



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

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CALIBRATION

Valid To: June 30, 2022

Certificate Number: 1855.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1, 10</sup>:

I. Acoustical

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Sound Level Meters <sup>3</sup>	(94 & 114) dB	0.60 dB	Sound level calibrator

II. Chemical Quantities

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
pH Meters <sup>3</sup>	4 pH unit 7 pH unit 10 pH unit	0.014 pH 0.015 pH 0.025 pH	Certified pH standards
Conductivity Meters <sup>3</sup>	10 µS 100 µS 1000 µS 1430 µS	0.12 µS 0.86 µS 5.9 µS 8.5 µS	Certified µS standards

III. Dimensional

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
Gage Blocks	(0.010 to 4) in (5 to 12) in	(2.1 + 1.4L) μin (6.5 + 1.1L) μin	P&W Labmaster™ (UMM) & gage blocks
Sphere Diameter	Up to 1 in	8.2 μin	P&W Labmaster™ (UMM) & gage blocks
1D – Length Standards	Up to 10 in (11 to 48) in	(23 + 2.6L) μin (37 + 4.1L) μin	Supermicrometer™  Linear amplifier w/ probe, gage blocks, & surface plate
Cylindrical Plug Gage	(0.01 to 1) in (1 to 2) in (2 to 3) in (3 to 4) in (4 to 5) in (5 to 6) in	5.1 μin 9.1 μin 13 μin 17 μin 21 μin 25 μin	P&W Labmaster™ (UMM), gage blocks
Pin Gage	(0.011 to 1) in (0.22 to 25.4) mm	18 μin 0.83 μm	Supermicrometer™
Angle Blocks	1", 3", 5", 20", 30" 1', 3', 5', 20', 30' 1°, 3°, 5°, 15°, 30°, 45°	5 s	Reference angle blocks, P&W Labmaster™ (UMM)
Flatness	Up to 1 μin Deflection <sup>7</sup>	3.4 μin	Optical flat & monochromatic light
Dial Indicator <sup>3</sup>	Up to 1 in (1 to 12) in	(19 + 0.6R) μin (76 + 0.6R) μin	Indicator calibrator  Indicator calibrator & gage blocks
Test Indicator <sup>3</sup>	Up to 0.2 in	(38 + 0.6R) μin	Indicator calibrator
Bore Gages <sup>3</sup>	Up to 12 in	(70 + 4.0L) μin	Gage blocks & cylindrical rings

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
Height Gages <sup>7</sup>	Up to 24 in	$(30 + 3.2L + 0.6R) \mu\text{in}$	Gage blocks & surface plates
Height Masters	Up to 24 in	$(35 + 2.7L) \mu\text{in}$	Linear amplifier w/ probe & gage blocks
Calipers <sup>3</sup> –  Dial/Digital/Vernier	Up to 6 in (6 to 12) in (12 to 72) in	$(190 + 0.6R) \mu\text{in}$ $(190 + 0.6R) \mu\text{in}$ $(370 + 0.6R) \mu\text{in}$	Gage blocks & cylindrical rings
Inside/Outside Calipers	Up to 2 in	200 $\mu\text{in}$	Gage blocks
Micrometers <sup>3</sup> –  Depth	Up to 12 in	$(80 + 0.6R) \mu\text{in}$	Gage blocks     Optical comparator & gage blocks  Cylindrical rings
Groove	Up to 1 in (1 to 4) in (4 to 36) in	$(20 + 0.6R) \mu\text{in}$ $(40 + 0.6R) \mu\text{in}$ $(37 + 4.0L + 0.6R)$	
O.D.	Up to 1 in (1 to 4) in (4 to 36) in	$(20 + 0.6R) \mu\text{in}$ $(40 + 0.6R) \mu\text{in}$ $(37 + 4.0L + 0.6R)$	
I.D.	Up to 36 in	$(490 + 0.6R) \mu\text{in}$	
Thread Micrometers (Screw Thread, Pitch, Point) <sup>3</sup>	Up to 2 in	$(40 + 0.6R) \mu\text{in}$	
Angle	Up to 60°	340 s	
Hole Micrometers <sup>3</sup>	Up to 6 in	$(80 + 0.6R) \mu\text{in}$	

