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

GREAT LAKES CALIBRATION, INC.
1795 W. Cortland Court Suite A
Addison, IL 60101
Josh Hitchcock Phone: 630 613 9350

CALIBRATION

Valid until: June 30, 2020 Certificate Number: 3312.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1, 6]:

I. Chemical

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
pH[3]	(2, 4, 7, 10 & 12) pH units	0.05 pH	NIST traceable buffer solutions
Conductivity[3]	(1 to 10) µS/cm (50 to 1413) µS/cm (5000 to 10 000) µS/cm (50 to 100) mS/cm (150 to 200) mS/cm	0.56 µS/cm 4.7 µS/cm 40 µS/cm 0.36 mS/cm 0.52 mS/cm	NIST traceable conductivity solutions
Refractometers[3]	(10, 20, 30) % Brix (40, 50) % Brix	0.015 % Brix 0.027 % Brix	Sucrose solutions

II. Dimensional

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Angular[3] –			
Displacement	(0.01 to 36 000) deg	0.022 degrees per revolution	Rotary encoder
Speed	Up to 300 000 degrees per minute	0.046 degrees per minute	Rotary encoder and stopwatch
Bore Gages[3] Tri-Bore Gage	Up to 14 in	(41 + 0.6*R*) µin	UMM, master rings master rings
Calipers[3]	Up to 6 in (>6 to 20) in (>20 to 60 in	(41 + 0.6*R*) µin (45 + 3.1*L* + 0.6*R*) µin (64 + 3.1*L* + 0.6*R*) µin	Gage blocks, master rings
Coating Thickness Shims/Precision Shims	25 µin to 0.5 in	21 µin	Universal measuring machine
Cylindrical Plugs – OD Dimension	Up to 4 in	(48+ 2*L*) µin	Universal measuring machine
Cylindrical Rings – ID Dimension	(0.1 to 6) in	(40 + 2.2*L*) µin	Universal measuring machine
Dial/Digital Indicators[3]	Up to 10 in	(28 + 0.6*R*) µin	Gage blocks, indicator calibrator stand
Feeler/Thickness Gauges	Up to 0.25 in	21 µin	Universal measuring machine
Gage Balls	Up to 4 in	(11 + 15*D*) µin	Universal measuring machine
Gage Blocks	Up to 6 in	16 µin	Grade K gage blocks and gage block comparator
	(>6 to 20) in	(19 + 3.1*L*) µin	Grade 0 gage blocks and UMM

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Height Gages[3]	Up to 6 in (>6 to 24) in (>24 to 60) in	(32 + 0.6*R*) µin (320 + 0.6*R*) µin (330 + 8.1*L* + 0.6*R*) µin	Gage blocks, height gage calibrator
Laser Micrometers	(0.01 to 0.75) in (>0.75 to 2) in	27 µin 33 µin	XX pins masters OEM cal procedures
Length Standards	Up to 4 in (>4 to 20) in	(26 + 1.9*L*) µin (19 + 8.2*L*) µin	Universal measuring machine
Micrometers[3] –			
Inside, Depth, Outside	Up to 6 in (>6 to 20) in (>20 to 60) in	(73 + 0.6*R*) µin (100 + 3.1*L* + 0.6*R*) µin (110 + 3.1*L* + 0.6*R*) µin	Gage blocks
Microscopes[3] –			
Eyepiece Reticules and Video Systems	Up to 2 in Up to 25 mm	42 µin 3.5 µm	ASTM E1951 stage micrometers
Micrograph Magnification	Up to 2000x (inches) Up to 2000x (mm)	210 µin 5.4 µm	
Optical Comparators[3]			
Linear	Up to 12 in	(170 + 3.8*L* + 0.6*R*) µin	Glass scale and magnification checker
Magnification	Up to 100x	0.00022 in	
Angle	(15,30,45,60,90, 120,150,180) deg	0.017 deg	
Plain Plugs/Pin gages[3]	Up to 0.75 in (>0.75 to 2) in	41 µin 48 µin	
Snap Gages[3]	Up to 20 in	(43 + 0.6*R*) µin	Universal measuring machine, master rings
Surface Flatness[3]	Up to 1.0 in	4.2 µin	Optical flat, monochromatic light

