



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

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CALIBRATION

Valid To: June 30, 2023

Certificate Number: 2357.13

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1,6}:

I. Chemical Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
Conductivity ³	10 µS ± 10 % µS 100 µS ± 10 % µS 1000 µS ± 10 % µS 1413 µS ± 10 % µS 10 000 µS ± 10 % µS 100 000 µS ± 10 % µS	0.31 µS 0.90 µS 4.2 µS 4.9 µS 43 µS 370 µS	Standard solutions
pH ³	2 pH 4 pH 7 pH 10 pH	0.021 pH 0.013 pH 0.011 pH 0.012 pH	Certified reference materials

II. Dimensional

Parameter/Equipment	Range	CMC ^{2,4} (\pm)	Comments
Micrometers ^{3,4} – Length Flatness Parallelism	(0.05 to 4) in (4 to 48) in	(7.5 + 1.6L + 0.58R) μ m (14 + 4.7L + 0.58R) μ m 4.3 μ m 8.8 μ m	Grade 00 gage blocks Grade 0 gage blocks Master pins/optical parallels
Height Gages ³	(0.05 to 4) in (4 to 48) in	(7.5 + 1.6L + 0.58R) μ m (14 + 4.7L + 0.58R) μ m	Grade 00 gage blocks Grade 0 gage blocks
Depth Gages ³	Up to 4 in (4 to 48) in	(7.5 + 1.6L + 0.58R) μ m (14 + 4.7L + 0.58R) μ m	Grade 00 gage blocks Grade 0 gage blocks
Calipers ³	(0.05 to 4) in (4 to 48) inch	(7.5 + 1.6L + 0.58R) μ m (14 + 4.7L + 0.58R) μ m	Grade 00 gage blocks Grade 0 gage blocks
Rulers	Up to 48 in (48 to 84) in	0.0090 in 0.0091 in	Grade 00 gage blocks Grade 0 gage blocks
Straight Edges ³	Up to 20 in	37 μ m	Federal 832 w/ head granite surface plate
Inspection Fixtures (1-2-3 Blocks, bar Parallels, Angle Irons, Angle Squares, V-Blocks) Squareness Perpendicularity Parallelism Flatness	Up to 24 in Up to 24 in Up to 24 in Up to 24 in	29 μ m 29 μ m 29 μ m 29 μ m	Federal 832 w/ head granite surface plate granite angle block
Optical Flats ³	Up to 5 in	1.5 μ m	Compare to reference flat

Parameter/Equipment	Range	CMC ^{2,4} (\pm)	Comments
Optical Comparators ³ – Angles	Up to 45°	0.024°	15, 30, 45 degree angle blocks
Length	Up to 36 in	(66 + 5.7L) μ in	Glass scale
Thickness (Feeler) Gage	Up to 0.15 in	8.8 μ in	Labmaster™ and gage blocks
Cylindrical Pin and Plugs	Up to 1.05 in Up to 2 in	24 μ in (5.8 + 1.0L) μ in	LaserMicrometer Labmaster™ and gage blocks
Rings	(0.05 to 5.0) in	(8.8 + 2.6L) μ in	Labmaster™ and gage blocks
Thread Wires	(4 to 120) TPI	17 μ in	Labmaster™ and gage blocks
Threaded Plugs – Major Diameter	Up to 4 in	(47 + 18L) μ in	Supermicrometer™
Pitch Diameter	Up to 4 in	(24 + 0.60L) μ in	
Gage Blocks	(0.01 to 1) in (1 to 4) in (4 to 12) in (12 to 20) in	(2.4 + 1.2L) μ in (1.8 + 1.8L) μ in (2.4 + 1.7L) μ in (1.7 + 1.7L) μ in	Master blocks and Labmaster™
Variation in Length	Variation in Length	0.47 μ in	
Length Standards – Linearity	(0.01 to 1) in (1 to 4) in (4 to 12) in (12 to 20) in	(2.4 + 1.2L) μ in (1.8 + 1.8L) μ in (2.4 + 1.7L) μ in (1.7 + 1.7L) μ in	Master blocks and Labmaster™

Parameter/Equipment	Range	CMC ² (±)	Comments
Length Displacement, Indicators and Transducers ³	Up to 4 in	22 μin	Labmaster™ and gage blocks
Angle Indicators – (Protractors, Levels, and Inclinometers)	Up to 360°	42 arc seconds	Sine plate and gage blocks
Angle Gage Blocks ³	1° 2° 3° 4° 5° 10° 15° 20° 25° 30° 45°	0.0096° 0.0096° 0.0096° 0.0096° 0.0096° 0.0096° 0.0017° 0.0096° 0.0096° 0.0017° 0.0017°	SPO 1-30 10 pc angle gage set and 45 degree block
Tape Measures ³	Up to 50 ft Up to 400 ft	0.036 in 0.047 in	Grade 00 gage blocks
Sine Plate, Bars, Parallels – Parallelism Angle	Up to 20 in 15° 30° 45°	21 μin 66 μin 80 μin 120 μin	Electronic amplifier w/ angle blocks and gage blocks
Radius Gages	Up to 1 in	410 μin	MicroVu Spectra

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
DC Voltage – Generate ³	(0 to 219.999 999) mV (0.22 to 2.199 999) V (2.2 to 10.999 999) V (11 to 21.999 999) V (22 to 219.999 999) V (220 to 1100) V	7.1 μ V/V + 0.39 μ V 4.0 μ V/V + 0.62 μ V 3.3 μ V/V + 2.3 μ V 3.4 μ V/V + 3.9 μ V 3.9 μ V/V + 39 μ V 5.3 μ V/V + 0.39 mV	Fluke 5720A
	10 V	6.2 μ V	Fluke 732A
DC Voltage – Generate and Measure	(1.1 to 150) kV	0.11 mV/V	Ross VD210 w/ DMM4050
	0 V	0.58 nV	Copper short
DC Current – Generate ³ (Ohms Law Method)	(0 to 2) pA (2 to 20) pA (20 to 200) pA (0.2 to 2) nA (2 to 20) nA (20 to 200) nA (0.2 to 2) μ A	4.4 mA/A + 0.4 fA 0.85 mA/A + 4.0 fA 0.66 mA/A + 40 fA 0.56 mA/A + 40 fA 0.56 mA/A + 25 fA 0.56 mA/A + 7.0 fA 0.56 mA/A + 4.0 fA	Tektronix/Keithley 5156 w/ Fluke 5720A
	(0 to 219.9999) μ A (0.22 to 2.199 999) mA (2.2 to 21.999 99) mA (22 to 219.9999) mA (0.22 to 2.199 999) A (0 to 11) A (11 to 20.5) A	33 μ A/A + 5.4 nA 28 μ A/A + 6.2 nA 28 μ A/A + 39 nA 35 μ A/A + 0.62 μ A 56 μ A/A + 12 μ A 0.27 mA/A + 0.37 mA 0.78 mA/A + 0.58 mA	Fluke 5720A/5725A Fluke 5520A
	Up to 20 μ A (20 to 100) μ A (0.1 to 1) mA (1 to 3) mA (3 to 10) mA (10 to 20) mA (20 to 100) mA (0.1 to 0.5) A	13 μ A/A + 4.0 pA 10 μ A/A + 40 pA 8.1 μ A/A + 0.40 nA 6.5 μ A/A + 4.0 nA 8.1 μ A/A + 4.0 nA 7.1 μ A/A + 4.0 nA 9.1 μ A/A + 40 nA 8.9 μ A/A + 0.10 μ A	8508A w/Fluke 742A-10 M Ω 742A-1 M Ω 742A-100 k Ω 742A -10 k Ω 742A-1 k Ω 742A-100 Ω 742A-10 Ω 742A-1 Ω

