CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Rothe Development, Inc. Metrology Services Division
229 Sandhill Street
Webster, Texas 77598

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 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.

Jason Stine, Vice President

Expiry Date: 11 March 2027

Certificate Number: AC-1440

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

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

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CALIBRATION

Valid to: **March 11, 2027** Certificate Number: **AC-1440**

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	Up to 120 mV 120 mV to 1.2 V (1.2 to 12) V (12 to 120) V 120 V to 1020 V	9.7 µV/V + .83 µV 6.6 µV/V + 1µV 6.7 µV/V + 10 µV 9.1 µV/V + 0.11 mV 9.3 µV/V + 1.0 mV	Comparison to Fluke 5560A SC2100 Multifunction Calibrator
DC Voltage – Measure [1]	(10 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100V to 1 kV	10.0 µV/V + 0.36 µV 9.1 µV/V + 0.45 µV 9.1 µV/V + 1.1 µV 11.0 µV/V + 48 µV 11.0 µV/V + 0.59 mV	Comparison to HP 3458A Multimeter
	(1 to 15) kV	1.2 mV/V + 1.2 mV	Comparison to Ross VD15 Divider with HP 3458A Multimeter
	Up to 150 kV	6.4 mV/V + 19 V	Comparison to Ross VD150 Divider with HP 3458A Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1]	Up to 120 µA 120 µA to 1.2 mA (1.2 to 12) mA (12 to 120) mA 120 mA to 1.2A (1.2 to 3.1) A (3.1 to 12) A (12 to 30.2) A	2 µA/A + 31 pA 0.84 nA/A + 0.67 pA 0.73 µA/A + 4.1 nA 0.83 µA/A + 62nA 0.13 mA/A + 10 µA 0.24 mA/A + 0.15mA 0.24 mA/A + 0.25 mA 0.8 mA/A + 0.50 mA	Comparison to Fluke 5560A SC2100 Multifunction Calibrator
DC Current – Source [1]	(25 to 120) A	80 µA/A + 4.8 mA	Comparison to 52120A Transconductance Amplifier
DC Current – Source [1]	20 A to 1 kA	1.5 mA/A + 0.67 A	Comparison to Fluke 5560A SC2100 Multifunction Calibrator with 5500A Coil
DC Current – Measure [1]	(10 to 100) nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	1.8 mA/A + 0.58 nA 0.17 mA/A + 0.58 nA 32 µA/A + 0.59 nA 30 µA/A + 1.1 nA 46 µA/A + 82 nA 0.13 mA/A + 0.13 µA 0.13 mA/A + 1.3 µA 0.14 mA/A + 13 µA	Comparison to HP 3458A Multimeter
DC Current – Measure [1]	10 µA 100 µA 1 mA 10 mA 100 mA 1 A 10 A 30 A 100 A 200 A	1.2 nA 12 nA 0.12 µA 1.2 µA 12 µA 0.12 mA 1.2 mA 3.5 mA 58 mA 0.12 A	Comparison to HP 3458A Multimeter with Guildline Shunts

