



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Calibration Laboratory, LLC
3330 East 83rd Place
Merrillville, IN 46410

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

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

In the fields of

CALIBRATION and DIMENSIONAL MEASUREMENT

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

A handwritten signature in black ink, appearing to be 'Jason Stine', is positioned above a horizontal line.

Jason Stine, Vice President

Expiry Date: 15 February 2027
Certificate Number: L2216



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)

Calibration Laboratory, LLC

3330 East 83rd Place

Merrillville, IN 46410

Jeff Breidigan 708-596-5800

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: February 15, 2027

Certificate Number: L2216

CALIBRATION

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters ¹ (Fixed Points)	4 pH 7 pH 10 pH	0.016 pH 0.016 pH 0.016 pH	Comparison to Accredited Reference Solutions, RTD Probe

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure @ 1 kHz	(0.1 to 10) pF (10 to 100) pF 100 pF to 10 μF (10 to 100) μF (100 to 1 000) μF	4.8 mF/F 0.58 mF/F 0.46 mF/F 0.58 mF/F 4.7 mF/F	Comparison to GenRad 1689M LCR Meter
Capacitance – Source ^{1,15} (Fixed Artifacts)	0.1 nF 1 nF 10 nF 100 nF 200 nF 300 nF 400 nF 500 nF	0.58 pF 1.2 pF 12 pF 0.12 nF 0.24 nF 0.36 nF 0.47 nF 0.59 nF	Comparison to Arco SS-32 Standard Capacitors



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ^{1,15} (Simulation)	(0.19 to 3.3) nF (3.3 to 110) nF (110 to 330) nF (0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	4 pF/nF + 7.9 pF 2 pF/nF + 7.8 pF 2 pF/nF + 24 pF 2 nF/μF + 0.75 nF 2 nF/μF + 0.77 nF 2 nF/μF + 0.13 nF 3 nF/μF + 2.2 nF 3 nF/μF + 78 nF 3 nF/μF + 0.23 μF 3 nF/μF + 0.78 μF 3 μF/mF + 2.3 μF 4 μF/mF + 7.8 μF 6 μF/mF + 24 μF 9 μF/mF + 77 μF	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
AC Current – Source	(9 to 220) μA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 to 2.2) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.29 nA/μA + 23 nA 0.19 nA/μA + 14 nA 0.12 nA/μA + 10 nA 0.35 nA/μA + 15 nA 1.3 nA/μA + 80 nA 0.2 μA/mA + 350 nA 0.19 μA/mA + 78 nA 0.12 μA/mA + 47 nA 0.24 μA/mA + 0.13 μA 1.3 μA/mA + 0.8 μA 0.12 μA/mA + 4.3 μA 0.2 μA/mA + 0.42 μA 0.12 μA/mA + 0.44 μA 0.24 μA/mA + 0.7 μA 1.3 μA/mA + 6 μA 0.25 μA/mA + 4.3 μA 0.14 μA/mA + 8.6 μA 0.1 μA/mA + 3.3 μA 0.2 μA/mA + 3.6 μA 1.1 μA/mA + 10 μA 0.3 mA/A + 4.4 μA 0.45 mA/A + 81 μA 7 mA/A + 0.16 mA	Comparison to Fluke 5730A Multi Product Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.46 mA/A + 19 nA 0.95 mA/A + 6.3 μA 3.6 mA/A + 2.6 μA	Comparison to Fluke 5730A Multi Product Calibrator, Fluke 5725A Amplifier
AC Current – Source	(0.2 to 2) A (10 to 850) Hz 850 Hz to 6 kHz (6 to 10) kHz (2 to 20) A 10 Hz to 850 Hz 850 Hz to 6 kHz (6 to 10) kHz (20 to 120) A 10 Hz to 850 Hz 850 Hz to 6 kHz (6 to 10) kHz	0.11 mA/A + 36 μA 0.44 mA/A + 72 μA 16 mA/A + 62 mA 0.11 mA/A + 36 μA 0.44 mA/A + 72 μA 23 mA/A + 94 mA 29 μA/A + 23 mA 0.44 mA/A + 72 μA 31 mA/A + 0.7 A	Comparison to Fluke 5730A Multi Product Calibrator, Fluke 52120A Transconductance Amplifier
AC Current – Source ^{1,15}	(30 to 330) μA (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 (0.33 to 3.3) 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 (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	1.6 nA/μA + 78 nA 1.2 nA/μA + 78 nA 0.97 nA/μA + 78 nA 2.3 nA/μA + 0.12 μA 6.2 nA/μA + 0.16 μA 12 nA/μA + 0.31 μA 1.5 μA/mA + 0.18 μA 0.97 μA/mA + 0.12 μA 0.77 μA/mA + 0.12 μA 1.6 μA/mA + 0.16 μA 3.9 μA/mA + 0.23 μA 7.8 μA/mA + 0.47 μA 1.4 μA/mA + 1.6 μA 0.7 μA/mA + 1.6 μA 0.31 μA/mA + 1.6 μA 0.62 μA/mA + 1.6 μA 1.6 μA/mA + 2.3 μA 3.1 μA/mA + 3.1 μA	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ^{1,15}	(33 to 330) mA		Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	(10 to 20) Hz	1.4 μ A/mA + 16 μ A	
	(20 to 45) Hz	0.69 μ A/mA + 17 μ A	
	45 Hz to 1 kHz	0.31 μ A/mA + 16 μ A	
	(1 to 5) kHz	0.78 μ A/mA + 39 μ A	
	(5 to 10) kHz	1.6 μ A/mA + 78 μ A	
	10 kHz to 30 kHz	3.1 μ A/mA + 0.16 mA	
	(0.33 to 1.1) A		
	(10 to 45) Hz	1.1 μ A/mA + 78 μ A	
	45 Hz to 1 kHz	0.3 μ A/mA + 78 μ A	
	(1 to 5) kHz	3.6 μ A/mA + 0.78 mA	
	(5 to 10) kHz	15 μ A/mA + 3.9 mA	
	(1.1 to 3) A		
	(10 to 45) Hz	1.4 mA/A + 79 μ A	
	45 Hz to 1 kHz	0.47 mA/A + 78 μ A	
	(1 to 5) kHz	4.7 mA/A + 0.78 mA	
(5 to 10) kHz	19 mA/A + 3.9 mA		
(3 to 11) A			
(45 to 100) Hz	0.47 mA/A + 1.6 mA		
100 Hz to 1 kHz	0.78 mA/A + 1.6 mA		
(1 to 5) kHz	23 mA/A + 1.6 mA		
(11 to 20) A			
(45 to 100) Hz	0.93 mA/A + 3.9 mA		
100 Hz to 1 kHz	1.2 mA/A + 3.9 mA		
(1 to 5) kHz	23 mA/A + 3.9 mA		
AC Current Source – Current Clamps ^{1,15}	(45 to 65) Hz		Comparison to Fluke 5522A/SC1100 Multi Product Calibrator, Fluke 50-Turn Coil
	(10 to 16.5) A	2.2 mA/A + 3.5 mA	
	(16.5 to 150) A	2.1 mA/A + 44 mA	
	(150 to 1 025) A	2.5 mA/A + 52 mA	
	(65 to 440) Hz		
	(10 to 16.5) A	4.6 mA/A + 30 mA	
(16.5 to 150) A	6.2 mA/A + 33 mA		
(150 to 1 025) A	6.4 mA/A + 62 mA		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Source – Current Clamps	(0.2 to 25) A (6 kHz to 10 kHz)	39 mA/A + 16 mA	Comparison to Fluke 5730A Multi Product Calibrator, Fluke 52120A Transconductance Amplifier, Fluke 3KA 25-Turn Coil
	(0.2 to 50) A (3 kHz to 6 kHz)	12 mA/A + 16 mA	
	(0.2 to 50) A (1 kHz to 3 kHz)	6.2 mA/A + 16 mA	
	(0.2 to 50) A 10 Hz to 1 kHz	5.4 mA/A + 11 mA	
	(50 to 75) A (3 kHz to 6 kHz)	12 mA/A + 0.15 A	
	(50 to 300) A (1 kHz to 3 kHz)	6.2 mA/A + 0.16 A	
	(50 to 500) A 10 Hz to 1 kHz	5.4 mA/A + 0.11 A	
	(500 to 1 000) A 300 Hz to 1 kHz	3.6 mA/A + 0.45 A	
	(500 to 3 000) A 10 Hz to 300 Hz	3.6 mA/A + 0.45 A	
	DC Current – Source ^{1,15}	(0 to 330) μ A	
(0.33 to 3.3) mA		78 nA/mA + 39 nA	
(3.3 to 33) mA		77 nA/mA + 37 nA	
(33 to 330) mA		77 nA/mA + 2.2 μ A	
(0.33 to 1.1) A		0.13 mA/A + 75 μ A	
(1.1 to 3) A		0.29 mA/A + 32 μ A	
(3 to 11) A (11 to 20) A		0.39 mA/A + 0.41 mA 0.78 mA/A + 0.59 mA	
DC Current – Source	(0 to 220) μ A	50 μ A/A + 7 nA	Comparison to Fluke 5730A Multi Product Calibrator
	(0.22 to 2.2) mA	35 μ A/A + 7 nA	
	(2.2 to 22) mA	35 μ A/A + 40 nA	
	(22 to 220) mA (0.22 to 2.2) A	45 μ A/A + 0.7 μ A 80 μ A/A + 12 μ A	
DC Current – Source	(2.2 to 11) A	0.36 mA/A + 0.51 mA	Comparison to Fluke 5730A Multi Product Calibrator, Fluke 5725A Amplifier
DC Current – Source	(0 to 100) A	35 μ A/A + 23 mA	Comparison to Fluke 5730A Multi Product Calibrator, Fluke 52120A Transconductance Amplifier

