CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Imperial Metrology, Inc.
301 Hurricane Creek Road
Piedmont, SC 29673

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

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

ANSI/NCSL Z540.3-2006 (R2013)

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.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 18 September 2022
Certificate Number: ACT-1235

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, ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3-2006 (R2013)

Imperial Metrology, Inc.
301 Hurricane Creek Road
Piedmont, SC 29673
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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **September 18, 2022** Certificate Number: **ACT-1235**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters 2 x 10^{-5} Pa @1kHz	94 dB 114 dB	0.6 dB 0.7 dB	Dwyer SMC-1 Sound Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	6 µV/V + 5 µV 11 µV/V + 2 µV 13 µV/V + 16 µV 18 µV/V + 13 µV 15 µV/V + 2 mV	Fluke 5520A/11 Multiproduct Calibrator
DC Voltage – Measure [1]	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	57 µV/mV + 3.6 µV 7.9 µV/V + 1.7 µV 7.3 µV/V + 2.2 µV 5.3 µV/V + 37 µV 13 µV/V + 0.14 V	Keysight 3458A Multimeter
DC High Voltage Measure [1]	(1 to 35) kV (20 to 100) kV	3.8 V + 2.3 % of reading 6.4 V + 0.12 % of reading	Multimeter and High Voltage Probe
	(2.1 to 24) kV	7.4 V + 2 % of reading	Sensitive Research ESH-29 Electrostatic Voltmeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1] Range Locked	(0 to 330) µA (0 to 3.3) mA (0 to 33) mA (0 to 330) mA (0 to 3) A (0 to 20) A	12 nA/A + 16 nA 77 nA/A + 39 nA 78 nA/A + 0.2 µA 78 nA/A + 2 µA 0.3 µA/A + 66 µA 0.24 mA/A + 0.4 mA	Fluke 5520A/11 Multiproduct Calibrator
DC Current – Measure [1]	(0 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	12 pA/µA + 5.9 nA 0.2 µA/mA + 5.8 µA 30 nA/mA + 62 nA 49 nA/mA + 0.6 µA 0.2 mA/A + 12 µA	Keysight 3458A Multimeter
	(1 to 3) A	1.8 mA/A	Agilent 34401A Multimeter
	(3 to 10) A	1.5 mA/A + 77 µA	Fluke 45 Multimeter
	(3 to 30) A (30 to 150) A	0.2 mA/A + 5.1 mA 0.1 mA/A + 18 mA	Current Shunts w/ Agilent 34401A Multimeter
AC Voltage – Source [1]	(3.3 to 33) mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 450) kHz (33 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 330 mV to 3.3 V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 90) kHz	 0.2 µV/V + 7.4 µV 0.2 µV/V +7.4 µV 41 nV/V + 8.6 µV 1.2 µV/V + 7 µV 4.2 µV/V + 13 µV 9.3 µV/V + 58 µV 0.3 µV/V + 4 µV 0.2 µV/V + 0.2 µV 0.2 µV/V + 9 µV 0.4 µV/V + 9.3 µV 0.9 µV/V + 37 µV 2.3 µV/V + 82 µV 0.3 mV/V + 1 mV 0.2 mV/V + 0.5 mV 0.2 mV/V + 91 µV 0.3 mV/V + 59 µV 0.7 mV/V + 0.2 mV	Fluke 5520A/11 Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(3.3 to 33) V		Fluke 5520A/11 Multiproduct Calibrator
	(10 to 45) Hz	0.3 mV/V + 1 mV	
	45 Hz to 10 kHz	0.2 mV/V + 0.7 mV	
	(10 to 20) kHz	0.2 mV/V + 1.1 mV	
