Schedule of Accreditation

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United Kingdom Accreditation Service

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

0221

Accredited to ISO/IEC 17025:2017

Druck Ltd

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Calibration performed by the Organisation at the locations specified below

Locations covered by the organisation and their relevant activities

Laboratory locations:

Location details		Activity	Location code
Address Fir Tree Lane Groby Leicester LE6 0FH	**Contact**: Mr S Berdej Tel: +44 (0)116-231 7100 Fax: +44 (0)116-231 7101 Email: sensing.grobyukas@bakerhughes.com	Electrical Pressure Temperature Mass Humidity	UK

Site activities performed away from the locations listed above:

Location details	Activity	Location code
The customer's site or premises must be suitable for the nature of the particular calibrations undertaken and will be the subject of contract review arrangements between the laboratory and the customer	Pressure	Site

DETAIL OF ACCREDITATION

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
PRESSURE <u>Gas pressure (absolute)</u>			Methods consistent with EURAMET CG3 and CG17	
Calibration of pressure measuring instruments and gauges and "Pressure equivalent" calibration of Dead Weight Testers (pressure balances supplied with an associated mass set) and Effective area calibration of Dead Weight Testers	0 kPa to 450 kPa 450 kPa kPa to 3.1 MPa 3.1 MPa to 21.1 MPa 21.1 MPa to 40.1 MPa	0.0025 % + 0.40 Pa 0.0028 % + 0.40 Pa 0.0032 % + 0.40 Pa 0.0039 % + 11 Pa	Calibration of pressure measuring devices with an electrical output may be undertaken.	UK and Site
<u>Gas pressure (gauge)</u>				
Calibration of pressure measuring instruments and gauges and "Pressure equivalent" calibration of Dead Weight Testers (pressure balances supplied with an associated mass set) and Effective area calibration of Dead Weight Testers	- 100 kPa to - 3.5 kPa - 3.5 kPa to 3.5 kPa 3.5 kPa to 350 kPa 350 kPa to 3 MPa 3 MPa to 21 MPa 21 MPa to 40 MPa	0.0025 % + 0.60 Pa 0.55 Pa 0.0025 % 0.0028% 0.0032 % 0.0039 %		UK and Site
<u>Hydraulic pressure (gauge)</u>				
Calibration of pressure measuring instruments and gauges. "Pressure equivalent" calibration of Dead Weight Testers (Pressure balance with associated mass set). Effective area calibration of Dead Weight Testers.	0.50 MPa to 140 MPa 140 MPa to 500 MPa	0.0036 % + 0.12 ppm/MPa 0.010 % + 0.30 ppm/MPa	Absolute pressure calibrations can be undertaken using gauge pressure generation and the associated barometric pressure with the additional uncertainty of 11 Pa	UK and Site

