CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

NATIONAL METROLOGY INSTITUTE OF SOUTH AFRICA

ELECTRICAL DCLF LABORATORY

Accreditation Number: **1612**

is a South African National Accreditation System accredited Calibration Laboratory provided that all SANAS conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying scope of accreditation, Annexure "A", bearing the above accreditation number for

DC LOW FREQUENCY METROLOGY

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2017

The accreditation demonstrates technical competency for a defined scope and the operation of a laboratory quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant SANAS accreditation symbol to issue facility reports and/or certificates

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Mr T Baleni
Acting Chief Executive Officer

Effective Date: 02 August 2021
Certificate Expires: 10 July 2026

ANNEXURE A

SCOPE OF ACCREDITATION

DC LOW FREQUENCY METROLOGY

Accreditation Number: 1612

Permanent Address of Laboratory:
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Mr M Khoza (Items 1.1.1b ,1.1.2, 1.1.3, 1.2, 2, 3 & 4)
Mr PJ Prinsloo (Items 5, 6 & 7)
Dr E Golovins (Item 5.1, 5.2, 6.1 & 6.2)
Mr M Hlakola (Items 1.1.1b, 1.1.2, 1.1.3,1.2, 2.1, 2.3, 4, 4.2 & 4.3.5)

Nominated Representative: Ms LN Ntatamala

Issue No.: 16
Date of Issue: 26 April 2022
Expiry Date: 10 July 2026

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
1	**DC Voltage**			
1.1	**DC Voltage sources**			
1.1.1 (a)	Single values (≤ 10 V) DC reference standards (Josephson Voltage)			
	1 V	DC	$1 \cdot 10^{-7} \cdot U$	Direct comparison with Josephson voltage standard.
	1,018 V	DC	$1 \cdot 10^{-7} \cdot U$	
	10 V	DC	$2 \cdot 10^{-8} \cdot U$	
1.1.1 (b)	Single values (≤ 10 V) DC reference standards (8 000A)			
	1 V	DC	$4 \cdot 10^{-7} \cdot U$	Direct comparison with DC voltage reference standard using an automatic potentiometer.
	1,018 V	DC	$4 \cdot 10^{-7} \cdot U$	
	10 V	DC	$2 \cdot 10^{-7} \cdot U$	
1.1.2	Low values (≤ 10 V) Multifunction calibrator			
	100 mV	DC	$12 \cdot 10^{-6} \cdot U$	Direct comparison with DC voltage reference standard using a reference divider.
	1 V	DC	$1,6 \cdot 10^{-6} \cdot U$	
	10 V	DC	$1,2 \cdot 10^{-6} \cdot U$	

The CMC, expressed as an expanded uncertainty of measurement, is stated as the standard uncertainty of measurement multiplied by a coverage factor k = 2, corresponding to a confidence level of approximately 95%

