



## Accredited Laboratory

A2LA has accredited

# Century Labs II dba Century Calibrations

Fort Wayne, IN

for technical competence in the field of

## Calibration

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 R205 – *Specific Requirements – Calibration Laboratory Accreditation Program*. 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 4<sup>th</sup> day of November 2016.

A handwritten signature in black ink, written over a horizontal line.

President and CEO  
For the Accreditation Council  
Certificate Number 2417.01  
Valid to May 31, 2018  
Revised January 16, 2017

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



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

CENTURY LABS II dba CENTURY CALIBRATIONS  
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CALIBRATION

Valid To: May 31, 2018

Certificate Number: 2417.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1</sup>:

I. Chemical Quantities

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
pH – Generate <sup>3</sup> , Fixed Points	(4, 7, 10) pH	0.029 pH	Certified pH solutions

II. Electrical – DC & Low Frequency

Parameter/Equipment	Range	CMC <sup>2, 4</sup> (±)	Comments
DC Voltage – Generate <sup>3</sup>	(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	32 µV/V + 0.80 µV 8.9 µV/V + 1.2 µV 8.7 µV/V + 4.0 µV 9.2 µV/V + 8.0 µV 9.2 µV/V + 0.10 mV 9.7 µV/V + 0.60 mV	5700 Fluke calibrator

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Voltage – Generate <sup>3</sup> (cont)	1100 V to 10 kV	0.03 %	HV source output monitored with Vitrek 4700
	(10 to 150) kV	0.08 %	HV source output monitored with Vitrek 4700 and HVL-150 probe
DC Voltage – Measure <sup>3</sup>	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V	11 µV/V 5.3 µV/V 3.8 µV/V 5.5 µV/V	8508A DMM
	(200 to 1000) V	6.1 µV/V	
DC High Voltage	(1 to 2) kV	0.043 % + 0.40 V	Vitrek 4600A
	(2 to 20) kV	0.31 % + 4 V	Vitrek 4700A with HVL-150 Probe
	(20 to 50) kV	2.4 %	
	(50 to 100) kV	2.5 %	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments	
AC Voltage – Generate <sup>3</sup>	(0.22 to 2.2) mV	(10 to 20) Hz	0.53 % + 5.0 µV	5700A calibrator
		(20 to 40) Hz	0.50 % + 5.0 µV	
		40 Hz to 20 kHz	0.51 % + 5.0 µV	
		(20 to 50) kHz	0.56 % + 5.0 µV	
		(50 to 100) kHz	0.83 % + 8.0 µV	
		(100 to 300) kHz	1.8 % + 15 µV	
		(300 to 500) kHz	4.1 % + 30 µV	
	(500 to 1000) kHz	14 % + 40 µV		
	(2.2 to 22) mV	(10 to 20) Hz	0.11 % + 6.0 µV	
		(20 to 40) Hz	0.074 % + 6.0 µV	
		40 Hz to 20 kHz	0.064 % + 6.0 µV	
		(20 to 50) kHz	0.093 % + 6.0 µV	
		(50 to 100) kHz	0.16 % + 8.0 µV	
		(100 to 300) kHz	0.34 % + 15 µV	
(300 to 500) kHz		0.53 % + 30 µV		
(500 to 1000) kHz	0.72 % + 40 µV			