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
DC Resistance – Generate ³	0 Ω	0.48 μΩ	Copper short
Fixed Points	1 Ω	75 μΩ	Fluke 5720A
	1.9 Ω	0.14 mΩ	
	10 Ω	0.20 mΩ	
	19 Ω	0.38 mΩ	
	100 Ω	0.98 mΩ	
	190 Ω	1.7 mΩ	
	1 kΩ	7.6 mΩ	
	1.9 kΩ	15 mΩ	
	10 kΩ	73 mΩ	
	19 kΩ	0.14 Ω	
	100 kΩ	1.0 Ω	
	190 kΩ	2.0 Ω	
	1 MΩ	16 Ω	
	1.9 MΩ	32 Ω	
	10 MΩ	0.31 kΩ	
	19 MΩ	0.72 kΩ	
	100 MΩ	11 kΩ	
	0.33 mΩ	0.045 μΩ	Guildline 9211A
	1 mΩ	0.055 μΩ	
	10 mΩ	0.14 μΩ	
	0.1 Ω	1.4 μΩ	Leeds & Northrup 4015-B, Fluke 742- X
	1 Ω	6.4 μΩ	
	10 Ω	71 μΩ	
	100 Ω	0.50 mΩ	
	1 kΩ	5.0 mΩ	
	10 kΩ	37 mΩ	
	100 kΩ	0.52 Ω	
	1 MΩ	7.6 Ω	
	10 MΩ	0.11 kΩ	
DC Voltage – Measure ³	(0 to 200) mV	5.1 μV/V + 0.093 μV	Fluke 8508A
	(0.2 to 2) V	3.6 μV/V + 0.39 μV	
	(2 to 20) V	3.6 μV/V + 3.9 μV	
	(20 to 200) V	5.5 μV/V + 39 μV	
	(200 to 1050) V	5.5 μV/V + 0.49 mV	
DC Voltage – Divider Calibration	(1 to 200) kV	0.16 mV/V	Ross VD210 w/ Tek DMM4050

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
DC Current – Measure ³	(0 to 200) μ A (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A	13 μ A/A + 0.31 nA 13 μ A/A + 3.1 nA 15 μ A/A + 31 nA 47 μ A/A + 0.62 μ A 0.17 mA/A + 12 μ A 0.41 mA/A + 0.31 mA	Fluke 8508A
	(0.2 to 3) A (2 to 20) A (20 to 100) A (100 to 300) A (300 to 3000) A	16 μ A/A 17 μ A/A 93 μ A/A 95 μ A/A 3.1 mA/A	L&N 4015-B Y5020 Guildline shunt Empro 1000-100
DC Resistance – Measure ³	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) k Ω (2 to 20) k Ω (20 to 200) k Ω (0.2 to 2) M Ω	19 $\mu\Omega/\Omega$ + 3.9 $\mu\Omega$ 11 $\mu\Omega/\Omega$ + 14 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 47 $\mu\Omega$ 7.9 $\mu\Omega/\Omega$ + 0.47 m Ω 7.9 $\mu\Omega/\Omega$ + 4.7 m Ω 9.4 $\mu\Omega/\Omega$ + 47 m Ω 12 $\mu\Omega/\Omega$ + 0.93 Ω	Fluke 8508A
	(2 to 20) M Ω (20 to 200) M Ω (0.2 to 2) G Ω (2 to 20) G Ω	35 $\mu\Omega/\Omega$ + 9.3 Ω 96 $\mu\Omega/\Omega$ + 0.93k Ω 0.49 m Ω/Ω + 93 k Ω 1.5 m Ω/Ω + 9.3 M Ω	Fluke 8508A in HV mode
Shunt Measurements	(1 to 10) G Ω (10 to 100) G Ω (0.1 to 1) T Ω (1 to 10) T Ω (10 to 100) T Ω	0.85 m Ω/Ω 1.2 m Ω/Ω 2.4 m Ω/Ω 3.6 m Ω/Ω 5.9 m Ω/Ω	Guildline 9520
Ratio Measurements	(0 to 0.2) m Ω (0.2 to 2) m Ω (2 to 20) m Ω (20 to 200) m Ω	0.23 m Ω/Ω + 0.40 $\mu\Omega$ 0.58 m Ω/Ω + 0.40 $\mu\Omega$ 83 $\mu\Omega/\Omega$ 59 $\mu\Omega/\Omega$	Fluke 8508A and standard resistors
	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) k Ω (2 to 20) k Ω (20 to 200) k Ω (0.2 to 2) M Ω (2 to 20) M Ω	9.0 $\mu\Omega/\Omega$ + 3.1 $\mu\Omega$ 5.0 $\mu\Omega/\Omega$ + 11 $\mu\Omega$ 4.9 $\mu\Omega/\Omega$ + 23 $\mu\Omega$ 3.3 $\mu\Omega/\Omega$ + 0.23 m Ω 3.2 $\mu\Omega/\Omega$ + 2.3 m Ω 4.0 $\mu\Omega/\Omega$ + 23 m Ω 7.6 $\mu\Omega/\Omega$ + 0.78 Ω 11 $\mu\Omega/\Omega$ + 7.8 Ω	742-X and 8508A in ratio mode High voltage mode

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage – Generate ³			
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 (0.5 to 1) MHz	0.52 mV/V + 3.9 μV 0.47 mV/V + 3.9 μV 0.46 mV/V + 3.9 μV 0.52 mV/V + 3.9 μV 0.65 mV/V + 4.7 μV 1.2 mV/V + 9.3 μV 1.5 mV/V + 19 μV 2.8 mV/V + 19 μV	Fluke 5720A w/ 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) MHz	0.23 mV/V + 3.9 μV 0.11 mV/V + 3.9 μV 0.10 mV/V + 3.9 μV 0.20 mV/V + 3.9 μV 0.43 mV/V + 4.7 μV 0.94 mV/V + 9.3 μV 1.2 mV/V + 19 μV 2.4 mV/V + 19 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) MHz	0.22 mV/V + 12 μV 86 μV/V + 6.2 μV 73 μV/V + 6.2 μV 0.18 mV/V + 6.2 μV 0.42 mV/V + 16 μV 0.70 mV/V + 16 μV 1.2 mV/V + 23 μV 2.3 mV/V + 47 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 (0.5 to 1) MHz	0.22 mV/V + 39 μV 78 μV/V + 16 μV 38 μV/V + 7.8 μV 67 μV/V + 9.3 μV 0.12 mV/V + 31 μV 0.33 mV/V + 78 μV 0.86 mV/V + 0.19 mV 1.4 mV/V + 0.47 mV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.21 mV/V + 0.39 mV 79 μV/V + 0.16 mV 38 μV/V + 54 μV 67 μV/V + 93 μV 90 μV/V + 0.19 mV 0.24 mV/V + 0.62 mV 0.85 mV/V + 1.9 mV 1.2 mV/V + 3.1 mV	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage – Generate ³ (cont)			
(22 to 220) V (Subject to 2.2x10 ⁷ V-Hz limitation)	(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	0.21 mV/V + 3.9 mV 79 µV/V + 1.6 mV 48 µV/V + 0.54 mV 75 µV/V + 0.93 mV 0.13 mV/V + 2.3 mV 0.78 mV/V + 16 mV 4.0 mV/V + 39 mV 7.0 mV/V + 78 mV	Fluke 5720A w/ 5725A
(220 to 250) V	(15 to 50) Hz	0.25 mV/V + 16 mV	
(220 to 1000) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	68 µV/V + 3.1 mV 0.11 mV/V + 4.7 mV 0.29 mV/V + 8.5 mV	
(220 to 750) V	30 kHz to 50 kHz (50 to 100) kHz	0.29 mV/V + 8.5 mV 1.0 mV/V + 35 mV	
AC Voltage – Generate & Measure			
(1 to 100) kV Leveled Output	60 Hz	2.3 mV/V	Ross VD210 w/ Tek DMM4050
Up to 1.1 mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.8 mV/V 0.95 mV/V 1.6 mV/V + 2.3 µV 3.4 mV/V + 2.3 µV 5.2 mV/V + 2.3 µV 12 mV/V + 12 µV	Fluke 5720A Option 003
(1.1 to 3) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.88 mV/V 0.88 mV/V + 2.3 µV 1.8 mV/V + 2.3 µV 4.1 mV/V + 2.3 µV 12 mV/V + 2.3 µV	
(3 to 11) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.88 mV/V 0.88 mV/V + 2.3 µV 1.7 mV/V + 2.3 µV 3.3 mV/V + 2.3 µV 8.0 mV/V + 2.3 µV	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage – Generate ³ (cont)			
(11 to 33) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.88 mV/V 0.88 mV/V + 2.3 μV 1.7 mV/V + 2.3 μV 3.3 mV/V + 2.3 μV 8.0 mV/V + 2.3 μV	Fluke 5720A Option 003
(33 to 110) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.85 mV/V 0.85 mV/V + 2.3 μV 1.7 mV/V + 2.3 μV 3.3 mV/V + 2.3 μV 8.0 mV/V + 2.3 μV	
(110 to 330) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.82 mV/V 0.80 mV/V + 2.3 μV 1.7 mV/V + 2.3 μV 3.3 mV/V + 2.3 μV 8.0 mV/V + 2.3 μV	
330 mV to 1.1 V	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.82 mV/V 0.82 mV/V + 2.3 μV 1.7 mV/V + 2.3 μV 3.3 mV/V + 2.3 μV 8.0 mV/V + 2.3 μV	
(0.33 to 3) V	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.82 mV/V 0.82 mV/V + 2.3 μV 1.7 mV/V + 2.3 μV 3.3 mV/V + 2.3 μV 8.0 mV/V + 2.3 μV	
AC Voltage ³ – Measure			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz	1.3 mV/V + 1.0 μV 0.58 mV/V + 1.0 μV 0.33 mV/V + 1.0 μV 0.63 mV/V + 1.6 μV 0.93 mV/V + 1.9 μV	Fluke 5790A

