



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

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CALIBRATION

Valid To: July 31, 2012

Certificate Number: 2192.01

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

I. Acoustical Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Sound – Measure Microphone Sensitivity	250 Hz	0.10 dB	Bruel & Kjaer model 9699 reciprocity system with 4160 1 inch microphones

II. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Angle Blocks – Measure, Fixed Points	45°, 30°, 15°, 5°, 3°, 1° (30, 20, 5, 3, 1) min (30, 20, 5, 3, 1) s	0.75 "	Autocollimator

Parameter/Equipment	Range	CMC ^{2,3} (±)	Comments
Laser Frequency – Measure Laser Heads HP 5518A ML10	Nominal 4.74×10^8 MHz	 3 MHz (3.3×10^{-6}) nm 12 MHz (1.6×10^{-5}) nm	Iodine stabilized laser
Gage Blocks – Measure Thin Blocks Fixed Point Short Blocks Long Blocks Fixed Points	 (0.01 to 0.09375) in 0.5 mm (0.1 to 1) in (2 to 4) in (1 to 25) mm (30 to 100) mm (5, 6, 7, 8, 10, 12, 16, 20) in (125, 150, 175, 200, 250, 300, 400, 500) mm	 3 μ in 75 nm 2 μ in ($1.2 + 0.7L$) μ in 50 nm ($46 + 0.6L$) nm ($2.4 + 0.4L$) μ in ($60 + 0.4L$) nm	 Chrome carbide and steel blocks (English) Chrome carbide and steel blocks (Metric) Chrome carbide and steel blocks (English) Chrome carbide and steel blocks (Metric) Steel blocks (English) Steel blocks (Metric)
Plug Gages – Measure Outside Diameter	(0.1 to < 0.825) in (0.825 to < 5.0) in (5.0 to 11.0) in (2.54 to < 20.955) mm (20.955 to < 127) mm (127 to 279.4) mm	5.0 μ in ($4.4 + 1.4L$) μ in ($12 + 1.4L$) μ in 130 nm ($120 + 1.4L$) nm ($310 + 1.4L$) nm	Federal comparators, models 136B-3, 130B-24

Parameter/Equipment	Range	CMC ^{2,3} (±)	Comments
Ring Gages – Measure Inside Diameter	(0.125 to < 0.825) in (0.825 to < 1.51) in (1.51 to < 2.51) in (2.51 to < 5.0) in (5.0 to 11.0) in (3.175 to < 20.955) mm (20.955 to < 38.354) mm (38.354 to < 63.754) mm (63.754 to < 127) mm (127 to 279.4) mm	6.5 μin 7.5 μin 10 μin (7.8 + 1.2L) μin (14 + 1.3L) μin 170 nm 200 nm 260 nm (200 + 1.2L) nm (360 + 1.3L) nm	Federal comparator, model 136B-3
Angle – Measure			Dual closure with:
Polygons	0 ° to 360 °	0.25 "	Autocollimator, indexing tables
Indexing Tables	0 ° to 360 ° (30 ° and 15 ° increments)	0.35 "	Autocollimator, polygon, indexing tables

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
DC Voltage – Measure			
Fixed Points	10.0 V	0.15 μV/V	Solid state reference standards (Zener) with Array Josephson junction
	10.0 V	0.67 μV/V	Zeners compared against Zeners

