BS EN 60688:2013

Incorporating corrigendum December 2013

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN 60688:2013. It is identical to IEC 60688:2012, incorporating corrigendum December 2013. It supersedes BS EN 60688:1992 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/85, Measuring equipment for electrical and electromagnetic quantities.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Amendments/corrigenda issued since publication

Date	Text affected
30 April 2014	Implementation of IEC corrigendum December 2013: F-33 in Table 7 amended

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60688

January 2013

ICS 17.220.20

English version

Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals
(IEC 60688:2012)

Transducteurs électriques de mesure convertissant les grandeurs électriques alternatives ou continues en signaux analogiques ou numériques
(CEI 60688:2012)

Elektrische Messumformer zur Umwandlung von elektrischen Wechselstromgrößen und Gleichstromgrößen in analoge oder digitale Signale
(IEC 60688:2012)

This European Standard was approved by CENELEC on 2012-11-23. 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.

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

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Ref. No. EN 60688:2013 E

Foreword

The text of document 85/421/FDIS, future edition 3 of IEC 60688, prepared by IEC/TC 85 "Measuring equipment for electrical and electromagnetic quantities" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60688:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2013-08-23
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2015-11-23

This document supersedes EN 60688:1992 + A1:1999 + A2:2001.

EN 60688:2013 includes the following significant technical changes with respect to EN 60688:1992 + A1:1999 + A2:2001:

- 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 EN 61010 series;
- updating EMC requirements with EN 61326-1.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 60688:2012 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60044-7	NOTE	Harmonised as EN 60044-7.
IEC 60044-8	NOTE	Harmonised as EN 60044-8.
IEC 60051 Series	NOTE	Harmonised as EN 60051 Series (not modified).
IEC 60068-2-30	NOTE	Harmonised as EN 60068-2-30.
IEC 60359	NOTE	Harmonised as EN 60359.
IEC 60770-1	NOTE	Harmonised as EN 60770-1.
IEC 60770-2	NOTE	Harmonised as EN 60770-2.
IEC 60770-3	NOTE	Harmonised as EN 60770-3.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60051-1	1997	Direct acting indicating analogue electrical measuring instruments and their accessories - Part 1: Definitions and general requirements common to all parts	EN 60051-1	1998
IEC 60068-2-6	-	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-27	-	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 60255-151	-	Measuring relays and protection equipment - Part 151: Functional requirements for over/under current protection	EN 60255-151	-
IEC 61010	Series	Safety requirements for electrical equipment for measurement, control, and laboratory use	EN 61010	Series
IEC 61010-1	-	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements	EN 61010-1	-
IEC 61010-2-030	-	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-030: Particular requirements for testing and measuring circuits	EN 61010-2-030	-
IEC 61326	Series	Electrical equipment for measurement, control and laboratory use - EMC requirements	EN 61326	Series
IEC 61326-1	-	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements	EN 61326-1	-
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)	EN 61557-12	-
IEC 60417-DB		Graphical symbols for use on equipment	-	-

CONTENTS

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 corres-ponding 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

3.6 Influence quantities and reference conditions

3.6.1
influence quantity
quantity (other than the measurand) that may affect the performance of a transducer

3.6.2
reference conditions
specified conditions under which the transducer complies with the requirements concerning intrinsic errors

Note 1 to entry: These conditions may be defined by either a reference value or a reference range.

3.6.2.1
reference value
specified single value of an influence quantity at which the transducer complies with the requirements concerning intrinsic errors

3.6.2.2
reference range
specified range of values of an influence quantity within which the transducer complies with the requirements concerning intrinsic errors

3.6.3
nominal range of use
specified range of values over which it is intended that an influence quantity can assume without the output signal of the transducer changing by amounts in excess of those specified

3.7 Errors and variations

3.7.1
error
actual value of the output signal minus the intended value of the output signal, expressed algebraically

3.7.2
error expressed as a percentage of the fiducial value
one hundred times the ratio of the error and the fiducial value

3.7.3
intrinsic error
error determined when the transducer is under reference conditions

3.7.4
variation due to an influence quantity
difference between the two values of the output signal for the same value of the measurand when an influence quantity assumes successively two different specified values

3.7.5
variation due to an influence quantity expressed as a percentage of the fiducial value
one hundred times the ratio of the variation due to an influence quantity and the fiducial value

3.8 Accuracy, accuracy class, class index

3.8.1
accuracy
value defined by the limits of intrinsic error and by the limits of variations

3.8.2
accuracy class
class of transducers for which the accuracy of all can be designated by the same number if they comply with all the requirements of this standard

3.8.3
class index
number which designates the accuracy class

Note 1 to entry: The class index is applicable to the intrinsic error as well as to the variations.

Note 2 to entry: Throughout this standard, the phrase "x % of the class index" denotes "x % of the limits of error relating to the class index".

4 Class index, permissible limits of intrinsic error, auxiliary supply and reference conditions

4.1 Transducer general architecture

Organization of the measurement chain: the electrical quantity to be measured may be either directly accessible, as is generally the case in low-voltage systems, or accessible via measurement sensors such as voltage sensors (VS) or current sensors (CS).

Figure 1 below shows the common organization of a transducer.

