



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Transcat – Philadelphia
100 Dobbs Lane, Suite 108-110
Cherry Hill, NJ 08034

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.

A handwritten signature in black ink, appearing to read 'R.D.L.', is positioned above a horizontal line.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 07 September 2021

Certificate Number: AC-2489.03



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 – Philadelphia
100 Dobbs Lane, Suite 108-110
Cherry Hill, NJ 08034
Joffrey McClure
856-441-5097

CALIBRATION

Valid to: **September 7, 2021**

Certificate Number: **AC-2489.03**

Chemical Quantities

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH – Measuring Equipment ¹	4 pH	0.011 pH	Standard Buffer Solutions
	7 pH	0.011 pH	
	10 pH	0.012 pH	
Conductivity Meters – Measuring Equipment	5 µS	0.35 µS	Standard Solutions
	10 µS	0.35 µS	
	100 µS	0.84 µS	
	1000 µS	3.5 µS	
	10 000 µS	38 µS	
	100 000 µS	310 µS	
	150 000 µS	610 µS	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Current – Measuring Equipment ¹	0 µA to 220 µA		
	10 Hz to 20 Hz	0.03 % + 16 nA	
	20 Hz to 40 Hz	0.019 % + 10 nA	Fluke 5700A-EP
	40 Hz to 1 kHz	0.015 % + 8 nA	
	1 kHz to 5 kHz	0.03 % + 12 nA	
	5 kHz to 10 kHz	0.11 % + 65 nA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Current – Measuring Equipment ¹	0.22 mA to 2.2 mA		Fluke 5700A-EP
	10 Hz to 20 Hz	0.03 % + 40 nA	
	20 Hz to 40 Hz	0.018 % + 35 nA	
	40 Hz to 1 kHz	0.013 % + 35 nA	
	1 kHz to 5 kHz	0.021 % + 0.11 μA	
	5 kHz to 10 kHz	0.11 % + 0.65 μA	
	2.2 mA to 22 mA		
	10 Hz to 20 Hz	0.039 % + 0.4 μA	
	20 Hz to 40 Hz	0.019 % + 0.35 μA	
	40 Hz to 1 kHz	0.014 % + 0.35 μA	
	1 kHz to 5 kHz	0.021 % + 0.55 μA	
	5 kHz to 10 kHz	0.11 % + 5 μA	
AC Current – Measuring Equipment ¹	22 mA to 220 mA		Fluke 5700A-EP
	10 Hz to 20 Hz	0.033 % + 4 μA	
	20 Hz to 40 Hz	0.018 % + 3.5 μA	
	40 Hz to 1 kHz	0.014 % + 2.5 μA	
	1 kHz to 5 kHz	0.021 % + 3.5 μA	
	5 kHz to 10 kHz	0.11 % + 10 μA	
	0.22 A to 2.2 A		Fluke 5700A-EP with 5725A
	20 Hz to 1 kHz	0.027 % + 35 μA	
	1 kHz to 5 kHz	0.046 % + 80 μA	
	5 kHz to 10 kHz	0.7 % + 160 μA	
	2.2 A to 11 A		Fluke 5522A
	40 Hz to 1 kHz	0.048 % + 170 μA	
1 kHz to 5 kHz	0.096 % + 380 μA		
5 kHz to 10 kHz	0.36 % + 750 μA		
11 A to 20.5 A			
45 Hz to 100Hz	0.092 % + 3.9 mA		
100 Hz to 1 kHz	0.12 % + 3.9 mA		
1 kHz to 5 kHz	2.3 % + 3.9 mA		

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment		
AC Current – Measuring Equipment ¹	20.5 A to 40 A 1 kHz to 5 kHz	3.3 % + 11 mA	Parallel Fluke 5522A		
Extended Frequency Ranges ¹	29 μA to 330 μA 10 kHz to 30 kHz	1.2 % + 0.31 μA	Fluke 5522A		
	330 μA to 3.3 mA 10 kHz to 30 kHz	0.78 % + 0.47 μA			
	3.3 mA to 33 mA 10 kHz to 30 kHz	0.31 % + 3 μA			
	29 mA to 330 mA 10 kHz to 30 kHz	0.31 % + 0.16 mA			
Clamp-on Ammeter Toroidal Type ¹ Transformer Type	20 A to 150 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.34 % + 35 mA 0.95 % + 66 mA	Fluke 5520A with 5500A/Coil		
	150 A to 1 000 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.38 % + 0.17 A 1.2 % + 0.29 A			
	Clamp-on Ammeter Non- Toroidal Type Hall Effect Sensor	20 A to 150 A 45 Hz to 65 Hz 65 Hz to 440 Hz		0.66 % + 0.26 A 1.2 % + 0.29 A	Fluke 5520A with 5500A/Coil
		150 A to 1 000 A 45 Hz to 65 Hz 65 Hz to 440 Hz		0.68 % + 1 A 1.4 % + 1.1 A	
Clamp-on Ammeter Non- Toroidal Type Hall Effect Sensor	1 000 A to 6 000 A 10 Hz to 300 Hz	0.60 %	Fluke 52120A, with 5520A, 3 kA or 6 kA coil		
	1 000 A to 2 000 A 30 Hz to 440 Hz	0.80 %			
	2 000 A to 6 000 A 30 Hz to 440 Hz	0.66 %			



