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

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CALIBRATION

Valid until: January 31, 2020 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[3] –			
Inside & Outside	Up to 1 in	66 µin	Grade 1 gage blocks
Depth	(1 to 18) in	(66 + 4*L*) µin	
Calipers[3] –			
Inside & Outside	Up to 1 in	160 µin	Grade 1 gage blocks
Depth	(1 to 18) in	(160 + 4*L*) µin	

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Voltage – Measure[3]	Up to 100 mV 100 mV to 1 V	9.3 µV/V + 0.3 µV 5.5 µV/V + 0.3 µV	HP 3458A opt 002

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Parameter/Equipment	Range	CMC[2, 4, 6, 7] (±)	Comments
DC Voltage – Measure[3] (cont.)	(1 to 10) V (10 to 100) V (100 to 1000) V 100 mV 1 V 100 V 1000 V (1 to 70) kV	5.6 µV/V + 0.5 µV 8.7 µV/V + 30 µV 11 µV/V + 100 µV 1.6 µV/V 1.2 µV/V 1.2 µV/V 1.3 µV/V 0.10 %	HP 3458A opt 002 *Above 100 V add* *12 ppm x (Vin/1000)^2* Fluke 732B/752A/8508A Vitrek 4700 w/ 4710 Divider
DC Voltage – Generate[3]	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 25) kV	0.61 µV/V 14 µV/V 7.0 µV/V + 0.4 µV 4.3 µV/V + 0.7 µV 3.1 µV/V + 2.5 µV 3.8 µV/V + 4 µV 4.3 µV/V + 40 µV 5.5 µV/V + 400 µV 0.028 %	Fluke 732B Fluke 732A Fluke 5720A DC source w/ HP 3458A and Fluke 80D
DC Current – Measure[3]	Up to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (0.2 to 2) A (2 to 20) A (1 to 20) A (2.2 to 100) A (50 to 300) A	24 µA/A + 0.04 nA 24 µA/A + 0.1 nA 24 µA/A + 5 nA 24 µA/A + 7 nA 24 µA/A + 70 nA 41 µA/A + 0.5 µA 0.013 % + 10 µA 0.026 % + 8 µA 0.058 % + 20 µA 0.02 % 0.069 % 0.052 %	HP 3458A Fluke 8508A HP 3458A w/ Fluke Y5020 HP 3458A w/ L&N shunt HP 3458A w/ L&N shunt

Parameter/Equipment	Range	CMC[2, 4, 6, 7] (±)	Comments
DC Current – Generate[3]	(2 to 20) pA (20 to 200) pA (0.2 to 2) nA (2 to 20) nA (20 to 200) nA	0.44 % + 0.01 pA 0.29 % + 0.03 pA 0.076 % + 0.1 pA 0.076 % + 1 pA 0.042 % + 10 pA	Keithley 263
	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	68 µA/A + 6 nA 36 µA/A + 7 nA 37 µA/A + 40 nA 48 µA/A + 0.7 µA 71 µA/A + 12 µA	Fluke 5720A
Clamp-On	(0 to 1000) A	0.33 % + 0.75 mA	Fluke 5522A w/ 5500A coil
Resistance – Measure[3]	(0.1 to 100) Ω (0.1 to 100) kΩ	15 µΩ/Ω + 500 µΩ 12 µΩ/Ω + 50 mΩ	HP 3458A
	(0.1 to 1) MΩ (1 to 10) MΩ	20 µΩ/Ω + 2 Ω 58 µΩ/Ω + 100 Ω	
	(10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ	0.012 % 0.014 % 0.034 %	
	(10 to 200) GΩ (0.2 to 2) TΩ	0.041 % 0.041 %	
Resistance – Generate[3]			
Fixed Points	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 kΩ	64 µΩ/Ω 55 µΩ/Ω 55 µΩ/Ω 7.6 µΩ/Ω 1.2 µΩ/Ω	L&N 4223 L&N 4222 L&N 4221 L&N 4210 ESI SR-104

