BRITISH STANDARD

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50470-2:2006

Electricity metering equipment (a.c.) —

Part 2: Particular requirements — Electromechanical meters for active energy (class indexes A and B)

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National foreword

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Part 2: Particular requirements - Electromechanical meters for active energy (class indexes A and B)

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Partie 2: Prescriptions particulières - Compteurs électromécaniques d'énergie active
(classes de précision A et B)

Wechselstrom-Elektrizitätszähler
Teil 2: Besondere Anforderungen - Elektromechanische Wirkverbrauchszähler der Genauigkeitsklassen A und B

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 13, Equipment for electrical energy measurement and load control.

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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)	2007-05-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2009-05-01

This EN 50470-2 is related to EN 62053-11:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2)*.

The structure of the two standards is similar, modifications in this European Standard are provided in the perspective of compliance with the Essential Requirements of the Directive 2004/22/EC on Measuring Instruments (MID).

This standard is to be used with EN 50470-1:2006, *Electricity metering equipment (a.c.) – Part 1: General requirements, tests and test conditions – Metering equipment (class indexes A, B and C).*

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive 2004/22/EC. See Annex ZZ.

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1 Scope

This European Standard applies to newly manufactured electromechanical watt-hour meters intended for residential, commercial and light industrial use, of class indexes A and B, for the measurement of alternating current electrical active energy in 50 Hz networks. It specifies particular requirements and type test methods.

It applies to electromechanical watt-hour meters for indoor and outdoor application, consisting of a measuring element and register(s) enclosed together in a meter case. It also applies to operation indicator(s) and test output(s).

If the meter has (a) measuring element(s) for more than one type of energy (multi-energy meters), or when other functional elements, like maximum demand indicators, electronic tariff registers, time switches, ripple control receivers, data communication interfaces etc. are enclosed in the meter case (multi-function meters) then this standard applies only for the active energy metering part.

This standard distinguishes between:

– meters of class indexes A and B;
– direct connected and transformer operated meters;
– meters for use in networks equipped with or without earth fault neutralizers.

It does not apply to:

– watt-hour meters where the voltage across the connection terminals exceeds 600 V (line-to-line voltage for meters for polyphase systems);
– portable meters.

Methods for acceptance testing are covered by the IEC 62058 series of standards [1)].

The dependability aspect is covered by the documents of the IEC 62059 series.

2 Normative references

The following referenced documents are indispensable for the application 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.

Publication	Year	Title
EN 50470-1	2006	*Electricity metering equipment (a.c.) – Part 1: General requirements, tests and test conditions – Metering equipment (class indexes A, B and C)*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in EN 50470-1 apply.

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1) At draft stage.

4 Standard electrical values

The values given in EN 50470-1 apply.

5 Mechanical requirements

In addition to the mechanical requirements in EN 50470-1, electromechanical meters shall fulfil the following requirements.

5.1 General

The case of an electromechanical watt-hour meter shall be so constructed that, if mounted according to the manufacturer's instructions, the meter shall not deviate by more than 0,5° in all directions from its vertical position (see also Footnote c of Table 12).

5.2 Register (counting mechanism)

The register may be of the drum or the pointer type.

In drum-type registers, the principal unit in which the register records shall be marked adjacent to the set of drums.

In this type of register, only the last drum, i.e. the drum on the extreme right, may be continuously movable.

In pointer-type registers, the unit in which the register records shall be marked adjacent to the units dial in the form: 1 kWh/div, or 1 MWh/div, and the decimal multiples may be marked adjacent to the other dials. For example, in a meter registering in terms of kilowatt-hours, the units dial shall be marked: 1 kWh/div and, adjacent to the other dials to the left of the units dial, shall be marked: 10 - 100 - 1 000, etc.

5.3 Direction of rotation and marking of the rotor

The edge of the rotor nearest to an observer viewing a meter from the front shall move from left to right for positive registration. The direction of rotation shall be marked by a clearly visible arrow.

The edge and/or upper surface of the disk shall carry an easily visible mark to facilitate revolution counting. Other marks may be added for stroboscopic or other tests, but such marks shall be so placed as not to interfere with the use of the main visible mark for photoelectric revolution counting.

6 Climatic conditions

The conditions given in EN 50470-1 apply.

7 Electrical requirements

In addition to the electrical requirements in EN 50470-1, meters shall fulfil the following requirements.

7.1 Power consumption

7.1.1 Measuring method

The power consumption in the voltage and current circuits shall be determined at reference conditions given in 8.7.1 by any suitable method. The overall maximum error of the measurement of the power consumption shall not exceed 5 %.

7.1.2 Voltage circuits

The active and apparent power loss in each voltage circuit of a meter at reference voltage, reference temperature and reference frequency shall not exceed the values shown in Table 1.

Table 1 – Power consumption in voltage circuits

Meters (single- and polyphase)	Class index	
	A	B
Power consumption in voltage circuit	2 W and 10 VA	3 W and 12 VA
NOTE In order to match voltage transformers to meters, the meter manufacturer should state the power factor of the burden (for transformer operated meters only).		

7.1.3 Current circuits

The apparent power taken by each current circuit of a meter at reference current, reference frequency and reference temperature shall not exceed the values shown in Table 2.

Table 2 – Power consumption in current circuits

Meters, (single- and polyphase)	Test current	Class index	
		A	B
Direct connected I_{ref} < 30 A	I_{ref} = 10 I_{tr}	2,5 VA	4,0 VA
Direct connected I_{ref} ≥ 30 A	I_{ref} = 10 I_{tr}	4,0 VA	6,0 VA
Transformer operated	I_n	2,5 VA	4,0 VA
NOTE In order to match current transformers to meters, the meter manufacturer should state the power factor of the burden (for transformer operated meters only).			