Parameter/Equipment	Range	CMC <sup>2, 6, 8</sup> (±)	Comments
Sine Plates/Bars – Flatness	(5, 10, 15) in	9.6 μin	Optical flat & monochromatic light
Parallelism	(5, 10, 15) in	51 μin	Linear amplifier w/ probe & surface plate
Angle	Up to 45°	7.8 arcsec	Linear amplifier w/ probe, gage blocks, angle blocks & surface plate
Thickness Gages <sup>3</sup> – Dial & Digital	Up to 1 in	(40 + 0.6R) μin	Gage blocks
Thickness Tester <sup>3</sup> – Coating	Up to 0.060 in	1.1 % + 2.2 μin (0.0022 mils)	Master films
Chamfer Gages/Counter Sink Gages <sup>3</sup>	Up to 2 in	(52 + 0.6R) μin	Cylindrical rings
Linear Gage Amplifier w/ Probe	Up to 1 in	(9 + 0.6R) μin	Gage blocks
Riser Blocks & Stands	Up to 24 in	(35 + 2.7H) μin	Gage blocks & gage amplifier w/ probe
Clinometers & Inclinometers <sup>3</sup>	360°	0.043°	Sine bar & gage blocks / master angle blocks
Straightness & Straight Edges	Up to 72 in	76 μin	Linear amplifier w/ probe, gage blocks, & surface plate

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	Comments
V-Blocks –  Parallelism  Squareness & Parallelism of the V Center  Squareness of Block	Up to 8 in × 8 in × 8 in	51 μin  39 μin  56 μin	Linear amplifier w/ probe, surface plate & master setting disk
Indicator Calibrator	Up to 1 in: 0.0001 in resolution 0.000 01 in resolution	120 μin 12 μin	Gage blocks
Box Parallels –  Parallelism Squareness	5 in × 10 in × 10 in	43 μin 26 μin	Gage blocks & linear amplifier w/ probe & surface plate
Microscopes <sup>3</sup> –  Reticule	Up to 6 in	76 μin	Glass scale
Rules & Scales –  Tape Measures  PI Tapes	Up to 100 in  Up to 300 ft  Up to 48 in (48 to 780) in	0.0031 in  0.008 in/25 ft  0.0011 in 0.018 in	Horizontal Trimos w/ microscope attachment
Squareness – Perpendicularity	Up to 24 in	27 μin	Linear amplifier w/ probe, surface plate & gage block
Parallels –  Steel  Granite	1.5 in × 6 in  8 in × 48 in	43 μin  43 μin	Linear amplifier w/ probe & surface plate

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
Snap Gages <sup>3</sup>	Up to 3 in	0.0002 in	Gage amplifier w/ gage block
Plain Ring Gages – I.D. Measurements	(0.125 to 4) in (5 to 12) in	(3.9 + 3.8 <i>D</i> ) μin (9.5 + 5.5 <i>D</i> ) μin	P&W Labmaster™ (UMM), gage blocks
Thread Plugs/Thread Lead – Pitch Diameter			Supermicrometer™ w/ thread measuring wires &:
Screw: Standard 60° Acme Stub Acme Buttress Inch Metric  Pipe: Inch (NPT, NPSM, NPSL) Inch (ANPT) Dryseal British Taper British Parallel Plain Taper	(0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in (1.58 to 254) mm  (0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in Up to 1 in	(120 + 4.0 <i>L</i> ) μin (120 + 4.0 <i>L</i> ) μin (120 + 4.0 <i>L</i> ) μin (120 + 4.0 <i>L</i> ) μin (3.0 + 0.1 <i>L</i> ) μm  (120 + 4.0 <i>L</i> ) μin (120 + 4.0 <i>L</i> ) μin (120 + 4.0 <i>L</i> ) μin (120 + 4.0 <i>L</i> ) μin (120 + 4.0 <i>L</i> ) μin 40 μin	ASME B1.2 ASME B1.5 ASME B1.8 ASME B1.9 ASME B1.16M  ASME B1.20.1 MIL P-7105B ASME B1.20.5 BS21 BS2779 MIL P-7105B
Thread Rings –			
Adjustable  Pipe Rings: Inch (NPT, NPSM, NPSL) Inch (ANPT) Dryseal British Taper British Parallel	Up to 12 in  (0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in (0.0625 to 10) in	XX (Set Plug Tolerance)  (190 + 4.0 <i>L</i> ) μin (190 + 4.0 <i>L</i> ) μin (190 + 4.0 <i>L</i> ) μin (190 + 4.0 <i>L</i> ) μin (190 + 4.0 <i>L</i> ) μin	Set using master plug gages; ASME/ANSI B1.2 & ASME/ANSI B1.3  ASME B1.20.1 MIL P-7105B ASME B1.20.5 BS21 BS2779
Bench Micrometers <sup>3</sup> – Supermicrometers	Up to 10 in	(9 + 4.0 <i>L</i> ) μin	Gage blocks
Depth Gage <sup>3</sup>	Up to 12 in	(190 + 0.6 <i>R</i> ) μin	Gage blocks