Parameter/Equipment	Range	CMC[2, 6, 7] (±)	Comments
Resistance – Generate[3] (cont)			
Fixed Points	1.9 Ω	0.011 %	Fluke 5720A
	10 Ω	28 µΩ/Ω	
	19 Ω	26 µΩ/Ω	
	100 Ω	13 µΩ/Ω	
	190 Ω	14 µΩ/Ω	
	1 kΩ	11 µΩ/Ω	
	1.9 kΩ	12 µΩ/Ω	
	10 kΩ	11 µΩ/Ω	
	19 kΩ	9.6 µΩ/Ω	
	100 kΩ	11 µΩ/Ω	
	190 kΩ	15 µΩ/Ω	
	1 MΩ	21 µΩ/Ω	
	1.9 MΩ	21 µΩ/Ω	
	10 MΩ	36 µΩ/Ω	
	19 MΩ	52 µΩ/Ω	
	10 Ω	10 µΩ/Ω	Fluke 742A
	100 Ω	7.7 µΩ/Ω	
	1 kΩ	7.6 µΩ/Ω	
	10 kΩ	5.5 µΩ/Ω	
	100 kΩ	8.1 µΩ/Ω	
	1 MΩ	11 µΩ/Ω	
	10 MΩ	13 µΩ/Ω	
	100 MΩ	28 µΩ/Ω	IET SRX
	1 GΩ	0.012 %	Fluke 8508A – 7000 K
	1 GΩ	0.13 %	Keithley 263
	10 GΩ	0.27 %	
	100 GΩ	0.45 %	

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
Inductance – Generate, Fixed Points			
100 µH to 10 H	1 kHz	0.13 %	GenRad 1482 inductors
Inductance – Measure			
1 µH to 10 H	1 kHz	0.059 %	HP 4284A
AC Voltage – Generate[3]			
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	0.026 % + 4 µV 0.010 % + 4 µV 89 µV/V + 4 µV 0.021 % + 4 µV 0.054 % + 5 µV 0.11 % + 10 µV 0.14 % + 20 µV 0.29 % + 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	0.026 % + 4 µV 0.010 % + 4 µV 89 µV/V + 4 µV 0.021 % + 4 µV 0.054 % + 5 µV 0.11 % + 10 µV 0.14 % + 20 µV 0.28 % + 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	0.029 % + 12 µV 0.013 % + 7 µV 0.012 % + 7 µV 0.024 % + 7 µV 0.052 % + 17 µV 0.092 % + 20 µV 0.15 % + 25 µV 0.29 % + 45 µV	

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
AC Voltage – Generate[3] (cont)			
(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	0.026 % + 40 µV 94 µV/V + 15 µV 48 µV/V + 8 µV 82 µV/V + 10 µV 0.13 % + 30 µV 0.040 % + 80 µV 0.11 % + 200 µV 0.18 % + 300 µV	Fluke 5720A
(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	0.026 % + 0.4 mV 94 µV/V + 0.15 mV 47 µV/V + 0.05 mV 82 µV/V + 0.1 mV 0.012 % + 0.2 mV 0.031 % + 0.6 mV 0.11 % + 2 mV 0.16 % + 3.2 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	0.026 % + 4 mV 94 µV/V + 1.5 mV 55 µV/V + 0.6 mV 88 µV/V + 1 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.031 % + 16 mV 82 µV/V + 3.5 mV	
(1 to 15) kV	60 Hz	0.13 %	Hipotronics 140 HV power supply w/ Vitrek 4700 w/ 4710 divider

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
AC Voltage – Measure[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 (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.27 % + 1.3 µV 0.11 % + 1.3 µV 0.058 % + 1.3 µV 0.1 % + 2 µV 0.17 % + 2.5 µV 0.33 % + 4 µV 0.35 % + 8 µV 0.61 % + 8 µV 0.091 % (Flatness) 0.24 % (Flatness) 0.38 % (Flatness) 0.85 % (Flatness)	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 500 kHz to 1 MHz (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.13 % + 1.3 µV 0.064 % + 1.3 µV 0.048 % + 1.3 µV 0.081 % + 2 µV 0.12 % + 2.5 µV 0.19 % + 4 µV 0.25 % + 8 µV 0.46 % + 8 µV 0.089 % (Flatness) 0.15 % (Flatness) 0.25 % (Flatness) 0.47 % (Flatness)	
(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	0.041 % + 1.3 µV 0.029 % + 1.3 µV 0.02 % + 1.3 µV 0.035 % + 2 µV 0.044 % + 2.5 µV 0.091 % + 4 µV 0.12 % + 8 µV 0.18 % + 8 µV 0.097 % (Flatness) 0.15 % (Flatness) 0.24 % (Flatness) 0.47 % (Flatness)	

