SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017
& ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

ACUCAL INC., A TRESCAL COMPANY
11090 Industrial Rd
Manassas, VA 20109
Dainna Lowrance Phone: 703-369-3090

CALIBRATION

Valid To: April 30, 2021 Certificate Number: 2737.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1, 6]:

I. Dimensional

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Hand Tools[3] –			
Calipers	Up to 72 in	2.2 µin/in + 12 µin	Gage blocks
Micrometers	Up to 48 in	2.2 µin/in + 12 µin	
Height Gages	Up to 48 in	2.2 µin/in + 12 µin	
Indicators: Dial or Digital	Up to 2 in	2.2 µin/in + 12 µin	
Depth Micrometers	Up to 12 in	2.2 µin/in + 12 µin	
Diameter, External – (Plug Gages, Thread Wires, Pins)	Up to 12.1 in	2.2 µin/in + 14 µin	Pratt&Whitney Labmaster™ w/ master gage block set
Angle – Measure	Up to 90°	5.9”	Gage blocks and sine bars
Angle – Measuring Equipment	5°, 15°, 30°, 45°	5.2”	Gage blocks

5202 Presidents Court, Suite 220 | Frederick, MD 21703-8515 | Phone: 301 644 3248 | Fax: 240 454 9449 | www.A2LA.org

Parameter/Equipment	Range	CMC[2] (±)	Comments
Tape Measure and Steel Ruler[3]	(1 to 12) in (12 to 36) in (3 to 100) ft	0.008 in + 0.2 in/in 0.0034 in + 0.002 in/in 0.0002 in + 0.0043 in/ft	Gage blocks, no tension applied

II. Dimensional Testing/Calibration[1]

Parameter/Equipment	Range	CMC[2] (±)	Comments
Length – 1D Measure[8]	Up to 12.1 in	2.2 µin/in + 0.2 in/in	Pratt & Whitney Labmaster™ w/ master gage bock set

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Voltage[3] – Generate	(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 1100) V	9.2 µV/V + 0.4 µV 5.0 µV/V + 0.7 µV 3.5 µV/V + 2.5 µV 3.5 µV/V + 4.0 µV 5.0 µV/V + 40 µV 6.5 µV/V + 400 µV	Fluke 5720A
DC Voltage[3] – Measure	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1000) V	9.4 µV/V + 0.1 µV 4.2 µV/V + 0.4 µV 4.7 µV/V + 4.0 µV 6.4 µV/V + 40 µV 6.4 µV/V + 0.5 mV	Fluke 8508A
DC High Voltage[3] – Measure/Generate	Up to 1400 V (>1.4 to 35) kV (>35 to 70) kV	0.035 % + 13 mV 0.047 % + 130 mV 0.039 % + 1.3 V	Vitrek 4700 w/ HVL-70

