



THE AMERICAN ASSOCIATION FOR
LABORATORY ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

ACR ENVIRONMENTAL SERVICES

Newport News, VA

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 20th day of March 2009.

A handwritten signature in cursive script, reading "Peter Abney", positioned above a horizontal line.

President
For the Accreditation Council
Certificate Number 2171.01
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 17025:2005
& ANSI/NCSL Z540-1-1994

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CALIBRATION

Valid To: June 30, 2010

Certificate Number: 2171.01

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

I. Acoustics & Vibration

Parameter/Range	Frequency	Best Uncertainty ^{2,7} (±)	Comments
Vibration – Measuring Equipment ³ (0.02 to 5000) pC/g (1 to 10 000) mV/g	5 Hz to 2 kHz	1.5 %	B&K 9610 w/ 4808
	(2 to 4) kHz	1.7 %	
	(4 to 7) kHz	1.8 %	
	(7 to 10) kHz	2.1 %	B&K 9610 w/ 4809
	(10 to 15) kHz	2.4 %	
	(15 to 20) kHz	3.1 %	
	100 Hz, 160 Hz	1.3 %	

II. Dimensional

Parameter/Equipment	Range	Best Uncertainty ^{2,6} (±)	Comments
Dial Indicators ³	(0 to 1) in	0.6R + 60 μin	Universal calibrator

Parameter/Equipment	Range	Best Uncertainty ^{2,6} (\pm)	Comments
Micrometers and Calipers ³	(0.05 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 (12 to 13) in (13 to 14) in (14 to 15) in (15 to 16) in (16 to 17) in (17 to 18) in (18 to 19) in (19 to 20) in	0.6R + 7.8 μ in 0.6R + 12 μ in 0.6R + 13 μ in 0.6R + 14 μ in 0.6R + 15 μ in 0.6R + 14 μ in 0.6R + 7.8 μ in 0.6R + 30 μ in 0.6R + 32 μ in 0.6R + 44 μ in 0.6R + 45 μ in 0.6R + 30 μ in 0.6R + 30 μ in 0.6R + 39 μ in 0.6R + 40 μ in 0.6R + 52 μ in 0.6R + 53 μ in 0.6R + 61 μ in 0.6R + 62 μ in 0.6R + 46 μ in	Gage blocks
Anvil and Spindle Flatness on Micrometers and Calipers ³	2 in diameter Convex Concave	14 μ in 14 μ in	Optical flat and monochromatic light

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	Best Uncertainty ^{2,4} (\pm)	Comments
DC Voltage – Generate ³	(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 (1 to 10) kV	8.8 μ V/V + 0.4 μ V 6 μ V/V + 0.7 μ V 4.4 μ V/V + 2.5 μ V 4.4 μ V/V + 4 μ V 6 μ V/V + 40 μ V 7.7 μ V/V + 400 μ V 0.2 % of output	Fluke 5700A/EP HP 3458A, opt 002 Fluke 80E Glassman EH

Parameter/Equipment	Range	Best Uncertainty ^{2,4,5,7} (\pm)	Comments
DC Voltage – Generate, Fixed Points ³	0.1 V 1 V 10 V 100 V 1000 V	1.9 μ V/V 1.4 μ V/V 1 μ V/V 1.2 μ V/V 1.5 μ V/V	Fluke 732A Fluke 752A
DC Voltage – Measure ³	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (0.1 to 1) kV* (1 to 10) kV	14 μ V/V + 0.3 μ V 5 μ V/V + 0.3 μ V 5 μ V/V + 0.5 μ V 7.3 μ V/V + 30 μ V 14 μ V/V + 100 μ V 0.2 %	HP 3458A, opt 002 *add 12 (V _{in} /1000) ² ppm with Fluke 80E
DC Current – Generate ³ Clamp-On Meters Only	(0 to 220) μ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 3) A (3 to 11) A (11 to 21) A (0 to 1000) A	47 μ A/A + 6 nA 42 μ A/A + 7 nA 42 μ A/A + 40 nA 53 μ A/A + 0.7 μ A 93 μ A/A + 12 μ A 0.044 % + 6 μ A 0.058 % + 0.5 mA 0.12 % + 0.75 mA 0.13 % + 0.75 A	Fluke 5700A/EP Fluke 5520A Fluke 5520A with Fluke 5500A, 50-turn coil
DC Current – Measure ³	100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (1 to 300) A	37 μ A/A + 40 pA 23 μ A/A + 40 pA 23 μ A/A + 100 pA 23 μ A/A + 800 pA 23 μ A/A + 5 nA 23 μ A/A + 50 nA 40 μ A/A + 500 nA 0.012 % + 10 μ A	HP 3458A, opt 002 HP 3458A, opt 002 with Guildline 9211A or ESI SR1060