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	Up to 12 mV		Comparison to Fluke 5560A SC2100 Multifunction Calibrator
	(10 to 45) Hz	0.12 µV/V + 6.1 µV	
	45 to 10 kHz	0.12 µV/V + 6 µV	
	(10 to 20) kHz	0.12 µV/V + 6 µV	
	(20 to 50) kHz	0.30 µV/V + 6 µV	
	(50 to 100) kHz	1.2 µV/V + 15 µV	
	(100 to 500) kHz	6.4 µV/V + 30 µV	
	(12 to 120) mV		
	(10 to 45) Hz	0.15 mV/V + 6 µV	
	45 to 10 kHz	0.11mV/V + 6 µV	
	(10 to 20) kHz	0.12mV/V + 6 µV	
	(20 to 50) kHz	0.28 mV/V + 8 µV	
	(50 to 100) kHz	0.64 mV/V + 20 µV	
	(100 to 500) kHz	1.6 mV/V + 30 µV	
	120 mV to 1.2 V		
	(10 to 45) Hz	0.15 mV/V + 58 µV	
	45 to 10 kHz	0.11 mV/V + 8.3 µV	
	(10 to 20) kHz	0.11 mV/V + 8.2 µV	
	(20 to 50) kHz	0.24 mV/V + 14 µV	
	(50 to 100) kHz	0.56 mV/V + 40 µV	
	(100 to 500) kHz	1.5 mV/V + 80 µV	
	(1.2 to 12) V		
	(10 to 45) Hz	0.12 mV/V + 0.38 mV	
	45 to 10 kHz	0.11 mV/V + 53 µV	
	(10 to 20) kHz	0.11 mV/V + 52 µV	
	(20 to 50) kHz	0.24 mV/V + 50 µV	
	(50 to 100) kHz	0.56 mV/V + 0.12 mV	
	(100 to 500) kHz	1.6 mV/V + 0.6 mV	
	(12 to 120) V		
	(10 to 45) Hz	0.13 mV/V + 3.4 mV	
	45 to 10 kHz	0.11 mV/V + 52 µV	
	(10 to 20) kHz	0.11 mV/V + 52 µV	
	(20 to 50) kHz	0.24 mV/V + 53 µV	
	(50 to 100) kHz	0.24 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]	(120 V to 330) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (330 V to 1.02kV) (10 to 45) Hz (45 Hz to 1 kHz) (1 to 10kHz)	 0.15 mV/V + 6.2mV 0.11 mV/V + 8.1 mV 0.11 mV/V + 8.1 mV 0.24 mV/V + 8.1 mV 1.2 mV/V + 13mV 0.34mV/V + 5.7 mV 0.22 mV/V + 45 mV 0.23 mV/V + 43 mV	Comparison to Fluke 5560A SC2100 Multifunction Calibrator
AC Voltage – Measure [1]	(1 to 10) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1MHz (1 to 4) MHz (4 to 8) MHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz	 0.37 mV/V + 3.5 µV 0.27 mV/V + 1.3 µV 0.36 mV/V + 1.3 µV 1.2 mV/V + 1.3 µV 5.8 mV/V + 1.3 µV 40 mV/V + 2.3 µV 14 mV/V + 5.8 µV 81 mV/V + 1.2 µV 0.23 V/V + 9.2 µV 86 µV/V + 4.7 µV 95 µV/V + 2.4 µV 0.17 mV/V + 2.4 µV 0.35 mV/V + 2.4 µV 0.93 mV/V + 2.4 µV 3.5 mV/V + 12 µV 12 mV/V + 12 µV 17 mV/V + 12 µV 46 mV/V + 81 µV 46 mV/V + 92 µV 0.17 V/V + 0.1 mV	Comparison to HP 3458A Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	100 mV to 1 V		Comparison to HP 3458A Multimeter
	(1 to 40) Hz	86 µV/V + 47 µV	
	40 Hz to 1 kHz	91 µV/V + 24 µV	
	(1 to 20) kHz	0.17 mV/V + 24 µV	
	(20 to 50) kHz	0.35 mV/V + 24 µV	
	(50 to 100) kHz	0.93 mV/V + 24 µV	
	(100 to 300) kHz	3.5 mV/V + 0.12 mV	
	300 kHz to 1 MHz	12 mV/V + 0.12mV	
	(1 to 2) MHz	17 mV/V + 0.12 mV	
	(2 to 4) MHz	46 mV/V + 0.81 mV	
	(4 to 8) MHz	46 mV/V + 0.92 mV	
	(8 to 10) MHz	0.17 V/V + 1.2 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.11 mV/V + 0.47 mV	
	40 Hz to 1 kHz	0.11 mV/V + 0.24 mV	
	(1 to 20) kHz	0.18 mV/V + 0.24 mV	
	(20 to 50) kHz	0.35 mV/V + 0.24 mV	
	(50 to 100) kHz	0.93 mV/V + 0.24 mV	
	(100 to 300) kHz	3.5 mV/V + 1.2 mV	
	300 kHz to 1 MHz	12 mV/V + 1.2 mV	
	(1 to 2) MHz	17 mV/V + 1.2 mV	
	(2 to 4) MHz	46 mV/V + 8.1 mV	
	(4 to 8) MHz	46 mV/V + 9.2 mV	
	(8 to 10) MHz	0.17 V/V + 12 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.23 mV /V + 4.7 mV	
	40Hz to 1 kHz	0.25 mV /V + 2.4 mV	
	(1 to 20) kHz	0.25 mV /V + 2.4 mV	
	(20 to 50) kHz	0.41 mV/V + 2.4 mV	
	(50 to 100) kHz	1.4 mV/V + 2.4 mV	
