



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

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CALIBRATION

Valid To: November 30, 2024

Certificate Number: 2171.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1,9}:

I. Acoustics & Vibration

Parameter/Range	Frequency	CMC ^{2,8} (±)	Comments
Sound Level – Measuring Equipment 94 dB	1 kHz	0.31 dB	Bruel & Kjaer 4230
Sound Level – Measure 94 dB	125 Hz to 8 kHz	1.1 dB	Sound level meter

II. Chemical

Parameter/Equipment	Range	CMC ^{2,8} (±)	Comments
pH – Measuring Equipment	4 pH 7 pH 10 pH	0.020 pH 0.020 pH 0.026 pH	pH buffer solutions

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Conductivity – Measuring Equipment Liquid	~1 µS/cm ~10 µS/cm ~100 µS/cm ~1000 µS/cm ~1413 µS/cm ~10 000 µS/cm ~100 000 µS/cm	0.43 µS/cm 0.69 µS/cm 4.2 µS/cm 29 µS/cm 31 µS/cm 230 µS/cm 2100 µS/cm	Conductivity solutions
Gas Detection Equipment C ₃ H ₈ CH ₄ CO O ₂ H ₂ S	0.7 % 2.5 % 0.005 % 0.01 % 20.9 % 0.0016 % 0.0025 %	2.1 % 2.1 % 2.6 % 1.6 % 1.1 % 7.6 % 5.1 %	Calibration gases: Propane Methane Carbon monoxide Oxygen Hydrogen sulfide

III. Dimensional

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Dial Indicators ^{3, 7}	Up to 1 in	170 µin	Universal calibrator
Dial Indicator Calibrator	Up to 2 in	25 µin	Gage blocks & electronic height gage
Rulers – Tape Measures	Up to 24 in (24 to 48) in Up to 360 in	0.017 in 0.022 in 0.015 % + 0.019 in	Steel rule

Parameter/Equipment	Range	CMC ^{2, 5, 6} (\pm)	Comments
Coating Thickness Gauges	Up to 10 mils Up to 100 mils	0.074 mils + 0.66 % 0.13 mils + 0.13 %	Coating thickness shims
Coating Thickness Shims	Up to 1000 mils Up to 25 mm	0.057 mils + 0.0093 % 1.4 μ m + 0.0093 %	Micrometer
Feeler Gauges	Up to 0.125 in	94 μ m	Micrometer
Loupes, Glass Reticles, Glass Scales, & Microscopes	(0.001 to 0.22) in (0.01 to 1) mm	610 μ m 7.1 μ m	Stage micrometer
Micrometers & Calipers ^{3, 7}	Up to 0.1 in (> 0.1 to 4) in (4 to 20) in	60 μ m 53 μ m (32 + 3.6L) μ m	Gage blocks
Micrometer Rods & Length End Standards	Up to 10 in	(96 + 2.4L) μ m	Gage block & super micrometer
Anvil & Spindle Flatness on Micrometers & Calipers ³	2 In Diameter Convex Concave	5.4 μ m 5.6 μ m	Optical flat & monochromatic light
Height Gauges	Up to 4 in (4 to 20) in	(47 + 3.0L) μ m (44 + 2.7L) μ m	Gage blocks
Crimpers	(0.011 to 0.06) in (> 0.06 to 0.25) in	270 μ m (210 + 380D) μ m	Pin gages

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 6} (±)	Comments
DC Voltage ³ – Generate	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	9.0 μV/V + 0.4 μV 5.2 μV/V + 0.7 μV 4.3 μV/V + 2.5 μV 4.3 μV/V + 4 μV 5.2 μV/V + 40 μV 7.3 μV/V + 400 μV	Fluke 5700A/EP w/ opt 3
	(1 to 10) kV	1.0 %	Fluke 80K40 & Agilent 3458A, opt 002
DC Voltage – Fixed Points	0.1 V 1 V 10 V 100 V 1000 V	7.9 μV/V 1.3 μV/V 1.1 μV/V 2.7 μV/V 4.5 μV/V	Fluke 732A & Fluke 752A
	10 V Fixed	0.80 μV/V	Fluke 732A
DC Voltage ³ – Measure	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (0.1 to 1) kV*	12 μV/V + 0.3 μV 4.5 μV/V + 0.3 μV 4.3 μV/V + 0.5 μV 4.7 μV/V + 30 μV 7.3 μV/V + 100 μV	Agilent 3458A, opt 002 ACAL (24hrs and ± 1°C); TCAL ± 5°C, & MATH NULL, *add 12 (V _{in} /1000) ² · (3×10 ⁻⁶)
	(1 to 10) kV	1.0 %	Fluke 80K40 & Agilent 3458A, opt 002
DC Current ³ – Measure	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	37 μA/A + 40 pA 23 μA/A + 40 pA 23 μA/A + 100 pA 23 μA/A + 800 pA 23 μA/A + 5 nA 23 μA/A + 50 nA 40 μA/A + 500 nA	Agilent 3458A, opt 002
	Ohm's Law Method	(10 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	9.7 μA/A 8.9 μA/A 8.6 μA/A 7.9 μA/A 7.2 μA/A 7.0 μA/A

Parameter/Equipment	Range	CMC ^{2, 4, 6} (±)	Comments
DC Current ³ – Measure (cont) Ohm's Law Method	(10 to 100) mA 100 mA to 1 A (1 to 10) A (10 to 100) A	7.8 µA/A 8.4 µA/A 8.8 µA/A 18 µA/A	Fluke 5700A/EP Agilent 3458A, opt 002 ESI SR1060 Guildline 9211A
DC Current ³ – Generate Clamp-On Meters Ohm's Law Method	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 3) A (2.2 to 11) A (11 to 20) A (0 to 100) A (10 to 16.5) A (16.5 to 150) A (150 to 1025) A (10 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 (1 to 10) A (10 to 100) A	44 µA/A + 6 nA 39 µA/A + 7 nA 37 µA/A + 40 nA 50 µA/A + 0.7 µA 93 µA/A + 12 µA 0.041 % + 6 µA 0.03 % + 1 mA 0.034 % + 1 mA 0.046 % + 20 mA 0.40 % + 0.055A 0.52 % + 0.15 A 0.49 % + 0.54 A 9.7 µA/A 8.9 µA/A 8.6 µA/A 7.9 µA/A 7.2 µA/A 7.0 µA/A 7.8 µA/A 8.4 µA/A 8.8 µA/A 18 µA/A	Fluke 5700A/EP Fluke 5520A SC600 Fluke 5700A/EP w/ Fluke 5520A SC600 Fluke 5700A/EP w/ Ballantine 1620A Fluke 5700A/EP Fluke 5520A SC600 Fluke 5500A coil Fluke 5700A/EP Agilent 3458A, opt 002, ESI SR1060 Guildline 9211A
Resistance ³ – Generate Fixed Values 1 mΩ Fixed 10 mΩ Fixed 100 mΩ Fixed	1 mΩ 10 mΩ 100 mΩ	430 µΩ/Ω 270 µΩ/Ω 230 µΩ/Ω	Guildline 9211A

