



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

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CALIBRATION

Valid To: January 31, 2019

Certificate Number: 1625.01

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
Conductivity Meter/Probe Calibration ³ – Discrete Points	10 µS 100 µS 1000 µS 10 000 µS 100 000 µS	0.42 µS 2.5 µS 4.8 µS 66 µS 410 µS	Conductivity solutions
pH Meter/Probe Calibration ³	(4, 7, 10) pH (0 to 14) pH	0.027 pH 0.068 pH	pH buffer Comparison to pH meter

II. Dimensional

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Angle Blocks ³	(0.25 to 60)°	0.0054°	Gage blocks, sine bar, electronic probe
Calipers ³	Up to 12 in (12 to 72) in	540 μin 980 μin	Gage blocks
Cylindrical Diameter – Outside	Up to 5 in (5 to 18) in (18 to 24) in	26 μin + 0.43 μin/in 110 μin 290 μin	Measuring machine, plug gage Height gage
Inside	(0.5 to 2.5) in (2.5 to 6) in	38 μin + 0.56 μin/in 39 μin + 1.6 μin/in	Measuring machine, ring gage
Cylindrical Diameter ³ – Outside	Up to 24 in	480 μin	Height gage
Cylindrical Squares – Squareness	(4 to 20) in	17 μin	Electronic probe
Dial, Digital, and Test Indicators ³	Up to 4 in	11 μin/in + 0.87 μin + 0.6R	Gage blocks
Flatness Measurements ³	Up to 2 in diameter Up to 10 in length	4 μin 35 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

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Gage Block Comparator – Force	Up to 200 μin (0 to 1.47) N	3.4 μin 0.089 N	Gage blocks Somfy force gage
Height/Depth Gages	Up to 24 in (24 to 72) in	(21 + 7L) μin 150 μin + 16 μin/in	Gage blocks
Height/Depth Gages ³	Up to 24 in (24 to 72) in	130 μin + 13 μin/in 150 μin + 16 μin/in	Gage blocks
Length Standards ³	Up to 1 in (1 to 7) in (7 to 24) in	120 μin 130 μin 200 μin	Bench micrometer, gage blocks
Length Standards	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
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	37 μin	Pin/plug gages
Bore Micrometers	(0.25 to 5) in	8.5 μin/in + 60 μin	Ring gages
Bench Micrometers	Up to 12 in	17 μin	Gage blocks
Optical Comparators ³ –			
Length	Up to 11.8 in Up to 24 in	170 μin 300 μin	Glass artifact
Radius / Diameter	Up to 1 in	500 μin	
Angle	(0 to 360)°	0.014°	

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Optical Comparators 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 and glass magnification scale
Protractors ³	(0 to 90)°	0.012°	Gage blocks/ sine plate
Parallel Measurements ³	Up to 1 in diameter Up to 10 in length	5.7 μin 38 μin	Optical parallels Electronic probe
Sine Bars –			
Length	(5 to 10) in	70 μin	UMM
Parallelism	(5 to 10) in	38 μin	Electronic probe
Surface Finish Meters ³ – Profilometers	(12 to 122) Ra	0.81 μin + 0.1 μin/μin	Roughness specimens
Spherical Diameter	Up to 5 in	23 μin + 1.2 μin/in	UMM
Surface Plates ³ –			
Flatness	Up to 107D in	(23 + 0.69D) μin	Electronic level system D = diagonal inches
Repeatability	Up to 0.015 in	30 μin	Repeatability gage
Taper Thread Plug –			
Pitch Diameter	(4 to 80) TPI	130 μin	Gage blocks, thread wires, measuring machine
Major Diameter	Up to 2 in	90 μin	
Notch Length	Up to 2 in	120 μin	Height 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	200 μin 180 μin 120 μin	Gage blocks, thread wires, measuring machine Height gage
Thickness Gages ³	(0.001 to 0.06) in	19 μin + 0.00031 in/in	Thickness films and gage blocks
Thread Plugs – Simple Pitch Diameter Major Diameter	(4 to 80) TPI Up to 4 in	130 μin 75 μin	Gage blocks, thread wires, measuring machine
Thread Plugs ³ – Simple Pitch Diameter Major Diameter	(4 to 80) TPI Up to 2 in	200 μin 100 μin	Gage blocks, thread wires, bench micrometer
Adjustable Thread Rings ^{3,9}	Up to 1.5 in	X (Set Plug Tolerance)	Set using master plug gages. ASME/ANSI B1.2-1983 and 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 24) in (24 to 48) in	250 μin + 2.4 μin/in 0.00099 in	Dimensional comparison

Parameter/Equipment	Range	CMC ² (±)	Comments
Wire Cloth and Sieves	(0.020 to 12.5) mm	6.9 μm	Optical comparator

