SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 &
ANSI/NCSL Z540-1-1994

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CALIBRATION

Valid until: December 31, 2019 Certificate Number: 1278.01

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

I. Acoustical

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Sound Level Meters ─ Measure @ 1000 Hz	94 dB 114 dB	0.40 dB 0.40 dB	Larson Davis CAL200

II. Dimensional

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Dial Indicators[3]	Up to 1 in	76 µin	Dial indicator calibrator
Dial Indicators	Up to 1 in	47 µin	Gage blocks w/MuMeter
Micrometers[3] – Heads, Inside, Outside	Up to 8 in (6 to 18) in	(22 + 18*L*) µin (68 + 20*L*) µin	Gage blocks Reference bar
Calipers[3]	Up to 8 in (8 to 18) in	(280 + 13*L*) µin (280 + 9.8*L*) µin	Gage blocks Reference bar

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Height Gages[3], Dual Column – MTI	Up to 18 in	(52 + 17*L*) µin	Reference bar w/ MuMeter
Pin Gages[3]	Up to 1 in	47 µin	Bench mic w/gage blocks
Plain Plug Gages	Up to 6 in	(13 + 16*L*) µin	Pratt & Whitney Supermicrocmeter[6] w/ gage blocks
Steel Rules 1/16 1/32	 Up to 12″ Up to 12″	 0.036″ 0.018″	Grade 3 gage blocks
Tape Measures	Up to 50′	0.02 in + 0.000 047 in/in	Steel rule
Thickness Gages[3] – Blade Dial	 Up to 1 in Up to 1 in	 47 µin (280 + 13*L*) µin	 Bench mic Gage blocks
Bore Gages[3]	Up to 1 in	76 µin	Dial indicator calibrator
Thread Plugs[3] – Major Diameter Pitch Diameter	 Non-Tapered: (4 to 80) TPI Up to 2 in	 (39 + 14*L*) µin (82 + 8*L*) µin	 Bench mic w/ thread wires
Thread Plugs – Major Diameter Pitch Diameter	 Non-Tapered: (4 to 80) TPI Up to 6 in	 (13 + 11*L*) µin (70 + 5.7*L*) µin	 Pratt & Whitney B w/ thread wires

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
DC Voltage – Measure[3]	Up to 200 mV 200 mV to 2 V (1 to 20) V (20 to 200) V (200 to 1000) V	0.0001 mV + 0.000 005 mV/mV 0.000 000 41 V + 0.000 003 5 V/V 0.000 004 1 V + 0.000 003 5 V/V 0.000 042 V + 0.000 005 5 V/V 0.000 52 V + 0.000 005 5 V/V	Fluke 8508
DC High Voltage – Measure[3]	(0 to 30) kV (31 to 120) kV	0.018 % 0.14 %	Ross VD30 Ross VD120
DC Voltage – Generate[3]	(0 to 220) mV 220 mV to 2.2V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	9.1 μV/V + 0.4 μV 4.4 μV/V + 0.7 μV 3 μV/V + 2.5 μV 3 μV/V + 4 μV 4.3 μV/V + 40 μV 5 μV/V + 0.4 mV	Fluke 5720A (using artifact calibrations)
DC Voltage – Generate, Fixed Points	100 mV 1 V 10 V 100 V 1000 V	3.6 μV/V 2.4 μV/V 1.8 μV/V 2 μV/V 2.4 μV/V	Fluke 732B w/ Fluke 752A
DC Current – Measure[3]	Up to 100 nA 100 nA to 1 μA (1 to 10) μA (10 to 200) μA 200 μA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (1 to 2) A (2 to 10) A (10 to 20) A (20 to 100) A	43 μA/A +0.04 nA 28 μA/A +0.04 nA 24 μA/A + 0.1 nA 0.000 41 μA + 0.000 012 μA/A 0.000 004 mA + 0.000 012 mA/mA 0.000 041 mA + 0.000 14 mA/mA 0.0008 mA + 0.000 048 mA/mA 0.000 016 A + 0.000 190 A/A 59 μA/A 75 μA/A 0.015 % 0.077 %	HP 3458A opt 002 Fluke 8508A HP 3458A w/ L&N 4221B current shunt HP 3458A w/ L&N 4222B HP 3458A w/ Fluke Y5020 Valhalla 2575A