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Source – Current Clamps ^{1,15}	(10 to 150) A (150 to 1 025) A	2 mA/A + 1.4 mA 2 mA/A + 48 mA	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator, Fluke 50-Turn Coil
DC Current Source – Current Clamps	(0 to 2 500) A	5.7 mA/A + 78 mA	Comparison to Fluke 5730A Multi Product Calibrator, Fluke 52120A Transconductance Amplifier, Fluke 3KA 25-Turn Coil
DC Current – Measure	10 pA to 10 nA (20 to 30) A	4.5 pA/nA + 5.9 pA 0.49 mA/A + 4.4 mA	Comparison to Transmille 8081 8.5 Digit Multimeter
DC Current – Measure ^{1,15}	(0 to 200) μ A (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A	0.33 mA/A + 12 nA 0.35 mA/A + 69 nA 2.8 μ A/A + 9.5 μ A 0.37 mA/A + 7.5 μ A 0.74 mA/A + 0.11 mA	Comparison to Keithley 2002 8.5 Digit Multimeter
DC Current – Measure ^{1,15}	(1 to 3) A	1.23 mA/A + 0.63 mA	Comparison to Agilent 34401A 6.5 Digit Multimeter
DC Current – Measure	(0 to 200) μ A 200 μ A to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	10 pA/ μ A + 0.4 nA 12 nA/mA + 4.2 nA 13 nA/mA + 41 nA 37 nA/mA + 0.82 μ A 200 μ A/A + 17 μ A 0.4 mA/A + 440 μ A	Comparison to Fluke 8508A 8.5 Digit Multimeter
AC Current – Measure	0.1 nA to 0.1 mA (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (20 to 30) A (10 to 40) Hz 40 Hz to 1 kHz	0.92 nA/ μ A + 16 nA 0.51 nA/ μ A + 13 nA 1.2 nA/ μ A + 31 nA 1.6 mA/A + 12 mA 1.2 mA/A + 9.2 mA	Comparison to Transmille 8081 8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure	(20 to 200) μ A (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (0.2 to 2) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (0.2 to 2) A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (2 to 20) A 10 Hz to 2 kHz (2 to 10) kHz	0.28 nA/ μ A + 83 nA 0.46 nA/ μ A + 19 nA 0.6 nA/ μ A + 19 nA 3 nA/ μ A + 19 nA 0.17 μ A/mA + 0.7 μ A 0.26 μ A/mA + 0.19 μ A 0.6 μ A/mA + 0.19 μ A 3.1 μ A/mA + 0.19 μ A 0.29 μ A/mA + 1.9 μ A 0.26 μ A/mA + 1.9 μ A 0.60 μ A/mA + 1.9 μ A 3.1 μ A/mA + 1.9 μ A 0.29 μ A/mA + 19 μ A 0.24 μ A/mA + 19 μ A 0.54 μ A/mA + 19 μ A 0.55 mA/A + 0.19 mA 0.63 mA/A + 0.19 mA 2.3 mA/A + 0.19 mA 0.70 mA/A + 1.9 mA 1.9 mA/A + 1.9 mA	Comparison to Fluke 8508A 8.5 Digit Multimeter
AC Current – Measure ^{1,15}	Up to 200 μ A (20 to 50) Hz (50 to 200) Hz 200 Hz to 1 kHz (1 to 10) kHz (0.2 to 2) mA (20 to 50) Hz (50 to 200) Hz 200 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (30 to 50) kHz (50 to 100) kHz	3.5 mA/A + 36 nA 2 mA/A + 38 nA 4 mA/A + 35 nA 4 mA/A + 0.27 μ A 3.5 mA/A + 0.34 μ A 1.5 mA/A + 0.3 μ A 1.2 mA/A + 0.37 μ A 0.51 mA/A + 3.2 μ A 1.6 mA/A + 3.1 μ A 2.1 mA/A + 3 μ A 5 mA/A + 0.3 μ A	Comparison to Keithley 2002 8.5 Digit Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ^{1,15}	(2 to 20) mA		Comparison to Keithley 2002 8.5 Digit Multimeter
	(20 to 50) Hz	3 mA/A + 3.4 μA	
	(50 to 200) Hz	1.5 mA/A + 3.6 μA	
	200 Hz to 1 kHz	1.2 mA/A + 3.7 μA	
	(1 to 10) kHz	0.54 mA/A + 30 μA	
	(10 to 30) kHz	1.6 mA/A + 28 μA	
	(30 to 50) kHz	2.1 mA/A + 28 μA	
	(50 to 100) kHz	4.1 mA/A + 25 μA	
	(20 to 200) mA		
	(20 to 50) Hz	3 mA/A + 33 μA	
	(50 to 200) Hz	1.5 mA/A + 34 μA	
	200 Hz to 1 kHz	1.2 mA/A + 35 μA	
	(1 to 10) kHz	0.94 mA/A + 0.21 mA	
	(10 to 30) kHz	4.4 mA/A + 0.17 mA	
	(30 to 50) kHz	9.6 mA/A + 0.13 mA	
(50 to 100) kHz	29.8 mA/A + 71 μA		
(0.2 to 2) A			
(20 to 50) Hz	4.1 mA/A + 0.35 mA		
(50 to 200) Hz	2.3 mA/A + 0.35 mA		
200 Hz to 1 kHz	3.5 mA/A + 0.35 mA		
(1 to 10) kHz	5.2 mA/A + 0.36 mA		
AC Current – Measure ^{1,15}	(1 to 3) A		Comparison to Agilent 34401A 6.5 Digit Multimeter
	(3 to 5) Hz	11 mA/A + 1.8 mA	
	(5 to 10) Hz	3.5 mA/A + 1.9 mA	
	10 Hz to 5 kHz	1.5 mA/A + 2 mA	
AC Current – Measure ¹	60 Hz		Comparison to AEMC 30K-24-2 Current Probe
	(5 to 30 000) A	10 mA/A + 1.8 A	
Inductance – Measure	1 kHz		Comparison to GenRad 1689M LCR Meter
	(10 to 100) μH	0.1 nH/μH + 0.2 μH	
	(0.1 to 1) mH	0.6 μH/mH + 0.2 μH	
	(1 to 10) mH	0.8 μH/mH + 0.2 μH	
	(10 to 100) mH	0.8 μH/mH + 2 μH	
	(0.1 to 1) H	0.8 mH/H + 20 μH	
(1 to 10) H	0.8 mH/H + 0.2 mH		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source ^{1,15} (Fixed Artifacts)	100 μ H 500 μ H 1 mH 10 mH 50 mH 100 mH 200 mH 1 H 2 H 10 H	0.12 μ H 0.62 μ H 1.2 μ H 12 μ H 61 μ H 0.12 mH 0.24 mH 1.2 mH 2.2 mH 12 mH	Comparison to GenRad 1482 Series Standard Inductors
Phase – Measure/Source ^{1,15} (0.01 to 100) V	(0 to 360) $^{\circ}$ 1 Hz to 100 Hz 1 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz	0.037 $^{\circ}$ 0.056 $^{\circ}$ 0.068 $^{\circ}$ 0.13 $^{\circ}$ 0.36 $^{\circ}$	Comparison to Keysight 53220A Phase Meter, Fluke 5522A/SC1100 Multi Product Calibrator
DC Power – Source ^{1,15}	(0 to 336) W (336 to 3 060) W (3 060 to 20 910) W	0.037 % of reading 0.053 % of reading 0.12 % of reading	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
AC Power – Source ^{1,15}	(45 to 65) Hz (0.11 to 3) mW (3 to 11) mW (11 to 30) mW (30 to 110) mW (110 to 300) mW (300 to 730) mW (0.73 to 1.5) W (1.5 to 6.8) W (6.8 to 9.2) W (9.2 to 34) W (34 to 92) W (92 to 337) W (337 to 918) W (918 to 2 244) W (2 244 to 4 590) W (4 590 to 11 220) W	0.11 % of reading 0.12 % of reading 0.17 % of reading 0.12 % of reading 0.16 % of reading 0.13 % of reading 0.15 % of reading 0.14 % of reading 0.14 % of reading 0.1 % of reading 0.14 % of reading 0.1 % of reading 0.13 % of reading 0.11 % of reading 0.14 % of reading 0.12 % of reading	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source (Fixed Artifacts)	25 Ω	0.3 mΩ	Comparison to Vishay Resistance Standards
	100 Ω	1.2 mΩ	
	200 Ω	2.3 mΩ	
	400 Ω	4.7 mΩ	
	1 kΩ	12 mΩ	
	1.9 kΩ	22 mΩ	
	4 kΩ	48 mΩ	
	10 kΩ	0.13 Ω	
	40 kΩ	0.46 Ω	
	90 kΩ	1.1 Ω	
	100 kΩ	1.2 Ω	
	900 kΩ	11 Ω	
1 MΩ	12 Ω		
Resistance – Source (Fixed Points)	0 Ω	40 μΩ	Comparison to Fluke 5730A Multi Product Calibrator
	1 Ω	95 μΩ	
	1.9 Ω	0.18 mΩ	
	10 Ω	0.23 mΩ	
	19 Ω	0.44 mΩ	
	100 Ω	1.5 mΩ	
	190 Ω	1.9 mΩ	
	1 kΩ	6.5 mΩ	
	1.9 kΩ	12 mΩ	
	10 kΩ	66 mΩ	
	19 kΩ	0.12 Ω	
	100 kΩ	0.85 Ω	
	190 kΩ	1.6 Ω	
	1 MΩ	13 Ω	
	1.9 MΩ	39 Ω	
	10 MΩ	0.42 kΩ	
	19 MΩ	1.2 kΩ	
100 MΩ	10 kΩ		
Resistance – Source (Fixed Artifacts)	1 GΩ	49 kΩ	Comparison to Measurements International Resistance Standards
	10 GΩ	0.64 MΩ	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ^{1,15} (Simulation)	(0 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 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 (0.33 to 1.1) GΩ	31 μΩ/Ω + 0.8 mΩ 23 μΩ/Ω + 1.2 mΩ 22 μΩ/Ω + 1.1 mΩ 22 μΩ/Ω + 1.7 mΩ 22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 16 mΩ 20 μΩ/Ω + 16 mΩ 20 μΩ/Ω + 0.16 Ω 22 μΩ/Ω + 0.17 Ω 25 μΩ/Ω + 1.6 Ω 46 μΩ/Ω + 24 Ω 44 μΩ/Ω + 35 Ω 93 μΩ/Ω + 160 Ω 0.18 mΩ/Ω + 2.7 kΩ 0.38 mΩ/Ω + 3.9 kΩ 2.3 mΩ/Ω + 84 kΩ 13 mΩ/Ω - 0.18 MΩ	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
Resistance – Measure ^{1,15}	(0 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ	9.1 μΩ/Ω + 0.45 mΩ 13.3 μΩ/Ω + 1.1 mΩ 5.5 μΩ/Ω + 11 mΩ 4.8 μΩ/Ω + 0.12 Ω 30.7 μΩ/Ω + 1.2 Ω 55 μΩ/Ω + 0.11 kΩ 0.23 mΩ/Ω + 0.58 kΩ 0.53 mΩ/Ω + 4.7 kΩ	Comparison to Keithley 2002 8.5 Digit Multimeter
Resistance – Measure	(0.1 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ	10 μΩ/Ω + 5 μΩ 9 μΩ/Ω + 14 μΩ 7.4 μΩ/Ω + 62 μΩ 7.4 μΩ/Ω + 0.6 mΩ 7.4 μΩ/Ω + 7 mΩ 7.5 μΩ/Ω + 60 mΩ 3.9 μΩ/Ω + 20 Ω 46 mΩ/MΩ + 0.8 kΩ	Comparison to Fluke 8508A 8.5 Digit Multimeter
Resistance – Measure	(2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	15 Ω/MΩ + 10 Ω 60 Ω/MΩ + 1 kΩ 0.15 MΩ/GΩ + 0.1 MΩ 0.52 MΩ/GΩ + 10 MΩ	Comparison to Fluke 8508A 8.5 Digit Multimeter (HV mode)
Resistance – Measure	24 GΩ to 2 TΩ	16 MΩ/GΩ + 2.8 MΩ	Comparison to Transmille 8081 8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices – Source ^{1,15}	Pt 385, 100 Ω		Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	(-200 to -80) °C	0.041 °C	
	(-80 to 0) °C	0.041 °C	
	(0 to 100) °C	0.056 °C	
	(100 to 300) °C	0.071 °C	
	(300 to 400) °C	0.079 °C	
	(400 to 630) °C	0.094 °C	
	(630 to 800) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.034 °C	
	(-80 to 0) °C	0.027 °C	
	(0 to 100) °C	0.034 °C	
	(100 to 260) °C	0.034 °C	
	(260 to 300) °C	0.086 °C	
	(300 to 400) °C	0.095 °C	
	(400 to 600) °C	0.095 °C	
	(600 to 630) °C	0.11 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.034 °C	
	(-80 to 0) °C	0.041 °C	
	(0 to 100) °C	0.041 °C	
	(100 to 260) °C	0.049 °C	
	(260 to 300) °C	0.064 °C	
	(300 to 400) °C	0.064 °C	
	(400 to 600) °C	0.071 °C	
	(600 to 630) °C	0.086 °C	
	Pt 385, 1 kΩ		
	(-200 to -80) °C	0.027 °C	
(-80 to 0) °C	0.027 °C		
(0 to 100) °C	0.034 °C		
(100 to 260) °C	0.041 °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		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices – Source ^{1,15}	Pt 3916, 100 Ω		Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.034 °C	
	(-80 to 0) °C	0.041 °C	
	(0 to 100) °C	0.048 °C	
	(100 to 260) °C	0.056 °C	
	(260 to 300) °C	0.063 °C	
	(300 to 400) °C	0.071 °C	
	(400 to 600) °C	0.079 °C	
	(600 to 630) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.041 °C	
	(-80 to 0) °C	0.041 °C	
	(0 to 100) °C	0.056 °C	
	(100 to 300) °C	0.071 °C	
(300 to 400) °C	0.079 °C		
(400 to 630) °C	0.094 °C		
Ni 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 Voltage – Source	(0 to 220) mV	8.2 μV/V + 0.41 μV	Comparison to Fluke 5730A Multi Product Calibrator
	(0.22 to 2.2) V	5 μV/V + 0.77 μV	
	(2.2 to 11) V	0.45 μV/V + 3.5 μV	
	(11 to 22) V	3.5 μV/V + 0.59 μV	
	(22 to 220) V	5.8 μV/V + 51 μV	
	(220 to 1 100) V	6.5 μV/V + 0.42 mV	
DC High Voltage – Source ^{1,15}	(0.01 to 1 400) V	0.3 mV/V + 37 mV	Comparison to HV Output monitored with Vitrek 4700 High Voltage Meter, HVL-35 Probe, HVL-100 Probe
	(1.4 to 10) kV	0.28 V/kV + 0.34 V	
	(1 to 35) kV	0.8 V/kV + 0.25 V	
	(10 to 100) kV	0.56 V/kV	
DC Voltage – Source ^{1,15}	(0 to 330) mV	13 μV/V + 2 μV	Fluke 5522A/SC1100 Multi Product Calibrator
	(0.33 to 3.3) V	8 μV/V + 4.1 μV	
	(3.3 to 33) V	8.9 μV/V + 34 μV	
	(33 to 330) V	13.6 μV/V + 0.26 mV	
	(330 to 1 000) V	14 μV/V + 1.1 mV	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source	(0.22 to 2.2) mV		Comparison to Fluke 5730A Multi Product Calibrator
	(10 to 20) Hz	0.23 $\mu\text{V}/\text{mV}$ + 3.9 μV	
	(20 to 40) Hz	410 nV/mV + 3.8 μV	
	40 Hz to 20 kHz	81 nV/mV + 3.9 μV	
	(20 to 50) kHz	0.19 $\mu\text{V}/\text{mV}$ + 3.9 μV	
	(50 to 100) kHz	0.46 $\mu\text{V}/\text{mV}$ + 4.7 μV	
	(100 to 300) kHz	1 $\mu\text{V}/\text{mV}$ + 9.3 μV	
	(300 to 500) kHz	1.3 $\mu\text{V}/\text{mV}$ + 19 μV	
	500 kHz to 1 MHz	2.6 $\mu\text{V}/\text{mV}$ + 19 μV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.23 $\mu\text{V}/\text{mV}$ + 3.9 μV	
	(20 to 40) Hz	89 nV/mV + 3.9 μV	
	40 Hz to 20 kHz	77 nV/mV + 3.9 μV	
	(20 to 50) kHz	0.19 $\mu\text{V}/\text{mV}$ + 3.9 μV	
	(50 to 100) kHz	0.47 $\mu\text{V}/\text{mV}$ + 4.7 μV	
	(100 to 300) kHz	1 $\mu\text{V}/\text{mV}$ + 9.3 μV	
	(300 to 500) kHz	1 $\mu\text{V}/\text{mV}$ + 9.3 μV	
	500 kHz to 1 MHz	2.6 $\mu\text{V}/\text{mV}$ + 19 μV	
	(22 to 220) mV		
	(10 to 20) Hz	0.23 $\mu\text{V}/\text{mV}$ + 12 μV	
	(20 to 40) Hz	89 nV/mV + 6.3 μV	
	40 Hz to 20 kHz	54 nV/mV + 6.2 μV	
	(20 to 50) kHz	0.12 $\mu\text{V}/\text{mV}$ + 6.2 μV	
	(50 to 100) kHz	0.31 $\mu\text{V}/\text{mV}$ + 16 μV	
	(100 to 300) kHz	1 $\mu\text{V}/\text{mV}$ + 9.3 μV	
	(300 to 500) kHz	1.3 $\mu\text{V}/\text{mV}$ + 27 μV	
	500 kHz to 1 MHz	2.6 $\mu\text{V}/\text{mV}$ + 47 μV	
(0.22 to 2.2) V			
(10 to 20) Hz	0.23 mV/V + 45 μV		
(20 to 40) Hz	85 $\mu\text{V}/\text{V}$ + 16 μV		
40 Hz to 20 kHz	37 $\mu\text{V}/\text{V}$ + 8.5 μV		
(20 to 50) kHz	62 $\mu\text{V}/\text{V}$ + 9.7 μV		
(50 to 100) kHz	78 $\mu\text{V}/\text{V}$ + 31 μV		
(100 to 300) kHz	0.31 mV/V + 78 μV		
(300 to 500) kHz	0.93 mV/V + 0.2 mV		
500 kHz to 1 MHz	1.6 mV/V + 0.31 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source	(2.2 to 22) V		Comparison to Fluke 5730A Multi Product Calibrator
	(10 to 20) Hz	0.23 mV/V + 0.46 mV	
	(20 to 40) Hz	85 μ V/V + 0.13 mV	
	40 Hz to 20 kHz	37 μ V/V + 58 μ V	
	(20 to 50) kHz	62 μ V/V + 0.95 mV	
	(50 to 100) kHz	77 μ V/V + 0.2 mV	
	(100 to 300) kHz	0.23 mV/V + 0.62 mV	
	(300 to 500) kHz	0.93 mV/V + 1.9 mV	
	500 kHz to 1 MHz	1.4 mV/V + 3.1 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.23 mV/V + 4.2 mV	
	(20 to 40) Hz	85 μ V/V + 1.7 mV	
	40 Hz to 20 kHz	50 μ V/V + 0.69 mV	
	(20 to 50) kHz	77 μ V/V + 0.96 mV	
(50 to 100) kHz	0.14 mV/V + 2.4 mV		
(100 to 300) kHz	0.85 mV/V + 16 mV		
AC Voltage – Source	(220 to 750) V		Comparison to Fluke 5730A Multi Product Calibrator, Fluke 5725A Amplifier
	(30 to 50) kHz	8.6 mV + 0.47 mV/V	
	(50 to 100) kHz	35 mV + 1.8 mV/V	
	(220 to 1 100) V		
	(1 to 20) kHz	4.7 mV + 0.13 mV/V	
(20 to 30) kHz	8.5 mV + 0.47 mV/V		
AC Voltage – Source ^{1,15}	(1 to 33) mV		Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	(10 to 45) Hz	0.62 μ V/mV + 5 μ V	
	45 Hz to 10 kHz	0.11 μ V/mV + 5.1 μ V	
	(10 to 20) kHz	0.13 μ V/mV + 1.3 μ V	
	(20 to 50) kHz	0.77 μ V/mV + 4.9 μ V	
	(50 to 100) kHz	2.7 μ V/mV + 9.4 μ V	
(100 to 500) kHz	6.2 μ V/mV + 39 μ V		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ^{1,15}	(33 to 330) mV		Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	(10 to 45) Hz	0.23 μ V/mV + 6.4 μ V	
	45 Hz to 10 kHz	0.11 μ V/mV + 6.4 μ V	
	(10 to 20) kHz	0.12 μ V/mV + 6.5 μ V	
	(20 to 50) kHz	0.27 μ V/mV + 6.4 μ V	
	(50 to 100) kHz	0.62 μ V/mV + 25 μ V	
	(100 to 500) kHz	1.6 μ V/mV + 54 μ V	
	(0.33 to 3.3) V		
	(10 to 45) Hz	0.12 mV/V + 47 μ V	
	45 Hz to 10 kHz	0.12 mV/V + 47 μ V	
	(10 to 20) kHz	0.15 mV/V + 47 μ V	
	(20 to 50) kHz	0.23 mV/V + 39 μ V	
	(50 to 100) kHz	0.54 mV/V + 97 μ V	
	(100 to 500) kHz	1.9 mV/V + 0.47 mV	
	(3.3 to 33) V		
(10 to 45) Hz	0.23 mV/V + 0.5 mV		
45 Hz to 10 kHz	0.12 mV/V + 0.47 mV		
(10 to 20) kHz	0.23 mV/V + 0.51 mV		
(20 to 50) kHz	0.27 mV/V + 0.47 mV		
(50 to 100) kHz	0.7 mV/V + 1.2 mV		
(33 to 330) V			
45 Hz to 1 kHz	0.15 mV/V + 1.7 mV		
(1 to 10) kHz	0.16 mV/V + 4.8 mV		
(10 to 20) kHz	0.19 mV/V + 4.8 mV		
(20 to 50) kHz	0.23 mV/V + 4.9 mV		
(50 to 100) kHz	1.6 mV/V + 39 mV		
(330 to 1 000) V			
45 Hz to 1 kHz	0.23 mV/V + 7.9 mV		
(1 to 5) kHz	0.19 mV/V + 8.1 mV		
(5 to 10) kHz	0.23 mV/V + 7.9 mV		
AC High Voltage – Source ^{1,15}	60 Hz 10 mV to 1 400 V (1.4 to 10) kV	0.3 mV/V + 40 mV 58 mV/kV + 17 V	Comparison to HV Output Monitored with Vitretek 4700 High Voltage Meter
DC Voltage – Measure ^{1,15}	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1 000) V	16.6 μ V/V + 2.6 μ V 7.3 μ V/V + 9.4 μ V 7.8 μ V/V + 59 μ V 19.3 μ V/V + 1.1 mV 18.6 μ V/V + 4.5 mV	Comparison to Keithley 2002 8.5 Digit Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1 000) V	4.4 $\mu\text{V/V} + 0.12 \mu\text{V}$ 3 $\mu\text{V/V} + 0.4 \mu\text{V}$ 3 $\mu\text{V/V} + 1.2 \mu\text{V}$ 4.5 $\mu\text{V/V} + 46 \mu\text{V}$ 4.5 $\mu\text{V/V} + 0.53 \text{mV}$	Comparison to Fluke 8508A 8.5 Digit Multimeter
DC High Voltage – Measure ^{1,15}	10 mV to 1 400 V (1.4 to 10) kV (1 to 35) kV (10 to 100) kV	0.3 mV/V + 37 mV 0.29 mV/V + 37 mV 0.27 mV/V + 0.65 V 0.57 mV/V	Comparison to Vitretek 4700 High Voltage Meter, HVL-35 Probe, HVL-100 Probe
AC Voltage – Measure ^{1,15}	(2 to 200) mV (1 to 10) Hz (10 to 50) Hz (50 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 50) kHz (50 to 100) kHz (100 to 200) kHz 200 kHz to 1 MHz (1 to 2) MHz (0.2 to 2) V (1 to 10) Hz (10 to 50) Hz (50 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 50) kHz (50 to 100) kHz (100 to 200) kHz 200 kHz to 1 MHz (1 to 2) MHz	0.79 mV/V + 59 μV 0.59 mV/V + 34 μV 0.34 mV/V + 34 μV 0.18 mV/V + 26 μV 0.18 mV/V + 26 μV 0.45 mV/V + 33 μV 0.45 mV/V + 33 μV 2.9 mV/V + 60 μV 7.3 mV/V + 0.1 mV 19 mV/V + 0.44 mV 49.5 mV/V + 0.52 mV 0.9 mV/V + 0.3 mV 0.4 mV/V + 0.3 mV 0.25 mV/V + 0.31 mV 0.2 mV/V + 0.22 mV 0.19 mV/V + 0.23 mV 0.49 mV/V + 0.23 mV 0.49 mV/V + 0.23 mV 3 mV/V + 0.31 mV 7.5 mV/V + 0.51 mV 20 mV/V + 2 mV 37 mV/V + 39 mV	Comparison to Keithley 2002 8.5 Digit Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ^{1,15}	(2 to 20) V		Comparison to Keithley 2002 8.5 Digit Multimeter
	(1 to 10) Hz	0.92 mV/V + 5.2 mV	
	(10 to 50) Hz	0.6 mV/V + 3.1 mV	
	(50 to 100) Hz	0.35 mV/V + 3.1 mV	
	100 Hz to 2 kHz	0.3 mV/V + 3.1 mV	
	(2 to 10) kHz	0.4 mV/V + 3.1 mV	
	(10 to 30) kHz	0.49 mV/V + 3.3 mV	
	(30 to 50) kHz	0.69 mV/V + 3.2 mV	
	(50 to 100) kHz	0.29 mV/V + 3.3 mV	
	(100 to 200) kHz	7.5 mV/V + 5.1 mV	
	200 kHz to 1 MHz	39.8 mV/V + 45 mV	
	(1 to 2) MHz	70 mV/V + 43 mV	
	(20 to 200) V		
	(1 to 10) Hz	0.92 mV/V + 52 mV	
	(10 to 50) Hz	0.49 mV/V + 31 mV	
	(50 to 100) Hz	0.29 mV/V + 32 mV	
	100 Hz to 2 kHz	0.29 mV/V + 32 mV	
	(2 to 10) kHz	0.39 mV/V + 32 mV	
	(10 to 30) kHz	0.49 mV/V + 33 mV	
	(30 to 50) kHz	0.69 mV/V + 33 mV	
	(50 to 100) kHz	3 mV/V + 30 mV	
	(100 to 200) kHz	7.5 mV/V + 53 mV	
	200 kHz to 1 MHz	40 mV/V + 0.4 V	
	(200 to 750) V		
	(1 to 10) Hz	1.3 mV/V + 0.12 V	
	(10 to 50) Hz	0.89 mV/V + 0.12 V	
	(50 to 100) Hz	0.49 mV/V + 0.12 V	
	100 Hz to 2 kHz	0.49 mV/V + 0.12 V	
	(2 to 10) kHz	0.6 mV/V + 0.11 V	
	(10 to 30) kHz	0.57 mV/V + 0.42 V	
(30 to 50) kHz	0.76 mV/V + 0.4 V		
(50 to 100) kHz	4.9 mV/V + 0.23 V		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	Up to 2.2 mV		Comparison to Fluke 5790A AC Voltage Measurement Standard
	(10 to 20) Hz	1.3 $\mu\text{V/mV}$ + 1 μV	
	(20 to 40) Hz	0.55 $\mu\text{V/mV}$ + 1.1 μV	
	40 Hz to 20 kHz	0.32 $\mu\text{V/mV}$ + 1 μV	
	(20 to 50) kHz	0.81 $\mu\text{V/mV}$ + 2 μV	
	(50 to 100) kHz	0.93 $\mu\text{V/mV}$ + 1.9 μV	
	(100 to 300) kHz	1.8 $\mu\text{V/mV}$ + 3.1 μV	
	(300 to 500) kHz	1.9 $\mu\text{V/mV}$ + 6.2 μV	
	500 kHz to 1 MHz	2.7 $\mu\text{V/mV}$ + 6.2 μV	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.85 $\mu\text{V/mV}$ + 1.3 μV	
	(20 to 40) Hz	0.28 $\mu\text{V/mV}$ + 1.1 μV	
	40 Hz to 20 kHz	0.16 $\mu\text{V/mV}$ + 1 μV	
	(20 to 50) kHz	2.8 nV/mV + 320 μV	
	(50 to 100) kHz	0.46 $\mu\text{V/mV}$ + 2 μV	
	(100 to 300) kHz	0.93 $\mu\text{V/mV}$ + 3.1 μV	
	(300 to 500) kHz	1 $\mu\text{V/mV}$ + 6.2 μV	
	500 kHz to 1 MHz	1.8 $\mu\text{V/mV}$ + 6.2 μV	
	(7 to 22) mV		
	(10 to 20) Hz	0.22 $\mu\text{V/mV}$ + 1.1 μV	
	(20 to 40) Hz	0.14 $\mu\text{V/mV}$ + 1.1 μV	
	40 Hz to 20 kHz	84 nV/mV + 1.1 μV	
	(20 to 50) kHz	0.16 $\mu\text{V/mV}$ + 1.6 μV	
	(50 to 100) kHz	0.24 $\mu\text{V/mV}$ + 1.9 μV	
	(100 to 300) kHz	0.63 $\mu\text{V/mV}$ + 3.1 μV	
	(300 to 500) kHz	0.69 $\mu\text{V/mV}$ + 6.2 μV	
	500 kHz to 1 MHz	1.3 $\mu\text{V/mV}$ + 6.2 μV	
	(22 to 70) mV		
(10 to 20) Hz	0.19 $\mu\text{V/mV}$ + 1.2 μV		
(20 to 40) Hz	0.09 $\mu\text{V/mV}$ + 1.4 μV		
40 Hz to 20 kHz	0.05 $\mu\text{V/mV}$ + 1.2 μV		
(20 to 50) kHz	0.1 $\mu\text{V/mV}$ + 1.6 μV		
(50 to 100) kHz	0.2 $\mu\text{V/mV}$ + 1.9 μV		
(100 to 300) kHz	0.4 $\mu\text{V/mV}$ + 3.1 μV		
(300 to 500) kHz	0.52 $\mu\text{V/mV}$ + 6.2 μV		
500 kHz to 1 MHz	0.85 $\mu\text{V/mV}$ + 6.2 μV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(70 to 220) mV		Comparison to Fluke 5790A AC Voltage Measurement Standard
	(10 to 20) Hz	0.16 $\mu\text{V}/\text{mV}$ + 1.6 μV	
	(20 to 40) Hz	65 nV/mV + 1.3 μV	
	40 Hz to 20 kHz	30 nV/mV + 1.2 μV	
	(20 to 50) kHz	50 nV/mV + 1.6 μV	
	(50 to 100) kHz	0.12 $\mu\text{V}/\text{mV}$ + 2 μV	
	(100 to 300) kHz	0.19 $\mu\text{V}/\text{mV}$ + 3.1 μV	
	(300 to 500) kHz	0.29 $\mu\text{V}/\text{mV}$ + 6.2 μV	
	500 kHz to 1 MHz	0.78 $\mu\text{V}/\text{mV}$ + 6.2 μV	
	(220 to 700) mV		
	(10 to 20) Hz	0.16 $\mu\text{V}/\text{mV}$ + 2.4 μV	
	(20 to 40) Hz	60 nV/mV + 1.8 μV	
	40 Hz to 20 kHz	30 nV/mV + 1.7 μV	
	(20 to 50) kHz	40 nV/mV + 1.9 μV	
	(50 to 100) kHz	60 nV/mV + 2.1 μV	
	(100 to 300) kHz	0.14 $\mu\text{V}/\text{mV}$ + 3.6 μV	
	(300 to 500) kHz	0.23 $\mu\text{V}/\text{mV}$ + 6.3 μV	
	500 kHz to 1 MHz	0.74 $\mu\text{V}/\text{mV}$ + 6.2 μV	
	(0.7 to 2.2) V		
	(10 to 20) Hz	0.15 mV/V + 6 μV	
	(20 to 40) Hz	51 $\mu\text{V}/\text{V}$ + 90 nV	
	40 Hz to 20 kHz	18 $\mu\text{V}/\text{V}$ + 1 μV	
	(20 to 50) kHz	35 $\mu\text{V}/\text{V}$ + 0.5 μV	
	(50 to 100) kHz	55 $\mu\text{V}/\text{V}$ + 0.1 μV	
	(100 to 300) kHz	0.12 mV/V + 0.6 μV	
	(300 to 500) kHz	0.20 mV/V - 0.2 μV	
	500 kHz to 1 MHz	0.7 mV/V	
	(2.2 to 7) V		
(10 to 20) Hz	200 $\mu\text{V}/\text{V}$ + 10 μV		
(20 to 40) Hz	50 $\mu\text{V}/\text{V}$ + 5 μV		
40 Hz to 20 kHz	20 $\mu\text{V}/\text{V}$ + 9 μV		
(20 to 50) kHz	40 $\mu\text{V}/\text{V}$ + 2 μV		
(50 to 100) kHz	60 $\mu\text{V}/\text{V}$ + 0.8 μV		
(100 to 300) kHz	0.1 mV/V + 1 μV		
(300 to 500) kHz	0.3 mV/V + 80 μV		
500 kHz to 1 MHz	0.9 mV/V - 1 μV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(7 to 22) V		Comparison to Fluke 5790A AC Voltage Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 70 μV	
	(20 to 40) Hz	50 μV/V + 20 μV	
	40 Hz to 20 kHz	20 μV/V + 10 μV	
	(20 to 50) kHz	40 μV/V + 3 μV	
	(50 to 100) kHz	60 μV/V + 2 μV	
	(100 to 300) kHz	0.1 mV/V + 2 μV	
	(300 to 500) kHz	0.3 mV/V	
	500 kHz to 1 MHz	0.9 mV/V + 4 μV	
	(22 to 70) V		
	(10 to 20) Hz	0.2 mV/V + 50 μV	
	(20 to 40) Hz	50 μV/V + 0.3 mV	
	40 Hz to 20 kHz	20 μV/V + 70 μV	
	(20 to 50) kHz	40 μV / V + 30 μV	
	(50 to 100) kHz	70 μV/V + 20 μV	
	(100 to 300) kHz	0.2 mV/V + 0.2 mV	
	(300 to 500) kHz	0.3 mV/V + 10 μV	
	500 kHz to 1 MHz	0.9 mV/V + 7 μV	
	(70 to 220) V		
	(10 to 20) Hz	0.2 mV/V + 0.3 mV	
	(20 to 40) Hz	50 μV/V + 0.2 mV	
	40 Hz to 20 kHz	20 μV/V + 0.2 mV	
	(20 to 50) kHz	50 μV/V + 30 μV	
	(50 to 100) kHz	80 μV/V + 20 μV	
	(100 to 300) kHz	0.2 mV/V + 0.2 mV	
	(300 to 500) kHz	0.4 mV/V + 90 μV	
	(220 to 700) V		
	(10 to 20) Hz	0.2 mV/V + 0.2 mV	
	(20 to 40) Hz	0.08 mV/V + 0.4 mV	
	40 Hz to 20 kHz	30 μV/V + 0.4 mV	
(20 to 50) kHz	0.1 mV/V + 0.1 mV		
(50 to 100) kHz	0.4 mV/V + 60 μV		
(700 to 1 000) V			
(10 to 20) Hz	0.2 mV/V - 0.4 mV		
(20 to 40) Hz	80 μV/V + 0.5 mV		
40 Hz to 20 kHz	30 μV/V + 0.2 mV		
(20 to 50) kHz	0.1 mV/V + 30 μV		
(50 to 100) kHz	0.4 mV/V - 6 μV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage – Measure ^{1,15}	(50 to 600) Hz 10 mV to 1 400 V (1.4 to 10) kV (1 to 35) kV	1.2 V/kV + 0.16 V 1.2 V/kV + 0.2 V 0.8 V/kV + 0.25 V	Comparison to Vitrek 4700 High Voltage Meter, HVL-35 Probe, HVL-100 Probe
	50 or 60 Hz (10 to 75) kV	1.2 V/kV + 1.1 V	
	(50 to 400) Hz (1 to 100) kV	10 V/kV + 0.12 V	Comparison to Hipotronics KVM 100 High Voltage Meter w/Probe
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure ^{1,15}	Type B (600 to 800) °C	0.34 °C	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	(800 to 1 000) °C	0.28 °C	
	(1 000 to 1 550) °C	0.25 °C	
	(1 550 to 1 820) °C	0.26 °C	
	Type C (0 to 150) °C	0.23 °C	
	(150 to 650) °C	0.21 °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	0.41 °C	
	(-100 to -25) °C	0.13 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.13 °C	
	(650 to 1 000) °C	0.17 °C	
	Type J (-210 to -100) °C	0.23 °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		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure ^{1,15}	Type N (-200 to -100) °C	0.31 °C	Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	(-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	0.45 °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	0.37 °C	
	(250 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	0.13 °C		
(120 to 400) °C	0.11 °C		
Oscilloscopes ^{1,15}			Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
Amplitude – DC Signal into 50 Ω load	± 1 mV to ± 6.6 V	1.5 mV/V + 28 μV	
into 1 MΩ load	± 1 mV to ± 130 V	0.39 mV/V + 32 μV	
Amplitude – Square Wave into 50 Ω load	1 mVp-p to 6.6 Vp-p 10 Hz to 10 kHz	1.9 mV/V + 32 μV	
into 1 MΩ load	1 mVp-p to 130 Vp-p 10 Hz to 1 kHz (1 to 10) kHz	0.78 mV/V + 34 μV 2 mV/V + 48 μV	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ^{1,15} Leveled Sine Wave – Amplitude (50 kHz ref) into 50 Ω load	5 mV to 5.5 V		Comparison to Fluke 5522A/SC1100 Multi Product Calibrator
	50 kHz to 100 MHz	27 mV/V + 1.7 mV	
	(100 to 300) MHz	31 mV/V + 0.25 mV	
	(300 to 600) MHz	47 mV/V + 0.25 mV	
	5 mV to 3.5 V		
	(600 to 1 100) MHz	0.42 mV + 54 mV/V	
	5 mVp-p to 5.5 Vp-p		
	50 kHz to 100 MHz	12 mV/V + 0.1 mV	
	(100 to 300) MHz	16 mV/V + 0.1 mV	
	(300 to 600) MHz	31 mV/V + 0.1 mV	
Time Markers	4 mVp-p to 3.5 Vp-p		
	(600 to 1 100) MHz	39 mV/V + 90 μV	
	1 ns to 20 ms	2. ps/μs	
	50 ms	4.4 μs	
	0.1 s	9.8 μs	
	0.2 s	35 μs	
	0.5 s	0.2 ms	
	1 s	0.8 ms	
Edge – Rise Time	2 s	3.1 ms	
	5 s	20 ms	
	(250 to 350) ps 1 kHz to 11 MHz	310 ps	
Total Harmonic Distortion ^{1,15}	10 Hz to 500 kHz		Comparison to Pico Technologies 4262 Digital Oscilloscope
	(-95 to -50) dB	0.021 dB	
	(-50 to -20) dB	0.13 dB	
	(-20 to 0) dB	0.89 dB	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Caliper Masters ²	(0.5 to 4) in (4 to 40) in (40 to 60) in	(1.8 + 4L) μin (4.5L) μin (130 + 1L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Cylindrical Plug Gauges ^{2,12}	(0.01 to 0.1) in (0.1 to 0.42) in (0.42 to 4) in (4 to 12) in	(3.1 – 2L) μin (2.9 + 2L) μin (1.9 + 4L) μin (1 + 4L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Cylindrical Ring Gauges ^{2,14}	(0.01 to 0.22) in (0.22 to 1) in (1 to 4) in (4 to 7) in (7 to 10) in (10 to 13) in	(8.3 + 2.8L) μin (8 + 4.5L) μin (10 + 2.7L) μin (22 + 2.7L) μin (9.2 + 5L) μin (9.4 + 5L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks, Master Ring Gauges
Depth Micrometer Master ²	(0.5 to 11.5) in	(28 + 1L) μin	Comparison to Gauging Amplifier, Gauge Blocks
End Measuring Rods ²	(0.5 to 4) in (4 to 20) in (20 to 80) in	(4.1 + 3L) μin (0.61 + 4L) μin (100 + 4L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Feeler Gauges ¹ (Leaf-Style)	Up to 0.25 in	76 μin	Comparison to Bench Micrometer
Gauge Balls ² (size only)	(0.062 5 to 0.1) in (0.1 to 0.42) in (0.42 to 2) in	(10 – 2L) μin (9 + 2L) μin (8 + 5L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Gauge Blocks ^{2,6}	(0.005 to 4) in	(3 + 0.45L) μin	Comparison to Mahr 130-B24 Comparator, Master Gauge Blocks
Gauge Blocks ^{2,6}	(0.005 to 0.1) in (0.1 to 0.42) in (0.42 to 4) in (5 to 20) in	(2.9 – 2L) μin (2.7 + 0.8L) μin (2.4 + 1L) μin (1.3 + 1L) μin	Comparison to P&W Labmaster® Universal 1000A, Master Gauge Blocks
Micrometer Masters ²	Up to 0.1 in (0.1 to 0.42) in (0.42 to 4) in (4 to 20) in (20 to 40) in	(3.1 – 4L) μin (2.6 + 2L) μin (1.8 + 4L) μin (0.53 + 4L) μin (4L – 8.1) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Flats and Parallels Flatness Up to 4 in Diameter	Up to 100 μin	5.6 μin	Comparison to Optical Flat, Monochromatic Light
	Parallelism (0 to 2) in thickness	4.5 μin	Comparison to Mahr 130-B24 Comparator
Parallels	Up to 36 in	66 μin	Comparison to Gauging Amplifier, Gauge Blocks
Pin Gauges – Class ZZ ²	(0.01 to 1) in	(93 + 2.44L) μin	Comparison to Digital Micrometer
Riser Blocks ²	(6 to 24) in	(19 + 7L) μin	Comparison to Gauging Amplifier, Gauge Blocks
Snap Gauges ²	(0.01 to 0.22) in (0.22 to 1) in (1 to 13) in	(23 – 1L) μin (24 – 4L) μin (16 + 3.7L) μin	Comparison to P&W Labmaster [®] Universal 1000A, Gauge Blocks
Squares – Perpendicularity ²	Up to 36 in	(35 + 8L) μin	Comparison to Indi-Square, Gauging Amplifier, Gauge Blocks, Tri-Square
Tapered Plugs ²	Up to 0.1 in (0.1 to 0.42) in (0.42 to 2) in	(23 – 0.8L) μin (22 + 0.26L) μin (22 + 0.87L) μin	Comparison to P&W Labmaster [®] Universal 1000A, Gauge Blocks, Plug Gauges
Tapered Rings ²	(0.01 to 0.22) in (0.22 to 1) in (1 to 2) in	(24 – 0.14L) μin (25 – 1.7L) μin (17 + 6.3L) μin	Comparison to P&W Labmaster [®] Universal 1000A, Gauge Blocks
Thickness (Film) Gauge Standards (Non-Ferrous)	Up to 0.05 in	6.1 μin	Comparison to P&W Labmaster [®] Universal 1000A, Gauge Blocks
Thread Measuring Wires ^{2,10}	Unified 60° (4 to 80) TPI	(13 – 50L) μin	Comparison to P&W Labmaster [®] Universal 1000A, Gauge Blocks
	Acme 29° (1 to 20) TPI	(13 – 50L) μin	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Micrometer Standards	1 in 2 in 3 in 4 in 5 in 6 in	8.8 μin 16 μin 24 μin 31 μin 40 μin 48 μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Angle Blocks	(1 to 60)°	0.002 2°	Comparison to Master Angle Blocks, Sine Plate, Gauging Amplifier
Angle Gauges (Leaf Style) ²	Up to 90°	3.7'	Comparison to STI Optical Comparator
Electronic Differential Levels ²	Up to 1 000"	1.4"	Comparison to Brunson 470 Angle Generator
Functional Gauges & Fixtures	Linear Up to 12 in	190 μin	Comparison to STI Optical Comparator
	Angle Up to 90°	0.065°	
Radius Gauges (Leaf Style)	Up to 1 in	210 μin	Comparison to STI Optical Comparator
Sine Bars, Sine Plates ²	Angle (1 to 60)°	6.5"	Comparison to Gauge Blocks, Angle Blocks, Gauging Amplifier
Thread Pitch Gauges ¹⁰ (Leaf Style)	(4 to 84) TPI	160 μin	Comparison to STI Optical Comparator
Tri-Blocks	Length (1 to 6) in	48 μin	Comparison to Gauging Amplifier, Gauge Blocks
	Flatness	41 μin	Comparison to Gauging Amplifier
	Perpendicularity	69 μin	Comparison to Indi-Square, Gauging Amplifier
V-Blocks	Parallelism	47 μin	Comparison to Gauging Amplifier, Gauge Blocks
	Perpendicularity	66 μin	Comparison to Gauging Amplifier, Indi-Square

