



# CERTIFICATE OF ACCREDITATION

## ANSI-ASQ National Accreditation Board

500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

**Martin Calibration, Inc.**

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

**Burnsville MN 55337**

Including satellite locations located in: Mundelein, IL, Watertown, SD, and Eau Claire, WI  
has been assessed by ANAB  
and meets the requirements of international standard

**ISO/IEC 17025:2005**

and national standard

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

while demonstrating technical competence in the fields of

**CALIBRATION & TESTING**

Refer to the accompanying Scope of Accreditation for information regarding the types of tests &/or calibrations to which this accreditation applies.

ACT-1265

Certificate Number

  
ANAB Approval

Certificate Valid: 06/13/2018-07/06/2020  
Version No. 005 Issued: 06/13/2018



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. 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 17025:2005 AND ANSI/NCSL Z540-1-1994 (R2002)

Martin Calibration, Inc.

11965 12th Avenue South  
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CALIBRATION

Valid to: July 6, 2020

Certificate Number: ACT-1265

Acoustics and Vibration

Table with 4 columns: Parameter/Equipment, Range, Expanded Uncertainty of Measurement (+/-), Reference Standard, Method, and/or Equipment. Rows include Sound Level - Source and Accelerometers.

Chemical Quantities

Table with 4 columns: Parameter/Equipment, Range, Expanded Uncertainty of Measurement (+/-), Reference Standard, Method, and/or Equipment. Rows include Conductivity Meters and Refractometers.





**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters <sup>1</sup>	4, 7, 10 pH	0.072 pH 0.023 pH 0.18 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 $\mu$ 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	8.3 mV/V	Hipotronics KVM100-A High Voltage Meter
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 20) A (20 to 120) A	80 $\mu$ A/A + 800 $\mu$ A 80 $\mu$ A/A + 4 mA	Fluke 52120A Amplifier



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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 (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 (7 to 22) 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 570 μV/V + 1.3 μV 250 μV/V + 1.3 μV 140 μV/V + 1.3 μV 270 μV/V + 2 μV 400 μV/V + 2.5 μV 800 μV/V + 4 μV 870 μV/V + 8 μV 1.5 mV/V + 8 μV 190 μV/V + 1.3 μV 130 μV/V + 1.3 μV 73 μV/V + 1.3 μV 140 μV/V + 2 μV 210 μV/V + 2.5 μV 540 μV/V + 4 μV 590 μV/V + 8 μV 1.1 mV/V + 8 μV	Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure	(22 to 70) mV		Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator
	(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 $\mu\text{V/V} + 8 \mu\text{V}$	
	(220 to 700) mV		
	(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 $\mu\text{V/V}$		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure	(2.2 to 7) 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	16 $\mu$ V/V	
	(20 to 50) kHz	32 $\mu$ V/V	
	(50 to 100) kHz	54 $\mu$ V/V	
	(100 to 300) kHz	130 $\mu$ V/V	
	(300 to 500) kHz	270 $\mu$ V/V	
	(0.5 to 1) MHz	800 $\mu$ V/V	
	(7 to 22) V		
	(10 to 20) Hz	130 $\mu$ V/V	
	(20 to 40) Hz	45 $\mu$ V/V	
	(0.04 to 20) kHz	18 $\mu$ V/V	
	(20 to 50) kHz	32 $\mu$ V/V	
	(50 to 100) kHz	54 $\mu$ 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	
	(22 to 70) 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	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		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure	(220 to 700) V (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	130 $\mu$ V/V 66 $\mu$ V/V 27 $\mu$ V/V 87 $\mu$ V/V 330 $\mu$ V/V	Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator
AC Voltage – Source & Measure Flatness relative to 1 kHz	(0 to 2.2) mV (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 (2.2 to 7) mV (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 (7 to 22) mV (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 + 1.3 $\mu$ V 0.05 % of reading + 1.3 $\mu$ V 0.05 % of reading + 1.3 $\mu$ V 0.05 % of reading + 2.0 $\mu$ V 0.07 % of reading + 1 $\mu$ V 0.07 % of reading + 1 $\mu$ V 0.07 % of reading + 1 $\mu$ V 0.17 % of reading + 1 $\mu$ V 0.32 % of reading + 1 $\mu$ V 0.7 % of reading + 2 $\mu$ V 0.1 % of reading 0.05 % of reading 0.05 % of reading 0.05 % of reading 0.07 % of reading + 1 $\mu$ V 0.07 % of reading + 1 $\mu$ V 0.07 % of reading + 1 $\mu$ V 0.1 % of reading + 1 $\mu$ V 0.17 % of reading + 1 $\mu$ V 0.37 % of reading + 1 $\mu$ V 0.1 % of reading 0.05 % of reading 0.05 % of reading 0.05 % of reading 0.05 % of reading 0.07 % of reading 0.07 % of reading 0.07 % of reading 0.07 % of reading 0.1 % of reading 0.17 % of reading 0.37 % of reading	Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband)



<p>AC Voltage – Source &amp; Measure Flatness relative to 1 kHz</p>	(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	
	(70 to 220) mV		
	(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		
			Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband)