Parameter/Equipment	Range	CMC <sup>2, 6, 8</sup> (±)	Comments
Coating Thickness Standards	(1 to 10) mils (10 to 360) mils	4.7 μin 28 μin	Gage blocks & Supermicrometer™
Surface Plates <sup>3</sup> –  Flatness	12 in to 20 ft	2.0√D μin	D is the diagonal in inches; Renishaw laser interferometer
Repeatability	12 in to 20 ft	38 μin	Repeat-O-Meter
Optical Comparators <sup>3</sup> –  Angle XY Linearity Magnification	(15°/30°/45°) (0.010 to 6) in 10x, 20x, 31.25x, 50x, 62.5x, 100x	3.3 s 76 μin 0.0023 in	Angle blocks Glass master scale Glass scale & magnification spheres
Angle Plates Squareness	Up to 36 in	27 μin	Surface plate, gage blocks & linear amplifier w/ probe
Angle Blocks – Non-Precision	(0 to 45)°	1.3"	Linear amplifier w/ probe & master angle blocks, surface plate
Protractor <sup>3</sup> – Digital & Mechanical	(0 to 180)°	0.016°	Angle blocks
Levels (Machinist) <sup>3</sup>	Up to 96 in	(49 + 0.6R) μin	Gage blocks, surface plate
Radius Gage	Up to 1 in	0.000 26 in	Optical comparator
Feeler/Thickness Gage	(0.0015 to 0.25) in	24 μin	Supermicrometer™ & gage blocks

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
Thread Wires (Working)	Up to 0.2 in	20 μin	P&W Labmaster™ (UMM) & gage blocks
CMM <sup>3</sup> – Non-articulating			
Linear Displacement Accuracy: X, Y, Z	Up to 200 in	(7 + 1.3L) μin	Gage blocks, Renishaw laser Interferometer
Squareness	Up to 18 in	43 μin	Granite square
Volumetric Repeatability	Up to 72 in	160 μin	Ball bar
CMM <sup>3</sup> – Articulating Arm			
Effective Diameter	(10 to 50) mm	17 μin	CMM sphere
Single Point Articulation		1 μin	Conical socket
Volumetric Performance	Up to 65 in	5L μin + 0.000 09"	Ball bar kit

#### IV. Dimensional Testing<sup>1</sup>

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Dimensional Measurement <sup>3, 9</sup> – Fixtures, Parts	Up to 72 in	0.0017 in	Faro articulated arm CMM



V. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2,4,8</sup> (±)	Comments
DC Voltage <sup>3</sup> – Measure	(10 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V  (1 to 10) kV	10 μV/V + 0.3 μV 10 μV/V + 0.3 μV 10 μV/V + 0.5 μV 10 μV/V + 30 μV 11 μV/V + 100 μV  0.3 % + 0.1 V	HP 3458A opt 002      Vitretek 4700
DC Voltage <sup>3</sup> – Generate	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1000) V	16 μV/V + 1.0 μV 10 μV/V + 2.0 μV 10 μV/V + 20 μV 14 μV/V + 150 μV 14 μV/V + 1.5 mV	Fluke 5522A
DC Current <sup>3</sup> – Measure	Up to 100 μA 100 μA to 10 mA (10 to 100) mA 100 mA to 1 A  (1 to 3) A (3 to 10) A (10 to 1000) A	24 μA/A + 0.8 nA 24 μA/A + 0.05 μA 35 μA/A + 0.5 μA 0.013 % + 10 μA  0.13 % 0.17 % 0.3 %	HP 3458A     Fluke 8845A Fluke 8845A Empro shunt
DC Current <sup>3</sup> – Generate	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	0.013 % + 0.02 μA 0.008 % + 0.05 μA 0.008 % + 0.25 μA 0.009 % + 2.5 μA 0.017 % + 40 μA 0.03 % + 40 μA 0.04 % + 0.5 mA 0.08 % + 0.75 mA	Fluke 5522A
Clamp Meter	(20 to 1000) A	0.25 % + 0.5 A	w/ 5500A coil
DC Power <sup>3</sup> – Generate	(0.33 to 330) mA (0.33 to 3) A (3 to 20) A	33 mV to 1020 V 33 mV to 1020 V 33 mV to 1020 V	0.010 % 0.031 % 0.081 %  Fluke 5522A

