



# CERTIFICATE OF ACCREDITATION

**ANSI National Accreditation Board**  
11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

**Fox Valley Metrology, Ltd.**  
**30447 Stacy Pond Drive**  
**Stacy MN 55079**

has been assessed by ANAB and meets the requirements of international standard

**ISO/IEC 17025:2017**

and national standards

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

while demonstrating technical competence in the fields of

**CALIBRATION and DIMENSIONAL MEASUREMENT**

Refer to the accompanying Scope of Accreditation for information regarding the types of activities to which this accreditation applies

ACT-1272.03

Certificate Number



ANAB Approval

Certificate Valid Through: 03/15/2021  
Version No. 004 Issued: 07/19/2019



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

**Fox Valley Metrology, Ltd.**  
30447 Stacy Pond Drive  
Stacy, MN 55079  
Chris Kuczynski 651-424-0035

**CALIBRATION AND DIMENSIONAL MEASUREMENT**

Valid to: **June 15, 2021**

Certificate Number: **ACT-1272.03**

**CALIBRATION**

**Acoustics and Vibration**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Level – Source <sup>1</sup> 100 Hz, 250 Hz, 500 Hz, 1 000 Hz, 2 000 Hz	114 dB	0.6 dB	Gen Rad 1562-A Sound Level Calibrator

**Chemical Quantities**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH Meters <sup>1</sup>	(4.01, 7, 10) pH	0.02 pH	pH Buffer Solutions
Conductivity Meters <sup>1</sup>	12.85 mS/cm 1408 µS/cm	0.18 mS/cm 14 µS/cm	Conductivity Solutions
Refractometers <sup>1</sup>	(0.0, 18.0, 29.7) Brix	0.24 Brix	Refractive Index 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 Value	10 V	0.8 µV/V	Fluke 732B Voltage Standard



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 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	12 $\mu$ V/V + 0.4 $\mu$ V 5.8 $\mu$ V/V + 0.7 $\mu$ V 4.2 $\mu$ V/V + 2.5 $\mu$ V 4.1 $\mu$ V/V + 4 $\mu$ V 5.8 $\mu$ V/V + 40 $\mu$ V 7.6 $\mu$ V/V + 0.4 mV	Fluke 5720A Multiproduct 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	7.8 $\mu$ V/V + 0.8 $\mu$ V 5.7 $\mu$ V/V + 0.8 $\mu$ V 5.6 $\mu$ V/V + 1 $\mu$ V 7.9 $\mu$ V/V + 80 $\mu$ V 7.9 $\mu$ V/V + 0.15 mV	Agilent 3458A Opt 002 Multimeter
DC Voltage - Measure <sup>1</sup>	Up to 200 mV 200 mV to 2 V (2 to 20) V (20 to 200) V 200 V to 1.05 kV	5 $\mu$ V/V + 0.10 $\mu$ V 3.5 $\mu$ V/V + 0.4 $\mu$ V 3.5 $\mu$ V/V + 4 $\mu$ V 5.5 $\mu$ V/V + 40 $\mu$ V 5.5 $\mu$ V/V + 500 $\mu$ V	Fluke 8508A Multimeter
DC High Voltage - Measure <sup>1</sup>	(1 to 10) kV (10 to 100) kV	60 V 0.6 kV	Hipotronics KVM-100 High Voltage Meter
DC Current - Source <sup>1</sup>	Up to 220 $\mu$ A 220 $\mu$ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	0.12 mA/A + 6 nA 42 $\mu$ A/A + 7 nA 41 $\mu$ A/A + 40 nA 52 $\mu$ A/A + 0.7 $\mu$ A 93 $\mu$ A/A + 12 $\mu$ A	Fluke 5720A Multiproduct Calibrator
DC Current - Source <sup>1</sup>	(2.2 to 11) A (11 to 20.5) A	0.58 mA/A + 0.5 mA 1.2 mA/A + 0.75 mA	Fluke 5520A Multiproduct Calibrator
DC Current - Source <sup>1</sup>	(20.5 to 1 000) A	86 mA/A + 0.5 A	Fluke 5520A Multiproduct Calibrator with 50-turn Coil
DC Current - Measure <sup>1</sup>	Up to 100 nA 100 nA to 1 $\mu$ A (1 to 10) $\mu$ A (10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	48 $\mu$ A/A + 65 pA 35 $\mu$ A/A + 65 pA 35 $\mu$ A/A + 0.15 nA 35 $\mu$ A/A + 1.3 nA 35 $\mu$ A/A + 10 nA 36 $\mu$ A/A + 0.1 $\mu$ A 15 $\mu$ A/A + 1 $\mu$ A 0.14 mA/A + 20 $\mu$ A	Agilent 3458A Opt 002 Multimeter



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Current - Measure <sup>1</sup>	Up to 200 $\mu$ A 200 $\mu$ A to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	12 $\mu$ A/A + 0.4 nA 12 $\mu$ A/A + 4 nA 14 $\mu$ A/A + 40 nA 48 $\mu$ A/A + 0.8 $\mu$ A 0.19 mA/A + 16 $\mu$ A 4 mA/A + 0.4 mA	Fluke 8508A Multimeter
DC Current - Measure <sup>1</sup>	(1 to 10) A	2.4 mA/A + 0.7 mA	Fluke Multimeter
Resistance - Measure <sup>1</sup> Normal Mode	Up to 2 $\Omega$ (2 to 20) $\Omega$ (20 to 200) $\Omega$ 200 $\Omega$ to 2 k $\Omega$ (2 to 20) k $\Omega$ (20 to 200) k $\Omega$ 200 k $\Omega$ to 2 M $\Omega$ (2 to 20) M $\Omega$ (20 to 200) M $\Omega$	17 $\mu\Omega/\Omega$ + 4 $\mu\Omega$ 9.5 $\mu\Omega/\Omega$ + 14 $\mu\Omega$ 8 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 8 $\mu\Omega/\Omega$ + 0.5 m $\Omega$ 8 $\mu\Omega/\Omega$ + 5 m $\Omega$ 8 $\mu\Omega/\Omega$ + 50 m $\Omega$ 9 $\mu\Omega/\Omega$ + 1 $\Omega$ 20 $\mu\Omega/\Omega$ + 0.1 k $\Omega$ 0.12 m $\Omega/\Omega$ + 10 k $\Omega$	Fluke 8508A Multimeter
Resistance - Measure <sup>1</sup> High Voltage Mode	(2 to 20) M $\Omega$ (20 to 200) M $\Omega$ 200 m $\Omega$ to 2 G $\Omega$ (2 to 20) G $\Omega$	17 $\mu\Omega/\Omega$ + 10 $\Omega$ 65 $\mu\Omega/\Omega$ + 1 k $\Omega$ 0.18 m $\Omega/\Omega$ + 0.1 M $\Omega$ 15 m $\Omega/\Omega$ + 10 M $\Omega$	Fluke 8508A Multimeter
Resistance - Source <sup>1</sup>	0 $\Omega$ 1 $\Omega$ 1.9 $\Omega$ 10 $\Omega$ 19 $\Omega$ 100 $\Omega$ 190 $\Omega$ 1 k $\Omega$ 1.9 k $\Omega$ 10 k $\Omega$ 19 k $\Omega$ 100 k $\Omega$ 190 k $\Omega$ 1 M $\Omega$ 1.9 M $\Omega$ 10 M $\Omega$	0.11 m $\Omega$ 0.11 m $\Omega$ 0.21 m $\Omega$ 0.27 m $\Omega$ 0.51 m $\Omega$ 1.4 m $\Omega$ 2.6 m $\Omega$ 11 m $\Omega$ 21 m $\Omega$ 0.11 $\Omega$ 0.21 $\Omega$ 1.3 $\Omega$ 2.7 $\Omega$ 24 $\Omega$ 48 $\Omega$ 0.48 k $\Omega$	Fluke 5720A Multiproduct Calibrator



