Parameter/Equipment	Range	CMC[2] (±)	Comments
Conductivity[3] –			
Solution (fixed point)	10 µS 100 µS 1 000 µS 10 000 µS	1 µS 5 µS 45 µS 430 µS	Standard conductivity solutions
Transfer	(20 to 200) µS (200 to 2 000) µS (2 000 to 20 000) µS (20 000 to 200 000) µS	1.3 µS 13 µS 125 µS 2.0 mS	Transfer with conductivity standard meter
Resistance Substitution	(20 to 200) µS (200 to 2 000) µS (2 000 to 20 000) µS (20 000 to 200 000) µS	0.2 µS 1.3 µS 15 µS 1.4 mS	Simulation with decade box

III. Dimensional

Parameter/Equipment	Range	CMC[2, 4](±)	Comments
Almen Gages[3]	(0.2 to 0.6) mm	0.0002 mm	Step blocks
Angle Blocks & Squares[3]	30°, 45°, 90°	(13 + 0.06 × Θ) arc sec	Mechanical comparison Θ is the numerical value of the nominal angle measured in degrees.
Bench Micrometers, UMMs and Supermics[3]	(0 to 4) in (4 to 80) in	(6.7 + 9.4 × *L*) µin (44 + 4.7 × *L*) µin	Gage blocks
Force	(25 to 250) cN (250 to 2000) cN	6.5 cN 65 cN	Force gages
Bore Micrometer & Bore Gage Anvil Style[3]	(0.5 to 10) in	(52 + 6.7 × *L*) µin.	Master rings
Calipers[3]	(0 to 72) in	(0.6 × *R* + 3 × *L*) µin	Gage blocks
Chamfer Gage[3]	Up to 4 in	120 µin	Master rings

Parameter/Equipment	Range	CMC[2, 4](±)	Comments
Coating Thickness Meters[3]	(2.09 to 20.24) mils	5.8 % of reading	Coating thickness standards
Coordinate Measuring Machines (CMMs) [3] –			
Linear Displacement Accuracy	(0 to 72) in	(8 + 3 × *L*) µin	Gage blocks, laser system
Volumetric Performance	(0 to 31.5) in	100 µin	Ball bar
Repeatability		50 µin	Master sphere
Point-to-Point Probe Performance		25 µin	Master sphere
Cylindrical Square[3]			
Squareness	Up to 24 in	20 µin	Electronic indicator
Depth Gage	(0 to 72) in	(100 + 10 × *L*) µin	Gage blocks
Dial Indicators & LVDT[3]	(0 to 11.5) in	(0.6 × *R* + 1 × *L*) µin	UMM
End Standards[3] –			
Micrometer Stds.	(0 to 72) in.	(5.6 + 2.1 × *L*) µin.	Mechanical comparison
Feeler Gages[3]	Up to 0.5 in	23 µin	UMM
Height Gages[3]	(0 to 40) in	(100 + 10 × *L*) µin	Gage blocks
Height Masters[3]	(0.01 to 24) in.	(25 + 3.7 × *L*) µin.	Gage blocks and electronic indicator
Inside Diameter[3] –			
Cylindrical Rings	(0.02 to 33) in	(19 + 1.7 × *L*) µin	UMM

Parameter/Equipment	Range	CMC[2, 4](±)	Comments
Gage Blocks[3]			
Standard	(0.01 to 4) in	(3.8 + 2.1 × *L*) µin	Mechanical comparison
Long Blocks	(4 to 6) in	(9 + 0.74 × *L*) µin	
	(6 to 40) in	(5.6 + 2.1 × *L*) µin	
Metric	(0.5 to 100) mm	(0.11 + 0.0011 × *L*) µm	Mechanical comparison
Long Blocks	(100 to 1000) mm	(0.14 + 0.0021 × *L*) µm	
Inside Pitch Diameter[3] –			
Thread Rings Fixed	(0.5 to 4) in	100 µin	Ball contacts, UMM
Thread Rings Adjustable	(0.5 to 4) in	210 µin	Master thread plug
Levels[3]	Up to 48 in	180 µin/ft	Gage blocks
Micrometers – Outside Diameter and Inside Diameter[3]	(0 to 72) in	(0.6 × *R* + 6.4 × *L*) µin	Gage blocks
Optical Flats and Optical Parallels[3]	Up to 4 in	6.4 µin	Standard flats, monochromatic light & UMM
Optical Comparators & Microscopes[3] –			
Measuring Stage Travel	Up to 12 in	110 µin	Glass scales
Squareness		110 µin	Glass scales
Magnification	10x to 100x	0.36 % of reading	Reticule or gage balls

