SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

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CALIBRATION

Valid To: December 31, 2017 Certificate Number: 4296.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1]:

I. Dimensional

| Parameter/Equipment | Range | CMC[2, 4] (±) | Comments |
|---|---|---|---|
| Calipers | Up to 60 in / 0.0005 in<br>Up to 60 in / 0.001 in | (300 + 4.5*L*) µin<br>(580 + 3*L*) µin | Gage blocks |
| Micrometers – Outside, Depth and Inside | Up to 12 in / 0.00005 in<br>Up to 36 in / 0.0001 in<br>Up to 72 in / 0.001 in | (31 + 6.3*L*) µin<br>(58 + 7*L*) µin<br>(580 + 3.4*L*) µin | Gage blocks |
| Height Gages | Up to 40 in / 0.00005 in<br>Up to 40 in / 0.0001 in<br>Up to 40 in / 0.0005 in<br><br>Up to 60 in / 0.001 in | (120 + 5.7*L*) µin<br>(130 + 5.6*L*) µin<br>(320 + 3.5*L*) µin<br><br>(590 + 2.9*L*) µin | Gage blocks |
| Indicators | Up to 1 in<br>Up to 2 in<br>Up to 10 in | 46 µin<br>92 µin<br>590 µin | Gage blocks |
| Indicator – (Amplified) | Up to 0.002 in | 3 µin | Gage blocks |
| Gage Block Comparators | Up to 0.0003 in x 0.1 µin<br>Up to 0.001 in x 1 µin | 2.0 µin<br>2.5 µin | Gage blocks |

| Parameter/Equipment | Range | CMC[2, 4] (±) | Comments |
|---|---|---|---|
| Master Comparators – Meter | Up to 0.0002 in x 5 µin<br>Up to 0.0004 in x 10 µin<br>Up to 0.002 in x 50 µin<br>Up to 0.004 in x 100 µin<br>Up to 0.02 in x 500 µin | 3.6 µin<br>6.2 µin<br>29 µin<br>58 µin<br>290 µin | Gage blocks |
| Height Master | Up to 12 in<br>(>12 to 24) in | 110 µin<br>170 µin | Gage blocks, amplifier |
| Gage blocks | (0.01 to 4) in<br>(5 to 20) in | (3.2 + 1.8*L*) µin<br>(1.2 + 2.4*L*) µin | Gage blocks and comparators |
| Ring Gages | Up to 1 in<br>(>1 to 12) in | 20 µin<br>(18 + 3*D*) µin | Master comparator, gage blocks |
| Thread Plug Gages (60°) –<br><br>Pitch Diameter<br><br>Major Diameter | <br><br>(0.06 to 1) in<br>(>1 to 6) in<br><br>(0.06 to 1) in<br>(>1 to 6) in | <br><br>(58 + 11*D*) µin<br>(60 + 9*D*) µin<br><br>20 µin<br>(18 + 3*D*) | <br><br>P&W Supermicrometer™, thread wires, gage blocks |
| P& W Supermicrometer™ –<br><br>Spindle<br><br>Meter | <br><br>1 in<br><br>0.001 in | <br><br>15 µin<br><br>10 µin | <br><br>Gage blocks |
| Thread Ring Gages (60°), Pitch Diameter | Up to 1 in<br>(>1 to 6) in | (58 + 11*D*) µin<br>(60 + 9*D*) µin | Comparison to thread set plugs |
| Plug Gages | Up to 1 in<br>(>1 to 12) in | 10 µin<br>(7 + 3*D*) µin | P&W Supermicrometer™, gage blocks, universal comparator |

II. Dimensional Testing/Calibration[1]

| Parameter/Equipment | Range | CMC[2, 4] (±) | Comments |
|---|---|---|---|
| 1D – Length Measure[5] | Up to 72 in | (120 + 6.6*L*) µin | Gage blocks, amplifier |

III. Electrical – DC/Low Frequency

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Electrical Simulation of Thermocouple Indicators and Indicating Systems – | | | |
| Type B | 600°C to 800°C | 0.44 °C | Fluke 5520A |
| | >800°C to 1000°C | 0.34 °C | |
| | >1000°C to 1550°C | 0.30 °C | |
| | >1550°C to 1820 | 0.33 °C | |
| Type C | 0 to 150°C | 0.30 °C | |
| | >150°C to 650°C | 0.26 °C | |
| | >650°C to 1000°C | 0.31 °C | |
| | >1000°C to 1800°C | 0.50 °C | |
| | >1800°C to 2316°C | 0.84 °C | |
| Type E | 250°C to -100°C | 0.50 °C | |
| | >-100°C to -25°C | 0.16 °C | |
| | >-25°C to 350°C | 0.14 °C | |
| | >350°C to 650°C | 0.16 °C | |
| | >650°C to 1000°C | 0.21 °C | |
| Type J | -210°C to -100°C | 0.27 °C | |
| | >-100°C to -30°C | 0.16 °C | |
| | >-30°C to 150°C | 0.14 °C | |
| | >150°C to 760°C | 0.17 °C | |
| | >760°C to 1200°C | 0.23 °C | |
| Type K | 0 to 150°C | 0.33 °C | |
| | >150°C to 650°C | 0.18 °C | |
| | >650°C to 1000°C | 0.16 °C | |
| | >1000°C to 1800°C | 0.26 °C | |
| | >1800°C to 2316°C | 0.40 °C | |
| Type L | -200°C to -100°C | 0.37 °C | |
| | >-100°C to 800°C | 0.26 °C | |
| | >800°C to 900°C | 0.17 °C | |

