



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3

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CALIBRATION

Valid To: September 30, 2019

Certificate Number: 1395.17

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Dimensional

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
Micrometers ³ – OD, Depth	Up to 36 in	(53 + 8L) μ in	Gage block set, optical flat
Height Gages ³	Up to 40 in	(310 + 4.2L) μ in	Gage block set, surface plate
Calipers ³	Up to 72 in	(330 + 7L) μ in	Gage blocks, pin gage
Linear Indicator – Digital and Analog	Up to 10 in: (50 μ in resolution) (100 μ in resolution) (0.001 in resolution)	(20 + 5.3L) μ in (35 + 5.3L) μ in (130 + 5.3L) μ in	Gage blocks

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
Linear Length – Micrometer Standards, Attribute Length Standards	Up to 12 in	$(11 + 1.6L) \mu\text{in}$	Pratt & Whitney Supermic™, gage block set
Ring Gages	Up to 1 in (>1 to 4) in	$(11 + 0.78L) \mu\text{in}$ $(11 + 2.7L) \mu\text{in}$	Pratt & Whitney Supermic™, gage block set
Cylindrical Gages – Pins, Plugs, Discs	(0.01 to <0.5) in (0.5 to 4) in	$24 \mu\text{in}$ $(18 + 13D) \mu\text{in}$	Pratt & Whitney Supermic™, gage block set
Flatness	Up to 1 in	$12 \mu\text{in}$	Optical flats
Parallelism	0.0001 in	$15 \mu\text{in}$	Optical parallel
Threaded Plug Gages – Pitch (60° Threads) Major Diameter	(5 to 80) TPI Up to 12 in	$(70 + 4.2L)$ $(31 + 4.2L)$	Gage blocks with thread wire and Pratt & Whitney Supermic™
Thread Ring Gages	Up to 1.5 in (1.5 to 5) in	$(210 + 5.8L) \mu\text{in}$ $(310 + 5.8L) \mu\text{in}$	Master setting plug
Bore Gages, Inside Micrometers, Intramikes ³	(0.081 to 6.0) in	$(58 + 18L) \mu\text{in}$	Gage blocks and ring gages
Gage Blocks	(0.05 to 1) in (>1 to 4) in	$2.7 \mu\text{in}$ $(1.8 + 2.1L) \mu\text{in}$	Master gage block set Federal 130B-24
Surface Plates ³ – Repeat Reading Flatness	(12 to 96) in (12 to 96) in	$41 \mu\text{in}$ $0.39 \mu\text{in}/\text{in} + 8.5 \mu\text{in}$	Repeat-O-Meter Optodyne MCV-2002

Parameter/Equipment	Range	CMC ^{2,4,7} (±)	Comments
AC Current – Measure ³ (cont)			
100 mA	50 Hz to 10 kHz	76 µA/A	Fluke A40 shunts Fluke 792A Fluke 5790A Agilent 3458A
200 mA		49 µA/A	
300 mA		0.015 %	
500		0.013 %	
1 A		0.012 %	
2 A		0.012 %	
3 A		0.062 %	
5 A		0.062 %	
10 A		0.049 %	
20 A		0.049 %	
AC High Voltage – Measure ³	(1 to 70) kV	0.6 % + 0.58R	HP 34401A, Hallmark PVD100
AC Power – Generate ³ , 50 Hz to 1 kHz	100 W (0.1 to 3) kW	0.11 % 0.13 %	Fluke 5520A
AC Voltage – Generate ³			
(Up to 2.2) mV	(Up 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 (>1 to 2) MHz (>2 to 4) MHz (>4 to 10) MHz	0.041 % + 6.2 µV 0.042 % + 6.2 µV 0.041 % + 3.2 µV 0.041 % + 3.2 µV 0.048 % + 4.1 µV 0.058 % + 4.1 µV 0.062 % + 6.2 µV 0.13 % + 6.2 µV 0.24 % + 4.1 µV 0.41 % + 4.1 µV 0.41 % + 4.1 µV	Fluke 5720A Opt 03 Fluke 5790A
(>2.2 to 22) mV	(Up 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	61 µV/V + 5.8 µV 41 µV/V + 5.8 µV 41 µV/V + 2.3 µV 51 µV/V + 2.3 µV 85 µV/V + 3.5 µV 0.02 % + 5.8 µV 0.027 % + 12 µV	



Parameter/Equipment	Range	CMC ^{2,4,7} (±)	Comments
AC Voltage – Generate ³ (cont)			
(>2.2 to 22) mV	(>0.5 to 1) MHz (>1 to 2) MHz (>2 to 4) MHz (>4 to 10) MHz	0.042 % + 17 μV 0.12 % + 270 μV 0.13 % + 270 μV 0.24 % + 270 μV	Fluke 5720A opt 03 Fluke 5790A
(>22 to 220) mV	(Up 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 (>1 to 2) MHz (>2 to 4) MHz (>4 to 10) MHz	0.017 % + 23 μV 95 μV/V + 17 μV 24 μV/V + 2.4 μV 43 μV/V + 2.4 μV 77 μV/V + 2.4 μV 0.012 % + 4.7 μV 0.018 % + 12 μV 0.034 % + 23 μV 0.12 % + 5.5 μV 0.23 % + 5.5 μV 0.24 % + 5.5 μV	
(>0.22 to 2.2) V	(Up 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 (>1 to 2) MHz (>2 to 4) MHz (>4 to 10) MHz	0.018 % + 23 μV 93 μV/V + 18 μV 17 μV/V + 4.6 μV 25 μV/V + 7.2 μV 21 μV/V + 7.2 μV 79 μV/V + 12 μV 0.012 % + 23 μV 0.03 % + 58 μV 0.12 % + 5.5 μV 0.23 % + 3.6 μV 0.24 % + 3.9 μV	
(>2.2 to 22) V	(Up 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 (>1 to 2) MHz (>2 to 4) MHz (>4 to 10) MHz	95 μV/V + 25 μV 93 μV/V + 25 μV 18 μV/V + 20 μV 21 μV/V + 21 μV 24 μV/V + 21 μV 93 μV/V + 25 μV 0.012 % + 120 μV 0.03 % + 120 μV 0.12 % + 5.6 μV 0.24 % + 5.6 μV 0.24 % + 5.6 μV	