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
ELECTRICAL			Calibration by comparison with a reference standard	UK
DC Resistance measurement (At low current)				
	0 Ω to 2 Ω	17 ppm + 5.3 µΩ		
	2 Ω to 20 Ω	7.0 ppm + 19 µΩ		
	20 Ω to 200 Ω	6.8 ppm + 280 µΩ		
	200 Ω to 2 kΩ	5.9 ppm + 2.3 mΩ		
	2 kΩ to 20 kΩ	6.2 ppm + 22 mΩ		
	20 kΩ to 200 kΩ	5.8 ppm + 140 mΩ		
	200 kΩ to 2 MΩ	12 ppm + 1.3 Ω		
	2 MΩ to 20 MΩ	72 ppm + 120 Ω		
	20 MΩ to 200 MΩ	750 ppm + 120 kΩ		
	200 MΩ to 2 GΩ	750 ppm + 1.2 MΩ		
DC Resistance measurement (At higher current)				
	0 Ω to 2 Ω	18 ppm + 5.9 µΩ		
	2 Ω to 20 Ω	4.7 ppm + 20 µΩ		
	20 Ω to 200 Ω	4.3 ppm + 100 µΩ		
	200 Ω to 2 kΩ	5.9 ppm + 1.1 mΩ		
	2 kΩ to 20 kΩ	6.2 ppm + 8.8 mΩ		
	20 kΩ to 200 kΩ	5.8 ppm + 95 mΩ		
	200 kΩ to 2 MΩ	10 ppm + 1.3 Ω		
	2 MΩ to 20 MΩ	72 ppm + 120 Ω		
	20 MΩ to 200 MΩ	750 ppm + 12 kΩ		
	200 MΩ to 2 GΩ	750 ppm + 1.2 MΩ		
DC Resistance Generation Specific values				
	1 mΩ	0.545%		
	10 mΩ	0.065 %		
	100 mΩ	245 ppm		
	1 Ω	91 ppm		
	1.9 Ω	55 ppm		
	10 Ω	16 ppm		
	19 Ω	18 ppm		
	25 Ω	18 ppm		
	50 Ω	17 ppm		
	100 Ω	6 ppm		
	190 Ω	16 ppm		
	250 Ω	18 ppm		
	300 Ω	8.5 ppm		
	1 kΩ	4.3 ppm		
	1.9 kΩ	7.5 ppm		
	10 kΩ	7.5 ppm		
	19 kΩ	7.5 ppm		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
DC Resistance Generation Specific values continued				UK
	100 kΩ	7.5 ppm		
	190 kΩ	10 ppm		
	1 MΩ	10 ppm		
	1.9 MΩ	18 ppm		
	10 MΩ	15 ppm		
	19 MΩ	35 ppm		
	100 MΩ	50 ppm		
	1.0GΩ	250 ppm		
	1.0 kΩ	0.25 %	With applied voltages of 50 V and 100 V	
	100 kΩ	0.25 %		
	1.0 MΩ	0.25 %		
	10 MΩ	0.25 %		
	100 MΩ	0.25 %		
	1.0 GΩ	0.50 %		
	10 GΩ	1.0 %		
	1.0 MΩ	0.30 %	With applied voltages of 250 V and 500 V	
	10 MΩ	0.30 %		
	100 MΩ	0.30 %		
	1.0 GΩ	0.30 %		
	10 GΩ	0.30 %		
	100 GΩ	2.0 %	With an applied voltage of 500 V	
	1.0 TΩ	2.5 %		
	100 MΩ	0.5 %		
	1.0 GΩ	0.5 %	With an applied voltage of 1000 V	
	10 GΩ	0.5 %		
	100 GΩ	2.0 %		
	1.0 TΩ	2.0 %		
	1.0 GΩ	1.1 %	With an applied voltage of 5000 V	
	10 GΩ	1.0 %		
	100 GΩ	2.0 %		
	1.0 TΩ	2.0 %		
Other values	0.1 Ω to 10 Ω	2.5 mΩ		
	10 Ω to 100 Ω	36 ppm		
	100 Ω to 1 kΩ	16 ppm		
	1 kΩ to 10 kΩ	10 ppm		
	10 kΩ to 100 kΩ	10 ppm		
	100 kΩ to 1 MΩ	50 ppm		
	1 MΩ to 10 MΩ	0.10 %		
	10 MΩ to 100 MΩ	0.15 %		
	100 MΩ to 1 GΩ	0.50 %		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
DC Voltage				UK
Voltage Reference Values	1.018 V 10 V	3.2 ppm 1.3 ppm		
Measurement	0 V to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	5.7 ppm + 1.2 μV 6.1 ppm + 1.3 μV 2.1 ppm + 5.8 μV 3.2 ppm + 61 μV 6.7 ppm + 680 μV		
DC High Voltage Measurement	0 V to 5 kV 5 kV to 10 kV 10 kV to 15 kV 15 kV to 20 kV 20 kV to 25 kV 25 kV to 30 kV 30 kV to 35 kV 35 kV to 40 kV	1.4 % 0.58 % 0.49 % 0.87 % 0.96 % 0.84 % 0.77 % 0.69 %		
Generation	0 mV to 200 mV 0.2 V to 2 V 2 V to 11 V 11 V to 20 V 20 V to 200 V 200 V to 1100 V	5.9 ppm + 0.70 μV 3.2 ppm + 1.1 μV 1.8 ppm + 3.1 μV 2.6 ppm + 11 μV 2.4 ppm + 120 μV 3.0 ppm + 700 μV		
DC Current				UK
Measurement	0 A 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	8.5 ppm + 1.4 nA 8.8 ppm + 5.3 nA 9.5 ppm + 52 nA 22 ppm + 950 nA 35 ppm + 19 μA 89 ppm + 460 μA		
Generation	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 10 A to 20 A 20 A to 60 A	7.0 ppm + 1.2 nA 10.5 ppm + 3.0 nA 9.2 ppm + 20 nA 10.5 ppm + 120 nA 25 ppm + 2.0 μA 2 mA 10 mA 40 mA		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC Voltage Measurement				UK
	50 µV to 200 mV			
	20 Hz to 55 Hz	8.0 µV		
	55 Hz to 305 Hz	10 µV		
	305 Hz to 1 kHz	8.0 µV		
	1 kHz to 3 kHz	7.2 µV		
	3 kHz to 10 kHz	9.5 µV		
	10 kHz to 30 kHz	20 µV		
	30 kHz to 60 kHz	21 µV		
	60 kHz to 100 kHz	40 µV		
	200 mV to 2 V			
	20 Hz to 55 Hz	45 µV		
	55 Hz to 305 Hz	45 µV		
	305 Hz to 1 kHz	45 µV		
	1 kHz to 3 kHz	50 µV		
	3 kHz to 10 kHz	61 µV		
	10 kHz to 30 kHz	90 µV		
	30 kHz to 60 kHz	290 µV		
	60 kHz to 100 kHz	330 µV		
	100 kHz to 500 kHz	2.9 mV		
	500 kHz to 1 MHz	24 mV		
	2 V to 20 V			
	20 Hz to 55 Hz	450 µV		
	55 Hz to 305 Hz	450 µV		
	305 Hz to 1 kHz	460 µV		
	1 kHz to 3 kHz	490 µV		
	3 kHz to 10 kHz	730 µV		
	10 kHz to 30 kHz	790 µV		
	30 kHz to 60 kHz	1.8 mV		
	60 kHz to 100 kHz	2.9 mV		
	100 kHz to 500 kHz	40 mV		
	500 kHz to 1 MHz	270 mV		
	20 V to 200 V			
	20 Hz to 55 Hz	6.0 mV		
	55 Hz to 305 Hz	6.0 mV		
	305 Hz to 1 kHz	6.0 mV		
	1 kHz to 3 kHz	6.0 mV		
