



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

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CALIBRATION

Valid To: June 30, 2013

Certificate Number: 2562.01

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, 11} (±)	Comments
DC Voltage – Generate and Measure			
Fixed Points	10 V 0 V 0.1 V 1 V 10 V 100 V 1000 V	0.5 μV/V 0.01 μV 17 μV/V 1.8 μV/V 0.85 μV/V 0.83 μV/V 0.92 μV/V	Zener voltage standard Low thermal short Zener, 752A ratio divider
Generate	(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 1000) V	13 μV/V + 1.2 μV 7.3 μV/V + 2.7 μV 5 μV/V + 8.3 μV 5 μV/V + 11 μV 6.9 μV/V + 0.18 mV 8.5 μV/V + 1.4 mV	Fluke 5720A
Measure	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V (2 to 10) kV (10 to 100) kV	9 μV/V + 0.6 μV 9 μV/V + 0.6 μV 5 μV/V + 0.9 μV 6 μV/V + 52 μV 6 μV/V + 10 mV* 0.03 % 570 V + 0.6R	3458A opt 2 ³ *See footnote 10 HVA100 34401A

Parameter/Range	Frequency	CMC ^{2,8} (±)	Comments
AC Voltage – Generate and Measure			
1 mv	(10 to 30) Hz (30 to 1000) Hz (1 to 120) kHz (120 to 500) kHz (500 to 1000) kHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.22 % 0.19 % 0.19 % 0.20 % 0.20 % 0.20 % 0.28 % 0.28 % 0.28 % 0.40 % 0.84 %	Fluke 5790A, 5720A
2 mv	(10 to 30) Hz (30 to 1000) Hz (1 to 120) kHz (120 to 500) kHz (500 to 1000) kHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.22 % 0.19 % 0.19 % 0.20 % 0.20 % 0.14 % 0.24 % 0.24 % 0.24 % 0.37 % 0.83 %	
10 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 (0.5 to 1) MHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.04 % 0.033 % 0.02 % 0.032 % 0.045 % 0.097 % 0.14 % 0.09 % 0.09 % 0.13 % 0.13 % 0.13 % 0.21 % 0.44 %	
20 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 (0.5 to 1) MHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz	0.03 % 0.021 % 0.014 % 0.025 % 0.035 % 0.081 % 0.1 % 0.093 % 0.093 % 0.13 % 0.13 %	

Parameter/Range	Frequency	CMC ^{2,8} (±)	Comments
AC Voltage – Generate and Measure (cont)			Fluke 5790A, 5720A
20 mV	(5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.13 % 0.21 % 0.44 %	
100 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 (0.5 to 1) MHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.018 % 81 μV/V 46 μV/V 71 μV/V 0.015 % 0.023 % 0.038 % 0.067 % 0.069 % 0.13 % 0.13 % 0.13 % 0.19 % 0.42 %	
200 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 (0.5 to 1) MHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.018 % 76 μV/V 40 μV/V 64 μV/V 0.014 % 0.025 % 0.035 % 0.066 % 0.068 % 0.13 % 0.13 % 0.13 % 0.18 % 0.42 %	
1 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 (0.5 to 1) MHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.018 % 61 μV/V 22 μV/V 37 μV/V 58 μV/V 0.014 % 0.022 % 0.066 % 0.068 % 0.13 % 0.13 % 0.13 % 0.18 % 0.42 %	

Parameter/Range	Frequency	CMC ^{2,8} (±)	Comments
AC Voltage – Generate and Measure (cont)			
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 (0.5 to 1) MHz	0.012 % 44 μV/V 25 μV/V 32 μV/V 58 μV/V 0.017 % 0.038 % 0.074 %	Fluke 5790A, 5720A
3 V	(0.5 to 1) MHz (1 to 2) MHz (2 to 3) MHz (3 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.076 % 0.080 % 0.14 % 0.15 % 0.15 % 0.26 % 0.55 %	
10 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 (0.5 to 1) MHz	0.016 % 56 μV/V 24 μV/V 39 μV/V 64 μV/V 0.017 % 0.032 % 0.096 %	
20 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 (0.5 to 1) MHz	0.016 % 56 μV/V 24 μV/V 39 μV/V 64 μV/V 0.017 % 0.032 % 0.096 %	
44 V	(300 to 500) kHz	0.032 %	
60 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	0.016 % 60 μV/V 26 μV/V 45 μV/V 73 μV/V 0.016 %	
100 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.016 % 58 μV/V 31 μV/V 56 μV/V 78 μV/V	

