

**SASO IEC 60051-3:2020
IEC 60051-3:2018**

**direct acting indicating analogue electrical
measuring instruments and their accessories –
Part 3: Special requirements for wattmeters and varmeters**

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Saudi Standards, Metrology and Quality Org (SASO)

this document is a draft saudi standard circulated for comment. it is, therefore subject to change and may not be referred to as a saudi standard until approved by the board of directors.

Foreword

The Saudi Standards ,Metrology and Quality Organization (SASO)has adopted the International standard No. IEC 60051-3:2018 “direct acting indicating analogue electrical measuring instruments and their accessories – Part 3: Special requirements for wattmeters and varimeters” issued by (IEC). The text of this international standard has been translated into Arabic so as to be approved as a Saudi standard.

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INTRODUCTION

IEC 60051 is published in separate parts according to the following structure and under the general title: *Direct acting indicating analogue electrical measuring instruments and their accessories*.

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

IEC 60051-3 is not complete in itself and is read in conjunction with IEC 60051-1.

All of these parts are arranged in the same format and a standard relationship between subject and clause number is maintained throughout these parts. This arrangement will assist the reader of IEC 60051 to distinguish information relating to the different types of instruments.

**DIRECT ACTING INDICATING ANALOGUE ELECTRICAL
MEASURING INSTRUMENTS AND THEIR ACCESSORIES –****Part 3: Special requirements for wattmeters and varimeters****1 Scope**

This part of IEC 60051 applies to direct acting indicating wattmeters and varimeters having an analogue display.

NOTE For multi-function instruments, see IEC 60051-7.

It also applies to:

- non-interchangeable accessories (as defined in 3.1.23 of IEC 60051-1:2016) used with wattmeters and varimeters;
- a combination of the instruments and the accessories provided that the adjustments have been made for the combination;
- direct acting indicating electrical measuring instruments whose scale marks do not correspond directly to their electrical input quantity, provided that the relationship between them is known;
- instruments and accessories having electronic devices in their measuring and/or auxiliary circuits.

This document does not apply to:

- special purpose instruments which are covered by their own IEC standards;
- special purpose devices which are covered by their own IEC standards when they are used as accessories.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60051-1:2016, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

IEC 60051-9, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 9: Recommended test methods*

3 Terms and definitions

See IEC 60051-1:2016.

4 Description, classification and compliance

4.1 Description

See IEC 60051-1:2016.

4.2 Classification

See IEC 60051-1:2016.

4.3 Compliance with the requirements of this standard

See IEC 60051-1:2016.

5 Requirements

5.1 Reference conditions

See IEC 60051-1:2016; the reference value of the influence quantities should be as given in Table 2 of IEC 60051-1:2016 and Table 1.

Table 1 – Reference conditions and tolerances, in addition to those given in Table 2 of IEC 60051-1:2016, for testing purposes relating to the influence quantities

Influence quantity	Reference conditions unless otherwise marked		Tolerance permitted for testing purposes, applicable for a single reference value ^a
Voltage component of the measured power	Rated voltage or any voltage within the reference range		±2 % of the rated value
Current component of the measured power	Any current up to the rated current or up to the upper limit of the reference range		–
Frequency of voltage and current components of the measured power	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
Power factor	PF = 1 or rated value ^b		0,01 lagging or leading
Phase balance (for polyphase instruments)	Symmetrical voltages and currents		^c ^d
^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 Power factor for varmeters. Positive sign for lagging (inductive), negative sign for leading (capacitive).			
^c The difference between any two line-to-line voltages and between any two line-to-neutral voltages shall not exceed 1 % of the average (line-to-line and line-to-neutral voltages, respectively). Each of the currents in the phases shall differ by not more than 1 % from the average of the currents. The angles between each of the currents and the corresponding phase-to-neutral voltages shall differ by not more than 2°.			
^d Single-phase testing of polyphase instruments is acceptable if permitted by the manufacturer.			

5.2 Limits of intrinsic uncertainty, fiducial value

5.2.1 Limits of intrinsic uncertainty

See IEC 60051-1:2016.

5.2.2 Correspondence between intrinsic uncertainty and accuracy class

See IEC 60051-1:2016.

