



# 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](http://www.anab.org).

Jason Stine, Vice President

Expiry Date: 27 May 2024

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**

**AND**

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

**ANSI/NCSL Z540.3-2006 (R2013)**

**Accredited Calibration Services, Inc.  
(Marsh Metrology)**

2-1016C Sutton Drive

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**CALIBRATION**

Valid to: **May 27, 2024**

Certificate Number: **AC-1172**

**Chemical Quantities**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH Meters	4 pH 7 pH 10 pH	0.012 pH 0.012 pH 0.012 pH	Standard pH 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 $\mu$ V/V + 1.2 $\mu$ V 6.3 $\mu$ V/V + 10 $\mu$ V 7.7 $\mu$ V/V + 81 $\mu$ V 12 $\mu$ V/V + 0.78 mV 14 $\mu$ V/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 $\mu$ V/V + 1.1 $\mu$ V 3.8 $\mu$ V/V + 10 $\mu$ V 8.4 $\mu$ V/V + 3.3 $\mu$ V 10 $\mu$ V/V + 38 $\mu$ V 10 $\mu$ V/V + 0.13 mV	High Resolution Digital Multimeter
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	Digital Multimeter, High Voltage Probe

**Electrical – DC/Low Frequency**

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

**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 (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (33 to 330) V 45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz 330 V to 1 kV 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mV/V + 0.53 mV 0.11 mV/V + 0.53 mV 0.19 mV/V + 0.49 mV 0.27 mV/V + 0.5 mV 0.7 mV/V + 1.3 mV 0.11 mV/V + 2.4 mV 0.15 mV/V + 5.5 mV 0.19 mV/V + 5.4 mV 0.23 mV/V + 5.3 mV 1.6 mV/V + 39 mV 0.23 mV/V + 8.1 mV 0.19 mV/V + 8 mV 0.23 mV/V + 8.2 mV	Multifunction Calibrator
AC Voltage – Measure	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz 100 mV to 1 V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (1 to 10) V (1 to 40) Hz 40 H to 1 kHz (1 to 20) kHz (20 to 50) kHz	0.47 mV/V + 4 μV 0.14 mV/V + 3 μV 0.22 mV/V + 3 μV 0.89 mV/V + 2.7 μV 70 μV/V + 4.3 μV 70 μV/V + 2.1 μV 0.14 mV/V + 2.1 μV 0.3 mV/V + 2.1 μV 70 μV/V + 40 μV 70 μV/V + 21 μV 0.14 mV/V + 21 μV 0.3 mV/V + 23 μV 70 μV/V + 0.4 mV 70 μV/V + 0.22 mV 0.14 mV/V + 0.21 mV 0.3 mV/V + 0.21 mV	High Resolution Digital Multimeter, Multifunction Calibrator



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Electrical – DC/Low Frequency

