



**LABORATORY
ACCREDITATION
BUREAU** a division of A-S-B

Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2222

Indiana Standards Laboratory

2919 Shelby Street
Indianapolis IN 46203-5236

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories".*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: **October 31, 2018**

R. Douglas Leonard, Jr., President, COO
Laboratory Accreditation Bureau
Presented the 15th of October 2015

*See the laboratory's Scope of Accreditation for details of accredited parameters

**Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).
Form 28.1 - Rev 1 7/3/13

Scope of Accreditation For Indiana Standards Laboratory

2919 Shelby Street
Indianapolis, IN 46203-5236
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317-787-6578

In recognition of a successful assessment to ISO/IEC 17025:2005 to the following Calibration and Measurement Capabilities, accreditation has been granted to **Indiana Standards Laboratory** for the following:

Accreditation granted through: **October 31, 2018**

Calibration

Acoustics, Ultrasound, and Vibration – Sound Pressure Level

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Sound Level Calibrator	(94 to 124) dB 250 Hz to 1 kHz	0.23 dB	GR 1562A B&K 2206 Fluke 931B
	(94 to 124) dB 125 Hz, 2 kHz	0.45 dB	
Sound Level Meters ¹	114 dB 250 Hz to 1 kHz	0.25 dB	GR 1562A AC Ratio
	114 dB 125Hz, 2 kHz	0.45 dB	

Amount of Substance – pH/Conductivity

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
pH Meters ¹	4 pH 7 pH 10 pH	0.02 pH	Standard pH Buffers Thermometer 0.1 °C
Conductivity Meters ¹	10 µS	0.62 µS	Standard Solutions
	100 µS	0.92 µS	
	1 000 µS	4 µS	
	10 000 µS	36 µS	
	100 000 µS	320 µS	
	1 412 µS	4.3 µS	

Amount of Substance – Refractive Index

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Refractive Index Brix	(0.1 to 20) Brix	0.2 % of reading	Scale Sugar Distilled Water

Electrical – Capacitance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Capacitance (Source)	(0.1 to 1) pF	0.0002 pF + 45 μ F/F	GR 1422-CD GR 1615A
	(1 to 10) pF	0.0014 pF + 50 μ F/F	
	(10 to 100) pF	0.00078 pF + 10 μ F/F	GR 1422-CL GR 1615A
	(100 to 1 000) pF	0.0036 pF + 23 μ F/F	GR-1422-CB GR-1615A
	(1 to 10) nF	0.000 004 2 nF + 17 μ F/F	GR 1423A GR 1615A
	(10 to 100) nF	0.000 14 nF + 29 μ F/F	
	(100 to 1 000) nF	0.000 13 nF + 37 μ F/F	
	(1 to 10) μ F	220 μ F/F	ISL Polaris Capacitance Decade GR 1615A
	(10 to 100) μ F	530 μ F/F	
Capacitance (Measure)	(0.1 to 1) pF	0.000 03 pF + 60 μ F/F	GR1615A GR 1403-K
	(1 to 10) pF	0.000 051 pF + 16 μ F/F	GR 1615A GR 1403-G
	(10 to 100) pF	0.000 076 pF + 7.2 μ F/F	GR 1615A GR 1404-B
	(100 to 1 000) pF	0.000 21 pF + 7.7 μ F/F	
	(1 to 10) nF	0.000 001 9 nF + 11 μ F/F	
	(10 to 100) nF	0.0001 nF + 21 μ F/F	GR 1615A GR 1615-P1
	(100 to 1 000) nF	0.000 41 nF + 27 μ F/F	GR 1615A GR 1409-T
	(1 to 10) μ F	0.000 008 6 μ F + 210 μ F/F	GR 1615A
	(10 to 100) μ F	-0.000 014 μ F + 530 μ F/F	GR 1689M

Electrical – Current

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Current (Source) ¹	(0.1 to 1) mA (10 to < 50) Hz	(160 µA/A + 0.3 nA)	GR 1440 Holt 6A Ratio Transformer Agilent 3458A
	(0.1 to 1) mA (0.05 to 1) kHz	88 µA/A	
	(0.1 to 1) mA (> 1 to 5) kHz	(100 µA/A + 0.5 nA)	
	(0.1 to 1) mA (>5 to 10) kHz	(240 µA/A + 3.1 nA)	
	(>1 to 10) mA (10 to <50) Hz	(150µA/A + 1.5 nA)	
	(>1 to 10) mA (0.05 to 1) kHz	(84 µA/A + 1.2 nA)	
	(>1 to 10) mA (>1 to 5) kHz	(83 µA/A + 10 nA)	
	(>1 to 10) mA (>5 to 10) kHz	(90 µA/A + 74 nA)	
	(>10 to 100) mA (10 to <50) Hz	150 µA/A	
	(>10 to 100) mA (0.05 to 1) kHz	90 µA/A	
	(>10 to 100) mA (>1 to 5) kHz	(96 µA/A + 22 nA)	
	(>10 to 100) mA (>5 to 10) kHz	(110 µA/A + 36 nA)	
	(>0.1 to 1) A (10 to <50) Hz	150 µA/A	
	(>0.1 to 1) A (0.05 to 1) kHz	91 µA/A	
	(>0.1 to 1) A (>1 to 5) kHz	(100 µA/A – 0.74 µA)	
	(>0.1 to 1) A (>5 to 10) kHz	(160 µA/A + 5 µA)	
	(>1 to 10) A (10 to <50) Hz	160 µA/A	
	(>1 to 10) A (0.05 to 1) kHz	(96 µA/A – 2.2 µA)	
	(>1 to 10) A (>1 to 5) kHz	(150 µA/A – 49 µA)	
	(>10 to 20) A (10 to <50) Hz	(150 µA/A + 110 µA)	
	(>10 to 20) A (0.05 to 1) kHz	100 µA/A	
	(>10 to 20) A (>1 to 5) kHz	160 µA/A	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks	
AC Current (Measure) ¹	(0.1 to 1) mA (10 to <50) Hz	(160 μ A/A + 0.3 nA)	GR 1440 Holt 6A Ratio Transformer Agilent 3458A	
	(0.1 to 1) mA (0.05 to 1) kHz	88 μ A/A		
	(0.1 to 1) mA (>1 to 5) kHz	(100 μ A/A + 0.5 nA)		
	(0.1 to 1) mA (>5 to 10) kHz	(240 μ A/A + 3.1 nA)		
	(>1 to 10) mA (10 to <50) Hz	(150 μ A/A + 1.5 nA)		
	(>1 to 10) mA (0.05 to 1) kHz	(84 μ A/A + 1.2 nA)		
	(>1 to 10) mA (>1 to 5) kHz	(83 μ A/A + 10 nA)		
	(>1 to 10) mA (>5 to 10) kHz	(90 μ A/A + 74 nA)		
	(>10 to 100) mA (10 to <50) Hz	150 μ A/A		Holt CS1 Holt 6A Agilent 3458A
	(>10 to 100) mA (0.05 to 1) kHz	90 μ A/A		
	(>10 to 100) mA (>1 to 5) kHz	(96 μ A/A + 22 nA)		
	(>10 to 100) mA (>5 to 10) kHz	(110 μ A/A + 36 nA)		
	(>0.1 to 1) A (10 to <50) Hz	150 μ A/A		
	(>0.1 to 1) A (0.05 to 1) kHz	91 μ A/A		
	(>0.1 to 1) A (>1 to 1) A	(100 μ A/A - 0.74 μ A)		
	(>0.1 to 1) A (>5 to 10) kHz	(160 μ A/A - 5 μ A)		
	(>1 to 10) A (10 to <50) Hz	160 μ A/A		
	(>1 to 10) A (0.05 to 1) kHz	(96 μ A/A - 2.2 μ A)		
	(>1 to 10) A (>1 to 5) kHz	(150 μ A/A - 49 μ A)		
	(>1 to 10) A (>5 to 10) kHz	(260 μ A/A - 110 μ A)		
	(>10 to 20) A (10 to <50) Hz	(150 μ A/A + 110 μ A)		
	(>10 to 20) A (0.05 to 1) kHz	100 μ A/A		
	(>10 to 20) A (>1 to 5) kHz	160 μ A/A		
	(>10 to 20) A	250 μ A/A		

