LABORATORY ACCREDITATION BUREAU a division of A-S-B

Certificate of Accreditation

ISO/IEC 17025:2005 **Certificate Number L2216**

Calibration Laboratory, LLC

3330 East 83rd Place
Merrillville, IN 46410

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ANSI Z540-1, ANSI/NCSL Z540.3 & 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: February 15, 2019

R. Douglas Leonard, Jr., President, COO
Laboratory Accreditation Bureau
Presented the 15th of February 2017

*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
Calibration Laboratory, LLC

3330 East 83rd Place
Merrillville, IN 46410
Jeff Breidigan
708-596-5800

In recognition of a successful assessment to ISO/IEC 17025:2005, ANSI/NCSL Z540.1:1994 (R2002) and ANSI/NCSL Z540.3:2006, accreditation is granted to **Calibration Laboratory, LLC** to perform the following **Calibrations / Dimensional Measurement**:

Accreditation granted through: **February 15, 2019**

Calibration

Amount of Substance – pH/Conductivity

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
pH Meters (Fixed Points)[1]	4, 7 & 10 pH	0.045 pH	Buffer Solutions and RTD Probe

Electrical – Capacitance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Capacitance – Synthesized Source [1]	(0.19 to 0.4) nF	0.005 nF/nF + 0.01 nF	Fluke 5520A/SC1100
	(0.4 to 1.1) nF	0.005 nF/nF + 0.01 nF	
	(1.1 to 3.3) nF	0.005 nF/nF + 0.01 nF	
	(3.3 to 11) nF	0.002 nF/nF + 0.1 nF	
	(11 to 33) nF	0.002 nF/nF + 0.1 nF	
	(33 to 110) nF	0.003 nF/nF + 0.088 nF	
	(110 to 330) nF	0.002 nF/nF + 0.3 nF	
	(0.33 to 1.1) µF	0.003 µF/µF + 0.98 nF	
	(1.1 to 3.3) µF	0.003 µF/µF + 3 nF	
	(3.3 to 11) µF	0.003 µF/µF + 10 nF	

Electrical – Capacitance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Capacitance – Synthesized Source[1]	(11 to 33) µF	0.004 µF/µF + 30 nF	
	(33 to 110) µF	0.005 µF/µF + 0.1 µF	
	(110 to 330) µF	0.005 µF/µF + 0.3 µF	
	(0.33 to 1.1) mF	0.005 µF/µF + 1 µF	
	(1.1 mF to 3.3) mF	0.9 mF/mF + 57 µF	
	(3.3 to 1) mF	3 µF/mF + 55 µF	
	(11 to 33) mF	7 µF/mF + 48 µF	
	(33 to 110) mF	10 µF/mF + 0.1 mF	
Capacitance – Measure @ 1 kHz	(0.1 to 10 pF	4.7 mF/F	GenRad1689M
	(10 to 100) pF	0.60 mF/F	
	(100 to 1000) pF	0.26 mF/F	
	(1 to 10) nF	0.26 mF/F	
	(10 to 100) nF	0.27 mF/F	
	(100 to 10 000) nF	0.26 mF/F	
	(1 to 10) µF	0.26 mF/F	
	(10 to 100) µF	0.59 mF/F	
	(100 to 1 000) µF	4.7 mF/F	

Electrical – Current

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Current - Source	(22 to 220) µA (10 to 20) Hz	0.7 nA/A + 25 nA	Fluke 5700A
	(20 to 40) Hz	0.36 nA/A + 20 nA	
	40 Hz to 1 kHz	0.14 nA/A + 16 nA	
	(1 to 5) kHz	0.6 nA/A + 40 nA	
	(5 to 10) kHz	1.6 nA/A + 80 nA	

Electrical – Current

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Current - Source	(0.22 to 2.2) mA (10 to 20) Hz	0.7 nA/µA + 41 nA	Fluke 5700A
	(20 to 40) Hz	0.35 nA/µA + 37 nA	
	40 Hz to 1 kHz	0.14 nA/µA + 39 nA	
	(1 to 5) kHz	0.6 nA/µA + 40 nA	
	(5 to 10) kHz	1.6 nA/µA + 80 nA	
AC Current - Source	(2.2 to 22) mA (10 to 20) Hz	0.7 nA/µA + 0.4 µA	Fluke 5700A
	(20 to 40) Hz	0.35 nA/µA + 0.35 µA	
	40 Hz to 1 kHz	0.17 nA/µA + 0.3 µA	
	(1 to 5) kHz	0.6 nA/µA + 4 µA	
	(5 to 10) kHz	1.6 nA/µA + 8 µA	
AC Current - Source	(22 to 220) mA (10 to 20) Hz	0.7 nA/µA + 4.1 µA	Fluke 5700A
	(20 to 40) Hz	0.38 nA/µA + 2.8 µA	
	40 Hz to 1 kHz	0.14 nA/µA + 3.8 µA	
	(1 to 5) kHz	0.6 nA/µA + 40 µA	
	(5 to 10) kHz	1.6 nA/µA + 80 µA	
AC Current - Source	(0.22 to 2.2) A 20 Hz to 1 kHz	0.35 nA/µA + 36 µA	Fluke 5700A
	(1 to 5) kHz	0.75 nA/µA + 81 µA	
	(5 to 10) kHz	8.5 nA/µA + 160 µA	
AC Current – Source[1]	(30 to 330) µA (10 to 20) Hz	2 nA/µA + 0.1 µA	Fluke 5520A/SC1100
	(20 to 45) Hz	1.5 nA/µA + 0.1 µA	
	45 Hz to 1 kHz	1.2 nA/µA + 0.1 µA	
	(1 to 5) kHz	3 nA/µA + 0.15 µA	
	(5 to 10) kHz	8 nA/µA + 0.2 µA	
	(10 to 30) kHz	16 nA/µA + 0.4 µA	

Electrical – Current

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Current – Source[1]	(0.33 to 3.3) mA[1]		Fluke 5520A/SC1100
	(10 to 20) Hz	2 µA/mA + 0.15 µA	
	(20 to 45) Hz	1.2 µA/mA + 0.15 µA	
	45 Hz to 1 kHz	1 µA/mA + 0.15 µA	
	(1 to 5) kHz	2 µA/mA + 0.2 µA	
	(5 to 10) kHz	5 µA/mA + 0.3 µA	
	(10 to 30) kHz	10 µA/mA + 0.6 µA	
AC Current – Source[1]	(3.3 to 33) mA		Fluke 5520A/SC1100
	(10 to 20) Hz	1.8 µA/mA + 2 µA	
	(20 to 45) Hz	0.9 µA/mA + 2 µA	
	45 Hz to 1 kHz	0.4 µA/mA + 2 µA	
	(1 to 5) kHz	0.8 µA/mA + 2 µA	
	(5 to 10) kHz	2 µA/mA + 3 µA	
	(10 to 30) kHz	4 µA/mA + 4 µA	
AC Current – Source[1]	(33 to 330) mA		Fluke 5520A/SC1100
	(10 to 20) Hz	1.8 µA/mA + 20 µA	
	(20 to 45) Hz	0.9 µA/mA + 20 µA	
	45 Hz to 1 kHz	0.4 µA/mA + 20 µA	
	(1 to 5) kHz	1 µA/mA + 50 µA	
	(5 to 10) kHz	2 µA/mA + 0.1 mA	
	10 kHz to 30 kHz	4 µA/mA + 0.2 mA	
AC Current – Source[1]	(0.33 to 1.1) A		Fluke 5520A/SC1100
	(10 to 45) Hz	1.6 µA/mA + 0.18 mA	
	45 Hz to 1 kHz	0.44 µA/mA + 0.12 mA	
	(1 to 5) kHz	5.2 µA/mA + 1.3 mA	
	(5 to 10) kHz	2.2 µA/mA + 0.61 mA	

