



# CERTIFICATE OF ACCREDITATION

**The ANSI National Accreditation Board**

Hereby attests that

**Metrología y Pruebas, S. A. de C. V.**  
**Privada Tecnológico No. 25**  
**Nogales, Sonora México**  
(and satellite locations as listed on the scope)

Fulfills the requirements of

**ISO/IEC 17025:2017**

In the fields of

**CALIBRATION, TESTING 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](http://www.anab.org).

A handwritten signature in black ink, appearing to read 'R. Douglas Leonard Jr.', is positioned above a horizontal line.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 11 November 2021  
Certificate Number: ACT-1890



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

### Metrología y Pruebas, S. A. de C. V.

Privada Tecnológico No.25

Nogales, Sonora, México

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## CALIBRATION, TESTING AND DIMENSIONAL MEASUREMENT

Valid to: November 11, 2021

Certificate Number: ACT-1890

### CALIBRATION

#### Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound	(20 to 140) dB 100 Hz to 10 kHz	0.86 dB	Sound Calibrator Sound Level Meter PMP-C-036
Acceleration <sup>3</sup>	(0.1 to 10) g @ (10 to 6 000) Hz	(0.000 7+0.013a) g	Accelerometer Brüel & Kjær PMP-C-051

#### Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Particle Counter	Size Particles 0.3 µm 0.5 µm 1.0 µm 5.0 µm 10.0 µm Concentration Limit (0 to 3 000 000) particles /ft <sup>3</sup>	(1.3 + 0.000 83Δ) particles /ft <sup>3</sup> Δ en particles /ft <sup>3</sup>	Particle counter PMP-C-050



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**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters <sup>5</sup>	2.00 pH 4.00 pH 6.80 pH 7.00 pH 9.00 pH 10.00 pH 12.50 pH	0.01 pH 0.014 pH 0.012 pH 0.012 pH 0.018 pH 0.024 pH 0.031 pH	pH Buffer Solutions PMP-C-040
Conductivity Meters <sup>5</sup>	100 $\mu\text{S}/\text{cm}^2$ 1 000 $\mu\text{S}/\text{cm}^2$ 5000 $\mu\text{S}/\text{cm}^2$ 10 000 $\mu\text{S}/\text{cm}^2$ 100 000 $\mu\text{S}/\text{cm}^2$	1 $\mu\text{S}/\text{cm}^2$ 5.1 $\mu\text{S}/\text{cm}^2$ 20 $\mu\text{S}/\text{cm}^2$ 20 $\mu\text{S}/\text{cm}^2$ 400 $\mu\text{S}/\text{cm}^2$	Traceable Conductivity Solutions PMP-C-043
Viscometers	Up to 10 cP (10 to 100) cP (100 to 1 000) cP (1 000 to 12 500) cP (12 500 to 100 000) cP	1.2 cP (1.1 + 0.004z) cP (0.42 + 0.01z) cP (0.68 + 0.01z) cP (14 + 0.01z) cP	Viscosity Standards PMP-C-37
Breathalyzer	0.020 g/210L @ 34 °C 0.030 g/210L @ 34 °C 0.1 g/210L @ 34 °C	0.000 8 g/210L 0.001 g/210L 0.003 g/210L	Alcohol Reference Solution PMP-C-049
Gas Measurement Equipment	CO (100 ppm) H <sub>2</sub> S (25 ppm) CH <sub>4</sub> (2.5% vol, 50%LEL) NO <sub>2</sub> (10ppm) SO <sub>2</sub> (20ppm) i-C <sub>4</sub> H <sub>10</sub>	2 % of reading	Gas Reference PMP-C-044

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes Leveled Sine Wave	5 mV to 5.5 V 50 kHz to 100 MHz (50 to 300) MHz (300 to 600) MHz	40 mV/V 45 mV/V 65 mV/V	Fluke Multifunction Calibrator PMP-C-010
Square Wave Signal 10 Hz to 10 kHz	(1 mV to 6.6 V) p-p (50 $\Omega$ load) (1 mV to 130 V) p-p (1 M $\Omega$ load)	1.2 mV/V 1.3 mV/V	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes Rise Time 5 mV to 2.5 V	1 kHz to 10 MHz	1 ms/s	Fluke Multifunction Calibrator PMP-C-010
DC High Voltage - Source	(1 to 10) kV	0.021 V/V	High Voltage Probe Charged Plate Analyzer Monroe Electronics PMP-C-001
DC High Voltage - Measure	(1 to 10) kV	0.021 V/V	High Voltage Probe Charged Plate Analyzer Monroe Electronics Up to 10 000 V Multimeter DC Hy-Pot PMP-C-001
DC Voltage – Source equipment	(1 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1.02 kV	12 $\mu$ V/V 8.3 $\mu$ V/V 8.1 $\mu$ V/V 10 $\mu$ V/V 10 $\mu$ V/V	HP Multimeter PMP-C-001
DC Voltage – Measure equipment	(1 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1.02 kV	12 $\mu$ V/V 8.3 $\mu$ V/V 8.1 $\mu$ V/V 10 $\mu$ V/V 10 $\mu$ V/V	HP Multimeter Fluke Multifunction Calibrator PMP-C-001
AC Voltage – Source equipment	(1 to 100) mV 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz 100 mV to 1V 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.1 mV/V 0.17 mV/V 0.4 mV/V 0.1 mV/V 0.16 mV/V 0.33 mV/V 0.82 mV/V	HP Multimeter PMP-C-003
AC Voltage – Source equipment	(1 to 10) V 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.41 mV/V 0.16 mV/V 0.32 mV/V 0.82 mV/V	HP Multimeter PMP-C-003



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment		
AC Voltage – Source equipment	(10 to 100) V 50 Hz to 1 kHz (1 to 20) kHz	0.22 mV/V 0.22 mV/V	HP Multimeter Fluke Multifunction Calibrator PMP-C-003		
	(100 to 1 000) V 50 Hz to 1 kHz	0.43 mV/V			
AC Voltage – Source equipment	(1 to 15) kV 60 Hz	0.02 V/V	Tektronix High Voltage Probe PMP-C-003		
AC Voltage – Source equipment	(15 to 60) kV 60 Hz	0.032 mV/V	Hipotronix Transformer		
AC Voltage – Measure equipment	(1 to 100) mV 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz	0.1 mV/V 0.17 mV/V 0.4 mV/V	HP Multimeter Fluke Multifunction Calibrator PMP-C-003		
	100 mV to 1V 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.1 mV/V 0.16 mV/V 0.33 mV/V 0.82 mV/V			
	1 to 10V 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.41 mV/V 0.16 mV/V 0.32 mV/V 0.82 mV/V			
	(10 to 100) V 50 Hz to 1 kHz (1 to 20) kHz	0.22 mV/V 0.23 mV/V			
	(100 to 1 000) V 50 Hz to 1 kHz	0.43 mV/V			
	(1 to 15) kV 60 Hz	0.02 V/V		Hipotronics Transformer PMP-C-003	
	(15 to 60) kV 60 Hz	0.02 V/V		High Voltage Probe PMP-C-003	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source equipment	(10 to 100) nA 100 nA to 1 $\mu$ A (1 to 10) $\mu$ A (10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	432 $\mu$ A/A 64 $\mu$ A/A 32 $\mu$ A/A 30 $\mu$ A/A 26 $\mu$ A/A 26 $\mu$ A/A 40 $\mu$ A/A 122 $\mu$ A/A	HP Multimeter PMP-C-002
	(1 to 11) A (11 to 550) A	0.54 mA/A 2.6 mA/A	HP Multimeter with standard shunts PMP-C-002
DC Current – Measure equipment	(10 to 100) nA 100 nA to 1 $\mu$ A (1 to 10) $\mu$ A (10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	720 $\mu$ A/A 64 $\mu$ A/A 32 $\mu$ A/A 30 $\mu$ A/A 26 $\mu$ A/A 26 $\mu$ A/A 41 $\mu$ A/A 121 $\mu$ A/A	HP Multimeter Fluke Multifunction Calibrator PMP-C-002
DC Current – Measure equipment Clamp-On Ammeters	(1 to 11) A (11 to 100) A (11 to 550) A	1.1 mA/A 0.92 mA/A 2.6 mA/A	Fluke Multifunction Calibrator Shunt Resistors 50-Turn Current coil PMP-C-002
AC Current – Source equipment	(1 to 10) mA (50 to 100) Hz 100 Hz to 1 kHz (10 to 100) mA (50 to 100) Hz 100 Hz to 1 kHz 100mA to 1 A (50 to 100) Hz 100 Hz to 1 kHz	0.8 mA/A 0.21 mA/A 0.21 mA/A 0.21 mA/A 0.21 mA/A 0.21 mA/A 0.21 mA/A	HP Multimeter PMP-C-004
	(1 to 11) A 60 Hz	1.4 mA/A	Fluke Multifunction Calibrator PMP-C-004 Current Shunts PMP-C-004

**Electrical – DC/Low Frequency**

<b>Parameter/Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method, and/or Equipment</b>
AC Current – Source equipment	(11 to 50) A 60 Hz (11 to 550) A 60 Hz	6.8 mA/A  8 mA/A	with Shunt Resistor Leeds & Northrup 4361 PMP-C-004
AC Current – Measure equipment	(1 to 10) mA (50 to 100) Hz 100 Hz to 1 kHz (10 to 100) mA (50 to 100) Hz 100 Hz to 1 kHz 100 mA to 1 A (50 to 100) Hz 100 Hz to 1 kHz	0.8 mA/A 0.5 mA/A  0.8 mA/A 0.51 mA/A  1 mA/A 1.2 mA/A	HP Multimeter Fluke Multifunction Calibrator PMP-C-003
	(1 to 11) A 60 Hz (11 to 50) A 60 Hz	1.6 mA/A  6.8 mA/A	
AC Current – Measure equipment Clamp-On Ammeters	(11 to 550) A 60 Hz	8 mA/A	Fluke Multifunction Calibrator with 50-Turn Coil PMP-C-003
DC Power Measure equipment	10.89 mW to 11 220 W	0.82 mW/W	Fluke Multifunction Calibrator PMP-C-005
DC Power Source equipment	10.89 mW to 11 220 W	0.41 mW/W	HP Multimeter Shunt resistors DC Power Supply PMP-C-005A
AC Power – Measure equipment	10.89 mW to 11 220 W @ 60 Hz, P.F. = 1	2.2 mW/W	Fluke Multifunction Calibrator PMP-C-005
	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.9	3.3 mW/W	
	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.8	3.9 mW/W	





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source equipment	10.89 mW to 11220 W @ 60 Hz, P.F. = 1	1.4 mW/W	HP Multimeter Shunt resistors DC Power Supply PMP-C-005
	10.89 mW to 11220 W @ 60 Hz, P.F. = 0.9	3 mW/W	
	10.89 mW to 11220 W @ 60 Hz, P.F. = 0.8	4.4 mW/W	
Resistance – Measure equipment	(1 to 10) Ω	20 μΩ/Ω	HP Multimeter Fluke Multifunction Calibrator PMP-C-006
	(10 to 100) Ω	17 μΩ/Ω	
	100 Ω to 1 kΩ	11 μΩ/Ω	
	(1 to 10) kΩ	11 μΩ/Ω	
	(10 to 100) kΩ	11 μΩ/Ω	
	100 kΩ to 1 MΩ	17 μΩ/Ω	
	(1 to 10) MΩ	60 μΩ/Ω	
	(10 to 100) MΩ	0.5 mΩ/Ω	
100 MΩ to 1 GΩ	5 mΩ/Ω		
Resistance – Source equipment	(1 to 10) Ω	20 μΩ/Ω	HP Multimeter PMP-C-006
	(10 to 100) Ω	17 μΩ/Ω	
	100 Ω to 1 kΩ	11 μΩ/Ω	
	(1 to 10) kΩ	11 μΩ/Ω	
	(10 to 100) kΩ	11 μΩ/Ω	
	100 kΩ to 1 MΩ	17 μΩ/Ω	
	(1 to 10) MΩ	60 μΩ/Ω	
	(10 to 100) MΩ	0.5 mΩ/Ω	
100 MΩ to 1 GΩ	5.1 mΩ/Ω		
Resistance Generation Equipment High value resistors and decade resistors	1 MΩ to 1 TΩ @ (50 to 1 000) V	0.023 Ω/Ω	Fluke Multifunction Calibrator HP Multimeter High Value R Decade (1 MΩ to 1 TΩ) PMP-C-006
Resistance Measuring Equipment Megaohmmeters	100 kΩ to 1 GΩ @ (Up to 5 000) V	0.08 Ω/Ω	Direct method with: High Value R Decade (1 MΩ to 1 TΩ) PMP-C-006
	1 GΩ to 1 TΩ @ (1 to 10) kV	0.023 Ω/Ω	
DC Shunt Resistance Equipment	0.5 mΩ to 1 Ω @ (Up to 300) A	0.45 mΩ/Ω	HP Multimeter Shunt resistor 0.01Ω Shunt resistor 0.1Ω PMP-C-006