7.2 AC voltage test

The a.c. voltage test shall be carried out in accordance with Table 3.

The test voltage shall be substantially sinusoidal, having a frequency between 45 Hz and 65 Hz, and applied for 1 min. The power source shall be capable of supplying at least 500 VA.

For the tests relative to earth, the auxiliary circuits with reference voltage equal to or below 40 V shall be connected to earth.

During this test no flashover, disruptive discharge or puncture shall occur.

Table 3 – AC voltage tests

Test	Test voltage r.m.s.	Points of application of the test voltage
A	2 kV for tests in Items a), b), c), d) and 500 V for test in Item e)	*Tests which may be carried out with the cover and terminal cover removed:* – between, on the one hand, the *frame* and, – on the other hand: a) each current circuit which, in normal service, is separated and suitably insulated from the other circuits [a]; b) each voltage circuit, or set of voltage circuits having a common point which, in normal service, is separated and suitably insulated from the other circuits [a]; c) each auxiliary circuit or set of auxiliary circuits having a common point, and whose reference voltage is over 40 V; d) each assembly of current-voltage windings of one and the same driving element which, in normal service, are connected together but separated and suitably insulated from the other circuits [b]; e) each auxiliary circuit whose reference voltage is equal to or below 40 V.
B	600 V or twice the voltage applied to the voltage windings under reference conditions, when this voltage is greater than 300 V (the higher value).	*Tests which may be carried out with the terminal cover removed, but with the cover in place when it is made of metal:* between the current circuit and the voltage circuit of each driving element, normally connected together, this connection being temporarily broken for the purpose of the test [c].
C	2 kV	*Tests to be carried out with the case closed, the cover and terminal cover in place:* between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is over 40 V, connected together, and, on the other hand, earth.
D	4 kV for test in Item a) 2 kV for test in Item b) 40 V for test in Item c)	*Additional tests for insulating encased meters of protective class II:* a) between on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is over 40 V, connected together, and, on the other hand, earth; b) between the *frame* and earth; c) between, on the one hand, all conductive parts inside the meter case connected together and, on the other hand, all conductive parts, outside the meter case that are accessible with the test finger, connected together [d].

[a] The simple breaking of the connection, which is normally included between current and voltage windings is not generally sufficient to ensure suitable insulation, which can withstand a test voltage of 2 kV.

Tests in part A) Items a) and b) generally apply to meters operated from instrument transformers and also to certain special meters having separate current and voltage windings.

[b] Circuits, which have been subjected to tests in part A) Items a) and b) are not subjected to the test in Item d). When the voltage circuits of a polyphase meter have a common point in normal service, this common point shall be maintained for the test and, in this case, all the circuits of the driving elements are subjected to a single test.

[c] It is not, strictly speaking, a dielectric strength test, but a means of verifying that the insulation distances are sufficient when the connecting device is open.

[d] The test on part D item c) is not necessary, if the visual inspection for compliance with the conditions of EN50470-1 subclause 5.7 leaves no doubt.

8 Accuracy requirements and tests

8.1 Limits of percentage error due to variation of the load

When the meter is under reference conditions given in 8.7.1, and the current and the power factor are varied, the percentage errors shall not exceed the limits specified for the relevant class indexes in Table 4 and Table 5.

Table 4 – Percentage error limits at reference conditions (single-phase meters and polyphase meters with balanced loads)

Value of current for direct connected or transformer operated meters	Power factor	Percentage error limits for meters of class index	
		A	B
$I_{min} \le I < I_{tr}$	1	± 2,5	± 1,5
$I_{tr} \le I \le I_{max}$	0,5 ind…1…cap 0,8	± 2,0	± 1,0
NOTE For the relationships I_{min} / I_{tr} and I_{max} / I_{tr} see EN 50470-1, Table 3.			

Table 5 – Percentage error limits at reference conditions (polyphase meters carrying a single-phase load, but with balanced polyphase voltages applied to voltage circuits)

Value of current for direct connected or transformer operated meters	Power factor	Percentage error limits for meters of class index	
		A	B
$5\ I_{tr} \le I \le I_{max}$	0,5 ind…1	± 3,0	± 2,0
NOTE For the relationship I_{max} / I_{tr} see EN 50470-1, Table 3.			

The difference between the percentage error when the meter is carrying a single-phase load and a balanced polyphase load at I_{ref} and unity power factor shall not exceed 2,5 % and 1,5 % for meters of class indexes A and B respectively.

8.2 Repeatability

The application of the same measurand under the same conditions of measurement shall result in the close agreement of successive measurements. The repeatability at any test point given in Table 13 shall be better than $1/10^{th}$ of the limit of percentage error at reference conditions. The manufacturer shall state the necessary number of revolutions.

8.3 Limits of additional percentage error due to influence quantities

When the current and the power factor are held constant at a point within their respective specified measuring ranges, and any single influence quantity is taken from its reference value and varied within its specified operating range, with the meter otherwise operated at reference conditions as specified in 8.7.1, the additional percentage error shall not exceed the limits specified for the relevant class indexes given in Table 6 and Table 7.

Concerning additional percentage error due to temperature variation, the requirements for each sub-range within the full temperature range specified by the manufacturer apply.

