CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

Transcat – Rochester
35 Vantage Point Drive
Rochester, NY 14624

has been assessed by ANAB and meets the requirements of international standard

ISO/IEC 17025:2017

and national standards

ANSI/NCSL Z540-1-1994 (R2002)

while demonstrating technical competence in the field of

CALIBRATION

Refer to the accompanying Scope of Accreditation for information regarding the types of activities to which this accreditation applies

AC-2489

Certificate Number

ANAB Approval

Certificate Valid Through: 09/07/2021

Version No. 004 Issued: 06/06/2019

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).

ANSI National Accreditation Board

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

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CALIBRATION

Valid to: **September 7, 2021** Certificate Number: **AC-2489**

Chemical Quantities

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH – Measuring Equipment [1]	4 pH	0.013 pH	Standard Buffer Solutions
	7 pH	0.013 pH	
	10 pH	0.012 pH	
Conductivity Meters – Measuring Equipment	5 µS	0.3 µS	Standard Solutions
	10 µS	0.3 µS	
	100 µS	0.88 µS	
	1 000 µS	4.4 µS	
	10 000 µS	46 µS	
	100 000 µS	420 µS	
	150 000 µS	710 µS	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage Flatness[1]	Up to 3 V 10 Hz 10 Hz to 1 MHz 1 MHz to 10 MHz 10 MHz to 30 MHz 30 MHz to 50 MHz 50 MHz to 80 MHz 80 MHz to 100 MHz	 0.2 % 0.11 % 0.21 % 0.32 % 0.36 % 0.48 % 0.53 %	Thermal Voltage Converter, HP3458A
AC Current - Measuring Equipment [1]	0 µA to 220 µA 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz	 0.031 % + 16 nA 0.019 % + 10 nA 0.015 % + 8.0 nA 0.030 % + 12 nA 0.11 % + 65 nA	Fluke 5720A
	220 µA to 2.2 mA 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz	 0.030 % + 40 nA 0.018 % + 35 nA 0.014 % + 35 nA 0.021 % + 0.11 µA 0.11 % + 0.65 µA	Fluke 5720A
	2.2 mA to 22 mA 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz	 0.039 % + 0.40 µA 0.019 % + 0.35 µA 0.014 % + 0.35 µA 0.021 % + 0.55 µA 0.11 % + 5.0 µA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current - Measuring Equipment [1]	22 mA to 220 mA 10 Hz to 20 Hz	0.033 % + 4.0 µA	Fluke 5720A
	20 Hz to 40 Hz	0.018 % + 3.5 µA	
	40 Hz to 1 kHz	0.014 % + 2.5µA	
	1 kHz to 5 kHz	0.021 % + 3.5 µA	
	5 kHz to 10 kHz	0.11 % + 10 µA	
	220 mA to 2.2 A 0.01 kHz to 1 kHz	0.027 % + 35 µA	
	1 kHz to 5 kHz	0.046 % + 80 µA	
	5 kHz to 10 kHz	0.70 % + 0.16 mA	
AC Current - Measuring Equipment [1]	2.2 A to 11 A 0.04 kHz to 1 kHz	0.048 % + 0.17 mA	Fluke 5720A w/5725A
	1 kHz to 5 kHz	0.096 % + 0.38 mA	
	5 kHz to 10 kHz	0.36 % + 0.75 mA	
	11 A to 20.5 A 10 Hz to 100 Hz	0.097 % + 3.9 mA	Fluke 5520A
	100 Hz to 1 kHz	0.12 % + 3.9 mA	
	1 kHz to 5 kHz	2.3 % + 3.9 mA	
AC Current - Measuring Equipment [1]	20.5 A to 40 A 10 Hz to 100 Hz	0.14 % + 11mA	2 Fluke 5520As in Parallel
	100 Hz to 1 kHz	0.17 % + 11mA	
	1 kHz to 5 kHz	3.3 % + 11 mA	
AC Current - Measuring Equipment [1]	29 µA to 330 µA 10 kHz to 30 kHz	1.2 % + 0.31 µA	Fluke 5520A
	330 µA to 3.3 mA 10 kHz to 30 kHz	0.78 % + 0.47 µA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current - Measuring Equipment [1]	3.3 mA to 33 mA 10 kHz to 30 kHz	0.31 % + 3.1 µA	Fluke 5520A
	33 mA to 330 mA 10 kHz to 30 kHz	0.31 % + 0.16 mA	
AC Current - Measuring Equipment Clamp-on Ammeter Toroidal Type [1] Transformer Type	20 A to 150 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.3 % + 0.026 A 0.83 % + 0.047 A	Fluke 5520A w/5500A/Coil
	150 A to 1 000 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.35 % + 0.12 A 1.1 % + 0.22 A	
AC Current - Measuring Equipment Clamp-on Ammeter Non-Toroidal Type [1] Hall Effect Sensor	20 A to 150 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.57 % + 0.25 A 1 % + 0.25 A	Fluke 5520A w/5500A/Coil
	150 A to 1 000 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.6 % + 0.9 A 1.3 % + 0.92 A	
AC Current - Measuring Equipment Clamp-on Ammeter Non-Toroidal Type [1] Hall Effect Sensor	1 000 A to 6 000 A 10 Hz to 300 Hz	0.77 %	Fluke 52120A, w/ 5520A, 3kA, 6kA coil
	1 000 A to 6 000 A 300 Hz to 440 Hz	0.77 %	
AC Current - Measure	0 µA to 100 mA 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 1 kHz	0.46 % + 35 nA 0.18 % + 35 nA 0.072 % + 35 nA 0.072 % + 35 nA	3458A opt 002
	100 µA to 1 mA 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 0.1 kHz to 5 kHz	0.46 % + 0.23 µA 0.17 % + 0.23 µA 0.071 % + 0.23 µA 0.038 % +0.23 µA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current - Measure	1 mA to 10 mA		3458A opt 002
	10 Hz to 20 Hz	0.46 % + 2.3 µA	
	20 Hz to 45 Hz	0.17 % + 2.3 µA	
	45 Hz to 100 Hz	0.071 % + 2.3 µA	
	100 Hz to 5 kHz	0.038 % + 2.3 µA	
	10 mA to 100 mA		
	10 Hz to 20 Hz	0.46 % + 23 µA	
	20 Hz to 45 Hz	0.17 % + 23 µA	
	45 Hz to 100 Hz	0.070 % + 23 µA	
	100 Hz to 5 kHz	0.037 % + 23 µA	
	100 mA to 1 A		
	10 Hz to 20 Hz	0.46 % + 0.23 mA	
	20 Hz to 45 Hz	0.19 % + 0.23 mA	
	45 Hz to 100 Hz	0.097 % + 0.23 mA	
	100 Hz to 5 kHz	0.12 % + 0.23 mA	
	1 A to 3 A		Fluke 8846A
	3 Hz to 5 Hz	1.3 % + 2 mA	
	5 Hz to 10 Hz	0.41 % + 2 mA	
	10 Hz to 5 kHz	0.18 % + 2 mA	
	5 kHz to 10 kHz	0.41 % + 24 mA	
	3 A to 10 A		
	3 Hz to 5 Hz	1.1 % + 13 mA	
	5 Hz to 10 Hz	0.41 % + 7 mA	
	10 Hz to 5 kHz	0.18 % + 7 mA	
	5 kHz to 10 kHz	0.42 % + 81 mA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current - Measure	1 A to 20 A 0.05 kHz to 5 kHz	0.1 % + 0.02 A	Valhalla 2575A
	20 A to 100 A 0.05 kHz to 5 kHz	0.11 % + 0.1 A	
Impedance - Measure [3]	0.1 Ω 1 kHz 10 kHz 100 kHz 1 MHz	 2 % 1.2 % 1.1% 1.2 %	Agilent E4980AL LCR Meter
	1 Ω 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.67 % 0.45 % 0.36 % 0.33 % 0.31 % 0.38 %	
	10 Ω 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.29 % 0.2 % 0.17 % 0.18 % 0.18 % 0.31 %	
	100 Ω 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.16 % 0.1 % 0.1 % 0.12 % 0.12 % 0.2 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Impedance - Measure [3]	1 kΩ 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.15 % 0.1 % 0.1 % 0.1 % 0.1 % 0.14 %	Agilent E4980AL LCR Meter
	10 kΩ 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.15 % 0.1 % 0.1 % 0.1 % 0.1 % 0.29 %	
	100 kΩ 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.17 % 0.1 % 0.1 % 0.17 % 0.28 % 0.38 %	
Resistance - Measuring Equipment and Measure [1]	0 Ω to 10 Ω	18 μΩ/Ω + 58 μΩ	HP3458A w/Decade Resistor
	10 Ω to 100 Ω	15 μΩ/Ω + 0.58 mΩ	
	100 Ω to 1 kΩ	12 μΩ/Ω + 0.58 mΩ	
	1 kΩ to 10 kΩ	12 μΩ/Ω + 5.8 mΩ	
	10 kΩ to 100 kΩ	12 μΩ/Ω + 58 mΩ	
	100 kΩ to 1 MΩ	19 μΩ/Ω + 2.3 Ω	
	1 MΩ to 10 MΩ	62 μΩ/Ω + 0.12 kΩ	
	10 MΩ to 100 MΩ	0.059 % + 1.2 kΩ	
	100 MΩ to 1 GΩ	0.58 % + 12 kΩ	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Resistance - Measuring Equipment [1]	1 mΩ	0.05 %	L & N Shunt
	10 mΩ	0.01 %	Guildline 9200
	100 mΩ	0.01 %	
	1 GΩ	0.58 %	Biddle Megadek
	10 GΩ	1.2 %	
Resistance - Measuring Equipment [1] 500 V to 5 kV	100 GΩ	1.8 %	IET Standard Resistor
	1 TΩ	0.6 %	
Resistance - Measuring Equipment [1] 5 kV	10 TΩ	1.2 %	
Resistance - Measuring Equipment [1] 2.5 kV	10 TΩ	1.0 %	IET Standard Resistor
1 kV	10 TΩ	1.5 %	
500 V	10 TΩ	0.86 %	
DC Current – Measuring Equipment [1]	0 mA to 0.22 mA	36 µA/A + 6 nA	Fluke 5720A
	0.22 mA to 2.2 mA	36 µA/A + 7 nA	
	2.2 mA to 22 mA	35 µA/A + 40 nA	
	22 mA to 220 mA	48 µA/A + 0.7 µA	
	220 mA to 2.2 A	0.02 % + 12 µA	
	2.2 A to 11 A	0.04 % + 0.48 mA	Fluke 5720A w/5725A
	11 A to 100 A	0.047 %	L&N 4360 Shunt w/source

