

Title: **STANDARD FOR CALIBRATION  
AND LIMITS OF ERRORS FOR  
SINGLE- AND THREE PHASE  
ENERGY METERS**

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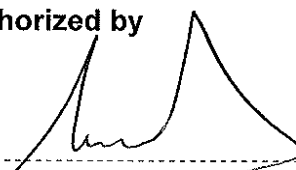


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## **1. Introduction**

This document describes the limits of errors for single and three phase energy meters and provides test requirements of all additional testing to be done during calibration.

## **2. Supporting clauses**

### **2.1 Scope**

#### **2.1.1 Purpose**

The purpose of this document is to specify the limits of errors for calibrating energy meters. It also covers minimum additional tests to be conducted during the calibration of energy meters.

#### **2.1.2 Applicability**

This document is applicable to all persons in Distribution who are responsible for the calibration and testing of energy meters.

### **2.2 Normative/informative references**

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

#### **2.2.1 Normative**

- [1] ISO 9001 Quality Management Systems.
- [2] SANS 62052 part 11, Electricity metering equipment (AC) - General requirements, tests and test conditions
- [3] SANS 62053 part 11, Electricity metering equipment (AC) - Particular requirements: Electromechanical meters for active energy (classes 0.5, 1 and 2)
- [4] SANS 62053 part 21, Electricity metering equipment (AC) - Particular requirements: Static meters for active energy (classes 1 and 2)
- [5] SANS 62053 part 22, Electricity metering equipment (AC) - Particular requirements: Static meters for active energy (classes 0.2S and 0.5S)
- [6] SANS 62053 part 23, Electricity metering equipment (AC) - Particular requirements: Static meters for reactive energy (classes 2 and 3)
- [7] SANS 62053 part 24, Electricity metering equipment (a.c.) – Particular requirements: Static meters for reactive energy at fundamental frequency (classes 0,5 S, 1 S and 1)
- [8] IEC 62058 part 21: Electricity metering equipment (AC) – Acceptance inspection Part 21: Particular requirements for electromechanical meters for active energy (classes 0.5, 1 and 2)
- [9] IEC 62058 part 31, Electricity metering equipment (AC) - Acceptance inspection: Particular requirements for static meters for active energy (classes 0.2S, 0.5S, 1 and 2)

#### **2.2.2 Informative**

None

## 2.3 Definitions

### 2.3.1 General

Definition	Description
<b>“Tested” sticker</b>	A sturdy label applied to the side of the meter cover, indicating that the meter was calibrated by whom, and when.
<b>Accuracy class</b>	A designation assigned to an instrument transformer, the current or voltage error and phase displacement of which remain within specified limits under prescribed conditions of use.
<b>Accuracy class index</b>	A number that gives the limits of the permissible percentage error as defined in the applicable specification for a meter when the meter is tested under reference conditions. <b>Note:</b> Multi-range and multi-purpose instruments may have more than one accuracy class index.
<b>Active energy meter</b>	An instrument intended to measure active energy by integrating active power with respect to time. For metering purposes, the unit of active energy is kWh
<b>Basic current (<math>I_b</math>)</b>	Basic current is that value of the current in accordance with which the relevant performance of the meter is fixed.
<b>Calibration</b>	Comparison of the indication of an instrument under test, or registration of the meter under test, with an appropriate standard.
<b>Electronic meter</b>	A device in which the measurements are made by means of an electronic technique.
<b>Induction meter</b>	A meter in which currents in fixed coils react with currents induced in the conducting moving element, generally a disk(s), which cause their movement proportional to the energy to be measured.
<b>Maximum current (<math>I_{max}</math>)</b>	Highest value of the current at which the meter purports to meet the accuracy requirements.
<b>Meter constant</b>	Value expressing the relation between the energy registered by the meter and the corresponding value of the test output. If the test output is pulses, the constant should be either pulses per kilowatt-hour (imp/kWh) or watt-hours per pulse (Wh/imp).
<b>Nominal current (<math>I_n</math>)</b>	Value of current in accordance with which the relevant performance of a transformer operated meter are fixed (1 A or 5 A).
<b>Reactive energy meter (var-hour meter)</b>	An instrument intended to measure reactive energy by integrating reactive power with respect to time. For metering purposes, the unit for reactive energy is kvarh
<b>Register</b>	This term was derived from the visible dial on the faceplate of the electro-mechanical meters, where the register provided an indication of the energy usage. In electronic meters, this term refers to the non-volatile memory locations within the metering device where similar energy usage information is stored.
<b>Starting current (<math>I_{st}</math>)</b>	The lowest value of the current at which the meter starts and continues to register.

