The American Association for Laboratory Accreditation

World Class Accreditation

Accredited Laboratory

A2LA has accredited

APPLIED TECHNICAL SERVICES, INC.

Marietta, GA

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets 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 26th day of May 2010.

President & CEO
For the Accreditation Council
Certificate Number 1888.03
Valid to January 31, 2012

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

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

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CALIBRATION

Valid To: January 31, 2012 Certificate Number: 1888.03

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations and dimensional inspections[1]:

I. Acoustical Quantities

Parameter/Equipment	Range	CMC[2] (±)	Comments
Sound Measuring Equipment[3]	114 dB	0.62 dB	General Radio 1562A

II. Chemical

Parameter/Equipment	Range	CMC[2] (±)	Comments
pH Measuring Equipment[3]	(4.01, 7.0, 10.0) pH	0.02 pH	pH buffer solutions

5301 Buckeystown Pike, Suite 350 | Frederick, Maryland 21704-8373 | Phone: 301 644 3248 | Fax: 301 662 2974 | www.A2LA.org

Parameter/Equipment	Range	CMC[2] (±)	Comments
Conductivity[3] –			
Liquid	1015 µS 1408 µS 12 850 µS 111 300 µS	11 µS 15 µS 90 µS 1200 µS	Conductivity solutions
Solid	8.4 % IACS 30 % IACS 48 % IACS 100 % IACS	1.5 % of value 1.5 % of value 0.50 % IACS 0.85 % IACS	Z-Tech conductivity standard blocks

III. Dimensional

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Gage Blocks	(0 to 1) in 2 in 3 in 4 in 5 in 6 in 7 in 8 in 10 in 12 in 16 in 20 in	3.7 µin 4.9 µin 6.2 µin 7.5 µin 9.1 µin 11 µin 13 µin 14 µin 17 µin 21 µin 27 µin 34 µin	By mechanical comparison
Length Measuring Equipment[3] –			
Calipers, Micrometers, Height Gages, Bore Gages, Countersink Gages, Indicators, Indicator Testers, Levels, Ultrasonic Thickness Gages, Tapes and Rulers	(0 to 80) in	$(42 + 6.4L)$ µin + $0.6R$	Comparison to master length standards
Tapes and Rulers	(80 to 240) in	$(500L)$ µin + $0.6R$	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Cylindricals –			
Inside/Outside Diameter	(0 to 1) in (1 to 2) in (2 to 4) in (4 to 8) in (8 to 12) in	12 µin 14 µin 20 µin 33 µin 48 µin	Master length standards
Thread Gages – Simple Pitch Diameter	(0 to 12) in	80 µin	Master length standards
Thread Wires	(5 to 80) TPI	20 µin	Master length standards
Angle Standards	0° to 360°	0.015°	CMM
Surface Plate[3]			
Flatness	8 in × 8 in to 12 ft × 12 ft	$60D^{1/2}$ + 80 µin	Electronic level system
Repeat Reading	0.002 in	44 µin	Repeat-O-Meter
Optical Comparator and Vision Machines[3]			
X-Y Linearity	(0 to 12) in	180 µin + 0.6*R*	Glass master
Crimp Tools[3]	Go/no go Crimp height Pullout	0.001 in 640 µin 3.5 lbf	Pin gages, crimp micrometer, crimp pull tester
Protractors[3]	0° to 360°	0.036° + 0.6*R*	Angle blocks

IV. Dimensional Testing

Parameter	Range	CMC[2] (±)	Technique	Standards
Geometry Measurements	27 in × 39 in × 27 in Linear Volumetric	 420 µin 820 µin	Coordinate measuring machine (CMM)	ASME Y 14.5
	47 in × 118 in × 39 in Linear Volumetric	800 µin 1100 µin	Coordinate measuring machine (CMM)	ASME Y 14.5
	12 in × 12 in × 8 in Linear	300 µin	Vision system	ASME Y 14.5
Surface Finish Standards (Specimens)[3]	(5 to 125) µin	4 µin	Master surface finish standard	Master surface finish standard

