



# CERTIFICATE OF ACCREDITATION

## The ANSI National Accreditation Board

Hereby attests that

**McHale & Associates, Inc.**  
**4700 Coster Road**  
**Knoxville, TN 37912**

Fulfills the requirements of

**ISO/IEC 17025:2017**

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).

A handwritten signature in black ink, appearing to be 'J. Stine', is positioned above a horizontal line.

Jason Stine, Vice President

Expiry Date: 17 September 2026

Certificate Number: AC-2909



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**

**McHale & Associates, Inc.**

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**CALIBRATION**

Valid to: **September 17, 2026**

Certificate Number: **AC-2909**

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source <sup>1,2</sup>	Up to 330 mV (0.33 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	16 nV/mV + 1.2 μV 21 μV/V + 4.4 μV 9.4 μV/V + 60 μV 14 μV/V + 0.7 mV 14 μV/V + 2.6 mV	Multi-Product Calibrator
DC Voltage - Measure <sup>1,2</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	6 nV/mV + 0.2 μV 2.9 μV/V + 0.3 μV 2.9 μV/V + 0.5 μV 4.3 μV/V + 30 μV 4.6 μV/V + 0.5 mV	Reference Multimeter
DC High Voltage – Measure <sup>1,2</sup>	Up to 10 kV	0.33 mV/V + 67 mV	Precision HV Meter
DC Current – Source <sup>1,2</sup>	Up to 330 μA (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (0.33 to 1.1) A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	0.12 nA/μA + 16 nA 78 nA/mA + 48 nA 78 nA/mA + 0.4 μA 78 nA/mA + 4.1 μA 0.16 mA/A + 52 μA 0.29 mA/A + 0.1 mA 0.39 mA/A + 0.7 mA 0.78 mA/A + 2.4 mA	Multi-Product Calibrator
DC Current – Source <sup>1,2</sup> (Clamp-on Devices)	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	11 mA/A + 2.5 mA 2.5 mA/A + 22 mA 2.6 mA/A + 0.2 A	Multi-Product Calibrator with 50-turn Coil



