



# CERTIFICATE OF ACCREDITATION

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

This is to certify that

**E2b Calibration, LLC**  
**521 Fifth Avenue**  
**Chardon, OH 44024**

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)**

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-1287

Certificate Number

  
ANAB Approval

Certificate Valid Through: 02/23/2021  
Version No. 008 Issued: 03/07/2019



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

### E2b Calibration, LLC

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### CALIBRATION

Valid to: February 23, 2021

Certificate Number: AC-1287

#### Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure <sup>1,3</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	1.5 $\mu$ V 13 $\mu$ V 45 $\mu$ V 1.1 mV 11 mV	HP 3458A (Opt 002) Multimeter
DC Voltage – Measure <sup>1,3</sup>	(1 to 60) kV	87 V	Ross VD60 Voltage Divider, HP3457A Multimeter
DC Voltage - Source <sup>1,3</sup>	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V 330 V to 1 kV	20 $\mu$ V/V + 1 $\mu$ V 11 $\mu$ V/V + 2 $\mu$ V 12 $\mu$ V/V + 20 $\mu$ V 18 $\mu$ V/V + 0.15 mV 18 $\mu$ V/V + 1.5 mV	Fluke 5522A Multiproduct Calibrator
DC Current - Measure <sup>1,3</sup>	Up to 100 $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	4.3 nA 39 nA 0.39 $\mu$ A 5.6 $\mu$ A 0.15 mA	HP 3458A (Opt 002) Multimeter
DC Current - Measure <sup>1,3</sup>	(1 to 14) A (14 to 30) A	1.5 mA 2.1 mA	HP 3458A (Opt 002) Multimeter with IET DCCS-0.01 and DCCS- 0.001 Shunts



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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source <sup>1,3</sup>	Up to 330 $\mu$ A 330 $\mu$ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	0.15 mA/A + 20 nA 0.1 mA/A + 50 nA 0.1 mA/A + 0.25 $\mu$ A 0.1 mA/A + 2.5 $\mu$ A 0.2 mA/A + 40 $\mu$ A 0.38 mA/A + 40 $\mu$ A 0.5 mA/A + 0.5 mA 1 mA/A + 0.75 mA	Fluke 5522A Multiproduct Calibrator
AC Voltage – Measure <sup>1,3</sup>	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 4) MHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz (2 to 8) MHz (8 to 10) MHz 100 mV to 1 V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz (2 to 8) MHz (8 to 10) MHz	9.8 $\mu$ V 6.6 $\mu$ V 7.7 $\mu$ V 17 $\mu$ V 62 $\mu$ V 470 $\mu$ V 160 $\mu$ V 170 $\mu$ V 15 $\mu$ V 13 $\mu$ V 21 $\mu$ V 40 $\mu$ V 97 $\mu$ V 370 $\mu$ V 1.2 mV 1.9 mV 4.8 mV 18 mV 150 $\mu$ V 120 $\mu$ V 210 $\mu$ V 390 $\mu$ V 970 $\mu$ V 3.7 mV 12 mV 19 mV 48 mV 180 mV	HP 3458A (Opt 002) Multimeter