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
DC Current (Source & Measure) ^{1,3}	(0 to 1) nA	0.1 % reading + 160 fA	Monitored Multi-function Calibrator Agilent 3458A Standard Resistor
	(>1 to 10) nA	55 μ A/A + 1.1 pA	
	(>10 to 100) nA	1.5 μ A/A + 5.8 pA	
	>100 nA to 1 μ A	0.4 μ A/A + 24 pA	
	(>1 to 10) μ A	1.2 μ A/A + 62 pA	
	(>10 to 100) μ A	1 μ A/A + 570 pA	
	>100 μ A to 1 mA	1.1 μ A/A + 5.7 nA	
DC Current (Source & Measure) ^{1,3}	(>1 to 10) mA	1 μ A/A + 57 nA	Monitored Multi-function Calibrator Agilent 3458A Standard Resistor
	(>10 to 100) mA	1.1 μ A/A + 570 nA	
	>100 mA to 2 A	4.1 μ A/A + 5.5 μ A	
	(>2 to 10) A	22 μ A/A + 32 μ A	Transconductance Amplifier Agilent 3458A Standard Shunt
	(>10 to 20) A	49 μ A/A – 14 μ A	Power Supply Agilent 3458A Standard Shunt
	(>20 to 100) A	67 μ A/A – 370 μ A	
DC Current (Measure) ^{1,3}	(>100 to 1 000) A	-0.53 mA + 0.1 % of reading	Agilent 3458A Standard Shunt
	(>1 000 to 2 000) A	0.13 % of reading – 32 mA	Agilent 3458A Standard Shunt
DC Current (Simulated Source) ¹	(20 to 40) ADC	0.04 A + 0.39 % of reading	Transconductance Amplifier Current Coil
	(40 to 200) ADC	0.037 A + 0.48 % of reading	
	(200 to 1 000) ADC	0.31 A + 0.32 % of reading	

Electrical – Inductance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Inductance (Source)	100 μ H @ 1 kHz	0.08 % of nominal	General Radio 1482-B
	1 mH @ 1 kHz	0.02 % of nominal	General Radio 1482-E
	10 mH @ 100 Hz	0.07 % of nominal	General Radio 1482-H
	10 mH @ 1 kHz	0.02 % of nominal	
	100 mH @ 100 Hz	0.08 % of nominal	General Radio 1482-L
	100 mH @ 1 kHz	0.02 % of nominal	
	1 H @ 100 Hz	0.07 % of nominal	General Radio 1482-P
	1 H @ 1 kHz	0.02 % of nominal	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
	10 H @ 100 Hz	0.07 % of nominal	General Radio 1482-T
	10 H @ 1 kHz	0.02 % of nominal	
Inductance (Measure)	100 μ H @ 1 kHz	0.1 % of reading	General Radio 1689
	1 mH @ 1 kHz	0.03 % of reading	
	10 mH @ 100 Hz	0.09 % of reading	
	10 mH @ 1 kHz	0.03 % of reading	
Inductance (Measure)	100 mH to 100 H @ 1 kHz	0.09 % of reading	General Radio 1689
	100 mH @ 1 kHz	0.03 % of reading	
	1 H @ 100 Hz	0.08 % of reading	
	1 H @ 1 kHz	0.03 % of reading	
	10 H @ 100 Hz	0.09 % of reading	
	10 H @ 1 kHz	0.03 % of reading	

Electrical – Magnetic Properties

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Magnetometers / Flux Meters	(0 to 20) G	0.014 G + 1.2 % of reading	Gauss Meter With Transverse Probe Helmholtz Coil
	(20 to 200) G	0.19 G + 1.2 % of reading	
	(200 to 2 000) G	1.6 G + 0.82 % of reading	
	(2 000 to 20 000) G	19 G + 0.73 % of reading	

Electrical – Resistance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Resistance Fixed Point (Source) ¹	100 μ Ω	4.2 μ Ω / Ω	Otto Wolff 0.0001 Guildline 9975 Guildline 9923 1 Ω Standard
	1 m Ω	2.8 μ Ω / Ω	
	10 m Ω	2.2 μ Ω / Ω	
	100 m Ω	1.8 μ Ω / Ω	
	1 Ω	1.6 μ Ω / Ω	Guildline 9975 1 Ω Standard
	10 Ω	1.2 μ Ω / Ω	Guildline 9975 100 Ω Standard
	100 Ω	1.4 μ Ω / Ω	
	1 k Ω	1.2 μ Ω / Ω	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Resistance Fixed Point (Source) ¹	10 kΩ	1.7 μΩ/Ω	Guildline 9975 1 kΩ Standard
	100 kΩ	2.3 μΩ/Ω	Guildline 9975 10 kΩ Standard
	1 MΩ	3.3 μΩ/Ω	Guildline 9975 100 kΩ Standard
	10 MΩ	4.6 μΩ/Ω	Agilent 3458 1 MΩ Standard 1 MΩ per step Decade
	100 MΩ	19 μΩ/Ω	Agilent 3458 10 MΩ Standard 10 MΩ per step Decade
	1 GΩ	110 μΩ/Ω	1 GΩ Fixed Point Source Agilent 3458 100 MΩ Standard 100 MΩ per Step Decade
	10 GΩ	0.085 % of reading	Leeds Northrup 4232B 1 GΩ Standard 1 GΩ per Step Decade
	100 GΩ	0.21 % of reading	Wavetek 4800A Agilent 3458A 100 GΩ Standard 1 MΩ Standard
Resistance Ranges (Source) ¹	100 μΩ to 1 mΩ	70 μΩ/Ω	Guildline 9975A Leeds & Northrup 4300 1 Ω Fixed Point Resistor
	(1 to 10) mΩ	-0.002 μΩ + 5.6 μΩ/Ω	Guildline 9975A Leeds & Northrup 4300
	(10 to 100) mΩ	2.3 μΩ + 28 μΩ/Ω	ESI RS925D Leeds & Northrup 4222-B Agilent 3458A
	100 mΩ to 1 Ω	1.1 μΩ + 14 μΩ/Ω	ESI RS925D Leeds & Northrup 4020-B Agilent 3458A
	(1 to 10) Ω	9.9 μΩ + 2.3 μΩ/Ω	ESI RS925A Agilent 3458A 10 Ω Fixed Point
	(10 to 100) Ω	90 μΩ + 1.7 μΩ/Ω	ESI RS925A Agilent 3458A 100 Ω Fixed Point