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current - Measure <sup>1,2</sup>	Up to 10 $\mu$ A (10 to 100) $\mu$ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 10) A (10 to 30) A	27 fA/ $\mu$ A + 0.4 nA 9.4 fA/ $\mu$ A + 0.4 nA 8.5 nA/mA + 4 nA 40 nA/mA + 40 nA 67 nA/mA + 1 $\mu$ A 0.26 mA/A + 0.1 mA 0.18 mA/A + 0.4 mA 0.51 mA/A + 4.4 mA	Reference Multimeter
Resistance – Source <sup>1</sup> (Fixed Artifacts)	25 $\Omega$ 100 $\Omega$ 200 $\Omega$ 400 $\Omega$	0.000 27 $\Omega$ 0.001 1 $\Omega$ 0.002 1 $\Omega$ 0.004 3 $\Omega$	Standard Resistors
Resistance – Source <sup>1,2</sup> (Simulation)	Up to 11 $\Omega$ (11 to 33) $\Omega$ (33 to 110) $\Omega$ (110 to 330) $\Omega$ (0.33 to 1.1) k $\Omega$ (1.1 to 3.3) k $\Omega$ (3.3 to 11) k $\Omega$ (11 to 33) k $\Omega$ (33 to 110) k $\Omega$ (110 to 330) k $\Omega$ (0.33 to 1.1) M $\Omega$ (1.1 to 3.3) M $\Omega$ (3.3 to 11) M $\Omega$ (11 to 33) M $\Omega$ (33 to 110) M $\Omega$ (110 to 330) M $\Omega$ (330 to 1 100) M $\Omega$	32 $\mu\Omega/\Omega$ + 0.8 m $\Omega$ 24 $\mu\Omega/\Omega$ + 1.2 m $\Omega$ 22 $\mu\Omega/\Omega$ + 1.2 m $\Omega$ 22 $\mu\Omega/\Omega$ + 1.9 m $\Omega$ 22 m $\Omega/k\Omega$ + 4.6 m $\Omega$ 23 m $\Omega/k\Omega$ + 20 m $\Omega$ 22 m $\Omega/k\Omega$ + 40 m $\Omega$ 22 m $\Omega/k\Omega$ + 0.2 $\Omega$ 22 m $\Omega/k\Omega$ + 0.4 $\Omega$ 25 m $\Omega/k\Omega$ + 2.4 $\Omega$ 25 $\Omega/M\Omega$ + 4.9 $\Omega$ 50 $\Omega/M\Omega$ + 30 $\Omega$ 0.1 k $\Omega/M\Omega$ + 0.1 k $\Omega$ 0.19 k $\Omega/M\Omega$ + 3 k $\Omega$ 0.39 k $\Omega/M\Omega$ + 0.1 M $\Omega$ 2.3 k $\Omega/M\Omega$ + 0.1 M $\Omega$ 12 k $\Omega/M\Omega$ + 0.8 M $\Omega$	Multi-Product Calibrator
Resistance - Measure <sup>1,2</sup>	Up to 1 $\Omega$ (1 to 10) $\Omega$ (10 to 100) $\Omega$ (0.1 to 1) k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$ (0.1 to 1) M $\Omega$ (1 to 10) M $\Omega$ (10 to 100) M $\Omega$ (0.1 to 1) G $\Omega$	11 $\mu\Omega/\Omega$ + 4 $\mu\Omega$ 8.2 $\mu\Omega/\Omega$ + 10 $\mu\Omega$ 7.4 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 7.2 m $\Omega/k\Omega$ + 0.5 m $\Omega$ 7.7 m $\Omega/k\Omega$ + 5 m $\Omega$ 7.5 m $\Omega/k\Omega$ + 50 m $\Omega$ 9.3 $\Omega/M\Omega$ + 1 $\Omega$ 12 $\Omega/M\Omega$ + 0.1 k $\Omega$ 44 $\Omega/M\Omega$ + 10 k $\Omega$ 0.51 M $\Omega/G\Omega$ + 1 M $\Omega$	Reference Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source <sup>1,2</sup>	(1 to 33) mV		Multi-Product Calibrator
	(10 to 45) Hz	0.62 $\mu\text{V/mV}$ + 5.4 $\mu\text{V}$	
	45 Hz to 10 kHz	0.12 $\mu\text{V/mV}$ + 5.5 $\mu\text{V}$	
	(10 to 20) kHz	0.16 $\mu\text{V/mV}$ + 5 $\mu\text{V}$	
	(20 to 50) kHz	0.78 $\mu\text{V/mV}$ + 5.5 $\mu\text{V}$	
	(50 to 100) kHz	2.7 $\mu\text{V/mV}$ + 10 $\mu\text{V}$	
	(100 to 500) kHz	6.2 $\mu\text{V/mV}$ + 42 $\mu\text{V}$	
	(33 to 330) mV		
	(10 to 45) Hz	0.23 $\mu\text{V/mV}$ + 6.2 $\mu\text{V}$	
	45 Hz to 10 kHz	0.11 $\mu\text{V/mV}$ + 6.2 $\mu\text{V}$	
	(10 to 20) kHz	0.12 $\mu\text{V/mV}$ + 10 $\mu\text{V}$	
	(20 to 50) kHz	0.27 $\mu\text{V/mV}$ + 13 $\mu\text{V}$	
	(50 to 100) kHz	0.62 $\mu\text{V/mV}$ + 31 $\mu\text{V}$	
	(100 to 500) kHz	1.6 $\mu\text{V/mV}$ + 84 $\mu\text{V}$	
	(0.33 to 3.3) V		
	(10 to 45) Hz	0.23 mV/V + 0.2 mV	
	45 Hz to 10 kHz	0.12 mV/V + 0.2 mV	
	(10 to 20) kHz	0.15 mV/V + 74 $\mu\text{V}$	
	(20 to 50) kHz	0.23 mV/V + 0.1 mV	
	(50 to 100) kHz	0.54 mV/V + 0.2 mV	
	(100 to 500) kHz	1.9 mV/V + 1 mV	
	(3.3 to 33) V		
	(10 to 45) Hz	0.23 mV/V + 1.8 mV	
	45 Hz to 10 kHz	0.12 mV/V + 2.2 mV	
	(10 to 20) kHz	0.19 mV/V + 0.9 mV	
	(20 to 50) kHz	0.27 mV/V + 1.2 mV	
	(50 to 100) kHz	0.7 mV/V + 1.9 mV	
	(33 to 330) V		
(10 to 45) Hz	0.15 mV/V + 7.4 mV		
45 Hz to 10 kHz	0.16 mV/V + 17 mV		
(10 to 20) kHz	0.19 mV/V + 13 mV		
(20 to 50) kHz	0.23 mV/V + 23 mV		
(50 to 100) kHz	1.6 mV/V + 76 mV		
(330 to 1 020) V			
45 Hz to 1 kHz	0.23 mV/V + 29 mV		
(1 to 5) kHz	0.19 mV/V + 34 mV		
(5 to 10) kHz	0.23 mV/V + 37 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1,2</sup>	Up to 10 mV		Reference Multimeter
	1 Hz to 2 kHz	0.28 $\mu\text{V}/\text{mV}$ + 1.1 $\mu\text{V}$	
	(2 to 10) kHz	0.36 $\mu\text{V}/\text{mV}$ + 1.1 $\mu\text{V}$	
	(10 to 30) kHz	0.39 $\mu\text{V}/\text{mV}$ + 1.1 $\mu\text{V}$	
	(30 to 100) kHz	3 $\mu\text{V}/\text{mV}$ + 1.1 $\mu\text{V}$	
	(100 to 300) kHz	10 $\mu\text{V}/\text{mV}$ + 4 $\mu\text{V}$	
	300 kHz to 1 MHz	20 $\mu\text{V}/\text{mV}$ + 4 $\mu\text{V}$	
	(10 to 100) mV		
	1 Hz to 2 kHz	0.075 $\mu\text{V}/\text{mV}$ + 0.5 $\mu\text{V}$	
	(2 to 10) kHz	0.12 $\mu\text{V}/\text{mV}$ + 0.5 $\mu\text{V}$	
	(10 to 30) kHz	0.21 $\mu\text{V}/\text{mV}$ + 1 $\mu\text{V}$	
	(30 to 100) kHz	0.51 $\mu\text{V}/\text{mV}$ + 5 $\mu\text{V}$	
	(100 to 300) kHz	2 $\mu\text{V}/\text{mV}$ + 30 $\mu\text{V}$	
	300 kHz to 1 MHz	10 $\mu\text{V}/\text{mV}$ + 0.1 mV	
	(1 to 2) MHz	15 $\mu\text{V}/\text{mV}$ + 0.5 mV	
	(2 to 4) MHz	40 $\mu\text{V}/\text{mV}$ + 1 mV	
	(4 to 8) MHz	80 $\mu\text{V}/\text{mV}$ + 1 mV	
	(8 to 10) MHz	0.15 mV/mV + 1 mV	
	(0.1 to 1) V		
	1 Hz to 2 kHz	0.067 mV/V + 5 $\mu\text{V}$	
	(2 to 10) kHz	0.11 mV/V + 5 $\mu\text{V}$	
	(10 to 30) kHz	0.21 mV/V + 10 $\mu\text{V}$	
	(30 to 100) kHz	0.51 mV/V + 50 $\mu\text{V}$	
	(100 to 300) kHz	2 mV/V + 0.3 mV	
	300 kHz to 1 MHz	10 mV/V + 1 mV	
	(1 to 2) MHz	16 mV/V + 5 mV	
	(2 to 4) MHz	40 mV/V + 10 mV	
	(4 to 8) MHz	81 mV/V + 10 mV	
	(8 to 10) MHz	0.15 V/V + 10 mV	
	(1 to 10) V		
1 Hz to 2 kHz	66 $\mu\text{V}/\text{V}$ + 50 $\mu\text{V}$		
(2 to 10) kHz	0.11 mV/V + 50 $\mu\text{V}$		
(10 to 30) kHz	0.21 mV/V + 0.1 mV		
(30 to 100) kHz	0.54 mV/V + 0.5 mV		
(100 to 300) kHz	2 mV/V + 3 mV		
300 kHz to 1 MHz	10 mV/V + 10 mV		
(1 to 2) MHz	15 mV/V + 50 mV		
(2 to 4) MHz	40 mV/V + 0.1 V		
(4 to 8) MHz	80 mV/V + 0.1 V		
(8 to 10) MHz	0.15 V/V + 0.1 V		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1,2</sup>	(10 to 100) V 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (100 to 1 000)V 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	73 $\mu\text{V}/\text{V} + 0.5 \text{ mV}$ 93 $\mu\text{V}/\text{V} + 0.5 \text{ mV}$ 0.21 $\text{mV}/\text{V} + 1 \text{ mV}$ 0.51 $\text{mV}/\text{V} + 5 \text{ mV}$ 3.5 $\text{mV}/\text{V} + 50 \text{ mV}$ 10 $\text{mV}/\text{V} + 0.5 \text{ V}$ 92 $\mu\text{V}/\text{V} + 25 \text{ mV}$ 0.1 $\text{mV}/\text{V} + 25 \text{ mV}$ 0.22 $\text{mV}/\text{V} + 25 \text{ mV}$ 0.52 $\text{mV}/\text{V} + 0.1 \text{ V}$	Reference Multimeter
AC High Voltage – Measure <sup>1,2</sup>	Up to 10 kV (30 to 600) Hz 30 Hz to 200 Hz 200 Hz to 450 Hz 450 Hz to 600 Hz (10 to 150) Hz 10 Hz to 65 Hz 65 Hz to 150 Hz (1 to 75) Hz 1 Hz to 35 Hz 35 Hz to 75 Hz (0.1 to 35) Hz 0.1 Hz to 15 Hz 15 Hz to 35 Hz (0.01 to 2) Hz 0.01 Hz to 1 Hz (1 to 2) Hz	1.9 $\text{mV}/\text{V} + 0.2 \text{ V}$ 4.4 $\text{mV}/\text{V} + 0.2 \text{ V}$ 7.7 $\text{mV}/\text{V} + 0.2 \text{ V}$ 1.9 $\text{mV}/\text{V} + 0.2 \text{ V}$ 4.3 $\text{mV}/\text{V} + 0.2 \text{ V}$ 1.9 $\text{mV}/\text{V} + 0.2 \text{ V}$ 4.3 $\text{mV}/\text{V} + 0.2 \text{ V}$ 1.9 $\text{mV}/\text{V} + 0.2 \text{ V}$ 4.3 $\text{mV}/\text{V} + 0.2 \text{ V}$ 1.9 $\text{mV}/\text{V} + 0.2 \text{ V}$ 4.3 $\text{mV}/\text{V} + 0.2 \text{ V}$	Precision HV Meter
AC Current – Source <sup>1,2</sup>	Up to 330 $\mu\text{A}$ (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 $\text{nA}/\mu\text{A} + 81 \text{ nA}$ 1.2 $\text{nA}/\mu\text{A} + 80 \text{ nA}$ 0.97 $\text{nA}/\mu\text{A} + 0.1 \mu\text{A}$ 2.3 $\text{nA}/\mu\text{A} + 0.2 \mu\text{A}$ 6.2 $\text{nA}/\mu\text{A} + 0.2 \mu\text{A}$ 12 $\text{nA}/\mu\text{A} + 0.3 \mu\text{A}$	Multi-Product Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source <sup>1,2</sup>	(0.33 to 3.3) mA		Multi-Product Calibrator
	(10 to 20) Hz	1.6 $\mu$ A/mA + 0.2 $\mu$ A	
	(20 to 45) Hz	0.97 $\mu$ A/mA + 0.2 $\mu$ A	
	45 Hz to 1 kHz	0.78 $\mu$ A/mA + 0.2 $\mu$ A	
	(1 to 5) kHz	1.6 $\mu$ A/mA + 0.7 $\mu$ A	
	(5 to 10) kHz	3.9 $\mu$ A/mA + 0.3 $\mu$ A	
	(10 to 30) kHz	7.8 $\mu$ A/mA + 1.1 $\mu$ A	
	(3.3 to 33) mA		
	(10 to 20) Hz	1.4 $\mu$ A/mA + 4.5 $\mu$ A	
	(20 to 45) Hz	0.7 $\mu$ A/mA + 2.7 $\mu$ A	
	45 Hz to 1 kHz	0.31 $\mu$ A/mA + 7 $\mu$ A	
	(1 to 5) kHz	0.62 $\mu$ A/mA + 7 $\mu$ A	
	(5 to 10) kHz	1.6 $\mu$ A/mA + 3.9 $\mu$ A	
	(10 to 30) kHz	3.1 $\mu$ A/mA + 9.1 $\mu$ A	
	(33 to 330) mA		
	(10 to 20) Hz	1.4 $\mu$ A/mA + 45 $\mu$ A	
	(20 to 45) Hz	0.7 $\mu$ A/mA + 28 $\mu$ A	
	45 Hz to 1 kHz	0.31 $\mu$ A/mA + 63 $\mu$ A	
	(1 to 5) kHz	0.78 $\mu$ A/mA + 75 $\mu$ A	
	(5 to 10) kHz	1.6 $\mu$ A/mA + 0.2 mA	
	(10 to 30) kHz	3.1 $\mu$ A/mA + 0.2 mA	
	(0.33 to 1.1) A		
	(10 to 45) Hz	1.4 mA/A + 0.1 mA	
	45 Hz to 1 kHz	0.39 mA/A + 0.1 mA	
	(1 to 5) kHz	4.7 mA/A + 0.9 mA	
	(5 to 10) kHz	19 mA/A + 4 mA	
	(1.1 to 3) A		
	(10 to 45) Hz	1.4 mA/A + 0.2 mA	
45 Hz to 1 kHz	0.47 mA/A + 0.2 mA		
(1 to 5) kHz	4.7 mA/A + 1.1 mA		
(5 to 10) kHz	19 mA/A + 4.3 mA		
(3 to 11) A			
(45 to 100) Hz	0.47 mA/A + 1.9 mA		
100 Hz to 1 kHz	0.78 mA/A + 2.1 mA		
(1 to 5) kHz	23 mA/A + 7.3 mA		
(11 to 20.5) A			
(45 to 100) Hz	0.93 mA/A + 4.7 mA		
100 Hz to 1 kHz	1.2 mA/A + 5.2 mA		
(1 to 5) kHz	23 mA/A + 16 mA		



