



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

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CALIBRATION

Valid To: March 31, 2011

Certificate Number: 2540.01

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

I. Chemical

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
pH ³ – Measuring Equipment, Fixed Points	4.01 pH 7.00 pH 10.00 pH	0.04 pH 0.04 pH 0.04 pH	pH solutions
Conductivity Measuring Equipment ³ , Fixed Points	447 µS 1443 µS 15 000 µS	1.2 µS 1.2 µS 1.2 µS	Conductivity solutions
Gas Detection Equipment ³ –			
Carbon Monoxide Indicators	0.01 % CO	6 %	Standard gases
Propane LEL Indicators	50 % LEL	6 %	
H2S (Hydrogen Sulfide)	0.0025 % H ₂ S	6 %	
O2 (Oxygen)	18 % O ₂	6 %	
Isobutylene	0.01 % Isobutylene	6 %	

II. Dimensional

Parameter/Equipment	Range	CMC ^{2, 4, 5, 6} (\pm)	Comments
Micrometers and Calipers ³	Up to 12 in (12 to 40) in	(54 + 13L + 0.6R) μ m (130 + 13L + 0.6R) μ m	Gage blocks
Steel Rules ³	Up to 48 in	3000 μ m	Glass ruler
Ring Gages ³ – Plain Threaded	Up to 16 in Up to 16 in	170 μ m 160 μ m	Fowler Labconcept
Plug Gages ³ – Plain, Cylindrical	Up to 5 in	47 μ m	Fowler Labconcept
Thread Plugs ³ – Pitch Diameter	Up to 16 in	130 μ m	Fowler Labconcept
Surface Plates, Granite ³ – Flatness	(12 \times 12) in to (72 \times 144) in	200 μ m	Planekator
Coating Thickness Gages ³ – Eddy Current & Magnetic Induction, Fixed Point Coating Thickness Shims	1031 μ m 511 μ m 246 μ m 178 μ m 125 μ m 50.2 μ m 23.4 μ m 12.5 μ m (10 to 5000) μ m	1.7 % of reading 1.7 % of reading 1.7 % of reading 1.7 % of reading 1.7 % of reading 1.7 % of reading 1.7 % of reading 1.7 % of reading 45 μ m	Coating thickness standards Fowler Labconcept
Dial Indicators ³	Up to 4 in	40 μ m	Universal calibrator

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 5} (\pm)	Comments
DC Voltage ³ – Generate	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1000) V	20 μ V/V + 1 μ V + 0.6R 11 μ V/V + 2 μ V + 0.6R 12 μ V/V + 20 μ V + 0.6R 18 μ V/V + 150 μ V + 0.6R 18 μ V/V + 1.5 mV + 0.6R	Fluke 5520A SC1100
DC Voltage ³ – Measure	Up to 200 mV 200 mV to 20 V (20 to 200) V (200 to 1000) V 1000 V to 10 kV (10 to 40) kV	4.5 μ V/V + 0.5 μ V 3 μ V/V + 0.2 μ V 4.5 μ V/V + 0.2 μ V 4.5 μ V/V + 0.5 μ V 0.012 % + 0.6R 2.3 % + 0.6R	Fluke 8508A opt 001 Fluke 80E Fluke 80k40HV probe
DC Current ³ – Generate	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20.5) A (20.5 to 1000) A	0.015 % + 0.02 μ A + 0.6R 100 μ A/A + 0.05 μ A + 0.6R 100 μ A/A + 0.25 μ A + 0.6R 100 μ A/A + 2.5 μ A + 0.6R 0.02 % + 40 μ A + 0.6R 0.038 % + 410 μ A + 0.6R 0.05 % + 500 μ A + 0.6R 0.10 % + 750 μ A + 0.6R 0.25 % + 0.6R	Fluke 5520A SC1100 Fluke 5520A SC 1100 w/50 turn coil
DC Current ³ – Measure	Up to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A 2 A to 20 A (20 to 1000) A	12 μ A/A + 2 μ A 13 μ A/A + 2 μ A 36 μ A/A + 4 μ A 0.017 % + 8 μ A 0.038 % + 20 μ A 0.25 % + 0.6R	Fluke 8508A opt 001 Fluke 5520A SC 1100 w/50 turn coil
Resistance ³ – Measure	Up to 2 Ω (2 to 20) Ω 20 Ω to 200 k Ω 200 k Ω to 2 M Ω (2 to 20) M Ω (20 to 200) M Ω 200 M Ω to 2 G Ω	15 $\mu\Omega/\Omega$ + 2 $\mu\Omega$ 9 $\mu\Omega/\Omega$ + 0.7 $\mu\Omega$ 7.5 $\mu\Omega/\Omega$ + 0.25 $\mu\Omega$ 8.5 $\mu\Omega/\Omega$ + 0.5 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 5 $\mu\Omega$ 60 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 0.053 % + 500 $\mu\Omega$	Fluke 8508A opt 001

