



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017
& ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

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CALIBRATION

Valid To: March 31, 2023

Certificate Number: 2046.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1,7}:

I. Acoustical Quantities

| Parameter/Equipment | Range | CMC ^{2,8} (±) | Comments |
|--|---|---|---------------------------|
| Sound Pressure Level ³ – Measurement Equipment | 74 dB 84 dB 94 dB 104 dB 114 dB | 0.41 dB 0.46 dB 0.48 dB 0.49 dB 0.42 dB | Sound level calibrator |

II. Chemical Quantities

| Parameter/Equipment | Range | CMC ^{2,4,5,8} (±) | Comments |
|--|------------------|----------------------------|--|
| pH ³ – Measuring Equipment | (4, 7, 10) pH | 0.015 pH units + 0.60R | Standard solutions w/comparison probe |
| | (0 to 14) pH | 0.015 pH units + 0.60R | Fluke 5520A |
| Conductivity ³ – Measuring Equipment | 100 µS to 100 mS | 1.2 % + 0.60R | Standard solutions w/comparison probe |

III. Device Specific Parameters

| Parameter/Equipment | Range | CMC ^{2,4} (±) | Comments |
|--|------------------|------------------------|---|
| ESD Simulator – | | | |
| Contact Discharge (Positive & Negative) | (2 to 8) kV | 1.0 % | Brandenberg 139 |
| Rise Time | (0.7 to 1) ns | 0.12 ns | Oscilloscope and ESD target |
| 30 nS Current | (2.8 to 20.8) A | 1.8 % | IEC 61000-4-2, IEC 61000-4-2 (2001-04) |
| 60 nS Current | (1 to 10) A | 1.8 % | |
| EFT/Burst Generator ³ – | | | |
| Voltage (±) | 10 V to 6 kV | 2.5 % | EN 6200-4-4 IEC 61000-4-6 |
| Rise Time | 5 ns ± 30 % | 0.81 ns | Tektronix TDS 3052, Haefely PAT 50 / 1000 probes |
| Impulse Duration | 50 ns ± 30 % | 0.81 ns | |
| Burst Duration | 15 ms ± 20 % | 0.81 ns | |
| Burst Period | 300 ms ± 20 % | 0.81 ns | |
| Repetition Rate | | | |
| 0.125 kV | 5 kHz ± 20 % | 1.2 Hz | Tektronix TDS 3052 |
| 0.25 kV | 5 kHz ± 20 % | 1.2 Hz | |
| 0.50 kV | 5 kHz ± 20 % | 1.2 Hz | |
| 1.0 kV | 5 kHz ± 20 % | 1.2 Hz | |
| 2.0 kV | 2.5 kHz ± 20 % | 1.2 Hz | |
| 4.0 kV | 2.5 kHz ± 20 % | 1.2 Hz | |
| CDN – | | | |
| Phase | | | CISPR 16-1-2, IEC 61000-4-6, HP8751A, Type N calibration kit |
| -6 dBm | (-0.8 to 0.8)° | 0.039° | |
| -10 dBm | (-0.12 to 0.12)° | 0.035° | |
| -30 dBm | (-0.12 to 0.12)° | 0.024° | |
| -40 dBm | (-0.12 to 0.12)° | 0.12° | |
| -50 dBm | (-0.12 to 0.12)° | 0.14° | |
| -60 dBm | (-0.3 to 0.3)° | 0.70° | |

| Parameter/Equipment | Range | CMC ^{2,4} (±) | Comments |
|--------------------------------------|--|------------------------------------|--|
| CDN – (cont) | | | |
| Impedance | (5 to 100) Hz 100 Hz to 1 MHz (1 to 300) MHz (300 to 500) MHz | 6.9 % 1.4 % 0.66 % 0.70 % | CISPR 16-1-2, IEC 61000-4-6, HP8751A, Type N calibration kit |
| Coupling Factor | 10 kHz to 500 MHz | 0.38 dB | |
| Current Probe – Transfer Impedance | 10 kHz to 100 MHz 100 MHz to 1 GHz (1 to 1.2) GHz | 0.25 dB 0.57 dB 1.3 dB | CISPR 16-1-2 Boonton 9242 w/ Boonton 952001B probes |
| LISN ³ – | | | |
| Insertion Loss | 9 kHz to 1 GHz | 0.38 dB | CISPR 16-1-2 |
| Impedance | 9 kHz to 1 GHz | 4.9 % | HP8751A, HP8753C Verification kit |
| Phase | 9 kHz to 1 GHz | 2.8° | |
| SpO ₂ /Pulse Oximeter – | | | |
| Beats Per Minute | 60 bpm 200 bpm | 1.3 bpm 2.4 bpm | Nelcor SRC-MAX |
| Pulse Oximetry (% SpO ₂) | (75 and 90) % | 1.3 % | |

IV. Dimensional

| Parameter/Equipment | Range | CMC ^{2,4} (±) | Comments |
|-------------------------------------|--|--|----------------------------|
| Micrometers & Calipers ³ | Up to 2 in (2 to 8) in (8 to 16) in (16 to 24) in | 4.4L + 3.2 μin + 0.6R 4.7L + 4.3 μin + 0.6R 5L + 5.3 μin + 0.6R 4.8L + 4.2 μin + 0.6R | Gage blocks (Grade 1) |
| Gage Blocks | (0.005 to 13) in | (3.4 + 0.94L) μin | Pratt & Whitney Labmaster™ |

| Parameter/Equipment | Range | CMC ^{2,4} (±) | Comments |
|---|--|--|---------------------------------------|
| Height Gages ³ | Up to 2 in (2 to 8) in (8 to 16) in (16 to 24) in | 4.4L + 15 μin + 0.6R 4.7L + 16 μin + 0.6R 5L + 16 μin + 0.6R 4.8L + 16 μin + 0.6R | Gage blocks (Grade 1) |
| Profilometers ³ – Fixed Points, Ra | 16 μin 119.3 μin | 3.8 μin 3.7 μin | Taylor Hobson surface standard blocks |
| Ring Gages | (0.04 to 14) in | (22 + 3.5D) μin | Pratt & Whitney Labmaster™ |
| Pin Gages | (0.011 to 6) in | (3.4 + 0.94D) μin | Pratt & Whitney Labmaster™ |
| Bore Gages – 3-Point | Up to 7.8 in | 170 μin | 3-Point bore gage master setting |

