CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Technical Maintenance, Inc.

4613 Northwest Parkway
Hilliard, OH 43026

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 & 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: 20 September 2021
Certificate Number: AC-2080.05

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)

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **September 20, 2021** Certificate Number: **AC-2080.05**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometers – Acceleration	(0.01 to 10) g (7 < 10) Hz (10 < 30) Hz (30 < 2 000) Hz (2 to 10) kHz	4 % of reading 3 % of reading 1.5 % of reading 4 % of reading	Accelerometer Calibrator

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters[1]	(4, 7, 10) pH	0.029 pH	Standard pH buffers
Conductivity Meters[1]	≈1 µS/cm ≈10 µS/cm ≈100 µS/cm ≈1000 µS/cm ≈10 000 µS/cm	0.5 µS/cm 0.41 µS/cm 2.7 µS/cm 15 µS/cm 140 µS/cm	Standard conductivity solutions

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Generate[1]	Up to 220 mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	11 µV/V + 0.4 µV 8.2 µV/V + 0.7 µV 7.1 µV/V + 2.5 µV 7.1 µV/V + 4 µV 8.2 µV/V + 40 µV 10 µV/V + 0.4 mV	Fluke 5720A Multiproduct Calibrator
DC Voltage – Measure[1]	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	12 µV/V + 0.3 µV 11 µV/V + 0.3 µV 11 µV/V + 0.5 µV 13 µV/V + 30 µV 12 µV/V + 100 µV	HP 3458A Multimeter
DC Current – Generate [1]	Up to 220 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A	55 µA/A + 6 nA 50 µA/A + 7 nA 50 µA/A + 40 nA 60 µA/A + 0.7 µA 98 µA/A + 12 µA 0.042 % of reading + 480 µA	Fluke 5720A Multiproduct Calibrator
	(11 to 20.5) A	0.11 % of reading + 0.75 mA	Fluke 5522A Multiproduct Calibrator
DC Current – Generate[1] Clamp Meters Only	(20.5 to 1 000) A	0.9 % of reading	Fluke 5522A Multiproduct Calibrator / 9100 Coil
DC Current – Measure[1]	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 10 mA (10 to 100) mA 100 mA to 1 A	35 nA/A + 0.04 nA 24 µA/A + 0.04 nA 24 µA/A + 0.1 nA 24 µA/A + 0.8 nA 24 µA/A + 0.05 µA 42 µA/A + 0.5 µA 0.13 mA/A + 10 µA	HP 3458A Multimeter
	(1 to 1 000) A	0.26 % of reading	Current shunt
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 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	35 µΩ/Ω + 100 µΩ 29 µΩ/Ω + 1 mΩ 23 µΩ/Ω + 1 mΩ 24 µΩ/Ω + 10 mΩ 24 µΩ/Ω + 100 mΩ 33 µΩ/Ω + 4 Ω 97 µΩ/Ω + 0.1 kΩ 0.12 % of reading + 1 kΩ 1.2 % of reading + 10 kΩ	HP 3458A Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance[1] – Fixed Points	1 Ω, 1.9 Ω 10 Ω, 19 Ω 100 Ω, 190 Ω 1 kΩ, 1.9 kΩ 10 kΩ, 19 kΩ 100 kΩ, 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	0.12 mΩ/Ω 31 μΩ/Ω 23 μΩ/Ω 12 μΩ/Ω 13 μΩ/Ω 14 μΩ/Ω 24 μΩ/Ω 26 μΩ/Ω 50 μΩ/Ω 59 μΩ/Ω 0.14 mΩ/Ω	Fluke 5720A Multiproduct Calibrator
Resistance – Generate[1]	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 kΩ 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 330 MΩ to 1.1 GΩ	47 μΩ/Ω + 0.01 Ω 35 μΩ/Ω + 0.015 Ω 33 μΩ/Ω + 0.015 Ω 33 μΩ/Ω + 0.02 Ω 33 μΩ/Ω + 0.02 Ω 33 μΩ/Ω + 0.1 Ω 33 μΩ/Ω + 0.1 Ω 33 μΩ/Ω + 1 Ω 33 μΩ/Ω + 1 Ω 37 μΩ/Ω + 10 Ω 37 μΩ/Ω + 10 Ω 70 μΩ/Ω + 150 Ω 0.015 % + 250 Ω 0.029 % of reading + 2.5 kΩ 0.06 % of reading + 3.0 kΩ 0.35 % of reading + 0.1 MΩ 1.7 % of reading + 0.5 MΩ	Fluke 5522A Multiproduct Calibrator
	10 GΩ	1.2 % of reading	Standard resistor
High Voltage – Measure DC Voltage AC Voltage – 50 - 60 Hz	 (1 to 60) kV (1 to 42) kV	 0.12 % of reading 0.6 % of reading	Ross VD150 Voltage Divider w/HP 34401 Multimeter
High Voltage -Generate DC Voltage	(1 to 6) KV	2.6 % of reading	Associated Research 3565D High Voltage Tester

