



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005,
ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

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CALIBRATION

Valid To: September 30, 2019

Certificate Number: 1818.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Dimensional

Parameter/Equipment	Range	CMC ^{2,4} (\pm)	Comments
Gage Blocks	(0.005 to 1) in (1 to 4) in (4 to 20) in	(4.1 + 0.36L) μ in (7.4 + 0.27L) μ in (7.8 + 2.1L) μ in	Pratt & Whitney Labmaster™, master gage blocks
Micrometers ³	Up to 1 in (1 to 2) in (2 to 6) in (6 to 12) in (12 to 36) in	(65 + 5L) μ in 100 μ in (99 + 0.75L) μ in (95 + 1.2L) μ in (29 + 19L) μ in	Gage blocks
Indicators ³ – Dial and Digital	Up to 2 in	48 μ in	Mitutoyo dial indicator calibrator

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
DC Current ³ – Measure	(10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	23 µA/A + 8 nA 46 µA/A + 5 nA 48 µA/A + 50 nA 47 µA/A + 0.5 µA 0.013 % + 10 µA	Agilent 3458A, option 002
	(0 to 200) µA (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A	22 µA/A + 0.4 nA 28 µA/A + 4 nA 28 µA/A + 20 nA 64 µA/A + 0.8 µA 0.025 % + 16 µA 0.053 % + 0.4 mA	Fluke 8508A
	(20 to 500) A	0.090 %	500 A shunts
DC Current ³ – Generate	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	82 µA/A + 8 nA 43 µA/A + 8 nA 41 µA/A + 80 nA 53 µA/A + 0.8 µA 77 µA/A + 25 µA	Fluke 5700A
	(1.1 to 3) A (3 to 11) A (11 to 20) A	0.029 % + 40 µA 0.043 % + 0.5 mA 0.074 % + 0.75 mA	Fluke 5520A
	(0.0 to 550) A (550 to 1000) A	0.61 % + 0.58 A 0.62 % + 0.57 A	50 turn coil
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	11 µV/V + 0.1 µV 6.6 µV/V + 0.4 µV 6.8 µV/V + 4 µV 6.8 µV/V + 40 µV 7 µV/V + 1 mV	Fluke 8508A
DC Voltage ³ – Generate	Up to 0.22 V (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	15 µV/V + 0.6 µV 6.7 µV/V + 1 µV 6.3 µV/V + 3.5 µV 6.7 µV/V + 6.5 µV 7.3 µV/V + 80 µV 9.4 µV/V + 0.6 µV	Fluke 5700A

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Resistance ³ – Generate, Fixed Points	0 Ω	45 μΩ	Fluke 5700A
	1 Ω	83 μΩ/Ω	
	1.9 Ω	48 μΩ/Ω	
	10 Ω	42 μΩ/Ω	
	19 Ω	31 μΩ/Ω	
	100 Ω	13 μΩ/Ω	
	190 Ω	14 μΩ/Ω	
	1 kΩ	11 μΩ/Ω	
	1.9 kΩ	12 μΩ/Ω	
	10 kΩ	10 μΩ/Ω	
	19 kΩ	11 μΩ/Ω	
	100 kΩ	15 μΩ/Ω	
	190 kΩ	16 μΩ/Ω	
	1 MΩ	17 μΩ/Ω	
	1.9 MΩ	17 μΩ/Ω	
	10 MΩ	30 μΩ/Ω	
	19 MΩ	34 μΩ/Ω	
100 MΩ	0.012 %		

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments	
AC Voltage Flatness ³ – Measure (0.5, 1 or 3) V	10 Hz to 10 MHz	0.13 %	Agilent 11049A, 11050A, Precision Measurements EL 1300	
	(10 to 30) MHz	0.25 %		
	(30 to 60) MHz	0.5 %		
	(60 to 100) MHz	1.5 %		
AC Voltage ³ – Generate Up to 2.2 mV	(10 to 20) Hz	0.056 % + 4.5 μV	Fluke 5700A	
	(20 to 40) Hz	0.022 % + 4.5 μV		
	40 Hz to 20 kHz	0.011 % + 4.5 μV		
	(20 to 50) kHz	0.038 % + 4.5 μV		
	(50 to 100) kHz	0.086 % + 7 μV		
	(100 to 300) kHz	0.11 % + 13 μV		
	(300 to 500) kHz	0.17 % + 25 μV		
	500 kHz to 1 MHz	0.34 % + 25 μV		
	(2.2 to 22) mV	(10 to 20) Hz		0.056 % + 5 μV
		(20 to 40) Hz		0.022 % + 5 μV
		40 Hz to 20 kHz		0.011 % + 5 μV
		(20 to 50) kHz		0.038 % + 5 μV
		(50 to 100) kHz		0.086 % + 7 μV

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Voltage ³ – Generate (cont)			
(2.2 to 22) mV	(100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.11 % + 12 μV 0.17 % + 25 μV 0.34 % + 25 μV	Fluke 5700A
(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	0.056 % + 13 μV 0.022 % + 8 μV 0.011 % + 8 μV 0.033 % + 8 μV 0.086 % + 25 μV 0.11 % + 25 μV 0.17 % + 35 μV 0.34 % + 80 μV	
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	0.051 % + 80 μV 0.017 % + 25 μV 0.008 % + 6 μV 0.013 % + 16 μV	
220 mV to 2.2 V	(50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.026 % + 70 μV 0.044 % + 130 μV 0.11 % + 0.35 mV 0.23 % + 0.85 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	0.051 % + 800 μV 0.017 % + 250 μV 0.008 % + 60 μV 0.013 % + 160 μV 0.026 % + 350 μV 0.051 % + 1.5 mV 0.13 % + 4.3 mV 0.27 % + 8.5 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.051 % + 8 mV 0.017 % + 2.5 mV 0.009 % + 0.8 mV 0.023 % + 3.5 mV 0.051 % + 8 mV 0.15 % + 90 mV 0.47 % + 90 mV 1.2 % + 190 mV	Subject to (2.2 x 10 ⁷) V-Hz limitation
(220 to 250) V	(15 to 50) Hz	0.041 % + 16 mV	
(220 to 1100) V	50 Hz to 1 kHz	82 μV/V + 3.5 mV	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Inductance ³ – Measure			
10 μH to 100 H	100 Hz; 120 Hz	0.1 % + 1 μH	GenRad 1659 Digibridge
1 μH to 10 H	1 kHz	0.1 % + 0.1 μH	
0.1 μH to 1 H	10 kHz	0.1 % + 0.02 μH	