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Voltage ³ – Generate (cont)			
(3.3 to 33) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.03 % + 650 μV + 0.6R 0.015 % + 600 μV + 0.6R 0.024 % + 600 μV + 0.6R 0.035 % + 600 μV + 0.6R 0.09 % + 1.6 mV + 0.6R	Fluke 5520A SC1100
(33 to 330) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.019 % + 2 mV + 0.6R 0.02 % + 6 mV + 0.6R 0.025 % + 6 mV + 0.6R 0.03 % + 6 mV + 0.6R 0.2 % + 50 mV + 0.6R	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 10 mV + 0.6R 0.02 % + 10 mV + 0.6R 0.025 % + 10 mV + 0.6R	
AC Voltage ³ – Measure			
Up to 200 mV	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.016 % + 70 μV 0.013 % + 20 μV 110 μV/V + 20 μV 0.011 % + 10 μV 0.011 % + 20 μV 0.031 % + 40 μV 0.071 % + 100 μV	Fluke 8508A Opt 001
200 mV to 200 V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 3000) kHz 300 kHz to 1 MHz	0.014 % + 60 μV 0.011 % + 10 μV 85 μV/V + 10 μV 65 μV/V + 10 μV 85 μV/V + 10 μV 0.021 % + 20 μV 0.051 % + 100 μV 0.3 % of reading + 0.1 % of full scale 1 % of reading + 1 % of full scale	
(200 to 1000) V	(1 to 10) Hz 45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 100) kHz	0.014 % + 70 μV 0.011 % + 20 μV 95 μV/V + 20 μV 0.021 % + 40 μV 0.051 % + 200 μV	

Parameter/Range	Frequency	CMC ^{2, 4, 5} (\pm)	Comments	
AC Current ³ – Generate				
(29 to 330) μ A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.2 % + 0.1 μ A + 0.6R 0.15 % + 0.1 μ A + 0.6R 0.13 % + 0.1 μ A + 0.6R 0.3 % + 0.15 μ A + 0.6R 0.8 % + 0.2 μ A + 0.6R 1.6 % + 0.4 μ A + 0.6R	Fluke 5520A SC 1100	
330 μ A to 3.3 mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.2 % + 0.15 μ A + 0.6R 0.13 % + 0.15 μ A + 0.6R 0.1 % + 0.15 μ A + 0.6R 0.2 % + 0.2 μ A + 0.6R 0.5 % + 0.3 μ A + 0.6R 1.0 % + 0.6 μ A + 0.6R		
(3.3 to 33) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.18 % + 2 μ A + 0.6R 0.09 % + 2 μ A + 0.6R 0.04 % + 2 μ A + 0.6R 0.08 % + 2 μ A + 0.6R 0.2 % + 3 μ A + 0.6R 0.4 % + 4 μ A + 0.6R		
(33 to 330) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.18 % + 20 μ A + 0.6R 0.09 % + 20 μ A + 0.6R 0.04 % + 20 μ A + 0.6R 0.1 % + 50 μ A + 0.6R 0.2 % + 100 μ A + 0.6R 0.4 % + 200 μ A + 0.6R		
330 mA to 1.1 A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.18 % + 100 μ A + 0.6R 0.05 % + 100 μ A + 0.6R 0.6 % + 1 mA + 0.6R 2.5 % + 5 mA + 0.6R		
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.18 % + 100 μ A + 0.6R 0.06 % + 100 μ A + 0.6R 0.6 % + 1 mA + 0.6R 2.5 % + 5 mA + 0.6R		
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.06 % + 2 mA + 0.6R 0.1 % + 2 mA + 0.6R 3 % + 2 mA + 0.6R		
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 5 mA + 0.6R 0.15 % + 5 mA + 0.6R 3 % + 5 mA + 0.6R		
(20 to 1000) A	(45 to 65) Hz	0.25 % + 0.6R		Fluke 5520A SC 1100 w/50 turn coil

