CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Tra-Cal, LLC (NSCA, LLC)
7901 Beechcraft Avenue, Suites M & N
Gaithersburg, MD 20879

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 field of

CALIBRATION

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.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 28 February 2022
Certificate Number: L2151

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

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3-2006 (R2013)

Tra-Cal, LLC (NSCA, LLC)
7901 Beechcraft Avenue, Suites M & N
Gaithersburg, MD 20879
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CALIBRATION

Valid to: **February 28, 2022** Certificate Number: **L2151**

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source			GR 1404-A Capacitor GR 1409-T Capacitor Fluke 5520A Multiproduct Calibrator
1 kHz	1 nF	0.2 pF	
1 kHz	0.1 µF	0.000 029 µF	
10 Hz to 10 kHz	190 pF to 1.099 9 nF	0.028 nF	
10 Hz to 3 kHz	1.1 nF to 3.299 9 nF	0.031 nF	
10 Hz to 1 kHz	3.3 nF to 10.999 9 nF	0.044 nF	
10 Hz to 1 kHz	(11 to 32.99) nF	0.21 nF	
10 Hz to 1 kHz	(33 to 109.99) nF	0.44 nF	
10 Hz to 1 kHz	(110 to 329.99) nF	1.3 nF	
(10 to 600) Hz	(0.33 to 1.09) µF	0.007 2 µF	
(10 to 300) Hz	(1.1 to 3.29) µF	0.014 µF	
(10 to 150) Hz	(3.3 to 10.99) µF	0.045 µF	
(10 to 120) Hz	(11 to 32.99) µF	0.19 µF	
(10 to 80) Hz	(33 to 109.99) µF	0.69 µF	
DC to 50 Hz	(110 to 329.99) µF	2.1 µF	
DC to 20 Hz	(0.33 to 1.09) mF	0.009 mF	
DC to 6 Hz	(1.1 to 3.29) mF	0.021 mF	
DC to 2 Hz	(3.3 to 10.99) mF	0.069 mF	
DC to 0.6 Hz	(11 to 32.99) mF	0.32 mF	
DC to 0.2 Hz	(33 to 99.99) mF	1.4 mF	
Capacitance - Measure 1 kHz	200 pF to 20 µF	0.045 µF	GenRad 1689 Precision RLC Digibridge
DC Current – Source	(0 to 2.2) mA	0.000 15 mA	Fluke 5700A Multiproduct Calibrator
	(2.2 to 22) mA	0.001 5 mA	
	(22 to 220) mA	0.018 mA	
	(0.22 to 2.2) A	0.24 mA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source	(2.2 to 11) A (11 to 20) A	0.007 4 A 0.023A	Fluke 5520A Multiproduct Calibrator
DC Current – Source	(20 to 100) A	2.7 A	HP 6260B power supply
DC Current – Measure	(0 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	0.3 nA 0.000 97 µA 0.000 45µA 0.003 2 µA 0.005 mA 0.007 mA 0.011 mA 0.15 mA	Agilent 3458A 8 ½ Digit Multimeter
DC Current – Measure	(1 to 10) A	0.025 A	Fluke 45 Multimeter
DC Current – Measure	(0.001 to 25) A (25 to 50) A (50 to 100) A (100 to 750) A (750 to 1 000) A	0.29 % of reading 0.34 % of reading 0.34 % of reading 0.36 % of reading 0.31 % of reading	Current Shunt Monitored with Multimeter
AC Current - Source	(0 to 220) µA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 to 2.2) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.2 µA 0.11 µA 0.042 µA 0.18 µA 0.46 µA 0.002 mA 0.001 1mA 0.000 42 mA 0.001 8 mA 0.004 6 mA 0.021 mA 0.011 mA 0.004 2 mA 0.018 mA 0.046 mA	Fluke 5700A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Source	(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 (0.22 to 2.2) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.2 mA 0.11 mA 0.047 mA 0.18 mA 0.46 mA 0.001 9 A 0.002 2 A 0.025 A	Fluke 5700A Multiproduct Calibrator
AC Current - Source	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.007 9 A 0.012 A 0.042 A	Fluke 5700A Multiproduct Calibrator /5725 Amplifier
AC Current - Measure	(0 to 100) µA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (0.1 to 1.0) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	 0.5 uA 0.22 uA 0.13 uA 0.004 6 mA 0.002 mA 0.001 mA 0.000 77mA 0.000 92 mA 0.005 1 mA 0.008 1 mA 0.049 mA 0.02 mA 0.011 mA 0.007 7 mA 0.011 mA 0.051 mA 0.081 mA	Agilent 3458A 8 ½ Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Measure	(10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz (0.1 to 1.0) A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	 0.49 mA 0.2 mA 0.11 mA 0.077 mA 0.11 mA 0.51 mA 0.81 mA 0.005 A 0.002 4 A 0.001 7 A 0.001 8 A 0.003 9 A 0.012 A	Agilent 3458A 8 ½ Digit Multimeter
AC Current - Measure	(1 to 10) A 45 Hz to 1 kHz	 0.34 A	Fluke 45 Multimeter
Inductance – Source 1 kHz 1 kHz 1 kHz (0.1 to 1) kHz 100 Hz 1 kHz (0.1 to 1) kHz (0.1 to 1) kHz	 100 µH 10 mH 100 mH 500 mH 1 H 1 H 10 H 10 H	 0.29 µH 0.012 mH 0.13 mH 0.76 mH 0.001 3 H 0.001 3 H 0.015 H 0.015 H	 GR 1482-B Inductor GR 1482-H Inductor GR 1482-L Inductor GR 1482-N Inductor GR 1482-P Inductor GR 1482-P Inductor GR 1482-T Inductor GR 1482-T Inductor
Inductance - Measure 1 kHz	100 µH to 10 H	0.23 % of reading 0.29 µH	GenRad 1689 Precision RLC Digibridge
Resistance Source	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ	85 µΩ 0.99 mΩ 3.8 mΩ 28 mΩ 0.13 Ω 3.4 Ω 38 Ω	L&N 4020B resistor L&N 4025B resistor L&N 4030B resistor L&N 4035B resistor Fluke 742A-10k resistor L&N 4045B resistor L&N 4050B resistor