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Generate[1]	(220 to 400) pF (0.4 to 3.299 9) nF (3.3 to 10.999 9) nF (11 to 32.999 9) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) uF (1.1 to 3.299 99) uF (3.3 to 10.999 9) uF (11 to 32.999 9) µF (33 to 109.999) µF (110 to 329.999) µF (0.33 to 1.099 99) mF (1.1 to 3.299 99) mF (3.3 to 10.999 9) mF (11 to 32.999 9) mF (33 to 110 mF	0.38% of Output + 7.6 pF 0.38 % of Output + 0.01 nF 0.19 % of Output + 0.01 nF 0.19 % of Output + 0.08 nF 0.19 % of Output + 0.08 nF 0.19 % of Output + 0.23 nF 0.19 % of Output + 0.76 nF 0.19 % of Output + 2.3 nF 0.19 % of Output + 7.6 nF 0.3 % of Output + 23 nF 0.34 % of Output + 76 nF 0.34 % of Output + 228 nF 0.34 % of Output + 0.76 µF 0.34 % of Output + 2.28 µF 0.34 % of Output + 7.6 µF 0.57 % of Output + 23 µF 0.84 % of Output + 76 µF	Fluke 5522A Multiproduct Calibrator
AC Voltage – Generate[1]	Up to 22 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	 0.36 mV/V + 5 µV 0.15 mV/V + 5 µV 0.13 mV/V + 5 µV 0.3 mV/V + 5 µV 0.71 mV/V + 6 µV 1.6 mV/V + 12 µV 2 mV/V + 25 µV 4 mV/V + 25 µV 0.35 mV/V + 15 µV 0.14 mV/V + 8 µV 0.12 mV/V + 8 µV 0.29 mV/V + 8 µV 0.7 mV/V + 20 µV 1.3 mV/V + 25 µV 2 mV/V + 30 µV 3.9 mV/V + 60 µV	Fluke 5720A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Generate[1]	220 mV to 2.2 V		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.51 mV/V + 50 µV	
	(20 to 40) Hz	0.4 mV/V + 20 µV	
	40 Hz to 20 kHz	0.38 mV/V + 10 µV	
	(20 to 50) kHz	1.4 mV/V + 12 µV	
	(50 to 100) kHz	0.41 mV/V + 40 µV	
	(100 to 300) kHz	0.69 mV/V + 0.1 mV	
	(300 to 500) kHz	1.5 mV/V + 0.25 mV	
	500 kHz to 1 MHz	2.4 mV/V + 0.4 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.48 mV/V + 0.5 mV	
	(20 to 40) Hz	0.39 mV/V + 0.2 mV	
	40 Hz to 20 kHz	0.38 mV/V + 70 µV	
	(20 to 50) kHz	0.39 mV/V + 0.12 mV	
	(50 to 100) kHz	0.4 mV/V + 0.25 mV	
	(100 to 300) kHz	0.5 mV/V + 0.8 mV	
	(300 to 500) kHz	1.3 mV/V + 2.5 mV	
	500 kHz to 1 MHz	1.9 mV/V + 4 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.51 mV/V + 5 mV	
	(20 to 40) Hz	0.4 mV/V + 2 mV	
	40 Hz to 20 kHz	0.38 mV/V + 0.7 mV	
	(20 to 50) kHz	0.39 mV/V + 1.2 mV	
	(50 to 100) kHz	0.43 mV/V + 3 mV	
	(100 to 300) kHz	1.4 mV/V + 20 mV	
	(300 to 500) kHz	6.3 mV/V + 50 mV	
	500 kHz to 1 MHz	12 mV/V + 0.1 V	
	(220 to 1 100) V		Fluke 5720A Multiproduct Calibrator / Fluke 5725A Amplifier
	40 Hz to 1 kHz	0.38 mV/V + 0.7 mV	
	(1 to 20) kHz	0.39 mV/V + 1.2 mV	
	(20 to 30) kHz	0.43 mV/V + 3 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.39 mV/V + 1.2 mV	
	(50 to 100) kHz	0.43 mV/V + 3 mV	
AC Voltage – Measure[1]	Up to 10 mV		HP 3458A Multimeter
	(1 to 40) Hz	0.044 % of reading + 0.003 mV	
	40 Hz to 1 kHz	0.026 % of reading + 0.001 1 mV	
	(1 to 20) kHz	0.044 % of reading + 0.001 1 mV	
	(20 to 50) kHz	0.11 % of reading + 0.001 1 mV	
	(50 to 100) kHz	0.5 % of reading + 0.001 1 mV	
	(100 to 300) kHz	4 % of reading + 0.002 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure[1]	10 mV to 100 mV		HP 3458A Multimeter
	(1 to 40) Hz	0.019 % of reading + 0.004 mV	
	40 Hz to 1 kHz	0.019 % of reading + 0.002 mV	
	(1 to 20) kHz	0.027 % of reading + 0.002 mV	
	(20 to 50) kHz	0.045 % of reading + 0.002 mV	
	(50 to 100) kHz	0.09 % of reading + 0.002 mV	
	(100 to 300) kHz	0.31 % of reading + 0.01 mV	
	300 kHz to 1 MHz	1 % of reading + 0.01 mV	
	(1 to 2) MHz	1.5 % of reading + 0.01 mV	
	100 mV to 1 V		
	(1 to 40) Hz	0.019 % of reading + 0.04 mV	
	40 Hz to 1 kHz	0.019 % of reading + 0.02 mV	
	(1 to 20) kHz	0.027 % of reading + 0.02 mV	
	(20 to 50) kHz	0.045 % of reading + 0.02 mV	
	(50 to 100) kHz	0.09 % of reading + 0.02 mV	
	(100 to 300) kHz	0.31 % of reading + 0.1 mV	
	300 kHz to 1 MHz	1 % of reading + 0.1 mV	
	(1 to 2) MHz	1.5 % of reading + 0.1 mV	
	1 V to 10 V		
	(1 to 40) Hz	0.019 % of reading + 0.000 4 V	
	40 Hz to 1 kHz	0.019 % of reading + 0.000 2 V	
	(1 to 20) kHz	0.027 % of reading + 0.000 2 V	
	(20 to 50) kHz	0.045 % of reading + 0.000 2 V	
	(50 to 100) kHz	0.09 % of reading + 0.000 2 V	
	(100 to 300) kHz	0.31 % of reading + 0.001 V	
	300 kHz to 1 MHz	1 % of reading + 0.001 V	
	(1 to 2) MHz	1.5 % of reading + 0.001 V	
	(10 to 100) V		
	(1 to 40) Hz	0.026 % of reading + 0.002 V	
	40 Hz to 1 kHz	0.041 % of reading + 0.002 V	
	(1 to 20) kHz	0.038 % of reading + 0.002 V	
	(20 to 50) kHz	0.048 % of reading + 0.002 V	
	(50 to 100) kHz	0.13 % of reading + 0.002 V	
	(100 to 300) kHz	0.4 % of reading + 0.01 V	
	300 kHz to 1 MHz	1.5 % of reading + 0.01 V	
	(100 to 700) V		
	(1 to 40) Hz	0.05 % of reading + 0.04 V	
	40 Hz to 1 kHz	0.05 % of reading + 0.02 V	
	(1 to 20) kHz	0.07 % of reading + 0.02 V	
	(20 to 50) kHz	0.13 % of reading + 0.02 V	
	(50 to 100) kHz	0.3 % of reading + 0.02 V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Generate[1]	Up to 200 µA		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.36 mA/A + 20 nA	
