



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: May 31, 2024

Certificate Number: 1022.03

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1, 8}:

I. Dimensional

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
Angle – Measuring Equipment ³	Up to 60°	5.4 arc-sec	Gage blocks w/ sine plate
Calipers ³ – Outside Step and Depth Inside	Up to 40 in Up to 40 in 1 in	10 µin + 4.8 µin/in 31 µin + 4.5 µin/in 73 µin	Gage blocks Master rings
Height Gages ³	Up to 40 in	31 µin + 4.5 µin/in	Gage blocks
Indicators ³	Up to 2 in	30 µin + 0.98 µin/in	Gage blocks
Micrometers ³ Spindle Linearity Anvil Flatness Parallelism	Up to 40 in Up to 50 µin Up to 50 µin	6.5 µin + 4.9 µin/in 7.3 µin 9.8 µin	Gage blocks Optical flats

Parameter/Equipment	Range	CMC ^{2, 5, 6} ($\pm$)	Comments
Linear Displacement ³ – Measuring Equipment	Up to 40 in	61 μ in + 4.1 μ in/in	Gage amplifier, Gage blocks
Plain Diameter – External	(0.003 to 0.5) in	33 μ in	Laser micrometer, Master pins
Steel Tapes ³	(1 to 100) ft	0.0046 in	Gage blocks, Jeweler's Loupe
Length Standards	Up to 40 in	61 μ in + 4.1 μ in/in	Gage amplifier, Gage blocks

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 6, 7} ($\pm$)	Comments
DC Voltage – Generate ³	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	0.68 μ V + 7 μ V/V 1 μ V + 6.2 μ V/V 3.4 μ V + 6.2 μ V/V 6.4 μ V + 6.2 μ V/V 79 μ V + 7 μ V/V 0.48 mV + 9 μ V/V	Fluke 5700A w/wideband option
DC Voltage – Generate, Fixed Points	1 V 1.018 V 10 V	4.2 μ V/V 4.6 μ V/V 0.68 μ V/V	Fluke 732A
DC Voltage – Measure ³	(0 to 1) mV (1 to 10) mV (0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	25 nV + 52 μ V/V 0.41 μ V + 53 μ V/V 0.33 μ V + 17 μ V/V 0.52 μ V + 8 μ V/V 8.8 μ V + 8.1 μ V/V 35 μ V + 10 μ V/V 1.2 mV + 11 μ V/V	Agilent 34420A Agilent 3458A

Parameter/Equipment	Range	CMC ^{2, 4, 6, 7} (±)	Comments
DC High Voltage ³ –			
Generate	(1 to 10) kV (10 to 35) kV (35 to 40) kV	0.04 % 0.042 % 0.062 %	Vitretek 4700 w/HVP-35 w/HVL-100
Measure	(1 to 10) kV (10 to 35) kV (35 to 100) kV	0.04 % 0.042 % 0.63 %	Vitretek 4700 w/HVP-35 w/HVL-100
Generate & Measure	(1 to 2) kV (2 to 20) kV	0.95 V + 0.45 mV/V 5.7 V + 0.46 mV/V	Vitretek 4620A
DC Current – Generate ³	0.1 nA 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 11) A	7.8 nA + 47 µA/A 8 nA + 46 µA/A 78 nA + 47 µA/A 0.8 µA + 62 µA/A 23 µA + 0.11 mA/A 0.38 mA + 0.28 mA/A	Fluke 5700A Fluke 5700A w/ 5725A
	(11 to 20.5) A	9.1 mA + 0.78 mA/A	Fluke 5520A
	(20 to 100) A	0.013 %	Agilent 3458A w/ Guildline 9211A
Clamp Meter	(10 to 16.5) A (16.5 to 150) A (150 to 1025) A	50 mA + 6.5 mA/A 0.18 A + 3.4 mA/A 0.83 A + 3.3 mA/A	Fluke 5520A w/ 5500A/coil
DC Current – Measure ³	Up to 2 nA (2 to 20) nA (20 to 200) nA (0.2 to 2) µA (2 to 20) µA (20 to 200) µA (0.2 to 2) mA (0 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 10) A (10 to 100) A (100 to 300) A (300 to 1000) A	0.51 pA + 3 mA/A 7.1 pA + 2.1 mA/A 51 pA + 1.6 mA/A 0.51 nA + 1.6 mA/A 4.1 nA + 1.1 mA/A 41 nA + 1 mA/A 0.41 µA + 0.99 mA/A 41 pA + 89 µA/A 70 pA + 21 µA/A 0.7 nA + 18 µA/A 5.8 nA + 9.2 µA/A 58 nA + 9.7 µA/A 0.58 µA + 8 µA/A 5.8 µA + 17 µA/A 59 µA + 81 µA/A 0.0025 % 0.0052 % 0.0054 % 0.2 %	Keithley 486 Agilent 3458A Agilent 3458A w/ Guildline 9211A Empro Shunt