Accreditation Manager

ANNEXURE A

Accreditation No.: 1612
Date of Issue: 26 April 2022
Expiry Date: 10 July 2026

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
1.1.3	Intermediate values (> 10 V to 1100 V) Multifunction calibrator			
	100 V 1 000 V	DC DC	$1{,}5 \cdot 10^{-6} \cdot U$ $1 \cdot 10^{-5} \cdot U$	Direct comparison with DC voltage reference standard using a reference divider.
1.2	**DC Voltage meters**			
1.2.1	Very low values (≤ 1 mV) Digital multimeter, nano voltmeters			
	0 mV 1 mV		10 nV $5 \cdot 10^{-5} \cdot U$	Direct comparison with DC voltage source using a resistive divider and short.
1.2.2	Intermediate values (> 1 mV to 1100 V) Digital multimeters, nano voltmeters			
	1 mV to 10 mV 10 mV to 100 mV 0,1 V to 1 000 V		$5 \cdot 10^{-5} \cdot U$ $2 \cdot 10^{-5} \cdot U$ $1 \cdot 10^{-5} \cdot U$	Direct comparison with DC voltage source using a resistive divider and direct comparison with DC voltage source.
2	**DC Resistance**			
2.1	**DC Resistance standards and sources.**			
2.1.1	Low values (≤ 1 Ω) Fixed resistor, resistance box, multifunction calibrator			
	10 µΩ to 1 mΩ 1 mΩ to 10 mΩ 10 mΩ to 100 mΩ 100 mΩ to 1 Ω		$7 \cdot 10^{-6} \cdot R$ $2 \cdot 10^{-6} \cdot R$ $2 \cdot 10^{-6} \cdot R$ $1 \cdot 10^{-6} \cdot R$	Comparison with reference standard resistors using an automated resistance bridge.
2.1.2	Intermediate values (> 1 Ω to 1 MΩ) Fixed resistor, resistance box, multifunction calibrator			
	1 Ω to 10 Ω 10 Ω to 100 Ω 100 Ω to 1 kΩ 1 kΩ to 10 kΩ 10 kΩ to 100 kΩ 100 kΩ to 1 MΩ		$2 \cdot 10^{-7} \cdot R$ $3 \cdot 10^{-7} \cdot R$ $4 \cdot 10^{-7} \cdot R$ $5 \cdot 10^{-7} \cdot R$ $2 \cdot 10^{-6} \cdot R$ $4 \cdot 10^{-6} \cdot R$	Comparison with reference standard resistors using an automated resistance bridge.

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Accreditation Manager

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PRECEDURE
2.1.3	High values (> 1 MΩ) Fixed resistor, resistance box, multifunction calibrator			
	1 MΩ to 10 MΩ 10 MΩ to 100 MΩ 100 MΩ to 1 GΩ 1 GΩ to 10 GΩ 10 GΩ to 100 GΩ 100 GΩ to 1 TΩ		$6•10^{-6}•R$ $6•10^{-6}•R$ $9•10^{-6}•R$ $7•10^{-5}•R$ $3•10^{-4}•R$ $2•10^{-3}•R$	Comparison with reference standard resistors using an automated resistance bridge.
2.2	**DC resistance meters**			
2.2.1	Low values (≤ 1 Ω) Micro-ohm meter, multimeter, resistance bridge			
	0 Ω 1 Ω		0,3 µΩ $1•10^{-6}•R$	Direct comparison with standard resistor or short.
2.2.2	Intermediate values (> 1 Ω to 1 GΩ) ohm meter, multimeter, resistance bridge			
	10 Ω to 100 Ω 100 Ω to 1 kΩ 1 kΩ to 10 kΩ 10 kΩ to 100 kΩ 100 kΩ to 1 MΩ 1 MΩ to 10 MΩ 10 MΩ to 100 MΩ 100 MΩ to 1 GΩ		$2 •10^{-6}•R$ $3•10^{-6}•R$ $3•10^{-6}•R$ $3•10^{-6}•R$ $5•10^{-6}•R$ $7•10^{-6}•R$ $9•10^{-6}•R$ $2•10^{-5}•R$	Direct comparison with standard resistors.
2.2.3	High values (> 1 GΩ) multimeter, multifunctional transfer std teraohmmeter			
	1 GΩ to 10 GΩ 10 GΩ to 100 GΩ 100 GΩ to 1 TΩ		$7•10^{-5}•R$ $3•10^{-4}•R$ $2•10^{-3}•R$	Direct comparison with standard resistors.
3	**DC current (up to 100A)**			
3.1	**DC current sources**			
3.1.1	Low values (≤ 0,1 mA) Current generator, multifunction calibrator.			
	0,1 µA to 1 µA 1 µA to 10 µA 10 µA to 100 µA	DC DC DC	$2•10^{-4}•I$ $5•10^{-5}•I$ $3•10^{-5}•I$	Current volt-drop method using standard resistors and DMM.
3.1.2	Intermediate values (> 0,1 mA to 20 A) Current generator, multifunction calibrator			
	0,1 mA to 1 mA 1 mA to 10 mA 10 mA to 100 mA 0,1 A to 1 A 1 A to 20 A	DC DC DC DC DC	$3•10^{-5}•I$ $3•10^{-5}•I$ $3•10^{-5}•I$ $3•10^{-5}•I$ $3•10^{-5}•I$	Current volt-drop method using standard resistors and DMM.

