CERTIFICATE OF ACCREDITATION

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Transcat - Indianapolis
2845 Tobey Drive
Indianapolis, IN 46219

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the fields of

CALIBRATION and DIMENSIONAL MEASUREMENT

This certificate is valid only when accompanied by a current scope of accreditation document.
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Jason Stine, Vice President

Expiry Date: 07 September 2027

Certificate Number: AC-2489.30

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

AND

ANSI/NCSL Z540-1-1994 (R2002)

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Certificate Number: **AC-2489.30** Certificate Expiry Date: **07 September 2027**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Measuring Devices [1]	94 dB 250 Hz 1 kHz 114 dB 250 Hz 1 kHz	 0.4 dB 0.4 dB 0.4 dB 0.4 dB	Comparison to Sound Level Calibrator
Sound Level – Measure [1]	(35 to 130) dB 63 Hz to 8 kHz	1.8 dB	Comparison to Sound Level Meter

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters [1,2]	4 pH 7 pH 10 pH	0.012 pH 0.012 pH 0.012 pH	Comparison to Accredited Solutions

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters [1,2]	5 µS/cm 10 µS/cm 100 µS/cm 1 000 µS/cm 10 000 µS/cm 100 000 µS/cm 150 000 µS/cm	0.32 µS/cm 0.32 µS/cm 0.82 µS/cm 3.3 µS/cm 36 µS/cm 300 µS/cm 590 µS/cm	Comparison to Accredited Solutions
Refractometers [1]	(1.3 to 1.395) nD (0 to 30) % Brix	0.0006 nD 0.032 % Brix	Comparison to Accredited Solutions
Gas Monitors and Detectors [1] CO (Carbon Monoxide)	0.002 5 % CO 0.005 % CO 0.01 % CO 0.03 % CO	0.000 15 % CO 0.000 22 % CO 0.000 28 % CO 0.000 63 % CO	Comparison to Accredited Gases
CO_2 (Carbon Dioxide)	1 % CO_2 3 % CO_2 5 % CO_2 15 % CO_2	0.025 % CO_2 0.068 % CO_2 0.11 % CO_2 0.31 % CO_2	
H_2S (Hydrogen Sulfide)	0.002 5 % H_2S	0.000 13 % H_2S	
LEL (Methane)	20 % LEL 50 % LEL	2 % LEL 2.2 % LEL	
O_2 (Oxygen)	18 % O_2 20.9 % O_2	0.48 % O_2 0.53 % O_2	
SO_2 (Sulfur Dioxide)	0.001 % SO_2	0.000 03 % SO_2	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meter Simulation [1] (Electrical)	(0 to 15) pH	0.001 pH	Comparison to Fluke 5522A Multiproduct Calibrator

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meter Simulation [1] (Resistance)	(10 to 100) µS (101 to 1000) µS (1001 to 10 000) µS (10 001 to 100 000) µS (100 001 to 1 000 000) µS	0.08 µS 0.09 µS 0.08 µS 0.06 µS 0.04 µS	Comparison to Fluke 5522A Multiproduct Calibrator
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 (0.22 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 (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 (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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.025 % of reading + 16 nA 0.016 % of reading + 10 nA 0.011 % of reading + 8 nA 0.028 % of reading + 12 nA 0.11 % of reading + 65 nA 0.025 % of reading + 40 nA 0.016 % of reading + 35 nA 0.011 % of reading + 35 nA 0.021 % of reading + 0.11 µA 0.11 % of reading + 0.65 µA 0.025 % of reading + 0.4 µA 0.016 % of reading + 0.35 µA 0.011 % of reading + 0.35 µA 0.021 % of reading + 0.55 µA 0.11 % of reading + 10 µA 0.025 % of reading + 4 µA 0.016 % of reading + 3.5 µA 0.011 % of reading + 2.5 µA 0.021 % of reading + 3.5 µA 0.11 % of reading + 10 µA 0.025 % of reading + 35 µA 0.045 % of reading + 80 µA 0.7 % of reading + 0.16 mA	Comparison to Fluke 5730A/03 Multiproduct Calibrator
AC Current – Source [1]	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.048 % of reading + 0.17 mA 0.096 % of reading + 0.38 mA 0.36 % of reading + 0.75 mA	Comparison to Fluke 5730A/03 Multiproduct Calibrator, Fluke 5725A Amplifier

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	(11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	 0.095 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.3 % of reading + 3.9 mA	Comparison to Fluke 5522A 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	 0.31 % of reading + 26 mA 0.84 % of reading + 47 mA 0.35 % of reading + 0.12 A 1.2 % of reading + 0.22 A	Comparison to Fluke 5522A Multiproduct Calibrator, Fluke 5500A/Coil 50-turn 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	 0.58 % of reading + 0.25 A 1.1 % of reading + 0.25 A 0.6 % of reading + 0.9 A 1.3 % of reading + 0.92 A	Comparison to Fluke 5522A Multiproduct Calibrator, Fluke 5500A/Coil 50-turn Coil
AC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(1 to 6) kA (10 to 300) Hz (1 to 2) kA (300 to 440) Hz (2 to 6) kA (300 to 440) Hz	 0.6 % of reading 0.8 % of reading 0.66 % of reading	Comparison to Fluke 5522A Multiproduct Calibrator, Fluke 52120A Transconductance Amplifier, 3 kA and 6 kA Coil
AC Current – Measure [1]	Up to 200 µA 1 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (0.2 to 2) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA 1 Hz to 10 Hz 10 Hz to 10 kHz (10 to 30) kHz	 0.031 % of reading + 20 nA 0.071 % of reading + 20 nA 0.4 % of reading + 20 nA 0.031 % of reading + 0.2 µA 0.03 % of reading + 0.2 µA 0.071 % of reading + 0.2 µA 0.4 % of reading + 0.2 µA 0.031 % of reading + 2 µA 0.03 % of reading + 2 µA 0.071 % of reading + 2 µA 0.4 % of reading + 2 µA 0.031 % of reading + 20 µA 0.029 % of reading + 20 µA 0.063 % of reading + 20 µA	Comparison to Fluke 8508A 8.5 Digit Multimeter