Electrical – Current

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Current – Source[1]	(1.1 to 3) A (10 to 45) Hz	1.8 mA/A + 0.1 mA	Fluke 5520A/SC1100
	45 Hz to 1 kHz	0.6 mA/A + 0.1 mA	
	(1 to 5) kHz	6 mA/A + 1 mA	
	(5 to 10) kHz	25 mA/A + 5 mA	
AC Current – Source[1]	(3 to 11) A (45 to 100) Hz	0.6 mA/A + 2 mA	Fluke 5520A/SC1100
	100 Hz to 1 kHz	1 mA/A + 2 mA	
	(1 to 5) kHz	30 mA/A + 2 mA	
AC Current – Source [1]	(11 to 20) A (45 to 100) Hz	1.2 mA/A + 5 mA	Fluke 5520A/SC1100
	100 Hz to 1 kHz	1.5 mA/A + 5 mA	
	(1 to 5) kHz	30 mA/A + 5 mA	
AC Current – Source	(20 to 100) A 45 Hz to 1 kHz	1.8 mA/A + 0.12 A	Ballantine 1620A
AC Current – Measure[1]	5A to 30 kA 60 Hz	7 A + 1% of reading	AEMC 30K-24-2
AC Current Source – Current Clamps[1]	(45 to 65) Hz (10 to 16.5) A	0.2 mA / A + 0.3 A	Fluke 5520A/SC1100 with 50-turn coil
	(16.5 to 150) A	2.7 mA / A + 0.25 A	
	(150 to 1 025) A	3.8 mA / A + 0.15 A	
	(65 to 440) Hz (10 to 16.5) A	0.27 mA / A + 0.28 A	
	(16.5 to 150) A	8.7 mA / A + 0.18 A	
	(150 to 1 025) A	9.5 mA/A + 0.14 A	
DC Current - Source	(0 to 220) µA	50 µA/A + 8.7 nA	Fluke 5700A
	(0.22 to 2.2) mA	50 µA/A + 8.3 nA	
	(2.2 to 22) mA	50 µA/A + 80 nA	
	(22 to 220) mA	69 µA/A + 0.6 µA	

Electrical – Current

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
	(0.22 to 2.2) A	0.12 mA/A + 0.24 mA	
DC Current – Source [1]	0 µA to 330 µA	0.14 nA/µA + 27 nA	Fluke 5520A/SC1100
	0.3 mA to 3.3 mA	0.1 µA/µA + 52 nA	
	3.3 mA to 33 mA	0.1 µA/µA + 0.28 µA	
	33 mA to 330 mA	0.1 µA/µA + 2.5 µA	
	0.33 A to 1.1 A	0.2 mA/A + 40 µA	
	1.1 A to 3 A	0.38 mA/A + 40 µA	
	3 A to 11 A	0.5 mA/A + 0.5 mA	
	11 A to 20 A	1 mA/A + 0.75 mA	
DC Current – Source	(20 to 100) A	0.4 mA/A + 22 mA	Ballantine 1620A
DC Source – Current Clamps [1]	(10 to 150) A	3.6 mA/A + 1.5 mA	Fluke 5520A/SC1100 Fluke 5500/Coil
	(150 to 1 025) A	3.4 mA/A + 0.11 A	
	(1 025 to 1 500) A	1.6 A + 0.3% of reading	Transmille 9041 Fluke 5500/Coil
DC Current – Measure	0.01 pA to 10 nA	0.003 nA + 0.5% of reading	Transmille 8081
	(100 to 200) µA	40 nA/µA + 17 nA	Fluke 8508A
	10 nA to 100 nA	5 pA + 0.2% of reading	Transmille 8081
	(0.1 to 1) uA	0.02 nA + 0.02% of reading	
	1 uA to 10 uA	0.1 nA + 0.003% of reading	
	(10 to 100) uA	0.5 nA + 0.001% of reading	
	200 µA to 2 mA	10 nA/µA + 6 nA	Fluke 8508A
	(2 to 20) mA	0.01 µA/mA + 6 nA	
DC Current – Measure	(20 to 200) mA	0.03 µA/mA + 0.9 µA	
	200 mA to 2 A	200 µA/A + 17 µA	
	(2 to 20) A	0.4 mA/A + 0.41 mA	
	(>20 to 30) A	4.4 mA + 0.05% of reading	Transmille 8081
	(>30 to 2 000) A	0.41% + 0.01% of reading	Empro Shunt, Fluke 8508A
AC Current – Measure	0.1 nA to 100 µA (10 to 40) Hz	0.015 µA + 0.05% of reading	Transmille 8081
	40 Hz to 1 kHz	0.012 µA + 0.03% of reading	

Electrical – Current

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
	(1 to 10) kHz	0.03 µA + 0.07% of reading	
AC Current – Measure	(100 to 200) µA 10 Hz to 10 kHz	0.3 nA/µA + 0.025 µA	Fluke 8508A
	(10 to 30) kHz	0.6 nA/µA + 0.024 µA	
	(30 to 100) kHz	4 nA/µA + 0.021 µA	
AC Current – Measure	(0.2 to 2) mA 10 Hz to 10 kHz	0.28 µA/mA + 0.2 µA	Fluke 8508A
	(10 to 30) kHz	0.65 µA/mA + 0.2 µA	
	(30 to 100) kHz	4 µA/mA + 0.2 µA	
AC Current – Measure	(2 to 20) mA 10 Hz to 10 kHz	0.28 µA/mA + 2 µA	Fluke 8508A
	(10 to 30) kHz	0.65 µA/mA + 2 µA	
	(30 to 100) kHz	4 µA/mA + 2 µA	
AC Current – Measure	(20 to 200) mA 10 Hz to 10 kHz	0.25 µA/mA + 20 µA	Fluke 8508A
	(10 to 30) kHz	0.6 µA/mA + 20 µA	
AC Current – Measure	200 mA to 2 A 10 Hz to 2 kHz	0.6 mA/A + 0.2 mA	Fluke 8508A
	(2 to 10) kHz	0.7 mA/A + 0.2 mA	
	(10 to 30) kHz	3 mA/A + 0.2 mA	
AC Current – Measure	(2 to 20) A 10 Hz to 2 kHz	0.8 mA/A + 2 mA	Fluke 8508A
	(2 to 10) kHz	2.5 mA/A + 2 mA	
AC Current – Measure	(>20 to 30) A (10 to 40) Hz	12 mA + 0.08% of reading	Transmille 8081
	40 Hz to 1 kHz	9.2 mA + 0.07% of reading	
AC Current – Measure	(>30 to 2 000) A 60 Hz	0.41 + 0.01% of reading	Empro Shunt, HP 34401A
AC Current – Measure[1]	5A to 30 kA 60 Hz	7.7 A + 1 % of reading	AEMC 30K-24-2

Electrical - Inductance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Inductance – Measure (100 Hz to 1 kHz)	(10 to 100) µH	2 nH/µH + 8 nH	GenRad1689M
	(0.1 to 1) mH	0.8 µH/mH + 0.2 µH	
	(1 to 10) mH	0.5 µH/mH + 0.5 µH	
	(10 to 100) mH	0.5 µH/mH + 3 mH	
	(0.1 to 1) H	0.3 mH/H + 0.3 mH	
	1 H to 10 H	0.5 mH/H + 0.3 mH	
Inductance – Generate Fixed Points (100 Hz, 1kHz) [1]	100 µH	0.12 % of reading	GenRad 1482 Series Inductors
	500 µH	0.12 % of reading	
	1 mH	0.12 % of reading	
	10 mH	0.12 % of reading	
	50 mH	0.12 % of reading	
	100 mH	0.12 % of reading	
	200 mH	0.12 % of reading	
	1 H	0.12 % of reading	
	2 H	0.12 % of reading	
	10 H	0.12 % of reading	

Electrical – Power

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
DC Power - Source [1]	(0 to 336) W	0.04% of output	Fluke 5520A/SC1100
	(336 to 3 060) W	0.054% of output	
	(3 060 to 20 910) W	0.13% of output	
AC Power – Source (45 to 65) Hz [1]	(0.11 to 3) mW	0.14% of output	Fluke 5520A/SC1100
	(3 to 11) mW	0.1% of output	
	(11 to 30) mW	0.16% of output	
	(30 to 110) mW	0.12% of output	
	(110 to 300) mW	0.15% of output	
	(300 to 730) mW	0.13% of output	

Electrical – Power

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Power – Source (45 to 65) Hz [1]	(0.73 to 1.5) W	0.15% of output	Fluke 5520A/SC1100
	(1.5 to 6.8) W	0.14% of output	
	(6.8 to 9.2) W	0.14% of output	
	(9.2 to 34) W	0.1% of output	
	(34 to 92) W	0.14% of output	
	(92 to 337) W	0.1% of output	
	(337 to 918) W	0.13% of output	
	(918 to 2 244) W	0.11% of output	
	(2 244 to 4 590) W	0.14% of output	
	(4 590 to 11 220) W	0.12% of output	

