CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Accredited Calibration Services, Inc.
(Marsh Metrology)
2-1016C Sutton Drive
Burlington, ON L7L 6B8 Canada

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

ANSI/NCSL Z540-1-1994 (R2002) and

ANSI/NCSL Z540.3-2006 (R2013)

In the field of

CALIBRATION

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 27 May 2022
Certificate Number: AC-1172

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3-2006 (R2013)

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CALIBRATION

Valid to: **May 27, 2022** Certificate Number: **AC-1172**

Chemical Quantities

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH Meters	(4, 7 and 10) pH	0.012 pH	Standard Buffer Solutions

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage - Source	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V 330 V to 1 kV	14 µV/V + 1.2 µV 6.3 µV/V + 10 µV 7.7 µV/V + 81 µV 12 µV/V + 0.78 mV 14 µV/V + 1.4 mV	Multifunction Calibrator
DC Voltage - Measure	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	9.6 µV/V + 1.1 µV 3.8 µV/V + 10 µV 8.4 µV/V + 3.3 µV 10 µV/V + 38 µV 10 µV/V + 0.13 mV	High Resolution DMM
DC Voltage - Measure	Up to 6 kV (6 to 20) kV (20 to 35) kV Up to 150 kV	10 mV/V + 0.6 V 20 mV/V + 2.4 V 90 mV/V + 51 V 5.1 mV/V + 6.9 V	DMM with High Voltage Probe

