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

TRESCAL, INC.
6601 N. Beltline Road, Suite 140
Irving, TX 75063
Dainna Lowrance Phone: 214 591 8300

Satellite[9] Location:
4620 North Beach St., Fort Worth, TX 76137

CALIBRATION

Valid To: March 31, 2021 Certificate Number: 2516.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1, 12]:

I. Chemical

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
pH – Measuring Equipment[3, 8]	(4, 7, 10) units	0.016 units	Buffer solutions
Electrolytic Conductivity – Measuring Equipment	≈10 µS/cm ≈100 µS/cm ≈1000 µS/cm ≈10 000 µS/cm	0.73 µS/cm 2.4 µS/cm 23 µS/cm 0.23 mS/cm	Conductivity solutions

II. Dimensional

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Angle – Measure[8]	Up to 60º	5.8”	Gage blocks and sine bar
Angle – Measuring Equipment[8]	5º, 15º, 30º, 45º	5.2”	Angle blocks
Bore Gages, Bore Micrometers and Holtests[3, 8]	Up to 20 in	2.3 µin/in + 28 µin	Plain ring gages
Chamfer Gages[3, 8]	Up to 1 in (1 to 2) in	350 µin 410 µin	Master chamfer rings
Coordinate Measuring Machines[3, 8] –			
Repeatability	(0.75 to 1) in	26 µin	Sphere
Linear Accuracy	Up to 40 in	2.0 µin/in + 36 µin	Step gage/gage blocks
Squareness	Up to 18 in	5.6 µin/in + 23 µin	Square
Volumetric Performance	600 mm	120 µin	Ball Bar[11]
Crimping Tools –			
Crimp Height	Up to 0.5 in	0.0002 in	Pin gages
Pull Test	Up to 288 lbf	0.023 %	Weights and customer-supplied cables and crimps
Diameter, External[8, 9] –			
Cylindrical Gauging – Pin, Thread/Gear Wire and Plug Gages, Datum Spheres, Steel Balls	Up to 20 in Up to 4 in[9]	2.2 µin/in + 9.2 µin 16 µin[9]	ULM THV w/ gage blocks

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Diameter, Internal[8] – Plain Ring Gages	(0.02 to 0.13) in (0.13 to 0.8) in (0.8 to 20) in	2.2 µin/in + 33 µin 16 µin 2.2 µin/in + 16 µin	ULM w/ ruby balls Ring comparator ULM w/ gage blocks
Flatness[8,9]	3”	4.0 µin	Optical flat
Gage Blocks	(0.005 to 4) in (4 to 20) in	1.9 µin/in + 2.3 µin 2.3 µin/in + 4.0 µin	Comparison to gage blocks
Hand Tools[3, 8] – Indicators Micrometers Depth Gages Height Gages Calipers	Up to 1 in (1 to 6) in (1 to 72) in (1 to 72) in (1 to 72) in (1 to 120) in	2.9 µin/in + 5.8 µin	Gage blocks
Height Master[3, 8] and Height gages –			
Displacement – Length	Up to 24 in	3 µin/in + 45 µin	Gage blocks, linear amplifier
Height Master Micrometer Head	Up to 2 in	17 µin	Gage blocks, linear amplifier
Fixture Gages[8] – (Inspection fixtures, Hard Tooling, Functional gages)			CMM, optical comparator, gage blocks and linear amplifier, hand tools
1D	Up to 24 in Up to 60 in	230 µin 3.9 µin/in + 25 µin	
2D	X to Y 24 in x 24 in X to Z or Y to Z 24 in x 20 in	350 µin 390 µin	
Volumetric	20 in x 20 in x 24 in	700 µin	

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Linear Scales[3, 8] – Machine Tools and Linear Scales, Glass Scales, Optical Magnifiers	Up to 1 in (1 to 6) in (6 to 12) in (12 to 144) in Up to 40 in	200 µin 280 µin 490 µin 9.2 µin/in + 380 µin 1.6 µin/in	Optical comparator Doppler laser
Length Standards[8, 9] (Micrometer Standards, End rods, Step Gages)	Up to 4 in[9] Up to 20 in (20 to 80) in	16 µin[9] 2.2 µin/in + 8.0 µin 1.8 µin/in + 15 µin	ULM, gage blocks, linear amplifier
Optical Comparators[3, 8] – Linear Travel Magnification Angle	 Up to 24 in 10x to 100x 0º to 360°	 10 µin/in + 74 µin 0.016 % 1.7 arc minute	 Glass scales, master balls
Surface Roughness Testers[3, 8] – (Profilometers)	≈ 16 Ra ≈ 120 Ra	2.7 µin 4.8 µin	Surface roughness standards
Radius Gages[8]	Up to 1 in (1 to 6) in (6 to 12) in	250 µin 350 µin 600 µin	Optical comparator
Sieves & Sieve Cloths[8]	20 µm to 26.5 mm	4.6 µm/mm + 2.6 µm	ASTM E11 w/ optical comparator
Squareness[8]	90º	8.8 µin/in + 10 µin	Master square
Rules[8] and Tapes[3, 8]	Up to 120 in Up to 100 ft	(120 + 10*L*) µin 35 µin/in + 0.031 in	Optical comparator, Master tapes and scales

