



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: February 29, 2012

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<sup>1</sup>:

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Micrometers <sup>3</sup> – Inside & Outside Depth	Up to 1 in (1 to 18) in	63 µin (63 + 45L) µin	Grade 1 gage blocks
Calipers <sup>3</sup> – Inside & Outside Depth	Up to 1 in (2 to 18) in	120 µin (120 + 32L) µin	Grade 1 gage blocks
Dial Indicators <sup>3</sup>	Up to 6 in	63 µin	Bench micrometer, grade 1 gage blocks and super micrometer
Depth & Height Gages <sup>3</sup>	Up to 1 in (1 to 18) in	63 µin (63 + 32L) µin	Grade 1 gage blocks
Pin Gages	(0.05 to 1) in	26 µin	Bench micrometer, grade 1 gage blocks and super micrometer

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	Comments
DC Voltage – Generate <sup>3</sup>	10 V Reference 1.0 V & 1.018 V	0.32 $\mu\text{V/V}$ 0.51 $\mu\text{V/V}$	Fluke 732A and 5720A
	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	11 $\mu\text{V/V} + 0.4 \mu\text{V}$ 6.2 $\mu\text{V/V} + 0.7 \mu\text{V}$ 4.6 $\mu\text{V/V} + 2.5 \mu\text{V}$ 4.6 $\mu\text{V/V} + 4.0 \mu\text{V}$ 6.7 $\mu\text{V/V} + 40 \mu\text{V}$ 8.5 $\mu\text{V/V} + 400 \mu\text{V}$  1.2 mV/V	DC source w/ HP 3458A and Fluke 80D
DC Current – Generate <sup>3</sup>	(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
	0.2 nA to 200 $\mu\text{A}$ (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	47 $\mu\text{A/A} + 8 \text{ nA}$ 47 $\mu\text{A/A} + 7 \text{ nA}$ 42 $\mu\text{A/A} + 40 \text{ nA}$ 53 $\mu\text{A/A} + 0.7 \text{ nA}$ 96 $\mu\text{A/A} + 12 \text{ nA}$	Fluke 5720A
	Clamp-On (2.2 to 100) A	0.058 %	DC source w/ L&N shunts and HP 3458A
	(100 to 900) A  (0 to 1000) A	0.29 %  0.33 mA/A + 0.05A	DC source w/ Empro shunt and HP 3458A  Fluke 5520A w/ 5500A coil

Parameter/Equipment	Range	CMC <sup>2,4</sup> ( $\pm$ )	Comments	
DC Current – Measure <sup>3</sup>	(10 to 100) $\mu$ A	46 $\mu$ A/A + 6 nA	HP 3458A	
	100 $\mu$ A to 10 mA	40 $\mu$ A/A + 7 $\mu$ A		
	(10 to 100) mA	52 $\mu$ A/A + 7 $\mu$ A		
	100 mA to 1 A	92 $\mu$ A/A + 12 $\mu$ A	HP 3458A w/ Fluke Y5020	
	(1 to 20) A	0.005 % + 4 $\mu$ A		
	(20 to 100) A	0.005 %		
	(100 to 1000) A	0.04 %	HP 3458A w/ L&N shunt HP 3458A w/ Empro shunt	
DC Voltage – Measure <sup>3</sup>	Up to 100 mV	8.7 $\mu$ V/V + 0.4 $\mu$ V	HP 3458A	
	100 mV to 1 V	5.8 $\mu$ V/V + 0.7 $\mu$ V		
	(1 to 10) V	4.0 $\mu$ V/V + 2.5 $\mu$ V		
	(10 to 100) V	5.8 $\mu$ V/V + 40 $\mu$ V	HP 3458A w/ Fluke 80E	
	(100 to 1000) V	14 $\mu$ V/V + 400 $\mu$ V		
	(1 to 10) kV	0.015 %		
	(10 to 30) kV	0.015 %	HP 3458A w/ Fluke 80D	
	(30 to 50) kV	0.07 %	Ross VD60-6.2Y-A – LB-AV w/ HP 34401A	
DC Resistance – Measure <sup>3</sup>	100 m $\Omega$ to 100 M $\Omega$	12 $\mu\Omega/\Omega$	ESI 242D	
	Fixed Points	1 G $\Omega$	0.16 %	HP 4339A
		10 G $\Omega$	0.56 %	
		100 G $\Omega$	0.10 %	



Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Capacitance – Measure <sup>3</sup>			
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 <sup>3</sup> –			
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	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Calibration of RTD Indicators <sup>3</sup> –			
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 <sup>2, 6</sup> ( $\pm$ )	Comments
Oscilloscopes <sup>3</sup> –			
Square Wave Signal 50 $\Omega$ , 1 kHz 1 M $\Omega$ , 1 kHz	1 mV to 130 V 1 mV to 130 V	2.5 mV/V + 40 $\mu$ V 1 mV/V + 40 $\mu$ V	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 $\mu$ V 35 mV/V + 300 $\mu$ V 40 mV/V + 300 $\mu$ V 55 mV/V + 300 $\mu$ V 60 mV/V + 300 $\mu$ V 70 mV/V + 300 $\mu$ V	
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 $\mu$ V 20 mV/V + 100 $\mu$ V 40 mV/V + 100 $\mu$ V 50 mV/V + 100 $\mu$ V	
Time Marker (Into 50 $\Omega$ )	1 ns to 20 ms 50 ms to 5 s	2.5 $\mu$ s 25 $\mu$ s	
Rise Time	< 125 ps	+0/-50 ps	Fluke 5520A w/ Fluke 5800A/TDP
AC Voltage – Generate <sup>3</sup>			
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	0.065 % + 4 $\mu$ V 0.06 % + 4 $\mu$ V 0.06 % + 4 $\mu$ V 0.06 % + 4 $\mu$ V 0.08 % + 5 $\mu$ V 0.13 % + 10 $\mu$ V 0.15 % + 20 $\mu$ V 1.1 % + 20 $\mu$ V	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	0.026 % + 4 $\mu$ V 0.14 % + 4 $\mu$ V 0.12 % + 4 $\mu$ V 0.02 % + 4 $\mu$ V 0.05 % + 5 $\mu$ V 0.11 % + 10 $\mu$ V 0.14 % + 20 $\mu$ V 0.27 % + 20 $\mu$ V	

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Parameter/Range	Frequency	CMC <sup>2,6</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (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 0.09 % + 7 μV 0.08 % + 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	0.028 % + 40 μV 0.09 % + 15 μV 0.04 % + 8 μV 0.07 % + 10 μV 0.01 % + 30 μV 0.03 % + 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 0.09 % + 0.15 mV 0.04 % + 0.05 mV 0.07 % + 0.1 mV 0.01 % + 0.2 mV 0.03 % + 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	0.24 % + 4 mV 0.09 % + 1.5 mV 0.05 % + 0.6 mV 0.08 % + 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 0.07 % + 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 <sup>2,6</sup> (±)	Comments
AC Current – Generate <sup>3</sup>			
(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	
(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	50 and 440 Hz	0.23 % of rdg + 0.5 mA	Fluke 5520A w/ 5500A coil
Capacitance – Generate <sup>3</sup>			
(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	

Parameter/Range	Frequency	CMC <sup>2,6</sup> (±)	Comments
Capacitance – Generate <sup>3</sup> (cont.)			
(33 to 110) μF (110 to 330) μF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	(10 to 80) Hz Up to 50 Hz Up to 20 Hz Up to 6 Hz Up to 2 Hz Up to 0.6 Hz Up to 0.2 Hz	0.52 % + 100 nF 0.52 % + 300 nF 0.52 % + 1 μF 0.52 % + 3 μF 0.52 % + 10 μF 0.87 % + 30 μF 1.3 % + 100 μF	Fluke 5520A
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 – Measure <sup>3</sup>			
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 (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.17 % + 1.3 μV 0.074 % + 1.3 μV 0.042 % + 1.3 μV 0.082 % + 2.0 μV 0.12 % + 2.5 μV 0.23 % + 4 μV 0.26 % + 8 μV 0.50 % + 8 μV 0.07 % + 1 μV 0.17 % + 1 μV 0.30 % + 1 μV 0.70 % + 2 μV	Fluke 5790A/03
(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	
(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	

