



# CERTIFICATE OF ACCREDITATION

## The ANSI National Accreditation Board

Hereby attests that

**Alliance Calibration**  
**11402 Reading Road**  
**Cincinnati, OH 45241**

Fulfills the requirements of

**ISO/IEC 17025:2017**

and national standard

**ANSI/NCSL Z540-1-1994 (R2002)**

In the field of

**CALIBRATION**

This certificate is valid only when accompanied by a current scope of accreditation document.  
The current scope of accreditation can be verified at [www.anab.org](http://www.anab.org).

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 15 September 2023

Certificate Number: L2181-1



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.  
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).

**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017  
AND ANSI/NC SL Z540-1-1994 (R2002)**

**Alliance Calibration**  
11402 Reading Road  
Cincinnati, OH 45241  
Sidney Taylor 513-769-1200

**CALIBRATION**

Valid to: **September 15, 2023**

Certificate Number: **L2181-1**

**Acoustics and Vibration**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometer Sensitivity	(0 to 5 000) mV/g (10 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5 000) Hz (5 001 to 10 000) Hz	1.7 % of reading 1.4 % of reading 1.4 % of reading 1.5 % of reading 1.7 % of reading	Comparison to Master Accelerometer per ISO 16063-21-2003

**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters	4 pH 7 pH 10 pH	0.02 pH 0.021 pH 0.03 pH	Compared to Accredited Solutions
Conductivity Meters	1 µS/cm 10 µS/cm 100 µS/cm 1 000 µS/cm 10 000 µS/cm 100 000 µS/cm	0.3 µS/cm 0.66 µS/cm 3.3 µS/cm 26 µS/cm 254 µS/cm 2 540 µS/cm	Compared to Accredited Solutions



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source <sup>3</sup>	1 kHz (330 to 400) pF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μF 100 Hz (0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF 50 Hz (33 to 110) μF (110 to 330) μF (330 to 1 100) μF	14 pF (0.002 + 0.02X) nF (0.002 + 0.01X) nF (0.001 + 0.004X) nF (0.002 + 0.004X) nF (0.001 + 0.003X) nF (0.002 + 0.003X) nF (0.000 1 + 0.004X) μF (0.000 1 + 0.004X) μF (0.000 1 + 0.003X) μF (0.001 + 0.004X) μF (0.002 + 0.006X) μF (0.01 + 0.006X) μF (0.03 + 0.006X) μF (0.4 + 0.006X) μF	Fluke 5522A Multiproduct Calibrator
Capacitance - Measure	(0.2 to 2) nF (2 to 20) nF (20 to 200) nF (0.2 to 2) μF (2 to 20) μF (20 to 200) μF	2 % of reading + 0.001 nF 1.6 % of reading + 0.009 nF 1.3 % of reading + 0.1 nF 1.3 % of reading + 0.002 nF 1.3 % of reading + 10 nF 1.6 % of reading + 0.1 μF	Tenma 72-8150 Capacitance Meter
DC Current – Measure <sup>3</sup>	(0.1 to 1) mA (1 to 10) mA (10 to 100) mA (100 to 1 000) mA (1 to 10) A (10 to 30) A	(0.000 006 + 0.00001X) mA (0.002 + 0.000 6X) mA (0.004 + 0.000 07X) mA (0.005 + 0.000 2X) mA 1.3 % of reading + 10 nF 1.6 % of reading + 0.1 μF	Transmille 8081 Digital Multimeter
	(10 to 200) A (200 to 500) A	(1.8 + 0.017X) A (0.6 + 0.02X) A	Fluke 336 Clamp Meter
DC Current – Source <sup>3</sup>	Up to 3.3 mA (3.3 to 33) mA (33 to 330) mA (0.33 to 3) A (3 to 20.5) A	(0.000 03 + 0.000 8X) mA (0.002 + 0.000 2X) mA (0.007 + 0.000 1X) mA (0.000 02 + 0.000 5X) A (0.000 4 + 0.001X) A	Fluke 5522A Multiproduct Calibrator
DC Current – Source <sup>3</sup>	(20.5 to 400) A (400 to 500) A	(0.1 + 0.000 3X) A (0.003 + 0.001X) A	Fluke 5522A Multiproduct Calibrator w/ Coil



