



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

GULF EQUIPMENT METROLOGY SERVICES (GEMS)
PB Box 10166
Jubail Industrial City, Saudi Arabia 31961
Kevin Sterling Phone: +966-3-341-9451

CALIBRATION

Valid To: January 31, 2015

Certificate Number: 3097.01

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

I. Acoustical

Parameter/Equipment	Range	CMC ² (±)	Comments
Sound Level Calibrators, Fixed Points	94 dB, 104 dB and 114 dB	0.6 dB	B&K model 4226 and Quest model 2700

Parameter/Range	Frequency	CMC ² (±)	Comments
Acoustical Levels Sound Level Meters, Noise Dosimeters – 94 dB, 104 dB and 114 dB	31.5 Hz to 4 kHz, Octave Step 8 kHz (12.5 to 16) kHz	0.4 dB 0.5 dB 0.7 dB	B&K model 4226 multifunction acoustic calibrator

II. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Angle – Measure	(1 to 90)°	2 arc minutes	Sine bar, gage blocks and comparator
Angle – Measuring Equipment	(1 to 90)°	2 arc minutes	Mitutoyo model 981-101 and 981-203 with sine bar and gage blocks
Calipers	Up to 12 in (12 to 24) in (24 to 36) in (36 to 48) in (48 to 60) in	590 µin 610 µin 640 µin 690 µin 690 µin	Starrett model SS8A1X and SC88A1X gage block set
Inside, Outside and Depth Micrometers	Up to 1 in (1 to 6) in (6 to 12) in (12 to 24) in (24 to 36) in (36 to 48) in (40 to 60) in	590 µin 590 µin 590 µin 610 µin 640 µin 690 µin 690 µin	Starrett model SS8A1X and SC88A1X gage block set
Digital Micrometers	Up to 1 in (1 to 6) in (6 to 12) in (12 to 24) in (24 to 36) in (36 to 48) in (40 to 60) in	310 µin 310 µin 310 µin 350 µin 400 µin 470 µin 480 µin	Starrett model SS8A1X and SC88A1X gage block set
Dial and Test Indicators	Up to 0.1 in Up to 0.5 in Up to 1 in	26 µin 65 µin 110 µin	Mahr model 400B-50 Starrett model 716

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
Height Gages	Up to 40 in	660 μ in	Starrett model SS8A1X and SC88A1X gage block set
Dial Indicator Testers	Up to 0.1 in (0.1 to 0.5) in (0.5 to 1) in (1 to 2) in	7 μ in 29 μ in 58 μ in 58 μ in	Starrett C88A1X gage block set
Gage Blocks	Up to 8 in (8 to 20) in	(2.5 + 0.5L) μ in 0.48 μ in/in	Pratt & Whitney LabMaster, Agilent model 5530A LMS
Measuring Tapes/ Steel Rules	Up to 130 ft	0.48 μ in/in	Agilent model 5530A LMS
Feeler Gages	(0.001 to 0.050) in	(4.2 + 0.5L) μ in	Pratt & Whitney LabMaster
Coating Thickness Gage –			
Ferrous	Up to 1500 μ m	0.72 μ m	Defelsko thickness standards
Non Ferrous	Up to 1500 μ m	0.59 μ m	Calibration shims, Starrett model 673
Thickness Gages –			
Digital	Up to 2 in	59 μ in	Starrett model SC88A1X gage block set
Dial Type	Up to 2 in	580 μ in	
Cylindrical Plug Gages	Up to 8 in	(2.5 + 0.5L) μ in	Pratt & Whitney LabMaster

Parameter/Equipment	Range	CMC ^{2,4,7} (\pm)	Comments
Threaded Plug Gages – Pitch Diameter & Major Diameter	Up to 8 in	$(200 + 0.5L) \mu\text{in}$	Pratt & Whitney LabMaster, measuring wires
Surface Flatness ³	Up to 50 ft	0.2 %	Agilent model 5530 LMS
Diameter – Measure, (Inside, Outside Class X Master Rings, Plugs & Discs)	(0.05 to 12) in (1.5 to 305) mm	33 μin	Federal model 136B-5 comparator

III. Dimensional Testing/Calibration¹

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
One Dimensional (1D) ⁸ – Length	Up to 4 in	$(2 + 0.5L) \mu\text{in}$	Pratt & Whitney LabMaster
	Up to 40 m	1.7 $\mu\text{m/m}$	Agilent model 5530 LMS
Length Standards (1D)/ Micrometer Standards ⁸	Up to 40 in	0.48 $\mu\text{in/in}$	Agilent model 5530A LMS