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Current[3] – Generate	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A (11 to 20.5) A (20 to 100) A	42 µA/A + 6.0 nA 37 µA/A + 7.0 nA 36 µA/A + 40 nA 55 µA/A + 0.7 uA 0.013 % + 12 uA 0.060 % + 0.33 mA 0.1 % + 58 µA 33 µA/A	Fluke 5720A Fluke 5520A Power Supply, L&N Shunt & 3458A
Clamp-On Only	(10 to 300) A (300 to 1000) A	0.30 % + 0.002 A 0.34 % + 0.05 A	Fluke 5522A w/ 5500A/coil
DC Current[3] – Measure	(0 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 (20 to 100) A	30 µA/A + 8.0 nA 15 µA/A+ 1 nA 15 µA/A + 0.16 nA 15 µA/A + 0.83 nA 15 µA/A + 9.2 nA 15 µA/A + 90 nA 30 µA/A + 0.92 µA 100 µA/A + 13 µA 33 µA/A	Agilent 3458A Agilent 3458A w/ shunts
DC Resistance[3] – Generate	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	0.1 mΩ/Ω + 40 µΩ 0.1 mΩ/Ω + 40µΩ 9.1 µΩ/Ω + 40 µΩ 15 µΩ/Ω + 40 µΩ 2.5 µΩ/Ω + 40 µΩ 7.1 µΩ/Ω + 40 µΩ 2.1 Ω/Ω + 40 µΩ 6.7 Ω/Ω + 40 µΩ 6.1 Ω/Ω + 40 µΩ 3.9 Ω/Ω + 40 µΩ 6.2 Ω/Ω + 40 µΩ 5.8 Ω/Ω + 40 µΩ 7.1 Ω/Ω + 40 µΩ 7.3 Ω/Ω + 40 µΩ 13 Ω/Ω + 40 µΩ 30 Ω/Ω + 40 µΩ 96 Ω/Ω + 40 µΩ	Fluke 5720A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Resistance[3] – Generate (cont)	(0 to 10.9999) Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω 330 Ω to 1.09999 kΩ (1.1 to 3.299 999) kΩ (3.3 to 10.99 999) kΩ (11 to 32.99 999) kΩ (33 to 109.9999) kΩ	40 µΩ/Ω + 1.0 mΩ 30 µΩ/Ω + 1.5 mΩ 28 µΩ/Ω + 1.4 mΩ 28 µΩ/Ω + 2.0 mΩ 28 µΩ/Ω + 6.8 mΩ 28 µΩ/Ω + 21 mΩ 28 µΩ/Ω + 25 mΩ 28 µΩ/Ω + 0.2 Ω 28 µΩ/Ω + 0.22 Ω	Fluke 5522A, 4-wire
	(110 to 329.9999) kΩ 330 kΩ to 1.099 999 MΩ (1.1 to 3.299 999) MΩ (3.3 to 10.99 999) MΩ (11 to 32.99 999) MΩ (33 to 109.9999) MΩ (110 to 329.9999) MΩ (330 to 1100) MΩ	32 µΩ/Ω + 2.0 Ω 32 µΩ/Ω + 2.6 Ω 60 µΩ/Ω + 42 Ω 0.013 % + 61 Ω 0.025 % + 2.7 kΩ 0.05 % + 5.4 kΩ 0.3 % + 0.12 MΩ 1.5 % + 0.56 MΩ	Fluke 5522A, 2-wire
DC Resistance[3] – Measure	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ	25 µΩ/Ω + 4.0 µΩ 12 µΩ/Ω + 14 µΩ 9.4 µΩ/Ω + 50 µΩ 9.4 µΩ/Ω + 0.5 mΩ 9.4 µΩ/Ω + 5.0 mΩ 9.5 µΩ/Ω + 50 mΩ 14 µΩ/Ω + 1.0 Ω 57 µΩ/Ω + 100 Ω 0.046 % + 10 kΩ 0.18 % + 0.1 MΩ	Fluke 8508A
Electrical Calibration of Thermocouples and Indicators[3] –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.35 °C 0.27 °C 0.24 °C 0.26 °C	Fluke 5522A
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.24 °C 0.21 °C 0.25 °C 0.39 °C 0.65 °C	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Electrical Calibration of Thermocouples and Indicators[3] – (cont)			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.53 °C 0.14 °C 0.12 °C 0.14 °C 0.17 °C	Fluke 5522A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.22 °C 0.14 °C 0.12 °C 0.14 °C 0.19 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.26 °C 0.15 °C 0.13 °C 0.21 °C 0.33 °C	
Type N	(-200 to -100) °C (-100 to - 25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.31 °C 0.18 °C 0.16 °C 0.15 °C 0.22 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.45 °C 0.28 °C 0.26 °C 0.31 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.37 °C 0.28 °C 0.29 °C 0.36 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.49 °C 0.19 °C 0.14 °C 0.15 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.44 °C 0.22 °C	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Electrical Calibration of RTD Indicators[3] –			
Pt 385, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.068 °C 0.055 °C 0.07 °C 0.098 °C 0.11 °C 0.18 °C	Fluke 5522A
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.039 °C 0.055 °C 0.07 °C 0.078 °C 0.093 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.2 °C 0.032 °C 0.039 °C 0.076 °C 0.073 °C 0.084 °C 0.09 °C 0.096 °C 0.18 °C	
Pt 385, 200 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.032 °C 0.032 °C 0.039 °C 0.093 °C 0.11 °C 0.11 °C 0.12 °C	
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 400) °C (400 to 600) °C (600 to 630) °C	0.032 °C 0.039 °C 0.047 °C 0.062 °C 0.07 °C 0.086 °C	
Pt 385, 1000 Ω	(-200 to 0) °C (0 to 100) °C (100 to 260) °C	0.024 °C 0.032 °C 0.039 °C	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Electrical Calibration of RTD Indicators[3] – (cont)			
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.062 °C 0.062 °C 0.11 °C	Fluke 5522A
Cu 427. 10 Ω	(-100 to 260) °C	0.23 °C	
Oscilloscope[3]–			
50 Ω Load	(-6.6 to 6.6) V	0.25 % of output + 40 µV	Fluke 5522A-SC1100
1 MΩ Load	(-130 to 130) V	0.12 % of output + 40 µV	
Rise Time	Single Sided	< 300 ps ± 120 ps	
Bandwidth	50 kHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	1.6 % + 0.3 mV 2.8 % + 0.3 mV 3.2 % + 0.3 mV 4.7 % + 0.3 mV 5.7 % + 0.3 mV	
	(1.1 to 4.2) GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	0.24 dB 0.36 dB 0.47 dB 1.9 dB	Power sensors w/splitters (phase lock to GPS)
Flatness 50 kHz Reference	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	1.4 % + 0.1 mV 1.6 % + 0.1 mV 3.2 % + 0.1 mV 3.9 % + 0.1 mV	
Time Markers: Source and Period into a 50 Ω load	5 s to 50 ms 20 ms to 1 ns	160 µs + *t* parts in 10^6 s 64 µs + *t* parts in 10^6 s	*t* = time
Amplitude 1 MΩ 50 Ω	 1.0 mV to 130 $V_{(pk-pk)}$ 1.0 mV to 5.0 $V_{(pk-pk)}$	 2.4 % + 0.1 mV 2.4 % + 0.1 mV	
Frequency	10 Hz to 50 GHz	34 parts in 10^{-11} Hz + 15 mHz	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
AC Power[3] @ (45 to 65) Hz – (PF =1)			
(3.3 to 9) mA	(33 to 330) mV (0.33 to 1020) V	0.11 % 0.1 %	Fluke 5522A
(9 to 33) mA	(33 to 330) mV (0.33 to 1020) V	0.08 % 0.06 %	
(33 to 90) mA	(33 to 330) mV (0.33 to 1020) V	0.11 % 0.09 %	
(90 to 330) mA	(33 to 330) mV (0.33 to 1020) V	0.08 % 0.06 %	
(0.33 to 0.9) A	(33 to 330) mV (0.33 to 1020) V	0.1 % 0.1 %	
(0.9 to 2.2) A	(33 to 330) mV (0.33 to 1020) V	0.09 % 0.07 %	
(2.2 to 4.5) A	(33 to 330) mV (0.33 to 1020) V	0.1 % 0.1 %	
(4.5 to 20.5) A	(33 to 330) mV (0.33 to 1020) V	0.09 % 0.31 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage[3] – Generate			