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

**Electrical – DC/Low Frequency**

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

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Measure	100 $\mu$ A to 1 mA		High Resolution Digital Multimeter
	(20 to 45) Hz	1.5 mA/A + 0.2 $\mu$ A	
	(45 to 100) Hz	0.6 mA/A + 0.2 $\mu$ A	
	100 Hz to 5 kHz	0.3 mA/A + 0.2 $\mu$ A	
	(1 to 10) mA		
	(20 to 45) Hz	4 mA/A + 2 $\mu$ A	
	(45 to 100) Hz	1.5 mA/A + 2 $\mu$ A	
	100 Hz to 5 kHz	0.6 mA/A + 2 $\mu$ A	
	(5 to 20) kHz	0.3 mA/A + 2 $\mu$ A	
	(10 to 100) mA		
	(20 to 45) Hz	4 mA/A + 20 $\mu$ A	
	(45 to 100) Hz	1.5 mA/A + 20 $\mu$ A	
	100 Hz to 5 kHz	0.6 mA/A + 20 $\mu$ A	
	(5 to 20) kHz	0.3 mA/A + 20 $\mu$ A	
100 mA to 1 A			
(20 to 45) Hz	4 mA/A + 0.2 mA		
(45 to 100) Hz	1.6 mA/A + 0.2 mA		
100 Hz to 5 kHz	0.6 mA/A + 0.2 mA		
(5 to 20) kHz	1 mA/A + 0.2 mA		
Resistors – Source (Fixed)	24.9 $\Omega$	6.9 m $\Omega$	Standard Resistors Kit
	375.6 $\Omega$	51 m $\Omega$	
	5.97 k $\Omega$	0.79 $\Omega$	
	95.3 k $\Omega$	12 $\Omega$	
Resistance – Source (Simulation)	Up to 11 $\Omega$	27 $\mu\Omega/\Omega$ + 1.2 m $\Omega$	Multifunction Calibrator
	(11 to 33) $\Omega$	19 $\mu\Omega/\Omega$ + 1.7 m $\Omega$	
	(33 to 110) $\Omega$	20 $\mu\Omega/\Omega$ + 1.4 m $\Omega$	
	(110 to 330) $\Omega$	21 $\mu\Omega/\Omega$ + 2 m $\Omega$	
	330 $\Omega$ to 1.1 k $\Omega$	22 $\mu\Omega/\Omega$ + 1.8 m $\Omega$	
	(1.1 to 3.3) k $\Omega$	20 $\mu\Omega/\Omega$ + 22 m $\Omega$	
	(3.3 to 11) k $\Omega$	22 $\mu\Omega/\Omega$ + 17 m $\Omega$	
	(11 to 33) k $\Omega$	19 $\mu\Omega/\Omega$ + 0.3 $\Omega$	
	(33 to 110) k $\Omega$	19 $\mu\Omega/\Omega$ + 0.52 $\Omega$	
	(110 to 330) k $\Omega$	24 $\mu\Omega/\Omega$ + 2.7 $\Omega$	
	330 k $\Omega$ to 1.1 M $\Omega$	24 $\mu\Omega/\Omega$ + 3.8 $\Omega$	
	(1.1 to 3.3) M $\Omega$	24 $\mu\Omega/\Omega$ + 0.1 k $\Omega$	
	(3.3 to 11) M $\Omega$	95 $\mu\Omega/\Omega$ + 0.12 k $\Omega$	
	(11 to 33) M $\Omega$	0.17 m $\Omega/\Omega$ + 3.1 k $\Omega$	
	(33 to 110) M $\Omega$	0.38 m $\Omega/\Omega$ + 3.7 k $\Omega$	
	(110 to 330) M $\Omega$	2.3 m $\Omega/\Omega$ + 81 k $\Omega$	
330 M $\Omega$ to 1.1 G $\Omega$	12 m $\Omega/\Omega$ + 0.4 M $\Omega$		

**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 Digital Multimeter
Electrical Simulation of RTD Indicating Devices – Measure	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 Digital Multimeter
Capacitance – Source (Simulation) 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





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Electrical – DC/Low Frequency

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

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes <sup>3</sup> Bandwidth (Leveled Sine Wave)	50 kHz to 600 MHz	0.68 % of reading + 4.8 MHz	Multifunction Calibrator
DC Voltage 50 Ω load	(0 to 6.6) V	1.9 mV/V + 0.37 mV	
1 M Ω load	(0 to 130) V	0.46 mV/V + 0.5 mV	
Square Wave - Amplitude 50 Ω load	(0 to 6.6) V	0.19 mV/V + 0.46 mV	
1 M Ω load	(0 to 130) V	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	(-86.98 to 13.01) dBm	0.015 dB	Synthesized Level Generator
Sine Wave into 75 Ω 200 Hz to 81 MHz	(-88.74 to 11.25) dBm	0.015 dB	
RF Absolute Power – Generate < 1 Hz to 100 kHz (0.1 to 20) MHz	(-56 to 23) dBm	0.33 dB	Function Generator
RF Absolute Power – Generate 100 kHz to 2.06 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 dB	Signal Generator.



