The American Association for Laboratory Accreditation

World Class Accreditation

Accredited Laboratory

A2LA has accredited

HAYES INSTRUMENT SERVICE, INC.

Billerica, MA

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 2nd day of April 2008.

President & CEO
For the Accreditation Council
Certificate Number 2117.01
Valid to March 31, 2010
Revised February 26, 2010

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 until: March 31, 2010 Certificate Number: 2117.01

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

I. Dimensional

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Micrometers –			
Inside & Outside	Up to 1 in	63 µin	Grade 1 gage blocks
Depth	(1 to 18) in	(63 + 45*L*) µin	
Calipers –			
Inside & Outside	Up to 1 in	120 µin	Grade 1 gage blocks
Depth	(2 to 18) in	(120 + 32*L*) µin	
Dial Indicators	Up to 6 in	63 µin	Bench micrometer, grade 1 gage blocks and super micrometer
Depth & Height Gages	Up to 1 in (1 to 18) in	63 µin (63 + 32*L*) µin	Grade 1 gage blocks
Pin Gages	(0.05 to 1) in	26 µin	Bench micrometer, grade 1 gage blocks and super micrometer

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II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
DC Voltage[3] – Generate	10 V Reference 1.0 V & 1.018 V Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V (1.1 to 30) kV	1.2 µV/V 1.4 µV/V 8.7 µV/V + 0.4 µV 5.8 µV/V + 0.7 µV 4.0 µV/V + 2.5 µV 4.0 µV/V + 4.0 µV 5.8 µV/V + 40 µV 7.5 µV/V + 400 µV 1.2 mV/V	Fluke 732A and 5720A DC source with HP 3458A and Fluke 80D
DC Current[3] – Generate	(2 to 20) pA (20 to 200) pA (2 to 20) nA (20 to 200) nA	0.43 pA/A + 0.01 pA 0.29 pA/A + 0.03 pA 0.08 nA/A + 1 pA 0.04 nA/A + 10 pA	Keithley 263
DC Current[3] – Generate	0.2 nA to 200 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 100) A (100 to 900) A Clamp-On (0 to 1000) A	46 µA/A + 8 nA 40 µA/A + 7 nA 40 µA/A + 40 nA 52 µA/A + 0.7 nA 92 µA/A + 12 nA 0 .058 % 0.29 % 0.33 mA/A+ 0.05A	Fluke 5720A w/ 5220A DC source w/ L&N shunts and HP 3458A DC source w/ Empro shunt and HP 3458A Fluke 5520A w/ 5500A coil

Parameter/Equipment	Range	CMC[2] (±)	Comments
DC Current[4] – Measure			
	(10 to 100) µA 100 µA to 10 mA (10 to 100) mA 100 mA to 1 A	27 µA/A + 8 nA 27µA/A + 5 µA 43 µA/A + 5 µA 0.013 of rdg + 10 µA	Keithley 616
	(1 to 20) A	0.005 % of rdg + 4 µA	
	(20 to 100) A	0.005 %	HP 3458A w/ Fluke Y5020
	(100 to 1000) A	0.04 %	HP 3458A w/ L&N shunt HP 3458A w/ Empro shunt
DC Voltage[4] – Measure	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V	11 µV/V + 0.3 µV 10 µV/V + 0 3 µV 10 µV/V + 0.5 µV 12 µV/V + 30 µV 17 µV/V + 100 µV	HP 3458A See footnote 5
	(1 to 10) kV	0.015 %	HP 3458A with Fluke 80E
	(10 to 30) kV	0.015 %	HP 3458A with Fluke 80D
	(30 to 50) kV	0.07 %	Ross VD60-6.2Y-A – LB-AV w/HP 34401A
DC Resistance – Measure	100 mΩ to 100 MΩ	8.6 µΩ/Ω	ESI 242D
Fixed Points	1 GΩ 10 GΩ 100 GΩ	1.6×10^{-6} 5.6×10^{-7} 1.0×10^{-8}	HP 4339A