	(20 to 50) kHz	0.4 mV/V + 0.7 mV	
	(50 to 90) kHz	1 mV/V + 2 mV	
	(33 to 330) V		
	45 Hz to 1 kHz	0.3 µV/V + 69 mV	
	(1 to 10) kHz	0.2 mV/V + 7 mV	
	(10 to 20) kHz	0.3 mV/V + 7 mV	
	(20 to 50) kHz	0.4 mV/V + 4.4 mV	
	(330 to 1 000) V		
	45 Hz to 1 kHz	0.3 mV/V + 40 mV	
	(1 to 5) kHz	0.3 mV/V + 14 mV	
	(5 to 10) kHz	0.4 mV/V + 15 mV	
AC Voltage – Measure [1]	Up to 10 mV		Keysight 3458A Multimeter
	(1 to 40) Hz	7.9 µV	
	40 Hz to 1 kHz	0.13 µV/mV + 4.1 µV	
	(1 to 20) kHz	0.25 µV/mV + 3.9 µV	
	(20 to 50) kHz	1.2 µV/mV + 3.5 µV	
	(50 to 100) kHz	5.6 µV/mV + 6.2 µV	
	(100 to 300) kHz	50 µV/mV + 3.4 µV	
	(10 to 100) mV		
	(1 to 40) Hz	0.5 µV/mV + 19 µV	
	40 Hz to 1 kHz	0.3 µV/mV + 3.8 µV	
	(1 to 20) kHz	0.3 µV/mV + 25 µV	
	(20 to 50) kHz	0.4 µV/mV + 10 µV	
	(50 to 100) kHz	0.5 µV/mV + 55 µV	
	(100 to 300) kHz	4 mV/mV + 29 µV	
	100 mV to 1V		
	(1 to 40) Hz	0.4 mV	
	40 Hz to 1 kHz	34 µV/V + 85 µV	
	(1 to 20) kHz	0.2 mV/V + 1 µV	
	(20 to 50) kHz	77 µV/V + 37 µV	
	(50 to 100) kHz	1 mV/V + 5.4 µV	
	(100 to 300) kHz	25 mV/V + 9 nV	
	300 kHz to 1MHz	27 mV/V + 10 nV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(1 to 10) V		Keysight 3458A Multimeter
	(1 to 40) Hz	57 µV/V + 1.1 mV	
	40 Hz to 1 kHz	64 µV/V + 0.5 mV	
	(1 to 20) kHz	53 µV/V + 0.3 mV	
	(20 to 50) kHz	72 µV/V + 0.3 mV	
	(50 to 100) kHz	0.9 mV/V + 0.2 mV	
	(100 to 300) kHz	3.5 mV/V + 1.1 mV	
	300 kHz to 2 MHz	12 mV/V + 1 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.1 mV/V + 12 mV	
	40 Hz to 1 kHz	0.3 mV/V + 2 mV	
	(1 to 20) kHz	2.8 mV/V + 10 µV	
	(20 to 50) kHz	0.1 mV/V + 3.5 mV	
	100 V to 1 kV		
	40 Hz to 1 kHz	0.7 mV/V + 1 mV	
	1 kHz to 20 kHz	1 mV/V + 1 mV	
AC High Voltage Measure [1]	(1 to 35) kV	3.3 V + 5.8% of reading	Multimeter and High Voltage Probe
	(20 to 90) kV	56 V + 1.1 % of reading	
	(2.1 to 24) kV	7 V + 2.1% of reading	Sensitive Research ESH-29 Electrostatic Voltmeter
AC Current – Source [1]	(33 to 330) µA		Fluke 5520A/11 Multiproduct Calibrator
	(10 to 20) Hz	2.3 nA/A + 0.1 µA	
	(20 to 45) Hz	1.4 nA/A + 0.1 µA	
	45 Hz to 1 kHz	1.5 nA/A + 99 nA	
	(1 to 5) kHz	3.4 nA/A + 0.2 µA	
	(5 to 30) kHz	18 nA/A + 0.5 µA	
	330 µA to 3.3 mA		
	(10 to 20) Hz	2.3 µA/A + 0.2 µA	
	(20 to 45) Hz	1.4 µA/A + 0.3 µA	
	45 Hz to 1 kHz	11 µA/A + 0.3 µA	
	(1 to 5) kHz	10 µA/A + 0.7 µA	
	(5 to 30) kHz	13 µA/A + 33 nA	
	(3.3 to 33) mA		
	(10 to 20) Hz	2.1 µA/A + 1.9 µA	
	(20 to 45) Hz	1.1 µA/A + 2.1 µA	
	45 Hz to 1 kHz	0.5 µA/A + 2.2 µA	
	(1 to 5) kHz	1 µA/A + 0.6 µA	
	(5 to 30) kHz	4.1 µA/A + 19 µA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	(33 to 330) mA		Fluke 5520A/11 Multiproduct Calibrator
	(10 to 20) Hz	2.2 µA/A + 20 µA	
	(20 to 45) Hz	1.2 µA/A + 17 µA	
	45 Hz to 1 kHz	0.5 µA/A + 23 µA	
	(1 to 5) kHz	1.2 µA/A + 58 µA	
	(5 to 30) kHz	4.7 µA/A + 0.2 mA	
	330 mA to 1.1 A		
	(10 to 45) Hz	2.1 mA/A + 0.1 mA	
	45 Hz to 1 kHz	0.6 mA/A + 0.1 mA	
	(1 to 5) kHz	6.9 mA/A + 1.2 mA	
	(5 to 10) kHz	29 mA + 5.8 mA	
	(1.1 to 3) A		