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source <sup>1,2</sup> (Clamp-on Devices)	(10 to 16.5) A		Multi-Product Calibrator with 50-turn Coil
	(45 to 65) Hz	2.8 mA/A + 3.3 mA	
	(65 to 440) Hz	2.8 mA/A + 25 mA	
	(16.5 to 150) A		
	(45 to 65) Hz	2.8 mA/A + 91 mA	
	(65 to 440) Hz	7.9 mA/A + 6.4 mA	
	(150 to 1 025) A		
	(45 to 65) Hz	8 mA/A + 0.2 A	
	(65 to 440) Hz	8 mA/A + 0.3 A	
AC Current - Measure <sup>1,2</sup>	Up to 10 µA		Reference Multimeter
	1 Hz to 30 kHz	2 nA/µA + 2.5 nA	
	(10 to 100) µA		
	1 Hz to 2 kHz	0.27 nA/µA + 5 nA	
	(2 to 10) kHz	0.51 nA/µA + 5 nA	
	(10 to 30) kHz	0.73 nA/µA + 5 nA	
	(30 to 100) kHz	4 nA/µA + 10 Na	
	(0.1 to 1) mA		
	1 Hz to 2 kHz	0.27 µA/mA + 50 nA	
	(2 to 10) kHz	0.51 µA/mA + 50 nA	
	(10 to 30) kHz	0.72 µA/mA + 50 nA	
	(30 to 100) kHz	4 µA/mA + 0.1 µA	
	(1 to 10) mA		
	1 Hz to 2 kHz	0.27 µA/mA + 0.5 µA	
	(2 to 10) kHz	0.51 µA/mA + 0.5 µA	
	(10 to 30) kHz	0.72 µA/mA + 0.5 µA	
	(30 to 100) kHz	4 µA/mA + 1 µA	
	(10 to 100) mA		
	1 Hz to 2 kHz	0.27 µA/mA + 5 µA	
	(2 to 10) kHz	0.5 µA/mA + 5 µA	
	(10 to 30) kHz	0.7 µA/mA + 5 µA	
	(0.1 to 1) A		
	1 Hz to 2 kHz	0.27 mA/A + 0.1 mA	
(2 to 10) kHz	0.51 mA/A + 0.1 mA		
(10 to 30) kHz	0.73 mA/A + 0.1 mA		
(1 to 10) A			
10 Hz to 10 kHz	0.8 mA/A + 0.5 mA		
(10 to 30) A			
10 Hz to 2 kHz	0.8 mA/A + 12 mA		
(2 to 10) kHz	1.2 mA/A + 12 mA		