Parameter/Equipment	Range	CMC ^{2, 4, 6, 7} ($\pm$)	Comments
DC Resistance – Generate, Fixed Points ³	333 $\mu\Omega$ 1 m Ω 10 m Ω 100 m Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω	0.0046 % 0.0045 % 0.0018 % 0.0018 % 0.0014 % 0.0014 % 0.0014 % 0.0014 % 0.0014 %	Guildline 9211A
	1 Ω 10 k Ω	8.9 $\mu\Omega$ 46 m Ω	Fluke 742A-1 Fluke 742A-10K
	0 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	39 $\mu\Omega$ 86 $\mu\Omega$ 0.16 m Ω 0.26 m Ω 0.46 m Ω 1.6 m Ω 3 m Ω 12 m Ω 22 m Ω 0.11 Ω 0.21 Ω 1.2 Ω 2.4 Ω 18 Ω 35 Ω 0.36 k Ω 0.81 k Ω 39 k Ω	Fluke 5700A
Up to 1000 V	1 M Ω 10 M Ω 100 M Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω 10 T Ω	21 Ω 0.38 k Ω 12 k Ω 0.61 M Ω 2.4 M Ω 0.36 G Ω 5 G Ω 0.15 T Ω	IET VRS-100-8-1M-BP
Up to 5000 V	1 M Ω 10 M Ω 100 M Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω 10 T Ω	5.4 k Ω 50 k Ω 0.5 M Ω 5 M Ω 50 M Ω 0.5 G Ω 5 G Ω 0.27 T Ω	

