



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

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CALIBRATION

Valid to: January 31, 2015

Certificate Number: 2724.01

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. Acoustical Quantities

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Sound Level – Measuring Equipment (84 to 114) dB	(125 to 1000) Hz	0.40 dB	GenRad 1986
Measure (84 to 114) dB	(50 to 2000) Hz	0.40 dB	Bruel & Kjaer 2610/ GenRad 1986

II. Chemical Quantities

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Conductivity	(100 to 100 000) µS	0.29 % @ 25 °C	Standard conductivity solutions
pH	(4, 7, 10) pH units	0.030 pH units	Standard buffer solutions

III. Dimensional

Parameter/Equipment	Range	CMC <sup>2,7</sup> ( $\pm$ )	Comments
UMM, Supermic <sup>TM, 10</sup>	Up to 11.5 in	(10 + 0.70L) $\mu$ in	Gage blocks
Bore Mic (Intramic) – 2 Point 3 Point	(0.04 to 0.25) in (1/4 to 1/2) in	32 $\mu$ in 32 $\mu$ in	Master ring gauges
Calipers <sup>3</sup>	Up to 12 in (12 to 60) in	300 $\mu$ in + 3 $\mu$ in/in 300 $\mu$ in + 6 $\mu$ in/in	Caliper checkers w/ gage blocks
Coordinate Measuring Machines (CMMs) <sup>3</sup> – Length	Up to 23.6 in	250 $\mu$ in	Ball bar, gage blocks
Cylindrical Square – Squareness, Straightness, Roundness	Up to 12 in	24 $\mu$ in	Federal comparator 232, surface plate
Dial Indicator <sup>3</sup>	(0.01 to 2) in	170 $\mu$ in	Dial indicator checker
End Standards	Up to 1 in (1 to 4) in (4 to 6) in (6 to 24) in (24 to 36) in	11 $\mu$ in 26 $\mu$ in 36 $\mu$ in 77 $\mu$ in 110 $\mu$ in	Laser measurement machine (LMM)
Feeler Gages	Up to 0.5 in	100 $\mu$ in	Gage blocks, or LMM and gage blocks
Height Gages	Up to 48 in	61 $\mu$ in + 9.6 $\mu$ in/in	Gage blocks, Federal comparator 232

Parameter/Equipment	Range	CMC <sup>2, 7</sup> ( $\pm$ )	Comments
Micrometers <sup>3</sup> –  Inside  Outside  Depth	Up to 1 in (1 to 4) in (4 to 6) in (6 to 24) in (24 to 36) in  Up to 36 in  Up to 12 in	11 $\mu\text{in} + 0.6R$ 26 $\mu\text{in} + 0.6R$ 36 $\mu\text{in} + 0.6R$ 77 $\mu\text{in} + 0.6R$ 110 $\mu\text{in} + 0.6R$  12 $\mu\text{in}/\text{in} + 0.6R$  12 $\mu\text{in}/\text{in} + 0.6R$	Gage blocks
Stage Micrometer Standard	(0.004 to 2) in	20 $\mu\text{in} + 10 \mu\text{in}/\text{in}$	LMM
Optical Comparator <sup>3</sup> –  Length Magnification	Up to 11 in 10x to 100x	100 $\mu\text{in}$ 0.6R	Gage blocks, magnification balls
Outside Diameter –  Pins/Plugs/Balls	Up to 10 in	30 $\mu\text{in}$	Pratt & Whitney Supermic <sup>TM, 10</sup>
Protractors	Up to 90°	0.01°	Since plate, gage blocks, cylindrical square
Paint Coat Thickness – Thin Film Shims	(0.001 to 0.060) in  (32 to 75) mils	1500 $\mu\text{in}$  1.0 % of IV	LMM, gage blocks, calibrated shims
Roughness <sup>3</sup>	(7 to 9) $\mu\text{in}$ (12 to 20) $\mu\text{in}$ 120 $\mu\text{in}$	1.6 $\mu\text{in}$ 1.5 $\mu\text{in}$ 4.6 $\mu\text{in}$	Roughness standards
Ultrasonic Thickness Standards	Up to 3 in	600 $\mu\text{in}$	LMM, gage blocks