Parameter/Equipment	Range	CMC ^{2, 4, 6} (\pm)	Comments
Resistance ³ – Generate (cont)			
Fixed Values			
1 Ω Steps	Up to 10 Ω	5.7 $\mu\Omega/\Omega$	ESI 242D
10 Ω Steps	Up to 100 Ω	5.1 $\mu\Omega/\Omega$	ESI SR-104U
100 Ω Steps	Up to 1000 Ω	4.0 $\mu\Omega/\Omega$	ESI SR-1060
1 k Ω Steps	Up to 10 k Ω	2.0 $\mu\Omega/\Omega$	
10 k Ω Steps	Up to 100 k Ω	2.5 $\mu\Omega/\Omega$	
100 k Ω Steps	Up to 1 M Ω	4.3 $\mu\Omega/\Omega$	
1 M Ω Steps	Up to 10 M Ω	5.5 $\mu\Omega/\Omega$	ESI SR-1050
10 M Ω Steps	Up to 100 M Ω	6.0 $\mu\Omega/\Omega$	
100 M Ω Steps	Up to 1 G Ω	0.33 % + 0.21 M Ω	IET HRRS-B-4-1 M
1 G Ω Steps	Up to 10 G Ω	0.62 %	
10 k Ω Fixed	10 k Ω	1.2 $\mu\Omega/\Omega$	ESI SR-104U
1 Ω Fixed	1 Ω	1.6 $\mu\Omega/\Omega$	Leeds & Northrop 4020B
1 Ω to 100 M Ω	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	80 $\mu\Omega/\Omega$ 84 $\mu\Omega/\Omega$ 29 $\mu\Omega/\Omega$ 29 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.9 $\mu\Omega/\Omega$ 8.4 $\mu\Omega/\Omega$ 6.9 $\mu\Omega/\Omega$ 8.9 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 140 $\mu\Omega/\Omega$	Fluke 5700A/EP
Up to 1.1 G Ω	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) k Ω (1.1 to 3.3) k Ω	40 $\mu\Omega/\Omega$ + 0.0010 Ω 30 $\mu\Omega/\Omega$ + 0.0015 Ω 28 $\mu\Omega/\Omega$ + 0.0014 Ω 28 $\mu\Omega/\Omega$ + 0.0020 Ω 28 $\mu\Omega/\Omega$ + 0.000 0020 k Ω 28 $\mu\Omega/\Omega$ + 0.000 020 k Ω	Fluke 5520ASC600

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Resistance ³ – Generate (cont) Fixed Values Up to 1.1 GΩ	(3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.33 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (0.33 to 1.1) GΩ	28 μΩ/Ω + 0.000 020 kΩ 28 μΩ/Ω + 0.000 20 kΩ 28 μΩ/Ω + 0.000 20 kΩ 32 μΩ/Ω + 0.0020 kΩ 32 μΩ/Ω + 0.000 0020 MΩ 60 μΩ/Ω + 0.000 030 MΩ 130 μΩ/Ω + 0.000 050 MΩ 250 μΩ/Ω + 0.0025 MΩ 500 μΩ/Ω + 0.0030 MΩ 0.30 % + 0.10 MΩ 1.5 % + 0.50 MΩ	Fluke 5520ASC600
Resistance ³ – Measure	Up to 10 Ω Up to 100 Ω Up to 1000 Ω Up to 10 kΩ Up to 100 kΩ Up to 1 MΩ Up to 10 MΩ Up to 100 MΩ Up to 1 GΩ	19 μΩ/Ω + 50 μΩ 15 μΩ/Ω + 500 μΩ 13 μΩ/Ω + 500 μΩ 12 μΩ/Ω + 5 mΩ 12 μΩ/Ω + 50 mΩ 18 μΩ/Ω + 2 Ω 58 μΩ/Ω + 100 Ω 0.057 % + 1 kΩ 0.57 % + 10 kΩ	Agilent 3458A, opt 002

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage, Fixed Points – Measure & Generate 2 mV	10 Hz 20 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	0.040 % 0.033 % 0.031 % 0.032 % 0.031 % 0.030 % 0.031 % 0.042 % 0.054 % 0.063 % 0.094 %	Fluke 792A

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments	
AC Voltage, Fixed Points – Measure & Generate (cont)			Fluke 792A	
6 mV	10 Hz	0.025 %		
	20 Hz	0.023 %		
	100 Hz	0.016 %		
	1 kHz	0.016 %		
	10 kHz	0.016 %		
	20 kHz	0.016 %		
	50 kHz	0.022 %		
	100 kHz	0.028 %		
	300 kHz	0.041 %		
	500 kHz	0.047 %		
	1 MHz	0.070 %		
	20 mV	10 Hz	0.015 %	
		20 Hz	78 μV/V	
100 Hz		72 μV/V		
1 kHz		78 μV/V		
10 kHz		61 μV/V		
20 kHz		63 μV/V		
50 kHz		91 μV/V		
100 kHz		0.016 %		
300 kHz		0.022 %		
500 kHz		0.032 %		
1 MHz		0.053 %		
60 mV		10 Hz	85 μV/V	
		20 Hz	47 μV/V	
	100 Hz	42 μV/V		
	1 kHz	34 μV/V		
	10 kHz	36 μV/V		
	20 kHz	36 μV/V		
	50 kHz	38 μV/V		
	100 kHz	81 μV/V		
	300 kHz	0.014 %		
	500 kHz	0.022 %		
	1 MHz	0.034 %		
	200 mV	10 Hz	59 μV/V	
		20 Hz	30 μV/V	
100 Hz		30 μV/V		
1 kHz		16 μV/V		
10 kHz		19 μV/V		

