



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

**Rothe Development, Inc.
DBA Rothe - Eastern Shore Metrology and
Calibration Services**

**6291 Lankford Highway
New Church, VA 23416**

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: 21 May 2027

Certificate Number: AC-2986



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)

Rothe Development, Inc.

DBA Rothe - Eastern Shore Metrology and Calibration Services

6291 Lankford Highway
New Church, VA 23416

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CALIBRATION

ISO/IEC 17025 Accreditation Granted: **21 May 2025**

Certificate Number: **AC-2986**

Certificate Expiry Date: **21 May 2027**

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters	4 pH 7 pH 10 pH	0.043 pH 0.054 pH 0.064 pH	Comparison to Reference Buffer Solutions
Conductivity	10 µS/cm 100 µS/cm 1 000 µS/cm 10 mS/cm 100 mS/cm 500 mS/cm	0.64 µS/cm 2.3 µS/cm 9.3 µS/cm 0.11 mS/cm 1.5 mS/cm 5.5 mS/cm	Comparison to Reference Conductivity Solutions

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 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V 330 V to 1 kV	3 μ V/V + 1 μ V 2 μ V/V + 1.5 μ V 12 μ V/V + 20 μ V 18 μ V/V + 150 μ V 18 μ V/V + 1.5 mV	Comparison to Fluke 5522A Multi-Product Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	9 μ V/V + 300 nV 8 μ V/V + 300 nV 8 μ V/V + 500 nV 10 μ V/V + 30 μ V 22 μ V/V + 100 μ V	Comparison to Hewlett Packard 3458A Digital Multimeter
DC Current – Source ¹	(0 to 330) μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1A (1.1 to 3.3) A (3.3 to 11) A (11 to 20.5) A	150 μ A/A + 0.02 μ A 100 μ A/A + 0.05 μ A 100 μ A/A + 0.25 μ A 100 μ A/A + 2.5 μ A 200 μ A/A + 40 μ A 380 μ A/A + 40 μ A 500 μ A/A + 500 μ A 1 mA/A + 750 μ A	Comparison to Fluke 5522A Multi-Product Calibrator
DC Current – Measure ¹	(0 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	20 μ A/A + 800 pA 20 μ A/A + 5 nA 20 μ A/A + 50 nA 20 μ A/A + 500 nA 110 μ A/A + 10 μ A	Comparison to Hewlett Packard 3458A Digital Multimeter
DC Current – Measure ¹	(0 A to 100) A	39 μ A/A + 10 μ A	Comparison to Hewlett Packard 3458A Digital Multimeter with Current Shunts
AC Voltage – Source ¹	(1 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 500) kHz	800 μ V/V + 6 μ V 150 μ V/V + 6 μ V 200 μ V/V + 6 μ V 1 mV/V + 6 μ V 3.5 mV/V + 12 μ V 8 mV/V + 50 μ V	Comparison to Fluke 5522A Multi-Product Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(33 to 330) mV		Comparison to Fluke 5522A Multi-Product Calibrator
	(10 to 45) Hz	300 μ V/V + 8 μ V	
	45 Hz to 10 kHz	145 μ V/V + 8 μ V	
	(10 to 20) kHz	160 μ V/V + 8 μ V	
	(20 to 50) kHz	350 μ V/V + 8 μ V	
	(50 to 100) kHz	800 μ V/V + 32 μ V	
	(100 to 500) kHz	2 mV/V + 70 μ V	
	(0.33 to 3.3) V		
	(10 to 45) Hz	300 μ V/V + 50 μ V	
	45 Hz to 10 kHz	150 μ V/V + 60 μ V	
	(10 to 20) kHz	190 μ V/V + 60 μ V	
	(20 to 50) kHz	300 μ V/V + 50 μ V	
	(50 to 100) kHz	700 μ V/V + 125 μ V	
	(100 to 500) kHz	2.4 mV/V + 600 μ V	
	(3.3 to 33) V		
	(10 to 45) Hz	300 μ V/V + 650 μ V	
	45 Hz to 10 kHz	150 μ V/V + 600 μ V	
	(10 to 20) kHz	240 μ V/V + 600 μ V	
