



THE AMERICAN ASSOCIATION FOR
LABORATORY ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

ESSCO CALIBRATION LABORATORY **Chelmsford, MA**

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 18 June 2005*).

Presented this 10th day of December 2008.

A handwritten signature in black ink, appearing to read "Peter Abney", written over a horizontal line.

President
For the Accreditation Council
Certificate Number 1388.01
Valid to June 30, 2010



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

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CALIBRATION

Valid To: June 30, 2010

Certificate Number: 1388.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Electrical – DC & Low Frequency

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
DC Voltage – Generate ³	(0 to 220) mV	9 μV/V + 0.8 μV	Fluke 5700A
	(0.2 to 2.2) V	8 μV/V + 1.2 μV	
	(0 to 11) V	8 μV/V + 4 μV	
(0 to 220) V	9 μV/V + 100 μV		
(0 to 1100) V	11 μV/V + 600 μV		
Fixed Value	(1 to 50) kV	1 kV	Hipotronics R50B
	10 V	0.92 parts in 10 ⁶	Fluke 732A
DC Voltage – Measure ³	(0 to 100) mV	8.1 parts in 10 ⁶	HP 3458A/002
	100 mV to 1 V	6.9 parts in 10 ⁶	
	(1 to 10) V	6.9 parts in 10 ⁶	
	(10 to 100) V	9.2 parts in 10 ⁶	
	(100 to 1000) V	18 parts in 10 ⁶	
	1000 V to 30 kV	0.75 %	Valhalla 4600 Sensitive research ESH
(30 to 50) kV	0.6 %		

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (\pm)	Comments
DC Current – Generate ³	(0.1 to 2) pA	0.5 % + 0.02 pA	Keithley 263
	(2 to 20) pA	0.4 % + 0.02 pA	
	20 pA to 0.1 nA	0.3 % + 0.03 pA	
Clamp-On Only	0.1 nA to 220 μ A	0.016 %	Fluke 5700A
	220 μ A to 22 mA	70 parts in 10^6	
	(22 to 220) mA	80 parts in 10^6	Valhalla 2555A
	220 mA to 2.2 A	0.012 %	
	(2.2 to 100) A	0.015 % range + 0.03 % rdg	
	(2.2 to 11) A	0.05 % + 0.33 mA	
(11 to 20) A	0.1 % + 0.75 mA		
DC Current – Measure ³	(20 to 500) A	0.6 % + 0.5 A	Fluke 5520A with 5500 coil
	(0 to 100) nA	40 parts in 10^6 + 40 pA	HP 3458A/002, uncertainties stated as a portion of reading plus a portion of the range.
	100 nA to 1 μ A	30 parts in 10^6 + 0.04 nA	
1 μ A to 100 μ A	30 parts in 10^6		
100 μ A to 10 mA	30 parts in 10^6		
(10 to 100) mA	46 parts in 10^6		
100 mA to 1 A	0.012 %		
Resistance – Generate ³	(1 to 20) A	0.016 % + 20 μ A/A	HP 3458A/002 with Y5020
	(20 to 100) A	0.01 %	HP 3458A/002 with Guildline 9230-0.01
	(1 to 10) M Ω	71 parts in 10^6	ESI SR 1060 ESI SR 1050 HP 16074A
(10 to 110) M Ω	0.01 %		
100 Ω to 100 k Ω	0.03 %		
Fixed Values	0.001 Ω	0.015 %	L & N 4333 Guildline 9230/100 Guildline 9230/15 Fluke 742-1 Guildline 9334-10 Guildline 9334-100 Fluke 742-1K Fluke 742-10K Fluke 742-1M Guildline 9334-100M Guildline 9334-1G Keithley 263 Triax output only
	0.01 Ω	0.01 %	
	0.1 Ω	0.011 %	
	1 Ω	10 parts in 10^6	
	10 Ω	6 parts in 10^6	
	100 Ω	6 parts in 10^6	
	1 k Ω	8 parts in 10^6	
	10 k Ω	5 parts in 10^6	
	1 M Ω	11 parts in 10^6	
	100 M Ω	22 parts in 10^6	
	1 G Ω	0.045 %	
	10 G Ω	0.3 %	
	100 G Ω	0.5 %	

