



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Micro Precision Calibration, Inc.

22835 Industrial Place

Grass Valley, CA 95949

(and satellite locations as shown on the scope)

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

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

ANSI/NCSL Z540.3-2006 (R2013)

In the field of

CALIBRATION and DIMENSIONAL MEASUREMENT

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.

Jason Stine, Vice President

Expiry Date: 31 October 2028

Certificate Number: AC-1969



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)

ANSI/NCSL Z540.3-2006 (R2013)

Micro Precision Calibration, Inc.

22835 Industrial Place

[Grass Valley](#), CA 95949

CALIBRATION AND DIMENSIONAL MEASUREMENT

ISO/IEC 17025 Accreditation Granted: **24 September 2026**

Certificate Number: **AC-1969** Certificate Expiry Date: **31 October 2028**

Services identified on tables as “Global Scope” are performed at all locations.

The lowest uncertainties are achieved at the Grass Valley location.

Services identified on tables with specified locations are performed at those locations using the methods and to the uncertainties as specified

Customers submitting items to Micro Precision for calibration will be directed to the appropriate delivery site based on capability, geography and capacity.

Calibrations are performed at the most appropriate center based on the customer's needs and location, and the resulting uncertainties may be higher depending on the equipment's performance.

Satellite locations in:

Micro Precision Calibration, Inc.
670 International Parkway
[Richardson](#), TX 75081 USA

Micro Precision Calibration, Inc.
2165 N. Glassell
[Orange](#) (Los Angeles), CA 92865 USA

Micro Precision Calibration, Inc.
9831 S 51st Street, Suite C-108
[Phoenix](#), AZ 85044 USA

Micro Precision Calibration, Inc.
3570 Commerce Drive
[Columbus](#), IN 47201 USA

Micro Precision Calibration, Inc.
7877 SW Cirrus Drive, Building 25
[Beaverton](#) (Portland), OR 97008 USA

Micro Precision Calibration, Inc.
2590 Oakmont Dr., Unit 30
[Round Rock](#), TX 78665 USA (Austin)

Micro Precision Calibration, Inc.
16 Columbia Drive
[Amherst, NH 03031 USA](#)

Micro Precision Calibration, Inc.
17072 Tye St. SE, Suite #170
[Monroe, WA 98272 USA \(Seattle\)](#)

Micro Precision Calibration de Mexico S. de R.L. de CV
Calle Paraíso #1596 Colonia Del Fresno
[Guadalajara, Jalisco 44900 Mexico](#)

Micro Precision Calibration de Mexico S. de R.L. de CV
Av. Nacional No. 3. Col Ejidos de San Cristobal
[Ecatepec de Morelos, Estado de Mexico C.P. 55024 Mexico \(Mexico City\)](#)

Micro Precision Instrument Calibration Sdn. Bhd.
22 Jalan Hang Tuah 26 Taman, Skudai Baru
[Johor Bahru, Malaysia 81300](#)

Micro Precision Calibration (Wuxi) Co. Ltd.
Room 101 Building C, Innovation and Creation Science Park
No 5 Xinhau Road, Wuxi New District
[Wuxi, Jiangsu PR China](#)

Micro Precision Calibration Laboratory(Thailand) Co. Ltd.
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[Nonthaburi 11120, Thailand](#)

Micro Precision Calibration Vietnam Ltd. Co.
No 201, 2nd Floor, Sacom Chipsang Building, Saigon High Tech Park
Thu Duc City, [Ho Chi Minh City, Vietnam](#)

Micro Precision Calibration Cebu, Inc.
U-201 IMEZ Bldg., Osmena St. MEZ II Basak
[Lapu-Lapu City, Philippines 6015](#)

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11451 US-301, Suite #105
[Thonotosassa, FL 33592 USA](#)

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Street #11, Gate 74, Bldg 163,
Salwa Industrial Area
[Doha, Qatar](#)

Micro Precision Calibration Vietnam Ltd. Co.
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Yen Phong Industrial Zone, Yen Phong District
[Bac Ninh Province, Vietnam](#)

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[San Jose, CA 95119 USA](#)

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[Seoul, South Korea 150-772](#)

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TechPlace II [Singapore 569874](#)

Micro Precision Calibration Sdn. Bhd.
No. 6 Jalan, Lelisa Emas, Taman Kelisa,
Seberang Jaya 13600, [Penang, Malaysia](#)

Micro Precision Calibration Shezhen Inc.
3D-1505 Tian'an Cloud Park, 2018 Xuegang Road
Longgang District
[Shenzhen, Guanngdong 518129 PR China](#)

Micro Precision Calibration (India) Private Limited
No 57 Avadi Road, Sippoy Lane, Karayanchavadi
Poonamalle, [Chennai 600 056, India](#)

Microprecision Calibration, Inc.
Block 2 Lot 6 Calamba Premiere International Park
Brgy Batino, [Calamba City, Laguna Philippines 4027](#)

Micro Precision Calibration Taiwan Co. Ltd.
3F, No. 21, Shuili Road
[Hsinchu City 300053, Taiwan ROC](#)

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6546 BC [Nijmegen, Netherlands](#)

Micro Precision Calibration de Mexico S. de R.L. de CV
Carretera a San Luis Rio Colorado KM 10.5 Locales 13y 14
Parque Industrial las California
[Mexicali, BC C.P. 21394 Mexico](#)

Micro Precision Calibration, Inc.
12701 Tejon Street, Suite 100
[Westminster, CO USA \(Denver\)](#)

Micro Precision Brazil LTDA
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[Manaus, AM 69065-020 Brazil](#)

Micro Precision Calibration de Mexico S. de R.L. de C.V.
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[Silao](#), Guanajuato, Mexico, C.P.36100

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Micro Precision Calibration, Inc.
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[Giroc](#) 307220, Timis County, Romania

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Micro Precision Calibration, Inc.
8847 Long Street
[Lenexa](#), KS 66215

Miro Precision Calibration Pty Ltd
Unit 13/63 Ricky Way
[Epping](#), Victoria 3076 Australia

Services performed at Main Site laboratory and Satellite Locations

Acoustics and Vibration

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Calibrator ¹	(74 to 114) dB 125 Hz to 1 kHz (1 to 4) kHz	0.2 dB 0.25 dB	Comparison to Standard Sound Level Calibrator and Sound Level Meter
Sound Level Meter ^{1,2}	(74 to 114) dB 125 Hz to 4 kHz	0.22 dB	Comparison to Standard Sound Level Calibrator

Chemical Quantities

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters ^{1,4}	(4, 7, 10) pH units	0.012 pH	Comparison to Standard pH Solutions

Chemical Quantities

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	1 μ S/cm 5 μ S/cm 10 μ S/cm 84 μ S/cm 100 μ S/cm 1 000 μ S/cm 1 413 μ S/cm 10 000 μ S/cm 12 880 μ S/cm 100 000 μ S/cm	0.62 μ S/cm 0.62 μ S/cm 0.62 μ S/cm 0.8 μ S/cm 2.1 μ S/cm 5.2 μ S/cm 5.6 μ S/cm 47 μ S/cm 81 μ S/cm 440 μ S/cm	Comparison to Standard Conductivity Solutions

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 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 1.1 kV	5.1 μ V/V + 0.5 μ V 3.6 μ V/V + 0.8 μ V 2.5 μ V/V + 3.1 μ V 2.5 μ V/V + 4.7 μ V 3.6 μ V/V + 50 μ V 4.9 μ V/V + 0.46 mV	Comparison to Multifunction Calibrator
DC Voltage – Source ¹	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1 020) V	17 μ V/V + 1.2 μ V 10 μ V/V + 2.4 μ V 12 μ V/V + 24 μ V 18 μ V/V + 0.17 mV 18 μ V/V + 1.7 mV	Comparison to Multiproduct Calibrator
pH Meters – Electrical Simulation ¹	(-414.12 to 414.12) mV (0 to 14) pH	6 μ V/V + 0.8 μ V 0.000 68 pH	Comparison to Multifunction Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	2.8 μ V/V + 0.37 μ V 1.7 μ V/V + 0.37 μ V 0.6 μ V/V + 0.65 μ V 2.9 μ V/V + 37 μ V 5.2 μ V/V + 120 μ V	Comparison to Multimeter
DC High Voltage – Measure ¹	Up to 10 kV	0.37 mV/V + 0.01 V	Comparison to High Voltage Meter

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source ¹	(0 to 220) μ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	37 μ A/A + 6.9 nA 30 μ A/A + 8.6 nA 29 μ A/A + 63 nA 41 μ A/A + 0.91 μ A 60 μ A/A + 14 μ A 0.38 mA/A + 540 μ A	Comparison to Multifunction Calibrator, Amplifier
DC Current – Source ¹	(0 to 330) μ A (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (330 to 1.1) A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	0.14 mA/A + 24 nA 0.094 mA/A + 63 nA 0.095 mA/A + 0.46 μ A 0.1 mA/A + 3 μ A 0.17 mA/A + 64 μ A 0.32 mA/A + 0.13 mA 0.44 mA/A + 0.63 mA 0.92 mA/A + 0.87 mA	Comparison to Multiproduct Calibrator
DC Current – Source ¹	Up to 200 pA 200 pA to 20 nA 20 nA to 20 mA	96 μ A/A + 0.01 fA 34 μ A/A + 0.026 pA 32 μ A/A	Comparison to Stable Source, Standard Voltmeter and Standard Resistors
DC High Current – Source ¹	Up to 16.5 A (16.5 to 1 025) A	2.4 mA/A + 0.12 mA 2.4 mA/A	Comparison to Multiproduct Calibrator with w/50-turn Coil
DC Current – Measure ¹	Up to 100 nA (0.1 to 1) μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	10 μ A/A + 40 pA 10 μ A/A + 40 pA 10 μ A/A + 70 pA 10 μ A/A + 0.6 nA 10 μ A/A + 4 nA 10 μ A/A + 40 nA 25 μ A/A + 0.4 μ A 0.1 mA/A + 10 μ A	Comparison to 8.5 Digits Multimeter
DC Current – Measure ¹	Up to 1 μ A (1 to 10) μ A (10 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (1 to 3) A (3 to 10) A	0.34 mA/A + 0.069 nA 0.35 mA/A + 0.24 nA 0.35 mA/A + 1.2 nA 0.36 mA/A + 0.034 μ A 0.35 mA/A + 2.3 μ A 0.35 mA/A + 4.7 μ A 0.81 mA/A + 0.07 mA 2.4 mA/A + 0.67 mA 1.4 mA/A + 1.1 mA	Comparison to 6.5 Digits Multimeter
DC Current – Measure ¹	Up to 200 pA 200 pA to 20 nA 20 nA to 20 mA	96 μ A/A + 0.01 fA 34 μ A/A + 0.026 pA 32 μ A/A	Comparison to Standard Voltmeter and Standard Resistors

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Power – Source ^{1, 2} (0 to 330) μ A (0.33 to 330) mA (0.33 to 1.1) A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	(0 to 330) mW (0.33 to 330) W (0.33 to 3.3) kW (3.3 to 33) kW (33 to 330) kW (330 to 3 366) kW	0.022 % of reading + 0.58R 0.013 % of reading 0.024 % of reading 0.037 % of reading 0.05 % of reading 0.1 % of reading	Comparison to Multiproduct Calibrator
Inductance – Source ^{1, 2} (Fixed Artifacts) 100 Hz to 10 kHz	100 μ H 1 mH 2 mH 10 mH 20 mH 50 mH 100 mH 200 mH 1 H 2 H 5 H 10 H	0.016 μ H 0.12 μ H 0.33 μ H 2.2 μ H 7 μ H 8.2 μ H 12 μ H 33 μ H 0.2 mH 0.33 mH 0.82 mH 1.2 mH	Comparison to Standard Inductors
Inductance – Source ^{1, 2} (Variable Artifacts) 100 Hz to 10 kHz	100 μ H to 10 H	0.41 mH/H + 0.58R	Comparison to Decade Inductor
Inductance – Measure ^{1, 2} 12 Hz to 100 kHz	0.01 μ H to 10 H	0.16 mH/H	Comparison to Precision LCR Meter w/Standard Inductors
	0.01 μ H to 10 H	0.27 mH/H + 0.58R	Comparison to RLC Digibridge
Resistance – Source ¹	(1 to 10) m Ω 10 m Ω to 100 Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 11) M Ω (10 to 110) M Ω (0.1 to 1) G Ω (1 to 10) G Ω (10 to 100) G Ω	1.6 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 1.6 $\mu\Omega/\Omega$ 1.4 $\mu\Omega/\Omega$ 1.6 $\mu\Omega/\Omega$ 3.8 $\mu\Omega/\Omega$ 7.3 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 61 $\mu\Omega/\Omega$ 200 $\mu\Omega/\Omega$	Comparison to Standard Resistors

