



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

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CALIBRATION

Valid To: July 31, 2021

Certificate Number: 3466.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1,9</sup>:

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Feeler Gages	(0.001 to 0.1) in	78 µin	Digital micrometer, Supermicrometer™
Thread Measuring Wires	(0.001 to 1.0) in	27 µin	Supermicrometer™
Height Master <sup>3</sup>	(0.3 to 24) in Up to 40 in	(15 + 4.4L) µin (14 + 5.4L) µin	Reference bar, amplifier, gage blocks, surface plate
Length Standards <sup>3</sup>	(1.0 to 38) in	(130 + 1.5L) µin	Reference bar, amplifier, surface plate
Steel Rulers	(0.5 to 60) in	(210 + 9.8L) µin	Vision system
Pin Gages <sup>3</sup>	(0.011 to 1.0) in	37 µin	Laser micrometer

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Plug Gages	(0.004 to 8.0) in	(14 + 2.4L) μin	Supermicrometer™, gage blocks
Ring Gages	(0.24 to 4.0) in (4.1 to 12.0) in	(14 + 2L) μin (4 + 6.5L) μin	Gage blocks, master rings, Supermicrometer™/ universal comparator
Gage Blocks – Steel Ceramic Tungsten Carbide Chrome Carbide	Up to 20 in Up to 20 in Up to 20 in Up to 20 in	(3.7 + 3.5L) μin (3.8 + 3.9L) μin (2.4 + 5.6L) μin (2.8 + 3.0L) μin	Comparator, gage blocks
Radius Gages	(0.001 to 1.0) in	86 μin	Vision system, optical comparator
Thread / Set Plugs – Pitch Diameter Major Diameter	(0.01 to 8.0) in (0.01 to 8.0) in	(100 + 0.27L) μin (16 + 1.5L) μin	Supermicrometer™, thread wires, gage blocks
Adjustable Thread Rings – Pitch Diameter Minor Diameter	Up to 1.0 inch Up to 1.0 inch	380 μin 380 μin	Thread plug, go/nogo plug gage
Roundness Gage	Up to 11.8 in	5.5 μin	Gage blocks, optical flat, flick master
Spheres – Size Roundness	Up to 2.0 in Up to 2.0 in	18 μin 5.7 μin	Supermicrometer™ Roundness machine

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Bore Gages – 2 pt 0.0001 in Resolution 0.0005 in Resolution	100 μin to 1.0 in 100 μin to 1.0 in	140 μin 580 μin	Height master, surface plate, indicator calibrator
Calipers <sup>3</sup> – 0.0005 in Resolution 0.001 in Resolution	Up to 40 in Up to 60 in	(580 + 2L) μin 1200 μin	Gage blocks, surface plate, ring gage
Depth Micrometers/ Depth Gages <sup>3</sup> – 0.0005 in Resolution 0.01 in Resolution	Up to 12 in Up to 12 in	(84 + 11L) μin 1300 μin	Gage blocks, surface plate
Indicators – High Resolution  0.001 in Resolution 0.0005 in Resolution 0.0001 in Resolution 0.000 05 in Resolution 0.000 02 in Resolution 0.000 01 in Resolution 0.000 05 in Resolution 0.01 in Resolution 0.0005 in Resolution 0.0001 in Resolution	Up to 1.0 in Up to 1.0 in Up to 1.0 in Up to 1.0 in Up to 0.001 in Up to 1.0 in Up to 0.0002 in Up to 1.0 in Up to 0.5 in Up to 0.5 in	1200 μin 580 μin 130 μin (61+ 1.2L) μin (22 + 5900L) μin 18 μin (6.2 + 700L) μin 1200 μin 600 μin 190 μin	Supermicrometer™, gage blocks  Indicator checker
Indicators <sup>3</sup> – Test  0.001 in Resolution 0.0005 in Resolution 0.0001 in Resolution 0.000 05 in Resolution 0.000 01 in Resolution	Up to 0.06 in Up to 0.06 in Up to 0.06 in Up to 0.06 in Up to 0.06 in	1200 μin 580 μin 130 μin 84 μin 62 μin	Height master, surface plate