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Surface Finish Standards[3, 8]	≈ 16 Ra ≈ 120 Ra > 120 Ra	3.0 µin 5.2 µin 4.4 µin + 12 %	Surface finish standards w/ surface texture analyzers
Surface Plates[3] – Overall Flatness Repeat Readings	 Up to 170 in diagonal Up to 0.0002 inch	 1.5*D* µin 28 µin	 Doppler Laser Repeat-A-Meter
Thread Gauging, External[8] –			
Plug Gages, Discs Major Diameter	Up to 1 in (>1 to 8) in	23 µin 3.0 µin/in + 13 µin	ULM Gage blocks, contact method
Pitch Diameter Up to 8 in	29 º 55 º 60 º	6.1 µin/in + 72 µin 6.1 µin/in + 81 µin 14 µin/in + 120 µin	Master wires
National Pipe (NPT) Pitch Diameter	Up to 3 in	18 µin/in + 72 µin	
Step	Up to 4 in	41 µin	Gage blocks, linear amplifier
Thread Gauging, Internal[8] –			
Ring Gages: Minor Diameter	 Up to 0.5 in Up to 3.2 in	 350 µin (180 + 17*L*) µin	 Hole micrometer, pins Master ring
Pitch Diameter: Up to 8 in (Adj.) (1.1 to 12) (Fixed)	 29° 7/45°, 55º, 60° 29°,7/45°, 55º, 60°	 (200 + 55*L*) µin (160 + 45*L*) µin (70 + 2.2*L*) µin	 Master plug set (functional fit only) T-ball measurements

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 5, 6, 7] (±)	Comments
DC Voltage[3, 8] – Generate	Up 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	6.8 µV/V + 0.40 µV 3.7 µV/V + 0.80 µV 4.9 µV/V + 3.0 µV 4.9 µV/V + 4.3 µV 3.7 µV/V + 48 µV 4.7 µV/V + 0.48 mV	Fluke 5720A
DC Voltage – Generate[3, 8], Fixed Points	10 V	1.3 µV/V	Fluke 732B
DC Voltage – Generate & Measure[3, 8]	Up to 1000 V	2.1 µV/V	Fluke 732B w/ 752A and Agilent 3458A
DC Voltage– Measure[3, 8]	Up to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	9.5 µV/V + 0.37 µV 6.1 µV/V + 0.37 µV 5.8 µV/V + 0.60 µV 8.7 µV/V + 37 µV 8.7 µV/V + 0.12 mV	Agilent 3458A
DC High Voltage– Measure[3, 8]	(1 to 60) kV	0.13 %	Ross VD60 w/ HP 8842A
DC Current – Generate[3, 8]	Up to 200 pA (0.2 to 200) nA Up to 220 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A (11 to 20.5) A (20.5 to 150) A (150 to 1000) A (2 to 20) A (20 to 120) A 120 A to 5 kA	1.9 % + 13 fA 0.35 % + 13 fA 35 µA/A + 6.0 nA 31 µA/A + 7.0 nA 30 µA/A + 41 nA 41 µA/A + 0.71 µA 77 µA/A + 12 µA 0.034 % + 0.48 mA 0.10 % + 0.91 A 0.58 % + 0.16 A 0.60 % + 0.58 A 0.04 % 0.06 % 0.9 %	Keithley 617 and voltage source Fluke 5720A Fluke 5520A Fluke 5520A w/ coil Fluke 5522A, 52120A w/ coil

Parameter/Equipment	Range	CMC[2, 6, 7] (±)	Comments
DC Current – Measure[3, 8]	Up to 200 pA (0.2 to 200) nA	1.9 % + 13 fA 0.35 % + 13 fA	Keithley 617
	Up to 100 µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	17 µA/A + 0.80 nA 17 µA/A + 5.0 nA 17 µA/A + 50 nA 31 µA/A + 0.50 µA 0.010 % + 10 µA	Agilent 3458A
	(1 to 10) A (10 to 100) A (100 to 1200) A	0.31 mA 0.012 % 0.05 %	w/ L&N 4222 w/ L&N 4223 w/ RAM shunt
Resistance – Generate[3, 8]	Up to 10.9999 Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω (0.33 to 1.099999) kΩ (1.1 to 3.299999) kΩ (3.3 to 10.99999) kΩ (11 to 32.99999) kΩ (33 to 109.999) kΩ (110 to 329.999) kΩ	40 µΩ/Ω + 1.0 mΩ 30 µΩ/Ω + 2.0 mΩ 28 µΩ/Ω + 2.0 mΩ 28 µΩ/Ω + 4.0 mΩ 28 µΩ/Ω + 13 mΩ 28 µΩ/Ω + 13 mΩ 28 µΩ/Ω + 30 mΩ 28 µΩ/Ω + 0.30 Ω 28 µΩ/Ω + 0.30 Ω 32 µΩ/Ω + 2.0 Ω	Fluke 5520A, 4-wire
	(0.33 to 1.09999) MΩ (1.1 to 3.29900) MΩ (3.3 to 10.9999) MΩ (11 to 32.9999) MΩ (33 to 109.9999) MΩ (110 to 329.9999) MΩ (330 to 1100) MΩ	32 µΩ/Ω + 2.2 Ω 60 µΩ/Ω + 39 Ω 0.013 % + 63 Ω 0.025 % + 2.5 kΩ 0.050 % + 3.0 kΩ 0.30 % + 0.10 MΩ 1.5 % + 0.50 MΩ	Fluke 5520A, 2-wire