III. Dimensional Testing/Calibration¹

Parameter/Equipment	Range	CMC ² (±)	Comments
Angle ^{3,7}	(0 to 360)°	0.039°	Optical comparator
Diameter/Radius ^{3,7}	Up to 6 in	0.00029 in	Optical comparator
One Dimensional Length ^{3,7}	Up to 12 in (12 to 72) in Up to 300 mm (300 to 1800) mm	0.0013 in 0.012 in 0.034 mm 0.59 mm	Digital scale Steel ruler Digital scale Steel ruler

IV. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC ^{2,4} (±)	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 0.016 % + 16 nA 0.013 % + 9.5 nA 0.027 % + 21 nA 0.10 % + 83 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	0.022 % + 190 nA 0.0065 % + 500 nA 0.013 % + 43 nA 0.019 % + 210 nA 0.10 % + 0.87 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 % + 710 nA 0.016 % + 590 nA 0.013 % + 430 nA 0.016 % + 2.3 μA 0.11 % + 6.1 μA	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Generate			
(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	0.019 % + 28 µA 0.012 % + 17 µA 0.013 % + 3.1 µA 0.017 % + 16 µA 0.082 % + 77 µA	Fluke 5720A
(0.22 to 2.2) A	(0.02 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.028 % + 52 µA 0.041 % + 240 µA 0.69 % + 720 µA	
(2.2 to 11) A	(0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 3.9 mA 0.068 % + 5.1 mA 0.30 % + 13 mA	Fluke 5725A
AC Current – Generate ³			
(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	0.24 % + 120 nA 0.18 % + 120 nA 0.15 % + 120 nA 0.35 % + 170 nA 0.93 % + 230 nA 1.9 % + 460 nA	Fluke 5520A
(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 % + 280 nA 0.15 % + 220 nA 0.12 % + 170 nA 0.24 % + 230 nA 0.58 % + 350 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 % + 3.3 µA 0.11 % + 2.5 µA 0.049 % + 2.4 µA 0.096 % + 2.4 µA 0.24 % + 3.5 µA 0.47 % + 4.7 µA	
(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 % + 70 µA 0.11 % + 28 µA 0.048 % + 24 µA 0.12 % + 58 µA 0.24 % + 120 µA 0.47 % + 240 µA	
(0.33 to 1.1) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.21 % + 190 µA 0.059 % + 120 µA 0.7 % + 1.2 mA 2.9 % + 5.8 mA	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Generate ³ (cont)			
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.21 % + 190 µA 0.07 % + 120 µA 0.70 % + 1.2 mA 2.9 % + 5.8 mA	Fluke 5520A
(3 to 11) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.057 % + 4.6 mA 0.094 % + 5.6 mA 0.34 % + 13 mA	
(11 to 20.5) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.14 % + 7 mA 0.17 % + 7.7 mA 3.4 % + 14 mA	
(20.5 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.65 % + 0.58 A 1.2 % + 0.58 A	Fluke 5520A and 50 turn coil
(150 to 1000) A	(45 to 65) Hz (65 to 440) Hz	0.70 % + 0.058 A 1.2 % + 0.058 A	
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	0.03 % + 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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Measure (cont) (20 to 100) A	40 Hz to 1 kHz	0.68 % of rdg	Valhalla 2575A with DMM
AC Current – Measure ³ (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

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
AC Power – Generate ³			
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, opt PQ
(9 to 33) mA	(0.30 to 10) mW (0.003 m 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 % 0.1 %	
(0.33 to 0.9) A	(11 to 300) mW (0.11 to 900) W	0.087 % 0.081 %	
(0.9 to 2.2) A	(30 to 720) mW (0.30 to 2000) W	0.09 % 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 %	



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
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	0.058 % + 5.2 μV 0.022 % + 5.2 μV 0.011 % + 5.2 μV 0.038 % + 5.3 μV 0.087 % + 8.1 μV 0.12 % + 15 μV 0.18 % + 29 μV 0.36 % + 29 μV	Fluke 5700A
(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	0.059 % + 5.9 μV 0.023 % + 5.8 μV 0.012 % + 5.8 μV 0.039 % + 5.9 μV 0.088 % + 8.1 μV 0.12 % + 16 μV 0.18 % + 30 μV 0.34 % + 37 μV	
(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	0.059 % + 16 μV 0.023 % + 10 μV 0.012 % + 10 μV 0.018 % + 62 μV 0.057 % + 130 μV 0.12 % + 38 μV 0.18 % + 41 μV 0.37 % + 93 μV	
(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	0.052 % + 130 μV 0.016 % + 48 μV 75 μV/V + 13 μV 30 μV/V + 710 μV 0.016 % + 380 μV 0.046 % + 160 μV 0.12 % + 420 μV 0.23 % + 1.0 mV	



Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
AC Voltage – Generate (cont)			
(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	0.052 % + 1.2 mV 0.017 % + 380 μV 75 μV/V + 160 μV 0.011 % + 830 μV 0.025 % + 480 μV 0.053 % + 1.8 mV 0.14 % + 5.0 mV 0.3 % + 10 mV	Fluke 5700A
(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	0.053 % + 11 mV 0.017 % + 3.9 mV 85 μV/V + 1.3 mV 0.023 % + 4.2 mV 0.053 % + 9.5 mV 0.17 % + 110 mV 0.53 % + 110 mV 1.3 % + 220 mV	
(220 to 1100) V	(15 to 50) Hz (0.050 to 1) kHz	0.043 % + 19 mV 80 μV/V + 9.3 mV	
AC Voltage – Generate ³			
(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 0.04 % + 70 μV 0.27 % + 80 μV 0.81 % + 110 μV	Fluke 5520A
(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	
(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	

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
AC Voltage – Generate ³ (cont)			
(3.3 to 33) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.036 % + 790 μV 0.018 % + 710 μV 0.028 % + 720 μV 0.041 % + 740 μV 0.11 % + 1.9 mV	Fluke 5520A
(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	0.2 % + 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	
(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	
(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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Measure (cont)			
(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	Fluke 5790A
(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	
(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	
(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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Measure (cont)			
(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	Fluke 5790A
(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 % + 289 μV 79 μV/V + 154 μV 36 μV/V + 133 μV 66 μV/V + 69 μV 0.011 % + 121 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 % + 457 μV 80 μV/V + 551 μV 37 μV/V + 332 μV 79 μV/V + 320 μV 0.011 % + 258 μV 0.023 % + 2.8 mV 0.058 % + 1.0 mV	
(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	
(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	



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Measure ³			
(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 0.09 % + 530 μV 0.34 % + 2.2 mV 1.2 % + 2.8 mV	
(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 0.04 % + 3.9 mV 0.14 % + 4.8 mV 0.46 % + 15 mV 1.8 % + 17 mV	
(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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – HV Measure ³			
(1 to 4) kV	60 Hz	0.26 V + 4 %	Fluke 77 w/80K-40
(4 to 100) kV	60 Hz	0.15 kV + 0.12 %	Hipotronics KV100A
AC Voltage Flatness – Measure			
(0.005 to 7) V	10 Hz to 30 MHz	0.47 % of rdg	Fluke 5790A
(0.005 to 5.5) V	(10 to 1100) MHz	1.6 % of rdg	Power meter and power sensors
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 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	



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Capacitance ³ – Generate (cont)			
Discrete Capacitance Points			
1 pF	1 kHz	0.85 fF	Agilent 16380A standard capacitors
10 pF	1 kHz	1.6 pF	
100 pF	1 kHz	6.5 pF	
1000 pF	1 kHz	54 fF	
1 nF	100 Hz	99 fF	Genrad 1409 series standard capacitors
2 nF	100 Hz	0.28 pF	
10 nF	100 Hz	1.0 pF	
100 nF	100 Hz	10 pF	
200 nF	100 Hz	21 pF	
1 μF	100 Hz	0.12 nF	
1 nF	120 Hz	0.24 pF	
2 nF	120 Hz	0.28 pF	
10 nF	120 Hz	1.0 pF	
100 nF	120 Hz	10 pF	
200 nF	120 Hz	21 pF	
1 μF	120 Hz	0.12 nF	
1 nF	1 kHz	57 fF	
2 nF	1 kHz	0.28 pF	
10 nF	1 kHz	1.0 pF	
100 nF	1 kHz	10 pF	
200 nF	1 kHz	21 pF	
1 μF	1 kHz	0.12 nF	
1 nF	10 kHz	57 fF	
2 nF	10 kHz	0.28 pF	
10 nF	10 kHz	1.0 pF	
100 nF	10 kHz	10 pF	
200 nF	10 kHz	21 pF	
1 μF	10 kHz	0.12 nF	
1 nF	100 kHz	55 fF	
2 nF	100 kHz	0.33 pF	
10 nF	100 kHz	1.5 pF	
100 nF	100 kHz	10 pF	
200 nF	100 kHz	22 pF	
1 μF	100 kHz	0.16 pF	



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Capacitance ³ – Measure			
(1 to 10) pF	10 kHz	0.12 % + 0.012 pF	GenRad 1692 RLC digibridge
(10 to 100) pF	1 kHz	0.058 % + 0.12 pF	
(0.1 to 10) nF	1 kHz	0.057 % + 0.33 pF	
(10 to 100) nF	1 kHz	0.058 % + 1.2 pF	
(0.1 to 1) μF	1 kHz	0.059 % + 5.8 pF	
(1 to 10) μF	100 Hz	0.049 % + 1.1 nF	
(10 to 100) μF	100 Hz	0.063 % + 1.2 nF	
(0.1 to 1) mF	100 Hz	0.12 % + 5.8 nF	
(1 to 10) mF	100 Hz	0.64 % + 58 nF	
(10 to 100) mF	100 Hz	5.8 % + 0.58 μF	
(0.1 to 1) mF	DC	0.014 %	Charge technique using DC source and voltmeter
(1 to 10) mF	DC	0.014 %	
(10 to 110) mF	DC	0.017 %	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Conductivity Simulation ³ – Generate	Up to 1 μS 1 μS to 10 mS	0.015 μS 16 μS	ESI DB 877 decade resistor
DC Current– Generate	(0 to 220) μA	41 μA/A + 7.1 nA	Fluke 5720A
	(0.22 to 2.2) mA	35 μA/A + 8.5 nA	
	(2.2 to 22) mA	35 μA/A + 54 nA	
	(22 to 220) mA	47 μA/A + 850 nA	
	(0.22 to 2.2) A	64 μA/A + 31 μA	
	(2.2 to 11) A	0.040 % + 570 μA	Fluke 5725A
(20.5 to 100) A	0.63 % + 0.12 A	Valhalla 2575A with DMM	
(100 to 150) A	0.65 % + 0.01 A	Fluke 5520A and 50 turn coil	
(150 to 1000) A	0.65 % + 0.13 A		



