



# CERTIFICATE OF ACCREDITATION

## The ANSI National Accreditation Board

Hereby attests that

### The Tool & Gage House

538 E. Hebron St.  
Charlotte, NC 28273

Fulfills the requirements of

### ISO/IEC 17025:2017

In the fields of

### CALIBRATION and DIMENSIONAL MEASUREMENT

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).

A handwritten signature in black ink, appearing to be 'J. Stine', is positioned above a horizontal line.

Jason Stine, Vice President

Expiry Date: 18 February 2025

Certificate Number: L1050-1



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**

**The Tool & Gage House**

538 E. Hebron St.  
Charlotte, NC 28273  
Brian Samuelson  
704-285-7066

**CALIBRATION AND DIMENSIONAL MEASUREMENT**

Valid to: February 18, 2025

Certificate Number: L1050-1

**CALIBRATION**

**Acoustics and Vibration**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Measuring Equipment	(74 to 104) dB 125 Hz to 2 kHz 4 kHz	0.66 dB 0.87 dB	IET 1986 Sound Level Calibrator
	114 dB 125 Hz to 2 kHz 4 kHz	0.4 dB 0.64 dB	
Sound Level Calibrators @ 1 kHz	114 dB 94 dB	0.41 dB 0.49 dB	IET 1986 Sound Level Calibrator with Sound Meter