	(20 to 40) Hz	0.25 mA/A + 12 nA	
	40 Hz to 1 kHz	0.19 mA/A + 10 nA	
	(1 to 5) kHz	0.42 mA/A + 15 nA	
	(5 to 10) kHz	1.6 mA/A + 80 nA	
	(0.2 to 2.2) mA		
	(10 to 20) Hz	0.36 mA/A + 50 nA	
	(20 to 40) Hz	0.25 mA/A + 40 nA	
	40 Hz to 1 kHz	0.18 mA/A + 40 nA	
	(1 to 5) kHz	0.3 mA/A + 0.18 µA	
	(5 to 10) kHz	1.6 mA/A + 0.8 µA	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.26 mA/A + 0.5 µA	
	(20 to 40) Hz	0.24 mA/A + 0.4 µA	
	40 Hz to 1 kHz	0.18 mA/A + 0.4 µA	
	(1 to 5) kHz	0.3 mA/A + 0.7 µA	
	(5 to 10) kHz	1.6 mA/A + 6 µA	
	(22 to 200) mA		
	(10 to 20) Hz	0.36 mA/A + 5 µA	
	(20 to 40) Hz	0.24 mA/A + 4 µA	
	40 Hz to 1 kHz	0.18 mA/A + 3 µA	
	(1 to 5) kHz	0.3 mA/A + 4 µA	
	(5 to 10) kHz	1.6 mA/A + 12 µA	
	(0.2 to 2.2) A		
	20 Hz to 1 kHz	0.28 mA/A + 40 µA	
	(1 to 5) kHz	0.6 mA/A + 0.1 mA	
	(5 to 10) kHz	9.3 mA/A + 0.2 mA	
AC Current – Generate[1]	(2.2 to 11) A		Fluke 5720A Multiproduct Calibrator / Fluke 5725A Amplifier
	40 Hz to 1 kHz	0.81 mA/A + 0.17 mA	
	(1 to 5) kHz	1.3 mA/A + 0.38 mA	
	(5 to 10) kHz	4.3 mA/A + 0.75 mA	
	(11 to 20.5) A		Fluke 5522A Multiproduct Calibrator
	(45 to 100) Hz	0.1 % of reading + 2 mA	
	100 Hz to 1 kHz	0.12 % of reading + 5 mA	
	(1 Hz to 5) kHz	2.28 % of reading + 5 mA	
AC Current – Generate[1] Clamp Meters Only	(20.5 to 500) A		Fluke 5522A Multiproduct Calibrator /coil
	(45 to 440) Hz	1.6 % of reading + 900 mA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure[1]	Up to 100 µA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz 100 µA to 100 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	 0.6 % of reading + 0.03 pA 0.23 % of reading + 0.03 pA 0.09 % of reading + 0.03 pA 0.61 % of reading + 20 µA 0.23 % of reading + 20 µA 0.09 % of reading + 20 µA 0.05 % of reading + 20 µA 0.09 % of reading + 20 µA 0.61 % of reading + 40 µA 0.84 % of reading + 0.15 mA 0.61 % of reading + 0.2 mA 0.24 % of reading + 0.2 mA 0.12 % of reading + 0.2 mA 0.15 % of reading + 0.2 mA 0.46 % of reading + 0.2 mA 1.5 % of reading + 0.4 mA	HP 3458A Multimeter
Low Frequency Power – Generate[1] (45 to 65) Hz, 0 PF DC	Up to 20 kW	0.44 % of reading 0.13 % of reading	Fluke 5522A Multiproduct Calibrator
Electrical Calibration of Thermocouple Indicators[1]	Type B (600 to 800) °C (800 to 1 550) °C (1 550 to 1 820) °C Type C (0 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 000) °C (2 000 to 2 316) °C Type E (-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 600) °C (600 to 1 000) °C	 0.27 °C 0.22 °C 0.17 °C 0.13 °C 0.18 °C 0.2 °C 0.27 °C 0.19 °C 0.1 °C 0.07 °C 0.07 °C 0.08 °C	Fluke 7526A Process Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators[1]	Type J		Fluke 7526A Process Calibrator
	(-210 to -100) °C	0.11 °C	
	(-100 to 800) °C	0.07 °C	
	(800 to 1 200) °C	0.08 °C	
	Type K		
	(-250 to -200) °C	0.35 °C	
	(-200 to -100) °C	0.13 °C	
	(-100 to 800) °C	0.08 °C	
	(800 to 1 372) °C	0.1 °C	
	Type L		
	(-200 to -100) °C	0.08 °C	
	(-100 to 900) °C	0.07 °C	
	Type N		
	(-250 to -200) °C	0.56 °C	
	(-200 to -100) °C	0.18 °C	
	(-100 to 0) °C	0.1 °C	
	(0 to 100) °C	0.09 °C	
	(100 to 800) °C	0.08 °C	
	(800 to 1 300) °C	0.1 °C	
	Type R		
	(-50 to -25) °C	0.42 °C	
	(-25 to 0) °C	0.34 °C	
	(0 to 100) °C	0.3 °C	
	(100 to 400) °C	0.22 °C	
	(400 to 600) °C	0.17 °C	
	(600 to 1 000) °C	0.16 °C	
	(1 000 to 1 600) °C	0.15 °C	
	(1 600 to 1 767) °C	0.18 °C	
	Type S		
	(50 to -25) °C	0.39 °C	
	(-25 to 0) °C	0.33 °C	
	(0 to 100) °C	0.29 °C	
	(100 to 400) °C	0.22 °C	
	(400 to 600) °C	0.18 °C	
	(600 to 1 600) °C	0.17 °C	
	(1 600 to 1 767) °C	0.2 °C	
	Type T		
	(-250 to -200) °C	0.26 °C	
	(-200 to -100) °C	0.13 °C	
	(-100 to 0) °C	0.09 °C	
	(0 to 400) °C	0.07 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators[1]	Type U (-200 to 0) °C (0 to 600) °C	 0.13 °C 0.08 °C	Fluke 7526A Process Calibrator
Electrical Calibration of RTD Indicating Devices[1]	Pt 385, 100 Ω (-200 to 800) °C Pt 3926, 100 Ω (-200 to 630) °C Pt 3916, 100 Ω (-200 to 630) °C Pt 385, 200 Ω (-200 to 400) °C (400 to 630) °C Pt 385, 500 Ω (-200 to 630) °C Pt 385, 1 000 Ω (-200 to 630) °C	 0.05 °C 0.05 °C 0.05 °C 0.4 °C 0.5 °C 0.17 °C 0.09 °C	Fluke 7526A Process Calibrator
Oscilloscopes Calibration[1] – Generate Voltage DC - 50Ω DC - 1MΩ Square Wave 1 kHz - 50Ω Square Wave 1 kHz - 1MΩ Leveled Sine Flatness 50 kHz to 10 MHz Reference	 (0 to 6.6) V (0 to 130) V 1 mV to 6.6 Vpp 1 mV to 130 Vpp (5 to 20) mVpp 50 kHz to 100) MHz (100 to 300) MHz (300 to 500) MHz (500 to 600) MHz (600 to 16 00) MHz (1 600 to 2 100) MHz 50 mV to 3.5 Vpp 50 kHz to 100 MHz (100 to 300) MHz (300 to 500) MHz (500 to 600) MHz (600 to 16 00) MHz (1 600 to 2 100) MHz	 0.19 % of reading + 31 µV 0.019 % of reading + 19 µV 0.19 % of reading + 31 µV 0.038 % of reading + 4 µV 0.35 dB 0.37 dB 0.43 dB 0.45 dB 0.51 dB 0.56 dB 0.23 dB 0.25 dB 0.31 dB 0.34 dB 0.39 dB 0.45 dB	Fluke 5820A Oscilloscope Calibrator w/ GHz Option