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Current – Measure ¹	0 μ A to 100 μ A		Agilent 3458A opt 002
	10 Hz to 20 Hz	0.46 % + 35 nA	
	20 Hz to 45 Hz	0.17 % + 35 nA	
	45 Hz to 100 Hz	0.072 % + 35 nA	
	100 Hz to 5 kHz	0.072 % + 35 nA	
	100 μ A to 1 mA		
	10 Hz to 20 Hz	0.46 % + 0.23 μ A	
	20 Hz to 45 Hz	0.17 % + 0.23 μ A	
	45 Hz to 100 Hz	0.071 % + 0.23 μ A	
	100 Hz to 5 kHz	0.038 % + 0.23 μ A	
	1 mA to 10 mA		
	10 Hz to 20 Hz	0.46 % + 2.3 μ A	
	20 Hz to 45 Hz	0.17 % + 2.3 μ A	
	45 Hz to 100 Hz	0.071 % + 2.3 μ A	
	100 Hz to 5 kHz	0.038 % + 2.3 μ A	
	10 mA to 100 mA		
10 Hz to 20 Hz	0.46 % + 23 μ A		
20 Hz to 45 Hz	0.17 % + 23 μ A		
45 Hz to 100 Hz	0.071 % + 23 μ A		
100 Hz to 5 kHz	0.038 % + 23 μ A		
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		
AC Current – Measure ¹	1 A to 10 A		Ohm-Labs CS-100 w/3458A
	50 Hz to 999 Hz	0.05 % + 1.3 mA	
	1 kHz	0.12 % + 1.3 mA	
	10 A to 100 A		
	50 Hz to 100 Hz	0.038 % + 2.3 mA	
	100 Hz to 999 Hz	0.042 % + 2.3 mA	
1 kHz	0.13 % + 2.3 mA		

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Resistance – Measure ¹	10 Ω to 100 kΩ	0.039 % + 0.01 Ω	GenRad 1689M
	12 Hz to 99.9 kHz		
DC Resistance – Measuring Equipment and Measure ¹	250 μΩ to 4 mΩ	85 μΩ/Ω	Fluke 1594A bridge in ratio mode with characterized resistors
	4 mΩ to 40 mΩ	25 μΩ/Ω	
	40 mΩ to 400 mΩ	20 μΩ/Ω	
	400 mΩ to 4 Ω	16 μΩ/Ω	
	4 Ω to 400 kΩ	5 μΩ/Ω	
	0 Ω to 10 Ω	18 μΩ/Ω + 58 μΩ	Agilent 3458A with Decade Resistor
	10 Ω to 100 Ω	15 μΩ/Ω + 0.6 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	
DC Resistance – Measuring Equipment and Measure ¹	100 kΩ to 1 MΩ	19 μΩ/Ω + 2.3 Ω	Agilent 3458A with Decade Resistor
	1 MΩ to 10 MΩ	62 μΩ/Ω + 0.12 kΩ	
	10 MΩ to 100 MΩ	588 μΩ/Ω + 1.2 kΩ	
	100 MΩ to 1 GΩ	0.58 % + 10 kΩ	
DC Resistance – Measuring Equipment ¹	1 mΩ	59 μΩ/Ω	Fixed Resistor
	10 mΩ	58 μΩ/Ω	
	100 mΩ	58 μΩ/Ω	
	1 Ω	58 μΩ/Ω	
	100 Ω	1.3 μΩ/Ω	
	2 GΩ to 10 GΩ	0.58 %	IET HRRS-B-7-100k-5KV
	20 GΩ to 100 GΩ	1.2 %	
	200 GΩ to 1 TΩ	2.6 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
DC Current – Measuring Equipment and Measure ¹	0 μA to 100 μA	26 μA/A + 0.9 nA	Agilent 3458A with Current Source
	100 μA to 1 mA	26 μA/A + 6 nA	
	1 mA to 10 mA	26 μA/A + 58 nA	
	10 mA to 100 mA	43 μA/A + 0.58 μA	
	100 mA to 1 A	128 μA/A + 12 μA	
	0 A to 100 A	0.012 % + 500 μA	CS-100 with 3458A
	100 A to 1 500 A	0.29 % + 0.025 μA	WT-1500-50 with 3458A
DC Current – Measuring Equipment ¹	0 μA to 220 μA	41 μA/A + 6 nA	Fluke 5700A-EP with 5725A
	0.22 mA to 2.2 mA	36 μA/A + 7 nA	
	2.2 mA to 22 mA	36 μA/A + 40 nA	
DC Current – Measuring Equipment ¹	22 mA to 220 mA	57 μA/A + 0.7 μA	Fluke 5700A-EP with 5725A
	0.22 A to 2.2 A	202 μA/A + 12 μA	
	2.2 A to 11 A	403 μA/A + 0.48 mA	
	11 A to 20 A	0.096 % + 580 μA	Fluke 5522A
Clamp-on Ammeter Non- Toroidal Type Hall Effect Sensor	20 A to 1 000 A	0.58 % + 0.52 A	Fluke 5522A with 5500A/Coil
	1 000 A to 5 000 A	0.58 %	Fluke 52120A, with 5520A, 3 kA or 6 kA coil
DC Voltage – Measure ¹	0 mV to 100 mV	7.1 μV/V + 0.58 μV	Agilent 3458A
	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	0.035 % + 0.035 V	Vitretek 4700