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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC electrical Resistance at 60 Hz Shunt Resistance	0.5 mΩ to 1 Ω @ (1 to 60) A	2.5. mΩ/Ω	Fluke Multifunction Calibrator HP Multimeter DC Power Supply Shunt resistors PMP-C-006
Capacitance Source equipment	0.01 pF to 10 μF 12 Hz to 100 kHz	0.42 mF/F	Capacitance Bridge Precision LCR Meter PMP-C-009
Capacitance – Measure equipment	(1 to 10 000) pF 0.33 pF to 0.33 mF	4 mF/F 0.9 mF/F	Capacitance decade 1 pF Capacitor 1000 pF Capacitor 10 000 pF Capacitor Fluke Multifunction Calibrator PMP-C-009
Inductance – Source equipment	Up to 10 H @ 12 Hz to 100 kHz	0.069 mH/H	LCR Bridge Precision LCR Meter PMP-C-029
Inductance – Measure equipment	1 mH to 10 H	0.23 mH/H	Precision LCR Meter Standard Inductors PMP-C-029
Phase Angle Output	(0 to 180) °	0.15 °	Krohn-Hite Phase Meter PMP-C-005
RTD Simulation Measure/ Source	Pt 385, 100 Ω (-196 to 1 000) °C	0.03 °C	HP Multimeter Fluke Multifunction Calibrator PMP-C-020
Thermocouple Simulation Type B Type C Type E Type J Type K Type L Type N Type R Type T Type S Type U	(600 to 1 820) °C (0 to 2 316) °C (-250 to 1 000) °C (-250 to 1 200) °C (-200 to 1 372) °C (-200 to 900) °C (-200 to 1 300) °C (0 to 1 767) °C (-250 to 400) °C (0 to 1 767) °C (-200 to 600) °C	0.07 °C 0.11 °C 0.08 °C 0.05 °C 0.07 °C 0.06 °C 0.07 °C 0.08 °C 0.06 °C 0.07 °C 0.08 °C	Fluke Multifunction Calibrator HP Multimeter PMP-C-020

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Magnetic Field <sup>3</sup>	3 mT to 3 T	(0.01+ 1P) mT	Magnetic Field Meter PMP-C-051

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Power - Source 50 Ω load	(-30 to 20) dBm (10 MHz to 18 GHz) 20 dBm -30 dBm	0.092 dB 1.1 dB	Power Sensor Power Meter PMP-C-008
	(-90 to 20) dBm (10 MHz to 13.2 GHz) 20 dBm -90 dBm	0.26 dB 0.4 dB	Spectrum Analyzer PMP-C-008
Power - Measure 50 Ω load	(-90 to 20) dBm (10 MHz to 4 GHz) 20 dBm -90 dBm	0.41 dB 0.49 dB	Signal Generator Spectrum Analyzer PMP-C-008
Power - Measure 50 Ω load	(-90 to 8) dBm (2 GHz to 13.2 GHz) 8 dBm -30 dBm	0.23 dB 1.1 dB	Signal Generator Power Sensor Power Meter PMP-C-008
Power - Measure 50 Ω load	(-30 to 8) dBm (2 to 18) GHz 8 dBm -90 dBm	0.33 dB 0.45 dB	Signal Generator Spectrum Analyzer PMP-C-008
RF/Microwave Phase Modulation – Measure / Generate	Carrier Frequency: 100 kHz to 13.2 MHz (0.1 to 45) rad	0.84 % of reading	Agilent PSA Spectrum Analyzer Frequency Synthesizer Frequency Generator PMP-C-008
Amplitude Modulation - Source and Measure Rate: Depths: 5% to 99%	20 Hz to 10 kHz 50 Hz to 100 kHz	0.7 % of reading	Agilent PSA Spectrum Analyzer Frequency Synthesizer Frequency Generator PMP-C-008
	Flatness – Measure Rate: 90 Hz to 10 kHz  100 kHz to 10 MHz 10 MHz to 13.2 GHz		

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF/Microwave Frequency Modulation-Source and Measure	20 Hz to 10 kHz 50 Hz to 200 kHz FM Dev 50 Hz to 50 kHz 250 kHz to 10 MHz 10 MHz to 13.2 GHz	1 % of reading	Agilent PSA Spectrum Analyzer Frequency Synthesizer Frequency Generator PMP-C-008

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Depth Micrometers <sup>3</sup>	Up to 1016 mm Up to 40 in	$(1.5 + 0.008L) \mu\text{m}$ $(61 + 8L) \mu\text{in}$	Gage Blocks Grade 2 Gage Blocks Grade 3 PMP-C-014
Outside Micrometers <sup>3</sup>	Up to 1 016 mm Up to 40 in	$(0.78 + 0.008 7L) \mu\text{m}$ $(31 + 8.7L) \mu\text{in}$	Gage Blocks Grade 2 Gage blocks Grade 3 PMP-C-014 Reference Standard NMX-CH-099-IMNC-2005
Inside Micrometers <sup>3</sup>	5.08 to 1016 mm 0.2 to 40 in	$(0.7+ 0.008 8L) \mu\text{m}$ $(27 + 8.8L) \mu\text{in}$	Gage Blocks Grade 2 Gage blocks Grade 3 PMP-C-014 NMX-CH-099-IMNC-2005
Dial and Digital Indicators <sup>3</sup>	Up to 101.6 mm Up to 4 in	$(0.91+ 0.004 3L) \mu\text{m}$ $(36 + 4.3L) \mu\text{in}$	Gage Blocks Grade 2 PMP-C-014 NMX-CH-36-1994
Optical Comparator <sup>2,3</sup> Linear	Up to 508 mm Up to 20 in	$(0.23 + 0.001 9L) \mu\text{m}$ $(9.2 + 1.9L) \mu\text{in}$	Glass Scales Gage Blocks Grade 2 Gage Block Grade 3 PMP-C-014
Optical Comparators <sup>2</sup> Angular	(0 to 360) °	0.015 °	Angle block PMP-C-014
Optical Comparators <sup>2</sup> Squareness	4 in of Y axis travel or maximum, Y axis travel if maximum is less than 4 in. 276.5 μin at 4 in	1 °	Master Square PMP-C-014

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Comparators <sup>2</sup> Magnification	5x 10x 20x 50x 100x	0.07x 0.13x 0.24x 0.45x 0.7 x	Glass Ruler PMP-C-014
Height Measuring Equipment <sup>3</sup>	Up to 609.6 mm (Up to 24 in)	(7.33 + 0.0032L) μm (289 + 3.2L) μin	Granite Surface Gage Blocks PMP-C-014
Graduated Rules and Flexometers <sup>3</sup>	Up to 25 m (Up to 984 in)	(0.000 5L+0.000 84) μm (0.51L+0.033) μin,	MPC490 API Laser Interferometer PMP-C-014 NOM-040-SCFI-1994 & NOM-046-SCFI-1999
Graduated Rules and Flexometers <sup>3</sup>	Up to 508 mm (Up to 20 in)	(20+0.041L) μm (791+41L) μin	Digital Indicator Stainless Ruler 5X Amplification Lens PMP-C-014 NOM-040-SCFI-1994 & NOM-046-SCFI-1999
Calipers <sup>3</sup>	Up to 1 016 mm	(20 + 0.002 2L) μm	Gage Blocks Grade 2 PMP-C-014 NMX-CH-2:1993-SCFI
Calipers <sup>3</sup>	(Up to 40 in)	(780 + 2.2L) μin	Gage Blocks Grade 3 PMP-C-014 NMX-CH-2:1993-SCFI
Coordinate Measuring Machines <sup>2,3</sup> Linear Error	Up to 609.6 mm (Up to 24 in)	(0.087 + 0.00 13L) μm (3.4 + 1.4L) μin	Gage Blocks Grade 2 Gage Blocks Grade 3 PMP-C-014
	(100 to 25 000) mm (4 in to 984 in)	(0.11 + 0.000 5L) μm (4.1 + 0.5L) μin	API Laser Interferometer PMP-C-014
Coordinate Measuring Machines <sup>2</sup> Volumetric error	(200 to 800) mm (8 to 32 in)	4.34 μm 171 μin	Ball Bars PMP-C-014
Coating Thickness <sup>3</sup>	Up to 1.52 mm Up to 60 000 μin	(2+16L) μm (77+ 0.016L) μin	Digital Indicator Gage Blocks Grade 2 PMP-C-014

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rugosity	Ra = 2.94 μm (116 μin) Ry = 9.3 μm (366 μin) Ra = 0.41 μm (15.8 μin) Ry = 1.58 μm (62.2 μin)	0.061 μm 2.4 μin 0.21 μm 8.1 μin 0.061 μm 2.4 μin 0.21 μm 8.1 μin	Rugosity Standard (Ra, Ry) Mitutoyo PMP-C-038
Surface Roughness Standards	(0.13 to 3.8) μm (5 to 150) μin	0.021 μm/μm 0.007 μin/in	Roughness Tester PMP-C-038
Levels	(0 to 1.15) °	0.000 12 °	MPC286 Level Table Traceable to NIST PMP-C-014
Surface Plates <sup>1</sup> Local Area Flatness only (Repeat Reading)	Up to 1 727 mm (0 to 0.000 2) in	0.99 μm 39 μin	Repeatability Gauge PMP-C-014
Surface Plates <sup>1</sup> Overall Flatness	Up to (609.6 x 914.4) mm Diagonal (24 x 36) in	0.43 μm 17 μin	API Laser Interferometer PMP-C-014
Gages Blocks <sup>3</sup> Grade 1, 2 and 3 (FS)	(0.254 to 152.9) mm (0.01 to 6) in	(0.1 + 0.000 8L) μm (4 + 0.75L) μin	Gage Blocks Grade 1 FS Gage Blocks Comparator PMP-C-014
Gages Blocks <sup>3</sup>	(152.4 to 1 016) mm (6 to 40) in	(-0.033 + 0.000 8L) μm (-1.3 + 0.8L) μin	Laser Interferometer PMP-C-014
Pin/Plug Gauges	(0.254 to 101.6) mm (0.01 to 4) in	0.36 μm 14 μin	Gage Blocks Grade 2 Universal measuring machine PMP-C-014
Ring Gages	(12.7 to 101.6) mm (0.5 to 4) in	0.36 μm 14 μin	Universal measuring machine PMP-C-014
Thickness gauges & Measuring Equipment	(0.006 to 11.46) mm 236 μin to 0.45 in	2 μm 79 μin	ASTM E797 Thickness Gauge PMP-C-014
Angle Blocks	(0 to 90) °	0.014 °	Microscope "Vision Engineering Hawk" PMP-C-014