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Current – Generate ³	(0 to 330) μ A (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	0.018 % + 24 nA 0.012 % + 65 nA 0.012 % + 440 nA 0.01 % + 8.5 μ A 0.023 % + 51 μ A 0.04 % + 200 μ A 0.055 % + 920 μ A 0.11 % + 3.0 mA	Fluke 5520A
	(20.5 to 100) A (100 to 1000) A	0.60 % + 0.25 A 0.63 % + 0.6 A	Fluke 5520A and 50 turn coil
DC Current – Measure	(0 to 200) μ A (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A	14 μ A/A + 660 pA 15 μ A/A + 5.0 nA 16 μ A/A + 53 nA 43 μ A/A + 200 nA 0.019 % + 28 μ A 0.058 % + 1.9 mA	Fluke 8508A
	(20 to 100) A	0.46 % + 0.25 A	Valhalla 2575A with DMM
DC Current – Measure ³	(0 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	20 μ A/A + 1.5 nA 22 μ A/A + 7.9 nA 22 μ A/A + 81 nA 39 μ A/A + 790 nA 0.011 % + 37 μ A	HP 3458A, opt 002
	(1 to 10) A	23 mA	Fluke 45
	(100 to 1000) A	2.0 % + 5 A	Fluke 77 /80I-1010 clamp

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Power – Generate ³			
(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 5520, opt PQ
(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	0.05 % 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 % 0.07 %	
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 1 100) 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
Fixed Point	10 V	1.0 μV/V	Fluke 732A
DC Voltage – Generate ³	(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 + 2.5 μV 15 μV/V + 24 μV 22 μV/V + 190 μV 22 μV/V + 1.9 mV	Fluke 5520A
DC Voltage – HV Generate ³	(1 to 50) kV	2.3 % of rdg	HV source with divider

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Voltage – Measure	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1050) V	5.9 μV/V + 130 nV 3.6 μV/V + 480 nV 3.6 μV/V + 4.7 μV 5.3 μV/V + 50 μV 5.2 μV/V + 760 μV	Fluke 8508A
Fixed Point	10 V	1 μV/V	Fluke 732A
DC Voltage – Measure ³	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	5.5 μV/V + 400 nV 4.2 μV/V + 840 nV 4.2 μV/V + 5.7 μV 6.5 μV/V + 89 μV 5.4 μV/V + 2.0 mV	HP 3458A, opt 002
DC Voltage – HV Measure ³	(1 to 40) kV (40 to 100) kV	14 V + 2.8 % 2.9 kV	Fluke 87 w/80K-40 Hipotronics KV100A

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Inductance – Generate ³ 100 mH, 1 H, 10 H 100 μH to 1 H	(100, 120) Hz (1, 10) kHz	0.024 % + 2.2 μH 0.057 % + 1.6 μH	Genrad 1482 series standard inductors
Inductance – Measure ³ (0.002 to 10) H	(100, 120) Hz	0.26 % + 580 nH	Genrad 1482 series standard inductors,
(0.002 to 10) H	(1, 10) kHz	0.27 % + 480 nH	Genrad 1692 RLC digi-bridge

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Oscilloscope – Amplitude DC 50 Ω 1 MΩ	(0 to 6.6) V (0 to 130) V	0.29 % + 49 μV 0.058 % + 48 μV	Fluke 5500A/SC1100

