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Electricity metering equipment (AC) - Particular requirements - Part 11: Electromechanical meters for active energy (classes 0.5, 1 and 2)

National Foreword

This Philippine National Standard is a modified adoption of IEC 62053-11: 2003 Electricity metering equipment (AC) - Particular requirements - Part 11: Electromechanical meters for active energy (classes 0.5, 1 and 2). It was approved for adoption as a Philippine National Standard by the Bureau of Product Standards upon the review and endorsement of the Technical Committee on Electrical energy measurement, tariff and load control (ERC-BPS/TC70) of the Energy Regulatory Commission.

Efforts had been done to have a unified Philippine National Standard for electric meters but different construction of the said equipment made it difficult to do so. In this regard, it has been agreed that, for single phase, this standard shall be applicable only for bottom-connected type electric watt-hour meters. For the requirements of socket connected type watt-hour meters, PNS.ERC ANSI C12.1 shall be used. While for polyphase, this standard may also be applicable for bottom-connected type electric watt-hour meter upon verification of the test sample by the recognized certifying and inspection body. Otherwise, PNS/ERC ANSI C12.1 shall be used.

Within the text of the standard, the following are the minimal editorial changes:

a) the decimal comma shall be interpreted as a decimal point to be consistent with existing convention on our number format

b) the words "International Standard" shall mean "National Standard".

The following is the technical deviation in this standard:

Clause/Subclause	Modifications
1 Scope	Replace the first paragraph with the following:
	"This part of PNS/ERC IEC 62053 covers type tests for electromechanical watt-hour meters of accuracy classes 0.5, 1 and 2 for the measurement of alternating current and electrical active energy in 60 Hz."

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Partie 11: Compteurs électromécaniques d'énergie active (classes 0,5, 1 et 2)

Electricity metering equipment (a.c.) – Particular requirements –

Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICITY METERING EQUIPMENT (AC) – PARTICULAR REQUIREMENTS –

Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2)

FOREWORD

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International Standard IEC 62053-11 has been prepared by IEC technical committee 13: Equipment for electrical energy measurement and load control.

This standard together with IEC 62052-11 cancels and replaces IEC 60521 second edition published in1988 and constitutes a technical revision.

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

FDIS	Report on voting
13/1287/FDIS	13/1293/RVD

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

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

The committee has decided that the contents of this publication will remain unchanged until 2012. At this date, the publication will be

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

INTRODUCTION

This part of IEC 62053 is to be used with the following relevant parts of the IEC 62052, IEC 62053 and IEC 62059 series, Electricity metering equipment:

IEC 62052-11:2003, *Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62053-21:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

Replaces particular requirements of IEC 61036: 2000 (2nd edition)

IEC 62053-22:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)*

Replaces particular requirements of IEC 60687: 1992 (2nd edition)

IEC 62053-23:2002, *Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)*

Replaces particular requirements of IEC 61268: 1995 (1st edition)

IEC 62053-31:1998, *Electricity metering equipment (a.c.) – Particular requirements – Part 31: Pulse output devices for electromechanical and electronic meters (two wires only)*

IEC 62053-61:1998, *Electricity metering equipment (a.c.) – Particular requirements – Part 61: Power consumption and voltage requirements*

IEC 62059-11:2002, *Electricity metering equipment (a.c.) – Dependability – Part 11: General concepts*

IEC 62059-21:2002, *Electricity metering equipment (a.c.) – Dependability – Part 21: Collection of meter dependability data from the field*

This part is a standard for type testing electricity meters. It covers the particular requirements for meters, being used indoors and outdoors in large quantities world-wide. It does not deal with special implementations (such as metering-part and/or displays in separate housings).

This standard is intended to be used in conjunction with IEC 62052-11. When any requirement in this standard concerns an item already covered in IEC 62052-11, the requirements of this standard take precedence over the requirements of IEC 62052-11.

This standard distinguishes:

- between accuracy class index 0,5, accuracy class index 1 and accuracy class index 2 meters;
- between protective class I and protective class II meters;
- between meters for use in networks equipped with or without earth fault neutralizers.

The test levels are regarded as minimum values that provide for the proper functioning of the meter under normal working conditions. For special application, other test levels might be necessary and should be agreed on between the user and the manufacturer.