Parameter/Range	Frequency	CMC ^{2, 4, 7} (\pm)	Comments
AC Voltage – Generate ³ (cont)			
(>22 to 220) V	(Up 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	95 μ V/V + 240 μ V 94 μ V/V + 240 μ V 20 μ V/V + 190 μ V 24 μ V/V + 200 μ V 27 μ V/V + 200 μ V 0.09 % + 16 mV 0.44 % + 40 mV 0.8 % + 80 mV	Fluke 5720A Opt 03 Fluke 5790A
(>220 to 1100) V	(Up to 50) Hz >50 Hz to 1 kHz	0.018 % + 2 mV 37 μ V/V + 2 mV	Fluke 5720A opt 03 Fluke 5790A
AC Voltage – Measure ³			
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	0.2 % + 1.5 μ V 0.088 % + 1.5 μ V 0.052 % + 1.5 μ V 0.096 % + 2.3 μ V 0.14 % + 2.9 μ V 0.27 % + 4.6 μ V 0.28 % + 9.2 μ V 0.42 % + 9.2 μ V	Fluke 5790A
6 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	0.098 % + 1.5 μ V 0.043 % + 1.5 μ V 0.026 % + 1.5 μ V 0.047 % + 2.3 μ V 0.07 % + 2.9 μ V 0.14 % + 4.6 μ V 0.15 % + 9.2 μ V 0.27 % + 9.2 μ V	
20 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	0.034 % + 1.5 μ V 0.023 % + 1.5 μ V 0.013 % + 1.5 μ V 0.025 % + 2.3 μ V 0.036 % + 2.9 μ V 0.094 % + 4.6 μ V 0.1 % + 9.2 μ V 0.2 % + 9.2 μ V	

Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
AC Voltage – Measure ³ (cont)			
60 mV	(10 to 20) Hz	0.029 % + 1.7 μV	Fluke 5790A
	(20 to 40) Hz	0.015 % + 1.7 μV	
	40 Hz to 20 kHz	0.009 % + 1.7 μV	
	(20 to 50) kHz	0.016 % + 2.3 μV	
	(50 to 100) kHz	0.031 % + 2.9 μV	
	(100 to 300) kHz	0.061 % + 4.6 μV	
	(300 to 500) kHz	0.082 % + 9.2 μV	
200 mV	500 kHz to 1 MHz	0.13 % + 9.2 μV	
	(10 to 20) Hz	0.025 % + 1.7 μV	
	(20 to 40) Hz	0.01 % + 1.7 μV	
	40 Hz to 20 kHz	0.005 % + 1.7 μV	
	(20 to 50) kHz	0.008 % + 2.3 μV	
	(50 to 100) kHz	0.019 % + 2.9 μV	
	(100 to 300) kHz	0.03 % + 4.6 μV	
600 mV	(300 to 500) kHz	0.046 % + 9.2 μV	
	500 kHz to 1 MHz	0.12 % + 9.2 μV	
	(10 to 20) Hz	0.024 % + 1.8 μV	
	(20 to 40) Hz	0.01 % + 1.8 μV	
	40 Hz to 20 kHz	0.004 % + 1.8 μV	
	(20 to 50) kHz	0.007 % + 2.3 μV	
	(50 to 100) kHz	0.010 % + 2.9 μV	
2 V	(100 to 300) kHz	0.023 % + 4.6 μV	
	(300 to 500) kHz	0.035 % + 9.2 μV	
	500 kHz to 1 MHz	0.11 % + 9.2 μV	
	(10 to 20) Hz	0.023 % + 0.59 μV	
	(20 to 40) Hz	0.008 % + 0.59 μV	
	40 Hz to 20 kHz	0.003 % + 0.59 μV	
	(20 to 50) kHz	0.006 % + 0.59 μV	
6 V	(50 to 100) kHz	0.009 % + 0.59 μV	
	(100 to 300) kHz	0.021 % + 0.59 μV	
	(300 to 500) kHz	0.031 % + 0.59 μV	
	500 kHz to 1 MHz	0.11 % + 0.59 μV	
	(10 to 20) Hz	0.023 % + 0.59 μV	
	(20 to 40) Hz	0.008 % + 0.59 μV	
	40 Hz to 20 kHz	0.003 % + 0.59 μV	
	(20 to 50) kHz	0.006 % + 0.59 μV	
	(50 to 100) kHz	0.01 % + 0.59 μV	
	(100 to 300) kHz	0.094 % + 0.59 μV	
	(300 to 500) kHz	0.047 % + 0.59 μV	
	500 kHz to 1 MHz	0.14 % + 0.59 μV	



Parameter/Range	Frequency	CMC ^{2,4,7} (±)	Comments
AC Voltage – Measure ³ (cont)			
20 V	(10 to 20) Hz	0.023 % + 0.59 μV	Fluke 5790A
	(20 to 40) Hz	0.008 % + 0.59 μV	
	40 Hz to 20 kHz	0.004 % + 0.59 μV	
	(20 to 50) kHz	0.006 % + 0.59 μV	
	(50 to 100) kHz	0.01 % + 0.59 μV	
	(100 to 300) kHz	0.024 % + 0.59 μV	
	(300 to 500) kHz	0.047 % + 0.59 μV	
60 V	500 kHz to 1 MHz	0.14 % + 0.59 μV	
	(10 to 20) Hz	0.023 % + 5.8 μV	
	(20 to 40) Hz	0.009 % + 5.8 μV	
	40 Hz to 20 kHz	0.004 % + 5.8 μV	
	(20 to 50) kHz	0.008 % + 5.8 μV	
	(50 to 100) kHz	0.011 % + 5.8 μV	
	(100 to 300) kHz	0.024 % + 5.8 μV	
200 V	(300 to 500) kHz	0.047 % + 5.8 μV	
	500 kHz to 1 MHz	0.14 % + 5.8 μV	
	(10 to 20) Hz	0.023 % + 5.8 μV	
	(20 to 40) Hz	0.009 % + 5.8 μV	
	40 Hz to 20 kHz	0.004 % + 5.8 μV	
	(20 to 50) kHz	0.009 % + 5.8 μV	
	(50 to 100) kHz	0.012 % + 5.8 μV	
600 V	(100 to 300) kHz	0.024 % + 5.8 μV	
	(300 to 500) kHz	0.058 % + 5.8 μV	
	(10 to 20) Hz	0.023 % + 58 μV	
	(20 to 40) Hz	0.011 % + 58 μV	
	40 Hz to 20 kHz	0.006 % + 58 μV	
1000 V	(20 to 50) kHz	0.015 % + 58 μV	
	(50 to 100) kHz	0.058 % + 58 μV	
	(10 to 20) Hz	0.025 % + 58 μV	
	(20 to 40) Hz	0.013 % + 58 μV	
	40 Hz to 20 kHz	0.005 % + 58 μV	
	(20 to 50) kHz	0.016 % + 58 μV	
	(50 to 100) kHz	0.058 % + 58 μV	



