SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

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CALIBRATION

Valid To: April 30, 2018 Certificate Number: 2678.01

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

I. Dimensional

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Micrometers[3]	Up to 20 in (20 to 48) in	(45 + 21*L*) µin (170 + 15*L*) µin	Gage blocks
Calipers[3]	Up to 20 in (20 to 48) in	(580 + 8.2*L*) µin (520 + 11*L*) µin	Gage blocks
Height Gages[3] (Excluding Height Masters)	Up to 20 in (20 to 48) in	(160 + 13*L*) µin (250 + 8*L*) µin	Gage blocks
Depth Gages[3]	Up to 20 in (20 to 48) in	(150 + 14*L*) µin (250 + 7.9*L*) µin	Gage blocks
Length Indicators[3]	Up to 2 in	(81 + 7.4*L*) µin	Gage blocks

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Surface Plates[3] – Flatness Only	Up to 96 in x 48 in	12 µin + (3.9 µin * *DL)*	Mahr-Federal electronic level system
Cylindrical Gages –			Gage blocks, linear measuring machine
Plugs, Pins	Up to 4 in	(52 + 17*D*) µin	
Rings	(0.5 to 4) in	(52 + 17*D*) µin	
Thread Plugs –			
Major Diameter	Up to 4 in	(26 + 16*D*) µin	Gage blocks, linear measuring machine
Pitch Diameter	(4 to 80) TPI Up to 4 in	(74 + 9.7*D*) µin	Three wire method
Length Standards[3]	Up to 20 in	(210 + 12*L*) µin	Gage blocks and linear measuring machine
Optical Comparator[3]			
X, Y Axis Accuracy	Up to 15 in	(130 + 4.9*L*) µin	Glass masters
Magnification	10X, 20X, 31.25X, 50X, 62.5X, & 100X	0.016 %	Magnification master
Angle	30 ° 45 ° 60 ° 90 °	33 s 20 s 3 min 4 s 1 min 6 s	Angle block
Angle[3] –			
Protractor	(0.25 to 10) ° (10 to 90) °	3 min 58 s 39 min 36 s	Sine plate / Gage blocks

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
DC Voltage – Generate[3]	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	13 µV/V + 8.8 µV 12 µV/V + 3.4 µV 12 µV/V + 40 µV 13 µV/V + 66 µV 18 µV/V + 65 µV	Fluke 5500A
DC Voltage – Measure	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	6.8 µV/V + 0.86 µV 6.0 µV/V + 0.80 µV 6.7 µV/V + 1.3 µV 7.0 µV/V + 32 µV 7.8 µV/V + 59 µV	HP 3458A
DC Current – Generate[3] Clamp-On Only	(0 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (0.33 to 2.2) mA (2.2 to 11) mA (0 to 550) A	83 µA/A + 26 nA 69 µA/A + 0.30 µA 62 µA/A + 0.91 µA 0.016 % + 15 µA 0.047 % + 0.14 mA 0.3 % + 65 mA	Fluke 5500A Fluke 5500A/coil
DC Current – Measure	(10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	20 µA/A + 0.67 nA 17 µA/A + 5.4 nA 41 µA/A + 37 nA 37 µA/A + 0.43 µA 98 µA/A + 9.9 µA	HP 3458A
DC Resistance – Generate[3]	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.33 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ	0.046 % + 0.008 Ω 0.031 % + 0.015 Ω 0.012 % + 0.015 Ω 74 µΩ/Ω + 0.015 Ω 76 µΩ/Ω + 0.06 Ω 83 µΩ/Ω + 0.06 Ω 76 µΩ/Ω + 0.6 Ω 60 µΩ/Ω + 0.6 Ω 86 µΩ/Ω + 6 Ω 76 µΩ/Ω + 6 Ω 0.010 % + 55 Ω 0.012 % + 55 Ω 0.033 % + 0.55 kΩ 0.089 % + 0.55 kΩ 0.28 % + 5.5 kΩ 2.8 % + 17 kΩ	Fluke 5500A