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0 Ω	40 $\mu\Omega$	Comparison to Multifunction Calibrator
	1.0 Ω	80 $\mu\Omega/\Omega$	
	1.9 Ω	80 $\mu\Omega/\Omega$	
	10 Ω	21 $\mu\Omega/\Omega$	
	19 Ω	21 $\mu\Omega/\Omega$	
	100 Ω	9.1 $\mu\Omega/\Omega$	
	190 Ω	9.1 $\mu\Omega/\Omega$	
	1 k Ω	7.7 $\mu\Omega/\Omega$	
	1.9 k Ω	7.7 $\mu\Omega/\Omega$	
	10 k Ω	7.6 $\mu\Omega/\Omega$	
	19 k Ω	7.7 $\mu\Omega/\Omega$	
	100 k Ω	9.1 $\mu\Omega/\Omega$	
	190 k Ω	9.1 $\mu\Omega/\Omega$	
	1 M Ω	15 $\mu\Omega/\Omega$	
	1.9 M Ω	16 $\mu\Omega/\Omega$	
	10 M Ω	31 $\mu\Omega/\Omega$	
	19 M Ω	40 $\mu\Omega/\Omega$	
	100 M Ω	95 $\mu\Omega/\Omega$	
Resistance – Source ¹	(0 to 11) Ω	43 $\mu\Omega/\Omega + 1.2$ m Ω	Comparison to Multiproduct Calibrator
	(11 to 33) Ω	31 $\mu\Omega/\Omega + 1.7$ m Ω	
	(33 to 110) Ω	28 $\mu\Omega/\Omega + 1.6$ m Ω	
	(110 to 330) Ω	28 $\mu\Omega/\Omega + 2.3$ m Ω	
	(0.33 to 1.1) k Ω	32 $\mu\Omega/\Omega + 1.9$ m Ω	
	(1.1 to 3.3) k Ω	32 $\mu\Omega/\Omega + 19$ m Ω	
	(3.3 to 11) k Ω	29 $\mu\Omega/\Omega + 34$ m Ω	
	(11 to 33) k Ω	35 $\mu\Omega/\Omega + 0.16$ Ω	
	(33 to 110) k Ω	31 $\mu\Omega/\Omega + 0.14$ Ω	
	(110 to 330) k Ω	33 $\mu\Omega/\Omega + 2.5$ Ω	
	(0.33 to 1.1) M Ω	34 $\mu\Omega/\Omega + 2.6$ Ω	
	(1.1 to 3.3) M Ω	49 $\mu\Omega/\Omega + 35$ Ω	
	(3.3 to 11) M Ω	0.13 m $\Omega/\Omega + 58$ Ω	
	(11 to 33) M Ω	0.24 m $\Omega/\Omega + 2.8$ k Ω	
	(33 to 110) M Ω	0.50 m $\Omega/\Omega + 3.2$ k Ω	
	(110 to 330) M Ω	2.9 m $\Omega/\Omega + 0.11$ M Ω	
	(330 to 1 100) M Ω	15 m $\Omega/\Omega + 0.54$ M Ω	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	5 $\mu\Omega/\Omega$ + 31 $\mu\Omega$ 3 $\mu\Omega/\Omega$ + 0.3 m Ω 2 $\mu\Omega/\Omega$ + 0.21 m Ω 2 $\mu\Omega/\Omega$ + 2.1 m Ω 2 $\mu\Omega/\Omega$ + 21 m Ω 10 $\mu\Omega/\Omega$ + 1 Ω 50 $\mu\Omega/\Omega$ + 50 Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	Comparison to Multimeter
Resistance – Measure ¹	(0.22 to 2.2) V 50 Ω to 1 k Ω (1 to 100) k Ω 100 k Ω to 1 M Ω (2.2 to 22) V 500 Ω to 10 k Ω 10 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω (22 to 220) V (5 to 100) k Ω 100 k Ω to 10 M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (220 to 1000) V 100 k Ω to 100 M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω	89 $\mu\Omega/\Omega$ 42 $\mu\Omega/\Omega$ 96 $\mu\Omega/\Omega$ 92 $\mu\Omega/\Omega$ 43 $\mu\Omega/\Omega$ 91 $\mu\Omega/\Omega$ 0.74 m Ω/Ω 90 $\mu\Omega/\Omega$ 42 $\mu\Omega/\Omega$ 94 $\mu\Omega/\Omega$ 0.75 m Ω/Ω 6.6 m Ω/Ω 44 $\mu\Omega/\Omega$ 0.1 m Ω/Ω 0.75 m Ω/Ω 6.5 m Ω/Ω	Comparison to Multifunction Calibrator and Multimeter
AC Resistance – Source ¹ 100 Hz to 100 kHz	1 m Ω to 100 k Ω	0.34 m Ω	Comparison to Calibration RL Standard
AC Resistance – Measure ¹ 100 Hz to 100 kHz	1 m Ω to 10 Ω 10 Ω to 100 k Ω 100 k Ω to 10 M Ω	0.44 m Ω/Ω 0.28 m Ω/Ω 0.4 m Ω/Ω	Comparison to RLC Digibridge

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 nF to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 µF (1.1 to 3.3) µF (3.3 to 11) µF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 0.23 nF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF	Comparison to Multiproduct Calibrator
Capacitance – Source ¹ 50 Hz to 1 kHz	(11 to 33) µF (33 to 110) µF (110 to 330) µF 330 µF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 0.23 µF 3.5 mF/F + 0.78 µF 3.5 mF/F + 2.3 µF 3.5 mF/F + 7.8 µF 5.8 mF/F + 23 µF 8.5 mF/F + 78 µF	Comparison to Multi-Product Calibrator
Capacitance – Source ^{1,2} Fixed Values	(1, 10, 100, 1 000) pF 1 kHz 1 kHz to 13 MHz	2 µF/F + 0.58R 67 µF/F + 0.58R	Comparison to Standard Capacitors
	(10, 100, 1 000) nF 120 Hz to 100 kHz	62 µF/F + 0.58R	
Dissipation Factor ¹ Terminal Capacitors and LCR Meters	0 < DF < 1 1 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.000 02 0.000 03 0.000 06 0.000 09 0.000 14 0.000 20 0.000 57 0.000 83	Comparison to Standard Capacitors

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dissipation Factor ¹ Terminal Capacitors and LCR Meters	0 < DF <1		Comparison to Standard Capacitors
	10 pF		
	1 kHz	0.000 02	
	1 MHz	0.000 02	
	2 MHz	0.000 02	
	3 MHz	0.000 03	
	4 MHz	0.000 03	
	5 MHz	0.000 03	
	10 MHz	0.000 07	
	13 MHz	0.000 09	
	100 pF		
	1 kHz	0.000 02	
	1 MHz	0.000 02	
	2 MHz	0.000 02	
	3 MHz	0.000 03	
	4 MHz	0.000 05	
	5 MHz	0.000 06	
	10 MHz	0.000 16	
	13 MHz	0.000 24	
	1 000 pF		
	1 kHz	0.000 02	
	1 MHz	0.000 03	
	2 MHz	0.000 07	
	3 MHz	0.000 12	
	4 MHz	0.000 18	
	5 MHz	0.000 26	
	10 MHz	0.000 71	
	13 MHz	0.001 1	
	10 nF		
	120 Hz	0.000 04	
	1 kHz	0.000 04	
	10 kHz	0.000 04	
	100 kHz	0.000 04	
	100 nF		
	120 Hz	0.000 05	
	1 kHz	0.000 04	
	10 kHz	0.000 04	
	100 kHz	0.000 05	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dissipation Factor ¹ Terminal Capacitors and LCR Meters	0 < DF <1 1 000 nF 120 Hz 1 kHz 10 kHz 100 kHz	0.000 06 0.000 04 0.000 05 0.000 66	Comparison to Standard Capacitors
Capacitance – Measure ^{1,2} 12 Hz to 13 MHz	(0 to 10) pF 10 pF to 10 nF 10 nF to 100 µF (100 to 1 000) µF	0.45 mF/F + 0.58R 0.26 mF/F 0.27 mF/F 0.37 mF/F	Direct measurement using RLC Digibridge
Electrical Calibration of Thermocouple Indicators and Calibrators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C Type C (0 to 150) °C (150 to 650) °C (650 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 316) °C 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	0.36 °C 0.29 °C 0.27 °C 0.28 °C 0.27 °C 0.24 °C 0.27 °C 0.41 °C 0.66 °C 0.41 °C 0.18 °C 0.17 °C 0.18 °C 0.21 °C 0.25 °C 0.18 °C 0.17 °C 0.18 °C 0.22 °C 0.29 °C 0.19 °C 0.18 °C 0.24 °C 0.34 °C	Comparison to Multiproduct Calibrator