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
AC Voltage – Measure[3] (cont)			
(22 to 70) mV	(10 to 20) Hz	0.032 % + 1.5 µV	Fluke 5790A/03
	(20 to 40) Hz	0.018 % + 1.5 µV	
	40 Hz to 20 kHz	99 µV/V + 1.5 µV	
	(20 to 50) kHz	0.018 % + 2 µV	
	(50 to 100) kHz	0.036 % + 2.5 µV	
	(100 to 300) kHz	0.071 % + 4 µV	
	(300 to 500) kHz	0.091 % + 8 µV	
	500 kHz to 1 MHz	0.16 % + 8 µV	
	(1 to 2) MHz	0.071 % (Flatness)	
	(2 to 10) MHz	0.15 % (Flatness)	
	(10 to 20) MHz	0.22 % (Flatness)	
	(20 to 30) MHz	0.44 % (Flatness)	
(70 to 220) mV	(10 to 20) Hz	0.028 % + 1.5 µV	
	(20 to 40) Hz	0.012 % + 1.5 µV	
	40 Hz to 20 kHz	56 µV/V + 1.5 µV	
	(20 to 50) kHz	97 µV/V + 2 µV	
	(50 to 100) kHz	0.022 % + 2.5 µV	
	(100 to 300) kHz	0.047 % + 4 µV	
	(300 to 500) kHz	0.062 % + 8 µV	
	500 kHz to 1 MHz	0.15 % + 8 µV	
	(1 to 2) MHz	0.074 % (Flatness)	
	(2 to 10) MHz	0.15 % (Flatness)	
	(10 to 20) MHz	0.24 % (Flatness)	
	(20 to 30) MHz	0.44 % (Flatness)	
(220 to 700) mV	(10 to 20) Hz	0.025 % + 1.5 µV	
	(20 to 40) Hz	93 µV/V + 1.5 µV	
	40 Hz to 20 kHz	49 µV/V + 1.5 µV	
	(20 to 50) kHz	69 µV/V + 2 µV	
	(50 to 100) kHz	0.011 % + 2.5 µV	
	(100 to 300) kHz	0.027 % + 4 µV	
	(300 to 500) kHz	0.043 % + 8 µV	
	500 kHz to 1 MHz	0.14 % + 8 µV	
	(1 to 2) MHz	0.074 % (Flatness)	
	(2 to 10) MHz	0.15 % (Flatness)	
	(10 to 20) MHz	0.26 % (Flatness)	
	(20 to 30) MHz	0.45 % (Flatness)	

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
AC Voltage – Measure[3] (cont)			
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	0.024 % 83 µV/V 40 µV/V 62 µV/V 93 µV/V 0.023 % 0.041 % 0.15 % 0.074 % (Flatness) 0.15 % (Flatness) 0.22 % (Flatness) 0.44 % (Flatness)	Fluke 5790A/03
(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 500 kHz to 1 MHz (1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.024 % 83 µV/V 35 µV/V 63 µV/V 0.011 % 0.028 % 0.058 % 0.18 % 0.074 % (Flatness) 0.15 % (Flatness) 0.22 % (Flatness) 0.44 % (Flatness)	
(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	0.028 % 84 µV/V 40 µV/V 74 µV/V 0.012 % 0.031 % 0.059 % 0.18 %	
(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	0.028 % 86 µV/V 49 µV/V 84 µV/V 0.014 % 0.031 % 0.063 % 0.18 %	

