



# CERTIFICATE OF ACCREDITATION

## The ANSI National Accreditation Board

Hereby attests that

**Martin Calibration, Inc.**

**11965 12<sup>th</sup> Avenue South**

**Burnsville, MN 55337**

**Including satellite locations located in: Mundelein, IL and Eau Claire, WI**

Fulfills the requirements of

**ISO/IEC 17025:2017**

and national standard

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

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](http://www.anab.org).

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 06 July 2021

Certificate Number: ACT-1265



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)**

**Martin Calibration, Inc.**

11965 12<sup>th</sup> Avenue South  
Burnsville, MN 55337  
Corey Garbers  
952-882-1528

**CALIBRATION AND DIMENSIONAL MEASUREMENT**

Valid to: July 6, 2021

Certificate Number: ACT-1265

**CALIBRATION**

**Acoustics and Vibration**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level – Fixed Points	(94, 104, 114) dB	0.2 dB	Briel & Kjaer Sound Pressure Calibrator
Sound Level - Linearity	(50 to 143) dB	0.13 dB	
Sound Level - Frequency	(0.031 to 16) kHz	1 % of reading	
Sound Level - Distortion	(25 to 123) dB (0.031 to 16) kHz	0.14 dB	
Accelerometers	(5 to 9) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz 921 Hz to 5 kHz (5 to 8) kHz (8 to 10) kHz (10 to 15) kHz	2.6 % of reading 1.6 % of reading 0.75 % of reading 1.3 % of reading 2.2 % of reading 3.8 % of reading 4.8 % of reading 8.6 % of reading	PCB Shaker Table with PCB Reference Accelerometer



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**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters <sup>1</sup>	(0.86 to 10) $\mu\text{S/cm}$ (10 to 100) $\mu\text{S/cm}$ (100 to 1 500) $\mu\text{S/cm}$ 12 800 $\mu\text{S/cm}$	0.42 $\mu\text{S/cm}$ 0.89 $\mu\text{S/cm}$ 0.42 % of reading 0.42 % of reading	Conductivity Standards
Refractometers	0.00 Brix 10.00 Brix 40.00 Brix 70.00 Brix	0.000 6 Brix 0.018 Brix 0.019 Brix 0.03 Brix	Calibration Solutions
pH Meters <sup>1</sup>	4 pH 7 pH 10 pH	0.016 pH 0.016 pH 0.016 pH	Buffer Solutions

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage - Source <sup>1</sup> Fixed Point	10V	0.5 $\mu\text{V/V}$	732B Voltage Standards with Fluke Maps
DC Voltage - Source <sup>1</sup>	0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V	20 nV 100 nV 22 $\mu\text{V/V} + 25 \text{ nV}$ 5.3 $\mu\text{V/V}$ 0.5 $\mu\text{V/V}$ 0.31 $\mu\text{V/V}$ 0.35 $\mu\text{V/V}$ 1 $\mu\text{V/V}$	MI Potentiometer/ Divider & Fluke 5720A Multi Product Calibrator
DC Voltage - Measure <sup>1</sup>	0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V	20 nV 100 nV 22 $\mu\text{V/V} + 25 \text{ nV}$ 5.3 $\mu\text{V/V}$ 0.5 $\mu\text{V/V}$ 0.31 $\mu\text{V/V}$ 0.35 $\mu\text{V/V}$ 1 $\mu\text{V/V}$	Nano Voltmeter Fluke 732B Voltage Standard with MI Potentiometer/ Divider
DC High Voltage - Measure <sup>1</sup>	(1.1 to 10) kV (10 to 30) kV (30 to 50) kV (50 to 70) kV (70 to 100) kV	0.05 % of reading 0.055 % of reading 0.079 % of reading 0.12 % of reading 0.83 % of reading	Hipotronics KVM100-A High Voltage Meter



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source & Measure <sup>1</sup>	0 A (0 to 200) pA (0.2 to 20) nA (20 to 100) nA	76 fA 1.9 % of reading + 10 fA 0.29 % of reading + 1 pA 8 μA/A + 1.3 pA	Electrometer
DC Current – Source & Measure <sup>1</sup>	(0.1 to 1) μA (1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	30 μA/A 6.8 μA/A 6.2 μA/A 4.1 μA/A 4.2 μA/A 3.9 μA/A 17 μA/A	Standard resistors and DMM and Multifunction Calibrator
DC Current – Source & Measure <sup>1</sup>	(1 to 20) A (20 to 120) A	26 μA/A 80 μA/A + 4 mA	Fluke 52120A Amplifier with shunts
DC Current - Source <sup>1</sup>	(100 to 150) A (150 to 1 025) A	5 mA/A + 20 mA 5.1 mA/A + 0.9 A	Fluke 5520A Multi Product Calibrator with 50-turn Coil
DC Power – Source	10.9 μW to 10.9 mW 10.9 mW to 3.06 kW (3.06 to 20.9) kW	0.18 mW/W 0.17 mW/W 0.54 mW/W	Fluke 5520A Multi Product Calibrator
AC Power – Source (45 to 65) Hz	109 μW to 1.09 mW (1.09 to 297) μW 297 μW to 2.97 mW 2.97 mW to 337 W 337 W to 2.24 kW (2.24 to 20.9) kW	1.1 mW/W 930 μW/W 780 μW/W 620 μW/W 700 μW/W 780 μW/W	Fluke 5520A Multi Product Calibrator
AC Voltage – Source & Measure <sup>1</sup>	(0 to 2.2) mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	1.1 mV/V + 1.3 μV 490 μV/V + 1.3 μV 280 μV/V + 1.3 μV 540 μV/V + 2 μV 800 μV/V + 2.5 μV 1.5 mV/V + 4 μV 1.6 mV/V + 8 μV 2.3 mV/V + 8 μV	Fluke 5790A AC Standard w/ 5720A 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 Voltage – Source & Measure <sup>1</sup>	(2.2 to 7) mV		Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator
	(10 to 20) Hz	570 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(20 to 40) Hz	250 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(0.04 to 20) kHz	140 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(20 to 50) kHz	270 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	400 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	800 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	870 $\mu\text{V/V} + 8 \mu\text{V}$	
	(0.5 to 1) MHz	1.5 mV/V + 8 $\mu\text{V}$	
	(7 to 22) mV		
	(10 to 20) Hz	190 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(20 to 40) Hz	130 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(0.04 to 20) kHz	73 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(20 to 50) kHz	140 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	210 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	540 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	590 $\mu\text{V/V} + 8 \mu\text{V}$	
	(0.5 to 1) MHz	1.1 mV/V + 8 $\mu\text{V}$	
	(22 to 70) mV		
	(10 to 20) Hz	160 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 40) Hz	80 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(0.04 to 20) kHz	43 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	170 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	340 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	450 $\mu\text{V/V} + 8 \mu\text{V}$	
	(0.5 to 1) MHz	730 $\mu\text{V/V} + 8 \mu\text{V}$	
	(70 to 220) mV		
(10 to 20) Hz	140 $\mu\text{V/V} + 1.5 \mu\text{V}$		
(20 to 40) Hz	57 $\mu\text{V/V} + 1.5 \mu\text{V}$		
(0.04 to 20) kHz	25 $\mu\text{V/V} + 1.5 \mu\text{V}$		
(20 to 50) kHz	46 $\mu\text{V/V} + 2 \mu\text{V}$		
(50 to 100) kHz	110 $\mu\text{V/V} + 2.5 \mu\text{V}$		
(100 to 300) kHz	170 $\mu\text{V/V} + 4 \mu\text{V}$		
(300 to 500) kHz	250 $\mu\text{V/V} + 8 \mu\text{V}$		
(0.5 to 1) MHz	670 $\mu\text{V/V} + 8 \mu\text{V}$		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure <sup>1</sup>	(220 to 700) mV		Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator
	(10 to 20) Hz	140 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 40) Hz	51 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(0.04 to 20) kHz	22 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 50) kHz	34 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	200 $\mu\text{V/V} + 8 \mu\text{V}$	
	(0.5 to 1) MHz	640 $\mu\text{V/V} + 8 \mu\text{V}$	
	(0.7 to 2.2) V		
	(10 to 20) Hz	130 $\mu\text{V/V}$	
	(20 to 40) Hz	44 $\mu\text{V/V}$	
	(0.04 to 20) kHz	16 $\mu\text{V/V}$	
	(20 to 50) kHz	31 $\mu\text{V/V}$	
	(50 to 100) kHz	47 $\mu\text{V/V}$	
	(100 to 300) kHz	110 $\mu\text{V/V}$	
	(300 to 500) kHz	170 $\mu\text{V/V}$	
	(0.5 to 1) MHz	600 $\mu\text{V/V}$	
	(2.2 to 7) V		
	(10 to 20) Hz	130 $\mu\text{V/V}$	
	(20 to 40) Hz	45 $\mu\text{V/V}$	
	(0.04 to 20) kHz	16 $\mu\text{V/V}$	
	(20 to 50) kHz	32 $\mu\text{V/V}$	
	(50 to 100) kHz	54 $\mu\text{V/V}$	
	(100 to 300) kHz	130 $\mu\text{V/V}$	
	(300 to 500) kHz	270 $\mu\text{V/V}$	
	(0.5 to 1) MHz	800 $\mu\text{V/V}$	
	(7 to 22) V		
(10 to 20) Hz	130 $\mu\text{V/V}$		
(20 to 40) Hz	45 $\mu\text{V/V}$		
(0.04 to 20) kHz	18 $\mu\text{V/V}$		
(20 to 50) kHz	32 $\mu\text{V/V}$		
(50 to 100) kHz	54 $\mu\text{V/V}$		
(100 to 300) kHz	130 $\mu\text{V/V}$		
(300 to 500) kHz	270 $\mu\text{V/V}$		
500kHz to 1MHz	800 $\mu\text{V/V}$		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure	(22 to 70) V		Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator
	(10 to 20) Hz	130 $\mu$ V/V	
	(20 to 40) Hz	45 $\mu$ V/V	
	(0.04 to 20) kHz	21 $\mu$ V/V	
	(20 to 50) kHz	38 $\mu$ V/V	
	(50 to 100) kHz	63 $\mu$ V/V	
	(100 to 300) kHz	130 $\mu$ V/V	
	(300 to 500) kHz	270 $\mu$ V/V	
	500kHz to 1MHz	800 $\mu$ V/V	
	(70 to 220) V		
	(10 to 20) Hz	130 $\mu$ V/V	
	(20 to 40) Hz	45 $\mu$ V/V	
	(0.04 to 20) kHz	21 $\mu$ V/V	
	(20 to 50) kHz	46 $\mu$ V/V	
	(50 to 100) kHz	65 $\mu$ V/V	
	(100 to 300) kHz	140 $\mu$ V/V	
	(300 to 500) kHz	330 $\mu$ V/V	
	AC Voltage – Source & Measure Flatness relative to 1 kHz	(220 to 700) V	
(10 to 20) Hz		130 $\mu$ V/V	
(20 to 40) Hz		66 $\mu$ V/V	
(0.04 to 20) kHz		27 $\mu$ V/V	
(20 to 50) kHz		87 $\mu$ V/V	
(50 to 100) kHz		330 $\mu$ V/V	
(0 to 2.2) mV			
(10 to 30) Hz		0.1 % of reading + 1.3 $\mu$ V	
(30 to 120) Hz		0.05 % of reading + 1.3 $\mu$ V	
(0.12 to 1.2) kHz		0.05 % of reading + 1.3 $\mu$ V	
(1.2 to 120) kHz	0.05 % of reading + 2 $\mu$ V		
(120 to 500) kHz	0.07 % of reading + 1 $\mu$ V		
(0.5 to 1.2) MHz	0.07 % of reading + 1 $\mu$ V		
(1.2 to 2) MHz	0.07 % of reading + 1 $\mu$ V		
(2 to 10) MHz	0.17 % of reading + 1 $\mu$ V		
(10 to 20) MHz	0.32 % of reading + 1 $\mu$ V		
(20 to 30) MHz	0.7 % of reading + 2 $\mu$ 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 & Measure Flatness relative to 1 kHz	(2.2 to 7) mV		Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband)
	(10 to 30) Hz	0.1 % of reading	
	(30 to 120) Hz	0.05 % of reading	
	(0.12 to 1.2) kHz	0.05 % of reading	
	(1.2 to 120) kHz	0.05 % of reading	
	(120 to 500) kHz	0.07 % of reading + 1 $\mu$ V	
	(0.5 to 1.2) MHz	0.07 % of reading + 1 $\mu$ V	
	(1.2 to 2) MHz	0.07 % of reading + 1 $\mu$ V	
	(2 to 10) MHz	0.1 % of reading + 1 $\mu$ V	
	(10 to 20) MHz	0.17 % of reading + 1 $\mu$ V	
	(20 to 30) MHz	0.37 % of reading + 1 $\mu$ V	
	(7 to 22) mV		
	(10 to 30) Hz	0.1 % of reading	
	(30 to 120) Hz	0.05 % of reading	
	(0.12 to 1.2) kHz	0.05 % of reading	
	(1.2 to 120) kHz	0.05 % of reading	
	(120 to 500) kHz	0.07 % of reading	
	(0.5 to 1.2) MHz	0.07 % of reading	
	(1.2 to 2) MHz	0.07 % of reading	
	(2 to 10) MHz	0.1 % of reading	
	(10 to 20) MHz	0.17 % of reading	
	(20 to 30) MHz	0.37 % of reading	
	(22 to 70) mV		
	(10 to 30) Hz	0.1 % of reading	
	(30 to 120) Hz	0.05 % of reading %	
	(0.12 to 1.2) kHz	0.05 % of reading	
	(1.2 to 120) kHz	0.05 % of reading	
(120 to 500) kHz	0.05 % of reading		
(0.5 to 1.2) MHz	0.05 % of reading		
(1.2 to 2) MHz	0.05 % of reading		
(2 to 10) MHz	0.1 % of reading		
(10 to 20) MHz	0.15 % of reading		
(20 to 30) MHz	0.35 % of reading		





