



**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
AND ANSI/NCSL Z540-1-1994 (R2002)**

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CALIBRATION

Valid to: **September 19, 2020**

Certificate Number: **L2299**

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Source 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz (50 to 400) Hz (50 to 400) Hz (50 to 200) Hz (50 to 100) Hz (50 to 100) Hz	(0.33 to 11) nF (11 to 110) nF (110 to 330) nF (0.33 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 (0.33 to 1.1) mF	0.4 % of reading + 0.01 nF 0.25 % of reading + 0.1 nF 0.25 % of reading + 0.3 nF 0.25 % of reading + 1 nF 0.35 % of reading + 3 nF 0.35 % of reading + 10 nF 0.4 % of reading + 30 nF 0.5 % of reading + 100 nF 0.7 % of reading + 300 nF 0.85 % of reading + 300 nF	Fluke 5500A Multiproduct Calibrator
DC Current – Source	(0 to 3.2) mA (0 to 32) mA (0 to 320) mA (0 to 2.1) A (0 to 11) A	0.11 mA/A + 0.05 μA 90 μA/A + 0.25 μA 90 μA/A + 3.35 μA 0.28 mA/A + 44 μA 0.55 mA/A + 330 μA	Fluke 5500A Multiproduct Calibrator
DC Current – Measure	(1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	35 μA/A + 0.1 nA 35 μA/A + 0.8 nA 35 μA/A + 0.005 μA 35 μA/A + 0.05 μA 51 μA/A + 0.5 μA 0.14 mA/A + 10 μA	HP 3458A Multimeter

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AC Current – Source	(0.03 to 0.33) mA		Fluke 5500A Multiproduct Calibrator
	(10 to 20) Hz	0.2 % of reading + 0.15 μ A	
	(20 to 45) Hz	0.1 % of reading + 0.15 μ A	
	45 Hz to 1 kHz	0.1 % of reading + 0.15 μ A	
	(1 to 5) kHz	0.3 % of reading + 0.15 μ A	
	(5 to 10) kHz	1 % of reading + 0.15 μ A	
	(0.33 to 3.3) mA		
	(10 to 20) Hz	0.2 % of reading + 0.3 μ A	
	(20 to 45) Hz	0.1 % of reading + 0.3 μ A	
	45 Hz to 1 kHz	0.1 % of reading + 0.3 μ A	
	(1 to 5) kHz	0.2 % of reading + 0.3 μ A	
	(5 to 10) kHz	0.6 % of reading + 0.3 μ A	
	(3.3 to 33) mA		
	(10 to 20) Hz	0.2 % of reading + 3 μ A	
	(20 to 45) Hz	0.1 % of reading + 3 μ A	
45 Hz to 1 kHz	0.08 % of reading + 3 μ A		
(1 to 5) kHz	0.2 % of reading + 3 μ A		
(5 to 10) kHz	0.5 % of reading + 3 μ A		
AC Current – Source	(33 to 330) mA		Fluke 5500A Multiproduct Calibrator
	(10 to 20) Hz	0.2 % of reading + 30 μ A	
	(20 to 45) Hz	0.1 % of reading + 30 μ A	
	45 Hz to 1 kHz	0.08 % of reading + 30 μ A	
	(1 to 5) kHz	0.2 % of reading + 30 μ A	
	(5 to 10) kHz	0.5 % of reading + 30 μ A	
	(0.33 to 2.2) A		
	(10 to 45) Hz	0.16 % of reading + 300 μ A	
	45 Hz to 1 kHz	0.08 % of reading + 300 μ A	
	(1 to 5) kHz	0.6 % of reading + 300 μ A	
	(2.2 to 11) A		
	(45 to 65) Hz	0.06 % of reading + 2 mA	
	(65 to 500) Hz	0.1 % of reading + 2 mA	
	500 Hz to 1 kHz	0.33 % of reading + 2 mA	

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AC Current – Measure	(0 to 100) μ A		HP 3458A Multimeter
	(20 to 45) Hz	2 μ A/mA + 0.03 μ A	
	(45 to 100) Hz	1.1 μ A/mA + 0.03 μ A	
	100 Hz to 5 kHz	1 μ A/mA + 0.03 μ A	
	(0.1 to 1) mA		
	(20 to 45) Hz	2 μ A/mA + 0.2 μ A	
	(45 to 100) Hz	1.1 μ A/mA + 0.2 μ A	
	100 Hz to 5 kHz	0.7 μ A/mA + 0.2 μ A	
	(1 to 10) mA		
	(20 to 45) Hz	2 μ A/mA + 2 μ A	
	(45 to 100) Hz	1.1 μ A/mA + 2 μ A	
	100 Hz to 5 kHz	0.7 μ A/mA + 2 μ A	
	(10 to 100) mA		
	(20 to 45) Hz	2 μ A/mA + 20 μ A	
(45 to 100) Hz	1 μ A/mA + 20 μ A		
100 Hz to 5 kHz	0.7 μ A/mA + 20 μ A		
Resistance – Source	(0 to 11) Ω	0.01 % of reading + 5 m Ω	Fluke 5500A Multiproduct Calibrator
	(11 to 33) Ω	0.01 % of reading + 0.01 Ω	
	(33 to 330) Ω	0.008 % of reading + 0.01 Ω	
	330 Ω to 3.3 k Ω	0.008 % of reading + 0.06 Ω	
	(3.3 to 33) k Ω	0.008 % of reading + 0.6 Ω	
	(33 to 110) k Ω	0.009 % of reading + 6 Ω	
	(110 to 330) k Ω	0.01 % of reading + 6 Ω	
	330 k Ω to 3.3 M Ω	0.013 % of reading + 55 Ω	
	(3.3 to 11) M Ω	0.05 % of reading + 0.55 k Ω	
	(11 to 33) M Ω	0.09 % of reading + 0.55 k Ω	
	(33 to 110) M Ω	0.4 % of reading + 5.5 k Ω	
	(110 to 330) M Ω	0.4 % of reading + 17 k Ω	



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Resistance – Measure	(0 to 10) Ω	20 $\mu\Omega/\Omega$ + 0.5 m Ω	HP 3458A Multimeter	
	(10 to 100) Ω	17 $\mu\Omega/\Omega$ + 0.5 m Ω		
	(0.1 to 1) k Ω	15 $\mu\Omega/\Omega$ + 0.5 m Ω		
	(1 to 10) k Ω	15 $\mu\Omega/\Omega$ + 5 m Ω		
	(10 to 100) k Ω	16 $\mu\Omega/\Omega$ + 0.05 Ω		
	(0.1 to 1) M Ω	21 $\Omega/M\Omega$ + 2 Ω		
	(1 to 10) M Ω	57 $\Omega/M\Omega$ + 100 Ω		
DC Voltage – Source	(10 to 100) M Ω	600 $\Omega/M\Omega$ + 1 k Ω	Fluke 5500A Multiproduct Calibrator	
	(0.1 to 1) G Ω	6 k $\Omega/M\Omega$ + 10 k Ω		
	(0 to 330) mV	48 $\mu\text{V}/\text{V}$ + 3 μV		
	(0 to 3.3) V	40 $\mu\text{V}/\text{V}$ + 5 μV		
DC Voltage – Measure	(0 to 33) V	40 $\mu\text{V}/\text{V}$ + 50 μV	HP 3458A Multimeter	
	(33 to 330) V	48 $\mu\text{V}/\text{V}$ + 0.5 mV		
	(100 to 1 020) V	48 $\mu\text{V}/\text{V}$ + 1.5 mV		
	DC Voltage – Measure	(1 to 100) mV	16 $\mu\text{V}/\text{V}$ + 0.3 μV	HP 3458A Multimeter
		(0.1 to 1) V	15 $\mu\text{V}/\text{V}$ + 0.3 μV	
		(1 to 10) V	15 $\mu\text{V}/\text{V}$ + 0.5 μV	
		(10 to 100) V	18 $\mu\text{V}/\text{V}$ + 30 μV	
DC Voltage – Measure	(100 to 1 000) V	15 $\mu\text{V}/\text{V}$ + 0.1 mV	Vitretek 4640A Voltmeter	
	(0 to 2 000) V	0.7 mV/V + 0.4 V		
	(2 000 to 40 000) V	1 mV/V + 8 V		

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AC Voltage – Source	(1 to 33) mV		Fluke 5500A Multiproduct Calibrator
	(10 to 45) Hz	0.32 % of reading + 20 μ V	
	45 Hz to 10 kHz	0.11 % of reading + 20 μ V	
	(10 to 20) kHz	0.18 % of reading + 20 μ V	
	(20 to 50) kHz	0.19 % of reading + 20 μ V	
	(50 to 100) kHz	0.3 % of reading + 33 μ V	
	(100 to 500) kHz	0.9 % of reading + 60 μ V	
	(33 to 330) mV		
	(10 to 45) Hz	0.25 % of reading + 50 μ V	
	45 Hz to 10 kHz	0.05 % of reading + 20 μ V	
	(10 to 20) kHz	0.1 % of reading + 20 μ V	
	(20 to 50) kHz	0.16 % of reading + 40 μ V	
	(50 to 100) kHz	0.24 % of reading + 0.17 mV	
	(100 to 500) kHz	0.7 % of reading + 0.33 mV	
	(0.33 to 3.3) V		
(10 to 45) Hz	0.15 % of reading + 0.25 mV		
45 Hz to 10 kHz	0.03 % of reading + 60 μ V		
(10 to 20) kHz	0.08 % of reading + 60 μ V		
(20 to 50) kHz	0.14 % of reading + 0.3 mV		
(50 to 100) kHz	0.24 % of reading + 1.7 mV		
(100 to 500) kHz	0.5 % of reading + 3.3 mV		
(3.3 to 33) V			
(10 to 45) Hz	0.12 % of reading + 2.5 mV		
45 Hz to 10 kHz	0.04 % of reading + 0.6 mV		
(10 to 20) kHz	0.08 % of reading + 2.6 mV		
(20 to 50) kHz	0.15 % of reading + 5 mV		
(50 to 100) kHz	0.24 % of reading + 17 mV		
AC Voltage – Source	(33 to 330) V		Fluke 5500A Multiproduct Calibrator
	45 Hz to 1 kHz	0.05 % of reading + 6.6 mV	
	(1 to 10) kHz	0.08 % of reading + 15 mV	
	(10 to 20) kHz	0.09 % of reading + 33 mV	
	(330 to 1 020) V		
	45 Hz to 1 kHz	0.05 % of reading + 80 mV	
(1 to 5) kHz	0.2 % of reading + 0.1 V		
(5 to 10) kHz	0.2 % of reading + 0.5 V		



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Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure	(0 to 10) mV		HP 3458A Multimeter
	40 Hz to 1 kHz	365 $\mu\text{V}/\text{V}$ + 1.1 μV	
	(1 to 20) kHz	425 $\mu\text{V}/\text{V}$ + 1.1 μV	
	(20 to 50) kHz	1.5 $\mu\text{V}/\text{mV}$ + 1.1 μV	
	(10 to 100) mV		
	40 Hz to 1 kHz	200 $\mu\text{V}/\text{V}$ + 2 μV	
	(1 to 20) kHz	250 $\mu\text{V}/\text{V}$ + 2 μV	
	(20 to 50) kHz	450 $\mu\text{V}/\text{V}$ + 2 μV	
	(0.1 to 1) V		
	40 Hz to 1 kHz	200 $\mu\text{V}/\text{V}$ + 20 μV	
	(1 to 20) kHz	230 $\mu\text{V}/\text{V}$ + 20 μV	
	(20 to 50) kHz	450 $\mu\text{V}/\text{V}$ + 20 μV	
AC Voltage – Measure	(1 to 10) V		HP 3458A Multimeter
	40 Hz to 1 kHz	200 $\mu\text{V}/\text{V}$ + 0.2 mV	
	(1 to 20) kHz	230 $\mu\text{V}/\text{V}$ + 0.2 mV	
	(20 to 50) kHz	450 $\mu\text{V}/\text{V}$ + 0.2 mV	
	(10 to 100) V		
	40 Hz to 1 kHz	320 $\mu\text{V}/\text{V}$ + 2 mV	
	(1 to 20) kHz	320 $\mu\text{V}/\text{V}$ + 2 mV	
	(20 to 50) kHz	560 $\mu\text{V}/\text{V}$ + 2 mV	
	AC Voltage – Measure	(100 to 1 000) V	
40 Hz to 1 kHz		0.5 mV/V + 20 mV	
(1 to 20) kHz		0.8 mV/V + 20 mV	
(20 to 50) kHz		1.5 mV/V + 20 mV	Vitrek 4640A Voltmeter
(0 to 2 000) V			
(40 to 100) Hz		11 mV/V + 2 V	
(100 to 400) Hz		14 mV/V + 4 V	BL 1395B Thermal Converter w/ HP 3458A Multimeter
(2 000 to 40 000) V			
(50 to 60) Hz		8 mV/V + 60 V	
AC Voltage – Measure	(0.001 to 1) V		BL 1395B Thermal Converter w/ HP 3458A Multimeter
	(0 to 10) MHz	1.5 mV/V	
	(10 to 100) MHz	16 mV/V	



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Indicating Systems-Source	Type E		Fluke 5500A Multiproduct Calibrator
	(-250 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.13 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.13 °C	
	(650 to 1 000) °C	0.17 °C	
	Type J		
	(-210 to -100) °C	0.16 °C	
	(-100 to -30) °C	0.13 °C	
	(-30 to 150) °C	0.12 °C	
	(150 to 760) °C	0.14 °C	
	(760 to 1 200) °C	0.18 °C	
	Type K		
	(-200 to -100) °C	0.26 °C	
	(-100 to 125) °C	0.15 °C	
	(125 to 120) °C	0.13 °C	
	(120 to 1 000) °C	0.21 °C	
	(1 000 to 1 372) °C	0.32 °C	
	Type R		
	(0 to 250) °C	0.45 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.31 °C	
	Type S		
(0 to 250) °C	0.37 °C		
(250 to 1 000) °C	0.3 °C		
(1 000 to 1 400) °C	0.31 °C		
(1 400 to 1 767) °C	0.31 °C		
Type T			
(-250 to -150) °C	0.5 °C		
(-150 to 0) °C	0.2 °C		
(0 to 120) °C	0.13 °C		
(120 to 400) °C	0.12 °C		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude – DC 50 Ω 1 MΩ	(-2.2 to 2.2) V (-33 to 33) V	0.21 % of reading + 0.1 mV 0.2 % of reading + 0.1 mV	Fluke 5500A w/ SC300 Multiproduct Calibrator
Amplitude – Square Wave 50 Ω 1 MΩ	1.8 mV to 2.2 V (p-p) 1.8 mV to 105 V (p-p)	0.23 % of reading + 0.1 mV 0.28 % of reading + 0.1 mV	
Leveled Sine Wave	50 kHz reference	1.8 % of reading + 0.2 mV	
Amplitude	50 kHz to 100 MHz (100 to 300) MHz	3.4 % of reading + 0.3 mV 3.6 % of reading + 0.3 mV	
Flatness	50 kHz to 100 MHz (100 to 300) MHz	1.8 % of reading + 0.1 mV 2 % of reading + 0.1 mV	
Time Marker ²	5 s to 100 μs (50 to 2) μs 1 μs to 2 ns	(20 + 1 000t) μs/s (20 + 15 000t) μs/s 20 μs/s	

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Force – Measure	(0 to 100) lbf	0.2 lbf	Chatillon DFS2-100 Force Gage
Pressure – Measure	(-0.3 to 0.3) psi (-5 to 5) psi (-10 to 10) psi (-14.7 to 75) psi (-14.7 to 100) psi	0.000 05 psi 0.000 59 psi 0.001 2 psi 0.008 8 psi 0.012 psi	Mensor APC600 Pressure Controller
Torque – Measure	(4 to 50) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (20 to 250) lbf·ft	0.4 % of reading 0.4 % of reading 0.4 % of reading 0.4 % of reading	Snap On Versatest w/ TTC400 Transducer

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Source	0.01 Hz to 12 kHz (12 to 120) kHz 120 kHz to 1.2 MHz (1.2 to 2) MHz	63 μ Hz/Hz + 1 mHz 70 μ Hz/Hz + 15 mHz 62 μ Hz/Hz + 15 mHz 290 μ Hz/Hz + 15 mHz	Fluke 5500A Multiproduct Calibrator
Frequency – Measure	(1 to 40) Hz 40 Hz to 10 MHz	0.6 mHz/Hz 0.2 mHz/Hz	HP 3458A Multimeter

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 ($k=2$), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
2. t = time in seconds.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. L2299.



Vice President