Electrical – Resistance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Resistance – Source Fixed Points	0 Ω	50 μΩ	Fluke 5700A
	1 Ω	95 μΩ	
	1.9 Ω	0.18 mΩ	
	10 Ω	0.28 mΩ	
	19 Ω	0.51 mΩ	
	100 Ω	1.7 mΩ	
	190 Ω	2.5 mΩ	
	1 kΩ	13 mΩ	
	1.9 kΩ	25 mΩ	
	10 kΩ	120 mΩ	
	19 kΩ	230 mΩ	
	100 kΩ	1.4 Ω	
	190 kΩ	2.7 Ω	
	1 MΩ	21 Ω	

Electrical – Resistance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Resistance – Source Fixed Points	1.9 MΩ	40 Ω	Fluke 5700A
	10 MΩ	400 Ω	
	19 MΩ	890 Ω	
	100 MΩ	11 kΩ	
	(0.1 to 2) Ω	10 µΩ /Ω + 4 µΩ	
Fixed Resistors	1 Ω	12 µΩ	Transmille 3000RS
	10 Ω	58 µΩ	
	100 Ω	620µΩ	
	1 kΩ	6.3 mΩ	
	10 kΩ	18 mΩ	
	100 kΩ	400 mΩ	
	1 MΩ	6.5 Ω	
	10 MΩ	56 Ω	
Resistance – Source [1]	(0 to 11) Ω	40 µΩ/Ω + 1 mΩ	Fluke 5520A/SC1100
	(11 to 33) Ω	30 µΩ/Ω + 1.5 mΩ	
	(33 to 110) Ω	28 µΩ/Ω + 1.4 mΩ	
	(110 to 330) Ω	28 µΩ/Ω + 2.1 mΩ	
	(330 to 1 100) Ω	28 µΩ Ω + 2 mΩ	
	(1.1 to 3.3) kΩ	28 µΩ/Ω + 200 mΩ	
	(3.3 to 11) kΩ	30 µΩ/Ω + 200 mΩ	
	(11 to 33) kΩ	30 µΩ/Ω + 210 mΩ	
	(33 to 110) kΩ	28 µΩ/Ω + 240 mΩ	
	(110 to 330) kΩ	32 µΩ/Ω + 2 Ω	
	(0.33 to 1.1) MΩ	32 µΩ/Ω + 2 Ω	
	(1.1 to 3.3) MΩ	69 µΩ/Ω + 21 Ω	
	(3.3 to 11) MΩ	130 µΩ/Ω + 50 Ω	
	(11 to 33) MΩ	250 µΩ/Ω + 2.5 kΩ	
	(33 to 110) MΩ	0.5 mΩ/Ω + 3 kΩ	
	(110 to 330) MΩ	3 mΩ/Ω + 100 kΩ	
	(330 to 1 100) MΩ	15 mΩ/Ω + 0.5 MΩ	

Electrical – Resistance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Resistance – Measure	(0.1 to 2) Ω	10 μΩ/Ω + 4 μΩ	Fluke 8508A
	(2 to 20) Ω	9 μΩ/Ω + 14 μΩ	
	(20 to 200) Ω	7.5 μΩ/Ω + 50 μΩ	
	(0.2 to 2) kΩ	7.5 μΩ/Ω + 0.5 mΩ	
	(2 to 20) kΩ	8 μΩ/Ω + 5 mΩ	
	(20 to 200) kΩ	7.5 μΩ/Ω + 50 mΩ	
	(0.2 to 2) MΩ	8.9 μΩ/Ω + 0.9 Ω	
	(2 to 20) MΩ	15 Ω/MΩ + 110 Ω	
	(20 to 200) MΩ	10 kΩ + 65 Ω/MΩ	Fluke 8508A HV mode
	(0.2 to 2) GΩ	1 MΩ + 0.51 MΩ/Ω	
	(2 to 20) GΩ	10 MΩ + 0.53 MΩ/Ω	
	24 GΩ to 2 TΩ	1 MΩ + 1.2% of reading	Transmille 8081
Electrical Simulation of RTD Indicating Devices [1] Pt 385, 100 Ω	(-200 to -80) °C	0.052 °C	Fluke 5520A/SC1100
	(-80 to 0) °C	0.052 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.091 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
Electrical Simulation of RTD Indicating Devices [1] Pt 385, 200 Ω	(-200 to -80) °C	0.043 °C	Fluke 5520A/SC1100
	(-80 to 0) °C	0.043 °C	
	(0 to 100) °C	0.043 °C	
	(100 to 260) °C	0.052 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	

Electrical – Resistance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Electrical Simulation of RTD Indicating Devices [1] Pt 385, 500 Ω	(-200 to -80) °C	0.043 °C	Fluke 5520A/SC1100
	(-80 to 0) °C	0.052 °C	
	(0 to 100) °C	0.052 °C	
	(100 to 260) °C	0.062 °C	
	(260 to 300) °C	0.081 °C	
	(300 to 400) °C	0.081 °C	
	(400 to 600) °C	0.091 °C	
	(600 to 630) °C	0.11 °C	
Electrical Simulation of RTD Indicating Devices [1] Pt 385, 1000 Ω	(-200 to -80) °C	0.034 °C	Fluke 5520A/SC1100
	(-80 to 0) °C	0.034 °C	
	(0 to 100) °C	0.043 °C	
	(100 to 260) °C	0.052 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.072 °C	
	(400 to 600) °C	0.072 °C	
	(600 to 630) °C	0.23 °C	
Electrical Simulation of RTD Indicating Devices [1] Pt 3916, 100 Ω	(-200 to -190) °C	0.25 °C	Fluke 5520A/SC1100
	(-190 to -80) °C	0.043 °C	
	(-80 to 0) °C	0.053 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.072 °C	
	(260 to 300) °C	0.082 °C	
	(300 to 400) °C	0.092 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
Electrical Simulation of RTD Indicating Devices [1] Pt 3926, 100 Ω	(-200 to -80) °C	0.053 °C	Fluke 5520A/SC1100
	(-80 to 0) °C	0.053 °C	
	(0 to 100) °C	0.072 °C	
	(100 to 300) °C	0.092 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	

Electrical – Resistance

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Electrical Simulation of RTD Indicating Devices [1] PtNi 385, 120 Ω	(-80 to 0) °C	0.083 °C	Fluke 5520A/SC1100
	(0 to 100) °C	0.083 °C	
	(100 to 260) °C	0.14 °C	
Electrical Simulation of RTD Indicating Devices [1] Cu 427, 10 Ω	(-100 to 260) °C	0.3 °C	Fluke 5520A/SC1100