	(100 to 300) kHz	4.6 mV/V + 12 mV	
	300 kHz to 1 MHz	0.2 V/V + 12 mV	
	(100 to 700) V		
	(1 to 40) Hz	0.46 mV V/V + 47 mV	
	40 Hz to 1 kHz	0.46 mV /V + 24 mV	
	(1 to 20) kHz	0.88 mV V + 24 mV	
	(20 to 50) kHz	1.4 mV/V + 24 mV	
	(50 to 100) kHz	3.5 mV/V + 24 mV	
AC Voltage – Measure [1]	(1 to 15) kV @ 60 Hz	5.9 mV/V + 4.9 mV	Comparison to Ross VD15 Divider with HP 3458A Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	Up to 100 kV @ 60 Hz	9.5 mV/V + 2.6 V	Comparison to Ross VD150 Divider with HP 3458A Multimeter
AC Current – Source [1]	(Up to 120) µA (3 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz 120 µA to 1.2 mA (3 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (1.2 to 12) mA (3 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (12 to 120) mA (3 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz 120 mA to 1.2 A (3 to 20) Hz (20 Hz to 45) Hz (45 Hz to 1kHz) (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	 0.22 mA/A + 0.05 µA 1.2 µA/A + 1.3 nA 5.3 µA/A + 1.2 nA 4.5 µA/A + 1.3 nA 0.78 µA/A + 1.4 nA 0.55 µA/A + 1.4 nA 11 nA/A + 5.3 nA 1.5 µA/A + 2.1 nA 1.6 µA/A + 2.1 nA 2 µA/A + 1.7 nA 0.87 µA/A + 2.2 nA 4.8 µA/A + 5.3 nA 5.6 µA/A + 95 nA 4.4 µA/A + 20 nA 0.93 µA/A + 17 nA 1.3 µA/A + 27nA 1 µA/A + 12 nA 3.4 µA/A + 23 nA 6.9 µA/A + 0.42 µA 0.48 µA/A + 0.23 µA 12 nA/A + 0.16 µA 0.78 nA/A + 0.35 µA 0.4 µA/A + 0.27 µA 5.3 µA/A + 0.19 µA 0.21 µA/A + 0.1 µA 0.2 µA/A + 0.05 µA 0.2 µA/A + 0.05 µA 0.2 µA/A + 0.08 µA 2 µA/A + 0.3 µA 4 µA/A + 0.3 µA	Comparison to Fluke 5560A SC2100 Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	(1.2 to 3.1) A (10 to 45) Hz 45Hz to 1kHz (1 to 5) kHz (5 to 10) kHz (3 to 11) A (40 to 100) Hz 100 Hz to 1kHz (1 to 5) kHz (11 to 20.5) A (40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	 1.4 mA/A + 0.12 mA 0.47 mA/A + 0.12 mA 4.7 mA/A + 1.2 mA 19 mA/A + 5.8 mA 0.47 mA/A + 2.3 mA 0.78 mA/A + 5.8 mA 23 mA/A + 5.8 mA 0.93 mA/A + 2.3 mA 1.2 mA/A + 5.8 mA 23 mA/A + 5.8 mA	Comparison to Fluke 5560A SC2100 Multifunction Calibrator
AC Current – Source [1]	(20 to 200) A 60 Hz	6.56 mA/A	Comparison to Fluke 5520A SC1100 Multifunction Calibrator with Fluke 9100-200 Coil
AC Current – Source [1]	(25 to 120) A 60 Hz 400 Hz	 13 mA/A + 19 mA 0.78 mA/A + 94 mA	Comparison to 52120A Transconductance Amplifier
AC Current – Source [1]	(20 to 50) A (45 to 65) Hz (65 to 440) Hz (50 to 150) A (45 to 65) Hz (65 to 440) Hz	 3.3 mA/A + 30 mA 8.4 mA/A + 32 mA 3.4 mA/A + 30 mA 8.5 mA/A + 32 mA	Comparison to Fluke 5520A SC1100 Multifunction Calibrator with 5500 Coil
AC Current – Source [1]	(150 to 500) A (45 to 65) Hz (65 to 440) Hz	 3.4 mA/A + 0.19 A 8.9 mA/A + 0.2 A	Comparison to Fluke 5520A SC1100 Multifunction Calibrator with 5500 Coil
AC Current – Source [1]	(500 to 1 000) A (45 to 65) Hz (65 to 440) Hz	 4 mA/A + 0.28 A 9.4 mA/A + 0.35 A	Comparison to Fluke 5520A SC1100 Multifunction Calibrator with 5500 Coil
AC Current – Source [1]	(500 to 3 000) A 60 Hz 400 Hz	 7.3 mA/A + 0.56 mA 7.3 mA/A + 0.5 mA	Comparison to 52120A Transconductance Amplifier with 25 turn Coil
AC Current – Source [1]	(3 000 to 6 000) A 60 Hz 400 Hz	 7.5 mA/A + 780 mA 7.5 mA/A + 780 mA	Comparison to 52120A Transconductance Amplifier with 50 turn Coil