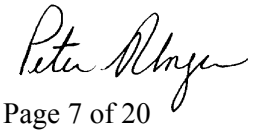
V. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
DC Voltage Measuring Equipment[3]	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V	10 µV/V + 0.8 µV 9 µV/V + 1.2 µV 9 µV/V + 4 µV 9 µV/V + 8 µV 10 µV/V + 0.1 mV	Fluke 5700A
	(220 to 1100) V	12 µV/V + 0.6 mV	Fluke 5700A
	(1.1 to 6) kV	0.15 %	Ross VD60-2
DC Voltage – Measure[3]	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V 0.66to 20) kV (60 to 200) kV	10 µV/V + 3 µV 9 µV/V + 3 µV 9 µV/V + 5 µV 11 µV/V + 30 µV 11 µV/V + 100 µV 20 V 210 V	Agilent 3458A Hipotronics KVM 200A
	(1.0 to 60) kV	0.15 %	Ross VD60-2

Parameter/Equipment	Range	CMC[2,5] (±)	Comments
DC Current Measuring Equipment[3]	(0 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.3 to 11) A	65 µA/A + 10 nA 65 µA/A + 100 nA 75 µA/A + 1 µA 0.5 % + 30 µA 0.037 % + 0.48 mA	Fluke 5700A/5725A
Clamp-on only	(11 to 20.5) A	0.11 % + 0.75 mA	Fluke 5520A
	(20 to 1000) A	0.5 % + 0.5 A	Fluke 5520A/coil
DC Current – Measure[3]	(10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (1 to 3) A 3 A to 2 kA (2 to 10) kA	22 µA/A + 1 nA 22 µA/A + 5 nA 22 µA/A + 50 nA 37 µA/A + 0.5 µA 0.012 % + 10 µA 0.13 % + 0.6 mA 0.25 % 1.0 %	Agilent 3458A Agilent 34401A Empro shunts
Resistance Measuring Equipment – Fixed Points[3]	0 Ω (1, 1.9) Ω 10 Ω 19 Ω (100, 190) Ω (1, 1.9) kΩ (10, 19) kΩ (100, 190) kΩ 1.0 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	50 µΩ 0.012 % 38 parts in 10^6 36 parts in 10^6 25 parts in 10^6 20 parts in 10^6 19 parts in 10^6 20 parts in 10^6 28 parts in 10^6 29 parts in 10^6 50 parts in 10^6 60 parts in 10^6 0.014 %	Fluke 5700A
Resistance Measuring Equipment[3]	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω 110 Ω to 1.1 kΩ 0.66to 11) kΩ (11 to 110) kΩ 110 kΩ to 1.1 MΩ 0.66to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (330 to 1100) MΩ	40 µΩ/Ω + 1 mΩ 30 µΩ/Ω + 1.5 mΩ 28 µΩ/Ω + 1.4 mΩ 28 µΩ/Ω + 2 mΩ 28 µΩ/Ω + 20 mΩ 28 µΩ/Ω + 0.2 Ω 32 µΩ/Ω + 2 Ω 60 µΩ/Ω + 30 Ω 0.013 % + 50 Ω 0.025 % + 2.5 kΩ 0.05 % + 3 kΩ 0.3 % + 100 kΩ 1.5 % + 500 kΩ	Fluke 5520A

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Resistance – Measure[3]	(0 to 10) Ω (10 to 100) Ω (100 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ (1 to 10) GΩ	20 μΩ/Ω + 7.3 μΩ/Ω 15 μΩ/Ω + 7.3 μΩ/Ω 13 μΩ/Ω + 7.3 μΩ/Ω 18 μΩ/Ω + 2.3 μΩ/Ω 50 μΩ/Ω + 10 μΩ/Ω 0.051 % + 37 μΩ/Ω 0.51 % + 0.028 % 10 %	Agilent 3458A Quad tech Sentry 30
Capacitance Measuring Equipment[3]	(0.19 to 3.3) nF (3.3 to 330) nF 330 nF to 3.3 μF (3.3 to 33) μF (33 to 330) μF 330 μF to 3.3 mF (3.3 to 33) mF (33 to 110) mF	0.5 % + 0.01 nF 0.25 % + 0.3 nF 0.25 % + 3 nF 0.4 % + 30 nF 0.45 % + 0.3 μF 0.45 % + 3 μF 0.75 % + 30 μF 0.66 % + 100 μF	Fluke 5520A
Capacitance Measuring Equipment – Fixed Points[3]	(0.001, 0.01, 0.1) μF 1 μF (0 to 1.1) μF (50 to 1100) μF	0.05 % 0.05 % 0.07 % 1.5 pF	GR 1409 series Quad Tech 1413 GR 1422-CB air cap
Capacitance – Measure, at 1 kHz[3]	(0 to 1120) μF	0.2 %	GR 1689
Inductance Measuring Equipment[3] –	1.0 mH @ 400 Hz 1 mH @ 1 kHz	0.08 % 0.07 %	GR 1482-E
Inductance – Measure[3]	1 μH to 100 H	0.25 %	GR 1689
Magnetic Flux Density – Fixed Points[3]	-2.0 G 2.0G -10 G 10 G 50 G 100 G 500 G 1000 G	0.04 G 0.04 G 0.20 G 0.071 G 0.06 G 0.10 G 0.33 G 0.66 G	Reference magnets

