



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

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CALIBRATION

Valid To: March 31, 2018

Certificate Number: 1741.13

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

I. Dimensional

| Parameter/Equipment | Range | CMC ^{2, 6} (±) | Comments |
|--|---------------------------------|---|--|
| Calipers ³ | Up to 12 in (12 to 40) in | (6.4 + 3.2L) μin + 0.6R (14 + 2.6L) μin + 0.6R | Gage blocks |
| Micrometers ³ – | Up to 12 in (12 to 40) in | (6.4 + 3.2L) μin + 0.6R (14 + 2.6L) μin + 0.6R | Gage blocks |
| Linear Indicators ³ , Dial and Test | Up to 0.1 in (0.1 to 0.5) in | 13 μin + 0.6R 61 μin + 0.6R | Federal indicator calibrator |
| | (0.5 to 4) in | (4.3 + 3.3L) μin + 0.6R | Gage blocks |
| | Up to 12 in | (6.9 + 1.5L) μin + 0.6R | Pratt & Whitney Labmaster ⁵ 1000M |
| Hand Tools ³ – Depth Gages, Snap Gages, Fixture Gages, Thickness Gages | Up to 12 in (12 to 40) in | (6.4 + 3.2L) μin + 0.6R (14 + 2.6L) μin + 0.6R | Gage blocks |
| Pin Gages Class Z, ZZ ³ | Up to 1 in | 41 μin | Bench comparator and probe w/ preset gage blocks |
| Height Gages ³ | Up to 48 in | (56 + 1.3L) μin | Gage blocks |

| Parameter/Equipment | Range | CMC ^{2, 6} (±) | Comments | |
|--|---|-------------------------|---|------------------|
| Gage Blocks | (0.05 to 4) in | (2.7 + 1.7L) μin | Federal gage block comparator and master block | |
| | (4 to 20) in | (6.9 + 1.5L) μin | Pratt & Whitney Labmaster ⁸ 1000M and master block | |
| Thread Measuring Wires | (0.008 to 1.5) in | (6.9 + 1.5L) μin | Pratt & Whitney Labmaster ⁸ 1000M | |
| Micrometer Heads | Up to 2 in | (4.3+ 3.3L) μin + 0.6R | Gage blocks | |
| Micrometer / End Standards | Up to 48 in | (63 + 8.4L) μin | Gage blocks w/ lever probe | |
| Cylindrical Measure – Plain Rings | Up to 20 in | (6.9 + 1.5L) μin | Pratt & Whitney Labmaster ⁸ 1000M | |
| | Pins, Plain Plugs, Discs, Spheres – External Diameter | Up to 20 in | | (6.9 + 1.5L) μin |
| Thread Plugs – Pitch Diameter | (0.05 to 6) in | (74 + 0.3L) μin | Fowler ULM w/ thread wire set | |
| | Major Diameter | (0.05 to 6) in | | (34 + 0.7L) μin |
| Thread Rings – Simple Pitch Diameter – Solid Rings | (0.05 to 6) in | 190 μin | Pratt & Whitney Labmaster ⁸ 1000M w/setting plugs | |
| | Adjustable Rings | (0.05 to 6) in | | 220 μin |
| | | | | |
| Spline/Gear Gages – Plugs Diameter (Over Pins) | Up to 8 in | (34 + 0.7L) μin | Fowler ULM w/ gear wire set | |
| | Rings Diameter (Between Pins) | Up to 8 in | | (34 + 0.7L) μin |