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Voltage, High – Measure			
1 V Tap	10 kV 50 kV 75 kV 100 kV	0.0075 % 0.0071 % 0.0070 % 0.0090 %	Julie Research, model HVA 100
10 V Tap	10 kV 50 kV 75 kV 100 kV	0.0089 % 0.0079 % 0.011 % 0.016 %	
DC Current – Measure, Shunts	10 kΩ, 10 μA 1 kΩ, 100 μA 100 Ω, 1 mA 10 Ω, 10 mA 1 Ω, 100 mA 0.1 Ω, 1 A 0.01 Ω, 10 A/2 A 0.01 Ω, 10 A/10 A 0.001 Ω, 10 A/20 A 0.0003333 Ω, 100 A/100 A	20 μΩ/Ω 15 μΩ/Ω 26 μΩ/Ω 18 μΩ/Ω 9 μΩ/Ω 6 μΩ/Ω 11 μΩ/Ω 25 μΩ/Ω 57 μΩ/Ω 0.026 %	Measurement International resistance bridge, Guildline 9211A DC shunt
DC Resistance – Measure, Fixed Points	1 Ω 10 Ω 100 Ω 1000 Ω 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	3.6 μΩ/Ω 2.2 μΩ/Ω 1.4 μΩ/Ω 1.4 μΩ/Ω 2.2 μΩ/Ω 4.9 μΩ/Ω 12 μΩ/Ω 21 μΩ/Ω 24 μΩ/Ω	6634RS/4310AF using Measurement International and Guildline resistance bridges 6634TS/4304AF using Measurement International and Guildline resistance bridges

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Inductance – Measure, Fixed Point	100 mH	0.07 %	General Radio model 1689M Digibridge
Capacitance – Measure Fixed Points			
1 pF	400 Hz 1000 Hz	8.6 μF/F 6.6 μF/F	Andeen-Hagerling 2700A
10 pF	400 Hz 1000 Hz	6.1 μF/F 6.0 μF/F	
100 pF	400 Hz 1000 Hz	6.1 μF/F 6.0 μF/F	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Measure, Shunts			
(0.02, 0.03, 0.05, 0.1, 0.2, 0.3, 0.5, 1.0, 2.0, 3.0, 5.0, 10, 20) A	40 Hz, (1, 5, 10, 20) kHz	0.07 %	Fluke AC current shunts A45
AC–DC Voltage Difference – Measure, Fixed Points			
Thermal Voltage Converters			Precision measurement model EL 2400
0.5 V, (50 & 75) Ω	1 MHz	0.20 %	
1V, (15,75,135,& 150)	10 MHz	0.20 %	
Ω, 3V, 50Ω, 3V, 600Ω	20 MHz	0.20 %	
	30 MHz	0.29 %	
	40 MHz	0.38 %	
	50 MHz	0.40 %	
	60 MHz	0.50 %	
	70 MHz	0.60 %	
	80 MHz	0.70 %	
	90 MHz	0.80 %	
	100 MHz	1.1 %	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current, High – Measure ⁴ , Fixed Points			
DC Resistance			
10 mA	80 Ω	43 μΩ/Ω	Fluke AC Current Shunts – A40B DC Resistance
20 mA	40 Ω	43 μΩ/Ω	
50 mA	16 Ω	43 μΩ/Ω	
100 mA	8 Ω	43 μΩ/Ω	
200 mA	4 Ω	43 μΩ/Ω	
500 mA	1.6 Ω	43 μΩ/Ω	
1 A	0.8 Ω	43 μΩ/Ω	
2 A	0.4 Ω	43 μΩ/Ω	
5 A	0.16 Ω	43 μΩ/Ω	
10 A	0.08 Ω	43 μΩ/Ω	
20 A	0.04 Ω	43 μΩ/Ω	
50 A	0.016 Ω	43 μΩ/Ω	
100 A	0.008 Ω	43 μΩ/Ω	
AC/DC Difference			
10 mA, 80Ω	1 kHz	68 μA/A	Fluke AC Current Shunts – A40B
	10 kHz	67 μA/A	
	30 kHz	74 μA/A	
	100 kHz	0.014 %	
20 mA, 40Ω	1 kHz	68 μA/A	
	10 kHz	67 μA/A	
	30 kHz	75 μA/A	
	100 kHz	0.013 %	
50 mA, 16Ω	1 kHz	68 μA/A	
	10 kHz	67 μA/A	
	30 kHz	69 μA/A	
	100 kHz	84 μA/A	
100 mA, 8Ω	1 kHz	79 μA/A	
	10 kHz	77 μA/A	
	30 kHz	90 μA/A	
	100 kHz	0.012 %	
200 mA, 4Ω	1 kHz	86 μA/A	
	10 kHz	85 μA/A	
	30 kHz	88 μA/A	
	100 kHz	0.012 %	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current, High – Measure ⁴ AC/DC Difference, Fixed Points (cont)			
500 mA, 1.6Ω	1 kHz	95 μA/A	Fluke AC Current Shunts – A40B
	10 kHz	95 μA/A	
	30 kHz	99 μA/A	
	100 kHz	0.013 %	
1 A, 0.8Ω	1 kHz	88 μA/A	
	10 kHz	88 μA/A	
	30 kHz	92 μA/A	
	100 kHz	0.012 %	
2 A, 0.4Ω	1 kHz	87 μA/A	
	10 kHz	85 μA/A	
	30 kHz	88 μA/A	
	100 kHz	0.012 %	
5 A, 0.16Ω	1 kHz	95 μA/A	
	10 kHz	95 μA/A	
	30 kHz	97 μA/A	
	100 kHz	0.012 %	
10 A, 0.08Ω	1 kHz	89 μA/A	
	10 kHz	88 μA/A	
	30 kHz	89 μA/A	
	100 kHz	0.011 %	
20 A, 0.04Ω	1 kHz	85 μA/A	
	10 kHz	85 μA/A	
	30 kHz	89 μA/A	
	100 kHz	0.012 %	
50 A, 0.016Ω	1 kHz	95 μA/A	
	10 kHz	95 μA/A	
	30 kHz	98 μA/A	
	100 kHz	0.013 %	
100 A, 0.008Ω	1 kHz	88 μA/A	
	10 kHz	95 μA/A	
	30 kHz	89 μA/A	
	100 kHz	0.011 %	

