SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994 & ANSI/NCSLI Z540.3-2006

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CALIBRATION

Valid To: June 30, 2012 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[1]:

I. Chemical Quantities

Parameter/Equipment	Range	CMC[2] (±)	Comments
pH Meters	(2 to 14) pH unit	0.005 pH unit	Using certified standards

II. Dimensional

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Gage Blocks, Sphere Diameter	(0.010 to 4) in (0.254 to 102) mm	4.1 µin 0.12 µm	Laser interferometer and gage blocks
Length Standards	(0 to 18) in (18 to 36) in	(20 + 8*L*) µin (240 + 4*L*) µin	Supermicrometer and horizontal Trimos
Cylindrical Plug Gage	(0 to 6) in	(10 + 3*D*) µin	Laser interferometer and gage blocks

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Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Pin Gage	(0.011 to 1) in (0.22 to 25.4) mm	(20 + 8*L*) µin (0.51 + 0.18*L*) µm	Supermicrometer
Angularity	1”, 3”, 5”, 20”, 30” 1’, 3’, 5’, 20’, 30’ 1°, 3°, 5°, 15°, 30°, 45°	5” 5” 5”	Angle blocks
Flatness[3]	(2 to 100) µin Deflection[7]	4.8 µin	Optical flat and monochromatic light
Roundness/ Concentricity	0.01 in Deflection[7]	5 µin	Roundness tester
Dial Indicator[3]	(0 to 4) in	0.6*R*	Indicator calibrator
Test Indicator[3]	(0 to 0.06) in	0.6*R*	Indicator calibrator and gage blocks
Bore Gages[3]	(0 to 12) in	(0.6*R* + 10*L*) µin	Gage blocks and cylindrical rings
Height Gages[7]	(0 to 48) in	(0.6*R* + 10*L*) µin	Gage blocks
Height Masters[3]	(0 to 24) in	(12 + 8*H*) µin	Gage blocks and gage amplifier w/ probe
Calipers[3]	(0 to 80) in	(0.6*R* + 10*L*) µin	Gage blocks and cylindrical rings
OD Micrometers[3] ID Micrometers[3] Depth Micrometers[3]	(0 to 42) in (0 to 294) in (0 to 12) in	(0.6*R* + 10*L*) µin	Gage blocks and cylindrical rings

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Tri-Bores[3]	(0 to 6) in	(0.6*R* + 10*L*) µin	Gage blocks and cylindrical rings
Intertest Calipers[3]	(0 to 4) in	(0.6*R* + 52) µin	Cylindrical rings
Oditest Calipers[3]	(0 to 4) in	(0.6*R* + 52) µin	Gage blocks
Sine Plates/Bars –			
Flatness	(2 to 100) µin	4.8 µin	Optical flat and monochromatic light
Parallelism	(0 to 20) in	50 µin	Gage amplifier w/ probe
Parallelism Cylinder to Base	– – –	50 µin	
Angle Calibration	– – –	4 min	Angle blocks
Thickness Gages[3] – Dial and Digital	(0 to 1) in	(0.6*R* + 52) µin	Gage blocks
Chamfer Gages/Hole Gages[3]	(0 to 12) in	(0.6*R* + 20*L*) µin	Cylindrical rings
Gage Amplifier w/ Probe[3]	– – –	(0.6*R* + 4) µin	Gage blocks
Riser Blocks and Stands	(0 to 24) in	(12 + 8*H*) µin	Gage blocks and gage amplifier w/ probe
Clinometers and Inclinometers[3]	360°	(0.6*R* + 16) min	Sine bar and gage blocks
Cylindrical Squares	(0 to 12) in	14 µin + 0.0008 % FS	Gage amplifier w/ probe

