CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

Angel's Instrumentation, A Transcat Company

928 Canal Drive
Chesapeake, VA 23323

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

ISO/IEC 17025:2005

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

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

AC-2489.21
Certificate Number

ANAB Approval

Certificate Valid Through: 09/07/2021
Version No. 002 Issued: 01/24/2019

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

ANSI National Accreditation Board

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005, ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3-2006 (R2013)

ANGEL'S INSTRUMENTATION, A TRANSCAT COMPANY

928 Canal Drive
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CALIBRATION

Valid to: **September 7, 2021** Certificate Number: **AC-2489.21**

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Vibration – Measure Voltage Sensitivity @ 100 Hz	10 mV/g	2 %	Dytran Instruments 3120B & Signal Conditioner
Frequency Response	(20 to 100) Hz	1.6 %	
	(100 to 2 500) Hz	1.4 %	
	(2500 to 10 000) Hz	2.8 %	
Sound – Generate @ 1kHz	110 dB	0.42 dB	SPL Calibrator

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
pH – Measuring Equipment[3], Fixed Points	4 pH	0.44 %	pH solutions
	7 pH	0.37 %	
	10 pH	0.35 %	

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Conductivity – Measuring Equipment[3], Fixed Points	25 µS/cm	5.4 %	Conductivity solutions
	1 015 µS/cm	1.9 %	
	1 408 µS/cm	1.7 %	
Gas Detection Equipment[1] – Carbon Monoxide Indicators	0.002 % CO	0.82 %	Standard gases
	0.01 % CO	0.84 %	
	0.1 % CO	0.87 %	
	0.5 % CO	0.60 %	
Propane LEL Indicators	50 % LEL	0.66 %	
H_2S (Hydrogen Sulfide)	0.0025 % H_2S	1.5 %	
O_2 (Oxygen)	18 % O_2	0.5 %	
Isobutylene	0.01 % Isobutylene	1.1 %	
CO_2	0.5 % CO_2	0.8 %	
	5 % CO_2	0.8 %	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
DC Voltage – Generate[1]	(0 to 220) mV	1.3 µV	Fluke 5730A-03 Multifunction Calibrator
	(0.22 to 2.2) V	5.9 µV	
	(2.2 to 11) V	40 µV	
	(11 to 22) V	75 µV	
	(22 to 220) V	560 µV	
	(220 to 1 100) V	7 100 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
DC Voltage – Measure[1]	Up to 200 mV	1 µV	Fluke 8508A opt 001 Reference DMM
	200 mV to 20 V	36 µV	
	(20 to 200) V	550 µV	
	(200 to 1 000) V	5 600 µV	
DC High Voltage – Measure[1]	Up to 40 kV	2%	Fluke 80k40HV probe, Fluke 8508A opt 001, Reference DMM
DC Current – Generate[1]	0.1 nA to 220 µA	12 nA	Fluke 5730A-03 Multifunction Calibrator
	(0.22 to 2.2) mA	90 nA	
	(2.2 to 22) mA	820 nA	
	(22 to 220) mA	5.9 µA	
	(0.22 to 2.2) A	110 µA	
	(2.2 to 3) A	0.9 mA	Fluke 5520A SC1100 Multifunction Calibrator
	(3 to 11) A	4.1 mA	
	(11 to 20.5) A	14 mA	
	(20 to 1000) A	0.5 % + 0.5 A	Fluke 5520A w/ COIL
	(20 to 100) A	0.04 %	SR-100/ Fluke 8508A
DC Current – Measure[1]	Up to 2 mA	2.1 µA	Fluke 8508A opt 001 Reference DMM
	(2 to 20) mA	2.2 µA	
	(20 to 100) mA	8.5 µA/A	Fluke 8508A opt 001 w/ Shunts
	100 mA to 1 A	8.5 µA/A + 6 µA	
	(1 to 15) A	40 µA/A + 8 µA	
	(15 to 100) A	0.04 % + 24 µA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Resistance – Measure[1]	Up to 2 Ω	20 μΩ	Fluke 8508A opt 001 Reference DMM
	(2 to 20) Ω	0.1 mΩ	
	(0.02 to 200) kΩ	0.80 Ω	
	(0.2 to 2) MΩ	9.6 Ω	
	(2 to 20) MΩ	0.18 kΩ	
	(20 to 200) MΩ	7.2 kΩ	
	(0.2 to 2) GΩ	0.26 GΩ	
Resistance[1] – Generate	Up to 11 Ω	7 mΩ	Fluke 5520A SC1100 Multifunction Calibrator
	(11 to 33) Ω	1.7 mΩ	
	(33 to 110) Ω	3.1 mΩ	
	(110 to 330) Ω	19 mΩ	
	(0.33 to 1.1) kΩ	34 mΩ	
	(1.1 to 3.3) kΩ	0.20 Ω	
	(3.3 to 11) kΩ	0.29 Ω	
	(11 to 33) kΩ	1.3 Ω	
	(33 to 110) kΩ	2.9 Ω	
	(110 to 330) kΩ	14 Ω	
	(0.33 to 1.1) MΩ	31 Ω	
	(1.1 to 3.3) MΩ	0.23 kΩ	
	(3.3 to 11) MΩ	1.2 kΩ	
	(11 to 33) MΩ	7.1 kΩ	
	(33 to 110) MΩ	40 kΩ	
	(110 to 330) MΩ	0.66 MΩ	
	(330 to 1 100) MΩ	12 MΩ	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Resistance[1] – Generate	0 Ω	42 µΩ	Fluke 5730-03 Multifunction Calibrator
	1 Ω	98 µΩ	
	1.9 Ω	0.19 mΩ	
	10 Ω	0.25 mΩ	
	19 Ω	0.47 mΩ	
	100 Ω	1.1 mΩ	
	190 Ω	2.0 mΩ	
	1 kΩ	6.8 mΩ	
	1.9 kΩ	13 mΩ	
	10 kΩ	68 mΩ	
	19 kΩ	0.13 Ω	
	100 kΩ	0.88 Ω	
	190 kΩ	1.8 Ω	
	1 MΩ	14 Ω	
	1.9 MΩ	35 Ω	
	10 MΩ	0.42 kΩ	
	19 MΩ	0.96 kΩ	
	100 MΩ	12 kΩ	
	1 Ω	7.1 µΩ/Ω	Fluke 742A-1 Fluke 742A-10k Resistance Standards
	10 kΩ	4.3 µΩ/Ω	
High Resistance – Generate[3]	(1 to 1 000) MΩ	0.2 %	Biddle 72-6346-1 Decade resistor
	(1 to 100 GΩ)	1 %	
	1 GΩ	110 µΩ/Ω	Fluke 8508A-7000k Reference DMM