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure [1]	(0.2 to 2) A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (2 to 20) A 10 Hz to 2 kHz (2 to 10) kHz	 0.062 % of reading + 0.2 mA 0.074 % of reading + 0.2 mA 0.3 % of reading + 0.2 mA 0.082 % of reading + 2 mA 0.25 % of reading + 2 mA	Comparison to Fluke 8508A 8.5 Digit Multimeter
AC Voltage – Source [1]	Up to 2.2 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 kHz to 1 MHz (2.2 to 22) 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 kHz to 1 MHz (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 kHz to 1 MHz	 0.16 % of reading + 4 µV 0.1 % of reading + 4 µV 0.078 % of reading + 4 µV 0.13 % of reading + 4 µV 0.17 % of reading + 5 µV 0.33 % of reading + 10 µV 0.47% of reading + 20 µV 0.58 % of reading + 20 µV 0.042 % of reading + 4 µV 0.03 % of reading + 4 µV 0.014 % of reading + 4 µV 0.03 % of reading + 4 µV 0.058 % of reading + 5 µV 0.12 % of reading + 10 µV 0.16 % of reading + 20 µV 0.27 % of reading + 20 µV 0.028 % of reading + 12 µV 0.011 % of reading + 7 µV 0.009 % of reading + 7 µV 0.021 % of reading + 7 µV 0.047 % of reading + 17 µV 0.091 % of reading + 20 µV 0.14 % of reading + 25 µV 0.28 % of reading + 45 µV	Comparison to Fluke 5730A/03 Multiproduct Calibrator

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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		Comparison to Fluke 5730A/03 Multiproduct Calibrator
	(10 to 20) Hz	0.027 % 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	0.01 % of reading + 0.2 mV	
	500 kHz to 1 MHz	0.18 % of reading + 0.3 mV	
	(2.2 to 22) V		
	(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		
	(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 o 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	
AC Voltage – Source [1]	(220 to 1 100) V		Comparison to Fluke 5730A/03 Multiproduct Calibrator, Fluke 5725A Amplifier
	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 – Source [1] Extended Frequency Ranges	(220 to 750) V		Comparison to Fluke 5730A/03 Multiproduct Calibrator, Fluke 5725A Amplifier
	(30 to 50) kHz	0.061 % of reading + 11 mV	
	(50 to 100) kHz	0.23 % of reading + 45 mV	

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AC Voltage – Measure [1]	Up to 200 mV		Comparison to Fluke 8508A 8.5 Digit Multimeter
	(1 to 10) Hz	0.021 % of reading + 14 µV	
	(10 to 40) Hz	0.017 % of reading + 4 µV	
	(40 to 100) Hz	0.014 % of reading + 4 µV	
	(0.1 to 2) kHz	0.013 % of reading + 2 µV	
	(2 to 10) kHz	0.016 % of reading + 4 µV	
	(10 to 30) kHz	0.04 % of reading + 8 µV	
	(30 to 100) kHz	0.09 % of reading + 20 µV	
	(0.2 to 2) V		
	(1 to 10) Hz	0.019 % of reading + 0.12 mV	
	(10 to 40) Hz	0.014 % of reading + 20 µV	
	(40 to 100) Hz	0.011 % of reading + 20 µV	
	(0.1 to 2) kHz	89 µV/V of reading + 20 µV	
	(2 to 10) kHz	0.013 % of reading + 20 µV	
	(10 to 30) kHz	0.026 % of reading + 40 µV	
	(30 to 100) kHz	0.068 % of reading + 0.2 mV	
	(100 to 300) kHz	0.37 % of reading + 2 mV	
	(0.3 to 1) MHz	1.3 % of reading + 20 mV	
	(2 to 20) V		
	(1 to 10) Hz	0.019 % of reading + 1.2 mV	
	(10 to 40) Hz	0.014 % of reading + 0 .2 mV	
	(40 to 100) Hz	0.011 % of reading + 0.2 mV	
	(0.1 to 2) kHz	90 µV/V + 0.2 mV	
	(2 to 10) kHz	0.013 % of reading + 0.2 mV	
	(10 to 30) kHz	0.026 % of reading + 0.4 mV	
	(30 to 100) kHz	0.068 % of reading + 2 mV	
	(100 to 300) kHz	0.37 % of reading + 20 mV	
	(0.3 to 1) MHz	2.2 % of reading + 0.2V	
	(20 to 200) V		
	(1 to 10) Hz	0.02 % of reading + 12 mV	
	(10 to 40) Hz	0.014 % of reading + 2 mV	
	(40 to 100) Hz	0.011 % of reading + 2 mV	
	(0.1 to 2) kHz	90 µV/V + 2 mV	
	(2 to 10) kHz	0.013 % of reading + 2 mV	
	(10 to 30) kHz	0.026 % of reading + 4 mV	
	(30 to 100) kHz	0.068 % of reading + 20 mV	
	(200 to 1 000) V		
	(1 to 10) Hz	0.019 % of reading + 70 mV	
	(10 to 40) Hz	0.015 % of reading + 20 mV	
	(0.04 to 10) kHz	0.014 % of reading + 20 mV	
	(10 to 30) kHz	0.027 % of reading + 40 mV	
	(30 to 100) kHz	0.071 % of reading + 0.2 V	
AC High Voltage – Measure [1]	Up to 28 kV 60 Hz	5.2 % of reading + 1.7 V	Comparison to Keysight 34401A 6.5 Digit Multimeter, Fluke 80K-40