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Height Gages <sup>3</sup> –  0.001 in Resolution 0.0005 in Resolution 0.001 in Resolution 0.0005 in Resolution	Up to 24 in Up to 24 in (25 to 40) in (25 to 40) in	1200 μin (580 + 1.2L) μin (1100 + 1.9L) μin (530 + 3.7L) μin	Reference bar, gage blocks, surface plate
Analog Amplifier	5 μin to 0.001 in	6.8 μin	Gage blocks
Outside Micrometers <sup>3</sup> –  5 μin Resolution 0.001 in Resolution 0.0001 in Resolution 0.00005 in Resolution 0.001 in Resolution 0.0001 in Resolution 0.00005 in Resolution 0.001 in Resolution 0.0001 in Resolution 0.0005 in Resolution	Up to 1 in Up to 12 in Up to 12 in Up to 12 in (13 to 24) in (13 to 24) in (13 to 24) in (13 to 24) in (25 to 48) in (25 to 48) in (25 to 48) in	40 μin (1200 + 0.52L) μin (110 + 1.7L) μin (77 + 2.2L) μin (1100 + 1.4L) μin (93 + 7.2L) μin (60 + 7.7L) μin (1100 + 0.65L) μin (84 + 5.8L) μin (180 + 3.3L) μin	Gage block, optical flats
Bench Micrometer <sup>3</sup>	Up to 5.0 in	(7.8 + 1.9L) μin	Gage blocks
Laser Micrometer <sup>3</sup>	10 μin to 1.0 in	23 μin	Master plug gages
Bore Gages <sup>3</sup> – 3 pt  0.0001 in Resolution 0.0002 in Resolution	(0.275 to 4.0) in (0.275 to 4.0) in	130 μin 240 μin	Master rings

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Levels – Bubble	± 0.002 in/ft	250 μin/ft	Surface plate, gage blocks
Digital	Up to 90°	0.002 in/in	
Levels – Differential	± 990 arc sec	3.6 arc sec	Sine plate, gage blocks, surface plate
Bevel Protractor <sup>3</sup>	Up to 45°	0.04°	Sine plate, gage blocks, amplifier
Sine Plate <sup>3</sup>	5 in	29 μin	Amplifier, height master
Optical Comparator <sup>3</sup> – Linear	50 μin to 12 in	(220 + 22L) μin	High precision glass scale
Vision System <sup>3</sup> – Linear	Up to 30 in	(82 + 4.4L) μin	High precision, glass scale
Surface Plate – Overall Flatness <sup>3</sup>	(6.0 to 144) in	(22 + 0.7D) μin	Electronic level
Surface Plate – Local Area Flatness <sup>3</sup>	10 μin to 0.002 in	22 μin	Differential level
Parallels	(0.1 to 4.0) in	29 μin	Surface plate, amplifier, gage blocks
Squares	(0.1 to 4.0) in	18 μin	Surface plate, amplifier, master square, granite angle

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Optical Flats	(0.1 to 6.0) in	4.2 μin	Gage Blocks, amplifier, surface plate
Coordinate Measuring Machine (CMM) <sup>3</sup> – X, Y, Z Linear Accuracy	(0.1 to 120) in	(40 + 17L) μin	ASME B89.4.1 - 2001 Renishaw laser system, ball bar, sphere
Machine Tool <sup>3</sup> – X, Y, Z Linear Accuracy	(0.1 to 120) in	(12 + 37L) μin	Renishaw laser system, ball bar, laser transducer
Surface Finish <sup>3</sup> – Profilometer and Surface Roughness Standards	(1.0 to 120) μin Ra	13 μin	Master surface finish standards

## II. Dimensional Testing/Calibration<sup>1</sup>

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Roundness Measurement <sup>6</sup>	(0.25 to 0.75) in	10 μin	Roundness checker
Surface Finish <sup>6</sup>	(1.0 to 120) μin Ra	13 μin	Profilometer
Length 1D <sup>6</sup>	Up to 12 in	(62 + 1.4L) μin	Height master, surface plate, amplifier
	Up to 3.0 in	(120 + 1.6L) μin	Micrometer
	Up to 12 in	(580 + 1.2L) μin	Caliper

