



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

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CALIBRATION

Valid To: September 30, 2019

Certificate Number: 2374.01

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

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
Hand Tools <sup>3</sup> – Micrometers, Calipers, Dial & Test Indicators, Linear Indicators, Depth Gages	(0.05 to 0.4) in (0.4 to 1) in (1 to 8) in	18 µin 17 µin + 1 µin/in 12 µin + 6.1 µin/in	Gage blocks

II. Chemical

Parameter/Equipment	Range	CMC <sup>2, 6</sup> (±)	Comments
pH Meter – Fixed Points	4 pH 7 pH 10 pH	0.016 pH 0.016 pH 0.016 pH	Buffer solutions
Conductivity Solutions – Fixed Points	10 µS/cm 100 µS/cm 1000 µS/cm 10 000 µS/cm 100 000 µS/cm	0.53 µS/cm 2.2 µS/cm 5.4 µS/cm 48 µS/cm 2.2 mS/cm	Conductivity solutions

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2, 4, 6</sup> (±)	Comments
DC Voltage <sup>3</sup> – Generate	(0 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	8 μV/V + 0.41 μV 5.7 μV/V + 0.71 μV 4.2 μV/V + 2.5 μV 5 μV/V + 4 μV 6.3 μV/V + 40 μV 7.6 μV/V + 0.4 mV	Fluke 5720A
DC Voltage <sup>3</sup> – Measure	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	9.8 μV/V + 0.54 μV 5.5 μV/V + 0.54 μV 5.5 μV/V + 0.71 μV 8.5 μV/V + 37 μV 10 μV/V + 0.12 mV	Agilent 3458A, option 002
DC Current <sup>3</sup> – Generate	(0 to 220) μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A (11 to 20.5) A	41 μA/A + 6 nA 37 μA/A + 7.4 nA 36 μA/A + 46 nA 57 μA/A + 0.74 μA 200 μA/A + 12 μA 400 μA/A + 480 μA 0.082 % + 580 μA	Fluke 5720A  Fluke 5522A
DC Current <sup>3</sup> – Clamp On Meter			
Toroidal	Up to 1000 A	0.3 % + 0.5 A	Fluke 5522A with 5500A/ coil
Non-Toroidal	Up to 1000 A	0.58 % + 0.5 A	
DC Current <sup>3</sup> – Measure	(10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A  (1 to 20) A  (20 to 100) A  (100 to 1000) A	26 μA/A + 0.93 nA 26 μA/A + 5.8 nA 26 μA/A + 59 nA 43 μA/A + 0.59 μA 0.012 % + 12 μA  0.017 %  0.014 %  0.018 %	Agilent 3458A, option 002  Agilent 3458A, Fluke Y5020  Agilent 3458A, Honeywell 1166  Guideline 9230A



Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> ( $\pm$ )	Comments
AC Voltage <sup>3</sup> – Generate			
(1 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	0.16 % + 4 $\mu$ V 0.16 % + 4 $\mu$ V 0.10 % + 4 $\mu$ V 0.12 % + 4 $\mu$ V 0.17 % + 5 $\mu$ V 0.33 % + 10 $\mu$ V 0.47 % + 20 $\mu$ V 0.58 % + 20 $\mu$ V	Fluke 5720A
(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	0.044 % + 4 $\mu$ V 0.036 % + 4 $\mu$ V 0.017 % + 4 $\mu$ V 0.032 % + 4 $\mu$ V 0.06 % + 5 $\mu$ V 0.12 % + 10 $\mu$ V 0.16 % + 20 $\mu$ V 0.30 % + 20 $\mu$ 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	0.029 % + 12 $\mu$ V 0.019 % + 7.1 $\mu$ V 0.013 % + 7.1 $\mu$ V 0.023 % + 7.4 $\mu$ V 0.048 % + 18 $\mu$ V 0.093 % + 21 $\mu$ V 0.14 % + 26 $\mu$ V 0.28 % + 45 $\mu$ V	
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.029 % + 42 $\mu$ V 0.018 % + 16 $\mu$ V 0.010 % + 8.1 $\mu$ V 0.012 % + 10 $\mu$ V 0.015 % + 30 $\mu$ V 0.045 % + 82 $\mu$ V 0.10 % + 0.21 mV 0.18 % + 0.32 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	0.029 % + 0.42 mV 0.018 % + 0.15 mV 0.0095 % + 51 $\mu$ V 0.012 % + 0.1 mV 0.014 % + 0.21 mV 0.033 % + 0.62 mV 0.10 % + 2 mV 0.17 % + 3.3 mV	

