



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

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CALIBRATION

Valid To: January 31, 2027

Certificate Number: 1625.01

In recognition of the successful completion of the A2LA evaluation process (including an assessment of the organization's compliance with R205 – A2LA's Calibration Program Requirements), accreditation is granted to this laboratory to perform the following calibrations^{1,11}:

I. Chemical

Parameter/Equipment	Range	CMC ² (±)	Comments
Conductivity Meter/Probe Calibration ³ – Discrete Points	10 µS 100 µS 1000 µS 10 000 µS 100 000 µS	0.42 µS 1.2 µS 4.3 µS 46 µS 410 µS	Conductivity solutions
pH Meter/Probe Calibration ³	(4, 7, 10) pH	0.027 pH	pH buffer
	Up to 14 pH	0.034 pH	Comparison to pH meter

II. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Angle Blocks ³	(0.25 to 60)°	0.0054°	Gage blocks, sine bar, electronic probe

Parameter/Equipment	Range	CMC ^{2, 5, 10} (±)	Comments
Calipers ³	Up to 12 in (12 to 72) in	540 μin 980 μin	Gage blocks
Cylindrical Diameter ³ – Measure & Measuring Equipment	Outside Up to 5 in (5 to 18) in (18 to 24) in Inside (0.5 to 2) in (2 to 4) in (4 to 6) in (6 to 24) in	26 μin + 0.43 μin/in 110 μin 290 μin 29 μin + 0.80 μin/in 32 μin + 1.4 μin/in 33 μin + 1.8 μin/in 290 μin	Measuring machine, plug gage Height gage Measuring machine, ring gage Height gage
Cylindrical Squares – Squareness	(4 to 20) in	17 μin	Electronic probe
Dial, Digital, & Test Indicators ³	Up to 0.35 in Up to 1 in Up to 4 in	6.6 μin + 0.58R 7.8 μin + 0.58R 2.5 μin/in + 5.0 μin + 0.58R	Gage blocks
Flatness ³ – Measure & Measuring Equipment	Up to 4 in diameter Up to 10 in length	4 μin 31 μin	Optical flat Electronic probe
Gage Blocks	Up to 1 in (1 to 2) in 3 in 4 in	3 μin + 0.5 μin/in 3.4 μin 5.6 μin 5.3 μin	Dimensional comparator
Gage Block Comparator – Force	Up to 200 μin Up to 1.47 N	3.4 μin 0.089 N	Gage blocks Correx force gage

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Height/Depth Gages ³	Up to 24 in (24 to 72) in	(1.8 + 4.8L) μin 150 μin + 16 μin/in	Gage blocks
Length Standards ³	Up to 18 in (18 to 48) in	13 μin + 10 μin/in 42 μin + 5.5 μin/in	Measuring machine, gage blocks
Levels ³ – Bubble Vial	---	0.62R	Gage blocks
Levels – Electronic Level Systems	---	3.7 arc seconds	Gage blocks and sine bar
Micrometers ³ –	Up to 3 in (3 to 48) in	20 μin + 12 μin/in 64 μin + 1.5 μin/in	Gage blocks
Micrometer Heads	Up to 2 in	8.2 μin	Electronic probe
Laser Micrometers	Up to 2 in	17 μin	Pin/plug gages
Bore Micrometers	(0.2 to 0.5) in (0.5 to 1.4) in (1.4 to 2.5) in (2.5 to 4.5) in (4.5 to 6) in	47 μin 66 μin 76 μin 86 μin 99 μin	Ring gages
Bench Micrometers	Up to 1 in (>1 to 5) in (>5 to 12) in	17 μin 28 μin 46 μin	Gage blocks
Optical Comparators, Microscopes ³ – Length	Up to 3 in (3 to 9) in (9 to 16) in (16 to 24) in	250 μin 210 μin 140 μin 150 μin	Glass artifact
Radius/Diameter Angle	Up to 1 in Up to 360 °	200 μin 0.030°	

Parameter/Equipment	Range	CMC ^{2, 5, 10} (±)	Comments
Optical Comparators, Microscopes ³ – cont. Magnification	10x 20x 31.25x 50x 62.5x 100x	700 μin 580 μin 520 μin 380 μin 360 μin 340 μin	Glass artifact & glass magnification scale
Protractors ³	Up to 90 °	0.0010°	Gage blocks/sine plate
Parallel Measurements ³ – Measure & Measuring Equipment	Up to 1 in diameter Up to 10 in length	5.7 μin 34 μin	Optical parallels Electronic probe
Rulers ³	Up to 72 in Up to 1000 mm (1000 to 1800) mm	0.017 in 0.50 mm 0.55 mm	Ruler
Sine Bars – Length Parallelism	(5 to 10) in (5 to 10) in	60 μin 34 μin	UMM Electronic probe
Surface Finish Meters ³ – Profilometers	(12 to 122) Ra	2.1 μin + 0.01 μin/μin	Roughness specimens
Spherical Diameter – Measure & Measuring Equipment	Up to 5 in	23 μin + 1.2 μin/in	UMM
Spherical Diameter ³ –	Up to 6 in	200 μin	Micrometer
Surface Plates ³ – Flatness Repeatability	Up to 107 diagonal in Up to 0.015 in	(3.1√ <i>D</i> + 170) μin 38 μin	Electronic level system <i>D</i> = diagonal inches Repeatability gage

Parameter/Equipment	Range	CMC ² (±)	Comments
Taper Thread Plug ³ – Pitch Diameter Major Diameter Notch Length	(4 to 80) TPI Up to 2 in Up to 2 in	130 μin 90 μin 100 μin	Gage blocks, thread wires, measuring machine Height gage
Thickness Gages ³	(0.001 to 0.06) in	19 μin + 0.000 31 in/in	Thickness films & gage blocks
Thread Plugs ³ – Simple Pitch Diameter Major Diameter	(4 to 80) TPI Up to 1 in (1 to 1.5) in (1.5 to 4) in	95 μin 35 μin 38 μin 150 μin	Gage blocks, thread wires, measuring machine
Adjustable Thread Rings ^{3,9}	Up to 1.5 in	X (Set Plug Tolerance)	Set using master plug gages. ASME/ANSI B1.2-1983 & ASME/ANSI B1.3-2007
Thread Wires – Inch Metric	(4 to 80) TPI (0.2 to 10) pitch	27 μin 0.69 μm	UMM
Torque Arms	(2 to 8) in (8 to 24) in (24 to 48) in	220 μin 0.0010 in 0.000 99 in	Dimensional comparison
Wire Cloth & Sieves	(0.020 to 12.5) mm	6.9 μm	Optical comparator

III. Dimensional Testing/Calibration¹

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Angle ^{3, 7} – Measure	Up to 360 °	0.039°	Optical comparator
Diameter/Radius ^{3, 7} – Measure	Up to 6 in	0.000 39 in	Optical comparator
One Dimensional Length ^{3, 7} – Measure	Up to 12 in (12 to 72) in Up to 300 mm (300 to 1800) mm	0.000 33 in 0.012 in 0.0083 mm 0.59 mm	Optical comparator Steel ruler Optical comparator Steel ruler