V. Electrical – DC/Low Frequency

| Parameter/Equipment | Range | CMC ^{2,5,6} (±) | Comments |
|---|---|---|---|
| DC Voltage ³ – Generate | (0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V (1000 to 10 000) V (10 000 to 40 000) V | 9.0 μV/V + 0.40 μV 5.3 μV/V + 0.70 μV 3.6 μV/V + 2.5 μV 3.6 μV/V + 4.0 μV 5.1 μV/V + 40 μV 6.7 μV/V + 400 μV 0.015 % 0.041 % | Fluke 5720A HV supply w/source voltage monitored under measure |
| DC Voltage ³ – Generate Fixed Points | 100 mV 1 V 10 V 100 V 1000 V | 3.5 μV/V 3.5 μV/V 3.5 μV/V 3.5 μV/V 3.5 μV/V | Ratio metric techniques Fluke 752A, Fluke 10 DC reference standard |

| Parameter/Equipment | Range | CMC ^{2, 5, 6} (±) | Comments |
|------------------------------------|---|--|---|
| DC Voltage ³ – Measure | (0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1000) V | 7.8 μV/V + 0.10 μV 4.4 μV/V + 0.40 μV 3.6 μV/V + 4.0 μV 5.4 μV/V + 40 μV 8.2 μV/V + 0.50 mV | Fluke 8508A |
| | (1 to 10) kV | 0.012 % | Voltage divider & precision DMM |
| | (10 to 35) kV (35 to 100) kV | 0.045 % 0.057 % | Precision high voltage meter |
| DC Current ³ – Measure | (0 to 200) μA 200 μA to 2.0 mA (2.0 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A | 13 μA/A + 400 pA 13 μA/A + 4.0 nA 14 μA/A + 40 nA 38 μA/A + 800 nA 0.018 % + 16 μA 0.040 % + 400 μA | Fluke 8508A |
| | (20 to 100) A (100 to 1000) A (1000 to 3000) A | 0.054 % 0.26 % 0.30 % | Various current shunts |
| DC Current ³ – Generate | 10 fA to 1 pA (1 to 10) pA (10 to 100) pA 100 pA to 1 nA (1 to 10) nA (10 to 100) nA 100 nA to 110 μA | 2.9 % 1.8 % 1.8 % 1.8 % 1.8 % 1.7 % 1.6 % | Pico ampere source |
| | (110 to 220) μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A | 49 μA/A + 6.0 nA 37 μA/A + 7.0 nA 38 μA/A + 40 nA 48 μA/A + 0.70 μA 83 μA/A + 12 μA | Fluke 5720A |
| | (2.2 to 11) A | 0.040 % + 480 μA | Fluke 5725A amplifier |
| | (11 to 20) A (20 to 120) A | 0.011 % + 1.0 mA 90 μA/A + 6.0 mA | Fluke 52120A |
| | (120 to 1000) A (1000 to 5000) A | 0.26 % 0.56 % | 1 kA shunt Fluke 52120A w/current coils |

| Parameter/Range | Frequency | CMC ^{2,6} (±) | Comments |
|------------------------------------|--|---|-------------|
| AC Voltage ³ – Generate | | | |
| Up 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 (0.5 to 1) MHz | 0.026 % + 4.0 μV 0.015 % + 4.0 μV 0.013 % + 4.0 μV 0.023 % + 4.0 μV 0.051 % + 5.0 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 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 (0.5 to 1) MHz | 0.027 % + 4.0 μV 0.013 % + 4.0 μV 0.013 % + 4.0 μV 0.023 % + 4.0 μV 0.057 % + 5.0 μV 0.11 % + 10 μV 0.15 % + 20 μV 0.30 % + 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 (0.5 to 1) MHz | 0.025 % + 12 μV 95 μV/V + 7.0 μV 0.012 % + 7.0 μV 0.022 % + 7.0 μV 0.048 % + 17 μV 0.094 % + 20 μV 0.14 % + 25 μV 0.28 % + 45 μV | |
| 220 mV to 2.2 V | (10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz | 0.025 % + 40 μV 95 μV/V + 15 μV 51 μV/V + 8.0 μV 78 μV/V + 10 μV 0.013 % + 30 μV 0.044 % + 80 μV 0.10 % + 200 μV 0.19 % + 300 μV | |
| (2.2 to 22) V | (10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz | 0.025 % + 400 μV 95 μV/V + 150 μV 50 μV/V + 50 μV 78 μV/V + 100 μV 0.012 % + 200 μV 0.031 % + 600 μV 0.10 % + 2.0 mV 0.19 % + 3.2 mV | |

| Parameter/Range | Frequency | CMC ^{2,6} (±) | Comments |
|--|--|---|--|
| AC Voltage ³ – Generate (cont) | | | |
| (22 to 220) V | (10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz | 0.025 % + 4.0 mV 94 µV/V + 1.5 mV 57 µV/V + 600 µV 83 µV/V + 1.0 mV 0.018 % + 2.5 mV 0.091 % + 16 mV 0.44 % + 40 mV 0.80 % + 80 mV | Subject to 2.2 E ⁷ V-Hz limitation |
| (220 to 1100) V | (15 to 50) Hz (0.05 to 1) kHz | 0.031 % + 16 mV 77 µV/V + 3.5 mV | |
| 1100 V | 40 Hz to 1.0 kHz (1 to 20) kHz (20 to 30) kHz | 90 µV/V + 4.0 mV 0.017 % + 6.0 mV 0.06 % + 11 mV | 5725A amplifier |
| 750 V | (30 to 50) kHz (50 to 100) kHz | 0.060 % + 11 mV 0.23 % + 45 mV | 5725A amplifier |
| AC Voltage ³ – Measure | | | |
| Up 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 (0.5 to 1) MHz | 0.17 % + 1.3 µV 0.076 % + 1.3 µV 0.044 % + 1.3 µV 0.083 % + 2.0 µV 0.12 % + 2.5 µV 0.23 % + 4.0 µV 0.25 % + 8.0 µV 0.36 % + 8.0 µV | Fluke 5790A |
| (2.2 to 7) 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 (0.5 to 1) MHz | 0.087 % + 1.3 µV 0.038 % + 1.3 µV 0.022 % + 1.3 µV 0.041 % + 2.0 µV 0.061 % + 2.5 µV 0.12 % + 4.0 µV 0.13 % + 8.0 µV 0.20 % + 8.0 µV | |

