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

INNOCAL
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CALIBRATION

Valid To: October 31, 2019 Certificate Number: 1746.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1]:

I. Acoustical

Parameter/Range	Frequency	CMC[2] (±)	Comments
Sound Level Meters – Measure[3]			
94 dB	250 Hz 1000 Hz	0.38 dB 0.39 dB	Sound calibrator
114 dB	250 Hz 1000 Hz	0.4 dB 0.38 dB	

II. Chemical

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
pH – Buffer[3]	4 pH 7 pH 10 pH	0.014 pH 0.016 pH 0.016 pH	Standard reference buffer

5202 Presidents Court, Suite 220 | Frederick, MD 21703-8398 | Phone: 301 644 3248 | Fax: 240 454 9449 | www.A2LA.org

Parameter/Equipment	Range	CMC[2] (±)	Comments
Conductivity – Buffer[3]	5 µS 30 µS 84 µS 300 µS 1413 µS 3000 µS 12 880 µS	0.04 µS 0.15µS 0.4 µS 1.6 µS 6.2 µS 16 µS 0.27 mS	Standard reference buffer
pH Simulation[3]	(0 to 14) pH	0.00035 pH	Fluke 5520A

III. Dimensional

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Calipers and Micrometers[3] –	Up to 6 inches (6 to 12) in (12 to 24) in (24 to 60) in	(17 + 11*L*) µin (3 + 14*L*) µin (20*L*) µin (110 + 13*L*) µin	Gage blocks
Universal Measuring Machines[3]	Up to 6 in (6 to 10) in	(4.4 + 13*L*) µin 14 µin	
Protractors/Angle Meters/Levels[3]	(0 to 360)°	0.0079°	Sine plate, gage blocks
Length Measurements – 1D[3]	Up to 0.1 in (0.1 to 1) in (1 to 4) in (4 to 6) in (6 to 10) in (10 to 12) in (12 to 24) in	4.9 µin (3.9 + 0.28*L*) µin (2.8 + 1.5*L*) µin (5.1 + 0.9*L*) µin (6 + 0.71*L*) µin (8.5 + 1.3*L*) µin (7.8*L*) µin	Gage blocks and Supermic Gage blocks
Rulers/Tape Measures[3]	Up to 6 in (6 to 12) in (12 to 24) in (2 to 100) ft	(180 + 2.9*L*) µin (160 + 7.4*L*) µin (61 + 16*L*) µin 450 µin every 2 ft	Gage blocks

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Pin/Plug/Thread Wire Gages[3]	Up to 0.1 in (0.1 to 1) in (1 to 3) in (3 to 4) in (4 to 6) in (6 to 10) in	5.1 µin (4 + 0.28*L*) µin (2.9 + 1.4*L*) µin (2.7 + 1.5*L*) µin (5.2 + 0.9*L*) µin (6 + 0.7*L*) µin	Gage blocks Gage blocks and Supermic (H28 Handbook)
Radius Gages	Up to 12 in	0.001 in	Optical comparator
Thread Gages	Up to 0.1 in (0.1 to 1) in (1 to 2) in (2 to 10) in	24 µin (24 + 0.05*L*) µin (24 + 0.3*L*) µin (24 + 0.4*L*) µin	Supermic, gage blocks, and thread wires
Height/Depth Gages[3]	Up to 12 in (12 to 60) in	(170 + 0.18*L*) µin (110 + 5.4*L*) µin	Gage blocks and surface plate
Thickness Gages[3]	Up to 1 in	(0.0021 + 0.03*L*) in	Step blocks
Surface Plate/Block Repeatability only[3], Partial Calibration[3]	Up to 36 in x 36 in	23 µin	Mahr indicator using Union Jack method
Squareness[3]	Up to 4 in (4 to 17) in	79 µin 120 µin	Granite angle block, surface plate, gage amplifier and master square
Surface Flatness[3] –			
Optical Flat	Up to 4 in	3.7 µin	Optical flats and Van Keuren monochromatic light
Surface	Up to 24 in	93 µin	Surface plate with reference standard
Parallelism[3]	Up to 24 in	46 µin	Surface plate with reference standard

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Gage Blocks	Up to 0.1 in (0.1 to 1) in (1 to 3) in (3 to 4) in (4 to 6) in	4.9 µin (3.8 + 0.35*L*) µin (2.7 + 1.5*L*) µin (2.9 + 1.4*L*) µin (3.3 + 1.3*L*) µin	Gage blocks CROBLOX/Grade 00 and lab master
Sieves – Opening Size (X/Y) & Wire Diameter (X/Y)	Up to 5 in	(88 + 15*L*) µin	ASTM E11 Optical comparator with gage blocks
Optical Comparators[3] (Up to 36 in) – Angles Linear Accuracy	Up to 360° Up to 2 in (2 to 3) in (3 to 4) in (4 to 6) in (6 to 10) in (10 to 20) in (20 to 36) in	0.007° (76 + 0.11*L*) µin (76 + 0.14*L*) µin (76 + 0.17*L*) µin (76 + 0.13*L*) µin (14 + 0.46*L*) µin (4.1*L*) µin (5.3*L*) µin	Angle blocks Gage blocks standard
Durometers[3] – Types A, B, C, D, O, DO and OO	Indentor extension length Up to 5 kg	830 µin 0.26 g	ASTM D2240 Optical comparator Mass and balance
Angle Blocks	Up to 180°	0.097°	Optical comparator
V-block[3] – Parallelism Squareness Flatness	Up to 24 in Up to 4 inches (4 to 17) inches Up to 24 in	46 µin 79 µin 120 µin 93 µin	Surface plate, reference standard, and master square

