



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

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CALIBRATION

Valid To: April 30, 2020

Certificate Number: 2626.01

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

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 3, 4, 5} (±)	Comments
DC Voltage – Generate	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V	8.7 μV/V + 0.40 μV 5.8 μV/V + 0.70 μV 4.2 μV/V + 2.5 μV	Fluke 5720A
DC Voltage – Measure	(0 to 100) mV 100 mV to 1 V (1 to 10) V	13 μV/V + 0.70 μV 13 μV/V + 0.70 μV 13 μV/V + 0.90 μV	Agilent 3458A, opt 002 (2-year specifications)
DC Resistance – Measure	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ	29 μΩ/Ω + 0.14 mΩ 29 μΩ/Ω + 1.4 mΩ 24 μΩ/Ω + 1.4 mΩ 24 μΩ/Ω + 14 mΩ	Agilent 3458A, opt 002 (2-year specifications)
DC Resistance – Generate, Fixed Points	(1, 1.9) Ω (10, 19) Ω (100, 190) Ω (1, 1.9, 10, 19) kΩ	0.011 % 27 μΩ/Ω 12 μΩ/Ω 11 μΩ/Ω	Fluke 5720A

Parameter/Equipment	Range	CMC ^{2,3,4} (±)	Comments
DC Current – Measure	(1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA	39 µA/A + 0.14 nA 39 µA/A + 1.2 nA 39 µA/A + 9.0 nA 39 µA/A + 90 nA 56 µA/A + 0.90 µA	Agilent 3458A, opt 002
DC Current – Generate	(10 to 100) µA (0 to 220) µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA	590 µA/A + 20 nA 47 µA/A + 6.0 nA 41 µA/A + 7.0 nA 41 µA/A + 40 nA 52 µA/A + 0.70 µA	Keithley 236/237 Fluke 5720A

Parameter/Range	Frequency	CMC ^{2,3,4,5} (±)	Comments
AC Voltage – Generate			
(0 to 2.2) mV	10 Hz to 50 kHz 50 kHz to 1 MHz	0.033 % + 4.0 µV 0.33 % + 20 µV	Fluke 5720A
(2.2 to 22) mV	10 Hz to 50 kHz 50 kHz to 1 MHz	0.029 % + 4.0 µV 0.32 % + 20 µV	
(22 to 220) mV	10 Hz to 50 kHz 50 kHz to 1 MHz	0.028 % + 12 µV 0.32 % + 45 µV	
220 mV to 2.2 V	10 Hz to 50 kHz 50 kHz to 1 MHz	0.028 % + 40 µV 0.20 % + 300 µV	
AC Voltage – Measure			
(0 to 10) mV	1 Hz to 100 kHz (100 to 300) kHz	0.59 % + 9.1 µV 4.7 % + 10 µV	Agilent 3458A, opt 002 (ACBAND ≤ 2 MHz)
(10 to 100) mV	1 Hz to 100 kHz 100 kHz to 2 MHz	0.11 % + 2.4 µV 1.8 % + 11 µV	
100 mV to 1 V	1 Hz to 100 kHz 100 kHz to 2 MHz	0.11 % + 24 µV 1.8 % + 0.11 mV	

Parameter/Range	Frequency	CMC ^{2, 3, 4, 5} (±)	Comments
AC Voltage – Measure (cont)			
(1 to 10) V	1 Hz to 100 kHz 100 kHz to 2 MHz	0.11 % + 240 μV 1.8 % + 1.1 mV	Agilent 3458A, opt 002 (ACBAND ≤ 2 MHz)
(10 to 100) V	1 Hz to 100 kHz 100 kHz to 1 MHz	0.15 % + 2.4 mV 1.8 % + 11 mV	
(100 to 700) V	1 Hz to 100 kHz	0.36 % + 24 mV	
AC Current – Generate			
(9 to 220) μA	10 Hz to 5 kHz (5 to 10) kHz	0.033 % + 12 nA 0.13 % + 65 nA	Fluke 5720A
220 μA to 2.2 mA	10 Hz to 5 kHz (5 to 10) kHz	0.030 % + 110 nA 0.13 % + 650 nA	
(2.2 to 22) mA	10 Hz to 5 kHz (5 to 10) kHz	0.030 % + 550 nA 0.13 % + 5 μA	
(22 to 220) mA	10 Hz to 5 kHz (5 to 10) kHz	0.030 % + 3.5 μA 0.13 % + 10 μA	
AC Current – Measure			
(5 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	1 kHz 1 kHz 1 kHz 1 kHz 1 kHz	0.079 % + 30 nA 0.079 % + 0.30 μA 0.045 % + 2.0 μA 0.045 % + 20 μA 0.13 % + 0.20 mA	Agilent 3458A, opt 002

