



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: April 30, 2020

Certificate Number: 2681.01

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

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
DC Voltage – Measure ³			
Fixed Points	1 V 10 V 100 V	3.1 μV/V 1.9 μV/V 3.4 μV/V	Fluke 732A, Fluke 8508A
Variable DC	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1000) V	5.8 μV/V + 0.10 μV 3.7 μV/V + 0.40 μV 3.6 μV/V + 4.0 μV 5.6 μV/V + 40 μV 6.1 μV/V + 500 μV	Fluke 8508A
DC Voltage – Generate			
Fixed Points	0.1 V 1 V 10 V 100 V 1000 V	1.9 μV/V 1.8 μV/V 1.8 μV/V 1.8 μV/V 1.9 μV/V	Fluke 732A, Fluke 752A
Variable DC	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	8.5 μV/V + 0.40 μV 5.2 μV/V + 0.70 μV 3.7 μV/V + 2.5 μV 3.7 μV/V + 4.0 μV 5.2 μV/V + 40 μV 6.7 μV/V + 400 μV	Fluke 5730A

Parameter/Equipment	Range	CMC ^{2, 7, 8, 9} (±)	Comments
DC Current – Generate	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 20) A (20 to 100) A (100 to 1000) A	41 µA/A + 6.0 nA 36 µA/A + 7.0 nA 36 µA/A + 40 nA 46 µA/A + 0.70 µA 84 µA/A + 12 µA 0.017 % + 1.6 mA 0.013 % + 9.6 mA 0.40 % + 0.39 A	Fluke 5730A Fluke 5730A/52120A Fluke 5730A/52120A, 5500A coil
	(1000 to 5000) A	0.54 % + 0.66 A	Fluke 5730A/52120A, Coil 6KA
DC Current – Measure ³	(1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 10) A (10 to 100) A (100 to 300) A (300 to 1000) A	32 µA/A 30 µA/A 24 µA/A 24 µA/A 25 µA/A 44 µA/A 70 µA/A 0.047 % 0.023 % 0.054 %	Fluke 8508A, Guildline 9211A shunt Fluke 8508A, Ohm- Labs CS-1000

Parameter/Range	Frequency	CMC ^{2, 7, 8} (±)	Comments
AC Voltage – Measure ⁴ 600 µV 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	0.18 % + 1.3 µV 0.076 % + 1.3 µV 0.044 % + 1.3 µV 0.083 % + 2 µV 0.13 % + 2.5 µV 0.24 % + 4.0 µV 0.25 % + 8.0 µV 0.37 % + 8.0 µV	Fluke 5790A
	(2.2 to 7) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (\pm)	Comments
AC Voltage – Measure ⁴ (cont.)			
(2.2 to 7) mV	(100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.13 % + 4.0 μ V 0.14 % + 8.0 μ V 0.24 % + 8.0 μ V	Fluke 5790A
(7 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	0.030 % + 1.3 μ V 0.020 % + 1.3 μ V 0.012 % + 1.3 μ V 0.022 % + 2.0 μ V 0.032 % + 2.5 μ V 0.083 % + 4.0 μ V 0.092 % + 8.0 μ V 0.18 % + 8.0 μ V	
(22 to 70) 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 % + 1.5 μ V 0.014 % + 1.5 μ V 80 μ V/V + 1.5 μ V 0.015 % + 2.0 μ V 0.030 % + 2.5 μ V 0.058 % + 4.0 μ V 0.075 % + 8.0 μ V 0.12 % + 8.0 μ V	
(70 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	0.022 % + 1.5 μ V 89 μ V/V + 1.5 μ V 42 μ V/V + 1.5 μ V 79 μ V/V + 2.0 μ V 0.018 % + 2.5 μ V 0.028 % + 4.0 μ V 0.040 % + 8.0 μ V 0.11 % + 8.0 μ V	
(220 to 700) 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	0.022 % + 1.5 μ V 84 μ V/V + 1.5 μ V 36 μ V/V + 1.5 μ V 56 μ V/V + 2.0 μ V 83 μ V/V + 2.5 μ V 0.021 % + 4.0 μ V 0.032 % + 8.0 μ V 0.098 % + 8.0 μ V	
(0.7 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	0.021 % 70 μ V/V 26 μ V/V 49 μ V/V 73 μ V/V	

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (\pm)	Comments
AC Voltage – Measure ⁴ (cont.)			
(0.7 to 2.2) V	(100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.019 % 0.028 % 0.094 %	Fluke 5790A
(2.2 to 7) 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	0.021 % 71 μ V/V 26 μ V/V 53 μ V/V 84 μ V/V 0.021 % 0.041 % 0.13 %	
(7 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	0.021 % 71 μ V/V 30 μ V/V 50 μ V/V 83 μ V/V 0.021 % 0.041 % 0.13 %	
(22 to 70) 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	0.021 % 72 μ V/V 36 μ V/V 65 μ V/V 99 μ V/V 0.022 % 0.042 % 0.12 %	
(70 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	0.021 % 72 μ V/V 36 μ V/V 71 μ V/V 0.010 % 0.022 % 0.050 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.020 % 99 μ V/V 45 μ V/V 0.014 % 0.051 %	

