CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Fox Valley Metrology, Ltd.
3114 Medalist Drive
Oshkosh, WI 54902
(and satellite locations as shown on the scope)

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

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

In the fields of

CALIBRATION AND DIMENSIONAL MEASUREMENT

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

Jason Stine, Vice President
Expiry Date: 15 June 2025
Certificate Number: ACT-1272

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

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

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

Fox Valley Metrology, Ltd.
3114 Medalist Drive
Oshkosh, WI 54902
Jacob Jurotich 815-205-4101 x7104

Services performed at satellite locations as indicated in far-right column
308 Axminister Drive, Fenton, MO 63026
30447 Stacy Ponds Drive, Stacy, MN 55079
5245 27th Avenue, Rockford, IL 61109
3012 Old Charlotte Hwy., Monroe, NC 28110
1740 State Route 61, Crestline, OH 44827
2205 North Willow Avenue, Unit B, Broken Arrow, OK 74012

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **June 15, 2025** Certificate Number: **ACT-1272**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level – Source [1] (100 Hz, 250 Hz, 500 Hz, 1 000 Hz, 2 000 Hz)	114 dB	0.6 dB	Comparison to Gen Rad 1562-A Sound Level Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometers 1 g reference 1 g reference	 10 Hz to 2 kHz (2 to 10) kHz	 1.5 % of reading 1.4 % of reading	Comparison to PCB 9150C Accelerometer Calibration Workstation Oshkosh, WI

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters [1,6]	4.01 pH 7 pH 10 pH	0.02 pH 0.02 pH 0.02 pH	Comparison to Accredited pH Buffer Solutions Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Conductivity Meters [1,6]	12.85 mS/cm 1 408 µS/cm 10 µS/cm	0.18 mS/cm 14 µS/cm 0.18 µS/cm	Comparison to Accredited Conductivity Solutions Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Refractometers [1,6]	4.99 Brix 7.52 Brix 10.03 Brix 12.53 Brix 14.98 Brix 30.08 Brix	0.24 Brix 0.24 Brix 0.24 Brix 0.24 Brix 0.24 Brix 0.24 Brix	Comparison to Accredited Refractive Index Solutions Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Gas Detectors [1,6] O_2	0 % Concentration 21.9 % Concentration 100 % Concentration	2.4 % Concentration 2.4 % Concentration 2.6 % Concentration	Comparison to Accredited Gas Mixtures Oshkosh, WI