| Parameter/Equipment | Range | CMC[2, 7] (±) | Comments |
|---|---|---|---|
| Electrical Simulation of Thermocouple Indicators and Indicating Systems – (Cont) | | | |
| Type N | -200°C to -100°C<br>>-100°C to -25°C<br>>-25°C to 120°C<br>>120°C to 410°C<br>>410°C to 1300°C | 0.40 °C<br>0.22 °C<br>0.19 °C<br>0.18 °C<br>0.27 °C | Fluke 5520A |
| Type R | 0°C to 250°C<br>>250°C to 400°C<br>>400°C to 1000°C<br>>1000°C to 1767°C | 0.57 °C<br>0.35 °C<br>0.33 °C<br>0.40 °C | |
| Type S | 0°C to 250°C<br>>250°C to 1000°C<br>>1000°C to 1400°C<br>>1400°C to 1767°C | 0.47 °C<br>0.36 °C<br>0.37 °C<br>0.46 °C | |
| Type T | -250°C to -150°C<br>>-150°C to 0°C<br>>0°C to 120°C<br>>120°C to 400°C | 0.63 °C<br>0.24 °C<br>0.16 °C<br>0.14 °C | |
| Type U | -200°C to 0°C<br>>0°C to 600°C | 0.56 °C<br>0.27 °C | |
| DC Voltage – Generate | (0 to 219.99) mV<br>220 mV to 2.19 V<br>(2.2 to 10.99) V<br>(11 to 21.99) V<br>(22 to 219.99) V<br>(220 to 1100) V | 7.5 µV/V + 0.4 µV<br>5 µV/V + 0.7 µV<br>3.5 µV/V + 2.5 µV<br>3.5 µV/V + 4 µV<br>5 µV/V + 40 µV<br>6.5 µV/V + 400 µV | Fluke 5720A / 5700A |
| DC Voltage – Measure | 0 to 199.99 mV<br>200 mV to 1.99 V<br>2 to 19.99 V<br>20 to 199.99 V<br>200 to 1050 V | 5.0 µV/V + 0.25 µV<br>3.5 µV/V + 0.4 µV<br>3.5 µV/V + 4 µV<br>5.0 µV/V + 40 µV<br>5.5 µV/V + 500 µV | |

| Parameter/Equipment | Range | CMC[2, 7] (±) | Comments |
|---|---|---|---|
| DC Current – Generate | (0 to 219.99) µA<br>220 µA to 2.19 mA<br>(2.2 to 21.99) mA<br><br>(22 to 219.99) mA<br>220 mA to 2.2 A<br>(2.2 to 11) A<br><br>(1.1 to 2.99) A<br>(0 to 10.99) A<br>(11 to 20.5) A | 40 µA/A+ 6 nA<br>35 µA/A + 7 nA<br>35 µA/A+ 40 nA<br><br>45 µA/A + 0.7 µA<br>80 µA/A + 12 µA<br>360 µA/A + 480 µA<br><br>380 µA/A + 40 µA<br>500 µA/A + 500 µA<br>1.0 mA/A + 750 µA | Fluke 5720A / 5700A<br><br><br><br>Fluke 5720A / 5725A Amplifier<br><br><br>Fluke 5520A |
| DC Current – Measure | (0 to 199.99) µA<br>200 µA to 1.99 mA<br>(2 to 19.99) mA<br>(20 to 199.99) mA<br>200 mA to 1.99 A<br>(2 to 19.99) A | 12 µA/A + 0.0004 µA<br>12 µA/A + 0.004 µA<br>14 µA/A + 0.04 µA<br>48 µA/A + 0.8 µA<br>190 µA/A + 16 µA<br>400 µA/A + 200 µA | Fluke 5720A / 5700A |

| Parameter/Equipment | Range | CMC[2, 7] (±) | Comments |
|---|---|---|---|
| AC Voltage – Generate | | | |
| 0.22 to 21.99999 mV | 10 to 20 Hz<br>>20 to 40 Hz<br>>40 to 20 kHz<br>>20 to 50 kHz<br>>50 to 100 kHz<br>>100 to 300 kHz<br>>300 to 500 kHz<br>>500 to 1 MHz | 240 µV/V + 4 µV<br>90 µV/V + 4 µV<br>80 µV/V + 4 µV<br>200 µV/V + 4 µV<br>500 µV/V + 5 µV<br>1.1 mV/V + 10 µV<br>1.4 mV/V + 20 µV<br>2.7 mV/V + 20 µV | Fluke 5720A / 5700A |
| 22 to 219.9999 mV | 10 to 20 Hz<br>>20 to 40 Hz<br>>40 to 20 kHz<br>>20 to 50 kHz<br>>50 to 100 kHz<br>>100 to 300 kHz<br>>300 to 500 kHz<br>>500 to 1 MHz | 240 µV/V + 12 µV<br>90 µV/V + 7 µV<br>80 µV/V + 7 µV<br>200 µV/V + 7 µV<br>460 µV/V + 17 µV<br>900 µV/V + 20 µV<br>1.4 mV/V + 25 µV<br>2.7 mV/V + 45 µV | |