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Current – Measure [1]	0 to 100 µA	26 µA/A + 0.9 nA	Agilent 3458A Opt 002
	100 µA to 1 mA	26 µA/A + 5.8 nA	
	1 mA to 10 mA	26 µA/A + 58 nA	
DC Current – Measure [1]	10 mA to 100 mA	43 µA/A + 0.58 µA	Agilent 3458A Opt 002
	100 mA to 1 A	0.013 % + 10 µA	
DC Current – Measure [1]	1 A to 3 A	0.14 %	Fluke 8846A
	3 A to 10 A	0.18 % + 0.8 mA	
	1 A to 10 A	0.047 %	L&N 4361 Shunt
	10 A to 100 A	0.047 %	L&N 4360 Shunt

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Current – Measuring Equipment Clamp-on Ammeter Non-Toroidal Type [1] Hall Sensor	20 A to 150 A	0.51 % + 0.14 A	Fluke 5520A w/ 5500A/Coil
	150 A to 1 000 A	0.52 % + 0.5 A	
DC Current – Measuring Equipment Clamp-on Ammeter Non-Toroidal Type [1] Hall Sensor	1 000 A to 5 000 A	0.58 %	Fluke 52120A, w/ 5520A, 3kA or 6 kA coil
DC Voltage - Measure	0 mV to 100 mV	7.1 µV/V + 0.58 µV	3458A Opt 002
	100 mV to 1 V	5.0 µV/V + 0.58 µV	
	1 V to 10 V	5.1 µV/V + 0.58 µV	
	10 V to 100 V	7.6 µV/V + 35 µV	
	100 V to 500 V	11 µV/V + 0.12 mV	
	500 V to 800 V	16 µV/V + 0.12 mV	
	800 V to 1 kV	21 µV/V + 0.12 mV	
	1 kV to 10 kV	0.049 % + 0.62 V	Vitrek 4700A
	10 kV to 20 kV	0.08 % + 0.35 V	4700A w/HVP-35
	20 kV to 35 kV	0.14 % + 1 V	
	15 kV to 30 kV	0.065 % + 1 V	4700A w/HVL-70
	30 kV to 45 kV	0.09 % + 3 V	
	45 kV to 70 kV	0.17 % + 1 V	
	25 kV to 100 kV	0.11 % + 0.5 V	4700A w/HVL-100
DC Voltage - Measuring Equipment [1]	0 V to 0.22 V	8.5 µV/V + 0.4 µV	Fluke 5720A
	0.22 V to 2.2 V	5.1 µV/V + 0.7 µV	
	2.2 V to 11 V	4 µV/V + 2.5 µV	
	11 V to 22 V	3.9 µV/V + 4 µV	
	22 V to 220 V	6.2 µV/V + 40 µV	
	220 V to 1 100 V	7.6 µV/V + 0.4 mV	Fluke 5720A w/5725A