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1,6] (Fixed Artifact)	10 V	0.8 µV/V	Comparison to Fluke 732B Voltage Standard Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	7.5 µV/V + 0.5 µV 5.1 µV/V + 0.77 µV 3.6 µV/V + 2.6 µV 3.7 µV/V + 4.2 µV 5.2 µV/V + 43 µV 6.7 µV/V + 0.4. mV	Comparison to Fluke 5730A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
DC Voltage – Measure [1]	Up to 202 mV 202 mV to 2.02 V (2.02 to 20.2) V (20.2 to 202) V (202 to 1 050) V	5.7 µV/V + 0.26 µV 2.9 µV/V + 0.31 µV 2.9 µV/V + 0.94 µV 4.4 µV/V + 30 µV 4.6 µV/V + 0.58 mV	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
DC High Voltage – Measure [1]	(1 to 10) kV (10 to 100) kV	60 V 600 V	Comparison to Hipotronics KVM-100 High Voltage Meter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1]	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	39 µA/A + 6.3 nA 36 µA/A + 7.3 nA 36 µA/A + 42 nA 47 µA/A + 0.71 µA 83 µA/A + 12 µA	Comparison to Fluke 5730A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
DC Current – Source [1]	(1.2 to 3.1) A (3.1 to 12) A (12 to 30) A	0.3 mA/A + 0.15 mA 0.3 mA/A + 0.25 mA 1 mA/A + 0.78 mA	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
DC Current – Source [1]	Up to 100 A	0.008 % of reading + 4 mA	Comparison to Fluke 52120A Transconductance Amplifier Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1] Clamp-on Meters	Up to 2 500 A	0.6 % of reading	Comparison to Fluke 52120A Transconductance Amplifier with 25-turn coil Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
DC Current – Measure [1]	Up to 20.2 µA (20.2 to 202) µA 202 µA to 2.02 mA (2.02 to 20.2) mA (20.2 to 200.2) mA 200.2 mA to 2.02 A (2.02 to 20.2) A (20.2 to 30.2) A	6.2 µA/A + 0.89 nA 10 µA/A + 0.42 nA 9.2 µA/A + 4.3 nA 9.8 µA/A + 48 nA 32 µA/A + 1 µA 100 µA/A + 100 µA 0.18 mA/A + 0.4 mA 0.49 mA/A + 4.4 mA	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Resistance – Measure [1] (Normal Mode)	Up to 2.02 Ω (2.02 to 20.2) Ω (20.2 to 202) Ω 202 Ω to 2.02 kΩ (2.02 to 20.2) kΩ (20.2 to 202) kΩ 202 kΩ to 2.02 MΩ (2.02 to 20.2) MΩ (20.2 to 202) MΩ 202 MΩ to 2.02 GΩ	13 µΩ/Ω + 4.1 µΩ 8 µΩ/Ω + 17 µΩ 7.8 µΩ/Ω + 58 µΩ 7.2 µΩ/Ω + 0.58 mΩ 7.4 µΩ/Ω + 5.8 mΩ 7.5 µΩ/Ω + 58 mΩ 9.1 µΩ/Ω + 1 Ω 13 µΩ/Ω + 0.1 kΩ 43 µΩ/Ω + 10 kΩ 0.52 mΩ/Ω + 1 MΩ	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure [1] (High Voltage Mode)	Up to 20.2 MΩ (20.2 to 202) MΩ 202 MΩ to 2.02 GΩ (2.02 to 20.2) GΩ	16 μΩ/Ω + 10 Ω 68 μΩ/Ω + 1 kΩ 0.16 mΩ/Ω + 0.1 MΩ 0.54 mΩ/Ω + 10 MΩ	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Resistance – Source [1,6] (Fixed Points)	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	40 μΩ 10 μΩ 0.18 mΩ 0.25 mΩ 0.46 mΩ 1 mΩ 1.9 mΩ 6.8 mΩ 12.8 mΩ 67.5 mΩ 0.13 Ω 0.88 Ω 1.7 Ω 13.6 Ω 35 Ω 0.42 kΩ 0.94 kΩ 10.9 kΩ	Comparison to Fluke 5730A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Resistance – Source [1,6] (Variable Artifact)	1 GΩ 10 GΩ 100 GΩ	1.9 MΩ 47 MΩ 0.95 GΩ	Comparison to IET Labs HRRS Decade Box Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	Up to 2.2 mV		Comparison to Fluke 5730A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
	(10 to 20) Hz	0.25 mV/V + 4 µV	
	(20 to 40) Hz	0.23 mV/V + 4 µV	
	40 Hz to 20 kHz	90 µV/V + 4 µV	
	(20 to 50) kHz	0.21 mV/V + 4 µV	
	(50 to 100) kHz	0.51 mV/V + 5 µV	
	(100 to 300) kHz	1.1 mV/V + 10 µV	
	(300 to 500) kHz	1.5 mV/V + 20 µV	
	500 kHz to 1 MHz	3 mV/V + 20 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.25 mV/V + 4 µV	
	(20 to 40) Hz	9.2 µV/V + 4.3 µV	
	40 Hz to 20 kHz	84 µV/V + 4 µV	
	(20 to 50) kHz	0.2 mV/V + 4 µV	
	(50 to 100) kHz	0.51 mV/V + 5 µV	
	(100 to 300) kHz	1.1 mV/V + 10 µV	
	(300 to 500) kHz	1.7 mV/V + 20 µV	
	500 kHz to 1 MHz	3 mV/V + 20 µV	
	(22 to 220) mV		
	(10 to 20) Hz	0.28 mV/V + 3.3 µV	
	(20 to 40) Hz	0.11 mV/V + 3.9 µV	
	40 Hz to 20 kHz	73 µV/V + 4.3 µV	
	(20 to 50) kHz	0.13 mV/V + 5.4 µV	
	(50 to 100) kHz	0.36 mV/V + 7.8 µV	
	(100 to 300) kHz	0.68 mV/V + 18 µV	
	(300 to 500) kHz	1.4 mV/V + 25 µV	
	500 kHz to 1 MHz	2.9 mV/V + 21 µV	
	220 mV to 2 V		
	(10 to 20) Hz	0.26 mV/V + 8.9 µV	
	(20 to 40) Hz	96 µV/V + 6.8 µV	
	40 Hz to 20 kHz	42 µV/V + 10 µV	
	(20 to 50) kHz	64 µV/V + 19 µV	
	(50 to 100) kHz	68 µV/V + 67 µV	
	(100 to 300) kHz	0.35 mV/V + 85 µV	
	(300 to 500) kHz	1.1 mV/V + 95 µV	
	500 kHz to 1 MHz	1.8 mV/V + 0.25 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(2 to 22) V (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) V (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 (220 to 1 100) V (15 to 50) Hz 50 Hz to 1 kHz	 0.24 mV/V + 0.49 mV 90 µV/V + 0.19 mV 46 µV/V + 2.3 µV 73 µV/V + 1.9 µV 94 µV/V + 16 µV 0.29 mV/V + 0.2 mV 1.1 mV/V + 4.4 µV 1.9 mV/V + 92 µV 0.26 mV /V + 7.4 µV 61 µV/V + 7.9 mV 48 µV/V + 2.1 mV 75 µV/V + 2.5 mV 160 µV/V + 3 mV 0.9 mV/V + 16 mV 4.4 mV/V + 40 mV 8 mV/V + 80 mV 0.3 mV/V + 16 mV 70 µV/V + 11 mV	Comparison to Fluke 5730A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Voltage – Source [1]	(330 to 1 020) V (3 to 5) Hz (5 to 10) Hz 10 Hz to 10 kHz	 2.5 mV/V + 75 mV 0.87 mV/V + 75 mV 0.14 mV/V + 80 mV	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Harmonics – Source [1] (2^{nd} to 50^{th}) (10 to 45) Hz (45 to 65) Hz (65 to 500) Hz 500 Hz to 5 kHz (5 to 10) kHz	 32 mV to 33 V 33 mV to 1 000 V 33 mV to 1 000 V 330 mV to 1 000 V (3.3 to 1 000) V	 0.35 mV/V + 16 µV 0.21 mV/V + 16 µV 0.21 mV/V + 16 µV 0.21 mV/V + 0.21 mV 0.21 mV/V + 1.2 mV	Comparison to Fluke 5522A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC High Voltage – Measure [1]	(1 to 10) kV (50 to 60) Hz (10 to 100) kV (50 to 60) Hz	 0.12 kV 1.2 kV	Comparison to Hipotronics KVM-100 High Voltage Meter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Voltage – Measure [1]	Up to 12.12 mV 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (12.12 to 121.2) mV 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz	 0.22 mV/V + 1.9 µV 0.29 mV/V + 1.9 µV 0.3 mV/V + 1.9 µV 2.9 mV/V + 1.9 µV 10 mV/V + 4.3 µV 20 mV/V + 4.3 µV 39 µV/V + 3.8 µV 77 µV/V + 4.1 µV 0.19 mV/V + 3.1 µV 0.29 mV/V + 28 µV 1.5 mV/V + 89 µV 10 mV/V + 0.1 mV 15 mV/V + 0.5 mV 40 mV/V + 1 mV 81 mV/V + 1 mV 0.15 V/V + 1 mV	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	121.2 mV to 12.12 V 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz (12.12 to 121.2) V 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (121.2 to 1 050) V 1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	 71 µV/V + 0.62 µV 0.12 mV/V + 0.15 µV 0.22 mV/V + 84 nV 0.52 mV/V + 0.57 mV 2.4 mV/V + 1.9 µV 11 mV/V + 22 µV 20 mV/V + 16 µV 50 mV/V + 25 µV 90 mV/V + 0.11 mV 0.16 V/V + 0.11 mV 73 µV/V + 0.48 mV 95 µV/V + 0.21 mV 0.23 mV/V + 0.81 mV 0.54 mV/V + 4.7 mV 3.5 mV/V + 50 mV 10 mV/V + 0.5 V 92 µV/V + 25 mV 95 µV/V + 0.21 mV 0.22 mV/V + 24 mV 0.53 mV/V + 98 mV	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Current – Source [1]	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	 0.25 mA/A + 16 nA 0.17 mA/A + 10 nA 0.11 mA/A + 8.2 nA 0.32 mA/A + 12 nA 1.1 mA/A + 65 nA 0.27 mA/A + 12 nA 0.18 mA/A + 7.5 nA 0.13 mA/A + 5.5 nA 0.25 mA/A + 25 nA 1.4 mA/A + 4.9 nA	Comparison to Fluke 5730A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	(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 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.26 mA/A + 0.4 µA 0.17 mA/A + 0.35 µA 0.11 mA/A + 0.34 µA 0.21 mA/A + 0.54 µA 1.1 mA/A + 5 µA 0.26 mA/A + 3.9 µA 0.17 mA/A + 3.4 µA 0.12 mA/A + 2.2 µA 0.21 mA/A + 3.4 µA 1.1 mA/A + 9.7 µA 0.25 mA/A + 34 µA 0.47 mA/A + 77 µA 7.1 mA/A + 0.14 mA	Comparison to