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
			High Voltage Probe
Capacitance – Source [1] (Simulation)	(0.22 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 (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF	0.4 % of reading + 7.8 pF 0.4 % of reading + 7.8 pF 0.4 % of reading + 7.8 pF 0.21 % of reading + 7.8 pF 0.2 % of reading + 78 pF 0.21 % of reading + 78 pF 0.2 % of reading + 0.23 nF 0.21 % of reading + 0.78 nF 0.21 % of reading + 2.3 nF 0.2 % of reading + 7.8 nF 0.32 % of reading + 23 nF	Comparison to Fluke 5522A Multiproduct Calibrator
Capacitance – Source [1] (Simulation)	(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	0.37 % of reading + 78 nF 0.38 % 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 0.85 % of reading + 78 µF	Comparison to Fluke 5522A Multiproduct Calibrator
Capacitance – Measure [1]	1 kHz (1 to 1 000) pF (1 to 1 000) nF (1 to 1 000) µF	 0.5 fF/pF + 23 fF 0.5 pF/nF + 0.88 pF 4.2 nF/µF	Comparison to Hameg LCR Meter
DC Current – Source [1]	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	40 µA/A + 6 nA 35 µA/A + 7 nA 35 µA/A + 40 nA 45 µA/A + 0.7 µA 80 µA/A + 12 µA	Comparison to Fluke 5730A/03 Multiproduct Calibrator
DC Current – Source [1]	(2.2 to 3) A (3 to 11) A (11 to 20.5) A	0.3 mA/A + 31 µA 0.51 mA/A + 0.39 mA 0.93 mA/A + 0.58 mA	Comparison to Fluke 5522A Multiproduct Calibrator
DC Clamp-on Ammeters (Non-Toroidal Type) Hall Effect Sensor [1]	(20 to 150) A (150 to 1 000) A (1 000 to 5 000) A	0.51 % of reading + 0.14 A 0.51 % of reading + 0.5 A 0.58 % of reading	Comparison to Fluke 5522A Multiproduct Calibrator, Fluke 5500A/COIL, Fluke 55120A Transconductance Amplifier, 1 kA and 6 kA Coils

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure [1]	Up to 200 µA (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A	13 µA/A + 0.31 nA 13 µA/A + 3.1 nA 14 µA/A + 31 nA 47 µA/A + 0.62 µA 0.18 mA/A + 12 µA 0.39 mA/A + 0.31 mA	Comparison to Fluke 8508A 8.5 Digit Multimeter
DC Current – Measure [1]	(0 to 500) A	0.2 mA/A + 0.16 A	Comparison to Fluke 8508A 8.5 Digit Multimeter, DC Current Shunt
DC Voltage – Source [1]	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	7.5 µV/V + 0.4 µV 5 µV/V + 0.7 µV 3.5 µV/V + 2.5 µV 3.5 µV/V + 4 µV 5 µV/V + 40 µV 6.5 µV + 0.4 mV	Comparison to Fluke 5730A/03 Multiproduct Calibrator
DC Voltage – Source [1] (Fixed Point)	10 V	0.31 µV/V	Comparison to Fluke 732A DC Voltage Reference Standard
DC Voltage – Measure [1]	Up to 200 mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1 000) V	5.2 µV/V + 90 nV 3.6 µV/V + 0.39 µV 3.5 µV/V + 3.9 µV 5.5 µV/V + 39 µV 5.5 µV/V + 0.47 mV	Comparison to Fluke 8508A 8.5 Digit Multimeter
DC High Voltage – Measure [1]	(1 to 20) kV (20 to 35) kV (35 to 40) kV	2 % of reading 1 % of reading 2 % of reading	Comparison to Keysight 34401A 6.5 Digit Multimeter, Fluke 80K-40 High Voltage Probe

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source [1,2,4]			Comparison to Fluke 5520A Multiproduct Calibrator
PF = 1			
(3.3 to 9) mA	(10 to 65) Hz		
	110 µW to 3 mW	0.13 % of reading	
	3 mW to 9 W	0.077 % of reading	
(9 to 33) mA	(10 to 65) W		
	300 µW 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	
(330 to 900) mA	(10 to 65) Hz		
	(11 to 300) mW	0.071 % of reading	
	300 mW 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	
DC Power – Source [1]			Comparison to 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	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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° 0.21° 0.39° 1.9° 3.9° 7.8°	Comparison to Fluke 5522A Multiproduct Calibrator

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices – Source [1]	Pt 385, 100 Ω		Comparison to Fluke 5522A Multiproduct Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 kΩ		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices – Source [1]	Pt 3916, 100 Ω		Comparison to Fluke 5522A Multiproduct Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	PtNi 385, 120 Ω		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.1 °C	
	Cu 427, 10 Ω		
	(-100 to 260) °C	0.23 °C	
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure [1]	Type B		Comparison to Fluke 5522A Multiproduct Calibrator
	(600 to 800) °C	0.35 °C	
	(800 to 1 000) °C	0.28 °C	
	(1 000 to 1 550) °C	0.24 °C	
	(1 550 to 1 820) °C	0.26 °C	
	Type C		
	(0 to 150) °C	0.24 ºC	
	(150 to 650) °C	0.21 ºC	
	(650 to 1000) °C	0.24 ºC	
	(1 000 to 1 800) °C	0.39 ºC	
	(1 800 to 2 316) °C	0.65 ºC	
	Type E		
	(-250 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.13 °C	
	(-25 to 350) °C	0.12 °C	
	(350 to 650) °C	0.13 °C	
	(650 to 1 000) °C	0.17 °C	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure [1]	Type J		Comparison to Fluke 5522A Multiproduct Calibrator
	(-210 to -100) °C	0.21 °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 -25) °C	0.15 °C	
	(-25 to 120) °C	0.13 °C	
	(120 to 1 000) °C	0.21 °C	
	(1 000 to 1 372) °C	0.31 °C	
	Type L		
	(-200 to -100) °C	0.29 °C	
	(-100 to 800) °C	0.21 °C	
	(800 to 900) °C	0.14 °C	
	Type N		
	(-200 to -100) °C	0.31 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.15 °C	
	(120 to 410) °C	0.15 °C	
	(410 to 1 300) °C	0.21 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.26 °C	
	(1 000 to 1 767) °C	0.32 °C	
	Type S		
	(0 to 250) °C	0.45 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.29 °C	
	(1 400 to 1 767) °C	0.36 °C	
	Type T		
	(-250 to -150) °C	0.49 °C	
	(-150 to 0) °C	0.19 °C	
	(0 to 120) °C	0.13 °C	
	(120 to 400) °C	0.12 °C	
	Type U		
	(-200 to 0) °C	0.44 °C	
	(0 to 600) °C	0.21 °C	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Magnetic Flux Density – Source [1,5] (Gauss Meters)	(0 to 35) G	0.26 % of reading	Comparison to Digital Multimeter, Helmholtz Coils
Resistance – Source [1] (Simulation)	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.33 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (0.33 to 1.1) GΩ	32 µΩ/Ω + 0.78 mΩ 24 µΩ/Ω + 1.2 mΩ 22 µΩ/Ω + 1.1 mΩ 22 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 0.16 Ω 22 µΩ/Ω + 0.16 Ω 27 µΩ/Ω + 1.6 Ω 26 µΩ/Ω + 1.6 Ω 66 µΩ/Ω + 23 Ω 0.1 mΩ/Ω + 39 Ω 0.19 mΩ/Ω + 1.9 kΩ 0.41 mΩ/Ω + 2.3 kΩ 0.23 % of reading + 78 kΩ 1.2 % of reading + 0.39 MΩ	Comparison to Fluke 5522A Multiproduct Calibrator
Resistance – Source [1] (Fixed Artifacts)	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	40 µΩ 95 µΩ/Ω 95 µΩ/Ω 23 µΩ/Ω 23 µΩ/Ω 10 µΩ/Ω 10 µΩ/Ω 6.5 µΩ/Ω 6.5 µΩ/Ω 6.5 µΩ/Ω 6.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 13 µΩ/Ω 18 µΩ/Ω 40 µΩ/Ω 47 µΩ/Ω 0.011 % of reading	Comparison to Fluke 5730A/03 Multiproduct Calibrator
Resistance – Source [1] (Fixed Artifacts)	1 Ω 10 kΩ	9.3 µΩ/Ω 7.6 µΩ/Ω	Comparison to Fluke 742A Resistance Standards

