



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017  
& ANSI/NCSL Z540-1-1994

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CALIBRATION

Valid To: January 31, 2021

Certificate Number: 2724.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1, 8</sup>:

I. Acoustical Quantities

Parameter/Range	Frequency	CMC <sup>2, 9</sup> (±)	Comments
Sound Level – Generate (94 to 114) dB	(125 to 1000) Hz	0.4 dB	GenRad 1986
Measure (84 to 114) dB	(50 to 2000) Hz	0.4 dB	Bruel & Kjaer 2610/ 4160

II. Chemical Quantities

Parameter/Equipment	Range	CMC <sup>2, 6, 9</sup> (±)	Comments
Conductivity – Measuring Equipment	(100 to 100 000) µS	0.3 %	Standard conductivity solutions
pH – Measuring Equipment	(4, 7) pH units 10 pH units	0.02 pH units 0.03 pH units	Standard buffer solutions

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
Gas Detection Equipment –			Calibration gases:
C <sub>2</sub> H <sub>6</sub>	0.005 %	2.2 %	Ethane
C <sub>5</sub> H <sub>12</sub>	0.35 %	2.0 %	Pentane
CH <sub>4</sub>	1 %	7 %	Methane
	1.45 %	4.8 %	
	2.5 %	2.4 %	
CO	0.001 %	5.1 %	Carbon monoxide
	0.006 %	5.2 %	
	0.01 %	1.7 %	
	0.2 %	2.1 %	
	2.5 %	3.2 %	
CO <sub>2</sub>	0.05 %	2.6 %	Carbon dioxide
	0.1 %	2.5 %	
	5 %	2.4 %	
	10 %	2.2 %	
H	0.01 %	5.3 %	Hydrogen
	2 %	4.8 %	
H <sub>2</sub> S	0.0020 %	11 %	Hydrogen sulfide
	0.0025 %	2.6 %	
O <sub>2</sub>	0.1 %	2.5 %	Oxygen
	0.4 %	15 %	
	5 %	3.2 %	
	15 %	0.54 %	
	19 %	0.63 %	
	20 %	2.5 %	
	20.9 %	2.4 %	
SO <sub>2</sub>	0.001 %	1.1 %	Sulfur dioxide

### III. Dimensional

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
UMM, Supermicrometer™	Up to 11.5 in	$(10 + 0.7L) \mu\text{in}$	Gage blocks
Bore Micrometer (Intramic)	(0.10 to 6.5) in	$40 \mu\text{in} + 0.6R$	Ring gage
Calipers <sup>3</sup>	Up to 40 in	$(20 + 7L) \mu\text{in} + 0.6R$	Gage blocks
Cylindrical Square – Squareness	Up to 12 in	$24 \mu\text{in}$	Federal comparator 232, surface plate
Dial Indicator <sup>3</sup>	(0.01 to 2) in	$170 \mu\text{in}$	Dial indicator checker
Length Standards	Up to 50 in	$(10 + 2.0L) \mu\text{in}$	Laser measurement machine (LMM)
Feeler Gages	Up to 0.06 in	$0.1 \% IV + 20 \mu\text{in}$	Gage blocks, or LMM and gage blocks
Height Gages	Up to 48 in	$61 \mu\text{in} + 9.6 \mu\text{in/in}$	Gage blocks, federal comparator 232

Parameter/Equipment	Range	CMC <sup>2, 6, 9</sup> ( $\pm$ )	Comments
Micrometers <sup>3</sup> –  Inside  Outside  Depth	Up to 1 in (1 to 4) in (4 to 6) in (6 to 24) in (24 to 36) in  Up to 36 in  Up to 12 in	11 $\mu\text{in} + 0.6R$ 26 $\mu\text{in} + 0.6R$ 37 $\mu\text{in} + 0.6R$ 85 $\mu\text{in} + 0.6R$ 120 $\mu\text{in} + 0.6R$  12 $\mu\text{in/in} + 0.6R$  12 $\mu\text{in/in} + 0.6R$	Gage blocks, LMM
Stage Micrometer Standard	(0.004 to 2) in	20 $\mu\text{in} + 10 \mu\text{in/in}$	LMM/Agilent 5519A laser
Optical Comparator <sup>3</sup> –  Length Magnification, (Only for Overlay and Lens Systems) Angle	Up to 11 in 10 $\times$ to 100 $\times$ Up to 45 $^\circ$	100 $\mu\text{in}$ 0.6 $M$ 0.033 $^\circ$	Gage blocks, magnification balls  $M$ is resolution of the overlay
Outside Diameter –  Pins/Plugs  Spheres/Balls	Up to 10 in  Up to 6 in	15 $\mu\text{in} + 3 \mu\text{in/in}$  15 $\mu\text{in} + 3 \mu\text{in/in}$	Pratt & Whitney Supermic <sup>TM</sup>
Protractors	Up to 90 $^\circ$	0.01 $^\circ$	Sine plate, gage blocks, cylindrical square
Paint Coat Thickness –  Thin Film Shims  Paint Thickness Gauge	(0.001 to 0.060) in	0.1 % IV + 20 $\mu\text{in}$  100 $\mu\text{in} + 0.6R$	LMM, gage blocks  Calibrated shims
Roughness <sup>3</sup>  Measure Generate	(<1 to 200) $\mu\text{in Ra}$ 38, 120 $\mu\text{in Ra}$	2 % IV + 2.0 $\mu\text{in Ra}$ 1 % IV + 2.0 $\mu\text{in Ra}$	Roughness tester Roughness standards