Parameter/Equipment	Range	Best Uncertainty ^{2,4,7} (\pm)	Comments
Resistance – Generate ³			
Fixed Values			
1 Ω steps	Up to 10 Ω	6.8 $\mu\Omega/\Omega$	ESI 242D ESI SR-104U ESI SR-1060
10 Ω steps	Up to 100 Ω	6 $\mu\Omega/\Omega$	
100 Ω steps	Up to 1000 Ω	5.6 $\mu\Omega/\Omega$	
1 k Ω steps	Up to 10 k Ω	2.1 $\mu\Omega/\Omega$	
10 k Ω steps	Up to 100 k Ω	2.4 $\mu\Omega/\Omega$	
100 k Ω steps	Up to 1 M Ω	4 $\mu\Omega/\Omega$	
1 M Ω steps	Up to 10 M Ω	7.3 $\mu\Omega/\Omega$	ESI SR-1050
10 M Ω steps	Up to 100 M Ω	7.9 $\mu\Omega/\Omega$	
Resistance – Measure ³			
	Up to 10 Ω	19 $\mu\Omega/\Omega$ + 50 $\mu\Omega$	HP 3458A, opt 002
	Up to 100 Ω	15 $\mu\Omega/\Omega$ + 500 $\mu\Omega$	
	Up to 1000 Ω	13 $\mu\Omega/\Omega$ + 500 $\mu\Omega$	
	Up to 10 k Ω	12 $\mu\Omega/\Omega$ + 5 m Ω	
	Up to 100 k Ω	12 $\mu\Omega/\Omega$ + 50 m Ω	
	Up to 1 M Ω	18 $\mu\Omega/\Omega$ + 2 Ω	
	Up to 10 M Ω	58 $\mu\Omega/\Omega$ + 100 Ω	
	Up to 100 M Ω	0.057 % + 1 k Ω	
	Up to 1 G Ω	0.57 % + 10 k Ω	

Parameter/Range	Frequency	Best Uncertainty ^{2,4,7} (\pm)	Comments
AC Voltage – Generate ³			
(0.22 to 2.2) mV	(10 to 20) Hz	0.024 % + 4 μ V	Fluke 5700A/EP
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	0.02 % + 4 μ V	
	(50 to 100) kHz	0.05 % + 4 μ V	
	(100 to 300) kHz	0.11 % + 10 μ V	
	(300 to 500) kHz	0.14 % + 10 μ V	
	500 kHz to 1 MHz	0.27 % + 20 μ V	
(2.2 to 22) mV	(10 to 20) Hz	0.024 % + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	0.02 % + 4 μ V	
	(50 to 100) kHz	0.05 % + 4 μ V	
	(100 to 300) kHz	0.11 % + 10 μ V	
	(300 to 500) kHz	0.14 % + 10 μ V	
	500 kHz to 1 MHz	0.27 % + 20 μ V	

Parameter/Range	Frequency	Best Uncertainty ^{2, 4, 7} (\pm)	Comments
AC Voltage – Generate (cont) ³			
(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 μ V 90 μ V/V + 7 μ V 80 μ V/V + 7 μ V 0.02 % + 7 μ V 0.05 % + 17 μ V 0.11 % + 20 μ V 0.14 % + 25 μ V 0.27 % + 45 μ V	Fluke 5700A/EP
(0.22 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 μ V 90 μ V/V + 15 μ V 50 μ V/V + 8 μ V 80 μ V/V + 10 μ V 0.011 % + 30 μ V 0.042 % + 80 μ V 0.10 % + 200 μ V 0.17 % + 300 μ V	
(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 % + 0.4 mV 90 μ V/V + 0.15 mV 50 μ V/V + 0.05 mV 80 μ V/V + 0.1 mV 0.010 % + 0.2 mV 0.028 % + 0.6 mV 0.10 % + 2 mV 0.15 % + 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 % + 4 mV 90 μ V/V + 1.5 mV 50 μ V/V + 0.6 mV 80 μ V/V + 1 mV 0.015 % + 2.5 mV 0.090 % + 16 mV 0.44 % + 40 mV 0.80 % + 80 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.3 % + 16 mV 0.07 % + 3.5 mV	