Parameter/Equipment	Frequency	CMC ^{2, 4, 7} (±)	Comments
Capacitance – Generate ³	(0.19 to 0.3999) nF (0.4 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.9999) nF (11 to 32.9999) nF (33 to 109.9999) nF (110 to 329.999) nF (0.33 to 1.09999) μF (1.1 to 3.29999) μF (3.3 to 10.9999) μF (11 to 32.9999) μF (33 to 109.999) μF (110 to 329.999) μF (0.33 to 1.09999) mF (1.1 to 3.2999) mF (3.3 to 10.9999) mF (11 to 32.9999) mF (33 to 110) mF	1.0 % + 0.01 nF 0.74 % + 0.01 nF 0.82 % + 0.01 nF 0.32 % + 0.01 nF 0.6 % + 0.1 nF 0.32 % + 0.1 nF 0.3 % + 0.1 nF 0.34 % + 1.0 nF 0.49 % + 3.0 nF 0.32 % + 3.0 nF 0.51 % + 10 nF 0.55 % + 100 nF 0.67 % + 300 nF 0.54 % + 1 μF 0.56 % + 3 μF 0.54 % + 10 μF 0.9 % + 30 μF 1.3 % + 100 μF	Fluke 5520A
Capacitance – Generate ³ Fixed Points (0.1, 0.4, 1) kHz	10 pF 100 pF 1000 pF 10 nF 100 nF 1000 nF	0.016 % 0.01 % 6.5 μF/F 0.01 % 0.01 % 0.022 %	GenRad capacitors
Capacitance – Measure ³	10 pF 100 pF 400 pF 1600 pF 6.4 nF 25 nF 100 nF 400 nF 1600 nF 6 μF 25 μF 100 μF 1000 μF	0.0023 pF 0.023 pF 0.092 pF 0.37 pF 0.0015 nF 0.0058 nF 0.023 nF 0.093 nF 0.37 nF 0.0014 μF 0.0058 μF 0.024 μF 0.25 μF	GenRad 1693



Parameter/Equipment	Range	CMC ^{2, 4, 6, 7} (\pm)	Comments
DC Current – Clamp on Meters ³	(20 to 150) A (150 to 1000) A	0.3 % 0.3 %	Fluke 5520A/SC600 Fluke 5500A/Coil
DC Current – Generate ³	(Up to 220) μ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 22) mA (0.22 to 2.2) A (2.2 to 11) A (11 to 20) A (20 to 100) A	6.9 μ A/A + 1.2 nA 7 μ A/A + 5.8 nA 7.1 μ A/A + 58 nA 10 μ A/A + 0.35 μ A 11 μ A/A + 8.1 μ A 0.036 % + 480 μ A 1.4 mA/A + 0.53 mA 18 mA/A + 18 mA	Fluke 5720A HP 3458A Standard resistors Fluke 5725A Fluke 5520A Valhalla 2555A
DC Current – Measure ³	Up to 1 nA (>1 to 10) nA (>10 to 100) nA (>0.1 to 1) μ A (>1 to 10) μ A (>10 to 100) μ A (>0.1 to 1) mA (>1 to 10) mA (>10 to 100) mA (>0.1 to 1) A (>1 to 10) A (>10 to 100) A	18 μ A/A + 0.35 nA 13 μ A/A + 0.35 nA 7 μ A/A + 0.35 nA 7 μ A/A + 0.35 nA 7 μ A/A + 0.35 nA 7.3 μ A/A + 0.35 nA 8.1 μ A/A + 0.67 nA 7 μ A/A + 5.8 nA 6.7 μ A/A + 0.35 μ A 7.3 μ A/A + 0.67 μ A 13 μ A/A + 5.8 μ A 24 μ A/A + 0.35 μ A	HP 3458A Precision resistors
DC High Voltage – Measure ³	(1 to 100) kV	0.067 % + 0.58R	HP 34401A Hallmark PVD 100
DC Reference Calibration – Measure & Generate, Fixed Points	10 V Reference 1.018 V Reference 1.00 V Reference	0.25 μ V/V 0.82 μ V/V 0.82 μ V/V	Direct transfer techniques performed utilizing Fluke 732A

Parameter/Equipment	Range	CMC ^{2, 4, 5, 7} (\pm)	Comments
DC Resistance – Fixed Points	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω	12 $\mu\Omega/\Omega$ 1.2 $\mu\Omega/\Omega$ 0.68 $\mu\Omega/\Omega$ 0.67 $\mu\Omega/\Omega$ 0.67 $\mu\Omega/\Omega$ 0.95 $\mu\Omega/\Omega$ 1.2 $\mu\Omega/\Omega$ 1.1 $\mu\Omega/\Omega$ 1.6 $\mu\Omega/\Omega$ 2.2 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 64 $\mu\Omega/\Omega$ 0.30 % 0.24 % 0.17 % 0.23 %	L&N 4214, 10 k Ω L&N 4210, 1 Ω MI 6000A bridge MI 6010A bridge and L&N working standard resistors in oil bath. Specific values are those which fall within ± 50 parts in 10^6 of the nominal value. Resistors are normally calibrated in an oil bath at 25 $^\circ$ C. Guildline 6520
DC Resistance – Generate ³	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω (0.33 to 1.1) M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (0.11 to 1.1) G Ω	0.02 % + 10 m Ω 0.011 % + 15 m Ω 36 $\mu\Omega/\Omega$ + 15 m Ω 43 $\mu\Omega/\Omega$ + 20 m Ω 36 $\mu\Omega/\Omega$ + 20 m Ω 43 $\mu\Omega/\Omega$ + 200 m Ω 34 $\mu\Omega/\Omega$ + 100 m Ω 38 $\mu\Omega/\Omega$ + 1 Ω 35 $\mu\Omega/\Omega$ + 1 Ω 63 $\mu\Omega/\Omega$ + 10 Ω 29 $\mu\Omega/\Omega$ + 25 Ω 39 $\mu\Omega/\Omega$ + 330 Ω 0.013 % + 520 Ω 0.023 % + 5.2 k Ω 0.057 % + 6.2 k Ω 0.33 % + 200 k Ω 1.7 % + 1.0 M Ω	Fluke 5520A/SC600