### 2.3.2 Disclosure classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

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## 2.4 Abbreviations

Abbreviation	Description
<b>C</b>	Celcius
<b>I</b>	Current.
<b>I<sub>b</sub></b>	The basic current of the meter (direct connect or whole current meters).
<b>I<sub>max</sub></b>	The maximum current of the meter.
<b>I<sub>n</sub></b>	The nominal current of the meter (transformer connected meters).
<b>kWh</b>	Kilowatt hour
<b>pf</b>	Power factor
<b>SABS</b>	South African Bureau of Standards
<b>SANAS</b>	South African National Accreditation System.
<b>V</b>	Voltage
<b>V<sub>nom</sub></b>	Nominal voltage. For the purpose of this specification the voltage is 230V

## 2.5 Roles and responsibilities

The requirements of this document shall be used in the calibration of energy meters by calibration laboratories.

## 2.6 Process for monitoring

The Metering and Measurement Study Committee shall ensure that this standard be implemented.

## 2.7 Related/supporting documents

This document supersedes 240-77224537 revision 1 – Standard for calibration and limits of errors for single- and three phase energy meters.

## 3. Requirements

### 3.1 Calibration reference conditions

- 3.1.1** Ideally the meter shall be tested with its cover in position.
- 3.1.2** The voltage and auxiliary circuits shall have been energized for a time sufficient to reach thermal stability.
- 3.1.3** For polyphase meters:
- The phase sequence shall be as marked on the diagram of connections.
  - Each of the voltages between line and neutral and between any two lines shall not differ from the average corresponding voltage by more than  $\pm 1\%$ .
  - Each of the currents shall not differ from the average current by more than  $\pm 1\%$
  - The phase displacement of each of these currents from the corresponding line – to – neutral voltage, irrespective of the power factor, shall not differ from each other by more than 2 degrees.
- 3.1.4** The voltage shall be within  $\pm 1\%$  of the nominal voltage.
- 3.1.5** The ambient temperature shall be 23 degrees C  $\pm$  3 degrees C.

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**3.1.6** The voltage and current wave-forms shall be sinusoidal with a distortion factor less than 2 %.

**3.1.7** Magnetic induction external to the meter shall not exceed 0,05 mT.

**3.1.8** An appropriate energy standard shall be used as reference device. The standard shall:

- Be traceable to National Measuring Standards.
- Be at least five times more accurate than the device under test (Ten times more accurate is preferred).

## 3.2 Limits of errors

### 3.2.1 Active energy meters percentage error limits (single- and polyphase meters with balanced loads)

When the meter is under the reference conditions given in 3.1, the percentage errors shall not exceed the limits for the relevant accuracy class given in the following table:

Direct / Transformer connected	Current Value (A)	Power Factor	± Percentage error limits per meter class					
			0,2S	0,5S	0,2	0,5	1	2
Transformer	$0,01 I_n \leq I < 0,05 I_n$	1	0,4	1,0				
	$0,05 I_n \leq I \leq I_{max}$	1	0,2	0,5				
	$0,02 I_n \leq I < 0,1 I_n$	0,5 lag 0,8 lead	0,5	1,0				
	$0,1 I_n \leq I \leq I_{max}$	0,5 lag 0,8 lead	0,3	0,6				
Transformer	$0,02 I_n \leq I < 0,05 I_n$	1			0,5	1,2	1,5	2,5
	$0,05 I_n \leq I \leq I_{max}$	1			0,2	0,5	1,0	2,0
	$0,05 I_n \leq I < 0,1 I_n$	0,5 lag 0,8 lead			0,5	1,0	1,5	2,5
	$0,1 I_n \leq I \leq I_{max}$	0,5 lag 0,8 lead			0,2	0,5	1,0	2,0
Direct	$0,05 I_b \leq I < 0,1 I_b$	1			0,5	1,2	1,5	2,5
	$0,1 I_b \leq I \leq I_{max}$	1			0,2	0,5	1,0	2,0
	$0,1 I_b \leq I < 0,2 I_b$	0,5 lag 0,8 lead			0,5	1,0	1,5	2,5
	$0,2 I_b \leq I \leq I_{max}$	0,5 lag 0,8 lead			0,2	0,5	1,0	2,0
								-

### 3.2.2 Active energy meters percentage error limits (polyphase meters carrying a single phase load, but with balanced polyphase voltages applied to the voltage circuits)

When the meter is under the reference conditions given in 3.1, (\*EXCEPT IF AND WHERE OTHERWISE INDICATED), the percentage errors shall not exceed the limits for the relevant accuracy class given in the following table:

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Direct/ Transformer connected	Current Value (A)	Power Factor	± Percentage error limits per meter class			
			0,2S	0,5S	1	2
Transformer	$0,05 I_n \leq I \leq I_{max}$	1	0,3	0,6	2,0	3,0
	$0,1 I_n \leq I \leq I_{max}$	0,5 lag	0,4	1,0	2,0	3,0
Direct	$0,1 I_b \leq I \leq I_{max}$	1			2,0	3,0
	$0,2 I_b \leq I \leq I_{max}$	0,5 lag			2,0	3,0

### 3.2.3 Reactive energy meters percentage error limits (single- and polyphase meters with balanced loads)

When the meter is under the reference conditions given in 3.1, the percentage errors shall not exceed the limits for the relevant accuracy class given in the following table:

Direct/ Transformer connected	Current Value (A)	Power Factor	± Percentage error limits per meter class			
			0,5S	1S&1	2,0	3,0
Transformer	$0,02 I_n \leq I < 0,05 I_n$	0	1,0	1,5	2,5	4,0
	$0,05 I_n \leq I \leq I_{max}$	0	0,5	1,0	2,0	3,0
	$0,05 I_n \leq I < 0,1 I_n$	0,866 lag	1,0	1,5	2,5	4,0
	$0,1 I_n \leq I \leq I_{max}$	0,866 lag	0,5	1,0	2,0	3,0
	$0,1 I_n \leq I \leq I_{max}$	0,966 lag	1,0	2,0	2,5	4,0
Direct	$0,05 I_b \leq I < 0,1 I_b$	0	1,0	1,5	2,5	4,0
	$0,1 I_b \leq I \leq I_{max}$	0	0,5	1,0	2,0	3,0
	$0,1 I_b \leq I < 0,2 I_b$	0,866 lag	1,0	1,5	2,5	4,0
	$0,2 I_b \leq I \leq I_{max}$	0,866 lag	0,5	1,0	2,0	3,0
	$0,2 I_b \leq I \leq I_{max}$	0,966 lag	1,0	2,0	2,5	4,0

### 3.2.4 Reactive energy meters percentage error limits (polyphase meters carrying a single phase load, but with balanced polyphase voltages applied to the voltage circuits)

When the meter is under the reference conditions given in 3.1, (\* EXCEPT IF AND WHERE OTHER WISE INDICATED), the percentage errors shall not exceed the limits for the relevant accuracy class given in the following table:

Direct/ Transformer connected	Current Value (A)	Power Factor	± Percentage error limits per meter class			
			0,5S	1S&1	2,0	3,0
Transformer	$0,05 I_n \leq I \leq I_{max}$	0	0,7	1,5	3,0	4,0
	$0,1 I_n \leq I \leq I_{max}$	0,866 lag	1,0	2,0	3,0	4,0
Direct	$0,1 I_b \leq I \leq I_{max}$	0	0,7	1,5	3,0	4,0
	$0,2 I_b \leq I \leq I_{max}$	0,866	1,0	2,0	3,0	4,0

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### 3.3 Running with no-load

When the voltage is applied with no current flowing in the current circuit, the test output of the meter shall not produce more than one pulse or one revolution within 10 minutes.