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Resistance – Measure ³	(0 to 2) mΩ	0.068 %	Valhalla 4300B ESI 242C system HP 4339A
	(2 to 20) mΩ	0.064 %	
	20 mΩ to 100 mΩ	0.054 %	
	100 mΩ to 100 MΩ	22 parts in 10 ⁶	
	100 MΩ to 1 GΩ	1 %	

Parameter/Range	Frequency	Best Uncertainty ^{2,5} (±)	Comments
AC Voltage – Generate ³	(0 to 2.2) mV	(10 to 20) Hz	Fluke 5700A/03
		(20 to 40) Hz	
		40 Hz to 20 kHz	
		(20 to 50) kHz	
	(50 to 100) kHz	0.095 % + 8 μV	
	(100 to 300) kHz	0.13 % + 15 μV	
	(300 to 500) kHz	0.18 % + 30 μV	
	500 kHz to 1 MHz	0.36 % + 30 μV	
(2.2 to 22) mV	(10 to 20) Hz	0.06 % + 6 μV	Fluke 5700A/03
		(20 to 40) Hz	
		40 Hz to 20 kHz	
		(20 to 50) kHz	
	(50 to 100) kHz	0.095 % + 8 μV	
	(100 to 300) kHz	0.13 % + 15 μV	
	(300 to 500) kHz	0.18 % + 30 μV	
	500 kHz to 1 MHz	0.36 % + 30 μV	
(22 to 220) mV	(10 to 20) Hz	0.06 % + 16 μV	Fluke 5700A/03
		(20 to 40) Hz	
		40 Hz to 20 kHz	
		(20 to 50) kHz	
	(50 to 100) kHz	0.09 % + 30 μV	
	(100 to 300) kHz	0.11 % + 30 μV	
	(300 to 500) kHz	0.18 % + 40 μV	
	500 kHz to 1 MHz	0.36 % + 100 μV	
220 mV to 2.2 V	(10 to 20) Hz	0.06 % + 100 μV	Fluke 5700A/03
		(20 to 40) Hz	
		40 Hz to 20 kHz	
		(20 to 50) kHz	
	(50 to 100) kHz	0.028 % + 80 μV	

Parameter/Range	Frequency	Best Uncertainty ^{2,5} (\pm)	Comments
AC Voltage – Generate ³ (cont)			
220 mV to 2.2 V	(100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.048 % + 150 μ V 0.12 % + 400 μ V 0.24 % + 1 mV	Fluke 5700A/03
(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	0.06 % + 1 mV 0.018 % + 300 μ V 85 μ V/V + 70 μ V 0.014 % + 200 μ V 0.028 % + 400 μ V 0.06 % + 1.7 mV 0.14 % + 5 mV 0.3 % + 9 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	0.06 % + 10 μ V 0.018 % + 3 μ V 90 μ V/V + 1 μ V 0.025 % + 4 μ V 0.06 % + 10 μ V 0.16 % + 110 μ V 0.54 % + 110 μ V 1.3 % + 220 μ V	
(220 to 1100) V	50 Hz to 1 kHz	90 μ V/V + 4 μ V	
AC Voltage – Measure ³			
(0 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	0.17 % + 1.3 μ V 0.074 % + 1.3 μ V 0.042 % + 1.3 μ V 0.082 % + 2 μ V 0.12 % + 2.5 μ V 0.23 % + 4 μ V 0.36 % + 30 μ V 0.5 % + 8.0 μ V	Fluke 5790A/03
(2.2 to 7) 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	0.085 % + 1.3 μ V 0.037 % + 1.3 μ V 0.021 % + 1.3 μ V 0.041 % + 2 μ V 0.061 % + 2.5 μ V 0.12 % + 4 μ V 0.14 % + 8 μ V 0.36 % + 8 μ V	