| Parameter/Range | Frequency | CMC ^{2, 5, 6} (\pm) | Comments |
|---|--|--|-------------|
| AC Voltage ³ – Measure (cont) | | | |
| (7 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 (0.5 to 1) MHz | 0.030 % + 1.3 μ V 0.018 % + 1.3 μ V 0.011 % + 1.3 μ V 0.021 % + 2 μ V 0.032 % + 2.5 μ V 0.083 % + 4.0 μ V 0.088 % + 8.0 μ V 0.14 % + 8.0 μ V | Fluke 5790A |
| (22 to 70) 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 (0.5 to 1) MHz | 0.021 % + 1.5 μ V 0.011 % + 1.5 μ V 72 μ V/V + 1.5 μ V 0.012 % + 2.0 μ V 0.026 % + 2.5 μ V 0.048 % + 4.0 μ V 0.060 % + 8.0 μ V 0.092 % + 8.0 μ V | |
| (70 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 (0.5 to 1) MHz | 0.019 % + 1.5 μ V 83 μ V/V + 1.5 μ V 59 μ V/V + 1.5 μ V 93 μ V/V + 2.0 μ V 0.020 % + 2.5 μ V 0.030 % + 4.0 μ V 0.039 % + 8.0 μ V 0.084 % + 8.0 μ V | |
| (220 to 700) 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 (0.5 to 1) MHz | 0.018 % + 1.5 μ V 67 μ V/V + 1.5 μ V 34 μ V/V + 1.5 μ V 60 μ V/V + 2.0 μ V 86 μ V/V + 2.5 μ V 0.020 % + 4.0 μ V 0.028 % + 8.0 μ V 0.077 % + 8.0 μ V | |
| 700 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 (0.5 to 1) MHz | 0.017 % 57 μ V/V 22 μ V/V 54 μ V/V 75 μ V/V 0.017 % 0.024 % 0.071 % | |

| Parameter/Range | Frequency | CMC ^{2, 5, 6} (±) | Comments |
|---|--|--|-------------|
| AC Voltage ³ – Measure (cont) | | | |
| (2.2 to 7) 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 (0.5 to 1) MHz | 0.017 % 59 μV/V 23 μV/V 55 μV/V 81 μV/V 0.019 % 0.034 % 0.094 % | Fluke 5790A |
| (7 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 (0.5 to 1) MHz | 0.017 % 58 μV/V 27 μV/V 56 μV/V 81 μV/V 0.020 % 0.034 % 0.095 % | |
| (22 to 70) 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 (0.5 to 1) MHz | 0.017 % 59 μV/V 33 μV/V 67 μV/V 98 μV/V 0.021 % 0.036 % 0.095 % | |
| (70 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 to 300) kHz (300 to 500) kHz | 0.017 % 60 μV/V 31 μV/V 81 μV/V 0.011 % 0.021 % 0.041 % | |
| (220 to 700) V | (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz | 0.018 % 85 μV/V 44 μV/V 0.012 % 0.040 % | |
| (700 to 1000) V | (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz | 82 μV/V 40 μV/V 0.012 % 0.040 % | |

| Parameter/Range | Frequency | CMC ^{2, 5, 6} (±) | Comments |
|---|---|---|---|
| AC Voltage ³ – Measure (cont) | | | |
| (1 to 10) kV | (0.01 to 1) Hz (1 to 200) Hz (200 to 450) Hz | 0.14 % 0.14 % 0.41 % | Precision high voltage meter |
| (10 to 30) kV | (0.01 to 1) Hz (1 to 200) Hz (200 to 450) Hz | 0.14 % 0.08 % 0.52 % | |
| (30 to 70) kV | (0.01 to 1) Hz (1 to 70) Hz (70 to 200) Hz | 0.32 % 0.15 % 1.1 % | |
| (70 to 100) kV | (50 to 60) Hz | 0.66 % | AC voltage standard w/voltage divider & precision DMM |
| AC Current ³ – Generate | | | |
| Up to 220 µA | (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.026 % + 16 nA 0.017 % + 10 nA 0.014 % + 8.0 nA 0.029 % + 12 nA 0.11 % + 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 | 0.026 % + 40 nA 0.017 % + 35 nA 0.013 % + 35 nA 0.021 % + 110 nA 0.11 % + 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 | 0.026 % + 400 nA 0.017 % + 350 nA 0.013 % + 350 nA 0.021 % + 550 nA 0.11 % + 5.0 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 | 0.026 % + 4.0 µA 0.017 % + 3.5 µA 0.013 % + 2.5 µA 0.021 % + 3.5 µA 0.11 % + 10 µA | |
| 220 mA to 2.2 A | 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.028 % + 35 µA 0.046 % + 80 µA 0.71 % + 160 µA | |

| Parameter/Range | Frequency | CMC ^{2, 5, 6} (±) | Comments |
|--|--|---|---------------------------------|
| AC Current ³ – Generate (cont) | | | |
| (2.2 to 11) A | 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.046 % + 170 µA 0.095 % + 380 µA 0.36 % + 750 µA | Fluke 5720A |
| (11 to 20.5) A | (45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz | 0.11 % + 5.0 mA 0.12 % + 5.0 mA 2.4 % + 5.0 mA | Fluke 5720A w/5725 amplifier |
| (20.5 to 100) A | 1 kHz 10 kHz 30 kHz 100 kHz | 84 µA/A 0.012 % 0.013 % 0.024 % | Fluke A40B-100A |
| (100 to 550) A | (45 to 440) Hz | 0.36 % | Fluke 5520A w/coil |
| (550 to 3000) A | 10 Hz to 1 kHz | 0.56 % | Fluke 52120A w/current coils |
| (3 to 6) kA | 10 Hz to 1 kHz | 0.56 % | |
| AC Current ³ – Measure | | | |
| Up to 200 µA | (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz | 0.034 % + 20 nA 0.035 % + 20 nA 0.068 % + 20 nA 0.57 % + 20 nA | Fluke 8508A |
| 200 µA to 2 mA | (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz | 0.033 % + 200 nA 0.029 % + 200 nA 0.066 % + 200 nA 0.40 % + 200 nA | |
| (2 to 20) mA | (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz | 0.034 % + 2.0 µA 0.030 % + 2.0 µA 0.066 % + 2.0 µA 0.40 % + 2.0 µA | |
| (20 to 200) mA | (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz | 0.033 % + 20 µA 0.026 % + 20 µA 0.061 % + 20 µA | |
| 200 mA to 2 A | 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz | 0.061 % + 200 µA 0.072 % + 200 µA 0.30 % + 200 µA | |
| (2 to 20) A | 10 Hz to 2 kHz (2 to 10) kHz | 0.091 % + 2.4 mA 0.26 % + 2.4 mA | |

