CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

TECHMASTER ASIA (Thailand) Co., Ltd
5/41 Home In Town, Paholyothin 73, Sanambin Donmuang
Bangkok 10210, Thailand

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the field of

CALIBRATION

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 29 October 2022
Certificate Number: AC-1736.08

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 AND ANSI/NCSL Z540-1-1994 (R2002)

Techmaster Asia (Thailand) Co. Ltd.

5/41 Home In Town, Paholyothin 73, Sanambin, Donmuang
Bangkok 10210, Thailand
Ernesto Matamoros + 1 760-536-0227
Quality.mx@techmaster.us
Nopparat Homta +66 02-531-5142
nopparat@techmaster.asia

CALIBRATION

Valid to: **October 28, 2022** Certificate Number: **AC-1736.08**

Acoustics and Vibration

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Level Meters	94 dB, 1 kHz 114 dB, 1 kHz	0.62 dB	Center 326 Sound Level Calibrator

Chemical Quantities

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH – Source	4.01 pH 7.00 pH 10.00 pH	0.01 pH 0.02 pH 0.02 pH	pH Solutions
Conductivity – Source	84 µS/cm 1 413 µS/cm 5 000 µS/cm 12 880 µS/cm 111 800 µS/cm	1.9 µS/cm 7.2 µS/cm 28 µS/cm 71 µS/cm 0.56 mS/cm	Conductivity Solutions

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage - Source[1]	Up to 220 mV 220 mV to 2.2 V	7.7 µV/V + 0.86 µV 5.9 µV/V + 0.87 µV	Fluke 5700A Multifunction Calibrator
DC Voltage - Source[1]	(2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	4.2 µV/V + 3.1 µV 3.9 µV/V + 14 µV 5.9 µV/V + 48 µV 7.5 µV/V + 0.76 mV	Fluke 5700A Multifunction Calibrator
DC Voltage - Measure[1]	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	7.2 µV/V + 0.55 µV 7 µV/V + 0.42 µV 6.9 µV/V + 0.86 µV 9.2 µV/V + 38 µV 9.3 µV/V + 0.13 µV	HP 3458A Opt 002 Multimeter
	(1 to 20) kV (20 to 35) kV (35 to 40) kV	20 mV/V 10 mV/V 20 mV/V	HP 3458A Opt 002 Multimeter with Fluke 80K-40 High Voltage Probe
DC Current - Source[1]	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	48 µA/A + 7.1 nA 41 µA/A + 9.6 nA 42 µA/A + 49 nA 54 µA/A + 0.84 µA 95 µA/A + 15 µA	Fluke 5700A Multifunction Calibrator
	(2.2 to 3) A (3 to 11) A (11 to 20.5) A	0.45 mA/A + 66 µA 0.59 mA/A + 0.60 mA 1.2 mA/A + 0.91 mA	Fluke 5520A Multifunction Calibrator
DC Current - Source[1] Clamp-On Ammeters	(20 to 1 000) A	2.9 mA/A + 0.08 A	Fluke 5520A Multifunction Calibrator with Fluke Coil
DC Current - Measure[1]	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	22 µA/A + 93 pA 18 µA/A + 0.10 nA 28 µA/A + 0.14 nA 30 µA/A + 0.98 nA 30 µA/A + 6.5 nA 30 µA/A + 63 nA 44 µA/A + 1 µA 0.14 mA/A + 12 µA	HP 3458A Opt 002 Multimeter
	Up to 300 A	2.5 mA/A + 1 mA	HP 3458A Opt 002 Multimeter with Empro HA-300-100 Shunt