Parameter/Equipment	Range	CMC <sup>2,4,8</sup> (±)	Comments
Resistance <sup>3</sup> – Measure	(1 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	15 μΩ/Ω + 50 μΩ 10 μΩ/Ω + 0.5 mΩ 15 μΩ/Ω + 0.5 mΩ 10 μΩ/Ω + 5 mΩ 10 μΩ/Ω + 50 mΩ 15 μΩ/Ω + 2 Ω 51 μΩ/Ω + 100 Ω 0.05 % + 1 kΩ 0.5 % + 10 kΩ	HP 3458A
Resistance <sup>3</sup> – Generate	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ  (110 to 330) kΩ 330 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	39 μΩ/Ω + 0.001 Ω 22 μΩ/Ω + 0.0015 Ω 21 μΩ/Ω + 0.0015 Ω 23 μΩ/Ω + 0.002 Ω 22 μΩ/Ω + 0.002 Ω 23 μΩ/Ω + 0.015 Ω 21 μΩ/Ω + 0.07 Ω 23 μΩ/Ω + 0.2 Ω 23 μΩ/Ω + 0.15 Ω  32 μΩ/Ω + 10 Ω 33 μΩ/Ω + 10 Ω 0.006 % + 150 Ω 0.013 % + 250 Ω 0.026 % + 2500 Ω 0.51 % + 3000 Ω 0.3 % + 0.1 MΩ 1.5 % + 0.5 MΩ	Fluke 5522A
Stated Value	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ	0.07 % 0.07 % 0.07 % 0.012 % 0.023 % 0.009 % 0.007 % 0.006 % 0.003 % 0.005 %	Biddle 601240 L&N 4222-B L&N 4221 L&N 4020-B L&N 4025-B L&N 4030-B L&N 4035-B L&N 4040-B L&N 4045-B L&N 4050-B

Parameter/Equipment	Range	CMC <sup>2, 4, 8</sup> (±)	Comments
Oscilloscope <sup>3</sup> –			
Squarewave Signal 50 Ω at 1 kHz Source	1 mV to 6.6 V	0.28 % + 40 μV	Fluke 5522A w/ SC1100
Squarewave Signal 1 MΩ at 1 kHz Source	1 mV to 130 V	0.10 % + 40 μV	
DC Signal – 50 Ω	1 mV to 6.6 V	0.28 % + 40 μV	
DC Signal – 1 MΩ	1 mV to 130 V	0.05 % + 40 μV	
Leveled Sine Wave Amplitude at 50 kHz Reference	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	2.0 % + 300 μV 3.5 % + 300 μV 4.0 % + 300 μV 6.0 % + 300 μV 7.0 % + 300 μV	
Leveled Sine Wave Flatness (Relative to 50 kHz)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	1.5 % + 100 μV 2.0 % + 100 μV 4.0 % + 100 μV 5.0 % + 100 μV	
Time Marker 50 Ω Generate & Period	5 s to 50 ms 20 ms to 2 ns	0.0026 % + 0.07 ms 0.000 26 %	
Rise Time	≤ 300 ps	+0/-100 ps	

Parameter/Range	Frequency	CMC <sup>2, 4, 8</sup> (±)	Comments
AC Power <sup>3</sup> – Generate, PF=1			
45 Hz to 1 kHz	33 mA to 1 A (1 to 3) A (3 to 11) A (11 to 20.5) A	0.053 % 0.055 % 0.065 % 0.12 %	Fluke 5522A
(1 to 5) kHz	33 mA to 3 A (3 to 20.5) A	0.50 % 2.4 %	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Simulation of Thermocouple Indicators & Indicating Systems <sup>3</sup> – Generate and Measure			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.39 °C 0.14 °C 0.12 °C 0.14 °C 0.17 °C	Fluke 5522A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.22 °C 0.14 °C 0.12 °C 0.14 °C 0.19 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.26 °C 0.15 °C 0.14 °C 0.21 °C 0.32 °C	
Type R	(0 to 250) °C (250 to 1000) °C (1000 to 1767) °C	0.45 °C 0.28 °C 0.32 °C	
Type S	(0 to 250) °C (250 to 1400) °C (1400 to 1767) °C	0.37 °C 0.29 °C 0.36 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.49 °C 0.20 °C 0.14 °C 0.12 °C	
Electrical Simulation of RTD Indicators & Indicating Systems <sup>3</sup> –			
Pt 385, 100 Ω	(-200 to 0) °C (0 to 400) °C (400 to 630) °C (630 to 800) °C	0.05 °C 0.08 °C 0.10 °C 0.18 °C	Fluke 5522A
Pt 3926, 100 Ω	(-200 to 630) °C (0 to 400) °C (400 to 630) °C	0.05 °C 0.08 °C 0.10 °C	
PtNi 385, 120 Ω	(-80 to 100) °C (100 to 260) °C	0.07 °C 0.12 °C	

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Capacitance <sup>3</sup> – Generate	(0.19 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 300 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF	0.40 % + 0.01 nF 0.20 % + 0.01 nF 0.20 % + 0.1 nF 0.20 % + 0.3 nF 0.26 % + 1.0 nF 0.21 % + 3.0 nF 0.26 % + 10 nF 0.31 % + 30 nF 0.35 % + 100 nF 0.37 % + 300 nF 0.39 % + 1.0 μF 0.37 % + 3.0 μF 0.35 % + 10 μF 0.60 % + 30 μF	Fluke 5522A
Inductance <sup>3</sup> – Generate  50 μH to 50 mH	(50, 100, 200, 500) μH (1, 5, 20, 50) mH	0.6 % of stated value	GenRad 1482 series
Electrical Conductivity Meters (% IACS) – Generate  Fixed Value	24.85 % 29.73 % 44.95 % 58.67 %	0.26 % IACS 0.34 % IACS 0.39 % IACS 0.47 % IACS	Eddy current conductivity standards

