BRITISH STANDARD

BS EN
60051-1:1999
IEC
60051-1:1997

Direct acting indicating analogue electrical measuring instruments and their accessories —

Part 1: Definitions and general requirements common to all parts

The European Standard EN 60051-1:1998 has the status of a British Standard

ICS 17.220.20

National foreword

This British Standard is the English language version of EN 60051-1:1998. It is identical with IEC 60051-1:1997. It supersedes BS 89-1:1990 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/85, Measuring equipment for electrical and electromagnetic quantities, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

From 1 January 1997, 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.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 35 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 June 1999

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EUROPEAN STANDARD

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EUROPÄISCHE NORM

EN 60051-1

December 1998

ICS 17.220.20

Supersedes EN 60051-1:1989 + A1:1995 + A2:1995

Descriptors: Electrical measuring instruments, analogue indicating instruments, direct acting measuring instruments, accessories for electrical measuring instruments

English version

Direct acting indicating analogue electrical measuring instruments and their accessories Part 1: Definitions and general requirements common to all parts

(IEC 60051-1:1997)

Appareils mesureurs électriques indicateurs analogiques à action directe et leurs accessoires
Partie 1: Définitions et prescriptions générales communes à toutes les parties
(CEI 60051-1:1997)

Direkt wirkende anzeigende elektrische Meßgeräte und ihr Zubehör — Meßgeräte mit Skalenanzeige
Teil 1: Definitionen und allgemeine Anforderungen für alle Teile dieser Norm
(IEC 60051-1:1997)

This European Standard was approved by CENELEC on 1997-10-01. 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, Czech Republic, 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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

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Foreword

The text of document 85/166/FDIS, future amendment to IEC 60051-1:1984, prepared by IEC TC 85, Measuring equipment for electromagnetic quantities, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A3 to EN 60051-1:1989 on 1997-10-01.

The text of this document, together with that of IEC 60051-1:1984 and its amendments 1:1994 and 2:1995, was published by IEC as the fifth edition of IEC 60051-1 in December 1997. According to a decision of principle taken by the Technical Board of CENELEC, the approval of EN 60051-1:1989/A3 has been converted into the approval of a new EN 60051-1.

The following dates were fixed:

— latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-09-01

— latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1999-09-01

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative. Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60051-1:1997 was approved by CENELEC as a European Standard without any modification.

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Introduction

IEC 60051 is published in separate parts according to the following structure and under the general title *Direct acting indicating analogue electrical measuring instruments and their accessories*.

— *Part 1: Definitions and General Requirements Common to all Pans;*

— *Part 2: Special Requirements for Ammeters and Voltmeters;*

— *Part 3: Special Requirements for Wattmeters and Varmeters;*

— *Part 4: Special Requirements for Frequency Meters;*

— *Part 5: Special Requirements for Phase Meters, Power Factor Meters and Synchroscopes;*;

— *Part 6: Special Requirements for Ohmmeters (Impedance Meters) and Conductance Meters;*

— *Part 7: Special Requirements for Multi-function Instruments;*

— *Part 8: Special Requirements for Accessories;*

— *Part 9: Recommended Test Methods*.

Parts 2 to 9 are not complete in themselves and shall be read in conjunction with this Part 1.

All of these pans are arranged in the same format and a standard relationship between subject and clause number is maintained throughout. In addition, tables, figures and annexes add a suffix to the part number in order to differentiate the pans. This re-arrangement will assist the reader of IEC 60051 to distinguish information relating to the different types of instruments.

1 General

1.1 Scope

This standard applies to direct acting indicating electrical measuring instruments having an analogue display, such as:

— ammeters and voltmeters;

— wattmeters and varmeters;

— frequency meters of pointer and vibrating-reed types;

— phasemeters, power-factor meters and synchroscopes;

— ohmmeters, impedance meters and conductance meters;

— multi-function instruments of the above types.

It also applies to certain accessories used with these instruments, such as:

— shunts;

— series resistors and impedance elements.

If other accessories are associated with instruments, this standard is applicable to the combination of the instrument and the accessory provided that the adjustments have been made for the combination.

This standard also applies to a direct acting indicating electrical measuring instrument whose scale marks do not correspond directly to its electrical input quantity, provided that the relationship between them is known.

This standard also applies to instruments and accessories having electronic devices in their measuring and/or auxiliary circuits.

This standard does not apply to special purpose instruments which are covered by their own IEC standards.

This standard does not apply to special purpose devices which are covered by their own IEC standards when they are used as accessories.

This standard does not contain either requirements for protection against environmental conditions or the relevant tests. However, when necessary, and then only by agreement between the manufacturer and the user, tests to approximate the conditions of use may be selected from IEC 60068.

This standard does not specify requirements concerning dimensions of instruments or accessories (for the former, see IEC 60473).

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60051. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60051 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 60027, *Letter symbols to be used in electrical technology.*

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.*

IEC 60051-9:1988, *Direct acting indicating analogue electrical measuring instruments and their accessories — Part 9: Recommended test methods.*

IEC 60068-2-6:1995, *Environmental tests — Part 2: Tests — Test Fc and guidance: Vibrations (sinusoidal).*

IEC 60068-2-27:1987, *Environmental testing — Part 2: Tests — Test Ea and guidance: Shock.*

IEC 60417:1973, *Graphical symbols for use on equipment — Index, survey and compilation of the single sheets.*

IEC 60473:1974, *Dimensions for panel-mounted indicating and recording electrical measuring instruments*[1)].

IEC 60617-2:1996, *Graphical symbols for diagrams — Part 2: Symbol elements, qualifying symbols and other symbols having general application.*

IEC 61010-1:1990, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements.*

2 Definitions

The values of a.c quantities, given in this standard, are r.m.s. values unless otherwise stated.

For the purpose of this standard, terms as defined in IEC 60050 apply, together with the following additional terms.

2.1 General terms

2.1.1
electrical measuring instrument

a measuring instrument intended to measure an electrical or non-electrical quantity using electrical means

2.1.2
analogue display instrument

a measuring instrument intended to present or display the output information as a continuous function of the measured quantity

NOTE An instrument in which a change of the indication occurs by small discrete steps, but which does not have a digital display, is considered to be an analogue instrument.

2.1.3
indicating instrument

a measuring instrument which displays at any time the value of the measured quantity without recording it

NOTE The indicated value may be different from the value of the quantity measured by the instrument and may be in units of a different quantity.

2.1.4
direct acting indicating instrument

an instrument in which the indicating device is mechanically connected to and actuated by the moving element

[1)] Revision in preparation

2.1.5
electronic measuring instrument

a measuring instrument intended to measure an electrical or non-electrical quantity using electronic means

2.1.6
single function instrument

an instrument intended for the measurement of one kind of quantity only

2.1.7
multi-function instrument

an instrument having a single means of indication intended for the measurement of more than one kind of quantity (e.g. an instrument measuring current, voltage and resistance)

2.1.8
fixed instrument

an instrument designed to be permanently mounted and which is intended to be connected to (an) external circuit(s) by means of permanently installed leads

2.1.9
portable instrument

an instrument specifically designed to be carried out by hand

NOTE The instrument is intended to be connected and disconnected by the user.

2.1.10
polyphase instrument

an instrument for measurement in a polyphase system and arranged for connection to more than one phase of the system

2.1.11
balanced load polyphase instrument

a polyphase instrument for use in a balanced polyphase system. This does not include a single phase wattmeter scaled in terms of polyphase power

2.1.12
instrument with magnetic screen

an instrument shielded by ferro-magnetic material from the influence of a magnetic field of external origin

2.1.13
astatic instrument

an instrument in which the measuring element is so constructed as to be unaffected by a uniform magnetic field of external origin

2.1.14
instrument with electric screen

an instrument shielded by conductive material from the influence of an electric field of external origin

2.1.15 accessory

an element group of elements or device associated with the measuring circuit of a measuring instrument in order to confer specified characteristics to the measuring instrument

2.1.15.1
interchangeable accessory

an accessory having its own properties and accuracy, these being independent of those of the instrument with which it may be associated

NOTE An accessory is considered to be interchangeable when its rated characteristics are known and marked and are sufficient to enable its errors and variations to be determined without using the associated instrument. A shunt whose adjustment takes into account an instrument current which is not negligible and which is known, is considered to be interchangeable.