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source [1] (Fixed Artifacts)	1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ	15 µΩ/Ω 15 µΩ/Ω 20 µΩ/Ω 25 µΩ/Ω 31 µΩ/Ω 0.013 % of reading 0.07 % of reading 0.25 % of reading 0.45 % of reading	Comparison to Standard Resistors
DC Resistance – Measure [1] Normal Mode	Up to 2 Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ	17 µΩ/Ω + 3.9 µΩ 9.5 µΩ/Ω + 14 µΩ 7.8 µΩ/Ω + 47 µΩ 8.1 µΩ/Ω + 0.47 mΩ 7.8 µΩ/Ω + 4.7 mΩ 8.6 µΩ/Ω + 47 mΩ 9.5 µΩ/Ω + 93 mΩ 27 µΩ/Ω + 9.3 Ω 0.12 mΩ/Ω + 0.93 kΩ 0.14 % of reading + 93 kΩ	Comparison to Fluke 8508A 8.5 Digit Multimeter
DC Resistance – Measure [1] Low Current Mode	Up to 2 Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ	17 µΩ/Ω + 3.9 µΩ 9.4 µΩ/Ω + 14 µΩ 8 µΩ/Ω + 0.14 mΩ 8.2 µΩ/Ω + 1.4 mΩ 7.9 µΩ/Ω + 14 mΩ 8.6 µΩ/Ω + 93 mΩ 21 µΩ/Ω + 0.93 Ω 88 µΩ/Ω + 93 Ω 0.14 % of reading + 93 kΩ 0.14 % of reading + 0.93 MΩ	Comparison to Fluke 8508A 8.5 Digit Multimeter
DC Resistance – Measure [1] High Voltage Mode	(2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	25 µΩ/Ω + 9.3 Ω 70 µΩ/Ω + 0.93 kΩ 0.19 mΩ/Ω + 93 kΩ 0.14 % of reading + 9.3 MΩ	Comparison to Fluke 8508A opt 001 8.5 Digit Multimeter
Inductance – Source [1] (Variable Artifact)	1 kHz 1 µH to 999 mH	0.5 % of reading	Comparison to Inductance Decade Box characterized with Hameg LCR Meter
Inductance – Measure [1]	1 kHz 1 µH to 100 H	0.5 % of reading	Comparison to Hameg LCR Meter

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,2]			
Amplitude DC			
into 50 Ω load	(-6.6 to 6.6) V	0.22 % of reading + 31 µV	
into 1 MΩ load	(-130 to 130) V	0.12 % of reading + 31 µV	
Amplitude Square Wave			
into 50 Ω load	10 Hz to 10 kHz		
	1 mVp-p to 6.6 Vp-p	0.22 % of reading + 31 µV	
into 1 MΩ load	10 Hz to 1 kHz		
	1 mVp-p to 130 Vp-p	0.078 % of reading + 31 µV	
	(1 to 10) kHz		
	1 mVp-p to 130 Vp-p	0.19 % of reading + 31 µV	
Timing – Generate			
into 50 Ω load	1 ns to 20 ms	0.000 22 % reading	
	50 ms	0.005 9 % reading	
	100 ms	0.009 8 % reading	
	200 ms	0.018 % reading	Comparison to Fluke 5522A/11 Multiproduct Calibrator
	500 ms	0.041 % reading	
	1 s	0.08 % reading	
	2 s	0.16 % reading	
	5 s	0.39 % reading	
Rise Time – Generate			
into 50 Ω Load	5 mVp-p to 2.5 Vp-p		
Rate: 1 kHz to 2 MHz	(200 to 300) ps	50 ps	
Rate: 2 MHz to 10 MHz	(250 to 350) ps	50 ps	
Leveled Sine Wave – Generate			
into 50 Ω load	5 mVp-p to 5.5 Vp-p		
	50 kHz	1.8 % of reading + 0.23 mV	
	100 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 + 0.23 mV	