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
DC Voltage – Measure ¹	10 kV to 35 kV	0.031 % + 0.081 V	Vitretek 4700 w/HVL-35
	35 kV to 70 kV	0.038 % + 0.23 V	Vitretek 4700 w/HVL-70
	70 kV to 100 kV	0.063 % + 0.35 V	Vitretek 4700 w/HVL-100
DC Voltage – Measuring Equipment ¹	0 to 220 mV	8.5 μV/V + 0.4 μV	Fluke 5700A-EP with 5725A
	220 mV 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 + 4.0 μV	
	22 V to 220 V	6.2 μV/V + 40 μV	
	220 V to 1 100 V	7.6 μV/V + 0.40 mV	
DC Voltage – Measuring Equipment and Measure ¹	0 V to 100 mV	7.1 μV/V + 0.5 μV	Agilent 3458A opt 2 with Fluke 5700A-EP
	100 mV to 1V	5 μV/V + 0.5 μV	
	1 V to 10 V	5.1 μV/V + 0.5 μV	
	10 V to 100 V	7.6 μV/V + 35 μV	
	100 V to 500 V	11 μV/V + 120 μV	
	500 V to 800 V	17 μV/V + 120 μV	
	800 V to 1 000 V	21 μV/V + 120 μV	
AC Voltage – Measure ¹	0 mV to 10 mV		Agilent 3458A
	1 Hz to 40 Hz	0.039 % + 3.5 μV	
	40 Hz to 1 kHz	0.028 % + 1.3 μV	
	1 kHz to 20 kHz	0.038 % + 1.3 μV	
	20 kHz to 50 kHz	0.15 % + 1.3 μV	
	50 kHz to 100 kHz	0.59 % + 1.3 μV	
	100 kHz to 300 kHz	4.6 % + 2.3 μV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	10 mV to 100 mV		Agilent 3458A
	1 Hz to 40 Hz	0.013 % + 5 μV	
	40 Hz to 1 kHz	0.009 4 % + 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 4 % + 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	
	1 V to 10 V		
	1 Hz to 40 Hz	0.009 4 % + 0.46 mV	
	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	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	10 V to 100 V		Agilent 3458A
	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		
AC Voltage – Measuring Equipment ¹	0.7 kV to 10 kV		Vitrek 4700 with associated probes
	60 Hz	0.14 % + 0.12 V	
	10 kV to 30 kV		
	60 Hz	0.064 % + 0.23 V	
30 kV to 50 kV			
60 Hz	0.091 % + 0.46 V		
50 kV to 70 kV			
60 Hz	0.14 % + 0.7 V		
AC Voltage – Measuring Equipment ¹	0 mV to 2.2 mV		Fluke 5700A-EP
	10 Hz to 20 Hz	0.16 % + 4 μV	
	20 Hz to 40 Hz	0.16 % + 4 μV	
	40 Hz to 20 kHz	0.1 % + 4 μV	
	20 kHz to 50 kHz	0.12 % + 4 μV	
	50 kHz to 100 kHz	0.17 % + 5 μV	
	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		

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Voltage – Measuring Equipment ¹	2.2 mV to 22 mV		Fluke 5700A-EP
	10 Hz to 20 Hz	0.044 % + 4 μV	
	20 Hz to 40 Hz	0.035 % + 4 μV	
	40 Hz to 20 kHz	0.015 % + 4 μV	
	20 kHz to 50 kHz	0.031 % + 4 μV	
	50 kHz to 100 kHz	0.059 % + 5 μV	
	100 kHz to 300 kHz	0.12 % + 10 μV	
	300 kHz to 500 kHz	0.16 % + 20 μV	
	500 kHz to 1 MHz	0.3 % + 20 μV	
	22 mV to 220 mV		
	10 Hz to 20 Hz	0.028 % + 12 μV	
	20 Hz to 40 Hz	0.017 % + 7 μV	
	40 Hz to 20 kHz	0.010 % + 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	0.092 % + 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	0.028 % + 40 μV	
	20 Hz to 40 Hz	0.016 % + 15 μV	
	40 Hz to 20 kHz	0.006 % + 8 μV	
	20 kHz to 50 kHz	0.008 % + 10 μV	
	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		