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
DC Resistance – Measure	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	23 μΩ/Ω + 50 μΩ 9.5 μΩ/Ω + 0.5 mΩ 7.6 μΩ/Ω + 0.5 mΩ 8.1 μΩ/Ω + 5 mΩ 9.7 μΩ/Ω + 50 mΩ 14 μΩ/Ω + 2 Ω 29 μΩ/Ω + 100 Ω 0.033 % + 1 kΩ 0.42 % + 10 kΩ	HP 3458A
Capacitance – Generate[3]	(0.33 to 0.49) nF (0.5 to 1.09) nF (1.1 to 3.29) nF (3.3 to 10.9) nF (11 to 32.9) nF (33 to 109.9) nF (110 to 329.9) nF (330 to 1.09) μF (1.1 to 3.29) μF (3.3 to 10.9) μF (11 to 32.9) μF (33 to 109.9) μF (110 to 329.9) μF (0.33 to 1.1) mF	0.14 % + 59 pF 0.16 % + 59 pF 0.22 % + 59 pF 0.38 % + 53 pF 0.28 % + 130 pF 0.14 % + 570 pF 0.05 % + 5.8 nF 0.14 % + 5.7 nF 0.08 % + 58 nF 0.23 % + 56 nF 0.11 % + 580 nF 0.38 % + 530 nF 0.28 % + 5.6 μF 0.17 % + 58 μF	Fluke 5500A