Parameter/Range	Frequency	Best Uncertainty ^{2,4,7} (±)	Comments
AC Voltage – Measure ³			
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	0.17 % 0.074 % 0.042 % 0.081 % 0.12 % 0.23 % 0.24 % 0.35 %	Fluke 5790A
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % 0.17 % 0.3 % 0.7 %	Uncertainty of wideband is for flatness relative to 1 kHz.
(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	0.85 % 0.037 % 0.021 % 0.04 % 0.06 % 0.12 % 0.13 % 0.23 %	
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % 0.1 % 0.17 % 0.37 %	
(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 % 0.019 % 0.011 % 0.021 % 0.031 % 0.081 % 0.089 % 0.17 %	
Wideband	(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	(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 % 0.012 % 0.007 % 0.013 % 0.026 % 0.051 % 0.067 % 0.11 %	

Parameter/Range	Frequency	Best Uncertainty ^{2, 4, 7} (\pm)	Comments
AC Voltage – Measure (cont) ³			
(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 % 0.009 % 0.004 % 0.007 % 0.016 % 0.025 % 0.038 % 0.1 %	Fluke 5790A Uncertainty of wideband is for flatness relative to 1 kHz.
Wideband	(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	(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 μ V/V 20 μ V/V 50 μ V/V 70 μ V/V 0.016 % 0.026 % 0.09 %	
Wideband	(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	(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 % 80 μ V/V 30 μ V/V 50 μ V/V 80 μ V/V 0.018 % 0.03 % 0.10 %	
Wideband	(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/Range	Frequency	Best Uncertainty ^{2, 4, 7} (\pm)	Comments
AC Voltage – Measure (cont) ³			
(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	0.020 % 70 μ V/V 20 μ V/V 50 μ V/V 70 μ V/V 0.016 % 0.026 % 0.09 %	Fluke 5790A Uncertainty of wideband is for flatness relative to 1 kHz.
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	
(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 (0.5 to 1) MHz	0.020 % 70 μ V/V 20 μ V/V 50 μ V/V 80 μ V/V 0.019 % 0.040 % 0.12 %	
(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 (0.5 to 1) MHz	0.020 % 70 μ V/V 30 μ V/V 50 μ V/V 90 μ V/V 0.020 % 0.041 % 0.12 %	
(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	0.020 % 70 μ V/V 30 μ V/V 70 μ V/V 0.010 % 0.021 % 0.050 %	
(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	0.020 % 0.010 % 40 μ V/V 0.013 % 0.050 %	

Parameter/Range	Frequency	Best Uncertainty ^{2, 4, 5, 7} (\pm)	Comments
AC Voltage – Measure (cont) ³			
(700 to 1000) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.020 % 0.010 % 0.004 % 0.013 % 0.050 %	Fluke 5790A
AC Voltage – Measure ³			
(0 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 (0.3 to 1) MHz (1 to 4) MHz (4 to 8) MHz	0.03 % + 3 μ V 0.02 % + 1.1 μ V 0.03 % + 1.1 μ V 0.1 % + 1.1 μ V 0.5 % + 1.1 μ V 4 % + 2 μ V 1.2 % + 5 μ V 7 % + 7 μ V 20 % + 8 μ V	HP 3458A, opt 002
(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 (0.3 to 1) MHz (1 to 2) MHz (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz	70 μ V/V + 4 μ V 70 μ V/V + 2 μ V 0.014 % + 2 μ V 0.03 % + 2 μ V 0.08 % + 2 μ V 0.3 % + 10 μ V 1 % + 10 μ V 1.5 % + 10 μ V 4 % + 70 μ V 4 % + 80 μ V 15 % + 100 μ V	
(0.1 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 (0.3 to 1) MHz (1 to 2) MHz (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz	70 μ V/V + 0.4 mV 70 μ V/V + 0.2 mV 0.014 % + 0.2 mV 0.03 % + 0.2 mV 0.08 % + 0.2 mV 0.3 % + 1 mV 1 % + 1 mV 1.5 % + 1 mV 4 % + 7 mV 4 % + 8 mV 15 % + 10 mV	
(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 (0.3 to 1) MHz	0.02 % + 4 mV 0.02 % + 2 mV 0.035 % + 2 mV 0.12 % + 2 mV 0.4 % + 10 mV 1.5 % + 10 mV	