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
<p>AC Voltage – Source &amp; Measure Flatness relative to 1 kHz</p>	(70 to 220) mV		<p>Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband)</p>
	(10 to 30) Hz	0.1 % of reading	
	(30 to 120) Hz	0.04 % of reading	
	(0.12 to 1.2) kHz	0.04 % of reading	
	(1.2 to 120) kHz	0.04 % of reading	
	(120 to 500) kHz	0.04 % of reading	
	(0.5 to 1.2) MHz	0.05 % of reading	
	(1.2 to 2) MHz	0.05 % of reading	
	(2 to 10) MHz	0.1 % of reading	
	(10 to 20) MHz	0.15 % of reading	
	(20 to 30) MHz	0.35 % of reading	
	(220 to 700) mV		
	(10 to 30) Hz	0.1 % of reading	
	(30 to 120) Hz	0.03 % of reading	
	(0.12 to 1.2) kHz	0.03 % of reading	
	(1.2 to 120) kHz	0.03 % of reading	
	(120 to 500) kHz	0.03 % of reading	
	(0.5 to 1.2) MHz	0.05 % of reading	
	(1.2 to 2) MHz	0.05 % of reading	
	(2 to 10) MHz	0.1 % of reading	
	(10 to 20) MHz	0.15 % of reading	
	(20 to 30) MHz	0.35 % of reading	
	(0.7 to 2.2) V		
	(10 to 30) Hz	0.1 % of reading	
	(30 to 120) Hz	0.03 % of reading	
	(0.12 to 1.2) kHz	0.03 % of reading	
	(1.2 to 120) kHz	0.03 % of reading	
(120 to 500) kHz	0.03 % of reading		
(0.5 to 1.2) MHz	0.05 % of reading		
(1.2 to 2) MHz	0.05 % of reading		
(2 to 10) MHz	0.1 % of reading		
(10 to 20) MHz	0.15 % of reading		
(20 to 30) MHz	0.35 % of reading		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure Flatness relative to 1 kHz	(2.2 to 7) V (10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.1 % of reading 0.03 % of reading 0.03 % of reading 0.03 % of reading 0.03 % of reading 0.05 % of reading 0.05 % of reading 0.1 % of reading 0.15 % of reading 0.35 % of reading	Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband)
AC Current – Source <sup>1</sup>	Up to 1 mA DC to 10 kHz 1 mA to 1 A DC to 10 kHz (1 to 20) A DC to 10 kHz	75 $\mu$ A/A 28 $\mu$ A/A 52 $\mu$ A/A	Fluke 5720A Multi Product Calibrator w/ A40B Shunts
AC Current – Source <sup>1</sup>	(20 to 120) A DC to 1 kHz (1 to 6) kHz	3 mA/A 12 mA/A	Fluke 5720A Multi Product Calibrator w/ A40B Shunts
AC Current – Measure <sup>1</sup>	Up to 1 mA (DC to 30) kHz (30 to 100) kHz 1mA to 1A (DC to 100) kHz (1 to 20) A (DC to 10) kHz (10 to 30) kHz (30 to 100) kHz	90 $\mu$ A/A 0.18 mA/A 35 $\mu$ A/A 61 $\mu$ A/A 83 $\mu$ A/A 0.13 mA/A	Fluke A40B Shunts
AC Current - Measure <sup>1</sup>	Up to 200 $\mu$ A (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz 200 $\mu$ A to 2 mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.62 mA/A 0.54 mA/A 0.94 mA/A 8.4 mA/A 0.6 mA/A 0.54 mA/A 0.94 mA/A 4.2 mA/A	Fluke 8508A Multimeter

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Measure <sup>1</sup>	(2 to 20) mA		Fluke 8508A Multimeter
	(1 to 10) Hz	0.6 mA/A	
	10 Hz to 10 kHz	0.54 mA/A	
	(10 to 30) kHz	0.94 mA/A	
	(30 to 100) kHz	4.2 mA/A	
	(20 to 200) mA		
	(1 to 10) Hz	0.57 mA/A	
	10 Hz to 10 kHz	0.49 mA/A	
	(10 to 30) kHz	0.83 mA/A	
	200 mA to 2 A		
	10 Hz to 2 kHz	0.83 mA/A	
	(2 to 10) kHz	0.93 mA/A	
	(10 to 30) kHz	3.2 mA/A	
	(2 to 20) A		
10 Hz to 2 kHz	1 mA/A		
(2 to 10) kHz	2.7 mA/A		
Resistance - Source <sup>1</sup>	0.001 Ω	3.5 μΩ/Ω	Standard resistors
	0.01Ω	4.3 μΩ/Ω	
	0.1 Ω	1.5 μΩ/Ω	
	1Ω	0.67 μΩ/Ω	
	10Ω	0.56 μΩ/Ω	
	100 Ω	0.68 μΩ/Ω	
	1 kΩ	0.51 μΩ/Ω	
	10 kΩ	0.8 μΩ/Ω	
	100 kΩ	0.57 μΩ/Ω	
	1 MΩ	1.3 μΩ/Ω	
	10 MΩ	14 μΩ/Ω	
	100 MΩ	130 μΩ/Ω	
	1 GΩ	26 μΩ/Ω	
	(1 to 10) GΩ	0.16 % of reading	
	(10 to 100) GΩ	0.54 % of reading	
	(100 to 900) GΩ	0.56 % of reading	
	1 TΩ	1.6 % of reading	
10 TΩ	1.7 % of reading		
Resistance - Measure <sup>1</sup>	(10 to 100) μΩ	0.15 % of reading	Standard resistors with bridge and DMM
	(0.1 to 1) mΩ	15 μΩ/Ω	
	(1 to 10) mΩ	5.1 μΩ/Ω	
	(10 to 100) mΩ	1.8 μΩ/Ω	
	(0.1 to 1) Ω	0.67 μΩ/Ω	
	(1 to 10) Ω	0.56 μΩ/Ω	
	(10 to 100) Ω	0.68 μΩ/Ω	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance - Measure <sup>1</sup>	(0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ	0.51 μΩ/Ω 0.8 μΩ/Ω 0.57 μΩ/Ω 1.3 μΩ/Ω 14 μΩ/Ω	Standard resistors with bridge and DMM
Resistance - Measure <sup>1</sup>	(10 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	72 μΩ/Ω + 1kΩ 0.18 mΩ/Ω + 100 kΩ 0.67 mΩ/Ω + 10 MΩ	Decade resistors with bridge and DMM
Resistance - Measure <sup>1</sup> High Voltage Mode up to 200 V	(2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ	15 μΩ/Ω + 10 Ω 60 μΩ/Ω + 1 kΩ 0.15 mΩ/Ω + 100 kΩ 0.53 mΩ/Ω + 10 MΩ	Decade resistors with bridge and DMM
AC Resistance (Impedance)	(1, 500) kHz, 1 MHz 25 Ω 375 Ω (1, 250, 500) kHz, 1 MHz 6 kΩ (1, 25, 50) kHz 100 kΩ	100 μΩ/Ω	AC Resistor Set
Capacitance - Measure <sup>1</sup>	1 pF @ 1 kHz 10 pF @ 1 kHz 100 pF @ 1kHz 1 nF 1kHz 1 μF @ 1 kHz	1.9 mF/F 1.1 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F	QuadTech 1730 LCR Meter
Capacitance - Source <sup>1</sup> (fixed values) @ 100 Hz @ 1 kHz	1 pF 1 nF 10 nF 100 nF 1 μF	1.8 mF/F 0.23 mF/F 0.25 mF/F 0.21 mF/F 0.25 mF/F	Standard Capacitors
Capacitance - Source <sup>1</sup> 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz 10 Hz to 300 Hz 10 Hz to 150 Hz 10 Hz to 120 Hz	0.19 nF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF	15 mF/F 8.4 mF/F 3.6 mF/F 3.6 mF/F 3.7 mF/F 3.6 mF/F 3.6 mF/F 3.6 mF/F 5.1 mF/F	Fluke 5520A Multi Product Calibrator



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance - Source <sup>1</sup> 10 Hz to 80 Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	(33 to 110) $\mu$ F (110 to 330) $\mu$ F 330 $\mu$ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	5.6 mF/F 5.6 mF/F 8.7 mF/F 5.5 mF/F 5.5 mF/F 8.5 mF/F 12 mF/F	Fluke 5520A Multi Product Calibrator
Inductance - Measure <sup>1</sup>	100 $\mu$ H @ 1 kHz 1 mH @ 1 kHz 10 mH @ 1 kHz 100 mH @ 1 kHz 1 H @ 1 kHz	1.2 mH/H	QuadTech 1730 LCR Meter
Inductance - Source <sup>1</sup>	500 $\mu$ H @ 100 Hz 500 $\mu$ H @ 1 kHz 2 mH @ 100 Hz 2 mH @ 1 kHz 20 mH @ 100 Hz 20 mH @ 1 kHz 1 H @ 100 Hz 1 H @ 1 kHz 10 H @ 100 Hz 10 H @ 1 kHz	1.2 mH/H 1 mH/H 1.1 mH/H 1 mH/H 1.1 mH/H 1 mH/H 1 mH/H 1 mH/H 1 mH/H 1 mH/H	Standard Inductors
Oscilloscopes <sup>1</sup> Square Wave Signal 50 $\Omega$ at 1 kHz  Square Wave Signal 1 M $\Omega$ at 1 kHz  DC Voltage, 50 $\Omega$ DC Voltage, 1 M $\Omega$  Leveled Sine Wave Amplitude  Leveled Sine Wave Flatness (relative to 50 kHz)	40 $\mu$ V to 5 V  40 $\mu$ V to 5 V  1 mV to 5 V 1 mV to 200 V  5 mV to 5 V  4.4 mVpp to 5.6 Vpp 0.1 Hz to 300 MHz (300 to 550) MHz	1 mV/V  1 mV/V  0.26 mV/V 0.25 mV/V  15 mV/V  43 mV/V 43 mV/V	Fluke 9500B/3200/9530 Oscilloscope Calibrator



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1</sup>			
Leveled Sine Wave Flatness (relative to 50 kHz)	4.4 mVpp to 3.3 Vpp 550 MHz to 1.1 GHz (1.1 to 3.2) GHz	52 mV/V 52 mV/V	Fluke 9500B/3200/9530 Oscilloscope Calibrator
Time Marker 50 Ω Source and Period	9 ns to 55 s	0.25 μs/s	
Rise/Fall Time - Source	150 ps	27 ps	
Pulse Width - Source	(1 to 100) ns	52 ms/s	
Electrical Simulation of Thermocouple Indicators <sup>1</sup>	Type B (250 to 350) °C (350 to 445) °C (445 to 580) °C (580 to 750) °C (750 to 1 000) °C (1 000 to 1 820) °C Type C (0 to 250) °C (250 to 1 000) °C (1 000 to 1 500) °C (1 500 to 1 800) °C (1 800 to 2 000) °C (2 000 to 2 250) °C (2 250 to 2 315) °C Type E (-270 to -245) °C (-245 to -195) °C (-195 to -155) °C (-155 to -90) °C (-90 to 15) °C (15 to 890) °C (890 to 1 000) °C Type J (-210 to -180) °C (-180 to -120) °C (-120 to -50) °C (-50 to 990) °C (990 to 1 200) °C	1.1 °C 0.85 °C 0.67 °C 0.52 °C 0.43 °C 0.33 °C 0.23 °C 0.18 °C 0.21 °C 0.24 °C 0.27 °C 0.33 °C 0.37 °C 1.38 °C 0.21 °C 0.12 °C 0.09 °C 0.08 °C 0.07 °C 0.08 °C 0.14 °C 0.12 °C 0.09 °C 0.08 °C 0.08 °C	Ectron 1140A Thermocouple Simulator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators <sup>1</sup>	Type K		Ectron 1140A Thermocouple Simulator
	(-270 to -255) °C	2.5 °C	
	(-255 to -195) °C	0.81 °C	
	(-195 to -115) °C	0.14 °C	
	(-115 to -55) °C	0.1 °C	
	(-55 to 1 000) °C	0.08 °C	
	(1 000 to 1 372) °C	0.09 °C	
	Type N		
	(-270 to -260) °C	5.8 °C	
	(-260 to -200) °C	1.2 °C	
	(-200 to -140) °C	0.27 °C	
	(-140 to -70) °C	0.17 °C	
	(-70 to 25) °C	0.14 °C	
	(25 to 160) °C	0.12 °C	
	(160 to 1 300) °C	0.1 °C	
	Type R		
	(-50 to -30) °C	0.75 °C	
	(-30 to 45) °C	0.63 °C	
	(45 to 160) °C	0.46 °C	
	(160 to 380) °C	0.35 °C	
	(380 to 775) °C	0.3 °C	
	(775 to 1 768) °C	0.25 °C	
	Type S		
	(-50 to -30) °C	0.71 °C	
	(-30 to -45) °C	0.64 °C	
	(-45 to -105) °C	0.46 °C	
	(-105 to 310) °C	0.38 °C	
	(310 to 615) °C	0.33 °C	
(615 to 1 768) °C	0.3 °C		
Type T			
(-270 to -255) °C	2.1 °C		
(-255 to -240) °C	0.56 °C		
(-240 to -210) °C	0.35 °C		
(-210 to -150) °C	0.21 °C		
(-150 to -40) °C	0.14 °C		
(-40 to 100) °C	0.09 °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 <sup>1</sup>	PT 395 100 Ω		Fluke 5520A Multi Product Calibrator
	(-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.11 °C	
	(300 to 400) °C	0.12 °C	
	(400 to 630) °C	0.14 °C	
	(630 to 800) °C	0.27 °C	
	PT 3926 100 Ω		
	(-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.11 °C	
	(300 to 400) °C	0.12 °C	
	(400 to 630) °C	0.14 °C	
	PT 3916 100 Ω		
	(-200 to -190) °C	0.29 °C	
	(-190 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.06 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 260) °C	0.08 °C	
	(260 to 300) °C	0.09 °C	
	(300 to 400) °C	0.11 °C	
	(400 to 600) °C	0.12 °C	
	(600 to 630) °C	0.27 °C	
	PT 385 200 Ω		
	(-200 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.14 °C	
	(300 to 400) °C	0.15 °C	
(400 to 600) °C	0.16 °C		
(600 to 630) °C	0.19 °C		
PT 385 500 Ω			
(-200 to -80) °C	0.05 °C		
(-80 to 100) °C	0.06 °C		
(100 to 260) °C	0.07 °C		
(260 to 400) °C	0.09 °C		
(400 to 600) °C	0.01 °C		
(600 to 630) °C	0.13 °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 RTDs <sup>1</sup>	PT 395 100 Ω		Fluke 5520A Multi Product Calibrator
	(-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.11 °C	
	(300 to 400) °C	0.12 °C	
	(400 to 630) °C	0.14 °C	
	(630 to 800) °C	0.27 °C	
	PT 3926 100 Ω		
	(-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.11 °C	
	(300 to 400) °C	0.12 °C	
	(400 to 630) °C	0.14 °C	
	PT 3916 100 Ω		
	(-200 to -190) °C	0.29 °C	
	(-190 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.06 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 260) °C	0.08 °C	
	(260 to 300) °C	0.09 °C	
	(300 to 400) °C	0.11 °C	
	(400 to 600) °C	0.12 °C	
	(600 to 630) °C	0.27 °C	
	PT 385 200 Ω		
	(-200 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.14 °C	
	(300 to 400) °C	0.15 °C	
(400 to 600) °C	0.16 °C		
(600 to 630) °C	0.19 °C		
PT 385 500 Ω			
(-200 to -80) °C	0.05 °C		
(-80 to 100) °C	0.06 °C		
(100 to 260) °C	0.07 °C		
(260 to 400) °C	0.09 °C		
(400 to 600) °C	0.01 °C		
(600 to 630) °C	0.13 °C		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTDs <sup>1</sup>	PT 385 1 000 Ω		Fluke 5520A Multi Product Calibrator
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.07 °C	
	(300 to 600) °C	0.08 °C	
	(600 to 630) °C	0.27 °C	
	PtNi 120 Ω		
	(-80 to 100) °C	0.09 °C	
	(100 to 260) °C	0.16 °C	
Cu 427 10 Ω			
(-100 to 260) °C	0.35 °C		