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
AC Voltage – Measuring Equipment ¹	2.2 V to 22 V		Fluke 5700A-EP
	10 Hz to 20 Hz	0.028 % + 0.4 mV	
	20 Hz to 40 Hz	0.016 % + 0.15 mV	
	40 Hz to 20 kHz	0.005 % + 0.05 mV	
	20 kHz to 50 kHz	0.008 % + 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	0.006 % + 0.6 mV	
	20 kHz to 50 kHz	0.009 % + 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 1 100 V		Fluke 5720A-EP with 5725A
	50 Hz to 1 kHz	0.011 % + 4 mV	
	1 kHz to 20 kHz	0.017 % + 6 mV	
	20 kHz to 30 kHz	0.061 % + 11 mV	
	220 V to 750 V		
	30 kHz to 50 kHz	0.061 % + 11 mV	
50 kHz to 100 kHz	0.23 % + 45 mV		
Capacitance – Measure ¹ 0.1 kHz to 1 kHz	Up to 10 pF	0.5 % + 0.05 pF	GenRad 1689M
	10 pF to 100 pF	0.59 % + 0.05 pF	
	100 pF to 1 μF	0.024 % + 0.05 pF	
	1 μF to 100 μF	0.12 %	
	100 μF to 1 000 μF	0.24 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Capacitance - Measuring Equipment ¹	0.19 nF to < 1.1 nF 10 Hz to 10 kHz	0.39 % + 7.8 pF	5522A
	1.1 nF to < 3.3 nF 10 Hz to 3 kHz	0.39 % + 7.8 pF	
	3.3 nF to < 11 nF 10 Hz to 1 kHz	0.21 % + 7.8 pF	
	11 nF to < 110 nF 10 Hz to 1 kHz	0.21 % + 78 pF	
	110 nF to < 330 nF 10 Hz to 1 kHz	0.21 % + 0.23 nF	
	0.33 μF to < 1.1 μF 10 Hz to 600 Hz	0.21 % + 0.78 nF	
	1.1 μF to < 3.3 μF 10 Hz to 300 Hz	0.21 % + 2.3 nF	
	3.3 μF to < 11 μF 10 Hz to 150 Hz	0.21 % + 7.8 nF	
	11 μF to < 33 μF 10 Hz to 120 Hz	0.32 % + 23 nF	
	33 μF to < 110 μF 10 Hz to 80 Hz	0.36 % + 78 nF	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Capacitance - Measuring Equipment ¹	110 μF to < 330 μF DC to 50 Hz	0.36 % + 0.23 μF	5522A
	0.33 mF to < 1.1 mF DC to 20 Hz	0.35 % + 0.78 μF	
	1.1 mF to < 3.3 mF DC to 6 Hz	0.35 % + 2.3 μF	
	3.3 mF to < 11 mF DC to 2 Hz	0.35 % + 7.8 μF	
	11 mF to < 33 mF DC to 0.6 Hz	0.58 % + 23 μF	
	33 mF to < 110 mF DC to 0.2 Hz	0.85 % + 78 μF	
Inductance – Measure ¹ 0.1 kHz to 1 kHz	1 mH to 10 mH	0.041 % + 0.1 μH	GenRad 1689M
	10 mH to 10 H	0.035 % + 1.4 μH	
Inductance – Measuring Equipment ¹ 1 kHz	1 mH	0.13 %	Fixed Inductor
	10 mH	0.13 %	
	100 mH	0.13 %	
	1 H	0.13 %	
Electrical Calibration of Thermocouple Devices 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	1.2 °C 0.90 °C 0.71 °C 0.55 °C 0.45 °C 0.35 °C	Ectron 1140A

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 E	(-270 to -245) °C	1.6 °C	Ectron 1140A
	(-245 to -195) °C	0.24 °C	
	(-195 to -155) °C	0.12 °C	
	(-155 to -90) °C	0.095 °C	
	(-90 to 0) °C	0.080 °C	
	(0 to 15) °C	0.076 °C	
	(15 to 890) °C	0.064 °C	
(890 to 1 000) °C	0.074 °C		
Type J	(-210 to -180) °C	0.15 °C	
	(-180 to -120) °C	0.12 °C	
	(-120 to -50) °C	0.093 °C	
	(-50 to 990) °C	0.080 °C	
	(990 to 1 200) °C	0.094 °C	
Type K	(-270 to -255) °C	2.5 °C	
	(-255 to -195) °C	0.85 °C	
	(-195 to -115) °C	0.16 °C	
	(-115 to -55) °C	0.12 °C	
	(-55 to 1 000) °C	0.087 °C	
(1 000 to 1 372) °C	0.096 °C		
Type N	(-270 to -260) °C	5.4 °C	
	(-260 to -200) °C	1.5 °C	
	(-200 to -140) °C	0.29 °C	
	(-140 to -70) °C	0.18 °C	
	(-70 to 25) °C	0.14 °C	
	(25 to 160) °C	0.12 °C	
(160 to 1 300) °C	0.11 °C		
Type R	(-50 to -30) °C	0.80 °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	0.30 °C	
	(775 to 1 768) °C	0.26 °C	
Type S	(-50 to -30) °C	0.76 °C	
	(-30 to 45) °C	0.68 °C	
	(45 to 105) °C	0.49 °C	
	(105 to 310) °C	0.41 °C	
	(310 to 615) °C	0.35 °C	
	(615 to 1 768) °C	0.31 °C	
Type T	(-270 to -255) °C	1.9 °C	
	(-255 to -240) °C	0.60 °C	
	(-240 to -210) °C	0.36 °C	
	(-210 to -150) °C	0.22 °C	

