



# CERTIFICATE OF ACCREDITATION

## ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

**CBRE, Inc.**

**9410 Bunsen Parkway, Suite 100B  
Louisville, KY 40220**

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

**ISO/IEC 17025:2017**

while demonstrating technical competence in the field of

**CALIBRATION**

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

L1117-1

Certificate Number

  
ANAB Approval

Certificate Valid Through: 02/12/2021  
Version No. 002 Issued: 02/05/2019



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017**

**CBRE, Inc.**

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**CALIBRATION**

Valid to: **February 12, 2021**

Certificate Number: **L1117-1**

**Acoustics and Vibration**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Acceleration Sensitivity/Frequency Response	(2 to 19) Hz	2.4 % of reading	Vibration Controller w/ Reference Accelerometer
	(20 to 99) Hz	2.2 % of reading	
	(100 to 2 499) Hz	2 % of reading	
	(2.5 to 10) kHz	3.1 % of reading	
Sound Level Meters	94 dB @ 250 Hz	0.45 dB	Sound Level Calibrator
	114 dB @ 250 Hz	0.45 dB	
	94 dB @ 1 kHz	0.45 dB	
	114 dB @ 1 kHz	0.45 dB	

**Chemical Quantities**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters (Range values referenced to 25°C)	≈ 5 μS	0.35 μS	Compared to Standard Solutions
	≈ 10 μS	0.52 μS	
	≈ 100 μS	0.88 μS	
	≈ 1 000 μS	4.9 μS	
	≈ 1 400 μS	5.6 μS	
	≈ 10 000 μS	33 μS	
pH Meters & Controllers	≈ 100 mS	0.38 mS	Standard Solutions
	(4.01, 7, 10) pH	0.021 pH	



Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Indicators - Electrical Simulation	(0 to 14) pH	0.006 4 pH	Voltage Calibrator
Capacitance – Source 10 Hz to 10 kHz	(220 to 400) pF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF	0.4 % of reading + 7.8 pF 0.4 % of reading + 7.8 pF 0.4 % of reading + 7.8 pF 0.2 % of reading + 7.8 pF 0.2 % of reading + 78 pF 0.2 % of reading + 78 pF 0.2 % of reading + 230 pF	Multifunction Calibrator
Capacitance – Source (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	(0.33 to 1.1) μF (1.1 to 3.30) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	0.4 % of reading + 0.78 nF 0.2 % of reading + 2.3 nF 0.2 % of reading + 7.8 nF 0.3 % of reading + 23 nF 0.35 % of reading + 23 nF 0.35 % of reading + 0.23 μF 0.35 % of reading + 0.78 μF 0.35 % of reading + 2.3 μF 0.35 % of reading + 7.8 μF 0.58 % of reading + 23 μF 0.85 % of reading + 78 μF	Multifunction calibrator Frequencies Indicate Maximum Charge / Discharge Rate
Capacitance Source 1 kHz	10 pF (20 to 30) pF 40 pF to 1 μF	0.7 % of reading + 5 pF 0.61 % of reading + 5 pF 0.59 % of reading + 5 pF	Decade Capacitor
Capacitance – Measure  50, 60, 100 & 120 Hz 200 Hz to 20 kHz (100 Hz Steps)  100 kHz	0.1 pF to 1.1 mF	0.14 % of reading   0.47 % of reading	RCL Meter @ 1V
DC Current – Measure	(0 to 200) μA 200 μA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	0.4 nA + 12 μA/A 4 nA + 12 μA/A 40 nA + 13 μA/A 8 μA + 36 μA/A 16 μA + 170 μA/A 0.4 mA + 380 μA/A	Digital Multimeter

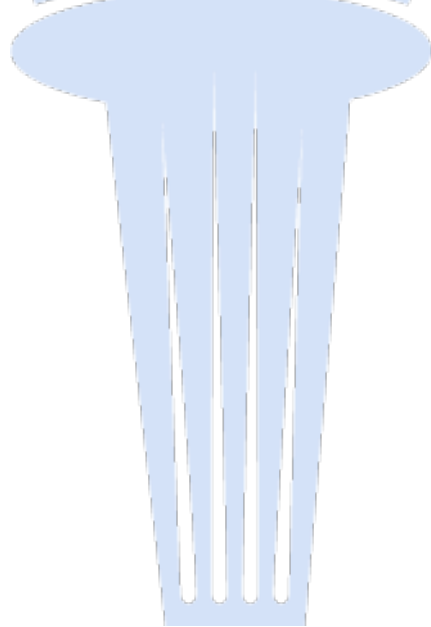
**Electrical – DC/Low Frequency**

<b>Parameter/Equipment<sup>1</sup></b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
DC Current – Measure	(0 to 100) A (0 to 300) A (200 to 500) A (500 to 1 000) A (1 000 to 1 200) A	0.012 A 0.087 A 0.26 % of reading 0.47 % of reading 0.48% of reading	Reference DMM with Shunts
DC Current – Source	(0 to 330) $\mu$ A (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (0.33 to 1.1) A (1.1 to 3.0) A (3 to 11) A (11 to 20.5) A	0.016 $\mu$ A + 0.12 mA/A 0.04 $\mu$ A + 78 $\mu$ A/A 0.2 $\mu$ A + 78 $\mu$ A/A 1.9 $\mu$ A + 78 $\mu$ A/A 31 $\mu$ A + 0.16 mA/A 31 $\mu$ A + 0.3 mA/A 0.39 mA + 0.4 mA/A 0.58 mA + 0.78 mA/A	5522A Multifunction Calibrator – with 8508A Reference Multimeter
DC Current – Source	(0 to 220) $\mu$ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	6 nA + 40 $\mu$ A/A 7 nA + 35 $\mu$ A/A 0.4 $\mu$ A + 35 $\mu$ A/A 0.7 $\mu$ + 45 $\mu$ A/A 12 $\mu$ A + $\mu$ A/A	5730A Multifunction Calibrator
DC Current – Source	(20 to 100) A (50 to 300) A (300 to 600) A	0.038 A 0.087 A 0.46 A	High Current Power Supply & Shunts
DC Current – Simulate	(11 to 1 050) A	0.21 % of reading	Multifunction Calibrator w/ 50 turn coil
	(1 050 to 2 500) A	0.83 % of reading	Transconductance Amplifier w/ 25 turn coil



Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source	29 $\mu$ A to 330 $\mu$ A (10 to 45) Hz (45 to 1 000) Hz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (0.33 to 3.3) mA (10 to 20) Hz (20 to 45) Hz (45 to 1 000) Hz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (3.3 to 33) mA (10 to 20) Hz (20 to 45) Hz (45 to 1 000) Hz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.08 nA + 0.16 % of reading 0.08 $\mu$ A + 0.97 % of reading 0.12 $\mu$ A + 0.23 % of reading 0.16 $\mu$ A + 0.62 % of reading 0.31 $\mu$ A + 1.3 % of reading 0.12 $\mu$ A + 0.16 % of reading 0.12 $\mu$ A + 0.097 % of reading 0.12 $\mu$ A + 0.78 % of reading 0.16 $\mu$ A + 0.16 % of reading 0.23 $\mu$ A + 0.39 % of reading 0.47 $\mu$ A + 0.78 % of reading 1.6 $\mu$ A + 0.14 % of reading 1.6 $\mu$ A + 0.07 % of reading 1.6 $\mu$ A + 0.03 % of reading 1.6 $\mu$ A + 0.62 % of reading 2.3 $\mu$ A + 0.16 % of reading 3.1 $\mu$ A + 0.31 % of reading	Multifunction Calibrator