IV. Electrical – RF/Microwave

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Power – Measure, Fixed Points, (Coaxial) Calibration Factors of Thermistor Mounts	0.1 MHz	1.5 %	Weinschel Engineering F1116 thermistor mount against M1111
	0.2 MHz	1.2 %	
	0.4 MHz	1.2 %	
	0.5 MHz	0.95 %	
	1.0 MHz	0.77 %	
	2.0 MHz	0.75 %	
	4.0 MHz	0.72 %	
	6.0 MHz	0.73 %	
	8.0 MHz	0.71 %	
	10.0 MHz	0.71 %	
RF Power – Measure, Fixed Points, (Coaxial) Calibration Factors of Thermistor Mounts	10 MHz	0.78 %	Weinschel Engineering F1109 thermistor mount against M1111
	30 MHz	0.8 %	
	50 MHz	1.0 %	
	100 MHz	0.8 %	
	200 MHz	0.8 %	
	300 MHz	0.9 %	
	400 MHz	0.9 %	
	500 MHz	0.9 %	
	950 MHz	0.9 %	
	1000 MHz	0.9 %	
	1030 MHz	0.8 %	
	1050 MHz	0.9 %	
	1090 MHz	0.8 %	
	1100 MHz	0.9 %	
	1150 MHz	1.1 %	
	1200 MHz	1.1 %	
1225 MHz	1.1 %		
1250 MHz	1.1 %		

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Power (cont) – Measure, Fixed Points, (Coaxial) Calibration Factors of Thermistor Mounts	1300 MHz	1.1 %	Weinschel Engineering F1109 thermistor mount against M1110
	1350 MHz	1.2 %	
	1400 MHz	1.2 %	
	1450 MHz	1.2 %	
	1500 MHz	1.2 %	
	1550 MHz	1.2 %	
	1600 MHz	1.3 %	
	1650 MHz	1.1 %	
	1700 MHz	1.3 %	
	1750 MHz	1.3 %	
	1800 MHz	1.2 %	
	1850 MHz	1.2 %	
	1900 MHz	1.2 %	
	1950 MHz	1.0 %	
	2000 MHz	1.0 %	
	2100 MHz	1.0 %	
	2200 MHz	1.2 %	
	2300 MHz	1.2 %	
	2400 MHz	1.2 %	
	2500 MHz	1.2 %	
	2600 MHz	1.2 %	
	2700 MHz	1.2 %	
	2800 MHz	1.2 %	
	2900 MHz	1.3 %	
	3000 MHz	1.3 %	
	3100 MHz	1.3 %	
	3200 MHz	1.3 %	
	3300 MHz	1.3 %	
	3400 MHz	1.3 %	
	3500 MHz	1.3 %	
	3600 MHz	1.3 %	
3700 MHz	1.3 %		
3800 MHz	1.4 %		
3900 MHz	1.4 %		
4000 MHz	1.4 %		
4200 MHz	1.4 %		
4400 MHz	1.4 %		
4600 MHz	1.4 %		
4800 MHz	1.5 %		
5000 MHz	1.5 %		
5200 MHz	1.5 %		
5400 MHz	1.5 %		
5600 MHz	1.5 %		
5800 MHz	1.5 %		