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure [1]	(5 to 100) µA		Comparison to HP 3458A Multimeter
	(10 to 20) Hz	4.6 mA/A + 35 nA	
	(20 to 45) Hz	1.7 mA/A + 35 nA	
	(45 to 100) Hz	1.2 mA/A + 35 nA	
	100 Hz to 5 kHz	1.2 mA/A + 35 nA	
	(5 to 20) kHz	0.7 mA + 35 nA	
	100 µA to 1 mA		
	(10 to 20) Hz	4.6 mA/A + 0.24 µA	
	(20 to 45) Hz	1.9 mA/A + 0.24 µA	
	(45 to 100) Hz	1.9 mA/A + 0.24 µA	
	100 Hz to 5 kHz	0.36 mA/A + 0.24 µA	
	(5 to 20) kHz	0.7 mA/A + 0.24 µA	
	(20 to 50) kHz	4.6 mA/A + 0.47 µA	
	(50 to 100) kHz	6.4 mA/A + 1.7 µA	
	(1 to 10) mA		
	(10 to 20) Hz	4.6 mA/A + 2.4 µA	
	(20 to 45) Hz	1.7 mA/A + 2.4 µA	
	(45 to 100) Hz	0.7 mA/A + 2.4 µA	
	100 Hz to 5 kHz	0.35 mA/A + 2.4 µA	
	(5 to 20) kHz	0.70 mA/A + 2.3 µA	
	(20 to 50) kHz	4.6 mA/A + 4.6 µA	
	(50 to 100) kHz	6.4 mA/A + 17 µA	
	(10 to 100) mA		
	(10 to 20) Hz	4.6 mA/A + 23 µA	
	(20 to 45) Hz	1.7 mA/A + 23 µA	
	(45 to 100) Hz	0.7 mA/A + 23 µA	
	100 Hz to 5 kHz	0.36 mA/A + 23 µA	
	(5 to 20) kHz	1.1 mA/A + 23 µA	
	(20 to 50) kHz	4.7 mA/A + 46 µA	
	(50 to 100) kHz	6.4 mA/A + 0.17 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4.6 mA/A + 0.23 mA	
	(20 to 45) Hz	1.8 mA/A + 0.23 mA	
	(45 to 100) Hz	0.93 mA/A + 0.23 mA	
	100 Hz to 5 kHz	1.2 mA/A + 0.23 mA	
	(5 to 20) kHz	3.5 mA/A + 0.23 mA	
	(20 to 50) kHz	10 mA/A + 0.4 mA	
AC Current – Measure [1]	(1 to 10) A		Comparison to Keysight 34461A Multimeter
	60 Hz to 400 Hz	2.5 mA/A + 1.2 mA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source [1]	Up to 11 Ω (11 to 33) Ω (33 to 111) Ω (110 to 330) Ω 330 Ω to 1.1k Ω (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.19 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	0.12 mΩ/Ω + 1.2 mΩ 0.12 mΩ/Ω + 1.7 mΩ 27 µΩ/Ω + 1.6 mΩ 24 µΩ/Ω + 2.3 mΩ 25 µΩ/Ω + 2.3 mΩ 26 µΩ/Ω + 2.3 mΩ 25 µΩ/Ω + 2.3 mΩ 23 µΩ/Ω + 0.23 Ω 23 µΩ/Ω + 0.23 Ω 26 µΩ/Ω + 2.3 Ω 35 µΩ/Ω + 2.3 Ω 48 µΩ/Ω + 35 Ω 0.12 mΩ/Ω + 58 Ω 0.28 mΩ/Ω + 2.9 kΩ 0.47 mΩ/Ω + 3.5 kΩ 2.3 mΩ/Ω + 0.12 MΩ 12 mΩ/Ω + 0.5 MΩ	Comparison to Fluke 5520A SC1100 Multifunction Calibrator
Resistance Source	0.333 mΩ 0.001 Ω 0.010 Ω 0.10 Ω 1.0 Ω 10.0 Ω 100.0 Ω 1 000 Ω 10 000 Ω	0.11 mΩ 84 uΩ 71 uΩ 78 uΩ 0.23 mΩ 0.23 mΩ 2 mΩ 0.75 mΩ 0.14 Ω	Comparison to Guildline 9711 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	23 µΩ/Ω + 86 µΩ 17 µΩ/Ω + 0.64 mΩ 15 µΩ/Ω + 0.86 mΩ 15 µΩ/Ω + 8.6 µΩ 15 µΩ/Ω + 86 µΩ 21 µΩ/Ω + 2.4 Ω 61 µΩ/Ω + 0.12 kΩ 0.58 mΩ/Ω + 3.5 kΩ 5.8 mΩ/Ω + 0.33 MΩ	Comparison to HP 3458A Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermocouple Indicators - Source and Measure [1]	Type B		Electrical Simulation using Fluke 5520A SC1100 Multifunction Calibrator
	(600 to 800) °C	0.34 °C	
	(800 to 1 000) °C	0.26 °C	
	(1 000 to 1 550) °C	0.23 °C	
	(1 550 to 1 820) °C	0.26 °C	
	Type C		
	(0 to 150) °C	0.23 °C	
	(150 to 650) °C	0.2 °C	
	(650 to 1 000) °C	0.24 °C	
	(1 000 to 1 800) °C	0.39 °C	
	(1 800 to 2 316) °C	0.65 °C	
	Type E		
	(-250 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.12 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.12 °C	
	(650 to 1 000) °C	0.16 °C	
	Type B		
	(600 to 800) °C	0.34 °C	
	(800 to 1 000) °C	0.26 °C	
	(1 000 to 1 550) °C	0.23 °C	
	(1 550 to 1 820) °C	0.26 °C	
	Type C		
	(0 to 150) °C	0.23 °C	
	(150 to 650) °C	0.2 °C	
	(650 to 1 000) °C	0.24 °C	
	(1 000 to 1 800) °C	0.39 °C	
	(1 800 to 2 316) °C	0.65 °C	
	Type E		
	(-250 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.12 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.12 °C	
	(650 to 1 000) °C	0.16 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermocouple Indicators - Source and Measure [1]	Type J		Electrical Simulation using Fluke 5520A SC1100 Multifunction Calibrator
	(-210 to -100) °C	0.21 °C	
	(-100 to -30) °C	0.13 °C	
	(-30 to 150) °C	0.11 °C	
	(150 to 760) °C	0.13 °C	
	(760 to 1 200) °C	0.18 °C	
	Type K		
	(-200 to -100) °C	0.26 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 120) °C	0.13 °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 250) °C	0.47 °C	
	(250 to 1 000) °C	0.36 °C	
	(1 000 to 1 400) °C	0.37 °C	
	(1 400 to 1 767) °C	0.46 °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	0.56 °C	
