CALIBRATION LABORATORIES **NVLAP LAB CODE 200566-0**

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

Global Calibration Laboratory at Fluke Biomedical	Fields of Calibration
2 Science Road Glenwood, Illinois 60425 Mr. Richard Abbott Phone: 440-542-3644 Fax: 440-542-3682 E-mail: richard.abbott@flukebiomedical.com URL: www.globalcal.com	Electromagnetics - DC/Low Frequency Time and Frequency Thermodynamic This laboratory is compliant to ANSI/NCSL Z540-1-1994; Part 1. (20/A01)

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Note: The parameters listed in this scope of accreditation are for the calibration of electrical analyzers used in the biomedical field and do not apply to other devices.

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty Note 3,5	Remarks
ELECTROMAGNETICS – DC/LOW FREQUENCY				
AC RESISTORS (20/E02)				
AC Current – Measuring Equipment	> 0 µA to 220 µA	20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz	0.017 % + 9.8 nA 0.011 % + 7.8 nA 0.027 % + 12 nA	Fluke 5720A
	0.22 mA to 2.2 mA	20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz	0.016 % + 36 nA 0.011 % + 32 nA 0.019 % + 0.10 µA	
	2.2 mA to 22 mA	20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz	0.016 % + 0.39 µA 0.011 % + 0.32 µA 0.019 % + 0.54 µA	
	22 mA to 220 mA	20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz	0.016 % + 4.3 µA 0.011 % + 2.5 µA 0.019 % + 3.1 µA	
	0.22 A to 2.2 A	20 Hz to 1 kHz 1 kHz to 5 kHz	0.025 % + 71 µA 0.039 % + 81 µA	

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty Note 3,5	Remarks
AC Current -- Measure	2.2 A to 11 A	40 Hz to 1 kHz 1 kHz to 5 kHz	0.036 % + 0.17 mA 0.074 % + 0.31 mA	Fluke 5720A / 5725A
	0.1 A to 15 A	40 Hz to 1 kHz	0.35 % + 70 mA	Current Source Characterized with Fluke 8846A and Shunt
	330 µA to 3.3 mA	45 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz 10 kHz to 30 kHz	0.12 % + 0.60 µA 0.23 % + 0.62 µA 0.58 % + 0.67 µA 1.2% + 0.90 µA	Fluke 5520A
	Up to 100 µA	20 Hz to 5 kHz 5 kHz to 10 kHz	0.017 % + 69 nA 0.40 % + 0.81 µA	Fluke 8846A
	> 100 µA to 1 mA	20 Hz to 5 kHz 5 kHz to 10 kHz	0.12 % + 0.46 µA 0.23 % + 2.9 µA	
	> 1 mA to 10 mA	20 Hz to 5 kHz 5 kHz to 10 kHz	0.17 % + 6.9 µA 0.40 % + 81 µA	
	> 10 mA to 100 mA	20 Hz to 5 kHz 5 kHz to 10 kHz	0.12 % + 46 µA 0.23 % + 0.29 mA	
	> 100 mA to 400 mA	20 Hz to 1 kHz 1 kHz to 10 kHz	0.12 % + 0.47 mA 0.23 % + 3.2 mA	
	> 400 mA to 1 A	20 Hz to 5 kHz 5 kHz to 10 kHz	0.12 % + 0.47 mA 0.40 % + 8.1 mA	

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty [Note 3,5]	Remarks
	> 1 A to 3 A	20 Hz to 5 kHz 5 kHz to 10 kHz	0.17 % + 2.1 mA 0.40 % + 24 mA	
	> 3 A to 10 A	20 Hz to 5 kHz 5 kHz to 10 kHz	0.17 % + 6.9 mA 0.40 % + 81 mA	
	> 10 A to 25 A	50 Hz to 60 Hz	0.27 A	Fluke 8846A w/Shunt

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty [Note 3,5]	Remarks
DC RESISTANCE and CURRENT (20/E05)			
DC Resistance – Measuring Equipment	0 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	86 μΩ 0.16 mΩ 0.29 mΩ 1.3 mΩ 8.5 mΩ 88 mΩ 1.1 Ω 19 Ω 0.38 kΩ 12 kΩ	Fluke 5720A
	0 Ω to 110 Ω > 0.11 kΩ to 1.111 kΩ	0.012 % +2.3 mΩ 0.012 % +2.4 mΩ	IET Labs 1433-02
	0 Ω to 1 MΩ	1.2 % + 58 mΩ	IET Labs HPRS
	1 kΩ to 100 kΩ > 100 kΩ to 10 MΩ > 10 MΩ to 100 MΩ	0.035 % + 23 mΩ 0.035 % 0.12 %	IET Labs HRRS

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty [Note 3,5]	Remarks
	> 100 MΩ to 1GΩ	0.23 %	
	0.05 Ω	0.14 mΩ	Shunt Resistor
	0.10 Ω	0.30 mΩ	
	0.15 Ω	0.50 mΩ	
DC Resistance -- Measure	45 mΩ to 165 mΩ	0.008 % + 0.24 mΩ	Fluke 5520 and Agilent 3458A
	0.05 Ω	87 µΩ	Fluke 5520A with Fluke 8846A
	0.10 Ω	0.27 mΩ	
	0.15 Ω	0.47 mΩ	
	0 Ω to 100 Ω	0.012 % + 2.3 mΩ	Keithley 2700
	> 0.1 kΩ to 1 kΩ	0.012 % + 7.0 mΩ	
	> 1 kΩ to 10 kΩ	0.012 % + 70 mΩ	
	> 10 kΩ to 100 kΩ	0.012 % + 1.2 Ω	
	> 0.1 MΩ to 1 MΩ	0.012 % + 12 Ω	
	> 1 MΩ to 10 MΩ	0.046 % + 0.12 kΩ	
	> 10 MΩ to 100 MΩ	0.23 % +3.5 kΩ	
	0 Ω to 10 Ω	0.012 % + 3.5 mΩ	Fluke 8846A
	> 10 Ω to 100 Ω	0.012 % + 4.6 mΩ	
	> 0.1 kΩ to 1 kΩ	0.012 % + 12 mΩ	
	> 1 kΩ to 10 kΩ	0.012 % + 0.12 Ω	
	> 10 kΩ to 100 kΩ	0.012 % + 1.2 Ω	
	> 0.1 MΩ to 1 MΩ	0.012 % + 12 Ω	
	> 1 MΩ to 10 MΩ	0.046 % + 0.12 kΩ	
	> 10 MΩ to 100 MΩ	0.92 % + 1.2 kΩ	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty Note 3,5	Remarks
DC Current – Measure	0 µA to 100 µA	0.058 % + 29 nA	Fluke 8846A
	> 100 µA to 1 mA	0.058 % + 58 nA	
	> 1 mA to 10 mA	0.058 % + 2.3 µA	
	> 10 mA to 100 mA	0.058 % + 5.8 µA	
	> 100 mA to 400 mA	0.058 % + 40 µA	
	> 400 mA to 1 A	0.058 % + 0.23 mA	
	> 1 A to 3 A	0.12 % + 0.69 mA	
	> 3A to 10 A	0.17 % + 0.93 mA	
DC Current – Generate	0 µA to 220 µA	39 µA/A + 6.6 nA	Fluke 5720A
	> 220 µA to 2.2 mA	31 µA/A + 7.6 nA	
	> 2.2 mA to 22 mA	31 µA/A + 0.37 µA	
	> 22 mA to 100 mA	39 µA/A + 0.84 µA	
	> 100 mA to 220 mA	46 µA/A + 0.84 µA	
	> 220 mA to 1 A	62 µA/A + 34 µA	
	> 1 A to 2.2 A	0.01 % + 34 µA	
	> 2.2 A to 11 A	0.028 % + 0.38 mA	Fluke 5702A/5725A
DC VOLTAGE (20/E06)			
DC Voltage – Measuring Equipment	0 V to 0.22 V	7.0 µV/V + 0.70 µV	Fluke 5720A
	> 0.22 V to 2.2 V	4.7 µV/V + 1.0 µV	
	> 2.2 V to 11 V	3.1 µV/V + 6.7 µV	
	> 11 V to 22 V	3.1 µV/V + 58 µV	
	> 22 V to 220 V	4.7 µV/V + 0.12 mV	
	>220 V to 1100 V	6.2 µV/V + 0.82 mV	
DC Voltage Measure	0 V to 0.1 V	0.0043 % + 4.1 µV	Fluke 8846A
	> 0.1 V to 1 V	0.0029 % + 8.1 µV	
	> 1 V to 10 V	0.0028 % + 58 µV	
	> 10 V to 100 V	0.0044 % + 0.7 mV	
	> 100 V to 1000 V	0.0047 % + 7.0 mV	
	0 V to 0.1 V	0.0035 % + 4.1 µV	Keithley 2700
	> 0.1 V to 1 V	0.0035 % + 8.1 µV	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty [Note 3,5]	Remarks
	> 1 V to 10 V > 10 V to 100 V > 100 V to 500 V > 500 V to 1000 V	0.0035 % + 58 µV 0.0052 % + 1.0 mV 0.0058 % + 10 mV 0.0069 % + 10 mV	

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty [Note 3,5]	Remarks
LF AC VOLTAGE (20/E09)				
AC Voltage Measuring Equipment	22 mV to 220 mV	40 Hz to 20 kHz	78 µV/V + 6.3 µV	Fluke 5720A
		> 20 kHz to 50 kHz	0.019 % + 6.2 µV	
		> 50 kHz to 100 kHz	0.047 % + 16 µV	
		> 100 kHz to 300 kHz	0.085 % + 19 µV	
	220 mV to 2.2 V	40 Hz to 20 kHz	40 µV/V + 11 µV	
		> 20 kHz to 50 kHz	70 µV/V + 12 µV	
		> 50 kHz to 100 kHz	0.010 % + 32 µV	
		> 100 kHz to 300 kHz	0.039 % + 88 µV	
	2.2 V to 22 V	40 Hz to 20 kHz	40 µV/V + 0.12 mV	
		> 20 kHz to 50 kHz	70 µV/V + 0.21 mV	
		> 50 kHz to 100 kHz	93 µV/V + 0.37 mV	
		> 100 kHz to 300 kHz	0.025 % + 0.81 mV	
	22 V to 220 V	40 Hz to 20 kHz	50 µV/V + 0.99 mV	
		> 20 kHz to 50 kHz	78 µV/V + 2.4 mV	
		> 50 kHz to 100 kHz	0.014 % + 4.0 mV	
		> 100 kHz to 300 kHz	0.085 % + 16 mV	
	220 V to 1000 V	40 Hz to 1 kHz	70 µV/V + 6.1 mV	Fluke 5720A/5725A
		> 1 kHz to 20 kHz	0.13 % + 9.0 mV	

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty Note 3,5	Remarks
		> 20 kHz to 30 kHz	0.47 % + 12 mV	
	220 V to 750 V	30 kHz to 50 kHz	0.047 % + 8.6 mV	
		> 50 kHz to 100 kHz	0.18 % + 35 mV	
AC Voltage – measure	5 mV to 100 mV	40 Hz to 20 kHz	0.069 % + 46 µV	Fluke 8846A
		> 20 kHz to 50 kHz	0.14 % + 58 µV	
		> 50 kHz to 100 kHz	0.69 % + 92 µV	
		> 100 kHz to 300 kHz	4.6 % + 0.58 mV	
	0.1 V to 1 V	40 Hz to 20 kHz	0.069 % + 0.35 mV	
		> 20 kHz to 50 kHz	0.14 % + 0.58 mV	
		> 50 kHz to 100 kHz	0.69 % + 0.92 mV	
		> 100 kHz to 300 kHz	4.6 % + 5.8 mV	
	1 V to 10 V	40 Hz to 20 kHz	0.069 % + 3.5 mV	
		> 20 kHz to 50 kHz	0.14 % + 5.8 mV	
		> 50 kHz to 100 kHz	0.69 % + 9.2 mV	
		> 100 kHz to 300 kHz	4.6 % + 58 mV	
	10 V to 100 V	40 Hz to 20 kHz	0.069 % + 35 mV	
		> 20 kHz to 50 kHz	0.14 % + 58 mV	
		> 50 kHz to 100 kHz	0.69 % + 92 mV	
		> 100 kHz to 300 kHz	4.6 % + 0.58 V	
	100 V to 1000 V	40 Hz to 20 kHz	0.069 % + 0.26 V	
		> 20 kHz to 30 kHz	0.14 % + 0.43 V	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty [Note 3,5]	Remarks
LF POWER/ENERGY (20/E12)			
LF Energy -- Measure	0.1 J to 400 J	0.28 % + 0.044 J	Agilent 3458A, Reference Resistor, Reference Divider
LF Energy -- Generate	0.1 J to 400 J	0.28 % + 0.14 J	Impulse 7000 "Gold Std"
AC Power - Source 300 kHz to 500 kHz	1 W to 320 W	2.5 %	RF Voltmeter, Current Coil, Fluke 8846A
TIME & FREQUENCY			
FREQUENCY DISSEMINATION (20/F01)			
Frequency	1 Hz to 10 Hz 10 Hz to 100 kHz	0.027 % 0.011 %	Keithley 2700
MECHANICAL			
FLOW RATE (20/M05)			
Gas Flow	0.1 SLM to 1 SLM 3 SLM to 11 SLM 11 SLM to 110 SLM 110 SLM to 220 SLM 220 SLM to 300 SLM	0.23 % + 0.0017 SLM 0.22 % + 0.13 SLM 0.24 % + 0.27 SLM 0.23 % + 1.4 SLM 0.23 % + 2.4 SLM	Gas flow measured at ambient T & P, then data standardized to 21.0 °C and 1013 mbar. Fluke Molblocs, Molbox1
THERMODYNAMIC			
HUMIDITY (20/T02)			
Relative Humidity – Measuring Equipment			
20 °C to 50 °C	25 % to 65 % RH	1.4 % RH	Fluke RH Sensor with PRT & DewK, Thermal Chamber
19 °C to 26 °C	0 % RH	1.3 %	Vaisala RH Sensor, MI70, HMP77B

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty [Note 3,5]	Remarks
LABORATORY THERMOMETERS, DIGITAL and ANALOG (20/T03)			
Resistance Thermometers	0 °C to 50 °C	0.05 °C	Fluke PRT with Chub E4
PRESSURE (20/T05)			
Pneumatic Gauge Pressure - Measure	0 psi to 10 psi	0.0032 psi	Heise HQS-2
Pneumatic Gauge Pressure - Source	-15 psi to -2 psi > -2 psi to < -1 psi -1 psi to 1 psi 0 psi to 2 psi > 1 psi to 2 psi > 2 psi to 10 psi > 10 psi to 15 psi > 15 psi to 50 psi > 50 psi to 75 psi > 75 psi to 100 psi > 100 psi to 150 psi	0.0065 psi 0.00070 psi 0.00064 psi 0.00070 psi 0.00070 psi 0.0013 psi 0.0026 psi 0.0067 psi 0.011 psi 0.013 psi 0.018 psi	Mensor APC 600
	-90 kPa to -60 kPa -60 kPa to 60 kPa 60 kPa to 100 kPa 100 kPa to 1 MPa -1 kPa to 1 kPa ± (1 to 4.5) kPa ± (4.5 to 15) kPa	133 Pa 94 Pa 110 Pa 340 Pa 0.003 % + 1 Pa 0.003 % + 8 Pa 0.02 % + 10 Pa	Fluke 6270A Pressure Controller / Calibrator
Pneumatic Absolute Pressure - Source	60 kPa to 200 kPa	110 Pa	Fluke 6270A Pressure Controller / Calibrator

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty Note 3,5	Remarks
TEMPERTURE INDICATORS (20/T08)			
Electrical Calibration of Thermocouple Devices Type K	0 °C to 60 °C	0.25 °C	Fluke 525A, Fluke 5500A
END			

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Notes

Note 1: A Calibration and Measurement Capability (CMC) is a description of the best result of a calibration or measurement (result with the smallest uncertainty of measurement) that is available to the laboratory's customers under normal conditions, when performing more or less routine calibrations of nearly ideal measurement standards or instruments. The CMC is described in the laboratory's scope of accreditation by: the measurement parameter/device being calibrated, the measurement range, the uncertainty associated with that range (see note 3), and remarks on additional parameters, if applicable.

Note 2: Calibration and Measurement Capabilities are traceable to the national measurement standards of the U.S. or to the national measurement standards of other countries and are thus traceable to the internationally accepted representation of the appropriate SI (Système International) unit.

Note 3: The uncertainty associated with a measurement in a CMC is an expanded uncertainty with a level of confidence of approximately 95 %, typically using a coverage factor of $k = 2$. However, laboratories may report a coverage factor different than $k = 2$ to achieve the 95 % level of confidence. Units for the measurand and its uncertainty are to match. Exceptions to this occur when marketplace practice employs mixed units, such as when the artifact to be measured is labeled in non-SI units and the uncertainty is given in SI units (Example: 5 lb weight with uncertainty given in mg).

Note 3a: The uncertainty of a specific calibration by the laboratory may be greater than the uncertainty in the CMC due to the condition and behavior of the customer's device and specific circumstances of the calibration. The uncertainties quoted do not include possible effects on the calibrated device of transportation, long term stability, or intended use.

Note 3b: As the CMC represents the best measurement results achievable under normal conditions, the accredited calibration laboratory shall not report smaller uncertainty of measurement than that given in a CMC for calibrations or measurements covered by that CMC.

Note 3c: As described in Note 1, CMCs cover calibrations and measurements that are available to the laboratory's customers under *normal conditions.* However, the laboratory may have the capability to offer special tests, employing special conditions, which yield calibration or measurement results with lower uncertainties. Such special tests are not covered by the CMCs and are outside the laboratory's scope of accreditation. In this case, NVLAP requirements for the labeling, on calibration reports, of results outside the laboratory's scope of accreditation apply. These requirements are set out in Annex A.5. of NIST Handbook 150, Procedures and General Requirements.

Note 4: Uncertainties associated with field service calibration may be greater as they incorporate on-site environmental contributions, transportation effects, or other factors that affect the measurements. (This note applies only if marked in the body of the scope.)

Note 5: Values listed with percent (%) are percent of reading or generated value unless otherwise noted.

Note 6: NVLAP accreditation is the formal recognition of specific calibration capabilities. Neither NVLAP nor NIST guarantee the accuracy of individual calibrations made by accredited laboratories.

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