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Length 2D <sup>6</sup>	Up to 48 in	(210 + 7.8L) μin	Video inspection machine
	Up to 8.0 × 9 in	530 μin	Optical comparator
Length 3D <sup>6</sup> – Steel Aluminum Plastic	Up to (80 × 48 × 40) in	(86 + 27L) μin	Coordinate measuring machine
	Up to (80 × 48 × 40) in	(91 + 23L) μin	
	Up to (80 × 48 × 40) in	(11 + 160L) μin	
Angle <sup>6</sup>	Up to 360°	0.0026°	Vision system
	Up to 360°	0.0005°	Coordinate measuring machine
	Up to 360°	0.0043	Optical comparator

### III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
DC Current – Generate	(0 to 330) μA	0.018 % + 23 nA	Fluke 5520A/SC600  Fluke 5520A w/50 turn coil
	330 μA to 3.3 mA	0.012 % + 59 nA	
	(3.3 to 33) mA	0.012 % + 300 nA	
	(33 to 330) mA	0.018 % + 310 nA	
	330 mA to 1.1 A	0.024 % + 47 μA	
	(0.35 to 3) A	0.043 % + 110 μA	
	(3 to 11) A	0.058 % + 580 μA	
	(11 to 20.5) A	0.12 % + 940 μA	
	(20.5 to 1000) A	0.58 % + 580 mA	

Parameter/Equipment	Range	CMC <sup>2, 4, 8</sup> (±)	Comments
DC Current – Measure	(0 to 100) nA 100 nA to 1 µA (0.35 to 10) µA (10 to 100) µA 100 µA to 1 mA (0.35 to 10) mA (10 to 100) mA 100 mA to 1 A  (0.35 to 10) A  (10 to 30) A	26 µA/A + 63 pA 24 µA/A + 51 pA 28 µA/A + 110 pA 25 µA/A + 1.2 nA 23 µA/A + 6.1 nA 30 µA/A + 54 nA 44 µA/A + 650 nA 0.016 % + 9.6 µA  0.24 % + 790 µA  0.35 %	HP 3458A, option 002        Fluke 45  Current shunt, HP 3458A, option 002
DC Voltage – Generate	(0 to 330) mV (0 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1000) V	23 µV/V + 1.6 µV 14 µV/V + 2.5 µV 14 µV/V + 27 µV 21 µV/V + 180 µV 24 µV/V + 1.6 mV	Fluke 5520A / SC600
DC Voltage – Measure	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V  (1000 to 6000) V	11 µV/V + 0.77 µV 6.8 µV/V + 0.83 µV 7.0 µV/V + 0.21 µV 8.2 µV/V + 25 µV 8.7 µV/V + 95 µV  0.081 % + 12 mV	HP 3458A, option 002      Fluke 45 and 80K-6 HV probe
DC Power – Generate	(0.09 to 330) W (0.33 to 3) kW (3 to 20) kW	0.04 % 0.039 % 0.084 %	Fluke 5520A/SC600



Parameter/Equipment	Range	CMC <sup>2, 4, 8</sup> (±)	Comments
AC Power – Generate PF = 1 @ 60Hz	(0.11 to 3.0) mW (3.0 to 11) mW (11 to 30) mW (30 to 110) mW (110 to 300) mW (300 to 730) mW (0.73 to 1.5) W (1.5 to 6.8) W (6.8 to 9.2) W (9.2 to 34) W (34 to 92) W (92 to 337) W (337 to 918) W (918 to 2244) W (2244 to 4590) W (4590 to 20 910) W	0.44 % 0.16 % 0.17 % 0.13 % 0.16 % 0.17 % 0.20 % 0.15 % 0.14 % 0.11 % 0.14 % 0.097 % 0.13 % 0.11 % 0.15 % 1.2 mW/W	Fluke 5520A/SC600
Resistance – 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 MΩ to 1.1 GΩ	46 μΩ/Ω + 1.2 mΩ 41 μΩ/Ω + 1.7 mΩ 35 μΩ/Ω + 1.7 mΩ 34 μΩ/Ω + 2.5 mΩ 34 μΩ/Ω + 3.0 mΩ 35 μΩ/Ω + 22 mΩ 35 μΩ/Ω + 24 mΩ 35 μΩ/Ω + 220 mΩ 35 μΩ/Ω + 270 mΩ 37 μΩ/Ω + 2.6 Ω 36 μΩ/Ω + 4.6 Ω 69 μΩ/Ω + 37 Ω 0.015 % + 83 Ω 0.03 % + 3.2 kΩ 0.051 % + 6.2 kΩ 0.35 % + 120 kΩ 1.8 % + 600 kΩ	Fluke 5520A/SC600
Resistance – Measure	Up to 10 Ω (10 to 100) Ω 100 Ω to 1.0 kΩ (0.35 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1.0 MΩ (0.35 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1.0 GΩ	26 μΩ/Ω + 87 μΩ 16 μΩ/Ω + 620 μΩ 15 μΩ/Ω + 600 μΩ 15 μΩ/Ω + 5.0 mΩ 17 μΩ/Ω + 20 mΩ 20 μΩ/Ω + 10 Ω 67 μΩ/Ω + 110 Ω 0.057 % + 2.9 kΩ 0.54 % + 430 kΩ	HP 3458A, option 002