ELECTRICITY METERING EQUIPMENT (AC) – PARTICULAR REQUIREMENTS –

Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2)

1 Scope

This part of IEC 62053 applies only to newly manufactured electromechanical watt-hour meters of accuracy classes 0,5, 1 and 2, for the measurement of alternating current electrical active energy in 50 Hz or 60 Hz networks and it applies to their type tests only.

It applies only 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 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, then the relevant standards for these elements also apply.

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;
- data interfaces to the register of the meter.

Regarding acceptance tests, a basic guideline is given in IEC 60514.

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.

IEC 60514:1975, *Acceptance inspection of Class 2 alternating-current watt-hour meters*

IEC 60736:1982, *Testing equipment for electrical energy meters*

IEC 62052-11:2003, *Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 11: Metering equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62052-11 apply.

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 %.

NOTE For testing of meters having contacts in the current circuits, see appropriate standards.

Table 3 – Variations due to short-time overcurrents

Meters for	Value of current	Power factor	Limits of variations in percentage error for meters of class		
			0,5	1	2
Direct connection	I_b	1	–	1,5	1,5
Connection through current transformers	I_n	1	0,3	0,5	1,0

7.3 Influence of self-heating

The variation of error due to self-heating shall not exceed the values given in Table 4.

Table 4 – Variations due to self-heating

Value of current	Power factor	Limits of variations in percentage error for meters of class		
		0,5	1	2
I_{max}	1	0,5	0,7	1,0
	0,5 inductive	0,7	1,0	1,5

The test shall be carried out as follows: after the voltage circuits have been energized at reference voltage for at least 4 h for class 0,5, 2 h for class 1 and 1 h for class 2, without any current in the current circuits, the maximum current shall be applied to the current circuits. The meter error shall be measured at unity power factor 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 0,2 %.

The same test shall then be carried out at 0,5 (inductive) power factor.

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.

7.4 AC voltage test

The a.c. voltage test shall be carried out in accordance with Table 5.

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 5 – AC voltage tests

Test	Test voltage r.m.s	Points of application of the test voltage
A)		*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:
	2kV for tests in Items *a), b), c), d)*	*a)* each current circuit which, in normal service, is separated and suitably insulated from the other circuits [1];
		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 [1];
	and	*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 [2];
	500 V for test in Item *e)*	*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 [3].
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)		*Additional tests for insulating encased meters of protective-class II*
	4 kV for test in Item *a)*	*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;
	2 kV for test in Item *b)*	*b)* between the *frame* and earth;
		c) a visual inspection for compliance with the conditions of IEC 62052-11, Sub-clause 5.7;
	40 V for test in Item *d)*	*d)* 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 [4].

1) 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.

2) 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.

3) 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.

4) The test in part D) Item *d)* is not necessary, if the test in Item *c)* leaves no doubt.

8 Accuracy requirements

Tests and test conditions given in IEC 62052-11 apply.

8.1 Limits of error due to variation of the current

When the meter is under the reference conditions given in 8.5, the percentage errors shall not exceed the limits for the relevant accuracy class given in Tables 6 and 7. The percentage error limits for meters of class 0,5 are only valid for transformer operated meters.

Table 6 – Percentage error limits (single-phase meters and polyphase meters with balanced loads)

Value of current		Power factor	Percentage error limits for meters		
for direct connected meters	for transformer operated meters		0,5	1	2
$0,05\ I_b \le I < 0,1\ I_b$	$0,02\ I_n \le I < 0,05\ I_n$	1	±1,0	±1,5	±2,5
$0,1\ I_b \le I \le I_{max}$	$0,05\ I_n \le I \le I_{max}$	1	±0,5	±1,0	±2,0
$0,1\ I_b \le I < 0,2\ I_b$	$0,05\ I_n \le I < 0,1\ I_n$	0,5 inductive	±1,3	±1,5	±2,5
		0,8 capacitive	±1,3	±1,5	-
$0,2\ I_b \le I \le I_{max}$	$0,1\ I_n \le I \le I_{max}$	0,5 inductive	±0,8	±1,0	±2,0
		0,8 capacitive	±0,8	±1,0	–
When specially requested by the user: from					
$0,2\ I_b \le I \le I_b$	$0,1\ I_n \le I \le I_n$	0,25 inductive	±2,5	±3,5	–
		0,5 capacitive	±1,5	±2,5	–

Table 7 – Percentage error limits (polyphase meters carrying a single-phase load, but with balanced polyphase voltages applied to voltage circuits)