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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure <sup>1,3</sup>	(1 to 10) V		HP 3458A (Opt 002) Multimeter
	(1 to 40) Hz	2.5 mV	
	40 Hz to 1 kHz	1.2 mV	
	(1 to 20) kHz	2.1 mV	
	(20 to 50) kHz	3.9 mV	
	(50 to 100) kHz	9.7 mV	
	(100 to 300) kHz	37 mV	
	300 kHz to 1 MHz	120 mV	
	(1 to 2) MHz	180 mV	
	(2 to 8) MHz	480 mV	
	(8 to 10) MHz	1.8 V	
	(10 to 100) V		
	40 Hz to 20 kHz	28 mV	
	(20 to 50) kHz	45 mV	
(50 to 100) kHz	150 mV		
100 V to 1 kHz			
40 Hz to 1 kHz	0.46 mV/V + 39 mV		
(1 to 20) kHz	0.73 mV/V + 0.75 mV		
AC Voltage – Measure <sup>1</sup>	(1 to 42) kV 60Hz	0.26 kV	Ross VD60 Voltage Divider, HP3457A Multimeter
AC Voltage - Source <sup>1,3</sup>	Up to 33 mV		Fluke 5522A Multiproduct Calibrator
	(10 to 45) Hz	0.8 mV/V + 6 μV	
	45 Hz to 10 kHz	0.15 mV/V + 6 μV	
	(10 to 20) kHz	0.2 mV/V + 6 μV	
	(20 to 50) kHz	1 mV/V + 6 μV	
	(50 to 100) kHz	3.5 mV/V + 12 μV	
	(100 to 500) kHz	8 mV/V + 50 μV	
	(33 to 330) mV		
	(10 to 45) Hz	0.3 mV/V + 8 μV	
	45 Hz to 10 kHz	0.15 mV/V + 8 μV	
	(10 to 20) kHz	0.16 mV/V + 8 μV	
	(20 to 50) kHz	0.35 mV/V + 8 μV	
	(50 to 100) kHz	0.8 mV/V + 32 μV	
	(100 to 500) kHz	2 mV/V + 70 μV	
	330 mV to 3.3 V		
	(10 to 45) Hz	0.3 mV/V + 50 μV	
	45 Hz to 10 kHz	0.15 mV/V + 60 μV	
	(10 to 20) kHz	0.19 mV/V + 60 μV	
(20 to 50) kHz	0.3 mV/V + 50 μV		
(50 to 100) kHz	0.7 mV/V + 0.13 mV		
(100 to 500) kHz	2.4 mV/V + 0.6 mV		