Parameter/Range	Frequency	CMC <sup>2, 8</sup> (±)	Comments
Capacitance – Generate			
(0.19 to 3.3) nF	10 Hz to 3 kHz	0.59 % + 12 pF	Fluke 5520A/SC600  Frequencies indicate maximum charge / discharge rate from a measuring device such as an Instek 819 LCR meter
(3.3 to 11) nF	10 Hz to 1 kHz	0.3 % + 12 pF	
(11 to 33) nF	10 Hz to 1 kHz	0.24 % + 130 pF	
(33 to 110) nF	10 Hz to 1 kHz	0.3 % + 110 pF	
(110 to 330) nF	10 Hz to 1 kHz	0.3 % + 340 pF	
330 nF to 1.1 µF	(10 to 600) Hz	0.3 % + 1.1 nF	
(1.1 to 3.3) µF	(10 to 300) Hz	0.3 % + 3.5 nF	
(3.3 to 11) µF	(10 to 150) Hz	0.3 % + 11 nF	
(11 to 33) µF	(10 to 120) Hz	0.49 % + 32 nF	
(33 to 110) µF	(10 to 80) Hz	0.53 % + 120 nF	
(110 to 330) µF	(0 to 50) Hz	0.52 % + 360 nF	
330 µF to 1.1 mF	(0 to 20) Hz	0.53 % + 1.1 µF	
(1.1 to 3.3) mF	(0 to 6) Hz	0.53 % + 1.2 µF	
(3.3 to 11) mF	(0 to 2) Hz	0.53 % + 12 µF	
(11 to 33) mF	(0 to 0.6) Hz	0.87 % + 35 µF	
(33 to 110) mF	(0 to 0.2) Hz	1.3 % + 120 µF	

