



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

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CALIBRATION

Valid until: April 30, 2018

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 calibrations¹:

I. Acoustical

Parameter/Frequency	Range	CMC ^{2,4} (±)	Comments
Sound Level Meters — Measure @ 1000 Hz	94 dB 114 dB	.40 dB .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 + 18L) µin (68 + 20L) µin	Gage blocks Reference bar
Calipers ³	Up to 8 in (8 to 18) in	(280 + 13L) µin (280 + 9.8L) µin	Gage blocks Reference bar
Height Gages ³ , Dual Column – MTI	Up to 18 in	(52 + 17L) µin	Reference bar with MuMeter

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Pin Gages ³	Up to 1 in	47 μin	Bench mic w/gage blocks
Plain Plug Gages	Up to 6 in	(13 + 16L) μin	Pratt & Whitney Super Microcmeter ^{TM,6} w/ gage blocks
Steel Rules			
1/16	Up to 12"	0.036"	Grade 3 gage blocks
1/32	Up to 12"	0.018"	
Tape Measures			
1/16	Up to 50'	0.037" per 4'	Steel rule
1/32	Up to 50'	0.020" per 4'	
Thickness Gages ³ –			
Blade	Up to 1 in	47 μin	Bench mic Gage blocks
Dial	Up to 1 in	(280 + 13L) μin	
Bore Gages ³	Up to 1 in	76 μin	Dial indicator calibrator
Thread Plugs ³ –			
Major Diameter	Non-Tapered, (4 to 80) TPI Up to 2 in	(39 + 14L) μin	Bench mic w/thread wires
Pitch Diameter		(82 + 8L) μin	
Thread Plugs –			
Major Diameter	Non-Tapered, (4 to 80) TPI Up to 6 in	(13 + 11L) μin	Pratt & Whitney B w/ thread wires
Pitch Diameter		(70 + 5.7L) μin	



III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,5,7} (\pm)	Comments
DC Voltage – Measure ³	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V	9.5 μ V/V + 0.3 μ V 4.7 μ V/V + 0.3 μ V 4.7 μ V/V + 0.5 μ V 7 μ V/V + 30 μ V 7.1 μ V/V + 0.1 mV*	HP 3458A opt 002 *Add 12 μ V/V \cdot (V _{IN} /1000) ² μ V/V for inputs > 100 V
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 μ V/V + 0.4 μ V 4.4 μ V/V + 0.7 μ V 3 μ V/V + 2.5 μ V 3 μ V/V + 4 μ V 4.3 μ V/V + 40 μ V 5 μ V/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 μ V/V 2.4 μ V/V 1.8 μ V/V 2 μ V/V 2.4 μ V/V	Fluke 732B w/ Fluke 752A
DC Current – Measure ³	Up to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (1 to 2) A (2 to 10) A (10 to 20) A (20 to 100) A	43 μ A/A + 0.04 nA 28 μ A/A + 0.04 nA 24 μ A/A + 0.1 nA 24 μ A/A + 0.8 nA 24 μ A/A + 50 nA 24 μ A/A + 50 nA 42 μ A/A + 0.5 μ A 0.013 % + 10 μ A 59 μ A/A 75 μ A/A 0.015 % 0.077 %	HP 3458A opt 002 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} (\pm)	Comments
DC Current – Generate ³	(0 to 220) μ A	39 μ A/A + 6 nA	Fluke 5720A (using artifact calibrations)
	220 μ A to 2.2 mA (2.2 to 22) mA	33 μ A/A + 7 nA 36 μ A/A + 40 nA	
	(22 to 220) mA	44 μ A/A + 0.7 μ A*	*Add (200 x I ²) μ A/A for I > 100 mA
	220 mA to 2.2 A	66 μ A/A + 12 μ A*	*Add (10 x I ²) μ A/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 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	24 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 16 $\mu\Omega/\Omega$ + 0.5 m Ω 12 $\mu\Omega/\Omega$ + 0.5 m Ω 13 $\mu\Omega/\Omega$ + 5 m Ω 12 $\mu\Omega/\Omega$ + 50 m Ω 18 $\mu\Omega/\Omega$ + 2 Ω 58 $\mu\Omega/\Omega$ + 0.10 k Ω 0.058 $\mu\Omega/\Omega$ + 1 k Ω 0.58 % + 10 k Ω *	HP 3458A opt 002 *additional error from Tcal for last ACAL +/- 1 $^{\circ}$ C
Resistance – Generate, Fixed Values ³	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω (1, 1.9) k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	93 $\mu\Omega/\Omega$ 86 $\mu\Omega/\Omega$ 26 $\mu\Omega/\Omega$ 27 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 8.8 $\mu\Omega/\Omega$ 8.6 $\mu\Omega/\Omega$ 8.7 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 35 $\mu\Omega/\Omega$ 44 $\mu\Omega/\Omega$ 0.013 %	Fluke 5720A (using artifact calibrations)