Parameter/Equipment	Range	CMC ^{2, 4, 6, 7} ($\pm$)	Comments
DC Resistance – Measure	(0 to 1) Ω (1 to 10) Ω (0 to 10) Ω (10 to 100) Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω	3.2 $\mu\Omega$ + 71 $\mu\Omega/\Omega$ 86 $\mu\Omega$ + 60 $\mu\Omega/\Omega$ 55 $\mu\Omega$ + 15 $\mu\Omega/\Omega$ 0.52 m Ω + 13 $\mu\Omega/\Omega$ 0.53 m Ω + 10 $\mu\Omega/\Omega$ 5.3 m Ω + 10 $\mu\Omega/\Omega$ 53 m Ω + 11 $\mu\Omega/\Omega$ 2.3 Ω + 17 $\mu\Omega/\Omega$ 0.1 k Ω + 55 $\mu\Omega/\Omega$ 1 k Ω + 0.52 m Ω/Ω 10 k Ω + 5.1 m Ω/Ω	Agilent 34420A Agilent 3458A
DC Resistance – Measure	333 $\mu\Omega$ 1 m Ω 10 m Ω 100 m Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω	0.0051 % 0.005 % 0.0028 % 0.0028 % 0.0025 % 0.0025 % 0.0025 % 0.0025 % 0.0025 %	Current transfer method using Guildline 9211A, Agilent 3458A
Resistance – Generate ³	Up 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) k Ω (1.1 to 3.299 999) k Ω (3.3 to 10.999 99) k Ω (11 to 32.999 99) k Ω (33 to 109.999) k Ω (110 to 329.999) k Ω (0.33 to 1.099 99) M Ω (1.1 to 3.299 99) M Ω (3.3 to 10.9999) M Ω (11 to 32.9999) M Ω (33 to 109.9999) M Ω (110 to 329.9999) M Ω (330 to 1100) M Ω	1.1 m Ω + 23 $\mu\Omega/\Omega$ 1.4 m Ω + 23 $\mu\Omega/\Omega$ 2 m Ω + 22 $\mu\Omega/\Omega$ 4.4 m Ω + 22 $\mu\Omega/\Omega$ 9.8 m Ω + 22 $\mu\Omega/\Omega$ 42 m Ω + 22 $\mu\Omega/\Omega$ 98 m Ω + 22 $\mu\Omega/\Omega$ 0.42 Ω + 22 $\mu\Omega/\Omega$ 0.97 Ω + 22 $\mu\Omega/\Omega$ 8.2 Ω + 25 $\mu\Omega/\Omega$ 14 Ω + 25 $\mu\Omega/\Omega$ 90 Ω + 47 $\mu\Omega/\Omega$ 0.39 k Ω + 0.1 m Ω/Ω 4.2 k Ω + 0.19 m Ω/Ω 15 k Ω + 0.39 m Ω/Ω 0.34 M Ω + 2.3 m Ω/Ω 4.2 M Ω + 12 m Ω/Ω	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2, 7} ($\pm$)	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	3.9 μ V + 0.47 mV/V 3.9 μ V + 0.19 mV/V 3.9 μ V + 93 μ V/V 3.9 μ V + 0.32 mV/V 6.2 μ V + 0.74 mV/V 12 μ V + 1 mV/V 23 μ V + 1.4 mV/V 31 μ V + 3.7 mV/V	Fluke 5700A/5725A w/wideband option
(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	5.7 μ V + 0.47 mV/V 5.1 μ V + 0.19 mV/V 4.9 μ V + 93 μ V/V 5.4 μ V + 0.32 mV/V 7.9 μ V + 0.74 mV/V 14 μ V + 1 mV/V 27 μ V + 1.4 mV/V 40 μ V + 3.7 mV/V	
(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	23 μ V + 0.47 mV/V 12 μ V + 0.19 mV/V 9.7 μ V + 85 μ V/V 14 μ V + 0.28 mV/V 39 μ V + 0.7 mV/V 43 μ V + 0.85 mV/V 63 μ V + 1.4 mV/V 0.14 mV + 2.8 mV/V	
(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	0.18 mV + 0.47 mV/V 55 μ V + 0.14 mV/V 38 μ V + 66 μ V/V 40 μ V + 0.11 mV/V 0.11 mV + 0.22 mV/V 0.2 mV + 0.37 mV/V 0.65 mV + 0.88 mV/V 1.2 mV + 1.9 mV/V	
(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	1.8 mV + 0.47 mV/V 0.55 mV + 0.14 mV/V 0.21 mV + 66 μ V/V 0.4 mV + 0.11 mV/V 0.79 mV + 0.22 mV/V 2.4 mV + 0.47 mV/V 6.3 mV + 1.1 mV/V 12 mV + 2.3 mV/V	

Parameter/Range	Frequency	CMC ^{2, 6, 7} ($\pm$)	Comments
AC Voltage – Generate ³ (cont)			Fluke 5700A/5725A w/wideband option
Amplitude Flatness Up to 1.1 mV (1.1 to 3) mV (3 to 11) mV (11 to 33) mV (33 to 110) mV (110 to 330) mV (0.33 to 1.1) V (1.1 to 3.5) V	30 Hz to 500 kHz	2.2 μ V + 6.2 mV/V 8.4 μ V + 5.4 mV/V 23 μ V + 5.4 mV/V 68 μ V + 4.7 mV/V 0.19 mV + 4.7 mV/V 0.51 mV + 3.9 mV/V 1.6 mV + 3.9 mV/V 3.8 mV + 3.1 mV/V	
Referenced to 1 kHz Up to 1.1 mV	(10 to 30) Hz 30 Hz to 120 kHz 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	1.3 μ V + 2.3 mV/V 0.44 μ V + 0.76 mV/V 3.2 μ V + 1.6 mV/V 4 μ V + 3.1 mV/V 4.9 μ V + 4.7 mV/V 18 μ V + 12 mV/V	
(1.1 to 3) mV	(10 to 30) Hz 30 Hz to 120 kHz 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.6 μ V + 2.3 mV/V 0.86 μ V + 0.77 mV/V 3.2 μ V + 0.77 mV/V 4.9 μ V + 2.3 mV/V 6.6 μ V + 3.9 mV/V 15 μ V + 12 mV/V	
≥ 3 mV	(10 to 30) Hz 30 Hz to 120 kHz 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.23 % 0.078 % 3 μ V + 0.078 % 3 μ V + 0.16 % 3 μ V + 0.31 % 3 μ V + 0.78 %	
(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 (0.5 to 1) MHz	18 mV + 0.47 mV/V 5.5 mV + 0.14 mV/V 2.4 mV + 70 μ V/V 7.7 mV + 0.19 mV/V 18 mV + 0.47 mV/V 0.11 V + 1.2 mV/V 0.18 V + 4.2 mV/V 0.39 V + 10 mV/V	*220 V range subject to 2.2E7 V-Hz limitation
(220 to 1100) V	(15 to 50) Hz** 50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	95 mV + 0.36 mV/V 19 mV + 70 μ V/V 36 mV + 0.13 mV/V 0.11 V + 0.46 mV/V	** Maximum 250 V
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.11 V + 0.46 mV/V 0.43 V + 1.8 mV/V	

