CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

Fox Valley Metrology, Ltd.

308 Axminister Drive
Fenton MO 63026

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 field 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-1272.02
Certificate Number

ANAB Approval

Certificate Valid Through: 06/15/2021
Version No. 003 Issued: 03/19/2019

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).

ANSI National Accreditation Board

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.
308 Axminister Drive
Fenton, MO 63026
Caleb Pohlman 636-326-1601

CALIBRATION

Valid to: **June 15, 2021** Certificate Number: **ACT-1272.02**

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	Gen Rad 1562-A Sound Level Calibrator

Chemical Quantities

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH Meters[1]	(4.01, 7, 10) pH	0.02 pH	pH Buffer Solutions
Conductivity Meters[1]	12.85 mS/cm 1 408 µS/cm	0.18 mS/cm 14 µS/cm	Conductivity Solutions
Refractometers[1]	(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[1] 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[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 V to 1.1 kV	12 µV/V + 0.4 µV 5.8 µV/V + 0.7 µV 4.2 µV/V + 2.5 µV 4.1 µV/V + 4 µV 5.8 µV/V + 40 µV 7.6 µV/V + 0.4 mV	Fluke 5720A Multiproduct Calibrator
DC Voltage - Measure[1]	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	7.8 µV/V + 0.8 µV 5.7 µV/V + 0.8 µV 5.6 µV/V + 1 µV 7.9 µV/V + 80 µV 7.9 µV/V + 0.15 mV	Agilent 3458A Opt 002 Multimeter
DC High Voltage - Measure[1]	(1 to 10) kV (10 to 100) kV	60 V 0.6 kV	Hipotronics KVM-100 High Voltage Meter
DC Current - Source[1]	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mV to 2.2 A	0.12 mA/A + 6 nA 42 µA/A + 7 nA 41 µA/A + 40 nA 52 µA/A + 0.7 µA 93 µA/A + 12 µA	Fluke 5720A Multiproduct Calibrator
DC Current - Source[1]	(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[1]	(20.5 to 1 000) A	86 mA/A + 0.5 A	Fluke 5520A Multiproduct Calibrator with 50-turn Coil
DC Current - Measure[1]	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	48 µA/A + 65 pA 35 µA/A + 65 pA 35 µA/A + 0.15 nA 35 µA/A + 1.3 nA 35 µA/A + 10 nA 36 µA/A + 0.1 µA 15 µA/A + 1 µA 0.14 mA/A + 20 µA	Agilent 3458A Opt 002 Multimeter
DC Current - Measure[1]	(1 to 10) A	2.4 mA/A + 0.7 mA	Fluke Multimeter
Resistance - Source[1]	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω	0.11 mΩ 0.11 mΩ 0.21 mΩ 0.27 mΩ 0.51 mΩ 1.4 mΩ	Fluke 5720A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance - Source[1]	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	2.6 mΩ 11 mΩ 21 mΩ 0.11 Ω 0.21 Ω 1.3 Ω 2.7 Ω 24 Ω 48 Ω 0.48 kΩ 1.1 kΩ 23 kΩ	Fluke 5720A Multiproduct Calibrator
Resistance - Source[1]	1 GΩ 10 GΩ 100 GΩ	1.9 MΩ 47 MΩ 0.95 GΩ	IET Labs HRRS Decade Box
Resistance - Measure[1]	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[1]	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	 2.4 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	Fluke 5720A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source[1]	(2.2 to 22) mV		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.61 mV/V + 4 µV	