Parameter/Equipment	Range	CMC <sup>2, 6</sup> ( $\pm$ )	Comments
Ultrasonic Thickness Gages	Up to 5 in	100 $\mu$ in + 0.6R	LMM, gage blocks
Rulers <sup>3</sup>	(1 to 120) in	0.005 % IV + 0.6R	LMM
Sine Plate, Sine Bar, Fixed Points	5 in 10 in 20 in	190 $\mu$ in 160 $\mu$ in 450 $\mu$ in	Angle blocks, gage blocks, federal comparator 232
Levels –  Digital Bubble	120 in 96 in	0.25° 0.6R	Sine plate, gage blocks
Tape Measure	Up to 300 ft	0.01 % + 0.6R	LMM
Flatness <sup>3</sup>	(2 to 6) in	6 $\mu$ in	Optical flat
Surface Plate <sup>3</sup> (Flatness Only)	72 in $\times$ 240 in	100 $\mu$ in	Autocollimator
Thread Rings	Up to 1.5 in (1.5 to 4) in (4 to 6) in  Minor Diameter	220 $\mu$ in 270 $\mu$ in 320 $\mu$ in  200 $\mu$ in	Master thread plugs  Plain pins/plugs, bore plugs, optical comparator
Thread Wires	(4 to 80) TPI	14 $\mu$ in	LMM, Pratt & Whitney Supermic <sup>TM</sup> , gage blocks
Thread Plugs	(0.1 to 4) in (4 to 80) TPI	75 $\mu$ in 75 $\mu$ in	Pratt & Whitney Supermic <sup>TM</sup> , gage blocks, master thread wires

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Ring Gages	(0.25 to 8.0) in	15 μin + 2 μin/in	Pratt & Whitney Supermic™, gage blocks, master ring gages

#### IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range <sup>4</sup>	CMC <sup>2, 6, 10</sup> (±)	Comments
DC Voltage <sup>3</sup> – Generate	(0 to 220) mV	7 μV/V + 0.5 μV	Fluke 5720A
	(0.22 to 2.2) V	4 μV/V + 0.8 μV	
	(2.2 to 11) V	3 μV/V + 5 μV	
	(11 to 22) V	3 μV/V + 5 μV	
	(22 to 220) V	4 μV/V + 50 μV	
	(220 to 1100) V	6 μV/V + 0.5 mV	
DC Voltage <sup>3</sup> – Measure	100.0 mV	0.9 μV/V	Fluke 732A array Fluke 732A, 752A
	1.0 V	0.8 μV/V	
	10.0 V	0.75 μV/V	
	100.0 V	0.8 μV/V	
	1000.0 V	0.9 μV/V	
DC Voltage <sup>3</sup> – Measure	(0 to 120) mV	5 μV/V + 1 μV	Agilent 3458A
	(0.1 to 1.2) V	4 μV/V + 1 μV	
	(1.0 to 12) V	4 μV/V + 2 μV	
	(10 to 120) V	6 μV/V + 30 μV	
	(100 to 1050) V	18 μV/V + 100 μV	
	10.00 V	1.0 μV/V	
DC Voltage <sup>3</sup> – Measure	(0.5 to 10) kV	0.04 % IV + 0.03 V	Fluke 732A array Vitretek 4700A w/ HVL-100
	(10 to 100) kV	0.075 % IV + 0.3 V	

