CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Transcat-Dayton
2056 South Alex Road
West Carrollton, OH 45449

Fulfills the requirements of

ISO/IEC 17025:2017

and the 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 2023
Certificate Number: AC-2489.06

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 Z540.3-2006 (R2013)

Transcat – Dayton
2056 South Alex Road
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CALIBRATION

Valid to: **September 7, 2023** Certificate Number: **AC-2489.06**

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters	4 pH 7 pH 10 pH	0.012 pH 0.011 pH 0.012 pH	Accredited Buffer Solutions
Conductivity Meters	1 µS/cm 10 µS/cm 100 µS/cm 1 000 µS/cm 1 413 µS/cm 10 000 µS/cm 100 000 µS/cm 150 000 µS/cm 200 000 µS/cm	0.3 µS/cm 0.3 µS/cm 2.1 µS/cm 5 µS/cm 4 µS/cm 44 µS/cm 330 µS/cm 570 µS/cm 670 µS/cm	Accredited Solutions

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	Up to 220 µA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.033 % of reading + 16 nA 0.019 % of reading + 10 nA 0.014 % of reading + 8 nA 0.026 % of reading + 10 nA 0.11 % of reading + 65 nA	Fluke 5720A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	220 µA to 2.2 mA		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.031 % of reading + 40 nA	
	(20 to 40) Hz	0.018 % of reading + 35 nA	
	40 Hz to 1 kHz	0.014 % of reading + 35 nA	
	(1 to 5) kHz	0.021 % of reading + 0.11 µA	
	(5 to 10) kHz	0.11 % of reading + 0.65 µA	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.033 % of reading + 40 nA	
	(20 to 40) Hz	0.02 % of reading + 0.35 µA	
	40 Hz to 1 kHz	0.015 % of reading + 0.35 µA	
	(1 to 5) kHz	0.022 % of reading + 0.55 µA	
	(5 to 10) kHz	0.11 % of reading + 5 µA	
	(22 to 220) mA		
	(10 to 20) Hz	0.04 % of reading + 4 µA	
	(20 to 40) Hz	0.19 % of reading + 3.5 µA	
	40 Hz to 1 kHz	0.014 % of reading + 2.5 µA	
	(1 to 5) kHz	0.021 % of reading + 3.5 µA	
	(5 to 10) kHz	0.11 % of reading + 10 µA	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.027 % of reading + 35 µA	
	(1 to 5) kHz	0.045 % of reading + 80 µA	
	(5 to 10) kHz	0.7 % of reading + 0.16 mA	
	(2.2 to 11) A		Fluke 5720A Multiproduct Calibrator, Fluke 5725 Amplifier
	40 Hz to 1 kHz	0.047 % of reading + 0.17 mA	
	(1 to 5) kHz	0.095 % of reading + 0.38 mA	
	(5 to 10) kHz	0.36 % of reading + 0.75 mA	
	(11 to 20.5) A		Fluke 5520A Multiproduct Calibrator
	(10 to 100) Hz	0.091 % of reading + 3.9 mA	
	100 Hz to 1 kHz	0.12 % of reading + 3.9 mA	
	(1 to 5) kHz	2.3 % of reading + 3.9 mA	
AC Current – Source [1] Extended Frequency Ranges	(10 to 30) kHz		Fluke 5520A Multiproduct Calibrator
	(29 to 330) µA	1.2 % of reading + 0.31 µA	
	(0.33 to 3.3) mA	0.78 % of reading + 0.47 µA	
	(3.3 to 33) mA	0.31 % of reading + 3.1 µA	
	(33 to 330) mA	0.31 % of reading + 0.16 mA	
AC Clamp-on Ammeters (Toroidal Type) Transformer Type Sensor [1]	(20 to 150) A		Fluke 5520A Multiproduct Calibrator, Fluke 5500A/COIL 50-turn Coil
	(45 to 65) Hz	0.34 % of reading + 30 mA	
	(65 to 440) Hz	0.95 % of reading + 47 mA	
	(150 to 1 000) A		
	(45 to 65) Hz	0.38 % of reading + 0.12 A	
	(65 to 440) Hz	1.2 % of reading + 0.22 A	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	 0.65 % of reading + 0.29 A 1.2 % of reading + 0.29 A 0.68 % of reading + 1 A 1.4 % of reading + 1.1 A	Fluke 5520A Multiproduct Calibrator, Fluke 5500A/COIL 50-turn Coil
AC Current – Measure [1]	Up to 100 µA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz 100 µA to 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 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 + 35 nA 0.17 % of reading + 35 nA 0.073 % of reading + 35 nA 0.46 % of reading + 0.23 µA 0.17 % of reading + 0.23 µA 0.071 % of reading + 0.23 µA 0.039 % of reading + 0.23 µA 0.46 % of reading + 2.3 µA 0.17 % of reading + 2.3 µA 0.071 % of reading + 2.3 µA 0.039 % of reading + 2.3 µA 0.46 % of reading + 23 µA 0.17 % of reading + 23 µA 0.071 % of reading + 23 µA 0.038 % of reading + 23 µA 0.46 % of reading + 0.23 mA 0.19 % of reading + 0.23 mA 0.098 % of reading + 0.23 mA 0.12 % of reading + 0.23 mA	Agilent 3458A Opt. 002 8.5 Digit Multimeter
	(1 to 100) A 50 Hz to 1 kHz	 0.12 % of reading + 2.3 mA	Ohms Labs CS-100 Current Shunt, Agilent 3458A Opt. 002 8.5 Digit Multimeter
DC Current – Source [1]	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	45 µA/A + 7 nA 39 µA/A + 8 nA 39 µA/A + 46 nA 58 µA/A + 0.7 µA 0.24 mA/A + 12 µA	Fluke 5720A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1]	(2.2 to 11) A	0.4 mA/A + 0.48 mA	Fluke 5720A Multiproduct Calibrator, Fluke 5725 Amplifier
	(11 to 20) A	0.084 % of reading + 0.58 mA	Fluke 5520A Multiproduct Calibrator
DC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(20 to 150) A (150 to 1 000) A	0.58 % of reading + 0.16 A 0.59 % of reading + 0.58 A	Fluke 5520A Multiproduct Calibrator, Fluke 5500A/Coil 50-turn Coil
DC Current – Measure [1]	Up to 100 µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	33 µA/A + 0.9 nA 29 µA/A + 5.8 nA 29 µA/A + 58 nA 46 µA/A + 0.58 µA 0.13 mA/A + 12 µA	Agilent 3458A Opt. 002 8.5 Digit Multimeter
	(1 to 100) A	0.012 % of reading + 0.5 mA	Ohms Labs CS-100 Current Shunt, Agilent 3458A Opt. 002 8.5 Digit Multimeter
	(100 to 650) A	0.31 % of reading + 10 mA	Canadian Shunt Ind. Ltd. LC-1000-50 Current Shunt, Agilent 3458A Opt. 002 8.5 Digit Multimeter
DC Resistance – Source [1] (Fixed Artifacts)	1 mΩ 10 mΩ 100 mΩ	0.16 mΩ/Ω 0.16 mΩ/Ω 0.16 mΩ/Ω	Standard Resistors
DC Resistance – Source [1] (Variable Artifact)	(1 to 10) GΩ (10 to 100) GΩ 100 GΩ to 1 TΩ	0.58 % of reading + 1.2 µΩ/Ω/V 1.2 % of reading + 2.3 µΩ/Ω/V 1.2 % of reading + 5.8 µΩ/Ω/V	IET HRRS-B-7-100k-5kV Decade Resistor (V is the DUT Voltage)
DC Resistance – Source/Measure [1]	Up to 25 Ω (25 to 400) Ω 400 Ω to 1 kΩ (1 to 40) kΩ	56 µΩ 2.1 µΩ/Ω 4.4 µΩ/Ω 10 µΩ/Ω	Hart 1590 Super Thermometer, Reference Resistors
Resistance – Source/Measure [1]	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	20 µΩ/Ω + 58 µΩ 15 µΩ/Ω + 0.58 mΩ 13 µΩ/Ω + 0.58 mΩ 12 µΩ/Ω + 5.8 mΩ 13 µΩ/Ω + 58 mΩ 21 µΩ/Ω + 2.3 Ω 62 µΩ/Ω + 0.12 kΩ 0.059 % of reading + 1.2 kΩ 0.58 % of reading + 12 kΩ	Agilent3458A 8.5 Digit Multimeter, Decade Resistor

