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The ANSI National Accreditation Board

Hereby attests that

Transcat - Portland

**14058 SW Milton Court
Portland, OR 97224**

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

**ANSI/NCSL Z540-1-1994 (R2002) AND
ANSI/NCSL Z540.3-2006 (R2013)**

In the field of

CALIBRATION

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 07 September 2021

Certificate Number: AC-2489.01



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
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 April 2017).

**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017,
ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3 (R2013)**

Transcat - Portland

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CALIBRATION

Valid to: **September 7, 2021**

Certificate Number: **AC-2489.01**

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sine Wave Flatness ¹	Up to 3 V		Thermal Voltage Converters
	(10 to 100) Hz	0.07 % of reading	
	100 Hz to 300 kHz	0.071 % of reading	
	300 kHz to 10 MHz	0.13 % of reading	
	(10 to 20) MHz	0.21 % of reading	
	(20 to 30) MHz	0.22 % of reading	
	(30 to 50) MHz	0.48 % of reading	
	(50 to 70) MHz	0.75 % of reading	
(70 to 80) MHz	0.89 % of reading		
(80 to 100) MHz	1 % of reading		
DC Current – Source/Measure ¹	(0 to 100) μ A	26 μ A/A + 0.92 nA	Agilent 3458A 8.5 Digit Multimeter, Current Source
	100 μ A to 1 mA	26 μ A/A + 5.8 nA	
	(1 to 10) mA	26 μ A/A + 58 nA	
	(10 to 100) mA	43 μ A/A + 0.58 μ A	
	100 mA to 1 A	0.01 % of reading + 12 μ A	
	(1 to 10) A	0.013 % of reading	Guildline 9211 DC Current Shunt, Current Source
	(10 to 100) A	0.048 % of reading	
	(100 to 300) A	0.062 % of reading	
DC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor ¹	(20 to 150) A	0.5 % of reading + 0.14 A	Fluke 5520A Multiproduct Calibrator, Wavetek Coil
	(150 to 1 000) A	0.52 % of reading + 0.5 A	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
DC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor ¹	(1 000 to 5 000) A	0.58 % of reading	Fluke 52120A Transconductance Amplifier, Fluke 5520A Multiproduct Calibrator, 3 kA or 6 kA Coil	
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	0.46 % of reading + 30 nA 0.17 % of reading + 30 nA 0.072 % of reading + 30 nA	Agilent 3458A 8.5 Digit Multimeter	
	(0.1 to 1) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 0.2 μ A 0.17 % of reading + 0.2 μ A 0.071 % of reading + 0.2 μ A 0.038 % of reading + 0.2 μ A		
	(1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 2 μ A 0.17 % of reading + 2 μ A 0.071 % of reading + 2 μ A 0.038 % of reading + 2 μ A		
	(10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 20 μ A 0.17 % of reading + 20 μ A 0.071 % of reading + 20 μ A 0.038 % of reading + 20 μ A		
	100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 0.2 mA 0.19 % of reading + 0.2 mA 0.1 % of reading + 0.2 mA 0.12 % of reading + 0.2 mA		
	(1 to 3) A 10 Hz to 5 kHz	0.17 % of reading + 1.8 mA		
	(3 to 10) A 10 Hz to 1 kHz	0.18 % of reading + 6 mA		
	(10 to 100) A 10 Hz to 1 kHz	0.12 % of reading		
				Fluke 8846A 6.5 Digit Multimeter
				Ohms Labs Current Shunt, Digital Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
AC Current – Source ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.03 % of reading + 16 nA 0.02 % of reading + 10 nA 0.02 % of reading + 8 nA 0.03 % of reading + 12 nA 0.11 % of reading + 65 nA	Fluke 5720A Multiproduct Calibrator	
	(0.22 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	0.03 % of reading + 40 nA 0.02 % of reading + 35 nA 0.01 % of reading + 35 nA 0.02 % of reading + 0.11 μ A 0.11 % of reading + 0.65 μ A		
	(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	0.04 % of reading + 0.4 μ A 0.02 % of reading + 0.35 μ A 0.01 % of reading + 0.35 μ A 0.02 % of reading + 0.55 μ A 0.11 % of reading + 5 μ A		
	(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	0.03 % of reading + 4 μ A 0.02 % of reading + 3.5 μ A 0.01 % of reading + 2.5 μ A 0.02 % of reading + 3.5 μ A 0.11 % of reading + 10 μ A		
	(0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.03 % of reading + 35 μ A 0.05 % of reading + 80 μ A 0.7 % of reading + 0.16 mA		
	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.05 % of reading + 0.17 mA 0.1 % of reading + 0.38 mA 0.36 % of reading + 0.75 mA		Fluke 5720A-EP Multiproduct Calibrator, Fluke 5725A Amplifier
	(11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.09 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.3 % of reading + 3.9 mA		Fluke 5520 A Multiproduct Calibrator
	(20 to 100) A 10 Hz to 1 kHz	0.12 % of reading		Ohms Labs Current Shunt, Current Source

