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

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CALIBRATION

Valid To: November 30, 2026 Certificate Number: 2348.01

In recognition of the successful completion of the A2LA evaluation process (including an assessment of the organization's compliance with A2LA's – R205 Calibration Program Requirements), accreditation is granted to this laboratory at the location listed above to perform the following calibrations[1, 10]:

I. Acoustical

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Sound Level Meters[3]–			
94 dB	31.5 Hz to 12.5 kHz 16 kHz	0.31 dB 0.32 dB	Bruel & Kjaer 4226
104 dB	31.5 Hz to 12.5 kHz 16 kHz	0.30 dB 0.34 dB	
114 dB	31.5 Hz to 12.5 kHz 16 kHz	0.30 dB 0.57 dB	

II. Chemical

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
pH – Measuring Equipment[3]	4.00 pH 7.00 pH 10.00 pH	0.012 pH 0.012 pH 0.012 pH	Buffer solutions

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Parameter/Equipment	Range	CMC[2, 5, 8] (±)	Comments
Conductivity – Measuring Equipment[3]	10 µS/cm 100 µS/cm 1410 µS/cm 10 000 µS/cm	0.65 µS/cm 2.2 µS/cm 6 µS/cm 41 µS/cm	Laboratory standard conductivity solution
Aerosol Particle Counters	(0.3 to 10) µm	2.9 %	TSI electrostatic classifier 3082 TSI condensation particle counter 3772

III. Dimensional

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Gage Blocks	Up to 4 in (> 4 to 20) in	(2.9 + 0.7*L*) µin (3.1 + 1.3*L*) µin	Electronic comparator, master steel gage blocks
Caliper[3]	Up to 20 in (> 20 to 40) in	(4.8*L* + 0.6*R*) µin (370 + 6*L*) µin	Gage blocks
Micrometer[3]	Up to 12 in (> 12 to 36) in	(4.8*L* + 0.6*R*) µin (43 + 8.8*L*) µin	Gage blocks
Bench Micrometers	Up to 20 in	(12 + 1.3*L*) µin	Gage blocks
Dial, Digital, & Test Indicator[3]	Up to 4 in	(4.8*L* + 0.6*R*) µin	Gage blocks
Height Gages[3]	Up to 40 in	(4.8*L* + 0.6*R*) µin	Gage blocks
Optical Flats	(1 to 8) in	6.2 µin	Standard optical flat

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Measuring Microscopes[3]	Up to 12 in	(95 + 3.0*L*) µin	Glass scale
Cylindrical Gages –			
Plug & Pin Gages	Up to 1 in (> 1 to 4) in (> 4 to 16) in	(6.8 + 0.7*D*) µin (5.4 + 2.2*D*) µin (10 + 1.7*D*) µin	Universal measuring standard-Supra-500
Plain Ring Gages	Up to 1 in (> 1 to 4) in (> 4 to 16) in	(13 + 0.9*D*) µin (13 + 1.2*D*) µin (12 + 2.2*D*) µin	Universal measuring standard-Supra-500 w/ID probes
Thread Wires	(4 to 20) TPI (> 20 to 80) TPI	17 µin 12 µin	Supermicrometer™ Universal measuring standard-Supra-500
Thread Plug Gage			Supermicrometer™ Universal measuring standard-Supra-500 w/ thread wires
Pitch Diameter	(4 to 20) TPI (> 20 to 80) TPI	(28 + 1.5*D*) µin (24 + 0.5*D*) µin	
Major Diameter	Up to 16 in	(11 + 1.5*D*) µin	Universal measuring standard-Supra-500
Thread Plug Gage –			
Minor Lead Angle	(4 to 80) TPI	(95 + 5.4*D*) µin (31 + 2.6*D*) µin 0.054°	Quest thread view machine
Major Minor Pitch Flank Angle	Up to 6 in	(80 + 4.5*L*) µin (84 + 3.8*L*) µin (50 + 5.5*L*) µin 0° 6” 32’	MicroScanner™
Thread Ring Gage –	(80 to 4.5) TPI	(67 + 0.5*D*) µin	Universal measuring standard-Supra-500 w/ probe MicroScanner™
Major Minor Pitch Flank Angle	Up to 6 in	(83 + 4.2*L*) µin (81 + 4.9*L*) µin (51 + 7.7*L*) µin 0° 6” 32’ 3’	

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Surface Plate[3] – Flatness Repeatability	(18 x 18) in to (36 × 72) in	13 µin 28 µin	Autocollimator, repeat-o-meter
Optical Comparator[3] – X Axis Y Axis Angle	Up to 12 in Up to 12 in Up to 360°	(46 + 4*L*) µin (47 + 3*L*) µin 2.5 min	Gage blocks, angle blocks
Angle Blocks[3]	Up to 45°	2.1 arc sec	Sine plate, gage blocks & electronic indicator
Crimping Tools[3]	Up to 1 in diameter	200 µin	Pin gages, optical comparator & pull tester
Precision Levels[3]	(2 to 15) in	150 µin	Gage blocks
Protractors/Clinometer[3]	Up to 180°	1.3 arc sec + 0.6*R*	Sine plate w/ angle blocks
Surface Roughness Specimens	Up to 400 µin	0.62 µin	SurfTest w/ reference specimen
Profilometers	Up to 400 µin	0.55 µin	Surface roughness specimen
Rotary Table	(1 to 360)°	4.1 arc sec	Renishaw laser
Steel Rules & Tapes – Steel Rules Measuring Tapes	Up to 72 in Up to 1200 in (in 40 in segments)	0.0027 in (6600 + 16*L*) µin	Kudale TSCU

IV. Dimensional Testing[1]

Parameter/Range	Range	CMC[2, 6] (±)	Comments
Length – 1D[9]	Up to 40 in Up to 110 in	5.2 µin/in (12 + 0.8*L*) µin	Gage blocks, CMM, Supra 500, etc Renishaw laser

V. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Voltage – Generate[3]	10 V Up to 220 mV 220 mV to 2.2V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	0.52 µV/V 7.5 µV/V + 0.39 µV 4.6 µV/V + 0.62 µV 3.1 µV/V + 2.3 µV 3.2 µV/V + 3.9 µV 4.7 µV/V + 39 µV 6.2 µV/V + 0.39 mV	Fluke 732B Fluke 5730A
DC Voltage – Measure[3] High Voltage	Up to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V (1000 to 10 000) V (10 000 to 70 000) V	5.7 µV/V + 0.2 µV 2.8 µV/V + 0.3 µV 2.8 µV/V + 0.5 µV 4.1 µV/V + 30 µV 4.3 µV/V + 0.5 mV 0.042 % + 0.6*R* 0.048 % + 0.6*R*	FLUKE 8588A Vitrek 4700/HLV-70
DC Current – Generate[3]	20 nA to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A (11 to 20) A (20 to 700) A (20.5 to 120) A	39 µA/A + 5.4 nA 31 µA/A + 6.2 nA 32 µA/A + 40 nA 46 µA/A + 0.70 µA 85 µA/A + 12 A 0.28 mA/A + 0.37 mA 1.1 mA/A + 0.75 mA 1.5 mA/A + 0.52 A 0.8 mA/A + 5.3 mA	Fluke 5730A, Fluke 5730A, Fluke 5725A Fluke 5522A Keysight 6680A HP 3458A, current shunts Fluke 5730A, 52120A

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
DC Current – Clamp Meters	(16.5 to 150) A (150 to 1000) A (1 to 5) kA	0.51 % + 0.15 A 0.52 % + 0.54 A 0.6 % + 1 A	Fluke 5522A w/ Fluke 5500 coils Fluke 5730A/52120A/ 6KA coil
DC Current – Measure[3]	(10 to 20) pA (20 to 200) pA (0.2 to 2) nA (2 to 20) nA (20 to 100) nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1A (1 to 10) A (10 to 30) A (30 to 100) A (100 to 700) A	1.2 % + 3.5 fA 1.2 % + 6 fA 0.27 % + 0.32 pA 0.24 % + 0.6 pA 0.018 % + 60 pA 35 µA/A + 60 pA 27 µA/A + 0.14 nA 31 µA/A + 1 nA 29 µA/A + 7 nA 30 µA/A + 70 nA 48 µA/A + 0.7 µA 0.014 % + 13 µA 0.028 % + 0.43 mA 0.07 % + 4.4 mA 0.026 % 0.038 %	Keithley 6517A HP 3458A, option 002 Fluke 8588A HP 3458A, current shunts
Resistance – Generate	(0 to 10.9999) Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω (0.33 to 1.099 999) kΩ (1.1 to 3.299 999) kΩ (3.3 to 10.999 99) kΩ (11 to 32.999 99) kΩ (33 to 109.9999) kΩ (110 to 329.9999) kΩ (0.33 to 1.099 999) MΩ (1.1 to 3.299 999) MΩ (3.3 to 10.999 99) MΩ (11 to 32.999 99) MΩ (33 to 109.9999) MΩ (110 to 330) MΩ (330 to 1100) MΩ	32 µΩ/Ω + 0.8 mΩ 24 µΩ/Ω + 1.2 mΩ 22 µΩ/Ω + 1.1 mΩ 23 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 16 mΩ 22 µΩ/Ω + 16 mΩ 22 µΩ/Ω + 0.16 Ω 22 µΩ/Ω + 0.16 Ω 26 µΩ/Ω + 5.4 Ω 25 µΩ/Ω + 5.4 Ω 47 µΩ/Ω + 39 Ω 0.1 mΩ/Ω + 54 Ω 0.22 mΩ/Ω + 2.1 kΩ 0.39 mΩ/Ω + 2.5 KΩ 2.3 mΩ/Ω + 79 KΩ 12 mΩ/Ω + 0.39 MΩ	Fluke 5522A
Fixed Points	1 Ω 10 kΩ 19 kΩ	10 µΩ/Ω 5 µΩ/Ω 5.2 µΩ/Ω	Fluke742A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Resistance – Generate (cont)			
Fixed 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	39 µΩ 85 µΩ/Ω 85 µΩ/Ω 21 µΩ/Ω 21 µΩ/Ω 9.3 µΩ/Ω 9.5 µΩ/Ω 6.3 µΩ/Ω 6.2 µΩ/Ω 6.3 µΩ/Ω 6.3 µΩ/Ω 7.8 µΩ/Ω 10 µΩ/Ω 12 µΩ/Ω 17 µΩ/Ω 36 µΩ/Ω 44 µΩ/Ω 98 µΩ/Ω	Fluke 5730A
High Resistance – Generate, Fixed Points[3]	1 MΩ 10 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ 10 TΩ	11 µΩ/Ω 16 µΩ/Ω 26 µΩ/Ω 46 µΩ/Ω 0.1 mΩ/Ω 0.14 mΩ/Ω 4 mΩ/Ω 12 mΩ/Ω	Ohm-Labs high resistors
Resistance – Measure[3]	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ (0.1 to 2) GΩ (2 to 20) GΩ (20 to 200) GΩ (0.2 to 2) TΩ (2 to 10) TΩ	12 µΩ/Ω + 4 µΩ 8.2 µΩ/Ω + 14 µΩ 7.2 µΩ/Ω + 0.05 mΩ 7.2 µΩ/Ω + 0.5 mΩ 7.2 µΩ/Ω + 5 mΩ 8.9 µΩ/Ω + 1 Ω 17 µΩ/Ω + 10 Ω 68 µΩ/Ω + 1 KΩ 0.02 µΩ/Ω + 0.1 MΩ 0.0053 % + 10 MΩ 0.27 % + 20 kΩ 0.27 % + 0.2 MΩ 0.44 % + 2 MΩ 0.44 % + 20 MΩ 1.3 % + 0.2 GΩ	Fluke 8588A *High voltage mode Keithley 6517A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Electrical Simulation of Thermocouple[3] –			
Type J	(-210 to 1200) °C	0.13 °C	Fluke 5522A w/ zero reference junction & SPRT
Type K	(-200 to 1372) °C	0.13 °C	
Type T	(-250 to 400) °C	0.13 °C	
Type N	(-200 to 1300) °C	0.14 °C	
Type E	(-250 to 1000) °C	0.14 °C	
Type B	(600 to 1820) °C	0.15 °C	
Type S	(0 to 1767) °C	0.15 °C	
Type R	(0 to 1767) °C	0.15 °C	
Capacitance – Measure[3]	(0.1 to 1) nF	0.12 % + 0.1 pF	Fluke 8588A
	(1 to 10) nF	0.066 % + 2 pF	
	(10 to 100) nF	0.041 % + 10 pF	
	(0.1 to 1) µF	0.042 % + 0.1 nF	
	(1 to 10) µF	0.044 % + 1 nF	
	(10 to 100) µF	0.062 % + 10 nF	
	(0.1 to 1) mF	0.063 % + 0.1µF	
	(1 to 10) mF	0.075 % + 1 µF	
	(10 to 100) mF	0.074 % + 10 µF	
Capacitance – Generate[3]	(0.22 to 0.4) nF	0.45 % + 8 pF	Fluke 5522A
	(0.40 to 1.1) nF	0.39 % + 8 pF	
	(1.1 to 3.3) nF	0.46 % + 8 pF	
	(3.3 to 11) nF	0.2 % + 8 pF	
	(11 to 33) nF	0.2 % + 80 pF	
	(33 to 110) nF	0.2 % + 80 pF	
	(0.11 to 0.33) µF	0.2 % + 0.24 nF	
	(0.33 to 1.1) µF	0.2 % + 0.8 nF	
	(1.1 to 3.3) µF	0.2 % + 2.4 nF	
	(3.3 to 11) µF	0.2 % + 8 nF	
	(11 to 33) µF	0.31 % + 24 nF	
	(33 to 110) µF	0.35 % + 80 nF	
	(0.11 to 0.33) mF	0.35 % + 0.24 µF	
	(0.33 to 1.1) mF	0.35 % + 0.8 µF	
	(1.1 to 3.3) mF	0.35 % + 2.4 µF	
	(3.3 to 11) mF	0.35 % + 8 µF	
	(11 to 33) mF	0.58 % + 24 µF	
	(33 to 110) mF	0.85 % + 80 µF	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
Capacitance Generate[3]			
Fixed Point:			
1 pF	1 kHz to 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.037 % 0.027 % 0.044 % 0.065 % 0.089 % 0.25 % 0.37 %	Agilent 16380A
10 pF	1 kHz to 1 MHz 2 MHz/3 MHz 4 MHz/5 MHz 10 MHz 13 MHz	0.011 % 0.011 % 0.012 % 0.016 % 0.019 %	
100 pF	1 kHz to 1 MHz 2 MHz/3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.011 % 0.012 % 0.014 % 0.017 % 0.035 % 0.050 %	
1000 pF	1 kHz to 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.012 % 0.015 % 0.030 % 0.046 % 0.063 % 0.19 % 0.28 %	
10 nF	(100/120) Hz (1/10/100) kHz	0.014 % 0.014 %	Agilent 16380C
100 nF	(100/120) Hz/1 kHz (1/10/100) kHz (100/120) Hz (1/10) kHz 100 kHz	0.014 % 0.014 % 0.014 % 0.014 % 0.015 %	
1000 nF	(100/120) Hz/1 kHz 10 kHz 100 kHz	0.014 % 0.021 % 0.70 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage – Generate[3]			
300 µV 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 1.0) MHz	0.25 mV/V + 4.0 µV 90 µV/V + 4.0 µV 90 µV/V + 4.0 µV 0.20 mV/V + 4.0 µV 0.50 mV/V + 5.0 µV 1.0 mV/V + 10 µV 1.4 mV/V + 20 µV 2.7 mV/V + 20 µV	Fluke 5730A, Fluke 5725A
(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 1.0) MHz	0.24 mV/V + 4.0 µV 90 µV/V + 4.0 µV 80 µV/V + 4.0 µV 0.20 mV/V + 4.0 µV 0.47 mV/V + 4.0 µV 1.0 mV/V + 10 µV 1.4 mV/V + 20 µV 1.4 mV/V + 20 µV	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.24 mV/V + 12 µV 90 µV/V + 6.2 µV 54 µV/V + 6.2 µV 0.12 mV/V + 6.2 µV 0.31 mV/V + 16 µV 0.62 mV/V + 20 µV 1.4 mV/V + 24 µV 2.7 mV/V + 47 µV	
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.24 mV/V + 40 µV 85 µV/V + 16 µV 37 µV/V + 8 µV 62 µV/V + 10 µV 77 µV/V + 31 µV 0.31 mV/V + 80 µV 0.93 mV/V + 0.2 µV 1.6 mV/V + 0.31 µV	
(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 1.0) MHz	0.24 mV/V + 0.4 mV 85 µV/V + 0.16 mV 38 µV/V + 54 µV 62 µV/V + 93 µV 77 µV/V + 0.2 mV 0.24 mV/V + 0.62 mV 0.93 mV/V + 2 mV 1.4 mV/V + 3.1 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	0.24 mV/V + 4 mV 0.85 mV/V + 1.5 mV 51 µV/V + 0.5 mV 80 µV/V + 1 mV 0.15 mV/V + 2.4 mV	

