



# CERTIFICATE OF ACCREDITATION

## ANSI-ASQ National Accreditation Board

500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

### **Precision Measurements, Inc.**

**1630 Zanker Road**

**San Jose, CA 95112**

has been assessed by ANAB  
and meets the requirements of international standard

## **ISO/IEC 17025:2005**

and national standard

## **ANSI/NCSL Z540-1-1994**

while demonstrating technical competence in the field of

## **CALIBRATION**

Refer to the accompanying Scope of Accreditation for information regarding the types of calibrations to which this accreditation applies.

AC-1768

Certificate Number

  
ANAB Approval

Certificate Valid: 04/07/2017-03/14/2019  
Version No. 003 Issued: 04/07/2017



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. 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 January 2009).



# ANSI-ASQ National Accreditation Board

## SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 AND ANSI/NCSL Z540-1-1994

### Precision Measurements, Inc.

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### CALIBRATION

Valid to: March 14, 2019

Certificate Number: AC-1768

#### Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage - Source	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	12 $\mu\text{V/V} + 0.4 \mu\text{V}$ 5 $\mu\text{V/V} + 0.7 \mu\text{V}$ 3.5 $\mu\text{V/V} + 2.5 \mu\text{V}$ 3.5 $\mu\text{V/V} + 4 \mu\text{V}$ 5 $\mu\text{V/V} + 40 \mu\text{V}$ 6.7 $\mu\text{V/V} + 0.40 \text{ mV}$	Fluke 5720A
DC Voltage – Source Fixed Points	10 V	0.9 $\mu\text{V/V}$	Fluke 732A
DC Voltage - Source <sup>2</sup>	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (30 to 330) V 100 V to 1 kV	66 $\mu\text{V/V} + 1 \mu\text{V}$ 33 $\mu\text{V/V} + 2 \mu\text{V}$ 36 $\mu\text{V/V} + 20 \mu\text{V}$ 54 $\mu\text{V/V} + 0.15 \text{ mV}$ 54 $\mu\text{V/V} + 1.5 \text{ mV}$	Fluke 5520A
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	17 $\mu\text{V/V} + 3 \mu\text{V}$ 8.6 $\mu\text{V/V} + 0.3 \mu\text{V}$ 7.8 $\mu\text{V/V} + 0.05 \mu\text{V}$ 11 $\mu\text{V/V} + 0.3 \mu\text{V}$ 15 $\mu\text{V/V} + 0.1 \mu\text{V}$	HP/Agilent 3458A Opt 002
	(1 to 40) kV	16 mV/V	Fluke 80K40, HP 34401A
DC Voltage – Measure <sup>2</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 to 1 kV	51 $\mu\text{V/V} + 10 \mu\text{V}$ 27 $\mu\text{V/V} + 1 \mu\text{V}$ 24 $\mu\text{V/V} + 2 \mu\text{V}$ 33 $\mu\text{V/V} + 30 \mu\text{V}$ 45 $\mu\text{V/V} + 0.1 \text{ mV}$	HP/Agilent 3458A Opt 002
	(1 to 40) kV	20 mV/V	Fluke 80K40 HP 34401A