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	Up to 10 A 50 Hz to 1 kHz 1 kHz (10 to 100) A (50 to 100) Hz (100 to 999) Hz	0.05 % of reading + 1.3 mA 0.12 % of reading + 1.3 mA 0.04 % of reading + 2.3 mA 0.42 % of reading + 2.3 mA	Ohms Labs CS-100 Precision Shunt w/ Agilent 3458A Multimeter and Source
AC Current – Source ¹ Extended Frequency Ranges	(29 to 330) μ A (10 to 30) kHz (0.33 to 3.3) mA (10 to 30) kHz (3.3 to 33) mA (10 to 30) kHz (33 to 330) mA (10 to 30) kHz	1.2 % of reading + 3 μ A 0.78 % of reading + 0.5 μ A 0.31 % of reading + 3 μ A 0.31 % of reading + 0.16 mA	Fluke 5520A Multiproduct Calibrator
AC Clamp-on Ammeters (Toroidal Type) Transformer Type Sensor ¹	(20 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz	0.34 % of reading + 35 mA 0.95 % of reading + 66 mA 0.38 % of reading + 0.17 A 1.2 % of reading + 0.29 A	Fluke 5520A Calibrator, Wavetek Coil
AC Clamp-on Ammeters (Non-Toroidal Type) Hall Effect Sensor ¹	(20 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz (1 000 to 6 000) A (10 to 300) Hz (300 to 440) Hz	0.66 % of reading + 0.26 A 1.2 % of reading + 0.29 A 0.68 % of reading + 1 A 1.4 % of reading + 1.2 A 0.77 % of reading 0.77 % of reading	
DC Resistance – Source/Measure ¹	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω	18 $\mu\Omega/\Omega$ + 58 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.58 m Ω 12 $\mu\Omega/\Omega$ + 0.58 m Ω 12 $\mu\Omega/\Omega$ + 5.8 m Ω 12 $\mu\Omega/\Omega$ + 58 m Ω 19 $\mu\Omega/\Omega$ + 2.3 Ω 62 $\mu\Omega/\Omega$ + 120 Ω 0.06 % of reading + 1.2 k Ω 0.58 % of reading + 12 k Ω	Agilent 3458A 8.5 Digit Multimeter, Decade Resistor