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 (0.5 to 1) MHz	0.024 % + 4.0 µV 90 µV/V + 4.0 µV 80 µV/V + 4.0 µV 0.020 % + 4.0 µV 0.050 % + 5.0 µV 0.11 % + 13 µV 0.14 % + 20 µV 0.27 % + 20 µV	Fluke 5720A
(2.2 to 22) 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 (0.5 to 1) MHz	0.024 % + 4.0 µV 90 µV/V + 4.0 µV 80 µV/V + 4.0 µV 0.020 % + 4.0 µV 0.050 % + 5.0 µV 0.11 % + 10 µV 0.14 % + 20 µV 0.27 % + 20 µV	
(22 to 220) 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 (0.5 to 1) MHz	0.024 % + 12 µV 90 µV/V + 7.0 µV 80 µV/V + 7.0 µV 0.020 % + 7.0 µV 0.046 % + 17 µV 0.090 % + 20 µV 0.14 % + 25 µV 0.27 % + 45 µV	
(0.22 to 2.2) 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	0.024 % + 40 µV 90 µV/V + 15 µV 50 µV/V + 8.0 µV 80 µV/V + 10 µV 0.011 % + 30 µV 0.042 % + 80 µV 0.10 % + 0.2 mV 0.17 % + 0.30 mV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % + 400 µV 90 µV/V + 150 µV 50 µV/V + 51 µV 80 µV/V + 0.10 mV 0.010 % + 0.2 mV 0.028 % + 0.60 mV 0.10 % + 2.0 mV 0.15 % + 3.2 mV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage[3] – Generate (cont)			
(22 to 220) V	(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*	0.024 % + 4.0 µV 90 µV/V + 2.0 µV 50 µV/V + 1.0 µV 80 µV/V + 1.0 µV 0.015 % + 3.0 µV 0.090 % + 16 µV 0.44 % + 40 µV	Fluke 5720A * Limited to 2.2E7 V-Hz
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.030 % + 16 µV 0.0070 % + 4.0 µV	Fluke 5522A
(33 to 330) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.23 % + 2 mV 0.23 % + 6 mV 0.24 % + 6 mV 0.40 % + 6 mV 0.43 % + 6 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.41 % + 10 mV 0.41 % + 10 mV 0.40 % + 10 mV	
AC Voltage – Measure			
(0 to 10) mV	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.039 % + 3 µV 0.023 % + 1.1 µV 0.034 % + 1.1 µV 0.11 % + 1.1 µV 0.57 % + 1.1 µV 4.5 % + 2 µV	Agilent 3458A-002
(10 to 100) mV	(10 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.049 % + 4 µV 0.12 % + 2 µV 0.045 % + 2 µV 0.091 % + 2 µV 0.12 % + 2 µV 0.35 % + 10 µV	
(0.1 to 1) V	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.008 % + 40 µV 0.008 % + 20 µV 0.016 % + 20 µV 0.034 % + 20 µV 0.091 % + 20 µV 0.34 % + 100 µV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage – Measure (cont)			
(1 to 10) V	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.043 % + 400 µV 0.027 % + 200 µV 0.023 % + 200 µV 0.041 % + 200 µV 0.094 % + 200 µV 0.34 % + 1 mV	Agilent 3458A-002
(10 to 100) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.21 % + 4 mV 0.21 % + 2 mV 0.21 % + 2 mV 0.28 % + 2 mV 0.31 % + 2 mV	
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	1.6 % + 40 mV 1.7 % + 20 mV 2.3 % + 20 mV 2.3 % + 20 mV 0.36 % + 20 mV	
AC High Voltage[3] – Measure			
Up to 1.4 kV	Up to 600 Hz	0.12 % + 13 mV	Vitrek 4700 w/ HVL-70
(>1.4 to 35) kV	Up to 30 Hz (30 to 200) Hz (200 to 450) Hz (450 to 600) Hz	0.59 % + 0.13 V 0.12 % + 0.13 V 0.71 % + 0.13 V 1.5 % + 0.13 V	
(>35 to 50) kV	Up to 30 Hz (30 to 70) Hz (70 to 200) Hz (200 to 450) Hz	0.35 % + 1.3 V 0.14 % + 1.3 V 1.2 % + 1.3 V 1.8 % + 1.3 V	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Capacitance[3] – Generate			
(0.19 to 0.3999) nF	10 Hz to 10 kHz	0.55 % + 0.01 nF	Fluke 5522A
(0.4 to 1.0999) nF	10 Hz to 10 kHz	0.42 % + 0.01 nF	
(1.1 to 3.2999) nF	10 Hz to 3 kHz	0.43 % + 0.01 nF	
(3.3 to 10.9999) nF	10 Hz to 1 kHz	0.19 % + 0.01 nF	
(11 to 32.9999) nF	10 Hz to 1 kHz	0.19 % + 0.1 nF	
(33 to 109.999) nF	10 Hz to 1 kHz	0.19 % + 0.1 nF	
(110 to 329.999) nF	10 Hz to 1 kHz	0.19 % + 0.3 nF	
(0.33 to 1.0999) µF	(10 to 600) Hz	0.19 % + 1 nF	
(1.1 to 3.29999) µF	(10 to 300) Hz	0.19 % + 3 nF	
(3.3 to 10.9999) µF	(10 to 150) Hz	0.19 % + 10 nF	
(11 to 32.9999) µF	(10 to 120) Hz	0.31 % + 30 nF	
(33 to 109.999) µF	(10 to 80) Hz	0.36 % + 100 nF	
(110 to 329.999) µF	(10 to 50) Hz	0.35 % + 300 nF	
(0.33 to 1.09 999) mF	(10 to 20) Hz	0.35 % + 1 µF	
(1.1 to 3.2999) mF	(0 to 6) Hz	0.35 % + 3 µF	
(3.3 to 10.9999) mF	(0 to 2) Hz	0.35 % + 10 µF	
(11 to 32.9999) mF	(0 to 0.6) Hz	0.58 % + 30 µF	
(33 to 110) mF	(0 to 0.2) Hz	0.85 % + 100 µF	
AC Current[3] – Generate			
Up to 220 µA	(10 to 20) Hz	0.26 mA/A+ 25 nA	Fluke 5720A
	(20 to 40) Hz	0.16 mA/A + 20 nA	
	40 Hz to 1 kHz	0.12 mA/A + 16 nA	
	(1 to 5) kHz	0.28 mA/A + 40 nA	
	(5 to 10) kHz	1.1 mA/A + 80 nA	
(0.22 to 2.2) mA	(10 to 20) Hz	0.25 mA/A + 40 nA	
	(20 to 40) Hz	0.16 mA/A + 35 nA	
	40 Hz to 1 kHz	0.12 mA/A + 35 nA	
	(1 to 5) kHz	0.20 mA/A + 400 nA	
	(5 to 10) kHz	1.1 mA/A + 800 nA	
(2.2 to 22) mA	(10 to 20) Hz	0.25 mA/A + 400 nA	
	(20 to 40) Hz	0.16 mA/A + 350 nA	
	40 Hz to 1 kHz	0.12 mA/A + 350 nA	
	(1 to 5) kHz	0.20 mA/A + 4 µA	
	(5 to 10) kHz	1.1 mA/A + 8 µA	
(22 to 220) mA	(10 to 20) Hz	0.25 mA/A + 4 µA	
	(20 to 40) Hz	0.16 mA/A + 3.5 µA	
	40 Hz to 1 kHz	0.12 mA/A + 3.5 µA	
	(1 to 5) kHz	0.20 mA/A + 40 µA	
	(5 to 10) kHz	1.1 mA/A + 80 µA	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Current[3] – Generate (cont)			
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.30 mA/A + 35 µA 0.51 mA/A + 380 µA 7.3 mA/A + 0.75 mA	
(1.1 to 2.99 999) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.21 % + 100 µA 0.13 % + 100 µA 0.14 % + 1 mA 2 % + 5 mA	
(3 to 10.9999) A	(45 to 100) Hz (0.100 to 1) kHz (1 to 5) kHz	0.31 % + 2 mA 0.31 % + 2 mA 2.4 % + 2 mA	Fluke 5522A
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 5 mA 0.15 % + 5 mA 3 % + 5 mA	
(10 to 1000) A	(45 to 440) Hz	0.42 % + 0.05A	Fluke 5522A w/5500A/coil
AC Current[3] – Measure			
Up to 200 µA (0.2 to 2) mA (2 to 20) mA	1 Hz to 30 kHz	0.034 % + 20 nA 0.030 % + 0.2 µA 0.040 % + 2 µA	Fluke 8508A
(20 to 200) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.040 % + 20 µA 0.030 % + 20 µA 0.070 % + 20 µA	
(0.2 to 2) A	(10 to 2) kHz (2 to 10) kHz (10 to 30) kHz	0.070 % + 0.2 mA 0.080 % + 0.2 mA 0.68 % + 0.2 mA	
(2 to 20) A	(10 to 2) kHz (2 to 10) kHz	0.09 % + 0.2 mA 0.57 % + 0.2 mA	

