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:-

CONCILIUM TECHNOLOGIES (PTY) LTD Co. Reg. No.: 1999/013330/07 ELECTRICAL DC LOW FREQUENCY LABORATORY

Accreditation Number: 106

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

Mr T Baleni Acting Chief Executive Officer

Effective Date: 31 January 2022 Certificate Expires: 30 January 2027

SCOPE OF ACCREDITATION

DC LOW FREQUENCY METROLOGY

Accreditation Number: 106

| Concilium Electrical 1 Standfo 12 Bauhin | ent Address of Laboratory: In Technologies (Pty) Ltd DC Low Frequency Laboratory ord Office Park Inia Street Technopark | <u>Technical Signatories:</u> | Mr BJH Brem Mr GD Schus | |
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| Tel: (0 ⁻ | 12) 678-9200 | Issue No.: | 15 | |
| | 12) 665-4160 | Date of Issue: | 31 January 20 |)22 |
| | part bremmer@concilium.co.za | Expiry Date: | 30 January 20 | |
| ITEM | MEASURED QUANTITY OR TYPE OF GAUGE OR INSTRUMENT AND RANGE OF MEASURED QUANTITY | NOMINAL FREQUENCY | CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±) | METHOD/ PROCEDURE |
| 1 | DC Voltage (up to 1100 V) | | | |
| 1.1 | DC voltage sources | | | |
| 1.1.1 | Single values | | | |
| | 1,0 V 10 V | DC DC | 1∙10 ⁻⁶ •U 1∙10 ⁻⁶ •U | Direct comparison with a DC voltage standard. |
| 1.1.2 | Low values (<= 10 V) | | | |
| | 0 V to 10 V | DC | 1•10 ⁻⁶ •U + 0,3 μV | Direct measurement or comparison with a DC voltage standard. |
| 1.1.3 | Intermediate values (>10 V to 1 10 | 00 V) | | |
| | 10 V to 100 V 100 V to 1 000 V | DC DC | 3•10 ⁻⁶ •U 5•10 ⁻⁶ •U | Direct measurement or comparison with a DC voltage Source or multifunction calibrator. |
| 1.2 1.2.1 | DC voltage meters Very low values (<= 10 V) | | | |
| | 0 mV to 10 V | DC | 1•10 ⁻⁶ •U + 0,3 μV | Direct measurement or comparison with a DC Voltage source and short. |
| 1.2.2 | Intermediate values (> 1 mV to 1 | 100 V) | | |
| | 10 V to 100 V 100 V to 1 000 V | DC DC | 3•10 ⁻⁶ •U 5•10 ⁻⁶ •U | Direct measurement or comparison with a DC voltage source or multifunction calibrator. |

Original Date of Accreditation: 1980

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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 No.: 106 Date of Issue: 31 January 2022 Expiry Date: 30 January 2027