| Parameter/Equipment | Range | CMC ^{2, 6} (±) | Comments |
|---|--|--|--|
| Caliper Masters | Up to 20 in | (6.9 + 1.5L) μin | Pratt & Whitney Labmaster ⁸ 1000M |
| Micrometer Master | Up to 20 in | (6.9 + 1.5L) μin | Pratt & Whitney Labmaster ⁸ 1000M |
| Protractor & Angle Indicators ³ | 30°, 45°, 60°, 75°, 90° | 0.03° | Angle block set |
| Combination Squares/Protractors/Angle Gages | Up to 180° | 0.16° | Optical comparator or protractor |
| Steel Rules ³ | Up to 72 in | (5 + 10L) μin + 0.6R | Gage blocks |
| Tape Measures ³ | Up to 25 ft | (5 + 10L) μin + 0.6R | Gage blocks |
| Optical Comparator ³ – X-Y Linearity Magnification Angle | (0 to 6) in 10x to 250x 0° to 90° | 85 μin + 0.6R 0.014 in 0.1 ° | Glass master scales Angle block set |
| Length 1-D | Up to 6 in Up to 24 in | 135μin 360 μin + 12 μin/in | O.D. micrometer, height gage |
| Surface Plates ³ – Grades AA, A, and B – Repeatability Flatness | 0.002 in Up to 60 DL in (>60 to 120) DL in | 40 μin (31 + 0.2) DL μin (30 + 0.3) DL μin | Repeat-o-Meter Federal level system |
| Gage Block Comparators ³ – Amplifier Gain Contact Force | 0.002 in Up to 150 g | 2.1 μin 5.2 g | Master gage block, force gage |

| Parameter/Equipment | Range | CMC ^{2, 6} (±) | Comments |
|---|---------------|------------------------------------|--------------------------------|
| Bench Micrometers, Universal Length Measuring Machines ³ | | | |
| Linearity | Up to 4 in | $(3.9 + 1.5L) \mu\text{in} + 0.6R$ | Gage blocks |
| Flatness & Parallelism | Up to 12 in | 5 μin | Reference sphere |
| Force | Up to 80 oz | 0.32 oz | Futek load cell |
| Feeler/Thickness Shims and Thickness Standards ³ | Up to 1 in | 80 μin | Micrometer |
| Coating Thickness Gages ³ (Film, Ultrasonic) | Up to 20 mils | 0.1 mils | Coating thickness standards |
| Radius Gages | Up to 2 in | 480 μin | Optical comparator |

II. Dimensional Testing/Calibration¹

| Parameter/Equipment | Range | CMC ^{2, 6, 7} (±) | Comments |
|------------------------------|-------------------------------|----------------------------|--|
| Length ⁹ | | | |
| X-Axis | Up to 27 in (700 mm) | $(82 + 8.5L) \mu\text{in}$ | Zeiss Contura G2 CMM |
| Y-Axis | Up to 27 in (700 mm) | $(82 + 8.5L) \mu\text{in}$ | |
| Z-Axis | Up to 24 in (600 mm) | $(82 + 8.5L) \mu\text{in}$ | |
| Volumetric ⁹ | Up to 24 in (600 mm) | $(150 + 10L) \mu\text{in}$ | |
| Surface Finish ¹⁰ | Ra (10 to 200) μin | $1.5 \mu\text{in} + 7 \%$ | Reference standard & mechanical comparison |

