



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

McHale & Associates, Inc.
4700 Coster Road
Knoxville, TN 37912

Fulfills the requirements of

ISO/IEC 17025:2017

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.

A handwritten signature in black ink, appearing to read 'R. Douglas Leonard Jr.', is positioned above a horizontal line.

R. Douglas Leonard Jr., VP, PILR SBU
Expiry Date: 17 September 2022
Certificate Number: AC-2909



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

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CALIBRATION

Valid to: **September 17, 2022**

Certificate Number: **AC-2909**

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	Up to 330 mV (0.33 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	0.016 μ V/mV + 0.8 μ V 0.009 mV/V + 1.9 μ V 0.01 mV/V + 0.019 V 0.014 mV/V + 0.16 V 0.014 mV/V + 1.6 V	Fluke 5520A Multi-Product Calibrator
DC Current – Source ¹	Up to 330 μ A (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (0.33 to 1.1) A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	0.11 nA/ μ A + 0.019 nA 0.078 μ A/mA + 0.012 mA 0.078 μ A/mA + 0.12 mA 0.08 μ A/mA + 1.2 mA 0.16 mA/A + 0.012 A 0.3 mA/A + 0.012 A 0.39 mA/A + 0.12 A 0.78 mA/A + 0.12 A	Fluke 5520A Multi-Product Calibrator
DC Current – Source ¹	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	2.5 μ A/mA + 58 mA 3.3 mA/A + 5.8 A 2.6 mA/A + 5.8 A	Fluke 5520A Multi-Product Calibrator with 50-turn Coil

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	Up to 11Ω	0.033 mΩ/Ω + 0.8 mΩ	Fluke 5520A Multi-Product Calibrator
	(11 to 33) Ω	0.024 mΩ/Ω + 1.2 mΩ	
	(33 to 110) Ω	0.022 mΩ/Ω + 1.1 mΩ	
	(110 to 330) Ω	0.022 mΩ/Ω + 1.6 mΩ	
	(0.33 to 1.1) kΩ	0.022 mΩ/Ω + 0.19 mΩ	
	(1.1 to 3.3) kΩ	0.022 mΩ/Ω + 0.016 Ω	
	(3.3 to 11) kΩ	0.022 mΩ/Ω + 0.019 Ω	
	(11 to 33) kΩ	0.022 mΩ/Ω + 0.16 Ω	
	(33 to 110) kΩ	0.022 mΩ/Ω + 0.19 Ω	
	(110 to 330) kΩ	0.025 mΩ/Ω + 1.6 Ω	
	(0.33 to 1.1) MΩ	0.025 mΩ/Ω + 1.9 Ω	
	(1.1 to 3.3) MΩ	0.047 mΩ/Ω + 23 Ω	
	(3.3 to 11) MΩ	0.1 mΩ/Ω + 40 Ω	
	(11 to 33) MΩ	0.19 mΩ/Ω + 1.9 kΩ	
	(33 to 110) MΩ	0.39 mΩ/Ω + 2.3 kΩ	
(110 to 330) MΩ	2.3 mΩ/Ω + 78 kΩ		
(330 to 1 100) MΩ	12 mΩ/Ω + 3878 kΩ		
AC Voltage – Source ¹	(1 to 33) mV		Fluke 5520A Multi-Product Calibrator
	(10 to 45) Hz	0.62 μV/mV + 4.8 μV	
	45 Hz to 10 kHz	0.12 μV/mV + 4.8 μV	
	(10 to 20) kHz	0.16 μV/mV + 4.8 μV	
	(20 to 50) kHz	0.78 μV/mV + 4.8 μV	
	(50 to 100) kHz	2.7 μV/mV + 9.4 μV	
	(100 to 500) kHz	6.2 μV/mV + 0.039 mV	
	(33 to 330) mV		
	(10 to 45) Hz	0.23 μV/mV + 0.63 μV	
	45 Hz to 10 kHz	0.1 μV/mV + 6.3 μV	
	(10 to 20) kHz	0.12 μV/mV + 6.3 μV	
	(20 to 50) kHz	0.27 μV/mV + 6.3 μV	
	(50 to 100) kHz	0.62 μV/mV + 0.025 mV	
	(100 to 500) kHz	1.6 μV/mV + 0.054 mV	
	(0.33 to 3.3) V		
	(10 to 45) Hz	0.27 mV/V	
	45 Hz to 10 kHz	0.12 mV/V	
	(10 to 20) kHz	0.15 mV/V	
(20 to 50) kHz	0.24 mV/V		
(50 to 100) kHz	0.55 mV/V + 0.1 mV		
(100 to 500) kHz	1.9 mV/V + 0.5 mV		