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
DC Voltage – Source	(0 to 220) mV	8 nV/mV + 0.61 µV	Fluke 5700A
	(0.22 to 2.2) V	7 µV/V + 1 µV	
	(2.2 to 11) V	7 µV/V + 4 µV	
	(11 to 22) V	7 µV/V + 6.6 µV	
	(22 to 220) V	8 µV/V + 81 µV	
	(220 to 1 000) V	9 µV/V + 0.5 mV	
	(1 to 15) kV	1 mV/V + 85 mV	Ross VMP15-GH Keithley 2000
DC Voltage – Source [1]	(1 to 10) kV	0.58 kV + 0.005% of reading	Hipotronics KVM 100
	(10 to 100) kV	0.082 kV + 0.001% of reading	
DC Voltage - Source [1]	(0 to 330) mV	0.018 µV/mV + 2.1 V	Fluke 5520A/SC1100
	(0.3 to 3.3) V	10.6 µV/V + 3.8 µV	
	(3.3 to 33) V	12 µV/V + 35 µV	
	(33 to 330) V	18 µV/V + 260 µV	
	(330 to 1 000) V	18 mV/V + 1.5 mV	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Source	(0.22 to 2.2) mV (10 to 20) Hz	0.5 µV/mV + 4.5 µV	Fluke 5700A
	(20 to 40) Hz	0.2 µV/mV + 4.5 µV	
	40 Hz to 20 kHz	0.11 µV/mV + 4.5 µV	
	(20 to 50) kHz	0.37 µV/mV + 4.5 µV	
	(50 to 100) kHz	0.85 µV/mV + 7 µV	
	(100 to 300) kHz	1.1 µV/mV + 13 µV	
	(300 to 500) kHz	2.7 µV/mV + 23 µV	
	500 kHz to 1 MHz	3.4 µV/mV + 25 µV	
AC Voltage – Source	(2.2 to 22) mV (10 to 20) Hz	0.5 µV/mV + 5 µV	Fluke 5700A
	(20 to 40) Hz	0.2 µV/mV + 5 µV	
	40 Hz to 20 kHz	0.1 µV/mV + 5 µV	
	(20 to 50) kHz	0.4 µV/mV + 5 µV	
	(50 to 100) kHz	0.8 µV/mV + 7 µV	
	(100 to 300) kHz	1 µV/mV + 12 µV	
	(300 to 500) kHz	2 µV/mV + 25 µV	
	500 kHz to 1 MHz	3 µV/mV + 25 µV	
AC Voltage – Source	(22 to 220) mV (10 to 20) Hz	0.5 µV/mV + 5 µV	Fluke 5700A
	(20 to 40) Hz	0.2 µV/mV + 5 µV	
	40 Hz to 20 kHz	0.1 µV/mV + 5 µV	
	(20 to 50) kHz	0.3 µV/mV + 5 µV	
	(50 to 100) kHz	0.8 µV/mV + 7 µV	
	(100 to 300) kHz	1 µV/mV + 12 µV	
	(300 to 500) kHz	2 µV/mV + 25 µV	
	500 kHz to 1 MHz	3 µV/mV + 25 µV	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Source	(0.22 to 2.2) V (10 to 20) Hz	0.5 mV/V + 80 µV	Fluke 5700A
	(20 to 40) Hz	0.2 mV/V + 0.25 mV	
	40 Hz to 20 kHz	70 µV/V + 6.5 µV	
	(20 to 50) kHz	0.1 mV/V + 16 µV	
	(50 to 100) kHz	0.2 mV/V + 70 µV	
	(100 to 300) kHz	0.4 mV/V + 0.13 mV	
	(300 to 500) kHz	1 mV/V + 0.35 mV	
	500 kHz to 1 MHz	2 mV/V + 0.85 mV	
AC Voltage – Source	(2.2 to 22) V (10 to 20) Hz	0.5 mV/V + 0.80 mV	Fluke 5700A
	(20 to 40) Hz	0.2 mV/V + 0.25 mV	
	40 Hz to 20 kHz	70 µV/V + 62 µV	
	(20 to 50) kHz	0.1 mV/V + 0.16 mV	
	(50 to 100) kHz	0.2 mV/V + 0.35 mV	
	(100 to 300) kHz	0.5 mV/V + 1.5 mV	
	(300 to 500) kHz	1 mV/V + 4.3 mV	
	500 kHz to 1 MHz	3 mV/V + 8.5 mV	
AC Voltage – Source	(22 to 220) V (10 to 20) Hz	0.5 mV/V + 8 mV	Fluke 5700A
	(20 to 40) Hz	0.2 mV/V + 2.5 mV	
	40 Hz to 20 kHz	80 µV/V + 0.83 mV	
	(20 to 50) kHz	0.2 mV/V + 3.5 mV	
	(50 to 100) kHz	0.5 mV/V + 8 mV	
	(100 to 300) kHz	1 mV/V + 90 mV	
	(300 to 500) kHz	5 mV/V + 90 mV	
	500 kHz to 1 MHz	10 mV/V + 190 mV	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Source	(220 to 1100) V (15 to 50) Hz	80 µV/V + 1.8 mV	Fluke 5700A
	50 Hz to 1 kHz	0.4 mV/V + 16 mV	
AC Voltage - Source [1]	(1 to 33) mV (10 to 45) Hz	0.8 µV/mV + 6 µV	Fluke 5520A/SC1100
	45 Hz to 10 kHz	0.15 µV/mV + 6.3 µV	
	(10 to 20) kHz	0.2 µV/mV + 6.3 µV	
	(20 to 50) kHz	1 µV/mV + 6.2 µV	
	(50 to 100) kHz	3.5 µV/mV + 12 µV	
	(100 to 500) kHz	8 µV/mV + 50 µV	
AC Voltage - Source [1]	(33 to 330) mV (10 to 45) Hz	0.3 µV/mV + 8.1 µV	Fluke 5520A/SC1100
	45 Hz to 10 kHz	0.15 µV/mV + 8.1 µV	
	(10 to 20) kHz	0.16 µV/mV + 8.1 µV	
	(20 to 50) kHz	0.35 µV/mV + 8.1 µV	
	(50 to 100) kHz	0.8 µV/mV + 32 µV	
	(100 to 500) kHz	2 µV/mV + 70 µV	
AC Voltage - Source [1]	(0.33 to 3.3) V (10 to 45) Hz	300 µV/V + 50 µV	Fluke 5520A/SC1100
	45 Hz to 10 kHz	150 µV/V + 60 µV	
	(10 to 20) kHz	190 µV/V + 60 µV	
	(20 to 50) kHz	300 µV/V + 50 µV	
	(50 to 100) kHz	700 µV/V + 130 µV	
	(100 to 500) kHz	2.4 mV/V + 0.6 mV	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage - Source [1]	(3.3 to 33) V (10 to 45) Hz	0.3 mV/V + 0.65 mV	Fluke 5520A/SC1100
	45 Hz to 10 kHz	0.3 mV/V + 0.65 mV	
	(10 to 20) kHz	0.24 mV/V + 0.6 mV	
	(20 to 50) kHz	0.35 mV/V + 0.6 mV	
	(50 to 100) kHz	0.9 mV/V + 1.6 mV	
AC Voltage - Source [1]	(33 to 330) V 45 Hz to 1 kHz	0.19 mV/V + 2 mV	Fluke 5520A/SC1100
	(1 to 10) kHz	0.2 mV/V + 6 mV	
	(10 to 20) kHz	0.25 mV/V + 6 mV	
	(20 to 50) kHz	0.3 mV/V + 6 mV	
	(50 to 100) kHz	2 mV/V + 50 mV	
AC Voltage - Source [1]	(330 to 1 000) V 45 Hz to 1 kHz	0.3 mV/V + 10 mV	Fluke 5520A/SC1100
	(1 to 5) kHz	0.25 mV/V + 10 mV	
	(5 to 10) kHz	0.3 mV/V + 10 mV	
AC Voltage – Source	DC to 60Hz (1 to 15) kV	0.017 V + 1% of reading	Hipotronics Source, Ross Divider & Keithley
DC Voltage – Measure	(0 to 200) mV	4 µV/V + 0.11 µV	Fluke 8508A
	(0.2 to 2) V	4 µV + 3 µV/V	
	(2 to 20) V	4 µV + 3 µV/V	
	(20 to 200) V	0.04 mV + 4.5 µV/V	
	(200 to 1 000) V	0.53 mV + 4.5 µV/V	
	(1 to 15) kV	1 mV/V + 85 mV	Ross Divider & Keithley 2000
DC Voltage – Measure [1]	(1 to 100) kV	0.002 kV + 0.5% of reading	Hipotronics KVM 100
	(20 to 200) kV	0.02 kV + 0.5% of reading	Hipotronics KVM 200
pH Calibrators	(-120 to 120) mV	0.027 mV	Fluke 8508A