Parameter/Range	Frequency	CMC[2, 4, 6] (±)	Comments
AC Voltage – Generate[3] (cont)			
(220 to 750) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	72 µV/V + 3.1 mV 0.13 mV/V + 4.7 mV 0.47 mV/V + 8.5 mV 0.2 % + 35 mV	Fluke 5730A, Fluke 5725A
(750 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	70 µV/V + 3.1 mV 0.13mV/V + 4.7 mV 0.47mV/V + 8.5 mV	
AC Voltage – Measure[3]			
Up to 10 mV	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.026 % + 1.1 µV 0.034 % + 1.1 µV 0.035 % + 1.1 µV 0.03 % + 0.8 µV 1 % + 4 µV 2.1 % + 3.8 µV	Fluke 8588A
(10 to 100) mV	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.007 % + 0.5 µV 0.012 % + 0.5 µV 0.024 % + 1 µV 0.055 % + 5 µV 0.23 % + 31 µV 1.2 % + 0.1 mV	
100 mV to 1 V	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.0073 % + 5 µV 0.012 % + 5 µV 0.022 % + 0.01 mV 0.053 % + 0.05 mV 0.21 % + 0.3 mV 1 % + 1 mV	
(1 to 10) V	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.0066 % + 0.05 mV 0.012 % + 0.05 mV 0.022 % + 0.1 mV 0.052 % + 0.5 mV 0.21 % + 3.1 mV 1.1 % + 10 mV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage – Measure[3] (cont)			
(10 to 100) V	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.007 % + 0.5 mV 0.0091 % + 0.5 mV 0.022 % + 1 mV 0.052 % + 5 mV 0.35 % + 47 mV 1.1 % + 0.5 V	Vitrek 4700/HLV-70
(100 to 1000) V	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.0094 % + 25 mV 0.0093 % + 25 mV 0.023 % + 25 mV 0.054 % + 0.1 V	Fluke 8588A
High Voltage:			
(1000 to 10 000) V	60 Hz	0.18 % + 0.6*R*	Vitrek 4700/HLV- 70
(10 000 to 50 000) V	60 Hz	0.14 % + 0.6*R*	
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 1.0) MHz	1.4 mV/V + 1 µV 0.58 mV/V + 1 µV 0.33 mV/V + 1 µV 0.62 mV/V + 1.6 µV 0.93 mV/V + 2 µV 1.8 mV/V + 3.1 µV 1.9 mV/V + 6.2 µV 2.7 mV/V + 6.2 µV	Fluke 5790B
(2.2 to 7) 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 1.0) MHz	0.66 mV/V + 1 µV 0.29 mV/V + 1 µV 0.17 mV/V + 1 µV 0.32 mV/V + 1.5 µV 0.48 mV/V + 2 µV 0.93 mV/V + 3.1 µV 1 mV/V + 6.2 µV 1.8 mV/V + 6.2 µV	
(7 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 1.0) MHz	0.24 mV/V + 1 µV 0.15 mV/V + 1 µV 85 µV/V + 1 µV 0.17 mV/V + 1.6 µV 0.25 mV/V + 2 µV 0.63 mV/V + 3.1 µV 0.7 mV/V + 6.2 µV 1.4 mV/V + 6.2 µV	
(22 to 70) 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 1.0) MHz	0.19 mV/V + 1.2 µV 93 µV/V + 1.2 µV 51 µV/V + 1.2 µV 0.17 mV/V + 1.5 µV 0.25 mV/V + 2 µV 0.63 mV/V + 3.1 µV 0.52 mV/V + 6.2 µV 0.86 mV/V + 6.2 µV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage – Measure[3] (cont)			
(70 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 1.0) MHz	0.18 mV/V + 1.2 µV 66 µV/V + 1.2 µV 30 µV/V + 1.2 µV 54 µV/V + 1.6 µV 0.13 mV/V + 2 µV 0.2 mV/V + 3.1 µV 0.3 mV/V + 6.2 µV 0.78 mV/V + 6.2 µV	Fluke 5790B
(220 to 700) 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 1.0) MHz	0.17 mV/V + 1.2 µV 60 µV/V + 1.2 µV 26 µV/V + 1.2 µV 40 µV/V + 1.5 µV 62 µV/V + 2 µV 0.14 mV/V + 3.1 µV 0.24 mV/V + 6.2 µV 0.75 mV/V + 6.2 µV	
700 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.16 mV/V 52 µV/V 20 µV/V 36 µV/V 55 µV/V 0.13 mV/V 0.2 mV/V 0.7 mV/V	
(2.2 to 7) 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 1.0) MHz	0.16 mV/V 52 µV/V 19 µV/V 38 µV/V 64 µV/V 0.15 mV/V 0.32 mV/V 0.94 mV/V	
(7 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 1.0) MHz	0.16 mV/V 52 µV/V 21 µV/V 37 µV/V 64 µV/V 0.15 mV/V 0.31 mV/V 0.95 mV/V	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
AC Voltage – Measure[3] (cont)			
(22 to 70) 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 1.0) MHz	0.16 mV/V 54 µV/V 26 µV/V 44 µV/V 74 µV/V 0.16 mV/V 1.4 mV/V 1.4 mV/V	Fluke 5790B
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.16 mV/V 55 µV/V 25 µV/V 55 µV/V 80 µV/V 1.4 mV/V 1.4 mV/V	
(220 to 700) V	(15 to 50) Hz 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	1.6 mV/V 80 µV/V 32 µV/V 0.11 mV/V 0.4 mV/V	
(700 to 1000) V	(15 to 50) Hz 50 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	1.4 mV/V 80 µV/V 30 µV/V 1.4 mV/V 1.4 mV/V	
AC Voltage Flatness Measure[3]			
2.2 mV	30 Hz 120 kHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.04 % 0.06 % + 0.8 µV 0.14 % + 0.8 µV 0.24 % + 0.8 µV 0.54 % + 1.6 µV 0.8 % + 1.6 µV	Fluke 5790B
(2.2 to 7) mV	30 Hz 120 kHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.04 % 0.06 % + 0.8 µV 0.08 % + 0.8 µV 0.14 % + 0.8 µV 0.3 % + 0.8 µV 0.4 % + 0.8 µV	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
AC Voltage Flatness Measure[3] (cont)			
(7 to 22) mV	30 Hz 120 kHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.04 % 0.054 % 0.08 % 0.14 % 0.29 % 0.47 %	
(22 to 70) mV	30 Hz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.04 % 0.08 % 0.12 % 0.27 % 0.47 %	
(70 to 220) mV	30 Hz 500kHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.04 % 0.04 % 0.08 % 0.12 % 0.27 % 0.47 %	Fluke 5790B
(220 to 700) mV	30 Hz 500kHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.03 % 0.04 % 0.08 % 0.12 % 0.27 % 0.47 %	
700 mV to 2.2 V	30 Hz 500kHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.03 % 0.04 % 0.08 % 0.12 % 0.27 % 0.47 %	
(2.2 to 7) V	30 Hz 500kHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz	0.08 % 0.03 % 0.04 % 0.08 % 0.12 % 0.27 % 0.47 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Current – Generate[3]			
(29 to 330) µA	(10 to 30) kHz	1.3 % + 0.31 µA	Fluke 5522A
(0.33 to 3.3) mA	(10 to 30) kHz	0.77 % + 0.47 µA	
(3.3 to 33) mA	(10 to 30) kHz	0.31 % + 3.1 µA	
(33 to 330) mA	(10 to 30) kHz	0.31 % + 0.16 mA	
(0.33 to 1.1) A	(10 to 45) Hz	0.14 % + 77 µA	
(1.1 to 3) A	(10 to 45) Hz	0.14 % + 77 µA	
(3 to 20.5) A	(45 to 100) Hz	0.093 % + 5 mA	
	100 Hz to 1kHz	0.12 % + 5 mA	
	(1 to 5) kHz	2.4 % + 5 mA	
Up to 220 µA	(10 to 20) Hz	0.024 % + 16 nA	Fluke5730A/5725A
	(20 to 40) Hz	0.016 % + 10 nA	
	40 Hz to 1 kHz	0.01 % + 8 nA	
	(1 to 5) kHz	0.028 % + 12 nA	
	(5 to 10) kHz	0.1 % + 62 nA	
220 µA to 2.2 mA	(10 to 20) Hz	0.024 % + 39 nA	
	(20 to 40) Hz	0.016 % + 31 nA	
	40 Hz to 1 kHz	0.01 % + 31 nA	
	(1 to 5) kHz	0.019 % + 0.1 µA	
	(5 to 10) kHz	0.1 % + 0.62 µA	
(2.2 to 22) mA	(10 to 20) Hz	0.024 % + 0.39 µA	
	(20 to 40) Hz	0.016 % + 0.31 µA	
	40 Hz to 1 kHz	0.01 % + 0.31 µA	
	(1 to 5) kHz	0.019 % + 0.54 µA	
	(5 to 10) kHz	0.1 % + 4.7 µA	
(22 to 220) mA	(10 to 20) Hz	0.024 % + 3.8 µA	
	(20 to 40) Hz	0.016 % + 3.1 µA	
	40 Hz to 1 kHz	0.01 % + 2.4 µA	
	(1 to 5) kHz	0.019 % + 3.1 µA	
	(5 to 10) kHz	0.1 % + 9.3 µA	
220 mA to 2.2 A	20 Hz to 1 kHz	0.024 % + 31 µA	
	(1 to 5) kHz	0.039 % + 77 µA	
	(5 to 10) kHz	0.62 % + 0.16 mA	
(2.2 to 11) A	20 Hz to 1 kHz	0.036 % + 0.14 mA	
	(1 to 5) kHz	0.078 % + 0.3 mA	
	(5 to 10) kHz	0.28 % + 0.6 mA	
Up to 120 A	(10 to 65) Hz	0.026 % + 29 mA	Fluke 5730A /52120A
	(65 to 300) Hz	0.024 % + 46 mA	
	(0.3 to 1) kHz	0.077 % + 0.13 mA	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Clamp On Meters			
(16.5 to 150) A	(45 to 65) Hz (65 to 400) Hz	0.31 % + 0.03 A 0.86 % + 0.032 A	Fluke 5522A w/5500 coil
(150 to 1025) A	(45 to 5) Hz (65 to 400) Hz	0.34 % + 0.19 A 1.2 % + 0.35 A	
(1000 to 6000) A	(10 to 1000) Hz	0.58 % + 1 A	Fluke 5730A/ 52120A/6KA coil
AC Current – Measure			
Up to 20 µA	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.2 % + 2.5 nA 0.20 % + 2.5 nA 0.23 % + 2.5 nA	Fluke 8588A
(20 to 200) µA	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.026 % + 5 nA 0.051 % + 5 nA 0.072 % + 5 nA 0.45 % + 10 nA	
200 µA to 2 mA	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.026 % + 50 nA 0.051 % + 50 nA 0.072 % + 50 nA 0.45 % + 0.1 µA	
(2 to 20) mA	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.026 % + 0.5 µA 0.051 % + 0.5 µA 0.072 % + 0.5 µA 0.46 % + 1 µA	
(20 to 200) mA	1 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.026 % + 5 µA 0.05 % + 5 µA 0.07 % + 5 µA	
200 mA to 2 A	1 Hz to 2 kHz 2 to 10) kHz (10 to 30) kHz	0.026 % + 0.1 mA 0.051 % + 0.1 mA 0.084 % + 0.1 mA	
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.08 % + 0.5 mA 0.08 % + 0.5 mA	
(20 to 30) A	10 Hz to 2 kHz (2 to 5) kHz	0.08 % + 12 mA 0.12 % + 12 mA	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
AC Current – Measure (cont)			
Up to 1 mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (30 to 50) kHz (50 to 100) kHz	0.017 % 0.0075 % 0.006 % 0.0078 % 0.0083 % 0.016 % 0.017 %	
(1 to 10) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.016 % 0.0058 % 0.0033 % 0.0044 % 0.0069 %	
(10 to 200) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.016 % 0.0058 % 0.0033 % 0.0044 % 0.006 %	Fluke 5790B/A40B
(0.2 to 2) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (30 to 50) kHz (50 to 100) kHz	0.016 % 0.0058 % 0.0035 % 0.0038 % 0.0085 % 0.0068 % 0.008 %	
(2 to 20) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 30) kHz (30 to 100) kHz	0.017 % 0.0068 % 0.0048 % 0.0057 % 0.0079 % 0.0085 % 0.013 %	
(20 to 100) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz	0.018 % 0.0085 % 0.0069 % 0.0095 % 0.011 % 0.011 % 0.018 % 0.019 %	