Parameter/Equipment	Range	CMC[2, 5, 7] (±)	Comments
Resistance – Generate[3, 8] (cont)			
Fixed Points	0.1 mΩ	0.29 %	Shunt
	1 mΩ 10 mΩ 100 mΩ 1 Ω (1.9, 10) Ω 100 Ω 1 kΩ 10 kΩ 19 kΩ 100 kΩ 1 MΩ 10 MΩ 19 MΩ	93 μΩ/Ω 65 μΩ/Ω 75 μΩ/Ω 6.9 μΩ/Ω 7.2 μΩ/Ω 4.7 μΩ/Ω 6.9 μΩ/Ω 5.2 μΩ/Ω 6.1 μΩ/Ω 6.8 μΩ/Ω 8.7 μΩ/Ω 15 μΩ/Ω 19 μΩ/Ω	Standard resistors L&N 4221,4222, 4223 Fluke 742A's
Fixed Points	0 Ω 1 Ω 1.9 Ω 10, 19 Ω 100, 190 Ω 1, 1.9 kΩ 10, 19 kΩ 100, 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	41 μΩ 80 μΩ/Ω + 6.3 μΩ 80 μΩ/Ω + 11 μΩ 21 μΩ/Ω + 120 μΩ 21 μΩ/Ω + 1.2 mΩ 7.5 μΩ/Ω + 58 mΩ 7.5 μΩ/Ω + 0.58 Ω 9 μΩ/Ω + 0.9 Ω 15 μΩ/Ω + 5 Ω 16 μΩ/Ω + 13 Ω 31 μΩ/Ω + 70 Ω 39 μΩ/Ω + 0.16 kΩ 95 μΩ/Ω + 0.84 kΩ	Fluke 5720A

Parameter/Equipment	Range	CMC[2, 6, 7] (±)	Comments
Resistance – Measure[3, 8]	Up to 10 Ω (10 to 100) Ω (100 to 1000) Ω (1 to 10) kΩ (10 to 100) kΩ (100 to 1000) kΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	18 μΩ/Ω + 58 μΩ 12 μΩ/Ω + 0.58 mΩ 9.5 μΩ/Ω + 5.8 mΩ 9.5 μΩ/Ω + 58 mΩ 9.7 μΩ/Ω + 0.58 Ω 15 μΩ/Ω + 2.3 Ω 58 μΩ/Ω + 0.12 kΩ 0.058 % + 1.2 kΩ 0.59 % + 12 kΩ	Agilent 3458A
	(0.1 to 1) Ω (1 to 1.9) Ω (1.9 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 19) kΩ (19 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 19) MΩ (19 to 100) MΩ	60 μΩ/Ω 16 μΩ/Ω 13 μΩ/Ω 14 μΩ/Ω 14 μΩ/Ω 4.8 μΩ/Ω 4.8 μΩ/Ω 4.8 μΩ/Ω 7.2 μΩ/Ω 10 μΩ/Ω 13 μΩ/Ω 19 μΩ/Ω	Resistance transfer method using Fluke 742A Reference Resistors

AC Voltage – Measure[3, 13] w/ Fluke 5790A

	Frequency								
Voltage	*9.5 Hz*	*(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*
2.2 mV		0.15%	0.066%	0.038%	0.073%	0.140%	0.270%	0.30%	0.50%
7 mV		0.061%	0.018%	0.013%	0.025%	0.052%	0.100%	0.15%	0.29%
22 mV		0.032%	0.018%	0.016%	0.022%	0.049%	0.099%	0.14%	0.29%
70 mV	0.26%	0.027%	0.013%	0.012%	0.019%	0.044%	0.078%	0.12%	0.26%
220 mV	0.26%	0.025%	0.010%	0.008%	0.018%	0.043%	0.076%	0.12%	0.26%
700 mV	0.55%	0.025%	0.009%	0.005%	0.008%	0.011%	0.035%	0.091%	0.55%
2.2 V	0.55%	0.024%	0.009%	0.005%	0.008%	0.012%	0.036%	0.092%	0.55%
7 V	0.14%	0.024%	0.009%	0.004%	0.008%	0.011%	0.033%	0.10%	0.14%
22 V	0.15%	0.024%	0.009%	0.004%	0.008%	0.012%	0.034%	0.10%	0.16%
70 V		0.024%	0.009%	0.005%	0.008%	0.015%	0.081%	0.42%	0.70%
220V		0.029%	0.010%	0.005%	0.009%	0.016%	0.082%	0.42%	
700 V			0.027%	0.013%	0.041%	0.140%			
1000 V			0.028%	0.013%	0.039%				

AC Voltage Flatness – Measure[3, 13] @ 50 Ω w/ Fluke 5790A[8]

		Frequency			
V_{P-P}	*V_{RMS}*	*10 Hz to 50 kHz*	*50 kHz to 1 MHz*	*(1 to 10) MHz*	*(10 to 30) MHz*
0.005 V	0.00177 V	0.092%	0.21%	0.27%	0.27%
0.0075 V	0.002655 V	0.092%	0.21%	0.27%	0.27%
0.01 V	0.00354 V	0.095%	0.21%	0.28%	0.27%
0.025 V	0.00885 V	0.092%	0.21%	0.27%	0.27%
0.04 V	0.01416 V	0.092%	0.21%	0.26%	0.26%
0.07 V	0.02478 V	0.092%	0.21%	0.26%	0.26%
0.1 V	0.0354 V	0.095%	0.21%	0.26%	0.26%
0.25 V	0.0885 V	0.092%	0.21%	0.26%	0.26%
0.4 V	0.1416 V	0.093%	0.21%	0.23%	0.23%
0.8 V	0.2832 V	0.092%	0.19%	0.23%	0.23%
1.2 V	0.4248 V	0.092%	0.19%	0.23%	0.23%
3.4 V	1.2036 V	0.093%	0.19%	0.22%	0.22%
5.5 V	1.947 V	0.092%	0.19%	0.22%	0.22%