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
AC Voltage – Measure[3] (cont)			
(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	0.024 % 86 µV/V 51 µV/V 0.011 % 0.015 % 0.033 % 0.084 %	Fluke 5790A/03
(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	0.024 % 0.013 % 64 µV/V 0.019 % 0.099 %	
(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	0.024 % 0.013 % 58 µV/V 0.021 % 0.11 %	
(1 to 70) kV	60 Hz	0.13 %	Vitrek 4700 w/ 4710 Divider
AC Current – Generate[3]			
(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	0.027 % + 16 nA 0.017 % + 10 nA 0.014 % + 8 nA 0.031 % + 12 nA 0.12 % + 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	0.027 % + 40 nA 0.017 % + 35 nA 0.014 % + 35 nA 0.024 % + 110 nA 0.12 % + 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	0.027 % + 400 nA 0.017 % + 350 nA 0.014 % + 350 nA 0.024 % + 550 nA 0.12 % + 5 µA	

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
AC Current – Generate[3] (cont.)			
(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	0.027 % + 4 µA 0.017 % + 3.5 µA 0.013 % + 3.5 µA 0.021 % + 3.5 µA 0.11 % + 10 µA	Fluke 5720A
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.032 % + 35 µA 0.052 % + 80 µA 0.70 % + 160 µA	
(2.2 to 20) A	30 Hz to 5 kHz	0.042 %	Fluke Y5020 shunt
(20 to 300) A	60 Hz	0.069 %	EIL current source w/ L&N shunt
Clamp-On			
(10 to 1000) A	(45 to 65) Hz	0.87 %	Fluke 5522A w/ 5500A coil
AC Current – Measure[3]			
(2 to 20) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.022 % 0.021 % 0.021 % 0.022 %	Fluke 5709A w/ A40 Shunt
(20 to 200) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.022 % 0.021 % 0.021 % 0.022 %	
(200 to 500) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.022 % 0.021 % 0.021 % 0.022 %	
(0.5 to 2) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.022 % 0.021 % 0.021 % 0.023 %	

Parameter/Range	Frequency	CMC[2, 4, 6, 7] (±)	Comments
AC Current – Measure[3] (cont.)			
(2.0 to 5.0) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.022 % 0.021 % 0.021 % 0.023 %	Fluke 5709A w/ A40 Shunt
(5.0 to 20.0) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.026 % 0.024 % 0.027 % 0.043 %	
(0 to 100) µA (0.1 to 100) mA (0.1 to 1) A	45 Hz to 5 kHz 45 Hz to 5 kHz 45 Hz to 5 kHz	0.06 % + 30 nA 0.07 % + 20 nA 0.13 % + 200 µA	HP 3458A
(0.2 to 2) A	10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.085 % + 240 µA 0.10 % + 240 µA 0.35 % + 240 µA	Fluke 8508A
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.11 % + 2.4 mA 0.29 % + 2.4 mA	
(1 to 20) A	60 Hz to 5 kHz	0.042 %	HP 3458A w/ Fluke Y5020
(20 to 300) A	60 Hz	0.070 %	HP 3458A w/ L&N shunt
Capacitance – Measure			
1 pF to 1 µF	50 Hz to 1 kHz	0.013 %	GenRad 1620A
1 pF to 1 nF 1 nF to 1 µF 1 µF to 1 mF (1 to 10) mF	1 kHz to 1 MHz (1 to 100) kHz 50 Hz to 1 kHz (50 to 120) Hz	0.059 % 0.059 % 0.12 % 0.12 %	HP 4284A