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source[1]	(1 to 2.2) mV		Fluke 5700A Multifunction Calibrator
	(10 to 20) Hz	0.34 mV/V + 5.8 µV	
	(20 to 40) Hz	0.12 mV/V + 5.1 µV	
	40 Hz to 20 kHz	98 µV/V + 4.9 µV	
	(20 to 50) kHz	0.25 mV/V + 4.9 µV	
	(50 to 100) kHz	0.67 mV/V + 6.7 µV	
	(100 to 300) kHz	1.5 mV/V + 13 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.3 mV/V + 4.9 µV	
	(20 to 40) Hz	0.11 mV/V + 4.9 µV	
	40 Hz to 20 kHz	96 µV/V + 4.8 µV	
	(20 to 50) kHz	24 µV/V + 4.8 µV	
	(50 to 100) kHz	0.6 mV/V + 6 µV	
	(100 to 300) kHz	1.3 mV/V + 12 µV	
	(300 to 500) kHz	1.7 mV/V + 24 µV	
	500 kHz to 1 MHz	3.2 mV/V + 24 µV	
	(22 to 220 mV		
	(10 to 20) Hz	0.29 mV/V + 14 µV	
	(20 to 40) Hz	0.1 mV/V + 9.4 µV	
	40 Hz to 20 kHz	92 µV/V + 9.2 µV	
	(20 to 50) kHz	0.24 mV/V + 88 µV	
	(50 to 100) kHz	0.55 mV/V + 20 µV	
	(100 to 300) kHz	1.1 mV/V + 24 µV	
	(300 to 500) kHz	1.7 mV/V + 30 µV	
	500 kHz to 1 MHz	3.2 mV/V + 53 µV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.23 mV/V + 54 µV	
	(20 to 40) Hz	0.11 mV/V + 19 µV	
	40 Hz to 20 kHz	54 µV/V + 10 µV	
	(20 to 50) kHz	88 µV/V + 14 µV	
	(50 to 100) kHz	0.13 mV/V + 38 µV	
	(100 to 300) kHz	0.5 mV/V + 96 µV	
	(300 to 500) kHz	1.2 mV/V + 0.24 mV	
	500 kHz to 1 MHz	2 mV/V + 0.35 mV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source[1]	(2.2 to 22) V		Fluke 5700A Multifunction Calibrator
	(10 to 20) Hz	0.3 mV/V + 0.54 mV	
	(20 to 40) Hz	0.12 mV/V + 0.20 mV	
	40 Hz to 20 kHz	53 µV/V + 67 µV	
	(20 to 50) kHz	91 µV/V + 0.13 mV	
	(50 to 100) kHz	0.12 mV/V + 0.26 mV	
	(100 to 300) kHz	0.33 mV/V + 0.72 mV	
	(300 to 500) kHz	1.2 mV/V + 2.4 mV	
	500 kHz to 1 MHz	1.2 mV/V + 3.8 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.3 mV/V + 5.4 mV	
	(20 to 40) Hz	0.12 mV/V + 1.8 mV	
	40 Hz to 20 kHz	59 µV/V + 0.85 mV	
	(20 to 50) kHz	99 µV/V + 1.4 mV	
	(50 to 100) kHz	0.18 mV/V + 3.1 mV	
	(100 to 300) kHz	1.2 m/V + 19 mV	
	220 V to 1.1 kV		
	(15 to 50) Hz	0.36 mV/V + 20 mV	
	50 Hz to 1 kHz	82 µV/V + 5.5 mV	
AC Voltage - Source[1] Wide Band	300 µV to 3.5 V		Fluke 5700A/03 Multifunction Calibrator Wide Band Function
	(10 to 30) Hz	4.9 µV/V + 3.7 µV	
	30 Hz to 120 kHz	4.9 µV/V + 3.7 µV	
	300 µV to 1.1 mV		
	120 kHz to 2 MHz	2.4 µV/V + 3.5 µV	
	(2 to 10) MHz	4.7 µV/V + 3.5 µV	
	(10 to 20) MHz	7.1 µV/V + 3.5 µV	
	(20 to 30) MHz	18 µV/V + 18 µV	
	300 µV to 3 mV		
	120 kHz to 2 MHz	1.2 µV/V + 3.5 µV	
	(2 to 10) MHz	3.5 µV/V + 3.5 µV	
	(10 to 20) MHz	5.9 µV/V + 3.5 µV	
	(20 to 30) MHz	18 µV/V + 3.5 µV	
	3 mV to 3.5 V		
	120 kHz to 2 MHz	1.2 µV/V + 3.5 µV	
	(2 to 10) MHz	2.4 µV/V + 3.5 µV	
	(10 to 20) MHz	4.7 µV/V + 3.5 µV	
	(20 to 30) MHz	12 µV/V + 3.5 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure[1]	(1 to 10) mV		HP 3458A Opt 002 Multimeter
	(1 to 40) Hz	0.36 mV/V + 3.6 µV	
	40 Hz to 1 kHz	0.23 mV/V + 1.4 µV	
	(1 to 20) kHz	0.32 V/V + 1.7 µV	
	(20 to 50) kHz	1.2 mV/V + 1.6 µV	
	(50 to 100) kHz	5.7 mV/V + 2 µV	
	(100 to 300) kHz	46 mV/V + 2.6 µV	
	100 mV to 10 V		
	(1 Hz to 40) Hz	72 µV/V + 0.85 mV	
	40 Hz to 1 kHz	84 µV/V + 0.26 mV	
	(1 to 20) kHz	0.17 mV/V + 0.26 mV	
	(20 to 50) kHz	0.35 mV/V + 0.25 mV	
	(50 to 100) kHz	0.93 mV/V + 0.27 mV	
	(100 to 300) kHz	3.5 mV/V + 1.2 mV	
	300 kHz to 1 MHz	12 mV/V + 1.2 mV	
	(1 to 2) MHz	18 mV/V + 1.2 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.24 mV + 4.7 mV	
	40 Hz to 1 kHz	0.15 mV + 16 mV	
	(1 to 20) kHz	0.15 mV + 17 mV	
	(20 to 50) kHz	0.36 mV + 8.6 mV	
	(50 to 100) kHz	1.4 mV/V + 3.9 mV	
	(100 to 300) kHz	4.8 mV/V + 12 mV	
	300 kHz to 1 MHz	18 mV/V + 12 mV	
	100 V to 1 kV		
	(1 to 40) Hz	0.46 mV/V + 50 mV	
	40 Hz to 1 kHz	0.46 mV/V + 28 mV	
	(1 to 20) kHz	0.69 mV/V + 29 mV	
	(20 to 50) kHz	1.5 mV/V + 24 mV	
	(50 to 100) kHz	3.6 mV/V + 24 mV	
AC Voltage - Measure[1]	(1 to 40) kV		HP 3458A Opt 002 Multimeter with Fluke 80K-40 High Voltage Probe
	60 Hz	50 mV/V + 0.11 V	
AC Current - Source[1]	(9 to 220) µA		Fluke 5700A Multifunction Calibrator
	(10 to 20) Hz	0.36 mA/A + 25 nA	
	(20 to 40) Hz	0.24 mA/A + 16 nA	
	40 Hz to 1 kHz	0.17 mA/A + 12 nA	
	(1 to 5) kHz	0.42 mA/A + 18 nA	
	(5 to 10) kHz	1.6 mA/A + 95 nA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Source[1]	220 µA 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 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz 220 mA to 2.2 A 20 Hz to 1kHz (1 to 5) kHz (5 to 10) kHz	 0.37 mA/A + 73 nA 0.25 mA/A + 68 nA 0.19 mA/A + 54 nA 0.32 mA/A+ 0.17 µA 1.6 mA/A + 0.95 µA 0.32 mA/A + 0.67 µA 0.2 mA/A + 0.57 µA 0.16 mA/A + 0.46 µA 0.27 mA/A + 0.73 µA 1.3 mA/A + 5.9 µA 0.32 mA/A + 6.1 µA 0.2 mA/AA + 5 µA 0.16 mA/A + 3.4 µA 1.4 µA/A + 12 µA 0.31 mA/A + 44 µA 0.53 mA/A + 0.11 mV 8.3 mA/A + 0.29 mV	Fluke 5700A Multifunction Calibrator
AC Current - Source[1] Clamp-On Ammeters	(20 to 1 000) A 45 Hz to 5 kHz	 2.8 mA/A + 0.14 A	Fluke 5520A Multifunction Calibrator with Fluke Coil
AC Current - Measure[1]	Up to 100 µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz 100 µA to 100 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	 4.7 mA/A + 36 nA 1.8 mA/A + 35 nA 0.71 mA/A + 35 nA 0.7 mA/A + 35 nA 4.7 mA/A + 24 µA 1.8 mA/A + 24 µA 0.71 mA/A + 24 µA 0.36 mA/A + 23 µA 0.71 mA/A + 24 µA 4.7 mA/A + 47 µA 6.5 mA/A + 0.18 mA	Agilent 3458A Opt 002 Multimeter