Parameter/Equipment	Range	CMC[2, 4](±)	Comments
Outside Diameter[3] –			
Pins & Plugs	(0 to 40) in	(12 + 2.4 × *L*) µin	UMM
Spheres & Gage Balls	(0 to 4) in	17 µin	
Thread Wires	(0 to 0.825) in.	11 µin	
Thread Plugs	Up to 2 in Over 2 up to 20 in	80 µin + 0.23*D* 78 µin + 3.5*D*	3-wire measurement, master thread wires, UMM
Parallels[3]	(0.25 to 3) in	78 µin	Height gage and surface plate
Planekators[3]	Up to 48 in	56 µin	Laser and surface plate
Profilometers & Surface Testers Indirect Verification of Ra Measurement[3]	Ra 120 µin Ra (10 to 200) µin	8.4 µin 2.6 µin + 7 % of reading	Roughness standards
Protractors[3]	30°, 45°, 90°	45 arc sec	Comparison to angle blocks
Radius Gage[3]	Up to 2 in	420 µin	Optical comparator
Roughness Standards & Patches[3] ISO Type C	Ra (10 to 200) µin	1.5 µin + 7 % of reading	Master roughness standard & mechanical comparison
Rules[3]	(0 to 72) in	(330 + 13 × *L*) µin	Optical Comparator
Sine Plates & Bars[3] –			
Parallelism	Up to 15 in	78 µin	Gage blocks and angle blocks. Θ is the numerical value of the nominal angle measured in degrees.
Angle	Up to 2 in	(10 + 0.6 × Θ) arc sec	

Parameter/Equipment	Range	CMC[2, 4, 6](±)	Comments
Squares[3] –			
Squareness	Up to 0.020 in	31 µin	Electronic indicator, surface plate and cylindrical square
Surface Plate[3]			
Flatness	8 in × 12 in to 72 in × 144 in	(40 + 0.7 × *L*) µin	Optodyne laser or planekator
Repeat Reading	Up to 0.005 in	40 µin	Repeat-o-meter
Tape Measures[3]	(0 to 33) ft (33 to 100) ft	0.025 in 0.065 in	Gage blocks and master tapes
Tapered Thread Plugs[3]	Up to 40 in	430 µin	UMM, thread wires, tapered thread fixture
Thread Pitch Gages[3]	(0 to 6) in	420 µin	Optical comparator
Torque Arms[3]	Up to 40 in	0.00048 in	Surface plate and height gage
V Blocks[3] –			
V-Groove	Up to 4 in	66 µin	Electronic indicator
Squareness		45 µin	Cylindrical square

IV. Dimensional Testing/Calibration[8]

Parameter/Equipment	Range	CMC[2, 4](±)	Comments
Inspection of Test Fixtures & Attribute Gages – CMM[3]	(0 to 72) in	(760 + 15 × *L*) µin	CMM

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Inspection of Test Fixtures & Attribute Gages – Optical Comparator[3]	(0 to 6) in	(420 + 8 × *L*) µin	Optical comparator

V. Dimensional Testing[9]

Parameter	Range	CMC[2, 4] (±)	Technique / Method
Inspection of Test Fixtures & Attribute Gages – CMM[3, 10]	(0 to 72) in	(760 + 15 × *L*) µin	CMM
Inspection of Test Fixtures & Attribute Gages – Optical Comparator[3, 10]	(0 to 6) in	(420 + 8 × *L*) µin	Optical comparator

VI. Electrical – DC & Low Frequency

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
AC Current – Generate[3]			
(10 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.074 % + 84 nA 0.043 % + 45 nA 0.016 % + 33 nA 0.077 % + 70 nA 0.21 % + 0.12 µA	Fluke 5700A
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.092 % + 58 µA 0.048 % + 46 µA 0.018 % + 46 µA 0.081 % + 0.58 mA 0.21 % + 1.2 mA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.092 % + 0.58 mA 0.048 % + 0.46 mA 0.018 % + 0.46 mA 0.081 % + 5.8 mA 0.21 % + 12 mA	