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 T	(-180 to -40) °C (-40 to 100) °C (100 to 400) °C	0.15 °C 0.095 °C 0.080 °C	Ectron 1140A
Power Measuring Equipment ¹ DC Power 0.33 mA to 330 mA	11 μW to 1.1 mW 1.1 mW to 110 mW 0.11W to 110 W 110 W to 330 W	0.024 % 0.027 % 0.024 % 0.018 %	Fluke 5520A
0.33 A to 3 A	11 W to 110 mW 0.11 W to 990 W 1 W to 3 kW	0.044 % 0.053 % 0.009 6 %	
3 A to 20.5 A	0.099 W to 0.99 W 0.99 W to 6.8 kW 6.8 W to 20.5 kW	0.088 % 0.07 % 0.04 %	
AC Power ⁴ (PF=1) 10 Hz to 65 Hz 3.3 mA to 9.0 mA	0.11 mW to 3.0 mW 3 mW to 9.0 W	0.13% 0.077%	Fluke 5520A
9.0 mA to 33 mA	0.3 mW to 10 mW 10 mW to 33W	0.089 % 0.077%	
33 mA to 90 mA	1 mW to 30 mW 30 mW to 90 W	0.071 % 0.057 %	
90 mA to 330 mA	3 mW to 100 mW 100 mW to 300 W	0.089 % 0.078 %	
0.33 A to 0.9 A	11 mW to 300 mW 300 mW to 900 W	0.071 % 0.081 %	
0.9 A to 2.2 A	30 mW to 720 mW 720 mW to 2 kW	0.089 % 0.079 %	
2.2 A to 4.5 A	80 mW to 1.4 W 1.4 W to 4.5 kW	0.088 % 0.18 %	
4.5 A to 20.5 A	150 mW to 6.7 W 6.7 W to 20 kW	0.17 % 0.17 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Phase Meters – Measure Equipment ¹	0° to 180°		Fluke 5520A
	10 Hz to 65 Hz	0.11°	
	65 Hz to 500 Hz	0.2°	
	500 Hz to 1 kHz	0.4°	
	1 kHz to 5 kHz	1.9°	
	5 kHz to 10 kHz	3.9°	
10 kHz to 20 kHz	7.8°		
Oscilloscopes ¹			Fluke 5520A/SC1100
Amplitude DC ¹			
into 50 Ω Load	(-6.6 to 6.6) V	0.2 % + 31 μV	
into 1 MΩ Load	(-130 to 130) V	0.039 % + 31 μV	
Amplitude Square Wave ¹			
into 50 Ω Load			
Rate: 10 Hz to 10 kHz	1 mV _(pk-pk) to 6.6 V _(pk-pk)	0.19 % + 31 μV	
into 1 MΩ Load			
Rate: 10 Hz to 1 kHz	1 mV _(pk-pk) to 6.6 V _(pk-pk)	0.078 % + 31 μV	
Rate: 1 kHz to 10 kHz	1 mV _(pk-pk) to 6.6 V _(pk-pk)	0.19 % + 31 μV	
Timing - Generate ¹			Fluke 5520A/SC1100
50 Ω Load			
	5 s	0.3 %	
	2 s	0.12 %	
	1 s	0.062 %	
	500 ms	0.032 %	
	200 ms	0.014 %	
	100 ms	0.007 6 %	
	50 ms	0.004 6 %	
	20 mS to 1 nS	0.000 22 %	
Rise Time – Generate ^{1,3}			Fluke 5520A/SC1100
50 Ω Load			
5.0 mV _(pk-pk) to 2.5 V _(pk-pk)	250 ps (nominal)	50 ps	
Rate: 1 kHz to 2 MHz	250 ps (nominal)	50 ps	
Rate: 2 MHz to 10 MHz			

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Rise Time – Measure ¹	≥ 700 ps	130 ps	HP 54615B
Leveled Sine Wave Generate ¹ 50 Ω Load 5.0 mV _(pk-pk) to 5.5 V _(pk-pk) 5.0 mV _(pk-pk) to 3.5 V _(pk-pk)	50 kHz 50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 600 MHz 600 MHz to 1 GHz	1.8 % + 230 μV 2.8 % + 230 μV 3.2 % + 230 μV 4 % + 230 μV 5.5 % + 230 μV	Fluke 5520A/SC1100
Bandwidth/Flatness Measure ¹ 50 Ω (50 kHz Reference) 5.0 mV _(pk-pk) to 5.5 V _(pk-pk) 5.0 mV _(pk-pk) to 3.5 V _(pk-pk)	50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 600 MHz 600 MHz to 1.1 GHz	1.4 % + 78 μV 1.8 % + 78 μV 3.2 % + 78 μV 4 % + 78 μV	Fluke 5520A/SC1100
Input Impedance Measure ¹ 50 Ω 1 MΩ	40 Ω to 60 Ω 500 kΩ to 1.5 MΩ	0.082 % 0.081 %	Fluke 5520A/SC1100
Input Capacitance Measure ¹	5 pF to 50 pF	3.9 % + 0.39 pF	Fluke 5520A/SC1100
Wave Generator – Source ¹ Amplitude (10 Hz to 10 kHz) Sine, Square, Triangle 50 Ω Load 1 MΩ Load	1.8 mV _(pk-pk) to 2.5 V _(pk-pk) 1.8 mV _(pk-pk) to 55 V _(pk-pk)	2.3 % + 78 μV _(pk-pk) 2.3 % + 78 μV _(pk-pk)	Fluke 5520A/SC1100
Wave Generator – Source ¹ Frequency Sine, Square, Triangle	10 Hz to 10 kHz	0.001 9% + 0.012 Hz	Fluke 5520A/SC1100

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ⁵	Reference Standard, Method and/or Equipment
Angle Measuring Devices Protractors, Inclinometers, Squares, Angle Gages	0.1° to 60° 0° to 30° 30° to 90° 90°	15 arc-sec 24 arc-sec 24 arc-sec + 9.5 arc-sec/degree 1.4 arc-sec	Sine Bar, Gage Blocks, Gage Amp, Plate Angle Blocks w/plate
Micrometers and Calipers – Outside, Inside, Depth, Step ¹	0.01 in to 1 in 1 in to 9 in 4 in to 15 in 15 in to 40 in	(16 + 1L) μin (11 + 4L) μin (13 + 4.5 L) μin (15 + 4.6 L) μin	Comparison to Gage Blocks
Anvil Flatness ¹	0 in to 1 in Diameter	4.4 μin	Optical Flats
Anvil Parallelism ¹	0 in to 1 in Diameter	8.2 μin	Optical Parallel
Digital/Dial Indicators, LVDTs & Gage Amplifiers	0 in to 2 in 2 in to 6 in	(17 + 1.0 L) μin (18 + 2.2 L) 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 + 3.5 L) μin (1 + 4 L) μin (24 + 5 L) μin	ULM Gage Amp w/Gage blocks
Length Single Axis Inside Dimension	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) in	11 μin 11 μin (18 + 3 L) μin	ULM
Height Gages ¹	(10 to 14) in 0 in to 4 in 4 in to 44 in	(38 + 3 L) μin 110 μin (94 + 3 L) μin	Gage Blocks w/Plate

