



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION

Valid until: October 31, 2022

Certificate Number: 6176.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations as well as the types of tests on metals listed below:^{1,4}

I. Acoustical Quantities

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Acoustic ³ – Measure	94 dB @ 1 kHz 114 dB @ 1kHz	0.14 dB	Acoustic calibrator
Acoustic ³ – Measuring Equipment	94 dB @ 1 kHz 114 dB @ 1kHz	0.14 dB	Acoustic calibrator/meter

II. Chemical

Parameter/Equipment	Range	CMC ² (±)	Comments
Conductivity Meter ³	10 µS/cm 100 µS/cm 1000 µS/cm 1400 µS/cm 10 000 µS/cm 100 000 µS/cm	0.037 µS 0.64 µS 5.9 µS 5.9 µS 38 µS 380 µS	Conductivity solutions

Parameter/Equipment	Range	CMC ² (±)	Comments
pH Meter ³	4 pH 7 pH 10 pH	0.02 pH 0.02 pH 0.02 pH	Buffer solutions

III. Dimensional

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Angle Blocks ³	Up to 90°	0.12°	CMM
Calipers ³	(0.05 to 24) in (24 to 100) in	(520 + 21L) μin (480 + 22L) μin	Grade 2 gage blocks
Cylindrical Gage, Internal Diameter ³	(0.125 to 19) in	(15 + 9.7L) μin	Grade 2 gage blocks with internal diameter comparator
Cylindrical Gage, Outside Diameter ³	(0.01 to 27) in	(13 + 19L) μin	Grade 2 gage blocks with outside diameter comparator
	(0.01 to 1.2) in	(23 + 3.8L) μin	Laser mic
Gage Blocks ³	(0.05 to 4) in (4 to 24) in	(2 + 3.3L) μin (3 + 3.3L) μin	Grade 1 Blocks w/ gage comparator
Height Gage ³	(0.05 to 48) in	900 μin	Grade 2 gage blocks
Indicator, Plunger ³	Up to 4 in	300 μin	Grade 2 gage blocks
Indicator, Test ³	Up to 0.125 in	100 μin	Grade 2 gage blocks
Length Standards ³	(0.05 to 27) in	(20 + 19L) μin	Grade 2 gage blocks w/comparator

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Micrometer, Depth ³	(0.05 to 12) in	650 μin	Grade 2 gage blocks
Micrometer, Inside ³	(1.5 to 24) in	1300 μin	Grade 2 gage blocks
Micrometer, Outside ³	(0.05 to 24) in	(29 + 30L) μin	Grade 2 gage blocks
Protractor ³	Up to 90°	0.01°	Grade 2 gage blocks w/ sine bar
Ruler ³	Up to 36 in	(8000 + 22L) μin	Grade 2 gage blocks
Thickness, Ultrasonic ³	Up to 20 in	(4000 + 18L) μin	Grade 2 gage blocks
Thread Ring Gage, Pitch Diameter 60° ³	1/2-80 to 16-6	(100 + 20L) μin	Grade 2 gage blocks w/ comparator & spheres
Thread Plug Gage, Pitch Diameter 60° ³	0-80 to 20-6	(90 + 19L) μin	Grade 2 gage blocks w/ comparator & wires
CMM Axis Length ³	(12 to 96) in	(70 + 7.4L) μin	Ball bar & gage blocks – ASME B89.4.10360.2- 2008
AACMM Radial Length	Up to 72 in	200 μin	Ball bar & gage blocks – ASME B89.4.10360.2- 2008
CMM Repeatability ³	1 in	66 μin	Ball bar & gage blocks standard
CMM Squareness ³	(12 to 24) in	(40 + 11L) μin	Ball bar
CMM Volumetric ³	(12 to 96) in	(65 + 6.6L) μin	Ball bar
V Block – Angle ³	(5 to 60)°	57 μin	CMM
V Block – Parallelism ³	(1 to 8) in	170 μin	CMM

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
V Block – Perpendicularity ³	(1 to 8) in	180 μin	CMM
Bore Gage (Indicator) ³	(0.07 to 12) in	(15 + 1.4L) μin	Gage blocks
Tri-Micrometer ³	(0.28 to 12) in	(50 + 11L) μin	Ring gages
Surface Plate Flatness ³	(12 to 160) in	(25 + 0.6D) μin	Auto collimator
Surface Plate, Repeat Reading ³	0.002 in	25 μin	Repeat-o-meter
Optical Comparator Axis Linearity ³	304.8 mm Maximum (12 in Maximum)	(38 + 5.5L) μin	Gage blocks, glass master, glass scale
Optical Comparator Axial Squareness ³	(101.6 mm of Y axis travel or maximum Y axis travel is less than 101.6 mm) (4 in of Y axis travel or maximum Y axis travel is less than 4 in)	55 μin	Glass master
Optical Comparator Chart Angularity ³	(0 to 90)°	0.018°	Glass master

