


Schedule of Accreditation

issued by

United Kingdom Accreditation Service

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

 <p>UKAS CALIBRATION 0489</p> <p>Accredited to ISO/IEC 17025:2017</p>	<h3>Trescal Limited</h3> <p>Issue No: 105 Issue date: 01 April 2021</p>	
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<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
<p>PRESSURE</p> <p><u>Hydraulic Pressure (Gauge)</u></p> <p>“Pressure equivalent” calibration of Dead Weight Testers (pressure balances supplied with an associated mass set)</p> <p>Calibration of pressure indicating instruments and gauges</p> <p><u>Hydraulic Pressure (Absolute)</u></p> <p>Calibration of pressure indicating instruments and gauges</p> <p><u>Gas Pressure (Gauge)</u></p> <p>Calibration of pressure indicating instruments and gauges</p> <p>“Pressure equivalent” calibration of Dead Weight Testers (pressure balances supplied with an associated mass set and Ametek gas Pressure standards)</p> <p><u>Gas pressure (Absolute)</u></p> <p>“Pressure Equivalent” calibration or dead-weight testers</p> <p>Calibration of pressure indicating instruments and gauges</p>	<p>0.5 MPa to 7 MPa 7 MPa to 140 MPa 140 MPa to 500 MPa</p> <p>0.6 MPa to 7 MPa 7 MPa to 140 MPa 140 MPa to 500 MPa</p> <p>-100 kPa to -2.5 kPa -2.5 kPa to 2.5 kPa 2.5 kPa to 7 MPa 7 MPa to 21 MPa 21 MPa to 80 MPa</p> <p>2.5 kPa to 7 MPa</p> <p>2.5 kPa to 21 MPa 21 MPa to 80 MPa</p>	<p>0.0040 % 0.0053 % 0.011 %</p> <p>0.0040 % + 25 Pa 0.0053 % 0.011 %</p> <p>0.0040 % 0.012 % + 0.035 Pa 0.0034 % 0.0036 % 0.0055 %</p> <p>0.0041 %</p> <p>0.0039 % 0.0055 %</p>	<p>Methods consistent with EURAMET CG3 and CG17</p> <p>Calibration of pressure measuring devices with an electrical output may be undertaken. Devices may be calibrated using the digital communication protocol including Fieldbus</p> <p>Thommen and capsule pressure gauges can be calibrated. Aneroid Barometers without a pressure port can be calibrated</p>



0489

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<p>PRESSURE (continued)</p> <p><u>Gas Pressure (Differential)</u></p> <p>Calibration of pressure indicating instruments and gauges</p>	0 Pa to 1 MPa (line pressure 0 Pa to 40 MPa)	0.50 ppm/MPa of line pressure, plus 0.0040 % of differential pressure, plus 5 Pa	Differential pressure cells may be calibrated using the digital communication protocol including Fieldbus
<p>VACUUM</p> <p>Calibration of indicating instruments and gauges</p>	1.0x10 ⁻⁴ Pa to 2.0 Pa 1.3x10 ⁻² Pa to 1.3x10 ⁻¹ Pa 0.13 Pa to 1.3 Pa 1.3 Pa to 13.3 Pa 13.3 Pa to 133 Pa 133 Pa to 1.33 kPa 1.33 kPa to 13.3 kPa 13.3 kPa to 133 kPa	7.0 % + 2 x 10 ⁻⁶ Pa 1.5 % + 1.5 x 10 ⁻⁴ Pa 1.2 % + 6 x 10 ⁻⁴ Pa 0.85 % + 8 x 10 ⁻³ Pa 0.60 % + 4 x 10 ⁻² Pa 0.35 % + 1.8 x 10 ⁻² Pa 0.25 % + 1.4 Pa 0.30 %	Calibration using N ₂ gas. By comparison
<p>ELECTRICAL MEASUREMENTS and electrical simulations listed below can be both sourced and measured at the same uncertainty unless otherwise stated and so are applicable for the calibration of both measuring instruments and for those instruments with an output. the method used is by direct comparison unless otherwise stated in the remarks column.</p>			
<p>DC VOLTAGE</p> <p>Specific Values</p>	10 mV 100 mV 1 V 10 V 19 V 100 V 1 kV	10 ppm 6.0 ppm 4.0 ppm 4.0 ppm 4.0 ppm 5.0 ppm 5.0 ppm	
Other Values	0 V to 200 mV 200 mV to 20 V 20 V to 1 kV	10 ppm + 0.60 μV 11 ppm 24 ppm	
<p>HIGH VOLTAGE</p>	1 kV to 20 kV 20 kV to 30 kV 30 kV to 50 kV	0.30 % 0.50 % 0.50 %	Measurement only



