



# CERTIFICATE OF ACCREDITATION

## ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

### Techmaster Electronics Joint Stock Company

707 Street 07, Lot A An Phu-An Khanh An Phu Ward, District 02  
Ho Chi Minh City, Vietnam

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

## ISO/IEC 17025:2005

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

AC-1868

Certificate Number



ANAB Approval

Certificate Valid Through: 10/29/2020  
Version No. 006 Issued: 03/04/2019



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. 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 17025:2005**

**Techmaster Electronics Joint Stock Company**

707 Street 07, Lot A An Phu-An Khanh, An Phu Ward,  
District 02, Ho Chi Minh City, Vietnam (Primary Laboratory).  
Website: [www.techmaster.com.vn](http://www.techmaster.com.vn)

Authorized Leadership for Techmaster in Vietnam

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**CALIBRATION**

Valid to: **October 29, 2020**

Certificate Number: **AC-1868**

**Acoustics and Vibration**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters <sup>1</sup>	94 dB 114 dB	0.5 dB 0.84 dB	Sound Calibrator
Vibration Meters <sup>1</sup> Acceleration Velocity Displacement	(10 to 5 000) Hz, (0.1 to 200) m/s <sup>2</sup>	0.86 % of reading	Vibration Calibration System VMI International AB-CA200

**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Measure <sup>1</sup>	4.01 pH 7.00 pH 10.00 pH	0.013 pH 0.013 pH 0.015 pH	Control Company Solutions
Conductivity - Measure <sup>1</sup>	2 µS/cm 5 µS/cm 100 µS/cm 1 413 µS/cm	0.83 µS/cm 0.93 µS/cm 1.4 µS/cm 9.2 µS/cm	

**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Refractometers – Measure	15 Brix 40 Brix 5 % Refraction 10 % Refraction 15 % Refraction 20 % Refraction 25 % Refraction	0.22 Brix 0.21 Brix 0.18 % Refraction 0.18 % Refraction 0.18 % Refraction 0.18 % Refraction 0.18 % Refraction	Bellingham + Stanley Solutions, NaCl
Viscosity Meters - Measure <sup>1</sup>	1 000 mPa.s (cP) 5 000 mPa.s (cP) 8 000 mPa.s (cP) 10 000 mPa.s (cP)	0.92 % of reading 0.93 % of reading 0.93 % of reading 0.92 % of reading	Paragon Scientific Solutions
Gas Detectors <sup>1</sup>	H <sub>2</sub> S 25 ppm Concentration CO 50 ppm Concentration CH <sub>4</sub> 50 % Concentration LEL O <sub>2</sub> 12 % Concentration in N <sub>2</sub>	6 ppm Concentration 8.6 ppm Concentration  3 % of reading  2.4 % of reading	Standard Gases
Total Volatile Organic Compounds (TVOC) <sup>1</sup>	Up to 100 ppm Concentration	0.8 ppm Concentration	Standard Gas
Turbidity Meter <sup>1</sup>	(0 to 500) NTU (0 to 1 000) NTU	0.1 NTU + 0.01 NTU / NTU 0.2 NTU + 0.001 NTU / NTU	Turbidity Calibration Standards Solution
Alcoholmeter <sup>1</sup>	(0 to 100) % Concentration	0.43 % Concentration	High Precision Alcoholmeter

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage - Source <sup>1</sup>	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1 kV	8.1 μV/V + 0.8 μV 7.1 μV/V + 1 μV 8.1 μV/V + 3.5 μV 7.1 μV/V + 6.5 μV 8.1 μV/V + 80 μV 11 μV + 0.5 μV	Fluke 5700 A w Opt 03 Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage - Measure <sup>1</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V	11 $\mu$ V/V + 1.2 $\mu$ V 9.5 $\mu$ V/V + 1.2 $\mu$ V 9.5 $\mu$ V + 2.6 $\mu$ V 12 $\mu$ V/V + 36 $\mu$ V	Agilent 3458A w Opt 002 Multimeter
	100 V to 1 kV	12 $\mu$ V/V + 0.12 mV	Kikisui Digital High Voltage Meter
	(1 to 10) kV	1 mV/V + 4 V	High Voltage Meter
DC Current - Measure <sup>1</sup>	Up to 100 nA 100 nA to 1 $\mu$ A (1 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	35 $\mu$ A/A + 0.05 nA 24 $\mu$ A/A + 0.05 nA 24 $\mu$ A/A + 0.95 nA 24 $\mu$ A/A + 5.9 nA 24 $\mu$ A/A + 5.9 nA 41 $\mu$ A/A + 0.6 nA 0.13 $\mu$ A/A + 0.01 mA	Agilent 3458A w Opt 002 Multimeter
	(1 to 20) A (20 to 300) A	0.14 $\mu$ A/A 6.8 mA/A	Agilent 3458A w Opt 002 Multimeter with L&N Current Shunt
DC Current – Source <sup>1</sup>	Up to 220 $\mu$ A 220 $\mu$ A to 22 mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	50 $\mu$ A/A + 8 nA 50 $\mu$ A/A + 8 nA 50 $\mu$ A/A + 80 nA 60 $\mu$ A/A + 0.8 $\mu$ A 80 $\mu$ A/A + 25 $\mu$ A	Fluke 5700A w Opt 03 Multiproduct Calibrator
	330 $\mu$ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 2.2 A (2.2 to 11) A	0.15 mA/A + 0.06 $\mu$ A 0.11 mA/A + 0.46 $\mu$ A 0.10 $\mu$ A/A + 8.8 $\mu$ A 0.32 $\mu$ A/A + 0.12 mA 0.66 $\mu$ A/A + 0.81 mA	Fluke 5500A Multiproduct Calibrator
	(1 to 500) A	2.7 mA/A	Fluke 5500A Multiproduct Calibrator w 50 Turn Coil
AC Voltage – Source <sup>1</sup>	Up to 2.2 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	0.55 mV/V + 4.5 $\mu$ V 0.21 mV/V + 4.5 $\mu$ V 0.11 mV/V + 4.5 $\mu$ V 0.37 mV/V + 4.5 $\mu$ V 0.85 mV/V + 7 $\mu$ V 1.1 mV/V + 13 $\mu$ V 1.7 mV/V + 25 $\mu$ V 3.4 mV/V + 25 $\mu$ V	Fluke 5700A w Opt 03 Multiproduct Calibrator

**Electrical – DC/Low Frequency**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
AC Voltage – Source <sup>1</sup>	(2.2 to 22) mV		Fluke 5700A w Opt 03 Multiproduct Calibrator
	(10 to 20) Hz	0.55 mV/V + 5 μV	
	(20 to 40) Hz	0.21 mV/V + 5 μV	
	40 Hz to 20 kHz	0.11 mV/V + 5 μV	
	(20 to 50) kHz	0.37 mV/V + 5 μV	
	(50 to 100) kHz	0.85 mV/V + 7 μV	
	(100 to 300) kHz	1.1 mV/V + 12 μV	
	(300 to 500) kHz	1.7 mV/V + 25 μV	
	500 kHz to 1 MHz	3.4 mV/V + 25 μV	
	(22 to 220) mV		
	(10 to 20) Hz	0.55 mV/V + 13 μV	
	(20 to 40) Hz	0.21 mV/V + 8 μV	
	40 Hz to 20 kHz	0.11 mV/V + 8 μV	
	(20 to 50) kHz	0.37 mV/V + 8 μV	
	(50 to 100) kHz	0.85 mV/V + 25 μV	
	(100 to 300) kHz	1.1 mV/V + 25 μV	
	(300 to 500) kHz	1.7 mV/V + 35 μV	
	500 kHz to 1 MHz	3.4 mV/V + 80 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.50 mV/V + 80 μV	
	(20 to 40) Hz	0.16 mV/V + 25 μV	
	40 Hz to 20 kHz	80 μV/V + 6 μV	
	(20 to 50) kHz	0.13 mV/V + 16 μV	
	(50 to 100) kHz	0.26 mV/V + 70 μV	
	(100 to 300) kHz	0.44 mV/V + 0.13 mV	
	(300 to 500) kHz	1.8 mV/V + 35 mV	
	500 kHz to 1 MHz	2.6 mV/V + 8.5 mV	
(2.2 to 22) V			
(10 to 20) Hz	0.55 mV/V + 0.8 mV		
(20 to 40) Hz	0.16 mV/V + 0.25 mV		
40 Hz to 20 kHz	80 μV/V + 0.06 mV		
(20 to 50) kHz	0.13 mV/V + 0.16 mV		
(50 to 100) kHz	0.27 mV/V + 0.35 mV		
(100 to 300) kHz	0.5 mV/V + 1.5 mV		
(300 to 500) kHz	1.9 mV/V + 4.3 mV		
500 kHz to 1 MHz	3.1 mV/V + 8.5 mV		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source <sup>1</sup>	(22 to 220) 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 220 V to 1.1 kV (15 to 50) Hz 50 Hz to 1 kHz	0.5 mV/V + 8 mV 0.16 mV/V + 2.5 mV 80 μV/V + 0.8 mV 0.22 mV/V + 3.5 mV 0.5 mV/V + 8 mV 2 mV/V + 90 mV 0.4 mV/V + 16 mV 80 μV/V + 3.5 mV	Fluke 5700A w Opt 03 Multiproduct Calibrator
AC Voltage – Measure <sup>1</sup>	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 1 V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.36 mV/V + 3.5 μV 0.24 mV/V + 1.3 μV 0.35 mV/V + 1.3 μV 1.2 mV/V + 1.3 μV 5.9 mV/V + 1.3 μV 47 mV/V + 2.4 μV 0.008 mV/V + 2.4 μV 0.017 mV/V + 2.4 μV 0.035 mV/V + 2.4 μV 0.095 mV/V + 2.4 μV 0.354 mV/V + 12 μV 1.181 mV/V + 12 μV 1.772 mV/V + 12 μV 18 mV/V + 12 μV 0.08 mV/V + 48 μV 0.08 mV/V + 24 μV 0.17 mV/V + 24 μV 0.35 mV/V + 24 μV 0.95 mV/V + 24 μV 0.36 mV/V + 0.12 mV 12 mV/V + 0.12 mV 18 mV/V + 0.12 mV	Agilent 3458A w Opt 002 Multimeter