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Straightness and Straight Edges	(0 to 60) in	50 µin	Gage amplifier w/ probe
Groove Micrometers[3]	(0 to 4) in	(0.6*R* + 50) µin	Gage blocks
Snap (Jaw) Calipers[3]	(0 to 12) in	(0.6*R* + 50) µin	Gage blocks
V-Blocks – Parallelism Side V Squareness	Up to 8 in × 8 in × 8 in	 14 µin 20 µin (28 + 8*H*) µin	 Gage amplifier w/ probe and cylindrical square Cylindrical plug
Indicator Calibrator[3]	– – –	(0.6*R* + 11) µin	Gage blocks
Box Parallels – Parallelism Squareness	Up to 5 in × 10 in × 10 in	 (12 + 20*H*) µin (24 + 12*H*) µin	 Gage amplifier w/ probe and cylindrical square
Microscopes[3]– Reticule Magnification	 (0 to 25) mm Up to 1000x	 23 µm 3.6 µm	 Glass scale
Rules & Scales	100 in	(170 + 5*L*) µin	Horizontal Trimos w/ microscope attachment
Tape Measures	(0 to 300) ft	0.06 in	Horizontal Trimos w/ microscope attachment
PI Tapes	(0 to 48) in (48 to 780) in	200 µin + 0.0004 % of *L* 0.0013 in + 0.0006 % of *L*	Horizontal Trimos w/ microscope attachment

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Squareness – Perpendicularity	(0 to 24) in	0.00015 in	Gage amplifier w/ probe
Parallels –			Gage amplifier w/ probe; *L* is the distance between the parallel surfaces.
Steel	1.5 in × 6 in	(8.6 + 5*L*) µin	
Granite	8 in × 48 in	(8.6 + 2.8*L*) µin	
Snap Gages[3]	(0 to 3) in	0.0002 in	Gage amplifier w/gage block
Height Measures[3]	(0 to 24) in	0.00025 in	Height gage and gage amplifier w/ probe
Thread Micrometers (Screw thread, Pitch, Point)[3]	(0 to 4) in	(0.6*R* + 10*L*) µin	Pitch standard; *L* is the measured displacement in inches.
Plain Ring Gages – I.D. Measurements	(0.25 to 10) in	7.5 µin	Laser interferometer and gage blocks
Thread Plugs –			Supermicrometer w/ thread measuring wires and:
Screw:			
Standard 60°	(0.0625 to 10) in	40 µin	ASME B1.2
Acme	(0.0625 to 10) in	40 µin	ASME B1.5
Stub Acme	(0.0625 to 10) in	40 µin	ASME B1.8
Buttress Inch	(0.0625 to 10) in	40 µin	ASME B1.9)
Metric	(1.58 to 254) mm	1.1 µm	ASME B1.16M
Pipe:			
Inch (NPT, NPSM, NPSL)	(0.0625 to 10) in	53 µin	ASME B1.20.1
Inch (ANPT)	(0.0625 to 10) in	53 µin	MIL P-7105B
Dryseal	(0.0625 to 10) in	53 µin	ASME B1.20.5
British Taper	(0.0625 to 10) in	53 µin	BS21: 1985
British Parallel	(0.0625 to 10) in	53 µin	BS2779: 1986

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Thread Rings –			Master plug set and:
Screw:			
Standard 60°	(0.0625 to 10) in	170 µin	ASME B1.2
Acme	(0.0625 to 10) in	170 µin	ASME B1.5
Stub Acme w/	(0.0625 to 10) in	170 µin	ASME B1.8
Buttress Inch	(0.0625 to 10) in	170 µin	ASME B1.9
Metric	(1.58 to 254) mm	190 µm	ASME B1.16M
Pipe:			
Inch (NPT, NPSM, NPSL)	(0.0625 to 10) in	190 µin	ASME B1.20.1
Inch (ANPT)	(0.0625 to 10) in	190 µin	MIL P-7105B
Dryseal	(0.0625 to 10) in	190 µin	ASME B1.20.5
British Taper	(0.0625 to 10) in	190 µin	BS21
British Parallel	(0.0625 to 10) in	190 µin	BS2779
Benchmics[3]	(0 to 2) in	30 µin	Gage blocks
Depth Gage[3]	(0 to 8) in	$(0.6R + 10L)$ µin	Gage blocks
Coating Thickness Gages[3]	(0 to 65) mils	$(0.6R + 50)$ µin	Thickness standards
Surface Plates[3] –			
Flatness	18 in to 20 ft	$(10 + 0.07L^2)$ µin	Laser measurement system
Repeat Reading	18 in to 20 ft	12 µin	Repeat-o-meter
Optical Comparators[3] –			
Angularity	(0 to 360)º	$(0.6R + 30)''$	Glass master scale
XY Linearity	(0.010 to 6) in (6 to 30) in	63 µin 62 µin	Glass master scale Gage blocks
Magnification	1x to 100x	87 µin	Glass scale & magnification spheres
Edge Detection	---	0.0001 in	Magnification spheres