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
Oscilloscope – (cont)			
Amplitude Square Wave 50 Ω 1 MΩ	1 mV to 6.6 V _(p-p) 1 mV to 130 V _(p-p)	0.29 % + 49 μV 0.12 % + 48 μV	Fluke 5500A/SC1100
Leveled Sine Wave Amplitude (50 kHz Ref)	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	3.0 % + 0.34 mV 4.5 % + 0.35 mV 5.0 % + 0.36 mV 7.2 % + 0.36 mV 8.3 % + 0.31 mV	
Time Marker	5 s to 50 ms 20 s to 2 ns	(30 + 1200t) μs/s 5.0 μs/s	t = time in seconds
Pulse Characterization			
Transition (Rise) Time - Generate	1 kHz to 2 MHz Nominal 250 ps	53 ps	Fluke 5520A SC1100
	(2 to 10) MHz Nominal 300 ps	53 ps	
Transition (Rise / Fall) Time - Measure	17.5 ps to 1 μs	24 ps	Tek 11801B with SD 26 sampling head
pH Simulation – Generate ³	(0 to 14) pH units	0.011 pH	Fluke 700 series process calibrator
Phase – Generate ³ (0 to 999.999)°	0.02 Hz to 6.25 kHz (6.25 to 50) kHz (50 to 100) kHz	0.015° 0.031° 0.06°	Clark Hess 5000
Phase – Measure ³ (0 to 360)° (-180 to 180)°	(0.02 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.06° 0.063° 0.0023 x f – 0.050°	Clark Hess 6000 f = frequency in kHz

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
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
Resistance – Generate ³ , Synthesized Resistance Points	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.33 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (0.33 to 1.1) GΩ	46 μΩ/Ω + 1.2 mΩ 35 μΩ/Ω + 1.8 mΩ 25 μΩ/Ω + 3.2 mΩ 29 μΩ/Ω + 4.2 mΩ 29 μΩ/Ω + 6.6 mΩ 29 μΩ/Ω + 41 mΩ 27 μΩ/Ω + 100 mΩ 29 μΩ/Ω + 400 mΩ 27 μΩ/Ω + 1.0 Ω 35 μΩ/Ω + 3.5 Ω 32 μΩ/Ω + 9.6 Ω 66 μΩ/Ω + 50 Ω 0.014 % + 250 Ω 0.027 % + 3.9 kΩ 0.052 % + 12 kΩ 0.35 % + 130 kΩ 1.7 % + 1.9 MΩ	Fluke 5520A
Resistance – Measure	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ	18 μΩ/Ω + 7.2 μΩ 13 μΩ/Ω + 25 μΩ 12 μΩ/Ω + 59 μΩ 11 μΩ/Ω + 730 μΩ 10 μΩ/Ω + 6.2 mΩ 8.6 μΩ/Ω + 120 mΩ 6.3 μΩ/Ω + 17 Ω 22 μΩ/Ω + 120 Ω 70 μΩ/Ω + 12 kΩ 0.061 % + 1.2 MΩ	Fluke 8508A

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Resistance – Measure and Generate	(0.1 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ	0.4 μΩ/Ω 0.47 μΩ/Ω 0.47 μΩ/Ω	Current comparator resistance bridge and standard oil resistors
Fixed Point	1 Ω (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (1 to 100) MΩ	0.25 μΩ/Ω 12 μΩ/Ω 17 μΩ/Ω 34 μΩ/Ω 54 μΩ/Ω	MIL 6000B bridge and standard oil resistors
Resistance – Measure ³	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	17 μΩ/Ω + 62 μΩ 14 μΩ/Ω + 590 μΩ 12 μΩ/Ω + 1.0 mΩ 11 μΩ/Ω + 11 mΩ 11 μΩ/Ω + 170 mΩ 8.8 μΩ/Ω + 18 Ω 54 μΩ/Ω + 170 Ω 0.051 % + 9.4 kΩ 0.55 % + 350 kΩ	HP 3458A, opt 002
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	0.048 °C 0.048 °C 0.048 °C	
Pt 385, 200 Ω	(100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °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	

Parameter/Equipment	Range	CMC ² (±)	Comments
RTD Indicators ³ – (cont)			Fluke 5520A
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	
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.095 °C 0.095 °C 0.017 °C	
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 –			Fluke 5520A
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 0.4 °C	
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	

Parameter/Equipment	Range	CMC ² (±)	Comments
Thermocouple Indicators ³ – (cont)			
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	Fluke 5520A
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	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.4 °C 0.23 °C 0.21 °C 0.32 °C 0.47 °C	
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, 8} (±)	Comments
Refractometers – Brix Salt (NaCl)	1.336 59 n _D 1.344 01 n _D 1.355 68 n _D 1.399 86 n _D 1.464 58 n _D 1.516 55 n _D (0 to 50) % NaCl solution	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	Up to 33 % of Scale (33 to 66) % of Scale (66 to 100) % of Scale	2.7 % of rdg 1.8 % of rdg 1.7 % of rdg	Viscosity oils
Viscosity Dip Cups ³ – Efflux Time	(0 to 100) mm ² /s (100 to 1000) mm ² /s	1.8 % of rdg 1.3 % of rdg	Viscosity oils
Volumetric Flow ³ – Gas	(1 to 250) sccm (0.02 to 6) slpm (2 to 30) slpm	0.016 sccm + 1.5 % rdg 0.01 slpm + 1.1 % rdg 0.035 slpm + 1.2 % rdg	Comparison to flow standards

