



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

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CALIBRATION

Valid To: July 31, 2018

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 calibrations¹:

I. Chemical Quantities

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

II. Dimensional

Parameter/Equipment	Range	CMC ^{2,6} (±)	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 TM (UMM) & gage blocks
Sphere Diameter	Up to 1 in	3.6 µin	

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Length Standards – 1D	Up to 10 in (11 to 48) in	(23 + 2.6L) μ in (37 + 4.1L) μ in	Supermicrometer™ Linear amplifier w/ probe, gage blocks, & surface plate
Cylindrical Plug Gage	Up to 6 in: (0 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 μ in 9.1 μ in 13 μ in 17 μ in 21 μ in 25 μ in	P&W Labmaster™ (UMM), gage blocks
Pin Gage	(0.011 to 1) in (0.22 to 25.4) mm	18 μ in 0.83 μ m	Supermicrometer™
Angle – Precision Angle Blocks	1", 3", 5", 20", 30" 1', 3', 5', 20', 30' 1°, 3°, 5°, 15°, 30°, 45°	5 seconds	Reference angle blocks, P&W Labmaster™ (UMM)
Flatness	Up to 1 μ in Deflection ⁷	4.8 μ in	Optical flat & monochromatic light
Dial Indicator ³	Up to 1 in (1 to 12) in	(19 + 0.6R) μ in (76 + 0.6R) μ in	Indicator calibrator Indicator calibrator & gage blocks
Test Indicator ³	Up to 0.2 in	(38 + 0.6R) μ in	Indicator calibrator
Bore Gages ³	Up to 12 in	(70 + 4.0L) μ in	Gage blocks & cylindrical rings
Height Gages ⁷	Up to 24 in	(30 + 3.2L + 0.6R) μ in	Gage blocks & surface plates

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Height Masters	Up to 24 in	$(35 + 2.7L) \mu\text{in}$	Linear amplifier w/ probe and gage blocks
Calipers ³ –			
Dial/Digital/Vernier	Up to 6 in (6 to 12) in (12 to 72) in	$(110 + 0.6R) \mu\text{in}$ $(120 + 0.6R) \mu\text{in}$ $(370 + 0.6R) \mu\text{in}$	Gage blocks and cylindrical rings
Inside/Outside Calipers	Up to 2 in	200 μin	Gage blocks
Snap Gages	Up to 12 in	$(190 + 4.0L) + 0.6R \mu\text{in}$	Gage blocks
Micrometers ³ –			
Depth	Up to 12 in	$(80 + 0.6R) \mu\text{in}$	Gage blocks
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) ³	Up to 2 in	$(40 + 0.6R) \mu\text{in}$	Optical comparator and gage blocks
Angle	Up to 60°	340 seconds	
Hole Micrometers ³	Up to 6 in	$(80 + 0.6R) \mu\text{in}$	Cylindrical rings

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	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 seconds	Linear amplifier w/ probe, gage blocks, angle blocks & surface plate
Thickness Gages ³ – Dial & Digital	Up to 1 in	(40 + 0.6R) μin	Gage blocks
Thickness Tester – Coating ³	Up to 0.060 in	1.1 % + 2.2 μin (0.0022 mils)	Master films
Chamfer Gages/Counter Sink Gages ³	Up to 2 in	(52 + 0.6R) μin	Cylindrical rings
Linear Gage Amplifier w/ Probe	Up to 1 in	(0.6R + 8) μin	Gage blocks
Riser Blocks & Stands	Up to 24 in	(35 + 2.7H) μin	Gage blocks & gage amplifier w/ probe
Clinometers & Inclinometers ³	360°	2.6'	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 ^{2, 6} (±)	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 0.00001 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 ³ – Reticule	Up to 50 mm	4.2 μm	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	26 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
Snap Gages ³	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 + 3.8D) μin (9.5 + 5.5D) μin	P&W Labmaster™ (UMM), gage blocks