Parameter/Equipment	Range	CMC[2] (±)	Comments
DC Resistance[3] – Generate			
Fixed Points	0.001 Ω	1.7 parts in 10^6	L&N 4223
	0.01 Ω	1.7 parts in 10^6	L&N 4222
	0.1 Ω	1.7 parts in 10^6	L&N 4221
	1 Ω	1.4 parts in 10^6	L&N 4210
	10 k Ω	0.7 parts in 10^6	ESI SR-104
	1.9 Ω	96 parts in 10^6	Fluke 5720A
	10 Ω	30 parts in 10^6	
	19 Ω	29 parts in 10^6	
	100 Ω	17 parts in 10^6	
	190 Ω	17 parts in 10^6	
	1 kΩ	13 parts in 10^6	
	1.9 kΩ	17 parts in 10^6	
	19 kΩ	12 parts in 10^6	
	100 kΩ	14 parts in 10^6	
	190 kΩ	14 parts in 10^6	
	1 MΩ	20 parts in 10^6	
	1.9 MΩ	21 parts in 10^6	
	10 MΩ	40 parts in 10^6	
	19 MΩ	47 parts in 10^6	
	100 MΩ	0.011 %	
	1 GΩ	500 kΩ	Keithley 263
	10 GΩ	7 MΩ	
	100 GΩ	100 MΩ	
Inductance – Measure @ 1kHz	1 nH to 1kH	0.05 % rdg	HP 4284A
Inductance – Generate			
Fixed Points @ 1 kHz	100 µH to 1 kH	0.06 % rdg	GenRad1482 Inductors