Parameter/Range	Frequency	CMC[2, 6, 7] (±)	Comments
Capacitance – Generate[3]			
(0.19 to 3.3) nF	10 Hz to 3 kHz	0.6 % + 0.01 nF	Fluke 5522A
(3.3 to 11) nF	10 Hz to 1 kHz	0.33 % + 0.1 nF	
(11 to 330) nF	10 Hz to 1 kHz	0.32 % + 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	0.31 % + 10 nF	
(11 to 33) µF	(10 to 120) Hz	0.47 % + 30 nF	
(33 to 110) µF	(10 to 80) Hz	0.54 % + 100 nF	
(110 to 330) µF	Up to 50 Hz	0.53 % + 300 nF	
(0.33 to 1.1) mF	Up to 20 Hz	0.53 % + 1 µF	
(1.1 to 3.3) mF	Up to 6 Hz	0.54 % + 3 µF	
(3.3 to 11) mF	Up to 2 Hz	0.53 % + 10 µF	
(11 to 33) mF	Up to 0.6 Hz	0.88 % + 30 µF	
(33 to 110) mF	Up to 0.2 Hz	1.4 % + 100 µF	
Fixed Points:			
1000 pF	1 kHz	29 µF/F	GenRad 1404
(10, 100) pF	100 Hz to 1 MHz	0.035 %	GenRad 1409 Series
(0.001, 0.01, 0.1, 1) µF	(50 to 1000) Hz	0.068 %	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple Indicators[3] –			
Type E	(-250 to -100) °C	0.59 °C	Fluke 5522A
	(-100 to 650) °C	0.2 °C	
	(650 to 1000) °C	0.25 °C	
Type J	(-210 to -100) °C	0.32 °C	
	(-100 to 760) °C	0.21 °C	
	(760 to 1200) °C	0.28 °C	
Type K	(-200 to -100) °C	0.39 °C	
	(-100 to 120) °C	0.22 °C	
	(120 to 1000) °C	0.27 °C	
	(1000 to 1372) °C	0.5 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple Indicators[3] – (cont.)			
Type S	(0 to 250) °C (250 to 1400) °C (1400 to 1767) °C	0.55 °C 0.46 °C 0.56 °C	Fluke 5522A
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 400) °C	0.73 °C 0.29 °C 0.18 °C	
Electrical Calibration of RTD Indicators[3]			
Pt 385, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C (630 to 800) °C	0.06 °C 0.083 °C 0.12 °C 0.14 °C 0.27 °C	Fluke 5522A
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C	0.061 °C 0.083 °C 0.12 °C 0.14 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to 0) °C (0 to 300) °C (300 to 600) °C (600 to 630) °C	0.29 °C 0.061 °C 0.094 °C 0.12 °C 0.27 °C	
Pt 385, 200 Ω	(-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.049 °C 0.06 °C 0.17 °C 0.19 °C	
Pt 385, 500 Ω	(-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.061 °C 0.072 °C 0.11 °C 0.13 °C	
Pt 385, 1 kΩ	(-200 to 0) °C (0 to 260) °C (260 to 600) °C (600 to 630) °C	0.039 °C 0.061 °C 0.083 °C 0.27 °C	

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Electrical Calibration of RTD Indicators[3] (cont)			
PtNi 385, 120 Ω	(-80 to 100) °C (100 to 260) °C	0.094 °C 0.17 °C	Fluke 5522A
Cu 427, 10 Ω	(-100 to 260) °C	0.35 °C	
Oscilloscopes[3] –			
Square Wave Signal 50 Ω, 1 kHz 1 MΩ, 1 kHz	 1 mV to 6.6 V 1 mV to 130 V	 0.46 % + 40 µV 0.37 % + 40 µV	 Fluke 5522A w/ SC 1100
Leveled Sine Wave Amplitude	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	2.4 % + 300 µV 4.2 % + 300 µV 4.8 % + 300 µV 7.1 % + 300 µV 8.2 % + 300 µV	
Flatness (Up to 50 kHz)	 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	 2 % + 100 µV 2.6 % + 100 µV 4.8 % + 100 µV 6 % + 100 µV	
Time Marker (Into 50 Ω)	1 ns to 20 ms 50 ms to 5 s	24 µs/s 27 µs/s	
Rise Time	< 300 ps	(+0 / -120) ps	