Parameter/Equipment	Range	CMC <sup>2,7</sup> ( $\pm$ )	Comments
Rulers <sup>3</sup>	(1 to 104) in	790 $\mu$ in	LMM, gage blocks
Sine Plate, Sine Bar, Fixed Points	5 in 10 in 20 in	150 $\mu$ in 150 $\mu$ in 450 $\mu$ in	Angle blocks, gage blocks, Federal comparator 232
Levels –  Digital Bubble	120 in 96 in	0.25" 0.60R	Sine plate, gage blocks
Tape Measure	Up to 300 ft	0.010 % + 0.60R	LMM
Flatness <sup>3</sup>	(2 to 6) in	3 $\mu$ in	Optical flat
Surface Plate <sup>3</sup>	72 in x 240 in	100 $\mu$ in	Autocollimator
Thread Rings	(Up to 1.5) in (1.5 to 4) in (4 to 6) in  Minor Diameter	220 $\mu$ in 270 $\mu$ in 320 $\mu$ in  200 $\mu$ in	Master thread plugs  Plain pins/plugs, bore plugs, optical comparator
Thread Wires	(4 to 80) tpi	13 $\mu$ in	LMM, Pratt & Whitney Supermic <sup>TM, 10</sup> , gage blocks
Thread Plugs	(0.1 to 4) in (4 to 80) tpi	75 $\mu$ in 75 $\mu$ in	Pratt & Whitney Supermic <sup>TM, 10</sup> , gage blocks, master thread wires
Ring Gages	(0.25 to 8.0) in	25 $\mu$ in	Pratt & Whitney Supermic <sup>TM, 10</sup> , gage blocks, master ring gages

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range <sup>4</sup>	CMC <sup>2,7</sup> ( $\pm$ )	Comments
DC Voltage <sup>3</sup> – Generate	(0 to 220) mV	7 $\mu$ V/V + 0.5 $\mu$ V	Fluke 5720A
	(0.22 to 2.2) V	4 $\mu$ V/V + 0.8 $\mu$ V	
	(2.2 to 11) V	3 $\mu$ V/V + 5 $\mu$ V	
	(11 to 22) V	3 $\mu$ V/V + 5 $\mu$ V	
	(22 to 220) V	4 $\mu$ V/V + 50 $\mu$ V	
	(220 to 1100) V	6 $\mu$ V/V + 0.5 mV	Fluke 732A array
	10.00 V	1 $\mu$ V/V	
	100.0 mV	1.5 $\mu$ V/V	Fluke 732A, 752A
	1.0 V	1.3 $\mu$ V/V	
	10.0 V	1.2 $\mu$ V/V	
100.0 V	1.3 $\mu$ V/V		
1000.0 V	1.5 $\mu$ V/V		
DC Voltage <sup>3</sup> – Measure	(0 to 120) mV	5 $\mu$ V/V + 1 $\mu$ V	Agilent 3458A
	(0.1 to 1.2) V	4 $\mu$ V/V + 1 $\mu$ V	
	(1.0 to 12) V	4 $\mu$ V/V + 2 $\mu$ V	
	(10 to 120) V	6 $\mu$ V/V + 30 $\mu$ V	Virtek 4670A w/ HVL-100
	(100 to 1050) V	18 $\mu$ V/V + 100 $\mu$ V	
	(0.5 to 10) kV	0.04 % IV + 0.03 V	
(10 to 100) kV	0.075 % IV + 0.3 V		
DC Current <sup>3</sup> – Measure	(2 to 20) A	0.01 % IV	Fluke Y5020, HP 3458A
	(10 to 100) A	0.05 % IV	Guildline 9211A, Agilent 3458A
	(30 to 300) A	0.1 % IV	
	(12 to 120) $\mu$ A	20 $\mu$ A/A + 800 pA	Agilent 3458A
	(0.12 to 1.2) mA	20 $\mu$ A/A + 5.0 nA	
	(1.2 to 12) mA	20 $\mu$ A/A + 50 nA	
	(12 to 120) mA	35 $\mu$ A/A + 500 nA	
	(0.12 to 1.2) A	0.011 % IV + 10 $\mu$ A	