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Universal Measuring Machines/Bench Micrometer[3] –			
Length	Up to 20 in	(10 + 8*L*) µin	Gage blocks
Anvil Flatness	Up to 1 in	4.8 µin	Optical flat
Measuring Force	(0.2 to 45) oz	0.3 %	Load cells
Vision Systems[3] –			
X-Y Linear Scale	Up to 12 in	(170 + 3.8*L* + 0.6*R*) µin	Glass scale
Z-Axis Scale	Up to 2 in	190 µin	Linear gage
Angularity	(45, 90, 135, 180) deg	(0.2 + 0.6*R*) deg	Glass scale
Magnification	(10 to 100) x	0.00022 in	Magnification checker
Extensometer, COD Gage, Deflectometers[3] –	Up to 2 in (>2 to 25) in	40 µin 0.008 in	ASTM E 83, ISO 9513 calibrator and encoder
Gage Length	(0.25 to 8) in	(69 + 6.4*L*) µin	Calipers

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
DC Voltage[3] – Measure	(0 to 120) mV 120 mV to 1.2 V (1.2 to 12) V (12 to 120) V (120 to 1000) V	5 µV/V + 1.4 µV 4 µV/V + 4.1 µV 4 µV/V + 37 µV 6 µV/V + 560 µV 6 µV/V + 5.7 mV	Agilent 3458A w/ OPT-002

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Resistance[3] – Measure	(0 to 12) Ω (12 to 120) Ω 120 Ω to 1.2 kΩ (1.2 to 12) kΩ (12 to 120) kΩ 120 kΩ to 1.2 MΩ (1.2 to 12) MΩ (12 to 100) MΩ	15 µΩ/Ω + 0.2 mΩ 12 µΩ/Ω + 1.6 mΩ 8 µΩ/Ω + 7 mΩ 10 µΩ/Ω + 70 mΩ 10 µΩ/Ω + 0.9 Ω 15 µΩ/Ω + 10 Ω 50 µΩ/Ω + 1 kΩ 0.05 % + 7 kΩ	Agilent 3458A w/ OPT-002
DC Current[3] – Measure	(0 to 1.2) µA (1.2 to 12) µA 12 µA to 1.2 mA (1.2 to 12) mA (12 to 120) mA 0.12 A to 1.00 A (1.00 to 3.00) A (3 to 25) A	36 µA/A + 51 pA 0.011 % + 110 nA 21 µA/A + 81 nA 21 µA/A + 0.2 nA 39 µA/A + 0.62 µA 0.011 % + 10 µA 0.12 % + 1.2 mA 0.12 % + 24 mA	Agilent 3458A w/ OPT-002 HP 34401A
DC Voltage[3] – Generate	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V	30 µV/V + 4.3 µV 30 µV/V + 23 µV 30 µV/V + 210 µV 32 µV/V + 1.9 mV	Martel 3001A
Resistance[3] – Generate	(5 to 400) Ω (400 to 4000) Ω	0.058 Ω 0.33 Ω	Martel 3001A
DC Current[3] – Generate	(0 to 100) mA	50 µA/A + 2.4 µA	Martel 3001A
Electrical Calibration of Thermocouple Indicating Devices[3] – Generate and Measure			
Type E	(-210 to -100) ºC (-100 to 1000) ºC	0.40 ºC 0.17 ºC	Martel 3001A
Type J	(-210 to -100) ºC (-100 to 1200) ºC	0.22 ºC 0.19 ºC	
Type K	(-210 to -100) ºC (-100 to 120) ºC (120 to 1000) ºC (1000 to 1372) ºC	0.26 ºC 0.15 ºC 0.21 ºC 0.32 ºC	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Electrical Calibration of Thermocouple Indicating Devices[3] – Generate and Measure (cont)			
Type N	(-200 to -100) ºC (-100 to 410) ºC (410 to 1300) ºC	0.32 ºC 0.18 ºC 0.22 ºC	Martel 3001A
Type R	(0 to 250) ºC (250 to 1400) ºC (1000 to 1767) ºC	0.45 ºC 0.28 ºC 0.32 ºC	
Type S	(0 to 250) ºC (250 to 1400) ºC (1400 to 1767) ºC	0.37 ºC 0.29 ºC 0.36 ºC	
Type T	(-250 to -150) ºC (-150 to 0) ºC (0 to 400) ºC	0.49 ºC 0.20 ºC 0.14 ºC	
Electrical Calibration of RTD Indicators[3] – Generate and Measure			
Pt (385), 100 Ω	(-200 to 100) ºC (100 to 400) ºC (400 to 630) ºC (630 to 800) ºC	0.07 ºC 0.09 ºC 0.11 ºC 0.21 ºC	Martel 3001A
Pt (385), 200 Ω	(-200 to 260) ºC (260 to 630) ºC	0.06 ºC 0.13 ºC	
Pt (385), 500 Ω	(-200 to 260) ºC (260 to 630) ºC	0.05 ºC 0.09 ºC	
Pt (385), 1000 Ω	(-200 to 600) ºC (600 to 630) ºC	0.07 ºC 0.09 ºC	
Pt (3916), 100 Ω	(-200 to -190) ºC (-190 to 600) ºC (600 to 630) ºC	0.23 ºC 0.08 ºC 0.19 ºC	
Pt (3926), 100 Ω	(-200 to 100) ºC (100 to 630) ºC	0.06 ºC 0.10 ºC	
PtNi (385), 100 Ω	(-80 to 260) ºC	0.13 ºC	
PtNi (385), 120 Ω	(-80 to 260) ºC	0.13 ºC	