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,4,5,6} (±)	Comments
DC Voltage – Measure ³	Up to 200 mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1000) V 1 V, 1.018 V, 10 V	5.3 μV/V + 0.1 μV 3.6 μV/V + 0.4 μV 4.0 μV/V + 8 μV 5.3 μV/V + 0.08 mV 5.7 μV/V + 1 mV 0.53 μV/V	Fluke 8508A Fluke732B with HP 3458A DMM
DC Voltage – Generate ³	(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 1 V, 1.018 V, 10 V	8.8 μV/V + 0.4 μV 5.5 μV/V + 0.7 μV 3.6 μV/V + 2.5 μV 3.6 μV / + 4 μV 9.4 μV/V + 40 μV 6.6 μV/V + 400 μV 0.53 μV/V	Fluke 5700A/EP with 5725A Fluke 732B
DC High Voltage – Measure ³	(0 to 200) kV	0.23 %	Ross Engineering model VMP300-5Y with HP 3458A DMM
DC Current – Generate ³	220 μA 2.2 mA 22 mA 220 mA 2.2 A 11 A Up to 100 A	40 μA/A + 6 nA 44 μA/A + 7 nA 36 μA/A + 40 nA 46 μA/A + 0.7 μA 0.015 % + 12 μA 0.038 % + 480 μA 0.06 %	Fluke 5700A /EP with 5725A Fluke 5500A with Valhalla 2555A
DC Current – Generate & Measure ³			
Clamp-On Ammeters (Toroidal)	(20 to 150) A (150 to 1000) A	0.28 % + 0.015 A 0.29 % + 0.05 A	Fluke model 5520A with 5500A coil
(Non-Toroidal)	(20 to 150) A (150 to 1000) A	0.58 % + 0.014 A 0.58 % + 0.5 A	

Parameter/Equipment	Range	CMC ^{2, 4, 5} (\pm)	Comments
DC Current ³ – Measure, Fixed Points	200 μ A 2 mA 20 mA 200 mA 2 A 20 A	14 μ A/A 14 μ A/A 15 μ A/A 40 μ A/A 0.018 % 0.04 %	Fluke 8508A
	(20 to 2000) A	0.25 %	Fluke 8508A with current shunts
DC Resistance ³ – Generate, Fixed Points	0.1 Ω	0.64 $\mu\Omega/\Omega$	Guildline model 6634-10
	1 Ω	0.04 $\mu\Omega/\Omega$	L&N 4210,
	10 Ω	0.35 $\mu\Omega/\Omega$	Guildline model 6634-10,
	25 Ω	0.48 $\mu\Omega/\Omega$	Tinsely 5685A
	100 Ω	0.40 $\mu\Omega/\Omega$	Guildline model 6634-10,
	1 k Ω	0.35 $\mu\Omega/\Omega$	Guildline model 6634-10,
	10 k Ω	0.32 $\mu\Omega/\Omega$	IET Labs
100 k Ω	0.47 $\mu\Omega/\Omega$	Guildline model 6634-10	
1 M Ω	4.0 $\mu\Omega/\Omega$		
10 M Ω	5 $\mu\Omega/\Omega$		
100 M Ω	18 $\mu\Omega/\Omega$		
	10 M Ω to 1 G Ω	1.5 %	Victoreen resistors, Fluke 8508A
	1 G Ω	0.011 %	Fluke 8508A-7000k
DC Resistance – Measure	1 m Ω to 100 m Ω	1.6 $\mu\Omega/\Omega$ + 1.0 $\mu\Omega/\Omega$ /Ratio	Guildline 6675A with model 6623
	(0.1 to 1) Ω	0.58 $\mu\Omega/\Omega$	Guildline 6675A with standard resistors and oil bath
	(1 to 10) Ω	0.12 $\mu\Omega/\Omega$	
	(10 to 100) Ω	0.25 $\mu\Omega/\Omega$	
	100 Ω to 1 k Ω	0.50 $\mu\Omega/\Omega$	
	(1 to 10) k Ω	1.1 $\mu\Omega/\Omega$	
	(10 to 100) k Ω	0.18 $\mu\Omega/\Omega$	
100 k Ω to 1 M Ω	0.40 $\mu\Omega/\Omega$		
(1 to 10) M Ω	1.2 $\mu\Omega/\Omega$		
	20 M Ω	15 $\mu\Omega/\Omega$ + 100 Ω	Fluke 8508A (normal mode)
	200 M Ω	60 $\mu\Omega/\Omega$ + 1 k Ω	
	2 G Ω	0.053 % + 0.001 G Ω	
	20 G Ω	0.053 % + 0.001 G Ω	Fluke 8508A (high voltage)

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
AC Voltage – Generate ³			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.03 % + 4 μ V 0.017 % + 4 μ V 0.015 % + 4 μ V 0.027 % + 4 μ V 0.061 % + 5 μ V 0.12 % + 10 μ V 0.16 % + 20 μ V 0.29 % + 20 μ V	Fluke 5700A/EP
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.03 % + 4 μ V 0.017 % + 4 μ V 0.014 % + 4 μ V 0.027 % + 4 μ V 0.061 % + 5 μ V 0.12 % + 10 μ V 0.16 % + 20 μ V 0.29 % + 20 μ V	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.026 % + 12 μ V 96 μ V/V + 7 μ V 85 μ V/V + 7 μ V 0.021 % + 7 μ V 0.048 % + 17 μ V 0.092 % + 20 μ V 0.15 % + 25 μ V 0.28 % + 45 μ V	
(0.22 to 2.2) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.025 % + 40 μ V 93 μ V/V + 15 μ V 46 μ V/V + 8 μ V 78 μ V/V + 10 μ V 0.012 % + 300 μ V 0.044 % + 80 μ V 0.11 % + 200 μ V 0.18 % + 300 μ V	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.025 % + 400 μ V 93 μ V/V + 150 μ V 51 μ V/V + 50 μ V 78 μ V/V + 100 μ V 0.011 % + 200 μ V 0.03 % + 600 μ V 0.11 % + 2 mV 0.16 % + 3.2 mV	