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Angle Irons[3] –			
Parallelism	Up to 24 in	46 µin	Surface plate, reference standard, and master square
Squareness	Up to 4 in (4 to 17) in	79 µin 120 µin	
Flatness	Up to 24 in	93 µin	
Ring Gages[3]	Up to 0.1 in (0.1 to 1) in (1 to 3) in (3 to 4) in (4 to 6) in (6 to 10) in	5.6 µin (4.7 + 0.24*L*) µin (3.6 + 1.3*L*) µin (3.2 + 1.5*L*) µin (5.6 + 0.9*L*) µin (6.4 + 0.7*L*) µin	Gage blocks and Supermic

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple – Generate and Measure[3]			
Type B	(250 to 350) °C (350 to 445) °C (445 to 580) °C (580 to 600) °C (600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	1.2 °C 0.87 °C 0.69 °C 0.53 °C 0.35 °C 0.28 °C 0.24 °C 0.26 °C	Ectron 1140A or Fluke 5520A
Type E	(-270 to -250) °C (-250 to -245) °C (-245 to -195) °C (-195 to -155) °C (-155 to -90) °C (-90 to 15) °C (15 to 890) °C (890 to 1000) °C	1.4 °C 0.39 °C 0.21 °C 0.12 °C 0.1 °C 0.08 °C 0.07 °C 0.08 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple – Generate and Measure[3] (cont.)			
Type J	(-210 to -180) °C (-180 to -120) °C (-120 to -50) °C (-50 to 1200) °C	0.15 °C 0.12 °C 0.1 °C 0.09 °C	Ectron 1140A or Fluke 5520A
Type K	(-270 to -255) °C (-255 to -200) °C (-200 to -195) °C (-195 to -115) °C (-115 to -55) °C (-55 to 1000) °C (1000 to 1372) °C	2.6 °C 0.81 °C 0.26 °C 0.14 °C 0.11 °C 0.09 °C 0.1 °C	
Type N	(-270 to -260) °C (-260 to -200) °C (-200 to -140) °C (-140 to -70) °C (-70 to 25) °C (25 to 160) °C (160 to 1300) °C	5.9 °C 1.2 °C 0.27 °C 0.18 °C 0.14 °C 0.12 °C 0.11 °C	
Type R	(-50 to -30) °C (-30 to 0) °C (0 to 250) °C (250 to 400) °C (400 to 1768) °C	0.77 °C 0.64 °C 0.26 °C 0.27 °C 0.26 °C	
Type S	(-50 to -30) °C (-30 to 0) °C (0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1768) °C	0.73 °C 0.66 °C 0.37 °C 0.29 °C 0.3 °C 0.31 °C	
Type T	(-270 to -255) °C (-255 to -250) °C (-250 to -240) °C (-240 to -210) °C (-210 to -150) °C (-150 to -40) °C (-40 to 100) °C (100 to 400) °C	2.1 °C 0.59 °C 0.5 °C 0.35 °C 0.21 °C 0.14 °C 0.1 °C 0.09 °C	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Electrical Calibration of Thermocouple – Generate and Measure[3] (cont.)			
Type U	(-200 to 0) °C (0 to 600) °C	0.65 °C 0.31 °C	Ectron 1140A or Fluke 5520A
Electrical Calibration of RTD's – Generate			
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	0.039 °C 0.054 °C 0.07 °C 0.078 °C 0.093 °C 0.18 °C	Fluke 5520A
Pt 385, 200 Ω	(-200 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.031 °C 0.039 °C 0.093 °C 0.1 °C 0.11 °C 0.12 °C	
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 400) °C (400 to 600) °C (600 to 630) °C	0.031 °C 0.039 °C 0.047 °C 0.062 °C 0.07 °C 0.085 °C	
Pt 385, 1000 Ω	(-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C	0.023 °C 0.031 °C 0.039 °C 0.047 °C 0.054 °C 0.18 °C	