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DC CURRENT Specific Values	100 μ A 1 mA 10 mA 100 mA 1 A 10 A	30 ppm 20 ppm 20 ppm 22 ppm 50 ppm 70 ppm	Clamp-on ammeters can be calibrated up to 2000 A with increased uncertainties.
Other Values	0 A to 200 μ A 200 μ A to 200 mA 200 mA to 2 A	77 ppm + 7.0 nA 75 ppm 86 ppm	
	2 A to 10 A 10 A to 20 A 20 A to 100 A	240 ppm 300 ppm 190 ppm	
AC VOLTAGE Specific Values	1 mV		
	20 Hz, 30 Hz, 40 Hz, 55 Hz, 300 Hz, 1 kHz and 10 kHz 20 kHz, 30 kHz and 50 kHz 100 kHz	700 ppm 700 ppm 0.10 %	
	10 mV 20 Hz, 30 Hz, 40 Hz, 300 Hz, 1 kHz, 10 kHz and 20 kHz 55 Hz 30 kHz and 50 kHz 100 kHz	220 ppm 240 ppm 270 ppm 0.0011 %	
	100 mV 10 Hz, 20 Hz, 30 Hz, 40 Hz and 55 Hz 300 Hz, 1 kHz and 10 kHz 20 kHz 30 kHz and 50 kHz 100 kHz	130 ppm 110 ppm 120 ppm 180 ppm 340 ppm	



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AC VOLTAGE Specific Values continued	1 V 10 Hz, 20 Hz and 30 Hz 40 Hz, 55 Hz, 300 Hz, 1 kHz, 10 kHz, 20 kHz and 30 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	40 ppm 29 ppm 34 ppm 37 ppm 140 ppm 330 ppm 0.11 %	
	10 V 10 Hz, 20 Hz, 30 Hz and 40 Hz 55 Hz, 300 Hz, 1 kHz, 10 kHz, 20 kHz, 30 kHz, 50 kHz and 100 kHz 300 kHz 500 kHz 1 MHz	45 ppm 35 ppm 120 ppm 320 ppm 0.11 %	
	19 V 1 kHz	40 ppm	
	100 V 10 Hz, 20 Hz, 30 Hz, 40 Hz and 55 Hz 300 Hz, 1 kHz, 10 kHz, 20 kHz and 30 kHz 50 kHz 100 kHz	50 ppm 45 ppm 50 ppm 80 ppm	
	700 V 50 kHz 100 kHz	150 ppm 500 ppm	
	1 kV 40 Hz, 55 Hz, 300 Hz and 1 kHz 10 kHz, 20 kHz 30 kHz	50 ppm 60 ppm 90 ppm	
Other values	100 mV to 200 mV 40 Hz to 30 kHz	200 ppm + 12 μ V	
	200 mV to 2 V 40 Hz to 30 kHz	170 ppm	
	2 V to 200 V 40 Hz to 30 kHz	180 ppm	
	200 V to 1 kV 40 Hz to 30 kHz	440 ppm	



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HIGH VOLTAGE	1 kV to 20 kV 50 Hz	0.80 %	For the calibration of high voltage probes, meters and sources
	20 kV to 35 kV 50 Hz	0.90 %	
AC CURRENT			
Specific Values			
	100 μ A 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	130 ppm 120 ppm 90 ppm 140 ppm	
	1 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	120 ppm 110 ppm 90 ppm 140 ppm	
	10 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	120 ppm 110 ppm 90 ppm 140 ppm	
	100 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz and 300 Hz 1 kHz 5 kHz	120 ppm 110 ppm 90 ppm 90 ppm 140 ppm	
	1 A 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	160 ppm 150 ppm 120 ppm 230 ppm	
	3 A 40 Hz, 95 Hz, 110 Hz and 440 Hz 3 kHz	470 ppm 470 ppm	