Parameter/Range	Frequency	CMC[2, 4, 5, 7] (±)	Comments
Capacitance – Measure[3, 8]			
(1 to 10) pF	(0.1 to 10) kHz	0.77 %	QuadTech 1689M
(10 to 100) pF		0.31 %	
(100 to 1000) pF		0.13 %	CMC is stated at 1 kHz[10]
(1 to 10) nF		0.14 %	
(10 to 100) nF		0.14 %	
(100 to 1000) nF		0.16 %	
(1 to 10) µF		0.13 %	
(10 to 100) µF		0.21 %	
(100 to 1000) µF		0.50 %	
Capacitance – Generate[3, 8]			
(0.10 to 3.299) nF	10 Hz to 10 kHz	0.51 % + 12 pF	Fluke 5520A
(0.33 to 10.999) nF	(10 to 1000) Hz	0.26 % + 12 pF	
(11 to 109.999) nF	(10 to 1000) Hz	0.26 % + 0.12 nF	
(110 to 329.99) nF	(10 to 1000) Hz	0.26 % + 0.31 nF	
(0.33 to 1.0999) µF	(10 to 600) Hz	0.26 % + 1.2 nF	
(1.1 to 3.2999) µF	(10 to 300) Hz	0.26 % + 3.1 nF	
(3.3 to 10.999) µF	(10 to 150) Hz	0.26 % + 12 nF	
(11 to 32.999) µF	(10 to 120) Hz	0.42 % + 31 nF	
(33 to 109.99) µF	(10 to 80) Hz	0.46 % + 0.12 µF	
(110 to 329.99) µF	Up to 50 Hz	0.46 % + 0.31 µF	
(0.33 to 1.0999) mF	Up to 20 Hz	0.46 % + 1.2 µF	
(1.1 to 3.2999) mF	Up to 6 Hz	0.46 % + 3.1 µF	
(3.3 to 10.999) mF	Up to 2 Hz	0.46 % + 12 µF	
(11 to 32.999) mF	Up to 0.6 Hz	0.78 % + 31 µF	
(33 to 110) mF	Up to 0.2 Hz	1.2 % + 0.12 mF	
Fixed Points[3]			
1 pF	1 kHz to 13 MHz	0.37 % + 0.6*R*	Agilent 16381A
10 pF	1 kHz to 13 MHz	0.040 % + 0.6*R*	Agilent 16382A
100 pF	1 kHz to 13 MHz	0.067 % + 0.6*R*	Agilent 16383A
1000 pF	1 kHz to 13 MHz	0.33 % + 0.6*R*	Agilent 16384A
(10, 100, 1000) nF	120 Hz to 100 kHz	0.010 % + 0.6*R*	Agilent 16380C

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
Inductance – Measure[3, 8] 1 µH to 10 H	(0.1 to 1) kHz	0.2 % + 0.06 µH	QuadTech 1689M CMC is stated at 1 kHz[10]
Inductance – Generate[3] Fixed Points 100 µH 1 mH 100 mH 1 H 10 H	400 Hz & 1 kHz	 1.2 % 0.13 % 0.083 % 0.083 % 0.17 %	General Radio 1482 series

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
AC Voltage – Generate[3, 8]			
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 500 kHz to 1 MHz	0.022 % + 4.0 µV 85 µV/V + 4.0 µV 75 µV/V + 4.0 µV 0.018 % + 4.0 µV 0.046 % + 5.0 µV 0.090 % + 10 µV 0.12 % + 20 µV 0.25 % + 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 500 kHz to 1 MHz	0.022 % + 4.0 µV 85 µV/V + 4.0 µV 75 µV/V + 4.0 µV 0.018 % + 4.0 µV 0.046 % + 5.0 µV 0.090 % + 10 µV 0.12 % + 20 µV 0.25 % + 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 500 kHz to 1 MHz	0.022 % + 12 µV 85 µV/V + 7.0 µV 75 µV/V + 7.0 µV 0.018 % + 7.0 µV 0.042 % + 17 µV 0.075 % + 20 µV 0.12 % + 25 µV 0.25 % + 45 µV	
220 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 500 kHz to 1 MHz	0.022 % + 82 µV 85 µV/V + 82 µV 40 µV/V + 82 µV 70 µV/V + 82 µV 0.011 % + 82 µV 0.034 % + 82 µV 0.090 % + 0.22 mV 0.15 % + 0.31 mV	
(2.2 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 500 kHz to 1 MHz	0.022 % + 0.40 mV 80 µV/V + 0.15 mV 40 µV/V + 50 µV 70 µV/V + 0.10 mV 95 µV/V + 0.20 mV 0.026 % + 0.60 mV 0.090 % + 2.0 mV 0.13 % + 3.2 mV	

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
AC Voltage – Generate[3, 8] (cont)			
(22 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 500 kHz to 1 MHz	0.022 % + 4.0 mV 80 µV/V + 1.5 mV 47 µV/V + 0.61 mV 75 µV/V + 1.0 mV 0.013 % + 2.5 mV 0.080 % + 16 mV 0.42 % + 40 mV 0.70 % + 80 mV	Fluke 5720A * 220 V range subject to 2.2E7 V-Hz limitation
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	80 µV/V + 4.1 mV 0.013 % + 6.1 mV 0.036 % + 11 mV	
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) KHz	0.036 % + 11 mV 0.080 % + 45 mV 0.13 % + 83 mV 0.42 % + 91 mV 0.70 % + 1.1 V	
AC High Voltage – Measure[3, 8]			
(1 to 42) kVrms	60 Hz	0.30 %	Ross VD60 w/ HP 8842A