Parameter/Equipment	Range	CMC[2, 4, 10] (±)	Comments
Electrical Calibration of RTD's – Generate (cont.)			
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	0.19 °C 0.031 °C 0.039 °C 0.047 °C 0.055 °C 0.062 °C 0.07 °C 0.078 °C 0.18 °C	Fluke 5520A
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.039 °C 0.054 °C 0.07 °C 0.078 °C 0.093 °C	
DC Voltage – Generate[3]	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	0.61 µV + 0.000 82 % 1 µV + 0.000 72 % 3.6 µV + 0.000 72 % 6.5 µV + 0.000 72 % 82 µV + 0.000 82 % 0.51 mV + 0.000 92 %	Fluke 5700A
DC Voltage – Measure[3]	(0 to 199.999 999) mV (0.2 to 1.999 999 99) V (2 to 19.999 999 9) V (20 to 199.999 999) V (200 to 1000.000 00) V (1 to 2) kV (2 to 15) kV	0.11 µV + 0.0005 % 0.42 µV + 0.000 35 % 4.3 µV + 0.000 36 % 43 µV + 0.000 55 % 0.5 mV + 0.000 55 % 0.3 V + 0.066 % 7.6 V + 0.033 %	Fluke 8508A High voltage divider Fluke 80F-15
DC Current – Generate[3]	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A (11 to 20.5) A (20 to 100) A (100 to 1000) A	8.2 nA + 0.0051 % 8.2 nA + 0.0052 % 82 nA + 0.0051 % 820 nA + 0.0062 % 26 µA + 0.0082 % 490 µA + 0.037 % 57 µA + 0.078 % 18 mA + 0.035 % 0.093 A + 0.027 %	Fluke 5700A Fluke 5520A, Valhalla 2555A with 5700A Fluke 5520A with 5500 coil

Parameter/Equipment	Range	CMC[2, 4, 10] (±)	Comments
DC Current – Measure[3]	(0 to 200) µA (0.2 to 2) mA (2 to 20) mA 200 mA (0.2 to 2) A (2 to 20) A (20 to 100) A	0.52 nA + 0.0012 % 4.9 nA + 0.0012 % 48 nA + 0.0014 % 0.8 µA + 0.0048 % 16 µA + 0.019 % 0.4 mA + 0.04 % 0.0043 %	Fluke 8508A Leeds & Northrop resistors with 8508A

Parameter/Range	Frequency	CMC[2, 4, 10] (±)	Comments
AC Voltage – Generate[3]			
(0.22 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	4.6 µV + 0.057 % 4.6 µV + 0.022 % 4.6 µV + 0.011 % 4.6 µV + 0.038 % 7.2 µV + 0.086 % 13 µV + 0.12 % 26 µV + 0.18 % 26 µV + 0.35 %	Fluke 5700A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	5.1 µV + 0.057 % 5.1 µV + 0.022 % 5.1 µV + 0.011 % 5.1 µV + 0.038 % 5.1 µV + 0.087 % 12 µV + 0.12 % 26 µV + 0.18 % 26 µV + 0.35 %	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	1.3 µV + 0.057 % 8.2 µV + 0.022 % 8.2 µV + 0.011 % 8.2 µV + 0.033 % 26 µV + 0.087 % 26 µV + 0.12 % 36 µV + 0.18 % 82 µV + 0.35 %	

Parameter/Range	Frequency	CMC[2, 4, 10] (±)	Comments
AC Voltage – Generate[3] (cont.)			
(0.22 to 2.2) V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	0.31 mV + 0.041 % 0.026 mV + 0.017 % 6.1 µV + 0.0077 % 16 µV + 0.013 % 71 µV + 0.026 % 0.13 mV + 0.044 % 0.36 mV + 0.11 % 0.87 mV + 0.23 %	Fluke 5700A
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	0.82 mV + 0.051 % 0.26 mV + 0.017 % 62 µV + 0.0077 % 0.16 mV + 0.013 % 0.36 mV + 0.026 % 1.5 mV + 0.051 % 4.4 mV + 0.13 % 8.7 mV + 0.28 %	Fluke 5700 with amplifier
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	8.2 mV + 0.051 % 2.6 mV + 0.017 % 0.82 mV + 0.0082 % 3.6 mV + 0.023 % 8.2 mV + 0.051 % 92 mV + 0.16 % 92 mV + 0.48 % 0.19 V + 1.2 %	Fluke 5700
(220 to 250) V	(15 to 40) Hz	16 mV + 0.041 %	
(220 to 1100) V	(40 to 50) Hz (50 to 1000) Hz (1 to 20) kHz (20 to 30) kHz	4.1 mV + 0.01 % 3.6 mV + 0.009 % 6.2 mV + 0.017 % 11 mV + 0.062 %	
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	11 mV + 0.062 % 46 mV + 0.24 %	