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators and Calibrators ¹	Type L (-200 to -100) °C	0.31 °C	Comparison to Multiproduct Calibrator
	(-100 to 800) °C	0.24 °C	
	(800 to 900) °C	0.18 °C	
	Type N (-200 to -100) °C	0.34 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.2 °C	
	(120 to 410) °C	0.19 °C	
	(410 to 1 300) °C	0.25 °C	
	Type R (0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.3 °C	
	(400 to 1 000) °C	0.29 °C	
	(1 000 to 1 767) °C	0.34 °C	
	Type S (0 to 250) °C	0.39 °C	
	(250 to 1 000) °C	0.31 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.38 °C	
Electrical Calibration of Thermocouple Indicators and Calibrators ¹	Type T (-250 to -150) °C	0.51 °C	Comparison to Multifunction Calibrator, Multimeter and SPRT
	(-150 to 0) °C	0.23 °C	
	(0 to 120) °C	0.18 °C	
	(120 to 400) °C	0.17 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.25 °C	
	Type B (600 to 1 820) °C	0.098 °C	
	Type C (0 to 2 316) °C	0.091 °C	
	Type E (-250 to 1 000) °C	0.078 °C	
	Type J (-210 to 1 200) °C	0.078 °C	
	Type K (-200 to 1 372) °C	0.08 °C	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators and Calibrators ¹	Type L (-200 to 900) °C	0.079 °C	Comparison to Multifunction Calibrator, Multimeter and SPRT
	Type N (-200 to 1 300) °C	0.081 °C	
	Type R (0 to 1 767) °C	0.096 °C	
	Type S (0 to 1 767) °C	0.097 °C	
	Type T (-250 to 400) °C	0.081 °C	
	Type U (-200 to 600) °C	0.078 °C	
Electrical Calibration of RTD Indicators and Calibrators ¹	Pt 385, 100 Ω (-200 to -80) °C	0.04 °C	Comparison to Multiproduct Calibrator
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.055 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.055 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.055 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators and Calibrators ¹	Pt 385, 200 Ω		Comparison to Multiproduct Calibrator
	(-200 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.032 °C	
	(0 to 100) °C	0.032 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.063 °C	
	(300 to 400) °C	0.063 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.086 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.025 °C	
	(-80 to 0) °C	0.025 °C	
	(0 to 100) °C	0.032 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.055 °C	
	(400 to 600) °C	0.055 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 100 Ω		
	(-80 to 0) °C	0.063 °C	
	(0 to 100) °C	0.063 °C	
	(100 to 260) °C	0.11 °C	
	Cu 427, 10 Ω		
	(-100 to 260) °C	0.23 °C	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	Up to 2.2 mV		Comparison to Multifunction Calibrator
	(10 to 20) Hz	0.37 mV/V + 4 μ V	
	(20 to 40) Hz	0.31 mV/V + 4 μ V	
	40 Hz to 20 kHz	0.31 mV/V + 4 μ V	
	(20 to 50) kHz	0.35 mV/V + 4 μ V	
	(50 to 100) kHz	0.61 mV/V + 5 μ V	
	(100 to 300) kHz	1 mV/V + 10 μ V	
	(300 to 500) kHz	1.3 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.6 mV/V + 20 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.24 mV/V + 4 μ V	
	(20 to 40) Hz	0.11 mV/V + 4 μ V	
	40 Hz to 20 kHz	96 μ V/V + 4 μ V	
	(20 to 50) kHz	0.2 mV/V + 4 μ V	
	(50 to 100) kHz	0.46 mV/V + 5 μ V	
	(100 to 300) kHz	0.9 mV/V + 10 μ V	
	(300 to 500) kHz	1.2 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.5 mV/V + 20 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	0.22 mV/V + 12 μ V	
	(20 to 40) Hz	86 μ V/V + 7 μ V	
	40 Hz to 20 kHz	76 μ V/V + 7 μ V	
	(20 to 50) kHz	0.18 mV/V + 7 μ V	
	(50 to 100) kHz	0.42 mV/V + 17 μ V	
	(100 to 300) kHz	0.75 mV/V + 20 μ V	
	(300 to 500) kHz	1.2 mV/V + 25 μ V	
	500 kHz to 1 MHz	2.5 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.22 mV/V + 40 μ V	
	(20 to 40) Hz	80 μ V/V + 15 μ V	
	40 Hz to 20 kHz	40 μ V/V + 8 μ V	
	(20 to 50) kHz	70 μ V/V + 10 μ V	
	(50 to 100) kHz	0.11 mV/V + 30 μ V	
	(100 to 300) kHz	0.34 mV/V + 8 μ V	
	(300 to 500) kHz	0.9 mV/V + 0.2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 0.3 mV	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Comparison to Multifunction Calibrator
	(10 to 20) Hz	0.22 mV/V + 0.4 mV	
	(20 to 40) Hz	80 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	40 μ V/V + 50 μ V	
	(20 to 50) kHz	70 μ V/V + 0.1 mV	
	(50 to 100) kHz	96 μ V/V + 0.2 mV	
	(100 to 300) kHz	0.26 mV/V + 0.6 mV	
	(300 to 500) kHz	0.9 mV/V + 2 mV	
	500 kHz to 1 MHz	1.3 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.22 mV/V + 4 mV	
	(20 to 40) Hz	80 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	48 μ V/V + 0.6 mV	
	(20 to 50) kHz	76 μ V/V + 1 mV	
	(50 to 100) kHz	0.13 mV/V + 2.5 mV	
	(100 to 300) kHz	0.8 mV/V + 16 mV	
	(300 to 500) kHz	4.2 mV/V + 40 mV	
	500 kHz to 1 MHz	7 mV/V + 80 mV	
AC Voltage – Source ¹	(220 to 1 100) V		Comparison to Multifunction Calibrator with Amplifier
	(15 to 50) Hz	0.26 mV/V + 16 mV	
	50 Hz to 1 kHz	61 μ V/V + 3.5 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.36 mV/V + 11 mV	
	(50 to 100) kHz	1.3 mV/V + 45 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	0.08 mV/V + 4 mV	
	(1 to 20) kHz	0.13 mV/V + 6 mV	
	(20 to 30) kHz	0.36 mV/V + 11 mV	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Source ¹ Referenced to 1 kHz	(0.3 to 1.1) mV		Comparison to Multifunction Calibrator with Wideband Option
	(10 to 30) Hz	3.7 mV/V	
	30 Hz to 120 kHz	1.7 mV/V	
	120 kHz to 1.2 MHz	2.6 mV/V + 3.6 μV	
	(1.2 to 2) MHz	2.5 mV/V + 3.6 μV	
	(2 to 10) MHz	4.9 mV/V + 3.6 μV	
	(10 to 20) MHz	7.3 mV/V + 3.6 μV	
	(20 to 30) MHz	18 mV/V + 18 μV	
	(1.1 to 3) mV		
	(10 to 30) Hz	3.6 mV/V + 0.1 μV	
	30 Hz to 120 kHz	1 mV/V + 0.8 μV	
	120 kHz to 2 MHz	1.2 mV/V + 3.8 μV	
	(2 to 10) MHz	3.6 mV/V + 3.8 μV	
	(10 to 20) MHz	6 mV/V + 3.6 μV	
	(20 to 30) MHz	18 mV/V + 3.6 μV	
	3 mV to 3.5 V		
	(10 to 30) Hz	3.6 mV/V	
AC Voltage – Measure ¹	30 Hz to 120 kHz	1.3 mV/V	Comparison to Multimeter
	120 kHz to 2 MHz	1.3 mV/V + 3.3 μV	
	(2 to 10) MHz	2.5 mV/V + 3.4 μV	
	(10 to 20) MHz	4.8 mV/V + 3.5 μV	
	(20 to 30) MHz	12 mV/V + 3.6 μV	
	Up to 10 mV		
	(1 to 40) Hz	0.36 mV/V + 3.6 μV	
	40 Hz to 1 kHz	0.24 mV/V + 1.3 μV	
	(1 to 20) kHz	0.35 mV/V + 1.3 μV	
	(20 to 50) kHz	1.2 mV/V + 1.3 μV	
	(50 to 100) kHz	5.9 mV/V + 1.3 μV	
	(100 to 300) kHz	47 mV/V + 2.4 μV	
	300 kHz to 1 MHz	14 mV/V + 5.9 μV	
	(1 to 4) MHz	83 mV/V + 8.2 μV	
	(4 to 8) MHz	240 mV/V + 9.1 μV	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) mV		Comparison to Multimeter
	(1 to 40) Hz	0.083 mV/V + 4.8 μ V	
	40 Hz to 1 kHz	0.083 mV/V + 2.4 μ V	
	(1 to 20) kHz	0.17 mV/V + 2.4 μ V	
	(20 to 50) kHz	0.36 mV/V + 2.4 μ V	
	(50 to 100) kHz	0.95 mV/V + 2.4 μ V	
	(100 to 300) kHz	3.6 mV/V + 12 μ V	
	300 kHz to 1 MHz	12 mV/V + 12 μ V	
	(1 to 2) MHz	18 mV/V + 12 μ V	
	(2 to 4) MHz	48 mV/V + 82 μ V	
	(4 to 8) MHz	47 mV/V + 94 μ V	
	(8 to 10) MHz	180 mV/V + 110 μ V	
	100 mV to 1 V		
	(1 to 40) Hz	0.083 mV/V + 0.047 mV	
	40 Hz to 1 kHz	0.083 mV/V + 0.024 mV	
	(1 to 20) kHz	0.17 mV/V + 0.024 mV	
	(20 to 50) kHz	0.36 mV/V + 0.024 mV	
	(50 to 100) kHz	0.95 mV/V + 0.024 mV	
	(100 to 300) kHz	3.6 mV/V + 0.12 mV	
	300 kHz to 1 MHz	12 mV/V + 0.12 mV	
	(1 to 2) MHz	18 mV/V + 0.12 mV	
	(2 to 4) MHz	48 mV/V + 0.83 mV	
	(4 to 8) MHz	47 mV/V + 1 mV	
	(8 to 10) MHz	180 mV/V + 1.1 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.083 mV/V + 0.48 mV	
	40 Hz to 1 kHz	0.083 mV/V + 0.24 mV	
	(1 to 20) kHz	0.17 mV/V + 0.24 mV	
	(20 to 50) kHz	0.36 mV/V + 0.24 mV	
	(50 to 100) kHz	0.95 mV/V + 0.23 mV	
	(100 to 300) kHz	3.6 mV/V + 1.2 mV	
	300 kHz to 1 MHz	12 mV/V + 1.2 mV	
	(1 to 2) MHz	18 mV/V + 1.1 mV	
	(2 to 4) MHz	47 mV/V + 8.4 mV	
	(4 to 8) MHz	48 mV/V + 9.3 mV	
	(8 to 10) MHz	180 mV/V + 12 mV	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(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	0.24 mV/V + 4.7 mV 0.24 mV/V + 2.4 mV 0.24 mV/V + 2.4 mV 0.42 mV/V + 2.4 mV 1.4 mV/V + 2.4 mV 4.7 mV/V + 12 mV 18 mV/V + 13 mV	Comparison to Multimeter
	(100 to 1 000) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.48 mV/V + 47 mV 0.47 mV/V + 24 mV 0.71 mV/V + 24 mV 1.4 mV/V + 24 mV 3.6 mV/V + 120 mV	
AC High Voltage – Measure ¹	(0 to 10) kV (45 to 65) Hz	0.87 mV/V + 0.87 V	Comparison to High Voltage Meter and High Voltage Probe
AC Current – Source ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 16 nA 0.14 mA/A + 10 nA 0.11 mA/A + 8 nA 0.25 mA/A + 12 nA 0.9 mA/A + 65 nA	Comparison to Multifunction Calibrator and Amplifier
	220 μ 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 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 40 nA 0.14 mA/A + 35 nA 0.11 mA/A + 35 nA 0.18 mA/A + 0.11 μ A 0.9 mA/A + 0.65 μ A 0.23 mA/A + 0.4 μ A 0.14 mA/A + 0.35 μ A 0.11 mA/A + 0.35 μ A 0.18 mA/A + 0.5 μ A 0.9 mA/A + 5 μ A	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(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 (2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 4 μ A 0.14 mA/A + 3.5 μ A 0.11 mA/A + 2.6 μ A 0.18 mA/A + 3.5 μ A 0.9 mA/A + 10 μ A 0.25 mA/A + 35 μ A 0.39 mA/A + 80 μ A 6 mA/A + 0.16 mA 0.42 mA/A + 0.17 mA 0.85 mA/A + 0.38 mA 3.3 mA/A + 0.75 mA	Comparison to Multifunction Calibrator and Amplifier
AC Current – Source ¹	Up to 330 μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (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 Hz to 1 kHz (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 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	1.9 mA/A + 0.12 μ A 1.4 mA/A + 0.12 μ A 1.2 mA/A + 0.12 μ A 2.9 mA/A + 0.17 μ A 6.9 mA/A + 0.23 μ A 14 mA/A + 0.46 μ A 1.9 mA/A + 0.17 μ A 1.2 mA/A + 0.17 μ A 0.93 mA/A + 0.17 μ A 1.8 mA/A + 0.23 μ A 4.6 mA/A + 0.35 μ A 9.2 mA/A + 0.69 μ A 1.7 mA/A + 2.3 μ A 0.88 mA/A + 2.3 μ A 0.42 mA/A + 2.3 μ A 0.76 mA/A + 2.3 μ A 1.9 mA/A + 3.5 μ A 3.7 mA/A + 4.6 μ A	Comparison to Multiproduct Calibrator

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(33 to 330) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (0.33 to 1.1) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (1.1 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	1.7 mA/A + 23 μ A 0.87 mA/A + 23 μ A 0.42 mA/A + 23 μ A 0.93 mA/A + 58 μ A 1.9 mA/A + 0.12 mA 3.7 mA/A + 0.23 mA 1.7 mA/A + 0.12 mA 0.44 mA/A + 0.11 mA 5.8 mA/A + 1.2 mA 23 mA/A + 5.8 mA 1.7 mA/A + 0.12 mA 0.59 mA/A + 0.11 mA 5.8 mA/A + 1.2 mA 23 mA/A + 5.8 mA 0.59 mA/A + 2.3 mA 0.93 mA/A + 2.3 mA 29 mA/A + 2.3 mA 1.2 mA/A + 5.8 mA 1.5 mA/A + 5.8 mA 29 mA/A + 5.8 mA	Comparison to Multiproduct Calibrator
	(10 to 16.5) A (45 to 65) Hz (65 to 1 000) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	2.5 mA/A + 1.4 mA 3.1 mA/A + 5 mA 2.7 mA/A + 1.4 mA 3.8 mA/A + 47 mA 2.7 mA/A + 57 mA 8 mA/A + 0.1 A	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A	Comparison to 8.5 Digits Multimeter
	100 μ A to 1 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 (1 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 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 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.3 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A 4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.3 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A 4 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.6 mA/A + 20 μ A 0.3 mA/A + 20 μ A 0.6 mA/A + 20 μ A 4 mA/A + 40 μ A 5.5 mA/A + 0.15 mA 4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.8 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	
AC Current – Measure ¹	(1 to 3) A 3 Hz to 10 kHz (3 to 10) A 3 Hz to 10 kHz	2.7 mA/A + 1.4 mA 1.8 mA/A + 4.7 mA	Comparison to 6.5 Digits Multimeter