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
DC High Voltage ³ – Generate	(1 to 10) kV (10 to 20) kV (21 to 50) kV	0.08 % + 0.004 kV 0.2 % 0.4 %	Glassman high voltage PS-EK 50N12.0- 11 w/ Vitrek 4670A
DC High Voltage ³ – Measure	(1 to 10) kV (10 to 20) kV (21 to 70) kV	0.08 % + 0.004 kV 0.2 % 0.4 %	Vitretek 4670A
AC High Voltage ³ – Measure			
(20 to 100) Hz	(1 to 10) kV _{rms} AC (10 to 20) kV _{rms} AC	0.2 % + 0.025 kV 0.5 %	Vitretek 4670A
(50 to 60) Hz	(20 to 35) kV _{rms} AC	0.4 % + 0.11 kV	

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Current ³ – Generate			
Up to 220 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.03 % + 20 nA 0.02 % + 12 nA 0.014 % + 10 nA 0.035 % + 15 nA 0.13 % + 80 nA	Fluke 5700A
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	0.03 % + 50 nA 0.02 % + 40 nA 0.014 % + 40 nA 0.024 % + 130 nA 1.3 % + 0.8 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	0.03 % + 0.5 µA 0.02 % + 0.4 µA 0.014 % + 0.4 µA 0.024 % + 0.7 µA 1.3 % + 6 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	0.03 % + 5 µA 0.02 % + 4 µA 0.014 % + 3 µA 0.024 % + 4 µA 1.3 % + 12 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.032 % + 40 µA 0.05 % + 100 µA 0.8 % + 200 µA	
(2.2 to 3) A	(10 to 100) Hz (100 to 440) Hz	0.12 % + 200 µA 0.3 % + 1 mA	
(3 to 20) A	(10 to 100) Hz 100 Hz to 1 kHz	0.12 % + 2 mA 1 % + 5 mA	



Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Voltage ³ – Measure			
(1 to 10) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.03 % + 3 μV 0.02 % + 1.1 μV 0.03 % + 1.1 μV 0.1 % + 1.1 μV 0.5 % + 1.1 μV 4 % + 2 μV	Agilent 3458A, option 002
(10 to 100) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	72 μV/V + 4 μV 72 μV/V + 2 μV 0.015 % + 2 μV 0.03 % + 2 μV 0.08 % + 2 μV 0.3 % + 1 μV 1 % + 1 μV 1.5 % + 1 μV	
100 mV to 1 V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	72 μV/V + 40 μV 72 μV/V + 20 μV 0.015 % + 20 μV 0.03 % + 20 μV 0.08 % + 20 μV 0.3 % + 10 μV 1 % + 10 μV 1.5 % + 10 μV	
(1 to 10) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	72 μV/V + 400 μV 72 μV/V + 200 μV 0.015 % + 200 μV 0.03 % + 200 μV 0.08 % + 200 μV 0.3 % + 100 μV 1 % + 100 μV 1.5 % + 100 μV	
(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 (100 to 300) kHz (0.3 to 1) MHz	0.02 % + 4 mV 0.02 % + 2 mV 0.02 % + 2 mV 0.035 % + 2 mV 0.12 % + 2 mV 0.4 % + 1 mV 1.5 % + 1 mV	

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Voltage ³ – Measure (cont) (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	0.04 % + 40 mV 0.04 % + 20 mV 0.06 % + 20 mV 1.2 % + 20 mV 3 % + 20 mV	Agilent 3458A, option 002
AC Current ³ – Measure (5 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (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 (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 (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	0.4 % + 30 nA 0.15 % + 30 nA 0.06 % + 30 nA 0.06 % + 30 nA 0.4 % + 200 nA 0.15 % + 200 nA 0.06 % + 200 nA 0.03 % + 200 nA 0.06 % + 200 nA 0.4 % + 400 nA 0.55 % + 1.5 µA 0.4 % + 0.2 µA 0.15 % + 0.2 µA 0.06 % + 0.2 µA 0.03 % + 0.2 µA 0.06 % + 0.2 µA 0.4 % + 0.4 µA 0.55 % + 15 µA 0.4 % + 2 µA 0.15 % + 2 µA 0.06 % + 2 µA 0.03 % + 2 µA 0.06 % + 2 µA 0.4 % + 4 µA 0.55 % + 150 µA 0.4 % + 20 µA 0.16 % + 20 µA 0.08 % + 20 µA 0.1 % + 20 µA 0.3 % + 20 µA 1 % + 40 µA	Agilent 3458A, option 002