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gage Pitch Diameter	M 1.6 x 0.35 to M 100 x 6 (0-80 to 4-12)	5.1 µm 200 µm	Supermicrometer Brown & Sharpe Gage block set grade 2 PMP-C-014
Thread Plug Gage Major Diameter	M 1.6 x 0.35 to M 100 x 6 (0-80 to 4-12)	1.8 µm 71 µm	Supermicrometer Brown & Sharpe Gage block set grade 2 PMP-C-014
Protractors	(0 to 360) °	0.059 °	Angle Block PMP-C-014
Bore Gage	(0.762 to 304.8) mm (0.03 to 12) in	3.1 µm 120 µm	Ring gages (anillos) -Microscope "Vision Engineering Hawk" PMP-C-014
Radius Gage	(0.254 to 25.4) mm (0.01 to 1) in	4.1 µm 160 µm	Microscope "Vision Engineering Hawk" PMP-C-014

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dead Weights <sup>3</sup>	(0.01 to 200) g (0.2 to 3) kg (3 to 34) kg (34 to 50) kg	(0.005 8 + 0.000 31W) mg (2.1W - 0.34) mg (9.1W - 22) mg (18W - 320) mg	Class 1 Stainless Weights Digital Scale as Comparison Element Class M2 Weights and Scales PMP-C-021 NIST Handbook 44 OIML R111 ABBA Method



**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances <sup>1,3,4</sup>	(1 to 200) g (Res. = 0.01 mg)	(0.005 7+0.000 31W) mg	ASTM class 1 Weight set MPC088 Weight set MPC458 Weight MPC091 Weight MPC092 Weight MPC093 Weight MPC094 Weight MPC095 Weight MPC096 Weight MPC097 PMP-C-012
	(200 to 500) g (Res. = 0.1 mg)	(0.049+0.000 1W) mg	
	(500 to 2 000) g (Res. = 0.5 mg)	(-0.058+0.000 31W) mg	
	(2 000 to 5 000) g (Res. = 0.5 mg)	(0.37+0.000 1W) mg	
	(5 000 to 15 000) g (Res. = 0.5 mg)	(0.18+0.000 14W) mg	
	(15 to 50) kg (Res.= 0.01 g)	(-0.055+0.0038W) g	
	(50 to 100) kg (Res.= 0.1 g)	(-2.6+0.055W) g	
	(100 to 200) kg (Res.= 0.1 g)	(-0.68+0.036W) g	
	(200 to 500) kg (Res.= 5 g)	(1.7+0.024W) g	
	(500 to 1 000) kg (Res.= 5 g)	(-33 + 0.094W) g	
	(1 000 to 2 500) kg (Res.= 100 g)	(-39 + 0.1W) g	
	Volumetric Recipients <sup>3</sup> (Pipettes, Burettes) (Test Tubes, Syringes) (Flask, Beakers, Hasty Glasses) (Graduated volumetric containers) (Graduated volumetric containers)	(0.1 to 200) ml (0.1 to 200) c m <sup>3</sup>	
(0.1 to 200) ml (0.1 to 200) c m <sup>3</sup>		(0.000 0013+ 0.000 13V) ml (0.00 13 + 0.13V) mm <sup>3</sup>	Digital Scale PMP-C-033
(1 to 2000) ml (1 to 2000) c m <sup>3</sup>		(0.000 014+ 0.000 14V) ml (-0.014 + 0.14V) mm <sup>3</sup>	Digital Scale PMP-C-033
Volumetric Recipients <sup>3</sup> (Pipettes, Burettes) (Test Tubes, Syringes) (Flask, Beakers, Hasty Glasses) (Graduated volumetric containers) (Graduated volumetric containers)	(200 to 3 000) ml (200 to 3 000) cm <sup>3</sup>	(-0.016 + 0.000 21V) ml (-0.016 + 0.000 21V) cm <sup>3</sup>	Digital Scale PMP-C-033
	(3 000 to 30 000) ml (3 000 to 30 000) cm <sup>3</sup>	(0.000 13 + 0.03V) ml (0.000 13 + 0.03V) cm <sup>3</sup>	Digital Scale PMP-C-033





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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Water Flow <sup>1,3</sup>	Up to 1 500 l/min	(0.6 + 0.01f) l/min	Digital Flow Meter Badger meter Magneto Flow Primo PMP-C-034
Torque <sup>1</sup>	(0.005 to 1) Nm (0.044 to 8.9) lbf-in	0.007 2 Nm 0.064 lbf-in	Dead Weights Rice Lake PMP-C-015 CNM-MMF-PT-002 & EA-10/14
Torque <sup>1</sup>	(0.9 to 20) Nm 8.0 lbf-in to 15 lbf-ft	0.056 Nm 0.5 lbf-in	Torque Transducer PMP-C-015 CNM-MMF-PT-002 & EA-10/14
Torque <sup>1</sup>	(7.4 to 500) Nm (5.5 to 369) lbf-ft	0.62 Nm 0.46 lbf-ft	Torque Transducer PMP-C-015 CNM-MMF-PT-002 & EA-10/14
Torque <sup>1</sup>	(400 to 678) Nm (295 to 500) lbf-ft	1.6 Nm 1.2 lbf-ft	Torque Transducer PMP-C-015 CNM-MMF-PT-002 & EA-10/14
Air Flow <sup>1,3</sup>	Up to 1 L/min (1 to 20) L/min (20 to 300) L/min	(0.00039 + 0.011f) l/min (0.00076 + 0.0035f) l/min (0.45 + 0.0082f) l/min	Flow Transducers PMP-C-030
Air Velocity <sup>1,3</sup>	(0.4 to 25) m/s	(0.16 + 0.01y) m/s	TPI 575 Digital Anemometer PMP-C-030
Hydrometer <sup>3</sup>	(0.62 to 3) SG	(0.023 – 0.004G) SG	Dead Weights, Digital Scale, Digital Thermometer PMP-C-032 NBS Circular 555
Vacuum <sup>1,3</sup>	(-100 to 0) kPa (-14.5 to 0) psi	(-1.1 x 10 <sup>-8</sup> + 0.013ρ) kPa (-1.6 x 10 <sup>-9</sup> + 0.013ρ) psi	Pressure Sensor Edwards high Vacuum PMP-C-013
Rockwell and Rockwell Superficial Hardness Testers <sup>2</sup>	(20 to 40) HRA (41 to 75) HRA (76 to 88) HRA  (40 to 59) HRBW (60 to 80) HRBW (81 to 100) HRBW	0.33 HRA 0.39 HRA 0.19 HRA  1.41 HRBW 0.9 HRBW 0.44 HRBW	Indirect Verification using Hardness Blocks



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell and Rockwell Superficial Hardness Testers <sup>2</sup>	(20 to 39) HRC	0.4 HRC	Indirect Verification using Hardness Blocks
	(40 to 59) HRC	0.34 HRC	
	(60 to 70) HRC	0.35 HRC	
	(70 to 77) HR15N	0.43 HR15N	
	(78 to 88) HR15N	0.43 HR15N	
	(89 to 92) HR15N	0.23 HR15N	
	(42 to 54) HR30N	0.43 HR30N	
	(55 to 73) HR30N	0.3 HR30N	
	(74 to 80) HR30N	0.35 HR30N	
	(20 to 37) HR45N	0.65 HR45N	
	(38 to 62) HR45N	0.65 HR45N	
	(63 to 74) HR45N	0.65 HR45N	
	(73 to 80) HR15TW	0.41 HR15TW	
	(81 to 87) HR15TW	0.34 HR15TW	
	(88 to 93) HR15TW	0.34 HR15TW	
(43 to 56) HR30TW	0.51 HR30TW		
(57 to 69) HR30TW	0.35 HR30TW		
(70 to 82) HR30TW	0.35 HR30TW		
(12 to 32) HR45TW	0.65 HR45TW		
(33 to 52) HR45TW	0.65 HR45TW		
(53 to 73) HR45TW	0.65 HR45TW		
Direct verification of Hardness Tester A, B, C, D, E, O & DO Extension at zero Reading	(2.46 to 2.54) mm	5 μm	ASTM D-2240 Load Cell, Force Gauge, Balance & Gage Block Optical Projection
Durometer Indentor Spring Types A, B, E & O Types C, D & DO	(0.55 to 8.05) N (4.445 to 44.45) N	0.05 N/N 0.005 N/N	The Durometer Spring is verified with Dead Weights PMP-C-027
Indentor Shape (Not all parameters apply to all of Durometer Types) Indentor Diameter Indentor Tip Diameter Indentor Tip Radius	(1 to 20) mm	5 μm 5 μm 5 μm	Microscope "Vision Engineering Hawk"

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indenter Shape (Not all parameters apply to all of Durometer Types) Indenter Tip Angle	(5 to 90) °	0.02 °	Microscope “Vision Engineering Hawk”
Standardized Rockwell Hardness Test Blocks	≥ 80 HRA (60 to 80) HRA ≤ 60 HRA	0.17 HRA 0.15 HRA 0.14 HRA	MPC159 Hardness Tester PMP-C-027
	≥ 80 HRBW (60 to 80) HRBW ≤ 60 HRBW	0.28 HRBW 0.21 HRBW 0.17 HRBW	
	≥ 60 HRC (40 to 60) HRC ≤ 40 HRC	0.2 HRC 0.16 HRC 0.14 HRC	
	≥ 90 HR15N (80 to 90) HR15N < 80 HR15N	0.21 HR15N 0.2 HR15N 0.2 HR15N	
	≥ 79 HR30N (60 to 79) HR30N ≤ 60 HR30N	0.22 HR30N 0.2 HR30N 0.19 HR30N	
	≥ 65 HR45N (50 to 65) HR45N ≤ 50 HR45N	0.2 HR45N 0.25 HR45N 0.23 HR45N	
	≥ 100 HR15TW (80 to 100) HR15TW ≤ 80 HR15TW	0.22 HR15TW 0.22 HR15TW 0.22 HR15TW	
	≥ 70 HR30TW (50 to 70) HR30TW ≤ 55 HR30TW	0.2 HR30TW 0.21 HR30TW 0.23 HR30TW	
	≥ 50 HR45TW (25 to 50) HR45TW ≤ 25 HR45TW	0.24 HR45TW 0.23 HR45TW 0.2 HR45TW	

### Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force <sup>1</sup> (Tension and Compression)	(0.1 to 5.5) N 5.6 N to 2.5 kN	5.5 mN/N 2.7 mN/N	Dead weights PMP-C-011 NMX-CH-27-1994-SCFI & NMX-CH-023-1994-SCFI
Force <sup>1</sup> (Tension and Compression)	(2.5 to 45) kN (45 to 450) kN	0.7 mN/N	Load Cell PMP-C-011 NMX-CH-27-1994-SCFI & NMX-CH-023-1994-SCFI
Equipment to measure Relative Pressure <sup>1</sup>	Up to 500 Pa	1.8 Pa	2" column Dwyer PMP-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC
Equipment to measure Relative Pressure <sup>1,3</sup>	Up to 21 MPa	(0.027 + 0.73ρ) kPa	Calibrador de Presion 3000 psi PMP-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC
Equipment to measure Relative Pressure <sup>1</sup>	21 MPa to 137 MPa	37 kPa	Bascula de pesos muertos PMP-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC
Equipment to measure Absolute Pressure <sup>3</sup>	UP to 106 kPa	(0.16 + 0.000 58ρ) kPa	Absolute Pressure 0 to 31.5 Hg-in PMP-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC

### Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Light Intensity Meters <sup>3</sup>	(0.1 to 10 000) lux	(0.043+0.011χ) lux	Minolta T-1 PMP-C-035
UV Meters <sup>3</sup> Medidores de UV	Up to 19W/cm <sup>2</sup>	(3.4 x 10 <sup>-6</sup> +0.001 7v) W/cm <sup>2</sup>	Meter UV PMP-C-035

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity	(10 to 75) %RH (75 to 97) %RH	2.2 %RH 2.5 %RH	MPP132 Digital Meter Omega iTXH-SD PMP-C-028
Temperature <sup>1</sup>	(-80 to 0) °C (0 to 150) °C (150 to 230) °C (230 to 400) °C (400 to 950) °C	0.027 °C 0.034 °C 0.043 °C 0.052 °C 1.4 °C	MPC036 PRT Thermometer HP Multimeter Temperature Calibration Bath type JH01, 117PT000, 106F0H920 (-30 °C to 0 °C) HETOFRIG Temperature Calibration Bath type KB 03, CB 217 (300 °C to 400 °C) ASSOCIATED Enviromental System Oven PMP-C-007