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Capacitance – Generate[1]	(0.19 to 3.3) nF	11 pF	Fluke 5520A SC1100 Multifunction Calibrator
	(3.3 to 11) nF	26 pF	
	(11 to 110) nF	0.26 nF	
	(110 to 330) nF	0.74 nF	
	(0.33 to 1.1) µF	2.6 nF	
	(1.1 to 3.3) µF	7.3 nF	
	(3.3 to 11) µF	27 nF	
	(11 to 33) µF	0.11 µF	
	(33 to 110) µF	0.42 µF	
	(110 to 330) µF	1.2 µF	
	(0.33 to 1.1) mF	4.2 µF	
	(1.1 to 3.3) mF	12 µF	
	(3.3 to 11) mF	40 µF	
	(11 to 33) mF	0.18 mF	
	(33 to 110) mF	0.8 mF	
Capacitance – Measure[1]			Genrad 1689 RLC Digibridge – The CMC is only valid at 1 kHz
12 Hz to 100 kHz	400 pF to 25 µF	0.02 % + 1 digit	
	(25 to 100) µF	0.05 % + 1 digit	
12 Hz to 100 kHz	(100 to 500) µF	0.05 % + 1 digit	
	(0.5 to 1) mF	0.09 % + 1 digit	
Inductance – Measure[1]			Genrad 1689 RLC – The CMC is only valid at 1 kHz
12 Hz to 100 kHz	1 mH to 10 H	0.02 % + 1 digit	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
AC Voltage – Generate[1]	(Up to 2.2) mV		Fluke 5730A-03 Multifunction Calibrator
	(10 to 20) Hz	4.8 µV	
	(20 to 40) Hz	4.5 µV	
	(0.04 to 20) kHz	4.5 µV	
	(20 to 50) kHz	5.1 µV	
	(50 to 100) kHz	6.5 µV	
	(100 to 300) kHz	13 µV	
	(300 to 500) kHz	24 µV	
	(0.5 to 1) MHz	52 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	9 µV	
	(20 to 40) Hz	6.1 µV	
	(0.04 to 20) kHz	6.0 µV	
	(20 to 50) kHz	8.5 µV	
	(50 to 100) kHz	16 µV	
	(100 to 300) kHz	32 µV	
	(300 to 500) kHz	49 µV	
	(0.5 to 1) MHz	0.11 mV	
	(22 to 220) mV		
	(10 to 20) Hz	61 µV	
	(20 to 40) Hz	26 µV	
	(0.04 to 20) kHz	20 µV	
	(20 to 50) kHz	34 µV	
	(50 to 100) kHz	81 µV	
	(100 to 300) kHz	0.16 mV	
	(300 to 500) kHz	0.31 mV	
	(0.5 to 1) MHz	0.6 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
AC Voltage – Generate[1]	(220 mV to 2.2) V		Fluke 5730A-03 Multifunction Calibrator
	(10 to 20) Hz	0.53 mV	
	(20 to 40) Hz	0.21 mV	
	(0.04 to 20) kHz	0.11 mV	
	(20 to 50) kHz	0.16 mV	
	(50 to 100) kHz	0.21 mV	
	(100 to 300) kHz	0.78 mV	
	(300 to 500) kHz	2.3 mV	
	(0.5 to 1) MHz	3.8 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	5.3 mV	
	(20 to 40) Hz	2.1 mV	
	(0.04 to 20) kHz	1.1 mV	
	(20 to 50) kHz	1.6 mV	
	(50 to 100) kHz	2 mV	
	(100 to 300) kHz	6 mV	
	(300 to 500) kHz	22 mV	
	(0.5 to 1) MHz	35 mV	
	(22 to 220) V		
	(10 to 20) Hz	53 mV	
	(20 to 40) Hz	21 mV	
	(0.04 to 20) kHz	12 mV	
	(20 to 50) kHz	19 mV	
	(50 to 100) kHz	35 mV	
	(100 to 300) kHz	62 mV	
	(300 to 500) kHz	0.18 V	
	(0.5 to 1) MHz	0.26 V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
AC Voltage – Generate[1]	(220 to 1100) V (15 to 50) Hz	0.32 V	Fluke 5730A-03 Multifunction Calibrator
	50 Hz to 1 kHz	78 mV	
	(220 to 330) V (1 to 10) kHz	46 mV	Fluke 5520A SC1100 Multifunction Calibrator
	(10 to 20) kHz	56 mV	
	(20 to 50) kHz	71 mV	
	(50 to 100) kHz	0.3 V	
	(330 to 1020) V (1 to 5) kHz	0.18 V	
	(5 to 10) kHz	0.21 V	
Wideband Amplitude[1] 30 Hz to 500 kHz	(0.3 to 1.1) mV	6.9 µV	Fluke 5730A-03 Multifunction Calibrator
	(1.1 to 3) mV	12 µV	
	(3 to 11) mV	52 µV	
	(11 to 33) mV	0.14 mV	
	(33 to 110) mV	0.43 mV	
	(110 to 330) mV	1.1 mV	
	(0.33 to 1.1) V	3.6 mV	
	(1.1 to 3.5) V	5.7 mV	
Wideband Flatness[1] Up to 1.1 mV	(10 to 30) Hz	2.1 µV	
	(30 to 120) Hz	0.89 µV	
	(0.12 to 1.2) kHz	0.83 µV	
	(1.2 to 12) kHz	0.83 µV	
	(12 to 120) kHz	0.83 µV	
	(0.12 to 1.2) MHz	3.7 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Wideband Flatness[1] Up to 1.1 mV	(1.2 to 2) MHz	3.6 µV	Fluke 5730A-03 Multifunction Calibrator
	(2 to10) MHz	4.8 µV	
	(10 to 20) MHz	6.2 µV	
	(20 to 30) MHz	23 µV	
(1.1 to 3.3) mV	(10 to 30) Hz	4.2 µV	
	(30 to 120) Hz	1.6 µV	
	(0.12 to 1.2) kHz	1.6 µV	
	(1.2 to 12) kHz	1.6 µV	
	(12 to 120) kHz	1.6 µV	
	(0.12 to 1.2) MHz	3.6 µV	
	(1.2 to 2) MHz	3.8 µV	
	(2 to10) MHz	6.6 µV	
	(10 to 20) MHz	6.2 µV	
(3.3 to 11) mV	(10 to 30) Hz	21 µV	
	(30 to 120) Hz	7.6 µV	
	(0.12 to 1.2) kHz	7.6 µV	
	(1.2 to 12) kHz	7.6 µV	
	(12 to 120) kHz	7.6 µV	
	(120 to 1.2) MHz	9.7 µV	
	(1.2 to 2) MHz	9.7 µV	
	(2 to10) MHz	19 µV	
	(10 to 20) MHz	36 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
AC Voltage[1] – Measure	Up to 220 mV (1 to 10) Hz	0.017 % + 70 µV	Fluke 8508A opt 001 Reference DMM
	220 mV to 220 V (1 to 10) Hz	0.015 % + 60 µV	
	(220 to 1000) V (1 to 10) Hz	0.015 % + 70 µV	
	600 µV to 2.2 mV (10 to 20) Hz	0.17 % + 1.3 µV	Fluke 5790A-03 AC Measurement Standard
	(20 to 40) Hz	0.074 % + 1.3 µV	
	(0.04 to 20) kHz	0.042 % + 1.3 µV	
	(20 to 50) kHz	0.081 % + 2 µV	
	(50 to 100) kHz	0.12 % + 2.5 µV	
	(100 to 300) kHz	0.23 % + 4 µV	
	(300 to 500) kHz	0.24 % + 8 µV	
	(0.5 to 1) MHz	0.35 % + 8 µV	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.07 % + 1 µV	Fluke 5790A-03 AC Measurement Standard
	(1.2 to 2) MHz	0.07 % + 1 µV	
	(2 to 10) MHz	0.17 % + 1 µV	
	(10 to 20) MHz	0.3 % + 1 µV	
	(20 to 30) MHz	0.7 % + 2 µV	
(2.2 to 7) mV	(10 to 20) Hz	0.085 % + 1.3 µV	
	(20 to 40) Hz	0.037 % + 1.3 µV	
	(0.04 to 20) kHz	0.021 % + 1.3 µV	
	(20 to 50) kHz	0.04 % + 2 µV	
	(50 to 100) kHz	0.06 % + 2.5 µV	
	(100 to 300) kHz	0.12 % + 4 µV	
	(300 to 500) kHz	0.13 % + 8 µV	
	(0.5 to 1) MHz	0.23% + 8 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.07 % + 1 µV	Fluke 5790A-03 AC Measurement Standard
	(1.2 to 2) MHz	0.07 % + 1 µV	
	(2 to 10) MHz	0.1 % + 1 µV	
	(10 to 20) MHz	0.17 % + 1 µV	
	(20 to 30) MHz	0.37 % + 1 µV	
(7 to 22) mV	(10 to 20) Hz	0.029 % + 1.3 µV	
	(20 to 40) Hz	0.019 % + 1.3 µV	
	(0.04 to 20) kHz	0.011 % + 1.3 µV	
	(20 to 50) kHz	0.021 % + 2 µV	
	(50 to 100) kHz	0.031 % + 2.5 µV	
	(100 to 300) kHz	0.081 % + 4 µV	
	(300 to 500) kHz	0.089 % + 8 µV	
	(0.5 to 1) MHz	0.17 % + 8 µV	
Wideband Flatness - 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.07 %	
	(1.2 to 2) MHz	0.07 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.17 %	
	(20 to 30) MHz	0.37 %	
(22 to 70) mV	(10 to 20) Hz	0.024 % + 1.5 µV	
	(20 to 40) Hz	0.012 % + 1.5 µV	
	(0.04 to 20) kHz	65 µV/V + 1.5 µV	
	(20 to 50) kHz	0.013 % + 2 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
(22 to 70) mV	(50 to 100) kHz	0.026 % + 2.5 µV	Fluke 5790A-03 AC Measurement Standard
	(100 to 300) kHz	0.051 % + 4 µV	
	(300 to 500) kHz	0.067 % + 8 µV	
	(0.5 to 1) MHz	0.11 % + 8 µV	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.05 %	
	(1.2 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	
(70 to 220) mV	(10 to 20) Hz	0.021 % + 1.5 µV	
	(20 to 40) Hz	85 µV/V + 1.5 µV	
	(0.04 to 20) kHz	38 µV/V + 1.5 µV	
	(20 to 50) kHz	69 µV/V + 2 µV	
	(50 to 100) kHz	0.016 % + 2.5 µV	
	(100 to 300) kHz	0.025 % + 4 µV	
	(300 to 500) kHz	0.038 % + 8 µV	
	(0.5 to 1) MHz	0.1 % + 8 µV	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.05 %	
	(1.2 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
(220 to 700) mV	(10 to 20) Hz	0.021 % + 1.5 µV	Fluke 5790A-03 AC Measurement Standard
	(20 to 40) Hz	76 µV/V + 1.5 µV	
	(0.04 to 20) kHz	33 µV/V + 1.5 µV	
	(20 to 50) kHz	51 µV/V + 2 µV	
	(50 to 100) kHz	79 µV/V + 2.5 µV	
	(100 to 300) kHz	0.018 % + 4 µV	
	(300 to 500) kHz	0.03 % + 8 µV	
	(0.5 to 1) MHz	0.096 % + 8 µV	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.05 %	
	(1.2 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	
700 mV to 2.2 V	(10 to 20) Hz	0.021 % + 1.5 µV	
	(20 to 40) Hz	76 µV/V + 1.5 µV	
	(0.04 to 20) kHz	33 µV/V + 1.5 µV	
	(20 to 50) kHz	51 µV/V + 2 µV	
	(50 to 100) kHz	79 µV/V + 2.5 µV	
	(100 to 300) kHz	0.018 % + 4 µV	
	(300 to 500) kHz	0.03 % + 8 µV	
	(0.5 to 1) MHz	0.096 % + 8 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.05 %	Fluke 5790A-03 AC Measurement Standard
	(1.2 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	
(2.2 to 7) V	(10 to 20) Hz	0.02%	
	(20 to 40) Hz	67 µV/V	
	(0.04 to 20) kHz	24 µV/V	
	(20 to 50) kHz	48 µV/V	
	(50 to 100) kHz	81 µV/V	
	(100 to 300) kHz	0.02 %	
	(300 to 500) kHz	0.04 %	
	(0.5 to 1) MHz	0.12 %	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	(0.5 to 1.2) MHz	0.05 %	
	(1.2 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	
(7 to 22) V	(10 to 20) Hz	0.02 %	
	(20 to 40) Hz	67 µV/V	
	(0.04 to 20) kHz	27 µV/V	
	(20 to 50) kHz	48 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
(7 to 22) V	(50 to 100) kHz	81 µV/V	Fluke 5790A-03 AC Measurement Standard
	(100 to 300) kHz	0.02%	
	(300 to 500) kHz	0.04%	
	(0.5 to 1) MHz	0.12%	
(22 to 70) V	(10 to 20) Hz	0.02%	
	(20 to 40) Hz	68 µV/V	
	(0.04 to 20) kHz	32 µV/V	
	(20 to 50) kHz	57 µV/V	