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Current ³ – Measure (cont)			
(1 to 2) A	10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.071 % + 240 µA 0.082 % + 240 µA 0.3 % + 240 µA	Fluke 8508A
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.09 % + 2.4 mA 0.25 % + 2.4 mA	
Capacitance ³ – Measure			
20 pF to 100 µF	100 Hz; 120 Hz	0.1 % + 2 pF	GenRad 1659 RLC Digibridge
1 pF to 10 µF	1 kHz	0.1 % + 1 pF	
0.1 pF to 1 µF	10 kHz	0.1 % + 0.1 pF	
Capacitance ³ – Generate			
(0.2 to 0.4) nF	10 Hz to 10 kHz	0.5 % + 0.01 nF	Fluke 5520A
(0.4 to 1.1) nF	10 Hz to 10 kHz	0.5 % + 0.01 nF	
(1.1 to 3.3) nF	10 Hz to 3 kHz	0.5 % + 0.01 nF	
(3.3 to 11) nF	10 Hz to 1 kHz	0.25 % + 0.01 nF	
(11 to 33) nF	10 Hz to 1 kHz	0.25 % + 0.1 nF	
(33 to 110) nF	10 Hz to 1 kHz	0.25 % + 0.1 nF	
(110 to 330) nF	10 Hz to 1 kHz	0.25 % + 0.3 nF	
330 nF to 1.1 µF	(10 to 600) Hz	0.25 % + 1 nF	
(1.1 to 3.3) µF	(10 to 300) Hz	0.25 % + 3 nF	
(3.3 to 11) µF	(10 to 150) Hz	0.25 % + 10 nF	
(11 to 33) µF	(10 to 120) Hz	0.4 % + 30 nF	
(33 to 110) µF	(10 to 80) Hz	0.45 % + 100 nF	
(110 to 330) µF	(0 to 50) Hz	0.45 % + 300 nF	
330 µF to 1.1 mF	(0 to 20) Hz	0.45 % + 1 µF	
(1.1 to 3.3) mF	(0 to 6) Hz	0.45 % + 3 µF	
(3.3 to 11) mF	(0 to 2) Hz	0.45 % + 10 µF	
(11 to 33) mF	(0 to 0.6) Hz	0.75 % + 30 µF	
(33 to 110) mF	(0 to 0.2) Hz	1.1 % + 100 µF	

Parameter/Equipment	Frequency	CMC ^{2,5} (\pm)	Comments
Oscilloscope Calibration ³ – Generate			Fluke 9500 oscilloscope calibration system
Voltage – DC to 1 M Ω DC to 50 Ω	1 mV to 200 V 1 mV to 5 V	0.03 % + 25 μ V 0.03 % + 25 μ V	Fluke 9500B with 9530, 9550 and 9560 heads
Square Wave – 50 Ω	(0.04 to 1) mV 1 mV to 5 V	1.5 % + 10 μ V 0.12 % + 10 μ V	
Rise Time	150 ps @ 5 mV to 3 V 70 ps @ 25 mV to 2 V 25 ps @ (425 to 575) mV	27 ps 20 ps 8.1 ps	
Timing	Narrow Triangle 900.91 ns to 55 s	3.4 μ s/s	
Leveled Sine Wave –			
Amplitude	5 mV to 5 V	1.5 %	
Single	0.1 Hz to 300 MHz (300 to 550) MHz 550 MHz to 3.0 GHz (3.0 to 6.0) GHz	2.0 % 2.5 % 3.5 % 5.0 %	
Dual	wrt Reference Frequency: 0.1 Hz to 1 GHz (1 to 3.2) GHz	10 % 25 %	
Pulse Width	(1 to 100) ns	5.0 % + 200 ps	
Time Marker Output – Measuring Equipment ³	50 kHz to 2.5 GHz	0.004 %	
Bandwidth Measurement ³	1 MHz to 2.5 GHz	2.3 %	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Thermocouple Indicators ³ – Measure & Generate			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.60 °C 0.26 °C 0.24 °C 0.26 °C 0.30 °C	Fluke 5520A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.36 °C 0.26 °C 0.24 °C 0.27 °C 0.32 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.42 °C 0.27 °C 0.26 °C 0.35 °C 0.50 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.40 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.40 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.75 °C 0.33 °C 0.26 °C 0.24 °C	



III. Electrical – RF/Microwave: RF Power Sensor Calibration

Parameter/Frequency	Range	CMC ^{2, 6, 8} (±)	Comments
VSWR of Power Sensor ³ – 100 kHz to 50 GHz	(1.0 to 1.2) VSWR (1.2 to 1.4) VSWR (1.4 to 1.6) VSWR (1.6 to 1.8) VSWR (1.8 to 2.0) VSWR	0.0074 VSWR 0.016 VSWR 0.026 VSWR 0.038 VSWR 0.050 VSWR	Agilent 4395A, 87512A
10 MHz to 50 GHz	(1.0 to 1.2) VSWR (1.2 to 1.4) VSWR (1.4 to 1.6) VSWR (1.6 to 1.8) VSWR (1.8 to 2.0) VSWR	0.0094 VSWR 0.020 VSWR 0.033 VSWR 0.047 VSWR 0.063 VSWR	Agilent 8757D 85027F

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
Range to Range Calibration Uncertainty ³	(3, 10, 30, 100, 300) μW (1, 3, 10, 30, 100) mW	0.49 % 0.49 %	Agilent 11683A
Power Meter Accuracy Check ³	(0.1 to 10) mW (0.01 to 0.03) mW	1.4 % 1.5 %	Agilent 432A

IV. Electrical – RF/Microwave: RF/Microwave Calibration

Parameter/Range	Frequency	CMC ^{2, 4, 6, 8} (±)	Comments
RF Absolute Power ³ – Measure Using Master: (+20 to -60) dBm	9 kHz to 50 MHz 50 MHz to 5.0 GHz (5.0 to 9.0) GHz (9.0 to 15) GHz (15 to 18) GHz	0.98 % 1.1 % 1.3 % 1.5 % 1.7 %	Agilent E9304A- H18

Parameter/Range	Frequency	CMC ^{2, 4, 6, 8} (±)	Comments
RF Absolute Power ³ – Measure (cont)			
(+20 to -30) dBm	50 MHz to 7 GHz (7 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 40) GHz (40 to 47) GHz (47 to 50) GHz	1.1 % 1.6 % 2.0 % 2.6 % 3.0 % 3.6 % 3.8 %	Agilent 8487A
(-20 to -70) dBm	50 MHz to 7 GHz (7 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 40) GHz (40 to 47) GHz (47 to 50) GHz	1.6 % 1.9 % 2.1 % 2.2 % 3.4 % 3.7 % 3.8 %	Agilent 8487D
Using Secondary: (+20 to -60) dBm	9 kHz to 50 MHz 50 MHz to 5.0 GHz (5.0 to 9.0) GHz (9.0 to 15) GHz (15 to 18) GHz	1.8 % 2.2 % 2.6 % 2.7 % 2.8 %	Agilent E9304A- H18
(+20 to -30) dBm	50 MHz to 7 GHz (7 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 40) GHz (40 to 47) GHz (47 to 50) GHz	1.6 % 1.8 % 2.3 % 3.3 % 3.4 % 4.2 % 4.4 %	Agilent 8487A
(-20 to -70) dBm	50 MHz to 7 GHz (7 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 40) GHz (40 to 48) GHz (48 to 50) GHz	2.0 % 2.3 % 2.4 % 2.3 % 4.1 % 4.0 % 4.1 %	Agilent 8487D