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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,2]			
Bandwidth/Flatness – Measure			
(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			Comparison to Fluke 5522A/11 Multiproduct Calibrator
into 50 Ω load	(40 to 60) Ω	0.082 % of reading	
into 1 MΩ load	(0.5 to 1.5) MΩ	0.081 % of reading	
Input Capacitance – Measure	(5 to 50) pF	3.9 % of reading + 0.39 pF	
Wave Generator – Source Amplitude			
(Sine, Square, Triangle)	10 Hz to 10 kHz		
into 50 Ω load	1.8 mVp-p to 2.5 Vp-p	2.3 % of reading + 78 µV	
into 1 MΩ load	1.8 mVp-p to 55 Vp-p	2.3 % of reading + 78 µV	
Frequency			
	10 Hz to 10 kHz	0.001 9 % of reading + 12 mHz	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks, Length Standards [3]			
Standard Size Length	(0.005 to 0.5) in	2.6 µin	Mechanical Comparison using Master Gage Blocks
	(0.55 to 1) in	3.4 µin	
	2 in	5.5 µin	
	3 in	7.7 µin	
	4 in	9.9 µin	

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks, Length Standards [3]			Mechanical Comparison using Master Gage Blocks
Standard Size Length	5 in 6 in 7 in 8 in 10 in 12 in 16 in 20 in	13 µin 15 µin 27 µin 30 µin 37 µin 44 µin 58 µin 73 µin	
Non-standard Size Length	(0.001 to 0.005) in (0.005 to 1) in (1 to 6) in (6 to 20) in (20 to 40) in	4.9 µin (3 + 2L) µin (8.3 + 2.3L) µin (26 + 2.2L) µin (69 + 1.7L) µin	
Feeler Gages, [1] Shims	Up to 1 in Up to 25.4 mm	15 µin 0.38 µm	Comparison to Universal Length Measuring Machine, Gage Blocks
Height Masters [1]	Up to 24 in Up to 600 mm	24 µin 0.61 µm	Comparison to Indicator with Gage Amplifier, Gage Blocks, Surface Plate
Height Gages [1,3,5]	Up to 60 in Up to 1 500 mm	(8 + 3.5L) µin (0.2 + 0.003 5L) µm	Comparison to Gage Blocks, Surface Plate
Micrometers [1,3,5]	Up to 20 in Up to 500 mm	(7 + 4.5L) µin (0.2 + 0.005L) µm	Comparison to Gage Blocks
Calipers [1,3,5]	Up to 80 in Up to 2 000 mm	(24 + 4.6L) µin (0.6 + 0.005L) µm	Comparison to Gage Blocks
LVDT's, Indicators [1,3,5]	Up to 12 in Up to 300 mm	(3 + 3.3L) µin (0.08 + 0.005L) µm	Comparison to Gage Blocks, Surface Plates
Measuring Tapes, Rulers [1]	Up to 5 ft (5 to 10) ft (10 to 48) ft (48 to 1 000) ft	0.006 3 in 0.013 in 140 µin/in 120 µin/in	Comparison to Ruler Calibrator

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Blocks [1,3]	(0.25 to 90)°	(13 + 0.07*A*)″	Comparison to Sine Bar, Gage Blocks, Surface Plate
Angle Measuring Devices [1, 3] (Protractors, Inclinometers, Squares, Angle Gages, etc.)	0.005 6″ to 5° (5 to 20)° (20 to 35)° (35 to 45)° (45 to 60)° (60 to 75)° (75 to 85)°	3.3″ 6.5″ 12″ 17″ 28″ 59″ 190″	Comparison to 5 in Sine Bar, Gage Blocks
Chamfer Gage [1]	(0.15 to 2) in (3.8 to 50) mm	290 µin 7.5 µm	Comparison to Reference Ring Gages
Cylindrical Square Squareness	Up to 24 in Up to 600 mm	25 µin 0.6 µm	Comparison to Indicator, Height Stand, Surface Plate
Electronic Levels, Inclination Levels [3]	Up to 1 000″	0.23″	Comparison to Sine Bar, Gage Blocks, Surface Plate
Spirit Levels, Clinometers [5]	Up to 4 ft Up to 1.2 m	50 µin/ft 1.3 µm/m	Sine Bar, Gage Blocks, Surface Plate
Sine Plates/Bars [3] Parallelism Angle	Up to 15 in (0 to 45)°	78 µin (10 + 0.6*A*)″	Comparison to Surface Plate, Indicator with Gage Amplifier, Gage Blocks, Angle Blocks
Optical Flats/Parallels	Up to 4 in Up to 100 mm	6.4 µin 0.16 µm	Comparison to Master Optical Flat
Cylindrical Pins/Plugs [3]	(0.003 to 40) in	(8 + 0.8*D*) µin	Comparison to Gage Blocks, Universal Length Measuring Machine

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Cylindrical Rings/Bores [3]	(0.02 to 33) in	(4.8 + 0.9*D*) µin	Comparison to Gage Blocks, Universal Length Measuring Machine
CMM Spheres, Gage Balls	(0.015 to 4) in (0.38 to 100) mm	12 µin 0.3 µm	Comparison to Gage Blocks, Universal Length Measuring Machine
Thread Wires	(0.003 to 0.825) in 76 µm to 30 mm	10 µin 0.25 µm	Comparison to Master Thread Wires, Gage Blocks, Universal Length Measuring Machine
Thread Pitch Gages	Up to 6 in	430 µin	Comparison to Optical Comparator
Thread Plug Gages [1, 3] Pitch Diameter, (40 to 80) TPI Major Diameter Step Height	Up to 1.25 in (1.25 to 4.5) in (4.5 to 7) in Up to 1.75 in (1.75 to 7) in Up to 1 in	97 µin 100 µin 110 µin 59 µin (56 + 2*D*) µin 160 µin	Comparisons to Universal Length Measuring Machine, Master Thread Wires, Gage Blocks Universal Length Measuring Machine, Gage Blocks Gage Blocks, Test Stand
Thread Ring Gages [3] Pitch Diameter Minor Diameter	Up to 20 in Up to 20 in	(66 + 0.26*D*) µin 45 µin	Comparison to Universal Length Measuring Machine, Thread Balls, Gage Blocks
Thread Ring Gages [1,3] Inner Pitch Diameter	Up to 2 in (2 to 12) in	(140 + 27.5*D*) µin (160 + 18*D*) µin	Comparison to Master Thread Plug Gages
Adjustable Thread Rings [3] Pitch Diameter	Up to 2 in	(140 + 2*D*) µin	Tactile Fit to Class X Master Set Plugs
Parallels, Straight Edges	Up to 12 in	40 µin	Comparison to Indicator, Height Stand, Surface Plate