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Measure[1]	100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	 4.7 mA/A + 0.24 mA 1.9 mA/A + 0.24 mA 0.95 mA/A + 0.24 mA 1.1 mA/A + 0.26 mA 3.5 mA/A + 0.24 mA 12 mA/A + 0.47 mA	Agilent 3458A Opt 002 Multimeter
Resistance - Source[1]	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ 330 MΩ to 1.1 GΩ	5.7 μΩ/Ω + 1.1 mΩ 35 μΩ/Ω + 1.8 mΩ 29 μΩ/Ω + 0.57 mΩ 33 μΩ/Ω + 2.4 mΩ 30 μΩ/Ω + 4.3 mΩ 33 μΩ/Ω + 27 mΩ 4.5 μΩ/Ω + 1.7 Ω 34 μΩ/Ω + 0.23 Ω 33 μΩ/Ω + 0.33 Ω 35 μΩ/Ω + 4 Ω 37 μΩ/Ω + 2.4 Ω 71 μΩ/Ω + 36 Ω 0.15 mΩ/Ω + 67 Ω 0.39 mΩ/Ω + 3 kΩ 0.58 mΩ/Ω + 4.8 kΩ 3.5 mΩ/Ω + 0.12 MΩ 18 mΩ/Ω + 0.59 MΩ	Fluke 5520A Multifunction Calibrator
Resistance - Measure[1] Fixed Points	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ	22 μΩ/Ω + 62 μΩ 18 μΩ/Ω + 0.61 mΩ 16 μΩ/Ω + 0.73 mΩ 15 μΩ/Ω + 13 mΩ 15 μΩ/Ω + 67 mΩ 21 μΩ/Ω + 2.7 Ω 46 μΩ/Ω + 0.39 kΩ 0.56 mΩ/Ω + 1.2 kΩ 6 mΩ/Ω + 12 kΩ	HP 3458A Opt 002 Multimeter
Resistance - Source[1] Fixed Points	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ	0.12 mΩ 0.22 mΩ 0.28 mΩ 0.58 mΩ 1.3 mΩ 2.4 mΩ 10 mΩ 20 mΩ 90 mΩ 0.19 Ω	Fluke 5700A Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance - Source[1] Fixed Points	100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	1.3 Ω 2.5 Ω 2.4 Ω 47 Ω 0.47 kΩ 1.3 kΩ 12 kΩ	Fluke 5700A Multifunction Calibrator
Resistance - Source[1] Fixed Points	10 mΩ to 1 kΩ (1 to 100) kΩ 100 kΩ to 1 GΩ (1 to 10) GΩ (10 to 100) GΩ	0.1 mΩ/Ω + 2 mΩ 0.1 mΩ/Ω + 0.18 Ω 1 mΩ/Ω + 11 kΩ 2 mΩ/Ω + 0.58 kΩ 5 mΩ/Ω + 23 Ω	ESI DB62-11K ESI DB62-111K IET HRRS-Q-3-100M-5 kV Resistors
Capacitance - Source[1] 190 pF to 1.1 nF (1.1 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF 330 µF to 1.1 mF	 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 10 kHz 10 Hz to 10 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (10 to 80) Hz (10 to 80) Hz	 5 mF/F + 12 pF 5.8 mF/F + 12 pF 2.9 mF/F + 0.12 nF 2.9 mF/F + 0.35 nF 3 mF/F + 1.2 nF 4.1 mF/F + 3.5 nF 4.1 mF/F + 11 nF 4.7 mF/F + 35 nF 5.9 mF/F + 0.11 µF 8.1 mF/F + 0.35 µF 12 mF/F + 0.27 µF	Fluke 5520A Multifunction Calibrator
Capacitance - Source[1] @ 1 kHz	1 pF 10 pF 100 pF 1 nF	1.2 fF 12 fF 0.12 pF 1.2 pF	Hewlett Packard 16380A Air Capacitor Set consisting of 16381A, 16382A, 16383A, and 16384A
Capacitance - Source[1] Algorithmic Deviation	1 pF (1 to 3) MHz 4 MHz 5 MHz 10 MHz 13 MHz	 1.2 fF 1.3 fF 1.5 fF 2.8 fF 3.9 fF	Hewlett Packard 16380A Air Capacitor Set consisting of 16381A, 16382A, 16383A, and 16384A
Capacitance - Source[1] Algorithmic Deviation	10 pF (1 to 13) MHz	 12 fF	
Capacitance - Source[1] Algorithmic Deviation	100 pF (1 to 10) MHz 13 MHz	 0.12 pF 0.13 pF	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance - Source[1] Algorithmic Deviation	1 nF (1 to 4) MHz 5 MHz 10 MHz 13 MHz	 1.2 pF 1.3 pF 2.2 pF 3 pF	Hewlett Packard 16380A Air Capacitor Set consisting of 16381A, 16382A, 16383A, and 16384A
Inductance – Source 1 kHz	100 µH to 1 mH (1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	24 mH/H + 5 µH 24 mH/H + 0.7 mH 19 mH/H + 8.2 µH 9.5 mH/H + 0.13 mH 9.5 mH/H + 1.5 mH	IET 1491-G Decade Inductor
Electrical Simulation of Thermocouple Indicating Devices - Source and Measure[1]	Type K (-200 to -50) °C (-50 to 1 372) °C Type T (-200 to -50) °C (-50 to 400) °C Type J (-210 to -50) °C (-50 to 760) °C Type E (-230 to -50) °C (-50 to 1 000) °C Type R (0 to 1 768) °C	 0.56 °C (1 °F) 0.28 °C (0.5 °F) 0.56 °C (1 °F) 0.28 °C (0.5 °F) 0.56 °C (1 °F) 0.28 °C (0.5 °F) 0.56 °C (1 °F) 0.28 °C (0.5 °F) 0.95 °C (1.8 °F)	Fluke 5520A Multifunction Calibrator
Oscilloscopes[1] Square Wave Signal 10 Hz to 10 kHz 50 Ω 1 M Ω Level Sine Wave Amplitude Flatness referenced to 50 kHz reference	 1 mV to 6.6 V p-p 1 mV to 130 V p-p 5 mV to 5.5 V 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	 0.25 mV/V p-p + 0.11 V 2.5 mV/V p-p + 58 mV 11 mV/V + 0.11 V 25 mV/V + 0.11 V 30 mV/V + 0.11 V 52 mV/V + 0.11 V 6.3 mV/V + 0.11 V 5.9 mV/V + 0.17 V 23 mV/V + 0.17 V	Fluke 5520A Multifunction Calibrator

