



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Martin Calibration, Inc.

11965 12th Avenue South

Burnsville, MN 55337

Including satellite locations located in: Mundelein, IL and Eau Claire, WI

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the fields 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.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 06 July 2023

Certificate Number: ACT-1265



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)**

Martin Calibration, Inc.
11965 12th Avenue South
Burnsville, MN 55337
Corey Garbers
952-882-1528

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **July 6, 2023**

Certificate Number: **ACT-1265**

Satellite locations in:

[Mundelein, IL](#)

[Eau Claire, WI](#)



ANSI National Accreditation Board

Services performed at Main Site laboratory

Martin Calibration, Inc.

11965 12th Avenue South
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CALIBRATION

Acoustics and Vibration

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|----------------------------|-------------------------------------|---|---|
| Sound Level – Fixed Points | (94, 104, 114) dB | 0.2 dB | Briel & Kjaer Sound Pressure Calibrator |
| Sound Level - Linearity | (50 to 143) dB | 0.13 dB | |
| Sound Level - Frequency | (0.031 to 16) kHz | 1 % of reading | |
| Sound Level - Distortion | (25 to 123) dB (0.031 to 16) kHz | 0.14 dB | |
| Accelerometers | (5 to 9) Hz | 2.6 % of reading | PCB Shaker Table with PCB Reference Accelerometer |
| | (10 to 99) Hz | 1.6 % of reading | |
| | 100 Hz | 0.75 % of reading | |
| | (101 to 920) Hz | 1.3 % of reading | |
| | 921 Hz to 5 kHz | 2.2 % of reading | |
| | (5 to 8) kHz | 3.8 % of reading | |
| | (8 to 10) kHz | 4.8 % of reading | |
| (10 to 15) kHz | 8.6 % of reading | | |

Chemical Quantities

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|----------------------------------|---------------------------|---|--|
| Conductivity Meters ¹ | (0.86 to 10) μ S/cm | 0.42 μ S/cm | Conductivity Standards |
| | (10 to 100) μ S/cm | 0.89 μ S/cm | |
| | (100 to 1 500) μ S/cm | 0.42 % of reading | |
| | 12 800 μ S/cm | 0.42 % of reading | |
| Refractometers | 0.00 Brix | 0.000 6 Brix | Calibration Solutions |
| | 10.00 Brix | 0.018 Brix | |
| | 40.00 Brix | 0.019 Brix | |
| | 70.00 Brix | 0.03 Brix | |

Chemical Quantities

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|------------------------|-----------------------|---|--|
| pH Meters ¹ | 4 pH 7 pH 10 pH | 0.016 pH 0.016 pH 0.016 pH | Buffer Solutions |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|--|
| DC Voltage – Source ¹ Fixed Point | 10V | 0.5 μ V/V | 732B Voltage Standards with Fluke Maps |
| DC Voltage – Source ¹ | 0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V | 20 nV 100 nV 22 μ V/V + 25 nV 5.3 μ V/V 0.5 μ V/V 0.31 μ V/V 0.35 μ V/V 1 μ V/V | MI Potentiometer/ Divider & Fluke 5720A Multi Product Calibrator |
| DC Voltage – Measure ¹ | 0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V | 20 nV 100 nV 22 μ V/V + 25 nV 5.3 μ V/V 0.5 μ V/V 0.31 μ V/V 0.35 μ V/V 1 μ V/V | Nano Voltmeter Fluke 732B Voltage Standard with MI Potentiometer/ Divider |
| DC High Voltage – Measure ¹ | (1.1 to 10) kV (10 to 30) kV (30 to 50) kV (50 to 70) kV (70 to 100) kV | 0.05 % of reading 0.055 % of reading 0.079 % of reading 0.12 % of reading 0.83 % of reading | Hipotronics KVM100-A High Voltage Meter |
| DC Current – Source & Measure ¹ | 0 A (0 to 200) pA (0.2 to 20) nA (20 to 100) nA | 76 fA 1.9 % of reading + 10 fA 0.29 % of reading + 1 pA 8 μ A/A + 1.3 pA | Electrometer |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--|--|---|
| DC Current – Source & Measure ¹ | (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 | 30 μ A/A 6.8 μ A/A 6.2 μ A/A 4.1 μ A/A 4.2 μ A/A 3.9 μ A/A 17 μ A/A | Standard resistors and DMM and Multifunction Calibrator |
| DC Current – Source & Measure ¹ | (1 to 20) A (20 to 120) A | 26 μ A/A 80 μ A/A + 4 mA | Fluke 52120A Amplifier with shunts |
| DC Current – Source ¹ | (100 to 150) A (150 to 1 025) A | 5 mA/A + 20 mA 5.1 mA/A + 0.9 A | Fluke 5520A Multi Product Calibrator with 50-turn Coil |
| DC Power – Source | 10.9 μ W to 10.9 mW 10.9 mW to 3.06 kW (3.06 to 20.9) kW | 0.18 mW/W 0.17 mW/W 0.54 mW/W | Fluke 5520A Multi Product Calibrator |
| AC Power – Source (45 to 65) Hz | 109 μ W to 1.09 mW (1.09 to 297) μ W 297 μ W to 2.97 mW 2.97 mW to 337 W 337 W to 2.24 kW (2.24 to 20.9) kW | 1.1 mW/W 930 μ W/W 780 μ W/W 620 μ W/W 700 μ W/W 780 μ W/W | Fluke 5520A Multi Product Calibrator |
| AC Voltage – Source & Measure ¹ | (0 to 2.2) mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz | 1.1 mV/V + 1.3 μ V 490 μ V/V + 1.3 μ V 280 μ V/V + 1.3 μ V 540 μ V/V + 2 μ V 800 μ V/V + 2.5 μ V 1.5 mV/V + 4 μ V 1.6 mV/V + 8 μ V 2.3 mV/V + 8 μ V | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---------------------------------------|---|---|
| AC Voltage – Source & Measure ¹ | (2.2 to 7) mV | | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator |
| | (10 to 20) Hz | 570 $\mu\text{V/V} + 1.3 \mu\text{V}$ | |
| | (20 to 40) Hz | 250 $\mu\text{V/V} + 1.3 \mu\text{V}$ | |
| | (0.04 to 20) kHz | 140 $\mu\text{V/V} + 1.3 \mu\text{V}$ | |
| | (20 to 50) kHz | 270 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (50 to 100) kHz | 400 $\mu\text{V/V} + 2.5 \mu\text{V}$ | |
| | (100 to 300) kHz | 800 $\mu\text{V/V} + 4 \mu\text{V}$ | |
| | (300 to 500) kHz | 870 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (0.5 to 1) MHz | 1.5 mV/V + 8 μV | |
| | (7 to 22) mV | | |
| | (10 to 20) Hz | 190 $\mu\text{V/V} + 1.3 \mu\text{V}$ | |
| | (20 to 40) Hz | 130 $\mu\text{V/V} + 1.3 \mu\text{V}$ | |
| | (0.04 to 20) kHz | 73 $\mu\text{V/V} + 1.3 \mu\text{V}$ | |
| | (20 to 50) kHz | 140 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (50 to 100) kHz | 210 $\mu\text{V/V} + 2.5 \mu\text{V}$ | |
| | (100 to 300) kHz | 540 $\mu\text{V/V} + 4 \mu\text{V}$ | |
| | (300 to 500) kHz | 590 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (0.5 to 1) MHz | 1.1 mV/V + 8 μV | |
| | (22 to 70) mV | | |
| | (10 to 20) Hz | 160 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| | (20 to 40) Hz | 80 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| | (0.04 to 20) kHz | 43 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| | (20 to 50) kHz | 87 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (50 to 100) kHz | 170 $\mu\text{V/V} + 2.5 \mu\text{V}$ | |
| | (100 to 300) kHz | 340 $\mu\text{V/V} + 4 \mu\text{V}$ | |
| | (300 to 500) kHz | 450 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (0.5 to 1) MHz | 730 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (70 to 220) mV | | |
| | (10 to 20) Hz | 140 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| | (20 to 40) Hz | 57 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| (0.04 to 20) kHz | 25 $\mu\text{V/V} + 1.5 \mu\text{V}$ | | |
| (20 to 50) kHz | 46 $\mu\text{V/V} + 2 \mu\text{V}$ | | |
| (50 to 100) kHz | 110 $\mu\text{V/V} + 2.5 \mu\text{V}$ | | |
| (100 to 300) kHz | 170 $\mu\text{V/V} + 4 \mu\text{V}$ | | |
| (300 to 500) kHz | 250 $\mu\text{V/V} + 8 \mu\text{V}$ | | |
| (0.5 to 1) MHz | 670 $\mu\text{V/V} + 8 \mu\text{V}$ | | |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---------------------|---|---|
| AC Voltage – Source & Measure ¹ | (220 to 700) mV | | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator |
| | (10 to 20) Hz | 140 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| | (20 to 40) Hz | 51 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| | (0.04 to 20) kHz | 22 $\mu\text{V/V} + 1.5 \mu\text{V}$ | |
| | (20 to 50) kHz | 34 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (50 to 100) kHz | 53 $\mu\text{V/V} + 2.5 \mu\text{V}$ | |
| | (100 to 300) kHz | 120 $\mu\text{V/V} + 4 \mu\text{V}$ | |
| | (300 to 500) kHz | 200 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (0.5 to 1) MHz | 640 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (0.7 to 2.2) V | | |
| | (10 to 20) Hz | 130 $\mu\text{V/V}$ | |
| | (20 to 40) Hz | 44 $\mu\text{V/V}$ | |
| | (0.04 to 20) kHz | 16 $\mu\text{V/V}$ | |
| | (20 to 50) kHz | 31 $\mu\text{V/V}$ | |
| | (50 to 100) kHz | 47 $\mu\text{V/V}$ | |
| | (100 to 300) kHz | 110 $\mu\text{V/V}$ | |
| | (300 to 500) kHz | 170 $\mu\text{V/V}$ | |
| | (0.5 to 1) MHz | 600 $\mu\text{V/V}$ | |
| | (2.2 to 7) V | | |
| | (10 to 20) Hz | 130 $\mu\text{V/V}$ | |
| | (20 to 40) Hz | 45 $\mu\text{V/V}$ | |
| | (0.04 to 20) kHz | 16 $\mu\text{V/V}$ | |
| | (20 to 50) kHz | 32 $\mu\text{V/V}$ | |
| | (50 to 100) kHz | 54 $\mu\text{V/V}$ | |
| | (100 to 300) kHz | 130 $\mu\text{V/V}$ | |
| | (300 to 500) kHz | 270 $\mu\text{V/V}$ | |
| | (0.5 to 1) MHz | 800 $\mu\text{V/V}$ | |
| | (7 to 22) V | | |
| | (10 to 20) Hz | 130 $\mu\text{V/V}$ | |
| | (20 to 40) Hz | 45 $\mu\text{V/V}$ | |
| (0.04 to 20) kHz | 18 $\mu\text{V/V}$ | | |
| (20 to 50) kHz | 32 $\mu\text{V/V}$ | | |
| (50 to 100) kHz | 54 $\mu\text{V/V}$ | | |
| (100 to 300) kHz | 130 $\mu\text{V/V}$ | | |
| (300 to 500) kHz | 270 $\mu\text{V/V}$ | | |
| (0.5 to 1) MHz | 800 $\mu\text{V/V}$ | | |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|--|--|
| AC Voltage – Source & Measure | (22 to 70) V (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz (70 to 220) V (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (220 to 700) V (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz | 130 μ V/V 45 μ V/V 21 μ V/V 38 μ V/V 63 μ V/V 130 μ V/V 270 μ V/V 800 μ V/V 130 μ V/V 45 μ V/V 21 μ V/V 46 μ V/V 65 μ V/V 140 μ V/V 330 μ V/V 130 μ V/V 66 μ V/V 27 μ V/V 87 μ V/V 330 μ V/V | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator |
| AC Voltage – Source & Measure Flatness relative to 1 kHz | (0 to 2.2) mV (10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz | 0.1 % of reading + 1.3 μ V 0.05 % of reading + 1.3 μ V 0.05 % of reading + 1.3 μ V 0.05 % of reading + 2 μ V 0.07 % of reading + 1 μ V 0.07 % of reading + 1 μ V 0.07 % of reading + 1 μ V 0.17 % of reading + 1 μ V 0.32 % of reading + 1 μ V 0.7 % of reading + 2 μ V | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband) |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|-------------------|---|---|
| AC Voltage – Source & Measure Flatness relative to 1 kHz | (2.2 to 7) mV | | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband) |
| | (10 to 30) Hz | 0.1 % of reading | |
| | (30 to 120) Hz | 0.05 % of reading | |
| | (0.12 to 1.2) kHz | 0.05 % of reading | |
| | (1.2 to 120) kHz | 0.05 % of reading | |
| | (120 to 500) kHz | 0.07 % of reading + 1 μV | |
| | (0.5 to 1.2) MHz | 0.07 % of reading + 1 μV | |
| | (1.2 to 2) MHz | 0.07 % of reading + 1 μV | |
| | (2 to 10) MHz | 0.1 % of reading + 1 μV | |
| | (10 to 20) MHz | 0.17 % of reading + 1 μV | |
| | (20 to 30) MHz | 0.37 % of reading + 1 μV | |
| | (7 to 22) mV | | |
| | (10 to 30) Hz | 0.1 % of reading | |
| | (30 to 120) Hz | 0.05 % of reading | |
| | (0.12 to 1.2) kHz | 0.05 % of reading | |
| | (1.2 to 120) kHz | 0.05 % of reading | |
| | (120 to 500) kHz | 0.07 % of reading | |
| | (0.5 to 1.2) MHz | 0.07 % of reading | |
| | (1.2 to 2) MHz | 0.07 % of reading | |
| | (2 to 10) MHz | 0.1 % of reading | |
| | (10 to 20) MHz | 0.17 % of reading | |
| | (20 to 30) MHz | 0.37 % of reading | |
| | (22 to 70) mV | | |
| | (10 to 30) Hz | 0.1 % of reading | |
| | (30 to 120) Hz | 0.05 % of reading % | |
| | (0.12 to 1.2) kHz | 0.05 % of reading | |
| | (1.2 to 120) kHz | 0.05 % of reading | |
| (120 to 500) kHz | 0.05 % of reading | | |
| (0.5 to 1.2) MHz | 0.05 % of reading | | |
| (1.2 to 2) MHz | 0.05 % of reading | | |
| (2 to 10) MHz | 0.1 % of reading | | |
| (10 to 20) MHz | 0.15 % of reading | | |
| (20 to 30) MHz | 0.35 % of reading | | |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|-------------------|---|---|
| AC Voltage – Source & Measure Flatness relative to 1 kHz | (70 to 220) mV | | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband) |
| | (10 to 30) Hz | 0.1 % of reading | |
| | (30 to 120) Hz | 0.04 % of reading | |
| | (0.12 to 1.2) kHz | 0.04 % of reading | |
| | (1.2 to 120) kHz | 0.04 % of reading | |
| | (120 to 500) kHz | 0.04 % of reading | |
| | (0.5 to 1.2) MHz | 0.05 % of reading | |
| | (1.2 to 2) MHz | 0.05 % of reading | |
| | (2 to 10) MHz | 0.1 % of reading | |
| | (10 to 20) MHz | 0.15 % of reading | |
| | (20 to 30) MHz | 0.35 % of reading | |
| | (220 to 700) mV | | |
| | (10 to 30) Hz | 0.1 % of reading | |
| | (30 to 120) Hz | 0.03 % of reading | |
| | (0.12 to 1.2) kHz | 0.03 % of reading | |
| | (1.2 to 120) kHz | 0.03 % of reading | |
| | (120 to 500) kHz | 0.03 % of reading | |
| | (0.5 to 1.2) MHz | 0.05 % of reading | |
| | (1.2 to 2) MHz | 0.05 % of reading | |
| | (2 to 10) MHz | 0.1 % of reading | |
| | (10 to 20) MHz | 0.15 % of reading | |
| | (20 to 30) MHz | 0.35 % of reading | |
| | (0.7 to 2.2) V | | |
| | (10 to 30) Hz | 0.1 % of reading | |
| | (30 to 120) Hz | 0.03 % of reading | |
| | (0.12 to 1.2) kHz | 0.03 % of reading | |
| | (1.2 to 120) kHz | 0.03 % of reading | |
| (120 to 500) kHz | 0.03 % of reading | | |
| (0.5 to 1.2) MHz | 0.05 % of reading | | |
| (1.2 to 2) MHz | 0.05 % of reading | | |
| (2 to 10) MHz | 0.1 % of reading | | |
| (10 to 20) MHz | 0.15 % of reading | | |
| (20 to 30) MHz | 0.35 % of reading | | |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|--|
| AC Voltage – Source & Measure Flatness relative to 1 kHz | (2.2 to 7) V (10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz | 0.1 % of reading 0.03 % of reading 0.03 % of reading 0.03 % of reading 0.03 % of reading 0.05 % of reading 0.05 % of reading 0.1 % of reading 0.15 % of reading 0.35 % of reading | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator (Wideband) |
| AC Current – Source ¹ | 9 μA to 1 mA DC to 10 kHz 1 mA to 1 A DC to 10 kHz (1 to 20) A DC to 10 kHz | 75 μA/A 28 μA/A 52 μA/A | Fluke 5720A Multi Product Calibrator w/ A40B Shunts |
| AC Current – Source ¹ | (20 to 120) A DC to 1 kHz (1 to 6) kHz | 3 mA/A 12 mA/A | Fluke 5720A Multi Product Calibrator w/ A40B Shunts |
| AC Current – Measure ¹ | 9 μA to 1 mA (DC to 30) kHz (30 to 100) kHz 1mA to 1A (DC to 100) kHz (1 to 20) A (DC to 10) kHz (10 to 30) kHz (30 to 100) kHz | 90 μA/A 0.18 mA/A 35 μA/A 61 μA/A 83 μA/A 0.13 mA/A | Fluke A40B Shunts |
| AC Current – Measure ¹ | 9 μA to 200 μA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz 200 μA to 2 mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz | 0.62 mA/A 0.54 mA/A 0.94 mA/A 8.4 mA/A 0.6 mA/A 0.54 mA/A 0.94 mA/A 4.2 mA/A | Fluke 8508A Multimeter |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------------------|------------------|--|---|
| AC Current – Measure ¹ | (2 to 20) mA | | Fluke 8508A Multimeter |
| | (1 to 10) Hz | 0.6 mA/A | |
| | 10 Hz to 10 kHz | 0.54 mA/A | |
| | (10 to 30) kHz | 0.94 mA/A | |
| | (30 to 100) kHz | 4.2 mA/A | |
| | (20 to 200) mA | | |
| | (1 to 10) Hz | 0.57 mA/A | |
| | 10 Hz to 10 kHz | 0.49 mA/A | |
| | (10 to 30) kHz | 0.83 mA/A | |
| | 200 mA to 2 A | | |
| | 10 Hz to 2 kHz | 0.83 mA/A | |
| | (2 to 10) kHz | 0.93 mA/A | |
| | (10 to 30) kHz | 3.2 mA/A | |
| | (2 to 20) A | | |
| 10 Hz to 2 kHz | 1 mA/A | | |
| (2 to 10) kHz | 2.7 mA/A | | |
| Resistance – Source ¹ | 0.001 Ω | 3.5 μΩ/Ω | Standard resistors |
| | 0.01Ω | 4.3 μΩ/Ω | |
| | 0.1 Ω | 1.5 μΩ/Ω | |
| | 1Ω | 0.67 μΩ/Ω | |
| | 10Ω | 0.56 μΩ/Ω | |
| | 100 Ω | 0.68 μΩ/Ω | |
| | 1 kΩ | 0.51 μΩ/Ω | |
| | 10 kΩ | 0.8 μΩ/Ω | |
| | 100 kΩ | 0.57 μΩ/Ω | |
| | 1 MΩ | 1.3 μΩ/Ω | |
| | 10 MΩ | 14 μΩ/Ω | |
| | 100 MΩ | 130 μΩ/Ω | |
| | 1 GΩ | 26 μΩ/Ω | |
| | (1 to 10) GΩ | 0.16 % of reading | |
| | (10 to 100) GΩ | 0.54 % of reading | |
| | (100 to 900) GΩ | 0.56 % of reading | |
| 1 TΩ | 1.6 % of reading | | |
| 10 TΩ | 1.7 % of reading | | |
| Resistance – Measure ¹ | (10 to 100) μΩ | 0.15 % of reading | Standard resistors with bridge and DMM |
| | (0.1 to 1) mΩ | 15 μΩ/Ω | |
| | (1 to 10) mΩ | 5.1 μΩ/Ω | |
| | (10 o 100) mΩ | 1.8 μΩ/Ω | |
| | (0.1 to 1) Ω | 0.67 μΩ/Ω | |
| | (1 to 10) Ω | 0.56 μΩ/Ω | |
| | (10 to 100) Ω | 0.68 μΩ/Ω | |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|---|--|
| Resistance – Measure ¹ | (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ | 0.51 μΩ/Ω 0.8 μΩ/Ω 0.57 μΩ/Ω 1.3 μΩ/Ω 14 μΩ/Ω | Standard resistors with bridge and DMM |
| Resistance – Measure ¹ | (10 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ | 72 μΩ/Ω + 1kΩ 0.18 mΩ/Ω + 100 kΩ 0.67 mΩ/Ω + 10 MΩ | Decade resistors with bridge and DMM |
| Resistance – Measure ¹ High Voltage Mode up to 200 V | (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ | 15 μΩ/Ω + 10 Ω 60 μΩ/Ω + 1 kΩ 0.15 mΩ/Ω + 100 kΩ 0.53 mΩ/Ω + 10 MΩ | Decade resistors with bridge and DMM |
| AC Resistance (Impedance) | (1, 500) kHz, 1 MHz 25 Ω 375 Ω (1, 250, 500) kHz, 1 MHz 6 kΩ (1, 25, 50) kHz 100 kΩ | 100 μΩ/Ω | AC Resistor Set |
| Capacitance – Measure ¹ | 1 pF @ 1 kHz 10 pF @ 1 kHz 100 pF @ 1kHz 1 nF 1kHz 1 μF @ 1 kHz | 1.9 mF/F 1.1 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F | QuadTech 1730 LCR Meter |
| Capacitance – Source ¹ (fixed values) @ 100 Hz @ 1 kHz | 1 pF 1 nF 10 nF 100 nF 1 μF | 1.8 mF/F 0.23 mF/F 0.25 mF/F 0.21 mF/F 0.25 mF/F | Standard Capacitors |
| Capacitance – Source ¹ 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz 10 Hz to 300 Hz 10 Hz to 150 Hz 10 Hz to 120 Hz | 0.19 nF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF | 15 mF/F 8.4 mF/F 3.6 mF/F 3.6 mF/F 3.7 mF/F 3.6 mF/F 3.6 mF/F 3.6 mF/F 5.1 mF/F | Fluke 5520A Multi Product Calibrator |