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Power (cont) – Measure, Fixed Points, (Coaxial) Calibration Factors of Thermistor Mounts	6000 MHz	1.5 %	Weinschel Engineering F1109 thermistor mount against M1110
	6200 MHz	1.6 %	
	6400 MHz	1.5 %	
	6600 MHz	1.6 %	
	6800 MHz	1.6 %	
	7000 MHz	1.6 %	
	7200 MHz	1.5 %	
	7400 MHz	1.6 %	
	7600 MHz	1.7 %	
	7800 MHz	1.6 %	
	8000 MHz	1.9 %	
	8200 MHz	1.9 %	
	8400 MHz	1.9 %	
	8600 MHz	2.0 %	
	8800 MHz	2.2 %	
	9000 MHz	2.0 %	
	9200 MHz	2.0 %	
	9400 MHz	1.9 %	
	9600 MHz	1.8 %	
	9800 MHz	1.8 %	
	10000 MHz	1.8 %	
	10200 MHz	1.8 %	
	10400 MHz	1.9 %	
	10600 MHz	1.9 %	
	10800 MHz	1.8 %	
	11000 MHz	1.7 %	
	11200 MHz	1.8 %	
	11400 MHz	1.9 %	
	11600 MHz	2.0 %	
	11800 MHz	2.3 %	
12000 MHz	2.3 %		
12200 MHz	2.4 %		
12400 MHz	2.5 %		
12750 MHz	2.5 %		
13000 MHz	2.6 %		
13250 MHz	2.6 %		
13500 MHz	2.5 %		
13750 MHz	2.1 %		
14000 MHz	1.9 %		
14250 MHz	1.9 %		
14500 MHz	1.7 %		
14750 MHz	1.6 %		
15000 MHz	1.6 %		

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Power (cont) – Measure, Fixed Points, (Coaxial) Calibration Factors of Thermistor Mounts	15250 MHz 15500 MHz 15750 MHz 16000 MHz 16250 MHz 16500 MHz 16750 MHz 17000 MHz 17250 MHz 17500 MHz 17750 MHz 18000 MHz	1.6 % 1.5 % 1.5 % 1.5 % 1.5 % 1.6 % 1.6 % 1.7 % 1.8 % 1.9 % 2.2 % 2.0 %	Weinschel Engineering F1109 thermistor mount against M1110
RF Power – Measure, Fixed Points, (Coaxial) Calibration Factors of Thermistor Mounts	10 MHz 20 MHz 30 MHz 40 MHz 50 MHz 60 MHz 70 MHz 80 MHz 90 MHz 100 MHz 105 MHz 150 MHz 200 MHz 250 MHz 300 MHz 350 MHz 400 MHz 450 MHz 500 MHz 550 MHz 600 MHz 650 MHz 700 MHz 750 MHz 800 MHz 850 MHz 900 MHz 950 MHz 1000 MHz 1030 MHz 1090 MHz	0.6 % 0.6 % 0.6 % 0.6 % 0.5 % 0.6 % 0.6 % 0.6 % 0.6 % 0.6 % 1.1 % 1.1 % 1.1 % 1.1 % 1.1 % 1.1 % 1.1 % 1.1 % 1.1 % 1.1 % 1.2 % 1.2 % 1.3 % 1.4 % 1.4 % 1.4 % 1.4 % 1.4 % 1.4 % 1.5 % 1.4 % 1.4 %	Agilent 478A-H73 against Agilent 478A- H73