NOTE For example, if the manufacturer specifies that the meter is intended for the temperature range -10 °C to +40 °C, then the requirements for the sub-ranges 5 °C to 30 °C, -10 °C to 5 °C and 30 °C to 40 °C apply.

Table 6 – Limits of additional percentage error due to influence quantities (single-phase meters and polyphase meters with balanced loads)

Influence quantity	Value of current for direct connected or transformer operated meters	Power factor	Limits of additional percentage error for meters of class index	
			A	B
Temperature variation				
5 °C to 30 °C	$I_{min} \le I \le I_{max}$	1	± 1,8	± 0,9
	$I_{tr} \le I \le I_{max}$	0,5 ind, 0,8 cap	± 2,7	± 1,3
-10 °C to 5 °C	$I_{min} \le I \le I_{max}$	1	± 3,3	± 1,6
30 °C to 40 °C	$I_{tr} \le I \le I_{max}$	0,5 ind, 0,8 cap	± 4,9	± 2,3
-25 °C to -10 °C	$I_{min} \le I \le I_{max}$	1	± 4,8	± 2,4
40 °C to 55 °C	$I_{tr} \le I \le I_{max}$	0,5 ind, 0,8 cap	± 7,2	± 3,4
-40 °C to -25 °C	$I_{min} \le I \le I_{max}$	1	± 6,3	± 3,1
55 °C to 70 °C	$I_{tr} \le I \le I_{max}$	0,5 ind, 0,8 cap	± 9,4	± 4,4
Voltage variation ± 10 %	$I_{min} \le I \le I_{max}$	1	± 1,0	± 0,7
	$I_{tr} \le I \le I_{max}$	0,5 ind, 0,8 cap	± 1,5	± 1,0
Frequency variation ± 2 %	$I_{min} \le I \le I_{max}$	1	± 0,8	± 0,5
	$I_{tr} \le I \le I_{max}$	0,5 ind, 0,8 cap	± 1,0	± 0,7
NOTE For the relationships I_{min} / I_{tr} and I_{max} / I_{tr} see EN 50470-1, Table 3.				

Table 7 – Limits of additional percentage error due to influence quantities (polyphase meters carrying a single phase load, but with balanced polyphase voltages applied to voltage circuits)

Influence quantity	Value of current for direct connected or transformer operated meters	Power factor	Limits of additional percentage error for meters of class index	
			A	B
Temperature variation				
5 °C to 30 °C	5 $I_{tr} \le I \le I_{max}$	1	± 1,8	± 0,9
		0,5 ind	± 2,7	± 1,3
-10 °C to 5 °C	5 $I_{tr} \le I \le I_{max}$	1	± 3,3	± 1,6
30 °C to 40 °C		0,5 ind	± 4,9	± 2,3
-25 °C to -10 °C	5 $I_{tr} \le I \le I_{max}$	1	± 4,8	± 2,4
40 °C to 55 °C		0,5 ind	± 7,2	± 3,4
-40 °C to -25 °C	5 $I_{tr} \le I \le I_{max}$	1	± 6,3	± 3,1
55 °C to 70 °C		0,5 ind	± 9,4	± 4,4
Voltage variation ± 10 %	5 $I_{tr} \le I \le I_{max}$	1	± 1,5	± 1,0
		0,5 ind	± 2,0	± 1,5
Frequency variation ± 2 %	5 $I_{tr} \le I \le I_{max}$	1	± 1,0	± 0,7
		0,5 ind	± 1,3	± 1,0
NOTE For the relationship I_{max} / I_{tr} see EN 50470-1, Table 3.				

8.4 Maximum permissible error (MPE)

In addition to the requirements of 8.1 and 8.3, the composite error of the meter shall not exceed the values given in Table 8.

When the operating range of the meter covers more than one temperature range, then the respective requirements for each temperature range apply.

The composite error at a certain load shall be calculated from the following formula:

$$e_c = \sqrt{e^2(I,\cos\varphi) + \delta^2(T,I,\cos\varphi) + \delta^2(U,I,\cos\varphi) + \delta^2(f,I,\cos\varphi)}$$

where

$e(I,\cos\varphi)$ = the intrinsic error of the meter at a certain load;

$\delta(T,I,\cos\varphi)$ = the additional percentage error due to the variation of the temperature at the same load;

$\delta(U,I,\cos\varphi)$ = the additional percentage error due to the variation of the voltage at the same load;

$\delta(f,I,\cos\varphi)$ = the additional percentage error due to the variation of the frequency at the same load.

See also 8.7.6.

Table 8 – Maximum permissible error (MPE)

Value of current	Power factor	Operating temperature range							
		5 °C to 30 °C		-10 °C to 5 °C or 30 °C to 40 °C		-25 °C to -10 °C or 40 °C to 55 °C		-40 °C to -25 °C or 55 °C to 70 °C	
		Meter class index							
		A	B	A	B	A	B	A	B
Single-phase meter; polyphase meter with balanced loads									
$I_{min} \le I < I_{tr}$	1	± 3,5	± 2,0	± 5,0	± 2,5	± 7,0	± 3,5	± 9,0	± 4,0
$I_{tr} \le I \le I_{max}$	0,5 ind…1… 0,8 cap	± 3,5	± 2,0	± 4,5	± 2,5	± 7,0	± 3,5	± 9,0	± 4,0
Polyphase meter carrying a single-phase load, but with balanced voltage supplied to the voltage circuits									
$5\ I_{tr} \le I \le I_{max}$	0,5 ind…1	± 4,0	± 2,5	± 5,0	± 3,0	± 7,0	± 4,0	± 9,0	± 4,5

8.5 Effect of disturbances of long duration

When the meter is otherwise operated at reference conditions, the additional percentage error due to disturbances of long duration, when applied one by one, shall not exceed the critical change values specified in Table 9.