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Electrical – DC/Low Frequency

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| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|---|
| Capacitance – Source ¹ 10 Hz to 80 Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz | (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF | 5.6 mF/F 5.6 mF/F 8.7 mF/F 5.5 mF/F 5.5 mF/F 8.5 mF/F 12 mF/F | Fluke 5520A Multi Product Calibrator |
| Inductance – Measure ¹ | 100 μ H @ 1 kHz 1 mH @ 1 kHz 10 mH @ 1 kHz 100 mH @ 1 kHz 1 H @ 1 kHz | 1.3 mH/H | QuadTech 1730 LCR Meter |
| Inductance – Source ¹ | 500 μ H @ 100 Hz 500 μ H @ 1 kHz 2 mH @ 100 Hz 2 mH @ 1 kHz 20 mH @ 100 Hz 20 mH @ 1 kHz 1 H @ 100 Hz 1 H @ 1 kHz 10 H @ 100 Hz 10 H @ 1 kHz | 1.2 mH/H 1 mH/H 1.1 mH/H 1 mH/H 1.1 mH/H 1 mH/H 1 mH/H 1 mH/H 1 mH/H 1 mH/H | Standard Inductors |
| Oscilloscopes ¹ Square Wave Signal 50 Ω at 1 kHz Square Wave Signal 1 M Ω at 1 kHz DC Voltage, 50 Ω DC Voltage, 1 M Ω Leveled Sine Wave Amplitude Leveled Sine Wave Flatness (relative to 50 kHz) | 40 μ V to 5 V 40 μ V to 5 V 1 mV to 5 V 1 mV to 200 V 5 mV to 5 V 4.4 mVpp to 5.6 Vpp 0.1 Hz to 300 MHz (300 to 550) MHz | 1 mV/V 1 mV/V 0.26 mV/V 0.25 mV/V 15 mV/V 43 mV/V 43 mV/V | Fluke 9500B/3200/9530 Oscilloscope Calibrator |



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Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|---|--|
| Oscilloscopes ¹ Leveled Sine Wave Flatness (relative to 50 kHz) | 4.4 mVpp to 3.3 Vpp 550 MHz to 1.1 GHz (1.1 to 3.2) GHz | 52 mV/V 52 mV/V | Fluke 9500B/3200/9530 Oscilloscope Calibrator |
| Time Marker 50 Ω Source and Period | 9 ns to 55 s | 0.25 μs/s | |
| Rise/Fall Time - Source | 150 ps | 27 ps | |
| Pulse Width - Source | (1 to 100) ns | 52 ms/s | |
| Electrical Simulation of Thermocouple Indicators ¹ | Type B | | Ectron 1140A Thermocouple Simulator |
| | (250 to 350) °C | 1.1 °C | |
| | (350 to 445) °C | 0.85 °C | |
| | (445 to 580) °C | 0.67 °C | |
| | (580 to 750) °C | 0.52 °C | |
| | (750 to 1 000) °C | 0.43 °C | |
| | (1 000 to 1 820) °C | 0.33 °C | |
| | Type C | | |
| | (0 to 250) °C | 0.23 °C | |
| | (250 to 1 000) °C | 0.18 °C | |
| | (1 000 to 1 500) °C | 0.21 °C | |
| | (1 500 to 1 800) °C | 0.24 °C | |
| | (1 800 to 2 000) °C | 0.27 °C | |
| | (2 000 to 2 250) °C | 0.33 °C | |
| | (2 250 to 2 315) °C | 0.37 °C | |
| | Type E | | |
| | (-270 to -245) °C | 1.38 °C | |
| | (-245 to -195) °C | 0.21 °C | |
| | (-195 to -155) °C | 0.12 °C | |
| | (-155 to -90) °C | 0.09 °C | |
| (-90 to 15) °C | 0.08 °C | | |
| (15 to 890) °C | 0.07 °C | | |
| (890 to 1 000) °C | 0.08 °C | | |
| Type J | | | |
| (-210 to -180) °C | 0.14 °C | | |
| (-180 to -120) °C | 0.12 °C | | |
| (-120 to -50) °C | 0.09 °C | | |
| (-50 to 990) °C | 0.08 °C | | |
| (990 to 1 200) °C | 0.08 °C | | |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---------------------|---|--|
| Electrical Simulation of Thermocouple Indicators ¹ | Type K | | Ectron 1140A Thermocouple Simulator |
| | (-270 to -255) °C | 2.5 °C | |
| | (-255 to -195) °C | 0.81 °C | |
| | (-195 to -115) °C | 0.14 °C | |
| | (-115 to -55) °C | 0.1 °C | |
| | (-55 to 1 000) °C | 0.08 °C | |
| | (1 000 to 1 372) °C | 0.09 °C | |
| | Type N | | |
| | (-270 to -260) °C | 5.8 °C | |
| | (-260 to -200) °C | 1.2 °C | |
| | (-200 to -140) °C | 0.27 °C | |
| | (-140 to -70) °C | 0.17 °C | |
| | (-70 to 25) °C | 0.14 °C | |
| | (25 to 160) °C | 0.12 °C | |
| | (160 to 1 300) °C | 0.1 °C | |
| | Type R | | |
| | (-50 to -30) °C | 0.75 °C | |
| | (-30 to 45) °C | 0.63 °C | |
| | (45 to 160) °C | 0.46 °C | |
| | (160 to 380) °C | 0.35 °C | |
| | (380 to 775) °C | 0.3 °C | |
| | (775 to 1 768) °C | 0.25 °C | |
| | Type S | | |
| | (-50 to -30) °C | 0.71 °C | |
| | (-30 to -45) °C | 0.64 °C | |
| | (-45 to -105) °C | 0.46 °C | |
| | (-105 to 310) °C | 0.38 °C | |
| | (310 to 615) °C | 0.33 °C | |
| (615 to 1 768) °C | 0.3 °C | | |
| Type T | | | |
| (-270 to -255) °C | 2.1 °C | | |
| (-255 to -240) °C | 0.56 °C | | |
| (-240 to -210) °C | 0.35 °C | | |
| (-210 to -150) °C | 0.21 °C | | |
| (-150 to -40) °C | 0.14 °C | | |
| (-40 to 100) °C | 0.09 °C | | |
| (100 to 400) °C | 0.08 °C | | |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|-------------------|---|--|
| Electrical Simulation of RTD Indicators ¹ | PT 395 100 Ω | | Fluke 5520A Multi Product Calibrator |
| | (-200 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.08 °C | |
| | (100 to 300) °C | 0.11 °C | |
| | (300 to 400) °C | 0.12 °C | |
| | (400 to 630) °C | 0.14 °C | |
| | (630 to 800) °C | 0.27 °C | |
| | PT 3926 100 Ω | | |
| | (-200 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.08 °C | |
| | (100 to 300) °C | 0.11 °C | |
| | (300 to 400) °C | 0.12 °C | |
| | (400 to 630) °C | 0.14 °C | |
| | PT 3916 100 Ω | | |
| | (-200 to -190) °C | 0.29 °C | |
| | (-190 to -80) °C | 0.05 °C | |
| | (-80 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.07 °C | |
| | (100 to 260) °C | 0.08 °C | |
| | (260 to 300) °C | 0.09 °C | |
| | (300 to 400) °C | 0.11 °C | |
| | (400 to 600) °C | 0.12 °C | |
| | (600 to 630) °C | 0.27 °C | |
| | PT 385 200 Ω | | |
| | (-200 to 100) °C | 0.05 °C | |
| | (100 to 260) °C | 0.06 °C | |
| | (260 to 300) °C | 0.14 °C | |
| | (300 to 400) °C | 0.15 °C | |
| (400 to 600) °C | 0.16 °C | | |
| (600 to 630) °C | 0.19 °C | | |
| PT 385 500 Ω | | | |
| (-200 to -80) °C | 0.05 °C | | |
| (-80 to 100) °C | 0.06 °C | | |
| (100 to 260) °C | 0.07 °C | | |
| (260 to 400) °C | 0.09 °C | | |
| (400 to 600) °C | 0.01 °C | | |
| (600 to 630) °C | 0.13 °C | | |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|-------------------|---|--|
| Electrical Simulation of RTD Indicators ¹ | PT 395 100 Ω | | Fluke 5520A Multi Product Calibrator |
| | (-200 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.08 °C | |
| | (100 to 300) °C | 0.11 °C | |
| | (300 to 400) °C | 0.12 °C | |
| | (400 to 630) °C | 0.14 °C | |
| | (630 to 800) °C | 0.27 °C | |
| | PT 3926 100 Ω | | |
| | (-200 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.08 °C | |
| | (100 to 300) °C | 0.11 °C | |
| | (300 to 400) °C | 0.12 °C | |
| | (400 to 630) °C | 0.14 °C | |
| | PT 3916 100 Ω | | |
| | (-200 to -190) °C | 0.29 °C | |
| | (-190 to -80) °C | 0.05 °C | |
| | (-80 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.07 °C | |
| | (100 to 260) °C | 0.08 °C | |
| | (260 to 300) °C | 0.09 °C | |
| | (300 to 400) °C | 0.11 °C | |
| | (400 to 600) °C | 0.12 °C | |
| | (600 to 630) °C | 0.27 °C | |
| | PT 385 200 Ω | | |
| (-200 to 100) °C | 0.05 °C | | |
| (100 to 260) °C | 0.06 °C | | |
| (260 to 300) °C | 0.14 °C | | |
| (300 to 400) °C | 0.15 °C | | |
| (400 to 600) °C | 0.16 °C | | |
| (600 to 630) °C | 0.19 °C | | |
| PT 385 500 Ω | | | |
| (-200 to -80) °C | 0.05 °C | | |
| (-80 to 100) °C | 0.06 °C | | |
| (100 to 260) °C | 0.07 °C | | |
| (260 to 400) °C | 0.09 °C | | |
| (400 to 600) °C | 0.01 °C | | |
| (600 to 630) °C | 0.13 °C | | |