| Parameter/Range | Frequency | CMC ^{2, 5, 6} (±) | Comments |
|---|---------------|----------------------------|---------------------------|
| AC Current ³ – Measure (cont) | | | |
| (20 to 100) A | (0 to 100) Hz | 0.054 % | Fluke 8508A |
| (100 to 1000) A | (0 to 100) Hz | 0.30 % | |
| (1 to 1.2) kA | (0 to 100) Hz | 0.17 % | Various current shunts |
| (1.2 to 3) kA | (0 to 100) Hz | 0.30 % | |

| Parameter/Equipment | Range | CMC ^{2, 5, 6} (±) | Comments |
|------------------------------------|---------------------|----------------------------|---------------------|
| Resistance ³ – Generate | | | |
| Ranges | (1.00 to 1000) MΩ | 0.24 % | Biddle 72-6346-1 |
| | (1000 to 10 000) MΩ | 0.70 % | |
| | (10 to 100) GΩ | 1.5 % | |
| Fixed Points | 0.001 Ω | 0.056 % | Short current shunt |
| | 0.01 Ω | 0.049 % | |
| | 0.1 Ω | 0.040 % | |
| | 1.0 Ω | 0.17 μΩ/Ω | Fluke 742A-1 |
| | 100 Ω | 0.80 μΩ/Ω | Fluke 742-100 |
| | 10 kΩ | 0.33 μΩ/Ω | Fluke 742A-10k |
| | 1 Ω | 98 μΩ/Ω + 40 μΩ | Fluke 5720A |
| | 1.9 Ω | 98 μΩ/Ω + 40 μΩ | |
| | 10 Ω | 26 μΩ/Ω + 40 μΩ | |
| | 19 Ω | 26 μΩ/Ω + 40 μΩ | |
| | 100 Ω | 11 μΩ/Ω + 40 μΩ | |
| | 190 Ω | 11 μΩ/Ω + 40 μΩ | |
| | 1 kΩ | 9.0 μΩ/Ω | |
| | 1.9 kΩ | 9.0 μΩ/Ω | |
| | 10 kΩ | 9.0 μΩ/Ω | |
| | 19 kΩ | 9.0 μΩ/Ω | |
| | 100 kΩ | 12 μΩ/Ω | |
| | 190 kΩ | 12 μΩ/Ω | |
| | 1 MΩ | 21 μΩ/Ω | |
| | 1.9 MΩ | 22 μΩ/Ω | |
| 10 MΩ | 41 μΩ/Ω | | |
| 19 MΩ | 49 μΩ/Ω | | |
| 100 MΩ | 0.011 % | | |

| Parameter/Equipment | Range | CMC ^{2, 5, 6} (±) | Comments |
|---|------------------|----------------------------|----------------------|
| Resistance ³ – Generate (cont) | | | |
| Fixed Points | 10 MΩ | 0.14 % | Keithley 5155-7 |
| | 100 MΩ | 0.14 % | Keithley 5155-8 |
| | 1 GΩ | 0.14 % | Keithley 5155-9 |
| | 10 GΩ | 0.16 % | Keithley 5155-10 |
| | 100 GΩ | 0.59 % | Keithley 5155-11 |
| | 1 TΩ | 2.1 % | Keithley 5155-12 |
| Resistance ³ – Measure | | | |
| | (0 to 0.25) Ω | 60 μΩ/Ω | Hart Scientific 1590 |
| | (0.25 to 4.0) Ω | 47 μΩ/Ω | |
| | (2.5 to 40) Ω | 24 μΩ/Ω | |
| | (0 to 25) Ω | 8.7 μΩ/Ω | |
| | (25 to 400) Ω | 7 μΩ/Ω | |
| | (400 to 1000) Ω | 13 μΩ/Ω | |
| | (1 to 25) kΩ | 15 μΩ/Ω | |
| | (25 to 40) kΩ | 14 μΩ/Ω | |
| | (40 to 100) kΩ | 41 μΩ/Ω | |
| | (100 to 500) kΩ | 0.015 % | |
| | (2 to 20) kΩ | 7.7 μΩ/Ω + 5.0 mΩ | Fluke 8508A |
| | (20 to 200) kΩ | 8 μΩ/Ω + 50 mΩ | |
| | (0.2 to 2) MΩ | 10 μΩ/Ω + 1.0 Ω | |
| | (2 to 20) MΩ | 23 μΩ/Ω + 100 Ω | |
| | (20 to 200) MΩ | 77 Ω/Ω + 10 kΩ | |
| | (0.2 to 2) GΩ | 0.063 % + 1.0 MΩ | |
| | (2 to 100) GΩ | 0.55 % | Quadtech 1865 |
| | (100 to 1000) GΩ | 0.54 % | |

| Parameter/Equipment | Range | CMC ^{2,5,6} (±) | Comments |
|---|--|--|-----------------|
| Harmonic Distortion – Generate 10 Hz to 5 kHz Fundamental Frequency | (2 nd to 50 th) Harmonic, where frequency x harmonic ≤ 10 kHz | 0.21 % | Fluke 5520A |
| Harmonic Distortion – Measure 20 Hz to 20 kHz Fundamental Frequency | (2 nd to 64 th) Harmonic, where frequency x harmonic ≤ 50 kHz Total Harmonic Distortion | 0.13 % 0.13 % | Keithley 2016-P |
| Electrical Calibration of Thermocouples ³ – Generate & Measure Type B Type C Type E Type J Type K | (600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C (0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C (-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C | 0.34 °C 0.26 °C 0.23 °C 0.26 °C 0.23 °C 0.20 °C 0.24 °C 0.39 °C 0.66 °C 0.39 °C 0.13 °C 0.11 °C 0.13 °C 0.16 °C 0.21 °C 0.13 °C 0.11 °C 0.13 °C 0.18 °C 0.26 °C 0.14 °C 0.12 °C 0.20 °C 0.31 °C | Fluke 5520A |

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|---|---|---|-------------|
| Electrical Calibration of Thermocouples ³ – Generate & Measure (cont) | | | |
| Type L | (-200 to -100) °C (-100 to 800) °C (800 to 900) °C | 0.29 °C 0.20 °C 0.14 °C | Fluke 5520A |
| Type N | (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C | 0.31 °C 0.17 °C 0.15 °C 0.14 °C 0.21 °C | |
| Type R | (0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C | 0.44 °C 0.27 °C 0.26 °C 0.31 °C | |
| Type S | (0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C | 0.37 °C 0.28 °C 0.29 °C 0.36 °C | |
| Type T | (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C | 0.49 °C 0.19 °C 0.13 °C 0.11 °C | |
| Type U | (-200 to 0) °C (0 to 600) °C | 0.44 °C 0.21 °C | |