For testing, see 8.7.7.

Table 9 – Effect of disturbances of long duration – Critical change values

Disturbance	Value	Value of current (balanced unless otherwise stated)		Power factor	Critical change value for meters of class index, %	
		For direct connected meters	For trans-former operated meters		A	B
Severe voltage variation	0,8 $U_n \le U < 0,9\ U_n$ 1,1 $U_n < U \le 1,15\ U_n$	10 I_{tr}	I_n	1	± 3,0	± 2,1
				0,5 ind	± 4,5	± 3,0
	$U < 0,8\ U_n$			1 and 0,5 ind	+10…–100	
Reversed phase sequence	Any two phases interchanged	1-P or 3-P balanced		1	± 1,5	± 1,5
		5 $I_{tr} \le I \le I_{max}$	0,5 $I_n \le I \le I_{max}$			
		3-P unbalanced		1	± 2,0	± 2,0
		5 I_{tr}	0,5 I_n			
Voltage unbalance	Any one phase interrupted [a]	10 I_{tr}	I_n	1	± 4,0	± 2,0
Self-heating		I_{max}	I_{max}	1	± 1,0	± 0,7
				0,5 ind	± 1,5	± 1,0
Earth fault [b]	1,9 U_n on two lines	-	0,5 I_n	1	± 1,0	± 0,7
Waveform	10 % of third harmonic in the current	10 I_{tr}	I_n	1	± 0,8	± 0,6
Continuous magnetic fields of external origin	1 000 Ampere-turns	10 I_{tr}	I_n	1	± 3,0	± 2,0
Power frequency magnetic fields of external origin	0,5 mT	10 I_{tr}	I_n	1	± 3,0	± 2,0
Operation of auxiliary devices	Most unfavourable condition	I_{min}	I_{min}	1	± 1,0	± 0,5
Mechanical load of either single-rate or multi-rate register		I_{min}	I_{min}	1	± 2,0	± 1,5
Oblique suspension	3°	I_{min}	I_{min}	1	± 3,0	± 2,0
		10 I_{tr} and I_{max}	I_n and I_{max}	1	± 0,5	± 0,4
Electrical fast transient/burst	4 kV (2 kV)	10 I_{tr}	I_n	1	± 6,0	± 4,0
Conducted disturbances induced by RF fields	10 V	10 I_{tr}	I_n	1	± 3,0	± 2,0
Damped oscillatory waves [c]	2,5 kV / 1 kV	-	I_n	1	± 3,0	± 2,0

[a] Polyphase meters with three measuring elements shall measure and register, with limits of variation of percentage error less than the critical change value shown in this table, if any of the phases is interrupted. This only covers phase interruptions and does not cover events such as transformer fuse failures.

In case of polyphase meters with two measuring elements the requirement does not apply.

[b] Only for three-phase four-wire voltage transformer operated meters connected to distribution network equipped with earth fault neutralizers.

[c] For voltage transformer operated meters only.

For testing, see 8.7.7.

8.6 Short time overcurrents

Short-time overcurrents shall not damage the meter. The meter shall perform correctly when back to its initial working condition and the additional error shall not exceed the critical change value specified in Table 10.

NOTE This requirement does not apply to meters having a contact in the current circuits. For this case, see the appropriate standards.

Table 10 – Effect of short time overcurrents – Critical change value

Meters for	Value of current (balanced)		Power factor	Critical change value for meters of class index, %	
				A	B
Direct connection	10 I_{tr}	-	1	± 1,5	± 1,5
Connection through current transformer	-	I_n	1	± 1,5	± 1,5

For testing, see 8.7.8.

8.7 Performing the tests

8.7.1 Accuracy test conditions

To test the accuracy requirements, the following test conditions shall be maintained:

a) the meter shall be tested in its case with the cover in position; all parts intended to be earthed shall be earthed;

b) before any test is made, the voltage circuits shall have been energized for at least:

- 1 h for meters of class index A;
- 2 h for meters of class index B;

and the measuring currents shall be set progressively to increasing or decreasing values and the current circuits shall be energized at each value for a sufficient time to obtain thermal stability with corresponding constant speed of rotation.

c) in addition, for polyphase meters:

- the phase sequence shall be as marked on the diagram of connections;
- the voltages and currents shall be substantially balanced (see Table 11).

Table 11 – Voltage and current balance

Condition	Tolerance
Each of the voltages between phase and neutral and between any two phases shall not differ from the average corresponding voltage by more than	± 1 %
Each of the currents in the conductors shall not differ from the average current by more than	± 2 %
The phase displacements of each of these currents from the corresponding phase-to-neutral voltage, irrespective of the phase angle, shall not differ from each other by more than	2°

d) the reference conditions are given in Table 12;

e) for drum-type registers, only the most rapidly moving drum shall be rotating;

f) for requirements regarding test stations, see IEC/TR 60736.