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (cont)			5700A calibrator
(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 to 1000) kHz	0.16 % + 16 μV 0.031 % + 10 μV 0.020 % + 10 μV 0.042 % + 10 μV 0.11 % + 30 μV 0.14 % + 30 μV 0.33 % + 40 μV 3.6 % + 0.10 mV	
(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 (500 to 1000) kHz	0.059 % + 0.10 mV 0.020 % + 30 μV 0.010 % + 7.0 μV 0.015 % + 20 μV 0.034 % + 80 μV 0.059 % + 0.15 mV 0.15 % + 0.40 mV 0.32 % + 1.0 mV	
(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 to 1000) kHz	0.061 % + 1.0 mV 0.020 % + 0.30 mV 81 μV/V + 70 μV 0.015 % + 0.20 mV 0.031 % + 0.40 mV 0.069 % + 1.7 mV 0.16 % + 5.0 mV 0.39 % + 9.0 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	0.061 % + 10 mV 0.021 % + 3.0 mV 0.011 % + 1.0 mV 0.028 % + 4.0 mV 0.064 % + 10 mV	
(220 to 1100) V	(15 to 50 Hz) 50 Hz to 1 kHz	0.042 % + 4.0 mV 0.010 % + 4.0 mV	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup>			3458A option II DMM
(1 to 10) mV	(10 Hz to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.048 % + 3.0 μV 0.041 % + 1.1 μV 0.055 % + 1.1 μV 0.12 % + 1.1 μV 0.77 % + 1.1 μV 4.6 % + 2.0 μV	
(10 to 100) mV	(10 Hz to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	85 μV/V + 4.0 μV 86 μV/V + 2.0 μV 0.016 % + 2.0 μV 0.035 % + 2.0 μV 0.096 % + 2.0 μV 0.43 % + 10 μV	
(0.1 to 1) V	(10 Hz 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 1.0) MHz	0.013 % + 40 μV 0.012 % + 20 μV 0.024 % + 20 μV 0.044 % + 20 μV 0.12 % + 20 μV 0.48 % + 0.10 mV 1.7 % + 0.10 mV	
(1 to 10) V	(10 Hz 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 1.0) MHz	0.014 % + 0.40 mV 0.014 % + 0.20 mV 0.022 % + 0.20 mV 0.048 % + 0.20 mV 0.12 % + 0.20 mV 0.48 % + 1.0 mV 1.7 % + 1.0 mV	
(10 to 100) V	(10 Hz to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.033 % + 4.0 mV 0.033 % + 2.0 mV 0.033 % + 2.0 mV 0.056 % + 2.0 mV 0.19 % + 2.0 mV 0.63 % + 10 mV	
(100 to 700) V	(10 Hz to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz	0.056 % + 40 mV 0.056 % + 20 mV 0.074 % + 20 mV 0.14 % + 20 mV	
(0.0 to 2) kV	(20 to 100) Hz	0.54 % + 2 V	Vitrek 4600A
(0.0 to 2) kV	(100 to 400) Hz	0.67 % + 2 V	Vitrek 4700
(2 to 20) kV	(20 to 100) Hz	0.58 % + 20 V	Vitrek 4700 with HVL-150 HV probe
(20 to 100) kV	50 Hz to 1 kHz	2.9 %	



Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Current – Generate <sup>3</sup>	(0 to 220) $\mu$ A 220 $\mu$ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA	0.013 % + 10 nA 59 $\mu$ A/A + 10 nA 60 $\mu$ A/A + 0.10 $\mu$ A 70 $\mu$ A/A + 1.0 $\mu$ A	5700A calibrator  Add 200·I <sup>2</sup> $\mu$ A/A for I > 100 mA
	220 mA to 2.2 A	0.012 % + 30 $\mu$ A	Add 10·I <sup>2</sup> $\mu$ A/A for I > 1 A reference calibrator
	(1.1 to 2.99) A (2.2 to 11) A (11 to 20) A	0.051 % 0.060 % 0.11 %	Fluke 5520A calibrator
	(20 to 100) A	2.6 mA/A	Guildline 9211A shunt
	(16.5 to 149) A (150 to 1025) A	0.72 % 0.76 %	Fluke 5520, 5500A coil
DC Current – Measure <sup>3</sup>	(0 to 100) nA 100 nA to 1 $\mu$ A (1 to 10) $\mu$ A (10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	0.017 % + 40 pA 36 pA/A + 40 pA 0.67 nA/A + 0.1 nA 2.9 nA/A + 0.80 nA 30 nA/A + 5.0 nA 30 nA/A + 50 nA 47 $\mu$ A/A + 0.50 $\mu$ A 0.013 % + 10 $\mu$ A	3458A option II DMM
	(1 to 10) A (10 to 100) A (100 to 300) A	0.012 % + 3.0 $\mu$ A 0.058 % + 30 $\mu$ A 0.12 % + 30 $\mu$ A	Guildline 9211A
	(300 to 700) A (700 to 1000) A	3.6 % 5.9 %	Fluke 80i-1010 current probe



