



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

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CALIBRATION

Valid To: September 30, 2017

Certificate Number: 2560.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1</sup>:

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Gage Blocks	(0.05 to 4) in (>4 to 12) in	(5.2 + 3.5L) µin (4.0 + 5.4L) µin	P&W Labmaster™, gage blocks
Micrometers <sup>3</sup> – Head, Inside, Outside, Depth	Up to 20 in	69 µin	Gage blocks
Calipers <sup>3</sup> – Dial, Vernier, & Digital	Up to 48 in	330 µin	Gage blocks
Height Gages <sup>3</sup> – Dial, Vernier, & Digital	Up to 24 in	480 µin	Gage blocks, surface plates
Thread Plug Gages – English & Metric, 60° Pitch Diameter			
Major Diameter	(0.06 to 4) in	(40 + 5.0L) µin	P&W Labmaster™, gage blocks, thread wires
Pitch Diameter	(8 to 80) TPI	130 µin	

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Cylindrical Plug Gages & Thread Wires	Up to 7 in	(40 + 5.0L) µin	P&W Labmaster™, gage blocks
Ring Gages	(0.04 to 10) in	(40 + 3.7L) µin	P&W Labmaster™, gage blocks, master ring gages
Surface Plates <sup>3</sup> – Flatness	(15 to 192) in diagonal	3.0 µin/in	Talyvel 6 electronic level system

## II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Voltage <sup>3</sup> – Generate	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1000) V	11 µV/V + 0.40 µV 7.4 µV/V + 0.70 µV 4.7 µV/V + 2.5 µV 4.7 µV/V + 4.0 µV 7.4 µV/V + 40 µV 9.1 µV/V + 0.40 mV	Fluke 5720A
DC Voltage <sup>3</sup> – Measure	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 500) V (500 to 800) V (800 to 1000) V (0 to 10) kV (0 to 100) kV	26 µV/V + 0.30 µV 9.9 µV/V + 0.30 µV 9.6 µV/V + 0.50 µV 12 µV/V + 3.0 µV 13* µV/V + 0.10 mV 15* µV/V + 0.10 mV 19* µV/V + 0.10 mV 0.04 % + 30 mV 0.07 % + 0.30 V	HP 3458A  *Add 12 µV/V*(V <sub>in</sub> /1000) <sup>2</sup> additional uncertainty for inputs >100 V  Vitretek 4700

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Current <sup>3</sup> – Generate	(0 to 220) $\mu$ A 220 $\mu$ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11.0) A  (11 to 20) A	48 $\mu$ A/A + 6.0 nA 42 $\mu$ A/A + 7.0 nA 44 $\mu$ A/A + 40 nA 57 $\mu$ A/A + 0.70 $\mu$ A 0.021 % + 12 $\mu$ A 0.04 % + 0.48 mA  0.12 % + 0.75 mA*	Fluke 5720A  Fluke 5720A & 5725A  Fluke 5520A-SC1100 *floor after 30 s
DC Current <sup>3</sup> – Measure	(0 to 0.1) $\mu$ A (0.1 to 1) $\mu$ A (1 to 10) $\mu$ A (10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	0.15 % + 40 pA 91 $\mu$ A/A + 40 pA 55 $\mu$ A/A + 0.10 nA 53 $\mu$ A/A + 0.80 nA 49 $\mu$ A/A + 5.0 nA 49 $\mu$ A/A + 50 nA 0.011 % + 0.50 $\mu$ A 0.018 % + 10 $\mu$ A	HP 3458A
Resistance <sup>3</sup> – Generate  Fixed Points	1 $\Omega$ 1.9 $\Omega$ 10 $\Omega$ 19 $\Omega$ 100 $\Omega$ 190 $\Omega$ 1 k $\Omega$ 1.9 k $\Omega$ 10 k $\Omega$ 19 k $\Omega$ 100 k $\Omega$ 190 k $\Omega$ 1 M $\Omega$ 1.9 M $\Omega$ 10 M $\Omega$ 19 M $\Omega$ 100 M $\Omega$	0.017 % 0.013 % 57 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 57 $\mu\Omega/\Omega$ 32 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 56 $\mu\Omega/\Omega$ 32 $\mu\Omega/\Omega$ 0.020 % 0.011 % 48 $\mu\Omega/\Omega$ 57 $\mu\Omega/\Omega$ 0.013 %	Fluke 5720A

