



THE AMERICAN ASSOCIATION FOR  
LABORATORY ACCREDITATION

## ACCREDITED LABORATORY

A2LA has accredited

**PRECISION MEASUREMENTS, INC.**

**Sunnyvale, CA**

for technical competence in the field of

### **Calibration**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration. 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 8 January 2009*).



Presented this 16<sup>th</sup> day of June 2009.

A handwritten signature in cursive script, reading "Peter Abney".

President  
For the Accreditation Council  
Certificate Number 1796.01  
Valid to March 31, 2011

For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.

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

PRECISION MEASUREMENTS, INC.  
333 Moffett Park Drive  
Sunnyvale, CA 94089  
David Miller Phone: 408 733 8600

CALIBRATION

Valid To: March 31, 2011

Certificate Number: 1796.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1</sup>:

I. Dimensional

Parameter/Equipment	Range	Best Uncertainty <sup>2,6</sup> ( $\pm$ )	Comments
Micrometers <sup>3</sup>	(0 to 12) in	(20 + 5L) $\mu$ m	Mitutoyo BE1-81-1, Mitutoyo BE6-81-2F
Calipers <sup>3</sup>	(0 to 24) in	(670 + 5L) $\mu$ m	Mitutoyo BE1-81-1, Mitutoyo BE6-81-2F
Indicators <sup>3</sup>	(0 to 2) in	(140 + 5L) $\mu$ m	Mitutoyo BE1-81-1, Mitutoyo BE6-81-2F
Height and Depth Gages <sup>3</sup>	(0 to 12) in	(160 + 5L) $\mu$ m	Mitutoyo BE1-81-1, Mitutoyo BE6-81-2F
Height and Depth Gages	(12 to 24) in	(180 + 5L) $\mu$ m	Mitutoyo BE1-81-1 and BE6-81-2F
Pins	(0.05 to 1) in	(25 + 5L) $\mu$ m	Mitutoyo BE1-81-1
Plain Ring Gauges	(0 to 4) in	(35 + 5L) $\mu$ m	Mitutoyo BE1-81-1, Federal ID comparator

Parameter/Equipment	Range	Best Uncertainty <sup>2, 6</sup> ( $\pm$ )	Comments
V-Blocks			
Parallelism	Up to 10 in	100 $\mu$ in	By mechanical comparison
Squareness	Up to 10 in	100 $\mu$ in	
Thickness Gage (Feeler Type)	(0.0005 to 0.05) in	51 $\mu$ in	By mechanical comparison
Straight Edges	(0 to 6) ft	25 $\mu$ in/ft	Optical measurement
Riser Block	(0 to 12) in	(40 + 2L) $\mu$ in	By mechanical comparison
Radius Gage	Up to 1 in	0.0005 in	Optical comparison
Clinometer/Protractor	Up to 45°	0.08°	Brunson 470, gage blocks, and sine bars
Micrometer Heads	(0 to 2) in	(75 + 5L) $\mu$ in	By mechanical comparison
Micrometer End Standards	(0 to 24) in	(40 + 5L) $\mu$ in	By mechanical comparison
Master Height Gage	(0 to 24) in	(40 + 5L) $\mu$ in	Gage blocks
Level	Up to 1000 arc sec	1 arc sec	Brunson 470
Angle	(0 to 90)°	0.08°	Optical comparison

II. Electrical – DC & Low Frequency

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
DC Voltage – Generate <sup>5</sup>	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	12 μV/V + 0.4 μV 5 μV/V + 0.7 μV 3.5 μV/V + 2.5 μV 3.5 μV/V + 4 μV 5 μV/V + 40 μV 6.7 μV/V + 400 μV	Fluke 5720A
Fixed Points	1 V 10 V	1.6 μV/V 0.9 μV/V	Fluke 732A
DC Voltage – Generate <sup>3,5</sup>	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (30 to 330) V (100 to 1000) V	66 μV/V + 1 μV 33 μV/V + 2 μV 36 μV/V + 20 μV 54 μV/V + 150 μV 54 μV/V + 1.5 mV	Fluke 5520A
DC Voltage – Measure <sup>4</sup>	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V  (1 to 40) kV	17 μV/V + 3 μV 8.6 μV/V + 0.3 μV 7.8 μV/V + 0.05 μV 11 μV/V + 0.3 μV 15 μV/V + 0.1 μV  1.6 % of reading	HP/Agilent 3458A with option 002,  Fluke 80K40, and HP 34401A
DC Voltage – Measure <sup>3,4</sup>	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V  (1 to 40) kV	51 μV/V + 10 μV 27 μV/V + 1 μV 24 μV/V + 2 μV 33 μV/V + 30 μV 45 μV/V + 100 μV  2 % of reading	HP/Agilent 3458A with option 002,  Fluke 80K40, and HP 34401A
DC Current – Generate <sup>4</sup>	Up to 220 μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	42 μA/A + 6 nA 36 μA/A + 7 nA 37 μA/A + 40 nA 46 μA/A + 0.7 μA 82 μA/A + 12 μA	Fluke 5720A