Parameter/Equipment	Range <sup>4</sup>	CMC <sup>2, 7</sup> ( $\pm$ )	Comments
DC Current <sup>3</sup> – Generate	(0 to 220) $\mu$ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A  (2.0 to 11) A	42 $\mu$ A/A + 7 nA 35 $\mu$ A/A + 8 nA 35 $\mu$ A/A + 50 nA 45 $\mu$ A/A + 0.8 $\mu$ A 70 $\mu$ A/A + 15 $\mu$ A  0.034 % + 480 $\mu$ A	Fluke 5720A  Fluke 5720A w/ Fluke 5725A
Resistance <sup>3</sup> – Measure	(0.0 to 12) $\Omega$ (10 to 120) $\Omega$ (0.10 to 1.2) k $\Omega$ (1.0 to 12) k $\Omega$ (10 to 120) k $\Omega$ (0.10 to 1.2) M $\Omega$ (1.0 to 12) M $\Omega$ (10 to 120) M $\Omega$	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 500 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 500 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 5 m $\Omega$ 10 $\mu\Omega/\Omega$ + 50 m $\Omega$ 15 $\mu\Omega/\Omega$ + 2 $\Omega$ 50 $\mu\Omega/\Omega$ + 100 $\Omega$ 0.05 % IV + 1000 $\Omega$	Agilent 3458A
Resistance <sup>3</sup> – Generate	10 000.00 $\Omega$  1.0 $\Omega$  1.0 $\Omega$ (Nominal) 1.9 $\Omega$ 10.0 $\Omega$ 19.0 $\Omega$ 100.0 $\Omega$ 190.0 $\Omega$ 1.0 k $\Omega$ 1.9 k $\Omega$ 10.0 k $\Omega$ 19.0 k $\Omega$ 100.0 k $\Omega$ 190.0 k $\Omega$ 1.0 M $\Omega$ 1.9 M $\Omega$ 10.0 M $\Omega$ 19.0 M $\Omega$ 100.0 M $\Omega$	0.5 $\mu\Omega/\Omega$  0.5 $\mu\Omega/\Omega$  95 $\mu\Omega/\Omega$ 95 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 37 $\mu\Omega/\Omega$ 47 $\mu\Omega/\Omega$ 0.011 % IV	ESI SR-104  Leeds & Northrup 4210  Fluke 5720A

Parameter/Equipment	Range <sup>4</sup>	CMC <sup>2</sup> (±)	Comments
Resistance – Ratio Measurement	1:1 0.1:1 to 10:1 > 10:1 to 100:1	1.0 parts in 10 <sup>6</sup> 1.4 parts in 10 <sup>6</sup> 2.0 parts in 10 <sup>6</sup>	MI 6010, MI 6000

Parameter/Range <sup>4</sup>	Frequency	CMC <sup>2,7</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate			
(0 to 2.2) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 5 μV 0.011 % IV + 5 μV 90 μV/V + 5 μV 0.023 % IV + 5 μV 0.054 % IV + 6 μV 0.12 % IV + 12 μV 0.15 % IV + 25 μV 0.31 % IV + 25 μV	Fluke 5720A
(2.0 to 22) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 5 μV 0.011 % IV + 5 μV 90 μV/V + 5 μV 0.023 % IV + 5 μV 0.054 % IV + 6 μV 0.12 % IV + 12 μV 0.15 % IV + 25 μV 0.31 % IV + 25 μV	
(20 to 220) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 50 μV 0.010 % IV + 20 μV 50 μV/V + 10 μV 90 μV/V + 12 μV 0.013 % IV + 40 μV 0.042 % IV + 100 μV 0.11 % IV + 250 μV 0.18 % IV + 400 μV	
(0.20 to 2.2) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 500 μV 0.01 % IV + 200 μV 50 μV/V + 70 μV 90 μV/V + 120 μV 0.012 % IV + 250 μV 0.031% IV + 800 μV 0.11 % IV + 2.5 mV 0.16 % IV + 4 mV	