Parameter/Equipment	Range	CMC ^{2,5,7} (±)	Comments
Resistance – Generate	(0 to 10.999) Ω (11 to 32.999) Ω (33 to 109.999) Ω (110 to 329.999) Ω 330Ω 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 ^{2,7} (±)	Comments
AC Voltage – Measure ³			
3 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.11 % 0.093 % 0.13 % 0.25 % 0.5 %	Datron 4920A
10 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.034 % 0.021 % 0.052 % 0.14 % 0.35 %	
30 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.027 % 0.017 % 0.039 % 0.11 % 0.27 %	



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage – Measure ³ (cont)			
100 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.02 % 0.01 % 0.019 % 0.058 % 0.16 %	Datron 4920A
300 mV	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.029 % 0.013 % 30 μV/V 33 μV/V 0.018 % 0.029 % 0.079 %	
1V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.029 % 0.013 % 30 μV/V 32 μV/V 77 μV/V 0.029 % 0.078 %	
3V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.029 % 0.013 % 30 μV/V 32 μV/V 80 μV/V 0.029 % 0.078 %	
10 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.029 % 0.013 % 30 μV/V 30 μV/V 68 μV/V 0.029 % 0.078 %	
30 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.029 % 0.013 % 37 μV/V 30 μV/V 68 μV/V 0.029 % 0.078 %	



Parameter/Range	Frequency	CMC ^{2, 5, 7} (\pm)	Comments
AC Voltage – Measure ³ (cont)			
100 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 30 kHz (30 to 200) kHz	0.029 % 0.013 % 37 μ V/V 31 μ V/V 83 μ V/V	Datron 4920A
300 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.031 % 0.016 % 46 μ V/V 46 μ V/V 0.011 %	
1000 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.032 % 0.016 % 46 μ V/V 52 μ V/V 0.011 %	
AC High Voltage – Measure ³			
Up to 21 kV (20 to 85) kV	60 Hz 60 Hz	0.71 % 0.99 %	Ross VD30 Ross VD120



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} (\pm)	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 μ V/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 330V)	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 μ V/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			
(20 to 100) μ A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	0.46 % + 0.03 μ A 0.17 % + 0.03 μ A 0.070 % + 0.03 μ A 0.070 % + 0.03 μ A	HP 3458A opt 002
100 μ A to 1 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	0.46 % + 0.2 μ A 0.17 % + 0.2 μ A 0.07 % + 0.2 μ A 0.036 % + 0.2 μ A 0.07 % + 0.2 μ A 0.46 % + 0.4 μ A 0.64 % + 1.5 μ A	
(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	0.46 % + 2 μ A 0.17 % + 2 μ A 0.07 % + 2 μ A 0.036 % + 2 μ A 0.07 % + 2 μ A 0.46 % + 4 μ A 0.64 % + 15 μ A	



Parameter/Range	Frequency	CMC ^{2, 5, 7} (±)	Comments
AC Current – Measure ³ (cont)			
(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	0.46 % + 20 µA 0.17 % + 20 µA 0.07 % + 20 µA 0.036 % + 20 µA 0.07 % + 20 µA 0.46 % + 40 µA 0.64 % + 150 µA	HP 3458A opt 002
100 mA to 1 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	0.46 % + 0.2 mA 0.19 % + 0.2 mA 0.093 % + 0.2 mA 0.12 % + 0.2 mA 0.35 % + 0.2 mA 1.2 % + 0.4 mA	
(1 to 2) A	10 Hz to 5 kHz 5 kHz to 10 kHz	0.088 % 0.12 %	Datron 4920M w/ Fluke Y5020A Datron 4920M w/ Valhalla 2575A
(2 to 20) A	10 Hz to 5 kHz (5 to 10) kHz	0.091 % 0.58 %	Datron 4920M Fluke Y5020A Valhalla 2575A
(20 to 100) A	10 Hz to 1 kHz	0.12 %	Datron 4920M 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 (1 to 10) kHz	0.097 % + 5 mA 0.12 % + 5 mA 0.58 % of rng	Fluke 5522A 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/ Fluke
(20 to 1000) A	(65 to 440) Hz	1.4 % + 0.1 A	5500 coil
Non Toroidal			
(20 to 1000) A	(45 to 65) Hz	1.3 % + 0.25 A	Fluke 5522A w/ Fluke
(20 to 1000) A	(65 to 440) Hz	1.5 % + 0.9 A	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 ^{2,5,7} (±)	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
AC 4 Terminal Resistance –			
1 mΩ 10 mΩ 100 mΩ 1 Ω	DC DC DC DC	0.23 % 0.23 % 0.23 % 0.23 %	Agilent 42030A