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes[1]			
Time Markers (5-2-1 sequence) into a 50 Ω load	5 s to 50 ms 20 ms to 100 ns (50 to 20) ns 10 ns (5 to 2) ns	0.3 mHz/Hz + 0.12 Hz 2.5 x 10^{-6} Hz/Hz 2.5 x 10^{-6} Hz/Hz 2.5 x 10^{-6} Hz/Hz 2.5 x 10^{-6} Hz/Hz	Fluke 5520A Multifunction Calibrator
Rise Time	≤ 300 ps	0.06 ps/s + 0.03 ps	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude Modulation - Measure[1] 150 kHz to 10 MHz	Rate: 50 Hz to 10 kHz, (5 to 99) % Depth	0.044 % Depth + 2.3 % of reading	HP 8902A Measuring Receiver
10 MHz to 1.3 GHz	50 Hz to 100 kHz, (20 to 99) % Depth	0.012 % Depth + 1.2 % of reading	
Frequency Modulation - Measure[1] 250 kHz to 10 MHz	Rate: 20 Hz to 10 kHz Dev:20 Hz to 40 kHz peak	0.022 kHz + 2.3 % Deviation	HP8902A Measuring Receiver
10 MHz to 1.3 GHz	Rate: 50 Hz to 200 kHz Dev:250 Hz to 400 kHz peak	0.16 kHz + 5.8 % Deviation	
Frequency Modulation - Source[1] 250 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz (3.2 to 10) GHz (10 to 20) GHz	Rate: 1 kHz rate Max. Dev. 2 MHz Max. Dev. 4 MHz Max. Dev. 8 MHz Max. Dev. 16 MHz Max. Dev. 32 MHz	4 % Deviation + 24 Hz	HP 83620B Signal Generator
Phase Modulation - Measure[1] 150 kHz to 10.0 MHz 10 MHz to 1.3 GHz	>0.7 rad Deviation >0.6 rad Deviation	0.003 rad + 4.9 % Deviation 0.067 rad + 3.4 % Deviation	HP 8902A Measuring Receiver