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Resistance Ranges (Source) ¹	100 Ω to 1 kΩ	44 μΩ + 2.1 μΩ/Ω	ESI RS925A Agilent 3458A 1 kΩ Fixed Point
	(1 to 10) kΩ	350 μΩ + 2.5 μΩ/Ω	ESI RS925A Agilent 3458A 10 kΩ Fixed Point
	(10 to 100) kΩ	3 mΩ + 2.9 μΩ/Ω	ESI RS925A Agilent 3458A 100 kΩ Fixed Point
	100 kΩ to 1 MΩ	140 mΩ + 3.9 μΩ/Ω	ESI RS925A Agilent 3458A 1MΩ Fixed Point
	(1 to 10) MΩ	6.8 Ω + 7 μΩ/Ω	Agilent 3458A PPM-R3-1111
	(10 to 100) MΩ	250 Ω + 59 μΩ/Ω	1 MΩ Fixed Point
	100 MΩ to 1 GΩ	-0.014 Ω + 290 μΩ/Ω	PPM-R3-1111 Leeds & Northrup 4232B
Resistance Fixed Point (Measure) ¹	100 μΩ	4.2 μΩ/Ω	Otto Wolff 0.0001 Guildline 9975 Guildline 9923 1 Ω Standard
	1 mΩ	2.8 μΩ/Ω	
	10 mΩ	2.2 μΩ/Ω	
	100 mΩ	1.8 μΩ/Ω	
	1 Ω	1.6 μΩ/Ω	Guildline 9975 1 Ω Standard
	10 Ω	1.2 μΩ/Ω	Guildline 9975 100 Ω Standard
	100 Ω	1.4 μΩ/Ω	
	1 kΩ	1.2 μΩ/Ω	
	10 kΩ	1.7 μΩ/Ω	Guildline 9975 1 kΩ Standard
	100 kΩ	2.3 μΩ/Ω	Guildline 9975 10 kΩ Standard
	1 MΩ	3.3 μΩ/Ω	Guildline 9975 100 kΩ Standard
	10 MΩ	7.5 μΩ/Ω	Agilent 3458A 10 MΩ Fixed Point Reference
	100 MΩ	61 μΩ/Ω	Agilent 3458A 100 MΩ Fixed Point Reference Decade
1 GΩ	390 μΩ/Ω	Agilent 3458A 1 GΩ Fixed Point Reference Decade	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Resistance Fixed Point (Measure) ¹	10 GΩ	0.1 % of reading	Certified Leeds Northrup 4232B 10 GΩ Fixed Point Reference
	100 GΩ	0.21 % of reading	Wavetek 4800A Agilent 3458A 100 GΩ Standard 1 MΩ Standard
Resistance Ranges (Measure) ¹	(50 to 100) μΩ	0.006 μΩ – 60.4 μΩ/Ω	Guildline 9975/9923
	100 μΩ to 1 mΩ	6.3 μΩ/Ω	
	(50 to 100) μΩ	0.006 μΩ – 60.4 μΩ/Ω	Guildline 9975/9923
	100 μΩ to 1 mΩ	6.3 μΩ/Ω	
	(1 to 10) mΩ	-0.002 μΩ + 5.6 μΩ/Ω	Guildline 9975A Leeds & Northrup 4300
	(10 to 100) mΩ	0.029 μΩ + 5.8 μΩ/Ω	Guildline 9975/9923
	100 mΩ to 1 Ω	1.1 μΩ + 14 μΩ/Ω	Agilent 3458A 1 Ω Fixed Point
	(1 to 10) Ω	9.9 μΩ + 2.3 μΩ/Ω	Agilent 3458A 10 Ω Fixed Point
	(10 to 100) Ω	90 μΩ + 1.7 μΩ/Ω	ESI RS925D Agilent 3458A 100 Ω Fixed Point
	100 Ω to 1 kΩ	44 μΩ + 2.1 μΩ/Ω	ESI RS925D Agilent 3458A 1 kΩ Fixed Point
	(1 to 10) kΩ	350 μΩ + 2.5 μΩ/Ω	ESI RS925D Agilent 3458A 10 kΩ Fixed Point
	(10 to 100) kΩ	3 mΩ + 2.9 μΩ/Ω	ESI RS925D Agilent 3458A 10 kΩ Fixed Point
	100 kΩ to 1 MΩ	140 mΩ + 3.9 μΩ/Ω	ESI RS925D Agilent 3458A 1 MΩ Fixed Point
	(1 to 10) MΩ	6.8 Ω + 7.0 μΩ/Ω	PPM R3-1111 Agilent 3458A 10 MΩ Fixed Point
(10 to 100) MΩ	250 Ω + 59 μΩ/Ω	PPM R3-1111 Agilent 3458A 10 MΩ Fixed Point	
100 MΩ to 1 GΩ	-0.014 Ω + 290 μΩ/Ω	PPM R3-1111 Leeds & Northrup 4232B	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Electrical Calibration of RTD Indicators ¹	(-200 to 0) °C	0.01 °C	Resistance Decade RTD Tables
	(0 to 130) °C	0.02 °C	
	(130 to 600) °C	0.12 °C	
	(600 to 849) °C	0.16 °C	

Electrical – RF Power

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
RF Power (Source)	1 mW @ 50 MHz	0.024 mW	HP437A
RF Power (Measure)	1 mW @ 50 MHz	0.019 mW	HP 432A Agilent 478A
RF Power (Absolute, Measure)	0.1 nW to 10 μW (10 to 30) MHz	0.0000033 μW + 0.035 μW/μW	Agilent 437A Agilent 8484A
	0.1 nW to 10 μW (30 to 50) MHz	0.0000035 μW + 0.032 μW/μW	
	0.1 nW to 10 μW 50 MHz to 2 GHz	0.0000035 μw + 0.032 μW/μW	
	0.1 nW to 10 μW (2 to 12.4) GHz	0.0000034 μw + 0.032 μW/μW	
	0.1 nW to 10 μW (12.4 to 18) GHz	0.0000033 μW + 0.034 μW/μW	
RF Power (Absolute, Measure)	1 μW to 100 mW 100 kHz to 1 MHz	0.000037 mW + 0.037 mW/mW	Agilent 437A Agilent 8482A
	1 μW to 100 mW (1 to 50) MHz	0.00004 mW + 0.031 mW/mW	
	1 μW to 100 mW 50 MHz to 2 GHz	0.0004 mW + 0.031 mW/mW	
	1 μW to 100 mW (2 to 4.2) GHz	0.00004 mW + 0.032 mW/mW	
	(1 to 10) μW (4 to 10) GHz	0.072 μW + 0.028 μW/μW	HP 432A HP 478A
	(10 to 30) μW (4 to 10) GHz	0.15 μW + 0.03 μW/μW	
	(30 to 100) μW (4 to 10) GHz	0.47 μW + 0.03 μW/μW	
	(100 to 300) μW (4 to 10) GHz	1.5 μW + 0.03 μW/μW	
	(0.3 to 1) mW (4 to 10) GHz	0.0047 mW + 0.03 mW/mW	
	(1 to 3) mW (4 to 10) GHz	0.015 mW + 0.03 mW/mW	Agilent 437A Agilent 8484A
	(3 to 10) Mw (4 to 10) GHz	0.044 mW + 0.03 mW/mW	
	0.1 nW to 10 μW 10 MHz to 18 GHz	0.0000052 μW + 0.0069 μW/μW	
	1 μW to 100 mW 100 kHz to 4.2 GHz	0.000053 mW + 0.012 mW/mW	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage (Source) ¹	1 mV 50 Hz to 1 kHz	0.25 % of reading	Ratio Transformer
	10 mV 50 Hz to 1 kHz	120 μ V/V	
	100 mV 50 Hz to 1 kHz	46 μ V/V	
	100 mV 1 kHz to 20 kHz	0.035 % of reading	Fluke 5200A
	100 mV 20 kHz to 100 kHz	0.081 % of reading	
	(0.25 V to 0.5) V 10 Hz	150 μ V/V	Wavetek 4800A Holt 6A Thermal Transfer Standard
	(0.25 to 0.5) V 20 Hz	70 μ V/V	
	(0.25 to 0.5) V 50 Hz to 50 kHz	65 μ V/V	
	(0.25 to 0.5) V 50 kHz to 100 kHz	70 μ V/V	
	(0.25 to 0.5) V 100 kHz to 500 kHz	225 μ V/V	
	(0.25 to 0.5) V 500 kHz to 1 MHz	750 μ V/V	
	(>0.5 to 1) V 10 Hz	135 μ V/V	
	(>0.5 to 1) V 20 Hz	65 μ V/V	
	(>0.5 to 1) V 50 Hz to 1 kHz	55 μ V/V	
	(>0.5 to 1) V 1 kHz to 10 kHz	45 μ V/V	
	(>0.5 to 1) V 10 kHz to 50 kHz	40 μ V/V	
	(>0.5 to 1) V 50 kHz to 100 kHz	50 μ V/V	
	(>0.5 to 1) V 100 kHz to 500 kHz	150 μ V/V	
	(>0.5 to 1) V 500 kHz to 1 MHz	625 μ V/V	
	(>1 to 10) V 10 Hz	125 μ V/V	
	(>1 to 10) V 20 Hz	50 μ V/V	
(>1 to 10) V 50 Hz to 20 kHz	30 μ V/V		
(>1 to 10) V 20 kHz to 50 kHz	40 μ V/V		
(>1 to 10) V 50 kHz to 100 kHz	50 μ V/V		