Parameter/Range	Frequency	Best Uncertainty ^{2,5} (\pm)	Comments
AC Voltage – Measure ³ (cont)			
(7 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	0.029 % + 1.3 μ V 0.019 % + 1.3 μ V 0.011 % + 1.3 μ V 0.021 % + 2 μ V 0.031 % + 2.5 μ V 0.082 % + 4 μ V 0.1 % + 8 μ V 0.26 % + 8 μ V	Fluke 5790A/03
(22 to 70) 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 % + 1.5 μ V 0.013 % + 1.5 μ V 69 μ V/V + 1.5 μ V 0.013 % + 2 μ V 0.026 % + 2.5 μ V 0.053 % + 4 μ V 0.068 % + 8 μ V 0.13 % + 8 μ V	
(70 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	0.021 % + 1.5 μ V 87 μ V/V + 1.5 μ V 43 μ V/V + 1.5 μ V 73 μ V/V + 2 μ V 0.016 % + 2.5 μ V 0.028 % + 4 μ V 0.04 % + 8 μ V 0.12 % + 8 μ V	
(220 to 700) 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	0.021 % + 1.5 μ V 78 μ V/V + 1.5 μ V 38 μ V/V + 1.5 μ V 56 μ V/V + 2 μ V 84 μ V/V + 2.5 μ V 0.021 % + 4 μ V 0.034 % + 8 μ V 0.12 % + 8 μ V	
700 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	0.02 % 69 parts in 10 ⁶ 29 parts in 10 ⁶ 52 parts in 10 ⁶ 76 parts in 10 ⁶ 0.02 % 0.03 % 0.12 %	

Parameter/Range	Frequency	Best Uncertainty ^{2,5} (±)	Comments
AC Voltage – Measure ³ (cont)			
(2.2 to 7) 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	0.02 % 70 parts in 10 ⁶ 29 parts in 10 ⁶ 53 parts in 10 ⁶ 88 parts in 10 ⁶ 0.022 % 0.047 % 0.15 %	Fluke 5790A/03
(7 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	0.02 % 70 parts in 10 ⁶ 31 parts in 10 ⁶ 53 parts in 10 ⁶ 85 parts in 10 ⁶ 0.022 % 0.047 % 0.15 %	
(22 to 70) 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	0.02 % 70 parts in 10 ⁶ 29 parts in 10 ⁶ 63 parts in 10 ⁶ 0.011 % 0.022 % 0.051 % 0.15 %	
(70 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	0.02 % 72 parts in 10 ⁶ 38 parts in 10 ⁶ 77 parts in 10 ⁶ 0.011 % 0.026 % 0.07 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 0.011 % 47 parts in 10 ⁶ 0.015 % 0.085 %	
(700 to 1100) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 0.011 % 44 parts in 10 ⁶ 0.015 % 0.085 %	