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
DC Current – Generate[3]	(0 to 220) µA 220 µA to 2.2 mA (2.2 to 22) mA	39 µA/A + 6 nA 33 µA/A + 7 nA 36 µA/A + 40 nA	Fluke 5720A (using artifact calibrations)
	(22 to 220) mA	44 µA/A + 0.7 µA*	*Add (200 x I^2) µA/A for I > 100 mA
	220 mA to 2.2 A	66 µA/A + 12 µA*	*Add (10 x I^2) µA/A for I > 1 A
	(2.2 to 10.9999) A	0.039 % + 0.5 mA	Fluke 5522A
	(11 to 20) A (20 to 100) A	0.042 % + 0.03 % RNG 0.068 % + 0.03 % RNG	Fluke 5500A Valhalla 2555A
Clamp-On Only Toroidal	(20 to 1000) A	0.47 % + 0.05 A	Fluke 5522A w/ Fluke 5500 coil
Non-Toroidal	(20 to 1000) A	0.58 % + 0.5 A	
Resistance – Measure[3]	Up to 2 Ω (2 to 20) Ω 20 Ω to 2 kΩ	0.000 004 2 Ω + 0.000 017 Ω/Ω 0.000 014 Ω + 0.000 097 Ω/Ω 0.000 000 53 kΩ + 0.000 008 2 kΩ/kΩ	Fluke 8508
	(2 to 20) kΩ	0.000 005 8 kΩ + 0.000 008 14 kΩ/kΩ	
	(20 to 200) kΩ	0.000 056 kΩ + 0.000 082 kΩ/kΩ	
	200 kΩ to 2 MΩ	0.000 001 1 MΩ + 0.0000 092 MΩ/MΩ	
	(2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ	0.0001 MΩ + 0.000 020 MΩ/MΩ 0.0095 MΩ + 0.0013 MΩ/MΩ 0.0001 GΩ + 0.000 18 GΩ/ GΩ 0.01 GΩ + 0.0015 GΩ/ GΩ	

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
Resistance – Generate, Fixed Values[3]	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω (1, 1.9) kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	93 μΩ/Ω 86 μΩ/Ω 26 μΩ/Ω 27 μΩ/Ω 12 μΩ/Ω 11 μΩ/Ω 8.8 μΩ/Ω 8.6 μΩ/Ω 8.7 μΩ/Ω 10 μΩ/Ω 11 μΩ/Ω 18 μΩ/Ω 19 μΩ/Ω 35 μΩ/Ω 44 μΩ/Ω 0.013 %	Fluke 5720A (using artifact calibrations)
Resistance – Generate	(0 to 10.999) Ω (11 to 32.999) Ω (33 to 109.999) Ω (110 to 329.999) Ω 330 Ω to 1.0999 kΩ (1.1 to 3.299) kΩ (3.3 to 10.999) kΩ (11 to 32.999) kΩ (33 to 109.99) kΩ (110 to 329.999) kΩ 330 kΩ to 1.0999 MΩ (1.1 to 3.299) MΩ (3.3 to 10.999) MΩ (11 to 32.999) MΩ (33 to 109.999) MΩ (110 to 329.999) MΩ (330 to 1100) MΩ	46 μΩ/Ω + 0.001 Ω 27 μΩ/Ω + 0.0015 Ω 24 μΩ/Ω + 0.0014 Ω 24 μΩ/Ω + 0.002 Ω 23 μΩ/Ω + 0.002 Ω 23 μΩ/Ω + 0.02 Ω 24 μΩ/Ω + 0.02 Ω 24 μΩ/Ω + 0.2 Ω 24 μΩ/Ω + 0.2 Ω 26 μΩ/Ω + 2 Ω 26 μΩ/Ω + 2 Ω 54 μΩ/Ω + 30 Ω 0.011 % + 50 Ω 0.022 % + 2.5 kΩ 0.039 % + 3 kΩ 0.24 % + 0.1 MΩ 1.2 % + 0.5 MΩ	Fluke 5522A

Parameter/Range	Frequency	CMC[2] (±)	Comments
AC Voltage – Measure[3]			
200 mV	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.014 mV + 0.000 17 mV/ mV 0.0035 mV + 0.000 3 mV/mV 0.004 mV + 0.000 12 mV /mV 0.002 mV + 0.000 11 mV / mV 0.002 mV + 0.000 11 mV / mV 0.008 mV + 0.000 34 mV / mV 0.02 mV + 0.000 77 mV / mV	Fluke 8508
2V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.000 12 V + 0.000 15 V/V 0.000 021 V + 0.000 12 V/V 0.000 02 V + 0.000 093 V/V 0.000 021 V+ 0.000 077 V/V 0.000 021 V + 0.000 11 V/V 0.000 04 V + 0.000 22 V/V 0.0002 V + 0.000 57 V/V 0.002 V + 0.003 V/V 0.02 V + 0.01 V/V	
20V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.0012 V + 0.001 52 V/V 0.000 18 V + 0.001 16 V/V 0.000 18 V + 0.000 91 V/V 0.0002 V + 0.000 075 V/V 0.0002 V + 0.000 11 V/V 0.0004 V + 0.000 22 V/V 0.002 V + 0.000 57 V/V 0.02 V + 0.003 V/V 0.2 V + 0.01 V/V	
200 V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.012 V + 0.000 15 V/V 0.002 V + 0.000 12 V/V 0.002 V + 0.000 091 V/V 0.002 V + 0.000 076 V/V 0.002 V + 0.000 11 V/V 0.0068 V + 0.000 085 V/V 0.02 V + 0.000 57 V/V 0.2 V + 0.003 V/V 0.2 V + 0.003 V/V	
1000 V	(1 to 10) Hz (10 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.07 V + 0.000 15 V/V 0.021 V + 0.000 11 V/V 0.02 V + 0.000 12 V/V 0.04 V + 0.000 23 V/V 0.2 V + 0.000 58 V/V	