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AC CURRENT			
Specific Values	10 A 10 Hz, 20 Hz and 30 Hz 40 Hz 55 Hz 95 Hz 300 Hz 440 Hz 1 kHz 5 kHz 10 kHz	270 ppm 250 ppm 240 ppm 470 ppm 240 ppm 470 ppm 240 ppm 300 ppm 420 ppm	
Other Values	100 μ A to 200 μ A 40 Hz to 1 kHz 1 kHz to 5 kHz 200 μ A to 200 mA 40 Hz to 1 kHz 200 μ A to 20 mA 1 kHz to 5 kHz 20 mA to 200 mA 1 kHz to 5 kHz 200 mA to 2 A 40 Hz to 1 kHz 1 kHz to 5 kHz 40 Hz to 60 Hz: 2 A to 10 A 10 A to 20 A 20 A to 100 A	200 ppm + 3.0 nA 400 ppm + 4.0 nA 200 ppm 380 ppm 400 ppm 900 ppm 0.20 % 0.19 % 350 ppm 390 ppm	Clamp-on ammeters can be calibrated up to 2000 A ac with increased uncertainties.
DC RESISTANCE			
Specific values	10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω 1 G Ω 10 G Ω 100 G Ω	0.60 ppm 0.65 ppm 0.65 ppm 3.5 ppm 8.5 ppm 13 ppm 26 ppm 110 ppm 70 ppm 140 ppm 730 ppm	For the calibration of fixed resistors, including those comprising the resistance function of multifunction calibrators.



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DC RESISTANCE Other values	0 Ω to 10 Ω 10 Ω to 1k Ω 1k Ω to 2 k Ω 2 k Ω to 20 k Ω 20 k Ω to 200 k Ω 200 k Ω to 2 M Ω 2 M Ω to 20 M Ω 20 M Ω to 100 M Ω 100 $\mu\Omega$ to 10 Ω Maximum current 100 A 100 M Ω to 1G Ω 1G Ω to 10 G Ω 10 G Ω to 100 G Ω Voltages >250 V dc	33 ppm + 12 $\mu\Omega$ 0.65 ppm 11 ppm 11 ppm 16 ppm 32 ppm 80 ppm 260 ppm + 9.0 k Ω 130 ppm 70 ppm 140 ppm 730 ppm	The capability shown is for measurement of unknown resistance values. Known resistances within this range can be generated, but the uncertainties will be increased. 4 terminal resistors in the range 100 $\mu\Omega$ to 10 Ω can be measured using a dc voltage and current technique. The uncertainty quoted will be the sum of the corresponding voltage and current uncertainties attributable to the resistor under test. Generation of resistance in the range 100 $\mu\Omega$ to 10 Ω will be at an increased uncertainty to the dc voltage/current technique uncertainties. 100 M Ω to 100 G Ω can be measured using a dc voltage and current technique. The uncertainty quoted will be the sum of the corresponding voltage and current uncertainties. Values from 100 M Ω to 1G Ω can be generated with increased uncertainties.
Specific Values	10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω 1 G Ω 10 G Ω 100 G Ω	15 ppm 7.5 ppm 4.5 ppm 4.5 ppm 9.0 ppm 16 ppm 29 ppm 110 ppm 70 ppm 140 ppm 730 ppm	For the calibration of the dc resistance ranges of multimeters, analogue and digital, and similar devices.