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source <sup>1,2</sup>	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μF	4.6 pF/nF + 8.4 pF 4 pF/nF + 8.4 pF 3.9 pF/nF + 8.1 pF 1.9 pF/nF + 11 pF 1.9 pF/nF + 7.9 pF 1.9 pF/nF + 74 pF 1.9 pF/nF + 0.2 nF 1.9 nF/μF + 10 nF	Multi-Product Calibrator
Capacitance – Source <sup>1,2</sup>	(1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	1.9 nF/μF + 3.1 nF 1.9 nF/μF + 10.8 nF 3.1 nF/μF + 32 nF 3.5 nF/μF + 0.2 μF 3.5 nF/μF + 0.3 μF 3.5 μF/mF + 0.9 μF 3.5 μF/mF + 2.5 μF 3.5 μF/mF + 8.4 μF 5.8 μF/mF + 25 μF 8.5 μF/mF + 858 μF	Multi-Product Calibrator
Capacitance - Measure <sup>1,2</sup>	Up to 1 nF (1 to 10) nF (10 to 100) nF (0.1 to 1) μF (1 to 10) μF (10 to 100) μF (0.1 to 1) mF (1 to 10) mF (10 to 100) mF	1.1 pF/nF + 1 pF 0.64 pF/nF + 2 pF 0.42 pF/nF + 10 pF 0.41 nF/μF + 0.1 nF 0.42 nF/μF + 1 nF 0.61 nF/μF + 10 nF 0.61 μF/mF + 0.1 μF 0.71 μF/mF + 1 μF 0.71 μF/mF + 10 μF	Reference Multimeter
Electrical Simulation of Thermocouple Indicating Instruments – Source	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C Type C (0 to 150) °C (150 to 650) °C (650 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 316) °C	0.35 °C 0.27 °C 0.24 °C 0.26 °C 0.24 °C 0.21 °C 0.25 °C 0.39 °C 0.65 °C	Multi-Product Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Instruments – Source	Type E		Multi-Product Calibrator
	(-250 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 350) °C	0.13 °C	
	(350 to 650) °C	0.14 °C	
	(650 to 1 000) °C	0.18 °C	
	Type J		
	(-210 to -100) °C	0.22 °C	
	(-100 to -30) °C	0.14 °C	
	(-30 to 150) °C	0.12 °C	
	(150 to 760) °C	0.15 °C	
	(760 to 1 200) °C	0.19 °C	
	Type K		
	(-200 to -100) °C	0.26 °C	
	(-100 to -25) °C	0.15 °C	
	(-25 to 120) °C	0.14 °C	
	(120 to 1 000) °C	0.21 °C	
	(1 000 to 1 372) °C	0.32 °C	
	Type L		
	(-200 to -100) °C	0.29 °C	
	(-100 to 800) °C	0.21 °C	
	(800 to 900) °C	0.15 °C	
	Type N		
	(-200 to -100) °C	0.32 °C	
(-100 to -25) °C	0.18 °C		
(-25 to 120) °C	0.16 °C		
(120 to 410) °C	0.15 °C		
(410 to 1 300) °C	0.22 °C		
Type R			
(0 to 250) °C	0.45 °C		
(250 to 400) °C	0.28 °C		
(400 to 1 000) °C	0.26 °C		
(1 000 to 1 767) °C	0.32 °C		
Type S			
(0 to 200) °C	0.37 °C		
(250 to 1 400) °C	0.29 °C		
(1 400 to 1 767) °C	0.36 °C		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Instruments – Source	Type T		Multi-Product Calibrator
	(-250 to -150) °C	0.49 °C	
	(-150 to 0) °C	0.2 °C	
	(0 to 120) °C	0.14 °C	
	(120 to 400) °C	0.13 °C	
	Type U		
	(-200 to 0) °C	0.44 °C	
	(0 to 600) °C	0.22 °C	
Electrical Simulation of RTD Indicating Instruments – Source <sup>1</sup>	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	Pt 3916, 300 Ω		
	(0 to 400) °C	0.07 °C	
	Pt 3916, 400 Ω		
(0 to 600) °C	0.078 °C		
Pt 3916, 600 Ω			
(600 to 630) °C	0.18 °C		
Pt 385, 200 Ω			
(-200 to 100) °C	0.031 °C		
(100 to 260) °C	0.39 °C		
(260 to 300) °C	0.93 °C		
(300 to 400) °C	0.1 °C		
(400 to 600) °C	0.11 °C		
(600 to 630) °C	0.12 °C		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Instruments – Source <sup>1</sup>	Pt 385, 500 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.032 °C	
	(-80 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.086 °C	
	Pt 385, 1 000 Ω		
	(-200 to 0) °C	0.026 °C	
	(0 to 100) °C	0.033 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.048 °C	
	(300 to 600) °C	0.056 °C	
(600 to 630) °C	0.18 °C		
PtNi 385, 120 Ω			
(-80 to 100) °C	0.062 °C		
(100 to 260) °C	0.11 °C		
Cu 427, 10 Ω			
(-100 to 260) °C	0.23 °C		
AC Current Harmonics – Source <sup>1,2</sup>	(33 to 330) mA		Multi-product Calibrator
	(5 to 10) kHz	1.7 μA/mA + 0.2 mA	
	(10 to 30) kHz	3.1 μA/mA + 0.31 mA	
	3.3 mA to 3 A		
	(10 to 45) Hz	0.7 mA/A + 3.2 μA	
	3.3 mA to 20.5 A		
	(45 to 65) Hz	0.31 mA/A + 3.2 μA	
33 mA to 20.5 A			
(65 to 500) Hz	0.31 mA/A + 3.1 μA		
500 Hz to 5 kHz	0.62 mA/A + 3.1 μA		
DC Power Source <sup>1,2</sup>	33 mV to 1 020 V		Multi-Product Calibrator
	(0.33 to 330) mA	14 μW/W + 58 mW	
	330 mA to 3 A	0.29 mW/W + 0.6 W	
	(3 to 20.5) A	0.78 mW/W + 5.8 W	
AC Power- Source <sup>1,2</sup>	(33 to 330) mV		Multi-Product Calibrator
	(3.3 to 33) mA	0.33 μW/W + 6.5 μW	
	(33 to 330) mA	0.33 μW/W + 21 μW	
	(330 to 900) mA	0.39 mW/W + 0.1 mW	
	900 mA to 2.2 A	0.47 mW/W + 0.1 mW	
	(2.2 to 4.5) A	0.47 mW/W + 2 mW	
	(4.5 to 20.5) A	0.93 mW/W + 5 mW	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power- Source <sup>1,2</sup>	330 mV to 1 020 V (3.3 to 9) mA (9 to 90) mA (90 to 330) mA (330 to 900) mA 900 mA to 4.5 A (4.5 to 20.5) A	0.23 mW/W + 7.8 mW 0.23 mW/W + 9.7 mW 0.23 mW/W + 60 mW 0.45 mW/W + 60 mW 0.52 mW/W + 0.6 W 0.96 W/W + 5.8 W	Multi-Product Calibrator
Phase – Source <sup>1,2</sup>	(0 to 360) <sup>o</sup> (10 to 65) Hz (65 to 500) Hz (0.5 to 1) kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.083 <sup>o</sup> 0.19 <sup>o</sup> 0.39 <sup>o</sup> 1.9 <sup>o</sup> 3.9 <sup>o</sup> 7.8 <sup>o</sup>	Multi-Product Calibrator
Oscilloscopes <sup>1,2</sup> DC Voltage into 50 Ω load  into 1 MΩ load  AC Voltage into 50 Ω load  into 1 MΩ load	(1 to 109.99) mV (0.11 to 2.199 9) V (2.2 to 6.6) V  (1 to 24.999) mV (25 to 109.99) mV (0.11 to 2.199 9) V (2.2 to 10.999) V (11 to 130) V  (1 to 109.99) mV (0.11 to 2.1999) V (2.2 to 6.6) V  (1 to 24.999) mV (25 to 109.99) mV (0.11 to 2.199 9) V (2.2 to 10.999) V (11 to 130) V	1.9 μV/mV + 32 μV 2 mV/V + 0.1 mV 2 mV/V + 2.1 mV  0.46 μV/mV + 32 μV 0.39 μV/V + 35 μV 0.39 mV/V + 0.1 mV 0.39 mV/V + 0.9 mV 0.39 mV/V + 7.6 mV  1.9 μV/mV + 50 μV 2.2 mV/mV + 0.8 mV 2 mV/V + 1.4 mV  0.81 μV/mV + 47 μV 0.78 μV/V + 0.4 mV 0.82 mV/V + 1.4 mV 0.78 mV/V + 14 mV 0.79 mV/V + 0.2 V	Multi-Product Calibrator