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	0 mV to 10 mV		Agilent 3458A/002
	1 Hz to 40 Hz	0.039 % + 3.5 µV	
	40 Hz to 1 kHz	0.028 % + 1.2 µV	
	1 kHz to 20 kHz	0.038 % + 1.2 µV	
	20 kHz to 50 kHz	0.15 % + 1.2 µV	
	50 kHz to 100 kHz	0.59 % + 1.2 µV	
	100 kHz to 300 kHz	4.6 % + 2.3 µV	
	10 mV to 100 mV		
	1 Hz to 40 Hz	0.013 % + 4.6 µV	
	40 Hz to 1 kHz	0.009 5 % + 2.3 µV	
	1 kHz to 20 kHz	0.017 % + 2.3 µV	
	20 kHz to 50 kHz	0.037 % + 2.3 µV	
	50 kHz to 100 kHz	0.093 % + 2.3 µV	
	100 kHz to 300 kHz	0.36 % + 12 µV	
	300 kHz to 1 MHz	1.2 % + 12 µV	
	100 mV to 1 V		
	1 Hz to 40 Hz	0.009 8 % + 46 µV	
	40 Hz to 1 kHz	0.009 5 % + 23 µV	
	1 kHz to 20 kHz	0.017 % + 23 µV	
	20 kHz to 50 kHz	0.036 % + 23 µV	
	50 kHz to 100 kHz	0.093 % + 23 µV	
	100 kHz to 300 kHz	0.35 % + 0.12 mV	
	300 kHz to 1 MHz	1.2 % + 0.12 mV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	1 V to 10 V 1 Hz to 40 Hz	0.009 5 % + 0.46 mV	Agilent 3458A/002
	40 Hz to 1 kHz	0.009 5 % + 0.23 mV	
	1 kHz to 20 kHz	0.017 % + 0.23 mV	
	20 kHz to 50 kHz	0.036 % + 0.23 mV	
	50 kHz to 100 kHz	0.093 % + 0.23 mV	
	100 kHz to 300 kHz	0.35 % + 1.2 mV	
	300 kHz to 1 MHz	1.2 % + 1.2 mV	
	10 V to 100 V 1 Hz to 40 Hz	0.024 % + 4.6 mV	
	40 Hz to 1 kHz	0.024 % + 2.3 mV	
	1 kHz to 20 kHz	0.024 % + 2.3 mV	
	20 kHz to 50 kHz	0.041 % + 2.3 mV	
	50 kHz to 100 kHz	0.14 % + 2.3 mV	
	100 kHz to 300 kHz	0.46 % + 12 mV	
	300 kHz to 1 MHz	1.7 % + 12 mV	
	100 V to 700 V 1 Hz to 40 Hz	0.047 % + 46 mV	
	40 Hz to 1 kHz	0.047 % + 23 mV	
	1 kHz to 20 kHz	0.071 % + 23 mV	
	20 kHz to 50 kHz	0.14 % + 23 mV	
	50 kHz to 100 kHz	0.35% + 23 mV	
	700 V to 10 kV 60 Hz	0.17 % + 0.16 V	Vitrek 4700A
	10 kV to 20 kV 60 Hz	0.17 % + 0.6 V	4700A w/HVP-35