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
AC Current (cont) – Generate[3]			
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.061 % + 88 µA 0.034 % + 42 µA 0.016 % + 18 µA 0.073 % + 79 µA 0.21 % + 0.12 mA	Fluke 5700A
(0.22 to 2.2) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.021 % + 4.6 mA 0.081 % + 58 mA 0.21 % + 0.12 A	
Clamp on Only			
(2.2 to 110) A	(45 to 440) Hz	0.9 % of output	Fluke 5700A w/ Fluke 5500A/Coil
(110 to 1025) A	(45 to 440) Hz	1 % of output	Fluke 5520A w/ Fluke 5500A/Coil
AC Current – Measure[3]			
(0 to 200) µA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.040 % + 20 nA 0.042 % + 20 nA 0.086 % + 20 nA 0.49 % + 20 nA	Fluke 8508A
(0.2 to 2) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.040 % + 0.2 µA 0.042 % + 0.2 µA 0.086 % + 0.2 µA 0.47 % + 0.2 µA	
(2 to 20) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.040 % + 2 µA 0.039 % + 2 µA 0.086 % + 2 µA 0.47 % + 2 µA	
(20 to 200) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.040 % + 20 µA 0.037 % + 20 µA 0.076 % + 20 µA	
(0.2 to 2) A	10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.075 % + 0.2 mA 0.095 % + 0.2 mA 0.35 % + 0.2 mA	
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.098 % + 0.2 mA 0.30 % + 0.2 mA	
With Current Shunt			
(20 to 200) A	(0 to 100) Hz	0.52 % of reading	Isotek CS-30 & DMM

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
AC Power – Generate[3]			
(45 to 65) Hz			Fluke 5520A
(3.3 to 8.999) mA	(33 to 330) mV (0.33 to 1020) V	0.29 % 0.23 %	
(9 to 32.999) mA	(33 to 330) mV (0.33 to 1020) V	0.19 % 0.12 %	
(33 to 89.99) mA	(33 to 330) mV (0.33 to 1020) V	0.29 % 0.25 %	
(90 to 329.99) mA	(33 to 330) mV (0.33 to 1020) V	0.19 % 0.21 %	
(0.33 to 0.8999) A	(33 to 330) mV (0.33 to 1020) V	0.21 % 0.19 %	
(0.9 to 2.1999) A	(33 to 330) mV (0.33 to 1020) V	0.22 % 0.18 %	
(2.2 to 4.4999) A	(33 to 330) mV (0.33 to 1020) V	0.21 % 0.22 %	
(4.5 to 20.5) A	(33 to 330) mV (0.33 to 1020) V	0.22 % 0.13 %	
AC Voltage – Generate[3]			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.057 % + 7.3 µV 0.026 % + 6.2 µV 0.013 % + 6 µV 0.047 % + 13 µV 0.11 % + 21 µV 0.15 % + 38 µV 0.21 % + 77 µV 0.41 % + 77 µV	Fluke 5700A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.068 % + 7.2 µV 0.027 % + 7.1 µV 0.014 % + 7.1 µV 0.047 % + 7.1 µV 0.11 % + 9.9 µV 0.15 % + 18 µV 0.21 % + 35 µV 0.41 % + 37 µV	

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
AC Voltage (cont) – Generate[3]			
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.069 % + 20 µV 0.027 % + 14 µV 0.012 % + 12 µV 0.047 % + 12 µV 0.10 % + 35 µV 0.13 % + 38 µV 0.21 % + 53 µV 0.41 % + 0.13 mV	Fluke 5700A
(0.22 to 2.2) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.059 % + 0.23 mV 0.018 % + 71 µV 0.008 % + 42 µV 0.014 % + 39 µV 0.030 % + 60 µV 0.052 % + 78 µV 0.13 % + 0.21 mV 0.28 % + 1.2 mV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.069 % + 1.3 mV 0.018 % + 0.67 mV 0.008 % + 0.38 mV 0.014 % + 0.39 mV 0.029 % + 0.57 mV 0.069 % + 2.1 mV 0.18 % + 6 mV 0.34 % + 12 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.069 % + 13 mV 0.019 % + 7.5 mV 0.009 % + 4 mV 0.028 % + 6 mV 0.069 % + 12 mV 0.18 % + 130 mV	
(220 to 1100) V	50 Hz to 1 kHz	0.0081 % + 32 mV	
AC Voltage – HV Measure[3]			
(1 to 40) kV	(0 to 60) Hz	5.8 %	Agilent 34401A w/ Fluke 80k-40