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
DC Current – Generate <sup>3,4</sup>	Up to 330 µA 330 µA 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	0.045 % + 0.02 µA 0.045 % + 0.05 µA 0.03 % + 0.25 µA 0.03 % + 2.5 µA 0.06 % + 40 µA 0.1 % + 40 µA 0.15 % + 500 µA 0.3 % + 750 µA	Fluke 5520A
DC Current – Measure <sup>4</sup>	(10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	48 µA/A + 800 pA 47 µA/A + 5 pA 45 µA/A + 50 pA 63 µA/A + 0.5 pA 0.015 % + 10 µA	HP/Agilent 3458A with option 002
DC Current – Measure <sup>4,7</sup>	(10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	0.015 % + 800 pA 0.015 % + 5 nA 0.015 % + 50 nA 0.019 % + 0.5 µA 0.045 % + 10 µA	HP/Agilent 3458A with option 002
Resistance – Generate, Fixed Points <sup>5</sup>	(1, 1.9) Ω (10, 19) Ω (100, 190) Ω (1, 19) kΩ (100, 190) kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	95 µΩ/Ω 25 µΩ/Ω 11 µΩ/Ω 9 µΩ/Ω 14 µΩ/Ω 24 µΩ/Ω 25 µΩ/Ω 43 µΩ/Ω 52 µΩ/Ω 120 µΩ/Ω	Fluke 5720A
Resistance – Generate <sup>3,5</sup>	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω 110 Ω to 1.1 kΩ (1.1 to 11) kΩ (11 to 111) kΩ 111 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 to 1100) MΩ	0.012 % + 0.001 Ω 84 µΩ/Ω + 0.0015 Ω 84 µΩ/Ω + 0.0014 Ω 84 µΩ/Ω + 0.002 Ω 84 µΩ/Ω + 0.02 Ω 87 µΩ/Ω + 0.2 Ω 0.011 % + 2 Ω 0.018 % + 30 Ω 0.039 % + 50 Ω 0.076 % + 2.5 kΩ 0.15 % + 3 kΩ 0.9 % + 100 kΩ 4.5 % + 500 kΩ	Fluke 5520A

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
Resistance – Measure <sup>5</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 1 MΩ to 1 GΩ	30 μΩ/Ω + 50 μΩ 18 μΩ/Ω + 500 μΩ 15 μΩ/Ω + 5 mΩ 20 μΩ/Ω + 50 mΩ 32 μΩ/Ω + 2 Ω 73 μΩ/Ω + 100 Ω 0.059 % + 1 kΩ 5.8 mΩ/Ω + 10 MΩ	HP/Agilent 3458A with option 002
Resistance – Measure <sup>3,5</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 1 MΩ 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 0.021 % + 100 Ω 1.8 mΩ/Ω + 1 kΩ 15 mΩ/Ω + 10 kΩ	HP/Agilent 3458A with option 002
AC Voltage – Generate <sup>5</sup>  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	0.024 % + 4 μV 91 μV/V + 4 μV 81 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 5 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 20 μV	Fluke 5720A

Parameter/Equipment	Frequency	Best Uncertainty <sup>2</sup> (±)	Comments
AC Voltage – Generate <sup>5</sup> (cont)			
(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	0.24 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 5 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 20 μV	Fluke 5720A
(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	0.024 % + 12 μV 90 μV/V + 7 μV 80 μV/V + 7 μV 0.02 % + 7 μV 0.046 % + 17 μV 0.09 % + 20 μV 0.14 % + 25 μV 0.27 % + 45 μV	
220 mV to 2.2 V	(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	0.024 % + 40 μV 90 μV/V + 15 μV 45 μV/V + 8 μV 75 μV/V + 10 μV 0.11 % + 30 μV 0.042 % + 80 μV 0.1 % + 200 μV 0.17 % + 300 μV	
(2.2 to 22) V	(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	0.024 % + 400 μV 90 μV/V + 150 μV 80 μV/V + 50 μV 0.02 % + 100 μV 0.05 % + 200 μV 0.11 % + 600 μV 0.14 % + 2 mV 0.27 % + 3.2 mV	
(22 to 220) V	(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	0.024 % + 400 μV 90 μV/V + 150 μV 45 μV/V + 50 μV 75 μV/V + 100 μV 0.01 % + 200 μV 0.028 % + 600 μV 0.1 % + 2 mV 0.15 % + 3.2 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.03 % + 16 mV 70 μV/V + 3.5 mV	