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7, 8} (\pm)	Comments
RF Power ³ – Generate			
(+23 to 0) dBm	9 kHz to 80 MHz	0.1 dB + <i>M</i>	Agilent 33250A
(+24 to -130) dBm	10 Hz to 12.5 MHz	0.05 dB + <i>M</i>	Fluke 9640A
(+14 to -130) dBm	12.5 MHz to 4 GHz	0.06 dB + <i>M</i>	
(+10 to -110) dBm	10 MHz to 26.5 GHz	0.6 dB + <i>M</i>	Agilent 83650B
(+5 to -110) dBm	(26.5 to 40) GHz	0.8 dB + <i>M</i>	
(+2.5 to -110) dBm	(40 to 50) GHz	1.5 dB + <i>M</i>	

Parameter/Frequency	Range	CMC ^{2, 6, 8} (\pm)	Comments
VSWR ³ – Measure			
5 Hz to 500 MHz		0.93 % of indicated value	Agilent 8751A
100 kHz to 50 GHz	(1.0 to 1.2) VSWR	0.0074 VSWR	Agilent 4395A,
	(1.2 to 1.4) VSWR	0.016 VSWR	87512A
	(1.4 to 1.6) VSWR	0.026 VSWR	
	(1.6 to 1.8) VSWR	0.038 VSWR	
	(1.8 to 2.0) VSWR	0.050 VSWR	
10 MHz to 50 GHz	(1.0 to 1.2) VSWR	0.0094 VSWR	Agilent 8757D
	(1.2 to 1.4) VSWR	0.020 VSWR	85027F
	(1.4 to 1.6) VSWR	0.033 VSWR	
	(1.6 to 1.8) VSWR	0.047 VSWR	
	(1.8 to 2.0) VSWR	0.063 VSWR	

V. Electrical – RF/Microwave: Signal Generator Calibration

Parameter/Range	Frequency	CMC ^{2, 4, 6, 8} (±)	Comments
<p>Tuned RF Power Relative³ – Measure</p> <p>(0 to -3) dBm (-3 to -10) dBm (-10 to -40) dBm (-40 to -50) dBm (-50 to -80) dBm (-80 to -90) dBm (-90 to -110) dBm</p>	<p>2.5 MHz to 26.5 GHz 2.5 MHz to 26.5 GHz 2.5 MHz to 26.5 GHz 2.5 MHz to 26.5 GHz 2.5 MHz to 26.5 GHz 2.5 MHz to 26.5 GHz 2.5 MHz to 26.5 GHz</p>	<p>0.02 dB 0.02 dB 0.08 dB 0.14 dB 0.2 dB 0.26 dB 0.3 dB</p>	<p>Agilent 8902A Agilent 11722A Agilent 11792A Agilent 11793A</p>
<p>Sine Wave Distortion³ – Measure</p> <p>400 Hz and 1000 Hz Modulation</p>	<p>Modulation Depths: 1 % to 90 %</p>	<p>0.84 %</p>	<p>Agilent 8903B</p>
<p>Amplitude Modulation³ – Measure</p> <p>Rate: 50 Hz to 10 kHz Depth: 5 % to 99 %</p> <p>Rate: 20 Hz to 10 kHz Depth: 0 % to 99 %</p> <p>Rate: 50 Hz to 50 kHz Depth: 5 % to 99 %</p> <p>Rate: 20 Hz to 100 kHz Depth: 0 % to 99 %</p> <p>Rate: 50 Hz to 50 kHz Depth: 5 % to 99 %</p> <p>Rate: 30 Hz to 1 MHz</p>	<p>150 kHz to 10 MHz 150 kHz to 10 MHz (10 to 1300) MHz (10 to 1300) MHz (1.3 to 26.5) GHz (26.5 to 50) GHz</p>	<p>2.5 % 3.6 % 1.6 % 3.6 % 2.1 % 1.4 %</p>	<p>Agilent 8902A Agilent 8902A with 11793A, 11792A Agilent 8565E, option 001</p>

Parameter/Range	Frequency	CMC ^{2, 4, 6, 8} (±)	Comments
Amplitude Modulation ³ – Generate			
(11 to 13.5) MHz	10 MHz to 50 GHz	1.7 %	Hewlett Packard 83650B
Residual AM	50 Hz to 3 kHz bandwidth	0.0060 %	Hewlett Packard 11715A, 8903B
AM Distortion	50 % AM, 20 Hz to 100 kHz rates	0.11 %	
	95 % AM, 20 Hz to 100 kHz rates	0.16 %	
AM Flatness	50 Hz to 50 kHz rates	0.16 %	
	20 Hz to 100 kHz rates	0.32 %	
AM Linearity	<95 % AM	0.18 %	
	<99 % AM	0.27 %	
Incidental ΦM	12.5 MHz carrier, 50 % AM, 1 kHz rate, 50 Hz to 3 kHz bandwidth	0.020 radians	
Phase Modulation ³ – Measure			
Rate: 200 Hz to 10 kHz	(10 to 1300) MHz	3.6 %	Agilent 8902A
200 Hz to 20 kHz	10 MHz to 26.5 GHz	4.7 %	with 11973A, 11972A
Pulse Repetition Frequency ³ – Measure	3 Hz to 100 MHz	150 Hz	Agilent E4440A Agilent 8565E
Frequency Modulation ³ – Measure			
Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak	250 kHz to 10 MHz	2.4 %	Agilent 8902A
Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak	(10 to 1300) MHz	1.3 %	
Rate: (20 to 200) kHz Dev.: ≤ 400 kHz peak	(0.10 to 26.5) GHz	5.8 %	With Agilent 11793A, 11792A
30 Hz to 1 MHz	(26.5 to 50) GHz	150 Hz	Agilent 8565E, option 001

