



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSLI Z540.3-2006

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CALIBRATION

Valid To: June 30, 2014

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	(2 to 12) pH unit	0.03 pH unit	Using certified standards

II. Dimensional

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Gage Blocks Sphere Diameter	(0.010 to 4) in (0.245 to 102) mm	1.9L µin 0.19 µm	P&W Labmaster (UMM) & gage blocks
Length Standards – 1D	Up to 10 in (11 to 36) in (37 to 72) in	(26 + 4.0L) µin (34 + 4.0L) µin (270 + 4.0L) µin	Supermicrometer Linear amplifier w/ probe, gage blocks, & surface plate

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Cylindrical Plug Gage	Up to 4 in (5 to 6) in	19 μin 35 μin	P&W Labmaster (UMM), gage blocks
Pin Gage	(0.011 to 1) in (0.22 to 25.4) mm	(26 + 4.0L) μin (0.66 + 4.0L) μm	Supermicrometer
Angularity	1", 3", 5", 20", 30" 1', 3', 5', 20', 30' 1°, 3°, 5°, 15°, 30°, 45°	5 seconds	Angle blocks
Flatness ³	Up to 1 μin Deflection ⁷	6.6 μin	Optical flat and monochromatic light
Roundness/ Concentricity	0.01 in Deflection ⁷	5 μin	Roundness tester
Dial Indicator ³	Up to 1 in: 0.000 05 in resolution 0.0001 in resolution 0.0005 in resolution 0.001 in resolution >1 in	47 μin 69 μin 150 μin 290 μin (290 + 4.0L) μin	Indicator calibrator Indicator calibrator and gage blocks
Test Indicator ³	Up to 0.2 in: 0.000 05 in resolution 0.0001 in resolution 0.0005 in resolution 0.001 in resolution	47 μin 69 μin 150 μin 290 μin	Indicator calibrator
Bore Gages ³	Up to 12 in	44 μin	Gage blocks and cylindrical rings
Height Gages ⁷	Up to 48 in: 0.001 in resolution 0.0005 in resolution	(33 + 4.0L) μin (33 + 4.0L) μin	Gage blocks and surface plates

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Height Masters ³	Up to 12 in Up to 18 in Up to 24 in	86 μin 130 μin 180 μin	Linear amplifier w/ probe and gage blocks
Calipers ³	Up to 6 in (6 to 72) in	290 μin (290 + 4.0L) μin	Gage blocks and cylindrical rings
Intertest/Oditest	Up to 2 in: 0.0005 in resolution 0.001 in resolution	(150 + 4.0L) μin (290 + 4.0L) μin	
Snap (Jaw)	Up to 2 in: 0.0005 in resolution 0.001 in resolution	(150 + 4.0L) μin (290 + 4.0L) μin	
Micrometers ³ –			
Depth	Up to 12 in: 0.001 in resolution 0.0001 in resolution	(290 + 4.0L) μin (60 + 4.0L) μin	Gage blocks <i>L</i> is the measured displacement in inches
Groove	Up to 6 in: 0.001 in resolution	(290 + 4.0L) μin	
O.D.	Up to 6 in: 0.000 05 in resolution	(31 + 4.0L) μin	
	Up to 26 in: 0.0001 in resolution	(60 + 4.0L) μin	
	Up to 36 in: 0.001 in resolution	(290 + 4.0L) μin	
I.D.	Up to 10 in >10 in	(30 + 4.0L + 0.6R) μin (290 + 4.0L + 0.6R) μin	
Thread Micrometers (Screw Thread, Pitch, Point) ³	Up to 2 in: 0.0001 in resolution 0.001 in resolution	(60 + 40L) μin 23 seconds on angularity (290 + 40L) μin 23 seconds on angularity	Optical comparator and gage blocks
Hole Micrometers ³	Up to 6 in: 0.000 05 in resolution 0.0001 in resolution 0.0005 in resolution 0.001 in resolution	(61 + 40L) μin (79 + 40L) μin (110 + 40L) μin (300 + 40L) μin	Cylindrical rings