Fluke 5730A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Current – Source [1]	(3 to 12) A (3 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (12 to 30) A (3 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	 0.37 mA/A + 1 mA 0.3 mA/A + 0.5 mA 0.37 mA/A + 0.8 mA 2.5 mA/A + 1 mA 1 mA/A + 10 mA 0.7 mA/A + 8 mA 5 mA/A + 8 mA	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Current – Source [1]	Up to 50 A (6 to 10) kHz Up to 100 A (3 to 6) kHz Up to 300 A (1 to 3) kHz Up to 1 000 A 300 Hz to 1 kHz Up to 2 500 A (10 to 300) Hz	 0.8 % of reading 0.75 % of reading 0.7 % of reading 0.8 % of reading 0.6 % of reading	Comparison to Fluke 52120A Transconductance Amplifier with 25-turn Coil Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	Up to 120 A (10 to 65) Hz (65 to 300) Hz 300 Hz to 1 kHz	 0.012 % of reading + 19 mA 0.023 % of reading + 28 mA 0.078 % of reading + 94 mA	Comparison to Fluke 52120A Transconductance Amplifier Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Current Harmonics – Source [1] (2^{nd} to 50^{th}) (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	Comparison to Fluke 5522A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Current – Measure [1]	Up to 20.2 µA 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz 20.2 µA to 20.2 mA 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (20.2 to 202) mA 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz 202 mA to 2.02 A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	 2 mA/A + 2.8 nA 2 mA/A + 2.8 nA 2 mA/A + 2.8 nA 0.32 mA/A + 20 nA 0.56 mA/A + 17 nA 0.77 mA/A + 15 nA 4 mA/A + 1 µA 0.32 mA/A 0.55 mA/A + 0.11 µA 0.76 mA/A + 0.19 µA 0.27 mA/A + 0.1 mA 0.52 mA/A + 0.1 mA 0.71 mA/A + 0.1 mA	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure [1]	(2.02 to 20.2) A 10 Hz to 2 kHz (2 to 10) kHz (20.2 to 30.2) A 10 Hz to 2 kHz (2 to 10) kHz	 0.8 mA/A + 0.52 mA 0.8 mA/A + 0.51 mA 0.8 mA/A + 12 mA 1.2 mA/A + 12 mA	Comparison to Fluke 8588A 8.5 Digit Multimeter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Capacitance – Measure [1] 42 Hz to 5 MHz	0.32 pF to 370 mF	1.1 mF/F	Comparison to Hioki 3532-50 LCR Meter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Capacitance – Source [1] (Simulation)	(0.2 to 1.2) nF (1.2 to 12) nF (12 to 120) nF (0.12 to 1.2) µF (1.2 to 12) µF (12 to 120) µF (0.12 to 1.2) mF (1.2 to 12) mF (12 to 120) mF	0.12 % of reading + 2 pF 0.12 % of reading + 5 pF 0.13 % of reading + 30 pF 0.13 % of reading + 0.3 nF 0.13 % of reading + 3 nF 0.15 % of reading + 25 nF 0.25 % of reading + 0.25 µF 0.25 % of reading + 3 µF 0.5 % of reading + 30 µF	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase – Measure [1]	Up 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°	Comparison to Clark Hess 6000A Phase Meter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
DC Power – Source [1]	10 mW to 330 W 330 W to 3 kW (3 to 30) kW	0.005 4 % of reading 0.035 % of reading 0.1 % of reading	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
AC Power – Source [1]	100 µW to 9 W (9 to 33) W (33 to 90) W (90 to 330) W (330 to 900) W 900 W to 3 kW (3 to 30) kW	0.027 % of reading 0.043 % of reading 0.035 % of reading 0.05 % of reading 0.039 % of reading 0.052 % of reading 0.099 % of reading	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1]			Comparison to Fluke 5560A/SC2100 Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
DC Voltage (50 Ω)	(-6.6 to 6.6) V	0.25 % of reading + 40 µV	
DC Voltage (1 MΩ)	(-120 to 120) V	0.05 % of reading + 40 µV	
AC Voltage (50 Ω)	1 mVp-p to 6.6 Vp-p	0.25 % of reading + 40 µV	
AC Voltage (1 MΩ)	1 mVp-p to 130 Vp-p	0.1 % of reading + 40 µV	
Leveled Sine Wave			
50 kHz to 10 MHz	5 mVp-p to 5.5 Vp-p	1.5 % of reading + 0.1 mV	
(10 to 600) MHz	5 mVp-p to 5.5 Vp-p	3 % of reading + 0.1 mV	
600 MHz to 1.1 GHz	5 mVp-p to 3.5 Vp-p	4 % of reading + 0.1 mV	
(1.1 to 2.1) GHz	5 mVp-p to 3.5 Vp-p	5 % of reading + 0.1 mV	
Time Markers	500 ps to 5 s	0.000 25 % of reading	
Wave Generator (50 Ω)	1 mVp-p to 6.6 Vp-p	3 % of reading + 0.1 mV	
Wave Generator (1 MΩ)	1 mVp-p to 120 Vp-p	3 % of reading + 0.1 mV	
Pulse Generator – Width	4 ns to 0.5 µs	2 ns	
Pulse Generator – Period	0.2 µs to 22 ms	0.000 25 % of reading	
Input Impedance Measure	(40 to 60) Ω 500 kΩ to 1.5 MΩ	0.1 % of reading 0.1 % of reading	
Electrical Simulation of RTD Indicating Devices [1]	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	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices [1]	Pt 3926, 100 Ω		Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
	(-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	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	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 Indicating Devices [1]	Pt 385, 1 000 Ω		Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
	(-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		
	(-80 to 260) °C	0.03 °C	
	Cu 428, 50 Ω		
	(-180 to 200) °C	0.4 °C	
	Cu 428, 100 Ω		
	(-180 to 40) °C	0.4 °C	
	(40 to 200) °C	0.65 °C	
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure [1]	Type K		Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.13 °C	
	(-25 to 120) °C	0.11 °C	
	(120 to 1 000) °C	0.21 °C	
	(1 000 to 1 372) °C	0.35 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.13 °C	
	(-30 to 150) °C	0.11 °C	
	(150 to 760) °C	0.14 °C	
	(760 to 1 200) °C	0.2 °C	
	Type E		
	(-250 to -100) °C	0.4 °C	
	(-100 to -35) °C	0.14 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.16 °C	
	(650 to 1 000) °C	0.21 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure [1]	Type T		Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
	(-250 to -150) °C	0.6 °C	
	(-150 to 0) °C	0.21 °C	
	(0 to 120) °C	0.13 °C	
	(120 to 400) °C	0.11 °C	
	Type S		
	(0 to 250) °C	0.42 °C	
	(250 to 1 000) °C	0.31 °C	
	(1 000 to 1400) °C	0.32 °C	
	(1 400 to 1 767) °C	0.41 °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	0.25 °C	
	(150 to 650) °C	0.21 °C	
	(650 to 1 000) °C	0.26 °C	
	(1 000 to 1 800) °C	0.45 °C	
	(1 800 to 2 316) °C	0.79 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.2 °C	
	(800 to 900) °C	0.11 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.15 °C	
	(-25 to 120) °C	0.12 °C	
	(120 to 410) °C	0.11 °C	
	(410 to 1 300) °C	0.2 °C	
	Type R		
	(0 to 250) °C	0.51 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.27 °C	
	(1 000 to 1767) °C	0.34 °C	
	Type U		
	(-200 to 0) °C	0.4 °C	
	(0 to 600) °C	0.11 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source [1] (Simulation)	(13 to 120) µH (0.12 to 1.2) mH (1.2 to 12) mH (12 to 120) mH (0.12 to 1.2) H (1.2 to 12) H (12 to 120) H	0.2 % of reading + 0.2 µH 0.12 % of reading + 1 µH 0.12 % of reading + 10 µH 0.12 % of reading + 0.1 mH 0.15 % of reading + 1 mH 0.2 % of reading + 10 mH 0.25 % of reading + 0.1 H	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Inductance – Source [1] (Variable Artifact)	(1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	22 mH/H 11 mH/H 6 mH/H 3 mH/H	Comparison to General Radio 1490-D Decade Inductor Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Ionizers [1] Decay Time Float Voltage	 (0.1to 999.9) s (-1 100 to 1 100) V	 0.2 s 3.1 V	Comparison to Trek 156A Charged Plate Monitor Oshkosh, WI
ESD Simulators Rise Time Peak Current 30 ns Current 60 ns Current RC Time Constant	 700 ps to 1 ns (7.5 to 30) A (4 to 16) A (2 to 8) A 600 ns 300 ns	 0.14 ns 50 mA/A 0.1 A/A 0.12 A/A 20 ns 15 ns	Tektronix TDS684B Oscilloscope with EM Test CTR2 ESD Target; IEC 61000-4-2, SAE J1113-13 Oshkosh, WI