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Resistance <sup>3</sup> – Measure	(0.01 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	58 μΩ/Ω + 50 μΩ 61 μΩ/Ω + 0.50 mΩ 21 μΩ/Ω + 0.50 m 24 μΩ/Ω + 5.0 mΩ 56 μΩ/Ω + 50 mΩ 0.020 % + 2.0 Ω 0.016 % + 0.10 k Ω 0.074 % + 1.0 kΩ 0.70 % + 10 kΩ	HP 3458A
	0.001 Ω	0.045 %	Fluke 5720, HP 3458A

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Capacitance <sup>3</sup> – Generate			
(0.19 to 0.3999) nF	10 Hz to 10 kHz	0.85 % + 0.010 nF	Fluke 5520A-SC1100
(0.4000 to 1.0999) nF	10 Hz to 10 kHz	0.62 % + 0.010 nF	
(1.1000 to 3.2999) nF	10 Hz to 3 kHz	0.59 % + 0.010 nF	
(3.3000 to 10.9999) nF	10 Hz to 1 kHz	0.30 % + 0.010 nF	
(11.0000 to 109.999) nF	10 Hz to 1 kHz	0.30 % + 0.10 nF	
(110.000 to 329.999) nF	10 Hz to 1 kHz	0.30 % + 0.30 nF	
(0.33000 to 1.09999) μF	(10 to 600) Hz	0.29 % + 1.0 nF	
(1.10000 to 3.29999) μF	(10 to 300) Hz	0.30 % + 3.0 nF	
(3.3000 to 10.9999) μF	(10 to 150) Hz	0.30 % + 10 nF	
(11.0000 to 32.9999) μF	(10 to 120) Hz	0.47 % + 30 nF	
(33.000 to 109.999) μF	(10 to 80) Hz	0.53 % + 0.10 μF	
(110.000 to 329.999) μF	(0 to 50) Hz	0.53 % + 0.30 μF	
(0.33000 to 1.09999) mF	(0 to 20) Hz	0.53 % + 1.0 μF	
(1.10000 to 3.29999) mF	(0 to 6) Hz	0.52 % + 3.0 μF	
(3.3000 to 10.9999) mF	(0 to 2) Hz	0.52 % + 10 μF	
(11.0000 to 32.9999) mF	(0 to 0.6) Hz	0.87 % + 30 μF	
(33.00 to 110.00) mF	(0 to 0.2) Hz	1.3 % + 0.10 mF	



Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Simulation of Thermocouple <sup>3</sup> – Generate			
Type E	(-250 to -100) °C (-100 to -25.0) °C (-25.0 to 350) °C (350 to 650) °C (650 to 1000) °C	0.60 °C 0.19 °C 0.60 °C 0.19 °C 0.25 °C	Fluke 5520-SC1100
Type J	(-210 to -100) °C (-100 to -30.0) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.32 °C 0.19 °C 0.30 °C 0.20 °C 0.27 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.39 °C 0.21 °C 0.27 °C 0.31 °C 0.48 °C	
Type T	(-250 to -150) °C (-150 to 0.0) °C (0.0 to 120) °C (120 to 400) °C	0.75 °C 0.29 °C 0.27 °C 0.17 °C	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate			
(0 to 2.2) mV	10 Hz to 50 kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	6.4 % + 4.0 μV 6.4 % + 5.0 μV 6.4 % + 10 μV 6.4 % + 20 μV 6.9 % + 20 μV	Fluke 5720A
(2.2 to 22) mV	10 Hz to 50 kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.64 % + 4.0 μV 0.65 % + 5.0 μV 0.79 % + 10 μV 0.82 % + 20 μV 2.7 % + 20 μV	