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
Optical Comparator Magnification ³	5X 10X 20X 31.25X 50X 62.5X 100X	160 μin 160 μin 140 μin 150 μin 160 μin 150 μin 160 μin	Ball check gage, 10 in glass magnification scale
	10X 20X 31.25X 50X 62.5X 100X	170 μin 170 μin 200 μin 220 μin 200 μin 220 μin	Ball check gage, 20 in glass magnification scale
Optical/Video Measuring System (O/VMS), Linear X/Y Axis ³	(0.001 to 24) in	(65 + 6.1L) μin	Glass master
OMS Linear Z Axis ³	(1 to 8) in	(65 + 5.2L) μin	Gage blocks
OMS Axial Squareness ³	(101.6 mm of Y axis travel or maximum Y axis travel is less than 101.6 mm) (4 in of Y axis travel or maximum Y axis travel is less than 4 in)	1.4 μm (57 μin)	Gage blocks
OMS Magnification ³	10X to 200X	56 μin	Glass scale
Optical Flat ³	(0.5 to 12) in	0.5 μin	3 flat method
Roughness – Measure	(400 to 2000) μin	1.6 μin	Profilometer
Roughness – Measuring Equipment	(116 to 2000) μin	1.6 μin	Std roughness patch
Protractor ³	(0 to 90)°	0.021°	Sine bar, gage blocks & surface plate
Flatness ³	(4 to 40) μin	1.2 μin	Optical flat

Parameter/Equipment	Range	CMC ² (±)	Comments
Radius Gages ³	(0.01 to 8) in	(75 + 9.2L) μin	Optical comparator
Thickness Gage Ferrous Nonferrous Ultrasonic ³	(20 to 500) μm (800 to 0.06) in (0.8 to 59) mils	1.4 μm 55 μin 0.055 mils	Thickness standards & gauge blocks

IV. Dimensional Inspection⁹

Parameter/Equipment	Range	Comments
2-Dimensional & 3-Dimensional Features of Manufactured Products & Components Size, Location, & Orientation using CMM	58 in x 40 in x 25 in	ANSI Y14.5-M
2-Dimensional & Features of Manufactured Products & Components Size, Location, & Orientation using an Optical Comparator	24 in x 18 in	ANSI Y14.5-M
2-Dimensional & Features of Manufactured Products & Components Size using a LVDT & Gage Blocks	10 μin to 48 in	ANSI Y14.5-M
2-Dimensional & Features of Manufactured Products & Components Size using a DMS	50 μin to 2 in	ANSI Y14.5-M
2-Dimensional & Features of Manufactured Products & Components Size using a Vernier Micrometer	(2 to 10) in	ANSI Y14.5-M

V. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
DC Voltage ³ – Measure	60 nV to 1 mV (1 to 10) mV	50 μ V/V + 20 nV 50 μ V/V + 30 nV	Agilent 34420A
	1 μ V to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	10 μ V/V + 0.3 μ V 9 μ V/V + 0.3 μ V 9 μ V/V + 0.5 μ V 10 μ V/V + 350 μ V 10 μ V/V + 1.3 mV	Agilent 3458A
	(1 to 40) kV	2 μ V/V	Divider w/ DMM
	Fixed Point 10 V	2 μ V/V	Fluke 732A
DC Voltage ³ – Generate	2 μ V to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV (1 to 40) kV	8 μ V/V + 0.6 μ V 7 μ V/V + 1 μ V 7 μ V/V + 3.5 μ V 7 μ V/V + 6.5 μ V 8 μ V/V + 80 μ V 9 μ V/V + 500 μ V 2 % of rdg	Fluke 5700A DMM w/ divider
DC Current ³ – Measure	(1 to 100) μ A 100 μ A to 1 mA	4 μ A/A + 0.6 nA 30 μ A/A + 0.6 nA	Agilent 34420A
	(1 to 10) mA (10 to 100) mA 100 mA to 1 A	30 μ A/A + 0.1 nA 0.4 μ A/A + 0.6 μ A 130 μ A/A + 12 μ A	Agilent 3458A
	(1 to 2) A (2 to 20) A	190 μ A/A + 16 μ A 400 μ A/A + 40 μ A	Fluke 8508A
DC Current ³ – Generate	24 nA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	50 μ A/A + 8 nA 50 μ A/A + 80 nA 60 μ A/A + 0.8 μ A 80 μ A/A + 25 μ A	Fluke 5700A
	(1.1 to 3.0) A (3.0 to 11) A (11 to 20.5) A	4 mA/A + 120 μ A 0.5 mA/A + 6 mA 1 mA/A + 16 mA	Fluke 5520A
	(20 to 1000) A	0.5 % of rdg + 0.5 A	Fluke 5520A w/ coil