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power - Measure Absolute Level <sup>1</sup>	(-36 to 20) dBm	0.16 dB	Agilent E9304A/N1912A Agilent N5531S Measuring Receiver with N5532A Sensor Module
	9 kHz to 6 GHz		
	(20 to 30) dBm		
	(6 to 18) GHz		
RF Power - Measure Absolute Level <sup>1</sup>	(18 to 26.5) GHz	0.44 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Module
	(-20 to 20) dBm	0.5 dB	
	100 kHz to 30 MHz	0.2 dB	
	30 MHz to 2 GHz	0.21 dB	
	(1 to 18) GHz	0.31 dB	
RF Power - Measure Absolute Level <sup>1</sup>	(18 to 26.5) GHz	0.4 dB	Agilent N5531S Measuring Receiver with 8482A Sensor
	(-30 to 20) dBm	3.1 % of reading	
Relative Power - Measure <sup>1</sup> 100 kHz to 26.5 GHz	100 kHz to 30 MHz		Agilent N5531S Measuring Receiver with N5532A Sensor Module
	(-10 to 0) dB	0.02 dB	
	(-20 to -10) dB	0.03 dB	
	(-30 to -20) dB	0.03 dB	
	(-40 to -30) dB	0.05 dB	
	(-50 to -40) dB	0.06 dB	
	(-60 to -50) dB	0.06 dB	
	(-70 to -60) dB	0.07 dB	
	(-80 to -70) dB	0.07 dB	



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Power - Measure <sup>1</sup> 100 kHz to 26.5 GHz	(-90 to -80) dB (-100 to -90) dB (-110 to -100) dB (-120 to -110) dB (-130 to -120) dB (-140 to -130) dB	0.08 dB 0.08 dB 0.09 dB 0.1 dB 0.1 dB 0.1 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Module
RF Power - Source <sup>1</sup>	(-90 to -75) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz (-75 to -10) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz (-20 to -10) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz	0.73 dB 1 dB 1.2 dB 0.72 dB 1 dB 1.2 dB 1.4 dB 1.3 dB 1.3 dB	Agilent N5183A Signal Generator
RF Power - Source <sup>1</sup>	(-10 to 10) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz > 10 dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz	0.61 dB 0.91 dB 0.93 dB 0.63 dB 0.92 dB 1 dB	Agilent N5183A Signal Generator
Phase Modulation - Source <sup>1</sup> 100 kHz to 32 GHz	Rate: DC to 1 MHz DC to 4 MHz	0.59 % of reading + 0.01 rad	Agilent N5183A Signal Generator
LO Phase Noise @ 1GHz	(-50 to 20) dB Frequency offset: (0.10 to 1 000) Hz (1 to 9 900) kHz	0.48 dB 0.64 dB	Keysight E4440A Spectrum Analyzer
Amplitude Modulation <sup>1</sup> - Source 100 kHz to 32 GHz	Rate: DC to 10 kHz Depths: (1 to 90) %	4.1 % of reading	Agilent N5183A Signal Generator

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Measure <sup>1</sup>			
100 kHz to 10 MHz	Rate: 20 Hz to 10 kHz Depths: (5 to 99) %	0.83 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depths: (20 to 99) %	0.59 % of reading	
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depths: (5 to 20) %	2.6 % of reading	
(3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depths: (20 to 99) %	1.6 % of reading	
(3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depths: (5 to 20) %	4.7 % of reading	
Pulse Generation - Source <sup>1</sup> Repetition Frequency: 0.10 Hz to 10.0 MHz	30 ns to 42 s	10 ns	Agilent N5183A Signal Generator
Phase Modulation-Measure <sup>1</sup>			
100 kHz to 6.6 GHz	Rate: 200 Hz 20 kHz Dev.: > 0.7 rad	1.1 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
100 kHz to 6.6 GHz	Rate: 200 Hz, 20 kHz Dev.: > 0.3 rad	3.1 % of reading	
(6.6 to 13.2) GHz	Rate: 200 Hz 20 kHz Dev.: > 2.0 rad	1.1 % of reading	
(6.6 to 13.2) GHz	Rate: 200 Hz 20 kHz Dev.: > 0.6 rad	3.1 % of reading	
(13.2 to 26.5) GHz	Rate: 200 Hz 20 kHz Dev.: > 2.0 rad	1.1 % of reading	
(13.2 to 26.5) GHz	Rate: 200 Hz 20 kHz Dev.: > 0.6 rad	3.1 % of reading	
Frequency Modulation <sup>1</sup> - Source 100 kHz to 32 GHz	1 dB Rate: DC to 3 MHz 3 dB Rate: DC to 7 MHz	2 % of setting + 20 Hz	Agilent N5183A Signal Generator



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Freq Modulation-Measure <sup>1</sup> Freq. Dev. Mod Rate Ratio >0.2			
250 kHz to 10 MHz	Rate: 20 Hz to 10 kHz Dev.: 200 Hz to 40 kHz peak Freq. Dev. Mod Rate Ratio >0.2	1.6 % of reading	
250 kHz to 10 MHz	Rate: 20 Hz to 10 kHz Dev.: 200 Hz to 40 kHz peak Freq. Dev. Mod Rate Ratio >1.2	1.1 % of reading	
10 MHz to 6.6 GHz	Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.2	1.6 % of reading	
10 MHz to 6.6 GHz	Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.45	1.1 % of reading	
(6.6 to 13.2) GHz	Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.2	2.6 % of reading	
(6.6 to 13.2) GHz	Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >8	1.1 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Freq Modulation-Measure <sup>1</sup> Freq. Dev. Mod Rate Ratio >0.2  (13.2 to 26.5) GHz	Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.2	3.9 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
(13.2 to 26.5) GHz	Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak	1.1 % of reading	

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle	(0.25 to 365) °	0.69 m° (12 μin/ in)	Gage Blocks, Gage Amplifier, Sine Bar
Angle Plates - Squareness <sup>2</sup>	Up to 18 in	0.32 m° (5.6 μin/ in)	Gage Amplifier with probe, Master Square(s)
Gage Blocks <sup>2</sup>	(0.01 to 1) in (1 to 3) in 4 in	(1.4 + 1.3L) μin (1 + 1.3L) μin 9.4 μin	Gage Blocks Gage Block Comparator
	(5 to 12) in (12 to 20) in	(5 + 2L) μin (2 + 2.8L) μin	Horizontal Measuring Machine
	100 mm (125 to 500) mm	0.17 μm (0.06 + 0.000 6L) μm	Comparison to Primary Master Gage Blocks
Indicators <sup>1,2</sup>	(0.000 1 to 6) in	(5+8L) μin	Horizontal Measuring Machine
Calipers <sup>1,2</sup>	Up to 60 in	(5+8L) μin	Gage Blocks
Micrometers OD <sup>1,2</sup>	Up to 12 in	(5+8L) μin	Gage Blocks, Optical Parallels
Height Measuring Devices <sup>1,2</sup>	Up to 36 in (36 to 48) in	(45 + 2L) μin (7 + 3L) μin	Gage Blocks
Grind Gages	Up to 100 mm	0.35 mm	Digital Indicator

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Coating Thickness Gages <sup>1,2</sup>	Up to 0.02 in	58 $\mu\text{in}$ + 0.6R	Coating Thickness Standards
Coating Thickness Gage Standards	Up to 0.10 in	21 $\mu\text{in}$	Horizontal Measuring Machine
External Diameter <sup>1,2</sup>	(0.000 1 to 12) in	(3 + 3L) $\mu\text{in}$	Horizontal Measuring Machine
Internal Diameter <sup>1,2</sup>	(0.04 to 13) in	(3 + 3L) $\mu\text{in}$	Horizontal Measuring Machine
Thread Plugs <sup>1,2</sup> Pitch Diameter	Up to 8 in Pitch (0.2 to 5) mm	(87 + 1.9L) $\mu\text{in}$	Horizontal Measuring Machine
Major Diameter	Pitch 90 – 4 TPI Up to 4 in	(3.5 + 4.6L) $\mu\text{in}$	Thread Measuring Wires
Thread Rings (Adjustable) Pitch Diameter Tactile Fit (Set to Plug)	Up to 4 in	See footnote <sup>5</sup>	Thread Setting Plug
Optical Comparators <sup>1,2</sup> Linear Accuracy	Up to 6 in 6 to 12 in	(43 + 11L) $\mu\text{in}$ (30 + 7.5L) $\mu\text{in}$	Glass Scale
Magnification	(5 to 100) X	350 $\mu\text{in}$	Glass Scale (Sphere)
Surface Plates <sup>1,2</sup> Overall Flatness	Up to 54 inDL (54 to 238) inDL	(17 + 0.7DL) $\mu\text{in}$ (1 + 1.4DL) $\mu\text{in}$	Laser System
Local Area Flatness	Up to 238 inDL	34 $\mu\text{in}$	Repeat-O-Meter
Roundness/Cylindricity	Up to 150 mm	0.02 $\mu\text{m}$	Rondcom41c
Surface Finish Analysis	Up to 500 $\mu\text{in}$	2.4 $\mu\text{in}$	Profilometer, Master Patch
Profilometers <sup>1</sup>	Up to 500 $\mu\text{in}$	3.1 $\mu\text{in}$	Master Patch
Optical Flats Parallelism Flatness	Up to 6 in	2.7 $\mu\text{in}$ 3.5 $\mu\text{in}$	Gage Block Comparator, Master Flat
CMMs <sup>1,2</sup>	Linearity	(25 + 2.4L) $\mu\text{in}$	Laser Measuring System
	Volumetric Repeatability	66 $\mu\text{in}$ 45 $\mu\text{in}$	Ball Bar CMM Sphere

### Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
VMMs <sup>1,2</sup>	Linearity	$(32 + 4.1L) \mu\text{in}$	Glass Scales
Graduated Scales <sup>1,2</sup> Glass, Steel, Tape	Up to 12 in (1 to 200) ft	$(40 + 1L) \mu\text{in}$ $(10 + 3L) \mu\text{in}$	Laser Measuring System
Horizontal Measuring Systems <sup>1,2</sup>	Up to 8 in (8 to 60) in	$(6 + 1.7L) \mu\text{in}$ $(3 + 2.5L) \mu\text{in}$	Gage Blocks
Bore Gages <sup>2</sup> 2-point	(0.24 to 9) in	$(4.3 + 3L) \mu\text{in} + 0.6R$	Horizontal Measuring Machine
3-point		$(85 + 7L) \mu\text{in} + 0.6R$	Cylindrical Rings
Protractors	(0 to 90) °	0.16 °	Sine Bar, Gage Blocks
Chamfer Gages <sup>2</sup>	(0.179 to 2.749) in	$280 \mu\text{in} + 0.6R$	Chamfer Rings
Cylindrical Squares - Squareness	Up to 12 in	1.5 arc seconds	Gage Amplifier w/ probe, Master Square(s)
Cylindricity		0.02 $\mu\text{m}$	Roundness Machine
Feeler/Thickness Gages <sup>2</sup>	Up to 0.2 in	$(4.3 + 3L) \mu\text{in}$	Horizontal Measuring System
Gage Amplifier w/ Probe(s)	Up to 0.1 in	10 $\mu\text{in}$	Gage Blocks
Gage Balls/Spheres <sup>2</sup> - Diameter	Up to 6 in	$(4.3 + 3D) \mu\text{in}$	Gage Blocks, Horizontal Measuring System
Roundness		0.02 $\mu\text{m}$	Roundness Machine
Indicator Calibrator <sup>2</sup> - Linearity	Up to 6 in	$60 \mu\text{in} + 0.6R$	Horizontal Measuring System
Groove Micrometers <sup>2</sup>	Up to 12 in	$(44 + 2.6L) \mu\text{in} + 0.6R$	Gage Blocks
Machinist Levels <sup>2</sup> – Zero Check Linearity	Up to 24 in	350 $\mu\text{in}$ $(100 + 0.83L) \mu\text{in}$	Master Level Gage Blocks
Microscopes, Stereo Reticle Linearity	Up to 2 in	870 $\mu\text{in}$	Stage Micrometer
Microscopes - Toolmakers <sup>2</sup> Scale Linearity	Up to 4 in	$(774 + 70L) \mu\text{in} + 0.6R$	Stage Micrometer
Length Standards <sup>2</sup>	(1 to 60) in	$(3.4 + 3.5L) \mu\text{in}$	Horizontal Measuring System



**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers - Inside <sup>2</sup>	Up to 8 in 8 to 60 in	(6 + 1.7L) μin (3 + 2.5L) μin	Horizontal Measuring System
Pi Tapes <sup>2</sup> – Length	Up to 12 in	(40 + 1L) μin (10+ 3L) μin	Laser System
Thickness	(12 to 200) in	240 μin	Micrometer
Parallels <sup>2</sup> – Steel	Up to 18 in	(96 + 1.8L) μin	Electronic Amplifier with Probe
Granite		(49 + 0.7L) μin	Surface Plate
Pitch Micrometer Standard <sup>2</sup> Length	(1 to 65) in	(3.4 + 3.5L) μin	Horizontal Measuring System
Angle	60 °	0.004 ° (70 μin/ in)	Vision System
Radius Gages	(0.015 625 to 0.5) in	300 μin	Vision System
Sine Plates/Bars <sup>2</sup> – Top Surface Flatness	Up to 0.1 in	(41 + 2.2L) μin	Electronic Amplifier with Probe
Overall Length	Up to 10 in	(3.4 + 3.5L) μin	Horizontal Measuring System
Squares <sup>2</sup>	Up to 18 in	0.32 m° (5.6 μin/ in)	Electronic Amplifier with Probe, Master Square
Straightness and Straight Edges <sup>2</sup>	Up to 60 in	(208 + 2.3L) μin	Electronic Amplifier with Probe, Surface Plate
Tapered Plugs <sup>2</sup> - Pitch Diameter Major Diameter Step Height	(0.0625 to 6) in	(137 + 3.3L) μin (123 + 6.7L) μin 280 μin	Horizontal Measuring System, Sine Block Thread Wires Height Gage
Roundness Machine - Roundness (Spindle Performance)	Up to 0.016 in	15 μin	Master Sphere
Tapered Rings - Pitch Diameter	(0.0625 to 6) in	160 μin	NPT Master Plug, Electronic Amplifier with Probe
Step Height		5 μin	Height Gage

### Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thickness Gages <sup>2</sup> - Dial Digital	Up to 1 in	410 $\mu\text{in}$ + 0.6R 44 $\mu\text{in}$ + 0.6R	Gage Blocks
Thread Micrometers <sup>2</sup> (Screw Thread, Pitch Point)  Linearity Anvil Wear	Up to 12 in	(44 + 2.6L) $\mu\text{in}$ + 0.6R  690 $\mu\text{in}$	Gage Blocks Thread Setting Plug
Granite V Blocks - Side Parallelism V Parallelism Squareness	Up to 12 in	(51 + 0.47L) $\mu\text{in}$	Electronic Amplifier with Probe, Surface Plate
Extensometers <sup>1</sup>	Up to 2 in	16 $\mu\text{in}$	Extensometer Calibrator
Extensometers <sup>1</sup> Gage Length	(0 to 2) in	78 $\mu\text{in}$	Caliper

### Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force <sup>1</sup> Source and Measure	(0.035 to 16) ozf (1 to 10) lbf (10 to 50) lbf (50 to 500) lbf	0.018 % of reading + 0.21 $\mu\text{ozf}$ 0.018 % of reading + 0.33 $\mu\text{lbf}$ 0.018 % of reading + 9.3 mlbf 0.036 % of reading + 5.3 mlbf	Dead Weight
	(500 to 100 000) lbf	0.04 % of reading	Load Cells
	(30 000 to 400 000) lb	0.29 % of applied value	Load Cells, Class A (compression only)
Test Machine Crosshead Displacement <sup>1,2</sup>	Up to 1 in (1 to 36) in	0.000 3 in (150 $\mu\text{in}$ + 146L) $\mu\text{in}$	Indicator Indicator/Gage Blocks
Cable Tensiometers	Up to 600 lb (600 to 2 000) lb	1.2 % of applied value 1.3 % of applied value	Dead Weight Load Cells
Viscometers <sup>1</sup>	Up to 25 cP (25 to 1 500) cP (1 500 to 75 000) cP	0.33 % of reading 0.52 % of reading 0.55 % of reading	Viscosity Standards
Pressure <sup>1</sup>	(10 to 17) psia	0.000 4 psi	Pressure Calibrator



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure	(-14.5 to -0.5) psi (1 to 500) psi (500 to 10 000) psi	65 µpsi/psi 65 µpsi/psi 70 µpsi/psi	Dead Weight Tester
Mass Flow (Gas)	(5 to 50 000) SCCM (0.5 to 50) SLPM (50 to 500) SLPM	0.25 % of reading 0.22 % of reading 0.2 % of reading	Mesa Flow System
Air Velocity	30 FPM (40 to 60) FPM (60 to 150) FPM (150 to 275) FPM (275 to 9000) FPM	5.1 % of reading 2.6 % of reading 1.2 % of reading 0.9 % of reading 0.7 % of reading	Wind Tunnel with Pitot Tube
Torque Tools <sup>1</sup>	0.5 ozf·in to 200 ozf·in (5 to 50) lbf·in (50 to 400) lbf·in (400 to 1000) lbf·in (80 to 250) lbf·ft (250 to 600) lbf·ft (600 to 2 000) lbf·ft	0.56 % of reading 0.33 % of reading 0.36 % of reading 0.4 % of reading 0.28 % of reading 0.51 % of reading 0.75 % of reading	Torque Tester
Torque Transducers <sup>1</sup>	0.5 ozf·in to 1 000 lbf·ft	0.08 % of reading	Dead Weight Torque Arms
Graduated Cylinders	(1 to 200) mL (100 to 1 000) mL (600 to 6 000) mL	1.9 µL 3.2 µL 26 µL	Balances
Pipettes	Up to 1 µL (1 to 5) µL (5 to 10) µL (10 to 20) µL (20 to 50) µL (50 to 100) µL (100 to 200) µL (200 to 500) µL (500 to 1 000) µL (1 000 to 10 000) µL (10 to 20) mL	0.041 µL 0.033 µL 0.028 µL 0.034 µL 0.046 µL 0.061 µL 0.27µL 0.30µL 0.79 µL 2.7 µL 5.8 µL	Pipette Calibration System



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances <sup>1</sup>	Up to 5 mg	0.005 mg	OIML E2 Class 1 Weights
	(5 to 500) mg	0.006 mg	
	500 mg to 5 g	0.007 mg	
	(5 to 10) g	0.012 mg	
	(10 to 20) g	0.014 mg	
	(20 to 50) g	0.024 mg	
	(50 to 100) g	0.086 mg	
Scales and Balances <sup>1</sup>	250 g to 1.1 kg	1.4 mg	OIML E2 Class 1 Weights
	(1.1 to 6.1) kg	9 mg	
	(6.1 to 33) kg	90 mg	Class 6 Weights
(0.5 to 2 000) lb	0.01 % of reading		
Mass	1 mg to 5 g	0.04 mg	Class 1 Weights
	(5 to 50) g	0.04 mg	
	(50 to 100) g	0.04 mg	
	(100 to 250) g	0.12 mg	
	(250 to 500) g	0.17 mg	
	(500 to 1 kg	0.9 mg	
	(1 to 6) kg	9 mg	
(6 to 25) kg	90 mg		
Microindentation Hardness Testers <sup>1</sup> (Knoop and Vickers)	Repeatability under forces (gf):		Indirect Verification to Test Blocks
	100 ≤ HK ≤ 500 HV = 100	2.1 % of Reading 4.1 % of Reading	
Brinell Hardness Testers <sup>1</sup>	Repeatability at:		Indirect Verification to Test Blocks
	500kgf		
	≤ 100 HBW	0.025 mm	
	≥ 64 HBW	0.025 mm	
	1 500kgf		
	≤ 257 HBW	0.025 mm	
≥ 91 HBW	0.03 mm		
3 000kgf			
≤ 587 HBW	0.025 mm		
≥ 186 HBW	0.025 mm		

**Mass and Mass Related**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Rockwell Hardness Testers <sup>1</sup>	HRA Low	1.6 HRA	Indirect Verification to Test Blocks
	HRA Middle	1.6 HRA	
	HRA High	1.2 HRA	
	HRBW Low	1.6 HRBW	
	HRBW Middle	2.1 HRBW	
	HRBW High	1.6 HRBW	
	HRC Low	1.6 HRC	
	HRC Middle	1.6 HRC	
	HRC High	1.2 HRC	
Rockwell Hardness Testers <sup>1</sup>	HREW Low	1.6 HREW	Indirect Verification to Test Blocks
	HREW Middle	1.6 HREW	
	HREW High	1.6 HREW	
	HRMW Low	1.6 HRMW	
	HRMW Middle	1.6 HRMW	
	HRMW High	1.6 HRMW	
	HR15N Low	1.7 HR15N	
	HR15N Middle	1.6 HR15N	
	HR15N High	1.3 HR15N	
	HR15TW Low	1.6 HR15TW	
	HR15TW Middle	1.6 HR15TW	
	HR15TW High	1.6 HR15TW	
	HR30N Low	1.6 HR30N	
	HR30N Middle	1.6 HR30N	
	HR30N High	1.4 HR30N	
	HR30TW Low	1.6 HR30TW	
	HR30TW Middle	1.6 HR30TW	
	HR30TW High	1.6 HR30TW	
	HR45N Low	1.6 HR45N	
	HR45N Middle	1.6 HR45N	
	HR45N High	1.6 HR45N	



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Durometers Spring Force Types A, B, E, O Types C, D, and DO Types OO, OOO, OOO-S	(1.3 to 8.05) N (4.445 to 44.5) N (0.294 to 1.932) N	0.023 N 0.06 N 0.002 N	Shore Durometer Calibrator Balance
Indenter Angle Indenter Length Indenter Radius	(20 to 40) ° (0.049 to 0.198) in (0.05 to 0.1) in	0.004 ° 220 μin 250 μin	VMM

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature - Measure	(-200 to -20) °C (-20 to 120) °C (120 to 200) °C (200 to 300) °C (300 to 660) °C	0.006 2 °C 0.001 7 °C 0.023 °C 0.023 °C 0.024 °C	Fluke 5699 SPRT Fluke 1590 Super Thermometer
Temperature – Source	(-95 to -20) °C (-20 to 120) °C (120 to 425) °C (425 to 660) °C	0.032 °C 0.001 7 °C 0.038 °C 0.063 °C	SPRT Fluke 1590 Super Thermometer With liquid baths and Metrology Well
Infrared Temperature	(-15 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 500) °C	0.54 °C 0.69 °C 1.1 °C 1.6 °C 2.4 °C	Fluke 4180 and 4181 Black Body Calibrators $\lambda = (8 \text{ to } 14) \mu\text{m}$ , $\epsilon = (0.9 \text{ to } 1.0)$
Infrared Temperature	(550 to 1 500) °C	0.46 % of reading	Comparison to Reference Infrared Thermometer $\lambda = (8 \text{ to } 14) \mu\text{m}$ , $\epsilon = 0.95$
Humidity <sup>1</sup> Source and Measure	(5 to 10) %RH (10 to 50) %RH (50 to 90) %RH (90 to 95) %RH	0.56 %RH 0.5 %RH 0.55 %RH 0.58 %RH	Humidity Indicator

### Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source <sup>4</sup>	10 MHz	$5 \times 10^{-11}$ Hz	SRS FS Rubidium GPS Disciplined Oscillator

## DIMENSIONAL MEASUREMENT

### 2 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Angle	(0.25 to 365) °	0.69 m° (12 μin/ in)	Gage Blocks, Gage Amplifier, Sine Bar
Angle	(0.25 to 365) °	0.004 °	Coordinate Measuring Machine
Non-contact	(12 x 8 x 4) in	(44 + 1L) μin	Vision System

### 3 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Inspection Contact	(28 x 40 x 28) in	(74 + 4.7L) μin	Coordinate Measuring Machine



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### Services performed at satellite laboratory

1208 Allanson Road,  
Mundelein, IL 60060  
847-566-3700

General Manager: Curtis Anderson canderson@martincalibration.com

#### Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters <sup>1</sup>	4 pH 7 pH 10 pH	0.016 pH 0.016 pH 0.016 pH	Buffer Solutions

#### Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage - Source <sup>1</sup> fixed point	10V	0.3 $\mu$ V/V	732B Voltage Standards with Fluke Maps
DC Voltage - Source <sup>1</sup>	0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V	20 nV 100 nV 22 $\mu$ V/V + 25 nV 5.3 $\mu$ V/V 0.5 $\mu$ V/V 0.31 $\mu$ V/V 0.35 $\mu$ V/V 1 $\mu$ V/V	MI Potentiometer/ Divider & Fluke 5720A Multi Product Calibrator
DC Voltage - Measure <sup>1</sup>	0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V	20 nV 100 nV 22 $\mu$ V/V + 25 nV 5.3 $\mu$ V/V 0.5 $\mu$ V/V 0.31 $\mu$ V/V 0.35 $\mu$ V/V 1 $\mu$ V/V	Nano Voltmeter Fluke 732B Voltage Standard with MI Potentiometer/ Divider
DC Voltage - Measure <sup>1</sup>	(1.05 to 100) kV	0.1 % of reading	Hipotronics KVM100-A High Voltage Meter





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source & Measure <sup>1</sup>	Up to 100 nA (0.1 to 1) $\mu$ A (1 to 10) $\mu$ A (10 to 100) $\mu$ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	22 pA 30 $\mu$ A/A 6.8 $\mu$ A/A 6.2 $\mu$ A/A 4.1 $\mu$ A/A 4.2 $\mu$ A/A 3.9 $\mu$ A/A 17 $\mu$ A/A	Standard resistors and DMM and Multifunction Calibrator
DC Current – Source & Measure <sup>1</sup>	(1 to 10) A (10 to 20) A (20 to 100) A	80 $\mu$ A/A + 80 $\mu$ A 80 $\mu$ A/A + 800 $\mu$ A 80 $\mu$ A/A + 40 mA	Fluke 52120A Amplifier
DC Current - Source <sup>1</sup>	(100 to 150) A (150 to 1 025) A	5 mA/A + 20 mA 5.1 mA/A + 0.9 A	Fluke 5520A Multi Product Calibrator with 50-turn Coil
AC Voltage – Source & Measure <sup>1</sup>	(0 to 2.2) mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz (2.2 to 7) mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.035 % of reading + 1.3 $\mu$ V 0.037 % of reading + 1.3 $\mu$ V 0.04 % of reading + 1.3 $\mu$ V 0.025 % of reading + 2 $\mu$ V 0.027 % of reading + 2.5 $\mu$ V 0.033 % of reading + 4 $\mu$ V 0.036 % of reading + 8 $\mu$ V 0.02 % of reading + 8 $\mu$ V 0.023 % of reading + 1.3 $\mu$ V 0.024 % of reading + 1.3 $\mu$ V 0.022 % of reading + 1.3 $\mu$ V 0.014 % of reading + 2 $\mu$ V 0.009 % of reading + 2.5 $\mu$ V 0.029 % of reading + 4 $\mu$ V 0.055 % of reading + 8 $\mu$ V 0.056 % of reading + 8 $\mu$ V	Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator
AC Current – Source and Measure <sup>1</sup>	Up to 10 mA (0.01 to 100) kHz (10 to 20) mA (0.01 to 100) kHz (20 to 200) mA (0.01 to 100) kHz	250 $\mu$ A/A 250 $\mu$ A/A 250 $\mu$ A/A	Fluke 5720A Multi Product Calibrator and Fluke 5725A Amplifier w/ A40B Shunts



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source and Measure <sup>1</sup>	(0.2 A to 20) A 0.01 to 1) kHz (1 to 10) kHz (10 to 30) kHz (30 to 100) kHz	250 $\mu$ A/A 250 $\mu$ A/A 300 $\mu$ A/A 350 $\mu$ A/A	Fluke 5720A Multi Product Calibrator and Fluke 5725A Amplifier w/ A40B Shunts
AC Current – Source and Measure <sup>1</sup>	(20 to 100) A	0.015 % of reading	Fluke 52120A Amplifier
AC Current - Source <sup>1</sup>  (45 to 65) Hz  (65 to 440) Hz	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A  (10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	5.9 mA/A + 30 mA 5.7 mA/A + 25 mA 5.7 mA/A + 0.9 A  11 mA/A + 30 mA 10 mA/A + 0.25 A 13 mA/A + 0.9 A	Fluke 5520A Multi Product Calibrator with 50-turn Coil
AC Current - Measure <sup>1</sup>	Up to 200 $\mu$ A (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz 200 $\mu$ A to 2 mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz 200 mA to 2 A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.62 mA/A 0.54 mA/A 0.94 mA/A 8.4 mA/A 0.6 mA/A 0.54 mA/A 0.94 mA/A 4.2 mA/A 0.6 mA/A 0.54 mA/A 0.94 mA/A 4.2 mA/A 0.57 mA/A 0.49 mA/A 0.83 mA/A 0.83 mA/A 0.93 mA/A 3.2 mA/A	Fluke 8508A Multimeter
AC Current - Measure <sup>1</sup>	(2 to 20) A 10 Hz to 2 kHz (2 to 10) kHz	1 mA/A 2.7 mA/A	Fluke 8508A Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance - Source <sup>1</sup>	0.001 Ω	3.5 μΩ/Ω	Standard resistors
	0.01Ω	4.3 μΩ/Ω	
	0.1 Ω	1.5 μΩ/Ω	
	1Ω	0.85 μΩ/Ω	
	10Ω	0.66 μΩ/Ω	
	100 Ω	1.7μΩ/Ω	
	1 kΩ	1.2 μΩ/Ω	
	10 kΩ	2.4 μΩ/Ω	
	100 kΩ	0.57 μΩ/Ω	
	1 MΩ	1.3 μΩ/Ω Ω	
	10 MΩ	14 μΩ/Ω	
	100 MΩ	130 μΩ/Ω	
1 GΩ	0.32 μΩ/Ω		
Resistance - Source <sup>1</sup>	(0.01 to 10) MΩ (0.01 to 10) GΩ	10 μΩ/Ω 0.5 % of reading	Decade resistors with bridge and DMM
Resistance - Source <sup>1</sup>	(10 to 100) GΩ	1.2 % of reading	Decade Resistor
Resistance - Measure <sup>1</sup> Normal Mode	(10 to 100) μΩ	0.15 % of reading	Decade resistors with bridge and DMM
	(0.1 to 1) mΩ	15 μΩ/Ω	
	(1 to 10) mΩ	5.1 μΩ/Ω	
	(10 o 100) mΩ	1.8 μΩ/Ω	
	(0.1 to 1) Ω	0.92 μΩ/Ω	
	(1 to 10) Ω	0.74 μΩ/Ω	
	(10 to 100) Ω	1.7 μΩ/Ω	
	(0.01 to 1) kΩ	1.3 μΩ/Ω	
	(1 to 10) kΩ	2.4 μΩ/Ω	
	(10 o 100) kΩ	1.1 μΩ/Ω	
	(0.1 to 1) MΩ	8.2 μΩ/Ω	
	(1 to 10) MΩ	21μΩ/Ω	
	(10 to 200) MΩ	72 μΩ/Ω + 1kΩ	
	(0.2 to 2) GΩ	0.18 mΩ/Ω + 100 kΩ	
(2 to 20) GΩ	0.67 mΩ/Ω + 10 MΩ		
Resistance - Measure <sup>1</sup> High Voltage Mode up to 200 V	(2 to 20) MΩ	15 μΩ/Ω + 10 Ω	Decade resistors with bridge and DMM
	(20 to 200) MΩ	60 μΩ/Ω + 1 kΩ	
	200 MΩ to 2 GΩ	0.15 mΩ/Ω + 100 kΩ	
	(2 to 20) GΩ	0.53 mΩ/Ω + 10 MΩ	
Capacitance - Measure <sup>1</sup>	1 pF @ 1 kHz	1.9 mF/F	QuadTech 1730 LCR Meter
	10 pF @ 1 kHz	1.1 mF/F	
	100 pF @ 1kHz	1.2 mF/F	
	1 nF 1kHz	1.2 mF/F	
	1 μF @ 1 kHz	1.2 mF/F	



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance - Source <sup>1</sup> (fixed values) @ 100 Hz @ 1 kHz	1 pF 1 nF 10 nF 100 nF 1 μF	1.8 mF/F 0.23 mF/F 0.25 mF/F 0.21 mF/F 0.25 mF/F	Standard Capacitors
Capacitance - Source <sup>1</sup> 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz 10 Hz to 300 Hz 10 Hz to 150 Hz 10 Hz to 120 Hz 10 Hz to 80 Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	0.19 nF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	15 mF/F 8.4 mF/F 3.6 mF/F 3.6 mF/F 3.7 mF/F 3.6 mF/F 3.6 mF/F 3.6 mF/F 5.1 mF/F 5.6 mF/F 5.6 mF/F 8.7 mF/F 5.5 mF/F 5.5 mF/F 8.5 mF/F 12 mF/F	Fluke 5520A Multi Product Calibrator
Inductance - Measure <sup>1</sup>	100 μH @ 1 kHz 1 mH @ 1 kHz 10 mH @ 1 kHz 100 mH @ 1 kHz 1 H @ 1 kHz	1.2 mH/H	QuadTech 1730 LCR Meter
Inductance - Source <sup>1</sup>	500 μH @ 100 Hz 500 μH @ 1 kHz 2 mH @ 100 Hz 2 mH @ 1 kHz 20 mH @ 100 Hz 20 mH @ 1 kHz	1.2 mH/H 1 mH/H 1.1 mH/H 1 mH/H 1.1 mH/H 1 mH/H	Standard Inductors
Inductance - Source <sup>1</sup>	1 H @ 100 Hz 1 H @ 1 kHz 10 H @ 100 Hz 10 H @ 1 kHz	1 mH/H 1 mH/H 1 mH/H 1 mH/H	Standard Inductors



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1</sup> Square Wave Signal 50 Ω at 1 kHz	40 μV to 5 V	1 mV/V	Fluke 9500B/3200/9530 Oscilloscope Calibrator
Square Wave Signal 1 MΩ at 1 kHz	40 μV to 5 V	1 mV/V	
Oscilloscopes <sup>1</sup> DC Voltage, 50 Ω DC Voltage, 1 MΩ	1 mV to 5 V 1 mV to 200 V	0.26 mV/V 0.25 mV/V	Fluke 9500B/3200/9530 Oscilloscope Calibrator
Leveled Sine Wave Amplitude	5 mV to 5 V	15 mV/V	
Leveled Sine Wave Flatness (relative to 50 kHz)	4.4 mVpp to 5.6 Vpp 0.1 Hz to 300 MHz	43 mV/V	
	(300 to 550) MHz	43 mV/V	
Time Marker 50 Ω Source and Period	4.4 mVpp to 3.3 Vpp 550 MHz to 1.1 GHz	52 mV/V	
	(1.1 to 3.2) GHz	52 mV/V	
Rise/Fall Time - Source	9 ns to 55 s	0.25 μs/s	
Pulse Width - Source	150 ps	27 ps	
	(1 to 100) ns	52 ms/s	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators <sup>1</sup>	Type B		Ectron 1140A Thermocouple Simulator
	(250 to 350) °C	1.1 °C	
	(350 to 445) °C	0.85 °C	
	(445 to 580) °C	0.67 °C	
	(580 to 750) °C	0.52 °C	
	(750 to 1 000) °C	0.43 °C	
	(1 000 to 1 820) °C	0.33 °C	
	Type C		
	(0 to 250) °C	0.23 °C	
	(250 to 1 000) °C	0.18 °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		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators <sup>1</sup>	Type E		Ectron 1140A Thermocouple Simulator
	(-270 to -245) °C	1.4 °C	
	(-245 to -195) °C	0.21 °C	
	(-195 to -155) °C	0.12 °C	
	(-155 to -90) °C	0.09 °C	
	(-90 to 15) °C	0.08 °C	
	(15 to 890) °C	0.07 °C	
	(890 to 1 000) °C	0.08 °C	
	Type J		
	(-210 to -180) °C	0.14 °C	
	(-180 to -120) °C	0.12 °C	
	(-120 to -50) °C	0.09 °C	
	(-50 to 990) °C	0.08 °C	
	(990 to 1 200) °C	0.08 °C	
	Type K		
	(-270 to -255) °C	2.5 °C	
	(-255 to -195) °C	0.81 °C	
	(-195 to -115) °C	0.14 °C	
	(-115 to -55) °C	0.10 °C	
	(-55 to 1 000) °C	0.08 °C	
	(1 000 to 1 372) °C	0.09 °C	
	Type N		
	(-270 to -260) °C	5.8 °C	
	(-260 to -200) °C	1.2 °C	
	(-200 to -140) °C	0.27 °C	
	(-140 to -70) °C	0.17 °C	
	(-70 to 25) °C	0.14 °C	
	(25 to 160) °C	0.12 °C	
(160 to 1 300) °C	0.1 °C		
Type R			
(-50 to -30) °C	0.75 °C		
(-30 to 45) °C	0.63 °C		
(45 to 160) °C	0.46 °C		
(160 to 380) °C	0.35 °C		
(380 to 775) °C	0.3 °C		
(775 to 1 768) °C	0.25 °C		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators <sup>1</sup>	Type S (-50 to -30) °C (-30 to -45) °C (-45 to -105) °C (-105 to 310) °C (310 to 615) °C (615 to 1 768) °C Type T (-270 to -255) °C (-255 to -240) °C (-240 to -210) °C (-210 to -150) °C (-150 to -40) °C (-40 to 100) °C (100 to 400) °C	0.71 °C 0.64 °C 0.46 °C 0.38 °C 0.33 °C 0.3 °C 2.1 °C 0.56 °C 0.35 °C 0.21 °C 0.14 °C 0.09 °C 0.08 °C	Ectron 1140A Thermocouple Simulator
Electrical Simulation of RTD Indicators <sup>1</sup>	PT 395 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C PT 3926 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C PT 3916 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.06 °C 0.08 °C 0.11 °C 0.12 °C 0.14 °C 0.27 °C 0.06 °C 0.08 °C 0.11 °C 0.12 °C 0.14 °C 0.29 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.11 °C 0.12 °C 0.27 °C	Fluke 5520A 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 RTD Indicators <sup>1</sup>	PT 385 200 Ω		Fluke 5520A Multi Product Calibrator
	(-200 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.14 °C	
	(300 to 400) °C	0.15 °C	
	(400 to 600) °C	0.16 °C	
	(600 to 630) °C	0.19 °C	
	PT 385 500 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 400) °C	0.09 °C	
	(400 to 600) °C	0.01 °C	
	(600 to 630) °C	0.13 °C	
	PT 395 100 Ω		
	(-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.11 °C	
	(300 to 400) °C	0.12 °C	
	(400 to 630) °C	0.14 °C	
	(630 to 800) °C	0.27 °C	
	PT 3926 100 Ω		
	(-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.11 °C	
	(300 to 400) °C	0.12 °C	
	(400 to 630) °C	0.14 °C	
PT 3916 100 Ω			
(-200 to -190) °C	0.29 °C		
(-190 to -80) °C	0.05 °C		
(-80 to 0) °C	0.06 °C		
(0 to 100) °C	0.07 °C		
(100 to 260) °C	0.08 °C		
(260 to 300) °C	0.09 °C		
(300 to 400) °C	0.11 °C		
(400 to 600) °C	0.12 °C		
(600 to 630) °C	0.27 °C		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicators <sup>1</sup>	PT 385 200 Ω		Fluke 5520A Multi Product Calibrator
	(-200 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.14 °C	
	(300 to 400) °C	0.15 °C	
	(400 to 600) °C	0.16 °C	
	(600 to 630) °C	0.19 °C	
	PT 385 500 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 400) °C	0.09 °C	
	(400 to 600) °C	0.01 °C	
	(600 to 630) °C	0.13 °C	
	PT 385 1 000 Ω		
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.07 °C	
	(300 to 600) °C	0.08 °C	
(600 to 630) °C	0.27 °C		
PtNi 120 Ω			
(-80 to 100) °C	0.09 °C		
(100 to 260) °C	0.16 °C		
Cu 427 10 Ω			
(-100 to 260) °C	0.35 °C		