Parameter/Range	Frequency	CMC ^{2, 7} (\pm)	Comments
AC Voltage ³ – Measure (cont)			
(0 to 2.2) mV	(100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	1.8 mV/V + 3.1 μ V 1.9 mV/V + 6.2 μ V 2.7 mV/V + 6.2 μ V	Fluke 5790A
(2.2 to 7) mV	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.66 mV/V + 1.0 μ V 0.29 mV/V + 1.0 μ V 0.17 mV/V + 1.0 μ V 0.31 mV/V + 1.6 μ V 0.47 mV/V + 1.9 μ V 0.94 mV/V + 3.1 μ V 1.0 mV/V + 6.2 μ V 1.6 mV/V + 6.2 μ V	
(7 to 22) mV	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.23 mV/V + 1.0 μ V 0.16 mV/V + 1.0 μ V 91 μ V/V + 1.0 μ V 0.17 mV/V + 1.6 μ V 0.25 mV/V + 1.9 μ V 0.64 mV/V + 3.1 μ V 0.71 mV/V + 6.2 μ V 1.3 mV/V + 6.2 μ V	
(22 to 70) mV	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.19 mV/V + 1.2 μ V 0.10 mV/V + 1.2 μ V 60 μ V/V + 1.2 μ V 0.11 mV/V + 1.6 μ V 0.21 mV/V + 1.9 μ V 0.40 mV/V + 3.1 μ V 0.54 mV/V + 6.2 μ V 0.89 mV/V + 6.2 μ V	
(70 to 220) mV	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.17 mV/V + 1.2 μ V 74 μ V/V + 1.2 μ V 33 μ V/V + 1.2 μ V 56 μ V/V + 1.6 μ V 0.13 mV/V + 1.9 μ V 0.20 mV/V + 3.1 μ V 0.31 mV/V + 6.2 μ V 0.79 mV/V + 6.2 μ V	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage ³ – Measure (cont)			
(0.22 to 700) mV	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.16 mV/V + 1.2 μV 63 μV/V + 1.2 μV 27 μV/V + 1.2 μV 41 μV/V + 1.6 μV 62 μV/V + 1.9 μV 0.14 mV/V + 3.1 μV 0.24 mV/V + 6.2 μV 0.75 mV/V + 6.2 μV	Fluke 5790A
(0.70 to 2.2) V	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.16 mV/V 56 μV/V 20 μV/V 36 μV/V 56 μV/V 0.12 mV/V 0.20 mV/V 0.70 mV/V	
(2.2 to 7.0) V	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.16 mV/V 58 μV/V 20 μV/V 38 μV/V 64 μV/V 0.15 mV/V 0.31 mV/V 0.93 mV/V	
(7.0 to 22) V	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.16 mV/V 57 μV/V 23 μV/V 38 μV/V 66 μV/V 0.15 mV/V 0.31 mV/V 0.93 mV/V	
(22 to 70) V	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.50 to 1.0) MHz	0.16 mV/V 58 μV/V 26 μV/V 45 μV/V 74 μV/V 0.16 mV/V 0.32 mV/V 0.93 mV/V	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage ³ – Measure (cont)			
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.16 mV/V 58 μV/V 26 μV/V 54 μV/V 77 μV/V 0.16 mV/V 0.39 mV/V	Fluke 5790A
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.16 mV/V 79 μV/V 34 μV/V 0.10 mV/V 0.39 mV/V	
(700 to 1000) V	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.16 mV/V 80 μV/V 36 μV/V 0.10 mV/V 0.39 mV/V	
AC Voltage Flatness – Measure			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.59 mV/V + 0.78 μV 0.61 mV/V + 0.78 μV 1.4 mV/V + 0.78 μV 2.5 mV/V + 0.78 μV 5.7 mV/V + 1.6 μV	Fluke 5790A

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Voltage Flatness – Measure			
(2.2 to 7) mV	(0.50 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.56 mV/V + 0.78 μV 0.58 mV/V + 0.78 μV 0.91 mV/V + 0.78 μV 1.6 mV/V + 0.78 μV 3.4 mV/V + 0.78 μV	Fluke 5790A Option 003
(7 to 22) mV	(0.50 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.56 mV/V 0.58 mV/V 0.90 mV/V 1.4 mV/V 3.4 mV/V	
(22 to 70) mV	(0.50 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.42 mV/V 0.44 mV/V 0.90 mV/V 1.4 mV/V 3.2 mV/V	
(70 to 220) mV	(0.50 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.41 mV/V 0.43 mV/V 0.90 mV/V 1.4 mV/V 3.2 mV/V	
(220 to 700) mV	(0.50 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.41 mV/V 0.43 mV/V 0.90 mV/V 1.4 mV/V 3.2 mV/V	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments	
AC Voltage Flatness – Measure				
(0.7 to 2.2) V	(0.50 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.41 mV/V 0.43 mV/V 0.90 mV/V 1.4 mV/V 3.2 mV/V	Fluke 5790A Option 003	
(2.2 to 7.0) V	(0.50 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.41 mV/V 0.43 mV/V 0.90 mV/V 1.4 mV/V 3.2 mV/V		
AC Voltage – Divider Calibration				
(1.1 to 100) kV	60 Hz	2.5 mV/V	Ross VD210 w/ Tek DMM4050	
Phase – Generate ³				
(0 to 360) °			Clark Hess 5000	
1:1	1 Hz to 1 kHz (1 to 5) kHz (5 to 50) kHz (50 to 100) kHz	0.0066° 0.0066° 0.012° 0.046°		
10:1	1 Hz to 1 kHz (1 to 5) kHz (5 to 50) kHz (50 to 100) kHz	0.0066° 0.012° 0.018° 0.047°		
100:1	1 Hz to 1 kHz (1 to 5) kHz (5 to 50) kHz (50 to 100) kHz	0.0066° 0.012° 0.018° 0.047°		
Phase – Measure ³				
(0 to 360) °	(5 to 100) Hz 100 Hz to 1 kHz (1 to 90) kHz	0.029° + (0.0058*f)° 0.038° + (0.0058*f)° 0.068° + (0.0058*f)°		North Atlantic 2000; f=frequency

