

Direct acting indicating analogue electrical measuring instruments and their accessories —

Part 2: Specification for special requirements for ammeters and voltmeters

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The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the National Committees of the following countries.

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National foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee and is the English language version of EN 60051-2 “*Direct acting indicating analogue electrical measuring instruments and their accessories — Part 2: Special requirements for ammeters and voltmeters*”, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical to the English language version of IEC Publication 51-2 published by the International Electrotechnical Commission (IEC) as amended by the editorial corrections listed in the Technical text source on page 2.

For the purposes of this British Standard, any references to the IEC page numbers in the text should be ignored.

This Part of BS 89 together with Parts 1, 3, 4, 5, 6, 7, 8 and 9 of this Standard supersedes BS 89:1977, which is withdrawn.

BS 89 comprises the following parts which will be the English language version of the listed European Standards.

European Standard	Corresponding Part of BS 89
EN 60051-1	Part 1 <i>Specification for definitions and general requirements common to all parts</i>
EN 60051-2	Part 2 <i>Specification for special requirements for ammeters and voltmeters</i>
EN 60051-3	Part 3 <i>Specification for special requirements for wattmeters and varmeters</i>
EN 60051-4	Part 4 <i>Specification for special requirements for frequency meters</i>
EN 60051-5	Part 5 <i>Specification for special requirements for phase meters power factor meters and synchrosopes</i>
EN 60051-6	Part 6 <i>Specification for special requirements for ohmmeters (impedance meters) and conductance meters</i>
EN 60051-7	Part 7 <i>Specification for special requirements for multi-function instruments</i>
EN 60051-8	Part 8 <i>Specification for special requirements for accessories</i>
EN 60051-9	Part 9 <i>Recommended test methods</i>

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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 12, an inside back cover 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.

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Key words: Electrical measuring instruments; analogue indicating instruments; direct acting measuring instruments; accessories for electrical measuring instruments; ammeters; voltmeters

English version

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

(IEC 51-2:1984 edition 4)

Appareils mesureurs électriques indicateurs
analogiques à action directe et leurs accessoires
Deuxième partie: Prescriptions particulières
pour les ampèremètres et les voltmètres
(CEI 51-2:1984 édition 4)

Direkt wirkende anzeigende elektrische
Meßgeräte und ihr Zubehör Meßgeräte mit
Skalenanzeige Teil 2: Spezielle Anforderungen
für Strom- und Spannungs-Meßgeräte
(IEC 51-2:1984 Ausgabe 4)

This European Standard was ratified by CENELEC on 11 September 1989. CENELEC members are bound to comply with the requirements of the 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 CENELEC Central Secretariat or to any CENELEC member.

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

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxemburg, 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

Brief history

The text of IEC Publication 51-2 (4th edition — 1984) was submitted to the CENELEC members for unique acceptance.

Technical text

The text of the International Standard IEC 51-2 (4th edition — 1984) was approved by CENELEC on 11 September 1989 as a European Standard with the following editorial correction to the English version:

Table II-2, note 3, paragraph a: delete the words “instrument” and “capability”.

The following dates are applicable:

- latest date of announcement of the EN at national level (doa): 1990-03-01
- date of latest publication of a new harmonized standard (dop): 1990-09-01
- date of withdrawal of conflicting national standards (dow): 1990-09-01

Foreword

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

Preface

This standard has been prepared by IEC Technical Committee No. 85: Measuring Equipment for Basic Electrical Quantities (formerly Sub-Committee 13B: Electrical Measuring Instruments).

This fourth edition replaces the third edition of IEC Publication 51.

This standard constitutes Part 2.

The general layout for the revised Publication 51 is as follows:

- *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 Synchrosopes;*
- *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 Part 1.

All of these parts are arranged in the same format and a standard relationship between subject and clause number is maintained throughout. In addition, tables, figures and appendices add a suffix to the part number in order to differentiate the parts. This re-arrangement will assist the reader of IEC Publication 51 to distinguish information relating to the different types of instruments.