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Source	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	0.000 13 Ω 0.000 013 Ω 0.000 094 Ω 0.000 15 Ω 0.000 25 Ω 0.000 41 Ω 0.002 Ω 0.003 3 Ω 0.018 Ω 0.039 Ω 0.22 Ω 0.55 Ω	Fluke 5700A Multiproduct Calibrator
Resistance Source	1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	4.1 Ω 62 kΩ 35 kΩ 53 kΩ 62 kΩ	Fluke 5700A Multiproduct Calibrator
Resistance Source	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.29) kΩ (3.3 to 11) kΩ (11 to 32.99) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (330 to 1 100) MΩ	0.001 2 Ω 0.001 7 Ω 0.001 7 Ω 0.002 9 Ω 0.006 1 Ω 0.034 Ω 0.083 Ω 0.34 Ω 0.84 Ω 3.2 Ω 6.9 Ω 50 Ω 210 Ω 3.5 kΩ 9.7 kΩ 140 kΩ 1.4 MΩ	Fluke 5520A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Measure	(0 to 1) Ω (1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	81 µΩ 0.39 mΩ 2.5 mΩ 17 mΩ 17 mΩ 1.7 Ω 27 Ω 0.61 MΩ 4.2 MΩ 8.2 MΩ	Agilent 3458A 8 ½ Digit Multimeter
RTD Resistance Simulation Pt 385, 100 Ω Pt 385, 200 Ω Pt 385, 500 Ω Pt 385, 1 k Ω Pt 3916, 100 Ω Pt 3926, 100 Ω Cu 427, 10 Ω	 (-200 to 800) °C (-200 to 630) °C (-200 to 630) °C (-200 to 630) °C (-200 to 630) °C (-200 to 630) °C (-100 to 260) °C	 0.27 ºC 0.2 ºC 0.22 ºC 0.46 ºC 0.29 ºC 0.14 ºC 0.35 ºC	Fluke 5520A Multiproduct Calibrator
DC Voltage - Source	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 000) V	6.6 µV 22 µV 0.1 mV 0.23 mV 2.4 mV 15 mV	Fluke 5700A Multiproduct Calibrator /5725 Amplifier
DC Voltage – Measure	1 µV to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	3.3 µV 14 µV 59 µV 0.8 mV 16 mV	Agilent 3458A 8 ½ Digit Multimeter
DC Voltage – Measure	(1 to 10) kV (10 to 25) kV (25 to 40) kV	360 V 400 V 1.9 kV	Fluke 80K-40 High Voltage Probe w/8 ½ Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source	2.2 mV to 22 mV		Fluke 5700A Multiproduct Calibrator /5725 Amplifier
	(10 to 20) Hz	0.002 7 mV	
	(20 to 40) Hz	0.001 8 mV	
	40 Hz to 20 kHz	0.001 7 mV	
	(20 to 50) kHz	0.003 1 mV	
	(50 to 100) kHz	0.004 6 mV	
	(100 to 300) kHz	0.007 6 mV	
	(300 to 500) kHz	0.011 mV	
	(0.5 to 1) MHz	0.015 mV	
	22 mV to 220 mV		
	(10 to 20) Hz	0.015 mV	
	(20 to 40) Hz	0.006 3 mV	
	40 Hz to 20 kHz	0.003 4 mV	
	(20 to 50) kHz	0.011 mV	
	(50 to 100) kHz	0.024 mV	
	(100 to 300) kHz	0.034 mV	
	(300 to 500) kHz	0.047 mV	
	(0.5 to 1) MHz	0.08 mV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.15 mV	
	(20 to 40) Hz	0.061 mV	
	40 Hz to 20 kHz	0.028 mV	
	(20 to 50) kHz	0.092 mV	
	(50 to 100) kHz	0.2 mV	
	(100 to 300) kHz	0.28 mV	
	(300 to 500) kHz	0.46 mV	
	(0.5 to 1) MHz	0.92 mV	
	2.2 V to 22 V		
	(10 to 20) Hz	0.015 V	
	(20 to 40) Hz	0.004 6 V	
	40 Hz to 20 kHz	0.002 2 V	
	(20 to 50) kHz	0.003 6 V	
	(50 to 100) kHz	0.007 2 V	
	(100 to 300) kHz	0.012 V	
	(300 to 500) kHz	0.031 V	
	(0.5 to 1) MHz	0.061 V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source	22 V 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 (0.5 to 1) MHz 220 V to 750 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 0.5 to 1) MHz	 0.15 V 0.046 V 0.022 V 0.036 V 0.072 V 0.15 V 0.36 V 0.76 V 0.15 V 0.046 V 0.023 V 0.064 V 0.15 V 0.41 V 1.4 V 3.3 V	Fluke 5700A Multiproduct Calibrator /5725 Amplifier