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} (\pm)	Comments
AC Voltage ³ – Generate (cont)			
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.029 % + 4 mV 94 μ V/V + 1.5 mV 57 μ V/V + 0.6 mV 95 μ V/V + 1 mV 0.017 % + 2.5 mV 0.09 % + 16 mV 0.44 % + 40 mV 0.08 % + 80 mV	Fluke 5700A/EP
(220 to 1100) V	(0.04 to 1) kHz (1 to 20) kHz (20 to 30) kHz	90 μ V/V + 2 mV 0.012 % + 6 mV 0.06 % + 11 mV	Fluke 5700A/EP with 5725A
(229 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.06 % + 11 mV 0.23 % + 45 mV	
AC Voltage – Measure AC/DC Difference			
0.006 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	0.08 % 0.06 % 0.06 % 0.06 % 0.06 % 0.06 % 0.06 % 0.08 % 0.12 % 0.2 % 0.24 % 0.24 % 0.24 %	Fluke model 792A AC/DC transfer standard
0.01 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	0.5 % 0.5 % 0.5 % 0.5 % 0.5 % 0.5 % 0.5 % 0.5 % 0.7 % 0.1 % 0.16 % 0.18 % 0.18 %	

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Voltage – Measure AC/DC Difference (cont)			
0.02 V	10 Hz	0.03 %	Fluke model 792A AC/DC transfer standard
	20 Hz	0.024 %	
	40 Hz	0.02 %	
	100 Hz	0.02 %	
	1 kHz	0.02 %	
	10 kHz	0.02 %	
	20 kHz	0.02 %	
	50 kHz	0.03 %	
	100 kHz	0.06 %	
	300 kHz	0.1 %	
	500 kHz	0.12 %	
	800 kHz	0.14 %	
	1 MHz	0.14 %	
	0.06 V	10 Hz	
20 Hz		0.02 %	
40 Hz		0.014 %	
100 Hz		0.01 %	
1 kHz		0.01 %	
10 kHz		0.01 %	
20 kHz		0.01 %	
50 kHz		0.03 %	
100 kHz		0.036 %	
300 kHz		0.1 %	
500 kHz		0.12 %	
800 kHz		0.14 %	
1 MHz		0.14 %	
0.10 V		10 Hz	0.02 %
	20 Hz	0.016 %	
	40 Hz	90 µV/V	
	100 Hz	90 µV/V	
	1 kHz	90 µV/V	
	10 kHz	90 µV/V	
	20 kHz	90 µV/V	
	50 kHz	0.011 %	
	100 kHz	0.02 %	
	300 kHz	0.038 %	
	500 kHz	0.05 %	
	800 kHz	0.06 %	
	1 MHz	0.06 %	

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Voltage – Measure AC/DC Difference (cont)			
0.20 V	10 Hz	0.016 %	Fluke model 792A AC/DC transfer standard
	20 Hz	0.012 %	
	40 Hz	80 µV/V	
	100 Hz	80 µV/V	
	1 kHz	80 µV/V	
	10 kHz	80 µV/V	
	20 kHz	80 µV/V	
	50 kHz	0.01 %	
	100 kHz	0.02 %	
	300 kHz	0.032 %	
	500 kHz	0.04 %	
	800 kHz	0.052 %	
	1 MHz	0.052 %	
0.60 V	10 Hz	0.016 %	
	20 Hz	0.014 %	
	40 Hz	50 µV/V	
	100 Hz	36 µV/V	
	1 kHz	36 µV/V	
	10 kHz	36 µV/V	
	20 kHz	36 µV/V	
	50 kHz	60 µV/V	
	100 kHz	90 µV/V	
	300 kHz	0.02 %	
	500 kHz	0.022 %	
	800 kHz	0.024 %	
	1 MHz	0.024 %	
1.00 V	10 Hz	0.024 %	
	20 Hz	0.01 %	
	40 Hz	44 µV/V	
	100 Hz	24 µV/V	
	1 kHz	24 µV/V	
	10 kHz	24 µV/V	
	20 kHz	24 µV/V	
	50 kHz	50 µV/V	
	100 kHz	60 µV/V	
	300 kHz	0.02 %	
	500 kHz	0.021 %	
	800 kHz	0.022 %	
	1 MHz	0.022 %	