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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source <sup>1,3</sup>	(3.3 to 33) V		Fluke 5522A Multiproduct Calibrator
	(10 to 45) Hz	0.3 mV/V + 0.65 mV	
	45 Hz to 10 kHz	0.15 mV/V + 0.6 mV	
	(10 to 20) kHz	0.24 mV/V + 0.6 mV	
	(20 to 50) kHz	0.35 mV/V + 0.6 mV	
	(50 to 100) kHz	0.9 mV/V + 1.6 mV	
	(33 to 330) V		
	45 Hz to 1 kHz	0.19 mV/V + 2 mV	
	(1 to 10) kHz	0.2 mV/V + 6 mV	
	(10 to 20) kHz	0.25 mV/V + 6 mV	
	(20 to 50) kHz	0.3 mV/V + 6 mV	
	(50 to 100) kHz	2 mV/V + 50 mV	
	AC Current - Source <sup>1,3</sup>	330 V to 1.02 kV	
45 Hz to 1 kHz		0.3 mV/V + 10 mV	
(1 to 5) kHz		0.25 mV/V + 10 mV	
(5 to 10) kHz		0.3 mV/V + 10 mV	
(29 to 330) $\mu$ A			
(10 to 20) Hz		2 mA/A + 0.1 $\mu$ A	
(20 to 45) Hz		1.5 mA/A + 0.1 $\mu$ A	
45 Hz to 1 kHz		1.3 mA/A + 0.1 $\mu$ A	
(1 to 5) kHz		3 mA/A + 0.15 $\mu$ A	
(5 to 10) kHz		8 mA/A + 0.2 $\mu$ A	
(10 to 30) kHz		16 mA/A + 0.4 $\mu$ A	
330 $\mu$ A to 3.3 mA			
(10 to 20) Hz		2 mA/A + 0.15 $\mu$ A	
(20 to 45) Hz	1.3 mA/A + 0.1 $\mu$ A		
45 Hz to 1 kHz	1 mA/A + 0.15 $\mu$ A		
(1 to 5) kHz	2 mA/A + 0.2 $\mu$ A		
(5 to 10) kHz	5 mA/A + 0.3 $\mu$ A		
(10 to 30) kHz	10 mA/A + 0.6 $\mu$ A		
(3.3 to 33) mA			
(10 to 20) Hz	1.8 mA/A + 2 $\mu$ A		
(20 to 45) Hz	0.9 mA/A + 2 $\mu$ A		
45 Hz to 1 kHz	0.4 mA/A + 2 $\mu$ A		
(1 to 5) kHz	0.8 mA/A + 2 $\mu$ A		
(5 to 10) kHz	2 mA/A + 3 $\mu$ A		
(10 to 30) kHz	4 mA/A + 4 $\mu$ A		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Source <sup>1,3</sup>	(33 to 330) mA		Fluke 5522A Multiproduct Calibrator
	(10 to 20) Hz	1.8 mA/A + 20 µA	
	(20 to 45) Hz	0.9 mA/A + 20 µA	
	45 Hz to 1 kHz	0.4 mA/A + 20 µA	
	(1 to 5) kHz	1 mA/A + 50 µA	
	(5 to 10) kHz	2 mA/A + 0.1 mA	
	(10 to 30) kHz	4 mA/A + 0.2 mA	
	330 mA to 1.1 A		
	(10 to 45) Hz	1.8 mA/A + 0.1 mA	
	45 Hz to 1 kHz	0.5 mA/A + 0.1 mA	
	(1 to 5) kHz	6 mA/A + 1 mA	
	(5 to 10) kHz	25 mA/A + 5 mA	
	(1.1 to 3) A		
	(10 to 45) Hz	1.8 mA/A + 0.1 mA	
	45 Hz to 1 kHz	0.6 mA/A + 0.1 mA	
	(1 to 5) kHz	6 mA/A + 1 mA	
(5 to 10) kHz	25. mA/A + 5 mA		
(3 to 11) A			
(45 to 100) Hz	0.6 mA/A + 2 mA		
100 Hz to 1 kHz	1 mA/A + 2 mA		
(1 to 5) kHz	30 mA/A + 2 mA		
(11 to 20.5) A			
(45 to 100) Hz	1.2 mA/A + 5 mA		
100 Hz to 1 kHz	1.5 mA/A + 5 mA		
(1 to 5) kHz	30 mA/A + 5 mA		
AC Current - Measure <sup>1,3</sup>	Up to 100 µA		HP 3458A (Opt 002) Multimeter
	(10 to 20) Hz	0.5 µA	
	(20 to 45) Hz	0.21 µA	
	45 Hz to 1 kHz	0.11 µA	
	100 µA to 1 mA		
	(10 to 20) Hz	4.9 µA	
	(20 to 45) Hz	1.8 µA	
	(45 to 100) Hz	0.74 µA	
	100 Hz to 5 kHz	0.41 µA	
	(1 to 10) mA		
	(10 to 20) Hz	49 µA	
	(20 to 45) Hz	18 µA	
(45 to 100) Hz	7.4 µA		
100 Hz to 5 kHz	4.1 µA		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Measure <sup>1,3</sup>	(10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.49 mA 0.18 mA 73 µA 0.04 mA 4.9 mA 1.9 mA 1 mA 1.3 mA	HP 3458A (Opt 002) Multimeter
AC Current – Measure <sup>1,3</sup>	(1 to 20) A 40 Hz to 1 kHz	3.1 mA/A + 6.6 mA	HP 3458A (Opt 002) Multimeter with Agilent 34330A Shunt
Inductance - Source <sup>1</sup>	50 µH 1 000 µH 5 H	0.32 µH 2 µH 0.014 H	GenRad Fixed Inductors
Inductance - Measure <sup>1</sup>	100 µH to 1 mH (1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	0.20 nH 2.4 µH 2.4 µH 0.24 mH 2.4 mH	RLC Bridge GenRad 1689
Capacitance - Measure <sup>1</sup>	Up to 1 nF (1 to 10) nF (10 to 100) nF 100 nF to 1 µF (1 to 1.111) µF	0.2 pF 2.4 pF 24 pF 0.24 nF 0.29 nF	RLC Bridge GenRad 1689
Capacitance - Source <sup>1</sup> 20 Hz to 1 kHz	100 pF to 1 nF (1 to 10) nF (10 to 100) nF 100 nF to 1 µF	1.3 pF 0.013 nF 0.14 nF 1.3 nF	1423A Decade Box
Capacitance – Source <sup>1,3</sup> 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz	(220 to 400) pF 400 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 µF (1.1 to 3.3) µF (3.3 to 11) µF	5 mF/F + 0.01 nF 5 mF/F + 0.01 nF 5 mF/F + 0.01 nF 2.5 mF/F + 0.01 nF 2.5 mF/F + 0.1 nF 2.5 mF/F + 0.1 nF 2.5 mF/F + 0.3 nF 2.5 mF/F + 1 nF 2.5 mF/F + 3 nF 2.5 mF/F + 10 nF	Fluke 5522A Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source <sup>1,3</sup> (10 to 120) Hz (10 to 80) Hz (10 to 50) Hz (10 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	(11 to 33) $\mu$ F (33 to 110) $\mu$ F (110 to 330) $\mu$ F 330 $\mu$ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	4 mF/F + 30 nF 4.5 mF/F + 0.1 $\mu$ F 4.5 mF/F + 0.3 $\mu$ F 4.5 mF/F + 1 $\mu$ F 4.5 mF/F + 3 $\mu$ F 4.5 mF/F + 10 $\mu$ F 7.5 mF/F + 30 $\mu$ F 11 mF/F + 0.1 mF	Fluke 5522A Multiproduct Calibrator
DC Resistance - Source <sup>1,3</sup>	Up to 11 $\Omega$ (11 to 33) $\Omega$ (33 to 110) $\Omega$ (110 to 330) $\Omega$ 330 $\Omega$ to 1.1 k $\Omega$ (1.1 to 3.3) k $\Omega$ (3.3 to 11) k $\Omega$ (11 to 33) k $\Omega$ (33 to 110) k $\Omega$ (110 to 330) k $\Omega$ 330 k $\Omega$ to 1.1 M $\Omega$ (1.1 to 3.3) M $\Omega$ (3.3 to 11) M $\Omega$ (11 to 33) M $\Omega$ (33 to 110) M $\Omega$ (110 to 330) M $\Omega$ 330 M $\Omega$ to 1.1 G $\Omega$	40 $\mu\Omega/\Omega$ + 1 m $\Omega$ 30 $\mu\Omega/\Omega$ + 1.5 m $\Omega$ 28 $\mu\Omega/\Omega$ + 1.4 m $\Omega$ 28 $\mu\Omega/\Omega$ + 2 m $\Omega$ 28 $\mu\Omega/\Omega$ + 2 m $\Omega$ 28 $\mu\Omega/\Omega$ + 20 m $\Omega$ 28 $\mu\Omega/\Omega$ + 20 m $\Omega$ 28 $\mu\Omega/\Omega$ + 0.2 $\Omega$ 28 $\mu\Omega/\Omega$ + 0.2 $\Omega$ 32 $\mu\Omega/\Omega$ + 2 $\Omega$ 32 $\mu\Omega/\Omega$ + 2 $\Omega$ 60 $\mu\Omega/\Omega$ + 30 $\Omega$ 0.13 m $\Omega/\Omega$ + 50 $\Omega$ 0.25 m $\Omega/\Omega$ + 2.5 k $\Omega$ 0.5 m $\Omega/\Omega$ + 3 k $\Omega$ 3 m $\Omega/\Omega$ + 0.1 M $\Omega$ 15 m $\Omega/\Omega$ + 0.5 M $\Omega$	Fluke 5522A Multiproduct Calibrator
DC Resistance - Measure <sup>1,3</sup>	Up to 10 $\Omega$ (10 to 100) $\Omega$ 100 $\Omega$ to 1 k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$ (1 to 10) M $\Omega$ (10 to 100) M $\Omega$	0.36 m $\Omega$ 2.7 m $\Omega$ 19 m $\Omega$ 0.19 $\Omega$ 2 $\Omega$ 30 $\Omega$ 0.85 k $\Omega$ 64 k $\Omega$	HP 3458A (Opt 002) Multimeter
Oscilloscopes <sup>1,2,3</sup> Amplitude - DC 50 $\Omega$ 1 M $\Omega$ Amplitude - Square Wave 50 $\Omega$ 1 M $\Omega$	(-6.6 to 6.6) V (-130 to 130) V  1 mV to 6.6 V (p-p) 1 mV to 130 V (p-p)	6.5 mV/V + 40 $\mu$ V 6 mV/V + 40 $\mu$ V  6.5 mV/V + 40 $\mu$ V 6.1 mV/V + 40 $\mu$ V	Fluke 5522A/SC1100 Multiproduct Calibrator





