



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Calibration Laboratory, LLC

3330 East 83rd Place

Merrillville, IN 46410

(and satellite location as listed on the scope)

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

ANSI/NCSL Z540-1-1994 (R2002) and

ANSI/NCSL Z540.3-2006 (R2013)

In the fields of

CALIBRATION 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.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 15 February 2025

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

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **February 15, 2025**

Certificate Number: **L2216**

CALIBRATION

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters (Fixed Points) ¹	4, 7 & 10 pH	0.05 pH	Buffer Solutions and 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 0.6 mF/F 0.26 mF/F 0.6 mF/F 4.7 mF/F	GenRad 1689M LCR Meter
Capacitance – Source ¹ (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	Arco SS-32 Standard Capacitors

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (Simulation)	(0.19 to 3.3) nF (3.3 to 11) nF (11 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	40 pF/nF + 8 pF 2 pF/nF + 8 pF 2 pF/nF + 80 pF 2 pF/nF + 0.23 nF 2 nF/μF + 0.75 nF 2 nF/μF + 2.3 nF 2 nF/μF + 8 nF 3 nF/μF + 23 nF 3 nF/μF + 80 nF 3 nF/μF + 0.23 μF 3 nF/μF + 0.78 μF 4 μF/mF + 2.3 μF 4 μF/mF + 7.6 μF 6 μF/mF + 23 μF 9 μF/mF + 80 μF	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	0.3 nA/μA + 20 nA 0.2 nA/μA + 12 nA 0.12 nA/μA + 10 nA 0.35 nA/μA + 15 nA 1.3 nA/μA + 80 nA 0.3 nA/μA + 50 nA 0.2 nA/μA + 40 nA 0.12 nA/μA + 40 nA 0.24 nA/μA + 0.13 μA 1.3 nA/μA + 0.8 μA 0.3 nA/μA + 0.5 μA 0.2 nA/μA + 0.4 μA 0.12 nA/μA + 0.4 μA 0.24 nA/μA + 0.7 μA 1.3 nA/μA + 6 μA 0.25 nA/μA + 4 μA 0.16 nA/μA + 3.5 μA 0.1 nA/μA + 2.5 μA 0.2 nA/μA + 3.5 μA 1.1 nA/μA + 10 μA	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	(0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 nA/μA + 35 μA 0.45 nA/μA + 80 μA 7 nA/μA + 0.16 mA	Fluke 5730A Multi Product Calibrator
AC Current – Source	(2.2 to 11) A 40 Hz to 1kHz (1 to 5) kHz (5 to 10) kHz	0.46 mA/A + 0.17 mA 0.95 mA/A + 0.38 mA 3.6 mA/A + 0.75 mA	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 0.11 mA/A + 36 μA 0.44 mA/A + 72 μA 31 mA/A + 0.7 A	Fluke 5730A Multi Product Calibrator, Fluke 52120A Transconductance Amplifier
AC Current – Source ¹	(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 + 80 nA 1.2 nA/μA + 80 nA 1 nA/μA + 80 nA 2.3 nA/μA + 0.12 μA 6.2 nA/μA + 0.16 μA 12 nA/μA + 0.31 μA 1.6 μA/mA + 0.12 μA 0.97 μA/mA + 0.12 μA 0.78 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	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	(33 to 330) mA		Fluke 5522A/SC1100 Multi Product Calibrator
	(10 to 20) Hz	1.4 μ A/mA + 16 μ A	
	(20 to 45) Hz	0.7 μ A/mA + 16 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	1.2 μ A/mA + 0.14 mA	
	45 Hz to 1 kHz	0.34 μ A/mA + 94 μ A	
	(1 to 5) kHz	4.1 μ A/mA + 0.98 mA	
	(5 to 10) kHz	19 μ A/mA + 3.9 mA	
	(1.1 to 3) A		
	(10 to 45) Hz	1.4 mA/A + 78 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		
AC Current Source – Current Clamps ¹	(3 to 11) A		Fluke 5522A/SC1100 Multi Product Calibrator, Fluke 50-Turn Coil
	(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	
	(45 to 65) Hz	1.6 mA/A + 21 mA	
	(10 to 16.5) A	1.1 mA/A + 0.28 A	
(16.5 to 150) A	2.4 mA/A + 0.12 A		
(150 to 1 025) A			
(65 to 440) Hz			
(10 to 16.5) A	4.4 mA/A + 36 mA		
(16.5 to 150) A	5.2 mA/A + 0.22 A		
(150 to 1 025) A	6.4 mA/A + 94 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	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	5.4 mA/A + 0.66 A	
	(500 to 3 000) A 10 Hz to 300 Hz	5.4 mA/A + 0.65 A	
DC Current – Source ¹	(0 to 330) μ A	0.11 nA/ μ A + 23 nA	Fluke 5522A/SC1100 Multi Product Calibrator
	(0.33 to 3.3) mA	77 nA/mA + 41 nA	
	(3.3 to 33) mA	81 nA/mA + 0.24 μ A	
	(33 to 330) mA	78 nA/ μ A + 2 μ A	
	(0.33 to 1.1) A	0.16 mA/A + 31 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 + 0.39 mA 0.78 mA/A + 0.58 mA	
DC Current – Source	(0 to 220) μ A	40 μ A/A + 6 nA	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	45 μ A/A + 0.7 μ A	
	(0.22 to 2.2) A	80 μ A/A + 12 μ A	
DC Current – Source	(2.2 to 11) A	0.36 mA/A + 0.48 mA	Fluke 5730A Multi Product Calibrator, Fluke 5725A Amplifier
DC Current – Source	(0 to 100) A	0.12 mA/A + 80 μ A	Fluke 5730A Multi Product Calibrator, Fluke 52120A Transconductance Amplifier