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thermocouple Simulation and Measure	J-type thermocouple (63 to 1 473) K (-210 to 1 200) °C K-type thermocouple (73 to 1 645) K (-200 to 1 372) °C S-type thermocouple (273 to 1 673) K (0 to 1 400) °C T-type thermocouple (23 to 673) K (-250 to 400) °C E-type thermocouple (23 to 1 273) K (-250 to 1 000) °C N-type thermocouple (73 to 1 573) K (-200 to 1 300) °C	 0.24 K (0.24 °C) 0.25 K (0.25 °C) 0.52 K (0.52 °C) 0.25 K (0.25 °C) 0.43 K (0.43 °C) 0.37 K (0.37 °C)	Multifunction Calibrator
AC Voltage - Source	(1 to 33) mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz (33 to 330) mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 330 mV to 3.3 V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	 0.62 mV/V + 4.8 µV 0.12 mV/V + 4.7 µV 0.15 mV/V + 4.8 µV 0.78 mV/V + 4.7 µV 2.7 mV/V + 9.4 µV 6.2 mV/V + 39 µV 0.39 mV/V + 6.8 µV 0.11 mV/V + 7.1 µV 0.12 mV/V + 7.4 µV 0.27 mV/V + 6.7 µV 0.62 mV/V + 25 µV 1.6 mV/V + 54 µV 0.23 mV/V + 43 µV 0.11 mV/V + 66 µV 0.14 mV/V + 58 µV 0.23 mV/V + 42 µV 0.54 mV/V + 0.1 mV 1.9 mV/V + 0.47 mV	Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source	(3.3 to 33) V		Multifunction Calibrator
	(10 to 45) Hz	0.23 mV/V + 0.53 mV	
	45 Hz to 10 kHz	0.11 mV/V + 0.53 mV	
	(10 to 20) kHz	0.19 mV/V + 0.49 mV	
	(20 to 50) kHz	0.27 mV/V + 0.5 mV	
	(50 to 100) kHz	0.7 mV/V + 1.3 mV	
	(33 to 330) V		
	45 Hz to 1 kHz	0.11 mV/V + 2.4 mV	
	(1 to 10) kHz	0.15 mV/V + 5.5 mV	
	(10 to 20) kHz	0.19 mV/V + 5.4 mV	
	(20 to 50) kHz	0.23 mV/V + 5.3 mV	
	(50 to 100) kHz	1.6 mV/V + 39 mV	
	330 V to 1 kV		
	45 Hz to 1 kHz	0.23 mV/V + 8.1 mV	
	(1 to 5) kHz	0.19 mV/V + 8 mV	
	(5 to 10) kHz	0.23 mV/V + 8.2 mV	
AC Voltage - Measure	Up to 10 mV		High Resolution DMM, Multifunction Calibrator
	(1 to 40) Hz	0.47 mV/V + 4 µV	
	40 Hz to 1 kHz	0.14 mV/V + 3 µV	
	(1 to 20) kHz	0.22 mV/V + 3 µV	
	(20 to 50) kHz	0.89 mV/V + 2.7 µV	
	(10 to 100) mV		
	(1 to 40) Hz	70 µV/V + 4.3 µV	
	40 Hz to 1 kHz	70 µV/V + 2.1 µV	
	(1 to 20) kHz	0.14 mV/V + 2.1 µV	
	(20 to 50) kHz	0.3 mV/V + 2.1 µV	
	100 mV to 1 V		
	(1 to 40) Hz	70 µV/V + 40 µV	
	40 Hz to 1 kHz	70 µV/V + 21 µV	
	(1 to 20) kHz	0.14 mV/V + 21 µV	
	(20 to 50) kHz	0.3 mV/V + 23 µV	
	(1 to 10) V		
	(1 to 40) Hz	70 µV/V + 0.4 mV	
	40 H to 1 kHz	70 µV/V + 0.22 mV	
	(1 to 20) kHz	0.14 mV/V + 0.21 mV	
	(20 to 50) kHz	0.3 mV/V + 0.21 mV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure	(10 to 100) V (1 to 40) Hz 40 H to 1 kHz (1 to 20) kHz (20 to 50) kHz 100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz Up to 6 kV 60 Hz (6 to 35) kV 60 Hz Up to 150 kV 1 kHz	 0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.2 mV/V + 2.1 mV 0.35 mV/V + 2.1 mV 0.4 mV/V + 40 mV 0.4 mV/V + 20 mV 0.6 mV/V + 20 mV 1.1 mV/V + 79 mV 10 mV/V + 5 V 51 mV/V + 9 V 8.5 mV/V + 38 V	High Resolution DMM, Multifunction Calibrator
DC Current - Source	Up to 330 µA 330 µA to 3.3 mA (3.3 to 330) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A	59 µA/A + 61 nA 73 µA/A + 57 nA 77 µA/A + 0.21 µA 75 µA/A + 2.8 µA 0.16 mA/A + 31 µA 0.29 mA/A + 31 µA 0.42 mA/A + 31µA	Multifunction Calibrator
DC Current - Source	(10 to 16.5) A (16.5 to 150) A (150 to 1 000) A	4.7 mA/A + 29 mA 4.7 mA/A + 0.21 A 4.7 mA/A + 0.99 A	Multifunction Calibrator with Current Coil
DC Current - Measure	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	16 µA/A + 45 pA 11 µA/A + 54 pA 20 µA/A + 0.1 nA 20 µA/A + 0.81 nA 15 µA/A + 14 nA 20 µA/A + 51 nA 35 µA/A + 0.51 µA 35 µA/A + 5.5 µA/A	High Resolution DMM
AC Current - Source	(29 to 330) µA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	 1.6 mA/A + 78 nA 1.2 mA/A + 78 nA 0.97 mA/A + 78 nA 2.3 mA/A + 0.12 µA 6.2 mA/A + 0.16 µA 12 mA/A + 0.31 µA	Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Source	330 µA to 3.3 mA		Multifunction Calibrator
	(10 to 20) Hz	1.6 mA/A + 0.13 µA	
	(20 to 45) Hz	0.97 mA/A + 0.12 µA	
	45 Hz to 1 kHz	0.78 mA/A + 0.12 µA	
	(1 to 5) kHz	1.6 mA/A + 0.16 µA	
	(5 to 10) kHz	3.9 mA/A + 0.23 µA	
	(10 to 30) kHz	7.8 mA/A + 0.47 µA	
	(3.3 to 33) mA		
	(10 to 20) Hz	1.4 mA/A + 1.6 µA	