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Measure	Up to 2.2 mV (10 to 20) Hz	1.3 µV + 1.7 µV/mV	Fluke 5790A
	(20 to 40) Hz	1.3 µV + 0.73 µV/mV	
	40 Hz to 20 kHz	1.3 µV + 0.41 µV/mV	
	(20 to 50) kHz	2 µV + 0.81 µV/mV	
	(50 to 100) kHz	2.5 µV + 1.2 µV/mV	
	(100 to 300) kHz	4 µV + 2.3 µV/mV	
	(300 to 500) kHz	8 µV + 2.4 µV/mV	
	500 kHz to 1 MHz	8 µV + 3.5 µV/mV	
AC Voltage – Measure	(2.2 to 7) mV (10 to 20) Hz	1.3 µV + 0.85 µV/mV	Fluke 5790A
	(20 to 40) Hz	1.3 µV + 0.37 µV/mV	
	(40 to 20) kHz	1.3 µV + 0.21 µV/mV	
	(20 to 50) kHz	2 µV + 0.4 µV/mV	
	(50 to 100) kHz	2.5 µV + 0.6 µV/mV	
	(100 to 300) kHz	4 µV + 1.2 µV/mV	
	(300 to 500) kHz	8 µV + 1.3 µV/mV	
	500 kHz to 1 MHz	8 µV + 2.3 µV/mV	
AC Voltage – Measure	(7 to 22) mV (10 to 20) Hz	1.3 µV + 0.29 µV/mV	Fluke 5790A
	(20 to 40) Hz	1.3 µV + 0.19 µV/mV	
	40 Hz to 20 kHz	1.3 µV + 0.11 µV/mV	
	(20 to 50) kHz	2 µV + 0.21 µV/mV	
	(50 to 100) kHz	2.5 µV + 0.31 µV/mV	
	(100 to 300) kHz	4 µV + 0.81 µV/mV	
	(300 to 500) kHz	8 µV + 0.89 µV/mV	
	500 kHz to 1 MHz	8 µV + 1.7 µV/mV	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Measure	(22 to 70) mV (10 to 20) Hz	1.5 µV + 0.24 µV/mV	Fluke 5790A
	(20 to 40) Hz	1.5 µV + 0.12 µV/mV	
	40 Hz to 20 kHz	1.5 µV + 0.07 µV/mV	
	(20 to 50) kHz	2 µV + 0.13 µV/mV	
	(50 to 100) kHz	2.5 µV + 0.26 µV/mV	
	(100 to 300) kHz	4 µV + 0.51 µV/mV	
	(300 to 500) kHz	8 µV + 0.67 µV/mV	
	500 kHz to 1 MHz	8 µV + 1.1 µV/mV	
AC Voltage – Measure	(70 to 220) mV (10 to 20) Hz	1.5 µV + 0.21 µV/mV	Fluke 5790A
	(20 to 40) Hz	1.5 µV + 0.09 µV/mV	
	40 Hz to 20 kHz	1.5 µV + 0.04 µV/mV	
	(20 to 50) kHz	2 µV + 0.07 µV/mV	
	(50 to 100) kHz	2.5 µV + 0.16 µV/mV	
	(100 to 300) kHz	4 µV + 0.25 µV/mV	
	(300 to 500) kHz	8 µV + 0.38 µV/mV	
	500 kHz to 1 MHz	8 µV + 1 µV/mV	
AC Voltage – Measure	(220 to 700) mV (10 to 20) Hz	1.6 µV + 0.21 µV/mV	Fluke 5790A
	(20 to 40) Hz	1.7 µV + 0.08 µV/mV	
	40 Hz to 20 kHz	2 µV + 0.03 µV/mV	
	(20 to 50) kHz	2.3 µV + 0.05 µV/mV	
	(50 to 100) kHz	2.7 µV + 0.08 µV/mV	
	(100 to 300) kHz	4.1 µV + 0.18 µV/mV	
	(300 to 500) kHz	8 µV + 0.3 µV/mV	
	500 kHz to 1 MHz	8 µV + 0.96 µV/mV	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Measure	(0.7 to 2.2) V (10 to 20) Hz	0.02 µV + 200 µV/V	Fluke 5790A
	(20 to 40) Hz	0.07 µV + 66 µV/V	
	40 Hz to 20 kHz	0.2 µV + 24 µV/V	
	(20 to 50) kHz	0.1 µV + 46 µV/V	
	(50 to 100) kHz	0.07 µV + 71 µV/V	
	(100 to 300) kHz	0.03 µV + 160 µV / V	
	(300 to 500) kHz	0.02 µV + 260 µV/V	
	500 kHz to 1 MHz	0.01 µV + 900 µV/V	
AC Voltage – Measure	(2.2 to 7) V (10 to 20) Hz	0.6 µV + 200 µV/V	Fluke 5790A
	(20 to 40) Hz	2 µV + 70 µV/V	
	40 Hz to 20 kHz	5 µV + 20 µV/V	
	(20 to 50) kHz	2 µV + 50 µV/V	
	(50 to 100) kHz	1 µV + 80 µV/V	
	(100 to 300) kHz	0.6 µV + 200 µV/V	
	(300 to 500) kHz	0.3 µV + 400 µV/V	
	500 kHz to 1 MHz	0.09 µV + 1 mV/V	
AC Voltage – Measure	(7 to 22) V (10 to 20) Hz	0.1 µV + 0.2 mV/V	Fluke 5790A
	(20 to 40) Hz	0.1 µV + 0.07 mV/V	
	40 Hz to 20 kHz	0.1 µV + 0.03 mV/V	
	(20 to 50) kHz	0.6 µV + 0.05 mV/V	
	(50 to 100) kHz	30 µV + 0.08 mV/V	
	(100 to 300) kHz	0.1 µV + 0.2 mV/V	
	(300 to 500) kHz	0.1 µV + 0.4 mV/V	
	500 kHz to 1 MHz	0.02 µV + 1 mV/V	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Measure	(22 to 70) V (10 to 20) Hz	2 µV + 0.2 mV/V	Fluke 5790A
	(20 to 40) Hz	2 µV + 0.07 mV/V	
	40 Hz to 20 kHz	10 µV + 0.03 mV/V	
	(20 to 50) kHz	7 µV + 0.06 mV / V	
	(50 to 100) kHz	4 µV + 0.09 mV/V	
	(100 to 300) kHz	2 µV + 0.2 mV/V	
	(300 to 500) kHz	1 µV + 0.4 mV/V	
	500 kHz to 1 MHz	0.3 µV + 1 mV/V	
AC Voltage – Measure	(70 to 220) V (10 to 20) Hz	2 µV + 0.2 mV/V	Fluke 5790A
	(20 to 40) Hz	6 µV + 0.07 mV/V	
	40 Hz to 20 kHz	10 µV + 0.03 mV/V	
	(20 to 50) kHz	6 µV + 0.07 mV/V	
	(50 to 100) kHz	4 µV + 0.1 mV/V	
	(100 to 300) kHz	2 µV + 0.2 mV/V	
	(300 to 500) kHz	0.8 µV + 0.5 mV/V	
AC Voltage – Measure	(220 to 700) V (10 to 20) Hz	50 µV + 0.2 mV/V	Fluke 5790A
	(20 to 40) Hz	100 µV + 0.1 mV/V	
	40 Hz to 20 kHz	200 µV + 0.04 mV/V	
	(20 to 50) kHz	80 µV + 0.1 mV/V	
	(50 to 100) kHz	20 µV + 0.5 mV/V	
AC Voltage – Measure	(700 to 1 000) V (10 to 20) Hz	30 µV + 0.2 mV/V	Fluke 5790A
	(20 to 40) Hz	70 µV + 0.1 mV/V	
	40 Hz to 20 kHz	200 µV + 0.04 mV/V	
	(20 to 50) kHz	50 µV + 0.1 mV/V	
	(50 to 100) kHz	10 µV + 0.5 mV/V	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Measure	Up to 200 mV (1 to 10) Hz	14 µV + 0.160 mV/V	Fluke 8508A
	(10 to 40) Hz	4 µV + 0.11 mV/V	
	(40 to 100) Hz	20 µV + 85 µV/V	
	100 Hz to 2 kHz	2 µV + 100 µV/V	
	(2 to 10) kHz	3.9 µV + 100 µV/V	
	(10 to 30) kHz	8 µV + 0.3 mV/V	
	(30 to 100) kHz	20 µV + 0.7 mV/V	
	(100 to 300) kHz	2 mV + 3 mV/V	
	300 kHz to 1 MHz	20 mV + 10 mV/V	
AC Voltage – Measure	(0.2 to 2) V (1 to 10) Hz	120 µV + 0.140 mV/V	Fluke 8508A
	(10 to 40) Hz	20 µV + 0.1 mV/V	
	(40 to 100) Hz	20 µV + 85 µV/V	
	100 Hz to 2 kHz	20 µV + 65 µV/V	
	(2 to 10) kHz	20 µV + 85 µV/V	
	(10 to 30) kHz	40 µV + 0.20 mV/V	
	(30 to 100) kHz	0.2 mV + 0.5 mV/V	
	(100 to 300) kHz	2 mV + 3 mV/V	
	300 kHz to 1 MHz	20 mV + 10 mV/V	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Measure	(2 to 20) V (1 to 10) Hz	1.2 mV + 0.14 mV/V	Fluke 8508A
	(10 to 40) Hz	0.2 mV + 0.11 mV/V	
	(40 to 100) Hz	0.19 mV + 0.09 mV/V	
	100 Hz to 2 kHz	0.19 mV + 0.07 mV/V	
	(2 to 10) kHz	0.19 mV + 0.09 mV/V	
	(10 to 30) kHz	0.38 mV + 0.22 mV/V	
	(30 to 100) kHz	1.9 mV + 0.53 mV/V	
	(100 to 300) kHz	20 mV + 3.2 mV/V	
	300 kHz to 1 MHz	0.2 V + 11 mV/V	
AC Voltage – Measure	(20 to 200) V (1 to 10) Hz	12 mV + 0.15 mV/V	Fluke 8508A
	(10 to 40) Hz	2 mV + 0.11 mV/V	
	(40 to 100) Hz	2 mV + 90 µV/V	
	100 Hz to 2 kHz	2 mV + 16 µV/V	
	(2 to 10) kHz	2 mV + 89 µV/V	
	(10 to 30) kHz	4 mV + 0.22 mV/V	
	(30 to 100) kHz	20 mV + 0.53 mV/V	
	(100 to 300) kHz	0.2 V + 3.2 mV/V	
	300 kHz to 1 MHz	2 V + 11 mV/V	
AC Voltage – Measure	(200 to 1 000) V (1 to 10) Hz	0.38 mV/V + 21 mV	Fluke 8508A 300 V, add 0.00004 (reading - 300)^2 µV/V
	(10 to 40) Hz	0.12 mV/V + 20 mV	
	40 Hz to 10 kHz	0.3 mV/V + 10 mV	
	(10 to 30) kHz	0.2 mV/V + 40 mV	
	(30 to 100) kHz	0.000 5 mV/V + 0.21 mV	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
AC Voltage – Measure	(1 to 15) kV @ 60Hz	10 mV/V + 17 mV	Ross Divider & Keithley 2000
AC Voltage – Measure [1]	(1 to 100) kV @ 60Hz	5 V/kV + 2 V	Hipotronics KVM 100
AC Voltage – Measure [1]	(20 to 200) kV @ 60Hz	5 V/kV + 20 V	Hipotronics KVM 200
Electrical Simulation of Thermocouple Indicating Devices 1 Type B	(600 to 800) °C	0.44 °C	Fluke 5520A/SC1100
	(800 to 1 000) °C	0.34 °C	
	(1 000 to 1 550) °C	0.3 °C	
	(1 550 to 1 820) °C	0.33 °C	
Electrical Simulation of Thermocouple Indicating Devices 1 Type C	(0 to 150) °C	0.3 °C	Fluke 5520A/SC1100
	(150 to 650) °C	0.26 °C	
	(650 to 1 000) °C	0.31 °C	
	(1 000 to 1 800) °C	0.5 °C	
	(1 800 to 2 316) °C	0.84 °C	
Electrical Simulation of Thermocouple Indicating Devices 1 Type E	(-250 to -100) °C	0.5 °C	Fluke 5520A/SC1100
	(-100 to -25) °C	0.16 °C	
	(-25 to 350) °C	0.14 °C	
	(350 to 650) °C	0.16 °C	
	(650 to 1 000) °C	0.21 °C	
Electrical Simulation of Thermocouple Indicating Devices 1 Type J	(-210 to -100) °C	0.27 °C	Fluke 5520A/SC1100
	(-100 to -30) °C	0.16 °C	
	(-30 to 150) °C	0.14 °C	
	(150 to 760) °C	0.17 °C	
	(760 to 1 200) °C	0.23 °C	