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
AC Current – Generate[3, 8]			
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	0.023 % + 16 nA 0.014 % + 10 nA 0.011 % + 8.0 nA 0.025 % + 12 nA 0.090 % + 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	0.023 % + 40 nA 0.014 % + 36 nA 0.011 % + 36 nA 0.025 % + 0.11 µA 0.090 % + 0.65 µA	
(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	0.023 % + 0.41 µA 0.014 % + 0.36 µA 0.011 % + 0.36 µA 0.025 % + 0.56 µA 0.090 % + 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	0.023 % + 4.0 µA 0.014 % + 4.0 µA 0.011 % + 3.0 µA 0.018 % + 4.0 µA 0.090 % + 10 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 35 µA 0.039 % + 80 µA 0.60 % + 0.16 mA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.040 % + 0.19 mA 0.085 % + 0.39 mA 0.33 % + 0.75 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 5.1 mA 0.15 % + 5.1 mA 3.0 % + 5.1 mA	Fluke 5520A
(16.5 to 150) A (150 to 1000) A	60 Hz (45 to 65) Hz 60 Hz (45 to 65) Hz	0.37 % + 0.029 A 1.0 % + 0.031 A	Fluke 5520A w/ coil
(16.5 to 150) A (150 to 1000) A	(65 to 440) Hz (65 to 440) Hz	1.0 % + 0.031 A 0.95 % + 0.12 A	
Up to 20 A	(10 to 65) Hz (65 to 300) Hz 300 Hz to 1 kHz	0.62 % 0.49 % 0.38 %	Fluke 52120A

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
AC Current – Generate[3, 8] (cont)			
(20 to 120) A	(10 to 65) Hz (65 to 300) Hz 300 Hz to 1 kHz	0.29 % 0.29 % 0.29 %	Fluke 52120A
120 A to 6 kA	(10 to 65) Hz (65 to 300) Hz 300 Hz to 1 kHz	0.97 % 0.95 % 0.94 %	Fluke 52120A w/ coil
AC Current – Measure[3, 8]			
10 µA to 20A	10 Hz to 10 kHz	0.013 %	Fluke 5790A w/ A40s
(5 to 100) µA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	0.46 % + 35 nA 0.15 % + 30 nA 0.060 % + 30 nA	Agilent 3458A
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.40 % + 0.20 µA 0.15 % + 0.20 µA 0.060 % + 0.20 µA 0.030 % + 0.20 µA 0.060 % + 0.20 µA 0.40 % + 0.40 µA 0.55 % + 1.5 µA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.40 % + 2.0 µA 0.15 % + 2.0 µA 0.060 % + 2.0 µA 0.030 % + 2.0 µA 0.060 % + 2.0 µA 0.40 % + 4.0 µA 0.55 % + 15 µA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz	0.40 % + 0.02 mA 0.15 % + 0.02 mA 0.06 % + 0.02 mA	

Parameter/Range	Frequency	CMC[2, 4, 6, 7, 13] (±)	Comments
AC Current – Measure[3, 8] (cont)			
(10 to 100) mA	100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.03 % + 0.02 mA 0.06 % + 0.02 mA 0.40 % + 0.04 mA 0.55 % + 0.04 mA	Agilent 3458A
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.40 % + 0.2 mA 0.160 % + 0.2 mA 0.080 % + 0.2 mA 0.10 % + 0.2 mA 0.30 % + 0.2 mA 1.0 % + 0.4 mA	
AC Resistance – Generate[3, 8]			
0.1 Ω 1 Ω 10 Ω (0.1, 1, 10, 100) kΩ	DC to 13 MHz	1.2 % + 0.6*R* 0.12 % + 0.6*R* 0.11 % + 0.6*R* 0.032 % + 0.6*R*	Agilent 16074A AC

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
Oscilloscopes[3, 8] –			
Risetime – Generate	10 Hz to 2 MHz (420 to 540) ps	20 ps	Fluke 9500B with 9510 Active Head
	10 Hz to 2 MHz (125 to 175) ps	17 ps	Fluke 9500B with 9530 Active Head
	10 Hz to 1 MHz (59 to 81) ps	14 ps	Fluke 9500B with 9560 Active Head
	10 Hz to 1 MHz (13 to 17) ps	3.4 ps	Tektronix, Step Gen. 067-1338-00
Risetime – Measure	7 ps to 540 ps	8 ps	Tektronix 80E01
Bandwidth (Flatness)	50 kHz to 300 MHz (300 to 550) MHz (0.55 to 1.1) GHz (0.11 to 3.2) GHz (3.2 to 6.0) GHz	3.4 % 3.5 % 4.4 % 5.3 % 5.6 %	Fluke 9500B
	100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	1.4 % 1.9 % 3.0 % 4.1 %	Signal generator w/ power sensor
Phase Angle – Generate[3, 8]			
(0.0 to 360)º (0.05 to 120) V	(1 to 1000) Hz (1.01 to 6.25) kHz (6.26 to 50) kHz (50.01 to 100) kHz	6.2 mº 12 mº 17 mº 46 mº	Clarke-Hess 5500, mº = milli degree
Phase Angle – Measure[3, 8]			
(0.0 to 360)º (0.01 to 120) V	20 Hz to 10 kHz (10 to 40) kHz (40 to 100) kHz	81 mº 0.29º 0.98º	Krohn-Hite 6500

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Distortion[3, 8]	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	Agilent 8903A
	100 kHz to 2.5 GHz	1.8 dB	Agilent E4448A
	(2.5 to 26.5) GHz	2.6 dB	Agilent E4448A
Electrical Calibration of Thermocouple Indicators –			
Type E	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 600) °C (600 to 1000) °C	0.25 °C 0.12 °C 0.09 °C 0.08 °C 0.1 °C	Fluke 7526A
Type J	(-210 to -100) °C (-100 to 800) °C (800 to 1200) °C	0.14 °C 0.09 °C 0.1 °C	
Type K	(-250 to -200) °C (-200 to -100) °C (-100 to 500) °C (500 to 800) °C (800 to 1372) °C	0.46 °C 0.16 °C 0.1 °C 0.1 °C 0.13 °C	
Type N	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 100) °C (100 to 800) °C (800 to 1300) °C	0.73 °C 0.23 °C 0.12 °C 0.11 °C 0.1 °C 0.12 °C	