Parameter/Range	Frequency	CMC ^{2, 7} (±)	Comments
AC Current – Generate ³			
(1 to 219.999) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz	0.40 mA/A + 16 nA 0.15 mA/A + 10 nA 0.11 mA/A + 7.9 nA 0.25 mA/A + 12 nA 0.85 mA/A + 63 nA	Fluke 5720A
(0.22 to 2.19999) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz	0.35 mA/A + 40 nA 0.18 mA/A + 32 nA 0.15 mA/A + 32 nA 0.20 mA/A + 0.10 µA 0.86 mA/A + 0.63 µA	
(2.2 to 21.9999) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz	0.34 mA/A + 0.40 µA 0.15 mA/A + 0.32 µA 0.12 mA/A + 0.32 µA 0.18 mA/A + 0.56 µA 0.86 mA/A + 4.8 µA	
(22 to 219.999) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1.0 kHz (1.0 to 5.0) kHz (5.0 to 10) kHz	0.35 mA/A + 4.0 µA 0.15 mA/A + 3.2 µA 0.12 mA/A + 2.4 µA 0.18 mA/A + 3.2 µA 0.86 mA/A + 9.5 µA	
(0.22 to 2.2) A	20 Hz to 1.0 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 32 µA 0.37 mA/A + 79 µA 5.4 mA/A + 0.16 mA	
(2.2 to 11) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.34 mA/A + 0.13 mA 0.68 mA/A + 0.30 mA 2.6 mA/A + 0.60 mA	Fluke 5720A w/ 5725A
(11 to 20.5) A	(10 to 100) Hz (0.10 to 1.0) kHz (1.0 to 5.0) kHz	0.80 mA/A + 4.0 mA 1.0 mA/A + 4.0 mA 19 mA/A + 4.0 mA	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Current – Generate ³ (cont)			
(16.5 to 149.999) A	(45 to 65) Hz (65 to 440) Hz	3.5 mA/A + 4.0 mA 3.5 mA/A + 4.0 mA	Fluke 5520A w/ 5500A coil
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	3.6 mA/A + 0.20 A 3.6 mA/A + 0.20 A	
AC Current – Measure ³ and Measuring Equipment ³			
(0.009 to 10) mA	(40 to 400) Hz (0.4 to 20) kHz (20 to 30) kHz	0.16 mA/A 0.16 mA/A 0.24 mA/A	Fluke A40 shunts w/ Fluke 5720A and 5790A
(10 to 30) mA	(40 to 400) Hz (0.4 to 20) kHz (20 to 30) kHz	0.17 mA/A 0.17 mA/A 0.25 mA/A	
(30 to 200) mA	(40 to 400) Hz (0.4 to 20) kHz (20 to 30) kHz	0.16 mA/A 0.16 mA/A 0.24 mA/A	
(200 to 300) mA	(40 to 400) Hz (0.4 to 20) kHz (20 to 30) kHz	0.20 mA/A 0.20 mA/A 0.27 mA/A	
(300 to 500) mA	(40 to 400) Hz (0.4 to 10) kHz	0.19 mA/A 0.19 mA/A	
(0.5 to 1) A	(40 to 400) Hz (0.4 to 10) kHz	0.18 mA/A 0.18 mA/A	
(1 to 2) A	(40 to 400) Hz (0.4 to 10) kHz	0.18 mA/A 0.18 mA/A	
(2 to 3) A	(40 to 400) Hz (0.4 to 10) kHz	0.44 mA/A 0.44 mA/A	
(3 to 5) A	(40 to 400) Hz (0.4 to 10) kHz	0.39 mA/A 0.40 mA/A	
(5 to 20) A	(40 to 400) Hz (0.4 to 10) kHz	0.41 mA/A 0.30 mA/A	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Current – Measure ³ and Measuring Equipment ³ (cont) (2 to 20) A	40 Hz to 1 kHz (1 to 5) kHz	0.26 mA/A 0.28 mA/A	Y5020 w/ 8508A
AC Current – Measure ³ (9 to 199.99) µA (0.2 to 1.9999) mA (2 to 19.999) mA (20 to 199.99) mA (0.2 to 1.9999) A (2 to 19.999) A	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz 10 Hz to 2 kHz (2 to 10) kHz	0.49 mA/A + 19 nA 0.49 mA/A + 19 nA 0.65 mA/A + 19 nA 3.1 mA/A + 19 nA 0.32 mA/A + 0.19 µA 0.30 mA/A + 0.19 µA 0.60 mA/A + 0.19 µA 3.1 mA/A + 0.19 µA 0.32 mA/A + 1.9 µA 0.29 mA/A + 1.9 µA 0.60 mA/A + 1.9 µA 3.1 mA/A + 1.9 µA 0.31 mA/A + 19 µA 0.28 mA/A + 19 µA 0.60 mA/A + 19 µA 0.55 mA/A + 0.19 mA 0.65 mA/A + 0.19 mA 2.4 mA/A + 0.19 mA 0.75 mA/A + 1.9 mA 2.0 mA/A + 1.9 mA	Fluke 8508A
Distortion ³ – Measure (0 to 99.9) dB	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	HP 8903B

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
AC Power ³ – Generate PF = 1 (45 to 65) Hz	(0.1089 to 2.97) mW	1.1 mW/W	Fluke 5520A
	(0.297 to 10.89) mW	1.3 mW/W	
	(1.089 to 29.7) mW	1.1 mW/W	
	(2.97 to 108.9) mW	1.3 mW/W	
	(10.89 to 297) mW	1.0 mW/W	
	(29.7 to 726) mW	1.0 mW/W	
	72.6 mW to 1.49 W	1.1 mW/W	
	149 mW to 6.76 W	1.0 mW/W	
	1.09 mW to 9.18 W	0.94 mW/W	
	2.97 mW to 33.6 W	0.62 mW/W	
	10.9 mW to 91.8 W	0.94 mW/W	
	29.7 mW to 337 W	0.68 mW/W	
	109 mW to 918 W	0.87 mW/W	
	297 mW to 2244 W	0.85 mW/W	
72.6 mW to 4.59 kW	0.98 mW/W		
1.49 W to 20.91 kW	0.81 mW/W		

Parameter/Range	Frequency	CMC ^{2, 5, 7} (±)	Comments	
AC Level Flatness – Measure ³				
	1 V	(10 to < 100) Hz (100 to < 1000) Hz (1 to < 10) kHz (10 to < 30) kHz (30 to < 100) kHz (100 to < 300) kHz (0.3 to < 1) MHz (1 to < 3) MHz (3 to < 8) MHz (8 to < 10) MHz (10 to < 20) MHz (20 to < 30) MHz (30 to < 50) MHz (50 to < 70) MHz (70 to < 80) MHz (80 to < 100) MHz 100 MHz	0.12 % 0.12 % 0.12 % 0.12 % 0.23 % 0.29 % 0.29 % 0.58 % 0.70 % 0.71 % 0.71 % 0.76 % 1.8 % 2.8 % 3.6 % 3.9 % 4.8 %	1 V Thermal converter
	3 V	(10 to < 100) Hz (100 to < 1000) Hz (1 to < 10) kHz (10 to < 30) kHz (30 to < 100) kHz (100 to < 300) kHz (0.3 to < 1) MHz (1 to < 3) MHz (3 to < 8) MHz (8 to < 10) MHz (10 to < 20) MHz (20 to < 30) MHz (30 to < 50) MHz (50 to < 70) MHz (70 to < 80) MHz (80 to < 100) MHz 100 MHz	0.12 % 0.12 % 0.12 % 0.12 % 0.23 % 0.29 % 0.29 % 0.58 % 0.70 % 0.71 % 0.71 % 0.76 % 1.8 % 2.8 % 3.6 % 3.9 % 4.8 %	3 V Thermal converter



Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouples ³ – Generate and Measure			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.40 °C 0.29 °C 0.25 °C 0.27 °C	Fluke 5520A
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000C to 1800) °C (1800 to 2316) °C	0.25 °C 0.21 °C 0.25 °C 0.39 °C 0.66 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.39 °C 0.13 °C 0.11 °C 0.13 °C 0.16 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.25 °C 0.13 °C 0.12 °C 0.14 °C 0.18 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.27 °C 0.14 °C 0.13 °C 0.20 °C 0.31 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.32 °C 0.18 °C 0.15 °C 0.14 °C 0.21 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.47 °C 0.29 °C 0.27 °C 0.32 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.42 °C 0.29 °C 0.30 °C 0.37 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouples ³ – Generate and Measure (cont)			
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.50 °C 0.19 °C 0.13 °C 0.11 °C	Fluke 5520A
Type U	(-200 to 0) °C (0 to 600) °C	0.45 °C 0.23 °C	
Electrical Calibration of RTD Indicators ³			
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.085 °C 0.12 °C 0.12 °C 0.11 °C 0.097 °C 0.11 °C 0.20 °C	Fluke 5520A
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	0.064 °C 0.076 °C 0.075 °C 0.089 °C 0.095 °C 0.17 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.21 °C 0.060 °C 0.068 °C 0.070 °C 0.077 °C 0.084 °C 0.090 °C 0.13 °C 0.19 °C	

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Electrical Calibration of RTD Indicators ³ (cont)			
Pt 385, 200 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.041 °C 0.043 °C 0.044 °C 0.051 °C 0.11 °C 0.13 °C	Fluke 5520A
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.081 °C 0.11 °C 0.11 °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	0.036 °C 0.043 °C 0.044 °C 0.051 °C 0.066 °C 0.066 °C 0.073 °C 0.088 °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	0.029 °C 0.029 °C 0.036 °C 0.042 °C 0.050 °C 0.18 °C 0.057 °C 0.18 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.69 °C	
Inductance – Generate			
100 μH 1 mH 10 mH 100 mH 1 H 5 H	(0.1 to 100) kHz (0.1 to 100) kHz (0.1 to 100) kHz (0.1 to 100) kHz (0.1 to 100) kHz (0.1 to 100) kHz	58 nH 0.59 μH 6.1 μH 39 μH 0.86 mH 2.6 mH	GenRad 1482x