**Electrical – DC/Low Frequency**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
DC Current - Source	(10 to 220) $\mu$ A 220 $\mu$ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	42 $\mu$ A/A + 6 nA 36 $\mu$ A/A + 7 nA 37 $\mu$ A/A + 40 nA 46 $\mu$ A/A + 0.7 $\mu$ A 82 $\mu$ A/A + 12 $\mu$ A	Fluke 5720A
DC Current – Source <sup>2</sup>	Up to 330 $\mu$ A 330 $\mu$ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	45 $\mu$ A/A + 0.02 $\mu$ A 45 $\mu$ A/A + 0.05 $\mu$ A 30 $\mu$ A/A + 0.25 $\mu$ A 30 $\mu$ A/A + 2.5 $\mu$ A 60 $\mu$ A/A + 40 $\mu$ A 1.2 mA/A + 40 $\mu$ A 1.5 mA/A + 0.50 mA 3 mA/A + 0.75 mA	Fluke 5520A
DC Current - Measure	(10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	48 $\mu$ A/A + 0.80 nA 47 $\mu$ A/A + 5 pA 45 $\mu$ A/A + 50 pA 63 $\mu$ A/A + 0.5 pA 0.15 mA/A + 10 $\mu$ A	HP/Agilent 3458A Opt 002
DC Current – Measure <sup>2</sup>	(10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	0.15 mA/A + 800 pA 0.15 $\mu$ A/A + 5 nA 0.15 $\mu$ A/A + 50 nA 0.19 $\mu$ A/A + 0.5 $\mu$ A 0.45 $\mu$ A/A + 10 $\mu$ A	HP/Agilent 3458A Opt 002
Resistance - Source Fixed Points	(1, 1.9) $\Omega$ (10, 19) $\Omega$ (100, 190) $\Omega$ (1, 19) k $\Omega$ (100, 190) k $\Omega$ 1 M $\Omega$ 1.9 M $\Omega$ 10 M $\Omega$ 19 M $\Omega$ 100 M $\Omega$	95 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 43 $\mu\Omega/\Omega$ 52 $\mu\Omega/\Omega$ 0.12 m $\Omega/\Omega$	Fluke 5720A
Resistance – Source <sup>2</sup>	Up to 11 $\Omega$ (11 to 33) $\Omega$ (33 to 110) $\Omega$ 110 $\Omega$ to 1.1 k $\Omega$ (1.1 to 11) k $\Omega$ (11 to 111) k $\Omega$ 111 k $\Omega$ 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 M $\Omega$ to 1.1 G $\Omega$	12 $\mu\Omega/\Omega$ + 1 m $\Omega$ 84 $\mu\Omega/\Omega$ + 1.5 m $\Omega$ 84 $\mu\Omega/\Omega$ + 1.4 m $\Omega$ 84 $\mu\Omega/\Omega$ + 2 m $\Omega$ 84 $\mu\Omega/\Omega$ + 2 m $\Omega$ 87 $\mu\Omega/\Omega$ + 0.2 $\Omega$ 0.11 m $\Omega/\Omega$ + 2 $\Omega$ 0.18 m $\Omega/\Omega$ + 30 $\Omega$ 0.39 m $\Omega/\Omega$ + 50 $\Omega$ 0.76 m $\Omega/\Omega$ + 2.5 k $\Omega$ 1.5 m $\Omega/\Omega$ + 3 k $\Omega$ 9 m $\Omega/\Omega$ + 0.10 M $\Omega$ 45 $\mu\Omega/\Omega$ + 0.50 M $\Omega$	Fluke 5520A

**Electrical – DC/Low Frequency**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
Resistance - Measure	Up to 10 Ω (10 to 100) Ω 100 Ω to 10 kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	30 μΩ/Ω + 50 μΩ 18 μΩ/Ω + 0.50 mΩ 15 μΩ/Ω + 5 mΩ 20 μΩ/Ω + 50 mΩ 32 μΩ/Ω + 2 Ω 73 μΩ/Ω + 0.10 kΩ 0.59 mΩ/Ω + 1 kΩ 5.8 mΩ/Ω + 10 MΩ	HP/Agilent 3458A Opt 002
Resistance – Measure <sup>2</sup>	Up to 10 Ω (10 to 100) Ω 100 Ω to 10 kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	87 μΩ/Ω + 50 μΩ 51 μΩ/Ω + 500 μΩ 45 μΩ/Ω + 5 mΩ 55 μΩ/Ω + 50 mΩ 87 μΩ/Ω + 2 Ω 0.21 mΩ/Ω + 100 Ω 1.8 mΩ/Ω + 1 kΩ 15 mΩ/Ω + 10 kΩ	HP/Agilent 3458A Opt 002
AC Voltage - Source	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.24 mV/V + 4 μV 91 μV/V + 4 μV 81 μV/V + 4 μV 0.20 mV/V + 4 μV 0.50 mV/V + 5 μV 1.1 mV/V + 10 μV 1.4 mV/V + 20 μV 2.7 mV/V + 20 μV 2.4 mV/V + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.2 mV/V + 4 μV 0.5 mV/V + 5 μV 1.1 mV/V + 10 μV 1.4 mV/V + 20 μV 2.7 mV/V + 20 μV 0.24 mV/V + 12 μV 90 μV/V + 7 μV 80 μV/V + 7 μV 0.20 mV/V + 7 μV 0.46 mV/V + 17 μV 0.9 mV/V + 20 μV 1.4 mV/V + 25 μV 2.7 mV/V + 45 μV	Fluke 5720A