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance Source <sup>1</sup>	(0.2 to 3.29) nF (3.3 to 329) nF (0.3 to 3.29) μF (3.3 to 32.9) μF (33 to 300) μF (0.3 to 3.29) mF (3.3 to 30) mF (33 to 110) mF	7.2 pF + 7.3 pF/nF 6.7 pF+ 4.7 pF/nF 0.6 nF + 3 nF/μF 1.7 nF + 4 nF/μF 0.11 μF + 4.2 nF/μF 0.18 μF + 6.5 μF/mF 0.14 μF+ 8.6 μF/mF 0.1 mF + 8.5 μF/mF	Comparisons performed with a Multifunction Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Source <sup>1</sup>	(0 to 329) $\mu$ A (0 to 3.29) mA (0 to 32.9) mA (0 to 329) mA (0 to 2.99) A (0 to 10.9) A (11 to 20) A	19 nA + 0.12 nA/ $\mu$ A 0.04 $\mu$ A + 0.14 $\mu$ A/mA 0.2 $\mu$ A + 0.079 $\mu$ A/mA 1.9 $\mu$ A + 0.084 $\mu$ A/mA 24 $\mu$ A + 0.3 mA/A 0.38 mA + 0.4 mA/A 0.39 mA + 0.8 mA/A	Comparisons with a Multifunction Calibrator
AC Current Source <sup>1</sup> (Sine Wave) (0.045 to 30) kHz	(33 to 329) $\mu$ A 45 Hz to 1kHz 1kHz to 10 kHz 10 kHz to 30 kHz (0.33 to 3.29) mA 45 Hz to 1kHz 1kHz to 10 kHz 10 kHz to 30 kHz (3.3 to 32.9) mA 45 Hz to 1kHz 1kHz to 10 kHz 10 kHz to 30 kHz (33 to 329) mA 45 Hz to 1kHz 1kHz to 10 kHz 10 kHz to 30 kHz (0.33 to 1.09) A 45 Hz to 1kHz 1kHz to 5 kHz 5 kHz to 10 kHz (1.1 to 2.9) A 45 Hz to 1kHz 1kHz to 5 kHz 5 kHz to 10 kHz (3 to 10.9) A 45 Hz to 100 Hz 100 Hz to 1 kHz 1 kHz to 10 kHz (11 to 20) A 45 Hz to 100 Hz 100 Hz to 1 kHz 1 kHz to 10 kHz	0.11 $\mu$ A + 0.001 1 $\mu$ A/ $\mu$ A 0.16 $\mu$ A + 0.006 2 $\mu$ A/ $\mu$ A 0.31 $\mu$ A + 0.012 $\mu$ A/ $\mu$ A 0.091 $\mu$ A + 1.1 $\mu$ A/mA 0.27 $\mu$ A + 3.8 $\mu$ A/mA 0.54 $\mu$ A + 7.6 $\mu$ A/mA 1.2 $\mu$ A + 0.7 $\mu$ A/mA 2.3 $\mu$ A + 1.7 $\mu$ A/mA 3.1 $\mu$ A + 3.2 $\mu$ A/mA 9.1 $\mu$ A + 0.81 $\mu$ A/mA 80 $\mu$ A + 1.5 $\mu$ A/mA 160 $\mu$ A + 3.1 $\mu$ A/mA 0.18 mA + 0.68 mA/A 1.3 mA + 4.2 mA/A 3.8 mA + 20 mA/A 91 $\mu$ A + 0.47 mA/A 0.78 mA + 4.7 mA/A 3.9 mA + 19 mA/A 1.6 mA + 0.43 mA/A 1.2 mA + 0.81 mA/A 1.6 mA + 23 mA/A 21 mA + 0.77 mA/A 21 mA + 0.72 mA/A 6.3 mA + 23 mA/A	Comparisons performed with a Multifunction Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Clamp-On Meter <sup>1</sup>	(20 to 1 000) A (45 Hz to 65 Hz) (65 Hz to 100 Hz)	110 mA + 1.9 mA/A 140 mA + 4.6 mA/A	Comparison to a Multifunction Calibrator and 50 Turn Coil
DC Current Clamp-On Meter <sup>1</sup>	(20 to 1 000) A	170 mA + 2.3 mA/A	
DC Current (Measure) <sup>1</sup>	(0 to 100) $\mu$ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 2) A (2 to 10) A	0.6 nA + 0.022 nA/ $\mu$ A 0.12 $\mu$ A + 2.6 $\mu$ A/mA 0.088 $\mu$ A + 0.019 $\mu$ A/mA 0.51 $\mu$ A + 0.41 $\mu$ A/mA 58 $\mu$ A + 0.1 $\mu$ A/A 0.11 mA + 0.72 mA/A 0.69 mA + 1.8 mA/A	Utilizing an 8½ Digit Digital Multimeter
DC Current (Measure) <sup>1</sup>	(10 to 100) A (100 to 1 000) A	0.061 A + 0.0024 A/A 0.085 A + 0.0026 A/A	Utilizing a shunt
AC Current (Measure) <sup>1</sup>	(0 to 100) $\mu$ A 45 Hz to 5 kHz (0.1 to 100) mA 45 Hz to 100 Hz (0.1 to 100) mA 100 Hz to 5 kHz (0.1 to 1) A 45 Hz to 100 Hz (0.1 to 1) A 100 Hz to 5 kHz (1 to 10) A 45 Hz to 1 kHz	0.07 $\mu$ A + 0.000 49 $\mu$ A/ $\mu$ A 0.12 $\mu$ A + 1.1 $\mu$ A/mA 0.13 $\mu$ A + 1.6 $\mu$ A/mA 23 $\mu$ A + 1.1 $\mu$ A/mA 56 $\mu$ A + 1.2 $\mu$ A/mA 1.6 mA + 2.1 mA/A	Utilizing an 8½ Digit Digital Multimeter
AC Current (Measure) <sup>1</sup>	(10 to 100) A 60 Hz (100 to 1 000) A 60 Hz	8.8 mA + 1.9 mA/A 85 mA + 2.6 mA/A	Utilizing a shunt
Capacitance (Measure) <sup>1</sup>	(0.4 to 1) nF (1.0 to 10) nF (10 to 100) nF 100 nF to 1 $\mu$ F (1 to 100) $\mu$ F 100 $\mu$ F to 10 mF (10 to 100) mF	31 pF + 22 pF/ nF 59 pF + 12 pF/ nF 0.58 nF + 0.012 nF/ nF 0.02 nF + 0.018 nF/nF 12 nF + 17 nF/ $\mu$ F 7.5 $\mu$ F + 17 $\mu$ F/mF 0.23 mF + 0.047 mF/mF	Utilizing a Digital Multimeter

