

Direct acting indicating analogue electrical measuring instruments and their accessories —

Part 5: Specification for special requirements for phase meters, power factor meters and synchrosopes

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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.

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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 60051-5 “*Direct acting indicating analogue electrical measuring instruments and their accessories — Part 5: Special requirements for phase meters, power factor meters and synchrosopes*”, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with the English language version of IEC Publication 51-5 published by the International Electrotechnical Commission (IEC).

This Part of BS 89 together with Parts 1, 2, 3, 4, 6, 7, 8 and 9 of this standard supersedes BS 89:1977, which is withdrawn.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 10, 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; phase meters; power factor meters; synchronoscopes

English version

Direct acting indicating analogue electrical measuring
instruments and their accessories
Part 5: Special requirements for phase meters, power factor
meters and synchrosopes

(IEC 51-5 (1985) edition 4)

Appareils mesureurs électriques indicateurs
analogues à action directe et leurs accessoires
Cinquième partie: Prescriptions particulières
pour les phasemètres, les indicateurs de facteur
de puissance et les synchronoscopes
(CEI 51-5 (1985) édition 4)

Direkt wirkende anzeigende elektrische
Meßgeräte und ihr Zubehör Meßgeräte mit
skalenanzeige
Teil 5: Spezielle Anforderungen für
Phasenverschiebungswinkel-Meßgeräte,
Leistungsfaktor-Meßgeräte und
Synchronoskope
(IEC 51-5 (1985) 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.

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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 51-5 (4th edition – 1985) was submitted to the CENELEC members for unique acceptance.

Technical text

The text of the International Standard IEC 51-5 (4th edition – 1985) was approved by CENELEC on 11 September 1989 as a European Standard with the following editorial corrections:

- Page 6, Table II-5, column 4, for “distortion of voltage and/or current components of the measured quantity”: replace 3.7.3 by 3.7.4.
- Page 7, note 2 – c): replace “S.I.” by “SI”.

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

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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 (former Sub-Committee 13B: Electrical Measuring Instruments).

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

This standard constitutes Part 5.

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	Two Months' Procedure	Report on Voting
13B(CO)88	13B(CO)97	13B(CO)103	85(CO)1

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

1 Scope

1.1 Part 5 of this standard applies to direct acting indicating analogue phase meters, power factor meters and synchrosopes.

1.2 This part also applies to non-interchangeable accessories (as defined in Sub-clause **2.1.15.3** of Part 1) used with phase meters, power factor meters and synchrosopes.

1.3 This part also applies to a phase meter or power factor meter whose scale marks do not correspond directly to its electrical input quantity, provided that the relationship between them is known.

1.4 to 1.8 See Part 1.

2 Definitions

See Part 1.

3 Description, classification and compliance

3.1 Description

Phase meters, power factor meters and synchrosopes shall be described according to their method of operation as given in Sub-clause 2.2 of Part 1.

3.2 Classification

Phase meters, power factor meters and synchrosopes shall be classified in one of the accuracy classes denoted by the following class indices:

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

4.1.1 The reference values of the influence quantities shall be as given in Table I-1 and Table I-5.

Table I-5 — Reference conditions and tolerances, additional to those given in Table I-1, for testing purposes

Influence quantity	Reference conditions unless otherwise marked		Tolerance permitted for testing purposes, applicable for a single reference value ^a
Voltage component of the measured quantity	Rated voltage or any voltage within the reference range, if any		± 2 % of the rated value
Current component of the measured quantity	40 % ... 100 % of rated current		—
Phase balance (for polyphase instruments)	Symmetrical voltages and currents		^b
Frequency of current and voltage components of the measured quantity	Instruments using phase shifting devices	Reference frequency	± 0.1 % of the reference frequency
	Other instruments	45 Hz to 65 Hz	± 2 % of the reference frequency

^a This tolerance applies when a single reference value is specified in this table or is marked by the manufacturer. For a reference range, no tolerance is allowed.

^b Each of the voltages (between any two lines or between line and neutral) should not differ by more than 1 % from the average of the voltages (line-to-line or line-to-neutral) of the system.

Each of the currents in the phases should not differ by more than 1 % from the average of the currents.

The angles between each of the currents and the corresponding phase-to-neutral voltages should not differ by more than 2° from the average of the angles.

4.1.2 See Part 1.

4.1.3 Reference conditions different from those given in Table I-1 and Table I-5 may be specified, but they shall then be marked in accordance with Clause 8 of Part 1.

4.2 Limits of intrinsic error, fiducial value

See Part 1.

For a synchroscope, the accuracy requirements apply only at the synchronizing mark.

4.2.1 Correspondence between intrinsic error and accuracy class

See Part 1.

4.2.2 Fiducial value

The fiducial value corresponds to 90 electrical degrees.

The class index is marked using Symbol E-1 given in Table III-1 of Part 1 (see Part 1, Clause 8).

5 Nominal range of use and variations

5.1 Nominal range of use

See Part 1 and Table II-5.

5.2 Limits of variations

See Part 1 and Table II-5.

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.

6.2 Damping

The requirements of Part 1 do not apply to phase meters, power factor meters and synchrosopes.

6.3 Self-heating

See Part 1.

However, the requirements of Part 1 do not apply to synchrosopes.

6.4 Permissible overloads

6.4.1 *Continuous overload*

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

All phase meters and power factor meters, 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 rated value for all current circuits simultaneously for a period of 2 h.

After having cooled to the reference temperature, the instrument together with its non-inter-changeable accessory(ies), if any, shall comply with its accuracy requirements but without repeating the overload.