Parameter/Equipment	Frequency	CMC ^{2, 6, 8} (±)	Comments
Single Sideband Phase Noise (SSB) ³	(10 to 1300) MHz	1 dB	Agilent 8902A, option 036/037
Frequency Accuracy ³	(1.5, 4, 9, 16, 21) GHz (21, 26.5, 40) GHz	3 kHz	Agilent 8902A
	50 GHz	5 kHz	Agilent 8565E

VI. Electrical – RF/Microwave: Spectrum Analyzer/EMI Receiver Calibration

Parameter/Range	Frequency	CMC ^{2, 4, 6, 8} (±)	Comments
Frequency Modulation ³ – Generate			
250 kHz to 40 GHz	For 400 Hz and 1000 Hz Internal Modulation	3.5 % + 20 Hz	Agilent E8257C
10 MHz to 50 GHz	1 MHz rate, 1 MHz deviation	10 %	Agilent 83650B
(11 to 13.5) MHz, (88 to 108) MHz, (352 to 432) MHz			
Residual FM	50 Hz to 15 kHz bandwidth	0.14 Hz	Hewlett Packard 11715A, 8903B
FM Distortion	12.5 MHz, 12.5 kHz deviation, <10 kHz modulation rate 100 MHz, 100 kHz deviation, <100 kHz modulation rate 400 MHz, 400 kHz deviation, <100 kHz modulation rate	0.021 %	
FM Flatness	DC to 100 kHz rates, DC to 200 kHz rates, DC to 10 MHz	0.27 %	



Parameter/Equipment	Frequency	CMC ^{2, 6, 8} (\pm)	Comments
Frequency Accuracy ³	(1.5, 4, 9, 16, 21) GHz (21, 26.5, 40) GHz 50 GHz	3 kHz 5 kHz	Agilent 83650B
Span Accuracy ³	1 kHz to 2 MHz (2 to 500) MHz	1 Hz 1 kHz	Agilent 3335A Agilent 86350A
Residual FM ³ (At 500 MHz)	5 kHz span and 1 kHz RBW	0.24 kHz	Agilent 3335A Agilent 86350A
Cal Output Port Check ³	300 MHz -20 dBm	1.2 Hz 0.44 dB	Agilent 53132A Agilent E9304A and 8482A (based on Agilent 8593E)
Average Noise ³	9 kHz to 50 GHz	0.31 dB	50 Ω load
Residuals ³	20 Hz to 50 GHz	0.31 dB	50 Ω load
Reference Level ³ – Log Scale Linear Scale	50 MHz 50 MHz	0.14 dB 0.32 dB	Agilent 11792 with: Agilent 3335A Agilent 83650B (based on Agilent 8593E)
Attenuator Check ³	50 MHz	0.15 dB	Agilent 8593E

Parameter/Equipment	Frequency	CMC ^{2, 6, 8} (±)	Comments
Log Fidelity ³	50 MHz	1.1 dB	Agilent 3335A
	50 MHz	1.1 dB	Agilent 83650B (based on Agilent 8593E)
Linear Fidelity ³	50 MHz	1 dB	Agilent 3335A
	50 MHz	1 dB	Agilent 83650B (based on Agilent 8593E)
BW Accuracy ³	20 Hz to 50 GHz	1 Hz	Agilent 83650B (based on Agilent 8565E)
BW Switching ³	20 Hz to 50 GHz	1.1 dB	Agilent 83650B (based on Agilent 8565E)
2 nd Harmonic Distortion ³	30 Hz to 50 GHz	1.4 dB	Agilent 8565E
	200 Hz to 80 MHz	1.4 dB	Agilent 3335A
	(10 to 50) GHz	1.4 dB	Agilent 83650B (based on Agilent 8565E)
3 rd Order Intermodulation ³	200 Hz to 80 MHz	0.5 dB	Agilent 3335A
	(10 to 50) GHz	0.5 dB	Agilent 83650B (based on Agilent 8565E)
Noise Sidebands ³	200 Hz to 80 MHz (10 to 50) GHz	0.7 dB 0.8 dB	Agilent 3335A Agilent 83650B (based on Agilent 8565E)

Parameter/Equipment	Frequency	CMC ^{2, 4, 6, 8} (\pm)	Comments
System Sidebands ³	200 Hz to 80 MHz (10 to 50) GHz	0.48 dB 0.52 dB	Agilent 3335A Agilent 83650B (based on Agilent 8565E)
Sweep Time ³	10 MHz to 50 GHz	6.1 %	Agilent 83650B (based on Agilent 8565E)
Harmonic Measurements ³	30 Hz to 50 GHz 200 Hz to 80 MHz (10 to 50) GHz	0.5 dB 0.6 dB 0.8 dB	Agilent 8565E Agilent 3335A Agilent 83650B (based on Agilent 8565E)
Tracking Generator Non-Harmonics ³	9 kHz to 2.9 GHz	0.59 dB	Agilent 8565E
Tracking Generator Feedthrough ³	9 kHz to 2.9 GHz	0.63 dB	50 Ω load
Tracking Absolute Amplitude Output ³	9 kHz to 2.9 GHz	0.61 dB	Agilent E9304A Agilent E4418B
Frequency Response ³	9 kHz to 40 GHz 50 MHz to 50 GHz	1.1 dB 1.3 dB	Agilent 8902A Agilent 8487A (based on Agilent 8565E)
Gain Compression ³	200 Hz to 80 MHz (10 to 50) GHz	1.5 dB 1.5 dB	Agilent 3335A Agilent 83650B (based on Agilent 8565E)