	(20 to 50) kHz	350 μ V/V + 600 μ V	
	(50 to 100) kHz	900 μ V/V + 1.6 mV	
AC Voltage – Measure ¹	(33 to 330) V		Comparison to Hewlett Packard 3458A Digital Multimeter
	45Hz to 1 kHz	190 μ V/V + 2 mV	
	(1 to 10) kHz	200 μ V/V + 6 mV	
	(10 to 20) kHz	250 μ V/V + 6 mV	
	(20 to 50) kHz	300 μ V/V + 6 mV	
	(50 to 100) kHz	2 mV/V + 50 mV	
	(330 to 1 020) V		
	45 Hz to 1 kHz	300 μ V/V + 10 mV	
	(1 to 5) kHz	250 μ V/V + 10 mV	
	(5 to 10) kHz	300 μ V/V + 10 mV	
	Up to 10 mV		
	(1 to 40) Hz	300 μ V/V + 3 μ V	
40 Hz to 1 kHz	200 μ V/V + 1.1 μ V		
(1 to 20) kHz	300 μ V/V + 1.1 μ V		
(20 to 50) kHz	1 mV/V + 1.1 μ V		
(50 to 100) kHz	5 mV/V + 1.1 μ V		
(100 to 300) kHz	40 mV/V + 2 μ V		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) mV		Comparison to Hewlett Packard 3458A Digital Multimeter
	(1 to 40) Hz	70 μ V/V + 4 μ V	
	40 Hz to 1 kHz	70 μ V/V + 2 μ V	
	(1 to 20) kHz	140 μ V/V + 2 μ V	
	(20 to 50) kHz	300 μ V/V + 2 μ V	
	(50 to 100) kHz	800 μ V/V + 2 μ V	
	(100 to 300) kHz	3 mV/V + 10 μ V	
	300 kHz to 1 MHz	10 mV/V + 10 μ V	
	(1 to 2) MHz	15 mV/V + 10 μ V	
	(0.1 to 1) V		
	(1 to 40) Hz	70 μ V/V + 40 μ V	
	40 Hz to 1 kHz	70 μ V/V + 20 μ V	
	(1 to 20) kHz	140 μ V/V + 20 μ V	
	(20 to 50) kHz	300 μ V/V + 20 μ V	
	(50 to 100) kHz	800 μ V/V + 20 μ V	
	(100 to 300) kHz	3 mV/V + 100 μ V	
	300 kHz to 1 MHz	10 mV/V + 100 μ V	
	(1 to 2) MHz	15 mV/V + 100 μ V	
	(1 to 10) V		
	(1 to 40) Hz	70 μ V/V + 400 μ V	
	40 Hz to 1 kHz	70 μ V/V + 200 μ V	
	(1 to 20) kHz	140 μ V/V + 200 μ V	
	(20 to 50) kHz	300 μ V/V + 200 μ V	
	(50 to 100) kHz	800 μ V/V + 200 μ V	
	(100 to 300) kHz	3 mV/V + 1 mV	
	300 kHz to 1 MHz	10 mV/V + 1 mV	
	(1 to 2) MHz	15 mV/V + 1 mV	
(10 to 100) V			
(1 to 40) Hz	200 μ V/V + 4 mV		
40 Hz to 1 kHz	200 μ V/V + 2 mV		
(1 to 20) kHz	200 μ V/V + 2 mV		
(20 to 50) kHz	350 μ V/V + 2 mV		
(50 to 100) kHz	1.2 mV/V + 2 mV		
(100 to 300) kHz	4 mV/V + 10 mV		
300 kHz to 1 MHz	15 mV/V + 10 mV		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(100 to 1 000) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	400 μ V/V + 40 mV 400 μ V/V + 20 mV 600 μ V/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	Comparison to Hewlett Packard 3458A Digital Multimeter
AC Voltage – Measure	Up to 2.2 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 (2.2 to 7) 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 (7 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	0.17 % of reading + 1.3 μ V 0.074 % of reading + 1.3 μ V 0.042 % of reading + 1.3 μ V 0.082 % of reading + 2 μ V 0.12 % of reading + 2.5 μ V 0.23 % of reading + 4 μ V 0.26 % of reading + 8 μ V 0.5 % of reading + 8 μ V 0.085 % of reading + 1.3 μ V 0.037 % of reading + 1.3 μ V 0.021 % of reading + 1.3 μ V 0.041 % of reading + 2 μ V 0.061 % of reading + 2.5 μ V 0.12 % of reading + 4 μ V 0.14 % of reading + 8 μ V 0.36 % of reading + 8 μ V 0.29 % of reading + 1.3 μ V 0.019 % of reading + 1.3 μ V 0.011 % of reading + 1.3 μ V 0.021 % of reading + 2 μ V 0.031 % of reading + 2.5 μ V 0.082 % of reading + 4 μ V 0.1 % of reading + 8 μ V 0.26 % of reading + 8 μ V	Comparison to Fluke 5790A AC Measurement Standard