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
Amplitude Modulation – Measure[3]			
Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 %	(0.15 to 10) MHz	4.1 % + 1 digit	Agilent 8902A measuring receiver plus Agilent 11722A power sensor
Rate: 20 Hz to 10 kHz, Depth: 5 % to 99 %	(0.15 to 10) MHz	5.0 % + 1 digit	
Rate: 50 Hz to 50 kHz, Depth: 5 % to 99 %	(10 to 1300) MHz	3.6 % + 1 digit	
Rate: 20 Hz to 100 kHz, Depth: to 99 %	(10 to 1300) MHz	4.6 % + 1 digit	
Rate: 50 Hz to 50 kHz, Depth: 5 % to 99 %	(1.3 to 26.5) GHz	4.0 % + 1 digit	
Rate: 20 Hz to 100 kHz, Depth: to 99 %	(0.01 to 26.5) GHz	5.3 % + 1 digit	
Frequency Modulation – Measure[3]			
Rate: 20 Hz to 10 kHz, ≤ 40 kHz Peak	(0.25 to 10) MHz	4.1 % + 1 digit	Agilent 8902A measuring receiver plus Agilent 11722A power sensor
Rate: 50 Hz to 100 kHz, ≤ 400 kHz Peak	(10 to 1300) MHz	3.4 % + 1 digit	
Rate: 20 Hz to 200 kHz, ≤ 400 kHz Peak	(10 to 1300) MHz	7.3 % + 1 digit	
Rate: 50 Hz to 100 kHz, ≤ 400 kHz Peak	(0.01 to 26.5) GHz	2.7 % + 1 digit	Agilent 8902A measuring receiver plus Agilent 11792A power sensor
Rate: 20 Hz to 200 kHz, ≤ 400 kHz Peak	(0.01 to 26.5) GHz	7 % + 1 digit	