Parameter/Equipment	Frequency	CMC ^{2, 6, 8} (±)	Comments
Source Errors for CISPR Bands A, B, C and D for Impulse Spectral Amplitude ³	Band A (10 to 150) kHz	0.82 dB	IGUU 2916 IGUU 2918
	Band B (0.15 to 30) MHz	0.82 dB	
	Band C and D (30 to 1000) MHz	1.1 dB	
	Band E (1 to 18) GHz	0.77 dB	Agilent 83650B, Agilent 33250A
Pulse Generator ³ – Level Change	Band A through E	0.5 dB	Agilent E4440
Source Errors for Sinewave Output for CISPR Checks ³ (at 60 dB/μV)	Band A through D	0.26 dB	IGUU 2916 IGUU 2918
	Band E	0.26 dB	Agilent 83650B, Agilent 33250A
Peak and Average Detector Response ³	Band A through D	1.3 dB	IGUU 2916 IGUU 2918
	Band E	0.96 dB	Agilent 83650B, Agilent 33250A
Source Errors for Frequency Response ³	Band A	0.53 dB	Agilent E4440
	Band B	0.62 dB	
	Band C	0.57 dB	
	Band D	0.69 dB	
	Band E	0.62 dB	
Band E Impulse BW Measurement ³	Above 1 GHz	3.7 kHz	Agilent 83650B, Agilent 33250A

VII. Electrical – RF/Microwave: Network Analyzer Calibration

Parameter/Equipment	Frequency	CMC ² (±)	Comments
Non-Sweep Linearity Test (NA) ³	(-90 to +20) dBm	0.24 dB	Agilent 438A, E4418B, Agilent 8481D
Frequency Accuracy Test (NA) ³	10 Hz to 26.5 GHz	12 Hz	Agilent 53151A rubidium frequency standard
Source Level Accuracy/Flatness Test (NA) ³	10 Hz to 50 GHz	0.14 dB	Agilent 438A, E4418B, 8482A, 8487A, and 34401A
Power Sweep Linearity Test (NA) ³	(0 to 20) dB	0.23 dB	Agilent 438A, E4418B, and 8481D
Harmonics/Non-Harmonic Test (NA) ³	(-30 to -120) dBc	0.46 dB	Agilent 8563E
Receiver Noise Level Test (NA) ³	(-30 to -120) dBm	0.31 dB	50 Ohm load
Input Crosstalk Test (NA) ³	(-30 to -120) dB	0.23 dB	50 Ohm load
Input Impedance Test (NA) ³	(0 to 110) dB	0.37 dB	Agilent 8757D
Absolute Amplitude Accuracy Test (NA) ³	(0 to -60) dBm	0.13 dB	Agilent 438A, E4418B, and 8482A



Parameter/Equipment	Frequency	CMC ² (±)	Comments
Magnitude Ratio/Phase Dynamic Accuracy Test (NA) ³ – Magnitude Ratio Dynamic Phase Dynamic	(0 to -100) dB (0 to -100) dB	0.37 dB 0.06°	Agilent 11667A, P8496A/G, and N4693A
Receiver Trace Noise (NA) ³	300 kHz to 50 GHz	0.33 dB	Agilent 11850C
Magnitude Ratio/Phase Frequency Response Test (NA) ³ – Magnitude Ratio Accuracy Phase Frequency Response	100 kHz to 50 GHz 100 kHz to 50 GHz	0.37 dB 0.6°	Agilent 1167A, P8496A/G, and N4693A
Receiver Input Impedance (NA) ³	(0 to 120) dB return loss	0.37 dB	Agilent 85032B, N4693A
Receiver Magnitude Accuracy (NA) ³	300 kHz to 50 GHz	0.1 dB	Agilent 438A, E4418B, 8482A, 8487A
Receiver Phase Compression (NA) ³	300 kHz to 50 GHz	0.1 dB	Agilent 438A, E4418B, 8482A, 8487A
Port Match (NA) ³	300 kHz to 50 GHz	0.1 dB	Agilent 85032B, 85044A N4693A
Switch Repeatability (NA) ³	300 kHz to 50 GHz	0.1 dB	Associated network analyzer used with S parameter test set

Parameter/Equipment	Frequency	CMC ² (±)	Comments
Effective Source Match (NA) ³	300 kHz to 50 GHz	0.1 dB	Agilent 85031B, N4693A
Directivity ³	300 kHz to 50 GHz	0.1 dB	Agilent 85031B, N4693A
Current Monitor Conversion Factors ³	(0.001 to 1) V/A	0.05 %	Fluke 5700A, Agilent 3458A

VIII. Electrical RF/Microwave: Device Specific Parameters

EMI receivers (CISPR 16-1), EFT/Burst Generators (EN 61000-4-4), ESD Guns and Targets (IEC 61000-4-2, ANSI C63.16, SAE J1113-13), Surge Generators (EN 61000-4-5), Generators for Voltage Dips, Short Interrupts and Voltage Variations (EN 61000-4-11), Ring Wave Generators (ANSI C62.41), Network Analyzers, Impulse Generators (CISPR 16-1-1), Oscilloscopes, Power Meters, Power Sensors, Signal Generators, Spectrum Analyzers, 50 Ω Terminators

Parameter/Equipment	Frequency	CMC ² (±)	Comments
General RF Insertion Loss/Gain ³	9 kHz to 6 GHz	0.42 dB	Agilent E9304A, Agilent E4418B
	10 MHz to 18 GHz	0.42 dB	Agilent E4412A, Agilent E4418B
	(18 to 26.5) GHz	0.6 dB	Agilent E4418B, 8487A
	(26.5 to 40) GHz	0.8 dB	
(40 to 50) GHz	1.1 dB		