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	V-Centrality	55 μin	Comparison to Gauging Amplifier, Master Plugs
Pipe Thread Plugs ^{2,10}	Simple Pitch Diameter (4 to 80 TPI)	(100 + 2L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks, Sine Plug
	Standoff Up to 1 in (1 to 2) in	(36 + 0.9L) μin (35 + 0.59L) μin	Comparison to Gauging Amplifier Gauge Blocks
Thread Plugs – Setting ^{2,5,10}	Simple Pitch Diameter (4 to 80 TPI)	(47 + 5L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks, Thread Measuring Wires
	Major Diameter (0.06 to 4) in	(16 + 4.7L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Thread Plugs – Setting ^{2,5,10}	Root Radius & Minor Diameter	203 μin	Comparison to STI Optical Comparator
Thread Plugs – Working ^{2,5,10}	Simple Pitch Diameter (4 to 80 TPI)	(96 + 0.4L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks, Thread Measuring Wires
Thread Plugs – Working ^{2,5,10}	Major Diameter (0.060 to 4) in	(26 + 4L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Thread Plugs – Working ^{2,5,10}	Root Radius & Minor Diameter	200 μin	Comparison to STI Optical Comparator
Bench Micrometers ¹	Length Up to 2 in	12 μin	Comparison to Gauge Blocks
Bench Micrometers ^{1,2}	Length Up to 2 in	12 μin	Comparisons to Gauge Blocks
	Anvil Flatness Up to 0.5 in Diameter	9.4 μin	Optical Flat, Monochromatic Light