Parameter/Equipment	Range	CMC ^{2, 4, 6, 7} (\pm)	Comments
DC Resistance – Measure ³	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω (100 to 1000) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω 100 G Ω to 1 T Ω	20 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 17 $\mu\Omega/\Omega$ + 0.5 m Ω 13 $\mu\Omega/\Omega$ + 0.5 m Ω 13 $\mu\Omega/\Omega$ + 5 m Ω 13 $\mu\Omega/\Omega$ + 50 m Ω 20 $\mu\Omega/\Omega$ + 2 Ω 68 $\mu\Omega/\Omega$ + 100 Ω 0.059 % + 1 k Ω 0.59 % + 10 k Ω 0.30 % 0.24 % 0.17 % 0.23 %	Agilent/HP 3458A OPT-2 within ± 5 °C of T _{CAL} with AutoCal Guildline 6520 Teraohmmeter
DC Voltage – Generate ³	(0 to 1) V (1 to 10) V (10 to 22) V (22 to 220) V (220 to 1100) V	0.19 $\mu\text{V}/\text{V}$ + 0.09 μV 0.2 $\mu\text{V}/\text{V}$ + 0.44 μV 4.7 $\mu\text{V}/\text{V}$ + 4.1 μV 1.4 $\mu\text{V}/\text{V}$ + 49 μV 1.6 $\mu\text{V}/\text{V}$ + 260 μV	Fluke 732A/Fluke 720A, Fluke 5700A
DC Voltage – Measure ³ 57xx & 55xx Series Calibrators	(0 to 1) V (1 to 10) V (10 to 1100) V 100 mV 1 V 10 V 100 V 1000 V	0.4 $\mu\text{V}/\text{V}$ + 0.39 μV 0.4 $\mu\text{V}/\text{V}$ + 1.8 μV 0.24 $\mu\text{V}/\text{V}$ + 0.55 μV 0.4 $\mu\text{V}/\text{V}$ + 0.28 μV 0.4 $\mu\text{V}/\text{V}$ + 0.35 μV 0.25 $\mu\text{V}/\text{V}$ + 2.1 μV 0.24 $\mu\text{V}/\text{V}$ + 1.5 μV 0.24 $\mu\text{V}/\text{V}$ + 1.5 μV	Fluke 732A/ Fluke 720A/ Agilent 34420A Fluke 732A/ Fluke 752A/ Agilent 34420A Agilent 3458A



Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Thermocouple Indicators and Indicating Systems ³ –			
Type E	-250 °C to -100 °C -100 °C to -25 °C 25 °C to 350 °C 350 °C to 650 °C 650 °C to 1000 °C	0.56 °C 0.2 °C 0.17 °C 0.2 °C 0.27 °C	Fluke 5520A
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to 150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.31 °C 0.2 °C 0.17 °C 0.19 °C 0.29 °C	
Type K	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.37 °C 0.21 °C 0.19 °C 0.31 °C 0.6 °C	
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.66 °C 0.27 °C 0.19 °C 0.22 °C	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
Fluke 5790A AC Measurement Standard –			
2 mV	10 Hz 20 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	0.043 % 0.034 % 0.037 % 0.031 % 0.032 % 0.033 % 0.031 % 0.043 % 0.051 % 0.063 % 0.074 %	Fluke 792A Agilent/HP 3458A



Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments		
Fluke 5790A AC Measurement Standard (cont) –	6 mV	10 Hz	0.022 %	Fluke 792A Agilent/HP 3458A	
		20 Hz	0.022 %		
		100 Hz	0.017 %		
		1 kHz	0.018 %		
		10 kHz	0.017 %		
		20 kHz	0.017 %		
		50 kHz	0.022 %		
		100 kHz	0.029 %		
		300 kHz	0.041 %		
		500 kHz	0.048 %		
		1 MHz	0.074 %		
		20 mV	10 Hz		82 μV/V
			20 Hz		68 μV/V
	100 Hz		81 μV/V		
	1 kHz		64 μV/V		
	10 kHz		73 μV/V		
	20 kHz		64 μV/V		
	50 kHz		91 μV/V		
	100 kHz		0.015 %		
	300 kHz		0.022 %		
	500 kHz		0.034 %		
	1 MHz		0.039 %		
	60 mV		10 Hz		52 μV/V
			20 Hz		41 μV/V
		100 Hz	36 μV/V		
		1 kHz	36 μV/V		
		10 kHz	31 μV/V		
		20 kHz	32 μV/V		
		50 kHz	41 μV/V		
		100 kHz	78 μV/V		
		300 kHz	0.015 %		
		500 kHz	0.022 %		
		1 MHz	0.029 %		



Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments	
Fluke 5790A AC Measurement Standard (cont) –	200 mV	10 Hz	37 μV/V	Fluke 792A Agilent/HP 3458A
		20 Hz	31 μV/V	
		100 Hz	26 μV/V	
		1 kHz	25 μV/V	
		10 kHz	28 μV/V	
		20 kHz	26 μV/V	
		50 kHz	31 μV/V	
		100 kHz	44 μV/V	
		300 kHz	79 μV/V	
		500 kHz	0.012 %	
	1 MHz	0.02 %		
	600 mV	10 Hz	34 μV/V	
		20 Hz	30 μV/V	
		100 Hz	23 μV/V	
		1 kHz	24 μV/V	
		10 kHz	28 μV/V	
		20 kHz	23 μV/V	
		50 kHz	23 μV/V	
		100 kHz	32 μV/V	
		300 kHz	40 μV/V	
		500 kHz	59 μV/V	
	1 MHz	92 μV/V		
	2 V	10 Hz	32 μV/V	
		20 Hz	28 μV/V	
		100 Hz	21 μV/V	
		1 kHz	20 μV/V	
		10 kHz	20 μV/V	
		20 kHz	21 μV/V	
		50 kHz	20 μV/V	
		100 kHz	22 μV/V	
		300 kHz	32 μV/V	
		500 kHz	37 μV/V	
	1 MHz	48 μV/V		



Parameter/Range	Frequency	CMC ^{2, 4, 6} (±)	Comments
Fluke 5790A AC Measurement Standard (cont) –			
6 V	10 Hz	36 μV/V	Fluke 792A Agilent/HP 3458A
	20 Hz	28 μV/V	
	100 Hz	21 μV/V	
	1 kHz	20 μV/V	
	10 kHz	21 μV/V	
	20 kHz	21 μV/V	
	50 kHz	21 μV/V	
	100 kHz	22 μV/V	
	300 kHz	28 μV/V	
	500 kHz	32 μV/V	
1 MHz	45 μV/V		
20 V	10 Hz	37 μV/V	
	20 Hz	29 μV/V	
	100 Hz	22 μV/V	
	1 kHz	21 μV/V	
	10 kHz	21 μV/V	
	20 kHz	21 μV/V	
	50 kHz	22 μV/V	
	100 kHz	23 μV/V	
	300 kHz	29 μV/V	
	500 kHz	33 μV/V	
60 V	10 Hz	37 μV/V	
	20 Hz	29 μV/V	
	100 Hz	22 μV/V	
	1 kHz	21 μV/V	
	10 kHz	21 μV/V	
	20 kHz	21 μV/V	
	50 kHz	23 μV/V	
	100 kHz	23 μV/V	
300 kHz	34 μV/V		



Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} (\pm)	Comments
Fluke 5790A AC Measurement Standard (cont) –			
200 V	10 Hz 20 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	48 μ V/V 33 μ V/V 27 μ V/V 26 μ V/V 26 μ V/V 26 μ V/V 27 μ V/V 29 μ V/V	Fluke 792A Agilent/HP 3458A
600 V	100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	31 μ V/V 28 μ V/V 28 μ V/V 28 μ V/V 37 μ V/V 46 μ V/V	
1000 V	100 Hz 1 kHz 10 kHz 20 kHz	32 μ V/V 31 μ V/V 31 μ V/V 32 μ V/V	
Inductance – Generate, Fixed Points ³	100 μ H 1 mH 10 mH 100 mH 1 H 10 H	0.11 % 0.03 % 0.03 % 0.03 % 0.05 % 0.21 %	GenRad 1452B GenRad 1482E GenRad 1482H GenRad 1482L GenRad 1482T
Inductance – Measure ³	100 μ H to 1 mH 1 mH to 1 H (1 to 5) H (5 to 10) H	0.12 % 0.035 % 0.014 % 0.25 %	GenRad 1693



Parameter/Range	Frequency	CMC ^{2,7} (\pm)	Comments
Oscilloscopes ³ –			
Level Sine Amp 50 kHz Ref.	5 mV to 5.0 V _(p-p)	3 % + 0.3 mV	Fluke 5520A/SC1100
Level Sine Flatness 5 mV to 5.5 V Relative to 50 kHz Ref.	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	2 % + 0.1 mV 2.5 % + 0.1 mV 4.5 % + 0.1 mV 5.5 % + 0.1 mV	
Square Wave 1 M Ω , 100 Hz 50 Ω , 1 kHz	1 mV to 150 V _(p-p) 1 mV to 6.6 V _(p-p)	0.2 % + 40 μ V 0.35 % + 40 μ V	
Time Marker Output Into 50 Ω	1 ns to 20 ms	5 μ s/s	
Rise Time – Generate	1 kHz to 2 MHz (200 to 300) ps	40 ps	
	(2 to 10) MHz (200 to 350) ps	59 ps	
Rise Time – Measure	1 kHz to 10 MHz (18 to 350) ps	11 ps	Agilent 86100A, 86105A
Phase Angle – Generate ³			
(0 to 360) °	(10 to 65) Hz (65 to 500) Hz >500 Hz to 1 kHz (>1 to 5) kHz (>5 to 10) kHz	0.14° 0.30° 0.59° 2.9° 5.8°	Fluke 5520A/SC600

Parameter/Range	Frequency	CMC ² (±)	Comments
Phase Angle – Measure			
Voltage: Voltage			
0° to 360°	5 Hz to 2 kHz	0.016°	Clark Hess 6000A
10 mV to 630 V	(>2 to 5) kHz	0.022°	
	(>5 to 10) kHz	0.024°	
	(>10 to 50) kHz	0.024°	
	(>50 to 200) kHz	0.15°	
Voltage: Current			
0° to 360°	5 Hz to 2 kHz	0.017°	Clark Hess 6000A, V = current shunt
10 mV to 630 V	(>2 to 5) kHz	0.023°	
	(>5 to 10) kHz	0.025°	
	(>10 to 50) kHz	0.025°	
	(>50 to 200) kHz	0.16°	

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ² (±)	Comments
RF Power – Generate ³			
(7 to 0) dBm	250 kHz to 2 GHz	0.7 dB	Agilent/HP E4432B
(<0 to -129) dBm		0.6 dB	
>10 dBm	<2 GHz	1.4 dB	Agilent/HP 83650B
(10 to -10) dBm		0.72 dB	
(<-10 to -60) dBm		1.1 dB	
(<-60 to -110) dBm		1.6 dB	
>10 dBm	(2 to 20) GHz	1.5 dB	
(10 to -10) dBm		0.83 dB	
(<-10 to -60) dBm		1.2 dB	
(<-60 to -110) dBm		1.74 dB	
(10 to -10) dBm	>20 to 40) GHz	1.1 dB	
(<-10 to -60) dBm		1.4 dB	
(<-60 to -110) dBm		2 dB	



Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
RF Power – Generate ³ (10 to -10) dBm (<-10 to -60) dBm (<-60 to -110) dBm	(>40 to 50) GHz	2 dB 2.3 dB 3 dB	Agilent/HP 83650B
RF Power – Measure ³ (-20 to +30) dBm (-20 to +30) dBm (-70 to 20) dBm	10 MHz to 2.6 GHz 50 MHz to 26.5 GHz (>26.5 to 40) GHz (>40 to 50) GHz	0.14 dB 0.36 dB 0.38 dB 0.63 dB	Agilent/HP 8902A with 11793A mixer and 11722a, 11792 A sensors Agilent 8487A/D w/ N1914A
Distortion – Measure ³ ≤ -80 dB ≤ -65 dB	< 20 Hz to 20 kHz (20 to 100) kHz	1.7 dB 2.3 dB	HP 8903B
Power Sensor Calibration Factor ³ – 1 mW	100 kHz 200 kHz 0.3 MHz to 2 GHz (>2 to 3.6) GHz (>3.6 to 4.6) GHz (>4.6 to 10) GHz (>10 to 12) GHz (>12 to 18) GHz (>18 to 22) GHz (>22 to 26) GHz 26.5 GHz 27 GHz 28 GHz 29 GHz 30 GHz 32 GHz 34 GHz 36 GHz	0.77 % 0.73 % 0.71 % 0.72 % 0.74 % 0.78 % 0.82 % 0.89 % 2.2 % 2.3 % 3.0 % 2.3 % 2.4 % 2.3 % 2.4 % 2.4 % 2.5 % 2.6 %	Tegam F1130B Tegam 1830A Agilent E8364A Tegam 2510A Tegam 1830A Agilent E8364A



Parameter/Range	Frequency	CMC ^{2,7} (\pm)	Comments
Power Sensor Calibration Factor ³ – (cont)			
1 mW	38 GHz 40 GHz 41 GHz 42 GHz 43 GHz 44 GHz 45 GHz 46 GHz 47 GHz 48 GHz 49 GHz 50 GHz	2.6 % 2.7 % 2.8 % 2.9 % 3.0 % 2.5 % 3.3 % 3.3 % 3.5 % 3.5 % 3.7 % 3.9 %	Tegam 2510A Tegam 1830A Agilent E8364A
RF Attenuation – Measure ³			
2.5 MHz to 1.3 GHz	(0 to -1) dB (-1 to -2) dB (-2 to -3) dB (-3 to -4) dB (-4 to -5) dB (-5 to -6) dB (-6 to -7) dB (-7 to -8) dB (-8 to -9) dB (-9 to -10) dB (-10 to -11) dB	0.072 dB 0.072 dB 0.073 dB 0.075 dB 0.072 dB 0.075 dB 0.074 dB 0.072 dB 0.073 dB 0.078 dB 0.077 dB	Agilent 8494B step attenuator & Agilent/HP 8902A measuring receiver
(>1.3 to 18) GHz	(0 to -1) dB (-1 to -2) dB (-2 to -3) dB (-3 to -4) dB (-4 to -5) dB (-5 to -6) dB (-6 to -7) dB (-7 to -8) dB (-8 to -9) dB (-9 to -10) dB (-10 to -11) dB	0.35 dB 0.48 dB 0.25 dB 0.67 dB 0.13 dB 0.27 dB 0.44 dB 0.54 dB 0.61 dB 0.64 dB 0.61 dB	



Parameter/Range	Frequency	CMC ² (±)	Comments
RF Attenuation – Measure ³ (cont)			
2.5 MHz to 1.3 GHz	(0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB (-100 to -110) dB	0.61 dB 0.83 dB 1.1 dB 1.4 dB 1.7 dB 2.1 dB 2.5 dB 2.8 dB 3.2 dB 3.5 dB 3.9 dB	Agilent 8496B step attenuator & Agilent/HP 8902A measuring receiver
(>1.3 to 18) GHz	(0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB (-100 to -110) dB	0.85 dB 0.83 dB 1.5 dB 1.9 dB 2.4 dB 2.8 dB 3.3 dB 3.8 dB 4.2 dB 4.7 dB 5.2 dB	
(>18 to 26.5) GHz	(0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB (-100 to -110) dB	0.98 dB 0.10 dB 0.11 dB 0.12 dB 0.14 dB 0.16 dB 0.18 dB 0.21 dB 0.23 dB 0.25 dB 0.34 dB	HP 8902A measuring receiver w/11792A sensor and 11793A microwave converter
(>26.5 to 40) GHz	(0 to -30) dB (-30 to -70) dB	0.42 dB 0.72 dB	Agilent 8487A Power Sensor w/ N1914A
(>40 to 50) GHz	(0 to -30) dB (-30 to -70) dB	0.74 dB 1.1 dB	Agilent 8487D Power Sensor w/N1914A



Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
<p>Amplitude Modulation – Measure³</p> <p>Rate: 50 Hz to 10 kHz Depths: (5 to 99) %</p> <p>Rate: 20 Hz to 10 kHz Depths: Up to 99 %</p> <p>Rate: 50 Hz to 50 kHz Depths: (5 to 99) %</p> <p>Rate: 20 Hz to 100 kHz Depths: Up to 99 %</p> <p>Rate: 50 Hz to 50 kHz Depths: (5 to 99) %</p> <p>Rate: 20 Hz to 100 kHz Depths: Up to 99 %</p>	<p>150 kHz to 10 MHz</p> <p>>10 MHz to 1.3 GHz</p> <p>(>1.3 to 26.5) GHz</p>	<p>2.5 % + 1 digit</p> <p>3.6 % + 1 digit</p> <p>1.5 % + 1 digit</p> <p>3.6 % + 1 digit</p> <p>1.9 % + 1 digit</p> <p>3.5 % + 1 digit</p>	<p>Agilent/HP 8902A measuring receiver with 11722A sensor and 11793A mixer</p> <p>plus Agilent/HP 11793A mixer</p>
<p>Amplitude Modulation – Generate³</p> <p>50 Hz to 50 kHz <95 %</p> <p>50 Hz to 50 kHz <99 %</p> <p>20 Hz to 100 kHz <95 %</p> <p>20 Hz to 100 kHz <99 %</p> <p>20 Hz to 10 MHz <95 %</p> <p>20 Hz to 10 MHz <99 %</p>	<p>(11 to 13.5) MHz</p>	<p>0.27 %</p> <p>0.31 %</p> <p>0.36 %</p> <p>0.42 %</p> <p>2.9 %</p> <p>2.9 %</p>	<p>HP 11715A</p>
<p>Frequency Modulation – Measure³</p> <p>Rate: 20 Hz to 10 kHz Dev.: ≤40 kHz peak</p> <p>Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak</p> <p>Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak</p> <p>Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak</p>	<p>(0.25 to 10) MHz</p> <p>(10 to 1300) MHz</p> <p>(10 to 1300) MHz</p> <p>(10 to 26 500) MHz</p>	<p>2.3 % + 1 digit</p> <p>1.2 % + 1 digit</p> <p>5.8 % + 1 digit</p> <p>1.2 % + 1 digit</p>	<p>Agilent/HP 8902A with 11722A and 11792A sensors</p> <p>plus Agilent/HP 11793A mixer</p>