	(10 to 45) Hz	2.1 mA/A + 0.1 mA	
	45 Hz to 1 kHz	0.7 mA/A + 72 µA	
	(1 to 5) kHz	6.9 mA/A + 1.2 mA	
	(5 to 10) kHz	26 mA/A + 8.9 mA	
	(3 to 10) A		
	(45 to 100) Hz	0.7 mA/A + 2.3 mA	
	100 Hz to 1 kHz	0.5 mA/A + 4.4 mA	
	(1 to 5) kHz	35 mA/A + 2.3 mA	
	(10 to 20) A		
	(45 to 100) Hz	1.6 mA/A + 5.2 mA	
	100 Hz to 1 kHz	1.9 mA/A + 5.3 mA	
	(1 to 5) kHz	35 mA/A + 5.8 mA	
AC Current – Measure [1]	Up to 100 µA		Keysight 3458A Multimeter
	(10 to 20) Hz	4.6 nA/µA + 39 nA	
	(20 to 45) Hz	1.7 nA/µA + 42 nA	
	(45 to 100) Hz	0.6 nA/µA + 45 nA	
	100 Hz to 1 kHz	0.6 nA/µA + 45 nA	
	100 µA to 1 mA		
	(10 to 20) Hz	8.5 µA/A	
	(20 to 45) Hz	15 µA/A	
	(45 to 100) Hz	15 µA/A	
	100 Hz to 1 kHz	14 µA/A	
	(1 to 10) mA		
	(10 to 20) Hz	5.6 nA/mA + 2 µA	
	(20 to 45) Hz	5.7 nA/mA + 0.3 µA	
	(45 to 100) Hz	5.8 µA/mA + 80 nA	
	100 Hz to 1 kHz	5.8 µA/mA + 15 nA	
	(1 to 5) kHz	5.8 µA/mA + 30 nA	
	(5 to 10) kHz	5.8 µA/mA + 79 nA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure [1]	(10 to 100) mA		Agilent 34401A Multimeter
	(10 to 20) Hz	5.1 µA/mA + 71 µA	
	(20 to 45) Hz	5.8 µA/mA + 40 nA	
	(45 to 100) Hz	5.8 µA/mA + 12 nA	
	100 Hz to 1 kHz	5.8 µA/mA + 7 nA	
	(1 to 5) kHz	5.8 µA/mA + 0.2 µA	
	(5 to 20) kHz	5.8 µA/mA + 11 nA	
	100 mA to 1 A		
	(10 to 20) Hz	1.9 mA/A + 5.6 mA	
	(20 to 45) Hz	1.2 mA/A + 5.7 mA	
	(45 to 100) Hz	0.1 mA/A + 5.8 mA	
	100 Hz to 1 kHz	0.2 mA/A + 5.8 mA	
	(1 to 20) kHz	1.2 mA/A + 5.7 mA	
	(1 to 3) A		
	(10 to 20) Hz	4.2 mA/A + 2.8 mA	
	(20 to 45) Hz	1.7 mA/A + 4.4 mA	
	(45 to 100) Hz	1.7 mA/A + 4.4 mA	
	100 Hz to 1 kHz	1.7 mA/A + 4.3 mA	
	(1 to 5) kHz	1.7 mA/A + 4.3 mA	
AC Current – Measure [1]	(3 to 10) A		Fluke 45 Multimeter
	(10 to 20) Hz	3.9 mA/A + 52 mA	
	(20 to 45) Hz	3.9 mA/A + 52 mA	
	(45 to 100) Hz	1 mA/A + 60 mA	
	100 Hz to 1 kHz	1.5 mA/A + 55 mA	
	(1 to 5) kHz	1 mA/A + 0.17 A	
Resistance – Source [1] Simulation	Up to 11 Ω	46 µΩ/Ω + 1.2 mΩ	Fluke 5520A/11 Multiproduct Calibrator
	(11 to 33) Ω	33 µΩ/Ω + 1.8 mΩ	
	(33 to 110) Ω	27 µΩ/Ω + 1.6 mΩ	
	(110 to 330) Ω	26 µΩ/Ω + 2.3 mΩ	
	330 Ω to 1.1 kΩ	27 mΩ/Ω + 1.9 mΩ	
	(1.1 to 3.3) kΩ	26 mΩ/Ω + 23 mΩ	
	(3.3 to 11) kΩ	26 mΩ/Ω + 19 mΩ	
	(11 to 33) kΩ	26 mΩ/Ω + 0.2 Ω	
	(33 to 110) kΩ	27 mΩ/Ω + 0.2 Ω	
	(110 to 330) kΩ	30 mΩ/Ω + 2.8 Ω	
	330 kΩ to 1.1MΩ	36 Ω/MΩ + 3.9 Ω	
	(1.1 to 3.3) MΩ	36 Ω/MΩ + 65 Ω	
	(3.3 to 11) MΩ	130 Ω/MΩ + 26 Ω	
	(11 to 33) MΩ	300 Ω/MΩ + 2.7 kΩ	
	(33 to 110) MΩ	500 Ω/MΩ + 3.5 kΩ	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source [1] Simulation	(110 to 330) MΩ (330 to 1 100) MΩ	3.1 kΩ/MΩ + 89 kΩ 15 kΩ/MΩ + 200 kΩ	Fluke 5520A/11 Multiproduct Calibrator
Resistance – Source [1] Fixed	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	0.000 074 Ω 0.000 6 Ω 0.000 6 Ω 0.001 7 mΩ 0.017 Ω 0.035 Ω 0.012 kΩ 0.12 kΩ 0.13 kΩ 0.027 MΩ 0.03 MΩ 0.24 MΩ 0.01 GΩ 0.12 GΩ 1.2 GΩ 0.2 TΩ	Standard Resistors