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure <sup>1</sup>	(1 to 10) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.08 mV/V + 0.47 mV 0.08 mV/V + 0.24 mV 0.17 mV/V + 0.24 mV 0.35 mV/V + 0.24 mV 0.95 mV/V + 0.24 V 3.6 mV/V + 1.2 mV 12 mV/V + 1.2 mV 18 mV/V + 1.2 mV	Agilent 3458A w Opt 002 Multimeter
	(10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.24 mV/V + 4.7 mV 0.24 mV/V + 2.4 mV 0.24 mV/V + 2.4 mV 0.43 mV/V + 2.4 mV 0.43 mV/V + 2.4 mV 4.7 mV/V + 12 mV 4.7 mV/V + 12 mV 0.47 mV/V + 47 mV 0.47 mV/V + 47 mV 0.71 mV/V + 24 mV 1.46 mV/V + 24 mV 3.6 mV/V + 2.4 mV	
	(1 to 30) kV (50 to 60) Hz	9 mV/V	Kikusui Digital High Voltage Meter
AC Current – Source <sup>1</sup>	Up 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 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	0.90 mA/A 0.50 mA/A 0.30 mA/A 0.80 mA/A 2 mA/A 0.90 mA/A 0.60 mA/A 0.30 mA/A 2.5 mA/A 5.3 mA/A	Fluke 5700A w Opt 03 Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source <sup>1</sup>	(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 (5 to 10) kHz 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	2.6 mA/A 2 mA/A 1.8 mA/A 19 mA/A 38 mA/A 0.7 mA/A 0.4 mA/A 0.2 mA/A 0.8 mA/A 1.9 mA/A 0.8 μA/A 1.1 mA/A 8.8 mA/A	Fluke 5700A w Opt 03 Multiproduct Calibrator
	(1 to 500) A 60Hz	2.7 mA/A	Fluke 5500A Multiproduct Calibrator with Coil
AC Current – Measure <sup>1</sup>	(5 to 100) μA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μA to 10 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 (10 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	4.8 mA/A + 24 nA 1.8 mA/A + 24 nA 0.7 mA/A + 24 nA 0.7 mA/A + 24 nA 4.7 mA/A + 2.4 nA 1.8 mA/A + 2.4 nA 0.7 mA/A + 2.4 nA 0.4 mA/A + 2.4 nA 0.7 mA/A + 2.4 nA 4.7 mA/A + 4.7 nA 6.5 mA/A + 18 μA 4.7 mA/A + 24 μA 1.8 mA/A + 24 μA 0.7 mA/A + 24 μA 0.4 mA/A + 24 μA 0.7 mA/A + 24 μA 4.7 mA/A + 47 μA 6.5 mA/A + 0.18 mA	Agilent 3458A w Opt 002 Multimeter



**Electrical – DC/Low Frequency**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
AC Current – Measure <sup>1</sup>	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 0.9 mA/A + 0.24 mA 1.2 mA/A + 0.24 mA 3.5 mA/A + 0.24 mA 12 mA/A + 0.47 mA	Agilent 3458A w Opt 002 Multimeter
Oscilloscopes <sup>1</sup> Square Wave Signal 10 Hz to 10 kHz 50 Ω 1 M Ω  Leveled Sine Wave Flatness referenced to 50 kHz reference  Amplitude  Time Markers (5-2-1 Sequency) Into 50 Ω load  Rise Time	1.8 mV to 2.2 V p-p 1.8 mV to 105 V p-p 5 mV to 5.5 V  50 kHz to 100 MHz (100 to 300) MHz  50 kHz to 100 MHz (100 to 300) MHz  5 s to 100 μs 50 μs to 2 μs 1 μs to 20 ns 10 ns to 2 ns  ≤ 300 ps	3.2 mV/V + 60 μV 3 mV/V + 60 μV 20 mV/V + 0.11 mV  35 mV/V + 0.30 mV 40 mV/V + 0.30 mV  15 mV/V + 0.10 mV 20 mV/V + 0.10 mV  25 μHz/Hz + 15 mHz 25 μHz/Hz + 15 mHz 25 μHz/Hz 25 μHz/Hz  + 0 ps / - 100 ps	Fluke 5500A w Opt SC300 Multiproduct Calibrator
LCR Meters <sup>1</sup> (1 kHz to 10 MHz)	Up to 1 M Ω Up to 1000 pF Up to 10 H	0.02 % of reading 0.01 % of reading 0.1 % of reading	IET HARS-X-9-0.001 Decade Resistor, Agilent 16380A Capacitor Set, Decade Inductors ALD-22, ALD-32, ALD-42
HiPot Testers <sup>1</sup>	Up to 10 kV Up to 100 mA (Cut of Current)	0.002 % of reading + 1.5 V 1.15 % of reading + 7.5 μA	Kikisui 149-10A Voltmeter Kikisui TOS 1200 Withstanding Meter
Withstanding / Insulation Testers <sup>1</sup>	Up to 10 kV Up to 100 GΩ	0.002 % of reading + 1.5 V 0.09 % of reading + 1.5 MΩ	Kikisui 149-10A Voltmeter IET HRRS-B-5-1M-5KV Decade Resistor, Time Electronics 5069 Ins-Cal Insulation Tester

**Electrical – DC/Low Frequency**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Resistance – Source <sup>1</sup>	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) k (33 to 110) kΩ (110 to 330) kΩ 0.33 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	0.1 mΩ/Ω + 8 mΩ 0.1 mΩ/Ω + 17 mΩ 1 mΩ/Ω + 17 mΩ 1 mΩ/Ω + 17 mΩ 0.1 mΩ/Ω + 0.07 Ω 0.1 mΩ/Ω + 0.08 Ω 0.1 mΩ/Ω + 0.71 Ω 0.1 mΩ/Ω + 0.70 Ω 0.1 mΩ/Ω + 7 Ω 0.1 mΩ/Ω + 7 Ω 0.2 mΩ/Ω + 64 Ω 0.2 mΩ/Ω + 64 Ω 0.7 mΩ/Ω + 6.4 kΩ 1 mΩ/Ω + 6.1 kΩ 6 mΩ/Ω + 6.4 kΩ 6 mΩ/Ω + 19 kΩ	Fluke 5500A Multiproduct Calibrator
Resistance – Source Fixed Points <sup>1</sup>	1.9 Ω 10 Ω 10 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	95 μΩ/Ω 28 μΩ/Ω 27 μΩ/Ω 17 μΩ/Ω 17 μΩ/Ω 20 μΩ/Ω 20 μΩ/Ω 18 μΩ/Ω 18 μΩ/Ω 19 μΩ/Ω 19 μΩ/Ω 26 μΩ/Ω 26 μΩ/Ω 50 μΩ/Ω 50 μΩ/Ω 10 mΩ/Ω	Fluke 5700A Multiproduct Calibrator
Resistance – Measure <sup>1</sup>	(0 to 10) Ω (10 to 100) Ω 100 to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	16 μΩ/Ω + 81 μΩ 14 μΩ/Ω + 0.59 μΩ 12 μΩ/Ω + 0.61 μΩ 12 μΩ/Ω + 6.2 mΩ 12 μΩ/Ω + 61 mΩ 18 μΩ/Ω + 2.4 Ω 59 μΩ/Ω + 0.12 kΩ 0.59 mΩ/Ω + 1.2 kΩ 5.9 mΩ/Ω + 12 kΩ	Agilent 3458A w Opt 002 Multimeter