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes Calibration[1] – Generate Leveled Sine Flatness 50 kHz to 10 MHz Reference	(3.5 to 5) Vpp 50 kHz to 100 MHz (100 to 300) MHz (300 to 500) MHz (500 to 600) MHz	 0.23 dB 0.25 dB 0.31 dB 0.34 dB	Fluke 5820A Oscilloscope Calibrator w/ GHz Option
Oscilloscopes Calibration[1] – Generate	50 mV to 3.5Vpp (2 100 to 4 000) MHz (4 000 to 8 000) MHz (8 000 to 18 000) MHz	 0.28 dB 0.4 dB 0.59 dB	EPM Power Meter w/ E Series Power Sensors
Oscilloscopes Calibration[1] – Generate Time Marker Rise Time	 500 ps to 20 ms 50 ms to 5 s < 150 ps	 0.25 µs/s 1.9 µs/s + 3.9 µHz +0 / -50 ps	Fluke 5820A Oscilloscope Calibrator w/ GHz Option
Fundamental AC Voltage – Generate[1]	(15 to 17) V (45 to 65) Hz (0 to 23) V (45 to 65) Hz (16 to 850) Hz (28 to 32) V (45 to 65) Hz (23 to 45) V (45 to 65) Hz (16 to 850) Hz (56 to 64) V (45 to 65) Hz (45 to 90) V (45 to 65) Hz (16 to 850) Hz (110 to 128) V (45 to 65) Hz (90 to 180) V (45 to 65) Hz (16 to 850) Hz (215 to 246) V (45 to 65) Hz	 42 µV/V 42 µV/V + 0.2 mV 60 µV/V + 0.2 mV 42 µV/V 42 µV/V + 0.4 mV 60 µV/V + 0.4 mV 42 µV/V 42 µV/V + 0.8 mV 60 µV/V + 0.8 mV 44 µV/V 44 µV/V + 1.6 mV 60 µV/V + 1.6 mV 44 µV/V	Fluke 6105A Power Quality Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fundamental AC Voltage – Generate[1]	(180 to 360) V (45 to 65) Hz (16 to 850) Hz (425 to 490) V (45 to 65) Hz (360 to 650) V (45 to 65) Hz (16 to 850) Hz (740 to 850) V (45 to 65) Hz (650 to 1 008) V (45 to 65) Hz (16 to 850) Hz	 60 µV/V + 3.2 mV 61 µV/V + 3.2 mV 44 µV/V 60 µV/V + 5.8 mV 61 µV/V + 5.8 mV 44 µV/V 60 µV/V + 10 mV 61 µV/V + 10 mV	Fluke 6105A Power Quality Calibrator
Additive DC Offset Voltage – Generate[1] Additive signal to the Fundamental AC Voltage, up to 50% of range	(0 to 11.5) V (0 to 22.5) V (0 to 45) V (0 to 90) V (0 to 180) V (0 to 325) V (0 to 504) V	91 µV/V + 2 mV 91 µV/V + 4 mV 91 µV/V + 8 mV 91 µV/V + 16 mV 91 µV/V + 32 mV 92 µV/V + 60 mV 92 µV/V + 100 mV	Fluke 6105A Power Quality Calibrator
Additive AC Voltage Harmonics – Generate[1] Additive signal to the Fundamental AC Voltage, up to 30% of range	(0 to 6.9) V (16 to 850) Hz (850 to 6000) Hz (0 to 13.5) V (16 to 850) Hz (850 to 6 000) Hz (0 to 27) V (16 to 850) Hz (850 to 6 000) Hz (0 to 54) V (16 to 850) Hz (850 to 6 000) Hz (0 to 108) V (16 to 850) Hz (850 to 6 000) Hz (0 to 195) V (16 to 850) Hz (850 to 6 000) Hz (0 to 302) V (16 to 850) Hz (850 to 6 000) Hz	 58 µV/V + 1 mV 451 µV/V + 1 mV 58 µV/V + 2 mV 451 µV/V + 2 mV 60 µV/V + 2.2 mV 451 µV/V + 2.2 mV 60 µV/V + 4.4 mV 451 µV/V + 4.4 mV 60 µV/V + 12 mV 451 µV/V + 12 mV 61 µV/V + 22 mV 451 µV/V + 22 mV 61 µV/V + 33 mV 451 µV/V + 33 mV	Fluke 6105A Power Quality Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fundamental AC Current – Generate[1]	Up to 0.25 A (45 to 65) Hz (16 to 850) Hz (0.25 to 0.5) A (45 to 65) Hz (16 to 850) Hz (0. 5 to 1) A (45 to 65) Hz (16 to 850) Hz (1 to 2) A (45 to 65) Hz (16 to 850) Hz (2 to 5) A (45 to 65) Hz (16 to 850) Hz (5 to 10) A (45 to 65) Hz (16 to 850) Hz (10 to 21) A (45 to 65) Hz (16 to 850) Hz (21 to 50) A (45 to 65) Hz (40 to 850) Hz	 46 µA/A + 2.5 µA 60 µA/A + 5 µA 46 µA/A + 5 µA 61 µA/A + 10 µA 47 µA/A + 10 µA 61 µA/A + 20 µA 46 µA/A + 20 µA 61 µA/A + 40 µA 49 µA/A + 50 µA 64 µA/A + 100 µA 49 µA/A + 100 µA 65 µA/A + 200 µA 49 µA/A + 200 µA 69 µA/A + 400 µA 49 µA/A + 500 µA 74 µA/A + 1 mA	Fluke 6105A Power Quality Calibrator
Fundamental AC Current – Generate[1]	(50 to 80) A (40 to 450) Hz (450 to 850) Hz	 106 µA/A + 2.8 mA 118 µA/A + 2.8 mA	Fluke 6105A Power Quality Calibrator
Additive DC Offset Current – Generate[1] Additive signal to the Fundamental AC Current, up to 50% of range	(0 to 0.125) A (0 to 0.25) A (0 to 0.5) A (0 to 1) A (0 to 2.5) A (0 to 5) A (0 to 10) A	89 µA/A + 25 µA 89 µA/A + 50 µA 89 µA/A + 100 µA 89 µA/A + 200 µA 89 µA/A + 500 µA 89 µA/A + 1 mA 90 µA/A + 2 mA	Fluke 6105A Power Quality Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Additive AC Current Harmonics – Generate[1] Additive signal to the Fundamental AC Current, up to 30% of range	Up to 0.075 A (16 to 850) Hz (850 to 6 000) Hz Up to 0.15 A (16 to 850) Hz (850 to 6 000) Hz Up to 0.3 A (16 to 850) Hz (850 to 6 000) Hz Up to 0.6 A (16 to 850) Hz (850 to 6 000) Hz Up to 1.5 A (16 to 850) Hz (850 to 6 000) Hz Up to 3 A (16 to 850) Hz (850 to 6 000) Hz Up to 6 A (16 to 850) Hz (850 to 6 000) Hz Up to 15 A (16 to 850) Hz (850 to 3000) Hz Up to 24 A (16 to 850) Hz (850 to 3 000) Hz	 61 µA/A + 5 µA 400 µA/A + 5 µA 61 µA/A + 10 µA 400 µA/A + 10 µA 61 µA/A + 20 µA 400 µA/A + 20 µA 61 µA/A + 40 µA 400 µA/A + 40 µA 61 µA/A + 100 µA 400 µA/A + 100 µA 64 µA/A + 200 µA 400 µA/A + 200 µA 65 µA/A + 400 µA 400 µA/A + 400 µA 69 µA/A + 1 mA 400 µA/A + 1 mA 112 µA/A + 2 mA 400 µA/A + 2 mA	Fluke 6105A Power Quality Calibrator
Current to Voltage Phase Offsets (regardless of voltage range)	(-180 to +180) ° or (0 to 360) ° Up to 50 A (45 to 65) Hz (16 to 69) Hz (69 to 180) Hz (180 to 450) Hz (450 to 850) Hz (850 to 3 000) Hz (3 000 to 6 000) kHz	 0.002 3 ° 0.003 ° 0.007 ° 0.018 ° 0.033 ° 0.12 ° 0.23 °	Fluke 6105A Power Quality Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Current to Voltage Phase Offsets (regardless of voltage range)	(-180 to +180) ° or (0 to 360) ° Up to 80 A (45 to 65) Hz (16 to 69) Hz (69 to 180) Hz (180 to 450) Hz (450 to 850) Hz (850 to 3 000) Hz	 0.003 ° 0.003 ° 0.008 ° 0.025 ° 0.05 ° 0.25 °	Fluke 6105A Power Quality Calibrator