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
Phase Modulation – Measure[3]			
Rate: 200 Hz to 10 kHz	(0.15 to 10) MHz	6.2 % + 1 digit	Agilent 8902A measuring power receiver plus Agilent 11722A powers sensor
Rate: 200 Hz to 20 kHz	(10 to 1300) MHz	5.5 % + 1 digit	
Rate: 200 Hz to 20 kHz	10 MHz to 26.5 GHz	5.1 % + 1 digit	Agilent 8902A measuring receiver plus Agilent 11792A power sensor
RF Absolute Power – Measure			
Power Reference[3]			
1 mW, Type-N(f), 50 Ω	50 MHz	1.2 %	HP 432A power meter w/ 478A-H76 power sensor
Coaxial Power Sensors[3]			
(+20 to -30) dBm, 50 Ω	10 MHz to 4.2 GHz	1.6 %	Tegam 1806, Tegam F1135 RF transfer standard
(+20 to -30) dBm, 50 Ω	10 MHz to 18 GHz	2.6 %	
(+20 to -30) dBm, 50 Ω	50 MHz to 26.5 GHz	2.6 %	
Direct Measure[3]			
(+20 to -30) dBm, 50 Ω	(50 to < 100) MHz	0.13 dB	HP 8902A measuring receiver w/ 8487A power sensor
	100 MHz to 2 GHz	0.13 dB	
	(2 to 12.4) GHz	0.15 dB	
	(12.4 to 18) GHz	0.19 dB	
	(18 to 26.5) GHz	0.24 dB	
	(26.5 to 40) GHz	0.31 dB	
	(40 to 50) GHz	0.40 dB	
(+20 to -70) dBm, 50 Ω	10 MHz to 18 GHz	0.22 dB	w/ E4412A power sensor
	30 MHz to < 2 GHz	0.17 dB	
	(2 to < 6) GHz	0.19 dB	
	(6 to < 11) GHz	0.21 dB	
	(11 to 18) GHz	0.27 dB	