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
Resistance ³ – Measure	100 $\mu\Omega$ to 2 Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 k Ω (2 to 20) k Ω (20 to 200) k Ω 200 k Ω to 2 M Ω	17 $\mu\Omega/\Omega$ + 4 $\mu\Omega$ 9.5 $\mu\Omega/\Omega$ + 14 $\mu\Omega$ 8 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 8 $\mu\Omega/\Omega$ + 0.5 m Ω 8 $\mu\Omega/\Omega$ + 5 m Ω 8 $\mu\Omega/\Omega$ + 50 m Ω 9 $\mu\Omega/\Omega$ + 1 Ω	Fluke 8508A
	(1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	52 $\Omega/\text{M}\Omega$ + 100 Ω 520 $\Omega/\text{M}\Omega$ + 1.5 k Ω 5 k $\Omega/\text{M}\Omega$ + 11 k Ω	Fluke 3458A
Resistance ³ – Generate	(0.1 to 1) Ω (1 to 1.9) Ω (1.9 to 10) Ω (10 to 19) Ω (19 to 100) Ω (100 to 190) Ω 190 Ω to 1 k Ω (1 to 1.9) k Ω (1.9 to 10) k Ω (10 to 19) k Ω (19 to 100) k Ω (100 to 190) k Ω 190 to 1 M Ω (1 to 1.9) M Ω (1.9 to 10) M Ω (10 to 19) M Ω (19 to 100) M Ω	95 $\mu\Omega/\Omega$ 95 $\mu\Omega/\Omega$ 28 $\mu\Omega/\Omega$ 27 $\mu\Omega/\Omega$ 17 $\mu\Omega/\Omega$ 17 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 47 $\mu\Omega/\Omega$ 110 $\mu\Omega/\Omega$	Fluke 5700A
Resistance ³ – Measure	(1 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 11) k Ω (11 to 110) k Ω 110 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1100) M Ω	2 m Ω 30 $\mu\Omega/\Omega$ + 2 m Ω 15 $\mu\Omega/\Omega$ + 2 m Ω 0.04 m Ω/Ω + 2 m Ω 0.04 m Ω/Ω + 2 m Ω 35 m $\Omega/\text{k}\Omega$ + 25 m Ω 35 m $\Omega/\text{k}\Omega$ + 250 m Ω 36 m $\Omega/\text{k}\Omega$ + 35 Ω 140 $\Omega/\text{M}\Omega$ + 55 Ω 320 $\Omega/\text{M}\Omega$ + 55 Ω 0.2 k $\Omega/\text{M}\Omega$ + 3 k Ω 0.5 k $\Omega/\text{M}\Omega$ + 3.5 k Ω 3 k $\Omega/\text{M}\Omega$ + 0.1 M Ω 15 k $\Omega/\text{M}\Omega$ + 5 M Ω	Fluke 5520A

