



Laboratory  
Accreditation  
Bureau

Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2216

Cal Lab Co., Inc  
17035 Westview Avenue  
South Holland, IL 60473

**has met the requirements set forth in L-A-B's policies and procedures, and all requirements of ANSI Z540-1 & ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories." 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 January 2009).**

**Accreditation valid through September 29, 2010**

**R. Douglas Leonard, Jr., Managing Director  
Laboratory Accreditation Bureau**

\*Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

## Scope of Accreditation For Cal Lab Co., Inc.

17035 Westview Avenue  
South Holland, IL 60473  
J. Brent Snoddy  
708-596-5800

In recognition of a successful assessment to ISO/IEC 17025:2005 and ANSI Z540-1, accreditation is granted to **Cal Lab Co., Inc.** to perform the following Calibrations:

Accreditation granted through: **September 29, 2010**

### Calibration

#### Length - Dimensional Metrology – Hand Tools and Precision Gages 1D

Calibration Parameter/Equipment	Range	Best Measurement Capability (+/-) <sup>2,3</sup>	Remarks
Micrometers ID & OD <sup>1</sup>	(0 to 4) in	(28 + 13.4L) μin	Gauge Blocks
	(5 to 20) in	(47 + 13L) μin	
	(21 to 40) in	(740 + 11L) μin	
	(41 to 60) in	(900 + 8L) μin	
Micrometer Heads	(0 to 1) in	36 μin	P&W Labmaster
Calipers <sup>1</sup>	(0 to 20) in	(570 + 5L) μin	Gauge Blocks
	(20 to 40) in	(830 + 6L) μin	
	(40 to 60) in	(960 + 7L) μin	
Height Gages <sup>1</sup>	(0 to 24) in	(430 + 6L) μin	Gauge Blocks
	(>24 to 40) in	(530 + 10L) μin	
Height Masters	(0 to 24) in	(27 + 14L) μin	Gauge Blocks
Indicators	(0 to 0.001) in	8 μin	P&W Labmaster
	(0 to 0.01) in	12 μin	
	(>0.010 to 8) in	(36 + 9L) μin	Gauge Blocks <sup>1</sup>

**Length – Dimensional Metrology – Hand Tools and Precision Gages 2D**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
Optical Comparators <sup>1</sup>			
Magnification	10X, 20X, 31.25X, 50X and 62.5X	0.0012 in	Magnification Checker
Linear	0 to 6 in	165 μin	Glass Scale
Angle	0° to 90°	0.021°	Angle Block Set
Protractors & Clinometers	(0 to 90)°	4.7 min	Optical Comparator

**Length - Dimensional Metrology – Artifacts and Standards 1D**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Cylindrical Plug Gages	(0 to 12) in	(8.6 + 3.7L) μin	P&W Labmaster
Cylindrical Ring Gauges	(0.02 to 1) in	14 μin	P&W Labmaster
	(>1 to 13) in	(8 + 6.5L) μin	
End Measuring Rods	(0.5 to 12) in	(7 + 1.3L) μin	P&W Labmaster
	(13 to 60) in	(210 + 0.3L) μin	Comparator and Gauge Blocks
Feeler Gauges (Leaf-Style) <sup>1</sup>	(0 to 0.25) in	77 μin	Bench micrometer
Gage Blocks	(0 to 1) in	4.6 μin	P&W Labmaster
	(2 to 12) in	(1.7 + 1.8L) μin	
Pin Gauges – Class ZZ <sup>1</sup>	(0.011 to 1) in	78 μin	Bench Micrometer
Riser Blocks	(6 to 24) in	(28 + 7L) μin	Gauge Blocks

**Length - Dimensional Metrology – Artifacts and Standards 2D**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
Radius Gauges	Up to 1 in	240 μin	Optical comparator

**Length - Dimensional Metrology – Other**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Thread Plugs	(4 to 80 TPI) Pitch Diameter	(84 + 1.4L) μin	Labmaster Universal & Thread Measuring Wires
	(0.060 to 4) in Major Diameter	(10 + 6L) μin	