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1,2</sup> Leveled Sine Wave – Voltage	5.5 mVp-p to 5.5 Vp-p Up to 50 kHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 5.5 mVp-p to 3.5 Vp-p 600 MHz to 1.1 GHz	19 mV/V + 0.62 mV 28 mV/V + 0.62 mV 31 mV/V + 0.62 mV 47 mV/V + 0.62 mV 54 mV/V + 0.64 mV	Multi-Product Calibrator
Time Markers	(1 to 5) ns 10 ns (20 to 50) ns (0.1 to 20) ms 50 ms to 5 s	1.9 fs/ns + 0.6 ps 1.9 fs/ns + 0.6 ps 1.9 fs/ns + 5.8 ps 25 ns/ms + 5.8 μs 11 ms/s + 20 ms	
Wave Generator into 50 Ω load into 1 MΩ load	1.8 mVp-p to 2.5 Vp-p 1.8 mVp-p to 55 Vp-p	24 mV/V + 1 mV 23 mV/V + 80 μV	
Pulse Generator – Width	(4 to 45) ns (45 to 500) ns	39 ps/ns + 1.6 ns 39 ps/ns + 2.2 ns	
Pulse Generator – Period	200 ns to 20 ms	25 ns/ms + 0.6 μs	
Input Impedance Measure	(40 to 60) Ω (0.5 to 1.5) MΩ	0.78 mΩ/Ω + 6 mΩ 0.78 kΩ/MΩ + 60 Ω	
Input Capacitance Measure	(5 to 50) pF	39 fF/pF + 0.6 pF	