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Power – Measure (Waveguide) Calibration Factors for Thermistor Mounts plus Couplers	(8.2 to 12.4) GHz (12.4 to 18.0) GHz (18 to 26.5) GHz (26.5 to 40) GHz	1.6 % 1.9 % 4.2 % 4.0 %	Comparison of 486A against 486A/DBG-675-3 X-band P-band K-band R-band
RF Power – Measure (Waveguide) Calibration Factors for Thermistor	(8.2 to 12.4) GHz (12.4 to 18.0) GHz (18 to 26.5) GHz (26.5 to 40) GHz	1.9 % 2.5 % 4.3 % 3.9 %	Comparison of 486A/DBG-675-3 against 486A X-band P-band K-band R-band
Reflection Measurements – S11/S22, Magnitude & Phase Coaxial Type N	(0 to 0.10) lin; (0.045 to 2.0) GHz (0 to 0.10) lin; (2.0 to 8.0) GHz (0 to 0.10) lin; (8.0 to 18.0) GHz (0.10 to 0.30) lin; (0.045 to 2.0) GHz (0.10 to 0.30) lin; (2.0 to 8.0) GHz (0.10 to 0.30) lin; (8.0 to 18.0) GHz	0.0051 to 0.0056 (3.2 to 180) ° 0.0091 to 0.0096 (7.0 to 180) ° 0.0094 to 0.01 (9.2 to 180) ° 0.0056 to 0.0076 (1.3 to 2.95) ° 0.0097 to 0.013 (3.7 to 6.5) ° 0.01 to 0.014 (5.9 to 8.7) °	HP 8510C, test set 8515A, source 8340B, cables 85132F, cal kit 85054B

Parameter/Equipment	Range	CMC ² (±)	Comments
Reflection Measurements (cont) – S11/S22, Magnitude & Phase			
Coaxial Type N	(0.30 to 0.70) lin; (0.045 to 2.0) GHz	0.0076 to 0.013 (0.9 to 3.7) °	HP 8510C, test set 8515A, source 8340B, cables 85132F, cal kit 85054B
	(0.30 to 0.70) lin; (2.0 to 8.0) GHz	0.013 to 0.022 (3.1 to 3.7) °	
	(0.30 to 0.70) lin; (8.0 to 18.0) GHz	0.014 to 0.027 (5.5 to 5.8) °	
	(0.70 to 1.0) lin; (0.045 to 2.0) GHz	0.013 to 0.018 (0.83 to 0.89) °	
	(0.70 to 1.0) lin; (2.0 to 8.0) GHz	0.022 to 0.031 (3.1 to 3.1) °	
	(0.70 to 1.0) lin; (8.0 to 18.0) GHz	0.027 to 0.042 (5.7 to 5.5) °	
Coaxial 7 mm	(0 to 0.10) lin; (0.045 to 2.0) GHz	0.0035 to 0.004 (2.3 to 180) °	
	(0 to 0.10) lin; (2.0 to 8.0) GHz	0.0036 to 0.0041 (3.9 to 180) °	
	(0 to 0.10) lin; (8.0 to 18.0) GHz	0.0048 to 0.0054 (6.0 to 180) °	
	(0.10 to 0.30) lin; (0.045 to 2.0) GHz	0.004 to 0.0059 (1.0 to 2.1) °	
	(0.10 to 0.30) lin; (2.0 to 8.0) GHz	0.0041 to 0.0063 (2.6 to 3.7) °	
	(0.10 to 0.30) lin; (8.0 to 18.0) GHz	0.0052 to 0.0079 (4.7 to 5.8) °	
	(0.30 to 0.70) lin; (0.045 to 2.0) GHz	0.006 to 0.011 (0.68 to 0.98) °	
	(0.30 to 0.70) lin; (2.0 to 8.0) GHz	0.0063 to 0.0124 (2.4 to 2.6) °	
	(0.30 to 0.70) lin; (8.0 to 18.0) GHz	0.0079 to 0.017 (4.6 to 4.7) °	