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage (Source) ¹	(>1 to 10) V 100 kHz to 500 kHz	150 μ V/V	Wavetek 4800A Holt 6A Thermal Transfer Standard
	(>1 to 10) V 500 kHz to 1 MHz	625 μ V/V	
	(>10 to 50) V 10 Hz	125 μ V/V	
	(>10 to 50) V 20 Hz	50 μ V/V	
	(>10 to 50) V 50 Hz to 20 kHz	30 μ V/V	
	(>10 to 50) V 20 Hz to 50 kHz	40 μ V/V	
	(>10 to 50) V 50 Hz to 100 kHz	50 μ V/V	
	(>10 to 50) V 100 Hz to 200 kHz	150 μ V/V	
	(>50 to 100) V 10 Hz	125 μ V/V	
	(>50 to 100) V 20 Hz	50 μ V/V	
	(>50 to 100) V 50 Hz to 20 kHz	30 μ V/V	
	(>50 to 100) V 20 kHz to 50 kHz	40 μ V/V	
	(>50 to 100) V 50 kHz to 100 kHz	50 μ V/V	
	(>100 to 150) V 10 Hz	125 μ V/V	
	(>100 to 150) V 20 Hz	50 μ V/V	
	(>100 to 150) V 50 Hz to 1 kHz	30 μ V/V	
	(>100 to 150) V 1 kHz to 10 kHz	40 μ V/V	
	(>100 to 150) V 10 kHz to 20 kHz	50 μ V/V	
	(>100 to 150) V 20 kHz to 50 kHz	65 μ V/V	
	(>100 to 150) V 50 kHz to 100 kHz	100 μ V/V	
	(>150 to 300) V 10 Hz	125 μ V/V	
	(>150 to 300) V 20 Hz	50 μ V/V	
	(>150 to 300) V 50 Hz to 1 kHz	30 μ V/V	
(>150 to 300) V 1 kHz to 10 kHz	40 μ V/V		
(>150 to 300) V 10 kHz to 20 kHz	50 μ V/V		

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage (Source) ¹	(>150 to 300) V 20 kHz to 50 kHz	65 μ V/V	Wavetek 4800A Holt 6A Thermal Transfer Standard
	(>300 to 500) V 10 Hz	125 μ V/V	
	(>300 to 500) V 20 Hz	50 μ V/V	
	(>300 to 500) V 50 Hz to 1 kHz	35 μ V/V	
	(>300 to 500) V 1 kHz to 10 kHz	60 μ V/V	
	(>300 to 500) V 10 kHz to 20 kHz	90 μ V/V	
	(>300 to 500) V 20 kHz to 50 kHz	110 μ V/V	
	(>500 to 1 200) V 10 Hz	125 μ V/V	
	(>500 to 1 200) V 20 Hz	50 μ V/V	
	(>500 to 1 200) V 50 Hz to 1 kHz	40 μ V/V	
	(>500 to 1 200) V 1 kHz to 10 kHz	60 μ V/V	
	(>500 to 1 200) V 10 kHz to 20 kHz	120 μ V/V	
	(>500 to 1 200) V 20 kHz to 50 kHz	145 μ V/V	
AC Voltage (Measure) ¹	1 mV 50 Hz to 1 kHz	0.26 % of reading	Ratio Transformer
	10 mV 50 Hz to 1 kHz	120 μ V/V	
	100 mV 50 Hz to 1 kHz	49 μ V/V	
	100 mV 1 kHz to 20 kHz	0.36 % of reading	Fluke 8506A
	100 mV 20 kHz to 50 kHz	0.07 % of reading	
	100 mV 50 kHz to 100 kHz	0.23 % of reading	
	0.25 V to 0.5 V 10 Hz	150 μ V/V	
	0.25 V to 0.5 V 20 Hz	70 μ V/V	Holt 6A Thermal Transfer Standard
	(0.25 to 0.5) V 50 Hz to 50 kHz	65 μ V/V	
	(0.25 to 0.5) V 50 kHz to 100 kHz	70 μ V/V	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage (Measure) ¹	(0.25 to 0.5) V 100 kHz to 500 kHz	225 μ V/V	Holt 6A Thermal Transfer Standard
	(0.25 to 0.5) V 500 kHz to 1 MHz	750 μ V/V	
	(>0.5 to 1) V 10 Hz	135 μ V/V	
	(>0.5 to 1) V 20 Hz	65 μ V/V	
	(>0.5 to 1) V 50 Hz to 1 kHz	55 μ V/V	
	(>0.5 to 1) V 1 kHz to 10 kHz	45 μ V/V	
	(>0.5 to 1) V 10 kHz to 50 kHz	40 μ V/V	
	(>0.5 to 1) V 50 kHz to 100 kHz	50 μ V/V	
	(>0.5 to 1) V 100 kHz to 500 kHz	150 μ V/V	
	(>0.5 to 1) V 500 kHz to 1 MHz	625 μ V/V	
	(>1 to 10) V 10 Hz	125 μ V/V	
	(>1 to 10) V 20 Hz	50 μ V/V	
	(>1 to 10) V 50 Hz to 20 kHz	30 μ V/V	
	(>1 to 10) V 20 kHz to 50 kHz	40 μ V/V	
	(>1 to 10) V 50 kHz to 100 kHz	50 μ V/V	
	(>1 to 10) V 100 kHz to 500 kHz	150 μ V/V	
	(>1 to 10) V 500 kHz to 1 MHz	625 μ V/V	
	(>10 to 50) V 10 Hz	125 μ V/V	
	(>10 to 50) V 20 Hz	50 μ V/V	
	(>10 to 50) V 50 Hz to 20 kHz	30 μ V/V	
	(>10 to 50) V 20 Hz to 50 kHz	40 μ V/V	
(>10 to 50) V 50 Hz to 100 kHz	50 μ V/V		