AC Voltage Source	750 V (30 to 50) kHz (50 to 100) kHz	 0.52 V 2 V	Fluke 5725A Multiproduct Calibrator
AC Voltage Source	1 100 V 50 Hz to 1 kHz	 0.12 V	Fluke 5700A Multiproduct Calibrator
AC Voltage Source	1 100 V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	 0.11 V 0.21 V 0.76 V	Fluke 5725A Multiproduct Calibrator
AC Voltage –Measurement	10 mV to 100 mV (1 to 40) Hz 40Hz to 1kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	 0.003 6 mV 0.002 5 mV 0.003 6 mV 0.012 mV 0.058 mV 0.46 mV	Agilent 3458A 8 ½ Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage –Measurement	(0.1 to 10) V		Agilent 3458A 8 ½ Digit Multimeter
	(1 to 40) Hz	0.000 085 V	
	40Hz to 1kHz	0.000 085 V	
	(1 to 20) kHz	0.000 17 V	
	(20 to 50) kHz	0.000 36 V	
	(50 to 100) kHz	0.001 2 V	
	(100 to 300) kHz	0.005 8 V	
	300 kHz to 1MHz	0.012 V	
	(1 to 2) MHz	0.018 V	
	(10 to 100) V		
	(1 to 40) Hz	0.024 V	
	40Hz to 1kHz	0.024 V	
	(1 to 20) kHz	0.024 V	
	(20 to 50) kHz	0.041 V	
	(50 to 100) kHz	0.14 V	
	(100 to 300) kHz	0.46 V	
	(100 to 1 000) V		
	(1 to 40) Hz	0.46 V	
	40 Hz to 1 kHz	0.46 V	
	(1 to 20) kHz	0.69 V	
	(20 to 50) kHz	1.4 V	
	(50 to 100) kHz	3.5 V	
AC Voltage –Measurement	(2 to 20) mV		Fluke 8920A True RMS Voltmeter
	200 kHz to 1 MHz	1.7 mV	
	(1 to 10) MHz	2.0 mV	
	(10 to 20) MHz	2.5 mV	
	(0.02 to 20) V		
	200kHz to 1MHz	0.25 V	
	(1 to 10) MHz	0.29 V	
	(10 to 20) MHz	0.36 V	
Thermocouple Millivolt Simulation			Fluke 5520A Multiproduct Calibrator
Type C	(0 to 2 316) °C	0.98 ºC	
Type E	(-250 to 1 000) °C	0.44 ºC	
Type J	(-210 to 1 200) °C	0.31 ºC	
Type K	(-200 to 1 372) °C	0.47 ºC	
Type N	(-200 to 1 300) °C	0.47 ºC	
Type R	(0 to 1 767) °C	0.66 ºC	
Type S	(0 to 1 767) °C	0.55 ºC	
Type T	(-250 to 400) °C	0.73 ºC	
Type U	(-200 to 600) °C	0.65 ºC	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Square Wave into 1 MΩ (Peak-to-Peak)	(1 to 24.999) mV (25 to 109.99) mV 110 mV to 2.1999 V	0.075 mV 0.17 mV 0.049 V	Fluke 5520A-SC600 Multiproduct Calibrator
Amplitude Square Wave into 1 MΩ (Peak-to-Peak)	(2.2 to 10.999) V (11 to 130) V	0.013 V 0.15 V	Fluke 5520A-SC600 Multiproduct Calibrator
Amplitude Square Wave into 50 Ω (Peak-to-Peak)	(1 to 24.999) mV (25 to 109.99) mV 10 mV to 2.199 9 V (2.2 to 6.6) V	0.12 mV 0.36 mV 0.005 8 V 0.014 V	Fluke 5520A-SC600 Multiproduct Calibrator
Rise / Fall-time 50 Ω load 5 mV to 2.5 V (Peak-to-Peak)	1 kHz to 2 MHz 2 MHz to 10 MHz	350 pS 400 pS	Fluke 5520A-SC600 Multiproduct Calibrator
Bandwidth relative to 50 kHz 50 Ω load	(0.05 to 100) MHz (100 to 300) MHz (300 to 600) MHz (0.05 to 100) MHz (100 to 300) MHz (300 to 600) MHz	0.087 mV 0.23 mV 0.23 mV 0.058 V 0.058 V 0.059 V	Fluke 5520A-SC600 Multiproduct Calibrator
	(600 to 3 200) MHZ	0.014 V	Fluke 9500B-3200 Calibrator
Timebase 50 Ω Load	5 s to 50 mS 20 mS to 2 nS	0.029 S 0.002 9 mS	Fluke 5520A-SC600 Multiproduct Calibrator