5.2.3 Fiducial value

5.2.3.1 The fiducial value for a wattmeter or varmeter corresponds to the following.

5.2.3.2 The upper limit of the measuring range for the following:

- instruments with the mechanical and/or electrical zero at one end of the scale;
- instruments with the mechanical zero outside the scale irrespective of the position of the electrical zero;
- instruments with the electrical zero outside the scale irrespective of the position of the mechanical zero.

The class index for these wattmeters or varmeters is marked using Symbol E-1 given in Table 6 of IEC 60051-1:2016 (see Clause 6 of IEC 60051-1:2016).

5.2.3.3 The sum of the absolute values of the upper and lower limit of the measuring range when both the mechanical and the electrical zeros are displaced within the scale.

The class index for these wattmeters or varmeters is marked using Symbol E-1 given in Table 6 of IEC 60051-1:2016 (see Clause 6 of IEC 60051-1:2016).

5.2.3.4 The span for an instrument whose scale marks do not correspond directly to its electrical input quantity.

The class index for these wattmeters or varmeters is marked using Symbol E-10 given in Table 6 of IEC 60051-1:2016 (see Clause 6 of IEC 60051-1:2016).

This does not apply to a wattmeter or varmeter designed to be used in conjunction with one or more shunt(s), series resistor(s) (impedance(s)) or (an) instrument transformer(s). These instruments are treated in accordance with 5.2.3.2 or 5.2.3.3 as appropriate.

5.3 Nominal range of use and variations

5.3.1 Nominal range of use

See IEC 60051-1:2016; the limits of the nominal range of use for influence quantities shall be as given in Table 3 of IEC 60051-1:2016 and Table 2.

**Table 2 – Limits of the nominal range of use and permissible variations
in addition to those given in Table 3 of IEC 60051-1:2016**

Influence quantity		Limits of the nominal range of use unless otherwise marked		Permissible variation expressed
Distortion of AC voltage or current components of the measured power	Distortion factor	Instruments using phase shifting devices	5 %	100 %
		Other instruments	20 %	
	Peak factor ^a	1 to 3 ^b		200 %
Frequency of AC voltage and current components of the measured power	Instruments using phase shifting devices	Reference frequency ± 1 % or lower limit of reference range - 1 % and upper limit of reference range + 1 %		100 %
	Other instruments	Reference frequency ± 10 % or lower limit of reference range - 10 % and upper limit of reference range + 10 %		
Voltage components of the measured power		Reference voltage ± 15 % or lower limit of reference range - 15 % and upper limit of reference range + 15 %		100 %
Power factor for wattmeters	Class indices 0,3 and smaller	Any: lagging or leading		100 %
	Class indices 0,5 and greater	Phase angle $0^\circ \dots 60^\circ$ ^c lagging (inductive)		
Power factor for varmeters	Class indices 0,3 and smaller	Any: lagging or leading		100 %
	Class indices 0,5 and greater	Phase angle $0^\circ \dots 60^\circ$ ^c lagging (inductive)		
Phase balance (for polyphase instruments)		Disconnection of one current component of the measured power		200 %
Interaction between measuring elements of polyphase instruments ^d		Disconnection of one voltage component of the measured power		200 %

Influence quantity	Limits of the nominal range of use unless otherwise marked	Permissible variation expressed		
Magnetic field of external origin	0,4kA/m		Class indices 0,3 and smaller	Class indices 0,5 and greater
		Electrodynamic instruments if not static and/or not having a magnetic screen	3 % of the fiducial values ^e	6 % of the fiducial values ^e
		Ferrodynamic instruments if not static and/or not having a magnetic screen	1,5 % of the fiducial values ^e	3 % of the fiducial values ^e
		All other instruments	0,75 % of the fiducial values ^e	1,5 % of the fiducial values ^e

^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 a sine wave) is included in the permissible variation due to distortion of the measured power.

For instruments having a peak factor capability greater than 3, the manufacturer shall state:

- 1) the instrument peak factor capability producing a variation of 100 % of the class index;
- 2) the upper and lower limits of the frequency response (bandwidth) to 0,707 times the indication at the reference frequency;
- 3) the effective maximum rate of change of internal instrument AC amplifier response (slew rate), expressed in volts per second using appropriate SI prefixes.