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	Up to 2.2 mV		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.16 % of reading + 4 µV	
	(20 to 40) Hz	0.1 % of reading + 4 µV	
	40 Hz to 20 kHz	0.077 % of reading + 4 µV	
	(20 to 50) kHz	0.13 % of reading + 4 µV	
	(50 to 100) kHz	0.17 % of reading + 5 µV	
	(100 to 300) kHz	0.33 % of reading + 10 µV	
	(300 to 500) kHz	0.47 % of reading + 20 µV	
	500 kHz to 1 MHz	0.58 % of reading + 20 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.044 % of reading + 4 µV	
	(20 to 40) Hz	0.031 % of reading + 4 µV	
	40 Hz to 20 kHz	0.015 % of reading + 4 µV	
	(20 to 50) kHz	0.031 % of reading + 4 µV	
	(50 to 100) kHz	0.059 % of reading + 5 µV	
	(100 to 300) kHz	0.12 % of reading + 10 µV	
	(300 to 500) kHz	0.16 % of reading + 20 µV	
	500 kHz to 1 MHz	0.3 % of reading + 20 µV	
	(22 to 220) mV		
	(10 to 20) Hz	0.028 % of reading + 12 µV	
	(20 to 40) Hz	0.011 % of reading + 7 µV	
	40 Hz to 20 kHz	0.009 % of reading + 7 µV	
	(20 to 50) kHz	0.021 % of reading + 7 µV	
	(50 to 100) kHz	0.047 % of reading + 17 µV	
	(100 to 300) kHz	0.092 % of reading + 20 µV	
	(300 to 500) kHz	0.14 % of reading + 25 µV	
	500 kHz to 1 MHz	0.28 % of reading + 45 µV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.028 % of reading + 40 µV	
	(20 to 40) Hz	0.01 % of reading + 15 µV	
	40 Hz to 20 kHz	0.005 % of reading + 8 µV	
	(20 to 50) kHz	0.008 % of reading + 10 µV	
	(50 to 100) kHz	0.012 % of reading + 30 µV	
	(100 to 300) kHz	0.043 % of reading + 80 µV	
	(300 to 500) kHz	0.1 % of reading + 0.2 mV	
	500 kHz to 1 MHz	0.18 % of reading + 0.3 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(2.2 to 22) V		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	0.028 % of reading + 0.4 mV	
	(20 to 40) Hz	0.01 % of reading + 0.15 mV	
	40 Hz to 20 kHz	0.005 % of reading + 50 µV	
	(20 to 50) kHz	0.008 % of reading + 0.1 mV	
	(50 to 100) kHz	0.011 % of reading + 0.2 mV	
	(100 to 300) kHz	0.03 % of reading + 0.6 mV	
	(300 to 500) kHz	0.1 % of reading + 2 mV	
	500 kHz to 1 MHz	0.17 % of reading + 3.2 mV	
	(22 to 220) V		Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier
	(10 to 20) Hz	0.028 % of reading + 4 mV	
	(20 to 40) Hz	0.01 % of reading + 1.5 mV	
	40 Hz to 20 kHz	0.006 % of reading + 0.6 mV	
	(20 to 50) kHz	0.009 % of reading + 1 mV	
	(50 to 100) kHz	0.016 % of reading + 2.5 mV	
	(100 to 300) kHz	0.09 % of reading + 16 mV	
	(300 to 500) kHz	0.44 % of reading + 40 mV	
	500 kHz to 1 MHz	0.8 % of reading + 80 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.061 % of reading + 11 mV	
	(50 to 100) kHz	0.23 % of reading + 45 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	0.011 % of reading + 4 mV	
	(1 to 20) kHz	0.017 % of reading + 6 mV	
	(20 to 30) kHz	0.061 % of reading + 11 mV	
AC Voltage – Measure [1]	Up to 10 mV		Agilent3458A 8.5 Digit Multimeter
	(1 to 40) Hz	0.04 % of reading + 3.5 µV	
	40 Hz to 1 kHz	0.03 % of reading + 1.3 µV	
	(1 to 20) kHz	0.04 % of reading + 1.3 µV	
	(20 to 50) kHz	0.16 % of reading + 1.3 µV	
	(50 to 100) kHz	0.59 % of reading + 1.3 µV	
	(100 to 300) kHz	4.6 % of reading + 2.3 µV	
	(10 to 100) mV		
	(1 to 40) Hz	0.013 % of reading + 4.6 µV	
	40 Hz to 1 kHz	0.009 7 % of reading + 2.3 µV	
	(1 to 20) kHz	0.017 % of reading + 2.3 µV	
	(20 to 50) kHz	0.038 % of reading + 2.3 µV	
	(50 to 100) kHz	0.094 % of reading + 2.3 µV	
	(100 to 300) kHz	0.37 % of reading + 12 µV	
	300 kHz to 1 MHz	1.2 % of reading + 12 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	100 mV to 1 V		Agilent3458A 8.5 Digit Multimeter
	(1 to 40) Hz	0.008 8 % of reading + 46 µV	
	40 Hz to 1 kHz	0.008 3 % of reading + 23 µV	
	(1 to 20) kHz	0.017 % of reading + 23 µV	
	(20 to 50) kHz	0.036 % of reading + 23 µV	
	(50 to 100) kHz	0.094 % of reading + 23 µV	
	(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 10) V		
	(1 to 40) Hz	0.01 % of reading + 0.46 mV	
	40 Hz to 1 kHz	0.008 6 % of reading + 0.23 mV	