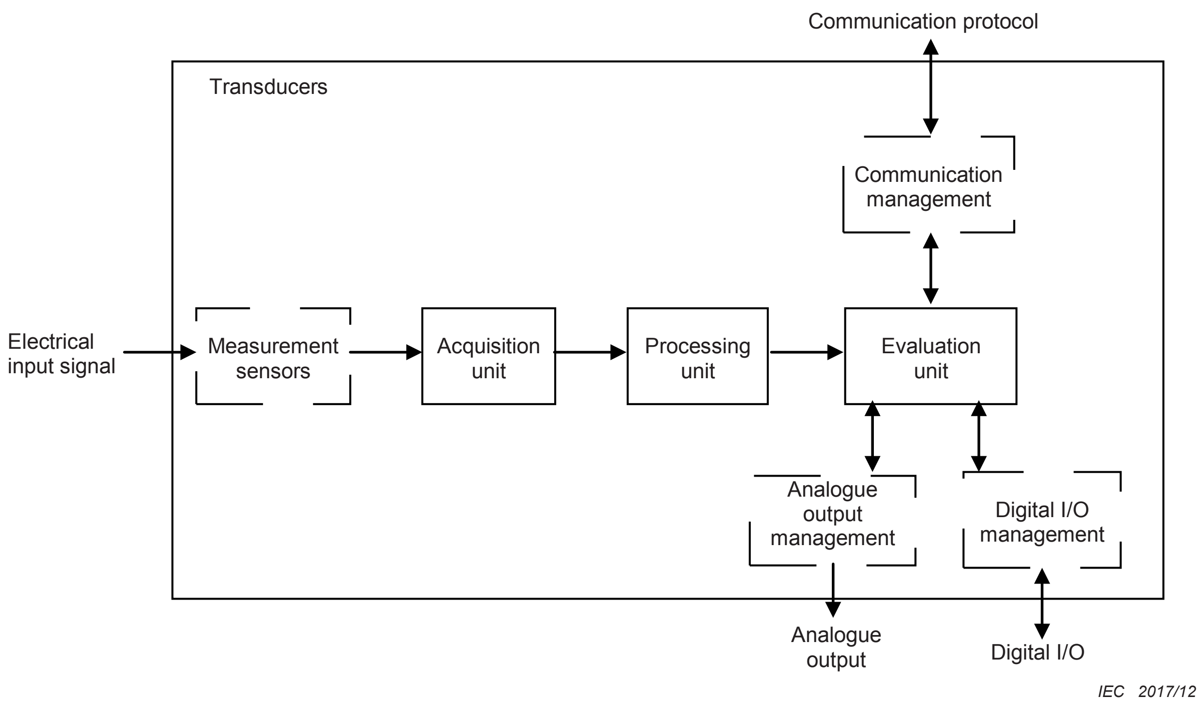


Figure 1 – Transducer architecture

4.2 Class index

The class index for a transducer shall be chosen from those given in Table 1.

This class index definition only applies for the analogue output of the transducers.

Table 1 – Relationship between the limits of intrinsic error, expressed as a percentage of the fiducial value, and the class index

Class index	0,2	0,5	1	2	2,5	3	5	10	20
Limits of error	±0,2 %	±0,5 %	±1 %	±2 %	±2,5 %	±3 %	±5 %	±10 %	±20 %
NOTE Class indices of 0,3 and 1,5, although non-preferred, may be used.									

4.3 Class index for transducer used with sensors

If the transducers are used with sensors the manufacturer shall specify the accuracy class of the whole system transducer & sensor.

In some cases when a transducer does not include the sensors, their associated uncertainties are not considered. When a transducer includes the sensors, their associated uncertainties are considered.

4.4 Intrinsic error

When the transducer is under reference conditions, the error at any point between the upper and lower nominal values of the output signal shall not exceed the limits of the intrinsic error given in Table 1 expressed as a percentage of the fiducial value.

Values stated in a table of corrections, if any, supplied with the transducer shall not be taken into account in determining the errors.

4.5 Conditions for the determination of intrinsic error

4.5.1 Prior to pre-conditioning and before determination of the intrinsic error, preliminary adjustments shall be carried out in accordance with the manufacturer's instructions. The transducer shall be at the reference temperature.

4.5.2 The transducer shall be left in circuit under the conditions specified in Table 2.

Table 2 – Pre-conditioning

Conditions	**Values**
Voltage (including any auxiliary supply)	Nominal value
Current	Nominal value
Frequency	Reference value
Power factor	Reference value
Time between connection into circuit and start of determination of errors	30 min

4.5.3 After the specified pre-conditioning, transducers having adjustments available to the user shall be adjusted in accordance with the manufacturer's instructions.

4.5.4 The reference conditions relative to each of the influence quantities are given in Table 3. The reference conditions relative to the measurand are given in Table 4.

Table 3 – Reference conditions of the influence quantities and tolerances or testing purposes

Influence quantity	Reference conditions unless otherwise marked	Tolerances permitted for testing purposes applicable to a single reference value [a]
Ambient temperature	To be marked in the type test report	±1 °C
Usage group (see 6.1.2)		–
I	K55	–
II	K70	–
III	Kx [c]	
Frequency of the input quantity		
Non-frequency sensitive	Nominal value	±2 %
Frequency sensitive	To be marked in the type test report	±0,1 %
Waveform of the input quantity	Sinusoidal, except for harmonics transducers	The distortion factor × 100 shall not exceed the class index, unless otherwise specified by the manufacturer
Output load		
Fixed output load transducers	Nominal value	±1 %
Variable output load transducers	Mean value of the nominal range	±1 %
Auxiliary supply		
Voltage a.c.	Nominal value	±2 %
Voltage d.c.	Nominal value	±1 %
Frequency	Nominal value	±1 %
Distortion factor	0,05 maximum	–
Magnetic field of external origin	Total absence	40 A/m at frequencies from d.c. to 65 Hz in any direction [b]

[a] When a reference range is marked, no tolerance is allowed.

[b] 40 A/m is approximately the highest value of the earth's magnetic field.

[c] Kx stands for extended conditions.

Table 4 – Reference conditions relative to the measurand

Measurand	Reference conditions		
	Voltage	**Current**	**Power factor, active or reactive**
Apparent power	Nominal voltage ±2 %	Any current up to the nominal current	$\lvert\cos \varphi\rvert$ or $\lvert\sin \varphi\rvert$ = 1,0 to 0,8 lagging or leading
Active power	Nominal voltage ±2 %	Any current up to the nominal current	$\lvert\cos \varphi\rvert$ = 1,0 to 0,8 lagging or leading
Reactive power	Nominal voltage ±2 %	Any current up to the nominal current	$\lvert\sin \varphi\rvert$ = 1,0 to 0,8 lagging or leading [a]
Phase angle or power factor	Nominal voltage ±2 %	40% to 100 % of the nominal current	–
Frequency	Nominal voltage ±2 %	–	–
Polyphase quantities	Symmetrical voltages (note 2)	Symmetrical currents (note 2)	–

[a] Apparent, active power and reactive power transducers are normally used together and are connected to the same current and voltage transformers. It must be noted that sin φ = 1,0 to 0,8 is used here for ease of testing only.

[b] The difference between any two line-to-line voltages and between any two line-to-neutral voltages shall not exceed 1 % of the average (line-to-line and line-to-neutral voltages respectively).Each of the currents in the phases shall differ by not more than 1 % from the average of the currents.

The angles between each of the currents and the corresponding phase-to-neutral (star) voltages shall differ by not more than 2°.

Where interactions between the separate measuring elements of a multi-element transducer are adequately characterized, single-phase testing of the transducer is acceptable.

4.6 Auxiliary supply

4.6.1 General

Some transducers dealt with in this standard may need an auxiliary supply. This is specified in two separate categories, d.c. and a.c. supplies.