Parameter/Range	Frequency	Best Uncertainty ^{2,5} (±)	Comments
AC Voltage – Measure ³ (cont)			
(1 to 15) kV	(20 to 60) Hz	0.75 %	Valhalla 4600
(15 to 50) kV	(0 to 1) kHz	0.6 %	Sensitive research ESH-23BX
AC Voltage Wideband – Measure			
(0 to 2.2) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % + 1 μV 0.17 % + 1 μV 0.3 % + 1 μV 0.7 % + 2 μV	Fluke 5790/03
(2.2 to 7) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % + 1 μV 0.1 % + 1 μV 0.17 % + 1 μV 0.37 % + 1 μV	
(7 to 22) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % 0.1 % 0.17 % 0.37 %	
(22 to 70) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	
(70 to 220) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	
(220 to 700) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	
700 mV to 2.2 V	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (\pm)	Comments
Capacitance – Measure ³	1 pF to 1 μ F	0.013 %	ESI 701
Capacitance – Generate ³			
Fixed Points			
1 kHz	0.001 μ F	0.013 %	Genrad 1404, 874 connectors
	(0.002, 0.005, 0.01, 0.1, 1) μ F	0.064 %	Genrad 1409 5 way binding posts
Up to 3 MHz	(1, 10, 100, 1000) pF (0.01, 0.1, 1) μ F	90 parts in 10 ⁶ 0.017 %	HP 16380A HP 16380C
Inductance – Measure ³	50 μ H to 10 H	0.03 %	GR 1482L, ESI DT72A, ESI 861A, ESI RS925C
	0.01 nH to 10 H	0.03 % + (0.001 <i>F</i>) %	HP4284A LCR meter; <i>F</i> is the measuring frequency.
Inductance – Generate ³			Genrad 1482 inductors
Fixed Points	(50, 100, 200, 500) μ H (1, 2, 5, 10, 20, 50) mH (100, 200, 500) mH (1, 2, 5, 10) H	0.15 %	
DC Power – Generate ³			Fluke 5520A
33 mV to 1020 V	0.33 mA to 330 mA	0.023 W	
	330 mA to 3 A	0.22 W	
	(3 to 20.5) A	0.07 W	
LF AC Power – Generate ³			Fluke 5520A
	(33 to 330) mV 3.3 mA to 20.5 A	0.14 %	
	330 mV to 1020 V 3.3 mA to 20.5 A	0.12 %	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Oscilloscopes ³ –			
Square – 50 Ω @ 1 kHz source	1 mV to 130 V	0.25 % + 40 μV	Fluke 5820A Uncertainty stated as percent of output plus floor specification.
Square - 1 MΩ @ 1 kHz source	1 mV to 130 V	0.05 % + 5 μV	
Leveled Sine Amplitude	50 kHz reference	2 % + 300 μV	
	50 kHz to 100 MHz	3.5 % + 300 μV	
	(100 to 300) MHz	4 % + 300 μV	
	(300 to 500) MHz	5.5 % + 300 μV	
	(500 to 600) MHz	6 % + 300 μV	
	10 MHz reference	2 % + 300 μV	
Leveled Sine Flatness	600 MHz to 1.1 GHz	7 % + 300 μV	
	(1.1 to 1.6) GHz	7 % + 300 μV	
	(1.6 to 2.1) GHz	8 % + 300 μV	
Relative to 50 kHz	50 kHz to 100 MHz (100 to 300) MHz (300 to 500) MHz	1.5 %+ 100 μV 2 % + 100 μV 3.5 % + 100 μV	
Relative to 10 MHz	(500 to 600) MHz 600 MHz to 1.1 GHz (1.1 to 1.6) GHz (1.6 to 2.1) GHz	4 % + 100 μV 5 % + 100 μV 5 % + 100 μV 6 % + 100 μV	
Time Marker, 50 Ω	5 s to 50 ms 20 ms to 100 ns (50 to 20) ns 10 ns (5 to 2) ns 5 ns to 500 ps	2.5 μHz/Hz + 5 μHz 0.33 parts in 10 ⁶ 0.33 parts in 10 ⁶ 0.33 parts in 10 ⁶ 0.33 parts in 10 ⁶ 0.33 parts in 10 ⁶	Fluke 5820A/2.1 GHz
Rise Time	≤ 150 ps	+0 / -50 ps	Fluke 5820A
Rise Time – Measure	< 10 ps	9.2 ps	Agilent 83480/83485

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Phase ³ – (0.01 to 0.1) V _{rms} (0.1 to 120) V _{rms}	10 Hz to 10 kHz (10 to 50) kHz (50 to 100) kHz (10 to 50) kHz (50 to 100) kHz	0.24° 0.41° 0.81° 0.07° 0.41°	KH 6620 phase meter
Electrical Calibration of Thermocouple Indicating Systems – Generate ³ Type K Type J Type T Type E Type S	-200 °C to -100 °C -100 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C -210 °C to -100 °C -100 °C to 760 °C 760 °C to 1200 °C -250 °C to -150 °C -150 °C to 0 °C 0 °C to 400 °C -250 °C to -100 °C -100 °C to 650 °C 650 °C to 1000 °C 0 °C to 250 °C 250 °C to 1400 °C 1400 °C to 1767 °C	0.33 °C 0.18 °C 0.26 °C 0.4 °C 0.27 °C 0.17 °C 0.23 °C 0.63 °C 0.24 °C 0.16 °C 0.5 °C 0.16 °C 0.21 °C 0.47 °C 0.37 °C 0.46 °C	Fluke 5520A
Electrical Calibration of RTD Indicating Systems – Generate ³ Pt 385, 100 Ω	-200° C to 0 °C 0 °C to 100 °C 100 °C to 400 °C 400 °C to 630 °C 630 °C to 800 °C	0.05 °C 0.07 °C 0.1 °C 0.12 °C 0.23 °C	Fluke 5520A