	(1 to 20) kHz	0.017 % of reading + 0.23 mV	
	(20 to 50) kHz	0.036 % of reading + 0.23 mV	
	(50 to 100) kHz	0.093 % 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	
	(10 to 100) V		
	(1 to 40) Hz	0.025 % of reading + 4.6 mV	
	40 Hz to 1 kHz	0.024 % of reading + 2.3 mV	
	(1 to 20) kHz	0.024 % of reading + 2.3 mV	
	(20 to 50) kHz	0.042 % 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	0.048 % of reading + 46 mV	
	40 Hz to 1 kHz	0.048 % of reading + 23 mV	
	(1 to 20) kHz	0.071 % of 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]	700 V to 10 kV		Vitrek 4700 Digital HV Meter
	(30 to 200) Hz	0.014 % of reading + 2.1 V	
	(200 to 450) Hz	0.46 % of reading + 2.1 V	
	(10 to 35) kV		Vitrek 4700 Digital HV Meter, Vitrek HVP-35 High Voltage Probe
	(30 to 200) Hz	0.12 % of reading + 37 V	
	(200 to 450) Hz	0.71 % of reading + 37 V	
	(35 to 70) V		Vitrek 4700 Digital HV Meter, Vitrek HVL-70 High Voltage Probe
	(30 to 100) Hz	0.12 % of reading + 55 V	
	(100 to 200) Hz	0.69 % of reading + 55 V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage – Measure [1]	(70 to 75) kV (30 to 70) Hz (70 to 200) Hz	0.15 % of reading + 0.16 kV 1.2 % of reading + 0.16 kV	Vitrek 4700 Digital HV Meter, Vitrek HVL-100 High Voltage Probe
DC Voltage – Source [1]	Up to 220 µV 220 µV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V	9.1 µV/V + 0.4 µV 5.7 µV/V + 0.7 µV 4.4 µV/V + 2.5 µV 4 µV/V + 4 µV 6.3 µV/V + 40 µV	Fluke 5720A Multiproduct Calibrator
	(220 to 1 100) V	7.6 µV/V + 0.4 mV	Fluke 5720A Multiproduct Calibrator, Fluke 5725A Amplifier
DC Voltage – Measure [1]	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 500) V (500 to 800) V (800 to 1 000) V	8.3 µV/V + 0.53 µV 5.3 µV/V + 0.53 µV 5.3 µV/V + 0.53 µV 7.6 µV/V + 35 µV 11 µV/V + 0.12 mV 17 µV/V + 0.12 mV 21 µV/V + 0.12 mV	Agilent 3458A 8.5 Digit Multimeter
DC High Voltage – Measure [1]	(1 to 10) kV	0.035 % of reading + 2.1 V	Vitrek 4700 Digital HV Meter
	(10 to 35) kV	0.041 % of reading + 37 V	Vitrek 4700 Digital HV Meter, Vitrek HVP-35 High Voltage Probe
	(35 to 70) kV	0.038 % of reading + 55 V	Vitrek 4700 Digital HV Meter, Vitrek HVL-70 High Voltage Probe
	(70 to 100) kV	0.063 % of reading + 0.16 kV	Vitrek 4700 Digital HV Meter, Vitrek HVL-100 High Voltage Probe
Capacitance – Source [1] (Simulation)	10 Hz to 10 kHz 190 pF to 1.1 nF 10 Hz to 3 kHz (1.1 to 3.3) nF	0.4 % of reading + 7.8 pF 0.4 % of reading + 7.8 pF	Fluke 5520A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source [1] (Simulation)	10 Hz to 1 kHz (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (10 to 600) Hz 330 nF to 1.1 µF (10 to 300) Hz (1.1 to 3.3) µF (10 to 150) Hz (3.3 to 11) µF (10 to 120) Hz (11 to 33) µF (10 to 80) Hz (33 to 110) µF DC to 50 Hz (110 to 330) µF DC to 20 Hz 330 µF to 1.1 mF DC to 6 Hz (1.1 to 3.3) mF DC to 2 Hz (3.3 to 11) mF DC to 600 mHz (11 to 33) mF DC to 200 mHz (33 to 110) mF	 0.22 % of reading + 7.8 pF 0.22 % of reading + 78 pF 0.22 % of reading + 78 pF 0.22 % of reading + 0.23 nF 0.22 % of reading + 0.78 nF 0.22 % of reading + 2.3 nF 0.22 % of reading + 7.8 nF 0.33 % of reading + 23 nF 0.42 % of reading + 78 µF 0.42 % of reading + 0.23 µF 0.36 % 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 0.85 % 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	 1.2 °C 0.9 °C 0.71 °C 0.55 °C 0.45 °C 0.35 °C 0.24 °C 0.19 °C 0.21 °C 0.24 °C 0.27 °C 0.33 °C 0.37 °C	Ectron 1140A Thermocouple Calibrator/Simulator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source [1]	Type E		Ectron 1140A Thermocouple Calibrator/Simulator
	(-270 to -245) °C	1.6 °C	
	(-245 to -195) °C	0.24 °C	
	(-195 to -155) °C	0.12 °C	
	(-155 to -90) °C	0.09 °C	
	(-90 to 0) °C	0.08 °C	
	(0 to 15) °C	0.08 °C	
	(15 to 890) °C	0.06 °C	
	(890 to 1 000) °C	0.07 °C	
	Type J		
	(-210 to -180) °C	0.13 °C	
	(-180 to -120) °C	0.11 °C	
	(-120 to -50) °C	0.09 °C	
	(-50 to 990) °C	0.08 °C	
	(990 to 1 200) °C	0.08 °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	0.09 °C	