**Electrical – DC/Low Frequency**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment		
AC Current – Source	(33 to 330) mA (10 to 20) Hz (20 to 45) Hz (45 to 1 000) Hz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	16 $\mu$ A + 0.14 % of reading 16 $\mu$ A + 0.07 % of reading 16 $\mu$ A + 0.03 % of reading 39 $\mu$ A + 0.078 % of reading 78 $\mu$ A + 0.16 % of reading 0.16 A + 0.3 % of reading	Multifunction Calibrator		
	(0.33 to 1.1) A (10 to 45) Hz (45 to 1 000) Hz (1 to 5) kHz (5 to 10) kHz	78 $\mu$ A + 0.14 % of reading 78 $\mu$ A + 0.04 % of reading 0.78 mA + 0.47 % of reading 3.8 mA + 1.9 % of reading			
	(1.1 to 3.0) A (10 to 45) Hz (45 to 1 000) Hz (1 to 5) kHz (5 to 10) kHz	78 $\mu$ A + 0.14 % of reading 78 $\mu$ A + 0.047 % of reading 0.78 mA + 0.47 % of reading 0.39 mA + 1.9 % of reading			
	(3.0 to 11) A (45 to 100) Hz (100 to 1 000) Hz (1 to 5) kHz	1.6 mA + 0.047 % of reading 1.6 mA + 0.078 % of reading 1.6 mA + 2.3 % of reading			
	(11 to 20.5) A (45 to 100) Hz (100 to 1 000) Hz (1 to 5) kHz	3.9 mA + 0.093 % of reading 3.9 mA + 0.12 % of reading 3.9 mA + 2.3 % of reading			
	(0 to 100) A (1 to 60) Hz 61 Hz to 1 kHz	0.013 A 0.12 A		Current Source w/ shunt & DMM	
	(0 to 100) A 1 Hz to 1 kHz	0.29 A		Transconductance Amplifier w/ Multifunction Calibrator	
	AC Current - Source	(9 to 220) $\mu$ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz		16 nA + 250 $\mu$ A/A 10 nA + 160 $\mu$ A/A 8 nA + 103 $\mu$ A/A 12 nA + 280 $\mu$ A/A 65 nA + 1.1 mA/A	5730A Multifunction Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Source	220 $\mu$ A to 2.2 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	40 nA + 250 $\mu$ A/A 35 nA + 160 $\mu$ A/A 35nA + 103 $\mu$ A/A 110 nA + $\mu$ A/A 0.65 mA + 1.1 mA/A 4 $\mu$ A + 250 $\mu$ A/A 3.5 $\mu$ A + 160 $\mu$ A/A 2.5 $\mu$ A + 103 $\mu$ A/A 3.5 $\mu$ A + 200 $\mu$ A/A 10 $\mu$ A + 1.1 mA/A 35 $\mu$ A + 244 $\mu$ A/A 80 $\mu$ A + 450 $\mu$ A/A 160 $\mu$ A + 7 mA/A	5730A Multifunction Calibrator
AC Current – Simulate	(110 to 2 500) A	0.8 A	Multifunction Calibrator w/ multi turn coils



**Electrical – DC/Low Frequency**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure	200 $\mu$ A (1 to 10) Hz	20 nA + 0.25 mA/A	Digital Multimeter
	10 Hz to 10 kHz	20 nA + 0.28 mA/A	
	(10 to 30) kHz	20 nA + 0.65 mA/A	
	(30 to 100) kHz	0.4 % of reading + 20 nA	
	2 mA (1 to 10) Hz	200 nA + 0.25 mA/A	
	10 Hz to 10 kHz	200 nA + 0.28 mA/A	
	(10 to 30) kHz	200 nA + 0.65 mA/A	
	(30 to 100) kHz	0.4 % of reading + 0.2 $\mu$ A	
	20 mA (1 to 10) Hz	2 $\mu$ A + 0.25 mA/A	
	10 Hz to 10 kHz	2 $\mu$ A + 0.28 mA/A	
(10 to 30) kHz	2 $\mu$ A + 0.65 mA/A		
(30 to 100) kHz	0.4 % of reading + 2 $\mu$ A		
200 mA (1 to 10) Hz	20 $\mu$ A + 0.25 mA/A	Digital Multimeter	
10 Hz to 10 kHz	20 $\mu$ A + 0.25 mA/A		
(10 to 30) kHz	20 $\mu$ A + 0.6 mA/A		
(10 to 30) kHz	20 $\mu$ A + 0.6 mA/A		
2 A 10 Hz to 2 kHz	0.2 mA + 0.6 mA/A	Digital Multimeter	
(2 to 10) kHz	0.2 mA + 0.7 mA/A		
(10 to 30) kHz	0.3 % of reading + 0.2 mA		
AC Current – Measure	20 A 10 Hz to 2 kHz (2 to 10) kHz	2 mA + 0.8 mA/A 0.25 % of reading + 2 mA	Digital Multimeter
AC Current - Measure	(1 to 20) A, 60 Hz (20 to 100) A, 60 Hz (100 to 300) A, 60 Hz (20 to 100) A, 1 kHz (100 to 300) A, 1 kHz	0.18 % of reading 0.013 A 0.087 A 0.12 A 0.35 A	DMM w/ Shunts
Inductance – Measure  (50, 60, 100 & 120) Hz 200 Hz to 20 kHz (100 Hz Steps)  100 kHz	100 $\mu$ H to 10 H    100 $\mu$ H to 10 H	0.14 % of reading    0.47 % of reading	RCL Meter @ 1V





Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance - Source	(1 to 10) mH, 1 kHz (10 to 100) mH, 500 Hz 100 mH to 1 H, 200 Hz (1 to 10) H, 100 Hz	2.2 % of reading 1.1 % of reading 0.6 % of reading 0.3 % of reading	Decade Inductor
AC Power – Source	(1.1 to 3) mW (3 to 11) mW (11 to 300) mW (300 to 726) mW (0.7 to 1.5) W (1.5 to 6.77) W (0.6 to 92) W (92 to 336) W (336 to 918) W (918 to 2 244) W (2 244 to 4 590) W (4.5 to 20.9) kW	0.11 % of reading 0.078 % of reading 0.1 % of reading 0.08 % of reading 0.11 % of reading 0.086 % of reading 0.093 % of reading 0.062 % of reading 0.93 % of reading 0.07 % of reading 0.093 % of reading 0.078 % of reading	Multifunction Calibrator 45 Hz to 65 Hz Power Factor = 1
DC Power – Source	11 $\mu$ W to 330 W 330 W to 3 kW (3 to 21) kW	0.018 % of reading 0.025 % of reading 0.054 % of reading	Multifunction Calibrator
Energy - Watt Hour Meters	1.5 W·h to 20.9 kW·h	0.08 % of reading	Multifunction Calibrator / Electronic Counter 45 Hz to 65 Hz Power Factor = 1
Resistance - Current Shunts	Up to 100 m $\Omega$ (100 A) Up to 100 m $\Omega$ (300 A)	2.5 m $\Omega$ / $\Omega$ 29 m $\Omega$ / $\Omega$	Current Shunt, Digital Multimeter
DC Resistance – Measure	(0 to 2) $\Omega$ (2 to 20) $\Omega$ (20 to 200) $\Omega$ 200 $\Omega$ to 2 k $\Omega$ (2 to 20) k $\Omega$ (20 to 200) k $\Omega$ 200 k $\Omega$ to 2 M $\Omega$ (2 to 20) M $\Omega$ (20 to 200) M $\Omega$ 200 M $\Omega$ to 2 G $\Omega$	4 $\mu\Omega$ + 15 $\mu\Omega$ / $\Omega$ 14 $\mu\Omega$ + 9 $\mu\Omega$ / $\Omega$ 50 $\mu\Omega$ 7.5 $\mu\Omega$ / $\Omega$ 0.5 m $\Omega$ + 7.5 $\mu\Omega$ / $\Omega$ 5 m $\Omega$ + 7.5 $\mu\Omega$ / $\Omega$ 50 m $\Omega$ + 7.5 $\mu\Omega$ / $\Omega$ 1 $\Omega$ + 8.5 $\mu\Omega$ / $\Omega$ 100 $\Omega$ + 15 $\mu\Omega$ / $\Omega$ 10 k $\Omega$ + 60 $\mu\Omega$ / $\Omega$ 100 k $\Omega$ + 525 $\mu\Omega$ / $\Omega$	Digital Multimeter
AC Resistance – Measure	(0.01 to 200) M $\Omega$ 50 Hz to 2 kHz (2 to 20) kHz 100 kHz	0.063 % of reading 0.13 % of reading 0.47 % of reading	Philips RLC Meter



Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source	(0 to 11) Ω	31 μΩ/Ω + 0.8 mΩ	Multifunction Calibrator
	(11 to 33) Ω	23 μΩ/Ω + 1.2 mΩ	
	(33 to 330) Ω	21 μΩ/Ω + 1.6 mΩ	
	330 Ω to 1.1 kΩ	23 μΩ/Ω + 1.6 mΩ	
	1.1 kΩ to 3.3 kΩ	22 μΩ/Ω + 16 mΩ	
	(3.3 to 11) kΩ	22 μΩ/Ω + 16 mΩ	
	(11 to 33) kΩ	22 μΩ/Ω + 0.16 Ω	
	(33 to 110) kΩ	22 μΩ/Ω + 0.16 Ω	
	(110 to 330) kΩ	25 μΩ/Ω + 1.6 Ω	
	330 kΩ to 1.1 MΩ	25 μΩ/Ω + 1.6 Ω	
	1.1 MΩ to 3.3 MΩ	47 μΩ/Ω + 24 Ω	
	(3.3 to 11) MΩ	0.10 mΩ/Ω + 39 Ω	
	(11 to 33) MΩ	0.19 mΩ/Ω + 1.9 kΩ	
(33 to 110) MΩ	0.39 mΩ/Ω + 2.4 kΩ		
DC Resistance – Source	(110 to 330) MΩ	0.23 mΩ/Ω + 78 kΩ	Multifunction Calibrator
	(330 to 1 100) MΩ	2.3 mΩ/Ω + 0.39 MΩ	
DC Resistance – Source	0 Ω	40 μΩ	5730A Multifunction Calibrator
	1 Ω	95 μΩ	
	1.9 Ω	95 μΩ	
	10 Ω	23 μΩ	
	19 Ω	23 μΩ	
	100 Ω	10 μΩ	
	190 Ω	10 μΩ	
DC Resistance – Source	1 kΩ	6.5 μΩ	5730A Multifunction Calibrator
	1.9 kΩ	6.5 μΩ	
	10 kΩ	6.5 μΩ	
	19 kΩ	6.5 μΩ	
	100 kΩ	8.5 μΩ	
	190 kΩ	8.5 μΩ	
	1 MΩ	13 μΩ	
	1.9 MΩ	18 μΩ	
	10 MΩ	40 μΩ	
	19 MΩ	47 μΩ	
	100 MΩ	100 μΩ	



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## Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source	25 Ω	7.8 μΩ/Ω	Fixed Resistors
	75 Ω	7.8 μΩ/Ω	
	100 Ω	7.8 μΩ/Ω	
	200 Ω	7.8 μΩ/Ω	
	400 Ω	7.8 μΩ/Ω	
	10 kΩ	7.7 μΩ/Ω	
	40 kΩ	7.7 μΩ/Ω	
	100 kΩ	7.8 μΩ/Ω	
	300 kΩ	8.1 μΩ/Ω	
	500 kΩ	9.8 μΩ/Ω	
	1 GΩ	2 MΩ	
	10 GΩ	19 MΩ	
	100 GΩ	0.58 GΩ	
1 TΩ	2.3 GΩ		
Electrical Simulation of RTD Indicators	100 Ω RTD Pt (385)		Multifunction Calibrator
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 630) °C	0.09 °C	
(630 to 800) °C	0.18 °C		



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicators	100 Ω RTD Pt (3916)		Multifunction Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.03 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 260) °C	0.05 °C	
	(260 to 300) °C	0.06 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.08 °C	
	(600 to 630) °C	0.18 °C	
	100 Ω RTD Pt (3926)		
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 630) °C	0.09 °C	
	200 Ω RTD Pt (385)		
	(-200 to 100) °C	0.03 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	500 Ω RTD Pt (385)		
	(-200 to -80) °C	0.03 °C	
	(-80 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 400) °C	0.06 °C	
	(400 to 600) °C	0.07 °C	
(600 to 630) °C	0.09 °C		
1000 Ω RTD Pt (385)			
(-190 to 0) °C	0.02 °C		
(0 to 100) °C	0.03 °C		
(100 to 260) °C	0.04 °C		
(260 to 600) °C	0.05 °C		
(600 to 630) °C	0.18 °C		
120 Ω RTD Ni (120)			
(-80 to 100) °C	0.08 °C		
(100 to 260) °C	0.12 °C		



Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicators	10 Ω RTD Cu (427) (-100 to 260) °C	0.24 °C	Multifunction Calibrator
DC Volts – Measure	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1 000) V	0.1 μV + 4.5 μV/V 0.4 μV + 3 μV/V 4 μV + 3 μV/V 40 μV + 4.5 μV/V 0.5 mV + 4.5 μV/V	Digital Multimeter
	(1 to 10) kV	300 mV + 0.3 mV/V	High Voltage Meter
	(10 to 100) kV	0.69 % of reading	High Voltage Divider & DMM
DC Volts – Source	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1 000) V	0.1 μV + 4.5 μV/V 0.4 μV + 3 μV/V 4 μV + 3 μV/V 40 μV + 4.5 μV/V 0.5 mV + 4.5 μV/V	5522A Multifunction Calibrator with 8508A Digital Multimeter
DC Volts - Source	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	0.4 μV + 7.5 μV/V 0.7 μV + 2.5 μV/V 2.6 μV + 2.5 μV/V 4 μV + 3.5 μV/V 40 μV + 5 μV/V 400 μV + 6.5 μV/V	5730A Multifunction Calibrator
AC Volts True RMS (Source)	(1 to 200) mV (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 500) kHz (2 to 20) V (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	4 μV + 0.13 mV/V 4 μV + 0.11 mV/V 2 μV + 0.11 mV/V 4 μV + 0.11 mV/V 8 μV + 0.31 mV/V 20 μV + 0.71 mV/V 0.3 % of reading + 0.2 mV 1 % of reading + 2 mV 1.2 mV + 0.1 mV/V 0.2 mV + 85 μV/V 0.2 mV + 65 μV/V 0.2 mV + 85 μV/V 0.4 mV + 0.21 mV/V 2 mV + 0.51 mV/V	5522A Multifunction Calibrator with 8508A Digital Multimeter