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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Bore Gauges ² (2 point)	Up to 4 in (4 to 40) in	(8.4 + 7L) μin (3.6 + 8L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Bore Gauges (3 point) ^{1,2}	Up to 8 in	(72 + 3L) μin	Comparison to Ring Gauges
Calipers ^{1,2,3} (Inside and Outside)	Up to 20 in (20 to 40) in (40 to 60) in	(280 + 10L) μin (440 + 5L) μin (920 + 4L) μin	Comparison to Gauge Blocks, Gauge Block Accessories
Chamfer Gauges ^{1,2}	Up to 1 in	(77 + 3.2L) μin	Comparison to Modified Ring Gauges
Gauging Amplifiers, LVDT Heads	Up to 0.001 in	(6.8 – 3L) μin	Comparison to P&W Labmaster® Universal 1000A
Height Gauges ^{1,2}	Up to 24 in (24 to 40) in	(430 + 2L) μin (390 + 4L) μin	Comparison to Gauge Blocks, Surface Plate
Height Masters ² Length	Up to 24 in	(68 + 6L) μin	Comparison to Gauging Amplifier, Gauge Blocks
Parallelism	Up to 0.001 in	15 μin	
Indicators ^{2,7}	(0 to 0.1) in (0.1 to 0.42) in (0.42 to 4) in (4 to 8) in	(58 – 0.3L) μin (58 + 0.1L) μin (58 + 0.6L) μin (46 + 4L) μin	Comparison to P&W Labmaster® Universal 1000A, Gauge Blocks
Micrometer Heads ² Length	(0 to 0.1) in (0.1 to 0.42) in (0.42 to 2) in	(11 – 2L) μin (10 + 1.6L) μin (8.9 + 4.72L) μin	Comparisons to P&W Labmaster® Universal 1000A, Gauge Blocks
Anvil Flatness	Up to 3 in Diameter	9.4 μin	Optical Flat, Monochromatic Light
Depth Micrometers ^{1,2} Length	Up to 12 in	(45 + 5L) μin	Comparisons to Gauge Blocks
Base Flatness	Up to 3 in	9.4 μin	Optical Flat, Monochromatic Light
Inside Micrometer ^{1,2}	Up to 4 in (4 to 20) in (21 to 40) in (41 to 60) in	(37 + 5L) μin (55 + 7L) μin (300 + 6L) μin (590 + 4L) μin	Comparison to Gauge Blocks, Gauge Block Accessories