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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>	19 MΩ 100 MΩ	1.1 kΩ 23 kΩ	Fluke 5720A Multiproduct Calibrator
Resistance - Source <sup>1</sup>	1 GΩ 10 GΩ 100 GΩ	1.9 MΩ 47 MΩ 0.95 GΩ	IET Labs HRRS Decade Box
Resistance - Measure <sup>1</sup>	Up 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 100 MΩ to 1 GΩ	24 μΩ/Ω + 0.1 mΩ 20 μΩ/Ω + 1 mΩ 18 μΩ/Ω + 1 mΩ 18 μΩ/Ω + 10 mΩ 18 μΩ/Ω + 0.1 Ω 24 μΩ/Ω + 7 mΩ 87 μΩ/Ω + 0.2 Ω 0.73 mΩ/Ω + 2 Ω 7.2 mΩ/Ω + 20 kΩ	Agilent 3458A Opt 002 Multimeter
AC Voltage - Source <sup>1</sup>	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	2.4 mV/V + 4 μV 2.4 mV/V + 4 μV 2.2 mV/V + 4 μV 2.2 mV/V + 4 μV 2.3 mV/V + 5 μV 2.5 mV/V + 10 μV 2.7 mV/V + 20 μV 3.8 mV/V + 20 μV 0.61 mV/V + 4 μV 0.56 mV/V + 4 μV 0.36 mV/V + 4 μV 0.42 mV/V + 4 μV 0.7 mV/V + 5 μV 1.3 mV/V + 10 μV 1.7 mV/V + 20 μV 3.4 mV/V + 20 μV 0.29 mV/V + 12 μV 0.13 mV/V + 7 μV 0.11 mV/V + 7 μV 0.24 mV/V + 7 μV 0.54 mV/V + 17 μV 1.1 mV/V + 20 μV 1.6 mV/V + 25 μV 3.3 mV/V + 45 μV	Fluke 5720A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source <sup>1</sup>	(0.22 to 2.2) V		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.28 mV/V + 40 μV	
	(20 to 40) Hz	0.11 mV/V + 15 μV	
	40 Hz to 20 kHz	55 μV/V + 8 μV	
	(20 to 50) kHz	0.12 mV/V + 10 μV	
	(50 to 100) kHz	0.13 mV/V + 30 μV	
	(100 to 300) kHz	0.49 mV/V + 80 μV	
	(300 to 500) kHz	1.2 mV/V + 0.2 mV	
	500 kHz to 1 MHz	2.0 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.28 mV/V + 0.2 mV	
	(20 to 40) Hz	0.11 mV/V + 0.15 mV	
	40 Hz to 20 kHz	56 μV/V + 50 μV	
	(20 to 50) kHz	0.12 mV/V + 0.1 mV	
	(50 to 100) kHz	0.12 mV/V + 0.2 mV	
	(100 to 300) kHz	0.32 mV/V + 0.6 mV	
	(300 to 500) kHz	1.2 mV/V + 2 mV	
	500 kHz to 1 MHz	1.8 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.28 mV/V + 4 mV	
(20 to 40) Hz	0.11 mV/V + 1.5 mV		
40 Hz to 20 kHz	65 μV/V + 0.6 mV		
(20 to 50) kHz	0.12 mV/V + 1 mV		
(50 to 100) kHz	0.18 mV/V + 2.5 mV		
(100 to 300) kHz	1.1 mV/V + 16 mV		
(300 to 500) kHz	5.1 mV/V + 40 mV		
500 kHz to 1 MHz	9.3 mV/V + 80 mV		
220 V to 1.1 kV			
(15 to 50) Hz	0.35 mV/V + 16 mV		
50 Hz to 1 kHz	88 μV/V + 3.5 mV		
AC Voltage Harmonics – Source (2 <sup>nd</sup> to 50 <sup>th</sup> ) <sup>1</sup>			Fluke 5520A Multiproduct Calibrator
(10 to 45) Hz	32 mV to 33 V	0.35 mV/V + 16 μV	
(45 to 65) Hz	33 mV to 1 kV	0.21 mV/V + 16 μV	
(65 to 500) Hz	33 mV to 1 kV	0.21 mV/V + 16 μV	
500 Hz to 5 kHz	330 mV to 1 kV	0.21 mV/V + 0.21 mV	
(5 to 10) kHz	3.3 V to 1 kV	0.21 mV/V + 1.2 mV	