Parameter/Equipment	Range	CMC[2] (±)	Comments
Capacitance – Measure			
50 Hz to 10 kHz	0.0001 pF to 1.1 µF	0.012 % of rdg	GenRad 1620A
10 kHz to 1 MHz	10 µF to 10 F	0.02 % of rdg	HP 4284A
Electrical Calibration of Thermocouple Indicators			
Type E			
	-250 °C to -100 °C	0.50 °C	Fluke 5520A
	-100 °C to 650 °C	0.16 °C	
	650 °C to 1000 °C	0.21 °C	
Type J			
	-210 °C to -100 °C	0.27 °C	
	-100 °C to 760 °C	0.17 °C	
	760 °C to 1200 °C	0.23 °C	
Type K			
	-200 °C to -100°C	0.33 °C	
	-100 °C to 120 °C	0.18 °C	
	120 °C to 1000 °C	0.26 °C	
	1000 °C to 1372 °C	0.40 °C	
Type S			
	0 °C to 250 °C	0.47 °C	
	250 °C to 1400 °C	0.37 °C	
	1400 °C to 1767 °C	0.46 °C	
Type T			
	-250 °C to -150 °C	0.63 °C	
	-150 °C to 0 °C	0.24 °C	
	0 °C to 400 °C	0.60 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of RTD Indicators –			
Pt 385, 100 Ω	-200 °C to 0 °C 0 °C to 100 °C 100 °C to 400 °C 400 °C to 630 °C 630 °C to 800 °C	0.05 °C 0.07 °C 0.10 °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 400 °C 400 °C to 630 °C	0.05 °C 0.07 °C 0.10 °C 0.12 °C	
Pt 3916, 100 Ω	-200 °C to -190 °C -190 °C to 0 °C 0 °C to 300 °C 300 °C to 600 °C 600 °C to 630 °C	0.25 °C 0.05 °C 0.08 °C 0.10 °C 0.23 C	
Pt 385, 200 Ω	-200 °C to 100 °C 100 °C to 260°C 260 °C to 600 °C 600 °C to 630 °C	0.04 °C 0.05 °C 0.14 °C 0.16 °C	
Pt 385, 500 Ω	-200 °C to 100 °C 100 °C to 260°C 260 °C to 600 °C 600 °C to 630 °C	0.05 °C 0.06 °C 0.09 °C 0.11 °C	
Pt 385, 1 kΩ	-200 °C to 0 °C 0 °C to 260°C 260 °C to 600 °C 600 °C to 630 °C	0.03 °C 0.05 °C 0.07 °C 0.23 °C	
PtNi 385, 100 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	0.3 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Oscilloscopes[3] –			
Square Wave Signal			
50 Ω, 1 kHz	1 mV to 130 V	2.5 mV/V + 40 µV	Fluke 5520A w/ SC 1100
1 MΩ, 1 kHz	1 mV to 130 V	1 mV/V + 40 µV	
Leveled Sine Wave Amplitude	50 kHz reference	20 mV/V + 300 µV	
	50 kHz to 100 MHz	35 mV/V + 300 µV	
	(100 to 300) MHz	40 mV/V + 300 µV	
	(300 to 500) MHz	55 mV/V + 300 µV	
	(500 to 600) MHz	60 mV/V + 300 µV	
	(600 to 1100) MHz	70 mV/V + 300 µV	
Flatness			
(Up to 50 kHz)	50 kHz to 100 MHz	15 mV/V + 100 µV	
	(100 to 300) MHz	20 mV/V + 100 µV	
	(300 to 600) MHz	40 mV/V + 100 µV	
	(600 to 1100) MHz	50 mV/V + 100 µV	
Time Marker			
(Into 50 Ω)	1 ns to 20 ms	2.5 parts in 10^6	
	50 ms to 5s	25 parts in 10^6	
Rise Time	< 125 ps	+0/-50 ps	Fluke 5520A w/ Fluke 5800A/TDP
AC Voltage[3] – Generate			
1 nV to 2.2 mV	(10 to 20) Hz	0.024 % + 4 µV	Fluke 5720A
	(20 to 40) Hz	91 µV/V + 4 µV	
	40 Hz to 20 kHz	81 µV/V + 4 µV	
	(20 to 50) kHz	0.02 % + 4 µV	
	(50 to 100) kHz	0.05 % + 5 µV	
	(100 to 300) kHz	0.11 % + 10 µV	
	(300 to 500) kHz	0.14 % + 20 µV	
	(0.5 to 1) MHz	0.27 % + 20 µV	
(2.2 to 22) mV	(10 to 20) Hz	0.024 % + 4 µV	
	(20 to 40) Hz	90 µV/V + 4 µV	
	40 Hz to 20 kHz	80 µV/V + 4 µV	
	(20 to 50) kHz	0.02 % + 4 µV	
	(50 to 100) kHz	0.05 % + 5 µV	
	(100 to 300) kHz	0.11 % + 10 µV	
	(300 to 500) kHz	0.14 % + 20 µV	
	(0.5 to 1) MHz	0.27 % + 20 µV	

Parameter/Range	Frequency	CMC[2] (±)	Comments
AC Voltage[3] – Generate (cont.)			
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % + 12 µV 90 µV/V + 7 µV 80 µV/V + 7 µV 0.02 % + 7 µV 0.05 % + 17 µV 0.11 % + 20 µV 0.14 % + 25 µV 0.27 % + 45 µV	Fluke 5720A
(0.22 to 2.2) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % + 40 µV 90 µV/V + 15 µV 45 µV/V + 8 µV 75 µV/V + 10 µV 0.01 % + 30 µV 0.028 % + 80 µV 0.10 % + 200 µV 0.17 % + 300 µV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % + 0.4 mV 90 µV/V + 0.15 mV 45 µV/V + 0.05 mV 75 µV/V + 0.1 mV 0.01 % + 0.2 mV 0.028 % + 0.6 mV 0.10 % + 0.2 mV 0.16 % + 0.32 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	240 µV/V + 4 mV 90 µV/V + 1.5 mV 52 µV/V + 0.6 mV 80 µV/V + 1 mV 0.15 % + 2.5 mV 0.09 % + 16 mV 0.44 % + 40 mV 0.8 % + 80 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.03 % + 16 mV 70 µV/V + 3.5 mV	
(1 to 15) kV	60 Hz	0 .2 % of rdg	Hipotronics 140 HV power supply w/ Ross VD60-6.2Y-A-LB-AL w/ HP 34001A