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation [1]	(10 to 1 300) MHz (-10 to 0) dB (-20 to -11) dB (-30 to -21) dB (-40 to -31) dB (-50 to -41) dB (-60 to -51) dB (-70 to -61) dB (-80 to -71) dB (-90 to -81) dB (-100 to -91) dB (-110 to -101) dB (-120 to -111) dB	 0.057 dB 0.058 dB 0.058 dB 0.059 dB 0.061 dB 0.063 dB 0.065 dB 0.067 dB 0.07 dB 0.077 dB 0.11 dB 0.24 dB	HP 8902A Measuring Receiver, HP 11722A Power Sensor
RF Power[1]	100 kHz to 2.6 GHz (0 to 30) dBm	3.6 % of reading	HP 8902A Measuring Receiver, HP 11722A Power Sensor
Distortion[1]	400 Hz and 1KHz	0.9 % of reading	HP8903A Distortion Analyzer
Amplitude Modulation[1] – Measure 150 kHz to 10 MHz (10 to 1 300) MHz	(5 to 99) % Depth	3.2 % Depth + 1 digit 2 % Depth + 1 digit	HP 8902A Measuring Receiver
Frequency Modulation[1] – Measure 250 kHz to 10 MHz 10 MHz to 26.5 GHz	$\leq$ 400 kHz Deviation	3.3 % Deviation + 1 digit 1.7 % Deviation + 1 digit	HP 8902A Measuring Receiver