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Timers and Stopwatches	0.01 ms to 604 800 s	$(2.5 \times 10^{-8} + 2.5 \times 10^{-9} t)$	Frequency Counter PMP-C-008
Frequency Counting Equipment	0.1 Hz to 18 GHz	$1 \times 10^{-9}$ Hz/Hz	GPS Receiver, Spectrum Analyzer, Frequency Counter, Signal Generator, Frequency Synthesizer, PMP-C-008
Frequency Generating Equipment	Up to 18 GHz	$1 \times 10^{-9}$ Hz/Hz	GPS Receiver, Spectrum Analyzer, Frequency Counter, Power Meter, Power Sensors PMP-C-008

## DIMENSIONAL MEASUREMENT

### 3 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Inspection CMM 3D / Inspection Dimensional	X = Up to 700 mm Y = Up to 650 mm Z = Up to 550 mm	0.005 1 mm	Coordinate Measuring Machine and Vision System used as Reference Customer Drawings CMM and Vision Software

## TESTING

### Mechanical

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Force Testing/ Tension and Compression Up to 445 kN	Universal Testing Equipment	Cables and Materials	Universal Testing Machine and Load Cell System used as Reference



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### Services performed at satellite location

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## CALIBRATION

### Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound <sup>1</sup>	(20 to 130) dB 100 Hz to 10 kHz	1 dB	Sound Calibrator Sound Level Meter PMPH-C-036

### Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters <sup>5</sup>	10 µS 100 µS 1 000 µS 10 000 µS 100 000 µS	0.35 µS/cm <sup>2</sup> 2.2 µS/cm <sup>2</sup> 4.9 µS/cm <sup>2</sup> 20 µS/cm <sup>2</sup> 300 µS/cm <sup>2</sup>	Traceable Conductivity Solutions PMPH-C-043
pH Meters <sup>5</sup>	4.00 pH 6.86 pH 10.1 pH	0.013 pH 0.011 pH 0.013 pH	pH Buffer Solutions PMPH-C-040

### Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1,3</sup> Leveled Sine Wave (Relative to 50 kHz)	5 mV to 5.5 V 50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 600 MHz	1.5 mV 2.7 mV 3.9 mV	Fluke 5500A-SC600 Multiproduct Calibrator PMPH-C-010





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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1,3</sup> Square Wave Signal 10 Hz to 10 kHz  Rise Time 5 mV to 2.5 V	$\pm (1 \text{ mV to } 6.6 \text{ V}) \text{ p-p}$ (50 $\Omega$ load) $\pm (1 \text{ mV to } 130 \text{ V}) \text{ p-p}$ (1 M $\Omega$ load)  1 kHz to 10 MHz	(0.000 2 + 0.000 5E) mV  (0.000 08 + 0.001 2E) mV  0.1 ns	Fluke 5500A-SC600 Multiproduct Calibrator PMPH-C-010
DC High Voltage <sup>1,3</sup> - Source and Measure	(1 to 5) kV	(-0.005 6 + 0.028E) kV	Tektronix P6015A Charged Plate Analyzer Monroe Electronics 268A-1T PMPH-C-001
AC High Voltage <sup>3</sup> - Source and Measure	700 V to 1.02 kV 40 Hz to 10 kHz (1.02 to 35) kV 60 Hz	(-56 + 0.082E) V  (-5.5 + 0.032E) V	(standard) Multimeter Fluke 8840A High Voltage Probe P6015A (generator) High Voltage Test Hipotronics PMPH-C-003
DC Voltage – Source equipment	(1 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1.02 kV	12 $\mu\text{V/V}$ 8 $\mu\text{V/V}$ 8 $\mu\text{V/V}$ 10 $\mu\text{V/V}$ 10 $\mu\text{V/V}$	Multimeter HP 3458A PMPH-C-001
DC Voltage – Measure equipment <sup>1</sup>	(1 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1.02 kV	12 $\mu\text{V/V}$ 8 $\mu\text{V/V}$ 8 $\mu\text{V/V}$ 10 $\mu\text{V/V}$ 10 $\mu\text{V/V}$	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMPH-C-001
AC Voltage – Source equipment	(1 to 100) mV 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz	0.073 mV/V 0.072 mV/V 0.073 mV/V	Multimeter HP 3458A PMPH-C-003
AC Voltage – Source equipment <sup>3</sup>	100 mV to 1V 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.78 mV/V 0.78 mV/V 0.78 mV/V 1.1 mV/V	Multimeter HP 3458A PMPH-C-003



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source equipment <sup>3</sup>	(1 to 10) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (10 to 100) V 40 Hz to 1 kHz (1 to 20) kHz (100 to 1 020) V 40 Hz to 1 kHz	9.5 mV/V 12 mV/V 9.5 mV/V 9.5 mV/V 95 mV/V 120 mV/V (1 300 + 0.21E) mV/V	Multimeter HP 3458A PMPH-C-003
AC Voltage – Source equipment <sup>3</sup>	(1 to 5) kV 60 Hz	(-43 + 0.044E) mV/V	Multimeter Fluke 8840A High Voltage Probe P6015A PMPH-C-003
AC Voltage – Measure equipment <sup>1,3</sup>	(1 to 100) mV 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz 100 mV to 1V 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (1 to 10) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.073 mV/V 0.072 mV/V 0.073 mV/V 0.78 mV/V 0.78 mV/V 0.78 mV/V 1.1 mV/V 9.5 mV/V 12 mV/V 9.5 mV/V 9.5 mV/V	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMPH-C-003
AC Voltage – Measure equipment <sup>1,3</sup>	(10 to 100) V 40 Hz to 1 kHz (1 to 20) kHz (100 to 1 020) V 40 Hz to 1 kHz	95 mV/V 120 mV/V (1 300 + 0.21E) mV/V	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMPH-C-003
AC Voltage – Measure equipment <sup>1,3</sup>	(1 to 5) kV 60 Hz	(-43 + 0.049E) mV/V	(standards) Multimeter Fluke 8840A High Voltage Probe P6015A (generator) High Voltage Test Hipotronics PMPH-C-003



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure equipment <sup>1,3</sup>	(1 to 100) mV		(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMPH-C-003
	40 Hz to 1 kHz	0.073 mV/V	
	(1 to 20) kHz	0.072 mV/V	
	(20 to 50) kHz	0.073 mV/V	
	100 mV to 1V		
	40 Hz to 1 kHz	0.78 mV/V	
	(1 to 20) kHz	0.78 mV/V	
	(20 to 50) kHz	0.78 mV/V	
	(50 to 100) kHz	1.1 mV/V	
	(1 to 10) V		
40 Hz to 1 kHz	9.5 mV/V		
(1 to 20) kHz	12 mV/V		
(20 to 50) kHz	9.5 mV/V		
(50 to 100) kHz	9.5 mV/V		
(10 to 100) V			
40 Hz to 1 kHz	95 mV/V		
(1 to 20) kHz	120 mV/V		
(100 to 1 020) V			
40 Hz to 1 kHz	(1 300 + 0.21E) mV/V		
AC Voltage – Measure equipment <sup>1,3</sup>	(1 to 5) kV 60 Hz	(-43 + 0.044E) mV/V	(standards) Multimeter Fluke 8840A High Voltage Probe P6015A (generator) High Voltage Test Hipotronics PMPH-C-003
DC Current – Source equipment	(10 to 100) nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	0.076 nA 64 μA/A 35 μA/A 36 μA/A 0.028 μA 0.1 μA 0.12 μA 0.000 12 A	Multimeter HP 3458A PMPH-C-002
DC Current <sup>1</sup> – Source equipment	(1 to 50) A	(-0.002 1 + 0.002 2I) A	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMPH-C-002

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current <sup>1</sup> – Measure equipment	(10 to 100) nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	0.076 nA 64 μA/A 35 μA/A 36 μA/A 0.028μA 0.1 μA 0.12 μA 0.000 12 A	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMPH-C-002
DC Current <sup>1</sup> – Measure equipment	(1 to 11) A (11 to 50) A	(-0.011 + 0.011 <i>I</i> ) A (0.14 - 0.000 54 <i>I</i> ) A	(generator) Calibrator Fluke 5500A with Shunt Resistor Leeds & Northrup 4361 PMPH-C-002
DC Current <sup>1</sup> – Measure equipment Clamp-On Ammeters	(50 to 550) A	(0.09 + 0.002 2 <i>I</i> ) A	(generator) Calibrator Fluke 5500A with Fluke 5500A coil PMPH-C-002
AC Current – Source equipment	(1 to 10) mA (40 to 100) Hz 100 Hz to 1 kHz (10 to 100) mA (40 to 100) Hz 100 Hz to 1 kHz 100mA to 1 A (40 to 100) Hz 100 Hz to 1 kHz	(0.002 + 0.000 6 <i>I</i> ) mA (0.002 + 0.000 3 <i>I</i> ) mA (0.02 + 0.000 6 <i>I</i> ) mA (0.02 + 0.000 3 <i>I</i> ) mA (0.2 + 0.000 8 <i>I</i> ) mA (0.2 + 0.001 <i>I</i> ) mA	Multimeter HP 3458A PMPH-C-004
AC Current – Source equipment	(1 to 50) A 60 Hz	0.000 7 A	Multimeter HP 3458A with Shunt Resistor Leeds & Northrup 4361 PMPH-C-004
AC Current <sup>1</sup> – Measure equipment	(1 to 10) mA (40 to 100) Hz 100 Hz to 1 kHz (10 to 100) mA (40 to 100) Hz 100 Hz to 1 kHz 100mA to 1 A (40 to 100) Hz 100 Hz to 1 kHz	(0.002 + 0.000 6 <i>I</i> ) mA (0.002 + 0.000 3 <i>I</i> ) mA (0.02 + 0.000 6 <i>I</i> ) mA (0.02 + 0.000 3 <i>I</i> ) mA (0.2 + 0.000 8 <i>I</i> ) mA (0.2 + 0.001 <i>I</i> ) mA	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMPH-C-004

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current <sup>1</sup> – Measure equipment	(1 to 11) A 60 Hz (11 to 50) A 60 Hz	(-0.000 9 + 0.001 5 <i>J</i> ) A  (0.14 - 0.000 5 <i>J</i> ) A	(generator) Calibrator Fluke 5500A with Shunt Resistor Leed & Northrup 4361 PMPH-C-004
AC Current <sup>1</sup> – Measure equipment Clamp-On Ammeters	(50 to 550) A 60 Hz	(0.07 + 0.002 <i>J</i> ) A	(generator) Calibrator Fluke 5500A with Fluke 5500A coil PMPH-C-004
DC Power Source equipment <sup>3</sup>	10.89 mW to 11 220 W	(-0.002 + 0.000 4 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMPH-C-005
AC Power – Source equipment <sup>3</sup>	10.89 mW to 11 220 W @ 60 Hz, P.F. = 1	(0.01 + 0.001 2 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMPH-C-005
AC Power – Source equipment <sup>3</sup>	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.9	(0.012 + 0.002 1 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMPH-C-005
AC Power - Source equipment <sup>3</sup>	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.8	(0.009 2 + 0.003 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMPH-C-005
DC Power Measure equipment <sup>1,3</sup>	10.89 mW to 11 220 W	(-0.002 + 0.004 <i>J</i> ) mW	Calibrator Fluke 5500A PMPH-C-005
AC Power <sup>1,3</sup> – Measure equipment	10.89 mW to 11 220 W @ 60 Hz, P.F. = 1	(0.01 + 0.001 2 <i>J</i> ) mW	Calibrator Fluke 5500A PMPH-C-005
AC Power <sup>1,3</sup> – Measure equipment	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.9	(0.012 + 0.002 1 <i>J</i> ) mW	Calibrator Fluke 5500A PMPH-C-005
AC Power <sup>1,3</sup> – Measure equipment	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.8	(0.009 2 + 0.003 <i>J</i> ) mW	Calibrator Fluke 5500A PMPH-C-005