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Voltage – Measure AC/DC Difference (cont)			
2.00 V	10 Hz	0.024 %	Fluke model 792A AC/DC transfer standard
	20 Hz	70 µV/V	
	40 Hz	40 µV/V	
	100 Hz	16 µV/V	
	1 kHz	16 µV/V	
	10 kHz	16 µV/V	
	20 kHz	16 µV/V	
	50 kHz	40 µV/V	
	100 kHz	50 µV/V	
	300 kHz	0.02 %	
	500 kHz	0.021 %	
	800 kHz	0.022 %	
	1 MHz	0.022 %	
6.00 V	10 Hz	0.024 %	
	20 Hz	80 µV/V	
	40 Hz	40 µV/V	
	100 Hz	18 µV/V	
	1 kHz	18 µV/V	
	10 kHz	18 µV/V	
	20 kHz	18 µV/V	
	50 kHz	50 µV/V	
	100 kHz	60 µV/V	
	300 kHz	0.02 %	
	500 kHz	0.021 %	
	800 kHz	0.022 %	
	1 MHz	0.022 %	
10.00 V	10 Hz	0.024 %	
	20 Hz	90 µV/V	
	40 Hz	50 µV/V	
	100 Hz	24 µV/V	
	1 kHz	24 µV/V	
	10 kHz	24 µV/V	
	20 kHz	24 µV/V	
	50 kHz	40 µV/V	
	100 kHz	50 µV/V	
	300 kHz	0.02 %	
	500 kHz	0.021 %	
	800 kHz	0.022 %	
	1 MHz	0.022 %	

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Voltage – Measure AC/DC Difference (cont)			
20.00 V	10 Hz	0.024 %	Fluke model 792A AC/DC transfer standard
	20 Hz	80 µV/V	
	40 Hz	44 µV/V	
	100 Hz	24 µV/V	
	1 kHz	24 µV/V	
	10 kHz	24 µV/V	
	20 kHz	24 µV/V	
	50 kHz	40 µV/V	
	100 kHz	50 µV/V	
	300 kHz	0.011 %	
	500 kHz	0.022 %	
	800 kHz	0.023 %	
	1 MHz	0.023 %	
60.00 V	10 Hz	0.024 %	
	20 Hz	80 µV/V	
	40 Hz	30 µV/V	
	100 Hz	30 µV/V	
	1 kHz	30 µV/V	
	10 kHz	30 µV/V	
	20 kHz	80 µV/V	
	50 kHz	90 µV/V	
	100 kHz	0.02 %	
	100.00 V	10 Hz	
20 Hz		0.01 %	
40 Hz		50 µV/V	
100 Hz		40 µV/V	
1 kHz		40 µV/V	
10 kHz		40 µV/V	
20 kHz		90 µV/V	
50 kHz		0.01 %	
200.0 V	10 Hz	0.028 %	
	20 Hz	0.01 %	
	40 Hz	50 µV/V	
	100 Hz	40 µV/V	
	1 kHz	40 µV/V	
	10 kHz	40 µV/V	
	20 kHz	90 µV/V	
	50 kHz	0.01 %	

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} (±)	Comments
AC Voltage – Measure AC/DC Difference (cont)			
600.0 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz	0.036 % 0.012 % 60 µV/V 46 µV/V 40 µV/V 40 µV/V 90 µV/V 0.011 %	Fluke model 792A AC/DC transfer standard
1000 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz	0.038 % 90 µV/V 46 µV/V 46 µV/V 44 µV/V 44 µV/V 90 µV/V 0.012 %	
AC High Voltage – Measure ³			
(0 to 10) kV (10 to 21) kV (21 to 42) kV (42 to 64) kV (64 to 85) kV	60 Hz	0.46 % 0.30 % 0.23 % 0.63 % 0.51 %	Ross Engineering VMP300-5Y with HP 34401A DMM
AC Current – Generate ³			
(0 to 220) µA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 16 nA 0.017 % + 10 nA 0.013 % + 8 nA 0.029 % + 12 nA 0.12 % + 65 nA	Fluke 5700A/EP with 5725A
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.029 % + 40 nA 0.02 % + 35 nA 0.018 % + 35 nA 0.024 % + 110 nA 0.12 % + 650 µA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.029 % + 400 nA 0.02 % + 350 nA 0.017 % + 350 nA 0.024 % + 550 nA 0.12 % + 5 µA	

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} (\pm)	Comments
AC Current – Generate ³ (cont)			
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 4 μ A 3.5 μ V/V + 3.5 μ A 0.013 % + 3.5 μ A 0.027 % + 3.5 μ A 0.12 % + 10 μ A	Fluke 5700A/EP
(0.22 to 2.2) A	(0.02 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 35 μ A 0.046 % + 80 μ A 0.7 % + 160 μ A	
(2.2 to 11) A	(0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.048 % + 170 μ A 0.097 % + 380 μ A 0.37 % + 750 μ A	
(11 to 20) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.12 % + 5 mA 0.15 % + 5 mA 3 % + 5 mA	
AC Current – Generate & Measure ³			
Toroidal (10 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.33 % + 0.09 A 0.93 % + 0.11 mA	Fluke model 5500A/coil with 5520A
Non-Toroidal (10 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.65 % + 0.09 A 1.2 % + 1 A	
AC Current – Measure ³			
Up to 200 μ A	10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.032 % + 0.02 μ A 0.068 % + 0.02 μ A 0.41 % + 0.02 μ A	Fluke model 8508A
200 μ A to 2 mA	10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.03 % + 0.0002 mA 0.068 % + 0.0002 mA 0.41 % + 0.002 mA	
(2 to 20) mA	10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.03 % + 0.002 mA 0.067 % + 0.002 mA 0.41 % + 0.002 mA	