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source	220 mV to 2.2 V		Fluke 5720A
	(10 to 20) Hz	0.24 mV/V + 40 μV	
	(20 to 40) Hz	90 μV/V + 15 μV	
	40 Hz to 20 kHz	45 μV/V + 8 μV	
	(20 to 50) kHz	75 μV/V + 10 μV	
	(50 to 100) kHz	1.1 mV/V + 30 μV	
	(100 to 300) kHz	0.42 mV/V + 80 μV	
	(300 to 500) kHz	1 mV/V + 0.20 mV	
	500 kHz to 1 MHz	1.7 mV/V + 0.30 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.24 mV/V + 0.40 mV	
	(20 to 40) Hz	90 μV/V + 0.15 mV	
	40 Hz to 20 kHz	80 μV/V + 50 μV	
	(20 to 50) kHz	0.2 mV/V + 0.10 mV	
	(50 to 100) kHz	0.5 mV/V + 0.2 mV	
(100 to 300) kHz	1.1 mV/V + 0.6 mV		
(300 to 500) kHz	1.4 mV/V + 2 mV		
500 kHz to 1 MHz	2.7 mV/V + 3.2 mV		
AC Voltage – Source <sup>2</sup>	(22 to 220) V		Fluke 5520A
	(10 to 20) Hz	0.24 mV/V + 0.40 mV	
	(20 to 40) Hz	90 μV/V + 0.15 mV	
	40 Hz to 20 kHz	45 μV/V + 50 μV	
	(20 to 50) kHz	75 μV/V + 1.2 V	
	(50 to 100) kHz	0.1 mV/V + 0.2 mV	
	(100 to 300) kHz	0.28 mV/V + 0.6 mV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	5 mV/V + 3.2 mV	
	220 V to 1.1 kV		
	(15 to 50) Hz	0.3 mV/V + 16 mV	
	50 Hz to 1 kHz	70 μV/V + 3.5 mV	
	(1 to 33) mV		
	(10 to 45) Hz	0.24 mV/V + 6 μV	
	45 Hz to 10 kHz	60 μV/V + 6 μV	
(10 to 20) kHz	70 μV/V + 6 μV		
(20 to 50) kHz	0.3 mV/V + 6 μV		
(50 to 100) kHz	1.1 mV/V + 12 μV		
(100 to 500) kHz	2.4 mV/V + 50 μV		
(33 to 330) mV			
(10 to 45) Hz	90 μV/V + 8 μV		
45 Hz to 10 kHz	50 μV/V + 8 μV		
(10 to 20) kHz	50 μV/V + 8 μV		
(20 to 50) kHz	0.11 mV/V + 8 μV		
(50 to 100) kHz	0.24 mV/V + 32 μV		
(100 to 500) kHz	0.6 mV/V + 70 μV		

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Source <sup>2</sup>	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 (3.3 to 33) V 45 Hz to 1 kHz (1 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 1.02 kV 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	90 $\mu$ V/V + 50 $\mu$ V 50 $\mu$ V/V + 60 $\mu$ V 60 $\mu$ V/V + 60 $\mu$ V 90 $\mu$ V/V + 50 $\mu$ V 0.24 mV/V + 0.13 mV 0.72 mV/V + 0.60 mV 90 $\mu$ V/V + 0.65 mV 50 $\mu$ V/V + 0.60 mV 70 $\mu$ V/V + 0.60 mV 0.11 mV/V + 0.60 mV 0.27 mV/V + 1.6 mV 60 $\mu$ V/V + 2 mV 60 $\mu$ V/V + 6 mV 80 $\mu$ V/V + 6 mV 90 $\mu$ V/V + 6 mV 0.6 mV/V + 50 mV 90 $\mu$ V/V + 10 mV 80 $\mu$ V/V + 10 mV 0.1 mV/V + 10 mV	Fluke 5520A
AC Voltage - Measure	(1 to 10) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 1 V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.40 mV/V + 3 $\mu$ V 0.24 mV/V + 1 $\mu$ V 0.4 mV/V + 1 $\mu$ V 1.2 mV/V + 1 $\mu$ V 5.8 mV/V + 1 $\mu$ V 46 mV/V + 2 $\mu$ V 0.1 mV/V + 0.40 $\mu$ V 0.1 mV/V + 0.20 $\mu$ V 0.2 mV/V + 0.20 $\mu$ V 0.4 mV/V + 0.20 $\mu$ V 0.9 mV/V + 0.20 $\mu$ V 3.5 mV/V + 1 $\mu$ V 12 mV/V + 1 $\mu$ V 17 mV/V + 1 $\mu$ V 0.1 mV/V + 4 $\mu$ V 0.1 mV/V + 2 $\mu$ V 0.2 mV/V + 2 $\mu$ V 0.4 mV/V + 2 $\mu$ V 0.9 mV/V + 2 $\mu$ V 3.5 mV/V + 1 $\mu$ V 12 mV/V + 1 $\mu$ V 17 mV/V + 1 $\mu$ V	HP/Agilent 3458A Opt 002 Synchronous AC Mode