Parameter/Range	Frequency	CMC <sup>2, 6</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (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 0.09 % + 1.5 μV 0.04 % + 1.5 μV 0.07 % + 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 <sup>2, 6</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (cont)			
(220 to 700) 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	0.021 % + 1.5 μV 0.09 % + 1.5 μV 0.04 % + 1.5 μV 0.06 % + 2.0 μV 0.08 % + 2.5 μV 0.021 % + 4.0 μV 0.034 % + 8.0 μV 0.12 % + 8.0 μV 0.05 % 0.1 % 0.15 % 0.35 %	Fluke 5790A/03
700 mV 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 500 kHz to 1 MHz (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.20 % 0.07 % 0.03 % 0.05 % 0.08 % 0.02 % 0.031 % 0.12 % 0.05 % 0.1 % 0.15 % 0.35 %	
(2.2 to 7) 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 % 0.07 % 0.03 % 0.05 % 0.09 % 0.022 % 0.047 %	
(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 %	

Parameter/Range	Frequency	CMC <sup>2,6</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (cont)			
(7 to 22) V	(10 to 20) Hz	0.02 %	Fluke 5790A/03
	(20 to 40) Hz	0.07 %	
	40 Hz to 20 kHz	0.03 %	
	(20 to 50) kHz	0.05 %	
	(50 to 100) kHz	0.09 %	
	(100 to 300) kHz	0.022 %	
	(300 to 500) kHz	0.047 %	
500 kHz to 1 MHz	0.15 %		
(22 to 70) V	(10 to 20) Hz	0.02 %	
	(20 to 40) Hz	0.07 %	
	40 Hz to 20 kHz	0.04 %	
	(20 to 50) kHz	0.06 %	
	(50 to 100) kHz	0.011 %	
	(100 to 300) kHz	0.022 %	
	(300 to 500) kHz	0.051 %	
500 kHz to 1 MHz	0.15 %		
(70 to 220) V	(10 to 20) Hz	0.02 %	
	(20 to 40) Hz	0.07 %	
	40 Hz to 20 kHz	0.04 %	
	(20 to 50) kHz	0.08 %	
	(50 to 100) kHz	0.011 %	
	(100 to 300) kHz	0.026 %	
	(300 to 500) kHz	0.07 %	
(220 to 700) V	(10 to 20) Hz	0.02 %	
	(20 to 40) Hz	0.011 %	
	40 Hz to 20 kHz	0.05 %	
	(20 to 50) kHz	0.015 %	
	(50 to 100) kHz	0.085 %	
(700 to 1100) V	(10 to 20) Hz	0.02 %	
	(20 to 40) Hz	0.011 %	
	40 Hz to 20 kHz	0.04 %	
	(20 to 50) kHz	0.015 %	
	(50 to 100) kHz	0.085 %	
(1 to 11) kV	60 Hz	0.1 %	Ross VD60-6.2Y-A- LB-AL w/HP 34401A
(11 to 42) kV	60 Hz	0.4 %	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current – Measure <sup>3</sup>			
(0 to 100) μA	45 Hz to 1 kHz	0.03 % + 16 nA	HP 3458A
(0.1 to 100) mA	(45 to 100) Hz 100 Hz to 5 kHz	0.014 % + 2.5 μA 0.02 % + 3.5 μA	
(0.1 to 1) A	(45 to 100) Hz 100 Hz to 5 kHz	0.03 % + 35 μA 0.05 % + 80 μA	
(1 to 20) A	DC to 1 kHz (1 to 5) kHz	0.03 % 0.04 %	HP 3458A w/ Fluke Y5020
Impedance – Measure			
1 Ω 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	(0.4 to 110) MHz	2.3 % of rdg	
100 Ω to 1 kΩ	(0.4 to 110) MHz	4.8 % of rdg	
(1 to 10) kΩ	(0.4 to 110) MHz	1.7 % of rdg	
(10 to 100) kΩ	(0.4 to 40) MHz	1.7 % of rdg	
(100 to 120) kΩ	(0.4 to 1) MHz	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 <sup>2</sup> (±)	Comments
RF Power – Generate			
100 W	10 kHz to 220 MHz	0.25 dB	Amp. Res. 100L w/ calibrated power meter
300 W	(0.3 to 35) MHz	0.25 dB	EIN 300 w/ calibrated power meter
300 W	(100 to 500) MHz	0.25 dB	Ophir 5068 w/ calibrated power meter
(+24 to -56) dBm	0.01 Hz to 20 MHz	0.7 dB	HP 3325A
(+10 to -20) dBm	10 MHz to 40 GHz	0.2 dB	HP 83640L w/
(-20 to -50) dBm	10 MHz to 40 GHz	0.47 dB	HP 8490D/ 10, 20
(-50 to -90) dBm	10 MHz to 40 GHz	0.47 dB	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	0.11 dB	HP 4418B, 8482A,
	(8 to 18) GHz	0.12 dB	VSWR<1.18:1,
	(18 to 26.5) GHz	0.12 dB	HP E4413A VSWR
	(26.5 to 40) GHz	0.13 dB	<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 w/ 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 <sup>2</sup> (±)	Comments
RF Attenuation – Measure  (0 to 100) dB Dynamic Range  (0 to 70) dB Dynamic Range	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  0.88 dB	HP 4418B, 8482A VSWR <1.18:1, E4413A VSWR <1.27:1  HP 8757D/002 w/ 85025D/ 2.4 mm
Amplitude Modulation – Measure  Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %  Rate: 20 Hz to 10 kHz Depths: to 99 %  Rate: 50 Hz to 50 kHz Depths: 5 % to 99 %  Rate: 20 Hz to 100 kHz Depths: to 99 %	150 kHz to 10 MHz  150 kHz to 10 MHz  10 MHz to 1.3 GHz  10 MHz to 1.3 GHz	0.36 % of rdg + 1 digit  0.36 % of rdg + 1 digit  0.36 % of rdg + 1 digit  0.36 % of rdg + 1 digit	HP 8902A
Frequency Modulation – Measure  Rate: 20 Hz to 10 kHz Dev: 5 % to 99 %  Rate: 50 Hz to 100 kHz Dev: 5% to 99 %	250 kHz to 10 MHz  10 MHz to 1.3 GHz	0.6 % of rdg + 1 digit  0.6 % of rdg + 1 digit	HP 8902A