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Oscilloscopes[3] –			
Amplitude DC Signal:			
Into 50 Ω Load	(-6.6 to 6.6) V	0.25 % + 40 µV	Fluke 5522A/SC1100
Into 1 MΩ Load	(-130 to 130) V	0.050 % + 40 µV	
Rise Time	< 300 ps	+0 ps/-100 ps	
Leveled Sine Wave Flatness, Relative to 50 kHz, 5 mV(p-p) to 5.5 V(p-p)	50 Hz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 MHz to 1.1 GHz	1.5 % + 100 µV 2.0 % + 100 µV 4.0 % + 100 µV 5.0 % + 100 µV	
Time Marker	(5 to 50) ms	(25 + 1000*t*) parts in 10^6	*t* is time in seconds
Into 50 Ω Load	20 ms to 2 ns	2.5 parts in 10^6	
Bandwidth	(0.1 to 300) MHz (300 to 550) MHz 550 MHz to 1.1 GHz 1.1 GHz to 3.2 GHz	2 % 2.7 % 3.3 % 4.1 %	FLUKE 9500B/9530
Time Marker	9.0091 ns to 83 µs 83 µs to 55 s	0.22 µs/s 2.4 µs/s	
Voltage:			
DC Into 1 MΩ	± 1 mV to 200 V	0.024 % + 20 µV	
DC Into 50 Ω	± 1 mV to 5 V	0.024 % + 20 µV	
Squarewave Into 1 MΩ	40 µV + 200 Vp-p	0.08 % + 8 µV	
Squarewave Into 50 Ω	40 µV + 5 Vp-p	0.08 % + 8 µV	
Risetime	10 Hz to 2 MHz	22 ps	
Tachometers[3]	(6 to 99 999) RPM	0.004 %	Frequency standard w/LED
Phase – Measure (0 to 360)[3]	5 Hz to 2 kHz (2 to 5) kHz (5 to 10) kHz (10 to 50) kHz	0.03° 0.04° 0.05° 0.06°	Clark Hess 6000A

VI. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
Power Sensor – Calibration Factors (-30 to 20) dBm (-30 to 20) dBm	 0.1 MHz to 4.2 GHz 50 MHz to 26.5 GHz	 2.8 % *CF* 3.5 % *CF*	Agilent power sensors 8482A & 8485A *CF* is calibration factor
Amplitude Modulation[3] – Carrier: (0.15 to 10) MHz Depth: Up to 99 % Carrier: 10 MHz to 1.3 GHz Depth: Up to 99 %	 (20 to 50) Hz 50 Hz to 10 kHz (20 to 50) Hz 50 Hz to 50 kHz (50 to 100) kHz	 3.8 % 2.7 % 3.8 % 1.6 % 3.8 %	HP 8902A measuring receiver w/ 11722A power sensor
Frequency Modulation[3] – Carrier: 250 kHz to 10 MHz Dev: Up to 40 kHz Carrier: 10 MHz to 1.3 GHz Dev: Up to 400 kHz	 20 Hz to 10 kHz (20 to 50) Hz 50 Hz to 100 kHz (100 to 200) kHz	 2.9 % 5.9 % 1.3 % 5.9 %	HP 8902A measuring receiver w/ 11722A power sensor
Phase Modulation[3] – Carrier: 150 kHz to 10 MHz Carrier: 10 MHz to 1.3 GHz	 200 Hz to 10 kHz 200 Hz to 20 kHz	 4.8 % 3.7 %	HP 8902A measuring receiver w/ 11722A power sensor
Absolute Power – Measure[3] (0 to -10) dBm (-10 to -20) dBm (-20 to -30) dBm (-30 to -40) dBm (-40 to -50) dBm (-50 to -60) dBm (-60 to -70) dBm (-70 to -80) dBm (-80 to -90) dBm (-90 to -100) dBm (-100 to -110) dBm (-110 to -120) dBm	 10 MHz to 26.5 GHz	 0.08 dB 0.10 dB 0.12 dB 0.13 dB 0.15 dB 0.17 dB 0.20 dB 0.23 dB 0.28 dB 0.33 dB 0.39 dB 0.43 dB	HP 8902A measuring receiver w/ 11722A & 11792A power sensors

VII. Fluid Quantities

Parameter/Equipment	Range[7]	CMC[2, 8] (±)	Comments
Flow – Gas[3]	(0.5 to 5) sccm (5 to 50) sccm (0.05 to 0.5) lpm (0.5 to 5) lpm (3 to 30) lpm (30 to 100) lpm (100 to 2500) lpm	1.2 % Rdg 1.2 % Rdg 0.28 % Rdg 0.26 % Rdg 0.42 % Rdg 0.65 % Rdg 1.2 % Rdg	DH instruments flow meter calibrator Molbox1 Alicat MCR2500SLM
Flow – Liquid[3]	(0.02 to 3) gpm (0.5 to 60.0) gpm (1.5 to 160) gpm (0.1 to 10) gpm (10 to 400) gpm	0.11 % Rdg 0.09 % Rdg 0.09 % Rdg 0.067 % Rdg 0.079 % Rdg	Flow technology turbine meter Compuflow test stand

VIII. Magnetic Quantities

Parameter/Equipment	Range[7]	CMC[2, 8] (±)	Comments
Gauss Meter[3]	(1 to 200) Gauss	0.88 % Rdg	Helmholtz coil, zero gauss chamber

IX. Optical Quantities

Parameter/Equipment	Range[7]	CMC[2, 8] (±)	Comments
Illuminance – Light Meters	(5 to 200) fc (200 to 2000) fc	2.8 % 3.1 %	Hoffman light source w/ PCS 600 light meter
Optical Wavelength – Measure	(700 to 1650) nm	0.000 48 % Rdg	Keysight 86120A
Optical Absolute Power – Measure	-20 dBm @ 850 nm -20 dBm @ 1550 nm	0.091 dBm 0.090 dBm	Agilent 81624A

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Optical Power Linearity – Measure			
850 nm	0 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm	0.022 dBm 0.024 dBm 0.023 dBm 0.024 dBm 0.024 dBm 0.029 dBm	Agilent 81624A
1310 nm	0 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm	0.023 dBm 0.024dBm 0.025 dBm 0.025 dBm 0.027 dBm 0.030 dBm	
1550 nm	0 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm	0.022 dBm 0.025 dBm 0.023 dBm 0.024 dBm 0.024 dBm 0.030 dBm	

X. Mechanical

Parameter/Equipment	Range	CMC[2] (±)	Comments
Pressure Gauges & Transducer /Vacuum[3]			
Vacuum	Up to 1 Torr (1 to 1000) Torr	0.0008 Torr 0.26 Torr	INFICON CDGsci DH Instrument PPC3
Pneumatic			
	(0 to 17) psia Up to 600 psig Up to 3000 psig Up to 6000 psig Up to 10 000 psig	0.002 % Rdg+ 0.001 psia 0.010 % Rdg + 0.001 psig 0.010 % Rdg+ 0.01 psig 0.011 % Rdg+ 0.1 psig 0.021 % Rdg+ 0.1 psig	Mensor CPC 8000 DH Instruments pressure calibrator, PPCH-G
Hydraulic			
	(5 to 40 000) psig (725 to 72 500) psi	0.030 % Rgd 0.030 % Rdg	Ruska Model 2450-701 DH-Budenberg 5306

Parameter/Equipment	Range	CMC[2] (±)	Comments
Torque Analyzers[3]	(1 to 10) ozf·in (10 to 100) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1000) lbf·in (20 to 250) lbf·ft (200 to 2000) lbf·ft	0.16 % Rdg Rdg 0.12 % Rdg 0.065 % Rdg 0.025 % Rdg 0.026 % Rdg 0.017 % Rdg 0.086 % Rdg	Torque arms w/ Class F weights
Torque Tools[3]	(1 to 10) ozf·in (10 to 100) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1000) lbf·in (20 to 250) lbf·ft (200 to 2000) lbf·ft	0.11 % Rdg 0.01 % Rdg 0.19 % Rdg 0.51 % Rdg 0.34 % Rdg 0.34 % Rdg 0.36 % Rdg	Mountz MTX10Z AWS: QC10-100 CDI torque, force & tension calibration system, Model: 200-400-02
Air Velocity Instruments	(25 to 350) fpm (350 to 1000) fpm (1000 to 9000) fpm	2.6 % Rdg 2.4 % Rdg 1.3 % Rdg	Omega WT4401-D petit tube
Fume Hood Anemometer Air Volume Flow	 (25 to 500) fpm (200 to 400) cfm	 4.9 % Rdg 9 cfm	 Testo anemometer Testo flow hood systems
Force Gages & Transducers[3]	Up to 1 lbf (1 to 100) lbf (1 to 1000) lbf (350 to 1000) lbf (1000 to 30 000) lbf (30 000 to 100 000) lbf	0.064 % Rdg 0.049 % Rdg 0.037 % Rdg 0.12 % Rdg 0.026 % Rdg + 1.5 lbf 0.028 % Rdg	Dead weights Morehouse force machine w/ load cell
Durometer Calibrator – A Scale D Scale	 (56.08 to 820.87) g (0 to 4.53) kg	 2.6 g 0.012 kg	 25 lbf load cell

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Pipettes	≤ 1 µL ≤ 10 µL ≤ 100 µL ≤ 1000 µL ≤ 5 mL ≤ 10 mL	0.007 µL 0.008 µL 0.017 µL 0.040 µL 0.045 µL 0.66 µL	Sartorius CC111, Sartorius WZA 225-CW mass comparator
Volumetric – Measure	(0 to 5) L	0.094 mL/L	Sartorius mass comparator
Durometers – Type A, B, O Type C, D, DO Indentor Geometry: Length Diameter Angle Radius	 (0 to 100) DUROS (0 to 100) DUROS Up to 0.2 in Up to 1 in (0 to 90)° Up to 1 in	 0.52 DUROS 0.46 DUROS 0.58 m·in 0.41 m·in 0.049° 0.18 m·in	 REX-1 durometer calibrator Optical comparator
Indirect Verification of Rockwell Hardness Testers[3]	HRA: Low Mid High HRBW: Low Mid High HRC: Low Mid High HR15N: Low Mid High	 0.31 HRA 0.22 HRA 0.19 HRA 0.60 HRBW 0.50 HRBW 0.68 HRBW 0.56 HRC 0.46 HRC 0.40 HRC 0.54 HR15N 0.47 HR15N 0.61 HR15N	ASTM E18

Parameter/Equipment	Range	CMC[2] (±)	Comments
Indirect Verification of Rockwell Hardness Testers[3] (cont)	HR15TW: Low Mid High HR30N: Low Mid High HR30TW: Low Mid High HR45N: Low Mid High HR45TW: Low Mid High	 0.29 HR15TW 0.29 HR15TW 0.47 HR15TW 0.35 HR30N 0.52 HR30N 0.57 HR30N 0.40 HR30TW 0.38 HR30TW 0.34 HR30TW 0.56 HR45N 0.35 HR45N 0.29 HR45N 0.89 HR45TW 0.62 HR45TW 0.61 HR45TW	ASTM E18
Direct Verification of Rockwell Hardness Testers Verification of Test Force Verification of Depth Measuring Device	 (15 to 150) kgf (0 to 260) µm	 0.08 % + 0.01 kgf 0.17 µm	 Load cell Digital indicator system
Accelerometers – Vibration: Sensitivity/Frequency Response Shock: Linearity Dynamic Pressure: Linearity	 (0.5 to 10) Hz (5 to 10 000) Hz (10 000 to 15 000) Hz Up to 10 000 g Up to 15 000 psi	 1.7 % Rdg 1.9 % Rdg 2.2 % Rdg 2.3 % Rdg 3.1 % Rdg	 Modal shop 9155w/ PCB accelerometers

Parameter/Equipment	Range	CMC[2, 6, 8] (±)	Comments
Balances[3]	Up to 310 g Up to 4100 g Up to 15 kg	0.3 mg + 0.6*R* 48 mg + 0.6*R* 0.52 g + 0.6*R*	Class 1 master weights
Scales[3]	Up to 100 lb Up to 1000 lb Up to 7200 lb	7.7 g + 0.6*R* 0.12 kg + 0.6*R* 0.051 % + 0.6*R*	Class 4 master weights Standard weights
Mass – Measure	30 kg 25 kg 20 kg 10 kg 5 kg 3 kg 2 kg 1 kg 500g 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 200 mg 100 mg 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	15 mg 13 mg 10g 5.5 mg 2.5 mg 4.9 mg 2.3 mg 1.6 mg 0.57 mg 0.36 mg 0.19 mg 0.19 mg 73 µg 64 µg 9.3 µg 6.1 µg 4.6 µg 4.2 µg 4.6 µg 4.6 µg 3.3 µg 3.2 µg 2.9 µg 2.9 µg 2.5 µg 3.0 µg 2.5 µg 2.5 µg 2.5 µg 2.9 µg 2.5 µg 2.5 µg	Single substitution
Mass – Measure (Avoirdupois)	1 lb 5 lb 10 lb 25 lb 50 lb 500 lb 1000 lb	5.3 µlb (2.4 mg) 5.3 µlb (2.4 mg) 2.1 µlb (9.5 mg) 11 µlb (4.8 mg) 33 µlb (15 mg) 0.026 lb (12 g) 0.068 lb (31 g)	Single substitution Load cell

X. Thermodynamics

Parameter/Equipment	Range	CMC[2, 6, 8] (±)	Comments
Temperature – Measure & Measuring Equipment	(-196 to -80) °C (-80 to 100) °C (100 to 660) °C (400 to 1600) °C	0.034 °C 0.021 °C 0.039 °C 0.27 % + 0.6*R*	Fluke 1560 w/SPRT, TempSens cal-sys -196/-80 & Fluke 7380 Type R TC w/ Tempsens cal-sys 1700
Infrared / Pyrometers[3]	(50 to 500) °C (150 to 1200) °C (-30 to 150) °C	1.4 °C + 0.6*R* 0.48 % + 0.6*R* 0.8 °C	Fluke 9132 ε = 0.95 (8 to 14) mm IsoTech Pegasus R970 ε = 0.995 (9 to 14) mm Fluke 9133 ε = 0.95 (8-14) mm
Humidity – Measuring Equipment (10 to 30) °C	(5 to 15) % RH (5 to 25) % RH (25 to 35) % RH (35 to 50) % RH (50 to 65) % RH (65 to 80) % RH (80 to 95) % RH	0.40 % RH 0.49 % RH 0.52 % RH 0.59 % RH 0.62 % RH 0.66 % RH 0.83 % RH	Rotronic HC2-SH & GEO 2000
Temperature – Measuring Equipment, Fixed Point	Triple Point of Water Liquid Nitrogen	8.3 mK 7.5 mK	Pond Engineering TPW
Humidity – Measure[3]			
(-50 to 90) °C	Frost Point Dew Point	1.1 °C 0.14 °C	Chilled mirror
(10 to 30) °C	(5 to 15) % RH (5 to 25) % RH (25 to 35) % RH	0.20 % RH 0.36 % RH 0.40 % RH	Rotronic HC2-SH
Sat(10 to 30) °C	(35 to 50) % RH (50 to 65) % RH (65 to 80) % RH (80 to 95) % RH	0.47 % RH 0.51 % RH 0.56 % RH 0.77 % RH	Rotronic HC2-SH