	(1 000 to 1 372) °C	0.1 °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	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source [1]	Type S		Ectron 1140A Thermocouple Calibrator/Simulator
	(-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	0.31 °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	0.09 °C	
	(100 to 400) °C	0.08 °C	
DC Power – Source [1]			Fluke 5520A Multiproduct Calibrator
330 µW to 330 mA	11 µW to 1.1 mW	0.024 % of reading	
	(1.1 to 110) mW	0.027 % of reading	
	110 mW to 110 W	0.024 % of reading	
	(110 to 330) W	0.018 % of reading	
330 mA to 3 A	11 µW to 110 mW	0.044 % of reading	
	110 mW to 990 W	0.053 % of reading	
	990 W to 3 kW	0.01 % of reading	
(3 to 20.5) A	99 mW to 0.99 W	0.088 % of reading	
	0.99 W to 6.8 kW	0.07 % of reading	
	(6.8 to 20.5) kW	0.04 % of reading	
AC Power – Source [1,2]			Fluke 5520A Multiproduct Calibrator
PF = 1			
(3.3 to 9) mA	(10 to 65) Hz		
	(0.11 mW to 3) mW	0.13 % of reading	
	3 mW to 9 W	0.077 % of reading	
(9 to 33) mA	(10 to 65) W		
	(0.3 to 10) mW	0.089 % of reading	
	10 mW to 33 W	0.077 % of reading	
(33 to 90) mA	(10 to 65) Hz		
	(1 to 30) mW	0.071 % of reading	
	30 mW to 90 W	0.057 % of reading	
(90 to 330) mA	(10 to 65) Hz		
	(3 to 100) mW	0.089 % of reading	
	100 mW to 300 W	0.078 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source [1,4]			Fluke 5520A Multiproduct Calibrator
PF = 1			
(330 to 900) mA	(10 to 65) Hz		
	(11 to 300) mW	0.071 % of reading	
	(0.3 to 900) W	0.081 % of reading	
900 mA to 2.2 A	(10 to 65) Hz		
	(30 to 720) mW	0.089 % of reading	
	0.72 W to 2 kW	0.079 % of reading	
(2.2 to 4.5) A	(10 to 65) Hz		
	80 mW to 1.4 W	0.088 % of reading	
	1.4 W to 4.5 kW	0.18 % of reading	
(4.5 to 20.5) A	(10 to 65) Hz		
	150 mW to 20kW	0.17 % of reading	
Phase – Source [1]	Up to 180 °		Fluke 5520A Multiproduct Calibrator
	(10 to 65) Hz	0.11°	
	(65 to 500) Hz	0.2°	
	500 Hz to 1 kHz	0.4°	
	(1 to 5) kHz	1.9°	
	(5 to 10) kHz	3.9°	
	(10 to 20) kHz	7.8°	
Oscilloscopes [1,3]			Fluke 5520A/11 Multiproduct Calibrator with 1.1 GHz Scope Option
Amplitude – DC			
into 50 Ω load	(-6 to 6) V	0.2 % of reading + 31 µV	
into 1 MΩ load	(-130 to 130) V	0.04 % of reading + 31 µV	
Amplitude – Square Wave			
into 50 Ω load	10 Hz to 100 kHz		
	1 mVp-p to 6.6 Vp-p	0.19 % of reading + 31 µV	
into 1 MΩ load	10 Hz to 1 kHz		
	1 mVp-p to 6.6 Vp-p	0.08 % of reading + 31 µV	
	(1 kHz to 10) kHz		
	1 mVp-p to 6.6 Vp-p	0.19 % of reading + 31 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,3]			
Time Markers			
into 50 Ω load	1 ns to 20 ms	0.000 22 % of reading	
	50 ms	2.3 µs	
	0.1 s	7.6 µs	
	0.2 s	28 µs	
	0.5 s	0.16 ms	
	1 s	0.62 ms	
	2 s	2.4 ms	
	5 s	15 ms	
Rise Time			
into 50 Ω load	5 mVp-p to 2.5 Vp-p		
Rate: 1 kHz to 2 MHz	250 ps (nominal)	50 ps	
Rate: 2 MHz to 10 MHz	250 ps (nominal)	50 ps	
Leveled Sine Wave			
into 50 Ω load	5 mVp-p to 5 Vp-p		Fluke 5520A/11 Multiproduct Calibrator with 1.1 GHz Scope Option
	50 kHz	1.8 % of reading + 0.23 mV	
	50 kHz to 100 MHz	2.8 % of reading + 0.23 mV	
	(100 to 300) MHz	3.2 % of reading + 0.23 mV	
	(300 to 600) MHz	4 % of reading + 0.23 mV	
	5 mVp-p to 3.5 Vp-p		
	600 MHz to 1.1 GHz	5.5 % of reading + 0.2 mV	
Bandwidth/Flatness (50 kHz Reference)			
into 50 Ω load	5 mVp-p to 5.5 Vp-p		
	50 kHz to 100 MHz	1.4 % of reading + 78 µV	
	(100 to 300) MHz	1.8 % of reading + 78 µV	
	(300 to 600) MHz	3.2 % of reading + 78 µV	
	5 mVp-p to 3.5 Vp-p		
	600 MHz to 1.1 GHz	4 % of reading + 78 µV	
Input Impedance – Measure	(40 to 60) Ω	0.082 % of reading	
	500 kΩ to 1.5 MΩ	0.081 % of reading	
Input Capacitance – Measure	(5 to 50) pF	3.9 % of reading + 0.39 pF	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,3] Waveform Generator (Sine, Square, Triangle) Amplitude into 50 Ω load into 1 MΩ load Frequency	 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 0.002 % of reading + 12 mHz	Fluke 5520A/11 Multiproduct Calibrator with 1.1 GHz Scope Option