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|--|--|--|------------------------------------|
| Electrical Calibration of RTDs ³ – Measure & Generate | | | |
| Type Pt 385, 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 | 0.047 °C 0.055 °C 0.075 °C 0.078 °C 0.11 °C 0.18 °C | Fluke 5520A 4 wire compensation |
| Type Pt 3926, 100 Ω | (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C | 0.045 °C 0.056 °C 0.071 °C 0.081 °C 0.093 °C | |
| Type 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 | 0.19 °C 0.034 °C 0.042 °C 0.049 °C 0.062 °C 0.063 °C 0.072 °C 0.078 °C 0.18 °C | |
| Type Pt 385, 200 Ω | (-200 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 | 0.047 °C 0.034 °C 0.039 °C 0.047 °C 0.093 °C 0.10 °C 0.11 °C 0.12 °C | |
| Type Pt 385, 500 Ω | (-200 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 | 0.039 °C 0.041 °C 0.042 °C 0.049 °C 0.064 °C 0.064 °C 0.085 °C 0.085 °C | |

| Parameter/Equipment | Range | CMC ^{2, 5, 6} (±) | Comments |
|---|---|---|------------------------------------|
| Electrical Calibration of RTDs ³ – Measure & Generate (cont) | | | |
| Type Pt 385, 1000 Ω | (-200 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 | 0.035 °C 0.027 °C 0.035 °C 0.042 °C 0.047 °C 0.056 °C 0.060 °C 0.18 °C | Fluke 5520A 4 wire compensation |
| Type PtNi, 120 Ω (Ni 120) | (-80 to 0) °C (0 to 100) °C (100 to 260) °C | 0.063 °C 0.063 °C 0.11 °C | |
| Type Cu 427, 10 Ω | (-100 to 260) °C | 0.23 °C | |
| DC Power ³ – Measuring Equipment | | | |
| 33 mV to 1020 V | (0.33 to 330) mA (0.33 to 3) A (3 to 20.5) A | 0.018 % 0.017 % 0.054 % | Fluke 5520A |

| Parameter/Range | Frequency | CMC ^{2, 5, 6} (±) | Comments |
|-------------------------------------|--|--|--------------------------------|
| Capacitance ³ – Generate | | | |
| Fixed Points | 1 kHz 1 kHz | 14 μF/F 16 μF/F | GenRad 1404-A GenRad 1404-B |
| 1 pF | 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz | 45 μF/F 91 μF/F 0.023 % 0.042 % 0.064 % 0.089 % 0.25 % 0.37 % | HP 1638XX standard capacitor |
| 10 pF | 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz | 39 μF/F 39 μF/F 40 μF/F 44 μF/F 47 μF/F 57 μF/F 0.013 % 0.016 % | |
| 100 pF | 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz | 39 μF/F 40 μF/F 48 μF/F 68 μF/F 94 μF/F 0.014 % 0.033 % 0.051 % | |
| 1000 pF | 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz | 41 μF/F 64 μF/F 0.015 % 0.028 % 0.044 % 0.061 % 0.19 % 0.28 % | |

| Parameter/Range | Frequency | CMC ^{2,5,6} (±) | Comments |
|---|-----------------|--------------------------|--------------------------------|
| Capacitance ³ – Generate (cont) | | | |
| Fixed Points | | | |
| 0.001 µF | 20 Hz to 1 kHz | 1.2 pF | GenRad 1409 series |
| 0.01 µF | 20 Hz to 1 kHz | 13 pF | |
| 0.1 µF | 20 Hz to 1 kHz | 120 pF | |
| 1.0 µF | 20 Hz to 1 kHz | 1.1 nF | |
| 0.02 µF | 20 Hz to 1 kHz | 23 pF | |
| 0.005 µF | 20 Hz to 1 kHz | 7.1 pF | |
| 0.05 µF | 20 Hz to 1 kHz | 56 pF | |
| 1000 pF | 1 kHz | 14 µF/F | GenRad 1404-A GenRad 1404-B |
| 100 PF | 1 kHz | 16 µF/F | |
| (0.19 to 0.3999) nF | 10 Hz to 10 kHz | 0.51 % + 0.010 nF | Fluke 5520A |
| (0.4 to 1.0999) nF | 10 Hz to 10 kHz | 0.51 % + 0.010 nF | |
| (1.1 to 3.29) nF | 10 Hz to 3 kHz | 0.51 % + 0.010 nF | |
| (3.3 to 10.9) nF | 10 Hz to 1 kHz | 0.27 % + 0.010 nF | |
| (11 to 32.9999) nF | 10 Hz to 1 kHz | 0.27 % + 0.10 nF | |
| (33 to 109.9) nF | 10 Hz to 1 kHz | 0.27 % + 0.10 nF | |
| (110 to 329.999) nF | 10 Hz to 1 kHz | 0.27 % + 0.30 nF | |
| (0.33 to 1.09) µF | (10 to 600) Hz | 0.27 % + 1.0 nF | |
| (1.1 to 3.299 99) µF | (10 to 300) Hz | 0.27 % + 3.0 nF | |
| (3.3 to 10.9999) µF | (10 to 150) Hz | 0.27 % + 10 nF | |
| (11 to 32.9999) µF | (10 to 120) Hz | 0.41 % + 30 nF | |
| (33 to 109.999) µF | (10 to 80) Hz | 0.46 % + 100 nF | |
| (110 to 329.999) µF | (10 to 50) Hz | 0.46 % + 300 nF | |
| (0.3 to 1.099 99) mF | (10 to 20) Hz | 0.46 % + 1.0 µF | |
| (1.1 to 3.2999) mF | (0 to 6) Hz | 0.46 % + 3.0 µF | |
| (3.3 to 10.9999) mF | (0 to 2) Hz | 0.46 % + 10 µF | |
| (11 to 32.9999) mF | (0 to 0.6) Hz | 0.76 % + 30 µF | |
| (33 to 110) mF | (0 to 0.2) Hz | 1.1 % + 100 µF | |

