



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: May 31, 2012

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 calibrations<sup>1</sup>:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2, 3, 8</sup> (±)	Comments
DC Voltage – Measure	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1000) V	5 µV/V + 0.1 µV 3.5 µV/V + 0.4 µV 3.5 µV/V + 4 µV 5.5 µV/V + 40 µV 5.5 µV/V + 500 µV	Fluke 8508A
DC Voltage – Generate			
Fixed Points	0.1 V 1 V 10 V 100 V 1000 V	3.5 µV/V 3.5 µV/V 3.5 µV/V 3.5 µV/V 3.5 µV/V	Fluke 732 DC/Fluke 752A/Fluke 8508A
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	7.5 µV/V + 0.4 µV 5 µV/V + 0.7 µV 3.5 µV/V + 2.5 µV 3.5 µV/V + 4 µV 5 µV/V + 40 µV 6.5 µV/V + 400 µV	Fluke 5720A

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
DC Current – Generate	(0 to 220) $\mu$ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A (11 to 20) A (20 to 149.9) A (150 to 550) A (550 to 1025) A	50 $\mu$ A/A + 8 nA 50 $\mu$ A/A + 8 nA 50 $\mu$ A/A + 80 nA 60 $\mu$ A/A + 0.8 $\mu$ A 80 $\mu$ A/A + 25 $\mu$ A 0.036 % + 480 $\mu$ A 0.078 % + 29 mA 0.030 % + 1.6 mA 0.039 % + 19 mA 0.078 % + 29 mA	Fluke 5720A /5725A  Fluke 5520A Fluke 5520A/5500A coil
DC Current – Measure	10 $\mu$ A 100 $\mu$ A 1 mA 10 mA 100 mA 1 A 10 A 100 A 300 A	11 $\mu$ A/A 6.4 $\mu$ A/A 3.2 $\mu$ A/A 3.4 $\mu$ A/A 3.4 $\mu$ A/A 3.7 $\mu$ A/A 7.6 $\mu$ A/A 21 $\mu$ A/A 43 $\mu$ A/A	Fluke 8508A/Guidline 9211A shunt
AC Voltage – Measure <sup>4</sup>			
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	0.17 % + 1.3 $\mu$ V 0.07 % + 1.3 $\mu$ V 0.042 % + 1.3 $\mu$ V 0.081 % + 2 $\mu$ V 0.12 % + 2.5 $\mu$ V 0.23 % + 4 $\mu$ V 0.24 % + 8 $\mu$ V 0.35 % + 8 $\mu$ V	Fluke 5790A
7 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	0.085 % + 1.3 $\mu$ V 0.037 % + 1.3 $\mu$ V 0.021 % + 1.3 $\mu$ V 0.04 % + 2 $\mu$ V 0.06 % + 2.5 $\mu$ V 0.12 % + 4 $\mu$ V 0.13 % + 8 $\mu$ V 0.23 % + 8 $\mu$ V	
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	0.029 % + 1.3 $\mu$ V 0.019 % + 1.3 $\mu$ V 0.011 % + 1.3 $\mu$ V 0.021 % + 2 $\mu$ V 0.031 % + 2.5 $\mu$ V 0.081 % + 4 $\mu$ V 0.089 % + 8 $\mu$ V 0.17 % + 8 $\mu$ V	

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
AC Voltage – Measure <sup>4</sup> (cont)			
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	0.024 % + 1.5 μV 0.012 % + 1.5 μV 65 μV/V + 1.5 μV 0.013 % + 2 μV 0.026 % + 2.5 μV 0.051 % + 4 μV 0.067 % + 8 μV 0.11 % + 8 μV	Fluke 5790A
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	0.021 % + 1.5 μV 85 μV/V + 1.5 μV 38 μV/V + 1.5 μV 69 μV/V + 2 μV 0.016 % + 2.5 μV 0.025 % + 4 μV 0.038 % + 8 μV 0.1 % + 8 μV	
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	0.021 % + 1.5 μV 76 μV/V + 1.5 μV 33 μV/V + 1.5 μV 51 μV/V + 2 μV 79 μV/V + 2.5 μV 0.018 % + 4 μV 0.03 % + 8 μV 0.096 % + 8 μV	
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	0.02 % 66 μV/V 24 μV/V 46 μV/V 71 μV/V 0.016 % 0.026 % 0.09 %	
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	0.02 % 67 μV/V 24 μV/V 48 μV/V 81 μV/V 0.019 % 0.04 % 0.12 %	