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure <sup>1</sup> Bandwidth < 2 MHz	Up to 10 mV		Agilent 3458A Opt 002 Multimeter
	(1 to 40) Hz	0.46 mV/V + 13 μV	
	40 Hz to 1 kHz	0.35 mV/V + 11 μV	
	(1 to 20) kHz	0.46 mV/V + 11 μV	
	(20 to 50) kHz	1.3 mV/V + 11 μV	
	(50 to 100) kHz	5.9 mV/V + 11 μV	
	(100 to 300) kHz	46 μV/V + 12 μV	
	(10 to 100) mV		
	(1 to 40) Hz	0.14 mV/V + 4.5 μV	
	40 Hz to 1 kHz	0.14 mV/V + 2.5 μV	
	(1 to 20) kHz	0.22 mV/V + 2.5 μV	
	(20 to 50) kHz	0.41 mV/V + 2.5 μV	
	(50 to 100) kHz	0.99 mV/V + 2.5 μV	
	(100 to 300) kHz	3.5 mV/V + 11 μV	
	300 kHz to 1 MHz	12 mV/V + 11 μV	
	(1 to 2) MHz	18 mV/V + 11 μV	
	100 mV to 1 V		
	(1 to 40) Hz	0.14 mV/V + 45 μV	
	40 Hz to 1 kHz	0.14 mV/V + 25 μV	
	(1 to 20) kHz	0.22 mV/V + 25 μV	
	(20 to 50) kHz	0.41 mV/V + 25 μV	
	(50 to 100) kHz	0.99 mV/V + 25 μV	
	(100 to 300) kHz	3.5 mV/V + 0.11 mV	
	300 kHz to 1 MHz	12 mV/V + 0.11 mV	
	(1 to 2) MHz	18 mV/V + 0.11 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.14 mV/V + 0.45 mV	
	40 Hz to 1 kHz	0.14 mV/V + 0.25 mV	
	(1 to 20) kHz	0.22 mV/V + 0.25 mV	
	(20 to 50) kHz	0.41 mV/V + 0.25 mV	
(50 to 100) kHz	0.98 mV/V + 0.25 mV		
(100 to 300) kHz	3.5 mV/V + 1.1 mV		
300 kHz to 1 MHz	12 mV/V + 1.1 mV		
(1 to 2) MHz	18 mV/V + 1.1 mV		
(10 to 100) V			
(1 to 40) Hz	0.29 mV/V + 4.5 mV		
40 Hz to 1 kHz	0.29 mV/V + 2.5 mV		
(1 to 20) kHz	0.29 mV/V + 2.5 mV		
(20 to 50) kHz	0.29 mV/V + 2.5 mV		
(50 to 100) kHz	1.5 mV/V + 2.5 mV		
(100 to 300) kHz	4.7 mV/V + 11 mV		
300 kHz to 1 MHz	18 mV/V + 11 mV		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure <sup>1</sup> Bandwidth < 2 MHz	100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.52 mV/V + 45 mV 0.52 mV/V + 25 mV 0.75 mV/V + 25 mV 1.5 mV/V + 25 mV 3.5 mV/V + 25 mV	Agilent 3458A Opt 002 Multimeter
AC Voltage - Measure <sup>1</sup> Bandwidth < 2 MHz	(1 to 10) kV (50 to 60) Hz (10 to 100) kV (50 to 60) Hz	0.12 kV 1.2 kV	Hipotronics KVM-100 High Voltage Meter
AC Voltage – Measure <sup>1</sup> Bandwidth > 2 MHz	Up to 10 mV 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (10 to 100) mV 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz 100 mV to 1 V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz (1 to 10) V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz	1.2 mV/V + 6 μV 14 mV/V + 5.1 μV 83 mV/V + 7.1 μV 0.24 V/V + 8.1 μV 1.1 mV/V + 61 μV 24 mV/V + 51 μV 47 mV/V + 71 μV 47 mV/V + 81 μV 0.18 V/V + 0.1 mV 1.1 mV/V + 0.61 mV 24 mV/V + 0.51 mV 47 mV/V + 0.71 mV 47 mV/V + 0.81 mV 0.18 V/V + 1 mV 1.2 mV/V + 6.1 μV 24 mV/V + 5.1 μV 47 mV/V + 7.1 μV 47 mV/V + 8.1 μV 0.18 V/V + 10 μV	Agilent 3458A Opt 002 Multimeter
AC Voltage – Measure <sup>1</sup> Bandwidth > 2 MHz	(10 to 100) V 45 Hz to 100 kHz 100 V to 1 kV 45 Hz to 100 kHz	1.5 mV/V + 2.5 mV 3.6 mV/V + 0.11 V	Hipotronics KVM-100 High Voltage Meter





Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure <sup>1</sup> Bandwidth < 1 MHz	Up to 200 mV		Fluke 8508A Multimeter
	(1 to 10) Hz	0.17 mV/V + 14 μV	
	(10 to 40) Hz	0.14 mV/V + 4 μV	
	(40 to 100) Hz	0.12 mV/V + 4 μV	
	100 Hz to 2 kHz	0.11 mV/V + 2 μV	
	(2 to 10) kHz	0.14 mV/V + 4 μV	
	(10 to 30) kHz	0.34 mV/V + 8 μV	
	(30 to 100) kHz	0.77 mV/V + 20 μV	
	200 mV to 2 V		
	(1 to 10) Hz	0.15 mV/V + 0.12 mV	
	(10 to 40) Hz	0.12 mV/V + 20 μV	
	(40 to 100) Hz	90 μV/V + 20 μV	
	100 Hz to 2 kHz	75 μV/V + 20 μV	
	(2 to 10) kHz	0.11 mV/V + 20 μV	
	(10 to 30) kHz	0.22 mV/V + 0.84 mV	
	(30 to 100) kHz	0.57 mV/V + 0.2 mV	
	(100 to 300) kHz	3 mV/V + 2 mV	
	300 kHz to 1 MHz	10 mV/V + 2 mV	
	(2 to 20) V		
	(1 to 10) Hz	0.15 mV/V + 1.2 mV	
	(10 to 40) Hz	0.12 mV/V + 0.2 mV	
	(40 to 100) Hz	90 μV/V + 0.2 mV	
	100 Hz to 2 kHz	75 μV/V + 0.2 mV	
	(2 to 10) kHz	0.11 mV/V + 0.2 mV	
	(10 to 30) kHz	0.22 mV/V + 8.4 mV	
	(30 to 100) kHz	0.57 mV/V + 2 mV	
	(100 to 300) kHz	3 mV/V + 20 mV	
	300 kHz to 1 MHz	10 mV/V + 20 mV	
(20 to 200) V			
(1 to 10) Hz	0.15 mV/V + 12 mV		
(10 to 40) Hz	0.12 mV/V + 2 mV		
(40 to 100) Hz	90 μV/V + 2 mV		
100 Hz to 2 kHz	75 μV/V + 2 mV		
(2 to 10) kHz	0.11 mV/V + 2 mV		
(10 to 30) kHz	0.22 mV/V + 84 mV		
(30 to 100) kHz	0.57 mV/V + 20 mV		
(100 to 300) kHz	3 mV/V + 0.2 V		
300 kHz to 1 MHz	10 mV/V + 0.2 V		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure <sup>1</sup> Bandwidth < 1 MHz	200 V to 1.05 kV (1 to 10) Hz (10 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.15 mV/V + 70 mV 0.12 mV/V + 20 mV 0.12 mV/V + 20 mV 0.23 mV/V + 40 mV 0.58 mV/V + 0.2 V	Fluke 8508A Multimeter
AC Current - Source <sup>1</sup>	Up to 220 μA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 μA to 2.2 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2 to 3) A (10 to 45) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.30 mA/A + 16 nA 0.20 mA/A + 10 nA 0.16 mA/A + 8 nA 0.22 mA/A + 12 nA 1.3 mA/A + 65 nA 0.31 mA/A + 40 nA 0.22 mA/A + 35 nA 0.15 mA/A + 35 nA 0.24 mA/A + 0.11 μA 1.3 mA/A + 0.65 μA 0.32 mA/A + 0.4 μA 0.23 mA/A + 0.35 μA 0.15 mA/A + 0.35 μA 0.24 mA/A + 0.55 μA 1.3 mA/A + 5 μA 0.30 mA/A + 4 μA 0.20 mA/A + 3.5 μA 0.15 mA/A + 2.5 μA 0.24 mA/A + 3.5 μA 1.3 mA/A + 10 μA 0.31 mA/A + 35 μA 0.53 mA/A + 80 μA 8.1 mA/A + 0.16 mA 2.1 mA/A + 0.1 mA 0.75 mA/A + 0.1 mA 6.9 mA/A + 1 mA 29 mA/A + 5 mA	Fluke 5720A Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Source <sup>1</sup>	(3 to 11) A (45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.74 mA/A + 2 mA 1.2 mA/A + 2 mA 35 mA/A + 2 mA	Fluke 5520A Multiproduct Calibrator
	(11 to 20.5) A (45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	1.4 mA/A + 5 mA 1.8 mA/A + 5 mA 35 mA/A + 5 mA	
AC Current - Source <sup>1</sup>	(20.5 to 1 000) A (45 to 65) Hz	90 mA/A + 0.5 A	Fluke 5520A Multiproduct Calibrator w/ 50-turn Coil
	(20.5 to 150) A (65 to 440) Hz	0.55 mA/A + 0.5 mA	
AC Current Harmonics - Source <sup>1</sup> (2 <sup>nd</sup> to 50 <sup>th</sup> ) (10 to 45) Hz (45 to 65) Hz (65 to 500) Hz 500 Hz to 5 kHz (5 to 10) kHz	3.3 mA to 3 A 3.3 mA to 20.5 A 33 mA to 20.5 A 33 mA to 20.5 A (33 to 330) mA	1.1 mA/A + 4 μA 0.5 mA/A + 4 μA 1.2 mA/A + 0.1 mA 2.3 mA/A + 0.2 mA 4.6 mA/A + 0.4 mA	Fluke 5520A Multiproduct Calibrator
AC Current - Measure <sup>1</sup>	Up to 100 μA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.8 mA/A + 30 nA 1.9 mA/A + 30 nA 0.83 mA/A + 30 nA 0.83 mA/A + 30 nA	Agilent 3458A Opt 002 Multimeter
	100 μA to 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.9 mA/A + 0.2 μA 1.9 mA/A + 0.2 μA 0.83 mA/A + 0.2 μA 0.47 mA/A + 0.2 μA	
	(5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.83 mA/A + 0.2 μA 4.9 mA/A + 0.4 μA 6.6 mA/A + 1.5 μA	
	(1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.9 mA/A + 2 μA 1.9 mA/A + 2 μA 0.83 mA/A + 2 μA 0.47 mA/A + 2 μA	
	(5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.83 mA/A + 2 μA 4.9 mA/A + 4 μA 6.6 mA/A + 15 μA	



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Measure <sup>1</sup>	(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	4.9 mA/A + 20 μA 1.9 mA/A + 20 μA 0.83 mA/A + 20 μA 0.47 mA/A + 20 μA 0.47 mA/A + 20 μA 4.9 mA/A + 40 μA 6.6 mA/A + 0.15 mA  4.8 mA/A + 0.2 mA 2 mA/A + 0.2 mA 1.1 mA/A + 0.2 mA 1.3 mA/A + 0.2 mA 3.7 mA/A + 0.2 mA 12 mA/A + 0.4 mA	Agilent 3458A Opt 002 Multimeter
AC Current - Measure <sup>1</sup>	(1 to 10) A (20 to 50) Hz 50 Hz to 2 kHz	0.23 A/A + 10 mA 36 mA/A + 10 mA	Fluke Multimeter
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 200 μA to 2 mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.31 mA/A + 20 nA 0.3 mA/A + 20 nA 0.71 mA/A + 20 nA 4 mA/A + 20 nA  0.31 mA/A + 0.2 μA 0.3 mA/A + 0.2 μA 0.71 mA/A + 0.2 μA 4 mA/A + 0.2 μA  0.31 mA/A + 2 μA 0.3 mA/A + 2 μA 0.71 mA/A + 2 μA 4 mA/A + 2 μA  0.31 mA/A + 20 μA 0.3 mA/A + 20 μA 0.63 mA/A + 20 μA	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 mA to 2A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (2 to 20) A 10 Hz to 2 kHz (2 to 10) kHz	0.62 mA/A + 0.2 mA 0.73 mA/A + 0.2 mA 3 mA/A + 0.2 mA  0.82 mA/A + 2 mA 2.5 mA/A + 2 mA	Fluke 8508A Multimeter
Capacitance - Measure <sup>1</sup> 42 Hz to 5 MHz	0.32 pF to 370 mF	1.1 mF/F	Hioki 3532-50 LCR Meter
Capacitance - Source <sup>1</sup>	130 pF 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	5.8 mF/F + 10 pF 2.9 mF/F + 10 pF 2.9 mF/F + 0.1 nF 2.9 mF/F + 0.3 nF 2.9 mF/F + 1 nF 2.9 mF/F + 3 nF 2.9 mF/F + 10 nF 4.7 mF/F + 30 nF 5.3 mF/F + 0.1 μF 1 mF/F + 0.3 μF 6 mF/F + 1 μF 5.3 mF/F + 3 μF	Fluke 5520A Multiproduct Calibrator
Capacitance - Source <sup>1</sup>	(3.3 to 11) mF (11 to 33) mF (33 to 110) mF	5.3 mF/F + 10 μF 8.9 mF/F + 30 μF 13 mF/F + 0.1 mF	Fluke 5520A Multiproduct Calibrator
Phase - Measure <sup>1</sup>	(0 to 360) ° 10 Hz to 2 kHz (2 to 5) kHz (5 to 10) kHz (10 to 50) kHz (50 to 60) kHz (60 to 70) kHz (70 to 80) kHz (80 to 90) kHz (90 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	0.026 ° 0.036 ° 0.048 ° 0.059 ° 0.07 ° 0.082 ° 0.093 ° 0.1 ° 0.12 ° 0.58 ° 1.2 °	Clark Hess 6000A Phase Meter