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
<p>Thread Plugs/Thread Lead – Pitch Diameter</p> <p>Screw:</p> <p>Standard 60°</p> <p>Acme</p> <p>Stub Acme</p> <p>Buttress Inch</p> <p>Metric</p> <p>Pipe:</p> <p>Inch (NPT, NPSM, NPSL)</p> <p>Inch (ANPT)</p> <p>Dryseal</p> <p>British Taper</p> <p>British Parallel</p> <p>Plain Taper</p>	<p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(1.58 to 254) mm</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>Up to 1 in</p>	<p>(120 + 4.0L) μin</p> <p>(120 + 4.0L) μin</p> <p>(120 + 4.0L) μin</p> <p>(120 + 4.0L) μin</p> <p>(3.0 + 0.1L) μm</p> <p>(120 + 4.0L) μin</p> <p>(120 + 4.0L) μin</p> <p>(120 + 4.0L) μin</p> <p>(120 + 4.0L) μin</p> <p>(120 + 4.0L) μin</p> <p>40 μin</p>	<p>Supermicrometer™ w/ thread measuring wires &:</p> <p>ASME B1.2</p> <p>ASME B1.5</p> <p>ASME B1.8</p> <p>ASME B1.9</p> <p>ASME B1.16M</p> <p>ASME B1.20.1</p> <p>MIL P-7105B</p> <p>ASME B1.20.5</p> <p>BS21</p> <p>BS2779</p> <p>MIL P-7105B</p>
<p>Thread Rings –</p> <p>Adjustable</p> <p>Pipe Rings:</p> <p>Inch (NPT, NPSM, NPSL)</p> <p>Inch (ANPT)</p> <p>Dryseal</p> <p>British Taper</p> <p>British Parallel</p>	<p>Up to 12 in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p> <p>(0.0625 to 10) in</p>	<p>XX (Set Plug Tolerance)</p> <p>(190 + 4.0L) μin</p> <p>(190 + 4.0L) μin</p> <p>(190 + 4.0L) μin</p> <p>(190 + 4.0L) μin</p> <p>(190 + 4.0L) μin</p>	<p>Set using master plug gages.</p> <p>ASME/ANSI B1.2 & ASME/ANSI B1.3</p> <p>ASME B1.20.1</p> <p>MIL P-7105B</p> <p>ASME B1.20.5</p> <p>BS21</p> <p>BS2779</p>
<p>Bench Micrometers³ – Supermicrometers</p>	<p>Up to 10 in</p>	<p>(9 + 4.0L) μin</p>	<p>Gage blocks</p>
<p>Depth Gage³</p>	<p>Up to 12 in</p>	<p>(190 + 0.6R) μin</p>	<p>Gage blocks</p>
<p>Coating Thickness Standards</p>	<p>(1 to 10) mils</p> <p>(10 to 65) mils</p>	<p>4.7 μin</p> <p>28 μin</p>	<p>Gage blocks & Supermicrometer™</p>

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Surface Plates ³ – Flatness	12 in to 20 ft	$2.0\sqrt{D}$	<i>D</i> is the diagonal in inches Renishaw laser interferometer
Repeatability	12 in to 20 ft	46 μin	Repeat-O-Meter
Optical Comparators ³ – Angle	(15° / 30° / 45°)	3.3 seconds	Angle blocks
XY Linearity	(0.010 to 6) in	76 μin	Glass master scale
Magnification	10x, 20x, 31.25x, 50x, 62.5x, 100x	0.0023 in	Glass scale & magnification spheres
Angle Plates Squareness	Up to 36 in	26 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 ³ – Digital & Mechanical	(0 to 180)°	$0.6R + 0.06 \%$	Angle blocks
Levels (Machinist) ³	Up to 96 in	$(49 + 0.6R) \mu\text{in}$	Gage blocks, surface plate
Radius Gage	Up to 1 in	0.00026 in	Optical comparator
Feeler/Thickness Gage	(0.0015 to 0.25) in	24 μin	Supermicrometer TM & gage blocks
Thread Wires (Working)	Up to 0.2 in	20 μin	P&W Labmaster TM (UMM) & gage blocks

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
CMM ³ – 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	45 μin	Granite square
Volumetric Repeatability	Up to 72 in	160 μin	Ball bar
CMM ³ – Articulating Arm			
Effective Diameter	(10 to 50) mm	8.2 μin	CMM sphere
Single Point Articulation		1 μin	Conical socket
Volumetric Performance	Up to 65 in	32 μinL + 0.0009"	Ball bar kit