| Parameter/Equipment | Range | CMC[2, 7] (±) | Comments |
|---|---|---|---|
| AC Voltage – Generate (cont) | | | |
| 0.22 to 2.199999 V | 10 to 20 Hz<br>>20 to 40 Hz<br>>40 to 20 kHz<br>>20 to 50 kHz<br>>50 to 100 kHz<br>>100 to 300 kHz<br>>300 to 500 kHz<br>>500 to 1 MHz | 240 µV/V + 40 µV<br>90 µV/V + 15 µV<br>45 µV/V + 8 µV<br>75 µV/V + 10 µV<br>110 µV/V + 30 µV<br>420 µV/V + 80 µV<br>1.0 mV/V + 200 µV<br>1.7 mV/V + 300 µV | Fluke 5720A / 5700A |
| 2.2 to 21.99999 V | 10 to 20 Hz<br>>20 to 40 Hz<br>>40 to 20 kHz<br>>20 to 50 kHz<br>>50 to 100 kHz<br>>100 to 300 kHz<br>>300 to 500 kHz<br>>500 to 1 MHz | 240 µV/V + 400 µV<br>90 µV/V + 150 µV<br>45 µV/V + 50 µV<br>75 µV/V + 100 µV<br>100 µV/V + 200 µV<br>280 µV/V + 600 µV<br>1.0 mV/V + 2000 µV<br>1.5 mV/V + 3200 µV | |
| 22 to 219.9999 V | 10 to 20 Hz<br>>20 to 40 Hz<br>>40 to 20 kHz<br>>20 to 50 kHz<br>>50 to 100 kHz<br>>100 to 300 kHz<br>>300 to 500 kHz<br>>500 to 1 MHz | 240 µV/V + 4 mV<br>90 µV/V + 1.5 mV<br>52 µV/V + 0.6 mV<br>80 µV/V + 1 mV<br>150 µV/V + 2.5 mV<br>900 µV/V + 16 mV<br>4.4 mV/V + 40 mV<br>8.0 mV/V + 80 mV | |
| 220 to 1100.000 V | 15 to 50 Hz<br>>50 to 1 kHz | 300 µV/V + 16 mV<br>70 µV/V + 3.5 mV | Fluke 5720A/5700A maximum output 250V @ (15 to 50) Hz |
| 220 to 750.000 V | 40 Hz to 1 kHz<br>1 to 20 kHz<br>20 to 30 kHz<br>30 to 50 kHz<br>50 to 100 kHz | 90 µV/V + 4 mV<br>170 µV/V + 6 mV<br>600 µV/V + 11 mV<br>440 µV/V + 11 mV<br>1.6 mV/V + 45 mV | Fluke 5720A/5700A/ 5725A amplifier |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| AC Voltage – Measure | | | |
| 0 to 199.9999 mV | 1 Hz to 10 Hz<br>>10 Hz to 40 Hz<br>>40 Hz to 100 Hz<br>>100 Hz to 2 kHz<br>>2 kHz to 10 kHz<br>>10 kHz to 30 kHz<br>>30 kHz to 100 kHz | 170 µV/V + 14 µV<br>140 µV/V + 4 µV<br>120 µV/V + 4 µV<br>110 µV/V + 2 µV<br>140 µV/V + 4 µV<br>340 µV/V + 8 µV<br>770 µV/V + 20 µV | Fluke 8508A |
| 200 mV to 1.9999 V | 1 Hz to 10 Hz<br>>10 Hz to 40 Hz<br>>40 Hz to 100 Hz<br>>100 Hz to 2 kHz<br>>2 kHz to 10 kHz<br>>10 kHz to 30 kHz<br>>30 kHz to 100 kHz<br>>100 kHz to 300 kHz<br>>300 kHz to 1 MHz | 150 µV/V + 400 µV<br>120 µV/V + 20 µV<br>90 µV/V + 20 µV<br>75 µV/V + 20 µV<br>110 µV/V + 20 µV<br>220 µV/V + 40 µV<br>570 µV/V +200 µV<br>3 mV/V + 6 mV<br>10 mV/V + 2 mV | |
| 2 V to 19.999 V | 1 Hz to 10 Hz<br>>10 Hz to 40 Hz<br>>40 Hz to 100 Hz<br>>100 Hz to 2 kHz<br>>2 kHz to 10 kHz<br>>10 kHz to 30 kHz<br>>30 kHz to 100 kHz<br>>100 kHz to 300 kHz<br>>300 kHz to 1 MHz | 150 µV/V + 4000 µV<br>120 µV/V + 200 µV<br>90 µV/V + 200 µV<br>75 µV/V + 200 µV<br>110 µV/V + 200 µV<br>220 µV/V + 400 µV<br>570 µV/V +2000 µV<br>3 mV/V + 20 mV<br>10 mV/V + 200 mV | |
| 20 V to 199.99 V | 1 Hz to 10 Hz<br>>10 Hz to 40 Hz<br>>40 Hz to 100 Hz<br>>100 Hz to 2 kHz<br>>2 kHz to 10 kHz<br>>10 kHz to 30 kHz<br>>30 kHz to 100 kHz<br>>100 kHz to 300 kHz<br>>300 kHz to 1 MHz | 0.15 mV/V + 40 mV<br>0.12 mV/V + 2 mV<br>0.09 mV/V + 2 mV<br>0.075 mV/V + 2 mV<br>0.11 mV/V + 2 mV<br>0.22 µV/V + 4 mV<br>0.57 µV/V +20 mV<br>3 mV/V + 200 mV<br>10 mV/V + 2000 mV | |
| 200 V to 1050 V | @ 1 Hz to 10 Hz<br>>10 Hz to 40 Hz<br>>40 Hz to 10 kHz<br>>10 kHz to 30 kHz<br>>30 kHz to 100 kHz | 0.15 mV/V + 70 mV<br>0.12 mV/V + 20 mV<br>0.12 mV/V + 20 mV<br>0.23 mV/V + 40 mV<br>0.58 mV/V + 200 mV | |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| AC Current – Generate | | | Fluke 5720A |
| 9 to 219.999 µA | @ 10 to 20Hz<br>>20 to 40Hz<br>>40Hz to 1 kHz<br>>1 to 5 kHz<br>>5 to 10kHz | 250 µA/A + 16 nA<br>160 µA/A + 10 nA<br>120 µA/A + 8 nA<br>280 µA/A + 12 nA<br>1.1 mA/A + 65 nA | |
| 220 µA to 2.19999 mA | @ 10 to 20Hz<br>>20 to 40Hz<br>>40Hz to 1 kHz<br>>1 to 5 kHz<br>>5 to 10kHz | 250 µA/A + 40 nA<br>160 µA/A + 35 nA<br>120 µA/A + 35 nA<br>200 µA/A + 110 nA<br>1.1 mA/A + 650 nA | |
| 2.2 mA to 21.9999 mA | 10 to 20Hz<br>>20 to 40Hz<br>>40Hz to 1 kHz<br>>1 to 5 kHz<br>>5 to 10kHz | 250 µA/A + 4 µA<br>160 µA/A + 3.5 µA<br>120 µA/A + 2.5 µA<br>200 µA/A + 3.5 µA<br>1.1 mA/A + 10 µA | |
