


Schedule of Accreditation

issued by

United Kingdom Accreditation Service

2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK

| | | |
|---|---|--|
|  <p>UKAS CALIBRATION 7949</p> <p>Accredited to ISO/IEC 17025:2005</p> | <p>Newtons4th Ltd</p> <p>Issue No: 006 Issue date: 25 October 2017</p> | |
| | <p>1 Bede Island Road Leicester LE2 7EA United Kingdom</p> | <p>Contact: Mr Mark Wade Tel: +44 (0)1162 301 066 Fax: +44 (0)1162 301 061 E-Mail: office@newtons4th.com Website: www.newtons4th.com</p> |
| <p>Calibration performed at the above address only</p> | | |

DETAIL OF ACCREDITATION

| Measured Quantity Instrument or Gauge | Range | Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$) | Remarks |
|--|--|---|---------|
| CALIBRATION OF AC POWER ANALYSERS Voltage sine amplitude | 1 V to 23 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 90 ppm + 0.20 mV 79 ppm + 0.20 mV 90 ppm + 0.20 mV | |
| | 23 V to 45 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 86 ppm + 0.40 mV 74 ppm + 0.40 mV 86 ppm + 0.40 mV | |
| | 45 V to 90 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 85 ppm + 0.80 mV 73 ppm + 0.80 mV 85 ppm + 0.80 mV | |
| | 90 V to 180 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 90 ppm + 1.6 mV 80 ppm + 1.6 mV 90 ppm + 1.6 mV | |
| | 180 V to 215 V 16 Hz to 850 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 87 ppm + 3.2 mV 87 ppm + 3.2 mV 87 ppm + 3.2 mV | |
| | 215 V to 246 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 87 ppm + 3.2 mV 75 ppm 87 ppm + 3.2 mV | |
| | 246 V to 360 V 16 Hz to 850 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 87 ppm + 3.2 mV 87 ppm + 3.2 mV 87 ppm + 3.2 mV | |



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| Measured Quantity Instrument or Gauge | Range | Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$) | Remarks | |
|---|--|---|---------------------------------------|--|
| Voltage sine amplitude (continued) | 360 V to 425 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 86 ppm + 5.8 mV 85 ppm 86 ppm + 5.8 mV | | |
| | 425 V to 490 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 86 ppm + 5.8 mV 75 ppm 86 ppm + 5.8 mV | | |
| | 490 V to 650 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 86 ppm + 5.8 mV 85 ppm 86 ppm + 5.8 mV | | |
| | 650 V to 1008 V 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 90 ppm + 10 mV 90 ppm + 10 mV 90 ppm + 10 mV | | |
| | Voltage harmonic amplitude | 0 V to 6.9 V Total rms 1 V to 23 V 16 Hz to 850 Hz 850 Hz to 6 kHz | 600 ppm + 1.0 mV 1300 ppm + 1.0 mV | |
| | | 0 V to 13.5 V Total rms 23 V to 45 V 16 Hz to 850 Hz 850 Hz to 6 kHz | 600 ppm + 2.0 mV 1300 ppm + 2.0 mV | |
| | | 0 V to 27 V Total rms 45 V to 90 V 16 Hz to 850 Hz 850 Hz to 6 kHz | 600 ppm + 2.2 mV 1300 ppm + 2.2 mV | |
| | | 0 V to 54 V Total rms 90 V to 180 V 16 Hz to 850 Hz 850 Hz to 6 kHz | 600 ppm + 4.4 mV 1300 ppm + 4.4 mV | |
| | | 0 V to 108 V Total rms 180 V to 360 V 16 Hz to 850 Hz 850 Hz to 6 kHz | 600 ppm + 12 mV 1300 ppm + 12 mV | |
| | | 0 V to 195 V Total rms 360 V to 650 V 16 Hz to 850 Hz 850 Hz to 6 kHz | 600 ppm + 22 mV 1300 ppm + 22 mV | |
| 0 V to 302 V Total rms 650 V to 1008 V 16 Hz to 850 Hz 850 Hz to 6 kHz | | 600 ppm + 33 mV 1300 ppm + 33 mV | | |