	(20 to 45) Hz	0.7 mA/A + 1.6 µA	
	45 Hz to 1 kHz	0.31 mA/A + 1.6 µA	
	(1 to 5) kHz	0.62 mA/A + 1.6 µA	
	(5 to 10) kHz	1.6 mA/A + 2.3 µA	
	(10 to 30) kHz	3.1 mA/A + 3.1 µA	
	(33 to 330) mA		
	(10 to 20) Hz	1.4 mA/A + 16 µA	
	(20 to 45) Hz	0.7 mA/A + 16 µA	
	45 Hz to 1 kHz	0.31 mA/A + 16 µA	
	(1 to 5) kHz	0.78 mA/A + 39 µA	
	(5 to 10) kHz	1.6 mA/A + 78 µA	
	(10 to 30) kHz	3.1 mA/A + 0.16 mA	
	330 mA to 3 A		
	(10 to 45) Hz	1.4 mA/A + 78 µA	
	45 Hz to 1 kHz	0.47 mA/A + 78 µA	
	(1 to 5) kHz	4.7 mA/A + 0.78 mA	
	(5 to 10) kHz	19 mA/A + 3.9 mA	
	(3 to 11) A		
	(45 to 100) Hz	0.45 A/A + 1.9 mA	
	100 Hz to 1 kHz	0.77 A/A + 1.6 mA	
	(5 to 10) kHz	23 mA/A + 1.6 mA	
AC Current - Source	(10 to 16.5) A		Multifunction Calibrator with Current Coil
	(45 to 65) Hz	5.5 mA/A + 33 mA	
	(65 to 440) Hz	10 mA/A + 35 mA	
	(16.5 to 150) A		
	(45 to 65) Hz	5.6 mA/A + 0.27 A	
	(65 to 440) Hz	10 mA/A + 0.27 A	
	(150 to 1 000) A		
	(45 to 65) Hz	5.1 mA/A + 1.7 A	
	(65 to 440) Hz	12 mA/A + 1.1 A	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Measure	100 µA to 1 mA (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 10) mA (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (10 to 100) mA (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz 100 mA to 1 A (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	 1.5 mA/A + 0.2 µA 0.6 mA/A + 0.2 µA 0.3 mA/A + 0.2 µA 4 mA/A + 2 µA 1.5 mA/A + 2 µA 0.6 mA/A + 2 µA 0.3 mA/A + 2 µA 4 mA/A + 20 µA 1.5 mA/A + 20 µA 0.6 mA/A + 20 µA 0.3 mA/A + 20 µA 4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.6 mA/A + 0.2 mA 1 mA/A + 0.2 mA	High Resolution DMM
Resistors - Source Fixed Values (at 1 kΩ)	24.9 Ω 375.6 Ω 5.97 kΩ 95.3 kΩ	6.9 mΩ 51 mΩ 0.79 Ω 12 Ω	Standard Resistors Kit
Resistance - Source	Up to 11 Ω (11 to 33) Ω (33 to110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ 330 MΩ to 1.1 GΩ	27 µΩ/Ω + 1.2 mΩ 19 µΩ/Ω + 1.7 mΩ 20 µΩ/Ω + 1.4 mΩ 21 µΩ/Ω + 2 m Ω 22 µΩ/Ω + 1.8 mΩ 20 µΩ/Ω + 22 mΩ 22 µΩ/Ω + 17 mΩ 19 µΩ/Ω + 0.3 Ω 19 µΩ/Ω + 0.52 Ω 24 µΩ/Ω + 2.7 Ω 24 µΩ/Ω + 3.8 Ω 24 µΩ/Ω + 0.1 kΩ 95 µΩ/Ω + 0.12 kΩ 0.17 mΩ/Ω + 3.1 kΩ 0.38 mΩ/Ω + 3.7 kΩ 2.3 mΩ/Ω + 81 kΩ 12 mΩ/Ω + 0.4 MΩ	Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance - Measure	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	14 µΩ/Ω + 75 µΩ 12 µΩ/Ω + 0.52 mΩ 10 µΩ/Ω + 0.57 mΩ 9.7 µΩ/Ω + 13 mΩ 10 µΩ/Ω + 57 mΩ 15 µΩ/Ω + 2.1 Ω 49 µΩ/Ω + 0.12 kΩ 0.16 mΩ/Ω + 79 kΩ 4.5 mΩ/Ω + 0.56 MΩ	High Resolution DMM
RTD Simulation	Pt 385 (100 Ω) (73 to 1 073) K (-200 to 800) °C Pt 385 (1 000 Ω) (73 to 903) K (-200 to 630) °C Pt 3916 (100 Ω) (73 to 903) K (-200 to 630) °C Pt 3926 (100 Ω) (73 to 903) K (-200 to 903) °C Ni 120 (120 Ω) (193 to 533) K (-80 to 260) °C Pt 385 (200 Ω) (73 to 903) K (-200 to 630) °C Pt 385 (500 Ω) (73 to 903) K (-200 to 630) °C	 0.09 K (0.09 °C) 0.1 K (0.1 °C) 0.09 K (0.09 °C) 0.09 K (0.09 °C) 0.13 K (0.13 °C) 0.1 K (0.1 °C) 0.1 K (0.1 °C)	High Resolution DMM
Capacitance – Source 10 Hz to 1 kHz Charge/Discharge Rate 10 Hz to 600 Hz Charge/Discharge rate 10 Hz to 300 Hz Charge/Discharge rate	 (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) µF (1.1 to 3.3) µF	 1.8 mF/F + 11 pF 1.7 mF/F + 95 pF 1.7 mF/F + 0.13 nF 1.4 mF/F + 0.57 nF 1.9 mF/F + 0.91 mF 1.4 mF/F + 5.7 nF	Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Source 10 Hz to 150 Hz Charge/Discharge rate	(3.3 to 11) µF	1.8 mF/F + 10 nF	Multifunction Calibrator
10 Hz to 120 Hz Charge/Discharge rate	(11 to 33) µF	2.6 mF/F + 52 nF	
10 Hz to 80 Hz Charge/Discharge rate	(33 to 110) µF	3.4 mF/F + 88 nF	
Up to 50 Hz Charge/Discharge rate	(110 to 330) µF	3 mF/F + 0.51 µF	
Up to 50 Hz Charge/Discharge rate	330 µF to 1 mF	3.4 mF/F + 0.99 µF	
Capacitance - Source Fixed Values	1 nF 1 kHz 1 µF 100 Hz 120 Hz 1 kHz 10 µF 100 Hz 120 Hz 1 kHz 100 µF 100 Hz 120 Hz 1 kHz 1 mF 100 Hz 120 Hz 1 kHz 10 mF 100 Hz 120 Hz 1 kHz	0.28 nF 1.5 nF 1.5 nF 1.5 nF 15 nF 15 nF 15 nF 0.15 µF 0.15 µF 0.15 µF 1.9 µF 2.1 µF 2.1 µF 0.11 mF 0.11 mF 0.15 mF	Standard Capacitors
Inductance - Source Fixed Values	10 mH 100 Hz 1 kHz	 6.5 µH 6.5 µH	Standard Inductors