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Source – Current Clamps ¹	(10 to 150) A (150 to 1 025) A	2 mA/A + 1.3 mA 2 mA/A + 0.13 A	Fluke 5522A/SC1100 Multi Product Calibrator, Fluke 50-Turn Coil
DC Current Source – Current Clamps	(0 to 2 500) A	5.7 mA/A + 11 mA	Fluke 5730A Multi Product Calibrator, Fluke 52120A Transconductance Amplifier, Fluke 3KA 25-Turn Coil
DC Current – Measure	(0.01 to 10) nA	14.7 mA/A + 5.9 pA	Transmille 8081 8.5 Digit Multimeter
DC Current – Measure ¹	(0 to 200) μA (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 μA/A + 9.5 μA 0.37 mA/A + 7.5 μA 0.74 mA/A + 0.11 mA	Keithley 2002 8.5 Digit Multimeter
DC Current – Measure ¹	(1 to 3) A	1.23 mA/A + 0.63 mA	Agilent 34401A 6.5 Digit Multimeter
DC Current – Measure	(20 to 30) A	0.76 mA/A + 4.3 mA	Transmille 8081 8.5 Digit Multimeter
DC Current – Measure	(30 to 3 000) A	0.1 mA/A + 0.81 A	Empro Shunt, Fluke 8508A 8.5 Digit Multimeter
DC Current – Measure ¹	(30 to 3 000) A	0.11 mA/A + 0.81 A	Empro Shunt, HP 34401A 6.5 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	0.9 nA/μA + 15 nA 0.5 nA/μA + 12 nA 1.2 nA/μA + 30 nA 1.5 mA/A + 30 mA 5 mA/A + 0.15 A	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		Fluke 8508A 8.5 Digit Multimeter
	(1 to 10) Hz	0.29 nA/ μ A + 25 nA	
	10 Hz to 10 kHz	0.26 nA/ μ A + 25 nA	
	(10 to 30) kHz	0.6 nA/ μ A + 24 nA	
	(30 to 100) kHz	4 nA/ μ A + 21 nA	
	(0.2 to 2) mA		
	(1 to 10) Hz	0.31 μ A/mA + 0.2 μ A	
	10 Hz to 10 kHz	0.28 μ A/mA + 0.2 μ A	
	(10 to 30) kHz	0.65 μ A/mA + 0.2 μ A	
	(30 to 100) kHz	4 μ A/mA + 0.2 μ A	
	(2 to 20) mA		
	(1 to 10) Hz	0.31 μ A/mA + 2 μ A	
	10 Hz to 10 kHz	0.28 μ A/mA + 2 μ A	
	(10 to 30) kHz	0.65 μ A/mA + 2 μ A	
(30 to 100) kHz	4 μ A/mA + 2 μ A		
AC Current – Measure ¹	(20 to 200) mA		Keithley 2002 8.5 Digit Multimeter
	(1 to 10) Hz	0.31 μ A/mA + 20 μ A	
	10 Hz to 10 kHz	0.25 μ A/mA + 20 μ A	
	(10 to 30) kHz	0.6 μ A/mA + 20 μ A	
	(0.2 to 2) A		
	10 Hz to 2 kHz	0.6 mA/A + 0.2 mA	
	(2 to 10) kHz	0.7 mA/A + 0.2 mA	
	(10 to 30) kHz	3 mA/A + 0.2 mA	
	(2 to 20) A		
	10 Hz to 2 kHz	0.8 mA/A + 2 mA	
	(2 to 10) kHz	2.5 mA/A + 2 mA	
	Up to 200 μ A		
	(20 to 50) Hz	3.5 mA/A + 36 nA	
	(50 to 200) Hz	2 mA/A + 38 nA	
200 Hz to 1 kHz	4 mA/A + 35 nA		
(1 to 10) kHz	4 mA/A + 0.27 μ A		
(0.2 to 2) mA			
(20 to 50) Hz	3.5 mA/A + 0.34 μ A		
(50 to 200) Hz	1.5 mA/A + 0.3 μ A		
200 Hz to 1 kHz	1.2 mA/A + 0.37 μ A		
(1 to 10) kHz	0.51 mA/A + 3.2 μ A		
(10 to 30) kHz	1.6 mA/A + 3.1 μ A		
(30 to 50) kHz	2.1 mA/A + 3 μ A		
(50 to 100) kHz	5 mA/A + 0.3 μ A		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(2 to 20) mA		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	3.4 mA/A + 0.44 mA		
(50 to 200) Hz	1.9 mA/A + 0.48 mA		
200 Hz to 1 kHz	2.9 mA/A + 0.45 mA		
(1 to 10) kHz	2.4 mA/A + 7.2 mA		
(10 to 30) kHz	12.8 mA/A + 5.7 mA		
(30 to 50) kHz	38.6 mA/A + 3.5 mA		
AC Current – Measure ¹	(1 to 3) A (3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz	11 mA/A + 1.8 mA 3.5 mA/A + 1.9 mA 1.5 mA/A + 2 mA	Agilent 34401A 6.5 Digit Multimeter
AC Current – Measure ¹	60 Hz (30 to 3 000) A	0.11 mA/A + 0.81 A	Emprow Shunt, HP 34401A 6.5 Digit Multimeter
AC Current – Measure ¹	60 Hz (5 to 30 000) A	10 mA/A + 7.7 A	AEMC 30K-24-2 Current Probe
Inductance – Measure	1 kHz (10 to 100) μH (0.1 to 1) mH (1 to 10) mH (10 to 100) mH (0.1 to 1) H (1 to 10) H	0.1 nH/μH + 0.2 μH 0.5 μH/mH + 0.3 μH 0.8 μH/mH + 0.2 μH 0.8 μH/mH + 4 μH 0.6 mH/H + 0.2 mH 0.8 mH/H + 0.2 mH	GenRad 1689M LCR Meter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source ¹ (Fixed Artifacts)	100 μH 500 μH 1 mH 10 mH 50 mH 100 mH 200 mH 1 H 2 H 10 H	0.12 μH 0.61 μH 1.2 μH 12 μH 61 μH 0.12 mH 0.25 mH 1.2 mH 2.5 mH 12 mH	GenRad 1482 Series Standard Inductors
Phase – Measure/Source ¹ (0.01 to 100) V	(0 to 360) ^o 1 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz	0.002 5 ^o 0.003 3 ^o 0.032 ^o 0.32 ^o	Keysight 53220A Phase Meter, Fluke 5522A/SC1100 Multi Product Calibrator
DC Power – Source ¹	(0 to 336) W (336 to 3 060) W (3 060 to 20 910) W	0.04 % of reading 0.053 % of reading 0.12 % of reading	Fluke 5522A/SC1100 Multi Product Calibrator
AC Power – Source ¹	(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 0.16 % of reading 0.12 % of reading 0.15 % 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	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	Vishay Resistance Standards
	100 Ω	1.2 mΩ	
	200 Ω	2.3 mΩ	
	400 Ω	4.7 mΩ	
	1 kΩ	13 mΩ	
	1.9 kΩ	23 mΩ	
	4 kΩ	47 mΩ	
	10 kΩ	0.12 Ω	
	40 kΩ	0.47 Ω	
	90 kΩ	1.1 Ω	
	100 kΩ	1.2 Ω	
	400 Ω	4.7 Ω	
	900 kΩ	12 Ω	
	1 MΩ	12 Ω	
Resistance – Source (Simulation)	0 Ω	40 μΩ	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 mΩ	
	190 Ω	1.9 mΩ	
	1 kΩ	6.5 mΩ	
	1.9 kΩ	12 mΩ	
	10 kΩ	65 mΩ	
	19 kΩ	120 mΩ	
	100 kΩ	0.85 Ω	
	190 kΩ	1.6 Ω	
	1 MΩ	13 Ω	
	1.9 MΩ	34 Ω	
10 MΩ	400 Ω		
19 MΩ	890 Ω		
100 MΩ	10 kΩ		
Resistance – Source (Fixed Artifacts)	1 GΩ	49 kΩ	Measurements International Resistance Standards
	10 GΩ	0.64 MΩ	
Resistance – Source (Fixed Artifacts)	1 Ω	12 μΩ	Transmille 3000RS Resistance Standard
	10 Ω	58 μΩ	
	100 Ω	0.62 mΩ	
	1 kΩ	6.3 mΩ	
	10 kΩ	18 mΩ	
	100 kΩ	0.4 Ω	
	1 MΩ	6.5 Ω	
10 MΩ	56 Ω		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ (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 + 17 mΩ 20 μΩ/Ω + 0.17 Ω 21 μΩ/Ω + 0.2 Ω 25 μΩ/Ω + 1.6 Ω 25 μΩ/Ω + 1.7 Ω 53 μΩ/Ω + 18 Ω 0.1 mΩ/Ω + 40 Ω 0.19 mΩ/Ω + 1.9 kΩ 0.39 mΩ/Ω + 2.3 kΩ 1.7 mΩ/Ω + 0.15 MΩ 12 mΩ/Ω + 0.39 MΩ	Fluke 5522A/SC1100 Multi Product Calibrator
Resistance – Measure ¹	(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	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 + 4 Ω 9 μΩ/Ω + 14 μΩ 7.5 μΩ/Ω + 50 μΩ 7.5 μΩ/Ω + 0.5 mΩ 8 μΩ/Ω + 5 mΩ 7.5 μΩ/Ω + 50 mΩ 9 μΩ/Ω + 1 Ω 20 Ω/MΩ + 0.1 kΩ	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	14 Ω/MΩ + 20 Ω 65 Ω/MΩ + 1 kΩ 0.18 kΩ/MΩ + 0.1 MΩ 1.5 kΩ/MΩ + 10 MΩ	Fluke 8508A 8.5 Digit Multimeter (HV mode)
Resistance – Measure	24 GΩ to 2 TΩ	16 MΩ/GΩ + 1.2 MΩ	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	Pt 385, 100 Ω		Fluke 5522A/SC1100 Multi Product Calibrator
	(-200 to -80) °C	0.042 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.056 °C	
	(100 to 300) °C	0.072 °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	0.035 °C	
	(-80 to 0) °C	0.035 °C	
	(0 to 100) °C	0.035 °C	
	(100 to 260) °C	0.042 °C	
	(260 to 300) °C	0.094 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.13 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.035 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.042 °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	0.072 °C	
	(600 to 630) °C	0.087 °C	
	Pt 385, 1 kΩ		
	(-200 to -80) °C	0.028 °C	
(-80 to 0) °C	0.028 °C		
(0 to 100) °C	0.035 °C		
(100 to 260) °C	0.042 °C		
(260 to 300) °C	0.049 °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	Pt 3916, 100 Ω		Fluke 5522A/SC1100 Multi Product Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.035 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.049 °C	
	(100 to 260) °C	0.057 °C	
	(260 to 300) °C	0.064 °C	
	(300 to 400) °C	0.072 °C	
	(400 to 600) °C	0.079 °C	
	(600 to 630) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.042 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.057 °C	
	(100 to 300) °C	0.072 °C	
(300 to 400) °C	0.079 °C		
(400 to 630) °C	0.095 °C		
Ni 385, 120 Ω			
(-80 to 0) °C	0.066 °C		
(0 to 100) °C	0.066 °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	8.3 μV/V + 0.4 μV	Fluke 5730A Multi Product Calibrator
	(0.22 to 2.2) V	5 μV/V + 0.7 μV	
	(2.2 to 11) V	3.5 μV/V + 2.5 μV	
	(11 to 22) V	3.5 μV/V + 4 μV	
	(22 to 220) V	5.8 μV/V + 58 μV	
(220 to 1 100) V	6.5 μV/V + 0.4 mV		
DC High Voltage – Source ¹	(0.01 to 1 400) V	0.3 mV/V + 37 mV	HV Output monitored with Vitrek 4700 High Voltage Meter, HVL-35 Probe, HVL-100 Probe
	(1.4 to 10) kV	0.29 V/kV + 0.37 V	
	(1 to 35) kV	0.25 V/kV + 1.8 V	
	(10 to 100) kV	0.57 V/kV	
DC Voltage – Source ¹	(0 to 330) mV	13 μV/V + 2.1 μV	Fluke 5522A/SC1100 Multi Product Calibrator
	(0.33 to 3.3) V	8 μV/V + 3.8 μV	
	(3.3 to 33) V	8.9 μV/V + 35 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		Fluke 5730A Multi Product Calibrator
	(10 to 20) Hz	0.24 mV/V + 4 μV	
	(20 to 40) Hz	90 nV/mV + 4 μV	
	40 Hz to 20 kHz	80 nV/mV + 4 μV	
	(20 to 50) kHz	0.2 μV/mV + 4 μV	
	(50 to 100) kHz	0.5 μV/mV + 5 μV	
	(100 to 300) kHz	1.1 μV/mV + 10 μV	
	(300 to 500) kHz	1.4 μV/mV + 20 μV	
	500 kHz to 1 MHz	2.7 μV/mV + 20 μV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.24 μV/mV + 4 μV	
	(20 to 40) Hz	90 nV/mV + 4 μV	
	40 Hz to 20 kHz	80 nV/mV + 4 μV	
	(20 to 50) kHz	0.2 μV/mV + 4 μV	
	(50 to 100) kHz	0.5 μV/mV + 5 μV	
	(100 to 300) kHz	1.1 μV/mV + 10 μV	
	(300 to 500) kHz	1.4 μV/mV + 20 μV	
	500 kHz to 1 MHz	2.7 μV/mV + 20 μV	
	(22 to 220) mV		
	(10 to 20) Hz	0.24 μV/mV + 12 μV	
	(20 to 40) Hz	90 nV/mV + 7 μV	
	40 Hz to 20 kHz	57 nV/mV + 7 μV	
	(20 to 50) kHz	0.12 μV/mV + 7 μV	
	(50 to 100) kHz	0.31 μV/mV + 17 μV	
	(100 to 300) kHz	0.66 μV/mV + 20 μV	
	(300 to 500) kHz	1.4 μV/mV + 25 μV	
	500 kHz to 1 MHz	2.7 μV/mV + 45 μV	
(0.22 to 2.2) V			
(10 to 20) Hz	0.24 mV/V + 40 μV		
(20 to 40) Hz	90 μV/V + 15 μV		
40 Hz to 20 kHz	42 μV/V + 8 μV		
(20 to 50) kHz	67 μV/V + 10 μV		
(50 to 100) kHz	85 μV/V + 30 μV		
(100 to 300) kHz	0.34 mV/V + 80 μV		
(300 to 500) kHz	1 mV/V + 0.2 mV		
500 kHz to 1 MHz	1.7 mV/V + 0.3 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		Fluke 5730A Multi Product Calibrator
	(10 to 20) Hz	0.24 mV/V + 0.4 mV	
	(20 to 40) Hz	90 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	42 μ V/V + 50 μ V	
	(20 to 50) kHz	67 μ V/V + 0.1 mV	
	(50 to 100) kHz	83 μ V/V + 0.2 mV	
	(100 to 300) kHz	0.25 mV/V + 0.6 mV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.24 mV/V + 4 mV	
	(20 to 40) Hz	90 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	52 μ V/V + 0.6 mV	
	(20 to 50) kHz	80 μ V/V + 1 mV	
(50 to 100) kHz	0.15 mV/V + 2.5 mV		
(100 to 300) kHz	0.9 mV/V + 16 mV		
(300 to 500) kHz	3.6 mV/V + 40 mV		
500 kHz to 1 MHz	8 mV/V + 80 mV		
AC Voltage – Source	(220 to 1 100) V		Fluke 5730A Multi Product Calibrator, Fluke 5725A Amplifier
	(15 to 50) Hz	0.3 mV/V + 16 mV	
	50 Hz to 1 kHz	70 μ V/V + 3.5 mV	
	(220 to 750) V		
	(30 to 50) kHz	11 mV + 0.6 mV/V	
(50 to 100) kHz	45 mV + 2.3 mV/V		
AC Voltage – Source	(220 to 1 100) V		Fluke 5522A/SC1100 Multi Product Calibrator
	40 to 1 kHz	4 mV + 90 μ V/V	
	(1 to 20) kHz	6 mV + 0.17 mV/V	
	(20 to 30) kHz	11 mV + 0.6 mV/V	
	(1 to 33) mV		
(10 to 45) Hz	0.62 μ V/mV + 5 μ V		
45 Hz to 10 kHz	0.11 μ V/mV + 5 μ V		
(10 to 20) kHz	0.15 μ V/mV + 5 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		