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 Multi-Product Calibrator
	(10 to 45) Hz	0.27 mV/V + .05 mV	
	45 Hz to 10 kHz	0.12 mV/V + 0.5 mV	
	(10 to 20) kHz	0.19 mV/V + 0.5 mV	
	(20 to 50) kHz	0.27 mV/V + 0.5 mV	
	(50 to 100) kHz	0.7 mV/V + 1.2 mV	
	(33 to 330) V		
	(10 to 45) Hz	0.39 mV/V + 1.9 mV	
	45 Hz to 10 kHz	0.16 mV/V + 4.8 mV	
	(10 to 20) kHz	0.2 mV/V + 4.8 mV	
	(20 to 50) kHz	0.24 mV/V + 4.8 mV	
	(50 to 100) kHz	1.6 mV/V + 0.039 V	
	(330 to 1 020) V		
	45 Hz to 1 kHz	0.24 mV/V + 0.014 V	
	(1 to 5) kHz	0.2 mV/V + 0.014 V	
(5 to 10) kHz	0.24 mV/V + 0.014 V		
AC Current – Source ¹	Up to 330 μ A		Fluke 5520A Multi-Product Calibrator
	(10 to 20) Hz	1.6 nA/ μ A + 0.078 μ A	
	(20 to 45) Hz	1.18 nA/ μ A + 0.078 μ A	
	45 Hz to 1 kHz	0.98 nA/ μ A + 0.078 μ A	
	(1 to 5) kHz	2.3 nA/ μ A + 0.12 μ A	
	(5 to 10) kHz	6.2 nA/ μ A + 0.16 μ A	
	(10 to 30) kHz	12 nA/ μ A + 0.31 μ A	
	(0.33 to 3.3) mA		
	(10 to 20) Hz	1.6 μ A/mA + 0.1 μ A	
	(20 to 45) Hz	0.98 μ A/mA + 0.1 μ A	
	45 Hz to 1 kHz	0.78 μ A/mA + 0.1 μ A	
	(1 to 5) kHz	1.6 μ A/mA + 0.2 μ A	
	(5 to 10) kHz	4 μ A/mA + 0.2 μ A	
	(10 to 30) kHz	7.8 μ A/mA + 0.5 μ A	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(3.3 to 33) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10 kHz (10 to 30) kHz	1.4 μA/mA + 1.6 μA 0.71 μA/mA + 1.6 μA 0.34 μA/mA + 1.6 μA 0.64 μA/mA + 1.6 μA 1.6 μA/mA + 2.3 μA 3.2 μA/mA + 3.1 μA	Fluke 5520A Multi-Product Calibrator
	(33 to 330) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10 kHz (10 to 30) kHz	1.4 μA/mA + 0.016 mA 0.71 μA/mA + 0.016 mA 0.33 μA/mA + 0.016 mA 0.79 μA/mA + 0.039 mA 1.6 μA/mA + 0.078 mA 3.2 μA/mA + 0.16 mA	
AC Current – Source ¹	(0.33 to 1.1) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	1.4 mA/A + 0.1 mA 0.4 mA/A + 0.1 mA 4.7 mA/A + 0.8 mA 19 mA/A + 3.9 mA	Fluke 5520A Multi-Product Calibrator
	(1.1 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	1.4 mA/A + 0.1 mA 0.55 mA/A + 0.1 mA 4.7 mA/A + 0.8 mA 19 mA/A + 3.9 mA	
	(3 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.52 mA/A + 1.6 mA 0.81 mA/A + 1.6 mA 23 mA/A + 1.6 mA	
AC Current – Source ¹	(11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.96 mA/A + .39 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	Fluke 5520A Multi-Product Calibrator with 50-turn Coil
	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz	2.8 μA/mA + 0.78 mA 7.9 μA/mA + 0.78 mA	
AC Current – Source ¹	(16.5 to 150) A (45 to 65) Hz (65 to 440) Hz	14 mA/A + 0.027 A 16 mA/A + 0.027 A	Fluke 5520A Multi-Product Calibrator with 50-turn Coil
	(150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.6 mA/A + 0.21 A 8.2 mA/A + 0.22 A	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹	(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 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	6 mF/F 4.3 mF/F 4 mF/F 2 mF/F 1.9 mF/F 2 mF/F 2.1 mF/F 2 mF/F 2 mF/F 2.1 mF/F 3.2 mF/F 3.7 mF/F 3.7 mF/F 12 mF/F 3.5 mF/F 3.5 mF/F 5.8 mF/F 8.5 mF/F + 0.1 mF	Fluke 5520A Multi-Product Calibrator
Electrical Simulation of Thermocouple Indicating Instruments – 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	0.34 °C 0.26 °C 0.23 °C 0.26 °C 0.23 °C 0.2 °C 0.24 °C 0.39 °C 0.65 °C 0.39 °C 0.12 °C 0.11 °C 0.12 °C 0.16 °C 0.21 °C 0.12 °C 0.11 °C 0.13 °C 0.18 °C	Fluke 5520A Multi-Product Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Instruments – Source ¹	Type K		Fluke 5520A Multi-Product Calibrator
	(-200 to -100) °C	0.26 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 120) °C	0.12 °C	
	(120 to 1 000) °C	0.2 °C	
	(1 000 to 1 372) °C	0.31 °C	
	Type L		
	(-200 to -100) °C	0.29 °C	
	(-100 to 800) °C	0.2 °C	
	(800 to 900) °C	0.13 °C	
	Type N		