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	20 kV to 35 kV 60 Hz	0.23 % + 3.5 V	4700A w/HVP-35
	12.5 kV to 25 kV 60 Hz	0.15 % + 1.4 V	4700A w/HVL-70
	25 kV to 37.5 kV 60 Hz	0.16 % + 2.8 V	
	37.5 kV to 50 kV 60 Hz	0.2 % + 0.2 V	
AC Voltage – Measure [1]	25 kV to 75 kV 60 Hz	0.19 % + 3.5 V	4700A w/ HVL-100
	0 mV to 1 mV 100 kHz to 1 MHz 1 MHz to 3 MHz 3 MHz to 10 MHz 10 MHz to 20 MHz	2 % + 2.4 µV 3.8 % + 2.4 µV 10 % + 2.4 µV 25 % + 2.4 µV	R&S URE3
	1 mV to 3 mV 100 kHz to 1 MHz 1 MHz to 3 MHz 3 MHz to 10 MHz 10 MHz to 20 MHz	1 % + 2 µV 3.8 % + 2 µV 11 % + 2 µV 25 % + 2 µV	
	3 mV to 100 mV 100 kHz to 1 MHz 1 MHz to 3 MHz 3 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz	0.98 % + 3 µV 1.9 % + 3 µV 3.2 % + 3 µV 7.6 % + 3 µV 16 % + 3 µV	
	0 mV to 2.2 mV 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz	0.16 % + 4 µV 0.10 % + 4 µV 0.077 % + 4 µV 0.13 % + 4 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage - Measuring Equipment [1]	50 kHz to 100 kHz	0.17 % + 5 µV	5720A
	100 kHz to 300 kHz	0.33 % + 10 µV	
	300 kHz to 500 kHz	0.47 % + 20 µV	
	500 kHz to 1 MHz	0.58 % + 20 µV	
	2.2 mV to 22 mV 10 Hz to 20 Hz	0.042 % + 4 µV	
	20 Hz to 40 Hz	0.03 % + 4 µV	
	40 Hz to 20 kHz	0.014 % + 4 µV	
	20 kHz to 50 kHz	0.03 % + 4 µV	
	2.2 mV to 22 mV 50 kHz to 100 kHz	0.058 % + 5.0 µV	
	100 kHz to 300 kHz	0.12 % + 10 µV	
	300 kHz to 500 kHz	0.16 % + 20 µV	
	500 kHz to 1 MHz	0.27 % + 20 µV	
	22 mV to 220 mV 10 Hz to 20 Hz	0.028 % + 12 µV	
	20 Hz to 40 Hz	0.011 % + 7 µV	
	40 Hz to 20 kHz	0.008 5 % + 7 µV	
	20 kHz to 50 kHz	0.021 % + 7 µV	
	50 kHz to 100 kHz	0.047 % + 17 µV	
	100 kHz to 300 kHz	0.091 % + 20 µV	
	300 kHz to 500 kHz	0.14 % + 25 µV	
	500 kHz to 1 MHz	0.28 % + 45 µV	
	220 mV to 2.2 V 10 Hz to 20 Hz	0.027 % + 40 µV	
	20 Hz to 40 Hz	0.01 % + 15 µV	
	40 Hz to 20 kHz	0.004 8 % + 8 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage - Measuring Equipment [1]	20 kHz to 50 kHz	0.008 % + 10 µV	5720A
	50 kHz to 100 kHz	0.012 % + 30 µV	
	100 kHz to 300 kHz	0.043 % + 80 µV	
	300 kHz to 500 kHz	0.1 % + 0.2 mV	
	500 kHz to 1 MHz	0.18 % + 0.3 mV	
	2.2 V to 22 V 10 Hz to 20 Hz	0.028 % + 0.40 mV	
	20 Hz to 40 Hz	0.01 % + 0.15 mV	
	40 Hz to 20 kHz	0.004 9 % + 50 µV	
	2.2 V to 22 V 20 kHz to 50 kHz	0.008 3 % + 0.1 mV	
	50 kHz to 100 kHz	0.011 % + 0.2 mV	
	100 kHz to 300 kHz	0.03 % + 0.6 mV	
	300 kHz to 500 kHz	0.1 % + 2 mV	
	500 kHz to 1 MHz	0.17 % + 3.2 mV	
	22 V to 220 V 10 Hz to 20 Hz	0.028 % + 4 mV	
	20 Hz to 40 Hz	0.01 % + 1.5 mV	
	40 Hz to 20 kHz	0.005 6 % + 0.6 mV	
	20 kHz to 50 kHz	0.009 3 % + 1 mV	
	50 kHz to 100 kHz	0.016 % + 2.5 mV	
	100 kHz to 300 kHz	0.09 % + 16 mV	
	300 kHz to 500 kHz	0.44 % + 40 mV	
	500 kHz to 1 MHz	0.8 % + 80 mV	
AC Voltage - Measuring Equipment [1]	220 V to 750 V 30 kHz to 50 kHz	0.061 % + 11 mV	5720A w/ 5725A
	50 kHz to 100 kHz	0.23 % + 45 mV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage - Measuring Equipment [1]	220 V to 1100 V 40 Hz to 1 kHz	0.011 % + 4 mV	5720A w/ 5725A
	1 kHz to 20 kHz	0.017 % + 6 mV	
	20 kHz to 30 kHz	0.061 % + 11 mV	
DC Power – Measuring Equipment 0.33 mA to 330 mA	11 µW to 1.1 mW	0.024 %	Fluke 5520A
	1.1 mW to 0.11 W	0.027 %	
	0.11W to 110 W	0.024 %	
	110 W to 330 W	0.018 %	
0.33 A to 3 A	11 mW to 110 mW	0.044 %	
	0.11 W to 990 W	0.053 %	
	1 W to 3 kW	0.009 6 %	
3 A to 20.5 A	99 mW to 0.99 W	0.088 %	
	0.99 W to 6.8 kW	0.07 %	
	6.8 W to 20.5 kW	0.04 %	
AC Power – Measuring Equipment (PF = 1)[7] 3.3 mA to 9 mA	0.11 mW to 3 mW 10 Hz to 65 Hz	0.13 %	Fluke 5520A
	3 mW to 9 W 10 Hz to 65 Hz	0.077 %	
9 mA to 33 mA	0.3 mW to 10 mW 10 Hz to 65 Hz	0.089 %	
	10 mW to 33 W 10 Hz to 65 Hz	0.077 %	
33 mA to 90 mA	1 mW to 30 mW 10 Hz to 65 Hz	0.071 %	
	30 mW to 90 W 10 Hz to 65 Hz	0.057 %	
90 mA to 330 mA	3.0 mW to 100 mW 10 Hz to 65 Hz	0.089 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Power – Measuring Equipment (PF = 1)[7]	100 mW to 300 W 10 Hz to 65 Hz	0.078 %	Fluke 5520A
0.33 A to 0.9 A	11 mW to 0.3 W 10 Hz to 65 Hz	0.071 %	
	0.3 W to 900 W 10 Hz to 65 Hz	0.081 %	
0.9 A to 2.2 A	30 mW to 0.72 W 10 Hz to 65 Hz	0.089 %	
	0.72 W to 2 kW 10 Hz to 65 Hz	0.079 %	
2.2 A to 4.5 A	80 mW to 1.4 W 10 Hz to 65 Hz	0.088 %	
	1.4 W to 4.5 kW 10 Hz to 65 Hz	0.18 %	
4.5 A to 20.5 A	150 mW to 6.7 W 10 Hz to 65 Hz	0.17 %	
	6.7 W to 20 kW 10 Hz to 65 Hz	0.17 %	
Phase Meters	0° to 90° 10 Hz to 65 Hz	0.11°	Fluke 5520A
	65 Hz to 500 Hz	0.20°	
	500 Hz to 1 kHz	0.39°	
	1 kHz to 5 kHz	1.9°	
	5 kHz to 10 kHz	3.9°	
	10 kHz to 30 kHz	7.8°	
Distortion[1] (-80 to 0) dB	20 Hz to 100 kHz	1 dB	Agilent 8903