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
AC Voltage – Measure[3]			
(0 to 200) mV	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.021 % + 14 µV 0.017 % + 4 µV 0.014 % + 4 µV 0.013 % + 2 µV 0.016 % + 4 µV 0.040 % + 8 µV 0.090 % + 20 µV	Fluke 8508A
(0.2 to 2) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.019 % + 120 µV 0.014 % + 20 µV 0.011 % + 20 µV 0.0099 % + 20 µV 0.014 % + 20 µV 0.027 % + 40 µV 0.078 % + 200 µV 0.47 % + 2 mV 2.4 % + 20 mV	
(2 to 20) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.019 % + 120 µV 0.014 % + 20 µV 0.011 % + 20 µV 0.0088 % + 20 µV 0.013 % + 20 µV 0.026 % + 40 µV 0.068 % + 200 µV 0.36 % + 2 mV 2.4 % + 20 mV	
(20 to 200) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.02 % + 120 µV 0.014 % + 20 µV 0.011 % + 20 µV 0.009 % + 20 µV 0.013 % + 20 µV 0.026 % + 40 µV 0.068 % + 200 µV	
(200 to 1000) V	(1 to 10) Hz (10 to 40) Hz (0.04 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.019 % + 70 mV 0.015 % + 20 mV 0.014 % + 20 mV 0.027 % + 40 mV 0.073 % + 200 mV	

Parameter/Range	Frequency	CMC[2, 7] (±)	Comments
Capacitance – Generate[3]			
< 3.3 nF	1 kHz	1.2 %	Fluke 5520A
(3.3 to 11) nF	1 kHz	0.42 %	
(11 to 33) nF	1 kHz	0.87 %	
(33 to 110) nF	1 kHz	0.46 %	
(110 to 330) nF	1 kHz	0.48 %	
(0.33 to 1.1) µF	100 Hz	0.40 %	
(1.1 to 3.3) µF	100 Hz	0.47 %	
(3.3 to 11) µF	100 Hz	0.41 %	
(11 to 33) µF	100 Hz	0.59 %	
(33 to 110) µF	50 Hz	0.66 %	
(110 to 330) µF	54 µADC	0.71 %	
(0.33 to 1.1) mF	90 µADC	0.90 %	
(1.1 to 3.3) mF	(90 to 270) µADC	0.74 %	
(3.3 to 11) mF	(0.27 to 0.8) mADC	0.65 %	
(11 to 33) mF	(0.9 to 2.7) mADC	1.1 %	
(33 to 110) mF	(5.4 to 8) mADC	1.4 %	
Capacitance - Measure[3]			
(0.9 pF to 100 µF)	120 Hz 1 kHz	1 % of reading 1.3 % of reading	BK Precision 878

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
DC Current – Measure[3]	(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	7.9 µA/A + 0.47 nA 6.8 µA/A + 6.5 nA 7.3 µA/A + 101 nA 36 µA/A + 1.4 µA 0.019 % + 26 µA 0.042 % + 0.9 mA	Fluke 8508A
	(20 to 200) A	0.045 % of reading	w/ current shunt
DC Current – Generate[3]	(0 to 220) µA (0 to 2.2) mA (0 to 22) mA (0 to 220) mA (0 to 2.2) A	45 µA/A + 7.2 nA 35 µA/A + 21 nA 32 µA/A + 0.24 mA 27 µA/A + 8.3 µA 23 µA/A + 0.39 mA	Fluke 5700A

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
DC Current – Generate[3] (cont)	(1.1 to 3) A (3 to 11) A (11 to 20.5) A (20.5 to 1000) A	0.003 % + 8.8 mA 0.019 % + 9.1 mA 0.044 % + 16 mA 0.29 % + 66 mA	Fluke 5520A Fluke 5520A w/ Fluke 5500A/Coil
DC Power – Generate[3]			
(0.33 to 329.99) mA (0.33 to 2.9999) A (3 to 20.5) A	(0.33 to 1020) V (0.33 to 1020) V (0.33 to 1020) V	0.044 % 0.05 % 0.086 %	Fluke 5520A
DC Voltage – Generate[3]	(0 to 220) mV (0.2 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1000) V	11 µV/V + 0.9 µV 9 µV/V + 1.5 µV 11 µV/V + 6.4 µV 9 µV/V + 11 µV 11 µV/V + 0.12 mV 12 µV/V + 1.1 mV	Fluke 5700A
Fixed Point	10 V	2 µV/V	Fluke 732B
DC Voltage – HV Measure[3]	(1050 to 40) kV	0.76 %	Agilent 34401A w/ Fluke 80k-40
DC Voltage – Measure[3]	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1050) V	4.8 µV/V + 0.38 µV 4.1 µV/V + 0.59 µV 4.1 µV/V + 4.7 µV 6.4 µV/V + 53 µV 6.6 µV/V + 0.62 mV	Fluke 8508A
Electrical Calibration of RTD Indicators[3] – Generate			
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	0.14 °C 0.089 °C 0.14 °C 0.15 °C 0.15 °C 0.20 °C 0.29 °C	Fluke 5520A