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance <sup>1</sup> – Measure equipment	(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 (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	20 μΩ/Ω 19 μΩ/Ω 11 μΩ/Ω 11 μΩ/Ω 11 μΩ/Ω 18 μΩ/Ω 61 μΩ/Ω 520 μΩ/Ω 290 μΩ/Ω	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMPH-C-006
Resistance – Source equipment	(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 (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	20 μΩ/Ω 19 μΩ/Ω 11 μΩ/Ω 11 μΩ/Ω 11 μΩ/Ω 18 μΩ/Ω 61 μΩ/Ω 520 μΩ/Ω 290 μΩ/Ω	HP 3458A PMPH-C-006
Generation and Measuring Resistance Equipment <sup>1</sup> High value resistors and decade	0.5 mΩ to 1 Ω up to 50 A Max	450 μΩ/Ω	Indirect method Calibrator Fluke 5500A Multimeter HP 3458A Shunt resistor 0.01Ω Shunt resistor 0.1Ω PMPH-C-006
Generation and Measuring Resistance Equipment <sup>1</sup> High value resistors and decade	100 kΩ to 1 TΩ up to 5 000 V Max	23 mΩ/Ω	Indirect method Calibrator Fluke 5500A Multimeter HP 3458A High Voltage Probe Tektronix P6015A PMPH-C-006
DC Shunt Resistance Equipment <sup>1,3</sup>	1 mΩ to 1 Ω @ (1 to 11) A 1mΩ to 1Ω @ (11 to 50) A	(0.011 + 0.000 05R) mΩ	Multimeter HP 3458A Shunt resistor 0.01Ω Shunt resistor 0.1Ω PMPH-C-006
AC electrical Resistance at 60 Hz Shunt Resistance <sup>1,3</sup>	1 mΩ to 1 Ω @ (1 to 11) A 1 mΩ to 1 Ω @ (11 to 50) A	(0.011 + 0.000 05R) mΩ	Multimeter HP 3458A Shunt resistor 0.01Ω Shunt resistor 0.1Ω PMPH-C-006
Capacitance <sup>1,3</sup> Source equipment	100 pF to 10 μF 50 Hz to 1 kHz 75 kHz to 30 MHz	0.042 mF/mF	LCR HP 4285A PMPH-C-009



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance <sup>1,3</sup> – Measure equipment	100pF to 1 μF 50 Hz to 1 kHz 75kHz to 30MHz	(0.07 + 0.000 001C) pF	LCR Bridge GenRad 1689-PI LCR HP 4285A PMPH-C-009
D Factor <sup>1</sup> – Measure equipment	(0.000 1 to 9 999) DF 50 Hz to 100 kHz	0.000 1 DF	LCR Bridge GenRad 1689M
	(0.000 001 to 9.999 99) DF 75 kHz to 30 MHz	0.000 5 DF	LCR HP 4285A PMPH-C-009
Inductance <sup>1</sup> – Source equipment	0.01 pH to 99 999 H @ 50 Hz to 100 kHz	0.02 % of reading	LCR Bridge GenRad 1689M
	0.001 nH to 99 999 H 75 kHz to 30 MHz	0.05 % of reading	LCR HP 4285A PMPH-C-029
Inductance <sup>1,3</sup> – Measure equipment	100 mH to 2 H	0.23 mH/H	LCR HP 4285A GenRad 1482-L GenRad 1482-Q PMPH-C-029
Q Factor – Measure equipment <sup>1</sup>	(0.000 1 to 9 999) Q 50 Hz to 100 kHz	0.000 1 Q	LCR Bridge GenRad 1689M
	(0.01 to 99 999.9) Q 75 kHz to 30 MHz	0.000 5 Q	LCR HP 4285A PMPH-C-029
Thermocouple Simulation <sup>1</sup>	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	0.44 °C 0.34 °C 0.3 °C 0.33 °C 0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C 0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	Calibrator Fluke 5500A PMPH-C-020





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermocouple Simulation <sup>1</sup>	Type J		Calibrator Fluke 5500A PMPH-C-020
	(-250 to -100) °C	0.27 °C	
	(-100 to -30) °C	0.16 °C	
	(-30 to 150) °C	0.14 °C	
	(150 to 760) °C	0.17 °C	
	(760 to 1 200) °C	0.23 °C	
	Type K		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.16 °C	
	(120 to 1 000) °C	0.26 °C	
	(1 000 to 1 372) °C	0.4 °C	
	Type L		
	(-200 to -100) °C	0.37 °C	
	(-100 to 800) °C	0.26 °C	
	(800 to 900) °C	0.17 °C	
	Type N		
	(-200 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.22 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.27 °C	
	Type R		
	(0 to 250) °C	0.57 °C	
	(250 to 400) °C	0.35 °C	
	(400 to 1000) °C	0.33 °C	
	(1000 to 1767) °C	0.4 °C	
	Type S		
(0 to 250) °C	0.47 °C		
(250 to 1 000) °C	0.36 °C		
(1 000 to 1 400) °C	0.37 °C		
(1 400 to 1 767) °C	0.46 °C		
Type T			
(-250 to -150) °C	0.63 °C		
(-150 to 0) °C	0.24 °C		
(0 to 120) °C	0.16 °C		
(120 to 400) °C	0.14 °C		
Type U			
(-200 to 0) °C	0.56 °C		
(0 to 600) °C	0.27 °C		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RTD Simulation <sup>1</sup>	Cu 427 10 Ω (-100 to 260) °C	0.3 °C	Calibrator Fluke 5500A PMPH-C-020
	Pt 385, 100 Ω (-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
(0 to 100) °C	0.04 °C		
(100 to 260) °C	0.05 °C		
(260 to 300) °C	0.12 °C		
(300 to 400) °C	0.13 °C		
(400 to 600) °C	0.14 °C		
(600 to 630) °C	0.16 °C		



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RTD Simulation <sup>1</sup>	Pt 385, 500 Ω		Calibrator Fluke 5500A PMPH-C-020
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	
	Pt 385, 1000 Ω		
	(-200 to -80) °C	0.03 °C	
	(-80 to 0) °C	0.03 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.06 °C	
(300 to 400) °C	0.07 °C		
(400 to 600) °C	0.07 °C		
(600 to 630) °C	0.23 °C		
PtNi 385, 120 Ω (Ni120)			
(-80 to 0) °C	0.08 °C		
(0 to 100) °C	0.08 °C		
(100 to 260) °C	0.14 °C		

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power - Measure <sup>1</sup> 50 Ω load	(-136 to +30) dBm (10 kHz to 13.2 GHz)	0.2 dB	HP 8484A, HP 8481A Agilent E9301A Power Sensors, Agilent E4418- EPM, HP E4445A Power Meters PMPH-C-008
	(-60 to +20) dBm (10 MHz to 6 GHz)	0.2 dB	
	(-35 to + 20) dBm (10 MHz to 18 GHz)	0.2 dB	
	(-70 to -20) dBm (10 MHz to 18 GHz)	0.2 dB	



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power - Source <sup>1</sup> 50 Ohm load	(-127 to +13) dBm (100 KHz to 999 MHz) (-120 to +8) dBm (2 to 18) GHz (-136 to +17) dBm (250 kHz to 4 GHz)	0.2 dB 0.2 dB 0.2 dB	HP 8484A, HP 8481A Agilent E9301A Power Sensors, Agilent E4418- EPM, HP 8673E, HP E4433B, HP E4445A Power Meters PMPH-C-008
Phase Modulation <sup>1</sup> – Measure Carrier Frequency: 100 kHz to 13.2 MHz	200 Hz to 20 kHz	1 % of reading	Agilent PSA E4445A Network Analyzer HP 8673E, HP E4433B Power Meters PMPH-C-008
Amplitude Modulation <sup>1</sup> - Source and Measure Rate: 20 Hz to 10 kHz 50 Hz to 100 kHz  Flatness – Measure	Depths: 5% to 99% 100 kHz to 10 MHz 10 MHz to 13.2 GHz  10 MHz to 13.2 GHz Rate: 90 Hz to 10 kHz Depth (5 to 99) %	0.75 % of reading 1.5 % of reading  0.4 % of reading	Agilent PSA E4445A Network Analyzer HP 8673E, HP E4433B Power Meters PMPH-C-008
Frequency Modulation <sup>1</sup> - Source and Measure Modulation Rate: 20 Hz to 10 kHz 50 Hz to 200 kHz Modulation Distortion	250 kHz to 10 MHz 10 MHz to 13.2 GHz  200 Hz to 300 kHz (-80 to -0.1) dB	1.5 % of reading  1 % of reading	Agilent PSA E4445A Network Analyzer HP 8673E, HP E4433B Power Meters PMPH-C-008

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Outside Micrometers <sup>1,3</sup>	Up to 1 016 mm Up to 40 in	(1 + 0.22L) μm (39 + 8.6L) μin	Gage Blocks Grade 2 Gage blocks Grade 3 PMPH-C-014 Reference Standard NMX- CH-099-IMNC-2005
Depth Micrometers <sup>1,3</sup>	Up to 1 016 mm Up to 40 in	(1 + 0.22L) μm (39 + 8.6L) μin	Gage Blocks Grade 2 Gage Blocks Grade 3 PMPH-C-014

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dial and Digital Indicators <sup>1,3</sup>	Up to 101.6 mm Up to 4 in	$(0.88 + 0.083L) \mu\text{m}$ $(35 + 3.3L) \mu\text{in}$	Calibration Tester Dial Gage Tester PMPH-C-014 NMX-CH-36-1994
Calipers <sup>1,3</sup>	Up to 1 016 mm Up to 40 in	$(9.6 + 0.089L) \mu\text{m}$ $(380 + 3.5L) \mu\text{in}$	Gage Blocks Grade 2 Gage Blocks Grade 3 PMPH-C-014 NMX-CH-2:1993-SCFI
Height Measuring Equipment <sup>3</sup>	Up to 1 016 mm Up to 40 in	$(0.95 + 0.22L) \mu\text{m}$ $(38 + 8.6L) \mu\text{in}$	Gage Blocks Grade 2 Gage Blocks Grade 3 PMPH-C-014
Optical Comparators <sup>1,3</sup>	Up to 508 mm Up to 20 in	$(0.96 + 0.048L) \mu\text{m}$ $(38 + 1.9L) \mu\text{in}$	Glass Scales Gage Blocks Grade 2 Gage Block Grade 3 PMPH-C-014
Graduated Rules and Flexometers <sup>3</sup>	Up to 25 m Up to 985 in	$0.076 \mu\text{m}$ $3 \mu\text{in}$	MPC273 API Laser Interferometer PMPH-C-014 NOM-040-SCFI-1994 & NOM-046-SCFI-1999
Graduated Rules and Flexometers <sup>3</sup>	Up to 101.6 mm Up to 4 in	$(20 + 0.008L) \mu\text{m}$ $(790 + 0.33L) \mu\text{in}$	Digital Indicator Stainless Ruler 5X Amplification Lens PMPH-C-014 NOM-040-SCFI-1994 & NOM-046-SCFI-1999
Coordinate Measuring Machines Linear Error <sup>2,3</sup>	Up to 609.6 mm Up to 24 in	$(0.23 + 0.05L) \mu\text{m}$ $(9.1 + 2L) \mu\text{in}$	Gage Blocks Grade 2 Gage Blocks Grade 3 PMPH-C-014
Coordinate Measuring Machines Linear Error <sup>2,3</sup>	(100 to 25 000) mm (3.93 to 98) in	$(0.005 + 0.013L) \mu\text{m}$ $(0.2 + 0.5L) \mu\text{in}$	API Laser Interferometer XD5LS
Coordinate Measuring Machines Volumetric error <sup>2</sup>	(200 to 800) mm (8 to 32) in	$4.3 \mu\text{m}$ $170 \mu\text{in}$	Ball Bars PMPH-C-014
Coating Thickness <sup>1,3</sup>	Up to 6.35 mm Up to 0.25 in	$(0.72 + 0.043L) \mu\text{m}$ $(28 + 1.7L) \mu\text{in}$	Digital Indicator Gage Blocks Grade 2 PMPH-C-014