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(22 to 70) mV		Comparison to Fluke 5790A AC Measurement Standard
	(10 to 20) Hz	0.024 % of reading + 1.5 μ V	
	(20 to 40) Hz	0.013 % of reading + 1.5 μ V	
	40 Hz to 20 kHz	0.006 9 % of reading + 1.5 μ V	
	(20 to 50) kHz	0.013 % of reading + 2 μ V	
	(50 to 100) kHz	0.026 % of reading + 2.5 μ V	
	(100 to 300) kHz	0.053 % of reading + 4 μ V	
	(300 to 500) kHz	0.068 % of reading + 80 μ V	
	500 kHz to 1 MHz	0.013 % of reading + 8 μ V	
	(70 to 220) mV		
	(10 to 20) Hz	0.021 % of reading + 1.5 μ V	
	(20 to 40) Hz	0.008 7 % of reading + 1.5 μ V	
	40 Hz to 20 kHz	0.004 3 % of reading + 1.5 μ V	
	(20 to 50) kHz	0.007 3 % of reading + 2 μ V	
	(50 to 100) kHz	0.016 % of reading + 2.5 μ V	
	(100 to 300) kHz	0.028 % of reading + 4 μ V	
	(300 to 500) kHz	0.04 % of reading + 8 μ V	
	500 kHz to 1 MHz	0.12 % of reading + 8 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.021 % of reading + 1.5 μ V	
	(20 to 40) Hz	0.007 8 % of reading + 1.5 μ V	
	40 Hz to 20 kHz	0.003 8 % of reading + 1.5 μ V	
	(20 to 50) kHz	0.005 6 % of reading + 2 μ V	
	(50 to 100) kHz	0.008 4 % of reading + 2.5 μ V	
	(100 to 300) kHz	0.021 % of reading + 4 μ V	
	(300 to 500) kHz	0.034 % of reading + 8 μ V	
	500 kHz to 1 MHz	0.12 % of reading + 8 μ V	
	(0.7 to 2.2) V		
(10 to 20) Hz	0.02 % of reading		
(20 to 40) Hz	0.006 9 % of reading		
40 Hz to 20 kHz	0.002 9 % of reading		
(20 to 50) kHz	0.005 2 % of reading		
(50 to 100) kHz	0.007 6 % of reading		
(100 to 300) kHz	0.02 % of reading		
(300 to 500) kHz	0.031 % of reading		
500 kHz to 1 MHz	0.12 % of reading		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(2.2 to 7) V		Comparison to Fluke 5790A AC Measurement Standard
	(10 to 20) Hz	0.02 % of reading	
	(20 to 40) Hz	0.007 % of reading	
	40 Hz to 20 kHz	0.0029 % of reading	
	(20 to 50) kHz	0.0053 % of reading	
	(50 to 100) kHz	0.0088 % of reading	
	(100 to 300) kHz	0.022 % of reading	
	(300 to 500) kHz	0.047 % of reading	
	500 kHz to 1 MHz	0.15 % of reading	
	(7 to 22) V		
	(10 to 20) Hz	0.02 % of reading	
	(20 to 40) Hz	0.007 % of reading	
	40 Hz to 20 kHz	0.0031 % of reading	
	(20 to 50) kHz	0.0053 % of reading	
	(50 to 100) kHz	0.0085 % of reading	
	(100 to 300) kHz	0.022 % of reading	
	(300 to 500) kHz	0.047 % of reading	
	500 kHz to 1 MHz	0.015 % of reading	
	(22 to 70) V		
	(10 to 20) Hz	0.02 % of reading	
	(20 to 40) Hz	0.0072 % of reading	
	40 Hz to 20 kHz	0.0039 % of reading	
	(20 to 50) kHz	0.0063 % of reading	
	(50 to 100) kHz	0.011 % of reading	
	(100 to 300) kHz	0.022 % of reading	
	(300 to 500) kHz	0.051 % of reading	
	500 kHz to 1 MHz	0.15 % of reading	
	(70 to 220) V		
(10 to 20) Hz	0.02 % of reading		
(20 to 40) Hz	0.0072 % of reading		
40 Hz to 20 kHz	0.0038 % of reading		
(20 to 50) kHz	0.0077 % of reading		
(50 to 100) kHz	0.011 % of reading		
(100 to 300) kHz	0.026 % of reading		
(300 to 500) kHz	0.07 % of reading		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(220 to 700) V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (700 to 1 000) V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % of reading 0.011 % of reading 0.004 7 % of reading 0.015 % of reading 0.085 % of reading 0.02 % of reading 0.011 % of reading 0.004 4 % of reading 0.015 % of reading 0.085 % of reading	Comparison to Fluke 5790A AC Measurement Standard
AC Voltage – Measure Flatness referenced to 1 kHz	Up to 2.2 mV (10 Hz to 30) Hz (30 Hz to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) mV (10 Hz to 30) Hz (30 Hz to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.1 % of reading 0.05 % of reading 0.05 % of reading 0.05 % of reading 0.07 % of reading + 1 μV 0.07 % of reading + 1 μV 0.07 % of reading + 1 μV 0.17 % of reading + 1 μV 0.3 % of reading + 1 μV 0.7 % of reading + 2 μV 0.1 % of reading 0.05 % of reading 0.05 % of reading 0.05 % of reading 0.07 % of reading + 1 μV 0.07 % of reading + 1 μV 0.07 % of reading + 1 μV 0.1 % of reading + 1 μV 0.17 % of reading + 1 μV 0.37 % of reading + 1 μV	Comparison to Fluke 5790A AC Measurement Standard