Parameter/Range	Frequency	CMC ^{2,8,11} (±)	Comments
AC Voltage – Generate and Measure (cont)			
200 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.017 % 63 μV/V 25 μV/V 54 μV/V 76 μV/V	Fluke 5790A, 5720A
300 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.016 % 77 μV/V 33 μV/V 0.011 % 0.039 %	
600 V	50 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	33 μV/V 0.011 % 0.039 %	
1000 V	50Hz to 1 kHz	33 μV/V	
AC Voltage – Measure			
(10 to 100) kV (2 to 10) kV	60 Hz	300 V + 0.6R 0.18 %	HVA100, 34401A

Parameter/Equipment	Range	CMC ² (±)	Comments
DC Current – Generate and Measure			
Fixed Points	100 μA 1 mA 10 mA 20 mA 100 mA 200 mA 1 A 10 A	1.9 nA 14 nA 0.14 μA 0.28 μA 1.4 μA 2.8 μA 20 μA 550 μA	Guildline 9334A ⁴ Guildline 9330 ⁴ Fluke Y5020 ⁴
Generate	(0 to 220) μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2A	40 μA/A + 5.5 nA 32 μA/A + 6.2 nA 32 μA/A + 39 nA 39 μA/A + 0.62 μA 70 μA/A + 12 μA	Fluke 5700A/EP
Measure	(10 to 100) μA (1 to 10) mA (10 to 100) mA 100 mA to 1A	55 μA/A + 0.2 nA 55 μA/A + 0.1 μA 0.012 % rdg + 1 μA 0.014 % rdg + 12 μA	AT 3458A AT 3458A GDI-9230

Parameter/Range	Frequency	CMC ^{2,8} (±)	Comments
AC Current – Measure			
10 mA	10 Hz 20 Hz 40 Hz (1,5,10) kHz	23 µA 17 µA 1.6 µA 1.6 µA	Thermal current transfer
20 mA	10 Hz 20 Hz 40 Hz (1,5,10) kHz	46 µA 34 µA 3.2 µA 3.2 µA	
100 mA	10 Hz 20 Hz 40 Hz (1,5,10) kHz	23 µA 17 µA 16 µA 16 µA	
200 mA	10 Hz 20 Hz 40 Hz (1,5,10) kHz	46 µA 34 µA 32 µA 32 µA	
1 A	40 Hz (1,5,10) kHz	170 µA 170 µA	
2 A	40 Hz (1,5,10) kHz	330 µA 330 µA	
10 A	40 Hz (1,5,10) kHz	1.8 mA 1.8 mA	
AC Current – Generate			
(0 to 220) µA	(10 to 20) Hz (20 to 45) Hz (45 to 1000) Hz (1 to 1) kHz (5 to 10) kHz	0.023 % + 0.022 µA 0.016 % + 0.015 µA 0.011 % + 0.013 µA 0.027 % + 0.034 µA 0.10 % + 0.081 µA	Fluke 5700A/EP
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 45) Hz (45 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.023 % + 0.15 µA 0.016 % + 0.10 µA 0.011 % + 0.095 µA 0.019 % + 0.17 µA 0.10 % + 0.64 µA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 45) Hz (45 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.023 % + 2.4 µA 0.016 % + 1.3 µA 0.011 % + 0.95 µA 0.019 % + 1.3 µA 0.10 % + 5.0 µA	

Parameter/Range	Frequency	CMC ^{2,8} (±)	Comments
AC Current – Generate (cont)			Fluke 5700A/EP
(22 to 220) mA	(10 to 20) Hz (20 to 45) Hz (45 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.023 % + 24 μA 0.016 % + 12 μA 0.011 % + 93 μA 0.019 % + 13 μA 0.1 % + 47 μA	
(0.22 to 2.2) A	(10 to 20) Hz (20 to 45) Hz (45 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.025 % + 14 μA 0.025 % + 14 μA 0.025 % + 14 μA 0.039 % + 160 μA 0.62 % + 890 μA	
(100 to 1000) A*	(45 to 65) Hz	0.24 % + 0.02 A	5520A 34401A *Coil ampere turns