Parameter/Equipment	Range <sup>4</sup>	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
DC Current <sup>3</sup> – Measure	(2 to 20) A	0.01 % IV	Fluke Y5020, HP 3458A
	(10 to 100) A (30 to 300) A	0.05 % IV 0.1 % IV	Guildline 9211A, Agilent 3458A
	(12 to 120) $\mu$ A (0.12 to 1.2) mA (1.2 to 12) mA (12 to 120) mA (0.12 to 1.2) A	20 $\mu$ A/A + 800 pA 20 $\mu$ A/A + 5.0 nA 20 $\mu$ A/A + 50 nA 35 $\mu$ A/A + 500 nA 0.011 % IV + 10 $\mu$ A	Agilent 3458A
DC Current <sup>3</sup> – Generate	(0 to 220) $\mu$ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	42 $\mu$ A/A + 7 nA 35 $\mu$ A/A + 8 nA 35 $\mu$ A/A + 50 nA 45 $\mu$ A/A + 0.8 $\mu$ A 70 $\mu$ A/A + 15 $\mu$ A	Fluke 5720A
	(2.0 to 11) A	0.034 % + 480 $\mu$ A	Fluke 5720A w/ Fluke 5725A
	(10 to 100) A	0.10 %	Guildline 9211A, Agilent 3458A, Valhalla 2555A
Resistance – Ratio Measurement	1:1 (0.1 $\Omega$ to 10 k $\Omega$ ) 0.1:1 to 10:1 (0.1 $\Omega$ to 10 k $\Omega$ ) 100:1 (10 k $\Omega$ to 100 M $\Omega$ )	1.0 parts in 10 <sup>6</sup> 1.4 parts in 10 <sup>6</sup> 2.0 parts in 10 <sup>6</sup>	MI 6010, MI 6000 w/ MI 6011 extender
Resistance <sup>3</sup> – Measure	(0.0 to 12) $\Omega$ (10 to 120) $\Omega$ (0.10 to 1.2) k $\Omega$ (1.0 to 12) k $\Omega$ (10 to 120) k $\Omega$ (0.10 to 1.2) M $\Omega$ (1.0 to 12) M $\Omega$ (10 to 120) M $\Omega$	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 500 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 500 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 5 m $\Omega$ 10 $\mu\Omega/\Omega$ + 50 m $\Omega$ 15 $\mu\Omega/\Omega$ + 2 $\Omega$ 50 $\mu\Omega/\Omega$ + 100 $\Omega$ 0.05 % IV + 1000 $\Omega$	Agilent 3458A

Parameter/Equipment	Range <sup>4</sup>	CMC <sup>2, 6, 10</sup> (±)	Comments
Resistance <sup>3</sup> – Generate	10 000.00 Ω	0.5 μΩ/Ω	ESI SR-104
	1.0 Ω	0.5 μΩ/Ω	Leeds & Northrup 4210
	1.0 Ω (Nominal)	95 μΩ/Ω	Fluke 5720A
	1.9 Ω	95 μΩ/Ω	
	10.0 Ω	25 μΩ/Ω	
	19.0 Ω	25 μΩ/Ω	
	100.0 Ω	11 μΩ/Ω	
	190.0 Ω	11 μΩ/Ω	
	1.0 kΩ	9 μΩ/Ω	
	1.9 kΩ	9 μΩ/Ω	
	10.0 kΩ	9 μΩ/Ω	
	19.0 kΩ	9 μΩ/Ω	
	100.0 kΩ	11 μΩ/Ω	
	190.0 kΩ	11 μΩ/Ω	
	1.0 MΩ	18 μΩ/Ω	
	1.9 MΩ	19 μΩ/Ω	
	10.0 MΩ	37 μΩ/Ω	
19.0 MΩ	47 μΩ/Ω		
100.0 MΩ	0.011 % IV		

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate			
	(0 to 2.2) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 5 μV 0.011 % IV + 5 μV 90 μV/V + 5 μV 0.023 % IV + 5 μV 0.054 % IV + 6 μV 0.12 % IV + 12 μV 0.15 % IV + 25 μV 0.31 % IV + 25 μV
(2.0 to 22) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 5 μV 0.011 % IV + 5 μV 90 μV/V + 5 μV 0.023 % IV + 5 μV 0.054 % IV + 6 μV 0.12 % IV + 12 μV 0.15 % IV + 25 μV 0.31 % IV + 25 μV	



Parameter/ Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
AC Voltage <sup>3</sup> – Generate (cont)			
(20 to 220) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 50 $\mu$ V 0.01 % IV + 20 $\mu$ V 50 $\mu$ V/V + 10 $\mu$ V 90 $\mu$ V/V + 12 $\mu$ V 0.013 % IV + 40 $\mu$ V 0.042 % IV + 100 $\mu$ V 0.11 % IV + 250 $\mu$ V 0.18 % IV + 400 $\mu$ V	Fluke 5720A
(0.20 to 2.2) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 500 $\mu$ V 0.01 % IV + 200 $\mu$ V 50 $\mu$ V/V + 70 $\mu$ V 90 $\mu$ V/V + 120 $\mu$ V 0.012 % IV + 250 $\mu$ V 0.031 % IV + 800 $\mu$ V 0.11 % IV + 2.5 mV 0.16 % IV + 4 mV	
(2.0 to 22) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 5 mV 0.01 % IV + 2 mV 60 $\mu$ V/V + 7 mV 0.01 % IV + 1.2 mV 0.017 % IV + 3 mV 0.1 % IV + 20 mV 0.52 % IV + 50 mV 0.9 % IV + 100 mV	
(20 to 220) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.027 % IV + 5 mV 0.01 % IV + 2 mV 60 $\mu$ V/V + 700 $\mu$ V 0.01 % IV + 12 mV 0.017 % IV + 3 mV	
(200 to 1100) V	(0.05 to 1) kHz	80 $\mu$ V/V + 4 mV	
(200 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.036 % IV + 11 mV 0.13 % IV + 45 mV	
(200 to 1100) V	(0.04 to 1) kHz (1 to 20) kHz (20 to 30) kHz	80 $\mu$ V/V + 4 mV 0.013 % IV + 6 mV 0.036 % IV + 11 mV	Fluke 5720A w/ Fluke 5725A