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure Flatness referenced to 1 kHz	(7 to 22) mV		Comparison to Fluke 5790A AC Measurement Standard
	(10 Hz to 30) Hz	0.1 % of reading	
	(30 Hz to 120) Hz	0.05 % of reading	
	120 Hz to 1.2 kHz	0.05 % of reading	
	(1.2 to 120) kHz	0.05 % of reading	
	(120 to 500) kHz	0.07 % of reading	
	500 kHz to 1.2 MHz	0.07 % of reading	
	(1.2 to 2) MHz	0.07 % of reading	
	(2 to 10) MHz	0.1 % of reading	
	(10 to 20) MHz	0.17 % of reading	
	(20 to 30) MHz	0.37 % of reading	
	(22 to 70) mV		
	(10 Hz to 30) Hz	0.1 % of reading	
	(30 Hz to 120) Hz	0.05 % of reading	
	120 Hz to 1.2 kHz	0.05 % of reading	
	(1.2 to 120) kHz	0.05 % of reading	
	(120 to 500) kHz	0.05 % of reading	
	500 kHz to 1.2 MHz	0.05 % of reading	
	(1.2 to 2) MHz	0.05 % of reading	
	(2 to 10) MHz	0.1 % of reading	
	(10 to 20) MHz	0.15 % of reading	
	(20 to 30) MHz	0.35 % of reading	
	(70 to 220) mV		
	(10 Hz to 30) Hz	0.1 % of reading	
	(30 Hz to 120) Hz	0.04 % of reading	
	120 Hz to 1.2 kHz	0.04 % of reading	
	(1.2 to 120) kHz	0.04 % of reading	
(120 to 500) kHz	0.04 % of reading		
500 kHz to 1.2 MHz	0.05 % of reading		
(1.2 to 2) MHz	0.05 % of reading		
(2 to 10) MHz	0.1 % of reading		
(10 to 20) MHz	0.15 % of reading		
(20 to 30) MHz	0.35 % of reading		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure Flatness referenced to 1 kHz	(220 to 700) mV		Comparison to Fluke 5790A AC Measurement Standard
	(10 Hz to 30) Hz	0.1 % of reading	
	(30 Hz to 120) Hz	0.03 % of reading	
	120 Hz to 1.2 kHz	0.03 % of reading	
	(1.2 to 120) kHz	0.03 % of reading	
	(120 to 500) kHz	0.03 % of reading	
	500 kHz to 1.2 MHz	0.05 % of reading	
	(1.2 to 2) MHz	0.05 % of reading	
	(2 to 10) MHz	0.1 % of reading	
	(10 to 20) MHz	0.15 % of reading	
	(20 to 30) MHz	0.35 % of reading	
	(0.7 to 2.2) V		
	(10 Hz to 30) Hz	0.1 % of reading	
	(30 Hz to 120) Hz	0.03 % of reading	
	120 Hz to 1.2 kHz	0.03 % of reading	
	(1.2 to 120) kHz	0.03 % of reading	
	(120 to 500) kHz	0.03 % of reading	
	500 kHz to 1.2 MHz	0.05 % of reading	
	(1.2 to 2) MHz	0.05 % of reading	
	(2 to 10) MHz	0.1 % of reading	
	(10 to 20) MHz	0.15 % of reading	
	(20 to 30) MHz	0.35 % of reading	
	(2.2 to 3.5) V		
	(10 Hz to 30) Hz	0.1 % of reading	
	(30 Hz to 120) Hz	0.03 % of reading	
	120 Hz to 1.2 kHz	0.03 % of reading	
	(1.2 to 120) kHz	0.03 % of reading	
(120 to 500) kHz	0.03 % of reading		
500 kHz to 1.2 MHz	0.05 % of reading		
(1.2 to 2) MHz	0.05 % of reading		
(2 to 10) MHz	0.1 % of reading		
(10 to 20) MHz	0.15 % of reading		
(20 to 30) MHz	0.35 % of reading		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(29 to 330) μ A		Comparison to Fluke 5522A Multi-Product Calibrator
	(10 to 20) Hz	0.2 % of reading + 0.1 nA	
	(20 to 45) Hz	0.15 % of reading + 0.1 nA	
	45 Hz to 1 kHz	0.13 % of reading + 0.1 nA	
	(1 to 5) kHz	0.3 % of reading + 0.15 nA	
	(5 to 10) kHz	0.8 % of reading + 0.2 nA	
	(10 to 30) kHz	1.6 % of reading + 0.4 nA	
	(0.33 to 3.3) mA		
	(10 to 20) Hz	0.2 % of reading + 0.15 nA	
	(20 to 45) Hz	0.13 % of reading + 0.15 nA	