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure <sup>3</sup>	Up to 100 $\mu$ A	(0.016 + 0.000 8X) A	Transmille 8081 Digital Multimeter
	(1 to 10) kHz		
	(0.1 to 1) mA	(0.000 2 + 0.000 6X) A	
	(1 to 10) kHz		
	(1 to 10) mA	(0.001 + 0.000 8X) mA	
	(10 to 40) Hz	(0.000 6 + 0.000 5X) mA	
	40 Hz to 1 kHz	(0.002 + 0.001X) mA	
	(1 to 10) kHz		
	10 mA to 1 A	(0.000 1 + 0.000 8X) A	
	(10 to 40) Hz	(0.000 1 + 0.000 6X) A	
	40 Hz to 1 kHz	(0.000 3 + 0.001X) A	
	(1 to 10) kHz		
	(1 to 10) A	(0.002 + 0.001X) A	
	(10 to 40) Hz	(0.002 + 0.001 2X) A	
40 Hz to 1 kHz			
(10 to 30) A	(0.006 + 0.001 4X) A		
(10 to 40) Hz	(0.005 + 0.001 2X) A		
40 Hz to 1 kHz			
AC Current – Measure <sup>3</sup> (45 to 65) Hz	(10 to 200) A (200 to 500) A	(1 + 0.02X) A (0.02 + 0.03X) A	Fluke 336 Clamp Meter
AC Current – Source <sup>3</sup>	Up to 0.33 mA	(0.000 1 + 0.01X) mA	Fluke 5522A Multiproduct Calibrator
	(1 to 10) kHz		
	(0.33 to 3.3) mA	(0.000 1 + 0.006X) mA	
	(1 to 10) kHz		
	(3.3 to 33) mA	(0.002 + 0.001X) mA	
	(20 to 45) Hz	(0.002 + 0.000 5X) mA	
	45 Hz to 1 kHz	(0.002 + 0.001X) mA	
	(1 to 5) kHz	(0.004 + 0.002X) mA	
	(5 to 10) kHz	(0.003 + 0.005X) mA	
	(10 to 30) kHz		
	(33 to 330) mA	(0.03 + 0.001X) mA	
	(20 to 45) Hz	(0.02 + 0.000 5X) mA	
	45 Hz to 1 kHz	(0.06 + 0.001X) mA	
	(1 to 5) kHz	(0.1 + 0.002X) mA	
	(5 to 10) kHz	(0.2 + 0.005X) mA	
	(10 to 30) kHz		
	(0.33 to 3) A	(0.000 1 + 0.002X) A	
	(10 to 45) Hz	(0.000 1 + 0.001X) A	
45 Hz to 1 kHz	(0.001 + 0.007X) A		
(1 to 5) kHz	(0.006 + 0.03X) A		
(5 to 10) kHz			