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Electrical Calibration of RTD Indicating Systems ³ – Generate ³ (cont)			
Pt 3926, 100 Ω	-200 °C to 0 °C 0 °C to 100 °C 100 °C to 400 °C 400 °C to 630 °C	0.05 °C 0.07 °C 0.1 °C 0.12 °C	Fluke 5520A
Pt 3916, 100 Ω	-200 °C to -190 °C -190 °C to 0 °C 0 °C to 300 °C 300 °C to 600 °C 600 °C to 630 °C	0.25 °C 0.05 °C 0.08 °C 0.1 °C 0.23 °C	
Pt 385, 200 Ω	-200 °C to 100 °C 100 °C to 260 °C 260 °C to 600 °C 600 °C to 630 °C	0.04 °C 0.05 °C 0.14 °C 0.16 °C	
Pt 385, 500 Ω	-200 °C to 100 °C 100 °C to 260 °C 260 °C to 600 °C 600 °C to 630 °C	0.05 °C 0.06 °C 0.09 °C 0.11 °C	
Pt 385, 1000 Ω	-200 °C to 0 °C 0 °C to 260 °C 260 °C to 600 °C 600 °C to 630 °C	0.03 °C 0.05 °C 0.07 °C 0.23 °C	
Pt 385, 120 Ω	-80 °C to 100 °C 100 °C to 260 °C	0.08 °C 0.14 °C	
Cu 427, 10 Ω	-100 °C to 260 °C	0.3 °C	

II. Electrical – RF & Microwave

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
RF Power	(-20 to 30) dBm 100 kHz to 4.2 GHz	0.19 dBm + <i>M</i>	HP 437/8482A
	(-20 to 30) dBm 10 MHz to 40 GHz	0.39 dBm + <i>M</i>	HP 437/8487A <i>M</i> = Mismatch Error

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Tuned RF Level / Attenuation	2.5 MHz to 1.3 GHz (0 to -10) dBm (-10 to -40) dBm (-40 to -50) dBm (-50 to -80) dBm (-80 to -90) dBm (-90 to -110) dBm (-110 to -127) dBm	0.02 dB 0.08 dB 0.14 dB 0.20 dB 0.26 dB 0.30 dB 0.40 dB	HP 8902 with 11722A
Pulse Width Measurement	(1 to 500) ns	10 ps	Agilent 83480/83485
Harmonics	50 kHz to 26.5 GHz	0.3 dB + 0.01dB/dB + 2 dB	HP 8593E
RF Power – Generate (+24 to -56) dBm (+20 to -30) dBm	0.01 Hz to 20 MHz 10 MHz to 40 GHz	0.59 dB 0.56 dBm + <i>M</i>	HP 3325A Agilent E8257D with HP437/8487A/11667C <i>M</i> = Mismatch Error
Amplitude Modulation – Measure	150 kHz to 10 MHz (10 to 1300) MHz Rate: 50 Hz to 50 kHz	2.3 % 1.2 %	HP 8902A
Frequency Modulation – Measure	250 kHz to 10 MHz (10 to 1300) MHz Rate: 50 Hz to 100 kHz	2.3 % 1.2 %	HP 8902A
Phase Modulation – Measure	(10 to 1300) MHz Rate: 200 Hz to 20 kHz	3.5 %	HP 8902A