Value of current		Power factor	Percentage error limits for meters of class		
for direct connected meters	for transformer operated meters		0,5	1	2
$0,2\ I_b \le I \le I_b$	$0,1\ I_n \le I \le I_n$	1	±1,5	±2,0	±3,0
$0,5\ I_b$	$0,2\ I_n$	0,5 inductive	±1,5	±2,0	–
I_b	I_n	0,5 inductive	±1,5	±2,0	±3,0
$I_b \le I \le I_{max}$	$I_n \le I \le I_{max}$	1	–	–	±4,0

The difference between the percentage error when the meter is carrying a single-phase load and a balanced polyphase load at basic current I_b and unity power factor for direct connected meters, respectively at rated current I_n and unity power factor for transformer operated meters, shall not exceed 1 %, 1,5 % and 2,5 % for meters of classes 0,5, 1 and 2 respectively.

NOTE When testing for compliance with Table 7, the test current should be applied to each measuring element in sequence.

8.2 Limits of error due to influence quantities

The additional percentage error due to the change of influence quantities with respect to reference conditions, as given in 8.5, shall not exceed the limits for the relevant accuracy class given in Table 8. The limits of variation in percentage error for meters of class 0,5 are only valid for transformer operated meters.

Table 8 – Influence quantities

Influence quantity	Value of current (balanced unless otherwise stated)		Power factor	Mean temperature coefficient %/K for meters of class		
	For direct connected meters	For transformer-operated meters		0,5	1	2
Ambient temperature variation [6]	$0,1\ I_b \le I \le I_{max}$	$0,05\ I_n \le I \le I_{max}$	1	0,03	0,05	0,10
	$0,2\ I_b \le I \le I_{max}$	$0,1\ I_n \le I \le I_{max}$	0,5 inductive	0,05	0,07	0,15
				Limits of variation in percentage error for meters of class		
				0,5	1	2
Voltage variation ±10 % [1]	$0,1\ I_b$	$0,1\ I_n$	1	0,8	1,0	1,5
	$0,5\ I_{max}$	$0,5\ I_{max}$	1	0,5	0,7	1,0
	$0,5\ I_{max}$	$0,5\ I_{max}$	0,5 inductive	0,7	1,0	1,5
Frequency variation ±2 %	$0,1\ I_b$	$0,1\ I_n$	1	0,7	1,0	1,5
	$0,5\ I_{max}$	$0,5\ I_{max}$	1	0,6	0,8	1,3
	$0,5\ I_{max}$	$0,5\ I_{max}$	0,5 inductive	0,8	1,0	1,5
Reversed phase sequence	$0,5\ I_b \le I \le I_{max}$	$0,5\ I_n \le I \le I_{max}$	1	1,5	1,5	1,5
	$0,5\ I_b$ (single phase load)	$0,5\ I_n$ (single phase load)	1	2,0	2,0	2,0
Waveform: 10 % of third harmonic in the current [2]	I_b	I_n	1	0,5	0,6	0,8
Magnetic induction of external origin 0,5 mT [3]	I_b	I_n	1	1,5	2,0	3,0
Operation of accessories [4]	$0,05\ I_b$	$0,02\ I_n$	1	0,3	0,5	1,0
Mechanical load of either single or multi-rate register [5]	$0,05\ I_b$	$0,02\ I_n$	1	0,8	1,5	2,0
Oblique suspension 3°	$0,05\ I_b$	$0,02\ I_n$	1	1,5	2,0	3,0
	I_b and I_{max}	I_n and I_{max}	1	0,3	0,4	0,5

[1] For the voltage ranges from –20 % to –10 % and +10 % to +15 % the limits of variation in percentage errors are three times the values given in this table.

Below $0,8\ U_n$ the error of the meter may vary between +10 % and –100 %.

[2] The distortion factor of the voltage shall be less than 1 %.

The variation in percentage error shall be measured under the most unfavourable phase displacement of the third harmonic in the current compared with the fundamental current.

[3] A magnetic induction of external origin of 0,5 mT produced by a current of the same frequency as that of the voltage applied to the meter and under the most unfavourable conditions of phase and direction shall not cause a variation in the percentage error of the meter exceeding the values shown in this table.

The magnetic induction shall be obtained by placing the meter in the centre of a circular coil, 1 m in mean diameter, of square section and of small radial thickness relative to the diameter, and having 400 At.

[4] Such an accessory, when enclosed in the meter case, is energized intermittently, for example the electromagnet of a multi-rate register.