Parameter/Range	Frequency	CMC ^{2, 6, 7} ($\pm$)	Comments
AC Voltage – Measure ³			Agilent 3458A
(0.1 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	3.3 μ V + 0.3 mV/V 1.3 μ V + 0.2 mV/V 1.4 μ V + 0.3 mV/V 2.1 μ V + 1 mV/V 6.1 μ V + 5 mV/V 42 μ V + 40 mV/V	
(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 (1 to 2) MHz	4.7 μ V + 7 μ V/V 2.7 μ V + 7 μ V/V 3.4 μ V + 14 μ V/V 5 μ V + 0.3 mV/V 10 μ V + 0.8 mV/V 40 μ V + 3 mV/V 0.11 mV + 10 mV/V 0.16 V + 15 mV/V	
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 (0.3 to 1) MHz (1 to 2) MHz	47 μ V + 7 μ V/V 27 μ V + 7 μ V/V 35 μ V + 14 μ V/V 50 μ V + 0.3 mV/V 0.1 mV + 0.8 mV/V 0.4 mV + 3 mV/V 1.1 mV + 10 mV/V 1.6 mV + 15 mV/V	
(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 (1 to 2) MHz	0.47 mV + 7 μ V/V 0.27 mV + 7 μ V/V 0.34 mV + 14 μ V/V 0.5 mV + 0.3 mV/V 1 mV + 0.8 mV/V 4 mV + 3 mV/V 11 mV + 10 mV/V 16 mV + 15 mV/V	
(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 (0.3 to 1) MHz	6 mV + 0.2 mV/V 4 mV + 0.2 mV/V 4 mV + 0.2 mV/V 5.5 mV + 0.35 mV/V 14 mV + 1.2 mV/V 50 mV + 4 mV/V 0.16 V + 15 mV/V	
(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	56 mV + 0.4 mV/V 42 mV + 0.4 mV/V 56 mV + 0.6 mV/V 98 mV + 1.2 mV/V 0.22 V + 3 mV/V	

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} (±)	Comments
AC High Voltage ³ –			
Generate (1 to 10) kV (10 to 20) kV	60 Hz	0.16 % 0.12 %	Vitretek 4700 w/HVP-35
Measure (1 to 10) kV (10 to 35) kV (35 to 70) kV	50/60 Hz	0.16 % 0.12 % 0.12 %	Vitretek 4700 w/HVP-35 w/HVL-100
Generate & Measure (1 to 2) kV	(20 to 100) Hz (100 to 400) Hz	3.1 V + 0.81 mV/V 9.3 V + 4.6 mV/V	Vitretek 4620A
(2 to 20) kV	(20 to 100) Hz	28 V + 2.3 mV/V	
AC Flatness – Measure, Fixed Points			
Up to 3 V	10 Hz 100 Hz 10 kHz 30 kHz 100 kHz 300 kHz 1 MHz 2 MHz 10 MHz 20 MHz 30 MHz 50 MHz 100 MHz	0.096 % 0.096 % 0.096 % 0.096 % 0.096 % 0.096 % 0.096 % 0.098 % 0.13 % 0.19 % 0.24 % 0.53 % 1.4 %	Thermal voltage converter