III. Dimensional Testing/Calibration¹

Parameter/Equipment	Range	CMC ² (±)	Comments
Dimensional Measurement ^{3,9} – Fixtures, Parts	Up to 72 in	0.0016 in	Faro articulated arm CMM

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 8} (±)	Comments
DC Voltage ³ – Measure	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V	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	HP 3458A opt 002
	(1 to 10) kV	0.3 % + 0.1 V	Vitrek 4700
DC Voltage ³ – Generate	(0 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 5520A
DC Current ³ – Measure	Up to 100 μA 100 μA to 10 mA (10 to 100) mA 100 mA to 1 A	24 μA/A + 0.8 nA 24 μA/A + 0.05 μA 35 μA/A + 0.5 μA 0.013 % + 10 μA	HP 3458A
	(1 to 3) A (3 to 10) A (10 to 1000) A	0.13 % 0.17 % 0.3 %	Fluke 8845A Fluke 8845A Empro shunt
DC Current ³ – Generate	(0 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 5520A
	Clamp Meter (20 to 1000) A	0.25 % + 0.5 A	w/ 5500A coil
DC Power ³ –			
(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 5520A

Parameter/Equipment	Range	CMC ^{2, 4, 8} (±)	Comments
Resistance ³ – 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 ³ – 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 5520A
Stated Value	(0.001, 0.01, 0.1) Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ	0.07 % 0.012 % 0.023 % 0.009 % 0.007 % 0.006 % 0.003 % 0.005 %	Biddle 601240; L&N 4222-B, 4221, 4020-B, 4030-B, 4035-B, 4025-B, 4045-B, 4050-B



Parameter/Equipment	Range	CMC ^{2, 4, 8} (±)	Comments
Oscilloscope ³ – Squarewave Signal 50 Ω at 1 kHz Source	(1 to 110) mV 110 mV to 2.2 V (2.2 to 11) V (11 to 1100) V	0.28 % + 48 μV 0.28 % + 120 μV 0.28 % + 1.2 mV 0.28 % + 12 mV	Fluke 5520A w/ SC600
Squarewave Signal 1 MΩ at 1 kHz Source	(1 to 110) mV 110 mV to 2.2 V (2.2 to 11) V (11 to 1100) V	0.12 % + 48 μV 0.12 % + 120 μV 0.12 % + 1.2 mV 0.12 % + 12 mV	Fluke 5520A w/ SC600
Leveled Sine Wave Amplitude at 50 kHz Ref	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2.0 % + 300 μV 3.5 % + 300 μV 4.0 % + 300 μV 6.0 % + 300 μV	
Leveled Sine Wave Flatness (Relative to 50 kHz)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.5 % + 100 μV 2.0 % + 100 μV 4.0 % + 100 μV	
Time Marker 50 Ω Generate & Period	5 s to 50 ms 20 ms to 2 ns	0.0026 % + 0.07 ms 0.00026 %	
Rise Time	≤ 300 ps	+0 / -100 ps	
AC Power ³ , 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 5520A
(1 to 5) kHz	33 mA to 3 A (3 to 20.5) A	0.50 % 2.4 %	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Thermocouple Indicators & Indicating Systems ³ Source 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 5520A
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 ³ –			
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 5520A
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 ^{2,4} (±)	Comments
Capacitance – Generate ³	(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 5520A
Inductance – 50 µH to 50 mH	(50, 100, 200, 500) µH (1, 5, 20, 50) mH	0.6 % of stated value	GenRad 1482 (a-k)
AC Current ³ – Measure			
Up to 100 µA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz	0.41 % + 0.03 µA 0.16 % + 0.03 µA 0.07 % + 0.03 µA	HP 3458A
100 µA to 100 mA	(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 % + 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	
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	
(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

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current ³ – 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 5520A
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	
(20 to 1000) A	(45 to 65) Hz (65 to 440) Hz	0.25 % + 0.5 A 0.5 % + 0.5 A	