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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1,2,3</sup> Amplitude - DC Leveled Sine Wave Relative to 50 kHz	50 kHz reference	20 mV/V + 0.3 mV	Fluke 5522A/SC1100 Multiproduct Calibrator
Amplitude	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 MHz to 1.1 GHz	35 mV/V + 0.3 mV 40 mV/V + 0.3 mV 60 mV/V + 0.3 mV 70 mV/V + 0.3 mV	
Flatness	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 MHz to 1.1 GHz	16 mV/V + 0.1 mV 21 mV/V + 0.1 mV 40 mV/V + 0.1 mV 50 mV/V + 0.1 mV	
Time Marker	5 s to 50 ms 20 ms to 2 ns	(2 500 + 1 000t) μs/s 2.5 ms/s	
Rise Time	≤ 300 ps	+0/-100 ps	
Electrical Simulation of Thermocouple Indicators <sup>1,3</sup>	Type B		Fluke 5522A Multiproduct Calibrator
	(600 to 800) °C	0.27 °C	
	(800 to 1 000) °C	0.21 °C	
	(1 000 to 1 550) °C	0.18 °C	
	(1 550 to 1 820) °C	0.2 °C	
	Type C		
	(0 to 150) °C	0.18 °C	
	(150 to 650) °C	0.16 °C	
	(650 to 1 000) °C	0.19 °C	
	(1 000 to 1 800) °C	0.3 °C	
	(1 800 to 2 316) °C	0.5 °C	
	Type E		
	(-250 to -100) °C	0.3 °C	
	(-100 to -25) °C	0.1 °C	
	(-25 to 350) °C	0.09 °C	
	(350 to 650) °C	0.1 °C	
	(650 to 1 000) °C	0.13 °C	
	Type J		
	(-210 to -100) °C	0.16 °C	
(-100 to -30) °C	0.1 °C		
(-30 to 150) °C	0.09 °C		
(150 to 760) °C	0.11 °C		
(760 to 1 200) °C	0.14 °C		



