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

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CALIBRATION

Valid To: February 29, 2012 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 calibrations[1]:

I. Electrical – DC & Low Frequency

Parameter/Equipment	Range	CMC[2, 3, 4] (±)	Comments
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	8.9 µV/V + 0.4 µV 5.8 µV/V + 0.7 µV 4.1 µV/V + 2.5 µV 4.1 µV/V + 4.0 µV 5.8 µV/V + 40 µV 7.6 µV/V + 0.4 mV	Fluke 5720A
DC Voltage – Generate, Fixed Point	10 V	2.4 µV/V	Fluke 732B
DC Voltage – Measure	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V	12 µV/V + 3 µV/V 12 µV/V + 0.30 µV/V 12 µV/V + 0.05 µV/V 12 µV/V + 0.30 µV/V 12 µV/V + 100 µV/V*	Agilent 3458A, opt. 002 (2 year specifications) *Add 12 µV/V × $(V_{in} / 1000)^2$ for inputs > 100V

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Parameter/Equipment	Range	CMC[2, 3, 4] (±)	Comments
DC Resistance – Measure	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	24 μΩ/Ω + 10 μΩ/Ω 24 μΩ/Ω + 10 μΩ/Ω 18 μΩ/Ω + 1.0 μΩ/Ω 18 μΩ/Ω + 1.0 μΩ/Ω 18 μΩ/Ω + 1.0 μΩ/Ω 24 μΩ/Ω + 4.0 μΩ/Ω 87 μΩ/Ω + 10 μΩ/Ω 0.12 % + 10 μΩ/Ω 1.2 % + 10 μΩ/Ω	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 (100, 190) kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ 1Ω 10 kΩ	100 μΩ/Ω 27 μΩ/Ω 12 μΩ/Ω 10 μΩ/Ω 13 μΩ/Ω 24 μΩ/Ω 25 μΩ/Ω 47 μΩ/Ω 59 μΩ/Ω 120 μΩ/Ω 0.4 μΩ/Ω 1.2 μΩ/Ω	Fluke 5720A Fluke 742A-1 Fluke 742A-10k
DC Current – Measure	(1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	30 μA/A + 10 μA/A 30 μA/A + 8.0 μA/A 30 μA/A + 5.0 μA/A 30 μA/A + 5.0 μA/A 47 μA/A + 5.0 μA/A 0.014 % + 10 μA/A	Agilent 3458A, Opt 002
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	47 μA/A + 6 nA 41 μA/A + 7 nA 41 μA/A + 40 nA 53 μA/A + 0.7 μA 93 μA/A + 12 μA 0.042 % + 0.48 mA	Fluke 5720A Add (200*I^2) μA/A for I > 100 mA Add (10*I^2) μA/A for I > 1 A Fluke 5720A with Fluke 5725A

Parameter/Range	Frequency	CMC[2, 3] (±)	Comments
AC Voltage – Generate			
(0 to 2.2) mV	10 Hz to 50 kHz 50 kHz to 1 MHz	0.034 % + 4.5 µV 0.33 % + 25 µV	Fluke 5720A
(2.2 to 22) mV	10 Hz to 50 kHz 50 kHz to 1 MHz	0.030 % + 5 µV 0.33 % + 25 µV	
(22 to 220) mV	10 Hz to 50 kHz 50 kHz to 1 MHz	0.028 % + 13 µV 0.32 % + 80 µV	
220 mV to 2.2 V	10 Hz to 50 kHz 50 kHz to 1 MHz	0.028 % + 5 µV 0.20 % + 25 µV	
(2.2 to 22) V	10 Hz to 50 kHz 50 kHz to 1 MHz	0.028 % + 5 µV 0.18 % + 25 µV	
(22 to 220) V	10 Hz to 50 kHz 50 kHz to 1 MHz	0.058 % + 8 mV 0.93 % + 190 mV	
(220 to 1100) V	15 Hz to1 kHz	0.035 % + 16 mV	
(220 to 1100) V	40 Hz to 30 kHz	0.070 % + 11 mV	Fluke 5720A with 5725A amplifier
AC Voltage – Measure			
(0 to 10) mV	1 Hz to 100 kHz (100 to 300) kHz	0.58 % + 11 µV 4.7 % + 20 µV	Agilent 3458A, Opt 002
(10 to 100) mV	1 Hz to 100 kHz 100 kHz to 2 MHz	0.58 % + 110 µV 4.7 % + 200 µV	
100 mV to 1 V	1 Hz to 100 kHz 100 kHz to 2 MHz	0.093 % + 20 µV 1.8 % + 100 µV	
(1 to 10) V	1 Hz to 100 kHz 100 kHz to 2 MHz	0.093 % + 200 µV 1.7 % + 1.0 mV	
(10 to 100) V	1 Hz to 100 kHz 100 kHz to 1 MHz	0.14 % + 2.0 mV 1.8 % + 10 mV	Agilent 3458A, Opt 002 (ACBAND ≤ 2 MHz)
1 V to 1 kV	1 Hz to 100 kHz	0.35 % + 40 mV	
(0 to 10) mV	45 Hz to 100 kHz 100 kHz to 4 MHz	0.11 % + 6 µV 8.1 % + 7 µV	Agilent 3458A, Opt 002 (ACBAND > 2 MHz
(10 to 100) mV	45 Hz to 100 kHz 100 kHz to 4 MHz	0.11 % + 60 µV 4.7 % + 80 µV	