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers[1]	Up to 24 in (24 to 80) in	(49 + 4.3*L*) µin (230 + 3.7*L*) µin	Grade 2 gage blocks
Micrometers[1]	Up to 46 in	(19 + 9*L*) µin	
Dial Indicators[1,2] Resolution: ≥ 50µin < 50µin	 Up to 10 in Up to 0.1 in	 (27 + 3.3*L*) µin 7 µin	
Feeler Gages[1]	Up to 1 in	52 µin	Micrometer
Height Gages[1]	Up to 46 in	(137 + 2.2*L*) µin	Grade 2 gage blocks
Protractors	(0 to 360) º	0.013 º	Angle blocks
Surface Plates [1] – Overall Flatness Local Area Flatness	 Up to 6 ft × 6 ft (-0.001 to 0.001) in	 47 µin 44 µin	 Leveling system Repeat-o-Meter
Cylindrical Gages[1] – Plain Pin, Plug Gages Ring Gages	 (0 to 13) in (0 to 14) in	 (2.3*D* + 5) µin (2.2*D* + 5.7) µin	Universal measuring machine, gage blocks (Grade 1)
Coating Thickness Gages[1] – Eddy Current & Magnetic Induction, Fixed Point Coating Thickness Shims[1,3]	 (0.737 to 100) mils (100 to 243) mils Up to 243 mils	 53 µin 280 µin 98 µin	 Coating thickness standards Micrometer
Metal Tapes and Rules[1]	Up to 100 ft	(0.023 + 0.000 27*L*) in	Standard rule
Gage Blocks	(0 to 10) in	(2.3 + 2.9*L*) µin	Universal measuring machine, master gage block set
Thread Plugs – Major Diameter Pitch Diameter	 Up to 12 in (6 to 72) TPI	 46 µin 92 µin	 Gage Blocks, P&W Model C Bench Micrometer, Van Keuren thread wire set
Adjustable Thread Rings[3] Pitch Diameter (Tactile Fit)	Up to 12 in	(350 + 47*D*) µin	Thread Setting Plug Gages