Parameter/Range	Frequency	Best Uncertainty ^{2, 4, 5, 7} (\pm)	Comments
AC Voltage – Measure ³ (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	0.04 % + 40 mV 0.04 % + 20 mV 0.06 % + 20 mV 0.12 % + 20 mV 0.3 % + 20 mV	HP 3458A, opt 002
AC Voltage Ratio – Measure ³ 0.1 to 1.1 0.0 to 0.1	50 Hz to 1 kHz 50 Hz to 1 kHz	1.7 parts in 10^6 1.7 (10 \times setting) ^{1/2} + 0.01 parts in 10^6 of setting	DT72A with Fluke 5520A
AC Current – Generate ³ (29 to 330) μ A (0.33 to 3.3) mA (3.3 to 33) mA (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 (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 (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 (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	0.2 % + 0.1 μ A 0.15 % + 0.1 μ A 0.13 % + 0.1 μ A 0.3 % + 0.15 μ A 0.8 % + 0.2 μ A 1.6 % + 0.4 μ A 0.2 % + 0.15 μ A 0.13 % + 0.15 μ A 0.1 % + 0.15 μ A 0.2 % + 0.2 μ A 0.5 % + 0.3 μ A 1 % + 0.6 μ A 0.18 % + 2 μ A 0.09 % + 2 μ A 0.04 % + 2 μ A 0.08 % + 2 μ A 0.2 % + 3 μ A 0.4 % + 4 μ A 0.18 % + 20 μ A 0.09 % + 20 μ A 0.04 % + 20 μ A 0.1 % + 50 μ A 0.2 % + 100 μ A 0.4 % + 200 μ A	Fluke 5520A

Parameter/Range	Frequency	Best Uncertainty ^{2,4,5,7} (±)	Comments
AC Current – Generate ³ (cont)			Fluke 5520A
(0.33 to 1.1) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.18 % + 0.1 mA 0.05 % + 0.1 mA 0.06 % + 1 mA 2.5 % + 5 mA	
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.18 % + 0.1 mA 0.06 % + 0.1 mA 0.6 % + 1 mA 2.5 % + 5 mA	
(3 to 11) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.06 % + 2 mA 0.1 % + 2 mA 3 % + 2 mA	
(11 to 20.5) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.12 % + 5 mA 0.15 % + 5 mA 3 % + 5 mA	
AC Current – Measure ³			HP 3458A opt02
(0 to 100) μA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	0.40 % + 30 nA 0.15 % + 30 nA 0.06 % + 30 nA	
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.40 % + 0.2 μA 0.15 % + 0.2 μA 0.06 % + 0.2 μA 0.03 % + 0.2 μA	
(1 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.40 % + 20 μA 0.15 % + 20 μA 0.06 % + 20 μA 0.03 % + 20 μA 0.06 % + 20 μA 0.40 % + 40 μA 0.60 % + 150 μA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 20) kHz (20 to 50) kHz	0.40 % + 0.2 mA 0.16 % + 0.2 mA 0.08 % + 0.2 mA 0.10 % + 0.2 mA 0.30 % + 0.2 mA 1 % + 0.4 mA	