Parameter/Range	Frequency	CMC[2, 4, 10] (±)	Comments
AC Voltage – Measure[3]			
(0 to 200) mV	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (100 to 2000) Hz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	14 µV + 0.017 % 4 µV + 0.014 % 4 µV + 0.012 % 2 µV + 0.011 % 0.004 mV + 0.012 % 0.008 mV + 0.034 % 20 µV + 0.077 %	Fluke 8508A
(0.2 to 2.0) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (100 to 2000) Hz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.12 mV + 0.015 % 20 µV + 0.012 % 20 µV + 0.009 % 20 µV + 0.0075 % 20 µV + 0.011 % 40 µV + 0.022 % 0.2 mV + 0.057 % 2 mV + 0.3 % 20 mV + 1 %	
(2.0 to 20) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (100 to 2000) Hz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	1.2 mV + 0.015 % 0.2 mV + 0.0115 % 0.2 mV + 0.009 % 0.2 mV + 0.0075 % 0.2 mV + 0.011 % 0.4 mV + 0.022 % 2 mV + 0.057 % 20 mV + 0.3 % 200 mV + 1 %	
(20 to 200) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (100 to 2000) Hz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	12 mV + 0.015 % 2 mV + 0.012 % 2 mV + 0.009 % 2 mV + 0.0075 % 2 mV + 0.011 % 4 mV + 0.022 % 20 mV + 0.057 % 200 mV + 0.3 % 2 V + 1 %	
(200 to 1000) V	(1 to 10) Hz (10 to 40) Hz (40 to 10 000) Hz (10 to 30) kHz (30 to 100) kHz	70 mV + 0.015 % 21 mV + 0.012 % 20 mV + 0.012 % 40 mV + 0.023 % 0.2 V + 0.058 %	

Parameter/Range	Frequency	CMC[2, 4, 10] (±)	Comments
AC Current – Generate[3]			
(0 to 220) µA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	26 nA + 0.072 % 20 nA + 0.036 % 16 nA + 0.015 % 41 nA + 0.062 % 82 nA + 0.17 %	Fluke 5700A
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	41 nA + 0.072 % 36 nA + 0.036 % 36 nA + 0.015 % 0.41 µA + 0.062 % 0.82 µA + 0.17 %	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.41 µA + 0.072 % 0.36 µA + 0.036 % 0.36 µA + 0.015 % 4.1 µA + 0.062 % 8.2 µA + 0.16 %	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	4.1 µA + 0.072 % 3.6 µA + 0.036 % 3.6 µA + 0.015 % 41 µA + 0.062 % 82 µA + 0.17 %	
(0.22 to 2.2) A	(20 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	36 µA + 0.067 % 82 µA + 0.077 % 0.16 mA + 0.87 %	
(2.2 to 11) A	(40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.18 mA + 0.047 % 0.39 mA + 0.097 % 0.77 mA + 0.37 %	
(29 to 329.99) µA	(10 to 30) kHz	0.31 µA + 1.3 %	Fluke 5520A
(0.33 to 3.2999) mA	(1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.16 µA + 0.16 % 0.23 µA + 0.39 % 0.47 µA + 0.78 %	
(3.3 to 32.999) mA	(1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	1.6 µA + 0.062 % 2.3 µA + 0.16 % 3.1 µA + 0.32 %	
(33 to 329.99) mA	(1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	39 µA + 0.078 % 78 µA + 0.16 % 160 µA + 0.32 %	

Parameter/Range	Frequency	CMC[2, 4, 10] (±)	Comments
AC Current – Generate[3] (cont.)			
(11 to 20.5) A	(45 to 100) Hz (100 to 1000) Hz (1 to 5) kHz	3.9 mA + 0.093 % 3.8 mA + 0.12 % 3.9 mA + 2.4 %	Fluke 5520A
(20.5 to 1000) A	(45 to 65) Hz (65 to 440) Hz	0.1 A + 0.33 % 0.12 A + 0.92 %	Fluke 5520A and 5500 coil
AC Current – Measure[3]			
(0 to 200) µA	(1 to 10 000) Hz (10 to 30) kHz (30 to 100) kHz	0.02 µA + 0.031 % 0.02 µA + 0.071 % 0.02 µA + 0.4 %	Fluke 8508A
(0.2 to 2) mA	(1 to 10) Hz (10 to 10 000) Hz (10 to 30) kHz (30 to 100) kHz	0.2 µA + 0.031 % 0.2 µA + 0.03 % 0.2 µA + 0.071 % 0.2 µA + 0.4 %	
(2 to 20) mA	(1 to 10) Hz (10 to 10 000) Hz (10 to 30) kHz (30 to 100) kHz	2 µA + 0.031 % 2 µA + 0.03 % 2 µA + 0.071 % 2 µA + 0.4 %	
(20 to 200) mA	(1 to 10) Hz (10 to 10 000) Hz (10 to 30) kHz	20 µA + 0.031 % 20 µA + 0.029 % 20 µA + 0.063 %	
(0.2 to 2) A	(10 to 2000) Hz (2 to 10) kHz (10 to 30) kHz	0.2 mA + 0.062 % 0.2 mA + 0.073 % 0.2 mA + 0.3 %	
(2 to 20) A	(10 to 2000) Hz (2 to 10) kHz	2 mA + 0.082 % 2 mA + 0.25 %	
(20 to 30) A	20 to 400 Hz	0.56 A + 5 %	Fluke 5320A