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source <sup>3</sup>	(3 to 20.5) A (45 to 65) Hz 65 Hz to 1 kHz (1 to 5) kHz (20.5 to 500) A (45 to 100) Hz	(0.002 + 0.002X) A (0.002 + 0.002X) A (0.006 + 0.03X) A (0.1 + 0.002X) A	Fluke 5522A Multiproduct Calibrator w/ Coil
DC Power – Measure <sup>3</sup>	Up to 33 W (33 to 330) W (330 to 11 000) W	(0.000 2 + 0.000 7X) W (0.001 + 0.000 8X) W (0.02 + 0.000 7X) W	Fluke 5522A Multiproduct Calibrator
AC Power – Measure <sup>3</sup> (45 to 65) Hz	Up to 33 W (33 to 330) W (330 to 11 000) W	(0.000 2 + 0.001X) W 0.1 % reading (0.01 + 0.001X) W	Fluke 5522A Multiproduct Calibrator
Resistance – Measure <sup>3</sup>	Up to 1 Ω (1 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	0.002 % of reading 0.001% of reading 0.002 % of reading + 0.1 mΩ 0.002 % of reading 0.001 % of reading + 0.1 Ω 0.001 % of reading + 0.1 Ω 0.001 % of reading + 2 Ω 0.002 % of reading + 50 Ω	Transmille 8081 Digital Multimeter
	(0 to 5 000) mΩ (10 to 100) MΩ	(0.005 + 0.000 2X) mΩ (0.04 + 0.009X) MΩ	Agilent 34401A Digital Multimeter
Resistance – Source <sup>3</sup>	Up 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	(0.001 + 0.000 05X) Ω (0.002 + 0.000 04X) Ω (0.000 5 + 0.000 05X) Ω (0.002 + 0.000 03X) Ω (0.000 007 + 0.000 05X) kΩ (0.000 02 + 0.000 03X) kΩ (0.000 01 + 0.000 04X) kΩ (0.000 2 + 0.000 03X) kΩ (0.000 1 + 0.000 04X) kΩ (0.000 6 + 0.000 04X) kΩ (0.000 001 + 0.000 04X) MΩ (0.000 04 + 0.000 07X) MΩ (0.000 02 + 0.000 2X) MΩ (0.000 7 + 0.001X) MΩ (0.002 + 0.006X) MΩ (0.001 + 0.006X) MΩ	Fluke 5522A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source <sup>3</sup> Fixed	500 μΩ 5 mΩ 50 mΩ 500 mΩ 5 Ω	(0.001 + 0.006X) mΩ (0.001 + 0.006X) mΩ (0.001 + 0.006X) mΩ (0.001 + 0.006X) mΩ (0.001 + 0.006X) mΩ	Fluke 5500A Multiproduct Calibrator, Agilent 34401A Digital Multimeter, Current Shunts
Electrical Simulation of RTD Indicators	Pt 385, 100 Ω (-200 to 800) °C	0.058 °C	Fluke 5500A Multiproduct Calibrator
DC Voltage – Measure <sup>3</sup>	Up to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	(0.000 001 + 0.000 005X) V (0.000 003 + 0.000 006X) V (0.000 04 + 0.000 008X) V (0.000 6 + 0.000 008X) V	Transmille 8081 Multimeter
DC High Voltage – Measure <sup>3</sup>	(1 to 80) kV	0.12 % of reading	Ross Engineering HV Probe w/ Digital Multimeter
DC Voltage – Source <sup>3</sup>	(0 to 330) mV (0.33 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1 020) V	(0.001 + 0.000 02X) mV (0.000 002 + 0.000 006X) V (0.000 01 + 0.000 02X) V (0.000 3 + 0.000 02X) V (0.002 + 0.000 02X) V	Fluke 5522A Multiproduct Calibrator