III. Electrical – DC/Low Frequency

| Parameter/Equipment | Range | CMC ^{2, 4, 5, 7} (±) | Comments |
|------------------------------------|---|--|--|
| DC Voltage – Measure ³ | (0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V | 11 $\mu\text{V}/\text{V}$ + 3 μV 10 $\mu\text{V}/\text{V}$ + 0.3 μV 10 $\mu\text{V}/\text{V}$ + 0.05 μV 12 $\mu\text{V}/\text{V}$ + 0.3 μV 27 $\mu\text{V}/\text{V}$ + 0.1 μV | HP 3458A |
| | (1 to 10) kV | 0.05 % + 0.3 V | Vitrek 4700 |
| | (10 to 70) kV | 0.06 % + 0.2 V | Vitrek 4700 w/ HVL-70 |
| DC Voltage – Generate ³ | (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 | 11 $\mu\text{V}/\text{V}$ + 0.4 μV 6.7 $\mu\text{V}/\text{V}$ + 0.7 μV 5 $\mu\text{V}/\text{V}$ + 2.5 μV 5.1 $\mu\text{V}/\text{V}$ + 4 μV 6.7 $\mu\text{V}/\text{V}$ + 40 μV 8.5 $\mu\text{V}/\text{V}$ + 400 μV | Fluke 5720A |
| DC Current – Measure ³ | Up to 100 nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A | 35 $\mu\text{A}/\text{A}$ + 0.04 nA 25 $\mu\text{A}/\text{A}$ + 0.04 nA 25 $\mu\text{A}/\text{A}$ + 0.1 nA 25 $\mu\text{A}/\text{A}$ + 0.8 nA 25 $\mu\text{A}/\text{A}$ + 5 nA 25 $\mu\text{A}/\text{A}$ + 50 nA 40 $\mu\text{A}/\text{A}$ + 0.5 μA 0.012 % + 10 μA | HP 3458A |
| | (1 to 300) A | 0.07 % | GL 9230A/300 shunt with HP 3458A |
| DC Current – Generate ³ | (0 to 220) μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA | 50 $\mu\text{A}/\text{A}$ + 6 nA 44 $\mu\text{A}/\text{A}$ + 7 nA 44 $\mu\text{A}/\text{A}$ + 40 nA 55 $\mu\text{A}/\text{A}$ + 0.7 μA | Fluke 5720A |
| | 220 mA to 2.2 A | 0.011 % + 12 μA | $\pm (200 I^2)$ $\mu\text{A}/\text{A}$ for $I > 100$ mA $\pm (10 I^2)$ $\mu\text{A}/\text{A}$ for $I > 1$ A |
| | (1.1 to 3) A (3 to 11) A (11 to 20.5) A | 0.046 % + 40 μA 0.06 % + 500 μA 0.12 % + 750 μA | Fluke 5520A |
| | | | |

| Parameter/Equipment | Range | CMC ^{2, 4, 5, 7} (±) | Comments |
|--|--|---|----------------------------|
| DC Current – Generate (cont) | | | |
| Clamp-On Meters (Toroidal) | (20.5 to 1000) A | 0.39 % + 0.5A | Fluke 5520A w/5500 coil |
| (Non Toroidal) | (20.5 to 1000) A | 0.65 % + 0.5A | |
| Resistance – Measure ³ | (0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ | 18 μΩ/Ω + 50 μΩ 15 μΩ/Ω + 0.5 mΩ 13 μΩ/Ω + 0.5 mΩ 13 μΩ/Ω + 5 mΩ 13 μΩ/Ω + 50 mΩ 18 μΩ/Ω + 2 Ω 53 μΩ/Ω + 100 Ω 0.062 % + 1 kΩ 0.51 % + 10 kΩ | HP 3458A |
| Resistance – Generate ³ | (0 to 11) Ω (11 to 33) Ω (33 to 110) Ω 110 Ω to 1.1 kΩ (1.1 to 11) kΩ (11 to 110) kΩ 110 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 to 1100) MΩ | 49 μΩ/Ω + 0.001 Ω 37 μΩ/Ω + 0.0015 Ω 34 μΩ/Ω + 0.0014 Ω 34 μΩ/Ω + 0.002 Ω 34 μΩ/Ω + 0.02 Ω 34 μΩ/Ω + 0.2 Ω 39 μΩ/Ω + 2 Ω 73 μΩ/Ω + 30 Ω 0.016 % + 50 Ω 0.03 % + 2.5 kΩ 0.06 % + 3 kΩ 0.36 % + 100 kΩ 1.8 % + 500 kΩ | Fluke 5520A |
| Resistance – Generate ³ Fixed Points | 0 Ω (1, 1.9) Ω (10, 19) Ω (100, 190) Ω (1, 1.9, 10, 19) kΩ (100, 190) kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ | 50 μΩ 0.012 % 31 μΩ/Ω 13 μΩ/Ω 8.2 μΩ/Ω 11 μΩ/Ω 16 μΩ/Ω 22 μΩ/Ω 50 μΩ/Ω 59 μΩ/Ω 0.013 % | Fluke 5720A |