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
AC Voltage <sup>3, 5</sup> – Measure			
(0 to 2.2) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.17 % IV + 1.3 $\mu$ V 0.074 % IV + 1.3 $\mu$ V 0.042 % IV + 1.3 $\mu$ V 0.081 % IV + 2.0 $\mu$ V 0.12 % IV + 2.5 $\mu$ V 0.23 % IV + 4.0 $\mu$ V 0.24 % IV + 8.0 $\mu$ V 0.35 % IV + 8.0 $\mu$ V	Fluke 5790A
(2.2 to 7.0) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.085 % IV + 1.3 $\mu$ V 0.037 % IV + 1.3 $\mu$ V 0.021 % IV + 1.3 $\mu$ V 0.04 % IV + 2.0 $\mu$ V 0.06 % IV + 2.5 $\mu$ V 0.12 % IV + 4.0 $\mu$ V 0.13 % IV + 8.0 $\mu$ V 0.23 % IV + 8.0 $\mu$ V	
(7.0 to 22.0) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.029 % IV + 1.3 $\mu$ V 0.019 % IV + 1.3 $\mu$ V 0.011 % IV + 1.3 $\mu$ V 0.021 % IV + 2.0 $\mu$ V 0.031 % IV + 2.5 $\mu$ V 0.081 % IV + 4.0 $\mu$ V 0.089 % IV + 8.0 $\mu$ V 0.17 % IV + 8.0 $\mu$ V	
(22 to 70) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % IV + 1.5 $\mu$ V 0.012 % IV + 1.5 $\mu$ V 65 $\mu$ V/V + 1.5 $\mu$ V 0.013 % IV + 2.0 $\mu$ V 0.026 % IV + 2.5 $\mu$ V 0.051 % IV + 4.0 $\mu$ V 0.067 % IV + 8.0 $\mu$ V 0.11 % IV + 8.0 $\mu$ V	
(70 to 220) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.021 % IV + 1.5 $\mu$ V 85 $\mu$ V/V + 1.5 $\mu$ V 38 $\mu$ V/V + 1.5 $\mu$ V 69 $\mu$ V/V + 2.0 $\mu$ V 0.016 % IV + 2.5 $\mu$ V 0.025 % IV + 4.0 $\mu$ V 0.038 % IV + 8.0 $\mu$ V 0.1 % IV + 8.0 $\mu$ V	

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
AC Voltage <sup>3, 5</sup> – Measure (cont)			
(220 to 700) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.021 % IV + 1.5 $\mu$ V 76 $\mu$ V/V + 1.5 $\mu$ V 33 $\mu$ V/V + 1.5 $\mu$ V 51 $\mu$ V/V + 2.0 $\mu$ V 79 $\mu$ V/V + 2.5 $\mu$ V 0.018 % IV + 4.0 $\mu$ V 0.03 % IV + 8.0 $\mu$ V 0.096 % IV + 8.0 $\mu$ V	Fluke 5790A
(0.7 to 2.2) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.02 % IV 66 $\mu$ V/V 24 $\mu$ V/V 46 $\mu$ V/V 71 $\mu$ V/V 0.016 % IV 0.026 % IV 0.09 % IV	
(2.2 to 7.0) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.02 % IV 67 $\mu$ V/V 24 $\mu$ V/V 48 $\mu$ V/V 81 $\mu$ V/V 0.019 % IV 0.04 % IV 0.12 % IV	
(70 to 220) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.02 % IV 68 $\mu$ V/V 31 $\mu$ V/V 69 $\mu$ V/V 98 $\mu$ V/V 0.021 % IV 0.05 % IV	
(220 to 700) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % IV 96 $\mu$ V/V 39 $\mu$ V/V 0.012 % IV 0.04 % IV	