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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		Fluke 5522A/SC1100 Multi Product Calibrator
	(10 to 45) Hz	0.23 μ V/mV + 6.3 μ V	
	45 Hz to 10 kHz	0.11 μ V/mV + 6.3 μ V	
	(10 to 20) kHz	0.12 μ V/mV + 6.3 μ V	
	(20 to 50) kHz	0.27 μ V/mV + 6.3 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	0.23 mV/V + 39 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	0.19 mV/V + 0.47 mV	
	(20 to 50) kHz	0.27 mV/V + 0.47 mV	
	(50 to 100) kHz	0.7 mV/V + 1.2 mV	
AC High Voltage – Source ¹	60 Hz		HV Output Monitored with Vitretek 4700 High Voltage Meter
	(0.01 to 1 400) V	0.31 mV/V + 36 mV	
DC Voltage – Measure ¹	(1.4 to 10) kV	0.4 mV/V + 0.24 V	Keithley 2002 8.5 Digit Multimeter
	(0 to 200) mV	16.6 μ V/V + 2.6 μ V	
	(0.2 to 2) V	7.3 μ V/V + 9.4 μ V	
	(2 to 20) V	7.8 μ V/V + 59 μ V	
	(20 to 200) V	19.3 μ V/V + 1.1 mV	
	(200 to 1 000) V	18.6 μ V/V + 4.5 mV	