Parameter/Equipment	Range	CMC[2, 4, 5, 10] (±)	Comments
Resistance – Generate[3]	(0 to 10.9999) Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (0.11 to 1.099 999) kΩ (1.1 to 10.999 99) kΩ (11 to 109.999 99) kΩ (0.11 to 1.099 999) MΩ (1.1 to 3.299 999) MΩ (3.3 to 10.999 99) MΩ (11 to 32.999 99) MΩ (33 to 109.9999) MΩ (110 to 329.9999) MΩ (330 to 1100) MΩ (1.1 to 10) GΩ (10 to 20) GΩ (20 to 100) GΩ. (100 to 1000) GΩ (1 to 10) TΩ	0.78 mΩ + 0.003 % 1.2 mΩ + 0.002 % 1.1 mΩ + 0.0022 % 1.6 mΩ + 0.0022 % 1.6 mΩ + 0.0022 % 0.16 Ω + 0.0022 % 1.6 Ω + 0.0025 % 23 Ω + 0.0047 % 40 Ω + 0.01 % 2 kΩ + 0.019 % 2.3 kΩ + 0.039 % 75 kΩ + 0.24 % 390 kΩ + 1.2 % 0.96 MΩ + 0.59 % 0.79 MΩ + 1.2 % 6.2 MΩ + 1.2 % 2.1 % 9 MΩ + 3.2 %	Fluke 5520A Resistance decade box Fluke 5320A
Resistance – Measure[3]	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω (200 to 2000) Ω (2 to 20) kΩ (20 to 200) kΩ (200 to 2000) kΩ (2 to 20) MΩ (20 to 200) MΩ (200 to 2000) MΩ (2 to 20) GΩ	5.3 μΩ + 0.0016 % 1.4 μΩ + 0.000 97 % 50 μΩ + 0.000 82 % 0.56 mΩ + 0.0008 % 5 mΩ + 0.000 817 % 50 mΩ + 0.0008 % 1Ω + 0.000 93 % 100 Ω + 0.0021 % 10 kΩ + 0.012 % 1 MΩ + 0.15 % 15 MΩ + 0.14 %	Fluke 8508A
Resistance- Generate, Fixed Points[3]	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ	52 μΩ 97 μΩ 180 μΩ 290 μΩ 530 μΩ 1.7 mΩ 3.3 mΩ 13 mΩ 25 mΩ 120 mΩ 230 mΩ 1.4 Ω 2.7 Ω 20 Ω	Fluke 5700A

Parameter/Equipment	Range	CMC[2, 4, 5, 10] (±)	Comments
Resistance – Generate, Fixed Points[3] (cont.)	1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	41 Ω 410 Ω 910 Ω 11 kΩ	Fluke 5700A
Capacitance – Generate[3]	(0.19 to 3.2999) nF (3.3 to 10.9999) nF (11 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) µF (1.1 to 3.299 99) µF (3.3 to 10.999 9) µF (11 to 32.999 9) µF (33 to 109.999) µF (110 to 329.999) µF (0.33 to 1.099 99) mF (1.1 to 3.2999) mF (3.3 to 10.9999) mF (11 to 32.9999) mF (33 to 110) mF	8 pF + 0.39 % 7.9 pF + 0.2 % 78 pF + 0.2 % 0.23 nF + 0.2 % 0.81 nF + 0.2 % 2.3 nF + 0.2 % 1.8 nF + 0.38 % 23 nF + 0.31 % 76 nF + 0.36 % 0.24 µF + 0.35 % 0.76 µF + 0.36 % 2.4 µF + 0.35 % 7.2 µF + 0.37 % 24 µF + 0.58 % 78 µF + 0.85 %	Fluke 5520A
Fixed Points	0.0001 µF 0.0002 µF 0.0003 µF 0.0004 µF 0.0005 µF 0.0006 µF 0.0007 µF 0.0008 µF 0.0009 µF 0.001 µF 0.002 µF 0.003 µF 0.004 µF 0.005 µF 0.006 µF 0.007 µF 0.008 µF 0.009 µF 0.01 µF 0.02 µF 0.03 µF 0.04 µF 0.05 µF 0.06 µF	120 fF 240 fF 350 fF 470 fF 600 fF 710 fF 820 fF 960 fF 1.1 pF 1.2 pF 2.5 pF 3.7 pF 4.9 pF 5.9 pF 7.1 pF 8.2 pF 9.4 pF 11 pF 12 pF 24 pF 36 pF 47 pF 58 pF 71 pF	Precision capacitors

Parameter/Equipment	Range	CMC[2, 4, 5, 10] (±)	Comments
Capacitance – Generate[3] (cont.)			
Fixed Points	0.07 µF 0.08 µF 0.09 µF 0.1 µF 0.2 µF 0.3 µF 0.4 µF 0.5 µF	82 pF 94 pF 110 pF 120 pF 250 pF 360 pF 490 pF 610 pF	Precision capacitors