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (\pm)	Comments
AC Voltage – Measure ⁴ (cont.) (700 to 1000) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.020 % 99 μ V/V 46 μ V/V 0.014 % 0.051 %	Fluke 5790A
AC Voltage – Generate (0.22 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	0.037 % + 4.0 μ V 0.022 % + 4.0 μ V 0.023 % + 4.0 μ V 0.053 % + 4.0 μ V 0.075 % + 5.0 μ V 0.13 % + 10 μ V 0.17 % + 20 μ V 0.34 % + 20 μ V	Fluke 5730A
(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 % + 4.0 μ V 0.010 % + 4.0 μ V 98 μ V/V + 4.0 μ V 0.023 % + 4.0 μ V 0.053 % + 5.0 μ V 0.11 % + 10 μ V 0.15% + 20 μ V 0.30 % + 20 μ V	
(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 μ V 0.010 % + 7.0 μ V 64 μ V/V + 7.0 μ V 0.013 % + 7.0 μ V 0.032 % + 17 μ V 0.067 % + 20 μ V 0.14 % + 25 μ V 0.28 % + 45 μ V	
(0.22 to 2.2) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.025 % + 40 μ V 99 μ V/V + 15 μ V 51 μ V/V + 8.0 μ V 73 μ V/V + 10 μ V 90 μ V/V + 30 μ V 0.035 % + 80 μ V 0.10 % + 0.20 mV 0.18 % + 0.30 mV	

Parameter/Range	Frequency	CMC ^{2,7,8} (±)	Comments
AC Voltage – Generate (cont.)			
(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	0.026 % + 0.40 mV 98 μV/V + 0.15 mV 52 μV/V + 50 μV 73 μV/V + 0.10 mV 88 μV/V + 0.20 mV 0.027 % + 0.60 mV 0.10 % + 2.0 mV 0.16 % + 3.2 mV	Fluke 5730A
(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	0.026 % + 4.0 mV 0.010 % + 1.5 mV 60 μV/V + 0.60 mV 89 μV/V + 1.0 mV 0.016 % + 2.5 mV	Fluke 5730A, 5725A
(220 to 750) V	50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz	82 μV/V + 3.5 mV 0.017 % + 6.0 mV 0.061 % + 11 mV 0.061 % + 11 mV 0.23 % + 45 mV	
(750 to 1100) V	50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	82 μV/V + 3.5 mV 0.017 % + 6.0 mV 0.061 % + 11 mV	
AC Voltage – Measure Wideband ⁴			
(0.7 to 2.2) mV	10 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.47 % + 1.5 μV 0.49 % + 2.5 μV 0.57 % + 2.5 μV 0.67 % + 2.5 μV 0.88 % + 3.5 μV	5790A, option 03 wideband input – 50 Ω
(2.2 to 7) mV	10 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.35 % + 7.0 μV 0.39 % + 8.0 μV 0.42 % + 8.0 μV 0.48 % + 8.0 μV 0.64 % + 8.0 μV	
(7 to 22) mV	10 Hz to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz	0.36 % + 13 μV 0.42 % + 13 μV 0.44 % + 13 μV	

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (±)	Comments
AC Voltage – Measure Wideband ⁴ (cont.)			
(7 to 22) mV	(10 to 20) MHz (20 to 30) MHz	0.50 % + 13 μV 0.66 % + 13 μV	5790A, option 03 wideband input – 50 Ω
(22 to 70) mV	10 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.37 % + 30 μV 0.41 % + 30 μV 0.45 % + 30 μV 0.49 % + 30 μV 0.66 % + 30 μV	
(70 to 220) mV	10 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.30 % + 80 μV 0.34 % + 80 μV 0.38 % + 80 μV 0.42 % + 80 μV 0.58 % + 80 μV	
(220 to 700) mV	10 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.30 % + 0.30 mV 0.32 % + 0.30 mV 0.37 % + 0.30 mV 0.42 % + 0.30 mV 0.58 % + 0.30 mV	
(0.7 to 2.2) V	10 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.27 % + 0.40 mV 0.31 % + 0.40 mV 0.35 % + 0.40 mV 0.39 % + 0.40 mV 0.56 % + 0.40 mV	
(2.2 to 7) V	10 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.27 % + 0.80 mV 0.31 % + 0.80 mV 0.35 % + 0.80 mV 0.39 % + 0.80 mV 0.56 % + 0.80 mV	
AC Voltage – Generate Wideband			
(0.3 to 1.1) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.83 % + 2.0 μV 0.68 % + 2.0 μV 0.68 % + 5.0 μV 0.84 % + 5.0 μV 1.0 % + 5.0 μV 1.5 % + 17 μV	Fluke 5730A, option 03 wideband output – 50 Ω

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (\pm)	Comments
AC Voltage – Generate Wideband (cont.)			
(1.1 to 3) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.76 % + 3.0 μ V 0.61 % + 3.0 μ V 0.58 % + 6.0 μ V 0.66 % + 6.0 μ V 0.90 % + 6.0 μ V 1.7 % + 6.0 μ V	Fluke 5730A, option 03 wideband output – 50 Ω
(3 to 11) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.76 % + 8.0 μ V 0.61 % + 8.0 μ V 0.60 % + 11 μ V 0.68 % + 11 μ V 0.84 % + 11 μ V 1.3 % + 11 μ V	
(11 to 33) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.69 % + 16 μ V 0.54 % + 16 μ V 0.53 % + 19 μ V 0.61 % + 19 μ V 0.77 % + 19 μ V 1.3 % + 19 μ V	
(33 to 110) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.69 % + 40 μ V 0.54 % + 40 μ V 0.54 % + 43 μ V 0.62 % + 43 μ V 0.78 % + 43 μ V 1.3 % + 43 μ V	
(110 to 330) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.62 % + 0.10 mV 0.46 % + 0.10 mV 0.46 % + 0.11 mV 0.54 % + 0.11 mV 0.70 % + 0.11 mV 1.2 % + 0.11 mV	
(0.33 to 1.1) V	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.62 % + 0.4 mV 0.46 % + 0.40 mV 0.46 % + 0.41 mV 0.54 % + 0.41 mV 0.70 % + 0.41 mV 1.2 % + 0.41 mV	