Table 12 – Reference conditions

Influence quantity	Reference value	Permissible tolerances for meters of class index	
		A	B
Ambient temperature	Reference temperature or, in its absence, 23 °C [a]	± 2 °C	± 2 °C
Voltage	Reference voltage	± 1,0 %	± 1,0 %
Frequency	Reference frequency	± 0,5 %	± 0,3 %
Phase sequence	L1 – L2 – L3	--	--
Voltage unbalance	All phases connected	--	--
Wave-form	Sinusoidal voltages and currents	Distortion factor less than: 3 %	2 %
Continuous magnetic field of external origin	Equal to zero	--	--
Power frequency magnetic field of external origin	Equal to zero	Induction value which causes a variation of error not greater than [b] ± 0,3 %	± 0,2 %
Operation of auxiliary devices	No operation of auxiliary devices	--	--
Working position	Vertical working position [c]	± 0,5°	± 0,5°
Conducted disturbances, induced by RF fields, 150 kHz to 80 MHz	Equal to zero	< 1 V	< 1 V

a If the tests are made at a temperature other than the reference temperature, including permissible tolerances, the results shall be corrected by applying the appropriate temperature coefficient of the meter determined for the temperature ranges T_{ref} + 10 °C and T_{ref} - 10 °C respectively.

b The test consist of:

- for a single-phase meter, determining the errors first with the meter normally connected to the mains and then after inverting the connections to the current circuits as well as to the voltage circuits. Half of the difference between the two errors is the value of the variation of error. Because of the unknown phase of the external field, the test should be made at Itr at unity power factor and at 2 Itr at 0,5 power factor;
- for a three-phase meter, making three measurements at Itr at unity power factor, after each of which the connection to the current circuits and to the voltage circuits are changed over 120° while the phase sequence is not altered. The greatest difference between each of the errors so determined and their average value is the value of the variation of error.

c Determination of the vertical working position (see 5.1).

The construction and assembly of the meter should be such that the correct vertical position is ensured (in both the front-to-back and left-to-right vertical planes) when:

- the base of the meter is supported against a vertical wall, and
- a reference edge (such as the lower edge of the terminal block) or a reference line marked on the meter case is horizontal.

8.7.2 Accuracy test at reference conditions

The accuracy test at reference conditions shall be performed at least at the test points shown in Table 13 and it shall be verified that the requirements of 8.1 are met.

In case of polyphase meters, tests shall be performed with balanced three-phase voltage and with balanced three-phase or single-phase load as indicated. For testing with single-phase load, the test current shall be applied to each measuring element in sequence.

Table 13 – Test points for determining the intrinsic error and the additional percentage error due to influence quantities

Value of current for meters for		Meter / Load		Power factor
Direct connection	Transformer connection			
I_{min}	I_{min}	1-P	3-P balanced	1
I_{tr}	I_{tr}	1-P	3-P balanced	0,5 ind, 1, 0,8 cap
5 I_{tr}	5 I_{tr}	-	3-P unbalanced	1 and 0,5 ind
10 I_{tr}	I_n	1-P	3-P balanced	0,5 ind, 1, 0,8 cap
10 I_{tr}	I_n	-	3-P unbalanced	1 and 0,5 ind
I_{max}	I_{max}	1-P	3-P balanced	0,5 ind, 1, 0,8 cap
I_{max}	I_{max}	-	3-P unbalanced	1 and 0,5 ind
NOTE "1-P" means single-phase meter. "3-P balanced" means polyphase meter with balanced load. "3-P unbalanced" means polyphase meter carrying a single-phase load, but with balanced polyphase voltages applied to voltage circuits.				

8.7.3 Interpretation of accuracy test results

Certain test results may fall outside the percentage limits indicated in Table 4 and Table 5, owing to uncertainties involved in the measurement process. However, if by one displacement of the zero line parallel to itself by no more than the limits indicated in Table 14, all the test results are brought within the limits, it shall be considered that the requirements set in those tables are met.

Table 14 – Interpretation of test results

	Meters of class index	
	A	B
Permissible displacement of the zero line (%)	± 1,0	± 0,5

8.7.4 Repeatability

To verify that the requirement of 8.2 is met, at each test point shown in Table 13 at least three measurements shall be done.

8.7.5 Test of effects of influence quantities

8.7.5.1 General

The additional percentage error due to influence quantities shall be determined for each influence quantity one by one, at the test points specified in Table 13, with all other influence quantities kept at their reference values (see Table 12).

8.7.5.2 Temperature variation

The additional percentage error due to temperature variation shall be determined for each sub-range within the temperature range selected by the manufacturer.

NOTE If the variation of error is known to be a monotonic function of the temperature, it is sufficient to perform the test at the extremes of each sub-range.

It shall be verified that the requirements of Table 6 and Table 7 for each relevant temperature range are met.

8.7.5.3 Voltage variation

The additional percentage error due to voltage variation shall be determined and it shall be verified that the requirements of Table 6 and Table 7 are met.

If the meter has more than one reference voltage, the test shall be repeated for each value of U_n.

NOTE If the variation of error is known to be a monotonic function of the voltage, it is satisfactory to perform the test at the extremes of the voltage range(s).

8.7.5.4 Frequency variation

The additional percentage error due to frequency variation shall be determined and it shall be verified that the requirements of Table 6 and Table 7 are met.

NOTE If the variation of error is known to be a monotonic function of the frequency, it is satisfactory to perform the test at the extremes of the frequency range.

8.7.6 Calculation of the composite error

The composite error shall be calculated using the formula given in 8.4. For each test point, the intrinsic error and the largest corresponding values of additional percentage errors due to the variation of the respective influence quantities within their specified operating range shall be taken into account.

An example is shown in Annex A.

8.7.7 Test of effects of disturbances of long duration

8.7.7.1 General

The effect of disturbances of long duration shall be determined for each disturbance one by one, at the test points shown in Table 9, while otherwise the meter is under reference conditions as specified in 8.7.1.