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
AC Voltage – Generate[3]			
Up to 2.2 mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.033 % + 4 µV 0.016 % + 4 µV 0.015 % + 4 µV 0.028 % + 4 µV 0.067 % + 5 µV 0.13 % + 10 µV 0.17 % + 20 µV 0.36 % + 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 500 kHz to 1 MHz	0.026 % + 4 µV 0.015 % + 4 µV 0.015 % + 4 µV 0.027 % + 4 µV 0.055 % + 5 µV 0.099 % + 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 500 kHz to 1 MHz	0.025 % + 12 µV 0.013 % + 7 µV 0.012 % + 7 µV 0.021 % + 7 µV 0.045 % + 17 µV 0.078 % + 20 µV 0.12 % + 25 µV 0.26 % + 450 µV	
220 mV 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 500 kHz to 1 MHz	0.023 % + 40 µV 95 µV/V + 15 µV 62 µV/V + 8 µV 89 µV/V + 10 µV 0.012 % + 30 µV 0.036 % + 80 µV 0.093 % + 0.2 mV 0.15 % + 0.3 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 500 kHz to 1 MHz	0.023 % + 0.4 mV 84 µV/V + 0.15 mV 46 µV/V + 50 µV 78 µV/V + 0.1 mV 0.011 % + 0.2 mV 0.028 % + 0.6 mV 0.093 % + 2 mV 0.14 % + 3.2 mV	

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
AC Voltage – Generate[3] (cont)			
(22 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 500 kHz to 1 MHz	0.023 % + 4 mV 0.010 % + 1.5 mV 76 µV/V + 0.6 mV 0.01 % + 1 mV 0.015 % + 2.5 mV 0.082 % + 16 mV 0.43 % + 40 mV 0.71 % + 80 mV	Fluke 5720A
(220 to 330) V	45 Hz to 1kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.016 % + 2 mV 0.017 % + 6 mV 0.021 % + 6 mV 0.026 % + 6 mV 0.16 % + 50 mV	Fluke 5522A
(220 to 1100) V	50 Hz to 1 kHz	75 µV/V + 3.5 mV	Fluke 5720A
(330 to 1020) V	(1 to 5) kHz (5 to 10) kHz	0.021 % + 10 mV 0.025 % + 10 mV	Fluke 5522A
AC Current – Measure[3]			
Up to 200 µA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.021 µA + 0.000 50 µA/µA 0.022 µA + 0.000 50 µA/µA 0.022 µA + 0.000 71 µA/µA	Fluke 8508
200 µA to 2 mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz 30 kHz to 100 kHz	0.0002 mA + 0.000 31 mA/mA 0.0002 mA + 0.000 31 mA/mA 0.0002 mA + 0.000 71 mA/mA 0.0002 mA + 0.004 mA/mA	
(2 to 20) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.0019 mA + 0.000 32 mA/mA 0.002 mA + 0.000 31 mA/mA 0.002 mA + 0.000 71 mA/mA 0.002 mA + 0.004 mA/mA	

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
AC Current – Measure[3] (cont)			
(20 to 200) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.02 mA + 0.000 31 mA/mA 0.02 mA + 0.000 29 mA/mA 0.02 mA + 0.000 63 mA/mA	Fluke 8508
100 mA to 1 A	(20 to 50) kHz 10 Hz to 2 kHz	1.2 % + 0.4 mA 0.0002 A + 0.000 62 A/A	HP 3458A opt 002
200 mA to 2 A	(2 to 10) kHz (10 to 30) kHz	0.0002 A +0.000 74 A/A 0.0002 A + 0.003 A/A	
(1 to 2) A	10 Hz to 5 kHz (5 to 10) kHz	0.03 % 0.12 %	Fluke 8508 w/ Fluke Y5020A Fluke 8508 w/ Valhalla 2575A
(2 to 20) A	10 Hz to 5 kHz (5 to 10) kHz	0.09 % 0.58 %	Fluke 8508 Fluke Y5020A Valhalla 2575A
(20 to 100) A	10 Hz to 1 kHz	0.12 %	Fluke 8508 w/ Valhalla 2575A
AC Current – Generate[3]			
(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	0.025 % + 16 nA 0.015 % + 10 nA 0.012 % + 8 nA 0.03 % + 12 nA 0.095 % + 65 nA	Fluke 5720A
220 µA 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	0.025 % + 40 nA 0.017 % + 35 nA 0.015 % + 35 nA 0.021 % + 0.11 µA 0.093 % + 0.65 µA	

