Schedule of Accreditation

issued by

United Kingdom Accreditation Service

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

0149

Accredited to ISO/IEC 17025:2017

TER Calibration Ltd

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Unit 1
Armstrong Point
Swan Lane
Hindley Green
Wigan
WN2 4AU

Contact: Mr L J Finnen
Tel: +44 (0)1942-882275
Fax: +44 (0)1942-897958
E-Mail: me@ter.co.uk
Website: www.tercalibration.com

Calibration performed at the above address only

DETAIL OF ACCREDITATION

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
Values and uncertainties listed below are applicable for the calibration of both measurement instruments and for instruments with an output. the method used is by direct comparison unless otherwise stated in the remarks column			
ELECTRICAL MEASUREMENTS			
DC RESISTANCE			
Specific values (sourcing)	1 mΩ	35 ppm	
	10 mΩ	12 ppm	
	100 mΩ	8.0 ppm	
	1 Ω	2.0 ppm	
	10 Ω	2.5 ppm	
	100 Ω	3.0 ppm	
	1 kΩ	2.0 ppm	
	10 kΩ	1.5 ppm	
	100 kΩ	3.0 ppm	
	1 MΩ	10 ppm	
	10 MΩ	20 ppm	
	100 MΩ	20 ppm	
	1 GΩ	250 ppm	
	10 GΩ	0.15 %	
Specific values (measurement)	1 mΩ	40 ppm	
	10 mΩ	20 ppm	
	100 mΩ	20 ppm	
	1 Ω	4.0 ppm	
	10 Ω	5.0 ppm	
	100 Ω	3.0 ppm	
	1 kΩ	2.0 ppm	
	10 kΩ	2.0 ppm	
	100 kΩ	5.0 ppm	
	1 MΩ	7.0 ppm	
	10 MΩ	15 ppm	
	100 MΩ	28 ppm	
	1 GΩ	220 ppm	
	10 GΩ	0.14 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
DC RESISTANCE (continued)			
Other values (measurement)	0 μΩ to 200 μΩ 200 μΩ to 2 mΩ 2 mΩ to 20 mΩ 20 mΩ to 200 mΩ 200 mΩ to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 KΩ 20 KΩ to 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 200 MΩ to 2 GΩ 2 GΩ to 20 GΩ	40 nΩ 200 ppm 180 ppm 180 ppm 25 ppm 20 ppm 6.0 ppm 3.5 ppm 4.0 ppm 6.0 ppm 10 ppm 60 ppm 65 ppm 700 ppm 0.60 %	
DC VOLTAGE			
Standard cell value	Nominal 1.018 V and 10 V	1.5 ppm	
Specific values	100 mV 200 mV 1 V 2 V 10 V 20 V 100 V 200 V 1 kV	6.0 ppm 6.0 ppm 3.0 ppm 4.0 ppm 4.0 ppm 4.0 ppm 4.0 ppm 5.0 ppm 6.0 ppm	
Other values	0 mV to 20 mV 20 mV to 200 mV 200 mV to 2 V 12 V to 20 V 20 V to 200 V 200 V to 1 kV 1 kV to 30 kV 30 kV to 90 kV	0.60 μV 8.5 ppm 5.0 ppm 5.0 ppm 7.0 ppm 7.0 ppm 0.12 % 0.15 %	
DC VOLTAGE RATIO	0.1 to unity	0.5 ppm	
DC Voltage linearity	0 V to 10 mV 0 V to 100 mV	0.40 μV 0.60 μV	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
DC CURRENT	0 μA to 1 μA	100 ppm + 80 pA	
	1 μA to 10 μA	120 ppm	
	10 μA to 100 μA	35 ppm	
	100 μA to 1 mA	30 ppm	
	1 mA and 10 mA	20 ppm	
	1 mA to 10 mA	30 ppm	
	10 mA to 100 mA	20 ppm	
	100 mA to 1 A	30 ppm	
	1 A to 10 A	60 ppm	
	10 A to 150 A	500 ppm	
DC Current linearity	0 A to 1 μA	7.5 pA	
	0 A to 10 μA	12 pA	
DC POWER	1 W to 20 kW	The arithmetic sum of the individual uncertainties of the corresponding voltages and current measurements	
AC VOLTAGE Specific values at specific frequencies			
	10 mV at 1 kHz	100 ppm	
	100 mV		
	20 Hz, 55 Hz	100 ppm	
	305 Hz, 1 kHz, 10 kHz	90 ppm	
	30 kHz	100 ppm	
	60 kHz	180 ppm	
	100 kHz	190 ppm	
	1 V		
	100 Hz	55 ppm	
	20 Hz, 55 Hz, 305 Hz	50 ppm	
	1 kHz	40 ppm	
	3 kHz, 10 kHz	50 ppm	
	30 kHz	60 ppm	