AC Voltage – Measure <sup>3</sup>	Up to 100 mV (10 to 40) Hz (40 to 200) Hz 200 Hz to 2 kHz (2 to 20) kHz (20 to 100) kHz (0.1 to 1) V (10 to 40) Hz (40 to 200) Hz 200 Hz to 1 kHz (1 to 2) kHz (2 to 20) kHz (20 to 100) kHz 100 kHz to 1 MHz (1 to 10) V (10 to 40) Hz (40 to 200) Hz 200 Hz to 1 kHz (1 to 2) kHz (2 to 20) kHz (20 to 100) kHz	(0.005 + 0.000 6X) mV (0.02 + 0.000 2X) mV (0.02 + 0.000 2X) mV (0.01 + 0.000 3X) mV (0.06 + 0.000 8X) mV (0.000 2 + 0.000 5X) V (0.000 03 + 0.000 2X) V (0.000 04 + 0.000 2X) V (0.000 1 + 0.000 2X) V (0.000 5 + 0.000 3X) V (0.000 6 + 0.000 7X) V (0.02 + 0.02X) V (0.000 2 + 0.000 5X) V (0.000 3 + 0.000 2X) V (0.000 4 + 0.000 2X) V (0.001 + 0.000 2X) V (0.005 + 0.000 4X) V (0.006 + 0.000 7X) V	Transmille 8081 Digital Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure <sup>3</sup>	(10 to 100) V (10 to 40) Hz (40 to 200) Hz 200 Hz to 1 kHz (1 to 2) kHz (2 to 20) kHz (20 to 50) kHz (100 to 1 000) V (10 to 40) Hz (40 to 200) Hz 200 Hz to 2 kHz (2 to 10) kHz	(0.01 + 0.000 5X) V (0.02 + 0.000 2X) V (0.01 + 0.000 2 X) V (0.01 + 0.000 2X) V (0.04 + 0.000 4X) V (0.04 + 0.001X) V (0.2 + 0.000 5X) V (0.2 + 0.000 2X) V (0.3 + 0.000 3X) V (0.4 + 0.000 2X) V	Transmille 8081 Digital Multimeter
AC High Voltage – Measure <sup>3</sup>	60 Hz (1 to 80) kV	(0.01 + 0.01X) kV	Ross Engineering HV Probe w/ Digital Multimeter
AC Voltage – Source <sup>3</sup>	Up to 330 mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz (0.33 to 3.3) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz (3.3 to 33) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (33 to 330) V 45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	(0.004 + 0.000 4X) mV (0.005 + 0.000 2X) mV (0.02 + 0.000 2X) mV (0.01 + 0.000 4X) mV (0.04 + 0.000 9X) mV (0.1 + 0.002X) mV (0.000 04 + 0.000 04X) V (0.000 08 + 0.000 2X) V (0.000 09 + 0.000 2X) V (0.000 1 + 0.000 4X) V (0.000 2 + 0.000 8X) V (0.001 + 0.003X) V (0.000 7 + 0.000 4X) V (0.000 9 + 0.000 2X) V (0.000 8 + 0.000 3X) V (0.001 + 0.000 4X) V (0.003 + 0.001X) V (0.01 + 0.000 2X) V (0.01 + 0.000 2X) V (0.01 + 0.000 3X) V (0.04 + 0.000 3X) V (0.06 + 0.002X) V	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source <sup>3</sup>	(330 to 1 000) V 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	(0.02 + 0.000 3X) V (0.01 + 0.000 3X) V (0.02 + 0.000 3X) V	Fluke 5522A Multiproduct Calibrator
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure <sup>3</sup>	Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type J (-210 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type N (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1 300) °C Type R (0 to 250) °C (250 to 1 767) °C Type S (0 to 250) °C (250 to 1 400) °C (1 400 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.44 °C 0.14 °C 0.12 °C 0.14 °C 0.19 °C 0.14 °C 0.12 °C 0.15 °C 0.21 °C 0.29 °C 0.17 °C 0.14 °C 0.22 °C 0.35 °C 0.35 °C 0.35 °C 0.18 °C 0.17 °C 0.25 °C 0.66 °C 0.39 °C 0.55 °C 0.33 °C 0.4 °C 0.56 °C 0.22 °C 0.15 °C 0.13 °C	Fluke 5522A Multiproduct Calibrator
Oscilloscopes – Time Base	(2 to 10) ns 20 ns to 1 μs (2 to 50) μs (0.1 to 5 000) ms	0.03 ps 0.000 2 μs 0.000 2 % of reading + 0.04 ns 0.2 % of reading + 0.2 ms	Fluke 5500A-SC600 Multiproduct Calibrator