Parameter/Equipment	Range	CMC <sup>2, 4, 8</sup> (±)	Comments
Oscilloscopes – Amplitude DC Signal			Fluke 5520A/SC600
Into 50 Ω Load	1.0 mV to 6.6 V	0.29 % + 510 µV	
Into 1 MΩ Load	1.0 mV to 130 V	0.063 % + 570 µV	
Bandwidth – Leveled Sine Wave			
Into 50 Ω Load	50 kHz to 600 MHz	6.9 % + 2.1 mV	
Time Marker			
Into 50 Ω Load	2.0 ns to 5.0 s	0.047 %	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Simulation of RTD –			
Pt 385 (100 Ω)	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.073 °C (0.14 °F) 0.092 °C (0.17 °F) 0.11 °C (0.20 °F) 0.12 °C (0.22 °F) 0.15 °C (0.27 °F) 0.27 °C (0.49 °F)	Fluke 5520A/SC600
Pt 3926 (100 Ω)	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.073 °C (0.14 °F) 0.073 °C (0.14 °F) 0.092 °C (0.17 °F) 0.11 °C (0.20 °F) 0.12 °C (0.22 °F) 0.15 °C (0.27 °F)	
Pt 3916 (100 Ω)	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.29 °C (0.53 °F) 0.064 °C (0.12 °F) 0.073 °C (0.14 °F) 0.082 °C (0.15 °F) 0.092 °C (0.17 °F) 0.10 °C (0.18 °F) 0.11 °C (0.20 °F) 0.12 °C (0.22 °F) 0.27 °C (0.49 °F)	
Electrical Simulation of Thermocouples –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.56 °C (1.0 °F) 0.46 °C (0.83 °F) 0.42 °C (0.76 °F) 0.44 °C (0.80 °F)	Fluke 5520A/SC600
Type E	(-210 to -100) °C (-100 to -25) °C (-25 to 650) °C (650 to 1000) °C	0.41 °C (0.74 °F) 0.32 °C (0.58 °F) 0.28 °C (0.51 °F) 0.33 °C (0.60 °F)	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.39 °C (0.71 °F) 0.30 °C (0.54 °F) 0.28 °C (0.51 °F) 0.30 °C (0.54 °F) 0.33 °C (0.60 °F)	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Simulation of Thermocouples – (cont)			
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.45 °C (0.81 °F) 0.31 °C (0.56 °F) 0.30 °C (0.54 °F) 0.38 °C (0.69 °F) 0.51 °C (0.92 °F)	Fluke 5520A/SC600
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.49 °C (0.89 °F) 0.38 °C (0.69 °F) 0.28 °C (0.51 °F)	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.52 °C (0.94 °F) 0.34 °C (0.62 °F) 0.32 °C (0.58 °F) 0.31 °C (0.56 °F) 0.38 °C (0.69 °F)	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.70 °C (1.3 °F) 0.47 °C (0.85 °F) 0.45 °C (0.81 °F) 0.51 °C (0.92 °F)	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.59 °C (0.1.1 °F) 0.48 °C (0.87 °F) 0.49 °C (0.89 °F) 0.58 °C (1.1 °F)	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.76 °C (1.4 °F) 0.36 °C (0.65 °F) 0.30 °C (0.54 °F) 0.28 °C (0.51 °F)	

Parameter/Range	Frequency	CMC <sup>2,8</sup> (±)	Comments	
AC Current – Generate				
(29 to 330) µA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz (10 to 30) kHz	0.24 % + 120 nA 0.18 % + 120 nA 0.15 % + 120 nA 0.35 % + 170 nA 0.93 % + 230 nA 1.9 % + 460 nA	Fluke 5520A/SC600	
330 µA to 3.3 mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz (10 to 30) kHz	0.24 % + 170 nA 0.15 % + 180 nA 0.12 % + 180 nA 0.21 % + 300 nA 0.58 % + 350 nA 12 % + 690 nA		
(3.3 to 33) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz (10 to 30) kHz	0.21 % + 2.3 µA 0.11 % + 2.3 µA 0.048 % + 2.3 µA 0.093 % + 2.3 µA 0.24 % + 3.5 µA 0.47 % + 4.6 µA		
(33 to 330) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz (10 to 30) kHz	0.21 % + 23 µA 0.11 % + 23 µA 0.048 % + 23 µA 0.12 % + 58 µA 0.24 % + 120 µA 0.47 % + 230 µA		
330 mA to 1.1 A	(10 to 45) Hz 45 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz	0.21 % + 110 µA 0.064 % + 99 µA 0.7 % + 1.2 mA 2.9 % + 5.8 mA		
(0.35 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz	0.22 % + 74 µA 0.084 % + 1.2 µA 0.6 % + 5.6 mA 2.9 % + 5.8 mA		
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (0.35 to 5.0) kHz	0.089 % + 1.9 mA 0.13 % + 2.0 mA 3.5 % + 2.3 mA		
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (0.35 to 5.0) kHz	0.2 % + 440 µA 0.23 % + 1.3 mA 3.5 % + 5.5 mA		
(20.5 to 1000) A	60 Hz	1.5 % + 930 mA		Fluke 5520A w/ 50-turn coil