Parameter/Equipment	Range	CMC ^{2,12} (±)	Comments
Resistance – Generate and Measure			
Fixed Points ⁴	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ	7.0 μΩ/Ω 4.1 μΩ/Ω 5.4 μΩ/Ω 5.6 μΩ/Ω 4.3 μΩ/Ω	Guildline 9334A
Fixed Points ⁴	100 kΩ 1 MΩ 10 MΩ 100 MΩ (100 to 1000) MΩ (1 to 10) GΩ (10 to 1000) GΩ	5.7 μΩ/Ω 7.1 μΩ/Ω 21 μΩ/Ω 160 μΩ/Ω 0.73 % 0.98 % 1.3 %	Guildline 9334A IET-HRRS-B-9-1K-10KV
Measure Only ⁵	(0.01 to 1) Ω (1 to 10) Ω (10 to 100) Ω (100 to 1000) Ω (1 to 10) kΩ (10 to 100) kΩ (100 to 1000) kΩ (1 to 10) MΩ (10 to 100) MΩ	0.058 % + 80 μΩ* 15 μΩ/Ω + 80 μΩ* 14 μΩ/Ω + 800 μΩ 13 μΩ/Ω + 2.5 mΩ 13 μΩ/Ω + 25 mΩ 13 μΩ/Ω + 250 mΩ 13 μΩ/Ω + 6 Ω 44 μΩ/Ω + 130 Ω 0.036 % + 1.4 kΩ	Agilent 3458A *See footnote 11

Parameter/Equipment	Range	CMC ^{2,12} (±)	Comments
Oscilloscope –			
Generate Amplitude Volt	0 V (0.9 to 80) mV (0.08 to 2) V (2 to 20) V (20 to 200)V (200 to 230) V	25 μV 0.045 % + 25 μV 0.056 % + 16 μV 0.055 % + 0.2 mV 0.055 % + 1.6 μV 0.047 % + 32 mV	9500B
Measure Resistance	50 Ω 1 MΩ	1.4 mΩ 19 Ω	Agilent 3458A
AC Voltage Bandwidth – Generate and Measure	50 kHz to 550 MHz 50 kHz to 3.2 GHz 50 MHz to 26 GHz	4.5 % 5.5 % 7 % + <i>M</i>	9500B 9500B 9560 E8257D 11667 8487 E4418
Pulse – Generate & Measure			<i>M</i> = mismatch error
Transition Time	(20 to 2000) ps	5 ps + 0.02* <i>T</i> rdg	9500B SD24/11801C <i>T</i> = transition time
Generate Only			
Transition Time	<20 ps	5 ps	Tek 067-1338-00

II. Electrical – RF & Microwave

Parameter/Range	Frequency	CMC ² (±)	Comments
Power Measure – Milliwatt Reference			
1 mW @ 50 Ω	50 MHz	0.4 % rdg	432A w/478AH76, 3458A
Power Measure ⁹			
(-10 to 20) dBm	(9 to 100) kHz	0.10 db	Agilent E9304A-H19 with E4419B
(-20 to -10) dBm	(9 to 100) kHz	0.26 db	
(10 to 20) dBm	(100 to 300) kHz SWR < 1.6:1	0.14 dB	Agilent 8482A-H84 with E4419B
	300 kHz to 1 MHz SWR < 1.2:1	0.13 dB	
	1 MHz to 2 GHz SWR < 1.1:1	0.13 dB	
	(2 to 4.2) GHz SWR < 1.3:1	0.14 dB	
(-20 to 10) dBm	(100 to 300) kHz SWR < 1.6:1	0.056 dB	Agilent 8482A-H84 with E4419B
	300 kHz to 1 MHz SWR < 1.2:1	0.051 dB	
	1 MHz to 2 GHz SWR < 1.1:1	0.054 dB	
	(2 to 4.2) GHz SWR < 1.3:1	0.055 dB	