Parameter/Equipment	Range	CMC[2] (±)	Comments
Dew Point	(100 to -65) °C	0.35 °C	Edge tech 1500
Environmental Chambers, Ovens, Furnaces, Freezers, Temperature Baths & Dry Wells	(-80 to 1000) °C	2.0 ° C	Type K TCs & Vaisala RH probe

XI. Time & Frequency

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Frequency –Measuring Equipment	10 MHz Reference Signal	2.0 parts in 10^{10} Hz	Datum 9390-6000 w/ GPS
Frequency – Measure	1 MHz to 40 GHz	9.3 parts in 10^{9} Hz 1.4 part in 10^{7} Hz	10 MHz signal from Datum 9390-6000 w/GPS to: 53131 counter 53152A counter
Stopwatches	Up to 24 hrs	0.048 s/day	Timometer 4500

SATELLITE

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I. Chemical

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
pH – Measuring Equipment[3]	4 pH 7 pH 10 pH	0.01 pH 0.01 pH 0.01 pH	Buffer solutions
Gage Blocks	(0.05 to 12) in	(2.3 + 0.9L) µin	Pratt & Whitney LMU
Plain Ring Gages	(0.05 to 12) in	(4.1 + 0.9L) µin	Pratt and Whitney LMU
Caliper [3]	Up to 12 in	(157 + 3.7L) µin	Gage blocks
Micrometer [3]	Up to 24 in	(74.5 + 6.5L) µin	Gage blocks
Dial, Digital & Test Indicator [3]	(0.05 to 1) in	(61.95 + 5.4L) µin	Gage blocks
Height Gages[3]	Up to 40 in	(69.5 + 3.4L) µin	Gage blocks
Pin Gages [3]	(0.05 to 1) in	43 µin	Pratt & Whitney LMU

II. Electrical DC/Low

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
DC Voltage – Generate [3]	31 µV to 32.9999mV (0.33 to 3.299) V (3.3 to 32.999) V (30 to 329.999) V (100 to 1000) V	0.1 µV/mV + 4.5 µV 59 µV/V + 6.7 µV 59 µV/V + 67 µV 65 µV/V + 659 µV 65 µV/V + 1778 mV	Fluke 5500A
DC Voltage – Measure [3]	47 µV to 200 mV 200 mV to 2.0 V (2 to 20) V (20 to 200) V (200 to 1000) V	0.01 µV/mV + 47 µV 46 µV/V + 39 µV 42 µV/V + 47 µV 23 µV/V + 745 µV 1.7 µV/V + 4974 µV	Fluke 8508A
DC Current – Generate [3]	0.017 µA to 3.2999 mA (3.3 to32.999) mA (33 to 329.999) mA (0.33 to 2.199) A (2.2 to 11) A	0.61 µA/mA + 11 µA 0.47 µA/mA + 9.5 µA 0.08 µA/mA + 26 µA 182 µA/mA + 50 µA 694 µA/mA + 475 µA	Fluke 5500A
DC Current – Measure [3]	0.5 µA to 200 µA 200 µA to 2.0 mA 2.0 mA to 20 mA 20mA to 200 mA 200 mA to 2.0 A	0.049 µA 6.2 µA/mA + 0.7 µA 0.67 µA/mA + 12 µA 0.47 µA/mA + 16 µA 28 µA/mA +1045 µA	Fluke 8508A
Electrical Simulation of Thermocouple[3] –			Fluke 7526A
Type B	(600 to 800) °C (800 to 1550 °C (1550 to 1820) °C	0.55 °C 0.36 °C 0.31 °C	
Type C	Up to 1000 ºC (1000 to 1800) ºC (1800 to 2000) ºC (2000 to 2316) ºC	0.22 °C 0.31 °C 0.34 °C 0.45 °C	
Type E	(-200 to -100) ºC (-100 to 0) ºC Up to 600 ºC (600 to 1000) ºC	0.36 °C 0.24 °C 0.12 °C 0.13 °C	

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Electrical Simulation of Thermocouple[3] – (cont)			
Type J	(-210 to -100) ºC (-100 to 800) ºC (800 to 1200) ºC (600 to 800) ºC (800 to 1550) ºC	0.25 °C 0.13 °C 0.15 °C 0.55 °C 0.36 °C	Fluke 7526A
Type K	(-250 to -200) ºC (-200 to -100) ºC (-100 to 500) ºC (500 to 800) ºC (800 to 1372) ºC	0.57 °C 0.29 °C 0.15 °C 0.15 °C 0.18 °C	
Type N	(-250 to -200) ºC (-200 to -100) ºC (-100 to 0) ºC (0 to 100) ºC (100 to 800) ºC (800 to 1300) ºC	0.87 °C 0.34 °C 0.25 °C 0.25 °C 0.16 °C 0.18 °C	
Type R	(0 to 100) ºC (100 to 400) ºC (400 to 1000) ºC (1000 to 1767) ºC	0.63 °C 0.38 °C 0.33 °C 0.32 °C	
Type S	(0 to 400) ºC (400 to 1000) ºC (1000 to 1600) ºC (1600 to 1767) ºC	0.70 °C 0.39 °C 0.32 °C 0.59 °C	
Type T	(-250 to -200) ºC (-200 to -100) ºC (-100 to 0) ºC (0 to 200) ºC (200 to 400) ºC	0.44 °C 0.25 °C 0.21 °C 0.29 °C 0.29 °C	

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Simulation of RTD Indicators/Detectors [3]			Electrical Simulation of RTD output Fluke 7526A OEM manual
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.061 °C 0.031 °C 0.035 °C 0.037 °C 0.047 °C 0.052 °C	
Pt 385, 200 Ω	(-200 to -80) °C (-80 to 00 °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 630) °C	0.064 °C 0.067 °C 0.071 °C 0.071 °C 0.083 °C 0.085 °C 0.11 °C	
Pt 385, 500 Ω	(-200 to -0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.04 °C 0.043 °C 0.048 °C 0.047 °C 0.055 °C	
Pt 385, 1kΩ	(-200 to -0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.031 °C 0.033 °C 0.033 °C 0.035 °C 0.041 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) ° (400 to 600) °C (600 to 630) °C	0.02 °C 0.023 °C 0.024 °C 0.026 °C 0.032 °C 0.036 °C 0.041 °C 0.043 °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	0.021 °C 0.023 °C 0.025 °C 0.031 °C 0.035 °C 0.043 °C	

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Eddy Current – Measure[3]			Sigmascope SMP10 & Conductivity reference blocks BAC 5651
Conductivity	(16 to 25) % IACS (25.1 to 63) % IACS (63.1 to 101) % IACS	0.38 % IACS 0.5 % IACS 1.4 % IACS	
Standard Blocks	(16 to 25) % IACS (25.1 to 63) % IACS (63.1 to 101 % IACS	0.38 % IACS 0.5 % IACS 1.4 % IACS	

III. Mechanical

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Pressure Gauges & Vacuum [3]			DWT/PSI Gage Comparator Test Gages
Pneumatic	(0.1 to 30) psig (31 to 1000) psig (1001 to 5000) psig (5001 to 10 000) psig	0.24 psig 1.7 psig 1.8 psig 2.7 psig	
Vacuum Gauges	(-0.1 to -30) inHg	0.02 inHg	Reference Grade Digital
Torque Tools [3]	(4 to 50) lbf·in (51 to 1000) lbf·in (1001 to 2400) lbf·in (30 to 250) lbf·ft (100 to 1000) lbf·ft	0.21 lbf·in 2.7 lbf·in 3.5 lbf·in 1.3 lbf·ft 8.9 lbf·ft	AKO Torque Calibration System NAVAIR 17-20MU-81
Force, Tension & Compression [3]	Up to 15000 lbf	0.5 % of Rdg	Calibrated load cell
Balances [3]	Up to 5 g (5 to 205) g (200 to 500) g (500 to 4000)g (4 to 10) Kg	0.038 mg 0.34 mg 3.3 mg 33 mg 330 mg	Class 1 weights
Scales [3]	Up to 1500 lb	0.52 lb	Class F weights

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Indirect Verification of Microindentation Hardness Knoop	(100 to 1000) HK	(17 + 0.008X) HK	ASTM E92
Indirect Verification of Microindentation Vickers[3]	(100 to 1000) HV	(12 + 0.012X) HV	ASTM E92
Indirect Verification of Hardness Brinell 10mm ball	HBW 500 kg 1000 kg 3000 kg (0 to 173) HBW 3000 kg (174 to 395) HBW 3000 kg (396 to 561) HBW	 1.5 HBW 1.2 HBW 1.5 HBW 4.9 HBW 7.4 HBW	Brinell Test Blocks ASTM E10
Indirect Verification of Rockwell Hardness[3]	HRA (20 to 65) HRA (70 to 78) HRA (79 to 84) HRA HRBW (40 to 59) HRBW (60 to 79) HRBW (80 to 100) HRBW HRC (20 to 30) HRC (35 to 55) HRC (60 to 65) HRC HREW (70 to 79) HREW (83 to 90) HREW (93 to 100) HREW HR15 (70 to 77) HR15 (78 to 88) HR15 (90 to 92) HR15	 0.54 HRA 0.68 HRA 0.57 HRA 0.54 HRBW 0.58 HRBW 0.64 HRBW 0.58 HRC 0.59 HRC 0.54 HRC 0.61 HREW 0.58 HREW 0.58 HREW 0.57 HR15 0.66 HR15 0.55 HR15	Rockwell test blocks ASTM E18

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Indirect Verification of Rockwell Hardness[3] (cont)	HR30N (42 to 50) HR30N (55 to 73) HR30N (77 to 82) HR30N HR45N (20 to 31) HR45N (37 to 61) HR45N (66 to 72) HR45N HR15TW (74 to 80) HR15TW (81 to 86) HR15TW (87 to 93) HR15TW HR30TW (43 to 56) HR30TW (57 to 69) HR30TW (70 to 83) HR30TW	 0.68 HR30N 0.66 HR30N 0.60 HR30N 0.55 HR45N 0.54 HR45N 0.54 HR45N 0.54 HR15TW 0.60 HR15TW 0.76 HR15TW 0.59 HR30TW 0.66 HR30TW 0.65 HR30TW	Rockwell test blocks ASTM E18

IV. Thermodynamics

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Temperature Measure [3]	(50 to 749) ºC (750 to 999) ºC (1000 to 1450) ºC	0.3 ºC 1 ºC 0.7 ºC	Fluke 5605, thermocouple S, Fluke 7526A, ASTM E220 ε = 0.99
Infrared / Pyrometers [3]	(38 to 600) ºC (601 to 1100) ºC (1101 to 1200) ºC	2.8 °C 4.9 °C 5.9 °C	IR-564 Blackbody Source, IR-300 Control NAVAIR 17-20ST-220
Ovens, Autoclaves, Freezers, Refrigerators, Environmental Chambers, Liquid Baths [3] Type K Type N Type K Type N	(-87.2 to 1204.4) °C TUS TUS SAT SAT	 ± 1.2 °C ± 1.3 °C ± 1.4 °C ± 1.2 °C	Thermocouples AMS 2750 Customer Specific Specifications

V. Time & Frequency

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Digital Stop Watches & Timers [3]	1 sec to 24 Hr	0.24 sec / 24 Hr	Robic Digital Timer
Analog Stop Watches & Timers [3]	5 sec to 24 Hr	1.3 sec / 24 Hr	Robic Digital Timer

SATELLITE

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I. Acoustical

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Sound Level Meters[3] – 125 Hz to 4000 Hz	114 dB 104 dB 94 dB 84 dB 74 dB	0.26 dB 0.38 dB 0.39 dB 0.48 dB 0.86 dB	IET Labs 1986 Omnical Sound Level Calibrator

II. Chemical

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Conductivity – Liquid Measuring Equipment[3]	84 µS/cm 1413 µS/cm 12 880 µS/cm	0.8 µs/cm 4.0 µs/cm 50.0 µs/cm	Laboratory standard conductivity solution
Conductivity – Metal Measuring Equipment[3]	9.33 %IACS 14.92 %IACS 25.80 %IACS 32.56 %IACS 44.92 %IACS 59.42 %IACS 100.97 %IACS	0.2 %IACS 0.35 %IACS 0.31 %IACS 0.38 %IACS 0.37 %IACS 0.47 %IACS 1.5 %IACS	Metal Conductivity Standards
Metal Conductivity Standards	Up to 102 %IACS	0.013% + 0.2 %IACS	Conductivity Meter
pH – Measuring Equipment[3]	4.00 pH 7.00 pH 10.00 Ph	0.017 pH 0.017 pH 0.017 pH	Buffer solutions

III. Dimensional

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Angle Blocks	Up to 90°	0.0015°	Angle blocks
Angle Gages	Up to 120°	0.00 58°	Video measuring system
Bore Gages/Intramics	(0.150 to 1.000) in (3.810 to 25.400) mm (1.000 to 2.000) in (25.4025 to 50.800) mm (2.000 to 3.000) in (50.8025 to 76.200) mm (3.000 to 4.000) in (76.2025 to 101.600) mm (4.000 to 5.000) in (101.6025 to 127.000) mm (5.000 to 6.000) in (127.0025 to 152.40) mm (6.000 to 7.000) in (152.4025 to 177.800) mm	(4.2 + 1.4*D*) µin (110 + 1.4*D*) nm (3.5 + 2.1*D*) µin (89 + 2.1*D*) nm (3.1 + 2.3*D*) µin (79 + 2.3*D*) nm (4 + 2*D*) µin (100 + 2.0*D*) nm (12 + 6*D*) µin (300 + 6.0*D*) nm (8 + 2*D*) µin (200 + 2.0*D*) nm (8 + 2*D*) µin (200 + 2.0*D*) nm	Lab Master, gage blocks, cylindrical rings
Calipers[3]	Up to 6 in Up to 150 mm (6.000 5 to 12) in (150.001 to 300) mm (12.000 5 to 18) in (300.001 to 450) mm (18.000 5 to 24) in (450.001 to 600) mm (24.000 5 to 36) in (600.001 to 900) mm (36.000 5 to 48) in (900.001 to 1 200) mm (48.000 5 to 60) in (1 200.001 to 1 500) mm (60.00 5 to 72) in 1500.001 to 1 830) mm	(3.7 + 3.6*L*) µin (94 + 3.6*L*) nm (3 + 4*L*) µin (76 + 4*L*) nm (5 + 4.5*L*) µin 4.5*L* nm + 0.13 µm (20 + 5*L*) µin 5.0*L* nm + 0.51 µm (15 + 4.6*L*) µin 4.6*L* nm + 0.38 µm (11 + 4.2*L*) µin 4.2*L* nm + 0.28 µm (70 + 2.5*L*) µin 2.5*L* nm + 1.8 µm (270 + 7.5*L*) µin 7.5*L* nm + 6.9 µm	Gage Blocks