VI. Mechanical

Parameter/Equipment	Range	CMC ² (±)	Comments
Durometer Calibrators Beam Type	Type A Type D	0.014 % of rdg 0.012 % of rdg	Optical comparator and mass comparator
Force – Compression & Tension, Measure & Measuring Equipment	(200 to 5000) lbf (5000 to 20 000) lbf (20 000 to 60 000) lbf	1.2 lbf 4.6 lbf 15 lbf	Morehouse 1000 series proving rings

Parameter/Equipment	Range	CMC ² (±)	Comments
Force – Compression & Tension, Measure & Measuring Equipment ³	(0 to 2.5) N (2.5 to 50) N (10 to 500) lbf (500 to 2000) lbf (2000 to 30 000) lbf	0.0011 N 0.011 N 0.18 lbf 3.0 lbf 21 lbf	Deadweights, load cells
Measure Only – Compression Only	(30 000 to 200 000) lbf	130 lbf	Load cell
Extensometers ³	(0 to 1) in (1 to 4) in (4 to 18) in	0.00045 in 0.0018 in 0.008 in	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 HRD: Low Medium High HRG: Low Medium High HRF: 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 0.77 HRD 0.86 HRD 0.36 HRD 1.2 HRG 1.1 HRG 0.4 HRG 1.0 HRF 0.92 HRF 0.67 HRF	Indirect verification per ASTM E18



Parameter/Equipment	Range	CMC ² (±)	Comments
Indirect Verification of Rockwell Hardness Testers ³ (cont)	HRRW: Low Medium High HRSW: Low High HR15N: Low Medium High HR30N: Low Medium High HR45N: Low Medium High HR15T: Low Medium High HR30T: Low Medium High HR45T: Low Medium High	0.76 HRRW 0.61 HRRW 0.93 HRRW 0.93 HRSW 0.42 HRSW 1.2 HR15N 1.2 HR15N 1.2 HR15N 1.2 HR30N 1.2 HR30N 1.2 HR30N 1.2 HR45N 1.2 HR45N 1.2 HR45N 1.2 HR15T 1.2 HR15T 1.2 HR15T 1.3 HR30T 1.2 HR30T 1.2 HR30T 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	(70 to 80) HBW (80 to 101) HBW	2.5 HBW 3.7 HBW	Indirect verification method per ASTM E10



Parameter/Equipment	Range	CMC ² (±)	Comments
Indirect Verification of Brinell Hardness Testers at Test Condition(s) ³ (cont): 10/3000/15	239 HBW 349 HBW 416 HBW	8.4 HBW 13 HBW 15 HBW	Indirect verification method per ASTM E10
Indirect Verification of Microindentation Hardness Testers ³ (Knoop & Vickers)	(100 to 250) HK (250 to 650) HK (100 to 240) HV ≥600 HV	16 HK 38 HK 13 HV 37 HV	Indirect verification method per ASTM E384
Linear Velocity ³	Up to 50 mm/min 50 to 1000 mm/min	0.45 % rdg + 0.14 mm/min 2.0 % rdg	Linear scale and stopwatch
Mass – Measure, Fixed Points	50 kg 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 5 g 3 g 2 g 1 g 500 mg 300 mg	84 mg 40 mg 32 mg 14 mg 7.8 mg 4.8 mg 3.3 mg 2.0 mg 1.5 mg 1.4 mg 310 µg 160 µg 78 µg 47 µg 31 µg 17 µg 10 µg 5.7 µg 5.3 µg 8.2 µg 4.7 µg 3.3 µg	Double substitution with air buoyancy correction; Class E2 mass standards; Sartorius CC50, RC210P, CC5001, CC50002



Parameter/Equipment	Range	CMC ² (±)	Comments
Mass – Measure, Fixed Points (cont)	200 mg 100 mg 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	6.9 µg 4.9 µg 4.3 µg 4.4 µg 2.8 µg 2.8 µg 2.8 µg 2.8 µg 2.7 µg 2.7 µg	Double substitution with air buoyancy correction; Class E2 mass standards; Sartorius CC50, RC210P, CC5001, 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, and Absolute	(0.07 to 0.2) psi (0.2 to 1000) psi	0.0062 psi 0.0025 % rdg	PPC2+ Ruska 2465
Gauge Only	(1000 to 15 000) psig	0.0075 % rdg	Ruska 2475
Hydraulic	(2 to 20 000) psig	0.0075 % rdg	Ruska 2485
Pressure – Pneumatic Gauge, Negative Gauge, and Absolute ³	(0 to 2) inH ₂ O	0.0021 inH ₂ O	Microtector
Pressure – Gauge and Absolute	(2 to 20) inH ₂ O (20 to 40) inH ₂ O	0.18 inH ₂ O 0.24 inH ₂ O	Pressure transducers
Pressure – Gauge Only	(-14 to 30) psig (30 to 100) psig (100 to 500) psig (500 to 1000) psig (1000 to 5000) psig (5000 to 10 000) psig	0.038 psig 0.062 psig 0.33 psig 0.60 psig 1.8 psig 6.7 psig	