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Attenuation – Source <sup>1</sup> Relative to +16 dBm 100 kHz to 128 MHz	(0 to 33) dBm (33 to 64) dBm (64 to 100) dBm (100 to 116) dBm	0.04 dB 0.04 dB 0.1 dB 0.2 dB	RF Reference Source
Level Sine Wave Frequency – Source	10 kHz 1 MHz to 1.006 GHz (2 to 4.024) GHz	0.002 x 10 <sup>-6</sup> of reading + 0.6 mHz 0.002 x 10 <sup>-6</sup> of reading + 0.2 mHz 0.01 x 10 <sup>-6</sup> of reading + 5.8 mHz	Fluke 9640 RF Reference Source

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Level Sine Spurious Signal Content	(2.1 to 3.6) GHz (3.8 to 4) GHz	0.6 dB 1 dB	Fluke 9640 RF Reference Source
Level Sine Harmonic Distortion 24 dBm Power Reference	20 kHz to 125 MHz	0.6 dB	Fluke 9640 RF Reference Source
Level Sine Harmonic Distortion 20 dBm Power Reference	250 MHz to 1.4 GHz	0.6 dB	Fluke 9640 RF Reference Source
Level Sine Harmonic Distortion 14 dBm Power Reference	(1.45 to 2.7) GHz 4.024 GHz	0.6 dB 1 dB	Fluke 9640 RF Reference Source
AM Modulation Rate Accuracy 30 MHz Carrier Signal Modulation Depth: 50%	Modulation Rate: 20 kHz Modulation Rate: 100 kHz	0.05 Hz/kHz + 58 mHz 0.1 Hz/kHz + 58 mHz	Fluke 9640 RF Reference Source
AM Depth Accuracy 125 MHz Carrier Signal	1 kHz Modulation Rate	10 Hz/kHz + 7.5 Hz	Fluke 9640 RF Reference Source
AM Depth Accuracy 125 MHz Carrier Signal	100 kHz Modulation Rate	15 Hz/kHz + 750 Hz	Fluke 9640 RF Reference Source
AM Depth Accuracy 1 GHz Carrier Signal	1 kHz Modulation Rate	10 Hz/kHz + 7.5 Hz	Fluke 9640 RF Reference Source
AM Depth Accuracy 1 GHz Carrier Signal	20 kHz Modulation Rate	15 Hz/kHz + 150 Hz	Fluke 9640 RF Reference Source
AM Distortion	Modulation Depth (10 to 80) %	0.06 dB	Fluke 9640 RF Reference Source
FM Modulation Rate Accuracy	Modulation Rate 400 Hz 10 kHz 100 kHz 300 kHz	0.28 mHz / Hz + 0.059 Hz 0.1 Hz / kHz + 1 Hz 0.1 Hz / kHz + 10 Hz 0.03 Hz / kHz + 10 Hz	Fluke 9640 RF Reference Source
FM Deviation Accuracy	Modulation Rate 400 Hz to 300 kHz	10 Hz/kHz + 0.2 Hz	Fluke 9640 RF Reference Source
FM Distortion	Modulation Rate 400 Hz to 300 kHz	0.02 dB	Fluke 9640 RF Reference Source
Level Sine Phase Noise	Offset Frequency 1 kHz to 10 MHz	2.1 dB	Fluke 9640 RF Reference Source