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Current – Generate[3]			
(0.03 to 0.33) mA	(10 to 20) Hz (20 to 45) Hz (0.045 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.2 % + 680 nA 0.08 % + 700 nA 0.09 % + 740 nA 0.4 % + 650 nA 1.4 % + 510 nA	Fluke 5500A
(0.33 to 3.3) mA	(10 to 20) Hz (20 to 45) Hz (0.045 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.2 % + 5.5 μA 0.05 % + 5.7 μA 0.05 % + 5.7 μA 0.2 % + 5.5 μA 0.6 % + 4.5 μA	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Current – Generate[3] (cont)			
(3.3 to 33) mA	(10 to 20) Hz (20 to 45) Hz (0.045 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.3 % + 5.1 µA 0.2 % + 5.7 µA 0.1 % + 5.8 µA 0.3 % + 5.1 µA 0.7 % + 4.2 µA	Fluke 5500A/coil
(33 to 330) mA	(10 to 20) Hz (20 to 45) Hz (0.045 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.3 % + 51 µA 0.2 % + 31 µA 0.2 % + 35 µA 0.3 % + 9.3 µA 0.8 % - 170 µA	
(0.33 to 2.2) A	(10 to 45) Hz (0.045 to 1) kHz (1 to 5) kHz	0.3 % + 510 µA 0.2 % + 580 µA 0.9 % + 410 µA	
(2.2 to 11) A	(45 to 65) Hz (65 to 500) Hz (0.5 to 1) kHz	0.06 % + 5.8 mA 0.1 % + 5.5 mA 0.4 % + 4.1 mA	
Clamp-On Only (0 to 110) A (0 to 550) A	 (65 to 440) Hz (45 to 65) Hz	 1 % + 38 mA 1 % + 770 mA	
AC Voltage – Generate[3]			
(0 to 33) mV	(10 to 45) Hz (45 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.18 % + 20 µV 0.088 % + 20 µV 0.12 % + 20 µV 0.14 % + 20 µV 0.21 % + 33 µV 0.52 % + 60 µV	Fluke 5500A
(33 to 330) mV	(10 to 45) Hz (45 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.13 % + 50 µV 0.033 % + 20 µV 0.056 % + 20 µV 0.089 % + 40 µV 0.13 % + 0.17 mV 0.56 % + 0.33 mV	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
AC Voltage – Generate[3] (cont)			
(0.33 to 3.3) V	(10 to 45) Hz (45 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.075 % + 0.25 mV 0.016 % + 60 µV 0.041 % + 60 µV 0.074 % + 0.30 mV 0.12 % + 1.7 mV 0.30 % + 3.3 mV	Fluke 5500A
(3.3 to 33) V	(10 to 45) Hz (45 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.075 % + 2.5 mV 0.023 % + 0.60 mV 0.042 % + 2.6 mV 0.097 % + 5.0 mV 0.12 % + 17 mV	
(33 to 330) V	(0.045 to 1) kHz (1 to 10) kHz (10 to 20) kHz	0.028 % + 6.6 mV 0.042 % + 15 mV 0.046 % + 33 mV	
(330 to 1000) V	(0.045 to 1) kHz (1 to 5) kHz (5 to 8) kHz	0.044 % + 80 mV 0.10 % + 0.10 V 0.10 % + 0.50 V	
AC Voltage – Measure			
(10 to 100) mV	(10 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.011 % + 4 µV 0.015 % + 2 µV 0.014 % + 2 µV 0.032 % + 2 µV 0.082 % + 2 µV 0.49 % + 10 µV 1.0 % + 10 µV	HP 3458A (synchronous sub-sampled mode)
(0.1 to 10) V	(10 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.012 % + 40 µV 0.013 % + 20 µV 0.019 % + 20 µV 0.022 % + 20 µV 0.045 % + 20 µV 0.21 % + 0.1 mV 0.82 % + 0.1 mV	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage – Measure (cont)			
(10 to 100) V	(1 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.018 % + 4 mV 0.019 % + 2 mV 0.019 % + 2 mV 0.029 % + 2 mV 0.10 % + 2 mV	HP 3458A (synchronous sub-sampled mode)
(100 to 1000) V	(0.04 to 1) kHz	0.025 % + 20 mV	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Simulation of Thermocouple Indicators[3] –			
Type B	(600 to 800) ºC (800 to 1000) ºC (1000 to 1550) ºC (1550 to 1820) ºC	0.45 ºC 0.36 ºC 0.32 ºC 0.35 ºC	Fluke 5500A
Type C	(0 to 150) ºC (150 to 650) ºC (650 to 1000) ºC (1000 to 1800) ºC (1800 to 2316) ºC	0.32 ºC 0.28 ºC 0.33 ºC 0.51 ºC 0.85 ºC	
Type E	(-250 to -100) ºC (-100 to -25) ºC (-25 to 350) ºC (350 to 650) ºC (650 to 1000) ºC	0.30 ºC 0.21 ºC 0.18 ºC 0.11 ºC 0.11 ºC	
Type J	(-210 to -100) ºC (-100 to -30) ºC (-30 to 150) ºC (150 to 760) ºC (760 to 1200) ºC	0.31 ºC 0.20 ºC 0.18 ºC 0.16 ºC 0.15 ºC	
Type K	(-200 to -100) ºC (-100 to -25) ºC (-25 to 120) ºC (120 to 1000) ºC (1000 to 1372) ºC	0.40 ºC 0.23 ºC 0.17 ºC 0.14 ºC 0.18 ºC	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Simulation of Thermocouple Indicators[3] (cont) –			
Type N	(-200 to -100) ºC (-100 to -25) ºC (-25 to 120) ºC (120 to 410) ºC (410 to 1300) ºC	0.41 ºC 0.24 ºC 0.22 ºC 0.21 ºC 0.29 ºC	Fluke 5500A
Type R	(0 to 250) ºC (250 to 400) ºC (400 to 1000) ºC (1000 to 1767) ºC	0.58 ºC 0.36 ºC 0.35 ºC 0.41 ºC	
Type S	(0 to 250) ºC (250 to 1000) ºC (1000 to 1400) ºC (1400 to 1767) ºC	0.48 ºC 0.37 ºC 0.38 ºC 0.47 ºC	
Type T	(-250 to -150) ºC (-150 to 0) ºC (0 to 120) ºC (120 to 400) ºC	0.96 ºC 0.57 ºC 0.31 ºC 0.17 ºC	
Type U	(-200 to 0) ºC (0 to 600) ºC	0.57 ºC 0.29 ºC	

III. Mechanical

Parameter/Equipment	Range	CMC[2] (±)	Comments
Indirect Verification of Rockwell Hardness Testers[3]	HRA: (20 to 65) HRA (70 to 78) HRA (80 to 84) HRA HRBW: (40 to 59) HRBW (60 to 79) HRBW (80 to 100) HRBW	 0.58 HRA 0.50 HRA 0.37 HRA 0.74 HRBW 0.92 HRBW 0.73 HRBW	Indirect verification per ASTM E18