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
RF Absolute Power – Measure (cont) Direct Measure[3]			HP 8902A measuring receiver w/ 8487A power sensor
(+20 to -70) dBm, 50 Ω	(50 to < 100) MHz 100 MHz to < 8 GHz (8 to < 18) GHz (18 to 26.5) GHz	0.21 dB 0.20 dB 0.24 dB 0.27 dB	w/ E4413A power sensor
Relative Power – Measure[3]			
0 dB, Reference (-0.0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB (-100 to -110) dB (-110 to -127) dB	10 MHz to 26.5 GHz	0.2 dB 0.2 dB 0.21 dB 0.21 dB 0.21 dB 0.21 dB 0.21 dB 0.21 dB 0.22 dB 0.22 dB 0.22 dB 0.22 dB 0.22 dB	HP 8902A measuring receiver w/ 11722A, 11792A power sensors
RF Absolute Power – Generate[3]			
Sine Wave into 50 Ω 10 mV to 10 $V_{(p-p)}$	1 µHz to 10 MHz (10 to 50) MHz (50 to 80) MHz	0.13 dB 0.27 dB 0.53 dB	Agilent 33250A arbitrary waveform generator or Agilent 3325A w/ BNC(f)
Full Amplitude, 50 Ω 13.01 dBm	200 Hz to 80 MHz	0.69 dB	Level generator 3335A w/ BNC(f)
Full Amplitude, 75 Ω 11.25 dBm	200 Hz to 25 MHz (25 to 80) MHz	0.29 dB 0.33 dB	