Parameter/Range	Frequency	CMC ² (\pm)	Comments
Frequency Modulation – Measure ³ (cont) Rate: 20 Hz to 200 kHz Dev.: \leq 400 kHz peak	(10 to 26 500) MHz	5.8 % + 1 digit	Agilent/HP 8902A with 11722A and 11792A sensors
Frequency Modulation – Generate ³ DC to 100 kHz Rates DC to 200 kHz Rates DC to 10 MHz Rates	(11 to 432) MHz	0.21 % + 1 digit 0.32 % + 1 digit 2.9 % + 1 digit	HP 11715A
Reflection S ₁₁ /S ₂₂ -Measure ¹⁰ (0.0 to 0.2) lin (>0.2 to 0.4) lin (>0.4 to 0.6) lin (>0.6 to 0.8) lin (>0.8 to 1.0) lin (0.0 to 0.2) lin (>0.2 to 0.4) lin (>0.4 to 0.6) lin (>0.6 to 0.8) lin	10 MHz to 18 GHz 10 MHz to 26.5 GHz	0.0081 to +0.0082) lin (180 to 2.3) ° (0.0082 to +0.0091) lin (2.3 to 1.3) ° (0.0091 to +0.012) lin (1.3 to 1.1) ° (0.012 to +0.018) lin (1.1 to 1.3) ° (0.018 to +0.026) lin (1.3 to 1.5) ° (0.0064 to +0.0066) lin (180 to 1.9) ° (0.0066 to +0.0081) lin (1.9 to 1.2) ° (0.0081 to +0.013) lin (1.2 to 1.3) ° (0.013 to +0.020) lin (1.2 to 1.4) °	Agilent E8364B W/ HP 85054A Type-N Agilent E8364B W/ HP 85052A 3.5mm



Parameter/Range	Frequency	CMC ² (±)	Comments
Reflection S ₁₁ /S ₂₂ - Measure ¹⁰ (cont)			
(>0.8 to 1.0) lin	10 MHz to 26.5 GHz	(0.020 to +0.030) lin (1.4 to 1.7) °	Agilent E8364B w/ HP 85052A 3.5 mm
(0.0 to 0.6) lin	10 MHz to 50 GHz	(0.017 to +0.020) lin (180 to 1.8) °	
(>0.6 to 0.8) lin	10 MHz to 50 GHz	(0.020 to +0.025) lin (1.8 to 1.7) °	Agilent E8364B w/ HP 85056B 2.4 mm
(>0.8 to 1.0) lin	10 MHz to 50 GHz	(0.025 to +0.033) lin (1.7 to 1.9) °	

IV. Mechanical

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Tensiometer/Force – Measuring Equipment ³	Up to 1000 lbf	0.021 % + 0.58R	Class F weights
Scales & Balances – Fixed Points ^{3,8}	10.0 mg 100.0 mg 1000.0 mg 10.0 g 100.0 g 1000.0 g 10.0 kg 30.0 kg	5 µg + 0.6R 5 µg + 0.6R 5.3 µg + 0.6R 53 µg + 0.6R 220 µg + 0.6R 3.5 mg + 0.6R 420 mg + 0.6R 420 mg + 0.6R	Class 1 weight sets
Pressure, Absolute – Measuring Equipment ³	(>8 to 380) kPa (>380 to 1900) kPa (>1900 to 7600) kPa (>7600 to 69 000) kPa	0.0012 % + 1.6 Pa 0.0014 % + 6 Pa 0.002 % + 3.5 Pa 0.013 % + 7.1 kPa	DHI FPG8601 DHI PG7601 w/ DHI PC-7100/7600 DHI RPM4 A100Ms/A20Ms



Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
POVA (Piston Operated Volumetric Apparatus) – Pipettes, Syringes, Burettes, Liquid Handlers, Dispensers	(1 to 10) µL (10 to 100) µL (100 to 1000) µL (1000 to 5000) µL (>5000 to 50 000) µL	0.048 µL/L + 0.064 µL 0.28 µL/L + 0.17 µL 0.28 µL/L + 2.0 µL 0.28 µL/L + 3.0 µL 0.29 µL/L + 4.9 µL	Gravimetric calibration referenced to mass balances and ASTM Class 1 mass standards
Torque Wrenches ³	(5 to 50) in·ozf (1 to 10) in·lbf (10 to 100) in·lbf (>100 to 1000) in·lbf (100 to 1000) ft·lbf	0.8 % + 0.58R 0.77 % + 0.58R 0.77 % + 0.58R 0.77 % + 0.58R 0.77 % + 0.58R	Hios HP-10 A.K.O. TSD 6000 w/ TSD-011 TSD-111 TSD-1011
Torque Transducers ³	(1 to 160) in·ozf (10 to 100) in·lbf (10 to 100) ft·lbf (100 to 1000) ft·lbf	0.027 % 0.023 % 0.023 % 0.023 %	Calibration arms & Class F weights
Mass – Measure	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg 30 kg	9.3 µg 9.4 µg 9.6 µg 5.2 µg 5.4 µg 5.7 µg 6.0 µg 6.0 µg 8.9 µg 9.5 µg 18 µg 18 µg 43 µg 56 µg 88 µg 140 µg 0.32 mg 8.7 mg 11 mg 11 mg 22 mg 35 mg 54 mg 51 mg	Mettler-Toledo MX5 Sartorius ME-215S Sartorius CC30001 Class 1 Mass Weight set using double substitution method



Parameter/Equipment	Range	CMC ^{2,7,9} (\pm)	Comments
RPM – Measure ³	(0 to 50) rpm (>50 to 500) rpm (>500 to 5000) rpm (>5000 to 40 000) rpm	0.016 rmp + 0.58R 0.19 rmp + 0.58R 1.6 rmp + 0.58R 13 rmp + 0.58R	Ametek 1726 tachometer

V. Optical Quantities

Parameter/Equipment ⁴	Range	CMC ² (\pm)	Comments
Fiber Optic Power – Measure ³			
Absolute Power (850 to 1650) nm	(-50 to 10) dBm	0.56 % + 0.016 dB	Agilent 8163A Agilent 81618A Agilent 81623B
Relative Power (850 to 1550) nm	(-60 to 0) dBm	0.3 % + 0.009 dB	
Fiber Optic Power – Generate ³			
850 nm 1310 nm 1550 nm 1625 nm	Up to 20 mW Up to 20 mW Up to 20 mW Up to 20 mW	20 μ W/W + 2.8 μ W 5.3 μ W/W + 1.4 μ W 5.3 μ W/W + 2.7 μ W 5.3 μ W/W + 2.7 μ W	Agilent 81652A Agilent 81551MM Agilent 81655A
Fiber Optic Wavelength – Measure ³	(600 to 1700) nm	0.004 nm	Agilent 86120C/86142B
Fiber Optic Wavelength – Generate ³	(1528 to 1563) nm	0.0017 nm	NIST SRM 2517a
Pyranometers	(Up to 1400) μ V/W/m ²	2.2 μ V/W/m ²	Eppley PSP Fluke Hydra

Parameter/Equipment ⁴	Range	CMC ² (±)	Comments
Spectral Irradiance UV-A, (315 to 400) nm	Up to 45 mW/cm ²	6 % + 0.58R	Laser Probe RS-5900 Laser Probe RSP-590 Laser ProbeCTX-515 DUV-NUV source

VI. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Direct Measurement by Comparison	-196 °C	4.9 mK	ASL F700 Bridge, Tinsley 25 Ω resistor, 162CE sPRT
	(-80 to 250) °C	11 mK	Comparison in liquid baths with 162CE sPRT and F700 bridge
	(>250 to 660) °C	5.2 mK	Comparison in 3 zone dry block with 162CE and F700 bridge
Temperature – Fixed Point Cells			
Mercury	-38.8344 °C	1.7 mK	ASL F700 Bridge Tinsley 25Ω resistor
Triple point of H ₂ O	0.010 °C	1.2 mK	
Gallium	29.7646 °C	1.5 mK	
Indium	156.5985 °C	1.7 mK	
Tin	231.9280 °C	2.1 mK	
Zinc	419.5270 °C	3.3 mK	
Aluminum	660.3230 °C	5.5 mK	
Infrared Thermometers ³	Up to 100 °C (100 to 300) °C (300 to 500) °C	0.6 °C 0.8 °C 1.1 °C	Fluke 9132

Parameter/Equipment	Range	CMC ² (±)	Comments
Humidity – Measure ³	(0 to 100) % RH	1 % RH	Vaisala HM70
Humidity – Measuring Equipment	(10 to 95) % RH	0.51 % RH	Thunder Scientific 2500

VII. Time & Frequency

Parameter/Equipment	Range ⁴	CMC ^{2, 7} (±)	Comments
Frequency – Measuring Equipment	10 MHz	5 parts in 10 ¹² Hz/Hz	Fluke 910 GPS controlled frequency standard
Frequency – Measure	DC to 225 MHz 225 MHz to 26.5 GHz (26.5 to 50) GHz	1.5 X 10 ⁻⁹ Hz/Hz + 0.58R 5 X 10 ⁻¹² Hz/Hz + 1.3 Hz 5 X 10 ⁻¹² Hz/Hz + 12 Hz	GPS Receiver w/: 53132A Counter 5351B Counter 8565E Analyzer
Timers/Stopwatches ³	Up to 24 hr	70 ms	Fluke 910R GPS controlled rubidium frequency standard

VIII. Chemical Quantities

Parameter/Equipment	Range ⁴	CMC ² (±)	Comments
pH Meters ³ – Three-point Calibration	4.000 pH 7.000 pH 10.000 pH	0.016 pH 0.016 pH 0.016 pH	Standard solutions



¹ This laboratory offers commercial and field calibration services.

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. CMCs 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 stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

⁵ Based on using the standard at the temperature the Fluke 5520A with SC600 was calibrated ($t_{cal} \pm 5 \text{ }^\circ\text{C}$) and assuming the instrument is zeroed at least every seven days or when the ambient temperature changes more than $5 \text{ }^\circ\text{C}$. For resistance, a zero calibration is performed at least every 12 hours within $\pm 1 \text{ }^\circ\text{C}$ of use.

⁶ Based on using the standard at the temperature the HP 3458A was calibrated ($t_{cal} \pm 5 \text{ }^\circ\text{C}$) and an auto-calibration (ACAL) was performed within the previous 24 hours ($\pm 1 \text{ }^\circ\text{C}$ of ambient temperature).

⁷ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches, R is the numerical value of the resolution of the device. In the statement of CMC, the value is defined as the percentage of reading.

⁸ In the statement of CMC, decade or cardinal values shown. Other values can be obtained using substitution method with uncertainty increased by a multiple for each substitution.



Accredited Laboratory

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SIMCO ELECTRONICS

Santa Clara, CA

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/NCSLI Z540-1-1994 and the requirements of ANSI/NCSLI Z540.3-2006 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 8 January 2009*).



Presented this 20th day of November 2017.

A handwritten signature in black ink, written over a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 1395.17
Valid to September 30, 2019

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