2.1.15.2
accessory of limited interchangeability

an accessory having its own properties and accuracy, which can only be associated with measuring instruments for which certain characteristics are within specified limits

2.1.15.3
non-interchangeable accessory

an accessory adjusted to take into account the electrical characteristics of a specific measuring instrument

2.1.16
shunt

a resistor connected in parallel with a measuring circuit of a measuring instrument

NOTE A shunt is generally intended to provide a voltage proportional to a current to be measured.

2.1.17
series resistor (impedance)

a resistor (impedance) connected in series with a measuring circuit of a measuring instrument

NOTE A series resistor (impedance) is generally intended to extend the voltage measuring range of an instrument.

2.1.18
instrument lead

a lead comprising one or more conductors, specially designed for interconnecting measuring instruments to external circuits or to accessories

2.1.19
calibrated instrument lead

an instrument lead whose resistance has a specified value

NOTE A calibrated instrument lead is considered as being an interchangeable accessory of a measuring instrument.

2.1.20
distortion factor (total harmonic distortion factor) (of a quantity)

$$\text{the ratio: } \frac{\text{r.m.s. value of the harmonic content}}{\text{r.m.s. value of the non-sinusoidal quantity}}$$

2.1.21
ripple content of a quantity

$$\text{the ratio: } \frac{\text{r.m.s. value of the fluctuating component}}{\text{value of the d.c. component}}$$

2.1.22
peak factor

the ratio of the peak value to the r.m.s. value of a periodic quantity

2.2 Description of instruments according to their method of operation

2.2.1
permanent-magnet moving-coil instrument

an instrument which operates by the interaction of the magnetic field due to a current in a movable coil with the field of a fixed permanent magnet

NOTE The instrument can have more than one coil, measuring the sum or ratio of the currents in them.

2.2.2
moving-magnet instrument

an instrument which operates by the interaction of the field of a movable permanent magnet with the magnetic field due to a current in a fixed coil

NOTE The instrument can have more than one coil.

2.2.3
moving-iron instrument

an instrument which operates by the attraction between a movable piece of "soft" magnetic material and the field due to a current in a fixed coil or by the repulsion (and attraction) between one (or more) fixed piece(s) of "soft" magnetic material and a movable piece of "soft" magnetic material, both (all) magnetized by a current in a fixed coil

2.2.4
polarized moving-iron instrument

an instrument comprising a movable piece of "soft" magnetic material polarized by a fixed permanent magnet and magnetically excited by a current in a fixed coil

2.2.5
electrodynamic instrument

an instrument which operates by the interaction of the magnetic field due to a current in a movable coil with the magnetic field due to a current in one or more fixed coils

2.2.6
ferrodynamic instrument (iron-cored electrodynamic instrument)

an electrodynamic instrument in which the electrodynamic effect is modified by the presence of "soft" magnetic material in the magnetic circuit

2.2.7
induction instrument

an instrument which operates by the interaction of the magnetic field(s) of (a) fixed a.c electromagnet(s) with the magnetic field(s) due to currents which they induce in (a) movable conductive element(s)

2.2.8 thermal instrument (electrothermal instrument)

an instrument which operates by the heating effect(s) of (a) current(s) m it(s) conductor(s)

2.2.8.1
bimetallic instrument

a thermal instrument in which the deformation of a bimetallic element (the materials having different rates of expansion due to a change in temperature), heated directly or indirectly by a current, produces the indication

2.2.8.2
thermocouple instrument

a thermal instrument making use of the e.m.f. of one or more thermocouples heated by the current to be measured

NOTE The e.m.f. is often measured using a permanent-magnet moving-coil instrument.

2.2.9
rectifier instrument

an instrument which is the combination of a measuring instrument sensitive to direct current and a rectifying device whereby alternating currents or voltages may be measured

2.2.10
electrostatic instrument

an instrument the operation of which depends on the effects of electrostatic forces between fixed and movable electrodes

2.2.11
pointer-type frequency meter

an instrument which indicates the measured frequency by the relationship between an index and a scale

2.2.12
vibrating-reed frequency meter

an instrument intended to measure frequency, comprising a set of tuned vibrating reeds, one or a few of which resonate under the action of an alternating current of the relevant frequency flowing through one or more fixed coils

2.2.13
phase meter

an instrument which indicates the phase angle between two electrical input quantities of the same frequency and of similar waveform

such an instrument measures:

— the phase angle between a voltage and another voltage or between a current and another current,

or

— the phase angle between a voltage and a current.

2.2.14
power factor meter

an instrument intended to measure the ratio between the active and the apparent power in an electrical circuit

in practice, power factor meters indicate the cosine of the phase angle between a current and a related voltage

2.2.15
ratiometer (quotientmeter)

an instrument for measuring the ratio (quotient) of two quantities

2.2.16
R.M.S.-responding instrument

an instrument which, over a specified frequency range, provides an indication which is designed to be proportional to the root-mean-square value of the measured quantity, even when it is not sinusoidal or containing a d.c. part

2.3 Constructional features of instruments

2.3.1 measuring circuit (of an instrument)

the part of the electrical circuit internal to the instrument and its accessories, together with the interconnecting leads, if any, which is energized by a voltage or a current, one or both of these quantities being a prime factor in determining the indication of the measured quantity (one of these quantities may be the measured quantity itself)

2.3.1.1
current circuit

a measuring circuit through which flows a current which is a prime factor in determining the indication of the measured quantity

NOTE It may be the current directly involved in the measurement or a proportional current supplied by an external current transformer or derived from an external shunt.

2.3.1.2
voltage circuit

a measuring circuit to which is applied a voltage which is a prime factor in determining the indication of a measured quantity

NOTE It may be the voltage directly involved in the measurement or a proportional voltage supplied by an external voltage transformer or an external voltage divider or derived by means of an external series resistor (impedance).

2.3.2
external measuring circuit

the part of the electrical circuit external to the instrument from which a measured value is obtained

2.3.3 auxiliary circuit

a circuit, other than a measuring circuit, required for the operation of the instrument

2.3.3.1
auxiliary supply

an auxiliary circuit which provides electrical energy

2.3.4
measuring element

the assembly of those parts of a measuring instrument which are acted upon by a measured quantity, resulting in a movement of the moving element related to that quantity

2.3.5
moving element

the moving part of a measuring element

2.3.6
indicating device

the part of a measuring instrument which displays values of the measured quantity

2.3.7
index

the means which, in conjunction with the scale, indicates the position of the moving element of an instrument

2.3.8 scale

the series of marks and numbers from which, in conjunction with the index, the value of the measured quantity is obtained

2.3.8.1
scale marks

marks on the dial for the purpose of dividing it into suitable intervals so that the position of the index may be determined

2.3.8.2
zero scale mark

the mark on the dial associated with the figure zero

2.3.8.3
scale division

the distance between any two consecutive scale marks

2.3.9
scale numbers

the series of numbers which are associated with the scale marks

2.3.10
dial

the surface which carries the scale and other marks and symbols

2.3.11 mechanical zero

the equilibrium position which the index will approach when the measuring element (if mechanically controlled) is de-energized. This may or may not coincide with the zero scale mark

In mechanically suppressed zero instruments, the mechanical zero does not correspond to a scale mark.

In instruments without restoring torque the mechanical zero is indeterminate.

2.3.11.1
mechanical zero adjuster

the mechanism by means of which the instrument may be adjusted so that the mechanical zero coincides with the appropriate scale mark

2.3.11.2
mechanical span adjuster

the mechanism by means of which the instrument may be adjusted so that the lower/upper limit of the measuring range coincides with the appropriate scale mark

2.3.12 electrical zero

the equilibrium position which the index will approach when the measured electrical quantity is either zero or a set value and the control circuit (if any), producing a restoring torque, is energized

2.3.12.1
electrical zero adjuster

for an instrument which needs an auxiliary supply, the mechanism by means of which the instrument may be adjusted so that the electrical zero coincides with the appropriate scale mark

2.3.12.2
electrical span adjuster

for an instrument which needs an auxiliary supply, the mechanism by means of which the instrument may be adjusted so that the lower/upper limit of the measuring range coincides with the appropriate scale mark

2.4 Characteristic features of instruments

2.4.1
scale length

the length of the line (curved or straight) which passes through the centres of all the shortest scale marks contained between the first and the last scale marks

it is expressed in units of length

NOTE If an instrument has more than one scale, each scale may have its own scale length. For convenience, the scale length of the instrument is taken to be that of the major scale.

