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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.
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Jason Stine, Vice President

Expiry Date: 07 September 2027
Certificate Number: AC-2489.23

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

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

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

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CALIBRATION AND DIMENSIONAL MEASUREMENT

ISO/IEC 17025 Accreditation Granted: **29 August 2025**

Certificate Number: **AC-2489.23** Certificate Expiry Date: **07 September 2027**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level – Source [1]	125 Hz to 2 kHz (74 to 104) dB 4 kHz (74 to 104) dB 125 Hz to 2 kHz 114 dB 4 kHz 114 dB	0.45 dB 0.72 dB 0.33 dB 0.6 dB	Comparison to General Radio 1986 Sound Level Calibrator
Sound Level – Measure [1]	125 Hz to 2 kHz (74 to 104) dB 4 kHz (74 to 104) dB 125 Hz to 2 kHz 114 dB 4 kHz 114 dB	0.46 dB 0.73 dB 0.35 dB 0.61 dB	Comparison to General Radio 1986 Sound Level Calibrator with Sound Level Meter

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Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters [8]	4 pH 7 pH 10 pH	0.013 pH 0.012 pH 0.012 pH	Comparison to Accredited Buffer Solutions
Conductivity Meters [8]	1 µS/cm 10 µS/cm 100 µS/cm 1 000 µS/cm 10 000 µS/cm 100 000 µS/cm	0.63 µS/cm 0.63 µS/cm 2.1 µS/cm 4.8 µS/cm 43 µS/cm 370 µS/cm	Comparison to Accredited Conductivity Solutions

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sine Wave Flatness – Measure [1]	(0.1 to 3) V 10 Hz to 1 MHz (1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 80) MHz (80 to 100) MHz	 0.056 % of reading 0.069 % of reading 0.11 % of reading 0.19 % of reading 0.35 % of reading 0.46 % of reading	Comparison to Thermal Voltage Converter, Keysight 3458A 8.5 Digit Multimeter
Capacitance – Source [1] (Simulation)	(220 to 400) pF 10 Hz to 10 kHz (0.4 to 1.1) nF 10 Hz to 10 kHz (1.1 to 3.3) nF 10 Hz to 3 kHz (3.3 to 11) nF 10 Hz to 3 kHz (11 to 33) nF 10 Hz to 1 kHz (33 to 110) nF 10 Hz to 1 kHz	 0.4 % of reading + 7.8 pF 0.4 % of reading + 7.8 pF 0.4 % of reading + 7.8 pF 0.21 % of reading + 7.8 pF 0.2 % of reading + 78 pF 0.21 % of reading + 78 pF	Comparison to Fluke 5522A Multiproduct Calibrator

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source [1] (Simulation)	(110 to 330) nF 10 Hz to 1 kHz (0.33 to 1.1) µF (10 to 600) Hz (1.1 to 3.3) µF (10 to 300) Hz (3.3 to 11) µF (10 to 150) Hz (11 to 33) µF (10 to 120) Hz (33 to 110) µF (10 to 80) Hz (110 to 330) µF DC to 50 Hz (0.33 to 1.1) mF DC to. 20 Hz (1.1 to 3.3) mF DC to 6 Hz (3.3 to 11) mF DC to 2 Hz (11 to 33) mF DC to 0.6 Hz (33 to 110) mF DC to 0.2 Hz	0.2 % of reading + 0.2 nF 0.21 % of reading + 0.8 nF 0.21 % of reading + 2.3 nF 0.2 % of reading + 7.8 nF 0.32 % of reading + 23 nF 0.37 % of reading + 78 nF 0.38 % of reading + 0.2 µF 0.35 % of reading + 0.8 µF 0.35 % of reading + 2.3 µF 0.35 % of reading + 7.8 µF 0.58 % of reading + 23 µF 0.85 % of reading + 78 µF	Comparison to Fluke 5522A Multiproduct Calibrator
Capacitance – Measure [1]	0.1 pF 100 kHz 1 pF 10 kHz 100 kHz 10 pF 1 kHz 10 kHz 100 kHz 100 pF 100 Hz 1 kHz 10 kHz 100 kHz	1.4 % of reading 1.4 % of reading 0.37 % of reading 1.4 % of reading 0.28 % of reading 0.28 % of reading 2.1 % of reading 0.23 % of reading 0.18 % of reading 0.21 % of reading	Comparison to Agilent E4980A Precision LCR Meter

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure [1]	1 nF		Comparison to Agilent E4980A Precision LCR Meter
	20 Hz	1.8 % of reading	
	100 Hz	0.3 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.1 % of reading	
	10 nF		
	20 Hz	0.31 % of reading	
	100 Hz	0.12 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.09 % of reading	
	100 nF		
	20 Hz	0.16 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.18 % of reading	
	1 µF		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.18 % of reading	
	100 kHz	0.25 % of reading	
	10 µF		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.16 % of reading	
	10 kHz	0.28 % of reading	
	100 kHz	0.73 % of reading	
	100 µF		
	20 Hz	0.16 % of reading	
	100 Hz	0.17 % of reading	
	1 kHz	0.29 % of reading	
	10 kHz	0.8 % of reading	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure [1]	Up to 2 nF	0.19 % of reading + 1 pF	Comparison to Fluke 8588A 8.5 Digit Multimeter
	(2 to 20) nF	0.081 % of reading + 2 pF	
	(20 to 200) nF	0.049 % of reading + 10 pF	
	(0.2 to 2) µF	0.041 % of reading + 0.1 nF	
	(2 to 20) µF	0.042 % of reading + 1 nF	
	(20 to 200) µF	0.061 % of reading + 10 nF	
	(0.2 to 2) mF	0.061 % of reading + 0.1 µF	
	(2 to 20) mF	0.071 % of reading + 1 µF	
	(20 to 200) mF	0.072 % of reading + 10 µF	
AC Current – Source [1]	Up to 220 µA		Comparison to Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.031 % of reading + 16 nA	
	(20 to 40) Hz	0.019 % of reading + 10 nA	
	40 Hz to 1 kHz	0.015 % of reading + 8 nA	
	(1 to 5) kHz	0.03 % of reading + 12 nA	
	(5 to 10) kHz	0.11 % of reading + 65 nA	
	(0.22 to 2.2) mA		
	(10 to 20) Hz	0.03 % of reading + 40 nA	
	(20 to 40) Hz	0.018 % of reading + 35 nA	
	40 Hz to 1 kHz	0.013 % of reading + 35 nA	
	(1 to 5) kHz	0.021 % of reading + 0.1 µA	
	(5 to 10) kHz	0.11 % of reading + 0.65 µA	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.039 % of reading + 0.4 µA	
	(20 to 40) Hz	0.019 % of reading + 0.35 µA	
	40 Hz to 1 kHz	0.014 % of reading + 0.35 µA	
	(1 to 5) kHz	0.021 % of reading + 0.55 µA	
	(5 to 10) kHz	0.11 % of reading + 5 µA	
	(22 to 220) mA		
	(10 to 20) Hz	0.033 % of reading + 4 µA	
	(20 to 40) Hz	0.018 % of reading + 3.5 µA	
	40 Hz to 1 kHz	0.014 % of reading + 2.5 µA	
	(1 to 5) kHz	0.021 % of reading + 3.5 µA	
	(5 to 10) kHz	0.11 % of reading + 10 µA	
	(0.22 to 2.2) A		
	10 Hz to 1 kHz	0.027 % of reading + 35 µA	
	(1 to 5) kHz	0.046 % of reading + 80 µA	
	(5 to 10) kHz	0.7 % of reading + 0.16 mA	

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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]	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.048 % of reading + 0.17 mA 0.096 % of reading + 0.38 mA 0.36 % of reading + 0.75 mA	Comparison to Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier
AC Current – Source [1]	(11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	 0.09 % of reading + 4 mA 0.12 % of reading + 4 mA 2.3 % of reading + 4 mA	Comparison to Fluke 5522A Multiproduct Calibrator
AC Current – Source [1]	(20.5 to 40) A (10 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	 0.14 % of reading + 11 mA 0.17 % of reading + 11 mA 2.3 % of reading + 11 mA	Comparison to (2) Fluke 5520A Multiproduct Calibrators in Parallel
AC Current – Source [1] Extended Frequency Ranges	(29 to 330) µA (10 to 30) kHz (0.33 to 3.3) mA (10 to 30) kHz (3.3 to 33) mA (10 to 30) kHz (33 to 330) mA (10 to 30) kHz	 1.2 % of reading + 0.3 µA 0.78 % of reading + 0.5 µA 0.31 % of reading + 3.1 µA 0.31 % of reading + 0.2 mA	Comparison to Fluke 5522A Multiproduct Calibrator
AC Current – Source [1]	Up to 60 Hz Up to 20 A (20 to 100) A 60 Hz to 1 kHz Up to 20 A (20 to 100) A	 0.12 % of reading + 3.5 mA 0.056 % of reading + 4.6 mA 0.056 % of reading + 1.2 mA 0.05 % of reading + 2.3 mA	Comparison to Current Source, Ohms Labs CS-100 Current Shunt, Keysight 3458A 8.5 Digit Multimeter
AC Current – Source [1]	(10 to 65) Hz (20 to 33) A (33 to 40) A (40 to 60) A (60 to 100) A (65 to 300) Hz (20 to 33) A (33 to 60) A (60 to 100) A 300 Hz to 1 kHz (20 to 33) A (33 to 60) A (60 to 100) A	 0.029 % of reading + 24 mA 0.037 % of reading + 36 mA 0.038 % of reading + 36 mA 0.034 % of reading + 36 mA 0.042 % of reading + 36 mA 0.05 % of reading + 45 mA 0.052 % of reading + 45 mA 0.12 % of reading + 0.12 A 0.12 % of reading + 0.12 A 0.12 % of reading + 0.12 A	Comparison to Fluke 52120A Transconductance Amplifier, Fluke 5520A Multiproduct Calibrator