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Volts True RMS (Source)	(20 to 200) V (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 20) kHz	2 mV + 0.11 mV/V 2 mV + 85 μV/V 2 mV + 65 μV/V 2 mV + 85 μV/V 4 mV + 0.21 mV/V	5522A Multifunction Calibrator with 8508A Digital Multimeter
	(200 to 1 000) V (10 to 40) Hz 40 Hz to 10 kHz	20 mV + 0.11 mV/V 20 mV + 95 μV/V	
AC Volts – Source	(2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	2 μV + 240 μV/V 4 μV + 90 μV/V 4 μV + 80 μV/V 4 μV + 200 μV/V 5 μV + 500 μV/V 10 μV + 1.05 mV/V 20 μV + 1.4 mV/V 20 μV + 2.7 mV/V	5730A Multifunction Calibrator
	(22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 220 mV to 2.2 V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	4 μV + 240 μV/V 4 μV + 90 μV/V 4 μV + 80 μV/V 4 μV + 200 μV/V 5 μV + 500 μV/V 10 μV + 1.1 mV/V 20 μV + 1.4 mV/V 20 μV + 2.7 mV/V 40 mV + 240 μV/V 15 mV + 90 μV/V 8 mV + 42 μV/V 10 mV + 67 μV/V 30 mV + 83 μV/V 80 mV + 336 μV/V 200 mV + 1 mV/V 300 mV + 1.7 mV/V	

**Electrical – DC/Low Frequency**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Volts – Source	(2.2 to 22) V		5730A Multifunction Calibrator
	(10 to 20) Hz	400 mV + 240 $\mu$ V/V	
	(20 to 40) Hz	150 mV + 90 $\mu$ V/V	
	40 Hz to 20 kHz	50 mV + 42 $\mu$ V/V	
	(20 to 50) kHz	100 mV + 67 $\mu$ V/V	
	(50 to 100) kHz	200 mV + 83 $\mu$ V/V	
	(100 to 300) kHz	600 mV + 254 $\mu$ V/V	
	(300 to 500) kHz	2 V + 1 mV/V	
	500 kHz to 1 MHz	3.2 V + 1.5 mV/V	
	(22 to 220) V		
	(10 to 20) Hz	4 mV + 240 $\mu$ V/V	
	(20 to 40) Hz	1.5 mV + 90 $\mu$ V/V	
	40 Hz to 20 kHz	0.6 mV + 240 $\mu$ V/V	
	(20 to 50) kHz	1 mV + 80 $\mu$ V/V	
	(50 to 100) kHz	2 mV + 150 $\mu$ V/V	
	(100 to 300) kHz	16 mV + 900 $\mu$ V/V	
	(300 to 500) kHz	40 mV + 4.4 mV/V	
	500 kHz to 1 MHz	80 mV + 1.5 mV/V	
	(220 to 1 100) V		
	(15 to 50) Hz	16 mV + 300 $\mu$ V/V	
50 Hz to 1kHz	3.5 mV + 70 $\mu$ V/V		



**Electrical – DC/Low Frequency**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Volts True RMS (Measure)	(0 to 200) mV		Digital Multimeter
	(1 to 10) Hz	14 $\mu$ V + 0.12 mV/V	
	(10 to 40) Hz	4 $\mu$ V + 0.13 mV/V	
	(40 to 100) Hz	4 $\mu$ V + 0.11 mV/V	
	(0 to 200) mV		
	100 Hz to 2 kHz	2 $\mu$ V + 0.11 mV/ $\mu$ V	
	(2 to 10) kHz	4 $\mu$ V + 0.11 mV/ $\mu$ V	
	(10 to 30) kHz	8 $\mu$ V + 0.31 mV/ $\mu$ V	
	(30 to 100) kHz	20 $\mu$ V + 0.71 mV/ $\mu$ V	
	(100 to 300) kHz	0.2 mV + 0.3 % of reading	
	300 kHz to 1 MHz	2 mV + 1 % of reading	
	200 mV to 2 V		
	(1 to 10) Hz	120 $\mu$ V + 0.1 mV/ $\mu$ V	
	(10 to 40) Hz	20 $\mu$ V + 0.11 mV/ $\mu$ V	
	(40 to 100) Hz	20 $\mu$ V + 85 $\mu$ V/V	
	100 Hz to 2 kHz	20 $\mu$ V + 65 $\mu$ V/V	
	(2 to 10) kHz	22 $\mu$ V + 85 $\mu$ V/V	
	(10 to 30) kHz	40 $\mu$ V + 0.21 mV/V	
	(30 to 100) kHz	0.2 mV + 0.51 mV/V	
	(100 to 300) kHz	2 mV + 0.3 % of reading	
300 kHz to 1 MHz	2 mV + 1 % of reading		

**Electrical – DC/Low Frequency**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Volts True RMS (Measure)	(2 to 20) V		Digital Multimeter
	(1 to 10) Hz	1.2 mV + 0.1 mV/V	
	(10 to 40) Hz	0.2 mV + 0.11 mV/V	
	(40 to 100) Hz	0.2 mV + 85 μV/V	
	100 Hz to 2 kHz	0.2 mV + 65 μV/V	
	(2 to 10) kHz	0.2 mV + 85 μV/V	
	(10 to 30) kHz	0.4 mV + 0.21 mV/V	
	(30 to 100) kHz	2 mV + 0.51 mV/V	
	(100 to 300) kHz	20 mV + 0.3 % of reading	
	300 kHz to 1 MHz	0.2 V + 1 % of reading	
	(20 to 200) V		
	(1 to 10) Hz	12 mV + 0.1 mV/V	
	(10 to 40) Hz	2 mV + 0.11 mV/V	
	(40 to 100) Hz	2 mV + 85 μV/V	
	100 Hz to 2 kHz	2 mV + 65 μV/V	
(2 to 10) kHz	2 mV + 85 μV/V		
(10 to 30) kHz	4 mV + 0.21 mV/V		
(20 to 200) V	(30 to 100) kHz	20 mV + 0.51 mV/V	
	(100 to 300) kHz	0.2 V + 0.3 % of reading	
	300 kHz to 1 MHz	2 V + 1 % of reading	
	(200 to 1 000) V		
(1 to 10) kV	(1 to 10) Hz	70 mV + 0.1 mV/V	High Voltage Meter
	(10 to 40) Hz	20 mV + 0.11 mV/V	
	40 Hz to 10 kHz	20 mV + 95 μV/V	
	(10 to 30) kHz	40 mV + 0.21 mV/V	
	30 kHz to 1 MHz	200 mV + 0.51 mV/V	
AC Volts True RMS (Measure)	(1 to 10) kV		High Voltage Meter
	(0.1 to 200) Hz	0.2 V + 180 μV/V	
	(200 to 450) Hz	0.1 V + 617 μV/V	
	(450 to 600) Hz	0.23 V + 1153 μV/V	
AC Volts True RMS (Measure)	(1 to 40) kV		Digital Multimeter w/ High Voltage Probe
	60 Hz	5 % of reading	
Electrical Simulation of Thermocouple Indicators	Type B		Multifunction Calibrator
	(600 to 800) °C	0.35 °C	
	(800 to 1 000) °C	0.27 °C	
	(1 000 to 1 550) °C	0.24 °C	
	(1 550 to 1 820) °C	0.26 °C	



