



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994

MICRO PRECISION CALIBRATION
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CALIBRATION

Valid To: September 30, 2013

Certificate Number: 0935.10

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Chemical

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|---------------------------|--------------------------|----------------------|----------------------------------|
| pH ³ – Measure | (1.68, 4, 7, 10) pH unit | 0.07 pH unit | Comparison to standard solutions |

II. Dimensional

| Parameter/Equipment | Range | CMC ^{2,6} (±) | Comments |
|--------------------------------------|-----------------|------------------------|--------------------------------------|
| Calipers & Height Gages ³ | (0.10 to 22) in | (50 + 8.4L) μin | Mitutoyo gage blocks and length rods |
| Micrometers ³ | (0.10 to 22) in | (51 + 8.4L) μin | Mitutoyo gage blocks |

| Parameter/Equipment | Range | CMC ^{2,6} (\pm) | Comments |
|---------------------------------------|----------------------------|------------------------------|--|
| Outside Diameter, External Threads | Up to 1 in (1 to 10) in | 68 μ in 79 μ in | Supermicrometer and thread wires (three wire method) |

III. Electrical – DC/Low Frequency

| Parameter/Equipment | Range | CMC ^{2,4,5,7} (\pm) | Comments |
|------------------------------------|--|--|---|
| DC Voltage ³ – Generate | (0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V | 12 μ V/V + 0.6 μ V 12 μ V/V + 1.0 μ V 10 μ V/V + 3.5 μ V 12 μ V/V + 6.5 μ V 10 μ V/V + 80 μ V 13 μ V/V + 500 μ V | Fluke 5700A w/option 03 |
| DC Voltage ³ – Measure | (0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1000) V | 7 μ V/V + 0.3 μ V 7 μ V/V + 0.3 μ V 8 μ V/V + 0.5 μ V 11 μ V/V + 30 μ V 20 μ V/V + 100 μ V | HP 3458A |
| DC Current ³ – Generate | (0 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A | 50 μ A/A + 8 nA 50 μ A/A + 80 nA 60 μ A/A + 0.8 μ A 80 μ A/A + 25 μ A 0.06 % + 330 μ A | Fluke 5700A w/option 03 Fluke 5500A |
| DC Current ³ – Measure | (10 to 100) μ A 100 μ A to 10 mA (10 to 100) mA 100 mA to 1 A | 26 μ A/A + 5 μ A 26 μ A/A + 5 μ A 60 μ A/A + 5 μ A 0.013 % + 10 μ A | HP 3458A |
| Resistance ³ – Measure | (0 to 10) Ω (10 to 100) Ω 100 Ω to 100 k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω | 19 parts in 10 ⁶ + 0.06 m Ω 15 parts in 10 ⁶ + 0.6 m Ω 13 parts in 10 ⁶ + 0.6 m Ω 18 parts in 10 ⁶ + 2.4 Ω 59 parts in 10 ⁶ + 120 Ω 0.058 % + 1.2 k Ω 1.8 % + 10 k Ω | HP 3458A |

| Parameter/Equipment | Range | CMC ^{2, 4, 7} (±) | Comments |
|-------------------------------------|--|--|----------------------------|
| Resistance ³ – Generate | Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 0.33 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ | 0.12 % + 0.008 Ω 0.53 % + 0.015 Ω 0.02 % + 0.015 Ω 0.014 % + 0.015 Ω 0.017 % + 0.06 Ω 0.013 % + 0.06 Ω 0.017 % + 0.6 Ω 0.013 % + 6 Ω 0.02 % + 6 Ω 0.016 % + 55 Ω 0.024 % + 55 Ω 0.02 % + 55 Ω 0.076 % + 550 Ω 0.012 % + 550 Ω 0.58 % + 5.5 kΩ 0.58 % + 17 Ω | Fluke 5500A |
| Fixed Points | 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ | 0.013 % 39 parts in 10 ⁶ 24 parts in 10 ⁶ 18 parts in 10 ⁶ 17 parts in 10 ⁶ 19 parts in 10 ⁶ 27 parts in 10 ⁶ 54 parts in 10 ⁶ 0.016 % | Fluke 5700A w/option 03 |
| Capacitance ³ – Generate | (0.33 to 0.49) nF (0.50 to 1.09) nF (1.10 to 3.29) nF (3.30 to 10.9) nF (11.0 to 32.9) nF (33 to 109.9) nF (110 to 329.9) nF (0.33 to 1.09) μF (1.10 to 3.29) μF | 3.3 % 1.7 % 0.93 % 0.69 % 0.64 % 0.40 % 0.40 % 0.40 % 0.51 % | Fluke 5500A |

