



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

GREAT LAKES CALIBRATION, INC.
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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 calibrations¹:

I. Chemical

Parameter/Equipment	Range	CMC ² (±)	Comments
pH ³	(2, 4, 7, 10 & 12) pH units	0.05 pH	NIST traceable buffer solutions
Conductivity ³	(1 to 10) μ S/cm (50 to 1413) μ S/cm (5000 to 10 000) μ S/cm (50 to 100) mS/cm (150 to 200) mS/cm	0.56 μ S/cm 4.7 μ S/cm 40 μ S/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} (\pm)	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	$(41 + 0.6R) \mu\text{in}$	UMM, master rings master rings
Calipers ³	Up to 6 in (>6 to 20) in (>20 to 60) in	$(41 + 0.6R) \mu\text{in}$ $(45 + 3.1L + 0.6R) \mu\text{in}$ $(64 + 3.1L + 0.6R) \mu\text{in}$	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	$(48 + 2L) \mu\text{in}$	Universal measuring machine
Cylindrical Rings – ID Dimension	(0.1 to 6) in	$(40 + 2.2L) \mu\text{in}$	Universal measuring machine
Dial/Digital Indicators ³	Up to 10 in	$(28 + 0.6R) \mu\text{in}$	Gage blocks, indicator calibrator stand
Feeler/Thickness Gauges	Up to 0.25 in	21 μin	Universal measuring machine
Gage Balls	Up to 4 in	$(11 + 15D) \mu\text{in}$	Universal measuring machine
Gage Blocks	Up to 6 in (>6 to 20) in	16 μin $(19 + 3.1L) \mu\text{in}$	Grade K gage blocks and gage block comparator Grade 0 gage blocks and UMM

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Height Gages ³	Up to 6 in (>6 to 24) in (>24 to 60) in	(32 + 0.6R) μin (320 + 0.6R) μin (330 + 8.1L + 0.6R) 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 + 1.9L) μin (19 + 8.2L) μin	Universal measuring machine
Micrometers ³ – Inside, Depth, Outside	Up to 6 in (>6 to 20) in (>20 to 60) in	(73 + 0.6R) μin (100 + 3.1L + 0.6R) μin (110 + 3.1L + 0.6R) μin	Gage blocks
Microscopes ³ – Eyepiece Reticules and Video Systems Micrograph Magnification	Up to 2 in Up to 25 mm Up to 2000x (inches) Up to 2000x (mm)	42 μin 3.5 μm 210 μin 5.4 μm	ASTM E1951 stage micrometers
Optical Comparators ³ Linear Magnification Angle	Up to 12 in Up to 100x (15,30,45,60,90, 120,150,180) deg	(170 + 3.8L + 0.6R) μin 0.00022 in 0.017 deg	Glass scale and magnification checker
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 + 0.6R) 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 Anvil Flatness Measuring Force	Up to 20 in Up to 1 in (0.2 to 45) oz	(10 + 8L) μin 4.8 μin 0.3 %	Gage blocks Optical flat Load cells
Vision Systems ³ – X-Y Linear Scale Z-Axis Scale Angularity Magnification	Up to 12 in Up to 2 in (45, 90, 135, 180) deg (10 to 100) x	(170 + 3.8L + 0.6R) μin 190 μin (0.2 + 0.6R) deg 0.00022 in	Glass scale Linear gage Glass scale Magnification checker
Extensometer, COD Gage, Deflectometers ³ – Gage Length	Up to 2 in (>2 to 25) in (0.25 to 8) in	40 μin 0.008 in (69 + 6.4L) μin	ASTM E 83, ISO 9513 calibrator and encoder 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} (\pm)	Comments
Resistance ³ – Measure	(0 to 12) Ω (12 to 120) Ω 120 Ω to 1.2 k Ω (1.2 to 12) k Ω (12 to 120) k Ω 120 k Ω to 1.2 M Ω (1.2 to 12) M Ω (12 to 100) M Ω	15 $\mu\Omega/\Omega$ + 0.2 m Ω 12 $\mu\Omega/\Omega$ + 1.6 m Ω 8 $\mu\Omega/\Omega$ + 7 m Ω 10 $\mu\Omega/\Omega$ + 70 m Ω 10 $\mu\Omega/\Omega$ + 0.9 Ω 15 $\mu\Omega/\Omega$ + 10 Ω 50 $\mu\Omega/\Omega$ + 1 k Ω 0.05 % + 7 k Ω	Agilent 3458A w/ OPT-002
DC Current ³ – Measure	(0 to 1.2) μ A (1.2 to 12) μ A 12 μ A 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 μ A/A + 51 pA 0.011 % + 110 nA 21 μ A/A + 81 nA 21 μ A/A + 0.2 nA 39 μ A/A + 0.62 μ A 0.011 % + 10 μ A 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 μ V/V + 4.3 μ V 30 μ V/V + 23 μ V 30 μ V/V + 210 μ V 32 μ V/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 μ A/A + 2.4 μ A	Martel 3001A
Electrical Calibration of Thermocouple Indicating Devices ³ – Generate and Measure			
Type E	(-210 to -100) $^{\circ}$ C (-100 to 1000) $^{\circ}$ C	0.40 $^{\circ}$ C 0.17 $^{\circ}$ C	Martel 3001A
Type J	(-210 to -100) $^{\circ}$ C (-100 to 1200) $^{\circ}$ C	0.22 $^{\circ}$ C 0.19 $^{\circ}$ C	
Type K	(-210 to -100) $^{\circ}$ C (-100 to 120) $^{\circ}$ C (120 to 1000) $^{\circ}$ C (1000 to 1372) $^{\circ}$ C	0.26 $^{\circ}$ C 0.15 $^{\circ}$ C 0.21 $^{\circ}$ C 0.32 $^{\circ}$ C	