Resistance – Measure [1]	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1GΩ	14 µΩ/Ω + 0.1 mΩ 17 µΩ/Ω + 0.6 mΩ 78 µΩ/Ω + 0.4 mΩ 15 mΩ/Ω + 5 mΩ 15 mΩ/Ω + 48 mΩ 19 mΩ/Ω + 2.5 Ω 78 Ω/Ω + 98 Ω 660 Ω/Ω + 1.1 kΩ 7.5 kΩ/MΩ + 0.3 MΩ	Keysight 3458A Multimeter (NPLC 100)
Capacitance – Source [1] Simulation	(0.19 to 0.4) nF (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 (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF	5.3 pF/nF + 13 pF 5.4 pF/nF + 13 pF 6.1 pF/nF + 14 pF 3 pF/nF + 15 pF 2.9 pF/nF + 0.1 nF 3 pF/nF + 0.1 nF 3.9 pF/nF + 0.2 nF 2.7 nF/µF + 1.4 nF 3 nF/µF + 3.4 nF 2.7 nF/µF + 1.4 nF 4.5 nF/µF + 38 nF 5.1 nF/µF + 0.1 µF	Fluke 5520A/11 Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source [1] Simulation	(110 to 330) µF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	5.1 nF/µF + 0.4 µF 86 nF/µF + 0.6 mF 4.8 µF/mF + 5.7 µF 4 µF/mF + 25 µF 8.4 µF/mF + 49 µF 14 µF/mF + 75 µF	Fluke 5520A/11 Multiproduct Calibrator
Capacitance – Source [1] Fixed, 1 kHz	0.001 µF (0.01 to 1) µF	0.000 02 µF 23 nF/µF + 0.2 nF	Standard Capacitor Decade Capacitor
Inductance – Source [1] Variable, 1 kHz	(1 to 1 000) mH (1 to 10) H	0.01 mH/mH + 0.015 mH 9 mH/H + 7 mH	Decade Inductor
Electrical Simulation of RTD Indicating Devices [1]	Pt 385, 100 Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C Pt 385, 1 000 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 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 Pt 3926, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	 0.07 °C 0.07 °C 0.08 °C 0.09 °C 0.1 °C 0.13 °C 0.23 °C 0.03 °C 0.05 °C 0.05 °C 0.09 °C 0.08 °C 0.26 °C 0.28 °C 0.07 °C 0.08 °C 0.09 °C 0.07 °C 0.09 °C 0.11 °C 0.11 °C 0.24 °C 0.06 °C 0.08 °C 0.09 °C 0.1 °C 0.13 °C	Fluke 5520A/11 Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices [1]	Cu 427, 10 Ω (-100 to 260) °C	0.45 °C	Fluke 5520A/11 Multiproduct Calibrator
Electrical Simulation of Thermocouples - Measure/Source [1]	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C Type C (0 to 150) ° C (150 to 650) °C (650 to 1 000) ° C (1 000 to 1 800) °C (1 800 to 2 316) °C 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 -100) °C (-100 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 L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C Type N (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1 300) °C	 0.46 °C 0.43 ° C 0.34 ° C 0.35 ° C 0.33 °C 0.29 °C 0.35 °C 0.52 °C 0.86 °C 0.51 °C 0.25 °C 0.21 °C 0.21 °C 0.31 °C 0.28 °C 0.18 °C 0.19 °C 0.2 °C 0.28 °C 0.34 °C 0.18 °C 0.2 °C 0.29 °C 0.47 °C 0.39 °C 0.3 °C 0.21 °C 0.42 °C 0.24 °C 0.22 °C 0.21 °C 0.29 °C	Fluke 5520A/11 Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouples - Measure/Source [1]	Type R (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 1 000) °C (1 000 to 1 400) °C (1 400 to 1767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C Type U (-200 to 0) °C (0 to 600) °C	 0.8 °C 0.7 °C 0.7 °C 0.7 °C 0.7 °C 0.7 °C 0.7 °C 0.7 °C 0.62 °C 0.25 °C 0.19 °C 0.18 °C 0.58 °C 0.32 °C	Fluke 5520A/11 Multiproduct Calibrator