| Parameter/Equipment | Range | CMC ^{2, 4, 7} (±) | Comments |
|--|--|--|-------------|
| Electrical Calibration of Thermocouple Indicators ³ – | | | |
| Type E | -250 °C to -100 °C -100 °C to 650 °C 650 to 1000 °C | 0.5 °C 0.16 °C 0.21 °C | Fluke 5500A |
| Type J | -210 °C to -100 °C -100 °C to 760 °C 760 °C to 1200 °C | 0.27 °C 0.17 °C 0.23 °C | |
| Type K | -200 °C to -100 °C -100 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C | 0.33 °C 0.18 °C 0.26 °C 0.04 °C | |
| Type S | 0 °C to 250 °C 250 °C to 1400 °C 1400 °C to 1767 °C | 0.47 °C 0.37 °C 0.46 °C | |
| Type T | -250 °C to -150 °C -150 °C to 0 °C 0 °C to 400 °C | 0.63 °C 0.24 °C 0.16 °C | |

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|---|---|---|-------------|
| Electrical Calibration of RTD Indicating Systems ³ – | | | |
| Pt 385, 100 Ω | -200 °C to 0 °C 0 °C to 100 °C 100 °C to 400 °C 400 °C to 630 °C 630 °C to 800 °C | 0.05 °C 0.07 °C 0.10 °C 0.12 °C 0.23 °C | Fluke 5500A |
| Pt 3926, 100 Ω | -200 °C to 0 °C 0 °C to 100 °C 100 °C to 400 °C 400 °C to 630 °C | 0.05 °C 0.07 °C 0.10 °C 0.12 °C | |
| Pt 3916, 100 Ω | -200 °C to -190 °C -190 °C to 0 °C 0 °C to 300 °C 300 °C to 600 °C 600 °C to 630 °C | 0.25 °C 0.05 °C 0.08 °C 0.10 °C 0.23 °C | |
| Pt 385, 200 Ω | -200 °C to 100 °C 100 °C to 260 °C 260 °C to 600 °C 600 °C to 630 °C | 0.04 °C 0.05 °C 0.14 °C 0.16 °C | |
| Pt 385, 500 Ω | -200 °C to 100 °C 100 °C to 260 °C 260 °C to 600 °C 600 °C to 630 °C | 0.05 °C 0.06 °C 0.09 °C 0.11 °C | |
| Pt 385, 1 kΩ | -200 °C to 100 °C 100 °C to 260 °C 260 °C to 600 °C 600 °C to 630 °C | 0.03 °C 0.05 °C 0.07 °C 0.23 °C | |
| PtNi 385, 100 Ω | -80 °C to 100 °C 100 °C to 260 °C | 0.08 °C 0.14 °C | |
| Cu 427, 10 Ω | -100 °C to 260 °C | 0.3 °C | |

| Parameter/Range | Frequency | CMC ^{2,4} (±) | Comments |
|------------------------------------|--|--|----------------------------|
| AC Voltage ³ – Generate | | | |
| (0 to 220) mV | (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 100 kHz to 1 MHz | 0.055 % + 13 μV 0.021 % + 8 μV 0.011 % + 8 μV 0.037 % + 8 μV 0.085 % + 25 μV 0.34 % + 80 μV | Fluke 5700A w/option 03 |
| 220 mV to 2.2 V | (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 100 kHz to 1 MHz | 0.05 % + 80 μV 0.016 % + 25 μV 75 μV/V + 6 μV 0.012 % + 16 μV 0.025 % + 70 μV 0.22 % + 850 μV | |
| (2.2 to 22) V | (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 100 kHz to 1 MHz | 0.05 % + 0.8 mV 0.016 % + 0.25 mV 75 μV/V + 0.06 mV 0.012 % + 0.16 mV 0.025 % + 0.35 mV 0.34 % + 8.5 mV | |
| (22 to 220) V | (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 100 kHz to 1 MHz | 0.05 % + 8 mV 0.016 % + 2.5 mV 80 μV/V + 0.8 mV 0.022 % + 3.5 mV 0.05 % + 8 mV 1.6 % + 190 mV | |
| (220 to 750) V | (30 to 50) kHz (50 to 100) kHz | 0.06 % + 11 mV 0.23 % + 45 mV | |
| (220 to 1100) V | (15 to 50) Hz 50 Hz to 1 kHz | 0.04 % + 16 mV 90 μV/V + 4 mV | |