Parameter/Range	Frequency	CMC ^{2,7,8,9} (±)	Comments
AC Voltage – Generate Wideband (cont.) (1.1 to 3.5) V	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.54 % + 0.50 mV 0.39 % + 0.50 mV 0.39 % + 0.51 mV 0.47 % + 0.51 mV 0.63 % + 0.51 mV 1.1 % + 0.51 mV	Fluke 5730A, option 03 wideband output – 50 Ω
AC Voltage – Measure Flatness with 1 kHz Reference ⁴ (70 to 220) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.081 % 0.035 % 0.043 % 0.084 % 0.14 % 0.30 %	5790A, option 03 wideband input – 50 Ω
(220 to 700) mV	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.080 % 0.028 % 0.043 % 0.084 % 0.14 % 0.30 %	
(0.7 to 2.2) V	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.080 % 0.027 % 0.043 % 0.084 % 0.14 % 0.30 %	
(2.2 to 7) V	(10 to 30) Hz 30 Hz to 500 kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.080 % 0.027 % 0.042 % 0.084 % 0.14 % 0.30 %	

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (\pm)	Comments	
AC Current – Measure ³				
(20 to 200) μ A	10 Hz to 10 kHz	0.034 % + 0.020 μ A	Fluke 8508A	
(0.2 to 2) mA	10 Hz to 10 kHz	0.031 % + 0.20 μ A		
(2 to 20) mA	10 Hz to 10 kHz	0.032 % + 2.0 μ A		
(20 to 200) mA	10 Hz to 10 kHz	0.031 % + 20 μ A		
(0.2 to 2) A	10 Hz to 2 kHz (2 to 10) kHz	0.063 % + 200 μ A 0.087 % + 200 μ A		
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.084 % + 2.0 mA 0.26 % + 2.0 mA		
AC Current – Generate				
(9 to 220) μ A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.026 % + 16 nA 0.017 % + 10 nA 0.012 % + 8.0 nA 0.032 % + 12 nA 0.12 % + 65 nA	Fluke 5730A	
(0.22 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	0.027 % + 40 nA 0.017 % + 35 nA 0.011 % + 35 nA 0.021 % + 110 nA 0.11 % + 650 nA		
(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	0.028 % + 400 nA 0.018 % + 350 nA 0.011 % + 350 nA 0.021 % + 550 nA 0.11 % + 5.0 μ A		
(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	0.028 % + 4.0 μ A 0.018 % + 3.5 μ A 0.012 % + 2.5 μ A 0.022 % + 3.5 μ A 0.11 % + 10 μ A		
(0.22 to 2) A	(10 to 850) Hz 850 Hz to 6 kHz (6 to 10) kHz	0.012 % + 40 μ A 0.041 % + 80 μ A 0.71 % + 0.16 mA		Fluke 5730A/52120A Fluke 5730A
(2 to 20) A	(10 to 850) Hz 850 Hz to 6 kHz	0.011 % + 0.4 mA 0.041 % + 0.8 mA		Fluke 5730A/52120A
(20 to 120) A	(10 to 850) Hz 850 Hz to 6 kHz	0.012 % + 2.4 mA 0.032 % + 4.8 mA		

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (±)	Comments
AC Current – Generate (cont.)			
(100 to 1000) A	(45 to 65) Hz (65 to 440) Hz	0.22 % + 70 mA 0.61 % + 70 mA	Fluke 5730A/52120A, 5500A coil
(1000 to 6000) A	(10 to 500) Hz	0.61 % + 0.65 A	Fluke 5730A/52120A, Coil 6KA
AC Power – Simulated 41.8 kilowatts			
(5 to 120) kW	60 Hz (45 to 1000) Hz	39 watts $25 + (0.0015 \cdot W)$	Fluke 5522A PF = 1
AC Voltage/Current Phase – Generate			
Voltage vs. Voltage (0 to 90)°	(10 to 65) Hz (65 to 500) Hz (0.5 to 1) kHz	0.095° 0.21° 0.40°	Fluke 5522A
Voltage vs. Current (0 to 90)°	(10 to 65) Hz (65 to 500) Hz	0.093° 0.22°	

Parameter/Equipment	Range	CMC ^{2, 7, 8, 9} (\pm)	Comments
Resistance – Generate			
Variable	(0 to 10.999) Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.999) Ω (0.33 to 1.099 999) k Ω (1.1 to 3.299 999) k Ω (3.3 to 10.999 99) k Ω (11 to 32.999 99) k Ω (33 to 109.9999) k Ω (110 to 329.9999) k Ω (0.33 to 1.099 999) M Ω (1.1 to 3.299 999) M Ω (3.3 to 10.999 99) M Ω (11 to 32.999 99) M Ω (33 to 109.9999) M Ω (110 to 329.9999) M Ω (330 to 1100) M Ω	12 $\mu\Omega/\Omega$ + 0.78 m Ω 13 $\mu\Omega/\Omega$ + 1.2 m Ω 20 $\mu\Omega/\Omega$ + 1.1 m Ω 21 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 23 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 0.16 Ω 23 $\mu\Omega/\Omega$ + 0.16 Ω 25 $\mu\Omega/\Omega$ + 1.6 Ω 26 $\mu\Omega/\Omega$ + 1.6 Ω 46 $\mu\Omega/\Omega$ + 24 Ω 0.011 % + 39 Ω 0.018 % + 1.9 k Ω 0.040 % + 2.3 k Ω 0.23 % + 78 k Ω 0.69 % + 0.39 M Ω	Fluke 5522A
Fixed Points	1 m Ω 10 m Ω 100 m Ω 1 Ω 1.9 Ω 10 Ω / 19 Ω 100 Ω / 190 Ω 1 k Ω / 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 1 G Ω 10 G Ω 100 G Ω 1T Ω	0.042 % 59 $\mu\Omega/\Omega$ 43 $\mu\Omega/\Omega$ 97 $\mu\Omega/\Omega$ 96 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 6.8 $\mu\Omega/\Omega$ 6.8 $\mu\Omega/\Omega$ 6.9 $\mu\Omega/\Omega$ 8.8 $\mu\Omega/\Omega$ 9.0 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 42 $\mu\Omega/\Omega$ 50 $\mu\Omega/\Omega$ 0.011 % 0.81 % 1.0 % 3.1 % 5.4 %	Guildline 9211A shunt Fluke 5730A IET VRS-100-10-1K- ROT