**Mass – Pressure**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Absolute – Measure & Generate	(-14.7 to 1 015) psi	2 x 10 <sup>-5</sup> psi + 0.6R	Deadweight Tester
Hydraulic – Measure & Generate	(20 to 6 000) psi	5.8 x 10 <sup>-5</sup> psi + 0.6R	Deadweight Tester
Low Pressure – Measure & Generate	(0 to 2) inH <sub>2</sub> O	0.0057 inH <sub>2</sub> O	Manometer
	(-10 to +10) inH <sub>2</sub> O	0.0045 inH <sub>2</sub> O	Micromanometer
Pneumatic – Measure & Generate	(0.2 to 25) psi	2 x 10 <sup>-5</sup> psi + 0.6R	Deadweight Tester
	(>25 to 100) psi		
	(>100 to 1 000) psi		
Pressure – Measure & Generate <sup>1</sup>	(0 to 15) psi	0.011 psig	Pressure Transducers
	(0 to 100) psi	0.07 psig	
	(0 to 1 000) psi	0.65 psig	
	(0 to 10 000) psi	10 psig	

**Mass – Vacuum**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Vacuum Measure & Generate	(0 to -29) inHg	$2 \times 10^{-5}$ inHg + 0.6R	Deadweight Tester
Vacuum – Measure & Generate <sup>1</sup>	(0 to -14.5) psig	0.016 psig	Pressure Transducer

**Mass – Torque**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
Torque - Measure	(20 to 200) ozf·in	0.08 ozf·in + 0.003 ozf·in / ozf·in	Torque Tester
	(4 to 50) lbf·in	0.0086 lbf·in + 0.003 lbf·in / lbf·in	
	(30 to 400) lbf·in	0.05 lbf·in + 0.003 lbf·in / lbf·in	
	(80 to 1 000) lbf·in	0.95 lbf·in + 0.002 lbf·in / lbf·in	
	(20 to 250) lbf·ft	0.07 lbf·ft + 0.003 lbf·ft / lbf·ft	
	(100 to 1 000) lbf·ft	0.01 lbf·ft + 0.007 lbf·ft / lbf·ft	
Torque - Source	(20 to 200) ozf·in	0.04 ozf·in + 0.00004 ozf·in / ozf·in	Weights, Torque Arms & Wheels
	(4 to 50) lbf·in	0.11 lbf·in + 0.000005 lbf·in / lbf·in	
	(30 to 400) lbf·in	0.03 lbf·in + 0.0002 lbf·in / lbf·in	
	(80 to 1 000) lbf·in	0.2 lbf·in + 0.000001 lbf·in / lbf·in	
	(20 to 250) lbf·ft	0.055 lbf·ft + 0.00005 lbf·ft / lbf·ft	

**Mass – Force**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
Force	(0 to 50) lbf	0.0002 lbf + 0.002 lbf/lbf	Class 6 weights
	(>5 to 50) lbf	0.009 lbf + 0.0001 lbf/lbf	Class 6 weights
	(>50 to 500) lbf	0.012 lbf + 0.0001 lbf/lbf	Class 6 weights

**Mass – Hardness**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
Durometers Force	Type A, B, O	0.05 N	Durometer Calibrator and/or Balance
	Type C, D, & DO	0.09 N	
Durometer Indentor	Diameter	200 μin	Optical Comparator
	Radius	200 μin	
	Angle	0.07°	