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power - Source 10 MHz to 2.3 GHz (2.3 to 18.6) GHz (18.6 to 26.5) GHz	(-20 to 18) dBm (-20 to 18) dBm (-20 to 18) dBm	1.1 dB 1.7 dB 2.3 dB	HP 8340B/83554A Signal Generator
RF Power - Source (26.5 to 40) GHz (40 to 50) GHz	(-25 to 3) dBm (-25 to 0) dBm	1.2 dB 2.2 dB	HP 83650B Signal Generator
RF Power - Source 200 Hz to 10.0 MHz 10MHz to 80.0MHz	(-86.98 to 13.01) dBm (-86.98 to 13.01) dBm	0.42 dB 0.13 dB	HP 3335A Signal Generator

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Flatness - Source 200 Hz to 10 MHz 10 MHz to 25 MHz 25 MHz to 80 MHz	 (-86.98 to 13.01) dBm (-86.98 to 13.01) dBm (-86.98 to 13.01) dBm	 0.42 dBm 0.14 dBm 0.21 dBm	HP 3335A Signal Generator
RF Power Flatness - Source 10 MHz to 2.3 GHz (2.3 to 18.6) GHz (18.6 to 26.5) GHz	 (-20 to 18) dBm (-20 to 18) dBm (-20 to 18) dBm	 1.1 dB 1.7 dB 2.3 dB	HP8340B Signal Generator
RF Power Flatness - Source (26.5 to 40) GHz (40 to 50) GHz	 (-25 to 3) dBm (-25 to 0) dBm	 1.2 dB 2.2 dB	HP 83650B Signal Generator
RF Relative Attenuation 5 MHz to 26.5 GHz	(-12 to 0) dB (-12 to -22) dB (-22 to -31) dB (-31 to -40) dB (-40 to -50) dB (-50 to -61) dB (-61 to -71) dB (-71 to -80) dB (-80 to -90) dB (-90 to -100) dB (-100 to -110) dB (-110 to -120) dB	0.18 dB 0.21 dB 0.23 dB 0.27 dB 0.29 dB 0.32 dB 0.34 dB 0.51 dB 0.60 dB 0.62 dB 0.65 dB 0.69 dB	HP 8902A Measuring Receiver w/11793A Power Sensor
RF Power - Measure	(-127 to -30) dBm 150 kHz to 2.6 GHz	 0.33 dB + 0.1 dB/dB	HP 8902A Measuring Receiver w/11722A Power Sensor
RF Power - Measure	(-25 to +20) dBm 100 kHz to 4.2 GHz 10 MHz to 18 GHz 50 MHz to 26.5 GHz 50 MHz to 50 GHz	 0.29 dB 0.13 dB 0.23 dB 0.4 dB	HP 438A Power Meter w/ 8482A Power Sensor w/ 8481A S Power Sensor w/ 8485A Power Sensor w/ 8487A Power Sensor
Distortion	(-80 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	 1.5 dB 3.1 dB	HP 8903B Audio Analyzer
Frequency Modulation – Measure CW (0.25 to 10) MHz CW (0.01 to 1.3) GHz	 Rate (20 Hz to 10 kHz) 40 kHz Peak Deviation Rate (20 Hz to 200 kHz) 400 kHz Peak Deviation	 0.24 kHz 5.9 kHz	HP 8902A Measuring Receiver