| 22 mA to 219.999 mA | 10 to 20Hz<br>>20 to 40Hz<br>>40Hz to 1 kHz<br>>1 to 5 kHz<br>>5 to 10kHz | 250 µA/A + 4 µA<br>160 µA/A + 3.5 µA<br>120 µA/A + 2.5 µA<br>200 µA/A + 3.5 µA<br>1.1 mA/A + 10 µA | |
| 220 mA to 2.20000A | 20Hz to 1kHz<br>>1 to 5 kHz<br>>5 to 10kHz | 260 µA/A + 35 µA<br>450 µA/A + 80 µA<br>7.0 mA/A + 160 µA | Fluke 5720A / 5725A Amplifier |
| 2.2 A to 11.0000 A | 40Hz to 1kHz<br>>1 to 5 kHz<br>>5 to 10kHz | 460 µA/A + 170 µA<br>950 µA/A + 380 µA<br>3.6 mA/A + 750 µA | Fluke 5520A (L Comp off) |
| 29.00 to 329.99 µA | 10 to 20Hz<br>>20 to 45Hz<br>>45Hz to 1 kHz<br>>1 to 5 kHz<br>>5 to 10kHz<br>>10 to 30kHz | 0.2 % + 0.1 µA<br>0.15 % + 0.1 µA<br>0.13 % + 0.1 µA<br>0.3 % + 0.15 µA<br>0.8 % + 0.2 µA<br>1.6 % + 0.4 µA | |
| 0.33 to 3.2999mA | 10 to 20Hz<br>>20 to 45Hz<br>>45Hz to 1kHz<br>>1 to 5kHz<br>>5 to 10kHz<br>>10 to 30kHz | 0.2 % + 0.15 µA<br>0.13 % + 0.15 µA<br>0.1 % + 0.15 µA<br>0.2 % + 0.2 µA<br>0.5 % + 0.3 µA<br>1.0 % + 0.6 µA | |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| AC Current – Generate (continued) | | | |
| 33 to 329.99 mA | 10 to 20Hz<br>>20 to 45Hz<br>>45Hz to 1kHz<br>>1 to 5kHz<br>>5 to 10kHz<br>>10 to 30kHz<br>>5 to 10kHz | 0.18 % + 20 µA<br>0.09 % + 20 µA<br>0.04 % + 20 µA<br>0.10 % + 50 µA<br>0.2 % + 100 µA<br>0.4 % + 200 µA<br>2.5 % + 5.0 mA | Fluke 5520A (L Comp off) |
| 0.33 to 1.09999A | @ 10 to 45Hz<br>>45Hz to 1kHz<br>>1 to 5kHz | 0.18 % + 100 µA<br>0.05 % + 100 µA<br>0.6 % + 1,000 µA | |
| 1.1 to 2.99999A | @ 10 to 45Hz<br>>45Hz to 1kHz<br>>1 to 5kHz<br>>5 to 10kHz | 0.18 % + 100 µA<br>0.06 % + 100 µA<br>0.6 % + 1,000 µA<br>2.5 % + 5,000 µA | |
| 3 to 10.9999A | @ 45 to 100Hz<br>>100Hz to 1kHz<br>>1 to 5kHz | 0.06 % + 2,000 µA<br>0.10 % + 2,000 µA<br>3.0 % + 2,000 µA | |
| 11 to 20.5A | @ 45 to 100Hz<br>>100Hz to 1kHz<br>>1 to 5kHz | 0.12 % + 5,000 µA<br>0.15 % + 5,000 µA<br>3.0 % + 5,000 µA | |
| 29.00 to 329.99µA | @ 10 to 100Hz<br>>100Hz to 1kHz | 0.25 % + 0.2 µA<br>0.6 % + 0.5 µA | |
| 0.33 to 3.2999mA | @ 10 to 100Hz<br>>100Hz to 1kHz | 0.25 % + 0.3 µA<br>0.6 % + 0.8 µA | |
| 3.3 to 32.999mA | @ 10 to 100Hz<br>>100Hz to 1kHz | 0.08 % + 4 µA<br>0.2 % + 10 µA | |
| 33 to 329.99mA | @ 10 to 100Hz<br>>100 to 1kHz | 0.08 % + 40 µA<br>0.2 % + 100 µA | |
| 0.33 to 2.99999A | @ 10 to 100Hz<br>>100 to 440Hz | 0.12 % + 200 µA<br>0.3 % + 1000 µA | |
| 3 to 20.5A | @ 10 to 100Hz<br>>100Hz to 1kHz | 0.12 % + 2000 µA<br>1.0 % + 5000 µA | |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| AC Current – Measure | | | |
| 0 to 199.99 µA | 1 to 10 Hz<br>>10 Hz to 10 kHz<br>>10 to 30 kHz<br>>30 to 100 kHz | 500 µA/A + 0.02 µA<br>500 µA/A + 0.02 µA<br>710 µA/A + 0.02 µA<br>4000 µA/A +0.02 µA | Fluke 5520A (L Comp off) |
| 200 µA to 1.9999 µA | 1 to 10 Hz<br>>10 Hz to 10 kHz<br>>10 to 30 kHz<br>>30 to 100 kHz | 310 µA/A + 0.2 µA<br>300 µA/A + 0.2 µA<br>710 µA/A + 0.2 µA<br>4000 µA/A +0.2 µA | |
| 2 to 19.999 99mA | 1 to 10 Hz<br>>10 Hz to 10 kHz<br>>10 to 30 kHz<br>>30 to 100 kHz | 310 µA/A + 2 µA<br>300 µA/A + 2 µA<br>710 µA/A + 2 µA<br>4000 µA/A +2 µA | |
| 20 mA to 199.99 mA | 1 to 10 Hz<br>>10 Hz to 10 kHz<br>>10 to 30 kHz | 310 µA/A + 20 µA<br>290 µA/A + 20 µA<br>630 µA/A + 20 µA | |
| 200mA to 1.999 999A | 10 Hz to 2 kHz<br>>2 to 10 kHz<br>>10 to 30 kHz | 620 µA/A + 200 µA<br>740 µA/A + 200 µA<br>3000 µA/A + 200 µA | |
| 2A to 19.999 99A | 10 Hz to 2 kHz<br>>2 to 10 kHz | 820 µA/A + 2000 µA<br>2500 µA/A + 2000 µA | |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Resistance – Generate (Fixed Points) | 0 Ω<br>1 Ω, 1.9 Ω<br>10 Ω, 19 Ω<br>100 Ω, 190 Ω<br>1 kΩ, 1.9 kΩ<br>10 kΩ, 19 kΩ<br>100 kΩ, 190 kΩ<br>1 MΩ<br>1.9 MΩ<br>10 MΩ<br>19 MΩ<br>100 MΩ | 40 µΩ<br>95 µΩ/Ω<br>23 µΩ/Ω<br>10 µΩ/Ω<br>8.5 µΩ/Ω<br>8.5 µΩ/Ω<br>11 µΩ/Ω<br>20 µΩ/Ω<br>21 µΩ/Ω<br>40 µΩ/Ω<br>47 µΩ/Ω<br>100 µΩ/Ω | Fluke 5720A |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Resistance – Generate | 0 to 10.999 9 Ω<br>11 to 32.999 9 Ω<br>33 to 109.999 9 Ω<br>110 to 329.999 9 Ω<br>330Ω to 1.099 999 kΩ<br>1.1 