**Electricity and Magnetism – Voltage**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
DC Voltage – Measure <sup>1</sup>	(0 to 200) mV	0.2 μV + 4.5 μV / V + 0.6R	Fluke 8508A & 5520A
	(0.2 to 2) V	0.8 μV + 3.5 μV / V + 0.6R	
	(2 to 20) V	2.2 μV + 2.3 μV / V + 0.6R	
	(20 to 200) V	0.04 mV + 5.5 μV / V + 0.6R	
	(200 to 1000) V	0.5 mV + 5.5 μV / V + 0.6R	
	(1.1 to 100) kV	0.59 kV	HV source/meter
DC Voltage – Measure only <sup>1</sup>	(0 to 5) kV	2.1 V + 10 mV / V + 0.6R	2012 Electrostatic meter
	(0.5 to 10) kV	3.1 V + 5 mV / V + 0.6R	HV meter
	(10 to 15) kV	2.1 V + 10 mV / V + 0.6R	Electrostatic meter
	(15 to 20) kV	2.1 V + 10 mV / V + 0.6R	
	(20 to 30) kV	6.7 V + 9.9 mV / V + 0.6R	
	(30 to 100) kV	0.59 kV + 0.6R	HV meter
	(100 to 200) kV	1.2 kV + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
AC Voltage – Measure and Generate <sup>1</sup> Up to 200 mV	(10 to 40) Hz	4 μV + 0.14 mV / V + 0.6R	Fluke 8508A & 5520A
	(40 to 100) Hz	4 μV + 0.11 mV / V + 0.6R	
	100 Hz to 2 kHz	2 μV + 0.11 mV / V + 0.6R	
	(2 to 10) kHz	4 μV + 0.13 mV / V + 0.6R	
	(10 to 30) kHz	8 μV + 0.34 mV / V + 0.6R	
	(30 to 100) kHz	0.02 mV + 0.76 mV / V + 0.6R	
(0.2 to 2) V <sup>1</sup>	(10 to 40) Hz	0.02 mV + 0.11 mV / V + 0.6R	Fluke 8508A & 5520A
	(40 to 100) Hz	0.02 mV + 0.09 mV / V + 0.6R	
	100 Hz to 2 kHz	0.02 mV + 75 μV / V + 0.6R	
	(2 to 10) kHz	0.02 mV + 0.11 mV / V + 0.6R	
	(10 to 30) kHz	0.04 mV + 0.22 mV / V + 0.6R	
	(30 to 100) kHz	0.2 mV + 0.57 mV / V + 0.6R	
	(100 to 300) kHz	2 mV + 3 mV / V + 0.6R	
(2 to 20) V <sup>1</sup>	(10 to 40) Hz	0.2 mV + 0.11 mV / V + 0.6R	Fluke 8508A & 5520A
	(40 to 100) Hz	0.2 mV + 90 μV / V + 0.6R	
	100 Hz to 2 kHz	0.2 mV + 75 μV / V + 0.6R	
	(2 to 10) kHz	0.2 mV + 0.11 mV / V + 0.6R	
	(10 to 30) kHz	0.4 mV + 0.22 mV / V + 0.6R	
	(30 to 100) kHz	2 mV + 0.57 mV / V + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
	(100 to 300) kHz	0.02 V + 3 mV / V + 0.6R	
	300 kHz to 1 MHz	0.2 V + 10 mV / V + 0.6R	
(20 to 200) V <sup>1</sup>	(10 to 40) Hz	2 mV + 0.11 mV / V + 0.6R	Fluke 8508A & 5520A
	(40 to 100) Hz	2 mV + 90 μV / V + 0.6R	
	100 Hz to 2 kHz	2 mV + 75 μV / V + 0.6R	
	(2 to 10) kHz	2 mV + 0.11 mV / V + 0.6R	
	(10 to 30) kHz	4 mV + 0.22 mV / V + 0.6R	
	(30 to 100) kHz	0.02 V + 0.57 mV / V + 0.6R	
	(100 to 300) kHz	0.2 V + 3 mV / V + 0.6R	
	300 kHz to 1 MHz	2 V + 10 mV / V + 0.6R	
(200 to 1000) V <sup>1</sup>	(10 to 40) Hz	0.02 V + 0.12 mV / V + 0.6R	Fluke 8508A > 300 V, add 0.00004 (reading - 300) <sup>2</sup> μV/V
	40 Hz to 10 kHz	0.02 V + 0.11 mV / V + 0.6R	
	(10 to 30) kHz	0.04 V + 0.22 mV / V + 0.6R	
	(30 to 100) kHz	0.2 V + 0.58 mV / V + 0.6R	
(0 to 25) kV	60 Hz	6.7 V + 9.9 mV / V + 0.6R	HV Source & Electrostatic meter
AC Voltage – Measure Only <sup>1</sup> (0 to 5) kV	DC to 160 kHz	2.1 V + 10 mV / V + 0.6R	Electrostatic meter
(0 to 10) kV <sup>1</sup>	60 Hz	5.1 V + 0.01 V / V + 0.6R	HV meter
(5 to 10) kV <sup>1</sup>	DC to 160 kHz	2.1 V + 10 mV / V + 0.6R	Electrostatic meter
(10 to 15) kV <sup>1</sup>		2.1 V + 10 mV / V + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
(15 to 20) kV <sup>1</sup>	DC to 160 kHz	2.1 V + 10 mV / V + 0.6R	
(20 to 30) kV <sup>1</sup>		6.7 V + 9.9 mV / V + 0.6R	
(30 to 100) kV <sup>1</sup>	60 Hz	1.2 kV + 0.6R	HV meter
(100 to 200) kV <sup>1</sup>		2.3 kV + 0.6R	