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Capacitance ³ – Generate	(0.19 to 3.3) nF (3.3 to 330) nF 330 nF to 3.3 μF (3.3 to 33) μF (33 to 330) μF 330 μF to 3.3 mF (3.3 to 33) mF (33 to 110) mF	0.5 % of rdg + 0.01 nF 0.25 % of rdg + 0.3 nF 0.25 % of rdg + 3 nF 0.4 % of rdg + 30 nF 0.45 % of rdg + 300 nF 0.45 % of rdg + 3 μF 0.75 % of rdg + 30 μF 1.1 % of rdg + 100 μF	Fluke 5520A
Capacitance ³ – Measure	(0.19 to 3.3) nF (3.3 to 330) nF 330 nF to 3.3 μF (3.3 to 33) μF (33 to 330) μF 330 μF to 3.3 mF (3.3 to 33) mF (33 to 110) mF	0.5 % of rdg + 0.01 nF 0.25 % of rdg + 0.3 nF 0.25 % of rdg + 3 nF 0.4 % of rdg + 30 nF 0.45 % of rdg + 300 nF 0.45 % of rdg + 3 μF 0.75 % of rdg + 30 μF 1.1 % of rdg + 100 μF	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage ³ – Generate			
15 μV to 2.2 mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	550 μV/V + 4.5 μV 210 μV/V + 4.5 μV 100 μV/V + 4.5 μV 370 μV/V + 4.5 μV	Fluke 5700A
21 μV to 2.2 mV	(50 to 100) kHz	850 μV/V + 7 μV	
39 μV to 2.2 mV	(100 to 300) kHz	1100 μV/V + 13 μV	
75 μV to 2.2 mV	(300 to 500) kHz 500 kHz to 1 MHz	1700 μV/V + 25 μV 3400 μV/V + 25 μV	
(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	550 μV/V + 5 μV 210 μV/V + 5 μV 100 μV/V + 5 μV 370 μV/V + 5 μV 850 μV/V + 7 μV 1100 μV/V + 25 μV 1700 μV/V + 35 μV 3400 μV/V + 80 μV	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage ³ – Generate (cont)			
(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	550 μV/V + 13 μV 210 μV/V + 8 μV 110 μV/V + 8 μV 320 μV/V + 8 μV 850 μV/V + 25 μV 1100 μV/V + 25 μV 1700 μV/V + 35 μV 3400 μV/V + 80 μV	Fluke 5700A
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	500 μV/V + 80 μV 160 μV/V + 25 μV 75 μV/V + 6 μV 120 μV/V + 16 μV 250 μV/V + 70 μV 430 μV/V + 130 μV 1100 μV/V + 350 μV 2200 μV/V + 850 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	500 μV/V + 800 μV 160 μV/V + 250 μV 750 μV/V + 60 μV 120 μV/V + 160 μV 250 μV/V + 350 μV 500 μV/V + 1.5 mV 1300 μV/V + 4.3 mV 2700 μV/V + 8.5 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	500 μV/V + 8 mV 160 μV/V + 2.5 mV 80 μV/V + 0.8 mV 220 μV/V + 3.5 mV 500 μV/V + 8 mV 1500 μV/V + 90 mV 4700 μV/V + 90 mV 11 000 μV/V + 190 mV	
220 V to 1.1 kV	(15 to 50) Hz 50 Hz to 1 kHz	400 μV/V + 16 mV 80 μV/V + 3.5 mV	
AC Voltage ³ – Measure			
1 V 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	0.4 μV /mV + 0.4 μV 0.5 μV /mV + 0.21 μV 0.64 μV /mV + 0.21 μV 1.2 μV /mV + 0.21 μV 2.6 μV /mV + 2.2 μV 76 μV /mV + 4 μV	Agilent 3458A

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage ³ – Measure (cont)			
(1 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	0.03 % of rdg + 4 µV 0.02 % of rdg + 2 µV 0.03 % of rdg + 2 µV 0.1 % of rdg + 2 µV 0.5 % of rdg + 2 µV 4 % of rdg + 3 µV	Agilent 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	70 µV/V + 450 µV 70 µV/V + 250 µV 140 µV/V + 250 µV 300 µV/V + 250 µV 800 µV/V + 250 µV 300 µV/V + 1 mV 1000 µV/V + 1 mV 15 000 µV/V + 1 mV	
(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 300 kHz to 1 MHz	200 µV/V + 4 mV 200 µV/V + 2 mV 200 µV/V + 2 mV 350 µV/V + 2 mV 1200 µV/V + 2 mV 4000 µV/V + 10 mV 15 000 µV/V + 10 mV	
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	400 µV/V + 40 mV 400 µV/V + 20 mV 600 µV/V + 20 mV 1200 µV/V + 20 mV 3000 µV/V + 20 mV	
AC Current ³ – Generate			
550 nA to 220 µA	(10 to 20) Hz (1 to 5) kHz	180 nA 170 nA	Fluke 5700A
300 nA to 220 µA	(20 to 40) Hz	97 nA	
150 nA to 220 µA	40 Hz to 1 kHz	47 nA	
(1.3 to 220) µA	(5 to 10) kHz	430 nA	
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	1.6 µA 800 nA 350 nA 1.7 µA 4.4 µA	
(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	16 µA 8.1 µA 3.5 µA 18 µA 43 µA	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Current ³ – Generate (cont) (22 to 220) mA 220 mA to 2.2 A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	160 µA 81 µA 35 µA 180 µA 430 µA 1.5 mA 1.8 mA 19 mA	Fluke 5700A
AC Current ³ – Generate (2.2 to 3) A (3 to 11) A (11 to 20.5) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	180 µA/A + 0.2 mA 60 µA/A + 0.1 mA 600 µA/A + 1 mA 25 000 µA/A + 5 mA 100 µA/A + 2 mA 1000 µA/A + 5 mA 30 000 µA/A + 2 mA 120 µA/A + 5 mA 150 µA/A + 5 mA 30 000 µA/A + 5 mA	Fluke 5520A
AC Current ³ – Measure; Clamp-On Meter (20.5 to 1025) A	(45 to 65) Hz (65 to 440) Hz	1 % of rdg 1.2 % of rdg	Fluke 5520A w/ coil
Oscilloscopes ³ – Level Sine Wave Flatness, Relative to 10 MHz 50 kHz to 100 MHz (100 to 300) MHz (0.3 to 3.2) GHz Square Wave DC Signal, 50 Ω DC Signal, 1 MΩ Time Marker 50 Ω	5 mV to 5.5 V 5 mV to 5.5 V 5 mV to 5.5 V (-6.6 to 6.6) V (-130 to 130) V 5 s to 50 ms 20 ms to 1 ns	1.5 % of rdg + 100 µV 2 % of rdg + 100 µV 7 % of rdg + 100 µV 0.25 % of rdg + 40 µV 0.05 % of rdg + 40 µV (20 + 1000t) µs/s 2.5 µs/s	Fluke 5520A/SC300 Fluke 9500B/9530 Fluke 5520A/SC300 t = time in µs