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current – Generate <sup>3</sup>			
(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	0.10 % + 30 nA 0.057 % + 25 nA 0.032 % + 20 nA 0.12 % + 50 nA 0.25 % + 0.10 µA	5700A calibrator
220 µA 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	0.076 % + 50 nA 0.040 % + 40 nA 0.020 % + 40 nA 0.10 % + 0.50 µA 0.24 % + 1.0 µA	
(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	0.078 % + 0.50 µA 0.046 % + 0.40 µA 0.020 % + 0.40 µA 0.10 % + 5.0 µA 0.24 % + 10 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	0.074 % + 5.0 µA 0.039 % + 4.0 µA 0.021 % + 4.0 µA 0.018 % + 50 µA 0.24 % + 0.10 mA	
220 mA to 2.2 A	(20 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.070 % + 40 µA 0.086 % + 0.10 mA 0.89 %	
(1.1 to 2.9) A	(10 to 45) Hz (0.45 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.19 % 0.11% 0.56 % 2.4 %	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current – Generate <sup>3</sup> (cont)			
(3 to 10.9) A	(45 to 100) Hz (0.1 to 1 ) kHz (1 to 5) kHz	0.36 % 0.38 % 2.5 %	5520A calibrator
(10.9 to 20.5) A	(45 to 100) Hz (0.1 to 1 ) kHz (1 to 5) kHz	0.14 % 0.17 % 2.4 %	
(16.5 to 149) A	(45 to 65) Hz (65 to 440) Hz	0.74 % 1.2 %	Fluke 5500A coil toroidal
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	1.3 % 1.9 %	
(16.5 to 149) A	(45 to 65) Hz (65 to 440) Hz	3.1 % 3.5 %	Fluke 5500A coil
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	9.6 % 10 %	
AC Current – Measure <sup>3</sup>			
(5 to 100) μA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.47 % + 30 nA 0.19 % + 30 nA 0.11 % + 30 nA 0.12 % + 30 nA	3458 A option II DMM
100 μA to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 0.20 μA 0.18 % + 0.20 μA 0.091 % + 0.20 μA 0.061 % + 0.20 μA 0.11 % + 0.20 μA 0.47 % + 0.40 μA 0.63 % + 1.5 μA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 2.0 μA 0.18 % + 2.0 μA 0.091 % + 2.0 μA 0.061 % + 2.0 μA 0.085 % + 2.0 μA 0.47 % + 4.0 μA 0.63 % + 15 μA	





Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current – Measure <sup>3</sup> (cont)			
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 20 µA 0.18 % + 20 µA 0.091 % + 20 µA 0.061 % + 20 µA 0.090 % + 20 µA 0.68 % + 40 µA 0.63 % + 0.15 mA	3458 A option II DMM
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.48 % + 0.20 mA 0.22 % + 0.20 mA 0.15 % + 0.20 mA 0.17 % + 0.20 mA 0.37 % + 0.20 mA 1.2 % + 0.40 mA	
(1 to 20) A (1 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.10 % 0.30 %	Fluke 8508A
(20 to 100) A (100 to 700) A 100 to 700) A	10 Hz to 1 kHz (48 to 62) Hz (62 to 440) Hz	0.16 % 3.5 % 5.8 %	Valhalla 2575 Fluke 80i-1010 Current probe
AC Watts <sup>3</sup> – Generate			
(0.1089 to 0.297) mW (0.297 to 2.97) mW (2.97 to 10.89) mW (10.89 to 72.60) mW (72.60 to 1485) mW (1.485 to 6.765) W (6.765 to 33.66) W (33.66 to 336.6) W (336.6 to 917.9) W (917.9 to 2244) W (2244 to 20 910) W	(45 to 65) Hz/PF=1	0.15 % 0.11 % 0.10 % 0.20 % 0.18 % 0.17 % 0.19 % 0.17 % 0.16 % 0.18 % 0.11 %	Fluke 5520A





Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Resistance – Measure <sup>3</sup>	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ	28 μΩ/Ω 25 μΩ/Ω 17 μΩ/Ω 14 μΩ/Ω 14 μΩ/Ω 14 μΩ/Ω 19 μΩ/Ω 28 μΩ/Ω 0.014 % 0.12 % 0.23 %	8508A DMM
Capacitance – Generate <sup>3</sup>			
(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz	0.52 % + 0.01 nF 0.52 % + 0.01 nF 0.52 % + 0.01 nF 0.27 % + 0.01 nF 0.27 % + 0.10 nF 0.27 % + 0.10 nF 0.27 % + 0.30 nF	5520A calibrator
330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	(10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	0.27 % + 1.0 nF 0.27 % + 3.0 nF 0.27 % + 10 nF 0.42 % + 30 nF 0.47 % + 0.10 μF 0.47 % + 0.30 μF 0.47 % + 1.0 μF 0.47 % + 3.0 μF 0.47 % + 10 μF 0.77 % + 30 μF 1.2 % + 0.10 mF	
Fixed Points –			
0.002 μF	(100, 120, 400) Hz, (1, 10 and 100) kHz	86 pF	GR 1409-X
0.5 μF	(100, 120, 400) Hz, 1kHz and 10 kHz	0.72 μF	GR 1409-G



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Capacitance – Measure <sup>3</sup>			
Up to 1 pF	40 kHz 100 kHz	0.34 % + 1 fF + 6 cts 0.34 % + 1 fF + 3 cts	Agilent 4274A LCR meter
(1 to 10) pF	4 kHz 10 kHz 20 kHz 40 kHz 100 kHz	0.34 % + 6 cts 0.34 % + 3 cts 0.34 % + 2 cts 0.34 % + 1 fF + 6 cts 0.34 % + 1 fF + 3 cts	cts: counts of LSD
(10 to 100) pF	400 Hz 1 kHz 2 kHz 4 kHz 10 kHz 20 kHz 40 kHz 100 kHz	0.34 % + 6 cts 0.34 % + 3 cts 0.34 % + 2 cts 0.34 % + 6 cts 0.34 % + 3 cts 0.34 % + 2 cts 0.34 % + 6 cts 0.34 % + 3 cts	
Up to 1 nF	100 Hz 120 Hz 200 Hz 400 Hz 1 kHz 2 kHz 4 kHz 10 kHz 20 kHz 40 kHz 100 kHz	0.3 % + 1 fF + 3 cts 0.3 % + 1 fF + 3 cts 0.3 % + 1 fF + 2 cts 0.3 % + 1 fF + 6 cts 0.3 % + 1 fF + 3 cts 0.3 % + 1 fF + 2 cts 0.3 % + 1 fF + 6 cts 0.3 % + 1 fF + 3 cts 0.3 % + 1 fF + 2 cts 0.34 % + 1 fF + 6 cts 0.34 % + 1 fF + 3 cts	
(1 to 10) nF	100 Hz 120 Hz 200 Hz 400 Hz 1 kHz 2 kHz 4 kHz 10 kHz 20 kHz 40 kHz 100 kHz	0.3 % + 1 fF + 3 cts 0.3 % + 1 fF + 3 cts 0.3 % + 1 fF + 2 cts 0.3 % + 1 fF + 6 cts 0.3 % + 1 fF + 3 cts 0.3 % + 2 cts 0.34 % + 6 cts 0.34 % + 3 cts 0.34 % + 2 cts 0.34 % + 1 fF + 6 cts 0.34 % + 1 fF + 3 cts	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments	
Capacitance – Measure <sup>3</sup> (cont)				
(10 to 100) nF	100 Hz	0.3 % + 3 cts	Agilent 4274A LCR meter  cts: counts of LSD	
	120 Hz	0.3 % + 3 cts		
	200 Hz	0.3 % + 2 cts		
	400 Hz	0.34 % + 6 cts		
	1 kHz	0.34 % + 3 cts		
	2 kHz	0.34 % + 2 cts		
	4 kHz	0.34 % + 6 cts		
	10 kHz	0.34 % + 3 cts		
	20 kHz	0.34 % + 2 cts		
	40 kHz	0.34 % + 6 cts		
	100 kHz	0.34 % + 3 cts		
	(100 to 1000) nF	100 Hz		0.34 % + 3 cts
		120 Hz		0.34 % + 3 cts
200 Hz		0.34 % + 2 cts		
400 Hz		0.34 % + 6 cts		
1 kHz		0.34 % + 3 cts		
2 kHz		0.34 % + 2 cts		
4 kHz		0.34 % + 1 cts		
10 kHz		0.34 % + 1 cts		
20 kHz		0.34 % + 1 cts		
40 kHz		0.34 % + 1 cts		
100 kHz		0.34 % + 1 cts		
(1 to 10) μF		100 Hz	0.34 % + 3 cts	
		120 Hz	0.34 % + 3 cts	
	200 Hz	0.34 % + 2 cts		
	400 Hz	0.34 % + 1 cts		
	1 kHz	0.34 % + 1 cts		
	2 kHz	0.34 % + 1 cts		
	4 kHz	0.34 % + 1 cts		
	10 kHz	0.34 % + 1 cts		
	20 kHz	0.34 % + 1 cts		
	40 kHz	3.0 % + 1 cts		
	100 kHz	3.0 % + 1 cts		