**Electricity and Magnetism – Resistance**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Resistance – Measure and Generate <sup>1</sup>	(0.1 to 2) Ω	4 μΩ + 17 μΩ / Ω + 0.6R	Fluke 8508A
	(2 to 20) Ω	14 μΩ + 9.5 μΩ / Ω + 0.6R	
	(20 to 200) Ω	50 μΩ + 8 μΩ / Ω + 0.6R	
	200 Ω to 2 kΩ	0.5 mΩ + 8 μΩ / Ω + 0.6R	
	(2 to 20) kΩ	5 mΩ + 8 μΩ / Ω + 0.6R	
	(20 to 200) kΩ	0.05 Ω + 8 μΩ / Ω + 0.6R	
	200 kΩ to 2 MΩ	1 Ω + 9 μΩ / Ω + 0.6R	
Resistance – Measure and Generate <sup>1</sup>	(2 to 20) MΩ	1 Ω + 17 μΩ / Ω + 0.6R	Fluke 8508A HV mode
	(20 to 200) MΩ	1 kΩ + 65 μΩ / Ω + 0.6R	
	200 MΩ to 2 GΩ	0.1 MΩ + 0.18 mΩ / Ω + 0.6R	
	(2 to 20) GΩ	10 MΩ + 1.5 mΩ / Ω + 0.6R	Keithley 619
	(5 to 100) GΩ	0.04 Ω / Ω + 0.6R	
	(0.5 to 1) TΩ	0.1 Ω / Ω + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Fixed Points <sup>1</sup>	(0.1, 1, 10, 100) mΩ	10 μΩ / Ω + 0.6R	Standard Resistors
	100 GΩ	120 μΩ / Ω + 0.6R	Keithley 5156
	1 TΩ	0.01 Ω / Ω + 0.6R	High Resistance Standard
	10 TΩ	900 μΩ / Ω + 0.6R	