Parameter/Equipment	Range	CMC ^{2, 7, 8, 9} (±)	Comments
Resistance – Measure			
Variable	(0.2 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	19 μΩ/Ω + 4.0 μΩ 10 μΩ/Ω + 14 μΩ 8.4 μΩ/Ω + 50 μΩ 8.2 μΩ/Ω + 0.5 mΩ 8.2 μΩ/Ω + 5.0 mΩ 8.4 μΩ/Ω + 50 mΩ 9.9 μΩ/Ω + 1.0 Ω 21 μΩ/Ω + 10Ω 68 μΩ/Ω + 1.0 kΩ 0.019 % + 0.1 MΩ 0.16 % + 10 MΩ	Fluke 8508A
Fixed Points	0.00033 Ω 0.001 Ω 0.01 Ω 0.1 Ω 1 kΩ 10 kΩ 100 kΩ	0.057 % 0.054 % 0.067 % 43 μΩ/Ω 3.9 μΩ/Ω 1.3 μΩ/Ω 3.9 μΩ/Ω	Fluke 8508A/Guildline 9211A shunt Fluke 8508A/ ESI SR-104

Parameter/Range	Frequency	CMC ^{2, 7, 8, 9} (±)	Comments
Capacitance – Generate			
(0.19 to 0.3999) nF (0.4 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.999) nF (11 to 32.999) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.0999) μF (1.1 to 3.2999) μF (3.3 to 10.9999) μF (11 to 32.9999) μF (33 to 109.999) μF (110 to 329.999) μF (0.33 to 1.099 99) mF (1.1 to 3.2999) mF (3.3 to 10.9999) mF (11 to 32.999) mF (33 to 110) mF	(0.01 to 10) kHz (0.01 to 10) kHz (0.01 to 3) kHz (0.01 to 1) kHz (0.01 to 1) kHz (0.01 to 1) kHz (0.01 to 1) kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	0.42 % + 7.8 pF 0.18 % + 7.8 pF 0.33 % + 7.8 pF 0.18 % + 7.8 pF 0.13 % + 78 pF 0.18 % + 78 pF 0.18% + 0.24 nF 0.18 % + 0.78 nF 0.18 % + 2.4 nF 0.19 % + 7.8 nF 0.30 % + 24 nF 0.35 % + 78 nF 0.35 % + 0.24 μF 0.35 % + 0.78 μF 0.33 % + 2.4 μF 0.34 % + 7.8 μF 0.57 % + 24 μF 0.84 % + 78 μF	Fluke 5522A

Parameter/Range	Frequency	CMC ^{2, 7, 8} (±)	Comments	
Capacitance – Generate (cont.)				
Fixed Points				
1 pF	1 kHz to 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.017 % 0.027 % 0.044 % 0.065 % 0.089 % 0.25 % 0.37 %	Agilent 16380A capacitor set	
10 pF	1 kHz to 1 MHz 2 MHz / 3 MHz 4 MHz / 5MHz 10 MHz 13 MHz	0.011 % 0.011 % 0.012 % 0.016 % 0.019 %		
100 pF	1 kHz to 1 MHz 2 MHz / 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.011 % 0.012 % 0.014 % 0.017 % 0.035 % 0.050 %		
1000 pF	1 kHz to 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.012 % 0.015 % 0.030 % 0.046 % 0.063 % 0.19 % 0.28 %		
0.01 μF	(100 / 120) Hz (1 / 10 / 100) kHz	0.014 % 0.014 %		Agilent 16380C capacitor set
0.1 μF	(100 / 120) Hz / 1 kHz (1 / 10 / 100) kHz	0.014 % 0.014 %		
1 μF	(100 / 120) Hz (1 / 10) kHz 100 kHz	0.014 % 0.014 % 0.015 %		
10 μF	(100 / 120) Hz / 1 kHz 10 kHz 100 kHz	0.014 % 0.021 % 0.70 %		