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|--|--|---|---------|
| Current sine amplitude | 100 mA to 250 mA 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 108 ppm + 5.0 μ A 101 ppm + 2.5 μ A 108 ppm + 5.0 μ A | |
| | 250 mA to 500 mA 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 85 ppm + 10 μ A 75 ppm + 5.0 μ A 85 ppm + 10 μ A | |
| | 0.5 A to 1 A 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 89 ppm + 20 μ A 80 ppm + 10 μ A 89 ppm + 20 μ A | |
| | 1 A to 2 A 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 89 ppm + 40 μ A 80 ppm + 20 μ A 89 ppm + 40 μ A | |
| | 2 A to 5 A 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 88 ppm + 100 μ A 78 ppm + 50 μ A 88 ppm + 100 μ A | |
| | 5 A to 10 A 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 92 ppm + 200 μ A 82 ppm + 100 μ A 92 ppm + 200 μ A | |
| | 10 A to 21 A 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 95 ppm + 400 μ A 82 ppm + 200 μ A 95 ppm + 400 μ A | |
| | 21 A to 48 A 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 850 Hz | 142 ppm + 1.0 mA 93 ppm + 0.50 mA 142 ppm + 1.0 mA | |
| Current harmonic amplitude | Harmonic 0 A to 75 mA Total rms 100 mA to 250 mA 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 5.0 μ A 1800 ppm + 5.0 μ A | |
| | Harmonic 0 A to 150 mA Total rms 250 mA to 500 mA 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 10 μ A 1800 ppm + 10 μ A | |



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|---|---|---|---------|
| Current harmonic amplitude (continued) | Harmonic 0 A to 300 mA Total rms 500 mA to 1 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 20 μ A 1800 ppm + 20 μ A | |
| | Harmonic 0 A to 600 mA Total rms 1 A to 2 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 40 μ A 1800 ppm + 40 μ A | |
| | Harmonic 0 mA to 1.5 A Total rms 2 A to 5 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 100 μ A 1800 ppm + 100 μ A | |
| | Harmonic 0 A to 3 A Total rms 5 A to 10 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 200 μ A 1800 ppm + 200 μ A | |
| | Harmonic 0 A to 6 A Total rms 10 A to 21 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 400 μ A 1800 ppm + 400 μ A | |
| | Harmonic 0 A to 15 A Total rms 21 A to 50 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 610 ppm + 1.0 mA 1800 ppm + 1.0 mA | |
| Current to voltage phase angle | -180° to +180° 16 Hz to 45 Hz 45 Hz to 65 Hz 65 Hz to 69 Hz 69 Hz to 180 Hz 180 Hz to 450 Hz 450 Hz to 850 Hz | 3.1 m° 2.4 m° 3.2 m° 7.1 m° 18 m° 33 m° | |
| Apparent power (VA product) | 100 mVA to 48.4 kVA 16 Hz to 850 Hz | The RSS summation of the uncertainties for voltage and current. | |



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| Measured Quantity Instrument or Gauge | Range | Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$) | Remarks |
|---|--|---|---|
| AC Power | Harmonic 0 W to 48.4 kW 16 Hz to 850 Hz | The RSS summation of the uncertainties for voltage, current and $\cos(\phi)$. | For power factors between 0 and unity, leading or lagging. The uncertainties at low power factors may be stated in absolute terms or as a fraction of the VA product. NOTE: For typical input voltages of 115 V and 230 V, the minimum power at unity p.f. is 5.5 W and 11 W respectively. Lower powers for these voltages can be obtained by using lower power factors. |
| Current harmonic amplitude to IEC61000-4-7 | Harmonic 0 A to 75 mA Total rms 100 mA to 250 mA 16 Hz to 850 Hz 850 Hz to 6 kHz | 0.16 % + 5.0 μ A 0.47 % + 5.0 μ A | |
| | Harmonic 0 A to 150 mA Total rms 250 mA to 500 mA 16 Hz to 850 Hz 850 Hz to 6 kHz | 0.16 % + 10 μ A 0.47 % + 10 μ A | |
| | Harmonic 0 A to 300 mA Total rms 500 mA to 1 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 0.16 % + 20 μ A 0.47 % + 20 μ A | |
| | Harmonic 0 A to 600 mA Total rms 1 A to 2 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 0.16 % + 40 μ A 0.47 % + 40 μ A | |
| | Harmonic 0 mA to 1.5 A Total rms 2 A to 5 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 0.16 % + 100 μ A 0.47 % + 100 μ A | |
| | Harmonic 0 A to 3 A Total rms 5 A to 10 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 0.16 % + 200 μ A 0.47 % + 200 μ A | |
| | Harmonic 0 A to 6 A Total rms 10 A to 21 A 16 Hz to 850 Hz 850 Hz to 6 kHz | 0.16 % + 400 μ A 0.47 % + 400 μ A | |