	(50 to 100) kHz	94 µV/V	
	(100 to 300) kHz	0.02%	
	(300 to 500) kHz	0.04%	
	(0.5 to 1) MHz	0.12%	
(70 to 220) V	(10 to 20) Hz	0.02%	
	(20 to 40) Hz	68 µV/V	
	(0.04 to 20) kHz	31 µV/V	
	(20 to 50) kHz	69 µV/V	
	(50 to 100) kHz	98 µV/V	
	(100 to 300) kHz	0.02%	
	(300 to 500) kHz	0.05%	
(220 to 700) V	(10 to 20) Hz	0.02%	
	(20 to 40) Hz	99 µV/V	
	(0.04 to 20) kHz	41 µV/V	
	(20 to 50) kHz	0.01%	
	(50 to 100) kHz	0.05%	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
(700 to 1 000) V	(10 to 20) Hz	0.02%	Fluke 5790A-03 AC Measurement Standard
	(20 to 40) Hz	99 µV/V	
	(0.04 to 20) kHz	38 µV/V	
	(20 to 50) kHz	0.01%	
	(50 to 100) kHz	0.05%	
AC Current[1]– Generate	Up to 220 µA		Fluke 5730A-03 Multifunction Calibrator
	(10 to 20) Hz	0.025 % + 16 nA	
	(20 to 40) Hz	0.016 % + 10 nA	
	(0.04 to 1) kHz	0.01 % + 8 nA	
	(1 to 5) kHz	0.028 % + 12 nA	
	(5 to 10) kHz	0.11 % + 65 nA	
	(0.22 to 2.2) mA		
	(10 to 20) Hz	0.025 % + 40 nA	
	(20 to 40) Hz	0.016 % + 35 nA	
	(0.04 to 1) kHz	0.01 % + 35 nA	
	(1 to 5) kHz	0.02 % + 110 nA	
	(5 to 10) kHz	0.11 % + 650 nA	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.025 % + 400 nA	
	(20 to 40) Hz	0.016 % + 350 nA	
	(0.04 to 1) kHz	0.01 % + 350 nA	
	(1 to 5) kHz	0.02 % + 550 nA	
	(5 to 10) kHz	0.11 % + 5 000 nA	
	(22 to 220) mA		
	(10 to 20) Hz	0.025 % + 4 µA	
	(20 to 40) Hz	0.016 % + 3.5 µA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
AC Current[1] – Generate	(0.04 to 1) kHz	0.01 % + 2.5 µA	Fluke 5730A-03 Multifunction Calibrator
	(1 to 5) kHz	0.02 % + 3.5 µA	
	(5 to 10) kHz	0.11 % + 10 µA	
	(0.22 to 2.2) A		
	(0.02 to 1) kHz	0.024 % + 35 µA	
	(1 to 5) kHz	0.045 % + 80 µA	
	(5 to 10) kHz	0.7 % + 160 µA	
	(2.2 to 3) A		Fluke 5520A SC 1100 Multifunction Calibrator
	(10 to 45) Hz	3.8 mA	
	(0.045 to 1) kHz	1.6 mA	
	(1 to 5) kHz	13 mA	
	(5 to 10) kHz	54 mA	
	(3 to 11) A		
	(45 to 100) Hz	6.3 mA	
	(0.1 to 1) kHz	9.0 mA	
	(1 to 5) kHz	0.22 A	
	(11 to 20.5) A		
	(45 to 100) Hz	20 mA	
	(0.1 to 1) kHz	24 mA	
	(1 to 5) kHz	0.41 A	
	(20 to 1000) A (45 to 65) Hz	1.3 A	Fluke 5520A/COIL 50 turn coil
	(20 to 150) A (65 to 440) Hz	0.3 A	
AC Current[1] – Measure	Up to 200 µA		Fluke 8508A opt 001 Reference DMM
	(0.1 to 10) kHz	0.031 % + 100 µA/A	
	(10 to 30) kHz	0.071 % + 100 µA/A	
	(30 to 100) kHz	0.4 % + 100 µA/A	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
AC Current[1] – Measure	200 µA to 20 mA (1 to 10) Hz (0.1 to 10) kHz (10 to 30) kHz (30 to 100) kHz	 0.031 % + 100 µA/A 0.03 % + 100 µA/A 0.071 % + 100 µA/A 0.4 % + 100 µA/A	Fluke 8508A opt 001 Reference DMM
	(20 to 200) mA (1 to 10) Hz (0.1 to 10) kHz (10 to 30) kHz	 0.031 % + 100 µA/A 0.029 % + 100 µA/A 0.063 % + 100 µA /A	
	200 mA to 2 A (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz	 0.062 % + 100 µA/A 0.074 % + 100 µA/A 0.3 % + 100 µA/A	
	(2 to 20) A (0.1 to 2) kHz (2 to 10) kHz	 0.082 % + 100 µA/A 0.25 % + 100 µA/A	
	(1 to 10) mA (5 to 400) Hz (0.4 to 20) kHz (20 to 50) kHz (50 to 100) kHz	 0.002 % 0.003 % 0.004 % 0.006 %	Fluke 5790-03 w/A40 Shunts AC Measurement Standard
	(10 to 30) mA (5 to 400) Hz (0.4 to 20) kHz (20 to 50) kHz (50 to 100) kHz	 0.002 % 0.003 % 0.005 % 0.007 %	
	(30 to 300) mA (5 to 400) Hz (0.4 to 20) kHz (20 to 50) kHz (50 to 100) kHz	 0.003 % 0.004 % 0.007 % 0.01 %	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
AC Current[1] – Measure	300 mA to 3 A (5 to 400) Hz (0.4 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.002 % 0.003 % 0.005 % 0.01 %	Fluke 5790-03 w/A40 Shunts AC Measurement Standard
	(3 to 10) A (5 to 400) Hz (0.4 to 20) kHz (20 to 50) kHz	0.002 % 0.003 % 0.005 %	
	(10 to 20) A (5 to 400) Hz (0.4 to 20) kHz (20 to 50) kHz	0.007 % 0.012 % 0.018 %	
Electrical Calibration of Thermocouple Indicating Devices[1] Type B	(600 to 800) ºC (800 to 1 000) ºC (1000 to 1550) ºC (1550 to 1820) ºC	0.44 ºC 0.34 ºC 0.3 ºC 0.33 ºC	Fluke 5520A SC1100 Multifunction Calibrator
Type C	(0 to 150) ºC (150 to 650) ºC (650 to 1000) ºC (1000 to 1800) ºC (1800 to 2316) ºC	0.3 ºC 0.26 ºC 0.31 ºC 0.5 ºC 0.84 ºC	
Type E	(-250 to -100) ºC (-100 to -25) ºC	0.5 ºC 0.16 ºC	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators[1]			Fluke 5520A SC1100 Multifunction Calibrator
Type E	(-25 to 350) ºC	0.14 ºC	
	(350 to 650) ºC	0.16 ºC	
	(650 to 1 000) ºC	0.21 ºC	
Type J	(-210 to -100) ºC	0.27 ºC	
	(-100 to -30) ºC	0.16 ºC	
	(-30 to 150) ºC	0.14 ºC	
	(150 to 760) ºC	0.17 ºC	
	(760 to 1 200) ºC	0.23 ºC	
Type K	(-200 to -100) ºC	0.33 ºC	
	(-100 to -25) ºC	0.18 ºC	
	(-25 to 120) ºC	0.16 ºC	
	(120 to 1 000) ºC	0.26 ºC	
	(1 000 to 1 372) ºC	0.4 ºC	
Type N	(-200 to -100) ºC	0.4 ºC	
	(-100 to -25) ºC	0.22 ºC	
	(-25 to 120) ºC	0.19 ºC	
	(120 to 410) ºC	0.18 ºC	
	(410 to 1 300) ºC	0.27 ºC	
Type R	(0 to 250) ºC	0.57 ºC	
	(250 to 400) ºC	0.35 ºC	
	(400 to 1 000) ºC	0.33 ºC	
	(1 000 to 1 767) ºC	0.4 ºC	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators[1]			Fluke 5520A SC1100 Multifunction Calibrator
Type S	(0 to 250) ºC	0.47 ºC	
	(250 to 1 000) ºC	0.36 ºC	
	(1 000 to 1 400) ºC	0.37 ºC	
	(1 400 to 1 767) ºC	0.46 ºC	
Type T	(-250 to -150) ºC	0.63 ºC	
	(-150 to 0) ºC	0.24 ºC	
	(0 to 120) ºC	0.16 ºC	
	(120 to 400) ºC	0.14 ºC	
Type U	(-200 to 0) ºC	0.56 ºC	
	(0 to 600) ºC	0.27 ºC	
Pt 385, 100 Ω	(-200 to -80) ºC	0.05 ºC	
	(-80 to 0) ºC	0.05 ºC	
	(0 to 100) ºC	0.07 ºC	
	(100 to 300) ºC	0.09 ºC	
	(300 to 400) ºC	0.1 ºC	
	(400 to 630) ºC	0.12 ºC	
	(630 to 800) ºC	0.23 ºC	
Pt 385, 200 Ω	(-200 to -80) ºC	0.04 ºC	
	(-80 to 0) ºC	0.04 ºC	
	(0 to 100) ºC	0.04 ºC	
	(100 to 260) ºC	0.05 ºC	
	(260 to 300) ºC	0.12 ºC	
	(300 to 400) ºC	0.13 ºC	
	(400 to 600) ºC	0.14 ºC	
	(600 to 630) ºC	0.16 ºC	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Electrical Calibation of RTD Indicators[1]	(-200 to -80) ºC	0.04 ºC	Fluke 5520A SC1100 Multifunction Calibrator
	(-80 to 0) ºC	0.05 ºC	
	(0 to 100) ºC	0.05 ºC	
Pt 385, 500 Ω	(100 to 260) ºC	0.06 ºC	
	(260 to 300) ºC	0.08 ºC	
	(300 to 400) ºC	0.08 ºC	
	(400 to 600) ºC	0.09 ºC	
	(600 to 630) ºC	0.11 ºC	
	(-200 to -80) ºC	0.03 ºC	
	(-80 to 0) ºC	0.03 ºC	
	(0 to 100) ºC	0.04 ºC	
	(100 to 260) ºC	0.05 ºC	
Pt 385, 1000 Ω	(260 to 300) ºC	0.06 ºC	
	(300 to 400) ºC	0.07 ºC	
	(400 to 600) ºC	0.07 ºC	
	(600 to 630) ºC	0.23 ºC	
	(-200 to -190) ºC	0.25 ºC	
	(-190 to -80) ºC	0.04 ºC	
	(-80 to 0) ºC	0.05 ºC	
	(0 to 100) ºC	0.06 ºC	
Pt 3916, 100 Ω	(100 to 260) ºC	0.07 ºC	
	(260 to 300) ºC	0.08 ºC	
	(300 to 400) ºC	0.09 ºC	
	(400 to 600) ºC	0.1 ºC	
	(600 to 630) ºC	0.23 ºC	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Electrical Calibation of RTD Indicators[1]	(-200 to -80) ºC	0.05 ºC	Fluke 5520A SC1100 Multifunction Calibrator
	(-80 to 0) ºC	0.05 ºC	
Pt 3926, 100 Ω	(0 to 100) ºC	0.07 ºC	
	(100 to 300) ºC	0.09 ºC	
	(300 to 400) ºC	0.1 ºC	
	(400 to 630) ºC	0.12 ºC	
PtNi 385, 120 Ω	(-80 to 0) ºC	0.08 ºC	
	(0 to 100) ºC	0.08 ºC	
	(100 to 260) ºC	0.14 ºC	
Cu 427, 10 Ω	(-100 to 260) ºC	0.3 ºC	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2, 3]	Reference Standard, Method, and/or Equipment
Phase – Generate[1] 0° to 180°	(10 to 65) Hz	0.1 °	Fluke 5520A SC 1100 Multifunction Calibrator
	(65 to 500) Hz	0.25 °	
	(0.5 to 1) kHz	0.5 °	
	(1 to 5) kHz	2.5 °	
	(5 to 10) kHz	5 °	
	(10 to 30) kHz	10 °	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2, 3]	Reference Standard, Method, and/or Equipment
Phase – Measure 0° to 360° Sine Wave	(5 to 10) Hz	0.23 °	Clarke-Hess Model 6000
10 mV to 350 V	10 Hz to 50 kHz	0.051 °	
10 mV to 12.5 V	(50 to 100) kHz	0.23 °	
12.5 V to 350 V	(0.10 to 10) kHz	0.051 °	
Oscilloscopes[1] –Amplitude DC DC Signal 50 Ω Load	(0 to ± 6.6) V	0.25 % + 40 µV	Fluke 5520A SC1100 Multifunction Calibration
1 MΩ Load	(0 to ± 130) V	0.05 % + 40 µV	
Amplitude-Square Wave (Peak to Peak) 50 Ω Load	± 1 mV to ± 6.6 V	0.25 % + 40 µV	Fluke 5520A SC1100 Multifunction Calibration
1 MΩ Load	± 1 mV to ± 130 V	0.1 % + 40 µV	
Time Marker (into 50 Ω)	5 s to 50 ms 20 ms to 1 ns	(25 + 1000t) µs/s 2.5 µs/s	t = time in Seconds
Edge Spec (Rise Time)	1 kHz to 10 MHz	<300 ps 5 mVp-p to 2.5Vp-p	
Bandwidth – Leveled Sine Wave (into 50 Ohm Load) 5 mV to 5.5 V	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz	2 % + 300 µV 3.5 % + 300 µV 4 % + 300 µV	Fluke 5520A SC1100 Multifunction Calibrator
Pulse Characterization - Rise Time - Measure	30 ps to 1µs	21 ps	CSA803C w/ SD-26