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage (Measure) ¹	(>10 to 50) V 100 Hz to 200 kHz	150 μ V/V	Holt 6A Thermal Transfer Standard
	(>50 to 100) V 10 Hz	125 μ V/V	
	(>50 to 100) V 20 Hz	50 μ V/V	
	(>50 to 100) V 50 Hz to 20 kHz	30 μ V/V	
	(>50 to 100) V 20 kHz to 50 kHz	40 μ V/V	
	(>50 to 100) V 50 kHz to 100 kHz	50 μ V/V	
	(>100 to 150) V 10 Hz	125 μ V/V	
	(>100 to 150) V 20 Hz	50 μ V/V	
	(>100 to 150) V 50 Hz to 1 kHz	30 μ V/V	
	(>100 to 150) V 1 kHz to 10 kHz	40 μ V/V	
	(>100 to 150) V 10 kHz to 20 kHz	50 μ V/V	
	(>100 to 150) V 20 kHz to 50 kHz	65 μ V/V	
	(>100 to 150) V 50 kHz to 100 kHz	100 μ V/V	
	(>150 to 300) V 10 Hz	125 μ V/V	
	(>150 to 300) V 20 Hz	50 μ V/V	
	(>150 to 300) V 50 Hz to 1 kHz	30 μ V/V	
	(>150 to 300) V 1 kHz to 10 kHz	40 μ V/V	
	(>150 to 300) V 10 kHz to 20 kHz	50 μ V/V	
	(>150 to 300) V 20 kHz to 50 kHz	65 μ V/V	
	(>300 to 500) V 10 Hz	125 μ V/V	
	(>300 to 500) V 20 Hz	50 μ V/V	
(>300 to 500) V 50 Hz to 1 kHz	35 μ V/V		

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage (Measure) ¹	(>300 to 500) V 1 kHz to 10 kHz	60 μ V/V	Holt 6A Thermal Transfer Standard
	(>300 to 500) V 10 kHz to 20 kHz	90 μ V/V	
	(>300 to 500) V 20 kHz to 50 kHz	110 μ V/V	
	(>500 to 1 200) V 10 Hz to 50 kHz	125 μ V/V	
	(>500 to 1 200) V 20 Hz	50 μ V/V	
	(>500 to 1 200) V 50 Hz to 1 kHz	40 μ V/V	
	(>500 to 1 200) V 1 kHz to 10 kHz	60 μ V/V	
	(>500 to 1 200) V 10 kHz to 20 kHz	0.12 mV/V	
	(>500 to 1 200) V 20 kHz to 50 kHz	0.15 mV/V	
AC High Voltage (Source)	(>1 to 5) kV	-0.11 V + 5 V/kV	AR 3605 Ohm-Labs KV-30A Agilent 34411A
AC High Voltage (Measure)	(>1 to 5) kV	-0.11V + 5 V/kV	AR 3605 Ohm-Labs KV-30A Agilent 34411A
	(>5 to 10) kV	1.1 V + 4.7 V/kV	Ohm-Labs KV-30A Agilent 34411A
	(>10 to 20) kV	0.021 kV + 0.004 2 kV/kV	Ohm-Labs KV-30A Agilent 34411A
	(>20 to 60) kV	0.018 kV + 0.006 7 kV/kV	Hipotronics KVM 200 Agilent 34411A Hipotronics KVM-200
DC Voltage Fixed Point (Source)	10 mV	19 μ V/V	Fluke 732A & 752A
	100 mV	2.6 μ V/V	
	1 V	1.1 μ V/V	
	10 V	1.0 μ V/V	Fluke 732A & 752A
	100 V	1.1 μ V/V	
	1 000 V	1.4 μ V/V	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
DC Voltage Ranges (Source) ¹	(0 to 10) μ V	9.7 nV + 460 μ V/V	Keithley 262 Wavetek 4800A Agilent 3458 1 V Fixed Point
	(10 to 100) μ V	3.7 nV + 130 μ V/V	
	(100 to 1 000) μ V	29 nV + 85 μ V/V	
	(1 to 10) mV	6 nV + 20 μ V/V	Keithley 262 Wavetek 4800A Agilent 3458 Keithley 182 10 mV Fixed Point
	(10 to 100) mV	0.18 μ V + 0.34 μ V/V	Wavetek 4800A Fluke 752A Agilent 3458 1 V Fixed Point 10 V Fixed Point
	(100 to 1 000) mV	0.14 μ V + 0.92 μ V/V	
	(1 to 10) V	0.38 μ V + 0.99 μ V/V	Wavetek 4800A Agilent 3458 1 V Fixed Point 10 V Fixed Point
	(10 to 100) V	1.0 μ V + 1.1 μ V/V	Wavetek 4800A Agilent 3458 1 V Fixed Point 10 V Fixed Point Fluke 752A
	(100 to 1 000) V	-13 μ V + 1.4 μ V/V	
DC High Voltage (Source)	(>1 to 5) kV	-0.037 V + 0.62 V/kV	Extech 7021 Ohm-Labs KV-30A Agilent 34411A
	(>5 to 10) kV	-3.3 V + 1.3 V/kV	AN/GSM-6B Ohm-Labs KV-30A Agilent 34411A
	(>10 to 30) kV	-9.4 V + 1.5 V/kV	AN/GSM-6B Ohm-Labs KV-30A Agilent 34411A
	(>30 to 50) kV	0.034 kV + 0.0055 kV/kV	AN/GSM-6B Hipotronics KVM-200
	(>50 to 70) kV	-0.03 kV + 0.0068 kV/kV	Agilent 34411A 1 M Ω Shunt
DC Voltage Fixed Point (Measure)	100 mV	2.6 μ V/V	Fluke 732A & 752A
	1 V	1.1 μ V/V	
	10 V	1.0 μ V/V	
	100 V	1.1 μ V/V	
	1 000 V	1.4 μ V/V	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
DC Voltage Ranges (Measure) ¹	(1 to 10) mV	0.18 μ V + 9.1 μ V/V	Keithley 182 10 mV Fixed Point
	(10 to 100) mV	0.18 μ V + 0.34 μ V/V	Agilent 3458A 100 mV Fixed Point
	(100 to 1 000) mV	0.14 μ V + 0.92 μ V/V	Wavetek 4800A Agilent 3458 1 V Fixed Point 10 V Fixed Point Fluke 752A
	(1 to 10) V	0.38 μ V + 0.99 μ V/V	Wavetek 4800A Agilent 3458 1 V Fixed Point 10 V Fixed Point
	(10 to 100) V	1.0 μ V + 1.1 μ V/V	Wavetek 4800A Agilent 3458 1 V Fixed Point 10 V Fixed Point Fluke 752A
	(100 to 1 000) V	-13 μ V + 1.4 μ V/V	Wavetek 4800A Agilent 3458 1 V Fixed Point 10 V Fixed Point Fluke 752A
DC High Voltage (Measure)	(>1 to 5) kV	-0.037V + 0.62 V/kV	Extech 7021 Ohm-Labs KV-30A
	(>5 to 10) kV	-3.3V + 1.3V/kV	AN/GSM-6B Ohm-Labs KV-30A
	(>10 to 30) kV	-9.4 V + 1.5 V/kV	AN/GSM-6B Ohm-Labs KV-30A
	(>30 to 50) kV	0.34 kV + 0.0055 kV/kV	AN/GSM-6B Hipotronics KVM-200
	(>50 to 100) kV	-0.049 kV + 0.007 2 kV/kV	Agilent 34411A 1 M Ω Shunt
DC Ratio (Source)	(0 to 0.1) ratio	0.28 μ V/V + (0.22 μ V/V of input X ratio)	Fluke 720A Kelvin Varley Divider
	(0.1 to 1) ratio	0.6 μ V/V of input ratio	
Thermocouple Simulation Type B	(250 to 350) °C	1.1 °C	Ectron 1140A
	(350 to 445) °C	0.86 °C	
	(445 to 580) °C	0.68 °C	
	(580 to 750) °C	0.54 °C	
	(750 to 1 000) °C	0.45 °C	
	(1 000 to 1 820) °C	0.36 °C	
Type E	(-270 to -245) °C	1.4 °C	Ectron 1140A
	(-245 to -195) °C	0.21 °C	
	(-195 to -155) °C	0.12 °C	
	(-155 to -90) °C	0.097 °C	
	(-90 to 15) °C	0.086 °C	
	(15 to 890) °C	0.072 °C	
	(890 to 1 000) °C	0.086 °C	