Parameter/Equipment	Range	CMC ² (±)	Comments
Reflection Measurements (cont) – S11/S22, Magnitude & Phase			
Coaxial 7 mm	(0.70 to 1.0) lin; (0.045 to 2.0) GHz	0.011 to 0.015 (0.62 to 0.68) °	HP8510C, test set 8515A, source 8340B, cables 85132F, cal kit 85050B
	(0.70 to 1.0) lin; (2.0 to 8.0) GHz	0.013 to 0.018 (2.4 to 2.4) °	
	(0.70 to 1.0) lin; (8.0 to 18.0) GHz	0.017 to 0.025 (4.6 to 4.6) °	
Coaxial 3.5 mm	(0 to 0.10) lin; (0.045 to 2.0) GHz	0.006 to 0.0065 (3.7 to 180) °	
	(0 to 0.10) lin; (2.0 to 8.0) GHz	0.0083 to 0.0088 (6.6 to 180) °	
	(0 to 0.10) lin; (8.0 to 20.0) GHz	0.0084 to 0.0089 (8.9 to 180) °	
	(0 to 0.10) lin; (20.0 to 26.5) GHz	0.0087 to 0.0091 (10.3 to 180) °	
	(0.10 to 0.30) lin; (0.045 to 2.0) GHz	0.0065 to 0.0086 (1.6 to 3.4) °	
	(0.10 to 0.30) lin; (2.0 to 8.0) GHz	0.0088 to 0.012 (3.7 to 6.2) °	
	(0.10 to 0.30) lin; (8.0 to 20.0) GHz	0.0089 to 0.013 (6.1 to 8.5) °	
	(0.10 to 0.30) lin; (20.0 to 26.5) GHz	0.0091 to 0.013 (7.4 to 9.8) °	
	(0.30 to 0.70) lin; (0.045 to 2.0) GHz	0.0086 to 0.016 (1.2 to 1.6) °	
	(0.30 to 0.70) lin; (2.0 to 8.0) GHz	0.012 to 0.024 (3.3 to 3.7) °	
	(0.30 to 0.70) lin; (8.0 to 20.0) GHz	0.013 to 0.027 (5.9 to 6.1) °	

Parameter/Equipment	Range	CMC ² (±)	Comments
Reflection Measurements (cont) – S11/S22, Magnitude & Phase, Coaxial 3.5 mm	(0.30 to 0.70) lin; (20.0 to 26.5) GHz	0.013 to 0.027 (7.1 to 7.3) °	HP 8510 C, test set 8515A, source 8340B, cables 85131F, cal kit 85052B
	(0.70 to 1.0) lin; (0.045 to 2.0) GHz	0.016 to 0.023 (1.2 to 1.6) °	
	(0.70 to 1.0) lin; (2.0 to 8.0) GHz	0.024 to 0.038 (3.5 to 3.3) °	
	(0.70 to 1.0) lin; (8.0 to 20.0) GHz	0.027 to 0.044 (6.2 to 5.9) °	
	(0.70 to 1.0) lin; (20.0 to 26.5) GHz	0.027 to 0.044 (7.4 to 7.1) °	

V. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Gas Flow	(2 to 10) sccm (10 to 100) sccm (0.1 to 1) slm (1 to 10) slm (4 to 40) slm	0.25 % + 0.02 % fs 0.27 % + 0.02 % fs 0.25 % + 0.02 % fs 0.19 % + 0.02 % fs 0.3 % + 0.02 % fs	DH Instruments Molbloc set

VI. Ionizing Radiation and Radioactivity

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Gamma Radiation – Measure			
Gamma Radiation Sources	20 µR/hr to 10 000 R/hr	4.5 %	Shonka-Wycoff ionization chambers with Cs ¹³⁷ and Co ⁶⁰ sources