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes – Bandwidth	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	4.3 % of reading 4.8 % of reading 7.2 % of reading	Fluke 5500A-SC600 Multiproduct Calibrator
Oscilloscopes – Amplitude	Up to 5 Vp-p	2.3 % of reading + 0.35 mV	Fluke 5500A-SC600 Multiproduct Calibrator

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks <sup>3</sup>	(0.005 to 4) in	(4.2 + 2L) μin	Gage Blocks, Gage Block Comparator
	(5 to 20) in	(4.3 + 2.5L) μin	Universal Length Measuring Machine, Gage Blocks
Plain Plug Gages <sup>3</sup>	(0.007 to 10) in	(8.4 + 2.3L) μin	Universal Length Measuring Machine, Gage Blocks
Height/Step Masters <sup>3</sup>	Up to 36 in	(10 + 3.7L) μin	Gage Blocks, Surface Plate, Indicator
Height Masters (Travel) <sup>3</sup>	(0 to 1) in	(14 + 6.8L) μin	Gage Blocks, Surface Plate, Indicator
Micrometer Standards <sup>3</sup>	(0.5 to 26) in	(2 + 2.1L) μin	P&W Supermic, Gage Blocks
Micrometer Standards <sup>3</sup>	(26 to 48) in	(65 + 2.4L) μin	Mu-Checker, Indicator, Gage Blocks, Surface Plate
Plain Ring Gages <sup>3</sup>	(0.15 to 10) in	(12 + 1.9L) μin	Precimar ULM
Thread Wires <sup>2</sup>	(0.007 to 0.2) in	11.4 μin	Universal Length Measuring Machine, XX Cylinder
Pin Gages <sup>3</sup>	(0.011 to 2) in	(32 + 0.3L) μin	Super Micrometer
Thickness Gages (Leaf) <sup>3</sup>	Up to 1 in	(31 + 2.9L) μin	Super Micrometer
Tape Measures	Up to 50 ft	(0.056 + 0.000 05L) in	Master Tape
Steel Rules <sup>3</sup>	Up to 72 in	(0.01 + 0.000 1L) in	Master Ruler
Plastic Shim Stock <sup>3,4</sup>	(1 to 50) mils	(0.03 + 3.0L) mils	Bench Micrometer

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gages <sup>3</sup> Major Diameter	(0.06 to 8) in	(25 + 35L) μin	Super Micrometer, Thread Wires
Pitch Diameter (4 to 80) TPI	(0.06 to 8) in	(85 + 1.2L) μin	
Thread Ring Gages <sup>3</sup> Minor Diameter	(0.06 to 8) in (0.25 to 1) in	(160 + 2.4L) μin (183 + 25L) μin	Vision System, Intra-Micrometer
Thread Ring Gages <sup>3</sup> Pitch Diameter Solid (4 to 80) TPI	(0.06 to 8) in	(7.5 + 4.2L) μin	Precimar, Plain Ring
Pitch Diameter Adjustable (4 to 80) TPI	(0.06 to 8) in	<i>See Set Plug Uncertainty</i>	Set Plugs
Thread Rings, Adjustable <sup>5</sup> Pitch Diameter Tactile Fit (Set to Plug)	(0.06 to 8) in	See footnote	Set Plugs
Radius Gage	(0.010 to 2) in	271 μin	Vision System
Spheres <sup>3</sup>	(0.013 2 to 2) in	(15.2 + 0.7L) μin	Universal Length Measuring Machine, Gage Blocks
Squares <sup>3</sup>	(2 to 24) in	(67.1 + 1.1L) μin	Grade 0 Square Gage Blocks
Surface Plates <sup>1,3</sup> Overall Flatness	(8 to 60) in diagonal (34 to 161) in diagonal	(50 + 0.7L) μin (41 + 0.5L) μin	Planekator Level System
Local Area Flatness (Repeat Reading)	Up to 0.001 in	45 μin	Repeat-o-Meter
Roughness Specimens	Up to 400 μin Ra	3.7 μin	Profilometers
Gages and Fixtures <sup>3</sup> Length Diameter Angle	Up to 16 in Up to 12 in Up to 360 °	(125 + 4.6L) μin (238 + 7.4L) μin 0.027 °	Vision System, CMM
Height Gage <sup>1,3</sup>	Up to 36 in	(122 + 1.1L) μin	Gage Blocks, Surface Plate
Calipers <sup>1,3</sup>	Up to 60 in (60 to 120) in	(353 + 5L) μin (236 + 7.4L) μin	Gage Blocks
Outside Micrometers <sup>1,3</sup>	Up to 36 in	(32 + 2.6L) μin	Gage Blocks
Depth Micrometers <sup>1,3</sup>	Up to 12 in	(574 + 0.6L) μin	Gage Blocks, Surface Plate
Inside Micrometers <sup>1,3</sup>	(0.1 to 36) in	(574 + 0.6L) μin	Gage Blocks, Surface Plate