IV. Mechanical

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Pressure Gages <sup>3</sup>	(-14 to 100) psi (15 to 10 000) psi	0.06 % of rdg 0.1 % of rdg	Druck DPI601 Ashcroft 1305B
Scales and Balances <sup>3</sup>	(0.005 to 50) lbs (50 to 350) lbs	14 mg 1.4 g	Class F Weights
Torque Wrenches and Drivers <sup>3</sup>	(2.5 to 25) in·lb	1.2 % of rdg	Mountz TL25i Mountz M100 Mountz TL25i w/ BMX500i
	(10 to 100) in·lb	1.2 % of rdg	
	(50 to 500) in·lb	1.6 % of rdg	
	(10 to 100) ft·lb	1.2 % of rdg	Mountz BT100F-V
	(100 to 500) ft·lb	1.6 % of rdg	Mountz BT500F-V

V. Thermodynamics

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

VI. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Frequency – Measuring Equipment <sup>3</sup>	0.01 Hz to 20 MHz 10 MHz to 40 GHz	1.2 x 10 <sup>-11</sup> Hz	Austron 2100F, LORAN C, HP 105B, 3325A and 83640L

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Frequency – Measure <sup>3</sup>	DC to 40 GHz	5 parts in 10 <sup>12</sup>	Austron 2100F, LORAN C, HP 105B, 5345A and 5352B

<sup>1</sup> This laboratory offers commercial calibration service.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> 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.

<sup>5</sup> In the statement of CMC,  $L$  is the numerical value of the nominal length of the device measured in inches.

<sup>6</sup> 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.



World Class Accreditation

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 8 January 2009*).

Presented this 5<sup>th</sup> day of May 2010.



  
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President & CEO

For the Accreditation Council  
Certificate Number 2117.01  
Valid to February 29, 2012  
Revised on January 20, 2012

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