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ⁵	Reference Standard, Method and/or Equipment
Parallelism, Flatness, Straightness	0 in to 12 in	45 μin	Gage Amp w/plate
	12 in to 24 in	55 μin	
	24 in to 36 in	67 μin	
	36 in to 48 in	160 μin	
Squareness	(0 to 6) in	100 μin	Gage Amp w/plate
	(6 to 12) in	100 μin	
Cylindrical Plug Gages Outside Diameter	(0 to 1) in (1 to 7) in	12 μin (9 + 3 L) μin	ULM
Cylindrical Ring Gages Inside Diameter	(0.04 to 1) in (1.0 to 2.5) in	11 μin 11 μin	ULM
Cylindrical Ring Gages Inside Diameter	(2.5 to 10) in (10 to 14) in	(18 + 3 L) μin (38 + 3 L) μin	ULM
Optical Comparators Length Magnification	(0 to 12) in 10X to 50X	(100 + 20 L) μin (240 + 21 L) μin	Calibration Grids Magnification Checker
Tapes and Rulers ¹	0 to 3 ft	0.0035 in	Glass Rule
	3 to 12 ft	(0.0034 in + 25 L) μin	
	12 to 100 ft	(0.0072 in + 12 L) μin	
Tapes and Rulers	Up to 1 ft	(463 + 2 L) μin	Single Axis Vision system
	(1 to 3) ft	(410 + 6 L) μin	
	(3 to 1 000) ft	(18 L) μin	
Thread Wires	2 TPI to 120 TPI (0.008 to 0.5) in	12 μin	ULM
Thread Plug Gages Pitch Diameter	(0 to 1) in	79 μin	ULM w/Thread Wires
	(1 to 7) in	80 μin	
	(7 to 12) in	83 μin	
Major Diameter	(0 to 1) in	13 μin	ULM
	(1 to 7) in	(10 + 3L) μin	
Thread Ring Gages Inner Diameter	(0 to 1) in	79 μin	Uncertainty of Master Ring
	(1 to 7) in	80 μin	
	(7 to 12) in	83 μin	

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ⁵	Reference Standard, Method and/or Equipment
Linear Dimension X Axis	0 in to 1 in	210 μin	Optical Comparator
	1 in to 3 in	370 μin	
	3 in to 6 in	480 μin	
Y Axis	0 in to 2 in	360 μin	
	2 in to 3 in	410 μin	
	3 in to 5 in	560 μin	
Angle	0° to 180°	0.008°	
Radius	0 in to 1 in	260 μin	
	1 in to 3 in	450 μin	
	3 in to 6 in	590 μin	

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Gas Flow	2 sccm to 200 sccm	0.33 %	Fluke Molbloc
	0.2 slpm to 40 slpm	0.23 %	
	40 slpm to 80 slpm	0.32 %	
	80 slpm to 100 slpm	0.57 %	Fluke Sonic Blox
	100 slpm to 300 slpm	0.6 %	
	300 slpm to 1 200 slpm	0.81 %	
Force Compression/Tension	(0 to 5) lbf	0.001 1 lbf	Characterized Class F Deadweight
	(5 to 10) lbf	0.002 0 lbf	
	(10 to 20) lbf	0.005 8 lbf	
	(20 to 30) lbf	0.009 3 lbf	
	(30 to 100) lbf	0.061 lbf	
	(0 to 5) lbf	0.001 2 lbf	
	(5 to 10) lbf	0.002 3 lbf	
	(10 to 20) lbf	0.006 2 lbf	
	(20 to 30) lbf	0.009 9 lbf	
	(30 to 100) lbf	0.063 lbf	

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Mass – Metric	1 mg	1.7 µg	Echelon II
	2 mg	1.7 µg	
	3 mg	1.7 µg	
	5 mg	1.7 µg	
	10 mg	1.7 µg	
	20 mg	1.7 µg	
	30 mg	1.7 µg	
	50 mg	1.7 µg	
	100 mg	1.7 µg	
	200 mg	1.7 µg	
	300 mg	1.7 µg	
	500 mg	1.7 µg	
	1 g	2.9 µg	
	2 g	2.9 µg	
	3 g	3.5 µg	
	5 g	4 µg	
	10 g	6.5 µg	
	20 g	9 µg	
	30 g	12 µg	
	50 g	12 µg	
	100 g	25 µg	
	200 g	41 µg	
	300 g	62 µg	
	500 g	91 µg	
	1 kg	0.22 mg	
	2 kg	1.1 mg	
3 kg	1.2 mg		
5 kg	1.3 mg		
10 kg	3.4 mg		

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Mass – Metric	1 mg	4 µg	Echelon III
	2 mg	4 µg	
	3 mg	4 µg	
	5 mg	4 µg	
	10 mg	4 µg	
	20 mg	4 µg	
	30 mg	4 µg	
	50 mg	4 µg	
	100 mg	4 µg	
	200 mg	4 µg	
	300 mg	4 µg	
	500 mg	4 µg	
	1 g	11 µg	
	2 g	11 µg	
	3 g	12 µg	
	5 g	11 µg	
	10 g	17 µg	
	20 g	25 µg	
	30 g	29 µg	
	50 g	43 µg	
	100 g	88 µg	
	200 g	0.17 mg	
	300 g	0.25 mg	
	500 g	0.42 mg	
	1 kg	0.84 mg	
	2 kg	2.4 mg	
	3 kg	2.9 mg	
	5 kg	4.4 mg	
10 kg	9.7 mg		
20 kg	0.1 g		
25 kg	0.1 g		