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Bore Micrometers <sup>3</sup>	(0.15 to 10) in	(26 + 42L) μin	Ring Gages
Bench Micrometer <sup>1,3</sup> Travel Anvil Flatness Anvil Parallelism	Up to 1 in	(11 + 1.6L) μin 8.2 μin 8.6 μin	Gage Blocks Optical Flat Sphere
Indicator <sup>1,3</sup> 0.001 in resolution 0.0005 in resolution 0.00025 in resolution 0.0001 in resolution 0.000 05 in resolution 0.000 02 in resolution 0.000 01 in resolution	Up to 4 in	(614 + 0.6L) μin (354 + 0.4L) μin (145 + 0.2L) μin (58 + 0.4L) μin (29 + 0.8L) μin (23 + 0.6L) μin (11 + 1.8L) μin	Indicator Tester, Gage Blocks
Universal Measuring Machine <sup>1,3</sup>	Up to 24 in	(6.9 + 3.1L) μin	Gage Blocks
Ultrasonic Thickness Gages	(0.005 to 2) in	578 μin	Gage Blocks
Magnetic Coating Thickness Gages <sup>3,4</sup>	(1 to 50) mils	(0.055 + 0.003L) mils	Precision Shims, Bench Micrometer
Profilometer (Ra) <sup>1</sup>	(0 to 200) μin	3.2 μin	Roughness Standard per ASME B46.1-2009
Protractor <sup>3</sup>	(0 to 180) °	(0.007 4 + 0.000 4X) °	Granite Squares, Sine Bar
Optical Comparators <sup>1,3</sup> Magnification Linearity Squareness	5x to 100x Up to 6 in Up to 6 in	(199 + 2.3L) μin (137 + 0.4) μin 76 μin	Glass Scale, Length Standards, Spheres
Microscopes <sup>3</sup> Stage Travel	Up to 1 in	(54 + 46L) μin	Gage Blocks
Vision Systems <sup>1,3</sup> Linearity Angles	Up to 6 in Up to 360 °	(180 + 3L) in (0.012 + 0.000 02A) °	Glass Scale
CMM <sup>1,3</sup> Linearity Repeatability	Up to 48 in Up to 48 in	(27 + 2.9L) μin 87 μin	Step Gage and Gage Blocks in accordance with B89.4.10360-2
CMM <sup>1,3</sup> Volumetric Accuracy	Up to 48 in	(63 + 2.1L) μin	Ball Bar in accordance with B89.4.1-1997



