



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION

Valid To: May 31, 2022

Certificate Number: 1741.13

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

I. Chemical

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
pH Meters <sup>3</sup>	4 pH 7 pH 10 pH	0.03 pH units 0.03 pH units 0.03 pH units	Standard pH solutions
Conductivity Meters <sup>3</sup>	1 mS/cm 1.4 mS/cm 100 mS/cm 150 mS/cm 200 mS/cm	0.004 mS/cm 0.006 mS/cm 0.36 mS/cm 0.6 mS/cm 0.72 mS/cm	Standard conductivity solutions

II. Dimensional

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	Comments
Calipers <sup>3</sup>	Up to 72 in	(5.7 + 9.4L) $\mu$ in + 0.6R	Gage blocks
Micrometers <sup>3</sup>	Up to 72 in	(5.7 + 9.4L) $\mu$ in + 0.6R	Gage blocks

Parameter/Equipment	Range	CMC <sup>2, 6</sup> ( $\pm$ )	Comments
Linear Indicators <sup>3</sup> & Dial and Test <sup>3</sup>	Up to 0.1 in (0.1 to 0.5) in	13 $\mu\text{in} + 0.6R$ 61 $\mu\text{in} + 0.6R$	Federal indicator calibrator
	Up to 4 in	(4.3 + 3.3L) $\mu\text{in} + 0.6R$	Gage blocks
	Up to 12 in	(6.9 + 1.5L) $\mu\text{in} + 0.6R$	Pratt & Whitney Labmaster™ 1000M
Hand Tools <sup>3</sup> – Depth Gages, Snap Gages, Fixture Gages, Thickness Gages	Up to 12 in (12 to 40) in	(6.4 + 3.2L) $\mu\text{in} + 0.6R$ (14 + 2.6L) $\mu\text{in} + 0.6R$	Gage blocks
Pin Gages Class Z, ZZ <sup>3</sup>	Up to 1 in	41 $\mu\text{in}$	Bench comparator and probe w/ preset gage blocks
Height Gages <sup>3</sup>	Up to 48 in	(56 + 1.3L) $\mu\text{in} + 0.6R$	Gage blocks
Gage Blocks	(0.05 to 4) in	(2.8 + 1.9L) $\mu\text{in}$	Federal gage block comparator and master block
	(4 to 20) in	(6.9 + 1.5L) $\mu\text{in}$	Pratt & Whitney Labmaster™ 1000M and master block
Thread Measuring Wires	(0.008 to 1.5) in	(6.9 + 1.5L) $\mu\text{in}$	Pratt & Whitney Labmaster™ 1000M
Micrometer Heads	Up to 2 in	(4.3 + 3.3L) $\mu\text{in} + 0.6R$	Gage blocks
Micrometer/End Standards	Up to 8 in Up to 72 in	(35 + 0.5L) $\mu\text{in}$ (63 + 8.4L) $\mu\text{in}$	Fowler ULM reference bar w/ lever probe
Cylindrical Measure –  Plain Rings	(0.04 to 20) in	(6.9 + 1.5L) $\mu\text{in}$	Pratt & Whitney Labmaster™ 1000M
	Pins, Plain Plugs, Discs, Spheres – External Diameter Up to 20 in	(6.9 + 1.5L) $\mu\text{in}$	

Parameter/Equipment	Range	CMC <sup>2,6</sup> ( $\pm$ )	Comments
Thread Plugs – Pitch Diameter Major Diameter	(2 to 108) TPI (0.25 to 8) mm Up to 8 in	(74 + 0.3L) $\mu$ in (34 + 0.7L) $\mu$ in	Fowler ULM w/ thread wire set
NPT Tapered Thread Plugs– Pitch Diameter	(2 to 108) TPI	150 $\mu$ in	Fowler ULM w/ thread wire set, taper master
Crest Check Gage – Height Max Truncation	80 $\mu$ in (0.05 to 8) in	80 $\mu$ in (34 + 0.7L) $\mu$ in	Surface plate, indicator, gage blocks Fowler ULM
NPT Taper Thread Rings Standoff	Up to 4 in	150 $\mu$ in	Depth gage
Thread Rings – Parallel Simple Pitch Diameter – Solid Rings Adjustable Rings <sup>9</sup>	Up to 8 in Up to 8 in	190 $\mu$ in Set Plug Tolerance	Pratt & Whitney Labmaster™ 1000M w/setting plugs ASME/ANSI B1.2-1983 and ASME/ANSI B1.3- 2007
Spline/Gear Gages – Plugs Diameter (Over Pins) Rings Diameter (Between Pins)	Up to 8 in Up to 8 in	(34 + 0.7L) $\mu$ in (34 + 0.7L) $\mu$ in	Fowler ULM w/ wire set