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure	(1 to 10) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz (10 to 100) V (1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.12 mV/V + 40 μV 0.1 mV/V + 20 μV 0.2 mV/V + 20 μV 0.4 mV/V + 20 μV 0.9 mV/V + 20 μV 3.5 mV/V + 10 μV 12 mV/V + 10 μV 17 mV/V + 10 μV 0.3 mV/V + 2 mV 0.2 mV/V + 2 mV 0.4 mV/V + 2 mV 1.4 mV/V + 2 mV 4.6 mV/V + 10 mV 17 mV/V + 10 mV 0.6 mV/V + 40 mV 0.5 mV/V + 20 mV 0.8 mV/V + 20 mV 1.4 mV/V + 20 mV 3.5 mV/V + 20 mV	HP/Agilent 3458A Opt 002 Synchronous AC Mode  Fluke 87 and Fluke 80K40
	(1 to 28) kV 60Hz	77 mV/V	
AC Voltage – Measure <sup>2</sup>	(1 to 10) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 1 V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	1.2 mV/V + 3 μV 0.72 mV/V + 1 μV 1.2 mV/V + 1 μV 3.6 mV/V + 1 μV 18 mV/V + 1 μV 0.14 mV/V + 2 μV 0.3 mV/V + 0.40 pV 0.3 mV/V + 0.20 pV 0.6 mV/V + 0.20 pV 1.2 mV/V + 0.20 pV 2.7 mV/V + 0.20 pV 11 mV/V + 1 μV 36 mV/V + 1 μV 54 mV/V + 1 μV 0.3 mV/V + 0.40 μV 0.3 mV/V + 0.20 μV 0.6 mV/V + 0.20 μV 1.2 mV/V + 0.20 μV 2.7 mV/V + 0.20 μV 11 mV/V + 1 μV 36 mV/V + 1 μV 54 mV/V + 1 μV	HP/Agilent 3458A Opt 002 Synchronous AC Mode



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure <sup>2</sup>	(1 to 10) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.36 mV/V + 0.40 μV 0.3 mV/V + 0.20 μV 0.6 mV/V + 0.20 μV 1.2 mV/V + 0.20 μV 2.7 mV/V + 0.20 μV 11 mV/V + 1 μV 36 mV/V + 1 μV 54 mV/V + 1 μV	HP/Agilent 3458A Opt 002 Synchronous AC Mode
	(10 to 100) V (1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.9 mV/V + 2 mV 0.6 mV/V + 2 mV 1.2 mV/V + 2 mV 4.2 mV/V + 2 mV 14 mV/V + 10 mV 51 mV/V + 10 mV 1.8 mV/V + 40 mV 1.5 mV/V + 20 mV 2.4 mV/V + 20 mV 4.2 mV/V + 20 mV 11 mV/V + 20 mV	
	(1 to 28) kV 60 Hz	77 mV/V	Fluke 87 and Fluke 80K40
AC Current - Source	Up to 220 μA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 16 nA 0.16 mA/A + 10 nA 0.12 mA/A + 8 nA 0.28 mA/A + 12 nA 1.1 mA/A + 65 nA	Fluke 5720A
	(0.22 to 2.2) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 40 nA 0.16 mA/A + 35 nA 0.12 mA/A + 35 nA 0.2 mA/A + 0.11 μA 1.1 mA/A + 0.65 μA	
	(2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 0.40 μA 0.16 mA/A + 0.35 μA 0.12 mA/A + 0.35 μA 0.2 mA/A + 0.55 μA 1.1 mA/A + 5 μA	
	(22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 4 μA 0.16 mA/A + 3.5 μA 0.12 mA/A + 2.5 μA 0.28 mA/A + 3.5 μA 1.1 mA/A + 10 μA	
	(0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.26 mA/A + 35 μA 0.45 mA/A + 80 μA 7 mA/A + 0.16 mA	