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate (cont)			
(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	0.029 % + 4.2 mV 0.013 % + 1.5 mV 0.0099 % + 0.61 mV 0.012 % + 1 mV 0.018 % + 2.6 mV 0.091 % + 1.6 mV 0.44 % + 4 mV 0.80 % + 8 mV	Fluke 5720A
(220 to 750) V	(15 to 50) Hz 50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz	0.061 % + 11 mV 0.014 % + 4 mV 0.019 % + 6 mV 0.061 % + 11 mV 0.061 % + 11 mV 0.23 % + 45 mV	Fluke 5720A / 5725A
(750 to 1100) V	(15 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.061 % + 11 mV 0.014 % + 4 mV 0.019 % + 6 mV 0.061 % + 11 mV	
AC Voltage <sup>3</sup> – Measure			
(10 to 100) mV	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.013 % + 5 μV 0.0094 % + 2.3 μV 0.017 % + 2.3 μV 0.037 % + 2.3 μV 0.093 % + 2.3 μV 0.36 % + 12 μV	Agilent 3458A, option 002
100 mV to 1 V	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.0098 % + 46 μV 0.0094 % + 23 μV 0.017 % + 23 μV 0.036 % + 23 μV 0.093 % + 23 μV 0.35 % + 120 μV	
(1 to 10) V	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.0094 % + 460 μV 0.0095 % + 230 μV 0.017 % + 230 μV 0.036 % + 230 μV 0.093 % + 230 μV 0.35 % + 1.2 mV	

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
AC Voltage <sup>3</sup> – Measure (cont)			
(10 to 100) V	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.024 % + 4.6 mV 0.024 % + 2.3 mV 0.024 % + 2.3 mV 0.041 % + 2.3 mV 0.14 % + 2.3 mV	Agilent 3458A, option 002
(100 to 700) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz (30 to 100) kHz	0.047 % + 23 mV 0.071 % + 23 mV 0.025 % + 32 mV 0.06 % + 160 mV	Fluke 8508A
(700 to 1050) V	(20 to 10) Hz (10 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.02 % + 85 mV 0.02 % + 24 mV 0.019 % + 24 mV 0.028 % + 48 mV 0.06 % + 240 mV	
AC Current <sup>3</sup> – Measure			
(0 to 100) μA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	0.46 % + 35 nA 0.17 % + 35 nA 0.072 % + 35 nA 0.072 % + 35 nA	Agilent 3458A, option 002
100 μA to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.46 % + 230 nA 0.17 % + 230 nA 0.071 % + 230 nA 0.038 % + 230 nA 0.071 % + 230 nA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.46 % + 2.3 μA 0.17 % + 2.3 μA 0.071 % + 2.3 μA 0.038 % + 2.3 μA 0.071 % + 2.3 μA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.46 % + 23 μA 0.17 % + 23 μA 0.071 % + 23 μA 0.038 % + 23 μA 0.071 % + 23 μA	