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source ¹ (Fixed)	0.33 mΩ	0.047 % of reading	DC Current Shunt
	1 mΩ	0.037 % of reading	
	10 mΩ	0.013 % of reading	
	100 mΩ	0.012 % of reading	
DC Resistance – Source (Variable)	(10 to 100) MΩ	0.036 % of reading	Decade Resistor
	(0.1 to 1) GΩ	0.13 % of reading	
	(1 to 10) GΩ	0.25 % of reading	
	(10 to 100) GΩ	0.59 % of reading	
	(100 to 900) GΩ 1 TΩ	0.77 % of reading 1.6 % of reading	
DC Voltage – Source/Measure ¹	(0 to 100) mV	7.1 μV/V + 0.58 μV	Agilent 3458A 8.5 Digit Multimeter, Fluke 5700A-EP Multiproduct Calibrator
	(0.1 to 10) V	5.1 μV/V + 0.58 μV	
	(10 to 100) V	7.6 μV/V + 35 μV	
	(100 to 500) V	11 μV/V + 0.12 mV	
	(500 to 800) V	16 μV/V + 0.12 mV	
	(800 to 1 000) V	21 μV/V + 0.12 mV	
DC High Voltage – Measure ¹	(1 to 10) kV	0.04 % of reading + 92 mV	Vitretek 4700 Digital HV Meter, Associated High Voltage Probes
	(10 to 20) kV	0.09 % of reading + 2.4 V	
	(20 to 70) kV	0.09 % of reading + 2.4 V	
	(70 to 100) kV	0.17 % of reading + 2.5 V	
DC Voltage – Source ¹	(Up to 0.22) V	10 μV/V + 0.71 μV	Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier
	(0.22 to 2.2) V	5.1 μV/V + 0.71 μV	
	(2.2 to 11) V	3.7 μV/V + 2.6 μV	
	(11 to 22) V	3.8 μV/V + 4.1 μV	
	(22 to 220) V	5.1 μV/V + 41 μV	
	(220 to 1 100) V	7 μV/V + 0.41 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	Up to 1 mV		Rohde & Schwarz URE3 RMS Voltmeter
	100 kHz to 1 MHz	1.8 % of reading + 2.4 μ V	
	(1 to 3) MHz	3.5 % of reading + 2.4 μ V	
	(3 to 10) MHz	9.3 % of reading + 2.4 μ V	
	(10 to 20) MHz	23 % of reading + 2.4 μ V	
	(1 to 3) mV		
	100 kHz to 1 MHz	0.97 % of reading + 2 μ V	
	(1 to 3) MHz	3.5 % of reading + 2 μ V	
	(3 to 10) MHz	9.3 % of reading + 2 μ V	
	(10 to 20) MHz	23 % of reading + 2 μ V	
	(3 to 100) mV		
	100 kHz to 1 MHz	0.91 % of reading + 3 μ V	
(1 to 3) MHz	1.8 % of reading + 3 μ V		
(3 to 10) MHz	2.9 % of reading + 3 μ V		
(10 to 20) MHz	7 % of reading + 3 μ V		
(20 to 30) MHz	14 % of reading + 3 μ V		
AC Voltage – Measure ¹	Up to 10 mV		Agilent 3458A 8.5 Digit Multimeter
	(1 to 40) Hz	0.04 % of reading + 3.5 μ V	
	40 Hz to 1 kHz	0.04 % of reading + 1.2 μ V	
	(1 to 20) kHz	0.04 % of reading + 1.2 μ V	
	(20 to 50) kHz	0.15 % of reading + 1.2 μ V	
	(50 to 100) kHz	0.59 % of reading + 1.2 μ V	
	(100 to 300) kHz	4.6 % of reading + 2.3 μ V	
	300 kHz to 1 MHz	1.5 % of reading + 5.8 μ V	
	(1 to 4) MHz	8.1 % of reading + 8.1 μ V	
	(10 to 100) mV		
	(1 to 40) Hz	0.01 % of reading + 4.6 μ V	
	40 Hz to 1 kHz	0.01 % of reading + 2.3 μ V	
	(1 to 20) kHz	0.02 % of reading + 2.3 μ V	
	(20 to 50) kHz	0.04 % of reading + 2.3 μ V	
	(50 to 100) kHz	0.09 % of reading + 2.3 μ V	
	(100 to 300) kHz	0.36 % of reading + 12 μ V	
	300 kHz to 1 MHz	1.2 % of reading + 12 μ V	
	(1 to 2) MHz	1.9 % of reading + 12 μ V	
(2 to 4) MHz	4.7 % of reading + 81 μ V		
(4 to 8) MHz	4.7 % of reading + 92 μ V		
(8 to 10) MHz	17 % of reading + 0.12 mV		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(0.1 to 1) V		Agilent 3458A 8.5 Digit Multimeter
	(1 to 40) Hz	0.01 % of reading + 46 μ V	
	40 Hz to 1 kHz	0.01 % of reading + 23 μ V	
	(1 to 20) kHz	0.02 % of reading + 23 μ V	
	(20 to 50) kHz	0.04 % of reading + 23 μ V	
	(50 to 100) kHz	0.09 % of reading + 23 μ V	
	(100 to 300) kHz	0.35 % of reading + 0.12 mV	
	300 kHz to 1 MHz	1.2 % of reading + 0.12 mV	
	(1 to 2) MHz	1.9 % of reading + 0.12 mV	
	(2 to 4) MHz	4.7 % of reading + 0.81 mV	
	(4 to 8) MHz	4.7 % of reading + 0.92 mV	
	(8 to 10) MHz	17 % of reading + 1.2 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.01 % of reading + 0.46 mV	
	40 Hz to 1 kHz	0.01 % of reading + 0.23 mV	
	(1 to 20) kHz	0.02 % of reading + 0.23 mV	
	(20 to 50) kHz	0.04 % of reading + 0.23 mV	
	(50 to 100) kHz	0.09 % of reading + 0.23 mV	
	(100 to 300) kHz	0.35 % of reading + 1.2 mV	
	300 kHz to 1 MHz	1.2 % of reading + 1.2 mV	
	(1 to 2) MHz	1.8 % of reading + 1.2 mV	
	(2 to 4) MHz	4.47% of reading + 8.1 mV	
	(4 to 8) MHz	4.7 % of reading + 9.2 mV	
	(8 to 10) MHz	17 % of reading + 12 mV	
(10 to 100) V			
(1 to 40) Hz	0.02 % of reading + 4.6 mV		
40 Hz to 1 kHz	0.02 % of reading + 2.3 mV		
(1 to 20) kHz	0.02% of reading + 2.3 mV		
(20 to 50) kHz	0.04 % of reading + 2.3 mV		
(50 to 100) kHz	0.14 % of reading + 2.3 mV		
(100 to 300) kHz	0.46 % of reading + 12 mV		
300 kHz to 1 MHz	1.7 % of reading + 12 mV		
(100 to 700) V			
(1 to 40) Hz	0.05 % or reading + 46 mV		
40 Hz to 1 kHz	0.05 % of reading + 23 mV		
(1 to 20) kHz	0.07 % or reading + 23 mV		
(20 to 50) kHz	0.14 % of reading + 23 mV		
(50 to 100) kHz	0.35 % of reading + 23 mV		
AC High Voltage – Measure ¹	(0.7 to 10) kV		Vitretek 4600 Digital HV Meter
	(20 to 100) Hz	0.14 % of reading + 0.37 V	
	(100 to 400) Hz	0.48 % of reading + 0.17 V	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage – Measure ¹	(10 to 30) kV	0.11 % of reading + 2.4 V	Vitretek 4700 Digital HV Meter, Associated High Voltage Probes
	(30 to 70) Hz	0.7 % of reading + 2.4 V	
	(70 to 200) Hz	1.4 % of reading + 2.4 V	
	(200 to 450) Hz	0.13 % of reading + 2.5 V	
	(30 to 50) kV	0.7 % of reading + 2.5 V	
	(30 to 70) Hz	2.9 % of reading + 2.5 V	
	(70 to 200) Hz	0.16 % of reading + 2.6 V	
	(200 to 450) Hz	1.2 % of reading + 2.6 V	
	(50 to 70) kV		
AC Voltage – Source ¹	Up to 2.2 mV	0.16 % of reading + 4 μV	Fluke 5700A-EP Multiproduct Calibrator
	(10 to 20) Hz	0.1 % of reading + 4 μV	
	(20 to 40) Hz	0.08 % of reading + 4 μV	
	40 Hz to 20 kHz	0.13 % of reading + 4 μV	
	(20 to 50) kHz	0.17 % of reading + 5 μV	
	(50 to 100) kHz	0.33 % of reading + 10 μV	
	(100 to 300) kHz	0.47 % of reading + 20 μV	Fluke 5720A Multiproduct Calibrator
	(300 to 500) kHz	0.58 % of reading + 20 μV	
	500 kHz to 1 MHz	0.04 % of reading + 4 μV	
	(2.2 to 22) mV	0.03 % of reading + 4 μV	
	(10 to 20) Hz	0.014 % of reading + 4 μV	
	(20 to 40) Hz	0.03 % of reading + 4 μV	
	40 Hz to 20 kHz	0.06 % of reading + 5 μV	
	(20 to 50) kHz	0.12 % of reading + 10 μV	
	(50 to 100) kHz	0.16 % of reading + 20 μV	
(100 to 300) kHz	0.27 % of reading + 20 μV		
(300 to 500) kHz	0.028 % of reading + 12 μV		
500 kHz to 1 MHz	0.011 % of reading + 7 μV		
(22 to 220) mV	0.009 % of reading + 7 μV		
(10 to 20) Hz	0.021 % of reading + 7 μV		
(20 to 40) Hz	0.047 % of reading + 17 μV		
40 Hz to 20 kHz	0.091 % of reading + 20 μV		
(20 to 50) kHz	0.14 % of reading + 25 μV		
(50 to 100) kHz	0.28 % of reading + 45 μV		
(100 to 300) kHz			
(300 to 500) kHz			
500 kHz to 1 MHz			