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Outside Micrometer ^{1,2}	Up to 4 in (4 to 20) in (21 to 40) in (41 to 60) in	(37 + 5L) μin (55 + 7L) μin (270 + 6L) μin (580 + 5L) μin	Comparison to Gauge Blocks
Micrometer Anvil Flatness	Up to 3 in Diameter	9.4 μin	Comparison to Optical Flat, Monochromatic Light
Screw Thread Micrometer ^{1,2,4}	Up to 1 in	(160 + 7.7L) μin	Comparison to Thread Setting Plugs
V-Anvil Micrometer ^{1,2}	(0.062 5 to 2) in	(53 + 1L) μin	Comparison to Gauge Balls
Steel Rules, Tape Measures ^{2,11}	Up to 12 in	890 μin	Comparison to Optical Comparator
	(1 to 300) ft	(1 800 + 5L) μin	Comparison to Optodyne LDDM
Thickness Gauges ¹ (Dial & Digital)	Up to 0.5 in	60 μin	Comparison to Gauge Blocks
Optical Comparators, Vision Measuring Machines ¹ Magnification	10X, 20X, 31.25X, 50X and 62.5X	0.001 2 in	Comparisons to Magnification Checker Glass Scale
Linear Length	X and Y Up to 6 in (6 to 12) in	110 μin 150 μin	Glass Scale Gauge Blocks
Angle	Up to 90°	0.021°	Angle Blocks
Protractors, Inclinometers ²	Up to 90°	0.59'	Comparison to Gauge Blocks, Angle Blocks, Gauging Amplifier, Sine Plate
Levels ²	Up to 1 000"	2.9"	Comparison to Brunson 470 Angle Generator

