

SCOPE OF ACCREDITATION TO ISO/IEC 17025-1999
& ANSI/NCSL Z540-1-1994
DRAFT

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CALIBRATION

Valid To:

Certificate Number: 2011.01

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	Best Uncertainty ² (±)	Comments
DC Voltage – Generate	(0 – 220) mV 220 mV - 2.2 V (0 – 11) V (11 – 22) V (22 - 275) V (275 – 1000) V	15 ppm +0.5 μV 14 ppm 10 ppm +5 μV 11 ppm 13 ppm 12 ppm	
Fixed Points	1.018 V 10.0 V Ratio: 10:1 Ratio: 100:1	0.20 ppm 0.80 ppm 0.4 ppm 1.0 ppm	
DC Voltage – Measure	100 mV 1 V 10 V 100 V 1000 V	14 ppm + 3 ppm (range) 10 ppm 8.2 ppm 12 ppm 12 ppm + [12ppm (V _{in} /1000) ² for V _{in} > 100V]	
Fixed Points	1.018 10 V	2.5 ppm 0.85 ppm	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
DC Current – Generate ⁴	(0 - 3.3) mA (3.3 - 33) mA (33 - 330) mA 330mA - 1.0 A (1.0 - 11) A 11 – 100 A	0.016 % + 0.05 uA 0.015 % 0.016 % 0.040 % 0.074 % 0.07 %	
DC Current – Measure ⁴	100 µA 1 mA 10 mA 100 mA 1 A (1 - 15) A (1 to 100) A	86 ppm 46 ppm 46 ppm 59 ppm 163 ppm 0.083 % 0.084 %	
DC Resistance – Generate Fixed Points	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ	3.5 ppm 3.4 ppm 3.4 ppm 0.22 ppm 0.38 ppm 0.75 ppm 0.30 ppm 0.36 ppm 0.38 ppm 0.90 ppm 2.4 ppm	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
DC Resistance – Measure	0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ	6 ppm 3 ppm 2 ppm 3 ppm 3 ppm 3 ppm 3 ppm 3 ppm 6 ppm 20 ppm 150 ppm	
DC Resistance – Measure	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	33 ppm + 5 ppm range 26 ppm 18 ppm 18 ppm 20 ppm 36 ppm 90 ppm 625 ppm	
Inductance – Generate Fixed Values (@ 1 kHz)	100 μH 1 mH 10 mH 100 mH 1 H 2 H	0.78 % 0.27 % 0.22 % 0.21 % 0.21 % 0.22 %	
Inductance – Measure (@1 kHz)	10 mH – 10 H	0.058 %	
Capacitance – Generate (@1 kHz) Fixed Values (@ 1 kHz) Fixed Values (@ 1 kHz)	1 pF – 1 μF 1 pF 10 pF 100 pF 1000 pF 10, 100 μF 1 mF 10 mF	0.10 % + 0.5 pF 5.6 ppm 5.1 ppm 5.1 ppm 5.1 ppm 0.30 % 0.30 % 0.37 %	