Parameter/Equipment	Frequency	Best Uncertainty <sup>2</sup> (±)	Comments
AC Voltage – Generate <sup>5,3</sup>			
(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	0.024 % + 6 μV 0.006 % + 6 μV 0.007 % + 6 μV 0.03 % + 6 μV 0.11 % + 12 μV 0.24 % + 50 μV	Fluke 5520A
(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	0.009 % + 8 μV 0.005 % + 8 μV 0.005 % + 8 μV 0.011 % + 8 μV 0.024 % + 32 μV 0.06 % + 70 μV	
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	0.009 % + 50 μV 0.005 % + 60 μV 0.006 % + 60 μV 0.009 % + 50 μV 0.024 % + 130 μV 0.072 % + 600 μV	
(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	0.009 % + 650 μV 0.005 % + 600 μV 0.007 % + 600 μV 0.011 % + 600 μV 0.027 % + 1.6 mV	
(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	0.006 % + 2 mV 0.006 % + 6 mV 0.008 % + 6 mV 0.009 % + 6 mV 0.06 % + 50 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.009 % + 10 mV 0.008 % + 10 mV 0.01 % + 10 mV	

Parameter/Equipment	Frequency	Best Uncertainty <sup>2</sup> (±)	Comments	
AC Voltage – Measure <sup>4</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	0.04 % + 3 μV 0.024 % + 1 μV 0.04 % + 1 μV 0.12 % + 1 μV 0.58 % + 1 μV 4.6 % + 2 μV	HP/Agilent 3458A with option 002 synchronous AC mode	
(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	0.01 % + 400 nV 0.01 % + 200 nV 0.02 % + 200 nV 0.04 % + 200 nV 0.09 % + 200 nV 0.35 % + 1 μV 1.2 % + 1 μV 1.7 % + 1 μV		
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	0.01 % + 4 μV 0.01 % + 2 μV 0.02 % + 2 μV 0.04 % + 2 μV 0.09 % + 2 μV 0.35 % + 1 μV 1.2 % + 1 μV 1.7 % + 1 μV		
(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	0.012 % + 40 μV 0.01 % + 20 μV 0.02 % + 20 μV 0.04 % + 20 μV 0.09 % + 20 μV 0.35 % + 10 μV 1.2 % + 10 μV 1.7 % + 10 μV		
(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	0.03 % + 2 mV 0.02 % + 2 mV 0.04 % + 2 mV 0.14 % + 2 mV 0.46 % + 10 mV 1.7 % + 10 mV		
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.06 % + 40 mV 0.05 % + 20 mV 0.08 % + 20 mV 0.14 % + 20 mV 0.35 % + 20 mV		
(1 to 28) kV	60Hz	7.7 % of reading		Fluke 87 and Fluke 80K40

Parameter/Equipment	Frequency	Best Uncertainty <sup>2</sup> (±)	Comments	
AC Voltage – Measure <sup>3,4</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	0.12 % + 3 μV 0.072 % + 1 μV 0.12 % + 1 μV 0.36 % + 1 μV 18 mV/V + 1 μV 0.014 % + 2 μV	HP/Agilent 3458A with option 002 synchronous AC mode	
(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	0.03 % + 400 nV 0.03 % + 200 nV 0.06 % + 200 nV 0.12 % + 200 nV 0.27 % + 200 nV 11 mV/V + 1 μV 36 mV/V + 1 μV 54 mV/V + 1 μV		
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	0.03 % + 400 nV 0.03 % + 200 nV 0.06 % + 200 nV 0.12 % + 200 nV 0.27 % + 200 nV 11 mV/V + 1 μV 36 mV/V + 1 μV 54 mV/V + 1 μV		
(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	0.036 % + 400 nV 0.03 % + 200 nV 0.06 % + 200 nV 0.12 % + 200 nV 0.27 % + 200 nV 11 mV/V + 1 μV 36 mV/V + 1 μV 54 mV/V + 1 μV		
(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	0.09 % + 2 mV 0.06 % + 2 mV 0.12 % + 2 mV 0.42 % + 2 mV 14 mV/V + 10 mV 51 mV/V + 10 mV		
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.18 % + 40 mV 0.15 % + 20 mV 0.24 % + 20 mV 0.42 % + 20 mV 1.1 % + 20 mV		
(1 to 28) kV	60 Hz	7.7 % of reading		Fluke 87 and Fluke 80K40