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes <sup>1</sup> DC Voltage (50 Ω) DC Voltage (1 MΩ)  AC Voltage (50 Ω) AC Voltage (1 MΩ)  Leveled Sine Wave 50 kHz to 1.1 GHz  Time Markers  Wave Generator (50 Ω) Wave Generator (1 MΩ)  Pulse Generator - Width  Pulse Generator - Period  Input Impedance Measure	1 mV to 6.6 V 1 mV to 130 V  1 mV to 6.6 V 1 mV to 130 V  5 mV to 5.5 V  1 ns to 5 s  1.8 mV to 2.5 V p-p 1.8 mV to 55 V p-p  (4 to 45) ns (45 to 500) ns  200 ns to 20 ms  (50 to 60) Ω 50 Ω to 1 MΩ	2.9 mV/V + 40 μV 0.55 mV/V + 40 μV  2.9 mV/V + 40 μV 1.1 mV/V + 40 μV  51 mV/V + 0.1 mV  6.4 μs/s  35 mV/V + 0.10 mV 35 mV/V + 0.10 mV  58 ms/s + 0.5 ns 58 ms/s + 4 ns  58 ms/s + 0.2 μs  1.2 mΩ/Ω 1.2 mΩ/Ω	Fluke 5520A SC1100 Multiproduct Calibrator
DC Power - Source <sup>1</sup>	10 mW to 330 W 330 W to 3 kW (3 to 20.5) kW	0.27 mW/W 0.26 mW/W 0.82 mW/W	Fluke 5520A Multiproduct Calibrator
AC Power - Source <sup>1</sup>	100 μW to 9 W (9 to 33) W (33 to 90) W (90 to 330) W (330 to 900) W 900 W to 2.2 kW	1.7 mW/W 1.2 mW/W 1.7 mW/W 1.2 mW/W 11 mW/W 4.6 mW/W	Fluke 5520A Multiproduct Calibrator
Electrical Simulation of RTD Instrumentation <sup>1</sup>	Pt 385, 100 Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (500 to 630) °C (630 to 800) °C	0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.23 °C	Fluke 5520A Multiproduct Calibrator



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of RTD Instrumentation <sup>1</sup>	Pt 3926, 100 Ω		Fluke 5520A Multiproduct 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	
	(500 to 630) °C	0.12 °C	
	Pt 3916 (JIS) 100 Ω		
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.07 °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	
	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		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of RTD Instrumentation <sup>1</sup>	Pt 385, 1 000 Ω		Fluke 5520A Multiproduct Calibrator
	(-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, Ni 120		
	(-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	0.03 °C		
Electrical Simulation of Thermocouple Instrumentation <sup>1</sup>	Type K		Fluke 5520A Multiproduct Calibrator
	(-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 J		
	(-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 E		
	(-250 to -100) °C	0.5 °C	
	(-100 to -35) °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	
	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		





Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of Thermocouple Instrumentation <sup>1</sup>	Type S (0 to 250) °C	0.47 °C	Fluke 5520A Multiproduct Calibrator
	(250 to 1 000) °C	0.36 °C	
	(1 000 to 1 400) °C	0.37 °C	
	(1 400 to 1 767) °C	0.46 °C	
	Type B (600 to 800) °C	0.44 °C	
	(-100 to -25) °C	0.34 °C	
	(-25 to 120) °C	0.3 °C	
	(120 to 1 000) °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 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 U (-200 to 0) °C	0.56 °C		
(0 to 600) °C	0.27 °C		
Inductance - Source <sup>1</sup>	(1 to 10) mH	22 mH/H	General Radio 1490-D Decade Inductor
	(10 to 100) mH	11 mH/H	
	100 mH to 1 H	6 mH/H	
	(1 to 10) H	3 mH/H	
Ionizers <sup>1</sup> Decay Time Float Voltage	(0.1 to 999.9) s	0.2 s	Trek 156A Charged Plate Monitor
	(-1 100 to 1 100) V	3.1 V	