III. Electrical – RF/ Microwave

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
RF Power – Measure			
Power Reference 1 mW, Type-N(f) 50 Ω	50 MHz	0.026 dB (5.8 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	0.22 dB	Bird 8322 VSWR<1.1:1
(+20 to -70) dBm	0.1 MHz to 6 GHz	0.18 dB	HP 4418B, E9304A, VSWR <1.18:1
	(6 to 26.5) GHz	0.23 dB	HP E4413A VSWR <1.27:1
	(26.5 to 50) GHz	0.25 dB	HP 8487A VSWR <1.30:1
Tuned RF Power, Relative – Measure	2.5 MHz to 1.3 GHz		
	(0 to -30) dB (-30 to -70) dB (-70 to -120) dB	0.24 dB 0.24 dB 0.5 dB	HP 8902A w/ HP 11722A & 11792A
Phase Modulation – Measure			
Carrier Frequency: 10 MHz to 1.3 GHz	200 Hz to 20 kHz	3.7 %	HP 8902A w/ HP 11793A

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
RF Attenuation/ Insertion Loss – Measure			
(0 to 120) dB	5 Hz to 3 GHz	0.48 dB	HP E5061B w/ HP 85032B
(0 to 70) dB Dynamic Range	0.1 MHz to 6 GHz	0.18 dB	HP 4418B, 8482A VSWR <1.18:1,
	(6 to 26.5) GHz	0.24 dB	HP 4418B, E4413A VSWR <1.27:1
	(26.5 to 40) GHz	0.27 dB	HP 4418B w/ HP 8487A/D SWR <1.30:1
Amplitude Modulation – Measure			
Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	150 kHz to 10 MHz	2.4 %	HP 8902A w/ HP 11722A or HP 11793A
Rate: 20 Hz to 10 kHz Depths: 5 % to 99 %	150 kHz to 10 MHz	3.5 %	
Rate: 50 Hz to 50 kHz Depths: 5 % to 99 %	10 MHz to 18 GHz	1.3 %	
Rate: 20 Hz to 100 kHz Depths: 5 % to 99 %	10 MHz to 18 GHz	3.5 %	
Frequency Modulation – Measure			
Rate: 20 Hz to 10 kHz Dev: 5 % to 99 %	250 kHz to 10 MHz	2.4 %	HP 8902A w/ HP 11722A or HP 11793A
Rate: 50 Hz to 100 kHz Dev: 5 % to 99 %	10 MHz to 18 GHz	1.2 %	

Parameter/Range	Frequency	CMC[2, 5, 7] (±)	Comments
Phase – Measure	5 Hz to 3 GHz	0.87°	HP E5061B w/ HP 85032B
LISN			
Insertion Loss	5 Hz to 3 GHz	0.48 dB	HP E5061B w/ HP 85032B
Impedance	5 Hz to 3 GHz	3.7 %	
Phase	5 Hz to 3 GHz	0.87°	
Isolation	5 Hz to 3 GHz	0.54 dB	
Impedance – Measure			
1 Ω to 1 kΩ	5 Hz to 1 MHz (1 to 13) MHz	0.15 % 0.41 %	HP 4192A
(1 to 100) kΩ	5 Hz to 1 MHz (1 to 13) MHz	0.48 % 0.83 %	
100 kΩ to 1 MΩ	5 Hz to 1 MHz	1.8 %	
(10 to 100) Ω	(10 to 110) MHz	3.1 % + 0.037*F* (MHz)	HP 4193A
100 Ω to 1 kΩ	(10 to 110) MHz	3.2 % + 0.11*F* (MHz)	
(1 to 10) kΩ	(10 to 40) MHz	1.3 % + 0.53*F* (MHz)	
Distortion – Measure			
20 Hz to 100 kHz	20 Hz to 20 kHz (20 to 100) kHz	0.2 % 0.28 %	HP 8903B