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple Indicators[3] –			
Type B	600 °C to 800 °C 800 °C to 1000 °C 1000 °C to 1550 °C 1550 °C to 1800 °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	Fluke 5520A
Type C	0 °C to 150 °C 150 °C to 650 °C 650 °C to 1000 °C 1000 °C to 1800 °C 1800 °C to 2316 °C	0.3 °C 0.26 °C 0.31 °C 0.50 °C 0.84 °C	
Type E	-250 °C to -100 °C -100 °C to -25 °C -25 °C to 350 °C 350 °C to 650 °C 650 °C to 1000 °C	0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to 150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	
Type K	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.40 °C	
Type L	-200 °C to -100 °C -100 °C to 800 °C 800 °C to 900 °C	0.37 °C 0.26 °C 0.17 °C	
Type N	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 410 °C 410 °C to 1300 °C	0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	0 °C to 250 °C 250 °C to 400 °C 400 °C to 1000 °C 1000 °C to 1767 °C	0.57 °C 0.35 °C 0.33 °C 0.4 °C	



Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple Indicators[3]– (cont)			
Type S	0 °C to 250 °C 250 °C to 1000 °C 1000 °C to 1400 °C 1400 °C to 1767 °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	Fluke 5520A
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	
Type U	-200 °C to 0 °C 0 °C to 600 °C	0.56 °C 0.27 °C	
Electrical Calibration of RTDs[3] –			
Pt 385, 100 Ω	-200 °C to 0 °C 0 °C to 100 °C 100 °C to 300 °C 300 °C to 400 °C 400 °C to 630 °C 630 °C to 800 °C	0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.23 °C	Fluke 5520A
Pt 3926, 100 Ω	-200 °C to 0 °C 0 °C to 100 °C 100 °C to 300 °C 300 °C to 400 °C 400 °C to 630 °C	0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C	
Pt 3916, 100 Ω	-200 °C to -190 °C -190 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.25 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.10 °C 0.23 °C	
Pt 385, 200 Ω	-200 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.04 °C 0.05 °C 0.12 °C 0.13 °C 0.14 °C 0.16 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of RTDs[3] – (cont)			
Pt 385, 500 Ω	-200 °C to -80 °C -80 °C to 100 °C 100 °C to 260 °C 260 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.04 °C 0.05 °C 0.06 °C 0.08 °C 0.09 °C 0.11 °C	Fluke 5520A
Pt 385, 1000 Ω	-200 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 600 °C 600 °C to 630 °C	0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.23 °C	
Ni 120, 120 Ω	-80 °C to 100 °C 100 °C to 260 °C	0.08 °C 0.14 °C	
Cu 427 10 Ω	-100 °C to 260 °C	0.30 °C	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage Measuring Equipment[3] –			
Up 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	0.061 % + 5 µV 0.025 % + 5 µV 0.013 % + 5 µV 0.045 % + 5 µV 0.096 % + 8 µV 0.18 % + 15 µV 0.21 % + 30 µV 0.38 % + 30 µV	Fluke 5700A
(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	0.061 % + 6 µV 0.025 % + 6 µV 0.012 % + 6 µV 0.042 % + 6 µV 0.096 % + 8 µV 0.15 % + 15 µV 0.2 % + 30 µV 0.38 % + 30 µV	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage Measuring Equipment[3] – (cont)			
(22 to 220) mV	(10 to 20) Hz	0.061 % + 16 µV	Fluke 5700A
	(20 to 40) Hz	0.025 % + 10 µV	
	40 Hz to 20 kHz	0.012 % + 10 µV	
	(20 to 50) kHz	0.037 % + 10 µV	
	(50 to 100) kHz	0.095 % + 30 µV	
	(100 to 300) kHz	0.11 % + 30 µV	
	(300 to 500) kHz	0.18 % + 40 µV	
	500 kHz to 1 MHz	0.36 % + 100 µV	
220 mV to 2.2 V	(10 to 20) Hz	0.061 % + 100 µV	
	(20 to 40) Hz	0.019 % + 30 µV	
	40 Hz to 20 kHz	0.009 % + 7 µV	
	(20 to 50) kHz	0.015 % + 20 µV	
	(50 to 100) kHz	0.029 % + 80 µV	
	(100 to 300) kHz	0.049 % + 0.15 mV	
	(300 to 500) kHz	0.15 % + 0.4 mV	
	500 kHz to 1 MHz	0.29 % + 1 mV	
(2.2 to 22) V	(10 to 20) Hz	0.061 % + 1 mV	
	(20 to 40) Hz	0.019 % + 0.3 mV	
	40 Hz to 20 kHz	0.009 % + 0.07 mV	
	(20 to 50) kHz	0.015 % + 0.2 mV	
	(50 to 100) kHz	0.029 % + 0.4 mV	
	(100 to 300) kHz	0.061 % + 1.7 mV	
	(300 to 500) kHz	0.15 % + 5 mV	
	500 kHz to 1 MHz	0.3 % + 9 mV	
(22 to 220) V	(10 to 20) Hz	0.061 % + 10 mV	
	(20 to 40) Hz	0.019 % + 3 mV	
	40 Hz to 20 kHz	0.0095 % + 1 mV	
	(20 to 50) kHz	0.026 % + 4 mV	
	(50 to 100) kHz	0.061 % + 10 mV	
	(100 to 300) kHz	0.19 % + 110 mV	
	(300 to 500) kHz	0.59 % + 110 mV	
	500 kHz to 1 MHz	1.4 % + 220 mV	
(220 to 1100) V	40 Hz to 1 kHz	0.0095 % + 4 mV	Fluke 5700A/5725A
	(1 to 20) kHz	0.017 % + 6 mV	
	(20 to 30) kHz	0.061 % + 11 mV	
(220 to 750) V	(30 to 50) kHz	0.061 % + 11 mV	
	(50 to 100) kHz	0.027 % + 45 mV	
(1 to 5) kV	(50 to 60) Hz	0.55 %	Ross VD60-2