	(20 to 40) Hz	0.56 mV/V + 4 µV	
	40 Hz to 20 kHz	0.36 mV/V + 4 µV	
	(20 to 50) kHz	0.42 mV/V + 4 µV	
	(50 to 100) kHz	0.70 mV/V + 5 µV	
	(100 to 300) kHz	1.3 mV/V + 10 µV	
	(300 to 500) kHz	1.7 mV/V + 20 µV	
	500 kHz to 1 MHz	3.4 mV/V + 20 µV	
	(22 to 220) mV		
	(10 to 20) Hz	0.29 mV/V + 12 µV	
	(20 to 40) Hz	0.13 mV/V + 7 µV	
	40 Hz to 20 kHz	0.11 mV/V + 7 µV	
	(20 to 50) kHz	0.24 mV/V + 7 µV	
	(50 to 100) kHz	0.54 mV/V + 17 µV	
	(100 to 300) kHz	1.1 mV/V + 20 µV	
	(300 to 500) kHz	1.6 mV/V + 25 µV	
	500 kHz to 1 MHz	3.3 mV/V + 45 µV	
	(0.22 to 2.2) V		
	(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	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source[1]	(22 to 220) V		Fluke 5720A Multiproduct Calibrator
	(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^{nd} to 50^{th}) [1]			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	
AC Voltage - Measure[1] 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	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure[1] Bandwidth < 2 MHz	100 mV to 1 V		Agilent 3458A Opt 002 Multimeter
	(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	
	100 V to 1 kV		
	(1 to 40) Hz	0.52 mV/V + 45 mV	
	40 Hz to 1 kHz	0.52 mV/V + 25 mV	
	(1 to 20) kHz	0.75 mV/V + 25 mV	
	(20 to 50) kHz	1.5 mV/V + 25 mV	
	(50 to 100) kHz	3.5 mV/V + 25 mV	
AC Voltage - Measure[1] Bandwidth < 2 MHz	(1 to 10) kV		Hipotronics KVM-100 High Voltage Meter
	(50 to 60) Hz	0.12 kV	
	(10 to 100) kV		
	(50 to 60) Hz	1.2 kV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure[1] Bandwidth > 2 MHz	Up to 10 mV		Agilent 3458A Opt 002 Multimeter
	45 Hz to 100 kHz	1.2 mV/V + 6 µV	
	100 kHz to 1 MHz	14 mV/V + 5.1 µV	
	(1 to 4) MHz	83 mV/V + 7.1 µV	
	(4 to 8) MHz	0.24 V/V + 8.1 µV	
	(10 to 100) mV		
	45 Hz to 100 kHz	1.1 mV/V + 61 µV	
	100 kHz to 1 MHz	24 mV/V + 51 µV	
	(1 to 4) MHz	47 mV/V + 71 µV	
	(4 to 8) MHz	47 mV/V + 81 µV	
	(8 to 10) MHz	0.18 V/V + 0.1 mV	
	100 mV to 1 V		
	45 Hz to 100 kHz	1.1 mV/V + 0.61 mV	
	100 kHz to 1 MHz	24 mV/V + 0.51 mV	
	(1 to 4) MHz	47 mV/V + 0.71 mV	
	(4 to 8) MHz	47 mV/V + 0.81 mV	
	(8 to 10) MHz	0.18 V/V + 1 mV	
	(1 to 10) V		
	45 Hz to 100 kHz	1.2 mV/V + 6.1 µV	
	100 kHz to 1 MHz	24 mV/V + 5.1 µV	
	(1 to 4) MHz	47 mV/V + 7.1 µV	
	(4 to 8) MHz	47 mV/V + 8.1 µV	
	(8 to 10) MHz	0.18 V/V + 10 µV	
AC Voltage - Measure[1] Bandwidth > 2 MHz	(10 to 100) V		Hipotronics KVM-100 High Voltage Meter
	45 Hz to 100 kHz	1.5 mV/V + 2.5 mV	
	100 V to 1 kV		
	45 Hz to 100 kHz	3.6 mV/V + 0.11 V	
AC Current - Source[1]	Up to 220 µA		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.30 mA/A + 16 nA	
	(20 to 40) Hz	0.20 mA/A + 10 nA	
	40 Hz to 1 kHz	0.16 mA/A + 8 nA	
	(1 to 5) kHz	0.22 mA/A + 12 nA	
	(5 to 10) kHz	1.3 mA/A + 65 nA	
	220 µA to 2.2 mA		
	(10 to 20) Hz	0.31 mA/A + 40 nA	
	(20 to 40) Hz	0.22 mA/A + 35 nA	
	40 Hz to 1 kHz	0.15 mA/A + 35 nA	
	(1 to 5) kHz	0.24 mA/A + 0.11 µA	
	(5 to 10) kHz	1.3 mA/A + 0.65 µA	