**Electricity and Magnetism – Current**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
DC Current – Measure and Generate <sup>1</sup>	(10 to 200) μA	0.4 nA + 12 μA / A + 0.6R	Fluke 8508A
	200 μA to 2 mA	4 nA + 12 μA / A + 0.6R	
	(2 to 20) mA	40 nA + 14 μA / A + 0.6R	
	(20 to 200) mA	0.8 μA + 48 μA / A + 0.6R	
	200 mA to 2 A	16 μA + 0.18 mA / A + 0.6R	
	(2 to 20) A	0.4 mA + 0.4 mA / A + 0.6R	
Current Clamps <sup>1</sup>	(16.5 to 149.999) A	7.8 mA + 2.2 mA / A + 0.6R	Fluke 5520A with Fluke 50-turn coil
	(150 to 1025) A	0.022 A + 2.1 mA / A + 0.6R	
AC Current – Measure and Generate <sup>1</sup> (20 to 200) μA <sup>1</sup>	10 Hz to 10 kHz	0.02 μA + 0.3 mA / A + 0.6R	Fluke 8508A
	(10 to 30) kHz	0.02 μA + 0.71 mA / A + 0.6R	
	(30 to 100) kHz	0.02 μA + 4 mA / A + 0.6R	
(0.2 to 2) mA <sup>1</sup>	10 Hz to 10 kHz	0.2 μA + 0.3 mA / A + 0.6R	
	(10 to 30) kHz	0.2 μA + 0.71 μA / A + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
	(30 to 100) kHz	0.2 $\mu$ A + 4 mA / A + 0.6R	
(2 to 20) mA <sup>1</sup>	10 Hz to 10 kHz	2 $\mu$ A + 0.3 mA / A + 0.6R	
	(10 to 30) kHz	2 $\mu$ A + 0.71 mA / m + 0.6R	
	(30 to 100) kHz	2 $\mu$ A + 4 mA / A + 0.6R	
(20 to 200) mA <sup>1</sup>	10 Hz to 10 kHz	0.02 mA + 0.3 mA / A + 0.6R	
	(10 to 30) kHz	0.02 mA + 0.62 mA / A + 0.6R	
200 mA to 2 A <sup>1</sup>	10 Hz to 10 kHz	0.2 mA + 0.72 mA / A + 0.6R	
	(10 to 30) kHz	0.2 mA + 03 mA / A + 0.6R	
(2 to 20) A <sup>1</sup>	10 Hz to 2 kHz	2 mA + 0.82 mA / A + 0.6R	
	(2 to 10) kHz	2 mA + 2.5 mA / A + 0.6R	
(20 to 100) A <sup>1</sup>	DC to 1 kHz	0.1 A + 1.5 mA / A + 0.6R	Transcond. amp
Current Clamps <sup>1</sup>	(45 to 65) Hz	0.022 A + 2.1 mA / A + 0.6R	Fluke 5520A with Fluke 50-turn coil
	(65 to 440) Hz	0.021 A + 6.2 mA / A + 0.6R	
	(45 to 65) Hz	0.055 A + 2.5 mA / A + 0.6R	
	(65 to 440) Hz	0.074 A + 6.3 mA / A + 0.6R	
5 A to 30 kA	60 Hz	500 mA + 0.01 A / A + 0.6R	AEMC 30K-24-2

**Electricity and Magnetism – Inductance**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Inductance – Measure and Generate <sup>1</sup>  1 kHz	(5 to 100) $\mu$ H	2 mH / H + 0.6R	SRS SR720
	100 $\mu$ H to 1 mH	1 mH / H + 0.6R	
	1 mH to 80 H	0.5 mH / H + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
	80 H to 1 kH	1 mH / H + 0.6R	
100 Hz	10 mH to 800 H	0.5 mH / H + 0.6R	
Fixed Values 1 kHz <sup>1</sup>	100 μH	0.03 μH + 0.6R	1232 Standard inductors
	500 μH	0.12 μH + 0.6R	
	1 mH	0.21 μH + 0.6R	
	2 mH	0.6 μH + 0.6R	
	10 mH	2.9 μH + 0.6R	
	50 mH	15 μH + 0.6R	
	100 mH	21 μH + 0.6R	
	200 mH	58 μH + 0.6R	
	1 H	0.29 mH + 0.6R	
	2 H	1 mH + 0.6R	
	10 H	2.9 mH + 0.6R	