Parameter/Range	Frequency	CMC[2, 3, 4] (±)	Comments
AC Voltage – Measure (cont)			
100 mV to 1 V	45 Hz to 100 kHz 100 kHz to 4 MHz	0.11 % + 600 µV 4.7 % + 1 mV	Agilent 3458A, Opt 002 (ACBAND > 2 MHz
(1 to 10) V	45 Hz to 100 kHz 100 kHz to 4 MHz	0.11 % + 6 mV 4.7 % + 8 mV	
(10 to 100) V	45 Hz to 100 kHz	0.14 % + 2 mV	
100 V to 1 kV	45 Hz to 100 kHz	0.35 % + 100 mV	
AC Current – Generate			
(0 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	
220 mA to 2.2 A	20 Hz to 5 kHz (5 to 10) kHz	0.053 % + 80 µA 0.81 % + 160 µA	
(0 to 11) A	40 Hz to 5 kHz (5 to 10) kHz	0.11 % + 380 µA 0.42 % + 750 µA	Fluke 5720A with 5725A Amplifier
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	0.070 % + 0.03 µA 0.070 % + 0.2 µA 0.037 % + 2 µA 0.037 % + 20 µA 0.12 % + 200 µA	Agilent 3458A, Opt 002

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Power – Generate and Measure			
Up to 10 kW, Fixed Frequencies	100.1 MHz 600 MHz	1.7 % of reading 1.8 % of reading	Calibrated with Bramall system
Up to 1 kW	100 kHz to 4.2 GHz	1.3 % of reading	Validated with Bird 6085 and 6091 RF calorimeters
RF Attentuation –			
(10 to 40) dB	(0.1 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.049 dB 0.071 dB 0.079 dB 0.11 dB	Agilent E8358A
(40 to 70) dB	(0.1 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	Weinschel Model 44 attenuator set
RF Impedance – Measure			
Reflection Coefficient			
0.0	(0.1 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.005 (linear, ratio) 0.010 (linear, ratio) 0.010 (linear, ratio) 0.010 (linear, ratio)	Agilent E8358A
0.2	(0.1 to 1300) MHz (1.3 to 3) GHz (3 to 6) GHz (6 to 9) GHz	0.008 (linear, ratio) 0.013 (linear, ratio) 0.014 (linear, ratio) 0.018 (linear, ratio)	
0.4	(0.1 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)	

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Impedance – Measure (cont)			
Reflection Coefficient			
0.6	(0.1 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)	Agilent E8358A
0.8	(0.1 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	(0.1 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	100 kHz to 4.2 GHz	0.00084 Hz	Agilent counter tied to Wavetek 910R GPS receiver
Frequency – Time Base	10 MHz	1.2 parts in 10^9	Wavetek 910R GPS receiver

[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] The measurands stated as Measuring Equipment are generated with the Fluke 5720A as source for calibration or test. This capability is suitable for the calibration of devices intended to measure the stated measurand in the ranges indicated. Best measurement uncertainty is read as a fraction/percentage of the output plus one-year floor specifications where defined. Certain parameters are available as fixed source input values only (e. g. Resistance).

[4] The measurands stated as Measure are quantified with the HP 3458A as the device to measure the output of an instrument being calibrated or verified. This capability is suitable for the calibration of devices intended to generate the measurand in the ranges indicated. Best measurement uncertainty is read as a fraction/percentage of the reading plus fraction/percentage of the range.