Parameter/Range	Frequency	CMC ^{2,7} (\pm)	Comments
AC Current ³ – Measure			
(5 to 100) μ A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	4000 μ A/A + 30 nA 1500 μ A/A + 30 nA 600 μ A/A + 30 nA	Agilent 3458A
(0.1 to 1) 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	4000 μ A/A + 200 nA 1500 μ A/A + 200 nA 600 μ A/A + 200 nA 300 μ A/A + 200 nA 600 μ A/A + 200 nA 4000 μ A/A + 400 nA 5500 μ A/A + 1.5 μ A	
(1 to 10) 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	4000 μ A/A + 2 μ A 1500 μ A/A + 2 μ A 600 μ A/A + 2 μ A 300 μ A/A + 2 μ A 600 μ A/A + 2 μ A 4000 μ A/A + 4 μ A 5500 μ A/A + 15 μ A	
(10 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	4000 μ A/A + 20 μ A 1500 μ A/A + 20 μ A 600 μ A/A + 20 μ A 300 μ A/A + 20 μ A 600 μ A/A + 20 μ A 4000 μ A/A + 40 μ A 5500 μ A/A + 150 μ A	
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	4000 μ A/A + 200 μ A 1600 μ A/A + 200 μ A 800 μ A/A + 200 μ A 1000 μ A/A + 200 μ A 3000 μ A/A + 200 μ A 10 000 μ A/A + 400 μ A	
200 mA to 2 A	10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	620 μ A/A + 200 μ A 740 μ A/A + 200 μ A 30 000 μ A/A + 200 μ A	
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	820 μ A/A + 200 μ A 25 000 μ A/A + 200 μ A	
(5 to 100) μ A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	0.0043 μ A/A + 0.03 mA 0.002 μ A/A + 0.03 mA 0.0007 μ A/A + 0.03 mA	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Current ³ – Measure (0.1 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	4 µA/mA + 23 µA 2 µA/mA + 23 µA 1 µA/mA + 23 µA 0.4 µA/mA + 23 µA 1 µA/mA + 23 µA 4 µA/mA + 45 µA 6 mA/mA + 160 µA	Agilent 3458A
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5kHz (5 to 20) kHz (20 to 50) kHz	2 mA/A + 0.2 mA 1 mA/A + 0.2 mA 1.3 mA/A + 0.2 mA 1.2 mA/A + 0.2 mA 3 mA/A + 0.2 mA 11 mA/A + 0.4 mA	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Thermocouple & Thermocouple Indicating Systems ³ –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1800) °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	Fluke 5520A
Type C	(0 to 150) °C (1000 to 1800) °C (1800 to 2316) °C (150 to 650) °C (650 to 1000) °C	0.3 °C 0.5 °C 0.84 °C 0.26 °C 0.31 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Thermocouple & Thermocouple Indicating Systems ³ – (cont)			
Type K	(-210 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.4 °C	Fluke 5520A
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.37 °C 0.26 °C 0.17 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.4 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	
Electrical Calibration of RTD Indicating Systems ³ –			
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	0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.23 °C	Fluke 5520A