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage – Measure[3]			
(1 to 10) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.04 % + 0.03 % 0.03 % + 0.011 % 0.04 % + 0.011 % 0.2 % + 0.011 % 0.6 % + 0.011 % 4.5 % + 0.02 %	Agilent 3458A
(10 to 100) mV, 100 mV to 1 V, (1 to 10) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.008 % + 0.004 % 0.008 %+ 0.002 % 0.015 % + 0.002 % 0.04 % + 0.002 % 0.09 % + 0.002 % 0.4 % + 0.01 % 2 % + 0.01 % 1.8 % + 0.01 %	
(10 to 100) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.03 % + 0.004 % 0.03 % + 0.002 % 0.03 % + 0.002 % 0.038 % + 0.002 % 0.14 % + 0.002 % 0.5 % + 0.01 % 1.8 % + 0.01 %	
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.05 % + 0.004 % 0.05 % + 0.002 % 0.07 % + 0.002 % 0.13 % + 0.002 % 0.4 % + 0.002 %	
(0.1 to 60) kV	(50 to 60) Hz	0.55 %	Ross VD60-2
(60 to 200) kV	(20 to 60) Hz	100 V	Hipotronics KVM 200A
AC Current Measuring Equipment[3] –			
Up to 220 μA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.082 %+ 30 nA 0.043 % + 25 nA 0.014 % + 20 nA 0.072 % + 50 nA 0.19 % + 100 nA	Fluke 5700A

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Current Measuring Equipment[3] – (cont)			
220 µA 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	0.082 % + 50 nA 0.044 % + 40 nA 0.018 % + 40 nA 0.072 % + 0.5 µA 0.19 % + 1 µA	Fluke 5700A
(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	0.082 % + 0.5 µA 0.043 % + 0.4 µA 0.018 % + 0.4 µA 0.072 % + 5 µA 0.19 % + 10 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.082 % + 5 µA 0.042 % + 4 µA 0.018 % + 4 µA 0.072 % + 50 µA 0.19 % + 100 µA	
220 mA to 2.2 A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.077 % + 40 µA 0.087 % + 100 µA 1.5 % + 200 µA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.048 % + 170 µA 0.098 % + 380 µA 0.38 % + 750 µA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.13 % + 5 mA 0.16 % + 5 mA 3.2 % + 5 mA	Fluke 5520A
Clamp-on only (20.5 to 1000) A	45 Hz to 1 kHz	0.6 % + 0.5A	Fluke 5520A w/Fluke 50-turn coil
AC Current – Measure[3]			
(5 to 100) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.5 % + 0.03 % 0.16 % + 0.03 % 0.07 % + 0.03 % 0.07 % + 0.03 %	Agilent 3458A