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
Capacitance – Measure (@1 kHz)	10 pF – 100 μF	0.58 %	
AC Voltage – Generate ⁴	<u>(1 - 33) mV</u> (10 - 45) Hz 45Hz - 10 kHz (10 - 20) kHz (20 - 50) kHz (50 - 100) kHz (100 - 500) kHz <u>(33 - 330) mV</u> (10 - 45) Hz 45Hz - 10 kHz (10 - 20) kHz (20 - 50) kHz (50 - 100) kHz (100 - 500) kHz <u>330mV - 3.3V</u> (10 - 45) Hz 45Hz - 10 kHz (10 - 20) kHz (20 - 50) kHz (50 - 100) kHz (100 - 500) kHz <u>(3.3 to 33) V</u> (10 Hz - 45) Hz 45Hz - 10 kHz (10 - 20) kHz (20 - 50) kHz (50 - 100) kHz <u>(33 - 330) V</u> 45Hz - 1 kHz (1 - 10) kHz (10 - 20) kHz <u>(330 to 1000) V</u> 45Hz - 1 kHz (1 - 10) kHz (10 - 20) kHz	0.55 % 0.35 % 0.40 % 0.45 % 0.68 % 1.6 % 0.30 % 0.070 % 0.12 % 0.20 % 0.41 % 1.3 % 0.18 % 0.036 % 0.086 % 0.17 % 0.41 % 0.83 % 0.18 % 0.046 % 0.11 % 0.24 % 0.41 % 0.057 % 0.080 % 0.098 % 0.058 % 0.20 % 0.20 %	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
AC Voltage – Measure ⁴	<u>10 mV</u>		HP 3458A w/ Opt 002
	(1 - 40) Hz	0.087 %	
	40 Hz - 1 kHz	0.064 %	
	(1 - 20) kHz	0.066 %	
	(20 - 50) kHz	0.14 %	
	(50 - 100) kHz	0.60 %	
	(100 - 300) kHz	4.7 %	
	<u>100 mV</u>		
	(1 - 40) Hz	0.018 %	
	40 Hz - 1 kHz	0.017 %	
	(1 - 20) kHz	0.024 %	
	(20 - 50) kHz	0.040 %	
	(50 - 100) kHz	0.11 %	
	(100 - 300) kHz	0.38 %	
	300 kHz - 1 MHz	1.2 %	
	(1 - 2) MHz	1.8 %	
	<u>1 V</u>		
	(1 - 40) Hz	0.014 %	
	40 Hz - 1 kHz	0.012 %	
	(1 - 20) kHz	0.019 %	
	(20 - 50) kHz	0.038 %	
	(50 - 100) kHz	0.095 %	
	(100 - 300) kHz	0.36 %	
	300 kHz - 1 MHz	1.2 %	
	(1 - 2) MHz	1.8 %	
	<u>10 V</u>		
	(1 to 40) Hz	0.014 %	
	40 Hz to 1 kHz	0.013 %	
	(1 to 20) kHz	0.019 %	
	(20 to 50) kHz	0.038 %	
	(50 to 100) kHz	0.096 %	
	(100 to 300) kHz	0.36 %	
	300 kHz to 1 MHz	1.2 %	
(1 to 2) MHz	1.8 %		
<u>100 V</u>			
(1 - 40) Hz	0.029 %		
40 Hz - 1 kHz	0.026 %		
(1 - 20) kHz	0.026 %		
(20 - 50) kHz	0.044 %		
(50 - 100) kHz	0.14 %		
(100 - 300) kHz	0.48 %		
300 kHz - 1 MHz	1.8 %		

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
AC Voltage – Measure ⁴	<u>1000 V</u> (1 - 40) Hz 40 Hz - 1 kHz (1 - 20) kHz (20 - 50) kHz (50 - 100) kHz	0.51 % 0.049 % 0.072 % 0.14 % 0.35 %	
AC Current – Generate ⁴	<u>(0.03 - 0.33) mA</u> (10 - 20) Hz (20 - 45) Hz 45 Hz - 1 kHz (1 - 5) kHz (5 - 10) kHz <u>(0.33 - 3.3) mA</u> (10 - 20) Hz (20 - 45) Hz 45 Hz - 1 kHz (1 - 5) kHz (5 - 10) kHz <u>(3.3 - 33) mA</u> (10 - 20) Hz (20 - 45) Hz 45 Hz - 1 kHz (1 - 5) kHz (5 - 10) kHz <u>(33 - 330) mA</u> (10 - 20) Hz (20 - 45) Hz 45 Hz - 1 kHz (1 - 5) kHz (5 - 10) kHz	0.40 % 0.38 % 0.38 % 0.55 % 1.4 % 0.23 % 0.13 % 0.13 % 0.23 % 0.63 % 0.23 % 0.13 % 0.12 % 0.23 % 0.63 % 0.23 % 0.13 % 0.12 % 0.23 % 0.63 %	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
AC Current – Generate ⁴	<u>330 mA - 2.2 A</u> (10 - 45) Hz 45 Hz - 1 kHz (1 - 5) kHz <u>(2.2 - 11) A</u> (45 - 65)Hz (65 - 500) Hz 500 Hz - 1 kHz <u>(11 - 100)A</u> (0.4 - 1) kHz	0.23 % 0.13 % 0.78 % 0.08 % 0.12 % 0.35 % 1.1 %	
AC Current – Measure	<u>100 μA</u> (10 - 20) Hz (20 - 45) Hz (45 - 100) Hz 100 Hz – 1 kHz <u>1 mA</u> (10 - 20) Hz (20 - 45) Hz (45 - 100) Hz 100 Hz – 5 kHz (5 - 20) kHz (20 - 50) kHz (50 - 100) kHz <u>10 mA</u> (10 - 20) Hz (20 - 45) Hz (45 - 100) Hz 100 Hz – 5 kHz (5 - 20) kHz (20 - 50) kHz (50 - 100) kHz	0.43 % 0.21 % 0.11 % 0.11 % 0.49 % 0.20 % 0.094 % 0.060 % 0.94 % 0.51 % 0.81 % 0.49 % 0.20 % 0.094 % 0.064 % 0.096 % 0.51 % 0.81 %	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
AC Current – Measure	<u>100 mA</u>		
	(10 - 20) Hz	0.49 %	
	(20 - 45) Hz	0.20 %	
	(45 - 100) Hz	0.12 %	
	100 Hz – 5 kHz	0.14 %	
	(5 - 20) kHz	0.094 %	
	(20 - 50) kHz	0.51 %	
	<u>1 A</u>		
	(10 - 20) Hz	0.49 %	
	(20 - 45) Hz	0.20 %	
	(45 - 100) Hz	0.12 %	
	100 Hz – 5 kHz	0.14 %	
	(5 - 20) kHz	0.37 %	
(20 - 50) kHz	1.3 %		
<u>10 mA - 2 A</u>			
100 Hz - 20 KHz	0.024%		