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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	4.5 μ V/V + 0.1 μ V 3 μ V/V + 0.4 μ V 3 μ V/V + 4 μ V 4.5 μ V/V + 40 μ V 4.5 μ V/V + 0.53 mV	Fluke 8508A 8.5 Digit Multimeter
DC High Voltage – Measure ¹	(0.01 to 1 400) V (1.4 to 10) kV (1 to 35) kV (10 to 100) kV	0.3 mV/V + 37 mV 0.28 mV/V + 37 mV 0.24 mV/V + 1.8 V 0.57 mV/V + 0.35 V	Vitrek 4700 High Voltage Meter, HVL-35 Probe, HVL-100 Probe
pH Calibrators – Measure (Simulation)	(-120 to 120) mV	4.5 nV/mV + 0.11 μ V	Fluke 8508A 8.5 Digit Multimeter
AC Voltage – Measure ¹	(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 μ V 0.59 mV/V + 34 μ V 0.34 mV/V + 34 μ V 0.18 mV/V + 26 μ V 0.18 mV/V + 26 μ V 0.45 mV/V + 33 μ V 0.45 mV/V + 33 μ V 2.9 mV/V + 60 μ V 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	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	(2 to 20) V		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		Fluke 5790A AC Voltage Measurement Standard
	(10 to 20) Hz	1.7 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	(20 to 40) Hz	0.73 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	40 Hz to 20 kHz	0.41 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	(20 to 50) kHz	0.81 $\mu\text{V}/\text{mV}$ + 2 μV	
	(50 to 100) kHz	1.2 $\mu\text{V}/\text{mV}$ + 2.5 μV	
	(100 to 300) kHz	2.3 $\mu\text{V}/\text{mV}$ + 4 μV	
	(300 to 500) kHz	2.4 $\mu\text{V}/\text{mV}$ + 8 μV	
	500 kHz to 1 MHz	3.5 $\mu\text{V}/\text{mV}$ + 8 μV	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.85 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	(20 to 40) Hz	0.37 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	40 Hz to 20 kHz	0.21 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	(20 to 50) kHz	0.4 $\mu\text{V}/\text{mV}$ + 2 μV	
	(50 to 100) kHz	0.6 $\mu\text{V}/\text{mV}$ + 2.5 μV	
	(100 to 300) kHz	1.2 $\mu\text{V}/\text{mV}$ + 4 μV	
	(300 to 500) kHz	1.3 $\mu\text{V}/\text{mV}$ + 8 μV	
	500 kHz to 1 MHz	2.3 $\mu\text{V}/\text{mV}$ + 8 μV	
	(7 to 22) mV		
	(10 to 20) Hz	0.29 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	(20 to 40) Hz	0.19 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	40 Hz to 20 kHz	0.11 $\mu\text{V}/\text{mV}$ + 1.3 μV	
	(20 to 50) kHz	0.21 $\mu\text{V}/\text{mV}$ + 2 μV	
	(50 to 100) kHz	0.31 $\mu\text{V}/\text{mV}$ + 2.5 μV	
	(100 to 300) kHz	0.81 $\mu\text{V}/\text{mV}$ + 4 μV	
	(300 to 500) kHz	0.89 $\mu\text{V}/\text{mV}$ + 8 μV	
	500 kHz to 1 MHz	1.7 $\mu\text{V}/\text{mV}$ + 8 μV	
	(22 to 70) mV		
(10 to 20) Hz	0.24 $\mu\text{V}/\text{mV}$ + 1.5 μV		
(20 to 40) Hz	0.12 $\mu\text{V}/\text{mV}$ + 1.5 μV		
40 Hz to 20 kHz	70 nV/mV + 1.5 μV		
(20 to 50) kHz	0.13 $\mu\text{V}/\text{mV}$ + 2 μV		
(50 to 100) kHz	0.26 $\mu\text{V}/\text{mV}$ + 2.5 μV		
(100 to 300) kHz	0.51 $\mu\text{V}/\text{mV}$ + 4 μV		
(300 to 500) kHz	0.67 $\mu\text{V}/\text{mV}$ + 8 μV		
500 kHz to 1 MHz	1.1 $\mu\text{V}/\text{mV}$ + 8 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		Fluke 5790A AC Voltage Measurement Standard
	(10 to 20) Hz	0.21 $\mu\text{V}/\text{mV}$ + 1.5 μV	
	(20 to 40) Hz	90 nV/mV + 1.5 μV	
	40 Hz to 20 kHz	40 nV/mV + 1.5 μV	
	(20 to 50) kHz	70 nV/mV + 2 μV	
	(50 to 100) kHz	0.16 $\mu\text{V}/\text{mV}$ + 2.5 μV	
	(100 to 300) kHz	0.25 $\mu\text{V}/\text{mV}$ + 4 μV	
	(300 to 500) kHz	0.38 $\mu\text{V}/\text{mV}$ + 8 μV	
	500 kHz to 1 MHz	1 $\mu\text{V}/\text{mV}$ + 8 μV	
	(220 to 700) mV		
	(10 to 20) Hz	0.21 $\mu\text{V}/\text{mV}$ + 1.6 μV	
	(20 to 40) Hz	80 nV/mV + 1.7 μV	
	40 Hz to 20 kHz	30 nV/mV + 2 μV	
	(20 to 50) kHz	50 nV/mV + 2.3 μV	
	(50 to 100) kHz	80 nV/mV + 2.7 μV	
	(100 to 300) kHz	0.18 $\mu\text{V}/\text{mV}$ + 4.1 μV	
	(300 to 500) kHz	0.3 $\mu\text{V}/\text{mV}$ + 8 μV	
	500 kHz to 1 MHz	0.96 $\mu\text{V}/\text{mV}$ + 8 μV	
	(0.7 to 2.2) V		
	(10 to 20) Hz	0.2 mV/V + 20 nV	
	(20 to 40) Hz	66 $\mu\text{V}/\text{V}$ + 70 nV	
	40 Hz to 20 kHz	24 $\mu\text{V}/\text{V}$ + 0.2 μV	
	(20 to 50) kHz	46 $\mu\text{V}/\text{V}$ + 0.1 μV	
	(50 to 100) kHz	71 $\mu\text{V}/\text{V}$ + 70 nV	
	(100 to 300) kHz	0.16 mV/V + 30 nV	
	(300 to 500) kHz	0.26 mV/V + 20 nV	
	500 kHz to 1 MHz	0.9 mV/V + 10 nV	
	(2.2 to 7) V		
	(10 to 20) Hz	0.2 nV/V + 0.6 μV	
	(20 to 40) Hz	70 $\mu\text{V}/\text{V}$ + 2 μV	
40 Hz to 20 kHz	20 $\mu\text{V}/\text{V}$ + 5 μV		
(20 to 50) kHz	50 $\mu\text{V}/\text{V}$ + 2 μV		
(50 to 100) kHz	80 $\mu\text{V}/\text{V}$ + 1 μV		
(100 to 300) kHz	0.2 nV/V + 0.6 μV		
(300 to 500) kHz	0.4 nV/V + 0.3 μV		
500 kHz to 1 MHz	1 mV/V + 90 nV		



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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		Fluke 5790A AC Voltage Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 0.1 μV	
	(20 to 40) Hz	70 μV/V + 0.1 μV	
	40 Hz to 20 kHz	30 μV/V + 0.1 μV	
	(20 to 50) kHz	50 μV/V + 0.6 μV	
	(50 to 100) kHz	80 μV/V + 30 μV	
	(100 to 300) kHz	0.2 mV/V + 0.1 μV	
	(300 to 500) kHz	0.4 mV/V + 0.1 μV	
	500 kHz to 1 MHz	1 mV/V + 20 nV	
	(22 to 70) V		
	(10 to 20) Hz	0.2 mV/V + 2 μV	
	(20 to 40) Hz	70 μV/V + 2 μV	
	40 Hz to 20 kHz	30 μV/V + 10 μV	
	(20 to 50) kHz	60 μV/V + 7 μV	
	(50 to 100) kHz	90 μV/V + 4 μV	
	(100 to 300) kHz	0.2 mV/V + 2 μV	
	(300 to 500) kHz	0.4 mV/V + 1 μV	
	500 kHz to 1 MHz	1 mV/V + 0.3 μV	
	(70 to 220) V		
	(10 to 20) Hz	0.2 mV/V + 2 μV	
	(20 to 40) Hz	70 μV/V + 6 μV	
	40 Hz to 20 kHz	30 μV/V + 10 μV	
	(20 to 50) kHz	70 μV/V + 6 μV	
	(50 to 100) kHz	0.1 mV/V + 4 μV	
	(100 to 300) kHz	0.2 mV/V + 2 μV	
	(300 to 500) kHz	0.5 mV/V + 0.8 μV	
	(220 to 700) V		
	(10 to 20) Hz	0.2 mV/V + 50 μV	
	(20 to 40) Hz	0.1 mV/V + 0.1 mV	
	40 Hz to 20 kHz	40 μV/V + 0.2 mV	
(20 to 50) kHz	0.1 mV/V + 80 μV		
(50 to 100) kHz	0.5 mV/V + 20 μV		
(700 to 1 000) V			
(10 to 20) Hz	0.2 mV/V + 30 μV		
(20 to 40) Hz	0.1 mV/V + 70 μV		
40 Hz to 20 kHz	40 μV/V + 0.2 mV		
(20 to 50) kHz	0.1 mV/V + 50 μV		
(50 to 100) kHz	0.5 mV/V + 10 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	(50 to 600) Hz (0.01 to 1 400) V (1.4 to 10) kV (1 to 30) kV 50 or 60 Hz (10 to 70) kV	1.2 V/kV + 0.16 V 1.2 V/kV + 0.2 V 0.8 V/kV + 0.2 V 1.8 V/kV	Vitretek 4700 High Voltage Meter, HVL-35 Probe, HVL-100 Probe
Electrical Simulation of Thermocouple Indicating Devices – Source/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 Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C	0.34 °C 0.26 °C 0.23 °C 0.26 °C 0.23 °C 0.2 °C 0.24 °C 0.39 °C 0.65 °C 0.39 °C 0.13 °C 0.11 °C 0.13 °C 0.16 °C 0.21 °C 0.13 °C 0.11 °C 0.13 °C 0.18 °C 0.26 °C 0.14 °C 0.13 °C 0.2 °C 0.31 °C	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
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure ¹	Type N		Fluke 5522A/SC1100 Multi Product Calibrator
	(-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	0.37 °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			Fluke 5522A/SC1100 Multi Product Calibrator
Amplitude – DC Signal into 50 Ω load	± 1 mV to ± 6.6 V	2.3 mV/V + 36 μV	
into 1 MΩ load	± 1 mV to ± 130 V	0.39 mV/V + 34 μV	
Amplitude – Square Wave into 50 Ω load	1 mVp-p to 6.6 Vp-p 10 Hz to 10 kHz	3.9 mV/V + 31 μV	
into 1 MΩ load	1 mVp-p to 130 Vp-p 10 Hz to 1 kHz (1 to 10) kHz	0.79 mV/V + 34 μV 2 mV/V + 33 μV	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Leveled Sine Wave – Amplitude (50 kHz ref) into 50 Ω load	5 mV to 5.5 V 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 5 mV to 3.5 V (600 to 1 100) MHz 5 mVp-p to 5.5 Vp-p 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 4 mVp-p to 3.5 Vp-p (600 to 1 100) MHz	27 mV/V + 0.26 mV 31 mV/V + 0.25 mV 47 mV/V + 0.26 mV 1.3 mV + 54 mV/V 12 mV/V + 0.1 mV 16 mV/V + 0.1 mV 31 mV/V + 90 μV 39 mV/V + 0.1 mV	Fluke 5522A/SC1100 Multi Product Calibrator
Time Markers	1 ns to 20 ms 50 ms 0.1 s 0.2 s 0.5 s 1 s 2 s 5 s	2.26 ps/μs 4.4 μs 9.8 μs 35 μs 0.21 ms 0.8 ms 3.1 ms 20 ms	
Edge – Rise Time	(250 to 350) ps 1 kHz to 11 MHz	+ 0 ps/-100 ps	
Total Harmonic Distortion ¹	10 Hz to 500 kHz (-95 to -50) dB (-50 to -20) dB (-20 to 0) dB	0.023 dB 0.088 dB 0.9 dB	Pico Technologies 4262 Digital Oscilloscope