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Clamp-on Ammeters (Toroidal Type) Transformer Type Sensor [1]	(20 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz	 0.3 % of reading + 26 mA 0.83 % of reading + 47 mA 0.35 % of reading + 0.1 A 1.1 % of reading + 0.2 A	Comparison to Fluke 5522A Multiproduct Calibrator, 50-turn Coil
AC Clamp-on Ammeters (Non-Toroidal Type) Hall Effect Sensor [1]	(20 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz	 0.57 % of reading + 0.2 A 1 % of reading + 0.2 A 0.6 % of reading + 0.9 A 1.3 % of reading + 0.9 A	Comparison to Fluke 5522A Multiproduct Calibrator, 50-turn Coil
AC Clamp-on Ammeters (Non-Toroidal Type) Hall Effect Sensor [1]	(1 000 to 6 000) A (10 to 300) Hz (300 to 440) Hz	 0.77 % of reading 0.77 % of reading	Comparison to Fluke 52120A Transconductance Amplifier, Fluke 5520A Multiproduct Calibrator, 3 kA or 6 kA Coil
AC Current – Measure [1]	(1 to 20) A (> 0 to 100) Hz (100 to 300) Hz 300 Hz to 1 kHz (1 to 3) kHz (3 to 4) kHz (4 to 5) kHz	 0.02 % of reading 0.03 % of reading 0.03 % of reading 0.06 % of reading 0.07 % of reading 0.09 % of reading	Comparison to Fluke Y5020 Precision AC Current Shunt, Precision Digital Multimeter
AC Current – Measure [1]	Up to 60 Hz Up to 20 A (20 to 100) A 60 Hz to 1 kHz Up to 20 A (20 to 100) A	 0.12 % of reading + 3.5 mA 0.056 % of reading + 4.6 mA 0.056 % of reading + 1.2 mA 0.05 % of reading + 2.3 mA	Comparison to Ohms Labs CS-100 Current Shunt, Keysight 3458A 8.5 Digit Multimeter
AC High Current – Measure [1]	(1 to 5 000) A 60 Hz (1 to 8 000) A 60 Hz	 0.23 % of reading 0.35 % of reading	Comparison to Rocoil 6142 (SX-170) Rogowski Coil with Integrator

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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]	Up to 100 µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	 0.46 % of reading + 35 nA 0.17 % of reading + 35 nA 0.072 % of reading + 35 nA 0.072 % of reading + 35 nA	Comparison to Agilent 3458A 8.5 Digit Multimeter
AC Current – Measure [1]	(0.1 to 1) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	 0.46 % of reading + 0.23 µA 0.17 % of reading + 0.23µA 0.071 % of reading + 0.23 µA 0.038 % of reading + 0.23 µA 0.46 % of reading + 2.3 µA 0.17 % of reading + 2.3 µA 0.071 % of reading + 2.3 µA 0.038 % of reading + 2.3 µA 0.46 % of reading + 23 µA 0.17 % of reading + 23 µA 0.071 % of reading + 23 µA 0.037 % of reading + 23 µA 0.46 % of reading + 0.23 mA 0.19 % of reading + 0.23 mA 0.097 % of reading + 0.23 mA 0.12 % of reading + 0.23 mA	Comparison to Agilent 3458A 8.5 Digit Multimeter
AC Current – Measure [1]	(0.2 to 20) µA 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (20 to 200) µA 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	 0.2 % of reading + 2.5 nA 0.2 % of reading + 2.5 nA 0.2 % of reading + 2.5 nA 0.28 mA/A + 5 nA 0.53 mA/A + 5 nA 0.74 mA/A + 5 nA 4.1 mA/A + 10 nA	Comparison to Fluke 8588A 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]	(0.2 to 2) mA 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (0.2 to 2) A 1 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 (20 to 30) A 10 Hz to 2 kHz (2 to 10) kHz	 0.28 mA/A + 50 nA 0.53 mA/A + 50 nA 0.74 mA/A + 50 nA 4.1 mA/A + 0.1 µA 0.28 mA/A + 0.5 µA 0.53 mA/A + 0.5 µA 0.74 mA/A + 0.5 µA 4.1 mA/A + 1 µA 0.28 mA/A + 5 µA 0.52 mA/A + 5 µA 0.74 mA/A + 5 µA 0.3 mA/A + 0.1 mA 0.56 mA/A + 0.1 mA 0.8 mA/A + 0.1 mA 0.84 mA/A + 0.5 mA 0.86 mA/A + 0.5 mA 0.84 mA/A + 12 mA 1.2 mA/A + 12 mA	Comparison to Fluke 8588A 8.5 Digit Multimeter
DC Current – Source [1]	Up to 220 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	0.004 % of reading + 6 nA 0.003 6 % of reading + 7 nA 0.003 5 % of reading + 40 nA 0.004 8 % of reading + 0.7 µA 0.008 4 % of reading + 12 µA	Comparison to Fluke 5720A Multiproduct Calibrator
DC Current – Source [1]	(2.2 to 11) A	0.036 % of reading + 0.48 mA	Comparison to Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier
DC Current – Source [1]	(11 to 20.5) A	0.093 % of reading + 0.58 mA	Comparison to Fluke 5520 Multiproduct Calibrator

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1]	(20.5 to 22) A (22 to 40) A	0.072 % of reading + 0.55 mA 0.13 % of reading + 0.82 mA	Comparison to (2) Fluke 5520A Multiproduct Calibrators in Parallel
DC Current – Source [1]	Up to 100 A	0.008 7 % of reading + 0.58 mA	Comparison to Current Source, Ohms Labs CS-100 Current Shunt, Keysight 3458A 8.5 Digit Multimeter
DC Current – Source [1]	(11 to 100) A	0.012 % of reading + 5 mA	Comparison to Fluke 5520A Multiproduct Calibrator, Fluke 52120A Transconductance Amplifier
DC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(20 to 150) A (150 to 1 000) A	0.51 % of reading + 0.14 A 0.51 % of reading + 0.5 A	Comparison to Fluke 5520A Multiproduct Calibrator, 50-turn Coil
DC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(1 000 to 5 000) A	0.58 % of reading	Comparison to Fluke 5520A Multiproduct Calibrator, Fluke 52120A Transconductance Amplifier, 3 kA or 6 kA Coil
DC Current – Measure [1]	Up to 100 µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	0.003 3 % of reading + 0.92 nA 0.002 9 % of reading + 5.8 nA 0.002 9 % of reading + 58 nA 0.004 6 % of reading + 0.58 µA 0.013 % of reading + 12 µA	Comparison to Agilent 3458A 8.5 Digit Multimeter
DC Current – Measure [1]	Up to 20 µA (20 to 200) µA (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A (20 to 30) A	29 µA/A + 0.4 nA 10 µA/A + 0.39 nA 9.9 µA/A + 3.9 nA 15 µA/A + 39 nA 58 µA/A + 1 µA 0.13 mA/A + 0.1 mA 0.23 mA/A + 0.4 mA 0.55 mA/A + 4.4 mA	Comparison to Fluke 8588A 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 Current – Measure [1]	1 µA to 100 mA 100 mA to 1 A (1 to 10) A (10 to 100) A (100 to 300) A	0.013 % of reading 0.015 % of reading 0.015 % of reading 0.042 % of reading 0.058 % of reading	Comparison to Guideline 9211A Current Shunt, Agilent 3458A 8.5 Digit Multimeter
DC Current – Measure [1]	(50 to 667) A	0.12 % of reading	Comparison to Empro LAB-1000-100 Current Shunt, Agilent 3458A 8.5 Digit Multimeter
DC Current – Measure [1]	Up to 100 A	0.008 7 % of reading + 0.58 mA	Comparison to Ohms Labs CS-100 Current Shunt, Keysight 3458A 8.5 Digit Multimeter
DC High Current – Measure [1]	(100 to 3 000) A	0.17 % of reading + 0.36 A	Comparison to Canadian Shunt 90000-1400 Current Shunt, Keysight 34470A 7.5 Digit Multimeter
Inductance – Measure [1,6]	1 µH 10 kHz 100 kHz 10 µH 10 kHz 100 kHz 100 µH 1 kHz 10 kHz 100 kHz 1 mH 100 Hz 1 kHz 10 kHz 100 kHz	 1.6 % of reading 0.36 % of reading 0.37 % of reading 0.2 % of reading 0.41 % of reading 0.2 % of reading 0.12 % of reading 0.56 % of reading 0.19 % of reading 0.12 % of reading 0.1 % of reading	Comparison to Agilent E4980A Precision LCR Meter