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
RF Absolute Power – Generate[3] (cont)			
Attenutation, 50 Ω			
(0 to 18) dB	200 Hz to 80 MHz	0.66 dB	Agilent 33250A arbitrary waveform generator or Agilent 3325A w/ BNC(f)
(20 to 58) dB	200 Hz to 80 MHz	0.67 dB	
(60 to 98) dB	200 Hz to 80 MHz	0.71 dB	
Attenuation, 75 Ω	200 Hz to 25 MHz	0.28 dB	
(0 to 18) dB	(25 to 80) MHz	0.73 dB	
	200 Hz to 25 MHz	0.34 dB	
(20 to 58) dB	(25 to 80) MHz	0.78 dB	
	200 Hz to 25 MHz	0.38 dB	
(60 to 98) dB	(25 to 80) MHz	0.96 dB	
Into 50 Ω	200 kHz to 80 MHz	0.67 dB	3335A synthesized sweeper
(+13 to -87) dBm	10 MHz to 50 GHz	1.1 dB	HP sweeper 83650A, 3.5 mm(m) w/ 8487A power sensor, power splitter 11667A
	(10 to 23) GHz	1.2 dB	
	(23 to 36) GHz	1.4 dB	
(+10 to -110) dBm	(36 to 50) GHz	2.5 dB	