**Electricity and Magnetism – Capacitance**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Capacitance – Measure and Generate <sup>1</sup> 1 kHz	500 μF to 10 mF	2 mF / F + 0.6R	SRS SR720
	(50 to 500) μF	1 mF / F + 0.6R	
	500 pF to 50 μF	0.52 mF / F + 0.6R	
	(50 to 500) pF	1 mF / F + 0.6R	
	(5 to 50) pF	2 mF / F + 0.6R	
100 Hz	5 nF to 500 μF	0.5 mF / F + 0.6R	
Fixed Points <sup>1</sup> 1 kHz	1 nF	0.049 pF + 0.6R	Keithley 5156
	100 nF	0.51 pF + 0.6R	
	0.001 μF	0.1 pF + 0.6R	Standard capacitors

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
	0.002 $\mu\text{F}$	0.2 pF + 0.6R	
	0.005 $\mu\text{F}$	0.5 pF + 0.6R	
	0.01 $\mu\text{F}$	1 pF + 0.6R	
	0.1 $\mu\text{F}$	10 pF + 0.6R	
	0.5 $\mu\text{F}$	50 pF + 0.6R	
	1 $\mu\text{F}$	100 pF + 0.6R	
Range Values <sup>1</sup> 1 kHz	35 pF to 1.1 nF	0.53 mF / F + 0.6R	GenRad 1422D

**Electricity and Magnetism – Electrical Temperature Simulation**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Electrical Calibration of RTD Indicating Devices <sup>1</sup>  Pt 385, 100 $\Omega$	-200 °C to 0 °C	0.04 °C + 0.6R	Fluke 5520A
	>0 °C to 100 °C	0.05 °C + 0.6R	
	>100 °C to 300 °C	0.07 °C + 0.6R	
	>300 °C to 400 °C	0.08 °C + 0.6R	
	>400 °C to 630 °C	0.09 °C + 0.6R	
	>630 °C to 800 °C	0.18 °C + 0.6R	
Pt 3926, 100 $\Omega$	-200 °C to 0 °C	0.04 °C + 0.6R	Fluke 5520A
	>0 °C to 100 °C	0.05 °C + 0.6R	
	>100 °C to 300 °C	0.07 °C + 0.6R	
	>300 °C to 400 °C	0.08 °C + 0.6R	
	>400 °C to 630 °C	0.09 °C + 0.6R	



Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Pt 3916, 100 Ω	-200 °C to -190 °C	0.19 °C + 0.6R	Fluke 5520A
	>-190 °C to -80 °C	0.03 °C + 0.6R	
	>-80 °C to 0 °C	0.04 °C + 0.6R	
	>0 °C to 260 °C	0.05 °C + 0.6R	
	>260 °C to 300 °C	0.06 °C + 0.6R	
	>300 °C to 400 °C	0.07 °C + 0.6R	
	>400 °C to 600 °C	0.08 °C + 0.6R	
	>600 °C to 630 °C	0.18 °C + 0.6R	
Electrical Calibration of Thermocouple Indicating Devices <sup>1</sup>	-250 °C to -100 °C	0.39 °C + 0.6R	Fluke 5520A
	>-100 °C to -25 °C	0.12 °C + 0.6R	
	>-25 °C to 350 °C	0.11 °C + 0.6R	
	Type E >350 °C to 650 °C	0.12 °C + 0.6R	
	>650 °C to 1000 °C	0.16 °C + 0.6R	
Type J	-210 °C to -100 °C	0.21 °C + 0.6R	Fluke 5520A
	>-100 °C to -30 °C	0.12 °C + 0.6R	
	>-30 °C to 150 °C	0.11 °C + 0.6R	
	>150 °C to 760 °C	0.13 °C + 0.6R	
	>760 °C to 1200 °C	0.18 °C + 0.6R	
Type K	-200 °C to -100 °C	0.26 °C + 0.6R	Fluke 5520A
	>-100 °C to -25 °C	0.14 °C + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
	>-25 °C to 120 °C	0.12 °C + 0.6R	
	>120 °C to 1000 °C	0.20 °C + 0.6R	
	>1000 °C to 1372 °C	0.31 °C + 0.6R	
Type R	0 °C to 250 °C	0.44 °C + 0.6R	Fluke 5520A
	>250 °C to 400 °C	0.27 °C + 0.6R	
	>400 °C to 1000 °C	0.26 °C + 0.6R	
	>1000 °C to 1767 °C	0.31 °C + 0.6R	
Type S	0 °C to 250 °C	0.36 °C + 0.6R	Fluke 5520A
	>250 °C to 1000 °C	0.28 °C + 0.6R	
	>1000 °C to 1400 °C	0.29 °C + 0.6R	
	>1400 °C to 1767 °C	0.36 °C + 0.6R	
Type T	-250 °C to -150 °C	0.49 °C + 0.6R	Fluke 5520A
	>-150 °C to 0 °C	0.19 °C + 0.6R	
	>0 °C to 120 °C	0.12 °C + 0.6R	
	>120 °C to 400 °C	0.11 °C + 0.6R	