2.4.2
span

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

it is expressed in units of the measured quantity

2.4.3
measuring range (effective range)

the range defined by two values of the measured quantity within which the limits of error of a measuring instrument (and/or accessory) are specified

NOTE A measuring instrument (and/or accessory) can have several measuring ranges.

2.4.4
residual deflection

the part of the deflection of a mechanically controlled moving element which remains after the cause producing it has disappeared and all the measuring circuits are de-energized

2.4.5
overshoot

the difference between the extreme indication and the steady indication (expressed in terms of the scale length) when the measured quantity is abruptly changed from one steady value to another

2.4.6
response time

the time taken for the indication to first reach and then remain within a band centred on the final steady indication when the measured quantity is abruptly changed from zero (the unenergized condition) to a value such that the final steady indication is a specified proportion of the scale length

2.5 Characteristic values

2.5.1
nominal value

a value of a quantity indicating the intended use of an instrument or accessory. The intended characteristics of instruments and accessories are also nominal values

2.5.2
rated value

a value of a quantity assigned, generally by a manufacturer, for a specified operating condition

2.5.3
fiducial value

a clearly specified value of a quantity to which the error(s) of an instrument and/or an accessory are referred in order to specify their respective accuracies

NOTE This value can be, for example, the upper limit of the measuring range, the span or another clearly stated value.

2.6 Influence quantity, reference conditions, nominal range of use and preconditioning

2.6.1
influence quantity

any quantity, generally external to the measuring instrument and/or accessory, which may affect its performance

2.6.2 reference conditions

the appropriate set of specified values and of specified ranges of values of influence quantities under which the permissible errors of an instrument and/or an accessory are specified

each influence quantity may have either a reference value or a reference range

2.6.2.1
reference value

a specified value of one of a set of reference conditions

2.6.2.2
reference range

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

2.6.3
nominal range of use

a specified range of values which it is intended that an influence quantity can assume without causing a variation exceeding the specified amount

2.6.4
limiting values of an influence quantity

extreme values which it is intended that an influence quantity can assume without the instrument or accessory being damaged or permanently altered in such a way that it no longer satisfies the requirements of its accuracy class

NOTE The limiting values may depend on the duration of their application

2.6.5
preconditioning

the action whereby a specified value of the measured quantity is applied to the measuring circuit prior to carrying out testing or use of the instrument or accessory

2.7 Errors and variations

2.7.1
(absolute) error

for an instrument, the value obtained by subtracting the true value from the indicated value

for an accessory, the value obtained by subtracting the true value from the marked (intended) value

NOTE 1 Since the true value cannot be obtained by measurement, a value obtained under specified test conditions and at a specified time is used instead. This value is derived from national measurement standards or measurement standards agreed upon by the manufacturer and the user.

NOTE 2 Attention is drawn to the fact that an error of an accessory may be transformed into an error of the opposite sign when the accessory is used with an instrument.

2.7.2
intrinsic error

the error of an instrument and/or accessory when under reference conditions

2.7.3
tracking error

the difference between the indication of a measuring instrument and the proportional value of the measured quantity at points within the scale, the instrument having been previously set to have no error at two points

2.7.4
variation

the difference between the two indicated values for the same value of the measured quantity of an instrument or the two true values of an accessory when a single influence quantity assumes successively two different specified values within the nominal range of use

2.8 Accuracy, accuracy class and class index

2.8.1
accuracy

for a measuring instrument, the quality which characterizes the closeness of the indicated value to the true value

for an accessory, the quality which characterizes the closeness of the marked (intended) value to the true value

NOTE The accuracy of a measuring instrument or of an accessory is defined by the limits of intrinsic error end by the limits of variations.

2.8.2
accuracy class

a group of measuring instruments and/or accessories which meet certain metrological requirements intended to keep permissible errors and variations within specified limits

2.8.3
class index

the number which designates the accuracy class

NOTE Some instruments and/or accessories may have more than one class index.

3 Description, classification and compliance

3.1 Description

Instruments and/or accessories shall be described according to their method of operation or their nature as given in clause **2** and/or by their special characteristics as given in the relevant parts.

3.2 Classification

Class indices shall be selected from a 1-2-5 sequence and the decimal multiples and submultiples thereof.

In addition, class indices 0,3, 1,5, 2,5 and 3 may be used for instruments, class index 0,15 for frequency meters and class index 0,3 for accessories.

3.3 Compliance with the requirements of this standard

Instruments and accessories marked with a class index shall comply with the relevant requirements of this standard relating to their class index.

The recommended test methods for checking compliance with the requirements of this standard are given in IEC 60051-9.

In case of dispute, the test methods of IEC 60051-9 are referee methods.

3.3.1 If, for the determination of intrinsic errors preconditioning is specified, the manufacturer shall state the preconditioning period and the value(s) of the measured quantity(ies). The preconditioning period shall not exceed 30 min.

3.3.2 Instruments and accessories shall be adequately packed to ensure that, after transport to the user, under normal conditions, they comply with the requirements of this standard relating to their class index.

4 Reference conditions and intrinsic errors

4.1 Reference conditions

4.1.1 The reference values of the influence quantities shall be as given in Table I-1.

4.1.2 The reference value for the ambient temperature shall be selected from 20 °C, 23 °C or 27 °C.

4.1.3 Reference conditions different from those given in Table I-1 may be specified, but they shall then be marked in accordance with clause **8**.

4.2 Limits of intrinsic error, fiducial value

When the instrument together with its non-interchangeable accessory(ies) (if any) or accessory is under the reference condition given in Table I-1 and is used between the limits of its measuring range and in accordance with the manufacturer's instructions, the intrinsic error, expressed as a percentage of the fiducial value[2)], shall not exceed the limits appropriate to its accuracy class. Values stated in a table of corrections supplied with the instrument or accessory shall not be taken into account in determining the errors.

NOTE 1 The intrinsic error includes other errors such as those due to friction, amplifier drift, etc.
NOTE 2 The accuracy classes relating to each type of instrument or accessory are given in the appropriate parts (clause **3**).

4.2.1 Correspondence between intrinsic error and accuracy class

The maximum permissible error is related to the accuracy class such that the class index is used as the limit of error, expressed as a percentage with positive and negative signs.

NOTE For example, for a class index of 0,05, the limits of intrinsic error are ± 0,05 % of the fiducial value.

[2)] This is the fiducial error. See term 301-08-08 of IEC 60050-301, IEC 60050-302, IEC 60050-303.