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Accreditation Manager

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
3.1.3	High values (> 20 A to 100 A) Current generator.			
	20 A to 100 A	DC	$2 \cdot 10^{-4} \cdot I$	Current volt-drop method using standard resistors and DMM.
3.2	**DC current meters.**			
3.2.1	Low values (≤ 0,1 mA) pico ammeter, nano ammeter, multimeter.			
	0 µA		0,04 µA	Direct comparison with current source output.
	0,1 µA to 1 µA		$2 \cdot 10^{-4} \cdot I$	
	1 µA to 10 µA		$5 \cdot 10^{-5} \cdot I$	
	10 µA to 100 µA		$3 \cdot 10^{-5} \cdot I$	
3.2.2	Intermediate values (> 0,1 mA to 20 A) multimeter, current meter			
	0,1 mA to 1 mA		$3 \cdot 10^{-5} \cdot I$	Direct comparison with current source output.
	1 mA to 10 mA		$3 \cdot 10^{-5} \cdot I$	
	10 mA to 100 mA		$3 \cdot 10^{-5} \cdot I$	
	0,1 A to 1 A		$3 \cdot 10^{-5} \cdot I$	
	1 A to 20 A		$3 \cdot 10^{-5} \cdot I$	
4	**Impedance (up to 200 kHz range)**			
4.2	**Capacitance**			
4.2.1	Capacitance and dissipation factor for low loss capacitors, standard capacitor (sealed, dry-nitrogen, fused silica)			
	1 pF to 100 pF	1 kHz	$4 \cdot 10^{-7} \cdot C$	Comparison with reference standard capacitors using an LCR bridge.
	1 nF to 100 nF	1 kHz	$6 \cdot 10^{-6} \cdot C$	
	1 µF	1 kHz	$5 \cdot 10^{-5} \cdot C$	
	10 µF	1 kHz	$2 \cdot 10^{-4} \cdot C$	
	1 pF to 1 µF	10 kHz	$4 \cdot 10^{-4} \cdot C$	
	10 µF	10 kHz	$6 \cdot 10^{-4} \cdot C$	
	1 pF to 100 nF	100 kHz	$3 \cdot 10^{-4} \cdot C$	
	1 µF	100 kHz	$8 \cdot 10^{-4} \cdot C$	
	1 pF	1 MHz	$2 \cdot 10^{-3} \cdot C$	
	10 pF to 10 nF	1 MHz	$8 \cdot 10^{-4} \cdot C$	
	100 nF	1 MHz	$2 \cdot 10^{-3} \cdot C$	