**Electricity and Magnetism / Time and Frequency – Oscilloscopes**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Oscilloscopes <sup>1</sup> Amplitude DC 50Ω	(0 to ± 6.6) V	31 μV + 2 mV /V + 0.6R	

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks	
1 MΩ	(0 to ± 130) V	31 μV + 0.39 mV / V + 0.6R	Fluke 5520A/6	
Amplitude – Square Wave (peak to peak) <sup>1</sup> 50 Ω	± 1 mV to ± 6.6 V	31 μV + 2 mV / V + 0.6R		
1 MΩ	± 1 mV to ± 130 V	31 μV + 0.78 mV / V + 0.6R		
Leveled Sine Wave <sup>1</sup>	50 kHz reference	0.24 mV + 16 mV / V + 0.6R		
Amplitude <sup>1</sup> (@ 50 kHz ref.)	50 kHz to 100 MHz	0.24 mV + 27 mV / V + 0.6R		
	(>100 to 300) MHz	0.24 mV + 31 mV / V + 0.6R		
	(>300 to 600) MHz	0.24 mV + 47 mV / V + 0.6R		
Flatness <sup>1</sup> (@ 50 kHz ref.)	50 kHz to 100 MHz	78 μV + 12 mV / V + 0.6R		Fluke 5520A/1.1 GHz
	(>100 to 300) MHz	78 μV + 16 mV / V + 0.6R		
	(>300 to 600) MHz	78 μV + 31 mV / V + 0.6R		Tektronix SG 504
	(>600 to 1050) MHz	78 μV + 39 mV / V + 0.6R		
	(>600 to 1050) MHz	42 mV / V + 0.6R		
Time Marker <sup>1</sup>	0.2 Hz to 1 GHz	0.5 μHz / Hz + 0.6R	Tektronix TG501-01	
Rise Time – Voltage <sup>1</sup>	≤ 300 ps	130 ps + 0.6R	Tektronix 067-0681-00	
Rise Time – Current <sup>1</sup>	(0 to 65) A	20 ns + 0.6R	Pearson 110	

**Electricity and Magnetism – Other**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
DC Power <sup>1</sup> (0.33 to 330) mA	(0.033 to 1020) V	0.18 mA / A + 0.6R	Fluke 5520A