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current <sup>3</sup> – Measure  Up to 100 μA  100 μA to 100 mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz  (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.41 % + 0.03 μA 0.16 % + 0.03 μA 0.07 % + 0.03 μA  0.41 % + 20 μA 0.16 % + 20 μA 0.07 % + 20 μA 0.04 % + 20 μA 0.07 % + 20 μA 0.41 % + 40 μA 0.56 % + 150 μA	HP 3458A

Parameter/Range	Frequency	CMC <sup>2, 4</sup> (±)	Comments
AC Current <sup>3</sup> – Measure (cont)			
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.41 % + 0.2 mA 0.17 % + 0.2 mA 0.09 % + 0.2 mA 0.11 % + 0.2 mA 0.31 % + 0.2 mA 1.0 % + 0.4 mA	Fluke 3485A
(1 to 3) A (1 to 3) A (3 to 10) A (3 to 10) A	10 Hz to 5 kHz (5 to 10) kHz 10 Hz to 5 kHz (5 to 10) kHz	0.16 % + 2 mA 0.41 % + 21 mA 0.18 % + 6 mA 0.36 % + 70 mA	Fluke 8845A
AC Current <sup>3</sup> – Generate			
(29 to 330) µA	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.10 % + 0.1 µA 0.24 % + 0.15 µA 0.64 % + 0.2 µA	Fluke 5522A
330 µA to 3.3 mA	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.08 % + 0.15 µA 0.16 % + 0.2 µA 0.40 % + 0.3 µA	
(3.3 to 33) mA	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.05 % + 2 µA 0.064 % + 2 µA 0.16 % + 3 µA	
(33 to 330) mA	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.033 % + 20 µA 0.08 % + 50 µA 0.16 % + 100 µA	
330 mA to 1.1 A	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.04 % + 100 µA 0.47 % + 1000 µA 1.9 % + 5000 µA	
(1.1 to 3) A	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.033 % + 20 µA 0.08 % + 50 µA 0.16 % + 100 µA	
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.052 % + 2 mA 0.082 % + 2 mA 2.4 % + 2 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.1 % + 5 mA 0.12 % + 5 mA 2.4 % + 5 mA	

Parameter/Range	Frequency	CMC <sup>2, 4</sup> (±)	Comments
AC Current <sup>3</sup> – Generate (cont)  Clamp Meter –  (20 to 1000) A	(45 to 65) Hz (65 to 440) Hz	0.25 % + 0.5 A 0.5 % + 0.5 A	Fluke 5522A w/ 5500A coil
AC Voltage <sup>3</sup> – Generate  (1 to 33) mV  (33 to 330) mV  (0.33 to 3.3) V  (3.3 to 33) V  (33 to 330) V  (330 to 1020) 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  (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  (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  (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz  45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz  45 Hz to 10 kHz	0.063 % + 6.0 μV 0.016 % + 6.0 μV 0.019 % + 6.0 μV 0.08 % + 6.0 μV 0.27 % + 12 μV 0.63 % + 50 μV  0.023 % + 8.0 μV 0.012 % + 8.0 μV 0.013 % + 8.0 μV 0.028 % + 8.0 μV 0.063 % + 32 μV 0.16 % + 70 μV  0.024 % + 50 μV 0.012 % + 60 μV 0.015 % + 60 μV 0.024 % + 50 μV 0.055 % + 130 μV 0.19 % + 600 μV  0.023 % + 650 μV 0.012 % + 600 μV 0.019 % + 600 μV 0.028 % + 600 μV 0.073 % + 1.6 mV  0.015 % + 2.0 mV 0.016 % + 6.0 mV 0.02 % + 6.0 mV 0.025 % + 6.0 mV 0.16 % + 50 mV  0.024 % + 10 mV	Fluke 5522A