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes Bandwidth (Leveled Sine Wave)	50 kHz to 600 MHz	(4.8 + 0.006 8*X*) %	Multifunction Calibrator
DC Voltage 50 Ω load 1 M Ω load	 (0 to 6.6) V (0 to 130) V	 1.9 mV/V + 0.37 mV 0.46 mV/V + 0.5 mV	
Square Wave -Amplitude 50 Ω load 1 M Ω load	 (0 to 6.6) V (0 to 130) V	 0.19 mV/V + 0.46 mV 0.77 mV/V + 0.64 mV	
Rise Time	3.5 ns Pulse Edge	41 ps	
Time Marker	(2 to 10) ns (20 to 100) ns (100 to 500) ns (1 to 20) ms (50 to 500) ms (1 to 5) s	2.9 ns/s + 7.8 ps 27 ns/s + 7.7 ps 0.15 µs/s + 7.7 ps 4.6 ns/s + 8.6 ns 1.4 ns/s + 44 ns 2.8 ms/s + 9 ms	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Absolute Power - Generate Sine Wave into 50 Ω 200 Hz to 81 MHz Sine Wave into 75 Ω 200 Hz to 81 MHz	 (-86.98 to 13.01) dBm (-88.74 to 11.25) dBm	 0.015 dB 0.015 dB	Synthesized Level Generator
RF Absolute Power - Generate <1.0 Hz to 100 KHz (0.10 to 20) MHz	(-56 to 23) dBm	0.33 dB	Function Generator
RF Absolute Power - Generate 100 kHz to 2.060 GHz	(-140 to 13) dBm	0.099 dB	Signal Generator
RF Absolute Power - Generate 10 MHz to 2.3 GHz	(-9.95 to 10) dBm	0.018	Signal Generator.
RF Absolute Power - Generate (2.3 to 26.5) GHz	(-79.95 to -10) dBm	0.061 dB	Signal Generator
RF Absolute Power - Generate (20 to <26.5) GHz	(-100 to -80) dBm	0.074 dB	Signal Generator