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(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 kHz to 1 MHz	0.027 % of reading + 40 μV 0.01 % of reading + 15 μV 0.005 % of reading + 8 μV 0.008 % of reading + 10 μV 0.012 % of reading + 30 μV 0.044 % of reading + 80 μV 0.1 % of reading + 0.2 mV 0.18 % of reading + 0.3 mV	Fluke 5720A Multiproduct Calibrator
	(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 kHz to 1 MHz	0.028 % of reading + 0.4 mV 0.01 % of reading + 0.15 mV 0.005 % of reading + 50 μV 0.008 % of reading + 0.1 mV 0.011 % of reading + 0.2 mV 0.03 % of reading + 0.6 mV 0.1 % of reading + 2 mV 0.17 % of reading + 3.2 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.028 % of reading + 4 mV 0.01 % of reading + 1.5 mV 0.006 % of reading + 0.6 mV 0.009 % of reading + 1 mV 0.016 % of reading + 2.5 mV 0.09 % of reading + 16 mV 0.44 % of reading + 40 mV 0.8 % of reading + 80 mV	
	(220 to 750) V (30 to 50) kHz (50 to 100) kHz (220 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.061 % of reading + 11 mV 0.23 % of reading + 45 mV 0.011 % of reading + 4 mV 0.017 % of reading + 6 mV 0.061 % of reading + 11 mV	Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹	(0.19 to 3.3) nF (3.3 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 (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	0.39 % of reading + 7.8 pF 0.21 % of reading + 7.8 pF 0.21 % of reading + 78 pF 0.21 % of reading + 0.23 nF 0.2 % of reading + 0.78 nF 0.2 % of reading + 2.3 nF 0.2 % of reading + 7.8 nF 0.31 % of reading + 23 nF 0.35 % of reading + 78 nF 0.35 % of reading + 0.23 μF 0.35 % of reading + 0.78 μF 0.35 % of reading + 2.3 μF 0.35 % of reading + 7.8 μF 0.58 % of reading + 23 μF 0.86 % of reading + 78 μF	Fluke 5520A Multiproduct Calibrator
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source ¹	Type B (250 to 350) °C (350 to 445) °C (445 to 580) °C (580 to 750) °C (750 to 1 000) °C (1 000 to 1 820) °C Type C (0 to 250) °C (250 to 1 000) °C (1 000 to 1 500) °C (1 500 to 1 800) °C (1 800 to 2 000) °C (2 000 to 2 250) °C (2 250 to 2 315) °C Type E (-270 to -245) °C (-245 to -195) °C (-195 to -155) °C (-155 to -90) °C (-90 to 0) °C (0 to 15) °C (15 to 890) °C (890 to 1 000) °C	1.2 °C 0.9 °C 0.71 °C 0.55 °C 0.45 °C 0.35 °C 0.21 °C 0.17 °C 0.19 °C 0.22 °C 0.24 °C 0.30 °C 0.33 °C 1.6 °C 0.24 °C 0.12 °C 0.095 °C 0.08 °C 0.076 °C 0.064 °C 0.074 °C	Ectron 1140A Thermocouple Calibrator/Simulator