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Sine Plates/Bars – Flatness	(5, 10, 15) in	6.6 μin	Optical flat and monochromatic light
Parallelism	(5, 10, 15) in	35 μin	Linear amplifier w/ probe and surface plate
Angle Calibration	Up to 45°	3.9 seconds	Linear amplifier w/ probe, gage blocks, angle blocks and surface plate
Thickness Gages ³ – Dial and Digital	Up to 1 in: 0.0005 in resolution 0.001 in resolution	(150 + 4.0L) μin (290 + 4.0L) μin	Gage blocks
Chamfer Gages/Hole Gages ³	Up to 2 in: 0.001 in resolution 0.002 in resolution	(300 + 4.0L) μin (580 + 4.0L) μin	Cylindrical rings
Linear Gage Amplifier w/ Probe ³	---	(6R + 4.0) μin	Gage blocks
Riser Blocks and Stands	Up to 24 in	6.5H μin	Gage blocks and gage amplifier w/ probe
Clinometers and Inclinometers ³	360°	2.6"	Sine bar and gage blocks
Straightness and Straight Edges	Up to 60 in	55 μin	Linear amplifier w/ probe, gage blocks, and surface plate
V-Blocks – Parallelism Side V	Up to 8 in × 8 in × 8 in	35 μin	Linear amplifier w/ probe, surface plate and master setting disk
Squareness		38 μin	

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Indicator Calibrator ³	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	35 μin 38 μin	Linear amplifier w/ probe and surface plate
Microscopes ³ – Reticule	Up to 50 mm	11 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 0.007 in/25 ft 0.0011 in 0.018 in	Horizontal Trimos w/ microscope attachment
Squareness – Perpendicularity	Up to 24 in	35 μin	Linear amplifier w/ probe, surface plate and gage block
Parallels – Steel Granite	1.5 in × 6 in 8 in × 48 in	35 μin 35 μin	Linear amplifier w/ probe and surface plate
Snap Gages ³	Up to 3 in	(4.2 + 4.0L) μin	Gage amplifier w/gage block
Plain Ring Gages – I.D. Measurements	(0.125 to 4) in (5 to 10) in	19 μin 53 μin	P&W Labmaster (UMM), gage blocks

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
<p>Thread Plugs/Thread Lead – Measure Angle Measurement</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>(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>23 seconds of angularity</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>(3.1 + 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>(120 + 4.0L) μin</p>	<p>Supermicrometer w/ thread measuring wires and:</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: 1985</p> <p>BS2779: 1986</p>
<p>Thread Rings –</p> <p>Screw:</p> <p>Standard 60°</p> <p>Acme</p> <p>Stub Acme w/ 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>(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>(140 + 4.0L) μin</p> <p>(140 + 4.0L) μin</p> <p>(140 + 4.0L) μin</p> <p>(140 + 4.0L) μin</p> <p>(3.6 + 4.0L) μin</p> <p>(180 + 4.0L) μin</p> <p>(180 + 4.0L) μin</p> <p>(180 + 4.0L) μin</p> <p>(180 + 4.0L) μin</p> <p>(180 + 4.0L) μin</p>	<p>Master plug set and:</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>
Benchmics ³ – Supermicrometers	Up to 10 in	(19 + 4.0L) μin	Gage blocks
Depth Gage ³	Up to 12 in	(20 + 4.0L) μin	Gage blocks
Coating Thickness Gages ³	Up to 65 mils	30 μin	Thickness standards