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Roundness Testers[3] –			
Axial Error	– – –	3 µin	Calibration sphere and riser cylinder
Radial Accuracy	– – –	3 µin	
Coning Error	– – –	4 µin + 0.8 µin/in of height	
Angle Plates	(0 to 36) in	(20 + 8*L*) µin	Cylindrical square and gage amplifier w/ probe
Angle Blocks	0° to 90°	16′	Amplifier with probe and master angle blocks
Protractor[3] – Digital and Mechanical	0° to 180°	0.6*R* + 0.01 % of rdg	Angle blocks
Levels (Machinist)[3]	Up to 96 in	0.00015 in/ft	Gage blocks
Radius Gage	Up to 1 in	0.00026 in	Optical comparator
	(1 to 10) in	0.002 in	Articulating arm CMM
Feeler/Thickness Gage	Up to 0.2 in	36 µin	Supermicrometer
Fixed Gauging – Screw Pitch, Drill, Taper, Center, Sheet and Wire, Angle	– – –	0.0002 in (length measures)	Supermicrometer
		4′ (angular)	Optical comparator
Thread Wires	(0 to 0.5) in	4 µin	Laser measurement system

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
CMM[3] –			
Linear Displacement Accuracy: X, Y, Z	(0 to 80) in (0 to 500) in	(10 + 2*L*) μin (15 + 1.3*L*) μin	Reference bar Laser measurement system
Volumetric Performance	72 in (end to end)	100 μin	Ball bar
Squareness	Up to 24 in	36″	Granite square

III. Dimensional Testing/Calibration[8]

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Length[3]	(12 to 1600) in	(15 + 1.3*L*) μin + 0.6*R* μin	Laser measurement system
Linear Measure (CMM)[3]	(0 to 48) in (0 to 100) ft	0.002 in 0.002 in + 30 μin /ft	Faro articulating arm CMM Faro laser tracker

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4, 6] (±)	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	0.0011 % of rdg + 0.0003 % FS 0.001 % of rdg + 0.00003 % FS 0.001 % of rdg + 0.000005 % FS 0.0012 % of rdg + 0.00003 % FS 0.0012 % of rdg + 0.00001 % FS*	HP 3458A opt 002, Math Null, *12μV/V(V_{in}/1000)^2 for inputs >100 V
	(1 to 20) kV	1.2 % of rdg	Fluke 80K-40 with DMM

Parameter/Equipment	Range	CMC[2, 4, 5, 6] (±)	Comments
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	0.002 % of rdg + 1 mV 0.0011 % of rdg + 2 mV 0.0012 % of rdg + 15 mV 0.0018 % of rdg + 150 mV 0.0018 % of rdg + 1.5 V	Fluke 5520A
DC Current[3] – Measure	100 nA 1 µA 10 µA to 10 mA 100 mA 1 A (1 to 10) A (10 to 20) A	0.0036 % of rdg + 0.046 % FS 0.0023 % of rdg + 0.0046 % FS 0.0023 % of rdg + 0.0012 % FS 0.004 % of rdg + 0.0006 % of FS 0.013 % of rdg + 0.0012 % of FS 0.015 % rdg + 0.0012 % FS 0.015 % of rdg + 0.0012 % FS	HP 3458A L&N 4222 Biddle 601240
DC Current[3] – Generate Clamp Meter	(10 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 (2 to 11) A (11 to 20.5) A (0 to 1000) A	0.015 % of rdg + 0.02 µA 0.01 % of rdg + 0.05 µA 0.01 % of rdg + 0.25 µA 0.01 % of rdg + 2.5 µA 0.02 % of rdg + 40 µA 0.038 % of rdg + 40 µA 0.05 % of rdg + 0.5 mA 0.1 % of rdg + 0.75 mA 0.6 % of rdg	Fluke 5520A Fluke 20A with 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 % of rdg + 0.0008 % FS 0.022 % of rdg + 0.0008 % FS 0.07 % of rdg + 0.0008 % FS	Fluke 5520A
Resistance[3] – Measure	(1 to 10) Ω (10 to 100) Ω 100 Ω to 100 kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	0.0018 % of rdg + 0.0005 % FS 0.0015 % of rdg + 0.0005 % FS 0.0013 % of rdg + 0.0.0005 % FS 0.0018 % of rdg + 0.0002 % FS 0.0053 % of rdg + 0.001 % FS 0.05 % of rdg + 0.001 % FS 0.5 % of rdg + 0.001 % FS	HP 3458A