III. Time & Frequency

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Frequency – Measure ³	1 Hz to 320 MHz 10 Hz to 500 MHz 500 MHz to 26.5 GHz	1.5 parts in 10 ¹⁰ 3 parts in 10 ¹¹ + 1 Hz 3 parts in 10 ¹¹ + 1 Hz	HP 5360A HP 5343A HP 5343A
Frequency Measuring Equipment ³	10 MHz	3 parts in 10 ¹¹	GPS receiver
Timers and Watches ³	15 s to 24 hr	0.05 s/day	Timometer 4500

IV. Dimensional

Parameter/Equipment	Range	Best Uncertainty ^{2, 4} (±)	Comments
Gage Blocks	Up to 0.049 in (0.50 to 0.150) in (0.150 to 1.00) in	3.5 μin 2.6 μin 2.9 μin	Gage block comparator, gage blocks
Fixed Points	2.0 in 3.0 in 4.0 in 5.0 in	4.9 μin 6.3 μin 8.3 μin 12 μin	
Discs	(0.010 to 0.240) in	21 μin	
Length Standards, Rods			
Fixed Point	1 in (2 to 15) in	39 μin 100 μin	Pratt & Whitney supermicrometer
Calipers – Vernier, Dial, Digital	Up to 72 in	(20 + 25L) μin	Gage blocks, mic standards

Parameter/Equipment	Range	Best Uncertainty ^{2,4} (±)	Comments
Micrometer ³	Up to 1 in (1 to 2) in (2 to 3) in (3 to 4) in (4 to 5) in (5 to 6) in (6 to 7) in (7 to 8) in (8 to 9) in (9 to 10) in (10 to 11) in (11 to 12) in	33 μin 40 μin 49 μin 59 μin 70 μin 83 μin 94 μin 0.00011 in 0.00012 in 0.00013 in 0.00014 in 0.00015 in	Gage blocks, mic standards
Bore Micrometers, Bore Gages	Up to 8 in	15 μin/in + 50 μin	Master ring gages
Dial/Test Indicator ³	Up to 0.1 in (0.1 to 1) in (1 to 12) in	14 μin 38 μin (40 + 22L) μin	Gage blocks, micrometer head
Pin Gages	(0.011 to 1) in	60 μin	Supermicrometer
Cylindrical Plugs Fixed Points	Up to 1 in 1 in 2 in 3 in 4 in 5 in 6 in 7 in 8 in 9 in 10 in 11 in 12 in 13 in	5.2 μin 8.0 μin 13 μin 18 μin 24 μin 29 μin 34 μin 40 μin 45 μin 50 μin 55 μin 60 μin 65 μin 72 μin	Pratt & Whitney labmaster

Parameter/Equipment	Range	Best Uncertainty ^{2,4} (±)	Comments
Thread Plugs – Pitch Diameter	(6 to 80) TPI To 5 in diameter (0.25 to 10 mm) pitch To 127 mm diameter	84 µin 1.3 µm	Pratt & Whitney supermicrometer, thread wires
Depth Gages Indicators ³	Up to 8 in	(12 + 12L) µin	Gage blocks
Height Gages	Up to 40 in	(20 + 15L) µin	Gage blocks
Plain Ring Gages	(0.020 to 0.040) in (0.40 to 0.125) in (0.125 to 0.250) in (0.250 to 1.000) in (1.000 to 4.000) in (4.00 to 11.00) in	5.9 µin 4.8 µin 4.7 µin 4.9 µin 7.6 µin (2L + 4) µin	P&W labmaster, master rings
Durometers Indicator Length, Fixed Points	0.050 in 0.100 in 0.200 in	0.00013 in 0.00024 in 0.00047 in	Gage blocks
Spring Force, Fixed Points	113 gf 821 gf 4533 gf	0.87 gf 5.1 gf 17 gf	Electronic balance
Thread Wires	(4 to 120) TPI	6 µin	P&W labmaster, gage blocks

V. Mechanical

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Torque Indicators/Calibrators	1 in·oz to 100 ft·lb (2 to 240) in·lb (240 to 1000) ft·lb	0.14 % rdg 0.14 % rdg 0.14 % rdg	Wheels, arms and weights