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Surface Plates ³ – Flatness	12 in to 20 ft	$1.8\sqrt{D}$	Renishaw laser Interferometer <i>D</i> is the diagonal in inches
Optical Comparators ³ – Angularity XY Linearity Magnification	(15° / 30° / 45°) (0.010 to 6) in 10x, 20x, 31.25x, 50x, 62.5x, 100x	19’ 73 μin 110 μin	Angle blocks Glass master scale Glass scale & magnification spheres
Roundness Testers ³ –	---	3.6 μin	Calibration sphere and 3/5 in gage block
Angle Plates	Up to 36 in	38 μin	Cylindrical square and linear amplifier w/ probe
Angle Blocks – Non-Precision	0° to 90° 10’ / 20’ / 30’ 2” / 3”	1.2’ 1.2’ 1.2’	Linear amplifier w/ probe and master angle blocks
Protractor ³ – Digital and Mechanical	0° to 180°	$0.6R + 0.06 \% \text{ rdg}$	Angle blocks
Levels (Machinist) ³	Up to 96 in	$(36 + 0.6R) \mu\text{in}$	Gage blocks
Radius Gage	Up to 1 in	0.000 26 in	Optical comparator
Feeler/Thickness Gage	Up to 0.2 in	$(26 + 4.0L) \mu\text{in}$	Supermicrometer and gage blocks
Thread Wires	Up to 0.2in	$(26 + 4.0L) \mu\text{in}$	Supermicrometer and gage blocks

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
CMM ³ –			
Linear Displacement Accuracy: X, Y, Z	Up to 200 in	(9 + 1.3L) μin	Renishaw laser Interferometer
Volumetric Repeatability	72 in (end to end)	0.000 35 in	Ball bar
Squareness	Up to 24 in	72 μin	Granite square

III. Dimensional Testing/Calibration

Parameter/Equipment	Range	CMC ² (±)	Comments
Linear Measure (CMM) ^{3,9} – 1D	Up to 48 in	0.001 m	Faro articulating arm CMM

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,4,8} (±)	Comments
DC Voltage ³ – Measure	(10 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V (1 to 20) kV	11 μV/V + 0.3 μV 10 μV/V + 0.3 μV 10 μV/V + 0.5 μV 12 μV/V + 30 μV 12 μV/V + 100 μV 0.3 % + 0.1 V	HP 3458A opt 002, Vitretek 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	21 μV/V + 1 μV 12 μV/V + 2 μV 13 μV/V + 20 μV 19 μV/V + 150 μV 19 μV/V + 1.5 mV	Fluke 5520A

Parameter/Equipment	Range	CMC ^{2,4,5,8} (±)	Comments
DC Current ³ – Measure	Up to 100 μ A 100 μ A to 10 mA (10 to 100) mA 100 mA to 1 A 1 to 500 A	22 μ A/A + 0.8 nA 22 μ A/A + 0.05 μ A 37 μ A/A + 0.05 μ A 0.011 % + 10 μ A 0.3 %	HP 3458A Empro shunt
DC Current ³ – Generate	(10 to 330) μ A 330 μ A 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	0.016 % + 0.02 μ A 0.011 % + 0.05 μ A 0.011 % + 0.25 μ A 0.012 % + 2.5 μ A 0.021 % + 40 μ A 0.039 % + 40 μ A 0.051 % + 0.5 mA 0.1 % + 0.75 mA	Fluke 5520A
Clamp Meter	(0 to 1000) A	0.6 %	w/ 5500A coil
DC Power ³ – (0.33 to 30) mA (0.33 to 3) A (3 to 20) A	33 mV to 1020 V	0.024 % + 0.0008 % FS 0.022 % + 0.0008 % FS 0.07 % + 0.0008 % FS	Fluke 5520A
Resistance ³ – Measure	(1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	20 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 18 $\mu\Omega/\Omega$ + 0.5 m Ω 15 $\mu\Omega/\Omega$ + 0.5 m Ω 16 $\mu\Omega/\Omega$ + 5 m Ω 16 $\mu\Omega/\Omega$ + 5 m Ω 19 $\mu\Omega/\Omega$ + 2 Ω 51 $\mu\Omega/\Omega$ + 100 Ω 0.05 % + 1 k Ω 0.6 % + 10 k Ω	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 k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω	42 $\mu\Omega/\Omega$ + 0.01 Ω 43 $\mu\Omega/\Omega$ + 0.015 Ω 31 $\mu\Omega/\Omega$ + 0.015 Ω 32 $\mu\Omega/\Omega$ + 0.02 Ω 30 $\mu\Omega/\Omega$ + 0.01 Ω 31 $\mu\Omega/\Omega$ + 0.02 Ω 31 $\mu\Omega/\Omega$ + 0.02 Ω 31 $\mu\Omega/\Omega$ + 1 Ω 30 $\mu\Omega/\Omega$ + 1 Ω	Fluke 5520A