Parameter/Equipment	Frequency	CMC[2, 4] (±)	Comments
Inductance – Generate[3]			
Fixed Points			
100 µH	(0.1 to 10) kHz	0.47 µH	GenRad 1482x
200 µH	(0.1 to 10) kHz	0.71 µH	
500 µH	(0.1 to 10) kHz	0.76 µH	
1 mH	(0.1 to 10) kHz	4.1 µH	
100 mH	(0.1 to 10) kHz	0.17 mH	
Distortion – Measure[3]			
(0 to 99.99) dB	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	HP 8903B

V. Electrical/RF Microwave

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
RF Power – Measure[3] (+13 to -67) dB			
(-67 to -57) dB	0.1 MHz to 6 GHz	1 dB	Rohde & Schwarz NRV
(-57 to -47) dB	0.1 MHz to 6 GHz	0.19 dB	
(-47 to -37) dB	0.1 MHz to 2 GHz	0.075 dB	
	(2 to 4) GHz	0.093 dB	
	(4 to 6) GHz	0.15 dB	
(-37 to -27) dB	0.1 MHz to 2 GHz	0.076 dB	
	(2 to 4) GHz	0.092 dB	
	(4 to 6) GHz	0.15 dB	
(-27 to -17) dB	0.1 MHz to 2 GHz	0.078 dB	
	(2 to 4) GHz	0.093 dB	
	(4 to 6) GHz	0.15 dB	
(-17 to -7) dB	0.1 MHz to 2 GHz	0.078 dB	
	(2 to 4) GHz	0.093 dB	
	(4 to 6) GHz	0.5 dB	
(-7 to 3) dB	(0.1 to 30) MHz	0.077 dB	
	(0.03 to 2) GHz	0.092 dB	
	(2 to 4) GHz	0.19 dB	
	(4 to 6) GHz	0.33 dB	
(3 to 13) dB	(0.1 to 30) MHz	0.08 dB	
	(0.03 to 2) GHz	0.11 dB	
	(2 to 4) GHz	0.31 dB	
	(4 to 6) GHz	0.50 dB	
(-67 to 13) dB	(6 to 8) GHz	0.13 dB	
	(8 to 12.4) GHz	0.15 dB	
	(12.4 to 15) GHz	0.16 dB	
	(15 to 16) GHz	0.19 dB	
	(16 to 18) GHz	0.2 dB	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Frequency Response – Measure[3] AC Level Flatness (Up to 3) V	(0.010 to 1000) kHz (1 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	0.4 % 0.46 % 0.61 % 1.1 % 1.4 % 1.7 %	Precision Measurements EL-2257 with 3458A and Fluke 5700A
Amplitude Modulation – Measure[3] Rate: 20 Hz to 10 kHz Depth: to 99 % Rate: 50 Hz to 50 kHz Depth: 5 to 99 % Rate: 20 Hz to 50 Hz Depth: to 99 % Rate: 50 kHz to 100 kHz Depth: to 99 %	 (0.15 to 10) MHz (0.01 to 1300) MHz (0.01 to 1300) MHz (0.01 to 1300) MHz	 2.4 % 1.3 % 3.5 % 3.5 %	 HP8901A
Frequency Modulation – Measure[3] Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz peak Rate: 20 Hz to 200 kHz Dev: ≤ 40 kHz peak Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz peak	 (0.25 to 10) MHz (0.01 to 1300) MHz (0.01 to 1300) MHz	 0.015 kHz + 2.3 % 0.013 kHz + 5.8 % 0.012 kHz + 1.2 %	 HP 8901A
Phase Modulation – Measure[3] Rate: 200 Hz to 20 kHz	 (0.01 to 1300) MHz	 0.36 rad	 HP 8901A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Oscilloscopes[3] –			
Square Wave Signal - Generate (1 kHz input)			
50 Ω	(1 to 109.99) mV (0.11 to 6.599) V	32 µV + 0.21 % 32 µV + 0.19 %	Fluke 5520A/SC1100
1 MΩ	(1 to 109.99) mV (0.110 to 10.999) V (11 to 130) V	32 µV + 0.1 % 32 µV + 0.11 % 960 µV + 0.1 %	
Leveled Sine Wave Amplitude			
5 mV to 5.5 V	50 kHz Reference (0.050 to 100) MHz	0.24 mV + 1.6 % 0.23 mV + 2.8 %	
5 mV to 3.5 V	(100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	0.23 mV + 3.1 % 0.23 mV + 4.7 % 0.23 mV + 5.4 %	
Leveled Sine Wave Flatness			
5 mV to 5.5 V	(0.050 to 100) MHz (100 to 300) MHz (300 to 600) MHz	7.7 µV + 1.2 % 7.8 µV + 1.6 % 7.8 µV + 3.1 %	
5 mV to 3.5 V	(600 to 1100) MHz	0.23 mV + 5.4 %	
Time Marker			
50 Ω Load	(1 to 5) ns 10 ns (20 to 50) ns 100 ns to 20 ms 50 ms to 5 s	0.0002 % 0.0002 % 0.0002 % 0.0002 % 0.51 %	
Edge – Rise Time	≤ 300 ps	79 ps	
Edge – Amplitude	5 mV to 2.5 V	0.16 mV + 1.6 %	