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
AC Current <sup>3</sup> – Measure (cont)			
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.46 % + 230 µA 0.19 % + 230 µA 0.097 % + 230 µA 0.12 % + 230 µA 0.35 % + 230 µA	Agilent 3458A, option 002
(1 to 20) A	60 Hz	0.015 %	Agilent 3458A, Fluke Y5020
(20 to 100) A	60 Hz	0.014 %	Agilent 3458A, Honeywell 1166
AC Current <sup>3</sup> – Generate			
22 µA to 0.22 mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.032 % + 17 nA 0.021 % + 12 nA 0.017 % + 8 nA 0.031 % + 12 nA 0.11 % + 130 nA	Fluke 5720A
(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	0.031 % + 40 nA 0.020 % + 35 nA 0.016 % + 35 nA 0.022 % + 0.16 µA 0.11 % + 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	0.040 % + 0.4 µA 0.021 % + 0.35 µA 0.016 % + 0.35 µA 0.023 % + 0.8 µA 0.11 % + 5.1 µA	
22 mA to 0.22 A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.034 % + 4 µA 0.020 % + 3.5 µA 0.016 % + 2.5 µA 0.023 % + 4.2 µA 0.11 % + 12 µA	
(0.22 to 2.2) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.028 % + 35 µA 0.046 % + 80 µA 0.7 % + 0.16 mA	

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
AC Current <sup>3</sup> – Generate (cont)			
(2.2 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.18 % + 0.1 mA 0.062 % + 0.1 mA 0.6 % + 1 mA 2.5 % + 5 mA	Fluke 5522A
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.064 % + 1.6 mA 0.1 % + 1.6 mA 3 % + 1.6 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 3.9 mA 0.15 % + 3.9 mA 3 % + 3.9 mA	
AC Current <sup>3</sup> – Generate (Clamp On Meter)			
Toroidal Up to 1000 A	(45 to 65) Hz (65 to 440) Hz	0.38 % + 0.17 A 1.2 % + 0.29 A	Fluke 5522A with 5500A/ coil
Non-Toroidal Up to 1000 A	(45 to 65) Hz (65 to 440) Hz	0.68 % + 1.0 A 1.4 % + 1.1 A	
Capacitance <sup>3</sup> – Generate			
(0.22 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 1.1) nF (1.1 to 33) nF (33 to 110) nF (110 to 330) nF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz	0.39 % + 7.8 pF 0.39 % + 7.8 pF 0.39 % + 7.8 pF 0.21 % + 7.8 pF 0.21 % + 78 pF 0.21 % + 78 pF 0.21 % + 0.23 nF	Fluke 5522A
(0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF	(10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz	0.2 % + 0.78 nF 0.2 % + 2.3 nF 0.2 % + 7.8 nF 0.32 % + 23 nF 0.35 % + 78 nF 0.35 % + 0.23 μF	
0.33 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	(0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	0.35 % + 0.78 μF 0.35 % + 2.3 μF 0.35 % + 7.8 μF 0.59 % + 23 μF 0.86 % + 78 μF	



Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
AC Power <sup>3</sup> – Generate  (46 to 650) V (0.05 to 20) A	(16 to 850) Hz	0.024 %	Fluke 6105A

Parameter/Equipment	Range	CMC <sup>2, 4, 6</sup> (±)	Comments
Electrical Calibration of Thermocouple Indicating Devices <sup>3</sup> – Measure & Generate			
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.33 °C 0.19 °C 0.17 °C 0.27 °C 0.4 °C	Fluke 5522A
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.63 °C 0.25 °C 0.17 °C 0.15 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.28 °C 0.17 °C 0.15 °C 0.18 °C 0.24 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.4 °C 0.23 °C 0.2 °C 0.19 °C 0.28 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.5 °C 0.17 °C 0.15 °C 0.17 °C 0.22 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.4 °C	