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Electrical Simulation of Thermocouple Indicating Devices – Measure/Source ¹	Type J		
	(-210 to -180) °C	0.15 °C	
	(-180 to -120) °C	0.12 °C	
	(-120 to -50) °C	0.093 °C	
	(-50 to 990) °C	0.08 °C	
	(990 to 1 200) °C	0.094 °C	
	Type K		
	(-270 to -255) °C	2.5 °C	
	(-255 to -195) °C	0.85 °C	
	(-195 to -115) °C	0.16 °C	
	(-115 to -55) °C	0.12 °C	
	(-55 to 1 000) °C	0.087 °C	
	(1 000 to 1 372) °C	0.096 °C	
	Type N		
	(-270 to -260) °C	5.4 °C	
	(-260 to -200) °C	1.5 °C	
	(-200 to -140) °C	0.29 °C	
	(-140 to -70) °C	0.18 °C	
	(-70 to 25) °C	0.14 °C	
	(-25 to 160) °C	0.12 °C	
	(160 to 1 300) °C	0.11 °C	
	Type R		
	(-50 to -30) °C	0.8 °C	
(-30 to 45) °C	0.69 °C		
(45 to 160) °C	0.49 °C		
(160 to 380) °C	0.35 °C		
(380 to 775) °C	0.3 °C		
(775 to 1 768) °C	0.26 °C		
Type S			
(-50 to -30) °C	0.76 °C		
(-30 to 45) °C	0.68 °C		
(45 to 105) °C	0.49 °C		
(105 to 310) °C	0.41 °C		
(310 to 615) °C	0.35 °C		
(615 to 1 768) °C	0.31 °C		
Type T			
(-270 to -255) °C	1.9 °C		
(-255 to -240) °C	0.6 °C		
(-240 to -210) °C	0.36 °C		
(-210 to -150) °C	0.22 °C		
(-150 to -40) °C	0.15 °C		
(-40 to 100) °C	0.095 °C		
(100 to 400) °C	0.08 °C		
Scope Voltage – Source ¹ Amplitude DC into 50 Ω load into 1 MΩ load	(-6 to 6) V (-130 to 130) V	0.2 % of reading + 31 μV 0.04 % of reading + 31 μV	Ectron 1140A Thermocouple Calibrator/Simulator Fluke 5520A/11 Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scope Voltage – Source ¹ Square Wave into 50 Ω load	10 Hz to 100 kHz 1 mV p-p to 6.6 Vp-p	0.19 % of reading + 31 μV	Fluke 5520A/11 Multiproduct Calibrator
into 1 MΩ load	10 Hz to 1 kHz 1 mV p-p to 6.6 Vp-p (1 kHz to 10) kHz	0.08 % of reading + 31 μV	
	1 mV p-p to 6.6 Vp-p	0.19 % of reading + 31 μV	
Scope – Time Markers ¹ into 50 Ω load	1 ns to 20 ms 50 ms 0.1 s 0.2 s 0.5 s 1 s 2 s 5 s	0.000 2 % of reading 2.3 μs 7.6 μs 28 μs 0.16 ms 0.62 ms 2.4 ms 15 ms	Fluke 5520A/11 Multiproduct Calibrator
Scope Rise Time – Source ^{1,2} into 50 Ω load Rate: 1 kHz to 2 MHz Rate: 2 MHz to 10 MHz	5 mVp-p to 2.5 Vp-p 250 ps (nominal) 250 ps (nominal)	50 ps 50 ps	Fluke 5520A/11 Multiproduct Calibrator
Scope Levelled Sine Wave – Source ¹ into 50 Ω load	5 mVp-p to 5 Vp-p 50 kHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1 100) MHz	1.8 % of reading + 0.23 mV 2.8 % of reading + 0.23 mV 3.2 % of reading + 0.23 mV 4 % of reading + 0.23 mV 4.9 % of reading + 0.23 mV	Fluke 5520A/11 Multiproduct Calibrator
Scope Bandwidth/Flatness – Source ¹ into 50 Ω load (50 kHz Reference)	5 mVp-p to 5.5 Vp-p 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1 100) MHz	1.4 % of reading + 78 μV 1.8 % of reading + 78 μV 3.2 % of reading + 78 μV 3.9 % of reading + 78 μV	Fluke 5520A/11 Multiproduct Calibrator
Scope Input Impedance – Measure ¹	(40 to 60) Ω (0.5 to 1.5) MΩ	0.082 % of reading 0.081 % of reading	Fluke 5520A/11 Multiproduct Calibrator
Scope Input Capacitance – Measure ¹	(5 to 50) pF	3.9 % of reading + 0.39 pF	Fluke 5520A/11 Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scope Waveform Generator – Source ¹ Amplitude (Sine, Square, Triangle) into 50 Ω load into 1 MΩ load Frequency (Sine, Square, Triangle)	10 Hz to 10 kHz 1.8 mVp-p to 2.5 Vp-p 1.8 mVp-p to 55 Vp-p 10 Hz to 10 kHz	2.3 % of reading + 78 μV 2.3 % of reading + 78 μV 0.001 9 % of reading + 12 mHz	Fluke 5520A/11 Multiproduct Calibrator
LF Phase – Source ¹	(0 to 90) ° (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.11 ° 0.2 ° 0.39 ° 1.9 ° 3.9 ° 7.8 °	Fluke 5520A/1100 Calibrator
DC Power – Source ¹ (0.33 to 330) mA (0.33 to 3) A (3 to 20.5) A	11 μW to 1.1 mW 1.1 mW to 0.11 W (0.11 to 110) W (110 to 330) W 11 μW to 110 mW (0.11 to 990) W (0.99 to 3) kW 99 mW to 0.99 W 0.99 W to 6.8 kW (6.8 to 20.5) kW	0.024 % of reading 0.027 % of reading 0.024 % of reading 0.018 % of reading 0.044 % of reading 0.053 % of reading 0.009 6 % of reading 0.088 % of reading 0.07 % of reading 0.04 % of reading	Fluke 5520A/1100 Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,6} PF = 1			
(3.3 to 9) mA	(10 to 65) Hz (0.11 mW to 3) mW 3 mW to 9 W	0.13 % of reading 0.077 % of reading	Fluke 5520A/11 Multiproduct Calibrator
(9 to 33) mA	(10 to 65) W (0.3 to 10) mW 10 mW to 33 W	0.089 % of reading 0.077 % of reading	
(33 to 90) mA	(10 to 65) Hz (1 to 30) mW 30 mW to 90 W	0.071 % of reading 0.057 % of reading	
(90 to 330) mA	(10 to 65) Hz (3 to 100) mW 100 mW to 300 W	0.089 % of reading 0.078 % of reading	
(0.33 to 0.9) A	(10 to 65) Hz (11 to 300) mW (0.3 to 900) W	0.071 % of reading 0.081 % of reading	
(0.9 to 2.2) A	(10 to 65) Hz (30 to 720) mW 0.72 W to 2 kW	0.089 % of reading 0.079 % of reading	
(2.2 to 4.5) A	(10 to 65) Hz 80 mW to 1.4 W 1.4 W to 4.5 kW	0.088 % of reading 0.18 % of reading	
(4.5 to 20.5) A	(10 to 65) Hz 150 mW to 230 kW	0.17 % of reading	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Total Harmonic Distortion – Measure Input Voltage: < 30 V Level: (0.3 to 100) %	10 Hz to 1 MHz (1 to 3) MHz	3 % of reading 6 % of reading	Agilent 8592L Spectrum Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Total Harmonic Distortion – Measure Input Voltage: < 30 V Level: 0.1 %	(10 to 20) Hz (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz	12 % of reading 6 % of reading 3 % of reading 6 % of reading 12 % of reading	Agilent 334A Distortion Analyzer
Input Voltage: > 30 V Level: (0.3 to 100) %	10 Hz to 300 kHz (300 to 500) kHz (0.5 to 3) MHz	3 % of reading 6 % of reading 12 % of reading	
Input Voltage: > 30 V Level: 0.1 %	(20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz	12 % of reading 3 % of reading 6 % of reading 12 % of reading	
Harmonic Distortion	100 kHz to 100 MHz	1.7 dB	Agilent 8592L Spectrum Analyzer
Rise Time – Measure ¹	≥700 ps	0.81 ns	Tektronix TDS3052 Digital Oscilloscope