IV. Mechanical

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
Torque Equipment	Up to 200 in·ozf	0.29 %	CDI Suretest system
	(4 to 50) in·lbf	0.29 %	
	(40 to 400) in·lbf	0.29 %	
	(100 to 1000) in·lbf	0.29 %	
	(25 to 250) ft·lbf	0.29 %	
	(60 to 600) ft·lbf	0.29 %	
	(200 to 2000) ft·lbf	0.29 %	

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
Torque Transducers	(2 to 120) in·lbf (10 to 200) ft·lbf (200 to 1000) ft·lbf	0.32 % 0.36 % 0.25 %	Torque arms and weights
Scales and Balances[3]	Up to 20 g (20 to 100) g 2 oz to 1 lb (1 to 50) lb (50 to 300) lb (300 to 1000) lb	320 µg/g + 0.6*R* 67 µg/g + 0.6*R* 180 µg/g + 0.6*R* 120 µg/g + 0.6*R* 0.06 µg/g + 0.6*R* 0.012 % + 0.6*R*	Class 2 weights Class F weights
Pressure Gages, Transducers & Calibrators – Measure and Measuring Equipment[3]	(1 to 15) psia (0 to 100) psig (0 to 500) psig (0 to 1000) psig (0 to 10 000) psig	0.024 psia 0.08 psi 0.06 psi 0.61 psi 9.3 psi	Fluke 700PA4 Fluke 700P06 Fluke 700P07 Fluke 700P08 Fluke 700P31
Force – Measure Compression/Tension	 (1000 to 60 000) lbf	 0.072 % + 2.2 lbf	 Load cells
Vibration – Measure Voltage Sensitivity – 100 Hz Frequency Response	 10 mV/g 5 Hz to 10 kHz	 3.4 % 3.4 %	 PCB ICP accelerometer 301A4

V. Thermodynamics

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
Hygrometers	(20 to 70) % RH (16 to 24) °C	1.3 % RH + 0.6*R* 0.11 °C + 0.6*R*	Fluke 2626-H Thermo-hygrometer probe
Humidity/Temperature – Measuring Equipment[3] Humidity (-20 to +40) °C (-40 to +180) °C Temperature	 (0 to 97) % RH (0 to 97) % RH (0 to 40) °C (-40 to 100) °C (-70 to 140) °C (140 to 180) °C	 1.2 % 1.8 % 0.71 °C 0.79 °C 0.87 °C 0.95 °C	 Vaisala humidity meter/probe

VI. Time & Frequency

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Time Interval	Up to 86 400 s	30 ms	Counter phase locked to GPS
Frequency – Measure	1 mHz to 40 GHz	1.22 x 10^{-9} x f + 5 µHz	Counter phase locked to GPS (f is the frequency)
Frequency – Measuring Equipment	10 MHz 1 mHz to 50 GHz	1.2 x 10^{-9} x f 1.2 x 10^{-9} x f + 5 µHz	Spectracom Rubidium Signal generators Phase locked to GPS (f is the frequency)

[1] This laboratory offers commercial calibration and field calibration service.

[2] Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

[3] Field calibration service is available for this calibration and this laboratory meets A2LA *R104 – General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

[4] The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

[5] In the statement of CMC uncertainty, the value is defined as the percentage of reading unless otherwise indicated; *R* represents the resolution of the unit under test.

[6] This scope meets A2LA's *P112 Flexible Scope Policy*.

[7] The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.

[8] This laboratory meets *R205 – Specific Requirements: Calibration Laboratory Accreditation Program* for the types of dimensional tests listed above and is considered equivalent to that of a calibration.

Accredited Laboratory

A2LA has accredited

ACUCAL, INC – A TRESCAL COMPANY

Manassas, VA

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSLI Z540-1-1994 and the requirements of ANSI/NCSLI Z540.3-2006 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. 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*).

Presented this 7th day of August 2019.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2737.01
Valid to April 30, 2021

For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.