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Measure [1,6]	10 mH		Comparison to Agilent E4980A Precision LCR Meter
	20 Hz	0.86 % of reading	
	100 Hz	0.22 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.11 % of reading	
	100 mH		
	20 Hz	0.28 % of reading	
	100 Hz	0.11 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.21 % of reading	
	1 H		
	20 Hz	0.17 % of reading	
	100 Hz	0.1 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.11 % of reading	
	100 kHz	0.31 % of reading	
	10 H		
	20 Hz	0.15 % of reading	
	100 Hz	0.1 % of reading	
	1 kHz	0.11 % of reading	
	10 kHz	0.21 % of reading	
	100 kHz	0.69 % of reading	
	100 H		
	20 Hz	0.15 % of reading	
	100 Hz	0.11 % of reading	
	1 kHz	0.15 % of reading	
	10 kHz	0.62 % of reading	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Impedance – Measure [1]	0.1 Ω		Comparison to Agilent E4980A Precision LCR Meter
	1 kHz	2 % of reading	
	10 kHz	1.2 % of reading	
	100 kHz	1.1 % of reading	
	1 Ω		
	20 Hz	0.67 % of reading	
	100 Hz	0.45 % of reading	
	1 kHz	0.36 % of reading	
	10 kHz	0.33 % of reading	
	100 kHz	0.31 % of reading	
	10 Ω		
	20 Hz	0.29 % of reading	
	100 Hz	0.2 % of reading	
	1 kHz	0.17 % of reading	
	10 kHz	0.18 % of reading	
	100 kHz	0.18 % of reading	
	100 Ω		
	20 Hz	0.16 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.12 % of reading	
	100 kHz	0.12 % of reading	
	1 kΩ		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.09 % of reading	
	10 kΩ		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.1 % of reading	
	100 kΩ		
	20 Hz	0.17 % of reading	
	100 Hz	0.1 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.17% of reading	
	100 kHz	0.28 % of reading	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source/Measure [1] (Variable Artifacts)	Up to 10 Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	0.001 8 % of reading + 58 μΩ 0.001 5 % of reading + 0.58 mΩ 0.001 3 % of reading + 0.58 mΩ 0.001 2 % of reading + 5.8 mΩ 0.001 3 % of reading + 58 mΩ 0.002 1 % of reading + 2.3 Ω 0.006 2 % of reading + 0.12 kΩ 0.059 % of reading + 1.2 kΩ 0.58 % of reading + 12 kΩ	Comparison to Agilent 3458A 8.5 Digit Multimeter, Decade Resistor
DC Resistance – Source/Measure [1] (Variable Artifacts)	Up 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 (20 to 200) MΩ (0.2 to 2) GΩ	16 μΩ/Ω + 4 μΩ 10 μΩ/Ω + 14 μΩ 9.2 μΩ/Ω + 47 μΩ 9.1 μΩ/Ω + 0.47 mΩ 9.2 μΩ/Ω + 4.7 mΩ 9.3 μΩ/Ω + 47 mΩ 11 μΩ/Ω + 1 Ω 19 μΩ/Ω + 0.10 kΩ 0.12 mΩ/Ω + 10 kΩ 0.13 % of reading + 1 MΩ	Comparison to Fluke 8588A 8.5 Digit Multimeter, Decade Resistor
Low Current Resistance – Measure [1]	Up 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 (20 to 200) MΩ (0.2 to 2) GΩ	17 μΩ/Ω + 4 μΩ 10 μΩ/Ω + 14 μΩ 17 μΩ/Ω + 0.2 mΩ 18 μΩ/Ω + 2 mΩ 22 μΩ/Ω + 20 mΩ 22 μΩ/Ω + 62 mΩ 26 μΩ/Ω + 1 Ω 0.38 mΩ/Ω + 0.3 kΩ 0.13 % of reading + 10 kΩ 0.13 % of reading + 1 MΩ	Comparison to Fluke 8588A 8.5 Digit Multimeter
High Voltage Resistance – Measure [1]	(2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	17 μΩ/Ω + 10 Ω 68 μΩ/Ω + 0.1 kΩ 0.23 mΩ/Ω + 0.1 MΩ 0.13 % of reading + 10 MΩ	Comparison to Fluke 8588A 8.5 Digit Multimeter
Resistance – Measure [1]	Up to 1 Ω (1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ	0.008 2 % of reading + 2.3 μΩ 0.007 % of reading + 23 μΩ 0.007 % of reading + 0.23 mΩ 0.007 % of reading + 2.3 mΩ 0.007 % of reading + 0.023 Ω 0.007 % of reading + 0.46 Ω 0.008 4 % of reading + 4.6 Ω	Comparison to Keysight 34420A 7.5 Digit Nanovoltmeter

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source [1] (Fixed Artifact)	10 μΩ	30 nΩ	Comparison to Canadian Shunts LAB-500-5 Current Shunt
DC Resistance – Source [1] (Fixed Artifact)	100 μΩ	0.13 μΩ	Comparison to IET Labs DCCS/0.0001 Current Shunt
DC Resistance – Source [1] (Fixed Artifact)	1 mΩ	86 nΩ	Comparison to Ohms Labs CS-100 Current Shunt
DC Resistance – Source [1] (Fixed Artifact)	10 mΩ	1.4 μΩ	Comparison to Fluke Y5020 Precision Current Shunt
DC Resistance – Source [1] (Fixed Artifact)	1 Ω	10 μΩ	Comparison to Fluke 742A-1 Standard Resistor
DC Resistance – Source [1] (Fixed Artifact)	10 Ω	0.37 mΩ	Comparison to IET Labs SRX-10 Standard Resistor
DC Resistance – Source [1] (Fixed Artifact)	10 kΩ	52 mΩ	Comparison to Fluke 742A-10k Standard Resistor
DC Resistance – Source [1] (Multi-tap Artifact)	333.33 μΩ 1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ	0.19 μΩ 0.42 μΩ 1.7 μΩ 17 μΩ 0.15 mΩ 1.5 mΩ 15 mΩ 0.15 Ω 1.5 Ω	Comparison to Guideline 9211A Multi-tap Current Shunt
DC Resistance – Source [1] (Variable Artifacts)	100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ (1 to 10) GΩ (10 to 100) GΩ 100 GΩ to 1 TΩ	0.035 % of reading 0.035 % of reading 0.12 % of reading 0.3 % of reading 0.58 % of reading 1.2 % of reading 2.6 % of reading	Comparison to High Resistance Box (Up to 10 kV)

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Electrical – DC/Low Frequency

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DC Resistance – Source [1] (Simulation)	Up to 11 Ω	32 µΩ/Ω + 0.8 mΩ	Comparison to Fluke 5522A Multiproduct Calibrator
	(11 to 33) Ω	24 µΩ/Ω + 1.2 mΩ	
	(33 to 111) Ω	22 µΩ/Ω + 1.1 mΩ	
	(110 to 330) Ω	22 µΩ/Ω + 1.6 mΩ	
	330 Ω to 1.1kΩ	22 µΩ/Ω + 1.6 mΩ	
	(1.1 to 3.3) kΩ	22 µΩ/Ω + 1.6 mΩ	
	(3.3 to 11) kΩ	22 µΩ/Ω + 1.6 mΩ	
	(11 to 33) kΩ	22 µΩ/Ω + 0.2 Ω	
	(33 to 110) kΩ	22 µΩ/Ω + 0.2 Ω	
	(110 to 330) kΩ	27 µΩ/Ω + 1.6 Ω	
	330 kΩ to 1.19 MΩ	26 µΩ/Ω + 1.6 Ω	
	(1.1 to 3.3) MΩ	66 µΩ/Ω + 23 Ω	
	(3.3 to 11) MΩ	0.1 mΩ/Ω + 39 Ω	
	(11 to 33) MΩ	0.2 mΩ/Ω + 1.9 kΩ	
	(33 to 110) MΩ	0.4 mΩ/Ω + 2.3 kΩ	
	(110 to 330) MΩ	0.23 % of reading + 78 kΩ	
	330 MΩ to 1.1 GΩ	12 % of reading + 0.4 MΩ	
AC Voltage – Source [1]	Up to 2.2 mV		Comparison to Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.16 % of reading + 4 µV	
	(20 to 40) Hz	0.1 % of reading + 4 µV	
	40 Hz to 20 kHz	0.078 % of reading + 4 µV	
	(20 o 50) kHz	0.13 % of reading + 4 µV	
	(50 to 100) kHz	0.17 % of reading + 5 µV	
	(100 to 300) kHz	0.33 % of reading + 10 µV	
	(300 to 500) kHz	0.47 % of reading + 20 µV	
	500 kHz to 1 MHz	0.58 % of reading + 20 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.042 % of reading + 4 µV	
	(20 to 40) Hz	0.03 % of reading + 4 µV	
	40 Hz to 20 kHz	0.014 % of reading + 4 µV	
	(20 o 50) kHz	0.03 % of reading + 4 µV	
	(50 to 100) kHz	0.058 % of reading + 5 µV	
	(100 to 300) kHz	0.12 % of reading + 10 µV	
	(300 to 500) kHz	0.16 % of reading + 20 µV	
	500 kHz to 1 MHz	0.27 % of reading + 20 µV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(22 to 220) mV		Comparison to Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.028 % of reading + 12 µV	
	(20 to 40) Hz	0.011 % of reading + 7 µV	
	40 Hz to 20 kHz	0.008 5 % of reading + 7 µV	
	(20 o 50) kHz	0.021 % of reading + 7 µV	
	(50 to 100) kHz	0.047 % of reading + 17 µV	
	(100 to 300) kHz	0.091 % of reading + 20 µV	
	(300 to 500) kHz	0.14 % of reading + 25 µV	
	500 kHz to 1 MHz	0.28 % of reading + 45 µV	
	(0.22 to 2.2) V		
	(10 to 20) Hz	0.027 % of reading + 40 µV	
	(20 to 40) Hz	0.01 % of reading + 15 µV	
	40 Hz to 20 kHz	0.004 8 % of reading + 8 µV	
	(20 o 50) kHz	0.008 % of reading + 10 µV	
	(50 to 100) kHz	0.012 % of reading + 30 µV	
	(100 to 300) kHz	0.043 % of reading + 80 µV	
	(300 to 500) kHz	0.1 % of reading + 0.2 mV	
	500 kHz to 1 MHz	0.18 % of reading + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.028 % of reading + 0.4 mV	
	(20 to 40) Hz	0.01 % of reading + 0.15 mV	
	40 Hz to 20 kHz	0.004 9 % of reading + 50 µV	
	(20 o 50) kHz	0.008 3 % of reading + 0.1 mV	
	(50 to 100) kHz	0.011 % of reading + 0.2 mV	
	(100 to 300) kHz	0.03 % of reading + 0.6 mV	
	(300 to 500) kHz	0.1 % of reading + 2 mV	
	500 kHz to 1 MHz	0.17 % of reading + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.028 % of reading + 4 mV	
	(20 to 40) Hz	0.01 % of reading + 1.5 mV	
	40 Hz to 20 kHz	0.005 6 % of reading + 0.6 mV	
	(20 o 50) kHz	0.009 3 % of reading + 1 mV	
	(50 to 100) kHz	0.016 % of reading + 2.5 mV	
	(100 to 300) kHz	0.09 % of reading + 16 mV	
	(300 to 500) kHz	0.44 % of reading + 40 mV	
	500 kHz to 1 MHz	0.8 % of reading + 80 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	0.011 % of reading + 4 mV	
	(1 to 20) kHz	0.017 % of reading + 6 mV	
	(20 to 30) kHz	0.061 % of reading + 11 mV	

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AC Voltage – Source [1]	(220 to 750) V (30 to 50) kHz (50 to 100) kHz	 0.061 % of reading + 11 mV 0.23 % of reading + 45 mV	Comparison to Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier
AC Voltage – Measure [1]	Up to 1 mV 100 kHz to 1 MHz (1 to 3) MHz (3 to 10) MHz (10 to 20) MHz (1 to 3) mV 100 kHz to 1 MHz (1 to 3) MHz (3 to 10) MHz (10 to 20) MHz (3 to 100) mV 100 kHz to 1 MHz (1 to 3) MHz (3 to 10) MHz (10 to 20) MHz (20 to 30) MHz	 1.8 % of reading + 2.4 µV 3.5 % of reading + 2.4 µV 9.3 % of reading + 2.4 µV 23 % of reading + 2.4 µV 1 % of reading + 2 µV 3.5 % of reading + 2 µV 9.3 % of reading + 2 µV 23 % of reading + 2 µV 0.9 % of reading + 3 µV 1.8 % of reading + 3 µV 2.9 % of reading + 3 µV 7 % of reading + 3 µV 14 % of reading + 3 µV	Comparison to Rohde & Schwarz URE3 RMS Voltmeter
AC Voltage – Measure [1]	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 4) MHz	 0.04 % of reading + 3.5 µV 0.03 % of reading + 1.2 µV 0.04 % of reading + 1.2 µV 0.15 % of reading + 1.2 µV 0.59 % of reading + 1.2 µV 4.6 % of reading + 2.3 µV 1.5 % of reading + 5.8 µV 8.1 % of reading + 8.1 µV	Comparison to Agilent 3458A Opt 002 8.5 Digit Multimeter