VI. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
RF Power ³ – Measure (1 x 10 ⁻¹⁶ to 2.5 x 10 ⁻¹) W (24 to -130) dBm (1 x 10 ⁻¹⁶ to 2.5 x 10 ⁻²) W (14 to -130) dBm	10 Hz to 12.5 MHz 12.5 MHz to 4 GHz	0.05 dB 0.06 dB	HP 8568B W = reference power from source in watts
RF Power ³ – Generate (1 x 10 ⁻¹⁶ to 2.5 x 10 ⁻¹) W (24 to -130) dBm (1 x 10 ⁻¹⁶ to 2.5 x 10 ⁻²) W (14 to -130) dBm	10 Hz to 12.5 MHz 12.5 MHz to 4 GHz	0.05 dB 0.06 dB	HP 8340B W = reference power from source in watts

VII. Fluid Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Micropipettes ³	(1 to 10) µL (10 to 100) µL (100 to 1000) µL	0.19 nL 0.19 µL 1.9 µL	SG204, SOP14
Beakers ³	25 mL 50 mL 100 mL 150 mL 250 mL 400 mL 600 mL 800 mL 1 L 2 L	0.29 mL 0.58 mL 1.2 mL 1.7 mL 2.9 mL 4.6 mL 6.9 mL 9.2 mL 12 mL 23 mL	BG204, SOP14 EX1103, SOP14 EX1103, SOP14, gravimetric method SG32001, SOP14

Parameter/Equipment	Range	CMC ² (±)	Comments
Burettes ³	10 mL 25 mL 50 mL 100 mL	27 µL 60 µL 0.13 mL 0.14 mL	SG204, SOP14, gravimetric method
Flasks ³	1 mL 2 mL 5 mL 10 mL 20 mL 25 mL 50 mL 100 mL 200 mL 250 mL 500 mL 1 L 2 L	4.8 µL 6.4 µL 14 µL 27 µL 49 µL 60 µL 0.13 mL 0.13 mL 0.27 mL 0.27 mL 0.59 mL 1.4 mL 3.4 mL	SG204, SOP14, gravimetric method EX1103, SOP14, gravimetric method SG32001, SOP14, gravimetric method
Graduated Cylinders ³	1 mL 2 mL 5 mL 10 mL 20 mL 25 mL 50 mL 100 mL 250 mL 500 mL 1 L 2 L	4.8 µL 6.4 µL 14 µL 27 µL 49 µL 60 µL 0.13 mL 0.13 mL 0.27 mL 0.59 mL 1.4 mL 3.4 mL	SG204, SOP14, gravimetric method EX1103, SOP14, gravimetric method SG32001, SOP14, gravimetric method

Parameter/Equipment	Range	CMC ² (±)	Comments
Test Tubes ³	3 mL	6.4 µL	SG204, gravimetric method
	5 mL	14 µL	
	10 mL	27 µL	
	20 mL	53 µL	
	25 mL	58 µL	
	50 mL	140 µL	
	100 mL	140 µL	
	500 mL	590 µL	EX1103, gravimetric method
	1 L	1.2 mL	
	2 L	3.4 mL	SG32001, gravimetric method
Flow Meter ³ – N ₂ /Air	(.5 to 100) mL/min	0.8 % of rdg + 0.3 mL/min	Alicat M-Series
	(1 to 700) mL/min	1 % of rdg + 0.15 mL/min	DC-1LC
	(0.1 to 30) L/min	0.2 % of rdg + 0.01 L/min	Molbox/Molbloc
	(30 to 50) L/min	0.2 % of rdg + 0.02 L/min	
	(50 to 3200) L/min	0.3 % of rdg + 0.3 L/min	N ₂ flow bench
Flow Meter ³ – H ₂ O	(1 to 60) L/min	0.7 % of rdg + 0.02 L/min	H ₂ O flow bench
Flow Meter ³ – Hydraulic Flow	(1.9 to 230) L/min	0.3 % of rdg + 0.03 L/min	Hydraulic flow bench

VIII. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
Weighing Devices ³	135 mg to 220 g 220 g to 32 kg	0.42 mg (50 + 2 <i>W_i</i>) mg	Comparison to F Class weights
	(1 to 1000) lb	(0.01 + 1 x 10 ⁻⁴ <i>W_i</i>) lb	
Force ³ – Compression & Tension, Measure & Measuring Equipment	(100 to 5000) lb (5000 to 25 000) lb (25 000 to 100 000) lb	10 lb 50 lb 200 lb	Comparison to load cell