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		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.32 mA/A + 0.4 µA	
	(20 to 40) Hz	0.23 mA/A + 0.35 µA	
	40 Hz to 1 kHz	0.15 mA/A + 0.35 µA	
	(1 to 5) kHz	0.24 mA/A + 0.55 µA	
	(5 to 10) kHz	1.3 mA/A + 5 µA	
	(22 to 220) mA		
	(10 to 20) Hz	0.30 mA/A + 4 µA	
	(20 to 40) Hz	0.20 mA/A + 3.5 µA	
	40 Hz to 1 kHz	0.15 mA/A + 2.5 µA	
	(1 to 5) kHz	0.24 mA/A + 3.5 µA	
	(5 to 10) kHz	1.3 mA/A + 10 µA	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.31 mA/A + 35 µA	
	(1 to 5) kHz	0.53 mA/A + 80 µA	
	(5 to 10) kHz	8.1 mA/A + 0.16 mA	
	(2 to 3) A		
	(10 to 45) Hz	2.1 mA/A + 0.1 mA	
	40 Hz to 1 kHz	0.75 mA/A + 0.1 mA	
	(1 to 5) kHz	6.9 mA/A + 1 mA	
	(5 to 10) kHz	29 mA/A + 5 mA	
AC Current - Source[1]	(3 to 11) A		Fluke 5520A Multiproduct Calibrator
	(45 to 100) Hz	0.74 mA/A + 2 mA	
	(0.1 to 1) kHz	1.2 mA/A + 2 mA	
	(1 to 5) kHz	35 mA/A + 2 mA	
	(11 to 20.5) A		
	(45 to 100) Hz	1.4 mA/A + 5 mA	
	(0.1 to 1) kHz	1.8 mA/A + 5 mA	
	(1 to 5) kHz	35 mA/A + 5 mA	
AC Current - Source[1]	(20.5 to 1 000) A		Fluke 5520A Multiproduct Calibrator w/ 50-turn Coil
	(45 to 65) Hz	90 mA/A + 0.5 A	
	(20.5 to 150) A		
	(65 to 440) Hz	0.55 mA/A + 0.5 mA	
AC Current Harmonics - Source[1] (2^{nd} to 50^{th})			Fluke 5520A Multiproduct Calibrator
(10 to 45) Hz	3.3 mA to 3 A	1.1 mA/A + 4 µA	
(45 to 65) Hz	3.3 mA to 20.5 A	0.5 mA/A + 4 µA	
(65 to 500) Hz	33 mA to 20.5 A	1.2 mA/A + 0.1 mA	
500 Hz to 5 kHz	33 mA to 20.5 A	2.3 mA/A + 0.2 mA	
(5 to 10) kHz	(33 to 330) mA	4.6 mA/A + 0.4 mA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Measure[1]	Up to 100 µA		Agilent 3458A Opt 002 Multimeter
	(10 to 20) Hz	4.8 mA/A + 30 nA	
	(20 to 45) Hz	1.9 mA/A + 30 nA	
	(45 to 100) Hz	0.83 mA/A + 30 nA	
	100 Hz to 5 kHz	0.83 mA/A + 30 nA	
	100 µA to 1 mA		
	(10 to 20) Hz	4.9 mA/A + 0.2 µA	
	(20 to 45) Hz	1.9 mA/A + 0.2 µA	
	(45 to 100) Hz	0.83 mA/A + 0.2 µA	
	100 Hz to 5 kHz	0.47 mA/A + 0.2 µA	
	(5 to 20) kHz	0.83 mA/A + 0.2 µA	
	(20 to 50) kHz	4.9 mA/A + 0.4 µA	
	(50 to 100) kHz	6.6 mA/A + 1.5 µA	
	(1 to 10) mA		
	(10 to 20) Hz	4.9 mA/A + 2 µA	
	(20 to 45) Hz	1.9 mA/A + 2 µA	
	(45 to 100) Hz	0.83 mA/A + 2 µA	
	100 Hz to 5 kHz	0.47 mA/A + 2 µA	
	(5 to 20) kHz	0.83 mA/A + 2 µA	
	(20 to 50) kHz	4.9 mA/A + 4 µA	
	(50 to 100) kHz	6.6 mA/A + 15 µA	
	(10 to 100) mA		
	(10 to 20) Hz	4.9 mA/A + 20 µA	
	(20 to 45) Hz	1.9 mA/A + 20 µA	
	(45 to 100) Hz	0.83 mA/A + 20 µA	
	100 Hz to 5 kHz	0.47 mA/A + 20 µA	
	(5 to 20) kHz	0.47 mA/A + 20 µA	
	(20 to 50) kHz	4.9 mA/A + 40 µA	
	(50 to 100) kHz	6.6 mA/A + 0.15 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4.8 mA/A + 0.2 mA	
	(20 to 45) Hz	2 mA/A + 0.2 mA	
	(45 to 100) Hz	1.1 mA/A + 0.2 mA	
	100 Hz to 5 kHz	1.3 mA/A + 0.2 mA	
	(5 to 20) kHz	3.7 mA/A + 0.2 mA	
	(20 to 50) kHz	12 mA/A + 0.4 mA	
AC Current - Measure[1]	(1 to 10) A		Fluke Multimeter
	(20 to 50) Hz	0.23 A/A + 10 mA	
	50 Hz to 2 kHz	36 mA/A + 10 mA	
Capacitance - Measure[1] 42 Hz to 5 MHz	0.32 pF to 370 mF	1.1 mF/F	Hioki 3532-50 LCR Meter