| Parameter/Range | Frequency | CMC ^{2, 4, 5, 7} (\pm) | Comments |
|------------------------------------|--|--|--|
| AC Voltage ³ – Measure | | | |
| Up to 10 mV | (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz | 0.03 % + 3 μ V 0.02 % + 2 μ V 0.03 % + 2 μ V 0.12 % + 2 μ V 0.58 % + 2 μ V 4.6 % + 2 μ V | HP 3458A, synchronous sub-sampled mode |
| 10 mV to 10 V | (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz | 80 μ V/V + 0.4 mV 80 μ V/V + 0.2 mV 0.02 % + 0.2 mV 0.03 % + 0.2 mV 0.09 % + 0.2 mV 0.35 % + 1 mV 1.2 % + 1 mV 1.7 % + 1 mV | |
| (10 to 100) V | (1 to 40) Hz 40 Hz to 1 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz | 0.02 % + 4 mV 0.02 % + 2 mV 0.04 % + 2 mV 0.14 % + 2 mV 0.46 % + 10 mV 1.7 % + 10 mV | |
| (100 to 1000) V | (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz | 0.05 % + 40 mV 0.05 % + 20 mV 0.07 % + 20 mV 0.14 % + 20 mV 0.35 % + 20 mV | |
| AC Current ³ – Generate | | | |
| 40 Hz to 1 kHz | (1 to 220) μ A 220 μ A to 22 mA (22 to 220) mA 220 mA to 2.2 A | 0.09 % 0.024 % 0.026 % 0.093 % | Fluke 5700A w/option 03 |

| Parameter/Range | Frequency | CMC ^{2,5} (±) | Comments |
|-----------------------------------|---|--|----------|
| AC Current ³ – Measure | | | |
| Up to 100 µA | (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz | 0.46 % + 0.03 µA 0.18 % + 0.03 µA 0.078 % + 0.03 µA | HP 3458A |
| 100 µA to 100 mA | (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz | 0.46 % + 20 µA 0.17 % + 20 µA 0.073 % + 20 µA 0.042 % + 20 µA | |
| 100 mA to 1 A | (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz | 0.46 % + 200 µA 0.19 % + 200 µA 0.10 % + 200 µA 0.12 % + 200 µA | |

IV. Electrical – RF/Microwave

| Parameter/Range | Frequency | CMC ² (±) | Comments |
|---------------------------------|-------------------------------|----------------------|--|
| RF Tuned Power – Generate | | | |
| (0 to -100) dB | Up to 1.3 GHz Up to 18 GHz | 0.23 dB 0.25 dB | HP 8902A, HP11722A, HP 11793A, 11792A |
| RF Absolute Power – Generate | | | |
| (0.0) dB (1 mW) | 50 MHz | 0.02 dB | HP423A, HP8748A, HP34401A |
| (-20 to 10) dB | (0.0001 to 4.2) GHz | 0.09 dB | |
| (-20 to 10) dB | (2.0 to 50) GHz | 0.05 dB | HP 438B, 8484A, 8482A 8487A, 8487D |
| (-70 to -20) dB | (0.5 to 18) GHz | 0.11 dB | |
| (-70 to -20) dB | (18 to 50) GHz | 0.09 dB | |

| Parameter/Range | Frequency | CMC ^{2,7} (±) | Comments |
|---|--|--|----------|
| Phase Modulation – Generate Rate: 10 MHz to 1.3 GHz | 200 Hz to 20 kHz | 3.5 % + 1 digit of rdg | HP 8902A |
| Amplitude Modulation – Measure Rate: 150 kHz to 10 MHz Depth: (5 to 99) % Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) % | 50 Hz to 10 kHz 20 Hz to 10 kHz 50 Hz to 10 kHz 20 Hz to 10 kHz | 2 % + 1 digit of rdg 3 % + 1 digit of rdg 1 % + 1 digit of rdg 3 % + 1 digit of rdg | HP 8902A |
| Frequency Modulation – Measure Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz Rate: 10 MHz to 1.3 GHz Dev: ≤ 400 kHz | 50 Hz to 10 kHz 50 Hz to 100 kHz 20 Hz to 200 kHz | 2 % + 1 digit of rdg 1 % + 1 digit of rdg 5 % + 1 digit of rdg | HP 8902A |