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage <sup>3</sup> – Measure			
(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	0.031 % + 3 μV 0.022 % + 1 μV 0.033 % + 1.1 μV 0.11 % + 1.1 μV 0.5 % + 1.1 μV 4 % + 20 μV	HP 3458A
(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 % + 4 μV 0.01 % + 2 μV 0.016 % + 2 μV 0.032 % + 2 μV 0.081 % + 2 μV 0.3 % + 10 μV 1 % + 10 μV 1.5 % + 10 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 2 MHz	0.0072 % + 40 μV 0.0072 % + 20 μV 0.015 % + 20 μV 0.03 % + 20 μV 0.08 % + 20 μV 0.3 % + 100 μV 1.2 % + 100 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 2 MHz	0.0074 % + 400 μV 0.0072 % + 200 μV 0.015 % + 200 μV 0.03 % + 200 μV 0.08 % + 200 μV 0.3 % + 1 mV 1.5 % + 1 mV	
(10 to 100) V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % + 4 mV 0.02 % + 2 mV 0.035 % + 2 mV 0.12 % + 2 mV	
(100 to 700) 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	
(1 to 10) kV	(30 to 200) Hz	0.25 % + 0.1 V	Vitrek 4700



VI. Electrical – RF/Microwave

Parameter/Equipment	Frequency	CMC <sup>2, 4, 8</sup> (±)	Comments
Distortion – Measure	20 Hz to 20 kHz (20 to 100) kHz	1.3 dB 2.4 dB	HP 8903B
Amplitude Modulation – Measure			
150 kHz to 10 MHz	20 Hz to 10 kHz	3.5 %	HP 8902A
(10 to 1300) MHz	20 Hz to 100 kHz	3.5 %	
Frequency Modulation – Measure			
Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz	20 Hz to 10 kHz	3.5 %	HP 8902A
Rate: (10 to 1300) MHz Dev: < 400 kHz	20 Hz to 100 kHz	3.5 %	
Tuned RF Power, Relative <sup>3</sup> – Measure			
0 dB, Reference	2.5 MHz to 1.3 GHz	0.03 dB	HP 8902A HP11722A
(-0.0 to -3) dB		0.05 dB	
(-3 to -10) dB		0.05 dB	
(-10 to -40) dB		0.13 dB	
(-40 to -50) dB		0.13 dB	
(-50 to -80) dB		0.09 dB	
(-80 to -90) dB		0.12 dB	
(-90 to -110) dB		0.14 dB	
(-110 to -127) dB		0.35 dB	

## VII. Fluid Quantities

Parameter/Equipment	Range	CMC <sup>2, 8, 11</sup> (±)	Comments
Dynamic Viscosity <sup>3</sup> – Measure & Measuring Equipment	(10 to 30 000) cP	0.80 %	Viscosity standards
Gas Flow <sup>3</sup> –  Flow Meters & Rotameters	Up to 20 sccm (40 to 100) sccm (200 to 500 sccm (0.5 to 2) slpm (4 to 20) slpm (40 to 100) slpm (100 to 500) slpm	0.75 % + 0.04 sccm 0.75 % + 0.2 sccm 0.75 % + 1 sccm 0.75 % + 0.004 slpm 0.75 % + 0.04 slpm 0.75 % + 0.2 slpm 0.75 % + 1 slpm	Reference flow meters
POVA3 (Piston Operated Volumetric Apparatus) – Piston Pipettes, Burettes, Dispensers	(1 to 30) µL (>30 to 100) µL (>100 to 1000) µL (>1000 to 20 000) µL	0.074 µL 0.33 µL 2.5 µL 13 µL	Gravimetric method per ISO-8655-6

## VIII. Mechanical

Parameter/Equipment	Range	CMC <sup>2, 8</sup> (±)	Comments
Air Velocity – Anemometers, Velometers <sup>3</sup>	492 fpm 984 fpm 1969 fpm 2953 fpm	12 fpm 25 fpm 43 fpm 59 fpm	Standard anemometer
Pressure/Vacuum <sup>3</sup> – Gauges & Transducers	Up to 2.5 inH <sub>2</sub> O (>2.5 to 28) inH <sub>2</sub> O  (-15 to 10) psig  (>10 to 1000) psig (>1000 to 10 000) psig  Up to 30 Psia	0.0035 inH <sub>2</sub> O 0.0090 inH <sub>2</sub> O  0.020 psi  0.011 % + 0.0001 psi 0.031 %  0.018 Psia	Pressure transducer  Pressure transducer  Deadweight tester & pressure transducer  Pressure transducer