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transient Generators			Oscilloscope, High Voltage Differential Probe, Current Probe; IEC 61000-4-5, IEC 61000-4-12, IEC 61000-4-18. Oshkosh, WI
Rise Time			
Open Circuit	75 ns to 10 µs	1.5 % of reading + 0.12 µs	
Closed Circuit	75 ns to 10 µs	0.69 % of reading + 79 ns	
Duration/Pulse Width			
Open Circuit	(50 to 700) µs	0.058 % of reading + 0.28 µs	
Closed Circuit	(20 to 320) µs	0.12 % of reading + 34 ns	
Peak Voltage	(0.5 to 6) kV	1.6 % of reading + 9.5 V	
Peak Current	12.5 A to 3 kA	2.2 % of reading + 0.2 A	
Frequency	5 kHz to 1 MHz	0.12 % of reading + 1.6 Hz	
Defibrillators	Up to 360 J	0.41 % of reading + 0.77 J	Comparison to Oscilloscope, Tektronix P6015 High Voltage Probe, Digital Multimeter, Power Resistor Oshkosh, WI
Current Injection Probes	9 kHz to 400 MHz	0.22 dB	VNA, VNA Calibration Kit; IEC 61000-4-6. Oshkosh, WI
EFT/Burst Generator			Oscilloscope, 50 Ω Attenuator, 1 kΩ Attenuator; IEC 61000-4-4. Oshkosh, WI Stacy, MN
Peak Voltage			
50 Ω	Up to 4 kV	5.7 % of reading + 1.2 V	
1 kΩ	Up to 4 kV	3.9 % of reading + 1.7 V	
Rise Time	(5 to 5.5) ns	1.4 % of reading + 77 ps	
Pulse Width	(45 to 50) ns	0.21 % of reading + 65 ps	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Measure [1,4] Absolute Level	(20 to 30) dBm 100 kHz to 3 GHz (3 to 18) GHz (18 to 26.5) GHz (-20 to 20) dBm 100 kHz to 3 GHz (3 to 18) GHz (18 to 26.5) GHz	 0.37 dB 0.39 dB 0.4 dB 0.15 dB 0.18 dB 0.21 dB	Comparison to Agilent N5531S Measuring Receiver with N5532A Sensor Modules Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
RF Power – Measure [1] Relative Level	(3.05 to 6.6) GHz (-90 to +30) dBm (-113 to -90) dBm (6.6 to 13.2) GHz (-81 to +30) dBm (-104 to -81) dBm (13.2 to 19.2) GHz (-70 to +30) dBm (-93 to -70) dBm	 0.026 dB + 0.005 dB/10 dB 0.067 dB + 0.12 dB/10 dB 0.026 dB + 0.005 dB/10 dB 0.062 dB + 0.12 dB/10 dB 0.026 dB + 0.005 dB/10 dB 0.056 dB + 0.12 dB/10 dB	Comparison to Agilent N5531S Measuring Receiver with N5532A Sensor Modules Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
RF Power – Measure [1] Relative Level	(19.2 to 26.5) GHz (-62 to +30) dBm (-85 to -62) dBm	 0.026 dB + 0.005 dB/10 dB 0.051 dB + 0.12 dB/10 dB	Comparison to Agilent N5531S Measuring Receiver with N5532A Sensor Modules Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Source [1,4] 250 kHz to 40 GHz	Rate: DC to 100 kHz Depths: (0 to 100) %	7.1 % of reading	Comparison to Agilent E8257D Signal Generator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Amplitude Modulation – Measure [1,4] 100 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 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) % Rate: 50 Hz to 100 kHz Depths: (5 to 20) %	2.2 % of reading 1.2 % of reading 4.2 % of reading 3.5 % of reading 6 % of reading	Comparison to Agilent N5531S Measuring Receiver with N5532A Sensor Modules Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Phase Modulation – Source [1,4] Rate: DC to 100 kHz	250 kHz to 40 GHz	5.9 % of reading + 0.1 rad	Comparison to Agilent E8257D Signal Generator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Level – Measure [1,4] Absolute Level	500 kHz to 3.05 GHz (16 to 30) dBm (-106 to 16) dBm (-129 to –106) dBm (3.05 to 6.6) GHz (20 to 30) dBm (-90 to 20) dBm (-114 to -90) dBm (6.6 to 13.2) GHz (20 to 30) dBm (-81 to 20) dBm (-104 to -81) 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 0.39 dB + 0.005 dB/10 dB 0.18 dB + 0.005 dB/10 dB 0.23 dB + 0.12 dB/10 dB 0.39 dB + 0.005 dB/10 dB 0.18 dB + 0.005 dB/10 dB 0.23 dB + 0.12 dB/10 dB	Comparison to Agilent N5531S Measuring Receiver with N5532A Sensor Modules Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Tuned RF Level – Measure [1,4] Absolute Level	(13.2 to 19.2) GHz (+20 to +30) dBm (-70 to +20) dBm (-93 to -70) dBm (19.2 to 26.5) GHz (+20 to +30) dBm (-62 to +20) dBm (-85 to -62) dBm 500 kHz to 3.05 GHz (-90 to +30) dBm (-106 to -90) dBm (-129 to -106) 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 0.4 dB + 0.005 dB/10 dB 0.21 dB + 0.005 dB/10 dB 0.24 dB + 0.12 dB/10 dB 0.026 dB + 0.005 dB/10 dB 0.067 dB + 0.12 dB/10 dB 0.076 dB + 0.12 dB/10 dB	Comparison to Agilent N5531S Measuring Receiver with N5532A Sensor Modules Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
RF Power – Source [1]	> -10 dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (-10 to -70) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (-70 to -90) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz	 0.72 dB 0.96 dB 1.1 dB 0.89 dB 1.1 dB 1.2 dB 0.95 dB 1.2 dB 1.21 dB	Comparison to Agilent E8257D Signal Generator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors – Calibration Factor [1,4]	(-20 to +14) dBm 100 kHz to 10 MHz 10 MHz to 10 GHz (10 to 18) GHz	 1.5 % of reading 1.5 % of reading 1.7 % of reading	Comparison to Tegam 1827 Power Sensor Calibrator, Agilent 3458A 8.5 Digit Multimeter, Agilent E8257D Signal Generator, Agilent E4419B Power Meter, Agilent 3325B Function Generator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Frequency Modulation – Measure [1,4] 250 kHz to 10 MHz 10 MHz to 3 GHz (3 to 26.5) GHz	 Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	 3.1 % of reading 3.1 % of reading 7.7 % of reading	Comparison to Agilent N5531S Measuring Receiver with N5532A Sensor Modules Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Frequency Modulation – Source [1,4] 250 kHz to 40 GHz	1 dB Rate: DC to 100 kHz 3 dB Rate: DC to 10 MHz	4.2 % of reading + 20 Hz	Comparison to Agilent E8257D Signal Generator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pulse Generation – Measure [1,4] DC to 225 MHz Pulse Width Rise/Fall Time	 5 ns to 1 000 000 s 5 ns to 1 000 000 s	 1.1 ns 1.1 ns	Comparison to Agilent 53132A Counter Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Pulse Generation – Source [1,4] Repetition Frequency: 24 mHz to 14.28 MHz Period: 70 ns to 42 s	10 ns to 42 s	1.7 ns	Comparison to Agilent E8257D Signal Generator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Impulse Spectral Amplitude Source CISPR Band A CISPR Band B CISPR Band C and Band D CISPR Band E Sine Wave Output Accuracy CISPR	 (10 to 150) kHz > 150 kHz to 30 MHz > 30 MHz to 1 GHz (> 1 to 40) GHz 60 dB/µV 10 kHz to 40 GHz	 0.81 dB 0.74 dB 0.78 dB 1.1 dB 0.32 dB	Comparison to Schwarzbeck IGUU 2918 Pulse Generator, Keysight E8257D Signal Generator Oshkosh, WI Stacy, MN