Parameter/Range	Frequency	Best Uncertainty ^{2,5,7} (\pm)	Comments
AC Current – Measure ³ (cont)			
20 mA	5 Hz to 100 kHz	0.04 mA	Fluke 5790A with A40
50 mA	5 Hz to 100 kHz	0.01 mA	
(1 to 2) A	5 Hz to 100 kHz	0.4 mA	
(2 to 10) A	5 Hz to 100 kHz	2 mA	
(10 to 20) A	DC to 1 kHz (1 to 5) kHz	0.025 % 0.034 %	Fluke Y5020
Inductance – Measure ³			
0.01 μ H to 99 999 H	12 Hz to 200 kHz	0.032 %	GenRad 1693 Digibridge
Capacitance – Measure ³			
0.00001 pF to 99 999 μ F	12 Hz to 200 kHz	0.023 %	GenRad 1693 Digibridge
Capacitance – Generate ³			
(0.19 to 3.3) nF	10 Hz to 10 kHz	0.58 % + 0.01 nF	Fluke 5520A
(3.3 to 11) nF		0.29 % + 0.01 nF	
(11 to 110) nF		0.29 % + 0.1 nF	
(110 to 330) nF		0.29 % + 0.3 nF	
(0.33 to 1.1) μ F		0.29 % + 1 nF	
(1.1 to 3.3) μ F		0.29 % + 3 nF	
(3.3 to 11) μ F		0.29 % + 10 nF	
(11 to 33) μ F		0.46 % + 30 nF	
(33 to 110) μ F		0.52 % + 100 nF	
(110 to 330) μ F		0.52 % + 300 nF	
(0.33 to 1.1) mF		0.52 % + 1 μ F	
(1.1 to 3.3) mF		0.52 % + 3 μ F	
(3.3 to 11) mF		0.52 % + 10 μ F	
(11 to 33) mF		0.87 % + 30 μ F	
(33 to 110) mF	1.3 % + 100 μ F		
1000 pF	1 kHz	0.020 pF of value	GenRad 1404-A

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
Phase – Generate ³ 0° to 90°	1 Hz to 1 kHz (1 to 6.3) kHz (6.3 to 50) kHz (50 to 100) kHz	5.3 m° 10 m° 17 m° 46 m°	Clarke-Hess 5000
Phase – Measure ³ (10 to 32) mV rms 32 mV to 100V rms (100 to 320) V rms	1Hz to 10kHz (10 to 50) kHz 50 kHz to 10 MHz (1 to 10) Hz 10 Hz to 50 kHz 50 kHz to 10 MHz (1 to 10) Hz 10Hz to 5kHz	0.23° 0.40° 0.70° 0.10° 0.05° 0.40° 0.23° 0.11°	Krohn-Hite 6620 phase meter
Distortion – Measure ³ 0.3 to 100 %, < 30 V (30 to 300) V 0.1 % < 30 V > 30 V 0.001 % to 100 % 50 mV to 300 V	10 Hz to 1 MHz (1 to 3) MHz 10 Hz to 300 kHz (300 to 500) kHz (0.5 to 3) MHz (10 to 20) Hz (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz (10 to 20) Hz (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz 20 Hz to 20 kHz (20 to 100) kHz	3 % of full scale 7.1 % of full scale 3 % of full scale 7.1 % of full scale 13 % of full scale 13 % of full scale 7.1 % of full scale 3 % of full scale 7.1 % of full scale 13 % of full scale 13 % of full scale 7.1 % of full scale 3 % of full scale 7.1 % of full scale 13 % of full scale 1.2 dB 2.3 dB	HP 334A Agilent 8903B