Electrical – DC/Low Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|-----------------|---|--|
| Electrical Simulation of RTD Indicators ¹ | PT 385 1 000 Ω | | Fluke 5520A Multi Product Calibrator |
| | (-200 to 0) °C | 0.04 °C | |
| | (0 to 100) °C | 0.05 °C | |
| | (100 to 260) °C | 0.06 °C | |
| | (260 to 300) °C | 0.07 °C | |
| | (300 to 600) °C | 0.08 °C | |
| | (600 to 630) °C | 0.27 °C | |
| | PtNi 120 Ω | | |
| | (-80 to 100) °C | 0.09 °C | |
| | (100 to 260) °C | 0.16 °C | |
| Cu 427 10 Ω | | | |
| (-100 to 260) °C | 0.35 °C | | |

Electrical – RF/Microwave

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|-------------------|---|--|
| RF Power - Measure Absolute Level ¹ | (-36 to 20) dBm | 0.16 dB | Agilent E9304A/N1912A Agilent N5531S Measuring Receiver with N5532A Sensor Module |
| | 9 kHz to 6 GHz | | |
| | (20 to 30) dBm | | |
| | (6 to 18) GHz | | |
| RF Power - Measure Absolute Level ¹ | (18 to 26.5) GHz | 0.44 dB | Agilent N5531S Measuring Receiver with N5532A Sensor Module |
| | (-20 to 20) dBm | 0.5 dB | |
| | 100 kHz to 30 MHz | 0.2 dB | |
| | 30 MHz to 2 GHz | 0.21 dB | |
| | (1 to 18) GHz | 0.31 dB | |
| RF Power - Measure Absolute Level ¹ | (18 to 26.5) GHz | 0.4 dB | Agilent N5531S Measuring Receiver with 8482A Sensor |
| | (-30 to 20) dBm | 3.1 % of reading | |
| | 100 kHz to 30 MHz | | |
| Relative Power – Measure ¹ 100 kHz to 26.5 GHz | (-10 to 0) dB | | 0.02 dB |
| | (-20 to -10) dB | 0.03 dB | |
| | (-30 to -20) dB | 0.03 dB | |
| | (-40 to -30) dB | 0.05 dB | |
| | (-50 to -40) dB | 0.06 dB | |
| | (-60 to -50) dB | 0.06 dB | |
| | (-70 to -60) dB | 0.07 dB | |
| | (-80 to -70) dB | 0.07 dB | |

Electrical – RF/Microwave

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|---|
| Relative Power – Measure ¹ 100 kHz to 26.5 GHz | (-90 to -80) dB (-100 to -90) dB (-110 to -100) dB (-120 to -110) dB (-130 to -120) dB (-140 to -130) dB | 0.08 dB 0.08 dB 0.09 dB 0.1 dB 0.1 dB 0.1 dB | Agilent N5531S Measuring Receiver with N5532A Sensor Module |
| RF Power – Source ¹ | (-90 to -75) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz (-75 to -10) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz (-20 to -10) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz | 0.73 dB 1 dB 1.2 dB 0.72 dB 1 dB 1.2 dB 1.4 dB 1.3 dB 1.3 dB | Agilent N5183A Signal Generator |
| RF Power – Source ¹ | (-10 to 10) dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz > 10 dBm 250 kHz to 2 GHz (2 to 20) GHz (20 to 32) GHz | 0.61 dB 0.91 dB 0.93 dB 0.63 dB 0.92 dB 1 dB | Agilent N5183A Signal Generator |
| Phase Modulation - Source ¹ 100 kHz to 32 GHz | Rate: DC to 1 MHz DC to 4 MHz | 0.59 % of reading + 0.01 rad | Agilent N5183A Signal Generator |
| LO Phase Noise @ 1GHz | (-50 to 20) dB Frequency offset: (0.10 to 1 000) Hz (1 to 9 900) kHz | 0.48 dB 0.64 dB | Keysight E4440A Spectrum Analyzer |
| Amplitude Modulation ¹ - Source 100 kHz to 32 GHz | Rate: DC to 10 kHz Depths: (1 to 90) % | 4.1 % of reading | Agilent N5183A Signal Generator |

Electrical – RF/Microwave

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| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|--|
| Amplitude Modulation - Measure ¹ 100 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz | Rate: 20 Hz to 10 kHz Depths: (5 to 99) % Rate: 50 Hz to 100 kHz Depths: (20 to 99) % Rate: 50 Hz to 100 kHz Depths: (5 to 20) % Rate: 50 Hz to 100 kHz Depths: (20 to 99) % Rate: 50 Hz to 100 kHz Depths: (5 to 20) % | 0.83 % of reading 0.59 % of reading 2.6 % of reading 1.6 % of reading 4.7 % of reading | Agilent N5531S Measuring Receiver with N5532A Sensor Modules |
| Pulse Generation – Source ¹ Repetition Frequency: 0.10 Hz to 10.0 MHz | 30 ns to 42 s | 10 ns | Agilent N5183A Signal Generator |
| Phase Modulation-Measure ¹ 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz | Rate: 200 Hz 20 kHz Dev.: > 0.7 rad Rate: 200 Hz, 20 kHz Dev.: > 0.3 rad Rate: 200 Hz 20 kHz Dev.: > 2.0 rad Rate: 200 Hz 20 kHz Dev.: > 0.6 rad Rate: 200 Hz 20 kHz Dev.: > 2.0 rad Rate: 200 Hz 20 kHz Dev.: > 0.6 rad | 1.1 % of reading 3.1 % of reading 1.1 % of reading 3.1 % of reading 1.1 % of reading 3.1 % of reading | Agilent N5531S Measuring Receiver with N5532A Sensor Modules |
| Frequency Modulation ¹ - Source 100 kHz to 32 GHz | 1 dB Rate: DC to 3 MHz 3 dB Rate: DC to 7 MHz | 2 % of setting + 20 Hz | Agilent N5183A Signal Generator |



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Electrical – RF/Microwave

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| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|---|---|
| Freq Modulation-Measure ¹ Freq. Dev. Mod Rate Ratio >0.2 | | | |
| 250 kHz to 10 MHz | Rate: 20 Hz to 10 kHz Dev.: 200 Hz to 40 kHz peak Freq. Dev. Mod Rate Ratio >0.2 | 1.6 % of reading | Agilent N5531S Measuring Receiver with N5532A Sensor Modules |
| 250 kHz to 10 MHz | Rate: 20 Hz to 10 kHz Dev.: 200 Hz to 40 kHz peak Freq. Dev. Mod Rate Ratio >1.2 | 1.1 % of reading | |
| 10 MHz to 6.6 GHz | Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.2 | 1.6 % of reading | |
| 10 MHz to 6.6 GHz | Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.45 | 1.1 % of reading | |
| (6.6 to 13.2) GHz | Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.2 | 2.6 % of reading | |
| (6.6 to 13.2) GHz | Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >8 | 1.1 % of reading | |

Electrical – RF/Microwave

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|---|---|
| Freq Modulation-Measure ¹ Freq. Dev. Mod Rate Ratio >0.2 (13.2 to 26.5) GHz | Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak Freq. Dev. Mod Rate Ratio >0.2 | 3.9 % of reading | Agilent N5531S Measuring Receiver with N5532A Sensor Modules |
| (13.2 to 26.5) GHz | Rate: 50 Hz to 200kHz Dev.: 250 Hz to 400 kHz peak | 1.1 % of reading | |

Length – Dimensional Metrology

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---------------------------------------|---|--|
| Angle | (0.25 to 365) ° | 2.4 arc sec | Gage Blocks, Gage Amplifier, Sine Bar |
| Angle Plates – Squareness ² | Up to 18 in | 0.32 m° (5.6 μin/ in) | Gage Amplifier with probe, Master Square(s) |
| Gage Blocks ² | (0.01 to 1) in (2 to 3) in 4 in | (1.4 + 1.3L) μin (1.1 + 1.3L) μin 6.1 μin | Gage Blocks Gage Block Comparator |
| | (5 to 12) in (12 to 20) in | (5 + 2L) μin (2 + 2.8L) μin | Horizontal Measuring Machine |
| | 100 mm (125 to 500) mm | 0.17 μm (0.06 + 0.000 6L) μm | Comparison to Primary Master Gage Blocks |
| Indicators ^{1,2} | (0.000 1 to 6) in | (5+8L) μin | Horizontal Measuring Machine |
| Calipers ^{1,2} | Up to 60 in | (5+8L) μin | Gage Blocks |
| Micrometers OD ^{1,2} | Up to 12 in | (5+8L) μin | Gage Blocks, Optical Parallels |
| Height Measuring Devices ^{1,2} | Up to 36 in (36 to 48) in | (43 + 1.7L) μin (7 + 3L) μin | Gage Blocks |
| Grind Gages | Up to 100 mm | 0.35 mm | Digital Indicator |

Length – Dimensional Metrology

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|---|
| Coating Thickness Gages ^{1,2} | Up to 0.02 in | 58 μin + 0.6R | Coating Thickness Standards |
| Coating Thickness Gage Standards | Up to 0.10 in | 21 μin | Horizontal Measuring Machine |
| External Diameter ^{1,2} | (0.000 1 to 12) in | (3 + 3L) μin | Horizontal Measuring Machine |
| Internal Diameter ^{1,2} | (0.04 to 13) in | (3 + 3L) μin | Horizontal Measuring Machine |
| Thread Plugs ^{1,2} Pitch Diameter | Up to 8 in Pitch (0.2 to 5) mm | (81 + 2.3L) μin | Horizontal Measuring Machine |
| Major Diameter | Pitch 90 – 4 TPI Up to 4 in | (3.5 + 4.6L) μin | Thread Measuring Wires |
| Thread Rings (Adjustable) Pitch Diameter Tactile Fit (Set to Plug) | Up to 4 in | See footnote ⁵ | Thread Setting Plug |
| Optical Comparators ^{1,2} Linear Accuracy | Up to 6 in 6 to 12 in | (43 + 11L) μin (30 + 7.5L) μin | Glass Scale |
| Magnification | (5 to 100) X | 350 μin | Glass Scale (Sphere) |
| Surface Plates ^{1,2} Overall Flatness | Up to 54 inDL (54 to 238) inDL | (17 + 0.7DL) μin (1 + 1.4DL) μin | Laser System |
| Local Area Flatness | Up to 238 inDL | 34 μin | Repeat-O-Meter |
| Roundness/Cylindricity Artifacts | Up to 150 mm | 0.02 μm | Rondcom41c |
| Surface Finish Artifacts | Up to 118 μin 118.1 to 500 μin | 0.5 μin + 1 % of nominal 0.6 μin + 1.1 % of nominal | Profilometer, Master Patch |
| Profilometers ¹ | Up to 500 μin | 0.7 μin + 1.1 % of nominal | Master Patch |
| Optical Flats Parallelism Flatness | Up to 6 inD (0 to 80) μin | 2.7 μin 3.5 μin | Gage Block Comparator, Master Flat |
| CMMs ^{1,2} Linearity | (0 to 144) in | (25 + 2.4L) μin | Laser Measuring System |
| Volumetric Repeatability | (6 to 24) in (0.5 to 2) in | 66 μin 45 μin | Ball Bar CMM Sphere |