### 3.4 Starting current

The meter shall start and continue to register at the current values as specified in the table below.

Meter type	Class of meter				Power factor	
	0.2S	0.5S	1	2	Active energy meters	Reactive energy meters
Direct connection	-	-	0.4% $I_b$	0.5% $I_b$	1	0
Transformer connected	0.1% $I_n$	0.1% $I_n$	0.2% $I_n$	0.3% $I_n$	1	0

If the meter is designed for the measurement of energy in both directions, then the test shall be applied in each direction.

### 3.5 Meter constants

The following meter related constants shall be verified.

#### 3.5.1 Dial Constant

The meter shall be energized and enough energy registered to accumulate at least 10 least significant digits on the dial/register. The true energy consumed shall be compared to the dial/register reading to verify that the dial/register constant is correct.

#### 3.5.2 Calibration Constant

The calibration constant as indicated for the calibration pulses shall be used to calibrate the energy meter. Correct verification of these pulses will also prove the accuracy of the energy meter.

#### 3.5.3 Re-transmitting Pulses Constant

The re-transmitting pulses shall be verified against the stated constant for these pulses and an external energy standard. The pulse accuracies must be within the class limit of the meter.

These results need not be recorded, as it is a short term verification of coarse pulse values. The accuracy of the meter was proved with the calibration pulses.

## 4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
P Moyo	General Manager: Power Delivery Engineering
Sikelela Mkhabela	Senior Manager Maintenance and Operations



## 5. Revisions

Date	Rev	Compiler	Remarks
March 2019	2	HPD Groenewald	3.2.3 Added requirements for class 0.5S, 1S & 1 3.2.4 Added requirements for class 0.5S, 1S & 1
March 2014	1	HPD Groenewald	New number allocated to document No technical content changes.
Dec. 2008	0	HPD Groenewald	Development team, Keywords, Introduction added Document formatted into new template. Added starting current requirements Unique Identifier changed from SCSPVACZ3 to 34-855

## 6. Development team

The following people were involved in the development of this document:

- Henri Groenewald PTM&C
- D Solomons WCOU

## 7. Acknowledgements

Not applicable.

## **Annex A – Requirements for the "Tested" sticker**

- It shall be a polyurethane, permanent sticker.
- Printing shall be black on a yellow background.
- The sticker surface shall accept writing with a permanent marker.
- The size of the sticker shall be 40mm long and 8mm wide.
- The test facility's name shall be pre-printed on the sticker by using a bold Arial font, size 8 and all in capital letters - see samples.
- The "TESTED /20" shall be pre-printed on the sticker by using a bold Arial font, size 12 and all in capital letters - see samples.
- The letter spacing shall be as shown in the samples.



**SCHLUMBERGER TESTING**  
**TESTED /20**



**ESKOM BRACKENFELL**  
**TESTED /20**

**Figure A.1: Sample sticker**

### **Instructions for the use of the sticker**

- A permanent, black marker shall be used for writing. The month of calibration shall be written in the space between "TESTED" and "/20" on the sticker. Numbers shall be used, for example 01 for January and 12 for December. The year of calibration shall be written in the space after "/20" on the sticker. Two digits shall be used, for example 01 for 2001 and 05 for 2005.
- The sticker shall be applied to the nameplate of the meter. It shall be clearly visible from outside the meter with the meter cover in place. It shall not obscure information on the nameplate of the meter.