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Line Impedance Stabilization Network [1,4]			Vector Network Analyzer, Attenuators, VNA Cal Kit; ANSI C63.4, CISPR 25, CISPR 16-1-2, DO-160G, MIL-STD 461G Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Insertion Loss	(-20 to 0) dB 9 kHz to 400 MHz	0.25 dB	
Impedance – Magnitude	100 mΩ to 1 kΩ 9 kHz to 400 MHz	5.6 % of reading	
Impedance – Phase	(-180 to 180)° 9 kHz to 400 MHz	5.3°	
Isolation (De-coupling Factor)	(-90 to 0) dB 9 kHz to 400 MHz	0.37 dB	
Coupling/De-coupling Network [1,4]			Vector Network Analyzer, Attenuators, VNA Cal Kit; IEC 61000-4-6, CISPR 16-1-2 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Insertion Loss	(-20 to 0) dB 9 kHz to 230 MHz	0.25 dB	
Impedance – Magnitude	100 mΩ to 1 kΩ 9 kHz to 230 MHz	5.6 % of reading	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks [2]	Up to 30 in	(3.8 + 0.93L) µin	Mahr 828 Measuring Machine; ASME B89.1.9 Oshkosh, WI

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks [2]	Up to 11 in	(5.7 + 1.2*L*) µin	P & W Universal Labmaster®; ASME B89.1.9 Oshkosh, WI Rockford, IL
Gage Blocks [2]	Up to 20 in	(8.5 + 1*L*) µin	ULM 600 Measuring Machine; ASME B89.1.9 Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH
Length Standards [2]	Up to 24 in	(12 + 1*L*) µin	ULM 600 Measuring Machine; ASME B89.1.1 Fenton, MO Stacy, MN Rockford, IL Monroe, NC
Length Standards [2]	Up to 39 in	(12 + 1*L*) µin	Mahr 828 Measuring Machine; ASME B89.1.1 Oshkosh, WI
Length Standards [2]	(39 to 70) in	(390 + 2.6*L*) µin	Comparison to CMM Oshkosh, WI Stacy, MN
Length Standards [2]	Up to 4 in	(53 + 0.4*L*) µin	Comparison to Plug Gage Comparator Crestline, OH Tahlequah, OK

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Cylindrical Rings [2]	(0.02 to 18) in	(8 + 1.8*D*) µin	Mahr 828 Measuring Machine; ASME B89.1.6 Oshkosh, WI
Cylindrical Rings [1,2]	(0.25 to 8) in	(12 + 3*D*) µin	Fowler Lab Concept Measuring Machine; ASME B89.1.6 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Cylindrical Plugs [2]	Up to 30 in	(2.7 + 6*D*) µin	Comparison to Mahr 828 Measuring Machine Oshkosh, WI
Cylindrical Plugs [1,2]	Up to 4 in	(53 + 0.4*D*) µin	Comparison to Plug Gage Comparator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Rings [2] Pitch Diameter Minor Diameter	Up to Setting plug size Up to 16 in Up to 9 in	$(240 + 0.3D)$ µin 120 µin	Setting Plug Gages, Measuring Machine, ID Bore Gages; ASME B1.2 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Non-Standard Thread Rings [2] Pitch Diameter Minor Diameter	 Up to 14 in Up to 9 in	 $(120 + 2.5D)$ µin 120 µin	Mahr ULM 600 Measuring Machine; ID Bore Gages, ASME B1.2 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC
NPT Rings (Standoff and Basic Length)	(0.062 5 to 8) in	250 µin	NPT Plugs, P&W Labmaster®, P&W Laser Ruler; ASME B1.20.5, ASME B1.20.1 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
NPT Plugs (Standoff and Basic Length)	(0.062 5 to 6) in	490 µin	NPT Rings, P&W Labmaster®, P&W Laser Ruler; ASME B1.20.5, ASME B1.20.1 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH
Thread Plugs [2] Pitch Diameter Major Diameter	 Up to 24 in Up to 24 in	 (73 + 0.9*D*) µin (40 + 1.2*D*) µin	P&W Supermicrometer®, Thread Measuring Wires; ASME B1.2 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC
Thread Plugs [1,2] Pitch Diameter Major Diameter	 Up to 4 in Up to 4 in	 (73 + 3.2*D*) µin (53 + 4.1*D*) µin	Comparison to Plug Gage Comparator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Thread Wires [2]	Up to 0.5 in	(11 + 1.5*D*) µin	Mahr ULM 600 Measuring Machine; ASME B89.1.17 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers [1,2]	Up to 80 in	(380 + 15*L*) µin	Comparison to Gage Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Indicators [1,2]	Up to 4 in	(36 + 10*L*) µin	Comparison to Indicator Checker Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Test Indicators [1]	Up to 0.06 in	39 µin	Comparison to Indicator Checker Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
OD Micrometers [1,2]	Up to 60 in	(72 + 12*L*) µin	Comparison to Gage Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
ID Micrometer [1,2]	(1.5 to 40) in	(370 + 7*L*) µin	Comparison to Gage Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Height Gages [1,2]	Up to 40 in	(96 + 14*L*) µin	Comparison to Gage Blocks, Surface Plate Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Bore Gages [1]	(0.25 to 12) in	45 µin	Comparison to Cylindrical Rings Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Crimpers [1] Die Check Crimp Height	 (0.011 to 0.5) in (0.01 to 0.5) in	 230 µin 0.001 2 in	Comparison to Pin Gages, Micrometer Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Profilometers [1]	(2 to 300) µin Ra	2.2 µin	Comparison to Roughness Specimen Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Surface Plates [1,2] Repeat Reading Overall Flatness	 (4 to 34) in*DL* (34 to 175) in*DL*	 35 µin (92 + 0.14*DL*) µin	In accordance with ASME B89.3.7 using Repeat-O-Meter Electronic Levels Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Pi Tapes Diameter	Up to 204 in	0.000 14 % of reading + 260 µin	Comparison to Renishaw Laser Measuring System w/Microscope Oshkosh, WI
Profilometer Reference Specimens	(0.01 to 9 500) µin Ra	1.3 µin	Comparison to Mahr VD280 Profilometer Oshkosh, WI