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,7,8} (±)	Comments
<p>Amplitude Modulation – Measure</p> <p>Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %</p> <p>Rate: 50 Hz to 100 kHz Depths: 5 % to 20 % Depths: 20 % to 99 %</p> <p>Rate: 50 Hz to 100 kHz Depths: 5 % to 20 % Depths: 20 % to 99 %</p>	<p>100 kHz to 10 MHz</p> <p>10 MHz to 3 GHz</p> <p>(3 to 26.5) GHz</p>	<p>0.75 %</p> <p>2.5 % 0.50 %</p> <p>4.5 % 1.5 %</p>	<p>Keysight E4440 series opt 233</p>
<p>Frequency Modulation – Measure</p> <p>Rate: 20 Hz to 10 kHz Dev.: (0.2 to 40) kHz peak</p> <p>Rate: 50 Hz to 200 kHz Dev.: (0.25 to 400) kHz peak</p> <p>Rate: 50 Hz to 200 kHz Dev.: (0.25 to 400) kHz peak</p>	<p>250 kHz to 10 MHz</p> <p>10 MHz to 6.6 GHz</p> <p>(6.6 to 13.2) GHz</p>	<p>$\beta > 0.20$ 1.5 % $\beta > 1.2$ 1.0 %</p> <p>$\beta > 0.20$ 1.5 % $\beta > 0.45$ 1.0 %</p> <p>$\beta > 0.20$ 2.5 % $\beta > 8.0$ 1.0 %</p>	<p>Keysight E4440 series opt 233</p> <p>$\beta = \text{deviation} \div \text{rate}$</p>
<p>Phase Modulation – Measure</p> <p>Rate: 100 Hz to 100 kHz Dev.: (0.3 to 0.7) Radians peak</p> <p>Dev.: (0.7 to 100) Radians peak</p>	<p>100 kHz to 6.6 GHz</p>	<p>3.0 %</p> <p>1.0 %</p>	<p>Keysight E4440 series option 233</p>
<p>Sine Distortion – Measure</p> <p>(-80 to 0) dB</p>	<p>20 Hz to 250 kHz</p>	<p>1.0 dB</p>	<p>Keysight E4440 series option 233</p>

Parameter/Range	Frequency	CMC ^{2,7,8} (\pm)	Comments
RF Power – Generate			
(-36 to 23.98) dBm	1 Hz to 10 MHz (10 to 50) MHz	0.20 dB 0.30 dB	Keysight 33250A
(10 to 14) dBm (10 to 18) dBm (10 to 19) dBm (10 to 17) dBm (10 to 13) dBm	(15 to 60) MHz (60 to 400) MHz (0.4 to 3.2) GHz (3.2 to 15) GHz (15 to 30) GHz	0.70 dB 0.92 dB 0.92 dB 0.92 dB 1.2 dB	Keysight E8257D
(0 to 10) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 30) GHz	0.69 dB 0.92 dB 1.0 dB	
(0 to 9) dBm (0 to 8) dBm	(30 to 65) GHz (65 to 67) GHz	1.2 dB 1.5 dB	
(-10 to 0) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 65) GHz (65 to 67) GHz	0.69 dB 0.92 dB 1.1 dB 1.2 dB	
(-70 to -10) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.81 dB 1.1 dB 1.2 dB 1.7 dB	
Level Sine – Generate			
5 V p-p 5 V p-p 3 V p-p 3 V p-p 2 V p-p	1 kHz to 300 MHz (300 to 550) MHz 500 MHz to 1.1 GHz (1.1 to 2.5) GHz (2.5 to 3.2) GHz	2.0 % 2.3 % 3.0 % 3.4 % 3.4 %	Fluke 9500B and 9530 active head – 50 Ω
Phase Noise – Measurement			
1 Hz to 1 MHz Offset (1 to 100) MHz Offset	50 kHz to 26.5 GHz 50 kHz to 26.5 GHz	2.3 dB 4.4 dB	Keysight E5505A

Parameter/Range	Frequency	CMC ^{2,7,8} (±)	Comments
RF Attenuation – Generate			
1 dB	50 MHz	0.0024 dB	Keysight 8494 series
2 dB		0.0024 dB	
3 dB		0.0024 dB	
4 dB		0.0025 dB	
5 dB		0.0025 dB	
6 dB		0.0025 dB	
7 dB		0.0025 dB	
8 dB		0.0025 dB	
9 dB		0.0025 dB	
10 dB		0.0025 dB	
11 dB		0.0025 dB	
10 dB	50 MHz	0.0036 dB	Keysight 8496 series
20 dB		0.0040 dB	
30 dB		0.0070 dB	
40 dB		0.0070 dB	
50 dB		0.0090 dB	
60 dB		0.010 dB	
70 dB		0.015 dB	
80 dB		0.018 dB	
90 dB		0.021 dB	
100 dB		0.030 dB	
110 dB		0.037 dB	
10 dB	1 MHz	0.0037 dB	Keysight 8496 series
20 dB		0.0041 dB	
30 dB		0.0071 dB	
40 dB		0.0071 dB	
50 dB		0.0091 dB	
60 dB		0.010 dB	
70 dB		0.015 dB	
80 dB		0.018 dB	
90 dB		0.021 dB	
100 dB		0.030 dB	
110 dB		0.037 dB	



Parameter/Range	Frequency	CMC ^{2,7,8} (±)	Comments
Transmission S12/S21 – Measure			
50 Ω Type N			
(0 to 20) dB	9 kHz to 3 GHz	Mag (0.029 to 0.061) dB	Keysight E5071C/85032F, Type N connectors
(20 to 40) dB		Phase (0.19 to 0.44)°	
(40 to 50) dB		Mag (0.049 to 0.39) dB Phase (0.32 to 2.6)°	
(0 to 20) dB	(2 to 18) GHz	Mag (0.095 to 1.2) dB	Keysight N5245A/85054B, Type N connectors
(20 to 40) dB		Phase (0.63 to 8.2)°	
(40 to 50) dB		Mag (0.076 to 0.091) dB Phase (0.50 to 0.61)° Mag (0.091 to 0.12) dB Phase (0.39 to 5.4)° Mag (0.12 to 0.18) dB Phase (0.79 to 1.2)°	
50 Ω with 3.5 mm Connectors			
(0 to 20) dB	10 MHz to 26.5 GHz	Mag (0.031 to 0.11) dB	Keysight N5245A/85052B, 3.5 mm connectors
(20 to 40) dB		Phase (0.21 to 0.72)°	
(40 to 50) dB		Mag (0.059 to 0.78) dB Phase (0.39 to 5.4)° Mag (0.11 to 2.5) dB Phase (0.75 to 19)°	
50 Ω with 2.4 mm Connectors			
(0 to 20) dB	10 MHz to 50 GHz	Mag (0.032 to 0.19) dB	Keysight N5245A/85056A, 2.4 mm connectors
(20 to 40) dB		Phase (0.21 to 1.3)°	
(40 to 50) dB		Mag (0.062 to 0.78) dB Phase (0.40 to 5.4)° Mag (0.11 to 2.5) dB Phase (0.75 to 19)°	