	(-200 to -100) °C	0.31 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 120) °C	0.15 °C	
	(120 to 410) °C	0.14 °C	
	(410 to 1 300) °C	0.21 °C	
	Type R		
	(0 to 250) °C	0.44 °C	
	(250 to 400) °C	0.27 °C	
	(400 to 1 000) °C	0.26 °C	
(1 000 to 1 767) °C	0.31 °C		
Type S			
(0 to 200) °C	0.36 °C		
(200 to 1 000) °C	0.28 °C		
(1 000 to 1 400) °C	0.29 °C		
(1 400 to 1 767) °C	0.36 °C		
Type T			
(-250 to -150) °C	0.49 °C		
(-150 to 0) °C	0.19 °C		
(0 to 120) °C	0.12 °C		
(120 to 400) °C	0.11 °C		
Type U			
(-200 to 0) °C	0.43 °C		
(0 to 600) °C	0.21 °C		
Electrical Simulation of RTD Indicating Instruments – Source ¹	Pt 385 100 Ω		Fluke 5520A Multi-Product Calibrator
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.055 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.094 °C	
	(630 to 800) °C	0.18 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Instruments – Source ¹	Pt 3926 100 Ω		Fluke 5520A Multi-Product Calibrator
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.056 °C	
	(100 to 300) °C	0.071 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.094 °C	
	Pt 3916 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.033 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.048 °C	
	(100 to 260) °C	0.056 °C	
	(260 to 300) °C	0.063 °C	
	Pt 3916 300 Ω		
	(0 to 400) °C	0.071 °C	
	Pt 3916 400 Ω		
	(0 to 600) °C	0.078 °C	
	Pt 3916 600 Ω		
	(600 to 630) °C	0.18 °C	
	Pt 385 200 Ω		
	(-200 to -80) °C	0.033 °C	
	(-80 to 0) °C	0.033 °C	
	(0 to 100) °C	0.033 °C	
	(100 to 260) °C	0.4 °C	
	(260 to 300) °C	0.94 °C	
	(300 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385 500 Ω		
(-200 to -80) °C	0.033 °C		
(-80 to 0) °C	0.04 °C		
(0 to 100) °C	0.04 °C		
(100 to 260) °C	0.048 °C		
(260 to 300) °C	0.063 °C		
(300 to 400) °C	0.063 °C		
(400 to 600) °C	0.071 °C		
(600 to 630) °C	0.086 °C		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Instruments – Source ¹	Pt 385 1 000 Ω		Fluke 5520A Multi-Product Calibrator
	(-200 to -80) °C	0.026 °C	
	(-80 to 0) °C	0.026 °C	
	(0 to 100) °C	0.033 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.048 °C	
	(300 to 400) °C	0.056 °C	
	(400 to 600) °C	0.056 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385 120 Ω		
	(-80 to 0) °C	0.063 °C	
	(0 to 100) °C	0.063 °C	
(100 to 260) °C	0.11 °C		
Cu 427 10 Ω			
(-100 to 260) °C	0.23 °C		
DC Power Source ¹	33mV to 1 020 V		Fluke 5520A Multi-Product Calibrator
	(0.33 to 330) mA	179 mW/W	
	330 mA to 3 A	170 mW/W	
	(3 to 20.5) A	54 mW/W	
AC Power- Source ¹	(33 to 330) mV		Fluke 5520A Multi-Product Calibrator
	(3.3 to 9) mA	3.5 mW/W	
	(9 to 33) mA	1.2 mW/W	
	(33 to 90) mA	1.8 mW/W	
	(90 to 330) mA	0.87 mW/W	
	(330 to 900) mA	0.99 mW/W + 0.0012 W	
	900 mA to 2.2 A	0.63 mW/W + 0.012 W	
	(2.2 to 4.5) A	0.93 mW/W + 0.012 W	
	(4.5 to 20.5) A	0.62 W/W + 0.12 W	
	330 mV to 1 020 V		
	(3.3 to 9) mA	1.1 mW/W	
	(9 to 33) mA	1.4 mW/W + 0.0001 W	
	(33 to 90) mA	2 mW/W + 0.0001 W	
	(90 to 330) mA	11 mW/W + 0.0012 W	
	(330 to 900) mA	0.85 mW/W + 0.12 W	
	900 mA to 2.2 A	0.7 mW/W + 1.2 W	
	(2.2 to 4.5) A	0.93 mW/W + 1.2 W	
	(4.5 to 20.5) A	0.78 mW/W + 1.2 W	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ¹	Up to 8 in (8 to 24) in (24 to 40) in	74 μin 450 μin 510 μin	Gage Blocks
Depth Micrometer ¹	Up to 8 in (8 to 12) in (12 to 24) in (24 to 40) in	77 μin 100 μin 450 μin 870 μin	Gage Blocks Surface Plate
Height Gage ¹	Up to 24 in (24 to 40) in	190 μin 310 μin	Gage Blocks Surface Plate
Indicators ¹	Up to 6 in	63 μin	Gage Blocks Surface Plate
Micrometer, OD ¹	Up to 1 in (1 to 6) in (6 to 12) in (12 to 24) in (24 to 40) in	42 μin 62 μin 98 μin 200 μin 310 μin	Gage Blocks
Optical Comparators ¹ Linearity Magnification	Up to 12 in 10x to 200x	140 μin 590 μin	Glass Scale, Reticle