*A. C. Burt*

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate (cont)			
(22 to 220) mV	(10 to 20) Hz 20 Hz to 50 kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.31 % + 12 μV 0.31 % + 7.0 μV 0.32 % + 17 μV 0.55 % + 20 μV 0.60 % + 25 μV 1.5 % + 45 μV	Fluke 5720A
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	0.32 % + 40 μV 0.31 % + 15 μV 0.31 % + 8.0 μV 0.31 % + 10 μV 0.31 % + 30 μV 0.53 % + 80 μV 0.83 % + 0.20 mV 1.5 % + 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 500 kHz to 1 MHz	0.30 % + 0.40 mV 0.29 % + 0.15 mV 0.29 % + 0.050 mV 0.29 % + 0.10 mV 0.29 % + 0.20 mV 0.48 % + 0.60 mV 0.57 % + 2.0 mV 2.6 % + 3.2 mV	
(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	0.094 % + 4.0 mV 0.075 % + 1.5 mV 0.071 % + 0.60 mV 0.076 % + 1.0 mV 0.26 % + 2.5 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz  40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.21 % + 16 mV 0.091 % + 3.5 mV  0.090 % + 4.0 mV 0.15 % + 6.0 mV 0.45 % + 11 mV	plus Fluke 5725A
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.19 % + 11 mV 0.80 % + 45 mV	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage <sup>3</sup> – Measure			
(0 to 10) mV	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.48 % + 3.0 μV 0.18 % + 3.0 μV 0.08 % + 1.1 μV 0.043 % + 1.1 μV 0.18 % + 1.1 μV 0.84 % + 1.1 μV 4.8 % + 2.0 μV	HP 3458A
(10 to 100) mV	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 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 (1 to 2) MHz	0.48 % + 4.0 μV 0.18 % + 4.0 μV 0.073 % + 2.0 μV 0.027 % + 2.0 μV 0.18 % + 2.0 μV 0.72 % + 2.0 μV 2.4 % + 10 μV 3.6 % + 10 μV 6.0 % + 10 μV 12 % + 10 μV	
100 mV to 1 V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 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 (1 to 2) MHz	0.48 % + 40 μV 0.18 % + 40 μV 0.073 % + 20 μV 0.027 % + 20 μV 0.18 % + 20 μV 0.72 % + 20 μV 2.4 % + 0.10 mV 3.6 % + 0.10 mV 6.0 % + 0.10 mV 12 % + 0.10 mV	
(1 to 10) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 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 (1 to 2) MHz	0.48 % + 0.40 mV 0.18 % + 0.40 mV 0.073 % + 0.20 mV 0.028 % + 0.20 mV 0.18 % + 0.20 mV 0.72 % + 0.20 mV 2.4 % + 1.0 mV 3.6 % + 1.0 mV 6.0 % + 1.0 mV 12 % + 1.0 mV	