Parameter/Equipment	Frequency	Best Uncertainty <sup>2</sup> (±)	Comments
AC Current – Measure <sup>4</sup>			
(10 to 100) μA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	0.46 % + 20 nA 0.17 % + 20 nA 0.075 % + 20 nA	HP/Agilent 3458A with option 002
(1 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % + 200 nA 0.17 % + 200 nA 0.07 % + 200 nA 0.04 % + 200 nA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % + 200 μA 0.19 % + 200 μA 0.09 % + 200 μA 0.12 % + 200 μA	
AC Current – Measure <sup>3,4</sup>			
(10 to 100) μA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	1.4 % + 20 nA 0.51 % + 20 nA 0.21 % + 20 nA	HP/Agilent 3458A with option 002
(1 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	1.4 % + 200 nA 0.51 % + 200 nA 0.21 % + 200 nA 0.12 % + 200 nA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	1.4 % + 200 μA 0.57 % + 200 μA 0.27 % + 200 μA 0.36 % + 200 μA	
AC Current – Generate <sup>5</sup>			
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	0.025 % + 16 nA 0.016 % + 10 nA 0.012 % + 8 nA 0.028 % + 12 nA 0.11 % + 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	0.025 % + 40 nA 0.016 % + 35 nA 0.012 % + 35 nA 0.02 % + 110 nA 0.11 % + 650 nA	

Parameter/Equipment	Frequency	Best Uncertainty <sup>2</sup> (±)	Comments
AC Current – Generate <sup>5</sup> (cont)			
(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	0.025 % + 400 nA 0.016 % + 350 nA 0.012 % + 350 nA 0.02 % + 550 nA 0.11 % + 5 µA	Fluke 5720A
(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	0.025 % + 4 µA 0.016 % + 3.5 µA 0.012 % + 2.5 µA 0.028 % + 3.5 µA 0.11 % + 10 µA	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.026 % + 35 µA 0.045 % + 80 µA 0.7 % + 160 µA	
AC Current – Generate <sup>3,5</sup>			
(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	0.6 % + 0.1 µA 0.45 % + 0.1 µA 0.38 % + 0.1 µA 0.9 % + 0.15 µA 2.4 % + 0.2 µA 4.8 % + 0.4 µA	Fluke 5520A
(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	0.6 % + 0.15 µA 0.38 % + 0.15 µA 0.3 % + 0.15 µA 0.6 % + 0.2 µA 1.5 % + 0.3 µA 3 % + 0.6 µA	
(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	0.54 % + 2 µA 0.27 % + 2 µA 0.12 % + 2 µA 0.24 % + 2 µA 0.6 % + 3 µA 1.2 % + 4 µA	
(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	0.54 % + 20 µA 0.27 % + 20 µA 0.12 % + 20 µA 0.3 % + 50 µA 0.6 % + 100 µA 1.2 % + 200 µA	