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
RF Power – 1 mW Calibration Factor	100 kHz to 50 MHz 50 MHz to 1 GHz (1 to 2) GHz (2 to 3) GHz (3 to 4) GHz (4 to 6) GHz	0.64 % 0.57 % 0.57 % 0.59 % 0.61 % 0.65 %	Model F1130 transfer standard

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
RF Power – Generate & Measure			
1 mW	100 kHz to 50 MHz 50 MHz 50 MHz to 1 GHz (1 to 2) GHz (2 to 3) GHz (3 to 4) GHz (4 to 6) GHz	0.64 % 0.57 % 0.57 % 0.57 % 0.58 % 0.61 % 0.63 %	F1130 transfer standard
Up to 1 kW (0.3 to 10) W (10 to 100) W (100 to 250) W	450 kHz to 4.2 GHz 100 kHz to 4.2 GHz 100 kHz to 4.2 GHz 100 kHz to 4.2 GHz	1.2 % 1.1 % 1.1 % 1.2 %	Calibrated with Bramall method
1700 Watts	250 kHz to 5 MHz (10 to 15) MHz (25 to 30) MHz (35 to 65) MHz (95 to 105) MHz (150 to 170) MHz	0.39 % 0.39 % 0.39 % 0.39 % 0.39 % 0.39 %	Yokogawa WT3000 power analyzer PI 140ASX AC power supply (reference only) Bird 6080 calorimeter
700 Watts	250 kHz to 5 MHz (10 to 15) MHz (25 to 30) MHz (35 to 65) MHz (95 to 105) MHz (150 to 170) MHz	0.42 % 0.42 % 0.42 % 0.42 % 0.42 % 0.42 %	
1700 Watts	(12.88 to 14.24) MHz	0.22 %	Yokogawa WT3000E power analyzer pacific 160ASX AC power supply (reference only) MKS QL6513A RF Generator (reference only Bird 6085B Calorimeter
RF Attenuation –			
(10 to 40) dB	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.048 dB 0.070 dB 0.079 dB 0.11 dB	Agilent E8358A
(40 to 70) dB	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.12 dB 0.12 dB 0.14 dB 0.16 dB	

Parameter/Range	Frequency	CMC ² (±)	Comments
RF Impedance – Measure			
Reflection Coefficient			
0.0 to < 0.2	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.0050 (linear, ratio) 0.010 (linear, ratio) 0.010 (linear, ratio) 0.010 (linear, ratio)	Agilent E8358A
0.2 to < 0.4	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.0080 (linear, ratio) 0.013 (linear, ratio) 0.014 (linear, ratio) 0.018 (linear, ratio)	
0.4 to < 0.6	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.011 (linear, ratio) 0.017 (linear, ratio) 0.018 (linear, ratio) 0.028 (linear, ratio)	
0.6 to < 0.8	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.014 (linear, ratio) 0.022 (linear, ratio) 0.023 (linear, ratio) 0.036 (linear, ratio)	
0.8 to < 1.0	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.016 (linear, ratio) 0.027 (linear, ratio) 0.028 (linear, ratio) 0.043 (linear, ratio)	
1.0	(0.3 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.017 (linear, ratio) 0.033 (linear, ratio) 0.028 (linear, ratio) 0.038 (linear, ratio)	

III. Time & Frequency

Parameter/Range	Frequency	CMC ² (±)	Comments
Frequency – Measure & Measuring Equipment	10 Hz to 100 kHz 100 kHz to 300 MHz 300 MHz to 1 GHz (1 to 5) GHz (5 to 15) GHz	2.8 x 10 ⁻⁵ Hz 8.3 x 10 ⁻² Hz 7.0 Hz 35 Hz 110 Hz	Agilent 53230A counter, 910R GPS receiver, RF / Function generator
Frequency – Time Base	10 MHz	4.2 x 10 ⁻¹² Hz/Hz	Wavetek 910R GPS receiver

¹ This laboratory offers commercial calibration service.

² Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. 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 The measurands stated are generated with the Fluke 5720A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMC are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

⁴ The measurands stated are measured with the HP 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.

⁵ In the statement of CMC, uncertainties expressed as a percent are to be read as percent of reading unless otherwise indicated.