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Chamfer & Countersink Gages	Up to 3 in Up to 76.2 mm	(170 + 110*D*) µin 4.3 µm + 110*D* nm	Chamfer rings
Coating Thickness	Up to 0.060 in	0.022 + 0.0035*L* mils	Comparison to master films
Concentricity Gage	Up to 0.050 in	8 µin	LVDT with amplifier master cylinder
Crimpers	Up to 12 in Up to 3048 mm (0.011 to 0.060) in (0.061 to 0.250) in (0.251 to 0.500) in	(80 + 3.2*L*) µin (2 + 3.25*L*) µm (140 + 200*L*) µin (140 + 160*L*) µin (130 + 80*L*) µin	Video measuring system Pin Gages
Depth Measuring Instruments, Gages & Micrometers[3]	Up to 6 in Up to 150 mm (6000 to 12) in (150 001 to 300) mm (12 000 to 18) in (300 001 to 450) mm (18 000 to 24) in (450 001 to 600) mm	(12 + 1.3L) µin 1.30L nm + 0.30 µm (20 + 2.5L) µin 2.50L nm + 0.51 µm (14 + 5L) µin 5L nm + 0.36 µm (15 + 4.8L) µin 4.8L nm + 0.38 µm	Gage Blocks, Surface Plate
Flatness[3] – Anvils, Spindles, Gage Stands & Gage Blocks	 Up to 3 in diameter Up to 76.2 mm diameter	 2.8 µin 0.071 µm	Comparison to master optical flat under monochromatic light source
Gage Block – Length	(0.01 to 0.21) in (0.031 25 to 4) in 2 in 3 in 4 in (5 to 20) in (125 to 500) mm	4.7 µin (2.5 + 1.7*L*) µin 5.7 µin 7.2 µin 8.9 µin (8.8 + 1.2*L*) µin 1.218L nm + 0.224 µm	Gage Blocks, Gage Block Comparator Lab Master 175

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Gage Block – Parallelism	Up to 4 in Up to 100 mm (5 to 20) in (125 to 500) mm	2.7 µin 0.069 µm 1.6 µin 0.04 µm	Gage block Comparator Lab Master 175
Glass Scale / Stage Micrometer	Up to 12 in Up to 3048 mm	(80 + 3.2*L*) µin (2 + 3.2*L*) nm	Video measuring system
Height Gages[3] – Dial, Digital & Vernier	Up to 12 in Up to 300 mm (12.000 to 18) in (300 001 to 450) mm (18.000 to 24) in (450 001 to 600) mm (24 000 to 36) in (600 001 to 900) mm (36 000 to 48) in (900 001 to 1200) mm (48 000 to 60) in (1 200 001 to 1500) mm	(17 + 3*L*) µin 3*L* nm +0.43 µm (35 + 3.5*L*) µin 3.5*L* nm + 0.86 µm (21 + 6.3L) µin 6.3*L* nm + 0.53 µm (41 + 3.3L) µin 3.30*L* nm + 1.04 µm (30 + 5L) µin 5*L* nm + 0.76 µm (60 + 2.5L) µin 2.5*L* nm + 1.52 µm	Gage blocks surface plate
High Accuracy Height Gages	Up to 12 in Up to 300 mm (12.000 1 to 18) in (300 001 to 450) mm (18 000 1 to 24) in 450 000 1 to 609.6) mm	(23 + 1.7*L*) µin 0.17*L* nm + 0.58 µm (8 + 2*L*) µin 2*L* nm + 0.20 µm (14 + 1.8*L*) µin 1.8*L* nm + 0.36 µm	Gage blocks Surface plate
Indicators[3] – Digital, Dial, Bore Gages with Removable Indicator	Up to 4 in Up to 101.6 mm	(6.8 + 2.6*L*) µin (170 + 2.6*L*) nm	Gage blocks

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Indicators Test[3] –	Up to 0.05 in Up to 1.25 mm	15 µin 0.381 µm	Calibration Tester, Gage Blocks
Cylindrical Gages, Protusion Gages & Washer Rings			LMU-175,gage blocks
Inside measurements	(0.040 to 0.125) in (1.015 to 3.175) mm	4.4 µin 0.11 µm	
	(0.125 to 0.250) in (3.175 to 6.350) mm	4.5 µin 0.14 µm	
	(0.250 to 1.000) in (6.350 to 25.400) mm	5.2 µin 0.13 µm	
	(1.000 to 2.000) in (50.8025 to 76.2000) mm	5.5 µin 0.14 µm	
	(2.0001 to 3.0000) in (50.8025 to 76.2000) mm	5.5 µin 0.14 µm	
	(30001 to 4.0000) in (76.2025 to 101.6000) mm	5.5 µin 0.14 µm	
	(4.0001 to 5.0000) in (101.6025 to 127.0000) mm	6.2 µin 0.16 µm	
	(5.0001 to 6.0000) in (127.0025 to 152.4000) mm	6.6 µin 0.17 µm	
	(6.0001 to 7.0000) in (152.4025 to 177.8000) mm	8.8 µin 0.23 µm	
	(7.0001 to 8.0000) in (1778025 to 2032000) mm	9.2 µin 0.23 µm	
	(8.0001 to 9.0000) in (203.2025 to 228.6000) mm	9.2 µin 0.23 µm	
	(9.0001 to 10.0000) in (228.6025 to 254.0000) mm	9.2 µin 0.23 µm	
	(10.0001 to 11.0000) in (254.0025 to 279.4000) mm	10.0 µin 0.25 µm	
	(11.0001 to 12.0000) in (279.4025 to 304.8000) mm	13 µin 0.33 µm	

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Inside / Outside Measurement Non-Contact	 Up to 12 in Up to 304.8 mm	 (80 + 3.2L) µin (2.03 + 3.2L) µm	Video Measuring System
Inspection Fixtures Parallelism Perpendicularity / Squareness V-Groove Parallelism	 Up to 72 in Up to 1 825 mm Up to 24 in Up to 455 mm Up to 12 in Up to 305 mm	 (37 + 0.4L) µin (0.94 + 0.4L) nm (37 + 65.5L) µin (0.94 + 5.5L) nm (37 + 7L) µin (0.94 + 7L) nm	 Surface Plate, LVDT with Amplifier Surface Plate, Granite Square, LVDT with Amplifier Surface Plate, Master Cylinders, LVDT
Laser Micrometer[3]	(0.05 to 1.00) in (1.27 to 25.4) mm	(4.1 + 31L) µin (104 + 31L) nm	Master Cylinders
Step Height Parallelism	Up to 5 000 µin	8.5 µin	LVDT w/ Amplifier
Levels	Up to 18 in Up to 455 mm	(6.4+ 5.6L) µin (160 + 5.6L) nm	Gage Blocks & Surface Plate
Micrometers[3] Inside	 Up to 6 in Up to 150 mm (6.0001 to 12) in (150.001 to 300) mm (12.0001 to 32) in (300.001 to 800) mm (32.001 to 60) in (800.001 to 1525) mm	 (7.4 + 2.6L) µin (190 + 2.60L) nm (13 + 3.2L) µin (3.20L nm) + 0.33 µm (21 + 2.8L) µin (2.80L nm) + 0.53 µm (27 + 2.9L) µin (2.90L nm) + 0.69 µm	Gage blocks

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Micrometers[3] (cont) Outside	 Up to 6 in Up to 150 mm (6.0001 to 12) in (150.001 to 300) mm (12.0001 to 18) in (300.001 to 450) mm (18.0001 to 24) in (450.001 to 600) mm (24.0001 to 30) in (600.001 to 750) mm (30.0001 to 36) in (750.001 to 900) mm (36.0001 to 42) in (900.001 to 1050) mm (42.0001 to 48) in (1050.001 to 1200) mm (48.0001 to 54) in (1200.001 to 1375) mm (54.0001 to 60) in (1375.001 to 1525) mm	 (18 + 0.26L) µin (457.20 + 0.26L) nm (19 + 1L) µin (482.60 + 1.00L) nm (28 + 0.67L) µin (711.20 + 0.67L) nm (20 + 3.3L) µin (3.30L nm) + 0.51 µm (52 + 0.17L) µin (0.17L nm) + 1.3 µm (49 + 2.5L) µin 2.50L nm + 1.2 µm (97 + 3.5L) µin (3.50L nm) + 2.5 µm (89 + 2.8L) µin (2.80L nm) + 2.3 µm (76 + 2.2L) µin (2.20L nm) + 1.83 µm (110 + 2.7L) µin (2.70L nm) + 2.8 µm	Gage Blocks
Length/Height -Ranged - Caliper Checkers - Check Master - Depth Mic Master - Height Master - Mic Master - Micrometer Standards - Rise Blocks - Standard Reference Bars	Up to 6 in Up to 155 mm (6.0001 to 12) in (150.001 to 300) mm (12.0001 to 18) in (300.001 to 450) mm (18.0001 to 24) in (450.001 to 600) mm (24.0001 to 36) in (600.001 to 900) mm (36.0001 to 48) in (900.001 to 1200) mm (48.0001 to 60) in (1200.001 to 1500) mm	(12 + 0.2L) µin (0.20L nm) + 0.30 µm (12 + 0.33L) µin (0.33L nm) + 0.30 µm (17 + 0.33L) µin (0.33L nm) + 0.43 µm (14 + 0.67L) µin (0.67L nm) + 0.36 µm (19 + 0.58L) µin (0.58L nm) + 0.48 µm (21 + 0.17L) µin (0.17L nm) + 0.53 µm (22 + 0.17L) µin (0.17L nm) + 0.56 µm	Surface Plate, Gage Blocks and LVDT with Amplifier
Mu-Checker/Gage Amplifier & Probe[3]	Up to 0.05 in Up to 1.25 mm	5 µin 110 nm	Gage Blocks

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Microscope[3] Linearity X Y Angle	 Up to 4 in Up to 101.6 mm 0 to 90 °	 (8.8 + 1.5L) µin (220 + 1.50L) nm 0.012 °	 Gage Blocks Angle Blocks
Optical Comparator[3] – Stage Movement Angularity X Y Squareness X Y Magnification X Y	 (0.5 to 12) in (12.7 mm to 304.8 mm) 0° to 360° (12 in of X axis travel maximum, Y axis travel maximum less than 12 in) 10X, 20X, 31.25X, 50X, 62.5X, 100X	 (37 + 12L) µin (940 + 12.00L) nm 0.0013° 0.08 %	 Gage blocks True square Gage Blocks, glass scales
Optical Flats	Up to 3 in diameter Up to 76.2 mm diameter	2.8 µin 0.071 µm	Comparison to master optical flat
Optical Parallels Flatness parallelism	 Up to 3 in diameter Up to 76.2 mm dia Up to 3 in diameter Up to 76.2 mm dia	 2.8 µin 0.071 µm 0.75 µin 0.019 µm	Comparison to master optical flat
Protractors[3]	Up to 90°	0.023 °	Master angle blocks
Radius Length	Up to 6 in Up to 152.4 mm	(80 + 3.2L) µin (3.2L nm) + 2.03 µm	Video measuring system

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Outside Measurements Cylindrical Plug Gages, Deltronic Pin Gages, Discs, Master Cylinders, Spheres (Diameter)	Up to 1.0000 in Up to 25.4000 mm (1.0001 to 2.0000) in (25.4025 to 50.8000) mm (2.0001 to 3.0000) in (50.8025 to 76.2000) mm (3.0001 to 4.0000) in (76.2025 to 101.6000) mm (4.0001 to 5.0000) in (101.6025 to 127.0000) mm (5.0001 to 6.0000) in (127.0025 to 152.4000) mm (6.0001 to 7.0000) in (152.4025 to 177.8000) mm (7.0001 to 8.0000) in (177.8025 to 203.2000) mm (8.0001 to 9.0000) in (203.2025 to 228.6000) mm (9.0001 to 10.0000) in (228.6025 to 254.0000) mm	6.0 µin 0.150 µm 6.3 µin 0.160 µm 6.3 µin 0.160 µm 6.3 µin 0.160 µm 6.9 µin 0.170 µm 7.2 µin 0.180 µm 9.5 µin 0.240 µm 9.5 µin 0.240 µm 9.5 µin 0.240 µm 9.5 µin 0.240 µm	LMU-175, Gage Blocks
Rulers & Tape	Up to 12 in Up to 304.8 mm (12 to 300) in (304.0 to 365.7) mm	(80 + 3.2L) µin (3.2L nm) + 2.03 µm (1100 + 8.3L) µin (8.3L nm) + 27.94 µm	Video Measuring System Gage Blocks

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Sine Bars/Plates	Up to 5 in Up to 127 mm	(23 + 20L) µin 20*L* nm + 0.58 µm	Squares, angle blocks LVDT w/ amplifier, gage blocks
Surface Plates[3]			
Flatness	Up to 12 in Up to 300 mm	20 µin 0.51 µm	LVDT with Amplifier
	(12 to 120) in (300 to 3050) mm	21 µin 0.54 µm	Auto Collimator
Repeatability	0.002 in 0.05 mm	25 µin 0.64 µm	Repeat O Meter
Surface Roughness - Profilometer	118.6 µin Ra 2.96 µm Ra	1 µin 0.03 µm	Roughness Specimen
	40 µin Ra 1.02 µm Ra	2.5 µin 0.064 µm	
	20 µin Ra 0.508 µm Ra	1.2 µin 0.031 µm	
	15.9 µin Ra 0.378 µm Ra	1 µin 0.03 µm	
Surface Roughness Patch / Specimens	(2 to 500) µin Ra (0.0508 to 127) µm Ra	9.2 nin/µin + 0.92 µin 0.23 nm/µm + 0.023 µm	Profilometer w/ specimens
Tapered Thread Plug			
Major Diameter	Up to 6 in Up to 150 mm	(100 + 1.3*D*) µin 1.3*D* nm + 2.56 µm	Lab Master 175, thread wires
Pitch Diameter	Up to 6 in Up to 150 mm	(110 + 1.3*D*) µin 1.3*D* nm + 2.79 µm	
Tapered Thread Ring - Thickness / Step Height	Up to 6 in Up to 150 mm	(3.1 + 1.3D) µin 1.3*D* nm + 0.13 µm	Gage blocks, master taper plugs, Lab Master

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Thread Plug Major Diameter Pitch Diameter (127 to 4) TPI (0.35 to 2.50) mm	 Up to 10 in Up to 254 mm Up to 10 in Up to 254 mm	 (5.6 + 1.2*D*) µin 1.2*D* nm + 0.14 µm (29 + 1.2*D*) µin 1.2*D* nm + 0.74 µm	Lab Master 175, Gage Blocks, Thread Wires
Thread Rings Pitch Diameter Taper	 Up to 4.5000 in Up to 115.000 mm Up to 6 in Up to 150 mm	 (29.0 + 1.3D) µin (1.33D nm) + 0.74 µm (110 + 1.3D) µin (1.30D nm) + 2.8 µm	 Setting Plug Gages Gage blocks, master taper plugs, Lab Master 175
Thread & Gear Wires	Up to 1.000 0 in Dia Up to 25.400 mm Dia	7.9 µin 0.22 µm	Lab Master 175, gage blocks, master cylinders
Video Measuring System Keyence[3]	Up to 12 in	(6.6 + 16L) µin	Master Cylinders