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} ($\pm$)	Comments
AC Current – Generate ³			
(0 to 220) μ A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	66 nA + 0.5 mA/A 23 nA + 0.33 mA/A 17 nA + 0.12 mA/A 45 nA + 0.54 mA/A 93 nA + 1.4 mA/A 0.67 μ A + 12 mA/A	Fluke 5700A
(29 to 329.99) μ A			Fluke 5520A
(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 (10 to 30) kHz	0.18 μ A + 0.62 mA/A 0.1 μ A + 0.33 mA/A 59 nA + 0.12 mA/A 0.51 μ A + 0.54 mA/A 1.1 μ A + 1.4 mA/A 3.2 μ A + 7.7 mA/A	Fluke 5520A
(0.33 to 3.2999) mA			Fluke 5520A
(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 (10 to 30) kHz	1.8 μ A + 0.62 mA/A 1 μ A + 0.33 mA/A 0.59 μ A + 0.12 mA/A 5.1 μ A + 0.54 mA/A 11 μ A + 1.4 mA/A 13 μ A + 3.1 mA/A	Fluke 5520A
(3.3 to 32.999) mA			Fluke 5520A
(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 (10 to 30) kHz	18 μ A + 0.62 mA/A 10 μ A + 0.33 mA/A 6.2 μ A + 0.14 mA/A 51 μ A + 0.54 mA/A 0.11 mA + 1.4 mA/A 0.26 mA + 3.1 mA/A	Fluke 5520A
(33 to 329.99) mA			Fluke 5520A
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.16 mA + 0.58 mA/A 0.22 mA + 0.66 mA/A 1.9 mA + 7.8 mA/A	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.92 mA + 0.36 mA/A 1.9 mA + 0.74 mA/A 6.7 mA + 2.8 mA/A	Fluke 5700 w/ 5725A
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	14 mA + 0.9 mA/A 17 mA + 1.2 mA/A 0.26 A + 23 mA/A	Fluke 5520A
Toroidal			
(10 to 16.5) A (16.5 to 150) A (150 to 1025) A	(45 to 65) Hz	26 mA + 2.1 mA/A 50 mA + 1.9 mA/A 0.34 A + 1.9 mA/A	Fluke 5520A w/5500Coil
(10 to 16.5) A (16.5 to 150) A (150 to 1025) A	(65 to 440) Hz	60 mA + 6 mA/A 0.11 A + 5.3 mA/A 0.86 A + 5.3 mA/A	
Non-Toroidal			
(10 to 16.5) A (16.5 to 150) A (150 to 1025) A	(45 to 65) Hz	60 mA + 3.8 mA/A 0.23 A + 3.7 mA/A 1.2 A + 3.7 mA/A	
(10 to 16.5) A (16.5 to 150) A (150 to 1025) A	(65 to 440) Hz	90 mA + 7.2 mA/A 0.28 A + 6.7 mA/A 1.6 A + 6.7 mA/A	

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} ($\pm$)	Comments
AC Current – Measure ³			
(5 to 100) μ A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	55 nA + 4 mA/A 42 nA + 1.5 mA/A 38 nA + 0.64 mA/A	Agilent 3458A
(0.1 to 1) 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	0.41 μ A + 4.1 mA/A 0.28 μ A + 1.6 mA/A 0.24 μ A + 0.67 mA/A 0.22 μ A + 0.37 mA/A 0.24 μ A + 0.67 mA/A 0.61 μ A + 4.1 mA/A 1.8 μ A + 5.6 mA/A	
(1 to 10) 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	2.2 μ A + 4.1 mA/A 2.1 μ A + 1.6 mA/A 2 μ A + 0.67 mA/A 2 μ A + 0.37 mA/A 2 μ A + 0.67 mA/A 4.2 μ A + 4.1 mA/A 15 μ A + 5.6 mA/A	
(10 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	40 μ A + 4 mA/A 28 μ A + 1.5 mA/A 23 μ A + 0.6 mA/A 22 μ A + 0.3 mA/A 23 μ A + 0.6 mA/A 60 μ A + 4 mA/A 0.18 mA + 5.5 mA/A	
(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 mA + 4.1 mA/A 0.28 mA + 1.7 mA/A 0.24 mA + 0.9 mA/A 0.25 mA + 1.1 mA/A 0.35 mA + 3.1 mA/A 0.9 mA + 10 mA/A	
(1 to 20) A	Up to 1 kHz (1 to 5) kHz	0.026 % 0.039 %	Agilent 3458A, Fluke Y5020