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Accreditation Manager

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
4.2.2	Capacitance and dissipation factor for dielectric capacitors, fixed capacitor, switched capacitor, capacitance box			
	1 pF to 100 pF	1 kHz	$4 \cdot 10^{-7} \cdot C$	Comparison with reference standard capacitors using a LCR bridge.
	1 nF to 100 nF	1 kHz	$6 \cdot 10^{-6} \cdot C$	
	1 µF	1 kHz	$5 \cdot 10^{-5} \cdot C$	
	10 µF	1 kHz	$2 \cdot 10^{-4} \cdot C$	
	1 pF to 1 µF	10 kHz	$4 \cdot 10^{-4} \cdot C$	
	10 µF	10 kHz	$6 \cdot 10^{-4} \cdot C$	
	1 pF to 100 nF	100 kHz	$3 \cdot 10^{-4} \cdot C$	
	1 µF	100 kHz	$8 \cdot 10^{-4} \cdot C$	
	1 pF	1 MHz	$2 \cdot 10^{-3} \cdot C$	
	10 pF to 10 nF	1 MHz	$8 \cdot 10^{-4} \cdot C$	
	100 nF	1 MHz	$2 \cdot 10^{-3} \cdot C$	
4.2.3	Capacitance and dissipation factor for transformed capacitors, fixed capacitor, switched capacitor			
	1 pF to 100 pF	1 kHz	$4 \cdot 10^{-7} \cdot C$	Comparison with reference standard capacitors using a LCR bridge.
	1 nF to 100 nF	1 kHz	$6 \cdot 10^{-6} \cdot C$	
	1 µF	1 kHz	$5 \cdot 10^{-5} \cdot C$	
	10 µF	1 kHz	$2 \cdot 10^{-4} \cdot C$	
	1 pF to 1 µF	10 kHz	$4 \cdot 10^{-4} \cdot C$	
	10 µF	10 kHz	$6 \cdot 10^{-4} \cdot C$	
	1 pF to 100 nF	100 kHz	$3 \cdot 10^{-4} \cdot C$	
	1 µF	100 kHz	$8 \cdot 10^{-4} \cdot C$	
	1 pF	1 MHz	$2 \cdot 10^{-3} \cdot C$	
	10 pF to 10 nF	1 MHz	$8 \cdot 10^{-4} \cdot C$	
	100 nF	1 MHz	$2 \cdot 10^{-3} \cdot C$	
4.2.4	Meters, capacitance bridge, LCR meter			
	1 pF to 100 pF	1 kHz	$4 \cdot 10^{-7} \cdot C$	Comparison with reference standard capacitors using a LCR bridge.
	1 nF	1 kHz	$3 \cdot 10^{-4} \cdot C$	
	10 nF to 1 µF	1 kHz	$7 \cdot 10^{-5} \cdot C$	
	10 µF	1 kHz	$3 \cdot 10^{-4} \cdot C$	
	1 pF to 100 nF	10 kHz	$3 \cdot 10^{-4} \cdot C$	
	1 µF to 10 µF	10 kHz	$6 \cdot 10^{-4} \cdot C$	
	1 pF to 100 nF	100 kHz	$4 \cdot 10^{-4} \cdot C$	
	1 µF	100 kHz	$8 \cdot 10^{-4} \cdot C$	
	1 pF	1 MHz	$2 \cdot 10^{-3} \cdot C$	
	1 pF to 10 nF	1 MHz	$8 \cdot 10^{-3} \cdot C$	
	100 nF	1 MHz	$2 \cdot 10^{-3} \cdot C$	

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Accreditation Manager

ANNEXURE A

Accreditation No.: 1612
Date of Issue: 26 April 2022
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ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
4.3	**Inductance**			
4.3.1	Low values (< 1 mH) self-inductance and equivalent series resistance, fixed inductor, variable inductor, inductance box			
	100 µH	1 kHz	$3 \cdot 10^{-4} \cdot L$	Comparison with reference standard inductors using an LCR bridge
4.3.2	Intermediate values (≥1 mH to 1 H) self-inductance and equivalent series resistance, fixed inductor, variable inductor, inductance box			
	1 mH 10 mH 100 mH 1 H 1 H	1 kHz 1 kHz 1 kHz 1 Hz 100 Hz	$7 \cdot 10^{-5} \cdot L$ $7 \cdot 10^{-5} \cdot L$ $7 \cdot 10^{-5} \cdot L$ $7 \cdot 10^{-5} \cdot L$ $8 \cdot 10^{-5} \cdot L$	Comparison with reference standard inductors using an LCR bridge
4.3.3	High values (> 1 H) self inductance and equivalent series resistance, fixed inductor, variable inductor, inductance box			
	10 H 10 H	100 Hz 1 kHz	$8 \cdot 10^{-5} \cdot L$ $4 \cdot 10^{-5} \cdot L$	Comparison with reference standard inductors using an LCR bridge.
4.3.5	Meters, LCR meter			
	100 µH 1 mH 10 mH 100 mH 1 H 10 H 1 H 10 H	1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 100 Hz 100 Hz	$3 \cdot 10^{-4} \cdot L$ $7 \cdot 10^{-5} \cdot L$ $7 \cdot 10^{-5} \cdot L$ $7 \cdot 10^{-5} \cdot L$ $7 \cdot 10^{-5} \cdot L$ $4 \cdot 10^{-5} \cdot L$ $8 \cdot 10^{-5} \cdot L$ $8 \cdot 10^{-5} \cdot L$	Direct comparison with standard inductors.
5	**AC voltage (up to the MHz range)**			
5.1	**AC/DC voltage transfer**			
5.1.1	AC/DC transfer difference at low voltages (typically below or equal to 500 mV)			
	2 mV to 200 mV 2 mV to 200 mV 200 mV to 0,5 mV 0,2 V to 0,5 V	10 Hz to 300 kHz 300 kHz to 1 MHz 10 Hz to 1 MHz 10 Hz to 1 MHz	400 µV/V 900 µV/V 60 µV/V 60 µV/V	Micro-potentiometer step-down measurement; Direct comparison with reference standard