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

Six Months' Rule	Report on Voting
13B(CO)94	13B(CO)101

Further information can be found in the Report on Voting indicated in the table above.

The following IEC publication is quoted in this standard:

Publication No. 185 (1966): Current Transformers.

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1 Scope

1.1 Part 2 of the standard applies to direct acting indicating ammeters and voltmeters having an analogue display.

NOTE For multi-function instruments, see Part 7.

1.2 This part also applies to non-interchangeable accessories (as defined in Sub-clause **2.1.15.3** of Part 1) used with ammeters and voltmeters.

1.3 to 1.8 See Part 1.

2 Definitions

See Part 1.

3 Description, classification and compliance

3.1 Description

Ammeters and voltmeters shall be described according to their method of operation as given in Sub-clause **2.2** of Part 1.

3.2 Classification

Ammeters and voltmeters shall be classified in one of the accuracy classes denoted by the following class indices:

0.05, 0.1, 0.2, 0.3, 0.5, 1, 1.5, 2, 2.5, 3, 5.

3.3 Compliance with the requirements of this standard

See Part 1.

4 Reference conditions and intrinsic errors

4.1 Reference conditions

See Part 1.

4.2 Limits of intrinsic error; fiducial value

See Part 1.

4.2.1 Correspondence between intrinsic error and accuracy class

See Part 1.

4.2.2 Fiducial value

The fiducial value for an ammeter or a voltmeter corresponds to:

4.2.2.1 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 III-1 (see Part 1, Clause 8).

4.2.2.2 The sum of the electrical values, irrespective of sign, corresponding to the two limits 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 III-1 (see Part 1, Clause 8).

4.2.2.3 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-10 given in Table III-1 (see Part 1, Clause 8).

This sub-clause 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 Sub-clauses **4.2.2.1** or **4.2.2.2**, as appropriate.

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

5 Nominal range of use and variations

5.1 Nominal range of use

See Part 1 and Table II-2.

Limits of the nominal range of use and permissible variations additional to those given in Table II-1

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 Part 9, Sub-clause:
Ripple (45 Hz to 65 Hz and 90 Hz to 130 Hz) on d.c. measured quantity for other than r.m.s. responding instruments ¹⁾		20 %	50 %			3.6
Distortion of a.c. measured quantity for other than rectifier instruments ²⁾	Distortion factor	Instruments without electronic devices in their measuring circuits; 20 %	100 %			3.7.1
	Peak factor	Instruments having electronic devices in their measuring circuits: 1 to 3 ³⁾	100 %			Under consideration
Frequency of a.c. measured quantity		Reference frequency ± 10 % or lower limit of reference range for frequency $- 10$ % and upper limit of reference range for frequency $+ 10$ %	100 %			3.8.1
Magnetic field of external origin		0.4 kA/m		Class indices 0.3 and smaller	Class indices 0.5 and greater	3.5
			Moving magnet, moving iron and electrodynamic instruments if not astatic and/or not having a magnetic screen	3 % of the fiducial value ⁴⁾	6 % of the fiducial value ⁴⁾	
			Ferrodynamic instruments if not astatic and/or not having a magnetic screen	1.5 % of the fiducial value ⁴⁾	3 % of the fiducial value ⁴⁾	
			All other instruments	0.75 % of the fiducial value ⁴⁾	1.5 % of the fiducial value ⁴⁾	
<i>See notes, page 8.</i>						

Notes for Table II-2

1) For an r.m.s.-responding instrument which also responds to d.c., no permissible variation can be stated because the ripple is then part of the measured quantity.

2) For a.c. quantities, the requirements for instruments relate to r.m.s. 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 the r.m.s. value of a sinusoidal waveform. If the waveform is not sinusoidal, the indicated value may be seriously in error. However, if the waveform can be adequately characterized, this error is calculable.