| Parameter/Range | Frequency | CMC ^{2,5,6} (±) | Comments |
|------------------------------------|---|-----------------------------------|----------------|
| Capacitance ³ – Measure | | | |
| Fixed Points | | | |
| 1 pF | (0.1 to 1) kHz (1 to 10) kHz | 12 % 1.2 % | Agilent E4980A |
| 10 pF | (20 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (0.1 to 2) MHz | 12 % 1.2 % 0.13 % 0.35 % | |
| 100 pF | (20 to 100) Hz (0.1 to 1) kHz 1.0 kHz to 2 MHz | 12 % 1.2 % 0.12 % | |
| 1 nF | (20 to 100) Hz 100 Hz to 1 MHz (1 to 2) MHz | 1.2 % 0.12 % 0.36 % | |
| 10 nF | (20 to 100) Hz 100 Hz to 100 kHz 100 kHz to 2 MHz | 0.35 % 0.12 % 0.35 % | |
| 100 nF | 20 Hz to 10 kHz 10 kHz to 2 MHz | 0.12 % 0.35 % | |
| 1.0 μF | 20 Hz to 10 kHz 10 kHz to 2 MHz | 0.12 % 0.35 % | |
| 10.0 μF | (20 to 1000) Hz (1 to 100) kHz (0.1 to 2) MHz | 0.12 % 0.35 % 1.2 % | |
| 100.0 μF | 100 Hz to 10 kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz | 0.35 % 1.2 % 7.0 % 12 % | |
| 1.0 mF | (20 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz | 0.35 % 1.2 % 7.0 % 12 % | |
| 10 mF | (20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz | 0.81 % 1.2 % 9.3 % 12 % | |

| Parameter/Range | Frequency | CMC ^{2,5,6} (±) | Comments |
|---|------------------------------------|--------------------------|----------------|
| Capacitance ³ – Measure (cont) | | | |
| Fixed Points | | | |
| 100 mF | (20 to 100) Hz 100 Hz to 10 kHz | 5.8 % 12 % | Agilent E4980A |

| Parameter/Equipment | Range | CMC ^{2,5,6} (±) | Comments |
|--|---|--|-------------------------------------|
| Inductance ³ – Generate @ 1000 Hz, Generate Equipment | 100 µH to 1.111 H (100 µH Steps) | 2.4 % | GenRad 1490-F decade inductance box |
| Fixed Points | 200 µH 500 µH 1 mH 5 mH 10 mH 50 mH 500 mH 2 H | 0.15 % 0.15 % 0.15 % 0.15 % 0.15 % 0.15 % 0.15 % 0.15 % | GenRad 1482-x standard inductors |

| Parameter/Range | Frequency | CMC ^{2,5,6} (±) | Comments |
|-----------------------------------|--|--|----------------|
| Inductance ³ – Measure | | | |
| 1 pH to 1 mH | (20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz | 0.35 % 0.12 % 0.12 % 0.12 % 0.12 % 0.41 % | Agilent E4980A |
| (1 to 10) mH | (20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz | 0.35 % 0.12 % 0.14 % 0.12 % 0.12 % 1.7 % | |

| Parameter/Range | Frequency | CMC ^{2, 5, 6} (±) | Comments |
|--|---|--|---|
| Inductance ³ – Measure (cont) | | | |
| (10 to 100) mH | (20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz | 0.35 % 0.12 % 0.12 % | Agilent E4980A |
| 100 mH to 1 H | (20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz | 0.12 % 0.12 % 0.12 % | |
| (1 to 10) H | (20 to 100) Hz (0.1 to 1) kHz | 0.12 % 0.12 % | |
| Oscilloscopes ³ – | | | |
| Voltage (50 Ω) | (1 to 556) mV 556 mV to 5.56 V | 0.078 % + 10 μV 0.78 % + 10 μV | Fluke 9500B w/Fluke heads 9630 & 9560 |
| Sweep Time | 9 ns to 55 s | 2.3 μs/s | |
| Rise Time | 150 ps to 100 ms | 16 ps | |
| Bandwidth | 0.1 Hz to 6.0 GHz | 4.4 % flatness | |
| Phase Angle ³ – Generate | | | |
| (0 to 360)° | (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz | 0.079° 0.19° 0.39° 2.0° 3.9° 7.8° | Fluke 5520A |
| Synchro/Resolver Indicators – | | | |
| (0 to 360)° | 400 Hz | 0.000 70° | Gertsch 922711-1 |

VI. Electrical – RF/Microwave

| Parameter/Equipment | Range | CMC ^{2, 5, 6} (±) | Comments |
|---|--|--|---|
| AC Power ³ – Measuring Equipment | | | |
| (33 to 330) mV Power Factor = 1 | (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (330 to 900) mA 900 mA to 2.2 A (2.2 to 4.5) A (4.5 to 20.5) A | 0.15 % 0.11 % 0.15 % 0.14 % 0.16 % 0.16 % 0.14 % 0.15 % | Fluke 5520A frequency (45 to 65) Hz |
| 330 mV to 1020 V Power Factor = 1 | (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (330 to 900) mA 900 mA to 2.2 A (2.2 to 4.5) A (4.5 to 20.5) A | 0.13 % 0.10 % 0.13 % 0.10 % 0.15 % 0.13 % 0.14 % 0.11 % | |
| Attenuation ³ – Measure | | | |
| 2.5 MHz to 26.5 GHz | (0 to 10) dBm (-10 to 0) dBm (-20 to -10) dBm (-30 to -20) dBm (-40 to -30) dBm (-50 to -40) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-100 to -90) dBm (-110 to -100) dBm (-120 to -110) dBm (-127 to -120) dBm | 0.10 dB 0.10 dB 0.13 dB 0.15 dB 0.17 dB 0.20 dB 0.22 dB 0.24 dB 0.27 dB 0.29 dB 0.31 dB 0.33 dB 0.39 dB 0.61 dB | HP 8902A, Agilent 11793A |