	(0 to 600) °C	0.27 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RTD Indicating Devices [1,2]	Pt 385 (100 Ω) (-200 to 800) °C	(0.01 °C + 0.000 21*Y*) °C	Electrical Simulation using Fluke 5520A SC1100 Multifunction Calibrator
DC Power – Source [1] (1 to 1 000) V	1.5 W 6 W 12 W 20 W 30 W 60 W 120 W 500 W 1.5 kW 6 kW 30 kW 50 kW	0.06 % of Watts Output 0.05 % of Watts Output 0.07 % of Watts Output 0.06 % of Watts Output 0.1 % of Watts Output 0.08 % of Watts Output 0.05 % of Watts Output 0.07 % of Watts Output 0.07 % of Watts Output 0.1 % of Watts Output 0.09 % of Watts Output 0.09 % of Watts Output	Comparison to Fluke 5520A SC1100 Multifunction Calibrator
AC Power – Source [1] (45 to 65) Hz P=1 (1 to 1 000) V	1.5 W 6 W 12 W 20 W 30 W 60 W 120 W 500 W 1500 W 6 kW 30 kW 50 kW	0.07 % of Watts Output 0.07 % of Watts Output 0.07 % of Watts Output 0.07 % of Watts Output 0.07 % of Watts Output 0.07 % of Watts Output 0.07 % of Watts Output 0.11 % of Watts Output 0.08 % of Watts Output 0.11 % of Watts Output 0.11 % of Watts Output 0.01 % of Watts Output	Comparison to Fluke 5520A SC1100 Multifunction Calibrator
Capacitance – Source [1]	(4.7 to 470) nF 10Hz to 1kHz 1 µF to 1.1 mF (10 to 300) Hz	3.9 pF/nF + 42 pF 4.5 nF/µF + 2 nF	Comparison to Fluke 5520A SC1100 Multifunction Calibrator
Oscilloscope Functions Wave Generator – Source [1] Amplitude (10 Hz to 10 kHz) Square, Sine, Triangle into 1 MΩ Square, Sine, Triangle into 50 Ω Frequency	1.8 mV to 55 Vpp 1.8 mV to 2.5 Vpp 10 Hz to 100 kHz	30 mV/V + 0.1 mV 30 mV/V + 0.1 mV 25 parts in 10^6 Hz + 15 mHz	Comparison to Fluke 5520A SC1100 Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope Functions			
DC Signal			
into 50 Ω Load	(-6.6 to 6.6) V	2.9 mV/V + 47 µV	
into 1 MΩ Load	(-130 to 130) V	0.58 mV/V + 46 µV	
Square Wave	1 mV to 6.6 V p-p		
50 Ω Load	10 Hz to 10 kHz	2.9 mV/V + 48 µV	
1 MΩ Load	1 mV to 130 V p-p		
	10 Hz to 10 kHz	0.58 mV/V + 46 µV	
Leveled Sine Wave - Flatness	5 mV to 5.5 V		
Relative to 50 kHz	50 kHz to 100 MHz	17 mV	
	(100 to 300) MHz	23 mV	
	(300 to 600) MHz	46 mV	
	5mV to 3.5V		
	(600 to 1 100) MHz	58 mV	Comparison to Fluke 5520A SC1100 Multifunction Calibrator
Leveled Sine Wave – Frequency	50 kHz to 1.1 GHz	2.9 µHz/Hz + 4.2 mHz	
Leveled Sine Wave – Amplitude	5 mV to 5.5 Vpp	23 mV/V + 0.35 mV	
Time Marker [2] into 50 Ω Load-Source	5 s to 2 ns	5.8 ms/s + 0.1 µs	
Edge Specs into 50 Ω Load - Source	≤ 300 ps	120 ps	
Rise Time	5 mV to 2.5V	23 mV/V + 0.23 mV	
Amplitude	1 kHz to 10 MHz	2.9 µHz/Hz + 12 nHz	
Frequency			
Impedance Measurement	40 to 60 Ω	1.2 mΩ/Ω + 0.92 mΩ	
	500 kΩ to 1.5 MΩ	1.1 mΩ/Ω + 18Ω	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers, Outside [1,2]	(0 to 12) in (12 to 24) in	(580 + 0.21*L*) µin (570 + 0.72*L*) µin	Comparison to Grade 2 Gage Blocks
Micrometers, Inside [1,2]	Up to 12 in (12 to 24) in	(570 + .17*L*) µin (180 + .71*L*) µin	
Micrometers, Depth [1,2]	(0 to 12) in	(580 +.18*L*) µin	
Calipers [1,2]	Up to 6 in (6 to 12) in (12 to 24) in	(290 + 0.22*L*) µin (280 + 1.1*L*) µin (280 + 1.4*L*) µin	Comparison to Grade 2 Gage Blocks
Height Gages [1,2]	Up to 24 in	(170 + 3.7*L*) µin	Comparison to Grade 2 Gage Blocks, Grade A Surface Plate
Indicators [2]	Up to 1 in	(43 + 20*L*) µin	Comparison to P&W Labmaster Universal 1000A Measuring System
Plain Plug and Pin Gages	Up to 1 in	8.5 µin	Comparison to P&W LMU 1000A Measuring System Grade 00 Gage Blocks
Gage Blocks [2]	Up to 4 in (5 to 20) in	(3.7 + 0.97*L*) µin (4.7 + 2.8*L*) µin	Comparison to P&W LMU 1000A Measuring System Grade 00 Gage Blocks
Setting Standards [2]	Up to 40 in	(2.4 + 7.6*L*) µin	P&W Labmaster Universal 1000A Measuring System, Grade 00 Gage Blocks
Cylindrical Rings [2]	(0.25 to 4) in	(5.1 + 5.8*L*) µin	Comparison to P&W Labmaster Universal 1000A Measuring System, Class XXX Rings
Steel Tapes and Rules [2]	Up to 25 ft	(680 +34*L*) µin	Comparison to P&W Labmaster Universal 1000A Measuring System, Grade 00 Gage Blocks
Granite Surface Plates Overall Flatness Local Area Flatness (Repeat Reading)	 Diagonal up to 5 ft (X to X) µin Up to 0.04 in	 61 µin 86 µin	Comparison to: Mahr Federal EMD-832P-48-W2 Electronic Levels Repeat-o-meter