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Indirect Verification of Rockwell Hardness Testers[3] (cont)	HRC: (20 to 30) HRC (35 to 55) HRC (60 to 65) HRC HR15N: (70 to 77) HR15N (78 to 88) HR15N (90 to 92) HR15N HR30N: (42 to 50) HR30N (55 to 73) HR30N (77 to 82) HR30N HR15TW: (74 to 80) HR15TW (81 to 86) HR15TW (87 to 93) HR15TW	 0.88 HRC 0.70 HRC 0.42 HRC 0.86 HR15N 0.63 HR15N 1.4 HR15N 0.96 HR15N 0.64 HR15N 0.67 HR15N 0.62 HR15TW 0.58 HR15TW 0.45 HR15TW	Indirect verification per ASTM E18
Torque Tools[3]	(5 to 150) in·lbf (150 to 400) in·lbf (400 to 1000) in·lbf (60 to 600) ft·lbf	(0.38 % + 0.1) in·lbf (0.4 % + 0.1) in·lbf (0.4 % - 0.12) in·lbf (0.52 % + 0.3) ft·lbf	Snap-on versatest torque calibration system
Torque Calibrators, Transducers	(5 to 150) in·lbf (150 to 400) in·lbf (400 to 1000) in·lbf (50 to 600) ft·lbf	(0.03 % + 0.52) in·lbf (0.14 % + 0.014) in·lbf (0.07 % – 0.49) in·lbf (0.0013 % + 0.3) ft/lb	Torque arms/wheels and NIST class F weights
Pressure Gages[3]	(0 to 100) psig (100 to 500) psig (500 to 1000) psig (1000 to 5000) psig (5000 to 10 000) psig	0.09 psig 0.21 psig 0.56 psig 2.1 psig 13 psig	Fluke 700P pressure modules

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Force - Force gages[3]			
Tension & Compression	(0 to 100) lbf (100 to 500) lbf (500 to 1500) lbf (1500 to 10 000) lbf	(0.15 % + 0.05) lbf (0.11 % + 0.22) lbf (0.22 % + 2.5) lbf (0.27 % + 11) lbf	Rice-lake load cells
Compression only	(10 000 to 25 000) lbf	(0.13 % + 38) lbf	
Balances & Scales	20 g 50 g 100 g 200 g 500 g 1 Kg 2 Kg 3 Kg 5 Kg 10 Kg 20Kg	0.057 mg 0.087 mg 0.046 mg 0.23 mg 0.53 mg 1.4 mg 2.9 mg 2.5 mg 4.0 mg 180 mg 160 mg	ASTM class 1 weights
Mass – NIST Class F Weights Only	(1 to 100) g (100 to 250) g (250 to 6100) g (6.1 to 34) kg	5.4 µg/g + 41 µg 47 µg/g + 140 µg 0.9 µg/g + 1.5 mg 12 µg/g + 10 mg	Single mass substitution using ASTM class 1 weights

IV. Thermodynamics

Parameter/Equipment	Range	CMC[2] (±)	Comments
Temperature – Measure[3]	(-50 to 0) °C 0 °C (0 to 100) °C (100 to 250) °C	0.36 °C 0.37 °C 0.41 °C 0.46 °C	Fluke 744 & T100-250 PRT
	(-200 to -50) °C (-50 to 0) °C 0 °C (0 to 156) °C (156 to 232) °C (232 to 450) °C	0.30 °C 0.28 °C 0.27 °C 0.28 °C 0.28 °C 0.31 °C	Fluke 744 & T100-450 PRT

Parameter/Equipment	Range	CMC[2] (±)	Comments
Temperature – Analog and Digital Thermometers	(-50 to 0) °C 0 °C (0 to 100) °C (100 to 250) °C (250 to 350) °C	0.42 °C 0.44 °C 0.47 °C 0.51 °C 0.64 °C	Fluke 744, PRT and dry block Fluke 744, T100-450 and dry block

[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. The CMC's represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The CMC 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] The measurands stated are generated with the Fluke 5500 series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. The CMC's are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

[5] The measurands stated are measured with the HP 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. The CMC's are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.

[6] In the statement of CMC, *L* is the numerical value of the nominal length of the device measured in inches, *D* is the numerical value of the nominal diameter of the device measured in inches, *R* is the resolution of scale/balance, *DL* is the numerical value of the diagonal length of the surface plate. In addition, percentages are percentage of reading, unless otherwise indicated.

Accredited Laboratory

A2LA has accredited

EML, LLC

Franklin, TN

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets *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 8 January 2009*).

Presented this 28th day of September 2016.

Senior Director of Quality and Communications
For the Accreditation Council
Certificate Number 2678.01
Valid to April 30, 2018

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