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Absolute Power - Generate ≥10 MHz to ≤40 GHz	(-120 to 20) dBm	0.125 dB	Signal Generator
RF Absolute Power Measure 10 MHz to 18 GHz 10 MHz to 18 GHz 0.1 MHz to 4.2 GHz 0.1 MHz to 4.2 GHz 10 MHz to 18 GHz 10 MHz to 18 GHz 10 MHz to 18 GHz 10 MHz to 18 GHz	 (0 to 35) dBm (35 to 44) dBm (-30 to 10) dBm (10 to 20) dBm (-70 to -30) dBm (-30 to -20) dBm (-30 to 10) dBm (10 to 20) dBm	 0.12 dB 0.23 dB 0.08 dB 0.09 dB 0.1 dB 0.11 dB 0.08 dB 0.17 dB	RF Power Meter and Power Sensor
RF Absolute Power Measure 30 MHz to 26.5 GHz 30 MHz to 26.5 GHz	 (-20 to -10) dBm (-10 to 30) dBm	 0.15 dB 0.15 dB	RF Power Meter and Power Sensor

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Micrometers – Outside [3]	Up to 4 in (4 to 20) in (20 to 36) in	(44 + 16*L*) µin (32 + 22*L*) µin (32 + 22*L*) µin	Gage Blocks, Optical Flats
Calipers - Outside Jaws[3]	Up to 6 in (6 to 40) in	(420 + 3.9*L*) µin (350 + 17*L*) µin	Gage Blocks
Calipers - Inside Jaws[3]	Up to 24 in (24 to 40) in	(480 + 3.9*L*) µin (340 + 19*L*) µin	Reference Bar, Gage Blocks
Calipers - Depth [3]	Up to 24 in	(530 + 1.7*L*) µin	Gage Blocks, Surface Plate
Calipers - Step [3]	Up to 6 in	(650 + 1.5*L*) µin	Gage Blocks, Surface Plate
Height Gages[3]	Up to 24 in (24 to 40) in	(490 + 10*L*) µin (260 + 19*L*) µin	Reference Bar, Surface Plate, Test Indicator