Parameter/Range	Frequency	CMC ^{2, 6, 7} ($\pm$)	Comments
Capacitance – Generate ³			
(0.19 to 0.3999) nF	10 Hz to 10 kHz	8.5 pF + 3.8 pF/nF	Fluke 5520A
0.4 to 1.0999) nF	10 Hz to 10 kHz	9.4 pF + 3.9 pF/nF	
(1.1 to 3.299) nF	10 Hz to 3 kHz	12 pF + 3.9 pF/nF	
(3.3 to 10.999) nF	(10 to 1000) Hz	15 pF + 2 pF/nF	
(11 to 32.9999) nF	(10 to 1000) Hz	0.1 nF + 1.9 pF/nF	
(33 to 109.999) nF	(10 to 1000) Hz	0.14 nF + 1.9 pF/nF	
(110 to 329.99) nF	(10 to 1000) Hz	0.45 nF + 1.9 pF/nF	
(0.33 to 1.0999) μ F	(10 to 600) Hz	1.4 nF + 1.9 nF/ μ F	
(1.1 to 3.2999) μ F	(10 to 300) Hz	4.4 nF + 1.9 nF/ μ F	
(3.3 to 10.999) μ F	(10 to 150) Hz	14 nF + 1.9 nF/ μ F	
(11 to 32.999) μ F	(10 to 120) Hz	58 nF + 3.1 nF/ μ F	
(33 to 109.99) μ F	(10 to 80) Hz	0.19 μ F + 3.5 nF/ μ F	
(110 to 329.99) μ F	Up to 50 Hz	0.62 μ F + 3.5 nF/ μ F	
(0.33 to 1.0999) mF	Up to 20 Hz	1.9 μ F + 3.5 μ F/mF	
(1.1 to 3.2999) mF	Up to 6 Hz	6.8 μ F + 3.4 μ F/mF	
(3.3 to 10.999) mF	Up to 2 Hz	38 μ F + 2.4 μ F/mF	
(11 to 32.999) mF	Up to 0.6 Hz	87 μ F + 5.8 μ F/mF	
(33 to 110) mF	Up to 0.2 Hz	0.36 mF + 8.5 μ F/mF	
(1 to 10) pF	1 kHz	0.12 pF	GenRad 1413
(10 to 100) pF		0.12 pF	
(100 to 1000) pF		0.13 pF + 0.015 %	
(1 to 10) nF		0.31 pF + 0.016 %	
(10 to 100) nF		1.8 pF + 0.027 %	
100 nF to 1.1 μ F		26 pF + 0.045 %	

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} ($\pm$)	Comments
Distortion ³			
(-101 to 0) dB	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	U8903A
(-70 to +10) dB	100 kHz to 3 GHz (3 to 6.5) GHz (6.5 to 22) GHz (22 to 26.5) GHz	0.85 dB 1.9 dB 2.4 dB 3 dB	Agilent E4440A
Pulse Characterization – Rise & Fall Time Measure	350 ps to 1 ns	33 ps	Agilent DSO8104A
Oscilloscopes ³ –			
Voltage			Fluke 5820A
DC into 50 Ω	$\pm$ (0 to 6.6) V	44 μ V + 2.5 mV/V	
DC into 1 M Ω	$\pm$ (0 to 130) V	31 μ V + 0.25 mV/V	
Squarewave into 50 Ω	1 mV to 6.6 V _{p-p}	44 μ V + 2.5 mV/V	
Squarewave into 1 M Ω	1 mV to 130 V _{p-p}	17 μ V + 0.5 mV/V	
Fast Edge into 50 Ω	Nominal 150 ps	25 ps	
Leveled Sine Wave (relative to 50 kHz)	50 kHz Reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 500) MHz (500 to 600) MHz	0.41 mV + 20 mV/V 0.51 mV + 38 mV/V 0.54 mV + 45 mV/V 0.64 mV + 65 mV/V 0.67 mV + 72 mV/V	
Leveled Sine Wave (relative to 10 MHz)	10 MHz Reference 600 MHz to 1.6 GHz (1.6 to 2.1) GHz	0.41 mV + 20 mV/V 0.74 mV + 86 mV/V 0.81 mV + 0.1 V/V	
Time Marker	5 s to 50 ms 20 ms to 200 ps	0.0003 % + 5 ns 0.000 033 %	
Bandwidth			
(-3 to 0) dB (Relative to 10 MHz)	(2.1 to 6) GHz	3.7 %	N1914A w/
	(6 to 9.2) GHz	3.9 %	E9304A
	(9.2 to 13.5) GHz	4.1 %	
	(13.5 to 22) GHz	4.4 %	E4413A
	(22 to 26.5) GHz	4.7 %	