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage, Fixed Points – Measure & Generate (cont)			
200 mV	20 kHz	20 µV/V	Fluke 792A
	50 kHz	31 µV/V	
	100 kHz	48 µV/V	
	300 kHz	76 µV/V	
	500 kHz	0.011 %	
	1 MHz	0.024 %	
600 mV	10 Hz	33 µV/V	
	20 Hz	23 µV/V	
	100 Hz	13 µV/V	
	1 kHz	12 µV/V	
	10 kHz	12 µV/V	
	20 kHz	12 µV/V	
	50 kHz	13 µV/V	
	100 kHz	17 µV/V	
	300 kHz	31 µV/V	
	500 kHz	36 µV/V	
	1 MHz	89 µV/V	
2 V	10 Hz	28 µV/V	
	20 Hz	18 µV/V	
	100 Hz	11 µV/V	
	1 kHz	11 µV/V	
	10 kHz	11 µV/V	
	20 kHz	11 µV/V	
	50 kHz	11 µV/V	
	100 kHz	14 µV/V	
	300 kHz	23 µV/V	
	500 kHz	27 µV/V	
	1 MHz	44 µV/V	
	6 V	10 Hz	28 µV/V
		20 Hz	18 µV/V
100 Hz		10 µV/V	
1 kHz		10 µV/V	
10 kHz		10 µV/V	
20 kHz		10 µV/V	
50 kHz		11 µV/V	
100 kHz		11 µV/V	
300 kHz		22 µV/V	
500 kHz		27 µV/V	
1 MHz		43 µV/V	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments		
AC Voltage, Fixed Points – Measure & Generate (cont)					
20 V	10 Hz	30 µV/V	Fluke 792A		
	20 Hz	18 µV/V			
	100 Hz	16 µV/V			
	1 kHz	11 µV/V			
	10 kHz	11 µV/V			
	20 kHz	11 µV/V			
	50 kHz	12 µV/V			
	100 kHz	14 µV/V			
	300 kHz	23 µV/V			
	500 kHz	27 µV/V			
	1 MHz	53 µV/V			
	60 V	10 Hz		28 µV/V	
		20 Hz		19 µV/V	
100 Hz		13 µV/V			
1 kHz		12 µV/V			
10 kHz		12 µV/V			
20 kHz		12 µV/V			
50 kHz		13 µV/V			
100 kHz		15 µV/V			
300 kHz		32 µV/V			
200 V		10 Hz	42 µV/V		
	20 Hz	20 µV/V			
	100 Hz	16 µV/V			
	1 kHz	15 µV/V			
	10 kHz	15 µV/V			
	20 kHz	15 µV/V			
	50 kHz	17 µV/V			
	100 kHz	22 µV/V			
	600 V	100 Hz	82 µV/V		
		1 kHz	43 µV/V		
10 kHz		43 µV/V			
20 kHz		43 µV/V			
50 kHz		83 µV/V			
100 kHz		170 µV/V			
1000 V		100 Hz	28 µV/V		
	1 kHz	22 µV/V			
	10 kHz	43 µV/V			
	20 kHz	43 µV/V			
	50 kHz	82 µV/V			
	100 kHz	170 µV/V			

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage Flatness – Generate			
1 mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.062 % 0.038 % 0.038 % 0.038 % 0.046 % 0.05 % 0.05 % 0.071 % 0.23 % 0.74 %	Fluke 5700A/EP/03
3 mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.038 % 0.024 % 0.024 % 0.024 % 0.033 % 0.033 % 0.036 % 0.061 % 0.11 % 0.19 %	
10 mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.033 % 0.021 % 0.021 % 0.021 % 0.028 % 0.029 % 0.033 % 0.058 % 0.1 % 0.18 %	
30 mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.035 % 0.02 % 0.02 % 0.02 % 0.025 % 0.029 % 0.032 % 0.057 % 0.1 % 0.18 %	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage Flatness – Generate (cont)			
100 mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.035 % 0.02 % 0.02 % 0.02 % 0.025 % 0.029 % 0.032 % 0.057 % 0.1 % 0.18 %	Fluke 5700A/EP/03
300 mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.026 % 0.018 % 0.018 % 0.018 % 0.027 % 0.028 % 0.033 % 0.053 % 0.1 % 0.17 %	
1 V	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.031 % 0.017 % 0.016 % 0.015 % 0.022 % 0.026 % 0.03 % 0.055 % 0.1 % 0.17 %	
3 V	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.12 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.036 % 0.015 % 0.015 % 0.015 % 0.021 % 0.028 % 0.031 % 0.055 % 0.1 % 0.17 %	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Generate			
(0.22 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 4 μV 0.11 % + 10 μV 0.14 % + 10 μV 0.27 % + 20 μV	Fluke 5700A/EP
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 4 μV 0.11 % + 10 μV 0.14 % + 10 μV 0.27 % + 20 μV	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.02 % + 4 μV 0.05 % + 4 μV 0.11 % + 10 μV 0.14 % + 10 μV 0.27 % + 20 μV	
(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 500 kHz to 1 MHz	0.024 % + 40 μV 90 μV/V + 15 μV 50 μV/V + 8 μV 80 μV/V + 10 μV 0.011 % + 30 μV 0.042 % + 80 μV 0.1 % + 200 μV 0.17 % + 300 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 500 kHz to 1 MHz	0.024 % + 0.4 mV 90 μV/V + 0.15 mV 50 μV/V + 0.05 mV 80 μV/V + 0.1 mV 0.01 % + 0.2 mV 0.028 % + 0.6 mV 0.1 % + 2 mV 0.15 % + 3.2 mV	