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
AC Voltage – Measure <sup>4</sup> (cont)			
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	0.02 % 67 μV/V 27 μV/V 48 μV/V 81 μV/V 0.019 % 0.04 % 0.12 %	Fluke 5790A
70 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 68 μV/V 32 μV/V 57 μV/V 94 μV/V	
220 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 68 μV/V 31 μV/V 69 μV/V 98 μV/V	
700 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 99 μV/V 41 μV/V 0.013 % 0.05 %	
1000 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 99 μV/V 38 μV/V 0.013 % 0.05 %	
AC Voltage – Generate			
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	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 5 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 20 μV	Fluke 5720A

Parameter/Equipment	Range	CMC <sup>2, 8</sup> (±)	Comments
AC Voltage – Generate (cont)			
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	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 5 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 20 μV	Fluke 5720A
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	0.024 % + 12 μV 90 μV/V + 7 μV 80 μV/V + 7 μV 0.02 % + 7 μV 0.046 % + 17 μV 0.09 % + 20 μV 0.14 % + 25 μV 0.27 % + 45 μV	
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	0.024 % + 40 μV 90 μV/V + 15 μV 45 μV/V + 8 μV 75 μV/V + 10 μV 0.011 % + 30 μV 0.042 % + 80 μV 0.1 % + 0.2 mV 0.17 % + 0.3 mV	
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	0.024 % + 0.4 mV 90 μV/V + 0.15 mV 45 μV/V + 50 μV 75 μV/V + 0.1 mV 0.01 % + 0.2 mV 0.028 % + 0.6 mV 0.1 % + 2 mV 0.15 % + 3.2 mV	
220 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.024 % + 4 mV 90 μV/V + 1.5 mV 52 μV/V + 0.6 mV 80 μV/V + 1 mV 0.015 % + 2.5 mV	
1100 V	50 Hz to 1 kHz	70 μV/V + 3.5 mV	

Parameter/Equipment	Range	CMC <sup>2, 8</sup> (±)	Comments
AC Voltage – Measure Wideband <sup>1</sup>			
2.2 mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.6 % + 1.5 μV 0.6 % + 1.5 μV 0.6 % + 1.5 μV 0.6 % + 1.5 μV 0.67 % + 2.5 μV 0.77 % + 2.5 μV 0.9 % + 2.5 μV 1.3 % + 3.5 μV	5790A/option 03 wideband input – 50 Ω
7 mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.5 % + 7 μV 0.5 % + 7 μV 0.5 % + 7 μV 0.5 % + 7 μV 0.57 % + 8 μV 0.6 % + 8 μV 0.67 % + 8 μV 0.87 % + 8 μV	
22 mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.5 % + 13 μV 0.5 % + 13 μV 0.5 % + 13 μV 0.5 % + 13 μV 0.57 % + 13 μV 0.6 % + 13 μV 0.67 % + 13 μV 0.87 % + 13 μV	
70 mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.5 % + 30 μV 0.5 % + 30 μV 0.5 % + 30 μV 0.5 % + 30 μV 0.55 % + 30 μV 0.6 % + 30 μV 0.65 % + 30 μV 0.85 % + 30 μV	
220 mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.4 % + 80 μV 0.4 % + 80 μV 0.4 % + 80 μV 0.4 % + 80 μV 0.45 % + 80 μV 0.5 % + 80 μV 0.55 % + 80 μV 0.75 % + 80 μV	