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Resistance ³ – Generate (cont.)	(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	35 μΩ/Ω + 10 Ω 34 μΩ/Ω + 10 Ω 61 μΩ/Ω + 150 Ω 0.013 % + 250 Ω 0.025 % + 2500 Ω 0.5 % + 3000 Ω	Fluke 5520A
Stated Value	(0.001, 0.01, 0.1, 1, 10, 100, 1000) Ω, (10, 100) kΩ, 1 MΩ	0.01 %	Biddle 601240; L&N 4222-B, 4221, 4020-B, 4030-B, 4035-B, 4025-B, 4045-B, 4050-B
Oscilloscope Calibration 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 % + 300 μV 3.5 % + 300 μV 4 % + 300 μV 6 % + 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 % + 100 μV 4 % + 100 μV	
Time Marker 50 Ω Generate and 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 , Low Frequency	(33 to 330) mV 3.3 mA to 20 A 330 mV to 1020 V 3.3 mA to 20 A	0.14 % + 0.0082 % FS 0.12 % + 0.0082 % FS	Fluke 5520A

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Electrical Calibration of Thermocouple Indicators & Indicating Systems ³ – Type E Type J Type K Type R Type S Type T	-250 °C to 1000 °C -210 °C to 1200 °C -200 °C to 1372 °C 0 °C to 1767 °C 0 °C to 1767 °C -150 °C to 400 °C	0.40 °C 0.30 °C 0.35 °C 0.5 °C 0.5 °C 0.20 °C	Fluke 5520A
Electrical Calibration of RTD Indicators & Indicating Systems ³ – Pt 385, 100 Ω Pt 3926, 100 Ω PtNi 385, 120 Ω	-200 °C to 630 °C 630 °C to 800 °C -200 °C to 630 °C -80 °C to 260 °C	0.13 °C 0.24 °C 0.13 °C 0.15 °C	Fluke 5520A
Capacitance – Generate, at 1 kHz Stated Value	(10, 100, 1000) pF	0.02 %	GenRad 1404A, 1404B, 1404C
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)

Parameter/Range	Frequency	CMC ^{2, 4, 5, 8} (±)	Comments
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 pA 0.16 % + 0.03 pA 0.07 % + 0.03 pA	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 % + 0.4 mA	
(1 to 250) A	10 Hz to 20 kHz	0.4 %	Empro shunt
(20 to 1000) A	(45 to 65) Hz	0.3 %	Fluke 5520A w/ 5500A coil
AC Current ³ – Generate			
(29 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	40 Hz to 1 kHz	0.14 % + 0.1 µA 0.11 % + 0.15 µA 0.05 % + 2 µA 0.05 % + 2 µA 0.07 % + 100 µA 0.08 % + 1 mA 0.12 % + 2 mA 0.16 % + 5 mA	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2,5} (±)	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	0.09 % + 6 μV 0.03 % + 6 μV 0.03 % + 6 μV 0.1 % + 6 μV 0.36 % + 12 μV 0.8 % + 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	0.04 % + 8 μV 0.03 % + 8 μV 0.03 % + 8 μV 0.05 % + 8 μV 0.09 % + 32 μV 0.21 % + 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	0.04 % + 50 μV 0.03 % + 25 μV 0.03 % + 50 μV 0.04 % + 50 μV 0.09 % + 130 μV 0.25 % + 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	0.03 % + 650 μV 0.02 % + 200 μV 0.03 % + 600 μV 0.04 % + 600 μV 0.09 % + 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	0.02 % + 2 mV 0.02 % + 6 mV 0.03 % + 6 mV 0.03 % + 6 mV 0.20 % + 50 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.03 % + 10 mV 0.03 % + 10 mV 0.03 % + 10 mV	