to 3.299 999 kΩ<br>3.3 to 10.999 99 kΩ<br>11 to 32.999 99 Ω<br>33 to 109.9999 kΩ<br>110 to 329.999 9 kΩ<br>330kΩ to 1.099 999 MΩ<br>1.1 to 3.299 999 MΩ<br>3.3 to 10.999 99 MΩ<br>11 to 32.999 99 MΩ<br>33 to 109.999 9 MΩ<br>110 to 329.9999 MΩ<br>330 to 1100 MΩ | 40 μΩ/Ω + 0.01 Ω<br>30 μΩ/Ω + 0.015 Ω<br>28 μΩ/Ω + 0.015 Ω<br>28 μΩ/Ω + 0.02 Ω<br>28 μΩ/Ω + 0.02 Ω<br>28 μΩ/Ω + 0.2 Ω<br>28 μΩ/Ω + 0.1 Ω<br>28 μΩ/Ω + 1 Ω<br>28 μΩ/Ω + 1 Ω<br>32 μΩ/Ω + 10 Ω<br>32 μΩ/Ω + 10 Ω<br>60 μΩ/Ω + 150 Ω<br>130 μΩ/Ω + 250 Ω<br>250 μΩ/Ω + 2.5 kΩ<br>500 μΩ/Ω + 3 kΩ<br>3.0 mΩ/Ω + 100 kΩ<br>15 mΩ/Ω + 500 kΩ | Fluke 5720A |
| Resistance – Measure | 0 to 1.999 9 Ω<br>2 to 19.999 Ω<br>20 to 199.999 Ω<br>200 Ω to 1.9999 kΩ<br>2 kΩ to 19.9999 kΩ<br>20 kΩ to 199.99 kΩ<br>200 kΩ to 1.999 9 MΩ<br>2 MΩ to 19.999 MΩ<br>20 MΩ to 199.99 MΩ<br>200 MΩ to 1.999 9 GΩ<br>2 GΩ to 19.999 GΩ | 17 μΩ/Ω + 4 μΩ<br>9.5 μΩ/Ω + 28 μΩ<br>8.0 μΩ/Ω + 50 μΩ<br>8.0 μΩ/Ω + 500 μΩ<br>8.0 μΩ/Ω + 5 mΩ<br>8.0 μΩ/Ω + 50 mΩ<br>9.0 μΩ/Ω + 1 Ω<br>20 μΩ/Ω + 100 Ω<br>120 μΩ/Ω + 10 kΩ<br>1.6 mΩ/Ω + 100 kΩ<br>1.6 mΩ/Ω + 1 MΩ | Fluke 8508A |
| Capacitance – Generate<br><br>10 Hz to 10 kHz<br>10 Hz to 3 kHz<br>10 Hz to 1 kHz<br>10 Hz to 1 kHz<br>10 Hz to 1 kHz<br>(10 to 600) Hz<br>(10 to 300) Hz<br>(10 to 150) Hz<br>(10 to 120) Hz<br>(10 to 80) Hz<br>(0 to 50) Hz<br>(0 to 20) Hz<br>(0 to 6) Hz<br>(0 to 2) Hz<br>(0 to 0.6) Hz<br>(0 to 0.2) Hz | <br><br>(0.19 to 1.0999 nF<br>(1.1 to 3.2999 nF<br>(3.3 to 10.9999 nF<br>(11 to 109.999 nF<br>(110 to 329.999 nF<br>(0.33 to 1.09999) μF<br>(1.1 to 3.29999) μF<br>(3.3 to 10.9999) μF<br>(11 to 32.9999) μF<br>(33 to 109.999) μF<br>(110 to 329.999) μF<br>(0.33 F to 1.09999) mF<br>(1.1 to 3.2999) mF<br>(3.3 to 10.9999) mF<br>(11 to 32.9999) mF<br>(33 to 110) mF | <br><br>0.5 % + 0.01 nF<br>0.5 % + 0.01 nF<br>0.25 % + 0.01 nF<br>0.25 % + 0.1 nF<br>0.25 % + 0.3 nF<br>0.25 % + 1 nF<br>0.25 % + 3 nF<br>0.25 % + 10 nF<br>0.40 % + 30 nF<br>0.45 % + 10 nF<br>0.45 % + 300 nF<br>0.45 % + 1 F<br>0.45 % + 3 F<br>0.45 % + 10 F<br>0.75 % + 30 F<br>1.1 % + 100 F | Fluke 5520A |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Phase – Generate | (1 to 65) Hz<br>(>65 to 500) Hz<br>>500 Hz to 1 kHz<br>(>1 to 5) kHz<br>(>5 to 10) kHz<br>(>10 to 30) kHz | 0.10°<br>0.25°<br>0.5°<br>2.5°<br>5°<br>10° | Fluke 5520A |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Electrical Calibration of RTD Indicators – | | | |
| Pt 385,100Ω | -200 ºC to 0 ºC<br>>0 ºC to 100 ºC<br>>100 ºC to 300 ºC<br>>300 ºC to 400 ºC<br>>400 ºC to 630 ºC<br>>630 ºC to 800 ºC | 0.05 ºC<br>0.07 ºC<br>0.09 ºC<br>0.10 ºC<br>0.12 ºC<br>0.23 ºC | Fluke 5520A |
| Pt 3926,100Ω | -200 ºC to 0 ºC<br>>0 ºC to 100 ºC<br>1>00 ºC to 300 ºC<br>>300 ºC to 400 ºC<br>>400 ºC to 630 ºC | 0.05 ºC<br>0.07 ºC<br>0.09 ºC<br>0.10 ºC<br>0.12 ºC | |
| Pt 3916,100Ω | -200 ºC to -190 ºC<br>>-190 ºC to -80 ºC<br>>-80 ºC to 0 ºC<br>>0 ºC to 100 ºC<br>>100 ºC to 260 ºC<br>>260 ºC to 300 ºC<br>>300 ºC to 400 ºC<br>>400 ºC to 600 ºC<br>>600 ºC to 630 ºC | 0.25 ºC<br>0.04 ºC<br>0.05 ºC<br>0.06 ºC<br>0.07 ºC<br>0.08 ºC<br>0.09 ºC<br>0.10 ºC<br>0.23 ºC | |
| Pt 385, 200Ω | -200 ºC to 100 ºC<br>>100 ºC to 260 ºC<br>>260 ºC to 300 ºC<br>>300 ºC to 400 ºC<br>>400 ºC to 600 ºC<br>>600 ºC to 630 ºC | 0.04 ºC<br>0.05 ºC<br>0.12 ºC<br>0.13 ºC<br>0.14 ºC<br>0.16 ºC | |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Electrical Calibration of RTD Indicators – (cont) | | | |
| Pt 385, 500 Ω | -200 ºC to -80 ºC<br>>-80 ºC to 100 ºC<br>>100 ºC to 260 ºC<br>>260 ºC to 400 ºC<br>>400 ºC to 600 ºC<br>>600 ºC to 630 ºC | 0.04 ºC<br>0.05 ºC<br>0.06 ºC<br>0.08 ºC<br>0.09 ºC<br>0.11 ºC | Fluke 5520A |
| Pt 385, 1000 Ω | -200 ºC to 0 ºC<br>>0 ºC to 100 ºC<br>>100 ºC to 260 ºC<br>>260 ºC to 300 ºC<br>>300 ºC to 600 ºC<br>>600 ºC to 630 ºC | 0.03 ºC<br>0.04 ºC<br>0.05 ºC<br>0.06 ºC<br>0.07 ºC<br>0.23 ºC | |
| PtNi 385,120 Ω | -80 ºC to 100 ºC<br>>100 ºC to 260 ºC | 0.08 ºC<br>0.14 ºC | |
| Cu 427,10 Ω | -100 ºC to 260 ºC | 0.3 ºC | |