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Source <sup>1</sup>	(0 to 10.9) Ω (11 to 32.9) Ω (33 to 109) Ω (0.11 to 1.1) kΩ (1.2 to 10.9) kΩ (11 to 109) kΩ (0.110 to 1.09) MΩ (1.1 to 3.29) MΩ (3.3 to 10.9) MΩ (11 to 32.9) MΩ (33 to 109) MΩ (110 to 329) MΩ (0.33 to 1.1) GΩ	0.93 mΩ + 20 μΩ/Ω 2.4 mΩ + 4.4 μΩ/Ω 2.6 mΩ + 21 μΩ/Ω 3.4 mΩ + 21 μΩ/Ω 46 mΩ + 21 μΩ/Ω 0.15 Ω + 23 mΩ/kΩ 1.0 Ω + 31 mΩ/kΩ 15 Ω + 85 Ω/MΩ 0.025 kΩ + 120 Ω/MΩ 5.0 kΩ + 0.3 kΩ/MΩ 2.4 kΩ + 0.530 kΩ/MΩ 0.9 MΩ + 2.2 kΩ/MΩ 0.45 MΩ + 0.012 MΩ/MΩ	Comparison performed with Multifunction Calibrator
Resistance Fixed Values – Source <sup>1</sup>	0.0001 Ω 0.001 Ω 1 MΩ 10 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ	0.51 uΩ 0.003 6 mΩ 0.012 MΩ 0.12 MΩ 1.2 MΩ 0.012 GΩ 0.12 GΩ 1.2 GΩ	Shunts & High Resistance Box
Resistance Measure <sup>1</sup>	(0 to 10) Ω (10 to 100) Ω (100 to 1 000) Ω (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ	18 μΩ + 190 μΩ/Ω 90 μΩ + 29 μΩ/Ω 1.1 mΩ 17 μΩ/Ω 3.7 mΩ + 14 mΩ/kΩ 42 mΩ + 17 mΩ/kΩ 2.1 Ω + 20 Ω/ MΩ 0.10 kΩ + 0.071 kΩ/MΩ	Utilizing a 8½ digit Digital Multimeter
Resistance Measure <sup>1</sup>	(10 to 100) MΩ	0.74 kΩ + 0.68 kΩ/MΩ	Utilizing an 8½ digit DMM
Resistance Measure <sup>1</sup>	(0.1 to 1) GΩ	0.14 MΩ + 0.023 MΩ/MΩ	Utilizing a 6½ digit DMM
DC Voltage Source <sup>1</sup>	(0.01 to 329) mV (0.33 to 3.29) V (3.3 to 32.9) V (33 to 329.9) V (330 to 1 000) V	1.2 μV + 0.016 μV/ mV 1.5 μV + 11 μV/ V 25 μV + 15 μV/V 0.15 mV + 16 μV/V 1.3 mV + 15 μV/V	Comparisons performed with a Multifunction Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Volt Source <sup>1</sup> (Sine Wave) (0.045 to 450) kHz	(0.001 to 33) mV 45 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 450 kHz	5.5 μV + 0.11 μV/mV 5.7 μV + 0.11 μV/mV 40 μV + 6.2 μV/mV	Comparisons performed with a Multifunction Calibrator
	(33 to 330) mV 45 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 450 kHz	6.6 μV + 0.12 μV/mV 6.6 μV + 0.12 μV/mV 57 μV + 1.6 μV/ mV	
AC Volt Source <sup>1</sup> (Sine Wave) (0.045 to 90) kHz	(0.33 to 3) V 45 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 450 kHz	51 μV + 16 μV/V 65 μV + 110 μV/V 0.52 mV + 1.9 mV/ V	Comparisons performed with a Multifunction Calibrator
	(3 to 30) V 45 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 90 kHz	0.47 mV + 0.12 mV/V 0.44 mV + 0.13 mV/V 1.2 mV + 0.7 mV/V	
AC Volt Source <sup>1</sup> (Sine Wave) (0.045 to 50) kHz	(30 to 330) V 45 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 50 kHz	1.4 mV + 0.16 mV/V 4.7 mV + 0.16 mV/V 4 mV + 0.25 mV/V	Comparisons performed with a Multifunction Calibrator
	(330 to 1 000) V 45 Hz to 1kHz 1 kHz to 10 kHz	28 mV + 0.19 mV/V 8.4 mV + 0.23 mV/V	
DC Voltage Measure <sup>1</sup>	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	1.3 μV + 0.005 7 μV/mV 1.6 μV + 5.9 μV/V 2.1 μV + 7.6 μV/V 5.3 μV + 7.6 μV/V 0.51 mV + 0.021 mV/V	Utilizing an 8½ Digit Digital Multimeter
	(0 to 1 000) V (1 000 to 30 000) V	49 mV + 0.75 mV/V 0.89 V + 1.4 V/kV	Utilizing a High Voltage Meter & Probe
AC Voltage Measure <sup>1</sup> (40 /1000) Hz	0 to 100 mV 0.1 to 1 V 1 to 10 V 10 V to 100 V 100 V to 1 000 V	4.4 μV + 0.072 μV/mV 9.1 μV + 15 μV/V 47 μV + 0.11 mV/V 0.78 mV + 0.23 mV/V 70 mV + 0.68 mV/V	Utilizing an 8½ Digit Digital Multimeter
	(1 000 to 9 000) V (9 000 to 30 000) V	97 μV + 2 V/kV 8.3 V + 1.1 V/kV	