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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators <sup>1,3</sup>	Type K		Fluke 5522A Multiproduct Calibrator
	(-200 to -100) °C	0.2 °C	
	(-100 to -25) °C	0.11 °C	
	(-25 to 120) °C	0.1 °C	
	(120 to 1 000) °C	0.16 °C	
	(1 000 to 1 372) °C	0.24 °C	
	Type L		
	(-200 to -100) °C	0.22 °C	
	(-100 to 800) °C	0.16 °C	
	(800 to 900) °C	0.11 °C	
	Type N		
	(-200 to -100) °C	0.24 °C	
	(-100 to -25) °C	0.13 °C	
	(-25 to 120) °C	0.12 °C	
	(120 to 410) °C	0.11 °C	
	(410 to 1 300) °C	0.16 °C	
	Type R		
	(0 to 250) °C	0.34 °C	
	(250 to 400) °C	0.21 °C	
	(400 to 1 000) °C	0.2 °C	
(1 000 to 1 767) °C	0.24 °C		
Type S			
(0 to 250) °C	0.28 °C		
(250 to 1 000) °C	0.22 °C		
(1 000 to 1 400) °C	0.22 °C		
(1 400 to 1 767) °C	0.28 °C		
Type T			
(-250 to -150) °C	0.38 °C		
(-150 to 0) °C	0.15 °C		
(0 to 120) °C	0.1 °C		
(120 to 400) °C	0.09 °C		
Type U			
(-200 to 0) °C	0.34 °C		
(0 to 600) °C	0.16 °C		
Phase Angle - Source <sup>1,3</sup>	(0 to 360) °		Fluke 5522A Multiproduct Calibrator
	(10 to 65) Hz	0.1 °	
	(65 to 500) Hz	0.25 °	
	500 Hz 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 (+/-)	Reference Standard, Method, and/or Equipment
RF Power - Measure <sup>1,3</sup> Up to 18 GHz	(-70 to -30) dBm 50 MHz to 8 GHz (8 to 20) GHz (20 to 26.5) GHz (-30 to +20) dBm 100 kHz to 2.5 GHz (2.5 to 4.2) GHz (4.2 to 13) GHz (13 to 19) GHz (19 to 26.5) GHz	0.15 dB 0.2 dB 0.25 dB 0.37 dBm 0.041 dB 0.082 dB 0.12 dB 0.14 dB	Agilent E4418B Power Meter with Agilent 8485D, 8482A, and 8485A Power Sensors
Amplitude Modulation <sup>1</sup> - Measure	(5 to 99) %Depth 150 kHz to 10 MHz 10 MHz to 1.3 GHz	2.4 %Depth 1.2 %Depth	HP 8902A Measuring Receiver
Frequency Modulation <sup>1</sup> - Measure	(5 to 99) %Deviation 150 kHz to 10 MHz 10 MHz to 1.3 GHz	2.4 % of reading 1.2 % of reading	HP 8902A Measuring Receiver
Phase Modulation <sup>1</sup> - Measure	(5 to 99) % Deviation 150 kHz to 10 MHz 10 MHz to 1.3 GHz	3.6 % of reading 3.6 % of reading	
Tuned RF Level Attenuation <sup>1</sup> - Measure	2.5 MHz to 1.3 GHz (-10 to 0) dBm (-40 to -10) dBm (-50 to -40) dBm (-80 to -50) dBm (-90 to -80) dBm (-110 to -90) dBm (-120 to -110) dBm	0.02 dB 0.08 dB 0.14 dB 0.2 dB 0.26 dB 0.3 dB 0.4 dB	HP 8902A Measuring Receiver with HP 11722A Power Sensor
Harmonics - Measure <sup>1</sup>	(-80 to 0) dB 30 Hz to 6.5 GHz	1 dBm	HP 8561E Spectrum Analyzer
AM Distortion - Measure <sup>1</sup>	(-80 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	HP 8903B Audio Analyzer
FM Distortion - Measure <sup>1</sup>	(-80 to 0) dB 20Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	



Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers <sup>1,2</sup>	(0 to 4) in (4 to 24) in (24 to 60) in	(93 + 37L) μin (37 + 55L) μin (180 + 48L) μin	Gage Blocks and Length Standards
Micrometers <sup>1,2</sup>	(0 to 1) in (1-4) in (Up to 42) in	(77 + 17L) μin (51 + 41L) μin (620 + 37L) μin	
Dial Indicators <sup>1,2</sup> Resolution     0.000 05 in 0.001 in	Up to 1 in Up to 4 in	(74 + 44L) μin (1 400 + 87L) μin	

Mass and Mass-Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Gages & Transducers <sup>1,3</sup>	(0 to 29) psia (0 to 14.5) psi	0.002 3 psi 0.007 % of reading + 0.000 9 psi	Druck PACE6000 Pressure Controller
	(29 to 300) psia	0.14 % of reading	Druck DPI-145 Pressure indicator
Pressure Gages & Transducers <sup>1,3</sup>	(50 to 15 000) psi	0.03 % of reading	TD-4000N Deadweight Tester
Vacuum <sup>1,3</sup>	(-14.5 to 0) psi	0.007 % of reading + 0.000 9 psi	Druck PACE6000 Pressure Controller
Mass Flow <sup>1</sup>	(5 to 500) SCCM (500 to 50 000) SCCM	0.3 % of reading 0.3 % of reading	ML-800-10 Flow Cell ML-800-45 Flow Cell
	(0.7 to 7) SCFM (7 to 35) SCFM (35 to 90) SCFM	0.61 % of reading 0.65 % of reading 0.67 % of reading	Cox 16-064 Sonic Nozzle Cox 16-121 Sonic Nozzle Cox 16-228 Sonic Nozzle
	Up to 20 uL (20 to 50) uL (50 to 100) uL (100 to 200) uL (200 to 500) uL (500 to 1 000) uL	0.065 μL 0.066 μL 0.069 μL 0.08 μL 0.14 μL 0.24 μL	A&D 4212B-101 Balance and Software
Torque Transducers <sup>1,3</sup>	(0.84 to 100) lbf-ft	0.06 % of reading	F-Class Weights, 10 in Torque Arm
	(100 to 1 000) lbf-ft	0.6 % of reading	F-Class Weights, 4 ft Torque Arm