	45 Hz to 1 kHz	0.1 % of reading + 0.15 nA	
	(1 to 5) kHz	0.2 % of reading + 0.2 nA	
	(5 to 10) kHz	0.5 % of reading + 0.3 nA	
	(10 to 30) kHz	1 % of reading + 0.6 nA	
	(3.3 to 33) mA		
	(10 to 20) Hz	0.18 % of reading + 2 nA	
	(20 to 45) Hz	0.09 % of reading + 2 nA	
	45 Hz to 1 kHz	0.04 % of reading + 2 nA	
	(1-5) kHz	0.08 % of reading + 2 nA	
	(5 to 10) kHz	0.2 % of reading + 3 nA	
	(10 to 30) kHz	0.4 % of reading + 4 nA	
	(33 to 330) mA		
	(10 to 20) Hz	0.18 % of reading + 20 nA	
	(20 to 45) Hz	0.09 % of reading + 20 nA	
	45 Hz to 1 kHz	0.04 % of reading + 20 nA	
	(1 to 5) kHz	0.1 % of reading + 50 nA	
	(5 to 10) kHz	0.2 % of reading + 100 nA	
	(10 to 30) kHz	0.4 % of reading + 200 nA	
330 mA to 1.1 A			
(10 to 45) Hz	0.18 % of reading + 100 nA		
45 Hz to 1 kHz	0.05 % of reading + 100 nA		
(1 to 5) kHz	0.6 % of reading + 1 μ A		
(5 to 10) kHz	2.5 % of reading + 5 μ A		
(3 to 11) A			
(45 to 100) Hz	0.06 % of reading + 2 μ A		
100 Hz to 1 kHz	0.1 % of reading + 2 μ A		
(1 to 5) kHz	3 % of reading + 2 μ A		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % of reading + 5 μ A 0.15 % of reading + 5 μ A 3 % of reading + 5 μ A	Comparison to Fluke 5522A Multi-Product Calibrator
AC Current – Measure ¹	(5 to 100) μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (100 Hz to 1 kHz) (0.1 to 1) 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 (1 to 10) 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 (10 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	0.4 % of reading + 30 nA 0.15 % of reading + 30 nA 0.06 % of reading + 30 nA 0.06 % of reading + 30 nA 0.4 % of reading + 200 nA 0.15 % of reading + 200 nA 0.06 % of reading + 200 nA 0.03 % of reading + 200 nA 0.06 % of reading + 200 nA 0.4 % of reading + 400 nA 0.55 % of reading + 1.5 μ A 0.4 % of reading + 2 μ A 0.15 % of reading + 2 μ A 0.06 % of reading + 2 μ A 0.03 % of reading + 2 μ A 0.06 % of reading + 2 μ A 0.4 % of reading + 4 μ A 0.55 % of reading + 15 μ A 0.4 % of reading + 20 μ A 0.15 % of reading + 20 μ A 0.06 % of reading + 20 μ A 0.03 % of reading + 20 μ A 0.06 % of reading + 20 μ A 0.4 % of reading + 40 μ A 0.55 % of reading + 150 μ A 0.4 % of reading + 200 μ A 0.16 % of reading + 200 μ A 0.08 % of reading + 200 μ A 0.1 % of reading + 200 μ A 0.3 % of reading + 200 μ A 1 % of reading + 400 μ A	Comparison to Hewlett Packard 3458A Digital Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	0 Ω	40 μΩ	Comparison to Fluke 5522A Multi-Product Calibrator
	1 Ω	95 μΩ/Ω	
	1.9 Ω	95 μΩ/Ω	
	10 Ω	23 μΩ/Ω	
	19 Ω	23 μΩ/Ω	
	100 Ω	10 μΩ/Ω	
	190 Ω	10 μΩ/Ω	
	1 kΩ	8.5 μΩ/Ω	
	1.9 kΩ	8.5 μΩ/Ω	
	10 kΩ	8.5 μΩ/Ω	
	19 kΩ	8.5 μΩ/Ω	
	100 kΩ	11 μΩ/Ω	
	190 kΩ	11 μΩ/Ω	
	1 MΩ	20 μΩ/Ω	
	1.9 MΩ	21 μΩ/Ω	
	10 MΩ	40 μΩ/Ω	
19 MΩ	47 μΩ/Ω		
100 MΩ	100 μΩ/Ω		
Resistance – Source ¹	(0 to 11) Ω	40 μΩ/Ω + 0.01 Ω	Comparison to Fluke 5522A Multi-Product Calibrator
	(11 to 33) Ω	30 μΩ/Ω + 0.015 Ω	
	(33 to 110) Ω	28 μΩ/Ω + 0.015 Ω	
	(110 to 330) Ω	28 μΩ/Ω + 0.02 Ω	
	(330 to 1 100) Ω	28 μΩ/Ω + 0.02 Ω	