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators <sup>1</sup> Source	Type J		Multifunction Calibrator
	(-200 to -100) °C	0.35 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.17 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.19 °C	
	Type K		
	(-200 to -100) °C	0.36 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.26 °C	
	(1 000 to 1 372) °C	0.35 °C	
	Type R		
	(0 to 250) °C	0.55 °C	
	(250 to 400) °C	0.31 °C	
	(400 to 1 000) °C	0.31 °C	
	(1 000 to 1 767) °C	0.37 °C	
	Type S		
(0 to 250) °C	0.49 °C		
(250 to 1 000) °C	0.33 °C		
(1000 to 1 400) °C	0.34 °C		
(1 400 to 1 767) °C	0.44 °C		
Type T			
(-250 to -150) °C	0.58 °C		
(-150 to 0) °C	0.2 °C		
(0 to 120) °C	0.2 °C		
(120 to 400) °C	0.15 °C		
Electrical Simulation of RTD Indicators <sup>1</sup> Source	(-200 to -80) °C	0.15 °C	Multifunction Calibrator
	(-80 to 0) °C	0.17 °C	
	(0 to 100) °C	0.17 °C	
	(100 to 400) °C	0.16 °C	
	(400 to 630) °C	0.18 °C	
	(630 to 800) °C	0.26 °C	



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1</sup>			
DC: 50 Ω 1 M Ω	(0 to 6.6) V (0 to 130) V	0.29 % of reading + 40 μV 0.09 % of reading + 40 μV	Meter Calibrator w/ 600 MHz Scope option
Square Wave: 50 Ω 1 M Ω	(0 to 6.6) V 10 Hz to 10 kHz 10 Hz to 10 kHz	0.29 % of reading + 40 μV 0.13 % of reading + 40 μV	
Leveled Sine Wave Amplitude (Relative to 50 kHz)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	4 % of reading + 300 μV 4.6 % of reading + 300 μV 6.9 % of reading + 300 μV	
Flatness (Relative to 50 kHz)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.7 % of reading + 100 μV 2.3 % of reading + 100 μV 4.6 % of reading + 100 μV	
Time Markers (Into 50 Ω)	1 ns to 20 ms 20 ms to 5 s	0.0004 % of reading of reading 0.6 % of reading of reading	

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Thin Gage Blocks	(0.005 to 0.05) in	5.6 μin	Gage Block Comparator and Gage Blocks
Gage Blocks	(0.05 to 1) in 2 in 3 in 4 in	3.9 μin 6.2 μin 8.1 μin 9.9 μin	Gage Block Comparator and Gage Blocks
Long Gage Blocks <sup>2</sup>	(5 to 8 in) (8 to 12 in)	(3.3 + 5.3L) μin (4.4 + 4.4L) μin	Labmaster and Long Blocks
Long Gage Blocks <sup>2</sup>	(5 to 20 in)	(16 + 2.6L)	Trimos Labconcept Nano and Long Gage Blocks
Thickness Standards <sup>2</sup> (Shims)	(0 to 0.5) in	(24 + 23L) μin	Trimos Labconcept Nano and Gage Blocks