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Mass – Avoirdupois	0.0312 5 oz	12 µg	Echelon III
	0.062 5 oz	12 µg	
	0.125 oz	12 µg	
	0.25 oz	20 µg	
	0.5 oz	20 µg	
	1 oz	33 µg	
	2 oz	55 µg	
	4 oz	0.11 mg	
	8 oz	0.3 mg	
	1 lb	0.52 mg	
	2 lb	1 mg	
	5 lb	3 mg	
	7.5 lb	5.1 mg	
	10 lb	5.1 mg	
	15 lb	10 mg	
	20 lb	10 mg	
25 lb	0.1 g	ASTM E18	
50 lb	0.1 g		
HRC Scale			
High	0.43 HRC	ASTM E18	
Middle	0.59 HRC		
Low	0.78 HRC		
HRBw Scale			
High	1 HRBw		
Middle	1 HRBw		
Low	1.1 HRBw	Duro Calibrator	
Durometer (Spring Force)	Type A, B, E, 0		0.31 duro
	Type D, C, DO	0.16 duro	

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Torque - Wrenches, Drivers, Indicators ¹	(3 to 80) ozf·in	1.7 %	Torque Calibrators
	15 ozf·in to 600 lbf·ft	0.5 %	
	5 lbf·in to 800 lbf·ft	1 %	
Torque – Hydraulic ¹ (1 000 to 10 000) psi	270 Nm to 2 700 Nm (200 lbf·ft to 2 000 lbf·ft)	1.3%	Torque Calibration System
	2 700 Nm to 40 00 Nm (2 000 lbf·ft to 20 000 lbf·ft)	1.3%	
Torque – Multipliers ¹	270 Nm to 2 700 Nm (200 lbf·ft to 2 000 lbf·ft)	1.5%	Torque Calibration System
	2 700 Nm to 4 000 Nm (2 000 lbf·ft to 20 000 lbf·ft)	1.5%	
Torque Angle ¹	45°	0.35°	Torque Angle Fixture
	90°	0.35°	
	135°	0.35°	
	180°	0.35°	
	360°	0.35°	
Torque – Measuring Equipment	5 ozf·in to 2.5 lbf·in	0.09 %	Torque Wheel w/Weights
	2.5 lbf·in to 50 lbf·in	0.05 %	
	50 lbf·in to 250 lbf·ft	0.06 %	Torque Butterfly w/Weights

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Balances & Scales – Metric ^{1,7}	up to 500 mg	0.002 5 mg	Characterized ASTM Class 1 Weights
	(500 to 2 000) mg	0.006 2 mg	
	(2 to 5) g	0.006 7 mg	
	(5 to 10) g	0.011 mg	
	(10 to 20) g	0.016 mg	
	(20 to 50) g	0.027 mg	
	(50 to 100) g	0.058 mg	
	(100 to 200) g	0.11 mg	
	(200 to 500) g	0.27 mg	
	(500 to 1 000) g	0.54 mg	
	(1 to 2) kg	1.8 mg	
	(2 to 5) kg	3.0 mg	
	(5 to 10) kg	6.6 mg	
	(10 to 20) kg	14 mg	
	(20 to 30) kg	20 mg	
	(30 to 40) kg	27 mg	
	(40 to 50) kg	25 mg	
	(50 to 60) kg	26 mg	
(60 to 70) kg	28 mg		
(70 to 80) kg	29 mg		
(80 to 100) kg	30 mg		

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Balances & Scales – Metric ^{1,7}	up to 5 g	0.032 mg	Characterized ASTM Class 2 Weights
	(5 to 10) g	0.044 mg	
	(10 to 20) g	0.059 mg	
	(20 to 30) g	0.088 mg	
	(30 to 50) g	0.15 mg	
	(50 to 100) g	0.29 mg	
	(100 to 200) g	0.58 mg	
	(200 to 300) g	0.89 mg	
	(300 to 500) g	1.5 mg	
	(500 to 1 000) g	3.0 mg	
	(1 to 2) kg	6.2 mg	
	(2 to 3) kg	9.0 mg	
	(3 to 5) kg	15 mg	
	(5 to 6) kg	18 mg	
	(6 to 7) kg	21 mg	
(7 to 8) kg	24 mg		
(8 to 9) kg	27 mg		
(9 to 10) kg	30 mg		
Balances & Scales – Metric ^{1,7}	Up to 0.25 kg	0.023 %	Class F Mass
	(0.25 to 0.50) kg	0.017 %	
	(0.5 to 750) kg	0.012 %	
Balances & Scales – Avoirdupois ^{1,7}	Up to 0.5 lb	0.023 %	Class F Mass
	(0.5 to 1) lb	0.017 %	
	(1 to 1 700) lb	0.012 %	
Volume	1 mL to 5 000 mL	0.2 % + 0.02 mL	Gravimetric