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**Electrical - RF/Microwave**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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
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, 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, Power Sensor
Horn Antennas – Antenna Factors Gain dBi Gain Numeric	700 MHz to 18 GHz 1-meter 3-meter	1.7 dB 0.9 dB	Signal Generator, Power Meter, Power Sensor, Spectrum Analyzer
VSWR (Reflection Magnitude) (50 Ω)	300 kHz to 3 GHz	1.7 dB (VSWR = 1.007)	Vector Network Analyzer, Transmission and Reflection Test Set, Calibration KIT

**Length – Dimensional Metrology**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Micrometers – Outside <sup>3</sup>	Up to 4 in (4 to 20) in (20 to 36) in	(44 + 16L) μin (32 + 22L) μin (32 + 22L) μin	Gage Blocks, Optical Flats

**Length – Dimensional Metrology**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
Calipers – Outside Jaws <sup>3</sup>	Up to 6 in (6 to 40) in	$(420 + 3.9L) \mu\text{in}$ $(350 + 17L) \mu\text{in}$	Gage Blocks
Calipers – Inside Jaws <sup>3</sup>	Up to 24 in (24 to 40) in	$(480 + 3.9L) \mu\text{in}$ $(340 + 19L) \mu\text{in}$	Reference Bar, Gage Blocks
Calipers – Depth <sup>3</sup>	Up to 24 in	$(530 + 1.7L) \mu\text{in}$	Gage Blocks, Surface Plate
Calipers – Step <sup>3</sup>	Up to 6 in	$(650 + 1.5L) \mu\text{in}$	Gage Blocks, Surface Plate
Height Gages <sup>3</sup>	Up to 24 in (24 to 40) in	$(490 + 10L) \mu\text{in}$ $(260 + 19L) \mu\text{in}$	Reference Bar, Surface Plate, Test Indicator
Micrometers – Inside <sup>3</sup> (Head Movement Only)	Up to 1 in	$(81 + 24L) \mu\text{in}$	Gage Blocks, Gage Holder
Micrometers – Inside <sup>3</sup> (Resolution 0.0001 in) (Resolution 0.001 in)	Up to 6 in (6 to 24) in (24 to 40) in	$(100 + 12L) \mu\text{in}$ $(38 + 22L) \mu\text{in}$ $(460 + 17L) \mu\text{in}$	Reference Bar, Gage Blocks
Micrometers – Depth <sup>3</sup>	Up to 12 in	$(630 + 4.5L) \mu\text{in}$	Gage Blocks, Surface Plate
Bore Gages <sup>3</sup> (Resolution 0.0001 in)	(0.1 to 0.5) in (0.5 to 3) in	$(80 + 2L) \mu\text{in}$ $(150 + 19L) \mu\text{in}$	Master Ring Gages
Indicators <sup>3</sup> Test, Dial, Digital (Resolution 0.0001 in)	Up to 2 in	$(68 + 25L) \mu\text{in}$	Gage Blocks, Calibration Tester, Surface Plate
Flatness	Up to 4 in	5.5 $\mu\text{in}$	Master Flat
Optical Comparator <sup>3</sup> Horizontal Readout Vertical Readout	Up to 8 in Up to 8 in	$(740 + 8.6L) \mu\text{in}$ $(760 + 8.7L) \mu\text{in}$	Reading Scale
Thickness (Feeler) Gages	(0 to 0.05) in	125 $\mu\text{in}$	Digital Micrometer
Rulers <sup>3</sup>	Up to 40 in	$(3\ 200 + 112L) \mu\text{in}$	Caliper
Plain Plugs <sup>2</sup>	Up to 90 mm	0.002 8 $\mu\text{m}/\text{mm} + 4.3 \mu\text{m}$	IAC Master Scanner
Plain Ring <sup>2</sup>	2.5 to 100 mm	0.004 7 $\mu\text{m}/\text{mm} + 4.3 \mu\text{m}$	IAC Master Scanner
Thread Flank Angle Measurements <sup>2</sup>	Up to 60°	0.007 3 % of reading + 0.15°	IAC Master Scanner