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Measuring Instruments ¹	(0.025 to 64) inH ₂ O	0.02 % of reading	Pressurements V1600 Deadweight Tester
	(0.1 to 30) psia (15 to 1 000) psi	0.008 7 % of reading 0.008 3 % of reading	DHI A200Kp, A700Kp, A7Mp Pressure Controller
	9.5 to 500 psi (150 to 5000) psi	0.016 % of reading 0.015 % of reading	Pressurements M2000/3 Deadweight Tester
	(-30 to 30) inH ₂ O (-13.5 to 35) psi	0.044 inH ₂ O 0.013 psi	Additel ADT760 Pressure Calibrator
	(-13.5 to 300) psi (-12.5 to 1 000) psi	0.057 psi 0.23 psi	Additel ADT761 Pressure Calibrator

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-40 to 0) °C (0 to 420) °C (420 to 660) °C	0.0097 °C 0.026 °C 0.033 °C	Hart 5628 SPRT Hart 1502A Indicator
Temperature – Source	(-34.4 to 93) °C	0.017 °C	Hart 5699 SPRT Fluke 8505A Multimeter Hart 1529 Indicator Liquid Bath
	(50 to 660) °C	0.066 °C	Hart 5699 SPRT Fluke 8505A Multimeter Hart 1529 Indicator Dry Well Calibrator
Thermocouple Probes	(-34.4 to 93) °C	0.47 °C	Hart 5699 SPRT Fluke 8505A Multimeter Hart 1529 Indicator Liquid Bath
	(50 to 660) °C	0.47 °C	Hart 5699 SPRT Fluke 8505A Multimeter Hart 1529 Indicator Dry Well Calibrator
Temperature Uniformity Surveys ¹	(-34.4 to 93) °C	0.24 °C	RTD, IDEAS Data Logging System
	(50 to 660) °C	0.81 °C	Thermocouples, IDEAS Data Logging System

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. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2909.



R. Douglas Leonard Jr., VP, PILR SBU