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle – Source [1]	Up to 75 ° 90 °	6.6″ 2.7″	Angle Blocks Master Square
Angle – Measure [1]	Up to 360 °	0.25 °	Digital Protractor
Gage Blocks [4] (Steel and Chrome)	(0.01 to 1) in (1 to 4) in	3.3 µin (1.7 + 1.4*L*) µin	Gage Block Comparator, Master Gage Blocks
Long Gage Blocks [4] (Steel Only)	(4 to 20) in	(5.5 + 1.4*L*) µin	Gage Block Comparator, Master Gage Blocks
Calipers, Micrometers [1,4] Travel (Outside, Inside, Depth, Step) Anvil Flatness Anvil Parallelism	 Up to 0.4 in (0.4 to 1) in (1 to 4) in (4 to 40) in Up to 1 in diameter Up to 1 in diameter	 (8 + 1*L*) µin (7 + 2*L*) µin (4+ 5*L*) µin (8 + 5*L*) µin 6.4 µin 11 µin	 Gage Blocks Optical Flats Optical Parallels
Indicators [1,4] (Dial, Digital, Drop, Snap)	Up to 1 in (1 to 4) in (4 to 24) in	(31 + 0.3*L*) µin (29 + 3*L*) µin (25 + 4*L*) µin	Gage Blocks, Amplifier
Test Indicators	Up to 0.05 in	6.1 µin	Universal Length Measuring Machine
Height Gages [1,4]	Up to 1 in (1 to 4) in (4 to 24) in	(31 + 0.3*L*) µin (29 + 3*L*) µin (25 + 4*L*) µin	Gage Blocks, Amplifier