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Mass Standards ³	100 mg	390 µg	SG204 & ASTM Class 0 weights
	200 mg	390 µg	
	300 mg	390 µg	
	500 mg	390 µg	
	1 g	390 µg	
	3 g	390 µg	
	5 g	390 µg	
	10 g	390 µg	
	20 g	390 µg	
	30 g	390 µg	
	50 g	390 µg	
	100 g	390 µg	
	200 g	390 µg	
	300 g	1.2 mg	
	500 g	1.2 mg	
	1 kg	1.2 mg	
2 kg	5.8 mg	PR5002 & ASTM Class 0 weights	
3 kg	5.8 mg		
5 kg	5.8 mg		
5 kg	58 mg	SG32001 & ASTM Class 0 weights	
10 kg	58 mg		
20 kg	58 mg		
30 kg	58 mg		
Accelerometers & Vibration Meters	(5 to 10) m/s ² 7 Hz to 10 kHz	1.7 % of rdg	Comparison to 9100D calibrator
Pressure ³ – Measure	Up to 2.5 psig	0.0007 psi	APC/CPC/PCS
	Up to 5 psig	0.0009 psi	
	Up to 15 psig	0.002 psi	
	Up to 30 psig	0.003 psi	
	Up to 50 psig	0.006 psi	
	Up to 100 psig	0.013 psi	
	Up to 1000 psig	0.12 psi	
	Up to 6000 psig	0.7 psi	
Pressure ³ – Measure	Up to 100 psig	0.01 % of rdg + 0.003 psi	CPC4000
Pressure ³ – Measure	Up to 1000 psig	0.01 % of rdg + 0.03 psi	CPC4000
Pressure ³ – Measure	Up to 13.2 psia	0.002 psi	CPT9000 transducers
	Up to 40 psia	0.008 % of rdg	
	(40 to 165) psia	0.02 psi	
	(165 to 500) psia	0.008 % of rdg	

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Pressure Transducer ³	(58 to 16 000) psig (0.3 to 500) psig	0.0075 % rdg	DHI piston gauge C-1, P2 piston gauge
Torque Transducer ³	(0.16 to 4000) ozf•in (2.5 to 2500) lbf•ft (0.01 to 2500) lbf•ft	0.05 % rdg 0.05 % rdg 0.1 % rdg	Wheel w/ weights, bar w/ weights, torque calibrator
Torque Wrench ³	(160 to 1600) ozf•in (1 to 100) lbf•ft (100 to 500) lbf•ft (500 to 2500) lbf•ft	1% + 4 ozf•in 0.38% + 0.05 lbf•ft 0.5% + 2.4 lbf•ft 1% + 2.8 lbf•ft	1600 Calibrator 100 Calibrator 500 Calibrator 2500 Calibrator
Direct Verification of Durometers ³ – Type A, B, C, D, DO, E, M, O, OO, OOO, OOO-S Indentor Extension Indicator	1 µm to 5 mm	3.6 µm	Gage Blocks ASTM D 2240-05 5.1.1.8
Durometer Indentor Spring Force ³ Type A, B, C, D, DO, E, M, O, OO, OOO, OOO-S	0 g to 4.53 kg	1.3 g	Balance ASTM D 2240-05 5.1.1.13
Indentor ³ Diameter Tip Diameter Tip Radius Tip Angle	(1.25 to 50) mm (1.27 to 12) mm (0.1 to 11) mm (30 to 35)°	(3.6 x 10 ⁻⁶ + 7.0 x 10 ⁻⁶ L) m (3.6 x 10 ⁻⁶ + 7.0 x 10 ⁻⁶ L) m (3.6 x 10 ⁻⁶ + 7.0 x 10 ⁻⁶ L) m 0.027°	Optical comparator ASTM D 2240-05 5.1.1

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Indirect Verification of Rockwell Hardness & Rockwell Superficial Hardness Testers ³ –	HRBW: (40 to 59) HRBW (59 to 79) HRBW (79 to 100) HRBW HRC: (20 to 35) HRC (35 to 55) HRC (55 to 65) HRC HRA: (20 to 65) HRA (65 to 78) HRA (78 to 84) HRA HR15N: (70 to 77) HR15N (77 to 88) HR15N 88 to 92) HR15N HR30N: (40 to 54) HR30N (54 to 76) HR30N (76 to 86) HR30N HR45N: (19 to 36) HR45N (36 to 65) HR45N (65 to 78) HR45N HR15TW: (60 to 80) HR15TW (80 to 86) HR15TW (86 to 93) HR15TW HR30TW: (15 to 56) HR30TW (56 to 69) HR30TW (69 to 83) HR30TW HR45TW: (1 to 32) HR45TW (32 to 52) HR45TW (52 to 73) HR45TW	0.7 HRBW 0.71 HRBW 0.6 HRBW 0.45 HRC 0.44 HRC 0.38 HRC 0.46 HRA 0.23 HRA 0.24 HRA 0.4 HR15N 0.33 HR15N 0.27 HR15N 0.45 HR30N 0.39 HR30N 0.35 HR30N 0.53 HR45N 0.45 HR45N 0.45 HR45N 0.6 HR15TW 0.45 HR15TW 0.37 HR15TW 0.56 HR30TW 0.45 HR30TW 0.38 HR30TW 0.55 HR45TW 0.5 HR45TW 0.47 HR45TW	Rockwell hardness test block
Nuclear Density Gauge			
Density	(1770 to 2434) kg/m ³	1.1 % of rdg	Density & moisture Blocks
Moisture	(0 to 570) kg/m ³	1.1 % of rdg + 0.16 kg/m ³	