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks	
(0.33 to 3) A <sup>1</sup>	(0.033 to 1020) V	0.17 mA / A + 0.6R	Fluke 5520A	
(3 to 20.5) A <sup>1</sup>	(0.033 to 1020) V	0.5 mA / A + 0.6R		
AC Power (45 to 65) Hz <sup>1</sup> (3.3 to 9) mA	(33 to 330) mV	1.1 mA / A + 0.6R		
	(0.33 to 1020) V	0.9 mA / A + 0.6R		
(9 to 33) mA	(33 to 330) mV	1 mA / A + 0.6R		
	(0.33 to 1020) V	0.6 mA / A + 0.6R		
(33 to 90) mA	(33 to 330) mV	1.1 mA / A + 0.6R		
	(0.33 to 1020) V	0.9 mA / A + 0.6R		
(90 to 330) mA	(33 to 330) mV	1 mA / A + 0.6R		
	(0.33 to 1020) V	0.6 mA / A + 0.6R		
(0.33 to 0.9) A	(33 to 330) mV	1 mA / A + 0.6R		
	(0.33 to 1020) V	0.9 mA / A + 0.6R		
(0.9 to 2.2) A	(33 to 330) mV	0.9 mA / A + 0.6R		
	(0.33 to 1020) V	0.7 mA / A + 0.6R		
(2.2 to 4.5) A	(33 to 330) mV	1 mA / A + 0.6R		
	(0.33 to 1020) V	0.9 mA / A + 0.6R		
(4.5 to 20.5) A	(33 to 330) mV	0.9 mA / A + 0.6R		
	(0.33 to 1020) V	1 mA / A + 0.6R		
Phase – Measure and Generate <sup>1</sup>	10 Hz to 30 kHz	0.05° + 0.6R		Krohn-Hite 6500

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
RF Power – Measure <sup>1</sup> (+20 to -30) dBm 50 Ω	100 kHz	16 parts in $10^3 + M + 0.6R$	HP 436A power meter with: HP 8482A Type-N (m) power sensor  HP 436A power meter with: HP 8481D Type-N (m) power sensor
	300 kHz to 1 GHz	12 parts in $10^3 + M + 0.6R$	
	(2 to 4.2) GHz	13 parts in $10^3 + M + 0.6R$	
(-20 to -70) dBm 50 Ω	10 MHz to 15 GHz	23 parts in $10^3 + M + 0.6R$	
	(16 to 17) GHz	24 parts in $10^3 + M + 0.6R$	
	18 GHz	25 parts in $10^3 + M + 0.6R$	

**Time and Frequency – Frequency / Period**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Frequency – Measure	Up to 1.3 GHz	1 part in $10^{11} + 0.6R$	Counter & Rubidium Oscillator
Frequency Measuring Equipment	10 MHz	5 parts in $10^{12} + 0.6R$	WWVB receiver
	10 MHz	1 part in $10^{11} + 0.6R$	Rubidium Oscillator
Tachometers <sup>1</sup> (Contact Type)	1 rpm to 4 000 rpm	1 μrpm / rpm + 0.6R	Tachometer Calibrator
Tachometers <sup>1</sup> (Non-Contact Type)	(25 to 90 000) rpm	0.5 μrpm / rpm + 0.6R	Frequency Counter

**Time and Frequency – Time Dissemination**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2,3</sup>	Remarks
Stopwatch	1 s to 24 h	0.3 s + 0.6R	WWV

**Thermodynamic – Rhodium – IR Devices**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
IR Thermometers <sup>1</sup>	35° to 400°C	0.28°C + 0.001°C / °C	Blackbody Source ( $\epsilon = 0.95$ ), Reference Probe, Keithley 2002

**Thermodynamic – Thermodynamic Devices (all)**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
Temperature Generate <sup>1</sup>	Ice Point	0.046°C	Kaye Ice Point, Reference Probe, Keithley 2002
	33° to 300°C	0.58°C + 0.002°C / °C	Dry-well, Reference Probe, Keithley 2002
Temperature Measure <sup>1</sup>	-196 °C to 420 °C	0.037 °C	Reference Probe, Keithley 2002

**Thermodynamic – Humidity**

Calibration Parameter/Equipment	Range	Best Measurement Capability(+/-) <sup>2</sup>	Remarks
Humidity – Measure <sup>1</sup>	10 % to 80 %	1.4% RH	Thermohygrometer

**Notes:**

- 1) Laboratory offers calibration services at the laboratory's own facilities and at the client or other agreed upon facilities.
- 2) Best uncertainties represent expanded uncertainties at approximately the 95% confidence level using a coverage factor of k=2.
- 3)  $L$  = length in inches,  $R$  = Resolution of the unit under test,  $M$  = represents the source mismatch uncertainty.

Approved by:  Date: September 29, 2009

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