Parameter/Equipment	Frequency	CMC ^{2,8} (±)	Comments
Reflection S11/S22 – Measure			
50 Ω with Type N			
(0.0001 to 0.25) lin	9 kHz to 3 GHz	Lin Mag (0.0036 to 0.0052) Phase (0.87 to 180)°	Keysight E5071C/85032F, Type N connectors
(0.25 to 0.5) lin		Lin Mag (0.0038 to 0.0061) Phase (0.53 to 1.2)°	
(0.5 to 0.75) lin		Lin Mag (0.0047 to 0.0082) Phase (0.51 to 0.69)°	
(0.75 to 1) lin		Lin Mag (0.0067 to 0.012) Phase (0.51 to 0.68)°	
(0.0001 to 0.25) lin	(2 to 18) GHz	Lin Mag (0.0040 to 0.0083) Phase (0.97 to 180)°	Keysight N5245A/85054B, Type N connectors
(0.25 to 0.5) lin		Lin Mag (0.0042 to 0.0061) Phase (0.54 to 1.9)°	
(0.5 to 0.75) lin		Lin Mag (0.0047 to 0.010) Phase (0.44 to 1.2)°	
(0.75 to 1) lin		Lin Mag (0.0047 to 0.016) Phase (0.44 to 1.5)°	
50 Ω with 3.5 mm Connectors			
(0.0001 to 0.25) lin	10 MHz to 26.5 GHz	Lin Mag (0.0040 to 0.0068) Phase (0.96 to 180)°	Keysight N5245A/85052D, 3.5 mm connectors
(0.25 to 0.5) lin		Lin Mag (0.0042 to 0.0098) Phase (0.58 to 1.6)°	
(0.5 to 0.75) lin		Lin Mag (0.0051 to 0.017) Phase (0.55 to 1.3)°	
(0.75 to 1) lin		Lin Mag (0.0075 to 0.029) Phase (0.55 to 1.7)°	
50 Ω with 2.4 mm Connectors			
(0.0001 to 0.25) lin	10 MHz to 50 GHz	Lin Mag (0.0080 to 0.016) Phase (1.9 to 180)°	Keysight N5245A/85056A, 2.4 mm connectors
(0.25 to 0.5) lin		Lin Mag (0.0081 to 0.018) Phase (0.98 to 3.7)°	
(0.5 to 0.75) lin		Lin Mag (0.0085 to 0.021) Phase (0.74 to 1.7)°	
(0.75 to 1) lin		Lin Mag (0.0093 to 0.033) Phase (0.69 to 2.0)°	

Parameter/Equipment	Frequency	CMC ^{2, 7, 8} (±)	Comments
Absolute RF Power – Measure			
1 mW	50 MHz	3.1 µW	Keysight 432A/478A/Fluke 8508A
(20 to 30) dBm	9 kHz to 7 GHz (7 to 18) GHz (18 to 24) GHz	3.3 % 3.4 % 3.6 %	Keysight EPM power meter / E9300 Series power sensors
(10 to 20) dBm	(9 to 100) kHz (100 to 300) kHz 300 kHz to 7 GHz (7 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 34) GHz (34 to 38) GHz (38 to 43) GHz (43 to 48) GHz (48 to 50) GHz (50 to 70) GHz	2.4 % 1.5 % 1.4 % 1.6 % 2.0 % 2.2 % 2.3 % 2.5 % 2.9 % 3.0 % 3.3 % 4.0 %	Keysight EPM power meter / 8480/N8480 and E9300 series power sensors
(0 to 10) dBm	(9 to 100) kHz (100 to 300) kHz 300 kHz to 10 MHz 10 MHz to 8 GHz (8 to 16) GHz (16 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 38) GHz (38 to 43) GHz (43 to 48) GHz (48 to 49) GHz (49 to 50) GHz (50 to 70) GHz	2.4 % 1.4 % 1.3 % 1.2 % 1.3 % 1.5 % 1.9 % 2.1 % 2.4 % 2.8 % 2.9 % 3.0 % 3.3 % 3.9 %	
(-10 to 0) dBm	(9 to 100) kHz (100 to 300) kHz 300 kHz to 14 GHz (14 to 16) GHz (16 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 38) GHz (38 to 43) GHz	2.9 % 1.4 % 1.2 % 1.3 % 1.5 % 1.9 % 2.1 % 2.4 % 2.8 %	