IX. Optical Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Illuminance Response ³	(100 to 4500) fc	0.58 % of rdg + 0.45 fc	Standard of illuminance
Spectral Irradiance ³	100 μW/cm ² to 5 mW/cm ² @ 365 nm	0.98 % of rdg + 5.0 μW/cm ²	Radiometer & lamp
Wavelength	(253 to 579) nm	0.01 nm	Spectral lamps
	(200 to 1100) nm	0.02 nm	Spectral radiometer

X. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Humidity Meters ³	33 % RH	1.0 % RH	Vaisala w/ salts chamber
	75 % RH	1.1 % RH	
	25 °C	0.06 °C	SPRT w/ salts chamber
	(0 to 70) °C	0.16 °C	Thunder 2500
	(25 to 75) % RH	0.57 % RH	Thunder 2500
IR Temperature Devices ³	(35 to 350) °C	3 °C	IR calibrator
IR Temperature Devices ³	(35 to 350) °C	0.34 % of rdg + 0.38 °C	IR calibrator
Temperature ³ – Measuring Equipment	(-20 to 420) °C	0.16 °C	SPRT w/display
Temperature ³ – Measure	(-20 to 150) °C	0.02 °C	SPRT w/ bath
	(-25 to 150) °C	0.16 °C	SPRT w/ 9142
	(50 to 650) °C	0.16 °C	SPRT w/ 9141

XI. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Frequency ³ – Generate Fixed Point	10 Hz to 22.6 GHz 10 MHz	(6.8 x 10 ⁻⁹) Hz / Hz 2 μHz	Generator w/ GPSDO GPSDO
Frequency ³ – Measure Fixed Point	10 Hz to 3 GHz 10 MHz	(4.7 x 10 ⁻⁹) Hz / Hz 2 μHz	Counter w/ GPSDO GPSDO
Time Intervals, Timers ³	(6 x 10 ⁻⁹ to 1 x 10 ⁶) s	0.038 s/day	Counter
Stopwatches ³	(7.2 x 10 ³ to 8.7 x 10 ⁴) s (1 to 1.8 x 10 ³) s	0.68 s 6 ms	Direct comparison, stopwatch, or universal counter Time base method universal counter

MECHANICAL TESTING

Test:	Parameter⁸:	Test Methods¹⁰:
Metallic Testing	Rockwell Hardness: HRA 20 to HRA 84 HRC 20 to HRC 65 HRBW 40 to HRBW 100	ASTM E18

¹ This laboratory offers commercial calibration services and field calibration services.

² Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMC's 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. 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 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 This scope meets A2LA's *P112 Flexible Scope Policy*.

⁵ 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.

⁶ In the statement of CMC, L is the nominal length of device measure in inches or meters appropriate to the uncertainty statement, D is the diameter of the device in inches or meters appropriate to the uncertainty statement, and Wt represents weight in pounds or grams (including SI multiple and submultiple units) appropriate to the uncertainty statement.

⁷ 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 percent or fraction of the reading plus a fixed floor specification.

⁸ This laboratory also uses customer supplied specifications and/or methods developed by the lab and approved by the client directly related to the types of tests and within the parameters listed above.

⁹ This test is not equivalent to that of a calibration.

¹⁰ When the date, edition, version, etc. is not identified in the scope of accreditation, laboratories may use the version that immediately precedes the current version for a period of one year from the date of publication of the standard measurement method, per part C., Section 1 of A2LA *R101 - General Requirements – Accreditation of ISO-IEC 17025 Laboratories*.



Accredited Laboratory

A2LA has accredited

TOOL TESTING LAB, INC.

Tipp City, OH

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 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 10th day of September 2021.

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

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 6176.01
Valid to October 31, 2022

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