Parameter/Equipment	Range	CMC ² (±)	Comments
Scales and Balances ³	(1 to 200) g (200 to 3000) g (3 to 5) kg (5 to 15) kg (15 to 34) kg (50 to 250) lb (250 to 1000) lb (1000 to 3000) lb (3000 to 12 000) lb	250 µg + 2.3 µg/g 880 µg + 120 µg/g 0.60 g 1.8 g 4.3 g 0.17 lb 0.20 lb 0.38 lb 7.4 lb	Certified weights, NIST Handbook 44 E2, Class 1
Tachometers ³ –			
Contact	Up to 2000 rpm	0.08 rpm + 0.06 % rdg	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 99 999) rpm	0.0091 rpm 0.0076 rpm	
Torque Transducers	(4 to 80) in·ozf (5 to 60) in·lbf (5 to 250) ft·lbf (250 to 1000) ft·lbf	0.047 % of rdg 0.035 % of rdg 0.068 % of rdg 0.032 % of rdg	Torque arms and Class F weights
Torque Wrenches, Tools ³	(8 to 80) in·ozf (5 to 20) in·lbf (20 to 50) in·lbf (50 to 250) in·lbf (20 to 100) ft·lbf (100 to 250) ft·lbf (100 to 1000) ft·lbf	0.23 in·ozf 0.025 in·lbf 0.061 in·lbf 0.86 in·lbf 0.17 ft·lbf 1.0 ft·lbf 1.2 ft·lbf	Torque transducers
Volume –			
Volumetric Apparatus (Beakers, Cylinders, Flasks, etc.)	Up to 4000 mL (4000 to 19 000) mL	0.01 % of rdg 0.026 % of rdg	Balance and weights
Piston Operated Volumetric Apparatus (Pipettes, Burettes, etc.)	(10 to 100) µL (100 to 1000) µL	0.40 % of rdg 0.12 % of rdg	ASTM E1154 gravimetric determination

VII. Optical Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Gloss Meters ³	20° 60° 85°	0.60 GU 0.39 GU 0.42 GU	Gloss standards
Gloss Tiles ³	20° 60° 85°	0.64 GU 0.45 GU 0.48 GU	Comparison to gloss standards

VIII. Rubber and 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 and 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	0.05 °C	Digital thermometer
Capillary Rheometers – Rubber ³			ASTM D 5099
Barrel Inside Diameter and 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

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Capillary Rheometers – Rubber ³ (cont)			ASTM D 5099
Temperature Accuracy	(10 to 190) °C	0.05 °C	Digital thermometer
Crosshead Speed	(0 to 25.4) mm/min	0.048 mm/min	Dial indicator/stopwatch
Force	(0 to 5000) lbf	32 lbf	Load cell
Pressure	(0 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	(0 to 25) mm	0.0041 mm	Optical inspection under magnification
Radius	(0 to 25) mm	0.0038 mm	
Angle	(0 to 90)°	0.01°	
Extension	(0 to 25) mm	0.0043 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	
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	1.2 °C	Master temp probe and 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
Timer Accuracy	(0 to 7200) s	0.72 s	Comparison to stopwatch
Extrusion Plastometers ^{3,6} –			ASTM D1238
Cylinder Bore	Up to 2 in	0.00028 in	
Piston Measurements	Up to 2 in	0.00030 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	(0 to 7200) s	0.36 s	
Rubber Press ³ – Laboratory, Compression, Injection, Transfer			ASTM D 3182 ISO 2393
Closing Force	(0 to 2000) lbf (2000 to 30 000) lbf (30 000 to 100 000) lbf	24 lbf 41 lbf 200 lbf	
Temperature Uniformity	(50 to 350) °C	0.32 °C	
Parallelism	(0.001 to 0.01) in/ft	0.0028 in/ft	

Parameter/Equipment	Range	CMC ² (±)	Comments
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 and 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	(0 to 300) mm (0.3 to 1.8) m	0.1 mm 2.1 mm	Comparison to length standards
Plunger Speed	(0 to 900) mm/min	0.41 % of rdg + 2.1 mm/min	Length standards/stopwatch
Timer Accuracy	(0 to 7200) s	0.72 s	Comparison to stopwatch
Mooney Viscometers ³ , Stress Relaxation –			
Mooney Torque	(0 to 200) Mooney Units	0.098 Mooney Units	ASTM D 1646 Class F weights
Rotor rpm	(0.01 to 100) rpm	0.77 % of rdg	Optical encoder
Die Temperature	(0 to 400) °F	0.5 °F	ASTM D 1349 RTD with indicator
Die Closing Force	(500 to 2700) lbf	38 lbf	Load cell with indicator
Rotor Dimensions	Up to 2 in	0.00058 in	Micrometers