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|---|--|---|---|
| Flicker to IEC61000-4-15 | Pinst (sinusoidal modulation) Pinst (rectangular modulation) f_{mod} 0.5 Hz to 30 Hz f_{mod} 30.5Hz f_{mod} 31 Hz to 33.33 Hz Pst d_c and d_{max} 0 % to 5 % T_{max} Frequency changes Distorted voltage with multiple zero crossings Harmonics with sidebands Phase jumps Rectangular changes with duty cycle | 0.36 % 0.39 % 1.0 % 0.39 % 0.25 % 0.015 % of steady state Half cycle count 1.5 % 1.1 % 1.3 % 1.0 % 1.0 % | With respect to a nominal steady state of 100 V to 230 V at 50 Hz. This is a counting function and therefore there is no associated uncertainty. The results may also be reported as time corresponding to the nominal frequency (1/2f). |
| Power measurement as measured by Calorimeter | 45 Hz to 2 MHz 1 W to 2 W 2 W to 5 W | 0.28 % 0.21 % | |
| CALIBRATION OF IMPEDANCE NETWORKS | 16 Hz to 850 Hz: | | |
| Resistance | 33 mΩ to 400 Ω | 0.48 % to 0.10 % | Phase angle 0° to ±85° |
| Reactance | 33 mΩ to 400 Ω | 0.48 % to 0.10 % | Phase angle ±5° to ±90° |

END



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Appendix - Calibration and Measurement Capabilities

Introduction

The definitive statement of the accreditation status of a calibration laboratory is the Accreditation Certificate and the associated Schedule of Accreditation. This Schedule of Accreditation is a critical document, as it defines the measurement capabilities, ranges and boundaries of the calibration activities for which the organisation holds accreditation.

Calibration and Measurement Capabilities (CMCs)

The capabilities provided by accredited calibration laboratories are described by the Calibration and Measurement Capability (CMC), which expresses the lowest uncertainty of measurement that can be achieved during a calibration. If a particular device under calibration itself contributes significantly to the uncertainty (for example, if it has limited resolution or exhibits significant non-repeatability) then the uncertainty quoted on a calibration certificate will be increased to account for such factors. The CIPM-ILAC definition of the CMC is as follows:

A CMC is a calibration and measurement capability available to customers under normal conditions:

(a) as published in the BIPM key comparison database (KCDB) of the CIPM MRA; or

(b) as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement.

The CMC is normally used to describe the uncertainty that appears in an accredited calibration laboratory's schedule of accreditation and is the uncertainty for which the laboratory has been accredited using the procedure that was the subject of assessment. The CMC is calculated according to the procedures given in M3003 and is normally stated as an expanded uncertainty at a coverage probability of 95 %, which usually requires the use of a coverage factor of $k = 2$. An accredited laboratory is not permitted to quote an uncertainty that is smaller than the published CMC in certificates issued under its accreditation.

The CMC may be described using various methods in the Schedule of Accreditation:

As a single value that is valid throughout the range.

As an explicit function of the measurand or of a parameter (see below).

As a range of values. The range is stated such that the customer can make a reasonable estimate of the likely uncertainty at any point within the range.

As a matrix or table where the CMCs depend on the values of the measurand and a further quantity.

In graphical form, providing there is sufficient resolution on each axis to obtain at least two significant figures for the CMC.

Expression of CMCs - symbols and units

In general, only units of the SI and those units recognised for use with the SI are used to express the values of quantities and of the associated CMCs. Nevertheless, other commonly used units may be used where considered appropriate for the intended audience. For example, the term "ppm" (part per million) is frequently used by manufacturers of test and measurement equipment to specify the performance of their products. Terms like this may be used in Schedules of Accreditation where they are in common use and understood by the users of such equipment, providing their use does not introduce any ambiguity in the capability that is being described.

When the CMC is expressed as an explicit function of the measurand or of a parameter, this often comprises a relative term (e.g., percentage) and an absolute term, i.e. one expressed in the same units as those of the measurand. This form of expression is used to describe the capability that can be achieved over a range of values. Some examples, and an indication of how they are to be interpreted, are shown below.

DC voltage, 100 mV to 1 V: $0.0025 \% + 5.0 \mu\text{V}$:

Over the range 100 mV to 1 V, the CMC is $0.0025 \% \cdot V + 5.0 \mu\text{V}$, where V is the measured voltage.

Hydraulic pressure, 0.5 MPa to 140 MPa: $0.0036 \% + 0.12 \text{ ppm/MPa} + 4.0 \text{ Pa}$

Over the range 0.5 MPa to 140 MPa, the CMC is $0.0036 \% \cdot p + (0.12 \cdot 10^{-6} \cdot p \cdot 10^{-6}) + 4.0 \text{ Pa}$, where p is the measured pressure in Pa.

It should be noted that the percentage symbol (%) simply represents the number 0.01. In cases where the CMC is stated only as a percentage, this is to be interpreted as meaning percentage of the measured value or indication.

Thus, for example, a CMC of 1.5 % means $1.5 \cdot 0.01 \cdot i$, where i is the instrument indication.