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks	Up to 1 in (1 to 4) in	3.4 µin (1.7 + 1.5*L*) µin	Mahr 130B-24 Gage Block Comparator, Grade 00 Gage Blocks
Caliper s[1,2]	(0 to 24) in (24 to 48) in (48 to 80) in	(590 + 7.6*L*) µin (780 + 1.4*L*) µin (780 + 8.9*L*) µin	Gage Blocks
Outside Micrometer [1,2]	Up to 36 in	(55 + 27*L*) µin	
Inside Micrometer 3-point [1,2]	Up to 10 in	(93 + 12*L*) µin	Ring Gages
Tubular Inside Micrometer [1,2]	Up to 18 in Up to 48 in	(120 + 4.1*L*) µin (360 + 3.5*L*) µin	Trimos Horizon ULM Trimos V4 Electronic Height Gage
Length Standards [1,2]	(0 to 10) in (0 to 40) in (0 to 240) in	(96 + 4.6*L*) µin (120 + 6.2*L*) µin (59 + 22*L*) µin	Trimos Horizon ULM Trimos V4 Elect Height Gage B & S Validator CMM

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Feeler Gages/Thickness Shims [1,2]	Up to 0.2 in	(25 + 8.7*L*) µin	Trimos THV
Indicators [1,2] Dial/Digital/Test Incremental Probes/LVDT's	 Up to 4 in Up to 1 in	 (85 + 12*L*) µin (69 + 1.6*L*) µin	Gage Blocks
Linear Measurement Devices [1,2]	Up to 48 in	(530 + 12*L*) µin	
Height Gages [1,2]	Up to 48 in	(55 + 3.7*L*) µin	
Inclinometers/ Levels [2]	Up to 45 °	(1.1 + 0.06*L*) sec/°	Gage Blocks, Sine Plate
CMM Spheres & Gage Balls (Diameter) [2]	(0.1 to 1) in	21 µin	Trimos LabConcept Premium ULM
Roundness [2] (Geometric Form)	Up to 10 in	3.3 µin	Federal 6100 Form Scan
Radius Gages [2]	Up to 3 in	(120 + 30*L*) µin	OGP SmartScope Vision System
Thread Rings – Adjustable [2] Minor Diameter Pitch	 Up to 6.5 in Up to 6.5 in	 (50 + 6.6*L*) µin (240 + 79*L*) µin	Thread Set Plug or Trimos V4 Thread Set Plug
Thread Pitch Gages – Leaf Style [2]	Up to 0.25 in	(130 + 2 400*L*) µin	OGP SmartScope Vision System
Thread and Gear Wires [2]	Up to 0.15 in	(15 + 15*L*) µin	Trimos LabConcept
Ring Gages [2] X Class XX Class	 (0.38 to 8) in (0.38 to 8) in	 (28 + 6.5*L*) µin (15 + 5*L*) µin	Trimos Horizon Trimos LabConcept
Class X Ring Gages [1,2]	(0.18 to 4) in	(19 + 6.9*L*) µin	Trimos THV
Class Z & ZZ Pin Gages [2]	Up to 1 in	(38 + 5.9*L*) µin	Lasermike
Class ZZ Pin Gages [1,2]	Up to 1 in	(19 + 8.5*L*) µin	Trimos THV
Cylindrical Plugs and Pin Gages [2] (Z, ZZ, X, Y class)	Up to 8 in	(32 + 3.5*L*) µin	Trimos Horizon
Class X, XX Cylindrical Plugs and Pin Gages [2]	Up to 8 in	(14 + 6.2*L*) µin	Trimos LabConcept