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Gauges (Tension & Compression)	(0.5 to 5) lbf (5 to 50) lbf (50 to 600) lbf	0.2 % of reading + 0.000 2 lbf 0.02 % of reading + 0.008 lbf 0.02 % of reading + 0.042 lbf	Comparison to NIST Class F Weights
Force Gauges (Tension & Compression)	(2.5 to 100) lbf (10 to 500) lbf (20 to 1 000) lbf	0.015 % of reading + 0.01 lbf 0.015 % of reading + 0.06 lbf 0.001 8 % of reading + 0.06 lbf	Comparison to Morehouse Force Calibration System, Load Cell
Cable/Wire Tensiometers	(1 to 600) lbf	0.01 % of reading + 0.058 lbf	Comparison to NIST Class F Weights
Durometers Indenter Dimensions Angle Radius Diameter/Length Spring Force Types A, B, E, O Types C, D, DO	Up to 35° Up to 0.05 in Up to 0.2 in Up to 7.3 N Up to 40 N	0.065° 250 μin 180 μin 0.05 N 0.28 N	Full Verification per ASTM D2240 using STI Optical Comparator Durometer Calibrator
Durometer Calibrator Force Types A, B, E, O Types C, D, DO	Up to 7.3 N Up to 40 N	0.000 23 N 0.000 85 N	Comparison to ASTM E617 Class 1 Weights
Hydraulic Pressure – Measure/Source	(10 to 50) psig (50 to 500) psig (500 to 10 000) psig	0.011 psi 0.035 psi 0.007 9 % of reading + 0.043 psi	Comparison to Fluke P3224-PSI Deadweight Tester
Low Pressure/Vacuum – Measure/Source	Up to 2 inH ₂ O	0.000 69 inH ₂ O	Comparison to Dwyer 1430 Microtector
	(-20 to 20) inH ₂ O	0.003 1 inH ₂ O	Comparison to Meriam 34FBT2M Manometer
Pneumatic Absolute Pressure – Measure/Source	(0.2 to 1 015) psia	0.002 3 % of reading	Comparison to Ruska 2465 Deadweight Tester
Pneumatic Gauge Pressure – Measure/Source	(-14.4 to 1 000) psig	0.002 3 % of reading	Comparison to Ruska 2465 Deadweight Tester