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ 45 Hz to 1 kHz Power Factor = 1	(0.33 to 19) mA		Comparison to Multiproduct Calibrator
	(0.11 to 5.7) mW	1.4 mW/W + 0.015 μ W	
	5.7 mW to 19 W	0.53 mW/W + 1.1 μ W	
	(19 to 33) mA		
	(0.6 to 10) mW	1.8 mW/W	
	6 mW to 33 W	1.1 mW/W + 3.3 μ W	
	(33 to 190) mA		
	(1 to 57) mW	1.4 mW/W + 0.14 μ W	
	11 mW to 190 W	0.53 mW/W + 11 μ W	
	(190 to 330) mA		
	(6 to 100) mW	1.5 mW/W	
	100 mW to 330 W	0.77 mW/W	
	(0.33 to 1.09) A		
	(11 to 330) mW	1.4 mW/W	
	330 mW to 1.1 kW	0.53 mW/W + 0.066 mW	
	(1.09 to 2.9) A		
	36 mW to 0.9 W	1.4 mW/W	
	363 mW to 2.9 kW	0.62 mW/W	
AC Power – Source ¹ 45 Hz to 1 kHz Power Factor = (0.985 to 0.999)	(2.9 to 10.9) A		Comparison to Multiproduct Calibrator
	100 mW to 3.3 W	1.8 mW/W	
	1 W to 10.9 kW	1.1 mW/W	
	(10.9 to 20.5) A		
	(0.36 to 6) W	2.3 mW/W	
	3.6 W to 20 kW	1.8 mW/W	
	(0.33 to 19) mA		
	(0.11 to 5.7) mW	2.3 mW/W + 0.012 μ W	
	5.7 mW to 19 W	1.9 mW/W + 0.54 μ W	
	(19 to 33) mA		
	(0.6 to 10) mW	2.5 mW/W	
	6 mW to 33 W	2.2 mW/W + 2 μ W	
	(33 to 190) mA		
	(1 to 57) mW	2.3 mW/W + 0.087 μ W	
	11 mW to 190 W	1.9 mW/W + 5.1 μ W	
	(190 to 330) mA		
	(6 to 100) mW	2.4 mW/W	
	100 mW to 330 W	2 mW/W	
	(0.33 to 1.09) A		
	(11 to 330) mW	2.3 mW/W	
	330 mW to 1.1 kW	1.9 mW/W + 0.022 mW	

Electrical – DC/Low Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ 45 Hz to 1 kHz Power Factor = (0.985 to 0.999)	(1.09 to 2.9) A 36 mW to 0.9 W 363 mW to 2.9 kW (2.9 to 10.9) A 100 mW to 3.3 W 1 W to 10.9 kW (10.9 to 20.5) A (0.36 to 6) W 3.6 W to 20 kW	2.3 mW/W 1.9 mW/W 2.6 mW/W 2.2 mW/W 2.9 mW/W 2.6 mW/W	Comparison to Multiproduct Calibrator
Oscilloscopes ¹ Bandwidth	0.1 Hz to 3.2 GHz (3.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 20) GHz	2.7 % of reading 2.7 % of reading 2.8 % of reading 2.9 % of reading 3.3 % of reading	Comparison to Oscilloscope Calibrator, Signal Generator and RF Power Sensor
Oscilloscopes ¹ Amplitude Square Wave Signal 50 Ω , 10 Hz to 10 kHz 1 M Ω , 10 Hz to 10 kHz Amplitude Sine Wave Signal Into 50 Ω 50 kHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz Flatness Into 50 Ω , Relative to 50 kHz Rise Time Source 1 kHz to 10 MHz Pulse Width Pulse Period Time Marker Output Into 50 ohms	 1 mV to 6.6 V 1 mV to 130 V 5 mV to 5.5 V 5 mV to 5.5 V 5 mV to 5.5 V 5 mV to 5.5 V 5 mV to 5.5 V 5 mV to 5.5 V 5 mV to 5.5 V Up to 300 ps (4 to 500) ns 200 ns to 20 ms 2 ns to 20 ms 20 ms to 5 s	 0.25 % of reading + 40 μ V 0.1 % of reading + 40 μ V 2 % of reading + 0.3 mV 3.5 % of reading + 0.3 mV 4 % of reading + 0.3 mV 6 % of reading + 0.3 mV 1.5 % of reading + 0.1 mV 2 % of reading + 0.1 mV 4 % of reading + 0.1 mV 37 ps 5.8 % + 2.3 ns 2.9 μ s/s 2.5 μ s/s 5.1 ms/s	 Comparison to Multiproduct Calibrator w/Scope Option

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Electrical – RF/Microwave

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Meter ¹ Reference Output Indication	1 mW, 50 MHz 3 μ W to 100 mW	3.3 mW/W 0.37 mW/W + 0.4 nW	Comparison to Power Meter and Sensor Range Calibrator
RF Power Sensors Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 300) kHz 300 kHz to 50 MHz (50 to 100) MHz (100 to 600) MHz 600 MHz to 1 GHz (1 to 4) GHz (4 to 8) GHz (8 to 12) GHz (12 to 16) GHz (16 to 18) GHz (18 to 20) GHz	1 % 0.85 % 0.78 % 0.78 % 0.78 % 0.8 % 0.87 % 0.96 % 1 % 1.1 % 2 %	Comparison to Power Meter, Coaxial Thermistor and Thermocouple Power Sensors
Tuned RF Power, Relative – Measure ¹ 100 kHz to 26.5 GHz	(-130 to -120) dB (-120 to -100) dB (-100 to -80) dB (-80 to -60) dB (-60 to -50) dB (-50 to -30) dB (-30 to -20) dB (-20 to -10) dB (-10 to 10) dB (10 to 20) dB (20 to 30) dB	0.1 dB 0.098 dB 0.091 dB 0.084 dB 0.082 dB 0.079 dB 0.074 dB 0.072 dB 0.071 dB 0.072 dB 0.074 dB	Comparison to Power Sensors with Measuring Receiver, Power Meter and Spectrum Analyzers
Tuned RF Power, Absolute – Measure ¹ 100 kHz to 26.5 GHz	(-130 to -100) dBm (-100 to -80) dBm (-80 to -60) dBm (-60 to -50) dBm (-50 to -30) dBm (-30 to -20) dBm (-20 to 10) dBm (10 to 20) dBm (20 to 30) dBm	0.12 dB 0.11 dB 0.1 dB 0.095 dB 0.093 dB 0.084 dB 0.081 dB 0.082 dB 0.084 dB	Comparison to Power Sensors with Measuring Receiver, Power Meter and Spectrum Analyzers

Electrical – RF/Microwave

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure ¹	(-70 to -35) dBm 9 kHz to 14 GHz (14 to 26.5) GHz (-35 to 20) dBm 9 kHz to 14 GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 50) GHz (50 to 67) GHz (67 to 70) GHz	0.063 dB 0.071 dB 0.063 dB 0.071 dB 0.083 dB 0.092 dB 0.13 dB 0.15 dB 0.2 dB	Comparison to Power Sensors with Measuring Receiver, Power Meter and Spectrum Analyzers
Frequency Modulation – Measure ¹ FM Deviation Accuracy Rate: 20 Hz to 10 kHz Rate: 50 Hz to 200 kHz AM Rejection 50 Hz to 3 kHz BW Depth ≤ 50 % Residual FM 50 Hz to 3 kHz BW Distortion 100 kHz to 26.5 GHz	Dev: ≤ 40 kHz 100 kHz to 10 MHz Dev: ≤ 400 kHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Rate: 400 Hz to 1 kHz 150 kHz to 6.6 GHz (6.6 to 26.5) GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Rate: 20 Hz to 250 kHz	0.3 % of reading 0.4 % of reading 0.5 % of reading 0.6 % of reading 12 Hz 28 Hz 1.8 Hz 2.1 Hz 3 Hz 0.13 % of reading	Comparison to Signal Analyzer, Measuring Receiver

Electrical – RF/Microwave

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹			
AM Depth Accuracy Rate: 50 Hz to 10 kHz	Depth: (5 to 99) % 100 kHz to 10 MHz	0.32 % of reading	
Rate: 50 Hz to 100 kHz	Depth: (5 to 20) % 10 MHz to 3 GHz (3 to 26.5) GHz	0.6 % of reading 0.83 % of reading	
	Depth: (20 to 99) % 10 MHz to 3 GHz (3 to 26.5) GHz	0.33 % of reading 0.43 % of reading	
Flatness Rate: 90 Hz to 10 kHz	Depth: (5 to 99) % 10 MHz to 26.5 GHz	0.19 % of reading	Comparison to Signal Analyzer, Measuring Receiver
Distortion	Depth. (5 to 99) % 100 kHz to 1 300 MHz 1 300 MHz to 26.6 GHz	0.25 % THD 0.36 % THD	
FM Rejection 50 Hz to 3 kHz BW Rate: 400 Hz to 1 kHz	250 kHz to 10 MHz Dev: < 5 kHz 10 MHz to 26.5 GHz Dev: < 50 kHz	0.17 % AM 0.43 % AM	
Residual AM 50 Hz to 3 kHz BW	100 kHz to 26.5 GHz	0.012 % of reading	

Electrical – RF/Microwave

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ PM Accuracy Rate: 200 Hz to 20 kHz	100 kHz to 6.6 GHz Dev: (0.3 to 0.7) rad Dev: > 0.7 rad (6.6 to 13.2) GHz Dev: (0.6 to 2) rad Dev: > 2 rad (13.2 to 26.5) GHz Dev: (1.2 to 4) rad Dev: > 4 rad	0.4 % of reading 0.3 % of reading 0.4 % of reading 0.3 % of reading 0.4 % of reading 0.3 % of reading	Comparison to Signal Analyzer, Measuring Receiver
AM Rejection (Peak) 50 Hz to 3 kHz BW	100 kHz to 26.5 GHz	0.035 rad	
Residual PM (rms) 50 Hz to 3 kHz BW	100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	0.0023 rad 0.0041 rad 0.0079 rad	
Distortion 50 Hz to 3 kHz BW	100 kHz to 26.5 GHz	0.12 % THD	
Harmonic Measurements ¹ 3 Hz to 26.5 GHz	(-90 to 0.01) dB	0.8 dB	Comparison to Spectrum Analyzer
Distortion – Measure ¹ 20 Hz to 20 kHz (20 to 100) kHz	(0 to 99.9) dB (50 to 500) kHz (50 to 500) kHz	1.2 dB 2.4 dB	Comparison to Audio Analyzer

Length – Dimensional Metrology

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in Up to 1 500 mm	$(6.4 + 6.8 \cdot L) \mu\text{in} + 0.58R$ $(0.16 + 0.006 8 \cdot L) \mu\text{m} + 0.58R$	Comparison to Gage Blocks
Height Gages ^{1,2}	Up to 48 in Up to 1 500 mm	$(27 + 6.2 \cdot L) \mu\text{in} + 0.58R$ $(0.69 + 0.006 2 \cdot L) \mu\text{m} + 0.58R$	Comparison to Gage Blocks

Length – Dimensional Metrology

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Length Up to 48 in Up to 1 500 mm Flatness Up to 40 µin Up to 1.1 µm Parallelism Up to 50 µin Up to 1.3 µm	$(5 + 6.7 \cdot L) \mu\text{in} + 0.58R$ $(0.1 + 0.006 \cdot l) \mu\text{m} + 0.58R$ 4.5 µin 0.11 µm 5.6 µin 0.14 µm	Comparison to Gage Blocks, Optical Parallels or Optical Flats
Indicators ¹ Dial Gauge, Dial Test Indicator, LVDTs	Up to 4 in Up to 100 mm	$(3.1 + 2.3L) \mu\text{in}$ $(0.08 + 0.002 \cdot l) \mu\text{m} + 0.58R$	Comparison to Gage Block, Comparator Stand
Rigid Rules & Tape Measures ²	Up to 40 in (40 to 2 000) in Up to 1 000 mm (1 000 to 50 000) mm	0.000 43 in (11L) µin 11 µm (0.011 · l) µm	Comparison to Gage Blocks, Standard Scale
Optical Comparators and Vision Systems/Measuring Microscope ^{1,2} X, Y Axis	Up to 24 in Up to 610 mm	$(38 + 1.8L) \mu\text{in}$ $(1 + 0.001 \cdot l) \mu\text{m}$	Comparison to Glass Scale
Optical Comparators and Vision Systems/Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 24 in Up to 610 mm	$(9 + 2.5L) \mu\text{in}$ $(0.23 + 0.002 \cdot l) \mu\text{m}$	Comparison to Gage Blocks
Optical Comparators and Vision Systems/Measuring Microscope ^{1,2} Angle – 4 Quadrants	Up to 90°	0.001 1°	Comparison to Standard Angle Blocks
Length Measuring Machine, Linear Measurement ^{1,2}	Up to 4 in 4 to 24 in Up to 100 mm (100 to 610) mm	$(1.8 + 1.3L) \mu\text{in}$ $(4.9 + 1.3L) \mu\text{in}$ $(0.046 + 0.001 \cdot l) \mu\text{m}$ $(0.12 + 0.001 \cdot l) \mu\text{m}$	Comparison to Gage Blocks