Electrical – Voltage

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Electrical Simulation of Thermocouple Indicating Devices 1 Type K	(-200 to -100) °C	0.33 °C	Fluke 5520A/SC1100
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.16 °C	
	(120 to 1 000) °C	0.26 °C	
	(1 000 to 1 372) °C	0.4 °C	
Electrical Simulation of Thermocouple Indicating Devices 1 Type N	(-200 to -100) °C	0.4 °C	Fluke 5520A/SC1100
	(-100 to -25) °C	0.22 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.27 °C	
Electrical Simulation of Thermocouple Indicating Devices 1 Type R	(0 to 250) °C	0.57 °C	Fluke 5520A/SC1100
	(250 to 400) °C	0.57 °C	
	(400 to 1 000) °C	0.33 °C	
	(1 000 to 1 767) °C	0.4 °C	
Electrical Simulation of Thermocouple Indicating Devices 1 Type S	(0 to 250) °C	0.47 °C	Fluke 5520A/SC1100
	(250 to 1 000) °C	0.36 °C	
	(1 000 to 1 400) °C	0.37 °C	
	(1 400 to 1 767) °C	0.46 °C	
Electrical Simulation of Thermocouple Indicating Devices 1 Type T	(-250 to -150) °C	0.63 °C	Fluke 5520A/SC1100
	(-150 to 0) °C	0.24 °C	
	(0 to 120) °C	0.16 °C	
	(120 to 400) °C	0.14 °C	

Length – Artifacts and Standards 1D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Caliper Masters	(0.5 to 12) in	(16 + 9*L*) µin	P&W Labmaster Universal
	(13 to 60) in	(200 + 0.4*L*) µin	Gauging Amplifier, Gauge Blocks
Cylindrical Plug Gauges[12]	(0 to 12) in	(2 + 4*L*) µin	P&W Labmaster Universal
Cylindrical Ring Gauges	(0.02 to 1) in	15 µin	P&W Labmaster Universal
	(1 to 13) in	(15 + 1*L*) µin	
Depth Micrometer Master	(0.5 to 11.5) in	(28 + 1*L*) µin	Comparator and Gauge Blocks
End Measuring Rods	(0.5 to 12) in	(16 + 9*L*) µin	P&W Labmaster Universal
	(12 to 24) in	(9 + 7.4*L*) µin	P&W ULM
	(24 to 60) in	(200 + 0.4*L*) µin	Comparator and Gauge Blocks
Feeler Gauges (Leaf-Style)[1]	(0 to 0.25) in	76 µin	Bench Micrometer
Gauge Balls (size only)	(0.0625 to 2) in	(10 + 4*L*) µin	P&W Labmaster Universal
Gauge Blocks[6]	(0.05 to 4) in	(3.7 + 0.8*L*) µin	Mahr 130-B24 & Gauge Blocks
	(5 to 12) in	(1.4 + 2*L*) µin	P&W Labmaster Universal
Micrometer Masters	(0 to 12) in	(2 + 4*L*) µin	P&W Labmaster Universal
Optical Flats & Parallels	Flatness to 4 in diameter	4.3 µin	Optical Flat & Monochromatic Light
	Parallelism to 2 in thickness	4.5 µin	Mahr 130-B24
Parallels	(0 to 36) in	66 µin	Gauge Blocks, Surface Plate & Gauging Amplifier
Pin Gauges – Class ZZ[1]	(0.011 to 1) in	(88 + 0.4*L*) µin	P&W Labmaster Universal
Riser Blocks	(6 to 24) in	(19 + 7*L*) µin	Federal 832 Amplifier, Gauge Blocks

Length – Artifacts and Standards 1D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Snap Gauges	(0.02 to 13) in	(15 + 1*L*) µin	P&W Labmaster Universal
Squares- Perpendicularity	(0 to 36) in	(65 + 3*L*) µin	Indi-Square, Gauge Blocks, Amplifier, Tri-Square
Tapered Plugs	(0 to 2) in	(13 + 12*L*) µin	P&W Labmaster Universal, Gauge Blocks, Plug Gauges
Tapered Rings	(0 to 2) in	(15 + 5.3*L*) µin	P&W Labmaster Universal, Gauge Blocks
Thickness (Film) Gauge Standards (Non-Ferrous)	(0 to 0.050) in	9.7 µin	P&W Labmaster Universal
Thread Measuring Wires	Unified 60° (4 to 80) TPI [12]	(10 + 0.03*L*) µin	P&W Labmaster Universal
	Acme 29° (1 to 20) TPI [12]	(10 + 0.03*L*) µin	
Thread Micrometer Standards	(1 to 6) in	(170 + 1*L*) µin	P&W Labmaster Universal

Length – Artifacts and Standards 2D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Angle Blocks	(1 to 60)°	0.002 2º	Master Angle Blocks, Sine Plate, Gauging Amplifier
Angle Gauges (Leaf Style)	(0 to 90) °	3.7 min	Starrett Optical Comparator
Electronic Differential Levels	1 000 arc s	1.4 arc s	Brunson 470 Angle Generator
Functional Gauges & Fixtures	Linear (0 to 12) in	190 µin	STI Optical Comparator
	Angle (0 to 90) °	0.065º	