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Frequency	CMC[2, 4] (□)	Comments
AC Current – Generate[3]			
Up to 220 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	700 µA/A + 25 nA 350 µA/A + 20 nA 140 µA/A + 16 nA 600 µA/A + 40 nA 1.6 mA/A + 80 nA	Fluke 5700A, Fluke 5725A
220 µA to 2.02 mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	700 µA/A + 40 nA 350 µA/A + 35 nA 140 µA/A + 35 nA 600 µA/A + 400 nA 1.6 mA/A + 800 nA	
(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	700 µA/A + 400 nA 350 µA/A + 350 nA 140 µA/A + 350 nA 600 µA/A + 4 µA 1.6 mA/A + 8 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	700 µA/A + 4 µA 350 µA/A + 3.5 µA 140 µA/A + 3.5 µA 600 µA/A + 40 µA 1.6 mA/A + 80 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	650 µA/A + 35 µA 750 µA/A + 80 µA 8.5 mA/A + 160 µA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	460 µA/A + 170 µA 950 µA/A + 380 µA 3.6 mA/A + 760 µA	
(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	0.44 nA/A + 160 nA 0.22 nA/A + 98 nA 0.16 nA/A + 49 nA 1.1 nA/A + 18 nA 0.99 nA/A + 43 nA 9.5 nA/A + 220 nA	Fluke 5522A
330 µA 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	3.4 µA/A + 0.31 µA 2.5 µA/A + 0.27 µA 0.14 µA/A + 54 nA 0.14 µA/A + 46 nA 0.77 µA/A + 140 nA 0.44 µA/A + 1.1 µA	

Parameter/Equipment	Frequency	CMC[2, 4] (□)	Comments
AC Current – Generate[3] (cont)			Fluke 5522A
(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	0.81 µA/A + 2.3 µA 0.3 µA/A + 4 µA 90 nA/A + 330 nA 90 nA/A + 330 nA 210 nA/A + 1 µA 74 nA/A + 9.8 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	0.71 µA/A + 27 µA 47 nA/A + 48 µA 98 nA/A + 2.8 µA 160 nA/A + 0.82 µA 190 nA/A + 9.7 µA 0.44 µA/A + 66 µA	
(330 mA to 1.1 A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.79 mA/A + 0.45 mA 61 µA/A + 54 µA 1.6 mA/A + 0.45 mA 5.1 mA/A + 0.017 mA	
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	37 µA/A + 0.65 mA 270 µA/A + 180 µA 0.57 mA/A + 0.51 mA 6.2 mA/A + 5.5 mA	
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.17 mA/A + 3.5 mA 0.29 mA/A + 0.16 mA 22 mA/A + 72 mA	
(11 to 20.5) A	(45 to 100) Hz 100 to 1 kHz (1 to 5) kHz	0.64 mA/A + 4.2 mA 0.82 mA/A + 6.4 mA 29 mA/A + 310 mA	
Clamp Meters (20 to 150) A (150 to 1 050) A	 (50 to 400) Hz (50 to 400) Hz	 0.057 % + 0.14 A 0.026 % + 0.45 A	Fluke 5522A/ with 5500A COIL
AC Current – Measure[3]			
Up to 100 µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4 mA/A + 30 nA 1.5 mA/A + 30 nA 600 µA/A + 30 nA 600 µA/A + 30 nA	Keysight 3458A, option 002

Parameter/Equipment	Frequency	CMC[2, 4] (□)	Comments
AC Current – Measure[3]			Keysight 3458A, option 002
100 µA to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	4 mA/A + 200 nA 1.5 mA/A + 200 nA 600 µA/A + 200 nA 300 µA/A + 200 nA 600 µA/A + 200 nA 4 mA/A + 400 nA 5.5 mA/A + 1.5 µA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	4 mA/A + 2 µA 1.5 mA/A + 2 µA 600 µA/A + 2 µA 300 µA/A + 2 µA 600 µA/A + 2 µA 4 mA/A + 4 µA 5.5 mA/A + 15 µA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	4 mA/A + 20 µA 1.5 mA/A + 20 µA 600 µA/A + 20 µA 300 µA/A + 20 µA 600 µA/A + 20 µA 4 mA/A + 40 µA 5.5 mA/A + 150 µA	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	4 mA/A + 200 µA 1.6 mA/A + 200 µA 800 µA/A + 200 µA 1 mA/A + 200 µA 3 mA/A + 200 µA 10 mA/A + 400 µA	
(1 to 3) A	3 Hz to 5 kHz (5 to 10) kHz	20 µA/A + 0.1 mA 0.9 mA/A + 0.2 mA	Keysight 34465A
(3 to 10) A	33 Hz to 5 kHz (5 to 10) kHz	0.43 mA/A + 0.72 mA 0.2 mA/A + 1.6 mA	
(1 to 50) A	10 Hz to 1 kHz	0.59 mA/A + 2 mA	Keysight 34465A current shunt
(1 to 100) A	10 Hz to 1 kHz	0.42 mA/A + 0.27 mA	

Parameter/Equipment	Frequency	CMC[2, 4] (□)	Comments
AC Voltage – Generate[3]			Fluke 5700A with 5725A
Up to 2.2 mV	(10 to 20) Hz	550 µV/V + 4.5 µV	
	(20 to 40) Hz	210 µV/V + 4.5 µV	
	40 Hz to 20 kHz	105 µV/V + 4.5 µV	
	(20 to 50) kHz	370 µV/V + 4.5 µV	
	(50 to 100) kHz	850 µV/V + 7 µV	
	(100 to 300) kHz	1.1 mV/V + 13 µV	
	(300 to 500) kHz	1.7 mV/V + 25 µV	
	(500 to 1000) kHz	3.4 mV/V + 25 µV	
(2.2 to 22) mV	10 to 20) Hz	550 µV/V + 5 µV	
	(20 to 40) Hz	210 µV/V + 5 µV	
	40 Hz to 20 kHz	105 µV/V + 5 µV	
	(20 to 50) kHz	370 µV/V + 5 µV	
	(50 to 100) kHz	850 µV/V + 7 µV	
	(100 to 300) kHz	1.1 mV/V + 12 µV	
	(300 to 500) kHz	1.7 mV/V + 25 µV	
	(500 to 1000) kHz	3.4 mV/V + 25 µV	
(22 to 220) mV	(10 to 20) Hz	550 µV/V + 13 µV	
	(20 to 40) Hz	210 µV/V + 8 µV	
	40 Hz to 20 kHz	105 µV/V + 8 µV	
	(20 to 50) kHz	370 µV/V + 8 µV	
	(50 to 100) kHz	850 µV/V + 25 µV	
	(100 to 300) kHz	1.1 mV/V + 25 µV	
	(300 to 500) kHz	1.7 mV/V + 35 µV	
	(500 to 1000) kHz	3.4 mV/V + 80 µV	
220 mV to 2.2 V	(10 to 20) Hz	500 µV/V + 80 µV	
	(20 to 40) Hz	160 µV/V + 25 µV	
	40 Hz to 20 kHz	75 µV/V + 6 µV	
	(20 to 50) kHz	120 µV/V + 16 µV	
	(50 to 100) kHz	250 µV/V + 70 µV	
	(100 to 300) kHz	430 µV/V + 130 µV	
	(300 to 500) kHz	1.05 mV/V + 350 µV	
	(500 to 1000) kHz	2.2 mV/V + 850 µV	
(2.2 to 22) V	(10 to 20) Hz	500 µV/V + 800 µV	
	(20 to 40) Hz	160 µV/V + 250 µV	
	40 Hz to 20 kHz	75 µV/V + 60 µV	
	(20 to 50) kHz	120 µV/V + 160 µV	
	(50 to 100) kHz	250 µV/V + 350 µV	
	(100 to 300) kHz	500 µV/V + 1.5 mV	
	(300 to 500) kHz	1.25 mV/V + 4.3 mV	
	(500 to 1000) kHz	2.7 mV/V + 85 mV	

Parameter/Equipment	Frequency	CMC[2, 4]	Comments
AC Voltage – Generate[3] (cont)			
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	500 µV/V + 8 mV 160 µV/V + 2.5 mV 80 µV/V + 0.8 mV 220 µV/V + 3.5 mV 500 µV/V + 8 mV 1.5 mV/V + 90 mV 4.7 mV/V + 90 mV 11 mV/V + 190 mV	Fluke 5700A with 5725A
(220 to 750) V	30 to 50) kHz (50 to 100) kHz	600 µV/V + 11 mV 2.3 mV/V + 45 mV	
(220 to 1 100) V	(15 to 50) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	400 µV/V + 16 mV 90 µV/V + 4 mV 160 µV/V + 6 mV 600 µV/V + 11 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	160 µV/V + 0.82 mV 140 µV/V + 3.9 mV 230 µV/V + 0.91 mV 350 µV/V + 27 mV 1.1 mV/V + 30 mV	Fluke 5522A
(330 to 1 020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	66 µV/V + 11 mV 67 µV/V + 3.1 mV 91 µV/V + 6 mV	
AC Voltage – Measure[3]			Keysight 3458A
Up to 10 mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 100 kHz to 1 MHz	300 µV/V + 3 µV 200 µV/V + 1.1 µV 300 µV/V + 1.1 µV 1 mV/V + 1.1 µV 5 mV/V + 1.1 µV 40 mV/V + 2 µV 12 mV/V + 5 µV	AC Band ≤ 2 MHz
Up to 10 mV	(1 to 4) MHz (4 to 8) MHz	70 mV/V + 7 µV 200 mV/V + 8 µV	AC Band > 2 MHz

Parameter/Equipment	Frequency	CMC[2, 4]	Comments
AC Voltage – Measure[3] (cont)			
(10 to 100) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz	70 µV/V + 4 µV 70 µV/V + 2 µV 140 µV/V + 2 µV 300 µV/V + 2 µV 800 µV/V + 2 µV 3 mV/V + 10 µV 10 mV/V + 10 µV 15 mV/V + 10 µV 20 mV/V + 50 µV 40 mV/V + 70 µV 40 mV/V + 80 µV 150 mV/V + 100 µV	Keysight 3458A AC Band ≤ 2 MHz Keysight 3458A AC Band > 2 MHz
100 mV to 1 V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz	70 µV/V + 40 µV 70 µV/V + 20 µV 140 µV/V + 20 µV 300 µV/V + 20 µV 800 µV/V + 20 µV 3 mV/V + 100 µV 10 mV/V + 100 µV 15 mV/V + 100 µV 20 mV/V + 500 µV 40 mV/V + 700 µV 40 mV/V + 800 µV 150 mV/V + 1mV	Keysight 3458A AC Band ≤ 2 MHz Keysight 3458A AC Band > 2 MHz
(1 to 10) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 300 kHz to 1 MHz (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz	70 µV/V + 400 µV 70 µV/V + 200 µV 140 µV/V + 200 µV 300 µV/V + 200 µV 800 µV/V + 200 µV 3 mV/V + 1 mV 10 mV/V + 1 mV 15 mV/V + 1 mV 20 mV/V + 5 mV 40 mV/V + 7 mV 40 mV/V + 8 mV 150 mV/V + 10 mV	Keysight 3458A AC Band ≤ 2 MHz Keysight 3458A AC Band > 2 MHz
(10 to 100) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	200 µV/V + 4 mV 200 µV/V + 2 mV 200 µV/V + 2 mV 350 µV/V + 2 mV 1.2 mV/V + 2 mV 4 mV/V + 10 mV 15 mV/V + 10 mV	Keysight 3458A AC Band ≤ 2 MHz
(100 to 1 000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	400 µV/V + 40 mV 400 µV/V + 20 mV 600 µV/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	

Parameter/Equipment	Frequency	CMC[2, 4]	Comments
AC Voltage – Measure[3] (cont)			
(100 to 1 000) V	50 Hz to 400 Hz	820 µV/V + 480 mV	Vitrek 4700
(1 000 to 50 000) V	50 Hz to 400 Hz	0.72 mV/V + 170 mV	Vitrek HVL-70
Capacitance – Generate[3]			Fluke 5522A
(220 to 399.9) pF	10 Hz to 10 kHz	0.12 % + 1.6 pF	
(0.4 to 1.099 9) nF	10 Hz to 10 kHz	0.19 pF/F + 2.2 pF	
(1.1 to 3.299 9) nF	10 Hz to 3 kHz	2.8 pF/F + 7.6 pF	
(3.3 to 10.999 9) nF	10 Hz to 1 kHz	1.3 pF/F + 11 pF	
(11 to 32.999 9) nF	10 Hz to 1 kHz	1.3 pF/F + 7.6 pF	
(33 to 109.999) nF	10 Hz to 1 kHz	1.8 pF/F + 6 pF	
(110 to 329.999) nF	10 Hz to 1 kHz	1.3 pF/F + 50 pF	
(0.33 to 1.0999 9) µF	(10 to 600) Hz	1.8 nF/F + 0.04 nF	
(1.1 to 3.299 99) µF	(10 to 300) Hz	1.4 nF/F + 0.6 nF	
(3.3 to 10.999 9) µF	(10 to 150) Hz	2.1 nF/F + 4.7 nF	
(11 to 32.999 9) µF	(10 to 120) Hz	3 nF/F + 26 nF	
(33 to 109.999) µF	(10 to 80) Hz	2.8 nF/F + 86 nF	
(110 to 329.999) µF	(0 to 50) Hz	1.7 nF/F + 10 nF	
(0.33 to 1.099 9) mF	(0 to 20) Hz	1.7 µF/F + 0.38 µF	
(1.1 to 3.299 99) mF	(0 to 6) Hz	1.8 µF/F + 0.52 µF	
(3.3 to 10.999 9) mF	(0 to 2) Hz	2.1 µF/F + 0.87 µF	
(11 to 32.999 9) mF	(0 to 0.6) Hz	5.3 µF/F + 49 µF	
(33 to 110) mF	(0 to 0.2) Hz	1.9 µF/F + 130 µF	
Capacitance – Measure[3]			
1 pF to 1 mF	20 Hz to 300 kHz	0.11% Rdg + 3.6 fF	Keysight E4980AL

Parameter/Equipment	Range	CMC[2, 4]	Comments
DC Current – Generate[3]	Up to 220 µA	50 µA/A + 8 nA	Fluke 5700A w/
	220 µA to 2.2 mA	50 µA/A + 8 nA	5725A
	(2.2 to 22) mA	50 µA/A + 80 nA	
	(22 to 220) mA	60 µA/A + 0.8 µA	
	220 mA to 2.2 A	80 uA/A + 25 µA	
	(2.2 to 11) A	360 µA/A + 480 µA	