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Distortion (5 Hz to 600 kHz) Voltage Range < 30 V 100 % to 0.3 %	(Harmonic Range) 10 Hz to 1 MHz 1 MHz to 3 MHz	3.5 % 6.9 %	Agilent 334A
Distortion (5 Hz to 600 kHz) Voltage Range < 30 V 0.1%	10 Hz to 20 Hz	14 %	
	20 Hz to 30 Hz	6.9 %	
	30 Hz to 300 kHz	3.5 %	
	300 kHz to 500 kHz	6.9 %	
	500 kHz to 1.2 MHz	14 %	
Distortion Voltage Range > 30 V 100 % to 0.3 %	10 Hz to 300 kHz	3.5 %	
	300 kHz to 500 kHz	6.9 %	
	0.5 MHz to 3 MHz	14 %	
Distortion (5 Hz to 600 kHz) Voltage Range < 30 V 0.1 %	20 Hz to 30 Hz	14 %	
	30 Hz to 300 kHz	3.5 %	
	300 kHz to 500 kHz	6.9 %	
	500 kHz to 1.2 MHz	14 %	
Capacitance - Measure [3]	0.1 pF 100 kHz 1 MHz	 1.4 % 1.8 %	Agilent E4980AL LCR Meter
	1 pF 10 kHz 100 kHz 1 MHz	 1.4 % 0.37 % 0.44 %	
	10 pF 1 kHz 10 kHz 100 kHz 1 MHz	 1.4 % 0.28 % 0.28 % 0.3 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance - Measure [3]	100 pF		Agilent E4980AL LCR Meter
	100 Hz	2.1 %	
	1 kHz	0.23 %	
	10 kHz	0.18 %	
	100 kHz	0.21 %	
	1 MHz	0.23 %	
	1 nF		
	20 Hz	1.8 %	
	100 Hz	0.30 %	
	1 kHz	0.1 %	
	10 kHz	0.1 %	
	100 kHz	0.1 %	
	1 MHz	0.14 %	
	10 nF		
	20 Hz	0.31 %	
	100 Hz	0.12 %	
	1 kHz	0.1 %	
	10 kHz	0.1 %	
	100 kHz	0.1 %	
	1 MHz	0.25 %	
	100 nF		
	20 Hz	0.16 %	
	100 Hz	0.1 %	
	1 kHz	0.1 %	
	10 kHz	0.1 %	
	100 kHz	0.18 %	
	1 MHz	0.33 %	
	1 µF		
	20 Hz	0.15 %	
	100 Hz	0.10 %	
	1 kHz	0.10 %	
	10 kHz	0.18 %	
	100 kHz	0.25 %	
	1 MHz	0.79 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance - Measure [3]	10 µF 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz	 0.15 % 0.01 % 0.16 % 0.28 % 0.73 %	Agilent E4980AL LCR Meter
	100 µF 20 Hz 100 Hz 1 kHz 10 kHz	 0.16 % 0.17 % 0.29 % 0.8 %	
Capacitance - Measuring Equipment [1]	0.1 nF to 0.7 nF 0.1 kHz to 1 kHz	0.1 % + 0.53 pF	Arco SS32
	0.7 nF to 600 nF 0.1 kHz to 1 kHz	0.15 % + 0.2 pF	
	600 nF to 1400 nF 0.1 kHz to 1 kHz	0.045 % + 0.5 nF	
	0.5 nF to 1400 nF 0.1 kHz to 1 kHz	0.12 % + 0.018 pF	
	0.19 nF to 1.1 nF 10 Hz to 10 kHz	0.39 % + 6.1 pF	Fluke 5520A
	1.1 nF to 3.3 nF 10 Hz to 3 kHz	0.39 % + 6.1 pF	
	3.3 nF to 11 nF 10 Hz to 1 kHz	0.21 % + 6.1 pF	
	11 nF to 110 nF 10 Hz to 1 kHz	0.21 % + 61 pF	
	110 nF to 330 nF 10 Hz to 1 kHz	0.21 % + 0.18 nF	
	0.33 µF to 1.1 µF 10 Hz to 600 Hz	0.20 % + 0.61 nF	
	1.1 µF to 3.3 µF 10 Hz to 300 Hz	0.20 % + 1.9 nF	
	3.3 µF to 11 µF 10 Hz to 150 Hz	0.20 % + 6.1 nF	
	11 µF to 33 µF 10 Hz to 120 Hz	0.32 % + 18 nF	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance - Measuring Equipment [1]	33 µF to 110 µF 10 Hz to 80 Hz 110 µF to 330 µF DC to 50 Hz 0.33 mF to 1.1 mF DC to 20 Hz 1.1 mF to 3.3 mF DC to 6 Hz 3.3 mF to 11 mF DC to 2 Hz 11 mF to 33 mF DC to 0.6 Hz 33 mF to 110 mF DC to 0.2 Hz	 0.35 % + 61 nF 0.35 % + 0.18 µF 0.35 % + 0.61 µF 0.35 % + 1.8 µF 0.35 % + 6.1 µF 0.58 % + 18 µF 0.85 % + 61 µF	Fluke 5520A
Inductance - Measure [3]	1 µH 10 kHz 100 kHz 1 MHz	 1.6 % 0.36 % 0.27 %	Agilent E4980AL LCR Meter
	10 µH 10 kHz 100 kHz 1 MHz	 0.37 % 0.2 % 0.2 %	
	100 µH 1 kHz 10 kHz 100 kHz 1 MHz	 0.41 % 0.2 % 0.12 % 0.14 %	
	1 mH 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.56 % 0.19 % 0.12 % 0.1 % 0.23 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Inductance - Measure [3]	10 mH		Agilent E4980AL LCR Meter
	20 Hz	0.86 %	
	100 Hz	0.22 %	
	1 kHz	0.1 %	
	10 kHz	0.1 %	
	100 kHz	0.11 %	
	1 MHz	0.35 %	
	100 mH		
	20 Hz	0.28 %	
	100 Hz	0.11 %	
	1 kHz	0.1 %	
	10 kHz	0.1 %	
	100 kHz	0.21 %	
	1 MHz	0.88 %	
	1 H		
	20 Hz	0.17 %	
	100 Hz	0.1 %	
	1 kHz	0.1 %	
	10 kHz	0.11 %	
	100 kHz	0.31 %	
	10 H		
	20 Hz	0.15 %	
	100 Hz	0.1 %	
	1 kHz	0.11 %	
	10 kHz	0.21 %	
	100 kHz	0.69 %	
	100 H		
	20 Hz	0.15 %	
	100 Hz	0.11 %	
	1 kHz	0.15 %	
	10 kHz	0.62 %	
Inductance - Measuring Equipment [1]	100 mH		Standard Inductor
	1 kHz	0.14 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Devices [1] Type B	250 °C to 350 °C	1.0 °C	Ectron 1140A
	350 °C to 445 °C	0.77 °C	
	445 °C to 580 °C	0.61 °C	
	580 °C to 750 °C	0.47 °C	
	750 °C to 1 000 °C	0.39 °C	