Parameter/Equipment	Range	CMC ² (±)	Comments
Oscillating Disc Rheometers ³ –			ASTM D2084, ISO 3417
Torque	(0 to 200) in·lbf	0.33 in·lbf	OD torsion standard
Oscillatory Amplitude	(-90 to 90)° arc	0.0062° arc	Optical encoder
Die Temperature	(0 to 400) °F	0.5 °F	ASTM D 1349 RTD with indicator
Die Closing Force	(500 to 2700) lbf	38 lbf	ASTM E 4 Load cell with indicator
Rotor Dimensions	(0 to 2) in	0.00058 in	Measured at test temperatures with micrometers
Rotorless Cure Meters, Moving Die Rheometers, Rubber Process Analyzers ³ –			ASTM D 5289, ASTM D 6204, ASTM D6601
Torque	(0 to 200) in·lbf	0.29 in·lbf	MD torsion standard (Dynamic)
Oscillatory Amplitude	(-90 to 90)° arc	0.0064° arc	ASTM D 1349
Die Temperature	(0 to 400) °F	0.5 °F	Thermocouple or RTD with indicator
Die Closing Force	≥1820 lbf	38 lbf	Load cell with indicator
Torque Standards (Torsion Springs), MDR, ODR	Torque up to 200 lbf·in (peak-peak) 10° (peak-peak)	0.27 in·lbf 0.008° arc	Torque standard calibration system

IX. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Dew/Frost Point – Measuring Equipment	(-25 to 0) °C (0 to 65) °C	0.18 °C 0.16 °C	Dew point generator Thunder Scientific 2500
Humidity – Measure and Measuring Equipment	(10 to 95) % RH (10 to 95) % RH	1.0 % RH 1.0 % RH	Chilled mirror Thunder Scientific 2500
Humidity – Measure and Measuring Equipment ³	(10 to 90) % RH	2.9 % RH	Vaisala probe
IR Temperature ³ – Measuring Equipment	Ambient to 300 °C (285 to 800) °C	0.88 °C + 0.7 % 0.44 °C + 0.9 %	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 285 °C (285 to 800) °C	0.88 °C + 0.7 % 0.44 °C + 0.9 %	Blackbody source, IR thermometer
Ovens ³ – Temperature Uniformity System Accuracy Time Constant Ventilation Rate	Up to 1000 °C Up to 420 °C (420 to 1000) °C (5 to 800) s (5 to 300) Air changes/hr	4.0 °C 0.59 °C 2.8 °C 5.8 s 3.4 % of Air changes/hr	ASTM E145, ASTM A991, AMS 2750, HP 34970 RTD TC Fluke 54 II ASTM E145

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature– Measure, Temperature Baths, Dry Wells ³	Temperature Uniformity (-196 to 150) °C	27 mK	PRT, digital thermometer
	(0 to 30) °C	15 mK	SPRT, digital thermometer
Temperature Accuracy	(-196 to 0) °C (0 to 660) °C (660 to 1000) °C (1000 to 1450) °C	16 mK 20 µK/K + 16 mK 0.65 K 1.9 mK/K + 0.37 K	Characterized S thermocouple
Temperature – Measuring, Equipment TC/RTD Probes, LIG Thermometers ³	0.01 °C	16 mK	Triple point of water
	(-80 to 0) °C	32 µK/K + 21 mK	Comparison to reference probe and temperature baths
	(0 to 150) °C	22 mK	
	(150 to 300) °C	33 mK	
(300 to 400) °C	35 mK		
	(400 to 1000) °C (1000 to 1200) °C	3 K 1.3 mK/K + 2.4 K	Drywell and S thermocouple

X. Time and Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment	Up to 18 GHz	10 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	10 pHz/Hz + 0.58R	EIP 545 and HP 5335A electronic counters R is the resolution of the unit under test

Parameter/Equipment	Range	CMC ² (±)	Comments
Timers/Stop Watches	(1 to 28 800) s	0.06 s/day	Timometer
Timers/Stop Watches ³	(1 to 28 800) s	0.049 s	Electronic counter
Tuning Fork ³	35 Hz to 22 kHz	1.2 mHz/Hz	Electronic counter

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 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 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.

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.

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.

MECHANICAL TESTING

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

<u>Test Method:</u>	<u>Test Description:</u>
ASTM D1646	Rubber – Viscosity, Stress Relaxation, and Pre-Vulcanization Characteristics (Mooney Viscometer)
ASTM D2084	Rubber Property – Vulcanization Using Oscillating Disk Cure Meter, Excluding Hardness
ASTM D5289	Rubber Property – Vulcanization Using Rotorless Cure Meters
ASTM D6204	Rubber – Measurement of Unvulcanized Rheological Properties Using Rotorless Shear Rheometers
ASTM D6601	Rubber Properties – Measurement of Cure and After-Cure Dynamic Properties Using a Rotorless Shear Rheometers



Accredited Laboratory

A2LA has accredited

RICHARD J. BAGAN, INC. A.K.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 17025:2005 *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 8 January 2009*).



Presented this 3rd day of February, 2017.

A handwritten signature in black ink, appearing to read 'L. Bagan', written over a horizontal line.

President & CEO
For the Accreditation Council
Certificate Number 1625.01
Valid to January 31, 2019

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