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Measuring Devices	5 °	1.7 "	Sine Bar, Gage Blocks, Surface Plate
	(5 to 20) °	2.4 "	
	(20 to 35) °	3.6 "	
	(35 to 45) °	4.6 "	
	(45 to 60) °	8.1 "	
	(60 to 75) °	17 "	
	(75 to 85) °	52 "	
Micrometers and Calipers– Outside, Inside, Depth ^{1,3}	(0.05 to 8) in (8 to 42) in	(15 + 3L) μin (13 + 4L) μin	Gage Blocks, Long Gage Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Anvil Flatness ¹	Up to 1 in Diameter	4.7 μin	Optical Flats
Anvil Parallelism ¹	Up to 1 in	6.1 μin	Optical Parallels
Dial Indicators ^{1,3}	Up to 0.1 in (0.1 to 6) in	4.5 μin (4 + 4L) in	Gage Blocks, Surface Plate
Single Axis Length – Inside ³	(0.24 to 12) in	(3 + 4L) in	Horizontal Comparator
Single Axis Length – Outside ³	(0.001 to 10) in	(3 + 4L) in	Horizontal Comparator
Height Gages, Digital Indicators ³	Up to 4 in (4 to 24) in	(10 + 3L) μin (12 + 4L) μin	Gage Blocks, Surface Plate
Linear Dimensions – Two Axis (X-Y)	12 in x 12 in	320 μin	Vision System
Master 1-2-3 Blocks, Caliper Masters, Parallels ³	Up to 6 in (6 to 24) in	(10 + 3L) μin (12 + 4L) μin	Gage Blocks, Surface Plate, Gage Amplifier
Parallelism, Straightness	Up to 12 in	20 μin	Gage Amplifier, Surface Plate
Steel Rules	Up to 12 in	320 μin	Vision System
Surface Plates ^{1,3}			In accordance with Fed Spec GGG-P-463 using Optodyne LDDM
Overall Flatness	Up to 168.4 inDL	1.7 √DL + 5.5 μin	
Local Area Flatness (Repeat Readings)	Up to ± 0.001 in	32 μin	Supramess Indicator
Threaded Plug ³ Outer Pitch Diameter	Up to 6 in	(79 + 1L) μin	Comparator, Thread Wires
Threaded Ring Inner Pitch Diameter	Up to 6 in	150 μin	Comparison to Master Setting Plugs