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
Inductance – Measure 100 μH to 100 mH 100 mH to 1 H (1 to 10) H	12 Hz to 100 kHz 12 Hz to 100 kHz 12 Hz to 100 kHz	0.25 mH/H 0.25 mH/H 0.25 mH/H	General Radio 1689
Capacitance – Measure (0.1 to 10) pF (10 to 100) pF 100 pF to 25 μF (25 to 100) μF (0.1 to 1) mF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	12 Hz to 100 kHz DC	1.8 mF/F 1.5 mF/F 0.66 mF/F 0.63 mF/F 2.5 mF/F 0.14 mF/F 0.13 mF/F 0.14 mF/F 0.17 mF/F 0.33 mF/F	General Radio 1689 Fluke 5700A and Agilent 3458A
Capacitance – Generate ³ , Fixed Values 1 pF 10 pF	100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.40 fF 0.41 fF 0.46 fF 0.57 fF 0.74 fF 1.5 fF 2.5 fF 4.1 fF 3.6 fF 3.6 fF 3.9 fF 3.9 fF 3.6 fF 3.6 fF 4.2 fF 4.3 fF	HP 1638XX

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
Capacitance – Generate ³ , Fixed Values (cont)			
100 pF	100 Hz to 1 kHz	44 fF	HP 1638XX
	1 kHz to 1 MHz	36 fF	
	(1 to 2) MHz	37 fF	
	(2 to 3) MHz	38 fF	
	(3 to 4) MHz	39 fF	
	(4 to 5) MHz	40 fF	
	(5 to 10) MHz	53 fF	
	(10 to 13) MHz	64 fF	
1000 pF	100 Hz to 1 kHz	0.36 pF	
	1 kHz to 1 MHz	0.36 pF	
	(1 to 2) MHz	0.39 pF	
	(2 to 3) MHz	0.46 pF	
	(3 to 4) MHz	0.57 pF	
	(4 to 5) MHz	0.72 pF	
	(5 to 10) MHz	2.0 pF	
	(10 to 13) MHz	2.9 pF	
10 nF	(100 to 120) Hz	0.62 pF	
	120 Hz to 1 kHz	0.71 pF	
	(1 to 10) kHz	0.71 pF	
	(10 to 100) kHz	0.73 pF	
100 nF	(100 to 120) Hz	7.1 pF	
	120 Hz to 1 kHz	7.1 pF	
	(1 to 10) kHz	7.1 pF	
	(10 to 100) kHz	9.1 pF	

Parameter/Range	Frequency	CMC ^{2,7} (±)	Comments
Capacitance – Generate ³ , Fixed Values (cont)			
1 µF	(100 to 120) Hz 120 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	76 pF 70 pF 70 pF 0.58 nF	HP 1638XX
1.0 µF	100 Hz to 10 kHz	0.27 nF	
0.1 µF	100 Hz to 10 kHz	14 pF	
0.01 µF	100 Hz to 10 kHz	1.4 pF	
0.001 µF	100 Hz to 10 kHz	0.21 pF	
0.0001 µF	100 Hz to 10 kHz	2.4 fF	
(190 to 399.9) pF	10 Hz to 10 kHz	5.2 mF/F + 7.8 pF	General Radio 1409-Y
(0.40 to 1.1) nF	10 Hz to 10 kHz	4.0 mF/F + 7.8 pF	General Radio 509-T
(1.1 to 3.29) nF	10 Hz to 3 kHz	4.0 mF/F + 7.8 pF	General Radio 1409-L
(3.3 to 10.9) nF	10 Hz to 1 kHz	2.1 mF/F + 7.8 pF	General Radio 1409-F
(11 to 109.9) nF	10 Hz to 1 kHz	2.1 mF/F + 78 pF	General Radio 1409-D
(110 to 329.9) nF	10 Hz to 1 kHz	2.1 mF/F + 0.23 nF	
(0.33 to 1.09) µF	(10 to 600) Hz	2.1 mF/F + 0.78 nF	Fluke 5520A
(1.1 to 3.29) µF	(10 to 300) Hz	2.1 mF/F + 2.3 nF	
(3.29 to 10.9) µF	(10 to 150) Hz	2.1 mF/F + 7.8 nF	
(11 to 32.9) µF	(10 to 120) Hz	3.2 mF/F + 23 nF	
(33 to 109.9) µF	(10 to 80) Hz	3.6 mF/F + 78 nF	
(110 to 329.9) µF	(10 to 50) Hz	3.5 mF/F + 0.23 µF	
(0.33 to 1.09) mF	(10 to 20) Hz	3.5 mF/F + 0.78 µF	
(1.1 to 3.29) mF	(0 to 6.0) Hz	3.5 mF/F + 2.3 µF	
(3.3 to 10.9) mF	(0 to 2.0) Hz	3.5 mF/F + 7.8 µF	
(11 to 32.9) mF	(0 to 0.6) Hz	5.8 mF/F + 23 µF	
(33 to 110) mF	(0 to 0.2) Hz	8.5 mF/F + 78 µF	

Parameter/Range	Frequency	CMC ^{2,7} (\pm)	Comments
Oscilloscope Calibration – DC			
50 Ω	± 1 mV to ± 5.0 V	0.19 mV/V + 19 μ V	Wavetek 9500B
1 M Ω	± 1 mV to ± 200 V	0.20 mV/V + 19 μ V	
10 Hz to 100 kHz	Squarewave:		
50 Ω	± 1 mV to ± 5.0 V _(p-p)	0.78 mV/V + 7.8 μ V	
1 M Ω	± 1 mV to ± 200 V _(p-p)	0.80 mV/V + 7.8 μ V	
Bandwidth ³	0.01 Hz to 300 MHz	2.3 %	Wavetek 9500B w/ 9560 83630B, and 8485A
	(300 to 550) MHz	2.6 %	
	550 MHz to 3.0 GHz	3.3 %	
	(3.0 to 6.0) GHz	3.8 %	
	(6.0 to 26.5) GHz	6.6 %	
Time Marker	180 ps to 55 s	0.29 μ s/s	Wavetek 9500B w/ 9560
Input Impedance Measurement	(40 to 90) Ω	0.80 m Ω / Ω	
	(0.8 to 1.2) M Ω	0.81 m Ω / Ω	
Generate	≥ 50 ps	18 ps	Fluke 9500B with 9560 head
Measure	≥ 20 ps	17 ps	HP 54121T sampling oscilloscope
	≥ 150 ps	12 ps	

IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
RF Power – Measure ³			
(-60 to +20) dBm	9 kHz to 500 MHz 500 MHz to 6 GHz (6 to 12) GHz (12 to 18) GHz	1.4 % 1.6 % 2.2 % 2.8 %	E9304A H19 w/ power meter
(-20 to +20) dBm	(18 to 26.5) GHz	3.0 %	8485A w/ power meter
(-35 to + 20) dBm	DC to 100 MHz (> 0.10 to 2.4) GHz (> 2.4 to 8) GHz (> 8 to 12.4) GHz (>12.4 to 18) GHz (> 18 to 26.5) GHz (> 26.5 to 33) GHz (> 33 to 40) GHz (> 40 to 44) GHz (>44 to 50) GHz	0.044 dBm 0.056 dBm 0.073 dBm 0.087 dBm 0.11 dBm 0.11dBm 0.13 dBm 0.13 dBm 0.16 dBm 0.16 dBm	NRP-Z56 w/ power meter
1 mW	50 MHz 1000 MHz	0.59 % 0.60 %	Tegam 1807A
RF Attenuation – Tuned RF Power Measure ³			
(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 -95) dB (-95 to -100) dB (-100 to -105) dB (-105 to -110) dB (-110 to -120) dB (-120 to -125) dB	100 kHz to 10 MHz	0.018 dB 0.024 dB 0.029 dB 0.035 dB 0.041 dB 0.047 dB 0.052 dB 0.058 dB 0.064 dB 0.070 dB 0.073 dB 0.085 dB 0.092 dB 0.13 dB 0.27 dB	Rohde and Schwarz FSMR50