	3 kHz to 10 kHz	7.5 mV		
	10 kHz to 30 kHz	15 mV		
	30 kHz to 60 kHz	29 mV		
	60 kHz to 100 kHz	33 mV		
	At 100 kHz	240 mV		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC Voltage Measurement Continued				UK
	200 V to 1 kV			
	55 Hz to 305 Hz	75 mV		
	305 Hz to 1 kHz	80 mV		
	1 kHz to 3 kHz	90 mV		
	3 kHz to 10 kHz	100 mV		
	10 kHz to 30 kHz	130 mV		
	At 30 kHz	310 mV		
High Voltage AC Measurement Nom 50 Hz	2 kV	1.7 %	Claims for intermediate values more than 10 % away from the nominal value listed will be the highest of the adjacent points	
	3 kV	1.2 %		
	4 kV	0.97 %		
	5 kV	2.3 %		
	6 kV	0.96 %		
	7 kV	0.88 %		
	8 kV	0.81 %		
	10 kV	3.7 %		
	15 kV	3.4 %		
	20 kV	3.2 %		
	25 kV	2.0 %		
	28 kV	2.4 %		
Generation	*10 Hz to 40 Hz*			
	0.1 mV to 2 mV	7.0 µV		
	2 mV to 20 mV	9.0 µV		
	20 mV to 100 mV	25 µV		
	100 mV to 1 V	120 µV		
	1 V to 10 V	2.4 mV		
	10 V to 100 V	24 mV		
	40 Hz to 500 Hz			
	0.1 mV to 2 mV	7.0 µV		
	2 mV to 20 mV	8.0 µV		
	20 mV to 100 mV	14 µV		
	100 mV to 1 V	50 µV		
	1 V to 10 V	760 µV		
	10 V to 100 V	7.0 mV		
	500 Hz to 1 kHz			
	0.1 mV to 2 mV	7.0 µV		
	2 mV to 20 mV	8.0 µV		
	20 mV to 100 mV	12 µV		
	100 mV to 1 V	24 µV		
	1 V to 10 V	400 µV		
	10 V to 100 V	4.0 mV		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC Voltage Generation Continued				UK
	1 kHz to 10 kHz			
	0.1 mV to 2 mV	7.0 µV		
	2 mV to 20 mV	9.0 µV		
	20 mV to 100 mV	12 µV		
	100 mV to 1 V	24 µV		
	1 V to 10 V	400 µV		
	10 V to 100 V	4.0 mV		
	10 kHz			
	2 mV	7.0 µV		
	20 mV	7.0 µV		
	100 mV	12 µV		
	1 V	26 µV		
	10 V	410 µV		
	100 V	4.0 mV		
	1000 V			
	55 Hz to 500 Hz	58 mV		
	500 Hz to 1 kHz	61 mV		
	1 kHz	65 mV		
AC Current Measurement				UK
	30 nA to 200 µA			
	55 Hz to 305 Hz	27 nA		
	305 Hz to 1 kHz	25 nA		
	1 kHz to 3 kHz	30 nA		
	3 kHz to 10 kHz	40 nA		
	At 10 kHz	62 nA		
	200 µA to 2 mA			
	55 Hz to 305 Hz	250 nA		
	305 Hz to 1 kHz	250 nA		
	1 kHz to 3 kHz	280 nA		
	3 kHz to 10 kHz	280 nA		
	At 10 kHz	330 nA		
	2 mA to 20 mA			
	55 Hz to 305 Hz	2.6 µA		
	305 Hz to 1 kHz	2.4 µA		
	1 kHz to 3 kHz	2.7 µA		
	3 kHz to 10 kHz	4.0 µA		
	At 10 kHz	4.0 µA		
	20 mA to 200 mA			
	55 Hz to 305 Hz	25 µA		
	305 Hz to 1 kHz	25 µA		
	1 kHz to 3 kHz	25 µA		
	3 kHz to 10 kHz	25 µA		
	At 10 kHz	30 µA		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC Current Measurement Continued				UK
	200 mA to 2 A			
	55 Hz to 305 Hz	260 µA		
	305 Hz to 1 kHz	280 µA		
	1 kHz to 3 kHz	460 µA		
	3 kHz to 10 kHz	600 µA		
	At 10 kHz	590 µA		
	2 A to 20 A			
	55 Hz to 305 Hz	12 mA		
	305 Hz to 1 kHz	12 mA		
	1 kHz to 3 kHz	15 mA		
	3 kHz to 10 kHz	16 mA		
	At 10 kHz	18 mA		
AC Current Generation				
	55 Hz to 400 Hz			
	10 µA to 100 µA	20 nA		
	100 µA to 1 mA	150 nA		
	1 mA to 10 mA	580 nA		
	10 mA to 100 mA	5.0 µA		
	100 mA to 1 A	75 µA		
	60 Hz			
	1 A to 2 A	0.15 %		
	2 A to 10 A	0.80 %		
	10 A to 20 A	2.8 %		
	20 A to 50 A	4.7 %		
	400 Hz to 1 kHz			
	10 µA to 100 µA	20 nA		
	100 µA to 1 mA	180 nA		
	1 mA to 10 mA	700 nA		
	10 mA to 100 mA	5.2 µA		
	200 mA to 1 A	75 µA		
	1 kHz to 5 kHz			
	10 µA to 100 µA	30 nA		
	100 µA to 1 mA	200 nA		
	1 mA to 10 mA	1.1 µA		
	10 mA to 100 mA	15 µA		
	100 mA to 1 A	300 µA		
	5 kHz			
	100 µA	100 nA		
	1 mA	1.0 µA		
	10 mA	2.3 µA		
	100 mA	25 µA		
	1 A	500 µA		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
Frequency				UK
	10 MHz 1 Hz to 1 GHz	7.0 in 10^{11} 0.20 ppm	Measurement and generation of repetitive waveforms.	
Temperature indicators, calibration by electrical simulation				UK
Base metal thermocouples	- 210 °C to + 1360 °C	0.05 °C	Excluding cold junction compensation	
Nobel metal thermocouples	- 50 °C to + 2300 °C	0.17 °C	Excluding cold junction compensation	
Cold junction compensation	Ambient temperature 18 °C to 30 °C At 0 °C	0.56 °C 0.21 °C		
Resistance thermometers	- 200 °C to + 840 °C	0.050 °C		
Temperature simulators, calibration by electrical simulation				
Base metal thermocouples	- 210 °C to + 1360 °C	0.070 °C	Excluding cold junction compensation	
Noble metal thermocouples	- 50 °C to + 2300 °C	0.15 °C	Excluding cold junction compensation	
Base metal thermocouples	- 210 °C to + 1360 °C	0.11 °C	Including cold junction compensation	
Noble metal thermocouples	- 50 °C to + 2300 °C	0.19 °C	Including cold junction compensation	
Resistance thermometers	- 200 °C to + 840 °C	0.002 °C		