| ITEM | MEASURED QUANTITY OR TYPE OF GAUGE OR INSTRUMENT AND RANGE OF MEASURED QUANTITY | NOMINAL FREQUENCY | CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±) | METHOD / PROCEDURE | | | |
|-------|--|-------------------|---|--------------------------------|--|--|--|
| 2 | DC Resistance | | | | | | |
| 2.1 | DC Resistance Standards and Sources | | | | | | |
| 2.1.1 | Low values (<= 1Ω) | | | | | | |
| | 1 mΩ | DC | 2•10 ⁻⁴ •R | | | | |
| | 10 mΩ | DC | 1•10 ⁻⁴ •R | Direct substitution or current | | | |
| | 100 mΩ | DC | 1•10 ⁻⁴ •R | volt drop method. | | | |
| | 1 Ω | DC | 5•10 ⁻⁵ •R | | | | |
| 2.1.2 | Intermediate values (>1 Ω to 1 | ΜΩ) | | | | | |
| | 10 Ω | DC | 5•10 ⁻⁵ •R | | | | |
| | 100 Ω | DC | 5•10 ⁻⁵ •R | | | | |
| | 1 kΩ | DC | 5•10 ⁻⁵ •R | Direct substitution or current | | | |
| | 10 kΩ | DC | 5•10 ⁻⁵ •R | volt drop method. | | | |
| | 100 kΩ | DC | 5•10 ⁻⁵ •R | | | | |
| | 1 MΩ | DC | 1•10 ⁻⁴ •R | | | | |
| 2.1.3 | High values (>1 MΩ) | | | | | | |
| | 10 MΩ | DC | 2•10 ⁻⁴ •R | | | | |
| | 100 MΩ | DC | 5•10 ⁻⁴ •R | Direct or substitution method | | | |
| | 1 GΩ | DC | 1•10 ⁻³ •R | | | | |
| 2.2 | DC Resistance Meters | | | | | | |
| 2.2.1 | Low values (≤ 1 Ω) | | | | | | |
| | 1 mΩ | DC | 2•10 ⁻⁴ •R | | | | |
| | 10 mΩ | DC | 1•10 ⁻⁴ •R | Direct or substitution method | | | |
| | 100 mΩ | DC | 1•10 ⁻⁴ •R | Direct of substitution method | | | |
| | 1 Ω | DC | 5•10 ⁻⁶ •R | | | | |
| 2.2.2 | Intermediate values (>1 Ω to 1 GΩ) | | | | | | |
| | 10 Ω | DC | 5•10 ⁻⁵ •R | | | | |
| | 100 Ω | DC | 5•10 ⁻⁵ •R | Direct or substitution method | | | |
| | 1 kΩ | DC | 5•10 ⁻⁵ •R | | | | |
| | 10 kΩ | DC | 5•10 ⁻⁶ •R | | | | |
| | 100 kΩ | DC | 5•10 ⁻⁵ •R | Direct of Substitution method | | | |
| | 1 MΩ | DC | 1•10 ⁻⁴ •R | | | | |
| | 10 MΩ | DC | 2•10 ⁻⁴ •R | | | | |
| | 100 MΩ | DC | 5•10 ⁻⁵ •R | | | | |
| 2.2.3 | High values (>1 GΩ) | | | | | | |
| | 1 GΩ | DC | 1•10 ⁻³ •R | | | | |
| | 10 GΩ | DC | 2•10 ⁻³ •R | Direct or substitution method | | | |
| | 100 GΩ | DC | 5•10 ⁻³ •R | | | | |