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Flow Speed (Anemometers)	(490 to 3 300) ft/min	0.1 ft/min + 4 % of reading	TSI 9535 VelociCalc Air Velocity Meter
Gas Flow Meter	(50 to 500) sccm Up to 50 slm (50 to 250) slm	1 % of reading + 1.2 sccm 0.5 % of reading + 0.13 slm 0.7 % of reading + 1.4 slm	Alicat Flow Standard
Liquid Flow (gravimetric)	(0.3 to 50) gpm	0.5 % of reading + 0.002 gpm	Digital Scale
Bench Micrometer Measuring Force	(4 to 40) ozf	0.22 ozf	Force Gage
Force Gages <sup>3</sup>	1 gf to 45 kgf	(5.7 + 1.1 <i>F</i> ) gf	NIST Class F Weights
Force Gages <sup>3</sup>	(0.5 to 50) lbf (50 to 250) lbf	(0.005 + 0.000 3 <i>W</i> ) lbf (0.015 + 0.000 06 <i>W</i> ) lbf	ASTM Class 7 Weights
Force Gages <sup>3</sup> (Tension)	(6 to 100) lbf	(0.02 + 0.000 3 <i>F</i> ) lbf	ASTM E74 Load Cell
Force Gage s <sup>3</sup> (Compression)	(6 to 100) lbf	(0.024 + 0.000 3 <i>F</i> ) lbf	ASTM E74 Load Cell
Force Gages / Load Cells (Tension)	(6 to 300) lbf (40 to 2 000) lbf	(0.12 + 0.000 1 <i>F</i> ) lbf (0.18 + 0.000 1 <i>F</i> ) lbf	ASTM E74 Load Cell
Force Gages / Load Cells (Compression)	(6 to 300) lbf (40 to 2 000) lbf	(0.12 + 0.000 12 <i>F</i> ) lbf (0.04 + 0.000 3 <i>F</i> ) lbf	ASTM E74 Load Cell
Load Cells	(1 001 to 5 000) lbf (5 001 to 20 000) lbf	(6 + 0.000 3 <i>F</i> ) lbf (59 + 0.000 01 <i>F</i> ) lbf	Master Load Cells
Rockwell and Rockwell Superficial Hardness Testers <sup>1</sup>	HRBW Low Middle High HRC Low Middle High HRFW Low Middle High	2 HRBW 1.5 HRBW 1.4 HRBW  1.3 HRC 1.3 HRC 0.7 HRC  1.4 HRFW 1.4 HRFW 1.5 HRFW	Indirect Verification per ASTM E18 using test blocks.

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell and Rockwell Superficial Hardness Testers <sup>1</sup>	HR15N		Indirect Verification per ASTM E18 using test blocks.
	Low	1.4 HR15N	
	Middle	1.4 HR15N	
	High	1.1 HR15N	
	HR30N		
	Low	1.4 HR30N	
	Middle	1.4 HR30N	
	High	1.1 HR30N	
	HR45N		
	Low	1.4 HR45N	
	Middle	1.4 HR45N	
	High	1 HR45N	
	HR15TW		
	Low	2 HR15TW	
	Middle	1.4 HR15TW	
	High	1.3 HR15TW	
	HR30TW		
	Low	1.9 HR30TW	
Middle	2 HR30TW		
High	1.3 HR30TW		
HR45TW			
Low	1.4 HR45TW		
Middle	1.3 HR45TW		
High	1.4 HR45TW		
Mass Determination	1g	0.14 mg	ASTM Class 1 Weights, Electronic Balance
	2g	0.22 mg	
	5g	0.2 mg	
	10g	0.22 mg	
	20g	0.25 mg	
	50g	0.5 mg	
	100g	0.73 mg	
200g	1.2 mg		
Low Pressure Gages <sup>1</sup> (Magnehelic/Photohelic)	Up to 30 inH <sub>2</sub> O	0.006 % of reading + 0.021 inH <sub>2</sub> O	ABB 364DS Differential Pressure Transmitter
	(30 to 200) inH <sub>2</sub> O	0.006 % of reading + 0.056 inH <sub>2</sub> O	ABB DDN0200 Differential Pressure Transmitter
Pressure Gage <sup>1</sup>	Up to 30 psig	0.005 % of reading + 0.008 psi	Druck DPI 802 Pressure Calibrator – Pneumatic
Pressure Gage <sup>1</sup>	(10 001 to 15 000) psig	0.005 % of reading + 17 psi	Keller Gage – Hydraulic