| Parameter/Range | Frequency | CMC ^{2, 5, 6, 8} (±) | Comments |
|---|--|--|--------------------------|
| Tuned RF Power ³ – Relative Measure (0 to 10) dBm (-10 to 0) dBm (-20 to -10) dBm (-30 to -20) dBm (-40 to -30) dBm (-50 to -40) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-100 to -90) dBm (-110 to -100) dBm (-120 to -110) dBm (-127 to -120) dBm | 2.5 MHz to 26.5 GHz | 0.10 dB 0.10 dB 0.13 dB 0.15 dB 0.17 dB 0.20 dB 0.22 dB 0.24 dB 0.27 dB 0.29 dB 0.31 dB 0.33 dB 0.39 dB 0.61 dB | HP 8902A, Agilent 11793A |
| Tuned RF Power ³ – Absolute Measure (0 to +10) dBm (-10 to 0) dBm (-20 to -10) dBm (-30 to -20) dBm (-40 to -30) dBm (-50 to -40) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-100 to -90) dBm (-110 to -100) dBm (-120 to -110) dBm (-127 to -120) dBm | 2.5 MHz to 26.5 GHz | 0.17 dB 0.17 dB 0.19 dB 0.22 dB 0.24 dB 0.26 dB 0.28 dB 0.31 dB 0.33 dB 0.35 dB 0.37 dB 0.40 dB 0.45 dB 0.67 dB | HP 8902A, Agilent 11793A |
| RF Power ³ – Measure (-120 to 30) dBm | 100 kHz to 26 GHz | 0.17 dB | HP 8902A |
| RF Power – 1 mW – Measure | (0.10 to 10) MHz (0.01 to 10) GHz (10 to 18) GHz | 0.93 % 1.3 % 1.6 % | Tegam F1130A, 1830A |

| Parameter/Range | Frequency | CMC ^{2, 5, 6, 8} (±) | Comments |
|--|--|--|------------------------|
| Calibration Factor | (0.10 to 0.20) MHz (0.30 to 40) MHz (0.05 to 2.0) GHz (2.1 to 3.6) GHz (3.7 to 4.6) GHz (4.8 to 10) GHz (12 to 18) GHz | 0.65 % 0.58 % 0.57 % 0.59 % 0.61 % 0.66 % 0.78 % | Tegam F1130A, 1830A |
| Reflection Co-Efficient – Magnitude | 9.0 kHz to 6.0 GHz | 4.9 % | VNA |
| AM Modulation – Measure | | | |
| Rate: (0.05 to 10) kHz Depth: (5.0 to 99) % | (0.15 to 10) MHz | 0.024 AM + 0.10 % | HP8902A |
| Rate: (0.02 to 10) kHz Depth: Up to 99 % | (0.15 to 10) MHz | 0.036 AM + 0.10 % | |
| Rate: (0.05 to 50) kHz Depth: (5.0 to 99) % | (0.01 to 1.3) GHz | 0.013 AM + 0.10 % | |
| Rate: 20 Hz to 0.10 MHz Depth: Up to 99% | (0.01 to 1.3) GHz | 0.036 AM + 0.10 % | |
| Rate: (0.05 to 50) kHz Depth: (5.0 to 99) % | (1.3 to 26.5) GHz | 0.018 AM + 0.10 % | |
| Rate: 20 Hz to 0.10 MHz Depth: Up to 99 % | (0.01 to 26.5) GHz | 0.036 AM + 0.10 % | |

VII. Fluid

| Parameter/Equipment | Range | CMC ^{2,4} (±) | Comments |
|---------------------|--|--|--|
| Volume – Pipettes | (0 to 100) µL (100 to 500) µL (0.5 to 1) mL (1 to 5) mL | 0.014 % + 0.60R 40 µL/L + 0.60R 32 µL/L + 0.60R 29 µL/L + 0.60R | Gravimetric calibration using Sartorius balance & ANSI/ASTM E617 Class 1 weights |

VIII. Fluid Quantities

| Parameter/Equipment | Range | CMC ^{2,4,5,8} (±) | Comments |
|---------------------------------|---|--|--------------------------------------|
| Mass Flow – Measuring Equipment | (1 to 5) SCCM (5 to 50) SCCM (100 to 1000) SCCM (1 to 10) SLPM (3 to 50) SLPM (50 to 300) SLPM (120 to 1200) SLPM (400 to 4000) SLPM | 0.25 % + 0.60R 0.24 % + 0.60R 0.26 % + 0.60R 0.29 % + 0.60R 0.25 % + 0.60R 0.25 % + 0.60R 0.25 % + 0.60R 0.25 % + 0.60R | DHI molbox w/molbloc |
| Viscosity Meters ³ | 100 cps 1000 cps 12 500 cps 100 000 cps | (0.28 + 0.60R) cps (3.4 + 0.60R) cps (55 + 0.60R) cps (480 + 0.60R) cps | Cannon/Brookfield standard solutions |

IX. Mechanical

| Parameter/Equipment | Range | CMC ^{2, 4, 5, 8} (±) | Comments |
|--|-------------------------|-------------------------------|--|
| Pressure ³ – Measuring Equipment, Hydraulic & Pneumatic | (2 to 700) psig | 0.002 % | Ruska 2465A w/2460-706 |
| | (700 to 1100) psig | 76 µPa/Pa + 2.5 Pa | DHI PG 7202 |
| | (1100 to 5800) psig | 78 µPa/Pa + 13 Pa | w/PC-7200-100 |
| | (5800 to 10 100) psig | 84 µPa/Pa + 50 Pa | w/PC-7200-500 |
| | (10 100 to 16 000) psig | 87 µPa/Pa + 50 Pa | w/PC-7200-2 |
| | (16 000 to 20 000) psig | 12 psi | Additel pressure gauges |
| | (20 000 to 40 000) psig | 42 psi | |
| | (0 to 23.2) psia | 0.013 % | DHI RPM4 |
| Mass ³ | (0.001 to 6) g | 16 µg | Sartorius CCE6 Sartorius CC-500 Sartorius CCE-1201 Sartorius CC-30002 |
| | (1 to 500) g | 25 µg | |
| | (5 to 1000) g | 2.9 mg | |
| | (0.01 to 40) kg | 83 mg | |
| Scales & Balances ³ | 40 kg | 190 mg + 0.60R | Reference weights |
| | 30 kg | 130 mg + 0.60R | |
| | 20 kg | 46 mg + 0.60R | |
| | 10 kg | 62 mg + 0.60R | |
| | 5 kg | 58 mg + 0.60R | |
| | 1 kg | 3.0 mg + 0.60R | |
| | 500 g | 1.6 mg + 0.60R | |
| | 200 g | 0.57 mg + 0.60R | |
| | 100 g | 0.28 mg + 0.60R | |
| | 50 g | 140 µg + 0.60R | |
| | 20 g | 88 µg + 0.60R | |
| | 10 g | 62 µg + 0.60R | |
| | 5 g | 41 µg + 0.60R | |
| | 1 g | 41 µg + 0.60R | |
| | 500 mg | 18 µg + 0.60R | |
| | 100 mg | 18 µg + 0.60R | |
| | 10 mg | 18 µg + 0.60R | |
| | 1 mg | 18 µg + 0.60R | |