Parameter/Equipment	Range	CMC <sup>2, 4, 6</sup> ( $\pm$ )	Comments
Electrical Calibration of Thermocouple Indicating Devices <sup>3</sup> – Measure & Generate (cont)			
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	Fluke 5522A
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.3 °C 0.27 °C 0.31 °C 0.5 °C 0.84 °C	
Oscilloscopes <sup>3</sup> –			
DC Voltage: 50 $\Omega$ 1 M $\Omega$	(0 to $\pm 6.6$ ) V (0 to $\pm 130$ ) V	0.25 % + 40 $\mu$ V 0.06 % + 40 $\mu$ V	Fluke 5522A/SC1100
AC Voltage (Square wave): 50 $\Omega$	$\pm 1$ mV <sub>pk-pk</sub> to $\pm 6.6$ V <sub>pk-pk</sub> 10 Hz to 10 kHz	0.25 % + 40 $\mu$ V	
1 M $\Omega$	$\pm 1$ mV <sub>pk-pk</sub> to $\pm 130$ V <sub>pk-pk</sub> 10 Hz to 1 kHz (1 to 10) kHz	0.1 % + 40 $\mu$ V 0.25 % + 40 $\mu$ V	
Leveled Sine Wave (Amplitude)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 MHz to 1.1 GHz	0.19 V 0.22 V 0.33 V 0.25 V	
Time Markers	5 s to 50 ms 20 ms to 100 ns (50 to 20) ns 10 ns (5 to 2) ns	25 ms 50 ns 0.13 ps 26 fs 14 fs	

Parameter/Equipment	Range	CMC <sup>2, 4, 6</sup> (±)	Comments
Oscilloscopes <sup>3</sup> – (cont)			
Wave Generator: 50 Ω 1 MΩ	1.8 mV <sub>pk-pk</sub> to 2.5 V <sub>pk-pk</sub> 1.8 mV <sub>pk-pk</sub> to 55 V <sub>pk-pk</sub>	75 mV <sub>pk-pk</sub> 1.7 V <sub>pk-pk</sub>	Fluke 5522A/SC1100
Pulse Generator: (4 to 500) ns Width	10 mV to 2.5 V	0.2 μs	
Rise Time – Generate	12.8 ps	3.6 ps	Tektronix 067-1338-00
Rise Time – Measure	>7ps (50GHz BW)	2.5 ps	Keysight 83484A

#### IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC <sup>2, 5, 6</sup> (±)	Comments
RF Absolute Power <sup>3</sup> – Measure			
(-10 to 30) dBm	10 Hz to 20 kHz	0.13 %	Fluke 8846A
(-60 to 20) dBm	9 kHz to 18 GHz	2.6 %	Agilent E9304A H18
(-70 to -30) dBm	(18 to 40) GHz (40 to 50) GHz	3.8 % 5.5 %	Agilent 8487D
(-30 to 20) dBm	(18 to 40) GHz (40 to 50) GHz	4.4 % 5.5 %	Agilent 8487A
(20 to 30) dBm	30 MHz to 50 GHz	4.8 %	Agilent N5532A-550
RF Power <sup>3</sup> – Generate			
(-90 to -70) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.93 dBm 1.2 dBm 2.3 dBm 2.9 dBm	Agilent E8257D
(-70 to -10) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.82 dBm 1.1 dBm 1.2 dBm 1.8 dBm	

Parameter/Range	Frequency	CMC <sup>2, 5, 6</sup> (±)	Comments
RF Power <sup>3</sup> – Generate (cont)			
(-10 to 0) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.71 dBm 0.95 dBm 1.1 dBm 1.1 dBm	Agilent E8257D
(0 to 10 dBm)	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.71 dBm 0.95 dBm 1.1 dBm 1.5 dBm	
(10 to 14 dBm)	250 kHz to 2 GHz (2 to 20) GHz (20 to 50) GHz	0.71 dBm 0.95 dBm 1.2 dBm	
(14 to 19 dBm)	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz	0.93 dBm 0.95 dBm 1.2 dBm	