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Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators	Type C		Multifunction Calibrator
	(0 to 150) °C	0.24 °C	
	(150 to 650) °C	0.21 °C	
	(650 to 1 000) °C	0.25 °C	
	(1 000 to 1 800) °C	0.39 °C	
	(1 800 to 2 316) °C	0.65 °C	
	Type E		
	(-250 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 350) °C	0.12 °C	
	(350 to 650) °C	0.14 °C	
	(650 to 1 000) °C	0.17 °C	
	Type J		
	(-210 to -100) °C	0.22 °C	
	(-100 to -30) °C	0.14 °C	
	(-30 to 150) °C	0.12 °C	
	(150 to 760) °C	0.13 °C	
	(760 to 1 200) °C	0.19 °C	
	Type K		
	(-200 to -100) °C	0.26 °C	
	(-100 to -25) °C	0.15 °C	
	(-25 to 120) °C	0.14 °C	
	(120 to 1 000) °C	0.21 °C	
	(1 000 to 1 372) °C	0.32 °C	
	Type N		
	(-200 to -100) °C	0.32 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.16 °C	
(120 to 410) °C	0.15 °C		
(410 to 1 300) °C	0.22 °C		
Type R			
(0 to 250) °C	0.45 °C		
(250 to 400) °C	0.22 °C		
(400 to 1 000) °C	0.21 °C		
(1 000 to 1 767) °C	0.24 °C		
Type S			
(0 to 250) °C	0.37 °C		
(250 to 1 400) °C	0.29 °C		
(1 400 to 1 767) °C	0.36 °C		



Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators	Type T		Multifunction Calibrator
	(-250 to -150) °C	0.49 °C	
	(-150 to 0) °C	0.20 °C	
	(0 to 120) °C	0.14 °C	
	(120 to 400) °C	0.12 °C	
	Type U		
(-200 to 0) °C	0.44 °C		
(0 to 600) °C	0.22 °C		
Phase Angle - Source	(0 to 360) °		Multifunction Calibrator
	(10 to 65) Hz	0.078 °	
	(65 to 500) Hz	0.19 °	
	500 Hz to 1 kHz	0.39 °	
	(1 to 5) kHz	1.9 °	
	(5 to 10) kHz	3.9 °	
(10 to 30) kHz	7.8 °		
Phase Angle - Measure	(0 to 360) ° (±180) °		Phase meter
	5 Hz to 2 kHz	0.026 °	
	(2 to 5) kHz	0.036 °	
	(5 to 10) kHz	0.055 °	
	(10 to 50) kHz	0.065 °	
	(50 to 100) kHz	0.13 °	
	(100 to 500) kHz	0.61 °	
500 kHz to 1 MHz	1.2 °		
Squarewave – Amplitude Into 50 Ω  Into 1 MΩ	1mV <sub>p-p</sub> to 6.6V <sub>p-p</sub> (10 Hz to 10 kHz)	0.19 % of reading + 31 μV	Fluke 5522A/SC1100 Multifunction Calibrator
	1 mV <sub>p-p</sub> to 130 V <sub>p-p</sub> (10 Hz to 1 kHz)	0.08 % of reading + 31 μV	
	(> 1 Hz to 10 kHz)	0.19 % of reading + 31 μV	
Squarewave Frequency	10 Hz to 10 kHz	1.9 x 10 <sup>-6</sup> of reading	
Edge Transition Time	1 kHz to 2 MHz Nominal 250 ps	300 ps	Fluke 5522A/SC1100 Multifunction Calibrator
	(2 to 10) MHz Nominal 250 ps	350 ps	
Leveled Sinewave Amplitude (50 kHz ref.)	5 mV to 5.5 V <sub>p-p</sub>	1.6 % of reading + 0.24 mV	Fluke 5522A/SC1100 Multifunction Calibrator



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## Electrical – DC/Low Frequency

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Leveled Sinewave Flatness (50 kHz ref.)  Into 1 MΩ Into 50 Ω	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1 100) MHz	1.3 % of reading + 78 μV 1.7 % of reading + 78 μV 3.2 % of reading + 78 μV 3.9 % of reading + 78 μV	
Time Marker	1 ns to 20 ms 50 ms to 5 s	2 μs/s 19 + (780*t) μs/s	Fluke 5522A/SC1100 Multifunction Calibrator
Function Generation (Square, Triangle and Sine) (10 Hz to 10 kHz)	1.8 mV to 55 V p-p 1.8 mV to 2.5 V p-p	2.3 % of reading + 78 μV	
Pulse Generation Pulse Width Pulse Period	(4 to 500) ns 200 ns to 20 ms	3.9 % + 1.6 ns 1.9 x 10 <sup>-6</sup> s	
Input Impedance	(40 to 60) Ω 500 kΩ to 1.5 mΩ (5 to 50) pF	0.08 % of reading 0.08 % of reading 4 % of reading + 0.4 pF	

## Electrical – RF/Microwave

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Source	(-30 to 20) dBm 10 MHz to 1 090 MHz	3.6 % of reading	Signal Generator w/ Power Meter
RF Power – Measure	(-30 to 20) dBm 10 MHz to 18 GHz	3.6 % of reading	Power Meter
Harmonic Distortion 0.3 % to 100 % Range	< 30 V 10 Hz to 1 MHz (1 to 3) MHz (30 to 300) V 10 Hz to 300 kHz (300 to 500) kHz (0.5 to 3) MHz	3.6 % of reading 7.2 % of reading 3.6 % of reading 7 % of reading 14 % of reading	Distortion Analyzer



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## Electrical – RF/Microwave

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Harmonic Distortion 0.1 % Range	< 30 V (10 to 20) Hz (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 3) MHz	14 % of reading 7 % of reading 3.6 % of reading 7 % of reading 14 % of reading	Distortion Analyzer
	>30 V (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz	14 % of reading 3.6 % of reading 7 % of reading 14 % of reading	

## Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
End Measuring Rods <sup>2</sup> (Micrometer Standards)	(0.5 in to 39) in (12.7 to 1 000) mm	(16 + 2.4L) μin (0.41 + 0.002 4L) μm	ULM
Cylindrical Pins, Plugs & Wires <sup>1,2</sup>	(0 to 4) in (0 to 100) mm	(15 + 1.2D) μin (0.38 + 0.001 2D) μm	
Plain Ring Gages <sup>2</sup>	(0.25 to 12) in (6 to 300) mm	(19 + 1.3D) μin (0.48 + 0.001 3D) μm	
Thickness / Feeler Gages <sup>1</sup>	(0 to 0.2) in (0 to 5) mm	37 μin 0.94 μm	
Precision Squares: Perpendicularity <sup>2</sup>	(0 to 24) in (0 to 700) mm	(52 + 2.1L) μin (1.3 + 0.002 1L) μm	Comparison to Master Square and Gage Amp
Straight Edges & Precision Parallels	(0 to 0.02) in	92 μin	Gage Amp
Angle Gages	(1 to 90) °	28 "	Optical Comparator with Micropak 2
Thread Pitch Gages: (2.25 to 84) tpi Length Measures Angular Measure	(0.011 to 0.44) in	340 μin 2.3 "	Optical Comparator with Micropak 2
Sine Bars & Plates: Parallelism Angle Calibration	(0 to 0.02) in 15 °	33 μin 4 "	Gage Amp & Master Angle Block



**Length – Dimensional metrology**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Radius Gages	(0.02 to 1) in	280 $\mu$ in	Optical Comparator with Micropak 2
Angle Blocks	(0.25 to 45) °	7.8 ”	Gage Amplifier & Sine Plate
V-Blocks <sup>2</sup> : Parallelism – Side Parallelism – Vee Squareness	(0 to 0.02) in	50 $\mu$ in 50 $\mu$ in (38 + 1.7 <i>G</i> ) $\mu$ in	Gage Amplifier & Gage Blocks Master Square Plug Gage
Surface Plates <sup>1,2</sup> : Overall Flatness Local Area Flatness (Repeat Readings)	Up to (12 x 12) ft Up to (48 x 72) in Up to 0.031 in	(19 + 1.2 <i>Di</i> ) $\mu$ in (20 + 1.3 <i>Di</i> ) $\mu$ in 29 $\mu$ in	Differential Electronic Levels Planekator Repeat-o-meter
Thread Plugs (4 to 80) tpi <sup>1,2</sup> : Simple Pitch Diameter	(0 to 4) in (0 to 100) mm	(79 + 5.2 <i>D</i> ) $\mu$ in (2 + 0.005 <i>D</i> ) $\mu$ m	ULM 3-Wire Method
Thread Plugs (4 to 80) tpi <sup>1,2</sup> : Major Diameter	(0 to 4) in (0 to 100) mm	(15 + 1.2 <i>D</i> ) $\mu$ in (0.38 + 0.001 2 <i>D</i> ) $\mu$ m	ULM
H-Point Machine: Dimensional Measures	Up to 24 in Up to 600 mm	437 $\mu$ in 11 $\mu$ m	CMM Per SAE J826 & SAE J4002
Check Gages & Fixtures <sup>2</sup> : 1D Axis Length	X = (0 to 40) in Y = (0 to 40) in Z = (0 to 24) in	(210 + 12 <i>L</i> ) $\mu$ in (210 + 12 <i>L</i> ) $\mu$ in (210 + 12 <i>L</i> ) $\mu$ in	Zeiss CMM
Check Gages & Fixtures <sup>2</sup> 3D Length	Up to (24 x 24 x 24) in Up to (40 x 40 x 24) in	(350 + 24 <i>L</i> ) $\mu$ in (410 + 21 <i>L</i> ) $\mu$ in	Zeiss CMM
Torque Arms and Wheels <sup>2</sup> Effective Length	Up to 40 in	(220 + 14 <i>L</i> ) $\mu$ in	Zeiss CMM & Micrometer
Micrometers <sup>1,2</sup> : Inside, Outside, Depth, Bore Types - Length	(0 to 4) in (0 to 100) mm (5 to 20) in (100 to 500) mm (21 to 82) in (500 to 2 000) mm	(31 + 8 <i>L</i> ) $\mu$ in (0.79 + 0.008 <i>L</i> ) $\mu$ m (92 + 6 <i>L</i> ) $\mu$ in (2.4 + 0.006 <i>L</i> ) $\mu$ m (1 200 + 4 <i>L</i> ) $\mu$ in (31 + 0.004 <i>L</i> ) $\mu$ m	Gage Blocks Optical Flats & Optical Parallels
Anvil/Spindle Flatness	(0 to 100) $\mu$ in	9.7 $\mu$ in	
Anvil/Spindle Parallelism	(0 to 800) $\mu$ in	14 $\mu$ in	
Height Gages <sup>1,2</sup>	(0 to 40) in (0 to 1 000) mm	(340 + 8 <i>L</i> ) $\mu$ in (8.5 + 0.008 <i>L</i> ) $\mu$ m	Gage Blocks



**Length – Dimensional metrology**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Height Master and Riser Block	Up to 12 in Up to 18 in Up to 24 in	71 µin 81 µin 85 µin	Gage Blocks Gage Amp
Indicators, Digital, Dial & Test Indicators <sup>1,2</sup>	Resolution = 50 µin (0 to 4) in (0 to 100) mm	(38 + 5.5L) µin (1 + 0.004L) µm	Gage Blocks
Indicators, Digital, Dial & Test Indicators <sup>1</sup>	Resolution ≥ 100 µin  (0 to 1) in (0 to 25) mm  2 in (50 mm) 3 in (75 mm) 4 in (100 mm)	58 µin 1.5 µm  59 µin (1.5 µm) 59 µin (1.5 µm) 61 µin (1.6 µm)	Gage Blocks, or Indicator Calibrator
Gage Amplifiers & Comparators <sup>2</sup>	(0 to 0.03) in (0 to 0.8) mm	(9 + 220L) µin (0.23 + 0.22L) µm	Gage Blocks
Calipers & Linear Scales <sup>1,2</sup>	(0 to 24) in (0 to 600) mm (25 to 96) in (600 to 2 400) mm	(280 + 10L) µin (7.1 + 0.01L) µm (430 + 5L) µin (11 + 0.005L) µm	Gage Blocks
Flexible Tape Measures <sup>1,2</sup>	(0 to 100) ft	(0.01 + 0.001 5L) in	Glass Microrule
Steel Rules <sup>1</sup>	(0.1 to 96) in	0.02 % of reading	Glass Microrule
Pi Tapes <sup>1</sup>	(2 to 40) in	0.02 % of reading	
Ultrasonic Foam <sup>1</sup> - Height Testers	(5 to 300) mm	0.04 % of reading	Gage Blocks
Coating Thickness Gages <sup>1</sup>	0.354 mils 0.838 mils 3.050 mils	10 µin	Coating Thickness Masters
Universal Protractors <sup>1</sup>	(0 to 90) °	12 ″	Optical Comparator with Micropac2
Bubble Levels <sup>1</sup> : Level Vial Setting Vial Sensitivity	(2 to 48) in	93 µin 110 µin	Gage Blocks and Surface Plate
Digital Protractors and Clinometers <sup>1</sup>	(0 to 90) °	0.05 °	Gage Blocks and Sine Bar/Plate
Electronic Levels <sup>1</sup>	(0.1 to 990) ″	0.26 % of reading	Gage Blocks Sine Bar/Plate