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Planekator	Up to 48 in	57 µin	Comparison to Laser System, Surface Plate
Profilometers, Surface Testers [1] (Primary)	Ra = 120 µin	8.4 µin	Comparison to Master Surface Patch
Profilometers, Surface Testers [1] (Secondary)	Ra = (10 to 200) µin	8 % of reading + 2.6 µin	Comparison to Surface Patches
Roughness Standards/Patches (ISO Type C)	Ra = (10 to 200) µin	7 % of reading + 1.5 µin	Comparison to Master Surface Patch, Profilometer
Coating Thickness Meters [1]	(0.94 to 20.24) mils	0.095 mils	Comparison to Coating Thickness Standards
V-Blocks Groove Squareness	 Up to 4 in Up to 24 x 24 x 24 in	 64 µin 45 µin	Comparison to Indicator, Height Stand, Surface Plate
Bench Micrometers, Universal Length Measuring Machines [1,3,5] Standard Length Non-standard Length	 (> 0.005 to 1) in 2 in 3 in 4 in 5 in 6 in 7 in 8 in 10 in 12 in 16 in 20 in (20 to 40) in	 (2.5 + 0.5*L*) µin 4.2 µin 4.9 µin 6.4 µin 8.1 µin 8.9 µin 9.7 µin 11 µin 12 µin 14 µin 17 µin 20 µin (20 + 0.86*L*) µin	Comparison to Gage Blocks, Long Gage Blocks

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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Coordinate Measuring Machines (CMM's) [1,3]			
Linear Displacement Accuracy (X, Y, Z)	Up to 72 in	(8 + 3*L*) µin	Comparisons to Gage Blocks, Optical Flats
Volumetric Repeatability	Up to 72 in	100 µin	Ball Bar
Probe Repeatability	Up to 72 in	25 µin	Sphere
Optical Comparators [1,3]			
X,Y Measuring Stage Travel	Up to 12 in	(130 + 17*L*) µin	Comparisons to Calibration Grids
Squareness	(0.4 to 1) in	120 µin	Calibration Grids
Magnification	10X to 62.5X	(240 + 21*L*) µin	Magnification Checker
Radius Gages	Up to 2 in	460 µin	Comparison to Optical Comparator
Granite Surface Plates [1,3]			
Overall Flatness	(8.49 to 299.25) *DL*	4 $\sqrt{DL}$ µin	In accordance with ASME B89.3.7 using Electronic Level System
Local Area Flatness (Repeat Readings)	Up to 0.005 in	40 µin	Repeat-o-Meter
Torque Wheels, Torque Arms [3]	Up to 40 in	(470 + 2*L*) µin	Comparison to Surface Plate, Indicator with Gage Amplifier, Gage Blocks, Digital Outside Micrometer
Depth Micrometers [1,3]	(0.01 to 72) in	(50 + 55.1*L*) µin	Comparison to Gage Blocks

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Air Velocity Measuring Devices (Anemometers, Thermal, Pitot, Vane-style and Similar Equipment)	(30 to 250) ft/min (250 to 1 500) ft/min (1 500 to 9 000) ft/min	2.3 % of reading + 2.6 ft/min 2.3 % of reading + 6 ft/min 1.2 % of reading + 17 ft/min	Comparison to Wind Tunnel

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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Mass Flow [1] (Flow Meters, Flow Controllers, Rotameters, and Leak Orifices)	(1 to 10) sccm (10 to 1 000) sccm	0.25 sccm 0.22 % of reading	Comparison to Fluke molBloc-L Calibration System
	(1 to 1 000) slpm	0.1 % of reading	Comparison to Fluke molBloc-S Calibration System
Liquid Flow Meters [1]	Up to 10 gpm	1.4 % of reading + 0.001 8 gpm	Calibration by Time and Mass
Hydrometers	(0.6 to 0.64) SG (0.64 to 1.67) SG (1.67 to 2) SG	0.002 5 SG 0.001 4 SG 0.005 SG	Comparison to Reference Hydrometer per ASTM E126.
Kinematic Viscosity Meters [1]	< 10 mm²/s (11 to 100) mm²/s (101 to 1000) mm²/s (1001 to 10 000) mm²/s (10 001 to 100 000) mm²/s	0.25 % of reading 0.32 % of reading 0.37 % of reading 0.44 % of reading 0.51 % of reading	Comparison to Accredited Viscosity Standard, Temperature Indicator with Probe
Viscosity Cups [1] (Kinematic Viscosity @ 25 °C) Zahn Shell Ford	 (5 to 1 800) mm²/s (2 to 1 300) mm²/s (2 to 1 400) mm²/s	 2.2 % of reading 2.2 % of reading 2.2 % of reading	Accredited Viscosity Standard per ASTM D4212 ASTM D4212 ASTM D1200
Piston Operated Volumetric Apparatus [7] (Pipettes, Syringes, Burettes, Liquid, Handlers, Dispensers)	(1 to 2 000) µL (2000 to 10 000) µL (10 000 to 100 000) µL	94 nL 0.22 µL 2 µL	Gravimetric Method using Electronic Balances and ASTM E617 Class 1 Weights.
Volume Measuring Equipment [1]	(0.001 to 4 000) mL	0.8 µL	Per ASTM E542 using Temperature Indicator with Probe, Electronic Balance, Distilled Water, Barometer
Load Cells, Force Testers, Force Gages [1] (Tension and Compression)	(25 to 250) cN (250 to 2 000) cN	5.2 cN 52 cN	Comparison to Correx Gram Gauge
	(0 to 500) lbf	0.088 % of reading	Comparison to NIST Class F Weights