Parameter/Range	Frequency	CMC[2] (±)	Comments
AC Current[3] – Generate			
(9 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 16 nA 0.016 % + 10 nA 0.012 % + 8 nA 0.028 % + 12 nA 0.11 % + 65 nA	Fluke 5720A
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 40 nA 0.016 % + 35 nA 0.012 % + 35 nA 0.02 % + 110 nA 0.1 % + 650 nA	
(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	0.025 % + 400 nA 0.016 % + 350 nA 0.012 % + 350 nA 0.02 % + 550 nA 0.11 % + 5 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	0.025 % + 4 µA 0.016 % + 3.5 µA 0.012 % + 2.5 µA 0.02 % + 2.5 µA 0.11 % + 10 µA	
AC Current[3] – Generate			
(2.2 to 20) A	30 Hz to 5 kHz	0.035 % of rdg + 1 mA	Fluke Y5020 shunt
(20 to 300) A	60 Hz	0 .07 % of rdg	EIL current source w/ L&N shunt
Clamp-On			
(10 to 1000) A	DC to 440 Hz	0.23 % of rdg + 0.5 mA	Fluke 5520A w/ 5500A coil
Capacitance[3] – Generate			
(0.19 to 3.3) nF (3.3 to 11) nF (11 to 330) nF (0.33 to 3.3) µF (3.3 to 11) µF (11 to 33) µF	10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz	0.60 % + 0.01 nF 0.29 % + 0.1 nF 0.29 % + 0.3 nF 0.29 % + 3 nF 0.29 % + 10 nF 0.46 % + 30 nF	Fluke 5520A

Parameter/Range	Frequency	CMC[2] (±)	Comments
Capacitance[3] – Generate (cont.)			
(33 to 110) µF	(10 to 80) Hz	0.52 % + 100 nF	Fluke 5520A
(110 to 330) µF	Up to 50 Hz	0.52 % + 300 nF	
(0.33 to 1.1) mF	Up to 20 Hz	0.52 % + 1 µF	
(1.1 to 3.3) mF	Up to 6 Hz	0.52 % + 3 µF	
(3.3 to 11) mF	Up to 2 Hz	0.52 % + 10 µF	
(11 to 33) mF	Up to 0.6 Hz	0.87 % + 30 µF	
(33 to 110) mF	Up to 0.2 Hz	1.3 % + 100 µF	
Fixed Points			
1000, 100, 10 pF 0.001, 0.01, 0.1, 1 µF	(0.1 to 1) MHz	0.02 % rdg	GenRad 1404 & 1409 Series
AC Voltage[3] – Measure			
Up to 2.2 mV	(10 to 20) Hz	0.17 % + 1.3 µV	Fluke 5790A/03
	(20 to 40) Hz	0.074 % + 1.3 µV	
	(40 Hz to 20 kHz	0.042 % + 1.3 µV	
	(20 to 50) kHz	0.082 % + 2.0 µV	
	(50 to 100) kHz	0.12 % + 2.5 µV	
	(100 to 300) kHz	0.23 % + 4 µV	
	(300 to 500) kHz	0.26 % + 8 µV	
	500 kHz to 1 MHz	0.50 % + 8 µV	
	(1 to 2) MHz	0.07 % + 1 µV	
	(2 to 10) MHz	0.17 % + 1 µV	
	(10 to 20) MHz	0.30 % + 1 µV	
	(20 to 30) MHz	0.70 % + 2 µV	
(2.2 to 7) mV	(10 to 20) Hz	0.085 % + 1.3 µV	
	(20 to 40) Hz	0.037 % + 1.3 µV	
	40 Hz to 20 kHz	0.021 % + 1.3 µV	
	(20 to 50) kHz	0.041 % + 2 µV	
	(50 to 100) kHz	0.061 % + 2.5 µV	
	(100 to 300) kHz	0.12 % + 4 µV	
	(300 to 500) kHz	0.14 % + 8 µV	
(2.2 to 7) mV	500 kHz to 1 MHz	0.36 % + 8 µV	
	(1 to 2) MHz	0.07 % + 1 µV	
	(2 to 10) MHz	0.1 % + 1 µV	
	(10 to 20) MHz	0.17 % + 1 µV	
	(20 to 30) MHz	0.37 % + 1 µV	