**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Micrometer Length Standards <sup>2</sup>	(0.1 to 1) in (1 to 4) in (4 to 8) in (8 to 12) in	(4.8 + 1.9L) μin (3 + 3.8L) μin (3.3 + 5.3L) μin (4.4 + 4.4L) μin	P&W Labmaster and Long Blocks
	(12 to 20) in	(16 + 2.6L) μin	Trimos Labconcept Nano and Gage Blocks
	(20 to 40) in	(97 + 2.9L) μin	CMM utilized as a reference standard
Outside Diameter (w/Flats) Pin/Plug Gages/Spheres <sup>2</sup>	(0 to 1) in	(12 + 2.2L) μin	P&W Labmaster with Master Plug Gages
Outside Diameter and (Pin/Plug Gages/Spheres) <sup>2</sup>	(0 to 1) in (1 to 4) in (4 to 8) in (8 to 12) in	(4.8 + 1.9L) μin (3 + 3.8L) μin (3.3 + 5.3L) μin (4.4 + 4.4L) μin	P&W Labmaster with Master Blocks
	(12 to 20) in	(16 + 2.6L) μin	Trimos Labconcept Nano and Master Spheres/Pins/Plugs
Thread Wires	(0.005 to 1) in (All Pitches)	10 μin	Trimos Labconcept Nano and Master Plugs
Cylindrical ID <sup>2</sup> (Ring Gages)	(0.04 to 0.125) in (0.125 to 0.250) in (0.250 to 1) in (1 to 4) in (4 to 8) in (8 to 12) in	(8.6 + 3L) μin (9.1 + 0.47L) μin (6.7 + 1.5L) μin (4.7 + 3.5L) μin (5.3 + 3.4L) μin (19 + 2.9L) μin	P&W Labmaster and Master Cylindrical Rings
	(9 to 16) in	(78 + 3.9L) μin	CMM utilized as a reference standard
Plain Snap Gages <sup>1,2</sup>	(Up to 8) in	(9.2 + 8.7L) μin	Gage Blocks
Pin Gages Class Z and ZZ <sup>2</sup>	Up to 1 in	(35 + 7.9L) μin	Mitutoyo Laser Scan Micrometer and Master Plug Gages
Laser Micrometer/Scanner <sup>2</sup>	Up to 1 in	(25 + 5.6L) μin	Master Plug Gages
Thread Plugs <sup>2</sup> Major Diameter	Up to 9 in	(12 + 3.8L) μin	Trimos Labconcept Nano and Cylindrical Plugs
	(Up to 9 in) in 1 to 80 TPI	(87+1L) μin	Trimos Labconcept Nano and Thread Wires

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Thread Rings <sup>2</sup> Pitch Diameter Measure	(Up to 6 in) in 4 to 80 TPI	(13 + 4.6L) μin	Single Axis Measuring Machine and with T-Probe Attachment
Thread Ring Adjustable Tactile Fit (Set to Plug)	(Up to 9 in) in 4 to 80 TPI	N/A	Standard Set Thread Plug
Taper Thread Plug <sup>2</sup> Pitch Diameter	(Up to 12 in)	(63 + 3.1L) μin	Single Axis Measuring Machine and Thread Wires
Taper Thread Plug / Ring Standoff	(-0.02 to 0.02) in	375 μin	Single Axis Measuring Machine
Taper Thread Ring Pitch Diameter	(0.2 to 6 in)	165 μin	Single Axis Measuring Machine and with T-Probe Attachment
Taper Thread Ring Ring Thickness	(0.1 to 1.14) in	18 μin	Single Axis Measuring Machine
Rulers & Tape Measures <sup>2</sup>	(0 to 12) in	(220 + 11L) μin	VMM
	(0 to 100) ft	(550 + 5.4L) μin	Micro-Ruler
Thread Snap Gage <sup>1</sup> (Set to Plug)	(0.05 to 4) in	N/A	Set Plugs
Thread Plugs Depth Notch	0 to 30 mm	15 μm 25 μm	VMM Optical Comparator
Surface Finish Standards	Up to 10 μm Ra	0.023 μm + 0.022 μm/μm	Profilometer ASME B46.1
Profilometer / Surface Finish Tester	(0.4 to 3) μm Ra	0.062 μm + 0.096 μm/μm	Using Surface Specimen
Dial & Digital Indicators <sup>1,2</sup>	(0 to 1) in	(57 + 6.8L) μin	Indicator Calibrator
	(0 to 4) in	(44 + 4L) μin	Gage Blocks
Indicators <sup>2</sup> (Probes & LVDT's)	(0 to 4) in	(37 + 2.3L) μin	Single Axis Measuring Machine
Calipers (OD& ID) <sup>1,2</sup>	(0 to 12) in (12 to 80) in	(290 + 1.9L) μin (220 + 7.2L) μin	Gage Blocks
Outside Micrometers and Inside Micrometers <sup>1,2</sup>	(0 to 4) in (4 to 40) in (40 to 60) in	(32 + 14L) μin (39 + 12L) μin (310 + 5.2L) μin	Gage Blocks
Flatness of Micrometer Anvils and Indicator Stand Bases	Up to 1 in (1 to 4) in	7.2 μin 12 μin	Optical Flat