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
RF Attenuation – Tuned RF Power Measure ³ (cont)			
(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 -85) dB (-85 to -90) dB (-90 to -100) dB (-100 to -105) dB (-105 to -110) dB (-110 to -120) dB (-120 to -125) dB (-125 to -135) dB	10 MHz to 22 GHz	0.019 dB 0.024 dB 0.029 dB 0.035 dB 0.041 dB 0.047 dB 0.053 dB 0.059 dB 0.065 dB 0.067 dB 0.073 dB 0.082 dB 0.091 dB 0.093 dB 0.47 dB 1.3 dB	Rohde and Schwarz FSMR50
(0 to -10) dB (-10 to -15) dB (-15 to -20) dB (-20 to -25) dB (-25 to -30) dB (-30 to -35) dB (-35 to -40) dB (-40 to -45) dB (-45 to -50) dB (-50 to -55) dB (-55 to -60) dB (-60 to -65) dB (-65 to -70) dB (-70 to -75) dB (-75 to -80) dB (-80 to -85) dB (-85 to -90) dB (-90 to -95) dB (-95 to -100) dB (-100 to -105) dB (-105 to -110) dB (-110 to -120) dB (-120 to -125) dB (-125 to -135) dB	(22 to 26.5) GHz	0.28 dB 0.35 dB 0.34 dB 0.30 dB 0.21 dB 0.31 dB 0.26 dB 0.35 dB 0.41 dB 0.35 dB 0.32 dB 0.51 dB 0.38 dB 0.23 dB 0.27 dB 0.34 dB 0.31 dB 0.30 dB 0.27 dB 0.27 dB 0.31 dB 0.45 dB 2.9 dB 1.3 dB	

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
RF Attenuation – Tuned RF Power Measure ³ (cont)			
(0 to -20) dB	(26.5 to 40) GHz	0.25 dB	Rohde and Schwarz FSMR50
(-20 to -25) dB		0.39 dB	
(-25 to -30) dB		0.29 dB	
(-30 to -35) dB		0.22 dB	
(-35 to -40) dB		0.44 dB	
(-40 to -45) dB		0.31 dB	
(-45 to -50) dB		0.45 dB	
(-50 to -55) dB		0.61 dB	
(-55 to -60) dB		0.41 dB	
(-60 to -65) dB		0.51 dB	
(-65 to -70) dB		0.41 dB	
(-70 to -75) dB		0.29 dB	
(-75 to -80) dB		0.41 dB	
(-80 to -85) dB		0.42 dB	
(-85 to -90) dB		0.41 dB	
(-90 to -95) dB		0.42 dB	
(-95 to -100) dB		0.40 dB	
(-100 to -105) dB	0.38 dB		
(-105 to -110) dB	0.47 dB		
(-110 to -120) dB	0.55 dB		
(-120 to -125) dB	0.26 dB		
(0 to -10)	(40 to 50) GHz	0.31 dB	
(-10 to -15)		0.45 dB	
(-15 to -20)		0.44 dB	
(-20 to -25)		0.50 dB	
(-25 to -30)		0.52 dB	
(-30 to -35)		0.51 dB	
(-35 to -40)		0.55 dB	
(-40 to -45)		0.43 dB	
(-45 to -50)		0.49 dB	
(-50 to -55)		0.30 dB	
(-55 to -65)		0.36 dB	
(-65 to -70)		0.44 dB	
(-70 to -75)		0.35 dB	
(-75 to -80)		0.42 dB	
(-80 to -85)		0.36 dB	
(-85 to -90)		0.41 dB	
(-90 to -95)		0.37 dB	
(-95 to -100)	0.38 dB		
(-100 to -105)	0.39 dB		
(-105 to -110)	0.37 dB		
(-110 to -120)	0.35 dB		

Parameter/Range	Frequency	CMC ^{2,5,7} (±)	Comments
RF Power – Generate (cont)			
(10 to 24) dBm (-35 to 10) dBm (-45 to -35) dBm (-70 to -45) dBm (-75 to -70) dBm (-80 to -75) dBm (-85 to -80) dBm (-94 to -85) dBm	(0.01 to 100) kHz	0.023 dB 0.024 dB 0.025 dB 0.16 dB 0.39 dB 0.40 dB 0.41 dB 0.44 dB	Fluke 96270A/LL/FF w/ leveling head
(20 to 24) dBm (5 to 20) dBm (-20 to 5) dBm (-40 to -20) dBm (-45 to -40) dBm (-70 to -45) dBm (-80 to -70) dBm (-94 to -80) dBm	(0.1 to 10) MHz	0.047 dB 0.045 dB 0.047 dB 0.045 dB 0.047 dB 0.16 dB 0.39 dB 0.40 dB	
(20 to 24) dBm (5 to 20) dBm (-45 to 5) dBm (-50 to -45) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-105 to -90) dBm (-110 to -105) dBm (-115 to -110) dBm (-120 to -115) dBm (-130 to -120) dBm	(10 to 128) MHz	0.045 dB 0.043 dB 0.047 dB 0.082 dB 0.084 dB 0.086 dB 0.087 dB 0.24 dB 0.55 dB 0.56 dB 0.59 dB 0.61 dB 0.97 dB	
(0 to 20) dBm (-45 to 0) dBm (-50 to -45) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-115 to -90) dBm (-120 to -115) dBm (-130 to -120) dBm	(128 to 300) MHz	0.059 dB 0.063 dB 0.084 dB 0.085 dB 0.088 dB 0.24 dB 0.39 dB 1.2 dB 1.4 dB 2.4 dB	

Parameter/Range	Frequency	CMC ^{2, 5, 7} (±)	Comments
Amplitude Modulation – Measure ³			
Rate: 10 Hz to 10 kHz Depth: (5 to 99) %	(0.1 to 10) MHz	1.5 %	Rohde and Schwarz FSMR 50
Rate: 10 Hz to 50 kHz Depth: (5 to 99) %	(0.01 to 50) GHz	1.0 %	
Rate: 50 kHz to 100 kHz Depth: (5 to 99) %	(0.01 to 50) GHz	1.5 %	
Rate: 90 Hz to 150 Hz Depth: (5 to 99) %	(0.01 to 50) GHz	0.40 %	
Amplitude Modulation – Generate ³			
Rate: 10 Hz to 10 kHz Depth: (5 to 99) %	(0.1 to 10) MHz	1.5 %	HP 83630B monitored by Rohde and Schwarz FSMR 50
Rate: 10 Hz to 50 kHz Depth: (5 to 99) %	(0.01 to 50) GHz	1.0 %	
Rate: 50 kHz to 100 kHz Depth: (5 to 99) %	(0.01 to 50) GHz	1.5 %	
Rate: 90 Hz to 150 Hz Depth: (5 to 99) %	(0.01 to 50) GHz	0.40 %	
Frequency Modulation – Measure ³			
Rate: 10 Hz to 10 kHz Dev: ≤ 50 kHz peak	(0.1 to 10) MHz	1.2 %	Rohde and Schwarz FSMR 50
Rate: 10 Hz to 100 kHz Dev: ≤ 500 kHz peak	(0.01 to 50) GHz	1.2 %	
Rate: (100 to 200) kHz Dev: ≤ 500 kHz peak	(0.01 to 50) GHz	3.5 %	

Parameter/Range	Frequency	CMC ^{2, 5, 7} (±)	Comments
Frequency Modulation – Generate ³			
<100 kHz Rate	(11 to 13.5) MHz (88 to 108) MHz (352 to 432) MHz	0.19 % 0.19 % 0.19 %	HP 11715A
<200 kHz Rate	(11 to 13.5) MHz (88 to 108) MHz (352 to 432) MHz	0.32 % 0.32 % 0.32 %	
Digital Modulation – Measure and Generate ³			
Carrier: 2 MHz to 50 GHz for Measure			Rohde and Schwarz FSMR and E Series generator
Carrier: 2 MHz to 4 GHz for Generate			Types: 2FSK, 4FSK, GFSK, BPSK, QPSK (3GPP WCDMA, CDMA2000 [®]), OQPSK, DQPSK, $\pi/4$ DQPSK, 8PSK, D8PSK, 3 $\pi/8$ 8PSK (EDGE), 16QAM, 32QAM, 64QAM, 128QAM, 256 QAM, D16QAM, D32QAM, D64QAM, D128QAM, D256QAM, 8VSB, GSM, NADC, PDC, PHS, Bluetooth [®] , DECT, TETRA
Error Vector Magnitude for Modulation	Symbol Rate \leq 1 MHz \leq 10 MHz \leq 15 MHz	0.53 % 1.1 % 2.1 %	
Phase Error for Modulation	Mod Freq Span \leq 100 kHz \leq 1 MHz \leq 10 MHz $>$ 10 MHz	0.32° 0.42° 0.64° 1.3°	
Power Sensor Calibration –			
N Type Sensors	9 kHz 30 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz 3 MHz 5 MHz	0.043 % 0.063 % 0.056 % 0.77 % 0.71 % 0.70 % 0.70 % 0.71 % 0.70 %	Tegam M1120, dual type IV power meter, 8.5-digit reference multimeter, power meter, RF signal generator, function generator