**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Source <sup>2</sup>	(29 to 330) $\mu$ 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 (0.33 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 40) Hz 40 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 (0.33 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 (1 to 5) kHz (11 to 20.5) A 45 Hz to 100 Hz 100 Hz to 1 kHz (1 to 5) kHz	6 mA/A + 0.1 $\mu$ A 4.5 mA/A + 0.1 $\mu$ A 3.8 mA/A + 0.1 $\mu$ A 9 mA/A + 0.15 $\mu$ A 24 mA/A + 0.2 $\mu$ A 48 mA/A + 0.4 $\mu$ A 6 mA/A + 0.15 $\mu$ A 3.8 mA/A + 0.15 $\mu$ A 3 mA/A + 0.15 $\mu$ A 6 mA/A + 0.2 $\mu$ A 15 mA/A + 0.3 $\mu$ A 30 mA/A + 0.6 $\mu$ A 5.4 mA/A + 2 $\mu$ A 2.7 mA/A + 2 $\mu$ A 1.2 mA/A + 2 $\mu$ A 2.4 mA/A + 2 $\mu$ A 6 mA/A + 3 $\mu$ A 12 mA/A + 4 $\mu$ A 5.4 mA/A + 20 $\mu$ A 2.7 mA/A + 20 $\mu$ A 1.2 mA/A + 20 $\mu$ A 3 mA/A + 50 $\mu$ A 6 mA/A + 0.1 mA 12 mA/A + 0.2 mA 5.4 mA/A + 0.1 mA 1.8 mA/A + 0.1 mA 18 mA/A + 1 mA 75 mA/A + 5 mA 1.8 mA/A + 2 mA 3 mA/A + 2 mA 90 mA/A + 2 mA 3.6 mA/A + 5 mA 4.5 mA/A + 5 mA 90 mA/A + 5 mA	Fluke 5520A
AC Current - Measure	(10 to 100) $\mu$ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz (1 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 20 nA 1.7 mA/A + 20 nA 0.75 mA/A + 20 nA 4.6 mA/A + 0.20 $\mu$ A 1.7 mA/A + 0.20 $\mu$ A 0.7 mA/A + 0.20 $\mu$ A 0.4 mA/A + 0.20 $\mu$ A	HP/Agilent 3458A Opt 002

**Electrical – DC/Low Frequency**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
AC Current - Measure	(0.1 to 1) A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 0.20 mA 1.9 mA/A + 0.20 mA 0.9 mA/A + 0.20 μA 1.2 mA/A + 0.20 μA	HP/Agilent 3458A Opt 002
AC Current - Measure <sup>2</sup>	(10 to 100) μA (10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz (1 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (0.1 to 1) A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	14 mA/A + 20 nA 5.1 mA/A + 20 nA 2.1 mA/A + 20 nA 14 mA/A + 0.20 μA 5.1 mA/A + 0.20 μA 2.1 mA/A + 0.20 μA 1.2 mA/A + 0.20 μA 14 mA/A + 0.20 mA 5.7 mA/A + 0.20 mA 2.7 mA/A + 0.20 mA 3.6 mA/A + 0.20 mA	HP/Agilent 3458A Opt 002
Oscilloscope – Bandwidth <sup>2</sup>	At 50 kHz reference:	2.3 % + 300 μV	Fluke 5520A SC1100
	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 MHz to 1.1 GHz	4.1 % + 300 μV 4.7 % + 300 μV 7 % + 300 μV 8.1 % + 300 μV	
	(1.1 to 12.4) GHz (12.4 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz	4.5% +M 4.7% +M 5.5% +M 6.2% +M	E4418B with 8485A
	(40 to 50) GHz	8.1% +M	E4418B with 8487A