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks <sup>2</sup>	(0.01 to 1) in (1 to 2) in 4 in	(1.4 + 1.3L) μin (1 + 1.3L) μin 9.4 μin	Gage Blocks Gage Block Comparator
	(5 to 12) in (12 to 20) in	(5 + 2L) μin (2 + 2.8L) μin	Horizontal Measuring Machine
	100 mm (125 to 500) mm	0.17 μm (0.06 + 0.000 6L) μm	Comparison to Primary Master Gage Blocks
Indicators <sup>1,2</sup>	(0.000 1 to 6) in	(5+8L) μin	Horizontal Measuring Machine

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers <sup>1,2</sup>	Up to 60 in	$(5+8L) \mu\text{in}$	Gage Blocks
Micrometers OD <sup>1,2</sup>	Up to 12 in	$(5+8L) \mu\text{in}$	Gage Blocks, Optical Parallels
Height Measuring Devices <sup>1,2</sup>	Up to 36 in (36 to 48) in	$(45 + 2L) \mu\text{in}$ $(7 + 3L) \mu\text{in}$	Gage Blocks
Grind Gages	Up to 100 mm	0.35 mm	Digital Indicator
Coating Thickness Gages <sup>1,2</sup>	Up to 0.02 in	$58 \mu\text{in} + 0.6R$	Coating Thickness Standards
Coating Thickness Gage Standards	Up to 0.10 in	21 $\mu\text{in}$	Horizontal Measuring Machine
External Diameter <sup>1,2</sup>	(0.000 1 to 12) in	$(3 + 3L) \mu\text{in}$	Horizontal Measuring Machine
Internal Diameter <sup>1,2</sup>	(0.04 to 13) in	$(3 + 3L) \mu\text{in}$	Horizontal Measuring Machine
Thread Rings (Adjustable) Pitch Diameter Tactile Fit (Set to Plug)	Up to 4 in	See footnote <sup>5</sup>	Thread Setting Plug
Thread Plugs <sup>1,2</sup> Pitch Diameter	Up to 8 in Pitch (0.2 to 5) mm	$(87 + 1.9L) \mu\text{in}$	Horizontal Measuring Machine
Major Diameter	Pitch 90 – 4 TPI Up to 4 in	$(3.5 + 4.6L) \mu\text{in}$	Thread Measuring Wires
Optical Comparators <sup>1,2</sup> Linear Accuracy	Up to 6 in 6 to 12 in	$(43 + 11L) \mu\text{in}$ $(30 + 7.5L) \mu\text{in}$	Glass Scale
Magnification	(5 to 100) X	350 $\mu\text{in}$	Glass Scale (Sphere)
Surface Plates <sup>1,2</sup> Overall Flatness	Up to 238 inDL	$(25 + 2.9L) \mu\text{in}$	Laser System
Local Area Flatness	Up to 238 inDL	34 $\mu\text{in}$	Repeat-O-Meter
Surface Finish Analysis	Up to 500 $\mu\text{in}$	2.4 $\mu\text{in}$	Profilometer, Master Patch
Profilometers <sup>1</sup>	Up to 500 $\mu\text{in}$	3.1 $\mu\text{in}$	Master Patch



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**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Flats Parallelism Flatness	Up to 6 in	2.7 μin 3.5 μin	Gage Block Comparator, Master Flat
CMMs <sup>1,2</sup>	Linearity	(25 + 2.4L) μin	Laser Measuring System
	Volumetric Repeatability	66 μin 45 μin	Ball Bar, CMM Sphere
VMMs <sup>1,2</sup>	Linearity	(32 + 4.1L) μin	Glass Scales
Graduated Scales <sup>1,2</sup> Glass, Steel, Tape	Up to 12 in (1 to 200) ft	(40 + 1L) μin (10+ 3L) μin	Laser Measuring System
Horizontal Measuring Systems <sup>1,2</sup>	Up to 8 in 8 to 60 in	(6 + 1.7L) μin (3 + 2.5L) μin	Gage Blocks
Protractors	(0 to 90) °	0.16 °	Sine Bar, Gage Blocks
Length Standards <sup>2</sup>	(1 to 60) in	(3.4 + 3.5L) μin	Horizontal Measuring System
Micrometers - Inside <sup>2</sup>	Up to 8 in 8 to 60 in	(6 + 1.7L) μin (3 + 2.5L) μin	Horizontal Measuring System

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force <sup>1</sup> Source and Measure	(0.035 to 16) ozf (1 to 10) lbf (10 to 50) lbf (50 to 500) lbf	(0.018 % of reading + 0.21μ) ozf (0.018 % of reading + 0.33μ) lbf (0.018 % of reading + 9.3m) lbf (0.036 % of reading + 5.3m) lbf	Dead Weight
	(500 to 1 000) lbf (10 to 100) klf	0.05 % of reading 0.06 % of reading	Load Cells, Class AA
	(30 000 to 400 000) lbf	0.29 % of applied value	Load Cells, Class A (compression only)
Pressure <sup>1</sup>	(10 to 17) psia	0.000 4 psi	Pressure Calibrator
Pressure <sup>1</sup>	(-14.5 to -0.5) psi (1 to 16 000) psi	65 μpsi/psi 65 μpsi/psi	Deadweight Tester



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools <sup>1</sup>	0.5 ozf·in to 200 ozf·in (5 to 50) lbf·in (50 to 400) lbf·in (400 to 1000) lbf·in (80 to 250) lbf·ft (250 to 600) lbf·ft (600 to 1 000) lbf·ft	0.56 % of reading 0.33 % of reading 0.36 % of reading 0.4 % of reading 0.28 % of reading 0.51 % of reading 0.75 % of reading	Torque Tester
Scales and Balances <sup>1</sup>	Up to 5 mg (5 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 250) g 250 g to 1.1 kg (1.1 to 6.1) kg (6.1 to 33) kg	0.005 mg 0.006 mg 0.007 mg 0.012 mg 0.014 mg 0.024 mg 0.086 mg 0.092 mg 1.4 mg 9 mg 90 mg	OIML E2 Class 1 Weights
Scales and Balances <sup>1</sup>	(0.5 to 2 000) lb	0.01 % of reading	Class 6 Weights
Indirect Verification of Microindentation Hardness Testers <sup>1</sup> (Knoop and Vickers)	Repeatability under forces (gf): 100 ≤ HK ≤ 500 HV = 100	2.1 % of Reading 4.1 % of Reading	Indirect Verification to Test Blocks
Brinell Hardness Testers <sup>1</sup> Repeatability	500kgf ≤ 100 HBW ≥ 64 HBW 1 500kgf ≤ 257 HBW ≥ 91 HBW 3 000kgf ≤ 587 HBW ≥ 186 HBW	0.025 mm 0.025 mm 0.025 mm 0.03 mm 0.025 mm 0.025 mm	Indirect Verification to Test Blocks

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers <sup>1</sup>	HRA Low	1.6 HRA	Indirect Verification to Test Blocks
	HRA Middle	1.6 HRA	
	HRA High	1.2 HRA	
	HRBW Low	1.6 HRBW	
	HRBW Middle	2.1 HRBW	
	HRBW High	1.6 HRBW	
	HRC Low	1.6 HRC	
	HRC Middle	1.6 HRC	
	HRC High	1.2 HRC	
	HREW Low	1.6 HREW	
	HREW Middle	1.6 HREW	
	HREW High	1.6 HREW	
	HRMW Low	1.6 HRMW	
	HRMW Middle	1.6 HRMW	
	HRMW High	1.6 HRMW	
	HR15N Low	1.7 HR15N	
	HR15N Middle	1.6 HR15N	
	HR15N High	1.3 HR15N	
	HR15TW Low	1.6 HR15TW	
	HR15TW Middle	1.6 HR15TW	
	HR15TW High	1.6 HR15TW	
	HR30N Low	1.6 HR30N	
	HR30N Middle	1.6 HR30N	
	HR30N High	1.4 HR30N	
HR30TW Low	1.6 HR30TW		
HR30TW Middle	1.6 HR30TW		
HR30TW High	1.6 HR30TW		
HR45N Low	1.6 HR45N		
HR45N Middle	1.6 HR45N		
HR45N High	1.6 HR45N		



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Durometers Spring Force Types A, B, E, O Types C, D, and DO Types OO, OOO, OOO-S	(1.3 to 8.05) N (4.445 to 44.5) N (0.294 to 1.932) N	0.023 N 0.06 N 0.002 N	Shore Durometer Calibrator Balance
Indenter Angle Indenter Length Indenter Radius	(20 to 40) ° (0.049 to 0.198) in (0.05 to 0.1) in	0.05 ° 220 μin 250 μin	VMM

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature - Measure	(-200 to -20) °C (-20 to 120) °C (120 to 200) °C (200 to 300) °C (300 to 600) °C	0.006 2 °C 0.001 7 °C 0.023 °C 0.023 °C 0.024 °C	Fluke 5699 SPRT Fluke 1590 Super Thermometer
Temperature – Source	(-20 to 120) °C (120 to 425) °C (425 to 660) °C	0.001 7 °C 0.038 °C 0.063 °C	SPRT Fluke 1590 Super Thermometer With liquid baths and Metrology Well
Infrared Temperature	(50 to 100) °C (100 to 200) °C (200 to 250) °C (250 to 300) °C (300 to 400) °C (400 to 500) °C	0.8 °C 0.93 °C 0.96 °C 1 °C 1.1 °C 1.2 °C	Black Body Calibrator Monitored with a PRT
Infrared Temperature	(550 to 1 500) °C	0.46 % of reading	Comparison to Reference Infrared Thermometer $\lambda = (8 \text{ to } 14) \mu\text{m}$ , $\epsilon = 0.95$
Humidity <sup>1</sup> Source and Measure	(20 to 50) %RH (50 to 90) %RH	1.6 %RH 2.1 %RH	Humidity Indicator



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### Services performed at satellite laboratory

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General Manager: Stacy Franzwa    sfranzwa @martincalibration.com

#### Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source <sup>1</sup>	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1 020) V	21 $\mu$ V/V + 1 $\mu$ V 11 $\mu$ V/V + 2 $\mu$ V 13 $\mu$ V/V + 20 $\mu$ V 18 $\mu$ V/V + 150 $\mu$ V 18 $\mu$ V/V + 1.5 mV	5522A Multi Product Calibrator
DC Voltage - Measure <sup>1</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	12 $\mu$ V/V + 0.3 $\mu$ V 10 $\mu$ V/V + 0.3 $\mu$ V 10 $\mu$ V/V + 0.5 $\mu$ V 13 $\mu$ V/V + 30 $\mu$ V 13 $\mu$ V/V + 100 $\mu$ V	Keysight 3458A Multimeter
DC Current - Source <sup>1</sup>	Up to 330 $\mu$ A 330 $\mu$ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20) A	151 $\mu$ A/A + 20 nA 101 $\mu$ A/A + 50 nA 101 $\mu$ A/A + 250 nA 102 $\mu$ A/A + 2.5 $\mu$ A 201 $\mu$ A/A + 40 $\mu$ A 386 $\mu$ A/A + 40 $\mu$ A 504 $\mu$ A/A + 0.5 mA 1 mA/A + 0.75 mA	5522A Multi Product Calibrator
DC Current – Measure <sup>1</sup>	(10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	29 $\mu$ A/A + 0.8 nA 27 $\mu$ A/A + 5 nA 28 $\mu$ A/A + 50 nA 46 $\mu$ A/A + 0.5 $\mu$ A 121 $\mu$ A/A + 10 $\mu$ A	Keysight 3458A Multimeter