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
CMM Calibration [1,2] Volumetric Linearity	(5 to 40) in (1 to 60) in > 60 in	(12 + 14*L*) µin (7 + 14*L*) µin (20 + 0.4*L*) µin	Ball Bars, Step Gage, Renishaw Laser System, B89.4.10 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Linear Measurements	Up to 1 560 in	(38 + 0.5*L*) µin	Comparison to Renishaw Laser System Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Optical Comparators [1,2] Linearity of Table Travel Magnification	Up to 30 in 10x, 20x, 31.25x, 50x, 62.5x, 100x, 200x	(97 + 12*L*) µin 460 µin	Comparison to Glass Scale, Precision Balls, Calibration Sphere Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Roundness Testers [1] Axial Error Radial Error	(-1 000 to 1 000) µm (-1 000 to 1 000) µm	0.15 µm 0.15 µm	Comparison to Test Sphere Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
ULMs [1] (Length)	Up to 100 mm	0.19 µm	Comparison to Gage Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Thickness Gages [1]	Up to 0.06 in Up to 6 in	380 µin 380 µin	Comparison to Film Thickness Standards, Gage Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Brinell Scopes [1]	(1 to 6) mm	11 µm	Comparison to Stage Micrometer Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Measuring Devices [2] Protractors Inclinometers	 Up to 90° Up to 1°	 0.000 73 % of reading + 0.000 12° 0.009 8 % of reading + 0.000 16°	Comparison to Gage Blocks, Sine Bar, Granite Square Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Analytical Balances [1,5]	Up to 12 kg	0.000 31 % of reading + 12 µg	ASTM E617 Class 1 Weights and NIST Handbook 44 utilized in the calibration of the weighing system. Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Bench and Floor Scales [1,5]	Up to 1 000 lb	0.001 6 % of reading + 0.000 4 lb	NIST 105 Class F Weights and NIST Handbook 44 utilized in the calibration of the weighing system. Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Mass – Avoirdupois	50 lb 20 lb 5 lb 2 lb 1 lb 0.5 lb 1 oz	59 mg 58 mg 5.8 mg 5.8 mg 5.8 mg 5.8 mg 9.5 µg	Class 1 Weights and Analytical Balance; Modified Substitution Oshkosh, WI (Class 4 and below) Fenton, MO (Class F Only) Stacy, MN (Class F Only) Monroe, NC (Class 4 and below)

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass – SI	25 000 g 20 000 g 5 000 g 3 000 g 2 000 g 1 000 g 500 g 300 g 200 g 100 g 50 g 30 g 20 g 10 g 5 g 3 g 2 g 1 g 500 mg 200 mg 100 mg 50 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	0.29 g 0.29 g 5.9 mg 5.8 mg 5.8 mg 5.8 mg 5.8 mg 5.8 mg 0.11 mg 97 µg 95 µg 94 µg 11 µg 9.3 µg 3.8 µg 2.8 µg 2.4 µg 2.4 µg 2 µg 1.6 µg 1.6 µg 1.6 µg 1.7 µg 1.7 µg 1.7 µg 1.8 µg 1.7 µg 1.6 µg	Class 1 Weights and Analytical Balance; Modified Substitution Oshkosh, WI (Class 4 and below) Fenton, MO (Class F Only) Stacy, MN (Class F Only) Monroe, NC (Class 4 and below)
Gauge Pressure Devices [1]	Up to 854 inH_2O	0.03 % of reading + 0.000 044 inH_2O	Comparison to Ametek PK2 Deadweight Tester Oshkosh, WI

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute Pressure Devices	(0.2 to 25) psia (25 to 500) psia	0.001 2 % of reading 0.002 7 % of reading + 0.000 4 psi	Comparison to Ruska 2465 Deadweight Tester Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Gauge Pressure Devices	(500 to 3 000) psig	0.003 % of reading + 0.000 9 psi	Comparison to Ruska 2470 Deadweight Tester Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Gauge Pressure Devices	Up to 600 psig (600 to 40 000) psig	0.005 3 % of reading + 0.002 1 psi 0.008 % of reading	Comparison to Budenberg BGH2600 Deadweight Tester Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Gauge Pressure Devices	(40 000 to 60 000) psig	36 psi	Comparison to Additel Hydraulic Pump, Digital Pressure Test Gauge Oshkosh, WI

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vacuum Devices	(> 0 to 0.1) Torr (> 0.1 to 1) Torr	0.56 % of reading + 0.022 mTorr 0.26 % of reading + 0.55 mTorr	Comparison to MKS Capacitance Manometers Oshkosh, WI
Durometers Spring Force	Up to 100 Duro	0.1 Duro	Direct Verification per ASTM D2240 using Durometer Calibrator, Triple Beam Balance
Indenter Dimensions Indenter Angle	(20 to 40)°	0.11°	Video Measuring Machine
Indenter Radius	Up to 0.1 in	160 µin	Video Measuring Machine Gage Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC
Indenter Length	Up to 0.198 in	22 µin	
Durometer Test Blocks Types A, D	Up to 100 Duro	1.2 Duro	Comparison to Rex Reference Durometer, Rex Operating Stand Oshkosh, WI
Durometer Calibrator Type A	Up to 822 g	0.034 % of reading + 20 mg	Comparison to Dead Weights
Type B	Up to 10 lb	0.005 9 g	Oshkosh, WI