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Micrometers - Inside[3] (Head Movement Only)	Up to 1 in	(81 + 24*L*) µin	Gage Blocks, Gage Holder
Micrometers - Inside[3] (Resolution 0.0001 in) (Resolution 0.001 in)	Up to 6 in (6 to 24) in (24 to 40) in	(100 + 12*L*) µin (38 + 22*L*) µin (460 + 17*L*) µin	Reference Bar, Gage Blocks
Micrometers - Depth[3]	Up to 12 in	(630 + 4.5*L*) µin	Gage Blocks, Surface Plate
Bore Gages[3] (Resolution 0.000 1 in)	(0.1to 0.5) in (0.5 to 3) in	(80 + 2*L*) µin (150 + 19*L*) µin	Master Ring Gages
Indicators[3] Test, Dial, Digital (Resolution 0.000 1 in)	Up to 2 in	(68 + 25*L*) µin	Gage Blocks, Calibration Tester, Surface Plate
Flatness	Up to 4 in	5.5 µin	Master Flat
Optical Comparator[3] Horizontal Readout Vertical Readout	 Up to 8 in Up to 8 in	 (740 + 8.6*L*) µin (760 + 8.7*L*) µin	Reading Scale
Thickness (Feeler) Gages	(0 to 0.05) in	125 µin	Digital Micrometer
Rulers[3]	Up to 40 in	(3 200 + 112*L*) µin	Caliper
Plain Plugs [2]	Up to 90 mm	4.3 µm + 0.002 8 µm/mm	IAC Master Scanner
Plain Ring [2]	2.5 to 100 mm	4.3 µm+ 0.004 7 µm/mm	IAC Master Scanner
Thread Flank Angle Measurements [2]	Up to 60 °	0.15 deg + 0.000 073 deg/deg	IAC Master Scanner
Thread Plug Gages [2] Major / Minor Diameter Effective Pitch Diameter Pitch	 Up to 90 mm Up to 90 mm 0.1 to 40 mm	 4.2 µm+ 0.016 µm/mm 4.3 µm+ 0.016 µm/mm 1.4 µm + 0.003 7 µm/mm	IAC Master Scanner
Thread Ring Gages [2] Major / Minor Diameter Effective Pitch Diameter Pitch	 2.5 to 100 mm 2.5 to 100 mm 0.1 to 40 mm	 4.9 µm + 0.012 µm/mm 5.1 µm + 0.01 µm/mm 1.6 µm+ 0.003 3 µm/mm	IAC Master Scanner

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Surface Plates Overall Flatness	Up to 24” x 36”	25 µin + 0.088 µin / in	Level System
Local Area Flatness	Up to 18” x 18” in	39 µin	Repeat-O-Meter

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Balances	Up to 410 g	0.016 mg/g + 1.6 mg	Class 3 Weights
Balances	Up to 9 kg (20 lb)	0.092 mg/g + 0.1 g 0.000 092 lb/lb + 0.000 22 lb	Class 6 Weights
Scales	Up to 400 lb	0.24 lb + 0.000 21 lb/lb	Class 6 Weights
Torque Tools	(0.4 to 2) Nm (4 to 18) lbf in	0.000 56 Nm/Nm + 0.000 034 Nm 0.000 56 lbf in/lbf in + 0.003 lbf in	Torque Tester
Torque Tools	(2.26 to 11.29) Nm (20 to 100) lbf in (67 to 338.9) Nm (50 to 250) lbf ft (271.1 to 1 356) Nm (200 to 1 000) lbf ft	0.034 Nm + 0.002 6 Nm/Nm 0.3 lbf in + 0.002 3 lbf in / lbf in 0.22 Nm + 0.007 3 Nm/Nm 0.16 lbf ft + 0.005 36 lbf ft / lbf ft 0.46 Nm + 0.078 1 Nm/Nm 0.34 lbf ft + 0.005 76 lbf ft/lbf ft	Torque Transducer, Torque Display
Torque Sensors	Up to 150 lbf-in Up to 300 lbf-ft	0.000 7 lbf-in/lbf-in + 0.005 5 lbf-in 0.000 8 lbf-ft/lbf-ft + 0.005 4 lbf-ft	Class F Weights Torque Arms
Tensiometers [2,3]	(5 to 600) lbf	(1.6 + 0.034*F*) lbf	Class 6 Weights
Force Gage [2]	Up to 1 000 lbf	2 lb + 0.000 46 lb/lb	Load cell with indicator
Pressure - Pneumatic	(-12 to 0) psi (0 to 30) psi (30 to 100) psi (100 to 1 000) psi	0.008 2 psi + 64 µpsi/psi 0.000 7 psi + 98 µpsi/psi 0.008 2 psi + 64 µpsi/psi 0.081 psi + 78 µpsi/psi	Precision Pressure Controller used as Standard; Calibration Media -Nitrogen
Pressure [2] - Hydraulic, Cross Floating	41.4 kPa to 16.5 MPa (6 to 2 400) psi 207 kPa to 82.7 MPa (30 to 12 000) psi	0.22 kPa + 0.19 Pa/Pa 0.032 psi to 0.000 028 psi/psi 0.35 kPa + 0.25 Pa/Pa 0.05 psi + 0.000 037 psi/psi	Comparison to Ruska 2400 Standard Dead Weight Tester
Pressure [2] - Hydraulic	Up to 499.86 MPa (Up to 72 500) psi	4.8 MPa + 0.000 072 MPa/MPa 700 psi + 0.000 000 5 psi/psi	Pressure Transducer