4.6.2 D.C. supply

a) The value of the voltage of the d.c. supply shall be as specified in 5.1.3.

b) The battery supply may be earthed or floating. Suitable means shall be provided in the transducer to ensure isolation between the power supply and the input/output circuits of the transducer (for details of voltage tests, see 6.18).

c) The transducer shall withstand any voltage ripple up to a maximum of 10 % peak to peak superimposed on the d.c. power supply.

d) The noise fed back to the battery from the transducer shall be limited to 100 mV peak to peak when measured with a specified source resistance at all frequencies up to 100 MHz.

In addition, when the battery feeding the transducer is also used for telephone equipment the noise shall not exceed 2 mV psophometric.

NOTE The psophometric weighting characteristic is specified in ITU-T Recommendation O.41 .

4.6.3 A.C. supply

For the nominal value of the voltage of the a.c. supply, see 5.1. This voltage may be provided by a separate supply or may be derived from the measured voltage or current.

4.7 Safety requirements: Clearances and creepage distances

Transducers shall comply with the safety requirements of the IEC 61010 series, and in addition with the requirements of the following subclauses.

Clearances and creepage distances shall be selected at least in accordance with:

– pollution degree 2,
– measurement category III for measuring input circuits,
– overvoltage category III for mains circuits.

NOTE 1 Measurement category is defined in IEC 61010-2-030.

5 Requirements

5.1 Input values

5.1.1 The nominal values of voltage, current, frequency and auxiliary supply shall be specified by the manufacturer.

5.1.2 Adjustment range for transducers that can be adjusted by the user:

a) for the input voltage: 80 % to 120 % of the nominal value;
b) for the input current: 60 % to 130 % of the nominal value.

This means that the nominal value of the output signal can be obtained for any adjusted value of the measurand within the ranges given above.

5.1.3 The preferred nominal value of d.c. auxiliary supplies shall be 24 V, 48 V or 110 V.

5.2 Analogue output signals

5.2.1 General

The lower and upper nominal values of the output signal and the compliance voltage shall be chosen from those given in 5.2.2 and 5.2.3 or 5.2.6.

5.2.2 Output current

The signal 4 mA to 20 mA is preferred.

NOTE The condition "0 mA" has a special meaning (IEC 60381-1).

Other permissible values are:

0 mA to 20 mA
0 mA to 1 mA
0 mA to 10 mA
–1 mA to 1 mA
–5 mA to 5 mA
– 10 mA to 10 mA
– 20 mA to 20 mA

5.2.3 Compliance voltage

10 V
15 V

5.2.4 Maximum output voltage

The manufacturer shall state the maximum value of the output voltage occurring under any conditions of output load and input. This voltage shall not exceed the limit of safety extra-low voltage.

5.2.5 Inteference risk of output current

Attention is drawn to the interference problems which may result if the output current has a low value.

5.2.6 Output voltage

0 V to 1 V

0 V to 10 V

–1 V to 1 V

–10 V to 10 V

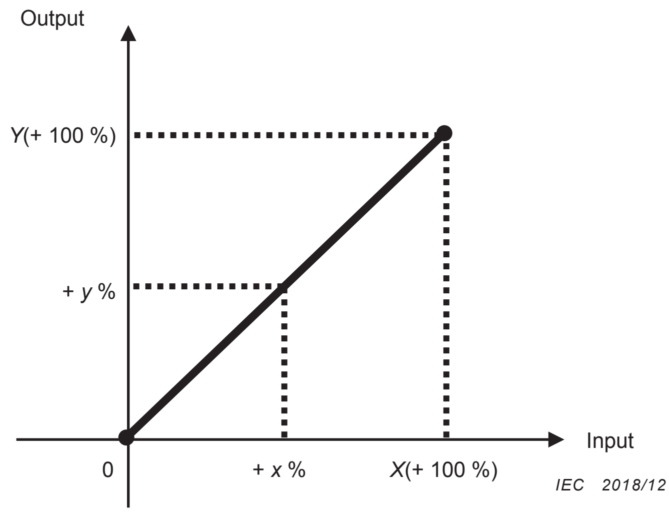
NOTE Transducers having a voltage output are non-preferred.

5.3 Output transfer function

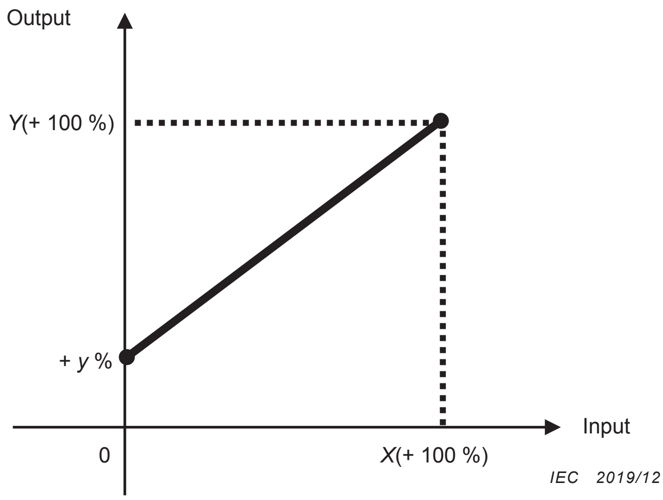
For analogue transducers, the used transfer function shall be one of the following curves.

For analogue transducers, variables x, y, y_1, y_2 can be adjustable.