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(10 to 100) mV		Comparison to Agilent 3458A Opt 002 8.5 Digit Multimeter
	(1 to 40) Hz	0.013 % of reading + 4.6 µV	
	40 Hz to 1 kHz	0.009 7 % of reading + 2.3 µV	
	(1 to 20) kHz	0.017 % of reading + 2.3 µV	
	(20 to 50) kHz	0.038 % of reading + 2.3 µV	
	(50 to 100) kHz	0.093 % of reading + 2.3 µV	
	(100 to 300) kHz	0.36 % of reading + 12 µV	
	300 kHz to 1 MHz	1.2 % of reading + 12 µV	
	(1 to 2) MHz	1.8 % of reading + 12 µV	
	(2 to 4) MHz	4.7 % of reading + 81 µV	
	(4 to 8) MHz	4.7 % of reading + 92 µV	
	(8 to 10) MHz	17 % of reading + 0.12 mV	
	(0.1 to 1) V		
	(1 to 40) Hz	0.008 8 % of reading + 46 µV	
	40 Hz to 1 kHz	0.008 3 % of reading + 23 µV	
	(1 to 20) kHz	0.017 % of reading + 23 µV	
	(20 to 50) kHz	0.036 % of reading + 23 µV	
	(50 to 100) kHz	0.093 % of reading + 23 µV	
	(100 to 300) kHz	0.35 % of reading + 0.12 mV	
	300 kHz to 1 MHz	1.2 % of reading + 0.12 mV	
	(1 to 2) MHz	1.8 % of reading + 0.12 mV	
	(2 to 4) MHz	4.6 % of reading + 0.81 mV	
	(4 to 8) MHz	4.6 % of reading + 0.92 mV	
	(8 to 10) MHz	17 % of reading + 1.2 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.009 8 % of reading + 0.46 mV	
	40 Hz to 1 kHz	0.009 5 % of reading + 0.23 mV	
	(1 to 20) kHz	0.017 % of reading + 0.23 mV	
	(20 to 50) kHz	0.036 % of reading + 0.23 mV	
	(50 to 100) kHz	0.093 % of reading + 0.23 mV	
	(100 to 300) kHz	0.35 % of reading + 1.2 mV	
	300 kHz to 1 MHz	1.2 % of reading + 1.2 mV	
	(1 to 2) MHz	1.8 % of reading + 1.2 mV	
	(2 to 4) MHz	4.6 % of reading + 8.1 mV	
	(4 to 8) MHz	4.6 % of reading + 9.2 mV	
	(8 to 10) MHz	17 % of reading + 12 mV	

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AC Voltage – Measure [1]	(10 to 100) V		Comparison to Agilent 3458A Opt 002 8.5 Digit Multimeter
	(1 to 40) Hz	0.024 % of reading + 4.6 mV	
	40 Hz to 1 kHz	0.024 % of reading + 2.3 mV	
	(1 to 20) kHz	0.024 % of reading + 2.3 mV	
	(20 to 50) kHz	0.041 % of reading + 2.3 mV	
	(50 to 100) kHz	0.14 % of reading + 2.3 mV	
	(100 to 300) kHz	0.46 % of reading + 12 mV	
	300 kHz to 1 MHz	1.7 % of reading + 12 mV	
	(100 to 700) V		
	(1 to 40) Hz	0.048 % or reading + 46 mV	
	40 Hz to 1 kHz	0.048 % of reading + 23 mV	
	(1 to 20) kHz	0.071 % or reading + 23 mV	
	(20 to 50) kHz	0.14 % of reading + 23 mV	
	(50 to 100) kHz	0.35 % of reading + 23 mV	
AC Voltage – Measure [1]	(0.1 to 10) mV		Comparison to Fluke 8588A 8.5 Digit Multimeter
	1 Hz to 2 kHz	0.029 % of reading + 1.1 µV	
	(2 to 10) kHz	0.037 % of reading + 1.1 µV	
	(10 to 30) kHz	0.038 % of reading + 1.1 µV	
	(30 to 100) kHz	0.3 % of reading + 0.78 µV	
	(100 to 300) kHz	1 % of reading + 3.9 µV	
	300 kHz to 1 MHz	2 % of reading + 3.9 µV	
	(10 to 100) mV		
	1 Hz to 2 kHz	0.008 9 % of reading + 0.5 µV	
	(2 to 10) kHz	0.013 % of reading + 0.5 µV	
	(10 to 30) kHz	0.023 % of reading + 1 µV	
	(30 to 100) kHz	0.053 % of reading + 5 µV	
	(100 to 300) kHz	0.21 % of reading + 31 µV	
	300 kHz to 1 MHz	1 % of reading + 0.1 mV	
	(1 to 2) MHz	1.5 % of reading + 0.5 mV	
	(2 to 4) MHz	4.1 % of reading + 1 mV	
	(4 to 8) MHz	8.4 % of reading + 1 mV	
	(8 to 10) MHz	16 % of reading + 1 mV	

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AC Voltage – Measure [1]	(0.1 to 1) V		Comparison to Fluke 8588A 8.5 Digit Multimeter
	1 Hz to 2 kHz	0.007 7 % of reading + 5 µV	
	(2 to 10) kHz	0.012 % of reading + 5 µV	
	(10 to 30) kHz	0.023 % of reading + 10 µV	
	(30 to 100) kHz	0.053 % of reading + 50 µV	
	(100 to 300) kHz	0.21 % of reading + 0.31 mV	
	300 kHz to 1 MHz	1 % of reading + 1 mV	
	(1 to 2) MHz	1.5 % of reading + 5 mV	
	(2 to 4) MHz	4 % of reading + 10 mV	
	(4 to 8) MHz	8.2 % of reading + 10 mV	
	(8 to 10) MHz	15 % of reading + 10 mV	
	(1 to 10) V		
	1 Hz to 2 kHz	0.007 6 % of reading + 50 µV	
	(2 to 10) kHz	0.012 % of reading + 50 µV	
	(10 to 30) kHz	0.023 % of reading + 0.1 mV	
	(30 to 100) kHz	0.053 % of reading + 0.5 mV	
	(100 to 300) kHz	0.21 % of reading + 3.1 mV	
	300 kHz to 1 MHz	1 % of reading + 10 mV	
	(1 to 2) MHz	1.5 % of reading + 50 mV	
	(2 to 4) MHz	4 % of reading + 0.1 V	
	(4 to 8) MHz	8.2 % of reading + 0.1 V	
	(8 to 10) MHz	15 % of reading + 0.1 V	
	(10 to 100) V		
	1 Hz to 2 kHz	0.009 % of reading + 0.5 mV	
	(2 to 10) kHz	0.011 % of reading + 0.5 mV	
	(10 to 30) kHz	0.023 % of reading + 1 mV	
	(30 to 100) kHz	0.059 % of reading + 5 mV	
	(100 to 300) kHz	0.37 % of reading + 47 mV	
	300 kHz to 1 MHz	1 % of reading + 0.5 V	
	(100 to 1 050) V		
	1 Hz to 2 kHz	0.011 % of reading + 25 mV	
	(2 to 10) kHz	0.011 % of reading + 25 mV	
	(10 to 30) kHz	0.023 % of reading + 25 mV	
	(30 to 100) kHz	0.059 % of reading + 0.1 V	

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AC High Voltage – Measure [1]	(0.7 to 10) kV (20 to 100) Hz (100 to 400) Hz (10 to 30) kV (30 to 70) Hz (70 to 200) Hz (200 to 450) Hz (30 to 50) kV (30 to 70) Hz (70 to 200) Hz (200 to 450) Hz (50 to 70) kV (30 to 70) Hz (70 to 200) Hz	 0.14 % of reading + 0.4 V 0.48 % of reading + 0.2 V 0.11 % of reading + 2.4 V 0.7 % of reading + 2.4 V 1.4 % of reading + 2.4 V 0.13 % of reading + 2.5 V 0.7 % of reading + 2.5 V 2.9 % of reading + 2.5 V 0.16 % of reading + 2.6 V 1.2 % of reading + 2.6 V	Comparison to Vitrek 4700 Digital HV Meter, Associated High Voltage Probes
AC High Voltage – Measure [1]	(1 to 60) kV 60 Hz (60 to 150) kV 60 Hz	 0.59 % of reading + 30 V 0.59 % of reading + 0.23 kV	Comparison to High Voltage Inc. DVR150 High Voltage Divider, Meter
DC Voltage – Source [1]	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V	0.000 86 % of reading + 0.4 µV 0.000 51 % of reading + 0.7 µV 0.000 4 % of reading + 2.5 µV 0.000 39 % of reading + 4 µV 0.000 62 % of reading + 40 µV	Comparison to Fluke 5720A Multiproduct Calibrator
DC Voltage – Source [1]	(220 to 1 100) V	0.000 76 % of reading + 0.4 mV	Comparison to Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier
DC Voltage – Measure [1]	Up to 1 mV (1 to 10) mV (10 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V	0.006 % of reading + 0.023 µV 0.006 % of reading + 0.035 µV 0.004 8 % of reading + 0.46 µV 0.004 1 % of reading + 0.004 6 mV 0.003 5 % of reading + 0.046 mV 0.004 1 % of reading + 0.58 mV	Comparison to Keysight 34420A 7.5 Digit Nanovoltmeter