	(1.1 to 3.3) kΩ	28 μΩ/Ω + 0.2 Ω	
	(3.3 to 11) kΩ	28 μΩ/Ω + 0.1 Ω	
	(11 to 33) kΩ	28 μΩ/Ω + 1 Ω	
	(33 to 110) kΩ	28 μΩ/Ω + 1 Ω	
	(110 to 330) kΩ	32 μΩ/Ω + 10 Ω	
	(330 to 1 100) kΩ	32 μΩ/Ω + 10 Ω	
	(1.1 to 3.3) MΩ	60 μΩ/Ω + 150 Ω	
	(3.3 to 11) MΩ	130 μΩ/Ω + 250 Ω	
	(11 to 33) MΩ	250 μΩ/Ω + 2500 Ω	
	(33 to 110) MΩ	500 μΩ/Ω + 3 kΩ	
(110 to 330) MΩ	3 mΩ/Ω + 100 kΩ		
(330 to 1 100) MΩ	15 mΩ/Ω + 500 kΩ		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	10 mΩ	0.4 μΩ	Comparison to HRRS Series 100G Ω High Resistance Decade Substituter
	1 Ω	0.2 μΩ	
	10 kΩ	4.1 mΩ	
	1 MΩ	10 Ω	
	2 MΩ	41 Ω	
	3 MΩ	61 Ω	
	4 MΩ	81 Ω	
	5 MΩ	100 Ω	
	6 MΩ	120 Ω	
	7 MΩ	140 Ω	
	8 MΩ	160 Ω	
	9 MΩ	180 Ω	
	10 MΩ	200 Ω	
	12 MΩ	2 Ω	
	13 MΩ	3 Ω	
	14 MΩ	4.1 Ω	
	15 MΩ	5.1 Ω	
	16 MΩ	6.1 kΩ	
	17 MΩ	7.1 kΩ	
	18 MΩ	8.1 kΩ	
	19 MΩ	9.1 kΩ	
	100 MΩ	10 kΩ	
	200 MΩ	71 kΩ	
	300 MΩ	110 kΩ	
	400 MΩ	140 kΩ	
	500 MΩ	180 kΩ	
	600 MΩ	210 kΩ	
	700 MΩ	250 kΩ/Ω	
	800 MΩ	280 kΩ/Ω	
	900 MΩ	320 kΩ/Ω	
1.0 GΩ	510 kΩ/ Ω		
2.0 GΩ	1 MΩ/Ω		
3.0 GΩ	1.5 MΩ/Ω		
4.0 GΩ	2 MΩ/Ω		
5.0 GΩ	2.5 MΩ/Ω		
6.0 GΩ	3 MΩ/Ω		
7.0 GΩ	3.6 MΩ/Ω		
8.0 GΩ	4.1 MΩ/Ω		
9.0 GΩ	4.6 MΩ/Ω		
10.0 GΩ	7.1 MΩ/Ω		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	0 to 10 Ω Up to 100 Ω Up to 1 kΩ Up to 10 kΩ Up to 100 kΩ Up to 1 MΩ Up to 10 MΩ Up to 100 MΩ Up to 1 GΩ	15 μΩ/Ω + 50 μΩ 12 μΩ/Ω + 500 μΩ 10 μΩ/Ω + 500 μΩ 10 μΩ/Ω + 5 mΩ 10 μΩ/Ω + 50 mΩ 15 μΩ/Ω + 2 Ω 50 μΩ/Ω + 100 Ω 500 μΩ/Ω + 1 kΩ 0.5 % of reading + 10 kΩ	Comparison to Hewlett Packard 3458A Digital Multimeter
Capacitance – Source ¹	(220 to 400) pF 0.4 pF 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	0.5 % of reading + 10 pF 0.5 % of reading + 0.01 nF 0.5 % of reading + 0.01 nF 0.25 % of reading + 0.01 nF 0.25 % of reading + 0.1 nF 0.25 % of reading + 0.1 nF 0.25 % of reading + 0.3 nF 0.25 % of reading + 1 nF 0.25 % of reading + 3 nF 0.25 % of reading + 10 nF 0.4 % of reading + 30 nF 0.45 % of reading + 100 nF 0.45 % of reading + 300 nF 0.45 % of reading + 1 μF 0.45 % of reading + 3 μF 0.45 % of reading + 10 μF 0.75 % of reading + 30 μF 1.1 % of reading + 100 μF	Comparison to Fluke 5522A Multi-Product Calibrator
Electrical Simulation of Thermocouple Indicators Source and Measure 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	0.44 °C 0.34 °C 0.3 °C 0.33 °C 0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C	Comparison to Fluke 5522A Multi-Product Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators Source and Measure ¹	Type E		Comparison to Fluke 5522A Multi-Product Calibrator
	(-250 to -100) °C	0.5 °C	
	(-100 to -25) °C	0.16 °C	
	(-25 to +350) °C	0.14 °C	
	(350 to 650) °C	0.16 °C	
	(650 to 1 000) °C	0.21 °C	
	Type J		
	(-210 to -100) °C	0.27 °C	
	(-100 to -30) °C	0.16 °C	
	(-30 to +150) °C	0.14 °C	
	(150 to 760) °C	0.17 °C	
	(760 to 1 200) °C	0.23 °C	
	Type K		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to +120) °C	0.16 °C	
	(120 to 1 000) °C	0.26 °C	
	(1 000 to 1 372) °C	0.4 °C	
	Type L		
	(-200 to -100) °C	0.37 °C	
	(-100 to +800) °C	0.26 °C	
	(800 to 900) °C	0.17 °C	
	Type N		