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment	
Electrical Calibration of RTD Indicators <sup>2</sup>	Pt 385, 100 Ω			
	(-200 to 0) °C	0.06 °C		
	(0 to 100) °C	0.08 °C		
	(100 to 300) °C	0.11 °C		
	(300 to 400) °C	0.12 °C		
	(400 to 630) °C	0.15 °C		
	(630 to 800) °C	0.13 °C		
	Pt 385, 200 Ω			
	(-200 to 100) °C	0.05 °C		
	(100 to 260) °C	0.06 °C		
	(260 to 300) °C	0.15 °C		
	(300 to 400) °C	0.16 °C		
	(400 to 600) °C	0.18 °C		
	(600 to 630) °C	0.2 °C		
	Pt 385, 500 Ω			
	(-200 to -80) °C	0.05 °C		
	(-80 to 100) °C	0.06 °C		
	(100 to 260) °C	0.08 °C		
	(260 to 400) °C	0.1 °C		
	(400 to 600) °C	0.12 °C		
	(600 to 630) °C	0.14 °C		
	Pt 385, 1 000 Ω			
	(-200 to 0) °C	0.04 °C		
	(0 to 100) °C	0.05 °C		
	(100 to 260) °C	0.07 °C		
	(260 to 300) °C	0.08 °C		
	(300 to 600) °C	0.1 °C		
	(600 to 630) °C	0.3 °C		
	Pt 3916, 100 Ω			
	(-200 to -190) °C	0.29 °C		
	(-190 to -80) °C	0.05 °C		
	(-80 to 0) °C	0.06 °C		
	(0 to 100) °C	0.07 °C		
(100 to 260) °C	0.09 °C			
(260 to 300) °C	0.1 °C			
(300 to 400) °C	0.13 °C			
(400 to 600) °C	0.11 °C			
(600 to 630) °C	0.27 °C			
Pt 3926, 100 Ω				
(-200 to 0) °C	0.08 °C			
(0 to 100) °C	0.08 °C			
(100 to 300) °C	0.11 °C			
(300 to 400) °C	0.12 °C			
(400 to 630) °C	0.15 °C			
PtNi 385, 120 Ω				
(-80 to 100) °C	0.09 °C			
(100 to 260) °C	0.46 °C			
Cu 427, 10 Ω				
(-100 to 260) °C	0.36 °C			
			Fluke 5520A	

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Indicating Systems <sup>2</sup>	Type B		Fluke 5520A
	(600 to 800) °C	0.51 °C	
	(800 to 1 000) °C	0.56 °C	
	(1 000 to 1 550) °C	0.49 °C	
	(1 550 to 1 820) °C	0.54 °C	
	Type C		
	(0 to 150) °C	0.49 °C	
	(150 to 650) °C	0.42 °C	
	(650 to 1 000) °C	0.51 °C	
	(1 000 to 1 800) °C	0.82 °C	
	(1 800 to 2 316) °C	1.4 °C	
	Type E		
	(-250 to -100) °C	0.82 °C	
	(-100 to -25) °C	0.26 °C	
	(-25 to 350) °C	0.23 °C	
	(350 to 650) °C	0.26 °C	
	(650 to 1 000) °C	0.34 °C	
	Type J		
	(-210 to -100) °C	0.44 °C	
	(-100 to -30) °C	0.26 °C	
	(-30 to 150) °C	0.23 °C	
	(150 to 760) °C	0.28 °C	
	(760 to 1200) °C	0.38 °C	
	Type K		
	(-200 to -100) °C	0.38 °C	
	(-100 to -25) °C	0.29 °C	
	(-25 to 120) °C	0.26 °C	
	(120 to 1000) °C	0.42 °C	
	(1000 to 1372) °C	0.65 °C	
	Type L		
(-200 to -100) °C	0.6 °C		
(-100 to 800) °C	0.42 °C		
(800 to 900) °C	0.28 °C		
Type N			
(-200 to -100) °C	0.65 °C		
(-100 to -25) °C	0.36 °C		
(-25 to 120) °C	0.31 °C		
(120 to 410) °C	0.29 °C		
(410 to 1 300) °C	0.44 °C		
Type R			
(0 to 250) °C	0.93 °C		
(250 to 400) °C	0.57 °C		
(400 to 1 000) °C	0.54 °C		
(1000 to 1767) °C	0.65 °C		
Type S			
(0 to 250) °C	0.77 °C		
(250 to 1 000) °C	0.59 °C		
(1 000 to 1 400) °C	0.6 °C		
(1 400 to 1 767) °C	0.75 °C		