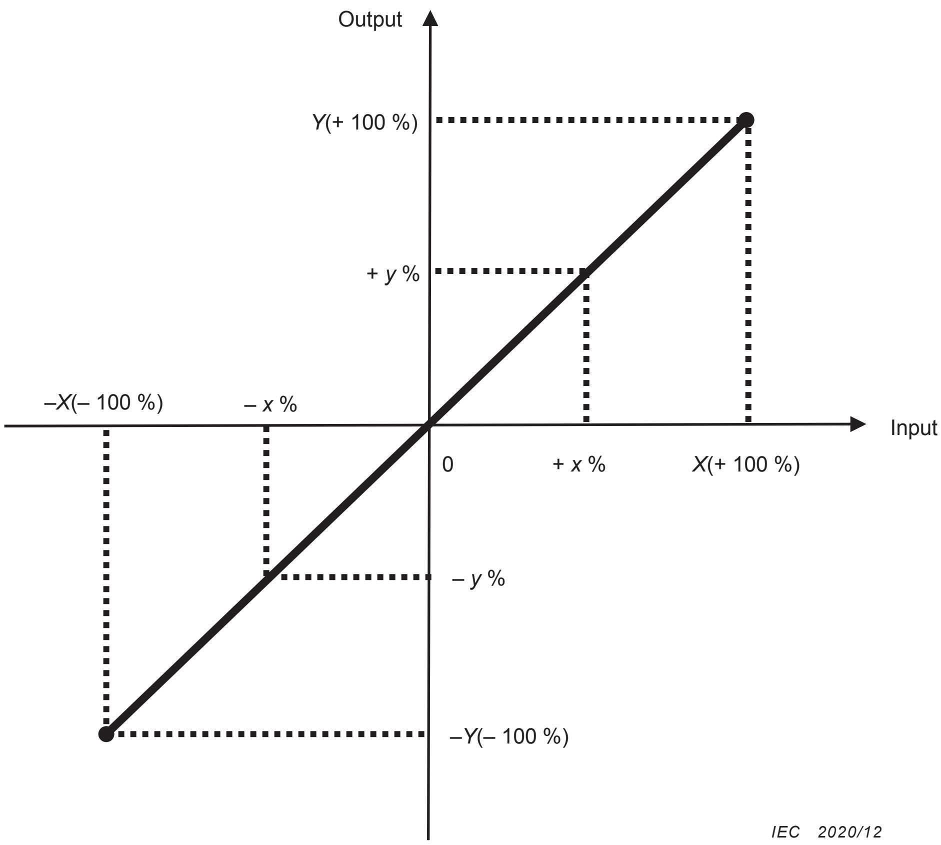
Curve A:



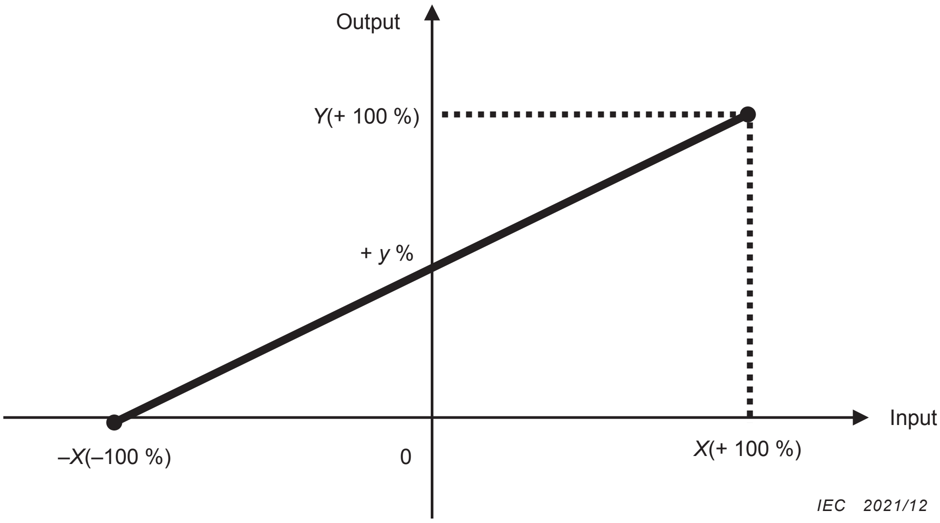
Curve B:



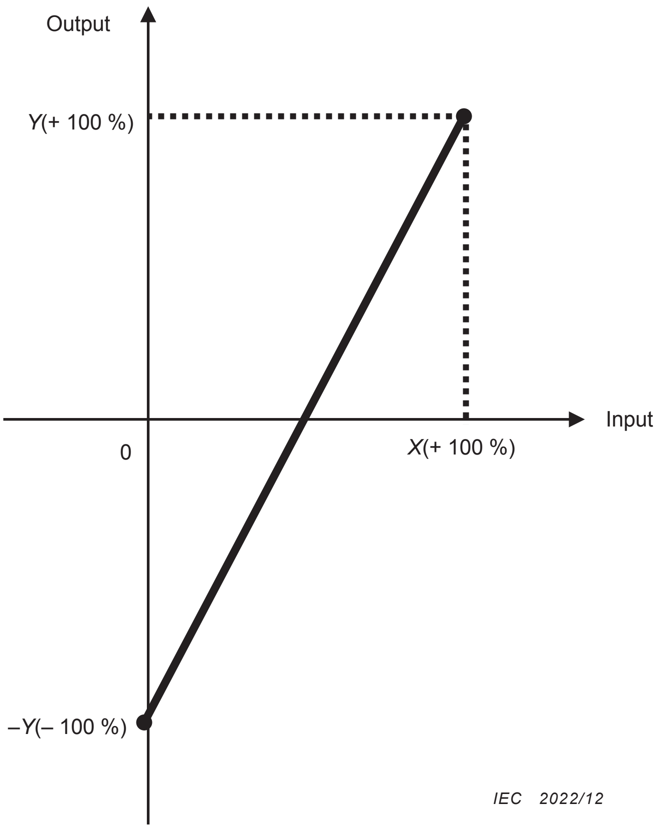
Curve C:



Curve D:



Curve E:



Curve F (all other kind of curves)

The accuracy class has to be checked for each point of the transfer function according to the formula: $\frac{Y-R}{R}\times 100$

NOTE For the curves F, replace *F* by *R* in all of the formulas below.

Figure 2 – Transfer function curves

5.4 Digital output signals

The digital output signals chosen shall correspond with the requirements for transducers concerning accuracy and response time as well as with the requirements of the communication system.

For the digital output the class index shall be in conformity with the performance class described in IEC 61557-12.

If outputs relays are provided they shall comply with IEC 60255-151.

5.5 Ripple (for analogue outputs)

The maximum ripple content in the output signal shall not exceed twice the class index.

5.6 Response time

5.6.1 Before determining the response time, the transducer shall be under reference conditions and the auxiliary circuit shall be energized for at least the pre-conditioning time unless it is energized from one of the input quantities and is not separately accessible.

5.6.2 The response time shall be stated by the manufacturer and shall be determined for an input step such that it would produce a change in output signal from 0 % to 90 % of the fiducial value.

5.6.3 If a test for decreasing input is required, the input step should produce a change in output signal from 100 % to 10 % of the fiducial value.

5.6.4 The interval (see 3.1.19) shall be ±1 % of the upper nominal value of the output signal.

5.6.5 Methods of test for frequency transducers and transducers with suppressed zero shall be stated by the manufacturer.