*Peter Abaya*

Parameter/ Range <sup>4</sup>	Frequency	CMC <sup>2,7</sup> ( $\pm$ )	Comments
AC Voltage <sup>3</sup> – Generate (cont)			
(2.0 to 22) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.027 % IV + 5 mV 0.01 % IV + 2 mV 60 $\mu$ V/V + 7 mV 0.01 % IV + 1.2 mV 0.017 % IV + 3 mV 0.1 % IV + 20 mV 0.52 % IV + 50 mV 0.9 % IV + 100 mV	Fluke 5720A
(20 to 220) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.027 % IV + 5 mV 0.01 % IV + 2 mV 60 $\mu$ V/V + 700 $\mu$ V 0.01 % IV + 12 mV 0.017 % IV + 3 mV	
(200 to 1100) V	(0.05 to 1) kHz	80 $\mu$ V/V + 4 mV	
(200 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.036 % IV + 11 mV 0.13 % IV + 45 mV	Fluke 5720A w/ Fluke 5725A
(200 to 1100) V	(0.04 to 1) kHz (1 to 20) kHz (20 to 30) kHz	80 $\mu$ V/V + 4 mV 0.013 % IV + 6 mV 0.036 % IV + 11 mV	
AC Voltage <sup>3,5</sup> – Measure			
(0 to 2.2) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.17 % IV + 1.3 $\mu$ V 0.074 % IV + 1.3 $\mu$ V 0.042 % IV + 1.3 $\mu$ V 0.081 % IV + 2.0 $\mu$ V 0.12 % IV + 2.5 $\mu$ V 0.23 % IV + 4.0 $\mu$ V 0.24 % IV + 8.0 $\mu$ V 0.35 % IV + 8.0 $\mu$ V	Fluke 5790A
(2.2 to 7.0) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.085 % IV + 1.3 $\mu$ V 0.037 % IV + 1.3 $\mu$ V 0.021 % IV + 1.3 $\mu$ V 0.04 % IV + 2.0 $\mu$ V 0.06 % IV + 2.5 $\mu$ V 0.12 % IV + 4.0 $\mu$ V 0.13 % IV + 8.0 $\mu$ V 0.23 % IV + 8.0 $\mu$ V	

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Parameter/ Range <sup>4</sup>	Frequency	CMC <sup>2,7</sup> ( $\pm$ )	Comments
AC Voltage <sup>3,5</sup> – Measure (cont)			
(7.0 to 22.0) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.3 $\mu$ V 0.019 % IV + 1.3 $\mu$ V 0.011 % IV + 1.3 $\mu$ V 0.021 % IV + 2.0 $\mu$ V 0.031 % IV + 2.5 $\mu$ V 0.081 % IV + 4.0 $\mu$ V 0.089 % IV + 8.0 $\mu$ V 0.17 % IV + 8.0 $\mu$ V	Fluke 5790A
(22 to 70) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.5 $\mu$ V 0.012 % IV + 1.5 $\mu$ V 65 $\mu$ V/V + 1.5 $\mu$ V 0.013 % IV + 2.0 $\mu$ V 0.026 % IV + 2.5 $\mu$ V 0.051 % IV + 4.0 $\mu$ V 0.067 % IV + 8.0 $\mu$ V 0.11 % IV + 8.0 $\mu$ V	
(70 to 220) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.021 % IV + 1.5 $\mu$ V 85 $\mu$ V/V + 1.5 $\mu$ V 38 $\mu$ V/V + 1.5 $\mu$ V 69 $\mu$ V/V + 2.0 $\mu$ V 0.016 % IV + 2.5 $\mu$ V 0.025 % IV + 4.0 $\mu$ V 0.038 % IV + 8.0 $\mu$ V 0.1 % IV + 8.0 $\mu$ V	
(220 to 700) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.021 % IV + 1.5 $\mu$ V 76 $\mu$ V/V + 1.5 $\mu$ V 33 $\mu$ V/V + 1.5 $\mu$ V 51 $\mu$ V/V + 2.0 $\mu$ V 79 $\mu$ V/V + 2.5 $\mu$ V 0.018 % IV + 4.0 $\mu$ V 0.03 % IV + 8.0 $\mu$ V 0.096 % IV + 8.0 $\mu$ V	
(0.7 to 2.2) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.02 % IV 66 $\mu$ V/V 24 $\mu$ V/V 46 $\mu$ V/V 71 $\mu$ V/V 0.016 % IV 0.026 % IV 0.09 % IV	

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Parameter/ Range <sup>4</sup>	Frequency	CMC <sup>2,7</sup> ( $\pm$ )	Comments
AC Voltage <sup>3,5</sup> – Measure (cont)			
(2.2 to 7.0) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.02 % IV 67 $\mu$ V/V 24 $\mu$ V/V 48 $\mu$ V/V 81 $\mu$ V/V 0.019 % IV 0.04 % IV 0.12 % IV	Fluke 5790A
(70 to 220) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.02 % IV 68 $\mu$ V/V 31 $\mu$ V/V 69 $\mu$ V/V 98 $\mu$ V/V 0.021 % IV 0.05 % IV	
(220 to 700) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % IV 96 $\mu$ V/V 39 $\mu$ V/V 0.012 % IV 0.04 % IV	
(700 to 1000) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % IV 96 $\mu$ V/V 37 $\mu$ V/V 0.012 % IV 0.04 % IV	
(0 to 10) kV	60 Hz	0.15 % IV + 0.1 V	Vitrek 4700A w/ HVL-100
(10 to 75) kV	60 Hz	0.15 % IV + 0.6 V	