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AC RESISTANCE NON-INDUCTIVE			
Specific Values	1 mΩ to 1 kΩ 40 Hz to 140 Hz	800 ppm	Uncertainties are dependent on the test voltage, current and frequency employed
DC POWER	100 mV to 1 kV 5 mA to 100 A 20 W to 2 MW (simulated)	The sum of the individual voltage and current uncertainties	
AC POWER			Voltage up to 1 kV and Current up to 1 kA giving product power up to a maximum of 1 MW
	5 W to 1 MW 40 Hz to 100 Hz	0.16 %	At unity power factor
	5 W to 1 MW 40 Hz to 100 Hz	0.20 %	At power factors from 1 to 0
PHASE	0° To 360° 40 Hz to 1 kHz	0.020°	
CAPACITANCE			
Values at 1 kHz	50 pF to 100 nF 100 nF to 1 μF	0.070 % + 0.80 pF 0.47 %	Sources up to 250 V Other frequencies (100 Hz to 10 kHz) can be accommodated at increased uncertainties. 2 or 3 wire devices.
At 1 kHz	10 pF to 100 pF 100 pF to 1 μF 1 μF to 10 μF 10 μF to 100 μF	2.2 % 0.21 % 0.22 % 0.32 %	These values can be measured



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FREQUENCY	10 mHz to 1.2 GHz	2.0 parts in 10^9	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> The uncertainties quoted for these parameters are particularly dependent on the stability and waveform. </div> Error and uncertainty expressed as seconds per day: (s/d) this uncertainty will be larger for mechanical devices, depending on stability.
PERIODIC TIME	20 ns to 100 s	2.0 parts in $10^9 + 3.0$ ns	
TIME INTERVAL AVERAGE	60 ns to 100 s	2.0 parts in $10^9 + 5.0$ ns	
Stop Watches	0 s to 10^4 s	0.025 s/d	
Additional Parameters suitable for Oscilloscope calibration			
<u>Rise Time</u>	150 ps nominal At 50 mV, 250 mV, 500 mV and 2.5 V	50 ps	
	500 ps nominal At 50 mV, 250 mV, 500 mV and 2.5 V	60 ps	
<u>Bandwidth</u>	1 Hz to 1 GHz at 100 mV nominal	2.5 %	
<u>AC Level flatness</u>	With respect to a set point at a nominal 1 V, 1 kHz being the 0 dB reference. 1 kHz to 1 MHz	0.040 dB	
Parameters specific to 16 th & 17 th Edition equipment testing, not covered in the main schedule headings			
<u>Trip times</u>	20 ms to 900 ms	0.70 ms	
<u>Trip Current</u>	10 mA, 30 mA, 90 mA, 100 mA and 110 mA 300 mA, 1 A & 2 A	0.50 mA 1.0 mA	
<u>AC resistance</u>	At 50 Hz: Residual loop impedance and up to 1.5 Ω 5 Ω 10 Ω 100 Ω 1 k Ω	50 m Ω 150 m Ω 500 m Ω 1.2 Ω 3.5 Ω	



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<u>Charge Amplifiers</u>	0.1 pC to 10 000 pC <i>20 Hz to 10 kHz</i> <i>10 kHz to 50 kHz</i>	0.050 % 0.11 %	
<u>Temperature indicators, calibration by electrical simulation</u>			
Resistance thermometers (PT 100)	-200 °C to +800 °C	0.020 °C	
Thermocouples: Internal reference junction disabled			
Type K	-200 °C to +1300 °C	0.052 °C	
Type T	-200 °C to +400 °C	0.050 °C	
Type J	-200 °C to +1200 °C	0.043 °C	
Type E	-200 °C to +1000 °C	0.040 °C	
Type N	-200 °C to +1300 °C	0.069 °C	
Type R	500 °C to +1760 °C	0.13 °C	
Type S	500 °C to +1760 °C	0.13 °C	
Type B	500 °C to +1800 °C	0.17 °C	
Thermocouples: Internal reference junction enabled.			
Type K	-200 °C to +1300 °C	0.30 °C	
Type T	-200 °C to +400 °C	0.30 °C	
Type J	-200 °C to +1200 °C	0.30 °C	
Type E	-200 °C to +1300 °C	0.30 °C	
Type N	-200 °C to +1300 °C	0.31 °C	
Type R	500 °C to +1760 °C	0.33 °C	
Type S	500 °C to +1760 °C	0.33 °C	
Type B	500 °C to +1800 °C	0.34 °C	
Temperature simulators, calibration by electrical simulation			
Resistance thermometers (PT 100)	-200 °C to +800 °C	0.020 °C	