Parameter/Equipment	Range	CMC <sup>2, 8</sup> (±)	Comments
AC Voltage – Measure Wideband <sup>3</sup> (cont)			
700 mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.4 % + 0.3 mV 0.4 % + 0.3 mV 0.4 % + 0.3 mV 0.4 % + 0.3 mV 0.45 % + 0.3 mV 0.5 % + 0.3 mV 0.55 % + 0.3 mV 0.75 % + 0.3 mV	5790A/Option 03 wideband input – 50 Ω
2.2 V	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.35 % + 0.4 mV 0.35 % + 0.4 mV 0.35 % + 0.4 mV 0.35 % + 0.4 mV 0.4 % + 0.4 mV 0.45 % + 0.4 mV 0.5 % + 0.4 mV 0.7 % + 0.4 mV	
7 V	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (120 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.35 % + 0.8 mV 0.35 % + 0.8 mV 0.35 % + 0.8 mV 0.35 % + 0.8 mV 0.4 % + 0.8 mV 0.45 % + 0.8 mV 0.5 % + 0.8 mV 0.7 % + 0.8 mV	
AC Voltage – Generate Wideband			
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	1 % + 8 μV 0.7 % + 8 μV 0.8 % + 11 μV 0.9 % + 11 μV 1.1 % + 11 μV 1.7 % + 11 μV	Fluke 5720A option 03 wideband output – 50 Ω
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	0.9 % + 13 μV 0.6 % + 13 μV 0.7 % + 16 μV 0.8 % + 16 μV 1 % + 16 μV 1.6 % + 16 μV	

Parameter/Equipment	Range	CMC <sup>2, 8</sup> (±)	Comments
AC Voltage – Generate Wideband (cont)			
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	0.9 % + 40 μV 0.6 % + 40 μV 0.7 % + 43 μV 0.8 % + 43 μV 1 % + 43 μV 1.6 % + 43 μV	Fluke 5720A option 03 wideband output – 50 Ω
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	0.8 % + 0.1 mV 0.5 % + 0.1 mV 0.6 % + 0.11 mV 0.7 % + 0.11 mV 0.9 % + 0.11 mV 1.5 % + 0.11 mV	
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	0.8 % + 0.4 mV 0.5 % + 0.4 mV 0.6 % + 0.41 mV 0.7 % + 0.41 mV 0.9 % + 0.41 mV 1.5 % + 0.41 mV	
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	0.7 % + 0.5 mV 0.4 % + 0.5 mV 0.5 % + 0.51 mV 0.6 % + 0.51 mV 0.8 % + 0.51 mV 1.4 % + 0.51 mV	
AC Current – Generate			
220 μA 2.2 mA 22 mA 220 mA 2.2 A 11 A	40 Hz to 1 kHz 40 Hz to 1 kHz 40 Hz to 1 kHz 40 Hz to 1 kHz 20 Hz to 1 kHz 40 Hz to 1 kHz	0.012 % + 8 nA 0.012 % + 35 nA 0.012 % + 0.35 μA 0.012 % + 2.5 μA 0.026 % + 35 μA 0.046 % + 170 μA	Fluke 5720A/5725A
20 A	(45 to 100) Hz 100 Hz to 1 kHz	0.093 % + 4 mA 0.12 % + 4 mA	Fluke 5520A
149.9A	(45 to 65) Hz (65 to 100) Hz (100 to 440) Hz	0.37 % + 33 mA 0.88 % + 35 mA 1.0 % + 66 mA	Fluke 5520A/5500A coil
1025A	(45 to 65) Hz (65 to 100) Hz (100 to 440) Hz	0.37 % + 0.17 A 0.88 % + 0.18 A 1.6 % + 0.3 A	

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
AC Current – Measure  200 µA 2 mA 20 mA 200 mA 2 A 2 A 20 A 20 A	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 2 kHz (2 to 10) kHz 10 Hz to 2 kHz (2 to 10) kHz	0.031 % + 0.02 µA 0.03 % + 0.2 µA 0.03 % + 2 µA 0.03 % + 20 µA 0.062 % + 200 µA 0.072 % + 200 µA 0.082 % + 2 mA 0.25 % + 2 mA	Fluke 8508A
Resistance – Generate Fixed Point	1 mΩ 10 mΩ 100 mΩ 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	0.05 % 0.01 % 0.01 % 95 µΩ/Ω 95 µΩ/Ω 23 µΩ/Ω 23 µΩ/Ω 10 µΩ/Ω 10 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 11 µΩ/Ω 11 µΩ/Ω 20 µΩ/Ω 21 µΩ/Ω 40 µΩ/Ω 47 µΩ/Ω 0.01 %	Guildline 9211A shunt/Fluke 5720A
Resistance – Measure	2 Ω 20 Ω 200 Ω 2 kΩ 20 kΩ 200 kΩ 2 MΩ 20 MΩ 200 MΩ 2 GΩ 20 GΩ	17 µΩ/Ω + 4 µΩ 9.5 µΩ/Ω + 14 µΩ 8 µΩ/Ω + 50 µΩ 8 µΩ/Ω + 0.5 mΩ 8 µΩ/Ω + 5 mΩ 8 µΩ/Ω + 50 mΩ 9 µΩ/Ω + 1 Ω 20 µΩ/Ω + 0.1 kΩ 0.012 % + 10 kΩ 0.15 % + 1 MΩ 0.15 % + 10 MΩ	Fluke 8508A