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Indicating Systems <sup>2</sup>	Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	1.1 °C 0.42 °C 0.26 °C 0.23 °C	Fluke 5520A
	Type U (-200 to 0) °C (0 to 600) °C	0.91 °C 0.44 °C	

**Electrical - RF/Microwave**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power – Power Meter Reference	1 mW @ 50 MHz	0.4 %	HP 432A and HP 8478B with HP 3458A
RF Power – Measure <sup>2, 4</sup>	(-20 to +20) dBm (10 to 30) MHz 30 MHz to 7 GHz (7 to 18) GHz	2.4 % 2.8 % 3.7 %	E4418B with 8481A
	(-20 to +20) dBm (18 to 26.5) GHz	4 % +M	E4418B with 8485A
	(-20 to +20) dBm (26.5 to 40) GHz (40 to 50) GHz	5 % +M 7.2 % +M	E4418B with 8487A

**Length – Dimensional Metrology**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Micrometers <sup>2,3</sup>	(0 to 12) in	(70 + 5L) μin	Mitutoyo BE1-81-1F, Mitutoyo BE6-81-2F
Calipers <sup>2,3</sup>	(0 to 24) in	(170 + 5L) μin	Mitutoyo BE1-81-1F, Mitutoyo BE6-81-2F
Indicators <sup>2,3</sup>	(0 to 2) in	(140 + 5L) μin	Mitutoyo BE1-81-1F, Mitutoyo BE6-81-2F
Height and Depth Gages <sup>3</sup>	(0 to 12) in	(140 + 5L) μin	Mitutoyo BE1-81-1F, Mitutoyo BE6-81-2F
Height and Depth Gages <sup>2,3</sup>	(12 to 24) in	(180 + 5L) μin	Mitutoyo BE1-81-1F, Mitutoyo BE6-81-2F
Pins <sup>3</sup>	(0.05 to 1) in	(35 + 5L) μin	Mitutoyo BE1-81-1F, SMM-1

## Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Plain Ring Gauges <sup>3</sup>	(0 to 4) in	(48 + 5L) μin	Mitutoyo BE1-81-1F, Federal ID Comparator
V-Blocks Parallelism Squareness	Up to 10 in Up to 10 in	100 μin 100 μin	Mitutoyo BE1-81-1F, Starrett Comparator Master Square
Thickness Gage (Feeler Type)	(0.0005 to 0.05) in	51 μin	Mitutoyo BE1-81-1F, SMM-1
Radius Gage	Up to 1 in	0.0005 in	Optical Comparator, GM4
Clinometer/Protractor	Up to 45 °	0.08 °	Brunson 470, Gage Blocks, Sine Bars
Micrometer Heads <sup>3</sup>	(0 to 2) in	(75 + 5L) μin	Mitutoyo BE1-81-1F, Mitutoyo BE6-81-2F
Master Height Gage <sup>3</sup>	(0 to 18) in	(40 + 5L) μin	
Level	Up to 1 000 arc sec	1 arc sec	Brunson 470
Angle	(0 to 90) °	0.08 °	Optical Comparator

## Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Pressure Gages	(2 to 25) psi (25 to 100) psi (100 to 500) psi (500 to 10 000) psi	0.3 % of Setting 0.05 % of Setting 0.02 % of Setting 0.15 % of Setting	Druck DPI 515, Pneumatic Deadweight Tester T2300/3, Ashcroft 1305B Deadweight Tester
Scales and Balances <sup>2,3</sup>	Up to 20 mg (20 to 500) mg (0.5 to 5) g	6 mg/g + 0.6R 60 μg/g + 0.6R 20 μg/g + 0.6R	Class 1, 3 and 4 Weights Mettler UMT2
	(5 to 50) g (50 to 500) g	32 μg/g + 0.6R 2 μg/g + 0.6R	Class 1, 3 and 4 Weights Mettler AE240
	(0.5 to 5) kg (5 to 15) kg (15 to 30) kg	0.4 mg/g + 0.6R 40 μg/g + 0.6R 13 μg/g + 0.6R	Class 1, 3 and 4 Weights Satorius CP 34001S
	Up to 1 000 lbs	0.5 μg/g + 0.6R	Class F Weights
Torque	(0.5 to 215) ozf-in 10 lbf-in to 100 lbf-ft (100 to 1 000) lbf-ft	1.5 % of Reading 1.5 % of Reading 1.5 % of Reading	Torque Testers, Mass, Torque Arms
Force Gages Tension/Compression	(0.1 to 500) lbf	1 % of Reading	Class F Weights
Mass Measurement	1 mg to 2.1 g (2.1 to 210) g 211 g to 4.1 kg (4.1 to 34) kg	0.01 mg 0.1 mg 0.1 g 1 g	Balances and ASTM Class 1 Weight Set

## Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Mass Flow Rate	(0 to 100) SLM	1.5 % of Setting	DHI Flow System
Pipettes	(0.1 to 2.0) $\mu\text{L}$ (2.1 to 5.0) $\mu\text{L}$ (5.1 to 10.0) $\mu\text{L}$ (10.1 to 20.0) $\mu\text{L}$	0.029 $\mu\text{L}$ 0.039 $\mu\text{L}$ 0.058 $\mu\text{L}$ 0.1 $\mu\text{L}$	Gravimetric Method using Balances and Weights
Pipettes <sup>2</sup>	(20.1 to 50.0) $\mu\text{L}$ (50.1 to 100.0) $\mu\text{L}$ (100.1 to 200.0) $\mu\text{L}$ (200.1 to 500.0) $\mu\text{L}$ (500.1 to 1 000.0) $\mu\text{L}$ (1 000.1 to 2 500.0) $\mu\text{L}$ (2 500.1 to 5 000.0) $\mu\text{L}$ (5 000.1 to 10 000) $\mu\text{L}$	0.83 $\mu\text{L}$ 0.96 $\mu\text{L}$ 1.2 $\mu\text{L}$ 1.9 $\mu\text{L}$ 3.1 $\mu\text{L}$ 6.9 $\mu\text{L}$ 13 $\mu\text{L}$ 39 $\mu\text{L}$	

## Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature - Source and Measure	(-95 to 660) $^{\circ}\text{C}$	0.08 $^{\circ}\text{C}$	Hart 1502 and 5628 Fluke 9190A and Hart 9173
Temperature – Source and Measure <sup>2</sup>	(-200 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	Hart 1521 and 5627-6 or 5623A-6 Hart 9141
Infrared Measure	(50 to 100) $^{\circ}\text{C}$ (100 to 200) $^{\circ}\text{C}$ (200 to 300) $^{\circ}\text{C}$ (300 to 400) $^{\circ}\text{C}$ (400 to 500) $^{\circ}\text{C}$	1.4 $^{\circ}\text{C}$ 2.4 $^{\circ}\text{C}$ 3.5 $^{\circ}\text{C}$ 4.7 $^{\circ}\text{C}$ 5.5 $^{\circ}\text{C}$	Hart 9132 and Hart 1502A with 5618B
Relative Humidity - Source	(11 to 20) % RH (20 to 40) % RH (40 to 70) % RH (70 to 80) % RH (80 to 90) % RH	0.65 % RH 0.7 % RH 0.73 % RH 0.75 % RH 1.1 % RH	Thunder Scientific 2500
Relative Humidity - Measure <sup>2</sup>	(10 to 90) % RH	1.6 % RH	Rotronic HP23-A HydroPalm/HC2-HK25

## Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency - Oscillator Characterization	10 MHz	5 parts in $10^{11}$ MHz	Symmetricom XLi

## Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Measure <sup>2</sup>	10 MHz to 26.5 GHz (26.5 to 46) GHz	(0.19 to 70) $\mu$ Hz/Hz of reading (40 to 70) $\mu$ Hz/Hz of reading	HP 5345A, HP 5355A, HP 5356A HP 53149A
Digital Stopwatch/Timer	(0 to 10) S/day	0.083 S/day	Helmut-Klein 4500 NIST 960-12

### Notes:

1. Calibration and Measurement Capabilities (Expanded Uncertainties) are based on approximately a 95% confidence interval, using a coverage of  $k=2$ .
2. 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.
3.  $L$  = length in inches;  $R$  = resolution of the device under test, % = percent of reading unless otherwise indicated.
4. Mismatch uncertainty is denoted by M. E4418B and 8481A do not include the mismatch uncertainty
5. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1768

  
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 Vice President