Parameter/Range	Frequency	CMC ^{2,4,6} (\pm)	Comments
AC Voltage ³ – Generate (cont)			
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.024 % + 0.4 mV 90 μ V/V + 0.15 mV 50 μ V/V + 0.05 mV 80 μ V/V + 0.1 mV 0.015 % + 0.2 mV 0.09 % + 0.6 mV 0.44 % + 2 mV 0.8 % + 3.2 mV	Fluke 5700A/EP
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.03 % + 16 mV 0.007 % + 3.5 mV	
AC Voltage ³ – Measure			
Up to 2.2 mV:	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.17 % + 1.3 μ V 0.074 % + 1.3 μ V 0.042 % + 1.3 μ V 0.081 % + 2 μ V 0.12 % + 2.5 μ V 0.23 % + 4 μ V 0.24 % + 8 μ V 0.35 % + 8 μ V	Fluke 5790A opt.003 uncertainty of wideband is for flatness relative to 1 kHz
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % + 1 μ V 0.17 % + 1 μ V 0.3 % + 1 μ V 0.7 % + 2 μ V	
(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 500 kHz to 1 MHz	0.085 % + 1.3 μ V 0.037 % + 1.3 μ V 0.021 % + 1.3 μ V 0.04 % + 2 μ V 0.06 % + 2.5 μ V 0.12 % + 4 μ V 0.13 % + 8 μ V 0.23 % + 8 μ V	
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % + 1 μ V 0.1 % + 1 μ V 0.17 % + 1 μ V 0.37 % + 1 μ V	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Measure (cont)			
(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 500 kHz to 1 MHz	0.029 % + 1.3 μV 0.019 % + 1.3 μV 0.011 % + 1.3 μV 0.021 % + 2 μV 0.031 % + 2.5 μV 0.081 % + 4 μV 0.089 % + 8 μV 0.17 % + 8 μV	Fluke 5790A opt.003 uncertainty of wideband is for flatness relative to 1 kHz
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % 0.1 % 0.17 % 0.37 %	
(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 500 kHz to 1 MHz	0.024 % + 1.5 μV 0.012 % + 1.5 μV 0.007 % + 1.5 μV 0.013 % + 2 μV 0.026 % + 2.5 μV 0.051 % + 4 μV 0.067 % + 8 μV 0.11 % + 8 μV	
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	
(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 500 kHz to 1 MHz	0.021 % + 1.5 μV 0.009 % + 1.5 μV 0.004 % + 1.5 μV 0.007 % + 2 μV 0.016 % + 2.5 μV 0.025 % + 4 μV 0.038 % + 8 μV 0.1 % + 8 μV	
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Measure (cont)			
(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 500 kHz to 1 MHz	0.02 % + 1.5 μV 70 μV/V + 1.5 μV 20 μV/V + 1.5 μV 50 μV/V + 2 μV 70 μV/V + 2.5 μV 0.016 % + 4 μV 0.026 % + 8 μV 0.09 % + 8 μV	Fluke 5790A opt.003 uncertainty of wideband is for flatness relative to 1 kHz
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	
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 500 kHz to 1 MHz	0.021 % 80 μV/V 30 μV/V 50 μV/V 80 μV/V 0.018 % 0.03 % 0.1 %	
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	
(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 500 kHz to 1 MHz	0.02 % 70 μV/V 20 μV/V 50 μV/V 70 μV/V 0.016 % 0.026 % 0.09 %	
Wideband	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.1 % 0.15 % 0.35 %	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Measure (cont)			
(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) MHz	0.02 % 70 μV/V 20 μV/V 50 μV/V 80 μV/V 0.019 % 0.04 % 0.12 %	Fluke 5790A opt.003 uncertainty of wideband is for flatness relative to 1 kHz
(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) MHz	0.02 % 70 μV/V 30 μV/V 50 μV/V 90 μV/V 0.02 % 0.041 % 0.12 %	
(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	0.02 % 70 μV/V 30 μV/V 70 μV/V 0.01 % 0.021 % 0.05 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 0.01 % 40 μV/V 0.013 % 0.05 %	
(700 to 1000) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 0.01 % 0.004 % 0.013 % 0.05 %	
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 (0.3 to 1) MHz	0.03 % + 3 μV 0.02 % + 1.1 μV 0.03 % + 1.1 μV 0.1 % + 1.1 μV 0.5 % + 1.1 μV 4 % + 2 μV 1.2 % + 5 μV	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Measure (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 (0.3 to 1) MHz	70 μV/V + 4 μV 70 μV/V + 2 μV 0.014 % + 2 μV 0.03 % + 2 μV 0.08 % + 2 μV 0.3 % + 10 μV 1 % + 10 μV	Agilent 3458A, opt 002 NOTE: synchronous sub- sampled mode
(0.1 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 (0.3 to 1) MHz	70 μV/V + 0.4 mV 70 μV/V + 0.2 mV 0.014 % + 0.2 mV 0.03 % + 0.2 mV 0.08 % + 0.2 mV 0.3 % + 1 mV 1 % + 1 mV	
(10 to 100) V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.02 % + 4 mV 0.02 % + 2 mV 0.035 % + 2 mV 0.12 % + 2 mV 0.4 % + 10 mV 1.5 % + 10 mV	
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.04 % + 40 mV 0.04 % + 20 mV 0.06 % + 20 mV 0.12 % + 20 mV 0.3 % + 20 mV	
(Up to 40) kV _{pk} (Up to 28) kV _{rms}	60 Hz 60 Hz	5 % 5 %	Fluke 80K-40
AC Power ³ – Generate			
Up to 300 W (330 to 2200) W (2200 to 20 500) W	(45 to 65) Hz	0.12 % 0.11 % 0.12 %	Fluke 5520A plus resistance standard