Parameter/Equipment	Range	CMC[2, 5, 6] (±)	Comments
Resistance[3] – Generate	1 Ω to 1 MΩ	0.006 % of rdg + 0.1 Ω	Fluke 5520A
Cardinal Points	(0.001, 0.01, 0.1) Ω	0.01 % of rdg	Biddle 601240, L&N 4222-B, 4221, 4020-B, 4030-B, 4035-B, 4025-B, 4045-B, 4050-B
	(1, 10, 100, 1000) Ω, (10, 100) kΩ 1 MΩ	0.009 % of rdg	
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 % of rdg + 48 µV 0.28 % of rdg + 120 µV 0.28 % of rdg + 1.2 mV 0.28 % of rdg + 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 % of rdg + 48 µV 0.12 % of rdg + 120 µV 0.12 % of rdg + 1.2 mV 0.12 % of rdg + 12 mV	
Leveled Sine Wave Amplitude @ 50 kHz ref	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2 % of rdg + 300 µV 3.5 % of rdg + 300 µV 4 % of rdg + 300 µV 6 % of rdg + 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 % of rdg + 100 µV 2 % of rdg + 100 µV 4 % of rdg + 100 µV	
Time Marker 50 Ω Generate and Period	5 s to 50 ms 20 ms to 2 ns	0.0026 % of rdg + 0.07 ms 0.00026 % of rdg	
Rise Time	≤ 300 ps	+0 / -100 ps	
AC Power[3], Low Frequency	(33 to 330) mV 3.3 mA to 20 A	0.14 % of rdg + 0.0082 % FS	Fluke 5520A
	330 mV to 1020 V 3.3 mA to 20 A	0.12 % of rdg + 0.0082 % FS	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Electrical Calibration of Thermocouple Indicators & Indicating Systems[3] –			
Type E	-250 °C to 1000 °C	0.75 °C	Fluke 5520A
Type J	-210 °C to 1200 °C	0.5 °C	
Type K	-200 °C to 1372 °C	0.6 °C	
Type R	0 °C to 1767 °C	0.75 °C	
Type S	0 °C to 1767 °C	0.75 °C	
Type T	-250 °C to 400 °C	0.75 °C	
Electrical Calibration of RTD Indicators & Indicating Systems[3] –			
Pt 385, 100 Ω	-200 °C to 630 °C 630 °C to 800 °C	0.13 °C 0.24 °C	Fluke 5520A
Pt 3926, 100 Ω	-200 °C to 630 °C	0.13 °C	
PtNi 385, 120 Ω	-80 °C to 260 °C	0.15 °C	
Inductance – Generate @ 1 kHz			
Fixed Values	50 µH 100 µH 200 µH 1 mH 5 mH 20 mH 50 mH	0.25 µH 0.5 µH 1 µH 5 µH 25 µH 0.1 mH 0.25 mH	GenRad 1482A GenRad 1482B GenRad 1482C GenRad 1482E GenRad 1482G GenRad 1482J GenRad 1482K

Parameter/Equipment	Range	CMC[2] (±)	Comments
Capacitance – Generate, @ 1 kHz			
Cardinal Point	(10, 100, 1000) pF	0.02 % of rdg	GenRad 1404A, 1404B, 1404C