| Parameter/Equipment | Range | CMC[2, 7] (±) | Comments |
|---|---|---|---|
| Oscilloscopes – | | | |
| DC Signal<br>Into 1 MΩ load<br>Into 50 Ω load | <br>Up to 130 V<br>Up to 6.6 V | <br>0.25 % + 40 µV<br>0.05 % + 40 µV | <br>Fluke 5520A<br>/SC1100 |
| Square Wave Signal<br>Into 1 MΩ load<br>Into 50 Ω load | <br>1 mV to 130 Vp-p<br>1 mV to 6.6 Vp-p | <br>0.1 % + 40 µV<br>0.25 % + 40 µV | *t* = time in seconds |
| Square Wave Frequency | | 2.5 µHz/Hz | |
| Edge – Rise Time (50 Ω) | ≤ 300 ps | +0 ps / -100ps | |
| Amplitude Range (p-p)<br>Frequency Range | 5.0 mV to 2.5 V<br>1 kHz to 10 MHz | 2 % +200 µV<br>2.5 µHz/Hz | |
| Leading Edge<br>Aberrations | <2 ns<br>>2 to 5 ns<br>>5 to 15 ns<br>> 15 ns | 3 % +2 mV<br>2 % +2 mV<br>1 % +2 mV<br>0.5 % +2 mV | |
| Leveled Sine Wave<br>5 mV to 5.5 V,<br>50 kHz (reference) | <br>>50 kHz to 100 MHz<br>>100 to 300 MHz<br>>300 to 600 MHz<br>>600 to 1100 MHz | <br>2 % + 300 µV<br>3.5 % + 300 µV<br>4 % + 300 µV<br>6 % + 300 µV | |
| 5 mV to 3.5 V | >50 kHz to 100 MHz<br>>100 to 300 MHz<br>>300 to 600 MHz<br>>600 to 1100 MHz | 7 % + 300 µV<br>1.5 % + 100 µV<br>2 % + 100 µV<br>4 % + 100 µV | |
| Flatness (Relative 50 kHz) | 50 kHz to 1100 MHz | 5 % + 100 µV | |
| Time Marker | 5s to 50 ms<br>20 ms to 100 ns<br>50 ns to 20 ns<br>10 ns<br>5 ns to 1 ns | 25 + *t**1000µs/s<br>2.5 µs/s<br>2.5 µs/s<br>2.5 µs/s<br>2.5 µs/s | |
| Wave - Square, Sine, Triangle | 1.8 mV to 2.5 V p-p<br>1.8 mV to 55 V p-p<br>10 Hz to 100 Hz | 3 % + 100 µV<br>3 % + 100 µV<br>25 µHz + 15 mHz | Into 50 Ω<br>Into 1 MΩ |