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Power Sensor Calibration – (cont)			
N Type Sensors	10 MHz	0.56 %	Tegam 1807A, dual type IV power meter, 8.5- digit reference multimeter, power meter, RF signal generator, function generator
	30 MHz	0.54 %	
	50 MHz	0.56 %	
	100 MHz	0.55 %	
	300 MHz	0.57 %	
	500 MHz	0.58 %	
	800 MHz	0.54 %	
	1 GHz	0.56 %	
	1.1 GHz	0.64 %	
	1.5 GHz	0.56 %	
	2 GHz	0.57 %	
	2.5 GHz	0.60 %	
	2.6 GHz	0.58 %	
	3 GHz	0.59 %	
	3.5 GHz	0.61 %	
	4 GHz	0.63 %	
	4.2 GHz	0.63 %	
	5 GHz	0.96 %	
	6 GHz	1.1 %	
	7 GHz	1.1 %	
	8 GHz	1.0 %	
	9 GHz	1.1 %	
	10 GHz	0.90 %	
	11 GHz	0.92 %	
	12 GHz	1.1 %	
	12.4 GHz	1.1 %	
	13 GHz	1.2 %	
	14 GHz	1.1 %	
	15 GHz	1.0 %	
	16 GHz	1.1 %	
	17 GHz	1.3 %	
	18 GHz	0.88 %	

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Transmission Phase ³ (Into 50 Ω, 0° to 360°)			
30 kHz to 3 GHz	(-15 to 10) dBm (-25 to 0) dBm (-35 to -10) dBm (-45 to -20) dBm (-55 to 30) dBm (-65 to -40) dBm (-75 to -50) dBm (-85 to -60) dBm	1.1° 0.75° 3.5° 2.3° 2.9° 1.8° 2.6° 2.5°	HP 8753ES
(3 to 6) GHz	(-15 to 10) dBm (-25 to 0) dBm (-35 to -10) dBm (-45 to -20) dBm (-55 to -30) dBm (-65 to -40) dBm (-75 to -50) dBm (-85 to -60) dBm	0.16° 0.13° 0.24° 0.48° 1.3° 2.0° 3.1° 3.1°	
Transmission Magnitude ³			
30 kHz to 3 GHz	(-15 to 10) (-25 to 0) (-35 to -10) (-45 to -20) (-55 to -30) (-65 to -40) (-75 to -50) (-85 to -60)	0.33 dB 0.21 dB 0.17 dB 0.84 dB 0.29 dB 0.47 dB 0.66 dB 1.1 dB	
(3 to 6) GHz	(-15 to 10) dBm (-25 to 0) dBm (-35 to -10) dBm (-45 to -20) dBm (-55 to -30) dBm (-65 to -40) dBm (-75 to -50) dBm (-85 to -60) dBm	0.078 dB 0.017 dB 0.025 dB 0.050 dB 0.13 dB 0.36 dB 0.71 dB 0.75 dB	

Parameter/Range	Frequency	CMC ^{2, 4, 5} (\pm)	Comments
Reflection Coefficient ³ (Into 50 Ω)			
0 < ρ \leq 0.2	30 kHz to 1.2 GHz (1.2 to 3) GHz (3 to 6) GHz	0.00042 ρ 0.00073 ρ 0.00088 ρ	HP 8753ES
0.2 < ρ \leq 0.4	30 kHz to 1.2 GHz (1.2 to 3) GHz (3 to 6) GHz	0.0013 ρ 0.0014 ρ 0.0015 ρ	
0.4 < ρ \leq 0.6	30 kHz to 1.2 GHz (1.2 to 3) GHz (3 to 6) GHz	0.0022 ρ 0.0022 ρ 0.0023 ρ	
0.6 < ρ \leq 0.8	30 kHz to 1.2 GHz (1.2 to 3) GHz (3 to 6) GHz	0.0028 ρ 0.0029 ρ 0.0041 ρ	
0.8 < ρ \leq 1	30 kHz to 1.2 GHz (1.2 to 3) GHz (3 to 6) GHz	0.0035 ρ 0.0035 ρ 0.0036 ρ	
0.000 < ρ \leq 0.0476	45 MHz to 3 GHz (4 to 8) GHz (9 to 14) GHz (15 to 20) GHz (20 to 26.5)	0.00086 ρ 0.0011 ρ 0.0013 ρ 0.0017 ρ 0.0021 ρ	HP 8510C w/ 85052B
0.0476 < ρ \leq 0.1111	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	0.0040 ρ 0.0054 ρ 0.0076 ρ 0.012 ρ	
0.1111 < ρ \leq 0.200	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	0.0040 ρ 0.0044 ρ 0.0076 ρ 0.011 ρ	
0.200 < ρ \leq 0.3333	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	0.0086 ρ 0.0096 ρ 0.014 ρ 0.015 ρ	
0.3333 < ρ \leq 0.500	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	0.012 ρ 0.014 ρ 0.017 ρ 0.022 ρ	

Parameter/Equipment	Range	CMC ^{2, 4, 5, 7} (\pm)	Comments
Reflection Phase ³ (Into 50 Ω , 0° to 360°) $0.0 < \rho \leq 1.0$	30 kHz to 1.2 GHz (1.2 to 3) GHz (3 to 6) GHz (0.045 to 3) GHz (3 to 8) GHz (8 to 14) GHz (14 to 20) GHz (20 to 26.5) GHz	1.2° 1.3° 1.5° 0.27° 0.24° 0.29° 0.36° 0.33°	HP 8753ES HP8510C w/ 85052B
Phase Noise – Measure ³ ≤ 1 Hz Offset ≤ 10 Hz Offset ≤ 100 Hz Offset ≤ 1 kHz Offset ≤ 10 kHz Offset ≤ 100 kHz Offset ≤ 1 MHz Offset ≤ 1 Hz Offset ≤ 10 Hz Offset ≤ 100 Hz Offset ≤ 1 kHz Offset ≤ 10 kHz Offset ≤ 100 kHz Offset ≤ 1 MHz Offset ≤ 10 MHz Offset (10 to 30) MHz Offset ≤ 1 Hz Offset ≤ 10 Hz Offset ≤ 100 Hz Offset ≤ 1 kHz Offset ≤ 10 kHz Offset ≤ 100 kHz Offset ≤ 1 MHz Offset ≤ 10 MHz Offset (10 to 30) MHz Offset	(1 to 10) MHz Carrier (10 to 100) MHz Carrier (0.1 to 1) GHz Carrier	2.7 dBc 2.5 dBc 1.6 dBc 1.6 dBc 1.6 dBc 1.6 dBc 4.0 dBc 3.7 dBc 2.8 dBc 1.6 dBc 1.6 dBc 1.6 dBc 1.6 dBc 2.7 dBc 3.3 dBc 4.0 dBc 3.2 dBc 2.4 dBc 1.7 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.9 dBc 4.0 dBc 4.0 dBc	Rohde and Schwarz FSWP50

Parameter/Equipment	Range	CMC ^{2, 4, 5, 7} (\pm)	Comments
Phase Noise Measure ³ (cont)			
≤ 1 Hz Offset	(1 to 3) GHz Carrier	4.2 dBc	Rohde and Schwarz FSWP50
≤ 10 Hz Offset		2.0 dBc	
≤ 100 Hz Offset		1.6 dBc	
≤ 1 kHz Offset		1.6 dBc	
≤ 10 kHz Offset		1.6 dBc	
≤ 100 kHz Offset		1.6 dBc	
≤ 1 MHz Offset		3.8 dBc	
≤ 10 MHz Offset		4.4 dBc	
(10 to 30) MHz Offset		4.1 dBc	
≤ 1 Hz Offset	(3 to 7) GHz Carrier	4.4 dBc	
≤ 10 Hz Offset		2.6 dBc	
≤ 100 Hz Offset		1.7 dBc	
≤ 1 kHz Offset		1.6 dBc	
≤ 10 kHz Offset		1.6 dBc	
≤ 100 kHz Offset		1.6 dBc	
≤ 1 MHz Offset		3.3 dBc	
≤ 10 MHz Offset		3.9 dBc	
(10 to 30) MHz Offset		4.6 dBc	
≤ 1 Hz Offset	(7 to 10) GHz Carrier	4.4 dBc	
≤ 10 Hz Offset		2.7 dBc	
≤ 100 Hz Offset		1.8 dBc	
≤ 1 kHz Offset		1.6 dBc	
≤ 10 kHz Offset		1.6 dBc	
≤ 100 kHz Offset		1.6 dBc	
≤ 1 MHz Offset		3.5 dBc	
≤ 10 MHz Offset		3.3 dBc	
(10 to 30) MHz Offset		4.6 dBc	
≤ 1 Hz Offset	(10 to 16) GHz Carrier	3.2 dBc	
≤ 10 Hz Offset		2.7 dBc	
≤ 100 Hz Offset		1.7 dBc	
≤ 1 kHz Offset		1.6 dBc	
≤ 10 kHz Offset		1.6 dBc	
≤ 100 kHz Offset		1.6 dBc	
≤ 1 MHz Offset		3.3 dBc	
≤ 10 MHz Offset		4.1 dBc	
(10 to 30) MHz Offset		4.0 dBc	