Parameter/ Range	Frequency	CMC <sup>2,7</sup> ( $\pm$ )	Comments
AC Current <sup>3</sup> – Measure			
(0 to 120) $\mu$ A	(10 to 19.99) Hz (20 to 44.99) Hz (45 to 100) Hz (0.1 to 1) kHz	0.4 % IV + 30 pA 0.15 % IV + 30 pA 0.06 % IV + 30 pA 0.06 % IV + 30 pA	Agilent 3458A
(0.12 to 1.2) mA	(10 to 19.99) Hz (20 to 44.99) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 200 pA 0.15 % IV + 200 pA 0.06 % IV + 200 pA 0.03 % IV + 200 pA	
(1.2 to 12) mA	(10 to 19.99) Hz (20 to 44.99) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 2 $\mu$ A 0.15 % IV + 2 $\mu$ A 0.06 % IV + 2 $\mu$ A 0.03 % IV + 2 $\mu$ A	
(12 to 120) mA	(10 to 19.99) Hz (20 to 44.99) Hz (45 to 100) Hz (0.1 to 5) kHz	0.15 % IV + 20 $\mu$ A 0.06 % IV + 20 $\mu$ A 0.03 % IV + 20 $\mu$ A 0.06 % IV + 20 $\mu$ A	
(0.12 to 2.2) A	(10 to 19.99) Hz (20 to 44.99) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 200 $\mu$ A 0.16 % IV + 200 $\mu$ A 0.08 % IV + 200 $\mu$ A 0.1 % IV + 200 $\mu$ A	
(2 to 20) A	(50 to 100) Hz 300 Hz 1 kHz 3 kHz 4 kHz 5 kHz	0.016 % IV 0.019% IV 0.027% IV 0.051% IV 0.063% IV 0.075% IV	Fluke Y5020, HP 3458A
(20 to 1200) A	60 Hz 400 Hz	0.05 % IV 0.09 % IV	Weston 327 current transformer, Fluke Y5020, HP 3458A

Parameter/ Range	Frequency	CMC <sup>2,7</sup> (±)	Comments
AC Current <sup>3</sup> – Generate			
(0 to 220) μA	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.036 % IV + 2.1 μA 0.023 % IV + 2.1 μA 0.017 % IV + 2.1 μA 0.042 % IV + 2.1 μA 0.15 % IV + 2.1 μA	Fluke 5720A
(0.2 to 2.2) mA	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.036 % IV + 2.1 μA 0.023 % IV + 2.1 μA 0.017 % IV + 2.1 μA 0.029 % IV + 2.2 μA 0.15 % IV + 3.1 μA	
(2.0 to 22) mA	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.028 % IV + 0.5 μA 0.018 % IV + 0.4 μA 0.013 % IV + 0.4 μA 0.022 % IV + 0.7 μA 0.11 % IV + 6 μA	
(20 to 220) mA	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.028 % IV + 5 μA 0.018 % IV + 4 μA 0.013 % IV + 3 μA 0.022 % IV + 4 μA 0.11 % IV + 12 μA	
(0.20 to 2.2) A	(0.02 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.03 % IV + 40 μA 0.046 % IV + 100 μA 0.7 % IV + 200 μA	
(2.0 to 11) A	(0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.04 % IV + 170 μA 0.085 % IV + 380 μA 0.33 % + 750 μA	Fluke 5720A w/ Fluke 5725A
(2 to 20) A	50 to 100 Hz 300 Hz 1 kHz 3 kHz 4 kHz 5 kHz	0.016 % IV 0.019 % IV 0.027 % IV 0.051 % IV 0.063 % IV 0.075 % IV	Fluke Y5020, HP 3458A, Fluke 5725A
(20 to 100) A	60 Hz	0.05 % IV	Fluke Y5020, HP 3458A, Weston 327 CT, Vahalla 2555A