Parameter/Equipment	Range	CMC[2, 4]	Comments
DC Current – Generate[3] (cont)	Up to 330 µA 330 µA to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	32 pA/A + 2.4 nA 47 nA/A + 24 nA 40 nA/A + 190 nA 35 nA/A + 1.4 µA 20 µA/A + 22 µA 66 µA/A + 34 µA 90 µA/A + 220 µA 270 µA/A + 1.2 mA	Fluke 5522A
Clamp Meters	(20 to 150) A (150 to 1 050) A	0.26 % + 40 mA 0.25 % + 100 mA	Fluke 5522A/ with 5500A COIL
DC Current – Measure[3]	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	30 µA/A + 40 pA 20 µA/A + 40 pA 20 µA/A + 100 pA 20 µA/A + 800 pA 20 µA/A + 5 nA 20 µA/A + 50 nA 35 µA/A + 500 nA 110 µA/A + 10 µA	Keysight 3458A option 2
	(1 to 50) A (1 to 100) A (1 to 500) A	0.59 mA/A + 60 mA 0.42 mA/A + 42 mA 0.28 mA/A + 28 mA	Keysight 3458A current shunts
	(1 to 3) A (3 to 10) A	390 µA/A + 190 µA 240 µA/A + 1.4 mA	Keysight 34465A
	(1 to 50) A (1 to 100) A (1 to 500) A	0.59 mA/A + 62 mA 0.42 mA/A + 45 mA 0.28 mA/A + 31 mA	Keysight 34465A current Shunts
DC Voltage – Generate[3]	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	8 µV/V + 0.6 µV 7 µV/V + 1 µV 7 µV/V + 3.5 µV 7 µV/V + 6.5 µV 8 µV/V + 80 µV 9 µV/V + 500 µV	Fluke 5700A
	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 V to 1 020) V	5.8 µV/V + 1.2 µV 4.5 µV/V + 5.3 µV 4.5 µV/V + 61 µV 3.3 µV/V + 720 µV 2.8 µV/V + 4.4 mV	Fluke 5522A

Parameter/Equipment	Range	CMC[2, 4]	Comments
DC Voltage – Measure[3]	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V (100 to 10 000) V (1000 to 70 000)	5 µV/V + 300 nV 4 µV/V + 300 nV 4 µV/V + 500 nV 6 µV/V + 30 µV 6 µV/V + 100 µV 160 µV/V + 55 mV 0.22 mV/V + 5.7 V	Keysight 3458A, option 002 Vitrek 4700, Vitrek HVL-70
Inductance – Generate[3]	100 mH	0.13 mH	Standard Inductor
Oscilloscopes[3]			Fluke 5522A/SC1100
AC Square Wave Signal Into 1 MΩ Into 50 Ω	 1.0 mVpp to 130 Vpp 1.0 mVpp to 6.6 Vpp	 0.1 % of output + 40 µV 0.25 % of output + 40 µV	
AC Square Wave Frequency	10 Hz to 10 kHz	2.5 µHz/Hz	
DC Signal Into 1 MΩ Into 50 Ω	 Up to ±130 V Up to ±6.6 V	 0.05 % of output + 40 µV 0.25 % of output + 40 µV	
Edge – Aberrations	Within 2 ns from 50 % of Rising Edge (2 to 5) ns (5 to 15) ns After 15 ns	<(3 % of output + 2 mV) <(2 % of output + 2 mV) <(1 % of output + 2 mV) <(0.5 % of output + 2 mV)	
Edge - Amplitude Range	5 mVpp to 2.5 Vpp	2 % of Output+ 200 µV	
Edge - Frequency Range	1 kHz to 10 MHz	2.5 µHz/Hz	
Edge - Rise Time	24 ps to 350 ps	23 ps	
Level Sine Wave – Amplitude			
(5 mV to 5.5 V)	50 kHz Reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2.0 % of output + 0.3 mV 3.5 % of output + 0.3 mV 4.0 % of output + 0.3 mV 6.0 % of output + 0.3 mV	
(5 mV to 3.5 V)	(600 to 1 100) MHz	7.0 % of output + 0.3 mV	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Oscilloscopes[3] (cont)			Fluke 5522A/SC1100
Level Sine Wave – Flatness			
(5 mV to 5.5 V)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.5% + 100 µV 2% + 100 µV 4% + 100 µV	
(5 mV to 3.5 V)	600 to 1 100) MHz	5% + 100 µV	
Frequency Range	50 kHz to 1100 MHz	2.5 µHz/Hz	
Time Marker	(1 to 5) ns 10 ns (20 to 50) ns 100 ns to 20 ms 50 ms to 5 s	1.2 ps 12 ps 12 ps 460 ps/s + 46 ps 42 µs/s + 108 ns	
Resistance – Generate[3] Fixed Points 4-Wire	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ	30 µΩ 33 µΩ 36 µΩ 75 µΩ 87 µΩ 550 µΩ 3.7 mΩ 90 mΩ 620 mΩ 9.9 Ω 310 Ω	Standard Resistors & Keysight 3458A, option 002
Fixed 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	50 µΩ 95 µΩ/Ω 95 µΩ/Ω 28 µΩ/Ω 27 µΩ/Ω 17 µΩ/Ω 17 µΩ/Ω 13 µΩ/Ω 13 µΩ/Ω 12 µΩ/Ω 12 µΩ/Ω 14 µΩ/Ω 14 µΩ/Ω 20 µΩ/Ω 21 µΩ/Ω 40 µΩ/Ω 47 µΩ/Ω 110 µΩ/Ω	Fluke 5700A

Parameter/Equipment	Range	CMC[2, 4]	Comments
Resistance – Generate[3] (cont)			
(1 to 10) kΩ Decade	1 kΩ 2 kΩ 3 kΩ 4 kΩ 5 kΩ 6 kΩ 7 kΩ 8 kΩ 9 kΩ 10 kΩ	150 mΩ 270 mΩ 400 mΩ 510 mΩ 660 mΩ 800 mΩ 930 mΩ 1 Ω 1 Ω 1 Ω	IET HRRS-F-9-1k-5kV-WT High Voltage Resistors
(10 to 100) kΩ Decade	10 kΩ 20 kΩ 30 kΩ 40 kΩ 50 kΩ 60 kΩ 70 kΩ 80 kΩ 90 kΩ 100 kΩ	46 mΩ 1.5 Ω 2.9 Ω 3.9 Ω 3.1 Ω 4.4 Ω 5.4 Ω 6.4 Ω 7.5 Ω 7.2 Ω	
(100 to 1 000) kΩ Decade	100 kΩ 200 kΩ 300 kΩ 400 kΩ 500 kΩ 600 kΩ 700 kΩ 800 kΩ 900 kΩ 1 000 kΩ	1.9 Ω 91 Ω 90 Ω 91 Ω 85 Ω 86 Ω 75 Ω 79 Ω 78 Ω 74 Ω	
(1 to 10) MΩ Decade	1 MΩ 2 MΩ 3 MΩ 4 MΩ 5 MΩ 6 MΩ 7 MΩ 8 MΩ 9 MΩ 10 MΩ	190 Ω 140 Ω 180 Ω 230 Ω 310 Ω 340 Ω 420 Ω 500 Ω 530 Ω 590 Ω	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Resistance – Generate[3] (cont)			IET HRRS-F-9-1k-5kV-WT High Voltage Resistors
(10 to 100) MΩ Decade	10 MΩ	2.4 kΩ	
	20 MΩ	17 kΩ	
	30 MΩ	34 kΩ	
	40 MΩ	57 kΩ	
	50 MΩ	80 kΩ	
	60 MΩ	100 kΩ	
	70 MΩ	130 kΩ	
	80 MΩ	120 kΩ	
	90 MΩ	130 kΩ	
	100 MΩ	78 kΩ	
(100 to 1 000) MΩ Decade	100 MΩ	37 kΩ	
	200 MΩ	80 kΩ	
	300 MΩ	290 kΩ	
	400 MΩ	480 kΩ	
	500 MΩ	600 kΩ	
	600 MΩ	910 kΩ	
	700 MΩ	1.1 MΩ	
	800 MΩ	1.3 MΩ	
	900 MΩ	1.6 MΩ	
	1 000 MΩ	1.8 MΩ	
(1 to 10) GΩ Decade	1 GΩ	0.72 MΩ	
	2 GΩ	1 MΩ	
	3 GΩ	1.7 MΩ	
	4 GΩ	4 MΩ	
	5 GΩ	6.4 MΩ	
	6 GΩ	8.7 MΩ	
	7 GΩ	21 MΩ	
	8 GΩ	22 MΩ	
	9 GΩ	28 MΩ	
	10 GΩ	35 MΩ	
(10 to 100) GΩ Decade	10 GΩ	60 MΩ	
	20 GΩ	140 MΩ	
	30 GΩ	290 MΩ	
	40 GΩ	510 MΩ	
	50 GΩ	750 MΩ	
	60 GΩ	990 MΩ	
	70 GΩ	1.4 GΩ	
	80 GΩ	1.9 GΩ	
	90 GΩ	2.1 GΩ	
	100 GΩ	1.3 GΩ	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Resistance – Generate[3] (cont)			
(100 to 1 000 GΩ) Decade	100 GΩ 200 GΩ 300 GΩ 400 GΩ 500 GΩ 600 GΩ 700 GΩ 800 GΩ 900 GΩ 1 000 GΩ	1.2 GΩ 2.4 GΩ 3.5 GΩ 7.2 GΩ 8.2 GΩ 9.7 GΩ 12 GΩ 16 GΩ 18 GΩ 20 GΩ	
Variable Points	Up to 11 Ω (10 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 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 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (1 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (330 to 1 100) MΩ	18 µΩ/Ω + 270 µΩ 32 µΩ/Ω + 340 µΩ 9.2 µΩ/Ω + 1.1 mΩ 11 µΩ/Ω + 110 µΩ 15 µΩ/Ω + 0.45 mΩ 29 µΩ/Ω + 17 mΩ 5.3 µΩ/Ω + 120 mΩ 10 µΩ/Ω + 31 mΩ 9.3 µΩ/Ω + 180 mΩ 30 µΩ/Ω + 12 Ω 1.3 µΩ/Ω + 14 Ω 23 µΩ/Ω + 51 Ω 100 µΩ/Ω + 150 Ω 100 µΩ/Ω + 10 Ω 150 µΩ/Ω + 4.7 kΩ 860 µΩ/Ω + 79 kΩ 8.2 mΩ/Ω + 2.6 MΩ	Fluke 5522A
Resistance – Measure[3]	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ (100 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	15 µΩ/Ω + 50 µΩ 12 µΩ/Ω + 500 µΩ 10 µΩ/Ω + 500 µΩ 10 µΩ/Ω + 5 mΩ 10 µΩ/Ω + 50 mΩ 10 µΩ/Ω + 2 Ω 50 µΩ/Ω + 100 Ω 500 µΩ/Ω + 1 kΩ 0.5 % + 10 kΩ	Keysight 3458A option 002

Parameter/Equipment	Range	CMC[2, 4]	Comments
Electrical Calibration of Thermocouples – Generate			Ectron 1140A SPRT with Readout & Ice Bath
Type E	(-175 to 950) °C (-283 to 1 742) °F	0.08 °C 0.140 °F	
Type K	(-200 to 1 200) °C (-328 to 2 192) °F	0.1 °C 0.170 °F	
Type J	(-105 to 1 100) °C (-157 to 2 012) °F	0.100 °C 0.180 °F	
Type N	(-175 to 1 000) °C (-283 to 1 832) °F	0.130 °C 0.240 °F	
Type T	(-135 to 300) °C (-211 to 572) °F	0.190 °C 0.340 °F	
Electrical Calibration of Thermocouples – Measure			Ectron 1140A SPRT with Readout & Ice Bath
Type E	(-175 to 950) °C (-283 to 1 742) °F	0.050 °C 0.090 °F	
Type K	(-200 to 1 200) °C (-328 to 2 192) °F	0.099 °C 0.178 °F	
Type J	(-105 to 1 100) °C (-157 to 2 012) °F	0.068 °C 0.120 °F	
Type N	(-175 to 1 000) °C (-283 to 1 832) °F	0.130 °C 0.230 °F	
Type T	(-135 to 300) °C (-211 to 572) °F	0.110 °C 0.210 °F	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Temperature Calibrations Electrical Indication & Control[3]			Ectron 1140A
Type B	(250 to 350) °C (350 to 445) °C (450 to 580) °C (580 to 750) °C (750 to 1 000) °C (1 000 to 1 820) °C	0.95 °C 0.74 °C 0.58 °C 0.45 °C 0.37 °C 0.29 °C	
Type C	(0 to 250) °C (250 to 1 0000 °C (1 000 to 1 500) °C (1 500 to 1 800) °C (1 800 to 2 000) °C (1 000 to 2 250) °C (2 250 to 2 315) °C	0.20 °C 0.16 °C 0.18 °C 0.21 °C 0.23 °C 0.29 °C 0.32 °C	
Type E	(-270 to -245) °C (-245 to -195) °C (-195 to -155)°C (-155 to -90) °C (-90 to 15) °C (15 to 890) °C (890 to 1 000) °C	1.20 °C 0.18 °C 0.10 °C 0.08 °C 0.07 °C 0.06 °C 0.07 °C	
Type J	(-210 to -180) °C (-180 to -120) °C (-120 to -50) °C (-50 to 990) °C (990 to 1 200) °C	0.12 °C 0.10 °C 0.08 °C 0.07 °C 0.07 °C	
Type K	(-270 to -255) °C (-255 to -195) °C (-195 to -115) °C (-115 to -55) °C (-55 to 1 000) °C (1 000 to 1 372) °C	2.20 °C 0.70 °C 0.12 °C 0.09 °C 0.07 °C 0.08 °C	
Type N	(-270 to -260) °C (-260 to -200) °C (-200 to -140) °C (-140 to -70) °C (-70 to 25) °C (25to 160) °C (160 to 1 300) °C	5 °C 1 °C 0.23 °C 0.15 °C 0.12 °C 0.10 °C 0.09 °C	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Temperature Calibrations Electrical Indication & Control[3] (cont)			
Type R	(-50 to -30) °C (-30 to 45) °C (45 to 160) °C (160 to 380) °C (380 to 775) °C (775 to 1 768) °C	0.65 °C 0.55 °C 0.40 °C 0.30 °C 0.26 °C 0.22 °C	
Type S	(-50 to -30) °C (-30 to 45) °C (45 to 105) °C (105 to 310) °C (310 to 615) °C (615 to 1 768) °C	0.62 °C 0.56 °C 0.40 °C 0.33 °C 0.29 °C 0.26 °C	
Type T	(-270 to -255) °C (-255 to -240) °C (-240 to -210) °C (-210 to -150) °C (-150 to -40) °C (-40 to 100) °C (100 to 400) °C	1.80 °C 0.49 °C 0.30 °C 0.18 °C 0.12 °C 0.08 °C 0.07 °C	
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.37 °C 0.26 °C 0.17 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	
Electrical Calibration of RTD			Fluke 5522A
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	0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C 0.23 °C	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Electrical Calibration of RTD (cont)			Fluke 5522A
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	0.25 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.10 °C 0.23 °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	0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C	
Pt 385, 200 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.04 °C 0.04 °C 0.05 °C 0.12 °C 0.13 °C 0.14 °C 0.16 °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	0.04 °C 0.05 °C 0.05 °C 0.06 °C 0.08 °C 0.08 °C 0.09 °C 0.11 °C	
Pt 385, 1000 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	0.03 °C 0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.07 °C 0.23 °C	
PtNi, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.08 °C 0.08 °C 0.14 °C	
Cu 427 10 Ω	(-120 to 260) °C	0.30 °C	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Welders[3] –			Keysight 34465A Current Shunt
AC Voltage 10 Hz to 20 kHz	Up to 750 V	0.43 mV/V + 330 mV	
AC Current 10 Hz to 20 kHz	Up to 100 A	0.42 mA/A + 24 mA	
DC Voltage	Up to 1000 V	6.7 µV/V + 14 mV	
DC Current	Up to 500 A	0.28 mA/A + 31 mA	
Wrist Strap/Footwear & Workstation Monitors[3]	675 kΩ 825 kΩ 8.5 MΩ 11.5 MΩ 35 MΩ 40 MΩ 80 MΩ 120 MΩ	5.6 kΩ 2.2 kΩ 2.2 kΩ 22 kΩ 140 kΩ 140 kΩ 610 kΩ 1.9 MΩ	Calibration Unit Desco 07010 & Charleswater 99090