**Length – Dimensional Metrology**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thread Plug Gages <sup>2</sup> Major / Minor Diameter	Up to 90 mm	16 nm/mm + 4.2 μm	IAC Master Scanner
Effective Pitch Diameter	Up to 90 mm	16 nm/mm + 4.3 μm	
Pitch	0.1 to 40 mm	3.7 nm/mm + 1.4 μm	
Thread Ring Gages <sup>2</sup> Major / Minor Diameter	2.5 to 100 mm	12 nm/mm + 4.9 μm	IAC Master Scanner
Effective Pitch Diameter	2.5 to 100 mm	10 nm/mm + 5.1 μm	
Pitch	0.1 to 40 mm	3.3 nm/mm + 1.6 μm	
Surface Plates Overall Flatness	Up to 24 in x 36 in	0.088 μin / in + 25 μin	Level System
Local Area Flatness	Up to 18 in x 18 in	39 μin	Repeat-O-Meter
Protractors	Up to 60°	0.06°	Sine Bar, Gage Blocks

**Mass and Mass Related**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Balances <sup>4</sup>	Up to 410 g	0.016 mg/g + 1.6 mg	ASTM E617 Class 3 weights and internal calibration procedure utilized in the calibration of the weighing system.
Balances <sup>4</sup>	Up to 9 kg (20 lb)	0.092 mg/g + 0.1 g 0.009 2 % of reading + 0.000 22 lb	ASTM E617 Class 3 weights and internal calibration procedure utilized in the calibration of the weighing system.
Scales <sup>4</sup>	Up to 400 lb	0.021 % of reading + 0.24 lb	
Torque Tools	(0.4 to 2) N·m (4 to 18) lbf·in	0.056 % of reading + 0.000 034 N·m 0.056 % of reading + 0.003 lbf·in	Torque Tester
Torque Tools	(2.26 to 11.29) N·m (20 to 100) lbf·in (67 to 338.9) N·m (50 to 250) lbf·ft (271.1 to 1 356) N·m (200 to 1 000) lbf·ft	0.26 % of reading + 0.034 N·m 0.23 % of reading + 0.3 lbf·in 0.73 % of reading + 0.22 N·m 0.54 % of reading + 0.16 lbf·ft 0.078 1 N·m/N·m + 0.46 N·m 0.58 % of reading + 0.34 lbf·ft	Torque Transducer, Torque Display

**Mass and Mass Related**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Torque Sensors	Up to 150 lbf·in Up to 300 lbf·ft	0.07 % of reading + 0.005 5 lbf·in 0.08 % of reading + 0.005 4 lbf·ft	NIST Class F Weights, Torque Arms
Tensiometers <sup>2,3</sup>	(5 to 600) lbf	(1.6 + 0.034F) lbf	ASTM E617 Class 6 Weights
Force Gage <sup>2</sup>	Up to 1 000 lbf	0.046 % of reading + 2 lb	Load Cell, Digital Indicator
Absolute Pressure Gages (Pneumatic)	(0.01 to 16) psia	0.002 2 psi/psi + 0.000 023 psi	Fluke PM500-A120K Pressure Module
Pneumatic Pressure Gages	(-12 to 0) psi Up to 30 psig (30 to 100) psig (100 to 1 000) psig	0.000 064 psi/psi + 0.008 2 psi 0.000 098 psi/psi + 0.000 7 psi 0.000 064 psi/psi + 0.008 2 psi 0.000 078 psi/psi + 0.081 psi	Precision Pressure Controller used as Standard; Calibration Media - Nitrogen
Pressure <sup>2</sup> (Hydraulic, Cross Floating)	41.4 kPa to 16.5 MPa (6 to 2 400) psig  207 kPa to 82.7 MPa (30 to 12 000) psig	0.22 kPa + 0.19 Pa/Pa 0.002 8 % of reading + 0.032 psi  0.35 kPa + 0.25 Pa/Pa 0.003 7 % of reading + 0.05 psi	Comparison to Ruska 2400 Standard Dead Weight Tester
Hydraulic Pressure Gages <sup>2</sup>	Up to 499.86 MPa (Up to 72 500) psig	0.007 2 % of reading + 4.8 MPa 0.000 05 % of reading + 700 psi	Pressure Transducer
	(34.48 to 137.92) MPa (5 000 to 20 000) psig	0.000 55 Pa/kPa + 77 kPa 0.008 % of reading + 11.2 psi	Precision Pressure Monitor
Rockwell Hardness Testers	HRBW Scale Low Mid High	2 HRBW 1.6 HRBW 1.8 HRBW	Indirect Comparison to Hardness Test Blocks.
Rockwell Superficial	HRC Scale Low Mid High HR30TW Scale Low Mid High	1.3 HRC 1.3 HRC 1.1 HRC  1.6 HR30TW 1.3 HR30TW 1.4 HR30TW	
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