| Parameter/Equipment | Range | CMC ^{2, 4, 5, 7} (±) | Comments |
|--|---|-------------------------------|-----------------------|
| Insulation Resistance ³ – Fixed Points | 10 Ω, 100, 1K, 10K, 100K, 1M, 10M, 100 MΩ, 1 GΩ, 10GΩ, 100GΩ | 1.2 % | Standard resistor set |

| Parameter/Range | Frequency | CMC ^{2, 4, 5, 7} (±) | Comments |
|---|---|--|-------------|
| Capacitance – Generate ³ (220 to 399.9) pF (0.4 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.9999) nF (11 to 109.999) nF (110 to 329.999) nF (0.33 to 1.09999) μF (1.1 to 3.29999) μF (3.3 to 10.9999) μF (11 to 32.9999) μF (33 to 109.999) μF (110 to 329.999) μF (0.33 to 1.09999) mF (1.1 to 3.29999) mF (3.3 to 10.9999) mF (11 to 32.9999) mF (33 to 110) mF | (10 to 10 000) Hz (10 to 10 000) Hz (10 to 3000) Hz (10 to 1000) Hz (10 to 1000) Hz (10 to 1000) Hz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 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 | 0.88 % + 10 pF 0.6 % + 0.01 nF 0.6 % + 0.01 nF 0.31 % + 0.1 nF 0.31 % + 0.1 nF 0.31 % + 0.3 nF 0.31 % + 1 nF 0.31 % + 3 nF 0.31 % + 10 nF 0.49 % + 30 nF 0.55 % + 100 nF 0.55 % + 300 nF 0.55 % + 1 μF 0.55 % + 3 μF 0.56 % + 10 μF 0.91 % + 30 μF 1.4 % + 100μF | Fluke 5520A |
| AC Voltage – Measure ³ Up to 10 mV 10 mV to 10V | (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 (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 | 0.031 % + 0.03 % of rng 0.022 % + 0.01 % of rng 0.031 % + 0.01 % of rng 0.11 % + 0.01 % of rng 0.51 % + 0.01 % of rng 4.1 % + 0.02 % of rng 0.008 % + 0.004 % of rng 0.008 % + 0.002 % of rng 0.015 % + 0.002 % of rng 0.031 % + 0.002 % of rng 0.081 % + 0.002 % of rng 0.31 % + 0.01 % of rng | HP 3458A |



| Parameter/Range | Frequency | CMC ^{2, 4, 5, 7} (±) | Comments |
|---|--|--|----------------------------|
| AC Voltage – Measure ³ (cont) | | | |
| (10 to 100) V | (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz | 0.021 % + 0.004 % of rng 0.021 % + 0.002 % of rng 0.021 % + 0.002 % of rng 0.036 % + 0.002 % of rng 0.13 % + 0.002 % of rng 0.41 % of rdg + 0.01 % of rng | HP 3458A |
| (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 | 0.041 % + 0.004 % of rng 0.041 % + 0.002 % of rng 0.061 % + 0.002 % of rng 0.13 % + 0.002 % of rng 0.31 % + 0.002 % of rng | |
| (1 to 10) kV | 60 Hz | 0.13 % + 0.1 V | Vitretek 4670 |
| (10 to 70) kV | 60 Hz | 0.13 % + 0.4 V | Vitretek 4670 w/ HVL-70 |
| AC Voltage – Generate ³ | | | |
| (0 to 2.2) mV | (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz | 0.19 % + 4 μV 0.12 % + 4 μV 0.086 % + 4 μV 0.15 % + 4 μV 0.21 % + 5 μV 0.37 % + 10 μV 0.53 % + 20 μV 0.69 % + 20 μV | Fluke 5720A |
| (2.2 to 22) mV | (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz | 0.031 % + 4 μV 0.014 % + 4 μV 0.013 % + 4 μV 0.03 % + 4 μV 0.066 % + 5 μV 0.14 % + 10 μV 0.18 % + 20 μV 0.35 % + 20 μV | |
| (22 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 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz | 0.03 % + 12 μV 0.011 % + 7 μV 0.01 % + 7 μV 0.025 % + 7 μV 0.056 % + 17 μV 0.11 % + 20 μV 0.17 % + 25 μV 0.34 % + 45 μV | |