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rugosity <sup>1</sup>	Ra = 2.94 μm (116 μin) Ry = 366 μm (9.3 μin)	0.061 μm  0.2 μm	Rugosity Standard (Ra, Ry) Mitutoyo PMPH-C-038
Levels <sup>1</sup>	(-4 125 to +4 125) arc sec	0.42 arc sec	MPC286 Level Table Traceable to NIST PMPH-C-014
Digital Levels <sup>1</sup>	(15, 30, 45, 90) °	0.42 arc sec	Angle Blocks Mitutoyo PMPH-C-014
Surface Plates <sup>1</sup> Local Area Flatness (Repeat Reading)	Up to (192 x 192) in	21 μin	Repeatability Gauge Repeat-o-meter PMPH-C-014
Surface Plates <sup>1</sup> Overall Flatness	Up to (192 x 192) in	11 μin	MPC273 API Laser Interferometer PMPH-C-014
Gages Blocks <sup>3</sup> Grade 1, 2 and 3 (FS)	(0.254 to 152.9) mm (0.01 to 6) in	(0.1 + 0.047L) μm (3.9 + 1.9L) μin	Gage Blocks Grade 1 FS Gage Blocks Comparator

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dead Weights <sup>3</sup>	(0.01 to 200) g	(0.000 3 + 0.000 001W) mg	Class 1 Stainless Weights PMPH-C-021 NIST Handbook 44 OIML R111 ABBA Method
Dead Weights <sup>3</sup>	(0.2 to 4) kg (4 to 20) kg (20 to 60) kg	(0.000 4 + 0.000 003W) g (-0.16 + 0.000 04W) g (0.29 + 0.000 01W) g	Digital Scale as Comparison Element Class M2 Weights and Scales PMPH-C-021 NIST Handbook 44 OIML R111 ABBA Method



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances <sup>3,4</sup>	Up to 20 kg	$(-0.0006 + 0.0003W)$ g	Class 1 Stainless Weights PMPH-C-012 NOM-010-SCFI-1994, NMX-CH-31-1982, NMX- CH-047-1996-IMNC & NMX-CH-059-1996-IMNC
Scales and Balances <sup>1,3,4</sup>	(20 to 2 000) kg	$(-0.0029 + 0.00018W)$ g	On site Class F Cast Iron Weights PMPH-C-012 NOM-010-SCFI-1994, NMX-CH-31-1982, NMX- CH-047-1996-IMNC & NMX-CH-059-1996-IMNC
Volume <sup>3</sup>	(0.0001 to 1) ml (1 to 200) ml (200 to 3 000) ml (3 000 to 30 000) ml (30 000 to 60 000) ml	(0.006 + 0.04V) ml (0.04 + 0.0005V) ml (0.015 + 0.0002V) ml (-0.01 + 0.0002V) ml (0.3 + 0.0002V) ml	Dead Weights Digital Scale PMPH-C-033 NOM-042-SCFI-1997 & NMX-CH-049-IMNC-2006
Water Flow <sup>2,3</sup>	Up to 3 000 l/min	$(0.9 + 0.005F)$ l/min	Water Flow Meter PMPH-C-034
Torque Transducers, Tools, and Measuring Equipment <sup>1,3</sup>	(0.005 to 1) Nm (1 to 20) Nm (20 to 500) Nm	(0.000001 + 0.004T) Nm (-0.004 + 0.007T) Nm (-0.02 + 0.008T) Nm	Dead Weights with Torque Arm PMPH-C-015 CNM-MMF-PT-002 & EA-10/14
Torque Transducers, Tools, and Measuring Equipment <sup>1,3</sup>	(67.8 to 678) Nm	$(-0.11 + 0.0048T)$ Nm	Torque Transducer Torque Meter TM-200 PMPH-C-015 CNM-MMF-PT-002 & EA-10/14
Torque Transducers, Tools, and Measuring Equipment <sup>3</sup>	(678 to 1 355) Nm	$(2.9 + 0.0007T)$ Nm	Torque Transducer Torque Meter ETA Mk. V PMPH-C-015 CNM-MMF-PT-002 & EA-10/14
Air Flow <sup>1,3</sup>	Up to 20 sl/min Up to 300 sl/min	(0.0004 + 0.0025A) sl/min (0.24 + 0.0033A) sl/min	Air Flow Transducers PMPH-C-030
Air Velocity <sup>3</sup> (Air Speed)	Up to 25 m/s	$(0.18 + 0.0087Y)$ m/s	Wind Tunnel with Anemometer Master PMPH-C-030





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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Specific Gravity <sup>3</sup>	(0.62 to 3) SG	(0.023 - 0.004 2G) SG	Dead Weights Digital Scale Digital Thermometer PMPH-C-032 NBS Circular 555
Vacuum meters <sup>1,3</sup> Generate / Measure	1 bar to 4 x 10 <sup>-3</sup> mbar (1x10 <sup>-3</sup> to 1x10 <sup>-9</sup> ) mbar	(0.000 05 + 0.013U) mbar 0.016U mbar	Pressure Sensor Instrutech CVG101GA Edwards high Vacuum AIM-S-MW25 PMPH-C-013
Rockwell Hardness Testers <sup>1</sup>	21.31 HRC 25.29 HRC 28.33 HRC 46.12 HRC 52.97 HRC 64.06 HRC 64.20 HRC  42.13 HRBW 42.66 HRBW 48.59 HRBW 71.42 HRBW 73.27 HRBW 73.43 HRBW 90.73 HRBW 91.51 HRBW 98.22 HRBW 98.40 HRBW	0.65 HRC 0.65 HRC 0.62 HRC 0.55 HRC 0.55 HRC 0.54 HRC 0.54 HRC  0.46 HRBW 0.37 HRBW 0.40 HRBW 0.29 HRBW 0.27 HRBW 0.31 HRBW 0.48 HRBW 0.41 HRBW 0.42 HRBW 0.42 HRBW	Indirect Verification using Test Blocks PMPH-C-027
Superficial Rockwell Hardness Testers <sup>1</sup>	76.88 HR15TW 84.07 HR15TW 91.21 HR15TW	0.26 HR15TW 0.25 HR15TW 0.44 HR15TW	Indirect Verification using Test Blocks PMPH-C-027
Shore Hardness Testers Spring Force Only Types A, B Types C, D	(0 to 100) Duro	0.58 Duro	Dead Weights Digital Scale PMPH-C-027
Force Transducers, Tools, and Measuring Equipment <sup>3</sup>	(0.1 to 5.5) N	(-0.000 004 + 0.003N) N	Dead weights PMPH-C-011 NMX-CH-27-1994-SCFI & NMX-CH-023-1994-SCFI



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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Transducers, Tools, and Measuring Equipment <sup>1,3</sup>	5.6 N to 6.67 kN (6.67 to 66.7) kN (45 to 222) kN	(0.008 + 0.002N) N (-0.005 + 0.002N) kN (0.000 08 + 0.001N) kN	Load Cell Fluke 5500A HP 3458A PMPH-C-011 NMX-CH-27-1994-SCFI & NMX-CH-023-1994-SCFI
Force Transducers, Tools, and Measuring Equipment <sup>1,3</sup> (compression)	(222 to 1 760) kN	(-0.003 7 + 0.01N) kN	Load Cell 250 Ton PMPH-C-011 NMX-CH-27-1994-SCFI & NMX-CH-023-1994-SCFI
Relative Pressure <sup>3</sup>	Up to 500 Pa Up to 2 inH2O	(-0.000 034 + 0.003 7P) inH2O	Water Column PMPH-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC
Relative Pressure <sup>3</sup>	Up to 0.2 Mpa Up to 30 psi  (Up to 20.7) Mpa (Up to 3 000) psi	(-0.000 004 + 0.001P) psi  (-0.000 001 + 0.000 7P) psi	Pressure Calibrator PMPH-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC
Relative Pressure	(20.7 to 138) Mpa (3 000 to 20 000) psi	5.3 psi	Pressure Sensor PMPH-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC

**Photometry and Radiometry**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power Wavelength (nm)	(-38 to 20) dB (850 to 1 550) nm	1 dB 4 % of reading	Power Meter PMPH-C-039
Light Intensity Meters <sup>3</sup>	(0.1 to 10 000) lux (10 k to 100 k) lux	(0.006 + 0.004x) lux (0.043x) lux	Minolta T-1 PMPH-C-035
UV Meters <sup>3</sup>	Up to 19.99 mW/cm <sup>2</sup> 20 mW to 19W/cm <sup>2</sup>	0.008 2 mW/cm <sup>2</sup> (-0.000 003 + 0.002z) W/cm <sup>2</sup>	Meter UV Dymax RCH-108-4 PMPH-C-035

### Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity <sup>1,3</sup>	(10 to 75) %RH (75 to 97) %RH	2.2 %RH 2.5 %RH	Reference Materials Humidity Meter Thermometer PMPH-C-028
Temperature <sup>3</sup>	(-30 to 400) °C (400 to 600) °C	(0.039 + 0.000 005 <i>t</i> ) °C 1.4 °C	RTD / SPRT / HP 34401 Thermocouple/ Fluke 51 II PMPH-C-007

### Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency <sup>1</sup> – Source and Measure	0.1 Hz to 18 GHz	1 x 10 <sup>-9</sup> Hz/Hz	GPS Receiver HP Z3801A PMPH-C-008

## DIMENSIONAL MEASUREMENT

### 3 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Inspection CMM 3D / Inspection Dimensional	X = Up to 24 in (609.6 mm) Y = Up to 2 in (508 mm) Z = Up to 12 in (304.8 mm)	(0.000 01 + 0.000 002 <i>L</i> ) in (0.000 01 + 0.000 001 <i>L</i> ) in (0.000 01 + 0.000 002 <i>L</i> ) in	Coordinate Measuring Machine and Vision System used as Reference Customer Drawings CMM and Vision Software



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### Services performed at satellite location

Ave. Mar del Norte #37-O Local #15

Colonia Versalles Residencial

Guaymas, Sonora, México

Eduardo Ricaud Gamboa Luis Armando Cota Campa

Gerente General Gerente de Calibración, Guaymas

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### CALIBRATION

#### Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound <sup>1</sup>	(20 to 130) dB 100 Hz to 10 kHz	1.1 dB	Sound Calibrator Sound Level Meter PMP-C-036

#### Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters <sup>5</sup>	1.77 µS/cm 9.8 µS/cm 84.6 µS/cm 501 µS/cm 1002 µS/cm 1413 µS/cm 10 070 µS/cm 99 880 µS/cm	0.13 µS/cm <sup>2</sup> 0.10 µS/cm <sup>2</sup> 0.82 µS/cm <sup>2</sup> 2.4 µS/cm <sup>2</sup> 3.3 µS/cm <sup>2</sup> 5.2 µS/cm <sup>2</sup> 31.2 µS/cm <sup>2</sup> 310 µS/cm <sup>2</sup>	Traceable Conductivity Solutions PMP-C-043
pH Meters <sup>5</sup>	4.00 pH 7.01 pH 10.00 pH	0.017 pH 0.013 pH 0.025 pH	pH Buffer Solutions PMP-C-040