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

The requirement for continuous overload does not apply to synchrosopes.

6.4.2 *Overloads of short duration*

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

All phase meters, power factor meters and synchrosopes, together with their non-interchangeable accessory(ies), if any, shall be subjected to overloads of short duration.

However, these requirements do not apply to instruments whose scale marks do not correspond directly to their electrical input quantities [but not excluding instruments intended to be used with (an) instrument transformer(s)].

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-5 and the rated value of voltage or the upper limit of the nominal range of use for current unless other values are stated by the manufacturer.

The overloads shall be applied separately to each input circuit.

Table II-5 — 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 test, see Part 9, Sub-clause:
Distortion of voltage and/or current components of the measured quantity	Distortion factor	5 %		100 %	3.7.3
	Peak factor ^a	1 ... 3 ^b		Under consideration	
Current component of the measured quantity		20 %... 120 % of rated current		100 %	Under consideration
Frequency of current and voltage components of the measured quantity		Instruments using phase shifting devices	Reference frequency ± 1 % or lower limit of reference range – 1 % and upper limit of reference range + 1 %	100 %	3.8.2 3.8.3 3.8.4
		Other instruments	Reference frequency ± 10 % or lower limit of reference range – 10 % and upper limit of reference range + 10 %		

Table II-5 — 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 test, see Part 9, Sub-clause:
Magnetic field of external origin	0.4 kA/m		Class indices 0.3 and smaller	Class indices 0.5 and greater	3.5
		Electrodynamic instruments if not astatic and/or not having a magnetic screen	3 % of the fiducial value ^c	6 % of the fiducial value ^c	
		Ferrodynamic instruments if not astatic and/or having a magnetic screen	1.5 % of the fiducial value ^c	3 % of the fiducial value ^c	
		All other instruments	0.75 % of the fiducial value ^c	1.5 % of the fiducial value ^c	
Voltage component of the measured quantity	Rated voltage ± 15 % or lower limit of reference range – 15 % and upper limit of reference range + 15 %	100			3.9.3 3.9.4 3.9.5
Phase balance (for polyphase instruments)	Disconnection of one current component of the measured quantity	200			3.12.2

^a For instruments having electronic devices in their measuring circuits.

^b The permissible variation due to a peak factor of other than $\sqrt{2}$ (corresponding to 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 peak factor 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.

^c Not as a percentage of the class index.

Table IV-5 — Overloads of short duration

Measuring circuit	Overload factor	Number of overloads	Duration of each overload (in seconds)	Interval between successive overloads (in seconds)
Class indices 0.5 and smaller				
Current circuit	2	5	1	15
Voltage circuit	2			
Class indices 1 and greater				
Current circuit	10	9	0.5	60
Voltage circuit	2			
Current circuit	10	1	5	—
Voltage circuit	2			
NOTE Where two series of tests are specified, they should both be carried out, in the order given.				

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-5.

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

6.4.2.3 After having been subjected to the overloads of short duration and after having cooled to the reference temperature, phase meters, power factor meters and synchrosopes, together with their non-interchangeable accessory(ies), if any, shall comply with their accuracy requirements; 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 a phase meter or a power factor meter has a setting mark (zero position mark) on the scale, it shall be tested for return to that mark 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 setting mark (zero position mark), expressed as a percentage of the scale length, shall not exceed a value corresponding to 50 % of the class index.

6.6.3 This requirement does not apply to synchrosopes.

6.7 Special requirements for synchrosopes

6.7.1 Synchrosopes shall have two separate input circuits, with no conductive connection between them.

6.7.2 For polyphase synchrosopes, the index shall be rotating in the correct direction when the difference between the frequencies applied to the two input circuits has been reduced to 1.5 Hz, one of the frequencies being the reference frequency or any frequency within the reference range for frequency (if any).

For single phase synchrosopes, the value of 1.5 Hz is changed to 1 Hz.

6.7.3 For polyphase synchrosopes, for any constant frequency difference not exceeding 1.5 Hz, the rate of rotation of the index shall be substantially uniform as judged visually.

For single phase synchrosopes, the value of 1.5 Hz is changed to 1 Hz.

6.7.4 Under reference conditions, but with one or both circuits disconnected, the index shall not indicate, at any time, within an angle of 30° on either side of the synchronizing mark. This requirement also applies if the disconnected circuit(s) remain connected to the secondary of the instrument transformer(s) with which it (they) is (are) normally associated, the disconnection being achieved on the primary of the transformer(s).

7 Constructional requirements

7.1 and 7.2 See Part 1.

7.3 Preferred values

The rated values for phase meters, power factor meters and synchrosopes shall be the subject of agreement between the manufacturer and the user.

7.4 Adjusters, mechanical and/or electrical

See Part 1.

7.4.1 *Zero adjuster(s)*

7.4.1.1 Phase meters and power factor meters having a mechanical zero position on the scale shall have a setting mark (zero position mark) at that position.

7.4.1.2 Phase meters and power factor meters not having a determinate mechanical zero or having a mechanical zero which is outside the scale shall not be provided with an accessible zero adjuster.

7.4.1.3 This requirement does not apply to synchrosopes.

7.5 Effects of vibration and Shock

See Part 1.

8 Information, general markings and symbols

8.1 Information

See Part 1.

8.1.1 If an instrument is provided with a phase shifting device, this shall be stated as required by Items *m)* and *z)* of Sub-clause 8.1 in Part 1.

8.2 and 8.3 See Part 1.

9 Markings and symbols for terminals

See Part 1.

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/13 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
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