Parameter/ Range <sup>4</sup>	Frequency	CMC <sup>2,7</sup> (±)	Comments
Capacitance <sup>3</sup> – Generate			
1000 pF	1000 Hz	5.0 μF/F	GenRad 1404A
(330 to 500) pF	(50 to 1000) Hz	0.5 % IV + 10 pF	Fluke 5500A
(0.5 to 1.1) nF		0.5 % IV + 10 pF	
(1.1 to 3.3) nF		0.5 % IV + 10 pF	
(3.3 to 11) nF		0.5 % IV + 10 pF	
(11 to 33) nF		0.25 % IV + 100 pF	
(33 to 110) nF		0.25 % IV + 100 pF	
(110 to 330) nF		0.25 % IV + 300 pF	
(0.330 to 1.10) μF		0.25 % IV + 1 nF	
(1.1 to 3.3) μF		0.35 % IV + 3 nF	
(3.3 to 11) μF	(50 to 400) Hz	0.35 % IV + 10 nF	
(11 to 33) μF		0.4 % IV + 30 nF	
(33 to 110) μF	(50 to 200) Hz	0.5 % IV + 100 nF	
(110 to 330) μF	(50 to 100) Hz	0.7 % IV + 300 nF	
(0.330 to 1.1) mF		1 % IV + 300 nF	
Capacitance <sup>3</sup> – Measure			
(0.1 to 1000) pF	1 kHz	0.01 % IV + 30 fF	GenRad 1620A
(0 to 1) nF	(0.050 to 2) kHz	0.1 % IV + 10 fF	Fluke PM6304C
(1 to 10) nF		0.1 % IV + 100 fF	
(10 to 100) nF		0.1 % IV + 1 pF	
(0.1 to 1) μF		0.1 % IV + 10 pF	
(1 to 10) μF		0.1 % IV + 100 pF	
(10 to 100) μF		0.1 % IV + 1 nF	
(0.1 to 1) mF		0.1 % IV + 10 nF	
(1 to 10) mF		0.1 % IV + 100 nF	
(10 to 100) mF		0.1 % IV + 1 μF	
(0.1 to 1) F		0.1 % IV + 10 μF	
(1 to 10) F		0.1 % IV + 100 μF	
(10 to 31.8) F		0.1 % IV + 1 mF	

Parameter/ Range	Frequency	CMC <sup>2, 7</sup> ( $\pm$ )	Comments
Inductance <sup>3</sup> – Measure  (0.00 to 1.00) mH (1.00 to 10) mH (10 to 100) mH (0.100 to 1.00) mH (1 to 9.9999) H (10 to 99.999) H (100 to 999.99) H	(0.050 to 2) kHz	0.1 % IV + 10 nH 0.1 % IV + 100 nH 0.1 % IV + 1 $\mu$ H 0.1 % IV + 10 $\mu$ H 0.1 % IV + 100 $\mu$ H 0.1 % IV + 1 mH 0.1 % IV + 10 mH	Fluke PM6304C
Oscilloscopes <sup>3</sup> –  Amplitude DC – DC Signal 50 $\Omega$ Load 1 M $\Omega$ Load  Amplitude – Square Wave (Peak to Peak) – 50 $\Omega$ Load  Amplitude – Square Wave 1 M $\Omega$ Load – (10 to 100) Hz (0.1 to 10) kHz  Leveled Sine Wave – (Into 50 $\Omega$ Load)  Flatness @ 50 kHz Reference  Time Marker – (Into 50 $\Omega$ Load)  Edge Spec (Rise Time)  Amplitude Flatness	(0 to $\pm$ 2.2) V (0 to $\pm$ 33) V  $\pm$ 1.8 mV to $\pm$ 2.2 V  $\pm$ 1.8 mV to $\pm$ 55 V  (95 to 105) V  50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz  50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz  5 s to 50 ms 20 ms to 1 ns  $\leq$ 1000 ps  0.1 Hz to 50 kHz (0.050 to 100) MHz (100 to 250) MHz (250 to 550) MHz	0.25 % IV + 100 $\mu$ V 0.25 % IV + 100 $\mu$ V  0.25 % IV + 100 $\mu$ V  0.25 % IV + 100 $\mu$ V  1.5 % IV $\pm$ 100 $\mu$ V 0.5 % IV $\pm$ 100 $\mu$ V  2 % IV + 300 $\mu$ V 3.5 % IV + 300 $\mu$ V 4 % IV + 300 $\mu$ V 6 % IV + 300 $\mu$ V  1.5 % IV + 100 $\mu$ V 2 % IV + 100 $\mu$ V 4 % IV + 100 $\mu$ V  (25 + 1000 <i>t</i> ) $\mu$ s/s 2.5 $\mu$ s/s  (+0 ps / -900 ps)  1.5 % IV 1.5 % IV 3 % IV 4 % IV	Fluke 5500A w/ SC600 scope option              <i>t</i> is the numerical value of the time in seconds   Referenced to 50 kHz