| Parameter/Range | Frequency | CMC ^{2, 4, 5, 7} (±) | Comments |
|---|--|--|-------------|
| AC Voltage – Generate ³ (cont.) | | | Fluke 5720A |
| 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 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz | 0.062 % + 40 µV 0.024 % + 15 µV 56 µV/V + 8 µV 93 µV/V + 10 µV 0.014 % + 30 µV 0.051 % + 80 µV 0.12 % + 200 µV 0.21 % + 300 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 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz | 0.029 % + 400 µV 0.12 % + 150 µV 58 µV/V + 50 µV 95 µV/V + 100 µV 0.013 % + 200 µV 0.035 % + 600 µV 0.12 % + 2 mV 0.19 % + 3.2 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 | 0.029 % + 4 mV 0.012 % + 1.5 mV 66 µV/V + 0.6 mV 0.011 % + 1 mV 0.019 % + 2.5 mV | |
| (220 to 1100) V | (15 to 50) Hz 50 Hz to 1 kHz | 0.037 % + 16 mV 58 µV/V + 3.5 mV | |
| AC Current – Measure ³ | | | HP 3458A |
| (0 to 100) µA | (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz 100 Hz to 5 kHz | 0.41 % + 0.03 % of rng 0.16 % + 0.03 % of rng 0.07 % + 0.03 % of rng 0.07 % + 0.03 % of rng | |
| (1 to 100) mA | (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz | 0.41 % + 0.02 % of rng 0.16 % + 0.02 % of rng 0.07 % + 0.02 % of rng 0.04 % + 0.02 % of rng 0.07 % + 0.02 % of rng 0.41 % + 0.04 % of rng 0.56 % + 0.15 % of rng | |

| Parameter/Range | Frequency | CMC ^{2, 4, 5, 7} (±) | Comments |
|--|--|---|-------------|
| AC Current – Measure ³ (cont.) | | | |
| 100 mA to 1 A | (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz | 0.41 % + 0.02 % of rng 0.17 % + 0.02 % of rng 0.09 % + 0.02 % of rng 0.11 % + 0.02 % of rng 0.31 % + 0.02 % of rng 1.1 % + 0.04 % of rng | HP 3458A |
| (1 to 3) A | 10 Hz to 5 kHz | 0.26 % | HP 34410A |
| AC Current – Generate ³ | | | |
| (0 to 220) µA | (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.031 % + 16 nA 0.020 % + 10 nA 0.014 % + 8 nA 0.029 % + 12 nA 0.14 % + 65 nA | Fluke 5720A |
| 220 µA to 2.2 mA | (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.031 % + 40 nA 0.020 % + 35 nA 0.013 % + 35 nA 0.025 % + 110 nA 0.14 % + 650 nA | |
| (2.2 to 22) mA | (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.033 % + 400 nA 0.020 % + 350 nA 0.013 % + 350 nA 0.025 % + 550 nA 0.14 % + 5 µA | |
| (22 to 220) mA | (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.033 % + 4 µA 0.020 % + 3.5 µA 0.013 % + 2.5 µA 0.025 % + 3.5 µA 0.14 % + 10 µA | |
| 220 mA to 2.2 A | 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.03 % + 35 µA 0.055 % + 80 µA 0.85 % + 160 µA | |
| (2.2 to 11) A | 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.056 % + 170 µA 0.12 % + 380 µA 0.44 % + 750 µA | |
| (11 to 20.5) A | 45 Hz to 1 kHz | 0.19 % + 5 mA | Fluke 5520A |