Parameter/Equipment	Range	CMC <sup>2, 6, 8</sup> (±)	Comments
Balances <sup>3</sup>	Up to 500 mg (1 to 3) g 5 g 10 g (20 to 30) g 50 g 100 g 200 g 300 g 500 g 1 kg 2 kg 3 kg 4 kg 5 kg 10 kg 20 kg 30 kg 50 kg	0.003 mg + 0.6R 0.006 mg + 0.6R 0.007 mg + 0.6R 0.011 mg + 0.6R 0.016 mg + 0.6R 0.025 mg + 0.6R 0.050 mg + 0.6R 0.10 mg + 0.6R 0.15 mg + 0.6R 0.25 mg + 0.6R 0.50 mg + 0.6R 1 mg + 0.6R 1.5 mg + 0.6R 2 mg + 0.6R 2.5 mg + 0.6R 5 mg + 0.6R 10 mg + 0.6R 15 mg + 0.6R 25 mg + 0.6R	ASTM Class 1 weights
Scales <sup>3</sup>	Up to 1 lb (1 to 2) lb (2 to 5) lb (5 to 10) lb (10 to 20) lb (20 to 50) lb  (50 to 100) lb (100 to 500) lb (500 to 2000) lb	0.000 008 oz + 0.6R 0.000 017 oz + 0.6R 0.000 035 oz + 0.6R 0.000 07 oz + 0.6R 0.000 14 oz + 0.6R 0.000 39 oz + 0.6R  0.0053 lb + 0.6R 0.03 lb + 0.6R 0.11 lb + 0.6R	ASTM Class 1 weights  NIST Class F weights

Parameter/Equipment	Range	CMC <sup>2, 6, 8</sup> (±)	Comments
Mass <sup>3</sup>	(10 to 500) mg  (1 to 10) g (20 to 40) g 50 g (100 to 200) g (300 to 500) g  (1 to 3) kg 5 kg (10 to 35) kg	0.029 mg  0.036 mg 0.050 mg 0.27 mg 0.30 mg 5.9 mg  6.1 mg 6.6 mg 800 mg	Analytical balance & weighing scale, by direct reading
Torque <sup>3</sup> –  Wrenches, Screwdrivers & Analyzers  Analyzers	(1 to 10) in·lbf  (10 to 100) in·lbf (10 to 100) ft·lbf (>100 to 800) ft·lbf (>800 to 2000) ft·lbf  (1 to 20) in·lbf (20 to 200) in·lbf	1.3 % + 0.01 in·lbf  0.13 % + 0.01 in·lbf 0.13 % + 0.01 ft·lbf 0.11 % + 0.05 ft·lbf 0.13 % + 1 ft·lbf  0.07 % + 0.001 in·lbf 0.06 % + 0.006 in·lbf	AWS-3000  Torque calibration system  Torque arms & hanging weights
Tachometers and Rotational Speed <sup>3</sup> –  Photo  Mechanical	Up to 999.99 rpm (1000 to 5000) rpm (5000 to 60 000) rpm  Up to 999.99 rpm (1000 to 5000) rpm (5000 to 60 000) rpm	(0.004 + 0.6R) rpm (0.009 + 0.6R) rpm (0.23 + 0.6R) rpm  (0.077 + 0.6R) rpm (0.55 + 0.6R) rpm (6.2 + 0.6R) rpm	Fluke 5522A & LED  Laser tachometer
RPM <sup>3</sup> – Measure	Up to 99.999 rpm (100 to 999.99) rpm (1000 to 9999.9) rpm (10 000 to 60 000) rpm	0.02 % + 0.005 rpm 0.012 % + 0.01 rpm 0.012 % 0.01 %	Laser tachometer

Parameter/Equipment	Range	CMC <sup>2, 6</sup> ( $\pm$ )	Comments
Force <sup>3</sup> – Tension & Compression, Dynamometers, Spring Testers	Up to 10 lbf (10 to 50) lbf (50 to 100) lbf (100 to 500) lbf	0.001 lb + 0.6R 0.0017 lb + 0.6R 0.008 lb + 0.6R 0.07 lb + 0.6R	NIST Class F weights
	(500 to 2000) lbf (2000 to 5000) lbf (5000 to 10 000) lbf (10 000 to 30 000) lbf (50 000 to 100 000) lbf	2.5 lb + 0.6R 6.2 lb + 0.6R 13 lb + 0.6R 22 lb + 0.6R 71 lb + 0.6R	Load cells
Durometer Calibration <sup>3</sup> – Types A, D			
Indenter Extension & Shape –			
Diameter	(0.028 to 0.055) in	180 $\mu$ m	Optical inspection under magnification
Angle	25° to 40°	0.094°	
Extension	(0.095 to 0.105) mm	0.25 $\mu$ m	Gage blocks
Indenter Display	(0.0 to 0.105) mm	0.25 $\mu$ m	Gage blocks
Spring Calibration – Force	(0 to 100) duro units	0.40 duros + 0.6R	Duro-calibrator

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
Indirect Verification of Rockwell & Rockwell Superficial Hardness Testers <sup>3</sup> – Portable Hardness Testers	HRC:		ASTM E18, ASTM E110
	Low	0.46 HRC	
	Medium	0.55 HRC	
	High	0.21 HRC	
	HRBW:		
	Low	0.62 HRBW	
	Medium	0.46 HRBW	
	High	0.59 HRBW	
	HRA:		
	Low	0.37 HRA	
	Medium	0.21 HRA	
	High	0.25 HRA	
	HRHW:		
	Low	0.37 HRHW	
	High	0.25 HRHW	
	HREW:		
	Low	0.35 HREW	
	Medium	0.51 HREW	
	High	0.35 HREW	
	HR15TW:		
	Low	0.77 HR15TW	
Medium	0.44 HR15TW		
High	0.30 HR15TW		
HR30TW:			
Low	0.66 HR30TW		
Medium	0.47 HR30TW		
High	0.31 HR30TW		