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Current – Measure ³ (cont)			
(20 to 200) mA	10 Hz to 10 kHz (10 to 30) kHz	0.027 % + 0.02 mA 0.061 % + 0.02 mA	Fluke model 8508A
200 mA to 2 A	10 Hz to 2 kHz (2 to 10) kHz 10 to 30) kHz	0.062 % + 0.2 mA 0.075 % + 0.2 mA 3 % + 0.2 mA	
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.082 % + 0.002 A 2.5 % + 0.002 A	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Capacitance – Measure			
1 kHz	(5 to 1000) pF	5.2 parts in 10 ⁶	Andeen Hagerling model 2500A capacitance bridge
120 (100) Hz, 10 kHz	1 nF to 10 mF	1.2 %	HP model 4262A
Capacitance – Generate, Fixed Points			
1000 Hz	100 pF	2.6 μF/F	Andeen Hagerling model AH11A
1 kHz	2 pF 100 pF 1000 pF 1800 pF 10 nF 100 nF 1 μF 10 μF 1000 μF	0.9 % 0.03 % 0.03 % 0.03 % 0.02 % 0.02 % 0.02 % 0.02 % 0.8 %	HP DUT box model 16361A
10 kHz	1 pF 10 pF 19 pF 100 pF 1000 pF 10 nF	0.9 % 0.06 % 0.94 % 0.02 % 0.04 % 0.03 %	HP DUT box model 16362A

Parameter/Equipment	Range	CMC ^{2,4,6} (±)	Comments
Capacitance – Generate (cont)			
@ 10 kHz	100 nF 1000 nF 10 µF 100 µF	0.03 % 0.04 % 0.4 % 0.5 %	HP DUT box model 16362A
@ 1 kHz	(0.19 to 0.3999) nF (0.4 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.9999) nF (11 to 32.999) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 µF to 1.09999 µF (1.1 to 3.299999) µF (3.3 to 10.9999) µF (11 to 32.9999) µF (33 to 109.9999) µF (110 to 329.999) µF (0.33 to 1.09999) mF (1.1 to 3.2999) mF (3.3 to 10.9999) mF (11 to 32.9999) mF (33 to 110) mF	0.6 % + 0.01 nF 0.5 % + 0.01 nF 0.5 % + 0.01 nF 0.25 % + 0.01nF 0.25 % + 0.1 nF 0.32 % + 0.1 nF 0.28 % + 0.3 nF 0.46 % + 1 nF 0.25 % + 3 nF 0.33 % + 10 nF 0.40 % + 30 nF 0.64 % + 100 nF 0.45 % + 300 nF 0.45 % + 1 µF 0.45 % + 3 µF 0.45 % +10 µF 0.75 % + 30 µF 1.1 % + 100 µF	Fluke 5520A
Inductance – Measure	0.01 µH to 1999 H	0.3 %	HP model 4262A digital LCR meter

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Inductance – Generate Fixed Points	10 mH, 1 kHz 10 mH, 5 kHz 10 mH, 10 kHz 100 mH, 1 kHz 100 mH, 5 kHz 100 mH, 10 kHz 100 µH, 1 kHz 100 µH, 5 kHz 100 µH, 10 kHz	23 µH/H 23 µH/H 38 µH/H 23 µH/H 50 µH/H 0.013 % 0.036 % 70 µH/H 50 µH/H	GR model 1482-B, 1482-H, 1482-L

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Devices ³ –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.30 °C 0.33 °C	Fluke 5520A
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C	0.30 °C 0.26 °C 0.31 °C 0.50 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 250) °C (350 to 650) °C (650 to 1000) °C	0.50 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	
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 0.18 °C 0.16 °C 0.26 °C 0.40 °C	
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.37 °C 0.26 °C 0.17 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.40 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °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 0.40 °C	
Type S	(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 0.40 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Devices ³ – (cont)			
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	Fluke 5520A
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	