Parameter/Range	Frequency	CMC <sup>2, 8</sup> (±)	Comments
AC Current – Measure			
(5 to 100) μA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5.0 kHz	0.47 % + 42 nA 0.18 % + 43 nA 0.071 % + 43 nA 0.071 % + 43 nA	HP 3458A, option 002
100 μA to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5.0 kHz (5.0 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 280 nA 0.18 % + 280 nA 0.071 % + 280 nA 0.045 % + 230 nA 0.085 % + 230 nA 0.56 % + 460 nA 0.77 % + 1.7 μA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5.0 kHz (5.0 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 2.8 μA 0.18 % + 2.8 μA 65 μA/A + 3.5 μA 0.037 % + 2.8 μA 0.071 % + 2.8 μA 0.47 % + 5.5 μA 0.64 % + 21 μA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5.0 kHz (5.0 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 28 μA 0.18 % + 28 μA 0.071 % + 28 μA 0.037 % + 28 μA 0.071 % + 28 μA 0.47 % + 55 μA 0.64 % + 210 μA	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5.0 kHz (5.0 to 20) kHz (20 to 50) kHz	0.47 % + 230 μA 0.19 % + 230 μA 0.096 % + 230 μA 0.12 % + 230 μA 0.35 % + 240 μA 1.2 % + 460 μA	
(1 to 10) A	(20 to 50) Hz (0.05 to 2.0) kHz	2.4 % + 12 mA 1.2 % + 12 mA	Fluke 45

Parameter/Range	Frequency	CMC <sup>2,8</sup> (±)	Comments
AC Voltage – Generate			
Up 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	0.093 % + 7.2 μV 0.019 % + 7.2 μV 0.024 % + 7.2 μV 0.12 % + 7.1 μV 0.41 % + 14 μV 0.93 % + 58 μV	Fluke 5520A/SC600
(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	0.035 % + 9.5 μV 0.018 % + 9.6 μV 0.019 % + 9.6 μV 0.041 % + 9.7 μV 0.093 % + 37 μV 0.24 % + 80 μV	
330 mV 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	0.035 % + 58 μV 0.018 % + 70 μV 0.023 % + 70 μV 0.036 % + 58 μV 0.082 % + 140 μV 0.3 % + 680 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	0.035 % + 750 μV 0.018 % + 680 μV 0.028 % + 680 μV 0.041 % + 680 μV 0.11 % + 1.8 mV	
(33 to 330) V	45 Hz to 1 kHz (0.35 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.023 % + 2.3 mV 0.024 % + 6.9 mV 0.03 % + 7.6 mV 0.038 % + 6.0 mV 0.24 % + 5.7 mV	
220 V to 1.1 kV	45 Hz to 1 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz	0.035 % + 12 mV 0.03 % + 12 mV 0.035 % + 12 mV	

Parameter/Range	Frequency	CMC <sup>2, 8</sup> (±)	Comments
AC Voltage – Measure			
(1 to 10) mV	(0.35 to 40) Hz 40 Hz to 1.0 kHz (0.35 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1.0 to 4.0) MHz (4.0 to 8.0) MHz	0.029 % + 3.5 μV 0.019 % + 1.3 μV 0.029 % + 1.3 μV 0.095 % + 1.5 μV 0.48 % + 2.3 μV 3.8 % + 11 μV 1.2 % + 8.3 μV 6.7 % + 23 μV 24 % + 11 μV	HP 3458A, option 002
(10 to 100) mV	(1.0 to 40) Hz 40 Hz to 1.0 kHz (0.35 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1.0 MHz (1.0 to 4.0) MHz (4.0 to 8) MHz (8.0 to 10) MHz	80 μV/V + 4.8 μV 99 μV/V + 2.3 μV 0.018 % + 2.4 μV 0.036 % + 2.4 μV 0.093 % + 2.3 μV 0.35 % + 12 μV 1.2 % + 12 μV 4.7 % + 83 μV 4.7 % + 110 μV 18 % + 130 μV	
100 mV to 1 V	(1.0 to 40) Hz 40 Hz to 1.0 kHz (0.35 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1.0 MHz (1.0 to 4.0) MHz (4.0 to 8.0) MHz (8.0 to 10) MHz	84 μV/V + 47 μV 83 μV/V + 26 μV 0.017 % + 24 μV 0.035 % + 24 μV 0.093 % + 24 μV 0.35 % + 120 μV 0.012 % + 120 μV 4.7 % + 970 μV 4.4 % + 4.1 mV 18 % + 1.3 mV	
(1 to 10) V	(1.0 to 40) Hz 40 Hz to 1.0 kHz (0.35 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1.0 MHz (1.0 to 4.0) MHz (4.0 to 8.0) MHz (8.0 to 10) MHz	80 μV/V + 480 μV 52 μV/V + 680 μV 0.017 % + 240 μV 0.035 % + 240 μV 0.093 % + 230 μV 0.35 % + 1.2 mV 1.2 % + 1.2 mV 4.7 % + 8.1 mV 4.7 % + 10 mV 18 % + 12 mV	