Parameter/Range	Frequency	Best Uncertainty ^{2, 4, 7} (\pm)	Comments
Sine-Wave Flatness – Measure ³	50 kHz to 100 MHz	1 %	EL1200 thermal converter and Fluke 5700A/EP
Oscilloscopes ³ –			
Square Wave Signal			
10 Hz to 10 kHz			
50 Ω Impedance	1 mV to 6.6 V _{pk-pk}	0.25 % + 40 μ V	Fluke 5520A with SC600
1 M Ω Impedance	1 mV to 130 V _{pk-pk}	0.10 % + 40 μ V	
Level Sine Wave	5 mV to 5.5 V	2 % + 300 μ V	
Amplitude (Reference, 50 kHz)	50 kHz to 100 MHz	3.5 % + 300 μ V	
	(100 to 300) MHz	4 % + 300 μ V	
	(300 to 600) MHz	6 % + 300 μ V	
Flatness (Reference, 50 kHz)	50 kHz to 100 MHz	1.5 % + 100 μ V	
	(100 to 300) MHz	2 % + 100 μ V	
	(300 to 600) MHz	4 % + 100 μ V	
Time Markers (5-2-1 sequence) into a 50 Ω load	5 s to 50 ms	25 μ s/s	
	20 ms to 100 ns	2.5 μ s/s	
	50 ns to 20 ns	2.5 μ s/s	
	10 ns	2.5 μ s/s	
	5 ns to 2 ns	2.5 μ s/s	
Rise Time	\leq 300 ps	+ 0 ps / - 100 ps	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Electrical Calibration of Thermocouple Indicating Systems ³ –			
Type B	(0 to 800) °C (800 to 1820) °C	0.16 °C 0.17 °C	Fluke 5700A/EP and Omega TRC III Icepoint reference
Type C	(0 to 2320) °C	0.20 °C	
Type N	(-270 to 0) °C (0 to 1300) °C	0.18 °C 0.28 °C	
Type E	(-270 to 0) °C (0 to 1300) °C	0.17 °C 0.20 °C	
Type R	(-50 to 0) °C (0 to 1767) °C	0.17 °C 0.16 °C	
Type S	(-50 to 0) °C (0 to 1767) °C	0.17 °C 0.16 °C	
Type J	(-210 to 0) °C (0 to 1200) °C	0.28 °C 0.18 °C	
Type K	(-210 to 0) °C (0 to 1200) °C	0.28 °C 0.18 °C	
Type T	(-270 to 0) °C (0 to 400) °C	0.23 °C 0.18 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.28 °C 0.20 °C	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Electrical Calibration of RTDs ³ –			
Pt 385, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.05 °C 0.08 °C 0.09 °C 0.10 °C 0.12 °C 0.24 °C	Fluke 5520A
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.05 °C 0.08 °C 0.09 °C 0.10 °C 0.12 °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	0.26 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.10 °C 0.11 °C 0.24 °C	
Pt 385, 200 Ω	(-200 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.05 °C 0.13 °C 0.14 °C 0.15 °C 0.16 °C	
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.05 °C 0.07 °C 0.08 °C 0.09 °C 0.12 °C	
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 0.06 °C 0.07 °C 0.08 °C 0.24 °C	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Electrical Calibration of RTDs ³ – (cont)			
PtNi 385, 120 Ω	(-80 to 100) °C (100 to 260) °C	0.08 °C 0.15 °C	Fluke 5520A
Cu 427, 10 Ω	(-100 to 260) °C	0.34 °C	

IV. Electrical – RF/Microwave

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
RF Power – Generate			
Sinewave (50Ω) 1 mV to 3 Vp-p (-56.02 to 13.52) dB	0.001 Hz to 100 kHz 100 kHz to 20 MHz	0.11 dB of output 0.46 dB of output	HP 3325A Opt 001,002
(3 to 10) Vp-p (13.52 to 23.98) dB	0.001 Hz to 100 kHz 100 kHz to 20 MHz	0.23 dB of output 0.58 dB of output	
10 MHz to 2 GHz	(25 to 10) dB (10 to -10) dB (-10 to -60) dB (-60 to -110) dB	1.2 dB of output 0.6 dB of output 0.9 dB of output 1.4 dB of output	HP 83630A Opt 001,008, H53
(2 to 18) GHz	(25 to 10) dB (10 to -10) dB (-10 to -60) dB (-60 to -110) dB	1.3 dB of output 0.7 dB of output 1.0 dB of output 1.5 dB of output	