Length – Dimensional Metrology

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|------------------------------|--|---|
| VMMs ^{1,2} | Linearity | $(32 + 4.1L) \mu\text{in}$ | Glass Scales |
| Graduated Scales ^{1,2} Glass, Steel, Tape | Up to 12 in (1 to 200) ft | $(40 + 1L) \mu\text{in}$ $(10 + 3L) \mu\text{in}$ | Laser Measuring System |
| Horizontal Measuring Systems ^{1,2} | Up to 8 in (8 to 60) in | $(6 + 1.7L) \mu\text{in}$ $(3 + 2.5L) \mu\text{in}$ | Gage Blocks |
| Bore Gages ² 2-point | (0.24 to 9) in | $(4.3 + 3L) \mu\text{in} + 0.6R$ | Horizontal Measuring Machine |
| 3-point | | $(85 + 7L) \mu\text{in} + 0.6R$ | Cylindrical Rings |
| Protractors | (0 to 90) ° | 0.16 ° | Sine Bar, Gage Blocks |
| Chamfer Gages ² | (0.179 to 2.749) in | $280 \mu\text{in} + 0.6R$ | Chamfer Rings |
| Cylindrical Squares - Squareness | Up to 12 in | 1.5 arc seconds | Gage Amplifier w/ probe, Master Square(s) |
| Cylindricity | | 0.02 μm | Roundness Machine |
| Feeler/Thickness Gages ² | Up to 0.2 in | $(4.3 + 3L) \mu\text{in}$ | Horizontal Measuring System |
| Gage Amplifier w/ Probe(s) | Up to 0.1 in | 10 μin | Gage Blocks |
| Gage Balls/Spheres ² - Diameter | Up to 6 in | $(4.3 + 3D) \mu\text{in}$ | Gage Blocks, Horizontal Measuring System |
| Roundness | | 0.02 μm | Roundness Machine |
| Indicator Calibrator ² - Linearity | Up to 6 in | $60 \mu\text{in} + 0.6R$ | Horizontal Measuring System |
| Groove Micrometers ² | Up to 12 in | $(44 + 2.6L) \mu\text{in} + 0.6R$ | Gage Blocks |
| Machinist Levels ² - Zero Check Linearity | Up to 24 in | 350 μin $(100 + 0.83L) \mu\text{in}$ | Master Level Gage Blocks |
| Microscopes, Stereo Reticle Linearity | Up to 2 in | 870 μin | Stage Micrometer |
| Microscopes – Toolmakers ² Scale Linearity | Up to 4 in | $(774 + 70L) \mu\text{in} + 0.6R$ | Stage Micrometer |
| Length Standards ² | (1 to 60) in | $(3.4 + 3.5L) \mu\text{in}$ | Horizontal Measuring System |

Length – Dimensional Metrology

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--------------------------|--|---|
| Micrometers – Inside ² | Up to 8 in 8 to 60 in | $(6 + 1.7L) \mu\text{in}$ $(3 + 2.5L) \mu\text{in}$ | Horizontal Measuring System |
| Pi Tapes ² – Length | Up to 12 in | $(40 + 1L) \mu\text{in}$ $(10 + 3L) \mu\text{in}$ | Laser System |
| Thickness | (12 to 200) in | 240 μin | Micrometer |
| Parallels ² – Steel | Up to 18 in | $(96 + 1.8L) \mu\text{in}$ | Electronic Amplifier with Probe |
| Granite | | $(49 + 0.7L) \mu\text{in}$ | Surface Plate |
| Pitch Micrometer Standard ² Length | (1 to 65) in | $(3.4 + 3.5L) \mu\text{in}$ | Horizontal Measuring System |
| Angle | 60 ° | 0.004 ° (70 $\mu\text{in}/\text{in}$) | Vision System |
| Radius Gages | (0.015 625 to 0.5) in | 300 μin | Vision System |
| Sine Plates/Bars ² – Top Surface Flatness | Up to 0.1 in | $(41 + 2.2L) \mu\text{in}$ | Electronic Amplifier with Probe |
| Overall Length | Up to 10 in | $(3.4 + 3.5L) \mu\text{in}$ | Horizontal Measuring System |
| Squares ² | Up to 18 in | 0.32 m° (5.6 $\mu\text{in}/\text{in}$) | Electronic Amplifier with Probe, Master Square |
| Straightness and Straight Edges ² | Up to 60 in | $(208 + 2.3L) \mu\text{in}$ | Electronic Amplifier with Probe, Surface Plate |
| Tapered Plugs ² - Pitch Diameter Major Diameter Step Height | (0.0625 to 6) in | $(137 + 3.3L) \mu\text{in}$ $(123 + 6.7L) \mu\text{in}$ 280 μin | Horizontal Measuring System, Sine Block Thread Wires Height Gage |
| Roundness Machine - Roundness (Spindle Performance) | Up to 0.016 in | 15 μin | Master Sphere |
| Tapered Rings - Pitch Diameter | (0.0625 to 6) in | 160 μin | NPT Master Plug, Electronic Amplifier with Probe |
| Step Height | | 5 μin | Height Gage |

Length – Dimensional Metrology

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|-------------|---|--|
| Thickness Gages ² - Dial Digital | Up to 1 in | 410 μin + 0.6R 44 μin+ 0.6R | Gage Blocks |
| Thread Micrometers ² (Screw Thread, Pitch Point) Linearity Anvil Wear | Up to 12 in | (44 + 2.6L) μin + 0.6R 690 μin | Gage Blocks Thread Setting Plug |
| Granite V Blocks - Side Parallelism V Parallelism Squareness | Up to 12 in | (51 + 0.47L) μin | Electronic Amplifier with Probe, Surface Plate |
| Extensometers ¹ | Up to 2 in | 16 μin | Extensometer Calibrator |
| Extensometers ¹ Gage Length | (0 to 2) in | 78 μin | Caliper |

Mass and Mass Related

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|--|
| Force ¹ Source and Measure | (0.035 to 16) ozf (1 to 10) lbf (10 to 50) lbf (50 to 500) lbf | 0.017 % of reading 0.018 % of reading 0.018 % of reading 0.036 % of reading | Dead Weight |
| | (500 to 100 000) lbf | 0.04 % of reading | Load Cells |
| | (30 000 to 400 000) lb | 0.29 % of applied value | Load Cells, Class A (compression only) |
| Test Machine Crosshead Displacement ^{1,2} | Up to 1 in (1 to 36) in | 0.000 3 in (150 + 146L) μin | Indicator Indicator/Gage Blocks |
| Cable Tensiometers | Up to 600 lb (600 to 2 000) lb | 1.2 % of applied value 1.3 % of applied value | Dead Weight Load Cells |
| Viscometers ¹ | Up to 25 cP (25 to 1 500) cP (1 500 to 75 000) cP | 0.33 % of reading 0.52 % of reading 0.55 % of reading | Viscosity Standards |
| Pressure ¹ | (10 to 17) psia | 0.000 4 psi | Pressure Calibrator |
| Pressure | (-14.5 to -0.5) psi (1 to 500) psi (500 to 10 000) psi | 65 μpsi/psi 65 μpsi/psi 70 μpsi/psi | Dead Weight Tester |



ANSI National Accreditation Board

Mass and Mass Related

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|------------------------------------|---|--|--|
| | (0 to 2) inH2O (2 to 60) inH2O | 0.000 35 inH2O 0.009 1 % of reading + 0.000 3 inH2O | Fluke 7250LP Low Pressure Calibrator |
| Mass Flow (Gas) | (5 to 50 000) SCCM (0.5 to 50) SLPM (50 to 500) SLPM | 0.25 % of reading 0.22 % of reading 0.2 % of reading | Mesa Flow System |
| Air Velocity | 30 FPM (40 to 60) FPM (60 to 150) FPM (150 to 275) FPM (275 to 9000) FPM | 5.1 % of reading 2.6 % of reading 1.2 % of reading 0.99 % of reading 0.74 % of reading | Wind Tunnel with Pitot Tube |
| Torque Tools ¹ | 0.5 ozf·in to 200 ozf·in (5 to 50) lbf·in (50 to 400) lbf·in (400 to 1000) lbf·in (80 to 250) lbf·ft (250 to 600) lbf·ft (600 to 2 000) lbf·ft | 0.56 % of reading 0.33 % of reading 0.36 % of reading 0.4 % of reading 0.28 % of reading 0.51 % of reading 0.75 % of reading | Torque Tester |
| Torque Transducers ¹ | 0.5 ozf·in to 1 000 lbf·ft | 0.08 % of reading | Dead Weight Torque Arms |
| Graduated Cylinders | (1 to 200) mL (100 to 1 000) mL (600 to 6 000) mL | 1.9 µL 3.2 µL 26 µL | Balances |
| Pipettes | Up to 1 µL (1 to 5) µL (5 to 10) µL (10 to 20) µL (20 to 50) µL (50 to 100) µL (100 to 200) µL (200 to 500) µL (500 to 1 000) µL (1 000 to 10 000) µL (10 to 20) mL | 0.041 µL 0.033 µL 0.028 µL 0.034 µL 0.046 µL 0.061 µL 0.27 µL 0.3 µL 0.79 µL 2.7 µL 5.8 µL | Pipette Calibration System |
| Scales and Balances ^{1,6} | Up to 5 mg (5 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 250) g | 0.005 mg 0.006 mg 0.007 mg 0.012 mg 0.014 mg 0.024 mg 0.086 mg 0.092 mg | OIML E2 Class 1 Weights |



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Mass and Mass Related

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|--|--|
| Scales and Balances ^{1,6} | 250 g to 1.1 kg (1.1 to 6.1) kg (6.1 to 33) kg | 1.4 mg 9 mg 90 mg | OIML E2 Class 1 Weights |
| | (0.5 to 2 000) lb | 0.01 % of reading | Class 6 Weights |
| Mass | 1 mg to 5 g (5 to 50) g (50 to 100) g (100 to 250) g (250 to 500) g (500 to 1 kg (1 to 6) kg (6 to 25) kg | 0.04 mg 0.04 mg 0.04 mg 0.12 mg 0.17 mg 0.9 mg 9 mg 90 mg | Class 1 Weights |
| Microindentation Hardness Testers ¹ (Knoop and Vickers) | Repeatability under forces (gf): 100 ≤ HK ≤ 500 HV = 100 | 2.1 % of Reading 4.1 % of Reading | Indirect Verification to Test Blocks |
| Brinell Hardness Testers ¹ | Repeatability at: 500 kgf ≤ 100 HBW ≥ 64 HBW 1 500 kgf ≤ 257 HBW ≥ 91 HBW 3 000 kgf ≤ 587 HBW ≥ 186 HBW | 0.025 mm 0.025 mm 0.025 mm 0.03 mm 0.025 mm 0.025 mm | Indirect Verification to Test Blocks |

Mass and Mass Related

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---------------|---|--|
| Rockwell Hardness Testers ¹ | HRA Low | 1.6 HRA | Indirect Verification to Test Blocks |
| | HRA Middle | 1.6 HRA | |
| | HRA High | 1.2 HRA | |
| | HRBW Low | 1.6 HRBW | |
| | HRBW Middle | 2.1 HRBW | |
| | HRBW High | 1.6 HRBW | |
| | HRC Low | 1.6 HRC | |
| | HRC Middle | 1.6 HRC | |
| | HRC High | 1.2 HRC | |
| | HREW Low | 1.6 HREW | |
| | HREW Middle | 1.6 HREW | |
| | HREW High | 1.6 HREW | |
| | HRMW Low | 1.6 HRMW | |
| | HRMW Middle | 1.6 HRMW | |
| | HRMW High | 1.6 HRMW | |
| | HR15N Low | 1.7 HR15N | |
| | HR15N Middle | 1.6 HR15N | |
| | HR15N High | 1.3 HR15N | |
| | HR15TW Low | 1.6 HR15TW | |
| | HR15TW Middle | 1.6 HR15TW | |
| | HR15TW High | 1.6 HR15TW | |
| | HR30N Low | 1.6 HR30N | |
| | HR30N Middle | 1.6 HR30N | |
| | HR30N High | 1.4 HR30N | |
| HR30TW Low | 1.6 HR30TW | | |
| HR30TW Middle | 1.6 HR30TW | | |
| HR30TW High | 1.6 HR30TW | | |
| HR45N Low | 1.6 HR45N | | |
| HR45N Middle | 1.6 HR45N | | |
| HR45N High | 1.6 HR45N | | |



ANSI National Accreditation Board

Mass and Mass Related

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|---|--|
| Durometers Spring Force Types A, B, E, O Types C, D, and DO Types M, OO, OOO, OOO-S | (1.3 to 8.05) N (4.445 to 44.5) N (0.294 to 1.932) N | 0.023 N 0.06 N 0.002 N | Full Direct Verification Shore Durometer Calibrator Balance |
| Indenter Angle Indenter Length Indenter Radius | (20 to 40) ° (0.049 to 0.198) in (0.05 to 0.1) in | 0.004 ° 220 μin 250 μin | VMM |

Thermodynamic

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|--|---|
| Temperature - Measure | (-200 to -20) °C (-20 to 120) °C (120 to 200) °C (200 to 300) °C (300 to 660) °C | 0.006 2 °C 0.001 7 °C 0.023 °C 0.023 °C 0.024 °C | Fluke 5699 SPRT Fluke 1590 Super Thermometer |
| Temperature – Source | (-95 to -20) °C (-20 to 120) °C (120 to 425) °C (425 to 660) °C | 0.032 °C 0.001 7 °C 0.038 °C 0.063 °C | SPRT Fluke 1590 Super Thermometer With liquid baths and Metrology Well |
| Radiation (Infrared) Thermometers | (-15 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 500) °C | 0.54 °C 0.69 °C 1.1 °C 1.6 °C 2.4 °C | Fluke 4180 and 4181 Black Body Calibrators $\lambda = (8 \text{ to } 14) \mu\text{m}$, $\epsilon = (0.9 \text{ to } 1.0)$ |
| Infrared Temperature | (550 to 1 500) °C | 0.46 % of reading | Comparison to Reference Infrared Thermometer $\lambda = (8 \text{ to } 14) \mu\text{m}$, $\epsilon = 0.95$ |
| Humidity ¹ Source and Measure | (5 to 10) %RH (10 to 50) %RH (50 to 90) %RH (90 to 95) %RH | 0.56 %RH 0.5 %RH 0.55 %RH 0.58 %RH | Humidity Indicator |