Peter Nijze

Parameter/ Range	Range	CMC <sup>2</sup> (±)	Comments
Thermocouple Simulation – Generate and Measure			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.50 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	Fluke 5500A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.40 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.40 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	

V. Fluid Quantities

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Specific Gravity	(1.00 to 1.43) SPG	0.0010 SPG	Hydrometer set

Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Gas Detection – Including, But Not Limited to:			
Carbon Dioxide	5 %, Balance N <sub>2</sub>	0.12 % of Cal Gas	Calibration gases
Carbon Monoxide	100 ppm, Balance Air	2.5 % of Cal Gas	
Hydrogen	2 %, Balance Air	1.2 % of Cal Gas	
Hydrogen Sulfide	25 ppm, Balance N <sub>2</sub>	0.76 % of Cal Gas	
Methane	1 %, Balance Air	0.061 % of Cal Gas	
Oxygen	20 %, Balance Air	0.50 % of Cal Gas	
Pentane	0.35 %, Balance Air	0.39 % of Cal Gas	
Other Gases as Available <sup>9</sup>			
Gas Flow	(0.3 to 100) SCFM	0.50 % IV	DHI Molbloc sonic nozzle system
	(0 to 60 000) SCCM	0.50 % IV or 0.04 SCCM	DHI Molbloc flow calibrator
Leak Rate <sup>3</sup>	(Down to 1.0 <sup>-8</sup> ) ATM cc/s He at 21°C	3.2 % IV	Leak detector standard
Volume – Measuring Equipment [e.g. Flasks, Graduated Cylinders]	(1 to 10 000) ml	0.065 % IV	Mass comparators

## VI. Mechanical

Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Hydraulic	(40 to 20 000) psig	0.01 % IV	DH Instruments 50316 dead weight tester



Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Indirect Verification of Rockwell Hardness <sup>3</sup>	HRBW: (30 to 49) HRBW (60 to 79) HRBW (80 to 100) HRBW  HRC: (20 to 30) HRC (35 to 55) HRC (59 to 65) HRC	1.2 HRBW 1.5 HRBW 1.3 HRBW  0.75 HRC 0.75 HRC 0.75 HRC	Hardness blocks
Verification of Durometer Spring –  Type A, B, O, OO	(10 to 100) Duro units	0.03 % of scale (0.26 g)	Weight scale
Pressure Gages, Controllers, Transducers <sup>3</sup> –  Pneumatic  Pneumatic	(0 to 3) in (>3 to 30) in  (0.2 to 1000) psig (0.2 to 1000) psia  (0 to 10 000) psig	0.00027 in H <sub>2</sub> O 0.0090 % IV  0.0050 % IV 0.0050 % IV + 0.00050 psia  0.080 % FS	Ruska 7250LP  Ruska 2465 dead weight tester  Fluke 700P31
Vacuum –  Gages  Controllers & Transducers	(10 to 1000) mmHg  (0.1 to 100) mmHg	0.005 % IV ± 0.03 mmHg  0.10 % IV	Ruska 2465 dead weight tester  MKS vacuum system
Force <sup>3</sup> – Tension & Compression	(0 to 1000) lbf (0 to 100 000) lbf	0.01 % IV 0.06 % IV	Dead weight Load cells



Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Torque Cell	(0 to 10 000) ft·lbf	0.11 % IV	Dead weight, torque arms
Torque Arms	(5 to 120) in	0.010 in (maximum)	Gage blocks, LMM
Torque Wrench <sup>3</sup>	(0.2 to 6500) ft·lbf	0.50 % IV	Torque cells
Vibration – Sensitivity Measurement & Frequency Response	(20 to < 100) Hz (0.1 to 1) kHz (>1 to 10) kHz	1.8 % IV 1.3 % IV 2.8 % IV	Bouche Labs 1000AD/2133F shaker/accelerometer system

#### VII. Optical Quantities

Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Light	(2 to 500) fc	2.7 % IV	Optronic OL 220P
Step Tablets	(0.2 to 4) density unit	0.02 density unit	NIST SRM 1008 photographic step tablet
Densitometers	(0.2 to 4) density unit	0.02 density unit	

#### VIII. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Dew Point	(-90 to 10) °C dp	0.25 °C dp	Thunder Scientific 3900
Temperature – Measuring Equipment			
Triple Point Cell	0.010 °C	0.0013 °C	Foxboro 130