Parameter/Range	Frequency	CMC[2] (±)	Comments
AC Voltage[3] – Measure (cont.)			
(7 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 (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.029 % + 1.3 µV 0.019 % + 1.3 µV 0.011 % + 1.3 µV 0.021 % + 2 µV 0.031 % + 2.5 µV 0.082 % + 4.0 µV 0.10 % + 8.0 µV 0.26 % + 8.0 µV 0.07 % 0.1 % 0.17 % 0.37 %	Fluke 5790A/03
(22 to 70) 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 (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.024 % + 1.5 µV 0.013 % + 1.5 µV 69 µV/V + 1.5 µV 0.013 % + 2.0 µV 0.026 % + 2.5 µV 0.053 % + 4.0 µV 0.068 % + 8.0 µV 0.13 % + 8.0 µV 0.05 % 0.1 % 0.15 % 0.35 %	
(70 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz	0.021 % + 1.5 µV 87 µV/V + 1.5 µV 43 µV/V + 1.5 µV 73 µV/V + 2.0 µV 0.016 % + 2.5 µV 0.028 % + 4.0 µV 0.04 % + 8.0 µV 0.12 % + 8.0 µV 0.05 % 0.1 % 0.15 %	

Parameter/Range	Frequency	CMC[2] (±)	Comments
AC Voltage[3] (cont.) – Measure			
(220 to 700) mV	(10 to 20) Hz	0.021 % + 1.5 µV	Fluke 5790A/03
	(20 to 40) Hz	87 µV/V + 1.5 µV	
	40 Hz to 20 kHz	38 µV/V + 1.5 µV	
	(20 to 50) kHz	56 µV/V + 2.0 µV	
	(50 to 100) kHz	84 µV/V + 2.5 µV	
	(100 to 300) kHz	0.021 % + 4.0 µV	
	(300 to 500) kHz	0.034 % + 8.0 µV	
	500 kHz to 1 MHz	0.12 % + 8.0 µV	
	(1 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	
700 mV to 2.2 V	(10 to 20) Hz	0.20 %	
	(20 to 40) Hz	69 µV/V	
	40 Hz to 20 kHz	29 µV/V	
	(20 to 50) kHz	52 µV/V	
	(50 to 100) kHz	76 µV/V	
	(100 to 300) kHz	0.02 %	
	(300 to 500) kHz	0.031 %	
	500 kHz to 1 MHz	012 %	
	(1 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.1 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	
(2.2 to 7) V	(10 to 20) Hz	0.02 %	
	(20 to 40) Hz	71 µV/V	
	40 Hz to 20 kHz	31 µV/V	
	(20 to 50) kHz	54 µV/V	
	(50 to 100) kHz	89 µV/V	
	(100 to 300) kHz	0.022 %	
	(300 to 500) kHz	0.047 %	
(2.2 to 7) V	500 kHz to 1 MHz	0.15 %	
	(1 to 2) MHz	0.05 %	
	(2 to 10) MHz	0.10 %	
	(10 to 20) MHz	0.15 %	
	(20 to 30) MHz	0.35 %	