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Phase Modulation - Measure[1] 150 kHz to 10 MHz 10 MHz to 1.3 GHz	 Rate:200 Hz to 10 kHz Rate:200 Hz to 20 kHz	 4.6 % Deviation + 1 digit 3.5 % Deviation + 1 digit	HP 8902A Measuring Receiver
Distortion - Measure[1] 20 Hz to 20 kHz (20 to 100) kHz	(0 to 99) dB Rate: 20 Hz to 250 kHz (0.01 to 100) % Distortion	 1.2 dB 2.3 dB	HP 8902B Measuring Receiver
Power - Measure[1] 1 mW reference	1 mW 50 MHz	1.1 % of reading + 0.66 uW	HP 432A Power Meter, HP 478A Thermistor Mount
	(-20 to 30) dB 100 kHz to 4.2 GHz 50 MHz to 26.5 GHz 50 MHz to 50 GHz	 3.2 % of reading + 0.22 dB 4 % of reading + 0.26 dB 4.6 % of reading + 0.29 dB	Power Meters with HP 8482A, E4419B, HP 8485A, E4419B, HP 8487A, E4419B Power Sensors
Noise Figure - Source[1] 10 MHz to 26.5 GHz	15 dB ENR	0.17 dB	HP 346C Noise Source
Noise Figure - Measure[1]	(5 to 17) dB ENR 100 kHz to 30 MHz 30 MHz to 3 GHz (3 to 26.5) GHz	 0.43 dB 0.42 dB 0.47 dB	HP 346C Noise Source, Agilent E4448A Spectrum Analyzer, HP 8449B Preamplifier