Parameter/Equipment	Range	CMC ^{2,4,5} (±)	Comments
Pressure – Hydraulic, Absolute			DHI 7302
Measuring Equipment	(72.5 to 5800) psi, or (0.5 to 40) MPa	0.004 % + 50 Pa	Using NIST calibrated pistons
	(290 to 23 206) psi, or (2 to 160) MPa	0.0037 % + 56 Pa	
	(725 to 40 000) psi, or (5 to 275) MPa	0.0041 % + 82 Pa	
	(40 to 58) kpsi, or (275 to 400) MPa	0.0062 % + 82 Pa	
(Cross Float), Measure, Calibration of Piston Areas	(72.5 to 3264) psi, or (0.5 to 22.5) MPa	0.0054 %	Calibration of UUT pistons with NIST calibrated pistons
	(290 to 13 053) psi, or (2 to 90) MPa	0.0047 %	
	(290 to 32 634) psi, or (5 to 225) MPa	0.005 %	
Calibration of Pressure Systems, Measure	(72.5 to 3264) psi, or (0.5 to 22.5) MPa	0.0056 % + 50 Pa	Calibration of UUTs (dead weight systems using piston uncertainties determined from crossfloats)
	(290 to 13 053) psi, or (2 to 90) MPa	0.0051 % + 56 Pa	
	(290 to 32 634) psi, or (5 to 225) MPa	0.0055 % + 82 Pa	
Differential Pressure – Measure			
Differential Pressure Gages	(0 to 15) kPa	0.0063 % + 0.40 Pa	DH Instruments force balanced piston gage, model FPG8601

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Pneumatic High Pressure –			
Measuring Equipment – Gage and Absolute	(2 to 110) MPa	0.0038 % + 69 Pa	DH Instruments PC-7202-2 using a NIST calibrated piston
Measure – Cross-Float, Calibration of Piston Areas	(2 to 110) MPa	0.0048 %	DH Instruments PC-7202-2
Measure Pressure Systems – Gage and Absolute	(2 to 110) MPa	0.0052 % + 85 Pa	DH Instruments PC-7202-2
Mass – Measure, Weights and Weight Sets, Fixed Points (Double Substitution)	20 kg 10 kg 5 kg 3 kg 2 kg 1 kg 500 g 300 g 200 g 100 g 50 g 30 g 20 g 10 g 5 g 3 g 2 g 1 g 500 mg 300 mg 200 mg 100 mg 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	11 mg 2.2 mg 0.80 mg 0.53 mg 0.39 mg 0.14 mg 95 µg 85 µg 47 µg 16 µg 12 µg 7.1 µg 6.0 µg 5.6 µg 7.8 µg 3.5 µg 3.6 µg 3.6 µg 2.1 µg 1.5 µg 1.5 µg 1.5 µg 1.5 µg 1.4 µg 1.4 µg 1.4 µg 1.6 µg 1.4 µg 1.5 µg 1.5 µg	Mettler comparator balance

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Mass – Measure, Weights and Weight Sets, Fixed Points (Double Substitution) (cont)	50 lb 30 lb 20 lb 10 lb 5 lb 3 lb 2 lb 1 lb 8 oz 4 oz 2 oz 1 oz 1/2 oz 1/4 oz 1/8 oz 1/16 oz 1/32 oz	28 µlb 9.9 µlb 6.3 µlb 3.2 µlb 1.6 µlb 1.1 µlb 0.80 µlb 0.18 µlb 0.09 µlb 0.043 µlb 0.042 µlb 0.022 µlb 0.016 µlb 0.012 µlb 0.017 µlb 0.0080 µlb 0.0081 µlb	Mettler comparator balance
Vacuum – Measure	(0.001 to 0.01) Torr (0.01 to 0.1) Torr (0.1 to 1.0) Torr (1.0 to 10) Torr (10 to 100) Torr	0.37 % + 0.35 mTorr 0.37 % + 1.1 mTorr 0.69 % + 0.21 mTorr 0.55 % + 4 mTorr 0.59 % + 49 mTorr	Capacitance manometers
Force – Measure Load Cells	Full Scale Range: 100 lbf to 2050 lbf (0.44kN to 9.2kN) Full Scale Range: 2,000 to 100,000 lbf (8.9kN to 445kN)	0.016 % fs 0.020 % fs	Morehouse (664000) Ormond (DSW-84-160-100K)