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Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage <sup>3</sup> – Measure (cont)			
(10 to 100) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 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	0.48 % + 4.0 mV 0.18 % + 4.0 mV 0.072 % + 2.0 mV 0.037 % + 2.0 mV 0.18 % + 2.0 mV 0.72 % + 2.0 mV 2.4 % + 10 mV 3.6 % + 10 mV 6.0 % + 10 mV	HP 3458A
(100 to 1000) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (0.1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.50 % + 40 mV 0.20 % + 40 mV 0.096 % + 20 mV 0.072 % + 20 mV 0.18 % + 20 mV 0.72 % + 20 mV	
(0 to 10) kV (0 to 100) kV	(50 to 60) Hz (50 to 60) Hz	0.15 % + 0.10 V 0.13 % + 0.60 V	Vitretek 4700
AC Current <sup>3</sup> – Generate			
(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	0.16 % + 16 nA 0.15 % + 10 nA 0.10 % + 8.0 nA 0.33 % + 12 nA 0.73 % + 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	0.099 % + 40 nA 0.088 % + 35 nA 0.072 % + 35 nA 0.31 % + 0.11 µA 0.71 % + 0.65 µA	
(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	0.093 % + 0.40 µA 0.081 % + 0.35 µA 0.072 % + 0.35 µA 0.31 % + 0.55 µA 0.71 % + 5.0 µA	
(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	0.092 % + 4.0 µA 0.081 % + 3.5 µA 0.078 % + 2.5 µA 0.32 % + 3.5 µA 0.71 % + 10 µA	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current <sup>3</sup> – Generate (cont)			
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.61 % + 35 µA 0.40 % + 80 µA 2.0 % + 1.6 mA	Fluke 5720A
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.11 % + 0.17 mA 0.25 % + 0.38 mA 1.0 % + 0.75 mA	plus 5725A
(11 to 20.5) A	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.19 % + 5.9 mA 0.21 % + 5.9 mA 3.7 % + 5.9 mA	Fluke 5520A- SC1100
AC Current <sup>3</sup> – Measure			
(0 to 100) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.54 % + 30 nA 0.26 % + 30 nA 0.25 % + 30 nA 0.15 % + 30 nA	HP 3458A, option II
100 µA 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	0.49 % + 0.20 µA 0.20 % + 0.20 µA 0.11 % + 0.20 µA 0.04 % + 0.20 µA 0.074 % + 0.20 µA 0.66 % + 0.40 µA 0.48 % + 1.5 µA	
(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	0.48 % + 2.0 µA 0.19 % + 2.0 µA 0.091 % + 2.0 µA 0.04 % + 2.0 µA 0.074 % + 2.0 µA 0.66 % + 4.0 µA 0.48 % + 15 µA	
(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	0.48 % + 20 µA 0.19 % + 20 µA 0.089 % + 20 µA 0.072 % + 20 µA 0.095 % + 20 µA 0.66 % + 40 µA 0.48 % + 0.15 mA	

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Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current <sup>3</sup> – Measure (cont)			
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	0.48 % + 0.20 mA 0.19 % + 0.20 mA 0.098 % + 0.20 mA 0.12 % + 0.20 mA 0.36 % + 0.20 mA 1.2 % + 0.40 mA	HP 3458A, option II
(1 to 1.4) A (1.4 to 2.8) A (2.8 to 7) A (7 to 14) A (14 to 28) A (28 to 40) A (40 to 100) A (100 to 240) A	(45 to 580) Hz (45 to 580) Hz (45 to 580) Hz (45 to 580) Hz (45 to 580) Hz (45 to 580) Hz (45 to 580) Hz (45 to 580) Hz	0.11 % + 0.7 mA 0.12 % + 1.4 mA 0.11 % + 3.5 mA 0.10 % + 7.0 mA 0.11 % + 10 mA 2.9 % + 10 mA 2.4 % + 10 mA 1.2 % + 10 mA	PA1000       PA1000 & MN213

### III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
RF Power <sup>3</sup> – Transfer			
Reference 1 mW	(0.01 to 10) MHz (0.01 to 4.2) GHz  (0.01 to 10) GHz (10 to 18) GHz	1.8 % 1.9 %  1.7 % 2.3 %	F1119C/1805B   1807A/1805B
RF Power – Measure @ 1 mW	50 MHz  1000 MHz	0.35 %  0.65 %	478A opt H75 w/ 432A
Attenuation <sup>3</sup> –			
(+16 to -129) dB (+16 to -134) dB (+16 to -140) dB (+16 to -135) dB (+16 to -129) dB (+16 to -121) dB	100 kHz to 2 MHz (2 to 10) MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 19.2) GHz (19.2 to 26.5) GHz	0.08 dB + 0.005 dB/10 dB Step	Keysight N5531S, add 0.031dB each time you switch between ranges