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage ³ – Generate			
(1 to 33) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.063 % + 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	Fluke 5520A
(33 to 330) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.023 % + 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	
(0.33 to 3.3) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.024 % + 50 μV 0.012 % + 60 μV 0.015 % + 60 μV 0.024 % + 50 μV 0.055 % + 130 μV 0.19 % + 600 μV	
(3.3 to 33) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.023 % + 650 μV 0.012 % + 600 μV 0.019 % + 600 μV 0.028 % + 600 μV 0.073 % + 1.6 mV	
(33 to 330) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.015 % + 2.0 mV 0.016 % + 6.0 mV 0.02 % + 6.0 mV 0.025 % + 6.0 mV 0.16 % + 50 mV	
(330 to 1020) V	45 Hz to 10 kHz	0.024 % + 10 mV	



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage ³ – 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	Vitretek 4700

V. Electrical – RF/Microwave

Parameter/Equipment	Frequency	CMC ^{2, 8} (±)	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 ³ – Measure			
0 dB, Reference (-0.0 to -3) dB (-3 to -10) dB (-10 to -40) dB (-40 to -50) dB (-50 to -80) dB (-80 to -90) dB (-90 to -110) dB (-110 to -127) dB	2.5 MHz to 1.3 GHz	0.03 dB 0.05 dB 0.05 dB 0.13 dB 0.13 dB 0.09 dB 0.12 dB 0.14 dB 0.35 dB	HP 8902A HP11722A



VI. Mechanical

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Mass ³	(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
Pressure ³ – Gauges	Up to 10 psi (11 to 1000) psi (1001 to 10000) psi (0 to 28) inH2O	0.020 psi 0.011 % + 0.0001 psi 0.031 % 0.009 inH2O	Deadweight tester & pressure transducer
Vacuum ³ – Gauges	(0 to -15) psi	0.020 psi	Pressure transducer
Torque ³ – Wrenches, Screwdrivers & Analyzers	(1 to 20) in·lbf (10 to 100) in·lbf (10 to 100) ft·lbf (51 to 800) ft·lbf (801 to 2000) ft·lbf	0.07 % + 0.001 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	Torque calibration system
Tachometers ³ – Photo	Up to 999.99 rpm (1000 to 5000) rpm (5000 to 60000) rpm	(0.004 + 0.6R) rpm (0.009 + 0.6R) rpm (0.13 + 0.6R) rpm	Fluke 5520A & LED
RPM ³ - Measure	Up to 99.999 rpm: (100 to 999.99) rpm (1000 to 9999.9) rpm (10000 to 60000) rpm	0.02 % + 0.005 rpm 0.012 % + 0.01 rpm 0.012 % 0.01 %	Laser tachometer



Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Balances ³	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 ³	Up to 1 lbs (1 to 2) lbs (2 to 5) lbs (5 to 10) lbs (10 to 20) lbs (20 to 50) lbs	0.000008 oz + 0.6R 0.000017 oz + 0.6R 0.000035 oz + 0.6R 0.00007 oz + 0.6R 0.00014 oz + 0.6R 0.00039 oz + 0.6R	ASTM Class 1 weights
Scales ³	(50 to 100) lbs (100 to 500) lbs (500 to 2000) lbs	0.0053 lbs + 0.6R 0.03 lbs + 0.6R 0.11 lbs + 0.6R	NIST Class F weights
Air Velocity – Anemometers, Velometers ³	492 fpm 984 fpm 1969 fpm 2953 fpm	8.5 fpm 15 fpm 28 fpm 40 fpm	Standard anemometer
Force ³ – Tension & Compression, Dynamometers, Spring Testers	Up to 10 lbf (10 to 50) lbf 50 to 100) lbf 100 to 500) lbf (500 to 2000) lbf (2000 to 5000) lbf (5000 to 10 000) lbf (10000 to 30 000) lbf (50 000 to 100 000) lbf	0.001 lbs + 0.6R 0.0017 lbs + 0.6R 0.008 lbs + 0.6R 0.07 lbs + 0.6R 2.5 lbs + 0.6R 6.2 lbs + 0.6R 13 lbs + 0.6R 22 lbs + 0.6R 71 lbs + 0.6R	NIST Class F weights Load cells