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Electrical Calibration of Thermocouple Indicators – (cont)			
Type R	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1000) °C (1000 to 1600) °C (1600 to 1767) °C	0.55 °C 0.45 °C 0.39 °C 0.28 °C 0.22 °C 0.21 °C 0.19 °C 0.23 °C	Fluke 7526A
Type S	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1000) °C (1000 to 1600) °C (1600 to 1767) °C	0.51 °C 0.43 °C 0.38 °C 0.29 °C 0.23 °C 0.22 °C 0.22 °C 0.26 °C	
Type T	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 200) °C (200 to 400) °C	0.35 °C 0.16 °C 0.11 °C 0.09 °C 0.09 °C	
Type U	(-200 to 0) °C (0 to 200) °C (200 to 600) °C	0.16 °C 0.1 °C 0.1 °C	

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Electrical Calibration of RTDs Indicators[3] –			
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 800) °C	0.013 °C 0.02 °C 0.024 °C 0.026 °C 0.033 °C 0.038 °C	Fluke 7526A
Pt 3926, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.013 °C 0.015 °C 0.017 °C 0.022 °C 0.026 °C 0.032 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.01 °C 0.013 °C 0.015 °C 0.017 °C 0.022 °C 0.026 °C 0.031 °C 0.033 °C	
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 630) °C	0.053 °C 0.056 °C 0.06 °C 0.06 °C 0.069 °C 0.071 °C 0.088 °C	
Pt 385, 500 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.026 °C 0.028 °C 0.034 °C 0.038 °C 0.045 °C	
Pt 385, 1000 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.015 °C 0.018 °C 0.024 °C 0.026 °C 0.033 °C	

Parameter/Equipment	Range	CMC[2, 7, 13] (±)	Comments
Electrical Calibration of RTDs Indicators[3] – (cont)			Fluke 7526A
Ni 385, 120 Ω	(-80 to 260) °C	0.009 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.11 °C	
SPRT	(-200 to 660) °C	0.06 °C	
Electrical Conductivity Meters (IACS)	Up to 16 % (>16 to 35) % (>35 to 62) % (>62 to 104) %	2.2 % 1.1 % 0.38 % IACS 1.0 % IACS	Conductivity standards

IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
Power Meter – Power Reference[3, 8] @ 1 mW	50 MHz	1.9 %	Agilent 432A w/ 478A
Relative Power (Tuned RF Level) [3, 8] – Measure			
(0 to -10) dB	100 kHz to 50 GHz	0.018 dB	Agilent E4448A
(-10 to -20) dB		0.019 dB	
(-20 to -30) dB		0.019 dB	
(-30 to -40) dB		0.056 dB	
(-40 to -50) dB		0.056 dB	
(-50 to -60) dB		0.057 dB	
(-60 to -70) dB		0.057 dB	
(-70 to -80) dB		0.094 dB	
(-80 to -90) dB		0.094 dB	
(-90 to -100) dB		0.095 dB	
(-100 to -110) dB		0.096 dB	
(-110 to -120) dB		0.096 dB	
(-120 to -130) dB		0.097 dB	

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
Absolute Power – Measure[3, 8]			Agilent N5532S system, Power sensor - N Type w/ power meter
(-30 to -50) dBm	10 MHz to 18 GHz	1.3 %	
(-50 to -60) dBm		2.6 %	
(-60 to -68) dBm		15 %	
(-30 to +10) dBm	100 kHz to 4.2 GHz	3.3 %	
	(4.2 to 18) GHz	3.5 %	
	(18 to 26.5) GHz	4.2 %	
	(26.5 to 50) GHz	5.0 %	
(+10 to +20) dBm	100 kHz to 4.2 GHz	5.9 %	
	(4.2 to 18) GHz	6.0 %	
	(18 to 26.5) GHz	6.5 %	
	(26.5 to 50) GHz	7.0 %	
VSWR[3, 8]	5 MHz to 2 GHz	0.11 dB	E4448A w/ Krytar / Wiltron SWR bridges
	(2 to 12.5) GHz	0.53 dB	
	(12.5 to 18) GHz	0.85 dB	
	(18 to 26.5) GHz	1.2 dB	
Frequency Modulation – Measure[3, 8]			E4448A opt 233 ß is the ratio of the frequency deviation to the modulation rate
Mod Rate: 20 Hz to 10 kHz Dev.: 200 Hz to 40 kHz (ß > 0.2)	250 kHz to 10 MHz	1.0 %	
Mod Rate: 50 Hz to 200 kHz Dev.: 250 Hz to 400 kHz (ß > 0.2)	1 MHz to 6.6 GHz	1.0 %	
	(6.6 to 13.2) GHz	1.0 %	
	(13.2 to 31.15) GHz	1.0 %	
	(31.15 to 50) GHz	1.0 %	

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
Amplitude Modulation – Measure[3, 8]			
Depth:			
(5 to 99) %	100 kHz to 10 MHz	0.75 %	E4448A opt 233
(5 to 20) %	10 MHz to 3 GHz	2.5 %	
(20 to 99) %	10 MHz to 3 GHz	0.50 %	
(5 to 20) %	(3 to 26.5) GHz	4.5 %	
(20 to 99) %	(3 to 26.5) GHz	1.5 %	
(5 to 20) %	(26.5 to 31.15) GHz	6.8 %	
(20 to 99) %	(26.5 to 31.15) GHz	1.9 %	
(5 to 20) %	(31.15 to 50) GHz	2.6 %	
(20 to 99) %	(31.15 to 50) GHz	6.0 %	
Phase Modulation[3, 8] –			
Mod Rate: (0.2 to 20) kHz			
0.3 rad < Dev ≤ 0.7 rad	100 kHz to 6.6 GHz	3.0 %	E4448A opt 233
Dev > 0.7 rad		1.0 %	
0.6 rad < Dev ≤ 2.0 rad	(6.6 to 13.2) GHz	3.0 %	
Dev > 2.0 rad		1.0 %	
1.2 rad < Dev ≤ 4.0 rad	(13.2 to 26.5) GHz	3.0 %	
Dev > 4.0 rad		1.0 %	
1.3 rad < Dev ≤ 4.0 rad	(26.5 to 31.5) GHz	3.0 %	
Dev > 4.0 rad		1.0 %	
2.4 rad < Dev ≤ 8.0 rad	(31.5 to 50) GHz	3.0 %	
Dev > 8.0 rad		1.0 %	
Transmission[3, 8] S_{12}/S_{21} – Measure			
Linear Phase	Type-N Connectors	(± 0.76 to ± 39)°	Agilent N5230A VNA w/ 85032B calibration kit
Linear Mag.	300 kHz to 2 GHz	(± 0.11 to ± 8.2) dB	
Linear Phase	(2 to 6) GHz	(± 2.1 to ± 15)°	
Linear Mag.		(± 0.25 to ± 1.9) dB	