	1 000 °C to 1 820 °C	0.31 °C	
Type C	0 °C to 250 °C	0.21 °C	Ectron 1140A
	250 °C to 1 000 °C	0.17 °C	
	1 000 °C to 1 500 °C	0.19 °C	
	1 500 °C to 1 800 °C	0.22 °C	
	1 800 °C to 2 000 °C	0.24 °C	
	2 000 °C to 2 250 °C	0.30 °C	
	2 250 °C to 2 315 °C	0.33 °C	
Type E	-270 °C to -245 °C	2.1 °C	Ectron 1140A
	-245 °C to -195 °C	0.20 °C	
	-195 °C to -155 °C	0.11 °C	
	-155 °C to -90 °C	0.09 °C	
	-90 °C to 0 °C	0.08 °C	
	0 °C to 15 °C	0.08 °C	
	15 °C to 890 °C	0.07 °C	
	890 °C to 1 000 °C	0.08 °C	
Type J	-210 °C to -180 °C	0.13 °C	Ectron 1140A
	-180 °C to -120 °C	0.11 °C	
	-120 °C to -50 °C	0.09 °C	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Type J	-50 °C to 990 °C	0.08 °C	Ectron 1140A
	990 °C to 1 200 °C	0.08 °C	
Type K	-270 °C to -255 °C	2.3 °C	Ectron 1140A
	-255 °C to -195 °C	0.73 °C	
	-195 °C to -115 °C	0.14 °C	
	-115 °C to -55 °C	0.10 °C	
	-55 °C to 1 000 °C	0.08 °C	
	1 000 °C to 1 372 °C	0.09 °C	
Type N	-270 °C to -260 °C	5.1 °C	Ectron 1140A
	-260 °C to -200 °C	1.1 °C	
	-200 °C to -140 °C	0.25 °C	
	-140 °C to -70 °C	0.16 °C	
	-70 °C to 25 °C	0.13 °C	
	25 °C to 160 °C	0.11 °C	
	160 °C to 1 300 °C	0.10 °C	
Type R	-50 °C to -30 °C	0.68 °C	Ectron 1140A
	-30 °C to -45 °C	0.58 °C	
	-45 °C to 160 °C	0.42 °C	
	160 °C to 380 °C	0.31 °C	
	380 °C to 775 °C	0.28 °C	
	775 °C to 1 768 °C	0.23 °C	
Type S	-50 °C to -30 °C	0.65 °C	Ectron 1140A
	-30 °C to 45 °C	0.59 °C	
	45 °C to 105 °C	0.42 °C	
	105 °C to 310 °C	0.35 °C	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Type S	310 °C to 615 °C	0.31 °C	Ectron 1140A
	615 °C to 1 768 °C	0.27 °C	
Type T	-270 °C to -255 °C	1.8 °C	Ectron 1140A
	-255 °C to -240 °C	0.52 °C	
	-240 °C to -210 °C	0.32 °C	
	-210 °C to -150 °C	0.19 °C	
	-150 °C to -40 °C	0.13 °C	
	-40 °C to 100 °C	0.09 °C	
	100 °C to 400 °C	0.08 °C	
Type B	600 °C to 800 °C	0.34 °C	Fluke 5520
	800 °C to 1 000 °C	0.26 °C	
	1 000 °C to 1 550 °C	0.23 °C	
	1 550 °C to 1 820 °C	0.26 °C	
Oscilloscopes[1]			
Amplitude DC			Fluke 9500B
into 50 Ω Load	(-5 to 5) V	0.023% + 19 µV	
into 1 MΩ Load	(-200 to 200) V	0.023% + 19 µV	
Amplitude Square Wave			9500B/3200, 9530
into 50 Ω Load			
Rate: 10 Hz to 100 kHz	40 $\mu V_{(pk-pk)}$ to 1.0 $mV_{(pk-pk)}$	0.78% + 7.8 µV	
	1.0 $mV_{(pk-pk)}$ to 5.0 $V_{(pk-pk)}$	0.078% + 7.8 µV	
into 1 MΩ Load			9500B/3200
Rate: 10 Hz to 10 kHz	40 $\mu V_{(pk-pk)}$ to 1.0 $mV_{(pk-pk)}$	0.78% + 7.8 µV	
Rate: 10 Hz to 100 kHz	1.0 $mV_{(pk-pk)}$ to 200 $V_{(pk-pk)}$	0.078% + 7.8 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Timing - Generate[1]			
100 $mV_{(pk-pk)}$ to 1.0 $V_{(pk-pk)}$			
Square Wave	9.0091 ns to 83 µs 83 µs to 55 s	0.19 µs/s 2.3 µs/s	9500B/3200
Sine Wave	450.5 ps to 9.009 ns	0.19 µs/s	9500B/3200
Pulse	900.91 ns to 83 µs 83 µs to 55 s	0.19 µs/s 2.3 µs/s	9500B/3200
Triangle Wave	900.91 ns to 83 µs 83 µs to 55 s	0.19 µs/s 2.3 µs/s	9500B/3200
Rise Time – Measure[1]	350 ps (nominal)	28 ps	Agilent DSO6102
Rise Time – Generate[1,6]			
50 Ω Load			
5.0 $mV_{(pk-pk)}$ to 3.0 $V_{(pk-pk)}$			
Rate: 10 Hz to 2 MHz	500 ps (nominal) 150 ps (nominal)	290 ps 35 ps	9500B/3200, 9530
425 mV(pk-pk) to 575 mV(pk-pk)			
Rate: 10 Hz to 1 MHz	25 ps (Nominal)	6.7 ps	Fluke 9500/9550
Leveled Sine Wave Generate[1]			
50 Ω Load			
Reference Frequency	50 kHz to 10 MHz	1.2 %	9500B/3200, 9530
Bandwidth/Flatness Measure[1]			
Into VSWR (1.2:1)			
(wrt Reference Frequency)			
5.0 $mV_{(pk-pk)}$ to 5.0 $V_{(pk-pk)}$	0.10 Hz to 300 MHz 300 MHz to 550 MHz	1.6 % 1.9 %	9500B/3200, 9530
5.0 $mV_{(pk-pk)}$ to 3.0 $V_{(pk-pk)}$	550 MHz to 1.1 GHz 1.1 GHz to2 .5 GHz	2.7 % 3.1 %	
5.0 $mV_{(pk-pk)}$ to 2.0 $V_{(pk-pk)}$	2.5 GHz to 3.2 GHz	3.1 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Input Impedance Measure[1]	10 Ω to 40 Ω 40 Ω to 90 Ω 90 Ω to 150 Ω 50 kΩ to 800 kΩ 800 kΩ to 1.2 MΩ 1.2 MΩ to 12 MΩ	0.39 % 0.083 % 0.39 % 0.39 % 0.083 % 0.39 %	9500B/3200
Input Capacitance Measure[1]	1 pF to 35 pF 35 pF to 95 pF	1.6 % + 0.19 pF 2.3 % + 0.19 pF	9500B/3200