Parameter/Equipment	Range	CMC <sup>2,6</sup> ( $\pm$ )	Comments
Caliper Masters	Up to 20 in	$(6.9 + 1.5L) \mu\text{in}$	Pratt & Whitney Labmaster™ 1000M
Micrometer Master	Up to 20 in	$(6.9 + 1.5L) \mu\text{in}$	Pratt & Whitney Labmaster™ 1000M
Protractor, Angle Indicators and Combination Squares <sup>3</sup>	1°, 2°, 3°, 4°, 5°, 10° 20°, 25°, 30°, 45°, 60°, 75°, 90°	$0.03^\circ + 0.6R$	Angle block set
	Up to 90°	13 Arc Sec + 0.6R	Sine plate w/ gage blocks, master square
Levels – Bubble & Precision (Vial Sensitivity)	Up to 10 in	13 Arc Sec + 0.6R	Surface plate w/ gage blocks
Angle Gages	Up to 180°	0.16°	Optical comparator or protractor
Angle Blocks	Up to 90°	5 Arc Sec	Sine plate w/ gage blocks, amplifier w/ indicator
Steel Rules <sup>3</sup>	Up to 120 in	$(5 + 10L) \mu\text{in} + 0.6R$	Gage blocks
Tape Measures <sup>3</sup>	Up to 25 ft	$(5 + 10L) \mu\text{in} + 0.6R$	Gage blocks
Optical Comparator <sup>3</sup> –			
X-Y Linearity Magnification	(0 to 12) in 10x to 250x	$85 \mu\text{in} + 0.6R$ 0.014 in	Glass master scales
Angle	0° to 90°	0.1°	Angle block set

Parameter/Equipment	Range	CMC <sup>2, 6</sup> ( $\pm$ )	Comments
Surface Plates <sup>3</sup> – Grades AA, A, and B – Repeatability Flatness	0.002 in Up to 60 <i>DL</i> in (>60 to 120) <i>DL</i> in	40 $\mu$ in (31 + 0.2 <i>DL</i> ) $\mu$ in (30 + 0.3 <i>DL</i> ) $\mu$ in	Repeat-o-Meter Federal level system
Bench Micrometers, Universal Length Measuring Machines <sup>3</sup> Linearity Parallelism Force	Up to 20 in Up to 12 in Up to 80 oz	(3.5 + 3.6 <i>L</i> ) $\mu$ in + 0.6 <i>R</i> 5 $\mu$ in 0.32 oz	Gage blocks Reference sphere Futek load cell
Feeler/Thickness Shims and Thickness Standards <sup>3</sup>	Up to 1 in	8.4 $\mu$ in	Pratt & Whitney Labmaster™ 1000M
Coating Thickness Gages <sup>3</sup> (Film, Ultrasonic)	Up to 60 mils	0.1 mils	Coating thickness standards
Radius Gages	Up to 2 in	280 $\mu$ in	Vision machine
Surface Roughness Meters and Profilometers <sup>3</sup>	Ra (10 to 200) $\mu$ in	1.1 $\mu$ in	Precision roughness standard
Linear Displacement Transducers, LVDT, String Potentiometers, Encoders <sup>3</sup>	Up to 12 in	(6.4 + 3.2 <i>L</i> ) $\mu$ in + 0.6 <i>R</i>	Gage blocks
Interim Verification of Coordinate Measuring Machines <sup>3</sup> X,Y,Z Linearity Volumetric Performance	Up to 36 in (1 to 11.5) in	(30 + 2.9 <i>L</i> ) $\mu$ in 85 $\mu$ in	Gage blocks CMM Quik-Chek

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

Parameter/Equipment	Range	CMC <sup>2, 6, 7</sup> (±)	Comments
Length <sup>8</sup>			
X-Axis	Up to 27 in (700 mm)	(82 + 8.5L) μin	
Y-Axis	Up to 27 in (700 mm)	(82 + 8.5L) μin	
Z-Axis	Up to 24 in (600 mm)	(82 + 8.5L) μin	
Volumetric <sup>8</sup>	Up to 36 in (600 mm)	(150 + 10L) μin	Zeiss Contura G2 CMM
Length – 1D	Up to 6 in Up to 24 in	140 μin 360 μin + 12 μin/in	O.D. micrometer, height gage
Surface Finish <sup>8</sup>	Ra (10 to 200) μin	2.7 μin	Reference standard & mechanical comparison

### IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2, 4, 5, 7, 12</sup> (±)	Comments
DC Voltage – Measure <sup>3</sup>	(0 to 100) mV	11 μV/V + 3 μV	HP 3458A
	100 mV to 1 V	10 μV/V + 0.3 μV	
	(1 to 10) V	10 μV/V + 0.05 μV	
	(10 to 100) V	12 μV/V + 0.3 μV	
DC Voltage – Measure <sup>3</sup>	(100 to 1000) V	27 μV/V + 0.1 μV	Vitretek 4700
	(1 to 10) kV	0.05 % + 0.3 V	
	(10 to 70) kV	0.06 % + 0.2 V	
DC Voltage – Generate <sup>3</sup>	(0 to 220) mV	11 μV/V + 0.4 μV	Fluke 5720A
	220 mV to 2.2 V	6.7 μV/V + 0.7 μV	
	(2.2 to 11) V	5 μV/V + 2.5 μV	
	(11 to 22) V	5.1 μV/V + 4 μV	
	(22 to 220) V	6.7 μV/V + 40 μV	
	(220 to 1100) V	8.5 μV/V + 400 μV	