Parameter/Equipment	Frequency	Best Uncertainty <sup>2</sup> ( $\pm$ )	Comments
AC Current – Generate <sup>3,5</sup> (cont)			
(0.33 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.54 % + 100 $\mu$ A 0.18 % + 100 $\mu$ A 1.8 % + 1 mA 7.5 % + 5 mA	Fluke 5520A
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.18 % + 2 mA 0.3 % + 2 mA 9 % + 2 mA	
(11 to 20.5) A	45 Hz to 100 Hz 100 Hz to 1 kHz (1 to 5) kHz	0.36 % + 5 mA 0.45 % + 5 mA 9 % + 5 mA	
Oscilloscope – Bandwidth <sup>3,5</sup>	At 50 kHz reference:  50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	2.3 % + 300 $\mu$ V  4.1 % + 300 $\mu$ V 4.7 % + 300 $\mu$ V 7 % + 300 $\mu$ V 8.1 % + 300 $\mu$ V	Fluke 5520A with option SC1100
Electrical Calibration of RTD Indicators <sup>3</sup> –			
Pt 385, 100 $\Omega$	(-200 to 0) $^{\circ}$ C (0 to 100) $^{\circ}$ C (100 to 300) $^{\circ}$ C (300 to 400) $^{\circ}$ C (400 to 630) $^{\circ}$ C (630 to 800) $^{\circ}$ C	0.06 $^{\circ}$ C 0.08 $^{\circ}$ C 0.11 $^{\circ}$ C 0.12 $^{\circ}$ C 0.15 $^{\circ}$ C 0.13 $^{\circ}$ C	Fluke 5520A
Pt 385, 200 $\Omega$	(-200 to 100) $^{\circ}$ C (100 to 260) $^{\circ}$ C (260 to 300) $^{\circ}$ C (300 to 400) $^{\circ}$ C (400 to 600) $^{\circ}$ C (600 to 630) $^{\circ}$ C	0.05 $^{\circ}$ C 0.06 $^{\circ}$ C 0.15 $^{\circ}$ C 0.16 $^{\circ}$ C 0.18 $^{\circ}$ C 0.2 $^{\circ}$ C	
Pt 385, 500 $\Omega$	(-200 to -80) $^{\circ}$ C (-80 to 100) $^{\circ}$ C (100 to 260) $^{\circ}$ C (260 to 400) $^{\circ}$ C (400 to 600) $^{\circ}$ C (600 to 630) $^{\circ}$ C	0.05 $^{\circ}$ C 0.06 $^{\circ}$ C 0.08 $^{\circ}$ C 0.1 $^{\circ}$ C 0.12 $^{\circ}$ C 0.14 $^{\circ}$ C	

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
Electrical Calibration of RTD Indicators <sup>3</sup> (cont) –			Fluke 5520A
Pt 385, 1000 Ω	(-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C	0.04 °C 0.05 °C 0.07 °C 0.08 °C 0.1 °C 0.3 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.29 °C 0.05 °C 0.06 °C 0.07 °C 0.09 °C 0.1 °C 0.13 °C 0.11 °C 0.27 °C	
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.08 °C 0.08 °C 0.11 °C 0.12 °C 0.15 °C	
PtNi 385, 120 Ω	(-80 to 100) °C (100 to 260) °C	0.09 °C 0.46 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.36 °C	
Electrical Calibration of Thermocouple Indicating Systems <sup>3</sup> –			Fluke 5520A
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.51 °C 0.56 °C 0.49 °C 0.54 °C	
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.49 °C 0.42 °C 0.51 °C 0.82 °C 1.4 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.82 °C 0.26 °C 0.23 °C 0.26 °C 0.34 °C	

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
Electrical Calibration of Thermocouple Indicating Systems <sup>3</sup> – (cont)			
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.44 °C 0.26 °C 0.23 °C 0.28 °C 0.38 °C	Fluke 5520A
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.38 °C 0.29 °C 0.26 °C 0.42 °C 0.65 °C	
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.6 °C 0.42 °C 0.28 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.65 °C 0.36 °C 0.31 °C 0.29 °C 0.44 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.93 °C 0.57 °C 0.54 °C 0.65 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.77 °C 0.59 °C 0.6 °C 0.75 °C	
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	
Type U	(-200 to 0) °C (0 to 600) °C	0.91 °C 0.44 °C	

### III. Electrical – RF & Microwave

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
RF Power – Measure  (-20 to +20) dbm	50 MHz (10 to 30) MHz 30 MHz to 7 GHz (7 to 18) GHz	2 % of reading 2.4 % of reading 2.8 % of reading 3.7 % of reading	HP 437B with 8481A

### IV. Fluid

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
Mass Flow Rate	(0 to 100) SLM	1.5 % of reading	DHI flow system

### V. Mechanical

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
Pressure Gages	(2 to 25) psi (>25 to 100) psi (>100 to 500) psi (>500 to 10 000) psi	0.3 % of reading 0.05 % of reading 0.02 % of reading 0.15% of reading	Pneumatic deadweight tester T2300/3  Ashcroft 1305B deadweight tester
Scales and Balances <sup>6</sup>	Up to 20 mg (>20 to 500) mg (>0.5 to 5) g  (>5 to 50) g (>50 to 500) g  (0.5 to 5) kg (>5 to 15) kg (>15 to 30) kg  Up to 1000 lbs	0.6 % of reading + 0.6R 0.006 % of reading + 0.6R 0.002 % of reading + 0.6R  0.00032 % of reading + 0.6R 0.0002 % of reading + 0.6R  0.04 % of reading + 0.6R 0.004 % of reading + 0.6R 0.0013 % of reading + 0.6R  0.05 % of reading + 0.6R	Class 1, 3 and 4 weights Mettler UMT2  Mettler AE240  Satorius CP 34001S  Class F weights