Parameter/Equipment	Frequency	CMC ^{2, 7, 8} (±)	Comments
Absolute RF Power – Measure (cont.)			
(-10 to 0) dBm	(43 to 48) GHz	2.9 %	Keysight EPM power meter / 8480/N8480 and E9300 series power sensors
	(48 to 49) GHz	3.0 %	
	(49 to 50) GHz	3.3 %	
	(50 to 70) GHz	3.9 %	
(-20 to -10) dBm	(9 to 100) kHz	3.3 %	
	(100 to 300) kHz	1.3 %	
	300 kHz to 6 GHz	1.2 %	
	(6 to 15) GHz	1.3 %	
	(15 to 18) GHz	1.5 %	
	(18 to 26) GHz	1.8 %	
	(26 to 33) GHz	2.0 %	
	(33 to 35) GHz	2.3 %	
	(35 to 38) GHz	2.4 %	
	(38 to 40) GHz	2.7 %	
	(40 to 43) GHz	2.8 %	
	(43 to 48) GHz	2.9 %	
	(48 to 49) GHz	3.0 %	
(49 to 50) GHz	3.3 %		
(50 to 70) GHz	3.9 %		
(-30 to -20) dBm	9 kHz to 5 GHz	1.6 %	
	(5 to 15) GHz	1.7 %	
	(15 to 18) GHz	1.8 %	
	(18 to 26) GHz	2.5 %	
	(26 to 33) GHz	2.7 %	
	(33 to 35) GHz	2.9 %	
	(35 to 38) GHz	3.0 %	
	(38 to 40) GHz	3.2 %	
	(40 to 43) GHz	3.3 %	
	(43 to 48) GHz	3.4 %	
(48 to 49) GHz	3.5 %		
(49 to 50) GHz	3.7 %		
(-40 to -30) dBm	9 kHz to 10 MHz	3.3 %	
	(10 to 300) MHz	1.6 %	
	300 MHz to 15 GHz	1.7 %	
	(15 to 17) GHz	1.8 %	
	(17 to 18) GHz	1.9 %	
	(18 to 26) GHz	2.2 %	
	(26 to 31) GHz	2.4 %	
	(31 to 34) GHz	2.5 %	
	(34 to 38) GHz	2.7 %	
	(38 to 40) GHz	2.9 %	



Parameter/Equipment	Frequency	CMC ^{2, 7, 8} (±)	Comments		
Absolute RF Power – Measure (cont.)	(-40 to -30) dBm	(40 to 49) GHz (49 to 50) GHz	3.0 % 3.2 %	Keysight EPM power meter / 8480/N8480 and E9300 series power sensors	
	(-50 to -40) dBm	(9 to 100) kHz	4.6 %		Keysight EPM power meter / 8480/N8480 and E9300 series power sensors / E4440 series spectrum analyzer
		100 kHz to 5 MHz	3.3 %		
		5 MHz to 3 GHz	1.7 %		
(3 to 8) GHz		2.4 %			
(8 to 16) GHz		2.5 %			
(16 to 18) GHz		2.6 %			
(18 to 26) GHz		2.8 %			
(26 to 33) GHz		2.9 %			
(33 to 34) GHz		3.0 %			
(34 to 38) GHz		3.2 %			
(38 to 44) GHz		3.5 %			
(44 to 48) GHz		3.6 %			
(48 to 49) GHz		3.7 %			
(49 to 50) GHz	3.8 %				
(-60 to -50) dBm	100 kHz to 10 MHz	3.3 %			
	10 MHz to 3 GHz	1.7 %			
	(3 to 7) GHz	2.6 %			
	(7 to 18) GHz	2.7 %			
	(18 to 26) GHz	3.0 %			
	(26 to 33) GHz	3.1 %			
	(33 to 38) GHz	3.3 %			
	(38 to 43) GHz	3.6 %			
	(43 to 48) GHz	3.7 %			
	(48 to 49) GHz	3.8 %			
(49 to 50) GHz	4.0 %				
(-70 to -60) dBm	100 kHz to 10 MHz	3.4 %			
	10 MHz to 3 GHz	1.9 %			
	(3 to 6) GHz	2.7 %			
	(6 to 16) GHz	2.9 %			
	(16 to 18) GHz	3.0 %			
	(18 to 26) GHz	3.2 %			
	(26 to 33) GHz	3.3 %			
	(33 to 34) GHz	3.4 %			
	(34 to 38) GHz	3.5 %			
	(38 to 43) GHz	3.8 %			
	(43 to 48) GHz	3.9 %			
	(48 to 49) GHz	4.0 %			
(49 to 50) GHz	4.1 %				



Parameter/Equipment	Frequency	CMC ^{2, 7, 8} (±)	Comments
Absolute RF Power – Measure (cont.)			
(-80 to -70) dBm	100 kHz to 10 MHz	3.5 %	Keysight EPM power meter / 8480/N8480 and E9300 Series power sensors / E4440 series spectrum analyzer
	10 MHz to 3 GHz	2.0 %	
	(3 to 6) GHz	2.9 %	
	(6 to 18) GHz	3.2 %	
	(18 to 26) GHz	3.4 %	
	(26 to 33) GHz	3.5 %	
	(33 to 34) GHz	3.6 %	
	(34 to 38) GHz	3.7 %	
	(38 to 43) GHz	4.0 %	
	(43 to 48) GHz	4.1 %	
(-90 to -80) dBm	100 kHz to 10 MHz	3.6 %	
	10 MHz to 3 GHz	2.2 %	
	(3 to 6) GHz	3.1 %	
	(6 to 15) GHz	3.4 %	
	(15 to 18) GHz	3.5 %	
	(18 to 28) GHz	3.7 %	
	(28 to 34) GHz	3.8 %	
	(34 to 35) GHz	3.9 %	
	(35 to 38) GHz	4.0 %	
	(38 to 43) GHz	4.2 %	
(-100 to -90) dBm	100 kHz to 10 MHz	3.7 %	
	10 MHz to 3 GHz	2.4 %	
	(3 to 6) GHz	3.3 %	
	(6 to 16) GHz	3.7 %	
	(16 to 18) GHz	3.8 %	
(-110 to -100) dBm	100 kHz to 10 MHz	3.8 %	
	10 MHz to 3 GHz	2.6 %	
	(3 to 6) GHz	3.6 %	
	(6 to 16) GHz	4.0 %	
	(16 to 18) GHz	4.1 %	
(-120 to -110) dBm	100 kHz to 10 MHz	4.0 %	
	10 MHz to 3 GHz	2.8 %	
	(3 to 6) GHz	3.9 %	