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Electrical – DC/Low Frequency

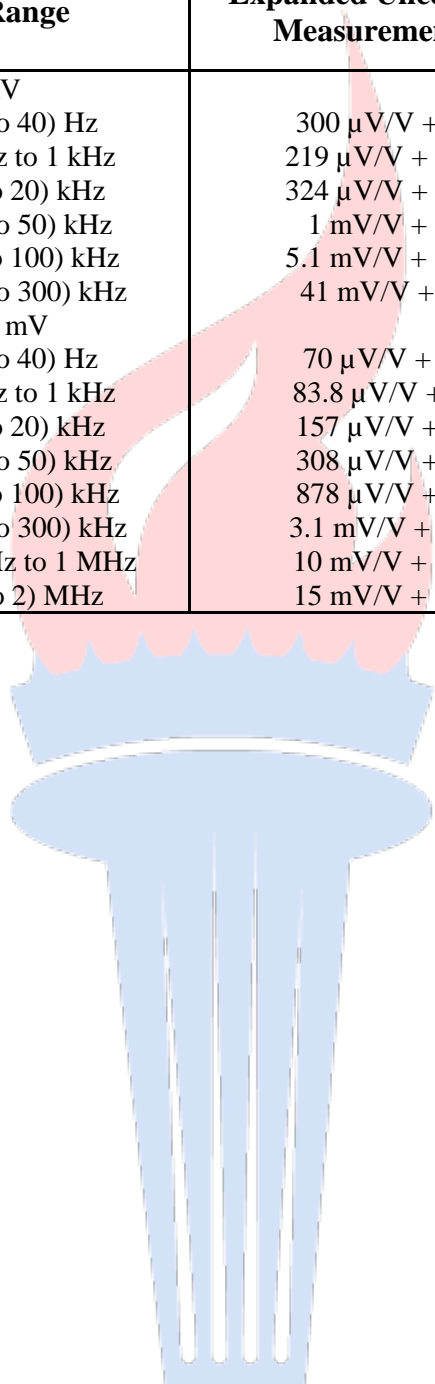
Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source	Up to 33 mV		5522A Multi Product Calibrator
	(10 to 45) Hz	806 $\mu\text{V/V} + 6 \mu\text{V}$	
	45 Hz to 10 kHz	176 $\mu\text{V/V} + 6 \mu\text{V}$	
	(10 to 20) kHz	220 $\mu\text{V/V} + 6 \mu\text{V}$	
	(20 to 50) kHz	1 mV/V + 6 $\mu\text{V}$	
	(50 to 100) kHz	3.5 mV/V + 12 $\mu\text{V}$	
	(100 to 500) kHz	8 mV/V + 50 $\mu\text{V}$	
	(33 to 330) mV		
	(10 to 45) Hz	302 $\mu\text{V/V} + 8 \mu\text{V}$	
	45 Hz to 10 kHz	148 $\mu\text{V/V} + 8 \mu\text{V}$	
	(10 to 20) kHz	163 $\mu\text{V/V} + 8 \mu\text{V}$	
	(20 to 50) kHz	353 $\mu\text{V/V} + 8 \mu\text{V}$	
	(50 to 100) kHz	804 $\mu\text{V/V} + 32 \mu\text{V}$	
	(100 to 500) kHz	2 mV/V + 70 $\mu\text{V}$	
AC Voltage – Source	330 mV to 3.3 V		5522A Multi Product Calibrator
	(10 to 45) Hz	302 $\mu\text{V/V} + 50 \mu\text{V}$	
	45 Hz to 10 kHz	153 $\mu\text{V/V} + 60 \mu\text{V}$	
	(10 to 20) kHz	192 $\mu\text{V/V} + 60 \mu\text{V}$	
	(20 to 50) kHz	302 $\mu\text{V/V} + 50 \mu\text{V}$	
	(50 to 100) kHz	703 $\mu\text{V/V} + 125 \mu\text{V}$	
	(100 to 500) kHz	2.4 mV/V + 0.6 mV	
	(3.3 to 33) V		
	(10 to 45) Hz	302 $\mu\text{V/V} + 650 \mu\text{V}$	
	45 Hz to 10 kHz	153 $\mu\text{V/V} + 600 \mu\text{V}$	
	(10 to 20) kHz	242 $\mu\text{V/V} + 600 \mu\text{V}$	
	(20 to 50) kHz	353 $\mu\text{V/V} + 600 \mu\text{V}$	
	(50 to 100) kHz	903 $\mu\text{V/V} + 1.6 \text{ mV}$	
	(33 to 330) V		
	45 Hz to 1 kHz	194 $\mu\text{V/V} + 2 \text{ mV}$	
	(1 to 10) kHz	204 $\mu\text{V/V} + 6 \text{ mV}$	
	(10 to 20) kHz	253 $\mu\text{V/V} + 6 \text{ mV}$	
	(20 to 50) kHz	314 $\mu\text{V/V} + 6 \text{ mV}$	
	(50 to 100) kHz	2 mV/V + 50 mV	
	(330 to 1020) V		
	45 Hz to 1 kHz	302 $\mu\text{V/V} + 10 \text{ mV}$	
	(1 to 5) kHz	252 $\mu\text{V/V} + 10 \text{ mV}$	
(5 to 10) kHz	302 $\mu\text{V/V} + 10 \text{ mV}$		



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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 10 mV		Keysight 3458A Multimeter
	(1 to 40) Hz	300 $\mu\text{V}/\text{V}$ + 3 $\mu\text{V}$	
	40 Hz to 1 kHz	219 $\mu\text{V}/\text{V}$ + 1.1 $\mu\text{V}$	
	(1 to 20) kHz	324 $\mu\text{V}/\text{V}$ + 1.1 $\mu\text{V}$	
	(20 to 50) kHz	1 mV/V + 6 $\mu\text{V}$	
	(50 to 100) kHz	5.1 mV/V + 1.1 $\mu\text{V}$	
	(100 to 300) kHz	41 mV/V + 2 $\mu\text{V}$	
	(10 to 100) mV		
	(1 to 40) Hz	70 $\mu\text{V}/\text{V}$ + 4 $\mu\text{V}$	
	40 Hz to 1 kHz	83.8 $\mu\text{V}/\text{V}$ + 2 $\mu\text{V}$	
	(1 to 20) kHz	157 $\mu\text{V}/\text{V}$ + 2 $\mu\text{V}$	
	(20 to 50) kHz	308 $\mu\text{V}/\text{V}$ + 2 $\mu\text{V}$	
	(50 to 100) kHz	878 $\mu\text{V}/\text{V}$ + 2 $\mu\text{V}$	
	(100 to 300) kHz	3.1 mV/V + 10 $\mu\text{V}$	
300 kHz to 1 MHz	10 mV/V + 10 $\mu\text{V}$		
(1 to 2) MHz	15 mV/V + 10 $\mu\text{V}$		





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	100 mV to 1 V		Keysight 3458A Multimeter
	(1 to 40) Hz	70 $\mu\text{V/V} + 40 \mu\text{V}$	
	40 Hz to 1 kHz	80.7 $\mu\text{V/V} + 20 \mu\text{V}$	
	(1 to 20) kHz	154 $\mu\text{V/V} + 20 \mu\text{V}$	
	(20 to 50) kHz	327 $\mu\text{V/V} + 20 \mu\text{V}$	
	(50 to 100) kHz	825 $\mu\text{V/V} + 20 \mu\text{V}$	
	(100 to 300) kHz	3.1 mV/V + 0.1 mV	
	300 kHz to 1 MHz	10 mV/V + 0.1 mV	
	(1 to 2) MHz	15 mV/V + 0.1 mV	
	(1 to 10) V		
	(1 to 40) Hz	77 $\mu\text{V/V} + 400 \mu\text{V}$	
	40 Hz to 1 kHz	81 $\mu\text{V/V} + 200 \mu\text{V}$	
	(1 to 20) kHz	154 $\mu\text{V/V} + 200 \mu\text{V}$	
	(20 to 50) kHz	324 $\mu\text{V/V} + 200 \mu\text{V}$	
	(50 to 100) kHz	816 $\mu\text{V/V} + 200 \mu\text{V}$	
	(100 to 300) kHz	3.1 mV/V + 1 mV	
	300 kHz to 1 MHz	10 mV/V + 1 mV	
	(1 to 2) MHz	15 mV/V + 1 mV	
	(10 to 100) V		
	(1 to 40) Hz	200 $\mu\text{V/V} + 4 \text{ mV}$	
40 Hz to 1 kHz	205 $\mu\text{V/V} + 2 \text{ mV}$		
(1 to 20) kHz	215 $\mu\text{V/V} + 2 \text{ mV}$		
(20 to 50) kHz	358 $\mu\text{V/V} + 2 \text{ mV}$		
(50 to 100) kHz	1.2 mV/V + 2 mV		
(100 to 300) kHz	4 mV/V + 2 mV		
300 kHz to 1 MHz	15 mV/V + 10 mV		
(100 to 1000) V			
(1 to 40) Hz	400 $\mu\text{V/V} + 40 \text{ mV}$		
40 Hz to 1 kHz	405 $\mu\text{V/V} + 20 \text{ mV}$		
(1 to 20) kHz	600 $\mu\text{V/V} + 20 \text{ mV}$		
(20 to 50) kHz	1.2 mV/V + 20 mV		
(50 to 100) kHz	3 mV/V + 20 mV		
AC Current – Measure	Up to 100 $\mu\text{A}$		Keysight 3458A Multimeter
	(10 to 20) Hz	4 mA/A + 30 nA	
	(20 to 45) Hz	1.5 mA/A + 30 nA	
	(45 to 100) Hz	605 $\mu\text{A/A} + 30 \text{ nA}$	
	100 Hz to 1 kHz	610 $\mu\text{A/A} + 30 \text{ nA}$	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure	100 $\mu$ A to 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	4 mA/A + 0.2 $\mu$ A 1.5 mA/A + 0.2 $\mu$ A 605 $\mu$ A/A + 0.2 $\mu$ A 325 $\mu$ A/A + 0.2 $\mu$ A 605 $\mu$ A/A + 0.2 $\mu$ A 4 mA/A + 0.4 $\mu$ A 5.5 mA/A + 1.5 $\mu$ A	Keysight 3458A Multimeter
	(1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz (10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	4 mA/A + 2 $\mu$ A 1.5 mA/A + 2 $\mu$ A 605 $\mu$ A/A + 2 $\mu$ A 325 $\mu$ A/A + 2 $\mu$ A 605 $\mu$ A/A + 2 $\mu$ A 4 mA/A + 4 $\mu$ A 5.5 mA/A + 15 $\mu$ A 4 mA/A + 20 $\mu$ A 1.5 mA/A + 20 $\mu$ A 605 $\mu$ A/A + 20 $\mu$ A 325 $\mu$ A/A + 20 $\mu$ A 605 $\mu$ A/A + 20 $\mu$ A 4 mA/A + 40 $\mu$ A 5.5 mA/A + 150 $\mu$ A 4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 805 $\mu$ A/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	
AC Current – Source	(29 to 330) $\mu$ A (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	2 mA/A + 0.1 $\mu$ A 1.5 mA/A + 0.1 $\mu$ A 1.3 mA/A + 0.1 $\mu$ A 3 mA/A + 0.15 $\mu$ A 8 mA/A + 0.2 $\mu$ A 16 mA/A + 0.4 $\mu$ A	5522A 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	(0.33 to 3.3) mA		5522A Multi Product Calibrator
	(10 to 20) Hz	2 mA/A + 0.15 $\mu$ A	
	(20 to 45) Hz	1.3 mA/A + 0.15 $\mu$ A	
	45 Hz to 1 kHz	1 mA/A + 0.15 $\mu$ A	
	(1 to 5) kHz	2 mA/A + 0.2 $\mu$ A	
	(5 to 10) kHz	5.1 mA/A + 0.3 $\mu$ A	
	(10 to 30) kHz	10 mA/A + 0.6 $\mu$ A	
	(3.3 to 33) mA		
	(10 to 20) Hz	1.8 mA/A + 2 $\mu$ A	
	(20 to 45) Hz	910 $\mu$ A/A + 2 $\mu$ A	
	45 Hz to 1 kHz	423 $\mu$ A/A + 2 $\mu$ A	
	(1 to 5) kHz	813 $\mu$ A/A + 2 $\mu$ A	
	(5 to 10) kHz	2 mA/A + 3 $\mu$ A	
	(10 to 30) kHz	4.1 mA/A + 4 $\mu$ A	
	(33 to 330) mA		
	(10 to 20) Hz	1.8 mA/A + 20 $\mu$ A	
	(20 to 45) Hz	909 $\mu$ A/A + 20 $\mu$ A	
	45 Hz to 1 kHz	417 $\mu$ A/A + 20 $\mu$ A	
	(1 to 5) kHz	1 mA/A + 50 $\mu$ A	
	(5 to 10) kHz	2 mA/A + 100 $\mu$ A	
	(10 to 30) kHz	4.1 mA/A + 200 $\mu$ A	
	(0.33 to 1.1) A		
	(10 to 45) Hz	1.8 mA/A + 100 $\mu$ A	
	45 Hz to 1 kHz	512 $\mu$ A/A + 100 $\mu$ A	
	(1 to 5) kHz	6 mA/A + 1 mA	
	(5 to 10) kHz	25 mA/A + 5 mA	
	(1.1 to 3) A		
	(10 to 45) Hz	1.8 mA/A + 100 $\mu$ A	
45 Hz to 1 kHz	664 $\mu$ A/A + 100 $\mu$ A		
(1 to 5) kHz	6 mA/A + 1 mA		
(5 to 10) kHz	25 mA/A + 5 mA		
(3 to 11) A			
(45 to 100) Hz	1.8 mA/A + 100 $\mu$ A		
100 Hz to 1 kHz	664 $\mu$ A/A + 100 $\mu$ A		
(1 to 5) kHz	6 mA/A + 1 mA		
(11 to 20.5) A			
(45 to 100) Hz	1.2 mA/A + 5 mA		
100 Hz to 1 kHz	1.5 mA/A + 5 mA		
(1 to 5) kHz	30 mA/A + 5 mA		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance - Source <sup>1</sup>	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω 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 330 kΩ 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 330 MΩ to 1.1 GΩ	36 μΩ/Ω 26 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 24 μΩ/Ω 26 μΩ/Ω 26 μΩ/Ω 42 μΩ/Ω 110 μΩ/Ω 201 μΩ/Ω 400 μΩ/Ω 2.5 mΩ/Ω 12 mΩ/Ω	5522A Multi Product Calibrator
Resistance - Measure <sup>1</sup>	100 μΩ to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ	20 μΩ/Ω + 50 μΩ 17 μΩ/Ω + 5 μΩ 15 μΩ/Ω + 500 μΩ 15 μΩ/Ω + 5 mΩ 15 μΩ/Ω + 50 mΩ 20 μΩ/Ω + 2 Ω 83 μΩ/Ω + 100 Ω 820 μΩ/Ω + 1 kΩ	Keysight 3458A Multimeter
Capacitance – Source	10 Hz to 10 kHz (220 to 400) pF (0.4 to 1.1) nF 10 Hz to 3 kHz (1.1 to 3.3) nF 10 Hz to 1 kHz (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (10 to 600) Hz (0.33 to 1.1) μF (10 to 300) Hz (1.1 to 3.3) μF (10 to 150) Hz (3.3 to 11) μF	6.4 mF/F + 10 pF 5.3 mF/F + 10 pF 5.1 mF/F + 10 pF 2.6 mF/F + 10 pF 2.6 mF/F + 100 pF 2.6 mF/F + 100 pF 2.6 mF/F + 300 pF 2.6 mF/F + 1 nF 2.6 mF/F + 3 nF 2.6 mF/F + 10 nF	5522A Multi Product Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment		
Capacitance – Source	(10 to 120) Hz (11 to 33) $\mu$ F	4.1 mF/F + 30 nF	5522A Multi Product Calibrator		
	(10 to 80) Hz (33 to 110) $\mu$ F	4.7 mF/F + 0.1 $\mu$ F			
	(0 to 50) Hz (110 to 330) $\mu$ F	4.6 mF/F + 0.3 $\mu$ F			
	(0 to 20) Hz (0.33 to 1.1) mF	4.6 mF/F + 1 $\mu$ F			
	(0 to 6) Hz (1.1 to 3.3) mF	4.5 mF/F + 3 $\mu$ F			
	(0 to 2) Hz (3.3 to 11) mF	4.5 mF/F + 10 $\mu$ F			
	(0 to 0.6) Hz (11 to 33) mF	7.5 mF/F + 30 $\mu$ F			
	(0 to 0.2) Hz (33 to 110) mF	11 mF/F + 100 $\mu$ F			
	Electrical Simulation of Thermocouple Indicators <sup>1</sup>	Type B			5522A Multi Product Calibrator
		(600 to 800) °C		0.44 °C	
(800 to 1 000) °C		0.34 °C			
(1 000 to 1 550) °C		0.3 °C			
(1 550 to 1 820) °C		0.33 °C			
Type C					
(0 to 150) °C		0.3 °C			
(150 to 650) °C		0.26 °C			
(650 to 1 000) °C		0.31 °C			
(1 000 to 1 800) °C		0.5 °C			
(1 800 to 2 316) °C		0.84 °C			
Type E					
(-250 to -100) °C		0.5 °C			
(-100 to -25) °C		0.16 °C			
(-25 to 350) °C		0.14 °C			
(350 to 650) °C	0.16 °C				
(650 to 1 000) °C	0.21 °C				