**Electrical - RF/Microwave**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power - Measure <sup>1</sup> Absolute Level 100 kHz to 3 GHz (3 to 18) GHz (18 to 26.5) GHz  100 kHz to 3 GHz (3 to 18) GHz (18 to 26.5) GHz	(+20 to +30) dBm  (-20 to +20) dBm	0.37 dB 0.39 dB 0.4 dB  0.15 dB 0.18 dB 0.21 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
Amplitude Modulation - Source <sup>1</sup> Rate: DC to 100 kHz Depths: 0 % to 100 %	250 kHz to 40 GHz	7.1 % of setting + 1 %	Agilent E8257D Signal Generator
Amplitude Modulation - Measure <sup>1</sup> 100 kHz to 10 MHz  10 MHz to 3 GHz  10 MHz to 3 GHz  (3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 99 %  Rate: 50 Hz to 100 kHz Depths: 20 % to 99 %  Rate: 50 Hz to 100 kHz Depths: 5 % to 20 %  Rate: 50 Hz to 100 kHz Depths: 20 % to 99 %	2.2 % of reading  1.2 % of reading  4.2 % of reading  3.5 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
Amplitude Modulation - Measure <sup>1</sup> (3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 20 %	6 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
Phase Modulation - Source <sup>1</sup> Rate: DC to 100 kHz	250 kHz to 40 GHz	5.9 % setting + 0.1 rad	Agilent E8257D 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	1.2 % 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	3.6 % of reading	
(6.6 to 13.2) GHz	Rate: 200 Hz 20 kHz Dev.: > 2.0 rad	1.2 % of reading	
(6.6 to 13.2) GHz	Rate: 200 Hz 20 kHz Dev.: > 0.6 rad	3.6 % of reading	
(13.2 to 26.5) GHz	Rate: 200 Hz 20 kHz Dev.: > 2.0 rad	1.2 % of reading	
(13.2 to 26.5) GHz	Rate: 200 Hz 20 kHz Dev.: > 0.6 rad	3.6 % of reading	
Tuned RF Level - Measure <sup>1</sup> Absolute Level			
500 kHz to 3.05 GHz	(+16 to +30) dBm (-106 to +16) dBm (-129 to -106) dBm	0.37 dB + 0.005 dB/10 dB 0.15 dB + 0.005 dB/10 dB 0.15 dB + 0.12 dB/10 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
(3.05 to 6.6) GHz	(+20 to +30) dBm (-90 to +20) dBm (-114 to -90) dBm	0.39 dB + 0.005 dB/10 dB 0.18 dB + 0.005 dB/10 dB 0.23 dB + 0.12 dB/10 dB	
(6.6 to 13.2) GHz	(+20 to +30) dBm (-81 to +20) dBm (-104 to -81) dBm	0.39 dB + 0.005 dB/10 dB 0.18 dB + 0.005 dB/10 dB 0.23 dB + 0.12 dB/10 dB	
(13.2 to 19.2) GHz	(+20 to +30) dBm (-70 to +20) dBm (-93 to -70) dBm	0.4 dB + 0.005 dB/10 dB 0.21 dB + 0.005 dB/10 dB 0.25 dB + 0.12 dB/10 dB	
(19.2 to 26.5) GHz	(+20 to +30) dBm (-62 to +20) dBm (-85 to -62) dBm	0.4 dB + 0.005 dB/10 dB 0.21 dB + 0.005 dB/10 dB 0.24 dB + 0.12 dB/10 dB	
Tuned RF Level - Measure <sup>1</sup> Relative Level			
500 kHz to 3.05 GHz	(-90 to +30) dBm (-106 to -90) dBm (-129 to -106) dBm	0.026 dB + 0.005 dB/10 dB 0.067 dB + 0.12 dB/10 dB 0.076 dB + 0.12 dB/10 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Modules



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power Sensors- Calibration Factor <sup>1</sup>  100 kHz to 10 MHz 10 MHz to 10 GHz (10 to 18) GHz	(-20 to +14) dBm	1.5 %CF 1.5 %CF 1.7 %CF	Tegam 1827 Power Sensor Calibrator, Agilent 3458A Multimeter, Agilent E8257D Signal Generator, Agilent E4419B Power Meter, Agilent 3325B Function Generator
Frequency Modulation - Measure <sup>1</sup>  250 kHz to 10 MHz  10 MHz to 3 GHz	Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak  Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	3.1 % of reading  3.1 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
Frequency Modulation - Measure <sup>1</sup>  (3 to 26.5) GHz	Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	7.7 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
Frequency Modulation - Source <sup>1</sup> 250 kHz to 40 GHz	1 dB Rate: DC to 100 kHz 3 dB Rate: DC to 10 MHz Dev.: ≤ (N X 800 kHz)	4.2 % setting + 20 Hz	Agilent E8257D Signal Generator
Pulse Generation - Measure <sup>1</sup> DC to 225 MHz Pulse Width Rise/Fall Time	5 ns to 10 <sup>5</sup> s 5 ns to 10 <sup>5</sup> s	1.1 ns 1.1 ns	Agilent 53132A Counter
Pulse Generation - Source <sup>1</sup> Repetition Frequency: 0.024 Hz to 14.28 MHz Period: 70 ns to 42 s	10 ns to 42 s	17 ns	Agilent E8257D Signal Generator
Pulse Modulation - Source <sup>1</sup> Level Rise/Fall Time	(0 to 9) dBm 10 MHz to 40 GHz	0.59 dB 12 ns	Agilent E8257D Signal Generator

**Length – Dimensional Metrology**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Gage Blocks <sup>2</sup>	Up to 10 in	$(3.9 + 1.3L) \mu\text{in}$	LabMaster Universal Measuring Machine Per ASME B89.1.9
Gage Blocks <sup>2</sup>	(10 to 20) in	$(8.5 + 1L) \mu\text{in}$	ULM 600 Measuring Machine Per ASME B89.1.9
Gage Blocks <sup>2</sup>	Up to 20 in	$(3.9 + 1.3L) \mu\text{in}$	Mahr 828 Measuring Machine Per ASME B89.1.9
Length Standards <sup>2</sup>	Up to 9 in	$(39 + 0.4L) \mu\text{in}$	P&W Supermicrometer
Length Standards <sup>2</sup>	(9 to 24) in	$(12 + 1L) \mu\text{in}$	ULM 600 Measuring Machine
Length Standards <sup>2</sup>	(24 to 70) in	$(390 + 2.6L) \mu\text{in}$	CMM
Cylindrical Rings <sup>2</sup>	(0.25 to 8) in (0.025 to 12) in	$(13 + 1.3D) \mu\text{in}$ $(13 + 1.8D) \mu\text{in}$	LabMaster Universal ULM 600 ASME B89.1.6
Cylindrical Rings <sup>1,2</sup>	(0.25 to 8) in	$(12 + 3D) \mu\text{in}$	Fowler Lab Concept Measuring Machine ASME B89.1.6
Cylindrical Plugs <sup>2</sup>	(0.010 to 8) in	$(2.7 + 6D) \mu\text{in}$	LabMaster Universal
Cylindrical Plugs <sup>1,2</sup>	(0.010 to 4) in	$(53 + 0.4D) \mu\text{in}$	Plug gage Comparator
Thread Wires <sup>2</sup>	(0.005 to 0.5) in	$(11 + 1.5D) \mu\text{in}$	ULM 600 Measuring Machine ASME B89.1.17
Thread Rings <sup>2</sup> Pitch Diameter Pitch Diameter Minor Diameter	Up to 8 in Up to 8 in Up to 8 in	$(240 + 0.3D) \mu\text{in}$ 38 $\mu\text{in}$ 120 $\mu\text{in}$	Setting Plug Gages ULM 600 Measuring Machine ID Bore Gages ASME B1.2
NPT Rings Standoff and Basic Length	(0.062 5 to 6) in	250 $\mu\text{in}$	NPT Plugs, P&W LabMaster ASME B1.20.5
NPT Plugs Standoff and Basic Length	(0.062 5 to 6) in	490 $\mu\text{in}$	NPT Rings, P&W LabMaster ASME B1.20.5