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
RF Power – Measure			
(1 μW to 100 mW) (-30 to +20) dB	(100 to 300) kHz 300 kHz to 1 MHz 1 MHz to 2 GHz (2 to 4.2) GHz	0.050 dB 0.049 dB 0.051 dB 0.050 dB	HP 436A with 8482A
(1 μW to 100 mW) (-30 to +20) dB	10 MHz to 3 GHz (3 to 10) GHz (10 to 15) GHz (15 to 18) GHz	0.045 dB 0.049 dB 0.054 dB 0.058 dB	HP 436A with 8481A
Tuned RF Power – Measure			
(0 to -20) dB	100 kHz to 18 GHz	0.03 dB	HP 8902A HP 11722A HP 11792A HP 11793A
(-10 to -20) dB		0.06 dB	
(-20 to -30) dB		0.08 dB	
(-30 to -40) dB		0.11 dB	
(-40 to -50) dB		0.14 dB	
(-50 to -60) dB		0.16 dB	
(-60 to -70) dB		0.20 dB	
(-70 to -80) dB		0.22 dB	
(-80 to -90) dB		0.24 dB	
(-90 to -100) dB		0.26 dB	
(-100 to -110) dB		0.32 dB	
(-110 to -120) dB		0.37 dB	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Reflection S_{11}/S_{22} – Measure 50 MHz to 18 GHz (3.5 mm)	(0.56 to 1) lin (0.32 to 0.56) lin (0.1 to 0.32) lin (0.032 to 0.1) lin (0 to 0.032) lin	(±0.005 to ±0.063) lin (±0.8 to ±1.7) deg (±0.004 to ±0.035) lin (±1.7 to ±2.1) deg (±0.004 to ±0.024) lin (±2.1 to ±5.1) deg (±0.004 to ±0.008) lin (±5.1 to ±8.2) deg (±0.004 to ±0.008) lin (±8.2 to ±180) deg	HP8720C w/ 85052D
Transmission S_{12}/S_{21} – Measure 50 MHz to 18 GHz (3.5 mm)	(0 to 12) dB (12 to 20) dB (20 to 30) dB (30 to 40) dB (40 to 50) dB (50 to 60) dB (60 to 70) dB (70 to 80) dB	(±0.056 to ±0.17) dB (±0.52 to ±1.76) deg (±0.079 to ±0.18) dB (±0.52 to ±1.77) deg (±0.081 to ±0.26) dB (±0.53 to ±1.77) deg (±0.089 to ±0.26) dB (±0.59 to ±1.78) deg (±0.092 to ±0.27) dB (±0.61 to ±2.55) deg (±0.095 to ±1.1) dB (±0.63 to ±7.76) deg (±0.121 to ±3.0) dB (±0.79 to ±24.8) deg (±0.248 to ±7.28) dB (±1.66 to ±180) deg	HP8720C w/ 85052D

Parameter/Equipment	Frequency	Best Uncertainty ² (±)	Comments
Amplitude Modulation - Generate Rate: 50 Hz to 100 kHz Depths: 5 % to 99 % Rate: DC to 100 kHz Depths: 5 % to 99 %	(11 to 13.5) MHz 10 MHz to 18 GHz	0.12 % of output 5 % of output	Agilent 11715A Agilent 83630A
Amplitude Modulation – Measure Rate: 150 kHz to 10 MHz Depths: 5 % to 99 % Rate: 150 kHz to 10 MHz Depths: To 99 % Rate: (10 to 1300) MHz Depths: 5 % to 99 % Rate: (10 to 1300) MHz Depths: To 99 % Rate: (1.3 to 18) GHz Depths: 5 % to 99 % Rate: (1.3 to 18) GHz Depths: To 99 %	50 Hz to 10 kHz 20 Hz to 10 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz	2 % + 1 digit 3 % + 1 digit 1 % + 1 digit 3 % + 1 digit 1 % + 1 digit 3 % + 1 digit	HP 8902A w/ 11793A
Frequency Modulation – Measure Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz	(0.25 to 10) MHz 10 MHz to 18 GHz 10 MHz to 18 GHz	2 % + 1 digit 1 % + 1 digit 5 % + 1 digit	HP 8902A w/ 11793A

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Frequency Modulation – Generate Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	(11 to 13.5) MHz (88 to 108) MHz (352 to 432) MHz	0.3 % of output	Agilent 11715A
Rate: 100 kHz to 8 MHz Dev: < 500 kHz peak	(2 to 18) GHz	10 % of output	Agilent 83630A

V. Mechanical

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Pressure and Vacuum Gauges ³ – Pneumatic	(0 to 24) in-H ₂ O (0.2 to 25) psia (0.2 to 25) psig (25 to 1000) psig (1000 to 12 140) psig	0.001 in-H ₂ O 12 x 10 ⁻⁶ psi/psi 16 x 10 ⁻⁶ psi/psi 22 x 10 ⁻⁶ psi/psi 29 x 10 ⁻⁶ psi/psi	Hook 1425-24 Ruska 2465 Ruska 120X
Hydraulic	(6 to 2428) psig (30 to 12 140) psig	21 x 10 ⁻⁶ psi/psi 29 x 10 ⁻⁶ psi/psi	Ruska 120X
Air/Nitrogen Flow ³	(0.01 to 1000) LPM (0.0004 to 35) CFM	0.5 %	CME FCS-8A