Length – Artifacts and Standards 2D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Radius Gauges (Leaf Style)	Up to 1 in	210 µin	STI Optical Comparator
Sine Bars & Plates	Angle (1 to 60) °	6.1 arc seconds	Gauge Blocks, Starrett Angle Blocks & Gauging Amplifier
Thread Pitch Gauges (Leaf Style)	(4 to 84) TPI[10]	160 µin	Starrett Optical Comparator
Tri-Blocks	Length (1 to 6) in	38 µin	Gauge Blocks and Gauging Amplifier
	Flatness	22 µin	Gauging Amplifier
	Perpendicularity	59 µin	Indi-Square and Gauging Amplifier
V-Blocks	Parallelism	22 µin	Gauging Amplifier
	Perpendicularity	59 µin	Indi-Square
	V-Centrality	41 µin	Gauging Amplifier and Master Plugs
Surface Plates[1]	Overall Flatness Up to (16 x 16) ft	$(52 + 1D_L)$ µin [(13)]	Optodyne LDDM per ASME B89.3.7
	Local Variation In Flatness	29 µin	Repeat-O-Meter per ASME B89.3.7
Pipe Thread Plugs	(4 to 80 TPI) Simple Pitch Diameter [11]	$(100 + 3L)$ µin	P&W Labmaster Universal, Sine Plug
	Up to 1 in	$(3.1 + 20L)$ µin	Comparator and Gauge Blocks
	(0 to 2) in Standoff	23 µin	Gauge Blocks & Gauging Amp
Thread Plugs – Setting [5]	(4 to 80 TPI) Simple Pitch Diameter [11]	$(84 + 4L)$ µin	P&W Labmaster Universal, Thread Measuring Wires
	(0.06 to 4) in Major Diameter	$(16 + 8.6L)$ µin	P&W Labmaster Universal
	Root Radius & Minor Diameter	210 µin	STI Optical Comparator

Length – Artifacts and Standards 2D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Thread Plugs - Working [5]	(4 to 80 TPI) Simple Pitch Diameter	(160 + 2*L*) µin	P&W Labmaster Universal, Thread Measuring Wires
	(0.060 to 4) in Major Diameter	(26 + 5*L*) µin	P&W Labmaster Universal
	Root Radius & Minor Diameter	210 µin	STI Optical Comparator

Length – Hand Tools and Precision Gages 1D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Bench Micrometers [1]	(0 to 2) in	12 µin	Gauge Blocks
Bench Micrometer Anvil Flatness [1]	Up to 0.5 in	9.4 µin	Optical Flat, He-Ne Monochromatic Light
Bore Gauges (2 point)[1]	(0 to 8) in	(91 + 4*L*) µin	P&W Labmaster Universal, Ring Gauges
Bore Gauges (3 point) [1]	(0 to 8) in	(63 + 80*L*) µin	Ring Gauges
Calipers Inside & Outside [1,3]	(0 to 20) in	(280 + 10*L*) µin	Gauge Blocks and Accessories
	(21 to 40) in	(380 + 7*L*) µin	
	(41 to 60) in	(960 + 3*L*) µin	
Chamfer Gauges [1]	(0 to 1) in	(74 + 29*L*) µin	Modified Ring Gauges
Gauging Amplifiers & LVDT Heads	(0 to 0.001) in	5.1 µin	P&W Labmaster Universal
Height Gauges[1]	(0 to 24) in	(290 + 2*L*) µin	Gauge Blocks, Surface Plate
	(24 to 40) in	(250 + 4*L*) µin	
Height Masters (Length)	(0 to 24) in	(24 + 6*L*) µin	Gauge Blocks, Gauging Amplifier
Height Masters Block (Parallelism)	(0 to 0.001) in	15 µin	Gauge Blocks, Gauging Amplifier
Indicators[1,7]	(0 to 0.001) in	6.9 µin	P&W Labmaster Universal
	(0 to 0.01) in	43 µin	
	(0.01 to 8) in [1]	(56 + 66*L*) µin	Gauge Blocks [1]

Length – Hand Tools and Precision Gages 1D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Micrometer Heads (Length)	(0 to 1) in	33 µin	P&W Labmaster Universal
Micrometer Heads (Anvil Flatness)	Up to 3 in Diameter	7.6 µin	Optical Flat, He-Ne Monochromatic Light
Micrometers, Depth (Length) [1]	(0 to 12) in	(45 + 5*L*) µin	Gauge Blocks
Micrometers, Depth (Base Flatness)	(0 to 3) in	7.6 µin	Optical Flat and He-Ne Monochromatic Light
Micrometers, Inside[1]	(0 to 4) in	(32 + 8*L*) µin	Gauge Blocks & Accessories
	(5 to 20) in	(46 + 7*L*) µin	
	(21 to 40) in	(350 + 3*L*) µin	
	(41 to 60) in	(580 + 4*L*) µin	
Micrometers, Outside[1]	(0 to 4) in	(32 + 8*L*) µin	Gauge Blocks
	(5 to 20) in	(46 + 7*L*) µin	
	(21 to 40) in	(350 + 3*L*) µin	
	(41 to 60) in	(580 + 4*L*) µin	
Micrometer Anvil (Flatness) [1]	Up to 3 in Diameter	9.4 µin	Optical Flat and He-Ne Monochromatic Light
Micrometers, Screw Thread [1,4]	(0 to 1) in	(160 + 10*L*) µin	Thread Setting Plugs
Micrometers, V-Anvil [1]	(0.0625 to 2) in	(53 + 7*L*) µin	Gauge Balls
Steel Rules Tape Measures [11]	(0 to 12) in	0.014 in	Optical Comparator
	(1 to 300) ft.	(1 400 + 5*L*) µin	Optodyne LDDM
Thickness Gauges (Dial & Digital) [1]	(0 to 0.5) in	60 µin	Gauge Blocks

Length – Hand Tools and Precision Gages 2D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Optical Comparators & Vision Measuring Machines[1]	Magnification 10X, 20X, 31.25X, 50X and 62.5X	0.001 2 in	Magnification Checker, Glass Scale &

Length – Hand Tools and Precision Gages 2D[9]

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Optical Comparators & Vision Measuring Machines[1]	Linear Length/ X/Y Axis Length (0 to 6) in	113 µin	Glass Scale
	(6 to 8) in	130 µin	Gauge Blocks
Optical Comparators & Vision Measuring Machines[1]	Angle (0 to 90) °	0.021º	Starrett AG8.TR
Protractors & Inclinometers	(0 to 90) °	2.88 min	Gauge Blocks, Cylindrical Square & Sine Plate
Levels	Up to 1 000 arc seconds	2.9 arc seconds	Brunson 470 Angle Generator

Mass – Force

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Force (Tension & Compression)	(0 to 5) lbf	0.000 2 lbf + 0.2% of reading	NIST Class F Deadweights
	(5 to 50) lbf	0.009 lbf + 0.01% of reading	
	(50 to 600) lbf	0.06 lbf + 0.01% of reading	
Cable/Wire Tensiometers	(1 to 600) lbf	0.06 lbf + 0.01% of reading	NIST Class F Deadweights
	(600 to 1 000) lbf	0.16 lbf + 0.3% of reading	CDI 2000

Mass – Hardness

Calibration Parameter/Equipment	Range	Calibration and Measurement Capability(+/-)	Remarks
Durometer Indenter	Angle	0.065º	STI Optical Comparator
	Diameter	220 µin	
	Radius	250 µin	
Durometer Force	Type A, B, E, O	0.05 N	Rex RDC-1
	Type C, D, & DO	0.1 N	
Durometer Calibrator Force	Type A, B, E, O	0.018 N	ASTM Class 1 Weights
	Type C, D, & DO	0.23 N	

Mass – Pressure/Low Vacuum

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Absolute – Measure and Generate	(-14.7 to 1 015) psia	0.002 3% of reading	Ruska 2465
Hydraulic – Measure and Generate	(20 to 6 000) psig	0.009 1% of reading	Ruska 5100
Low Pressure / Vacuum – Measure and Generate	(0 to 2) inH_2O	0.000 8 inH_2O	Dwyer 1430
	(-10 to +10) inH_2O	0.002 3 inH_2O	Meriam 34FBT2M
	(-20 to +20) inH_2O	0.003 1 inH_2O	Meriam 34FBT2M
Pneumatic – Measure and Generate	(0.2 to 1 000) psi	0.002 3 % of reading	Ruska 2465
Pressure – Measure and Generate[1]	(0 to 15) psi	0.01 psig	Fluke 700 Series Pressure Transducers
	(-15 to 30) psi	0.026 psig	
	(0 to 100) psi	0.06 psig	
	(0 to 500) psi	0.3 psig	
	(0 to 1 000) psi	0.66 psig	
	(0 to 10 000) psi	10 psig	
Vacuum – Measure & Generate	(-14.7 to 0) psig	2.3 x 10^{-5} % of reading	Ruska 2465
Vacuum – Measure & Generate [1]	(-14 to 0) psig	0.013 psig	Fluke 700 Series Pressure Transducer