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 and Measure <sup>1</sup>	Up to 1 mA (DC to 30) kHz (30 to 100) kHz 1mA to 1A (DC to 100) kHz	90 µA/A 170 µA/A 35 µA/A	Fluke 5720A Multi Product Calibrator and Fluke 5725A Amplifier w/ A40B Shunts
AC Current – Source and Measure <sup>1</sup>	(1 to 20) A DC to 10 kHz (10 to 20) kHz (20 to 120) A (DC to 1) kHz (1 to 6) kHz	61 µA/A 130 µA/A 3 mA/A 12 mA/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 µA (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	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>	200 $\mu$ A to 2 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	
	(2 to 20) mA		
	(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 $\Omega$	3.5 $\mu\Omega/\Omega$	Standard resistors
	0.01 $\Omega$	4.3 $\mu\Omega/\Omega$	
	0.1 $\Omega$	1.5 $\mu\Omega/\Omega$	
	1 $\Omega$	0.85 $\mu\Omega/\Omega$	
	10 $\Omega$	0.66 $\mu\Omega/\Omega$	
	100 $\Omega$	1.7 $\mu\Omega/\Omega$	
	1 k $\Omega$	1.2 $\mu\Omega/\Omega$	
	10 k $\Omega$	0.8 $\mu\Omega/\Omega$	
	100 k $\Omega$	0.57 $\mu\Omega/\Omega$	
	1 M $\Omega$	1.3 $\mu\Omega/\Omega$	
	10 M $\Omega$	14 $\mu\Omega/\Omega$	
	100 M $\Omega$	130 $\mu\Omega/\Omega$	
	1 G $\Omega$	0.32 $\mu\Omega/\Omega$	
Resistance - Source <sup>1</sup>	(0.01 to 10) M $\Omega$ (0.01 to 10) G $\Omega$	10 $\mu\Omega/\Omega$ 0.5 %	Decade resistors with bridge and DMM
	(10 to 100) G $\Omega$	1.2 % of reading	Decade Resistor



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance - Measure <sup>1</sup> Normal Mode	(10 to 100) $\mu\Omega$ (0.1 to 1) m $\Omega$ (1 to 10) m $\Omega$ (10 to 100) m $\Omega$ (0.1 to 1) $\Omega$ (1 to 10) $\Omega$ (10 to 100) $\Omega$ (0.1 to 1) k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$ (0.1 to 1) M $\Omega$ (1 to 10) M $\Omega$	0.15 % of reading 15 $\mu\Omega/\Omega$ 5.1 $\mu\Omega/\Omega$ 1.8 $\mu\Omega/\Omega$ 0.92 $\mu\Omega/\Omega$ 0.74 $\mu\Omega/\Omega$ 1.7 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 2.4 $\mu\Omega/\Omega$ 1.1 $\mu\Omega/\Omega$ 8.2 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$	Decade resistors with bridge and DMM
Resistance - Measure <sup>1</sup> Normal Mode	(10 to 200) M $\Omega$ (0.2 to 2) G $\Omega$ (2 to 20) G $\Omega$	72 $\mu\Omega/\Omega$ + 1k $\Omega$ 0.18 m $\Omega/\Omega$ + 100 k $\Omega$ 0.67 m $\Omega/\Omega$ + 10 M $\Omega$	Decade resistors with bridge and DMM
Resistance - Measure <sup>1</sup> High Voltage Mode up to 200 V	(2 to 20) M $\Omega$ (20 to 200) M $\Omega$ 200 M $\Omega$ to 2 G $\Omega$ (2 to 20) G $\Omega$	15 $\mu\Omega/\Omega$ + 10 $\Omega$ 60 $\mu\Omega/\Omega$ + 1 k $\Omega$ 0.15 m $\Omega/\Omega$ + 100 k $\Omega$ 0.53 m $\Omega/\Omega$ + 10 M $\Omega$	Decade resistors with bridge and DMM
AC Resistance (Impedance)	(1, 500) kHz, 1 MHz 25 $\Omega$ 375 $\Omega$ (1, 250, 500) kHz, 1 MHz 6 k $\Omega$ (1, 25, 50) kHz 100 k $\Omega$	100 $\mu\Omega/\Omega$	AC Resistor Set
Capacitance - Measure <sup>1</sup>	1 pF @ 1 kHz 10 pF @ 1 kHz 100 pF @ 1kHz 1 nF 1kHz 1 $\mu$ F @ 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 $\mu$ F	1.8 mF/F 0.23 mF/F 0.25 mF/F 0.21 mF/F 0.25 mF/F	Standard Capacitors



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 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 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



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	
DC Voltage, 50 Ω	1 mV to 5 V	0.26 mV/V	
DC Voltage, 1 MΩ	1 mV to 200 V	0.25 mV/V	
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	
	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	
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	1.1 °C 0.85 °C 0.67 °C 0.52 °C 0.43 °C 0.33 °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 C		Ectron 1140A Thermocouple Simulator
	(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	
	Type E		
	(-270 to -245) °C	1.38 °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	0.1 °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		



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 R		Ectron 1140A Thermocouple Simulator
	(-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		
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	



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 3916 100 Ω		Fluke 5520A Multi Product Calibrator
	(-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	
	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		





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 3916 100 Ω		Fluke 5520A Multi Product Calibrator
	(-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	
	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		



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 9 kHz to 6 GHz (20 to 30) dBm (6 to 18) GHz (18 to 26.5) GHz	0.16 dB 0.44 dB 0.50 dB	Agilent E9304A/N1912A Agilent N5531S Measuring Receiver with N5532A Sensor Module
RF Power - Measure Absolute Level <sup>1</sup>	(-20 to 20) dBm 100 kHz to 30 MHz 30 MHz to 2 GHz (1 to 18) GHz (18 to 26.5) GHz	0.2 dB 0.21 dB 0.31 dB 0.4 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Module
RF Power - Measure Absolute Level <sup>1</sup>	(-30 to 20) dBm 100 kHz to 30 MHz	3.1 % of reading	Agilent N5531S Measuring Receiver with 8482A Sensor
Relative Power - Measure <sup>1</sup> 100 kHz to 26.5 GHz	(-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (-100 to -90) dB (-110 to -100) dB (-120 to -110) dB (-130 to -120) dB (-140 to -130) dB	0.02 dB 0.03 dB 0.03 dB 0.05 dB 0.06 dB 0.06 dB 0.07 dB 0.07 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 dBm 1 dBm 1.2 dBm 0.72 dBm 1 dBm 1.2 dBm 1.4 dBm 1.3 dBm 1.3 dBm	Agilent N5183A Signal Generator



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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 dBm 0.91 dBm 0.93 dBm 0.63 dBm 0.92 dBm 1 dBm	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
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
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