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Ring Gages	Up to 4 in	(14 + 14*L*) µin	Mahr ULM 600
Thread Measuring Wires	Up to 0.096 23 in	(3.4 + 10*L*) µin	
Thread Plug Gages - External Diameter	Up to 2 in (2 to 4) in	85 µin (58 + 10*L*) µin	
Thread Ring Gages - Internal Diameter	Up to 4 in	(25 + 7.6*L*) µin	
Gage Blocks	Up to 4 in	(14 + 0.8*L*) µin	
Plug Gage	Up to 4 in	(25 + 1.3*L*) µin	

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Bore Gages	Up to 1 in	110 µin	Mahr ULM 600
Calipers External Diameter Inside Diameter (Fixed Points)	Up to 40 in (Up to 1 000 mm) (1 and 2) in (25.4 and 50.8) mm	13 µin/in + 590 µin 28 µin/in + 660 µin	Grade 2 Gage Blocks, End Rods Ring Gages
Micrometers and Thickness Gages	Up to 12 in (Up to 300 mm)	30 µin/in + 19 µin	Grade 2 Gage Blocks, End Rods
Height Gages	Up to 40 in (Up to 1 000 mm)	4.7 µin/in + 750 µin	
Depth Gages	Up to 40 in (Up to 1 000 mm)	21 µin/in + 140 µin	Grade 2 Gage Blocks, End Rods
Dial Indicators	Up to 4 in (Up to 100 mm)	21 µin/in + 1 800 µin	Grade 2 Gage Blocks
Steel Rules	Up to 12 in (Up to 300 mm)	0.04 in	Grade 2 Gage Blocks
Tape Measure	Up to 12 in (Up to 300 mm)	0.04 in	
Feeler (Thickness) Gages	Up to 1 mm	0.14 µm	Mahr ULM 600
Holtest	Extension to 25 mm	0.000 12 % of reading + 0.6 µm	
Optical Comparators and Visual System	Up to 300 mm	0.01 mm	Grade 2 Gage Blocks, Glass Scale

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Force Gages	Up to 20 kgf	23 gf	Class M1 Weights
Air Pressure - Source	(-12 to 300) psi	0.2 psi	Fluke 718 300G Pressure Calibrator
	(300 to 10 000) psi	0.000 1 % of Applied + 9.5 psi	Fluke 700P31 Pressure Gage
Differential Air Pressure - Source	(0 to 15) psi	0.21 psi	Fluke 700P-24 Pressure Module