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radius Gages	(0.01 to 1) in	340 µin	Optical comparator
Micrometer Standards Length Rods	(1 to 10) in	(21 + 2.2*L*) µin	Gage blocks (grade 2), P&W Model C Bench Micrometer

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances [1,4]	(1 to 500) mg 500 mg to 200 g (200 to 300) g 300 g to 3 kg	0.01 mg 10 mg 19 mg 47 mg	Class 1 weights
Scales & Balances [1,4]	(3 to 18) kg (18 to 30) kg	0.65 g 2.5 g	Class F weights & Class 2 weights
	(1 to 1 550) lb	0.01 % of reading	Class F weights
Torque Wrenches[1]	5 lbf·in to 1 000) lbf·ft	0.31 % of reading	CDI torque system
Torque Analyzers	Up to 1 000 lbf·ft	0.06 % of reading	Class F weights, torque arm
Pressure Gauges	(0 to 12) inH2O	0.002 5 inH2O	Dwyer 1425-25 Hook Gage
Pressure Gauges[1]	(-15 to 100) psi (10 to 500) psi (500 to 5 000) psi (0 to 10 000) psi	0.08 psi 0.019 % reading 0.022 % reading 3 psi	Digital gage Dead weight tester Additel 681
Force Gages, Load Cells & Dynamometers Tension/Compression	10 mg to 10 kg (20 to 500) lb	0.028 % of reading 0.024 % of reading	Class F weights
Rockwell Hardness Testers [1]	(20 to 65) HRA (70 to 78) HRA (80 to 84) HRA (40 to 59) HRBW (60 to 79) HRBW (80 to 100) HRBW	0.62 HRA 0.58 HRA 0.41 HRA 0.84 HRBW 0.79 HRBW 0.68 HRBW	Indirect Verification per ASTM E18-17e1