IV. Mechanical

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Scales and Balances[3]	(1 to 500) mg (0.5 to 5) g (5 to 100) g (100 to 200) g (200 to 500) g (500 to 1000) g (1 to 2) kg (2 to 5) kg (5 to 11) kg (0.001 to 0.01) lb (0.01 to 0.1) lb (0.1 to 1.0) lb (1 to 10) lb (10 to 50) lb (50 to 500) lb (500 to 1000) lb	0.02 mg 0.04 mg 0.25 mg 0.25 mg 0.5 mg 1.3 mg 2.5 mg 5.0 mg 99 mg 0.00006 lb 0.0002 lb 0.0004 lb 0.0022 lb 0.0064 lb 0.084 lb 0.087 lb	Class 1 weights Class F weights
Verification of Test Weights[3]	(0.001 to 44) lb	0.05 %	ASTM E-139 and NIST TN-577, comparison to Class F weights
Force[3] –			
Tension	(3 to 100) lbf (100 to 1000) lbf (1000 to 60 000) lbf (60 000 to 200 000) lbf (200 000 to 1 000 000) lbf	0.17 % + 0.028 lbf 0.14 % + 0.16 lbf 0.12 % + 4.9 lbf 0.12 % + 12 lbf 0.12 % + 0.13 klbf	ASTM E4 and Class A load cells
Compression	(8 to 100) lbf (100 to 1000) lbf (1000 to 60 000) lbf (60 000 to 200 000) lbf (200 000 to 1 000 000) lbf (1 000 000 to 1 500 000) lbf	0.17 % + 0.028 lbf 0.14 % + 0.12 lbf 0.12 % + 0.91 lbf 0.12 % + 42 lbf 0.12 % + 0.14 klbf 0.18 % + 0.19 klbf	

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Force – Tension and Compression	 (20 to 100) lbf (200 to 10 000) lbf (10 000 to 100 000) lbf	 0.26 % + 0.17 lbf 0.13 % + 0.19 lbf 0.13 % + 0.13 lbf	ISO 7500-1 & 7500-2 w/ Class 0.5 Class 00 Class 0.5
Force – Tension and Compression	 (0.01 to 500) lbf (1 to 500) mg (0.5 to 5) g	 0.28 % 0.024 mg 0.045 mg	ASTM E-4 and ISO 7500-1, Class 6 dead weights Class 1gram weights
Dynamic Force[3] –	(0.5 to 200 000) lbf (0.1 to 100) Hz	0.43 % of Force Indication	ASTM E-467 and NASM 1312, dynamometers & load cells
Verification of Test Frames[3] – Crosshead Displacement Crosshead Speed Strain Rate Load Rate Specimen Alignment	 (0.001 to 1) in (1 to 25) in (25 to 50) in (0.01 to 20) in/min (0.001 to 0.01) in/in/min (20 to 600 000) lb/min (0 to 50) % Bending	 230 µin 0.008 in 0.073 in 0.008 in/min 0.22 % 0.35 % 1.1 % Bending	ASTM E2309, E2658 Linear gauge Digital encoder Encoder w/ stop watch Extensometer and stop watch Load cell and stop watch ASTM E1012
Torque – Measuring Equipment[3]	(0.02 to 10) in·lbf (10 to 100) in·lbf (100 to 500) in·lbf (500 to 5000) in·lbf	0.0008 in·lbf 0.003 in·lbf 0.008 in·lbf 0.096 in·lbf	ASTM E2624 Dead weights and lever arms