Parameter/Equipment	Range	CMC <sup>2, 4, 5, 7, 12</sup> (±)	Comments
DC Current – Measure <sup>3</sup>	Up to 100 nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A  (1 to 100) A	35 μA/A + 0.04 nA 25 μA/A + 0.04 nA 25 μA/A + 0.1 nA 25 μA/A + 0.8 nA 25 μA/A + 5 nA 25 μA/A + 50 nA 40 μA/A + 0.5 μA 0.012 % + 10 μA  0.073 %	HP 3458A        GL 9230A/300 shunt w/ HP 3458A
DC Current – Generate <sup>3</sup>	(0 to 220) μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA  220 mA to 2.2 A  (1.1 to 3) A (3 to 11) A (11 to 20.5) A  (1 to 100) A	50 μA/A + 6 nA 44 μA/A + 7 nA 44 μA/A + 40 nA 55 μA/A + 0.7 μA  0.011 % + 12 μA  0.046 % + 40 μA 0.06 % + 500 μA 0.12 % + 750 μA  0.073 %	Fluke 5720A    ± (200 I <sup>2</sup> ) μA/A for I > 100 mA  ± (10 I <sup>2</sup> ) μA/A for I > 1 A  Fluke 5520A  GL 9230A/300 shunt w/ HP 3458A and power supply
Clamp-On Meters <sup>3</sup>			
Toroidal	(Up to 1000) A	0.39 % + 0.5A	Fluke 5520A w/5500 coil
Non-Toroidal	(Up to 1000) A	0.65 % + 0.5A	
DC Power – Generate <sup>3</sup>			
33 mV to 1020 V			Fluke 5522A
(0.33 to 329.99) mA (0.33 to 2.9999) A (3 to 20.5) A	(0.01 to 330) W (0.33 to 3.3) kW (3.3 to 20.5) kW	0.03 % 0.03 % 0.09 %	
	(20.5 to 500) kW	0.4 %	Fluke 5522A w/ coil

Parameter/Equipment	Range	CMC <sup>2, 4, 5, 7, 12</sup> ( $\pm$ )	Comments
Resistance – Measure <sup>3</sup>	(0 to 10) $\Omega$ (10 to 100) $\Omega$ 100 $\Omega$ to 1 k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$ (1 to 10) M $\Omega$ (10 to 100) M $\Omega$ 100 M $\Omega$ to 1 G $\Omega$	18 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.5 m $\Omega$ 13 $\mu\Omega/\Omega$ + 0.5 m $\Omega$ 13 $\mu\Omega/\Omega$ + 5 m $\Omega$ 13 $\mu\Omega/\Omega$ + 50 m $\Omega$ 18 $\mu\Omega/\Omega$ + 2 $\Omega$ 53 $\mu\Omega/\Omega$ + 100 $\Omega$ 0.062 % + 1 k $\Omega$ 0.51 % + 10 k $\Omega$	HP 3458A
Resistance – Generate <sup>3</sup>	(0 to 11) $\Omega$ (11 to 33) $\Omega$ (33 to 110) $\Omega$ 110 $\Omega$ to 1.1 k $\Omega$ (1.1 to 11) k $\Omega$ (11 to 110) k $\Omega$ 110 k $\Omega$ to 1.1 M $\Omega$ (1.1 to 3.3) M $\Omega$ (3.3 to 11) M $\Omega$ (11 to 33) M $\Omega$ (33 to 110) M $\Omega$ (110 to 330) M $\Omega$ (330 to 1100) M $\Omega$	49 $\mu\Omega/\Omega$ + 0.001 $\Omega$ 37 $\mu\Omega/\Omega$ + 0.0015 $\Omega$ 34 $\mu\Omega/\Omega$ + 0.0014 $\Omega$ 34 $\mu\Omega/\Omega$ + 0.002 $\Omega$ 34 $\mu\Omega/\Omega$ + 0.02 $\Omega$ 34 $\mu\Omega/\Omega$ + 0.2 $\Omega$ 39 $\mu\Omega/\Omega$ + 2 $\Omega$ 73 $\mu\Omega/\Omega$ + 30 $\Omega$ 0.016 % + 50 $\Omega$ 0.03 % + 2.5 k $\Omega$ 0.06 % + 3 k $\Omega$ 0.36 % + 100 k $\Omega$ 1.8 % + 500 k $\Omega$	Fluke 5522A
Resistance – Generate <sup>3</sup>  Fixed Points	10 m $\Omega$ 100 m $\Omega$  0 $\Omega$ (1, 1.9) $\Omega$ (10, 19) $\Omega$ (100, 190) $\Omega$ (1, 1.9, 10, 19) k $\Omega$ (100, 190) k $\Omega$ 1 M $\Omega$ 1.9 M $\Omega$ 10 M $\Omega$ 19 M $\Omega$ 100 M $\Omega$	0.07 % 0.07 %  50 $\mu\Omega$ 0.012 % 31 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 8.2 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 50 $\mu\Omega/\Omega$ 59 $\mu\Omega/\Omega$ 0.013 %	IET SRX Series  Fluke 5720A



Parameter/Equipment	Range	CMC <sup>2, 7</sup> (±)	Comments
Insulation Resistance <sup>3</sup> –			
Fixed Points	10 Ω, 100 Ω, 1 kΩ	1.2 %	Standard resistor set
	10 kΩ to 100 MΩ	0.026 %	
	100 MΩ to 1 GΩ	0.13 %	
	1 GΩ to 10 GΩ	0.24 %	
	100 GΩ to 1T	0.6 %	