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gages [1,2] Pitch Diameter Major Diameter	 Up to 6 in	 (54 + 17*L*) µin (50 + 17*L*) µin	 Trimos Horizon ULM Trimos Horizon ULM
Steel Rules [1,2]	Up to 72 in	(5 100 + 15*L*) µin	Gage Blocks
Tape Measures [2]	Up to 120 in	(2 200 + 11*L*) µin	Renishaw LM15 Linear Measuring Device
Optical Comparators [1,2]	Up to 12 in X Axis Y Axis	 (80 + 23*L*) µin (77 + 20*L*) µin	 Glass Scales Magnification Scales
Measuring Microscopes [1,2]	Up to 2 in X Axis Y Axis	 (57 + 10*L*) µin (61 + 3.3*L*) µin	 Glass Scales
Surface Finish [2] (Roughness Gages)	Up to 120 µin	(3.5 + 0.03*L*) µin	Mahr Contour/Surface Analyzer
Surface Plate [1] Overall Flatness Local Area Flatness (Repeat Reading) Surface Texture	 (43 to 161) in diagonal Up to 0.001in (0 to 32) µin (cutoff: 0.03 in)	 1.5 µin/in + 0.85 µin 33 µin 4.5 µin	 Wyler Level System Indicator/Probe Mahr Pocket Surf using ASME B89.3.7-2013
Vision Systems [1,2]	12 X 12 in X Axis Y Axis	 (65 + 4.2*L*) µin (69 + 2*L*) µin	 Glass Scales
Torque Arms/Wheels	2.5-inch Arm 5-inch Arm 20-inch Arm 40-inch Arm	1 200 µin 840 µin 1 300 µin 1 400 µin	B & S CMM