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	P&W Labmaster Universal 1000A, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	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 2) in (2 to 3) in (3 to 4) in (4 to 7) in (7 to 10) in (10 to 13) in	(8.3 + 2.8L) μin (8 + 4.5L) μin (7.9 + 5L) μin (8.1 + 5L) μin (8.4 + 5L) μin (8.7 + 5L) μin (9.2 + 5L) μin (9.4 + 5L) μin	P&W Labmaster Universal 1000A, Gauge Blocks
Depth Micrometer Master ²	(0.5 to 11.5) in	(28 + 1L) μin	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	P&W Labmaster Universal 1000A, Gauge Blocks
Feeler Gauges ¹ (Leaf-Style)	Up to 0.25 in	76 μin	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	P&W Labmaster Universal 1000A, Gauge Blocks
Gauge Blocks ^{2,6}	(0.005 to 4) in	(3 + 0.45L) μin	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	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	P&W Labmaster Universal 1000A, Gauge Blocks
Optical Flats and Parallels Flatness Up to 4 in Diameter	Up to 100 μin	5.6 μin	Optical Flat, Monochromatic Light
	Parallelism (0 to 2) in thickness	4.5 μin	Mahr 130-B24 Comparator
Parallels	Up to 36 in	66 μin	Gauging Amplifier, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pin Gauges – Class ZZ ²	(0.01 to 1) in	(93 + 2.44L) μin	Digital Micrometer
Riser Blocks ²	(6 to 24) in	(19 + 7L) μin	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	P&W Labmaster Universal 1000A, Gauge Blocks
Squares – Perpendicularity ²	Up to 36 in	(35 + 8L) μin	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	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	P&W Labmaster Universal 1000A, Gauge Blocks
Thickness (Film) Gauge Standards (Non-Ferrous)	Up to 0.05 in	6.1 μin	P&W Labmaster Universal 1000A, Gauge Blocks
Thread Measuring Wires ^{2,10}	Unified 60° (4 to 80) TPI Acme 29° (1 to 20) TPI	(13 – 50L) μin (13 – 50L) μin	P&W Labmaster Universal 1000A, Gauge Blocks
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	P&W Labmaster Universal 1000A, Gauge Blocks
Angle Blocks	(1 to 60)°	0.002 2°	Master Angle Blocks, Sine Plate, Gauging Amplifier
Angle Gauges (Leaf Style) ²	Up to 90°	3.7'	STI Optical Comparator
Electronic Differential Levels ²	Up to 1 000"	1.4"	Brunson 470 Angle Generator
Functional Gauges & Fixtures	Linear (0 to 12) in	190 μin	STI Optical Comparator
	Angle Up to 90°	0.065°	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radius Gauges (Leaf Style)	Up to 1 in	210 μ in	STI Optical Comparator
Sine Bars, Sine Plates ²	Angle (1 to 60) $^{\circ}$	6.48"	Gauge Blocks, Angle Blocks, Gauging Amplifier
Thread Pitch Gauges ¹⁰ (Leaf Style)	(4 to 84) TPI	160 μ in	STI Optical Comparator
Tri-Blocks	Length (1 to 6) in	48 μ in	Gauging Amplifier, Gauge Blocks
	Flatness	41 μ in	Gauging Amplifier
	Perpendicularity	69 μ in	Indi-Square, Gauging Amplifier
V-Blocks	Parallelism	47 μ in	Gauging Amplifier, Gauge Blocks
	Perpendicularity	66 μ in	Gauging Amplifier, Indi-Square
	V-Centrality	55 μ in	Gauging Amplifier, Master Plugs
Pipe Thread Plugs ^{2,10}	Simple Pitch Diameter (4 to 80 TPI)	(100 + 2L) μ in	P&W Labmaster Universal 1000A, Gauge Blocks, Sine Plug
	Standoff Up to 1 in (1 to 2) in	(36 + 0.9L) μ in (35 + 0.59L) μ in	Gauging Amplifier Gauge Blocks
Thread Plugs – Setting ^{2,5,10}	Simple Pitch Diameter (4 to 80 TPI)	(47 + 5L) μ in	P&W Labmaster Universal 1000A, Gauge Blocks, Thread Measuring Wires
	Major Diameter (0.06 to 4) in	(16 + 4.7L) μ in	P&W Labmaster Universal 1000A, Gauge Blocks
Thread Plugs – Setting ^{2,5,10}	Root Radius & Minor Diameter	203 μ in	STI Optical Comparator
Thread Plugs – Working ^{2,5,10}	Simple Pitch Diameter (4 to 80 TPI)	(96 + 0.4L) μ in	P&W Labmaster Universal 1000A, Gauge Blocks, Thread Measuring Wires

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plugs – Working ^{2,5,10}	Major Diameter (0.060 to 4) in	$(26 + 4L) \mu\text{in}$	P&W Labmaster Universal 1000A, Gauge Blocks
Thread Plugs – Working ^{2,5,10}	Root Radius & Minor Diameter	200 μin	STI Optical Comparator
Bench Micrometers ¹	Length Up to 2 in	12 μin	Gauge Blocks
Bench Micrometers ^{1,2} Length	Up to 2 in	12 μin	Gauge Blocks
Anvil Flatness	Up to 0.5 in Diameter	9.4 μin	Optical Flat, Monochromatic Light
Bore Gauges (2 point) ^{1,2}	Up to 1 in	$(48 + 0.6L) \mu\text{in}$	Indi-Check
Bore Gauges ² (2 point)	Up to 4 in (4 to 40) in	$(8.4 + 7L) \mu\text{in}$ $(3.6 + 8L) \mu\text{in}$	P&W Labmaster Universal 1000A, Gauge Blocks
Bore Gauges (3 point) ^{1,2}	Up to 8 in	$(72 + 3L) \mu\text{in}$	Ring Gauges
Calipers ^{1,2,3} (Inside and Outside)	Up to 20 in (20 to 40) in (40 to 60) in	$(280 + 10L) \mu\text{in}$ $(440 + 5L) \mu\text{in}$ $(920 + 4L) \mu\text{in}$	Gauge Blocks, Gauge Block Accessories
Chamfer Gauges ^{1,2}	Up to 1 in	$(77 + 3.2L) \mu\text{in}$	Modified Ring Gauges
Gauging Amplifiers, LVDT Heads	Up to 0.001 in	$(6.8 - 3L) \mu\text{in}$	P&W Labmaster Universal 1000A
Height Gauges ^{1,2}	Up to 24 in (24 to 40) in	$(430 + 2L) \mu\text{in}$ $(390 + 4L) \mu\text{in}$	Gauge Blocks, Surface Plate
Height Masters ² Length	Up to 24 in	$(68 + 6L) \mu\text{in}$	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	$(58 - 0.3L) \mu\text{in}$ $(58 + 0.1L) \mu\text{in}$ $(58 + 0.6L) \mu\text{in}$ $(46 + 4L) \mu\text{in}$	P&W Labmaster Universal 1000A, Gauge Blocks
Indicators ^{1,2,7}	(0 to 1) in	$(48 + 0.6L) \mu\text{in}$	Indi-Check

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	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	Gauge Blocks
Base Flatness	Up to 3 in	9.4 μin	Optical Flat, Monochromatic Light
Inside Micrometer ^{1,2}	Up to 4 in (5 to 20) in (21 to 40) in (41 to 60) in	(37 + 5L) μin (50 + 7L) μin (300 + 6L) μin (590 + 4L) μin	Gauge Blocks, Gauge Block Accessories
Outside Micrometer ^{1,2}	Up to 4 in (5 to 20) in (21 to 40) in (41 to 60) in	(37 + 5L) μin (50 + 7L) μin (270 + 6L) μin (580 + 5L) μin	Gauge Blocks
Micrometer Anvil Flatness	Up to 3 in Diameter	9.4 μin	Optical Flat, Monochromatic Light
Screw Thread Micrometer ^{1,2,4}	Up to 1 in	(160 + 7.7L) μin	Thread Setting Plugs
V-Anvil Micrometer ^{1,2}	(0.062 5 to 2) in	(53 + 1L) μin	Gauge Balls
Steel Rules, Tape Measures ^{2,11}	Up to 12 in	890 μin	Optical Comparator
	(1 to 300) ft	(1 800 + 5L) μin	Optodyne LDDM
Thickness Gauges ¹ (Dial & Digital)	Up to 0.5 in	60 μin	Gauge Blocks
Optical Comparators, Vision Measuring Machines ¹ Magnification	10X, 20X, 31.25X, 50X and 62.5X	0.001 2 in	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