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Current – Generate			
(0.02 to 220) µA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 20 nA 0.015 % + 15 nA 0.013 % + 9.5 nA 0.027 % + 21 nA 0.10 % + 82 nA	Fluke 5720A
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.023 % + 150 nA 0.0069 % + 480 nA 0.013 % + 42 nA 0.019 % + 190 nA 0.10 % + 0.86 µA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 570 nA 0.016 % + 510 nA 0.013 % + 420 nA 0.016 % + 2.0 µA 0.11 % + 5.9 µA	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Current – Generate cont.			
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.020 % + 24 µA 0.012 % + 15 µA 0.013 % + 3.0 µA 0.018 % + 12 µA 0.088 % + 58 µA	Fluke 5725A
(0.22 to 2.2) A	(20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 150 µA 0.028 % + 45 µA 0.042 % + 180 µA 0.70 % + 290 µA	
(2.2 to 11) A	(0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.029 % + 3.3 mA 0.077 % + 3.8 mA 0.34 % + 7.5 mA	
(29 to 330) µA	(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	0.23 % + 120 nA 0.18 % + 110 nA 0.14 % + 120 nA 0.35 % + 170 nA 0.93 % + 220 nA 1.8 % + 460 nA	
(0.33 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	0.23 % + 210 nA 0.15 % + 150 nA 0.12 % + 110 nA 0.28 % + 110 nA 0.59 % + 270 nA 1.2 % + 690 nA	
(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	0.21 % + 2.2 µA 0.10 % + 3.6 µA 0.048 % + 2.2 µA 0.093 % + 2.3 µA 0.23 % + 3.5 µA 0.46 % + 4.6 µA	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Current ³ – Generate (cont)			
(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	0.20 % + 45 µA 0.10 % + 32 µA 0.048 % + 22 µA 0.12 % + 50 µA 0.23 % + 120 µA 0.46 % + 230 µA	Fluke 5520A
(0.33 to 1.1) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.10 % + 27 µA 0.047 % + 23 µA 0.11 % + 62 µA 0.24 % + 110 µA	
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.21 % + 130 µA 0.075 % + 100 µA 0.69 % + 1.2 mA 2.9 % + 5.4 mA	
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.064 % + 3.9 mA 0.10 % + 4.7 mA 3.5 % + 160 µA	
(11 to 20.5) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.14 % + 6.2 mA 0.17 % + 6.8 mA 3.4 % + 16 mA	
(20.5 to 55) A	(45 to 65) Hz (65 to 440) Hz	0.65 % + 460 µA 1.1 % + 20 mA	Fluke 5520A & 50 turn coil
(55 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.65 % + 1.1 mA 1.1 % + 40 mA	
(150 to 550) A	(45 to 65) Hz (65 to 100) Hz (100 to 440) Hz	0.65 % + 20 mA 1.1 % + 160 mA 1.1 % + 190 mA	
(550 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.66 % + 85 mA 1.1 % + 570 mA	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Current – Measure			
(0 to 200) µA	(1 to 10) Hz (0.01 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.034 % + 25 nA 0.032 % + 26 nA 0.076 % + 28 nA 0.46 % + 39 nA	Fluke 8508A
(0.2 to 2) mA	(1 to 10) Hz (0.01 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.032 % + 300 nA 0.024 % + 550 nA 0.074 % + 280 nA 0.46 % + 470 nA	
(2 to 20) mA	(1 to 10) Hz (0.01 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.034 % + 2.4 µA 0.033 % + 2.4 µA 0.072 % + 3.2 µA 0.46 % + 2.7 µA	
(20 to 200) mA	(1 to 10) Hz (0.01 to 10) kHz (10 to 30) kHz	0.030 % + 36 µA 0.028 % + 29 µA 0.068 % + 28 µA	
(0.2 to 2) A	(0.01 to 2) kHz (2 to 10) kHz (10 to 30) kHz	0.067 % + 310 µA 0.081 % + 240 µA 0.35 % + 320 µA	
(2 to 20) A	(0.01 to 2) kHz (2 to 10) kHz	0.084 % + 4.6 mA 0.28 % + 5.6 mA	
(20 to 100) A	40 Hz to 1 kHz	0.68 %	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Current ³ – Measure			
(0 to 100) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 1) kHz	0.46 % + 42 nA 0.17 % + 41 nA 0.068 % + 38 nA 0.068 % + 38 nA	HP 3458A, opt 002
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.45 % + 360 nA 0.17 % + 310 nA 0.066 % + 280 nA 0.033 % + 280 nA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.45 % + 3.6 µA 0.17 % + 3.0 µA 0.066 % + 2.8 µA 0.033 % + 2.8 µA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.42 % + 71 µA 0.17 % + 32 µA 0.066 % + 28 µA 0.033 % + 28 µA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 320 µA 0.18 % + 320 µA 0.089 % + 320 µA 0.12 % + 280 µA	
(1 to 100) A	40 Hz to 1 kHz	0.68 %	Valhalla 2575A with DMM
(100 to 1000) A	(10 to 100) Hz (100 to 500) Hz	2.4 % + 0.60 A 3.0 % + 0.64 A	Fluke 376 clamp
AC Power ³ – Generate			
Watts ($\Phi = 0^\circ$) (10 to 65 Hz)			
(3.3 to 9) mA	(0.11 to 3.0) mW (0.001 to 9) W	0.089 % 0.082 %	Fluke 5520A
(9 to 33) mA	(0.30 to 10) mW (0.003 to 33) W	0.13 % 0.13 %	Note: CMC is higher if Φ is non-zero or if frequency is greater than 65 Hz. (Upper frequency limit: 30 kHz)
(33 to 90) mA	(1 to 30) mW (0.01 to 90) W	0.089 % 0.082 %	
(90 to 330) mA	(3.0 to 100) mW (0.03 to 300) W	0.11 % 0.10 %	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Power ³ – Generate (cont)			
(0.33 to 0.9) A	(11 to 300) mW (0.11 to 900) W	0.087 % 0.081 %	Fluke 5520A Note: CMC is higher if Φ is non-zero or if frequency is greater than 65 Hz. (Upper frequency limit: 30 kHz)
(0.9 to 2.2) A	(30 to 720) mW (0.30 to 2000) W	0.090 % 0.084 %	
(2.2 to 4.5) A	(0.08 to 1.4) W (0.73 to 4500) W	0.16 % 0.16 %	
(4.5 to 20.5) A	(0.15 to 6.7) W (1.5 to 20 000) W	0.18 % 0.18 %	
AC Voltage – Generate			
(0.005 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.026 % + 4.6 μ V 0.011 % + 4.6 μ V 0.010 % + 4.6 μ V 0.020 % + 4.7 μ V 0.052 % + 5.8 μ V 0.10 % + 12 μ V 0.15 % + 23 μ V 0.31 % + 23 μ V	Fluke 5720A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.026 % + 4.6 μ V 0.010 % + 4.6 μ V 88 μ V/V + 4.6 μ V 0.021 % + 4.7 μ V 0.054 % + 5.8 μ V 0.10 % + 13 μ V 0.14 % + 23 μ V 0.27 % + 30 μ V	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.026 % + 8.3 μ V 0.010 % + 8.1 μ V 87 μ V/V + 8.3 μ V 0.010 % + 5.8 μ V 0.026 % + 120 μ V 0.086 % + 28 μ V 0.14 % + 30 μ V 0.30 % + 45 μ V	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Voltage – Generate (cont)			
(0.22 to 2.2) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.025 % + 69 μV 89 μV/V + 31 μV 46 μV/V + 11 μV 15 μV/V + 690 μV 56 μV/V + 350 μV 0.040 % + 93 μV 0.11 % + 210 μV 0.18 % + 300 μV	Fluke 5720A
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.025 % + 670 μV 92 μV/V + 230 μV 46 μV/V + 80 μV 64 μV/V + 640 μV 0.011 % + 280 μV 0.031 % + 630 μV 0.11 % + 1.8 mV 0.15 % + 4.0 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.026 % + 4.9 mV 92 μV/V + 2.4 mV 55 μV/V + 790 μV 88 μV/V + 1.3 mV 0.015 % + 3.3 mV 0.094 % + 19 mV 0.50 % + 41 mV 0.83 % + 87 mV	
(220 to 1100) V	(15 to 40) Hz (0.040 to 1) kHz (1 to 20) kHz (20 to 30) kHz	0.031 % + 16 mV 95 μV/V + 4.2 mV 0.015 % + 5.3 mV 0.042 % + 16 mV	
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.043 % + 10 mV 0.15 % + 68 mV	Fluke 5720A and Fluke 5725A
AC Voltage ³ – Generate			
(1 to 33) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.052 % + 33 μV 20 μV/V + 100 μV 24 μV/V + 120 μV 0.040 % + 70 μV 0.27 % + 80 μV 0.81 % + 110 μV	Fluke 5520A