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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 Indicators <sup>1</sup>	Type J		5522A Multi Product Calibrator
	(-210 to -100) °C	0.27 °C	
	(-100 to -30) °C	0.16 °C	
	(-30 to 150) °C	0.14 °C	
	(150 to 760) °C	0.17 °C	
	(760 to 1 200) °C	0.23 °C	
	Type K		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.16 °C	
	(120 to 1 000) °C	0.26 °C	
	(1 000 to 1 372) °C	0.4 °C	
	Type L		
	(-200 to -100) °C	0.37 °C	
	(-100 to 800) °C	0.26 °C	
	(800 to 900) °C	0.17 °C	
	Type N		
	(-200 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.22 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.27 °C	
	Type R		
	(0 to 250) °C	0.57 °C	
	(250 to 400) °C	0.35 °C	
	(400 to 1 000) °C	0.33 °C	
	(1 000 to 1 767) °C	0.4 °C	
	Type S		
(0 to 250) °C	0.47 °C		
(250 to 400) °C	0.36 °C		
(400 to 1 000) °C	0.37 °C		
(1 000 to 1 767) °C	0.46 °C		
Type T			
(-250 to -150) °C	0.63 °C		
(-150 to 0) °C	0.24 °C		
(0 to 120) °C	0.16 °C		
(120 to 400) °C	0.14 °C		
Type U			
(-200 to 0) °C	0.56 °C		
(0 to 600) °C	0.27 °C		





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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 <sup>1</sup>	Pt 385, 100 Ω		5522A Multi Product Calibrator
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.10 °C	
	(400 to 630) °C	0.12 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
(0 to 100) °C	0.04 °C		
(100 to 260) °C	0.05 °C		
(260 to 300) °C	0.12 °C		
(300 to 400) °C	0.13 °C		
(400 to 600) °C	0.14 °C		
(600 to 630) °C	0.16 °C		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD indicators <sup>1</sup>	Pt 385, 500 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	
	Pt 385, 1 000 Ω		
	(-200 to -80) °C	0.03 °C	
	(-80 to 0) °C	0.03 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.06 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.23 °C	
PtNi 385, 120 Ω (Ni120)			
(-80 to 0) °C	0.08 °C		
(0 to 100) °C	0.08 °C		
(100 to 260) °C	0.14 °C		
Cu 427, 10 Ω			
(100 to 260) °C	0.30 °C		
			5522A Multi Product Calibrator

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indicators <sup>1,2</sup>	(0.000 1 to 6) in	(8+3L) μin	Horizontal Measuring Machine
Calipers <sup>1,2</sup>	Up to 60 in	(5+8L) μin	Gage Blocks
Micrometers OD <sup>1,2</sup>	Up to 60 in Anvil Flatness	(5+8L) μin 4 μin	Gage Blocks Optical Parallels
Height Measuring Devices <sup>1,2</sup>	Up to 36 in (36 to 48) in	(45 + 2L) μin (7 + 3L) μin	Gage Blocks
External Diameter <sup>1,2</sup>	(0.000 1 to 6) in	(8+3L) μin	Horizontal Measuring Machine

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Internal Diameter <sup>1,2</sup>	(0.04 to 13) in	$(8+3L) \mu\text{in}$	Horizontal Measuring Machine
Thread Plugs <sup>1,2</sup> Pitch Diameter	Up to 8 in Pitch (0.2 to 5) mm	$(87 + 1.9L) \mu\text{in}$	Horizontal Measuring Machine
Major Diameter	Pitch 90 – 4 TPI Up to 4 in	$(8+3L) \mu\text{in}$	Thread Measuring Wires
Thread Rings (Adjustable) Pitch Diameter Tactile Fit (Set to Plug)	Up to 4 in	See footnote <sup>5</sup>	Thread Setting Plug
Optical Comparators <sup>1,2</sup> Linear Accuracy	Up to 6 in 6 to 12 in	$(43 + 11L) \mu\text{in}$ $(30 + 7.5L) \mu\text{in}$	Glass Scale
Magnification	5X to 100X	$350 \mu\text{in}$	Glass Scale (Sphere)
Surface Plates <sup>1,2</sup> Overall Flatness	Up to 238 inDL	$(25 + 2.9L) \mu\text{in}$	Laser System
Local Area Flatness	Up to 238 inDL	$34 \mu\text{in}$	Repeat-O-Meter
CMMs <sup>1,2</sup>	Linearity	$(25 + 2.4L) \mu\text{in}$	Laser Measuring System
VMMs <sup>1,2</sup>	Linearity	$(32 + 4.1L) \mu\text{in}$	Glass Scales
Horizontal Measuring Systems <sup>1,2</sup>	Up to 8 in of Travel (8 to 60) in	$(6 + 1.7L) \mu\text{in}$ $(3 + 2.5L) \mu\text{in}$	Gage Blocks
Feeler/Thickness Gages <sup>2</sup>	Up to 0.2 in	$(4.3 + 3L) \mu\text{in}$	Horizontal Measuring System
Indicator Calibrator <sup>2</sup> Linearity	Up to 6 in	$60 \mu\text{in} + 0.6R$	Horizontal Measuring System
Groove Micrometers <sup>2</sup>	Up to 12 in	$(44 + 2.6L) \mu\text{in} + 0.6R$	Gage Blocks
Microscopes, Stereo Reticle Linearity	Up to 2 in	$870 \mu\text{in}$	Stage Micrometer
Microscopes – Toolmakers <sup>2</sup> Scale Linearity	Up to 4 in	$(774 + 70L) \mu\text{in} + 0.6R$	Stage Micrometer
Length Standards <sup>2</sup>	(1 to 60) in	$(3.4 + 3.5L) \mu\text{in}$	Horizontal Measuring System

### Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers – Inside <sup>2</sup>	Up to 8 in 8 to 60 in	$(6 + 1.7L) \mu\text{in}$ $(3 + 2.5L) \mu\text{in}$	Horizontal Measuring System
Parallels <sup>2</sup> – Steel Granite	Up to 18 in	$(96.3 + 1.8L) \mu\text{in}$ $(48.6 + 0.7L) \mu\text{in}$	Electronic Amplifier with Probe, Surface Plate
Thickness Gages <sup>2</sup> - Dial Digital	Up to 1 in	$410 \mu\text{in} + 0.6R$ $44 \mu\text{in} + 0.6R$	Gage Blocks
Thread Micrometers <sup>2</sup> (Screw Thread, Pitch Point) Linearity Anvil Wear	Up to 12 in	$(44 + 2.6L) \mu\text{in} + 0.6R$ $690 \mu\text{in}$	Gage Blocks Thread Setting Plug

### Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force <sup>1</sup> Source	(0.035 to 16) ozf (1 to 10) lbf (10 to 50) lbf (50 to 500) lbf	0.018 % of reading + 0.21 $\mu\text{ozf}$ 0.018 % of reading + 0.33 $\mu\text{lbf}$ 0.018 % of reading + 9.3 mlbf 0.036 % of reading + 5.3 mlbf	Dead Weight
Pressure <sup>1</sup>	(-15 to 30) psig (0 to 1) inH <sub>2</sub> O (0.036 to 1) psig (0 to 100) psia (100 to 300) psig (300 to 1 000) psig (1 000 to 10 000) psig	19 mpsi 0.003 5 inH <sub>2</sub> O 1.3 mpsi 0.07 psi 0.12 psi 0.4 psi 4 psi	Pressure Calibrator
Torque Tools <sup>1</sup>	(5 to 50) lbf·in (50 to 400) lbf·in (400 to 1000) lbf·in (80 to 250) lbf·ft (250 to 600) lbf·ft (600 to 2 000) lbf·ft	0.33 % of reading 0.36 % of reading 0.4 % of reading 0.28 % of reading 0.51 % of reading 0.75 % of reading	Torque Tester
Torque Transducers <sup>1</sup>	0.5 ozf·in to 1 000 lbf·ft	0.08 % of reading	Dead Weight Torque Arms

### Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances <sup>1</sup>	(0 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 30) g (30 to 50) g (50 to 100) g (100 to 200) g (200 to 300) g 300 g to 1 kg (1 to 2) kg (2 to 3) kg	0.01 mg 0.034 mg 0.05 mg 0.074 mg 0.12 mg 0.25 mg 0.5 mg 0.75 mg 2.5 mg 5 mg 7.5 mg	Class 1 Weights
Scales and Balances <sup>1</sup>	(3 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 25) kg (25 to 30) kg	12 mg 25 mg 50 mg 62 mg 75 mg	Class 1 Weights
Scales and Balances <sup>1</sup>	(0.5 to 1 000) lb	0.01 % of reading	Class 6 Weights

### Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure <sup>1</sup>	(-20 to 100) °C (100 to 425) °C (425 to 500) °C	0.058 °C 0.069 °C 0.086 °C	Digital Temperature Gage
Humidity- Measure <sub>1</sub>	(10 to 40) %RH (40 to 90) %RH (90 to 100) %RH	1.1 %RH 1.3 %RH 1.9 %RH	Humidity Indicator

### Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source <sup>4</sup>	1 MHz	2.5 x 10 <sup>-5</sup> Hz	5522A Multi Product Calibrator

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%.<sup>17</sup>otes:

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. The use of (R) signifies the Resolution of the unit under test, the use of (L) represents Length in inches, the use of (D) represents Diameter in inches.
3. Uncertainties listed for Electromagnetic - DC/Low Frequency and RF/Microwave does not include possible contributions from a “best available” unit under test
4. Derivatives of 10MHz will have different uncertainties due to resolution, noise, and gating errors.
5. The tactile fit of an adjustable thread ring to a thread-setting plug is not a measurement of pitch diameter. The uncertainty for this pitch diameter setting is based on the contributors associated with the thread setting plug and environmental contributors only.
6. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1265.



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