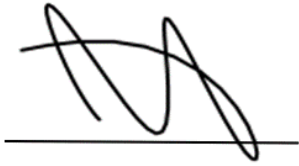
Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature – Ice Point	273.15 K (0 °C)	0.033 K (0.033 °C)	Standard Digital Multimeter, Platinum Resistance Thermometer
Temperature – Measure	(73 to 933) K (-200 to 660) °C	0.000 4 % of reading + 0.032 K (0.000 4 % of reading + 0.032 °C)	Standard Digital Multimeter, Platinum Resistance Thermometer
Temperature – Measure	(0 to 1 750) °C	0.43 % of reading + 0.57 °C	Type R Thermocouple, Multifunction Calibrator
Humidity – Source	(10 to 95) %RH	1.4 % of reading + 0.81 %RH	Humidity Chamber, Master Humidity Meter
Humidity – Measure	(10 to 95) %RH	1.5 % of reading + 0.7 %RH	Master Humidity Meter
Infrared Temperature Indicators	35 °C 100 °C 200 °C 350 °C 500 °C	0.5 °C 0.74 °C 1.1 °C 2 °C 2.7 °C	Fluke 4181 Blackbody Source (flat plate) $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$

### Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Source (using Calibrator's Normal Output)	10 mHz to 120 Hz	1.2 $\mu\text{Hz}/\text{Hz} + 0.11 \text{ mHz}$	Multifunction Calibrator
	120 Hz to 1.2 kHz	1.6 $\mu\text{Hz}/\text{Hz} + 0.48 \text{ mHz}$	
Frequency – Source (using Calibrator's Oscilloscope Output)	(1.2 to 12) kHz	1.9 $\mu\text{Hz}/\text{Hz} + 0.4 \text{ mHz}$	
	(12 to 120) kHz	1.9 $\mu\text{Hz}/\text{Hz} + 1.2 \text{ mHz}$	
	120 kHz to 1.2 MHz	1.9 $\mu\text{Hz}/\text{Hz} + 1.2 \text{ mHz}$	
	(1.2 to 2) MHz	1.9 $\mu\text{Hz}/\text{Hz} + 14 \text{ mHz}$	
Frequency – Measure	50 kHz to 100 MHz	1.9 $\mu\text{Hz}/\text{Hz} + 5.1 \text{ Hz}$	High Resolution DMM
	(100 to 300) MHz	1.9 $\mu\text{Hz}/\text{Hz} + 0.3 \text{ Hz}$	
	(300 to 600) MHz	1.9 $\mu\text{Hz}/\text{Hz} + 70 \text{ mHz}$	
Frequency – Measure	1 Hz to 10 MHz	0.5 mHz/Hz + 0.1 $\mu\text{Hz}$	
Stopwatches	Up to 24 h	0.19 s	NIST UTC Phone Time Signal
Frequency – Measure	0.1 $\mu\text{Hz}$ to 3 GHz 10 Hz to 26.5 GHz	0.385 Hz/MHz + 12 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. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The CMC presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
  5. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1172.



Jason Stine, Vice President