VI. Fluid Quantities

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Airflow – Mass Flow and Correlated, Direct Read[3]	(0.002 to 20) LPM (20 to 80) LPM (80 to 500) LPM	0.23 % 0.22 % 0.34 %	Laminar flow elements Volumetric comparison
Air Velocity – Measuring Equipment	(4 to 13) m/s (13 to 40) m/s	0.038 m/s + 0.056 % 0.61 %	Wind tunnel and pressure transducers
Refractive Index – Refractometers[3]	(7.5 to 91.75)° Brix	0.02° Brix + 0.012 %	Standard reference materials
Liquid Volume – Pipettes/Burettes[3, 9]	(0.1 to 1) µL (1 to 10) µL (10 to 100) µL (100 to 1000) µL (1 to 10) mL (10 to 500) mL (500 to 2000) mL (2000 to 4000) mL	2.4 nL + 1 % 1 nL + 1.2 % 130 nL + 1.1 nL/µL 100 nL + 1.4 nL/µL 1.6 µL/mL 2.1 µL + 1.3 µL/mL 1.4 µL/mL 4.2 µL/mL	Photometric calibrator Gravimetric method and Class 1 mass
Specific Gravity-Hydrometers[3]	(0.65 to 0.95) sg (0.95 to 1.05) sg (1.05 to 1.55) sg (1.55 to 2.00) sg	0.000 42 sg 0.000 14 sg 0.000 32 sg 0.000 78 sg	Hydrostatic weighing
Viscosity[3]	4.5 cP 9 cP 48 cP 96 cP 480 cP 969 cP 4859 cP 11 860 cP 30 160 cP 59 940 cP	0.012 cP 0.027 cP 0.15 cP 0.35 cP 1.8 cP 3.5 cP 22 cP 61 cP 150 cP 290 cP	Reference standard silicone oils

VII. Mechanical

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Barometers[3]	(700 to 1100) mBar	0.11 mBar	RPM4/BA100Ks and chamber
Vacuum[3]	(0 to 29.2) inHg	0.0009 in Hg + 0.001 %	Quartz reference transducer
Pressure[3]	(0 to 2) inH_2O (2 to 30) inH_2O (30 to 100) inH_2O (0 to 5) psi (5 to 15) psi (15 to 30) psi (30 to 100) psi (100 to 300) psi (300 to 1000) psi (1000 to 3000) psi (3000 to 10 000) psi (10 000 to 20 000) psi	0.00034 inH_2O 0.0011 inH_2O + 0.0005 % 0.00012 inH_2O + 0.00021 % 0.00048 psi + 0.002 % 0.00016 psi + 0.009 % 0.003 psi 0.01 % 0.03 psi 0.01 % 0.29 psi + 0.0009 % 0.012 % 0.43 psi + 0.02 %	MicroTector deadweight tester Quartz reference transducers
Torque – Measuring Equipment[3]	(0.5 to 160) in·oz (10 to 20) in·lb (20 to 600) in·lb (50 to 1000) ft-lb	0.0016 in·oz + 0.027 % 0.0034 in·lb + 0.15 % 0.12 % 0.07 %	Dead weights and torque arm or wheels
Torque – Generating Equipment[3]	(0.5 to 5) in·oz (5 to 40) in·oz (40 to 400) in·oz (25 to 50) in·lb (50 to 150) in·lb (150 to 400) in·lb (30 to 250) ft·lb (250 to 1000) ft·lb	0.006 in·oz + 0.006 % 1.5 % 0.32 in·oz + 0.51 % 0.32 in·lb + 0.11 % 0.13 in·lb + 0.26 % 0.061 in·lb + 0.31 % 0.16 ft·lb + 0.26 % 0.026 ft·lb + 0.31 %	Watch calibrator, torque transducers
Accelerometer/ Vibration Frequency Response (0 to 20 g)[3]	(10 to 30) Hz (30 to 2000) Hz (2000 to 10 000) Hz	4.9 % 3.8 % 5.3 %	Vibration calibrator

Parameter/Equipment	Range	CMC[2] (±)	Comments
Balance and Scales[3, 6] (1 mg to 160 kg)	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg	6.5 µg 6.4 µg 6.1 µg 6.1 µg 6.1 µg 5.2 µg 7.6 µg 6.2 µg 6.3 µg 20 µg 21 µg 28 µg 40 µg 52 µg 93 µg 0.19 mg 0.38 mg 0.97 mg 2.3 mg 4.6 mg 10 mg 33 mg 64 mg	OIML Ultra Class mass pieces ASTM Class 1 mass pieces
Mass[3, 6]	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 300 g 400 g 500 g 1 kg	6.2 µg 6.1 µg 6.1 µg 6 µg 6 µg 6 µg 6 µg 6 µg 6 µg 20 µg 20 µg 21 µg 32 µg 50 µg 92 µg 0.19 mg 0.37 mg 0.63 mg 0.7 mg 0.91 mg 1.7 mg	OIML Ultra Class