Electrical – RF/Microwave

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



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			
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	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
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	
(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	
(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 Blocks	(0.25 to 60) °	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
Coating Thickness Gages <sup>1,2</sup>	Up to 0.02 in	58 µin + 0.6R	Coating Thickness Standards
Coating Thickness Gage Standards	Up to 0.10 in	21 µin	Horizontal Measuring Machine
External Diameter <sup>1,2</sup>	(0.0001 to 12) in	(3 + 3L) µin	Horizontal Measuring Machine
Internal Diameter <sup>1,2</sup>	(0.04 to 13) in	(3 + 3L) µin	Horizontal Measuring Machine
Thread Plugs <sup>1,2</sup> Pitch Diameter	Up to 8 in Pitch (0.2 to 5) mm	(87 + 1.9L) µin	Horizontal Measuring Machine
Major Diameter	Pitch 90 – 4 TPI Up to 4 in	(3.5 + 4.6L) µin	Thread Measuring Wires
Thread Rings	Up to 4 in	160 µin	Thread Setting Plug



Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Comparators <sup>1,2</sup> Linear Accuracy	Up to 6 in 6 to 12 in	(43 + 11L) μin (30 + 7.5L) μin	Glass Scale
Magnification	(5 to 100) X	350 μin	Glass Scale (Sphere)
Surface Plates <sup>1,2</sup> Overall Flatness	Up to (168 by 168) in	(25 + 2.9L) μin	Laser System
Local Area Flatness	Up to (168 by 168) in	34 μin	Repeat-O-Meter
Roundness/Cylindricity	Up to 150 mm	0.02 μm	Rondcom41c
Surface Finish Analysis	Up to 500 μin	2.4 μin	Profilometer, Master Patch
Profilometers <sup>1</sup>	Up to 500 μin	3.1 μin	Master Patch
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
Bore Gages <sup>2</sup> 2-point	(0.24 to 9) in	(4.3 + 3L) μin + 0.6R	Horizontal Measuring Machine
3-point		(85 + 7L) μin + 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 μin + 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 μm	Roundness Machine



Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Feeler/Thickness Gages <sup>2</sup>	Up to 0.2 in	(4.3 + 3L) μin	Horizontal Measuring System
Gage Amplifier w/ Probe(s)	Up to 0.1 in	10 μin	Gage Blocks
Gage Balls/Spheres <sup>2</sup> - Diameter	Up to 6 in	(4.3 + 3D) μin	Gage Blocks, Horizontal Measuring System
Roundness		0.02 μm	Roundness Machine
Indicator Calibrator <sup>2</sup> - Linearity	Up to 6 in	60 μin + 0.6R	Horizontal Measuring System
Groove Micrometers <sup>2</sup>	Up to 12 in	(44 + 2.6L) μin + 0.6R	Gage Blocks
Machinist Levels <sup>2</sup> – Zero Check Linearity	Up to 24 in	350 μin (100 + 0.83L) μin	Master Level Gage Blocks
Microscopes, Stereo Reticle Linearity	Up to 2 in	870 μin	Stage Micrometer
Microscopes - Toolmakers <sup>2</sup> Scale Linearity	Up to 4 in	(774 + 70L) μin + 0.6R	Stage Micrometer
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
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





Length – Dimensional metrology

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



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
	(350 to 100 000) lb	0.09 % of applied value	Load Cells, Class AA
	(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 μin + 146L) μin	Indicator Indicator/Gage Blocks
Extensometers <sup>1</sup>	up to 2 in	220 μin	Extensometer Calibrator
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 (-14.7 to 300) psi (300 to 1 000) psi (1 000 to 10 000) psi	0.001 8 psi 65 μpsi/psi + 6e <sup>-4</sup> inch H <sub>2</sub> O 65 μpsi/psi 0.12 % of reading	Pressure Calibrator
Pressure	(1 to 500) psi (500 to 10,000) psi (300 to 16 000) psi	60 μpsi/psi 70 μpsi/psi 0.03 % of reading	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 1 000 lbf·ft	0.86 % 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



Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pipettes	up to 1 $\mu\text{L}$ (1 to 5) $\mu\text{L}$ (5 to 10) $\mu\text{L}$ (10 to 20) $\mu\text{L}$ (20 to 50) $\mu\text{L}$ (50 to 100) $\mu\text{L}$ (100 to 200) $\mu\text{L}$ (200 to 500) $\mu\text{L}$ (500 to 1 000) $\mu\text{L}$ (1 000 to 10 000) $\mu\text{L}$	0.041 $\mu\text{L}$ 0.033 $\mu\text{L}$ 0.028 $\mu\text{L}$ 0.034 $\mu\text{L}$ 0.046 $\mu\text{L}$ 0.061 $\mu\text{L}$ 0.27 $\mu\text{L}$ 0.30 $\mu\text{L}$ 0.79 $\mu\text{L}$ 2.7 $\mu\text{L}$	Pipette Calibration System
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
	(0.5 to 2 000) lb	0.01 % of reading	Class 6 Weights
Mass	1 mg to 5 g (5 to 50) g (50 to 100) g (100 to 250) g (250 to 500) g (500 to 1 kg (1 to 6) kg (6 to 25) kg	0.04 mg 0.04 mg 0.04 mg 0.12 mg 0.17 mg 0.9 mg 9 mg 90 mg	Class 1 Weights
Microindentation Hardness Testers <sup>1</sup> (Knoop and Vickers)	Repeatability under forces (gf): $100 \leq \text{HK} \leq 500$ HV = 100	2.1 % of Reading 4.1 % of Reading	Indirect Verification to Test Blocks



Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Brinell Hardness Testers <sup>1</sup>	Repeatability at: 500 kgf ≤ 100 HBW ≥ 64 HBW 1 500 kgf ≤ 257 HBW ≥ 91 HBW 3 000 kgf ≤ 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
Rockwell Hardness Testers <sup>1</sup>	HRA Low HRA Middle HRA High  HRBW Low HRBW Middle HRBW High  HRC Low HRC Middle HRC High  HREW Low HREW Middle HREW High  HRMW Low HRMW Middle HRMW High	1.6 HRA 1.6 HRA 1.2 HRA  1.6 HRBW 2.1 HRBW 1.6 HRBW  1.6 HRC 1.6 HRC 1.2 HRC  1.6 HREW 1.6 HREW 1.6 HREW  1.6 HRMW 1.6 HRMW 1.6 HRMW	Indirect Verification to Test Blocks
Rockwell Superficial Hardness Testers <sup>1</sup>	HR15N Low HR15N Middle HR15N High  HR15TW Low HR15TW Middle HR15TW High  HR30N Low HR30N Middle HR30N High	1.7 HR15N 1.6 HR15N 1.3 HR15N  1.6 HR15TW 1.6 HR15TW 1.6 HR15TW  1.6 HR30N 1.6 HR30N 1.4 HR30N	Indirect Verification to Test Blocks



Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Superficial Hardness Testers <sup>1</sup>	HR30TW Low HR30TW Middle HR30TW High  HR45N Low HR45N Middle HR45N High	1.6 HR30TW 1.6 HR30TW 1.6 HR30TW  1.6 HR45N 1.6 HR45N 1.6 HR45N	Indirect Verification to Test Blocks
Durometers Spring Force Types A, B, E, O Types C, D, and DO Types OO, OOO, OOO-S  Indenter Angle Indenter Length Indenter Radius	(1.3 to 8.05) N (4.445 to 44.5) N (0.294 to 1.932) N  (20 to 40) ° (0.049 to 0.198) in (0.05 to 0.1) in	0.023 N 0.06 N 0.002 N  0.004 ° 220 μin 250 μin	Shore Durometer Calibrator Balance  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 $\lambda = (8 \text{ to } 14) \mu\text{m}$ , $\epsilon = 0.95$



**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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

**TESTING**

**Dimensional**

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Inspection Contact	(18 x 20 x 12) in	$(163 + 4.8L) \mu\text{in}$	Coordinate Measuring Machine
Non-contact	(12 x 8 x 4) in	$(44 + 1L) \mu\text{in}$	Vision System



**Services performed at satellite laboratory**

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**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters <sup>1</sup>	4, 7, 10 pH	0.017 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



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





Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	(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	
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



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) A 10 Hz to 2 kHz (2 to 10) kHz	1 mA/A 2.7 mA/A	Fluke 8508A Multimeter
Resistance - Source <sup>1</sup>	0.001 Ω 0.01Ω 0.1 Ω 1Ω 10Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ	3.5 μΩ/Ω 4.3 μΩ/Ω 1.5 μΩ/Ω 0.85 μΩ/Ω 0.66 μΩ/Ω 1.7μΩ/Ω 1.2 μΩ/Ω 2.4 μΩ/Ω 0.57 μΩ/Ω 1.3 μΩ/Ω Ω 14 μΩ/Ω 130 μΩ/Ω 0.32 μΩ/Ω	Standard resistors
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 (0.1 to 1) mΩ (1 to 10) mΩ (10 o 100) mΩ (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (0.01 to 1) kΩ (1 to 10) kΩ (10 o 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	0.15 % of reading 15 μΩ/Ω 5.1 μΩ/Ω 1.8 μΩ/Ω 0.92 μΩ/Ω 0.74 μΩ/Ω 1.7 μΩ/Ω 1.3 μΩ/Ω 2.4 μΩ/Ω 1.1 μΩ/Ω 8.2 μΩ/Ω 21μΩ/Ω 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



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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 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

**Electrical – DC/Low Frequency**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
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
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	
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	
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 (300 to 550) MHz	43 mV/V 43 mV/V	
	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	
Time Marker 50 Ω Source and Period		0.25 μs/s	
Rise/Fall Time - Source	9 ns to 55 s	27 ps	
Pulse Width - Source	150 ps	52 ms/s	
	(1 to 100) ns		



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	
	Type E		
	(-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		



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 N		Ectron 1140A Thermocouple Simulator
	(-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		
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	



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 3926 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	
	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		
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		



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 3926 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	
	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	
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		





**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>	Cu 427 10 Ω (-100 to 260) °C	0.35 °C	Fluke 5520A Multi Product Calibrator

**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>	(0.0001 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
Coating Thickness Gages <sup>1,2</sup>	Up to 0.02 in	58 μin + 0.6R	Coating Thickness Standards
Coating Thickness Gage Standards	Up to 0.10 in	21 μin	Horizontal Measuring Machine
External Diameter <sup>1,2</sup>	(0.0001 to 12) in	(3 + 3L) μin	Horizontal Measuring Machine
Internal Diameter <sup>1,2</sup>	(0.04 to 13) in	(3 + 3L) μin	Horizontal Measuring Machine
Thread Rings	Up to 4 in	160 μin	Thread Setting Plug



Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plugs <sup>1,2</sup> Pitch Diameter	Up to 8 in Pitch (0.2 to 5) mm	(87 + 1.9L) μin	Horizontal Measuring Machine
Major Diameter	Pitch 90 – 4 TPI Up to 4 in	(3.5 + 4.6L) μin	Thread Measuring Wires
Optical Comparators <sup>1,2</sup> Linear Accuracy	Up to 6 in 6 to 12 in	(43 + 11L) μin (30 + 7.5L) μin	Glass Scale
Magnification	(5 to 100) X	350 μin	Glass Scale (Sphere)
Surface Plates <sup>1,2</sup> Overall Flatness	Up to (168 by 168) in	(25 + 2.9L) μin	Laser System
Local Area Flatness	Up to (168 by 168) in	34 μin	Repeat-O-Meter
Surface Finish Analysis	Up to 500 μin	2.4 μin	Profilometer, Master Patch
Profilometers <sup>1</sup>	Up to 500 μin	3.1 μin	Master Patch
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
	(350 to 100 000) lb	0.09 % of applied value	Load Cells, Class AA
	(30 000 to 400 000) lb	0.29 % of applied value	Load Cells, Class A (compression only)
Pressure <sup>1</sup>	(-14.7 to 300) psi (300 to 1 000) psi (1 000 to 10 000) psi	65 μpsi/psi + 6e <sup>-4</sup> inch H <sub>2</sub> O 65 μpsi/psi 0.12 % of reading	Pressure Calibrator
Torque Tools <sup>1</sup>	0.5 ozf-in to 1 000 lbf-ft	0.86 % 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 at: 500kgf ≤ 100 HBW ≥ 64 HBW 1 500kgf ≤ 257 HBW ≥ 91 HBW	0.025 mm 0.025 mm 0.025 mm 0.03 mm	Indirect Verification to Test Blocks



Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Brinell Hardness Testers <sup>1</sup>	Repeatability at: 3 000kgf ≤ 587 HBW ≥ 186 HBW	0.025 mm 0.025 mm	Indirect Verification to Test Blocks
Rockwell Hardness Testers <sup>1</sup>	HRA Low HRA Middle HRA High  HRBW Low HRBW Middle HRBW High  HRC Low HRC Middle HRC High  HREW Low HREW Middle HREW High  HRMW Low HRMW Middle HRMW High	1.6 HRA 1.6 HRA 1.2 HRA  1.6 HRBW 2.1 HRBW 1.6 HRBW  1.6 HRC 1.6 HRC 1.2 HRC  1.6 HREW 1.6 HREW 1.6 HREW  1.6 HRMW 1.6 HRMW 1.6 HRMW	Indirect Verification to Test Blocks
Rockwell Superficial Hardness Testers <sup>1</sup>	HR15N Low HR15N Middle HR15N High  HR15TW Low HR15TW Middle HR15TW High  HR30N Low HR30N Middle HR30N High  HR30TW Low HR30TW Middle HR30TW High	1.7 HR15N 1.6 HR15N 1.3 HR15N  1.6 HR15TW 1.6 HR15TW 1.6 HR15TW  1.6 HR30N 1.6 HR30N 1.4 HR30N  1.6 HR30TW 1.6 HR30TW 1.6 HR30TW	Indirect Verification to Test Blocks



**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Superficial Hardness Testers <sup>1</sup>	HR45N Low HR45N Middle HR45N High	1.6 HR45N 1.6 HR45N 1.6 HR45N	Indirect Verification to Test Blocks
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



**Services performed at satellite laboratory**

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**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters <sup>1</sup>	(25 to 2 060) $\mu$ S	0.25 % of reading	Conductivity Standards
Refractometers	10.00 Brix 40.00 Brix	0.19 Brix 0.15 Brix	Distilled Water Calibration Oils
pH Meters <sup>1</sup>	4, 7, 10 pH	0.017 pH	Buffer Solutions

**Length – Dimensional metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Blocks <sup>2</sup>	(0.25 to 60) °	0.019 °	Gage Blocks, Gage Amplifier, Sine Bar
Angle Plates - Squareness <sup>2</sup>	Up to 18 in	(96 + 2.8L) $\mu$ in	Gage Amplifier with probe, Master Square(s)
Gage Blocks <sup>2</sup>	(0.01 to 1) in (1 to 2) in 4 in	(1.4 + 1.3L) $\mu$ in (1 + 1.3L) $\mu$ in 9.4 $\mu$ in	Gage Blocks Gage Block Comparator
	(5 to 12) in (12 to 20) in	(5 + 2L) $\mu$ in (2 + 2.8L) $\mu$ in	Horizontal Measuring Machine
	100 mm (125 to 500) mm	0.17 $\mu$ m (0.06 + 0.000 6L) $\mu$ m	Comparison to Primary Master Gage Blocks
Indicators <sup>1,2</sup>	(0.0001 to 6) in	(5+8L) $\mu$ in	Horizontal Measuring Machine
Calipers <sup>1,2</sup>	Up to 60 in	(5+8L) $\mu$ in	Gage Blocks
Micrometers OD <sup>1,2</sup>	Up to 12 in	(5+8L) $\mu$ in	Gage Blocks, Optical Parallels
Height Measuring Devices <sup>1,2</sup>	Up to 36 in (36 to 48) in	(45 + 2L) $\mu$ in (7 + 3L) $\mu$ in	Gage Blocks



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 μin + 0.6R	Coating Thickness Standards
Coating Thickness Gage Standards	Up to 0.10 in	21 μin	Horizontal Measuring Machine
External Diameter <sup>1,2</sup>	(0.0001 to 12) in	(3 + 3L) μin	Horizontal Measuring Machine
Internal Diameter <sup>1</sup>	(0.04 to 13) in	(3 + 3L) μin	Horizontal Measuring Machine
Thread Plugs <sup>1,2</sup> Pitch Diameter	Up to 8 in Pitch (0.2 to 5) mm	(87 + 1.9L) μin	Horizontal Measuring Machine
Major Diameter	Pitch 90 – 4 TPI Up to 4 in	(3.5 + 4.6L) μin	Thread Measuring Wires
Thread Rings	Up to 4 in	160 μin	Thread Setting Plug
Optical Comparators <sup>1,2</sup> Linear Accuracy	Up to 6 in 6 to 12 in	(43 + 11L) μin (30 + 7.5L) μin	Glass Scale
Magnification	(5 to 100) X	350 μin	Glass Scale (Sphere)
Surface Plates <sup>1,2</sup> Overall Flatness	Up to (168 by 168) in	(25 + 2.9L) μin	Laser System
Local Area Flatness	Up to (168 by 168) in	34 μin	Repeat-O-Meter
Profilometers <sup>1</sup>	Up to 500 μin	3.1 μin	Master Patch
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</sup>	Up to 8 in 8 to 60 in	(6 + 1.7L) μin (3 + 2.5L) μin	Gage Blocks
Bore Gages <sup>2</sup> 2-point	(0.24 to 9) in	(4.3 + 3L) μin + 0.6R	Horizontal Measuring Machine
3-point		(85 + 7L) μin + 0.6R	Cylindrical Rings
Protractors	(0 to 90) °	0.16 °	Sine Bar, Gage Blocks