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Measuring Equipment	(10 to 100) gf	0.04 % of reading	ASTM E617 Class 2 Weights
	(0.2 to 500) lbf	0.025 % of reading + 0.001 lbf	NIST Class F Weights

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Measuring Equipment	(500 to 1 000) lbf	0.58 lbf	Comparison to Master Load Cells
Mass – Measure	1 g to 1 kg (1 to 5.1) kg	18 mg 0.18 g	Mettler PR5003 DR Electronic Balance
Balances and Scales ^{1,4} (Metric)	Up to 500 mg (0.5 to 10) g 10 g to 3 kg (3 to 8) kg (8 to 13) kg (13 to 19) kg (19 to 27) kg (27 to 38) kg (38 to 40) kg	6 µg 22 µg 6 mg 8 mg 13 mg 16 mg 76 mg 77 mg 78 mg	SET 1: ASTM E617 Class 1 weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances and Scales ^{1,4} (Metric)	Up to 500 mg (0.5 to 5) g (5 to 10) g (10 to 20) g 50 g to 3 kg (3 to 5) kg (5 to 10) kg (10 to 14) kg (14 to 19) kg (19 to 23) kg (23 to 26) kg (26 to 29) kg (29 to 33) kg (33 to 35) kg (35 to 40) kg	20 µg 40 µg 60 µg 90 µg 10 mg 15 mg 20 mg 34 mg 37 mg 76 mg 77 mg 78 mg 82 mg 83 mg 84 mg	SET 2: ASTM E617 Class 1 weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances and Scales ^{1,4} Avoirdupois	Up to 1 lb (1 to 1 600) lb	0.024 % of reading 0.012 % of reading	NIST Class F weights and internal calibration procedure utilized for the calibration of the weighing system.
Metric	Up to 500 g 500 g to 726 kg	0.024 % of reading 0.012 % of reading	
Torque Devices ¹	(3 to 15) ozf·in (15 to 200) ozf·in	1.7 % of reading + 0.006 ozf·in 0.44 % of reading + 0.3 ozf·in	Torque Calibrator
	(1 to 12.5) lbf·in	0.44 % of reading	
	(12.5 to 600) lbf·ft	0.34 % of reading	
	(600 to 2 000) lbf·ft	1.3 % of reading	