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Voltage ³ – Generate (cont)			
(33 to 330) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.036 % + 11 µV 0.015 % + 19 µV 31 µV/V + 250 µV 0.019 % + 140 µV 0.078 % + 100 µV 0.24 % + 87 µV	Fluke 5520A
(0.33 to 3.3) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.036 % + 60 µV 0.017 % + 130 µV 50 µV/V + 1.9 mV 0.016 % + 1.2 mV 0.074 % + 430 µV 0.28 % + 810 µV	
(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	0.036 % + 790 µV 0.018 % + 710 µV 0.028 % + 720 µV 0.041 % + 740 µV 0.11 % + 1.9 mV	
(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	0.023 % + 3.1 mV 0.024 % + 7.2 mV 0.029 % + 11 mV 0.032 % + 20 mV 0.23 % + 63 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.035 % + 20 mV 0.029 % + 20 mV 0.033 % + 32 mV	
AC Voltage – Measure			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.20 % + 1.6 µV 0.086 % + 1.5 µV 0.049 % + 1.6 µV 0.094 % + 2.4 µV 0.14 % + 3.0 µV 0.26 % + 4.9 µV 0.27 % + 9.4 µV 0.41 % + 9.5 µV	Fluke 5790A

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Voltage – Measure (cont)			
(2.2 to 7) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.098 % + 1.5 μV 0.043 % + 1.5 μV 0.025 % + 1.5 μV 0.047 % + 2.3 μV 0.070 % + 2.9 μV 0.14 % + 4.6 μV 0.15 % + 9.2 μV 0.27 % + 9.3 μV	Fluke 5790A
(7 to 22) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.033 % + 1.7 μV 0.022 % + 1.6 μV 0.013 % + 1.6 μV 0.023 % + 2.7 μV 0.036 % + 3.1 μV 0.095 % + 4.6 μV 0.10 % + 9.2 μV 0.20 % + 9.2 μV	
(22 to 70) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.029 % + 2.6 μV 0.015 % + 1.8 μV 81 μV/V + 1.8 μV 0.016 % + 2.3 μV 0.033 % + 2.9 μV 0.064 % + 4.7 μV 0.084 % + 9.3 μV 0.13 % + 9.3 μV	
(70 to 220) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.025 % + 1.8 μV 0.010 % + 1.8 μV 47 μV/V + 1.9 μV 87 μV/V + 2.7 μV 0.019 % + 4.9 μV 0.032 % + 5.0 μV 0.045 % + 9.5 μV 0.12 % + 9.6 μV	
(220 to 700) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.022 % + 22 μV 83 μV/V + 11 μV 24 μV/V + 18 μV 41 μV/V + 23 μV 59 μV/V + 35 μV 63 μV/V + 0.28 mV 0.014 % + 0.28 mV 0.080 % + 0.28 mV	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Voltage – Measure (cont)			
(0.7 to 2.2) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.020 % + 69 μV 58 μV/V + 55 μV 14 μV/V + 50 μV 37 μV/V + 49 μV 58 μV/V + 67 μV 0.010 % + 0.34 mV 0.019 % + 0.35 mV 0.092 % + 0.36 mV	Fluke 5790A
(2.2 to 7) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.022 % + 92 μV 67 μV/V + 96 μV 26 μV/V + 23 μV 57 μV/V + 16 μV 92 μV/V + 16 μV 0.023 % + 50 μV 0.029 % + 1.7 mV 0.12 % + 1.5 mV	
(7 to 22) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.023 % + 40 μV 77 μV/V + 71 μV 32 μV/V + 17 μV 54 μV/V + 67 μV 89 μV/V + 120 μV 0.023 % + 40 μV 0.046 % + 190 μV 0.14 % + 430 μV	
(22 to 70) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.023 % + 290 μV 79 μV/V + 150 μV 36 μV/V + 130 μV 66 μV/V + 69 μV 0.011 % + 120 μV 0.022 % + 0.86 mV 0.047 % + 0.75 mV 0.14 % + 0.58 mV	
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.023 % + 460 μV 80 μV/V + 550 μV 37 μV/V + 330 μV 79 μV/V + 320 μV 0.011 % + 260 μV 0.023 % + 2.8 mV 0.058 % + 1.0 mV	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Voltage – Measure (cont)			
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.023 % + 4.3 mV 0.011 % + 4.3 mV 44 μV/V + 4.5 mV 0.014 % + 5.3 mV 0.058 % + 2.2 mV	Fluke 5790A
(700 to 1000) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.023 % + 4.2 mV 0.011 % + 4.2 mV 45 μV/V + 2.0 mV 0.015 % + 2.0 mV 0.058 % + 6.9 mV	
AC Voltage ³ – Measure			
(0 to 10) mV	(1 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.034 % + 3.7 μV 0.023 % + 1.5 μV 0.034 % + 1.5 μV 0.12 % + 1.8 μV 0.58 % + 1.8 μV 4.6 % + 4.4 μV	HP 3458A, opt 002
(10 to 100) mV	(1 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	59 μV/V + 9.0 μV 58 μV/V + 6.1 μV 0.014 % + 5.6 μV 0.032 % + 5.8 μV 0.052 % + 62 μV 0.25 % + 140 μV 1.1 % + 160 μV	
(0.1 to 1) V	(1 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	55 μV/V + 110 μV 70 μV/V + 40 μV 0.015 % + 39 μV 91 μV/V + 710 μV 0.065 % + 380 μV 0.32 % + 400 μV 1.2 % + 270 μV	
(1 to 10) V	(1 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	54 μV/V + 1.1 mV 65 μV/V + 480 μV 0.015 % + 400 μV 0.029 % + 890 μV 0.090 % + 530 μV 0.34 % + 2.2 mV 1.2 % + 2.8 mV	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Voltage ³ – Measure cont.			
(10 to 100) V	(1 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.021 % + 7.7 mV 0.022 % + 4.0 mV 0.022 % + 3.9 mV 0.040 % + 3.9 mV 0.14 % + 4.8 mV 0.46 % + 15 mV 1.8 % + 17 mV	HP 3458A, opt 002
(100 to 700) V	(1 to 40) Hz (0.04 to 1) kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.046 % + 55 mV 0.045 % + 37 mV 0.068 % + 38 mV 0.14 % + 43 mV 0.35 % + 43 mV	
AC Voltage ³ – HV Measure			
(1 to 10) kV	60 Hz	0.16 % - 0.20 V	Vitretek 4700 with HVL35, HVL100
(10 to 35) kV	60 Hz	0.16 % - 5.8 V	
(35 to 100) kV	60 Hz	0.20 % - 15 V	
AC Voltage Flatness – Measure			
(0.005 to 7) V	10 Hz to 30 MHz	0.47 %	Fluke 5790A
(0.005 to 5.5) V	(10 to 1100) MHz	1.6 %	Power meter & power sensors