Parameter/Frequency	Range	CMC <sup>2, 6</sup> (±)	Comments
RF Relative Power (Tuned RF Level) <sup>3</sup> – Measure			
100 kHz to 50 GHz	(0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB	0.023 dB 0.02 dB 0.035 dB 0.041 dB 0.046 dB 0.095 dB 0.10 dB 0.14 dB 0.15 dB	Agilent E4448A
100 kHz to 45 GHz	(-90 to -100) dB (-100 to -110) dB	0.16 dB 0.29 dB	
100 kHz to 31.15 GHz	(-110 to -120) dB (-120 to -130) dB	0.29 dB 0.29 dB	

Parameter/Frequency	Range	CMC <sup>2, 5, 6</sup> (±)	Comments
Attenuation <sup>3</sup> –			
DC to 12.4 GHz	1 dB 2 dB 3 dB 4 dB 5 dB 6 dB 7 dB 8 dB 9 dB 10 dB 11 dB	0.31 dB 0.31 dB 0.4 dB 0.4 dB 0.5 dB 0.5 dB 0.6 dB 0.6 dB 0.6 dB 0.6 dB 0.7 dB	Agilent 8494H
(12.4 to 18) GHz	1 dB 2 dB 3 dB 4 dB 5 dB 6 dB 7 dB 8 dB 9 dB 10 dB 11 dB	0.7 dB 0.7 dB 0.7 dB 0.7 dB 0.7 dB 0.8 dB 0.8 dB 0.8 dB 0.8 dB 0.9 dB 0.9 dB	
DC to 12.4 GHz	10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB 80 dB 90 dB 100 dB 110 dB	0.5 dB 0.7 dB 0.9 dB 1.2 dB 1.5 dB 1.8 dB 2.1 dB 2.4 dB 2.7 dB 3 dB 3.3 dB	Agilent 8496H
(12.4 to 18) GHz	10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB 80 dB 90 dB 100 dB 110 dB	0.6 dB 0.8 dB 1.2 dB 1.6 dB 2 dB 2.4 dB 2.8 dB 3.2 dB 3.6 dB 4 dB 4.4 dB	

Parameter/Frequency	Range	CMC <sup>2, 5, 6</sup> ( $\pm$ )	Comments
Reflection <sup>3</sup> S <sub>11</sub> /S <sub>22</sub> - Magnitude			
300 kHz to 10 MHz	(0 to 0.5) lin (0.5 to 1) lin	0.0095 lin 0.019 lin	Agilent E5071C Agilent 85032F
(10 to 50) MHz	(0 to 0.5) lin (0.5 to 1) lin	0.012 lin 0.022 lin	
50 MHz to 2 GHz	(0 to 0.5) lin (0.5 to 1) lin	0.015 lin 0.023 lin	Agilent N5235A Agilent 85056K
(2 to 40) GHz	(0 to 0.5) lin (0.5 to 1) lin	0.028 lin 0.04 lin	
Transmission <sup>3</sup> S <sub>12</sub> /S <sub>21</sub> - Magnitude			
300 kHz to 10 MHz	(0 to -30) dB (-30 to -60) dB	0.092 dB 0.45 dB	Agilent E5071C Agilent 85032F
(10 to 50) MHz	(0 to -30) dB (-30 to -60) dB	0.092 dB 0.26 dB	
(50 to 500) MHz	(0 to -30) dB (-30 to -60) dB	0.072 dB 1.6 dB	Agilent N5235A Agilent 85056K
500 MHz to 2 GHz	(0 to -30) dB (-30 to -60) dB	0.046 dB 0.018 dB	
(2 to 40) GHz	(0 to -30) dB (-30 to -60) dB	0.14 dB 0.55 dB	
Electrical Fast Transients <sup>3</sup>	0.25 kV to 4 kV	2.7 %	Ametek CA EFT kit