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Height Masters, Caliper Masters, 1-2-3 Blocks, Parallels [1]	Up to 4 in (4 to 24) in	(52 + 0.5*L*) µin (41 + 3.7*L*) µin	Gage Blocks, Amplifier
Length – Single Axis [4] Outside Dimension Inside Dimension	 Up to 1 in (1 to 7) in (7 to 12) in (0.04 to 0.125) in (0.125 to 0.25) in (0.25 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	 (6 + 1.3*L*) µin (4.5 + 4*L*) µin (2 + 4*L*) µin 11 µin 11 µin 11 µin 18 µin (18 + 3*L*) µin (39 + 3*L*) µin	Universal Length Measuring Machine
Length Measuring Equipment [1,4] (Linear Displacement)	Up to 144 in	(1 + 2.1*L*) µin	Laser Interferometer
Cylindrical Plugs	Up to 1 in (1 to 7) in	12 µin (11 + 3*L*) µin	Universal Length Measuring Machine
Cylindrical Rings [4]	(0.04 to 0.125) in (0.125 to 0.25) in (0.25 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	11 µin 11 µin 11 µin 18 µin (18 + 3*L*) µin (39 + 3*L*) µin	Universal Length Measuring Machine
Thread Wires (2 to 120) TPI	(0.008 33 to 0.5) in	12 µin	Universal Length Measuring Machine
Thread Plug Gages [4] Pitch Diameter – 60 ° Thread Major Diameter	 Up to 1 in (1 to 4) in (4 to 7) in Up to 1 in (1 to 7) in	 79 µin 81 µin 84 µin 13 µin (10 + 3*L*) µin	Universal Length Measuring Machine, Master Thread Wires
Thread Ring Gages Inner Pitch Diameter	 Up to 1 in (1 to 4) in (4 to 7) in	 79 µin 81 µin 84 µin	Master Thread Setting Plug Uncertainty