Parameter/Range	Frequency	CMC <sup>2, 4, 7, 12</sup> (±)	Comments	
Capacitance – Generate <sup>3</sup>			Fluke 5522A	
(220 to 399.9) pF	(10 to 10 000) Hz	0.88 % + 10 pF		
(0.4 to 1.0999) nF	(10 to 10 000) Hz	0.6 % + 0.01 nF		
(1.1 to 3.2999) nF	(10 to 3000) Hz	0.6 % + 0.01 nF		
(3.3 to 10.9999) nF	(10 to 1000) Hz	0.31 % + 0.1 nF		
(11 to 109.999) nF	(10 to 1000) Hz	0.31 % + 0.1 nF		
(110 to 329.999) nF	(10 to 1000) Hz	0.31 % + 0.3 nF		
(0.33 to 1.09999) μF	(10 to 600) Hz	0.31 % + 1 nF		
(1.1 to 3.29999) μF	(10 to 300) Hz	0.31 % + 3 nF		
(3.3 to 10.9999) μF	(10 to 150) Hz	0.31 % + 10 nF		
(11 to 32.9999) μF	(10 to 120) Hz	0.49 % + 30 nF		
(33 to 109.999) μF	(10 to 80) Hz	0.55 % + 100 nF		
(110 to 329.999) μF	(0 to 50) Hz	0.55 % + 300 nF		
(0.33 to 1.09999) mF	(0 to 20) Hz	0.55 % + 1 μF		
(1.1 to 3.29999) mF	(0 to 6) Hz	0.55 % + 3 μF		
(3.3 to 10.9999) mF	(0 to 2) Hz	0.56 % + 10 μF		
(11 to 32.9999) mF	(0 to 0.6) Hz	0.91 % + 30 μF		
(33 to 110) mF	(0 to 0.2) Hz	1.4 % + 100 μF		
Fixed Points				
1 nF	1 kHz	0.08 %		IET 1409-F
10 nF	1 kHz	0.08 %	IET 1409-L	
100 nF	1 kHz	0.08 %	IET 1409-T	

Parameter/Range	Frequency	CMC <sup>2, 5, 7, 12</sup> (±)	Comments
Inductance – Generate <sup>3</sup>			
Fixed Points			
100 uH	1 kHz	0.31 %	Genrad 1482 series inductors
1 mH	1 kHz	0.14 %	
5 mH	1 kHz	0.14 %	
10 mH	1 kHz	0.14 %	
100 mH	1 kHz	0.14 %	
1 H	1 kHz	0.15 %	
10 H	1 kHz	0.25 %	
AC Voltage – Measure <sup>3</sup>			
Up 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 % + 0.03 % rng 0.022 % + 0.01 % rng 0.031 % + 0.01 % rng 0.11 % + 0.01 % rng 0.51 % + 0.01 % rng 4.1 % + 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	0.008 % + 0.004 % rng 0.008 % + 0.002 % rng 0.015 % + 0.002 % rng 0.031 % + 0.002 % rng 0.081 % + 0.002 % rng 0.31 % + 0.01 % rng	
(10 to 100) 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	0.021 % + 0.004 % rng 0.021 % + 0.002 % rng 0.021 % + 0.002 % rng 0.036 % + 0.002 % rng 0.13 % + 0.002 % rng 0.41 % + 0.01 % rng	
(100 to 600) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.041 % + 0.004 % rng 0.041 % + 0.002 % rng 0.061 % + 0.002 % rng 0.13 % + 0.002 % rng 0.31 % + 0.002 % rng	
(1 to 10) kV	60 Hz	0.13 % + 0.1 V	
(10 to 50) kV	60 Hz	0.13 % + 0.4 V	Vitrek 4670 w/ HVL-70

Parameter/Range	Frequency	CMC <sup>2, 4, 5, 7, 12</sup> ( $\pm$ )	Comments
AC Voltage – Generate <sup>3</sup>			
(0.22 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.19 % + 4 $\mu$ V 0.12 % + 4 $\mu$ V 0.086 % + 4 $\mu$ V 0.15 % + 4 $\mu$ V 0.21 % + 5 $\mu$ V 0.37 % + 10 $\mu$ V 0.53 % + 20 $\mu$ V 0.69 % + 20 $\mu$ V	Fluke 5720A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.031 % + 4 $\mu$ V 0.014 % + 4 $\mu$ V 0.013 % + 4 $\mu$ V 0.03 % + 4 $\mu$ V 0.066 % + 5 $\mu$ V 0.14 % + 10 $\mu$ V 0.18 % + 20 $\mu$ V 0.35 % + 20 $\mu$ V	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.03 % + 12 $\mu$ V 0.011 % + 7 $\mu$ V 0.01 % + 7 $\mu$ V 0.025 % + 7 $\mu$ V 0.056 % + 17 $\mu$ V 0.11 % + 20 $\mu$ V 0.17 % + 25 $\mu$ V 0.34 % + 45 $\mu$ V	
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.03 % + 12 $\mu$ V 0.011 % + 7 $\mu$ V 0.01 % + 7 $\mu$ V 0.025 % + 7 $\mu$ V 0.056 % + 17 $\mu$ V 0.11 % + 20 $\mu$ V 0.17 % + 25 $\mu$ V 0.34 % + 45 $\mu$ V	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.062 % + 40 $\mu$ V 0.024 % + 15 $\mu$ V 56 $\mu$ V/V + 8 $\mu$ V 93 $\mu$ V/V + 10 $\mu$ V 0.014 % + 30 $\mu$ V 0.051 % + 80 $\mu$ V 0.12 % + 200 $\mu$ V 0.21 % + 300 $\mu$ V	