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ELECTRICAL MEASUREMENT (continued)			
<u>Temperature simulators, calibration by electrical simulation</u> (continued)			
Thermocouples: Internal reference junction disabled			
Type K	-200 °C to +1300 °C	0.087 °C	
Type T	-200 °C to +400 °C	0.083 °C	
Type J	-200 °C to +1200 °C	0.065 °C	
Type E	-200 °C to +1000 °C	0.059 °C	
Type N	-200 °C to +1300 °C	0.13 °C	
Type R	500 °C to +1760 °C	0.16 °C	
Type S	500 °C to +1760 °C	0.17 °C	
Type B	500 °C to +1800 °C	0.27 °C	
Thermocouples: Internal reference junction enabled.			
Type K	-200 °C to +1300 °C	0.31 °C	
Type T	-200 °C to +400 °C	0.31 °C	
Type J	-200 °C to +1200 °C	0.31 °C	
Type E	-200 °C to +1300 °C	0.31 °C	
Type N	-200 °C to +1300 °C	0.33 °C	
Type R	500 °C to +1760 °C	0.34 °C	
Type S	500 °C to +1760 °C	0.35 °C	
Type B	500 °C to +1800 °C	0.40 °C	
Cold Junction Compensation	Nominal Ambient 17 °C to 23 °C	0.10 °C	
TEMPERATURE			
Resistance thermometers			
	-80 °C to -38 °C	0.010 °C	within Fluid Baths
	-38 °C to 0 °C	0.010 °C	
	0 °C to 200 °C	0.015 °C	
	200 °C to 300 °C	0.015 °C	
	300 °C to 550 °C	0.054 °C	
	550 °C to 660 °C	0.30 °C	within Tube Furnaces
	0.01 °C (triple point of water)	0.0010 °C	within Fixed Points
	29.7646 °C (melting point of Gallium)	0.0050 °C	
Electronic temperature indicators with sensors			
	-80 °C to +660 °C	As for resistance thermometers ...	Devices may be calibrated using the digital communication protocol including Fieldbus
	660 °C to 1100 °C	As for thermocouples plus 1/2 scale division for analogue indicators.	



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TEMPERATURE (continued)			
Thermocouples Noble metal type	-50 °C to +200 °C	0.40 °C	Within Fluid Baths
	200 °C to 550 °C	0.45 °C	
	550 °C to 660 °C	0.70 °C	Within Tube Furnace
	660 °C to 900 °C 900 °C to 1100 °C	1.8 °C 2.0 °C	
Thermocouples Base Metal	-80 °C to +200 °C	0.40 °C	Within Fluid Baths
	200 °C to 550 °C	0.55 °C	
Liquid-in-glass thermometers	550 °C to 660 °C	0.80 °C	Within Tube Furnace
	660 °C to 900 °C	1.8 °C	
	900 °C to 1100 °C	2.0 °C	
Temperature block calibrators and portable liquid baths	-80 °C to +0 °C	0.023 °C	Within Fluid baths
	0 °C to 100 °C	0.015 °C	
	100 °C to 300 °C	0.024 °C plus 1/4 scale division	
Temperature in air	-80 °C to -38 °C	0.040 °C	
	-38 °C to +200 °C	0.040 °C	
	200 °C to 660 °C	0.060 °C	
	660 °C to 1100 °C	1.2 °C	
Radiation thermometers (Pyrometers)	-70 °C to -25 °C	0.40 °C	Calibration by comparison with a reference Pyrometer
	-25 °C to -5 °C	0.28 °C	
	-5 °C to +70 °C	0.15 °C	
	70 °C to 100 °C	0.28 °C	
	-15 °C to 0 °C	2.0 °C	
	0 °C to 120 °C	1.5 °C	
120 °C to 150 °C	2.0 °C	Only thermometers operating at an emissivity setting of 0.95 can be calibrated	
150 °C to 250 °C	2.5 °C		
250 °C to 350 °C	3.5 °C		
350 °C to 500 °C	4.5 °C		
HUMIDITY			
Relative Humidity	10 %rh to 40 %rh	0.6 %rh	Calibration by comparison with a reference hygrometer and reference thermometers
	40 %rh to 95 %rh for the temperature range -5 °C to 70 °C	1.3 % of reading	
Salt capsules	10 %rh and 95 %rh	1.6 %rh	
	20 °C ± 3.0 °C		
Dew point	-75 °C to - 50 °C	0.30 °C	Including calculated units
	-50 °C to - 20 °C	0.20 °C	
	-20 °C to 60 °C	0.15 °C	