Parameter/Equipment	Frequency	CMC ² (±)	Comments	
Power Measure ⁹ (cont) – (-60 to -20) dBm	(50 to 100) MHz SWR < 1.15:1	0.16 dB	Agilent 8487D with E4419B	
	(0.1 to 2) GHz SWR < 1.1:1	0.16 dB		
	(2 to 12.4) GHz SWR < 1.15:1	0.16 dB		
	(12.4 to 18) GHz SWR < 1.2:1	0.17 dB		
	(18 to 26.5) GHz SWR < 1.25:1	0.17 dB		
	(26.5 to 40) GHz SWR < 1.4:1	0.18 dB		
	(40 to 50) GHz SWR < 1.5:1	0.24 dB		
Power Generate – (Includes DUT Mismatch 1.4 VSWR)	(-10 to 20) dBm	(9 to 100) kHz	Measure Transfer 33250A, E4419B, E9304H19	
	(-20 to -10) dBm	(9 to 100) kHz		
	(10 to 20) dBm	(100 to 300) kHz		
	(-20 to 10) dBm	300 kHz to 1 MHz	0.13 dB	33250A, E4419B, 8482A-H84 E8257D, E4419B, 8482A-H84
		1 MHz to 2 GHz	0.21 dB	
		(2 to 4.2) GHz	0.35 dB	
		(100 to 300) kHz	0.05 dB	
		300 kHz to 1 MHz	0.06 dB	
		1 MHz to 2 GHz	0.18 dB	
		(2 to 4.2) GHz	0.33 dB	

Parameter/Equipment	Frequency	CMC ² (±)	Comments		
Power Generate (cont) – (Includes DUT Mismatch 1.4 VSWR)	(10 to 20) dBm	(50 to 100) MHz	0.22 dB	E8257D, E4419B, 8487A-H84	
		(0.1 to 2) GHz	0.22 dB		
		(2 to 12.4) GHz	0.35 dB		
		(12.4 to 18) GHz	0.35 dB		
		(18 to 26.5) GHz	0.44 dB		
		(26.5 to 40) GHz	0.60 dB		
		(40 to 50) GHz	0.61 dB		
	(-20 to 10) dBm	(50 to 100) MHz	0.18 dB		E8257D, E4419B, 8487A-H84
		(0.1 to 2) GHz	0.19 dB		
		(2 to 12.4) GHz	0.33 dB		
		(12.4 to 18) GHz	0.33 dB		
		(18 to 26.5) GHz	0.43 dB		
		(26.5 to 40) GHz	0.59 dB		
		(40 to 50) GHz	0.60 dB		
	(-60 to -20) dBm	(50 to 100) MHz	0.23 dB	E8257D, E4419B, 8487D-H84	
		(0.1 to 2) GHz	0.23 dB		
		(2 to 12.4) GHz	0.36 dB		
		(12.4 to 18) GHz	0.36 dB		
		(18 to 26.5) GHz	0.45 dB		
		(26.5 to 40) GHz	0.61 dB		
		(40 to 50) GHz	0.62 dB		

Parameter/Equipment	Frequency	CMC ² (±)	Comments
<p>Network Analyzer Dynamic Accuracy Test –</p> <p>Network analyzer Calibration comparison 3.5mm Rho 0.999</p> <p>Rho 0.001</p>	<p>5 dBm change</p> <p>10 MHz (0.125 to 2) GHz (2.125 to 8) GHz (8.125 to 20) GHz (20.125 to 26.5) GHz</p> <p>10 MHz (0.125 to 2) GHz (2.125 to 8) GHz (8.125 to 20) GHz (20.125 to 26.5) GHz</p>	<p>0.002 lin</p> <p>0.0060 lin 0.0045 lin 0.0061 lin $0.012 + 6.7 \times 10^{-6} * f \text{ lin}$ $0.015 - 5.6 \times 10^{-6} * f \text{ lin}$</p> <p>0.00099 lin 0.00090 lin 0.0011 lin $0.0019 + 2.9 \times 10^{-6} * f \text{ lin}$ $0.0025 + 4.5 \times 10^{-6} * f \text{ lin}$</p>	<p>Agilent 8482A with E4419B</p> <p>E8361A with data based SOL cal kit</p> <p>Note: f in GHz</p>
<p>Cal Factor & Effective Efficiency⁶ @ 50 Ω –</p> <p>Nominal 1 mW</p>	<p>(0.1 to 4200) MHz (4.2 to 12.4) GHz (12.4 to 15) GHz (15 to 26) GHz (26 to 40) GHz (40 to 50) GHz</p>	<p>1.3 % cal factor 1.8 % cal factor 2 % cal factor 3 % cal factor 3 % cal factor 5 % cal factor</p>	<p>RF power transfer & DC substitution</p>