| Parameter/Equipment | Range | CMC ^{2,7} (\pm) | Comments |
|--|---------------------|--|---|
| Reflection $S_{11/22}$ Measure 30 kHz to 2 GHz | (0.56 to 1) lin | (± 0.0059 to ± 0.021) lin (± 0.61 to ± 1.5) deg | HP8751A, HP 87512C, HP85052B, calibration kit and network analyzer |
| | (0.32 to 0.56) lin | (± 0.0045 to ± 0.014) lin (± 0.61 to ± 2.0) deg | |
| | (0.1 to 0.32) lin | (± 0.0027 to ± 0.010) lin (± 1.0 to ± 4.1) deg | |
| | (0.032 to 0.1) lin | (± 0.0021 to ± 0.0068) lin (± 1.7 to ± 11) deg | |
| | (0.01 to 0.032) lin | (± 0.0018 to ± 0.059) lin (± 3.9 to ± 180) deg | |
| | (0 to 0.001) lin | $< \pm 0.0055$ lin ± 180 deg | |
| Transmission $S_{11/22}$ Measure 30 kHz to 2 GHz | (0 to 12) dB | (± 0.059 to ± 0.11) dB (± 0.39 to ± 0.91) deg | HP8751A, HP 87512C, HP85056D, calibration kit and network analyzer |
| | (12 to 30) dB | (± 0.074 to ± 0.11) dB (± 0.69 to ± 0.93) deg | |
| | (30 to 40) dB | (± 0.080 to ± 0.010) dB (± 1.0 to ± 4.1) deg | |
| | (40 to 50) dB | (± 0.081 to ± 0.13) dB (± 0.75 to ± 1.0) deg | |
| | (50 to 60) dB | (± 0.088 to ± 0.23) dB (± 0.78 to ± 1.6) deg | |
| | (60 to 70) dB | (± 0.13 to ± 0.60) dB (± 1.0 to ± 4.1) deg | |
| | (70 to 80) dB | (± 0.34 to ± 1.7) dB (± 2.3 to ± 13) deg | |
| | (80 to 100) dB | (± 0.99 to ± 10) dB (± 7.0 to ± 180) deg | |

V. Mechanical

| Parameter/Equipment | Range | CMC ^{2,7} (±) | Comments |
|---|--|----------------------------|--|
| Pressure ³ – Measure & Measuring Equipment | (-15 to 30) psi Up to 300 psi | 0.34 psi 0.49 psi | Druck calibrator |
| | Up to 15 000 psi | 0.58 % | Dead weight tester |
| Torque ³ – Measure | (0 to 100) in·oz (0 to 100) in·lb (0 to 100) ft·lb | 0.94 % 0.89 % 0.76 % | Norbar torque system |
| | (Up to 1000) ft·lb | 1.2 % | CDI torque system |
| Mass | (5 to 500) mg (0 to 500) g | 1.2 mg 1.2 g | NIST handbook 44 using class 1 weights |
| | Up to 600 lb | 0.3 % | NIST handbook 44 using class F weights |
| Accelerometers Frequency Response | 20 Hz to 10 kHz | 4.7 % FS | Vibration calibration system, standard accelerometers FS = full scale |

VI. Thermodynamics

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|-----------------------------------|-------------------------------|----------------------------------|---|
| Humidity – Measuring Equipment | 11 % RH 33 % RH 75 % RH | 1.6 % RH 1.7 % RH 1.5 % RH | Saturated salt solutions Vaisala HMI41/HMP46 |
| Temperature – Measuring Equipment | (-25 to 600) °C | 0.33 °C | Hart 1560 black stack, Minco PRT |
| Temperature – Measure | (-40 to 200) °C | 0.33 °C | Hart 1560 black stack, Minco PRT |

VII. Time & Frequency

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|--|----------------|----------------------------|----------------------------|
| Frequency – Measuring Equipment | 10 MHz | 1 part in 10 ¹¹ | HP 58503 GPS |
| Frequency ³ – Measuring Equipment | 1 Hz to 50 GHz | 1 part in 10 ⁹ | GPS, 3325A, 83650B, 53132A |

¹ This laboratory offers commercial calibration service and field calibration service.

² Calibration and Measurement Capability (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. Calibration and Measurement Capabilities represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

³ Field calibration service is available for this calibration and this laboratory meets A2LA R104 – *General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

⁴ The measurands stated are generated with the Fluke 5500A, Fluke 5700A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

⁵ The measurands stated are measured with the HP 3458A series of instruments. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.

⁶ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches. Pitch diameter is measured by the three-wire method.

⁷ In the statement of CMC, the value is defined as the percentage of reading.



World Class Accreditation

The American Association for Laboratory Accreditation

Accredited Laboratory

A2LA has accredited

MICRO PRECISION CALIBRATION

San Diego, CA

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration. 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 8 January 2009*).

Presented this 1st day of November 2011.





Peter Meyer

President & CEO
For the Accreditation Council
Certificate Number 935.10
Valid to September 30, 2013

For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.