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
AC Voltage <sup>3, 5</sup> – Measure (cont)			
(700 to 1000) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % IV 96 $\mu$ V/V 37 $\mu$ V/V 0.012 % IV 0.04 % IV	Fluke 5790A
(0 to 10) kV	60 Hz	0.15 % IV + 0.1 V	Vitretek 4700A w/ HVL-100
(10 to 75) kV	60 Hz	0.15 % IV + 0.6 V	
AC Current <sup>3</sup> – Measure			
(0 to 120) $\mu$ A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 1) kHz	0.4 % IV + 30 pA 0.15 % IV + 30 pA 0.06 % IV + 30 pA 0.06 % IV + 30 pA	Agilent 3458A
(0.12 to 1.2) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 200 pA 0.15 % IV + 200 pA 0.06 % IV + 200 pA 0.03 % IV + 200 pA	
(1.2 to 12) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 2 $\mu$ A 0.15 % IV + 2 $\mu$ A 0.06 % IV + 2 $\mu$ A 0.03 % IV + 2 $\mu$ A	
(12 to 120) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.15 % IV + 20 $\mu$ A 0.06 % IV + 20 $\mu$ A 0.03 % IV + 20 $\mu$ A 0.06 % IV + 20 $\mu$ A	
(0.12 to 2.2) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 200 $\mu$ A 0.16 % IV + 200 $\mu$ A 0.08 % IV + 200 $\mu$ A 0.1 % IV + 200 $\mu$ A	Fluke Y5020, HP 3458A
(2 to 20) A	(50 to 100) Hz 300 Hz 1 kHz 3 kHz 4 kHz 5 kHz	0.016 % IV 0.019 % IV 0.027 % IV 0.051 % IV 0.063 % IV 0.075 % IV	Fluke Y5020, HP 3458A

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
AC Current <sup>3</sup> – Measure (cont)  (20 to 1200) A	60 Hz 400 Hz	0.05 % IV 0.09 % IV	Weston 327 current transformer, Fluke Y5020, HP 3458A
AC Current <sup>3</sup> – Generate  (0 to 220) $\mu$ A	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.036 % IV + 2.1 $\mu$ A 0.023 % IV + 2.1 $\mu$ A 0.017 % IV + 2.1 $\mu$ A 0.042 % IV + 2.1 $\mu$ A 0.15 % IV + 2.1 $\mu$ A	Fluke 5720A
(0.2 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.036 % IV + 2.1 $\mu$ A 0.023 % IV + 2.1 $\mu$ A 0.017 % IV + 2.1 $\mu$ A 0.029 % IV + 2.2 $\mu$ A 0.15 % IV + 3.1 $\mu$ A	
(2.0 to 22) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.028 % IV + 0.5 $\mu$ A 0.018 % IV + 0.4 $\mu$ A 0.013 % IV + 0.4 $\mu$ A 0.022 % IV + 0.7 $\mu$ A 0.11 % IV + 6 $\mu$ A	
(20 to 220) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.028 % IV + 5 $\mu$ A 0.018 % IV + 4 $\mu$ A 0.013 % IV + 3 $\mu$ A 0.022 % IV + 4 $\mu$ A 0.11 % IV + 12 $\mu$ A	
(0.20 to 2.2) A	(0.02 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.03 % IV + 40 $\mu$ A 0.046 % IV + 100 $\mu$ A 0.7 % IV + 200 $\mu$ A	
(2.0 to 11) A	(0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.04 % IV + 170 $\mu$ A 0.085 % IV + 380 $\mu$ A 0.33 % + 750 $\mu$ A	

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
AC Current <sup>3</sup> – Generate (cont)			
(2 to 20) A	(50 to 100) Hz 300 Hz 1 kHz 3 kHz 4 kHz 5 kHz	0.016 % IV 0.019 % IV 0.027 % IV 0.051 % IV 0.063 % IV 0.075 % IV	Fluke Y5020, HP 3458A, Fluke 5725A
(20 to 100) A	60 Hz	0.05 % IV	Fluke Y5020, HP 3458A, Weston 327 CT, Vahalla 2555A
Capacitance <sup>3</sup> – Generate			
1000 pF	1000 Hz	5.0 $\mu$ F/F	GenRad 1404A
(330 to 500) pF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.330 to 1.10) $\mu$ F (1.1 to 3.3) $\mu$ F	(50 to 1000) Hz	0.5 % IV + 10 pF 0.5 % IV + 10 pF 0.5 % IV + 10 pF 0.5 % IV + 10 pF 0.25 % IV + 100 pF 0.25 % IV + 100 pF 0.25 % IV + 300 pF 0.25 % IV + 1 nF 0.35 % IV + 3 nF	Fluke 5500A
(3.3 to 11) $\mu$ F (11 to 33) $\mu$ F	(50 to 400) Hz	0.35 % IV + 10 nF 0.4 % IV + 30 nF	
(33 to 110) $\mu$ F	(50 to 200) Hz	0.5 % IV + 100 nF	
(110 to 330) $\mu$ F (0.330 to 1.1) mF	(50 to 100) Hz	0.7 % IV + 300 nF 1 % IV + 300 nF	