5.7 Variation due to over-range of the measurand

If, by agreement, a transducer is required to operate with an input up to 150 % of the nominal value, the difference between the intrinsic error at 100 % and the error at 150 % (under reference conditions) of the nominal value of the input shall not exceed 50 % of the class index.

For active power and reactive power transducers, 150 % of the nominal value is achieved by increasing the current while retaining the voltage at the nominal value.

5.8 Limiting value of the output signal

The output signal shall be limited to a maximum of twice the upper nominal value.

When the measurand is not between its lower and upper nominal values, the transducer shall not, under any conditions, for example over-current or under-voltage, produce an output having a value between its lower and upper nominal values.

5.9 Limiting conditions of operation

The limits of the nominal ranges of use given in Clause 6 are those within which the transducer will comply with the requirements of this standard. It is possible to operate transducers beyond these limits but the user should note that:

– the accuracy may not be maintained and/or

– the designed operational lifetime may be reduced.

As an example, many transducers will operate in ambient temperatures as low as –25 °C and as high as +70 °C but the manufacturer should be consulted as to the degradation to be expected in both accuracy and operational lifetime.

5.10 Limits of the measuring range

When the limits of the measuring range do not coincide with the lower and upper nominal values of the output, the limits of the measuring range shall be marked (see 7.1 i)).

5.11 Limiting conditions for storage and transport

Unless otherwise stated by the manufacturer, transducers shall be capable of withstanding, without damage, exposure to temperatures within the range –40 °C to +70 °C.

After returning to reference conditions, they shall meet the requirements of this standard.

The manufacturer shall specify any additional limiting condition required to ensure the integrity of the transducer.

5.12 Sealing

When the transducer is sealed to prevent unauthorized adjustment, access to the internal circuit and to the components within the case shall not be possible without destroying the seal.

5.13 Stability

Transducers shall comply with the relevant limits of intrinsic error specified for their respective accuracy classes for a period specified by the manufacturer, provided that the conditions of use, transport and storage specified by the manufacturer are complied with.

NOTE Usually the period will be below one year.

6 Tests

6.1 General

6.1.1 Determination of variations

The variations shall be determined for each influence quantity. During the tests, all other influence quantities shall be maintained at reference conditions.

All the influence quantities are given in the following subclauses, together with the appropriate testing procedure, computations and the permissible variations for each usage group expressed as a percentage of the class index. None of the variations determined shall exceed the permissible values.

Variations shall be determined at the upper nominal value of the output and, at least, at one other point. For apparent power, active power and reactive power transducers, these values shall be obtained by maintaining the voltage and power factor at their reference conditions and varying the value of the current.

When a reference range is specified, the influence quantity shall be varied between each of the limits of the reference range and any value in that part of the nominal range of use which is adjacent to the chosen limit of the reference range.

6.1.2 Environmental conditions

The conditions of temperature and humidity are classified according to the severity dictated by the usage group in accordance with Table 5.

Table 5 – Usage groups

	K55 class of transducer	K70 class of transducer	Kx[b] class of transducer
Usage group	I	II	III
Rated operating range (with specified uncertainty)	–5 °C to +55 °C	–25 °C to +70 °C	Above +70 °C and/or under –25 °C [a]
Limit range of operation (no hardware failures)	–5 °C to +55 °C	–25 °C to +70 °C	Above +70 °C and/or under –25 °C [a]
Limit range for storage and shipping	–25 °C to +70 °C	–40 °C to +85 °C	According to manufacturer specification [a]

a Limits are to be defined by manufacturer according to the application.

b Kx stands for extended conditions.

For the purpose of this standard, ambient temperature shall be the temperature measured at a single representative point with the transducer operating normally. This measuring point shall be adjacent to the transducer, exposed to free air circulation and not significantly affected by heat from the transducer or by direct solar radiation and other sources of heat.

Humidity is not considered to be an influence quantity provided that the environmental conditions are within the limits specified.

6.1.3 Computations

In the following subclauses, a computation is required according to a formula. The terms in the formulae follow a general principle:

- R is the value of the output signal under reference conditions;
- X (or Y) is the value of the output signal measured at one extreme of the influence quantity;
- F is the fiducial value.

NOTE For curves of type F (see 5.3), replace F by R in all of the following formulae.

6.2 Variations due to auxiliary supply voltage

6.2.1 Application

All transducers requiring a d.c. or an a.c. auxiliary supply except where this is obtained from the input voltage or current and the connections cannot be separated for testing purposes.

6.2.2 Procedure

Apply the nominal value of auxiliary supply voltage and record the value of the output signal (R).

At a constant value of the measurand, reduce the auxiliary supply voltage to the lower limit given in 6.2.4 and record the value of the output signal (X). Increase the auxiliary supply voltage to the upper limit given in 6.2.4 and record the value of the output signal (Y).

6.2.3 Computation

The variations are: $\frac{X-R}{F}\times 100$

and: $\frac{Y-R}{F}\times 100$

6.2.4 Permissible variations

For a.c. auxiliary supplies

Usage group	**Nominal range of use** (%)	**Variation** (% of class index)
I	90 to 110	50
II	80 to 120	50
III	80 to 120	50

For d.c. auxiliary supplies

Usage group	**Nominal range of use** (%)	**Variation** (% of class index)
I	85 to 125	50
II	85 to 125	50
III	85 to 125	50

6.3 Variations due to auxiliary supply frequency

6.3.1 Application

All transducers requiring an a.c. auxiliary supply except where this is obtained from the input voltage or current and the connections cannot be separated for testing purposes.

6.3.2 Procedure

Apply the nominal value of auxiliary supply frequency and record the value of the output signal (R). At a constant value of the measurand, reduce the auxiliary supply frequency to the lower limit given in 6.3.4 and record the value of the output signal (X).

Increase the auxiliary supply frequency to the upper limit given in 6.3.4 and record the value of the output signal (Y).

6.3.3 Computation

The variations are: $\frac{X-R}{F}\times 100$

and: $\frac{Y-R}{F}\times 100$

6.3.4 Permissible variations

Usage group	Nominal range of use (%)	Variation (% of class index)
I	90 to 110	50
II	90 to 110	50
III	90 to 110	50

6.4 Variations due to ambient temperature

6.4.1 Application

All transducers.

6.4.2 Procedure

At a constant value of the measurand and at reference temperature, record the value of the output signal (*R*).

Increase the ambient temperature to the upper limit given in 6.4.4 and allow sufficient time for conditions to stabilize (30 min is usually adequate). Record the value of the output signal (*X*).