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Mass and Mass Related

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	(100 to 5 000) lbf (5 000 to 10 000) lbf (10 000 to 25 000) lbf (25 000 to 50 000) lbf	0.008 % of reading + 1.7 lbf 0.013 % of reading + 1.7 lbf 0.013 % of reading + 4.2 lbf 0.013 % of reading + 8.3 lbf	Comparison to Tovey Engineering Calibration System
Durometers [1] (Type A, B, C, CF, D, DO, E, M, O, OO, OOO-S, SA, ASKER C) Indenter Dimensions Extension Length Diameter Angle Radius Spring Force	 Up to 0.2 in Up to 1 in Up to 35° Up to 1 in (0 to 100) Duro	 160 µin 170 µin 0.1° 170 µin 0.34 Duro	Direct Verification per ASTM D2240 using Optical Comparator Durometer Calibrator
Shore Durometer Calibrators Dimensional Measurements Mass	 Up to 8 in Up to 4 kg	 480 µin 30 mg	Comparisons to Optical Comparator Single Substitution Method using Electronic Balance
Rockwell Hardness and Superficial Testers [1]	HRBW (80 to 100) HRBW (60 to 79) HRBW (40 to 59) HRBW HRC (60 to 65) HRC (35 to 55) HRC (20 to 30) HRC	 0.48 HRBW 0.77 HRBW 1.1 HRBW 0.37 HRC 0.48 HRC 0.57 HRC	Indirect verification per ASTM E18 using hardness test blocks.
Mass Determination [1] (Variable)	1 mg to 5 g (5 to 30) g (30 to 200) g (200 to 500) g (500 to 2000) g (2 to 10) kg (10 to 30) kg (30 to 45) kg	21 µg 24 µg 0.21 mg 2.1 mg 21 mg 0.21 g 0.24 g 0.45 g	Comparison to Electronic Balances, OIML Class E1 Weights, ASTM E617 Class 1 Weights

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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination (Fixed Points)	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg	4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.3 µg 4.5 µg 4.5 µg 4.5 µg 8.6 µg 9.1 µg 11 µg 15 µg 19 µg 28 µg 18 µg 0.13 mg 0.91 mg 0.86 mg	Comparison to Electronic Balances, OIML Class E1 Weights
Pneumatic Pressure Measuring Equipment [1] (Absolute, Gauge)	(0.1 to 15) psi	0.003 4 % of reading + 0.000 5 psi	Comparison to Ruska 7010 Pressure Controller/Calibrator
	(0.1 to 1 000) psi	0.006 % of reading + 0.015 psi	Comparison to Ruska 7215I Pressure Controller/Calibrator
Pressure Measuring Equipment [1] (Absolute, Gauge, Negative and Positive)	(-104 to -7.5) kPa (-7.5 to -2.9) kPa (-2.9 to -0.75) kPa (-0.75 to 0.75) kPa (0.75 to 2.9) kPa	0.007 7 % of reading + 5.2 Pa 0.009 1 % of reading 0.009 % of reading + 35 mPa 0.007 5 % of reading + 51 mPa 0.009 % of reading + 35 mPa	Comparison to Fluke PPC4 Pressure Controller/Calibrator
Pressure Measuring Equipment [1] (Absolute, Gauge, Negative and Positive)	(2.9 to 7.5) kPa (7.5 to 26) kPa (26 to 63) kPa (63 to 700) kPa (700 to 7 000) kPa	0.009 1 % of reading 0.007 7 % of reading + 1.3 Pa 0.009 % of reading + 50 mPa 0.008 % of reading + 0.7 Pa 0.008 % of reading + 0.3 Pa	Comparison to Fluke PPC4 Pressure Controller/Calibrator
Pressure Measuring Equipment (Absolute, Gauge)	(7 000 to 82 737) kPa	0.005 % of reading	Comparison to Ruska 2400HL Hydraulic Piston Gauge

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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pneumatic Only Pressure Measuring Equipment Absolute, Gauge	(9 to 385) kPa (70 to 825) kPa (140 to 7 650) kPa	0.001 2 % of reading + 0.1 Pa 0.002 % of reading + 0.6 Pa 0.002 % of reading + 1.2 Pa	Comparison to Fluke PG7601 Gas Piston Gauge
Scales and Balances [1,8] Metric (SI)	Up to 500 mg (0.5 to 5) g (5 to 10) g (10 to 20) g (20 to 100) g (100 to 200) g (0.2 to 2) kg (2 to 20) kg	22 µg 29 µg 39 µg 54 µg 0.28 mg 0.43 mg 0.002 2% of reading 0.004 2% of reading	ASTM E617 Class 1 weights and NIST HB44 utilized in the calibration of the weighing system.
Scales and Balances [1,8] Avoirdupois	Up to 0.5 lb (0.5 to 1) lb (1 to 2 000) lb	0.026 % of reading 0.019 % of reading 0.013 % of reading	NIST Class F weights and NIST HB44 utilized in the calibration of the weighing system.
Scales and Balances [1,8] Metric (SI)	Up to 250 g (250 to 500) g (0.5 to 908) kg	0.026 % of reading 0.019 % of reading 0.013 % of reading	NIST Class F weights and NIST HB44 utilized in the calibration of the weighing system.
Torque Wrenches, Torque Watches [1]	(1 to 1 000) lbf·in (1 to 1 000) lbf·ft	0.52 % of reading 0.52 % of reading	Comparison to Torque Transducers, Torque Indicators, Manual Loader
Torque Transducers, Torque Meters [1]	(1 to 1 000) lbf·in (1 to 1 000) lbf·ft	0.09 % of reading 0.08 % of reading	Comparison to Torque Wheels, Torque Arms, NIST Class F Weights

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Light Meters	Up to 40 lux (40 to 400) lux (400 to 4 000) lux (4 000 to 40 000) lux	3.6 % of reading + 0.2 lux 3.6 % of reading + 2 lux 3.6 % of reading + 20 lux 4.5 % of reading + 200 lux	Comparison to Master Light Meter