Parameter/Equipment	Frequency	CMC ^{2, 7, 8} (±)	Comments
Absolute RF Power – Measure (cont.) (-127 to -120) dBm	100 kHz to 10 MHz 10 MHz to 3 GHz (3 to 6) GHz	4.1 % 3.0 % 4.2 %	Keysight EPM power meter / 8480/N8480 and E9300 series power sensors / E4440 series spectrum analyzer
Relative RF Peak Power Comparison – (-15 to 15) dBm	1 MHz to 26.5 GHz (26.5 to 50) GHz	0.024 dB 0.040 dB	Keysight 86100A/83484A
RF Power Sensor Calibration Factors	(9 to 300) kHz 300 kHz to 100 MHz 100 MHz to 5 GHz (5 to 15) GHz (15 to 18) GHz (18 to 26.5) GHz (26.5 to 34) GHz (34 to 38) GHz (38 to 43) GHz (43 to 48) GHz (48 to 49) GHz (49 to 50) GHz	1.0 % 0.80 % 0.90 % 1.0 % 1.2 % 1.7 % 2.0 % 2.3 % 2.7 % 2.8 % 2.9 % 3.2 %	Keysight EPM power meter / 8480/N8480 series H84/E9304A power sensors 11667 series splitters

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Network Analyzer Dynamic Accuracy (-60 to 5) dBm Reference -20 dBm	(-19 to 5) dBm (-21 to -60) dBm	0.020% + 0.0034% /dB step up from reference 0.020% + 0.0034% /dB step down from reference	Keysight E8257D/EPM power Meter/8480/N8480 series sensor and U3020AD01 test set

Parameter/Equipment	Range	CMC ^{2,6,8} (±)	Comments
Pulse and Pulse Modulation – Measure ⁵			
Rise/Fall	10 % to 90 % Pulse or Pulse Envelope	0.14 % + 9.0 ps	Keysight 86100A, 83484A
Width/Time Interval	(0.1 to 1) ns	0.18 % + 9.0 ps	
	1 to 100 μs	0.12 % + 9.0 ps	
Digital Modulation – Measure			Keysight 89441A
Carrier: 2 MHz to 50 GHz			
Error Vector Magnitude for Modulation Types: MSK, GMSK, BPSK, DQPSK, n/4DQPSK, 8PSK, 16QAM and 32QAM and QPSK	Mod Frequency Span 1 Hz to 100 kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz	0.37 % rms 0.59 % rms 1.2 % rms	
Phase Error for Modulation Types: MSK, GMSK, BPSK, DQPSK, n/4DQPSK, 8PSK, 16QAM and 32QAM & QPSK	Mod Frequency Span 1 Hz to 100 kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz	0.20° rms 0.40° rms 0.66° rms	
Error Vector Magnitude for FSK Modulation	Mod Frequency: 3.2 kHz 1.152 MHz	0.59 % rms 1.8 % rms	

III. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Frequency – Measuring Equipment	10 Hz to 15 MHz	2.7 pHz/Hz	Keysight 33120A phase locked to Fluke 910
	250 kHz to 67 GHz	2.7 pHz/Hz	Keysight E8257D phase locked to Fluke 910

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
Frequency – Measure	10 Hz to 12.4 GHz	120 pHz/Hz	Fluke 910, Agilent 53132A phase locked
	(12.4 to 26.5) GHz	1.6 Hz	Keysight 53151A phase locked
	(26.5 to 46) GHz	2.0 Hz	Keysight 53152A phase locked

¹ This laboratory offers commercial 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. Calibration and Measurement Capabilities 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 Based on using the Fluke 8508A at the temperature (TCal) it was calibrated ± 5 °C, 4 Hr. warm up, maximum resolution and an input zero or offset null performed if temp moves more than ± 1 °C from temperature at which previous input zero or null was performed. Calibration and Measurement Capability is based upon 1-year specifications and is read as parts in 10^6 or percent of reading plus parts in 10^6 or percent of range. TCal = 23 °C +/- 5 °C (73.4 °F \pm 9 °F).

⁴ Based on using the Fluke 5790A at the temperature (TCal) it was calibrated ± 5 °C with 30 minutes warm up. Calibration and Measurement Capability is based upon 1-year specifications and is read as parts in 10^6 or percent of reading plus fixed amount. TCal = 23 °C +/- 5 °C (73.4 °F \pm 9 °F).

⁵ Transition time characteristic calculated from $T = 0.35 / \text{Bandwidth}$ (26.5 GHz).

⁶ "rms" refers to root mean square.

⁷ In a statement of Calibration and Measurement Capability, percentage refers to percent of reading, unless otherwise noted.

⁸ The contributions from the "best existing device" are not included in the CMC claim.

⁹ The measurands stated are generated using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure the measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.



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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/NCSL Z540-1-1994 and the requirements of ANSI/NCSL Z540.3-2006 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).



Presented this 23rd day of April 2018.

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

President and CEO
For the Accreditation Council
Certificate Number 2681.01
Valid to April 30, 2020

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