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Phase Noise – Measure ³ (cont)			
(16 to 26) GHz Carrier	≤ 1 Hz Offset ≤ 10 Hz Offset ≤ 100 Hz Offset ≤ 1 kHz Offset ≤ 10 kHz Offset ≤ 100 kHz Offset ≤ 1 MHz Offset ≤ 10 MHz Offset (10 to 30) MHz Offset	4.1 dBc 2.7 dBc 1.7 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.6 dBc 4.2 dBc 4.0 dBc	Rohde and Schwarz FSWP50
(26 to 50) GHz Carrier	≤ 1 Hz Offset ≤ 10 Hz Offset ≤ 100 Hz Offset ≤ 1 kHz Offset ≤ 10 kHz Offset ≤ 100 kHz Offset ≤ 1 MHz ≤ 10 MHz Offset (10 to 30) MHz Offset	4.1 dBc 2.0 dBc 1.8 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.7 dBc 3.6 dBc 4.4 dBc	

V. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Force Gauges – Compression and Tension Test, Dyamometer ³	(0.0125 to 1) lbf (1 to 10) lbf (10 to 50) lbf (50 to 100) lbf (100 to 500) lbf	0.060 % 0.032 % 0.037 % 0.055 % 0.022 %	Class F weights
Torque – Measure ³	(5 to 50) ozf·in (15 to 200) ozf·in (5 to 50) lbf·in (25 to 250) lbf·in (100 to 1000) lbf·in (20 to 250) lbf·ft (60 to 600) lbf·ft (600 to 2000) lbf·ft	0.58 % 0.31 % 0.30 % 0.29 % 0.29 % 0.30 % 0.29 % 0.29 %	CDI 2000-4-02 CDI 2000-5-02 CDI 2000-400-02 CDI 2000-12-02 CDI 2000-14-02

Parameter/Equipment	Range	CMC ^{2, 4, 5, 7} (±)	Comments
Pressure – Measure Pneumatic	(-14.5 to 70) psig (70 to 145) psig (145 to 600) psig (600 to 3000) psig	0.013 % + 0.0084 psi 0.013 % 0.012 % 0.012 %	Mensor CPC6050 and barometer
Hydraulic	(0 to 5) in·H ₂ O (5 to 50) in·H ₂ O (0 to 10) psig (200 to 2000) psig (2000 to 10 000) psig	0.0035 in·H ₂ O 0.035 in·H ₂ O 0.0036 psi 0.12 % 0.12 %	Heise PTE-1 Crystal XP2i 2000 Crystal XP2i 10000
Durometers – (0 to 100) duro	Type A, B, O Type C, D, DO	(0.12 + 0.0021 <i>D</i>) duro (0.054 + 0.0053 <i>D</i>) duro	Rex RDC-1 Duro-calibrator, optical inspection
Scales & Balances ³	0 mg (1 to 2) mg (2 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg (0.5 to 1) g (1 to 2) g (2 to 3) g (3 to 5) g (5 to 10) g (10 to 50) g	0.58 <i>R</i> 1.5 µg 1.7 µg 1.8 µg 1.7 µg 1.7 µg 2.0 µg 1.8 µg 2.2 µg 20 µg 19 µg 27 µg 40 µg 16 µg 33 µg	Standard weights

Parameter/Equipment	Range	CMC ² (±)	Comments
Scales & Balances ³ (cont)	(50 to 100) g	68 µg	Standard weights
	(100 to 200) g	0.13 mg	
	(200 to 300) g	0.15 mg	
	(300 to 500) g	0.10 mg	
	(0.5 to 1) kg	0.14 mg	
	(1 to 2) kg	0.78 mg	
	(2 to 3) kg	6.5 mg	
	(3 to 5) kg	3.0 mg	
	(5 to 10) kg	4.5 mg	
	(10 to 25) kg	72 mg	
	(50 to 100) lbs	3.8 g	Class F weights
	(100 to 250) lbs	5.9 g	
	(250 to 500) lbs	8.4 g	
Mass – Fixed Points	(1 to 50) mg	6.0 µg	Mettler AT261 compare to standard weights
	100 mg	6.1 µg	
	200 mg	6.0 µg	
	500 mg	6.3 µg	
	1 g	20 µg	
	2 g	19 µg	
	3 g	27 µg	
	5 g	40 µg	
	10 g	16 µg	
	50 g	33 µg	
	100 g	68 µg	
	200 g	0.13 mg	
	220 g	0.13 mg	
	300 g	0.15 mg	
	500 g	98 µg	
	1000 g	0.14 mg	
	2000 g	0.78 mg	
	3000 g	6.5 mg	
	5000 g	3.0 mg	
	10 000 g	4.5 mg	
	20 000 g	72 mg	
	25 000 g	72 mg	

VI. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Temperature – Measuring Equipment ³	(-75.0 to -1.1) °C	0.018 °C	VWR Scientific 1197 Bath w/ Hart 1502 and 5626 probe
	(-5 to 200) °C	0.016 °C	Hart 7102 bath w/ Hart 1502 and 5626 PRT
	(200 to 400) °C	0.044 °C	Hart 9100 drywell w/ 1502 and 5626 PRT
Temperature – Measure ³	(-200 to 420) °C	0.016 °C	Fluke 8508A w/ 5628 SPRT
Relative Humidity – Measuring Equipment ³			
(15 to 20) °C	(60 to 95) % RH	1.1 % RH	General Eastern Optica monitoring chamber
(20 to 40) °C	(45 to 95) % RH	1.1 % RH	
(40 to 60) °C	(20 to 95) % RH	0.91 % RH	
(60 to 70) °C	(15 to 95) % RH	0.81 % RH	
(70 to 85) °C	(10 to 95) % RH	0.76 % RH	
Relative Humidity – Measure ³	(5 to 45) % RH	1.3 %	Vaisala HMI41 w/ HP76 probe
	(45 to 90) % RH	1.4 %	
	(90 to 100) % RH	2.2 %	

VII. Time & Frequency

Parameter/Equipment	Frequency	CMC ^{2, 4, 7} (\pm)	Comments
Frequency – Measure ³	1 mHz to 26.5 GHz	$5 \cdot 10^{-12} + 17 \mu\text{Hz} + 0.58R$	Datum GPS w/ frequency counter
Frequency – Generate ³	1 mHz to 50 GHz	$5 \cdot 10^{-12} + 17 \mu\text{Hz} + 0.58R$	Datum GPS w/ frequency generator
RPM – Measure & Generate	(10 to 100 000) RPM	0.0018 RPM	HP 3325A w/Datum GPS w/ 53132A
Time Interval ³	Up to 24 Hours	0.040 s/day	Vibrograf TM-4500

¹ This laboratory offers commercial and field calibration service.

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

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

⁴ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches. In the statement of CMC, D is nominal diameter in inches. The symbol ρ refers to the magnitude of the reflection value being read. In the statement of CMC, R is larger number of either resolution or repeatability.

⁵ In the statement of CMC, percentages are to be read as percent of reading, unless noted otherwise.

⁶ This scope meets A2LA's *P112 Flexible Scope Policy*.

⁷ 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.



Accredited Laboratory

A2LA has accredited

TEKTRONIX, INC.

Addison, IL

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 6th day of April 2021.

A blue ink signature of the Vice President of Accreditation Services.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2357.13
Valid to June 30, 2023

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