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
AC Current – Generate[3] (cont)			
(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	0.025 % + 0.4 µA 0.016 % + 0.35 µA 0.013 % + 0.35 µA 0.02 % + 0.55 µA 0.092 % + 5 µA	Fluke 5720A
(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	0.025 % + 4 µA 0.016 % + 3.5 µA 0.013 % + 2.5 µA 0.02 % + 3.5 µA 0.095 % + 10 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 35 µA 0.041 % + 80 µA 0.61 % + 0.16 mA	
(2.2 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.055 % + 2 mA 0.084 % + 2 mA 2.4 % + 5 mA	Fluke 5522A
(11 to 20) A	(45 to 100) Hz 100 Hz to 1 kHz	0.097 % + 5 mA 0.12 % + 5 mA	Fluke 5522A
	(1 to 10) kHz	0.58 % of rng	Vallhalla 2555A w/ Vallhalla 2575A
(11 to 100) A	20 Hz to 1 kHz	0.12 % of rng	Vallhalla 2555A w/ Vallhalla 2575A
Clamp-On Only Toroidal			
(20 to 1000) A	(45 to 65) Hz	0.97 % + 0.09 A	Fluke 5522A w/
(20 to 1000) A	(65 to 440) Hz	1.4 % + 0.1 A	Fluke 5500 coil
Non-Toroidal			
(20 to 1000) A	(45 to 65) Hz	1.3 % + 0.25 A	Fluke 5522A w/
(20 to 1000) A	(65 to 440) Hz	1.5 % + 0.9 A	Fluke 5500 coil

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
Capacitance			
Generate[3] –			
(220.0 to 399.9) pF	10 Hz to 10 kHz	0.64 % + 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	0.42 % + 0.01 nF	
(3.3 to 10.2999) nF	10 Hz to 1 kHz	0.42 % + 0.01 nF	
(11 to 32.999) nF	10 Hz to 1 kHz	0.23 % + 0.1 nF	
(33 to 109.99) nF	10 Hz to 1 kHz	0.22 % + 0.1 nF	
(110 to 329.99) nF	10 Hz to 1 kHz	0.27 % + 0.3 nF	
(0.33 to 1.0999) µF	(10 to 600) Hz	0.21 % +1 nF	
(1.1 to 3.2999) µF	(10 to 300) Hz	0.25 % + 3 nF	
(3.3 to 10.999) µF	(10 to 150) Hz	0.22 % + 10 nF	
(11 to 32.999) µF	(10 to 120) Hz	0.34 % + 30 nF	
(33 to 109.99) µF	(10 to 80) Hz	0.38 % + 100 nF	
(110 to 329.99) µF	(0 to 50) Hz	0.38 % + 300 nF	
(0.33 to 1.099) mF	(0 to 20) Hz	0.37 % + 1 µF	
(1.1 to 3.29) mF	(0 to 6) Hz	0.37 % + 3 µF	
(3.3 to 10.99) mF	(0 to 2) Hz	0.37 % + 10 µF	
(11 to 32.99) mF	(0 to 0.6) Hz	0.56 % + 30 µF	
(33 to 110) mF	(0 to 0.2) Hz	0.88 % + 100 µF	
Fixed Points[3] –			
1 pF	100 Hz to 1 kHz	0.038 %	HP 16381A
	1 kHz to 1 MHz	0.039 %	
	(1 to 2) MHz	0.058 %	
	(2 to 3) MHz	0.12 %	
	(3 to 4) MHz	0.2 %	
	(4 to 5) MHz	0.31 %	
	(5 to 10) MHz	1.2 %	
	(10 to 13) MHz	2.2 %	
10 pF	100 Hz to 1 kHz	0.037 %	HP 16382A, 16383A
	1 kHz to 1 MHz	0.037 %	
	(1 to 2) MHz	0.037 %	
	(2 to 3) MHz	0.037 %	
	(3 to 4) MHz	0.038 %	
	(4 to 5) MHz	0.041 %	
	(5 to 10) MHz	0.079 %	
	(10 to 13) MHz	0.15 %	
100 pF	100 Hz to 1 kHz	0.038 %	HP 16382A, 16383A
	1 kHz to 1 MHz	0.046 %	
	(1 to 2) MHz	0.046 %	
	(2 to 3) MHz	0.05 %	
	(3 to 4) MHz	0.059 %	
	(4 to 5) MHz	0.078 %	
	(5 to 10) MHz	0.18 %	
	(10 to 13) MHz	0.24 %	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
Capacitance – Generate, Fixed Points[3] (cont)			
1000 pF	100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.037 % 0.068 % 0.079 % 0.15 % 0.19 % 0.25 % 0.61 % 0.86 %	HP 16384A
0.01 µF	(0.12 to 100) kHz	0.13 %	HP 16385A
0.1 µF	(0.12 to 100) kHz	0.13 %	HP 16386A
1 µF	(0.12 to 100) kHz	0.13 %	HP 16386A
Inductance – Generate, Fixed Points[3]	100 µH 1 mH 10 mH 100 mH	2.3 % 2.4 % 2.4 % 1.2 %	Gen Rad 1490F