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance <sup>1</sup> – Source at 1 kHz	(330 to 500) pF 500 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) μF (110 to 330) μF (0.33 to 1.19) 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	5 pF/F + 12 pF 6 nF/F + 12 pF 6 nF/F + 12 pF 6 nF/F + 12 pF 3 nF/F + 0.12 nF 3 μF/F + 0.12 nF 3 μF/F + 0.35 nF 3 μF/F + 12 nF 4 μF/F + 3.5 nF 4 μF/F + 11 nF 5 μF/F + 35 nF 6 μF/F + 0.11 μF 8 μF/F + 0.35 μF 10 μF/F + 0.27 μF	Fluke 5500A Multiproduct Calibrator
Electrical Calibration of Thermocouple Indicators <sup>1</sup>	Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C	0.58 °C 0.19 °C 0.17 °C 0.19 °C 0.26 °C 0.31 °C 0.27 °C 0.16 °C 0.25 °C 0.28 °C	Fluke 5500A Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators <sup>1</sup>	Type K		Fluke 5500A Multiproduct Calibrator
	(-200 to -100) °C	0.41 °C	
	(-100 to -25) °C	0.26 °C	
	(-25 to 120) °C	0.24 °C	
	(120 to 1 000) °C	0.30 °C	
	(1 000 to 1 372) °C	0.47 °C	
	Type R		
	(0 to 250) °C	0.66 °C	
	(250 to 400) °C	0.43 °C	
	(400 to 1 000) °C	0.38 °C	
	(1 000 to 1 767) °C	0.46 °C	
	Type T		
	(-250 to -150) °C	0.73 °C	
(-150 to 0) °C	0.32 °C		
(0 to 120) °C	0.24 °C		
(120 to 400) °C	0.17 °C		
Electrical Calibration of RTD Indicating Systems <sup>1</sup>	Pt 385, 100 Ω		Fluke 5500A Multiproduct Calibrator
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	Pt 3926, 100 Ω		
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 400) °C	0.09 °C	
	(400 to 630) °C		
	Pt 385, 1 kΩ	0.11 °C	
	(-200 to 0) °C	0.03 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 400) °C	0.07 °C	
	(400 to 630) °C	0.23 °C	
Pt Ni 385, 100 Ω			
(-80 to 100) °C	0.08 °C		
(100 to 260) °C	0.14 °C		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems <sup>1</sup>	Cu 427, 10 Ω (-100 to 260) °C	0.3 °C	Fluke 5500A Multiproduct Calibrator
Pressure Transmitters <sup>1</sup>	(4 to 20) mA	0.003 mA	Pressure Calibrator
Tesla Meter <sup>1</sup> (Gauss Meter)	(0 to 300) mT	0.15 mT	Kanetec Reference Magnetic Field Kanetec TM-SMF-003, TM-SMF-050, TM-SMF-300

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation <sup>1</sup> – Source Rate: 6 MHz to 20 GHz (0 to 100) %	DC to 100 kHz	1.2 % of reading + 0.07 AM	Agilent N5531S Measuring Receiver, Agilent E4440A Spectrum Analyzer
Amplitude Modulation - Measure <sup>1</sup> Rate: 50 Hz to 10 kHz, (5 to 99) %	100 kHz to 10 MHz	0.002 % of reading + 0.01 AM	Agilent E4440A Spectrum Analyzer
50 Hz to 100 kHz, (20 to 99) %	10 MHz to 3 GHz	0.001 % of reading + 0.01 AM	
50 Hz to 100 kHz, (5 to 20) %	10 MHz to 3 GHz	0.01 % of reading + 0.03 AM	
(3 to 26.5) GHz, (5 to 20) %	(3 to 18) GHz	0.01 % of reading + 0.05 AM	
(3 to 26.5) GHz, (20 to 99) %	(3 to 18) GHz	0.001 % of reading + 0.02 AM	



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure <sup>1</sup> Rate: 20 Hz to 10 kHz Dev: 20 Hz to 40 kHz peak	250 kHz to 10 MHz	1.7 % of reading + 5.7 Hz 1.1 % of reading + 6.7 Hz	Agilent N5531S Measuring Receiver, Agilent E4440A Spectrum Analyzer
Rate: 50 Hz to 200 kHz Dev: 250 Hz to 400 kHz peak	250 kHz to 10 MHz	1.8 % of reading + 5.1 Hz 1.2 % of reading + 6.1 Hz	
Rate: 50 Hz to 200 kHz Dev: 250 Hz to 400 kHz peak	250 kHz to 10 MHz	2.9 % of reading + 4 Hz 1.2 % of reading + 6.4 Hz	
Rate: 50 Hz to 100 kHz Dev: 250 Hz to 400 kHz peak	250 kHz to 10 MHz	4.4 % of reading + 3.8 Hz 1.2 % of reading + 7.6 Hz	
Frequency Modulation – Source <sup>1</sup> Rate: 1 kHz rate Max. Dev. 2 MHz Max. Dev. 4 MHz Max. Dev. 8 MHz Max. Dev. 16 MHz Max. Dev. 32 MHz	250 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz (3.2 to 10) GHz (10 to 20) GHz	4 % of reading + 24 Hz	HP 83620B Signal Generator
Power – Measure <sup>1</sup>	1mW reference 50 MHz 100 kHz to 4.2 GHz 10 MHz to 18 GHz 30 MHz to 26.5 GHz	0.01 mW 3 % of reading + 0.1 dB 3.2 % of reading + 0.1 dB 3 % of reading + 0.1 dB	HP 432A Power Meter w/ HP 478A Thermistor Mount, or Agilent E4419B Power Meter w/ HP 8482A, HP 8481A, HP 8485A Power Sensors

Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks <sup>1</sup>	(1 to 100) mm (120 to 500) mm	0.11 μm + 0.6L/1 000 (L: mm) 0.2 μm + 0.6L/1 000 (L: mm)	DMS 680 Universal Length Measuring System, Gage Block Set Grade 0, Long Gage Block Set
Calipers <sup>1</sup>	Up to 600 mm (Up to 24 inch)	0.01 mm	Mitutoyo Gage Block Set

**Length – Dimensional metrology**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Micrometers <sup>1</sup>	Up to 300 mm (Up to 12 inch)	1.2 μm + 0.002 5 μm / mm	Optical Flat, Mitutoyo Gage Block Set
Height Gages <sup>1</sup>	Up to 600 mm (Up to 24 inch)	0.005 mm	Mitutoyo Gage Block Set
Steel Ruler <sup>1</sup>	Up to 1 000 mm	(0.09 + 0.008 x L) mm [L]: m	Standard Steel Ruler & Scale Lupe & Granite Surface Plate - Mitutoyo
Tape Ruler <sup>1</sup>	Up to 1 000 mm	0.015 mm	Tape and scale calibration unit KUDALE 1 000 mm
Glass Scales <sup>1</sup>	Up to 300 mm	(0.7 + 0.001 6 x L) μm, [L]: mm	Standard Glass Scale Microscope
Depth Gages <sup>1</sup>	Up to 100 mm (Up to 4 inch)	0.002 mm	Mitutoyo Gauge Block Set
Thickness Gages <sup>1</sup> (Measure Mode)	Up to 12 mm (Up to 0.4 inch)	0.002 mm	Mitutoyo Gage Block Set
Thickness Gages (Feeler Type)	Up to 1 mm (Up to 0.04 inch)	0.001 mm	DMS 680 Universal Length Measuring System
Indicators, Dial Indicators <sup>1</sup>	Up to 25 mm (Up to 1 inch)	0.003 mm	Mitutoyo Dial Gage Tester (UDT-2)
Dial Test Indicators <sup>1</sup>	Up to 1 mm (Up to 0.04 in)	0.001 mm	Mitutoyo Calibration Tester (UDT-3)
Pin Gages, Plug Gages <sup>1</sup>	Up to 100 mm (Up to 4 inch)	0.002 mm	DMS 680 Universal Length Measuring System
Dial Bore Gages <sup>1</sup>	Up to 50 mm (Up to 2 inch)	0.003 mm	DMS 680 Universal Length Measuring System
Setting Rings <sup>1</sup>	Up to 100 mm (Up to 4 inch)	0.000 2 mm	DMS 680 Universal Length Measuring System
Coordinate Measuring Machines (CMM) <sup>1</sup>	Axis X: 600 mm Axis Y: 600 mm Axis Z: 300 mm	0.3 μm + 0.007 μm / mm 0.3 μm + 0.007 μm / mm 0.4 μm + 0.007 μm / mm	Mitutoyo Long Gauge Block Set, Grade 0. Datum Sphere Assembly Renishaw
Surface Roughness Testers Ra Mode Contour Mode	(Up to 119.5 μin) Ra 6.350 mm	4.1 μin 0.026 μm	Mitutoyo 178-603, Roughness Specimen. Datum Sphere Assembly Renishaw



**Length – Dimensional metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Roundness Testing Machines	Up to 6.350 mm	0.026 $\mu\text{m}$	Master Ball of Calibration
Measuring Microscopes	Up to 300 mm (Up to 12 inch)	0.004 mm	Nikon 300 mm, Standard Glass Scale. Nikon, Stage Micrometer.
Surface Flatness – Local Area Flatness	(12 x 12 to 48 x 96) inch	41 $\mu\text{in}$	Rahn Repeat-o-Meter
Profile Projectors Linearity Only	Up to 300 mm (Up to 12 inch)	0.009 mm	Nikon 300 mm, Standard Glass Scale. Mitutoyo, Long Gauge Block Set, Grade 0 Standards Radius Scales
Thread Plug Gauges <sup>1</sup> (M1 to M52) Pitch Diameter	M1 to M52	0.29 $\mu\text{m}$	DMS 680 Universal Length Measuring System
Coating Thickness Meters <sup>1</sup>	Up to 1 500 $\mu\text{m}$	2 $\mu\text{m}$	Coating Thickness Standards