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers [1]	(20 to 30) HRC (35 to 55) HRC (56 to 65) HRC	0.57 HRC 0.5 HRC 0.44 HRC	Indirect Verification per ASTM E18-17e1
Mass - Fixed Points Metric	(1, 2, 5, 10, 20) mg (50, 100, 200, 500) mg (1, 2, 5) g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg 25 kg	1.2 µg 1.2 µg 5 µg 8 µg 10 µg 21 µg 42 µg 62 µg 0.2 mg 0.33 mg 0.62 mg 2.4 mg 3.3 mg 6.2 mg 8.1 mg	ASTM E617 Class 0 Weights OIML Class E2 Weights Precision Mass Comparators Balances
Mass - Fixed Points Avoirdupois	(0.001, 0.002) lb (0.005, 0.01) lb 0.02 lb 0.05 lb 0.1 lb 0.2 lb (0.5, 1) lb 2 lb 5 lb 10 lb 25 lb 50 lb	2.1 µg 6 µg 8.1 µg 16 µg 20 µg 38 µg 0.26 mg 0.34 mg 1 mg 2.3 mg 4.2 mg 14 mg	Comparison to ASTM E617 Class 1 weights Precision Mass Comparators Balances

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Durometers Scale (Force) Accuracy Types A, B, C, D, DO, M, O, OO	(0 to 100) duros	0.02 duros	Direct Verification Master balance
Indenter Geometry Length Diameter Angle	 0.1 in 0.05 in (30 to 35) °	 612 µin 612 µin 0.03 °	 Optical comparator

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gloss Meters[1]	20°, 60°, 85° (0 to 100) GU	0.71 GU	Gloss standards

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure	(-196 to 420) ºC	0.044 ºC	Hart 1502 Indicator, Burns Engineering 12005 PRT
Infrared (IR) Thermometry[1]	(20 to 100) ºC (100 to 300) ºC (300 to 500) ºC	0.59 ºC 0.76 ºC 0.93 ºC	Fluke 9132 Infrared Calibrator λ = (8 to 14) µm, Ɛ = 0.95
Humidity – Measure[1]	(10 to 90) %RH	1.4 %RH	Vaisala MI70 Indicator and HMP77B Probe
Relative Humidity[1] – Measuring Equipment	(10 to 95) %RH	0.5 %RH	Thunder Scientific 2500 Humidity Chamber

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Fixed	10 MHz	1×10^{-11} Hz/Hz	Agilent 58503A GPS Receiver
Frequency – Measure[1]	500 MHz	6.5×10^{-6} Hz/Hz	HP 53131A Counter
Timer, Stopwatch[1]	10 s to 24 hrs	34 ms	Totalize method with counter

DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length	X Axis (0.01 to 8) in Y Axis (0.01 to 4) in	612 µin 602 µin	Optical comparator

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle	Up to 360 °	0.03 °	Optical comparator

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, D = diameter in inches, R = resolution of the device under test, t = time in seconds.
3. The tactile fit of an adjustable thread ring to a thread-setting plug is not a measurement of pitch diameter. The uncertainty for this pitch diameter setting is based on the contributors associated with the thread setting plug and environmental contributors only.
4. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The uncertainties presented here do not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
5. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2080.05.

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