| Parameter/Range | Frequency | CMC ^{2, 4} (±) | Comments |
|---|--|--|-----------------------------|
| AC Current – Generate ³ (cont.) | | | |
| Clamp-On Meters | | | |
| (20.5 to 1000) A (Toroidal) | (50 to 400) Hz | 0.43 % + 0.025A | Fluke 5520A w/ 5500 coil |
| (Non Toroidal) | (50 to 400) Hz | 0.68 % + 0.025A | |
| Oscilloscopes ³ – | | | |
| Square Wave Amplitude: | | | |
| 50 Ω at 1 kHz | 1.0 mV to 6.6 V _{pk - pk} | 0.32 % + 40 μV | Fluke 5520A SC1100 |
| 1 MΩ at 1 kHz | 1.0 mV to 130 V _{pk - pk} | 0.16 % + 40 μV | |
| DC Voltage Amplitude: | | | |
| 50 Ω Load | (0 to ± 6.6) V | 0.30 % + 40 μV | |
| 1 MΩ Load | (0 to ± 130) V | 0.07 % + 40 μV | |
| Level Sine Wave: | Up to 1100 MHz | 3.3 μHz/Hz | |
| Frequency | 50 kHz Reference 50 kHz to 100 MHz | 2.4 % + 300 μV 4.4 % + 300 μV | |
| Amplitude | (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz | 4.9 % + 300 μV 7.3 % + 300 μV 8.4 % + 300 μV | |
| Flatness (Bandwidth) | 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz | 2.1 % + 100 μV 2.6 % + 100 μV 4.9 % + 100 μV 6 % + 100 μV | Fluke 5520A SC1100 |
| Time Markers: | | | |
| Into a 50 Ω load | 5 s to 50 ms 20 ms to 2 ns | (30 + 1000t) μs/s 3.5 μs/s | t = time in seconds |
| Rise Time: | | | |
| 1 kHz to 2 MHz (2 to 10) MHz | ≤ 300 ps ≤ 350 ps | 130 ps 130 ps | |

| Parameter/Equipment | Range | CMC ^{2,4} (±) | Comments |
|--|---|-------------------------------|-------------|
| Thermocouple Simulation ³ – | | | |
| Type E | (-250 to -100) °C (-100 to 650) °C (650 to 1000) °C | 0.56 °C 0.20 °C 0.26 °C | Fluke 5520A |
| Type J | (-210 to -100) °C (-100 to 760) °C (760 to 1200) °C | 0.33 °C 0.22 °C 0.29 °C | |
| Type K | (-200 to -100) °C (-100 to 1000) °C (1000 to 1372) °C | 0.40 °C 0.32 °C 0.49 °C | |
| Type T | (-250 to -150) °C (-150 to 0) °C (0 to 400) °C | 0.77 °C 0.31 °C 0.22 °C | |
| Type R | (0 to 250) °C (250 to 1000) °C (1000 to 1767) °C | 0.70 °C 0.42 °C 0.50 °C | |
| Type S | (0 to 250) °C (250 to 1400) °C (1400 to 1767) °C | 0.58 °C 0.46 °C 0.57 °C | |
| Electrical Calibration of RTD Indicators and Indicating Systems ³ – | | | |
| Pt 385, 100 Ω | (-200 to 800) °C | 0.25 °C | Fluke 5520A |
| Pt 385, 100 Ω | (-200 to 630) °C | 0.025 °C | |

IV. Mechanical

| Parameter/Equipment | Range | CMC ^{2,6,7} (±) | Comments |
|--------------------------------|---|---|-----------------------------------|
| Scales & Balances ³ | (1 to 20 000) g (Above 20 to 5000) kg Up to 1000 lbs (1000 to 120 000) lbs | 0.017 % + 0.6R 0.017 % per 20 000 g + 0.6R 0.017 % + 0.6R 0.017 % per 20 000 lb + 0.6R | Class F weights (applied load) |



