Schedule of Accreditation
issued by
United Kingdom Accreditation Service
2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK

0164

Accredited to ISO/IEC 17025:2017

Industrial Calibration Ltd

Issue No: 031 **Issue date:** 22 April 2020

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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
DC RESISTANCE			
Measurement and generation	0 Ω to 20 Ω 20 Ω 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 10 MΩ	20 ppm + 0.15 mΩ 15 ppm + 0.15 mΩ 24 ppm 70 ppm	Measurement of resistance values using digital multimeter and application of known values to resistance measuring instruments.
Generation only			Application of known resistance values to resistance measuring equipment, with two-wire or four-wire configurations as indicated.
4-wire values	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	25 ppm 15 ppm 10 ppm 9.0 ppm 12 ppm 25 ppm 44 ppm 220 ppm	
2-wire values	100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	340 ppm 130 ppm 25 ppm 25 ppm 30 ppm 41 ppm 220 ppm	
DC VOLTAGE			
Measurement	0 mV to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	15 ppm + 3.0 µV 6.0 ppm + 2.0 µV 5.0 ppm + 4.0 µV 7.0 ppm + 60 µV 15 ppm	Measurement of DC voltages by comparison with precision calibrator.
Generation	0 mV to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	15 ppm + 3.0 µV 6.0 ppm + 2.0 µV 5.0 ppm + 3.0 µV 7.0 ppm + 50 µV 13 ppm + 250 µV	Application of known DC voltages to voltage measuring equipment.

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
DC CURRENT			
Measurement and Generation			
Specific Values	10 μA 100 μA 1 mA 10 mA 100 mA 1 A	30 ppm 30 ppm 35 ppm 40 ppm 65 ppm 90 ppm	Using current shunts.
Other Values	0 μA to 200 μA 200 μA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2A to 10 A 10 A to 20 A 20 A to 50 A	80 ppm + 0.5 nA 80 ppm + 5 nA 80 ppm + 50 nA 80 ppm + 2.0 μA 100 ppm + 25 μA 0.035 % 0.050 % 0.10 %	Using multimeter (and current shunts above 2 A).
Generation only	0 μA to 200 μA 200 μA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 10 A	40 ppm + 4.0 nA 35 ppm + 10 nA 35 ppm + 100 nA 35 ppm + 1.0 μA 65 ppm + 10 μA 140 ppm	Application of known DC currents to current measuring equipment.
AC VOLTAGE			
Measurement	*40 Hz to 4 kHz* 10 mV to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	 0.040 % + 5.0 μV 0.025 % + 30 μV 0.025 % + 0.30 mV 0.025 % + 3.0 mV 0.030 % + 30 mV	Measurement of AC voltage sources using digital multimeter.
	4 kHz to 30 kHz 200 mV to 2 V 2 V to 20 V	 0.040 % + 50 μV 0.040 % + 0.50 mV	
	30 kHz to 100 kHz 200 mV to 2 V 2 V to 20 V	 0.04% + 0.5 mV 0.04% + 5 mV	
Generation	10 mV to 20 mV *40 Hz to 10 kHz* *10 kHz to 100 kHz*	 0.030 % + 5.0 μV 0.050 % + 5.0 μV	Application of known AC voltages to voltage measuring equipment.
	20 mV to 200 mV *40 Hz to 10 kHz* *10 kHz to 100 kHz*	 0.020 % + 5.0 μV 0.060 % + 5.0 μV	
	200 mV to 2 V *40 Hz to 10 kHz* *10 kHz to 100 kHz*	 0.013 % 0.015 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC VOLTAGE (continued)			
Generation	2 V to 20 V *40 Hz to 10 kHz* *10 kHz to 100 kHz*	 0.013 % 0.017 %	
	20 V to 200 V *40 Hz to 30 kHz*	 0.013 %	
	200 V to 1000 V *40 Hz to 1 kHz* *1 kHz to 10 kHz* *10 kHz to 30 kHz*	 0.013 % 0.014 % 0.017 %	
AC CURRENT			
Measurement	*40 Hz to 1 kHz* 20 μA to 200 μA 200 μA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A	 0.017 % + 5.0 nA 0.016 % + 50 nA 0.016 % + 0.50 μA 0.016 % + 5.0 μA 0.032 % + 50 μA	By comparison with precision calibrator. .
Generation	*40 Hz to 1 kHz* 20 μA to 200 μA 200 μA to 200 mA 200 mA to 2 A 2 A to 10 A	 0.017 % 0.016 % 0.032 % 0.050 %	Using precision calibrator. 400 Hz maximum above 2 A.
FREQUENCY			Using counter and GPS receiver.
Measurement	0.1 Hz to 100 kHz 100 kHz to 1 MHz 1 MHz to 1 GHz	2.0 in 10^7 + 30 μHz 2.0 in 10^7 2.0 in 10^8	
Generation	1 MHz and 10 MHz	5.0 in 10^{10}	
RISETIME	1 ns to 20 ns	90 ps	For oscilloscope risetime calibration, using fast pulse generator. There may be additional uncertainties relating to the screen resolution of the oscilloscope being calibrated.
CAPACITANCE			Known values of capacitance for application to capacitance measuring devices.
Generation, specific values	*At 1 kHz* 100 pF to 1 μF in decade steps	 0.030 % + 0.10 pF	
Generation, other values	*At 1 kHz* 1 nF to 1 μF	 0.030 % + 4.0 pF	

Measured Quantity Instrument or Gauge	Range		Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
INDUCTANCE				
Generation, specific values	*At 1 kHz* 100 μH to 1 H in decade steps		0.020 % + 0.12 μH	
TEMPERATURE	20 ºC nominal		0.060 ºC	For verification of thermocouple indicators and simulators (including cold junction compensation)at ambient temperature.
Electrical calibration of temperature indicators				
Indicators for base metal thermocouples	Type	Range ºC		
	K J T E N	-100 to +1370 -100 to +1200 -100 to +400 -100 to +1000 - 50 to +1300	0.10 ºC 0.10 ºC 0.10 ºC 0.10 ºC 0.15 ºC	By millivolt injection without cold junction compensation. The cold junction will normally be the subject of a separate calibration.
Indicators for noble metal thermocouples	Type	Range ºC		
	R S B B	+100 to +1750 +100 to +1750 +250 to +450 +450 to +1800	0.50 ºC 0.50 ºC 1.0 ºC 0.60 ºC	By millivolt injection without cold junction compensation. The cold junction will normally be the subject of a separate calibration.
Indicators for resistance thermometers	Type	Range ºC		
	PT100	-200 to +850	0.020 ºC	By resistance simulation.

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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 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.

<u>DC voltage, 100 mV to 1 V</u>: 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.

<u>Hydraulic pressure, 0.5 MPa to 140 MPa</u>: 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.