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance - Source[1]	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 (3.3 to 11) mF (11 to 33) mF (33 to 110) 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 5.3 mF/F + 10 µF 8.9 mF/F + 30 µF 13 mF/F + 0.1 mF	Fluke 5520A Multiproduct Calibrator
Phase - Measure[1]	(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
DC Power - Source[1]	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[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 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 – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes[1] DC Voltage (50 Ω)	1 mV to 6.6 V	2.9 mV/V + 40 µV	Fluke 5520A SC1100 Multiproduct Calibrator
DC Voltage (1 MΩ)	1 mV to 130 V	0.55 mV/V +40 µV	
AC Voltage (50 Ω)	1 mV to 6.6 V	2.9 mV/V + 40 µV	
Oscilloscopes[1] AC Voltage (1 MΩ)	1 mV to 130 V	1.1 mV/V + 40 µV	Fluke 5520A SC1100 Multiproduct Calibrator
Leveled Sine Wave 50 kHz to 1.1 GHz	5 mV to 5.5 V	51 mV/V + 0.1 mV	
Time Markers	1 ns to 5 s	6.4 µs/s	
Wave Generator (50 Ω)	1.8 mV to 2.5 V p-p	35 mV/V + 0.1 mV	
Wave Generator (1 MΩ)	1.8 mV to 55 V p-p	35 mV/V + 0.1 mV	
Pulse Generator - Width	(4 to 45) ns (45 to 500) ns	58 ms/s + 0.5 ns 58 ms/s + 4 ns	
Pulse Generator - Period	200 ns to 20 ms	58 ms/s + 0.2 µs	
Input Impedance Measure	(50 to 60) Ω 500 kΩ to 1 MΩ	1.2 mΩ/Ω 1.2 mΩ/Ω	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of RTD Instrumentation[1]	Pt 385, 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	
	(630 to 800) °C	0.23 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °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	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of RTD Instrumentation[1]	Pt 385, 200 Ω		Fluke 5520A Multiproduct Calibrator
	(-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	
	Pt 385, 1 000 Ω		
	(-200 to -80) °C	0.03 °C	
	(-80 to 0) °C	0.03 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.06 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.23 °C	
	PtNi 385, 120 Ω, 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[1]	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	