Reduce the ambient temperature to the lower limit given in 6.4.4 and allow the same stabilization to take place. Record the value of the output signal (*Y*).

6.4.3 Computation

The variations are: $$\frac{X-R}{F}\times 100$$

and: $$\frac{Y-R}{F}\times 100$$

6.4.4 Permissible variations

Usage group	Nominal range of use	Variation (% of class index)
I	10 °C to 35 °C	100
II	0 °C to 45 °C	100
III	–10 °C to 55 °C	100

6.5 Variations due to the frequency of the input quantity(ies)

6.5.1 Application

All transducers except frequency transducers. Frequency sensitive transducers (e.g. those employing phase shifting circuits) are exceptions and the nominal range of use shall always be marked.

6.5.2 Procedure

Apply the nominal value of the input frequency and record the value of the output signal (*R*).

At a constant value of the measurand, reduce the frequency to the lower limit given in 6.5.4 and record the value of the output signal (*X*).

Increase the frequency to the upper limit given in 6.5.4 and record the value of the output signal (Y).

6.5.3 Computation

The variations are: $\frac{X-R}{F}\times 100$

and: $\frac{Y-R}{F}\times 100$

6.5.4 Permissible variations

Usage group	**Nominal range of use** (%)	**Variation** (% of class index)
I	90 to 110	100
II	90 to 110	100
III	90 to 110	100
Frequency sensitive	As marked	100

6.6 Variations due to the input voltage

6.6.1 Application

All transducers except voltage and current transducers.

6.6.2 Procedure

Apply the nominal value of the input voltage and record the value of the output signal (R).

At a constant value of the measurand, reduce the voltage to the lower limit given in 6.6.4 and record the value of the output signal (X).

Increase the voltage to the upper limit given in 6.6.4 and record the value of the output signal (Y).

6.6.3 Computation

The variations are: $\frac{X-R}{F}\times 100$

and: $\frac{Y-R}{F}\times 100$

6.6.4 Permissible variations

Usage group	**Nominal range of use** (%)	**Variation** (% of class index)
I	90 to 110	50
II	80 to 120	50
III	80 to 120	50

6.7 Variations due to the input current

6.7.1 Application

Phase angle and power factor transducers.

6.7.2 Procedure

Apply the nominal value of the input current and record the value of the output signal (*R*).

At a constant value of the measurand, reduce the input current to the lower limit given in 6.7.4 and record the value of the output signal (*X*).

Increase the input current to the upper limit given in 6.7.4 and record the value of the output signal (*Y*).

6.7.3 Computation

The variations are: $\frac{X - R}{F} \times 100$

and: $\frac{Y - R}{F} \times 100$

6.7.4 Permissible variations

Usage group	**Nominal range of use** (%)	**Variation** (% of class index)
I	20 to 120	100
II	20 to 120	100
III	20 to 120	100

6.8 Variations due to power factor

6.8.1 Application

Apparent, active and reactive power transducers.

6.8.2 Procedure

Apply respectively 50 % (5 %) of the nominal value of the input current at a power factor of 1,0 and record the two values of the output signal (*R*). At a constant value of the measurand, increase the input current to 100 % (10 %) of the nominal value and reduce the power factor to 0,5 lag/lead, respectively. Record the two values of the output signal (*X*).

For convenience, when testing the reactive power transducers, it is usual to apply the equivalent values of sin φ.

Active power transducers shall also be tested for error at a power factor of zero and reactive power transducers at a sin $\varphi = 0$.

6.8.3 Computation

The variations are: $\frac{X - R}{F} \times 100$

and: $\frac{Y-R}{F}\times 100$

6.8.4 Permissible variations

Usage group	Nominal range of use	**Variation** (% of class index)
I	Cos (sin) φ = 0,5 … 1 … 0,5	50
II	Cos (sin) φ = 0,5 … 1 … 0,5	50
III	Cos (sin) φ = 0,5 … 1 … 0,5	50

For all transducers, the error at a power factor of zero (or sin φ = 0) shall not exceed 100 % of the class index.

6.9 Variation due to output load

6.9.1 Application

All variable output load transducers.

6.9.2 Procedure

Apply a value of output load equal to the mean value of the nominal range and record the value of the output signal (*R*).

At a constant value of the measurand, reduce the resistance of the output load to the lower limit given in 6.9.4 and record the value of the output signal (*X*).

Increase the resistance of the output load to the upper limit given in 6.9.4 and record the value of the output signal (*Y*).

6.9.3 Computation

The variations are: $\frac{X-R}{F}\times 100$

and: $\frac{Y-R}{F}\times 100$

6.9.4 Permissible variations

Usage group	**Nominal range of use** (%)	**Variation** (% of class index)
I	10 to 100	50
II	10 to 100	50
III	10 to 100	50

6.10 Variations due to distortion of the input quantity(ies)

6.10.1 Application

All transducers characterized by the manufacturer for use on systems having distorted waveforms, except harmonics transducers.

6.10.2 Procedure

Apply the chosen value of input quantity with no distortion and record the value of the output signal (*R*). Introduce third harmonic distortion at the level given in 6.10.4, maintaining the r.m.s. values constant, and record the value of the output signal (*X*). The phase relationship between the harmonic and the fundamental should be varied so as to determine the most unfavourable conditions.

For apparent, active and reactive power transducers, the test is performed with distorted current waveform and then repeated with distorted voltage waveform.

For apparent active and reactive power transducers not employing phase shifters, the permissible variations are given in 6.10.4.

For reactive power transducers employing phase shifters, the permissible variations shall be specified by the manufacturer.

6.10.3 Computation

The variation is: $\frac{X-R}{F}\times 100$

6.10.4 Permissible variations

Usage group	**Nominal range of use**	**Variation** (% of class index)
I	Distortion factor 0,2	200
II	Distortion factor 0,2	200
III	Distortion factor 0,2	200

6.11 Variation due to magnetic field of external origin

6.11.1 Application

All transducers.

6.11.2 Procedure

The transducer is placed in the centre of a coil of 1 m mean diameter, of square cross section and of radial thickness small compared with the diameter (see Note). 400 ampere-turns in this coil will produce, at the centre of the coil, in the absence of the transducer under test, a magnetic field strength of 0,4 kA/m. The magnetic field shall be produced by a current of the same kind and frequency as that which energizes the measuring circuit and shall be such as to have the most unfavourable combination of phase and orientation. The values of a.c. fields are expressed in r.m.s. values.