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
MASS	Nominal value (grams) 0.001 to 0.02 0.05 to 0.2 0.5 1 2 5 10 20 50 100 200 500 1 000 2 000 5 000 10 000 20 000 30 000	(mg) 0.012 0.015 0.018 0.020 0.024 0.030 0.040 0.050 0.060 0.10 0.20 0.50 1.0 2.0 5.0 10 20 30	Intermediate values under 100g can be calibrated with an uncertainty equal to the uncertainty of the next higher nominal value. Intermediate values over 100 g can be calibrated with an uncertainty of 1 part per million (1 mg per kg). Substitution Method	UK
TEMPERATURE				UK
Resistance thermometers and electronic thermometers with PRT, thermocouple or thermistor sensors	-75 °C to -40 °C -40 °C to 0 °C 0 °C (ice point) 0.01 °C (Triple Point of Water) 0 °C to 60 °C 60 °C to 150 °C 150 °C to 250 °C	0.048 °C 0.038 °C 0.022 °C 0.017 °C 0.022 °C 0.030 °C 0.045 °C	Calibration performed in liquid baths	
HUMIDITY				UK
Relative humidity meters	11 %rh 33 %rh 54 %rh 75 %rh 90 %rh For the temperature range 21 °C ± 3 °C	2.2 %rh 2.2 %rh 2.7 %rh 2.7 %rh 3.2 %rh	Calibrations by comparison with dew-point hygrometer and Platinum Resistance Thermometers	
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.