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Bore Gages <sup>1,2</sup> (Indicator Type)	(0 to 1) in	(57 + 6.8L) μin	Indicator Calibrator
Depth Micrometers <sup>1,2</sup>	(0 to 12) in (12 to 40) in	(73 + 7.3L) μin (81 + 6.6L) μin	Gage Blocks
Height and Depth Gages <sup>1,2</sup>	(0 to 60) in	(76 + 6.8L) μin	Gage Blocks
Single Axis Measuring Machine <sup>1,2</sup>	(0 to 20) in (20 to 60) in	(9.6 + 3.1L) μin (57+ 5.9L) μin	Gage Blocks
Radius Gage <sup>2</sup>	Up to 2 in Up to 50 mm	(160 + 13L) μin (4.1 + 0.013L) μm	Video Measuring Machine
Bubble Level (0 to 20) in	(0 to 0.02) in	178 μin or 0.01°	Sine Plate & Gage Blocks
Protractor	(0 to 45)°	0.16°	Surface Plate, Sine Bar/Plate, Gage Blocks
	90°	0.16°	Surface Plate, Cylindrical Square
	(0 to 180)°	0.03°	VMM
Coating Thickness Gages	Up to 0.2 in Up to 0.5 in	41 μin + 1.1 % of reading 18 μin + 0.022 % of reading	Thickness foils Gage Blocks
Bore Micrometers (3pt) <sup>2</sup>	(0 to 8) in	(72 + 9.3L) μin	Master Rings
Coordinate Measuring Machines <sup>1,2</sup> Linearity (X, Y, Z axis)	(0 to 40) in	(34 + 1.8L) μin (34 + 1.8L) μin (33 + 2.1L) μin	ISO 10360-2 Gage Blocks
Volumetric / Spatial Error	(0 to 40) in	(35 + 1.9L) μin	Gage Blocks
Probing Error	(0 to 8) in	35 μin	Sphere
Squareness	(0 to 8) in	33 μin	Master Square

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Optical Comparators <sup>1,2</sup> Length Angle  Magnification	(0 to 12) in Up to 90°  10 X 20 X 31.25 X 50 X 62.5 X 100 X	(110 + 2.2L) μin 0.03°  135 μin 105 μin 140 μin 133 μin 139 μin 102 μin	Glass Scale Glass Scale  Magnification Scale
Video Measuring Machines <sup>1,2</sup>	X (0 to 12) in Y (0 to 12) in Z (0 to 8) in  Angle	(77 + 1.3L) μin (79 + 1.2L) μin (53 + 5L) μin  0.012 °	Glass Scales & Gage Blocks  Glass Scale & with Angle Reference
Measuring Microscope <sup>1</sup>	(0 to 12) in	(100 + 1.9L) μin	Glass Scale

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force (Tension & Compression)	0 to 500 lbf	0.005 4 lbf + 0.000 4 lbf/lbf	Weights & Hanger
Durometers Spring Force Types A, B, O Types C, D, DO  Indenter Angle Radius / Length / Width	Up to 822 gf Up to 4 536 gf  Up to 45° Up to 0.5 in	0.63 Duro 0.63 Duro  0.05° 207 μin	ASTM D2240 using Duro Calibrator  Optical Comparator
Brinell Hardness Testers <sup>1</sup> (Diameter/Load)	2.5/187.5 Low 2.5/187.5 High  10/500 Low 10/500 High  10/3 000 Low 10/3 000 High	13.1 HBW 21 HBW  3 HBW 3.6 HBW  5.6 HBW 15 HBW	ASTM E-10 Indirect Verification with Test Blocks

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vickers Hardness Testers <sup>1</sup>	500 grf Low Mid High	11 HV 18 HV 24 HV	ASTM E-384 Indirect Verification with Test Blocks
Knoop Hardness Testers <sup>1</sup>	500 grf Low Mid High	12 HK 20 HK 26 HK	ASTM E-384 Indirect Verification with Test Blocks
Leeb Hardness Testers <sup>1</sup>	Low High	10 HLD 13 HLD	ASTM-A956 Indirect Verification with Test Blocks
Rockwell Hardness Testers <sup>1</sup>	HRA Low Mid High HRBW Low Mid High	1.4 HRA 1.4 HRA 0.9 HRA 3.2 HRBW 3.1 HRBW 1.5 HRBW	ASTM E-18 Indirect Verification with Test Blocks
Rockwell Hardness Testers <sup>1</sup>	HRC Low Mid High HREW Low Mid High HRFW Low Mid High	1.7 HRC 1.5 HRC 1.2 HRC 1.4 HREW 1.4 HREW 1.4 HREW 1.5 HRFW 1.5 HRFW 1.6 HRFW	ASTM E-18 Indirect Verification with Test Blocks