**Length – Dimensional Metrology**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
Tapered Thread Gages <sup>2</sup>	(0.25 to 5) in	$(53 + 6.2D) \mu\text{in}$	Universal Supermicrometer ASME B1.20.5
Threaded Plugs <sup>2</sup> Pitch Diameter Major Diameter	(0.01 to 10) in (0.01 to 10) in	$(73 + 0.9D) \mu\text{in}$ $(40 + 1.2D) \mu\text{in}$	P&W Supermicrometer, Thread Measuring Wires ASME B1.2
Threaded Plugs <sup>1,2</sup> Pitch Diameter Major Diameter	(0.01 to 4) in (0.01 to 4) in	$(73 + 3.2D) \mu\text{in}$ $(53 + 4.1D) \mu\text{in}$	Plug gage Comparator
Calipers <sup>1,2</sup>	Up to 80 in	$(380 + 15L) \mu\text{in}$	Gage Blocks
Indicators <sup>1,2</sup>	Up to 4 in	$(36 + 10L) \mu\text{in}$	Indicator Checker
Test Indicators <sup>1</sup>	Up to 0.06 in	39 $\mu\text{in}$	Indicator Checker
OD Micrometers <sup>1,2</sup>	Up to 60 in	$(72 + 12L) \mu\text{in}$	Gage Blocks
ID Micrometer <sup>1,2</sup>	(1.5 to 40) in	$(370 + 7L) \mu\text{in}$	Gage Blocks
Height Gages <sup>1,2</sup>	Up to 40 in	$(96 + 14L) \mu\text{in}$	Gage Blocks
Bore Gages <sup>1</sup>	(0.25 to 12) in	350 $\mu\text{in}$	Cylindrical Rings
Crimpers <sup>1</sup> Die Check Crimp Height	(0.011 to 0.5) in (0.01 to 0.5) in	230 $\mu\text{in}$ 0.001 2 in	Pin Gages Micrometer
Profilometers <sup>1</sup>	(2 to 300) $\mu\text{in Ra}$	2.2 $\mu\text{in}$	Roughness Specimen
Surface Plates <sup>1,2</sup> Repeat Reading Overall Flatness	(4 to 34) inD (34 to 175) inD	$(30 + 0.2D) \mu\text{in}$ $(66 + 0.2D) \mu\text{in}$	Repeat – O – Meter Electronic Levels
CMM Calibration <sup>1,2</sup> Volumetric Linearity Linearity	(5 to 40) in (1 to 60) in Above 60 in	$(12 + 14L) \mu\text{in}$ $(7 + 14L) \mu\text{in}$ $(20 + 0.4L) \mu\text{in}$	Ball Bars Step Gage Renishaw Laser System B89.4.1
Linear Measurements <sup>1,2</sup>	Up to 1 560 in	$(38 + 0.5L) \mu\text{in}$	Laser
Optical Comparators <sup>1,2</sup> Linearity Magnification	Up to 12 in 10x, 20x, 31.25x, 50x, 62.5x, 100x, 200x	$(97 + 12L) \mu\text{in}$ 0.000 46 in	Glass Scale Precision Balls Calibration Sphere



**Length – Dimensional Metrology**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Roundness Testers <sup>1</sup> Axial Error Radial Error	(-1 000 to 1 000) μm	0.15 μm 0.15 μm	Test Sphere
ULMs <sup>1</sup> Length	(1 to 100) mm	0.19 μm	Gage Blocks
Film Thickness Gages <sup>1</sup>	(0.01 to 0.06) in	380 μin	Film Thickness Standards
Brinell Scopes <sup>1</sup>	(1 to 6) mm	11 μm	Stage Micrometer