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure – Pneumatic [1]	(0 to 200) psig	0.007 3 psi	Pneumatic Deadweight Tester (Nitrogen)
	(0 to 300) psig	0.000 014 psi/psi + 0.058 psi	Druck DPI 611 Calibrator

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Pressure – Pneumatic [1]	(0 to 10) inH2O	0.001 7 inH2O/inH2O + 0.011 inH2O	Heise HM2-1 Pressure Module
Low Pressure – Pneumatic [1]	(0 to 25) inH2O	0.013 inH2O	Heise HM2-2 Pressure Module
Pressure, Absolute/ Barometric – Pneumatic [1]	(0 to 100) psia	0.042 psi	Heise HM2-2 Pressure Module
Vacuum [1]	(-30 to 0) inHg	0.000 031 inHg/inHg + 0.008 6 inHg	Druck DPI 611 Calibrator
Pressure – Hydraulic [1]	(0 to 5 000) psig	0.000 16 psi/psi + 2.8 psi	Druck iDOS UPM Pressure Module
	(0 to 10 000) psig	0.000 27 psi/psi + 0.046 psi	Deadweight Tester
	(0 to 40 000) psig	0.000 52 psi/psi + 25 psi	Additel ADT681 Hydraulic Pressure Test Gauge
Rockwell Hardness and Superficial Testers [1]	HRBW Low Middle High HRC Low Middle High HR15N Low Middle High HR30N Low Middle High HR45N Low Middle High	 1.5 HRBW 0.9 HRBW 0.6 HRBW 0.5 HRC 0.4 HRC 0.4 HRC 0.6 HR15N 0.3 HR15N 0.7 HR15N 0.6 HR30N 0.6 HR30N 0.3 HR30N 0.5 HR45N 0.5 HR45N 0.4 HR45N	Indirect Verification per ASTM E18 using Test Blocks
Rockwell Hardness and Superficial Testers [1]	HR15YW Low Mid High	 0.4 HR15YW 0.4 HR15YW 0.5 HR15YW	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
Vickers Hardness Testers [1]	272 HV 774 HV	9.1 HV 21.9 HV	Indirect Verification per ASTM E92 using Test Blocks
Knoop Hardness Testers [1]	290 HK 741 HK	15 HK 24 HK	
Brinell Hardness Testers [1]	87 HBW 201 HBW 216 HBW 437 HBW	(1.9 + 0.03 % of Applied) HBW	Indirect Verification per ASTM E10 using Test Blocks
Air Velocity	2.5 m/s 5.0 m/s 10.0 m/s 15.0 m/s	0.041 m/s 0.13 m/s 0.32 m/s 0.51 m/s	Omega WTM-1000 Wind Tunnel w/ Alnor 9535 Air Velocity Meter
Force Gages [1] Tension and Compression	Up to 250 lbf	0.000 2 lbf/lbf + 0.21 lbf	Class F Weights
Torque Tools [1]	(5 to 50) ozf·in (15 to 200) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (20 to 250) lbf·ft (60 to 600) lbf·ft (100 to 1 000) lbf·ft (200 to 2 000) lbf·ft	0.045 ozf·in + 0.11 % of reading 0.17 ozf·in + 0.4 % of reading 0.045 lbf·in + 0.48 % of reading 0.41 lbf·in + 0.1 % of reading 0.5 lbf·in + 0.1 % of reading 0.17 lbf·ft + 0.1 % of reading 0.51 lbf·ft + 0.15 % of reading 0.65 lbf·ft + 0.1 % of reading 1.6 lbf·ft + 0.1 % of reading	Reference Transducers, Digital Torque Tester
Torque Transducers and Testers [1]	(5 to 50) ozf·in (15 to 200) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (20 to 250) lbf·ft (60 to 600) lbf·ft (100 to 1 000) lbf·ft (200 to 2 000) lbf·ft	0.0063 ozf·in + 0.13 % of reading 0.0032 ozf·in + 0.11 % of reading 0.12 % of reading 0.013 lbf·in + 0.02% of reading 0.15 lbf·in + 0.01 % of reading 0.01 lbf·ft + 0.025 % of reading 0.017 lbf·ft + 0.01 % of reading 0.27 lbf·ft + 0.01 % of reading 0.55 lbf·ft + 0.01 % of reading	Lever Arms & Wheels, Dead Weights
Scales and Balances [1,3]	(1 to 210) g	0.13 µg/g + 31 µg	Class 1 Weight Set NIST HB 44
Scales and Balances [1,3]	Up to 2 110 g	0.000 14 g/g + 0.003 g	Class 6 Weight Set NIST HB 44
	(0.500 to 30.000) lb	0.000 3 lb/lb + 0.003 lb	Class 6 & Class F Weights NIST HB 44