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC 4 Terminal Resistance –			
1 mΩ	DC	0.23 %	Agilent 42030A
10 mΩ	DC	0.23 %	
100 mΩ	DC	0.23 %	
1 Ω	DC	0.23 %	
10 Ω	DC	0.12 %	
	1 MHz	0.12 %	
	2 MHz	0.13 %	
	3 MHz	0.14 %	
	4 MHz	0.14 %	
	5 MHz	0.16 %	
	10 MHz	0.42 %	
	13 MHz	0.62 %	
100 Ω	DC	0.12 %	
	1 MHz	0.12 %	
	2 MHz	0.13 %	
	3 MHz	0.13 %	
	4 MHz	0.13 %	
	5 MHz	0.13 %	
	10 MHz	0.24 %	
	13 MHz	0.33 %	
1 kΩ	DC	0.12 %	
	100 kHz	0.12 %	
	1 MHz	0.12 %	
	2 MHz	0.12 %	
	3 MHz	0.12 %	
	4 MHz	0.13 %	
	5 MHz	0.13 %	
	10 MHz	0.24 %	
	13 MHz	0.33 %	
10 kΩ	DC	0.12 %	
	100 kHz	0.12 %	
	1 MHz	0.12 %	
100 kΩ	DC	0.12 %	
	100 kHz	0.13 %	
	1 MHz	0.13 %	

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
Oscilloscope – Generate[3]			
DC Signal			
50 Ω Load	1 mV to 6.6 V	0.19 % + 40 µV	Fluke 5500A SC600
1 MΩ Load	(0 to 130) V	0.039 % + 40 µV	
Squarewave Signal			
50 Ω Load	1.0 mV to 6.6 V_{pk-pk}	0.19 % + 40 µV	* > 1 kHz, uncertainty is 0.25 % + 40 µV
1 MΩ Load	1.0 mV to 130 V_{pk-pk}	0.078 % + 40 µV*	
Edge Characteristics			
(50 Ω Load)	5 mV to 2.5 V	1.6 % + 0.2 mV	
Risetime			
(50 Ω Load)	≤ 300 ps	(+ 0 / - 78) ps	
Level Sine Wave, into 50 Ω Load 5 mV_{pk-pk} to 5.5 V_{pk-pk}	50 kHz reference	1.9 % + 0.3 mV	Fluke 5500A SC600
	50 kHz to 100 MHz	2.9 % + 0.3 mV	
	(100 to 300) MHz	3.3 % + 0.3 mV	
	(300 to 600) MHz	4.8 % + 0.3 mV	
Time Marker, 50 Ω	5 s to 50 ms	(25 + 1000*t*) µs/s	*t* = time in seconds
	20 ms to 2 ns	25 µs/s	
DC High Voltage – Generate[3]	Up to 10 kV	0.33 % RNG	Fluke 410B
Electrical Calibration of Thermocouple Indicating Devices[3] –			
Type J	(-210 to -100) °C	0.21 ºC	Fluke 5500A
	(-100 to 760) °C	0.14 ºC	
	(760 to 1200) °C	0.18 ºC	
Type K	(-200 to -100) °C	0.2 ºC	
	(-100 to 120) °C	0.11 ºC	
	(120 to 1000) °C	0.15 ºC	
	(1000 to 1372) °C	0.24 ºC	
Type T	(-250 to -150) °C	0.2 ºC	
	(-150 to 0) °C	0.11 ºC	
	(0 to 120) °C	0.1 ºC	
	(120 to 400) °C	0.15 ºC	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple Indicating Devices[3] – (cont)			
Type E	(-250 to -100) °C (-100 to 650) °C (650 to 1000) °C	0.39 ºC 0.14 ºC 0.17 ºC	Fluke 5500A
Electrical Calibration of RTD Devices[3]			
PT 385, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.04 °C 0.04 °C 0.05 °C 0.08 °C 0.08 °C 0.1 °C 0.19 °C	Fluke 5522A

IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2] (±)	Comments
Attenuation[3] –			
(1 to 2) dB (3 to 4) dB (5 to 6) dB (7 to 10) dB 11 dB	DC to 12.4 GHz	0.77 dB 0.83 dB 0.9 dB 0.98 dB 1.1 dB	HP 8494H 1 dB step attenuator
(1 to 6) dB (6 to 9) dB (10 to 11) dB	(12.4 to 18) GHz	1.3 dB 1.4 dB 1.5 dB	

Parameter/Range	Frequency	CMC[2] (±)	Comments
Attenuation[3] – (cont)			
10 dB	DC to 12.4 GHz	0.91 dB	HP 8496H
20 dB		1.1 dB	10 dB step attenuator
30 dB		1.3 dB	
40 dB		1.6 dB	
50 dB		1.9 dB	
60 dB		2.2 dB	
70 dB		2.6 dB	
80 dB		2.9 dB	
90 dB		3.2 dB	
100 dB		3.6 dB	
110 dB		3.9 dB	
10 dB	(12.4 to 18) GHz	1.2 dB	
20 dB		1.4 dB	
30 dB		1.7 dB	
40 dB		2.1 dB	
50 dB		2.5 dB	
60 dB		3 dB	
70 dB		3.4 dB	
80 dB		3.9 dB	
90 dB		4.3 dB	
100 dB		4.8 dB	
110 dB		5.2 dB	
RF Power (Tuned)– Measure[3]			
(10 to -100) dBm	(0.1 to 1.3) GHz	0.18 dB	HP 8902A w/ opt 050 and HP 11722A power sensor
(-100 to -120) dBm		0.22 dB	
(-120 to -127) dBm		0.37 dB	
(10 to -100) dBm	(1.3 to 26) GHz	0.29 dB	HP 8902A w/ 11793A down converter and HP 11792A power sensor
(-100 to -120) dBm		0.31 dB	
RF Absolute Power – Measure			
10 MHz to 18 GHz	(-70 to -20) dB	0.16 dB	HP 438A w/8481A/8482A/8484A
100 kHz to 26 GHz	(-20 to 10) dB	0.16 dB	

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Power – Generate			
+25 dB	(0.1 to 1300) MHz	2.4 dB	HP 8447F opt H64 w/ HP8340B
RF Power – Generate[3]			
(+13 to -56) dBm	0.001 Hz to 10 MHz	0.24 dB	Agilent 3325B
(-13 to -16) dBm	10 MHz to 20 MHz	0.69 dB	
(-16 to -56) dBm		1 dB	
(0 to -18) dBm	200 Hz to 81 MHz	0.05 dB	HP 3335A
(-20 to -58) dBm	200 Hz to 81 MHz	0.11 dB	
(-60 to -98) dBm	200 Hz to 81 MHz	0.23 dB	
(+16 to -119.9) dBm	100 kHz to 2.56 GHz	1.4 dB	HP 8663A
(-120 to -129.9) dBm	100 kHz to 2.56 GHz	3.6 dB	
(+10 to -9.95) dBm	(0.05 to 2.3) GHz	1 dB	HP 8340B
(-10 to -19.95) dBm		1.4 dB	
(-20 to -49.95) dBm		1.7 dB	
(-50 to -79.95) dBm		2.1 dB	
(-80 to -100) dbm		2.4 dB	
(-100 to -110) dBm		3.4 dB	
(+18 to +10) dBm	(2.3 to 20) GHz	2.1 dB	HP 8340B
(+10 to -9.95) dBm		1.8 dB	
(-10 to -19.95) dBm		2.3 dB	
(-20 to -49.95) dBm		2.7 dB	
(-50 to -79.95) dBm		3 dB	
(-80 to -100) dbm		3.4 dB	
(-100 to -110) dBm		4.3 dB	
(+18 to +10) dBm	(20 to 26.5) GHz	2.7 dB	
(+10 to -9.95) dBm		2.3 dB	
(-10 to -19.95) dBm		2.9 dB	
(-20 to -49.95) dBm		3.2 dB	
(-50 to -79.95) dBm		3.6 dB	
(-80 to -100) dbm		4 dB	
(-100 to -110) dBm		4.3 dB	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
Amplitude Modulation – Measure[3]			
Rate: 50 Hz to 10 kHz Depths: (5 to 99) %	150 kHz to 10 MHz	2.8 % + 1 digit	HP 8902A w/ HP 11722A power sensor
Rate: 20 Hz to 10 kHz Depths: Up to 99 %	150 kHz to 10 MHz	3.8 % + 1 digit	
Rate: 50 Hz to 50 kHz Depths: (5 to 99) %	10 MHz to 1.3 GHz	1.7 % + 1 digit	
Rate: 20 Hz to 100 kHz Depths: (5 to 99) %	10 MHz to 1.3 GHz	3.7 % + 1 digit	
Rate: 50 Hz to 50 kHz Depths: (5 to 99) %	(1.3 to 18) GHz	3.2 % + 1 digit	HP 8902A w/ HP 11792A power sensor
Rate: 20 Hz to 100 kHz Depths: Up to 99 %	10 MHz to 26.5 GHz	4.7 % + 1 digit	
Frequency Modulation – Measure[3]			
Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz pk	250 kHz to 10 MHz	2.9 % + 1 digit	HP 8902A w/ HP 11722A power sensor