Electrical Simulation of Thermocouple Instrumentation[1]	Type J (-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C Type E (-250 to -100) °C (-100 to -35) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C Type S (0 to 250) °C (250 to 1 000) °C (1 000 to 1400) °C (1 400 to 1 767) °C Type B (600 to 800) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C Type C (0 to 150) °C (150 to 650) °C (650 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2316) °C Type L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C Type N (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	 0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23°C 0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C 0.63 °C 0.24 °C 0.16 °C 0.14 °C 0.47 °C 0.36 °C 0.37 °C 0.46 °C 0.44 °C 0.34 °C 0.3 °C 0.33 °C 0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C 0.37 °C 0.26 °C 0.17 °C 0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	Fluke 5520A Multiproduct Calibrator
Electrical Simulation of Thermocouple Instrumentation[1]	Type R (0 to 250) °C (250 to 400) °C	 0.57 °C 0.35 °C	Fluke 5520A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
	(400 to 1 000) °C (1 000 to 1 767) °C Type U (-200 to 0) °C (0 to 600) °C	0.33 °C 0.4 °C 0.56 °C 0.27 °C	
Inductance - Source[1]	(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	General Radio 1490-D Decade Inductor
Ionizers[1] Decay Time Float Voltage	 (0.1to 999.9) s (-1 100 to 1 100) V	 0.2 s 3.1 V	Trek 156A Charged Plate Monitor

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power – Measure[1,4] 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
Relative Level (3.05 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 19.2) GHz (19.2 to 26.5) GHz	 (-90 to +30) dBm (-113 to -90) dBm (-81 to +30) dBm (-104 to -81) dBm (-70 to +30) dBm (-93 to -70) dBm (-62 to +30) dBm (-85 to -62) 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 0.026 dB + 0.005 dB/10 dB 0.051 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
Amplitude Modulation - Source[1,4] Rate: DC to 100 kHz Depths: 0 % to 100 %	250 kHz to 40 GHz	7.1 % of setting + 1 % of reading	Agilent E8257D Signal Generator
Amplitude Modulation - Measure[1,4]			Agilent N5531S Measuring Receiver with N5532A Sensor Modules
100 kHz to 10 MHz	Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	2.2 % of reading	
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depths: 20 % to 99 %	1.2 % of reading	
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 20 %	4.2 % of reading	
(3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depths: 20 % to 99 %	3.5 % of reading	
(3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 20 %	6 % of reading	
Phase Modulation - Source[1,4] Rate: DC to 100 kHz	250 kHz to 40 GHz	5.9 % setting + 0.1 rad	Agilent E8257D Signal Generator
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	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
Tuned RF Level - Measure[1,4] Absolute Level (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	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
(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	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tuned RF Level - Measure[1,4] Absolute Level (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	Agilent N5531S Measuring Receiver with N5532A Sensor Modules
Tuned RF Level - Measure[1,4] 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
RF Power - Source[1] 250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz 250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz 250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz	 > -10 dBm (-10 to -70) dBm (-70 to -90) dBm	 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	Agilent E8257D Signal Generator
RF Power Sensors- Calibration Factor[1,4] 100 kHz to 10 MHz 10 MHz to 10 GHz (10 to 18) GHz	 (-20 to +14) dBm	 1.5 % of reading 1.5 % of reading 1.7 % of reading	Tegam 1827 Power Sensor Calibrator, Agilent 3458A Multimeter, Agilent E8257D Signal Generator, Agilent E4419B Power Meter, Agilent 3325B Function Generator
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	Agilent N5531S Measuring Receiver with N5532A Sensor Modules

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency Modulation - Source[1,4] 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[1,4] DC to 225 MHz Pulse Width Rise/Fall Time	 5 ns to 10^5 s 5 ns to 10^5 s	 1.1 ns 1.1 ns	Agilent 53132A Counter
Pulse Generation - Source[1,4] 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

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Gage Blocks[2]	Up to 10 in	(3.9 + 1.3*L*) µin	LabMaster Universal Measuring Machine Per ASME B89.1.9
	(10 to 20) in	(8.5 + 1*L*) µin	ULM 600 Measuring Machine Per ASME B89.1.9
	Up to 20 in	(3.9 + 1.3*L*) µin	Mahr 828 Measuring Machine Per ASME B89.1.9
Length Standards[2]	Up to 9 in	(39 + 0.4*L*) µin	P&W Supermicrometer
	(9 to 24) in	(12 + 1*L*) µin	ULM 600 Measuring Machine
	(24 to 70) in	(390 + 2.6*L*) µin	CMM
Cylindrical Rings[2]	(0.25 to 8) in (0.025 to 12) in	(13 + 1.3*D*) µin (13 + 1.8*D*) µin	LabMaster Universal ULM 600 Measuring Machine ASME B89.1.6