| Parameter/Equipment | Range | CMC ^{2, 6, 7} (\pm) | Comments |
|--|--|--|-----------------------------|
| Scales & Balances ³ (cont) | (1 to 500) mg (Up to 5) g (Up to 10) g (Up to 30) g (Up to 50) g (Up to 100) g (Up to 200) g (Up to 300) g (Up to 500) g (Up to 1000) g (Above 1000) g | 0.013 mg + 0.6R 0.043 mg + 0.6R 0.062 mg + 0.6R 0.092 mg + 0.6R 0.17 mg + 0.6R 0.31 mg + 0.6R 0.63 mg + 0.6R 0.93 mg + 0.6R 1.5 mg + 0.6R 3.1 mg + 0.6R 3.1 mg per 1000 g + 0.6R | Class 1 weights |
| Verification of Force in Tension ³ | (0 to 500) lbf (0 to 10 000) lbf (0 to 25 000) lbf (0 to 50 000) lbf | 1.5 lbf 35 lbf 75 lbf 150 lbf | ASTM E74 using load cell |
| Verification of Force in Compression ³ (Field Only) | (0 to 500) lbf (0 to 10 000) lbf (0 to 25 000) lbf (0 to 50 000) lbf | 1.5 lbf 35 lbf 75 lbf 150 lbf | ASTM E74 using load cell |
| Verification of Force in Compression ³ (Field Only) (cont.) | (0 to 500 000) lbf | 0.12 % | ASTM E74 using load cell |
| Torque Wrenches ³ | Up to 250 ft·lbf 250 to 2000 ft·lbf | 0.65 % 1.0 % | CDI torque tester |
| Torque Transducers and Analyzers | Up to 2000 ft·lbf | 0.13% | Torque arms and weights |
| Verification of Durometer Spring | All durometer types | 5.0 g | Duro calibrator |
| Indenter Extension at Zero Reading | ----- | 70 μ m | Gage block |

| Parameter/Equipment | Range | CMC ^{2,7} (±) | Comments |
|---|--|--|-----------------------------------|
| Pressure ³ | (-14.5 to 0) psi (0 to 10) psi (0 to 500) psi | (7.5 × 10 ⁻³) psig (9.8 × 10 ⁻³) psig (3.1 × 10 ⁻³) psig | Fluke 7252i |
| | (0 to 3000) psi (0 to 30 000) psi | 0.75 psig 7 psig | Fluke RPM4-E-DWT |
| Atmospheric Pressure (Vacuum) ³ | (0.01 to 30) in Hg | 0.016 in Hg | Fluke 7252i |
| Air Velocity | (70 to 3000) FPM | 3.5 % | Anemometer standard |
| Indirect Verification of Rockwell Hardness Testers ³ | HRA (20 to 65) (70 to 78) (80 to 84) | 0.75 HRA 0.73 HRA 0.8 HRA | Indirect verification ASTM E18 |
| | HRBW (40 to 59) (60 to 79) (80 to 100) | 0.4 HRBW 0.45 HRBW 0.38 HRBW | |
| | HRC (20 to 30) (35 to 55) (60 to 65) | 0.43 HRC 0.43 HRC 0.38 HRC | |
| | HREW (70 to 79) (84 to 90) (93 to 100) | 0.77 HREW 0.77 HREW 0.77 HREW | |
| | HR15N (70 to 77) (78 to 88) (90 to 92) | 0.42 HR15N 0.42 HR15N 0.42 HR15N | |
| | HR30N (42 to 50) (55 to 73) (77 to 82) | 0.58 HR30N 0.5 HR30N 0.6 HR30N | |

| Parameter/Equipment | Range | CMC ^{2,7} (±) | Comments |
|---|---|---|---------------------------------------|
| Indirect Verification of Rockwell Hardness Testers ³ (cont.) | HR45N (20 to 31) (37 to 61) (66 to 72) HR15TW (74 to 80) (81 to 86) (87 to 93) HR30TW (43 to 56) (57 to 69) (70 to 83) HR45TW (13 to 32) (33 to 52) (53 to 73) | 0.48 HR45N 0.48 HR45N 0.49 HR45N 0.4 HR15TW 0.4 HR15TW 0.42 HR15TW 0.41 HR30TW 0.42 HR30TW 0.42 HR30TW 0.93 HR45TW 0.5 HR45TW 0.6 HR45TW | Indirect verification ASTM E18 |
| Indirect Verification of Brinell Hardness Testers at Test Condition ³ – HBW 10/3000 | (95.5 to 650) HBW | 5.6 HBW | Indirect verification ASTM E10 |
| Pipettes ³ | (1 to 10) µL (10 to 100) µL (100 to 1000) µL (1000 to 10000) µL | 0.11 µL 0.17 µL 0.63 µL 12 µL | Gravimetric method |
| Mass – Fixed Points | 10 kg 20 kg 25 lb 50 lb | 12 mg 31 mg 110 µlb (48 mg) 220 µlb (97 mg) | By comparison with Class 1 weights |