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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
PM Modulation <sup>1,2</sup>	150 kHz to 10 MHz 10 MHz to 1.30 GHz (1.30 to 2) GHz (2 to 6) GHz (6 to 10) GHz (10 to 14) GHz (14 to 18) GHz (18 to 22) GHz (22 to 26.5) GHz	46 mrad/rad + 0.5 rad 35 mrad/rad + 0.5 rad 44 mrad/rad + 0.5 rad 45 mrad/rad + 0.5 rad 48 mrad/rad + 0.5 rad 52 mrad/rad + 0.5 rad 54 mrad/rad + 0.5 rad 55 mrad/rad + 0.5 rad 58 mrad/rad + 0.5 rad	Keysight 8902 Measuring Receiver, Keysight 11793A Microwave Converter, HP 11729A Sensor Module, HP 8340B Sweeper
AM Modulation <sup>1,2</sup>	150 kHz to 10 MHz Rate: 50 Hz to 10 kHz 10 MHz to 1.3 GHz Rate: 50 Hz to 50 kHz 150 kHz to 1.3 GHz Rate: 20 Hz to 100 kHz (1.3 to 26.5) GHz Rate: DC to 100 kHz	23 Hz/kHz + 12 Hz 12 Hz/kHz + 12 Hz 35 Hz/kHz + 12 Hz 64 Hz/kHz	Keysight 8902 Measuring Receiver, Keysight 11793A Microwave Converter, HP 11729A Sensor Module, HP 8340B Sweeper
AM Modulation Flatness <sup>1,2</sup>	10 MHz to 26.5 GHz Rate: 90 Hz to 10 kHz 1.3 GHz to 14 GHz Rate: 90 Hz to 10 kHz 14 GHz to 26.5 GHz Rate: 90 Hz to 10 kHz	3.5 Hz/kHz + 12 Hz 27 Hz/kHz 38 Hz/kHz	Keysight 8902 Measuring Receiver, Keysight 11793A Microwave Converter, HP 11729A Sensor Module, HP 8340B Sweeper
FM Modulation <sup>1,2</sup>	250 kHz-10 MHz Rate: 20 Hz to 10 kHz 10 MHz-1.3 GHz Rate: 50 Hz to 100 kHz 10 MHz to 26.5 GHz Rate: 20 Hz to 200 kHz	23 Hz/kHz + 1.2 Hz 12 kHz/MHz + 1.2 Hz 100 kHz/MHz	Keysight 8902 Measuring Receiver, Keysight 11793A Microwave Converter, HP 11729A Sensor Module, HP 8340B Sweeper
Pulse Generation <sup>1</sup>	DC to 350 MHz 2.8 ns to 1 000 sec	0.4 ns	Agilent 53220A Counter
RF Power Measure <sup>1,2</sup>	(-20 to 30) dBm 0.1 MHz to 2.5 GHz 2.5 MHz to 14 GHz 14 MHz to 26.5 GHz	1.2 Hz/kHz + 0.05 dB 27 Hz/kHz + 0.05 dB 38 Hz/kHz + 0.05 dB	Keysight 8902 Measuring Receiver, HP 11722A Sensor Module, Keysight 11581A Attenuator Set, Keysight 11581A Attenuator Set, Keysight 11793A Microwave Converter, HP 11729A Sensor Module



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Amplitude <sup>1</sup>	(+20 to +24) dBm 10 Hz to 100 kHz 100 kHz 100 kHz to 10 MHz (10 to 128) MHz	0.03 dB 0.03 dB 0.05 dB 0.05 dB	Fluke 9640 RF Reference Source, HP 8340B Sweeper
RF Power Amplitude <sup>1</sup>	(+14 to +20) dBm 10 Hz to 100 kHz 100 kHz 100 kHz to 10 MHz (10 to 128) MHz (128 to 300) MHz 300 MHz to 1.4 GHz	0.03 dB 0.03 dB 0.05 dB 0.05 dB 0.07 dB 0.2 dB	Fluke 9640 RF Reference Source, HP 8340B Sweeper
RF Power Amplitude <sup>1</sup>	(-17 to +14) dBm 10 Hz to 100 kHz 100 kHz 100 kHz to 10 MHz (10 to 128) MHz (128 to 300) MHz 300 MHz to 1.4 GHz (1.4 to 3) GHz (3 to 4) GHz	0.03 dB 0.03 dB 0.05 dB 0.05 dB 0.07 dB 0.2 dB 0.3 dB 0.5 dB	Fluke 9640 RF Reference Source, HP 8340B Sweeper
RF Power Amplitude <sup>1</sup>	(-48 to -17) dBm 10 Hz to 100 kHz 100 kHz 100 kHz to 10 MHz (10 to 128) MHz (128 to 300) MHz 300 MHz to 1.4 GHz (1.4 to 3) GHz (3 to 4) GHz	0.03 dB 0.03 dB 0.05 dB 0.05 dB 0.07 dB 0.2 dB 0.3 dB 0.5 dB	Fluke 9640 RF Reference Source, HP 8340B Sweeper
RF Power Amplitude <sup>1</sup>	(-74 to -48) dBm 100 kHz 100 kHz to 10 MHz (10 to 128) MHz (128 to 300) MHz 300 MHz to 1.4 GHz (1.4 to 3) GHz (3 to 4) GHz	0.2 dB 0.2 dB 0.1 dB 0.1 dB 0.4 dB 0.5 dB 0.5 dB	Fluke 9640 RF Reference Source, HP 8340B Sweeper