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Torque Wrenches and Drivers ³	(1 to 215) in·oz	0.25 % rdg	Waters 6500T4 watch calibrator
	(1 to 10) in·lb	0.25 % rdg	Mountz torque calibrators
	(10 to 100) in·lb	0.25 % rdg	
	(1 to 500) in·lb	0.25 % rdg	
	(1 to 50) ft·lb	0.25 % rdg	
	(5 to 500) ft·lb	0.25 % rdg	
	(200 to 1000) ft·lb	0.25 % rdg	
High Vacuum/Absolute Pressure ³	(2 to 20) mTorr Up to 10 Torr Up to 760 Torr	10 % 0.15 % + 0.001 Torr 0.4 Torr	Hastings VT-5AB Edwards 1575/600AB Heise PTE-1/HQS-2
Gauge and Differential Pressure ³	(-2 to +2) inH ₂ O	0.0004 inH ₂ O	Dwyer 1430 microtector manometer
	(0 to +5) inH ₂ O	0.0035 inH ₂ O	Heise HQS1/ ± 5 inH ₂ O
	(-25 to +25) inH ₂ O	0.030 inH ₂ O	Heise HQS1/ ± 25 inH ₂ O transducermodule
	(-30 to 1) inHg (5 to 400) inH ₂ O (3 to 500) psi	0.01 % 0.01 % 0.01 %	Pressurements T3500 pneumatic deadweight tester
	(500 to 10 000) psi	0.015 %	Pressurements W2200 dead weight tester
	(0 to 30 000) psi	21 psi	Heise 901A/30000psig digital pressure meter
Mass	1 mg to 10 g (10 to 100) g (100 to 210) g (210 to 300) g (300 to 5000) g (5 to 30) kg	0.15 mg 0.18 mg 0.21 mg 0.39 mg 27 mg 350 mg	Mass substitution using digital balances and class 1 reference masses

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Scales and Balances ³	(1 to 20) mg	1.3 µg	Class 1 weights
	(50 to 200) mg	1.4 µg	
	500 mg	1.7 µg	
	1 g	2.2 µg	
	2 g	2.5 µg	
	5 g	4.3 µg	
	10 g	6.9 µg	
	20 g	8.9 µg	
	50 g	25 µg	
	100 g	48 µg	
	200 g	0.11 mg	
	300 g	0.16 mg	
	500 g to 2 kg	12 mg	
	5 kg	17 mg	
	(10 to 30) kg	0.12 g	
50 kg	0.23 g	Class F weights	
100 kg	0.55 g		
200 kg	1.1 g		
	250 kg	1.2 g	
Force	(0.5 to 500) lbf	0.093 % rdg	Class F weights

VI. Thermodynamic

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Temperature – Measuring Equipment	-45 °C to 140 °C	0.14 °C	Hart 9170 dry well Hart 9122 dry well Hart 9101 dry well ISOCAL Europa-6
	50 °C to 600 °C	0.18 °C	
	0 °C	0.058 °C	
	35 °C to 199.9 °C	0.62 °C	Hart 9125 surface source, with external monitor probes
Infrared – Measuring Equipment	50 °C to 100 °C	0.59 °C	Hart 9132 infrared source
	100 °C to 300 °C	0.76 °C	
	300 °C to 500 °C	0.93 °C	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Temperature – Measure	-70 °C to 0 °C 0 °C to 200 °C 200 °C to 400 °C 400 °C to 660 °C	0.022 °C 0.026 °C 0.052 °C 0.074 °C	Hart 1502A thermometer with PRT
Relative Humidity – Measure	(0 to 90 %) RH (90 to 100 %) RH	1.3 % RH 2.3 % RH	Humidity probe/indicator

VII. Fluid Quantities

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Gas Flow	0.5 SCCM to 100 SLPM	0.58 %	DHI Molbloc System

¹ This laboratory offers commercial calibration service and field calibration service, where noted.

² “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, to the environment (if the calibration is performed in the field) and to influences from the circumstances of the specific calibration.

³ 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.

⁴ In the statement of best uncertainty, L is the numerical value of the nominal length of the device measured in inches.

⁵ In the statement of best uncertainty, the value is defined as the percentage of reading.