IV. Electrical – RF/Microwave

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Tuned RF Power Absolute – Measure | | | |
| 2.5 MHz to 26.5 GHz | (≤ +10 to ≥ -22) dBm | 0.14 dBm | HP 8902 with 11722A or 11792A |
| | (< -22 to ≥ -42) dBm | 0.15 dBm | |
| | (< -42 to ≥ -50) dBm | 0.17 dBm | |
| | (< -50 to ≥ -60) dBm | 0.17 dBm | |
| | (< -60 to ≥ -72) dBm | 0.19 dBm | |
| | (< -72 to ≥ -80) dBm | 0.20 dBm | |
| | (< -80 to ≥ -92) dBm | 0.21 dBm | |
| | (< -92 to ≥ -102) dBm | 0.27 dBm | |
| | (< -102 to ≥ -110) dBm | 0.32 dBm | |
| | (< -110 to ≥ -120) dBm | 0.37 dBm | |
| | (< -120 to ≥ -127) dBm | 0.43 dBm | |
| 100 kHz to 2.6 GHz | (30 to-20) dBm, 50 Ω SWR 1.15:1 | 0.099 dBm | HP 8902 with 11722A |
| 50 MHz to 1.3 GHz | (30 to-20) dBm, 50 Ω SWR 1.15:1 | 0.12 dBm | HP 8902 with 11792A |
| 1.3 GHz to 18 GHz | SWR 1.25:1 | 0.13 dBm | |
| 18 GHz to 26.5 GHz | SWR 1.40:1 | 0.14 dBm | |
| Tuned RF Power Relative – Measure | | | |
| 2.5 MHz to 26.5 GHz | (≤ +10 to ≥ +2) dB | 0.081 dBm | HP 8902 with 11722A or 11792A |
| | (< + 2 to ≥ -12) dB | 0.070 dBm | |
| | (< -12 to ≥ -22) dB | 0.081 dBm | |
| | (< -22 to ≥ -31) dB | 0.081 dBm | |
| | (< -31 to ≥ -40) dB | 0.093 dBm | |
| | (< -40 to ≥ -50) dB | 0.10 dBm | |
| | (< -50 to ≥ -61) dB | 0.11 dBm | |
| | (< -61 to ≥ -71) dB | 0.12 dBm | |
| | (< -71 to ≥ -80) dB | 0.15 dBm | |
| | (< -80 to ≥ -90) dB | 0.16 dBm | |
| | (< -90 to ≥ -100) dB | 0.16 dBm | |
| | (< -100 to ≥ -110) dB | 0.20 dBm | |
| | (< -110 to ≥ -120) dB | 0.22 dBm | |
| | (< -120 to ≥ -127) dB | 0.34 dBm | |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Amplitude Modulation – Measure | | | |
| Rate: 50 Hz to 10 kHz<br>Depth 5% to 99% | (0.15 to 10) MHz<br>(5% to < 40%) AM | 0.033 % + 1 % display unit of measure | HP 8902A |
| | (40% to 99%) AM | 0.02 % + 0.41 % display unit of measure | |
| Rate: 20 Hz to 10 kHz<br>Depth 5% to 99% | (5% to < 10%) AM<br>(10% to 99%) AM | 3.5 %<br>3.6 % | |
| Rate: 50 Hz to 10 kHz<br>Depth 5% to 99% | (10 to 1300) MHz<br>(5% to < 10%) AM<br>(10% to 99%) AM | <br>1.2 %<br>1.2 % | |
| Rate: 20 Hz to 10 kHz<br>Depth to 99% | (5% to < 10%) AM<br>(10% to 99%) AM | 3.5 %<br>3.5 % | |
| Rate: 50 Hz to 10 kHz<br>Depth 5% to 99% | (1.3 to 26) GHz<br>(5% to < 10%) AM<br>(40% to 99%) AM | <br>2.0 %<br>2.0 % | |
| Rate: 20 Hz to 10 kHz<br>Depth 5% to 99% | (.010 to 26.5) GHz<br>(5% to < 40%) AM | 3.8 %<br>3.8 % | |

| Parameter/Equipment | Range | CMC[2, 6] (±) | Comments |
|---|---|---|---|
| Frequency Modulation – Measure | | | |
| Rate: 20 Hz to 10 kHz, ≤40 kHz | (0.25 to 10) MHz<br>(0 to <4) kHz Peak FM<br>(≥ 4 to < 40) kHz Peak FM | <br>2.3 % Reading + 1 Hz<br>1.2 % Reading + 1 Hz | |
| Rate: 50 Hz to 100 kHz, ≤400 kHz | (10 to 1300) MHz<br>(0 to <4) kHz Peak FM<br>(≥ 4 to < 40) kHz Peak FM<br>(≥ 40 to < 400) kHz Peak FM | <br>5.8 % Reading + 1 Hz<br>2.3 % Reading + 1 Hz<br>2.3 % Reading | |
| Rate: 20 Hz to 200 kHz, ≤400 kHz | (10 to 1300) MHz<br>(0 to <4) kHz Peak FM<br>(≥ 4 to < 40) kHz Peak FM<br>(≥ 40 to < 400) kHz Peak FM | <br>1.2 % Reading + 1 Hz<br>1.2 % Reading<br>1.2 % Reading | |
| Rate: 50 Hz to 100 kHz, ≤400 kHz | 10 MHz to 26.5 GHz<br>(0 to <4) kHz Peak FM<br>(≥ 4 to < 40) kHz Peak FM<br>(≥ 40 to < 400) kHz Peak FM | <br>5.8 % Reading<br>5.8 % Reading<br>5.8 % Reading | |
| Rate: 20 Hz to 200 kHz, ≤400 kHz | 10 MHz to 26.5 GHz<br>(0 to <4) kHz Peak FM<br>(≥ 4 to < 40) kHz Peak FM<br>(≥ 40 to < 400) kHz Peak FM | <br>1.2 % Reading<br>1.2 % Reading<br>1.2 % Reading | |