Parameter/Range	Frequency	CMC[2, 7, 13] (±)	Comments
Reflection[3, 8] S_{11}/S_{22} – Measure Linear Phase Linear Mag. Linear Phase Linear Mag.	 Type-N Connectors: 300 kHz to 2 GHz (2 to 6) GHz	 (± 2.4 to ± 13)° (± 0.33 to ± 0.36)dB (± 12 to ± 35)° (± 1.1 to ± 1.6) dB	 Agilent N5230A VNA w/ 85032B calibration kit
Single Side-Band Phase Noise – Measure[3, 8] Noise Floor : -110 dB -110 dB -130 dB -140 dB -150 dB -155 dB -155 dB -155 dB	Carrier: 1 MHz to 50 GHz Offset Freq: 10 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 10 MHz 100 MHz	 1.5 dB 1.5 dB 1.5 dB 1.5 dB 1.5 dB 1.5 dB 1.5 dB 1.5 dB	Agilent E4448A option 226

V. Fluid Quantities

Parameter/Equipment	Range	CMC[2, 7, 13] (±)	Comments
Gas Flow[3, 8]	Up to 1 sccm (1 to 10) sccm (10 to 100) sccm (0.1 to 1) slm (1 to 10) slm (10 to 100) slm	0.24 % + 0.006 sccm 0.33 % + 0.006 sccm 0.27 % + 0.006 sccm 0.27 % + 0.0006 slm 0.27 % + 0.006 slm 0.65 % + 0.006 slm	Flow standards
Liquid Flow[3, 8]	0.1 mL/min (0.5 to 20) mL/min	2 % + 0.6 µL/min 0.84 % + 0.6 µL/min	Comparator, Stopwatch, Distilled Water – Gravimetric Method

Parameter/Equipment	Range	CMC[2, 7, 13] (±)	Comments
Viscosity[3] – Ford, Dip and Other Viscosity Cups	Cup Nos. 1 through 5	2.8 %	ASTM D1200-94, D4212-93, ISO 2431
Volumetric Glassware and Volumetric Apparatus	10 mL 25 mL 50 mL 100 mL 250 mL 500 mL 1 L 2.5 L 5 L 10 L 15 L 20 L	0.0098 mL 0.024 mL 0.049 mL 0.098 mL 0.24 mL 0.49 mL 0.98 mL 2.4 mL 4.8 ml 9.8 mL 15 mL 20 mL	Gravimetric Method w/ Electronic Balance and Thermometer

VI. Magnetic Quantities

Parameter/Equipment	Range	CMC[2] (±)	Comments
DC Gauss Meters[3, 8]	10 G 20 G	0.62 G 0.62 G	R.B. Annis Gauss standards

VII. Mechanical

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Mass Measurement[8]	Up to 30 g (30 to 160) g (160 to 620) g 620 g to 4 kg (4 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 50) kg	0.12 mg 0.55 mg 3.2 mg 34 mg 66 mg 76 mg 0.23 g 0.41 g	Direct weighing Substitution method: Class 1 mass Class 3 mass

Parameter/Equipment	Range	CMC[2, 4, 7, 13] (±)	Comments
Scales and Balances[3, 8]	(1 to 10) mg (10 to 100) mg (0.1 to 1) g (1 to 10) g (10 to 3200) g (3.2 to 22) kg (22 to 55) kg Up to 1000 lb Up to 4800 lb	0.045 % + 0.6*R* 0.089 % + 0.6*R* 0.020 % + 0.6*R* 0.00040 % + 0.6*R* 0.00028 % + 0.6*R* 0.001 % + 0.6*R* 0.001 % + 0.6*R* 0.023 % 0.10 %	Class 1 weights Class 3 weights Class F weights
Force – Tension and Compression[3]	Up to 1400 lbf (1 to 2) klbf (2 to 5) klbf (5 to 10) klbf (10 to 25) klbf	0.023 % 4.6 lbf 4.8 lbf 5.2 lbf 10 lbf	Deadweight method Load cells
Torque[3] – Tools (Gages and drivers) Testers and Transducers	 (0.5 to 215) ozf·in 5 lbf·in to 250 lbf·ft (250 to 1000) lbf·ft (2 to 100) ozf·in (6 to 250) lbf·in (20 to 250) lbf·ft (250 to 1000) lbf·ft	 0.51 % 0.30 % + 0.6*R* 0.24 % + 0.6*R* 0.030 % + 0.05 ozf·in 0.030 % + 0.12 lbf·in 0.030 % + 0.08 lbf·ft 0.030 % + 0.20 lbf·ft	 Torque tester Torque arm and weights
Pressure[3, 8]	(0.5 to 23) psia (23 to 1015) psia (1000 to 5000) psig (5000 to 10 000) psig (10 to 30) kpsi	0.01 % + 0.00003 psi 0.010 % + 0.6*R* 0.035 % + 2.5 psig 0.035 % + 8.3 psig 25 psi	Pressure calibration system Pressure calibrator Pressure calibrator with Fluke 700 series Heise 901A