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Calibration Equipment	(2.5 to 15) ozf·in (15 to 80) ozf·in	0.055 % of reading 0.06 % of reading	Torque Wheels, Weights
	(0.42 to 50) lbf·ft (50 to 2 000) lbf·ft	0.06 % of reading 0.06 % of reading	Torque Arm, Weights
Absolute Pressure – Source	(0 to 30) psia (30 to 1 000) psia	0.002 4 psi 0.006 6 % of reading + 0.000 1 psi	Fluke/DHI RPM 4 Pressure Controller/Calibrator
Pressure – Source ¹	(0.14 to 25) psig	0.017 % of reading + 0.000 041 psi	Ametek RK-1000 WC Deadweight Tester
Pressure – Source	(-15 to 30) psig	0.002 1 psi	Fluke/DHI RPM 4 Pressure Controller/Calibrator
	(30 to 1 000) psig	0.006 6 % of reading + 0.000 1 psi	
Pressure – Source ¹ (Hydraulic)	(5 to 15 000) psig	0.018 % of reading	Fluke P3125-PSI Deadweight Tester

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Source	(-10 to 15) °C		Thunder Scientific 2500 Two-Pressure Humidity Generator
	(10 to 75) %RH	0.5 %RH	
	(75 to 95) %RH	0.65 %RH	
	(15 to 35) °C		
	(10 to 95) %RH	0.5 %RH	
Relative Humidity – Measure ¹	(35 to 70) °C		Vaisala HMI41/HMP46 Temperature/Humidity Indicator w/ Probe
	(50 to 70) %RH	0.7 %RH	
	(70 to 95) %RH	0.85 %RH	
Temperature – Measure ¹	(-196 to 0) °C	0.011 °C	AccuMac AM1760 Secondary SPRT, Black Stack Indicator
	(0 to 420) °C	0.026 °C	
	(420 to 660) °C	0.035 °C	
	(660 to 1 000) °C	0.93 °C	
	(1 000 to 1 200) °C	1.2 °C	
Temperature – Measure ¹	(660 to 1 000) °C	0.93 °C	AccuMac AM1210 Type S Reference Standard Thermocouple Probe, Black Stack Indicator
	(1 000 to 1 200) °C	1.2 °C	

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Source	(-20 to 120) °C	0.028 °C	Liquid Bath, RTD Probe, Temperature Indicator
	(120 to 600) °C	0.13 °C	Dry-block Calibrator, RTD Probe, Temperature Indicator
	(600 to 1 200) °C	3.1 °C	Furnace, AccuMac AM1210 Type S Reference Standard Thermocouple Probe, Temperature Indicator
Infrared Measuring Devices	(-15 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 120) °C (120 to 200) °C (200 to 350) °C (350 to 500) °C	0.98 °C 0.67 °C 0.71 °C 0.77 °C 0.94 °C 1.7 °C 2.1 °C	Hart Black Body (flat plate) $\epsilon = (0.1 \text{ to } 1)$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source/Measure ⁵	10 MHz	6.4 nHz/Hz	SRS FS725 Rubidium Frequency Standard
Frequency – Source/Measure ¹	10 MHz	2.1 μ Hz/Hz	HP 53131A (10) Frequency Counter
Time – Measure ¹	Up to 599 s/month	58 ms/day	Vibrograf 4500 Timometer

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. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 250 ps. In the typical application of measuring rise time of an oscilloscope, this value is one of the contributing factors, but other factors are derived from the DUT. The known source rise time is mathematically removed from the total measured rise time measured on the DUT.
3. L = length in inches; DL = diagonal length in inches.
4. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The CMC presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
5. As frequency & amplitude deviate from the listed values, uncertainty may be higher than stated. If needed, contact laboratory for more information regarding uncertainties at frequency and range combinations other than the ones shown.
6. The uncertainties shown are for the most favorable conditions. There is an increase in uncertainty that corresponds to the laboratory's AC voltage and current uncertainties at different frequencies other than the ones shown. Power factors (PF) other than the one shown contribute to the power uncertainty. PF is related to the cosine of phase. Therefore, uncertainties track the laboratory's phase uncertainty closely at PF near one but are magnified heavily as PF approaches zero. The lab may also report reactive power, apparent power, and power factor under this accreditation. If needed, contact laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
7. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.01.



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