
highest circuit voltage to earth of a transducer that determines its voltage test

3.4.5
nominal power factor
factor by which it is necessary to multiply the product of the nominal voltage and nominal current to obtain the nominal power

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

Note 1 to entry: When the current and voltage are sinusoidal quantities, the nominal power factor is cos φ where φ is the phase difference between the current and the voltage. For reactive power transducers, the nominal power factor is sin φ.

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

3.4.8
measuring range
range defined by two values of the measurand within which the performance complies with the requirements of this standard

(SOURCE: IEC 60051-1:1997, 2.4.3, modified – the wording of the definition has been changed.)

3.4.9
nominal value of the measured voltage
nominal value of the voltage of the external circuit (e.g. the secondary winding of a voltage transformer) to which the voltage input circuit of the transducer is to be connected

3.4.10
nominal value of the measured current
nominal value of the current in the external circuit (e.g. the secondary winding of a current transformer) to which the current input circuit of the transducer is to be connected

3.4.11
nominal value of the measurand
for active power and reactive power transducers, the value of the measured quantity corresponding to the nominal values of the measured voltage and current, and the power factor

3.5 User adjustment

Transducers can be supplied with provision to be adjusted by the user. (It should be noted that power sources and measuring equipment having adequate stability and accuracy are required). The following definitions apply to these transducers

3.5.1
calibration value
value of a quantity to which the nominal value is changed by user adjustment for a specific application

3.5.2
calibration value of the measured voltage
value of the voltage applied to the voltage input circuit of the transducer

3.5.3
calibration value of the measured current
value of the current applied to the current input circuit of the transducer

3.5.4
calibration value of the measurand
value of the measurand resulting from user adjustment

3.5.5
calibration value of the output signal
value of the output signal of the transducer corresponding to the calibration value of the measurand after adjustment

3.5.6
adjustment range
possible range of adjustment values of the measured current or voltage

3.5.7
conversion coefficient
relationship of the value of the measurand to the corresponding value of the output signal