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Cylindrical Rings[1,2]	(0.25 to 5) in	(12 + 3*D*) µin	Fowler Lab Concept Measuring Machine ASME B89.1.6
Cylindrical Plugs[2]	(0.010 to 8) in	(2.7 + 6*D*) µin	LabMaster Universal
Cylindrical Plugs[1,2]	(0.010 to 4) in	(53 + 0.4*D*) µin	Plug gage Comparator
Thread Rings[2] Pitch Diameter Pitch Diameter Minor Diameter	 Up to 8 in Up to 8 in Up to 8 in	 (240 + 0.3*D*) µin 38 µin 120 µin	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 µin	NPT Plugs, P&W LabMaster ASME B1.20.5
NPT Plugs Standoff and Basic Length	(0.062 5 to 6) in	490 µin	NPT Rings, P&W LabMaster ASME B1.20.5
Tapered Thread Gages[1,2]	(0.25 to 5) in	(53 + 6.2*D*) µin	Universal Supermicrometer ASME B1.20.5
Threaded Plugs[2] Pitch Diameter Major Diameter	 (0.01 to 10) in (0.01 to 10) in	 (73 + 0.9*D*) µin (40 + 1.2*D*) µin	P&W Supermicrometer, Thread Measuring Wires ASME B1.2
Threaded Plugs[1,2] Pitch Diameter Major Diameter	 (0.01 to 4) in (0.01 to 4) in	 (73 + 3.2*D*) µin (53 + 4.1*D*) µin	Plug gage Comparator
Calipers[1,2]	Up to 80 in	(380 + 15*L*) µin	Gage Blocks
Indicators[1,2]	Up to 4 in	(36 + 10*L*) µin	Indicator Checker
Test Indicators[1]	Up to 0.06 in	39 µin	Indicator Checker
OD Micrometers[1,2]	Up to 60 in	(72 + 12*L*) µin	Gage Blocks
ID Micrometer[1,2]	(1.5 to 40) in	(370 + 7*L*) µin	Gage Blocks
Height Gages[1,2]	Up to 40 in	(96 + 14*L*) µin	Gage Blocks
Bore Gages[1]	(0.25 to 12) in	350 µin	Cylindrical Rings

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Crimpers[1] Die Check Crimp Height	(0.011 to 0.5) in (0.01 to 0.5) in	230 µin 0.001 2 in	Pin Gages Micrometer
Profilometers[1] Ra	(2 to 300) µin	2.2 µin	Roughness Specimen
Surface Plates[1,2] Repeat Reading Overall Flatness	(4 to 34) in *DL* (34 to 175) in *DL*	(30 + 0.2*DL*) µin (66 + 0.2*DL*) µin	Repeat – O – Meter Electronic Levels
Optical Comparators[1,2] Linearity Magnification	Up to 12 in 10x, 20x, 31.25x, 50x, 62.5x, 100x, 200x	(97 + 12*L*) µin 0.000 46 in	Glass Scale Precision Balls Calibration Sphere
Roundness Testers[1,2] Axial Error Radial Error	(-1 000 to 1 000) µm	0.15 µm 0.15 µm	Test Sphere
ULMs[1,2] Length	(1 to 100) mm	0.19 µm	Gage Blocks
Film Thickness Gages[1]	(0.01 to 0.06) in	380 µin	Film Thickness Standards
Brinell Scopes[1]	(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[1]	Up to 120 lb Up to 5 000 lb	0.000 7 lb/lb	NIST 105 Class F Weights NIST Handbook 44
Analytical Balances[1]	Up to 13 kg	0.19 µg/g	ASTM E617 Class 1 Weights NIST Handbook 44
Pressure[1]	(-13 to 300) psi (300 to 1 000) psi	0.1 psi 1.3 psi	Pressure Calibrator
Pressure[1]	(1 000 to 10 000) psi (10 000 to 30 000) psi	3.9 psi 35 psi	Pressure Transducers