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools <sup>1</sup>	(1 to 10) lbf.in (2 to 25) lbf.in (5 to 50) lbf.in (10 to 100) lbf.in (5 to 50) lbf.ft (25 to 250) lbf.ft	0.7 % of reading + 0.008 lbf.in 0.7 % of reading + 0.02 lbf.in 0.7 % of reading + 0.04 lbf.in 0.7 % of reading + 0.07 lbf.in 0.7 % of reading + 0.04 lbf.ft 0.7 % of reading + 0.19 lbf.ft	Mountz Torque Transducers BMX10i BMX25i BMX50i BMX100i BMX50F BMX250F
Torque Transducers <sup>1</sup>	(20 to 200) lbf.ft	0.01 % of reading + 0.001 lbf.ft	Mountz Arm & Standard Weight Set
Mass	(1 to 500 g), OIML E2	0.01 mg + 0.002 mg / g	Weight Set E1, XPE205, XP504
	(1 to 500 g), OIML F1	0.36 mg + 0.005 mg / g	Weight Set E2, XPE205, XP504



**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	(1 mg to 500 g), OIML F2 (1 to 20) kg, OIML F2 (1 to 20) kg, OIML M1	0.006 mg + 0.02 mg / g 0.2 g + 0.01 mg / g 0.5 g + 0.04 mg / g	Weight Set F1, XP504 Weight Set F1, XS32001LDR Electronic Balance, Weight Set F2
Balances / Scales <sup>1</sup>	Class I 1 mg to 220 g 1 mg to 520 g Class II 10 mg to 6.1 kg Class III 1 g to 32.1 kg Platform (1 to 1 000) kg	0.6 mg 1.2 mg 100 mg 1.2 g 10 g	Weight Set E1 Weight Set E1 Weight Set F1 Weight Set F2 Weight Set M1
Force – Compression & Tension Machines Force Gages	Up to 50 kN Up to 20 kgf	0.05 kN + 0.01 kN/kN 0.03 kgf	Load cell & Indicator Standard Weight
Pneumatic Pressure <sup>1</sup>	(-14 to 1000) psi (-0.97 to 69) bar	0.5 psi	Deadweight Tester
Hydraulic Pressure <sup>1</sup>	(0 to 30 000) psi (0 to 2 000) bar	5.8 psi	Fluke 718-300G, 718-30G Pressure Calibrators w Pressure Module
Air Velocity <sup>1</sup>	Up to 15 m/s	0.17 m/s + 0.004 4 m/s / m/s	Wind Tunnel and Standard Anemometer
Flow Meters <sup>1</sup>	Up to 30 lpm	0.17 lpm + 0.008 lpm / lpm	Primary Air Flow Calibrator
Rockwell Hardness Testers <sup>1</sup>	40.8 HRC 50.7 HRC 60.4 HRC 70.1 HRC  43.1 HRBW 60.9 HRBW 84.4 HRBW	0.56 HRC  1.5 HRBW	ASTM E18 Indirect Verification using Yamamoto Scientific Standard Block for Hardness
Microindentation Hardness Testers <sup>1</sup>	328 HV 530 HV 774 HV	1.4 HV + 0.04 HV / HV	ASTM E192 Indirect Verification using Mitutoyo Vickers Test Blocks

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Particle Counters <sup>1</sup>	Up to 50 µm	7 % Concentration	PMS Laser II-310A Particle Counting System BIOS Defender 520 Air Flow Calibrator
Burette <sup>1</sup>	(1 to 100) ml	0.5 µl/ml + 10 µl	Analytical Scale, Standard Weight Set, Temperature Calibrator
Pipettes & Micropipettes	(1 to 100) ml	0.4 µl/ml + 6.6 µl	
Volumetric Flasks <sup>1</sup>	(10 to 2 000) ml	450 µl	
Grain Moisture Tester <sup>1</sup>	(6 to 40) % Moisture Content	0.8 % Moisture Content	Temperature & Humidity Chamber Analytical Balance
Hydrometer <sup>1</sup>	Up to 1.18 g/ml	0.003 g/ml	Hydrometer Standard
Durometer Calibration – Types A, B, C, D, D0, O Force Only	(0 to 100) duro	1.8 duro	Rubber Hardness Tester Calibrator Kudale 0-100

**Photometry and Radiometry**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Light Meters <sup>1</sup>	(20 to 20 000) lx	1 % of reading	Light System Calibration VMI-PRI-002
Radiometers	(1 to 225) mW	6.3 % of reading	Light Source S2000 Radiometer R2000
UV-VIS Spectrophotometers <sup>1</sup>	(200 to 650) nm (0 to 2) Abs	0.5 nm 0.007 9 Abs	Standard UV-VIS Spectrophotometer HELLMA 666.000
Gloss Meter <sup>1</sup>	92.4 SGU 94.8 SGU 99.5 SGU	0.7 SGU 0.6 SGU 0.6 SGU	Standards High Gloss



**Thermodynamic**

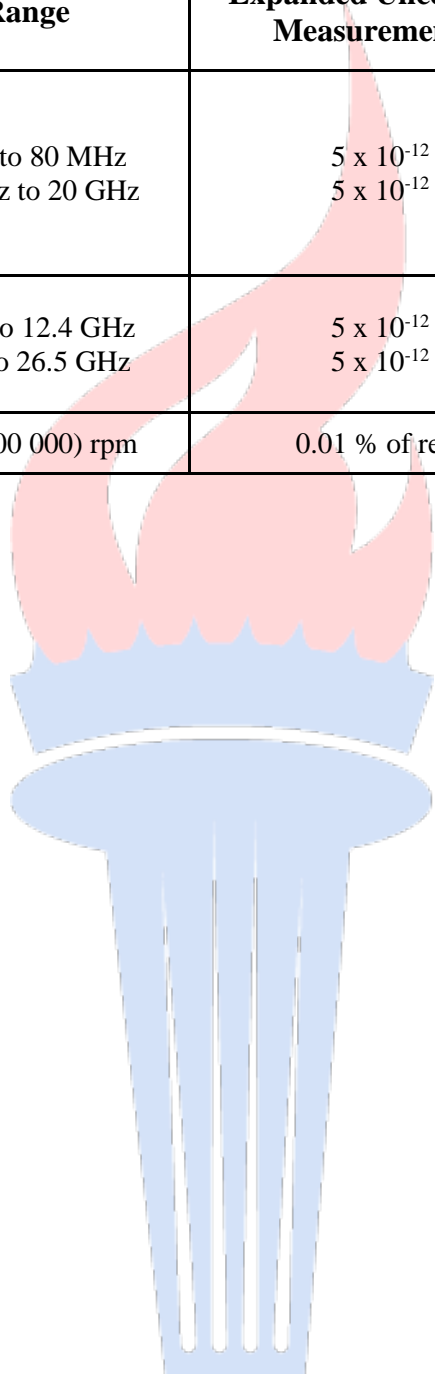
Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity <sup>1</sup>	(10 to 90) %RH	1.3 %RH	Temperature and Humidity Chamber ESPEC-642 Temp. & Humidity Meter Vaisala HMI41/HMP46
Relative Humidity Fixed Points <sup>1</sup>	11 %RH 33 %RH 75 %RH 97 %RH	1 %RH + 0.006 %RH/%RH	Salt Solutions, Temperature and Humidity Chamber ESPEC-642 Temp. & Humidity Meter Vaisala HMI41/HMP46
Temperature - Measure <sup>1</sup>	(-45 to 150) °C (150 to 1 200) °C	0.06 °C 0.5 °C	Ametek RTC-157B ISOTECH Pegasus 1200 Temperature Sensor Fluke 5626-12 Reference Thermometer Fluke 1523
Temperature - Source <sup>1</sup>	(-200 to 650) °C	0.1 °C	Temperature Sensor Fluke 5626-12 Reference Thermometer Fluke 1523
IR Temperature - Measure <sup>1</sup>	(35 to 500) °C	0.15 °C + 0.000 9 °C/ °C	Fluke 4181,4180 $\lambda = 8$ to $14 \mu\text{m}$ , $\epsilon = 0.95$
Chambers <sup>1</sup> Temperature Humidity	(-200 to 650) °C (10 to 100) %RH	0.06 °C 1.3 %RH	Agilent 34970A Agilent 34901A Mudgetech HiTemp 140
Transmitters <sup>1</sup> Temp. Transmitters	(-45 to 150) °C (150 to 1200) °C	0.06 °C 0.5 °C	Ametek RTC-157B Isotech Pegasus 1200 Agilent 3458A Temperature Sensor Fluke 5626
Humidity Transmitters Current	(10 to 90) %RH (4 to 20) mA	1 %RH + 0.06 %RH / %RH 0.003 mA	Reference Thermometer Fluke 1523

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stopwatches/Timers <sup>1</sup>	Up to 3 600 s	120 ms	Agilent 53132A Counter