8.7.7.2 Severe voltage variation

The additional percentage error due to severe voltage variation shall be determined and it shall be verified that it does not exceed the critical change value specified in Table 9.

If the meter has more than one reference voltage, the test shall be repeated for each value of U_n.

NOTE If the variation of error is known to be a monotonic function of the voltage, it is satisfactory to perform the test at the extremes of the voltage range(s).

8.7.7.3 Reversed phase sequence

This requirement applies only for three-phase meters. The test shall be performed first interchanging L1 and L2 then L1 and L3. It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.4 Voltage unbalance

This requirement applies only for poly-phase meters with three measuring elements.

The test shall be performed by interrupting each phase one by one.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.5 Self-heating

The test shall be carried out as follows: After the voltage circuits have been energized at reference voltage for at least 1 h for meters of class index A and 2 h for class index B, without any current in the current circuits, the maximum current shall be applied to the current circuits.

The percentage error of the meter shall be measured immediately after the current is applied and then at intervals short enough to allow a correct drawing to be made of the curve of error variation as a function of time. The test shall be carried out for at least 1 h, and in any event until the variation of error during 20 min does not exceed 10 % of limits of percentage error at reference conditions. With minimum interruptions for changing the measurement point, the percentage error of the meter shall be measured at power factor = 1 and power factor = 0,5 inductive.

The cable to be used for energizing the meter shall have a length of 1 m and a cross-section to ensure that the current density is between 3,2 A/mm^2 and 4 A/mm^2. If this would result in a cable with a cross section of less than 1,5 mm^2, then a cable with a cross section of 1,5 mm^2 shall be used.

It shall be verified that the variation in percentage error does not exceed the critical change value specified in Table 9.

8.7.7.6 Earth fault

This test applies only for three-phase four-wire voltage transformer operated meters, connected to distribution networks which are equipped with earth fault neutralizers or in which the star point is isolated (in the case of an earth fault and with 10 % overvoltage, the line-to-earth voltages of the two lines which are not affected by the earth fault will rise to 1,9 times the nominal voltage).

For a test under a simulated earth fault condition in one of the three lines, all voltages are increased to 1,1 times the nominal voltages during 4 h. The neutral terminal of the meter under test is disconnected from the ground terminal of the meter test equipment (MTE) and is connected to the MTE's line terminal at which the earth fault has to be simulated (see Annex B). In this way the two voltage terminals of the meter under test, which are not affected by the earth fault are connected to 1,9 times the nominal phase voltages. For this test, the current circuits are set to 50 % of rated current I_n, power factor 1 and symmetrical load. After the test, the meter shall show no damage and shall operate correctly.

After the application of the simulated earth fault condition, the meter shall be allowed to return to the initial temperature then an accuracy test shall be performed. It shall be verified that the variation in percentage error does not exceed the critical change value specified in Table 9.

8.7.7.7 Waveform - accuracy in the presence of harmonics

The test shall be performed with 10 % third harmonic added to the current. The distortion factor of the voltage shall be less than 1 %.

The measurement shall be done under the most unfavourable phase displacement of the third harmonic compared to the fundamental current.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.8 Immunity to continuous magnetic fields of external origin

The test procedure is described in EN 50470-1, Subclause 7.4.11.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.9 Immunity to power frequency magnetic fields of external origin

The test procedure is described in EN 50470-1, Subclause 7.4.12.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.10 Operation of auxiliary devices

This test applies to meters with auxiliary devices enclosed in the meter case. Such devices may not be operating or actuated continuously.

NOTE An example is an electromagnet of a multi rate register.

It shall be verified that due to the operation or actuation of such auxiliary devices, the additional percentage error does not exceed the critical change value specified in Table 9.

When such auxiliary devices are actuated by an external device, the auxiliary circuits shall preferably be marked to indicate the correct method of its connection. If these connections are made by means of plugs and sockets, they should be irreversible.

The test shall be performed with the connections specified by the manufacturer. In the absence of such markings or irreversible connections, the test shall be performed with the connections giving the most unfavourable condition.

8.7.7.11 Effect of mechanical load of the register

It shall be verified that additional error due to the effect of the mechanical load of the register does not exceed the critical change value specified in Table 9.

NOTE The effect of the mechanical load of registers is normally compensated during the calibration of the meter.

8.7.7.12 Effect of oblique suspension

The test shall be performed with the meter tilted from its ideal position to an angle of 3°.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.13 Immunity to electrical fast transients/bursts

The test procedure is described in EN 50470-1, Subclause 7.4.7.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.14 Immunity to conducted disturbances, induced by RF fields

The test procedure is described in EN 50470-1, Subclause 7.4.8.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.7.15 Immunity to damped oscillatory waves

NOTE This test is applicable to voltage transformer connected meters only.

The test procedure is described in EN 50470-1, Subclause 7.4.10.

It shall be verified that the additional percentage error does not exceed the critical change value specified in Table 9.

8.7.8 Short time overcurrents

The test circuit shall be practically non-inductive and the test shall be performed for polyphase meters phase-by-phase.

a) Meter for direct connection:

The meter shall be able to carry an impulse current whose peak value equals 50 I_{max} with a relative tolerance of + 0 % to - 10 % (or 7 000 A, whichever is less) and which remains over 25 I_{max} with a relative tolerance of + 0 % to - 10 % (or 3 500 A, whichever is less) during 1 ms.

