



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

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CALIBRATION

Valid To: August 31, 2013

Certificate Number: 2044.01

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 ^{2,4} (±)	Comments
Dial Indicators ³	(0 to 1) in	60 μin	Comparison to gage blocks
Micrometers ³	(0 to 36) in	(4 + 8L + 0.6R) μin	Comparison to gage blocks
Calipers ³	(0 to 36) in	(4 + 8L + 0.6R) μin	Comparison to gage blocks
Go/No-Go Gauges ³	(0 to 1) in	22 μin	Pratt & Whitney Model C Supermicrometer ^{TM 10} , compared to gage blocks

II. Electrical – DC & Low Frequency

Parameter/Equipment	Range	CMC ^{2,5,6} (±)	Comments
DC Voltage – Measure	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1000) V	4.5 $\mu\text{V}/\text{V} + 0.1 \mu\text{V}$ 3 $\mu\text{V}/\text{V} + 0.4 \mu\text{V}$ 3 $\mu\text{V}/\text{V} + 4 \mu\text{V}$ 4.5 $\mu\text{V}/\text{V} + 40 \mu\text{V}$ 4.5 $\mu\text{V}/\text{V} + 500 \mu\text{V}$	Fluke 8508A
Fixed Points	10 V Reference	8.4 μV	Standard cell intercomparison to Fluke 732B
DC High Voltage – Generate & Measure ³	(1 to 100) kV	0.02 %	Julie HVA-100 with Agilent 3458A
DC Voltage – Generate	(0 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	7.5 $\mu\text{V}/\text{V} + 0.4 \mu\text{V}$ 5 $\mu\text{V}/\text{V} + 0.7 \mu\text{V}$ 3.5 $\mu\text{V}/\text{V} + 2.5 \mu\text{V}$ 3.5 $\mu\text{V}/\text{V} + 4 \mu\text{V}$ 5 $\mu\text{V}/\text{V} + 40 \mu\text{V}$ 6.5 $\mu\text{V}/\text{V} + 400 \mu\text{V}$	Fluke 5700A/EP
DC Voltage – Generate & Measure, Fixed Points	0.1 V 1 V 10 V 100 V 1000 V	3.5 $\mu\text{V}/\text{V}$ 2.1 $\mu\text{V}/\text{V}$ 2.1 $\mu\text{V}/\text{V}$ 2.1 $\mu\text{V}/\text{V}$ 2.1 $\mu\text{V}/\text{V}$	Ratiometric measurement techniques performed utilizing the Fluke 732B and 752A
DC Current – Measure	(0 to 200) μA 200 μA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	12 $\mu\text{A}/\text{A} + 0.4 \text{nA}$ 12 $\mu\text{A}/\text{A} + 4 \text{nA}$ 13 $\mu\text{A}/\text{A} + 40 \text{nA}$ 36 $\mu\text{A}/\text{A} + 800 \text{nA}$ 0.017 % + 16 μA 0.038 % + 400 μA	Fluke 8508A
DC Current – Generate	(0 to 220) μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	40 $\mu\text{A}/\text{A} + 6 \text{nA}$ 35 $\mu\text{A}/\text{A} + 7 \text{nA}$ 35 $\mu\text{A}/\text{A} + 40 \text{nA}$ 45 $\mu\text{A}/\text{A} + 0.7 \mu\text{A}$ 80 $\mu\text{A}/\text{A} + 12 \mu\text{A}$ 0.036 % + 480 μA	Fluke 5700A/EP with 5725A

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
DC Current – Generate & Measure	(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	0.011 % 15 μ A/A 11 μ A/A 5 μ A/A 7 μ A/A 8.5 μ A/A 35 μ A/A	Standard resistors and long scale voltmeter
Resistance – Generate & Measure	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (100 to 1000) Ω (1 to 10) k Ω (10 to 100) k Ω (100 to 1000) k Ω (1 to 10) M Ω (10 to 100) M Ω (>100 to 200) M Ω (200 to <1000) M Ω (>1 to 2) G Ω (>2 to 9) G Ω (9 to 90) G Ω (90 to 900) G Ω 900 G Ω to 1 T Ω	0.85 $\mu\Omega/\Omega$ 0.8 $\mu\Omega/\Omega$ 0.85 $\mu\Omega/\Omega$ 0.9 $\mu\Omega/\Omega$ 0.95 $\mu\Omega/\Omega$ 0.95 $\mu\Omega/\Omega$ 0.75 $\mu\Omega/\Omega$ 1 $\mu\Omega/\Omega$ 3 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 60 $\mu\Omega/\Omega$ + 1 k Ω 0.015 % + 100 k Ω 0.015 % + 100 k Ω 0.058 % of reading + 100 k Ω 0.081 % of reading + 1 M Ω 0.12 % of reading + 5 M Ω 0.23 % of reading + 400 M Ω	MI 6010 bridge and working standard resistors MI 6000 bridge and working standard resistors Fluke 8508A Fluke 8508A Guildline 9520
Fixed Point	1 G Ω	0.011 %	SR1 10 M Ω , 3458A and 5700A

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
AC Resistance – Measure ³ (0.01 to 0.1) Ω (0.1 to 25 000) Ω (26 to 2000) k Ω (2 to 20) M Ω	(0.03 to 10) kHz (0.012 to 100) kHz (0.012 to 20) kHz (0.012 to 1) kHz	0.73 % of reading 0.03 % of reading 0.03 % of reading 0.1 % of reading	Quad Tech 1689

Parameter/Equipment	Range	CMC ² (±)	Comments
Resistance – Generate, Fixed Points	0.0 Ω	40 μΩ	Fluke 5700A/EP
	1 Ω	95 μΩ/Ω	
	1.9 Ω	95 μΩ/Ω	
	10 Ω	23 μΩ/Ω	
	19 Ω	23 μΩ/Ω	
	100 Ω	10 μΩ/Ω	
	190 Ω	10 μΩ/Ω	
	1 kΩ	8.5 μΩ/Ω	
	1.9 kΩ	8.5 μΩ/Ω	
	10 kΩ	8.5 μΩ/Ω	
	19 kΩ	8.5 μΩ/Ω	
	100 kΩ	11 μΩ/Ω	
	190 kΩ	11 μΩ/Ω	
	1 MΩ	20 μΩ/Ω	
	1.9 MΩ	21 μΩ/Ω	
	10 MΩ	40 μΩ/Ω	
19 MΩ	47 μΩ/Ω		
100 MΩ	100 μΩ/Ω		

Parameter/Range	Frequency	CMC ^{2, 6, 7} (±)	Comments
AC Voltage – Measure			
(1 to 12) mV	(1 to 10) Hz	0.03 % + 3 μV	HP 3458A
(12 to 120) mV	(1 to 10) Hz	72 μV/V + 4 μV	
120 mV to 1.2 V	(1 to 10) Hz	72 μV/V + 40 μV	
(1.2 to 12) V	(1 to 10) Hz	72 μV/V + 0.4 mV	
(12 to 120) V	(1 to 10) Hz	0.02 % + 4 mV	
(120 to 700) V	(1 to 10) Hz	0.04 % + 40 mV	
600 μV 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	0.17 % + 1.3 μV 0.074 % + 1.3 μV 0.042 % + 1.3 μV 0.081 % + 2 μV 0.12 % + 2.5 μV 0.23 % + 4 μV 0.24 % + 8 μV	Fluke 5790A/03
Flatness –	500 kHz to 1.2 MHz	0.07 % + 1 μV	
500 kHz to 30 MHz	(1.2 to 2) MHz	0.07 % + 1 μV	
(Relative to 1 kHz)	(2 to 10) MHz	0.17 % + 1 μV	
	(10 to 20) MHz	0.3 % + 1 μV	
	(20 to 30) MHz	0.7 % + 2 μV	

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Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage – Measure (cont)			
(2.2 to 7) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.085 % + 1.3 μV 0.037 % + 1.3 μV 0.021 % + 1.3 μV 0.04 % + 2 μV 0.06 % + 2.5 μV 0.12 % + 4 μV 0.13 % + 8 μV	Fluke 5790A/03
Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % + 1 μV 0.07 % + 1 μV 0.1 % + 1 μV 0.17 % + 1 μV 0.37 % + 1 μV	
(7 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.029 % + 1.3 μV 0.019 % + 1.3 μV 0.011 % + 1.3 μV 0.021 % + 2 μV 0.031 % + 2.5 μV 0.81 % + 4 μV 0.089 % + 8 μV	
Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % 0.07 % 0.1 % 0.17 % 0.37 %	
(22 to 70) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.024 % + 1.5 μV 0.012 % + 1.5 μV 65 μV/V + 1.5 μV 0.013 % + 2 μV 0.026 % + 2.5 μV 0.051 % + 4 μV 0.067 % + 8 μV	
Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 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	0.021 % 82 μV/V 34 μV/V 67 μV/V 0.016 % + 2.5 μV 0.025 % + 4 μV 0.038 % + 8 μV	

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Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage – Measure (cont)			
Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.05 % 0.1 % 0.15 % 0.35 %	Fluke 5790A/03
(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	0.021 % 73 µV/V 27 µV/V 47 µV/V 79 µV/V + 2.5 µV 0.018 % + 4 µV 0.03 % + 8 µV	
Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.05 % 0.1 % 0.15 % 0.35 %	
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	0.02 % 63 µV/V 18 µV/V 43 µV/V 71 µV/V 0.016 % 0.026 %	
Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 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 % 63 µV/V 18 µV/V 44 µV/V 81 µV/V 0.019 % 0.04 %	

Parameter/Range	Frequency	CMC ^{2, 6, 7} (±)	Comments
AC Voltage – Measure (cont)			
Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.05 % 0.1 % 0.15 % 0.35 %	Fluke 5790A/03
(7 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.02 % 63 µV/V 21 µV/V 44 µV/V 81 µV/V 0.019 % 0.04 % 0.12 %	
(22 to 70) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.02 % 63 µV/V 25 µV/V 55 µV/V 94 µV/V 0.02 % 0.041 % 0.12 %	
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.02 % 63 µV/V 23 µV/V 63 µV/V 98 µV/V 0.021 % 0.05 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 92 µV/V 36 µV/V 0.013 % 0.05 %	
(700 to 1000) V	(20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	92 µV/V 33 µV/V 0.013 % 0.05 %	
AC High Voltage – Generate & Measure (60 Hz Only) ³	(1 to 100) kV	0.14 %	

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Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage – Generate			Fluke 5700A/EP
(0.22 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	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 5 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 20 μV	
(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 500 kHz to 1 MHz	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 5 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 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 500 kHz to 1 MHz	0.024 % + 12 μV 90 μV/V + 7 μV 80 μV/V + 7 μV 0.02 % + 7 μV 0.046 % + 17 μV 0.09 % + 20 μV 0.14 % + 25 μV 0.27 % + 45 μV	
220 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	0.024 % + 40 μV 90 μV/V + 15 μV 45 μV/V + 8 μV 75 μV/V + 10 μV 0.011 % + 30 μV 0.042 % + 80 μV 0.1 % + 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 500 kHz to 1 MHz	0.024 % + 400 μV 90 μV/V + 150 μV 45 μV/V + 50 μV 75 μV/V + 100 μV 0.01 % + 200 μV 0.028 % + 600 μV 0.1 % + 2000 μV 0.15 % + 3200 μV	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage – Generate (cont)			
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.024 % + 4 mV 90 µV/V + 1.5 mV 52 µV/V + 0.6 mV 80 µV/V + 1 mV 0.015 % + 2.5 mV 0.09 % + 16 mV 0.44 % + 40 mV 0.8 % + 80 mV	Fluke 5700A/EP
(220 to 250) V	(15 to 50) Hz	0.03 % + 16 mV	
(220 to 1100) V	50 Hz to 1 kHz 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	70 µV/V + 3.5 mV 90 µV/V + 4 mV 0.017 % + 6 mV 0.06 % + 11 mV	w/ 5725A Amplifier w/ 5725A Amplifier w/ 5725A Amplifier
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.06 % + 11 mV 0.23 % + 45 mV	w/ 5725A Amplifier w/ 5725A Amplifier
AC Current – Generate & Measure			
(0.1 to 1) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz	0.022 % 0.013 % 90 µA/A	Fluke 5700AEP, 5790A and Holt HCS-1 current shunts
(1 to 100) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz	0.018 % 78 µA/A 60 µA/A	
(0.1 to 1) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz	0.018 % 80 µA/A 60 µA/A 75 µA/A	
(1 to 2) A	40 Hz to 1 kHz (1 to 10) kHz	85 µA/A 0.012 %	
(2 to 10) A	40 Hz to 10 kHz	0.013 %	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Current – Measure ³			
(0 to 200) µA	10 Hz to 10 kHz	0.048 % + 20 nA	Fluke 8508A
200 µA to 2 mA	10 Hz to 10 kHz	0.028 % + 200 nA	
(2 to 20) mA	10 Hz to 10 kHz	0.028 % + 2 µA	
(20 to 200) mA	10 Hz to 10 kHz	0.025 % + 20 µA	
200 mA to 2 A	10 Hz to 2 kHz (2 to 10) kHz	0.061 % + 200 µA 0.071 % + 200 µA	
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.08 % + 2 mA 0.25 % + 2 mA	
AC Current – Generate			
(10 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 5700A/EP
(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 0.11 % + 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 % + 5000 nA	

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
AC Current – Generate (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	0.025 % + 4 µA 0.016 % + 3.5 µA 0.012 % + 2.5 µA 0.02 % + 3.5 µA 0.11 % + 10 µA	Fluke 5700A/EP
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.026 % + 35 µA 0.045 % + 80 µA 0.70 % + 160 µA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.046 % + 170 µA 0.095 % + 380 µA 0.36 % + 750 µA	with 5725A amplifier
Capacitance – Measure ³			
(10 to 100) pF (100 to 1000) pF 1 nF to 1.6 µF	(0.1 to 20) kHz (0.1 to 100) kHz (0.012 to 100) kHz	0.06 % of reading 0.03 % of reading 0.03 % of reading	Quad Tech 1689

Parameter/Equipment	Range	CMC ^{2, 8} (±)	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 109.999) 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 109.9999) µF (110 to 329.9999) 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	0.5 % + 0.01 nF 0.5 % + 0.01 nF 0.5 % + 0.01 nF 0.25 % + 0.01 nF 0.25 % + 0.1 nF 0.25 % + 0.1 nF 0.25 % + 0.3 nF 0.25 % + 1 nF 0.25 % + 3 nF 0.25 % + 10 nF 0.4 % + 30 nF 0.45 % + 100 nF 0.45 % + 300 nF 0.45 % + 1 µF 0.45 % + 3 µF 0.45 % + 10 µF 0.75 % + 30 µF 1.1 % + 100 µF	Fluke 5520A

Parameter/Range	Frequency	CMC ² (±)	Comments
Inductance – Measure ³ (@ 1 kHz) (0.01 to 0.1) mH (0.1 to 1) mH (1 to 16) mH (16 to 40) mH (40 to 100) mH (0.1 to 20) H	(0.3 to 100) kHz (0.03 to 100) kHz (0.012 to 100) kHz (0.012 to 30) kHz (0.012 to 10) kHz (0.012 to 5) kHz	0.13 % of reading 0.05 % of reading 0.05 % of reading 0.05 % of reading 0.05 % of reading 0.03 % of reading	Quad Tech 1689
Phase ³ – Generate 50 mV to 1 V (1 to 100) V (100 to 120) V (Voltage & Current)	1 Hz to 1 kHz (1 to 6.25) kHz (6.25 to 50) kHz (50 to 100) kHz 1 Hz to 1 kHz (1 to 6.25) kHz (6.25 to 50) kHz (50 to 100) kHz 1 Hz to 1 kHz (1 to 6.25) kHz (6.25 to 50) kHz (50 to 100) kHz (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.0073° 0.012° 0.016° 0.041° 0.0051° 0.011° 0.016° 0.041° 0.011° 0.022° 0.016° 0.081° 0.1 ° 0.25 ° 0.5 ° 2.5 ° 5 ° 10 °	Clarke Hess 5500 Fluke 5520A
Phase ³ – Measure (0.01 to 0.032) V (0.032 to 100) V (100 to 320) V (Voltage to Current)	1 Hz to 10 kHz (10 to 50) kHz (1 to 10) Hz 10 Hz to 50 kHz (1 to 10) Hz 10 Hz to 5 kHz (20 to 500) Hz	0.2° 0.35° 0.1° 0.05° 0.2° 0.1° 0.05°	Krohn-Hite 6610 or 6620 Arbiter 931A

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Devices ³ –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	Fluke 5520A
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	
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 -30) °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 0.4 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °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 0.4 °C	

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Electrical Calibration of Thermocouple Devices ³ – (cont)			
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	Fluke 5520A
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	
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	
Oscilloscope ³ –			
50 Ω load	DC	0.25 % of output + 40 μV	Fluke 5520A/SC600
1 MΩ load	DC	0.05 % of output + 40 μV	
Squarewave Signal			
50 Ω at 1 kHz	1.8 mV to 2.2 V _{pk-pk}	0.25 % of output + 40 μV	
1 MΩ 10 Hz to 1 kHz	1.8 mV to 105 V _{pk-pk}	0.1 % of output + 40 μV	
1 MΩ (1 to 10) kHz	1.8 mV to 105 V _{pk-pk}	0.25 % of output + 40 μV	
Level Sine Wave			
Amplitude (50 kHz reference)	50 kHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2 % + 300 μV 3.5 % + 300 μV 4 % + 300 μV 6 % + 300 μV	
Flatness (50 kHz reference)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.5 % + 100 μV 2 % + 100 μV 4 % + 100 μV	
Time Markers – Source and Period into a 50 Ω load	5 s to 50 ms 20 ms to 2 ns	(25 + 1000 <i>t</i>) parts in 10 ⁶ 2.5 parts in 10 ⁶	<i>t</i> is the time in seconds

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Oscilloscope ³ – (cont)			
Rise Time –			Fluke 5520A/SC600
≤ 2 MHz	≤300 ps	+ 0 ps / -100 ps	
> 2 MHz	≤350 ps	+ 0 ps / -100 ps	
Wave Generator			
Amplitude			
1 MΩ	1.8 mV to 55 V _{pk-pk}	3 % of output + 100 μV	
50 Ω	1.8 mV to 2.5 V _{pk-pk}	3 % of output + 100 μV	
Frequency	10 Hz to 100 kHz	25 parts in 10 ⁶ + 15 mHz	
Time Interval – Measure	25 ps to 100 μs	0.1 % Δt + 10 ps	HP 54121T Δt is the nominal time interval

III. Electrical – RF & Microwave

Parameter/Equipment	Range	CMC ² (±)	Comments
Power – Measure ^{3, 9}			
1 mW, 50Ω	(10 to 30) MHz	0.41 %	HP 436A with HP 478A-H76 and HP 3458A
(-60 to -30) dBm, 50Ω	(10 to 30) MHz SWR ≤ 1.4:1	0.13 dB	HP 436A with HP 8484A
	30 MHz to 4 GHz SWR ≤ 1.15:1	0.13 dB	
	(4 to 10) GHz SWR ≤ 1.2:1	0.13 dB	
	(10 to 15) GHz SWR ≤ 1.3:1	0.13 dB	
	(15 to 18) GHz SWR ≤ 1.35:1	0.14 dB	

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Power – Measure (cont) ^{3, 9} (-30 to +20) dBm, 50Ω	(100 to 300) kHz SWR ≤ 1.6:1	0.13 dB	HP 436A with HP 8482A
	300 kHz to 1 MHz SWR ≤ 1.2:1	0.081 dB	
	1 MHz to 2 GHz SWR ≤ 1.1:1	0.078 dB	
	(2 to 4.2) GHz SWR ≤ 1.3:1	0.1 dB	
	(10 to 30) MHz SWR ≤ 1.4:1	0.069 dB	HP 436A with HP 8481A
	(30 to 50) MHz SWR ≤ 1.18:1	0.069 dB	
	50 MHz to 2 GHz SWR ≤ 1.1:1	0.071 dB	
	(2 to 12.4) GHz SWR ≤ 1.18:1	0.078 dB	
	(12.4 to 18) GHz SWR ≤ 1.28:1	0.097 dB	

IV. Mechanical

Parameter/Equipment	Range	CMC ² (±)	Comments
Torque Transducers	(0 to 50) in·lb	0.044 % of reading	Class F weights mounted on a calibration arm
	(0 to 100) ft·lb	0.067 % of reading	
	(0 to 1000) ft·lb	0.041 % of reading	
	(0 to 6500) ft·lb	0.042 % of reading	
Torque Wrenches ³	(0 to 6500) ft·lb	0.63 % of reading	AKO TSD-1200 torque calibration system
Mass – Measure	2 mg to 10 g (10 to 50) g (50 to 100) g (100 to 210) g (210 to 6200) g (6200 to 32 000) g	0.12 mg 0.14 mg 0.20 mg 0.30 mg 14 mg 130 mg	Comparison to class 1 standard weights using a balance

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Parameter	Range	CMC ² (±)	Comments
Gauge Pressure	(0 to 50) psig (0 to 1000) psig	13 parts in 10 ⁶ 20 parts in 10 ⁶	DH Instruments PG7601 deadweight tester
Absolute Pressure	(0 to 50) psi (0 to 1000) psi	13 parts in 10 ⁶ 19 parts in 10 ⁶	DH Instruments PG7601 deadweight tester
Differential Pressure	(15 to 100) kPa absolute (2.2 to 15) psia	17 parts in 10 ⁶	DH Instruments PG7601 deadweight tester
Gas Flow – Calibration of Gas Flow Measurement and Control Equipment	(0.02 to 100) slpm	0.21 % of reading	DH Instruments Molbox system
Force – Compression & Tension	(100 to 2000) lbf (2000 to 5000) lbf (5000 to 10 000) lbf (10 000 to 25 000) lbf (25 000 to 50 000) lbf (50 000 to 100 000) lbf	1.6 lbf 2.8 lbf 7.5 lbf 15 lbf 43 lbf 74 lbf	Interface load cell system
Scales and Balances ³	2 mg to 10 g (10 to 100) g (100 to 210) g (210 to 6200) g (6200 to 32 000) g	0.068 mg 0.17 mg 0.28 mg 8.7 mg 71 mg	Class 1 weights

V. Thermodynamics

Parameter	Range	CMC ² (±)	Comments
Temperature – Measuring Equipment	(-60 to 232) °C (232 to 500) °C	0.03 °C 0.035 °C	Hart 1575, Rosemount 162CE, Hart 7380, 7025, 6022 and 6050 baths.
Temperature – Measure	(-200 to 100) °C (100 to 420) °C	0.03 °C 0.034 °C	Hart 1575 and 5614

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Parameter	Range	CMC ² (±)	Comments
Infrared Temperature – Generate	(-15 to 0) °C (0 to 120) °C (120 to 200) °C (200 to 350) °C (350 to 500) °C	0.8 °C 0.71 °C 0.97 °C 1.8 °C 2.2 °C	Fluke (Hart) 4180 Fluke (Hart) 4181
Electrical Calibration of Thermocouple Reference Junction	(22 to 25) °C	0.067 °C	Hart 2560 and 5614 reference and Type J thermocouple
Relative Humidity – Measuring Equipment	(10 to 95) % RH	0.51 % RH	Thunder 2500

VI. Time and Frequency

Parameter/Range	Frequency	CMC ² (±)	Comments
Frequency – Measuring Equipment ³	0.01 Hz to 2 MHz	2.5 µHz/Hz + 5 µHz	Fluke 5520A
Frequency – Measure	(1 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz (1 to 10) MHz (10 to 100) MHz (100 to 225) MHz 100 MHz to 1 GHz (3 to 5) GHz (5 to 12.4) GHz	1.8 µHz 1 µHz 10 µHz 100 µHz 1 mHz 10 mHz 100 mHz 230 mHz 1 Hz 5 Hz 12 Hz	HP 53132A, referenced to the WWVB

¹ This laboratory offers commercial and field calibration service.

² 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.

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- 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 In the statement of Calibration and Measurement Capability, L is the numerical value of the nominal length of the device measured in inches, M is the mass in grams, R is the resolution of the device under test and t is time in seconds.
- ⁵ The measurands stated are generated with the Fluke 5700A/EP series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. Calibration and Measurement Capability is expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.
- ⁶ The measurands stated are measured with the HP 3458A or the Fluke 8508A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. Calibration and Measurement Capability is expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.
- ⁷ The measurands stated are measured with the Fluke 5790A/03. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. Calibration and Measurement Capability is expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.
- ⁸ The measurands stated are generated with the Fluke 5520A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. Calibration and Measurement Capability is expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.
- ⁹ The CMC associated with RF Power measurement does not include mismatch.
- ¹⁰ "Supermicrometer" is a registered trade mark owned by Pratt & Whitney Measurement Systems, Inc., Connecticut U.S.A.



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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 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 8th day of August 2011.





President & CEO
For the Accreditation Council
Certificate Number 2044.01
Valid to August 31, 2013

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