**Time and Frequency**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
Frequency - Source <sup>1</sup>	1μHz to 80 MHz 10 MHz to 20 GHz	5 x 10 <sup>-12</sup> Hz 5 x 10 <sup>-12</sup> Hz	Agilent 33250A Function Generator HP 83620B Signal Generator Agilent 58503A GPS Receiver
Frequency - Measure <sup>1</sup>	1μHz to 12.4 GHz 1 Hz to 26.5 GHz	5 x 10 <sup>-12</sup> Hz 5 x 10 <sup>-12</sup> Hz	Agilent 53132A Counter Agilent E4440A Agilent 58503A GPS Receiver
Tachometers <sup>1</sup>	(1 to 100 000) rpm	0.01 % of reading	Signal Generator w Lamp





# ANSI National Accreditation Board

## Services performed at satellite location

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### Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters <sup>1</sup>	94 dB 114 dB	0.5 dB 0.84 dB	Sound Calibrator
Vibration Meters <sup>1</sup> Acceleration Velocity Displacement	(10 to 5 000) Hz, (0.1 to 200) m/s <sup>2</sup>	0.86 % of reading	Vibration Calibration System VMI INTERNATIONAL AB-CA200

### Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Measure <sup>1</sup>	4.01 pH 7.00 pH 10.00 pH	0.013 pH 0.013 pH 0.015 pH	Control Company Solutions
Conductivity - Measure <sup>1</sup>	2 µS/cm 5 µS/cm 100 µS/cm 1 413 µS/cm	0.83 µS/cm 0.93 µS/cm 1.4 µS/cm 9.2 µS/cm	
Refractometers – Measure	15 Brix 40 Brix 5 % Refraction 10 % Refraction 15 % Refraction 20 % Refraction 25 % Refraction	0.22 Brix 0.21 Brix 0.18 % Refraction 0.18 % Refraction 0.18 % Refraction 0.18 % Refraction 0.18 % Refraction	Bellingham + Stanley Solutions, NaCl
Viscosity Meters - Measure <sup>1</sup>	1 000 mPa.s (cP) 5 000 mPa.s (cP) 8 000 mPa.s (cP) 10 000 mPa.s (cP)	0.92 % of reading 0.93 % of reading 0.93 % of reading 0.92 % of reading	Paragon Scientific Solutions



Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Detectors <sup>1</sup>	H <sub>2</sub> S 25 ppm Concentration CO 50 ppm Concentration CH <sub>4</sub> 50 % Concentration LEL O <sub>2</sub> 12 % Concentration in N <sub>2</sub>	6 ppm Concentration 8.6 ppm Concentration  3 % of reading  2.4 % of reading	Standard Gases
Total Volatile Organic Compounds (TVOC) <sup>1</sup>	Up to 100 ppm Concentration	0.8 ppm Concentration	Standard Gas
Turbidity Meter <sup>1</sup>	(0 to 500) NTU (0 to 1 000) NTU	0.1 NTU + 0.01 NTU / NTU 0.2 NTU + 0.001 NTU / NTU	Turbidity Calibration Standards Solution
Alcoholmeter <sup>1</sup>	(0 to 100) % Concentration	0.43 % Concentration	High Precision Alcoholmeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage - Source <sup>1</sup>	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1 kV	8.1 μV/V + 0.8 μV 7.1 μV/V + 1 μV 8.1 μV/V + 3.5 μV 7.1 μV/V + 6.5 μV 8.1 μV/V + 80 μV 11 μV + 0.5 μV	Fluke 5700 A w Opt 03 Multiproduct Calibrator
DC Voltage - Measure <sup>1</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V	11 μV/V + 1.2 μV 9.5 μV/V + 1.2 μV 9.5 μV + 2.6 μV 12 μV/V + 36 μV	Agilent 3458A w Opt 002 Multimeter
	100 V to 1 kV	12 μV/V + 0.12 mV	Kikusui Digital High Voltage Meter
	(1 to 10) kV	1 mV/V + 4 V	High Voltage Meter



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current - Measure <sup>1</sup>	Up to 100 nA 100 nA to 1 μA (1 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	35 μA/A + 0.05 nA 24 μA/A + 0.05 nA 24 μA/A + 0.95 nA 24 μA/A + 5.9 nA 24 μA/A + 5.9 nA 41 μA/A + 0.6 nA 0.13 μA/A + 0.01 mA	Agilent 3458A w Opt 002 Multimeter
DC Current - Measure <sup>1</sup>	(1 to 20) A (20 to 300) A	0.14 μA/A 6.8 mA/A	Agilent 3458A w Opt 002 Multimeter with L&N Current Shunt
DC Current – Source <sup>1</sup>	Up to 220 μA 220 μA to 22 mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	50 μA/A + 8 nA 50 μA/A + 8 nA 50 μA/A + 80 nA 60 μA/A + 0.8 μA 80 μA/A + 25 μA	Fluke 5700A w Opt 03 Multiproduct Calibrator
	330 μA to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 2.2 A (2.2 to 11) A	0.15 mA/A + 0.06 μA 0.11 mA/A + 0.46 μA 0.10 μA/A + 8.8 μA 0.32 μA/A + 0.12 mA 0.66 μA/A + 0.81 mA	Fluke 5500A Multiproduct Calibrator
	(1 to 500) A	2.7 mA/A	Fluke 5500A Multiproduct Calibrator w 50 Turn Coil
AC Voltage – Source <sup>1</sup>	Up to 2.2 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 (2.2 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	0.55 mV/V + 4.5 μV 0.21 mV/V + 4.5 μV 0.11 mV/V + 4.5 μV 0.37 mV/V + 4.5 μV 0.85 mV/V + 7 μV 1.1 mV/V + 13 μV 1.7 mV/V + 25 μV 3.4 mV/V + 25 μV 0.55 mV/V + 5 μV 0.21 mV/V + 5 μV 0.11 mV/V + 5 μV 0.37 mV/V + 5 μV 0.85 mV/V + 7 μV 1.1 mV/V + 12 μV 1.7 mV/V + 25 μV 3.4 mV/V + 25 μV	Fluke 5700A w Opt 03 Multiproduct Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source <sup>1</sup>	(22 to 220) mV		Fluke 5700A w Opt 03 Multiproduct Calibrator
	(10 to 20) Hz	0.55 mV/V + 13 μV	
	(20 to 40) Hz	0.21 mV/V + 8 μV	
	40 Hz to 20 kHz	0.11 mV/V + 8 μV	
	(20 to 50) kHz	0.37 mV/V + 8 μV	
	(50 to 100) kHz	0.85 mV/V + 25 μV	
	(100 to 300) kHz	1.1 mV/V + 25 μV	
	(300 to 500) kHz	1.7 mV/V + 35 μV	
	500 kHz to 1 MHz	3.4 mV/V + 80 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.50 mV/V + 80 μV	
	(20 to 40) Hz	0.16 mV/V + 25 μV	
	40 Hz to 20 kHz	80 μV/V + 6 μV	
	(20 to 50) kHz	0.13 mV/V + 16 μV	
	(50 to 100) kHz	0.26 mV/V + 70 μV	
	(100 to 300) kHz	0.44 mV/V + 0.13 mV	
	(300 to 500) kHz	1.8 mV/V + 35 mV	
	500 kHz to 1 MHz	2.6 mV/V + 8.5 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.55 mV/V + 0.8 mV	
	(20 to 40) Hz	0.16 mV/V + 0.25 mV	
	40 Hz to 20 kHz	80 μV/V + 0.06 mV	
	(20 to 50) kHz	0.13 mV/V + 0.16 mV	
	(50 to 100) kHz	0.27 mV/V + 0.35 mV	
(100 to 300) kHz	0.5 mV/V + 1.5 mV		
(300 to 500) kHz	1.9 mV/V + 4.3 mV		
500 kHz to 1 MHz	3.1 mV/V + 8.5 mV		
(22 to 220) V			
(10 to 20) Hz	0.5 mV/V + 8 mV		
(20 to 40) Hz	0.16 mV/V + 2.5 mV		
40 Hz to 20 kHz	80 μV/V + 0.8 mV		
(20 to 50) kHz	0.22 mV/V + 3.5 mV		
(50 to 100) kHz	0.5 mV/V + 8 mV		
(100 to 300) kHz	2 mV/V + 90 mV		
220 V to 1.1 kV			
(15 to 50) Hz	0.4 mV/V + 16 mV		
50 Hz to 1 kHz	80 μV/V + 3.5 mV		