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
Capacitance <sup>3</sup> – Measure (0.1 to 1000) pF (0 to 1) nF (1 to 10) nF (10 to 100) nF (0.1 to 1) $\mu$ F (1 to 10) $\mu$ F (10 to 100) $\mu$ F (0.1 to 1) mF (1 to 10) mF (10 to 100) mF (0.1 to 1) F (1 to 10) F (10 to 31.8) F	1 kHz (0.050 to 2) kHz	0.01 % IV + 30 fF 0.1 % IV + 10 fF 0.1 % IV + 100 fF 0.1 % IV + 1 pF 0.1 % IV + 10 pF 0.1 % IV + 100 pF 0.1 % IV + 1 nF 0.1 % IV + 10 nF 0.1 % IV + 100 nF 0.1 % IV + 1 $\mu$ F 0.1 % IV + 10 $\mu$ F 0.1 % IV + 100 $\mu$ F 0.1 % IV + 1 mF	GenRad 1620A Fluke PM6304C
Inductance <sup>3</sup> – Measure (0.00 to 1.00) mH (1.00 to 10) mH (10 to 100) mH (0.100 to 1.00) mH (1 to 9.9999) H (10 to 99.999) H (100 to 999.99) H	(0.050 to 2) kHz	0.1 % IV + 10 nH 0.1 % IV + 100 nH 0.1 % IV + 1 $\mu$ H 0.1 % IV + 10 $\mu$ H 0.1 % IV + 100 $\mu$ H 0.1 % IV + 1 mH 0.1 % IV + 10 mH	Fluke PM6304C

Parameter/Equipment	Range	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
Oscilloscopes <sup>3</sup> – Amplitude DC – DC Signal 50 $\Omega$ Load 1 M $\Omega$ Load	(0 to $\pm$ 2.2) V (0 to $\pm$ 33) V	0.25 % IV + 100 $\mu$ V 0.25 % IV + 100 $\mu$ V	Fluke 5500A w/ SC600 scope option
Amplitude – Square Wave (Peak to Peak) – 50 $\Omega$ Load	$\pm$ 1.8 mV to $\pm$ 2.2 V $\pm$ 1.8 mV to $\pm$ 55 V	0.25 % IV + 100 $\mu$ V 0.25 % IV + 100 $\mu$ V	
Amplitude – Square Wave 1 M $\Omega$ Load – (10 to 100) Hz (0.1 to 10) kHz	(95 to 105) V	1.5 % IV + 100 $\mu$ V 0.5 % IV + 100 $\mu$ V	

Parameter/Equipment	Range	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
Oscilloscopes <sup>3</sup> – (cont)			
Leveled Sine Wave – (Into 50 $\Omega$ Load)	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2 % IV + 300 $\mu$ V 3.5 % IV + 300 $\mu$ V 4 % IV + 300 $\mu$ V 6 % IV + 300 $\mu$ V	Fluke 5500A w/ SC600 scope option
Flatness @ 50 kHz Reference	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.5 % IV + 100 $\mu$ V 2 % IV + 100 $\mu$ V 4 % IV + 100 $\mu$ V	
Time Marker – (Into 50 $\Omega$ Load)	5 s to 50 ms 20 ms to 1 ns	(25 + 1000 <i>t</i> ) $\mu$ s/s 2.5 $\mu$ s/s	<i>t</i> is the numerical value of the time in seconds
Edge Spec (Rise Time)	$\leq$ 1000 ps	(+ 0 ps / -900 ps)	
Amplitude Flatness	0.1 Hz to 50 kHz (0.050 to 100) MHz (100 to 250) MHz (250 to 550) MHz	1.5 % IV 1.5 % IV 3 % IV 4 % IV	Referenced to 50 kHz
Thermocouple Simulation – Generate & Measure			
Type E	(-250 to -100) $^{\circ}$ C (-100 to -25) $^{\circ}$ C (-25 to 350) $^{\circ}$ C (350 to 650) $^{\circ}$ C (650 to 1000) $^{\circ}$ C	0.5 $^{\circ}$ C 0.16 $^{\circ}$ C 0.14 $^{\circ}$ C 0.16 $^{\circ}$ C 0.21 $^{\circ}$ C	Fluke 5500A
Type J	(-210 to -100) $^{\circ}$ C (-100 to -30) $^{\circ}$ C (-30 to 150) $^{\circ}$ C (150 to 760) $^{\circ}$ C (760 to 1200) $^{\circ}$ C	0.27 $^{\circ}$ C 0.16 $^{\circ}$ C 0.14 $^{\circ}$ C 0.17 $^{\circ}$ C 0.23 $^{\circ}$ C	
Type K	(-200 to -100) $^{\circ}$ C (-100 to -25) $^{\circ}$ C (-25 to 120) $^{\circ}$ C (120 to 1000) $^{\circ}$ C (1000 to 1372) $^{\circ}$ C	0.33 $^{\circ}$ C 0.18 $^{\circ}$ C 0.16 $^{\circ}$ C 0.26 $^{\circ}$ C 0.4 $^{\circ}$ C	
Type R	(0 to 250) $^{\circ}$ C (250 to 400) $^{\circ}$ C (400 to 1000) $^{\circ}$ C (1000 to 1767) $^{\circ}$ C	0.57 $^{\circ}$ C 0.35 $^{\circ}$ C 0.33 $^{\circ}$ C 0.4 $^{\circ}$ C	