It is preferable that the connection to the auxiliary device(s) is marked to indicate the correct method of connection. If these connections are made by means of plugs and sockets, they should be irreversible.

However, in the absence of those markings or irreversible connections, the variations of errors shall not exceed those indicated in this table if the meter is tested with the connections giving the most unfavourable condition.

[5] The effect is compensated when calibrating the meter.

[6] The mean temperature coefficient shall be determined for the whole operating range. The operating temperature range shall be divided into 20 K wide ranges. The mean temperature coefficient shall then be determined for these ranges, by taking measurements 10 K above and 10 K below the middle of the range. During the test, the temperature shall be in no case outside the specified operating temperature range.

Tests for variation caused by influence quantities should be performed independently with all other influence quantities at their reference conditions (see Table 11).

8.3 Test of starting and no-load condition

For these tests, the conditions and the values of the influence quantities shall be as stated in 8.5 except for any changes specified below.

8.3.1 Test of no-load condition

When the voltage is applied with no current flowing in the current circuit (current circuit 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.

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

8.3.2 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 9.

Table 9 – Starting current

Meters for	Class of meter			Power factor
	0,5	1	2	
Direct connection	–	0,004 I_b	0,005 I_b	1
Connection through current transformers	0,002 I_n	0,002 I_n	0,003 I_n	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.

8.4 Meter constant

It shall be verified that the ratio between the number of revolutions of the rotor of the meter and the indication of the register is correct.

8.5 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;

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

4 h for class 0,5 meters,

2 h for class 1 meters,

1 h for class 2 meters,

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 10).

Table 10 – Voltage and current balance

Polyphase meters	Class of meter		
	0,5	1	2
Each of the voltages between phase and neutral and between any two phases shall not differ from the average corresponding voltage by more than	±0,5 %	±1 %	±1 %
Each of the currents in the conductors shall not differ from the average current by more than	±1 %	±2 %	±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°	2°	2°

d) the reference conditions are given in Table 11;

e) for requirements regarding test stations, see IEC 60736;

f) for drum-type registers, only the most rapidly moving drum shall be rotating.

Table 11 – Reference conditions

Influence quantity	Reference value	Permissible tolerances for meters of class		
		0,5	1	2
Ambient temperature	Reference temperature or, in its absence, 23 °C [1)]	±1 °C	±2 °C	±2 °C
Voltage	Reference voltage	±0,5 %	±1,0 %	±1,0 %
Frequency	Reference frequency	±0,2 %	±0,3 %	±0,5 %
Phase sequence	L1 – L2 – L3	–	–	–
Voltage unbalance	All phases connected	–	–	–
Wave-form	Sinusoidal voltages and currents	Distortion factor less than:		
		2 %	2 %	3 %
Magnetic induction of external origin at the reference frequency	Magnetic induction equal to zero	Induction value which causes a variation of error not greater than: [3)]		
		±0,1 %	±0,2 %	±0,3 %
Operation of accessories	No operation of accessories	–	–	–
Working position	Vertical working position [2)]	±0,5°	±0,5°	±0,5°

Table 11 *(continued)*

1) 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.

2) 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.

3) The test consists of:

a) 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 0,1 I_b resp. 0,05 I_n at unity power factor and 0,2 I_b resp. 0,1 I_n at 0,5 power factor;

b) for a three-phase meter, making three measurements at 0,1 I_b resp. 0,05 I_n 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.

8.6 Interpretation of test results

Certain test results may fall outside the limits indicated in Tables 6 and 7, owing to uncertainties of measurements and other parameters capable of influencing the measurements. However, if by one displacement of the zero line parallel to itself by no more than the limits indicated in Table 12, all the test results are brought within the limits indicated in Tables 6 and 7, the meter type shall be considered as acceptable.

Table 12 – Interpretation of test results

	Class of meter		
	0,5	1	2
Permissible displacement of the zero line (%)	0,3	0,5	1,0

9 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 13.

Tests shall be made under the conditions stated in 8.5.

Table 13 – 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		
			0,5	1	2
Braking element	0,5 I_{max}	1	±2,0	±2,0	±4,0
Low load	0,05 I_b	1	±2,0	±2,0	±4,0
Inductive load	0,5 I_b	0,5 inductive	±1,0	±1,0	–
	0,5 I_{max}	0,5 inductive	–	–	±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 half the basic current 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.

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