

Direct acting indicating analogue electrical measuring instruments and their accessories —

Part 2: Specification for special requirements for ammeters and voltmeters

This European Standard EN 60051-2 has the status of a
British Standard

UDC: 621.317.725.037.33

Cooperating organizations

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

Austria	Italy
Belgium	Luxemburg
Denmark	Netherlands
Finland	Norway
France	Portugal
Germany	Spain
Greece	Sweden
Iceland	Switzerland
Ireland	United Kingdom

This British Standard was published under the authority of the Board of BSI and comes into effect on 31 August 1990

© BSI 01-2000

First published as
BS 89 October 1919
Second edition August 1926
Third edition September 1937
Fourth edition February 1954
Fifth edition March 1977
Published as BS 89-2
August 1990

The following BSI references relate to the work on this standard:
Committee reference PEL/13
Draft for comment 80/23262 DC

ISBN 0 580 18437 4

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
Cooperating organizations	Inside front cover
National foreword	ii
Brief history	2
Text of EN 60051-2	5
National appendix W	Inside back cover

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This Part of BS 89 together with Parts 1, 3, 4, 5, 6, 7, 8 and 9 of this Standard supersedes BS 89:1977, which is withdrawn.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

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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.

UDC: 621.317.725.037.33

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.

Contents

	Page
Brief history	2
Foreword	2
1 Scope	5
2 Definitions	5
3 Description, classification and compliance	5
4 Reference conditions and intrinsic errors	5
5 Nominal range of use and variations	6
6 Further electrical and mechanical requirements	8
7 Constructional requirements	10
8 Information, general markings and symbols	11
9 Markings and symbols for terminals	11
10 Tests to prove compliance with this standard	11
Table IV-2 — Overloads of short duration	10

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
Department of Energy (Electricity Division)
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
GAMBICA (BEAMA) Ltd.
General Electric Company Limited
Institution of Electrical Engineers

BS 89-2:
1990
EN 60051-2:
1989
IEC 51-2:
1984

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI.

This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

If permission is granted, the terms may include royalty payments or a licensing agreement. Details and advice can be obtained from the Copyright Manager. Tel: 020 8996 7070.

BSI
389 Chiswick High Road
London
W4 4AL