	60 kHz	65 ppm	
	100 kHz	160 ppm	
	500 kHz	0.135 %	
	1 MHz	0.30 %	
	10 V		
	20 Hz, 55 Hz, 100 Hz, 305 Hz, 1kHz	50 ppm	
	3 kHz, 10 kHz	60 ppm	
	30 kHz	80 ppm	
	60 kHz	180 ppm	
	100 kHz	190 ppm	
	500 kHz	0.135 %	
	1 MHz	0.30 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC VOLTAGE (continued) Specific values at specific Frequencies (continued)	100 V 20 Hz, 55 Hz, 305 Hz *100 Hz, 1 kHz* *3 kHz, 10 kHz* *30 kHz* *60 kHz* *100 kHz* 500 V *55 Hz* *100 Hz* *305 Hz* *1 kHz* *3 kHz, 10 kHz* *30 kHz* 1 kV *55 Hz* *305 Hz, 1 kHz, 3 kHz, 10 kHz* *30 kHz*	 60 ppm 55 ppm 60 ppm 80 ppm 180 ppm 200 ppm 80 ppm 90 ppm 80 ppm 70 ppm 80 ppm 150 ppm 80 ppm 80 ppm 200 ppm	
Specific values at other frequencies	1 V *20 Hz to 30 kHz* *30 kHz to 100 kHz* *100 kHz to 1MHz* 10 V *20 Hz to 30 kHz* *30 kHz to 100 kHz* *100 kHz to 1MHz* 100 V *20 Hz to 30 kHz* *30 kHz to 100 kHz* 1 kV *55 Hz to 10 kHz* *10 kHz to 30 kHz*	 70 ppm 160 ppm 0.30 % 90 ppm 180 ppm 0.30 % 85 ppm 150 ppm 100 ppm 200 ppm	
Other values	50 Hz to 2 kHz *100 µV to 1 mV* *1 mV to 10 mV* *10 mV to 100 mV* 100 mV to 200 mV *40 Hz to 10 kHz* *10 kHz to 30 kHz* *30 kHz to 100 kHz* 200 mV to 1 V *40 Hz to 10 kHz* *10 kHz to 30 kHz* *30 kHz to 100 kHz*	 0.75 % 750 ppm 100 ppm 150 ppm 360 ppm 850 ppm 160 ppm 250 ppm 0.13 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC VOLTAGE (continued) Other values (continued)	1 V to 2 V *40 Hz to 10 kHz* *10 kHz to 30 kHz* *30 kHz to 100 kHz* 2 V to 10 V *40 Hz to 10 kHz* *10 kHz to 30 kHz* *30 kHz to 100 kHz* 10 V to 20 V *40 Hz to 10 kHz* *10 kHz to 30 kHz* *30 kHz to 100 kHz* 20 V to 200 V *40 Hz to 10 kHz* *10 kHz to 30 kHz* *30 kHz to 100 kHz* 200 V to 1000 V *40 Hz to 10 kHz* *10 kHz to 30 kHz* 1 kV to 40 kV *50 Hz*	 120 ppm 250 ppm 650 ppm 160 ppm 350 ppm 0.13 % 160 ppm 300 ppm 300 ppm 150 ppm 150 ppm 150 ppm 200 ppm 700 ppm 1.0 %	
Waveform analysis	3 μV to 300 V *20 Hz to 76 kHz*	5.0 % of FSD*	* 15 ranges of 30 μV to 300 V FSD in 1-3-10 sequence
AC CURRENT Specific values and frequencies	100 μA *55 Hz, 305 Hz* *1 kHz* *5 kHz* 1 mA *55 Hz, 305 Hz* *1 kHz* *5 kHz* *10 kHz* 10 mA *55 Hz, 305 Hz* *1 kHz, 5 kHz, 10 kHz* 100 mA *55 Hz, 305 Hz* *1 kHz, 5 kHz, 10 kHz* 1 A *55 Hz, 305 Hz, 1 kHz, 5 kHz* *10 kHz*	 150 ppm 150 ppm 200 ppm 150 ppm 150 ppm 150 ppm 160 ppm 150 ppm 150 ppm 150 ppm 150 ppm 150 ppm 260 ppm	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC CURRENT (continued) Other Values (continued)	*10 A* *55 Hz, 305 Hz, 1 kHz* *5 kHz, 10 kHz*	 170 ppm 200 ppm	
Other Values	20 µA to 100 µA *50 Hz to 5 kHz*	 0.12 %	
	100 µA to 200 µA *50 Hz to 5 kHz*	 400 ppm	
	200 µA to 1 mA *55 Hz to 5 kHz*	 0.12 %	
	1 mA to 2 mA *50 Hz to 10 kHz*	 400 ppm	
	2 mA to 10 mA 50 Hz to 10 kHz	 0.12 %	
	10 mA to 20 mA *50 Hz to 10 kHz*	 400 ppm	
	20 mA to 100 mA *50 Hz to 10 kHz*	 0.12 %	
	100 mA to 200 mA *40 Ha to 10 kHz*	 400 ppm	
	200 mA to 1 A *1 kHz to 10 kHz*	 0.15 %	
	1 A to 2 A *55 Hz, 305 Hz, 1 kHz*	 750 ppm	
	2 A to 10 A *50 Hz to 1 kHz* *1 kHz to 10 kHz*	 0.15 % 0.32 %	
	10 A to 20 A *50 Hz to 1 kHz* *1 kHz to 10 kHz*	 0.10 % 0.30 %	