Mass and Mass Related

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Piston/Plunger Operated ¹ Volumetric Apparatus (POVA) Pipettes, Syringes, Dilutors, Titrators, Piston/Displacement Burettes (Burets), Dispensers, Liquid Handlers	Up to 50 μ l 50 μ l to 2 000 ml	0.02 μ l 0.007 % of reading + 0.016 μ l	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	Up to 10 ml (10 to 2 000) ml	0.001 5 ml 0.014 % of reading	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Scales and Balances ^{1,3}	Up to 20 mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 20) kg	0.0015 mg 0.0020 mg 0.0025 mg 0.0031 mg 0.0041 mg 0.0051 mg 0.0061 mg 0.0081 mg 0.01 mg 0.013 mg 0.018 mg 0.033 mg 0.065 mg 0.32 mg 0.63 mg 1.3 mg 3.2 mg 6.3 mg 0.64 μ g/g	Comparison to E1 Standard Weights
Torque Testers ^{1,2}	Up to 200 ozf-in (4 to 150) lbf-in (2.5 to 250) lbf-ft	0.1 % of reading + 0.58R 0.082 % of reading 0.075 % of reading	Comparison to Torque Wheel, Torque Standard, Calibration Arms, Weights

Photometry and Radiometry

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Wavelength – Measure and Source ¹	(400 to 1 800) nm	0.19 μ m/m + 0.13 pm	Comparison to Wavelength Meter
Optical Power – Measure and Source ¹ Absolute	(700 to 1 800) (-80 to 20) dBm	0.1 dB	Comparison to Optical Test System
Relative	(700 to 1800) nm (-60 to -30) dB (-30 to 20) dB	0.005 dB/dB 0.03 dB	

Thermodynamic

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-200 to 660) °C	0.009 °C	Comparison to Platinum Resistance Thermometers
Temperature – Measuring Equipment ¹	(-200 to 660) °C	0.009 °C	Comparison to Platinum Resistance Thermometers
Relative Humidity – Measuring Equipment ¹	(10 to 95) %RH	0.65 %RH	Comparison to Humidity Generator, Standard Humidity Meter
Relative Humidity – Measure ¹	(10 to 95) %RH	0.83 %RH	Comparison to Standard Humidity Meter

Time and Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.1 Hz to 26.5 GHz	6.8 pHz/Hz	Comparison to Frequency Reference Standard and Counter
Frequency Measuring Equipment ¹	1 mHz to 50 GHz (1, 5, 10) MHz	6.8 pHz/Hz 6.2 pHz/Hz	Comparison to Frequency Reference Standard and Signal Generator

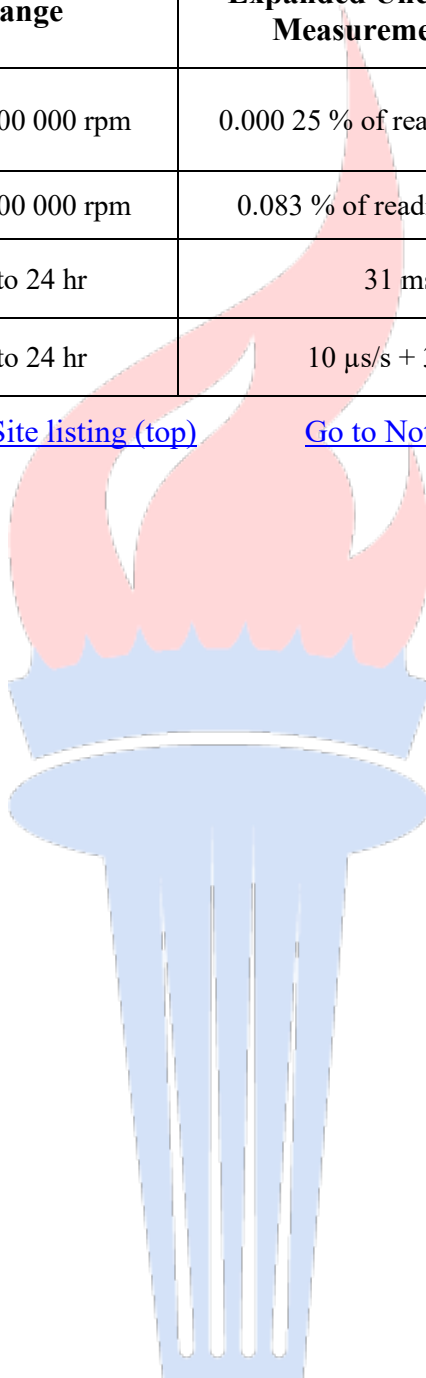
Time and Frequency

Global Scope

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Photo Tachometer ¹	Up to 100 000 rpm	0.000 25 % of reading + 0.58R	Comparison to Multi-Product Calibrator, Signal Generator with LED
Angular Speed – Measure ^{1, 2}	Up to 100 000 rpm	0.083 % of reading + 0.58R	Comparison to Standard Tachometer
Timers, Stopwatches, Chronometers ¹	Up to 24 hr	31 ms	Comparison to Frequency Counter
	Up to 24 hr	10 µs/s + 39 ms	Comparison to Stopwatch

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Services performed at satellite laboratory

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CALIBRATION

Acoustics and Vibration

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meter ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.13 dB	Comparison to Sound Level Calibrator
Sound Level Calibrator ^{1,2}	(74 to 124) dB 20 Hz to 20 kHz	0.11 dB	Comparison to Reference Microphone, Sound Calibration System
Microphones ¹ Sensitivity	(-80 to -10) dB re. 1V/Pa 20 Hz to 20 kHz	0.11 dB	Comparison to Reference Microphone, Sound Calibration System
Microphones ¹ Frequency Response	(-80 to -10) dB re. 1V/Pa (20 to 50) Hz (50 to 80) Hz (80 to 500) Hz (500 to 2 500) Hz (2.5 to 10) kHz (10 to 12.5) kHz (12.5 to 16) kHz (16 to 20) kHz	0.12 dB 0.09 dB 0.08 dB 0.09 dB 0.1 dB 0.14 dB 0.23 dB 0.34 dB	Comparison to Reference Microphone, Sound Calibration System
Accelerometers / Velocity Sensors / Displacement Sensors ¹ (0.2 Hz to 10 kHz)	Sensitivity: (0.04 to 1 000) pC/units (0.04 to 1 000) mV/units	0.54 % of sensitivity	Comparison to Reference Accelerometer, Vibration System
Vibration ¹ Acceleration (0.2 Hz to 10 kHz) Velocity (0.2 Hz to 10 kHz) Displacement (0.2 Hz to 10 kHz) (0.2 to 100) Hz	Up to 200 m/s ² Up to 200 mm/s Up to 200 μm (0.2 to 20) mm	0.69 % of reading + 0.004 7 m/s ² 0.69 % of reading + 0.004 7 mm/s 0.69 % of reading + 0.004 7 μm 0.72 % of reading + 0.001 6 mm	Comparison to Reference Accelerometer, Vibration System

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Acoustics and Vibration

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Shock and Drop Tester ¹ 700 mHz to 5 000 Hz	Up to 500 G	1.9 % of reading + 0.002 2 G	Comparison to Reference Accelerometer, Vibration System

Chemical Quantities

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	111.3 mS/cm	0.79 mS/cm	Comparison to Standard Solutions
pH Meters ^{1,4}	4 pH 7 pH 10 pH	0.009 1 pH 0.009 1 pH 0.014 pH	Comparison to Standard Solutions
Gas Detector, Gas Analyzer	10 parts in 10 ⁶ Isobutylene 100 parts in 10 ⁶ Isobutylene 1 % CO ₂ 50 parts in 10 ⁶ CO 10 parts in 10 ⁶ H ₂ S 50 % LEL CH ₄ 18 % O ₂ 10 parts in 10 ⁶ O ₂ 100 parts in 10 ⁶ O ₂ 1 000 parts in 10 ⁶ O ₂	0.27 parts in 10 ⁶ Isobutylene 2.6 parts in 10 ⁶ Isobutylene 0.024 % CO ₂ 1.1 parts in 10 ⁶ CO 0.25 parts in 10 ⁶ H ₂ S 0.059 % CH ₄ 0.42 % O ₂ 0.61 parts in 10 ⁶ Concentration 6.9 parts in 10 ⁶ Concentration 57 parts in 10 ⁶ Concentration	Comparison to Standard Gas
Optical System Aerosol Particle Counter	(0 to 100) % Counting Efficiency Particle sizes (0.3, 0.5, 1, 2, 5, 10) µm Flow Rate (5 to 500) ml/min (0.5 to 100) l/min	5.8 % Counting efficiency 0.82 % of reading 0.81 % of reading + 4 ml/min	Comparison to Master Particle Counter Standard Flow Calibrator
Refractometer	(0 to 25) % Salt (0 to 60) % Brix	0.12 % Salt 0.12 % Brix	Comparison to Standard Refractometer
Turbidity Meter ¹	1.01 NTU 15 NTU 100 NTU 750 NTU	0.022 NTU 0.15 NTU 0.84 NTU 7.4 NTU	Comparison to Standard Solutions
Viscometer ¹	1 000 cP 200 000 cP 87 KU	3.3 cP 1 000 cP 0.35 KU	Comparison to Standard Solutions

Chemical Quantities

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
ORP ¹	240 mV 470 mV	11 mV 11 mV	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source (Fixed Points)	1 V 1.018 V 10 V	2 μ V 2 μ V 6.6 μ V	Comparison to DC Voltage Reference Standard
DC High Voltage – Source ¹	Up to 10 kV (10 to 20) kV	0.3 mV/V + 31 mV 0.47 mV/V + 4.7 V	Comparison with High Voltage Meter
DC High Voltage – Source ¹ Electrostatic Field Meter	Up to 10 kV/in (10 to 20) kV/in	0.44 % of reading + 5.4 V/in 0.41 % of reading + 18 V/in	Comparison with High Voltage Meter
DC Voltage – Measure ¹	(10 to 20) kV (10 to 35) kV	0.47 mV/V + 4.7 V 0.47 mV/V + 11 V	Comparison to High Voltage Meter
DC Current – Source ¹	Up to 120 A	3.5 mA/A + 3 mA	Comparison to DC Power Supply, Multimeter and Current Transducer
DC Current – Source ¹	(2 to 20) pA (20 to 200) pA (0.2 to 2) nA (2 to 20) nA (20 to 200) nA (0.2 to 2) μ A (2 to 20) μ A (20 to 200) μ A (0.2 to 2) mA	4.4 mA/A + 0.012 pA 2.9 mA/A + 0.039 pA 0.72 mA/A + 0.22 pA 0.72 mA/A + 2.3 pA 0.41 mA/A + 13 pA 0.29 mA/A + 0.12 nA 0.30 mA/A + 1.2 nA 0.30 mA/A + 12 nA 0.29 mA/A + 0.12 μ A	Comparison to Calibrator/Source
DC Current – Measure ¹	(1 to 20) A (20 to 150) A (150 to 1 500) A	0.12 mA/A + 0.25 mA 0.61 mA/A + 2.7 mA 0.16 mA/A + 27 mA	Comparison to Shunt monitored with Multimeter
DC Current – Measure ¹	Up to 1 000 A	3 mA/A + 41 mA	Comparison to Current transducer with Multimeter

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
ESD Simulators			IEC 61000-4-2 ISO 10605
Contact Voltage	(-8 to 8) kV	1.2 mV/V + 0.6 V	Comparison to High Voltage Meter, ESD Target, Attenuator and Oscilloscope
Rise Time	(0.6 to 1) ns	74 ps	
Peak Current	(0.1 to 33) A	2 % of reading	
30 ns Current	(2 to 20.8) A	2 % of reading	
60 ns Current	(1 to 10.4) A	2 % of reading	
Air Discharge Voltage	Up to 30 kV	1.2 mV/V + 5.8 V	
Resistance – Source ¹ (Fixed Artifacts)	0.1 mΩ 1 mΩ 10 mΩ 100 mΩ	0.25 μΩ 3.5 μΩ 4 μΩ 38 μΩ	Comparison to Resistance Shunts
Resistance – Source ¹ (Fixed Artifacts)	1 Ω 10 kΩ	13 μΩ 77 mΩ	Comparison to Standard Resistors
Resistance – Measure ¹	(0 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ	39 μΩ/Ω + 29 μΩ 27 μΩ/Ω + 32 μΩ 24 μΩ/Ω + 130 μΩ 24 μΩ/Ω + 1.3 mΩ 24 μΩ/Ω + 13 mΩ 24 μΩ/Ω + 260 mΩ 32 μΩ/Ω + 2.9 Ω	Comparison to Nano Volt / Micro Ohm Meter
AC Resistance – Measure ¹ 12 Hz to 100 kHz	(0 to 10) kΩ	0.23 mΩ/Ω + 6 μΩ	Comparison to RLC Digibridge
Transformer Ratio – Source ¹ 50 Hz to 1 MHz ⁵	(0.001 to 1.110) Ratio 50 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.24 parts in 10 ⁶ + 0.000 000 63 5.3 parts in 10 ⁶ + 0.000 000 6 57 parts in 10 ⁶ + 0.000 000 6	Comparison to Decade Transformer
AC High Voltage – Source ¹	Up to 10 kV (50 to 60) Hz	1.4 mV/V + 0.13 V	Comparison to Comparison with High Voltage Meter
AC Voltage Measure ¹	(10 to 20) kV (45 to 65) Hz (20 to 30) kV (45 to 65) Hz	2.3 mV/V + 23 V 4.6 mV/V + 70 V	Comparison to High Voltage Meter