Peak factor relates to the total peak factor capability of the instrument and includes both the peak factor due to a distorted waveform and the peak factor due to spurious impulses (which may be random or harmonically related to the fundamental frequency) containing negligible average power.

^c Inductive power factor unless otherwise agreed between manufacturer and user.

^d It may sometimes be impossible to carry out a test for interaction between the measuring elements due to interconnection of the current and/or voltage circuits.

^e Not as a percentage of the class index.

5.3.2 Limits of variations

See IEC 60051-1:2016.

5.3.3 Conditions for the determination of variations

See IEC 60051-1:2016.

5.3.4 Determination of variation due to power factor

The power factor shall be lagging for instruments of class indices 0,5 and greater. For instruments of class indices 0,3 and smaller, the test shall be carried out using both lagging and leading power factors. The test shall be carried out with $PF = 0$.

For the recommended test, see IEC 60051-9.

5.3.5 Special tests for variations

Special tests using combinations of the components of the measured quantity may be carried out when considered necessary by agreement between manufacturer and user.

5.4 Operating uncertainty, overall system uncertainty and variations

See IEC 60051-1:2016.

5.5 Electrical requirements

5.5.1 Electrical safety requirements

See IEC 60051-1:2016.

5.5.2 Self-heating

See IEC 60051-1:2016.

5.5.3 Permissible overloads

5.5.3.1 Continuous overload

For the recommended test, see IEC 60051-9.

Wattmeters and varmeters, together with their non-interchangeable accessory (if any), except for instruments fitted with a non-locking switch, shall be subjected to a continuous overload of 120 % of the rated values of current and voltage sequentially, the other value being maintained at its rated value. The duration of each application shall be 2 h.

After having cooled to the reference temperature, the instrument, together with its non-interchangeable accessory (if any), shall comply with its accuracy requirements; however, the overload shall not be repeated.

The continuous overload test shall be carried out under reference conditions except for current and voltage. The test shall be carried out with $PF = 1$.

5.5.3.2 Overloads of short duration

5.5.3.2.1 For the recommended test, see IEC 60051-9.

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

However, these requirements do not apply to:

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

5.5.3.2.2 The values of current and voltage for the overloads of short duration shall be the product of the relevant factor given in Table 3 and the value of the upper limit of the nominal range of use for current and voltage unless other values are stated by the manufacturer. The power factor (reactive power factor) shall be at its reference value.

Table 3 – Overloads of short duration

Current factor	Voltage factor	Number of overloads	Duration of each overload (s)	Interval between successive overloads (s)
Class indices 0,5 and smaller				
1	2	1	5	–
2	1	5	0,5	15
Class indices 1 and greater				
10	1	9	0,5	60
10	1	1	5	–
1	2	1	5	–
When two or three series of tests are specified, all the tests should be carried out in the order given. The overloads of short duration are applied simultaneously to all the measuring elements of polyphase wattmeters and varmeters.				

5.5.3.2.3 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 3.

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

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

- a) the deviation of the index from the zero scale mark, expressed as a percentage of the scale length, shall not exceed the following value:
 - 1) 0,5 for instruments of class indices 0,5 and smaller,
 - 2) the class index for instruments of class indices 1 and greater;
- b) the wattmeter or varmeter, together with its non-interchangeable accessory (if any), after adjustment of the zero (if necessary) shall comply with the accuracy requirements; however, the overloads shall not be repeated.

A wattmeter or varmeter whose mechanical zero is outside the scale is considered to have complied with these requirements if, after having cooled to the reference temperature, it has errors not exceeding those relating to its class index; however, the overloads shall not be repeated.

5.5.4 Limiting range of temperature

See IEC 60051-1:2016.

5.5.5 Deviation from zero

5.5.5.1 General

For the recommended test, see IEC 60051-9.

If a wattmeter or varmeter has a zero position marked on the scale, it shall be tested for deviation from zero.

The test shall be carried out under reference conditions.

5.5.5.2 All circuits energized

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

5.5.5.3 Voltage circuit(s) only energized

With only the voltage circuit(s) energized, the deviation of the index from the zero scale mark shall not exceed a value corresponding to 100 % of the class index.

