THE AMERICAN ASSOCIATION FOR LABORATORY 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 18 June 2005*).

Presented this 2nd day of April 2008.

President
For the Accreditation Council
Certificate Number 2117.01
Valid to January 31, 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

HAYES INSTRUMENT SERVICE, INC.
530 Boston Road
Billerica, MA 01821
Thomas P. Fitzgerald Phone: 978 663 4800

CALIBRATION

Valid until: January 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. Electrical – DC & Low Frequency

Parameter/Equipment	Range	Best Uncertainty[2] (±)	Comments
DC Voltage[3] – Generate	10 V Reference 1.0 & 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

Parameter/Equipment	Range	Best Uncertainty[2] (±)	Comments
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	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	Fluke 5720A w/ 5220A
	(2.2 to 100) A	0 .058 %	DC source w/ L&N shunts and HP 3458A
	(100 to 900) A	0.29 %	DC source w/ Empro shunt and HP 3458A
Clamp-On	(0 to 1000) A	0.33 mA/A+ 0.05A	Fluke 5520A w/ 5500A coil
DC Current – 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 with
	(10 to 30) kV	0.015 %	HP 3458A with Fluke 80D

Parameter/Equipment	Range	Best Uncertainty[2] (±)	Comments
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
DC Resistance – Generate			
Fixed Points	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 k Ω	1.7 parts in 10^6 1.7 parts in 10^6 1.7 parts in 10^6 1.4 parts in 10^6 0.7 parts in 10^6	L&N 4223 L&N 4222 L&N 4221 L&N 4210 ESI SR-104
	1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	96 parts in 10^6 30 parts in 10^6 29 parts in 10^6 17 parts in 10^6 17 parts in 10^6 13 parts in 10^6 17 parts in 10^6 12 parts in 10^6 14 parts in 10^6 14 parts in 10^6 20 parts in 10^6 21 parts in 10^6 40 parts in 10^6 47 parts in 10^6 110 parts in 10^6	Fluke 5720A
	1 GΩ 10 GΩ 100 GΩ	500 kΩ 7 MΩ 100 MΩ	Keithley 263
Inductance – Generate			
Fixed Points @ 1 KHz	1 H	600 μH	GenRad 1482 P
Capacitance – Measure			
50 Hz to 10 kHz	0.0001 pF to 1.1 μF	0.012 % of rdg	GenRad 1620A

Parameter/Equipment	Range	Best Uncertainty[2] (±)	Comments
Electrical Calibration of Thermocouple Indicators –			
Type E	-250 °C to -100 °C -100 °C to 650 °C 650 °C to 1000 °C	0.50 °C 0.16 °C 0.21 °C	Fluke 5520A
Type J	-210 °C to -100 °C -100 °C to 760 °C 760 °C to 1200 °C	0.27 °C 0.17 °C 0.23 °C	
Type K	-200 °C to -100°C -100 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.33 °C 0.18 °C 0.26 °C 0.40 °C	
Type S	0 °C to 250 °C 250 °C to 1400 °C 1400 °C to 1767 °C	0.47 °C 0.37 °C 0.46 °C	
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 400 °C	0.63 °C 0.24 °C 0.60 °C	
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	

Parameter/Equipment	Range	Best Uncertainty[2] (±)	Comments
Electrical Calibration of RTD Indicators (cont.) –			
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	Fluke 5520A
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	
Oscilloscopes[3] –			
Square Wave Signal 50 Ω, 1 kHz 1 MΩ, 1 kHz	 1 mV to 130 V 1 mV to 130 V	 2.5 mV/V + 40 μV 1 mV/V + 40 μV	 Fluke 5520A w/ SC 1100
Leveled Sine Wave Amplitude	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 500) MHz (500 to 600) MHz (600 to 1100) MHz	20 mV/V + 300 μV 35 mV/V + 300 μV 40 mV/V + 300 μV 55 mV/V + 300 μV 60 mV/V + 300 μV 70 mV/V + 300 μV	
Flatness (Up to 50 kHz)	 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	 15 mV/V + 100 μV 20 mV/V + 100 μV 40 mV/V + 100 μV 50 mV/V + 100 μV	
Time Marker (Into 50 Ω)	 1 ns to 20 ms 50 ms to 5s	 2.5 parts in 10^6 25 parts in 10^6	
Rise Time	< 125 ps	+0/-50 ps	Fluke 5520A w/ Fluke 5800A/TDP

Parameter/Range	Frequency	Best Uncertainty[2] (±)	Comments
AC Voltage[3] – Generate			
1 nV 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 (0.5 to 1) MHz	0.024 % + 4 µV 91 µV/V + 4 µV 81 µV/V + 4 µV 0.02 % + 4 µV 0.05 % + 5 µV 1.1 mV/V + 10 µV 1.4 mV/V + 20 µV 2.7 mV/V + 20 µV	Fluke 5720A
(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 (0.5 to 1) MHz	0.024 % + 4 µV 90 µV/V + 4 µV 80 µV/V + 4 µV 0.02 % + 4 µV 0.05 % + 5 µV 1.1 mV/V + 10 µV 1.4 mV/V + 20 µV 2.7 mV/V + 20 µV	
(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 1.1 mV/V + 20 µV 1.4 mV/V + 25 µV 2.7 mV/V + 45 µV	
(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 1 mV/V + 200 µV 1.7 mV/V + 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 1 mV/V + 0.2 mV 1.6 mV/V + 0.32 mV	