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
Frequency Modulation – Measure[3] (cont)			
Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz pk	10 MHz to 1.3 GHz	1.9 % + 1 digit	HP 8902A w/ HP 11792A power sensor
Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz pk	10 MHz to 1.3 GHz	6 % + 1 digit	
Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz pk	10 MHz to 26.5 GHz	3.5 % + 1 digit	
Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz pk	10 MHz to 1.3 GHz	6.6 % + 1 digit	
Phase Modulation – Measure[3]			
Rate: 200 Hz to 10 kHz	150 kHz ≤ f_c < 10 MHz	5.3 % + 1 digit	HP 8902A w/ HP 11722A power sensor
Rate: 200 Hz to 20 kHz	10 MHz ≤ f_c ≤ 1.3 GHz	4.3 % + 1 digit	
Rate: 200 Hz to 20 kHz	10 MHz ≤ f_c ≤ 26.5 GHz	5.2 % + 1 digit	HP 8902A w/ HP 11792A power sensor f_c represents the frequency carrier
Power Meters, Fixed Points[3] –			
Instrument Accuracy	(3, 10, 30, 100, 300) µW (1, 3, 10, 30, 100) mW	0.32 % 0.32 %	Range calibrator, Agilent 11683A

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
Pulse – Generate Transition Time Width	 (10 to 90) % 500 ps to 89 ms	 6.1 % 230 ps	HP 8131A
Distortion – Measure Total Harmonic Distortion ≥140 dB	 10 Hz to 15.99 kHz 16 Hz to 110 kHz	 1.5 dB 3.7 dB	Panasonic VP-7722A
Harmonic Distortion – Measure	30 Hz to 26.5 GHz 20 Hz to 20 kHz (20 to 100) kHz	3.0 dB 1.3 dB 2.3 dB	HP 8563E HP 8903B
ESD Guns	Contact & Air Discharge Voltage: (1 to 16) kV Amplitude Rise Time	 6 % 0.24 nS	Tektronix TDS 794D and SR -ESH
Surge Generator[3] – Open Circuit Front Time Open Circuit Time to Half Value Open Circuit Front Time Open Circuit Time to Half Value Short Circuit Front Time Short Circuit Time to Half Value Short Circuit Front Time Short Circuit Time to Half Time Open Circuit Voltage Short Circuit Current	 (1.2 to 50) µs (1.2 to 50) µs (10 to 700) µs (10 to 700) µs (8 to 20) µs (8 to 20) µs (5 to 320) µs (5 to 320) µs 10 V to 6 kV (0.125 to 3) kA	 0.06 µs 1.3 µs 0.06 µs 2.4 µs 0.24 µs 0.24 µs 0.17 µs 5.1 µs 4.6 % 6.2 %	Tektronix TDS 460 and P 6015A, Pearson 110s

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
EFT/Burst Generator[3] – Voltage (±) Rise Time Impulse Duration Burst Duration Burst Period Repetition Rate	 10 V to 6 kV 5 ns ± 30 % 50 ns ± 30 % 15 ms ± 20 % 300 ms ± 20 %	 5 % 14 ns 14 ns 0.19 ms 3.6 ms	 Tektronix TDS 460 and P 6015A