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	Up to 2.2 mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	1.2 mV/V + 0.87 μ V	
	(20 to 40) Hz	0.52 mV/V + 0.87 μ V	
	40 Hz to 20 kHz	0.32 mV/V + 0.87 μ V	
	(20 to 50) kHz	0.58 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.85 μ V/V + 1.7 μ V	
	(100 to 300) kHz	1.6 mV/V + 2.7 μ V	
	(300 to 500) kHz	1.7 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	2.4 mV/V + 5.3 μ V	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.57 mV/V + 0.87 μ V	
	(20 to 40) Hz	0.26 mV/V + 0.87 μ V	
	40 Hz to 20 kHz	0.16 mV/V + 0.87 μ V	
	(20 to 50) kHz	0.28 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.4 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.8 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.87 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	1.5 mV/V + 5.3 μ V	
	(7 to 22) mV		
	(10 to 20) Hz	0.2 mV/V + 0.87 μ V	
	(20 to 40) Hz	0.13 mV/V + 0.87 μ V	
	40 Hz to 20 kHz	80 μ V/V + 0.87 μ V	
	(20 to 50) kHz	0.14 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.22 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.54 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.59 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	1.1 mV/V + 5.3 μ V	
	(22 to 70) mV		
	(10 to 20) Hz	0.16 mV/V + 1 μ V	
	(20 to 40) Hz	81 μ V/V + 1 μ V	
	40 Hz to 20 kHz	45 μ V/V + 1 μ V	
	(20 to 50) kHz	90 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.18 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.35 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.45 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 5.3 μ V	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(70 to 220) mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	57 μ V/V + 1 μ V	
	40 Hz to 20 kHz	26 μ V/V + 1 μ V	
	(20 to 50) kHz	47 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.17 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.26 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.67 mV/V + 5.3 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	51 μ V/V + 1 μ V	
	40 Hz to 20 kHz	23 μ V/V + 1 μ V	
	(20 to 50) kHz	35 μ V/V + 1.3 μ V	
	(50 to 100) kHz	54 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.12 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.2 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.64 mV/V + 5.3 μ V	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	44 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	31 μ V/V + 0.58 μ V	
	(50 to 100) kHz	48 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.11 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.18 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.6 mV/V + 0.58 μ V	
	(2.2 to 7) V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	45 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	33 μ V/V + 0.58 μ V	
	(50 to 100) kHz	55 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.13 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(7 to 22) V		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 5.8 µV	
	(20 to 40) Hz	45 µV/V + 5.8 µV	
	40 Hz to 20 kHz	19 µV/V + 5.8 µV	
	(20 to 50) kHz	33 µV/V + 5.8 µV	
	(50 to 100) kHz	55 µV/V + 5.8 µV	
	(100 to 300) kHz	0.13 mV/V + 5.8 µV	
	(300 to 500) kHz	0.27 mV/V + 5.8 µV	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 µV	
	(22 to 70) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 µV	
	(20 to 40) Hz	46 µV/V + 5.8 µV	
	40 Hz to 20 kHz	22 µV/V + 5.8 µV	
	(20 to 50) kHz	39 µV/V + 5.8 µV	
	(50 to 100) kHz	64 µV/V + 5.8 µV	
	(100 to 300) kHz	0.14 mV/V + 5.8 µV	
	(300 to 500) kHz	0.27 mV/V + 5.8 µV	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 µV	
	(70 to 220) V		
	(10 to 20) Hz	0.13 mV/V + 58 µV	
	(20 to 40) Hz	46 µV/V + 58 µV	
	40 Hz to 20 kHz	22 µV/V + 58 µV	
	(20 to 50) kHz	47 µV/V + 58 µV	
	(50 to 100) kHz	67 µV/V + 58 µV	
	(100 to 300) kHz	0.14 mV/V + 58 µV	
	(300 to 500) kHz	0.33 mV/V + 58 µV	
	(220 to 700) V		
	(10 to 20) Hz	0.13 mV/V + 58 µV	
	(20 to 40) Hz	67 µV/V + 58 µV	
	40 Hz to 20 kHz	29 µV/V + 58 µV	
	(20 to 50) kHz	87 µV/V + 58 µV	
	(50 to 100) kHz	0.34 mV/V + 58 µV	
	(700 to 1 000) V		
	(10 to 20) Hz	0.13 mV/V + 58 µV	
	(20 to 40) Hz	67 µV/V + 58 µV	
	40 Hz to 20 kHz	29 µV/V + 58 µV	
	(20 to 50) kHz	87 µV/V + 58 µV	
	(50 to 100) kHz	0.33 mV/V + 58 µV	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	Up to 2.2 mV		Comparison to AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.08 µV	
	(30 to 120) Hz	0.47 mV/V + 0.08 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.08 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.08 µV	
	(120 to 500) kHz	0.66 mV/V + 0.95 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.95 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.95 µV	
	(2 to 10) MHz	1.6 mV/V + 0.95 µV	
	(10 to 20) MHz	2.8 mV/V + 0.95 µV	
	(20 to 30) MHz	6.6 mV/V + 1.9 µV	
	(2.2 to 7) mV		
	(10 to 30) Hz	0.94 mV/V + 0.082 µV	
	(30 to 120) Hz	0.47 mV/V + 0.082 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.082 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.082 µV	
	(120 to 500) kHz	0.66 mV/V + 0.95 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.95 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.95 µV	
	(2 to 10) MHz	0.94 mV/V + 0.95 µV	
	(10 to 20) MHz	1.6 mV/V + 0.95 µV	
	(20 to 30) MHz	3.5 mV/V + 0.95 µV	
	(7 to 22) mV		
	(10 to 30) Hz	0.94 mV/V + 0.082 µV	
	(30 to 120) Hz	0.47 mV/V + 0.082 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.082 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.082 µV	
	(120 to 500) kHz	0.66 mV/V + 0.082 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.082 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.082 µV	
	(2 to 10) MHz	0.94 mV/V + 0.082 µV	
	(10 to 20) MHz	1.6 mV/V + 0.082 µV	
	(20 to 30) MHz	3.5 mV/V + 0.082 µV	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	(22 to 70) mV		Comparison to AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.47 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.47 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(70 to 220) mV		
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.38 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.38 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.38 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.38 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(220 to 700) mV		
	(10 to 30) Hz	0.94 mV/V + 8.2 μ V	
	(30 to 120) Hz	0.28 mV/V + 8.2 μ V	
	120 Hz to 1.2 kHz	0.28 mV/V + 8.2 μ V	
	(1.2 to 120) kHz	0.28 mV/V + 8.2 μ V	
	(120 to 500) kHz	0.28 mV/V + 8.2 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 8.2 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 8.2 μ V	
	(2 to 10) MHz	0.94 mV/V + 8.2 μ V	
	(10 to 20) MHz	1.4 mV/V + 8.2 μ V	
	(20 to 30) MHz	3.3 mV/V + 8.2 μ V	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	700 mV to 2.2 V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV	Comparison to AC Measurement Standard
AC Current – Measure ¹	1 mA to 20 A 45 Hz to 1 kHz (1 to 5) kHz (20 to 30) A 45 Hz to 1 kHz (1 to 5) kHz (30 to 1 000) A (45 to 400) Hz	0.29 mA/A + 2.1 mA 0.41 mA/A + 2.1 mA 2.1 mA/A + 3.2 mA 2.5 mA/A + 3.2 mA 2.9 mA/A + 110 mA	Comparison to Shunt with Multimeter
AC Current – Measure ¹	Up to 700 A (50 to 400) Hz	9.6 mA/A + 9.3 mA	Comparison to Current Transducer with Multimeter
Inductance – Measure ¹ 100 kHz to 1 MHz	Up to 1 μH (1 to 10) μH (10 to 100) μH 100 μH to 1 mH	1.2 mH/H + 0.005 8 nH 1.2 mH/H + 0.058 nH 1.2 mH/H + 0.58 nH 1.2 mH/H + 0.005 8 μH	Comparison to Precision LCR Meter

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source ¹ (Fixed Artifacts) 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 500 kHz 100 Hz to 200 kHz	10 μ H 50 μ H 100 μ H 1 mH	0.001 7 μ H 0.008 5 μ H 0.017 μ H 0.17 μ H	Comparison to Standard Inductors
Capacitance – Source ¹ (Fixed Artifacts)	100 Hz to 13 MHz 1 pF 10 pF 100 pF 1 000 pF 10 Hz to 100 kHz 1 nF 10 nF 100 nF 1 000 nF 100 Hz to 1 kHz 10 μ F 100 μ F 1 000 μ F	0.58 mF/F + 0.000 058 pF 0.58 mF/F + 0.000 58 pF 0.58 mF/F + 0.005 8 pF 0.58 mF/F + 0.058 pF 0.23 mF/F + 0.058 pF 0.23 mF/F + 0.58 pF 0.23 mF/F + 5.8 pF 0.23 mF/F + 58 pF 0.35 mF/F 0.35 mF/F 0.35 mF/F	Comparison to Standard Capacitors
Capacitance Dissipation Factor – Source ^{1, 5} (Fixed Artifacts)	100 Hz to 1 kHz (1 to 1 000) μ F 0 < DF < 1	0.000 82	Comparison to Standard Capacitors
Capacitance – Measure ^{1, 2}	(0 to 1 000) μ F 12 Hz to 100 kHz 100 kHz to 1 MHz 1 MHz to 30 MHz	1.1 mF/F + 0.58R 0.38 mF/F + 0.58R 0.89 mF/F + 0.58R	Comparison to RLC Digibridge / Precision LCR Meter
Oscilloscopes ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Comparison to Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Comparison to Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Comparison to Oscilloscope Calibrator and Active Head

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Bandwidth	100 mHz to 50 GHz	2.1 % of reading	Comparison to Oscilloscope Calibrator, Signal Generator, Power Sensor
Oscilloscopes ¹ Rise / Fall Time (10 to 90) %	Up to 1.25 s	1.3 ps	Comparison to Oscilloscope Calibrator and Active Head
Magnetic Field – Source ²	500 G 5 000 G Up to 8 000 G	0.17 % of reading 0.17 % of reading 1.2 % of reading + 0.58R	Comparison to Reference Magnets / Standard Gauss Meter with Probe
Magnetic Field – Measure ²	Up to 24 000 G	1.2 % of reading + 0.58R	Comparison to Standard Gauss Meter with Probe
Magnetic Flux Meter	10 mV Test Voltage (0.1 to 100) mWb 1 V Test Voltage (0.01 to 10) Wb	0.31 % of reading + 0.1 μWb 0.068 % of reading + 7 μWb	Comparison to Standard Volt-Second Generator
Moisture Meters	(7 to 25) % Moisture Content	0.26 % Moisture Content	Electrical Simulation using Resistance Standard
Phase – Measure ¹ (10 to 32) mV (10 to 100) mV 32 mV to 100 V 100 mV to 100 V (100 to 320) V	(0 to 360)° 1 Hz to 10 kHz (10 to 50) kHz 50 kHz to 10 MHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 50) kHz (50 to 100) kHz 100 kHz to 10 MHz (1 to 10) Hz 10 Hz to 5 kHz	0.25° 0.43° 0.86° 0.13° 0.071° 0.071° 0.43° 0.43° 0.25° 0.13°	Comparison to Precision Phasemeter