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Indirect Verification of Rockwell Hardness Testers[3]	HRA: Low Middle High HRBW: Low Middle High HRC: Low Middle High HREW: Low Middle High HRFW: Low Middle High HRHW: Low Middle High HRLW: Low Middle	 0.28 HRA 0.26 HRA 0.23 HRA 0.80 HRBW 0.66 HRBW 0.52 HRBW 0.43 HRC 0.40 HRC 0.38 HRC 0.56 HREW 0.5 HREW 0.5 HREW 0.60 HRFW 0.52 HRFW 0.48 HRFW 0.54 HRHW 0.54 HRHW 0.46 HRHW 0.54 HRLW 0.46 HRLW	ASTM E18
Indirect Verification of Rockwell Superficial Hardness Testers[3]	HR15TW: Low Middle High HR30TW: Low Middle High HR45TW: Low Middle High	 0.71 HR15TW 0.51 HR15TW 0.40 HR15TW 0.61 HR30TW 0.51 HR30TW 0.41 HR30TW 0.60 HR45TW 0.56 HR45TW 0.54 HR45TW	ASTM E18

Parameter/Equipment	Range	CMC[2] (±)	Comments
Indirect Verification of Rockwell Superficial Hardness Testers[3] (cont)	HR15N: Low Middle High HR30N: Low Middle High HR45N: Low Middle High	 0.44 HR15N 0.34 HR15N 0.27 HR15N 0.50 HR30N 0.44 HR30N 0.19 HR30N 0.59 HR45N 0.51 HR45N 0.51 HR45N	ASTM E18
Indirect Verification of Brinell Hardness Testers[3] –			
10/3000/15	(100 to 499) HBW (500 to 650) HBW	4.4 HBW 7.5 HBW	ASTM E10 and ASTM E110, error uncertainty is given as a Brinell hardness number
10/2000/15	(75 to 299) HBW (300 to 500) HBW	3.8 HBW 5.0 HBW	
10/1500/15	(45 to 199) HBW (200 to 345) HBW	2.5 HBW 3.2 HBW	
10/1000/15	(40 to 134) HBW (135 to 230) HBW	1.3 HBW 1.7 HBW	
10/500/15	(50 to 109) HBR	1.4 HBW	
2.5/187.5/10	(100 to 499) HBW (500 to 650) HBW	2.9 HBW 4.6 HBW	
2.5/62.5/10	(40 to 134) HBW (135 to 230) HBW	1.0 HBW 2.0 HBW	
Indirect Verification Leeb Hardness Testers[3]	714 HLD	9.9 HLD	ASTM A956

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Direct Verification of Brinell Hardness Testers[3] –			ASTM E10
Verification of Test Force	(187.5, 500, 1000, 1500, 2000, 3000) kgf	0.29 %	ASTM E74 load cells
Verification of Brinell Scope	(0 to 10) mm	0.017 mm	Stage micrometer
Indirect Verification of Microindentation Hardness Testers[3] – (Knoop & Vickers)			
Mean Hardness Value ≥1 kgf	(100 to 240) HV (240 to 600) HV (≥ 650) HV	1.6 % 0.82 % 0.64 %	ASTM E384/ ASTM E92
Mean Hardness Value ≤1 kgf	(100 to 240) HV (240 to 600) HV (≥ 650) HV (100 to 250) HK (250 to 650) HK (≥ 650) HK	0.72 % 0.47 % 0.34 % 0.71 % 0.47 % 0.22 %	
Stage Micrometer Verification	(0 to 2) in (0 to 25) mm	42 µin 6.6 µm	Glass stage micrometer