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plugs Pitch Diameter Major Diameter	 Up to 5 in Up to 5 in	 100 µin 51 µin	Comparison to P&W Model C Supermicrometer, Grade 2 Gage Blocks, Thread Wires

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Wrenches [1,2]	5 to 50) lbf·in (40 to 400) lbf·in (100 to 1 000) lbf·in (25 to 250) lbf·ft	(0.4 + 0.023*T*) lbf·in (0.15 + 0.003 5*T*) lbf·in (0.47 + 0.002 7*T*) lbf·in (0.052 + 0.003*T*) lbf·ft	Comparison to CDI 5000ST Torque System and 2000-400-02 Transducer Kit
Mass – Measure Fixed Points, Metric	0.5 g 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 700 g 1 kg 3 kg 5 kg 6 kg 10 kg 20 kg 30 kg	150 µg 190 µg 240 µg 330 µg 450 µg 650 µg 1 mg 1.9 mg 2.3 mg 12 mg 15 mg 20 mg 59 mg 95 mg 110 mg 230 mg 390 mg 570 mg	Comparison to ASTM Class 1 Weights, NIST Class S-1 Weights, Precision Mass Comparators/Balances
Mass – Precision Balances [2]	(0 to 2) g (2 to 20) g (20 to 200) g (200 to 1000) g (1 to 6) kg (0 to 30) kg	(350 + 240*M*) µg (140 + 350*M*) µg (20 + 360*M*) µg (310 + 15*M*) µg (17 + 0.014*M*) mg (160 + 0.016*M*) mg	Comparison to ASTM Class 1 Weights, NIST Class S-1 Weights