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors – Calibration Factors	Referenced at 1 mW (20 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	4.4 % CF 4.6 % CF 6.2 % CF	Comparison to Power Sensors, Power Meter, Coaxial Thermistor
RF Absolute Power – Measure ¹	(-70 to 44) dBm 9 kHz to 2 GHz (2 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	0.056 dB 0.057 dB 0.059 dB 0.12 dB 0.17 dB 0.23 dB	Comparison to Power Meter, Measuring Receiver and Power Sensors
RF Power – Source ¹	(-120 to 10) dBm Up to 250 kHz 250 kHz to 4 GHz (4 to 20) GHz (20 to 40) GHz	0.095 dB 0.11 dB 0.13 dB 0.16 dB	Comparison to Signal Generator / Synthesized Sweep Generator
Distortion – Measure ¹ 20 Hz to 22 kHz 20 Hz to 80 kHz 20 Hz to 250 kHz	40 kHz BW: -95 dB 80 kHz BW: -90 dB 250 kHz BW: -84 dB	0.016 dB 0.082 dB 0.24 dB	Comparison to Audio Analyzer
Phase – Measure ¹ (10 to 32) mV (10 to 100) mV 32 mV to 100 V 100 mV to 100 V (100 to 320) V	(0 to 360)° 1 Hz to 10 kHz (10 to 50) kHz 50 kHz to 100 MHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 50) kHz (50 to 100) kHz 100 kHz to 10 MHz (1 to 10) Hz 10 Hz to 5 kHz	0.25° 0.43° 0.86° 0.13° 0.07° 0.071° 0.43° 0.43° 0.25° 0.13°	Comparison to Phasemeter

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G Composite Rho ³	$\rho = (0.9 \text{ to } 1.0)$ 450 MHz to 26.5 GHz	0.001	Comparison to PSA Series Spectrum Analyzer, Signal Generator
Error Vector Magnitude (rms)	EVM = (0 to 25) % 450 MHz to 26.5 GHz	0.3 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	(1 to 15)° 450 MHz to 26.5 GHz	0.71°	
Frequency Error	3 Hz to 26.5GHz	0.21 μ Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Digital Modulation – Measure ¹ For 2/3/4/5G Channel Power	Power > -70 dBm 450 MHz to 26.5 GHz	0.62 dB	Comparison to PSA Series Spectrum Analyzer, Signal Generator
Amplitude Modulation – Source ¹	(11 to 13.5) MHz Rate: 20 Hz to 100 kHz Depth: (0 to 95) % Depth: (95 to 99) %	0.13 % Depth 0.24 % Depth	Comparison to AM/FM Test Source
Amplitude Modulation – Source ¹	AM Depth Error 250 kHz to 26.5 GHz ($f_{mod} : 1 \text{ kHz}$) Depth: (5 to 80) % AM Distortion 250 kHz to 26.5 GHz ($f_{mod} : 1 \text{ kHz}$) Depth: 30 % Depth: 80 %	2.4 % of reading + 1.2 % Depth 1.8 % Depth 2.4 % Depth	Comparison to Signal Generator
Frequency Modulation – Source ¹	(11 to 432) MHz Rate: 20 Hz to 100 kHz Deviations: $\leq 400 \text{ kHz}$	0.29 % Modulation	Comparison to AM/FM Test Source

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Source ¹	FM Deviation Error 250 kHz to 26.5 GHz (f_{mod} : 100 kHz) Deviations: ≤ 20 MHz FM Distortion 250 kHz to 26.5 GHz (f_{mod} : 100 kHz) Deviations: ≤ 4 MHz	0.46 % of reading 0.12 % of reading	Comparison to Signal Generator
Phase Modulation – Source ¹	PM Deviation Error 250 kHz to 26.5 GHz (f_{mod} : 10 kHz) Deviations: ≤ 40 rad PM Distortion 250 kHz to 26.5 GHz (f_{mod} : 10 kHz) Deviations: ≤ 40 rad	1.9 % of reading 1.1 % of reading	Comparison to Signal Generator
Pulse – Source ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3 GHz	12 ps	Comparison to Pulse Generator
Harmonic Distortion ¹ (Source and Measure) 1 kHz to 26.5 GHz	(-100 to 0.01) dB	0.86 dB	Comparison to Spectrum Analyzer
Phase Noise ¹ (Source and Measure) 1 MHz to 26.5 GHz Offset carrier ≤ 100 kHz	(-120 to -70) dBc/Hz	1.3 dB/Hz	Comparison to Signal Generator Spectrum Analyzer
Voltage Standing Wave Ratio (VSWR) ⁵	(1 to 20) 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz	0.022 0.034 0.071 0.074	Comparison to Calibration Kit and Network Analyzer
Reflection S11/ S22 – Measure ¹ Type N	Magnitude (0 to 110) dB 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz Phase (-180 to 180)° 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz	0.013 dB 0.034 dB 0.071 dB 0.074 dB 0.15° 0.25° 0.26° 2.3°	Comparison to Network Analyzer and Calibration Kits

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Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission S12/ S21 – Measure ¹ Type N	Magnitude (0 to 110) dB 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz Phase (-180 to 180)° 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz	0.016 dB 0.022 dB 0.073 dB 0.093 dB 0.15° 0.26° 0.26° 2.3°	Comparison to Network Analyzer and Calibration Kits
Coupling Decoupling Networks – CDNs ¹ Impedance Phase Angle Voltage Division Factor Isolation (Decoupling Factor)	15 kHz to 230 MHz (0.1 to 210) Ω (-360 to 360)° (-20 to 0 dB) (-80 to 0) dB	1.8 % of reading 1.2° 0.3 dB 2.5 dB	CISPR 16-1-2 IEC 6100-4-6 Comparison to Network Analyzer, Calibration Kit
Line Impedance Stabilization Networks – LISNs ¹ Impedance Phase Angle Voltage Division Factor Isolation (Decoupling Factor)	9 kHz to 400 MHz (0.1 to 210) Ω (-360 to 360)° (-10 to 0) dB (-80 to 0) dB	1.8 % of reading 1.2° 0.34 dB 2.5 dB	CISPR 16-1-2 ANSI C63.4 Comparison to Network Analyzer, Calibration Kit
Impedance Stabilization Networks – ISNs ¹ Impedance Phase Angle Voltage Division Factor Longitudinal Conversion Loss Isolation (Decoupling Factor)	150 kHz to 230 MHz (0.1 to 210) Ω (-360 to 360)° (-10 to 0) dB (-85 to -20) dB (-80 to 0) dB	1.8 % of reading 1.2° 0.3 dB 0.7 dB 2.5 dB	CISPR 16-1-2 Comparison to Network Analyzer, Calibration Kit

Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indicators, Dial Gauge, Dial Test Indicator, LVDTs ^{1, 2}	Up to 1mm Up to 100 mm	0.32 μm (0.32 + 0.004 6l) μm + 0.58R	Comparison to Universal Length Measuring Machine, Indicator Tester

Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Plain External Diameter ^{1,2} (Cylindrical and Taper)	Up to 300 mm	$(0.31 + 0.001\ 7l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Blocks
Plain Internal Diameter ² (Cylindrical and Taper)	(1 to 300) mm	$(0.26 + 0.002\ 2l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, Gage Blocks
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(1 to 300) mm	$(1.1 + 0.004\ 1l)\ \mu\text{m}$ $(0.33 + 0.001\ 7l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, Thread Wires, Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(3 to 300) mm	$(1.3 + 0.002\ 6l)\ \mu\text{m}$ $(0.31 + 0.002\ 6l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, Gage Blocks, Master Thread Plug Set
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	(0.1 to 100) mm	$(0.065 + 0.001l)\ \mu\text{m}$	Comparison to Gage Blocks, Gage Block Comparator
Variation in length	(0 to 0.5) mm	0.032 μm	
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	(0.1 to 100) mm (100 to 500) mm	$(0.16 + 0.000\ 61l)\ \mu\text{m}$ $(0.11 + 0.001l)\ \mu\text{m}$	Comparison to Gage Blocks, Universal Length Measuring Machine
Variation in length	(0 to 0.5) mm	0.15 μm	
Surface Plates ^{1,2} Overall Flatness	(150 to 3 600) mmD	$(0.5 + 0.001\ 3D)\ \mu\text{m}$	Comparison to Differential Level
Local Area Flatness (Repeat Reading - Variation)	Up to 0.13 mm	0.6 μm	Repeat-o-meter
Linear Measurements ^{1,2}	Up to 100 mm	$(0.056 + 0.002\ 8l)\ \mu\text{m}$	Comparison to Gage Blocks
	Up to 1 000 mm	$(1.5 + 0.008l)\ \mu\text{m}$	Comparison to Comparison to Precision Rule, Standard Scale
Setting Rod, Micrometer Standard, Length Standards ²	(0.1 to 500) mm	$(0.36 + 0.002\ 8l)\ \mu\text{m}$	Gage Blocks, Universal Length Measuring Machine

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Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rotational Length Measurement Devices Encoders, Cable Meters ¹	(0.03 to 10 000) m Up to 1.5 m/s	0.15 % of reading	Comparison to Contact Tachometer
Precision Level	Up to 1 mm/m (1 to 2) mm/m	0.85 % of reading + 3.5 µm/m 1.8 % of reading	Comparison to Differential Level
Master Level / Electronic Inclinometer / Angle Meter	Up to 5 mm/m (0 to 90) ° (4 Quadrants)	1.1 µm/m 0.000 82 °	Comparison to Sine Bar, Gage Block, Surface Plate
Bevel Protractor / Universal Bevel Protractor ¹	(0 to 90) ° (4 Quadrants)	2‘	Comparison to Standard Angle Block (4 Quadrant)
Roughness Tester ¹	Up to 5 µm Ra Up to 15 µm Rz	0.056 µm Ra 0.4 µm Rz	Comparison to Roughness Standard
Sine Bar & Sine Plate ²	Up to 300 mm	(0.35 + 0.001 7l) µm	Comparison to Universal length measuring machine, LVDT w/amplifier, granite surface plate, granite square, angle gage block, gauge block, optical flat, precision height gauge
Optical Comparators and Vision Systems /Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 1 000 mm	(0.14 + 0.011l) µm	Comparison to Standard Scales, Gage Blocks
Check Master / Caliper Checker / Height Master / Riser Block ² Block Pitch Accuracy Parallelism of Block Micrometer Head Accuracy	Up to 1 000 mm Up to 1 000 mm Up to 25 mm	(0.54 + 0.001l) µm 0.55 µm (0.24 + 0.002 5l) µm	Comparison to Gage Blocks, Surface Plate, Electric Comparator, Linear Gage, Precision Height Gages
Calibration Tester / Dial Gauge Tester / Indicator Calibrator ²	Up to 25 mm	(0.24 + 0.002 5l) µm	Comparison to Linear Gage and Optical Flat

Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures 1D Features ² Riser Blocks, Straight Edges, Bar Parallels	Up to 100 mm (100 to 500) mm	$(0.31 + 0.000\ 38l)\ \mu\text{m}$ $(0.23 + 0.001l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Blocks, Surface Plate, Smart Scope, Sine Bar, Differential Level, Granite Square
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 300 mm	$(1.3 + 0.000\ 38l)\ \mu\text{m}$	Comparison to Vision system, Gage Blocks, Glass Scale
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 100 mm (100 to 500) mm	$(0.31 + 0.000\ 38l)\ \mu\text{m}$ $(0.23 + 0.001l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Surface Plate, Smart Scope, Sine Bar, Differential Level, Granite Square
Coating Thickness Gauge ¹	Up to 5 000 μm	0.55 μm	Comparison to Calibration Foils
Ultrasonic Coating Thickness Gauge ²	Up to 500 mm	$(0.17 + 0.006\ 7l)\ \mu\text{m} + 0.58R$	Comparison to Gage Blocks
Thickness Gauge / Feeler Gauge ²	Up to 25 mm	$(0.35 + 0.000\ 53l)\ \mu\text{m}$	Comparison to Universal Measuring Machine, High-Accuracy Micrometer, Gage Blocks
Coordinate Measuring Machine (CMM) ^{1,2} X, Y, Z Axis	Up to 1 000 mm	$(0.16 + 0.002\ 1l)\ \mu\text{m} + 0.58R$	Comparison to Gage Block, Step Gage, Master Ball

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Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Glass Scale ²	Up to 300 mm	$(0.7 + 0.002\ 4l)\ \mu\text{m}$	Comparison to Reference Standard Scale, Smart Scope
Snap Gages ² (External / Internal)	(0.001 to 500) mm	$(0.26 + 0.002\ 2l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, Gage Blocks
Spherical Diameter, Standard Ball, Steel Ball ²	(0.1 to 100) mm	$(0.31 + 0.001l)\ \mu\text{m}$	Comparison to Universal Length Measuring Machine, Gage Blocks

Mass and Mass Related

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers ¹	HRC Low Middle High	0.53 HRC	Indirect Verification using Reference hardness test blocks
	HRBW Low Middle High	0.78 HRBW	
Brinell Hardness Testers ¹	5 mm / 750 kgf 172 HBW	2.3 HBW	Indirect Verification per ASTM E10
	10 mm / 1 000 kgf 132 HBW	1.4 HBW	
	10 mm / 3 000 kgf 107 HBW	1.2 HBW	
	598 HBW	7.3 HBW	
Brinell Hardness Testers ^{1,2} Force Indentation	Up to 3 333 kgf (0.1 to 10) mm	0.21 % of reading + 0.031 kgf $(2.6 + 0.094l)\ \mu\text{m}$	Direct Verification per ASTM E10
Vickers Hardness Tester ¹	232 HV1 550 HV10 712 HV30	3 HV 5.6 HV 4.6 HV	Indirect Verification using reference hardness test blocks
Hydrometer	(0.7 to 2) g/cm ³	0.015 % of reading	Comparison to Analytical Balance, Standard Thermometer