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Hardness Testers – Rockwell, Indirect Verification	HRA: Low Medium High HRBW: Low Medium High HRC: Low Medium High HREW: Low Medium High HRRW: Medium High HR15N: Low Medium High HR15TW: Low Medium High HR30N: Low Medium High HR30TW: Low Medium High	 0.43 HRA 0.35 HRA 0.18 HRA 0.58 HRBW 0.63 HRBW 0.48 HRBW 1.0 HRC 0.47 HRC 0.34 HRC 1.1 HREW 0.83 HREW 1.1 HREW 0.44 HRRW 0.31 HRRW 0.89 HR15N 0.77 HR15N 0.22 HR15N 0.89 HR15TW 0.77 HR15TW 0.22 HR15TW 0.61 HR30N 0.66 HR30N 0.91 HR30N 0.78 HR30TW 0.69 HR30TW 0.35 HR30TW	ASTM E18 Hardness Blocks

Parameter/Equipment	Range	CMC[2, 13] (±)	Comments
Hardness Testers – Rockwell, Indirect Verification (cont)	HR45N: Low Medium High HR45T: Low Medium High	 0.84 HR45N 0.51 HR45N 0.54 HR45N 0.79 HR45T 0.43 HR45T 0.47 HR45T	ASTM E18 hardness blocks
Hardness Testers – Brinell Indirect Verification at Test Conditions[3]	≤ 263 HBW > (263 to 591) HBW	2.6 HBW 7.1 HBW	ASTM E10
Equotip (Leeb) Testers[3]	≈ 800 LD	18 LD	ASTM A956
Durometer Calibration – Direct Verification[3]			ASTM D2240
Indenter Shape and Extension	Orifice Diameter Indentor extension length Cone angle Tip radius Indenter thickness	0.00028 in 0.00028 in 0.09º	Optical comparator
Spring Force	A, B, O, D, C, DO scales	0.43 pts	Shore durocalibrator w/ calibrated weights

VIII. Optical Quantities

Parameter/Equipment	Range	CMC[2] (±)	Comments
Gloss Meters[8]	20° 60° 85°	1.4 GU 1.3 GU 1.3 GU	Gloss standards

Parameter/Equipment	Range	CMC[2] (±)	Comments
Gloss Standards[8]	20°, 60°, 85°	1.5 GU	Gloss standards w/ Gloss meter

IX. Thermodynamics

Parameter/Equipment	Range	CMC[2, 7, 13] (±)	Comments
Temperature – Measuring Equipment[3, 8]	-78 °C (-25 to 425) °C	0.0036 % + 0.071 ºC 0.0037 % + 0.044 ºC	Hart 5628 PRT, Chub 1529, Isopropanol/Dry ice Slurry Hart 5628 PRT, Chub 1529, Temperature Baths / Blocks
Temperature – Measure[3, 8]	(-196 to 660) ºC (-40 to 1000) ºC	0.003 % + 0.041 ºC 0.34 % + 1.4 ºC	Hart 5628 PRT & 1529 indicator Fluke 743B w/ Type K Themocouple
Infrared Thermometers[3, 8]	(-15 to 120) ºC (35 to 500) ºC	0.36 % + 0.7 ºC 0.35 % + 0.5 ºC	Hart 4180 black body Hart 4181 black body ε = 0.9 to 1.0 λ = (8 to 14) µm
Relative Humidity – Measuring Equipment[3, 8]	(10 to 95) % RH	0.7 % RH	Thunder Scientific 2500
Relative Humidity – Measure[3, 8]	(10 to 90) % RH (15 to 25) ºC	1.2 % RH	Vaisala HM70 / HMP 77

X. Time & Frequency

Parameter/Equipment	Range	CMC[2, 4, 13] (±)	Comments
Frequency – Measure[3]	10 MHz	4.4 pHz/Hz + 0.6*R*	GPS receiver
Frequency – Measuring Equipment[3]	1 mHz to 50 GHz	4.4 pHz/Hz + 0.1 mHz	GPS receiver w/ generator
Frequency – Measure[3]	0.001 Hz to 50 GHz	4.4 pHz/Hz + 0.1 mHz	Counter locked to GPS10 MHz reference

[1] This laboratory offers commercial calibration service and field calibration service. This accreditation covers calibrations performed at the main laboratory listed, as well as the satellite location listed on page 1 of this scope of accreditation which is covered by either footnote 3 or 9.

[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. 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] In the statement of CMC, *L* is the numerical value of the nominal length of the device measured in inches; *R* is the value of the resolution of the device under test; *D* is the length of the diagonal in inches; *M* is the source of mismatch uncertainty

[5] The measurands stated are generated with the Fluke 5700A or 5520A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

[6] The measurands stated are measured with the Agilent 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.

[7] In the statement of CMC, percentages are percentage of reading unless otherwise indicated.

[8] Uncertainty components that can be reasonably attributed to the Unit Under Test have not been utilized in the calculation of the CMC value for this measurement parameter.

[9] Parameters/instruments identified by notes 3 and 9 can be performed at the satellite location with exceptions as noted. Exceptions: Durometers, Length Standards, Rules and Tapes.

[10] Measurement uncertainty at intermediate values is calculated using the Manufacturers Limits of Error Calculator

[11] Calibration method in accordance to ASME B89.4.1-1997

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

[13] 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

TRESCAL, INC.

Irving, TX

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/NCSLI Z540-1-1994 and the requirements of ANSI/NCSLI 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 1st day of June 2019.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2516.01
Valid to March 31, 2021

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