Parameter/Range	Frequency	CMC <sup>2, 5, 6</sup> (±)	Comments
Amplitude Modulation <sup>3</sup> – Measure			
AM Depth:			
100 kHz to 10 MHz	50 Hz to 10 kHz, (5 to 99) %	0.86 %	Agilent E4448A
10 MHz to 3 GHz	50 Hz to 100 kHz, (20 to 99) % (5 to 20) %	0.76 % 2.6 %	
(3 to 26.5) GHz	50 Hz to 100 kHz, (20 to 99) % (5 to 20) %	1.6 % 4.5 %	
(26.5 to 31.15) GHz	50 Hz to 100 kHz, (20 to 99) % (5 to 20) %	2.1 % 6.8 %	
(31.15 to 50) GHz	50 Hz to 100 kHz, (20 to 99) % (5 to 20) %	6 % 26 %	
AM Distortion:			
100 kHz to 10 GHz	20 Hz to 1 kHz > 1 % > 3 %	0.85 % 0.42 %	
10 MHz to 26.5 GHz	20 Hz to 1 kHz > 1 % > 3 %	1 % 0.5 %	
(26.5 to 50) GHz	20 Hz to 1 kHz > 1 % > 3 % > 5 %	6.2 % 2 % 1.5 %	
Amplitude Modulation <sup>3</sup> – Generate			
Depths (0 to 90) %	250 kHz to 50 GHz	6.6 %	Agilent E8257D

Parameter/Range	Frequency	CMC <sup>2, 5, 6</sup> (±)	Comments
Frequency Modulation <sup>3</sup> – Measure			
FM Deviation: 250 kHz to 10 MHz	20 Hz to 10 kHz Dev/Rate > 0.2 Dev/Rate > 1.2	1.5 % 1 %	Agilent E4448A
10 MHz to 6.6 GHz	50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 0.45	1.5 % 1 %	
(6.6 to 13.2) GHz	50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 8	2.5 % 1 %	
(13.2 to 31.15) GHz	50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 16	3.8 % 1 %	
(31.5 to 50) GHz	50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 32	8.5 % 1 %	
FM Distortion: 1 MHz to 6.6 GHz	20 Hz to 1 kHz Dev 500 Hz to 2 kHz Dev ≥ 2.0 kHz	0.3 % 0.11 %	
(6.6 to 13.2) GHz	20 Hz to 1 kHz Dev > 2.3 kHz Dev ≥ 4.5 kHz	0.3 % 0.11 %	
(13.2 to 31.15) GHz	20 Hz to 1 kHz Dev > 2.7 kHz Dev ≥ 6.0 kHz	0.31 % 0.12 %	
(31.15 to 50) GHz	20 Hz to 1 kHz Dev > 4.0 kHz Dev ≥ 12.0 kHz	0.32 % 0.14 %	
Frequency Modulation <sup>3</sup> – Generate			
Rate: DC to 10 MHz Dev.: ≤ 128 MHz	250 kHz to 50 GHz	3.9 %	Agilent E8257D



Parameter/Frequency	Range	CMC <sup>2, 5, 6</sup> (±)	Comments	
Phase Modulation <sup>3</sup> – Measure				
PM Deviation:				
100 kHz to 6.6 GHz	>0.7 rad > 0.3 rad	1.1 % 3.2 %	Agilent E4448A	
(6.6 to 13.2) GHz	> 2.0 rad > 0.6 rad	1.1 % 3.2 %		
(13.2 to 26.5) GHz	> 4.0 rad > 1.2 rad	1.1 % 3.2 %		
(26.5 to 31.15) GHz	> 4.0 rad > 1.3 rad	1.1 % 3.2 %		
(31.15 to 50) GHz	> 8.0 rad > 2.4 rad	1.1 % 3.2 %		
PM Distortion:				
1 MHz to 6.6 GHz	(20 to 500) Hz > 0.8 rad ≥ 2.5 rad 500 Hz to 1 kHz > 0.4 rad ≥ 1.0 rad	0.31 % 0.13 % 0.31 % 0.13 %		
(6.6 to 13.2) GHz	(20 to 500) Hz > 1.8 rad ≥ 5.5 rad 500 Hz to 1 kHz ≥ 0.8 rad ≥ 2.5 rad	0.31 % 0.13 % 0.31 % 0.13 %		
(13.2 to 31.15) GHz	(20 to 500) Hz > 3.5 rad ≥ 10.0 rad 500 Hz to 1 kHz > 1.2 rad ≥ 4 rad	0.31 % 0.13 % 0.31 % 0.13 %		
(31.15 to 50) GHz	(20 to 500) Hz > 7.5 rad ≥ 19.0 rad 500 Hz to 1 kHz > 3.0 rad ≥ 8.0 rad	0.31 % 0.13 % 0.31 % 0.13 %		