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2, 3]	Reference Standard, Method, and/or Equipment
RF Absolute Power[1] – Generate (-35 to + 14) dBm	(0.1 to 2.4) GHz (2.4 to 8) GHz (8 to 18) GHz (18 to 26.5) GHz	0.08 dB + *M* 0.11 dB + *M* 0.14 dB + *M* 0.17 dB + *M*	Fluke 96270A w/ Rohde & Schwarz NRP-Z55 (x2), Agilent 11667B & Sucoflex 102EA
RF Absolute Power[1] – Measure	1mW Ref @ 50 MHz	0.03%	HP 8478B Sensor w/ HP 432A Power Meter
(-65 to -35) dBm	(> 0.01 to ≤ 0.03) GHz (> 0.03 to ≤ 4.00) GHz (> 4.00 to ≤ 8.00) GHz (> 8.00 to ≤ 10.00) GHz (> 10.00 to ≤ 13.00) GHz (> 13.00 to ≤ 15.00) GHz (> 15.00 to ≤ 18.00) GHz	2.84% + *M* 1.9% + *M* 2.34% + *M* 2.44% + *M* 2.98% + *M* 3.48% + *M* 3.84% + *M*	HP 8484A sensor w/ Agilent E4419B Power Meter
RF Absolute Power[1] – Measure (-35 to + 20) dBm	(DC to ≤ 0.1) GHz (> 0.1 to ≤ 2.4) GHz (> 2.4 to ≤ 8) GHz (> 8 to ≤ 12.4) GHz (> 12.4 to ≤ 18) GHz (> 18 to ≤ 26.5) GHz (> 26.5 to ≤ 33) GHz (> 33 to ≤ 40) GHz	0.04 dB + *M* 0.048 dB + *M* 0.054 dB + *M* 0.063 dB + *M* 0.082 dB + *M* 0.086 dB + *M* 0.11 dB + *M* 0.11 dB + *M*	Fluke 96270A w/ Rohde & Schwarz NRP-Z55
Tuned RF Power, Absolute – Measure	(+10 to 0) dBm (0 to -10) dBm	0.3 dB + *M* 0.3 dB + *M*	HP 8902A w/ HP 11722A, 11792A, and 11793A