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Current – Measure[3] (cont)			
(1, 10, 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.5 % + 0.02 % 0.16 % + 0.02 % 0.07 % + 0.02 % 0.04 % + 0.02 % 0.07 %+ 0.02 % 0.5 % + 0.04 % 0.58 % + 0.15 %	Agilent 3458A
1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.5 % + 0.02 % 0.18 % + 0.02 % 0.09 % + 0.02 % 0.2 % + 0.02 % 0.4 % + 0.02 % 2 % + 0.04 %	Agilent 3458A
3 A	(3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz	1.5 % + 0.06 % 0.39 % + 0.06 % 0.19 % + 0.06 %	HP 34401A
3 A to 1 kA	45 Hz to 5 kHz	0.75 %	AEMC clamp-on meter
(1 to 10) kA	10 Hz to 20 kHz	1 %	

VI. Mechanical

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Force[3]	(0 to 600 000) lbf	0.15 lbf or 0.16 %, whichever is greater	Deadweights, load cells; The range for testing machines in tension is only to 60 000 lbf.
Vacuum Gages and Transducers[3]	(0 to 28) inHg	0.02 % + 0.6*R*	DH Instruments PPC2+; gage pressure only, not absolute.

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Pressure Gages and Transducers –			
Hydraulic[3]	Up to 15 000 psi	0.20 % + 0.6*R*	Ametek T150 deadweight tester
Hydraulic	Up to 16 000 psi	0.01 % + 0.6*R*	Ruska 480HX & Ametek DM-T150 dead weight tester
Pneumatic[3]	Up to 1000 psi	0.02 % + 0.6*R*	DH Instruments PPC2+
Pneumatic	Up to 30 psi	0.005 % + 0.6*R*	DH Instruments PPC3
Torque[3] –			
Wrenches	20 in·oz to 2000 ft·lb	1.0 %	Master dead weight standards, master length standard, CDI Datatest 950-DT
Analyzers	(0 to 50) in·lb	0.21 % + 0.6*R*	2.5-inch torque arm wheel weights
	(0 to 250) in·lb	0.21 % + 0.6*R*	5-inch torque arm wheel weights
	(0 to 3600) in·lb	0.21 % + 0.6*R*	10-inch torque arm wheel weights
	(0 to 7200) in·lb	0.21 % + 0.6*R*	12-inch torque arm wheel weights
	(0 to 24 000) in·lb	0.21 % + 0.6*R*	40-inch/60-inch torque arm wheel weight

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Calibration of Mass	(1, 2, 5, 10, 20) mg (50, 100, 200, 500) mg (1, 2, 5, 10, 20) g (50,100, 200) g 500 g 1 kg 2 kg (5, 10) kg 20 kg (1, 2) lb 5 lb (10, 20) lb 50 lb 100 lb	15 µg 15 µg 23 µg 0.14 mg 0.21 mg 0.36 mg 1.7 mg 7 mg 42 mg 0.12 mg 0.25 mg 6 mg 54 mg 205 mg	Comparison to class 1 weights Comparison to class F weights
Calibration of Precision Scales and Balances[3]	(1, 2, 5, 10, 20) mg (50, 100, 200, 500) mg (1, 2, 5) g (10, 20) g 50 g to 10 kg (1 to 20) lb	24 µg + 0.6*R* 24 µg + 0.6*R* 63 µg + 0.6*R* 0.001 % + 0.6*R* 0.0005 % + 0.6*R* 0.0005 % + 0.6*R*	Comparison to class 1 weights
Calibration of Weight Scales and Balances[3]	(1, 2, 5, 10, 20) mg (50, 100, 200, 500) mg (1, 2, 5, 10) g 20g to 5kg (1/16 to 1/8) oz 1/8 oz to 1 lb (1 to 1200) lb	45 µg + 0.6*R* 0.20 mg + 0.6*R* 0.24 mg + 0.6*R* 0.001 % + 0.6*R* 0.1 % + 0.6*R* 0.05 % + 0.6*R* 0.02 % + 0.6*R*	Comparison to class 2 weights Comparison to class F weights