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Electrical Calibration of RTD Indicators (cont) – Generate[3]			
Pt 385, 200 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.082 °C 0.13 °C 0.13 °C 0.15 °C 0.17 °C 0.19 °C 0.18 °C 0.21 °C	Fluke 5520A
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.11 °C 0.16 °C 0.11 °C 0.16 °C 0.13 °C 0.15 °C 0.13 °C 0.16 °C	
Pt 385, 1000 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.10 °C 0.18 °C 0.11 °C 0.12 °C 0.13 °C 0.16 °C 0.13 °C 0.30 °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	0.13 °C 0.084 °C 0.13 °C 0.14 °C 0.13 °C 0.18 °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	0.30 °C 0.13 °C 0.084 °C 0.12 °C 0.12 °C 0.13 °C 0.13 °C 0.17 °C 0.27 °C	

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Electrical Calibration of Thermocouple Indicators – Generate and Measure[3]			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.6 °C 0.25 °C 0.24 °C 0.25 °C 0.3 °C	Fluke 5520A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C	0.36 °C 0.25 °C 0.18 °C 0.26 °C 0.27 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C	0.42 °C 0.29 °C 0.2 °C 0.36 °C 0.47 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1 300) °C	0.52 °C 0.34 °C 0.25 °C 0.27 °C 0.35 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C	0.68 °C 0.44 °C 0.4 °C 0.5 °C	
Type S	(0 to 250) °C (250 to 1 000) °C (1 000 to 1 400) °C (1 400 to 1 767) °C	0.57 °C 0.45 °C 0.45 °C 0.56 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.75 °C 0.33 °C 0.2 °C 0.18 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.67 °C 0.36°C	
Gauss - Generate[3]			
Fixed Points	10 G 20 G	0.6 G 0.8 G	Gauss fixtures

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Inductance – Measure[3]			
1 µH to 100 H	120 Hz 1 kHz	2 % ± 5 cnts 2 % ± 5 cnts	BK Precision 878
Inductance – Generate[3]			
(1 to 9) mH (10 to 99) mH (100 to 999) mH	1 kHz 1 kHz 1 kHz	1.5 % of reading 1.4 % of reading 1.3 % of reading	Inductance standard IET LS-C-3-1mH-WC
Oscilloscopes[3] –			
Square Wave Signal – Generate (1 kHz input)			Fluke 5520A/ SC600
50 Ω	(1 to 25) mV (25 to 110) mV (0.11 to 2.2) V (2.2 to 11) V (11 to 130) V	3 % 3 % 3 % 3 % 3 %	
1 MΩ	(1 to 25) mV (25 to 110) mV (0.11 to 2.2) V (2.2 to 11) V (11 to 130) V	3.1 % 3.1 % 3.1 % 3.1 % 3.1 %	
Leveled Sine Wave – (50 kHz ref) Bandwidth	50 kHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	4.2 % 5.6 % 6.1 % 8.2 %	
Flatness	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	3.5 % 3.9 % 5.7 %	
Time Marker	2 ns to 20 ms 50 ms to 5 s	2 % 2 %	
Rise Time	≤ 300 ps	+0/ -70 ps	