Parameter/Range	Frequency	CMC <sup>2, 4, 5, 7, 12</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (cont)			
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.029 % + 400 μV 0.12 % + 150 μV 58 μV/V + 50 μV 95 μV/V + 100 μV 0.013 % + 200 μV	Fluke 5720A
(22 to 70) V	(100 to 300) kHz	0.11 % + 16 mV	
(220 to 1100) V	(100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.035 % + 600 μV 0.12 % + 2 mV 0.19 % + 3.2 mV	Fluke 5722A
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.062 % + 40 μV 0.024 % + 15 μV 56 μV/V + 8 μV 93 μV/V + 10 μV 0.014 % + 30 μV 0.051 % + 80 μV 0.12 % + 200 μV 0.21 % + 300 μV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.029 % + 400 μV 0.12 % + 150 μV 58 μV/V + 50 μV 95 μV/V + 100 μV 0.013 % + 200 μV 0.035 % + 600 μV 0.12 % + 2 mV 0.19 % + 3.2 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.029 % + 4 mV 0.012 % + 1.5 mV 66 μV/V + 0.6 mV 0.011 % + 1 mV 0.019 % + 2.5 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.037 % + 16 mV 58 μV/V + 3.5 mV	
AC Current – Measure <sup>3</sup>			
(0 to 100) μA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz 100 Hz to 5 kHz	0.41 % + 0.03 % rng 0.16 % + 0.03 % rng 0.07 % + 0.03 % rng 0.07 % + 0.03 % rng	HP 3458A

Parameter/Range	Frequency	CMC <sup>2, 4, 5, 7, 12</sup> (±)	Comments
AC Current – Measure <sup>3</sup> (cont)			
(1 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 % + 0.02 % rng 0.16 % + 0.02 % rng 0.07 % + 0.02 % rng 0.04 % + 0.02 % rng 0.07 % + 0.02 % rng 0.41 % + 0.04 % rng 0.56 % + 0.15 % rng	HP 3458A      HP 34410A
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 % + 0.02 % rng 0.17 % + 0.02 % rng 0.09 % + 0.02 % rng 0.11 % + 0.02 % rng 0.31 % + 0.02 % rng 1.1 % + 0.04 % rng	
(1 to 3) A	10 Hz to 5 kHz	0.26 %	
Up to 20 A	60 Hz	0.27 %	Yokogawa WT210
AC Current – Generate <sup>3</sup>			
(10 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.031 % + 16 nA 0.020 % + 10 nA 0.014 % + 8 nA 0.029 % + 12 nA 0.14 % + 65 nA	Fluke 5720A
(33 to 330) µA	(10 to 30) kHz	2 % + 0.4 µA	Fluke 5522A
220 µA to 2.2 mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.031 % + 40 nA 0.020 % + 35 nA 0.013 % + 35 nA 0.025 % + 110 nA 0.14 % + 650 nA	Fluke 5720A
(0.33 to 3.3) mA	(10 to 30) kHz	1.2 % + 0.6 µA	Fluke 5522A
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.033 % + 400 nA 0.020 % + 350 nA 0.013 % + 350 nA 0.025 % + 550 nA 0.14 % + 5 µA	Fluke 5720A

Parameter/Range	Frequency	CMC <sup>2, 4, 7, 12</sup> (±)	Comments
AC Current – Generate <sup>3</sup> (cont)			
(3.3 to 33) mA	(10 to 30) kHz	0.5 % + 4 µA	Fluke 5522A
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.033 % + 4 µA 0.020 % + 3.5 µA 0.013 % + 2.5 µA 0.025 % + 3.5 µA 0.14 % + 10 µA	
(33 to 330) mA	(10 to 30) kHz	0.5 % + 200 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.03 % + 35 µA 0.055 % + 80 µA 0.85 % + 160 µA	Fluke 5720A
(0.33 to 1.1) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.22 % + 100 µA 0.06 % + 100 µA 0.72 % + 1 mA 3 % + 5 mA	Fluke 5522A
(1.1 to 3.0) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.22 % + 100 µA 0.073 % + 100 µA 0.72 % + 1 mA 3 % + 5 mA	
(3.0 to 11) A	45 Hz to 1 kHz (1 to 5) kHz	0.2 % + 2 mA 3.6 % + 2 mA	
(11 to 20.5) A	45 Hz to 1 kHz (1 to 5) kHz	0.18 % + 5 mA 3.6 % + 5 mA	