Time and Frequency

Burnsville, MN

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---------------------------------|--------|---|--|
| Frequency – Source ⁴ | 10 MHz | 5 x 10 ⁻¹¹ Hz | SRS FS Rubidium GPS Disciplined Oscillator |

DIMENSIONAL MEASUREMENT

2 Dimensional

Burnsville, MN

| Specific Tests and / or Properties Measured | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method and/or Equipment |
|---|-----------------------------------|--|---|
| Angle | (0.25 to 365) ° | 0.69 m° (12 μin/ in) | Gage Blocks, Gage Amplifier, Sine Bar |
| Angle | (0.25 to 365) ° | 0.004 ° | Coordinate Measuring Machine |
| Non-contact | (12 x 8 x 4) in | (44 + 1L) μin | Vision System |
| Roundness/Cylindricity | Up to 150 mm | 0.02 μm | Rondcom41c |
| Surface Finish Analysis | Up to 118 μin 118.1 to 500 μin | 0.5 μin + 1 % of nominal 0.6 μin + 1.1 % of nominal | Profilometer, Master Patch |

3 Dimensional

Burnsville, MN

| Specific Tests and / or Properties Measured | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method and/or Equipment |
|---|-------------------|---|---|
| Dimensional Inspection Contact | (28 x 40 x 28) in | (74 + 4.7L) μin | Coordinate Measuring Machine |

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ANSI National Accreditation Board

Services performed at satellite laboratory

1208 Allanson Road,
Mundelein, IL 60060
847-566-3700

General Manager: Michael Crosby mcrosby@martincalibration.com

CALIBRATION

Chemical Quantities

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|------------------------|-----------------------|---|--|
| pH Meters ¹ | 4 pH 7 pH 10 pH | 0.016 pH 0.016 pH 0.016 pH | Buffer Solutions |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|--|
| DC Voltage – Source ¹ fixed point | 10V | 0.3 μ V/V | 732B Voltage Standards with Fluke Maps |
| DC Voltage – Source ¹ | 0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V | 20 nV 100 nV 22 μ V/V + 25 nV 5.3 μ V/V 0.5 μ V/V 0.31 μ V/V 0.35 μ V/V 1 μ V/V | MI Potentiometer/ Divider & Fluke 5720A Multi Product Calibrator |
| DC Voltage – Measure ¹ | 0V Up to 1 mV (1 to 10) mV (10 to 100) mV (100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1 100) V | 20 nV 100 nV 22 μ V/V + 25 nV 5.3 μ V/V 0.5 μ V/V 0.31 μ V/V 0.35 μ V/V 1 μ V/V | Nano Voltmeter Fluke 732B Voltage Standard with MI Potentiometer/ Divider |
| DC Voltage – Measure ¹ | (1.05 to 100) kV | 0.1 % of reading | Hipotronics KVM100-A High Voltage Meter |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--|--|---|
| DC Current – Source & 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 | 22 pA 30 μ A/A 6.8 μ A/A 6.2 μ A/A 4.1 μ A/A 4.2 μ A/A 3.9 μ A/A 17 μ A/A | Standard resistors and DMM and Multifunction Calibrator |
| DC Current – Source & Measure ¹ | (1 to 10) A (10 to 20) A (20 to 100) A | 80 μ A/A + 80 μ A 80 μ A/A + 800 μ A 80 μ A/A + 40 mA | Fluke 52120A Amplifier |
| DC Current – Source ¹ | (100 to 150) A (150 to 1 025) A | 5 mA/A + 20 mA 5.1 mA/A + 0.9 A | Fluke 5520A Multi Product Calibrator with 50-turn Coil |
| AC Voltage – Source & Measure ¹ | (0 to 2.2) mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz (2.2 to 7) mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz | 0.035 % of reading + 1.3 μ V 0.037 % of reading + 1.3 μ V 0.04 % of reading + 1.3 μ V 0.025 % of reading + 2 μ V 0.027 % of reading + 2.5 μ V 0.033 % of reading + 4 μ V 0.036 % of reading + 8 μ V 0.02 % of reading + 8 μ V 0.023 % of reading + 1.3 μ V 0.024 % of reading + 1.3 μ V 0.022 % of reading + 1.3 μ V 0.014 % of reading + 2 μ V 0.009 % of reading + 2.5 μ V 0.029 % of reading + 4 μ V 0.055 % of reading + 8 μ V 0.056 % of reading + 8 μ V | Fluke 5790A AC Standard w/ 5720A Multi Product Calibrator |
| AC Current – Source and Measure ¹ | Up to 10 mA (0.01 to 100) kHz (10 to 20) mA (0.01 to 100) kHz (20 to 200) mA (0.01 to 100) kHz | 250 μ A/A 250 μ A/A 250 μ A/A | Fluke 5720A Multi Product Calibrator and Fluke 5725A Amplifier w/ A40B Shunts |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|---|
| AC Current – Source and Measure ¹ | (0.2 A to 20) A 0.01 to 1) kHz (1 to 10) kHz (10 to 30) kHz (30 to 100) kHz | 250 μ A/A 250 μ A/A 300 μ A/A 350 μ A/A | Fluke 5720A Multi Product Calibrator and Fluke 5725A Amplifier w/ A40B Shunts |
| AC Current – Source and Measure ¹ | (20 to 100) A | 0.015 % of reading | Fluke 52120A Amplifier |
| AC Current – Source ¹ (45 to 65) Hz (65 to 440) Hz | (10 to 16.5) A (16.5 to 150) A (150 to 1 025) A (10 to 16.5) A (16.5 to 150) A (150 to 1 025) A | 5.9 mA/A + 30 mA 5.7 mA/A + 25 mA 5.7 mA/A + 0.9 A 11 mA/A + 30 mA 10 mA/A + 0.25 A 13 mA/A + 0.9 A | Fluke 5520A Multi Product Calibrator with 50-turn Coil |
| AC Current – Measure ¹ | Up to 200 μ A (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz 200 μ A to 2 mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz 200 mA to 2 A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz | 0.62 mA/A 0.54 mA/A 0.94 mA/A 8.4 mA/A 0.6 mA/A 0.54 mA/A 0.94 mA/A 4.2 mA/A 0.6 mA/A 0.54 mA/A 0.94 mA/A 4.2 mA/A 0.57 mA/A 0.49 mA/A 0.83 mA/A 0.83 mA/A 0.93 mA/A 3.2 mA/A | Fluke 8508A Multimeter |
| AC Current – Measure ¹ | (2 to 20) A 10 Hz to 2 kHz (2 to 10) kHz | 1 mA/A 2.7 mA/A | Fluke 8508A Multimeter |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|------------------------------------|--|---|
| Resistance – Source ¹ | 0.001 Ω | 3.5 μΩ/Ω | Standard resistors |
| | 0.01Ω | 4.3 μΩ/Ω | |
| | 0.1 Ω | 1.5 μΩ/Ω | |
| | 1Ω | 0.85 μΩ/Ω | |
| | 10Ω | 0.66 μΩ/Ω | |
| | 100 Ω | 1.7μΩ/Ω | |
| | 1 kΩ | 1.2 μΩ/Ω | |
| | 10 kΩ | 2.4 μΩ/Ω | |
| | 100 kΩ | 0.57 μΩ/Ω | |
| | 1 MΩ | 1.3 μΩ/Ω Ω | |
| | 10 MΩ | 14 μΩ/Ω | |
| | 100 MΩ | 130 μΩ/Ω | |
| 1 GΩ | 0.32 μΩ/Ω | | |
| Resistance – Source ¹ | (0.01 to 10) MΩ (0.01 to 10) GΩ | 10 μΩ/Ω 0.5 % of reading | Decade resistors with bridge and DMM |
| Resistance – Source ¹ | (10 to 100) GΩ | 1.2 % of reading | Decade Resistor |
| Resistance – Measure ¹ Normal Mode | (10 to 100) μΩ | 0.15 % of reading | Decade resistors with bridge and DMM |
| | (0.1 to 1) mΩ | 15 μΩ/Ω | |
| | (1 to 10) mΩ | 5.1 μΩ/Ω | |
| | (10 o 100) mΩ | 1.8 μΩ/Ω | |
| | (0.1 to 1) Ω | 0.92 μΩ/Ω | |
| | (1 to 10) Ω | 0.74 μΩ/Ω | |
| | (10 to 100) Ω | 1.7 μΩ/Ω | |
| | (0.01 to 1) kΩ | 1.3 μΩ/Ω | |
| | (1 to 10) kΩ | 2.4 μΩ/Ω | |
| | (10 o 100) kΩ | 1.1 μΩ/Ω | |
| | (0.1 to 1) MΩ | 8.2 μΩ/Ω | |
| | (1 to 10) MΩ | 21μΩ/Ω | |
| | (10 to 200) MΩ | 72μΩ/Ω + 1kΩ | |
| | (0.2 to 2) GΩ | 0.18 mΩ/Ω + 100 kΩ | |
| (2 to 20) GΩ | 0.67 mΩ/Ω + 10 MΩ | | |
| Resistance – Measure ¹ High Voltage Mode up to 200 V | (2 to 20) MΩ | 15 μΩ/Ω + 10 Ω | Decade resistors with bridge and DMM |
| | (20 to 200) MΩ | 60 μΩ/Ω + 1 kΩ | |
| | 200 MΩ to 2 GΩ | 0.15 mΩ/Ω + 100 kΩ | |
| | (2 to 20) GΩ | 0.53 mΩ/Ω + 10 MΩ | |
| Capacitance – Measure ¹ | 1 pF @ 1 kHz | 1.9 mF/F | QuadTech 1730 LCR Meter |
| | 10 pF @ 1 kHz | 1.1 mF/F | |
| | 100 pF @ 1kHz | 1.2 mF/F | |
| | 1 nF 1kHz | 1.2 mF/F | |
| | 1 μF @ 1 kHz | 1.2 mF/F | |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|--|--|
| Capacitance – Source ¹ (fixed values) @ 100 Hz @ 1 kHz | 1 pF 1 nF 10 nF 100 nF 1 μF | 1.8 mF/F 0.23 mF/F 0.25 mF/F 0.21 mF/F 0.25 mF/F | Standard Capacitors |
| Capacitance – Source ¹ 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz 10 Hz to 300 Hz 10 Hz to 150 Hz 10 Hz to 120 Hz 10 Hz to 80 Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz | 0.19 nF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF | 15 mF/F 8.4 mF/F 3.6 mF/F 3.6 mF/F 3.7 mF/F 3.6 mF/F 3.6 mF/F 3.6 mF/F 5.1 mF/F 5.6 mF/F 5.6 mF/F 8.7 mF/F 5.5 mF/F 5.5 mF/F 8.5 mF/F 12 mF/F | Fluke 5520A Multi Product Calibrator |
| Inductance – Measure ¹ | 100 μH @ 1 kHz 1 mH @ 1 kHz 10 mH @ 1 kHz 100 mH @ 1 kHz 1 H @ 1 kHz | 1.2 mH/H | QuadTech 1730 LCR Meter |
| Inductance – Source ¹ | 500 μH @ 100 Hz 500 μH @ 1 kHz 2 mH @ 100 Hz 2 mH @ 1 kHz 20 mH @ 100 Hz 20 mH @ 1 kHz | 1.2 mH/H 1 mH/H 1.1 mH/H 1 mH/H 1.1 mH/H 1 mH/H | Standard Inductors |
| Inductance – Source ¹ | 1 H @ 100 Hz 1 H @ 1 kHz 10 H @ 100 Hz 10 H @ 1 kHz | 1 mH/H 1 mH/H 1 mH/H 1 mH/H | Standard Inductors |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|---|
| Oscilloscopes ¹ Square Wave Signal 50 Ω at 1 kHz | 40 μV to 5 V | 1 mV/V | Fluke 9500B/3200/9530 Oscilloscope Calibrator |
| Square Wave Signal 1 MΩ at 1 kHz | 40 μV to 5 V | 1 mV/V | |
| Oscilloscopes ¹ DC Voltage, 50 Ω DC Voltage, 1 MΩ | 1 mV to 5 V 1 mV to 200 V | 0.26 mV/V 0.25 mV/V | Fluke 9500B/3200/9530 Oscilloscope Calibrator |
| Leveled Sine Wave Amplitude | 5 mV to 5 V | 15 mV/V | |
| Leveled Sine Wave Flatness (relative to 50 kHz) | 4.4 mVpp to 5.6 Vpp 0.1 Hz to 300 MHz | 43 mV/V | |
| | (300 to 550) MHz | 43 mV/V | |
| Time Marker 50 Ω Source and Period | 4.4 mVpp to 3.3 Vpp 550 MHz to 1.1 GHz | 52 mV/V | |
| | (1.1 to 3.2) GHz | 52 mV/V | |
| Rise/Fall Time - Source | 9 ns to 55 s | 0.25 μs/s | |
| Pulse Width - Source | 150 ps (1 to 100) ns | 27 ps 52 ms/s | |
| Electrical Simulation of Thermocouple Indicators ¹ | Type B | | Ectron 1140A Thermocouple Simulator |
| | (250 to 350) °C | 1.1 °C | |
| | (350 to 445) °C | 0.85 °C | |
| | (445 to 580) °C | 0.67 °C | |
| | (580 to 750) °C | 0.52 °C | |
| | (750 to 1 000) °C | 0.43 °C | |
| | (1 000 to 1 820) °C | 0.33 °C | |
| | Type C | | |
| | (0 to 250) °C | 0.23 °C | |
| | (250 to 1 000) °C | 0.18 °C | |
| | (1 000 to 1 500) °C | 0.21 °C | |
| | (1 500 to 1 800) °C | 0.24 °C | |
| | (1 800 to 2 000) °C | 0.27 °C | |
| | (2 000 to 2 250) °C | 0.33 °C | |
| (2 250 to 2 315) °C | 0.37 °C | | |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---------------------|---|--|
| Electrical Simulation of Thermocouple Indicators ¹ | Type E | | Ectron 1140A Thermocouple Simulator |
| | (-270 to -245) °C | 1.4 °C | |
| | (-245 to -195) °C | 0.21 °C | |
| | (-195 to -155) °C | 0.12 °C | |
| | (-155 to -90) °C | 0.09 °C | |
| | (-90 to 15) °C | 0.08 °C | |
| | (15 to 890) °C | 0.07 °C | |
| | (890 to 1 000) °C | 0.08 °C | |
| | Type J | | |
| | (-210 to -180) °C | 0.14 °C | |
| | (-180 to -120) °C | 0.12 °C | |
| | (-120 to -50) °C | 0.09 °C | |
| | (-50 to 990) °C | 0.08 °C | |
| | (990 to 1 200) °C | 0.08 °C | |
| | Type K | | |
| | (-270 to -255) °C | 2.5 °C | |
| | (-255 to -195) °C | 0.81 °C | |
| | (-195 to -115) °C | 0.14 °C | |
| | (-115 to -55) °C | 0.10 °C | |
| | (-55 to 1 000) °C | 0.08 °C | |
| | (1 000 to 1 372) °C | 0.09 °C | |
| | Type N | | |
| | (-270 to -260) °C | 5.8 °C | |
| | (-260 to -200) °C | 1.2 °C | |
| | (-200 to -140) °C | 0.27 °C | |
| | (-140 to -70) °C | 0.17 °C | |
| | (-70 to 25) °C | 0.14 °C | |
| | (25 to 160) °C | 0.12 °C | |
| (160 to 1 300) °C | 0.1 °C | | |
| Type R | | | |
| (-50 to -30) °C | 0.75 °C | | |
| (-30 to 45) °C | 0.63 °C | | |
| (45 to 160) °C | 0.46 °C | | |
| (160 to 380) °C | 0.35 °C | | |
| (380 to 775) °C | 0.3 °C | | |
| (775 to 1 768) °C | 0.25 °C | | |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|--|
| Electrical Simulation of Thermocouple Indicators ¹ | Type S (-50 to -30) °C (-30 to -45) °C (-45 to -105) °C (-105 to 310) °C (310 to 615) °C (615 to 1 768) °C Type T (-270 to -255) °C (-255 to -240) °C (-240 to -210) °C (-210 to -150) °C (-150 to -40) °C (-40 to 100) °C (100 to 400) °C | 0.71 °C 0.64 °C 0.46 °C 0.38 °C 0.33 °C 0.3 °C 2.1 °C 0.56 °C 0.35 °C 0.21 °C 0.14 °C 0.09 °C 0.08 °C | Ectron 1140A Thermocouple Simulator |
| Electrical Simulation of RTD Indicators ¹ | PT 395 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C PT 3926 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C PT 3916 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C | 0.06 °C 0.08 °C 0.11 °C 0.12 °C 0.14 °C 0.27 °C 0.06 °C 0.08 °C 0.11 °C 0.12 °C 0.14 °C 0.29 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.11 °C 0.12 °C 0.27 °C | Fluke 5520A Multi Product Calibrator |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|------------------|---|--|
| Electrical Simulation of RTD Indicators ¹ | PT 385 200 Ω | | Fluke 5520A Multi Product Calibrator |
| | (-200 to 100) °C | 0.05 °C | |
| | (100 to 260) °C | 0.06 °C | |
| | (260 to 300) °C | 0.14 °C | |
| | (300 to 400) °C | 0.15 °C | |
| | (400 to 600) °C | 0.16 °C | |
| | (600 to 630) °C | 0.19 °C | |
| | PT 385 500 Ω | | |
| | (-200 to -80) °C | 0.05 °C | |
| | (-80 to 100) °C | 0.06 °C | |
| | (100 to 260) °C | 0.07 °C | |
| | (260 to 400) °C | 0.09 °C | |
| | (400 to 600) °C | 0.01 °C | |
| | (600 to 630) °C | 0.13 °C | |
| | PT 395 100 Ω | | |
| | (-200 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.08 °C | |
| | (100 to 300) °C | 0.11 °C | |
| | (300 to 400) °C | 0.12 °C | |
| | (400 to 630) °C | 0.14 °C | |
| | (630 to 800) °C | 0.27 °C | |
| | PT 3926 100 Ω | | |
| | (-200 to 0) °C | 0.06 °C | |
| | (0 to 100) °C | 0.08 °C | |
| | (100 to 300) °C | 0.11 °C | |
| | (300 to 400) °C | 0.12 °C | |
| | (400 to 630) °C | 0.14 °C | |
| | PT 3916 100 Ω | | |
| (-200 to -190) °C | 0.29 °C | | |
| (-190 to -80) °C | 0.05 °C | | |
| (-80 to 0) °C | 0.06 °C | | |
| (0 to 100) °C | 0.07 °C | | |
| (100 to 260) °C | 0.08 °C | | |
| (260 to 300) °C | 0.09 °C | | |
| (300 to 400) °C | 0.11 °C | | |
| (400 to 600) °C | 0.12 °C | | |
| (600 to 630) °C | 0.27 °C | | |