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Mass[3, 6] (cont.)	1.5 kg 2 kg 5 kg 10 kg 20 kg	2.5 mg 4.4 mg 10 mg 31 mg 63 mg	OIML Ultra Class ASTM Class 1 Mass pieces
Force – Measuring Equipment[3]	(0 to 250) lbf (250 to 1000) lbf	0.0054 lbf + 0.0015 % 0.45 lbf + 0.03 %	Dead weights Load Cells

VIII. Thermodynamics

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Temperature – IR Systems[3]	(-15 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 500) °C	0.54 °C + 0.13 % 0.53 °C + 0.14 % 0.41 °C + 0.26 % 0.13 °C + 0.4 %	Blackbody IR calibrator
Temperature – Measuring Equipment and Measure[3, 8]	-196.0 °C (-80 to 0) °C 0 °C (0 to 90) °C (90 to 235) °C (235 to 550) °C (550 to 660) °C (660 to 700) °C (700 to 800) °C (800 to 900) °C (900 to 1000) °C (1000 to 1100) °C (1100 to 1200) °C	0.0046 °C 0.0098 °C 0.0045 °C 0.006 °C + 0.00077 % 0.007 °C + 0.0034 % 0.0042 % 0.022 °C + 0.00066 % 0.12 °C 0.27 °C 0.48 °C 0.75 °C 1.1 °C 1.5 °C	Liquid nitrogen BP apparatus, SPRT Liquid bath and SPRT Ice bath and SPRT Liquid bath and SPRT Salt bath, SPRT Sand bath, SPRT Dry well, SPRT, T/C Dry well, T/C
Relative Humidity[3, 8]	Up to 10 % RH (10 to 95) % RH	0.59 % RH 0.51 % RH	Chilled mirror two-pressure humidity generator

IX. Time & Frequency

Parameter/Equipment	Range	CMC[2,4,5,6] (±)	Comments
Stopwatches[3] – Mechanical Electronic	 60 s to 720 hr 60 s to 720 hr	 0.58 s/day 0.054 s/day	 Vibrograf
Stroboscopes[3]	(0 to 20 000) fpm (20 000 to 120 000) fpm	0.0031 fpm + 0.000 82 % 0.24 fpm + 0.000 67 %	Comparison to counter and detector
Optical Tachometers[3]	(0 to 100 000) rpm (100 000 to 125 000) rpm (125 000 to 150 000) rpm (150 000 to 175 000) rpm (175 000 to 200 000) rpm	0.000 51 rpm + 0.000 17 % 0.96 rpm 1.8 rpm 2.6 rpm 3.4 rpm	Comparison to function generator and lamp
Contact Tachometers[3]	(60 to 12 000) rpm (12 000 to 24 000) rpm	0.016 rpm + 0.003 % 0.31 rpm + 0.0003 %	Comparison to counter and tachometer tester
Frequency – Measure[3]	0.1 Hz to 3.1 GHz (3.1 to 18) GHz	2.1 µHz + 0.000 021 % 3.9 Hz + 0.68 Hz/Hz	Universal counter Spectrum analyzer
Frequency – Measuring Equipment[3]	0.1 Hz to 20 MHz (20 to 3200) MHz 10 MHz	12 nHz/Hz + 80 µHz (0.12 Hz + 0.000 24 %) 7.7 parts in 10^{-11} Hz/Hz	3325A Function generator with 5 x 10^{-11} oscillator 8648C Generator 10 MHz reference using Rubidium oscillator

[1] This laboratory offers commercial calibration service.

[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. 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.

[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] In the statement of CMC, % is to be read as % of the absolute value of reading unless otherwise noted. *R* indicates unit under test resolution. *L* is the numerical value of the nominal length of the device measured in inches.

[5] Resistance functions can be used to simulate conductivity, dissolved oxygen, RTD, and thermistor functions. Uncertainties are translated into simulated measurement units through known conversion factors.

[6] CMC values listed are for cardinal points. Other values within the range can be obtained using substitution method with uncertainty increased for each value added.

[7] Typical temperature measuring devices are liquid-in-glass (LIG) thermometers, thermocouples, RTDs, thermistors, bimetal thermometers, dry-well baths, liquid baths, ovens, PRTs, temperature transmitters, temperature controllers, temperature dataloggers, temperature recorders, and digital thermometers.

[8] Typical relative humidity devices are thermohygrometers, hygrometers, psychrometers, hygrothermographs, humidity dataloggers, transmitters and recorders.

[9] Typical liquid volume devices are pipettes, burettes, dispensers and rain gauges.

[10] 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.

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Presented this 8th day of December 2017.

President and CEO
For the Accreditation Council
Certificate Number 1746.01
Valid to October 31, 2019

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