Parameter/Range	Frequency	CMC[2,, 4, 5] (±)	Comments
AC Current[3] – Measure			
(10 to 100) µA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz	0.4 % of rdg + 0.03 % FS 0.15 % of rdg + 0.03 %FS 0.06 % of rdg + 0.03 % FS	HP 3458A opt 002
100 µA to 100 mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	0.4 % of rdg + 0.02 % FS 0.2 % of rdg + 0.02 % FS 0.6 % of rdg + 0.02 % FS 0.03 % of rdg + 0.02 %FS	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	0.4 % of rdg + 0.02 % FS 0.16 % of rdg + 0.02 % FS 0.08 % of rdg + 0.02 % FS 0.1 % of rdg + 0.02 % FS	
AC Current[3] – Generate			
(10 to 330) µA	50 Hz to 5 kHz	0.3 % of rdg + 0.15 µA	Fluke 5520A
330 µA to 3.3 mA	50 Hz to 5 kHz	0.2 % of rdg + 0.2 µA	
(3.3 to 33) mA	50 Hz to 5 kHz	0.08 % of rdg + 2 µA	
(33 to 330) mA	50 Hz to 5 kHz	0.1 % of rdg + 50 µA	
330 mA to 1.1 A	50 Hz to 5 kHz	0.6 % of rdg + 1 mA	
(1.1 to 3) A	50 Hz to 5 kHz	0.6 % of rdg + 1 mA	
(3 to 11) A	100 Hz to 1 kHz	0.1 % of rdg + 2 mA	
(11 to 20.5) A	100 Hz to 1 kHz	0.15 % of rdg + 5 mA	
(20 to 1000) A Clamp Meters	(45 to 65) Hz	1.2 % of rdg	Fluke 5520A with 5500A coil

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
AC Voltage[3] – Generate			
(33 to 330) mV	50 Hz to 10 kHz	0.015 % of rdg + 8 µV	Fluke 5520A
330 mV to 3.2 V	50 Hz to 10 kHz	0.015 % of rdg + 60 µV	
(3.2 to 33) V	50 Hz to 10 kHz	0.015 % of rdg + 0.6 mV	
(33 to 330) V	(1 to 10) kHz	0.02 % of rdg + 6 mV	
(330 to 1000) V	(1 to 10) kHz	0.025 % of rdg + 10 mV	
AC Voltage[3] – Measure			
(10 to 100) mV	(1 to 40) Hz	0.03 % of rdg + 0.03 % FS	HP 3458A opt 002
	40 Hz to 1 kHz	0.02 % of rdg + 0.011 % FS	
	(1 to 20) kHz	0.03 % of rdg + 0.011 % FS	
	(20 to 50) kHz	0.1 % of rdg + 0.011 % FS	
	(50 to 100) kHz	0.5 % of rdg + 0.011 % FS	
	(100 to 300) kHz	4 % of rdg + 0.02 % FS	
100 mV to 10 V	(1 to 40) Hz	0.007 % of rdg + 0.004 % FS	
	40 Hz to 1 kHz	0.007 % of rdg + 0.002 % FS	
	(1 to 20) kHz	0.014 % of rdg + 0.002 % FS	
	(20 to 50) kHz	0.03 % of rdg + 0.002 % FS	
	(50 to 100) kHz	0.08 % of rdg + 0.002 % FS	
	(100 to 300) kHz	0.3 % of rdg + 0.01 % FS	
(10 to 100) V	(1 to 40) Hz	0.02 % of rdg + 0.004 % FS	
	40 Hz to 1 kHz	0.02 % of rdg + 0.002 % FS	
	(1 to 20) kHz	0.02 % of rdg + 0.002 % FS	
	(20 to 50) kHz	0.035 % of rdg + 0.002 % FS	
	(50 to 100) kHz	0.12 % of rdg + 0.002 % FS	
	(100 to 300) kHz	0.4 % of rdg + 0.01 % FS	
(100 to 1000) V	(1 to 40) Hz	0.04 % of rdg + 0.004 % FS	
	40 Hz to 1 kHz	0.04 % of rdg + 0.002 % FS	
	(1 to 20) kHz	0.06 % of rdg + 0.002 % FS	
	(20 to 50) kHz	0.12 % of rdg + 0.002 % FS	
	(50 to 100) kHz	0.3 % of rdg + 0.002 % FS	
(1 to 20) kV	60 Hz	5.8 % of rdg	Fluke 80K-40 with DMM

V. Electrical – RF/Microwave

Parameter/Equipment	Frequency	CMC[2] (±)	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 % of rdg 3 % of rdg 3 % of rdg 3 % of rdg	HP 8902A HP11722A
Frequency Modulation – Measure Rate: 250 kHz to 10 MHz Dev: $\leq$ 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 % of rdg 3 % of rdg 3 % of rdg 3 % of rdg	HP 8902A HP11722A