**Length – Dimensional metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical & Video Comparators <sup>1</sup> : Magnification	10x, 20x, 50x	0.17 % of reading	Magnification Checker
Optical & Video Comparators <sup>1</sup> : Linear Scales	X, Y, Z Axis: (0 to 8) in	110 µin	Gage Blocks
	X, Y, Z Axis: (0 to 40) in	750 µin	Glass Micro-rule
Optical & Video Comparators <sup>1</sup> : Angle	(0 to 90) °	2.5 ″	Angle Blocks
Measuring Microscopes <sup>1,2</sup> : X, Y Axis Linear Scales	(0 to 4) in (0 to 100) mm	(93 + 0.6R) µin (2.4 + 0.6R) µm	Stage Micrometer
Profilometers & Surface Roughness Testers <sup>1</sup>	Ra: (14 to 16) µin Ra: (116 to 120) µin	2.5 µin 3.9 µin	Roughness Specimen
Accessibility Probes <sup>2</sup> : Length Diameter Diameter Angle Radius	(0 to 1 000) mm (0 to 100) mm (0 to 600) mm (0 to 360) ° (0 to 100) mm	(0.37 + 0.002 4L) µm (0.37 + 0.001 2D) µm 0.007 mm 28 ″ 0.009 3 mm	ULM ULM CMM Optical Comparator Optical Comparator

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Density Meters / Hydrometers	≈ 0.001 2 g/cm <sup>3</sup>	3.2 x 10 <sup>-4</sup> g/cm <sup>3</sup>	Air Density at ambient conditions
Density Meters / Hydrometers	(0.75 to 1.8) g/cm <sup>3</sup>	4.2 x 10 <sup>-4</sup> g/cm <sup>3</sup>	Gravimetric method at ambient conditions
Air Velocity (Hotwire, DP Anemometers)	(0.125 to 0.3) m/s (0.3 to 1.25) m/s (1.25 to 7.5) m/s (7.5 to 45) m/s	2.5 % of reading 2 % of reading 1.5 % of reading 1.1 % of reading	Wind Tunnel with differential pressure meter
Air Velocity (Vane Anemometers)	2.5 m/s 5.0 m/s 10 m/s 15 m/s	0.05 m/s 0.1 m/s 0.15 m/s 0.28 m/s	Wind Tunnel

**Mass and Mass Related**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Gas Mass Flow Rate <sup>3</sup>	(5 to 100) sccm (0.1 to 2) SLM (3 to 50) SLM	0.13 % of reading	Molbox1+ w/ Premium Laminar Flow Elements
	(12 to 120) SLM	0.14 % of reading	Sonic Nozzle Element
Liquid Flow Rate	(0.1 to 15) L/min	1.3 % of reading	Turbine Flow Meters
Force Gages <sup>1</sup> (Tension and Compression)	(0 to 100) lbf (100 to 500) lbf	(0.037 % of reading + 0.6R) lbf (0.37 % of reading + 0.6R) lbf	Dead Weights
Load Cells (Tension and Compression)	(20 to 1 000) lbf (400 to 20 000) lbf	0.024 % of reading 0.05 % of reading	Force Machine w/Elastic Force Devices
	(0.5 to 1 000) lbf <sup>1</sup>	0.012 % of reading	Dead Weights
Force Machines & Tensile Testers <sup>1</sup> Force (Tension and Compression)	(0.5 to 1 000) lbf	0.02 % of reading	Per ASTM E4 Dead Weights
	(0.4 to 20 000) lbf	0.078 % of reading	Per ASTM E4 Master Load cells
Durometer Calibrator Force	Type A, B, E & O Type C, D, & DO	0.001 N 0.002 7 N	ASTM Class 1 Masses
Durometer Spring Force	(0 to 8.1) N (0 to 45.45) N	0.004 3 N 0.026 N	Balance
Durometer Indenter	Length Radius Diameter Angle	9.7 μm 5.2 μm 5.5 μm 27 °	Optical Comparator w/ Micropac2



Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers <sup>1</sup>	HRC		Indirect Verification IAW ASTM E-18
	Low	0.48 HRC	
	Mid	0.45 HRC	
	High	0.61 HRC	
	HRBW		
	Low	0.56 HRBW	
	Mid	0.69 HRBW	
	High	0.61 HRBW	
	HRA		
	Low	0.52 HRA	
	Mid	0.31 HRA	
	High	0.26 HRA	
	HR15N		
	Low	0.49 HR15N	
Mid	0.5 HR15N		
High	0.51 HR15N		
HR15TW			
Low	0.26 HR15TW		
Mid	0.41 HR15TW		
High	0.47 HR15TW		
Mass / Weights	30 kg	0.16 g	Comparison to Standard Masses with Electronic Balances
	25 kg	0.15 g	
	20 kg	0.14 g	
	10 kg	0.12 g	
	5 kg	18 mg	
	3 kg	12 mg	
	2 kg	12 mg	
	1 kg	1.4 mg	
	500 g	1.3 mg	
	300 g	1.3 mg	
Mass / Weights	200 g	1.3 mg	Comparison to Standard Masses with Electronic Balances
	100 g	0.51 mg	
	50 g	0.35 mg	
	30 g	0.063 mg	
	20 g	0.056 mg	
	10 g	0.043 mg	
	5 g	0.037 mg	
	3 g	0.031 mg	
	2 g	0.029 mg	
	1 g	0.022 mg	

**Mass and Mass Related**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
H-Point Machine Weights	20 kg 10 kg 5 kg 3 kg 2 kg 1 kg	0.14 g 0.12 g 18 mg 12 mg 12 mg 1.4 mg	Balances Per SAE J826 & SAE J4002
Pressure <sup>1</sup> – Barometric	(8 to 17) psia	0.002 psi	Pressure Calibrator
Gage Pressure <sup>1,2</sup> – Hydraulic	(200 to 16 000) psi	(0.008 % of reading + 0.6R) psi	Deadweight Tester
Pressure <sup>1,2</sup> – Pneumatic	(0 to 300) psig	(0.02 % of reading + 0.6R) psi	Deadweight Tester
	(0 to 75) psia (-10 to 10) inH <sub>2</sub> O (-50 to 50) inH <sub>2</sub> O (-100 to 100) inH <sub>2</sub> O	0.023 psi 0.007 1 inH <sub>2</sub> O 0.012 inH <sub>2</sub> O 0.023 inH <sub>2</sub> O	Automatic Pressure Calibrator
	(-7 to 7) psig (-15 to 15) psig (-20 to 20) psig	0.002 3 psi 0.004 psi 0.014 psi	
	(0 to 500) psig (0 to 1 500) psig	0.06 psi (0.012 ± 0.000 4P) psi	
	(1.5 to 3) kpsig (3 to 5) kpsig (5 to 10) kpsig	0.35 psi 5.8 psi 12 psi	Digital Pressure Gages w/ Pressure Intensifier
	(-2 to 2) inH <sub>2</sub> O	0.000 49 inH <sub>2</sub> O	Electronic Point Gage
Micro-Balances <sup>1</sup> (0.01 mg resolution)	(0 to 230) g	0.051 mg	ASTM Class 1 Weights
Precision Balances (0.1 mg resolution)	(0 to 610) g	0.11 mg	
Analytical Balances <sup>1</sup> (1 mg resolution) (10 mg resolution)	(0 to 1 200) g	0.94 mg	ASTM Class 1 Weights
	(0 to 8 200) g	9.4 mg	
Bench Scales <sup>1</sup> (0.1 g resolution)	(0 to 32) kg	0.12 g	NIST Class F or ASTM Class 6 Weights