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Capacitance ³ – Generate			
Synthesized Capacitance			
(0.19 to 0.4) nF	(0.01 to 10) kHz	0.58 % + 12 pF	Fluke 5520A
(0.4 to 1.1) nF	(0.01 to 10) kHz	0.58 % + 12 pF	
(1.1 to 3.3) nF	(0.01 to 3) kHz	0.57 % + 12 pF	
(3.3 to 11) nF	(0.01 to 1) kHz	0.28 % + 14 pF	
(11 to 33) nF	(0.01 to 1) kHz	0.29 % + 120 pF	
(33 to 110) nF	(0.01 to 1) kHz	0.28 % + 140 pF	
(110 to 330) nF	(0.01 to 1) kHz	0.28 % + 390 pF	
(0.33 to 1.1) μF	(10 to 600) Hz	0.28 % + 1.4 nF	
(1.1 to 3.3) μF	(10 to 300) Hz	0.28 % + 3.9 nF	
(3.3 to 11) μF	(10 to 150) Hz	0.27 % + 15 nF	
(11 to 33) μF	(10 to 120) Hz	0.28 % + 43 nF	
(33 to 110) μF	(10 to 80) Hz	0.43 % + 170 nF	
(110 to 330) μF	(0 to 50) Hz	0.49 % + 480 nF	
(0.33 to 1.1) mF	(0 to 20) Hz	0.51 % + 1.4 μF	
(1.1 to 3.3) mF	(0 to 6) Hz	0.49 % + 5.0 μF	
(3.3 to 11) mF	(0 to 2) Hz	0.37 % + 36 μF	
(11 to 33) mF	(0 to 0.6) Hz	0.83 % + 49 μF	
(33 to 110) mF	(0 to 0.2) Hz	0.11 % + 360 μF	
Discrete Capacitance Points			
1 pF	1 kHz	0.85 fF	Agilent 16380A standard capacitors
10 pF	1 kHz	1.6 fF	
100 pF	1 kHz	6.5 fF	
1000 pF	1 kHz	54 fF	
1 nF	(20 to 70) Hz 70 Hz to 100 kHz	1.8 % 0.55 %	Genrad 1409 series standard capacitors
2 nF	(20 to 40) Hz 40 Hz to 100 kHz	1.0 % 0.55 %	
10 nF	20 Hz to 100 kHz	0.31 %	
100 nF	20 Hz to 50 kHz	0.17 %	
200 nF	20 Hz to 10 kHz	0.16 %	
1000 nF	20 Hz to 30 kHz	0.34 %	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Capacitance ³ – Measure			
(1 to 10) pF	(10 to 100) kHz 100 kHz to 1 MHz	1.0 % 0.34 %	Keysight E4980AL
(10 to 100) pF	(1 to 10) kHz 10 kHz to 1 MHz	1.2 % 0.15 %	
(100 to 1000) pF	(100 to 1000) Hz 1 kHz to 1 MHz	1.9 % 0.17 %	
(1 to 10) nF	(20 to 100) Hz 100 Hz to 1 MHz	1.5 % 0.28 %	
(10 to 100) nF	20 Hz to 1 MHz	0.24 %	
(100 to 1000) nF	20 Hz to 1 MHz	0.11 %	
(1 to 10) μF	20 Hz to 1 MHz	0.31 %	
(10 to 100) μF	20 Hz to 100 kHz 100 kHz to 1 MHz	0.33 % 2.6 %	
(100 to 1000) μF	(20 to 1000) Hz (1 to 100) kHz	0.16 % 2.8 %	
(1 to 10) mF	(20 to 125) Hz (125 to 1000) Hz	0.32 % 0.55 %	
(10 to 100) mF	(20 to 125) Hz	1.2 %	
(100 to 1000) mF	20 Hz	4.2 %	
Capacitance ³ – Measure			
(0.1 to 1) mF	DC	0.014 %	Charge technique using DC source & voltmeter
(1 to 10) mF	DC	0.014 %	
(10 to 110) mF	DC	0.017 %	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments	
DC Current – Generate	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	41 µA/A + 7.1 nA 35 µA/A + 8.5 nA 35 µA/A + 54 nA 47 µA/A + 850 nA 67 µA/A + 24 µA	Fluke 5720A	
	(2.2 to 11) A	0.040 % + 570 µA	Fluke 5725A	
	(11 to 20.5) A	0.11 % + 2.0 mA	Fluke 5520A & 50 turn coil	
	(20.5 to 100) A	0.63 % + 0.12 A	Valhalla 2575A with DMM	
DC Current ³ – Generate	(0 to 330) µA (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (0.33 to 1.1) A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	0.017 % + 24 nA 0.011 % + 69 nA 0.011 % + 360 nA 0.011 % + 5.3 µA 0.015 % + 200 µA 0.043 % + 85 µA 0.057 % + 690 µA 0.11 % + 1.9 mA	Fluke 5520A Fluke 5520A	
	(20.5 to 100) A (100 to 1000) A	0.58 % + 0.16 A 0.59 % + 0.55 A	Fluke 5520A & 50 turn coil	
	DC Current – Measure	(0 to 200) µA (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A	14 µA/A + 660 pA 15 µA/A + 5.0 nA 16 µA/A + 53 nA 43 µA/A + 200 nA 0.019 % + 28 µA 0.058 % + 1.9 mA	Fluke 8508A
		(20 to 100) A (100 to 1000) A	0.62 % + 0.26 A 2.4 % + 0.74 A	Valhalla 2575A with DMM Fluke 376 clamp
DC Current ³ – Measure	(0 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	20 µA/A + 1.5 nA 22 µA/A + 7.9 nA 22 µA/A + 81 nA 39 µA/A + 790 nA 0.011 % + 37 µA	HP 3458A, opt 002	
	(1 to 10) A	23 mA	Fluke 45	
	(10 to 1000) A	2.4 % + 0.74 A	Fluke 376 clamp	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
DC Power ³ – Generate			
(0.33 to 3.3) mA	(0.011 to 1.1) mW (0.11 to 11) mW (1.1 to 110) mW (0.011 to 1.1) W (0.11 to 3.3) W	0.043 % 94 μW/W 94 μW/W 95 μW/W 80 μW/W	Fluke 5520A
(3.3 to 33) mA	(0.11 to 11) mW (1.1 to 110) mW (0.011 to 1.1) W (0.11 to 11) W (1.1 to 33) W	0.043 % 90 μW/W 90 μW/W 91 μW/W 76 μW/W	
(33 to 330) mA	(1.1 to 110) mW (0.011 to 1.1) W (0.11 to 11) W (1.1 to 110) W (11 to 330) W	0.043 % 91 μW/W 91 μW/W 92 μW/W 77 μW/W	
(0.33 to 3) A	(11 to 990) mW (0.11 to 9.9) W (1.1 to 99) W (11 to 990) W (0.11 to 3) kW	0.050 % 0.028 % 0.028 % 0.028 % 0.027 %	
(3 to 20.5) A	(0.099 to 6.7) W (0.99 to 6.7) W (9.9 to 670) W (0.099 to 6.8) kW (0.99 to 20.9) kW	0.082 % 0.071 % 0.071 % 0.071 % 0.070 %	
DC Voltage – Generate	(0 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	8.0 μV/V + 650 nV 4.2 μV/V + 950 nV 3.0 μV/V + 3.3 μV 3.0 μV/V + 5.3 μV 3.8 μV/V + 180 μV 5.4 μV/V + 730 μV	Fluke 5720A
DC Voltage ³ – Generate	(0 to 330) mV (0.33 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1020) V	23 μV/V + 1.3 μV 13 μV/V + 2.2 μV 14 μV/V + 24 μV 21 μV/V + 190 μV 21 μV/V + 2.0 mV	Fluke 5520A
Fixed Point ³	10 V	1.0 μV/V	Fluke 732A

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Inductance ³ – Generate			
2 mH	(20 to 60) Hz 60 Hz to 10 kHz	1.8 % 0.60 %	Genrad 1482 series standard inductors
100 mH	20 Hz to 10 kHz	0.31 %	
1 H	20 Hz to 10 kHz	0.31 %	
10 H	20 Hz to 1 kHz	0.34 %	
Inductance ³ – Measure			Keysight E4980AL
(100 to 1000) nH	(100 to 300) kHz 300 kHz to 1 MHz	0.75 % 0.27 %	
(1 to 10) μH	(10 to 100) kHz 100 kHz to 1 MHz	0.89 % 0.12 %	Keysight E4980AL
Inductance ³ – Measure (cont)			
(10 to 100) μH	(1 to 10) kHz 10 kHz to 1 MHz	1.3 % 0.13 %	
(100 to 1000) μH	10 Hz to 1 kHz 1 kHz to 1 MHz	2.8 % 0.18 %	
(1 to 10) mH	(20 to 125) Hz 125 Hz to 1 MHz	2.7 % 0.24 %	
(10 to 100) mH	(20 to 100) Hz 100 Hz to 1 MHz	0.64 % 0.16 %	
(100 to 1000) mH	20 Hz to 300 kHz 300 kHz to 1 MHz	0.15 % 0.40 %	
(1 to 10) H	20 Hz to 100 kHz 100 kHz to 1 MHz	0.11 % 3.5 %	
(10 to 100) H	20 Hz to 10 kHz (10 to 100) kHz	0.10 % 0.41 %	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Pulse Characterization – Transition (Rise / Fall) Time – Measure	1 kHz to 2 MHz Nominal 250 ps	53 ps	Fluke 5520A-SC1100
	(2 to 10) MHz Nominal 300 ps	53 ps	
Phase – Generate (0 to 999.999)°	0.02 Hz to 6.25 kHz (6.25 to 50) kHz (50 to 100) kHz	0.015° 0.031° 0.060°	Clark Hess 5000
Phase – Measure (0 to 360)° (-180 to 180)°	(0.02 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.060° 0.063° 0.0023 <i>f</i> – 0.050°	Clark Hess 6000 <i>f</i> = frequency in kHz
Resistance – Generate, Discrete Resistance Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	47 μΩ 93 μΩ 0.18 mΩ 0.24 mΩ 0.46 mΩ 1.1 mΩ 2.0 mΩ 8.8 mΩ 17 mΩ 88 mΩ 0.17 Ω 1.1 Ω 2.0 Ω 24 Ω 40 Ω 360 Ω 890 Ω 12 kΩ	Fluke 5720A