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Type J	(-210 to -180) °C (-180 to -120) °C (-120 to -50) °C (-50 to 1 200) °C	0.14 °C 0.12 °C 0.098 °C 0.087 °C	Ectron 1140A
Type K	(-270 to -255) °C (-255 to -195) °C (-195 to -115) °C (-115 to -55) °C (-55 to 1 000) °C (1 000 to 1 372) °C	2.5 °C 0.81 °C 0.14 °C 0.11 °C 0.089 °C 0.1 °C	
Type N	(-270 to -260) °C (-260 to -200) °C (-200 to -140) °C (-140 to -70) °C (-70 to 25) °C (25 to 160) °C (160 to 1 300) °C	5.8 °C 1.2 °C 0.27 °C 0.18 °C 0.14 °C 0.12 °C 0.11 °C	
Type R	(-50 to -30) °C (-30 to 45) °C (45 to 160) °C (160 to 380) °C (380 to 775) °C (775 to 1 768) °C	0.78 °C 0.67 °C 0.52 °C 0.41 °C 0.38 °C 0.34 °C	
Type S	(-50 to -30) °C (-30 to 0) °C (0 to 250) °C (250 to 1 000) °C (1 000 to 1 400) °C (1 400 to 1 768) °C	0.75 °C 0.68 °C 0.51 °C 0.44 °C 0.4 °C 0.37 °C	
Type T	(-270 to -255) °C (-255 to -240) °C (-240 to -210) °C (-210 to -150) °C (-150 to -40) °C (-40 to 100) °C (100 to 400) °C	2.1 °C 0.57 °C 0.35 °C 0.21 °C 0.14 °C 0.1 °C 0.089 °C	

Length – Artifacts and Standards 1D

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Cylindrical Pins, Plugs & Thread Wires	(0.127 to 101.6) mm (0.005 to 4.0) in	(0.94 + 0.01 <i>l</i>) μm (37 + 10 <i>L</i>) μin	ULM Grade 0 Gage Blocks
End Measuring Rods (Micrometer Standards)	(25.4 to 609.6) mm (1 to 24) in	(0.86 + 0.0016 <i>l</i>) μm (34 + 1.6 <i>L</i>) μin	Master Blocks Test Indicator
Thickness Gages	(0.0254 to 1.27) mm (0.001 to 0.05) in	0.54 μm 21 μin	ULM

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Steel Rules	Up to 1219.2 mm (Up to 48) in	(0.19 + 0.00017 <i>l</i>) mm 0.007 5 in – 1.8 in/in	Steel Rule
Gage Blocks	(0.203 to 1.27) mm (0.008 to 0.05) in	(0.099 + 0.000063 <i>l</i>) μm (3.9 + 0.063 <i>L</i>) μin	Comparator Grade 0 Blocks
	(1.27 to 101.6) mm (0.05 to 4.0) in	(0.11 + 0.002 <i>l</i>) μm (4.2 + 1.952 <i>L</i>) μin	
Plain Ring Gages	(101.6 to 500) mm (4 to 20) in	(0.97 + 0.0026 <i>l</i>) μm (3.8 + 2.5 <i>L</i>) μin	Comparator Master Blocks
	Up to 50.8 mm (Up to 2) in	(0.55 + 0.00037 <i>l</i>) μm (22 + 0.37 <i>L</i>) μin	ULM Master Ring
	(50.8 to 101.6) mm (2 to 4) in	(0.73 + 0.00065 <i>l</i>) μm (29 + 0.65 <i>L</i>) μin	
	(101.6 to 203.2) mm (4 to 8) in	(0.68 + 0.0011 <i>l</i>) μm (27 + 1.1 <i>L</i>) μin	
	(203.2 to 254) mm (8 to 10) in	(0.42 + 0.0023 <i>l</i>) μm (17 + 2.3 <i>L</i>) μin	

Length – Artifacts and Standards 2D

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Radius Gages ⁸	(0.39624 to 25.4) mm (0.0156 to 1) in	0.05 mm 2 mil	Measuring Microscope Master Radius Gages

Length – Hand Tools and Precision Gages 1D

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Calipers & Linear Scales ¹	(0 to 304.8) mm (0 to 12) in	(12 + 0.00092 <i>l</i>) μm (480 + 0.92 <i>L</i>) μin	Gage Block
	(304.8 to 1 524) mm (12 to 60) in	(15 + 0.0014 <i>l</i>) μm (590 + 1.4 <i>L</i>) μin	
Tape Measures	Up to 30.48 m (Up to 100) ft	(0.031 + 0.00023 <i>l</i>) mm (0.0012 + 0.00023 <i>L</i>) in	Steel Rule
		(0.4 + 0.000 006 6 <i>l</i>) mm (0.016 + 0.000 006 6 <i>L</i>) in	50' Tape
Height Gages	(0 to 610) mm (0 to 24) in	(23 + 0.01 <i>l</i>) μm (910 + 10 <i>L</i>) μin	Gage Block Surface Plate
Height Master & Riser Block	(0 to 304.8) mm (0 to 12) in	(7.1 + 0.01 <i>l</i>) μm (280 + 13 <i>L</i>) μin	Gage Block
Indicators, Digital, Dial & Test ¹	(0 to 101.6) mm (0 to 4) in	(2 + 0.0043 <i>l</i>) μm (79 + 4.3 <i>L</i>) μin	Gage Block

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Micrometers ¹ , Inside, Outside, Depth, Bore Gages	(2.54 to 101.6) mm (0.010 to 4) in	(1.4 + 0.0024 <i>l</i>) μm (57 + 2.5 <i>L</i>) μin	Gage Block
	(101.6 to 508) mm (4 to 24) in	(2.8 + 0.0037 <i>l</i>) μm (110 + 3.7 <i>L</i>) μin	

Length – Hand Tools and Precision Gages 2D

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Bubble Levels Level Vial Setting Vial Sensitivity	(50 to 609.6) mm (1.96 to 24) in	4.1 s Vial Setting 3.9 s Vial Sensitivity	Gage Block Surface Plate
Digital Protractors & Inclinometers	(0 to 60) °	0.002 °	Gage Block Surface Plate Sine Bar
	90 °	0.036 °	Surface Plate Cylindrical Square
Measuring Microscopes ¹ Linear Scale	(0 to 101.6) mm (0 to 4 in)	5.1 μm 200 μin	Gage Blocks
Angle	(0 to 90) °	2.6 min	Angle Blocks
Profilometers ¹ & Surface Roughness Testers ¹	16 Ra 119 Ra	4.1 μin	Roughness Standard
Optical Comparators ¹ Linear Scale	(0 to 254) mm (0 to 10) in	4.1 μm 160 μin	Linear Scale
Angular Scales	90 °	36 s	Angle Block

Mass – Flow

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Air Speed Velocity (Anemometers, Pitot Tubes)	(1.5 to 30) m/s	0.009 m/s + 1.1 % of reading	Pitot Tube Manometer
Air Flow	(10 to 375) SCFM	0.082 CFM + 0.44 % of reading	Coriolis Flow Meter
Gas Flow ¹ (Mass & Volume Flow Meters)	(30 to 400) SLPM	0.2 SLPM + 0.27 % of reading	Bell Prover
	(0.1 to 35) SLPM	0.002 SLPM + 0.13 % of reading	Piston Prover
	(0 to 100) SCCM	0.42 SCCM + 0.98 % of reading	
Gas Flow (Balometers, Volume Flow Meters)	(200 to 2 000) SCFM	1.4 SCFM + 0.9 % of reading	Laminar Flow Element