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2, 3]	Reference Standard, Method, and/or Equipment
2.5 MHz to 26.5 GHz	(-10 to -40) dBm	0.31 dB + *M*	HP 8902A w/ HP 11722A, 11792A, and 11793A
	(-40 to -50) dBm	0.33 dB + *M*	
	(-50 to -80) dBm	0.34 dB + *M*	
	(-80 to -90) dBm	0.37 dB + *M*	
	(-90 to 110) dBm	0.39 dB + *M*	
	(-110 to -127) dBm	0.54 dB + *M*	
Amplitude Modulation – Measure			
(0.15 to 10) MHz	Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 %	3 % + 1 digit	
	Rate: 20 Hz to 10 kHz, Depth: to 99 %	3 % + 1 digit	
(10 to 1300) MHz	Rate: 50 Hz to 50 kHz, Depth: 5 % to 99 %	2 % + 1 digit	HP 8902A w/ HP 11722A, 11792A, and 11793A
	Rate: 20 Hz to 10 kHz, Depth: to 99 %	3 % + 1 digit	
(1.3 to 26.5) GHz	Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 %	2 % + 1 digit	
10 MHz to 26.5 GHz	Rate: 20 Hz to 10 kHz, Depth: to 99 %	3 % + 1 digit	
Frequency Modulation – Measure			
(0.25 to 10) MHz	Rate: 20 Hz to 10 kHz, Dev: ≤ 40 kHz pk	2 % + 1 digit	
10 MHz to 1.3 GHz	Rate: 50 Hz to 100 kHz, Dev: ≤ 400 kHz pk	1 % + 1 digit	
	Rate: 20 Hz to 200 kHz, Dev: ≤ 400 kHz pk	6 % + 1 digit	
10 MHz to 26.5 GHz	Rate: 50 Hz to 100 kHz, Dev: ≤ 400 kHz pk	1 % + 1 digit	
	Rate: 20 Hz to 200 kHz, Dev: ≤ 400 kHz pk	6 % + 1 digit	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2, 3]	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure			HP 8902A w/ HP11722A, 11792A, and 11793A
150 kHz to 10 MHz	200 Hz to 10 kHz Rate	5 % + 1 digit	
10 MHz to 26.5 GHz	200 Hz to 20 kHz Rate	4 % + 1 digit	
Power – Range Accuracy	3 µW to 100 mW	0.15 µW	HP 11683A
Distortion – Measure			HP 8903B
(-80 to 0) dB	20 Hz to 20 kHz	1.2 dB	
(-65 to 0) dB	(20 to 100) kHz	2.4 dB	
RF Amplitude Frequency Response – Measure	9 kHz to 2.9 GHz	1.01 dB	HP 8562A
	(2.90 to 6.46) GHz	1.50 dB	
	(6.46 to 13) GHz	2.01 dB	
	(13 to 19.7) GHz	3.01 dB	
	(19.7 to 22) GHz	3.01 dB	
VSWR – Measure	(0.01 to 18) GHz	0.1 dB	VSWR of 1 to 1.4 Giga-tronics 8003 with 80501
	(0 to 60) dB		
Absolute Power Measure – Swept Mode	(0.01 to 1) GHz	0.082 dB	Giga-tronics 8003 with 80301A or 80302A and 80501
	(1 to 2) GHz	0.089 dB	
	(2 to 4) GHz	0.096 dB	
	(4 to 6) GHz	0.1 dB	
	(6 to 8) GHz	0.11 dB	
	(8 to 12.4) GHz	0.13 dB	
	(12.4 to 18) GHz	0.14 dB	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2, 3]	Reference Standard, Method, and/or Equipment
Levelled Sine Wave Output – Absolute Amplitude Accuracy Level (dBm)			Fluke 96270A w/ Fluke 96040A-50
(+ 24 to - 17) dBm	10 Hz to 4 GHz	0.2 dB + *M*	
(- 17 to - 74) dBm	10 Hz to 4 GHz	0.34 dB + *M*	
(- 74 to - 94) dBm	10 Hz to 4 GHz	0.68 dB + *M*	
(- 94 to - 130) dBm	10 Hz to 4 GHz	1.1 dB + *M*	
(+ 18 to - 80) dBm	10 Hz to 4 GHz	0.34 dB + *M*	Fluke 96270A w/ Fluke 96040A-75
(- 80 to - 100) dBm	10 Hz to 4 GHz	0.67 dB + *M*	
(- 100 to - 120) dBm	10 Hz to 4 GHz	1.1 dB + *M*	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [3]	Reference Standard, Method, and/or Equipment
Micrometers and Calipers - Outside, Inside, Depth, & Step[1]	(0.01 to 0.04) in	13 µin	Comparison to Gage Blocks
	(0.05 to 1) in	(13 + 1*L*) µin	
	(1 to 4) in	(9 + 4*L*) µin	
	(4 to 15) in	(12 + 4*L*) µin	
	(15 to 40) in	(16 + 4*L*) µin	
Length Measurement Single Axis – Outside[1]	(0.05 to 1) in	(19 + 2*L*) µin	Fowler LabConcept & Gage Blocks
	(1 to 4) in	(15 + 4*L*) µin	
	(4 to 15) in	(17 + 4*L*) µin	
	(15 to 20) in	(5 + 5*L*) µin	
	(20 to 40) in	(64 + 4*L*) µin	Gage Check & Gage Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [3]	Reference Standard, Method, and/or Equipment
Flatness[1]	Up to 40 in	13.9 µin	Optical Flats
Parallelism[1]	Up to 1 in	13.9 µin	Optical Flats
Ring Gages			
Plain Ring Gages	Up to 16 in	(14 + 4.6*L*) µin	Fowler Labconcept
Threaded Ring Gages	Up to 6 in	(22 + 4.7*L*) µin	Using set plugs
Plug Gages			
Plain Plugs	Up to 16 in	(13 + 4.6*L*) µin	Fowler Labconcept
Threaded Plugs (OD)	Up to 6 in	(15 + 3.7*L*) µin	Fowler Labconcept
Threaded Plugs (PD)	Up to 6 in	(19 + 3.4*L*) µin	Labconcept measurement over wires
Surface Plates,	Up to (24 × 24) in	95 µin	Repeat-o-meter
Granite[1] – Flatness	Up to (72 × 144) in	95 µin	Planekator
Coating Thickness Gages[1]			
Eddy Current & Magnetic Induction, Fixed Point	Up to 3000 µm Up to 118 mils	(0.59 + 0.03*L*) µm (0.023 + 0.001*L*) mils	Fowler Labconcept & Gage Blocks
Dial Indicator[1]	(0.05 to 1) in	(22 + 2*L*) µin	Fowler Labconcept
	(1 to 4) in	(21 + 3*L*) µin	& Gage Blocks