Parameter/Range	Frequency	CMC[2] (±)	Comments
AC Voltage[3] (cont.) – Measure			
(7 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.02 % 71 µV/V 33 µV/V 54 µV/V 86 µV/V 0.022 % 0.047 % 0.15 %	Fluke 5790A/03
(22 to 70) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.02 % 73 µV/V 41 µV/V 64 µV/V 0.011 % 0.022 % 0.051 % 0.15 %	
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.02 % 73 µV/V 40 µV/V 78 µV/V 0.011 % 0.026 % 0.07 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 0.011 % 48 µV/V 0.015 % 0.085 %	
(700 to 1100) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 0.011 % 44 µV/V 0.015 % 0.085 %	
(1 to 11) kV (11 to 42) kV	60 Hz 60 Hz	0.1 % 0.4 %	Ross VD60-6.2Y-A-LB-AL w/HP 34401A

Parameter/Range	Frequency	CMC[2] (±)	Comments
AC Current[4] – Measure			
(0 to 100) µA	45 Hz to 1 kHz	0.07 % + 20 nA	HP 3458A
(0.1 to 100) mA	(45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.07 % + 20 µA 0.03 % + 20 µA 0.07 % + 20 µA 0.46 % + 40 µA 0.64 % + 150 µA	
(0.1 to 1) A	(45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.09 % + 200 µA 0.12 % + 200 µA 0.35 % + 200 µA 1.2 % + 400 µA	
(1 to 20) A	DC to 1 kHz (1 to 5) kHz	0.03 % 0.04 %	HP 3458A w/ Fluke Y5020
Impedance – Measure			
1Ω to 1 kΩ	5 Hz to 1 MHz (1 to 13) MHz	0.02 % of rdg 1.2 % of rdg	HP 4192A
(1 to 10) kΩ	5 Hz to 1 MHz (1 to 13) MHz	0.1 % of rdg 0.47 % of rdg	
10 kΩ to 1 MΩ	5 Hz to 1 MHz	0.1 % of rdg	HP 4193A
(10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ (100 to 120) kΩ	(0.4 to 110 MHz (0.4 to 110) MHz (0.4 to 110) MHz (0.4 to 40) MHz (0.4 to 1) MHz	2.3 % of rdg 4.8 % of rdg 1.7 % of rdg 1.7 % of rdg 0.65 % of rdg	
Distortion – Measure			HP 8903B
10 Hz to 0.5 MHz (3 dB)	20 Hz to 20 kHz (20 to 100) kHz	1 dB 2 dB	

III. Electrical – RF/ Microwave

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Power – Generate			
100 W	10 kHz to 220 MHz	0.25 dB	Amp. Res. 100L with calibrated power meter
10 W	0.5 MHz to 1 GHz	0.25 dB	Amp. Res. 10W1000 with calibrated power meter
(+24 to -56) dBm	0.01 Hz to 20 MHz	0 .7 dB	HP 3325A
(+10 to -20) dBm (-20 to -50) dBm (-50 to -90) dBm	10 MHz to 40 GHz 10 MHz to 40 GHz 10 MHz to 40 GHz	0.2 dB 0.47 dB 0.47 dB	HP 83640L w/ HP 8490D/ 10, 20 HP 8490D/ 40
RF Power – Measure			
Power Reference 1 mW, Type-N(f) 50 Ω	50 MHz	0.025 dB (5.7 μW)	HP 432A w/478A-H76 power sensor
1 μW to 1 mW	5 MHz to 1 GHz	0.027 dB	
500 W	Up to 500 MHz	0.15 dB	Bird 8322 VSWR<1.1:1,
(+20 to -70) dBm	0.1 MHz to 8 GHz (8 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz	0.11 dB 0.12 dB 0.12 dB 0.13 dB	HP 4418B, 8482A, VSWR<1.18:1, HP E4413A VSWR <1.27:1, HP 8487A VSWR <1.30:1
Tuned RF Power, Relative – Measure	(-127 to 0) dBm 2.5 MHz to 1.3 GHz	0.07 dB	HP 8902A with HP 11722A
Phase Modulation – Measure			
Carrier Frequency: 10 MHz to 1.3 GHz	200 Hz to 20 kHz	2.3 % of rdg + 1 digit	HP 8902A