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surface Plates [1,4]			In accordance with ASME B89.3.7 using Electronic Level System
Overall Flatness	(17 to 100) inDL	(24 + $\sqrt{DL}$) µin	
Local Area Flatness (Repeat Readings)	Up to 0.001 in	33 µin	Supramess with Repeat-o-Meter
Optical Comparators [1,4]			
X-Y Length	Up to 12 in	(80 + 19L) µin	Calibration Grids
Squareness	(0.04 to 0.5) in (0.5 to 1) in	(110 + 1L) µin (112 + 1.5L) µin	Calibration Grids
Magnification	10X to 50X	(240 + 21L) µin	Magnification Scale, Reticle
Flatness, Straightness, Parallelism [1]	Up to 18 in	36 µin	Gage Amplifier, Surface Plate

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Viscosity Cups [5] (Kinematic Viscosity)	18 mm²/s (cSt) 32 mm²/s (cSt) 65 mm²/s (cSt) 117 mm²/s (cSt) 230 mm²/s (cSt) 392 mm²/s (cSt) 734 mm²/s (cSt)	0.57 % of reading 0.78 % of reading 0.62 % of reading 0.75 % of reading 0.91 % of reading 1.1 % of reading 0.82 % of reading	Accredited Viscosity Standards (Nominal at 25°C)
Force Gages – Tension/Compression	(0.1 to 200) lbf	0.033 % of reading	NIST Class F Weights
Mass (Metric)	0.5 kg 1 kg 2 kg 5 kg 10 kg 20 kg 30 kg	11 mg 11 mg 15 mg 22 mg 0.2 g 0.3 g 0.3 g	Echelon III

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (Avoirdupois)	1 lb 2 lb 3 lb 5 lb 10 lb 20 lb 30 lb 50 lb 65 lb	10 mg 10 mg 10 mg 10 mg 20 mg 0.2 g 0.2 g 0.2 g 0.3 g	Echelon III
Balances and Scales [1,5] (Metric)	Up to 500 mg (0.5 to 10) g (10 to 30) g (30 to 50) g (50 to 200) g (200 to 500) g (0.5 to 5) kg (5 to 25) kg	4.7 µg 20 µg 40 µg 75 µg 0.22 mg 0.62 mg 3.7 mg 61 mg	ASTM E617 Class 1 & Class 2 weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances and Scales [1,5] (Avoirdupois)	(0.5 to 500) lb	0.033 % of reading	NIST Class F weights and internal calibration procedure utilized for the calibration of the weighing system.
Rockwell Hardness Testers [1]	HRC Low Middle High HRBW Low Middle High	 0.45 HRC 0.45 HRC 0.34 HRC 0.56 HRBW 0.47 HRBW 0.53 HRBW	Indirect verification per ASTM E18 using Test Blocks
Pressure – Absolute [1]	(0 to 30) psia (30 to 300) psia (300 to 1 000) psia	0.002 6 psi 0.008 9 % of reading 0.01 % of reading	DHI RPM4 Pressure Calibrator, Pressure Controller
Pressure – Hydraulic [1]	(200 to 1 600) psig (1 600 to 16 200) psig	0.091 psi 0.006 % of reading	Fluke P3125-PSI Deadweight Tester
Pressure – Pneumatic [1]	(-15 to 30) psig (30 to 300) psi (300 to 1 000) psig	0.002 2 psi 0.007 5 % of reading 0.01 % of reading	DHI RPM4 Pressure Calibrator, Pressure Controller
Pressure – Pneumatic [1]	(-60 to -22) inH_2O (-22 to 22) inH_2O (22 to 60) inH_2O	0.01 % of reading 0.002 2 inH_2O 0.01 % of reading	DHI PPC4 Pressure Controller