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

IV. Mechanical

Parameter/Equipment	Range	CMC ^{2,4} (±)	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	0.02 mg 0.04 mg 0.25 mg 0.25 mg 0.5 mg 1.3 mg 2.5 mg 5.0 mg 99 mg	Class 1 weights
	(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	0.00006 lb 0.0002 lb 0.0004 lb 0.0022 lb 0.0064 lb 0.084 lb 0.087 lb	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} (±)	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 –			ASTM E2309, E2658
Crosshead Displacement	(0.001 to 1) in (1 to 25) in (25 to 50) in	230 µin 0.008 in 0.073 in	Linear gauge Digital encoder
Crosshead Speed	(0.01 to 20) in/min	0.008 in/min	Encoder w/ stop watch
Strain Rate	(0.001 to 0.01) in/in/min	0.22 %	Extensometer and stop watch
Load Rate	(20 to 600 000) lb/min	0.35 %	Load cell and stop watch
Specimen Alignment	(0 to 50) % Bending	1.1 % Bending	ASTM E1012

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Torque – Measuring Equipment ³	(0.02 to 10) in·lbf (10 to 100) in·lbf (100 to 500) in·lbf (500 to 5 000) 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
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	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	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	

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	0.72 % 0.47 % 0.34 %	
	(100 to 250) HK (250 to 650) HK (≥ 650) HK	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} (±)	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 + 6.4L) 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 + 3.3L) μin 380 μin	UMM Gage blocks

V. Thermodynamics

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

Parameter/Equipment	Range	CMC ² (±)	Comments
Furnace Uniformity Survey ³	(-197 to 32) °F (32 to 2000) °F (2000 to 2400) °F	1.2 °F 1.7 °F 2.1 °F	AMS 2750E or CQI-9 Thermocouple scanner / Type-K or NTC
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 °C to -100 °C -100 °C to -25 °C -25 °C to 650 °C 650 °C to 1000 °C	0.74 °C 0.31 °C 0.52 °C 0.76 °C	ASTM E2846 / ASTM E220
Type J	-196 °C to -300 °C -30 °C to 660 °C 660 °C to 1100 °C 1100 °C to 1200 °C	0.44 °C 0.54 °C 0.77 °C 2.1 °C	
Type K	-196 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 660 °C 660 °C to 1100 °C 1100 °C to 1200 °C	0.52 °C 0.35 °C 0.28 °C 0.60 °C 0.80 °C 2.1 °C	
Type N	-196 °C to -100 °C -100 °C to -25 °C -25 °C to 410 °C 410 °C to 660 °C 660 °C to 1100 °C 1100 °C to 1200 °C	0.59 °C 0.40 °C 0.31 °C 0.60 °C 0.80 °C 2.1 °C	
Type R	-45 °C to 250 °C 250 °C to 400 °C 400 °C to 1000 °C 1000 °C to 1500 °C	0.76 °C 0.53 °C 0.86 °C 2.1 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Calibration of Thermocouples ³ – Measuring Equipment (cont)			
Type S	-45 °C to 250 °C 250 °C to 660 °C 660 °C to 1000 °C 1000 °C to 1500 °C	0.75 °C 0.70 °C 0.87 °C 2.1 °C	
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 (±)	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.



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/NCSL 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.

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

President and CEO
For the Accreditation Council
Certificate Number 3312.01
Valid to June 30, 2020

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