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vacuum Gage <sup>1</sup>	(-14.5 to 0) psiv	0.024 % of reading + 0.002 psi	Druck DPI 802 Pressure Calibrator – Pneumatic
Pressure Devices <sup>1</sup>	(2 to 500) psig (500 to 10 000) psig	0.04 % of reading + 0.003 psi 0.033 % of reading + 0.7 psi	Dead Weight Tester – Hydraulic
Precision Scales / Balances <sup>1,6</sup>	(0.000 01 to 1 100) g	(0.000 23 + 0.000 002 4M) g	OIML Class E2 Mass and NIST Handbook 44 utilized for the calibration of the weighing system.
Scales / Balances <sup>1,6</sup>	(0.5 to 38) kg	(0.013 + 0.000 12M) g	NIST Class F Weights and NIST Handbook 44 utilized for the calibration of the weighing system.
	(0.5 to 500) lb	(0.003 + 0.00012M) lb	ASTM Class 7 Weights and NIST Handbook 44 utilized for the calibration of the weighing system.
Torque Tools	(0.5 to 50) ozf·in (4 to 50) lbf·in (10 to 150) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (10 to 125) lbf·ft (60 to 600) lbf·ft (100 to 1 000) lbf·ft (1 000 to 2 000) lbf·ft	0.52 % of reading 0.33 % of reading 0.38 % of reading 0.34 % of reading 0.33 % of reading 0.37 % of reading 0.34 % of reading 0.6 % of reading 0.28 % of reading + 15.5 lbf·ft	CDI Torque Tester
Torque Transducers	(5 to 1 000) lbf·ft	0.11 % of reading	Torque Arms, NIST Class F Weights
Pipettes <sup>3</sup>	(10 to 1 000) µL	(0.09 µL + 0.000 73X) µl	Gravimetric Method using Precision Balance

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity <sup>1</sup>	(0 to 80) % RH	0.5 % of reading + 1.2 % RH	Vaisala MI70 / HMP77 Temperature/Humidity Indicator
Temperature Measure <sup>1</sup>	(-70 to 180) °C	0.25 °C	
Temperature Probes and Systems <sup>1,3</sup>	(-20 to 600) °C	(0.07 + 0.000 03T) °C	Hart Scientific Baths and Drywells w/ Fluke 5609 PRT

### Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Liquid in Glass Thermometers (Partial and Total Immersion)	(-20 to 600) °C	(0.1 + 0.000 5T) °C	Hart Scientific Bath w/ Fluke 5609 PRT
Temperature – Measure <sup>3</sup>	(-195 to 660) °C	(0.015 + 0.000 12T) °C	Fluke 5609 PRT w/ Display
Infrared Source <sup>1,3</sup>	50.0 °C 100.0 °C 200.0 °C 300.0 °C 400.0 °C	0.75 °C 0.9 °C 1.2 °C 1.5 °C 1.8 °C	ICI 500 Blackbody Source (flat plate) $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$

### Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source <sup>1,3</sup>	1 Hz to 50 MHz (50 to 600) MHz	0.001 Hz + 0.002 % of reading 0.003 % of reading	Fluke 5500A Multiproduct Calibrator, PM 5193 Function Generator
Frequency – Measure <sup>1</sup>	1 Hz to 225 MHz 225 MHz to 3 GHz	0.000 5 Hz 0.005 Hz	HP 53131A Frequency Counter
Timers and Stopwatches <sup>1</sup>	(0.1 to 60) min	0.006 % of reading + 34 ms	HP 53131A Frequency Counter
Tachometer – Source	Up to 60 000 rpm	0.003 % of reading + 0.001 1 rpm	Fluke 5500A Multiproduct Calibrator
Tachometer – Measure	Up to 1 800 rpm	0.3 % of reading + 0.05 rpm	Ametek 1726 Digital Tachometer

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 ( $k=2$ ), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
2. Uncertainty shown is per wire for thread wire sets.
3.  $L$  = length in inches;  $D$  = diameter in inches;  $T$  = temperature applied,  $X$  = flow / frequency / volts / ohms / amps / capacitance applied;  $M$  = mass applied;  $F$  = force in kg;  $V$  = volume;  $W$  = weight in lb;  $A$  = angle in degrees.
4. 1 mil = 0.001 in.
5. The setting of an adjustable thread ring is not a measurement for which an uncertainty can be estimated. The method for this activity is an accredited activity.
6. The uncertainties for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainties presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
7. This scope is formatted as part of a single document including Certificate of Accreditation No. L2181-1.



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