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Current ³ – Generate			
(0 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 16 nA 0.016 % + 10 nA 0.012 % + 8 nA 0.028 % + 12 nA 0.11 % + 65 nA	Fluke 5700A/EP
(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	0.025 % + 40 nA 0.016 % + 35 nA 0.012 % + 35 nA 0.02 % + 110 nA 0.11 % + 650 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	0.025 % + 400 nA 0.016 % + 350 nA 0.012 % + 350 nA 0.02 % + 550 nA 0.11 % + 5 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 4 µA 0.016 % + 3.5 µA 0.012 % + 2.5 µA 0.02 % + 3.5 µA 0.11 % + 10 µA	
(0.22 to 2.2) A	10 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.026 % + 35 µA 0.045 % + 80 µA 0.7 % + 160 µA	
(29 to 330) µA (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (1.1 to 3) A	(10 to 30) kHz (10 to 30) kHz (10 to 30) kHz (10 to 30) kHz (5 to 10) kHz	1.6 % + 0.4 µA 1 % + 0.6 µA 0.4 % + 4 µA 0.4 % + 200 µA 2.5 % + 5 mA	Fluke 5520A SC600
(2.2 to 22) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz*	0.055 % + 1 mA 0.051 % + 1 mA 0.05 % + 1 mA 0.05 % + 1 mA	Fluke 5700A/EP Fluke 5520A SC600 *multiply by f in kHz
Clamp-On Meters:			
(10 to 16.5) A	(45 to 65) Hz (65 to 440) Hz	0.33 % + 0.025 A 0.82 % + 0.027 A	Fluke 5700A/EP Fluke 5220A SC600 Fluke 5500A coil
(16.5 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.3 % + 0.025 A 0.78 % + 0.027 A	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Current ³ – Generate (cont)			
Clamp-On Meters: (150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.4 % + 0.025 A 0.87 % + 0.027 A	Fluke 5700A/EP Fluke 5220A SC600 Fluke 5500A coil
AC Current ³ – Measure			
Up to 100 µA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	0.4 % + 30 nA 0.15 % + 30 nA 0.06 % + 30 nA	Agilent 3458A opt. 002
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % + 0.2 µA 0.15 % + 0.2 µA 0.06 % + 0.2 µA 0.03 % + 0.2 µA	
(1 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.4 % + 20 µA 0.15 % + 20 µA 0.06 % + 20 µA 0.03 % + 20 µA 0.06 % + 20 µA 0.4 % + 40 µA 0.6 % + 150 µA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 20) kHz (20 to 50) kHz	0.4 % + 0.2 mA 0.16 % + 0.2 mA 0.08 % + 0.2 mA 0.1 % + 0.2 mA 0.3 % + 0.2 mA 1 % + 0.4 mA	
Up to 550 µA	(5 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.02 % 0.008 % 0.005 %	
550 µA to 5.5 mA	(5 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.02 % 0.008 % 0.005 %	
(5.5 to 22) mA	(5 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.02 % 0.008 % 0.005 %	Fluke 5790A w/ A40

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Current ³ – Measure (cont)			
(22 to 550) mA	(5 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.02 % 0.008 % 0.005 %	Fluke 5790A w/ A40
550 mA to 2.2 A	(5 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.02 % 0.009 % 0.008 %	
(2.2 to 11) A	(5 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.022 % 0.013 % 0.021 %	
(11 to 20) A	(5 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.038 % 0.034 % 0.034 %	
Inductance ³ – Measure			
0.01 µH to 4.1 H	(12 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.049 % 0.029 % 0.059 % 0.23 %	GenRad 1693 Digibridge NOTE: slow measure rate, averaging, open/short
(4.1 to 99 999) H	(12 to 100) Hz 100 Hz to 1 kHz (1 to 20) kHz	0.049 % 0.029 % 0.21 %	
Inductance ³ – Generate			
100 mH fixed	100 Hz 1 kHz	0.023 % 0.023 %	General ratio 1482-L
Capacitance ³ – Measure			
0.000 01 pF to 6.4 nF	(12 to 100) Hz 100 Hz to 1 kHz (1 to 20) kHz	0.049 % 0.029 % 0.21 %	GenRad 1693 Digibridge NOTE: slow measure rate, averaging, open/short
6.4 nF to 99 999 µF	(12 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.049 % 0.029 % 0.059 % 0.23 %	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
Phase ³ – Measure (cont) Up to 360°:			
1:1 Resistive	1 Hz to 1 kHz (1 to 50) kHz	0.002° 0.003°	Clarke-Hess 5002 Agilent 3458A opt. 002
1:1 Capacitive	(1 to 50) kHz (50 to 200) kHz	0.003° 0.009°	
10:1 Capacitive	(1 to 50) kHz (50 to 200) kHz	0.003° 0.009°	
100:1 Capacitive	(1 to 50) kHz (50 to 200) kHz	0.003° 0.009°	
Distortion ³ – Measure (0.3 to 100) %:			
< 30 V	10 Hz to 1 MHz (1 to 3) MHz	3 % of full scale 7.1 % of full scale	HP 334A
(30 to 300) V	10 Hz to 300 kHz (300 to 500) kHz (0.5 to 3) MHz	3 % of full scale 7.1 % of full scale 13 % of full scale	
0.1 %:			
< 30 V	(10 to 20) Hz (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz (0.5 to 1.2) MHz	13 % of full scale 7.1 % of full scale 3 % of full scale 7.1 % of full scale 13 % of full scale	
(0.001 to 100) %:			
50 mV to 300 V	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	Agilent 8903B

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
Oscilloscopes ³ –			
Square Wave Signal			
10 Hz to 10 kHz			
50 Ω Impedance	1 mV to 6.6 V _{pk-pk}	0.25 % + 40 μ V	Fluke 5520A SC600
1 M Ω Impedance	1 mV to 130 V _{pk-pk}	0.1 % + 40 μ V	
Level Sine Wave	5 mV to 5.5 V	2 % + 300 μ V	
Square Wave Signal	50 kHz to 100 MHz	3.5 % + 300 μ V	
	(100 to 300) MHz	4 % + 300 μ V	
	(300 to 600) MHz	6 % + 300 μ V	
Amplitude (Reference, 50 kHz)	50 kHz to 100 MHz	1.5 % + 100 μ V	
	(100 to 300) MHz	2 % + 100 μ V	
	(300 to 600) MHz	4 % + 100 μ V	
Flatness (Reference, 50 kHz)	5 s to 50 ms	25 μ s/s	
	20 ms to 100 ns	2.5 μ s/s	
Time Markers (5-2-1 Sequence) into a 50 W Load	(5 to 2) ns	2.5 μ s/s	
	10 ns	2.5 μ s/s	
	(50 to 20) ns	2.5 μ s/s	
Rise Time: 2.5 mV to 2.5 V	(24 to 300) ps	27 %	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Simulation of Thermocouples ³ –			
Type B	(600 to 800) °C (> 800 to 1000) °C (> 1000 to 1550) °C (> 1550 to 1820) °C	0.44 °C 0.36 °C 0.32 °C 0.35 °C	Fluke 5522A
Type C	(0 to 150) °C (> 150 to 650) °C (> 650 to 1000) °C (> 1000 to 1800) °C (> 1800 to 2316) °C	0.32 °C 0.29 °C 0.32 °C 0.45 °C 0.70 °C	
Type E	(-250 to -100) °C (> -100 to -25) °C (> -25 to 350) °C (> 350 to 650) °C (> 650 to 1000) °C	0.43 °C 0.22 °C 0.22 °C 0.21 °C 0.23 °C	
Type J	(-210 to -100) °C (> -100 to -25) °C (> -25 to 150) °C (> 150 to 760) °C (> 760 to 1200) °C	0.25 °C 0.18 °C 0.17 °C 0.21 °C 0.24 °C	
	(-210 to < 0) °C (0 to 1200) °C	0.28 °C 0.18 °C	Fluke 5700A/EP & digital multimeter & ice point reference