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Gauges, Transducers – Measure [1,2]	(3 to 30) psi (20 to 100) psi (100 to 500) psi (200 to 1 000) psi (1 000 to 5 000) psi (2 000 to 10 000) psi	(0.008 6 + 0.000 92*P*) psi (0.038 + 0.000 87*P*) psi (0.04 + 0.001 1*P*) psi (0.076 + 0.001 1*P*) psi (0.4 + 0.001 1*P*) psi (0.69 + 0.001 1*P*) psi	Comparison to Digital Pressure Gauges: Crystal 30PSIXP2I Crystal 100PSIXP2I Crystal 500PSIXP2I Crystal 1KPSIXP2I Crystal 5KPSIXP2I Crystal 10KPSIXP2I
	(-5 to 0) psi (0 to 3) psi (0 to 15) psi	0.000 6 psi 0.000 37 psi 0.001 8 psi	Comparison to Mensor CPG 2500 with: transducer CPT6100 transducer CPR2550-3 transducer CPR2550-15
	(4 000 to 20 000) psi (7 200 to 36 000) psi	(0.97 + 0.000 19*P*) psi (3.1 + 0.000 091*P*) psi	Comparison to : Additel 681-20KPSI Additel 681-36KPSI
Pressure Gauges, Transducers – Measure [1,2]	(-5 to 0) inH_2O (0 to -5) inH_2O	0.005 9 inH_2O 0.005 8 inH_2O	Comparison to Additel ADT681-05-DP5-H2O
Pressure Gauges, Transducers – Measure [2]	(-15 to 0) psi (0 to 30) psi (0 to 100) psi	(0.006 + 0.000 78*P*) psi (0.003 6 + 0.000 047*P*) psi (0.004 2 + 0.000 11*P*) psi	Comparison to GE Druck Pace 1002 Pressure Indicator
	(100 to 1 500) psi (1 500 to 15 000) psi	(0.007 + 0.000 11*P*) psi (0.56 + 0.000 08*P*) psi	Comparison to Mensor CPB5000 Pressure Balance
Absolute Pressure-Measure (Barometers)	(8 to 17) psi	0.001 3 psi	Comparison to Mensor CPG2500 without additional transducer