II. Electrical – RF / Microwave

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
RF Power Diode Sensors			
1 μW – 100 mW	50 MHz – 26.5 GHz	5.3 %	
1 μW – 100 mW	(33 to 50) GHz	5.3 %	
0.3 μW – 100 mW	DC – 4.2 GHz	5.1 %	
1 μW – 100 mW	(0.01 – 18) GHz	4.7 %	
100 pW – 100 μW	(0.05 – 16) GHz	5.8 %	
0.3 nW – 10 μW	(0.01 - 18) GHz	5.5 %	
RF Power Thermistor	10 MHz – 10 GHz	2.5 %	
Tuned RF Power Level – Measure			
0 dB Reference	2.5 MHz - 1.3 GHz	0 dB	
-0.0 to -10 dB		0.02 dB	
-10 to -20 dB		0.04 dB	
-20 to -30 dB		0.06 dB	
-30 to -40 dB		0.08 dB	
-40 to -50 dB		0.14 dB	
-50 to -60 dB		0.16 dB	
-60 to -70 dB		0.18 dB	
-70 to -80 dB		0.20 dB	
-80 to -90 dB		0.26 dB	
-90 to -100 dB		0.28 dB	
-100 to -110 dB		0.30 dB	
-110 to -127 dB	0.40 dB		

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
RF Fixed Coaxial Attenuation – Measure			
3 dB	DC – 12.4 GHz 12.4 – 18 GHz	0.35% 0.46%	
6 dB	DC – 12.4 GHz 12.4 – 18 GHz	0.35% 0.46%	
20 dB	DC – 12.4 GHz 12.4 – 18 GHz	0.69% 1.2%	
Network Analysis		From Cal Kit Report	
Reflection S ₁₁ /S ₂₂ Rho = 0.6 lin	45 MHz – 26.5 GHz	(0.00136 to 0.00843)lin	
Transmission S ₁₂ /S ₂₁ 20 dB Attenuator 40 dB Attenuator	45 MHz – 26.5 GHz	(0.038 to 0.054) dB (0.053 to 0.331) dB	

III. Time & Frequency

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
Frequency – Fixed Points	1, 5, 10 MHz	1 part in 10 ¹¹ (mfg specs)	
Generate	10 MHz 10 MHz – 26.5 GHz	0.5 parts in 10 ⁹ (24 hrs mfg specs) 1 part in 10 ⁹ (24 hrs mfg specs)	
	10 MHz - 20 GHz 20 GHz - 40 GHz	± 10 MHz ± 20 MHz (Army procedure)	
Frequency – Measure	10 Hz – 26.5 GHz	1 part in 10 ⁸ (1 year mfg specs)	