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DENSITY			
Density transducers -Nitrogen Gas	0.5 kg/m ³ to 300 kg/m ³ 300 kg/m ³ to 360 kg/m ³	0.030 % 0.60 %	By comparison with known gases at controlled temperatures and pressures
Density transducers - Argon gas	25 kg/m ³ to 400 kg/m ³	0.035 %	
Liquid Density	700 kg/m ³ to 1000 kg/m ³	0.064 kg/m ³	Liquids with viscosity up to 100 mPa.s by direct measurement
Density transducers - Liquid	700 kg/m ³ to 1000 kg/m ³	0.064 kg/m ³	By comparison with liquids of a known density
AIR VELOCITY			
Calibration of anemometers	0.1 m/s to 0.47 m/s 0.47 m/s to 7.5 m/s 7.5 m/s to 10 m/s 10 m/s to 30 m/s	0.083 m/s 1.5 % + 0.050 m/s 1.0 % + 0.10 m/s 1.5 % + 0.050 m/s	Method by comparison using an open jet wind tunnel Instruments up to 120 mm in diameter can be calibrated
Calibration of pitot tubes	As for anemometers	As for anemometers with the addition of 0.20 Pa + 0.53 % of the pitot pressure	Uncertainty obtained will be a combination of the pressure and velocity uncertainty
FLOW (Mass or volume)			
<u>Hydrocarbon oils</u>			
Mass - flow rate and quantity passed	0.6 kg/min to 60 kg/min 20 kg/min to 2000 kg/min 2000 kg/min to 2400 kg/min	0.050 % 0.075 % 0.13 %	Fluid temperature can be controlled from 10 °C to 80 °C depending on the ambient conditions. A range of oils is available covering the range 2 cSt to 150 cSt. Available oils: Kerosene, Gas oil, Shell Tellus 32, Shell Tellus 100.
Volume - flow rate and quantity passed	0.6 l/min to 75 l/min 25 l/min to 2500 l/min 2500 l/min to 3000 l/min	0.055 % 0.10 % 0.13 %	Devices with a Fieldbus output can be calibrated Gravimetric method
<u>Water flow</u>			
Mass flow rate	0.6 kg/min to 4 kg/min 4 kg/min to 600 kg/min	0.27 % 0.20 %	Gravimetric method
Volume flow rate	0.6 l/min to 4 l/min 4 l/min to 600 l/min	0.27 % 0.20 %	
<u>Gas flow</u>			
Flow-rate and quantity passed	0.2 l/min to 2 l/min 2 l/min to 1000 l/min	0.23 % 0.16 %	Volumetric prover and Reference meter methods Calibration medium air Any inert gases may be used.
Flow rate	5 ml/min to 50 ml/min 50 ml/min to 500 ml/min 0.5 l/min to 5 l/min 3 l/min to 30 l/min 5 l/min to 100 l/min	0.25% + 0.01 ml/min 0.35% + 0.05 ml/min 0.32% + 0.002 l/min 0.39% + 0.02 l/min 0.37% + 0.03 l/min	Calibration medium nitrogen, dry air, argon



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DIMENSIONAL Orifice plates	BS EN ISO 5167-2:2003 Bore diameter d 12.5 mm to 750 mm	0.020 + (0.0060 x diameter in m) mm	
END			



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Accredited to
ISO/IEC 17025:2017

Schedule of Accreditation

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United Kingdom Accreditation Service

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Calibration performed at main address only

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 μ V

Over the range 100 mV to 1 V, the CMC is 0.0025 % \cdot V + 5.0 μ V, 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.