Parameter/Range	Frequency	CMC <sup>2, 4, 5, 7, 12</sup> (±)	Comments
AC Clamp-On Meters <sup>3</sup> – (Up to 150) A			
Toroidal	(45 to 65) Hz (65 to 440) Hz	0.49 % + 0.025 A 1 % + 0.027 A	Fluke 5522A w/ 5500 coil
Non-Toroidal	(45 to 65) Hz (65 to 440) Hz	0.76 % + 0.25 A 1.3 % + 0.25 A	
(150 to 1025) A			
Toroidal	(45 to 65) Hz (65 to 440) Hz	0.49 % + 0.09 A 1 % + 0.1 A	
Non-Toroidal	(45 to 65) Hz (65 to 440) Hz	0.76 % + 0.9 A 1.3 % + 0.9 A	
AC Power <sup>3</sup> – Generate (45 to 65) Hz; PF=1			
(33 to 330) mV Range			
(3.3 to 8.99) mA	110 µW to 3 mW	0.17 %	Fluke 5522A
(9 to 32.99) mA	(3 to 11) mW	0.12 %	
(33 to 89.99) mA	(1.1 to 30) mW	0.17 %	
(90 to 329.99) mA	(3 to 110) mW	0.12 %	
(0.33 to 0.8999) A	(11 to 300) mW	0.16 %	
(0.9 to 2.1999) A	(30 to 730) mW	0.14 %	
(2.2 to 4.4999) A	73 mW to 1.5 W	0.16 %	
(4.5 to 20.5) A	150 mW to 6.8 W	0.14 %	
330 mV to 1020 V Range			
(3.3 to 8.99) mA	1.1 mW to 9 W	0.15 %	Fluke 5522A
(9 to 32.99) mA	3 mW to 33 W	0.1 %	
(33 to 89.99) mA	11 mW to 90 W	0.15 %	
(90 to 329.99) mA	30 mW to 330 W	0.1 %	
(0.33 to 0.8999) A	110 mW to 900 W	0.14 %	
(0.9 to 2.1999) A	300 mW to 2200 W	0.11 %	
(2.2 to 4.4999) A	730 mW to 4500 W	0.15 %	
(4.5 to 20.5) A	(1.5 to 20.9) kW	0.12 %	
(20.5 to 500) kW	60 Hz	0.46 %	Fluke 5522A w/coil
(20.5 to 500) kW	400 Hz	1 %	

Parameter/Range	Frequency	CMC <sup>2, 4, 5, 7</sup> (±)	Comments	
Oscilloscopes <sup>3</sup> –				
Square Wave Amplitude:				
50 Ω at 1 kHz	1.0 mV to 6.6 V <sub>pk - pk</sub>	0.32 % + 40 μV	Fluke 5520A SC1100	
1 MΩ at 1 kHz	1.0 mV to 130 V <sub>pk - pk</sub>	0.16 % + 40 μV		
DC Voltage Amplitude:				
50 Ω Load	(0 to ± 6.6) V	0.30 % + 40 μV		
1 MΩ Load	(0 to ± 130) V	0.07 % + 40 μV		
Level Sine Wave:				
Frequency	Up to 1100 MHz	3.3 μHz/Hz		
Amplitude	50 kHz Reference	2.4 % + 300 μV		
	50 kHz to 100 MHz	4.4 % + 300 μV		
	(100 to 300) MHz	4.9 % + 300 μV		
	(300 to 600) MHz	7.3 % + 300 μV		
	(600 to 1100) MHz	8.4 % + 300 μV		
Flatness (Bandwidth)	50 kHz to 100 MHz	2.1 % + 100 μV		
	(100 to 300) MHz	2.6 % + 100 μV		
	(300 to 600) MHz	4.9 % + 100 μV		
	(600 to 1100) MHz	6 % + 100 μV		
Time Markers:				
Into a 50 Ω load	5 s to 50 ms	(30 + 1000 <i>t</i> ) μs/s	<i>t</i> = time in seconds	
	20 ms to 2 ns	3.5 μs/s		
Rise Time:				
1 kHz to 2 MHz	≤ 300 ps	130 ps		
(2 to 10) MHz	≤ 350 ps	130 ps		
Thermocouple Simulation <sup>3</sup> –				
Type B	(600 to 800) °C	0.095 °C	Fluke 5520A w/ ice point reference	
	(800 to 1820) °C	0.095 °C		
Type E	(-270 to -100) °C	0.092 °C		
	(-100 to 650) °C	0.092 °C		
	(650 to 1000) °C	0.092 °C		
Type J	(-210 to -100) °C	0.092 °C		
	(-100 to 760) °C	0.092 °C		
	(760 to 1200) °C	0.092 °C		



Parameter/Range	Frequency	CMC <sup>2, 4, 5, 7, 12</sup> (±)	Comments
Thermocouple Simulation <sup>3</sup> – (cont)			
Type K	(-270 to -100) °C (-100 to 1000) °C (1000 to 1372) °C	0.092 °C 0.090 °C 0.092 °C	Fluke 5520A w/ ice point reference
Type N	(-200 to -100) °C (-100 to 410) °C (410 to 1300) °C	0.13 °C 0.13 °C 0.13 °C	
Type T	(-270 to -150) °C (-150 to 0) °C (0 to 400) °C	0.091 °C 0.091 °C 0.091 °C	
Type R	(-50 to 250) °C (250 to 1000) °C (1000 to 1768) °C	0.095 °C 0.095 °C 0.095 °C	
Type S	(-50 to 250) °C (250 to 1400) °C (1400 to 1768) °C	0.097 °C 0.097 °C 0.097 °C	

Parameter/Equipment	Range	CMC <sup>2, 4, 5, 7, 12</sup> (±)	Comments
Electrical Calibration of RTD Indicators and Indicating Systems <sup>3</sup> –			
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	0.07 °C 0.092 °C 0.11 °C 0.13 °C 0.15 °C 0.28 °C	Fluke 5522A
Distortion – Measure	20 Hz to 20 kHz (20 to 100) kHz	1.4 % 3 %	

IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC <sup>2, 6, 12</sup> (±)	Comments
RF Power – Measure  (-30 to 20) dBm 1 μW to 100 mW	100 kHz to 4.2 GHz	1.4 %	Agilent 4418B/8482A OKC-3138, OKC-3138A

V. Mechanical

Parameter/Equipment	Range	CMC <sup>2, 6, 7</sup> (±)	Comments
Scales & Balances <sup>3</sup>	(1 to 20 000) g	0.017 per 20 000 g % + 0.6R	Class F weights (applied load)
	(Above 20 to 5000) kg	0.017 % + 0.6R	
	Up to 1000 lbs	0.017 % + 0.6R	
	(1000 to 120 000) lbs	0.017 % per 20 000 lb + 0.6R	
	(1 to 500) mg	0.013 mg + 0.6R	Class 1 weights
	(Up to 5) g	0.043 mg + 0.6R	
	(Up to 10) g	0.062 mg + 0.6R	
	(Up to 30) g	0.092 mg + 0.6R	
	(Up to 50) g	0.17 mg + 0.6R	
	(Up to 100) g	0.31 mg + 0.6R	
	(Up to 200) g	0.63 mg + 0.6R	
	(Up to 300) g	0.93 mg + 0.6R	
	(Up to 500) g	1.5 mg + 0.6R	
	(Up to 1000) g	3.1 mg + 0.6R	
(Above 1000) g	3.1 mg per 1000 g + 0.6R		

Parameter/Equipment	Range	CMC <sup>2, 6, 7, 11</sup> (±)	Comments
Force – Measuring Equipment <sup>3</sup>			
Compression	(Up to 100) lbf (50 to 500) lbf (500 to 10 000) lbf (10000 to 25 000) lbf (25000 to 50 000) lbf	0.05 % 0.041 % 0.083 % 0.08 % 0.11 %	Class F Weights Load Cell
Tension	(Up to 2000) lbf (50 to 500) lbf (500 to 10 000) lbf (10000 to 25 000) lbf (25000 to 50 000) lbf	0.05 % 0.041 % 0.083 % 0.08 % 0.11 %	Class F Weights Load Cell
Compression	(50 000 to 100 000) lbf	190 lbf	Load Cell
Compression <sup>3</sup> – Field Only	(50 000 to 500 000) lbf	0.10 %	
Torque – Wrenches Measure <sup>3</sup>	(10 to 100) in·oz 4 in·lbf to 250 ft·lbf 250 to 2000 ft·lbf	0.65 % 0.65 % 1.0 %	CDI torque tester
Torque – Measuring Equipment Transducers and Analyzer	Up to 2000 ft·lbf	0.13 %	Torque arms and weights
Durometer Calibration – (Type A, B, C, D, DO, O, OO)			ASTM D2240
Indenter Extension and Shape –			
Diameter	Up to 0.105 in	120 μin	Vision system
Radius	Up to 0.125 in	120 μin	
Angle	25° to 40°	0.16°	
Extension	Up to 0.105 in	70 μin	Gage blocks
Indenter Display	(0 to 100) durometer units	0.7 durometer units	Gage blocks
Spring Calibration – Force	Up to 45 N	0.032 N	Durometer calibrator

Parameter/Equipment	Range	CMC <sup>2, 6, 7, 11</sup> (±)	Comments
Pressure – Measure & Measuring Equipment <sup>3</sup>	Pneumatic (-10 to 2.5) psig (2.5 to 10) psig	0.001 psig 0.0061 %	Fluke 7252i
	(-14.5 to 125) psig (125 to 500) psig	0.0078 psig 0.0062 %	
Hydraulic	(0 to 3000) psig (0 to 30 000) psig	0.025 % 0.025 %	Fluke RPM4-E-DWT
Absolute Pressure – Measure & Measuring Equipment	(0 to 500) psia	0.0062 % + 0.0026 psia	Fluke 7252i
Atmospheric Pressure (Vacuum) – Measure & Measuring Equipment <sup>3</sup>	(0.01 to 28) in·Hg	0.016 in·Hg	Fluke 7252i
Air Velocity – Measuring Equipment	(40 to 150) fpm (150 to 800) fpm (800 to 3000) fpm	3.7 % 2.5 % 1.8 %	Anemometer standards
Indirect Verification of Rockwell Hardness Testers	HRA: Low Medium High	0.75 HRA 0.73 HRA 0.8 HRA	Indirect verification per ASTM E1 ASTM E110
	HRBW: Low Medium High	0.4 HRBW 0.45 HRBW 0.38 HRBW	
	HRC: Low Medium High	0.43 HRC 0.43 HRC 0.38 HRC	
	HREW: Low Medium High	0.77 HREW 0.77 HREW 0.77 HREW	