Parameter/Equipment	Range	CMC ^{2, 10} (\pm)	Comments
Resistance ³ – Generate, Synthesized Resistance Points	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω (0.33 to 1.1) M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (0.33 to 1.1) G Ω	45 $\mu\Omega/\Omega$ + 1.2 m Ω 34 $\mu\Omega/\Omega$ + 1.8 m Ω 26 $\mu\Omega/\Omega$ + 3.0 m Ω 30 $\mu\Omega/\Omega$ + 3.5 m Ω 31 $\mu\Omega/\Omega$ + 4.0 m Ω 30 $\mu\Omega/\Omega$ + 34 m Ω 30 $\mu\Omega/\Omega$ + 59 m Ω 30 $\mu\Omega/\Omega$ + 340 m Ω 30 $\mu\Omega/\Omega$ + 590 m Ω 35 $\mu\Omega/\Omega$ + 3.0 Ω 35 $\mu\Omega/\Omega$ + 5.4 Ω 68 $\mu\Omega/\Omega$ + 41 Ω 0.014 % + 140 Ω 0.027 % + 3.6 k Ω 0.056 % + 6.0 k Ω 0.35 % + 110 k Ω 1.7 % + 870 k Ω	Fluke 5520A
	1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω	0.48 $\mu\Omega/\Omega$ 3.0 $\mu\Omega/\Omega$ 2.7 $\mu\Omega/\Omega$ 0.75 $\mu\Omega/\Omega$ 2.7 $\mu\Omega/\Omega$	Fluke 742A
Resistance – Measure	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) k Ω (2 to 20) k Ω (20 to 200) k Ω (0.2 to 2) M Ω (2 to 20) M Ω (20 to 200) M Ω (0.2 to 2) G Ω	19 $\mu\Omega/\Omega$ + 4.4 $\mu\Omega$ 11 $\mu\Omega/\Omega$ + 16 $\mu\Omega$ 8.9 $\mu\Omega/\Omega$ + 55 $\mu\Omega$ 8.9 $\mu\Omega/\Omega$ + 500 $\mu\Omega$ 8.9 $\mu\Omega/\Omega$ + 5.5 m Ω 9.1 $\mu\Omega/\Omega$ + 59 m Ω 11 $\mu\Omega/\Omega$ + 1.2 Ω 20 $\mu\Omega/\Omega$ + 110 Ω 70 $\mu\Omega/\Omega$ + 12 k Ω 0.061 % + 1.2 M Ω	Fluke 8508A
Resistance ³ – Measure	(0 to 12) Ω (12 to 120) Ω (0.12 to 1.2) k Ω (1.2 to 12) k Ω (12 to 120) k Ω (0.12 to 1.2) M Ω (1.2 to 12) M Ω (12 to 120) M Ω (0.12 to 1.2) G Ω	18 $\mu\Omega/\Omega$ + 58 $\mu\Omega$ 13 $\mu\Omega/\Omega$ + 730 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 430 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 4.0 m Ω 12 $\mu\Omega/\Omega$ + 39 m Ω 18 $\mu\Omega/\Omega$ + 2.2 Ω 58 $\mu\Omega/\Omega$ + 120 Ω 0.058 % + 1.3 k Ω 0.58 % + 7.0 k Ω	HP 3458A

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Resistance			
(0.05 to 0.1) Ω	(125 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	3.7 % 2.1 % 1.5 % 1.3 % 1.2 % 1.4 %	Keysight E4980AL
(0.1 to 1) Ω	(20 to 125) Hz (125 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	3.7 % 1.8 % 1.1 % 0.84 % 0.69 % 0.68 % 0.90 %	
(1 to 10) Ω	(20 to 125) Hz (125 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	0.92 % 0.49 % 0.46 % 0.34 % 0.39 % 0.39 % 0.91 %	
(10 to 100) Ω	(20 to 125) Hz (125 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	0.39 % 0.35 % 0.31 % 0.34 % 0.85 % 0.86 % 0.91 %	
(100 to 300) Ω	(20 to 125) Hz (125 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	0.87 % 0.30 % 0.31 % 0.85 % 0.85 % 0.85 % 0.87 %	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
AC Resistance (cont)			Keysight E4980AL
(0.3 to 1) kΩ	(20 to 125) Hz	0.16 %	
	(125 to 1000) Hz	0.30 %	
	(1 to 10) kHz	0.30 %	
	(10 to 100) kHz	0.85 %	
	(100 to 300) kHz	0.85 %	
	(0.3 to 1) MHz	0.85 %	
	(1 to 2) MHz	0.87 %	
(1 to 3) kΩ	(20 to 125) Hz	0.33 %	
	(125 to 1000) Hz	0.30 %	
	(1 to 10) kHz	0.85 %	
	(10 to 100) kHz	0.85 %	
	(100 to 300) kHz	0.85 %	
	(0.3 to 1) MHz	0.85 %	
	(1 to 2) MHz	0.87 %	
(3 to 10) kΩ	(20 to 125) Hz	0.33 %	
	(125 to 1000) Hz	0.30 %	
	(1 to 10) kHz	0.85 %	
	(10 to 100) kHz	0.85 %	
	(100 to 300) kHz	0.85 %	
	(0.3 to 1) MHz	0.85 %	
	(1 to 2) MHz	0.90 %	
(10 to 30) kΩ	(20 to 125) Hz	0.33 %	
	(125 to 1000) Hz	0.85 %	
	(1 to 10) kHz	0.85 %	
	(10 to 100) kHz	0.85 %	
	(100 to 300) kHz	0.86 %	
	(0.3 to 1) MHz	0.86 %	
	(1 to 2) MHz	0.91 %	
(30 to 100) kΩ	(20 to 125) Hz	0.34 %	
	(125 to 1000) Hz	0.85 %	
	(1 to 10) kHz	0.85 %	
	(10 to 100) kHz	0.85 %	
	(100 to 300) kHz	0.87 %	
	(0.3 to 1) MHz	0.87 %	
	(1 to 2) MHz	0.94 %	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
RTD Indicators ³ –			
Pt 385, 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 (>630 to 800) °C	0.060 °C 0.059 °C 0.083 °C 0.11 °C 0.12 °C 0.14 °C 0.27 °C	Fluke 5520A
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 600) °C (>600 to 630) °C	0.048 °C 0.048 °C 0.048 °C 0.060 °C 0.15 °C 0.16 °C 0.17 °C 0.19 °C	
Pt 385, 500 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 600) °C (>600 to 630) °C	0.048 °C 0.060 °C 0.060 °C 0.071 °C 0.095 °C 0.095 °C 0.11 °C 0.13 °C	
Pt 385, 1 kΩ	(-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 600) °C (>600 to 630) °C	0.036 °C 0.036 °C 0.048 °C 0.060 °C 0.071 °C 0.083 °C 0.083 °C 0.28 °C	

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments	
RTD Indicators ³ – cont.				
PtNi 385, 120 Ω (Ni 120)	(-80 to 0) °C (>0 to 100) °C (>100 to 260) °C	0.095 °C 0.095 °C 0.017 °C	Fluke 5520A	
Pt 3916, 100 Ω	(-200 to -190) °C (>-190 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 600) °C (>600 to 630) °C	0.048 °C 0.048 °C 0.060 °C 0.071 °C 0.083 °C 0.095 °C 0.11 °C 0.12 °C 0.28 °C		
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	0.060 °C 0.060 °C 0.083 °C 0.11 °C 0.12 °C 0.15 °C		
Cu 427, 10 Ω	(-100 to 260) °C	0.36 °C		
Thermocouple Indicators ³ –				
Type B	(600 to 800) °C (>800 to 1000) °C (>1000 to 1550) °C (>1550 to 1820) °C	0.52 °C 0.41 °C 0.36 °C 0.40 °C		Fluke 5520A
Type C	(0 to 150) °C (>150 to 650) °C (>650 to 1000) °C (>1000 to 1800) °C (>1800 to 2316) °C	0.36 °C 0.32 °C 0.37 °C 0.59 °C 0.98 °C		
Type E	(-250 to -100) °C (>-100 to -25) °C (>-25 to 350) °C (>350 to 650) °C (>650 to 1000) °C	0.59 °C 0.21 °C 0.19 °C 0.21 °C 0.26 °C		
Type J	(-210 to -100) °C (>-100 to -30) °C (>-30 to 150) °C (>150 to 760) °C (>760 to 1200) °C	0.33 °C 0.21 °C 0.18 °C 0.22 °C 0.28 °C		