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> ( $\pm$ )	Comments
Scales and Balances <sup>3,6</sup>	Up to 20 mg (>20 to 500) mg (>0.5 to 5) g	0.7 % of reading + 0.6R 0.01 % of reading + 0.6R 0.003 % of reading + 0.6R	Class 1, 3 and 4 weights Mettler UMT2
	(>5 to 50) g (>50 to 500) g	0.0004 % of reading + 0.6R 0.0003 % of reading + 0.6R	Mettler AE240
	(0.5 to 5) kg (>5 to 15) kg (>15 to 30) kg	0.05 % of reading + 0.6R 0.005 % of reading + 0.6R 0.002 % of reading + 0.6R	Satorius CP 34001S
	Up to 1000 lbs	0.05 % of reading + 0.6R	Class F weights
Torque	(0.5 to 215) in/oz 10 in/lb to 100 ft/lb (100 to 1000) ft/lb	1.5 % of reading 1.5 % of reading 1.5 % of reading	Torque testers, mass and torque arms
Force Gages	(0.1 to 500) lbf	1 % of reading	Class F weights
Mass Measurement  Greater Than Class 2	1 mg to 2.1 g (2.1 g to 210) g (211 to 4100) g (4.1 to 34) kg	0.01 mg 0.1 mg 0.1 g 1 g	Comparison

## VI. Thermodynamics

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> ( $\pm$ )	Comments
Temperature Measuring Equipment and Measure	(-25 to 400) °C	0.075 °C	Hart 1502 and 5628S
Temperature Measuring Equipment and Measure <sup>3</sup>	(-200 to 400) °C	0.1 °C	Hart 1521 and 5627-6 or 5623A-6
Infrared Measure	(50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	1.4 °C 2.4 °C 3.5 °C 4.7 °C 5.5 °C	Hart 9132 and hart 1502A with 5618B

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
Relative Humidity – Measure	(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>3</sup>	(10 to 90) % RH	1.6 % RH	Vaisala HMI-41 and HMP-46

## VII. Time and Frequency

Parameter/Equipment	Range	Best Uncertainty <sup>2</sup> (±)	Comments
Frequency – Oscillator Characterization	10 MHz	5 parts in 10 <sup>11</sup>	Symmetricom 58540A
Frequency – Measure	10 MHz to 26.5 GHz	5 parts in 10 <sup>11</sup>	HP 5345A, HP 5355A, HP 5356A
Frequency – Measure <sup>3</sup>	10 MHz to 26.5 GHz	7 × 10 <sup>-8</sup>	HP 5345A, HP 5355A, HP 5356A

<sup>1</sup> This laboratory offers commercial and field calibration service, where noted.

<sup>2</sup> “Best Uncertainty” is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards of nearly ideal measuring equipment. Best uncertainties represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of  $k = 2$ . The best uncertainty of a specific calibration performed by the laboratory may be greater than the best uncertainty due to the behavior of the customer’s device and to influences from the circumstances of the specific calibration.

<sup>3</sup> Field calibration service is available for this calibration and this laboratory meets A2LA R104 – *General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the uncertainties achievable on a customer’s site can normally be expected to be larger than the Best Measurement Capabilities (BMC) that the accredited laboratory has been assigned as Best Uncertainty on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the calibration uncertainty being larger than the BMC.

<sup>4</sup> The measurands stated are measured with the HP 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. Best measurement uncertainty is based upon one-year floor specifications and is read as output plus range. Best measurement uncertainties are expressed as either a specific value that covers the full range or as a combination of the percent or portion of the reading plus a fixed floor specification.

<sup>5</sup> The measurands stated are generated with the Fluke 5720A and 5520A with SC1100 option where noted. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. Best measurement uncertainty is read as output plus one-year floor specifications where defined. Best measurement uncertainties are expressed as either a specific value that covers the full range or as a combination of the percent or portion of the reading plus a fixed floor specification.

<sup>6</sup> In the statement of best uncertainty,  $L$  is the numerical value of the nominal length of the device measured in inches;  $R$  is the numerical value of the resolution of the device..