V. Electrical – RF/Microwave

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Absolute Power – Measure			
N Type	Power Reference 1 mW, 50 Ω, 50 MHz	7 μW	Tegam 1830A w/ HP 8478B-H43
	(-30 to + 20) dBm (100 kHz to 2 GHz) 75 Ω	4.4 % VSWR: ≤ 1.2:1	HP 436A w/ HP 8483A sensor
	(-30 to + 20) dBm (100 kHz to 4.2 GHz) 50 Ω	0.9 % to 1.2 % VSWR: ≤ 1.6:1	HP 436A w/ HP 8482A sensor (and F1130)
	(-30 to + 20) dBm (100 kHz to 4.2 GHz) 50 Ω	0.9 % to 1.8 % VSWR: ≤ 1.25:1	
	(-30 to + 20) dBm (10 MHz to 18 GHz) 50 Ω	0.9 % to 1.4 % VSWR: ≤ 1.25:1	Tegam 1830A w/ HP 8478B opt H43
3.5 mm Type	(-30 to + 20) dBm (50 MHz to 26.5) 50 Ω	0.9 % to 2.8 % VSWR: ≤ 1.25:1	HP 436A w/ HP8485A sensor (and F1135)
	(-70 to -30) dBm (50 MHz to 26.5) 50 Ω	1.3 % to 4.4 % VSWR: ≤ 1.29:1	HP 436A w/ HP 8485D sensor, F1135, 30 dB attenuator
Coaxial Power Sensors, 1 mW, Type N(f), 50 Ω 1 mW, 3.5 mm(f), 50 Ω	0.1 MHz to 26.6 GHz	0.8 % to 2.9 %	Tegam F1130, Tegam F1135, 8481A, 8478B-H43, various attenuators

Parameter/Equipment	Range	CMC ² (±)	Comments
Attenuation – Measure			
100 kHz to 22 GHz	(0.0 to -5.0) dB	0.002 dB	R&S FSMR , Agilent 5531S, HP 8902A
	(-6 to -15) dB	0.006 dB	
	(-16 to -25) dB	0.011 dB	
	(-26 to -35) dB	0.016 dB	
	(-36 to -42) dB	0.026 dB	
	(-43 to -65) dB	0.036 dB	
	(-66 to -75) dB	0.041 dB	
	(-76 to -85) dB	0.051 dB	
	(-86 to -95) dB	0.057 dB	
	(-96 to -100) dB	0.067 dB	
(22 to 26.5) GHz	(0.0 to -1.0) dB	0.006 dB	
	(-1 to -10) dB	0.007 dB	
	(-10 to -20) dB	0.017 dB	
	(-20 to -30) dB	0.020 dB	
	(-30 to -40) dB	0.045 dB	
	(-40 to -50) dB	0.048 dB	
	(-50 to -60) dB	0.053 dB	
	(-60 to -70) dB	0.059 dB	
	(-70 to -80) dB	0.080 dB	
	(-80 to -90) dB	0.085 dB	
	(-90 to -100) dB	0.085 dB	
	(-100 to -110) dB	0.13 dB	

Parameter/Equipment	Range	CMC ² (±)	Comments
Attenuation – Generate			
Coaxial – 1 dB Steps			
50 MHz	(1 to 11) dB	0.008 dB	Agilent 8494G
DC to 12.4 GHz	1 dB	0.3 dB	HP 8494B SWR DC to 8 < 1.5 8 to 12.4 < 1.6 12.4 to 18 < 1.9
	2 dB	0.3 dB	
	3 dB	0.4 dB	
	4 dB	0.4 dB	
	5 dB	0.5 dB	
	6 dB	0.5 dB	
	7 dB	0.6 dB	
	8 dB	0.6 dB	
	9 dB	0.6 dB	
	10 dB	0.6 dB	
	11 dB	0.7 dB	
(12.4 to 18) GHz	1 dB	0.7 dB	HP 8494B SWR DC to 8 < 1.5 8 to 12.4 < 1.6 12.4 to 18 < 1.9
	2 dB	0.7 dB	
	3 dB	0.7 dB	
	4 dB	0.7 dB	
	5 dB	0.7 dB	
	6 dB	0.8 dB	
	7 dB	0.8 dB	
	8 dB	0.8 dB	
	9 dB	0.8 dB	
	10 dB	0.9 dB	
	11 dB	0.9 dB	
Coaxial – 10 dB Steps			
50 MHz	(10 to 110) dB	0.072 dB	Agilent 8494G
DC to 12.4 GHz	10 dB	0.5 dB	HP 8495B SWR DC to 8 < 1.35 8 to 12.4 < 1.5 12.4 to 18 < 1.7
	20 dB	0.7 dB	
	30 dB	0.9 dB	
	40 dB	1.2 dB	
	50 dB	1.5 dB	
	60 dB	1.8 dB	
	70 dB	2.1 dB	
	70 dB	2.1 dB	
(12.4 to 18) GHz	10 dB	0.6 dB	
	20 dB	0.8 dB	
	30 dB	1.2 dB	
	40 dB	1.6 dB	
	50 dB	2.0 dB	
	60 dB	2.4 dB	
	70 dB	2.8 dB	