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

3) 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:

- a) the instrument peak factor capability producing a variation of 100 % of the class index.
- b) the upper and lower limits of the frequency response (bandwidth) to 0.707 times the indication at the reference frequency;
- c) the effective maximum rate of change of internal instrument a.c. amplifier response (slew rate), expressed in volts per second using appropriate S.I. 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.

4) Not as a percentage of the class index.

5.2 Limits of variations

See Part 1 and Table II-2.

5.3 Conditions for the determination of variations

See Part 1.

6 Further electrical and mechanical requirements

6.1 Voltage tests, insulation tests and other safety requirements

See Part 1.

6.1.1 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 transformers as specified in IEC Publication 185: Current Transformers), the measuring circuit shall not open when the ammeter is subjected to 30 times the nominal secondary current¹⁾ 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 Part 9, Sub-clause 4.8.

6.2 Damping

See Part 1.

6.2.1 Overshoot

See Part 1.

6.2.2 Response time

See Part 1.

However, the requirements of Sub-clauses 6.2.1 and 6.2.2 of Part 1 do not apply to the following types of ammeters and voltmeters:

- thermal instruments;
- electrostatic instruments;
- instruments having a freely suspended moving element;
- instruments having a material pointer longer than 150 mm;
- instruments in which the current or voltage corresponding to the upper limit of the measuring range is less than 200 μ A or 20 mV;
- special-purpose instruments where other response times may be required. Such instruments will be the subject of agreement between manufacturer and user.

¹⁾ IEC Publication 185 uses the term “rated current” for this concept.

6.2.3 Impedance of the external measuring circuit

See Part 1.

However, if the impedance of the external measuring circuit is not stated, it shall be assumed to be, at the reference frequency:

- more than 50 times the impedance of the instrument for ammeters, milliammeters and microammeters;
- less than 1/50 of the impedance of the instrument for voltmeters and millivoltmeters.

6.3 Self-heating

See Part 1.

6.4 Permissible overloads

6.4.1 Continuous overload

For the recommended test, see Part 9, Sub-clause 4.6.

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.

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.

6.4.2 Overloads of short duration

For the recommended test, see Part 9, Sub-clause 4.4.

Ammeters and voltmeters, together with their non-interchangeable accessory(ies), if any, shall be subjected to overloads of short duration.

However, these requirements do not apply to:

- thermocouple instruments;
- electrostatic instruments;
- instruments having a freely suspended moving element;

unless these instruments are internally protected against overloads of short duration.

6.4.2.1 The values of current and voltage for the overloads of short duration shall be the product of the relevant factor given in Table IV-2 and the value of the upper limit of the electrical input quantity unless other values are stated by the manufacturer.

6.4.2.2 The full duration of each overload shall be applied except when an automatic cut-out (fuse) fitted to the instrument has interrupted the circuit in less than the time specified in Table IV-2.

The automatic cut-out shall be reset (or the fuse replaced) before the application of the next overload.

Table IV-2 — Overloads of short duration

Instrument	Current factor	Voltage factor	Number of overloads	Duration of each overload (in seconds)	Interval between successive overloads (in seconds)
Instruments of class indices 0.5 and smaller and rectifier instruments of all class indices					
Ammeters	2	—	5	0.5	15
Voltmeters	—	2	5	0.5	15
Instruments of class indices 1 and greater					
Ammeters	10	—	9	0.5	60
	10	—	1	5	—
Voltmeters	—	2	9	0.5	60
	—	2	1	5	—

NOTE Where two series of tests are specified, they should both be carried out, in the order given.

6.4.2.3 After having been subjected to the overloads of short duration and after having cooled to the reference temperature, ammeters and voltmeters whose mechanical zero is within the scale, together with their non-interchangeable accessory(ies), if any, shall comply with both of the following requirements:

- 1) the deviation of the index from the zero scale mark, expressed as a percentage of the scale length, shall not exceed the following value:
 - a) 0.5 for instruments of class indices 0.3 and smaller,
 - b) the class index for instruments of class indices 0.5 and greater;
- 2) the ammeter or voltmeter together with its non-interchangeable accessory(ies), if any, after adjustment of the zero (if necessary) shall comply with the accuracy requirements; however, the overloads shall not be repeated.