Parameter/Range	Frequency	CMC <sup>2,8</sup> (±)	Comments
AC Voltage – Measure (cont)			
(10 to 100) V	(0.35 to 40) Hz 40 Hz to 1.0 kHz (0.35 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1.0 MHz	0.024 % + 4.7 mV 0.024 % + 2.3 mV 0.024 % + 2.3 mV 0.041 % + 2.3 mV 0.14 % + 2.4 mV 0.47 % + 12 mV 1.8 % + 12 mV	HP 3458A, option 002
100 V to 1 kV	(0.35 to 40) Hz 40 Hz to 1 kHz (0.35 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.043 % + 37 mV 0.047 % + 16 mV 0.07 % + 16 mV 0.14 % + 16 mV 0.35 % + 17 mV	
(1000 to 4300) VRMS	Up to 500 Hz	2.4 % + 0.32 mV	Fluke 45 and 80K-6 HV probe

#### IV. Mechanical

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Force /Load Cell	(1 to 10 000) g (1 to 220) lbf	0.15 mgf + 0.033 mgf/gf 2 µlbf + 75 µlbf/lbf	Class 1 weights Class 6 weights
Durometers –  Scale Accuracy  Type A, B, C, D, DO, E, M, O, OOO, OOO-S, R  Type OO  Indentor Geometry Length Diameter Angle	(0 to 100) duros     (0 to 100) duros  -- -- --	0.3 duro points     0.6 duro points  110 µin (2.8 µm) 260 µin (6.6 µm) 0.1° (6 arc min)	ASTM D2240:  Standard weights and balance    Optical comparator

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Indirect Verification of Rockwell Hardness Testers <sup>3</sup> –	<p>HRA: Low Medium High</p> <p>HRBW: Low Medium High</p> <p>HRC: Low Medium High</p> <p>HR15N: Low Medium High</p> <p>HR30N: Low Medium High</p> <p>HR45N: Low Medium High</p> <p>HR15TW: Low Medium High</p> <p>HR30TW: Low Medium High</p> <p>HR45TW: Low Medium High</p>	<p>0.69 HRA 0.66 HRA 0.31 HRA</p> <p>0.83 HRBW 0.96 HRBW 0.79 HRBW</p> <p>0.63 HRC 0.66 HRC 0.51 HRC</p> <p>0.61 HR15N 0.68 HR15N 0.58 HR15N</p> <p>0.77 HR30N 0.73 HR30N 0.59 HR30N</p> <p>0.83 HR45N 0.67 HR45N 0.50 HR45N</p> <p>0.84 HR15TW 0.67 HR15TW 0.52 HR15TW</p> <p>0.66 HR30TW 0.53 HR30TW 0.58 HR30TW</p> <p>0.65 HR45TW 0.77 HR45TW 0.64 HR45TW</p>	Indirect comparison with test blocks to ASTM E-18