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Accreditation Manager

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
5.1.2	AC/DC transfer difference at low voltages (typically above 500 mV to 5 V)			
	0,5 V to 5 V	10 Hz to 1 MHz	60 µV/V	Direct comparison with reference standard
5.1.3	AC/DC transfer difference at higher voltages (typically 5 V)			
	5 V to 30 V 5 V to 30 V 30 V to 1 000 V	10 Hz to 100 kHz 100 kHz to 1 MHz 10 Hz to 100 kHz	30 µV/V 100 µV/V 70 µV/V	Direct comparison with reference standard
5.2	**AC voltage up to 1100 V**			
5.2.1	Sources, multifunction calibrator			
	2 mV to 30 mV 30 mV to 200 mV 200 mV to 30 V 200 mV to 20 V 30 V to 1 000 V	10 Hz to 1 MHz 10 Hz to 1 MHz 10 Hz to 100 kHz 100 kHz to 1 MHz 10 Hz to 100 kHz	$1{,}3 \cdot 10^{-3} \cdot U$ $3 \cdot 10^{-4} \cdot U$ $4 \cdot 10^{-5} \cdot U$ $1 \cdot 10^{-4} \cdot U$ $1 \cdot 10^{-4} \cdot U$	Measurement with AC/DC transfer standard
5.2.2	Meters, ac voltmeter			
	2 mV to 200 mV 2 mV to 200 mV 200 mV to 30 V 200 mV to 30 V 30 V to 1 000 V	10 Hz to 300 kHz 300 kHz to 1 MHz 10 Hz to 100 kHz 100 kHz to 1 MHz 10 Hz to 100 kHz	$5 \cdot 10^{-4} \cdot U$ $1 \cdot 10^{-3} \cdot U$ $5 \cdot 10^{-5} \cdot U$ $1 \cdot 10^{-4} \cdot U$ $7 \cdot 10^{-5} \cdot U$	Measurement with AC/DC transfer standard
6	**AC current**			
6.1	**AC/DC current transfer**			
6.1.1	AC/DC transfer difference			
	2 mA to 5 mA 2 mA to 5 mA 2 mA to 5 mA 5 mA to 20 mA 5 mA to 20 mA 5 mA to 20 mA 20 mA to 50 mA 20 mA to 50 mA 20 mA to 50 mA 50 mA to 300 mA 50 mA to 300 mA 50 mA to 300 mA 50 mA to 300 mA 50 mA to 300 mA	10 Hz to 5 kHz 5 kHz to 50 kHz 50 kHz to 100 kHz 10 Hz to 5 kHz 5 kHz to 50 kHz 50 kHz to 100 kHz 10 Hz to 5 kHz 5 kHz to 50 kHz 50 kHz to 100 kHz 10 Hz to 20 Hz 20 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	20 µA/A 25 µA/A 41 µA/A 16 µA/A 20 µA/A 30 µA/A 20 µA/A 27 µA/A 39 µA/A 27 µA/A 23 µA/A 28 µA/A 37 µA/A 51 µA/A	Direct comparison with reference standard.