	(-200 to -100) °C	0.4 °C	
(-100 to -25) °C	0.22 °C		
(-25 to +120) °C	0.19 °C		
(120 to 410) °C	0.18 °C		
(410 to 1 300) °C	0.27 °C		
Type R			
(0 to 250) °C	0.57 °C		
(250 to 400) °C	0.35 °C		
(400 to 1 000) °C	0.33 °C		
(1 000 to 1 767) °C	0.4 °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		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators Source and Measure ¹	Type T		Comparison to Fluke 5522A Multi-Product Calibrator
	(-250 to -150) °C	0.63 °C	
	(-150 to 0) °C	0.24 °C	
	(0 to 120) °C	0.16 °C	
	(120 to 400) °C	0.14 °C	
	Type U		
(-200 to 0) °C	0.56 °C		
(0 to 600) °C	0.27 °C		
Electrical Simulation of RTD Indicating Devices ¹	PT385-100 Ω		Comparison to Fluke 5522A Multi-Product Calibrator
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	PT3926-100 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	PT3916-100 Ω		
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
(260 to 300) °C	0.08 °C		
(300 to 400) °C	0.09 °C		
(400 to 600) °C	0.1 °C		
(600 to 630) °C	0.23 °C		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices ¹	PT385-200 Ω		Comparison to Fluke 5522A Multi-Product Calibrator
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	PT385-500 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	
	PT385-1 000 Ω		
	(-200 to -80) °C	0.03 °C	
(-80 to 0) °C	0.03 °C		
(0 to 100) °C	0.04 °C		
(100 to 260) °C	0.05 °C		
(260 to 300) °C	0.06 °C		
(300 to 400) °C	0.07 °C		
(400 to 600) °C	0.07 °C		
(600 to 630) °C	0.23 °C		
PtNi 385-120 Ω			
(-80 to 0) °C	0.08 °C		
(0 to 100) °C	0.08 °C		
(100 to 260) °C	0.14 °C		
Electrical Simulation of RTD Indicating Devices ¹	Cu 427-10 Ω (-100 to +260) °C	0.3 °C	Comparison to Fluke 5522A Multi-Product Calibrator
Oscilloscopes ¹ Amplitude	1 mV to 130 VDC (into 1 MΩ) (into 50 Ω)	0.05 % of reading + 40 μV 0.25 % of reading + 40 μV	Comparison to Fluke 5522A SC1100 Multi-Product Calibrator
Oscilloscopes ¹ Square Wave, 10 Hz to 10 kHz	1 mV to 130 V, 1 MΩ 1 mv to 6.6 V, 50 Ω	0.1 % of reading + 40 μV 0.25 % of reading + 40 μV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Waveform Generator (Square, Sine, Triangle)	1.8 mV to 55 Vpp, 1 MΩ 1.8 mV to 2.5 Vpp, 50 Ω	3 % of reading + 100 μV	Comparison to Fluke 5522A SC1100 Multi-Product Calibrator
Oscilloscopes ¹ Pulse Generator	200 ns to 20 ms	5 % of Pulse Width reading + 2 ns	
Oscilloscopes ¹ Frequency Accuracy	0.2 Hz to 1 GHz	2.5 x 10 ⁻⁶ of reading	
Oscilloscopes ¹ Leveled Sinewave Absolute	50 kHz Reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1 100) MHz	2 % of reading + 300 μV 3.5 % of reading + 300 μV 4 % of reading + 300 μV 6 % of reading + 300 μV 7 % of reading + 300 μV	
Oscilloscopes ¹ Leveled Sinewave Flatness (relative to 50 kHz)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1 100) MHz	1.5 % of reading + 100 μV 2 % of reading + 100 μV 4 % of reading + 100 μV 5 % of reading + 100 μV	
Oscilloscopes ¹ Impedance Measurement	40 to 60 Ω 500 kΩ to 1.5 MΩ	0.1 % of reading	
Oscilloscopes ¹ Capacitance Measurement	5 pF to 50 pF	5 % of reading + 0.5 pF	