**Mass and Mass Related**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Bench and Floor Scales <sup>1</sup>	(0.001 to 5 000) lb	0.000 7 lb/lb	NIST 105 Class F Weights NIST Handbook 44
Analytical Balances <sup>1</sup>	(0.001 mg to 13 kg)	0.19 μg/g	ASTM E617 Class 1 Weights NIST Handbook 44
Pressure <sup>1</sup>	(-13 to 300) psi (300 to 1 000) psi	0.1 psi 1.3 psi	Pressure Calibrator
Pressure <sup>1</sup>	(1 000 to 10 000) psi	3.9 psi	Pressure Transducers
Environmental Pressure Gage <sup>1</sup>	(0 to 100) inH <sub>2</sub> O	0.017 inH <sub>2</sub> O	Pressure Module
Durometers <sup>1</sup>	Up to 100 duro	0.35 duro	Direct Verification per ASTM D2240 Durometer Calibrator
Spring Force Indenter Angle Indenter Radius	(0.1 to 45) N (20 to 40) ° (0.05 to 0.1) in	0.05 N 0.07 ° 340 μin	Triple Beam Balance, Video Measuring Machine
Indenter Length	(0.049 to 0.198) in	330 μin	Gage Blocks
Brinell Hardness Testers <sup>1</sup> Verification of Test Force	(500, 750, 1 500, 2 000, 3 000) kgf	7.2 Kgf	Direct Verification per ASTM E10 using Morehouse Proving Ring
Verification of Indenter Mean Diameter	10 mm 5 mm	0.002 mm 0.002 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>
Brinell Hardness Testers <sup>1</sup>	(1 to 7) mm	0.03 mm	Indirect Verification per ASTM E10 using Brinell Test Blocks & Brinell Scope
Knoop and Vickers Hardness Testers <sup>1</sup>	(1 to 200) $\mu\text{m}$ (1 to 200) $\mu\text{m}$	0.25 $\mu\text{m}$ 0.17 $\mu\text{m}$	Indirect Verification per ASTM E384 using Knoop & Vickers Test Blocks
Leeb Hardness Tester <sup>1</sup>	550 LD, 836 LD	20 LD	Indirect Verification per ASTM A596 using Leeb Test Block
Rockwell Hardness Testers <sup>1</sup>	HRA Low HRA Med HRA High  HRBW Low HRBW Med HRBW High  HRC Low HRC Med HRC High  HRE Low HRE Med HRE High  HRF Low HRF Med HRF High  HRH Low HRH Med HRH High	1.2 HRA 1.2 HRA 0.75 HRA  1.4 HRBW 1.4 HRBW 1.3 HRBW  1.2 HRC 1.2 HRC 0.7 HRC  1.3 HRE 1.4 HRE 1.4 HRE  1.4 HRF 1.4 HRF 1.4 HRF  1.4 HRH 1.4 HRH 1.4 HRH	Indirect Verification per ASTM E18 using Rockwell 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>	HRKW Low	1.4 HRKW	Indirect Verification per ASTM E18 using Rockwell Test Blocks
	HRKW Med	1.3 HRKW	
	HRKW High	1.3 HRKW	
	HRMW Low	1.4 HRMW	
	HRMW Med	1.4 HRMW	
	HRMW High	1.3 HRMW	
	HR15N Low	1.5 HR15N	
	HR15N Med	1.3 HR15N	
	HR15N High	0.9 HR15N	
	HR30N Low	1.3 HR30N	
	HR30N Med	1.3 HR30N	
	HR30N High	0.9 HR30N	
	HR45N Low	1.4 HR45N	
	HR45N Med	1.3 HR45N	
	HR45N High	0.95 HR45N	
	HR15TW Low	2 HR15TW	
	HR15TW Med	1.4 HR15TW	
	HR15TW High	1.5 HR15TW	
	HR30TW Low	2 HR30TW	
	HR30TW Med	1.5 HR30TW	
	HR30T High	1.3 HR30TW	
	HR45TW Low	2 HR45TW	
	HR45TW Med	1.3 HR45TW	
	HR45TW High	1.4 HR45TW	
Force <sup>1</sup>	(0.001 to 200) lb	0.05 % of reading	Dead Weight Load Cell
	(200 to 10 000) lb	0.07 % of reading	
	(10 000 to 50 000) lb	0.1 % of reading	
Torque Tools <sup>1</sup>	4 lbf-in to 2 500 lbf-ft	0.3 % of reading	AKO Torque System
Viscosity Rotational Viscometers	500 cP 5 000 cP	0.02 cP/cP	Viscosity Solutions, Temperature Bath



**Mass and Mass Related**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Viscosity Cups	17.82 cP 65.28 cP 231 cP	0.03 cP/cP	Viscosity Solutions, Temperature Bath, Stopwatch ASTM D4212

**Photometry and Radiometry**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Power - Measure <sup>1</sup> (800 to 1 650) nm	(-70 to +20) dBm	0.03 dB/dBm	Agilent 81533B Interface, 81525A Optical Head
Optical Power - Source <sup>1</sup> (820, 1 310, 1 550) nm	(-60 to 0) dB	0.05 dB/dB	Agilent 81554SM Laser Source Module, 81533B Interface, 81525A Optical Head, 81655A Laser Module, 81570A Optical Attenuator, and 81578A Optical Attenuator
Optical Attenuation - Source <sup>1</sup> (700 to 1 650) nm	(-60 to 0) dB	0.04 dB/dB	Agilent 81570A and 81578A Optical Attenuators
Optical Wavelength - Measure <sup>1</sup>	(700 to 1 650) nm	0.05 nm	Agilent 86120B Multi- Wavelength Meter

**Thermodynamic**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Immersion Probes <sup>1</sup>	(-95 to 140) °C	0.03 °C	Fluke 9190A Drywell with PRT
Temperature - Measure <sup>1</sup>	(-30 to 600) °C	0.03 °C	Hart Scientific 1502 Indicator with PRT
System Accuracy Test <sup>1</sup> (SAT)	(0 to 2 200) °F	2.6 °F	Certified Thermocouple



**Thermodynamic**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature Uniformity Survey <sup>1</sup> (TUS)	(0 to 2 200) °F	4.9 °F	MV 1000 Data Logger or Equivalent

**Time and Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Time Interval <sup>1</sup>	(1 to 86 400) s	0.000 45 s	Agilent 53132A Counter & Spectracom 8197B GPS Oscillator
Frequency Measure <sup>1</sup>	0.1 Hz to 225 MHz	6.7 parts in 10 <sup>-11</sup> Hz	Agilent 53132A Counter & Spectracom 8197B GPS Oscillator
Frequency Measure <sup>1</sup>	0.1 Hz to 26.5 GHz	6.7 parts in 10 <sup>-11</sup> Hz	Agilent N5531S Measuring Receiver, SRS FS725 Frequency Standard
Frequency Source <sup>1</sup>	10 MHz	6.7 parts in 10 <sup>-11</sup> Hz	SRS FS725 Frequency Standard
Frequency Source <sup>1</sup>	0.1 mHz to 40 GHz	6.7 parts in 10 <sup>-11</sup> Hz	Agilent 3325B Function Generator, Agilent E8257D Signal Generator, SRS FS725 Frequency Standard
Tachometers <sup>1</sup> Contact Non-Contact	(1 to 6 500) rpm (500 to 40 000) rpm	0.08 % of reading	King Nutronics 3711-B Tachometer Test Set
Tachometers <sup>1</sup> Non-Contact	(0.01 to 100 000) rpm	0.005 % of reading	Fluke 5520A Multiproduct Calibrator

**DIMENSIONAL MEASUREMENT**

**2 Dimensional**

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Inspection, Non - Contact Linear	Up to (12 x 8) in	(210 + 5.2L) μin	Vision System



2 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Surface Finish (Ra)	(0.01 to 300) $\mu$ in	2.1 $\mu$ in	Profilometer

3 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Inspection, Contact Volumetric Linear	Up to (12 x 8 x 8) in Up to (12 x 8 x 8) in	320 $\mu$ in (38 + 5.2L) $\mu$ in	Coordinate Measuring Machine (CMM)

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.  $D$  = diameter in inches,  $L$  = length in inches.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1272.03.

  
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 Vice President