Mass and Mass Related

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Gage ^{1,2} Absolute & Differential & Vacuum Gauges, Transmitters	(-1 245 to 1 245) Pa (-2 490 to 2 490) Pa (600 to 1 100) hPa abs (-14.5 to 0) psi (0.001 to 30) psi (30 to 300) psi (300 to 3 000) psi (3 000 to 10 000) psi	0.019 % of reading + 0.58R 0.016 % of reading + 0.58 Pa 0.011 % of reading 0.024 % of reading + 0.58R 0.081 % of reading 0.006 4 % of reading + 0.002 2 psi 0.014 % of reading 0.029 % of reading	Comparison to Pressure Calibrator & Pressure Module
Absolute Pressure ¹ - Gages and Transmitters	Up to 10 Torr (10 to 100) Torr	0.058 Torr 0.04 % of reading + 0.052 Torr	Comparison to Standard Calibration System
Scales & Balances ^{1,3} (Platform & Spring)	(20 to 500) kg	25 µg/g	Comparison to Standard Weights
Mass Determination (SI)	(1 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g 200 g to 20 kg	0.003 2 mg 0.004 2 mg 0.005 2 mg 0.006 2 mg 0.008 2 mg 0.01 mg 0.013 mg 0.015 mg 0.02 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.081 mg 0.15 mg 0.82 µg/g	Comparison to Standard Weight, Mass Comparator
Torque Tools ¹	Up to 50 cN·m (0.50 to 1) N·m (1 to 60) N·m (60 to 200) N·m (200 to 1 500) N·m	0.09 % of reading + 0.014 cN·m 0.072 % of reading + 0.001 5 N·m 0.04 % of reading + 0.002 N·m 0.029 % of reading + 0.16 N·m 0.012 % of reading + 0.18 N·m	Comparison to Torque Testers
Torque Testers ^{1,2}	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 500) N·m	0.064 % of reading + 0.58R 0.04 % of reading + 0.58R 0.027 % of reading + 0.58R 0.016 % of reading + 0.58R 0.011 % of reading + 0.58R	Comparison to Torque Calibration Wheel with Standard Weight

Mass and Mass Related

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 000) N	0.01 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Comparison to Standard weights
	Up to 220 kN (220 to 440) kN	0.14 % of reading + 0.58 N 0.14 % of reading	Comparison to Load cell
Hardness Durometers ² Spring Force	Up to 50 N	0.008 N	Full Verification using Electronic Balance, Load Cell
Extension at zero	Up to 5 mm	0.005 mm	Gage Blocks
Indenter Shape	Up to 15 mm Up to 90°	0.003 mm 2'	Smart Scope
Air Flow ^{1,2}	(5 to 500) ml/min (0.3 to 30) l/min (10 to 100) l/min	0.36 % of reading 0.38 % of reading + 0.000 6 l/min 0.63 % of reading	Comparison to Flow Calibrators
Air Velocity	(0.01 to 15) m/s	1.4 % of reading	Comparison to Wind Tunnel

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
UV Meter/ Radiometer	(0.001 to 1) W/cm ²	2.3 % of reading	Comparison to Standard UV/Radiometer
Gloss Meter ¹ 20°, 60°, 85°	Up to 100 GU	1.3 GU	Comparison to Gloss Standards
Illuminance Measuring Equipment	(0.01 to 19 000) lux	1.8 % of reading	Comparison with Chroma Meter
Light Box Illuminance	Up to 20 000 lx	1.6 % of reading + 0.58R	Comparison to Master Chroma Meter
Temperature Color	2856 K	35 K	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter (Spectral Diffuse Reflectance)	(380 to 780) nm (10 to 20) %R (20 to 30) %R (30 to 40) %R (40 to 50) %R (50 to 60) %R (60 to 70) %R (70 to 80) %R (80 to 90) %R (90 to 100) %R	0.19 %R 0.24 %R 0.34 %R 0.35 %R 0.47 %R 0.51 %R 0.6 %R 0.66 %R 0.72 %R	Comparison to Calibration Plate Colors
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: White Illuminant A x y Y% u' v' L* a* b* Illuminant C x y Y% u' v' L* a* b*	0.000 31 0.000 31 0.87 0.000 31 0.000 16 0.35 0.11 0.24 0.000 46 0.000 61 0.89 0.000 16 0.000 46 0.35 0.13 0.24	Comparison to Calibration Plate Colors

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: White		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 61	
	Y%	0.89	
	u'	0.000 16	
	v'	0.000 31	
	L*	0.35	
	a*	0.13	
	b*	0.24	
	Illuminant D50		
	x	0.000 46	
	y	0.000 46	
	Y%	0.87	
	u'	0.000 16	
	v'	0.000 31	
	L*	0.35	
	a*	0.12	
	b*	0.24	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Brown		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	Y	0.000 31	
	Y%	0.26	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.24	
	a*	0.092	
	b*	0.15	
	Illuminant C		
	x	0.000 46	
	y	0.000 46	
	Y%	0.24	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.23	
	a*	0.092	
	b*	0.15	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Brown		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 46	
	Y%	0.24	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.23	
	a*	0.11	
	b*	0.15	
	Illuminant D50		
	x	0.000 46	
	y	0.000 46	
	Y%	0.26	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.23	
	a*	0.092	
	b*	0.15	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Green		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 46	
	y	0.000 46	
	Y%	0.27	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.24	
	a*	0.15	
	b*	0.22	
	Illuminant C		
	x	0.000 46	
	y	0.000 77	
	Y%	0.31	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.26	
	a*	0.14	
	b*	0.21	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Green		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	Y	0.000 77	
	Y%	0.31	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.26	
	a*	0.14	
	b*	0.21	
	Illuminant D50		
	x	0.000 46	
	Y	0.000 77	
	Y%	0.31	
	u'	0.000 16	
	v'	0.000 31	
	L*	0.26	
	a*	0.14	
	b*	0.22	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Deep Pink		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.31	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.24	
	a*	0.11	
	b*	0.22	
	Illuminant C		
	x	0.000 46	
	y	0.000 77	
	Y%	0.29	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.24	
	a*	0.14	
	b*	0.22	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Deep Pink		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 77	
	Y%	0.27	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.24	
	a*	0.14	
	b*	0.22	
	Illuminant D50		
	x	0.000 46	
	y	0.000 61	
	Y%	0.29	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.24	
	a*	0.12	
	b*	0.22	
Calibration Plate Colors	Color: Yellow		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.67	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.13	
	b*	0.19	
	Illuminant C		
	x	0.000 46	
	y	0.000 31	
	Y%	0.63	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.15	
	b*	0.18	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Yellow		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 31	
	Y%	0.63	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.15	
	b*	0.18	
	Illuminant D50		
	x	0.000 46	
	y	0.000 31	
	Y%	0.64	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.15	
	b*	0.18	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Cyan		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 46	
	y	0.000 46	
	Y%	0.41	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.18	
	b*	0.27	
	Illuminant C		
	x	0.000 31	
	y	0.000 77	
	Y%	0.46	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.29	
	a*	0.18	
	b*	0.27	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Cyan		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 31	
	y	0.000 77	
	Y%	0.46	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.29	
	a*	0.18	
	b*	0.27	
	Illuminant D50		
	x	0.000 46	
	y	0.000 77	
	Y%	0.46	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.29	
	a*	0.17	
	b*	0.27	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Yellow Green		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.38	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.26	
	a*	0.12	
	b*	0.19	
	Illuminant C		
	x	0.000 46	
	y	0.000 61	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.14	
	b*	0.18	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Yellow Green		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 61	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.14	
	b*	0.18	
	Illuminant D50		
	x	0.000 46	
	y	0.000 46	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.14	
	b*	0.18	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Red		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 46	
	y	0.000 16	
	Y%	0.24	
	u'	0.000 46	
	v'	0.000 16	
	L*	0.24	
	a*	0.2	
	b*	0.24	
	Illuminant C		
	x	0.000 92	
	y	0.000 46	
	Y%	0.2	
	u'	0.000 61	
	v'	0.000 31	
	L*	0.23	
	a*	0.21	
	b*	0.21	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Red		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 92	
	y	0.000 46	
	Y%	0.2	
	u'	0.000 61	
	v'	0.000 31	
	L*	0.23	
	a*	0.21	
	b*	0.21	
	Illuminant D50		
	x	0.000 46	
	y	0.000 16	
	Y%	0.24	
	u'	0.000 46	
	v'	0.000 16	
	L*	0.24	
	a*	0.18	
	b*	0.24	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Purple		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 61	
	y	0.000 46	
	Y%	0.21	
	u'	0.000 46	
	v'	0.000 31	
	L*	0.21	
	a*	0.18	
	b*	0.27	
	Illuminant C		
	x	0.000 46	
	y	0.000 61	
	Y%	0.23	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.23	
	a*	0.23	
	b*	0.27	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Purple		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 61	
	Y%	0.23	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.23	
	a*	0.23	
	b*	0.27	
	Illuminant D50		
	x	0.000 61	
	y	0.000 61	
	Y%	0.23	
	u'	0.000 46	
	v'	0.000 46	
	L*	0.23	
	a*	0.2	
	b*	0.27	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Orange		Comparison to Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.43	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.27	
	a*	0.12	
	b*	0.18	
	Illuminant C		
	x	0.000 46	
	y	0.000 46	
	Y%	0.38	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.12	
	b*	0.19	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Orange		Comparison to Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 46	
	Y%	0.38	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.12	
	b*	0.19	
	Illuminant D50		
	x	0.000 31	
	y	0.000 46	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.12	
	b*	0.18	
Optical Power ¹ (Source & Measure) (800 to 1 000) nm (1 000 to 1 700) nm	(-90 to 10) dB (-110 to 10) dB	0.12 dB 0.12 dB	Comparison to Agilent optical test System
Laser Power Measure	(250 to 10 600) nm 10 mW to 10 W (10 to 30) W	1.8 % of reading + 0.04 mW 2.7 % of reading	Comparison to Thermopile Sensor, Silicon Detector

Thermodynamic

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Measure & Measuring Equipment, Transmitters ¹	(660 to 1 100) °C	0.88 °C	Comparison to SPRT, Thermocouple, Micro Bath, Dry-Well, Temperature Calibrator

Thermodynamic

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiation (Infrared) Thermometers ¹	-18 °C (-17.9 to 0) °C (0.1 to 32) °C (32.1 to 50) °C (50.1 to 100) °C (100.1 to 150) °C (150.1 to 200) °C	0.84 °C 0.93 °C 1.2 °C 1.3 °C 1.6 °C 2.2 °C 2.7 °C	Comparison to Omega Blackbody Calibrator (Plate) $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	(32 to 50) °C (50.1 to 100) °C (100.1 to 200) °C (200.1 to 300) °C (300.1 to 400) °C	1.6 °C 2 °C 2.9 °C 3.8 °C 4.8 °C	Comparison to Ametek Blackbody Calibrator (Plate) $\varepsilon = 0.96$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Chambers, Dry Oven, Furnace, Autoclave, Incubator, Vacuum Oven, System Calibration & Profiling ¹			Comparison to Datalogger with Thermocouple Sensors and Relative Humidity Sensor
Temperature	(-80 to 400) °C	0.63 °C	
Humidity	(5 to 40) %RH (40 to 95) %RH	0.83 %RH 1.3 %RH	

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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. D = diagonal length, f = frequency, L = length or diameter in inches, l = length or diameter in millimeters, P = power, R = resolution (or readability) of the unit under test, t = time in seconds, V = variation, W = applied weight; rpm = revolutions per minute.
3. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The uncertainties presented here do not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
4. The values of the solutions reflected in this scope of accreditation are the approximate reference value at a reference temperature of 25 °C as taken from the certificate of accreditation and will vary with change in temperature.
5. Unitless linear measure.
6. 1 mil = 0.001 inch., SpGr refers to specific gravity or relative density.
7. Adjustable threaded rings are adjusted for a tactile fit using threaded setting plug verified using a Universal Length Measuring Machine followed by a measurement of the minor diameter.
8. Nominal values are approximate. The actual values will be utilized at the time of calibration.



Jason Stine, Vice President