| Parameter/Equipment | Range | CMC ^{2, 4, 5, 8} (±) | Comments |
|--|---|--|--|
| Torque ³ – Measure Wrenches, Screwdrivers & Watches | (1 to 8) in·ozf (8 to 40) in·ozf (2.5 to 10) in·lbf (10 to 50) in·lbf (50 to 250) in·lbf (250 to 750) in·lbf (62.5 to 250) ft·lbf (250 to 1000) ft·lbf | 1.2 % 0.63 % 0.57 % 0.77 % 0.63 % 0.65 % 1.2 % 0.71 % | Torque mate 2000 |
| Torque – Measuring Equipment Transducers | (1 to 40) in·ozf (2.5 to 50) in·lbf (50 to 180) in·lbf (15 to 250) ft·lbf (250 to 1000) ft·lbf | 0.058 % 0.055 % 0.042 % 0.044 % 0.085 % | Lever arms & traceable hanging weights |
| RPM ³ – Measure | (1 to 3000) RPM | 0.11 RPM | Frequency counter w/ IR sensor |
| RPM ³ – Generate Optical | (1 to 100 000) RPM | 0.17 RPM + 0.60R | Fluke 5520A w/ LED fixture |
| RPM ³ – Contact Meters | (1 to 3000) RPM | 0.11 RPM + 0.60R | Frequency counter/motor |
| Air Velocity – Measuring Equipment | (25 to 7500) fpm | 1.2 % | Wind tunnel & omega differential pressure sensor, model WT4401S |
| Accelerometers ³ | 160 Hz 10 Hz to 4 kHz (4 to 7) kHz (7 to 12.8) kHz | 0.61 % 0.68 % 0.79 % 1.4 % | Reference accelerometer |
| Force – Measure Tension & Compression | (0 to 2500) lbf (2500 to 30 000) lbf (25 000 to 60 000) lbf | 0.34 lbf 3.3 lbf 720 lbf | Morehouse tension & compression Tinius Olsen Super-L w/computer display |

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|--|---|--------------------------------------|---|
| “Direct Verification” of Durometers ³ – Spring Force Indenter Display | A, B, O, D, C, DO scales (0 to 100) duro units | 0.52 duro points 0.58 duro units | Durocalibrator Gage blocks |
| Magnetics – Gauss Meters | 54.8 Gauss 995.8 Gauss 4940 Gauss | 0.20 Gauss 2.9 Gauss 9.5 Gauss | MII F343-50 MII F062-1K MII F062-5K |

X. Optical Radiation

| Parameter/Equipment | Range | CMC ^{2, 5, 8} (±) | Comments |
|------------------------------------|------------------|----------------------------|------------|
| Photometric – Measure ³ | (1 to 10 000) fc | 4.7 % | Radiometer |

XI. Thermodynamic

| Parameter/Equipment | Range | CMC ^{2, 8} (±) | Comments |
|---|------------|-------------------------|-------------------------------|
| Temperature – Measuring Equipment, Fixed Points | 0.01 °C | 0.0017 °C | Triple point water cell |
| | 29.7646 °C | 0.0047 °C | Melting point of Gallium cell |

| Parameter/Equipment | Range | CMC ^{2, 4, 5, 8} (±) | Comments |
|--|--|--|--|
| Dew Point ³ – Measuring Equipment | (-20 to 60) °C | 0.10 °C | Thunder Scientific 1200/2500 |
| Infrared Thermometers – Hart Furnace | (-15 to 0) °C (0 to 100) °C (100 to 120) °C (120 to 200) °C (200 to 350) °C (350 to 500) °C (500 to 1200) °C | 1.2 °C 1.4 °C 1.3 °C 2.1 °C 2.5 °C 2.9 °C 8.1 °C | Fluke 4181/4180 ε = 0.9 to 1.0 λ = (8 to 14) μm Fluke 9150 furnace w/Hart 1529 & Type S thermocouple |
| Temperature ³ – Measure & Measuring Equipment | (-80 to 110) °C (110 to 550) °C (550 to 1200) °C | 0.011 °C + 0.60R 0.042 °C + 0.60R 0.59 °C + 0.60R | Fluke 7381 precision bath w/Hart 1594A & 5698 SPRT Isotech medusa furnace, Fluke 9150 furnace w/Hart 1529 & Type S thermocouple |
| Humidity ³ – Measuring Equipment | (10 to 95) % RH | 0.51 % | Thunder Scientific 2500 |
| Humidity – Measure ³ Temperature | (10 to 90) % RH (90 to 100) % RH (-40 to 180) °C | 1.7 % RH 1.8 % RH (1.5 + 0.015X) % RH | Vaisala HumiCap (on-site only) X = reading |

XII. Time & Frequency

| Parameter/Equipment | Range | CMC ^{2, 4, 8} (\pm) | Comments |
|--|---|--|---|
| Frequency ³ – Measure Equipment | 0.05 Hz to 10 MHz 10 MHz to 4 GHz (4 to 26) GHz | 15 parts in 10^{12} Hz 21 parts in 10^{12} Hz 27 parts in 10^{12} Hz | GPS reference |
| Frequency – Measure | 0.05 Hz to 2.7 GHz (2.7 to 20) GHz | 25 parts in 10^{12} Hz 60 parts in 10^{12} Hz | Frequency counters w/external reference |
| Stopwatches & Timers | Up to 24 hr | 0.05 sec/day + 0.60R | Timometer |

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

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 This laboratory performs field calibration activities for these parameters. 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 In the statement of CMC; L is the numerical value of the nominal length of the device measured in inches; R is the numerical value of the resolution of the device in its respective units; D is the diameter of the device in inches

⁵ In the statement of CMC, percentages are read as percent of reading/output, unless otherwise noted.

⁶ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC are expressed as either a specific value that covers the full range or as a fraction or percent of the reading plus a fixed floor specification.

⁷ This scope meets A2LA's *P112 Flexible Scope Policy*.

⁸ The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.



Accredited Laboratory

A2LA has accredited

BROADVIEW INSTRUMENTATION SERVICES, INC.

Valley View, OH

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and the requirements of ANSI/NCSL Z540.3-2006 and 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 April 2017*).



Presented this 25th day of March 2021.

A blue ink signature of the Vice President of Accreditation Services.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2046.01
Valid to March 31, 2023

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