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Protractors, Inclinometers ²	Up to 90°	0.59'	Gauge Blocks, Angle Blocks, Gauging Amplifier, Sine Plate
Levels ²	Up to 1 000"	2.9"	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	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 0.004 6 % of reading + 0.6 lbf	Morehouse Force Calibration System, Load Cell
Cable/Wire Tensiometers	(1 to 600) lbf	0.01 % of reading + 0.058 lbf	NIST Class F Weights
Cable/Wire Tensiometers	(600 to 1 000) lbf	0.3 % of reading + 0.18 lbf	CDI 2000 Force Tension Kit
Durometers Indenter Dimensions Angle Radius Diameter/Length Spring Force Types A, B, E, O Types C, D, DO	Up to 30° 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 0.087 N 0.12 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	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	Fluke P3224-PSI Deadweight Tester
Low Pressure/Vacuum – Measure/Source	Up to 2 inH ₂ O	0.000 69 inH ₂ O	Dwyer 1430 Microtector
	(-20 to 20) inH ₂ O	0.003 1 inH ₂ O	Meriam 34FBT2M Manometer



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pneumatic Absolute Pressure – Measure/Source	(0.2 to 1 015) psia	0.002 3 % of reading	Ruska 2465 Deadweight Tester
Pneumatic Gauge Pressure – Measure/Source	(-14.4 to 1 000) psig	0.002 3 % of reading	Ruska 2465 Deadweight Tester
Pressure/Vacuum – Measure/Source ¹	(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	Fluke 700 Series Pressure Transducers
Scales & Balances ¹ (0.000 1 g resolution)	(0 to 610) g	2 µg/g + 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	3 µg/g + 0.8 mg	
Scales & Balances ¹ (0.01 g resolution)	Up to 35 000 g	2 µg/g + 9 mg	
Scales & Balances ¹ (0.000 1 kg resolution)	Up to 35 kg	1 mg/kg + 0.11 g	
Scales & Balances ¹ (0.001 lb resolution)	Up to 10 lb	0.009 % of reading + 0.000 8 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	0.01 % of reading + 0.008 lb	
Scales & Balances ¹ (0.1 lb resolution)	Up to 600 lb	0.004 % of reading + 0.084 lb	
Torque Indicating Devices ¹	(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	CDI 2000 Torque Tester
Torque Calibration Systems	(20 to 400) ozf·in (2.5 to 100) lbf·in (50 to 3 000) lbf·in (250 to 1 000) lbf·ft (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 + 0.1 lbf·ft 0.04% of reading + 0.09 lbf·ft	CDI Torque Arms, CDI Torque Wheels, NIST Class F Weights



ANSI National Accreditation Board

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure ¹	(10 to 30) °C (5 to 95) %RH	0.14 % of reading + 1.1 %RH	Rotronic HC2A Humidity Probe
Temperature and Humidity Devices			
Humidity	(15 to 40) °C (5 to 95) %RH	0.27 % of reading + 0.56 %RH	Thunder Scientific 2500LT Chamber
Temperature	(-10 to 70) °C	0.000 4 % of reading + 0.14 °C	
Radiation (Infrared) Thermometers ¹	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	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	Fluke 4180 Blackbody Source (Flat Plate) $\epsilon = (0.9 \text{ to } 1), \lambda = (8 \text{ to } 14) \mu\text{m}$
	35 °C 100 °C 200 °C 350 °C 500 °C	0.54 °C 0.84 °C 1 °C 1.8 °C 2.4 °C	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	Fluke 7196 Liquid N ₂ Calibrator, Fluke 5628 PRT
Temperature – Source ^{1,8}	0.0 °C	0.058 °C	Kaye X0240 Ice Point
Temperature – Source ⁸	0.01 °C	0.005 °C	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	Fluidized Baths, Thermometrics 1925-A, Fluke 5628 PRT
Temperature – Source ⁸	(100 to 250) °C	0.06 % of reading	

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Source ^{1,8}	(-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	Fluke 1586 Scanner, Fluke 5628 PRT
	(0 to 100) °C	0.003 % of reading + 0.009 °C	Fluke 1586 Scanner, Thermometrics 1925-A
Temperature – Measure ¹	(-10 to 60) °C	0.4 °C	Rotronic Hygropalm HP22-A, HC2A
Temperature – Measure ¹	(-40 to 0) °C	0.64 °C	Type T Thermocouple Probe, Fluke 52 II Temperature Indicator
Temperature – Measure ¹	(0 to 232) °C	0.05 % of reading + 0.64 °C	Type T Thermocouple Probe, Fluke 52 II Temperature Indicator
Dew Point	(-25 to 69) °C	0.22 °C	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	Keysight 53220A Counter, HP 58503A GPS Receiver
Frequency – Source	10 Hz to 1.3 GHz	59 pHz/Hz + 0.1 mHz	Keysight 53220A Counter, Efratom FRK-LN Oscillator
Tachometers ^{1,2}	Contact Type (1 to 40 000) rpm	0.88 rpm	Quantum Dynamics N-11-ECS/3A Tachometer, Keithley 53220A Counter
Tachometers ^{1,2}	Non-Contact Type (25 to 90 000) rpm	2 μ rpm/rpm + 0.13 rpm	Fluke 5522A Multi Product Calibrator

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tachometers ^{1,2}	Strobe Tachometer (25 to 90 000) rpm	5 μ rpm/rpm + 0.13 rpm	Keysight 53220A Counter, Solar Cell
Stopwatches & Timers	Up to 24 hr	58 ms/24 hr	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 in	ProScale OptoDyne LDDM
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) μ in (2.3 + 5L) μ in (1.6 + 4L) μ in (0.61 + 4L) μ in (75 + 5L) μ in	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) μ in (8 – 4.54L) μ in (7.9 + 5L) μ in (8.1 + 5L) μ in (8.4 + 5L) μ in (8.7 + 5L) μ in (9.2 + 5L) μ in (9.9 + 5L) μ in	P&W Labmaster Universal 1000A
Length Measures – Hand Tools ^{2,9}	Up to 1 in	(93 + 2.44L) μ in	Digital Micrometer
	Up to 8 in	(1 400 + 5L) μ in	Digital Caliper

2 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Angle	Up to 360°	0.065°	STI Optical Comparator
2D Length ⁹	X/Y Axis: Up to 12 in	210 μ in	STI Optical Comparator

2 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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	$(110 + 12L) \mu\text{in}$	Mitutoyo QV-L404Z1L-D with 1.0x, 1.5x, and 2.0x Objective Lenses
Gauges and Fixtures – 2D Angle	Up to 360°	0.015°	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 39.37 in Z Axis: Up to 23.62 in	$(110 + 3.1L) \mu\text{in}$	Mitutoyo Crysta-Apex S 9106 CMM with SP25M Scanning Probe
Angle	Up to 360°	0.02°	Mitutoyo Crysta-Apex S 9106 CMM with SP25M Scanning Probe

Services performed at satellite location

3695 N. 126th Street
 Brookfield, WI 53005
 Jeff Breidigan 708-596-5800

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (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	Arco SS-32 Standard Capacitors
Capacitance – Source ¹ (Simulation)	(0.19 to 3.3) nF (3.3 to 11) nF (11 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 mF to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	40 pF/nF + 8 pF 2 pF/nF + 8 pF 2 pF/nF + 80 pF 2 pF/nF + 0.23 nF 2 nF/μF + 0.75 nF 2 nF/μF + 2.3 nF 2 nF/μF + 8 nF 3 nF/μF + 23 nF 3 nF/μF + 80 nF 3 nF/μF + 0.23 μF 3 nF/μF + 0.78 μF 4 μF/mF + 2.3 μF 4 μF/mF + 7.6 μF 6 μF/mF + 23 μF 9 μF/mF + 80 μF	Fluke 5522A/SC1100 Multi Product Calibrator
DC Current – Source ¹	(0 to 330) μA (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (0.33 to 1.1) A (1.1 to 3) A (3 to 11) A (11 to 20) A	0.11 nA/μA + 23 nA 77 nA/mA + 41 nA 81 nA/mA + 0.24 μA 78 nA/μA + 2 μA 0.16 mA/A + 31 μA 0.29 mA/A + 32 μA 0.39 mA/A + 0.39 mA 0.78 mA/A + 0.58 mA	Fluke 5522A/SC1100 Multi Product Calibrator
DC Current Source – Current Clamps ¹	(10 to 150) A (150 to 1 025) A	2 mA/A + 1.3 mA 2 mA/A + 0.13 A	Fluke 5522A/SC1100 Multi Product Calibrator, Fluke 50-Turn Coil