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Liquid Flow ¹	(1 to 151) SLPM	0.0024 SLPM+ 0.22 % of reading	Coriolis Flowmeter
	(0.1 to 60) lph	0.004 1 lph + 0.36 % of reading	Time, Weight, Density Correction Applied
	(1 to 190) SLPM	0.0014 SLPM + 0.62 % of reading	Turbine Flowmeter

Mass – Force

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Force - Compression	(9.8 to 4 452) mN (1 to 454) grf	0.018 mN + 0.018 % of reading 0.0019 g + 0.018 % of reading	Dead Weight
	(4.44 to 4 440) N (1 to 1 000) lbf	0.0082 N + 0.016 % of reading 0.0018 lbf + 0.016 % of reading	
Force - Compression	(0.91 to 44.48) kN (204 to 10 000) lbf	9.4 N + 0.035 % of reading 2.1 lbf + 0.035 % of reading	10 000 lb 1000 Series Digital Proving Ring
	(2 to 89) kN (460 to 20 000) lbf	15 N + 0.013 % of reading 3.4 lbf + 0.013 % of reading	20 000 lb 1000 Series Digital Proving Ring
	(14.6 to 445) kN (3 284 to 100 000) lbf	69 N + 0.0 02 % of reading 16 lbf + 0.0 02 % of reading	100 000 lb 1000 Series Digital Proving Ring
Force - Tension	(9.8 to 4 452) mN (1 to 454) grf	0.018 mN + 0.018 % of reading 0.0019 g + 0.018 % of reading	Dead Weight
	(4.44 to 4 440) N (1 to 1 000) lbf	0.0075 N + 0.02 % of reading 0.0017 lbf + 0.02 % of reading	
	(0.91 to 44.48) kN (204 to 10 000) lbf	9.4 N + 0.035 % of reading 2.1 lbf + 0.035 % of reading	10 000 lb 1000 Series Digital Proving Ring
	(2 to 89) kN (460 to 20 000) lbf	110 N + 0.0024 % of reading 24 lbf + 0.0024 % of reading	20 000 lb 1000 Series Digital Proving Ring
	(14.6 to 445) kN (3 284 to 100 000) lbf	26 N + 0.1 1 % of reading 5.9 lbf + 0.1 1 % of reading	100 000 lb 1000 Series Digital Proving Ring

Mass – Mass Artifacts

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Weights	200 g to 15 kg	9.4 mg + 0.61 %	Mettler KA10-3 Class 3 Weights
	(10 to 50) kg	0.92 mg + 0.00074 %	Mettler KA50-2/P Class 3 Weights
	(0 to 3) g	5.6 µg + 0.44 %	Mettler M3 Balance Class 3 Weights
	(0 to 210) g	0.053 mg + 0.00047 %	Sartorius ME215S Balance Class 3 Weights
	(0 to 5 000) g	4.0 mg + 0.20 %	Voland Scale Class 3 Weights

Mass – Medium/High Vacuum

Calibration Parameter/Equipment ¹	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Vacuum	(0.001 to 10) torr	0.02 torr	Capacitance Manometer High Vacuum Pump Diffusion Pump

Mass – Pressure and Low Vacuum

Calibration Parameter/Equipment ¹	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Pressure-Pneumatic Gage and Absolute Gage Only	(18 to 1 000) psia	0.0023 % of reading	Ruska 2465 or Transducers ¹
	(124 to 6 895) kPa		
	(0.2 to 18.2) psia	0.0031 % of reading	
	(1.37 to 124.1) kPa		
Pressure, Hydraulic Gage	(1 000 to 15 000) psi	0.0067 % of reading	Ruska 2485 or Portable Dead Weight Tester ¹
	(6.894 to 103.42) MPa		
Manometers	(0 to 20) inH ₂ O	0.003 inH ₂ O	Meriam Micromanometer
	(0 to 2) inH ₂ O	0.0014 inH ₂ O	Dwyer Microtector

Mass – Scale and Balances

Calibration Parameter/Equipment ¹	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Precision Balances (Resolution 0.1 mg)	(0 to 205) g	0.35 mg	Standard Mass
Analytical Balances (Resolution 1 mg)	(0 to 500) g	0.8 mg	Standard Mass
	(Resolution 10 mg)	(0 to 3 200) g	

Calibration Parameter/Equipment ¹	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Bench Scales (Resolution 0.1 g)	(0 to 32) kg	69 mg	Standard Mass
Floor Scales (Resolution 22 g)	(0 to 907) kg	0.1 kg	Standard Mass

Mass – Torque

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Torque Analyzers	(0.1 to 2 712) N·m (0.1 to 2 000) lbf·ft	0.04 % of reading	Torque Arm Weights
Torque Wrenches ¹	(0.05 to 5.6) N·m (0.5 to 50) lbf·in	(0.0018 + 0.0027 <i>T</i>) N·m (0.016 + 0.0027 <i>T</i>) lbf·in	Torque Calibrator
	(5.6 to 22.6) N·m (50 to 200) lbf·in	(0.005 + 0.0027 <i>T</i>) N·m (0.044 + 0.0027 <i>T</i>) lbf·in	
	(20.3 to 135.6) N·m (15 to 100) lbf·ft	(0.025 + 0.0028 <i>T</i>) N·m (0.018 + 0.0028 <i>T</i>) lbf·ft	
	(135.6 to 2 711.6) N·m (100 to 2000) lbf·ft	(0.21 + 0.0028 <i>T</i>) N·m (0.15 + 0.0028 <i>T</i>) lbf·ft	
Torque Watches ¹	(2 to 17) N·m (0.5 to 2.5) ozf·in	0.42 N·m (0.059 ozf·in)	Torque Watch Calibrator
	(8 to 70) N·m (2 to 10) ozf·in	0.64 N·m (0.091 ozf·in)	
Torque Watches ¹	(42 to 303) N·m (6 to 43) ozf·in	1.6 N·m (0.22 ozf·in)	Torque Watch Calibrator
	(211 to 1 518) N·m (30 to 215) ozf·in	6.8 N·m (0.96 ozf·in)	

Mass – Viscosity

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Viscometers	< 10 cP	0.3 % of reading	Viscosity Standard Thermometer Water Bath
	(10 to 100) cP	0.46 % of reading	
	(100 to 1 000) cP	0.5 % of reading	
	(1 000 to 10 000) cP	0.68 % of reading	
	(10 000 to 100 000) cP	0.71 % of reading	
Viscosity Cups	< 10 cSt	0.98 % of reading	Viscosity Standard Thermometer Water Bath Stop Watch
	(10 to 100) cSt	1.7 % of reading	
	(100 to 1 000) cSt	1.7 % of reading	

Photometry and Radiometry – Spectrally-Integrated Measurements for Sources and Detectors

Calibration Parameter/Equipment	Range ⁶	Expanded Uncertainty of Measurement (+/-)	Remarks
Illuminance responsivity (Illuminant A – CIE) White Light Meters	(0.5 to 2 000) fc (5 to 21 527) lx	2.1 % of reading	Radiometer & White Light Detector
	(100 to 50 000) fl	2.3 % of reading	
Spectral Irradiance UV-A (315 to 400) nm Black Light Meters	(100 to 20 000) $\mu\text{W}/\text{cm}^2$	6.8 % of reading	Radiometer & Black Light Detector

Thermodynamics – Humidity

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Humidity (Source)	(10 to 95) % RH	0.59 % RH + 0.058 % of reading	Thunder 2500
Humidity (Measure and Source) ¹	(10 to 95) % RH	1.4 % RH	Vaisala HMP37E General Eastern C1

Thermodynamics – Infrared Temperature

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Infrared Pyrometers	(35 to 500) °C (95 to 932) °F	0.31 °C + 0.0043 °C / °C 0.56 °F + 0.0078 °F / °F	Fluke 4181