NOTE 1 An impulse current can be obtained, for example, by a capacitor discharge or thyristor control of the mains supply.

NOTE 2 I_{max} is the r.m.s. value of the meter's maximum current.

b) Meter for connection through current transformer:

The meter shall be able to carry for 0,5 s a current equal to 20 I_{max} with a relative tolerance of + 0 % to - 10 %.

After the application of the short time overcurrent, the meter shall be allowed to return to the initial temperature with the voltage circuit(s) energized (about 1 h) then an accuracy test shall be performed. It shall be verified that the requirements of 8.6 are met.

8.7.9 Test of starting and no-load condition

8.7.9.1 General test conditions

For these tests, the conditions and the values of the influence quantities shall be as stated in 8.7.1 except for any changes specified below.

8.7.9.2 Test of no-load condition

When the voltage is applied with no current flowing in the current circuits (current circuits shall be open circuit), the rotor of the meter shall not make a complete revolution at any voltage between 80 % and 110 % of the reference voltage.

NOTE If the meter has more than one reference voltage, the test shall be repeated for each value of U_n.

For drum-type registers, these conditions shall apply with only one drum moving.

8.7.9.3 Starting

The rotor of the meter shall start and continue to register at the starting current values (and in case of polyphase meters, with balanced load) shown in Table 15.

Table 15 – Starting current

Meters for	Meters of class index		Power factor
	A	B	
Direct connection	0,05 I_{tr}	0,04 I_{tr}	1
Connection through current transformers	0,06 I_{tr}	0,04 I_{tr}	1

It shall be verified that the rotor completes at least one revolution.

For meters with drum-type registers, the test shall be made with not more than two drums moving.

8.7.10 Meter constant

The relation between the number of revolutions of the rotor of the meter and the indication of the register shall comply with the marking on the name-plate. The difference of the percentage error determined from the test output and by reading the register shall be less than $1/10^{th}$ of the limit of percentage error at reference conditions.

This shall be verified by measuring a sufficient amount of energy, and observing the test output and reading the display.

8.7.11 Adjustment

Generally, suitable means of adjustment are provided. By agreement between user and manufacturer, the latter may produce meters without means of further adjustment.

A meter provided with means of adjustment and which has been adjusted satisfactorily according to this standard, shall be capable of being further adjusted at least to the extent shown in Table 16.

Tests shall be made under the conditions stated in 8.7.1.

Table 16 – Minimum range of adjustment

Adjustment	Value of current	Power factor	Minimum range of adjustment of rotation speed of the rotor in percentage for meters of class	
			A	B
Braking element	0,5 I_{max}	1	± 4,0	± 2,0
Low load	I_{min}	1	± 4,0	± 2,0
Inductive load	5 I_{tr} 0,5 I_{max}	0,5 ind	± 1,0 -	- ± 1,0
NOTE For polyphase meters, the verification of the range of adjustment for inductive load should be made on each driving element and should be determined when the current circuit of each element is carrying 5 I_{tr} lagging 60° behind the voltage at the terminals of that element, all the voltage circuits of all driving elements carrying balanced polyphase voltage, whose r.m.s. value is equal to the reference voltage in the phase-sequence as indicated on the connection diagram.				

9 Durability

The meter shall be designed to maintain an adequate stability of its metrological characteristics over a period estimated by the manufacturer, provided that it is properly installed, maintained and used according to the manufacturer's instruction when in the environmental conditions for which it is intended.

Conformity to this requirement shall be verified by the examination of test results and/or design documentation provided by the manufacturer.

These may include the following as appropriate:

- field test results of meter types of similar design;

  NOTE 1 IEC/TR 62059-21 provides guidance for collecting dependability data from the field.

- laboratory test results of key parts and assemblies determining the long term stability of the meter and/or of complete meters;

  NOTE 2 The test method should be described by the manufacturer and should be based – as far as possible – on internationally accepted standards and generally accepted methods.

- any specifications and calculations of the long term stability of such parts and assemblies;
- any operating principles used to maintain and improve long term stability;
- any manufacturing processes applied to ensure and improve long term stability;
- any methods to indicate if long term stability is affected.

10 Reliability

The meter shall be designed to operate reliably. It shall be designed to reduce as far as possible the effects of any fault that would lead to an inaccurate measurement result, unless such a defect is obvious.

Conformity to this requirement shall be verified by the examination of test results and/or design documentation provided by the manufacturer.

These may include the following as appropriate:

- field test results of meter types of similar design;

  NOTE 1 IEC/TR 62059-21 provides guidance for collecting dependability data from the field.

- laboratory reliability test results of key components and/or complete meters;

  NOTE 2 The test method should be described by the manufacturer and should be based – as far as possible – on internationally accepted standards and generally accepted methods.

- any methods applied to reduce the effect of eventual faults occurring on the accuracy of the measurement and/or integrity of data;
- any method used to indicate if measurement accuracy is affected and/or integrity of data is lost.

11 Protection against corruption

The requirements of EN 50470-1, Subclause 5.2.1 and the requirements of Table 9 of this standard for the operation of auxiliary devices specified in of this standard apply.

Annex A
(informative)

Calculation of the composite error

The following example shows the calculation of the composite error in the presence of influence quantities:

- the intrinsic error of a polyphase meter of class index A, measured at I_{tr}, balanced load, cos φ = 1 is + 0,7 %;
- at the same load, within the specified operating temperature range of -10 °C to 55 °C, the largest additional error observed in the subrange of -10 °C to 5 °C was at -10 °C, its value is - 1,9 %;
- at the same load, within the specified operating voltage range of 0,9 U_n to 1,1 U_n, the largest additional error observed was at 1,1 U_n, its value is + 0,8 %;
- at the same load, within the specified operating frequency range of 0,98 f_n to 1,02 f_n, the largest additional error observed was at 0,98 f_n, its value is + 0,3 %.