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<p>AC Voltage – Measure<sup>1</sup></p>	<p>Up to 10 mV            (1 to 40) Hz            40 Hz to 1 kHz            (1 to 20) kHz            (20 to 50) kHz            (50 to 100) kHz            (100 to 300) kHz            (10 to 100) mV            (1 to 40) Hz            40 Hz to 1 kHz            (1 to 20) kHz            (20 to 50) kHz            (50 to 100) kHz            (100 to 300) kHz            300 kHz to 1 MHz            (1 to 2) MHz            100 mV to 1 V            (1 to 40) Hz            40 Hz to 1 kHz            (1 to 20) kHz            (20 to 50) kHz            (50 to 100) kHz            (100 to 300) kHz            300 kHz to 1 MHz            (1 to 2) MHz            (1 to 10) V            (1 to 40) Hz            40 Hz to 1 kHz            (1 to 20) kHz            (20 to 50) kHz            (50 to 100) kHz            (100 to 300) kHz            300 kHz to 1 MHz            (1 to 2) MHz            (10 to 100) V            (1 to 40) Hz            40 Hz to 1 kHz            (1 to 20) kHz            (20 to 50) kHz            (50 to 100) kHz            (100 to 300) kHz            300 kHz to 1 MHz</p>	<p>0.36 mV/V + 3.5 μV            0.24 mV/V + 1.3 μV            0.35 mV/V + 1.3 μV            1.2 mV/V + 1.3 μV            5.9 mV/V + 1.3 μV            47 mV/V + 2.4 μV            0.008 mV/V + 2.4 μV            0.017 mV/V + 2.4 μV            0.035 mV/V + 2.4 μV            0.095 mV/V + 2.4 μV            0.4 mV/V + 12 μV            1.2 mV/V + 12 μV            1.8 mV/V + 12 μV            18 mV/V + 12 μV            0.08 mV/V + 48 μV            0.08 mV/V + 24 μV            0.17 mV/V + 24 μV            0.35 mV/V + 24 μV            0.95 mV/V + 24 μV            0.36 mV/V + 0.12 mV            12 mV/V + 0.12 mV            18 mV/V + 0.12 mV            0.08 mV/V + 0.47 mV            0.08 mV/V + 0.24 mV            0.17 mV/V + 0.24 mV            0.35 mV/V + 0.24 mV            0.95 mV/V + 0.24 V            3.6 mV/V + 1.2 mV            12 mV/V + 1.2 mV            18 mV/V + 1.2 mV            0.24 mV/V + 4.7 mV            0.24 mV/V + 2.4 mV            0.24 mV/V + 2.4 mV            0.43 mV/V + 2.4 mV            0.43 mV/V + 2.4 mV            4.7 mV/V + 12 mV            4.7 mV/V + 12 mV</p>	<p>Agilent 3458A w Opt 002            Multimeter</p>
<p>AC Voltage – Measure<sup>1</sup></p>	<p>100 V to 1 kV            (1 to 40) Hz            40 Hz to 1 kHz</p>	<p>0.47 mV/V + 47 mV            0.47 mV/V + 47 mV</p>	<p>Agilent 3458A w Opt 002            Multimeter</p>



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	(1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.71 mV/V + 24 mV 1.46 mV/V + 24 mV 3.6 mV/V + 2.4 mV	
	(1 to 30) kV (50 to 60) Hz	9 mV/V	Kikisui Digital High Voltage Meter
AC Current – Source <sup>1</sup>	Up to 220 μA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 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	0.90 mA/A 0.50 mA/A 0.30 mA/A 0.80 mA/A 2 mA/A 0.90 mA/A 0.60 mA/A 0.30 mA/A 2.5 mA/A 5.3 mA/A	Fluke 5700A w Opt 03 Multiproduct Calibrator
AC Current – Source <sup>1</sup>	(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 (5 to 10) kHz 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	2.6 mA/A 2 mA/A 1.8 mA/A 19 mA/A 38 mA/A 0.7 mA/A 0.4 mA/A 0.2 mA/A 0.8 mA/A 1.9 mA/A 0.8 μA/A 1.1 mA/A 8.8 mA/A	Fluke 5700A w Opt 03 Multiproduct Calibrator
	(1 to 500) A 60Hz	2.7 mA/A	Fluke 5500A Multiproduct Calibrator with Coil

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure <sup>1</sup>	(5 to 100) $\mu$ A		Agilent 3458A w Opt 002 Multimeter
	(10 to 20) Hz	4.8 mA/A + 24 nA	
	(20 to 45) Hz	1.8 mA/A + 24 nA	
	(45 to 100) Hz	0.7 mA/A + 24 nA	
	100 Hz to 5 kHz	0.7 mA/A + 24 nA	
	100 $\mu$ A to 10 mA		
	(10 to 20) Hz	4.7 mA/A + 2.4 nA	
	(20 to 45) Hz	1.8 mA/A + 2.4 nA	
	(45 to 100) Hz	0.7 mA/A + 2.4 nA	
	100 Hz to 5 kHz	0.4 mA/A + 2.4 nA	
	(5 to 20) kHz	0.7 mA/A + 2.4 nA	
	(20 to 50) kHz	4.7 mA/A + 4.7 nA	
	(50 to 100) kHz	6.5 mA/A + 18 $\mu$ A	
	(10 to 100) mA		
	(10 to 20) Hz	4.7 mA/A + 24 $\mu$ A	
	(20 to 45) Hz	1.8 mA/A + 24 $\mu$ A	
	(45 to 100) Hz	0.7 mA/A + 24 $\mu$ A	
	100 Hz to 5 kHz	0.4 mA/A + 24 $\mu$ A	
(5 to 20) kHz	0.7 mA/A + 24 $\mu$ A		
(20 to 50) kHz	4.7 mA/A + 47 $\mu$ A		
(50 to 100) kHz	6.5 mA/A + 0.18 mA		
100 mA to 1 A			
(10 to 20) Hz	4.7 mA/A + 0.24 mA		
(20 to 45) Hz	1.9 mA/A + 0.24 mA		
(45 to 100) Hz	0.9 mA/A + 0.24 mA		
100 Hz to 5 kHz	1.2 mA/A + 0.24 mA		
(5 to 20) kHz	3.5 mA/A + 0.24 mA		
(20 to 50) kHz	12 mA/A + 0.47 mA		
Oscilloscopes <sup>1</sup> Square Wave Signal 10 Hz to 10 kHz 50 $\Omega$ 1 M $\Omega$  Leveled Sine Wave Flatness referenced to 50 kHz reference  Amplitude	1.8 mV to 2.2 V p-p	3.2 mV/V + 60 $\mu$ V	Fluke 5500A w Opt SC300 Multiproduct Calibrator
	1.8 mV to 105 V p-p	3 mV/V + 60 $\mu$ V	
	5 mV to 5.5 V	20 mV/V + 0.11 mV	
	50 kHz to 100 MHz	35 mV/V + 0.30 mV	
	(100 to 300) MHz	40 mV/V + 0.30 mV	
	50 kHz to 100 MHz	15 mV/V + 0.10 mV	
(100 to 300) MHz	20 mV/V + 0.10 mV		



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1</sup> Time Markers (5-2-1 Sequency) Into 50 Ω load  Rise Time	5 s to 100 μs 50μ s to 2 μs 1 μs to 20 ns 10 ns to 2 ns  ≤ 300 ps	25 μHz/Hz + 15 mHz 25 μHz/Hz + 15 mHz 25 μHz/Hz 25 μHz/Hz  + 0 ps / - 100 ps	Fluke 5500A w Opt SC300 Multiproduct Calibrator
LCR Meters <sup>1</sup> (1 kHz to 10 MHz)	Up to 1 M Ω Up to 1000 pF Up to 10 H	0.02 % of reading 0.01 % of reading 0.1 % of reading	IET HARS-X-9-0.001 Decade Resistor, Agilent 16380A Capacitor Set, Decade Inductors ALD-22, ALD-32, ALD-42
HiPot Testers <sup>1</sup>	Up to 10 kV Up to 100 mA (Cut of Current)	0.002 % of reading + 1.5 V 1.15 % of reading + 7.5 μA	Kikisui 149-10A Voltmeter Kikisui TOS 1200 Withstanding Meter
Withstanding / Insulation Testers <sup>1</sup>	Up to 10 kV Up to 100 GΩ	0.002 % of reading + 1.5 V 0.09 % of reading + 1.5 MΩ	Kikisui 149-10A Voltmeter IET HRRS-B-5-1M-5KV Decade Resistor, Time Electronics 5069 Ins-Cal Insulation Tester
Resistance – Source <sup>1</sup>	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) k (33 to 110) kΩ (110 to 330) kΩ 0.33 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	0.1 mΩ/Ω + 8 mΩ 0.1 mΩ/Ω + 17 mΩ 1 mΩ/Ω + 17 mΩ 1 mΩ/Ω + 17 mΩ 0.1 mΩ/Ω + 0.07 Ω 0.1 mΩ/Ω + 0.08 Ω 0.1 mΩ/Ω + 0.71 Ω 0.1 mΩ/Ω + 0.70 Ω 0.1 mΩ/Ω + 7 Ω 0.1 mΩ/Ω + 7 Ω 0.2 mΩ/Ω + 64 Ω 0.2 mΩ/Ω + 64 Ω 0.7 mΩ/Ω + 6.4 kΩ 1 mΩ/Ω + 6.1 kΩ 6 mΩ/Ω + 6.4 kΩ 6 mΩ/Ω + 19 kΩ	Fluke 5500A Multiproduct Calibrator