**Length – Dimensional metrology**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Chamfer Gages <sup>2</sup>	(0.179 to 2.749) in	280 μin + 0.6R	Chamfer Rings
Feeler/Thickness Gages <sup>2</sup>	Up to 0.2 in	(4.3 + 3L) μin	Horizontal Measuring System
Gage Amplifier w/ Probe(s)	Up to 0.1 in	10 μin	Gage Blocks
Indicator Calibrator <sup>2</sup> - Linearity	Up to 6 in	60 μin + 0.6R	Horizontal Measuring System
Groove Micrometers <sup>2</sup>	Up to 12 in	(44 + 2.6L) μin + 0.6R	Gage Blocks
Microscopes, Stereo Reticle Linearity	Up to 2 in	870 μin	Stage Micrometer
Microscopes - Toolmakers <sup>2</sup> Scale Linearity	Up to 4 in	(774 + 70L) μin + 0.6R	Stage Micrometer
Micrometers - Inside <sup>2</sup>	Up to 8 in 8 to 60 in	(6 + 1.7L) μin (3 + 2.5L) μin	Horizontal Measuring System
Length Standards <sup>2</sup>	(1 to 60) in	(3.4 + 3.5L) μin	Horizontal Measuring System
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 Standards <sup>2</sup> Length	(1 to 65) in	(3.4 + 3.5L) μin	Horizontal Measuring System
Angle	60 °	0.18 °	Vision System
Radius Gages	(0.015625 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 - Granite Steel	Up to 18 in	(14 + 4.5L) μin (96 + 2.8L) μin	Electronic Amplifier with Probe, Master Square





**Length – Dimensional metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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
Tapered Rings - Pitch Diameter	(0.0625 to 6) in	160 μin	NPT Master Plug, Electronic Amplifier with Probe
Step Height		5 μin	Height Gage
Thickness Gages <sup>2</sup> - Dial Digital	Up to 1 in	410 μin + 0.6R 44 μin+ 0.6R	Gage Blocks
Thread Micrometers <sup>2</sup> (Screw Thread, Pitch Point)	Up to 12 in	(44 + 2.6L) μin + 0.6R	Gage Blocks Thread Setting Plug
Linearity Anvil Wear		690 μin	
Granite V Blocks <sup>2</sup> - Side Parallelism V Parallelism Squareness	Up to 12 in	(51 + 0.47L) μin	Electronic Amplifier with Probe, Surface Plate

**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
	(350 to 100 000) lb	0.09 % of applied value	Load Cells, Class AA
	(30 000 to 400 000) lb	0.29 % of applied value	Load Cells, Class A (compression only)
Pressure <sup>1</sup>	(-14.7 to 300) psi (300 to 1 000) psi (1 000 to 10 000) psi	65 μpsi/psi + 6e <sup>-4</sup> inch H <sub>2</sub> O 65 μpsi/psi 0.12 % of reading	Pressure Calibrator



**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 1 000 lbf·ft	0.86 % 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

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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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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 (0.33 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1 020) V	60 $\mu$ V/V + 3 $\mu$ V 50 $\mu$ V/V + 5 $\mu$ V 50 $\mu$ V/V + 50 $\mu$ V 55 $\mu$ V/V + 500 $\mu$ V 55 $\mu$ V/V + 1 500 $\mu$ V	5500A Multi Product Calibrator
DC Voltage - Measure <sup>1</sup>	(Up to 100) mV (100 to 1 000) mV (1 to 10) V (10 to 100) V (100 to 1 000) V	58 $\mu$ V/V + 3.5 $\mu$ V 46 $\mu$ V/V + 7 $\mu$ V 40 $\mu$ V/V + 50 $\mu$ V 52 $\mu$ V/V + 600 $\mu$ V 52 $\mu$ V/V + 10 mV	6.5 Digit DMM
DC Current - Source <sup>1</sup>	(Up to 3.3) mA (3.3 to 33) mA (33 to 330) mA (330 to 2200) mA (2.2 to 11) A	100 $\mu$ A/A + 39 nA 78 $\mu$ A/A + 190 nA 78 $\mu$ A/A + 2.6 $\mu$ A 230 $\mu$ A/A + 34 $\mu$ A 470 $\mu$ A/A + 260 $\mu$ A	5500A Multi Product Calibrator
DC Current – Measure <sup>1</sup>	Up to 10 mA (10 to 100) mA (100 to 1 000) mA (1 to 3) A	580 $\mu$ A/A + 2 $\mu$ A 580 $\mu$ A/A + 5 $\mu$ A 1.2 mA/A + 100 $\mu$ A 1.4 mA/A + 600 $\mu$ A	6.5 Digit DMM
DC Power – Source	109 $\mu$ W to 336 W (336 to 918) W (0.918 to 2.24) kW (2.24 to 4.59) kW (4.59 to 11.2) kW	0.23 mW/W 0.54 mW/W 0.47 mW/W 0.93 mW/W 0.7 mW/W	Fluke 5500A Multi Product Calibrator
AC Power - Source (45 to 65) Hz	109 $\mu$ W to 2.97 mW 1.09 mW to 9.18 W 297 $\mu$ W to 10.9 mW 2.97 mW to 33.66 W (1.09 to 29.7) mW 10.9 mW to 91.8 W (2.97 to 108.9) mW 29.7 mW to 336.6 W	1.4 mW/W 1.2 mW/W 1.1 mW/W 0.8 mW/W 1.4 mW/W 1.2 mW/W 1 mW/W 0.8 mW/W	Fluke 5500A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source and Measure	(1 to 33) mV	0.35 % of reading + 20 $\mu$ V	Fluke 5500A Multi Product Calibrator and DMM
	(10 to 45) Hz	0.15 % of reading + 20 $\mu$ V	
	45 Hz to 10 kHz	0.2 % of reading + 20 $\mu$ V	
	(10 to 20) kHz	0.25 % of reading + 20 $\mu$ V	
	(20 to 50) kHz	0.35 % of reading + 20 $\mu$ V	
	(50 to 100) kHz	1 % of reading + 20 $\mu$ V	
	(100 to 500) kHz		
	(33 to 330) mV	0.25 % of reading + 50 $\mu$ V	
	(10 to 45) Hz	0.05 % of reading + 20 $\mu$ V	
	45 Hz to 10 kHz	0.1 % of reading + 20 $\mu$ V	
	(10 to 20) kHz	0.19 % of reading + 40 $\mu$ V	
	(20 to 50) kHz	0.24 % of reading + 170 $\mu$ V	
	(50 to 100) kHz	0.7 % of reading + 330 $\mu$ V	
	(100 to 500) kHz		
330 mV to 3.3 V	0.15 % of reading + 250 $\mu$ V		
(10 to 45) Hz	0.03 % of reading + 60 $\mu$ V		
45 Hz to 10 kHz	0.08 % of reading + 60 $\mu$ V		
(10 to 20) kHz	0.14 % of reading + 300 $\mu$ V		
(20 to 50) kHz	0.24 % of reading + 1.7 mV		
(50 to 100) kHz	0.5 % of reading + 3.3 mV		
(100 to 500) kHz			
(3.3 to 33) V	0.15 % of reading + 2.5 mV		
(10 to 45) Hz	0.045 % of reading + 0.6 mV		
45 Hz to 10 kHz	0.083 % of reading + 2.6 mV		
(10 to 20) kHz	0.2 % of reading + 5 mV		
(20 to 50) kHz	0.24 % of reading + 17 mV		
(50 to 100) kHz			
(33 to 330) V	0.21 % of reading + 6.6 mV		
45 Hz to 1 kHz	0.22 % of reading + 15 $\mu$ V		
(1 to 10) kHz	0.22 % of reading + 33 $\mu$ V		
(10 to 20) kHz			
AC Voltage – Source and Measure	(330 to 1 020) V	0.21 % of reading + 80 mV	Fluke 5500A Multi Product Calibrator and DMM
	45 Hz to 1 kHz	0.28 % of reading + 0.1 mV	
	(1 to 10) kHz	0.29 % of reading + 0.5 mV	
	(5 to 10) kHz		