IV. Thermodynamic

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Temperature – Generate ⁴ Dry Blocks	(-30 to +93) °C (0 to 600) °C	1°C (From mfg) 1°C (from mfg)	
Temperature – Generate ⁴ Baths	(-30 to 125) °C (-10 to 110) °C	0.8°C (From mfg) 1°C (From mfg)	
Temperature – Measure Triple Point of Water	0.01°C @ 25°C	0.003K (From mfg)	
Infrared Black Body – Generate	(33 to 400) °C (100 to 982) °C	(From mfg) 2°C (33 to 250°C) 3°C (251 to 400°C) 25% of rdg	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Relative Humidity – Generate			
Fixed Points – Probe Kit	11.3% RH@25 °C 32.8% RH@25 °C 52.9% RH@25 °C 75.3% RH@25 °C	2% 2% 2% 2%	
Fixed Points – Salt Chamber	11.3% RH@25 °C 32.8% RH@25 °C 52.9% RH@25 °C 75.3% RH@25 °C	4% 4% 4% 4%	
Relative Humidity – Measure	(10 – 90) % RH	0.5% (From Mfg)	
Dew Point Measure	(0 - 50) °C	0.1% (From Mfg)	

V. Dimensional

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Gage Blocks	(0.05 – 0.9) in (1 – 4) in (0.5 – 5) mm (5 – 20) mm (20 – 25) mm (25 – 50) mm (50 – 75) mm (75 – 100) mm	(2.0 + 4.0L) µin (0.7 + 5.0L) µin 0.07 µm 0.12 µm 0.14 µm 0.26 µm 0.37 µm 0.48 µm	
Calipers ⁴	(0 - 40) in	0.6R	
Micrometers (Outside) ⁴	(0 - 40) in	0.6R	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Height Gages ⁴	(0.4 – 40) in	0.0013 μin	
Dial/Digimatic Indicators ⁴ Resolution: 50 μin Resolution: 100 μin Resolution: 1000 μin	0 - 2 in	0.6R 0.6R 0.6R	
Indicator Calibrator Resolution: 10 μin Resolution: 50 μin Resolution: 100 μin	0 – 1 in	10 μin 30 μin 60 μin	
Mu-Checker / Electronic Height Gage	± 0.00015 in ± 0.0005 in ± 0.0015 in ± 0.005 in ± 0.015 in ± 0.05 in	6.2 μin 12.0 μin 58.0 μin 116 μin 577 μin 1160 μin	
Inside Diameter	0-7 in	0.6R	
Height Masters	(1 – 12) in (12 – 24) in	60 μin 116 μin	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Ring Gages (Best is Class X)	(0.06 – 1) in (1 - 4) in (4 - 7) in (7 - 12) in	10 μin (10 +4L) μin (5 + 4L) μin (10 + 4L) μin	

VI. Mechanical

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Scale and Balances ⁴	1 mg – 200 g 2 oz – 200 lbs	0.2 mg 0.26 lbs	
Low Pressure	Up to 2 in H ₂ O	0.003 in H ₂ O	
Pressure – Measure			
Pneumatic Pistons	0.5 – 5 psig 1.5 – 100 psig 15 – 1000 psig	0.14% 0.14% 0.14%	
Hydraulic Pistons	6 – 15140 psig	0.14%	
Torque (For calibration of Transducers)	0.5 in oz to 200 in lbs 37.5 ft-lbs to 2000 ft-lbs	1.0 % 1.0 %	
Torque (For calibration of Wrenches and Screwdrivers)	0.5 in oz to 200 in lbs 37.5 ft-lbs to 2000 ft-lbs	2.4 % 2.4 %	

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Pipettes			
Spectrophotometric	0.1 – 5 000 µL	1 % (From Mfg.)	
Gravimetric	100 µL	0.2 µL	
	500 µL	1 µL	
	1000 µL	1 µL	
	2000 µL	2 µL	
	3000 µL	2 µL	
	4000 µL	2 µL	
	5000 µL	3 µL	

¹ This laboratory offers commercial and on-site calibration services.

² Best Uncertainties represent expanded uncertainties using a coverage factor of $k = 2$ which provides a level of confidence of approximately 95%.

³ L is the nominal length of the device in inches.

⁴ Calibration also performed onsite (client facility). Uncertainties obtained from on site calibrations are generally larger than the uncertainties obtained in the permanent laboratory environment.

"DISCLAIMER - The uncertainties achievable on a customer's site can normally be expected to be larger than the Best Measurement Capabilities (BMC) that the accredited laboratory has been assigned as Best Uncertainty 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 uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the calibration uncertainty being larger than the BMC."