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1,3</sup> Leveled Sine Wave (Relative to 50 kHz)  Square Wave Signal 10 Hz to 10 kHz  Rise Time 5 mV to 2.5 V	5 mV to 5.5 V 50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 600 MHz  $\pm (1 \text{ mV to } 6.6 \text{ V}) \text{ p-p}$ (50 $\Omega$ load)  $\pm (1 \text{ mV to } 130 \text{ V}) \text{ p-p}$ (1 M $\Omega$ load)  1 kHz to 10 MHz	1.5 mV 2.7 mV 3.9 mV  (0.00008 + 0.0010E) mV  (0.0078 + 0.0014E) mV  0.1 ns	Fluke 5500A-SC600 PMP-C-010
DC High Voltage <sup>1,3</sup> - Source and Measure	(1000 to 5000) V	(-0.49 + 0.024E) V	Tektronix P6015A Charged Plate Analyzer Monroe Electronics 268A-1T PMP-C-001
AC High Voltage <sup>3</sup> - Source and Measure	700 V to 1000 V 60 Hz (1 to 35) kV 60 Hz	(-43.05 + 0.07E) V  (-17.51 + 0.032E) V	(standard) Multimeter Fluke 8840A High Voltage Probe P6015A (generator) High Voltage Test Hipotronics PMP-C-003
DC Voltage – Source equipment	(1 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V 100 V to 1000 V	(0.035+0.00011E) $\mu$ V (0.043-0.03E) $\mu$ V (0.033+0.027E) $\mu$ V (0.38+0.013E) $\mu$ V (9.71+0.0078) $\mu$ V	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMP-C-001
DC Voltage – Measure equipment <sup>1</sup>	(1 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V 100 V to 1000 V	(0.035+0.00011E) $\mu$ V (0.043-0.03E) $\mu$ V (0.033+0.027E) $\mu$ V (0.38+0.013E) $\mu$ V (9.71+0.0078) $\mu$ V	(standard) Multimeter HP 3458A (generator) Calibrator Fluke 5500A PMP-C-001
AC Voltage – Source and Measure	(1 to 100) mV (50 Hz to 100kHz) 100 mV to 1V 50 Hz to 100kHz	(0.012+0.0002E) $\mu$ V  (0.052+0.094E) $\mu$ V	(Standard) Multimeter HP 3458A (Generator Calibrator Fluke 5500A) PMP-C-003

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source and Measure	(1 to 10) V 50 Hz to 100kHz (10 to 100) V 50 Hz to 50kHz (100 to 700) V 50 Hz to 1 kHz	$(0.12 + 0.094E) \mu V$ $(6.6 + 1E) \mu V$ $(-50 + 2.4E) \mu V$	(Standard) Multimeter HP 3458A (Generator Calibrator Fluke 5500A) PMP-C-003
AC Voltage – Source and Measure	(700 to 5 000) V 60 Hz	$(-8.96 + 0.02E) V$	(standards) Multimeter Fluke 8840A, High Voltage Probe P6015A, (generator) High Voltage Test Hipotronics PMP-C-003
DC Current – Source and Measure equipment	(10 to 100) nA 0.1 $\mu A$ to 1 $\mu A$ (1 to 10) $\mu A$ (10 to 100) $\mu A$ 100 $\mu A$ to 1 mA (1 to 10) mA  (10 to 100) mA 100 mA to 1 A	$(-0.28 + 0.012A) nA$ $(0.001 - 0.001 1A) \mu A$ $(0.000 027 + 0.000 029A) \mu A$ $(0.000 03 + 0.000 028A) \mu A$ $(0.000 000 27 + 0.000 025A) mA$ $(0.000 000 003 9 + 0.000 026A) mA$ $(-0.000 14 + 0.000 043A) mA$ $(-0.000 007 2 + 0.000 13A) A$	Multimeter HP 3458A PMP-C-002
DC Current <sup>1</sup> – Source and Measure equipment	(1 to 11) A (11 to 50) A	$(-0.000 64 + 0.000 59A) A$ $(0.004 1 + 0.000 11A) A$	(generator) Calibrator Fluke 5500A with Shunt Resistor Leeds & Northrup 4361 PMP-C-002
DC Current <sup>1</sup> – Measure equipment Clamp-On Ammeters	(50 to 550) A	$(-0.11 + 0.002 8A) A$	(generator) Calibrator Fluke 5500A with Fluke 5500A coil PMP-C-002
AC Current – Source and Measure equipment	(1 to 10) mA 40 Hz to 1 kHz (10 to 100) mA 40 Hz to 1 kHz 100 mA to 1 A 40 Hz to 1 kHz	$(0.000 000 15+0.0008A) mA$ $(-0.007 2 + 0.00089I) mA$ $(-0.000 018 + 0.001I) A$	(Standard) Multimeter HP 3458A (Generator Calibrator Fluke 5500A) PMP-C-004
AC Current – Source equipment	(1 to 50) A 60 Hz	$(0.006 - 0.000 076I) A$	Multimeter HP 3458A with Shunt Resistor Leeds & Northrup 4361 PMP-C-004



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current <sup>1</sup> – Measure equipment	(1 to 11) A 60 Hz (11 to 100) A 60 Hz	(0.000 4 + 0.001 <i>I</i> ) A  (0.008 - 0.000 016 <i>I</i> ) A	(generator) Calibrator Fluke 5500A with Shunt Resistor Leed & Northrup 4361 PMP-C-004
AC Current <sup>1</sup> – Measure equipment Clamp-On Ammeters	(50 to 550) A 60 Hz	(0.052+0.002 7 <i>I</i> ) A	(generator) Calibrator Fluke 5500A with Fluke 5500A coil PMP-C-004
DC Power Source equipment <sup>3</sup>	10.89 mW to 11 220 W	(-0.002 + 0.00 04 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMP-C-005
AC Power – Source equipment <sup>3</sup>	10.89 mW to 11 220 W @ 60 Hz, P.F. = 1	(0.01 + 0.001 2 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMP-C-005
AC Power – Source equipment <sup>3</sup>	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.9	(0.012 + 0.002 1 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMP-C-005
AC Power - Source equipment <sup>3</sup>	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.8	(0.009 2 + 0.003 <i>J</i> ) mW	Multimeter HP 3458A with Shunt Resistor Leed & Northrup 4361 PMP-C-005
DC Power Measure equipment <sup>1,3</sup>	10.89 mW to 11 220 W	(-0.002 + 0.000 4 <i>J</i> ) mW	Calibrator Fluke 5500A PMP-C-005
AC Power <sup>1,3</sup> – Measure equipment	10.89 mW to 11 220 W @ 60 Hz, P.F. = 1	(0.01 + 0.001 2 <i>J</i> ) mW	Calibrator Fluke 5500A PMP-C-005
AC Power <sup>1,3</sup> – Measure equipment	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.9	(0.012 + 0.002 1 <i>J</i> ) mW	Calibrator Fluke 5500A PMP-C-005
AC Power <sup>1,3</sup> – Measure equipment	10.89 mW to 11 220 W @ 60 Hz, P.F. = 0.8	(0.009 2 + 0.003 <i>J</i> ) mW	Calibrator Fluke 5500A PMP-C-005





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance <sup>1</sup> – Measure equipment	(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 (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	(0.000 003+ 0.000 022R) Ω (0.000 031+ 0.000 019R) Ω (0.000 000 58+ 0.000 012R) kΩ (0.000 000 0092+ 0.000 013R) kΩ (0.000 000 05+ 0.000 013R) kΩ (-0.000 000 54+ 0.000 02R) MΩ (-0.000 039+ 0.000 067R) MΩ (-0.000 006 2+ 0.000 063R) MΩ (-0.000 008 9+ 0.0002 9R) GΩ	(standard) Multimeter HP 3458A  (generator) Calibrator Fluke 5500A PMP-C-006
Resistance – Source equipment	(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 (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	(0.000 003+ 0.000 022R) Ω (0.000 031+ 0.000 019R) Ω (0.000 0005 8+ 0.000 012R) kΩ (0.000 0000 092+ 0.000 013R) kΩ (0.000 000 05+ 0.000 013R) kΩ (-0.000 000 54+ 0.000 02R) MΩ (-0.000 039+ 0.000 067R) MΩ (-0.000 006 2+ 0.000 063R) MΩ (-0.000 008 9+ 0.0002 9R) GΩ	HP 3458A PMP-C-006
Generation and Measuring Resistance Equipment <sup>1</sup> High value resistors and decade	1 mΩ to 1 Ω up to 50 A Max	(-0.017+ 0.000 59R) mΩ	Indirect method Calibrator Fluke 5500A Multimeter HP 3458A Shunt resistor 0.01Ω Shunt resistor 0.1Ω PMP-C-006
Generation and Measuring Resistance Equipment <sup>1</sup> High value resistors and decade	100 kΩ to 10 GΩ up to 5 000 V Max	(-0.012+ 0.026R) GΩ	Indirect method Calibrator Fluke 5500A Multimeter HP 3458A High Voltage Probe Tektronix P6015A PMP-C-006
DC Shunt Resistance Equipment <sup>1,3</sup>	1 mΩ to 1 Ω @ (1 to 11) A 1mΩ to 1Ω @ (11 to 50) A	(-0.017 + 0.000 59R) mΩ	Multimeter HP 3458A Shunt resistor 0.01Ω Shunt resistor 0.1Ω PMP-C-006
AC electrical Resistance at 60 Hz Shunt Resistance <sup>1,3</sup>	1 mΩ to 1 Ω @ (1 to 11) A 1 mΩ to 1 Ω @ (11 to 50) A	(-0.017 + 0.000 59R) mΩ	Multimeter HP 3458A Shunt resistor 0.01Ω Shunt resistor 0.1Ω PMP-C-006
Capacitance <sup>1,3</sup> Source equipment	100 pF to 10 μF 50 Hz to 1 kHz 75 kHz to 30 MHz	0.42 mF/F	LCR HP 4285A PMP-C-009



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance <sup>1,3</sup> – Measure equipment	100pF to 1 μF 50 Hz to 1 kHz 75kHz to 30MHz	(0.07 + 0.000 001C) pF	LCR Bridge GenRad 1689-PI LCR HP 4285A PMP-C-009
Thermocouple Simulation <sup>1</sup>	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 (-250 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C 0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C 0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C 0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C 0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.4 °C 0.37 °C 0.26 °C 0.17 °C	Calibrator Fluke 5500A PMP-C-020



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermocouple Simulation <sup>1</sup>	Type N		Calibrator Fluke 5500A PMP-C-020
	(-200 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.22 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.27 °C	
	Type R		
	(0 to 250) °C	0.57 °C	
	(250 to 400) °C	0.35 °C	
	(400 to 1000) °C	0.33 °C	
	(1000 to 1767) °C	0.4 °C	
	Type S		
	(0 to 250) °C	0.47 °C	
	(250 to 1 000) °C	0.36 °C	
	(1 000 to 1 400) °C	0.37 °C	
	(1 400 to 1 767) °C	0.46 °C	
Type T			
(-250 to -150) °C	0.63 °C		
(-150 to 0) °C	0.24 °C		
(0 to 120) °C	0.16 °C		
(120 to 400) °C	0.14 °C		
Type U			
(-200 to 0) °C	0.56 °C		
(0 to 600) °C	0.27 °C		
RTD Simulation <sup>1</sup>	Cu 427 10 Ω		Calibrator Fluke 5500A PMP-C-020
	(-100 to 260) °C	0.3 °C	
	Pt 385, 100 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
(400 to 630) °C	0.12 °C		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RTD Simulation <sup>1</sup>	Pt 3916, 100 Ω		Calibrator Fluke 5500A PMP-C-020
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	
	Pt 385, 1000 Ω		
	(-200 to -80) °C	0.03 °C	
(-80 to 0) °C	0.03 °C		
(0 to 100) °C	0.04 °C		
(100 to 260) °C	0.05 °C		
(260 to 300) °C	0.06 °C		
(300 to 400) °C	0.07 °C		
(400 to 600) °C	0.07 °C		
(600 to 630) °C	0.23 °C		
PtNi 385, 120 Ω Ni120)			
(-80 to 0) °C	0.08 °C		
(0 to 100) °C	0.08 °C		
(100 to 260) °C	0.14 °C		