Table I-1 — Reference conditions and tolerances for testing purposes relating to the influence quantities

Influence quantity		Reference conditions unless otherwise marked	Tolerances permitted for testing purposes, applicable for a single reference value[b]	
			Class indices 0,3 and smaller	Class indices 0,5 and greater
Ambient temperature		23 °C	± 1 °C	± 2 °C
Humidity		Relative humidity 40 % to 60 %	—	—
Ripple of d.c. measured quantity		Ripple content zero	Ripple content 1 %	Ripple content 3 %
Distortion of a.c. measured quantity	Distortion factor	Zero	1 Rectifier instruments, non r.m.s.-responding electronic instruments and instruments which employ phase-shifting networks in their measuring circuits: distortion factor less than or equal to half the class index or 1 % whichever is smaller. 2 Other instruments: distortion factor not exceeding 5 %	
	Peak factor	$\sqrt{2}$, approx. 1,414 (sine wave)	± 0,05	
Frequency of a.c. measured quantity except for wattmeters, varmeters, frequency meters and power factor meters		45 Hz to 65 Hz	± 2 % of the reference value or $\pm {}^{1}/_{10}$ of the reference range for frequency (if any), whichever is the smaller	
Position[c]		Fixed instruments: mounting plane vertical Portable instruments: mounting plane horizontal	± 1°	
Nature and thickness of panel or support	F-37 F-38 F-39[d] None	*Nature* / *Thickness* Ferrous / X mm Ferrous / Any Non-ferrous / Any Any / Any	± 0,1 X mm or ± 0,5 mm, whichever is — smaller — —	
Magnetic field of external origin		Total absence	40 A/m[a] at frequencies from d.c. to 65 Hz in any direction	
Electric field of external origin		Total absence	1 kV/m at frequencies from d.c. to 65 Hz in any direction	

(See notes on page 17)

Table I-1 — Reference conditions and tolerances for testing purposes relating to the influence quantities

Influence quantity		Reference conditions unless otherwise marked	Tolerances permitted for testing purposes, applicable for a single reference value[b]
Auxiliary supply	Voltage	Nominal value or nominal range	± 5 % of the nominal value[d]
	Frequency	Nominal value or nominal range	± 1 % of the nominal value[d]

[a] 40 A/m is approximately the highest value of the Earth's magnetic field.
[b] These tolerances apply when a single reference value is specified in this table or is marked by the manufacturer. For a reference range, no tolerance is allowed.
[c] Instruments provided with a level indicator shall be tested with the instrument set level using the level indicator.
[d] These symbols (or lack of symbol) refer to the nature and thickness of the panel or support on which the instrument is mounted. See Table III-1.
[e] Unless a different tolerance is stated by the manufacturer.

4.2.2 Fiducial value

The fiducial value for each type of instrument and accessory is given in each relevant part.

5 Nominal range of use and variations

(See Annex B-1.)

5.1 Nominal range of use

5.1.1 The limits of the nominal range of use for influence quantities shall be as given in Table II-1.

5.1.2 When a manufacturer assigns and marks a nominal range of use which is different from that shown in Table II-1, it shall include the reference range (or reference value with permitted tolerances) and will normally exceed it in at least one direction.

5.1.2.1 For values in the nominal range of use beyond the reference range (or reference value), the permissible variation is as stated in Table II-1.

Example: For an instrument having a class index of 0,2, the variation due to a lack of level of 5° in any direction shall not exceed:

$$0{,}2\ (\%) \times \frac{50}{100} = 0{,}1\ \%\ \text{of the fiducial value.}$$

5.1.2.2 When the influence quantity is not one of those shown in Table II-1, the relevant permissible variation shall be stated by the manufacturer and shall not exceed 100 % of the class index.

5.2 Limits of variations

When an instrument or an accessory is under reference conditions and a single influence quantity is varied, the variation shall not exceed the values given in Table II-1 and in **5.2.1**, **5.2.2** and **5.2.3**.

Table II-1 — Limits of the nominal range of use and permissible variations

Influence quantity		Limits of the nominal range of use unless otherwise marked	Permissible variation expressed as a percentage of the class index	For the recommended tests, see IEC 60051-9, subclause:
Ambient temperature		Reference temperature ± 10 °C or lower limit of reference range – 10 °C and upper limit of reference range + 10 °C	100 %	**3.2**
Humidity		Relative humidity 25 % and 80 %	100 %	**3.3**
Ripple on d.c. measured quantity		See relevant parts		**3.6**
Distortion of a.c. measured quantity		Distortion factor: see relevant parts		**3.7**
		Peak factor: see relevant: parts		Under consideration
Frequency on a.c. measured quantity		See relevant parts		**3.8**
Position[a]		Horizontal and vertical if the reference position is not marked	100 %	**3.4**
		5° in any direction from reference position	50 %	
Magnetic field of external origin		See **5.2.1** and the relevant parts		**3.5**
Electric field of external origin (electrostatic instruments only)		20 kV/m at d.c. and 45 Hz to 65 Hz. See **5.2.2**.	100 %	**3.14**
Auxiliary supply	Voltage	Reference value ± 10 % or lower limit of reference range – 10 % and upper limit of reference range + 10 %	50 %	**3.17**
	Frequency	Reference value ± 5 % or lower limit of reference range – 5 % and upper limit of reference range + 5 %	50 %	**3.18**

[a] Instruments provided with a level indicator shall always be set correctly for position using the level indicator. These instruments need not therefore be tested for variation due to position.

5.2.1 Variation due to a magnetic field of external origin

5.2.1.1 When the instrument is not marked with symbol F-30 (Table III-1), the magnetic field strength in the test equipment shall be 0,4 kA/m.

5.2.1.2 For instruments marked with symbol F-30 (Table III-1), the magnetic field strength in the test equipment shall have a value in kiloamperes per metre as shown in the symbol.

5.2.1.3 Under the conditions of **5.2.1.1** and **5.2.1.2**, the variation shall not exceed the limits given in Table II of the relevant parts.

5.2.2 Variation due to an electric field of external origin (electrostatic instruments only)

The variation due to an electric field of external origin at d.c. and 45 Hz to 65 Hz, having a strength of 20 kV/m and under the most unfavourable conditions of phase and orientation, shall not exceed 100 % of the class index.

If the instrument is marked with symbol F-34 (Table III-1), the field strength is made equal to the value given in the symbol.

5.2.3 Variation due to ferromagnetic supports

The error of instruments which are mounted on a panel of the nature and thickness implied by the relevant symbol F-37, F-38 or F-39 or on a panel of any nature and thickness when not so marked — shall remain within the limits of the intrinsic error.

For the recommended test, see **3.1** of IEC 60051-9.

5.2.4 Variation due to conductive supports

For the recommended test, see **3.13** of IEC 60051-9.

Instruments shall meet the requirements for intrinsic errors relating to their class index when used on a panel or support of high conductivity unless other requirements are given in a separate document and are shown by marking with symbol F-33 (Table III-1).

5.3 Conditions for the determination of variations

5.3.1 If preconditioning is specified for the determination of variations, the manufacturer shall state the preconditioning period and the value(s) of the measured quantity(ies) and of the auxiliary supply, if any.

The preconditioning period shall not exceed 30 min.

5.3.2 The variations shall be determined for each influence quantity separately.

During each test all influence quantities shall be maintained at their reference conditions except for the influence quantity for which the variation shall be determined.

5.3.2.1 When an influence quantity has a reference value, the influence quantity shall be varied between that value and any value within the limits of the nominal range of use as given in Table II-1, unless otherwise marked.

5.3.2.2 When an influence quantity has a reference range, the influence quantity shall be varied from each limit of the reference range to the adjacent limit of the nominal range of use.

6 Further electrical and mechanical requirements

6.1 Voltage tests, insulation tests and other safety requirements

The requirements for the voltage tests, insulation resistance tests and constructional requirements relating to safety are included in IEC 61010-1.

For additional requirements relating to electronic devices of instruments and/or accessories, IEC 61010-1 shall be applied.

6.2 Damping

The damping of instruments, except for instruments having an intentionally long response time, and unless otherwise specified in the relevant part, shall comply with the following requirements:

6.2.1 Overshoot

For the recommended test, see **4.2** of IEC 60051-9.

6.2.1.1 For instruments having a total angular deflection of less than 180°, the mechanical overshoot shall not exceed 20 % of the scale length. For other instruments, the limit shall be 25 %.

6.2.2 Response time

Unless otherwise agreed between the manufacturer and the user, the departure of the index from the position of rest shall not exceed 1,5 % of the scale length at any time after 4 s following the sudden application of an excitation producing a change of final indication of two-thirds of the scale length.

For the recommended test, see **4.3** of IEC 60051-9.

6.2.3 Impedance of the external measuring circuit

When the characteristics of the circuit into which the instrument is connected may affect the damping, the external circuit impedance shall be as stated in the relevant part or otherwise specified by the manufacturer.

6.3 Self-heating

For the recommended test, see **4.14** of IEC 60051-9.

6.3.1 Instruments, together with their non-interchangeable accessories (if any), interchangeable accessories and accessories of limited interchangeability shall comply with the requirements corresponding to their class index after being continuously operated at any time after the completion of the specified preconditioning period (if any).

For testing:

— instruments shall be energized to give an indication of about 90 % of the upper limit of the measuring range;

— shunts shall be energized at about 90 % of their nominal value;

— series resistors (impedances) shall be energized at about 90 % of their rated values.

6.3.2 The variation shall not exceed the value corresponding to 100 % of the class index.

Nonetheless, the instrument, together with its accessories, shall also comply with the requirements relating to its class index.

6.3.3 Instruments and accessories intended for intermittent use (e.g. those provided with a non-locking switch) are excluded from the requirements relating to self-heating.

6.3.4 The requirements of **6.3.1**, **6.3.2** and **6.3.3** do not apply to ohmmeters.

6.4 Permissible overloads

6.4.1 Continuous overload

Requirements for continuous overload are given in the relevant parts.

6.4.2 Overloads of short duration

Requirements for overloads of short duration are given in the relevant parts.

6.5 Limiting values of temperature

For the recommended test, see **4.1** of IEC 60051-9.

6.5.1 Unless otherwise specified, instruments and/or accessories shall operate without incurring permanent damage when subjected to the ambient temperatures stated below:

— instruments of class indices 0,3 and smaller:

– 10 °C to + 35 °C;

— instruments of class indices 0,5 and greater and accessories of all class indices:

– 25 °C to + 40 °C;

— instruments which incorporate batteries and/or which have built-in electronic devices and are marked with symbol F-20 or F-21:

0 °C to + 40 °C.

6.5.2 Absence of permanent damage is inferred if, on return to reference conditions, the instruments and/or accessories comply with the requirements relating to intrinsic error. Adjustment of the instrument zero is permissible.

6.6 Deviation from zero

Requirements for deviation from zero and for return to zero are given in the relevant parts.

7 Constructional requirements

7.1 Sealing to prevent access

When the instrument is sealed, access to the measuring element and to the accessories within the case shall not be possible without destroying the seal.

7.2 Scales

7.2.1 Scale divisions

The intervals shall correspond to 1, 2 or 5 times the unit of the measured or indicated quantity or that unit multiplied or divided by 10 or 100.

For multi-range and/or multi-scale instruments, the above requirements shall be fulfilled for at least one measuring range or scale.

7.2.2 Scale numbering

The numerals of the scale (whole number or decimal) marked on the dial should preferably not have more than three digits. SI units and their prefixes should be used in association with the scale numbering.

7.2.3 Direction of deflection

The direction of deflection of the index of an instrument should be from left to right or from bottom to top with increasing measured quantity.

When the angular deflection of the index exceeds 180°, the deflection with increasing measured quantities should be clockwise.

On multi-scale instruments, at least one of the scales shall be such as to comply with the above requirements.

7.2.4 Limits of the measuring range

If the measuring range does not occupy the whole scale length, the limits of the measuring range shall be clearly identified.

7.2.4.1 When the value of the scale divisions or the nature of the scale marks enables the measuring range to be identified without ambiguity, no marking is necessary. An example of this method is given in Figure 1-1.

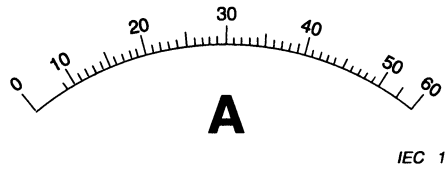
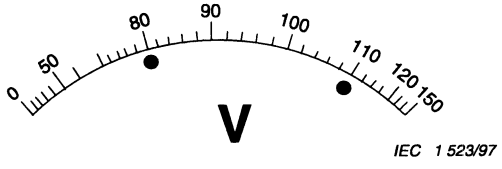


Figure 1-1 — Measuring range 8 A to 5.0 A

(Subdivisions are omitted outside the measuring range.)

7.2.4.2 When there is only one scale and marking is necessary, the limits of the measuring range shall be identified by means of small filled-in dots. An example of this method is given in Figure 2-1.



(The measuring range is ●...●.)

Figure 2-1 — Measuring range 80 V to 110 V

7.2.4.3 When there is more than one scale and marking is necessary, the limits of the measuring range shall be identified either by small filled-in dots or by means of widened scale arcs. An example of this latter method is given in Figure 3-1.

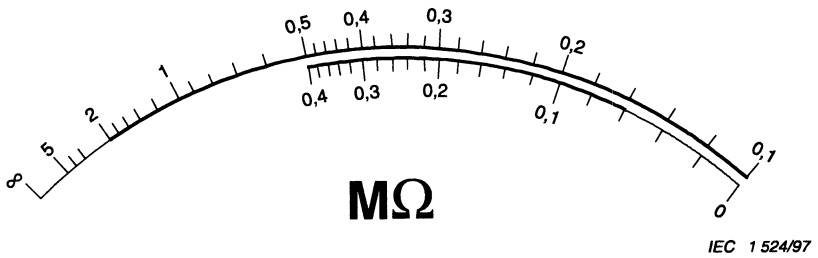


Figure 3-1 — Measuring ranges 0,06 MΩ to 0,4 MΩ and 0,1 MΩ to 2 MΩ

7.3 Indication of out-of-range values of the measurand

When the value of the measurand is such that it would provide an indication not between the limits of a scale range, a clear out-of-range indication of this shall be provided.

NOTE The method of out-of-range indication may be, for example, by permitting the index to pass above (or below) the extreme scale marks in a clearly visible manner.

7.4 Preferred values

The preferred values shall be used in the absence of a special agreement between the manufacturer and the user.

Requirements for preferred values are given in the relevant parts.

7.5 Adjusters, mechanical and/or electrical

7.5.1 Zero adjuster(s)

When an instrument is fitted with zero adjuster(s), intended for use by the user, it is preferable that it(they) be accessible from the front of the case.

The total range of adjustment shall be not less than 2 % of the scale length or 2°, whichever is the less, and the fineness of setting shall be appropriate to the class index of the instrument.

NOTE By "appropriate", it is understood that the fineness of the setting is such as to permit seeing to within 1/5 of the class index. For instruments where the effective centre of rotation cannot readily be determined, the requirement relating to 2° is not applicable.

The ratio between the higher and lower ranges of adjustment on either side of the zero mark shall not be greater than 2.

For the recommended test, see **4.18** of IEC 60051-9.

7.5.2 Span adjuster(s)

When an instrument is fitted with span adjuster(s), intended for use by the user, it is preferable that it(they) be accessible from the front of the case.

The total range of adjustment shall be not less than 2 % of the scale length or 2°, whichever is the less, and the fineness of setting shall be appropriate to the class index of the instrument.

NOTE By "appropriate", it is understood that the fineness of the setting is such as to permit setting to within 1/5 of the class index. For instruments where the effective centre of rotation cannot readily be determined, the requirement relating to 2° is not applicable.

The ratio between the higher and lower ranges of adjustment on either side of the zero mark shall not be greater than 2.

For the recommended test, see **4.18** of IEC 60051-9.

7.6 Effects of vibration and shock

Unless otherwise agreed, instruments and accessories of class indices 1 and greater shall be capable of withstanding the vibration and shocks of the following type tests.

7.6.1 Vibration test

The test method given in IEC 60068-2-6 shall be used with the details specified below:

— sweep frequency range: 10 Hz – 55 Hz – 10 Hz;

— displacement amplitude: 0,15 mm;

— number of sweep cycles: 5;

— sweep rate: 1 octave per minute.

The direction of vibration is vertical: the instrument is fastened in its normal position of use.

7.6.2 Shock test

The method given in IEC 60068-2-27 shall be used with the details specified below:

— peak acceleration:

a) 147 m/s^2 (15 g_n),

b) 490 m/s^2 (50 g_n);

— for the peak acceleration in case a) no information is needed. In case b) the manufacturer shall state the value 490 m/s^2 of the peak acceleration;

— pulse shape: half sine;

— number of shocks: three in both directions of three mutually perpendicular axes (total of 18 shocks);

— duration of pulse: 11 ms.

The instrument is mounted so that one of the three shock axes is parallel to the axis of rotation of the moving element.

7.6.3 The change of error due to the effects of vibration and shock shall not exceed a value corresponding to 100 % of the class index.

8 Information, general markings and symbols

8.1 Information

The following information shall be given by the manufacturer:

a) Unit(s) of measured quantity(ies).

b) Manufacturer's name or trade mark or that of the responsible supplier.

c) Type reference, if any, given by the manufacturer.

d) Serial number for instruments and accessories of class indices 0,3 and smaller. Serial number or date of manufacture (at least the year) for instruments and accessories of class indices 0,5 and greater.

e) Rated value(s).

f) Nature of measured quantity(ies) and number of measuring elements.

g) Accuracy class(as).

h) Reference value or reference range for temperature for instruments and accessories of class indices 0,5 and smaller.

i) Reference value(s) or reference range(s) for each influence quantity (other than temperature) given in Table I-1 if different from the values given in Table I-1 and the reference values or reference ranges for any other relevant influence quantities not given in Table I-1.

j) Nominal ranges of use for the influence quantities of Table II-1 if the values are different.

Nominal ranges of use for any other relevant influence quantities not given in Table II-1.

k) Value of acceleration.

I) Instructions for the use of the instrument and/or accessory(ies) when necessary.

m) Method of operation of the instrument.

n) The burden expressed in voltamperes at nominal current and/or nominal voltage.

o) Peak factor.

p) Where relevant, reference position and nominal range of use for position.

q) Temperature limits and other requirements for transport, storage and use, if necessary.

r) has been deleted.

s) For an instrument whose scale marks do not correspond directly to its electrical input quantity, the relationship between them. This does not apply to an instrument having a non-interchangeable accessory.

t) Preconditioning period if not negligible and the value(s) of the measured quantity(ies) to be used for preconditioning.

u) Symbol of the accessory for which the instrument has been adjusted, if relevant.

v) Transformation ratio(s) of instrument transformer(s) for which the instrument has been adjusted, if relevant.

w) Value of the total resistance of calibrated instrument leads, if relevant.

x) Impedance of the external measuring circuit, if relevant.

y) Statement concerning an intentionally long response time, if relevant.

z) Any other essential information.

aa) Installation category.

bb) Pollution degree.

8.2 Markings, symbols and their locations

The markings and symbols shall be and remain legible and indelible. SI units, together with their prefixes, shall be marked using the symbols given in IEC 60027.

The symbols specified in Table III-1 shall be used, where relevant.

8.2.1 The following information shall be marked on the dial or on a part which is visible while the instrument is in use (marking on the dial shall not impede the clear reading of the scale):

a) ;

f) [symbol(s) B-1 ... B-10];

g) [symbol(s) E-1 ... E-10];

p) [symbol D-1 ... D-6];

r) *has been deleted*;

z) symbol F-33 if some other essential information is given in a separate document).

aa) symbol according to IEC 61010-1, amendment 2, subclause **5.1.5**).

8.2.2 The following information shall be marked on the dial or anywhere on the case (marking on the dial shall not impede the clear reading of the scale):

b); c); d); h);

m) [symbol(s) F-1 ... F-22, F-27, F-28, F-29, if relevant];

u) [symbol F-23 ... F-26];

v) ;

where relevant, the nature and thickness of the panel or support (symbol F-37 ... F-39).

In addition, if the reference values of the influence quantities are different from those given in Table I-1, they shall be marked as follows:

— magnetic field of external origin (symbol F-30 and if relevant F-28 and/or F-29),

— electric field of external origin (symbol F-34 and if relevant F-27).

8.2.3 The following information shall be marked on the dial or anywhere on the case or given in a separate document (if any) (marking on the dial shall not impede the clear reading of the scale):

e); i); j); n); q); s); t); w); x).

8.2.4 Documentation (if any) shall state:

b); c); k); l);

o) (only for instruments containing electronic devices in their measuring circuits);

y) (by agreement between the manufacturer and the user); any information of **8.2.3** which is not marked.

8.2.5 Markings for accessories and special markings for instruments, together with their locations, are given in the relevant parts.

8.2.6 By agreement between the manufacturer and the user, any or all of the information may be omitted.

8.3 Markings relating to the reference values and nominal ranges of use of influence quantities

8.3.1 Where a reference value or a reference range is different from that given in Table I-1 it shall be marked and shall be distinguished by being underlined. It is identified by the symbol of the unit in which it is measured.

8.3.2 When a nominal range of use is different from that given in Table II-1 it shall be marked. The marking is carried out in conjunction with marking the reference value or reference range. This then requires the marking of the reference value or reference range even if it would not otherwise be necessary.

8.3.3 The marking is done by writing the limits of the nominal range of use and the reference value (or range) in ascending order, each number separated from its neighbour by three dots.

For example: 35 ... *50* ... 60 Hz implies a reference frequency of 50 Hz and a nominal range of use for frequency from 35 Hz to 60 Hz.

Similarly: 35 ... *45* ... *55* ... 60 Hz implies a reference frequency range of from 45 Hz to 55 Hz and a nominal range of use for frequency from 35 Hz to 60 Hz.

8.3.4 When any limit of the nominal range of use is the same as the reference value or the adjacent limit of the reference range, the number indicating the reference value or the limit of the reference range shall be repeated for the limit of the nominal range of use.

For example: 23 ... *23* ... 37 °C implies a reference temperature of 23 °C and a nominal range of use for temperature from 23 °C to 37 °C.

Similarly: 20 ... *20* ... *25* ... 35 °C implies a reference temperature range from 20 °C to 25 °C and a nominal range of use for temperature from 20 °C to 35 °C.

Table III-1 — Symbols for marking instruments and accessories

Symbols for units of measurement and their prefixes are given in IEC 60027. For convenience, the symbols most likely to be needed for marking instruments and accessories and a list of the SI prefixes are given below.

Units and quantities

Item	Symbol
ampere	A
decibel	dB
hertz	Hz
ohm	Ω
second	s (lower case)
siemens	S (capital)
tesla	T
volt	V (capital)
voltampere	VA (capitals)
voltampere reactive	var (lower case)
watt	W (capital)
power factor	cos ϕ or cos φ
degree Celsius	°C

SI prefixes

Item		Symbol
exa	10^{18}	E
péta	10^{15}	P
téra	10^{12}	T
giga	10^{9}	G
méga	10^{6}	M (capital)
kilo	10^{3}	k (lower case)
hecto[a]	10^{2}	h (lower case)
déca[a]	10	da (lower case)
déci[a]	10^{-1}	d (lower case)
centi[a]	10^{-2}	c (lower case)
milli	10^{-3}	m (lower case)
micro	10^{-6}	μ
nano	10^{-9}	n
pico	10^{-12}	p
femto	10^{-15}	f
atto	10^{18}	a

B Nature of measured quantity and number of measuring elements			
N°	Item	Symbol	
B-1	Direct current circuit and/or d.c. responding measuring element	(5031)*	
B-2	Alternating current circuit and/or a.c. responding measuring element	(5032)*	
B-3	Direct and/or alternating current circuit and/or d.c. and a.c. responding measuring element	(5033)*	

[a] These items are non-preferred and their use should be avoided. The symbol of a prefix (if needed) immediately precedes, without a space, the symbol of a unit. If there is a number, it is followed by a space before the prefix (if any) and the unit. For example: 23 °C, 120 mV.
Numbers identified by "" are the reference numbers of the symbols in IEC 60417.

Table III-1 — Symbols for marking instruments and accessories

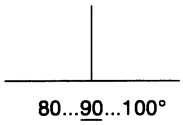
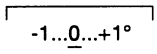
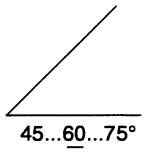
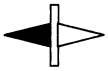
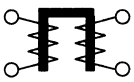
No.	Item	Symbol		
B-4	Three-phase alternating current circuit (general symbol)	3 ~ †		The symbols in this column are those given in the former edition of IEC 60051, and are given for information only.
B-6	One measuring element (E) for three-wire network	3 ~ 1E†		
B-7	One measuring element (E) for four-wire network	3N ~ 1E†		
B-8	Two measuring elements (E) for three-wire network with unbalanced loads	3 ~ 2E†		
B-9	Two measuring elements (E) for four-wire network with unbalanced loads	3N ~ 2E†		
B-10	Three measuring elements (E) for four-wire network with unbalanced loads	3N ~ 3E†		

c Safety (for application, see IEC 61010-1)

D Position of use		
D-1	Instrument to be used with the dial vertical	
D-2	Instrument to be used with the dial horizontal	
D-3	Instrument to be used with the dial inclined (e.g. 60°) from the horizontal plane	

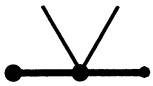
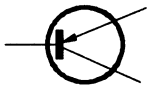
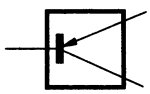
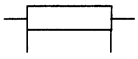
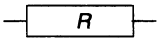
† Symbols identified by > are derived from symbol 02-02-04 in IEC 60617-2.
Numbers identified by "" are the reference numbers of the symbols in IEC 60417.