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Indirect Verification of Brinell Hardness Testers at Test Condition(s) <sup>7,3</sup> –  HBW 10/3000/15	HBW: (67 to 300) HBW (300 to 650) HBW (650 to 945) HBW	3.4 HBW 6.3 HBW 11 HBW	Indirect comparison with test blocks to ASTM E10
Indirect Verification of Micro Indentation Hardness Testers <sup>3</sup> –  Knoop  Vickers	(250 to 650) HK (650 to 700) HK  (240 to 600) HV (600 to 700) HV	14 HK 23 HK  11 HV 33 HV	Indirect comparison with test blocks to ASTM E384
Scales and Balances <sup>3</sup>	Up to 10 000 g Up to 22 lb (1 to 220) lb (0.46 to 99.8) Kg	40 µg + 25 µg/g 1.5 µoz + 25 µoz/oz 2.0 µlb + 75 µlb/lb 910 µg + 75 µg/g	ASTM Class 1 weights  OIML Class 6 weights
Torque Wrenches <sup>3</sup>	(5 to 50) in·lbf (0.57 to 5.7) Nm (40 to 400) in·lbf (4.6 to 46) Nm (100 to 1000) in·lbf (12 to 120) Nm (25 to 250) ft·lbf (34 to 340) Nm  (60 to 600) ft·lbf (82 to 820) Nm  (100 to 1000) ft·lbf (136 to 1356) Nm	0.59 in·lbf + 0.19 % (0.066 Nm + 0.19 %) 2.9 in·lbf + 0.049 % (0.33 Nm + 0.049 %) 5.9 in·lbf + 0.063 % (0.66 Nm + 0.063 %) 1.2 ft·lbf + 0.18 % (1.7 Nm + 0.18 %)  5.7 ft·lbf + 0.058 % (7.8 Nm + 0.058 %)  3.4 ft·lbf + 0.15 % (4.6 Nm + 0.15 %)	Torque transducer CDI 2000-400-02        CDI 2000-12-02   AWS QCMF-1000
Torque – Testers/Transducers	(5 to 2200) in·lbf (1.2 to 250) Nm (10 to 730) ft·lbf (14 to 990) Nm	0.043 %  0.049 %	Torque arm/weights

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Pressure	(-13 to 300) psi (300 to 3000) psi (3000 to 10 000) psi	0.087 psi 0.89 psi 2.9 psi	Pressure calibrator

#### V. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Infrared Thermometers	(122 to 932) °F	0.000 92 °F/°F + 0.93 °F	Hart Scientific 9132
Thermometers	(-25 to 150) °C  (50 to 420) °C (420 to 500) °C (550 to 600) °C	0.23 °C  0.42 °C 0.49 °C 0.60 °C	Hart Scientific 9142  Hart Scientific 9144
Thermocouples/RTDs	(-25 to 150) °C  (50 to 420) °C (420 to 500) °C (550 to 600) °C	0.4 °C  0.57 °C 0.62 °C 0.71 °C	Hart Scientific 9142, Fluke 5520A  Hart Scientific 9144, Fluke 5520A

#### VI. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Stopwatches and Timers	(0 to 1.0) hr	0.03 s	Frequency counter
Frequency – Measuring Equipment	10 MHz  (0 to 20) MHz	0.01 μHz/Hz  0.013 μHz/Hz + 0.29 Hz	Spectracom 8194B  HP 33250A w/Spectracom 8194B

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Frequency – Measure	DC to 3 GHz	0.013 μHz/Hz + 5.8 mHz	Agilent 53132A option 030 w/Spectracom 8194B
Tachometers – Non-Contact	Up to 100 000 RPM	0.035 RPM	HP 3325A function generator

### Mechanical Testing

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests on metals:

<u>Test</u>	<u>Test Method</u>
Hardness Rockwell HRC	ASTM E18

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

<sup>4</sup> In the statement of CMC, the value is defined as the percentage of reading.

<sup>5</sup> In the statement of CMC,  $L$  represents the numerical value of the nominal length of the device measured in inches,  $L_2$  represents the numerical value of the nominal length of the device measured in meters,  $D$  represents the numerical value of diagonal length of device measured in inches, and  $D_2$  represents the

numerical value of diagonal length of device measured in meters.

<sup>6</sup>This laboratory meets R205 – *Specific Requirements: Calibration Laboratory Accreditation Program* for the types of dimensional tests listed above and is considered equivalent to that of a calibration.

<sup>7</sup>The notation HBW 10/3000/15 gives the conditions of the verification: the 10 is the indenter diameter in millimeters, the 3000 is the test force in kilogram-force, and the 15 is the force application duration in seconds.

<sup>8</sup>The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a fraction/percentage of the reading plus a fixed floor specific.

<sup>9</sup>This scope meets A2LA's *P112 Flexible Scope Policy*.