Mass and Mass-Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools <sup>1</sup>	(10 to 96) ozf·in	0.6 % of reading	AIMCO UET-0100 Torque Tester
	(6 to 96) lbf·in	0.6 lbf·in	HIOS HP-100 Torque Tester
	(8 to 295) lbf·ft	0.6 % of reading + 0.03 lbf·ft	Norbar Pro Test 400 (43219)
	(295 to 1 100) lbf·ft	1.2 % of reading	Norbar Pro Test 1500ER (43189)
Force <sup>1,3</sup> - Compression & Tension	(0 to 50) lbf (50 to 1 000) lbf (1 000 to 10 000) lbf (10 000 to 50 000) lbf	0.006 lbf 0.31 lbf 2.5 lbf 13 lbf	Class F Weights Interface Load Cell - 1 000 lbf Interface Load Cell - 10 000 lbf Interface Load Cell - 50 000 lbf
Laboratory Balances <sup>1</sup> 0.000 1 mg 0.001 mg 0.01 mg Resolution 1 mg 1 mg 0.01 g 0.01 g 0.1 g 0.1 g	Up to 2 g Up to 20 g Up to 100 g Up to 1 000 g Up to 3 000 g Up to 5 000 g Up to 25 000 g Up to 25 000 g Up to 40 000 g	0.002 mg 0.01 mg 0.05 mg 1.7 mg 2.2 mg 16 mg 25 mg 160 mg 190 mg	Class 1 Weights
Scales <sup>1</sup> Resolution 0.05 lb 0.1 lb	Up to 250 lb Up to 600 lb	0.08 g 0.18 g	Class F Weights

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity - Measure <sup>1</sup>	(0 to 90) %RH (90 to 100) %RH	1.3 %RH 2.2 %RH	Vaisala HMP-363 Transmitter
Humidity - Source <sup>1</sup>	11.3 %RH 32.9 %RH 75.4 %RH 96.7 %RH	1.3 %RH 1.3 %RH 1.3 %RH 2.2 %RH	Vaisala HMP-363 Transmitter, Saturated Salt Solutions



**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature - Measure <sup>1</sup>	(-200 to 0) °C (0 to 200) °C (200 to 600) °C	28 mK (0.028 °C) 36 mK (0.036 °C) 56 mK (0.056 °C)	Fluke 5628 SPRT, HP 3457A Multimeter
Temperature - Source <sup>1</sup>	(0 to 125) °C	36 mK (0.036 °C)	Ametek ETC-125 Dryblock, Fluke 5628 SPRT, HP 3457A Multimeter

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency - Source <sup>1,3</sup>	1 μHz to 250 kHz	0.7 mHz	Agilent 33220A Signal Generator Locked to Datum LPRO Rubidium Freq Std
	250 kHz to 3 GHz	5.9 mHz	HP ESG-D3000A Signal Generator locked to Datum LPRO Rubidium Freq Std
Frequency - Measure <sup>1,3</sup>	100 mHz to 225 MHz	58 mHz	Agilent 53131A Counter locked to Datum LPRO Rubidium Freq Std
	225 MHz to 26.5 GHz	580 mHz	HP 5348A Counter locked to Datum LPRO Rubidium Freq Std

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,  $t$  = time in seconds.
3. Uncertainties do not include contributors from a “best available” unit under test.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1287.

  
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 Vice President