V. Mechanical

Parameter/Equipment	Range	CMC[2, 4]	Comments
Durometers –			Weight Scale ASTM D2240
Types: A, B, O	Up to 750 gf	0.016 % + 0.17 gf	
Types: C, D	Up to 4 100 gf	0.003 % + 0.3 gf	
Types: CF	Up to 10 000 gf	0.023 % + 0.39 gf	
Types: OO, OOO	Up to 2 610 gf	0.01 % + 0.18 gf	
Types: M	Up to 2 610 gf	0.01 % + 0.18 gf	
Indenter Length	Up to 1 in	(80 + 3.2L) µin	Video Measuring System ASTM D2240
Force[3] – Measuring & Sourcing Devices	Up to 10 gf (10 to 100) gf (100 to 500) gf	0.29 mgf/gf + 2.7 mgf 0.027 mgf/gf + 5.3 mgf 0.018 mgf/gf + 10 mgf	Class 3 Standard Weights
	(1 to 10) lbf (10 to 50) lbf	0.038 % + 0.013 ozf 0.006 % + 0.06 ozf	NIST Class F Weights
	Up to 300 lbf Up to 1 000 lbf Up to 5 000 lbf Up to 10 000 lbf	0.0010 % + 0.0020 lbf 0.0020 % + 0.006 lbf 0.0010 % + 0.010 lbf 0.0010 % + 0.030 lbf	Load Cell with Indicator

Parameter/Equipment	Range	CMC[2, 4]	Comments
Indirect Verification of Rockwell Hardness Testers[3]	(170 to 960) HLD	9.7 HLD	Leeb Hardness Test Blocks ASTM A956
	HRA		
	(20 to 70)	0.55 HRA	
	(70.01 to 79)	0.48 HRA	Rockwell Hardness Test Blocks ASTM E18
	(79.01 to 84)	0.41 HRA	
	HRB		
	(940 to 60)	1.60 HRB	
	(960.01 to 88	1.05 HRB	
	(88.01 to 100)	1.05 HRB	
	HRC		
	(20 to 35)	0.77 HRC	
	(35.01 to 60)	0.53 HRC	
	(60.01 to 71)	0.43 HRC	
	HRE		
	(70 to 84)	1.00 HRE	
	(84.01 to 93)	1.00 HRE	
	(93.01 to 150)	1.00 HRE	
	HR15N		
	(70 to 78)	0.63 HR15N	
	(78.01 to 90)	0.61 HR15N	
	(90.01 to 92)	0.61 HR15N	
	HRN30		
	(40 to 55)	1.0 HR30N	
	(55.01 to 77)	0.75 HR30N	
	(77.01 to 82)	0.62 HR30N	
	HRN45N		
	(20 to 37)	1.00 HR45N	
	(37.01 to 66)	1.00 HR45N	
	(66.01 to 72)	0.65 HR45N	
	HR15T		
	(74 to 79)	1.00 HR15T	
	(79.01 to 85)	1.00 HR15T	
	(85.01 to 93)	1.1 HR15T	
	HR30T		
	(42 to 57)	1.00 HR30T	
	(57.01 to 70)	1.00 HR30T	
	(70.01 to 87)	1.00 HR30T	
	HR45T		
	(13 to 33)	1.00 HR45T	
	(33.01 to 53)	1.00 HR45T	
	(53.01 to 73)	1.00 HR45T	

Parameter/Equipment	Range	CMC[2, 4]	Comments
Mass –	1 mg to 5 g	3 µg/g + 5.2 µg	Direct Reading Method Sartorius MC 5
	(1 to 220) g	1.4 µg/g + 11 µg	Comparison Method Mettler Toledo XP205
	(200 to 10 000) g (10 000 to 34 000) g	5.6 µg/g + 2 mg 100 µg/g + 80 mg	Comparison Method A&D, MC-10K
Fixed	10 g 20 g 30 g 50 g 100 g 200 g	41 µg 56 µg 52 µg 84 µg 200 µg 320 µg	Comparison Method Mettler Toledo XP205
	300 g 500 g 1 kg 2 kg 4 kg 5 kg 10 kg	8.6 mg 8.6 mg 8.8 mg 15 mg 17 mg 17 mg 66 mg	Comparison Method A&D, MC-10K
	20 kg	650 mg	Comparison Method *Mettler Toledo PM-34K*
Pressure Measuring & Sourcing Devices[3]	(-10 to 10) inH_2O	0.005 % + 0.02 in.H_2O	Fluke 700G01
	(-15 to 30) psi (-30 to 60) inHg	0.001 % + 0.0057 psi 0.001 % + 0.010 inHg	Additel ADT681
	Up to 100 psi	0.001 % + 0.030 psi	Additel ADT681
	(-12 to 300) psi (-24.4 to 610 inHg	0.003 % + 0.04 psi 0.003 % + 0.09 inHg	Fluke 2700G
	(-15 to 500) psi (-30 to 1 018) inHg	0.03 % + 0.043 psi 0.03 % + 0.09 inHg	Omega DPG4000
	Up to 1 000 psi Up to 3 000 psi Up to 5 000 psi Up to 10 000 psi	0.002 % + 0.15 psi 0.00 % + 0.23 psi 0.002 % + 0.91 psi 0.02 % + 0.36 psi	Additel ADT681 Fluke 2700G Additel ADT681 Fluke 2700G
	Up to 30 000 psi	0.0035 % + 2.8 psi	Addittel ADT681

Parameter/Equipment	Range	CMC[2, 4]	Comments
Pressure Measuring & Sourcing Devices[3] (cont)	(- 60 to 60) inH_2O Up to 300 psi (0.2 to 25) psi Up to 1 000 psi (8 to 17) psia (14.5 to 1 014) psia Up to 1 000 psi Up to 10 000 psi (100 to 3 000) psi (90 to 40 000) psi	0.0025 % + 0.000 48 inH_2O 0.0051 % + 0.0007 psi 0.0011 % of rdg + 0.00001 psi 0.0017 % of rdg + 0.00006 psi 0.003 % + 0.00002 psia 0.010 % + 0.01 psia 0.002 % + 0.02 psi 0.0029 % + 0.32 psi 0.004 % of rdg + 0.00002 psi 0.005 % of Reading	Ruska 7252i Ruska 2465 Mensor CPG2500 with CPR2550 Ruska 2470 DH-Budenberg CPB3800HP
Scales[3] – Analytical & Precision Balance & Scales	1 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 3 g 5 g 10 g 20 g 30 g 50 g 100 g 200 g 300 g 500 g 1 kg 2 kg 4 kg 5 kg 10 kg 20 kg	2.9 µg 17 µg 4.4 µg 8.3 µg 3.4 µg 3.9 µg 4.3 µg 7 µg 6.1 µg 7.1 µg 8.1 µg 14 µg 18 µg 46 µg 27 µg 63 µg 0.19 mg 0.16 mg 0.3 mg 0.57 mg 1 mg 2.2 mg 2.7 mg 5.3 mg 10 mg	Ultra & Class 1 Standard Weight

Parameter/Equipment	Range	CMC[2, 4]	Comments
Floor & Bench Scales	(0.001 to 1) lb (1 to 10) lb (10 to 50) lb (50 to 100) lb (100 to 200) lb (200 to 500) lb (500 to 1 000) lb (1 000 to 1 500) lb (1 500 to 2 000) lb	$(1.90 \times 10^{-6} + 1.50 \times 10^{-4}$ Wt) lb $(1.40 \times 10^{-4} + 8.90 \times 10^{-6}$ Wt) lb $(8.50 \times 10^{-4} + 1.50 \times 10^{-5}$ Wt) lb $(2.00 \times 10^{-4} + 1.80 \times 10^{-5}$ Wt) lb $(6.00 \times 10^{-4} + 2.50 \times 10^{-5}$ Wt) lb $(1.00 \times 10^{-2} + 1.30 \times 10^{-4}$ Wt) lb $(1.10 \times 10^{-2} + 3.60 \times 10^{-5}$ Wt) lb $(3.30 \times 10^{-2} + 1.40 \times 10^{-5}$ Wt) lb $(1.00 \times 10^{-2} + 2.00 \times 10^{-5}$ Wt) lb	NIST Class F Weights
Torque Tools[3] –	(2 to 20) ozf·in (10 to 100) ozf·in (2 to 20) lbf-in (24 to 240) lbf·in (20 to 200) lbf·ft (100 to 1 000) lbf·ft (200 to 2 000) lbf·ft	00.022 % Rdg + 0.005 6 ozf·in 0.026 % Rdg + 0.022 ozf·in 0.022 % Rdg + 0.003 9 lbf·in 0.013 % Rdg + 0.029 lbf·in 0.013 % Rdg + 0.029 lbf·ft 0.15 % Rdg + 0.1 lbf·ft 0.35 % Rdg + 0.02 lbf·ft	AKO TSD6500 with Transducers AWS QCMF-2000
Transducers, Tester & Analyzer	Up to 10 lbf·in (5 to 100) lbf·in (100 to 3 000) lbf·in (200 to 2 000) lbf·ft	0.016 % Rdg + 0.0018 lbf·in 0.01 % Rdg + 0.0049 lbf·in 0.01 % Rdg + 0.011 lbf·in 0.031 % Rdg + 0.039 lbf·ft	Torque Wheel/Arm 2.5, 5, 10 & 40 in with Weights

VI. Thermodynamics

Parameter/Equipment	Range	CMC[2, 4]	Comments
Humidity Generate –			RH Systems CGS-240 , Humidity Generator
at 0 °C	10 % RH (10 to 30) % RH (30 to 50) % RH (50 to 70) % RH (70 to 95) % RH	0.03 % RH 0.08 % RH 0.13 % RH 0.19 % RH 0.25 % RH	By Primary realization in accordance to RISP-5
at 25 °C	10 % RH (10 to 30) % RH (30 to 50) % RH (50 to 70) % RH (70 to 95) % RH	0.02 % RH 0.06 % RH 0.10 % RH 0.14 % RH 0.19 % RH	
at 50 °C	10 % RH (10 to 30) % RH (30 to 50) % RH (50 to 70) % RH (70 to 95) % RH	0.02 % RH 0.05 % RH 0.08 % RH 0.12 % RH 0.16 % RH	
at 70 °C	10 % RH (10 to 30) % RH (30 to 50) % RH (50 to 70) % RH (70 to 95) % RH	0.02 % RH 0.05 % RH 0.07 % RH 0.10 % RH 0.14 % RH	
Temperature Generate	(0 to 70) °C (32 to 158) °F	0.018 °C 0.032 °F	RH Systems CGS-240 Humidity Generator
Infrared Temperature Measuring Instruments	(-15 to 120) °C (35 to 500) °C	0.13 % Rdg + 0.85 °C 0.25 % Rdg + 0.33 °C	Fluke 4180 ε = 0.95 Fluke 4181 ε = 0.95
Oven/Chamber Temperature Uniformity Measure[3]	(32 to 1800) °F (32 to 1400) °F	0.073 % Rdg + 0.59 °F 0.11 % Rdg + 0.26 °F	Fluke 1586A Type K Thermocouple, AMS2750 Fluke 1586A Type J Thermocouple

Parameter/Equipment	Range	CMC[2, 4]	Comments
Temperature Bath, Dry Well Calibrators Generate	(-197 to 660) °C	0.001 % Rdg + 0.01 °C	Fluke 1594A w/SPRT
Temperature & Humidity Measure[3]	(-70 to 180) °C (-94 to 356) °F (10 to 95) % RH (-20 to 70) °C (-4 to 158) °F (2 to 100) % RH	0.080 °C 0.150 °F 1.2 % RH 0.080 °C 0.150 °F 0.61 % RH	Vaisala M170/HMP77 Chilled mirror, RH Systems 473-SH2
Temperature Measuring Instruments Glass, Bi-Metallic & Electronic Thermometers, Temperature Probes Fixed Point	(-80 to 20) °C (0 to 150) °C (35 to 300) °C (180 to 550) °C (50 to 600) °C 0 °C	0.0030 % Rdg + 0.008°C 0.007 % Rdg + 0.007 °C 0.007 % Rdg + 0.010 °C 0.01 % Rdg + 0.009 °C 0.020 % Rdg + 0.039 ° C 0.0064 °C	Fluke 1594A w/ SPRT, Baths, & Field Metrology Well Fluke 1594A w/ SPRT & ice bath
Thermocouple Probes & Wire Types E, J, K, N, T	(-80 to 0) °C (0 to 150) °C (25 to 250) °C (50 to 660) °C	0.16 °C 0.12 °C 0.11 °C 0.015 % + 0.13 °C	Temperature Baths, Ectron 1140A Fluke 1594A w/SPRT & field metrology well

VII. Time & Frequency

Parameter/Equipment	Range	CMC[2, 4]	Comments
Frequency – Measuring Equipment[3]	1 µHz to 30 MHz	56 nHz/Hz + 0.055 µHz	Keysight 33519B
	0.1 Hz to 225 MHz 100 MHz to 3 GHz	50 pHz/Hz + 1.2 mHz 340 pHz/Hz + 19 mHz	Agilent 53181A Counter
Stop Watches/ Timer[3]	Up to 24 hrs Up to 86 400 s Up to 86 400 s	0.063 s / 24 h 0.08 s 0.001 s/hr + 0.47 s	Timometer 4500 Photo Totalize Method Direct Comparison
Tachometer –			
Contact	(10 to 50 000) RPM	0.00012 % + 0.020 RPM	Ideal Aerosmith
Non - Contact	Up to 99 999 RPM	0.001% + 0.003 RPM	Generator with LED

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

[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 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. 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, percentages are to be read as percent of reading, unless noted otherwise.

[6] In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches,

R is the numerical value of the resolution of the device under test in microinches, *D* is the numerical value of the nominal diameter of the device measured in inches.

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

[8] 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.

[9] 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.

Accredited Laboratory

A2LA has accredited

MICRO QUALITY CALIBRATION, INC.

Chatsworth, CA

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 the requirements of ANSI/NCSL Z540.3-2006 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 30th day of January 2023.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2348.01
Valid to November 30, 2026
Revised March 10, 2025

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