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source Fixed Points <sup>1</sup>	1.9 Ω	95 μΩ/Ω	Fluke 5700A Multiproduct Calibrator
	10 Ω	28 μΩ/Ω	
	10 Ω	27 μΩ/Ω	
	100 Ω	17 μΩ/Ω	
	190 Ω	17 μΩ/Ω	
	1 kΩ	20 μΩ/Ω	
	1.9 kΩ	20 μΩ/Ω	
	10 kΩ	18 μΩ/Ω	
	19 kΩ	18 μΩ/Ω	
	100 kΩ	19 μΩ/Ω	
	190 kΩ	19 μΩ/Ω	
	1 MΩ	26 μΩ/Ω	
	1.9 MΩ	26 μΩ/Ω	
	10 MΩ	50 μΩ/Ω	
	19 MΩ	50 μΩ/Ω	
100 MΩ	10 mΩ/Ω		
Resistance – Measure <sup>1</sup>	(0 to 10) Ω	16 μΩ/Ω + 81 μΩ	Agilent 3458A w Opt 002 Multimeter
	(10 to 100) Ω	14 μΩ/Ω + 0.59 μΩ	
	100 to 1 kΩ	12 μΩ/Ω + 0.61 μΩ	
	(1 to 10) kΩ	12 μΩ/Ω + 6.2 mΩ	
	(10 to 100) kΩ	12 μΩ/Ω + 61 mΩ	
	(0.1 to 1) MΩ	18 μΩ/Ω + 2.4 Ω	
	(1 to 10) MΩ	59 μΩ/Ω + 0.12 kΩ	
	(10 to 100) MΩ	0.59 mΩ/Ω + 1.2 kΩ	
(0.1 to 1) GΩ	5.9 mΩ/Ω + 12 kΩ		
Capacitance <sup>1</sup> – Source at 1 kHz	(330 to 500) pF	5 pF/F + 12 pF	Fluke 5500A Multiproduct Calibrator
	500 pF to 1.1 nF	6 nF/F + 12 pF	
	(1.1 to 3.3) nF	6 nF/F + 12 pF	
	(3.3 to 11) nF	6 nF/F + 12 pF	
	(11 to 33) nF	3 nF/F + 0.12 nF	
	(33 to 110) μF	3 μF/F + 0.12 nF	
	(110 to 330) μF	3 μF/F + 0.35 nF	
	(0.33 to 1.19) μF	3 μF/F + 12 nF	
	(1.1 to 3.3) μF	4 μF/F + 3.5 nF	
	(3.3 to 11) μF	4 μF/F + 11 nF	
	(11 to 33) μF	5 μF/F + 35 nF	
	(33 to 110) μF	6 μF/F + 0.11 μF	
	(110 to 330) μF	8 μF/F + 0.35 μF	
	330 μF to 1.1 mF	10 μF/F + 0.27 μF	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators <sup>1</sup>	Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type R (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.58 °C 0.19 °C 0.17 °C 0.19 °C 0.26 °C 0.31 °C 0.27 °C 0.16 °C 0.25 °C 0.28 °C 0.41 °C 0.26 °C 0.24 °C 0.30 °C 0.47 °C 0.66 °C 0.43 °C 0.38 °C 0.46 °C 0.73 °C 0.32 °C 0.24 °C 0.17 °C	Fluke 5500A Multiproduct Calibrator
Electrical Calibration of RTD Indicating Systems <sup>1</sup>	Pt 385, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C (630 to 800) °C Pt 3926, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C	0.05 °C 0.07 °C 0.1 °C 0.12 °C 0.23 °C 0.05 °C 0.07 °C 0.1 °C 0.12 °C	Fluke 5500A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems <sup>1</sup>	Pt 385, 500 Ω (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C Pt 385, 1 kΩ (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C Pt Ni 385, 100 Ω (-80 to 100) °C (100 to 260) °C Cu 427, 10 Ω (-100 to 260) °C	0.05 °C 0.06 °C 0.09 °C 0.11 °C 0.03 °C 0.05 °C 0.07 °C 0.23 °C 0.08 °C 0.14 °C 0.3 °C	Fluke 5500A Multiproduct Calibrator
Pressure Transmitters <sup>1</sup>	(4 to 20) mA	0.003 mA	Pressure Calibrator
Tesla Meter <sup>1</sup> (Gauss Meter)	(0 to 300) mT	0.15 mT	Kanetec Reference Magnetic Field Kanetec <sup>TM</sup> -SMF-003, TM-SMF-050, TM-SMF-300

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation <sup>1</sup> – Source Rate: 6 MHz to 20 GHz (0 to 100) %	DC to 100 kHz	1.2 % of reading + 0.07 AM	Agilent N5531S Measuring Receiver, Agilent E4440A Spectrum Analyzer



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Measure <sup>1</sup> Rate: 50 Hz to 10 kHz, (5 to 99) %  50 Hz to 100 kHz, (20 to 99) %  50 Hz to 100 kHz, (5 to 20) %	100 kHz to 10 MHz  10 MHz to 3 GHz  10 MHz to 3 GHz	0.002 % of reading + 0.01 AM  0.001 % of reading + 0.01 AM  0.01 % of reading + 0.03 AM	Agilent E4440A Spectrum Analyzer
Amplitude Modulation - Measure <sup>1</sup> (3 to 26.5) GHz, (5 to 20) %  (3 to 26.5) GHz, (20 to 99) %	(3 to 18) GHz  (3 to 18) GHz	0.01 % of reading + 0.05 AM  0.001 % of reading + 0.02 AM	Agilent E4440A Spectrum Analyzer
Frequency Modulation – Measure <sup>1</sup> Rate: 20 Hz to 10 kHz Dev: 20 Hz to 40 kHz peak  Rate: 50 Hz to 200 kHz Dev: 250 Hz to 400 kHz peak  Rate: 50 Hz to 200 kHz Dev: 250 Hz to 400 kHz peak  Rate: 50 Hz to 100 kHz Dev: 250 Hz to 400 kHz peak	250 kHz to 10 MHz  250 kHz to 10 MHz  250 kHz to 10 MHz  250 kHz to 10 MHz	1.7 % of reading + 5.7 Hz 1.1 % of reading + 6.7 Hz  1.8 % of reading + 5.1 Hz 1.2 % of reading + 6.1 Hz  2.9 % of reading + 4 Hz 1.2 % of reading + 6.4 Hz  4.4 % of reading + 3.8 Hz 1.2 % of reading + 7.6 Hz	Agilent N5531S Measuring Receiver, Agilent E4440A Spectrum Analyzer
Frequency Modulation – Source <sup>1</sup> Rate: 1 kHz rate Max. Dev. 2 MHz Max. Dev. 4 MHz Max. Dev. 8 MHz Max. Dev. 16 MHz Max. Dev. 32 MHz	250 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz (3.2 to 10) GHz (10 to 20) GHz	4 % of reading + 24 Hz	HP 83620B Signal Generator





Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Power – Measure <sup>1</sup> 1mW reference	50 MHz 100 kHz to 4.2 GHz 10 MHz to 18 GHz 30 MHz to 26.5 GHz	0.01 mW 3 % of reading + 0.10 dBm 3.2 % of reading + 0.10 dBm 3 % of reading + 0.10 dBm	HP 432A Power Meter w/ HP 478A Thermistor Mount, or Agilent E4419B Power Meter w/ HP 8482A, HP 8481A, HP 8485A Power Sensors

Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks <sup>1</sup>	(1 to 100) mm (120 to 500) mm	0.11 μm + 0.6L/1 000 (L: mm) 0.2 μm + 0.6L/1 000 (L: mm)	DMS 680 Universal Length Measuring System, Gage Block Set Grade 0, Long Gage Block Set
Calipers <sup>1</sup>	Up to 600 mm (Up to 24 inch)	0.01 mm	Mitutoyo Gage Block Set
Micrometers <sup>1</sup>	Up to 300 mm (Up to 12 inch)	1.2 μm + 0.002 5 μm / mm	Optical Flat, Mitutoyo Gage Block Set
Height Gages <sup>1</sup>	Up to 600 mm (Up to 24 inch)	0.005 mm	Mitutoyo Gage Block Set
Steel Ruler <sup>1</sup>	Up to 1 000 mm	(0.09 + 0.008 x L) mm [L]: m	Standard Steel Ruler & Scale Lupe & Granite Surface Plate - Mitutoyo
Tape Ruler <sup>1</sup>	Up to 1 000 mm	0.015 mm	Tape and scale calibration unit KUDALE 1000mm
Glass Scales <sup>1</sup>	Up to 300 mm	(0.7 + 0.001 6 x L) μm, [L]: mm	Standard Glass Scale Microscope
Depth Gages <sup>1</sup>	Up to 100 mm (Up to 4 inch)	0.002 mm	Mitutoyo Gauge Block Set
Thickness Gages <sup>1</sup> (Measure Mode)	Up to 12 mm (Up to 0.4 inch)	0.002 mm	Mitutoyo Gage Block Set
Thickness Gages (Feeler Type)	Up to 1 mm (Up to 0.04 inch)	0.001 mm	DMS 680 Universal Length Measuring System
Indicators, Dial Indicators <sup>1</sup>	Up to 25 mm (Up to 1 inch)	0.003 mm	Mitutoyo Dial Gage Tester (UDT-2)



Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dial Test Indicators <sup>1</sup>	Up to 1 mm (Up to 0.04 in)	0.001 mm	Mitutoyo Calibration Tester (UDT-3)
Pin Gages, Plug Gages <sup>1</sup>	Up to 100 mm (Up to 4 inch)	0.002 mm	DMS 680 Universal Length Measuring System
Dial Bore Gages <sup>1</sup>	Up to 50 mm (Up to 2 inch)	0.003 mm	DMS 680 Universal Length Measuring System
Setting Rings <sup>1</sup>	Up to 100 mm (Up to 4 inch)	0.000 2 mm	DMS 680 Universal Length Measuring System
Coordinate Measuring Machines (CMM) <sup>1</sup>	Axis X: 600 mm Axis Y: 600 mm Axis Z: 300 mm	0.3 μm + 0.007 μm / mm 0.3 μm + 0.007 μm / mm 0.4 μm + 0.007 μm / mm	Mitutoyo Long Gauge Block Set, Grade 0. Datum Sphere Assembly Renishaw
Surface Roughness Testers Ra Mode Contour Mode	(Up to 119.5 μin) Ra 6.350 mm	4.1 μin 0.026 μm	Mitutoyo 178-603, Roughness Specimen. Datum Sphere Assembly Renishaw
Roundness Testing Machines	Up to 6.350 mm	0.026 μm	Master Ball of Calibration
Measuring Microscopes	Up to 300 mm (Up to 12 inch)	0.004 mm	Nikon 300 mm, Standard Glass Scale. Nikon, Stage Micrometer.
Surface Flatness – Local Area Flatness	(12 x 12 to 48 x 96) inch	41 μin	Rahn Repeat-o-Meter
Profile Projectors Linearity Only	Up to 300 mm (Up to 12 inch)	0.009 mm	Nikon 300 mm, Standard Glass Scale. Mitutoyo, Long Gauge Block Set, Grade 0 Standards Radius Scales
Thread Plug Gauges <sup>1</sup> (M1 to M52) Pitch Diameter	M1 to M52	0.29 μm	DMS 680 Universal Length Measuring System
Coating Thickness Meters <sup>1</sup>	Up to 1 500 μm	2 μm	Coating Thickness Standards

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools <sup>1</sup>	(1 to 10) lbf.in (2 to 25) lbf.in (5 to 50) lbf.in (10 to 100) lbf.in (5 to 50) lbf-ft (25 to 250) lbf-ft	0.7 % of reading + 0.008 lbf.in 0.7 % of reading + 0.02 lbf.in 0.7 % of reading + 0.04 lbf.in 0.7 % of reading + 0.07 lbf.in 0.7 % of reading + 0.04 lbf-ft 0.7 % of reading + 0.19 lbf-ft	Mountz Torque Transducers BMX10i BMX25i BMX50i BMX100i BMX50F BMX250F
Torque Transducers <sup>1</sup>	(20 to 200) lbf-ft	0.01 % of reading + 0.001 lbf-ft	Mountz Arm & Standard Weight Set
Mass	(1 to 500 g), OIML E2	0.01 mg + 0.002 mg / g	Weight Set E1, XPE205, XP504
Mass	(1 to 500 g), OIML F1	0.36 mg + 0.005 mg / g	Weight Set E2, XPE205, XP504
	(1 mg to 500 g), OIML F2	0.006 mg + 0.02 mg / g	Weight Set F1, XP504 Weight Set F1, XS32001LDR Electronic Balance, Weight Set F2
	(1 to 20) kg, OIML F2 (1 to 20 kg, OIML M1)	0.2 g + 0.01 mg / g 0.5 g + 0.04 mg / g	
Balances / Scales <sup>1</sup>	Class I 1 mg to 220 g	0.6 mg	Weight Set E1 Weight Set E1
	1 mg to 520 g	1.2 mg	
	Class II 10 mg to 6.1 kg	100 mg	Weight Set F1
	Class III 1 g to 32.1 kg	1.2 g	Weight Set F2
	Platform (1 to 1 000) kg	10 g	Weight Set M1
Force – Compression & Tension Machines Force Gages	Up to 50 kN Up to 20 kgf	0.05 kN + 0.01 kN/kN 0.03 kgf	Load cell & Indicator Standard Weight
Pneumatic Pressure <sup>1</sup>	(-14 to 1 000) psi (-0.97 to 69) bar	0.5 psi	Deadweight Tester
Hydraulic Pressure <sup>1</sup>	(0 to 30 000) psi (0 to 2 000) bar	5.8 psi	Fluke 718-300G, 718-30G Pressure Calibrators w Pressure Module
Air Velocity <sup>1</sup>	Up to 15 m/s	0.17 m/s + 0.004 4 m/s / m/s	Wind Tunnel and Standard Anemometer
Flow Meters <sup>1</sup>	Up to 30 lpm	0.17 lpm + 0.008 lpm / lpm	Primary Air Flow Calibrator

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers <sup>1</sup>	40.8 HRC 50.7 HRC 60.4 HRC 70.1 HRC  43.1 HRBW 60.9 HRBW 84.4 HRBW	0.56 HRC  1.5 HRBW	ASTM E18 Indirect Verification using Yamamoto Scientific Standard Block for Hardness
Microindentation Hardness Testers <sup>1</sup>	328 HV 530 HV 774 HV	1.4 HV + 0.04 HV / HV	ASTM E192 Indirect Verification using Mitutoyo Vickers Test Blocks
Particle Counters <sup>1</sup>	Up to 50 µm	7 % Concentration	PMS Laser II-310A Particle Counting System BIOS Defender 520 Air Flow Calibrator
Burette <sup>1</sup>	(1 to 100) ml	0.5 µl/ml + 10 µl	Analytical Scale, Standard Weight Set, Temperature Calibrator
Pipettes & Micropipettes	(1 to 100) ml	0.4 µl/ml + 6.6 µl	
Volumetric Flasks <sup>1</sup>	(10 to 2 000) ml	450 µl	
Grain Moisture Tester <sup>1</sup>	(6 to 40) % Moisture Content	0.8 % Moisture Content	Temperature & Humidity Chamber Analytical Balance
Hydrometer <sup>1</sup>	Up to 1.18 g/ml	0.003 g/ml	Hydrometer Standard
Durometer Calibration – Types A, B, C, D, D0, O Force Only	(0 to 100) duro	1.8 duro	Rubber Hardness Tester Calibrator Kudale 0-100

**Photometry and Radiometry**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Light Meters <sup>1</sup>	(20 to 20 000) lx	1 % of reading	Light System Calibration VMI-PRI-002

**Photometry and Radiometry**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiometers	(1 to 225) mW	6.3 % of reading	Light Source S2000 Radiometer R2000
UV-VIS Spectrophotometers <sup>1</sup>	(200 to 650) nm (0 to 2) Abs	0.5 nm 0.007 9 Abs	Standard UV-VIS Spectrophotometer HELLMA 666.000
Gloss Meter <sup>1</sup>	92.4 SGU 94.8 SGU 99.5 SGU	0.7 SGU 0.6 SGU 0.6 SGU	Standards High Gloss

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity <sup>1</sup>	(10 to 90) %RH	1.3 %RH	Temperature and Humidity Chamber ESPEC-642 Temp. & Humidity Meter Vaisala HMI41/HMP46
Relative Humidity Fixed Points <sup>1</sup>	11 %RH 33 %RH 75 %RH 97 %RH	1 %RH + 0.006 %RH/%RH	Salt Solutions, Temperature and Humidity Chamber ESPEC-642 Temp. & Humidity Meter Vaisala HMI41/HMP46
Temperature - Measure <sup>1</sup>	(-45 to 150) °C (150 to 1 200) °C	0.06 °C 0.5 °C	Ametek RTC-157B ISOTECH Pegasus 1200 Temperature Sensor Fluke 5626-12 Reference Thermometer Fluke 1523
Temperature - Source <sup>1</sup>	(-200 to 650) °C	0.1 °C	Temperature Sensor Fluke 5626-12 Reference Thermometer Fluke 1523
IR Temperature - Measure <sup>1</sup>	(35 to 500) °C	0.15 °C + 0.000 9 °C/ °C	Fluke 4181,4180 $\lambda = (8 \text{ to } 14) \mu\text{m}$ , $\epsilon = 0.95$
Chambers <sup>1</sup> Temperature Humidity	(-200 to 650) °C (10 to 100) %RH	0.06 °C 1.3 %RH	Agilent 34970A Agilent 34901A MADGETECH HiTemp 140



**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmitters <sup>1</sup> Temp. Transmitters	(-45 to 150) °C (150 to 1 200) °C	0.06 °C 0.5 °C	Ametek RTC-157B Isotech Pegasus 1200 Agilent 3458A
Humidity Transmitters Current	(10 to 90) %RH (4 to 20) mA	1 %RH + 0.06 %RH / %RH 0.003 mA	Temperature Sensor Fluke 5626 Reference Thermometer Fluke 1523

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stopwatches/Timers <sup>1</sup>	Up to 3 600 s	120 ms	Agilent 53132A Counter
Frequency - Source <sup>1</sup>	1 µHz to 80 MHz 10 MHz to 20 GHz	5 x 10 <sup>-12</sup> Hz 5 x 10 <sup>-12</sup> Hz	Agilent 33250A Function Generator HP 83620B Signal Generator Agilent 58503A GPS Receiver
Frequency - Measure <sup>1</sup>	1 µHz to 12.4 GHz 1 Hz to 26.5 GHz	5 x 10 <sup>-12</sup> Hz 5 x 10 <sup>-12</sup> Hz	Agilent 53132A Counter Agilent E4440A Agilent 58503A GPS Receiver
Tachometers <sup>1</sup>	(1 to 100 000) rpm	0.01 % of reading	Signal Generator w Lamp

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 meters
3. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1868.

Vice President