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Outside Micrometers <sup>1,3</sup>	Up to 1 016 mm Up to 40 in	$(0.26 + 0.23L) \mu\text{m}$ $(10 + 9.2L) \mu\text{in}$	Gage Blocks Grade 2 Gage blocks Grade 3 PMP-C-014 Reference Standard NMX-CH-099-IMNC-2005
Depth Micrometers <sup>1,3</sup>	Up to 1 016 mm Up to 40 in	$(0.3 + 0.23L) \mu\text{m}$ $(12 + 9.2L) \mu\text{in}$	Gage Blocks Grade 2 Gage Blocks Grade 3 PMP-C-014
Dial and Digital Indicators <sup>1,3</sup>	Up to 101.6 mm Up to 4 in	$(0.25 + 0.14L) \mu\text{m}$ $(9.7 + 5.3L) \mu\text{in}$	Calibration Tester Dial Gage Tester PMP-C-014 NMX-CH-36-1994
Calipers <sup>1,3</sup>	Up to 1 016 mm Up to 40 in	$(2.3 + 0.2L) \mu\text{m}$ $(89 + 7.8L) \mu\text{in}$	Gage Blocks Grade 2 Gage Blocks Grade 3 PMP-C-014 NMX-CH-2:1993-SCFI
Height Measuring Equipment <sup>3</sup>	Up to 1 016 mm Up to 40 in	$(0.81 + 0.22L) \mu\text{m}$ $(32 + 8.5L) \mu\text{in}$	Gage Blocks Grade 2 Gage Blocks Grade 3 PMP-C-014
Optical Comparators <sup>1,3</sup>	Up to 508 mm Up to 20 in	$(0.23 + 0.071L) \mu\text{m}$ $(9 + 2.8L) \mu\text{in}$	Glass Scales Gage Blocks Grade 2 Gage Block Grade 3 PMP-C-014
Graduated Rules and Flexometers <sup>3</sup>	Up to 25 m Up to 985 in	$(0.019 + 0.000\ 005L) \mu\text{m}$ $(0.73 + 0.000\ 2L) \mu\text{in}$	MPC273 API Laser Interferometer PMP-C-014 NOM-040-SCFI-1994 & NOM-046-SCFI-1999
Graduated Rules and Flexometers <sup>3</sup>	Up to 2 032 mm Up to 80 in	0.24 mm 0.009 4 in	Digital Indicator Stainless Ruler 5X Amplification Lens PMP-C-014 NOM-040-SCFI-1994 & NOM-046-SCFI-1999
Coating Thickness <sup>1,3</sup>	Up to 1.5 mm Up to 0.06 in	$(0.001\ 9 - 0.000\ 7L) \text{mm}$ $(0.000\ 075 + 0.000\ 028L) \text{in}$	Digital Indicator Gage Blocks Grade 2 PMP-C-014



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**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rugosity <sup>1</sup>	2.99 μm Ra (118 μin Ra) 0.4 μm Ry (16 μin Ry)	0.061 μm 2.4 μin 0.061 μm 2.4 μin	Rugosity Standard (Ra, Ry) Mitutoyo PMP-C-038
Levels <sup>1</sup>	(0 to 360) °	0.000 7 °	Surface Plate Sin Bar, Gage Blocks PMP-C-014
Surface Plates <sup>1</sup> Local Area Flatness (Repeat Reading)	Up to (192 x 192) in	(37+0.02L) μin	Repeatability Gauge Repeat-o-meter PMP-C-014
Pin/Plug Gauges	(0.254 to 101.6) mm (0.01 to 4) in	0.36 μm 14μin	Gage Blocks Grade 2 Universal measuring machine PMP-C-014
Thread Plug Gage Pitch Diameter	M 1.6 x 0.35 to M 100 x 6 (0-80 to 4-12)	5.1 μm 200 μin	Supermicrometer Brown & Sharpe Gage block set grade 2 PMP-C-014
Thread Plug Gage Major Diameter	M 1.6 x 0.35 to M 100 x 6 (0-80 to 4-12)	1.8 μm 71 μin	Supermicrometer Brown & Sharpe Gage block set grade 2 PMP-C-014
Protractors	(0 to 360) °	0.059 °	Angle Block PMP-C-014
Bore Gage	(0.762 to 304.8) mm (0.03 to 12) in	3.1 μm 120 μin	Ring gages (anillos) -Microscope "Vision Engineering Hawk" PMP-C-014
Radius Gage	(0.254 to 25.4) mm (0.01 to 1) in	4.1 μm 160 μin	Microscope "Vision Engineering Hawk" PMP-C-014
Angle Blocks	(0 to 90) °	0.014 °	Microscope "Vision Engineering Hawk" PMP-C-014
Ring Gages	(12.7 to 101.6) mm (0.5 to 4) in	0.36 μm 14 μin	Universal measuring machine PMP-C-014

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances <sup>1,3,4</sup>	(1 to 200) g (200 to 500) g (500 to 4 000) g (4 000 to 20 000) g (20 to 50) kg (50 to 200) kg (200 to 1 000) kg (1 000 to 2 500) kg	(0.000 011 + 0.000 0005 5W) g (-0.004 7 + 0.000 02W) g (-0.01 + 0.000 015W) g (0.02 + 0.000 007W) g (0.1 + 0.000 003W) g (0.16 + 0.000 002W) g (0.54 + 0.000 003W) g (-34 + 0.000 036W) g	Class 1 Stainless Weights and M2 PMP-C-012 NOM-010-SCFI-1994, NMX-CH-31-1982, NMX-CH-047-1996-IMNC & NMX-CH-059-1996-IMNC
Volume <sup>3</sup>	(0.0001 to 1) ml (1 to 200) ml (200 to 3 000) ml (3 000 to 30 000) ml (30 000 to 60 000) ml	(0.000 007 4 + 0.000 21V) ml (0.000 0009 1 + 0.000 22V) ml (0.000 001 2 + 0.000 22V) ml (0.00 019 + 0.000 22V) ml (-0.005 2 + 0.000 22V) ml	Dead Weights Digital Scale PMP-C-033 NOM-042-SCFI-1997 & NMX-CH-049-IMNC-2006
Torque Transducers, Tools, and Measuring Equipment <sup>1,3</sup>	(0.005 to 1) Nm (1 to 20) Nm (20 to 500) Nm (500 to 1000) Nm	(0.0008 4 + 0.003 7T) Nm (0.003 1 + 0.007 6T) Nm (-0.13 + 0.008 4T) Nm (3.26+0.001 9T) Nm	Dead Weights with Torque Arm & Torque Transducer PMP-C-015 CNM-MMF-PT-002 & EA-10/14
Specific Gravity <sup>3</sup>	(0.62 to 3) SG	(0.005 6 + 0.000 2G) SG	Dead Weights Digital Scale Digital Thermometer PMP-C-032 NBS Circular 555
Rockwell Hardness Testers <sup>1</sup> HRB & HRC	21.31 HRC 25.29 HRC 28.33 HRC 46.12 HRC 52.97 HRC 64.06 HRC 64.20 HRC  42.13 HRBW 42.66 HRBW 48.59 HRBW 71.42 HRBW 73.27 HRBW 73.43 HRBW 90.73 HRBW 91.51 HRBW 98.22 HRBW 98.40 HRBW	0.64 HRC 0.64 HRC 0.62 HRC 0.55 HRC 0.54 HRC 0.53 HRC 0.53 HRC  0.46 HRBW 0.37 HRBW 0.4 HRBW 0.29 HRBW 0.27 HRBW 0.31 HRBW 0.48 HRBW 0.41 HRBW 0.42 HRBW 0.42 HRBW	Indirect Verification using Test Blocks PMP-C-027



### Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Shore Hardness Testers Spring Force Only Types A, B Types C, D	(0 to 100) Duro	0.058 Duro	Dead Weights, Digital Scale PMP-C-027
Force Transducers, Tools, and Measuring Equipment <sup>3</sup>	(0.1 to 5.5) N	(0.007 2 + 0.001 6N) N	Dead weights PMP-C-011 NMX-CH-27-1994-SCFI & NMX-CH-023-1994-SCFI
Force Transducers, Tools, and Measuring Equipment <sup>1,3</sup>	5.5 N to 6.67 kN (6.67 to 66.7) kN (45 to 222) kN	(0.66 + 0.002 2N) N (-1.7 + 0.002 5N) N (115 + 0.002 3N) N	Load Cell, Fluke 5500A Calibrator HP 3458A Multimeter, PMP-C-011 NMX-CH-27-1994-SCFI & NMX-CH-023-1994-SCFI
Relative Pressure <sup>3</sup>	Up to 0.2 Mpa Up to 30 psi  (0.2 to 20.7) Mpa (30 to 3 000) psi	(0.002 3 + 0.000 11P) psi  (0.037 + 0.000 1P) psi	Pressure Calibrator PMP-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC
Relative Pressure	(20.7 to 138) Mpa (3 000 to 20 000) psi	9.1 psi	Pressure Sensor PMP-C-013 NMX-CH-058-1994 & NMX-CH-060-2006-IMNC

### Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Light Intensity Meters <sup>3</sup>	(0.1 to 10 000) lux (10 to 100) klux	(-75 + 0.07x) lux (-883 + 0.11x) lux	Minolta T-1 PMP-C-035
UV Meters <sup>3</sup>	Up to 19.99 mW/cm <sup>2</sup> 19.99 mW to 30 W/cm <sup>2</sup>	(0.000 2 + 0.05z) mW/cm <sup>2</sup> (0.002 5 + 0.04z) W/cm <sup>2</sup>	Meter UV PMP-C-035

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity <sup>1,3</sup>	(10 to 75) %RH (75 to 97) %RH	2.2 %RH 2.5 %RH	Reference Materials Humidity Meter Thermometer PMP-C-028
Temperature <sup>3</sup>	(-38 to 420) °C (0 to 1 000) °C	(0.044 + 0.000 04c) °C (0.34+0.002 21c) °C	RTD / SPRT / HP 34401 Thermocouple/ Fluke 51 II PMP-C-007

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency <sup>1</sup> – Source and Measure	0.1 Hz to 18 GHz	1 x 10 <sup>-9</sup> Hz/Hz	GPS Receiver HP Z3801A PMP-C-008

## DIMENSIONAL MEASUREMENT

### 3 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Inspection CMM 3D / Inspection Dimensional	X = Up to 24in (609.6mm) Y = Up to 20in (508mm) Z = Up to 12in (304.8mm)	(0.000 01+0.000 002L) in (0.000 01+0.000 001L) in (0.000 01+0.000 002L) in	Coordinate Measuring Machine and Vision System used as Reference Customer Drawings CMM and Vision Software

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:

- 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.
- This parameter is only available on-site and not in the laboratory's facilities.
- Symbols of applied units in the above scope of capabilities:  $a$  = applied to acceleration in g-force;  $A$  = applied air flow in standard liters/minute,  $c$  = applied temperature in degrees C,  $C$  = applied electromagnetic capacitance in Farads,  $E$  = applied electromagnetic voltage in Volts,  $f$  = applied flow in liters/minute;  $F$  = applied water flow in liters/minute,  $G$  = applied in terms of specific gravity;  $h$  = applied Relative Humidity in percent RH;  $H$  = applied inductance in Henrys;  $I$  = applied current in amperes,  $L$  = length in either mm or inches as applicable  $N$  = applied to force in Newtons,  $M$  = magnetic flux density in teslas,  $P$  = applied pressure in Pascal or psi as appropriate;  $t$  = applied time in seconds;  $U$  = applied vacuum in millibars;  $V$  = applied volume in liters;  $W$  = applied weight in grams;  $x$  = applied light intensity in lux;  $Y$  = applied air velocity or air speed in meters/second;  $v$  = applied volume in milli-liters or  $cm^3$ ;  $V$  = applied volume in liters,  $w$  = applied ultra-violet light in Watts/ $cm^2$ ,  $W$  = applied weight in grams or milli-grams;  $\chi$  = applied light intensity in lux;  $T$  = applied torque in Newton-meters,  $y$  = applied Air Velocity in m/s;  $z$  = applied viscosity in centi-poise-cP and ( $\Delta$ ) is applied particle counters in particle size/ $ft^3$ ,  $Y$  = applied air velocity or air speed in meters/second; and  $z$  = applied Ultraviolet light in Watts per centimeter squared.
- 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.
- Nominal values are approximate.
- This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1890.



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