5.5.6 Electromagnetic compatibility (EMC)

See IEC 60051-1:2016.

5.6 Constructional requirements

5.6.1 General constructional requirements

See IEC 60051-1:2016.

5.6.2 Damping

5.6.2.1 General

See IEC 60051-1:2016.

5.6.2.2 Overshoot

See IEC 60051-1:2016.

5.6.2.3 Response time

See IEC 60051-1:2016.

However, the requirements of 5.6.2.2 of IEC 60051-1:2016 do not apply to the following types of wattmeters and varmeters:

- thermal instruments;
- instruments having a freely suspended moving element;
- instruments having a material pointer longer than 150 mm;
- instruments in which the power (active or reactive) corresponding to the upper limit of the measuring range is less than 10 W or 10 var;
- special purpose instruments where other response times may be required. Such instruments will be the subject of agreement between manufacturer and user.

5.6.2.4 Impedance of the external measuring circuit

See IEC 60051-1:2016.

5.6.3 Sealing to prevent access

See IEC 60051-1:2016.

5.6.4 Scales

See IEC 60051-1:2016.

5.6.5 Stopper

See IEC 60051-1:2016.

5.6.6 Preferred values

The upper limit of the measuring range for wattmeters and varimeters shall preferably be one of the following values:

1, 1,2, 1,5, 2, 2,5, 3, 4, 5, 6, 7,5, 8

or their decimal multiples and sub-multiples.

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

5.6.7 Adjusters, mechanical and/or electrical

See IEC 60051-1:2016.

5.6.8 Effects of vibration and shock

See IEC 60051-1:2016.

5.6.9 Degrees of protection provided by enclosure

See IEC 60051-1:2016.

5.6.10 Terminals

See IEC 60051-1:2016.

6 Information, markings and symbols**6.1 Information**

See IEC 60051-1:2016.

6.2 Markings, symbols and their locations

See IEC 60051-1:2016.

6.3 Markings relating to the reference values and nominal ranges of use of influence quantities

See IEC 60051-1:2016.

6.4 The symbols for marking instruments and accessories

See IEC 60051-1:2016.

6.5 Markings and symbols for terminals

6.5.1 Requirements for markings

See IEC 60051-1:2016.

6.5.2 Earthing (grounding) terminals

See IEC 60051-1:2016.

6.5.3 Measuring circuit terminals

See IEC 60051-1:2016.

6.5.4 Special markings for terminals

6.5.4.1 General

All terminals shall be marked to ensure that they can be uniquely identified.

6.5.4.2 Single element instruments

Wattmeters and varmeters having only two current terminals and two voltage terminals shall have the current and voltage terminals easily distinguishable. The current terminal which is normally associated with a particular voltage terminal shall be identified by both of them being marked with a common sign.

6.5.4.3 Polyphase instruments

For all polyphase wattmeters and varmeters, a connection diagram shall be provided, preferably affixed to the case.

The identification of a terminal on the instrument and on the connection diagram shall be identical.

The connection diagram shall show the intended interconnection of the elements of the instrument with the external circuit.

6.6 Instructions for use

See IEC 60051-1:2016.

7 Package

See IEC 60051-1:2016.

8 Test rules

See IEC 60051-1:2016.

The recommended nonconformity classification of tests is given in Annex A.

The method of acceptance inspection may be agreed between the manufacturer and the customer.

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Annex A
(normative)

Nonconformity classification of tests

The recommended nonconformity classification of tests is listed in Table A.1.

Table A.1 – Nonconformity classification of tests

Test	Nonconformity class
Limits of intrinsic uncertainty (5.2.1)	A
Limits of variations (5.3.2)	B
Electrical safety requirements (5.5.1)	A
Self-heating (5.5.2)	B
Permissible overloads (5.5.3)	B
Limiting range of temperature (5.5.4)	B
Deviation from zero (5.5.5)	B
Electromagnetic compatibility (EMC) (5.5.6)	B
Damping (5.6.2)	B
Adjusters, mechanical and/or electrical (5.6.7)	B
Effects of vibration and shock (5.6.8)	B
Degrees of protection provided by enclosure (5.6.9)	B
Terminals (5.6.10)	B

Bibliography

IEC 60051-7, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 7: Special requirements for multi-function instruments*

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