Parameter/Equipment	Range	CMC <sup>2, 10</sup> (±)	Comments
Thermocouple Simulation – Generate & Measure (cont)			
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	Fluke 5500A
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	

#### V. Fluid Quantities

Parameter/Equipment	Range	CMC <sup>2, 6, 9</sup> (±)	Comments
Specific Gravity – Measuring Equipment	(1.00 to 1.43) SPG	0.0011 SPG	Hydrometer set
Gas Flow – Measuring Equipment & Measure	(0.3 to 100) SCFM  (0 to 60 000) sccm	0.5 % IV  0.5 % IV or 0.04 sccm	DHI Molbloc sonic nozzle system  DHI Molbloc flow calibrator
Leak Rate <sup>3</sup> –Measure	Down to 1.0 <sup>-8</sup> ATM cc/s He at 21°C	6.0 % IV	Leak detector standard
Volume – Measuring Equipment (e.g. Flasks, Graduated Cylinders)	(1 to 10 000) mL	0.065 % IV	Mass comparators

VI. Mechanical

Parameter/Equipment	Range	CMC <sup>2, 6, 9</sup> (±)	Comments
Indirect Verification of Rockwell Hardness <sup>3</sup>	HRBW: Low Medium High  HRC: Low Medium High	1.2 HRBW 1.5 HRBW 1.3 HRBW  0.75 HRC 0.75 HRC 0.75 HRC	Hardness blocks
Verification of Durometer Spring –  Type A, A-2, B, 306L, 1600, O, OO, D0, C, PTC 411&412	(10 to 100) Duro Units	0.15 Duro + 0.6R	Weight scale
Pressure Gages, Controllers, Transducers <sup>3</sup> –  Pneumatic  Hydraulic	(0 to 3) in (> 3 to 30) in  (0.2 to 1000) psig (0.2 to 1000) psia (0 to 10 000) psig  (40 to 20 000) psig	0.000 27 in H <sub>2</sub> O 0.009 % IV  0.005 % IV 0.005 % IV + 0.0005 psia 0.08 % FS  0.01 % IV	Ruska 7250LP  Ruska 2465 dead weight tester Fluke 700P31  DH Instruments 50316 dead weight tester
Vacuum –  Gages  Controllers & Transducers	(10 to 1000) mmHg  (0.1 to 100) mmHg	0.005 % IV + 0.03 mmHg  0.1 % IV	Ruska 2465 dead weight tester  MKS vacuum system
Force <sup>3</sup> – Tension & Compression, Measure & Measuring Equipment	(0 to 1000) lbf (0 to 100 000) lbf	0.01 % IV 0.06 % IV	Dead weight Load cells



Parameter/Equipment	Range	CMC <sup>2, 6, 9</sup> ( $\pm$ )	Comments
Torque – Measuring Equipment	(0 to 10 000) ft·lbf	0.11 % IV	Dead weight, torque arms
Torque Arms	(5 to 120) in	0.01 in	Gage blocks, LMM
Torque – Measure <sup>3</sup>	(0.2 to 6500) ft·lbf	0.5 % IV	Torque cells
Vibration – Sensitivity Measurement & Frequency Response	(20 to < 100) Hz (0.1 to 1) kHz (> 1 to 10) kHz	1.8 % IV 1.3 % IV 2.8 % IV	Bouche Labs 1000AD/2133F shaker/accelerometer system

#### VII. Optical Quantities

Parameter/Equipment	Range	CMC <sup>2, 6</sup> ( $\pm$ )	Comments
Illuminance – Light Meters	(2 to 500) fc	2.7 % IV	Optronic OL 220P

#### VIII. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2, 9</sup> ( $\pm$ )	Comments
Dew Point – Measuring Equipment	(-90 to 10) °C dp	0.25 °C dp	Thunder Scientific 3900
Temperature – Measuring Equipment Triple Point Cell	0.010 °C	0.000 12 °C	Fluke (Hart) 5901A-G