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Phase Modulation – Measure			
Rate: 200 Hz to 10 kHz Depth: 5 % of rdg to 90 % of rdg	150 kHz ≤ f_C ≤ 10 MHz	5 % of rdg	HP 8902A HP11722A
Rate: 200 Hz to 20 kHz Depth: 5 % of rdg to 90 % of rdg	10 MHz < f_C < 1.3GHz	4 % of rdg	
Tuned RF Power, Relative – Measure[3]			
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 0.12 dB 0.13 dB 0.09 dB 0.11 dB 0.13 dB 0.30 dB	HP 8920A HP11722A

VI. Mechanical

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Mass	(0 to 20) g (20 to 200) g (200 to 500) g 500 g to 2 kg (2 to 35) kg	0.000047 g 0.00024 g 0.0024 g 0.013 g 0.6 g	By direct reading
Pressure[3] – Gauges	(-15 to 200) psi (200 to 10 000) psi	0.04 % of rdg 0.05 % of rdg	Portable pressure calibrator, Deadweight Tester

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Torque[3] –			
Wrenches &	(1 to 100) in·lb	0.2 % rdg	Torque calibration system
Screwdrivers &	(1 to 2000) ft·lb	0.2 % rdg	
Analyzers			
Tachometers[3]–			
Photo	(0 to 100 000) rpm	0.05 % of rdg + 1.2*R*	Function generator
Contact	(0 to 5000) rpm	3.3 rpm	Tachometer
Dynamometers	(0 to 10 000) lbf	0.42 % FS	Load cells
Scales, Analytical Balances[3]	(0.5 to 10 000) lb	0.01 % of rdg	Class F weights
	(0 to 10 000) g	0.00032 % of rdg	Class 1, 2, or 4 weights
Force[3] – Tension and Compression	(1 to 100) lbf	0.05 lbf	Load cells and weights
	(100 to 300) lbf	0.15 lbf	
	(300 to 5000) lbf	6 lbf	
	(5000 to 10 000) lbf	12 lbf	
	(10 000 to 25 000) lbf	15 lbf	
	(25 000 to 50 000) lbf	25 lbf	
	(50 000 to 100 000) lbf	50 lbf	
Spring Testers[3] –			
Force Scale	(0 to 1000) lbf	0.15 % FS	Load cells and weights
Deflection Accuracy	– – –	0.0013”	Gage blocks
Direct Verification of Durometer Spring Force – Shore Types A, D, M, and O	(0 to 100) duro units	(0.6*R* + 0.36) duro units	The durometer spring is verified with a duro-calibrator that is calibrated with dead weights.

Parameter/Equipment	Range	CMC[2] (±)	Comments
Indirect Verification of Rockwell and Rockwell Superficial Hardness Testers[3]	> 45 HRB < 45HRB ≥ 60 HRC < 60 HRC ≥ 46.2 HR30T < 46.2 HR30T 15N scale 30N scale ≥ 17.6 HR45T (<17.6 to 1.0) HR45T ≥ 75.3 HR15T < 73.5 to 60.5 HR15T 45N scale	0.79 HRB 1.4 HRB 0.73 HRC 0.73 HRC 0.83 HR30T 0.90 HR30T 0.76 HRN 0.76 HR30N 0.73 HR45T 0.90 HR45T 0.75 HR15T 0.75 HR15T 0.77 HR45N	ASTM E18

VII. Thermodynamic

Parameter/Equipment	Range	CMC[2] (±)	Comments
Temperature – Measure[3]	-50 °C to 350 °C	0.1 ºC	Burns PRT
Infrared Thermometers	50 °C to 350 °C	6 ºC	Type K thermocouple
Relative Humidity – Measure	(10 to 90) % RH	1.8 % RH	Rotronic hygrometer

VIII. Time & Frequency

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

[1] This laboratory offers commercial calibration and field calibration 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 (tcal ± 5 °C) and an auto-calibration (ACAL) was performed with the previous 24 hours (± 1 °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 (tcal ± 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] In the 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 unless otherwise noted; % of FS indicates percentage of full scale.

[7] Deflection is the maximum deviation from the reference plane.

[8] This laboratory meets R205 – *Specific Requirements: Calibration Laboratory Accreditation Program* for the types of dimensional calibrations listed above. Accredited test reports issued containing appropriate statements of measurement results, measurement uncertainty, and traceability are considered equivalent to a "calibration" certificate.

The American Association for Laboratory Accreditation

World Class 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 Z540-1-1994 and 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 21st day of June 2010.

President & CEO
For the Accreditation Council
Certificate Number 1855.01
Valid to June 30, 2012

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