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Absolute Pressure – Source Pneumatic – In Lab	0 psia to 30 psia	0.002 6 psia	Fluke RPM4
	30 psia to 300 psia	0.008 8 % psia	
	300 psia to 1 000 psia	0.01 %	
Gage Pressure – Source Pneumatic – Field ¹	-15 psig to 3 psig	0.015 %	Cosa Instruments T3500/3
	3 psig to 500 psig	0.006 5 %	
Pneumatic – In Lab	-60 inH ₂ O to -22 inH ₂ O	0.009 % + 150 μinH ₂ O	Fluke PPC4
	-22 inH ₂ O to 22 inH ₂ O	0.002 inH ₂ O	
	22 inH ₂ O to 60 inH ₂ O	0.009 % + 150 μinH ₂ O	
	60 inH ₂ O to 72 inH ₂ O	0.006 5 inH ₂ O	
	72 inH ₂ O to 804 inH ₂ O	0.009 % + 150 μinH ₂ O	Fluke RPM4
	-15 psig to 30 psig	0.002 1 psig	
	30 psig to 1000 psig	0.006 6 % + 0.000 1 psig	
Hydraulic – Field ¹	50 psig to 15 000 psig	0.011 %	Ametek T-150
	50 psia to 15 000 psia	0.011 % + 0.002 6 psi	Ametek T-150 with RPM 4

Photometry and Radiometry

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Illuminance	5.4 lx to 10 764 lx	1.1 %	Standard Lamp
	10 764 lx to 21 258 lx	1.7 %	
	21 258 lx to 32 300 lx	2.1 %	

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Relative Humidity			
Generate (-10 °C to 15 °C)	(10 to 75) %RH (75 to 95) %RH	0.5 % RH 0.65 % RH	Humidity Generator
(15 °C to 35 °C)	(10 to 95) %RH	0.5 % RH	
(35 °C to 70 °C)	(10 to 50) %RH (50 to 75) %RH (75 to 95) %RH	0.5 % RH 0.7 % RH 0.85 % RH	
Measure ¹ (10 °C to 30 °C)	10 % RH to 90 % RH	1.3 % RH	Vaisala HMI41/HMP46
Temperature Measuring Equipment	-100 °C to 0 °C 0 °C to 150 °C 150 °C to 420 °C 420 °C to 600 °C	0.012 °C 0.023 °C + 0.001 % 0.039 °C + 0.001 % 0.072 °C + 0.001 %	SPRT, Metrology Wells
Infrared Temperature – Measuring Equipment $\epsilon = (0.1 \text{ to } 1.0)$ $\lambda = (8 \text{ to } 14) \mu\text{m}$	-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 0.95 °C 1.6 °C 2.1 °C	Black Body Sources
Temperature Measure ¹	-195 °C to 0 °C	0.012 °C	Hart Black Stack with SPRT
	0 °C to 420 °C	0.02 °C + 0.001 %	
	420 °C to 600 °C	0.028 °C + 0.001 %	
Temperature Measure	600 °C to 1 000 °C	0.94 °C	Type-S TC
	1 000 °C to 1450 °C	2.9 °C	

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
SPRT/PRT/RTD Calibration by Comparison	-195 °C	3.4 mK	SPRT with NBPLN ₂
	-78 °C	3.2 mK	SPRT with Precision Bath
	-38 °C	2.9 mK	
	0 °C	2.9 mK	
	0.01 °C	1.5 mK	TPW Cell
	100 °C	3.6 mK	SPRT with Precision Bath
	156 °C	4.6 mK	
	231 °C	6 mK	
	300 °C	5.8 mK	
	420 °C	8.4 mK	
500 °C	14 mK		
	-100 °C to 500 °C	2.9 mK to 21 mK	SPRT with Precision Bath
Thermocouple - Measuring Equipment	600 °C to 1 000 °C	0.94 °C	Type-S TC with Furnace
	1 000 °C to 1 200 °C	2.9 °C	

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment
Frequency – Source and Measure In-Lab	10 MHz	5.8 x 10 ⁻¹⁰ Hz/Hz	Rubidium Oscillator
Field ¹	10 MHz	2.1 x 10 ⁻⁷ Hz/Hz	Agilent 53132A
Total Harmonic Distortion	0 dB to -80 dB		Agilent 8903B
	20 Hz to 20 kHz	1.1 dB	
	20 kHz to 100 kHz	2 dB	
Total Harmonic Distortion 5 Hz to 600 kHz Fundamental Input Voltage Range < 30 V 100 % to 0.3 %	10 Hz to 1 MHz	3 %	HP 334A
	1 MHz to 3 MHz	6 %	
Total Harmonic Distortion	10 Hz to 20 Hz	12 %	

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) ²	Reference Standard, Method and/or Equipment	
5 Hz to 600 kHz Fundamental Input Voltage Range < 30 V 0.1 %	20 Hz to 30 Hz	6 %		
	30 Hz to 300 kHz	3 %		
	300 kHz to 500 kHz	6 %		
	500 kHz to 1.2 MHz	12 %		
Input Voltage Range > 30 V 100 % to 0.3 %	10 Hz to 300 kHz	3 %		
	300 kHz to 500 kHz	6 %		
	500 kHz to 3 MHz	12 %		
Input Voltage Range > 30 V 0.1 %	20 Hz to 30 Hz	12 %		HP 334A
	30 Hz to 300 kHz	3 %		
	300 kHz to 500 kHz	6 %		
	500 kHz to 1.2 MHz	12 %		
Time – Measure	Up to 599 sec/month	0.058 sec/day		Vibrograf 4500

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. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 250 ps. In the typical application of measuring rise time of an oscilloscope, this value is one of the contributing factors, but other factors are derived from the DUT. The known source rise time is mathematically removed from the total measured rise time measured on the DUT.
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 laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
5. L = Length in inches.
6. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.03.
7. 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.



R. Douglas Leonard Jr., VP, PILR SBU