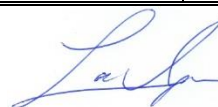
Parameter/Equipment	Frequency	CMC ^{2, 4, 7} (\pm)	Comments
Impedance ³ – Measure, 50 Ω Terminations	30 kHz to 6 GHz	0.93 %	Agilent 8757D, 85032B cal kit, S11 – 1 port calibration
	10 MHz to 18 GHz	0.95 %	Agilent E8364B, N4690A cal kit, S11 – 1 port calibration
	(18 to 50) GHz	1 %	Agilent E8364B, N4693A cal kit, S11 – 1 port calibration
Pin Depth ³	\pm 0.02 in	120 μ in	Gage
Impedance ³ – Measure 50 Ω Devices	30 kHz to 6 GHz	2.9 % + <i>M</i>	Agilent 8757D, 85032B cal kit, S11 – 1 port calibration
Attenuation Measurements ³ – (0 to 100) dB (0 to 80) dB	100 kHz to 18 GHz	0.24 dB	Agilent 8902A, 11792A
	(18 to 40) GHz	0.31 dB	Agilent E8364B, N4693A cal kit
EFT/Burst Generator ³ – Voltage Rise Time Impulse Duration Burst Duration Burst Period Repetition Rate	10 V to 6 kV	2.8 %	EN 61000-4-4; IEC 61000-4-4, IEC 61000-4-4(2004, 2011); GR 1089 CORE ISO 7637-2 Tektronix TDS 5104B
	5 ns \pm 30 %	0.74 ns	
	150 ns \pm 30 %	0.74 ns	
	15 ms \pm 20 % 0.75 ms \pm 20 %	0.74 ns	
	300 ms \pm 20 %	0.74 ns	
	1 kHz to 50 Mhz	23 Hz (freq) 2.8 % (volt)	

Parameter/Equipment	Frequency	CMC ^{2,4} (±)	Comments
ESD Simulators ³ –			
Contact Voltage (Positive and Negative)	(0.5 to 2) kV (2 to 8) kV (8 to 15) kV (15 to 30) kV	2.6 % 0.7 % 0.6 % 0.54 %	IEC/EN 61000-4-2; ISO 10605; SAE J1113-13 TEK TDS 7404 IEC ESD target applied kilovolt 149-3
Rise Time	(0.7 to 1) ns	65 ps	
Peak Current	(6.8 to 33) A	5.0 %	
30 ns Current	(2.8 to 20.8) A	5.6 %	
60 ns Current	(1.4 to 10.4) A	6.1 %	
Air Discharge Voltage (Positive and Negative)	(0 to 2) kV (2 to 20) kV (20 to 40) kV	0.15 % 0.61 % 1.2 %	
Rise Time	(0.7 to 1) ns	61 ps	
RC Time Constant (at ± 15 kV)	600 ns ± 130 ns (for 330 pF probe) 300 ns ± 60 ns (for 150 pF probe)	7.2 ns 6.0 ns	
Surge Generator ³ – Ring/ Impulse/ PQF			
Front Time Open Short	(0.1 to 50) µs	0.74 ns	IEC/EN61000-4-5; IEC/EN 61000-4-8; IEC/EN 61000-4-9; , IEC/EN 61000-4-10; IEC/EN 61000-4-11; IEC/EN 61000-4-12 UL 864; UL 1449; ISO 7637-2;
Rise Time Open Circuit Short Circuit	(0.1 to 50) µs	1.2 ns	
Time to Half-Value Impulse Duration	(20 to 1500) µs	0.74 ns	
Voltage	10 V to 18 kV	2.8 %	ITU Rec K.17, K.20, ITU Rec K.21; SBC-TP-76200; GR1089CORE
Current	(0.001 to 5) kA	2.8 %	
Frequency	100 kHz to 1 MHz	23 Hz (freq) 2.9 % (volt)	IEC/EN 61000-4-18
Phase Synchronization	50 Hz 60 Hz 400 Hz	0.11° 0.095° 0.21°	Tektronix TDS 5104B ANSI C62.41,

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Mains Harmonic Emissions ³	(100 to 280) V (0.1 to 20) A (20 to 60) A (0.5 to 179.5)°	0.07 % + 270 mV 0.2 % 0.1 A 0.1°	IEC/EN 61000-3-2; IEC/EN 61000-4-7; IEC/EN 61000-4-13; IEC/EN 61000-4-14;
Voltage Fluctuations (Flicker) ³	(100 to 280) V (0.1 to 20) A (20 to 60) A	0.1 % + 370 mV 0.2 % 0.1 A	IEC/EN 61000-3-3 IEC/EN 61000-3-12 IEC/EN 61000-4-15
Rise/Fall Time ³ – Measure			
Pulse Width	200 ps to 1000 s	2 % + 50 ps	TDS 5104B
Voltage Measure	(1 mV to 10 V)/div	2 %	

IX. Mechanical

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Accelerometers – Versus Primary Standard	(5 to 9) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5000) Hz (5001 to 10 000) Hz (10 to 15) kHz	1.7 % 1.2 % 0.79 % 1.1 % 1.4 % 1.9 % 2.3 %	Modal Shop 9155 workstation with 396C10/C11 air bearing shaker
Accelerometers Versus Secondary Standard	(5 to 9) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5000) Hz (5001 to 10 000) Hz (10 to 15) kHz	2.7 % 1.8 % 1.4 % 1.6 % 1.9 % 2.3 % 3 %	Modal Shop 9155 workstation with 396C10/C11 air bearing shaker
Barometers ³	(22 to 34) inHg (750 to 1150) mBar	0.011 inHg 0.39 mBar	DPI 740