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Indirect Verification of Rockwell & Rockwell Superficial Hardness Testers <sup>3</sup> – Portable Hardness Testers (cont)	HR45TW: Low Medium High  HR15N: Low Medium High  HR30N: Low Medium High  HR45N: Low Medium High	0.51 HR45TW 0.32 HR45TW 0.37 HR45TW  0.38 HR15N 0.42 HR15N 0.29 HR15N  0.35 HR30N 0.68 HR30N 0.33 HR30N  0.65 HR45N 0.42 HR45N 0.47 HR45N	ASTM E18, ASTM E110
Indirect Verification of Brinell & Portable Brinell Hardness Testers	HBW 10/3000/15: (100 to 350) HBW (351 to 650) HBW  HBW 10/500/15: (16 to 62) HBW (63 to 109) HBW	0.019 mm 0.018 mm  0.016 mm 0.016 mm	ASTM E10, ASTM E110
Indirect Verification of Knoop Microhardness Tester	HK: (250 to 650) HK (> 650) HK	1.7 µm 1.1 µm	ASTM E384
Indirect Verification of Vickers Microhardness Tester	HV: 300 HV 500 HV	0.22 µm 0.46 µm	ASTM E384

IX. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2,11</sup> (±)	Comments
Temperature <sup>3</sup> – Measuring Equipment	(-50 to 200) °C (200 to 400) °C	0.019 °C 0.11 °C	PRT w/1502A
Temperature <sup>3</sup> – Measure (Ovens, Baths, Dry Blocks)	(-50 to 200) °C (200 to 400) °C	0.019 °C 0.11 °C	PRT w/1502A
Infrared Thermometers <sup>3</sup>	(35 to 100) °C (>100 to 200) °C (>200 to 350) °C (>350 to 500) °C	0.70 °C 0.93 °C 1.7 °C 2.1 °C	Fluke 4181
Relative Humidity <sup>3</sup>	(10 to 95) % RH	1.2 % RH	Rotronic hygrometer

X. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2,11</sup> (±)	Comments
Frequency – Measure	10 Hz to 1 GHz	1.7 parts in 10 <sup>9</sup> Hz/Hz	GPS conditioned Agilent 5386A
Frequency – Measuring Equipment	1 Hz to 10 Mhz 10 MHz to 1 GHz	1.2 parts in 10 <sup>8</sup> Hz/Hz 1.2 parts in 10 <sup>8</sup> Hz/Hz	HP 3325A and Giga-Tronics 6061A monitored with GPS conditioned counter
Time Interval <sup>3</sup>	1 s to 86 400 s	0.036 s/day	Counter phase locked to GPS or chronometer

<sup>1</sup> This laboratory offers commercial dimensional testing/calibration and field service.



- <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> The measurands stated are generated and measured using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure the measurand in the ranges indicated. CMC are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.
- <sup>5</sup> Based on using the standard at the temperature the Fluke 5522A was calibrated ( $t_{cal} \pm 5 \text{ }^\circ\text{C}$ ) and assuming the instrument was zeroed at least every seven days or when the ambient temperature changes more than  $5 \text{ }^\circ\text{C}$ , the CMC is read as percent output plus 1-year floor specifications. For resistance, a zero calibration is performed at least every 12 hours within  $\pm 1 \text{ }^\circ\text{C}$  of use. For AC Current, CMC's are determined with LCOMP off.
- <sup>6</sup> Unless otherwise noted, in the statement of CMC  $L$  is the nominal length of the device in inches;  $R$  is the resolution of the unit;  $D$  is the nominal diameter in inches;  $H$  is the nominal height of the unit under test.
- <sup>7</sup> Deflection is the maximum deviation from the reference plane.
- <sup>8</sup> In the statement of CMC, the value is defined as the percentage of reading, unless otherwise noted.
- <sup>9</sup> This laboratory meets R205 – *Specific Requirements: Calibration Laboratory Accreditation Program* for the dimensional test listed above and is considered equivalent to that of a calibration.
- <sup>10</sup> This scope meets A2LA's *P112 Flexible Scope Policy*.
- <sup>11</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.



# Accredited Laboratory

A2LA has accredited

**TIC-MS, INC.**

*St. Louis, MO*

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 20<sup>th</sup> day of November 2020.

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

Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 1855.01  
Valid to June 30, 2022

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