Electrical – DC/Low Frequency

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|------------------|---|--|
| Electrical Simulation of RTD Indicators ¹ | PT 385 200 Ω | | Fluke 5520A Multi Product Calibrator |
| | (-200 to 100) °C | 0.05 °C | |
| | (100 to 260) °C | 0.06 °C | |
| | (260 to 300) °C | 0.14 °C | |
| | (300 to 400) °C | 0.15 °C | |
| | (400 to 600) °C | 0.16 °C | |
| | (600 to 630) °C | 0.19 °C | |
| | PT 385 500 Ω | | |
| | (-200 to -80) °C | 0.05 °C | |
| | (-80 to 100) °C | 0.06 °C | |
| | (100 to 260) °C | 0.07 °C | |
| | (260 to 400) °C | 0.09 °C | |
| | (400 to 600) °C | 0.01 °C | |
| | (600 to 630) °C | 0.13 °C | |
| | PT 385 1 000 Ω | | |
| | (-200 to 0) °C | 0.04 °C | |
| | (0 to 100) °C | 0.05 °C | |
| | (100 to 260) °C | 0.06 °C | |
| | (260 to 300) °C | 0.07 °C | |
| | (300 to 600) °C | 0.08 °C | |
| (600 to 630) °C | 0.27 °C | | |
| PtNi 120 Ω | | | |
| (-80 to 100) °C | 0.09 °C | | |
| (100 to 260) °C | 0.16 °C | | |
| Cu 427 10 Ω | | | |
| (-100 to 260) °C | 0.35 °C | | |

Length – Dimensional Metrology

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---------------------------|---------------------------------------|---|--|
| Gage Blocks ² | (0.01 to 1) in (1 to 2) in 4 in | (1.4 + 1.3L) μin (1 + 1.3L) μin 9.4 μin | Gage Blocks Gage Block Comparator |
| | (5 to 12) in (12 to 20) in | (5 + 2L) μin (2 + 2.8L) μin | Horizontal Measuring Machine |
| | 100 mm (125 to 500) mm | 0.17 μm (0.06 + 0.000 6L) μm | Comparison to Primary Master Gage Blocks |
| Indicators ^{1,2} | (0.000 1 to 6) in | (5+8L) μin | Horizontal Measuring Machine |

Length – Dimensional Metrology

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|-----------------------------------|--|---|
| Calipers ^{1,2} | Up to 60 in | (5+8L) μin | Gage Blocks |
| Micrometers OD ^{1,2} | Up to 12 in | (5+8L) μin | Gage Blocks, Optical Parallels |
| Height Measuring Devices ^{1,2} | Up to 36 in (36 to 48) in | (45 + 2L) μin (7 + 3L) μin | Gage Blocks |
| Grind Gages | Up to 100 mm | 0.35 mm | Digital Indicator |
| Coating Thickness Gages ^{1,2} | Up to 0.02 in | 58 μin + 0.6R | Coating Thickness Standards |
| Coating Thickness Gage Standards | Up to 0.10 in | 21 μin | Horizontal Measuring Machine |
| External Diameter ^{1,2} | (0.000 1 to 12) in | (3 + 3L) μin | Horizontal Measuring Machine |
| Internal Diameter ^{1,2} | (0.04 to 13) in | (3 + 3L) μin | Horizontal Measuring Machine |
| Thread Rings (Adjustable) Pitch Diameter Tactile Fit (Set to Plug) | Up to 4 in | See footnote ⁵ | Thread Setting Plug |
| Thread Plugs ^{1,2} Pitch Diameter | Up to 8 in Pitch (0.2 to 5) mm | (87 + 1.9L) μin | Horizontal Measuring Machine |
| Major Diameter | Pitch 90 – 4 TPI Up to 4 in | (3.5 + 4.6L) μin | Thread Measuring Wires |
| Optical Comparators ^{1,2} Linear Accuracy | Up to 6 in 6 to 12 in | (43 + 11L) μin (30 + 7.5L) μin | Glass Scale |
| Magnification | (5 to 100) X | 350 μin | Glass Scale (Sphere) |
| Surface Plates ^{1,2} Overall Flatness | Up to 238 inDL | (25 + 2.9L) μin | Laser System |
| Local Area Flatness | Up to 238 inDL | 34 μin | Repeat-O-Meter |
| Surface Finish Artifacts | Up to 500 μin | 2.4 μin | Profilometer, Master Patch |
| Profilometers ¹ | Up to 500 μin | 3.1 μin | Master Patch |

Length – Dimensional Metrology

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|-------------------------------|---|--|
| Optical Flats Parallelism Flatness | Up to 6 inD (0 to 80) μin | 2.7 μin 3.5 μin | Gage Block Comparator, Master Flat |
| CMMs ^{1,2} Linearity | (0 to 144) in | (25 + 2.4L) μin | Laser Measuring System |
| Volumetric Repeatability | (6 to 24) in (0.5 to 2) in | 66 μin 45 μin | Ball Bar, CMM Sphere |
| VMMs ^{1,2} | Linearity | (32 + 4.1L) μin | Glass Scales |
| Graduated Scales ^{1,2} Glass, Steel, Tape | Up to 12 in (1 to 200) ft | (40 + 1L) μin (10+ 3L) μin | Laser Measuring System |
| Horizontal Measuring Systems ^{1,2} | Up to 8 in 8 to 60 in | (6 + 1.7L) μin (3 + 2.5L) μin | Gage Blocks |
| Protractors | (0 to 90) ° | 0.16 ° | Sine Bar, Gage Blocks |
| Length Standards ² | (1 to 60) in | (3.4 + 3.5L) μin | Horizontal Measuring System |
| Micrometers - Inside ² | Up to 8 in 8 to 60 in | (6 + 1.7L) μin (3 + 2.5L) μin | Horizontal Measuring System |

Mass and Mass Related

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|--|
| Force ¹ Source and Measure | (0.035 to 16) ozf (1 to 10) lbf (10 to 50) lbf (50 to 500) lbf | 0.018 % of reading + 0.21 μozf 0.018 % of reading + 0.33 μlbf 0.018 % of reading + 9.3 mlbf 0.036 % of reading + 5.3 mlbf | Dead Weight |
| | (500 to 1 000) lbf (10 to 100) klbf | 0.05 % of reading 0.06 % of reading | Load Cells, Class AA |
| Force ¹ Source and Measure | (30 000 to 400 000) lbf | 0.29 % of applied value | Load Cells, Class A (compression only) |
| Pressure ¹ | (10 to 17) psia | 0.000 4 psi | Pressure Calibrator |
| Pressure ¹ | (-14.5 to -0.5) psi (1 to 16 000) psi | 65 μpsi/psi 65 μpsi/psi | Deadweight Tester |

Mass and Mass Related

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|--|---|
| Torque Tools ¹ | 0.5 ozf·in to 200 ozf·in (5 to 50) lbf·in (50 to 400) lbf·in (400 to 1000) lbf·in (80 to 250) lbf·ft (250 to 600) lbf·ft (600 to 1 000) lbf·ft | 0.56 % of reading 0.33 % of reading 0.36 % of reading 0.4 % of reading 0.28 % of reading 0.51 % of reading 0.75 % of reading | Torque Tester |
| Scales and Balances ^{1,6} | Up to 5 mg (5 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 250) g 250 g to 1.1 kg (1.1 to 6.1) kg (6.1 to 33) kg | 0.005 mg 0.006 mg 0.007 mg 0.012 mg 0.014 mg 0.024 mg 0.086 mg 0.092 mg 1.4 mg 9 mg 90 mg | OIML E2 Class 1 Weights |
| Scales and Balances ^{1,6} | (0.5 to 2 000) lb | 0.01 % of reading | Class 6 Weights |
| Indirect Verification of Microindentation Hardness Testers ¹ (Knoop and Vickers) | Repeatability under forces (gf): 100 ≤ HK ≤ 500 HV = 100 | 2.1 % of Reading 4.1 % of Reading | Indirect Verification to Test Blocks |
| Brinell Hardness Testers ¹ Repeatability | 500 kgf ≤ 100 HBW ≥ 64 HBW 1 500 kgf ≤ 257 HBW ≥ 91 HBW 3 000 kgf ≤ 587 HBW ≥ 186 HBW | 0.025 mm 0.025 mm 0.025 mm 0.03 mm 0.025 mm 0.025 mm | Indirect Verification to Test Blocks |

Mass and Mass Related

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---------------|---|--|
| Rockwell Hardness Testers ¹ | HRA Low | 1.6 HRA | Indirect Verification to Test Blocks |
| | HRA Middle | 1.6 HRA | |
| | HRA High | 1.2 HRA | |
| | HRBW Low | 1.6 HRBW | |
| | HRBW Middle | 2.1 HRBW | |
| | HRBW High | 1.6 HRBW | |
| | HRC Low | 1.6 HRC | |
| | HRC Middle | 1.6 HRC | |
| | HRC High | 1.2 HRC | |
| | HREW Low | 1.6 HREW | |
| | HREW Middle | 1.6 HREW | |
| | HREW High | 1.6 HREW | |
| | HRMW Low | 1.6 HRMW | |
| | HRMW Middle | 1.6 HRMW | |
| | HRMW High | 1.6 HRMW | |
| | HR15N Low | 1.7 HR15N | |
| | HR15N Middle | 1.6 HR15N | |
| | HR15N High | 1.3 HR15N | |
| | HR15TW Low | 1.6 HR15TW | |
| | HR15TW Middle | 1.6 HR15TW | |
| | HR15TW High | 1.6 HR15TW | |
| | HR30N Low | 1.6 HR30N | |
| | HR30N Middle | 1.6 HR30N | |
| | HR30N High | 1.4 HR30N | |
| HR30TW Low | 1.6 HR30TW | | |
| HR30TW Middle | 1.6 HR30TW | | |
| HR30TW High | 1.6 HR30TW | | |
| HR45N Low | 1.6 HR45N | | |
| HR45N Middle | 1.6 HR45N | | |
| HR45N High | 1.6 HR45N | | |

Mass and Mass Related

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--|---|--|
| Durometers Spring Force Types A, B, E, O Types C, D, and DO Types OO, OOO, OOO-S | (1.3 to 8.05) N (4.445 to 44.5) N (0.294 to 1.932) N | 0.023 N 0.06 N 0.002 N | Shore Durometer Calibrator Balance |
| Indenter Angle Indenter Length Indenter Radius | (20 to 40) ° (0.049 to 0.198) in (0.05 to 0.1) in | 0.05 ° 220 μin 250 μin | VMM |