Parameter/Range	Frequency	Best Uncertainty[2] (±)	Comments
AC Voltage[3] – Generate (cont.)			
(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 150 µV/V + 2.5 mV 0.09 % + 16 mV 4.4 mV/V + 40 mV 8 mV/V + 80 mV	Fluke 5720A
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.03 % + 16 mV 70 µV/V + 3.5 mV	
(1.1 to 20) kV	60 Hz	0 .6 % of rdg	Hipotronics 140 HV power supply w/ Sensitive Research ESH 23
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	

Parameter/Range	Frequency	Best Uncertainty[2] (±)	Comments
AC Current[3] – Generate			
(2.2 to 20) A	30 Hz to 5 kHz	350 µV/V + 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 % + 0.5 mA	Fluke 5520A w/ 5500A coil
Capacitance[3] – Generate			
(0.19 to 3.3) nF	10 Hz to 3 kHz	0.60 % + 0.01 nF	Fluke 5520A
(3.3 to 11) nF	10 Hz to 1 kHz	0.29 % + 0.1 nF	
(11 to 330) nF	10 Hz to 1 kHz	0.29 % + 0.3 nF	
(0.33 to 3.3) µF	(10 to 300) Hz	0.29 % + 3 nF	
(3.3 to 11) µF	(10 to 150) Hz	0.29 % + 10 nF	
(11 to 33) µF	(10 to 120) Hz	0.46 % + 30 nF	
(33 to 110) µF	(10 to 80) Hz	0.52 % + 100 nF	
(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 pF	(0.1 to 1) kHz	24 parts in 10^6	GenRad 1404A
AC Voltage[4] – 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	

Parameter/Range	Frequency	Best Uncertainty[2] (±)	Comments
AC Voltage[3] – Measure (cont.)			
(2.2 to 7) 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	0.085 % + 1.3 µV 0.037 % + 1.3 µV 0.021 % + 1.3 µV 0.041 % + 2 µV 0.061 % + 2.5 µV 0.12 % + 4 µV 0.14 % + 8 µV	Fluke 5790A/03
(2.2 to 7) mV	500 kHz to 1 MHz (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.36 % + 8 µV 0.07 % + 1 µV 0.1 % + 1 µV 0.17 % + 1 µV 0.37 % + 1 µV	
(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 %	
(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 %	

Parameter/Range	Frequency	Best Uncertainty[2] (±)	Comments
AC Voltage[3] (cont.) – Measure			
(70 to 220) 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	43 µV/V + 1.5 µV	
	(20 to 50) kHz	73 µV/V + 2.0 µV	
	(50 to 100) kHz	0.016 % + 2.5 µV	
	(100 to 300) kHz	0.028 % + 4.0 µV	
	(300 to 500) kHz	0.04 % + 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 %	
(220 to 700) mV	(10 to 20) Hz	0.021 % + 1.5 µV	
	(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	200 µV/V	
	(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 %	

Parameter/Range	Frequency	Best Uncertainty[2] (±)	Comments
AC Voltage[3] (cont.) – Measure			
(2.2 to 7) V	500 kHz to 1 MHz (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.15 % 0.05 % 0.10 % 0.15 % 0.35 %	Fluke 5790A/03
(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 %	
(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 %	

Parameter/Range	Frequency	Best Uncertainty[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) m	(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	

II. Electrical – RF & Microwave

Parameter/Range	Frequency	Best Uncertainty[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
(+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	VSWR<1.1:1, 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	Best Uncertainty[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	

III. Time & Frequency

Parameter/Equipment	Range	Best Uncertainty[2] (±)	Comments
Frequency – Measuring Equipment	0.01 Hz to 20 MHz 10 MHz to 40.0 GHz	1.2×10^{-11}	Austron 2100F, LORAN C, HP 105B, 3325A and 83640L
Frequency – Measure	DC to 40 GHz	5 parts in 10^{12}	Austron 2100F, LORAN C, HP 105B, 5345A and 5352B

IV. Mechanical

Parameter/Equipment	Range	Best Uncertainty[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	15 mg	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. Dimensional

Parameter/Equipment	Range	Best Uncertainty[2, 5] (±)	Comments
Micrometers – Inside & Outside Depth	 Up to 1 in (1 to 18) in	 63 µin (63 + 45*L*) µin	 Grade 1 gage blocks

Parameter/Equipment	Range	Best Uncertainty [2, 5] (±)	Comments
Calipers – Inside & Outside Depth	 Up to 1 in (2 to 18) in	 118 µin (118 + 32*L*) µin	 Grade 1 gage blocks
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

VI. Thermodynamics

Parameter/Equipment	Range	Best Uncertainty[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 well calibrator
Temperature – Measure	(-200 to 660) °C	0.017 °C	Hart 9173 w/PRT

[1] This laboratory offers commercial calibration service.

[2] "Best Uncertainty" is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards of nearly ideal measuring equipment. Best uncertainties represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The best uncertainty of a specific calibration performed by the laboratory may be greater than the best uncertainty due to the behavior of the customer's device, to the environment 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. Best measurement uncertainty is read as output plus floor specifications where defined.

[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. Best measurement uncertainty is based upon one-year floor specifications and is read as output plus range.

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