IEC 60051-2

Edition 5.0 2018-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Direct acting indicating analogue electrical measuring instruments and their accessories –
Part 2: Special requirements for ammeters and voltmeters

Appareils mesureurs électriques indicateurs analogiques à action directe et leurs accessoires –
Partie 2: Exigences particulières pour les ampèremètres et les voltmètres

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

DIRECT ACTING INDICATING ANALOGUE ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES –

Part 2: Special requirements for ammeters and voltmeters

FOREWORD

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International Standard IEC 60051-2 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

This fifth edition cancels and replaces the fourth edition published in 1984. This edition constitutes a technical revision.

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

a) updating of content in line with new editions of IEC 60051-1 and IEC 60051-9;
b) addition of Annex A to specify the nonconformity classification of test items.

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The text of this International Standard is based on the following documents:

CDV	Report on voting
85/555/CDV	85/578A/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

This International Standard is to be used in conjunction with IEC 60051-1:2016.

A list of all parts in the IEC 60051 series, published under the general title *Direct acting indicating analogue electrical measuring instruments and their accessories*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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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 parts

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

IEC 60051-2 is not complete in itself and is read in conjunction with IEC 60051-1.

All of these parts are arranged in the same format and a standard relationship between subject and clause number is maintained throughout these parts. This arrangement will assist the reader of IEC 60051 to distinguish information relating to the different types of instruments.

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DIRECT ACTING INDICATING ANALOGUE ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES –

Part 2: Special requirements for ammeters and voltmeters

1 Scope

This part of IEC 60051 applies to direct acting indicating ammeters and voltmeters having an analogue display.

NOTE For multi-function instruments, see IEC 60051-7.

It also applies to:

- direct acting indicating ammeters and voltmeters whose scale marks do not correspond directly to their electrical input quantity, provided that the relationship between them is known;
- direct acting indicating ammeters and voltmeters and accessories having electronic devices in their measuring and/or auxiliary circuits.

This document does not apply to:

– special purpose instruments which are covered by their own IEC standards;
– special purpose devices which are covered by their own IEC standards when they are used as accessories.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60051-1:2016, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

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

IEC 61869-2, *Instrument transformers – Part 2: Additional requirements for current transformers*

3 Terms and definitions

See IEC 60051-1:2016.

4 Description, classification and compliance

See IEC 60051-1:2016.

5 Requirements

5.1 Reference conditions

See IEC 60051-1:2016.

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5.2 Limits of intrinsic uncertainty, fiducial value

5.2.1 Limits of intrinsic uncertainty

See IEC 60051-1:2016.

5.2.2 Correspondence between intrinsic uncertainty and accuracy class

See IEC 60051-1:2016.

5.2.3 Fiducial value

5.2.3.1 The fiducial value for an ammeter or a voltmeter corresponds to the following.

5.2.3.2 The upper limit of the measuring range for the following:

- instruments with the mechanical and/or electrical zero at one end of the scale;
- instruments with the mechanical zero outside the scale irrespective of the position of the electrical zero;
- instruments with the electrical zero outside the scale irrespective of the position of the mechanical zero.

The class index is marked using Symbol E-1 given in Table 6 of IEC 60051-1:2016 (see Clause 6 of IEC 60051-1:2016).

5.2.3.3 The sum of the electrical values:

The sum of the absolute values of the upper and lower limit of the measuring range when both the mechanical and the electrical zeros are displaced within the scale.

The class index is marked using Symbol E-1 given in Table 6 of IEC 60051-1:2016 (see Clause 6 of IEC 60051-1:2016).

5.2.3.4 The span for an instrument:

The span for an instrument whose scale marks do not correspond directly to its electrical input quantity.

The class index is marked using Symbol E-4 given in Table 6 of IEC 60051-1:2016 (see Clause 6 of IEC 60051-1:2016).

Subclause 5.2.3.4 does not apply to a voltmeter or ammeter designed to be used in conjunction with a shunt, a series resistor (impedance) or an instrument transformer. These instruments are to be treated in accordance with 5.2.3.2 or 5.2.3.3, as appropriate.

5.2.3.5 The fiducial value for an ammeter with overload scale or an expanded scale voltmeter:

The fiducial value for an ammeter with overload scale or an expanded scale voltmeter corresponds to 5.2.3.2 or 5.2.3.3, as appropriate. The measuring range of an ammeter with overload scale is the upper limit of the non-overload part. The measuring range of an expanded scale voltmeter is the lower limit of the expanded part.

5.2.3.6 The fiducial value for an instrument with a special arrangement of scale marks:

For an instrument whose scale has been arranged to produce a special arrangement of scale marks, the fiducial value shall be as agreed between manufacturer and user. The fiducial value does not have to be the same at all points on the scale.

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5.3 Nominal range of use and variations

5.3.1 Nominal range of use

See Table 1.

Table 1 – Limits of the nominal range of use and permissible variations in addition to those given in Table 3 of IEC 60051-1:2016

Influence quantity		Limits of nominal range of use unless otherwise marked	Permissible variation expressed as a percentage of class index	
Ripple (45 Hz to 65 Hz and 90 Hz to 130 Hz) on DC measured quantity for other than RMS responding instruments[a]		20 %	50 %	
Distortion of AC measured quantity for other than rectifier instruments[b]	Distortion factor	Instruments without electronic devices in their measuring circuits: 20 %	100 %	
	Peak factor	Instruments having electronic devices in their measuring circuits: 1 to 3 [c]	100 %	
Frequency of AC measured quantity		Reference frequency ± 10 % or lower limit of reference range for frequency - 10 % and upper limit of reference range for frequency + 10 %	100 %	
Magnetic field of external origin	0,4 kA/m		Class indices 0,3 and smaller	Class indices 0,5 and greater
		Moving magnet, moving iron and electrodynamic instruments if not astatic and/or not having a magnetic screen	3 % of the fiducial value[d]	6 % of the fiducial value[d]
		Ferrodynamic instruments if not astatic and/or not having a magnetic screen	1,5 % of the fiducial value[d]	3 % of the fiducial value[d]
		All other instruments	0,75 % of the fiducial value[d]	1,5 % of the fiducial value[d]

[a] For an RMS-responding instrument which also responds to DC, no permissible variation can be stated because the ripple is then part of the measured quantity.

[b] For AC quantities, the requirements for instruments relate to RMS values irrespective of the principle of operation of the instrument. However, instruments incorporating rectifier(s) (except r.m.s.-responding instruments) usually respond to the rectified (mean) value of the waveform but are scaled to indicate theRMS value of a sinusoidal waveform .If the waveform is not sinusoidal, the indicated value may be seriously in uncertainty. However, if the waveform can be adequately characterized, this uncertainty is calculable.

Requirements for the influence of a distorted waveform on rectified (mean) and peak-sensing instruments are therefore not specified.

[c] The permissible variation due to a peak factor of other than $\sqrt{2}$ (corresponding to a sine wave) is included in the permissible variation due to distortion of the measured quantity.

For instruments having a peak factor capability greater than 3, the manufacturer shall state:

1) the instrument peak factor capability producing a variation of 100 % of the class index;
2) the upper and lower limits of the frequency response (bandwidth) to 0,707 times the indication at the reference frequency;
3) the effective maximum rate of change of internal instrument AC amplifier response (slew rate), expressed in volts per second using appropriate SI prefixes.

Peak factor relates to the total peak factor capability of the instrument and includes both the peak factor due to a distorted waveform and the peak factor due to spurious impulses (which may be random or harmonically related to the fundamental frequency) containing negligible average power.

[d] Not as a percentage of the class index.

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5.3.2 Limits of variations

See IEC 60051-1:2016.

5.3.3 Conditions for the determination of variations

See IEC 60051-1:2016.

5.4 Operating uncertainty, overall system uncertainty and variations

See IEC 60051-1:2016.

5.5 Electrical requirements

5.5.1 Electrical safety requirements

See IEC 60051-1:2016.

For a fixed ammeter having the upper limit of its measuring range of 1 A to 10 A and intended for use with a current transformer having a high over-current capability (Class P protective current transformers as specified in IEC 61869-2), the measuring circuit shall not open when the ammeter is subjected to 30 times the nominal secondary current of the associated current transformer for a period of 2 s.

A portable ammeter intended for similar use shall withstand 15 times the upper limit of its measuring range for a period of 2 s.

These ammeters need not be functional after application of this overload but shall not then be open-circuit.

For the recommended test, see IEC 60051-9.

5.5.2 Self-heating

See IEC 60051-1:2016.

5.5.3 Permissible overloads

5.5.3.1 Continuous overload

Ammeters and voltmeters, together with their non-interchangeable accessory(ies), if any, except for instruments fitted with a non-locking switch, shall be subjected to a continuous overload of 120 % of the upper limit of the electrical input quantity for a period of 2 h. The upper limit of the electrical input quantity of an ammeter with overload scale is the upper limit of the non-overload part. The upper limit of the electrical input quantity of an expanded scale voltmeter is the upper limit of the expanded part.

After removal of the excitation, the sum of the temporary and any permanent residual deflections shall not exceed 1 % of the scale length.

After having cooled to the reference temperature, the instrument, together with its non-interchangeable accessory(ies), if any, shall comply with its accuracy requirements; however the overload shall not be repeated.

The continuous overload test shall be carried out under reference conditions.

For the recommended test, see IEC 60051-9.

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