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Thermocouples ³ (cont) –			
Type K	(-210 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 1000) °C (> 1000 to 1372) °C	0.31 °C 0.22 °C 0.21 °C 0.25 °C 0.36 °C	Fluke 5522A
Type N	(-210 to < 0) °C (0 to 1200) °C	0.28 °C 0.18 °C	Fluke 5700A/EP & digital multimeter & ice point reference
Type R	(-200 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 410) °C (> 410 to 1300) °C	0.37 °C 0.26 °C 0.24 °C 0.22 °C 0.27 °C	Fluke 5522A
Type S	(0 to 250) °C (> 250 to 400) °C (> 400 to 1000) °C (> 1000 to 1767) °C	0.48 °C 0.34 °C 0.31 °C 0.36 °C	
Type T	(0 to 250) °C (> 250 to 1000) °C (> 1000 to 1400) °C (> 1400 to 1767) °C	0.41 °C 0.34 °C 0.34 °C 0.40 °C	
Electrical Calibration of RTD Indicating Systems ³ –			
Pt 385, 100 Ω	(-200 to 0) °C (> 0 to 100) °C (> 100 to 260) °C (> 260 to 300) °C (> 300 to 600) °C (> 600 to 630) °C	0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.24 °C	Fluke 5520A SC600
PtNi 385, 120 Ω	(-80 to 100) °C (> 100 to 260) °C	0.08 °C 0.15 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.34 °C	

V. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
RF Power – Generate			
Sine Wave (50 Ω): 1 mV to 3 V _{p-p} (-56.02 to 13.52) dB	0.001 Hz to 100 kHz	0.15 dB	HP 3325A opt 001, 002
	100 kHz to 20 MHz	0.23 dB	
(3 to 10) V _{p-p} (13.52 to 23.98) dB	0.001 Hz to 100 kHz	0.19 dB	HP 3325A opt 001, 002
	100 kHz to 20 MHz	0.25 dB	
(25 to 10) dB (10 to -10) dB (-10 to -60) dB (-60 to -110) dB	10 MHz to 2 GHz	1.0 dB	HP 83630A opt 001, 008, H53
		0.75 dB	
		1.0 dB	
		1.5 dB	
(25 to 10) dB (10 to -10) dB (-10 to -60) dB (-60 to -110) dB	(2 to 18) GHz	1.1 dB	
		0.75 dB	
		1.3 dB	
		2.0 dB	
1 mW	50 MHz	0.010 mW	HP 436A
Up to 50 W	(1 to 400) MHz	2.5 %	HP 83630A & amplifier
RF Power – Measure			
1 μ W to 100 mW (-30 to +20) dB	(100 to 300) kHz	0.20 dB	HP 436A with 8482A
	300 kHz to 10 MHz	0.11 dB	
	10 MHz to 2 GHz	0.11 dB	
	(2 to 4.2) GHz	0.12 dB	
1 μ W to 100 mW (-30 to +20) dB	10 MHz to 1 GHz	0.13 dB	HP 436A with 8481A
	(1 to 3) GHz	0.11 dB	
	(3 to 13) GHz	0.11 dB	
	(13 to 18) GHz	0.11 dB	
1 μ W to 100 mW (-30 to +20) dB	(1 to 4) GHz	0.11 dB	HP 436A with 8485A
	(4 to 12) GHz	0.11 dB	
	(12 to 18) GHz	0.12 dB	
	(18 to 26.5) GHz	0.14 dB	
1 mW	50 MHz	0.010 mW	HP 432A, 478AH73, & 34401A

Parameter/Range	Frequency	CMC ^{2,4,6} (\pm)	Comments
RF Power – Measure (cont) Up to 50 W	(1 to 400) MHz	2.5 %	HP 436A with 8482A, directional coupler, & attenuators
Tuned RF Power – Measure (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB (-100 to -110) dB (-110 to -120) dB	100 kHz to 26.5 GHz	0.17 dB 0.18 dB 0.20 dB 0.23 dB 0.24 dB 0.26 dB 0.34 dB 0.35 dB 0.37 dB 0.38 dB 0.41 dB 0.53 dB	HP 8902A, HP 11722A, HP 11792A
Attenuation – Generate SMA, 1 dB step (1 to 11) dB SMA, 10 dB step (10 to 110) dB	DC to 12.4 GHz (12.4 to 26.5) GHz DC to 12.4 GHz (12.4 to 26.5) GHz	2.1 % + 0.24 dB 2.1 % + 0.29 dB 2.3 % + 0.23 dB 2.7 % + 0.15 dB	Agilent 8494H Agilent 8496H
Frequency Modulation – Generate Rate: 100 kHz to 8 MHz Dev: < 500 kHz peak	(1 to 26.5) GHz	8.8 %	Agilent 83630A
Frequency Modulation – Measure Rate: 20 Hz to 10 kHz Dev: \leq 40 kHz Rate: 50 Hz to 100 kHz Dev: \leq 400 kHz	(0.25 to 10) MHz 10 MHz to 26.5 GHz	0.73 % + 1 digit 3.0 % + 1 digit	HP 8902A with 11793A

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
Frequency Modulation – Measure (cont) Rate: 20 Hz to 200 kHz Dev: \leq 400 kHz	10 MHz to 26.5 GHz	4.3 % + 1 digit	HP 8902A with 11793A
Amplitude Modulation – Measure Rate: 150 kHz to 10 MHz Depths: (5 to 99) % Rate: 150 kHz to 10 MHz Depths: To 99 % Rate: (10 to 1300) MHz Depths: (5 to 99) % Rate: (10 to 1300) MHz Depths: To 99 % Rate: (1.3 to 18) GHz Depths: (5 to 99) % Rate: (1.3 to 18) GHz Depths: To 99 %	50 Hz to 10 kHz 20 Hz to 10 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz	1.9 % + 1 digit 3.0 % + 1 digit 1.3 % + 1 digit 3.3 % + 1 digit 1.3 % + 1 digit 3.3 % + 1 digit	HP 8902A with 11793A
Amplitude Modulation – Generate Rate: DC to 100 kHz Depths: (5 to 99) %	10 MHz to 26.5 GHz	6.3 %	Agilent 83630A
Phase Modulation – Measure 150 kHz to <10 MHz Carrier 10 MHz to 18.0 GHz Carrier	200 Hz to 10 kHz 200 Hz to 20 kHz	5.1 % + 1 digit 6.7 % + 1 digit	HP 8902A with 11793A