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Resistance – Generate[3]	(0 to 11) Ω	43 µΩ/Ω + 1.3 mΩ	Fluke 5520A
	(11 to 33) Ω	33 µΩ/Ω + 1.9 mΩ	
	(33 to 110) Ω	32 µΩ/Ω + 1.7 mΩ	
	(110 to 330) Ω	32 µΩ/Ω + 2.5 mΩ	
	(0.33 to 1.1) kΩ	29 µΩ/Ω + 6.5 mΩ	
	(1.1 to 3.3) kΩ	32 µΩ/Ω + 24 mΩ	
	(3.3 to 11) kΩ	29 µΩ/Ω + 65 mΩ	
	(11 to 33) kΩ	36 µΩ/Ω + 0.3 Ω	
	(33 to 110) kΩ	32 µΩ/Ω + 0.32 Ω	
	(110 to 330) kΩ	37 µΩ/Ω + 2.4 Ω	
	(0.33 to 1.1) MΩ	33 µΩ/Ω + 7 Ω	
	(1.1 to 3.3) MΩ	69 µΩ/Ω + 36 Ω	
	(3.3 to 11) MΩ	0.14 mΩ/Ω + 0.16 kΩ	
	(11 to 33) MΩ	0.29 mΩ/Ω + 2.9 kΩ	
	(33 to 110) MΩ	0.55 mΩ/Ω + 6.1 kΩ	
	(110 to 330) MΩ	0.35 % + 0.12 MΩ	
	(330 to 1100) MΩ	1.7 % + 0.58 MΩ	
Fixed points	1 Ω	95 µΩ/Ω	Fluke 5700A
	1.9 Ω	95 µΩ/Ω	
	10 Ω	28 µΩ/Ω	
	19 Ω	27 µΩ/Ω	
	100 Ω	17 µΩ/Ω	
	190 Ω	17 µΩ/Ω	
	1 kΩ	13 µΩ/Ω	
	1.9 kΩ	13 µΩ/Ω	
	10 kΩ	12 µΩ/Ω	
	19 kΩ	12 µΩ/Ω	
	100 kΩ	14 µΩ/Ω	
	190 kΩ	14 µΩ/Ω	
	1 MΩ	21 µΩ/Ω	
	1.9 MΩ	21 µΩ/Ω	
	10 MΩ	46 µΩ/Ω	
	19 MΩ	59 µΩ/Ω	
	100 MΩ	0.011 % of reading	
	1 Ω	8.3 µΩ/Ω	Fluke 742A-1
	10 kΩ	7 µΩ/Ω	Fluke 742A-10k
	1 kΩ to 1MΩ	15 µΩ/Ω	IET Labs VRS-100-9-1k-BP
	10 MΩ	51 µΩ/Ω	
	100 MΩ	0.01 % of reading	
	1 GΩ	0.5 % of reading	
	10 GΩ	0.5 % of reading	
	100 GΩ	1 % of reading	

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Resistance – Measure[3]	(0 to 1) Ω (1 to 2) Ω (2 to 10) Ω (10 to 20) Ω (20 to 100) Ω (100 to 200) Ω (0.2 to 1) kΩ (1 to 2) kΩ (2 to 10) kΩ (10 to 20) kΩ (20 to 100) kΩ (100 to 200) kΩ (0.2 to 1) MΩ (1 to 2) MΩ (2 to 10) MΩ (10 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ	0.017 % + 0.1 mΩ 90 μΩ/Ω + 0.1 mΩ 17 μΩ/Ω + 0.1 mΩ 8.9 μΩ/Ω + 0.1 mΩ 8.8 μΩ/Ω + 0.7 mΩ 4.7 μΩ/Ω + 0.7 mΩ 6.8 μΩ/Ω + 3.6 mΩ 3.6 μΩ/Ω + 3.6 mΩ 6.9 μΩ/Ω + 36 mΩ 3.6 μΩ/Ω + 37 mΩ 6.8 μΩ/Ω + 360 mΩ 3.1 μΩ/Ω + 520 mΩ 6.7 μΩ/Ω + 6.4 Ω 3.8 μΩ/Ω + 5.5 Ω 13 μΩ/Ω + 250 Ω 5.8 μΩ/Ω + 330 Ω 0.04 μΩ/Ω + 9.9 kΩ 13 μΩ/Ω + 3.3 kΩ	Fluke 8508A

VII. Electrical – RF/Microwave

Parameter/Equipment	Range	CMC[2] (±)	Comments
RF Power – Generate[3]			
(+13 to -136) dBm	(0.25 to 1) GHz	1.2 dB	HP E4421B w/ HP 8482A Power sensor, power meter
(+10 to -60) dBm	(1 to 3) GHz	1.2 dB	

VIII. Fluid Quantities

Parameter/Equipment	Range	CMC[2] (±)	Comments
Air Velocity & Volume Flow[3] –			Wind tunnel, Δ P measurement with density correction for standard condition normalization.
Anemometers, thermal and vane style	(30 to 250) fpm (250 to 1500) fpm (1500 to 9000) fpm	(3.3 + 0.022 × *F*) fpm (12 + 0.023 × *F*) fpm (35 + 0.012 × *F*) fpm	*F* is the numerical value of the air velocity measured in fpm