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Pressure Gauges ³ – Pneumatic	(0 to 10) psig (0 to 100) psig (0 to 300) psig (0 to 1000) psig (0 to 3000) psig	0.011 psig 0.023 psig 0.068 psig 0.33 psig 0.67 psig	Additel 681 digital gages
Scales and Balances ³	(0.01 to 200) g 200 g to 3.3 kg (3.3 to 40) kg (50 to 300) lb	0.000 16 g + 0.015 % 0.0016 kg + 0.015 % 0.000 11 kg + 0.015 % 0.000 15 lb + 0.015 %	Class 1 weights, Class F weights
Mass – Measure	(1 to 200) g (0.2 to 3.2) kg (3.2 to 40) kg (0.0022 to 0.44) lb (0.44 to 7.1) lb (7.1 to 88) lb	0.027 mg + 3.7 ppm 5.4 mg + 0.063 ppm 170 mg + 3.2 ppm 0.000 000 38 lb + 2.8 ppm 0.000 026 lb + 1.6 ppm 0.000 34 lb + 11 ppm	Substitution method using reference weights
Torque Wrench, Torque Screwdriver, Torque Watch ³	(0.5 to 400) in·ozf (3.75 to 50) in·lbf (10 to 150) in·lbf (30 to 400) in·lbf (100 to 1000) in·lbf (25 to 250) ft·lbf (100 to 1000) ft·lbf	0.27 % + 0.090 in·oz 0.12 % + 0.15 in·lbf 0.19 % + 0.19 in·lbf 0.26 % + 0.15 in·lbf 0.28 % + 0.085 in·lbf 0.18 % + 0.39 ft·lbf 0.26 % + 0.29 ft·lbf	CDI torque transducers
Torque Transducers	(0.5 to 400) in·ozf (3.75 to 50) in·lbf (10 to 150) in·lbf (30 to 400) in·lbf (100 to 1000) in·lbf (25 to 250) ft·lbf (100 to 1000) ft·lbf	50 ppm + 0.011 in·oz 48 ppm + 0.0016 in·lbf 65 ppm + 0.0012 in·lbf 44 ppm + 0.016 in·lbf 43 ppm + 0.043 in·lbf 52 ppm + 0.0066 ft·lbf 42 ppm + 0.045 ft·lbf	Dead weights, CDI deployable torque calibration system

X. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
IR Temperature ³ – Measuring Equipment	(35 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 450) °C (450 to 500) °C	1.2 °C 1.3 °C 1.5 °C 1.9 °C 2.6 °C	Fluke 4181
Humidity – Measure ³	(0 to 90) % RH (90 to 100) % RH	1.3 % RH 2.4 % RH	Vaisala hygrometer
Relative Humidity – Measuring Equipment	(5 to 90) % RH (90 to 95) % RH	0.81 % RH 1.0 % RH	Rotronic HG2-S101 and Rotronic H290D sensor
Temperature ³ – Measure	(5 to 60) °C (-200 to 0) °C (0 to 200) °C (200 to 660) °C	0.14 °C 0.021 °C 0.022 °C 0.027 °C	Rotronics HG2-S101 and Rotronics H290D sensor Fluke 5618B, 5628B and 1523
Temperature – Measuring Equipment	(-70 to 0) °C (0 to 180) °C	0.021 °C 0.022 °C	Fluke 5628B and 1523, comparison to reference thermometer, in temperature chambers

XI. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Frequency ³ – Measuring Equipment	1 mHz to 80 MHz 10 Hz to 4 GHz 10 MHz to 50 GHz	2.5 µHz/Hz + 1 µHz 0.03 nHz/Hz + 0.6 mHz 0.03 nHz/Hz + 0.6 Hz	With GPS conditioning: Agilent 33250 Fluke 9640 Agilent 83650B w/ option 008

Parameter/Equipment	Range	CMC ^{2, 6, 8} (\pm)	Comments
Frequency ³ – Measuring Equipment (cont) 10 MHz Source (Rubidium)	10 MHz	0.03 nHz/Hz	Rubidium frequency standard referenced to GPS
Frequency ³ – Measure	1 Hz to 225 MHz 225 MHz to 50 GHz 10 MHz	0.06 nHz/Hz + 25 pHz 0.04 nHz/Hz + 2 Hz 0.003 nHz/Hz	With GPS conditioning: Agilent 5335A, 53132A, Agilent 53151A, 53132A, 8565E Agilent 53132A referenced to GPS
Time Interval ³ – Measure	500 ps to 400 s (1 to 3600) s	19 μ Hz/Hz + 24 ps 0.0088 s	Tektronix TDS 7404B oscilloscope Agilent 33250A, with photo comparison

¹ This laboratory offers commercial 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 all percentages shall be read as percent of reading, unless otherwise noted.

- ⁵ 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. CMCs 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.
- ⁶ Some of the types of instruments calibrated under these parameters are EMI Receivers, EFT/Burst Generators, ESD Guns and Targets, Surge Generators, Generators for Voltage Dips, Short Interrupts and Variations, Ring Wave Generators, Network Analyzers, Click Analyzers, Impulse Generators, Power Meters, Power Sensors, Signal Generators, Spectrum Analyzers, Attenuators and Terminations.
- ⁷ In the statement of CMC, M is the mismatch uncertainty for the unit under test. Mismatch uncertainties, due to the reflection coefficient of the device to be calibrated, are to be included in the overall measurement uncertainty. The approach of determining expanded uncertainties, expressed at approximately the 95 % level of confidence, (using a coverage factor of $k = 2$) is to be applied for this calculation as well.
- ⁸ Instruments are calibrated against manufacturer's specifications. These calibrations may also, at customer request, be based on conformance to the calibration requirements of various standards such as CISPR 16-1-1, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-11, EN 61000-4-5, IEC 61000-4-2, IEC 61000-3-2, IEC 61000-4-7, IEC 61000-4-8, IEC 61000-4-9, IEC 61000-4-10, IEC 61000-4-11, IEC 61000-4-12, IEC 61000-4-13, IEC 61000-4-14, IEC 61000-4-15, ANSI 62.41:1991, ANSI C63.16, ANSI C62-41, UL 864, UL 1449, ISO 7637-2, ISO 17069, ITU Rec K.17, ITU Rec K.20, ITU Rec K.21, SBC-TP-76200, GR1089CORE and SAE J1113-13. Other standards may apply and the customer should contact the lab for further information.



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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, ANSI/NCSLI Z540.3-2006, 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 April 2017).



Presented this 13th day of February 2018.

A handwritten signature in blue ink, written over a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 1818.01
Valid to September 30, 2019

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