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Temperature <sup>3</sup> – Measure	(0 to 100) °C	0.01 °C	Hart Black Stack w/ thermistor
	(0 to 250) °C	0.74 °C	Hart Scientific 5650 Type “S” thermocouple w/ Fluke 525A
	(250 to 1000) °C	0.76 °C	
	(1000 to 1400) °C	3.7 °C	
	(1400 to 1450) °C	4.1 °C	
	(-200 to 660) °C	0.016 °C	Rosemount 162CE PRT w/ Hart Scientific 1575 super thermometer
Humidity	(10 to 95) % RH	0.50 % RH	Thunder Scientific 1200 Thunder Scientific 2500
Temperature – Measuring Equipment Dry Blocks	(-40 to 140) °C	0.056 °C	Hart Scientific 9107 monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(35 to 600) °C	0.46 °C	Hart Scientific 9150, monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(600 to 1200) °C	2.7 °C	Hart Scientific 9150, monitored w/ Hart Scientific 5650 Type “S” TC & Fluke 525A <sup>8</sup>
Temperature IR – Measuring Equipment Black Body	(-15 °C to 120) °C	1.0 °C	Hart Scientific 4180 IR target
	(35 to 200) °C	1.0 °C	Hart Scientific 4181 IR target
	(>200 to 350) °C	2.0 °C	
	(>350 to 500) °C	3.0 °C	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Temperature – Measuring Equipment Calibration Bath	(-40 to 102) °C	0.016 °C	Hart Scientific 7040 (oil) monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(0.0 to 100) °C	0.01 °C	Hart Scientific 7040 (oil) monitored w/ Hart Blackstack & thermistor
	(100 to 180) °C	0.017 °C	Hart Scientific 6045 (oil) monitored w/ Rosemount 162CE PRT & Hart Scientific 1575
	(170 to 500) °C	0.023 °C	Hart Scientific 6050 (salt) monitored w/ Rosemount 162CE PRT & Hart Scientific 1575

#### IX. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Stop Watches & Timers <sup>3</sup>	(0.2 to 10 000) s	1.8 parts in 10 <sup>7</sup> + trigger error	HP 53131A
	(+10 to -10) s/day	0.05 s/day	Vibrograph TM4500
Frequency – Measuring Equipment	10 000 000 Hz	50 pHz/Hz	TrueTime XL-DC GPS receiver
	0.01 Hz to 80 MHz	2 μHz/Hz	Agilent 33250A
		10 nHz/Hz	33250A synchronized w/ GPS
	(0.1 to 3000) MHz	2 μHz/Hz	Agilent 8648C
10 nHz/Hz		8648C synchronized w/ GPS	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Frequency – Measure	10 MHz	100 pHz/Hz	TrueTime XL-DC GPS receiver
	0.1 Hz to 225 MHz	19 µHz/Hz	Agilent 53131A frequency counter
		1 nHz/Hz	53131A synchronized w/ GPS
	(0.1 to 3000) MHz	0.19 µHz/Hz	Agilent 53131A channel 3
		1 nHz/Hz	53131A synchronized w/ GPS

<sup>1</sup> This laboratory offers commercial calibration service and field calibration service where noted.

<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> Where ranges are not specified, the CMC stated is for the cardinal points only.

<sup>5</sup> This calibration performed in Absolute Measure Mode.

<sup>6</sup> This calibration performed in AC/DC Transfer Mode.

<sup>7</sup> In the statement of CMC, percentages are to be read as percent of reading unless noted otherwise, IV is defined as the indicated value, FS is defined as full scale,  $L$  is the numerical value of the nominal length of the device measured in inches, and  $R$  is the resolution of the unit under test.

<sup>8</sup> Hart Scientific 1575 from 35 °C to 660 °C (95 °F to 1220 °F), Fluke 525A from 660 °C to 1200 °C (1220 °F to 2192 °F).

<sup>9</sup> Contact the laboratory for information on availability of service for specific gasses not listed, gasses that are not listed are not considered accredited services.

<sup>10</sup> "Supermic" is a registered trade mark owned by Pratt & Whitney Measurement Systems, Inc., Connecticut U.S.A.





American Association for Laboratory Accreditation

## Accredited Laboratory

A2LA has accredited

# ENERGY NORTHWEST STANDARDS LABORATORY

*Richland, WA*

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 10<sup>th</sup> day of September 2013.



A handwritten signature in black ink, reading "Peter Abney".

President & CEO  
For the Accreditation Council  
Certificate Number 2724.01  
Valid to January 31, 2015

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