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2,6,8} (±)	Comments
Accelerometers Frequency Response			PCB 301A11 with signal conditioner, frequency generator, DMM, & shaker
(0.02 to 5000) pC/g	(10 to 100) Hz	2.7 %	
(1 to 10 000) mV/g	(0.1 to 2) kHz	2.4 %	
	(2 to 10) kHz	3.3 %	
Sensitivity @ 100 Hz	100 pC/g	2.4 %	
Pressure & Vacuum Measure & Measuring Equipment ^{3,7} –			
Pneumatic	(30 to 100) microns	4.3 % + 1.0 microns	Leybold CTR 90
	(> 100 to 1000) microns	6.4 % – 1.1 microns	
	(1 to 10) Torr	0.63 %	
	(0.1 to 1.0) in·H ₂ O	0.0013 in·H ₂ O	Dwyer 1425-24
	(> 1.0 to 24) in·H ₂ O	0.012 % 0.0012 in·H ₂ O	
	(0.2 to 25) psia	15 parts in 10 ⁶ psia	Ruska 2465-725
	(0.2 to 25) psig	15 parts in 10 ⁶ psig	
	(25 to 1000) psig	16 parts in 10 ⁶ psig	Ruska 2465-729
	(1000 to 10 000) psig	34 parts in 10 ⁶	Ruska 2400-735- 00, Ruska 2402
	(> 10 000 to 12 148) psig	0.0037 % – 0.03 psi	
	(20 to 100) psi	0.021 % - 0.000 90 psi	Fluke 2700G
	(> 100 to 1000) psi	0.018 % + 0.021 psi	
	(> 1000 to 10 000) psi	0.0050 % + 0.80 psi	
	(10 to 100) psi	0.031 % + 0.021 psi	Crystal XP2i
(> 30 to 300) psi	0.024 % + 0.028 psi		
(-14.5 to 0) psi	0.042 psi	Druck DPI-610 & transducers	
(> 0.5 to 5) psi	0.0012 psi		
(> 1.5 to 15) psia	0.0024 psi		
(> 30 to 300) psi	0.067 psi		
(> 100 to 1000) psi	0.28 psi		
(> 300 to 3000) psi	0.67 psi		
(> 500 to 5000) psi	1.2 psi		
(> 1000 to 10 000) psi	2.3 psi		

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Pressure & Vacuum Measure & Measuring Equipment ^{3, 7} – (cont)			
Hydraulic	(1000 to 10 000) psi (> 10 000 to 12 140) psi	31 parts in 10 ⁶ 0.0037 % + 0.06 psi	Ruska 2400-735-00
	(> 100 to 1000) psi (> 1000 to 10 000) psi	0.018 % + 0.021 psi 0.0050 % + 0.80 psi	Fluke 2700G
	(> 100 to 1000) psi (> 300 to 3000) psi (> 500 to 5000) psi (> 1000 to 10 000) psi	0.28 psi 0.67 psi 1.2 psi 2.3 psi	Druck DPI-610 & transducers
Air/Nitrogen Flow ^{3, 7} – Measure			
(0.01 to 1000) SLPM (0.0004 to 35) SCFM	(3 to 10) sccm (10 to 30) sccm (30 to 100) sccm (100 to 300) sccm (0.3 to 1.0) slpm (1.0 to 3.0) slpm (3.0 to 10) slpm (10 to 30) slpm (30 to 100) slpm (100 to 300) slpm (300 to 1000) slpm (1000 to 3000) slpm	0.68 % + 0.0090 sccm 0.67 % – 0.0031 sccm 0.65 % + 0.033 sccm 0.66 % + 0.012 sccm 0.59 % + 0.000 37 slpm 0.63 % + 0.000 47 slpm 0.56 % + 0.0054 slpm 0.63 % + 0.000 91 slpm 0.65 % + 0.017 slpm 0.72 % + 0.030 slpm 0.76 % + 0.062 slpm 0.99 % – 1.7 slpm	CME FCS-8A & laminar flow elements
Torque ^{3, 7} – Measure	(5 to 50) ozf·in (20 to 200) ozf·in (5 to 50) lbf·in (10 to 100) lbf·in (40 to 400) lbf·in (12.5 to 125) lbf·ft (60 to 600) lbf·ft (60 to 600) lbf·ft (100 to 1000) lbf·ft	0.60 % + 0.002 ozf·in 0.59 % + 0.012 ozf·in 0.59 % + 0.0035 lbf·in 0.59 % + 0.004 lbf·in 0.62 % + 0.012 lbf·in 0.35 % + 0.011 lbf·ft 0.36 % + 0.014 lbf·ft 0.60 % + 0.010 lbf·ft 0.33 % + 0.030 lbf·ft	CDI 2000-4-02 CDI 2000-5-02 CDI 501-I-DTT CDI 1001-I-DTT CDI 4002-I-DTT CDI 2000-10-02 CDI 2000-12-02 CDI 6004-F-DTT CDI 2000-13-02

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments	
Mass ⁷ – Measure (cont)	(0 to 600) g	0.000 14 % + 0.0037 g	Mettler XS603S	
	(0 to 6000) g	0.000 16 % + 0.025 g	Mettler XS6002S	
	(0.2 to 1) kg	0.34 %	TIF 9010A	
	(> 1 to 10) kg	0.035 %		
	(> 10 to 50) kg	0.007 %		
Piston Operated Volumetric Apparatus (POVA) –	(10 to 100) µL	0.16 % + 0.078 µL	Mettler AT261 & DI H2O Notes: pipettes & syringes	
	(100 to 1000) µL	0.21 % + 0.030 µL		
	(> 1 to 10) mL	0.22 % + 0.000 10 mL		
	(> 10 to 100) mL	0.21 % + 0.0010 mL		
	(> 100 to 200) mL	0.21 %		
Piston Operated Volumetric Apparatus (POVA) ³ –	(1 to 10) L	0.30 % + 0.0020 L	TIF 9010A & DI H2O Notes: pipettes & syringes	
Velocity ^{3, 7} – Measure	(1575 to 6000) fpm	1.5 % + 2.4 fpm	Alnor RVA501	
Rotational Speed, RPM ^{3, 7} – Measuring Equipment				
	Optical	(10 to 100 000) rpm	0.001 % + 0.13 rpm	HP 3325A
	Mechanical	Up to 5000 rpm	0.025 %	Quantum dynamics N-11-ECS/3A
Rotational Speed, RPM ^{3, 7} – Measure				
	Optical	(10 to 600) rpm (> 600 to 100 000) rpm	0.041 % + 0.42 RPM 0.010 % + 0.60 RPM	Tachometer
	Mechanical	Up to 5000 rpm	0.15 % + 2.0 RPM	