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DC Voltage – Measure [1]	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 500) V (500 to 800) V (800 to 1 000) V	0.000 83 % of reading + 0.58 µV 0.000 69 % of reading + 0.58 µV 0.000 53 % of reading + 0.58 µV 0.000 77 % of reading + 35 µV 0.001 4 % of reading + 0.12 mV 0.001 8 % of reading + 0.12 mV 0.002 1 % of reading + 0.12 mV	Comparison to Agilent 3458A Opt 002 8.5 Digit Multimeter
DC Voltage – Measure [1]	Up to 200 mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1 050) V	7.7 µV/V + 0.2 µV 2.9 µV/V + 0.3 µV 2.9 µV/V + 0.47 µV 4.3 µV/V + 30 µV 4.4 µV/V + 0.5 mV	Comparison to Fluke 8588A 8.5 Digit Multimeter
DC High Voltage – Measure [1]	(1 to 10) kV (10 to 20) kV (20 to 70) kV (70 to 100) kV	0.04 % of reading + 92 mV 0.09 % of reading + 2.4 V 0.09 % of reading + 2.4 V 0.17 % of reading + 2.5 V	Comparison to Vitrek 4700 Digital HV Meter, Associated High Voltage Probes
DC High Voltage – Measure [1]	(1 to 5) kV (5 to 50) kV (50 to 100) kV	0.22 % of reading + 1.6 V 0.2 % of reading + 16 V 0.2 % of reading + 0.16 kV	Comparison to Spellmann HVD100-1 High Voltage Divider, Meter
DC High Voltage – Measure [1]	(1 to 60) kV (60 to 150) kV	0.58 % of reading + 0.6 V 0.58 % of reading + 10 V	Comparison to High Voltage Inc DVR150 High Voltage Divider, Meter
AC Power – Source [1,3] PF = 1 (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA	 (10 to 65) Hz (0.11 mW to 3) mW 3 mW to 9 W (10 to 65) Hz (0.3 to 10) mW 10 mW to 33 W (10 to 65) Hz (1 to 30) mW 30 mW to 90 W (10 to 65) Hz (3 to 100) mW 100 mW to 300 W	 0.13 % of reading 0.08 % of reading 0.09 % of reading 0.08 % of reading 0.07 % of reading 0.06 % of reading 0.09 % of reading 0.08 % of reading	Comparison to Fluke 5522A Multiproduct Calibrator

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AC Power – Source [1,3]			Comparison to Fluke 5522A Multiproduct Calibrator
PF = 1			
(0.33 to 0.9) A	(10 to 65) Hz		
	(11 to 300) mW	0.07 % of reading	
	(0.3 to 900) W	0.08 % of reading	
(0.9 to 2.2) A	(10 to 65) Hz		
	(30 to 720) mW	0.09 % of reading	
	0.72 W to 2 kW	0.08 % of reading	
(2.2 to 4.5) A	(10 to 65) Hz		
	80 mW to 1.4 W	0.09 % of reading	
	1.4 W to 4.5 kW	0.18 % of reading	
(4.5 to 20.5) A	(10 to 65) Hz		
	150 mW to 20 kW	0.17 % of reading	
DC Power – Source [1]			Comparison to Fluke 5522A Multiproduct Calibrator
(0.33 to 330) mA	11 µW to 1.1 mW	0.02 % of reading	
	(1.1 to 110) mW	0.03 % of reading	
	110 mW to 110 W	0.02 % of reading	
	(110 to 330) W	0.02 % of reading	
(0.33 to 3) A	11 µW to 110 mW	0.04 % of reading	
	110 mW to 990 W	0.05 % of reading	
	990 W to 3 kW	0.01 % of reading	
(3 to 20.5) A	99 mW to 0.99 W	0.09 % of reading	
	0.99 W to 6.8 kW	0.07 % of reading	
	(6.8 to 20.5) kW	0.04 % of reading	
Low Frequency Phase – Source [1]	Up to 179.99°		Comparison to Fluke 5522A Multiproduct Calibrator
	(10 to 65) Hz	0.1°	
	(65 to 500) Hz	0.2°	
	500 Hz to 1 kHz	0.4°	
	(1 to 5) kHz	1.9°	
	(5 to 10) kHz	3.9°	
	(10 to 30) kHz	7.8°	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1]			Comparison to Fluke 5520A/11 Multiproduct Calibrator
Amplitude – DC			
into 50 Ω load	(-6 to 6) V	0.2 % of reading + 31 µV	
into 1 MΩ load	(-130 to 130) V	0.04 % of reading + 31 µV	
Amplitude – Square Wave			
into 50 Ω load	10 Hz to 100 kHz		
	1 mVp-p to 6.6 Vp-p	0.19 % of reading + 31 µV	
into 1 MΩ load	10 Hz to 1 kHz		
	1 mVp-p to 130 Vp-p	0.08 % of reading + 31 µV	
	(1 kHz to 10) kHz		
	1 mVp-p to 130 Vp-p	0.19 % of reading + 31 µV	
Time Markers			
into 50 Ω load	1 ns to 20 ms	0.000 22 % of reading	
	50 ms	0.005 9 % of reading	
	0.1 s	0.009 8 % of reading	
	0.2 s	0.018 % of reading	
	0.5 s	0.041 % of reading	
	1 s	0.08 % of reading	
	2 s	0.16 % of reading	
	5 s	0.39 % of reading	
Rise Time			
into 50 Ω load	5 mVp-p to 2.5 Vp-p		
Rate: 1 kHz to 2 MHz	250 ps (nominal)	51 ps	
Rate: 2 MHz to 10 MHz	250 ps (nominal)	51 ps	
Leveled Sine Wave			
into 50 Ω load	5 mVp-p to 5 Vp-p		
	50 kHz	1.8 % of reading + 0.2 mV	
	50 kHz to 100 MHz	2.8 % of reading + 0.2 mV	
	(100 to 300) MHz	3.2 % of reading + 0.2 mV	
	(300 to 600) MHZ	4 % of reading + 0.2 mV	
	(600 to 1 100) MHz	5.5 % of reading + 0.2 mV	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,4]			Comparison to Fluke 5520A/11 Multiproduct Calibrator
Bandwidth/Flatness (50 kHz Reference)			
into 50 Ω load	5 mVp-p to 5.5 Vp-p		
	50 kHz to 100 MHz	1.4 % of reading + 78 µV	
	(100 to 300) MHz	1.8 % of reading + 78 µV	
	(300 to 600) MHz	3.2 % of reading + 78 µV	
	(600 to 1 100) MHz	3.9 % of reading + 78 µV	
Input Impedance – Measure	(40 to 60) Ω	0.082 % of reading	
	(0.5 to 1.5) MΩ	0.081 % of reading	
Input Capacitance – Measure	(5 to 50) pF	3.9 % of reading + 0.4 pF	
Waveform Generator (Sine, Square, Triangle)			
Amplitude	10 Hz to 10 kHz		
into 50 Ω load	1.8 mVp-p to 2.5 Vp-p	2.3 % of reading + 78 µV	
into 1 MΩ load	1.8 mVp-p to 55 Vp-p	2.3 % of reading + 78 µV	
Frequency	10 Hz to 10 kHz	0.002 % of reading + 12 mHz	
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source [1]	Type B		Comparison to Ectron 1140A Thermocouple Calibrator/Simulator
	(250 to 350) °C	1.2 °C	
	(350 to 445) °C	0.9 °C	
	(445 to 580) °C	0.71 °C	
	(580 to 750) °C	0.55 °C	
	(750 to 1 000) °C	0.45 °C	
	(1 000 to 1 820) °C	0.35 °C	
	Type C		
	(0 to 250) °C	0.24 °C	
	(250 to 1 000) °C	0.19 °C	
	(1 000 to 1 500) °C	0.21 °C	
	(1 500 to 1 800) °C	0.24 °C	
	(1 800 to 2 000) °C	0.27 °C	
	(2 000 to 2 250) °C	0.33 °C	
	(2 250 to 2 315) °C	0.37 °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 – Measure/Source [1]	Type D		Comparison to Ectron 1140A Thermocouple Calibrator/Simulator
	(0 to 100) °C	0.34 °C	
	(100 to 300) °C	0.28 °C	
	(300 to 1 400) °C	0.18 °C	
	(1 400 to 1 650) °C	0.19 °C	
	(1 650 to 1 930) °C	0.23 °C	
	(1 930 to 2 100) °C	0.28 °C	
	(2 100 to 2 200) °C	0.3 °C	
	(2 200 to 2 320) °C	0.34 °C	
	Type E		
	(-270 to -245) °C	1.6 °C	
	(-245 to -195) °C	0.24 °C	
	(-195 to -155) °C	0.12 °C	
	(-155 to -90) °C	0.095 °C	
	(-90 to 0) °C	0.08 °C	
	(0 to 15) °C	0.076 °C	
	(15 to 890) °C	0.064 °C	
	(890 to 1 000) °C	0.074 °C	
	Type G		
	(0 to 100) °C	1.6 °C	
	(100 to 300) °C	0.5 °C	
	(300 to 600) °C	0.35 °C	
	(600 to 1 760) °C	0.18 °C	
	(1 760 to 2 030) °C	0.2 °C	
	(2 030 to 2 200) °C	0.25 °C	
	(2 200 to 2 315) °C	0.27 °C	
	Type J		
	(-210 to -180) °C	0.15 °C	
	(-180 to -120) °C	0.12 °C	
	(-120 to -50) °C	0.093 °C	
	(-50 to 990) °C	0.08 °C	
	(990 to 1 200) °C	0.094 °C	
	Type K		
	(-270 to -255) °C	2.5 °C	
	(-255 to -195) °C	0.85 °C	
	(-195 to -115) °C	0.16 °C	
	(-115 to -55) °C	0.12 °C	
	(-55 to 1 000) °C	0.087 °C	
	(1 000 to 1 372) °C	0.096 °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 – Measure/Source [1]	Type N		Comparison to Ectron 1140A Thermocouple Calibrator/Simulator
	(-270 to -260) °C	5.4 °C	
	(-260 to -200) °C	1.5 °C	
	(-200 to -140) °C	0.29 °C	
	(-140 to -70) °C	0.18 °C	
	(-70 to 25) °C	0.14 °C	
	(25 to 160) °C	0.12 °C	
	(160 to 1 300) °C	0.11 °C	
	Type PLII		
	(0 to 100) °C	0.1 °C	
	(100 to 925) °C	0.08 °C	
	(925 to 1 200) °C	0.1 °C	
	(1 200 to 1 395) °C	0.11 °C	
	Type R		
	(-50 to -30) °C	0.8 °C	
	(-30 to 45) °C	0.69 °C	
	(45 to 160) °C	0.49 °C	
	(160 to 380) °C	0.35 °C	
	(380 to 775) °C	0.3 °C	
	(775 to 1 768) °C	0.26 °C	
	Type S		
	(-50 to -30) °C	0.76 °C	
	(-30 to 45) °C	0.68 °C	
	(45 to 105) °C	0.49 °C	
	(105 to 310) °C	0.41 °C	
	(310 to 615) °C	0.35 °C	
	(615 to 1 768) °C	0.31 °C	
	Type T		
	(-270 to -255) °C	1.9 °C	
	(-255 to -240) °C	0.6 °C	
	(-240 to -210) °C	0.36 °C	
	(-210 to -150) °C	0.22 °C	
	(-150 to -40) °C	0.15 °C	
	(-40 to 100) °C	0.095 °C	
	(100 to 400) °C	0.08 °C	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicators – Source [1]	Pt 385, 100 Ω		Comparison to Fluke 5520A Multiproduct Calibrator
	(-200 to -80) ºC	0.05 ºC	
	(-80 to 0) ºC	0.05 ºC	
	(0 to 100) ºC	0.07 ºC	
	(100 to 300) ºC	0.09 ºC	
	(300 to 400) ºC	0.1 ºC	
	(400 to 630) ºC	0.12 ºC	
	(630 to 800) ºC	0.23 ºC	
	Pt 385, 200 Ω		
	(-200 to -80) ºC	0.04 ºC	
	(-80 to 0) ºC	0.04 ºC	
	(0 to 100) ºC	0.04 ºC	
	(100 to 260) ºC	0.05 ºC	
	(260 to 300) ºC	0.12 ºC	
	(300 to 400) ºC	0.13 ºC	
	(400 to 600) ºC	0.14 ºC	
	(600 to 630) ºC	0.16 ºC	
	Pt 385, 500 Ω		
	(-200 to -80) ºC	0.04 ºC	
	(-80 to 0) ºC	0.05 ºC	
	(0 to 100) ºC	0.05 ºC	
	(100 to 260) ºC	0.06 ºC	
	(260 to 300) ºC	0.08 ºC	
	(300 to 400) ºC	0.08 ºC	
	(400 to 600) ºC	0.09 ºC	
	(600 to 630) ºC	0.11 ºC	
	Pt 385, 1 000 Ω		
	(-200 to -80) ºC	0.03 ºC	
	(-80 to 0) ºC	0.03 ºC	
	(0 to 100) ºC	0.04 ºC	
	(100 to 260) ºC	0.05 ºC	
	(260 to 300) ºC	0.06 ºC	
	(300 to 400) ºC	0.07 ºC	
	(400 to 600) ºC	0.07 ºC	
	(600 to 630) ºC	0.23 ºC	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicators – Source [1]	Pt 3916, 100 Ω		Comparison to Fluke 5520A Multiproduct Calibrator
	(-200 to -190) ºC	0.25 ºC	
	(-190 to -80) ºC	0.04 ºC	
	(-80 to 0) ºC	0.05 ºC	
	(0 to 100) ºC	0.06 ºC	
	(100 to 260) ºC	0.07 ºC	
	(260 to 300) ºC	0.08 ºC	
	(300 to 400) ºC	0.09 ºC	
	(400 to 600) ºC	0.1 ºC	
	(600 to 630) ºC	0.23 ºC	
	Pt 3926, 100 Ω		
	(-200 to -80) ºC	0.05 ºC	
	(-80 to 0) ºC	0.05 ºC	
	(0 to 100) ºC	0.07 ºC	
	(100 to 300) ºC	0.09 ºC	
	(300 to 400) ºC	0.1 ºC	
	(400 to 630) ºC	0.12 ºC	
	PtNi 385, 120 Ω		
	(-80 to 0) ºC	0.08 ºC	
	(0 to 100) ºC	0.08 ºC	
	(100 to 260) ºC	0.14 ºC	
	Cu 427, 10 Ω		
	(-100 to 260) ºC	0.3 °C	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative RF Power [1]	100 kHz to 4.2 GHz		Comparison to Agilent 437B Power Meter, Agilent 8482A Power Sensor
	(-30 to -20) dB	1.9 % of reading	
	(-20 to -10) dB	1.8 % of reading	
	(-10 to 0) dB	1.8 % of reading	
Relative RF Power [1]	100 kHz to 4.2 GHz		Comparison to Agilent 437B Power Meter, Agilent 8482A Power Sensor
	(0 to 10) dB	1.8 % of reading	
	(10 to 20) dB	1.8 % of reading	