Original Date of Accreditation: 1980

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Accreditation Manager

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| $\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$ | Volt drop | | | |
|--|-----------|--|--|--|
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| $\begin{array}{ c c c c c c c c c c c c c c c c c c c$ | | | | |
| 2 A to 10 A DC $2 \cdot 10^{4} \cdot 1$ Direct or current V method. 31.3 High values (> 20 A to 100 A) DC $5 \cdot 10^{4} \cdot 1$ Direct or current V method. 31.3 High values (> 20 A to 100 A) DC $5 \cdot 10^{4} \cdot 1$ Direct or current V method. 32.0 Current Meters DC $2 \cdot 10^{4} \cdot 1$ Direct or current V method. 3.2 Low values (<0,1 mA) | | | | |
| 2 A to 10 A DC 2*10*1 method. 3.1.3 High values (> 20 A to 100 A) DC 5*10*4•1 Direct or current V 20 A to 50 A DC 2*10*4•1 Direct or current V method. 3.2 Current Meters DC 2*10*4•1 Direct or current V 3.2 Low values (<0,1 mA) | Volt drop | | | |
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| $\begin{array}{ c c c c c c c }\hline & 20 \ A \ to \ 50 \ A & DC & 5\cdot 10^{.4} \ I & Direct \ or \ current \ M \\ \hline & 50 \ A \ to \ 100 \ A & DC & 2\cdot 10^{.3} \ I & method. \\\hline & 3.2 & \hline & \hline & \\ \hline & & Low \ values \ (<0,1 \ mA) & DC & 5\cdot 10^{.5} \ I & Direct \ measure \\\hline & & 1 \ \muA \ to \ 100 \ \muA & DC & 5\cdot 10^{.5} \ I & Direct \ measure \\\hline & & 1 \ \muA \ to \ 100 \ \muA & DC & 2\cdot 10^{.4} \ I & \\\hline & & 100 \ mA \ to \ 20 \ A & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0,1 \ mA \ to \ 100 \ mA & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0,1 \ mA \ to \ 100 \ mA & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0,1 \ mA \ to \ 100 \ mA & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0,1 \ mA \ to \ 100 \ mA & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0,1 \ mA \ to \ 20 \ A & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0,1 \ mA \ to \ 20 \ A & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0 \ A \ to \ 20 \ A \ to \ 20 \ A & DC & 2\cdot 10^{.4} \ I & \\\hline & & 0 \ A \ to \ 20 \ A \ A \ A \ A \ A \ A \ A \ A \ A \ $ | | | | |
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| 10 A to 20 A DC 2 ⋅ 10 ⁻³ ⋅1 High values (>20 A to 100 A) DC 2 ⋅ 10 ⁻³ ⋅1 Direct measure 20 A to 50 A DC 2 ⋅ 10 ⁻³ ⋅1 Direct measure 4 Impendence (up to the MHz range Z Capacitance Z 4.2 Capacitance I 20 Hz to 10 kHz 1 ⋅ 10 ⁻³ ⋅C Direct measure 4.2.1 Standard Capacitors Direct measure Direct measure 4.2.1 Fit o 10 μF 1 20 Hz to 10 kHz 1 ⋅ 10 ⁻³ ⋅C Direct measure 4.2.2 Fixed Capacitor Direct measure Substitution measure 4.2.2 Fixed Capacitor Direct measure Substitution measure | ement. | | | |
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| 4.2.1 Standard Capacitors 100 pF to 1 μF 120 Hz to 10 kHz 1 • 10 ⁻³ • C 1 μF to 10 μF 120 Hz to 10 kHz 2 • 10 ⁻³ • C 10 μF to 100 μF 120 Hz to 1 kHz 2 • 10 ⁻³ • C 4.2.2 Fixed Capacitor | | | | |
| 100 pF to 1 μF 120 Hz to 10 kHz 1•10 ⁻³ •C Direct measurer 1 μF to 10 μF 120 Hz to 10 kHz 2•10 ⁻³ •C Direct measurer 10 μF to 100 μF 120 Hz to 1 kHz 2•10 ⁻³ •C Direct measurer 4.2.2 Fixed Capacitor 4.2.2 Fixed Capacitor | | | | |
| 1 μF to 10 μF 120 Hz to 10 kHz 2•10-3•C Direct measurer substitution measurer 10 μF to 100 μF 120 Hz to 1 kHz 2•10-3•C substitution measurer 4.2.2 Fixed Capacitor Fixed Capacitor Fixed Capacitor | | | | |
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| 4.2.2 Fixed Capacitor | | | | |
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| | | | | |
| 100 pF to 1 μF 120 Hz to 10 kHz 1•10 ⁻³ •C Direct measurem | | | | |
| 1 μ F to 10 μ F 120 Hz to 10 kHz 2·10 ⁻³ ·C output the substitution measurement | | | | |
| 10 μF to 100 μF 120 Hz to 1 kHz 2•10 ⁻³ •C substitution me | etnoù. | | | |
| Capacitance Meters and Bridges | | | | |
| 50 Hz to 1 kHz 5•10 ⁻⁵ •C | - | | | |
| 1 pF, 10 pF, 100 pF and 1 nF 1 kHz to 1 MHz 5•10 ⁻⁴ •C | | | | |
| 50 Hz to 1 kHz 5•10 ⁻⁵ •C | | | | |
| 10 nF 1 kHz to 100 kHz 5•10 ⁻⁴ •C | | | | |
| 100 KHZ to 500 KHZ 1•10 °•C | | | | |
| 500 kHz to 1 MHz 1•10 ⁻² •C 100 nF 50 Hz to 1 kHz 5•10 ⁻⁵ •C | ement of | | | |
| 100 nF50 Hz to 1 kHz5•10-5•CDirect measurer1 kHz to 10 kHz5•10-4•Creference standard | | | | |
| 10 kHz to 200 kHz 3•10 ⁻³ ·C | | | | |
| 1 μF 50 Hz to 1 kHz 5•10 ⁻⁵ •C | | | | |
| 1 kHz to 10 kHz 1•10 ⁻³ •C | | | | |
| | | | | |
| 10 kHz to 50 kHz 2•10 ⁻³ •C | | | | |