Length-Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers, Outside	0-1 Inch	3.3 μin/in + 39μin	Comparison to Grade 2 Gage Blocks
Calipers	Up to 6 in	31 μin/in + 270 μin	Comparison to Grade 2 Gage Blocks
Dial Indicators/Digital Indicators	Up to 1 Inch	1 μin/in + 170 μin	Comparison to Starrett Dial Indicator Calibrator
Plain Plug and Pin Gages	Up to 1 Inch	7.3 μin/in + 130 μin	Comparison to Benchtop Micrometer

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Source (Hydraulic)	(100 to 1 000) psi (1 000 to 10 000) psi	0.000 035 psi/psi + 1.2 psi 0.000 052 psi/psi + 2.4 psi	Comparison to Additel 680 and Additel 681 Pressure Gauges
Scales and Balances ³ Fixed Points, Metric	20 g 50 g 100 g 200 g 500 g 1 000 g	9.1 mg 11 mg 16 mg 15 mg 15 mg 18 mg	Comparison to Troemner Class 1 Weight Set
Scales and Balances ³ Fixed Points, Avoirdupois	0.5 lb 1.0 lb 2.0 lb 3.0 lb 4.0 lb 5.0 lb 10 lb 20 lb 50 lb	16 mg 22 mg 18 mg 18 mg 26 mg 24 mg 43 mg 150 mg 230 mg	Comparison to Troemner Class 1 Weight Set
Mass Calibration (Class F) Metric	(20 to 200) g (500 to 1 000) g	150 µg/g + 20 mg 44 µg/g + 17 mg	Comparison to Ohaus EX 6202
Mass Calibration (Class F) Avoirdupois	(5 to 13) lb (20 to 70) lb	81 µg/g + 3.5 mg 35 µg/g + 0.17g	Comparison to Ohaus EX 6202 Ohaus EX 35001
Torque Wrenches	(1 to 10) lbf in (5 to 50) lbf in (40 to 400) lbf in (100 to 1 000) lbf in (25 to 250) lbf ft (60 to 600) lbf ft	0.004 7 lbf in/lbf in + 0.13 lbf in 0.012 lbf in/lbf in + 0.13 lbf in 0.003 2 lbf in/lbf in + 0.003 6 lbf in 0.000 88 lbf in/lbf in + 2.6 lbf in 0.003 2 lbf ft/lbf ft + 0.14 lbf ft 0.00 19 lbf ft/lbf ft + 2.6 lbf ft	Comparison to AWS QCI-10 and CDI 5000ST Torque System

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature - Measure	(-25 to 140) °C	0.000 015 °C/°C + 0.13 °C	Comparison to ITS-90 using HP 3458A and Fluke 5614 PRT

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency - Source	10 MHz	1×10^{-11} Hz/Hz	Comparison to Spectracom 8194 GPS Receiver

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% of reading.

- 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. X = selected output value.
 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.



Jason Stine, Vice President