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



Parameter/Equipment	Range	CMC ^{2,5,7} (\pm)	Comments
Oscilloscope – Generate ³			
DC Signal 50 Ω Load 1 M Ω Load	1 mV to 6.6 V (0 to 130) V	0.19 % + 40 μ V 0.039 % + 40 μ V	Fluke 5500A SC600
Squarewave Signal 50 Ω Load 1 M Ω Load	1.0 mV to 6.6 V _{pk-pk} 1.0 mV to 130 V _{pk-pk}	0.19 % + 40 μ V 0.078 % + 40 μ V*	* > 1 kHz, uncertainty is 0.25 % + 40 μ V
Edge Characteristics (50 Ω Load)	5 mV to 2.5 V	1.6 % + 0.2 mV	
Risetime (50 Ω Load)	\leq 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 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.9 % + 0.3 mV 2.9 % + 0.3 mV 3.3 % + 0.3 mV 4.8 % + 0.3 mV	Fluke 5500A SC600
Time Marker, 50 Ω	5 s to 50 ms 20 ms to 2 ns	(25 + 1000*t) μ s/s 25 μ s/s	t = time in seconds
DC High Voltage – Generate ³	Up to 10 kV	0.33 % rmg	Fluke 410B
Electrical Calibration of Thermocouple Indicating Devices ³ –			
Type J	(-210 to -100) $^{\circ}$ C (-100 to 760) $^{\circ}$ C (760 to 1200) $^{\circ}$ C	0.21 $^{\circ}$ C 0.14 $^{\circ}$ C 0.18 $^{\circ}$ C	Fluke 5500A
Type K	(-200 to -100) $^{\circ}$ C (-100 to 120) $^{\circ}$ C (120 to 1000) $^{\circ}$ C (1000 to 1372) $^{\circ}$ C	0.2 $^{\circ}$ C 0.11 $^{\circ}$ C 0.15 $^{\circ}$ C 0.24 $^{\circ}$ C	
Type T	(-250 to -150) $^{\circ}$ C (-150 to 0) $^{\circ}$ C (0 to 120) $^{\circ}$ C (120 to 400) $^{\circ}$ C	0.2 $^{\circ}$ C 0.11 $^{\circ}$ C 0.1 $^{\circ}$ C 0.15 $^{\circ}$ C	



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 °C 0.14 °C 0.17 °C	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 (1 to 6) dB (6 to 9) dB (10 to 11) dB	DC to 12.4 GHz (12.4 to 18) GHz	0.77 dB 0.83 dB 0.9 dB 0.98 dB 1.1 dB 1.3 dB 1.4 dB 1.5 dB	HP 8494H 1 dB step attenuator



Parameter/Range	Frequency	CMC ² (±)	Comments
Attenuation ³ – (cont)			
10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB 80 dB 90 dB 100 dB 110 dB	DC to 12.4 GHz	0.91 dB 1.1 dB 1.3 dB 1.6 dB 1.9 dB 2.2 dB 2.6 dB 2.9 dB 3.2 dB 3.6 dB 3.9 dB	HP 8496H 10 dB step attenuator
10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB 80 dB 90 dB 100 dB 110 dB	(12.4 to 18) GHz	1.2 dB 1.4 dB 1.7 dB 2.1 dB 2.5 dB 3 dB 3.4 dB 3.9 dB 4.3 dB 4.8 dB 5.2 dB	
RF Power (Tuned)– Measure ³			
(10 to -100) dBm (-100 to -120) dBm (-120 to -127) dBm	(0.1 to 1.3) GHz	0.18 dB 0.22 dB 0.37 dB	HP 8902A w/ opt 050 and HP 11722A power sensor
(4 to 0) dBm	(1.3 to 26) GHz	0.29 dB	HP 8902A w/ 11793A down converter and HP 11792A power sensor
RF Absolute Power – Measure			
10 MHz to 18 GHz 100 kHz to 26 GHz	(-70 to -20) dB (-20 to 10) dB	0.16 dB 0.16 dB	HP 438A w/8481A/8482A/8484A