**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 to 330) $\mu$ A		Fluke 5500A Multi Product Calibrator and DMM
	(10 to 20) Hz	0.25 % of reading + 0.15 $\mu$ A	
	(20 to 45) Hz	0.13 % of reading + 0.15 $\mu$ A	
	45 Hz to 1 kHz	0.13 % of reading + 0.25 $\mu$ A	
	(1 to 5) kHz	0.4 % of reading + 0.15 $\mu$ A	
	(5 to 10) kHz	1.3 % of reading + 0.15 $\mu$ A	
	330 $\mu$ A to 3.3 mA		
	(10 to 20) Hz	0.2 % of reading + 0.3 $\mu$ A	
	20 Hz to 1 kHz	0.1 % of reading + 0.3 $\mu$ A	
	(1 to 5) kHz	0.1 % of reading + 0.3 $\mu$ A	
	(5 to 10) kHz	0.2 % of reading + 0.3 $\mu$ A	
	(3.3 to 33) mA		
	(10 to 20) Hz	0.2 % of reading + 3 $\mu$ A	
	(20 to 45) Hz	0.1 % of reading + 3 $\mu$ A	
	45 Hz to 1 kHz	0.1 % of reading + 3 $\mu$ A	
	(1 to 5) kHz	0.2 % of reading + 3 $\mu$ A	
	(5 to 10) kHz	0.6 % of reading + 3 $\mu$ A	
	(33 to 330) mA		
	(10 to 20) Hz	0.2 % of reading + 30 $\mu$ A	
	(20 to 45) Hz	0.1 % of reading + 30 $\mu$ A	
	45 Hz to 1 kHz	0.09 % of reading + 30 $\mu$ A	
(1 to 5) kHz	0.2 % of reading + 30 $\mu$ A		
(5 to 10) kHz	0.6 % of reading + 30 $\mu$ A		
330 mA to 2.2 A			
(10 to 45) Hz	0.2 % of reading + 300 $\mu$ A		
45 Hz to 1 kHz	0.1 % of reading + 300 $\mu$ A		
(1 to 5) kHz	0.8 % of reading + 300 $\mu$ A		
(2.2 to 11) A			
(45 to 65) Hz	0.07 % of reading + 2 mA		
(65 to 500) Hz	0.1 % of reading + 2 mA		
500 Hz to 1 kHz	0.34 % of reading + 2 mA		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance - Source <sup>1</sup>	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω (0.33 to 1.1) M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω	0.013 % of reading + 0.008 Ω 0.013 % of reading + 0.015 Ω 0.01 % of reading + 0.008 Ω 0.01 % of reading + 0.008 Ω 0.093 % of reading + 0.06 Ω 0.093 % of reading + 0.06 Ω 0.093 % of reading + 0.6 Ω 0.093 % of reading + 0.6 Ω 0.012 % of reading + 6 Ω 0.013 % of reading + 6 Ω 0.016 % of reading + 55 Ω 0.016 % of reading + 55 Ω 0.061 % of reading + 550 Ω 0.11 % of reading + 550 Ω 0.5 % of reading + 5.5 k Ω 0.5 % of reading + 17 k Ω	Fluke 5500A Multi Product Calibrator
Resistance - Measure <sup>1</sup>	(0 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 1 kΩ to 1 MΩ 100 Ω 10 MΩ 100 MΩ	0.01 % of reading + 0.004 % rng 0.01 % of reading + 0.001 % rng 0.01 % of reading + 0.001 % rng 0.01 % of reading + 0.001 % rng 0.01 % of reading + 0.001 % rng 0.04 % of reading + 0.001 % rng 0.8 % of reading + 0.01 % rng 0.01 % of reading + 0.001 % rng 0.01 % of reading + 0.004 % rng 0.04 % of reading + 0.001 % rng 0.8 % of reading + 0.01 % rng	Agilent 34401A Multimeter
Capacitance – Source (50 Hz to 1 kHz)	(0.33 to 11) nF (11 to 110) nF (110 to 330) nF (0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF (0.33 to 1.1) mF	0.51 % of reading + 0.01 nF 0.27 % of reading + 0.1 nF 0.27 % of reading + 0.3 nF 0.27 % of reading + 1 nF 0.38 % of reading + 3 nF 0.38 % of reading + 10 nF 0.45 % of reading + 30 nF 0.52 % of reading + 100 nF 0.74 % of reading + 300 nF 0.3 % of reading + 300 nF	Fluke 5500A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators <sup>1</sup>	Type B		Fluke 5500A Multi Product Calibrator
	(600 to 800) °C	0.35 °C	
	(800 to 1000) °C	0.27 °C	
	(1000 to 1550) °C	0.24 °C	
	(1550 to 1820) °C	0.26 °C	
	Type C		
	(0 to 150) °C	0.24 °C	
	(150 to 650) °C	0.21 °C	
	(650 to 1000) °C	0.25 °C	
	(1000 to 1800) °C	0.39 °C	
	(1800 to 2316) °C	0.65 °C	
	Type E		
	(-250 to -100) °C	0.53 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 350) °C	0.12 °C	
	(350 to 650) °C	0.14 °C	
	(650 to 1000) °C	0.17 °C	
	Type J		
	(-210 to -100) °C	0.22 °C	
	(-100 to -30) °C	0.14 °C	
	(-30 to 150) °C	0.12 °C	
	(150 to 760) °C	0.14 °C	
	(760 to 1200) °C	0.19 °C	
	Type K		
	(-200 to -100) °C	0.26 °C	
	(-100 to -25) °C	0.15 °C	
	(-25 to 120) °C	0.13 °C	
	(120 to 1000) °C	0.21 °C	
(1000 to 1372) °C	0.33 °C		
Type N			
(-200 to -100) °C	0.31 °C		
(-100 to -25) °C	0.18 °C		
(-25 to 120) °C	0.16 °C		
(120 to 410) °C	0.15 °C		
(410 to 1300) °C	0.22 °C		
Type R			
(0 to 250) °C	0.45 °C		
(250 to 400) °C	0.28 °C		
(400 to 1000) °C	0.26 °C		
(1000 to 1767) °C	0.31 °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 (0 to 250) °C	0.37 °C	Fluke 5500A Multi Product Calibrator
	(250 to 1000) °C	0.28 °C	
	(1000 to 1400) °C	0.29 °C	
	(1400 to 1767) °C	0.36 °C	
	Type T (-250 to -150) °C	0.49 °C	
	(-150 to 0) °C	0.19 °C	
	(0 to 120) °C	0.14 °C	
	(120 to 400) °C	0.15 °C	
	Type U (-200 to 0) °C	0.44 °C	
	(0 to 600) °C	0.22 °C	
Electrical Simulation of RTD indicators <sup>1</sup>	PT 395 100 Ω (-200 to 0) °C	0.06 °C	Fluke 5500A Multi Product Calibrator
	(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 Simulation of RTD indicators <sup>1</sup>	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
	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	
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	
			Fluke 5500A Multi Product Calibrator