Any transducer having an external dimension exceeding 250 mm shall be tested in a coil of mean diameter not less than four times the maximum dimensions of the transducer. The magnetic field strength being the same as that given above.

NOTE Other devices which produce an adequate homogeneous magnetic field in the absence of the transducer under test are also permissible.

In the absence of the external field, record the value of the output signal (*R*).

At a constant value of the measurand, apply the external field and record the value of the output signal (*X*).

6.11.3 Computation

The variation is: $\frac{X-R}{F}\times 100$

6.11.4 Permissible variations

Usage group	**Variation** (% of class index)
I	100
II	100
III	100

6.12 Variation due to unbalanced currents

6.12.1 Application

Multi-element apparent, active and reactive power transducers.

6.12.2 Procedure

The currents shall be balanced and adjusted so that the output signal is approximately in the middle of the span or, if zero output signal is within the span, half-way between zero and the upper nominal value of the output signal. Record the value of the output signal (*R*).

Disconnect one current, maintaining the voltages balanced and symmetrical, and adjust the other currents, maintaining them equal, so as to restore the initial value of the measurand.

Record the value of the output signal (*X*).

6.12.3 Computation

The variation is: $\frac{X-R}{F}\times 100$

6.12.4 Permissible variations

Usage group	**Variation** (% of class index
I	100
II	100
III	100

6.13 Variation due to interaction between measuring elements

6.13.1 Application

All multi-element apparent, active power and reactive power transducers except those employing two measuring elements for measuring three-phase four-wired unbalanced power with three current circuits (sometimes known as "two and a half elements") and those reactive power transducers using cross-connection methods.

6.13.2 Procedure

The voltage input of one measuring circuit alone shall be energized at nominal voltage. The current input of each of the other measuring circuits shall be energized in turn at nominal current. The maximum departure of the output signal (*X*) from that corresponding to zero of the measurand shall be noted whilst the phase angle between the voltage and currents is changed through 360°.

If the auxiliary supply is common to one of the voltage input circuits, this circuit shall be the one to which the voltage is applied.

6.13.3 Computation

The variation is: $\frac{X}{F} \times 100$

6.13.4 Permissible variations

Usage group	**Variation** (% of class index)
I	50
II	50
III	50

6.14 Variation due to self-heating

6.14.1 Application

All transducers.

6.14.2 Method

The transducer shall be at ambient temperature and shall have been disconnected for at least 4 h. Energize the transducer in accordance with 4.5.4 (except for the condition of "30 min" as specified in Table 2).

After 1 min and before the third minute, determine the value of the output signal (*X*). Repeat this procedure between the 30th and 35th minute after energization (R).

6.14.3 Computation

The variation is: $\frac{X - R}{F} \times 100$

6.14.4 Permissible variations

Usage group	**Variation** (% of class index
I	100
II	100
III	100

6.15 Variation due to continuous operation

6.15.1 Application

All transducers.

6.15.2 Procedure

Energize the transducer under reference conditions for at least the preconditioning period. Record the value of the output (*R*). After a convenient period of continuous operation, for example 6 h, note the value of the output (*X*).

6.15.3 Computation

The variation is: $\frac{X-R}{F}\times 100$

6.15.4 Permissible variation

A variation is allowed but the transducer shall continue to comply in all respects with the requirements appropriate to its accuracy class.

6.16 Variation due to common mode interference

6.16.1 Application

All transducers having an analogue output signal.

6.16.2 Procedure

At a constant value of the measurand near the upper nominal value, record the value of the output signal (*R*). Apply a voltage of 100 V r.m.s., at 45 Hz to 65 Hz, between either output terminal and earth. Record the value of the output signal (*X*).

6.16.3 Computation

The variation is: $\frac{X-R}{F}\times 100$

6.16.4 Permissible variations

Usage group	**Variation** (% of class index)
I	100
II	100
III	100

6.17 Variation due to series mode interference

6.17.1 Application

All transducers having an analogue current output signal.

6.17.2 Procedure

At a constant value of the measurand near the upper nominal value and with the compliance voltage at 80 % of the maximum value, record the value of the output signal (*R*).

Apply a voltage of 1 V r.m.s. at 45 Hz to 65 Hz, in series with the output signal. Record the value of the output signal (*X*).

NOTE The internal d.c. resistance of the source of the series-mode interference, if excessive, may influence the test results, especially for the fixed output load transducers.

6.17.3 Computation

The variation is: $$\frac{X - R}{F} \times 100$$

6.17.4 Permissible variations

Usage group	**Variation** (% of class index)
I	100
II	100
III	100

6.17.5 Permissible excessive inputs

After completion of the tests described in 6.17.6 and 6.17.7 and after having regained equilibrium with the reference value of the ambient temperature, the transducer shall comply with the requirements appropriate to its class index.

6.17.6 Continuous excessive inputs

The transducer shall withstand the application of excessive inputs simultaneously for 24 h.

a) Voltage inputs, including auxiliary supplies, shall be subjected to 120 % of the nominal value of the voltage.
b) Current inputs shall be subjected to 120 % of the nominal value of the current.

6.17.7 Excessive inputs of short duration

The tests shall be made under reference conditions. The excessive input amplitudes of short duration which shall be applied to transducers are:

a) for voltage inputs: 200 % of the nominal value of the measured voltage applied for 1 s and repeated 10 times at 10 s intervals;
b) for current inputs: 20 times the nominal value of the measured current applied for 1 s and repeated 5 times at 300 s intervals.

The test circuit shall be substantially non-reactive.

After testing, the intrinsic characteristics of the transducer shall be unchanged.

6.18 Voltage test, insulation tests and other safety requirements

The requirements for the voltage test and other safety requirements are included in IEC 61010-1 to which reference shall be made.

6.19 Impulse voltage tests

6.19.1 A peak test voltage of 5 kV in both positive and negative senses, having the standardized impulse waveform of 1,2/50 μs, shall be applied to transducers as follows:

– between the earth terminal and all the other terminals connected together;
– between the terminals of each circuit in turn, all other circuits being earthed.

Three positive and three negative impulses shall be applied at intervals of not less than 5 s. Any flashover (capacitance discharge) shall be considered a criterion of failure unless occurring in a component designed for such.

For further details of the impulse voltage test, reference shall be made to IEC 61010-1 and IEC 61010-2-030.

6.19.2 After completion of the impulse voltage test, the transducer shall comply with the requirements appropriate to its class index.