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Direct Verification per ASTM D2240 of Durometers[1]	Up to 100 duro	0.35 duro	Durometer Calibrator
Spring Force	(0.1 to 45) N	0.05 N	Triple Beam Balance, Video Measuring Machine
Indenter Angle	(20 to 40) °	0.07 °	
Indenter Length	(0.049 to 0.198) in	330 µin	Gage Blocks
Indenter Radius	(0.05 to 0.1) in	340 µin	

Rockwell Hardness Testers[1]	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 HRKW Low HRKW Med HRKW High HRMW Low HRMW Med HRMW High HR15N Low HR15N Med HR15N High HR30N Low HR30N Med HR30N High HR45N Low HR45N Med HR45N 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 1.4 HRKW 1.3 HRKW 1.3 HRKW 1.4 HRMW 1. 4 HRMW 1.3 HRMW 1.5 HR15N 1.3 HR15N 0.9 HR15N 1.3 HR30N 1.3 HR30N 0.9 HR30N 1.4 HR45N 1.3 HR45N 0.95 HR45N	Indirect Verification per ASTM E18 using Rockwell Test Blocks
Rockwell Hardness Testers[1]	HR15TW Low HR15TW Med HR15TW High	2 HR15TW 1.4 HR15TW 1.5 HR15TW	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
	HR30TW Low HR30TW Med HR30T High HR45TW Low HR45TW Med HR45TW High	2 HR30TW 1.5 HR30TW 1.3 HR30TW 2 HR45TW 1.3 HR45TW 1.4 HR45TW	
Force[1]	(0.001 to 200) lb (200 to 10 000) lb (10 000 to 50 000) lb	0.05 % of reading 0.07 % of reading 0.1 % of reading	Dead Weight Load Cell Load Cell
Force	1 g to 500 lb (500 to 1 000) lb (1 000 to 10 000) lb (10 000 to 100 000) lb	0.05 % reading 0.03 % reading 0.03 % reading 0.04 % reading	Dead Weight, Proving Ring
Torque Tools[1]	4 lbf·in to 2 000 lbf·ft	0.3 % of reading	CDI Torque System
Viscosity Rotational Viscometers	500 cP 5 000 cP	0.02 cP/cP	Viscosity Solutions, Temperature Bath
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[1] (800 to 1 650) nm	(-70 to +20) dBm	0.03 dB/dBm	Agilent 81533B Interface, 81525A Optical Head
Optical Power - Source[1] (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

Photometry and Radiometry

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Attenuation - Source[1] (700 to 1 650) nm	(-60 to 0) dB	0.04 dB/dB	Agilent 81570A and 81578A Optical Attenuators
Optical Wavelength - Measure[1]	(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[1]	(-95 to 140) °C	0.03 °C	Fluke 9190A Drywell with PRT
Temperature - Measure[1]	(-30 to 600) °C	0.03 °C	Hart Scientific 1502 Indicator with PRT
System Accuracy Test[1] (SAT)	(0 to 2 200) °F	2.6 °F	Certified Thermocouple
Temperature Uniformity Survey[1] (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[1]	(1 to 86 400) s	0.000 45 s	Agilent 53132A Counter & Spectracom 8197B GPS Oscillator
Frequency Measure[1]	0.1 Hz to 225 MHz	6.7 parts in 10^{-11} Hz	Agilent 53132A Counter & Spectracom 8197B GPS Oscillator
Frequency Measure[1]	0.1 Hz to 26.5 GHz	6.7 parts in 10^{-11} Hz	Agilent N5531S Measuring Receiver, SRS FS725 Frequency Standard
Frequency Source[1]	10 MHz	6.7 parts in 10^{-11} Hz	SRS FS725 Frequency Standard

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency Source[1]	0.1 mHz to 40 GHz	6.7 parts in 10^{-11} Hz	Agilent 3325B Function Generator, Agilent E8257D Signal Generator, SRS FS725 Frequency Standard
Tachometers[1] 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[1] Non-Contact	(0.01 to 100 000) rpm	0.005 % of reading	Fluke 5520A Multiproduct Calibrator

DIMENSIONAL MEASUREMENT

Dimensional 2D

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 + 5.2*L*) µin	Vision System
Surface Finish, (Ra)	(0.01 to 300) µin	2.1 µin	Profilometer

Dimensional 3D

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 µin (38 + 5.2*L*) µin	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. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1272.02.

Vice President