Parameter/Equipment	Range	CMC <sup>2, 7, 11</sup> (±)	Comments
Indirect Verification of Rockwell Hardness Testers <sup>3</sup> (cont)	HR15N: Low Medium High  HR30N: Low Medium High  HR45N: Low Medium High  HR15TW: Low Medium High  HR30TW: Low Medium High  HR45TW: Low Medium High	0.42 HR15N 0.42 HR15N 0.42 HR15N  0.58 HR30N 0.5 HR30N 0.6 HR30N  0.48 HR45N 0.48 HR45N 0.49 HR45N  0.4 HR15TW 0.4 HR15TW 0.42 HR15TW  0.41 HR30TW 0.42 HR30TW 0.42 HR30TW  0.93 HR45TW 0.5 HR45TW 0.6 HR45TW	Indirect verification per ASTM E18
Indirect Verification of Brinell Hardness Testers at Test Condition <sup>3-</sup>  HBW 10/3000/15	(200 to 600) HBW	5.6 HBW	Indirect verification per ASTM E10, ASTM E110
Pipettes <sup>3</sup>	(1 to 10) µL (10 to 100) µL (100 to 1000) µL (1000 to 10 000) µL	0.11 µL 0.17 µL 0.63 µL 12 µL	Gravimetric method

Parameter/Equipment	Range	CMC <sup>2, 7, 11</sup> (±)	Comments
Mass – Fixed Points	10 kg 20 kg  25 lb 50 lb	12 mg 31 mg  110 µlb (48 mg) 220 µlb (97 mg)	By comparison w/ Class 1 weights
Mass – Field Check Weight Comparison <sup>3</sup>  Load Fixtures, Hangers, Package and Check Weights	Up to 32kg	0.012 %	Scale w/Class F weights
Speed – Measuring Equipment <sup>3</sup>  Non-Contact	(6 to 200 000) rpm	0.001 %	Agilent 3325B
Speed – Measure <sup>3</sup>  Optical	Up to 250 000 rpm	0.01 %	Tachometer

#### V. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2, 11</sup> (±)	Comments
Temperature – Measure <sup>3</sup>	(-196 to 660) °C	0.06 °C	Fluke 1502A w/5626 PRT
Infrared Temperature Indicators <sup>3</sup>  (Optical Pyrometers)	35 °C (35 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 500) °C	0.84 °C 0.95 °C 1.2 °C 1.7 °C 2.3 °C	Fluke 4181 Emissivity = 0.95 8 to 14 µm

Parameter/Equipment	Range	CMC <sup>2, 11</sup> ( $\pm$ )	Comments
Temperature – Measuring Equipment <sup>3</sup>	(-20 to 300) °C	0.07 °C	Temperature Bath w/remote probe
	(30 to 250) °C	0.15 °C	
	(250 to 400) °C	0.53 °C	Calisto w/probe
	(50 to 700) °C	0.61 °C	Hart 9141 w/probe Hart 9173
Relative Humidity– Measure <sup>3</sup>	(15 to 90) % RH (90 to 95) % RH	1.5 % RH 2.5 % RH	Vaisala HMI41 w/ HMP- 46
Relative Humidity – Measuring Equipment <sup>3</sup>	(10 to 95) % RH	0.74 % RH	Thunder scientific 2500

## VI. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2, 7, 11</sup> ( $\pm$ )	Comments
Timers/Stopwatches <sup>3</sup>	(1 to 3600) s	0.026 s	Electronic counter
	24 Hr	.003 % + .02 s	Bench timer
Stroboscopes <sup>3</sup>	Up to 250 000 rpm	0.001 %	Electronic counter w/ photo diode
Frequency – Measuring Equipment <sup>3</sup>	Up to 1100 MHz	3.3 $\mu$ Hz/Hz	Fluke 5522A w/ SC1100
Frequency – Measure	Up to 225 MHz	0.22 $\mu$ Hz/Hz	HP 53132A Opt 010

<sup>1</sup> This laboratory offers commercial calibration and field calibration services, where noted.

- <sup>2</sup> Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of  $k = 2$ . The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.
- <sup>3</sup> Field calibration service is available for this calibration and this laboratory meets A2LA R104 – *General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.
- <sup>4</sup> Based on using the standard at the temperature the Fluke 5720A, Fluke 5520A was calibrated ( $t_{cal} \pm 5$  °C) and assuming the instrument is zeroed at least every seven days or when the ambient temperature changes more than 5 °C. For resistance, a zero calibration is performed at least every 12 hours within  $\pm 1$  °C of use.
- <sup>5</sup> Based on using the standard at the temperature the HP 3456A, 3457A, or 3458A was calibrated ( $t_{cal} \pm 5$  °C) and an auto-calibration (ACAL) was performed within the previous 24 hours ( $\pm 1$  °C of ambient temperature).
- <sup>6</sup> In the statement of Calibration and Measurement Capability,  $L$  is the numerical value of the nominal length of the device measured in microinches;  $R$  is the numerical value of the resolution of the device in microinches.  $DL$  is the diagonal length of the device in inches.
- <sup>7</sup> Unless otherwise noted, percentage refers to percent of reading.
- <sup>8</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>9</sup> Adjustable thread rings are set to applicable specifications using calibrated master set plug gages.
- <sup>10</sup> This scope meets A2LA's *P112 Flexible Scope Policy*.
- <sup>11</sup> The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.
- <sup>12</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. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.





# Accredited Laboratory

A2LA has accredited

**CROSS TECHNOLOGIES, INC DBA CROSS (FORMERLY J.A. KING)**

*Oklahoma City, OK*

for technical competence in the field of

## Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 27<sup>th</sup> day of February 2020.

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

Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 1741.13  
Valid to May 31, 2022  
Revised May 11, 2021

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