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Attenuation – Measure			
(0 to 100) dB Dynamic Range	Up to 500 MHz	0.17 dB	Bird 8322/Weinschel Attn. VSWR <1.1:1, Fluke 8920A HP E4418B, with E4413A VSWR <1.27:1
(0 to 100) dB Dynamic Range	0.1 MHz to 8 GHz (8 to 18) GHz (18 to 26.5) GHz	0.11 dB 0.12 dB 0.12 dB	HP 4418B, 8482A VSWR <1.18:1, E4413A VSWR <1.27:1
(0 to 70) dB Dynamic Range	(26.5 to 40) GHz	0.88 dB	HP 8757D/002 with 85025D/ 2.4 mm
Amplitude Modulation – Measure			
Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	150 kHz to 10 MHz	0.36 % of rdg + 1 digit	HP 8902A
Rate: 20 Hz to 10 kHz Depths: to 99 %	150 kHz to 10 MHz	0.36 % of rdg + 1 digit	
Rate: 50 Hz to 50 kHz Depths: 5 % to 99 %	10 MHz to 1.3 GHz	0.36 % of rdg + 1 digit	
Rate: 20 Hz to 100 kHz Depths: to 99 %	10 MHz to 1.3 GHz	0.36 % of rdg + 1 digit	
Frequency Modulation – Measure			
Rate: 20 Hz to 10 kHz Dev: 5 % to 99 %	250 kHz to 10 MHz	0.6 % of rdg + 1 digit	HP 8902A
Rate: 50 Hz to 100 kHz Dev: 5% to 99 %	10 MHz to 1.3 GHz	0.6 % of rdg + 1 digit	

IV. Mechanical

Parameter/Equipment	Range	CMC[2] (±)	Comments
Pressure Gages	(-14.00 to 100) psi (15.00 to 10 000) psi	0.06 % of rdg 0.1 % of rdg	Druck DPI601 Ashcroft 1305B
Scales and Balances	(0.005 to 50) lbs (50 to 350) lbs	15 mg 1.4 g	Class F Weights
Torque Wrenches and Drivers	(2.5 to 25) in·lb (10 to 100) in·lb (50 to 500) in·lb (10 to 100) ft·lb (100 to 500) ft·lb	1.2 % of rdg 1.2 % of rdg 1.6 % of rdg 1.2 % of rdg 1.6 % of rdg	Mountz TL25i Mountz M100 Mountz TL25i w/ BMX500i Mountz BT100F-V Mountz BT500F-V

V. Thermodynamics

Parameter/Equipment	Range	CMC[2] (±)	Comments
Temperature – Measuring Equipment	(-40 to 150) °C (50 to 660) °C	0.012 °C 0.017 °C	Hart 9173 w/PRT & temperature bath Hart Scientific 9173 dry w calibrator
Temperature – Measure	(-200 to 660) °C	0.017 °C	Hart 9173 w/PRT

VI. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Frequency – Measuring Equipment	0.01 Hz to 20 MHz 10 MHz to 40.0 GHz	1.2 x 10^{-11} Hz	Austron 2100F, LORAN C, HP 105B, 3325A and 83640L

Parameter/Equipment	Range	CMC[2] (±)	Comments
Frequency – Measure	DC to 40 GHz	5 parts in 10^{12}	Austron 2100F, LORAN C, HP 105B, 5345A and 5352B

[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 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] The measurands stated are generated with the Fluke 732A and 5220A, 5720A, 5790A, & 5790A/03 series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

[4] The measurands stated are measured with the HP 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

[5] In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches.