



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

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CALIBRATION

Valid To: December 31, 2011

Certificate Number: 1623.15

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, 6} (±)	Comments
Micrometers, Depth Gages, and Height Gages ³	(0 to 36) in	(65 + 1.6L) μin	Grade 2 gage blocks
Thread Plug ³	(0 to 4) in	(30 + 10L) μin	Grade 2 gage blocks, P&W Model B supermic, Thread wires
Length Measure ³	(0 to 10) in	(20 + 7L) μin	Grade 2 gage blocks and P&W Model B supermic
Diameter ³	(0 to 3) in	(20 + 7L) μin	Grade 2 gage blocks and P&W Model B supermic
Calipers ³	(0 to 36) in	(610 + 1.6L) μin	Grade 2 gage blocks

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Dial Indicator Calibrator ³	(0 to 1) in	(150 + 1.6L) μ in	Grade 2 gage blocks
Indicators ³	(0 to 2) in	(65 + 1.6L) μ in	Grade 2 gage blocks
Pin Gages ³	Up to 1 in	29 μ in	Z-Mike w/ standard pins
Surface Plates ³	Up to 48 in x 24 in	66 μ in	24" Planekator
Rulers and Tape Measures ³	(0 to 24) in	0.009 in	Gage blocks
Protractors & Levels ³	0.25° to 160°	190 arc sec	Sine plate & gage blocks

II. Electrical – DC & Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4} (\pm)	Comments
DC Voltage – Generate ³	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	8 μ V/V + 0.4 μ V 5.5 μ V/V + 0.7 μ V 4 μ V/V + 2.5 μ V 4 μ V/V + 4 μ V 5.5 μ V/V + 40 μ V 7 μ V/V + 400 μ V	Fluke 5720A
	10V	2.1 μ V/V	Fluke 732B
	1.1 V to 5 kV	0.12 % of rdg	Associated Research 4045A with Ross VD60
DC Current – Generate ³	(1 to 220) μ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 60 μ A/A + 0.8 μ A 80 μ A/A + 25 μ A 0.036 % + 480 μ A	Fluke 5720A with 5725A
	(11 to 20.5) A	0.1 % + 0.75 mA	Fluke 5520A with coil
	(20 to 100) A	0.07 % of output	Valhalla 2555A and DC source

Parameter/Equipment	Range	CMC ^{2, 4} (\pm)	Comments
DC Current – Generate ³ (cont.) Clamp-On Only	(0 to 550) A (550 to 1000) A	0.3 % + 0.5 A 0.44 % of reading	Fluke 5520A with coil
DC Power – Generate ³	(0.01 to 330) W (0.33 to 11) kW (11 to 20.5) kW (20 to 100) kW	0.2 % 0.21 % 0.23 % 0.04 % + 30 W	Fluke 5520A Fluke 5720A calibrators and Valhalla 2555A
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 (0.33 to 1.1) G Ω	40 $\mu\Omega/\Omega$ + 1 m Ω 30 $\mu\Omega/\Omega$ + 1.5 m Ω 28 $\mu\Omega/\Omega$ + 1.4 m Ω 28 $\mu\Omega/\Omega$ + 2 m Ω 28 $\mu\Omega/\Omega$ + 2 m Ω 28 $\mu\Omega/\Omega$ + 20 m Ω 28 $\mu\Omega/\Omega$ + 20 m Ω 28 $\mu\Omega/\Omega$ + 0.2 Ω 28 $\mu\Omega/\Omega$ + 0.2 Ω 32 $\mu\Omega/\Omega$ + 2 Ω 32 $\mu\Omega/\Omega$ + 2 Ω 60 $\mu\Omega/\Omega$ + 30 Ω 0.013 % + 50 Ω 0.025 % + 2.5 k Ω 0.05 % + 3 k Ω 0.3 % + 100 k Ω 1.5 % + 500 k Ω	Fluke 5520A
Fixed Values	100 M Ω to 100 G Ω (1, 1.9) Ω (10, 19) Ω (100, 190) Ω (1, 1.9, 10, 19) k Ω (100, 190) k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	0.29 % of reading 0.29 % of reading 95 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 50 $\mu\Omega/\Omega$ 0.01 %	Biddle Megadek Fluke 5720A

Parameter/Equipment	Range	CMC ^{2, 5} (\pm)	Comments
DC Resistance – Generate ³ (cont.)	1 Ω 10 Ω 10 k Ω	9.7 $\mu\Omega/\Omega$ 9.7 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$	Fluke 742A-1 Fluke 742A-10 Fluke 742A-10K
DC Voltage – Measure ³	(0 to 0.1) V (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1100) V (1 to 60) kV	11 $\mu\text{V}/\text{V} + 3$ parts in 10^6 9.5 $\mu\text{V}/\text{V} + 0.3$ parts in 10^6 9.5 $\mu\text{V}/\text{V} + 0.05$ parts in 10^6 12 $\mu\text{V}/\text{V} + 0.3$ parts in 10^6 12 $\mu\text{V}/\text{V} + 0.1$ parts in 10^6 0.12 % of rdg	HP 3458A Ross VD60-6.2
DC Current – Measure ³	100 pA to 100 μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 100) A (100 to 300) A	24 $\mu\text{A}/\text{A} + 0.8$ nA 24 $\mu\text{A}/\text{A} + 5$ nA 24 $\mu\text{A}/\text{A} + 50$ nA 41 $\mu\text{A}/\text{A} + 0.5$ μA 0.013 % + 10 μA 0.052 % of reading 0.11 % of reading	HP 3458A Guildline 9211A with Agilent 3458A
DC Resistance – Measure ³	(0.1 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 (0.1 to 1.2) G Ω	17 $\mu\Omega/\Omega + 0.05$ m Ω 14 $\mu\Omega/\Omega + 0.5$ m Ω 12 $\mu\Omega/\Omega + 0.5$ m Ω 12 $\mu\Omega/\Omega + 5$ m Ω 12 $\mu\Omega/\Omega + 0.05$ Ω 17 $\mu\Omega/\Omega + 2$ Ω 58 $\mu\Omega/\Omega + 100$ Ω 0.058 % + 1 k Ω 0.58 % + 10 k Ω	HP 3458A

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate ³			
(0.2 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	0.024 % + 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	Fluke 5720A
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % + 12 μV 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	
(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	0.024 % + 40 μV 90 μV/V + 15 μV 45 μV/V + 8 μV 75 μV/V + 10 μV 0.01 % + 30 μV 0.028 % + 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 (0.5 to 1) MHz	0.024 % + 0.4 mV 90 μV/V + 0.15 mV 45 μV/V + 0.05 mV 75 μV/V + 0.1 mV 0.01 % + 0.2 mV 0.028 % + 0.6 mV 0.1 % + 2 mV 0.15 % + 3.2 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % + 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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate ³ (cont.)			
(220 to 750) V	30 Hz to 50 kHz (50 to 100) kHz	0.06 % + 11 mV 0.23 % + 45 mV	Fluke 5720A
(220 to 1100) V	(15 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.03 % + 16 mV 90 μV/V + 4 mV 0.017 % + 6 mV 0.06 % + 11 mV	Fluke 5720A W/ 5725A
(1000 to 5000) V	60 Hz	0.58 %	Associated Research 4045A with Ross VD60
AC Voltage – Generate ³			
(1.1 to 3) mV	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	1.1 % of reading 1.1 % of reading 1.3 % of reading 1.5 % of reading 12 % of reading	Fluke 5720A Wideband
(3 to 11) mV	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.9 % of reading 0.9 % of reading 1.1 % of reading 1.3 % of reading 12 % of reading	
(11 to 33) mV	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.9 % of reading 0.9 % of reading 1 % of reading 1.2 % of reading 1.8 % of reading	
(33 to 110) mV	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.75 % of reading 0.75 % of reading 0.85 % of reading 1.1 % of reading 1.7 % of reading	
(110 to 330) mV	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.74 % of reading 0.74 % of reading 0.84 % of reading 1.1 % of reading 1.7 % of reading	

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
AC Voltage – Generate ³ (cont.)			
330 mV to 1.1 V	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.63 % of reading 0.63 % of reading 0.73 % of reading 0.93 % of reading 1.6 % of reading	Fluke 5720A Wideband
(1.1 to 3.5) V	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.64 % of reading 0.64 % of reading 0.74 % of reading 0.94 % of reading 1.6 % of reading	
(3.5 to 7) V	120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.52 % of reading 0.52 % of reading 0.62 % of reading 0.82 % of reading 1.5 % of reading	
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	0.025 % + 16 nA 0.016 % + 10 nA 0.012 % + 8 nA 0.028 % + 12 nA 0.11 % + 65 nA	Fluke 5720A with 5725A
(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 % + 0.4 µA 0.016 % + 0.35 µA 0.012 % + 0.35 µA 0.02 % + 0.6 µA 0.11 % + 5 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 4 µA 0.016 % + 3.5 µA 0.012 % + 2.5 µA 0.02 % + 3.5 µA 0.11 % + 10 µA	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Generate ³ (cont.)			
(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 0.7 % + 160 µA	Fluke 5720A with 5725A
(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	
(11 to 20.5) A	(50 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.15 % + 5 mA 0.18 % + 5 mA 3.5 % + 5 mA	Fluke 5520A
(11 to 20) A (20 to 100) A	(10 to 100) Hz (10 to 100) Hz	0.18 % + 0.03 A 0.18 % + 0.15 A	Fluke 5720 with Valhalla 2555A
(20 to 100) A (20 to 100) A	(100 to 400) Hz (0.4 to 1) KHz	0.24 % + 0.2 A 0.34 % + 0.3 A	Fluke 5720 with Valhalla 2555A
(Clamp-on Only)			
(0 to 550) A (0 to 110) A	(45 to 65) Hz (65 to 440) Hz	0.41 % + 0.5 A 0.32 % + 0.5 A	Fluke 5520A with coil

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage – Measure ³			
3 μV to 10 mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.03 % + 3 μV 0.02 % + 1.1 μV 0.03 % + 1.1 μV 0.12 % + 1.1 μV 0.28 % + 1.1 μV 4.6 % + 2 μV	HP 3458A (Synchronous sub-sampled mode)
(10 to 100) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	80 μV/V + 4 μV 80 μV/V + 2 μV 0.02 % + 2 μV 0.03 % + 2 μV 0.09 % + 2 μV 0.35 % + 10 μV 1.2 % + 10 μV 1.7 % + 10 μV	
(0.1 to 1) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	80 μV/V + 40 μV 80 μV/V + 20 μV 0.02 % + 20 μV 0.03 % + 20 μV 0.09 % + 20 μV 0.35 % + 100 μV 1.2 % + 100 μV 1.7 % + 100 μV	
(1 to 10) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	80 μV/V + 0.4 mV 80 μV/V + 0.2 mV 0.02 % + 0.2 mV 0.03 % + 0.2 mV 0.09 % + 0.2 mV 0.35 % + 1 mV 1.2 % + 1 mV 1.7 % + 1 mV	
(10 to 100) V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.02 % + 4 mV 0.02 % + 2 mV 0.04 % + 2 mV 0.14 % + 2 mV 0.46 % + 10 mV 1.7 % + 10 mV	
(100 to 700) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.05 % + 40 mV 0.05 % + 20 mV 0.07 % + 20 mV 0.14 % + 20 mV 0.35 % + 20 mV	
(0.7 to 30) kV	60 Hz	0.58 % of rdg	Ross HVD

Parameter/Range	Frequency	CMC ^{2,5} (\pm)	Comments
AC Current – Measure ³			
(10 to 100) μ A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 1) kHz	0.46 % + 0.03 μ A 0.17 % + 0.03 μ A 0.07 % + 0.03 μ A 0.07 % + 0.03 μ A	HP 3458A
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.5 % + 0.2 μ A 0.17 % + 0.2 μ A 0.07 % + 0.2 μ A 0.04 % + 0.2 μ A	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 2 μ A 0.17 % + 2 μ A 0.07 % + 2 μ A 0.04 % + 2 μ A	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 20 μ A 0.17 % + 20 μ A 0.07 % + 20 μ A 0.04 % + 20 μ A	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 200 μ A 0.18 % + 200 μ A 0.09 % + 200 μ A 0.12 % + 200 μ A	
(1 to 2) A (2 to 20) A (20 to 100) A	(DC to 10) kHz (DC to 1) kHz (1 to 10) kHz (DC to 1) kHz	0.12 % of rdg 0.12 % of rdg 0.59 % of rdg 0.12 % of rdg	HP 3458A with Valhalla 2575A
AC Resistance – Generate ³			
10 Ω	DC to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.13 % of rdg 0.14 % of rdg 0.17 % of rdg 0.19 % of rdg 0.23 % of rdg 0.66 % of rdg 1 % of rdg	HP 42030 resistor set

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Resistance – Generate ³ (cont.)			
100 Ω	DC to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.13 % of rdg 0.14 % of rdg 0.17 % of rdg 0.14 % of rdg 0.17 % of rdg 0.34 % of rdg 0.46 % of rdg	HP 42030 resistor set
1 kΩ	DC to 3 MHz (3 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.09 % of rdg 0.11 % of rdg 0.28 % of rdg 0.41 % of rdg	
10 kΩ	DC to 1 MHz	0.09 % of rdg	
100 kΩ	DC to 1 MHz	0.09 % of rdg	
AC Resistance – Measure ³			
0.1 Ω	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	3.4 % of rdg 1.8 % of rdg 0.94 % of rdg 0.67 % of rdg 0.59 % of rdg 0.53 % of rdg 0.63 % of rdg	Agilent E4980A
1 Ω	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.52 % of rdg 0.31 % of rdg 0.23 % of rdg 0.20 % of rdg 0.19 % of rdg 0.19 % of rdg 0.34 % of rdg	
10 Ω	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.22 % of rdg 0.13 % of rdg 0.12 % of rdg 0.11 % of rdg 0.11 % of rdg 0.11 % of rdg 0.21 % of rdg	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Resistance – Measure ³ (cont.)			
100 Ω	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.10 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.10 % of rdg	Agilent E4980A
1 kΩ	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.10 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.10 % of rdg	
10 kΩ	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.10 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.05 % of rdg 0.10 % of rdg 0.21 % of rdg	
100 kΩ	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.12 % of rdg 0.06 % of rdg 0.06 % of rdg 0.10 % of rdg 0.12 % of rdg 0.16 % of rdg 0.32 % of rdg	
1 MΩ	20 Hz 100 Hz 1 kHz	0.28 % of rdg 0.16 % of rdg 0.13 % of rdg	
AC Power – Generate ³			
(0.01 to 0.1) W (0.1 to 890) W (0.89 to 3) kW (3 to 11) kW (11 to 20.5) kW	(45 to 65) Hz; PF = 1	0.23 % of rdg 0.14 % of rdg 0.13 % of rdg 0.15 % of rdg 0.13 % of rdg	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2, 4, 5} (\pm)	Comments
AC Power – Generate ³ (cont.) (20.5 to 100) kW	(10 to 100) Hz (100 to 400) Hz 400 Hz to 1 kHz	0.66 % + 0.15 kW 0.66 % + 0.20 kW 0.67 % + 0.30 kW	Fluke 5720A phased locked with Valhalla 2555A
AC Level Flatness ³ 0.5 V, 1 V, and 3 V	10 Hz (0.1, 10, 30) kHz 100 kHz (0.3, 1) MHz (3, 8, 10) MHz (20, 30) MHz 50 MHz 70 MHz 80 MHz 100 MHz	0.033 % of rdg 0.015 % of rdg 0.019 % of rdg 0.044 % of rdg 0.067 % of rdg 0.15 % of rdg 0.33 % of rdg 1.1 % of rdg 1.2 % of rdg 1.3 % of rdg	HP 3458A, Fluke 5700A w/ thermal converters
Inductance – Generate ³ Fixed Values 100 μ H 200 μ H 300 μ H 500 μ H 1 mH 2 mH 5 mH 10 mH 20 mH 1 H 5 H 10 H	100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz	0.1 % of rdg 0.1 % of rdg 0.1 % of rdg 0.1 % of rdg 0.03 % of rdg 0.03 % of rdg 0.03 % of rdg 0.03 % of rdg 0.05 % of rdg 0.03 % of rdg 0.05 % of rdg 0.05 % of rdg 0.28 % of rdg	GenRad 1482X
Inductance – Measure ³ 3 μ H	10 kHz 100 kHz 1 MHz 2 MHz	0.43 % of rdg 0.15 % of rdg 0.10 % of rdg 0.10 % of rdg	Agilent E4980A

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Inductance – Measure ³ (cont.)			
10 µH	10 kHz	0.23 % of rdg	Agilent E4980A
	100 kHz	0.11 % of rdg	
	1 MHz	0.05 % of rdg	
	2 MHz	0.10 % of rdg	
100 µH	1 kHz	0.27 % of rdg	
	10 kHz	0.12 % of rdg	
	100 kHz	0.05 % of rdg	
	1 MHz	0.05 % of rdg	
	2 MHz	0.10 % of rdg	
200 µH	1 kHz	0.24 % of rdg	
	10 kHz	0.11 % of rdg	
	100 kHz	0.05 % of rdg	
	1 MHz	0.06 % of rdg	
	2 MHz	0.17 % of rdg	
300 µH	1 kHz	0.23 % of rdg	
	10 kHz	0.11 % of rdg	
	100 kHz	0.05 % of rdg	
	1 MHz	0.07 % of rdg	
500 µH	1 kHz	0.16 % of rdg	
	10 kHz	0.05 % of rdg	
	100 kHz	0.05 % of rdg	
	1 MHz	0.06 % of rdg	
1 mH	400 Hz	0.20 % of rdg	
	1 kHz	0.13 % of rdg	
	10 kHz	0.05 % of rdg	
	100 kHz	0.05 % of rdg	
	1 MHz	0.07 % of rdg	
2 mH	100 Hz	0.40 % of rdg	
	400 Hz	0.15 % of rdg	
	1 kHz	0.12 % of rdg	
	10 kHz	0.05 % of rdg	
	100 kHz	0.05 % of rdg	
5 mH	20 Hz	0.32 % of rdg	
	100 Hz	0.18 % of rdg	
	400 Hz	0.12 % of rdg	
	1 kHz	0.05 % of rdg	
	10 kHz	0.05 % of rdg	
	100 kHz	0.05 % of rdg	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Inductance – Measure ³ (cont.)			
10 mH	20 Hz	0.23 % of rdg	Agilent E4980A
	100 Hz	0.13 % of rdg	
	400 Hz	0.09 % of rdg	
	1 kHz	0.05 % of rdg	
	10 kHz	0.05 % of rdg	
	100 kHz	0.05 % of rdg	
	20 mH	20 Hz	
100 Hz		0.12 % of rdg	
400Hz		0.08 % of rdg	
1 kHz		0.05 % of rdg	
10 kHz		0.05 % of rdg	
50 mH	20 Hz	0.20 % of rdg	
	100 Hz	0.06 % of rdg	
	1 kHz	0.05 % of rdg	
	10 kHz	0.05 % of rdg	
100 mH	20 Hz	0.20 % of rdg	
	100 Hz	0.05 % of rdg	
	1 kHz	0.05 % of rdg	
	10 kHz	0.05 % of rdg	
200 mH	20 Hz	0.17 % of rdg	
	100 Hz	0.05 % of rdg	
	1 kHz	0.05 % of rdg	
	10 kHz	0.05 % of rdg	
500 mH	20 Hz	0.11 % of rdg	
	100 Hz	0.05 % of rdg	
	1 kHz	0.05 % of rdg	
	10 kHz	0.05 % of rdg	
1 H	20 Hz	0.10 % of rdg	
	100 Hz	0.05 % of rdg	
	1 kHz	0.05 % of rdg	
	10 kHz	0.05 % of rdg	
5 H	20 Hz	0.10 % of rdg	
	100 Hz	0.05 % of rdg	
	1 kHz	0.05 % of rdg	
10 H	20 Hz	0.10 % of rdg	
	100 Hz	0.05 % of rdg	
	1 kHz	0.05 % of rdg	

Parameter/Range	Frequency	CMC ² (±)	Comments
Capacitance – Measure ³			
1 pF	100 kHz 1 MHz 2 MHz	0.37 % of rdg 0.19 % of rdg 0.28 % of rdg	Agilent E4980A
10 pF	1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.012 % of rdg 0.002 % of rdg 0.0013 % of rdg 0.0011 % of rdg 0.0011 % of rdg	
100 pF	100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.018 % of rdg 0.0016 % of rdg 0.0011 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.001 % of rdg	
1000 pF	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.015 % of rdg 0.0023 % of rdg 0.0006 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.001 % of rdg	
0.01 pF	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.0024 % of rdg 0.0007 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.001 % of rdg 0.0021 % of rdg	
0.1 μF	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.0011 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.001 % of rdg 0.0015 % of rdg 0.0035 % of rdg	
1 μF	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.001 % of rdg 0.0005 % of rdg 0.0005 % of rdg 0.001 % of rdg 0.0016 % of rdg 0.0041 % of rdg 0.0081 % of rdg	

Parameter/Range	Frequency	CMC ² (±)	Comments
Capacitance – Measure ³ (cont)			
10 µF	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz	0.001 % of rdg 0.0005 % of rdg 0.0011 % of rdg 0.0017 % of rdg 0.0043 % of rdg	
100 µF	20 Hz 100 Hz 1 kHz 10 kHz	0.0011 % of rdg 0.0012 % of rdg 0.002 % of rdg 0.0048 % of rdg	
1 mF	20 Hz 100 Hz	0.0023 % of rdg 0.0032 % of rdg	
Capacitance – Generate ³			
Fixed Values			
1 pF	(0.1 to 1) kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.01 % of rdg 0.04 % of rdg 0.04 % of rdg 0.07 % of rdg 0.13 % of rdg 0.2 % of rdg 0.7 % of rdg 1 % of rdg	HP 1638XX standard capacitors
(10, 100) pF	(0.1 to 1) kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.01 % of rdg 0.02 % of rdg 0.02 % of rdg 0.03 % of rdg 0.04 % of rdg 0.05 % of rdg 0.11 % of rdg 0.14 % of rdg	

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Capacitance – Generate ³ (cont.)			
1000 pF	(0.1 to 1) kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.01 % of rdg 0.04 % of rdg 0.04 % of rdg 0.07 % of rdg 0.1 % of rdg 0.14 % of rdg 0.34 % of rdg 0.48 % of rdg	HP 1638XX standard capacitors
(10, 100) nF	(100 to 120) Hz (0.12 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.03 % of rdg 0.01 % of rdg 0.03 % of rdg 0.05 % of rdg	
1 μF	(100 to 120) Hz (0.12 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.04 % of rdg 0.01 % of rdg 0.04 % of rdg 0.1 % of rdg	
Fixed Values			
0.001 μF	1 kHz	0.03 % of rdg	GenRad 1409x
0.005 μF	1 kHz	0.03 % of rdg	
0.01 μF	1 kHz	0.03 % of rdg	
0.02 μF	1 kHz	0.03 % of rdg	
0.05 μF	1 kHz	0.03 % of rdg	
0.1 μF	1 kHz	0.03 % of rdg	
0.2 μF	1 kHz	0.03 % of rdg	
0.5 μF	1 kHz	0.03 % of rdg	
10 pF	1 kHz	0.03 % of rdg	GenRad 1403-G
100 pF	1 kHz	0.03 % of rdg	GenRad 1404-B
1000 pF	1 kHz	7.1 μF/F	GenRad 1404-A
50 pF to 1.1 μF	10 Hz to 1 kHz	0.58 % of reading + 5 pF	GenRad 1412-BC
(1 to 10) μF	10 Hz to 1 kHz	0.28 % of reading	GenRad 1424A
(0.19 to 1.09) nF	10 Hz to 10 kHz	0.54 % + 0.01 nF	Fluke 5520A
(1.1 to 3.29) nF	10 Hz to 3 kHz	0.54 % + 0.01 nF	
(3.3 to 10.09) nF	10 Hz to 1 kHz	0.32 % + 0.01 nF	
(11 to 109.9) nF	10 Hz to 1 kHz	0.27 % + 0.1 nF	
(110 to 329.9) nF	10 Hz to 1 kHz	0.27 % + 0.3 nF	
(0.33 to 1.09) μF	(10 to 600) Hz	0.27 % + 1 nF	
(1.1 to 3.29) μF	(10 to 300) Hz	0.27 % + 3 nF	
(3.29 to 10.09) μF	(10 to 150) Hz	0.29 % + 10 nF	
(11 to 32.9) μF	(10 to 120) Hz	0.46 % + 30 nF	
(33 to 109.9) μF	(10 to 80) Hz	0.51 % + 100 nF	
(110 to 329.9) μF	(10 to 50) Hz	0.54 % + 300 nF	
(0.33 to 1.09) mF	(10 to 20) Hz	0.62 % + 1 μF	

Peter Mlynski

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ –			
Type B	600 °C to 800 °C 800 °C to 1000 °C 1000 °C to 1550 °C 1550 °C to 1820 °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	Fluke 5520A
Type C	0 °C to 150 °C 150 °C to 650 °C 650 °C to 1000 °C 100 °C to 1800 °C 1800 °C to 2316 °C	0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C	
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	0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	
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	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °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	0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.4 °C	
Type N	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 410 °C 410 °C to 1300 °C	0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	0 °C to 250 °C 250 °C to 400 °C 400 °C to 1000 °C 1000 °C to 1767 °C	0.57 °C 0.35 °C 0.33 °C 0.4 °C	
Type S	0 °C to 250 °C 250 °C to 1000 °C 1000 °C to 1400 °C 1400 °C to 1767 °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ – (cont.)			
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	Fluke 5520A
Type U	-200 °C to 0 °C 0 °C to 600 °C	0.56 °C 0.27 °C	
Rise Time – Measure ³	1 ns	1 ns + 3.0 %	TDS744A
Oscilloscopes ³			
DC Signal			Fluke 5520A/SC1100
into 50Ω Load	0 to 6.6 V	2.5 mV/V + 40 μV	<i>t</i> = time in seconds
into 1MΩ Load	0 to 130 V	500 μV/V + 40 μV	
Amplitude Square Wave			
50 Ω Load	1 mV to 6.6 V (10 Hz to 10 kHz)	2.5 mV/V + 40 μV	
1 MΩ Load	1 mV to 130 V p-p (10 Hz to 10 kHz)	1 mV/V + 40 μV	
Leveled Sine Wave Flatness (Relative to 50 kHz)	5 mV to 5.5 V 50 kHz to 100 MHz (100 to 300) Mhz (300 to 600) MHz	15 mV/V + 100 μV 20 mV/V + 100 μV 40 mV/V + 100 μV	
	5 mV to 3.5 V (600 to 1100) MHz	50 mV/V + 100 μV	
Time Mark into 50Ω	5 s to 50 ms 20 ms to 100 ns (50 to 20) ns 10 ns (5 to 1) ns	(25 + 1000 <i>t</i>) μs/s 2.5 μs/s 2.5 μs/s 2.5 μs/s 2.5 μs/s	
Edge Spec into 50 Ω Load: Rise Time Amplitude(Peak to Peak)	≤350 ps 5 mV to 2.5 V	3.5% 20 mV/V + 200 μV	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTDs ³ (cont.)			
PtNi 385, 120 Ω	-80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C	0.08 °C 0.08 °C 0.14 °C	Fluke 5520A
Pt 3916, 100 Ω	-200 °C to -190 °C	0.25 °C	
	-190 °C to -80 °C	0.04 °C	
	-80 °C to 0 °C	0.05 °C	
	0 °C to 100 °C	0.06 °C	
	100 °C to 260 °C	0.07 °C	
	260 °C to 300 °C	0.08 °C	
	300 °C to 400 °C	0.09 °C	
	400 °C to 600 °C	0.1 °C	
600 °C to 630 °C	0.23 °C		
Pt 3926, 100 Ω	-200 °C to -80 °C	0.05 °C	
	-80 °C to 0 °C	0.05 °C	
	0 °C to 100 °C	0.07 °C	
	100 °C to 300 °C	0.09 °C	
	300 °C to 400 °C	0.10 °C	
400 °C to 630 °C	0.12 °C		
Cu 427, 10 Ω	-100 °C to 260 °C	0.30 °C	

Parameter/Range	Frequency	CMC ² (±)	Comments
Distortion ⁵ – Measure ³ (5 Hz to 600 kHz, Fundamental Frequency)			
(0.3 to 100) % distortion < 30 V	10 Hz to 1 MHz (1 to 3) MHz	3.5 % of rdg 7 % of rdg	HP 333A
(30 to 300) V	10 Hz to 300 kHz (300 to 500) kHz (0.5 to 3) MHz	3.5 % of rdg 7 % of rdg 14 % of rdg	
0.1 % distortion < 30 V	(10 to 20) Hz (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz	13 % of rdg 7 % of rdg 3.5 % of rdg 7 % of rdg 14 % of rdg	
> 30 V	(20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz	14 % of rdg 4 % of rdg 7 % of rdg 14 % of rdg	
	20 Hz to 20 kHz (20 to 100) kHz	1 dB 2 dB	HP 8903B

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ² (±)	Comments
RF Power – Generate ³			
(+23.98 to -56.00) dBm	DC to 20 MHz	0.52 dB	HP 3325B
(+13 to -110) dBm	0.1 GHz to 26.5 GHz	3.0 % of rdg	HP 83630B with 8902A and 11792A
(+10 to -110) dBm	0.1 GHz to 26.5 GHz	3.0 % of rdg	HP 83630B with 8902A, 11722A, 11793A, and 11792A
RF Power – Measure ³			
(+30 to -20) dBm	100 kHz to 26.5 GHz	2.9 % of rdg	HP 8902A with 11722A and 11792A
(-70 to -127) dBm	(0.1 to 26.5) GHz	3.0 % of rdg	
(-20 to -70) dBm	(0.05 to 26.5) GHz	2.9 % of rdg	HP 8485D with 438A
Power Reference Out 1 mW	50 MHz	0.9 % of rdg	HP 432A, 3458A, w/ 478A-H76
RF Attenuation – Generate ³			
Fixed Values	30 MHz	0.008 dB	11812A Verification Kit
(0 to 121) dB Range (1 dB step)	(DC to 18) GHz	0.34 dB	HP 8494B and 8496B

Parameter/Equipment	Range	CMC ² (±)	Comments
Power Sensor Calibration – Calibration Factor ³			
HP 8481A, B, H	10 MHz 30 MHz 50 MHz 100 MHz 300 MHz 500 MHz 1 GHz 1.5 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz 7 GHz 8 GHz 9 GHz 10 GHz 11 GHz 12 GHz 12.4 GHz 13 GHz 14 GHz 15 GHz 16 GHz (17, 18) GHz	0.79 % of rdg 0.89 % of rdg 0.86 % of rdg 0.86 % of rdg 0.86 % of rdg 0.82 % of rdg 0.82 % of rdg 0.82 % of rdg 0.81 % of rdg 0.81 % of rdg 0.81 % of rdg 0.84 % of rdg 0.86 % of rdg 0.86 % of rdg 0.87 % of rdg 0.87 % of rdg 0.89 % of rdg 0.90 % of rdg 0.87 % of rdg 0.82 % of rdg 0.90 % of rdg 0.92 % of rdg 0.90 % of rdg 0.90 % of rdg	HP 8481A-H84 (Gold Cal), HP 83630B, HP 438A, and HP 3325B
HP 8482A, B, H	0.1 MHz 0.3, 0.5, 1 MHz 3, 5, 10 MHz 30 MHz 50 MHz 100 MHz 300 MHz 500 MHz 1 GHz 1.5 GHz 2 GHz 2.5 GHz 3 GHz 2.5 GHz 4 GHz 4.2 GHz	0.82 % of rdg 0.79 % of rdg 0.76 % of rdg 0.92 % of rdg 0.80 % of rdg 0.80 % of rdg 0.80 % of rdg 0.80 % of rdg 0.80 % of rdg 0.80 % of rdg 0.81 % of rdg 0.81 % of rdg 0.81 % of rdg 0.81 % of rdg 0.81 % of rdg 0.82 % of rdg	

Parameter/Range	Frequency	CMC ² (±)	Comments
Power Sensor Calibration – Calibration Factor ³ (cont.)			
HP 8484A/ 8481D	10 MHz	1.6 % of rdg	HP 8481D-H84 (Gold Cal), HP 83630B, HP 438A, and HP 3325B
	30 MHz	1.6 % of rdg	
	50 MHz	1.6 % of rdg	
	100 MHz	1.6 % of rdg	
	300 MHz	1.6 % of rdg	
	500 MHz	1.6 % of rdg	
	1 GHz	1.6 % of rdg	
	1.5 GHz	1.6 % of rdg	
	2 GHz	1.6 % of rdg	
	3 GHz	1.6 % of rdg	
	4 GHz	1.6 % of rdg	
	5 GHz	1.6 % of rdg	
	6 GHz	1.6 % of rdg	
	7 GHz	1.6 % of rdg	
	8 GHz	1.6 % of rdg	
	9 GHz	1.7 % of rdg	
	10 GHz	1.7 % of rdg	
	11 GHz	1.7 % of rdg	
	12 GHz	1.7 % of rdg	
	12.4 GHz	1.7 % of rdg	
	13 GHz	1.7 % of rdg	
	14 GHz	1.7 % of rdg	
	15 GHz	1.7 % of rdg	
	16 GHz	1.7 % of rdg	
	17 GHz	1.7 % of rdg	
	18 GHz	1.7 % of rdg	

Parameter/Range	Frequency	CMC ² (±)	Comments
Amplitude Modulation – Generate ³ Rate: 50 Hz to 100 kHz Depths: 5 % to 95 %	11 MHz to 13.5 MHz	0.12 % of output	HP 11715A
Amplitude Modulation – Measure ³ Rate: 50 Hz to 10 kHz Depths: 5 % to 99 % Rate: 20 Hz to 10 kHz Depths: to 99 % Rate: 50 Hz to 50 kHz Depths: 5 % to 99 % Rate: 20 Hz to 100 kHz Depths: to 99 % Rate: 50 Hz to 50 kHz Depths: 5 % to 99 % Rate: 20 Hz to 100 kHz Depths: to 99 %	150 kHz to 10 MHz 150 kHz to 10 MHz 10 MHz to 1.3 GHz 10 MHz to 1.3 GHz (1.3 to 26.5) GHz (1.3 to 26.5) GHz	2.3 % rdg + 1 digit 3.5 % rdg + 1 digit 1.2 % rdg + 1 digit 3.5 % rdg + 1 digit 1.8 % rdg + 1 digit 3.5 % rdg + 1 digit	HP 8902A with 11722A with 11793A
Frequency Modulation – Generate ³ Rate: 20 Hz to 100 kHz Dev.: ≤ 12.5 kHz peak Rate: 20 Hz to 100 kHz Dev.: ≤ 100 kHz peak Rate: 20 Hz to 100 kHz Dev.: ≤ 400 kHz peak	11 MHz to 13.5 MHz 88 MHz to 108 MHz 352 MHz to 432 MHz	0.12 % output 0.12 % output 0.12 % output	HP 11715A

Parameter/Range	Frequency	CMC ² (±)	Comments
Frequency Modulation – Measure ³			
Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak	250 kHz to 10 MHz	2.3 % rdg + 1 digit	HP 8902A with 11722A
Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak	10 MHz to 1.3 GHz	1.2 % rdg + 1 digit	
Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	10 MHz to 1.3 GHz	5.8 % rdg + 1 digit	
Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak	(1.3 to 26.5) GHz	1.2 % rdg + 1 digit	HP 8902A with 11793A
Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	(1.3 to 26.5) GHz	5.8 % rdg + 1 digit	

IV. Mechanical

Parameter/Equipment	Range	CMC ² (±)	Comments
Pressure Gauges ³	(0 to 300) psig	0.03 % of reading	Omega DPI 610
	(0 to 10 000) psig	0.03 % of reading	Mansfield Green 10-10525
Vacuum Gauges ³	(0 to -14.5) psig	0.03 % of reading	Omega DPI 610
Torque Transducers and Calibrators ³	40 in·oz to 55 in·lb 20 in·lb to 300 ft·lb	0.12 % of rdg 0.12 % of rdg	Class F weights with: 5 in wheel 10 in butterfly
Torque – Measure ³	4 in·lb to 250 ft·lb	0.32 % of rdg	CDI 5000ST w/ TPP-441 & CDI 1000PF

Parameter/Equipment	Range	CMC ² (±)	Comments
Scales & Balances ³	(0.5 to 1) g (1 to 10) g (10 to 50) g (50 to 100) g (100 to 200) g	0.25 mg 0.34 mg 0.64 mg 1.1 mg 2.1 mg	Class S1 Weights
	(0.25 to 0.5) lbs (0.5 to 10) lbs (10 to 25) lbs (25 to 50) lbs (50 to 100) lbs (100 to 250) lbs (250 to 500) lbs	100 µlbs 0.001 lbs 0.004 lbs 0.006 lbs 0.014 lbs 0.051 lbs 0.095 lbs	Class F Weights
Force Gage, Compression, and Tension ³	(0 to 500) lbs	0.095 lbs	Class F Weights

V. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measuring Equipment ³	(-25 to 0) °C 0 °C to Ambient Ambient to 220 °C (220 to 660) °C	0.41 °C 0.06 °C 0.17 °C 0.25 °C	Rosemount 162CE SPRT, Hart 2560 Blackstack, Hart 9144 Drywell, Chilled Circulating bath, and Ice Point
Temperature – Measure ³	(-30 to 220) °C (220 to 660) °C	0.03 °C 0.06 °C	Rosemount 162CE SPRT and Hart 2560 Blackstack
Relative Humidity – Measure ³	(10 to 95) % RH	1.1 % RH	Cole Parmer 3312-20 psychrometer
IR – Measuring Equipment ³	(-30 to 150) °C (150 to 300) °C (300 to 500) °C	0.44 °C 0.77 °C 0.96 °C	Hart 9133 Hart 9132 Hart 9132

VI. Time & Frequency

Parameter/Equipment	Range	CMC ² (\pm)	Comments
Time Interval ³	1 s to 3 hr	0.52 s	HP 5345A
Frequency – Measuring Equipment ³	DC to 20 MHz	5 parts in 10 ¹²	HP 3325A
	20 MHz to 26.5 GHz	5 parts in 10 ¹²	HP 83630B
	10 MHz	5 parts in 10 ¹²	Datum GPS
Frequency – Measure ³	(DC to 500) MHz	5 parts in 10 ¹²	HP 5345A
	(0.5 to 26.5) GHz	5 parts in 10 ¹²	HP 5345A w/ 5355A, 5356B, and Datum GPS

¹ This laboratory offers commercial 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.

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 generated with the Fluke 5720A and 5520A. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. Best measurement uncertainties are expressed as either a specific value that covers the full range or as a combination of the percent or portion of the reading plus a fixed floor specification.

⁵ The measurands stated are measured with the HP 3458A, HP 1638XX, HP 54610B, HP 333A, HP 3325A, HP 11715A, and HP 42030. 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 combination of the percent or portion of the reading/output plus a range specification.

⁶ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches.



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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/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 18th day of September 2009.





Peter Meyer

President & CEO
For the Accreditation Council
Certificate Number 1623.15
Valid to December 31, 2011
Revised November 30, 2011

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