Parameter/Range	Frequency	CMC ^{2,4,8} (±)	Comments
AC Voltage ³ – Measure			
Up 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	0.04 % + 0.03 % rng 0.03% + 0.011% rng 0.04 % + 0.011 % rng 0.1 % + 0.011 % rng 0.5 % + 0.011 % rng 4 % + 0.02 % rng	HP 3458A
10 mV 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 1 MHz (1 to 2) MHz	0.02 % + 0.004 % rng 0.02 % + 0.002 % rng 0.026 % + 0.002 % rng 0.04 % + 0.002 % rng 0.09 % + 0.002 % rng 0.31 % + 0.01 % rng 1 % + 0.01 % rng 1.5 % + 0.01 % rng	
(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 300 kHz to 1 MHz	0.03 % + 0.002 % rng 0.04 % + 0.002 % rng 0.05 % + 0.002 % rng 0.13 % + 0.002 % rng 0.4 % + 0.002 % rng 1.5 % + 0.01 % rng	
(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	0.05 % + 0.004 % rng 0.05 % + 0.002 % rng 0.07 % + 0.002 % rng 0.13 % + 0.002 % rng 0.3 % + 0.002 % rng	
(1 to 10) kV	(30 to 200) Hz	0.45 % + 0.1 V	Vitrek 4700

V. Electrical – RF/Microwave

Parameter/Equipment	Frequency	CMC ^{2,8} (±)	Comments
Distortion – Measure	20 Hz to 100 kHz	2 dB	HP 8903B
RF Power – Measure Absolute (+30 to -20) dbm	100 kHz to 1.3 GHz	0.06 dB	HP 8902A HP11722A
RF Power – Measure Relative	2.5 MHz to 1.3 GHz	0.06 dB	HP 8902A, HP11722A
Amplitude Modulation – Measure 150 kHz to 10 MHz (10 to 1300) MHz	(20 to 50) Hz 50 Hz to 10 kHz (20 to 50) Hz 50 Hz to 100 kHz	3 % 3 % 3 % 3 %	HP 8902A HP11722A
Frequency Modulation – Measure Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz Rate: (10 to 1300) MHz Dev: < 400 kHz	20 Hz to 10 kHz (20 to 50) Hz 50 Hz to 100 kHz (100 to 200) kHz	3 % 3 % 3 % 3 %	HP 8902A HP11722A

Parameter/Equipment	Frequency	CMC ² (±)	Comments
Tuned RF Power, Relative – Measure ³			
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		0.12 dB	
(-40 to -50) dB		0.13 dB	
(-50 to -80) dB		0.09 dB	
(-80 to -90) dB		0.11 dB	
(-90 to -110) dB		0.13 dB	
(-110 to -127) dB		0.30 dB	

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Mass	(0 to 200) g (200 to 500) g 500 g to 2 kg (2 to 35) kg	0.044 mg 2.2 mg 12 mg 1.0 g	Class 1 weights, by direct reading
Pressure ³ – Gauges	(2 to 300) psi (301 to 10 000) psi	0.02 % + 0.02 psi 0.03 %	Deadweight tester
Vacuum ³ – Gauges	(0 to 30) inHg	0.1 %	Pressure transducer
Torque ³ – Wrenches, Screwdrivers & Analyzers	(1 to 100) in·lb (1 to 2000) ft·lb	0.2 % 0.2 %	Torque calibration system
Tachometers ³ – Photo Contact	(0 to 100 000) rpm (0 to 5000) rpm	0.05 % + 1.2R 3.3 rpm	Function generator Tachometer

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Scales and Analytical Balances ³	0.01 mg to 1 g (1 to 10) g (10 to 100) g (100 to 500) g (500 to 1000) g (1 to 10) kg (10 to 14) kg (14 to 450) kg	0.04 mg + 0.6R 0.06 mg + 0.6R 0.3 mg + 0.6R 1.4 mg + 0.6R 3 mg + 0.6R 30 mg + 0.6R 60 mg + 0.6R 0.013 %	Class 1 weights Class F weights
Force ³ – Tension and Compression, Dynamometers, Spring Testers	(1 to 1000) lbf (1000 to 100 000) lbf	0.06 % 0.06 %	Load cells and weights
Direct Verification of Durometer Spring Force – Shore Types A, D, M, and O	(0 to 100) duro units	0.4 duro units	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)	0.037 mm 0.029 mm	ASTM E10-12 ASTM E110-10
Indirect Verification of Knoop Hardness Tester	HK (250 to 650) HK (>650)	0.49 µm 0.52 µm	ASTM E384-11
Indirect Verification of Vickers	HV 300 (>600) HV 500 (250 to 350)	0.62 µm 0.78 µm	ASTM E384-11