6.19.3 Auxiliary circuits with a reference voltage of over 40 V shall be subjected to the impulse voltage test under the same conditions as those already given for the other circuits.

6.20 High frequency disturbance test

See the IEC 61326 series.

6.21 Test for temperature rise

The transducer shall be energized as follows:

– each current circuit shall carry a current of 1,1 times the nominal current and
– each voltage circuit shall be supplied with a voltage of 1,2 times the nominal voltage.

These conditions shall be maintained for at least 2 h. During the test the transducer shall not be exposed to forced ventilation nor to direct solar radiation.

The temperature rise of the following parts of the transducer shall not exceed:

– for input circuits: 60 K;
– for the exterior surface: 25 K.

6.22 Other tests

If, by agreement, other tests are required, refer to the following publications:

– for vibration: IEC 60068-2-6;
– for shock: IEC 60068-2-27;
– for electromagnetic compatibility: IEC 61326-1.

7 Marking and information

7.1 Marking on the case

Transducers shall bear, on (or visible through) one of the external surfaces of the case, the markings listed below. The markings shall be legible and indelible. The symbols referred to below are specified in Table 7.

a) Manufacturer's name or mark.
b) Manufacturer's type designation.
c) Serial number or date code.
d) Software version (version of software that resides in the transducer (if any, for digital transducers only)).
e) Class index (symbol E-10 or E-11).
f) Nature of the measurand and number of circuits (symbol B-2, B-4 or B-6 to B-10).
g) Lower and upper nominal values of the measurand.
h) Ratios of current transformers and voltage transformers, if any, with which the transducer is intended to be used.

i) Range of values of the output current (voltage) and output load within which specified operation is obtained (analogue signals only).

j) Limits of the measuring range, if appropriate (see 5.9).

k) Serial number(s) of the associated equipment, if applicable.

l) Value(s) of the auxiliary supply, if relevant.

m) Symbol showing that some other essential information is given in a separate document (symbol F-33).

n) Space for adjustment data (if appropriate).

o) Nominal range of use for temperature, symbolized as usage group I, II or III.

p) Common mode voltage.

q) Overvoltage category (see IEC 61010 series).

r) Pollution degree according to IEC 61010 series.

s) Other required safety symbols according to IEC 61010-1.

If the markings and symbols are on an easily removable part, such as a cover, the transducer shall have a serial number which shall also be marked on the body of the transducer.

Transducers having a non-linear relationship between input and output shall be marked with the symbol F-33, and actual relationship between input and output shall be given in a separate document.

NOTE To be given if there is sufficient space on the case, otherwise to be given in a separate document.

7.2 Markings relating to the reference conditions and nominal ranges of use for transducers

7.2.1 The reference values (or ranges) and nominal ranges of use, if different from those given in Tables 3 and 4 and Clause 6, shall be marked on the transducer or given in a separate document.

7.2.2 When a reference value or a reference range is marked, it shall be identified by underlining.

7.2.3 Table 6 shows the significance of the various markings, for example for temperature.

Table 6 – Examples of marking relating to the reference conditions and nominal range of use for temperature

Three or four numbers shall always be used.

Example	Meaning
-5 … 23 … 55 °C	Conforms to Group I
-25 … 15 … 30 … 70 °C	Conforms to Group II
–35 … 0 … 45 … 75 °C	Conforms to Group III
0 … 25 … 40 °C	Reference value: 25 °C Nominal range of use: 0 °C to 40 °C
–5 … 20 … 30 … 35 °C	Reference range: 20 °C to 30 °C Nominal range of use: –5 °C to 35 °C

7.3 Identification of connections and terminals

If so required for the correct use of the transducer, a diagram or table of connections shall be supplied and the terminals shall be clearly marked to show the proper method of connection.

If a terminal of a measuring circuit is intended to be kept at, or near to earth (ground) potential (for example, for safety or functional reasons), it shall either be marked with a capital N if it is intended to be connected to the neutral conductor of an a.c. supply circuit, or it shall be marked with symbol F-45 (see Table 7) in all other circumstances.

The earthing terminal(s) shall be marked using symbol(s) F-31 and/or F-42 to F-45, as appropriate.

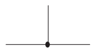
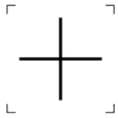
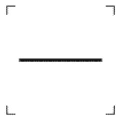
7.4 Information to be given in a separate document

The following information shall be given in the document supplied with the transducer:

– response time;
– the variation due to a magnetic field of external origin;
– the actual relationship between input and output. (see required indications according to type of curves given in 5.3 for output current transfer functions).

Table 7 – Symbols for marking transducers

No.	Item	Symbol
B	**Nature of input quantity(ies) and number of measuring circuits**	
B-1	**IEC 60417-5031**: Direct current; D.C. circuit (for auxiliary supply only)	⎓
B-2	**IEC 60417-5032**: Alternating current; A.C. circuit (single phase)	~
B-3	D.C. and a.c. circuit	≂
B-4	**IEC 60417-5032-1**: Three-phase alternating current; Three-phase a.c. circuit (general symbol)	3~
B-6	One measuring element for three-wire network	3 ~ 1E
B-7	**IEC 60417-5032-2**: Three-phase alternating current with neutral conductor; One measuring element for four-wire network	3N~
B-8	Two measuring elements for three-wire network with unbalanced load	3 ~ 2E
B-9	Two measuring elements for four-wire network with unbalanced load	3N ~ 2E
B-10	Three measuring elements for four-wire network with unbalanced load	3N ~ 3E
C	Safety (see IEC 61010-1)	
E	Accuracy class	
E-10	Class index (e.g. 1) when the fiducial value corresponds to the span	│ 1 │
E-11	Class index (e.g. 0,5) when the fiducial value corresponds to half the span	│ 0,5 / 0,5 │
F	General symbols	

F-31	**IEC 60417-5017**: Earth; ground; Earth (ground) terminal (general symbol)	
F-33	ISO 7000-0434A Caution; Caution	
F-42	**IEC 60417-5020**: Frame or chassis; Frame or chassis terminal	
F-43	**IEC 60417-5019**: Protective earth; protective ground; Protective earth (ground) terminal	
F-44	**IEC 60417-5018**: Functional earthing; functional grounding (US); Functional earth terminal	
F-45	Measuring circuit earth (ground) terminal	
F-46	**IEC 60417-5005**: Plus; positive polarity; Positive terminal	
F-47	**IEC 60417-5006**: Minus; negative polarity; Negative terminal	

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