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oil Pressure - Source	(0 to 10 000) psi	0.02 % of Applied + 0.21 psi	Fluke P324 Deadweight Tester
Torque Tools	(1 to 10) lbf in (10 to 100) lbf in (5 to 50) lbf ft (25 to 250) lbf ft	0.6 % of Applied + 0.008 lbf in 0.6 % of Applied + 0.07 lbf in 0.6 % of Applied + 0.04 lbf ft 0.7 % of Applied + 0.15 lbf ft	Torque Transducers Mountz LLT10i Mountz BMX100i Mountz BMX50F Mountz BMX250F
Torque Transducers	Up to 22 cm kg	0.03 % of Applied + 0.000 3 cm kg	Mountz 4 in Torque Wheel and Weights
Balances Resolution: 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg	Up to 18.11 kg	0.15 mg 0.15 mg 0.15 mg 0.23 mg 0.42 mg 1 mg 2 mg 4 mg 7 mg 0.01 g 0.02 g 0.05 g	Class F Weights
Balances Resolution: 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 20 kg	Up to 104 kg	0.7 mg 0.9 mg 1 mg 1.7 mg 3.3 mg 8.3 mg 17 mg 0.3 g	Class M1 Weights
Mass	Up to 100 g Up to 10 kg	0.1 mg 0.01 g	Class F Weights, Balance
Air Velocity	Up to 7 040 fpm	1.2 % of Applied + 1.6 fpm	Interactive Instruments JS500 Wind Tunnel, Omega HHF141A Anemometer

Photometry and Radiometry

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Wavelength – Measure[1]	(700 to 1 650) nm	3 parts in 10^6	Agilent 86120A Wavelength Meter
Laser Power - Measure	Up to 50 W	9.9 mW/W + 18 mW	Gentec Maestro UP50N-50H-W9-D0 Power Detector

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature - Measure Ovens and Chambers	(-100 to 1 300) °C	1.2 °C	Agilent 34970A Datalogger
Temperature - Measure	(-40 to 180) °C	0.24 °C	Vaisala HM141/HMP46 Temperature/Humidity Indicator and Probe
Temperature - Measure Dry Well and Liquid Bath	(-200 to 0) °C (0 to 660) °C	0.01 °C 0.02 °C	Fluke 5626 PRT, Agilent 3458A Multimeter
Infrared (IR) Temperature	(-18 to 149) °C	1 °C	Omega BB701 $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14)$ µm
	(100 to 932) °C	1.2 °C	Omega BB-4A $\varepsilon = 0.99$, $\lambda = (8 \text{ to } 14)$ µm
Relative Humidity - Measure, Ovens and Chambers	Up to 90 %RH (90 to 100) %RH	0.2 % of Applied + 1.3 %RH 2.5 %RH	Vaisala HM141/HMP46 Temperature/Humidity Indicator and Probe
Platinum Resistance Thermometers	(-8 to 100) °C (100 to 350) °C	0.001 8 % + 0.006 °C 0.002 2 % + 0.006 °C	Fluke 9009 Drywell, HP 3458A Multimeter, Fluke 5626 PRT
Thermocouple Sensors	(-8 to 100) °C (100 to 350) °C	0.26 °C 0.66 °C	Fluke 9009 Drywell, HP 3458A Multimeter, Fluke 5626 PRT

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Source[1]	1 µHz to 80 MHz 10 MHz to 26.5 GHz	5×10^{-12} Hz 5×10^{-12} Hz	Signal Generators HP 33250A Agilent 8340B

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Measure[1]	1 µHz to 12.4 GHz	5 x 10^{-12} Hz	HP 53132A Opt 124 Counter
	1 Hz to 26.5 GHz	5 x 10^{-12} Hz	Agilent E4440A Spectrum Analyzer
Stopwatches/Timers	Up to 3 600 s	0.25 s	HP 53132A Counter
RPM – Measure Non-Contact	(60 to 3 000) rpm (3 000 to 6 000) rpm (6 000 to 12 000) rpm (12 000 to 60 000) rpm (60 000 to 100 000) rpm (100 000 to 120 000) rpm	0.13 rpm + 0.000 2 rpm 0.13 rpm + 0.000 2 rpm 0.16 rpm + 0.000 2 rpm 1.3 rpm + 0.000 2 rpm 1.6 rpm + 0.000 2 rpm 2.4 rpm + 0.000 2 rpm	Agilent 33250ASignal Generator
Stroboscopes	(0 to 100 000) rpm	0.000 07 % of Applied + 0.58 rpm	Fluke 5520A Multifunction Calibrator

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. The use of (L) signifies Length in inches.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1736.08.

R. Douglas Leonard Jr., VP, PILR SBU