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2,3]	Reference Standard, Method, and/or Equipment
Air/Nitrogen Flow[1]	Up to 100 SLM	0.73%	CME FCS Laminar Flow Elements
Liquid Flow	Up to 250 GPM	0.33%	FT-32 turbine flow system

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2,3]	Reference Standard, Method, and/or Equipment
Air Velocity – Measuring Equipment	Up to 5 800 ft/min	1.7%	Alnor RVA801 with Wind Tunnel
Pressure and Vacuum Gauges Pneumatic - Gauge	-30 inHg to 1 000 psig	0.02 % of span	DHI PPC4EX-7M
Pneumatic - Absolute	(0.1 to 1 000) psia	0.02 % of span + 0.007 psia	DHI PPC4EX-7M
Pneumatic	(0.2 to 718) psia/psig	0.003%	Ruska 2465
Hydraulic	(100 to 50 000) psig	0.008 %	DHI 5306
Pressure and Vacuum Gauges Hydraulic & Pneumatic[1]	(0 to 900) mmHg	0.23 mmHg	Fluke PPH Calibrator
	(15 to 30) psig	0.08 psig	
	(30 to 300) psig	0.15 psig	
	(300 to 500) psig	0.13 psig	
	(500 to 3 000) psig	1.5 psig	
	(3 000 to 10 000) psig	8 psig	
Scales and Balances[1] Metric	Up to 20 g	0.024 mg	ASTM Class 1 weights
	Up to 200 g	0.18 mg	
	Up to 1 000 g	2.9 mg	ASTM Class 2 weights
	Up to 5 000 g	10 mg	
	Up to 10 000 g	58 mg	
	Up to 50 000 g	1.4 g	
Scales and Balances[1] English	Up to 10 lb	0.0012 lb	ASTM Class F weights
	Up to 25 lb	0.002 lb	
	Up to 50 lb	0.009 lb	
	Up to 150 lb	0.023 lb	
	Up to 250 lb	0.065 lb	
	Up to 500 lb	0.13 lb	