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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	(30 to 330) μ A		Fluke 5522A/SC1100 Multi Product Calibrator
	(10 to 20) Hz	1.6 nA/ μ A + 80 nA	
	(20 to 45) Hz	1.2 nA/ μ A + 80 nA	
	45 Hz to 1 kHz	1 nA/ μ A + 80 nA	
	(1 to 5) kHz	2.3 nA/ μ A + 0.12 μ A	
	(5 to 10) kHz	6.2 nA/ μ A + 0.16 μ A	
	(10 to 30) kHz	12 nA/ μ A + 0.31 μ A	
	(0.33 to 3.3) mA		
	(10 to 20) Hz	1.6 μ A/mA + 0.12 μ A	
	(20 to 45) Hz	0.97 μ A/mA + 0.12 μ A	
	45 Hz to 1 kHz	0.78 μ A/mA + 0.12 μ A	
	(1 to 5) kHz	1.6 μ A/mA + 0.16 μ A	
	(5 to 10) kHz	3.9 μ A/mA + 0.23 μ A	
	(10 to 30) kHz	7.8 μ A/mA + 0.47 μ A	
	(3.3 to 33) mA		
	(10 to 20) Hz	1.4 μ A/mA + 1.6 μ A	
	(20 to 45) Hz	0.7 μ A/mA + 1.6 μ A	
	45 Hz to 1 kHz	0.31 μ A/mA + 1.6 μ A	
	(1 to 5) kHz	0.62 μ A/mA + 1.6 μ A	
	(5 to 10) kHz	1.6 μ A/mA + 2.3 μ A	
	(10 to 30) kHz	3.1 μ A/mA + 3.1 μ A	
	(33 to 330) mA		
	(10 to 20) Hz	1.4 μ A/mA + 16 μ A	
	(20 to 45) Hz	0.7 μ A/mA + 16 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 to 30) kHz	3.1 μ A/mA + 0.16 mA	
	(0.33 to 1.1) A		
	(10 to 45) Hz	1.2 μ A/mA + 0.14 mA	
45 Hz to 1 kHz	0.34 μ A/mA + 94 μ A		
(1 to 5) kHz	4.1 μ A/mA + 0.98 mA		
(5 to 10) kHz	19 μ A/mA + 3.9 mA		
(1.1 to 3) A			
(10 to 45) Hz	1.4 mA/A + 78 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		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(3 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (11 to 20) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.47 mA/A + 1.6 mA 0.78 mA/A + 1.6 mA 23 mA/A + 1.6 mA 0.93 mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	Fluke 5522A/SC1100 Multi Product Calibrator
AC Current Source – Current Clamps ¹	(45 to 65) Hz (10 to 16.5) A (16.5 to 150) A (150 to 1 025) A (65 to 440) Hz (10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	1.6 mA/A + 21 mA 1.1 mA/A + 0.28 A 2.4 mA/A + 0.12 A 4.4 mA/A + 36 mA 5.2 mA/A + 0.22 A 6.4 mA/A + 94 mA	Fluke 5522A/SC1100 Multi Product Calibrator Fluke 50-Turn Coil
DC Current – Measure ¹	(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 2.75 μ A/A + 9.5 μ A 0.37 mA/A + 7.5 μ A 0.74 mA/A + 0.11 mA	Keithley 2002 8.5 Digit Multimeter
DC Current – Measure ¹	(1 to 3) A	1.23 mA/A + 0.63 mA	Agilent 34401A 6.5 Digit Multimeter
AC Current – Measure ¹	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 mA/A + 3 μ A 5 mA/A + 0.3 μ A	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	(2 to 20) mA		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	3.4 mA/A + 0.44 mA		
(50 to 200) Hz	1.9 mA/A + 0.48 mA		
200 Hz to 1 kHz	2.9 mA/A + 0.45 mA		
(1 to 10) kHz	2.4 mA/A + 7.2 mA		
(10 to 30) kHz	12.8 mA/A + 5.7 mA		
(30 to 50) kHz	38.6 mA/A + 3.5 mA		
AC Current – Measure ¹	(1 to 3) A		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	
Inductance – Source ¹ (Fixed Artifacts)	100 μH	0.12 μH	GenRad 1482 Series Standard Inductors
	500 μH	0.61 μH	
	1 mH	1.2 μH	
	10 mH	12 μH	
	50 mH	61 μH	
	100 mH	0.12 mH	
	200 mH	0.25 mH	
	1 H	1.2 mH	
	2 H	2.5 mH	
10 H	12 mH		
DC Power – Source ¹	(0 to 336) W	0.04 % of reading	Fluke 5522A/SC1100 Multi Product Calibrator
	(336 to 3 060) W	0.053 % of reading	
	(3 060 to 20 910) W	0.12 % of reading	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹	(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	0.11 % of reading 0.12 % of reading 0.16 % of reading 0.12 % of reading 0.15 % of reading 0.13 % of reading 0.15 % of reading 0.14 % of reading 0.14 % of reading	Fluke 5522A/SC1100 Multi Product Calibrator
AC Power – Source ¹	(45 to 65) Hz (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	0.1 % 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	Fluke 5522A/SC1100 Multi Product Calibrator
Resistance – Source ¹ (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 + 17 mΩ 20 μΩ/Ω + 0.17 Ω 21 μΩ/Ω + 0.2 Ω 25 μΩ/Ω + 1.6 Ω 25 μΩ/Ω + 1.7 Ω 53 μΩ/Ω + 18 Ω 0.1 mΩ/Ω + 40 Ω 0.19 mΩ/Ω + 1.9 kΩ 0.39 mΩ/Ω + 2.3 kΩ 1.7 mΩ/Ω + 0.15 MΩ 12 mΩ/Ω + 0.39 MΩ	Fluke 5522A/SC1100 Multi Product Calibrator

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	Pt 385, 100 Ω		Fluke 5522A/SC1100 Multi Product Calibrator
	(-200 to -80) °C	0.042 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.056 °C	
	(100 to 300) °C	0.072 °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	0.035 °C	
	(-80 to 0) °C	0.035 °C	
	(0 to 100) °C	0.035 °C	
	(100 to 260) °C	0.042 °C	
	(260 to 300) °C	0.094 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.13 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.035 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.042 °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	0.072 °C	
	(600 to 630) °C	0.087 °C	
	Pt 385, 1 kΩ		
	(-200 to -80) °C	0.028 °C	
(-80 to 0) °C	0.028 °C		
(0 to 100) °C	0.035 °C		
(100 to 260) °C	0.042 °C		
(260 to 300) °C	0.049 °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	Pt 3916, 100 Ω		Fluke 5522A/SC1100 Multi Product Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.035 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.049 °C	
	(100 to 260) °C	0.057 °C	
	(260 to 300) °C	0.064 °C	
	(300 to 400) °C	0.072 °C	
	(400 to 600) °C	0.079 °C	
	(600 to 630) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.042 °C	
	(-80 to 0) °C	0.042 °C	
	(0 to 100) °C	0.057 °C	
	(100 to 300) °C	0.072 °C	
	(300 to 400) °C	0.079 °C	
(400 to 630) °C	0.095 °C		
Ni 385, 120 Ω			
(-80 to 0) °C	0.066 °C		
(0 to 100) °C	0.066 °C		
(100 to 260) °C	0.11 °C		
Cu 427, 10 Ω			
(-100 to 260) °C	0.23 °C		
Resistance – Measure ¹	(0 to 20) Ω	9.1 μΩ/Ω + 0.45 mΩ	Keithley 2002 8.5 Digit Multimeter
	(20 to 200) Ω	13.3 μΩ/Ω + 1.1 mΩ	
	(0.2 to 2) kΩ	5.5 μΩ/Ω + 11 mΩ	
	(2 to 20) kΩ	4.8 μΩ/Ω + 0.12 Ω	
	(20 to 200) kΩ	30.7 μΩ/Ω + 1.2 Ω	
	(0.2 to 2) MΩ	55 μΩ/Ω + 0.11 kΩ	
DC Voltage – Source ¹	(0 to 330) mV	13 μV/V + 2.1 μV	Fluke 5522A/SC1100 Multi Product Calibrator
	(0.33 to 3.3) V	8 μV/V + 3.8 μV	
	(3.3 to 33) V	8.9 μV/V + 35 μV	
	(33 to 330) V	13.6 μV/V + 0.26 mV	
	(330 to 1 000) V	14 μV/V + 1.1 mV	
DC Voltage – Measure ¹	(0 to 200) mV	16.6 μV/V + 2.6 μV	Keithley 2002 8.5 Digit Multimeter
	(0.2 to 2) V	7.3 μV/V + 9.4 μV	
	(2 to 20) V	7.8 μV/V + 59 μV	
	(20 to 200) V	19.3 μV/V + 1.1 mV	
	(200 to 1 000) V	18.6 μV/V + 4.5 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 ¹	(1 to 33) mV		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 μ V	
	(10 to 20) kHz	0.15 μ V/mV + 5 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	
	(33 to 330) mV		
	(10 to 45) Hz	0.23 μ V/mV + 6.3 μ V	
	45 Hz to 10 kHz	0.11 μ V/mV + 6.3 μ V	
	(10 to 20) kHz	0.12 μ V/mV + 6.3 μ V	
	(20 to 50) kHz	0.27 μ V/mV + 6.3 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	0.23 mV/V + 39 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	0.19 mV/V + 0.47 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 + 1.6 mV		
(1 to 10) kHz	0.16 mV/V + 4.7 mV		
(10 to 20) kHz	0.19 mV/V + 4.7 mV		
(20 to 50) kHz	0.23 mV/V + 4.7 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 + 8.1 mV		
(1 to 5) kHz	0.19 mV/V + 8.1 mV		
(5 to 10) kHz	0.23 mV/V + 8.1 mV		
DC High Voltage – Measure ¹	(0.01 to 1 400) V	0.3 mV/V + 37 mV	Vitretek 4700 High Voltage Meter, HVL-100 Probe
	(1.4 to 10) kV	0.29 V/kV + 0.37 V	
	(10 to 100) kV	0.57 V/kV	