Parameter/Equipment	Range	Best Uncertainty ^{2,7} (±)	Comments
Torque ³ – Click, Adjustable, Dial, Beam, Screwdriver Wrenches	(10 to 20) in•lb (20 to 100) in•lb (5 to 50) ft•lb (25 to 250) ft•lb (100 to 1000) ft•lb	1.2 % 0.6 % 0.6 % of full scale 0.6 % of full scale 0.6 % of full scale	Mountz TL-100i Mountz BMX50F Mountz BMX250F Mountz BMX1000F
Torque Transducers ³	5 in•oz to 10 in•lb 10 in•lb to 5 ft•lb (5 to 250) ft•lb (250 to 1000) ft•lb	0.14 % of full scale 0.14 % of full scale 0.14 % of full scale 0.14 % of full scale	Torque arms and weights
Scales and Balances ³ Fixed Values	(1 to 500) mg (1 to 2) g 5 g 10 g (20, 30) g 50 g 100 g 200 g 300 g 500 g 1 kg 0.5 lb 1 lb 2 lb 5 lb 10 lb 20 lb 50 lb	0.01 mg 0.034 mg 0.18 mg 0.25 mg 0.35 mg 0.25 mg 0.50 mg 0.50 mg 0.75 mg 1.2 mg 2.5 mg 45 mg (100 µlb) 70 mg (160 µlb) 91 mg (210 µlb) 230 mg (510 µlb) 450 mg (1000 µlb) 910 mg (2100 µlb) 2300 mg (5100 µlb)	Class 1, 2, 3, and F weights

Parameter/Equipment	Range	Best Uncertainty ^{2,7} (\pm)	Comments
Velocity – Measure ³	(0 to 300) fpm (0 to 1250) fpm (0 to 2500) fpm (0 to 5000) fpm (0 to 10000) fpm	6 fpm 25 fpm 50 fpm 100 fpm 200 fpm	Alnor 6006AP
Rotational Speed, RPM – Measure ³			
Optical	(0 to 100 000) rpm	0.001 %	HP 3325A
Mechanical	(0 to 5700) rpm	0.03 %	Quantum Dynamics N-11-ECS/3A

VI. Thermodynamics

Parameter/Equipment	Range	Best Uncertainty ² (\pm)	Comments
Relative Humidity – Measure ³	(10 to 80) % RH (80 to 95) % RH	0.78 % RH 1.6 % RH	Vaisala MI70 w/ HMP-77B
Temperature – Measure ³			
	(-100 to 156) °C	0.06 °C	Hart Scientific 1521 with 5623B PRT
	(0 to 1000) °C	0.04 °C	with 5624 PRT
	(-200 to 0) °C (0 to 420) °C (420 to 661) °C	0.009 °C 0.008 °C 0.012 °C	with 5626 PRT
	(-196 to 0) °C (0 to 200) °C (200 to 420) °C	0.058 °C 0.058 °C 0.063 °C	with 5627 PRT

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Temperature – Measuring Equipment ³	(35 to 50) °C	0.16 °C	Hart 9100 HDRC
	(50 to 100) °C	0.27 °C	
	(100 to 375) °C	0.47 °C	
Infrared Measure	(50 to 400) °C	0.13 °C	Fluke 9141
	(400 to 660) °C	0.60 °C	
	(37.7 to 400) °C	1.4 °C	Omega BB703

VII. Time & Frequency

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Frequency – Measuring Equipment	10 MHz reference	55 pHz/Hz	Agilent Z3816A
	1 µHz to 21 MHz 10 MHz to 26.5 GHz	55 pHz/Hz 55 pHz/Hz	Agilent 3325B Agilent 83630A
Frequency – Measure	DC to 225 MHz	55 pHz/Hz	Agilent 53132A
	10 MHz to 20 GHz	55 pHz/Hz	HP 5350B

¹ This laboratory offers commercial calibration service and field calibration services.

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 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 The measurands stated are generated with the Fluke 5000 series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. Best measurement uncertainties are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.
- ⁵ 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 uncertainties are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.
- ⁶ R is the minimum resolution of the unit under test (UUT).
- ⁷ In the statement of best uncertainty, percentages are percentages of reading, unless otherwise indicated.