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



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: 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: 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: 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
<p>Frequency Modulation – Measure³ (cont)</p> <p>Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz pk</p> <p>Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz pk</p> <p>Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz pk</p> <p>Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz pk</p>	<p>10 MHz to 1.3 GHz</p> <p>10 MHz to 1.3 GHz</p> <p>10 MHz to 26.5 GHz</p> <p>10 MHz to 1.3 GHz</p>	<p>1.9 % + 1 digit</p> <p>6 % + 1 digit</p> <p>3.5 % + 1 digit</p> <p>6.6 % + 1 digit</p>	<p>HP 8902A w/ HP 11792A power sensor</p>
<p>Phase Modulation – Measure³</p> <p>Rate: 200 Hz to 10 kHz</p> <p>Rate: 200 Hz to 20 kHz</p> <p>Rate: 200 Hz to 20 kHz</p>	<p>150 kHz ≤ f_c < 10 MHz</p> <p>10 MHz ≤ f_c ≤ 1.3 GHz</p> <p>10 MHz ≤ f_c ≤ 26.5 GHz</p>	<p>5.3 % + 1 digit</p> <p>4.3 % + 1 digit</p> <p>5.2 % + 1 digit</p>	<p>HP 8902A w/ HP 11722A power sensor</p> <p>HP 8902A w/ HP 11792A power sensor</p> <p>f_c represents the frequency carrier</p>
<p>Power Meters, Fixed Points³ –</p> <p>Instrument Accuracy</p>	<p>(3, 10, 30, 100, 300) μW</p> <p>(1, 3, 10, 30, 100) mW</p>	<p>0.32 %</p> <p>0.32 %</p>	<p>Range calibrator, Agilent 11683A</p>



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Pulse – Generate Transition Time	10 % to 90 %	6.1 %	HP 8131A
Width	500 ps to 99.9 ms	230 ps	
Distortion-Measure Total Harmonic Distortion			Panasonic VP-7722A
≥140 dB	10 Hz to 15.99 kHz 16 Hz to 110 kHz	1.5 dB 3.7 dB	
ESD Guns	Contact & Air Discharge Voltage: (1 to 16) kV		Tektronix TDS 794D and SR -ESH
	Amplitude Rise Time	6 % 0.24 nS	
Surge Generator ³ –			Tektronix TDS 460 and P 6015A, Pearson 110s
Open Circuit Front Time Open Circuit Time to Half Value	(1.2 to 50) μs (1.2 to 50) μs	0.06 μs 1.3 μs	
Open Circuit Front Time Open Circuit Time to Half Value	(10 to 700) μs (10 to 700) μs	0.06 μs 2.4 μs	
Short Circuit Front Time Short Circuit Time to Half Value	(8 to 20) μs (8 to 20) μs	0.24 μs 0.24 μs	
Short Circuit Front Time Short Circuit Time to Half Time	(5 to 320) μs (5 to 320) μs	0.17 μs 5.1 μs	
Open Circuit Voltage Short Circuit Current	10 V to 6 kV (0.125 to 3) kA	4.6 % 6.2 %	



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

V. Mechanical

Parameter/Equipment	Range	CMC ^{2,4,5} (±)	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
Torque Wrench ³	Up to 100 in·lb Up to 240 in·lb (20 to 650) ft·lb	0.13 % + 0.6R 0.13 % + 0.6R 0.13 % + 0.6R	AKO TSD 1200 torque calibrator
Pressure (Liquid) ³	(1 to 30) psi (30 to 100) psi (100 to 1000) psi (1000 to 10 000) psi	0.011 psi 0.037 psi 0.34 psi 2.9 psi	Druck DPI 610 pressure calibrator
Speed- Measure ³ (Non-Contact)	(10 to 100 000) rpm	0.0037 % + 6R	Shimpo MT-200 Optical Tachometer



Parameter/Equipment	Range	CMC ^{2,4,5} (\pm)	Comments
Vacuum	(-24 to 0) psi	0.01 inHg	Druck DPI 610 pressure calibrator
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
Balances	(50 to 500) mg (5 to 100) g	0.029 mg 0.31 mg	Class S weights
Torque Cells / Standards	(1 to 100) in/lbf (1 to 650) ft/lbf	0.014 % + 0.6R 0.08 % + 0.6R	Torque arm and class 6 weights
Force Gages	Up to 300 lbs	0.034 lb + 0.00046lb/lb	Class F weights

VI. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,5} (\pm)	Comments
Temperature – Measure ³	(-170 to 660) °C	0.016 °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 & 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
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 100Hz 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	(6 to 599.9) rpm (600 to 9999) rpm (10 000 to 99 999) rpm	1.2 rpm 0.6 rpm + 0.000075 rpm/rpm 1.7 rpm + 0.000073 rpm/rpm	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.

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Presented this 5th day of February 2016.

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President and CEO
For the Accreditation Council
Certificate Number 1278.01
Valid to April 30, 2018
Revised March 30, 2018

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