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure/Vacuum – Measure/Source ^{1,15}	(0 to 15) psig (-14.4 to 0) psiv (-14.4 to 30) psig Up to 100 psig Up to 500 psig Up to 1 000 psig Up to 10 000 psig	0.008 9 psi 0.011 psi 0.023 psi 0.056 psi 0.25 psi 0.59 psi 8.3 psi	Comparison to Fluke 700 Series Pressure Transducers
Scales & Balances ¹ (0.000 1 g resolution)	Up to 610 g	0.000 2 % of reading + 0.1 mg	ASTM E617 Class 1 weights and NIST HB 44 utilized in the calibration of the weighing system.
Scales & Balances ¹ (0.001 g resolution)	Up to 5 000 g	0.000 2 % of reading + 1 mg	
Scales & Balances ¹ (0.01 g resolution)	Up to 35 000 g	0.000 2 % of reading + 10 mg	
Scales & Balances ¹ (0.000 1 kg resolution)	Up to 35 kg	0.000 8 % of reading + 95 mg	
Scales & Balances ¹ (0.001 lb resolution)	Up to 10 lb	0.004 % of reading + 0.001 lb	NIST Class F weights and NIST HB 44 utilized in the calibration of the weighing system.
Scales & Balances ¹ (0.01 lb resolution)	Up to 100 lb	0.005 % of reading + 0.009 5 lb	
Scales & Balances ¹ (0.1 lb resolution)	Up to 600 lb	0.003 % of reading + 0.1 lb	
Torque Indicating Devices	(15 to 200) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1000) lbf·in (20 to 250) lbf·ft (100 to 1 000) lbf·ft (200 to 2 000) lbf·ft	0.2 % of reading + 0.05 ozf·in 0.2 % of reading + 0.009 lbf·in 0.2 % of reading + 0.06 lbf·in 0.18 % of reading + 0.98 lbf·in 0.14 % of reading + 0.4 lbf·ft 0.61 % of reading + 0.01 lbf·ft 0.5 % of reading + 0.02 lbf·ft	Comparison to CDI 2000 Torque Tester
Torque Calibration Systems	(20 to 400) ozf·in (2.5 to 100) lbf·in (40 to 3 000) lbf·in (200 to 2 000) lbf·ft	0.2 % of reading + 0.002 ozf·in 0.06 % of reading + 0.009 lbf·in 0.038 % of reading + 0.19 lbf·in 0.04% of reading + 0.09 lbf·ft	Comparison to CDI Torque Arms, CDI Torque Wheels, NIST Class F Weights