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Thermocouple Indicators ³ – (cont)			
Type K	(-200 to -100) °C (>-100 to -25) °C (>-25 to 120) °C (>120 to 1000) °C (>1000 to 1372) °C	0.40 °C 0.23 °C 0.21 °C 0.32 °C 0.47 °C	Fluke 5520A
Type N	(-200 to -100) °C (>-100 to -25) °C (>-25 to 120) °C (>120 to 410) °C (>410 to 1300) °C	0.47 °C 0.27 °C 0.24 °C 0.23 °C 0.33 °C	
Type R	(0 to 250) °C (>250 to 400) °C (>400 to 1000) °C (>1000 to 1767) °C	0.67 °C 0.43 °C 0.41 °C 0.48 °C	
Type S	(0 to 250) °C (>250 to 1000) °C (>1000 to 1400) °C (>1400 to 1767) °C	0.56 °C 0.44 °C 0.45 °C 0.55 °C	
Type T	(-250 to -150) °C (>-150 to 0) °C (>0 to 120) °C (>120 to 400) °C	0.74 °C 0.29 °C 0.21 °C 0.19 °C	
Type U	(-200 to 0) °C (>0 to 600) °C	0.66 °C 0.33 °C	

V. Fluid Quantities

Parameter/Equipment	Range ⁸	CMC ^{2, 5, 8} (±)	Comments
Refractometers – Brix Salt (NaCl)	1.332 99 n _D 1.336 59 n _D 1.344 01 n _D 1.355 68 n _D 1.399 86 n _D 1.466 01 n _D 1.536 79 n _D (0 to 50) % NaCl solution	0.000 044 n _D 0.000 045 n _D 0.000 046 n _D 0.000 052 n _D 0.000 052 n _D 0.000 084 n _D 0.000 084 n _D 0.026 % NaCl solution	Standard solutions
Viscosity Meter Calibration ³	(1 to 33) % of Scale (33 to 66) % of Scale (66 to 100) % of Scale	2.7 % 1.8 % 1.7 %	Viscosity oils
Viscosity Dip Cups ³ – Efflux Time	(1 to 100) mm ² /s (100 to 1000) mm ² /s	1.8 % 1.3 %	Viscosity oils
Volumetric Flow ³ – Flowmeters Gas Liquid	(1 to 250) sccm (0.02 to 6) slpm (2 to 30) slpm 0 to 34 lpm	0.016 sccm + 1.5 % 0.01 slpm + 1.1 % 0.035 slpm + 1.2 % 0.17 % + 0.19 lpm	Comparison to flow standards Measured weight over time
Volume –Volumetric Apparatus (Beakers, Cylinders, Flasks, etc.)	(1 to 4000) mL (4000 to 19 000) mL	0.010 % 0.026 %	Balance & weights

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Durometer Calibrators – Beam Type	Type A Type D	0.026 Duro 0.025 Duro	Optical comparator & mass comparator
Force – Compression & Tension, Measure & Measuring Equipment	(200 to 5000) lbf (5000 to 20 000) lbf (20 000 to 60 000) lbf	2.0 lbf 8.0 lbf 25 lbf	Morehouse 1000 series proving rings
Force ³ – Compression & Tension, Measure & Measuring Equipment	Up to 2.5 N (2.5 to 50) N (11.2 to 50) lbf (50 to 500) lbf (500 to 2000) lbf (2000 to 30 000) lbf	0.0011 N 0.011 N 1.6E-4 lbf/lbf + 0.0015 lbf (1.3E-7·F ² + 1.2E-4·F + 4.2E-3) lbf 3.0 lbf 21 lbf	Deadweights, load cells <i>F</i> is the applied force in lbf
Measure Only – Compression Only	(30 000 to 200 000) lbf	130 lbf	Load cell
Extensometers ³	Up to 20 in	2.3 µin/in + 8.5 µin	Measuring machine, gage blocks, micrometer, bench micrometer, linear encoder, extension rod
Indirect Verification of Rockwell Hardness Testers ³	HRA: Low Medium High HRBW: Low Medium High HRC: Low Medium High	0.53 HRA 0.52 HRA 0.64 HRA 1.8 HRBW 1.3 HRBW 1.2 HRBW 0.98 HRC 1.2 HRC 0.73 HRC	Indirect verification per ASTM E18

Parameter/Equipment	Range	CMC ^{2, 10} (±)	Comments
Indirect Verification of Rockwell Hardness Testers ³ (cont)	HRD:	0.77 HRD	Indirect verification per ASTM E18
	Low	0.86 HRD	
	Medium	0.36 HRD	
	High		
	HRF:	1.0 HRF	
	Low	0.92 HRF	
	Medium	0.67 HRF	
	High		
	HRG:	1.2 HRG	
	Low	1.1 HRG	
	Medium	0.40 HRG	
	High		
	HRRW:	0.76 HRRW	
	Low	0.61 HRRW	
Medium	0.93 HRRW		
High			
HRSW:	0.93 HRSW		
Low	0.42 HRSW		
High			
HR15N:	1.2 HR15N		
Low	1.2 HR15N		
Medium	1.2 HR15N		
High			
HR30N:	1.2 HR30N		
Low	1.2 HR30N		
Medium	1.2 HR30N		
High			
HR45N:	1.2 HR45N		
Low	1.2 HR45N		
Medium	1.2 HR45N		
High			
HR15T:	1.2 HR15T		
Low	1.2 HR15T		
Medium	1.2 HR15T		
High			
HR30T:	1.3 HR30T		
Low	1.2 HR30T		
Medium	1.2 HR30T		
High			

Parameter/Equipment	Range	CMC ^{2, 5, 10} (±)	Comments
Indirect Verification of Rockwell Hardness Testers ³ (cont)	HR45T: Low Medium High	1.3 HR45T 1.3 HR45T 1.2 HR45T	Indirect verification per ASTM E18
Indirect Verification of Brinell Hardness Testers at Test Condition(s) ³ – 10/500/15 10/3000/15	(50 to 70) HBW (80 to 101) HBW 239 HBW 349 HBW 416 HBW	2.5 HBW 3.7 HBW 8.4 HBW 13 HBW 15 HBW	Indirect verification method per ASTM E10
Indirect Verification of Microindentation Hardness Testers ³ – (Knoop & Vickers)	(250 to 650) HK >650 HK (240 to 600) HV >600 HV	16 HK 38 HK 13 HV 37 HV	Indirect verification method per ASTM E92
Linear Velocity ³ – Measuring Equipment	(1 to 10) mm/min (10 to 450) mm/min (450 to 1020) mm/min	1.1 % + 0.0011 mm/min 0.39 % + 0.023 mm/min 1.3 % - 4.7 mm/min	Linear scale & stopwatch
Mass – Measure, Fixed Points	30 kg 20 kg 10 kg 5 kg 3 kg 2 kg 1 kg 500 g 300 g 200 g 100 g 50 g 30 g 20 g 10 g	7.3 mg 6.3 mg 5.4 mg 2.7 mg 2.6 mg 2.6 mg 2.6 mg 2.6 mg 2.6 mg 59 µg 48 µg 15 µg 14 µg 8.9 µg 8.3 µg	Double substitution with air buoyancy correction; Class E2 mass standards; Sartorius CC50, RC210P, A&D MC-6100, CC50002