Parameter/Equipment	Range	CMC ² (±)	Comments
Reflection Coefficient Measured (S ₁₁ /S ₂₂) –			
7 mm (N) (50 to 500) MHz	(0.0 to 1) lin	(0.0062 to 0.026) lin (180 to 1.5) deg	Agilent N5242A, (Options 200, P02, 010, 080, 082, 898, 014, 081); Agilent verification kit 85055A
500 MHz to 2 GHz	(0.0 to 1.0) lin	(0.0045 to 0.019) lin (180 to 1.1) deg	
(2 to 18) GHz	(0.0 to 1.0) lin	(0.0089 to 0.037) lin (180 to 1.1) deg	
3.5 mm (50 to 500) MHz	(0.0 to 1) lin	(0.005 to 0.22) lin (180 to 1.3) deg	Agilent N5242A, (Options 200, P02, 010, 080, 082, 898, 014, 081); Agilent verification kit 85053B
500 MHz to 2 GHz	(0.0 to 1.0) lin	(0.002 to 0.011) lin (180 to 0.62) deg	
(2 to 18) GHz	(0.0 to 1) lin	(0.005 to 0.019) lin (180 to 1.2) deg	
(20 to 26.5) GHz	(0.0 to 1.0) lin	(0.005 to 0.03) lin (180 to 1.8) deg	
Transmission Coefficient Measured (S ₁₂ /S ₂₁) –			
7 mm (N) (50 to 500) MHz	(10 to -100) dB	(0.10 to 17) dB (180 to 0.55) deg	Agilent N5242A, (Options 200, P02, 010, 080, 082, 898, 014, 081); Agilent verification kit 85055A
500 MHz to 2 GHz	(10 to -100) dB	(0.061 to 5.5) dB (0.40 to 6.4) deg	
(2 to 18) GHz	(10 to -100) dB	(0.11 to 2.7) dB (0.72 to 22) deg	
3.5 mm (50 to 500) MHz	(10 to -100) dB	(0.077 to 17) dB (180 to 0.51) deg	Agilent N5242A, (Options 200, P02, 010, 080, 082, 898, 014, 081); Agilent verification kit 85053B
500 MHz to 2 GHz	(10 to -100) dB	(0.042 to 5.6) dB (64 to 0.27) deg	
(2 to 18) GHz	(10 to -100) dB	(0.081 to 2.7) dB (22 to 0.53) deg	
(20 to 26.5) GHz	(10 to -100) dB	(0.13 to 5.1) dB (53 to 0.85) deg	

Parameter/Range	Frequency	CMC ² (±)	Comments
Group Delay, 1 GHz	(0.01 to 100) MHz	(31 to 0.01) ns	Agilent N5242A, (options 200, P02, 010, 080, 082, 898, 014, 081) Agilent verification kit 85055A

Parameter/Equipment	Range	CMC ² (±)	Comments
RF Power – Generate			
250 kHz to 2 GHz	(26 to > 20) dBm (20 to > 16) dBm (16 to > 10) dBm (10 to > 0) dBm (0 to -10) dBm (< 10 to -70) dBm (< 70 to -90) dBm	1.0 dB 0.8 dB 0.6 dB 0.6 dB 0.6 dB 0.7 dB 0.8 dB	Agilent E8257D signal generator
(> 2 to 20) GHz	(26 to > 20) dBm (20 to > 16) dBm (16 to > 10) dBm (10 to > 0) dBm (0 to -10) dBm (< 10 to -70) dBm (< 70 to -90) dBm	1.0 dB 0.8 dB 0.8 dB 0.8 dB 0.8 dB 0.9 dB 1.0 dB	
(> 20 to 31.8) GHz	(20 to > 16) dBm (16 to > 10) dBm (10 to > 0) dBm (0 to -10) dBm (< 10 to -70) dBm (< 70 to -90) dBm	1.0 dB 1.0 dB 0.9 dB 0.9 dB 1.0 dB 2.0 dB	
RF High Power – Generate			
(20 to 400) MHz	500 W	2.2 dB	Empower RF systems power amplifier with HP 436A/8482A power meter/sensor & Narda 3020A directional coupler (characterized using PNA Surecal calibration system)
(400 to 1000) MHz	(250 to 400) W	2.5 dB	

VI. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Density (Specific Gravity)	(0 to 3) g/cm ³	0.000067 g/cm ³	Mettler Toledo model DE45 density meter
Air Velocity ³ – Anemometers, Thermal, Pitot, Vane Style and Similar Equipment	(100 to 1000) fpm (1000 to 9000) fpm	2.4 % 1.2 %	Omega Engineering model WT4001-D-110V wind tunnel w/ electronics box WT 4401-D
Flow (Air)	(0.23 to 2.33) SCFM (0.85 to 8.5) SCFM (3.79 to 37.91) SCFM	1.3 % 1.4 % 1.2 %	Brook Instruments Flowmeter models: 1110CJ61CUHAA, 1110CK61CUHAA, 1110CM61CUHAA

VII. Mechanical

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Torque	(0 to 2000) ft·lbf (0 to 200) ft·lbf (0 to 200) in·lbf	0.2 % of IV 0.2 % of IV 0.2 % of IV	AKO Torque Specialties Model TSD 2050/3000 automated torque wrench calibration system
Acceleration Sensitivity – Frequency Response	(20 to 10 000) Hz Sensitivity 10 mV/g	6.4 %	Vibration test systems with 3120A accelerometer
Velocity (Vibration) – Measuring Equipment	(20 to 100) Hz (100 to 2500) Hz	2.0 % 1.5 %	Vibration test systems with 3120A accelerometer
Force ³	Up to 55 000 lbf	0.05 %	Tovey Engineering model 55K
Force	Up to 100 000 lbf	0.06 %	Interface load cells /w monitor