Thermodynamics – Thermodynamic Sources

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Temperature Uniformity ¹	(-90 to 1 000) °C (-130 to 1 832) °F	1.2 °C + 0.059 % of reading 2.2 °F + 0.059 % of reading	Datalogger w/ External CJC Thermocouple
	(-90 to 250) °C (-130 to 482) °F	0.25 °C + 0.015 % of reading 0.45 °F + 0.015 % of reading	Datalogger w/RTDs

Thermodynamics – Thermometers and Probes

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Temperature Measuring Equipment ¹	(-196 to 0) °C (-320.8 to 32) °F	0.013 °C + 0.014 % of reading 0.023 °F + 0.014 % of reading	Rosemount SPRT Instrulab Indicator Bath
	(0 to 410) °C (32 to 770) °F	0.014 °C + 0.0012 % of reading 0.025 °F + 0.0012 % of reading	
ITS 90 – Fixed Point	660 °C (1 220 °F)	0.54 °C 0.97 °F	Aluminum Freeze Point Thermocouple Indicator
Surface Temperature Measurement ¹	(0 to 250) °C (32 to 482) °F	1.3 °C 2.3 °F	Fluke 741 Type K Surface Probe

Time and Frequency – Frequency / Period

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Time Interval	(0.1 to 5) ns	1 % reading + 15 ps	Tektronix 2465
	(5 to 50) ns	0.5 % reading + 150 ps	
	3.3 ns to 10 ¹⁰ s	2.5 x 10 ⁻⁹ Hz / Hz + 500 ps	Fluke PM6681R
Frequency (Measure)	10 Hz to 200 MHz	2.5 x 10 ⁻⁹ Hz/Hz	Fluke PM6681R
	(0.2 to 2) GHz	2.6 x 10 ⁻⁹ Hz/Hz	
	(2 to 26) GHz	6.2 x 10 ⁻⁹ Hz/Hz	
Frequency (Source)	10 Hz to 200 MHz	2.5 x 10 ⁻⁹ Hz/Hz	Signal Generator monitored with Fluke PM6681R
	(0.2 to 2) GHz	2.6 x 10 ⁻⁹ Hz/Hz	
Stop Watches	(1 to 3 600) s	0.12 s	Timer Counter
Tachometers ¹ (Contact)	(5.76 to 4 189) rad/s	0.21 rad/s + 0.007 % of reading	Rpm Standard
	(55 to 40 000) rpm	0.2 rpm + 0.007 % of reading	
	(100 to 1 000) ft/min	0.026 % of reading	Rpm Standard Standard Wheel
Tachometers ¹ (Non-Contact) Strobo & Photo ¹	(0.62 to 10 472) rad/s	0.0062 rad/s + 0.0013 % of reading	Function Generator
	(6 to 100 000) rpm	(0.059 rpm + 0.0013 % of reading)	
Rpm (Measure)	(6 to 100 000) rpm	1.2 rpm	Optical Tachometer

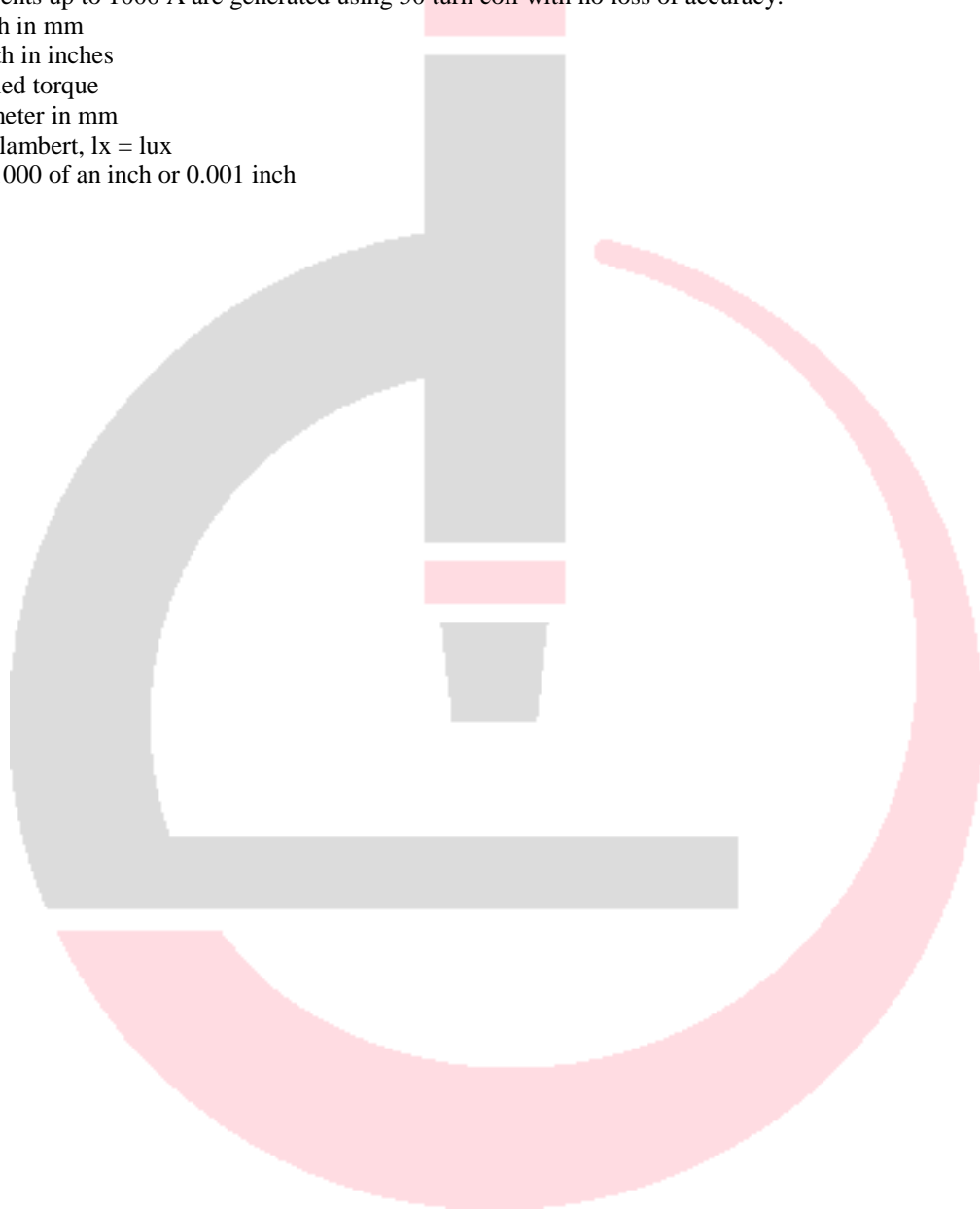
Time and Frequency – Oscilloscopes

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Squarewave (Source) Amplitude (1 MΩ)	200 μV to 100 V	0.29 % of reading	Tektronix PG506
Time Mark (Source)	1 ns/div to 5 s/div	12 μs/s	Tektronix TG501
Leveled Sinewave (Source) Flatness	250 kHz to 50 MHz	1.4 % of reading	Tektronix SG503
	(50 to 250) MHz	3.5 % of reading	
	(250 to 500) MHz	4.5 % of reading	Hewlett Packard 437B

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and remarks. 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) Laboratory offers calibration services at the laboratory's own facilities and at the client or other agreed upon facilities.
- 2) Test currents up to 1000 A are generated using 50 turn coil with no loss of accuracy.
- 3) l = length in mm
- 4) L = length in inches
- 5) T = applied torque
- 6) D = diameter in mm
- 7) fl = foot lambert, lx = lux
- 8) mil = 1/1000 of an inch or 0.001 inch



Approved by: 
R. Douglas Leonard
Chief Technical Officer

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