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		Fluke 5500A Multi Product Calibrator
	(-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
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
Internal Diameter <sup>1,2</sup>	(0.04 to 13) in	(8+3L) μin	Horizontal Measuring Machine



Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plugs <sup>1,2</sup> Pitch Diameter	Up to 8 in Pitch (0.2 to 5) mm	(87 + 1.9L) μin	Horizontal Measuring Machine
Major Diameter	Pitch 90 – 4 TPI Up to 4 in	(8+3L) μin	Thread Measuring Wires
Thread Rings <sup>2</sup>	Up to 4 in	160 μin	Thread Setting Plug
Optical Comparators <sup>1,2</sup> Linear Accuracy	Up to 6 in 6 to 12 in	(43 + 11L) μin (30 + 7.5L) μin	Glass Scale
Magnification	5X to 100X	350 μin	Glass Scale (Sphere)
Surface Plates <sup>1,2</sup> Overall Flatness	Up to (168 by 168) in	(25 + 2.9L) μin	Laser System
Local Area Flatness	Up to (168 by 168) in	34 μin	Repeat-O-Meter
CMMs <sup>1,2</sup>	Linearity	(25 + 2.4L) μin	Laser Measuring System
VMMs <sup>1,2</sup>	Linearity	(32 + 4.1L) μin	Glass Scales
Horizontal Measuring Systems <sup>1,2</sup>	Up to 8 in of Travel 8 to 60 in	(6 + 1.7L) μin (3 + 2.5L) μin	Gage Blocks
Feeler/Thickness Gages <sup>2</sup>	Up to 0.2 in	(4.3 + 3L) μin	Horizontal Measuring System
Indicator Calibrator <sup>2</sup> Linearity	Up to 6 in	60 μin + 0.6R	Horizontal Measuring System
Groove Micrometers <sup>2</sup>	Up to 12 in	(44 + 2.6L) μin + 0.6R	Gage Blocks
Microscopes, Stereo Reticle Linearity	Up to 2 in	870 μin	Stage Micrometer
Microscopes – Toolmakers <sup>2</sup> Scale Linearity	Up to 4 in	(774 + 70L) μin + 0.6R	Stage Micrometer
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



**Length – Dimensional metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Parallels <sup>2</sup> – Steel Granite	Up to 18 in	(96.3 + 1.8L) μin (48.6 + 0.7L) μin	Electronic Amplifier with Probe, Surface Plate
Thickness Gages <sup>2</sup> - Dial Digital	Up to 1 in	410 μin + 0.6R 44 μin+ 0.6R	Gage Blocks
Thread Micrometers <sup>2</sup> (Screw Thread, Pitch Point) Linearity Anvil Wear	Up to 12 in	(44 + 2.6L) μin + 0.6R 690 μin	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	9 μozf /ozf + 0.32 μozf 9 μlbf / lbf + 13 μlbf 0.012 % of reading + 0.13 mlbf 0.012 % 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 Transducers <sup>1</sup>	0.5 ozf·in to 1 000 lbf·ft	0.08 % of reading	Dead Weight Torque Arms
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

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	Fluke 5500A 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%.

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. 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. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1265.



Vice President