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	(0.5 to 250.0) lb (250 to 1 000) lb	0.000 03 lb/lb + 0.024 lb 0.000 1 lb/lb + 0.3 lb	Class F Weights NIST HB 44

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity - Source/ Measure	(10 to 90) %RH	0.9% RH + 0.2% of reading	Vaisala HM40/HMP113 Humidity Indicator and Probe
Temperature – Measure [1]	(-190 to 420) °C	0.000 9 °C/°C + 0.082 °C	Pt100-385 4-wire RTD w/ Process Calibrator
	(0 to 660) °C	0.000 06 °C/°C + 0.09 °C	Pt100-385 4-wire RTD w/ Keysight 3458A Multimeter
Temperature – Source/Measure [1]	(-10 to 350) ºC	0.001 2 °C/°C + 0.23 °C	Fluke 5520A Multiproduct Calibrator w/ Pt100-385 4-wire RTD Ice Point/Dry Block Calibrator
Infrared Thermometers [1]	20 °C 200 °C 400 °C 500 °C	2 °C 4.5 °C 7.6 °C 10 °C	Blackbody Source (Cavity) $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14)$ µm

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stopwatches and Timers [1]	Up to 1 200 s	480 ms	NIST Time Signal
Frequency – Source [1]	(0.01 to 119.99) Hz (120 to 1 199.9) Hz (1.2 to 11.999) kHz (12 to 119.99) kHz (120 to 1199.9) kHz (1.2 to 2) MHz (2 to 100) MHz	0.8 µHz/Hz + 0.3 mHz 3.1 µHz/Hz + 51 µHz 2.9 Hz/kHz + 5.8 mHz 2.9 Hz/kHz + 6 mHz 2.9 Hz/kHz + 6 mHz 0.2 Hz/MHz + 58 Hz 3.2 Hz/MHz	Fluke 5520A/11 Multiproduct Calibrator

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure	1 Hz to 10 MHz	0.6 mHz/Hz + 5.4 mHz	Keysight 3458A Multimeter
Tachometers – Non Contact (Photo) [1]	(60 to 96 000) rpm	0.000 03 rpm/rpm + 0.2 rpm	Fluke 5520A/11 Multiproduct Calibrator
Tachometers – Contact [1]	(250 to 5 000) rpm	0.000 15 rpm/rpm + 2.8 rpm	Ideal Tachometer Tester

DIMENSIONAL MEASUREMENT

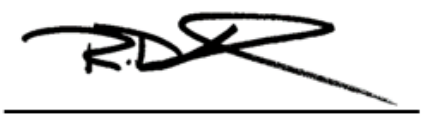
2 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Inspection by CMM B & S Excel 7-10-7 PC-DMIS CAD ++	X Axis (0 to 28) in Y Axis (0 to 40) in Z Axis (0 to 28) in	10 µin/in – 6.2 µin -7.3 µin/in + 21 µin -7 µin/in + 20 µin	Customer Drawing or CAD Model CMM Application Software
Inspection by CMM B & S Validator PC-DMIS CAD ++	X Axis (0 to 240) in Y Axis (0 to 72) in Z Axis (0 to 96) in	-0.5 µin/in + 2 300 µin -4.2 µin/in + 2 300 µin -1.2 µin/in + 2 400 µin	Customer Drawing or CAD Model CMM Application Software
Inspection by CMM B & S Global PC-DMIS CAD ++	X Axis (0 to 36) in Y Axis (0 to 48) in Z Axis (0 to 32) in	5.7 µin/in + 23 µin 7.3 µin/in + 21 µin 6.1 µin/in + 31 µin	Customer Drawing or CAD Model CMM Application Software

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.
3. The CMC for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainty 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.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1235.



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