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Amplitude Modulation <sup>3</sup> – Measure			
Rate: 20 Hz to 10 kHz Depth: (5 to 99) %	100 kHz to 10 MHz	0.98 %	Keysight N5531S
Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	10 MHz to 3 GHz	0.71 %	
Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	10 MHz to 3 GHz	3.0 %	
Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	(3 to 26.5) GHz	1.8 %	
Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	(3 to 26.5) GHz	5.4 %	
Frequency Modulation <sup>3</sup> – Measure			
Rates: 20 Hz to 10 kHz Deviations: 200 Hz to 40 kHz peak	250 kHz to 10 MHz	1.8 %	Keysight N5531S
Rates: 50 Hz to 200 kHz Deviations: 250 Hz to 400 kHz peak	10 MHz to 6.6 GHz	1.8 %	
Rates: 50 Hz to 200 kHz Deviations: 250 Hz to 400 kHz peak	(6.6 to 13.2) GHz	3.0 %	
Rates: 50 Hz to 200 kHz Deviations: 250 Hz to 400 kHz peak	(13.2 to 26.5) GHz	4.6%	
Rates: 50 Hz to 200kHz Deviations 250Hz to 400kHz peak <sup>6</sup>	250 kHz to 26.5 GHz	1.2%	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Phase Modulation <sup>3</sup> – Measure			
> 0.7 Radians Rate: 200 Hz to 20 kHz	100 kHz to 6.6 GHz	1 %	Keysight N5531S
> 0.3 Radians Rate: 200 Hz to 20 kHz	100 kHz to 6.6 GHz	3.5 %	
> 2.0 Radians Rate: 200 Hz to 20 kHz	(6.6 to 13.2) GHz	1.3 %	
> 0.6 Radians Rate: 200 Hz to 20 kHz	(6.6 to 13.2) GHz	3.5 %	
> 4.0 Radians Rate: 200 Hz to 20 kHz	(13.2 to 26.5) GHz	1.3 %	
> 1.2 Radians Rate: 200 Hz to 20 kHz	(13.2 to 26.5) GHz	3.5 %	
Modulation Rate <sup>3</sup> – Measure			
Amplitude Modulation Rate: 20 Hz to 10 kHz Depth: > 20%	100 kHz to 10 MHz	72 mHz	Keysight N5531S
Rate: 20 Hz to 100 kHz Depth: > 20%	10 MHz to 26.5 GHz	72 mHz	
Frequency & Phase Modulation Rate: 20 Hz to 10 kHz	100 kHz to 10 MHz	72 mHz	
Rate: 20 Hz to 200 kHz	10 MHz to 26.5 GHz	72 mHz	

IV. Mechanical

Parameter/Equipment	Range	CMC <sup>2,4,5</sup> (±)	Comments
Scales & Balances <sup>3</sup>	(1 to 500) mg (1 to 500) g 200 g to 10 kg (10 to 200) kg (1/32 to 32) oz (0.5 to 50) lb (20 to 970) lb	6 µg + 0.6R 30 µg/g + 0.6R 22 µg/g + 0.6R 0.040 % + 0.6R 0.019 % + 0.6R 0.029 % + 0.6R 0.033 % + 0.6R	Class 0 weights Class 0 weights Class 2 weights Class F weights Class F weights Class F weights Class F weights
Pressure <sup>3</sup> – Measuring Equipment	(400 to 4000) psi (3 to 400) psi  (0 to 35) inHg (0 to 1500) psi (0 to 10 000) psi	0.036 % + 0.04 psi 0.036 % + 0.007 psi  0.03 inHg 1.9 psi 4.9 psi	Dead weight tester M1900/3  Pressure calibrator DP1620, PM620-06A, PM620-165G, PM620-22A
Torque – Watches & Transducers	(6 to 250) cm·gf (6 to 1000) cm·gf (0.006 to 30) cm·kgf (25 to 300) cm·kgf (0.006 to 45) m·kgf  Up to 6 in·ozf Up to 25 in·ozf Up to 80 in·ozf (2.5 to 500) in·lbf (0.5 to 300) ft·lbf (300 to 4000) ft·lbf	0.60 % + 1 digit 0.60 % + 1 digit 0.70 % + 1 digit 0.70 % + 1 digit 0.70 % + 1 digit  0.70 % + 1 digit 0.70 % + 1 digit 0.70 % + 1 digit 0.70 % + 1 digit 0.70 % + 1 digit 0.50 % + 1 digit	Calibrated weights, torque wheels & arms
Torque – Wrenches & Drivers	(10 to 100) in·ozf  (5 to 50) in·lbf (25 to 250) in·lbf (100 to 1000) in·lbf (25 to 250) ft·lbf  (0 to 100) ft·lbf (100 to 2000) ft·lbf (2000 to 4000) ft·lbf	1.0 %  1.0 % 1.0 % 1.0 % 1.0 %  0.60 % 0.60 % 0.60 %	TTPM-41, 1001-0-TTP  TTPM-41, 2000-400-02  AKO torque tester