	10 A to 150 A *50 Hz to 60 Hz*	 0.10 %	
AC RESISTANCE	*At 40 Hz to 60 Hz* 10 mΩ to 100 mΩ 100 mΩ to 1Ω 1 Ω to 100 k Ω 100 kΩ to 10 MΩ	 300 ppm 300 ppm 75 ppm 0.10 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
FREQUENCY			
Generation			
Specific values	100 kHz, 1 MHz, 5 MHz and 10 MHz	7.0 in 10^{12}	Sine wave generation
	0.02 Hz to 10 MHz in 2-5-10 sequence	7.0 in 10^{12}	Square wave generation
Range values			
	1 Hz to 100 kHz 100 kHz to 10 MHz	2.0 in 10^{10} 5.0 in 10^{11}	Sine wave generation
	1 Hz to 10 kHz 10 kHz to 100 kHz 100 kHz to 10 MHz 10 MHz to 100 MHz 100 MHz to 500 MHz 500 MHz to 12 GHz	1.2 in 10^{8} 1.2 in 10^{9} 1.2 in 10^{9} 3.0 in 10^{10} 2.0 in 10^{8} 1.0 in 10^{7}	Measurement of sources These values may also be reported as the reciprocal; seconds, for repetative signals.
TIME INTERVAL	0 s to 500s 0 s to 500s	1.0 us 50 ms	Electronically triggered devices Mechanically triggered devices
Pulse period	1 µs to 1 s	5.0 ns	
Rise time	1 ns to 1 ms	3.0 ns	Into 50 Ω
RCD testers			
Trip time	10 ms to 5 s	0.25 ms	
Trip Current	3 mA to 3 A	1.0 %	
Temperature indicators, calibration by electrical simulation			The claims below cover test itmes with a resolutiuion of 10 m°C and with their internal reference junction enabled or disabled on a worst case.
Base metal thermocouples	- 200 °C to + 1600 °C	0.050 °C	
Noble metal thermocouples	- 200 °C to + 1760 °C	0.20 °C	
Resistance thermometer (Pt 100)	- 200 °C to + 800 °C	0.020 °C	
Supporting temperature measurements for electrical simulation and cold junction verification	At Nominal 0 °C Nominal ambient between 17 °C to 23 °C	0.050 °C 0.30 °C	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
PRESSURE			
<u>Hydraulic pressure (gauge)</u>			Methods consistent with EURAMET CG17
Calibration of pressure indicating instruments and gauges	600 kPa to 120 MPa 120 MPa to 280 MPa	0.010 % 340 kPa	Calibration of pressure measuring devices with an electrical output may be undertaken.
<u>Gas pressure (gauge)</u>			Absolute pressure calibrations may be undertaken by associated barometric pressure measurement with an additional uncertainty of ± 20 Pa
Calibration of pressure indicating instruments and gauges	-95 kPa to -70 kPa -70 kPa to 40 kPa 40 kPa to 27.5 MPa	30 Pa 15 Pa 0.0065 %	
<u>Gas pressure (absolute)</u>			
Calibration of pressure indicating instruments and gauges	3.5 kPa to 40 kPa 40 kPa to 5.2 MPa	20 Pa 0.0070 % + 3.0 Pa	
END			

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 are shown below. It should be noted that these expressions are *not* mathematical formulae but are instead written in a commonly used shorthand for expressing uncertainties - therefore, for purposes of clarity, an indication of how they are to be interpreted is also provided below.

DC voltage, 100 mV to 1 V: 0.0025 % + 5.0 µV

Over the range 100 mV to 1 V, the CMC is 0.0025 %·V + 5.0 µV, where V is the measured voltage.

Hydraulic pressure, 0.5 MPa to 140 MPa: 0.0036 % + 0.12 ppm/MPa + 4.0 Pa

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