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Capacitance – Measure <sup>3</sup> (cont)			
(10 to 100) µF	100 Hz	0.34 % + 1 cts	Agilent 4274A LCR meter  cts: counts of LSD
	120 Hz	0.34 % + 1 cts	
	200 Hz	0.34 % + 1 cts	
	400 Hz	0.34 % + 1 cts	
	1 kHz	0.34 % + 1 cts	
	2 kHz	0.34 % + 1 cts	
	4 kHz	1.0 % + 1 cts	
	10 kHz	1.0 % + 1 cts	
	20 kHz	3.0 % + 1 cts	
(100 to 1000) µF	100 Hz	0.34 % + 1 cts	
	120 Hz	0.34 % + 1 cts	
	200 Hz	0.34 % + 1 cts	
	400 Hz	1.0 % + 1 cts	
	1 kHz	1.0 % + 1 cts	
	2 kHz	1.0 % + 1 cts	
	4 kHz	3.0 % + 1 cts	
	10 kHz	3.0 % + 1 cts	
	20 kHz	3.0 % + 1 cts	
(1 to 10) mF	100 Hz	1.0 % + 1 cts	
	120 Hz	1.0 % + 1 cts	
	200 Hz	1.0 % + 1 cts	
	400 Hz	3.0 % + 1 cts	
	1 kHz	3.0 % + 1 cts	
	2 kHz	3.0 % + 1 cts	
(10 to 100) mF	100 Hz	3.0 % + 1 cts	
	120 Hz	3.0 % + 1 cts	
	200 Hz	3.0 % + 1 cts	
	400 Hz	5.0 % + 1 cts	
	1 kHz	10 % + 1 cts	
	2 kHz	10 % + 1 cts	
(100 to 1000) mF	100 Hz	10 % + 1 cts	
	120 Hz	10 % + 1 cts	
	200 Hz	10 % + 1 cts	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Inductance – Generate <sup>3</sup>			
1 H	(0.1 to 1) kHz	0.17 %	Standard inductors
10 mH	(0.1 to 1) kHz	0.16 %	
200 μH	10 Hz to 1 kHz	0.29 %	
Inductance – Measure <sup>3</sup>	Fixed Points		
Up to 100 nH	(100, 120) Hz	1.2 % + 0.1 nH + 5 cts	Agilent 4274A LCR meter  cts: counts of LSD
	200 Hz	1.2 % + 0.1 nH + 5 cts	
	400 Hz	1.2 % + 0.1 nH + 5 cts	
	1 kHz	1.2 % + 0.1 nH + 5 cts	
	2 kHz	1.2 % + 0.1 nH + 5 cts	
	4 kHz	1.2 % + 0.1 nH + 5 cts	
	10 kHz	1.2 % + 0.1 nH + 5 cts	
	20 kHz	1.2 % + 0.1 nH + 5 cts	
	40 kHz	1.2 % + 0.1 nH + 5 cts	
	100 kHz	1.2 % + 0.1 nH + 5 cts	
(100 to 1000) nH	(100, 120) Hz	1.2 % + 0.1 nH + 5 cts	Multi-frequency LCR meter
	200 Hz	1.2 % + 0.1 nH + 5 cts	
	400 Hz	1.2 % + 0.1 nH + 5 cts	
	1 kHz	1.2 % + 0.1 nH + 5 cts	
	2 kHz	1.2 % + 0.1 nH + 5 cts	
	4 kHz	1.2 % + 0.1 nH + 5 cts	
	10 kHz	0.58 % + 0.1 nH + 5 cts	
	20 kHz	1.2 % + 0.1 nH + 5 cts	
	40 kHz	1.2 % + 0.1 nH + 5 cts	
	100 kHz	0.35 % + 0.1 nH + 3 cts	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Inductance – Measure <sup>3</sup> (cont)			
(1 to 10) μH	(100, 120) Hz	1.2 % + 0.1 nH + 5 cts	Multi-frequency LCR meter  cts: counts of LSD
	200 Hz	1.2 % + 0.1 nH + 5 cts	
	400 Hz	1.2 % + 0.1 nH + 5 cts	
	1 kHz	0.58 % + 0.1 nH + 5 cts	
	2 kHz	0.58 % + 0.1 nH + 5 cts	
	4 kHz	0.58 % + 0.1 nH + 5 cts	
	10 kHz	0.35 % + 3 cts	
	20 kHz	0.35 % + 3 cts	
	40 kHz	0.35 % + 3 cts	
	100 kHz	0.12 % + 3 cts	
(10 to 100) μH	(100, 120) Hz	0.58 % + 0.1 nH + 5 cts	
	200 Hz	0.58 % + 0.1 nH + 5 cts	
	400 Hz	0.58 % + 0.1 nH + 5 cts	
	1 kHz	0.35 % + 3 cts	
	2 kHz	0.35 % + 3 cts	
	4 kHz	0.35 % + 3 cts	
	10 kHz	0.12 % + 3 cts	
	20 kHz	0.12 % + 3 cts	
	40 kHz	0.12 % + 3 cts	
	100 kHz	0.23 % + 3 cts	
(0.1 to 1) mH	(100, 120) Hz	0.35 % + 3 cts	
	200 Hz	0.35 % + 3 cts	
	400 Hz	0.35 % + 3 cts	
	1 kHz	0.12 % + 3 cts	
	2 kHz	0.12 % + 3 cts	
	4 kHz	0.12 % + 3 cts	
	10 kHz	0.23 % + 3 cts	
	20 kHz	0.23 % + 3 cts	
	40 kHz	0.23 % + 3 cts	
	100 kHz	0.12 % + 1 cts	





Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Inductance – Measure <sup>3</sup> (cont)			
(1 to 10) mH	(100, 120) Hz	0.12 % + 3 cts	Multi-frequency LCR meter  cts: counts of LSD
	200 Hz	0.12 % + 3 cts	
	400 Hz	0.12 % + 3 cts	
	1 kHz	0.23 % + 3 cts	
	2 kHz	0.23 % + 3 cts	
	4 kHz	0.23 % + 3 cts	
	10 kHz	0.12 % + 1 cts	
	20 kHz	0.12 % + 1 cts	
	40 kHz	0.12 % + 1 cts	
	100 kHz	0.12 % + 1 cts	
(10 to 100) mH	(100, 120) Hz	0.23 % + 1 cts	
	200 Hz	0.23 % + 1 cts	
	400 Hz	0.23 % + 1 cts	
	1 kHz	0.12 % + 1 cts	
	2 kHz	0.12 % + 1 cts	
	4 kHz	0.12 % + 1 cts	
	10 kHz	0.12 % + 1 cts	
	20 kHz	0.12 % + 1 cts	
	40 kHz	0.12 % + 1 cts	
	100 kHz	0.12 % + 1 cts	
100 mH to 1 H	(100, 120) Hz	0.12 % + 1 cts	
	200 Hz	0.12 % + 1 cts	
	400 Hz	0.12 % + 1 cts	
	1 kHz	0.12 % + 1 cts	
	2 kHz	0.12 % + 1 cts	
	4 kHz	0.12 % + 1 cts	
	10 kHz	0.12 % + 1 cts	
	20 kHz	0.12 % + 1 cts	
	40 kHz	0.12 % + 1 cts	
	100 kHz	3.5 % + 1 cts	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Inductance – Measure <sup>3</sup> (cont)			
(1 to 10) H	(100, 120) Hz 200 Hz 400 Hz 1 kHz 2 kHz 4 kHz 10 kHz 20 kHz 40 kHz	0.12 % + 1 cts 0.12 % + 1 cts 0.12 % + 1 cts 0.12 % + 1 cts 0.12 % + 1 cts 0.12 % + 1 cts 0.35 % + 1 cts 0.35 % + 1 cts 0.35 % + 1 cts	Multi-frequency LCR meter  cts: counts of LSD
(10 to 100) H	(100, 120) Hz 200 Hz 400 Hz 1 kHz 2 kHz 4 kHz	0.12 % + 1 cts 0.12 % + 1 cts 0.12 % + 1 cts 3.5 % + 1 cts 3.5 % + 1 cts 3.5 % + 1 cts	
1000 H	(100, 120) Hz 200 Hz 400 Hz 1 kHz 2 kHz 4 kHz	3.5 % + 1 cts 3.5 % + 1 cts 3.5 % + 1 cts 5.8 % + 1 cts 5.8 % + 1 cts 5.8 % + 1 cts	