Parameter/Range	Frequency	CMC <sup>2, 5, 6</sup> (±)	Comments
Phase Modulation <sup>3</sup> – Generate  (0 to 10) rad (0 to 20) rad (0 to 40) rad (0 to 80) rad (0 to 160) rad (0 to 320) rad (0 to 640) rad (0 to 1280) rad	(250 to 500) MHz 500 MHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz (3.2 to 10) GHz (10 to 20) GHz (20 to 40) GHz (40 to 50) GHz	5.8 % 5.8 % 5.8 % 5.8 % 5.8 % 5.8 % 5.8 % 5.8 %	Agilent E8257D
Single Sideband Phase Noise (SSB) <sup>3</sup> – Measure  CW Frequency: 3 Hz to 3 GHz (3 to 6.6) GHz (6.6 to 22) GHz (22 to 26.8) GHz (26.8 to 31.15) GHz (31.15 to 50) GHz	Markers: 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz	0.58 dB 1 dB 1.6 dB 1.7 dB 1.1 dB 1.4 dB	Agilent E4448A
Distortion (THD) <sup>3</sup>	10 Hz to 100 kHz	8.4 % of indicated harmonic distortion	Agilent U8903A

#### V. Mechanical

Parameter/Equipment	Range	CMC <sup>2, 5, 6</sup> (±)	Comments
Torque <sup>3</sup> – Tools/Wrenches	(5 to 50) in·lbf (50 to 400) in·lbf (400 to 1000) in·lbf (25 to 250) ft·lbf (250 to 600) ft·lbf	1 % 1 % 1 % 1 % 1 %	CDI 2000-400-02  CDI 2000-12-02
Scales & Balances <sup>3</sup>	Up to 400 lb	0.001 %	Class F weights

Parameter/Equipment	Range	CMC <sup>2, 5, 6</sup> (±)	Comments
Pressure Gauges <sup>3</sup>	(10 to 1000) psi	0.026 %	Ametek HK-1000

## VI. Time & Frequency

Parameter/Range	Frequency	CMC <sup>2, 6</sup> (±)	Comments
Frequency – Measure	0.001 Hz to 50 GHz	$5.6 \cdot 10^{-12} f$	Frequency counter $f$ = frequency
Frequency – Measuring Equipment			
Fixed Point	10 MHz	5.6 pHz/Hz	Fluke 910R
Sine Wave	100 μHz to 15 MHz	23 μHz/Hz	Agilent 33120A
Square Wave	100 μHz to 15 MHz	23 μHz/Hz	
Triangular Wave	100 μHz to 100 kHz	23 μHz/Hz	

<sup>1</sup> This laboratory offers commercial and field 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. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of  $k = 2$ . The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

<sup>3</sup> Field calibration service is available for this calibration and this laboratory meets A2LA R104 - General Requirements: Accreditation of Field Testing and Field Calibration Laboratories for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

<sup>4</sup> 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. CMC's 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.

<sup>5</sup> In the statement of Calibration and Measurement Capability (CMC), percentages are to be read as percent of reading unless otherwise noted.

<sup>6</sup> The contributions from the “best existing device” are not included in the CMC claim.