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2,3]	Reference Standard, Method, and/or Equipment
Force[1]– Measuring Equipment			
Compression	(0 to 500) lbf	0.13 lbf	ASTM class F weights
	(500 to 5 000) lbf	2.4 lbf	South Ocean MS-1
	(5 000 to 20 000) lbf	9.1 lbf	Transcell BSS-20K
Tension	(0 to 500) lbf	0.13 lbf	ASTM class F weights
	(500 to 5000) lbf	2.4 lbf	South Ocean MS-1
	(5000 to 10 000) lbf	6.8 lbf	Transcell BSS-10K
	(10 000 to 20 000) lbf	9.1 lbf	Transcell BSS-20K
	(20 000 to 100 000) lbf	42 lbf	Rinstrum TLWS-100K
Optical Rotational Speed, RPM[3] – Measure & Generate	(1 to 100 000) rpm	0.015 RPM	Agilent 33250A
Rotational Speed, RPM[3] – Measure & Generate	(0 to 5 500) rpm	0.015 %+ 0.6*R*	Quantum Dynamics N-11-FCS/3
Torque Transducers	20 ozf·in to 100 lbf·in	0.05%	Various torque arms and weights
	100 lbf·in to 125 lbf·ft	0.06%	
	(125 to 2 000) lbf·ft	0.08%	
Torque Devices	2 ozf·in to 2 000 lbf·ft	0.5 %	AKO TSD2050 Torque Master