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Mass – Fixed Points ³	20 kg 10 kg 5 kg 2 kg 1 kg 500 g 200 g 100 g 50 g 20 g 10 g 5 g 2 g 1 g 500 mg 200 mg 100 mg 50 mg 20 mg 10 mg 5 mg 2 mg 1 mg	18 mg 6.8 mg 5.6 mg 1.5 mg 0.86 mg 0.91 mg 0.13 mg 0.018 mg 0.028 mg 0.019 mg 0.015 mg 0.011 mg 0.0091 mg 0.0086 mg 0.0045 mg 0.0045 mg 0.0045 mg 0.0043 mg 0.0042 mg 0.0042 mg 0.0042 mg 0.0042 mg 0.0042 mg	OIML Class E1 OIML Class E2 OIML Class E1 OIML Class F1 weights and comparators
Mass Comparators – Fixed Points	20 g 200 g 3 kg 10 kg 30 kg 50 kg 10 kg	0.0012 mg 0.0056 mg 0.5 mg 3.0 mg 50 mg 5 mg 10 mg	Reverifications, comparators Mettler Toledo XP 64003L Mettler Toledo PR1003
Scales and Balances	(20 to 1500) kg in 20 kg increments	75 mg	Class M1, F1 weights
Pressure – Measuring Equipment ³			
Hydraulic	(200 to 20 000) psi (10 to 16 000) psi	35 parts in 10 ⁶ 0.015 %	Ruska model 2485-930S deadweight tester Pressurements model M2800-3-S deadweight tester
Pneumatic	(0.2 to 25) psi (2 to 1000) psi	0.001 % 0.0026 %	Fluke model 2465 gas piston gage

VIII. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measure ³	(-195 to 600) °C	0.0029 °C	SPRT and super thermometer
	(601 to 1100) °C	0.60 °C	Thermocouple and scanner 1560
Temperature – Measure	(-50 to 500) °C	0.061 °C	PRT and scanner 1560
	(501 to 1100) °C	0.60 °C	Type R thermocouple and scanner 1560
Temperature – Measuring Equipment	(-80 to 500) °C	0.0023 °C	Hart model 7380, 7012, 6035, 6050, 9122, 1590, Omega model LMF 3550, Hart 1560 thermometer, Type S thermocouple
	(501 to 600) °C	0.63 °C	
Fixed Points	(601 to 1100) °C	0.83 °C	TPW cell FP aluminum cell FP tin cell FP zinc cell TP mercury cell Liquid nitrogen Comparison calibrator, Hart model 7190, Hart 1590 super thermometer, Hart SPRT
	Triple Point of Water	0.21 mK	
	660.323 °C	3.6 mK	
	231.928 °C	2.6 mK	
	419.537 °C	2.6 mK	
	-38.7344 °C	2.6 mK	
-195 °C	3.1 mK		
Relative Humidity	(10 to 95) % RH	0.51 % RH	Thunder Scientific model 2500

IX. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment	5 MHz, 10 MHz 1 V	5.0×10^{-13} Hz	Symmetricom model 5071A cesium beam frequency standard
Sinewave Frequency – Measuring Equipment	0.1 Hz to 20 MHz 200 Hz to 80 MHz 250 Hz to 31.8 GHz	5.8 μ Hz/Hz 0.0058 μ Hz/Hz < 2.5×10^{-10} /day	HP 3325A/HP 5345A HP 3325A opt 001/ HS 20/ 54610/910R Agilent E8257D opt 007,1E1,1EUM 532, U01, UNX
Sinewave Frequency – Measure	(0 to 400) MHz (0.4 to 1.6) GHz (1.5 to 26) GHz	0.029 μ Hz/Hz 0.017 μ Hz/Hz 0.014 μ Hz/Hz	HP 5345A HP 5345A/ HP 5355A HP 5345A/HP 5355A/ HP 5356B
Time Interval	10 ns to 20 000 s	2.3 ns	HP 5345A
Stop Watches	(0.15 to 24) hr	0.33 s	Fluke 910R GPS

¹ This laboratory offers commercial calibration/dimensional testing service and field 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 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 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 actual 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.

- ⁴ In the statement of CMC, the value is defined as the percentage of reading, unless otherwise noted.
- ⁵ The measurands stated are measured with the Fluke 8508A or Fluke 792A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a combination of a percent/fraction of the reading/output plus a range specification.
- ⁶ The measurands stated are generated with the Fluke 5500 series of instruments or Fluke 5700A/EP. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a combination of a percent/fraction of the reading/output plus a range specification.
- ⁷ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches.
- ⁸ This laboratory meets R205 – *Specific Requirements: Calibration Laboratory Accreditation Program* for the types of dimensional tests listed above and is considered equivalent to that of a calibration.



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Presented this 13th day of February 2013.





Peter Meyer

President & CEO
For the Accreditation Council
Certificate Number 3097.01
Valid to January 31, 2015

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