Parameter/Equipment	Range	CMC ² (±)	Comments
S-Parameters –			
S ₁₁₍₂₂₎ Measure – @ 50 Ω			
2.4 mm 45 MHz to 2 GHz	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(0.019 to 0.028) lin (0.017 to 0.018) lin 0.017 lin	E8361A, 85056A
	(0.3 to 1) lin (0.01 to 0.3) lin	(3.5 to 1.6) deg (180 to 3.5) deg	
(2 to 20) GHz	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(0.023 to 0.034) lin (0.018 to 0.023) lin 0.018 lin	
	(0.3 to 1) lin (0.01 to 0.3) lin	(5 to 2) deg (180 to 5) deg	
(20 to 40) GHz	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(0.037 to 0.056) lin (0.03 to 0.037) lin 0.03 lin	
	(0.3 to 1) lin (0.01 to 0.3) lin	(9 to 3.2) deg (180 to 9) deg	
(40 to 50) GHz	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(0.044 to 0.07) lin (0.034 to 0.044) lin 0.034 lin	
	(0.3 to 1) lin (0.01 to 0.3) lin	(11 to 4) deg (180 to 11) deg	
S ₁₂₍₂₁₎ Measure –			
2.4 mm 45 MHz to 26 GHz	(0 to -60) dB	(0.08 to 0.6) dB (0.5 to 5.8) deg	

Parameter/Equipment	Range	CMC ² (±)	Comments
S-Parameters (cont) –			
S ₁₁₍₂₂₎ Measure – @ 50 Ω 3.5 mm 45 MHz to 2 GHz	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(0.01 to 0.022) lin (0.009 to 0.01) lin 0.009 lin	E8361A, 85052C
	(0.3 to 1) lin (0.01 to 0.3) lin	(2 to 1.3) deg (54 to 2) deg	
S ₁₁₍₂₂₎ Measure – @ 50 Ω 3.5 mm (2 to 20) GHz (20 to 26) GHz	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(0.012 to 0.015) lin (0.008 to 0.013) lin 0.008 lin	E8361A, 85050B
	(0.3 to 1) lin (0.01 to 0.3) lin	(2.6 to 0.82) deg (0.0045 to 2.6) deg	
	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(0.013 to 0.017) lin (0.008 to 0.014) lin 0.009 lin	
	(0.3 to 1) lin (0.01 to 0.3) lin	(2.8 to 1) deg (53 to 2.8) deg	
S ₁₂₍₂₁₎ Measure – 3.5 mm 45 MHz to 26 GHz	(0 to -60) dB	(0.05 to 0.27) dB; (0.3 to 1.9) deg	
S ₁₁₍₂₂₎ Measure – @ 50 Ω 7 mm, Type N ⁶ 45 MHz to 2 GHz (2 to 18) GHz	(0.01 to 1) lin	(0.003 to 0.01) lin	
	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(1 to 0.6) deg (6 to 1) deg (16 to 6) deg	
	(0.01 to 1) lin	(0.002 to 0.007) lin	
	(0.3 to 1) lin (0.03 to 0.3) lin (0.01 to 0.03) lin	(1.6 to 0.4) deg (5 to 1.6) deg (11 to 5) deg	
S ₁₂₍₂₁₎ Measure – 7 mm, Type N ⁶ 45 MHz to 18 GHz	(0 to -60) dB	(0.05 to 0.27) dB; (0.3 to 1.9) deg	