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method, and/or Equipment
Illuminance – Lux meters	(423 to 15 000) Lux	1.8 %	FEL 1000W lamp with PSU

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measure & Measuring Equipment	(10 to 90) %RH	1.3 %RH	Vaisala HMI-41 w/HMP-46
Temperature[3] – Measure	(-196 to 0) °C	0.042 °C	Hart Scientific 1521 w/5618B / 5627A
	(0 to 100) °C	0.042 °C	
	(100 to 420) °C	0.06 °C	Hart Scientific 1523 w/5624
	(420 to 960) °C	0.064 °C	
Infrared Devices[1]	Ambient to 212 °F	0.92 °F	Fluke 9132
	(212 to 572) °F	1.3 °F	$\varepsilon = 0.95$
	(572 to 932) °F	1.5 °F	λ = (8 to 14) µm

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency[1] – Generate	1 MHz to 27 GHz	0.05 µHz/Hz	Fluke 96270A
Frequency[1] – Measure	1 Hz to 160 MHz	3.2 µHz/Hz	Racal Dana 1992
	(0.4 to 1.3) GHz	5.9 µHz/Hz	
	(1.3 to 26.5) GHz	0.05 µHz/Hz + 1 count	HP 5343A

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. Values listed with percent (%) are percent of reading or generated value unless otherwise noted.
3. R = resolution of the unit under test, L = value of the nominal length of the device measured, and M = the mismatched value.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.21.

Vice President