V. Mechanical

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Torque Wrench[3]	Up to 100 in·lb Up to 240 in·lb (20 to 650) ft·lb	0.13 % + 0.6*R* 0.13 % + 0.6*R* 0.13 % + 0.6*R*	AKO TSD 1200 torque calibrator
Pressure – Hydraulic[3]	(1 to 30) psi (30 to 100) psi (100 to 1000) psi (1000 to 10 000) psi	0.01 psi 0.03 psi 0.25 psi 2.2 psi	Pressure calibrator; Fluke 525B w/750 sensors
RPM – Measure[3] (Non-Contact)	(6 to 599.9) rpm (600 to 9999) rpm (10 000 to 99 999) rpm	1.2 rpm 0.6 rpm + 0.000 075 rpm/rpm 1.7 rpm + 0.000 073 rpm/rpm	Shimpo MT-200 optical tachometer
Vacuum	(-14 to 0) psi	0.0099 psi	Pressure calibrator Fluke 525B w/750 sensors
Scales[3]	(1 to 500) g (0.5 to 5) kg (50 to 300) lb	0.082 g 5.8 g 0.017 lb	Class 6 weights

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Torque Cells / Standards	(1 to 100) in/lbf (1 to 650) ft/lbf	0.014 % + 0.6*R* 0.08 % + 0.6*R*	Torque arm and class 6 weights
Force Gages	Up to 300 lbs	0.034 lb + 0.000 46 lb/lb	Class F weights

VI. Thermodynamics

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Temperature – Measure[3]	(-170 to 660) °C	0.023 °C	Hart 5626 PRT probe w/ Azonix 1011 T9 display
Temperature – Measuring Equipment[3]	(35 to 200) °C	0.024 °C	Hart 5626 PRT w/ Azonix 1011 display, Hart 6102 bath
Relative Humidity – Measuring Equipment [3]	11.5 % 33 % 75 %	1.4 % 1.4 % 1.4 %	Vaisala HMT-337
Relative Humidity – Measure[3]	(10 to 90) % RH	1.4 % RH	Vaisala HMT-337

VII. Time & Frequency

Parameter/Equipment	Range	CMC [2] (±)	Comments
Timers and Stopwatches[3]	Per day/month	0.1 s/day	T-9 Timometer TM-4500 from Helmut Klein
Frequency – Measuring Equipment, Fixed Point	10 MHz reference	4.1 parts in 10^{11} Hz/Hz	GPS w/ Symmetricon Xli

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Frequency – Measuring Equipment	1 mHz to 100 Hz 100 Hz to 100 kHz 100 kHz to 100 MHz 100 MHz to 26.5 GHz	8.2 parts in 10^8 Hz/Hz 9.3 parts in 10^8 Hz/Hz 9 parts in 10^9 Hz/Hz 2.1 parts in 10^9 Hz/Hz	GPS w/ Symmetricon Xli w/HP 3325B HP8904A HP8648C HP8340A
Frequency – Measure	1 mHz to 100 Hz 100 Hz to 100 kHz 100 kHz to 100 MHz 100 MHz to 26.5 GHz	8.2 parts in 10^8 Hz/Hz 9.3 parts in 10^8 Hz/Hz 7.4 parts in 10^9 Hz/Hz 2.1 parts in 10^9 Hz/Hz	GPS w/ Symmetricon Xli w/HP53131A HP 5352B
Optical Tachometers	(10 to 100 000) rpm	0.0037 % + 6*R*	HP 3325B

[1] This laboratory offers commercial calibration service 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] In the statement of CMC, *L* is the numerical value of the nominal length of the device measured in inches; and *R* is the resolution of the device.

[5] In the statement of CMC, percentages are percentage of reading, unless otherwise indicated.

[6] "Supermicrometer" is a trademark owned by Pratt & Whitney Measurement Systems, Inc. of Broomfield, CT.

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

SATELLITE FACILITY

TRU CAL INTERNATIONAL, INC.
333 Pfingsten Rd
Northbrook, IL 60062
Scott Miller Phone: 630 238 8100

I. Mechanical

Parameter/Equipment	Range	CMC[2] (±)	Comments
Mass	5 g 10 g 20 g 50 g 100 g 200 g 300 g 400 g 500 g 1 kg 1.5 kg 2 kg 5 kg 10 kg 20 kg 30 kg 40 kg 50 kg 60 kg	2.5 mg 2.5 mg 2.5 mg 2.6 mg 2.6 mg 2.7 mg 2.8 mg 3 mg 3.1 mg 26 mg 27 mg 28 mg 38 mg 0.11 g 0.98 g 1.1 g 1.3 g 1.4 g 1.5 g	Mettler XP5003SDR Ohaus EX10202 AND GP-61K ASTM Class 1/2

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Accredited Laboratory

A2LA has accredited

TRU CAL INTERNATIONAL INC.

Bensenville, IL

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 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 26th day of June 2018.

President and CEO
For the Accreditation Council
Certificate Number 1278.01
Valid to December 31, 2019
Revised July 6, 2018

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