The composite error calculated:

$$e_c = \sqrt{(+0,7)^2 + (-1,9)^2 + (+0,8)^2 + (+0,3)^2} = \pm 2,2 \ \%$$

The calculation should be performed for each test point and each temperature sub-range the same way.

Annex B
(normative)

Test circuit diagram for the test of immunity to earth fault

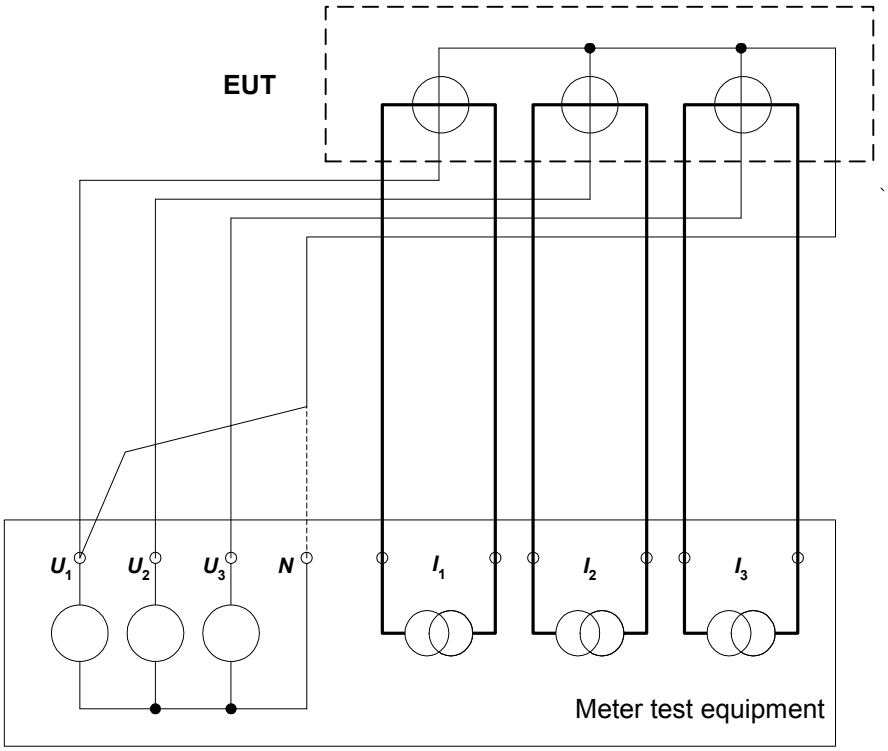

Figure B.1 – Circuit to simulate earth fault condition in phase 1

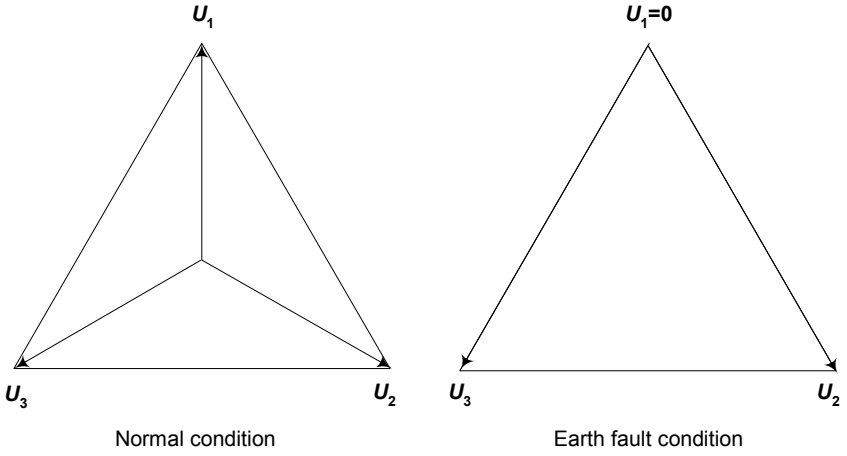

Figure B.2 – Voltages at the meter under test

Annex ZZ
(informative)

Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Annex I and Annex MI-003 of the EC Directive 2004/22/EC of the European Parliament and of the Council on Measuring Instruments except the following:

– Software requirements formulated in:
  Essential Requirement 7 Suitability,
  Essential Requirement 8 Protection against corruption.

  NOTE These requirements are not applicable to electromechanical meters.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

Bibliography

Publication	Year	Title
EN 62053-11	2003	*Electricity metering equipment (a.c.) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2) (IEC 62053-11:2003)*
IEC 62058-11	[1)]	*Electricity metering equipment (a.c.) – Acceptance inspection – Part 11: General acceptance inspection methods*
IEC 62058-21	[1)]	*Electricity metering equipment (a.c.) – Acceptance inspection – Part 21: Particular requirements for electromechanical meters for active energy (classes 1 and 2)*
IEC/TR 60736	1982	*Testing equipment for electrical energy meters*
IEC/TR 62059-11	2002	*Electricity metering equipment – Dependability – Part 11: General concepts*
IEC/TR 62059-21	2002	*Electricity metering equipment – Dependability – Part 21: Collection of meter dependability data from the field*

[1)] At draft stage.

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