Parameter/Equipment	Range	CMC[2] (±)	Comments
Leak Rate[3] (Pressure Decay) –			
Leak Orifices, Standards and Plates	(0.1 to 10^5) sccm	1.0 % of reading	By comparison to flow standards. Mass flow units, sccm and slm defined by SEMI E12.
Hydrometers[3]	(0.6 to 1.1) sp. gr.	0.0024 sp. gr.	ASTM E126; By comparison using a reference hydrometer
Mass & Volumetric Flow[3] –			
Gas – meters, controllers, rotometers and leak orifices	(0.1 to 100) sccm (0.1 to 1000) slm	1.0 % of reading 1.0 % of reading	By comparison to flow standards. Mass flow units, sccm and slm defined by SEMI E12.
Liquid – meters, controllers, rotometers and leak orifices	(0.01 to 10) gpm	(0.0018 + 0.014×*F*) gpm	Measured by time and weight. Density correction applied.
	(10 to 500) gpm	(0.015 + 0.0057×*F*) gpm	By comparison to flow standard in closed loop system. Density correction applied. *F* is the numerical value of the flow measured in gpm
Viscosity – Kinematic[3]			
Viscometers	(15 to 1 000) cSt	2.1 % of reading	OEM Specifications
Viscosity Cups	(15 to 1 000) cSt	2.1 % of reading	ASTM D1200 & D4212
Volume – Measuring Equipment[3]	(0.1 to 2 000) mL	0.3 mL	ASTM E542 Burettes graduated "to deliver", graduated cylinders, volumetric flasks, specific gravity flasks, measuring and dilution pipettes, and transfer and capacity pipettes.

IX. Mechanical

Parameter/Equipment	Range	CMC[2] (±)	Comments
Force[3] –			
Load Cells, Tensile & Compression Testers and Force Gauges	(25 to 250) cN (250 to 2000) cN	5.2 cN 53 cN	Correx gram gauge
	(0.01 to 500) lbf (100 to 100 000) lbf	0.08 % of reading 0.23 % of reading	ASTM E 74 & E 4, primary and secondary force standards
Direct Verification of Durometers[3] –			ASTM D2240
Verification of indenter shape and extension:			
Extension at zero reading	(0 to 0.2) in	160 µin	The dimensional characteristics of the indenter are verified by optical projection.
35° right circular conical frustum	Diameter of the base of the frustum	160 µin	
	Diameter of the top of the frustum	160 µin	
30° cone	Cone angle	0.1°	
	Diameter of the base of the cone	160 µin	
	Cone angle	0.1°	
1.2 mm radius	Tip radius	160 µin	
	Indenter thickness	160 µin	
	Indenter radius	160 µin	
Verification of the durometer spring	(0 to 100) Duro	0.89 Duro	Durocalibrator or balance

Parameter/Equipment	Range	CMC[2] (±)	Comments
Indirect Verification of Rockwell Hardness Testers[3] –			
HRA	HRA - Low Point HRA - Mid Point HRA - High Point	1.2 HRA 1.2 HRA 1.2 HRA	ASTM E18
HRB	HRB - Low Point HRB - Mid Point HRB - High Point	1.2 HRB 1.2 HRB 1.2 HRB	
HRC	HRC - Low Point HRC - Mid Point HRC - High Point	1.2 HRC 1.2 HRC 1.2 HRC	
HRE	HRE - Low Point HRE - Mid Point HRE - High Point	1.2 HRE 1.2 HRE 1.2 HRE	
HR15N	HR15N - Low Point HR15N - Mid Point HR15N - High Point	1.2 HR15N 1.2 HR15N 1.2 HR15N	
HR15T	HR15T - Low Point HR15T - Mid Point HR15T - High Point	1.2 HR15T 1.2 HR15T 1.2 HR15T	
HR30N	HR30N - Low Point HR30N - Mid Point HR30N - High Point	1.2 HR30N 1.2 HR30N 1.2 HR30N	
HR30T	HR30T - Low Point HR30T - Mid Point HR30T - High Point	1.2 HR30T 1.2 HR30T 1.2 HR30T	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Indirect Verification of Brinell Hardness Testers[3] –			
Repeatability:			ASTM E10
10/500/15	161 HBW	0.06*d*	*d* is the mean of the *n* mean test in millimeters
10/3000/15	270 HBW	0.06*d*	
Error:			
10/500/15	161 HBW	4.8 %	Uncertainty is stated as a percentage of the standardized test block hardness value.
10/3000/15	270 HBW	3.6 %	
Indirect Verification of Vickers Hardness Testers[3]	Error	The greater of 0.5 % of the mean of 5 diagonals or 0.6 µm (25 µin)	ASTM E92
	Repeatability	The greater of 0.25 µm (10 µin) or:	
	540 HV 18 HV	1.9 % 0.89 %	Repeatability uncertainty is given as a percentage of the mean of 5 diagonals.
Mass[3]	1 mg to 40 g (40 to 4000) g (4 to 32) kg	0.32 mg 30 mg 0.38 g	Single substitution
Pressure[3] –			
Gauges, Controllers and Transducers	(0 to 12 140) Lbf/in^2	50 parts in 10^6	Deadweight piston tester
Shore – Durometer Calibrators[3]			
Dimensional	(0 to 8) in.	490 µin	Optical Comparator
Mass	(0 to 4) kg	30 mg	Balance