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure CW (0.15 to 10) MHz	Rate (20 Hz to 10 kHz) Depth (10 to 99) %	3.6 % of reading	HP 8902A Measuring Receiver
CW (0.15 to 10) MHz	Rate (50 Hz to 10 kHz) Depth (10 to 99) %	2.4 % of reading	
CW (0.01 to 1.3) GHz	Rate (20 Hz to 100 kHz) Depth (10 to 99) %	3.6 % of reading	
CW (0.01 to 1.3) GHz	Rate (50 Hz to 50 kHz) Depth (10 to 99) %	1.3 % of reading	
Phase Modulation – Measure CW (0.15 to 10) MHz CW (0.01 to 1.3) GHz	 Rate (200 Hz to 10 kHz) Rate (200 Hz to 20 kHz)	 1.3 rad 8.8 rad	HP 8902A Measuring Receiver
LISN Insertion Loss Impedance	9 kHz to 30 MHz (0 to 12) dB (0 to 110) mV	 1.9 dB 2.6 mV	Spectrum Analyzer, Oscilloscope, Signal Generator

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools	(5 to 50) lbf·in (10 to 100) lbf·f (50 to 500) lbf·ft	0.58 % of reading 0.95 % of reading 1 % of reading	Torque Transducers TL50I BMX100F BMX500F

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Source Wavelength Single Mode	1 310 nm	0.2 nm	HP 8168F Tunable laser source
Source Wavelength Single Mode	1 550 nm	0.002 nm	HP 81554SM Laser Source

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Source Wavelength Multi-Mode	850 nm 1 300 nm	35 nm 58 nm	OWL DO-2 Optical Source
Source Power Multi-Mode	850 nm 1 300 nm	0.18 dB 0.15 dB	OWL DO-2 Optical Source
Measure Single Power measure	1 310 nm 1 550 nm	0.14 µW 0.19 µW	HP 8153A Lightwave Multimeter
Single Wavelength measure	1 310 nm 1 550 nm	0.3 nm 0.13 nm	HP 86120B Multi-Wavelength Meter

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity (23 ± 5) °C	(10 to 80) % RH	2.4 % RH	Veriteq SP-2000 Logger
Temperature Measurement (Ovens, Furnaces, Freezers, Chambers, Ice Baths – System Accuracy Test)	(-45 to 200) ºC (200 to 500) ºC	2.2 ºC 2.5 ºC	Fluke 51 Thermometer with Type J TC probe

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source[2]	10 MHz	$7.6 \cdot 10^{-11} \cdot f$	HP 58503A GPS Receiver
	DC to 20 MHz	$7.6 \cdot 10^{-11} \cdot f$ + 0.58 Hz	HP 3325B Generator
	10 MHz to 26.5 GHz	$7.6 \cdot 10^{-11} \cdot f$ + 1.2 Hz	HP 8340B Generator
Frequency - Measure[1,2]	1 Hz to 225 MHz	$7.6 \cdot 10^{-11} \cdot f$ + 0.6 mHz	HP 53131A Counter
Frequency - Measure[1,2]	10 Hz to 525 MHz (0.5 to 26.5) GHz	$7.6 \cdot 10^{-11} \cdot f$ + 0.58 Hz	5351B 50 Ω Counter

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. *f* is defined as the measured / generated frequency.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. L2151.

R. Douglas Leonard Jr., VP, PILR SBU