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| RF Attenuation – Measure | | | |
| 100 kHz to 1.3 GHz | (0 to 10) dB<br>(>10 to 20) dB<br>(>20 to 30) dB<br>(>30 to 40) dB<br>(>40 to 50) dB<br>(>50 to 60) dB<br>(>60 to 70) dB<br>(>70 to 80) dB<br>(>80 to 90) dB<br>(>90 to 100) dB<br>(>100 to 110) dB | 0.064 dB<br>0.068 dB<br>0.079 dB<br>0.094 dB<br>0.12 dB<br>0.14 dB<br>0.16 dB<br>0.20 dB<br>0.22 dB<br>0.24 dB<br>0.33 dB | HP 8902A Measuring Receiver w/ 11722A Sensor |
| (>1.3 to 18) GHz | (0 to 10) dB<br>(>10 to 20) dB<br>(>20 to 30) dB<br>(>30 to 40) dB<br>(>40 to 50) dB<br>(>50 to 60) dB<br>(>60 to 70) dB<br>(>70 to 80) dB<br>(>80 to 90) dB<br>(>90 to 100) dB | 0.078 dB<br>0.089 dB<br>0.090 dB<br>0.10 dB<br>0.13 dB<br>0.15 dB<br>0.17 dB<br>0.20 dB<br>0.32 dB<br>0.33 dB | HP 8902A Measuring Receiver w/ 11792A Sensor |
| (>18 to 26.5) GHz | (0 to 10) dB<br>(>10 to 20) dB<br>(>20 to 30) dB<br>(>30 to 40) dB<br>(>40 to 50) dB<br>(>50 to 60) dB<br>(>60 to 70) dB<br>(>70 to 80) dB<br>(>80 to 90) dB<br>(>90 to 100) dB<br>(>100 to 110) dB | 0.094 dB<br>0.097 dB<br>0.10 dB<br>0.12 dB<br>0.14 dB<br>0.16 dB<br>0.17 dB<br>0.21 dB<br>0.23 dB<br>0.32 dB<br>0.34 dB | |

V. Fluid Quantities

| Parameter/Equipment | Range | CMC[2, 6] (±) | Comments |
|---|---|---|---|
| Pipettes and Fluid Dispensers – | | | |
| Gravimetric Method | 2 to 50 µL<br>>50 µL to 15 mL<br>>15 to 50 mL | 0.89 % of reading<br>0.25 % of reading<br>0.4 % of reading | Laboratory Balance, Deionized Water |
| Photometric Method | Up to 2 µL<br>>2 to 20 µL | 0.06 µL<br>0.13 µL | Artel Pipette Calibration System, Reagents |

VI. Mechanical

| Parameter/Equipment | Range | CMC[2, 6] (±) | Comments |
|---|---|---|---|
| Torque Wrenches and Drivers | Up to 250 lbf/ft | 0.35% of reading | Torque Tester |
| Pressure | 10 to 10,000 psig | 0.017 % of reading + 0.3*R* | Pressurements M2200: R = Resolution |
| | 0 – 3000 psia<br>3000 – 6000 psia<br>6000 – 10000 psia | 0.5 psia<br>1.0 psia<br>1.7 psia | Ruska 7615 |
| | 0 to 116 psia<br>116 to 2330 psia | 0.015 psia<br>0.00065 psia + 0.012 % | Ruska 7215Xi |
| Vacuum | (0 to 30) psia<br>(0 to -14.6) psia | 0.004 psia<br>0.003 psia | Ruska 7215i |

VII. Thermodynamics

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Humidity – Measure | (10 to 95) % RH | 1.8 % RH | Hygrometer |
| Humidity – Generate | 10 to 95 %RH | 0.58 % RH | Thunder Scientific 2500 |
| Temperature – Measure | -190°C to <0°C<br>0°C<br>>0°C to 660°C | 0.011 °C<br>0.007 °C<br>0.009 °C | Fluke 8508A/1590 and Rosemount 162C/CE (Baths, Dry Wells) |
| Temperature – Measuring Equipment | -60°C to 250°C | 0.05 °C | Fluke 8508A/1590 and Rosemount 162C/CE (Baths, Dry Wells) |

VIII. Time & Frequency

| Parameter/Equipment | Range | CMC[2] (±) | Comments |
|---|---|---|---|
| Frequency – Measuring Equipment | 0.01 Hz to 2.000 MHz | 2.5 µHz/Hz + 5 µHz | Fluke 5520A |

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[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] 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] In the statement of CMC, *L* is the numerical value of the nominal length of the device measured in inches. *R* is the resolution of the unit under test. *D* is the numerical value of the nominal diameter of the device measured in inches.

[5] 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.

[6] In the statement of CMC, a percent refers to a percentage of reading unless otherwise noted.

[7] 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's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

# Accredited Laboratory

A2LA has accredited

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*Placentia, 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 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 28th day of March 2017.

President and CEO
For the Accreditation Council
Certificate Number 4296.01
Valid to December 31, 2017
Revised: September 26, 2017

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