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Indirect Verification of Charpy Impact Testers[3]	(9 to 20) J (88 to 135) J (175 to 250) J Level Torque Radius Measurements Distance Between Anvils	1.2 % 2.6 % 4.0 % 0.059° 4.7 % 0.005° (68 + 6.4*L*) µin	ASTM E23 ISO 148-2
Pressure Gauges[3] – Vacuum Pressure	 (-13.4 to 10) psi (0 to 200) in·Hg (10 to 10 000) psi	 0.05 % + 0.012 psi 0.058 in·Hg 0.03 %	 Winchester model-1 manometer Dead weight tester
Ultrasonic Thickness[3] – Blocks Testers	 Up to 20 in Up to 20 in	 (24 + 3.3*L*) µin 380 µin	 UMM Gage blocks

V. Thermodynamics

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Temperature – Measuring Equipment[3]	(-196 to -45) ºC (-45 to 25) ºC (25 to 420) °C (420 to 660) °C (660 to 1000) ºC (1000 to 1400) ºC	0.16 ºC 0.063 ºC 0.087 °C 0.45 °C 0.69 ºC 2.1 ºC	Bath, dry well, furnace, Hart 5628 PRT Type-S T/C
Temperature – Measure[3]	(-196 to 0) ºC (0 to 660) ºC (660 to 1100) ºC (1100 to 1400) ºC	0.033 ºC 0.036 ºC 0.54 ºC 1.9 ºC	PRT Thermocouples

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Furnace Uniformity Survey[3]	(-197 to 32) ºF (32 to 2000) ºF (2000 to 2400) ºF	1.2 ºF 1.7 ºF 2.1 ºF	AMS 2750E or CQI-9 Thermocouple scanner / Type-K or N TC
Humidity[3] – Measuring Equipment and Measure[3]	(10 to 80) % RH (80 to 97) % RH	1.4 % RH 2.1 % RH	Vaisala HM77B and M170
Humidity[3] – Measuring Equipment, Fixed Points	11 % RH 33 % RH 75 % RH 97 % RH	1.3 % RH 1.2 % RH 1.7 % RH 2.2 % RH	Saturated salts
Calibration of Thermocouples[3] – Measuring Equipment			
Type E	-196 ºC to -100 ºC -100 °C to -25 °C -25 °C to 650 °C 650 ºC to 1000 ºC	0.74 ºC 0.31 ºC 0.52 °C 0.76 °C	ASTM E2846 / ASTM E220
Type J	-196 ºC to -300 ºC -30 °C to 660 °C 660 ºC to 1100 ºC 1100 °C to 1200 °C	0.44 ºC 0.54 ºC 0.77 °C 2.1 °C	
Type K	-196 ºC to -100 ºC -100 ºC to -25 ºC -25 °C to 120 °C 120 °C to 660 °C 660 °C to 1100 °C 1100 °C to 1200 °C	0.52 ºC 0.35 ºC 0.28 °C 0.60 °C 0.80 °C 2.1 °C	
Type N	-196 ºC to -100 ºC -100 ºC to -25 ºC -25 °C to 410 °C 410 °C to 660 °C 660 °C to 1100 °C 1100 °C to 1200 °C	0.59 ºC 0.40 ºC 0.31 °C 0.60 °C 0.80 °C 2.1 °C	
Type R	-45 ºC to 250 ºC 250 ºC to 400 ºC 400 ºC to 1000 ºC 1000 °C to 1500 °C	0.76 ºC 0.53 ºC 0.86 ºC 2.1 °C	

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Calibration of Thermocouples[3] – Measuring Equipment (cont)			
Type S	-45 ºC to 250 ºC 250 ºC to 660 ºC 660 °C to 1000 °C 1000 °C to 1500 °C	0.75 ºC 0.70 ºC 0.87 °C 2.1 °C	ASTM E2846 / ASTM E220
Type T	-196 °C to -150 °C -150 °C to 0 °C 0 °C to 400 °C	0.91 °C 0.40 °C 0.27 °C	

VI. Time & Frequency

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Time[3]	(0 to 24) hrs	0.057 sec/24 hr	Stopwatch

---

[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, the percentage is defined as the percentage of reading. L is defined as the length of the unit under test in inches. R is defined as the resolution of the unit under test in inches.

[5] 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.

[6] This scope meets A2LA's *P112 Flexible Scope Policy*.

[7] 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

GREAT LAKES CALIBRATION, INC.

Addison, IL

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/NCSLI Z540-1-1994 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 10th day of July 2018.

Senior Director, Accreditation Services
For the Accreditation Council
Certificate Number 3312.01
Valid to June 30, 2020
Revised January 14, 2019

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