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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dew Point Measuring Equipment [1]	(-25 to 68) °C	0.15 °C	Comparison to Thunder Scientific 2500 Two-pressure Humidity Generator
Dew Point – Measure [1]	(-15 to 20) °C	0.26 °C	Comparison to Chilled Mirror
Relative Humidity – Source [1]	(-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 75) %RH (75 to 95) %RH	 0.5 %RH 0.65 %RH 0.5 %RH 0.5 %RH 0.7 %RH 0.85 %RH	Comparison to Thunder Scientific 2500 Two-Pressure Humidity Generator
Relative Humidity – Measure [1]	(10 to 95) %RH	1.3 %RH	Direct measure using Chilled Mirror
Temperature Measuring Equipment	0.01 °C	1.5 mK	Comparison to Triple Point of Water
Temperature Measuring Equipment by Comparison [2,3] $NBPLN_2$ Hg In Sn Zn Al	 -195 °C -38.8 °C 156.6 °C 231.9 °C 419.5 °C 660.3 °C	 4 mK 5 mK 5 mK 5 mK 4 mK 10 mK	Comparison to Fluke 1595A Super Thermometer, Fluke 5628 Secondary PRT
Temperature – Measure [1] (PRT, RTD, Thermistor, Thermocouple, Stirred Baths, Liquid Baths)	(-95 to 700) °C	10 mK	Comparison to SPRT and Indicator
Infrared Thermometers [1]	(-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	0.83 °C 0.66 °C 0.67 °C 0.72 °C 0.97 °C 1.6 °C 2.2 °C	Comparison to Blackbody Source (Flat Plate) λ = (8 to 14) µm, ε = (0.9 to 1)

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Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Reference [1]	10 MHz	3.7 pHz/Hz	Comparison to Fluke 910R GPS Frequency Standard
Frequency – Source [1]	1 µHz to 80 MHz	0.58 µHz/Hz	Comparison to Agilent 33250A Arbitrary Waveform Generator
	250 kHz to 3 GHz	0.58 µHz/Hz	Comparison to Agilent E4432B RF Signal Generator
Frequency – Measure [1]	1 Hz to 12.4 GHz	51 pHz/Hz	Comparison to Agilent 53132A Universal Frequency Counter
AC Duty Cycle – Source [1] Square Wave: < 3.3 Vp-p Freq: 0.1 Hz to 100 kHz	(1 to 10) % Duty Cycle 10 µs to 100 s (10 to 49) % Duty Cycle 10 µs to 100 s 50 % Duty Cycle 10 µs to 100 s (51 to 90) % Duty Cycle 10 µs to 100 s (90 to 99) % Duty Cycle 10 µs to 100 s	0.62 % of reading + 78 ns 0.039 % of reading + 78 ns 0.001 6 % of reading + 78 ns 0.039 % of reading + 78 ns 0.62 % of reading + 78 ns	Comparison to Fluke 5522A Multiproduct Calibrator
Stopwatches, Timers [1]	Up to 19.99 s/d	58 ms/d	Comparison to Helmut Klein TM-4500 Timometer
Tachometers – Optical Pickup [1,3]	(0 to 60 000) rpm	0.000 23 % of reading + 0.001 2 rpm	Comparison to Agilent 33250A Arbitrary Waveform Generator, LED
Tachometers – Contact [1,3]	(1 to 10) rpm (10 to 1 000) rpm (1 000 to 8 000) rpm (8 000 to 20 000) rpm	0.012 % of reading + 0.085 rpm 0.012 % of reading + 0.12 rpm 0.012 % of reading + 0.53 rpm 0.012 % of reading + 5 rpm	Comparison to Tachometer Calibrator, Master Optical Tachometer
Rotation Speed – Measure [1,3] (Conveyor Belts, Line Speed, Centrifuges, and Mechanical Tachometers)	(6 to 8 300) rpm (8 300 to 99 999) rpm	1.7 rpm 2.6 rpm	Direct measure using Optical Tachometer
	(6 to 8 300) rpm (8 300 to 99 999) rpm	2.4 rpm 3 rpm	Direct measure using Mechanical Tachometer

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DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement – 1D [1]	Up to 12 in	1 500 µin	Digital Caliper utilized as the reference standard for 1-D Length Measurements.
Dimensional Measurement – 1D [1]	Up to 1 in	150 µin	Digital Outside Micrometer utilized as the reference standard for 1-D Length Measurements.
Dimensional Measurement – 1D [1]	Up to 6 in	150 µin	Digital Depth Micrometer utilized as the reference standard for 1-D Length Measurements.
Dimensional Measurement – 1D [1]	Up to 1 in	600 µin	Gage Pins utilized as the reference standard for 1-D Length Measurements.

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement – 2D	Up to 6 in	(420 + 0.52*L*) µin	Optical Comparator utilized as the reference standard for 2-D Length Measurements.
Dimensional Measurement – 2D	Up to 30 in	200 µin	CMM utilized as the reference standard for 2-D Length Measurements.
Surface Finish [1]	Ra = (10 to 200) µin	7 % of reading + 1.5 µin	Profilometer utilized as a reference standard for Dimensional Inspection.

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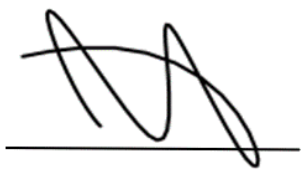
3 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurements – 3D [3] (Volumetric)	X-axis: Up to 18 in Y-axis: Up to 20 in Z-axis: Up to 16 in	(300 + 43*L*) µin (300 + 44*L*) µin (300 + 42*L*) µin	CMM utilized as the reference standard for 3-D Length Measurements.

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 values represented here are nominal values. The certified values and associated uncertainty will be reported at the time of calibration.
3. L = length in inches or millimeters; rpm = revolutions per minute; PF = Power Factor; A = Angle in degrees (°); ″ = arcsecond; D = diameter in inches or millimeters; DL = diagonal length in inches; $NBPLN_2$ = Boiling Point of Liquid Nitrogen.
4. 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 the laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
5. At the time of Calibration, 0.6R will be added to the Measurement Uncertainty, where R = resolution of the unit under calibration.
6. ΔP measurement with density correction for standard condition normalization.
7. The contributions from "the best existing device" are not included in the CMC presented claim.
8. 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.
9. Volume calculations are based on independent linear measurements.
10. Unless otherwise specified in the far-right column, the calibration procedure/method utilized by the laboratory was developed internally.
11. The legal entity name for this client is Transcat, Inc.



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