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Relative RF Power	100 kHz to 4.2 GHz (+20 to +10) dBm (+10 to 0) dBm 0 dB to -10 dB -10 dB to -20 dB -20 dB to -30 dB	 1.1% 1.1% 1.1% 1.1% 1.1%	Agilent 438A/8482A

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [4]	Reference Standard, Method and/or Equipment
Angle - Measuring Equipment	0º to 89º 90º	4.4” 1.1”	Angle Blocks Granite Square

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [4]	Reference Standard, Method and/or Equipment
Micrometers & Calipers -			Comparison to Gage Blocks
Outside, Inside, Depth [1]	0 in to 0.5 in 0.5 in to 1 in 1 in to 4 in 4 in to 15 in 15 in to 40 in	13 µin 14 µin (10 + 3.6*L*) µin (11 + 4.2*L*) µin (11 + 4.4*L*) µin	
Anvil Flatness [1]	(0 to 1) in	6.2 µin	Optical Flats
Anvil Parallelism [1]	(0 to 1) in	6.6 µin	Optical Parallels
Bore Gages	(0.125 to 0.25) in (0.25 to 1) in (1 to 6) in	34 µin 36 µin (30 + 7*L*) µin	Characterized Rings
Digital, Dial, Drop and Test Indicators [1]	(0 to 6) in	(6.3 + 3.2 *L*) µin	Gage Blocks/ Surface Plate
Test Indicators	(0 to 0.025) in	5.6 µin	ULM
Length Single Axis Outside Dimension	(0 to 1) in (1 to 7) in (7 to 12) in (12 to 24) in	(6 + 1*L*) µin (4 + 3.5 *L*) µin (4*L*) µin (53 + 3.*L*) µin	ULM P & W U304393
Inside Dimension	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	11 µin 17 µin (18 + 3*L*) µin (38 + 3*L*) µin	ULM
Height Measuring Equipment[1]	(0 to 4) in (4 to 24) in	(26 + 0.5*L*) µin (16 + 3*L*) µin	Gage Blocks
Height Measure	(0 to 12) in	(28 + 3.2 *L*) µin	Gage Blocks &Amplifier
Squareness	(0 to 18) in	5.9 µin/in	Master Square

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [4]	Reference Standard, Method and/or Equipment
Parallelism	(0 x 0) in to (3 x 12) in (3 x 12) in to (3 x 18) in (6 x 18) in to (6 x 30) in	33 µin 40 µin 45 µin	Indicator w/ Amp
Straightness	(0 to 12) in (12 to 18) in (18 to 30) in	35 µin 42 µin 46 µin	Indicator w/ Amp
Flatness	(0 to 4) in Diameter (0 x 0) in to (3 x 12) in (3 x 12) in to (3 x 18) in (6 x 18) in to (6 x 30) in (0 x 0) in to (6 x 12) in	6.2 µin 35 µin 42 µin 46 µin 138 µin	Optical Flat Indicator w/ Amp Vision System w/Probe
Length Measuring Equipment Linear Displacement	(0 to 12) ft	$(1 + 2.1L)$ µin	Laser Interferometer
Optical Comparator Length Squareness Magnification	(0 to 6) in (0.04 to 1) in 10X to 50X	$(100 + 14L)$ µin $(120 + 1.5L)$ µin $(240 + 21L)$ µin	Calibration Grids Calibration Grids Magnification Checker
Optical Reference Plane	(150 to 300) mm	2.1 µm	Calibration Grid
Thread Wires	2 TPI to 120 TPI (0.008 33 to 0.5) in	12 µin	ULM
Plug Gages Outside Diameter	(0 to 1) in (1 to 7) in	12 µin $(3 + 3L)$ µin	ULM
Pin Gage Outside Diameter Non-Contact	(0.004 to 1) in	33 µin	Laser Micrometer

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [4]	Reference Standard, Method and/or Equipment
Ring Gages Inside Diameter	(0.04 to 0.5) in (0.50 to 4) in (4 to 8.5) in (8.5 to 14) in	7.2 µin (7.2 + 3*L*) µin (4 + 3.6*L*) µin (11 + 3.6*L*) µin	ULM NIST Reference Rings
	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) in (8.5 to 14) in	11 µin 17 µin (18 + 3*L*) µin (38 + 3*L*) µin	Working Reference Rings
Laser Micrometers	(0 to 1) in	(7.4 + 1.3*L*) µin	Characterized Master Pins
Tapes and Rulers	(0 to 6) ft (6 to 12) ft (12 to 100) ft	(400 + 2*L*) µin (400 + 7*L*) µin (400 + 6*L*) µin	Vision System
Thread Plug Gages Pitch Diameter 60° Thread	(0 to 1) in (1 to 4) in (4 to 7) in	79 µin 80 µin 83 µin	ULM w/Thread Wires
Major Diameter	(0 to 1) in (1 to 7) in	13 µin (10 + 3*L*) µin	ULM
Tapered Thread Plug Pitch Diameter Taper	(0 to 3) in	90 µin	ULM w/Thread Wires
Standoff	(0 to 1) in	31 µin	Gage Blocks & Amplifier
Tapered Thread Ring Gage	(0 to 3) in	90 µin	Master Plug Uncertainty
Thread Ring Gage Inner Pitch Diameter	(0 to 1) in (1 to 4) in (4 to 7) in	79 µin 80 µin 83 µin	Master Plug Uncertainty

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [4]	Reference Standard, Method and/or Equipment
Two Dimensional Gages X-Y Axis	(0.000 05 to 1) in (1 to 2) in (2 to 3) in (3 to 4) in (4 to 5) in (5 to 6) in (6 to 9) in (9 to 12) in	84 µin 90 µin 96 µin 0.000 1 in 0.000 11 in 0.000 12 in 0.000 14 in 0.000 16 in	Vision System
Z Axis	(0.10 to 2) in (2 to 4) in (4 to 5) in	0.000 15 in 0.000 16 in 0.000 17 in	Vision System
Angle	0° to 360°	0.013°	Vision System

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Air Velocity	0.2 m/s to 2 m/s 2 m/s to 60 m/s	0.85% 0.65%	LDV
	0.2 m/s to 2 m/s 2 m/s to 60 m/s	0.06 m/s 1.3 % + 0.01 m/s	Westenberg Westi-box
Force – Tension and Compression	0 lbf to 400 lbf	0.012 %	Deadweight
Torque Tools	9 lbf·in to 800 lbf·ft	1 %	Torque Calibrator
Pneumatic Torque Tools	0.2 lbf·in to 18 lbf·in	0.55 lbf·in	Imada i-80
	18 lbf·in to 70 lbf·in	1.1 lbf·in	Imada i-80
	8 lbf·in to 130 lbf·in	0.89 lbf·in	Imada CD-150M