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Brinell Hardness Testers [1] Verification of Test Force	(500, 750, 1 500, 2 000, 3 000) kgf	0.072 % of reading + 4.2 kgf	Partial Direct Verification per ASTM E10 using Morehouse Proving Ring, Video Measuring Machine Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Brinell Hardness Testers [1]	(50 to 650) HBW	1.2 % of reading + 3.2 HBW	Indirect Verification per ASTM E10 using Brinell Test Blocks and Brinell Scope Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Knoop and Vickers Hardness Testers [1]	HK0.05 (250 to 650) HK > 650 HK HK0.1 (250 to 650) HK > 650 HK HK0.3 (250 to 650) HK > 650 HK HK0.5 (250 to 650) HK > 650 HK HK1.0 (250 to 650) HK > 650 HK	 11 HK 27 HK 11 HK 25 HK 11 HK 18 HK 14 HK 17 HK 11 HK 16 HK	Indirect Verification per ASTM E384 using Knoop and Vickers Test Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Knoop and Vickers Hardness Testers [1]	HV0.05 (250 to 650) HV > 650 HV HV0.1 (250 to 650) HV > 650 HV HV0.3 (250 to 650) HV > 650 HV HV0.5 (250 to 650) HV > 650 HV HV1.0 (250 to 650) HV > 650 HV	 10 HK 39 HK 9 HK 30 HK 10 HK 18 HK 7 HK 17 HK 7 HK 14 HK	Indirect Verification per ASTM E384 using Knoop and Vickers Test Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Leeb Hardness Tester [1]	(300 to 900) LD	7.3 LD	Indirect Verification per ASTM A596 using Leeb Test Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Rockwell Hardness Testers [1]	HRBW Low HRBW Med HRBW High HRA Low HRA Med HRA High	0.77 HRBW 0.79 HRBW 0.71 HRBW 0.56 HRA 0.49 HRA 0.47 HRA	Indirect Verification per ASTM E18 using Rockwell Test Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers [1]	HRC Low HRC Med HRC High HREW Low HREW Med HREW High HRFW Low HRFW Med HRFW High HRHW Low HRHW Med HRHW High HR15N Low HR15N Med HR15N High HR30N Low HR30N Med HR30N High HR45N Low HR45N Med HR45N High HR15TW Low HR15TW Med HR15TW High HR30TW Low HR30TW Med HR30T High HR45TW Low HR45TW Med HR45TW High	0.52 HRC 0.53 HRC 0.54 HRC 0.72 HREW 0.7 HREW 0.64 HREW 0.71 HRFW 0.59 HRFW 0.57 HRFW 0.72 HRH 0.58 HRH 0.6 HRH 0.72 HR15N 0.7 HR15N 0.55 HR15N 0.67 HR30N 0.66 HR30N 0.64 HR30N 0.58 HR45N 0.65 HR45N 0.62 HR45N 0.72 HR15TW 0.74 HR15TW 0.52 HR15TW 0.64 HR30TW 0.65 HR30TW 0.54 HR30TW 0.67 HR45TW 0.69 HR45TW 0.69 HR45TW	Indirect Verification per ASTM E18 using Rockwell Test Blocks Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Devices [1]	Up to 5 lbf (5 to 1 000) lbf (1 000 to 2 000) lbf (2 000 to 5 000) lbf (5 000 to 10 000) lbf (10 000 to 30 000) lbf (30 000 to 100 000) lbf (100 000 to 500 000) lbf	0.009 8 lbf 0.12 lbf 0.47 lbf 0.6 lbf 1.2 lbf 3.5 lbf 12 lbf 0.1 % of reading	Comparison to Load Cells Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Force Devices [1]	Up to 121.5 lbf (121.5 to 500) lbf	0.000 9 % of reading + 0.000 4 lbf 0.003 % of reading + 0.007 lbf	Comparison to Dead Weight Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Wedge Tester [1]	Up to 40 000 N	32 N	Comparison to Load Cell Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Torque Transducers [1]	(0.007 to 40) ozf·in (2.5 to 10) lbf·in (10 to 150) lbf·in (150 to 3 000) lbf·in (3 000 to 24 000) lbf·in	0.048 % of reading 0.014 % of reading 0.002 6 % of reading 0.000 5 % of reading + 0.000 04 lbf·in 0.047 % of reading + 0.034 lbf·in	Comparison to Torque Arms, Dead Weight Oshkosh, WI Fenton, MO Stacy, MN

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools [1]	(2 to 20) ozf·in (15 to 200) ozf·in (4 to 50) lbf·in (50 to 400) lbf·in (400 to 1 000) lbf·in (1 000 to 3 000) lbf·in (3 000 to 7 200) lbf·in (7 200 to 24 000) lbf·in	0.1 % of reading + 0.005 7 ozf·in 0.17 % of reading + 0.000 38 ozf·in 0.29 % of reading + 0.001 1 lbf·in 0.29 % of reading + 0.006 8 lbf·in 0.28 % of reading + 0.028 lbf·in 0.29 % of reading + 0.036 lbf·in 0.28 % of reading + 0.36 lbf·in 0.24 % of reading + 4.9 lbf·in	Comparison to AKO Low Torque System, CDI Torque System Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Viscosity Rotational Viscometers	10 cP 100 cP 500 cP 1 000 cP 5 000 cP 12 500 cP 100 000 cP	0.014 cP/cP 0.014 cP/cP 0.014 cP/cP 0.012 cP/cP 0.012 cP/cP 0.013 cP/cP 0.012 cP/cP	Comparison to Viscosity Solutions, Temperature Bath Oshkosh, WI Stacy, MN Monroe, NC Crestline, OH
Viscosity Cups	17.82 cP 65.28 cP 231 cP	0.03 cP/cP	Viscosity Solutions, Temperature Bath, Stopwatch; ASTM D4212 Oshkosh, WI Stacy, MN
Pipettes [1]	Up to 20 µL (20 to 200) µL (200 to 1 000) µL (1 000 to 5 000) µL (5 000 to 10 000) µL	64 nL 0.6 µL 1.8 µL 8.9 µL 18 µL	Analytical Balance; ISO 8655-6 Oshkosh, WI