Thermodynamic

Mundelein, IL

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|---|
| Temperature - Measure | (-200 to -20) °C (-20 to 120) °C (120 to 200) °C (200 to 300) °C (300 to 600) °C | 0.006 2 °C 0.001 7 °C 0.023 °C 0.023 °C 0.024 °C | Fluke 5699 SPRT Fluke 1590 Super Thermometer |
| Temperature – Source | (-20 to 120) °C (120 to 425) °C (425 to 660) °C | 0.001 7 °C 0.038 °C 0.063 °C | SPRT Fluke 1590 Super Thermometer With liquid baths and Metrology Well |
| Radiation (Infrared) Thermometers | (50 to 100) °C (100 to 200) °C (200 to 250) °C (250 to 300) °C (300 to 400) °C (400 to 500) °C | 0.8 °C 0.93 °C 0.96 °C 1 °C 1.1 °C 1.2 °C | Black Body Calibrator Monitored with a PRT $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$ |
| Infrared Temperature | (550 to 1 500) °C | 0.46 % of reading | Comparison to Reference Infrared Thermometer $\lambda = (8 \text{ to } 14) \mu\text{m}, \epsilon = 0.95$ |
| Humidity ¹ Source and Measure | (20 to 50) %RH (50 to 90) %RH | 1.6 %RH 2.1 %RH | Humidity Indicator |

DIMENSIONAL MEASUREMENT

2 Dimensional

Mundelein, IL

| Specific Tests and / or Properties Measured | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method and/or Equipment |
|---|---------------|---|---|
| Non-contact | (6 x 8) in | (239 + 1.4L) μin | Vision System |
| Surface Finish Analysis | Up to 500 μin | 2.4 μin | Profilometer, Master Patch |

3 Dimensional

Mundelein, IL

| Specific Tests and / or Properties Measured | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method and/or Equipment |
|---|-------------------|---|---|
| Dimensional Inspection Contact | (16 x 18 x 14) in | (209 + 1.2L) μin | Coordinate Measuring Machine |

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Services performed at satellite laboratory

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CALIBRATION AND DIMENSIONAL MEASUREMENT

CALIBRATION

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------------------|--|---|--|
| DC Voltage – Source ¹ | Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1 020) V | 21 μ V/V + 1 μ V 11 μ V/V + 2 μ V 13 μ V/V + 20 μ V 18 μ V/V + 150 μ V 18 μ V/V + 1.5 mV | 5522A Multi Product Calibrator |
| DC Voltage – Measure ¹ | Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV | 12 μ V/V + 0.3 μ V 10 μ V/V + 0.3 μ V 10 μ V/V + 0.5 μ V 13 μ V/V + 30 μ V 13 μ V/V + 100 μ V | Keysight 3458A Multimeter |
| DC Current – Source ¹ | Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20) A | 151 μ A/A + 20 nA 101 μ A/A + 50 nA 101 μ A/A + 250 nA 102 μ A/A + 2.5 μ A 201 μ A/A + 40 μ A 386 μ A/A + 40 μ A 504 μ A/A + 0.5 mA 1 mA/A + 0.75 mA | 5522A Multi Product Calibrator |
| DC Current – Measure ¹ | (10 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A | 29 μ A/A + 0.8 nA 27 μ A/A + 5 nA 28 μ A/A + 50 nA 46 μ A/A + 0.5 μ A 121 μ A/A + 10 μ A | Keysight 3458A Multimeter |
| AC Voltage – Source | Up to 33 mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz | 806 μ V/V + 6 μ V 176 μ V/V + 6 μ V 220 μ V/V + 6 μ V 1 mV/V + 6 μ V 3.5 mV/V + 12 μ V 8 mV/V + 50 μ V | 5522A Multi Product Calibrator |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|----------------------|---------------------------------------|---|--|
| AC Voltage – Source | (33 to 330) mV | | 5522A Multi Product Calibrator |
| | (10 to 45) Hz | 302 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | 45 Hz to 10 kHz | 148 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (10 to 20) kHz | 163 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (20 to 50) kHz | 353 $\mu\text{V/V} + 8 \mu\text{V}$ | |
| | (50 to 100) kHz | 804 $\mu\text{V/V} + 32 \mu\text{V}$ | |
| | (100 to 500) kHz | 2 mV/V + 70 μV | |
| | 330 mV to 3.3 V | | |
| | (10 to 45) Hz | 302 $\mu\text{V/V} + 50 \mu\text{V}$ | |
| | 45 Hz to 10 kHz | 153 $\mu\text{V/V} + 60 \mu\text{V}$ | |
| | (10 to 20) kHz | 192 $\mu\text{V/V} + 60 \mu\text{V}$ | |
| | (20 to 50) kHz | 302 $\mu\text{V/V} + 50 \mu\text{V}$ | |
| | (50 to 100) kHz | 703 $\mu\text{V/V} + 125 \mu\text{V}$ | |
| | (100 to 500) kHz | 2.4 mV/V + 0.6 mV | |
| | (3.3 to 33) V | | |
| | (10 to 45) Hz | 302 $\mu\text{V/V} + 650 \mu\text{V}$ | |
| | 45 Hz to 10 kHz | 153 $\mu\text{V/V} + 600 \mu\text{V}$ | |
| | (10 to 20) kHz | 242 $\mu\text{V/V} + 600 \mu\text{V}$ | |
| (20 to 50) kHz | 353 $\mu\text{V/V} + 600 \mu\text{V}$ | | |
| (50 to 100) kHz | 903 $\mu\text{V/V} + 1.6 \text{ mV}$ | | |
| (33 to 330) V | | | |
| 45 Hz to 1 kHz | 194 $\mu\text{V/V} + 2 \text{ mV}$ | | |
| (1 to 10) kHz | 204 $\mu\text{V/V} + 6 \text{ mV}$ | | |
| (10 to 20) kHz | 253 $\mu\text{V/V} + 6 \text{ mV}$ | | |
| (20 to 50) kHz | 314 $\mu\text{V/V} + 6 \text{ mV}$ | | |
| (50 to 100) kHz | 2 mV/V + 50 mV | | |
| (330 to 1020) V | | | |
| 45 Hz to 1 kHz | 302 $\mu\text{V/V} + 10 \text{ mV}$ | | |
| (1 to 5) kHz | 252 $\mu\text{V/V} + 10 \text{ mV}$ | | |
| (5 to 10) kHz | 302 $\mu\text{V/V} + 10 \text{ mV}$ | | |
| AC Voltage – Measure | Up to 10 mV | | Keysight 3458A Multimeter |
| | (1 to 40) Hz | 300 $\mu\text{V/V} + 3 \mu\text{V}$ | |
| | 40 Hz to 1 kHz | 219 $\mu\text{V/V} + 1.1 \mu\text{V}$ | |
| | (1 to 20) kHz | 324 $\mu\text{V/V} + 1.1 \mu\text{V}$ | |
| | (20 to 50) kHz | 1 mV/V + 6 μV | |
| | (50 to 100) kHz | 5.1 mV/V + 1.1 μV | |
| | (100 to 300) kHz | 41 mV/V + 2 μV | |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|----------------------|-------------------------------------|---|--|
| AC Voltage – Measure | (10 to 100) mV | | Keysight 3458A Multimeter |
| | (1 to 40) Hz | 70 $\mu\text{V/V} + 4 \mu\text{V}$ | |
| | 40 Hz to 1 kHz | 83.8 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (1 to 20) kHz | 157 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (20 to 50) kHz | 308 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (50 to 100) kHz | 878 $\mu\text{V/V} + 2 \mu\text{V}$ | |
| | (100 to 300) kHz | 3.1 mV/V + 10 μV | |
| | 300 kHz to 1 MHz | 10 mV/V + 10 μV | |
| | (1 to 2) MHz | 15 mV/V + 10 μV | |
| | 100 mV to 1 V | | |
| | (1 to 40) Hz | 70 $\mu\text{V/V} + 40 \mu\text{V}$ | |
| | 40 Hz to 1 kHz | 80.7 $\mu\text{V/V} + 20 \mu\text{V}$ | |
| | (1 to 20) kHz | 154 $\mu\text{V/V} + 20 \mu\text{V}$ | |
| | (20 to 50) kHz | 327 $\mu\text{V/V} + 20 \mu\text{V}$ | |
| | (50 to 100) kHz | 825 $\mu\text{V/V} + 20 \mu\text{V}$ | |
| | (100 to 300) kHz | 3.1 mV/V + 0.1 mV | |
| | 300 kHz to 1 MHz | 10 mV/V + 0.1 mV | |
| | (1 to 2) MHz | 15 mV/V + 0.1 mV | |
| | (1 to 10) V | | |
| | (1 to 40) Hz | 77 $\mu\text{V/V} + 400 \mu\text{V}$ | |
| | 40 Hz to 1 kHz | 81 $\mu\text{V/V} + 200 \mu\text{V}$ | |
| | (1 to 20) kHz | 154 $\mu\text{V/V} + 200 \mu\text{V}$ | |
| | (20 to 50) kHz | 324 $\mu\text{V/V} + 200 \mu\text{V}$ | |
| | (50 to 100) kHz | 816 $\mu\text{V/V} + 200 \mu\text{V}$ | |
| | (100 to 300) kHz | 3.1 mV/V + 1 mV | |
| | 300 kHz to 1 MHz | 10 mV/V + 1 mV | |
| | (1 to 2) MHz | 15 mV/V + 1 mV | |
| | (10 to 100) V | | |
| | (1 to 40) Hz | 200 $\mu\text{V/V} + 4 \text{ mV}$ | |
| | 40 Hz to 1 kHz | 205 $\mu\text{V/V} + 2 \text{ mV}$ | |
| (1 to 20) kHz | 215 $\mu\text{V/V} + 2 \text{ mV}$ | | |
| (20 to 50) kHz | 358 $\mu\text{V/V} + 2 \text{ mV}$ | | |
| (50 to 100) kHz | 1.2 mV/V + 2 mV | | |
| (100 to 300) kHz | 4 mV/V + 2 mV | | |
| 300 kHz to 1 MHz | 15 mV/V + 10 mV | | |
| (100 to 1 000) V | | | |
| (1 to 40) Hz | 400 $\mu\text{V/V} + 40 \text{ mV}$ | | |
| 40 Hz to 1 kHz | 405 $\mu\text{V/V} + 20 \text{ mV}$ | | |
| (1 to 20) kHz | 600 $\mu\text{V/V} + 20 \text{ mV}$ | | |
| (20 to 50) kHz | 1.2 mV/V + 20 mV | | |
| (50 to 100) kHz | 3 mV/V + 20 mV | | |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|----------------------|------------------------|---|--|
| AC Current – Measure | Up to 100 μ A | | Keysight 3458A Multimeter |
| | (10 to 20) Hz | 4 mA/A + 30 nA | |
| | (20 to 45) Hz | 1.5 mA/A + 30 nA | |
| | (45 to 100) Hz | 605 μ A/A + 30 nA | |
| | 100 Hz to 1 kHz | 610 μ A/A + 30 nA | |
| | 100 μ A to 1 mA | | |
| | (10 to 20) Hz | 4 mA/A + 0.2 μ A | |
| | (20 to 45) Hz | 1.5 mA/A + 0.2 μ A | |
| | (45 to 100) Hz | 605 μ A/A + 0.2 μ A | |
| | 100 Hz to 5 kHz | 325 μ A/A + 0.2 μ A | |
| | (5 to 20) kHz | 605 μ A/A + 0.2 μ A | |
| | (20 to 50) kHz | 4 mA/A + 0.4 μ A | |
| | (50 to 100) kHz | 5.5 mA/A + 1.5 μ A | |
| | (1 to 10) mA | | |
| | (10 to 20) Hz | 4 mA/A + 2 μ A | |
| | (20 to 45) Hz | 1.5 mA/A + 2 μ A | |
| | (45 to 100) Hz | 605 μ A/A + 2 μ A | |
| | 100 Hz to 5 kHz | 325 μ A/A + 2 μ A | |
| | (5 to 20) kHz | 605 μ A/A + 2 μ A | |
| | (20 to 50) kHz | 4 mA/A + 4 μ A | |
| | (50 to 100) kHz | 5.5 mA/A + 15 μ A | |
| | (10 to 100) mA | | |
| | (10 to 20) Hz | 4 mA/A + 20 μ A | |
| | (20 to 45) Hz | 1.5 mA/A + 20 μ A | |
| | (45 to 100) Hz | 605 μ A/A + 20 μ A | |
| | 100 Hz to 5 kHz | 325 μ A/A + 20 μ A | |
| | (5 to 20) kHz | 605 μ A/A + 20 μ A | |
| | (20 to 50) kHz | 4 mA/A + 40 μ A | |
| (50 to 100) kHz | 5.5 mA/A + 150 μ A | | |
| 100 mA to 1 A | | | |
| (10 to 20) Hz | 4 mA/A + 0.2 mA | | |
| (20 to 45) Hz | 1.6 mA/A + 0.2 mA | | |
| (45 to 100) Hz | 805 μ A/A + 0.2 mA | | |
| 100 Hz to 5 kHz | 1 mA/A + 0.2 mA | | |
| (5 to 20) kHz | 3 mA/A + 0.2 mA | | |
| (20 to 50) kHz | 10 mA/A + 0.4 mA | | |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---------------------|-----------------------------|---|--|
| AC Current – Source | (29 to 330) μ A | | 5522A Multi Product Calibrator |
| | (10 to 20) Hz | 2 mA/A + 0.1 μ A | |
| | (20 to 45) Hz | 1.5 mA/A + 0.1 μ A | |
| | 45 Hz to 1 kHz | 1.3 mA/A + 0.1 μ A | |
| | (1 to 5) kHz | 3 mA/A + 0.15 μ A | |
| | (5 to 10) kHz | 8 mA/A + 0.2 μ A | |
| | (10 to 30) kHz | 16 mA/A + 0.4 μ A | |
| | (0.33 to 3.3) mA | | |
| | (10 to 20) Hz | 2 mA/A + 0.15 μ A | |
| | (20 to 45) Hz | 1.3 mA/A + 0.15 μ A | |
| | 45 Hz to 1 kHz | 1 mA/A + 0.15 μ A | |
| | (1 to 5) kHz | 2 mA/A + 0.2 μ A | |
| | (5 to 10) kHz | 5.1 mA/A + 0.3 μ A | |
| | (10 to 30) kHz | 10 mA/A + 0.6 μ A | |
| | (3.3 to 33) mA | | |
| | (10 to 20) Hz | 1.8 mA/A + 2 μ A | |
| | (20 to 45) Hz | 910 μ A/A + 2 μ A | |
| | 45 Hz to 1 kHz | 423 μ A/A + 2 μ A | |
| | (1 to 5) kHz | 813 μ A/A + 2 μ A | |
| | (5 to 10) kHz | 2 mA/A + 3 μ A | |
| | (10 to 30) kHz | 4.1 mA/A + 4 μ A | |
| | (33 to 330) mA | | |
| | (10 to 20) Hz | 1.8 mA/A + 20 μ A | |
| | (20 to 45) Hz | 909 μ A/A + 20 μ A | |
| | 45 Hz to 1 kHz | 417 μ A/A + 20 μ A | |
| | (1 to 5) kHz | 1 mA/A + 50 μ A | |
| | (5 to 10) kHz | 2 mA/A + 100 μ A | |
| | (10 to 30) kHz | 4.1 mA/A + 200 μ A | |
| (0.33 to 1.1) A | | | |
| (10 to 45) Hz | 1.8 mA/A + 100 μ A | | |
| 45 Hz to 1 kHz | 512 μ A/A + 100 μ A | | |
| (1 to 5) kHz | 6 mA/A + 1 mA | | |
| (5 to 10) kHz | 25 mA/A + 5 mA | | |
| (1.1 to 3) A | | | |
| (10 to 45) Hz | 1.8 mA/A + 100 μ A | | |
| 45 Hz to 1 kHz | 664 μ A/A + 100 μ A | | |
| (1 to 5) kHz | 6 mA/A + 1 mA | | |
| (5 to 10) kHz | 25 mA/A + 5 mA | | |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------------------|--|---|---|
| AC Current – Source | (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 | 1.8 mA/A + 100 μA 664 μA/A + 100 μA 6 mA/A + 1 mA 1.2 mA/A + 5 mA 1.5 mA/A + 5 mA 30 mA/A + 5 mA | 5522A Multi Product Calibrator |
| Resistance - Source ¹ | Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ 330 MΩ to 1.1 GΩ | 36 μΩ/Ω 26 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 24 μΩ/Ω 26 μΩ/Ω 26 μΩ/Ω 42 μΩ/Ω 110 μΩ/Ω 201 μΩ/Ω 400 μΩ/Ω 2.5 mΩ/Ω 12 mΩ/Ω | 5522A Multi Product Calibrator |
| Resistance – Measure ¹ | 100 μΩ 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 | 20 μΩ/Ω + 50 μΩ 17 μΩ/Ω + 5 μΩ 15 μΩ/Ω + 500 μΩ 15 μΩ/Ω + 5 mΩ 15 μΩ/Ω + 50 mΩ 20 μΩ/Ω + 2 Ω 83 μΩ/Ω + 100 Ω 820 μΩ/Ω + 1 kΩ | Keysight 3458A Multimeter |
| Capacitance – Source | 10 Hz to 10 kHz (220 to 400) pF (0.4 to 1.1) nF 10 Hz to 3 kHz (1.1 to 3.3) nF | 6.4 mF/F + 10 pF 5.3 mF/F + 10 pF 5.1 mF/F + 10 pF | 5522A Multi Product Calibrator |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-------------------------------|---|---|--|
| Capacitance – Source | 10 Hz to 1 kHz | | 5522A Multi Product Calibrator |
| | (3.3 to 11) nF | 2.6 mF/F + 10 pF | |
| | (11 to 33) nF | 2.6 mF/F + 100 pF | |
| | (33 to 110) nF | 2.6 mF/F + 100 pF | |
| | (110 to 330) nF | 2.6 mF/F + 300 pF | |
| | (10 to 600) Hz | | |
| | (0.33 to 1.1) μ F | 2.6 mF/F + 1 nF | |
| | (10 to 300) Hz | | |
| | (1.1 to 3.3) μ F | 2.6 mF/F + 3 nF | |
| | (10 to 150) Hz | | |
| | (3.3 to 11) μ F | 2.6 mF/F + 10 nF | |
| | (10 to 120) Hz | | |
| | (11 to 33) μ F | 4.1 mF/F + 30 nF | |
| | (10 to 80) Hz | | |
| | (33 to 110) μ F | 4.7 mF/F + 0.1 μ F | |
| | Electrical Simulation of Thermocouple Indicators ¹ | Type B | |
| (600 to 800) $^{\circ}$ C | | 0.44 $^{\circ}$ C | |
| (800 to 1 000) $^{\circ}$ C | | 0.34 $^{\circ}$ C | |
| (1 000 to 1 550) $^{\circ}$ C | | 0.3 $^{\circ}$ C | |
| (1 550 to 1 820) $^{\circ}$ C | | 0.33 $^{\circ}$ C | |
| Type C | | | |
| (0 to 150) $^{\circ}$ C | | 0.3 $^{\circ}$ C | |
| (150 to 650) $^{\circ}$ C | | 0.26 $^{\circ}$ C | |
| (650 to 1 000) $^{\circ}$ C | | 0.31 $^{\circ}$ C | |
| (1 000 to 1 800) $^{\circ}$ C | | 0.5 $^{\circ}$ C | |
| (1 800 to 2 316) $^{\circ}$ C | 0.84 $^{\circ}$ C | | |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---------------------|---|--|
| Electrical Simulation of Thermocouple Indicators ¹ | Type E | | 5522A Multi Product Calibrator |
| | (-250 to -100) °C | 0.5 °C | |
| | (-100 to -25) °C | 0.16 °C | |
| | (-25 to 350) °C | 0.14 °C | |
| | (350 to 650) °C | 0.16 °C | |
| | (650 to 1 000) °C | 0.21 °C | |
| | Type J | | |
| | (-210 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 1 000) °C | 0.33 °C | | |
| (1 000 to 1 767) °C | 0.4 °C | | |
| Type S | | | |
| (0 to 250) °C | 0.47 °C | | |
| (250 to 400) °C | 0.36 °C | | |
| (400 to 1 000) °C | 0.37 °C | | |
| (1 000 to 1 767) °C | 0.46 °C | | |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|--|--|
| Electrical Simulation of Thermocouple Indicators ¹ | Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C Type U (-200 to 0) °C (0 to 600) °C | 0.63 °C 0.24 °C 0.16 °C 0.14 °C 0.56 °C 0.27 °C | 5522A Multi Product Calibrator |
| Electrical Simulation of RTD Indicators ¹ | Pt 385, 100 Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C Pt 3926, 100 Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C Pt 3916, 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C | 0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.23 °C 0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C 0.25 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.1 °C 0.23 °C | 5522A Multi Product Calibrator |