Table III-1 — Symbols for marking instruments and accessories

No.	Item	Symbol
D-4	Example for instrument to be used as D-1, nominal range of use from 80° to 100°	
D-5	Example for instrument to be used as D-2, nominal range of use from – 1° to + 1°	
D-6	Example for instrument to be used as D-3, nominal range of use from 45° to 75°	
E Accuracy class		
E-1	Class index (e.g. 1) except when the fiducial value corresponds to the scale length or the indicated value or the span	1
E-2	Class index (e.g. 1) when the fiducial value corresponds to the scale length	 [a]
E-3	Class index (e.g. 1) when the fiducial value corresponds to the indicated value	
E-10	Class index (e.g. 1) when the fiducial value corresponds to the span	
F General symbols (see also IEC 60617 and IEC 60417)		
F-1	Permanent-magnet moving-coil instrument	
F-2	Permanent-magnet ratiometer (quotientmeter)	
F-3	Moving permanent-magnet instrument	
F-4	Moving permanent-magnet ratiometer (quotientmeter)	
F-5	Moving-iron instrument	
F-6	Polarized moving-iron instrument	
F-7	Moving-iron ratiometer (quotientmeter)	

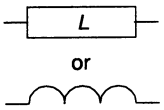
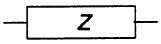
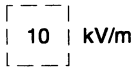
[a] Symbol E-2 is given for information only. It shall not be used on new designs of instruments.

Table III-1 — Symbols for marking instruments and accessories

No.	Item	Symbol
F-8	Ironless electrodynamic instrument	
F-9	Iron-cored electrodynamic (ferro-dynamic) instrument	
F-10	Ironless electro-dynamic ratiometer (quotientmeter)	
F-11	Iron-cored electro-dynamic (ferro-dynamic) ratiometer (quotientmeter)	
F-12	Induction instrument	
F-13	Induction ratiometer (quotientmeter)	
F-15	Bimetallic instrument	
F-16	Electrostatic instrument	
F-17	Vibrating-reed instrument	
F-18	Non-insulated thermocouple (thermal converter)	 [a]
F-19	Insulated thermocouple (thermal converter)	 [a]
F-20	Electronic device in a measuring circuit	 [a]
F-21	Electronic device in an auxiliary circuit	 [a]
F-22	Rectifier	 [a]
F-23	Shunt	
F-24	Series resistor	

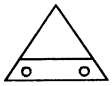
[a] If symbols F-18, F-19, F-20, F-21 or F-22 are combined with a symbol of an instrument, such as symbol F-1, the device is incorporated.

Table III-1 — Symbols for marking instruments and accessories

No.	Item	Symbol
F-25	Series inductor	
F-26	Series impedance	
F-27	Electric screen	
F-28	Magnetic screen	
F-29	Astatic instrument	ast
F-30	Magnetic field strength expressed in kiloamperes per metre, producing a variation corresponding to the class index (e.g. 2 kA/m)	
F-31	Earth (ground) terminal (general symbol)	 [a] (5017)*
F-32	Zero (span) adjuster	
F-33	Refer to a separate document	
F-34	Electric field strength expressed in kilovolts per metre, producing a variation corresponding to the class index (e.g. 10 kV/m)	
F-35	General accessory	 [b]
F-37	Ferrous support of thickness X mm	FeX
F-38	Ferrous support of any thickness	Fe
F-39	Non-ferrous support of any thickness	NFe

[a] Symbol F-31 is deprecated. One of the more explicit symbols F-42, F-43, F-44 or F-45 should be used instead.
[b] Symbol F-35 denotes that a device is external and shall be combined with one of the symbols F-18, F-19, F-20, F-21 or F-22.
Numbers identified by "" are the reference numbers of the symbols in IEC 60417.

Table III-1 — Symbols for marking instruments and accessories

No.	Item	Symbol
F-42	Frame or chassis terminal	 (5020)*
F-43	Protective earth (ground) terminal	 (5019)*
F-44	Noiseless earth (ground) terminal	 (5018)*
F-45	Signal low terminal	
F-46	Positive terminal	 (5005)*
F-47	Negative terminal	(5006)*
F-48	Resistance range setting control	
F-49	Overload protection device fitted	
F-50	Overload protection device reset control	
Numbers identified by "" are the reference numbers of the symbols in IEC 60417.		

9 Markings and symbols for terminals

9.1 Requirements for markings

9.1.1 The marking shall be applied on or adjacent to the relevant terminal.

9.1.2 If there is insufficient space adjacent to a terminal for the marking specified, a permanently attached nameplate shall be provided having details of the terminals and identifying them in an unambiguous way.

9.1.3 The markings shall be and remain legible and indelible and of a colour which contrasts with the background or shall be moulded.

9.1.4 A marking shall not be applied to a removable part of a terminal (such as a terminal head).

9.1.5 If markings are applied to a cover over several terminals, it shall not be possible to fit the cover so that the markings become incorrect.

9.1.6 When a diagram of connections is supplied, the marking for a terminal shall be identical to that on the diagram of connections relating to that terminal.

9.2 Earthing (grounding) terminals

9.2.1 Terminals which are required to be connected to a protective earth (ground) for reasons of safety shall be marked with symbol F-43 (Table III-1).

9.2.2 Terminals which are required to be connected to a noiseless earth (ground) to prevent impairment of performance shall be marked with symbol F-44 (Table III-1).

9.2.3 Terminals which are connected to accessible conductive material but which are not necessarily required to be connected to earth (ground) shall be marked with symbol F-42 (Table III-1).

9.3 Measuring circuit terminals

If a terminal of a measuring circuit is intended to be kept at or near to earth (ground) potential (e.g. 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 shall be marked with symbol F-45 (Table III-1) in all other circumstances.

These markings are additional to and shall follow any other markings prescribed for the relevant terminal.

9.4 Special markings for terminals

Special markings are given in the relevant parts.

10 Tests to prove compliance with this standard

10.1 The performance of instruments and accessories specified in this standard may be established using the tests given in IEC 60051-9 and these tests may be supplemented by tests given in other relevant IEC standards.

10.2 Tests under two categories are required: type tests and routine tests.

10.2.1 Type tests shall be made on a single specimen of each design or on a small number of specimens.

10.2.2 Routine tests shall be made on all items.

10.3 In general, this standard does not state which tests are type tests and which are routine tests.

NOTE 1 Some routine tests are given in Annex A-1.

NOTE 2 Routine tests are usually sufficient when made periodically during the life of an instrument or an accessory to ensure continued accurate performance and are normally used for recalibration.

Annex A-1 Tests

A-1.1 Routine tests

Test for intrinsic errors (clause **4**).

Test for variation due to position (clause **5**; Table II-1).

Voltage test (subclause **6.1**).

Test for return to zero (subclause **6.6**).

Other tests may also be carried out.

Annex B-1 Permissible errors and variations

B-1.1 When an instrument or an accessory is operated under reference conditions, it is permitted to have an error (the intrinsic error) no greater than is implied by its class index, for example, for a class 0,5 instrument, the errors are not permitted to exceed 0,5 % of the fiducial value.

B-1.2 However, when an instrument or an accessory is operated outside its reference conditions for a particular influence quantity (but under reference conditions for all the other influence quantities), it is permitted to have a change in its error, called a variation, when that influence quantity is changed up to the limit of its nominal range of use. The value of the permissible variation is expressed as a percentage (usually 100 %) of the permissible intrinsic error.