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of Thermocouple Indicating Devices ³ – (cont)			
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to 150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.27 °C + 0.6R 0.16 °C + 0.6R 0.14 °C + 0.6R 0.17 °C + 0.6R 0.23 °C + 0.6R	Fluke 5520A SC1100
Type K	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.33 °C + 0.6R 0.18 °C + 0.6R 0.16 °C + 0.6R 0.26 °C + 0.6R 0.4 °C + 0.6R	
Type L	-200 °C to -100 °C -100 °C to 800 °C 800 °C to 900 °C	0.37 °C + 0.6R 0.26 °C + 0.6R 0.17 °C + 0.6R	
Type N	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 410 °C 410 °C to 1300 °C	0.4 °C + 0.6R 0.22 °C + 0.6R 0.19 °C + 0.6R 0.18 °C + 0.6R 0.27 °C + 0.6R	
Type R	0 °C to 250 °C 250 °C to 400 °C 400 °C to 1000 °C 1000 °C to 1767 °C	0.57 °C + 0.6R 0.35 °C + 0.6R 0.33 °C + 0.6R 0.4 °C + 0.6R	
Type S	0 °C to 250 °C 250 °C to 1000 °C 1000 °C to 1400 °C 1400 °C to 1767 °C	0.47 °C + 0.6R 0.36 °C + 0.6R 0.37 °C + 0.6R 0.46 °C + 0.6R	
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.66 °C + 0.6R 0.4 °C + 0.6R 0.38 °C + 0.6R 0.46 °C + 0.6R	
Type U	-200 °C to 0 °C 0 °C to 600 °C	0.56 °C + 0.6R 0.27 °C + 0.6R	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of RTD Indicators ³ –			
Pt 385, 100 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 300 °C 300 °C to 400 °C 400 °C to 630 °C 630 °C to 800 °C	0.05 °C + 0.6R 0.05 °C + 0.6R 0.07 °C + 0.6R 0.09 °C + 0.6R 0.1 °C + 0.6R 0.12 °C + 0.6R 0.21 °C + 0.6R	Fluke 5520A SC1100
PT 385, 200 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.04 °C + 0.6R 0.04 °C + 0.6R 0.04 °C + 0.6R 0.05 °C + 0.6R 0.11 °C + 0.6R 0.12 °C + 0.6R 0.12 °C + 0.6R 0.14 °C + 0.6R	
Pt 385, 500 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.04 °C + 0.6R 0.05 °C + 0.6R 0.05 °C + 0.6R 0.06 °C + 0.6R 0.08 °C + 0.6R 0.08 °C + 0.6R 0.09 °C + 0.6R 0.11 °C + 0.6R	
Pt 385, 1000 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.03 °C + 0.6R 0.03 °C + 0.6R 0.04 °C + 0.6R 0.05 °C + 0.6R 0.06 °C + 0.6R 0.07 °C + 0.6R 0.07 °C + 0.6R 0.23 °C + 0.6R	
Pt 3916, 100 Ω	-200 °C to -190 °C -190 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.25 °C + 0.6R 0.04 °C + 0.6R 0.05 °C + 0.6R 0.06 °C + 0.6R 0.07 °C + 0.6R 0.08 °C + 0.6R 0.09 °C + 0.6R 0.1 °C + 0.6R 0.23 °C + 0.6R	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of RTD Indicators ³ – (cont)			
Pt 3926, 100 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 300 °C 300 °C to 400 °C 400 °C to 630 °C	0.04 °C + 0.6R 0.05 °C + 0.6R 0.07 °C + 0.6R 0.08 °C + 0.6R 0.09 °C + 0.6R 0.1 °C + 0.6R	Fluke 5520A SC1100
PtNi 385, 120 Ω	-80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C	0.06 °C + 0.6R 0.07 °C + 0.6R 0.13 °C + 0.6R	
Cu 427, 10 Ω	-100 °C to 260 °C	0.3 °C + 0.6R	