Parameter/Equipment	Range	CMC[2] (±)	Comments
Vacuum[3] –	(1 to 10) mmHg	(0.019 + 0.0015 × *P*) mmHg	Capacitance transducer
Gauges, Controllers and Transducers	(10 to 1000) mmHg	(0.57 + 0.0013 × *P*) mmHg	*P* is the numerical value of the pressure measured in mmHg
	(-15 to 0.01) lbf/in^2	0.021 % of reading	Deadweight piston tester
Rotation – Measure[3]			
Belt speed, Line speed, Centrifuges, and Mechanical Tachometers	(1 to 99 999) rpm	0.03 % of reading	Reference tachometer
Scales & Balances[3, 5]	(0 to 100) lb (100 to 1000) lb (1000 to 5000) lb (5000 to 10000) lb	0.002 lb 0.02 lb 0.1 lb 0.1 lb	Certified weights, NIST handbook 44
	1 mg to 500 mg (0.5 to 20) g (20 to 5000) g	12 µg 12 µg + 4 µg/g 90 µg + 5 µg/g	
Torque – Generate[3]			
Torque Meters and Transducers	(1 to 1000) in lbf (1 to 2000) ft lbf	0.08 % of reading 0.08 % of reading	Deadweight and torque arms
Torque – Measure[3]			
Wrenches and Watches	(1 to 1000) in lbf (1 to 2000) ft lbf	0.5 % of reading 0.5 % of reading	Bench loader and transducers

X. Optical Quantities

Parameter/Equipment	Range	CMC[2, 3] (±)	Comments
Illuminance – Visible Light[3]			
(380 to 760) nm	Up to 2000 fc	69 fc	Reference light meter

XI. Thermodynamics

Parameter/Equipment	Range	CMC[2] (±)	Comments
Dew Point[3]	(-80 to 50) °C	0.85 °C	Hygrocomputer
Infrared Thermometers[3]	(350 to 1200) °C (10 to 350) °C	4.0 °C (1.9 + 0.003 × *C*) °C	Blackbody source Blackbody source
Relative Humidity[3]	(10 to 95) % RH	1.6 % RH	Hygrocomputer
Temperature – Measure[3]	0.01 °C (-200 to 660) °C (660 to 1250) °C	0.2 °C 0.02 °C 1.3 °C	Triple point water SPRT & indicator T/C & indicator

XII. Time & Frequency

Parameter/Equipment	Range	CMC[2, 3] (±)	Comments
Frequency – Measuring Equipment[3]	10 MHz 1µHz to 80MHz 250 kHz to 3GHz 1 Hz to 20 MHz	0.0015 µHz/Hz 0.58 µHz/Hz 0.58 µHz/Hz 6.3 µHz/Hz	Agilent Z3801A GPS Agilent 33250A Agilent E4421B Agilent 3325A
Frequency – Measure[3]	1 Hz to 12.4 GHz 1 Hz to 18 GHz 500 MHz to 26.5 GHz	0.0015 µHz/Hz 0.22 µHz/Hz 7.1 µHz/Hz	Agilent 53132A HP 5335 HP 5343A
Stop Watches & Timers[3]	(0.1 to 1 000) s (0.1 to 86 400) s	600 µs/s 0.22 µs/s	EAI C-510 HP 5335
Tachometer – Optical Pickup[3]	(0 to 60 000) rpm	0.09 rpm	Agilent 3325A

[1] This laboratory offers commercial and field calibration service.

[2] Calibration and Measurement Capability (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. Calibration and Measurement Capabilities represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

[3] Field calibration service is available for this calibration and this laboratory meets A2LA *R104 – General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

[4] In the statement of CMC, *L* is the numerical value of the nominal length of the device measured in inches, *R* is the resolution of the device measured in inches, and *D* is the diameter measured in inches.

[5] Volumetric results have similar uncertainty but are dependant upon the thermal coefficients of the measured liquid.

[6] CMC is to be no less than the acceptable closure error for the procedure.

[7] The measurands stated are generated with the Fluke 5520A, 5700A, 5500A, & 8508A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. Calibration and Measurement Capability is expressed as either a specific value that covers the full range, as a percentage of the reading, or a combination of the two.

[8] 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.

[9] This laboratory offers commercial dimensional testing service only.

[10] This test is not equivalent to that of a calibration.

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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 any additional program requirements in the field of calibration. 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 13th day of January 2010.

President & CEO
For the Accreditation Council
Certificate Number 1318.01
Valid to May 31, 2012
Revised: April 30, 2012

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