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Dissipation Factor – Measure (Df) <sup>3</sup>			
1 pF to 100 µF	(0.0001 to 10) Df	3.5 % + 1 cts	Multi-frequency LCR meter  cts: counts of LSD



Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Electrical Calibration of Thermocouple Indicating Systems <sup>3</sup> – Simulation			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.30 °C 0.33 °C	5520A calibrator
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.30 °C 0.26 °C 0.31 °C 0.50 °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	0.50 °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 -25) °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 0.40 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.40 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	



Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Calibration of Thermocouple Indicating Systems <sup>3</sup> – Simulation (cont)			
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 0.40 °C	5520A calibrator
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	
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 0.20 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	
Electrical Calibration of RTD Indicators <sup>3</sup> – Simulation			
Pt 385, 100 Ω	(-200 to 100) °C (100 to 630) °C (630 to 800) °C	0.09 °C 0.15 °C 0.27 °C	5520A calibrator
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 300) °C (300 to 630) °C	0.08 °C 0.12 °C 0.15 °C	
Pt 3916, 100 Ω	(-190 to 0.0) °C (0.0 to 260) °C (260 to 600) °C (600 to 630) °C	0.07 °C 0.09 °C 0.12 °C 0.26 °C	



Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Electrical Calibration of RTD Indicators <sup>3</sup> – Simulation (cont)			
Pt 385, 200 Ω	(-200 to 260) °C (260 to 400) °C (400 to 630) °C	0.07 °C 0.15 °C 0.19 °C	5520A calibrator
Pt 385, 500 Ω	(-200 to 260) °C (260 to 600) °C (600 to 630) °C	0.08 °C 0.11 °C 0.13 °C	
Pt 385, 1000 Ω	(-200 to 100) °C (100 to 600) °C (600 to 630) °C	0.06 °C 0.08 °C 0.27 °C	
PtNi 385, 120 Ω	(-80 to 100) °C (100 to 260) °C	0.10 °C 0.16 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.35 °C	
Oscilloscopes <sup>3</sup> –			
Edge Rise Time 50 Ω Load @ 0.25V <sub>pk-pk</sub>	(1 to 999) kHz (1 to 10) MHz	0.03 % 0.03 %	5520A SC1100 calibrator
50 Ω Load @ 0.5V <sub>pk-pk</sub>	(1 to 999) kHz (1 to 10) MHz	0.03 % 0.03 %	
50 Ω Load @ 1V <sub>pk-pk</sub>	(1 to 999) kHz (1 to 10) MHz	0.03 % 0.03 %	
50 Ω Load @ 2.5V <sub>pk-pk</sub>	(1 to 999) kHz (1 to 10) MHz	0.03 % 0.03 %	
DC Voltage 1 M Ω Load	(0 to 130) V	0.058 % + 40 μV	
50 Ω Load	(0 to 6.6) V	0.29 % + 40 μV	
Square Wave 1 M Ω Load	1 mV to 130 V <sub>pk-pk</sub>	0.12 % + 40 μV	
Up to 1 kHz	1 mV to 130 V <sub>pk-pk</sub>	0.29 % + 40 μV	
>1 kHz	1 mV to 6.6 V <sub>pk-pk</sub>	0.29 % + 40 μV	
50 Ω Load			