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Balances & Scales – Metric[1]	10 kg	8.2 mg	ASTM Class 1
	2 kg	5.9 mg	
	1 kg	2.7 mg	
	500 g	1.5 mg	
	300 g	1.1 mg	
	200 g	0.63 mg	
	100 g	0.17 mg	
	50 g	0.18 mg	
	20 g	75 µg	
	10 g	47 µg	
	5 g	51 µg	
	2 g	90 µg	
	1 g	47 µg	
	500 mg	69 µg	
	200 mg	69 µg	
	100 mg	69 µg	
	50 mg	69 µg	
	20 mg	69 µg	
	10 mg	69 µg	
	5 mg	69 µg	
	2 mg	69 µg	
	1 mg	69 µg	

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Avoirdupois	2.2 lb to 500 lb	0.017 %	NIST Class F
Mass	0 g to 1200 g	0.0028 mg/g + 6.8 mg	XS1203S
Absolute Pressure – Pneumatic	0 psia to 30 psia	0.002 4 psia	DHI PPC4 Controller
	30 psia to 1 000 psia	0.006 6 % + 0.000 48 psia	
Absolute Pressure – Hydraulic	500 psia to 16 000 psia	0.019 %	P3125-3 DWT w/barometer
Gage Pressure – Pneumatic[1]	0 in H_2O to 0.5 in H_2O	0.000 5 in H_2O	Ashcroft ASQ-1
	0.5 in H_2O to 1.0 in H_2O	0.000 76 in H_2O	Ashcroft ASQ-1
	-14.7 psig to 30 psig	0.002 1 psig	DHI PPC4 Controller
	30 psig to 1000 psig	0.006 6 % + 0.001 psig	
	-36 in H_2O to -22 in H_2O	0.009 % + 150 µin H_2O	DHI PPC4-ui
	-22 in H_2O to 22 in H_2O	0.002 in H_2O	
	22 in H_2O to 60 in H_2O	0.009 % + 150 µin H_2O	
	60 in H_2O to 72 in H_2O	0.006 5 in H_2O	
	72 in H_2O to 804 in H_2O	0.009 % + 150 µin H_2O	
Gage Pressure – Pneumatic[1]	-14.7 psig to -0.5 psig	0.01 % + 0.000 11 psig	Fluke P3025-PSI
	3 psig to 500 psig	0.007 1 % + 0.003 9 psig	
Gage Pressure - Hydraulic[1]	500 psig to 16 000 psig	0.01 %	P3125-3 DWT

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Humidity - Measuring Equipment (-10 °C to 15 °C)	10 % RH to 75 %RH	0.5 %RH	Thunder Scientific 2500
	75 %RH to 95 %RH	0.65 %RH	
Humidity - Measuring Equipment (15 °C to 35 °C)	10 %RH to 95 %RH	0.5 %RH	Thunder Scientific 2500
(35 °C to 70 °C)	10 %RH to 50 %RH	0.5 %RH	
	50 %RH to 70 %RH	0.7 %RH	
	70 %RH to 95 %RH	0.85 %RH	
Humidity - Measure[1] (+15 to 25) °C	10 % RH to 90 % RH 90 % RH to 95 % RH	1.3 % RH 1.9 % RH	Vaisala MI70/HMP76B
(-20 to 15) °C (25 to 40) °C	0 to 95%RH	0.008 4% + 1.2% RH	Vaisala MI70/HMP76B
Dew / Frost Point Measuring Equipment	40 °C to 65 °C	0.17 °C	Thunder Scientific 2500
	30 °C to 40 °C	0.16 °C	
	20 °C to 30 °C	0.15 °C	
	20 °C to -10 °C	0.13 °C	
	-10 °C to -40 °C	0.15 °C	Thunder Scientific 3900
Dew / Frost Point - Measuring Equipment	-40 °C to -50 °C	0.25 °C	Thunder Scientific 3900
	-50 °C to -60 °C	0.36 °C	
	-60 °C to -70 °C	0.40 °C	
	-70 °C to -80 °C	0.61 °C	
	-80 °C to -85 °C	1.2 °C	

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Temperature - Measure[1]	-195 °C to 0 °C	0.015 °C	AccuMac AM1760 w/Black Stack
	0 °C to 420 °C	0.022 °C	
	420 °C to 660 °C	0.039 °C	
	600 °C to 800 °C	0.55 °C	Fluke 5649 w/3458A
	800 °C to 1 000 °C	0.76 °C	Fluke 5649 w/3458A
	1 000 °C to 1 450 °C	2.9 °C	
Temperature - Measuring Equipment [1]	-10 ºC to 70 ºC	0.086 ºC	Air Bath w/SPRT
	-75 °C to 100 ºC	0.033 °C	AccuMac AM1760 w/Hart Bath or Metrology Well & Black Stack
	100 °C to 200 ºC	0.051 °C	
	200 °C to 400ºC	0.074 °C	
	400 °C to 600 °C	0.092 °C	
	600 °C to 800 °C	1.2 °C	Fluke 5649 w/Furnace & 3458A
	800 °C to 1 000 °C	1.5 °C	
	1 000 °C to 1200 °C	3.6 °C	
Infrared Temperature – Measuring equipment λ = (8 to 14) µm Ɛ = (0.1 to 1)	-15 °C to 0 °C 0 °C to 50 °C 50 °C to 100 °C 100 °C to 120 °C 120 °C to 200 °C 200 °C to 350 °C 350 °C to 500 °C	0.8 °C 0.65 °C 0.7 °C 0.76 °C 0.94 °C 1.6 °C 2.1 °C	Black Body Sources

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Infrared Temperature – Measuring equipment Ɛ = (0.999) λ = (8 to 14) µm	500 °C to 1 000 °C	2.6 °C + 0.22 %	Black Body Sources

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency - Measure and Measuring Equipment	10 MHz	3.8×10^{-12} Hz/Hz	Fluke 910R
Frequency - Measure[1]	10 MHz	2.1×10^{-7} Hz/Hz	HP 53131A 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. Values listed with percent (%) are percent of reading or generated value unless otherwise noted.
3. 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.
4. L = Length in inches
5. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.
6. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 500 ps, 125 ps, and 25 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.
7. 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.

Vice President