Parameter/Equipment	Range	CMC <sup>2,9</sup> (±)	Comments
Temperature <sup>3</sup> – Measure	(0 to 100) °C	0.01 °C	Hart black stack w/ thermistor
	(0 to 250) °C	0.74 °C	Hart Scientific 5650 type “S” thermocouple w/ Fluke 525A
	(250 to 1000) °C	0.76 °C	
	(1000 to 1400) °C	3.7 °C	
	(1400 to 1450) °C	4.1 °C	
	(-200 to 660) °C	0.016 °C	Rosemount 162CE PRT w/ Hart Scientific 1575 super thermometer
Humidity – Measuring Equipment	(10 to 95) % RH	0.75 % RH	Thunder Scientific 1200 Thunder Scientific 2500
Temperature – Measuring Equipment w/ Dry Blocks	(-40 to 140) °C	0.056 °C	Hart Scientific 9107 monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(35 to 99) °C	0.075 °C	Hart Scientific 9122, monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(100 to 299) °C	0.15 °C	
	(300 to 600) °C	0.46 °C	
	(600 to 1200) °C	2.7 °C	Hart Scientific 9150, monitored w/ Hart Scientific 5650 Type “S” TC & Fluke 525A
Temperature IR – Measuring Equipment Black Body	(-15 to 120) °C	1.0 °C	Hart Scientific 4180 IR target
	(35 to 200) °C	1.0 °C	Hart Scientific 4181 IR target  $\lambda = (8 \text{ to } 14) \mu\text{m}$
	(> 200 to 350) °C	2.0 °C	
	(> 350 to 500) °C	3.0 °C	

Parameter/Equipment	Range	CMC <sup>2,9</sup> (±)	Comments
Temperature – Measuring Equipment w/ Calibration Bath	(-40 to 102) °C	0.016 °C	Hart Scientific 7040 (oil) monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(0.0 to 100) °C	0.01 °C	Hart Scientific 7040 (oil) monitored w/ Hart Blackstack & thermistor
	(100 to 180) °C	0.017 °C	Hart Scientific 6045 (oil) monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(170 to 500) °C	0.023 °C	Hart Scientific 6050 (salt) monitored w/ Rosemount 162CE PRT & Hart Scientific 1575

#### IX. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2,9</sup> (±)	Comments
Stop Watches & Timers <sup>3</sup>	(0.2 to 10 000) s	1.8 parts in 10 <sup>7</sup> + trigger error	HP 53131A
	(+10 to -10) s/day	0.05 s/day	Vibrograph TM4500
Frequency – Measuring Equipment	10 000 000 Hz	50 pHz/Hz	TrueTime XL-DC GPS receiver
	0.01 Hz to 80 MHz	2 µHz/Hz	Agilent 33250A
		10 nHz/Hz	33250A synchronized w/ GPS
	(0.1 to 3000) MHz	2 µHz/Hz	Agilent 8648C
		10 nHz/Hz	8648C synchronized w/ GPS

Parameter/Equipment	Range	CMC <sup>2,9</sup> (±)	Comments
Frequency – Measure	10 MHz	100 pHz/Hz	TrueTime XL-DC GPS receiver
	0.1 Hz to 225 MHz	0.19 µHz/Hz	Agilent 53131A frequency counter
		1 nHz/Hz	53131A synchronized w/ GPS
	(0.1 to 3000) MHz	0.19 µHz/Hz	Agilent 53131A channel 3
		1 nHz/Hz	53131A synchronized w/ GPS

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

<sup>2</sup> Calibration and Measurement Capability Uncertainty (CMC) 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 or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of  $k = 2$ . The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC 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 actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found 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 actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

<sup>4</sup> Where ranges are not specified, the CMC stated is for the cardinal points only.

<sup>5</sup> This calibration is performed in Absolute Measure Mode.

<sup>6</sup> In the statement of CMC, percentages are to be read as percent of reading unless noted otherwise, IV is defined as the indicated value, FS is defined as full scale,  $L$  is the numerical value of the nominal length of the device measured in inches,  $D$  is the diameter of the device in inches; and  $R$  is the resolution of the unit under test.

<sup>7</sup> Contact the laboratory for information on availability of service for specific gasses not listed, gasses that are not listed are not considered accredited services.

<sup>8</sup> This scope meets A2LA's P112 Flexible Scope Policy.

<sup>9</sup> The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.

<sup>10</sup> The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.





## Accredited Laboratory

A2LA has accredited

# ENERGY NORTHWEST STANDARDS LABORATORY

*Richland, WA*

for technical competence in the field of

## Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 18<sup>th</sup> day of April 2019.

A blue ink signature of the Vice President of Accreditation Services.

Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 2724.01  
Valid to January 31, 2021  
Revised February 13, 2020

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