B-1.3 The same value of variation is permitted over the whole of the nominal range of use up to both of its limits, but the sign need not be the same.

B-1.4 For example, an instrument having a class index of 0,5 and a reference temperature of 40 °C, marked as 40 °C in accordance with **8.3.1**, is permitted to have an intrinsic error of ± 100 % of the class index, at the reference temperature and over the testing tolerance of ± 2 °C (see Table I-1) around 40 °C.

B-1.5 In addition, over the nominal range of use for temperature of 30 °C to 50 °C (40 °C ± 10 °C: see Table II-1), this instrument is permitted to have a variation of ± 100 % of the class index around the value of the error which it had at the reference temperature (40 °C). It is thus possible for the instrument to have a smaller error at some temperature within the nominal range of use than it had at the reference temperature.

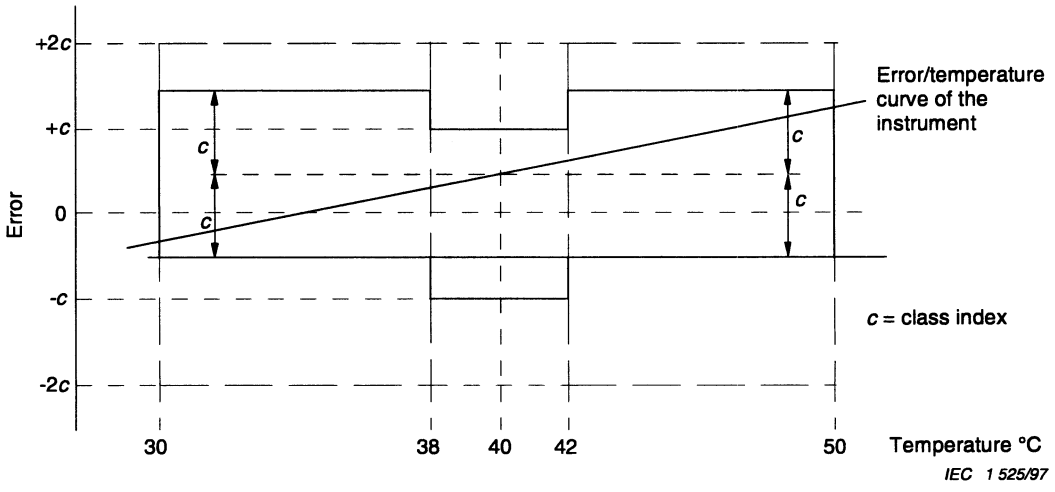


Figure 4-1 — Effect of temperature

Reference value: 40 °C.

Nominal range of use (Table II-1): 30 °C to 50 °C.

B-1.6 Figure 4-1 shows how the error of this instrument is permitted to alter with temperature, the class index being shown as *c*.

B-1.7 If the error at the reference temperature (the intrinsic error) had been at its maximum permitted value of +*c*, the total permitted error over the temperature ranges 30 °C to 38 °C and 42 °C to 50 °C would have been between zero and +*2c*. Similarly, if the intrinsic error had been –*c*, the total permitted error would have been from zero to –*2c*.

B-1.8 When the reference condition of a particular influence quantity is a reference range, over the parts of the nominal range of use which are outside the reference range, the permissible variation is centred on the value of the error at the adjacent limit of the reference range.

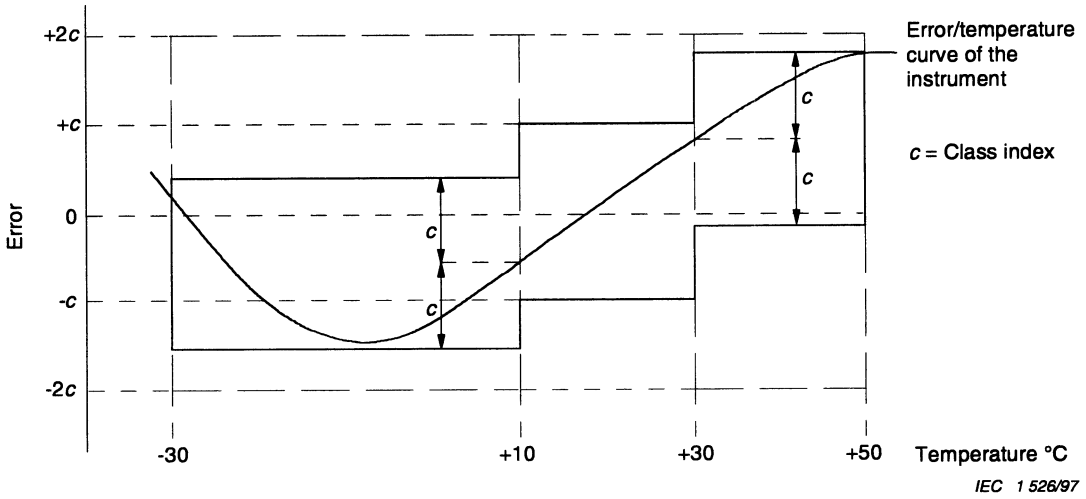


Figure 5-1 — Effect of temperature

Reference range: + 10 °C to + 30 °C (different from Table I-1).

Nominal range of use: – 30 °C to + 50 °C (different from Table II-1).

B-1.9 Figure 5-1 is an example of an instrument having a class index of 0,5 and marked – 30 ... + *10* ... + *30* ... + 50 °C in accordance with **8.3.3** (reference range for temperature + 10 °C to + 30 °C; nominal range of use for temperature – 30 °C to + 50 °C) is permitted to have an intrinsic error of ± 100 % of the class index over the temperature range + 10 °C to + 30 °C.

B-1.10 In addition, over the nominal range of use of – 30 °C to + 10 °C, a variation is permitted of ± 100 % of the class index centred on the error which the instrument had at + 10 °C. Similarly, a variation of ± 100 % of the class index, centred on the error which the instrument had at + 30 °C is permitted over the nominal range use from + 30 °C to + 50 °C.

B-1.11 If, as is likely in practice, more than one influence quantity is simultaneously outside its reference condition, the resultant error is unlikely to exceed the sum of the separate variations and may be smaller than any of them, as the resulting errors may to some extent cancel each other.

B-1.12 Information about the simultaneous effect of several influence quantities can usually only be determined by carrying out tests for particular combinations of values of influence quantities. The manufacturer may sometimes be able to provide this information.

Annex ZA (normative)
Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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 60027	series	*Letter symbols to be used in electrical technology*	HD 245	series
IEC 60050(301)	1983	*International Electrotechnical Vocabulary (IEV)* Chapter 301: *General terms on measurements in electricity*	—	—
IEC 60050(302)	1983	Chapter 302: *Electrical measuring instruments*	—	—
IEC 60050(303)	1983	Chapter 303: *Electronic measuring instruments*	—	—
IEC 60051-9	1988	*Direct acting indicating analogue electrical-measuring instruments and their accessories* Part 9: *Recommended test methods*	EN 60051-9	1989
IEC 60068-2-6 + corr. March	1995 1995	*Environmental testing* Part 2: *Tests — Test Fc: Vibration (sinusoidal)*	EN 60068-2-6	1995
IEC 60068-2-27	1987	Part 2: *Tests — Test Ea and guidance: Shock*	EN 60068-2-27	1993
IEC 60417	1973	*Graphical symbols for use on equipment Index, survey and compilation of the single sheets*	HD 243 S12[a]	1995
IEC 60473	1974	*Dimensions for panel-mounted indicating and recording electrical measuring instruments*	—	—
IEC 60617-2	1996	*Graphical symbols for diagrams* Part 2: *Symbol elements, qualifying symbols and other symbols having general application*	EN 60617-2	1996
IEC 61010-1 (mod)	1990	*Safety requirements for electrical equipment for measurement, control and laboratory use* Part 1: *General requirements*	EN 61010-1[b]	1993

[a] HD 243 S12 includes supplements A:1974 to M:1994 to IEC 60417.

[b] EN 61010-1 includes A1:1992 to IEC 61010-1.

BS EN 60051-1:1999 IEC 60051-1:1997

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