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Amplitude <sup>1</sup>	(-84 to -74) dBm 100 kHz 100 kHz to 10 MHz (10 to 128) MHz (128 to 300) MHz 300 MHz to 1.4 GHz (1.4 to 3) GHz (3 to 4) GHz	0.5 dB 0.5 dB 0.1 dB 0.3 dB 0.5 dB 1 dB 1 dB	Fluke 9640 RF Reference Source, HP 8340B Sweeper
RF Power Amplitude <sup>1</sup>	(-94 to -84) dBm 100 kHz 100 kHz to 10 MHz (10 to 128) MHz (128 to 300) MHz 300 MHz to 1.4 GHz (1.4 to 3) GHz	0.5 dB 0.5 dB 0.3 dB 0.5 dB 1 dB 1 dB	Fluke 9640 RF Reference Source, HP 8340B Sweeper
RF Power Source <sup>1</sup>	(-110 to 20) dBm 10 MHz to 26.5 GHz	0.9 dB	HP 8340B Sweeper
RF Power Sensors <sup>1,2</sup>	(-60 to 20) dBm 3.16 μW @ 10 MHz 10 μW @ 10 MHz 31.6 μW @ 10 MHz 100 μW @ 10 MHz 316 μW @ 10 MHz 1 mW @ 10 MHz 1.156 mW @ 10 MHz 10.02 mW @ 10 MHz 31.79 mW @ 10 MHz 101.4 mW @ 10 MHz	2.4 % reading + 8.1 nW 1.6 % reading + 0.026 μW 1.4 % reading + 0.079 μW 1.4 % reading + 0.26 μW 1.4 % reading + 0.79 μW 1.4 % reading + 2.6 μW 1.4 % reading + 7.9 μW 1.4 % reading + 26 μW 1.4 % reading + 79 μW 1.4 % reading + 0.26 mW	Agilent E4418B EPM Series Power Meter & 8482A, HP 8485A Power Sensor
Harmonic Distortion	100 kHz to 1.5 GHz	1.4 dB	ESA-L1500A Spectrum Analyzer

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers <sup>1</sup>	Up to 8 in (8 to 24) in (24 to 40) in	74 μin 450 μin 510 μin	Gage Blocks, Long Gage Blocks

### Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Depth Micrometer <sup>1</sup>	Up to 8 in (8 to 12) in (12 to 24) in (24 to 40) in	77 μin 100 μin 450 μin 870 μin	Gage Blocks, Surface Plate
Height Gage <sup>1</sup>	Up to 24 in (24 to 40) in	190 μin 310 μin	Gage Blocks, Surface Plate
Indicators <sup>1</sup> (Dial, Digital)	Up to 1 in (1 to 6) in	42 μin 63 μin	Gage Blocks, Surface Plate
Micrometer, OD <sup>1</sup>	Up to 1 in (1 to 6) in (6 to 12) in (12 to 24) in (24 to 40) in	42 μin 62 μin 98 μin 200 μin 310 μin	Gage Blocks, Long Gage Blocks
Optical Comparators <sup>1</sup> Linearity Magnification	Up to 12 in 10x to 200x	141 μin 588 μin	Glass Scale, Magnification Reticle, Magnification Checker

### Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Measuring Instruments <sup>1</sup>	(0.025 to 64) inH <sub>2</sub> O	0.02 % of reading	Deadweight Tester
	(0.1 to 30) psia (30 to 1 000) psia	0.008 7 % of reading 0.008 3 % of reading	Pressure Controller
	(9.5 to 500) psig (150 to 5 000) psig	0.016 % of reading 0.015 % of reading	Deadweight Tester
	(-30 to 30) inH <sub>2</sub> O (-13.5 to 35) psig	0.044 inH <sub>2</sub> O 0.013 psi	Pressure Calibrator
	(-13.5 to 300) psig (-12.5 to 1 000) psig	0.057 psi 0.23 psi	Pressure Calibrator

### Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure <sup>1</sup>	(-200 to -40) °C (-40 to 0) °C (0 to 420) °C (420 to 660) °C	0.01 °C 0.007 2 °C 0.026 °C 0.033 °C	SPRT, Temperature Indicator
Temperature – Source <sup>1</sup> (Temperature Indicating Probes)	(-40 to 95) °C	0.014 °C	SPRT, 8.5 Digit Multimeter, Temperature Indicator, Liquid Bath
Temperature – Source <sup>1</sup> (Temperature Indicating Probes)	(50 to 660) °C	0.018 °C	SPRT, 8.5 Digit Multimeter, Temperature Indicator, Dry Well Calibrator
Temperature Uniformity Surveys <sup>1</sup>	(-34.4 to 93) °C	0.24 °C	RTD, Data Logging System
Temperature Uniformity Surveys <sup>1</sup>	(50 to 660) °C	0.81 °C	Thermocouples, Data Logging System

### Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source <sup>1</sup>	10 mHz to 100 kHz 120 Hz to 2 MHz	87 nHz/Hz + 30 nHz 1.9 Hz/MHz + 0.1 kHz	Multi-Product Calibrator, GPS Receiver, Reference Multimeter
Frequency – Source <sup>1</sup> (Reference)	10 MHz	1 pHz	GPS Receiver
Frequency – Source <sup>1</sup> (Oscilloscopes)	600 MHz 1.1 GHz	1.9 Hz/MHz + 5.8 kHz 1.9 Hz/MHz + 60 kHz	Multi-Product Calibrator, GPS Receiver
Frequency – Measure <sup>1</sup>	10 Hz to 6 GHz	87 nHz/Hz + 30 nHz	Reference Multimeter, Keysight 53220A Universal Counter, GPS Receiver

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. On-site calibration service is available for this parameter, 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.
2. Uncertainties reported with both a relative and an absolute uncertainty in the format of “mV/V + mV” or “% reading + uW” are computed as the square root of the sum of the squares of the two uncertainty components.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2909.



Jason Stine, Vice President