VIII. Optical Quantities

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Spectral Transmittance – Measure (250 to 2500) nm Transmittance Wavelength Wavelength	(0.001 to 0.1) <i>T</i> Up to 0.9 <i>T</i> (240 to 650) nm 3267.78 nm	0.013 <i>T</i> 0.026 <i>T</i> 0.28 nm 0.45 nm	Varian Cary spectrophotometer model 500 scan with: neutral density filters; <i>T</i> is transmittance Polystyrene film, SRM 1921a Varian Cary spectrophotometer model 500 scan with polystyrene film, SRM 1921a
Lasers – Measure Calibration of Laser Power Meters High Energy	(50 to 1000) W (8 to 600) kJ	3.7 % 3.7 %	NIST designed calorimeter
UV Radiation – Measure Irradiance, at 365 nm	(0.5 to 2.5) mW/cm ²	7.3 %	Jerry Bachur Associates light source, LS90-NAFB

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Fiber Optics – Measure ⁴			
Linearity 850 nm 1310 nm 1550 nm	(+3 to -60) dbm (2.5 mW to 1 μW)	0.016 db (0.18 %) 0.015 db (0.17 %) 0.016 db (0.18 %)	NIST triplet superposition system as method to calibrate fiber optic power meter linearity
Power (Collimated) 850 nm 1310 nm 1550 nm	@ 100 μW	1.5 % 1.9 % 2.1 %	Judson IR fiber optic germanium detectors w/Anritsu model MS 9030A spectrum analyzer
Power (Connectorized) 850 nm 1310 nm 1550 nm	@ 100 μW	2.1 % 2.1 % 2.1 %	Agilent power meter model 8153A w/ Anritsu model MS 9030A spectrum analyzer

IX. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Dew Point – Measure, Calibration of Hygrometers	(-70 to 10) °C	0.6 °C	Thunder Scientific 3900
Relative Humidity – Measure, Calibration of RH Meters	(5 to 95) % RH	1 % RH	Thunder Scientific 9000

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measure			
SPRTs at Fixed Points	-189.3442 °C -38.8344 °C 0.01 °C 29.7646 °C	0.0021 °C 0.0007 °C 0.00047 °C 0.001 °C	Pond K38 cell (Ar TP) Pond K18 cell (HG TP) Jarrett TP cell (H ₂ O TP) Isotech 17402A cell (Ga MP)
	231.928 °C	0.0016 °C	Isotech ITL-N-17669 cell (Sn FP)
	419.527 °C	0.0027 °C	Isotech ITL-M-17671 cell (Zn FP)
SPRTs over Temperature Ranges	(-200 to -40) °C (-40 to 0) °C (0 to 450) °C (450 to 661) °C	0.0024 °C 0.001 °C 0.0037 °C 0.013 °C	Fixed point cells, bridge, SPRTs

X. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measure			
Frequency Standards and Meters – Fixed Points	10 MHz	4.5 parts in 10 ¹³	Automated frequency system from NIST with HP 5071A cesium beam
	10 MHz	1.5 parts in 10 ¹¹	Using HP 5071A cesium beam for typical Rubidium standard
	10 MHz	3.5 parts in 10 ⁹	Distributed signal Agilent 53132, opt 12 counter

¹ This laboratory offers commercial calibration service.

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 of nearly ideal measuring equipment. CMC represents expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The CMC of a specific calibration performed by the laboratory may be greater than the best CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

³ In the statement of CMC, L is the numerical value of the nominal length of the unit under test measured in inches or millimeters.

⁴ In the statement of CMC, percentages are percentage of reading, unless otherwise indicated; "fs" stands for "full scale".



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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/NCSL Z540-1-1994 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 13th day of December 2010.

A handwritten signature in black ink, appearing to read "Peter Meyer", written over a horizontal line.

President & CEO
For the Accreditation Council
Certificate Number 2192.01
Valid to July 31, 2012

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