Mass – Scale and Balances

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Scales & Balances[1]	(0 to 610) g	0.9 mg + 0.02 mg/mg	ASTM Class 1 Weights
	610 g to 35 kg	0.056 g + 0.002 g/kg	
	(0.5 to 600) lb	0.082 lb + 0.000 05 lb/lb	NIST 105-1 Class F Weights

Mass – Torque

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Torque – Measure	(20 to 200) ozf·in[1]	0.05 ozf·in + 0.3 %of reading	CDI 2000 Torque Tester
	(4 to 50) lbf·in[1]	0.009 lbf·in + 0.3 %of reading	
	(30 to 400) lbf·in[1]	0.05 lbf·in + 0.3 %of reading	
	(80 to 1 000) lbf·in[1]	0.95 lbf·in + 0.22 %of reading	
	(20 to 250) lbf·ft[1]	0.07 lbf·ft + 0.27 %of reading	
	(100 to 1 000) lbf·ft	0.01 lbf·ft + 0.63%of reading	
Torque – Source	(20 to 200) ozf·in	0.03ozf·in + 0.09% of reading	CDI Torque Arms & Wheels NIST Class F Weights
	(4 to 50) lbf·in	0.007 3lbf·in + 0.08% of reading	
	(30 to 400) lbf·in	0.001lbf·in + 0.1% of reading	
	(80 to 1 000) lbf·in	0.14lbf·in + 0.09% of reading	
	(20 to 250) lbf·ft	0.006 4lbf·ft + 0.09% of reading	
	(250 to 1 000) lbf·ft	0.2 lbf·ft + 0.01% of reading	

Thermodynamics – Humidity

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Humidity – Measure [1]	(10 to 80) %RH	1.4%RH	Vaisala HM70
Humidity – Generate	(10 to 90) %RH	0.57 %RH + 0.24 % of reading	Thunder Scientific 2500LT

Thermodynamics – Infrared (IR) Temperature

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Infrared – Source[1]	(50 to 500) °C	0.47 °C + 0.14 % of reading	Fluke 9132 Ɛ = 0.95 λ = (8 to 14) µm

Thermodynamics – Thermodynamic Sources

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Temperature - Generate [8]	-196 °C	0.023 °C	Fluke 7196 Fluke 5628

Thermodynamics – Thermodynamic Sources

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
	Ice Point [1]	0.158 °C	Kaye X0240
	(-50 to 0) °C	0.056 °C + 0.004 % of reading	Fluidized Baths Fluke 5610 Fluke 5628
	(0 to 100) °C	0.055 °C + 0.002 % of reading	
	(-100 to 250) °C	0.007 °C + 0.05 % of reading	
	(-15° to 350) °C[1]	0.26 °C + 0.15% of reading	Hart 9009
	(-95° to 140) °C	0.028 °C	Fluke 9190A [1] Fluke 5628
	(-45° to 140) °C	0.097 °C + 0.01 % of reading	Fluke 9170
	(50° to 700) °C	0.158 °C + 0.04 % of reading	Fluke 9173
Temperature - Generate	(-10° to 70) °C	0.14 °C	Thunder Scientific 2500LT
Temperature - Measure	(-200 to 660) °C	0.013 °C + 0.004% of reading	Hart Scientific 1560 Fluke 5628 SPRT
	(0 to 100) °C	0.009 °C + 0.003% of reading	Fluke 1586 5610 Thermistor
Dew Point	(-35 to 69) °C	0.14 °C	Thunder Scientific 2500LT

Time and Frequency – Frequency / Period

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Frequency – Measure	10 Hz to 1.3 GHz	6.9 parts in 10^{11}	Counter & Efratom M-100 [1]
Frequency Measuring Equipment	10 MHz	5 parts in 10^{12}	HP 58503A
	10 MHz	2.3 parts in 10^{11}	Efratom M-100[1]
Tachometers [1] (Contact Type)	(1 to 40 000) rpm	0.88 rpm	Quantum Dynamics N-11-ECS/3A
Tachometers [1] (Non-Contact Type)	(25 to 90 000) rpm	0.29 rpm + 3 µrpm/rpm	Frequency Counter
Stopwatches & Timers	(2 to 86 400) s/day	0.058 s/day	Helmut Klein 4500

Time and Frequency – Oscilloscopes

Calibration Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Amplitude – DC Signal 50 Ω [1] (1 mV to 6.6 V)	1 mV to 6.6 V	0.000 16 mV + 0.002 8 mV/V	Fluke 5520A/SC1100
Amplitude – DC Signal 1MΩ [1] (1 mV to 6.6 V)	1 mV to 130 V	0.000 6 mV + 0.000 50 mV/V	
Amplitude – Square Wave (peak to peak) 50 Ω[1] (1 mV to 6.6 V)	10 Hz to 10kHz	2.5 µV/V + 0.04 µV	Fluke 5520A/SC1100
Amplitude – Square Wave (peak to peak) 1 MΩ[1] (1 mV to 130 Vpp)	(0.01 to 1) kHz	1 µV/V + 0.04 µV	
	(1 to 10) kHz	2.5 µV/V + 0.04 µV	
Leveled Sine Wave Amplitude (@ 50 kHz ref.) [1] 5 mV to 5.5 V	50 kHz to 100 MHz	20 µV/V + 0.33 µV	Fluke 5520A/SC1100
	(100 to 300) MHz	40 µV/V + 0.31 µV	
	(300 to 600) MHz	60 µV/V + 0.31 µV	
5 mV to 3.5 V	(600 to 1 100) MHz	70 µV/V + 0.3 µV	
Flatness (@ 50 kHz ref.) [1] 5 mV to 5.5 V	50 kHz to 100 MHz	15 µV/V + 0.1 µV	Fluke 5520A/SC1100
	(100 to 300) MHz	20 µV/V + 0.1 µV	
	(300 to 600) MHz	40 µV/V + 0.1 µV	
4 mV to 3.5 V	(600 to 1 100) MHz	50 µV/V + 0.1 µV	
Time Marker [1]	1 ns to 20 ms	5 ps/µs	Fluke 5520A/SC1100
	50 ms	4.3 µs	
	0.1 s	0.13 µs	
	0.2 s	0.23 ms	
	0.5 s	0.53 ms	
	1 s	1 ms	
	2 s	2 ms	
	5 s	5 ms	
Rise Time – Voltage [1]	1 kHz to 2 MHz (200 to 300) ps	321 ps	Fluke 5520A/SC1100
	(2 to 10) MHz (200 to 350) ps	321 ps	

Certificate # L2216

Dimensional Measurement

Length - Dimensional Measurement 1D[9]

Inspection Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Length Measures – External	(0 to 12) in	(4 + 10*L*) µin	P&W Labmaster Universal
Length Measures – Internal	(0.02 to 13) in	(15 + 1*L*) µin	
Length Measures – Hand Tools	(0 to 2) in	(92 + 6*L*) µin	Digital Micrometers
	(0 to 8) in	(1400 + 5*L*) µin	Digital Caliper

Length - Dimensional Measurement 2D[9]

Inspection Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Remarks
Angle	(0 to 360) °	0.065°	STI Optical Comparator
2D Length	X/Y Axis: 0 to 8 in	190 µin	

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) *L* = length in inches
3) Measurements include the following measurement functions: Outside, Inside, Step and Depth Extension Rods.
4) Inch thread setting plugs only with 60° Included Angle.
5) Includes 60° Metric, Unified and 55° Whitworth pitch gauges.
6) Uncertainty is for Steel Blocks. Carbide and Ceramic blocks may have a different uncertainty due to deformation coefficients and different coefficients of thermal expansion.
7) Includes dial, digital and test indicators.
8) Includes Liquid-in-Glass Thermometers, RTDs, Thermocouples, Bi-metallic Thermometers, etc. Liquid-in-Glass Thermometers are only calibrated in fluidized baths to ensure correct immersion depth and stem effect corrections.
9) Metric equivalencies for this type of equipment are available and converted by 1 in equals 25.4 mm exactly.
10) TPI indicates Threads per inch.
11) Verification performed in 12 ft. increments before repositioning.
12) Includes Master Setting Discs and Progressive Diameter Plugs
13) D_l = Diagonal Length
14) This instrument/parameter has been characterized to lower the uncertainty.

Approved by: _____ Date: February 15, 2017

R. Douglas Leonard
Chief Technical Officer

Re-Issued: 2/15/17