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
Capacitance – Generate			
1 nF	(0.01 to 10) kHz	0.05 % + 0.01 nF	Fluke 5520A
10 nF	(0.01 to 1) kHz	0.25 % + 0.01 nF	
100 nF	(0.01 to 1) kHz	0.25 % + 0.1 nF	
1 μF	(10 to 600) Hz	0.25 % + 1 nF	
10 μF	(10 to 150) Hz	0.25 % + 10 nF	
100 μF	(10 to 80) Hz	0.45 % + 0.1 μF	
1 mF	(0 to 20) Hz	0.45 % + 1 μF	
10 mF	(0 to 2) Hz	0.45 % + 10 μF	
100 mF	(0 to 0.2) Hz	1.1 % + 0.1 mF	

## II. Electrical – RF & Microwave

Parameter/Equipment	Range	CMC <sup>2,5,8,9</sup> (±)	Comments
Amplitude Modulation – Measure			
Rate: 20 Hz to 10 kHz Depths: to 99 %	150 kHz to 10 MHz	3 % + 1 digit	Agilent 8902A
Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	150 kHz to 10 MHz	2 % + 1 digit	
Rate: 20 Hz to 10 kHz Depths: to 99 %	10 MHz to 6 GHz	3 % + 1 digit	
Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	10 MHz to 6 GHz	1 % + 1 digit	
Frequency Modulation – Measure			
Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak	250 kHz to 10 MHz	2 % + 1 digit	Agilent 8902A
Rate: 50 Hz to 100 kHz Dev.: ≤ 40 kHz peak	10 MHz to 6 GHz	1 % + 1 digit	
Rate: 20 Hz to 200 kHz Dev.: ≤ 40 kHz peak	10 MHz to 6 GHz	5 % + 1 digit	

Parameter/Equipment	Range	CMC <sup>2, 5, 8, 9</sup> ( $\pm$ )	Comments
Phase Modulation – Measure  Rate: 200 Hz to 1 kHz Dev.: $\leq 40$ Radians peak  Rate: 200 Hz to 10 kHz Dev.: $\leq 4$ Radians peak  Rate: 200 Hz to 1 kHz Dev.: $\leq 40$ Radians peak  Rate: 200 Hz to 20 kHz Dev.: $\leq 4$ Radians peak	150 kHz to 10 MHz  150 kHz to 10 MHz  10 MHz to 6 GHz  10 MHz to 6 GHz	4 % + 1 digit  4 % + 1 digit  3 % + 1 digit  3 % + 1 digit	Agilent 8902A
Sine Distortion – Measure  (-99.99 to 0) db (-99.99 to 0) db	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	Agilent 8903B
Tuned RF Level  Ranges (10 dBm step)  (0 to -100) dBm  (-100 to -120) dBm	(2.5 to 1300) MHz  (2.5 to 1300) MHz	0.005 dB/10 dB step + 0.015 dB + 1 digit  0.05 dB/10 dB step + 0.015 dB + 1 digit	Agilent 8902A/50
RF Power – Generate  Up to 23.98 dBm  Up to 7 dBm Up to 13 dBm Up to 9 dBm	100 $\mu$ Hz to 15 MHz  250 KHz to 3.2 GHz (3.2 to 20) GHz (20 to 50) GHz	0.3 dB  0.6 dB 0.8 dB 0.9 dB	Agilent 33120A  Agilent E8257D