Parameter/Equipment	Range	CMC ² (±)	Comments
Indirect Verification of Rockwell and Rockwell Superficial Hardness Testers ³ – Portable Hardness Testers	HRC (20 to 30)	0.75 HRC	ASTM E18-11 ASTME110-10
	HRC (35 to 55)	0.75 HRC	
	HRC (60 to 65)	0.70 HRC	
	HRBW (40 to 59)	0.98 HRBW	
	HRBW (60 to 79)	0.98 HRBW	
	HRBW (80 to 100)	0.78 HRBW	
	HRA(20 to 65)	0.81 HRA	
	HRA (70 to 78)	0.70 HRA	
	HRA (80 to 84)	0.64 HRA	
	HRHW (90 to 94)	0.93 HRHW	
	HRHW (96 to 100)	0.77 HRHW	
	HREW (70 to 79)	0.77 HREW	
	HREW (84 to 90)	0.84 HREW	
	HREW (93 to 100)	0.86 HREW	
	HR15TW (47 to 80)	0.76 HR15TW	
	HR15TW (81 to 86)	0.76 HR15TW	
	HR15TW (87 to 93)	0.67 HR15TW	
	HR30TW (43 to 56)	0.86 HR30TW	
	HR30TW (57 to 69)	0.80 HR30TW	
	HR30TW (70 to 83)	0.72 HR30TW	
HR45TW (13 to 32)	0.86 HR45TW		
HR45TW(33 to 52)	0.79 HR45TW		
HR45TW (53 to 73)	0.74 HR45TW		
HR15N (70 to 77)	0.78 HR15N		
HR15N (78 to 88)	0.78 HR15N		
HR15N (90 to 92)	0.74 HR15N		
HR30N (42 to 50)	0.89 HR30N		
HR30N (55 to 73)	0.89 HR30N		
HRN30N (77 to 83)	0.66 HR30N		
HR45N (20 to 31)	0.79 HR45N		
HR45N (37 to 61)	0.79 HR45N		
HR45N (66 to 72)	0.61 HR45N		

VII. Thermodynamic

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measure ³	(-50 to 350) °C	0.1 °C	Burns PRT
Infrared Thermometers	50 °C to 500 °C	1.5 °C	Fluke 9132
Relative Humidity – Measure	(10 to 90) % RH	1.5 % RH	Rotronic hygrometer

VIII. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment Measure	 1 Hz to 50 kHz 50 kHz to 1GHz 1 Hz to 500 kHz 100 kHz to 1GHz	 5 parts in 10 ¹⁰ 5 parts in 10 ¹⁰ 8 parts in 10 ¹⁰ 8 parts in 10 ¹⁰	 Phase locked to GPS receiver: Agilent 83752A HP53131A Agilent 5386A

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

² Calibration and Measurement Capability (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. Calibration and Measurement Capabilities 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 Based on using the standard at the temperature the HP 3458A was calibrated ($t_{cal} \pm 5 \text{ }^\circ\text{C}$) and an auto-calibration (ACAL) was performed with the previous 24 hours ($\pm 1 \text{ }^\circ\text{C}$ of ambient temperature), the CMC is based on 1-year specifications and is read as percent reading plus percent of range.
- ⁵ Based on using the standard at the temperature the Fluke 5520A 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.
- 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.



American Association for Laboratory Accreditation

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 Z540.3-2006 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 13th day of August 2012.





President & CEO

For the Accreditation Council
Certificate Number 1855.01
Valid to June 30, 2014

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