Parameter/Equipment	Range	CMC ^{2, 5, 10} (±)	Comments
Mass – Measure, Fixed Points (cont)	5 g 3 g 2 g 1 g 500 mg 300 mg 200 mg 100 mg 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	6.4 µg 6.1 µg 5.7 µg 5.6 µg 5.5 µg 5.7 µg 5.5 µg 5.5 µg 5.5 µg 6.0 µg 5.6 µg 5.6 µg 5.4 µg 5.7 µg 5.4 µg 5.4 µg	Double substitution with air buoyancy correction; Class E2 mass standards; Sartorius CC50, RC210P, A&D MC-6100, CC50002
Mass ³ – Measure	(0.2 to 3000) g (3 to 34) kg	0.014 % + 0.071 g 0.055 % + 0.50 g	ASTM class 6/7, OIML Class M2/M3, NIST Class F by single substitution
Pressure – Pneumatic Gauge, Negative Gauge, & Absolute	Up to 0.2 psi (0.2 to 1000) psi	0.000 73 psi 0.0025 %	Fluke 6270A Ruska 2465
Gauge Only	(1000 to 15 000) psig	0.0075 %	Ruska 2475
Hydraulic	(2 to 20 000) psig	0.0075 %	Ruska 2485
Pressure ³ – Pneumatic Gauge, Negative Gauge, & Absolute	Up to 2 inH ₂ O	0.0021 inH ₂ O	Microtector
Pressure – Gauge & Absolute	Up to 1 inH ₂ O Up to 4 inH ₂ O Up to 20 inH ₂ O (-20 to 20) inH ₂ O Up to 40 inH ₂ O	0.0065 inH ₂ O 0.075 inH ₂ O 0.12 inH ₂ O 0.35 inH ₂ O 0.23 inH ₂ O	Manometers
Pressure – Gauge Only	(-15 to 15) psig (15 to 30) psig (30 to 100) psig (100 to 500) psig (500 to 1000) psig (1000 to 10 000) psig	0.018 psig 0.027 psig 0.063 psig 0.29 psig 0.62 psig 4.6 psig	Pressure transducers

Parameter/Equipment	Range	CMC ^{2, 5, 10} (±)	Comments
Scales & Balances ³	(0.01 to 1) g (1 to 200) g (0.2 to 2) kg (2 to 11) kg (25 to 3000) lb (3000 to 12 000) lb	120 µg/g + 29 µg 4.6 µg/g + 130 µg 6.4 µg/g + 1.0 µg 110 µg/g + 40 mg 0.012 % 2.1 lb	Certified weights, NIST Handbook 44 E2, Class 1
Tachometers ³ –			
Contact	(50 to 100) rpm (100 to 500) rpm (500 to 1000) rpm (1000 to 1500) rpm (1500 to 2000) rpm	1.2 rpm 2.2 rpm 0.86 rpm + 0.026 % 0.84 rpm + 0.035 % 5.1 rpm	Tachometer test station signal generator
Strobo	Up to 500 rpm (500 to 20 000) rpm	0.013 rpm 0.054 rpm	
Photo	Up to 500 rpm (500 to 3000) rpm (3000 to 9000) rpm (9000 to 99 999) rpm	0.0091 rpm 0.0076 rpm 0.48 rpm 3.0 rpm	
Torque Transducers	(4 to 80) ozf·in (5 to 60) lbf·in (5 to 250) lbf·ft (250 to 1000) lbf·ft	0.046 % 0.035 % 0.068 % 0.032 %	Torque arms & Class F weights
Torque Wrenches, Tools ³	(8 to 80) ozf·in (5 to 20) lbf·in (20 to 50) lbf·in (50 to 250) lbf·in (20 to 100) lbf·ft (100 to 250) lbf·ft (100 to 1000) lbf·ft	0.23 ozf·in 0.025 lbf·in 0.061 lbf·in 0.86 lbf·in 0.17 lbf·ft 1.0 lbf·ft 1.2 lbf·ft	Torque transducers

VII. Optical Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Gloss Meters ³	20° 60° 85°	0.63 GU 0.42 GU 0.44 GU	Gloss standards
Gloss Tiles ³	20° 60° 85°	0.67 GU 0.48 GU 0.50 GU	Comparison to gloss standards

VIII. Rubber & Plastics Industry Specific Equipment

Parameter/Equipment	Range	CMC ² (±)	Comments
Capillary Rheometers – Polymeric ³ (Plastic)			ASTM D 3835 – excludes surface roughness, hardness of piston
Barrel Inside Diameter & Uniformity	(6.35 to 19) mm	0.0069 mm	Bore micrometer
Piston Tip Diameter & Length, Capillary Bore Length	(9 to 25.4) mm	0.0028 mm	Micrometer
Temperature Accuracy	(180 to 300) °C	0.088 °C	Digital thermometer
Capillary Rheometers ³ – Rubber			ASTM D 5099
Barrel Inside Diameter & Uniformity	(9 to 22) mm	0.0069 mm	Bore micrometer
Piston Tip Diameter & Length, Capillary Bore Length	(9 to 25.4) mm	0.0028 mm	Micrometer
Temperature Accuracy	(10 to 190) °C	0.088 °C	Digital thermometer

Parameter/Equipment	Range	CMC ² (±)	Comments
Capillary Rheometers ³ – Rubber cont.			ASTM D 5099
Crosshead Speed	Up to 25.4 mm/min	0.048 mm/min	Dial indicator/stopwatch
Force	Up to 5000 lbf	32 lbf	Load cell
Pressure	Up to 10 000 psi	24 psi	Deadweight pressure tester
Direct Verification of Durometers – Types A, B, C, D, DO, E, M, O, OO, OOO, OOO-S			ASTM D2240
Indentor Extension & Shape –			
Diameter	Up to 25 mm	0.0041 mm	Optical inspection under magnification
Radius	Up to 25 mm	0.0097 mm	
Angle	Up to 90°	0.031°	
Extension	Up to 25 mm	0.0069 mm	
Indentor Display	(0 to 100) Duro	0.58R + 12 μDuro	Gage blocks
Spring Calibration – Force			
Types A, B, E, & O	(0 to 100) Duro	0.63 Duro	Durometer calibrator
Types C, D, & DO	(0 to 100) Duro	0.61 Duro	
Types OO & OOO	(0 to 100) Duro	1.5 Duro	Balance
Type OOO-S	(0 to 100) Duro	1.3 Duro	
Type M	(0 to 100) Duro	1.9 Duro	
Durometer Test Blocks	Types A & D	1.4 Duro	Durometer

Parameter/Equipment	Range	CMC ² (±)	Comments
Extruders ³ –			
Temperature Controller Accuracy (T/C)	(0 to 350) °C	1.5 °C	TC calibrator
Thermocouple Accuracy	(0 to 350) °C	0.96 °C	Drywell
Screw Speed	(6 to 1000) rpm	2.1 rpm	Tachometer
Pressure	(2 to 30) psi (30 to 100) psi (100 to 500) psi (500 to 1000) psi (1000 to 5000) psi (5000 to 10 000) psi	0.038 psi 0.062 psi 0.33 psi 0.60 psi 1.8 psi 6.7 psi	Pressure transducer
Timer Accuracy	Up to 7200 s	0.72 s	Comparison to stopwatch
Extrusion Plastometers ^{3,6} –			ASTM D1238
Cylinder Bore	Up to 2 in	0.000 28 in	
Piston Measurements	Up to 2 in	0.000 30 in	
Temperature	(0 to 400) °C	0.12 °C	
Load to 3 kg	Up to 3 kg (3 to 20) kg	0.35 g 2.4 g	
Timing	Up to 7200 s	0.36 s	
Rapid Plastimeter RP3000 ³ –			ASTM D3194 ISO 2007
Plate Diameter	(7 to 15) mm	0.042 mm	
Effective Depth	Up to 10 mm	0.042 mm	
Platen Temperature	Ambient to 200 °C	0.23 °C	
Timer	Up to 1 min	0.36 s	
Sample Load	Up to 200 N	1.6 N	
Platen Gap	Up to 10 mm	0.0040 mm	