**Mass and Mass Related**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Floor Scales <sup>1</sup> (0.01 lb resolution) (0.02 lb resolution) (0.05 lb resolution) (0.1 lb resolution) (0.2 lb resolution) (1 lb resolution)	(0 to 300) lb (0 to 600) lb (0 to 1 000) lb (0 to 3 000) lb (0 to 6 000) lb (0 to 6 000) lb	0.015 lb 0.024 lb 0.047 lb 0.076 lb 0.17 lb 0.59 lb	NIST Class F or ASTM Class 6 Weights
Moisture Balances <sup>1</sup> (0.1 mg resolution)	(0 to 100) g	0.069 mg	ASTM Class 1 Weights
Torque Transducers and Analyzers <sup>1</sup>	1.5 lbf·in to 1 500 lbf·ft	0.15 % of reading	Torque Moment Arms with ASTM Class 6&7 Weights
Torque Tools <sup>1</sup>	0.5 lbf·in to 600 lbf·ft	0.4 % of reading	Torque Analyzer
Electrical Simulation of Torque Assembly Tools	0.59 mV/V (0 to 100) N·m 2.0 mV/V (0 to 110) N·m	0.11 N·m 0.18 N·m	Reference Torque Simulator
Viscosity Dip Cups <sup>1</sup> : Efflux Time	(5 to 120) s	0.1 s	Stopwatch
Viscosity Dip Cups <sup>1</sup> (Kinematic Viscosity)	18 mm <sup>2</sup> /s 34 mm <sup>2</sup> /s 50 mm <sup>2</sup> /s 66 mm <sup>2</sup> /s 120 mm <sup>2</sup> /s 465 mm <sup>2</sup> /s 500 mm <sup>2</sup> /s	0.3 mm <sup>2</sup> /s 0.6 mm <sup>2</sup> /s 0.59 mm <sup>2</sup> /s 1.2 mm <sup>2</sup> /s 1.8 mm <sup>2</sup> /s 11 mm <sup>2</sup> /s 7 mm <sup>2</sup> /s	ASTM D1200 & D4212 Using Standard Viscosity Oils (Nominal viscosities at 25 °C)
Rotational Viscometers <sup>1</sup> (Dynamic Viscosity)	< 10 mPa·s (10 to 100) mPa·s (100 to 1 000) mPa·s (1 000 to 10 000) mPa·s	0.34 % of reading 0.45 % of reading 0.54 % of reading 0.66 % of reading	Viscosity Standard Reference Fluids (Nominal viscosities at 25 °C)

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pipettes, Volumetric Containers and Glassware	1 mL ≤ 5 mL ≤ 10 mL ≤ 25 mL ≤ 50 mL ≤ 100 mL ≤ 200 mL ≤ 250 mL ≤ 500 mL ≤ 1 000 mL ≤ 2 000 mL ≤ 4 000 mL	4.8 µL 6.1 µL 7 µL 8.1 µL 8.9 µL 14 µL 26 µL 32 µL 69 µL 0.14 mL 0.27 mL 0.52 mL	ISO 8655 and ASTM E542: Gravimetric Method with Distilled Water

**Photometry and Radiometry**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Correlated Color Temperature	(2 300 to 3 200) K (3 200 to 7 600) K	48 K 122 K	Chroma Meter IAW Detroit Color Council Bulletin No. 3 and SAE J361
Illuminance Responsivity (Illuminant A – CIE)	(0 to 20 000) lx (0 to 1 858) fc	2.3 lx + 0.027 lx/lx 0.21 fc + 0.027 fc/fc	
Gloss Meters	89.3 SGU @ 20 ° 93.2 SGU @ 60 ° 99.5 SGU @ 85 °	1.2 SGU	Master Gloss Tile

**Thermodynamic**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Infrared Thermometers	Ambient to 100 °C (100 to 300) °C (300 to 500) °C	1.2 °C 1.6 °C 2 °C	Blackbody Source ε = 0.95, λ = (8 to 14) µm
Relative Humidity	(5 to 98) %RH	0.68 %RH	Chilled Mirror Hygrometer
Dew Point / Frost Point	(-20 to 50) °C	0.45 °C	





**Thermodynamic**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mechanical and Digital Thermometry systems	-196 °C (-95 to 140) °C (140 to 650) °C	13 mK 13 mK (5.3 + 0.15T) mK	Comparison to SPRT
Liquid in Glass Thermometers	(-40 to 0) °C (0 to 140) °C (140 to 420) °C	0.13 °C 0.2 °C 0.4 °C	Comparison to Working PRT
Resistance Temperature Devices	-196 °C	13 mK	SPRT with Super-thermometer & LN <sub>2</sub> comparator
	0.01 °C	4.8 mK	TPW Cell
	(-95 to 140) °C (-45 to 150) °C (50 to 420) °C (420 to 650) °C	13 mK 16 mK 54 mK 99 mK	Comparison to SPRT
Baths, Chambers and Drywells	(-95 to 140) °C 140 to 650 °C	27 mK (15 + 0.16T) mK	Comparison to Working PRT
Moisture Balances	(0 to 230) °C	0.058 °C	Working PRT

**Time and Frequency**

Parameter/Equipment <sup>1</sup>	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Measure	(0 to 1 300) MHz	2.3 x 10 <sup>-10</sup>	Electronic Counter Locked to GPS
Frequency Source	10.0 MHz	6 x 10 <sup>-12</sup>	GPS Receiver
	(0 to 1 050) MHz	4.4 x 10 <sup>-10</sup>	Signal Generator
Stop Watches	(0 to 24) h	0.052 s/d	Timometer
Tachometers & Stroboscopes	(6 to 99 999) rpm	0.001 % of reading	Electrical Simulation
Time Interval (Process Timers)	(0 to 8 x 10 <sup>5</sup> ) s	1.7 x 10 <sup>-4</sup> s	Electronic Counter
Linear Belt Speed	(2 to 200) RPM	0.8 % of reading	Tachometer w/ 10 cm Wheel
Rotational Speed	(5 to 25 000) RPM	0.03 % of reading	Laser Tachometer

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.  $L$  = length in inches or metric equivalent (mm),  $M$  = length in meters,  $D$  = diameter in inches or metric equivalent,  $D_i$  = diagonal length in inches or metric equivalent,  $G$  = length of side in inches or metric equivalent,  $R$  = resolution of the unit under test,  $T$  = Temperature in Celsius,  $t$  = time interval in seconds,  $P$  = Pressure in psig.
3. Gas flow range and CMC values are applicable to Nitrogen gas
4. In the uncertainty value the percent symbol (%) percent of reading unless otherwise indicated.
5. Scope uncertainty is for 1D length Axis measurements.
6. This scope is formatted as part of a single document including Certificate of Accreditation No. L1117-1.



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Vice President