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure ^{1,15}	(10 to 30) °C (5 to 95) %RH	0.14 % of reading + 1.1 %RH	Comparison to Rotronic HC2A Humidity Probe

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature and Humidity Devices			
Humidity	(15 to 40) °C (5 to 95) %RH	0.27 % of reading + 0.56 %RH	Comparison to Thunder Scientific 2500LT Two-pressure Humidity Generation System
Temperature	(-10 to 70) °C	0.000 4 % of reading + 0.14 °C	
Radiation (Infrared) Thermometers ^{1,15}	50 °C 100 °C 200 °C 300 °C 400 °C 500 °C	0.86 °C 1.6 °C 3.1 °C 4.7 °C 6.4 °C 8.2 °C	Comparison to Fluke 9132 Blackbody Source (Flat Plate) $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers	-15 °C 0 °C 50 °C 100 °C 120 °C	0.78 °C 0.57 °C 0.7 °C 0.69 °C 0.75 °C	Comparison to Fluke 4180 Blackbody Source (Flat Plate) $\epsilon = (0.9 \text{ to } 1), \lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers	35 °C 100 °C 200 °C 350 °C 500 °C	0.54 °C 0.84 °C 1 °C 1.8 °C 2.4 °C	Comparison to Fluke 4181 Blackbody Source (Flat Plate) $\epsilon = (0.9 \text{ to } 1), \lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature – Source ⁸	-196 °C	0.028 °C	Comparison to Fluke 7196 Liquid N ₂ Calibrator, Fluke 5628 PRT
Temperature – Source ^{1,8,15}	0 °C	0.058 °C	Comparison to Kaye X0240 Ice Point
Temperature – Source ⁸	0.01 °C	0.000 48 °C	Comparison to Triple Point of Water Cell
Temperature – Source	0 °C 25 °C 50 °C (-50 to 0) °C (0 to 100) °C	0.028 °C 0.025 °C 0.03 °C 0.056 °C 0.057 °C	Comparison to Fluidized Baths, Thermometrics 1925-A, Fluke 5628 PRT
Temperature – Source ⁸	(100 to 250) °C	0.06 % of reading	Comparison to Fluidized Baths, Thermometrics 1925-A, Fluke 5628 PRT

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Source ^{1,8,15}	(-15 to 350) °C	0.26 °C + 0.15 % of reading	Hart 9009 Drywell
Temperature – Source ⁸	(-95 to 140) °C	0.032 °C	Fluke 9190A Drywell, Fluke 5628 PRT
	(-45 to 140) °C	0.045 °C	Fluke 9170 Drywell, Fluke 5628 PRT
	(50 to 700) °C	0.003 7 % of reading + 0.087 °C	Fluke 9173 Drywell, Fluke 5628 PRT
Temperature – Measure	(-200 to 660) °C	0.004 % of reading + 0.013 °C	Comparison to Fluke 1586 Scanner, Fluke 5628 PRT
	(0 to 100) °C	0.003 % of reading + 0.009 °C	Comparison to Fluke 1586 Scanner, Thermometrics 1925-A
Temperature – Measure ^{1,15}	(-10 to 60) °C	0.4 °C	Comparison to Rotronic HygroPalm HP22-A, HC2A
Temperature – Measure ^{1,15}	(-200 to 0) °C	0.53 % of reading + 0.64 °C	Comparison to Type T Thermocouple Probe, Fluke 52 II Temperature Indicator
	(0 to 175) °C	0.06 % of reading + 0.64 °C	
	(175 to 350) °C	0.6 % of reading + 0.34 °C	
Temperature – Measure ^{1,15}	(-200 to 0) °C	0.24 % of reading + 1.2 °C	Comparison to Type K Thermocouple Probe, Fluke 52 II Temperature Indicator
	(0 to 275) °C	0.02 % of reading + 1.2 °C	
	(275 to 1 000) °C	0.4 % of reading + 0.16 °C	
Dew Point	(-25 to 69) °C	0.22 °C	Comparison to Thunder Scientific 2500LT Chamber

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure	10 Hz to 1.3 GHz	5.3 pHz/Hz + 0.1 mHz	Comparison to Keysight 53220A Counter, HP 58503A GPS Receiver

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ^{1,15}	0.1 Hz to 160 MHz	29 nHz/Hz + 6.1 mHz	Comparison to Phillips PM6669 Frequency Counter, Efratom FRK-LN Oscillator
Frequency – Source	10 Hz to 1.3 GHz	59 pHz/Hz + 0.1 mHz	Comparison to Keysight 53220A Universal Counter, Efratom FRK-LN Oscillator
Contact Tachometers ^{1,2,15}	(1 to 40 000) rpm	0.88 rpm	Comparison to Quantum Dynamics N-11-ECS/3A Tachometer, Keithley 53220A Counter
Non-contact Tachometers ^{1,2,15}	(25 to 90 000) rpm	0.000 2 % of reading + 0.1 rpm	Comparison to Fluke 5522A Multi Product Calibrator, Light Emitting Diode
Strobe Tachometers ^{1,2,15}	(25 to 90 000) rpm	0.000 5 % of reading + 0.13 rpm	Comparison to Keysight 53220A Counter, Solar Cell
Stopwatches & Timers ¹⁵	Up to 24 h	36 ms/24 h	Comparison to Helmut Klein 4500 Timometer

DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Length Measures ²	Up to 300 in	(3 100 + 10.2L) μ m	1D Measurements performed using ProScale OptoDyne LDDM

1 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Length Measures – External ^{2,9}	Up to 0.1 in (0.1 to 0.42) in (0.5 to 4) in (4 to 20) in (20 to 80) in	(3.2 – 3L) μin (2.3 + 5L) μin (1.6 + 4L) μin (0.61 + 4L) μin (75 + 5L) μin	1D Measurements performed using P&W Labmaster® Universal 1000A P&W Labmaster Universal 1000A
Length Measures – Internal ^{2,9}	(0.01 to 0.22) in (0.22 to 1) in (1 to 2) in (2 to 3) in (3 to 4) in (4 to 7) in (7 to 10) in (10 to 13) in	(8.8 + 0.7L) μin (8 – 4.54L) μin (7.9 + 5L) μin (8.1 + 5L) μin (8.4 + 5L) μin (8.7 + 5L) μin (9.2 + 5L) μin (9.9 + 5L) μin	1D Measurements performed using P&W Labmaster® Universal 1000A P&W Labmaster Universal 1000A
Length Measures – Using Hand Tools ^{2,9}	Up to 1 in	(93 + 2.44L) μin	1D Measurements performed using Digital Micrometer
	Up to 8 in	(1 400 + 5L) μin	1D Measurements performed using Digital Caliper

2 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
2D Angles	Up to 360°	0.065°	2D Measurements performed using STI Optical Comparator
2D Length ⁹	X/Y Axis: Up to 12 in	210 μin	2D Measurements performed using STI Optical Comparator
Gauges and Fixtures – 2D Length ^{2,9}	X Axis: Up to 15.75 in Y Axis: Up to 15.75 in Z Axis: Up to 7.87 in	(110 + 12L) μin	2D Measurements performed using Mitutoyo QV-L404Z1L-D with 1.0x, 1.5x, and 2.0x Objective Lenses

2 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Gauges and Fixtures – 2D Angles	Up to 360°	0.015°	2D Measurements performed using Mitutoyo QV-L404Z1L-D with 1.0x, 1.5x, and 2.0x Objective Lenses

3 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Volumetric Measurement ^{2,9}	X Axis: Up to 35.43 in Y Axis: Up to 39.37in Z Axis: Up to 23.62 in	(110 + 3.1L) μin	3D Measurements performed using Mitutoyo Crysta-Apex S 9106 CMM with SP25M Scanning Probe
3D Angles	Up to 360°	0.02°	3D Measurements performed using Mitutoyo Crysta-Apex S 9106 CMM with SP25M Scanning Probe

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:

- On-site calibration service is available for this parameter based out of the Merrillville, Indiana laboratory. 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.
- L = length in inches, DL = Diagonal Length; ' = arc-minute; " = arc-second; rpm = revolutions per minute.
- Measurements include the following measurement functions: Outside, Inside, Step and Depth Extension Rods.
- Inch thread setting plugs only with 60° Included Angle.
- Includes 60° Metric, Unified and 55° Whitworth pitch gauges.
- Uncertainty is for Steel Blocks. Carbide and Ceramic Blocks may have a different uncertainty due to deformation coefficients and different coefficients of thermal expansion.
- Includes dial, digital and test indicators.
- Includes Liquid-in-Glass Thermometers, RTDs, Thermocouples, Bi-metallic Thermometers, etc. Liquid-in-Glass Thermometers are only calibrated in fluidized baths to ensure correct immersion depth and stem effect corrections.
- Metric equivalencies for this type of equipment are available and converted by 1 in equals 25.4 mm exactly.
- TPI indicates threads per inch.
- Verification performed in 12 ft. increments before repositioning.
- Includes Master Setting Discs and Progressive Diameter Plugs.
- This instrument/parameter has been characterized to lower the uncertainty.
- The stated uncertainty is associated with a primary calibration which utilizes a comparison datum set with gauge blocks rather than a master ring.
- On-site calibration service is available for this parameter based out of the Brookfield, Wisconsin office. 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.
- Unless otherwise specified in the far-right column, the calibration procedure/method was internally written.
- This scope is formatted as part of a single document including Certificate of Accreditation No. L2216.



Jason Stine, Vice President