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure – Pneumatic [1]	(22 to 60) inH_2O (60 to 72) inH_2O (72 to 832) inH_2O	0.01 % of reading 0.006 7 inH_2O 0.01 % of reading	DHI PPC4 Pressure Controller
Torque Devices [1]	(0.2 lbf·in to 5) lbf·in	1.7 % of reading + 0.002 3 lbf·in	Tohnichi TDT60CN3-G Digital Torque Driver Tester
	(2 to 50) lbf·in	1.4 % of reading + 0.006 lbf·in	Tohnichi TDT600CN3-G Digital Torque Driver Tester
	(1.5 to 295) lbf·ft (295 to 740) lbf·ft	1 % of reading 1.7 % of reading	Stahlwille Torque Calibration System
Torque Calibration Systems	(2.5 to 50) lbf·in (4.2 to 250) lbf·ft (250 to 800) lbf·ft	0.2 % of reading 0.2 % of reading 0.2 % of reading	Torque Wheels, Torque Arm, NIST Class F Weights

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measure[1]	(-10 to 15) °C Up to 95 %RH (15 to 25) °C (0 to 90) %RH (90 to 95) %RH (25 to 40) °C Up to 50 %RH (50 to 75) %RH (75 to 95) %RH	 2.1 %RH 1.3 %RH 2 %RH 1.7 %RH 2 %RH 2.3 %RH	Thermohygrometer
Relative Humidity – Source	(-10 to 15) °C (10 to 75) %RH (75 to 95) %RH (15 to 35) °C (10 to 95) %RH (35 to 70) °C (10 to 50) %RH (50 to 70) %RH (70 to 95) %RH	 0.5 %RH 0.65 %RH 0.5 %RH 0.5 %RH 0.7 %RH 0.85 %RH	Humidity Generator

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure[1]	(-100 to 0.01) °C (0.01 to 230) °C (230 to 420) °C (420 to 660) °C	11 mK 19 mK 25 mK 36 mK	PRT, Precision Indicator
	(600 to 980) °C	0.87 % of reading + 1 °C	Type K Thermocouple Probe, Thermocouple Indicator
Temperature – Source	(-80 to -40) ºC (-40 to 100) ºC (100 to 270) ºC (270 to 400) ºC	1.9 mK 1.4 mK 2.4 mK 5.6 mK	Precision Bath, SPRT
	(400 to 600) °C	22 mK	Furnace, SPRT
Infrared Temperature 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	0.8 °C 0.65 °C 0.7 °C 0.76 °C 0.95 °C 1.6 °C 2.1 °C	Black Body (flat plate) ε = (0.9 to 1), λ = (8 to 14) µm
SPRT/PRT Calibration by Fixed Point	0.01 °C	0.6 mK	Comparison TPW Cell
	156.598 ºC	1.9 mK	Comparison to In Cell
	231.928 ºC	2.1 mK	Comparison to Sn Cell
	419.527 ºC	3.5 mK	Comparison to Zn Cell
	660.323 ºC	8.6 mK	Comparison to Al Cell
SPRT/PRT Calibration by Comparison	-195 °C	2.4 mK	Hart 5681 SPRT, $NBPLN_2$
	-80 °C	1.9 mK	Hart 5681 SPRT, Precision Bath
	-38.8 °C	1.2 mK	

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rise Time – Measure [1]	≥ 5 ns	4 ns	Agilent DSO5012 Digital Oscilloscope
Frequency – Source/Measure	10 MHz	6.4 nHz/Hz	Rubidium Frequency Oscillator
Frequency – Source/Measure [1]	10 MHz	2.8 µHz/Hz	Agilent 53132A Frequency Counter

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 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.
3. 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.
4. L = length in inches; DL = diagonal length in inches.
5. These numbers are nominal in nature. Uncertainty will reflect actual values reported.
6. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.06.

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