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|----------|---|--|--|---|--|--|
| 4 4.3 | Impedance (up to the MHz ra Inductance | nge) | | | | |
| 4.3.2 | Fixed Indicator, Variable, Indicator box (1 mH to 1 H) | | | | | |
| | 1 mH to 1 H | 120 Hz to 1 kHz | 2•10 ⁻³ •L | Direct measurement or substitution method. | | |
| 4.3.3 | Fixed Indicator, Variable, Ind | icator box (> 1 H) | 1 | | | |
| | 1 H to 10 H | 120 Hz | 5•10 ⁻³ •L | Direct measurement or substitution method. | | |
| 4.3.5 | Inductance Meters and Bridg | jes | • | | | |
| | 1 mH to 1 H 1 H to 10 H | 120 Hz to 1 kHz 120 Hz | 2•10 ⁻³ •L 5•10 ⁻³ •L | Direct measurement. | | |
| 5 | AC Voltage | | | | | |
| 5.2.1 | AC Voltage Sources (up to 1 | | | | | |
| | 0 V to 10 V | 30 Hz to 20 kHz 20 kHz to 100 kHz 100 kHz to 1 MHz | 1•10 ⁻⁴ •U + 10 μV 2•10 ⁻⁴ •U + 10 μV 3•10 ⁻⁴ •U + 10 μV | | | |
| | 10 V to 20 V | 30 Hz to 20 kHz 20 kHz to 100 kHz | 1•10 ⁻⁴ •U 2•10 ⁻⁴ •U | Direct measurement. | | |
| | 20 V to 200 V | 30 Hz to 20 kHz 20 kHz to 100 kHz | 1•10 ⁻⁴ •U 2•10 ⁻⁴ •U | Direct measurement. | | |
| | 200 V to 1 000 V | 30 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 100 kHz | 3•10 ⁻⁴ •U 4•10 ⁻⁴ •U 6•10 ⁻⁴ •U | | | |
| 5.2 | AC Voltage (up to 1 000 V) | | | | | |
| 5.2.2 | Meters | | | | | |
| | 0 V to 10 V | 30 Hz to 20 kHz 20 kHz to 100 kHz 100 kHz to 1 MHz | 1•10 ⁻⁴ •U + 10 μV 2•10 ⁻⁴ •U + 10 μV 3•10 ⁻⁴ •U + 10 μV | | | |
| | 10 V to 20 V | 30 Hz to 20 kHz 20 kHz to 100 kHz 100 kHz to 500 kHz 500 kHz to 1 MHz | 1•10 ⁻⁴ •U 2•10 ⁻⁴ •U 3•10 ⁻⁴ •U 4•10 ⁻⁴ •U | Direct measurement. | | |
| | 20 V to 200 V | 30 Hz to 20 kHz 20 kHz to 100 kHz | 1∙10 ⁻⁴ •U 2•10 ⁻⁴ •U |] | | |
| | 200 V to 1 000 V | 50 Hz to 1 kHz | 3•10 ⁻⁴ •U | | | |
| 6 6.2 | AC current AC current (up to 100 A) | | | | | |
| 6.2.1 | Sources | | | Discretesco | | |
| | 0 A to 2 A | 30 Hz to 5 kHz | 3•10 ⁻⁴ •I + 2 μA | Direct measurement or vol drop method. | | |
| 6.2.2 | Meter | | | | | |
| | 0 A to 2 A | 30 Hz to 5 kHz | 3•10 ⁻⁴ •I + 2 μA | Direct measurement or vol drop method. | | |

Original date of accreditation: 1980

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%

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