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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Harmonic Distortion – Measure [1]	20 Hz to 20 kHz (20 to 100) kHz	1.2 % of reading 2.3 % of reading	Comparison to HP 8903A Distortion Analyzer

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks [2]			Comparisons to Gage Block Comparator, Master Gage Blocks
Length			
Steel	(0.01 to 0.2) in	2.9 µin	
	(0.2 to 1) in	(2.8 + 0.7*L*) µin	
	(1 to 4) in	(2 + 1.7*L*) µin	
	(0.5 to 7.5) mm	83 nm	
	(7.5 to 30) mm	(0.075 + 0.001*L*) µm	
	(30 to 100) mm	(0.027 + 0.003*L*) µm	
Chrome	(0.01 to 0.2) in	3 µin	
	(0.2 to 1) in	(3 + 1*L*) µin	
	(1 to 4) in	(1 + 3*L*) µin	
	(0.5 to 6) mm	83 nm	
	(6 to 30) mm	(0.072 + 0.002*L*) µm	
	(30 to 100) mm	(0.05 + 0.003*L*) µm	
Ceramic	(0.01 to 0.2) in	3 µin	
	(0.2 to 1) in	(2.8 + 1*L*) µin	
	(1 to 4) in	(1.8 + 2*L*) µin	
	(0.5 to 1.01) mm	95 nm	
	(1.01 to 30) mm	(0.09 + 0.001*L*) µm	
	(30 to 100) mm	(0.03 + 0.003*L*) µm	
Parallelism	(100 to 500) mm	(0.16 + 0.001*L*) µm	Optical Parallels
Flatness	Up to 1 in*DL* (25.4 mm)	1 µin (25 nm)	Optical Flats

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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 mm Diameter	 3.5 µin 89 nm	Comparison to Master Optical Flat
Parallelism	Up to 1 in Up to 25.4 mm	2.9 µin 74 nm	P&W Measuring Machine
Angle Measuring Devices [1,2]	5° (5 to 20)° (20 to 35)° (35 to 45)° (45 to 60)° (60 to 75)° (75 to 85)° 90°	1.7″ 2.4″ 3.6″ 4.6″ 8.1″ 17″ 52″ 1.1″	Comparison to Sine Bar, Gage Blocks, Surface Plate, Granite Square
Calipers, Micrometers [1,2] Travel (Outside, Inside, Depth, Step)	 Up to 0.5 in (0.5 to 1) in (1 to 4) in (4 to 15) in (15 to 40) in	 13 µin 14 µin (10 + 3.6*L*) µin (11 + 4.2*L*) µin (11 + 4.4*L*) µin	Comparison to ASME B89.1 Grade 0 Gage Blocks
Anvil Flatness	Up to 1 in*DL*	4.4 µin	Optical Flats
Anvil Parallelism	Up to 1 in*DL*	7.2 µin	Optical Parallels
Bore Gages [1,2]	(0.125 to 0.25) in (0.25 to 1) in (1 to 6) in	34 µin 36 µin (30 + 7*L*) µin	Comparison to Characterized Ring Gages
Indicators [1,2] (Dial, Digital, Drop, Test)	Up to 6 in	(6.3 + 3.2*L*) µin	Comparison to Gage Blocks, Surface Plate
Test Indicators	Up to 0.025 in	5.6 µin	Comparison to Universal Length Measuring Machine
Wire Crimpers/Dies [1] Die Diameter 0.000 1 in step size 0.000 5 in step size 0.001 in step size	 (0.011 to 0.625) in (0.011 to 0.625) in (0.011 to 0.625) in	 150 µin 600 µin 1 200 µin	Comparisons to Pin Gages
Crimp Height	Up to 0.8 in	180 µin	Micrometer

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Wire Crimpers/Dies [1] Pull Test	Up to 200) lbf	0.52 lbf	Direct measure using Mark 10 Pull Tester
Height Gages [1,2]	Up to 4 in (4 to 24) in	(26 + 0.5*L*) µin (16 + 3*L*) µin	Comparison to Gage Blocks
Length – Single Axis [2] Outside Dimension	Up to 1 in (1 to 7) in (7 to 12) in	(6 + 1*L*) µin (4 + 3.5 *L*) µin (4*L*) µin	Comparison to Universal Length Measuring Machine
Inside Dimension	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	11 µin 17 µin (18 + 3*L*) µin (38 + 3*L*) µin	
Surface Plates [1,2] Overall Flatness	Up to 250 in*DL*	(38 + 1√*DL*) µin	In accordance with ASME B89.3.7 using Wyler Levels
Local Area Flatness (Repeat Readings) Up to 12.37 in*DL* (12.37 to 18.25) in*DL* (18.97 to 30.59) in*DL*	Up to 0.001 in Up to 0.001 in Up to 0.001 in	58 µin 65 µin 65 µin	Gage Amp, Probe Level Plate, Surface Plate
> 16.97 in*DL*	Up to 0.001 in	33 µin	Repeat-o-Meter
Optical Comparators [1,2] X-Y Length	Up to 6 in	(100 + 14*L*) µin	Comparisons to Calibration Grids
Squareness	(0.04 to 1) in	(120 + 1.5*L*) µin	Calibration Grids
Magnification	10X to 50X	(240 + 21*L*) µin	Magnification Checker
Optical Reference Plane [1]	Up to 6 in (6 to 12) in	51 µin 75 µin	Comparison to Glass Scale, Calibration Grids
Laser Micrometers [1,2]	Up to 0.1 in (0.1 to 0.4) in (0.4 to 1) in	13 µin 8 µin (11 + 5*L*) µin	Comparison to Characterized Master Pin Gages
Surface Roughness Testers [1]	Ra Rmax	70 nm (3 µin) 0.91 µm (36 µin)	Comparison to Calibrated Specimen