Parameter/Equipment	Range	CMC ² (±)	Comments
Pulse – Generate & Measure			
Transition Time	(20 to 2000) ps	5 ps + 0.02* <i>T</i> rdg	9500B
Generate Only			SD24/11801C
Transition Time	<20 ps	5 ps	<i>T</i> = transition time Tek 067-1338-00
RF Power – Measure			
Relative Level	100 kHz to 50 GHz	0.012 dB + 0.004 dB/10dB	E4448A/233
Insertion Loss	100 kHz to 50 GHz	0.026 dB + 0.004 dB/10dB + <i>M</i>	<i>M</i> = mismatch error
Amplitude Modulation – Measure			
200 MHz to 3 GHz	(30 to 90) % ratio; 1 kHz rate	0.45 % AM	E4448A/233
0.010 kHz to 50 GHz	5 % ratio; 50 Hz to 5 kHz rate	2.4 % AM	
	30 % ratio; 50 Hz to 5 kHz rate	1.2 % AM	
	99 % ratio; 50 Hz to 5 kHz rate	0.42 % AM	
	5 % ratio; (5 to 100) kHz rate	2.4 % AM	
	30 % ratio; (5 to 100) kHz rate	0.88 % AM	
	99 % ratio; (5 to 100) kHz rate	0.32 % AM	

Parameter/Equipment	Range	CMC ² (±)	Comments
Angular (Frequency) Modulation – Measure 200 MHz to 20 GHz	(100 to 240) kHz peak deviation modulation index > 1	0.8 kHz	AT-E4448A AT-33250A AT-34401A DTM-CSiii
Angular (Phase) Modulation – Measure 200 MHz to 20 GHz	(1 to 10) radian modulation index	0.77 % radian + 0.0025 radians	AT-E4448A DTM-CSiii

III. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measure	20 °C to 30 °C	0.07 °C	Hart 5628/1502
Relative Humidity – Measure (-20 to 20) °C (20 to 30) °C (30 to 50) °C	(10 to 90) % RH	3.5 % RH 2.3 % RH 3.5 % RH	Veriteq SP 2000

IV. Time & Frequency

Parameter/Range	Range	CMC ² (±)	Comments
Frequency – Measure	5, 10 MHz 1 Hz to 120 MHz 250 kHz to 50 GHz	2.5 pHz/Hz 10 pHz/Hz 10 nHz/Hz + 0.1 Hz	NIST FMAS, GPS receiver (1 Hz Steps) E4448A/233 with CSIII lock

Parameter/Range	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment	10 MHz distribution	10 pHz/Hz	CSIII, 58503B distribution amplifiers
	1 Hz to 10 MHz	2 μHz/Hz	AT 33250
	250 kHz to 50 GHz	10 nHz/Hz	E8257D-550 with CSIII lock
Time Interval – Measuring Equipment and Measure	1 ns to 10 s	0.92 ns + $TI \cdot 0.04 \mu\text{s/s}$	33250A/ 53132A/12 TI = Time interval in seconds

¹ This laboratory does not normally offer commercial calibration services.

² 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.

³ Agilent 3458A with Option 2, settings DCV, 100PLC, ACAL within prior 24 Hrs, 1 year cal cycle.

⁴ Transfer using Agilent 3458A

⁵ Agilent 3458A four wire ohms, ACAL within prior 24 Hrs, NPLC 100 < 100E6 Ohm > NPLC 10

⁶ Calibration Factor 100 kHz to 10 MHz is effective efficiency only.

⁷ Measure and Generate is limited to below 5 kHz; Measure only above 5 kHz.

⁸ The measurands stated are generated with the Fluke 5700, 5720 and/or 5790 series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMC is expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

⁹ The statement of CMC does not include the effects of mismatch error.

¹⁰ Add $12 \mu\text{V/V}$ times $(V_{\text{input}} / 1000)^2$ for voltage > 100 V

¹¹ R = resolution contribution from unit under test.

¹² In the statement of CMC, the value is defined as the percentage of reading.



The American Association for Laboratory Accreditation

World Class Accreditation

Accredited Laboratory

A2LA has accredited

ELECTRO RENT CORPORATION

Van Nuys, CA

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 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 19th day of July 2011.





President & CEO

For the Accreditation Council
Certificate Number 2562.01
Valid to June 30, 2013

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