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Liquid Volume Measuring Devices	Up to 200 mL (200 to 6 200) mL (6 200 to 61 000) mL	0.39 mL 1.4 mL 6.5 mL	Comparison to Balances Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Foundry Sand Test Equipment / Measurement [1]			
Ultrasonic Cleaner/Scrubber	18 ºF 30 m	1.7 ºF 1.2 s	Comparison to Temperature Calibrator Stopwatch
Wet Tensile Tester	0.449 N/cm² (300 to 320) ºF	0.003 1 N/cm² 2 ºF	Dead Weight Temperature Calibrator
Sand Squeezer	Up to 200 psi	3.8 psi	Proving Ring
Tensile Testers	Up to 10 000 lb	7.2 lb	Load Cell
AFS Clay Tester	Up to 10 min	1.2 s	Stopwatch
Friability Tester	60 s	1.2 s	Stopwatch
Sand Rammer	Up to 2 in	0.01 in	Impact Rings
Moisture Teller	(0 to 300) °F	1.9 °F	Temperature Calibrator
Permmeter	Up to 500 perm	0.43 perm	Perm Standards
Sand Strength Tester	Up to 500 psi Up to 1 000 lb	1.1 psi 4.2 lb	Proving Ring
Core Scratch Tester	Up to 0.1 in	0.006 in	Flatness Block
Green Sand Hardness Tester (B&C)	Up to 0.1 in	0.006 in	Flatness Block Oshkosh, WI

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Flow	50 sccm to 100 slpm	0.38 % of reading + 0.000 22 slpm	Comparison to Fluke molBox/molBloc Calibration System, Mass Flow Controller Stacy, MN
Liquid Flowmeters	(0.4 to 2) lpm	0.16 % of reading + 0.027 lpm	Comparison to Omega FLR1000 Flowmeter Oshkosh, WI
Liquid Flow – Syringe	(1 to 1 500) ml/h	0.074 % of reading + 20 µl/h	Comparison to Syringe Pump, Master Syringe Oshkosh, WI

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Measure [1] (800 to 1 650) nm	(-70 to 20) dBm	0.03 dB/dBm	Comparison to Agilent 81533B Interface, 81525A Optical Head Oshkosh, WI Fenton, MO Stacy, MN

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Source [1] (820, 1 310, 1 550) nm	(-60 to 0) dB	0.05 dB/dB+ 0.05 dB	Comparison to Agilent 81554SM Laser Source Module, 81533B Interface, 81525A Optical Head, 81655A Laser Module, 81570A Optical Attenuator, 81578A Optical Attenuator Oshkosh, WI Fenton, MO Stacy, MN
Optical Attenuation – Source [1] (700 to 1 650) nm	(-60 to 0) dB	0.04 dB/dB+ 0.04 dB	Comparison to Agilent 81570A and 81578A Optical Attenuators Oshkosh, WI Fenton, MO Stacy, MN
Optical Wavelength – Measure [1]	(700 to 1 650) nm	0.05 nm	Comparison to Agilent 86120B Multi-Wavelength Meter Oshkosh, WI Fenton, MO Stacy, MN
Gloss Meters [2] 20°, 60°, 85°	(0 to 100) GU	0.73 GU	Comparison to Standard Gloss Tiles Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Illuminance – Lux Meters	(180 to 1 000) lux (1 000 to 18 000) lux	2.7 % of reading + 1.3 lux 2.1 % of reading + 7.6 lux	Comparison to Illuminance Projector, Photometric Calibration System Oshkosh, WI

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Source (Temperature Measuring Devices)	(-95 to 600) °C (600 to 1200) °C	0.03 °C 2.3 °C	Comparison to Fluke 9011, 9190A Drywells, PRT Type S Probe Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Infrared Thermometers [1,6]	125 °F 200 °F 400 °F 500 °F 900 °F 932 °F	2.3 °F 2.9 °F 4.4 °F 5.2 °F 8.2 °F 8.5 °F	Comparison to Hart Scientific 9132 Blackbody λ = (8 to 14) µm, ε = 0.95 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surface Probes [1]	(35 to 400) °C	1.3 °C	Comparison to Hart Scientific 2200 Temperature Controller, Hot-plate Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Temperature – Measure [1]	(-30 to 600) °C (600 to 1 200) °C	0.03 °C 1.7 °C	Comparison to Hart Scientific 1502 Indicator, PRT Type S Probe Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Thermo-Hygrometers Temperature Humidity	(0 to 70) °C (10 to 98) %RH	0.2 °C 0.9 %RH	Comparison to Thunder Scientific 2500 Two Pressure Chamber Oshkosh, WI Fenton, MO Stacy, MN Monroe, NC

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
System Accuracy Test [1] (SAT)	(0 to 2 200) °F	2.6 °F	Comparison to Certified Thermocouple Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Temperature Uniformity Survey (TUS) [1]	(0 to 2 200) °F	4.9 °F	Comparison to MV 1000 Data Logger or Equivalent Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Time Interval [1]	(1 to 86 400) s	450 µs	Comparison to Agilent 53132A Universal Counter, Spectracom 8197B GPS Oscillator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure [1]	0.1 Hz to 26.5 GHz	7.6 % of reading	Comparison to Agilent N5531S Measuring Receiver, Spectracom 8197B GPS Oscillator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Frequency Reference [1]	10 MHz	24 pHz	Comparison to Spectracom 8197B GPS Oscillator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC
Frequency – Source [1]	0.1 mHz to 40 GHz	4.1 % of reading	Comparison to Agilent 3325B Function Generator, Agilent E8257D Signal Generator, SRS FS725 Frequency Standard Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tachometers [1,2] Contact Non-Contact	(1 to 6 500) rpm (500 to 40 000) rpm	0.08 % of reading 0.08 % of reading	Comparison to King Nutronics 3711-B Tachometer Test Set Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
Tachometers [1,2] Non-Contact	(0.01 to 100 000) rpm	0.005 % of reading	Comparison to Fluke 5560A Multiproduct Calibrator Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK

DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
1D Linear Measure	Up to 24 in	0.000 9 in	Direct Measure using Video Measuring Machine Oshkosh, WI Fenton, MO Stacy, MN

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Surface Finish Measure (Ra)	(0.01 to 600) µin	2.1 µin	Direct Measure using Profilometer Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC Crestline, OH Tahlequah, OK
2D Angular Measure	Up to 180°	0.002 5°	Direct Measure using Starrett AVR300 Oshkosh, WI Fenton, MO Stacy, MN Rockford, IL Monroe, NC

3 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
3D Dimensional Inspection [2] Volumetric Linear	Up to (28 x 40 x 24) in Up to (28 x 40 x 24) in	320 µin (38 + 5.2*L*) µin	Direct Measure using Coordinate Measuring Machine Oshkosh, WI Stacy, MN

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 (k=2), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
2. L = length in inches, D = diameter in inches, DL = diagonal length in inches, ′ = arc-minute, ″ = arc-second, GU = Gloss Unit; rpm = revolutions per minute, ® = Registered Trademark.
3. Where ranges overlap, the uncertainty associated with the higher range begins above the overlapping value.
4. RF/Microwave uncertainties do not include inaccuracies due to sensor mismatch.
5. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The CMC presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
6. The fixed values presented here are approximate values. Actual calibration values will be used at the time of calibration, along with the actual uncertainties.
7. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1272.

Jason Stine, Vice President