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Direct Verification of Durometer Spring Force ³ – Shore Types A, D	(0 to 100) duro units	0.36 duros + 0.6R	The durometer spring is verified with a duro-calibrator that is calibrated with dead weights.
Indirect Verification of Brinnell & Portable Brinnell Hardness Testers (HBW10/3000)	HBW: (100 to 350) HBW (351 to 650) HBW	0.037 mm 0.029 mm	ASTM E10 ASTM E110
Indirect Verification of Knoop Hardness Tester	HK: (250 to 650) HK (> 650) HK	0.49 µm 0.52 µm	ASTM E384
Indirect Verification of Vickers	HV: 300 HV 500 HV	0.63 µm 0.77 µm	ASTM E384
Indirect Verification of Rockwell & Rockwell Superficial Hardness Testers ³ – Portable Hardness Testers	HRC: Low Medium High HRBW: Low Medium High HRA: Low Medium High HRHW: Low High HREW: Low Medium High HR15TW: Low Medium High	0.46 HRC 0.55 HRC 0.21 HRC 0.61 HRBW 0.47 HRBW 0.59 HRBW 0.31 HRA 0.21 HRA 0.24 HRA 0.31 HRHW 0.25 HRHW 0.31 HREW 0.50 HREW 0.35 HREW 0.79 HR15TW 0.46 HR15TW 0.29 HR15TW	ASTM E18 ASTM E110

Parameter/Equipment	Range	CMC ² (±)	Comments
Indirect Verification of Rockwell & Rockwell Superficial Hardness Testers ³ – Portable Hardness Testers (cont)	HR30TW: Low Medium High HR45TW: Low Medium High HR15N: Low Medium High HR30N: Low Medium High HR45N: Low Medium High	0.67 HR30TW 0.48 HR30TW 0.30 HR30TW 0.58 HR45TW 0.23 HR45TW 0.37 HR45TW 0.39 HR15N 0.45 HR15N 0.29 HR15N 0.32 HR30N 0.67 HR30N 0.25 HR30N 0.65 HR45N 0.47 HR45N 0.42 HR45N	ASTM E18 ASTM E110
Electrical Conductivity Meters (% IACS) – Generate Stated Value	24.87 % 44.93 % 58.60 %	0.28 % IACS 0.49 % IACS 0.69 % IACS	Eddy current conductivity standards
Gas Flow ³ – Flow Meters & Rotameters	(1 to 100) SCCM (0.1 to 1000) SLPM	1.1 %	CME FCS-8A & Laminar flow elements



VII. Thermodynamic

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature ³ – Measuring Equipment	(-50 to 200) °C (200 to 400) °C	0.019 °C 0.11 °C	PRT w/1502A
Temperature ³ – Measure – Ovens, Baths, Dry Blocks	(-50 to 200) °C (200 to 400) °C	0.019 °C 0.11 °C	PRT w/1502A
Infrared Thermometers ³	(50 to 100) °C (100 to 300) °C (300 to 500) °C	0.65 °C 0.81 °C 1.0 °C	Fluke 9132
Relative Humidity ³	(10 to 95) % RH	1.2 % RH	Rotronic hygrometer

VIII. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment	1 Hz to 10 Mhz 10 MHz to 1 GHz	1.2 parts in 10 ⁸ Hz/Hz 1.2 parts in 10 ⁸ Hz/Hz	Monitored with GPS conditioned counter HP 3325a Giga-Tronics 6061A
Frequency – Measure	10 Hz to 1 GHz	1.7 parts in 10 ⁹ Hz/Hz	GPS conditioned Agilent 5386A

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

² 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.

- 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 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.
- ⁴ 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.
- ⁵ Based on using the standard at the temperature the Fluke 5520A was calibrated (± 5 °C) and assuming the instrument was zeroed at least every seven days or when the ambient temperature changes more than 5 °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 ± 1 °C of use. For AC Current, CMC's are determined with LCOMP off.
- ⁶ 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.
- ⁷ Deflection is the maximum deviation from the reference plane.
- ⁸ In the statement of CMC, the value is defined as the percentage of reading, unless otherwise noted.
- ⁹ 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.



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 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSLI 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 22nd day of August 2016.

A handwritten signature in black ink, written over a horizontal line.

President & CEO
For the Accreditation Council
Certificate Number 1855.01
Valid to July 31, 2018
Revised June 08, 2018

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