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature - Source	(-45 to 155) °C	0.07 °C	Comparison to Ametek RTC 157B Temperature Calibrator, STS 200 B915 PRT
Temperature - Source	(-90 to 140) °C	0.24 °C	Comparison to Fluke 9190A Dry Well Ultra-Cold Calibrator

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Source [2]	(50 to 650) °C	(1.1 + 0.000 012*Y*) °C	Comparison to Ametek CTC-650A Dry Block Calibrator
Temperature - Measure [1,2]	(-90 to 600) °C	(0.05 + 0.000 115 8Y) °C	Comparison to Fluke 1524 Thermometer with Fluke 5628 PRT
	(15 to 30) °C	0.3 °C	Comparison to Rotronic Hygropalm
Infrared (IR) Temperature – Source [1]	-15 °C 0 °C 50 °C 100 °C 120 °C	0.65°C 0.6 °C 0.72 °C 0.82 °C 0.8 °C	Comparison to Fluke 4180 IR Calibrator Ɛ = 0.95, λ = (8 to 14) µm
	200 °C 350 °C 500 °C	1 °C 1.7 °C 2.2 °C	Comparison to Fluke 4181 IR Calibrator Ɛ = 0.95, λ = (8 to 14) µm
Humidity	LiCl, 11 %RH MgCl, 33 %RH NaCl, 75 %RH	1.2 %RH 1.2 %RH 1.4 %RH	Comparison to Saturated Salt Solutions monitored with a reference Hygrometer
Humidity	(0 to 80) %RH	1.1 %RH	Comparison to Rotronic Hygropalm Hygrometer

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source [1]	0.01 Hz to 2 MHz	2 µHz/Hz + 8 µHz	Comparison to Fluke 5520A SC1100 Multifunction Calibrator
	10 MHz	1 part in 10^{-11} Hz	Comparison to Spectracom 8194 GPS Oscillator
Stopwatches /Timers [1]	Up to 24 hours	5.8 ms	Comparison to Fluke 5520A SC1100 Multifunction Calibrator with Spectracom 8194 GPS Oscillator and Fluke PM6680B Counter

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Non-Contact Tachometers [1]	(60 to 99 999) rpm	0.58 rpm	Comparison to Fluke 5520A SC1100 Multifunction Calibrator with Spectracom 8194 GPS Oscillator, Agilent 3325B Signal Generator

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, P = pressure in psi, p = pressure in inH2O, M = mass in grams, t = time in seconds, T = torque in applicable units of measurement, Y = temperature in degrees Celsius.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1440.

Jason Stine, Vice President