Parameter/Equipment	Range	CMC ² (±)	Comments
Rubber Press ³ – Laboratory, Compression, Injection, Transfer			ASTM D 3182 ISO 2393
Closing Force	(0 to 2000) lbf (2 to 30) klf (30 to 100) klf (100 to 200) klf (200 to 400) klf	24 lbf 41 lbf 200 lbf 390 lbf 1.7 klf	
Temperature Uniformity	(50 to 350) °C	0.42 °C	
Parallelism	(0.001 to 0.01) in/ft	0.0028 in/ft	
Injection Molders ³ –			
Temperature Controller Accuracy (T/C)	(0 to 350) °C	1.5 °C	TC calibrator
Thermocouple Accuracy	(0 to 350) °C	1.2 °C	Master temp probe & dry block calibrator
Screw Speed	(6 to 1000) rpm	2.1 rpm	Tachometer
Pressure	(2 to 30) psi (30 to 100) psi (100 to 500) psi (500 to 1000) psi (1000 to 5000) psi (5000 to 10 000) psi	0.038 psi 0.062 psi 0.33 psi 0.60 psi 1.8 psi 6.7 psi	Pressure transducer
Plunger Linear Displacement	Up to 300 mm (0.3 to 1.8) m	0.1 mm 2.1 mm	Comparison to length standards
Plunger Speed	Up to 900 mm/min	0.41 % + 2.1 mm/min	Length standards/stopwatch
Timer Accuracy	Up to 7200 s	0.72 s	Comparison to stopwatch
Mooney Viscometers ³ , Stress Relaxation –			ASTM D 1646
Mooney Torque	Up to 200 Mooney Units	1.6 Mooney Units	Butyl IRM-241
Rotor rpm	2 rpm	0.000 055 RPM	Frequency counter
Die Temperature	(0 to 230) °C	0.23 °C	RTD with indicator

Parameter/Equipment	Range	CMC ² (±)	Comments
Mooney Viscometers ³ , Stress Relaxation – cont.			
Die Closing Force	Up to 5000 lbf	41 lbf	Load cell with indicator
Rotor Diameter	1.2 in, 1.5 in	0.000 17 in	Micrometers
Rotor Thickness	0.218 in	0.000 16 in	
Oscillating Disk Rheometers ³			ASTM D2084, ISO 3417
Torque	Up to 200 lbf-in	0.33 lbf-in	OD torsion standard
Die Temperature	(0 to 230) °C	0.23 °C	ASTM D 1349 RTD with indicator
Die Closing Force	Up to 5000 lbf	41 lbf	Load cell with indicator
Rotor Dimensions	1.4 in	0.000 19 in	Micrometers
Disk Oscillation	1.67 Hz	0.000 071 Hz	Frequency counter
Rotorless Cure Meters, Moving Die Rheometers, Rubber Process Analyzers ³ –			ASTM D 5289, ASTM D 6204, ASTM D6601
Torque	Up to 200 lbf-in	0.29 lbf-in	MD torsion standard (Dynamic)
Die Temperature	(0 to 230) °C	0.23 °C	ASTM D 1349
Temperature Stability	(0 to 230) °C	0.092 °C	Thermocouple or RTD with indicator
Die Closing Force	Up to 5000 lbf	41 lbf	Load cell with indicator
Die Gap	Up to 1 in	0.000 16 in	Micrometer
Die Diameter	Up to 2 in	0.0016 in	Caliper
Die Oscillation	(0.02 to 50) Hz	0.020 % 0.0030 Hz	Tachometer

Parameter/Equipment	Range	CMC ² (±)	Comments
Torque Standards (Torsion Springs), MDR, ODR	Torque up to 200 lbf·in (peak-peak) 10° (peak-peak)	0.27 lbf·in 0.0062° arc	Torque standard calibration system

IX. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 5, 10} (±)	Comments
Humidity – Measure & Measuring Equipment	(10 to 95) % RH	1.0 % RH	Thunder Scientific 2500
Humidity ³ – Measure & Measuring Equipment	(10 to 90) % RH	2.6 % RH	Vaisala probe
IR Temperature ³ – Measuring Equipment	Ambient to 100 °C (100 to 780) °C (780 to 890) °C	1.3 °C 12 mK/°C + 0.14 °C 11 mK/°C + 0.48 °C	Mikron M316 ε = 0.99 λ = (8 to 14) μm Williamson Blackbody ε = 0.995 λ = (1 to 4) μm
IR Temperature ³ – Measure Blackbody Sources	Ambient to 100 °C (100 to 780) °C (780 to 890) °C	1.3 °C 12 mK/°C + 0.14 °C 11 mK/°C + 0.48 °C	Blackbody source, IR thermometer
Ovens ³ – Temperature Uniformity System Accuracy Time Constant	Up to 1000 °C Up to 420 °C (420 to 1000) °C (5 to 800) s	1.5 °C 0.59 °C 2.8 °C 5.8 s	ASTM E145 ASTM D5423 ASTM D 5374 AMS 2750 ASTM A991 RTD TC Fluke 54 II

Parameter/Equipment	Range	CMC ^{2, 5, 10} (\pm)	Comments
Ovens ³ – cont. Ventilation Rate	(5 to 300) Air changes/hr	3.4 % of Air changes/hr	ASTM E145
Temperature ³ – Measure, Temperature Baths, Dry Wells Temperature Uniformity Temperature Accuracy	(-196 to 660) °C (-196 to 660) °C (660 to 961) °C	3.3 mK 5.9 mK 0.74 °C	SPRT, Thermometry Bridge Characterized S thermocouple
Temperature – Measuring Equipment, SPRTs, PRTs ITS-90 Fixed Points	0.01 °C 156.598 °C 231.928 °C 419.527 °C 660.323 °C	0.0049 °C 0.0040 °C 0.0040 °C 0.0040 °C 0.0044 °C	TPW Cell Indium Cell Tin Cell Zinc Cell Aluminum Cell
Temperature – Measuring, Equipment, TC/RTD Probes, LIG Thermometers	-196 °C (-80 to 0) °C (0 to 25) °C (25 to 150) °C (150 to 200) °C (200 to 300) °C (300 to 420) °C	6.6 mK 13 mK 12 mK 16 mK 26 mK 32 mK 0.14 °C	LN2 Comparison SPRT, Thermometry Bridge and temperature baths
Temperature ³ – Measuring, Equipment, TC/RTD Probes, LIG Thermometers	(-40 to 350) °C (350 to 650) °C (650 to 961) °C	0.87 °C 5.8 mK/°C - 0.87 °C 3 °C	Drywells

X. Time and Frequency

Parameter/Equipment	Range	CMC ^{2, 10} (\pm)	Comments
Frequency ³ – Measuring Equipment	Up to 18 GHz	11 pHz/Hz + 0.58R	GPS disciplined receiver and signal generator R is the resolution of the unit under test
Frequency ³ – Measure	0.01 Hz to 18 GHz	11 pHz/Hz + 0.58R	EIP 545 and HP 5335A electronic counters R is the resolution of the unit under test
Timers/Stop Watches	(1 to 28 800) s	0.060 s/day	Timometer
Timers/Stop Watches ³	(1 to 28 800) s	0.049 s	Electronic Counter
Tuning Fork ³	20 Hz to 22 kHz	1.4 Hz	Electronic counter
Radar Guns ³			
K Band	2521 Hz (35 mph) 4681 Hz (65 mph)	1.4 Hz 1.4 Hz	Tuning forks
X Band	1099 Hz (35 mph) 2511 Hz (80 mph)	1.4 Hz 1.4 Hz	

¹ This laboratory offers commercial dimensional testing/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 This laboratory performs field calibration activities for these parameters. 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 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. CMCs 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.
- ⁵ In the statement of CMC, L is the length of the unit under test in inches. R is the resolution of the unit under test in microinches, and percentages are percentage of reading, unless otherwise indicated.
- ⁶ Using ASTM D1238 at 0 °C to 400 °C Temp, (0 to 20) kg force, and (0 to 2) in length.
- ⁷ 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 certificate.
- ⁸ The unit of n_D is defined as the following: 'n' indicates the refractive index and 'D' indicates the value was measured at the yellow doublet sodium D-line (wavelength: approx 589 nm).
- ⁹ Adjustable thread rings are set to applicable specifications using calibrated master set plug gages.
- ¹⁰ 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.
- ¹¹ This scope meets A2LA's *P112 Flexible Scope Policy*.



Accredited Laboratory

A2LA has accredited

RICHARD J. BAGAN, INC. D.B.A. MONTECH USA

Columbia City, IN

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/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 6th day of March 2025.

A blue ink signature of Mr. Trace McInturff, written over a horizontal line.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1625.01
Valid to January 31, 2027

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