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment		
Rockwell Superficial Hardness Testers <sup>1</sup>	HR15N Low Mid High	1.5 HR15N 1.4 HR15N 1 HR15N	ASTM E-18 Indirect Verification with Test Blocks		
	HR15T Low Mid High	2 HR15T 2 HR15T 1.6 HR15T			
	HR30N Low Mid High	1.5 HR30N 1.5 HR30N 1.3 HR30N			
	HR30T Low Mid High	1.9 HR30T 1.5 HR30T 1.7 HR30T			
	HR45N Low Mid High	1.5 HR45N 1.5 HR45N 1.3 HR45N			
	HR45T Low Mid High	1.9 HR45T 1.6 HR45T 1.4 HR45T			
	Hydraulic Pressure	(0 to 10 000) psig		1.1 psi + 0.000 5 psi/psi	Deadweight Tester
	Pneumatic / Hydraulic Pressure <sup>1</sup>	(0 to 15) psi		0.006 5 psi + 0.000 006 5 psi/psi	Reference Manometers and Pressure Modules
		(15 to 100) psi		0.03 psi + 0.000 048 psi/psi	
		(100 to 300) psi		0.029 psi + 0.000 15 psi/psi	
		(300 to 2 000) psi		0.4 psi + 0.000 067 psi/psi	
		(2 000 to 5 000) psi		0.62 psi + 0.000 22 psi/psi	
	(5 000 to 10 000) psi	2.9 psi + 0.000 016 psi/psi			
	Barometric Pressure	(0.98 to 1.05) bar		4 mbar	Compared to Barometer
Vacuum <sup>1</sup>	(-15 to 0) psi	0.007 4 psi + 0.000 3 psi/psi	Reference gage & Vacuum / Pressure Module		

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances <sup>1</sup> (0.000 001 g resolution) (0.000 01 g resolution) (0.000 1 g resolution) (0.000 1 g resolution) (0.001 g resolution) (0.01 kg resolution) (0.01 kg resolution)	(0 to 50) g (0 to 100) g (0 to 200) g (0 to 300) g (0 to 500) g (0 to 12) kg (0 to 50) kg	0.14 mg 0.29 mg 0.58 mg 0.87 mg 1.4 mg 1.7 mg 4.3 g	Class 1 Weights  Class S6 & Class F Class S6 & Class F
Scales <sup>1</sup> (0.01 lb resolution)	(1 to 650) lb	0.02 % of reading	Class F weights
Torque Analyzers / Testers	(5 to 200) ozf·in (10 to 500) lbf·in (25 to 250) lbf·ft (250 to 1 500) lbf·ft	0.002 5 ozf·in + 0.000 15 ozf·in/ozf·in 0.023 lbf·in + 0.000 17 lbf·in/lbf·in 0.025 lbf·ft + 0.000 031 lbf·ft/lbf·ft 0.07 lbf·ft + 0.000 31 lbf·ft/lbf·ft	Torque Arms with Weights
Torque Wrenches, Drivers, Watches <sup>1</sup>	(4 to 160) ozf·in (10 to 500) lbf·in (25 to 250) lbf·ft (250 to 1 000) lbf·ft (1 000 to 2 000) lbf·ft	0.026 ozf·in + 0.005 6 ozf·in/ozf·in 0.059 lbf·in + 0.005 7 lbf·in/lbf·in 0.013 lbf·ft + 0.005 8 lbf·ft/lbf·ft 0.16 lbf·ft + 0.005 7 lbf·ft/lbf·ft 0.22 lbf·ft + 0.007 3 lbf·ft/lbf·ft	Transducers with wrench Loader
Rotary Torque – DC, In-line, Impulse <sup>1</sup>	(2.5 to 25) lbf·in (25 to 100) lbf·in (120 to 1 200) lbf·in (100 to 400) lbf·ft	0.14 lbf·in + 0.002 7 lbf·in/lbf·in 0.67 lbf·in + 0.002 5 lbf·in/ lbf·in 0.5 lbf·in + 0.005 4 lbf·in/ lbf·in 0.27 lbf·ft + 0.005 3 lbf·ft/ lbf·ft	Torque Transducers with Run Down Adapters