An ammeter or voltmeter whose mechanical zero is outside the scale is considered to have complied with this requirement if, after having cooled to the reference temperature, it has errors not exceeding those relating to its class index; however, the overloads shall not be repeated.

6.5 Limiting values of temperature

See Part 1.

6.6 Deviation from zero

For the recommended test, see Part 9, Sub-clause 4.9.

6.6.1 If an ammeter or a voltmeter has a zero position marked on the scale, it shall be tested for return to zero when de-energized. The test shall be carried out under reference conditions.

6.6.2 After a period of energization of 30 s at the upper limit of the measuring range, the deviation of the index from the zero scale mark, expressed as a percentage of the scale length, shall not exceed a value corresponding to 50 % of the class index.

7 Constructional requirements

7.1 and 7.2 See Part 1.

7.3 Preferred values

7.3.1 The upper limit of the measuring range for ammeters and voltmeters shall preferably be one of the following values:

1, 1.2, 1.5, 2, 2.5, 3, 4, 5, 6, 7.5, 8

or their decimal multiples and sub-multiples.

For multi-range instruments, at least one of the ranges shall preferably comply with this requirement.

7.3.2 The voltage drop at the upper limit of the measuring range for an ammeter intended for use with an external shunt shall preferably be one of the following values:

50 mV, 60 mV, 75 mV, 100 mV, 300 mV.

7.3.3 If, to achieve the correct performance of an instrument, it is necessary to use calibrated instrument leads (i.e. leads having a specified value of resistance) to connect it to a shunt, the manufacturer shall state the value of the lead resistance.

Unless otherwise stated by the manufacturer, the value of the total resistance of the calibrated instrument leads shall not exceed 70 mΩ at the reference temperature.

The value of the lead resistance shall not differ from the stated value by more than 10 % at the reference temperature.

7.4 Adjuster(s), mechanical and/or electrical

See Part 1.

7.5 Effects of vibration and shock

See Part 1.

8 Information, general markings and symbols

See Part 1.

9 Markings and symbols for terminals

9.1 to 9.3 See Part 1.

9.4 Special markings for terminals

All terminals shall be marked so that they can be uniquely identified.

9.4.1 *Single range d.c. ammeters and voltmeters*

The positive terminal shall be marked using Symbol F-46 (+) given in Table III-1.

9.4.2 *Multi-range d.c. ammeters and voltmeters*

The range-selecting terminals shall be marked with the value corresponding to the upper limit of the relevant measuring range. If those terminals are positive terminals, they shall also be marked using Symbol F-46 (+) given in Table III-1. This marking shall follow the marking for the value of the range. If the common terminal is the positive terminal, it shall be marked using Symbol F-46 (+) given in Table III-1.

9.4.3 *Single range a.c. ammeters and voltmeters*

In the absence of special requirements, no markings are needed.

9.4.4 *Multi-range a.c. ammeters and voltmeters*

The range-selecting terminals shall be marked with the value corresponding to the upper limit of the measuring range.

10 Tests to prove compliance with this standard

See Part 1.

National appendix W

The United Kingdom participation in the preparation of this European Standard was entrusted by the Power Electrical Engineering Standards Policy Committee (PEL/-) to Technical Committee PEL/3 upon which the following bodies were represented:

Association of Consulting Engineers
Association of Supervisory and Executive Engineers
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Department of Trade and Industry (National Physical Laboratory)
Department of Trade and Industry (National Measurement Accreditation Service)
Electrical Power Engineers' Association
Electricity Supply Industry in England and Wales
Engineering Teaching Equipment Manufacturers' Association
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1984

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