Electrical – DC/Low Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|------------------|---|--|
| Electrical Simulation of RTD Indicators ¹ | 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, 1 000 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 | | |
| Cu 427, 10 Ω | | | |
| (100 to 260) °C | 0.3 °C | | |
| | | | 5522A Multi Product Calibrator |

Length – Dimensional Metrology

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---------------------------|-------------------|---|--|
| Indicators ^{1,2} | (0.000 1 to 6) in | (8+3L) μin | Horizontal Measuring Machine |

Length – Dimensional Metrology

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--------------------------------------|--|---|
| Calipers ^{1,2} | Up to 60 in | (5+8L) μin | Gage Blocks |
| Micrometers OD ^{1,2} | Up to 60 in Anvil Flatness | (5+8L) μin 4 μin | Gage Blocks Optical Parallels |
| Height Measuring Devices ^{1,2} | Up to 36 in (36 to 48) in | (45 + 2L) μin (7 + 3L) μin | Gage Blocks |
| External Diameter ^{1,2} | (0.000 1 to 6) in | (8+3L) μin | Horizontal Measuring Machine |
| Internal Diameter ^{1,2} | (0.04 to 13) in | (8+3L) μin | Horizontal Measuring Machine |
| Thread Plugs ^{1,2} Pitch Diameter | Up to 8 in Pitch (0.2 to 5) mm | (87 + 1.9L) μin | Horizontal Measuring Machine |
| Major Diameter | Pitch 90 – 4 TPI Up to 4 in | (8+3L) μin | Thread Measuring Wires |
| Thread Rings (Adjustable) Pitch Diameter Tactile Fit (Set to Plug) | Up to 4 in | See footnote ⁵ | Thread Setting Plug |
| Optical Comparators ^{1,2} Linear Accuracy | Up to 6 in 6 to 12 in | (43 + 11L) μin (30 + 7.5L) μin | Glass Scale |
| Magnification | 5X to 100X | 350 μin | Glass Scale (Sphere) |
| Surface Plates ^{1,2} Overall Flatness | Up to 238 inDL | (25 + 2.9L) μin | Laser System |
| Local Area Flatness | Up to 238 inDL | 34 μin | Repeat-O-Meter |
| CMMs ^{1,2} | (0 to 144) in | (25 + 2.4L) μin | Laser Measuring System |
| VMMs ^{1,2} | Up to 6 in | (32 + 4.1L) μin | Glass Scales |
| Horizontal Measuring Systems ^{1,2} | Up to 8 in of Travel (8 to 60) in | (6 + 1.7L) μin (3 + 2.5L) μin | Gage Blocks |
| Feeler/Thickness Gages ² | Up to 0.2 in | (4.3 + 3L) μin | Horizontal Measuring System |
| Indicator Calibrator ² Linearity | Up to 6 in | 60 μin + 0.6R | Horizontal Measuring System |
| Groove Micrometers ² | Up to 12 in | (44 + 2.6L) μin+ 0.6R | Gage Blocks |

Length – Dimensional Metrology

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--------------------------|---|--|
| Microscopes, Stereo Reticle Linearity | Up to 2 in | 870 μin | Stage Micrometer |
| Microscopes – Toolmakers ² Scale Linearity | Up to 4 in | (774 + 70L) μin + 0.6R | Stage Micrometer |
| Length Standards ² | (1 to 60) in | (3.4 + 3.5L) μin | Horizontal Measuring System |
| Micrometers – Inside ² | Up to 8 in 8 to 60 in | (6 + 1.7L) μin (3 + 2.5L) μin | Horizontal Measuring System |
| Parallels ² Steel Granite | Up to 18 in | (96.3 + 1.8L) μin (48.6 + 0.7L) μin | Electronic Amplifier with Probe, Surface Plate |
| Thickness Gages ² Dial Digital | Up to 1 in | 410 μin + 0.6R 44 μin + 0.6R | Gage Blocks |
| Thread Micrometers ² (Screw Thread, Pitch Point) Linearity Anvil Wear | Up to 12 in | (44 + 2.6L) μin + 0.6R 690 μin | Gage Blocks Thread Setting Plug |

Mass and Mass Related

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---------------------------|---|--|--|
| Force ¹ Source | (0.035 to 16) ozf (1 to 10) lbf (10 to 50) lbf (50 to 500) lbf | 0.018 % of reading + 0.21 μozf 0.018 % of reading + 0.33 μlbf 0.018 % of reading + 9.3 mlbf 0.036 % of reading + 5.3 mlbf | Dead Weight |
| Pressure ¹ | (-15 to 30) psig (0 to 1) inH ₂ O (0.036 to 1) psig (0 to 100) psia (100 to 300) psig (300 to 1 000) psig (1 000 to 10 000) psig | 19 mpsi 0.003 5 inH ₂ O 1.3 mpsi 0.07 psi 0.12 psi 0.4 psi 4 psi | Pressure Calibrator |

Mass and Mass Related

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|------------------------------------|---|---|--|
| Torque Tools ¹ | (5 to 50) lbf·in (50 to 400) lbf·in (400 to 1000) lbf·in (80 to 250) lbf·ft (250 to 600) lbf·ft (600 to 2 000) lbf·ft | 0.33 % of reading 0.36 % of reading 0.4 % of reading 0.28 % of reading 0.51 % of reading 0.75 % of reading | Torque Tester |
| Torque Transducers ¹ | 0.5 ozf·in to 1 000 lbf·ft | 0.08 % of reading | Dead Weight Torque Arms |
| Scales and Balances ^{1,6} | (0 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 30) g (30 to 50) g (50 to 100) g (100 to 200) g (200 to 300) g 300 g to 1 kg (1 to 2) kg (2 to 3) kg | 0.01 mg 0.034 mg 0.05 mg 0.074 mg 0.12 mg 0.25 mg 0.5 mg 0.75 mg 2.5 mg 5 mg 7.5 mg | Class 1 Weights |
| Scales and Balances ^{1,6} | (3 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 25) kg (25 to 30) kg | 12 mg 25 mg 50 mg 62 mg 75 mg | Class 1 Weights |
| Scales and Balances ^{1,6} | (0.5 to 1 000) lb | 0.01 % of reading | Class 6 Weights |

Thermodynamic

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|------------------------------------|---|---|--|
| Temperature – Measure ¹ | (-20 to 100) °C (100 to 425) °C (425 to 500) °C | 0.058 °C 0.069 °C 0.086 °C | Digital Temperature Gage |
| Humidity- Measure ¹ | (10 to 40) %RH (40 to 90) %RH (90 to 100) %RH | 1.1 %RH 1.3 %RH 1.9 %RH | Humidity Indicator |

Time and Frequency

Eau Claire, WI

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---------------------------------|-------|---|--|
| Frequency – Source ⁴ | 1 MHz | 2.5 x 10 ⁻⁵ Hz | 5522A Multi Product Calibrator |

DIMENSIONAL MEASUREMENT

2 Dimensional

Eau Claire, WI

| Specific Tests and / or Properties Measured | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method and/or Equipment |
|---|------------------|---|---|
| Non-contact | (15.4 x 10.8) in | (126 + 12L) μin | Vision System |

3 Dimensional

Eau Claire, WI

| Specific Tests and / or Properties Measured | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method and/or Equipment |
|---|-------------------|---|---|
| Dimensional Inspection Contact | (16 x 18 x 14) in | (209+ 1.2L) μin | Coordinate Measuring Machie |

[Return to Site listing \(top\)](#)

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 ($k=2$), corresponding to a confidence level of approximately 95%.

- Notes:
1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope
 2. The use of (R) signifies the Resolution of the unit under test, the use of (L) represents Length in inches, the use of (D) represents Diameter in inches.
 3. Uncertainties listed for Electromagnetic - DC/Low Frequency and RF/Microwave does not include possible contributions from a “best available” unit under test
 4. Derivatives of 10MHz will have different uncertainties due to resolution, noise, and gating errors.
 5. The tactile fit of an adjustable thread ring to a thread-setting plug is not a measurement of pitch diameter. The uncertainty for this pitch diameter setting is based on the contributors associated with the thread setting plug and environmental contributors only.
 6. The CMC for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainties presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
 7. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1265.



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