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Pressure - Hydraulic	Up to 499.86 MPa (Up to 72 500) psi	4.8 MPa + 0.000 072 MPa/MPa 700 psi + 0.000 000 5 psi/psi	Pressure Transducer
Pressure - Hydraulic	(34.48 to 137.92) MPa (5 000 to 20 000) psi	77 kPa + 0.000 55 Pa/kPa 11.2 psi + 0.000 08 psi/psi	Precision Pressure Monitor
Hardness Testers Rockwell Rockwell Superficial	HRBW Scale Low Mid High HRC Scale Low Mid High HR30TW Scale Low Mid High	 2 HRBW 1.6 HRBW 1.8 HRBW 1.3 HRC 1.3 HRC 1.1 HRC 1.6 HR30TW 1.3 HR30TW 1.4 HR30TW	Indirect Comparison to Hardness Test Blocks
Pipette Calibration	(0.1 to 0.49) µl (0.50 to 1.99) µl (2.0 to 9.9) µl (10 to 49) µl (50 to 199) µl (200 to 5 000) µl	2.5 % of reading 1.7 % of reading 0.55 % of reading 0.6 % of reading 0.49 % of reading 0.43 % of reading	Artel Pipette Calibration System

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature at Ice Point	273.15 K (0 °C)	0.033 K 0.033 °C	Standard Multimeter and Platinum Resistance Thermometer
Temperature - Measure	(73 to 933) K (-200 to 660) °C	0.000 004 K/K + 0.032 K 0.000 004 °C/°C + 0.032 °C	Standard Multimeter and Platinum Resistance Thermometer
Temperature - Measure	(0 to 1 750) °C	0.004 3 °C/°C + 0.57 °C	Type R Thermocouple and Multifunction Calibrator
Humidity - Source	(10 to 95) %RH	0.81 %RH + 0.014 %RH/%RH	Humidity Chamber and Humidity Meter

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Humidity - Measure	(10 to 95) %RH	0.7 %RH + 0.015 %RH/%RH	Humidity Chamber and Humidity Meter

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency - Source Using Calibrator's Normal Output	(0.01 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 12) kHz (12 to 120) kHz 120 kHz to 1.2 MHz (1.2 to 2) MHz	1.2 µHz/Hz + 0.11 mHz 1.6 µHz/Hz + 0.48 mHz 1.9 µHz/Hz + 0.4 mHz 1.9 µHz/Hz + 1.2 mHz 1.9 µHz/Hz + 1.2 mHz 1.9 µHz/Hz + 14 mHz	Multifunction Calibrator
Frequency - Source Using Calibrator's Oscilloscope Output	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.9 µHz/Hz + 5.1 Hz 1.9 µHz/Hz + 0.3 Hz 1.9 µHz/Hz + 70 mHz	
Frequency - Measure	1 Hz to 10 MHz	0.5 mHz/Hz + 0.1 µHz	High Resolution DMM
Stopwatches	Up to 24 hours	0.19 s	NIST UTC Phone Time Signal
Frequency – Source and Measure	0.1 µHz to 3 GHz 10 Hz to 26.5 GHz	0.012 Hz + 0.385 Hz/MHz 0.17 Hz	Frequency Counter

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 (k=2), corresponding to a confidence level of approximately 95%.

Notes:

1. Mobile and On-site calibration service is available for most parameters, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope. Marsh Mobile Lab environmental conditions are controlled to meet the conditions needed to achieve the uncertainties listed in the Calibration and Measurement Capability (CMC) of the laboratory.
2. These parameters can only be performed at the laboratory's fixed location.
3. X = measured value, F = measured value in lbf, L = Length in inches.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1172.

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