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Accreditation Manager

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
6.1.1	AC/DC transfer difference (Continued from previous page)			
	300 mA to 2 A	10 Hz to 20 Hz	41 µA/A	Direct comparison with reference standard
	300 mA to 2 A	20 Hz to 10 kHz	29 µA/A	
	300 mA to 2 A	10 kHz to 20 kHz	42 µA/A	
	300 mA to 1 A	20 kHz to 50 kHz	47 µA/A	
	300 mA to 1 A	50 kHz to 100 kHz	73 µA/A	
	1 A to 3 A	20 kHz to 50 kHz	76 µA/A	
	1 A to 3 A	50 kHz to 100 kHz	140 µA/A	
	2 A to 5 A	10 Hz to 20 Hz	65 µA/A	
	2 A to 5 A	20 Hz to 10 kHz	34 µA/A	
	2 A to 100 A	10 kHz to 20 kHz	73 µA/A	
	3 A to 100 A	20 kHz to 50 kHz	120 µA/A	
	3 A to 10 A	50 kHz to 100 kHz	210 µA/A	
	5 A to 100 A	10 Hz to 20 Hz	76 µA/A	
	5 A to 100 A	20 Hz to 10 kHz	40 µA/A	
	10 A to 100 A	50 kHz to 100 kHz	240 µA/A	
6.2	**AC current up to 100A**			
6.2.1	Sources, Multifunction calibrator			
	10 mA to 20 mA	20 Hz to 5 kHz	$6 \cdot 10^{-5} \cdot I$	Measurement with AC/DC transfer standard and shunt
	20 mA to 200 mA	20 Hz to 5 kHz	$9 \cdot 10^{-5} \cdot I$	
	200 mA to 2 A	20 Hz to 5 kHz	$2 \cdot 10^{-4} \cdot I$	
	2 A to 11 A	20 Hz to 5 kHz	$6 \cdot 10^{-4} \cdot I$	
6.2.2	Meters, ac meter, multimeter, multifunction transfer standard			
	10 mA to 200 mA	20 Hz to 5 kHz	$5 \cdot 10^{-4} \cdot I$	Measurement with AC/DC transfer standard and shunt; Direct comparison with reference source.
	200 mA to 2 A	20 Hz to 5 kHz	$9 \cdot 10^{-4} \cdot I$	
	2 A to 11 A	20 Hz to 1 kHz	$6 \cdot 10^{-4} \cdot I$	
	2 A to 11 A	1 kHz to 5 kHz	$4 \cdot 10^{-3} \cdot I$	

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ISSUED BY THE SOUTH AFRICAN NATIONAL ACCREDITATION SYSTEM

Accreditation Manager

ANNEXURE A

Accreditation No.: 1612
Date of Issue: 26 April 2022
Expiry Date: 10 July 2026

ITEM	NOMINAL RANGE	NOMINAL FREQUENCY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	METHOD / PROCEDURE
7	**AC power**			
7.1	**AC power and energy**			
7.1.1	Single phase (frequencies below or equal to 400Hz)			
	Active/ Reactive Power and Energy 30 V to 480 V 10 mA to 50 mA Power factor 0 to 1 inductive and capacitive	48 Hz to 63 Hz	$3 \cdot 10^{-4} \cdot VA$	Direct comparison with reference standard
	Active/ Reactive Power and Energy 30 V to 480 V 50 mA to 160 A Power factor 0 to 1 inductive and capacitive	48 Hz to 63 Hz	$8 \cdot 10^{-5} \cdot VA$	Direct comparison with reference standard

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