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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	(50 to 600) Hz (0.01 to 1 400) V (1.4 to 10) kV (30 to 70) Hz (10 to 75) kV	1.2 V/kV + 0.16 V 1.2 V/kV + 0.2 V 1.8 V/kV	Vitrek 4700 High Voltage Meter, HVL-100 Probe
AC Voltage – Measure ¹	(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 (2 to 20) 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 V/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 0.19 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 36.9 mV/V + 39 mV 0.92 mV/V + 5.2 mV 0.6 mV/V + 3.1 mV 0.35 mV/V + 3.1 mV 0.3 mV/V + 3.1 mV 0.4 mV/V + 3.1 mV 0.49 mV/V + 3.3 mV 0.69 mV/V + 3.2 mV 0.29 mV/V + 3.3 mV 7.5 mV/V + 5.1 mV 39.8 mV/V + 45 mV 69.9 mV/V + 43 mV	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	(20 to 200) 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 (200 to 750) 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	0.92 mV/V + 52 mV 0.49 mV/V + 31 mV 0.29 mV/V + 32 mV 0.29 mV/V + 32 mV 0.39 mV/V + 32 mV 0.49 mV/V + 33 mV 0.69 mV/V + 33 mV 3 mV/V + 30 mV 7.5 mV/V + 53 mV 40 mV/V + 0.4 V 1.3 mV/V + 0.12 V 0.89 mV/V + 0.12 V 0.49 mV/V + 0.12 V 0.49 mV/V + 0.12 V 0.6 mV/V + 0.11 V 0.57 mV/V + 0.42 V 0.77 mV/V + 0.4 V 4.9 mV/V + 0.23 V	Keithley 2002 8.5 Digit Multimeter
Electrical Simulation of Thermocouple Indicating Devices – Source/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 Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C	0.34 °C 0.26 °C 0.23 °C 0.26 °C 0.23 °C 0.2 °C 0.24 °C 0.39 °C 0.65 °C 0.39 °C 0.13 °C 0.11 °C 0.13 °C 0.16 °C	Fluke 5522A/SC1100 Multi Product Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure ¹	Type J		Fluke 5522A/SC1100 Multi Product 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 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	0.37 °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		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹			
Amplitude – DC Signal into 50 Ω load	± 1 mV to ± 6.6 V	2.3 mV/V + 36 μV	Fluke 5522A/SC1100 Multi Product Calibrator
into 1 MΩ load	± 1 mV to ± 130 V	0.39 mV/V + 34 μV	
Amplitude – Square Wave into 50 Ω load	1 mVp-p to 6.6 Vp-p 10 Hz to 10 kHz	3.9 mV/V + 31 μV	
into 1 MΩ load	1 mVp-p to 130 Vp-p 10 Hz to 1 kHz (1 to 10) kHz	0.79 mV/V + 34 μV 2 mV/V + 33 μV	
Amplitude – Leveled Sine Wave (50 kHz ref) into 50 Ω load	5 mV to 5.5 V 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	27 mV/V + 0.26 mV 31 mV/V + 0.25 mV 47 mV/V + 0.26 mV	
	5 mV to 3.5 V (600 to 1 100) MHz	1.3 mV + 54 mV/V	
Leveled Sine Wave – Flatness (50 kHz ref) into 50 Ω load	5 mVp-p to 5.5 Vp-p 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	12 mV/V + 0.1 mV 16 mV/V + 0.1 mV 31 mV/V + 90 μV	
	4 mVp-p to 3.5 Vp-p (600 to 1 100) MHz	39 mV/V + 0.1 mV	
Time Markers	1 ns to 20 ms 50 ms 0.1 s 0.2 s 0.5 s 1 s 2 s 5 s	2.26 ps/μs 4.4 μs 9.8 μs 35 μs 0.21 ms 0.8 ms 3.1 ms 20 ms	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Edge – Rise Time	(250 to 350) ps 1 kHz to 11 MHz	+ 0 ps/-100 ps	Fluke 5522A/SC1100 Multi Product Calibrator
Phase – Measure/Source ¹ (0.01 to 100) V	(0 to 360)° 1 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz	0.002 5° 0.003 3° 0.032° 0.32°	Keysight 53220A Phase Meter, Fluke 5522A/SC1100 Multi Product Calibrator

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure/Vacuum – Measure/Source ¹	(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	Fluke 700 Series Pressure Transducers

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure ¹	(10 to 30) °C (5 to 95) %RH	0.14 % of reading + 1.1 %RH	Rotronic HC2A Humidity Probe
Radiation (Infrared) Thermometers	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	Fluke 9132 Blackbody Source (Flat Plate) $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature – Source ^{1,8}	(-15° to 350) °C	0.26 °C + 0.15 % of reading	Hart 9009 Drywell
Temperature – Source ^{1,8}	0 °C	0.058 °C	Kaye X0240 Ice Point
Temperature – Measure ¹	(-10 to 60) °C	0.4 °C	Rotronic Hygropalm HP22-A, HC2A

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-40 to 0) °C	0.64 °C	Type T Thermocouple Probe, Fluke 52 II Temperature Indicator
Temperature – Measure ¹	(0 to 232) °C	0.05 % of reading + 0.64 °C	Type T Thermocouple Probe, Fluke 52 II Temperature Indicator

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	10 Hz to 1.3 GHz	5.3 pHz/Hz + 0.1 mHz	Keysight 53220A Counter, Efratom FRK-LN Oscillator
Frequency - Source ¹	10 Hz to 1.3 GHz	59 pHz/Hz + 0.1 mHz	Keysight 53220A Counter, Efratom FRK-LN Oscillator
Tachometers ^{1,2} (Non-Contact Type)	(25 to 90 000) rpm	2 μ rpm/rpm + 0.13 rpm	Fluke 5522A Multi Product Calibrator
Stopwatches & Timers	Up to 24 hr	58 ms/24 hr	Helmut Klein 4500 Timometer

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, DL = Diagonal Length; ' = arc-minute; " = arc-second; rpm = revolutions per minute.
3. Measurements include the following measurement functions: Outside, Inside, Step and Depth Extension Rods.
4. Inch thread setting plugs only with 60° Included Angle.
5. Includes 60° Metric, Unified and 55° Whitworth pitch gauges.
6. Uncertainty is for Steel Blocks. Carbide and Ceramic Blocks may have a different uncertainty due to deformation coefficients and different coefficients of thermal expansion.
7. Includes dial, digital and test indicators.
8. 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.
9. Metric equivalencies for this type of equipment are available and converted by 1 in equals 25.4 mm exactly.
10. TPI indicates threads per inch.
11. Verification performed in 12 ft. increments before repositioning.
12. Includes Master Setting Discs and Progressive Diameter Plugs.
13. This instrument/parameter has been characterized to lower the uncertainty.
14. The stated uncertainty is associated with a primary calibration which utilizes a comparison datum set with gauge blocks rather than a master ring.
15. This scope is formatted as part of a single document including Certificate of Accreditation No. L2216.



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