IV. Mechanical

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Pressure Gages[3]	(-14 to 15) psig	0.0035 psi	Druck DPI150
	(750 to 1150) mbar	0.37 mbar	Druck DPI150
	(0 to 2) inH_2O	0.00087 inH_2O	Ashcroft AQS-1
	(-1 to 1) psig	0.00075 psi	Druck DPI800/UPM-P
	(-15 to 30) psig	0.012 psi	Fluke 2700G-BG200K
	(-12 to 300) psig	0.082 psi	Fluke 2700G-BG2M
	(-12 to 1000) psig	0.26 psi	Fluke 2700G-BG7M
	(0 to 5000) psig	3.1 psi	Druck DPI104
	(15 to 10 000) psig	0.079 %	Ashcroft 1305B
Scales and Balances[3]	0.5 lb (0.23 kg)	0.052 g	Class F weights
	1 lb (0.46 kg)	0.12 g	
	2 lb (0.91 kg)	0.16 g	
	5 lb (2.3 kg)	0.38 g	
	10 lb (4.6 kg)	0.75 g	
	20 lb (9.1 kg)	1.6 g	
	50 lb (23 kg)	3.1 g	
	(1 to 5) g	0.044 mg	Class 1 weights
	10 g	0.17 mg	
	20 g	0.16 mg	
	50 g	0.21 mg	
	100 g	0.33 mg	
	200 g	0.62 mg	
	500 g	1.4 mg	
	1000 g	3.2 mg	
	2000 g	6 mg	
Mass – Measure	(1 to 500) g	0.31 g	Rice Lake TP-12K
	(500 to 1000) g	0.39 g	
	(1000 to 5000) g	1.2 g	
	(5000 to 12 000) g	2.8 g	
Torque[3]	(2.5 to 25) in·lbf	0.33 %	Ref weights/torque arm
	(10 to 100) in·lbf	0.26 %	
	(50 to 500) in·lbf	0.23 %	
	(10 to 100) ft·lbf	0.34 %	

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Torque Wrenches and Drivers[3]	(10 to 100) in·lb	0.6 %	Mountz M100
	(2.5 to 25) in·lb	0.68 %	Mountz TL25i
	(16 to 160) in·oz	0.62 %	Mountz TL25i w/ LPX160Z
	(50 to 500) in·lb	0.64 %	Mountz TL25i w/ BMX500i
	(10 to 100) ft·lb	0.63 %	Mountz BT100F-V

V. Thermodynamics

Parameter/Equipment	Range	CMC[2] (±)	Comments
Thermocouples –			
Type T, J, K, E	(-40 to 120) °C	0.27 °C	Liquid bath & Hart 5626 PRT & Fluke 5520A
	(100 to 425) °C (425 to 600) °C	0.31 °C 0.32 °C	Metrology well & Hart 5626 PRT & Fluke 5520A
Thermometers	(-40 to 120) °C	0.023 °C	Liquid bath & Hart 5626 PRT
	(50 to 100) °C (100 to 425) °C (425 to 600) °C	0.024 °C 0.044 °C 0.073 °C	Metrology well calibrator & Hart 5626 PRT

Parameter/Equipment	Range	CMC[2] (±)	Comments
Temperature – Measure[3]	(-100 to 0) °C (0 to 425) °C (425 to 600) °C	0.015 °C 0.03 °C 0.033 °C	Hart 5626 PRT/9173
Relative Humidity –			
Measure[3]	(5 to 95) % RH	1.4 % RH	Rotronic HP21/22
Measuring Equipment	(11, 33, 75) % RH (23 ± 5) °C	1.4 % RH	Rotronic HP21/22 humidity chamber

VI. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Frequency – Measuring Equipment	10 MHz 0.01 Hz to 20 MHz 10 MHz to 40 GHz	2.2 parts in 10^{12} 0.013 Hz 1.3 Hz	Symmetricom XLi 3325A 83640L & Symmetricom XLi
Frequency – Measure	(1, 5, 10) MHz 0.01 Hz to 500 MHz 10 MHz to 40 GHz	2.5 parts in 10^{12} Hz 5.3 parts in 10^{10} Hz 1.7 Hz	Symmetricom XLi 5345A 5352B & Symmetricom XLi

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

[2] Calibration and Measurement Capability Uncertainty (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. CMC's 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] 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/percentage of the reading plus a fixed floor specification.

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

[6] The measurands stated are generated with the Fluke 732A and 5520A, 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/percentage of the reading plus a fixed floor specification.

[7] In the statement of CMCs, percentages are to be read as percent of reading unless otherwise noted.

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 R205 – Specific Requirements: Calibration Laboratory Accreditation Program. 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 April 2017*).

Presented this 3rd day of April 2018.

President and CEO
For the Accreditation Council
Certificate Number 2117.01
Valid to January 31, 2020

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