Parameter/Equipment	Range	CMC <sup>2, 5</sup> (±)	Comments
Oscilloscopes <sup>3</sup> – (cont)			
Flatness @ 50 Ω Reference & Relative to 50 kHz	50 kHz to 10 MHz	0.12 % + 0.10 mV	5520A SC1100 calibrator
	50 kHz to 100 MHz	0.12 % + 0.10 mV	
	(100 to 300) MHz	0.012 % + 0.10 mV	
	(300 to 600) MHz	0.012 % + 0.10 mV	
	(0.6 to 1.1) GHz	0.012 % + 0.10 mV	
Timing @ 1Vp	(1 to 100) ns	0.11 %	
	(0.1 to 50) ms	0.11 %	
	(0.05 to 5) s	0.11 %	

### III. Mechanical

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Torque <sup>3</sup>	(2 to 4) in·ozf	1.2 % of reading	Torque transducers with torque analyzer
	(4 to 20) in·ozf	0.69 % of reading	
	(1 to 2) in·lbf	1.2 % of reading	
	(2 to 10) in·lbf	0.68 % of reading	
	(10 to 50) in·lbf	0.61 % of reading	
	(50 to 100) in·lbf	1.2 % of reading	
	(100 to 500) in·lbf	0.68 % of reading	
	(25 to 50) ft·lbf	1.3 % of reading	
	(50 to 250) ft·lbf	0.83 % of reading	
	(250 to 1000) ft·lbf	1.3 % of reading	



Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Vacuum and Pressure – Pneumatic <sup>3</sup>	(-25 to 100) psi (100 to 300) psi (300 to 1999) psi	0.06 % FS 0.09 % FS 0.53 % FS	Fluke 3130 calibrator
Manometer Pressure <sup>3</sup>	(0 to 20) inH <sub>2</sub> O (0 to 200) inH <sub>2</sub> O	0.04 inH <sub>2</sub> O 0.25 inH <sub>2</sub> O	MeriCal DP200C manometer
Absolute <sup>3</sup>	(0 to 900) mmHg	0.22 % FS	Miriam 350 absolute manometer
Hydraulic <sup>3</sup>	(500 to 7000) psi (0.0 to 10 000) psi	0.13 % FS + 0.06 psi 0.20 % FS	Ashcroft 7000 and Omegadyne DP4 transducers

#### IV. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Infrared <sup>3</sup>	(200 to 350) °C (350 to 700) °C (700 to 850) °C	4.8 °C 10 °C 13 °C	Black bodies: Micron 305 and 310
Relative Humidity – Measure <sup>3</sup>	(0 to 11) % RH (11 to 30) % RH (30 to 50) % RH (50 to 70) % RH (70 to 80) % RH (80 to 90) % RH	1.3 % RH 1.3 % RH 1.4 % RH 1.4 % RH 1.4 % RH 2.4 % RH	Vaisala HMI 31



Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Temperature – Measuring Equipment <sup>3</sup>	(-25 to 0) °C (0 to 150) °C (150 to 200) °C (200 to 300) °C (300 to 420) °C	0.013 °C 0.012 °C 0.012 °C 0.014 °C 0.024 °C	Fluke 9142  Fluke 9144 w/ Hart Scientific 5615-12 PRT
Temperature – Measure <sup>3</sup> , Fixed Points	-196 °C -39 °C 0.0 °C 232 °C 420 °C	32 mK 11 mK 16 mK 17 mK 30 mK	Hart Scientific 5615-12 PRT

## V. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Frequency – Measure <sup>3</sup>	20 Hz to 200 MHz (200 to 1300) MHz	1 part in 10 <sup>8</sup> Hz/Hz 1 part in 10 <sup>5</sup> Hz/Hz	Frequency counter and differential meter using 10 MHz distributed signal

<sup>1</sup> This laboratory offers commercial and field calibration services.

<sup>2</sup> 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.

<sup>3</sup> 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.





<sup>4</sup> The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC are expressed as either a specific value that covers the full range or as a fraction/percentage of the reading plus a fixed floor specification.

<sup>5</sup> The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

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