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Force <sup>3</sup> – Measuring Equipment	(1 to 500) gf (1/32 to 32) ozf (2 to 200) kgf  (1 to 970) lbf	0.20 % + 1 digit 0.20 % + 1 digit 0.20 % + 1 digit  0.20 % + 1 digit	Calibrated weights
Speed Measuring Devices <sup>3</sup> – Radar X, K, KA Bands			
Measure	(10.5 to 36.1) GHz	0.11 GHz	VOCAR HR
Tuning Forks – Measure	(200 to 15 000) Hz	0.12 % (≈ 0.22 MPH)	
Speed – Simulate	(15 to 140) MPH	1.0 %	
Accelerometers –	(5 to 9) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz 921 Hz to 5 kHz (5 to 10) kHz (10 to 15) kHz (15 to 20) kHz	2.2 % 1.3 % 1.1 % 1.2 % 1.5 % 2.1 % 2.6 % 3.6 %	The Modal Shop 9155D

#### V. Optical Quantities

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Power <sup>3</sup> – Measure			
(5 to -60) dBm	850, 1310, 1555 nm	3.7 %	IQS-1502-Q1

VI. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Humidity <sup>3</sup> – Measure	(10 to 90) % RH	1.0 % RH	HMI41/HMP46
Humidity – Measuring Equipment	(10 to 95) % RH	0.36 % RH	Thunder Scientific 2500S
Temperature <sup>3</sup> – Measure	(-196 to 0) °C (0 to 420) °C	40 mK 50 mK	PRT 5614

VII. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Frequency – Measuring Equipment  Fixed	(5, 10) MHz	4.0 parts in 10 <sup>10</sup> Hz	Fluke 910R
Frequency – Measure	1 mHz to 26.5 GHz	4.0 parts in 10 <sup>10</sup> Hz + 1 LSD	Agilent 53131A Keysight N5531S Fluke 910R

<sup>1</sup> This laboratory offers commercial calibration services and field calibration services.

<sup>2</sup> 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.



<sup>3</sup> 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.

<sup>4</sup> In the statement of CMC percentage refers to percent of reading unless stated otherwise.

<sup>5</sup> In the statement of CMC,  $L$  is the numerical value of the nominal length in inches and  $R$  is the numerical value of the resolution of the device under test.

<sup>6</sup> Ratio of Frequency deviations to modulation rate must be greater than the following:

250 kHz to 10 MHz:  $>1.2$ ,  
10 MHz to 6.6 GHz  $> 0.45$ ,  
6.6 GHz to 13.2 GHz  $> 8$ ,  
13.2 GHz to 26.5 GHz  $> 16$ .



## Accredited Laboratory

A2LA has accredited

**CASCADE ENGINEERING SERVICES, INC.**

*Kirkland, WA*

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/NCSLI Z540-1-1994 and any additional program requirements in the field of calibration. 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 8 January 2009).



Presented this 22<sup>nd</sup> day of February 2016.

A handwritten signature in blue ink, appearing to read "Jim C. Burt".

Senior Director of Quality & Communications  
For the Accreditation Council  
Certificate Number 2560.01  
Valid to September 30, 2017

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