Parameter/Equipment	Range	CMC <sup>2, 5, 8</sup> (±)	Comments
RF Attenuation – Generate			
1 dB	50 MHz	0.007 dB	Agilent 8494 series
2 dB		0.007 dB	
3 dB		0.007 dB	
4 dB		0.007 dB	
5 dB		0.009 dB	
6 dB		0.009 dB	
7 dB		0.01 dB	
8 dB		0.01 dB	
9 dB		0.009 dB	
10 dB		0.01 dB	
11 dB		0.011 dB	
10 dB	50 MHz	0.01 dB	Agilent 8496 series
20 dB		0.014 dB	
30 dB		0.019 dB	
40 dB		0.024 dB	
50 dB		0.028 dB	
60 dB		0.033 dB	
70 dB		0.037 dB	
80 dB		0.049 dB	
90 dB		0.061 dB	
100 dB		0.072 dB	
110 dB		0.084 dB	
Phase Noise – Measurement			
1 Hz to 1 MHz Offset	50 kHz to 50 GHz	2 dB	Agilent E5505A
(1 to 100) MHz Offset	50 kHz to 50 GHz	4 dB	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Reflection S11/S22 – Measure 50 Ohm Type N	300 kHz to 1.3 GHz (0.05 to 1) Lin	(0.004 to 0.018) Lin (1.1 to 5.2) Deg	Agilent 8753ES/85032F Type N connectors
	(1.3 to 3) GHz (0.05 to 1) Lin	(0.006 to 0.022) Lin (1.3 to 5.2) Deg	
	(3 to 6) GHz (0.05 to 1) Lin	(0.011 to 0.034) Lin (1.2 to 5.2) Deg	
50 Ohm Type N	45 MHz to 2 GHz (0.05 to 1) Lin	(0.005 to 0.015) Lin (0.85 to 5.8) Deg	Agilent E8364B/85054B Type N connectors
	(2 to 18) GHz (0.06 to 1) Lin	(0.01 to 0.04) Lin (2.1 to 9.2) Deg	
50 Ohm 3.5 mm Connectors	45 MHz to 2 GHz (0.05 to 1) Lin	(0.005 to 0.017) Lin (1.0 to 5.3) Deg	Agilent E8364B/85052B 3.5 mm connectors
	(2 to 20) GHz (0.06 to 1) Lin	(0.07 to 0.04) Lin (2.0 to 7.6) Deg	
50 Ohm 2.4 mm Connectors	(20 to 26.5) GHz (0.07 to 1) Lin	(0.008 to 0.042) Lin (2.1 to 6.6) Deg	Agilent E8364B/85056A 2.4 mm connectors
	45 MHz to 2 GHz (0.06 to 1) Lin	(0.009 to 0.02) Lin (1.4 to 9.5) Deg	
	(2 to 20) GHz (0.08 to 1) Lin	(0.009 to 0.026) Lin (1.5 to 6.4) Deg	
	(20 to 40) GHz (0.09 to 1) Lin	(0.015 to 0.043) Lin (2.4 to 9.4) Deg	
	(40 to 50) GHz (0.1 to 1) Lin	(0.019 to 0.055) Lin (3.0 to 10) Deg	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Absolute RF Power – Measure			
1 mW	50 MHz	3.5 µW	Agilent 432A/478A H78 Fluke 8508A
(-70 to -30) dBm	100 kHz to 4.2 GHz	0.05 dB	Agilent E4419/8481D-H70 N type connector
(-30 to 10) dBm (10 to 20) dBm		0.04 dB 0.08 dB	Agilent E4419/8482A-H84 N type connector
(-70 to -30) dBm	10 MHz to 18 GHz	0.05 dB	Agilent E4419/8481D-H84 N type connector
(-30 to 10) dBm (10 to 20) dBm		0.04 dB 0.08 dB	Agilent E4419/8481A-H84 N type connector
(-70 to -30) dBm	50 MHz to 26.5 GHz	0.06 dB	Agilent E4419/8485D-H84 3.5 mm connector
(-30 to 10) dBm (10 to 20) dBm		0.05 dB 0.09 dB	Agilent E4419/8485A-H84 3.5 mm connector
(-70 to -30) dBm	50 MHz to 50 GHz	0.06 dB	Agilent E4419/8487D-H84 2.4 mm connector
(-30 to 10) dBm (10 to 20) dBm		0.05 dB 0.04 dB	Agilent E4419/8487A-H84 2.4 mm connector
(-127 to -45) dBm	100 kHz to 4.2 GHz	0.16 dB	Agilent E4419/8481DH70/ E4448A spectrum analyzer
(-110 to -45) dBm	10 MHz to 18 GHz	0.16 dB	Agilent E4419/8481DH84/ E4448A spectrum analyzer
(-90 to -45) dBm	(2 to 50) GHz	0.16 dB	Agilent E4419/8487DH84/ E4448A spectrum analyzer
Pulse Modulation – Measure			
Rise	10 % to 90 % Pulse Envelope	14 picoseconds <sup>6</sup>	Agilent 86100A/83484A
Fall	10 % to 90 % Pulse Envelope		

Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Digital Modulation – Measure Carrier: 2 MHz to 6.0 GHz  Error Vector Magnitude for Modulation Types: MSK, GMSK, BPSK, DQPSK, n/4DQPSK, 8PSK, 16QAM and 32QAM & QPSK  Phase Error for Modulation Types: MSK, GMSK, BPSK, DQPSK, n/4DQPSK, 8PSK, 16QAM and 32QAM & QPSK  Error Vector Magnitude for FSK Modulation	Mod Frequency Span 1 Hz to 100 kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz  Mod Frequency Span 1 Hz to 100 kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz  Mod Frequency: 3.2 kHz 1.152 MHz	0.3 % rms 0.5 % rms 1 % rms  0.17° rms 0.34° rms 0.57° rms  0.5 % rms 1.5 % rms	Agilent 89441A

### III. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
Frequency – Generate	10 µHz to 15 MHz  250 kHz to 50 GHz	2 pHz/Hz  2 pHz/Hz	Agilent 33120A phase locked to Fluke 910  Agilent E8257D phase locked to Fluke 910
Frequency – Measuring Equipment	10 MHz 10 µHz to 12.4 GHz	2 pHz/Hz 2 pHz/Hz	Fluke 910 Agilent 53132A phase locked

<sup>1</sup> This laboratory offers commercial calibration service.

<sup>2</sup> Calibration and Measurement Capability (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.

<sup>3</sup> Based on using the Fluke 8508A at the temperature (TCal) it was calibrated  $\pm 5$  °C, 4 Hr. warm up, maximum resolution and an input zero or offset null performed if temp moves more than  $\pm 1$  °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 ppm or percent of reading plus ppm or percent of range. TCal = 23 °C (73.4 °F  $\pm$  9 °F).

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

<sup>5</sup> Agilent 8902A Modulation Resolution

AM 0 % to 9.99 %; 1 digit = 0.01 % / 10 % to 99.9%; 1 digit = 0.1 %

FM 0 to 3.999 kHz: 1 digit = 1 Hz / 4.00 to 39.99 kHz: 1 digit = 10 Hz / 40.0 to 400.0 kHz: 1 digit = 100Hz

PM 0 to 3.999 Radian; 1 digit = 0.001 Radian / 4.00 to 39.99 Radian: 1 digit = 0.01 Radian

Tuned RF 1 digit = 0.001 dB.

<sup>6</sup> Transition time characteristic calculated from  $T = 0.35 / \text{Bandwidth (26.5 GHz)}$

<sup>7</sup> “rms” refers to root mean square

<sup>8</sup> In a statement of Calibration and Measurement Capability, percentage refers to percent of reading, unless otherwise noted.

<sup>9</sup> Agilent 8902A frequency range extended by mixing to produce IF within normal operating range.



The American Association for Laboratory Accreditation

World Class Accreditation

# Accredited Laboratory

A2LA has accredited

## TRS-RENTELCO

*DFW Airport, TX*

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 the requirements of 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 8 January 2009).



Presented this 20<sup>th</sup> day of May 2010.

A handwritten signature in black ink, reading "Peter Abney".

President & CEO  
For the Accreditation Council  
Certificate Number 2681.01  
Valid to May 31, 2012  
Revised April 30, 2012

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