V. Thermodynamics

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|---|--|------------------------------------|---|
| Temperature – Measure ³ | (-196 to 660) °C | 0.06 °C | Fluke 1502A w/5626 PRT |
| Plate Temperature – Infrared Devices ³ | Up to 100 °C Up to 200 °C Up to 350 °C Up to 500 °C | 1 °C 1.2 °C 1.7 °C 2.3 °C | Fluke 4181 |
| Temperature – Measuring Equipment ³ | (30 to 250) °C (250 to 400) °C (50 to 700) °C | 0.15 °C 0.53 °C 0.61 °C | Calisto w/probe Hart 9141 w/probe Hart 9173 |
| Relative Humidity ³ | (10 to 80) % RH | 1.2 % RH | Vaisala HMI41 w/HMP- 46 |

VI. Time & Frequency

| Parameter/Equipment | Range | CMC ^{2,7} (±) | Comments |
|--|---|---|--|
| Timers/Stopwatches ³ | 15 s to 24 hr | 0.05 s | Reference stopwatch |
| Photo Tachometer ³ | (1 to 50 000) FPM | 0.003 % rdg + 1.2 FPM | Stroboscope FPM is flashes per minute |
| Frequency – Measuring Equipment ³ | (0.1 to 119.99) Hz (120 to 1199.99) Hz (1.2 to 11.999) kHz (12 to 119.99) kHz (120 to 1199.9) kHz (1.2 to 2.0) MHz | 5.8 mHz 6.0 mHz 26 mHz 0.52 Hz 60 Hz 69 Hz | Fluke 5520A |
| Frequency – Measure | Up to 225 MHz | 6.2 µHz/Hz + 3.6 ppm | HP 53132 |



- ¹ This laboratory offers commercial calibration and field calibration services, where noted.
- ² Calibration and Measurement Capability Uncertainty (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. CMCs 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 Based on using the standard at the temperature the Fluke 5720A, Fluke 5520A was calibrated (tcal ± 5 °C) and assuming the instrument is zeroed at least every seven days or when the ambient temperature changes more than 5 °C. For resistance, a zero calibration is performed at least every 12 hours within ± 1 °C of use.
- ⁵ Based on using the standard at the temperature the HP 3456A, 3457A, or 3458A was calibrated (tcal ± 5 °C) and an auto-calibration (ACAL) was performed within the previous 24 hours (± 1 °C of ambient temperature).
- ⁶ In the statement of Calibration and Measurement Capability, L is the numerical value of the nominal length of the device measured in microinches; R is the numerical value of the resolution of the device in microinches. DL is the diagonal length of the device in inches.
- ⁷ Unless otherwise noted, percentage refers to percent of reading.
- ⁸ Labmaster" and "Lengthmaster" are registered trademarks owned by Pratt & Whitney Measurement Systems, Inc., Connecticut U.S.A. (Scope Comments = P & W Labmaster™)
- ⁹ This laboratory meets R205 – *Specific Requirements: Calibration Laboratory Accreditation Program* for the types of dimensional tests listed above and is considered equivalent to that of a calibration.



Accredited Laboratory

A2LA has accredited

J.A. KING & COMPANY, LLC

Oklahoma City, OK

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 R205 – Specific Requirements: Calibration Laboratory Accreditation Program. 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 27th day of May 2016.

A handwritten signature in black ink, written over a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 1741.13
Valid to March 31, 2018

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