VII. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Viscosity ^{3, 7} – Dip Cups S90 Zahn Cup #2 EZ Zahn Cup #2	(63.7 to 104.6) mm ² /s (63.7 to 104.6) mm ² /s	0.98 % + 0.78 mm ² /s 0.98 % + 0.68 mm ² /s	Standard oils, thermometer, & stopwatch

VIII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Relative Humidity ³ – Measuring Equipment	11.31 % RH 33.07 % RH 75.47 % RH 97.6 % RH (10 to 40) % RH (> 40 to 97) % RH	0.61 % RH 0.62 % RH 0.97 % RH 1.5 % RH 0.97 % RH 1.3 % RH	LiCl MgCl ₂ NaCl K ₂ SO ₄ Vaisala MI70 with HMP-77B
Relative Humidity ³ – Measure	(10 to 40) % RH (> 40 to 97) % RH	0.83 % RH 1.1 % RH	Vaisala MI70 with HMP-77B
Temperature ³ – Measure Chambers	(-80 to 150) °C (0 to 1000) °C (-196 to 0) °C 0 °C (> 0 to 232) °C (> 232 to 420) °C (> 420 to 660) °C 0 °C (> 0 to 260) °C	0.26 °C 0.089 °C 0.031 °C 0.01 °C 0.037 °C 0.048 °C 0.34 °C 0.025 °C 0.15 °C	Fluke 1524 with PRT, Fluke 1524 with RTD, Fluke 5624 PRT, Fluke 5626 PRT Fluke 5627 PRT
Infrared	(0 to 100) °C (> 100 to 500) °C	1.1 % + 0.88 °C 1.7 % + 0.3 °C	Fluke 561

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Temperature ³ – Measure (cont)			
Infrared	(0 to 100) °C (> 250 to 500) °C	1.9 % + 0.86 °C 1.1 % + 2.8 °C	Fluke 62
Temperature ³ – Measuring Equipment			
	0 °C	20 mK	DI H ₂ O & shaved ice
	-78.5 °C -196 °C	0.5 °C 20 mK	Frozen CO ₂ & ethanol LN ₂
	(-25 to 70) °C (> 70 to 140) °C	0.26 °C – 0.063 % 0.11 % + 0.14 °C	Fluke 9103
	(-25 to 70) °C (> 70 to 140) °C	0.11 °C 0.11 °C	Comparison to PRT
	(50 to 250) °C (> 250 to 450) °C (> 450 to 650) °C	0.38 °C 0.73 °C 0.92 °C	Fluke 9141 Notes: add 1 °C for wells larger than 6.5 mm
Infrared	(50 to 250) °C (> 250 to 450) °C (> 450 to 650) °C	0.11 °C 0.52 °C 0.52 °C	Comparison to PRT
	(50 to 200) °C (> 200 to 500) °C	0.77 % + 0.36 °C 1.3 % – 0.7 °C	Reed BX-500
Temperature – System Accuracy Test (SAT). Controllers, Ovens, Furnaces, Freezers	(200 to 400) °F (> 400 to 1204) °F	2.0 °F 0.28 % + 0.88 °F	AMS 2750G Fluke 1586A DAQ w/ TC, Fluke 744
Temperature – Thermal Uniformity Survey (TUS). Ovens, Furnaces	(200 to 400) °F (> 400 to 1200) °F	2.1 °F 0.75 % – 0.90 °F	AMS 2750G Fluke 1586A DAQ w/ TC

IX. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,8} (±)	Comments
Frequency – Measuring Equipment	10 MHz reference	2.5×10^{-10} Hz/Hz	Agilent Z3816A
	(1 to 10) Hz (10 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 10) MHz (10 to 21) MHz	1.3×10^{-2} Hz/Hz 1.3×10^{-3} Hz/Hz 1.3×10^{-4} Hz/Hz 1.3×10^{-5} Hz/Hz 1.7×10^{-6} Hz/Hz 4.9×10^{-7} Hz/Hz 2.9×10^{-7} Hz/Hz 1.7×10^{-7} Hz/Hz	Agilent 3325B/GPS
	(10 to 100) MHz (0.1 to 1) GHz (1 to 10) GHz (10 to 18) GHz	2.4×10^{-8} Hz/Hz 4.5×10^{-9} Hz/Hz 5.0×10^{-10} Hz/Hz 3.1×10^{-10} Hz/Hz	Agilent 83630A/GPS
Frequency – Measure	1 Hz to 225 MHz 225 MHz to 3 GHz	2.9×10^{-10} Hz/Hz 2.9×10^{-9} Hz/Hz	Agilent 53132A/GPS
	(10 to 100) MHz (0.1 to 1) GHz (1 to 10) GHz (10 to 20) GHz	2.4×10^{-8} Hz/Hz 2.4×10^{-9} Hz/Hz 3.5×10^{-10} Hz/Hz 2.8×10^{-10} Hz/Hz	HP 5350B/GPS
Timers/Stopwatches	(1 to 86 400) sec	0.039 sec	Agilent 53132A/GPS
	(1 to 3600) sec	0.50 sec	Stopwatch

¹ This laboratory offers commercial calibration service and field calibration services.

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

- ³ Field calibration service is available for this calibration. 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 fraction/percentage of the reading plus a fixed floor specification.
- ⁵ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches, and D is the diameter of the device in inches.
- ⁶ In the statement of CMC, percentages are percentages of reading, unless otherwise indicated.
- ⁷ The contributions from the "best existing device" are not included in the CMC claim.
- 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 scope meets A2LA's *P112 Flexible Scope Policy*.



Accredited Laboratory

A2LA has accredited

ACR TECHNICAL SERVICES, INC.

Newport News, VA

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, 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 31st day of May 2023.

A blue ink signature of Trace McIntuff.

Mr. Trace McIntuff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2171.01
Valid to November 30, 2024
Revised October 30, 2024

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