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometer Head Spindle Displacement	Up to 1 in Up to 25.4 mm	10 µin 0.26 µm	Comparison to Laser Interferometer
Micrometer Standards [2]	Up to 36 in (36 to 80) in Up to 900 mm (900 to 2 000) mm	(30 + 4*L*) µin (200 + 5*L*) µin (0.8 + 0.004*L*) µm (5 + 0.005*L*) µm	Comparison to P&W Measuring Machine
Pin Gages [1]	(0.004 to 1) in	33 µin	Comparison to Laser Micrometer
Plug Gages [2] (Outside Diameter)	Up to 1 in (1 to 7) in	13 µin (10 + 3*L*) µin	Comparison to Universal Length Measuring Machine
Measuring Rules [2]	Up to 48 in	(30 + 8*L*) µin	Comparison to CSIP with Heidenhain LIP 401R Linear Encoder
Thread Wires	(2 to 120) TPI (0.008 33 to 0.5) in (2 to 120) TPI (0.211 6 to 12.7) mm	12 µin 0.3 µm	Comparison to Universal Length Measuring Machine
Cylindrical Ring Gages [2] Inside Diameter	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	11 µin 17 µin (18 + 3*D*) µin (38 + 3*D*) µin	Comparison to Universal Length Measuring Machine
Thread Plug Gages [2] Pitch Diameter, 60° Thread Major Diameter Step Height	Up to 1 in (1 to 4) in (4 to 7) in Up to 1 in (1 to 7) in Up to 1 in	79 µin 80 µin 83 µin 13 µin (10 + 3*D*) µin 32 µin	Comparisons to Universal Length Measuring Machine, Thread Wires Universal Length Measuring Machine Gage Amp, Probe, Gage Blocks

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Ring Gages Inner Pitch Diameter	Up to 1 in (1 to 4) in (4 to 7) in	79 µin 80 µin 83 µin	Tactile Fit to Master Setting Plug (Thread Plug Uncertainty)
Tapered Thread Plug Gages Pitch Diameter Taper Standoff	Up to 3 in Up to 1 in	90 µin 31 µin	Comparisons to Universal Length Measuring Machine, Thread Wires Gage Amp, Probe, Gage Blocks
Tapered Thread Ring Gage	Up to 3 in	90 µin	Tactile Fit to Master Tapered Thread Plug (Tapered Thread Plug Uncertainty)
Thickness Foils, Feeler Gages [2]	Up to 1 in	(6 + 1*L*) µin	Comparison to Universal Length Measuring Machine
Cylindrical Plug Gages, Cylindrical Ring Gages Diameter	(0.04 to 0.4) in (0.4 to 6) in (1 to 10) mm (10 to 152) mm	45 µin (45 + 5*D*) 1.1 µin (1.1 + 0.005*D*)	Comparison to MasterScanner XP16060 Master Scanner
Tapered Plug Gages, Tapered Ring Gages Diameter Taper	(0.04 to 0.4) in (0.4 to 6) in (1 to 10) mm (10 to 152) mm -	48 µin (48 + 5*L*) 1.2 µm (1.2 + 0.005*L*) 0.1°	Comparison to MasterScanner XP16060 Master Scanner

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gages [2,7]			
Effective Pitch Diameter	(0.04 to 0.4) in (0.4 to 6) in	87 µin (87 + 5*L*)	
	(1 to 10) mm (10 to 152) mm	2.2 µm (2.2 + 0.005*L*)	
Major/Minor Diameter	(0.04 to 0.4) in (0.4 to 6) in	49 µin (49 + 5*L*)	Comparison to MasterScanner XP16060 Master Scanner
	(1 to 10) mm (10 to 152) mm	1.2 µm (1.2 + 0.005*L*)	
Pitch	> 0 .004 in > 0.1 mm	30 µin 0.76 µm	
Flank Angle	Up to 60°	6′	
Tapered Plug Gages [2,7]			
Effective Pitch Diameter	(0.04 to 0.4) in (0.4 to 6) in	85 µin (85 + 5*D*)	
	(1 to 10) mm (10 to 152) mm	2.2 µm (2.2 + 0.005*D*)	
Major/Minor Diameter	(0.04 to 0.4) in (0.4 to 6) in	51 µin (51 + 5*D*)	Comparison to MasterScanner XP16060 Master Scanner
	(1 to 10) mm (10 to 152) mm	1.3 µm (1.3 + 0.005*D*)	
Pitch	> 0.004 in > 0.1 mm	30 µin 0.76 µm	
Flank Angle	Up to 60°	6′	
Taper	Up to 60°	0.1°	

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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Balances, Scales [1,5] Metric (SI)	Up to 500 mg 500 mg to 5 g (5 to 10) g (10 to 30) g (30 to 100) g 100 g to 5 kg (5 to 10) kg	12 µg 40 µg 61 µg 94 µg 0.000 9 % of reading 0.000 3 % of reading 0.000 3 % of reading	ASTM E617 Class 1 Weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances, Scales [1,5] Metric (SI)	(5 to 50) mg (50 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 20) g 20 g to 2 kg	16 µg 29 µg 63 µg 88 µg 0.12 mg 0.006 % of reading	ASTM E617 Class 2 Weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances, Scales [1,5] Metric (SI) Avoirdupois	450 g to 27 kg (1 to 62) lb	0.014 % of reading 0.014 % of reading	ASTM E617 Class 6 Weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances, Scales [1,5] Metric (SI) Avoirdupois	(450 to 211) kg (1 to 466) lb	0.012 % of reading 0.012 % of reading	NIST Class F Weights and internal calibration procedure utilized for the calibration of the weighing system.
Rockwell Hardness and Superficial Testers [1]	HRA Scale (45 to 55) HRA (70 to 80) HRA (80 to 88) HRA HRBw Scale (44 to 49) HRBw (73 to 79) HRBw (88 to 99) HRBw HRC Scale (24 to 28) HRC (42 to 47) HRC (60 to 65) HRC HREw Scale (69 to 76) HREw (83 to 91) HREw (96 to 100) HREw	 0.6 HRA 0.37 HRA 0.29 HRA 0.84 HRBw 0.75 HRBw 0.64 HRBw 0.44 HRC 0.42 HRC 0.38 HRC 0.62 HREw 0.63 HREw 0.59 HREw	Indirect verification per ASTM E18 using hardness test blocks.

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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness and Superficial Testers [1]	HR15TW Scale (72 to 75) HR15TW (82 to 86) HR15TW (90 to 92) HR15TW HR30N Scale (45 to 48) HR30N (65 to 68) HR30N (76 to 78) HR30N HR30TW Scale (48 to 53) HR30TW (59 to 63) HR30TW (72 to 81) HR30TW HR45TW Scale (25 to 30) HR45TW (43 to 49) HR45TW (61 to 64) HR45TW	 0.64 HR15TW 0.64 HR15TW 0.45 HR15TW 0.63 HR30N 0.65 HR30N 0.51 HR30N 0.67 HR30TW 0.55 HR30TW 0.48 HR30TW 0.65 HR45TW 0.65 HR45TW 0.6 HR45TW	Indirect verification per ASTM E18 using hardness test blocks.
Brinell Hardness Testers [1]	HBW Scale Low Medium High	 1.4 HBW 4.2 HBW 5.3 HBW	Indirect verification per ASTM E10 using hardness test blocks.
Knoop Hardness Testers [1]	HK 0.1 Scale (858 to 886) HK	 20 HK	Indirect verification per ASTM E384, ASTM E92 using hardness test blocks.
Leeb Hardness Testers [1]	HLD Scale (752 to 759) HLD (786 to 789) HLD	 9.9 HLD 9.4 HLD	Indirect verification per ASTM A956 using hardness test blocks.
Vickers Hardness Testers [1,7]	HV 0.3 Scale (476 to 494) HV (747 to 757) HV HV 0.5 Scale (493 to 519) HV HV 1 Scale (460 to 468) HV (741 to 752) HV	 10 HV 12 HV 12 HV 8 HV 13 HV	Indirect verification per ASTM E384, ASTM E92 using hardness test blocks.

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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute Pressure [1] (Pneumatic)	Up to 5 psia Up to 10 psia Up to 15 psia Up to 30 psia (14.7 to 45) psia (14.7 to 65) psia (14.7 to 115) psia (14.7 to 165) psia (14.7 to 265) psia (14.7 to 315) psia (14.7 to 515) psia (14.7 to 765) psia (14.7 to 1 515) psia	0.000 61 psi 0.001 2 psi 0.001 8 psi 0.003 6 psi 0.005 3 psi 0.007 psi 0.012 psi 0.018 psi 0.031 psi 0.037 psi 0.062 psi 0.09 psi 0.19 psi	Comparison to Mensor APC6000 Pressure Controller
Absolute Pressure [1] (Pneumatic)	Up to 62.5 psia (62.5 to 1 000) psia	0.006 3 psi 0.01 % of reading	Comparison to Mensor CPC6050 Pressure Controller
Absolute Pressure [1] (Pneumatic)	(14.7 to 507.5) psia (507.5 to 1 015) psia (14.7 to 1 507.5) psia (1 507.5 to 3 015) psia (14.7 to 3 007.5) psia (3 007.5 to 6 015) psia	0.05 psi 0.01 % of reading + 0.001 5 psi 0.15 psi 0.01 % of reading + 0.001 5 psi 0.3 psi 0.01 % of reading + 0.001 5 psi	Comparison to Mensor CPC8000 Pressure Controller
Gauge Pressure [1] (Pneumatic)	Up to 0.5 psig Up to 1 psig Up to 5 psig Up to 10 psig Up to 15 psig Up to 30 psig Up to 50 psig Up to 100 psig Up to 150 psig	0.000 06 psi 0.000 1 psi 0.000 6 psi 0.001 2 psi 0.001 8 psi 0.003 6 psi 0.006 psi 0.012 psi 0.018 psi	Comparison to Mensor APC6000 Pressure Controller
Gauge Pressure [1] (Pneumatic)	Up to 250 psig Up to 300 psig Up to 500 psig Up to 750 psig Up to 1 500 psig	0.031 psi 0.037 psi 0.062 psi 0.093 psi 0.19 psi	Comparison to Mensor APC6000 Pressure Controller
Gauge Pressure [1] (Pneumatic)	(-14.7 to 47.8) psig (47.8 to 1 000.3) psig	0.006 3 psi 0.01 % of reading	Comparison to Mensor CPC6050 Pressure Controller