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Infrared Thermometers	25 °C 50 °C 100 °C 200 °C 300 °C 400 °C 500 °C	0.67 °C 0.8 °C 1.1 °C 1.6 °C 2.1 °C 2.6 °C 3.1 °C	Blackbody w / PRT $\epsilon = (0.9 \text{ to } 1.0)$ $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature Measuring Equipment <sup>1</sup>	(0 to 500) °C	0.099 °C + 0.000 64 °C/°C	PRT Thermometer with Drywell
Temperature – Measure <sup>1</sup>	(0 to 500) °C	0.073 °C + 0.000 024°C/°C	PRT Thermometer/Probe



### Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity <sup>1</sup> (Source)	11.3 %RH 33.1 %RH 75.5 %RH 97.5 %RH	1.6 %RH 1.6 %RH 2 %RH 2.6 %RH	Aqueous Salt Solutions with Digital Temp/Humidity Probe
Relative Humidity <sup>1</sup> (Measure)	(0.1 to 90) %RH (>90 to 99) %RH	1.4 %RH 2.1 %RH	Reference Temperature/Humidity Meter
Temperature & Humidity meter <sup>1</sup>	(18 to 25) °C	0.5 °C	Temperature & Humidity Probe
Temperature/Humidity Meters	(-50 to < 20) °C (20 to 120) °C	0.65 °C 0.62 °C	Reference Temperature/Humidity Meter

### Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Source <sup>1</sup>	5 Hz to 119 Hz 120 Hz to 1 kHz (1 to 120) kHz	0.001 Hz 0.41 mHz + 0.004 9 mHz / Hz 1.5 mHz + 3.7 mHz / kHz	Comparison to a Multifunction Calibrator Fluke 5520A/5522A and Monitored with a Frequency Counter
Frequency Measure <sup>1</sup>	5 Hz to 1 MHz	2.4 mHz + 0.12 mHz/Hz	Comparison to a Universal Counter
Stopwatch & Timers <sup>1</sup>	(1 to 3 600) s	0.077 s + 0.000 39 s/s	Comparison to a Universal Counter
Tachometer <sup>1</sup>	(30 to 200 000) rpm	0.047 rpm + 0.000 46 % of reading	Multifunction Calibrator / Universal Counter
Stroboscopes <sup>2</sup>	(30 to 200 000) fpm	0.11 rpm + 0.000 39 % of reading	

## DIMENSIONAL MEASUREMENT

### 1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Dimensional Measurement (Mechanical Inspection and Testing) <sup>2</sup>	Up to 12 in	(140 + 11L) μin	Video probe utilized as Reference Standard for Dimensional Inspection

## 2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Dimensional Measurement (Mechanical Inspection and Testing)	Angle (0 to 360)°	0.035°	Video probe utilized as Reference Standard for Dimensional Inspection
Dimensional Measurement (Mechanical Inspection and Testing)	Angle (0 to 360)°	0.05°	Optical Comparator as Reference Standard for Dimensional Inspection
Geometric Form Perpendicularity Straightness	Up to 280 mm Up to 280 mm	2.1 μm 1.5 μm	Mahr MMQ400 Per ASME B89.3.1

## 3 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) <sup>2</sup>	Reference Standard, Method, and/or Equipment
Dimensional Measurement (Mechanical Inspection and Testing)	Up to 12 in	(155 + 12L) μin	Video probe utilized as Reference Standard for Dimensional Inspection
Dimensional Measurement (Mechanical Inspection and Testing) (Volumetric)	Up to 20 in (20 to 60) in Angle (0 to 360)°	(78 + 3.9L) μin (97 + 2.9L) μin 0.005°	Coordinate Measuring Machine utilized as Reference Standard for Dimensional Inspection
Geometric Form Out of Roundness Cylindricity	Up to 102 mm Up to 100 mm	0.43 μm 1.1 μm	Mahr MMQ400 Per ASME B89.3.1

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.  $L$  = length in inches,  $l$  = length in millimeters, fpm = flashes per minute.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. L1050-1.



Jason Stine, Vice President