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Calibration of Force Gages, Load Cells, Cable Tensiometers, Tensile Test Machines[3]	(0 to 1000) lb	0.02 % + 0.6*R*	Comparison to class F weights
Direct Verification of Durometers –			ASTM D2240
Verification of indenter shape and extension:			
Extension at zero reading	-----	10 µm	
35° right circular conical frustum	Diameter of the base of the frustum	31 µm	The dimensional characteristics of the indenters are verified by optical projection.
	Diameter of the top of the frustum	7.5 µm	
30° cone	Cone angle	0.06°	
	Diameter of the base of the cone	31 µm	
	Cone angle	0.06°	
1.2 mm radius	Tip radius	3 µm	
	Indenter thickness	20 µm	
	Indenter radius	12 µm	
Verification of the durometer spring	-----	0.003 *g*	The durometer spring is verified with an electronic balance. This CMC applies to all durometer types. *g* is the acceleration due to gravity

Parameter/Equipment	Range	CMC[2] (±)	Comments
Indirect Verification of Rockwell Hardness and Rockwell Superficial Hardness Tester[3]	HRA: Low Middle High HRBW: Low Middle High HRC: Low Middle High HR15N: Low Middle High HR15TW: Low Middle High HR30N: Low Middle High HR30TW: Low Middle High HR45N: Low Middle High HR45TW: Low Middle High	 0.55 HRA 0.55 HRA 0.34 HRA 0.65 HRBW 0.64 HRBW 0.47 HRBW 0.37 HRC 0.32 HRC 0.31 HRC 0.6 HR15N 0.72 HR15N 0.8 HR15N 0.72 HR15TW 0.85 HR15TW 0.73 HR15TW 0.91 HR30N 0.69 HR30N 0.56 HR30N 0.92 HR30TW 0.82 HR30TW 0.76 HR30TW 0.44 HR45N 0.21 HR45N 0.2 HR45N 0.63 HR45TW 0.62 HR45TW 0.41 HR45TW	ASTM E18

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Indirect Verification of Microindentation Hardness Testers (Knoop and Vickers)[3]	Repeatability under forces *P* (gf): 1 < *P* < 500 100 < HK < 250 100 < HV < 240 250 < HK < 650 240 < HV < 600 HK > 650 HV > 600 Repeatability under forces *P* (gf): 500 < *P* < 1000 100 < HK < 250 100 < HV < 240 250 < HK < 650 240 < HV < 600 HK > 650 HV > 600 Error	 1.5 % 1.2 % 1 % 1.2 % 1 % 0.75 % 0.5 % or 5 µin, whichever is greater	ASTM E384 CMC is stated as the repeatability as defined in E384. ASTM E384 CMC is stated as percent error or error as defined in E384.
Indirect Verification of Brinell Hardness Testers at Test Conditions:[3] 10/3000/15	 Repeatability: < 225 HBW (> 225 to 650) HBW Error	 0.01*D* 0.005*D* 0.75 %	Indirect verification method per ASTM E10. *D* is the mean of the n mean test diameters in millimeters Uncertainty is stated as a percentage of the standardiz test block hardness value.

VII. Optical Quantities

Parameter/Equipment	Range	CMC[2] (±)	Comments
Light – Measure			
White	(0 to 1000) FC	5 %	Radiometer standards
Black	(0 to 200) µW/cm²	5 %	Radiometer standards, 365 nm

VIII. Thermodynamics

Parameter/Equipment	Range	CMC[2] (±)	Comments
Temperature Measuring Equipment[3] –			
Liquid in Glass Thermometers, RTDs, and Thermocouples	-40 °C to 400 °C	0.05 °C	Instrulab 4202B with 832 probe, temperature bath
Temperature – Measure[3]	-40 °C to 400 °C	0.05 °C	Instrulab 4202B with 832 probe
Relative Humidity – Measure[3]	(10 to 95) % RH	0.5 % RH	Thunder Scientific Z500
IR Thermometry[3]	(20 to 500) °C	1.7 °C	Hart 9132

IX. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Frequency – Measure[3]	DC to 18 GHz	2 parts in 10^8	HP 5334B, HP 5343A GPS receiver
Frequency Measuring Equipment[3]	DC to 18 GHz	2 parts in 10^8	HP 3325A, HP 83640B GPS receiver

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[1] This laboratory offers commercial calibration service and field calibration service, where noted.

[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, *L* is the length of the unit under test in inches; *D* is the diagonal of the unit under test in inches; and *R* is the resolution of the device under test.

[5] In the statement of CMC, the first percentage given is the percentage of the reading, unless otherwise noted; the second percentage or fraction given is a percentage or fraction of the range.