IV. Fluid

Parameter/Equipment	Range	CMC ² (±)	Comments
Air/Nitrogen Flow ³	(0.01 to 1000) LPM	0.6 % of indicated value	CME FCS
Liquid Flow ³	(0.1 to 250) GPM	0.11 % of indicated value	FT-32 turbine flow system
Air Velocity ³ – Measuring Equipment	(25 to 100) ft/min (100 to 9000) ft/min	3.5 ft/min 4.2 ft/min	TSI 8355 air velocity meter

V. Mechanical

Parameter/Equipment	Range	CMC ^{2,4,5} (±)	Comments
Pressure and Vacuum Gauges –			
Pneumatic	(0.2 to 1000) psia/psig	12 μpsi/psi + 0.6R	Ruska 2465
Hydraulic	(100 to 50 000) psig	0.03 % + 0.6R	DHI 5306

Parameter/Equipment	Range	CMC ^{2,4,5} (\pm)	Comments
Optical Rotational Speed, RPM ³ – Measure	(60 to 100 000) rpm	0.015 % + 0.6R	Racal Dana 1992 w/ various generators
Rotational Speed, RPM ³ – Measure & Generate	(0 to 36 960) rpm	0.015 %+ 0.6R	Quantum Dynamics N-11-FCS/3
Torque Transducers ³	20 in·oz to 100 in·lbs 100 in·lbs to 125 ft·lbs (125 to 2000) ft·lbs	0.04 % + 0.6R 0.06 % + 0.6R 0.08 % + 0.6R	Various torque arms and weights
Torque Devices ³	(0.5 to 400) in·oz (25 to 50) in·lb (50 to 150) in·lb (150 to 400) in·lb (400 to 1000) in·lb (80 to 250) ft·lb (250 to 1000) ft·lb	0.58 % 0.58 % 0.58 % 0.28 % 0.28 % 0.58 % 1.2 %	CDI TTS-250 CDI 1000PF

VI. Time and Frequency

Parameter/Equipment	Range	CMC ² (\pm)	Comments
Frequency ³	10 Hz to 18 GHz	50 nHz/Hz	HP 5343A

VII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,5} (\pm)	Comments
Relative Humidity ³ – Measure	(10 to 90) % RH (90 to 98) % RH	1.3 % RH 2.4 % RH	Vaisala HMI-41 w/HMP-46
Temperature ³ –			
Source	30 °C to 700 °C	0.06 % + 0.1 °C	Omega CL 121
Measure	-200 °C to 1000 °C	0.06 °C	Hart Scientific 1521 w/5623-6A, PRT and 5624 PRT

Peter Abney

Parameter/Equipment	Range	CMC ² (±)	Comments
Infrared Devices ^{3, 7}	Ambient to 100 °C 100 °C to 500 °C	0.6 °C 0.9 °C	Fluke 9132

¹ This laboratory offers commercial calibration service and field calibration service, where noted.

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

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

⁴ R is the resolution of the unit under test.

⁵ In the statement of Calibration and Measurement Capability expressed as percentages are percentages of the reading/output, unless otherwise noted.

⁶ In the statement of Calibration and Measurement Capability, L is the numerical value of the nominal length of the device measured in inches.

⁷ Target emissivity is not calibrated and assumed to be 0.95 (± 0.02 from 8 to 14 μM) for blackbody.



World Class Accreditation

The American Association for Laboratory Accreditation

Accredited Laboratory

A2LA has accredited

ANGEL'S INSTRUMENTATION INC.

Chesapeake, VA

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 23rd day of June 2009.





President & CEO

For the Accreditation Council
Certificate Number 2540.01
Valid to March 31, 2011
Revised: January 24, 2011

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