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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gauge Pressure [1] (Pneumatic)	Up to 500 psig (500 to 1 000) psig Up to 1 500) psig (1 500 to 3 000) psig Up to 3 000) psig (3 000 to 6 000) psig	0.05 psi 0.01 % of reading 0.15 psi 0.01 % of reading 0.3 psi 0.01 % of reading	Comparison to Mensor CPC8000 Pressure Controller
Gauge Pressure [1] (Hydraulic)	Up to 10 000 psig	1.2 psi	Comparison to Mensor 2106 Digital Pressure Gage
Gauge Pressure [1] (Hydraulic)	(100 to 16 000) psig	0.025 % of reading	Comparison to Budenberg 580HXA Pressure Balance
Torque Drivers, Torque Indicators [1]	(10 to 100) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in	1.2 % of reading 1.1 % of reading 1.1 % of reading	Comparison to CDI Torque Transducers
Torque Wrenches [1]	4 lbf·in to 250 lbf·ft (60 to 600) lbf·ft	0.54 % of reading 0.49 % of reading	Comparison to CDI Torque Transducers
Torque Analyzers, Torque Transducers	(2 to 40) ozf·in 5 ozf·in to 25 lbf-in 2.5 lbf·in to 150 lbf·ft 50 lbf·in to 250 lbf·ft (25 to 1 000) lbf·ft	0.13 % of reading 0.085 % of reading 0.055 % of reading 0.053 % of reading 0.052 % of reading	Comparison to NIST Class F Weights, Torque Wheels, Torque Arm

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Humidity Controlled Chambers [1]	(-40 to -20) °C (0 to 95) RH% (-20 to 15) °C (0 to 95) RH% (15 to 25) °C (0 to 90) RH% (90 to 100) RH%	1.7 % of reading + 1.8 %RH 0.92 % of reading + 1.3 %RH 1.3 RH% 2 %RH	Comparison to Vaisala MI70/HMP76B Temp/Humidity Indicator/Probe
Humidity – Humidity Controlled Chambers [1]	(25 to 40) °C (0 to 95) RH% (40 to 180) °C (0 to 95) RH%	0.92 % of reading + 1.3 %RH 1.7 % of reading + 1.8 %RH	Comparison to Vaisala MI70/HMP76B Temp/Humidity Indicator/Probe

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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermo-Hygrometers [1] Temperature Humidity	(5 to 95) %RH (18 to 28) °C (18 to 25) °C (7 to 90) %RH (90 to 100) %RH	0.27 °C 1.4 %RH 2.1 %RH	Comparison to Kaymont 2000 Humidity Generator, Vaisala MI70/HMP76B Temp/Humidity Indicator/Probe
Dry Blocks, Liquid Baths, Temperature Chambers, Furnaces, Ovens [1]	(-195 to 0) °C (0 to 420) °C (420 to 660) °C	0.012 °C 0.026 °C 0.034 °C	Comparison to SPRT, Temperature Indicator
Dry Blocks, Liquid Baths, Temperature Chambers, Furnaces, Ovens [1]	(600 to 1 093) °C (1 093 to 1 200) °C	0.47 % of reading + 0.9 °C 0.47 % of reading + 1.9 °C	Comparison to Type N T/C Probe, Temperature Indicator
Dry Blocks, Liquid Baths, Temperature Chambers, Furnaces, Ovens [1]	(600 to 1 093) °C (1 093 to 1 200) °C	0.47 % of reading + 0.9 °C 0.47 % of reading + 1.9 °C	Comparison to Type K T/C Probe, Temperature Indicator
Dry Blocks, Liquid Baths, Temperature Chambers, Furnaces, Ovens [1]	(615 to 1 093) °C (1 093 to 1 200) °C	0.15 % of reading + 1 °C 0.15 % of reading + 1.9 °C	Comparison to Type S T/C Probe, Temperature Indicator
Dial/Digital Thermometers, RTD, PRT, Thermistor Probes	0.01 °C	0.83 mK	Comparison to Triple Point Water Cell
Dial/Digital Thermometers, RTD, PRT, Thermistor Probes [1]	(-30 to -20) ºC (-20 to 0) °C (0 to 150) °C (150 to 200) °C	0.043 ºC 0.018 °C 0.03 °C 0.05 °C	Comparison to Fluke 7320 Bath, Fluke 6102 Bath, SPRT, Temperature Indicator
Dial/Digital Thermometers, RTD, PRT, Thermistor Probes [1]	(50 to 100) °C (100 to 420) °C (420 to 660) °C	0.11 °C 0.26 °C 0.41 °C	Comparison to Fluke 9173 Dry-well, SPRT, Temperature Indicator
Thermocouple Wire, Thermocouple Probes (Types J, K, T, E)	(-30 to -20) °C (-20 to 0) °C (0 to 150) °C (150 to 200) °C (200 to 420) °C (420 to 660) °C	0.17 °C 0.15 °C 0.27 °C 0.32 °C 0.59 °C 0.87 °C	Comparison to Fluke 2560/5628 SPRT, Hart Black Stack, Ectron 1140A Thermocouple Calibrator/Simulator; Temperature Source

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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Infrared Thermometers [1]	(-15 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 120) °C (120 to 200) °C (200 to 350) °C (350 to 500) °C	0.83 °C 0.65 °C 0.71 °C 0.76 °C 0.95 °C 1.6 °C 2 °C	Comparison to Blackbody Source (Flat Plate) ε = (0.9 to 1) λ = (8 to 14) µm

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Reference – Frequency	10 MHz	640 pHz/Hz	Comparison to Rubidium Oscillator
Frequency – Measure [1]	10 MHz	0.21 µHz/Hz	Comparison to HP 53132A Opt 10 Universal Frequency Counter
Stopwatches, Timers [1]	Up to 599 s/mon	58 ms/day	Comparison to Vibrograf 4500 Timometer
AC Duty Cycle – Source [1] Square Wave: < 3.3 Vp-p Freq: 0.1 Hz to 100 kHz	(1 to 10) % Duty Cycle 10 µs to 100 s (10 to 49) % Duty Cycle 10 µs to 100 s 50 % Duty Cycle 10 µs to 100 s (51 to 90) % Duty Cycle 10 µs to 100 s (90 to 99) % Duty Cycle 10 µs to 100 s	 0.62 % of reading + 78 ns 0.039 % of reading + 78 ns 0.016 % of reading + 78 ns 0.039 % of reading + 78 ns 0.62 % of reading + 78 ns	Comparison to Fluke 55xxA Series Multiproduct Calibrator

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DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimension Measurement – 1D	X-axis Up to 1 in (1 to 3) in (3 to 6) in Y-axis Up to 2 in (2 to 3) in (3 to 5) in	 210 µin 370 µin 480 µin 360 µin 410 µin 560 µin	Optical Comparator used as a Reference Standard for Dimensional Measurement. (Length)
Dimensional Measurement – 1D [1,2]	Up to 12 in	(28 + 3.2*L*) µin	Gage Amp, Probe, and Gage Blocks utilized as Reference Standards for Dimensional Measurement. (Height)
Dimensional Measurement – 1D [1,2]	Up to 4 in*DL* Up to 12.37 in*DL* (12.37 to 18.25) in*DL* (18.97 to 30.59) in*DL*	6.2 µin 35 µin 42 µin 46 µin	Optical Flats, Gage Amp, and Indicator utilized as Reference Standards for Dimensional Measurement. (Flatness)
Dimensional Measurement – 1D [1,2]	Up to 12.37 in*DL* (12.37 to 18.25) in*DL* (18.97 to 30.59) in*DL*	33 µin 40 µin 45 µin	Gage Amp and Indicator utilized as Reference Standards for Dimensional Measurement. (Parallelism)
Dimensional Measurement – 1D [1,2]	Up to 18 in	163 µin	Gage Amp, Surface Plate, and Granite Square utilized as Reference Standards for Dimensional Measurement. (Squareness)
Dimensional Measurement – 1D [1,2]	Up to 12 in (12 to 18) in (18 to 30) in	35 µin 42 µin 46 µin	Gage Amp and Indicator utilized as Reference Standards for Dimensional Measurement. (Straightness)

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2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle [2]	Up to 180°	29″	Optical Comparator utilized as Reference Standard for Dimensional Measurement.
Radius	Up to 1 in (1 to 3) in (3 to 6) in	260 µin 450 µin 590 µin	Optical Comparator utilized as Reference Standard for Dimensional Measurement.

3 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement – 3D [2]	X = Up to 2 500 mm Y = Up to 1 500 mm Z = Up to 1 000 mm	$(6 + 0.009L)$ µm	Coordinate Measurement Machine utilized as Reference Standard for Dimensional Measurement.
Dimensional Measurement – 3D [2]	X = Up to 98.4 in Y = Up to 59 in Z = Up to 39.3 in	$(240 + 0.4L)$ µin	Coordinate Measurement Machine utilized as Reference Standard for Dimensional Measurement.

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 measurand unit (inches or millimeters); D = diameter in measured unit (inches or millimeters); ′ = arc-minute; ″ = arc-second; DL = diagonal length.
3. The uncertainties shown are for the most favorable conditions. There is an increase in uncertainty that corresponds to the laboratory's AC voltage and current uncertainties at different frequencies other than the ones shown. Power factors (PF) other than the one shown contribute to the power uncertainty. PF is related to the cosine of phase. Therefore, uncertainties track the laboratory's phase uncertainty closely at PF near one but are magnified heavily as PF approaches zero. The lab may also report reactive power, apparent power, and power factor under this accreditation. If needed, contact laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
4. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 250 ps. In the typical application of measuring rise time of an oscilloscope, this value is one of the contributing factors, but other factors are derived from the DUT.
5. The measurement uncertainty for scales and balances is highly dependent upon the resolution of the unit under test. The uncertainty presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
6. As frequency & amplitude deviate from the listed values, uncertainty may be higher than stated. If needed, contact the laboratory for more information regarding uncertainties at frequency and range combinations other than the ones shown.
7. Pitch is the distance from a point on the screw thread to a corresponding point on the next thread measured parallel to the axis. Pitch Diameter is the simple effective diameter of screw thread, approximately halfway between the major and minor diameters.
8. The value in the Range column is a Nominal value. The certified value will be used at the time of calibration along with the inherent uncertainty.
9. Unless otherwise specified in the far-right column, the calibration method/procedure utilized by the laboratory was developed internally.
10. The legal entity for this location is Transcat, Inc.

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