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} ($\pm$)	Comments
Inductance – Generate, Fixed Point			
1 mH	100 Hz 200 Hz 400 Hz 1 kHz 10 kHz	0.65 μ H 0.71 μ H 0.49 μ H 0.6 μ H 0.47 μ H	GenRad 1482-E
10 mH	100 Hz 200 Hz 400 Hz 1 kHz 10 kHz	0.82 μ H 0.87 μ H 0.56 μ H 0.54 μ H 0.63 μ H	GenRad 1482-H
100 mH	100 Hz 200 Hz 400 Hz 1 kHz 10 kHz	4.5 μ H 4.5 μ H 4.4 μ H 4.4 μ H 4.4 μ H	GenRad 1482-L
1 H	100 Hz 400 Hz 1 kHz	0.31 mH 0.27 mH 0.3 mH	GenRad 1482-M
10 H	100 Hz 200 Hz 400 Hz 1 kHz	0.6 mH 0.56 mH 0.61 mH 5.9 mH	GenRad 1482-T
100 μ H to 1 mH (1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	400 Hz and 1 kHz	0.015 μ H + 0.0023 % 1 μ H + 0.1 % 5.2 μ H + 0.5 % 53 μ H + 0.049 % 1.9 μ H + 0.09 %	GenRad 1491-G
AC Power ³ – (45 to 65) Hz, PF = 1	Up to 1020 V		Fluke 5520A
Up to 32.999 mA (33 to 329.999) mA (0.33 to 1.099 99) A (1.1 to 2.9999) A (3 to 10.999 99) A (11 to 20.5) A	Up to 33 W (33 to 330) W 330 W to 1.1 kW (1.1 to 3) kW (3 to 11) kW (11 to 20.9) kW	0.1 % 0.06 % 0.07 % 0.073 % 0.085 % 0.14 %	
DC Power – Generate ³	Up to 1020 V		Fluke 5520A
(0.33 to 3.2999) mA (3.3 to 32.999) mA (33 to 329.99) mA (0.33 to 2.2999) A (3 to 20.5) A	Up to 3 W (3 to 30) W (30 to 300) W (300 to 3) kW (3 to 20.9) kW	0.017 % 0.014 % 0.01 % 0.03 % 0.08 %	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTDs – Measure ³			
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	0.019 °C 0.023 °C 0.027 °C 0.031 °C 0.038 °C 0.048 °C	Fluke 7526A
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	0.018 °C 0.018 °C 0.02 °C 0.024 °C 0.029 °C 0.038 °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) °C (400 to 600) °C (600 to 630) °C	0.017 °C 0.018 °C 0.019 °C 0.019 °C 0.025 °C 0.03 °C 0.036 °C 0.043 °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 630) °C	0.054 °C 0.057 °C 0.061 °C 0.061 °C 0.071 °C 0.073 °C 0.09 °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	0.029 °C 0.029 °C 0.036 °C 0.041 °C 0.049 °C	
Pt 385, 1000 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.02 °C 0.02 °C 0.027 °C 0.03 °C 0.038 °C	
Ni 120, 120 Ω	(-80 to 260) °C	0.0097 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.11 °C	
YSI 400	(15 to 50) °C	0.0071 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTDs – Generate ³			
PT 385, 100 Ω	(-200 to 800) °C	0.052 °C	Fluke 7526A
PT 3926, 100 Ω	(-200 to 630) °C	0.052 °C	
PT 3916, 100 Ω	(-200 to 630) °C	0.052 °C	
PT 385, 200 Ω	(-200 to 400) °C (400 to 630) °C	0.4 °C 0.5 °C	
PT 385, 500 Ω	(-200 to 630) °C	0.17 °C	
PT 385, 1000 Ω	(-200 to 630) °C	0.091 °C	
Ni 120, 120 Ω	(-80 to 260) °C	0.021 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.38 °C	
YSI 400	(15 to 50) °C	0.009 °C	
Thermal Reference Probes (Half Junctions)			
Type E	0 °C	0.12 °C	Omega ice point, Fluke 5700A, Agilent 3458A
Type J	0 °C	0.12 °C	
Type K	0 °C	0.13 °C	
Type T	0 °C	0.13 °C	
Thermocouple – Indicating Systems & Measure ³			
Type B	(600 to 800) °C (800 to 1550) °C (1550 to 1820) °C	0.35 °C 0.28 °C 0.23 °C	Fluke 7526A
Type C	(0 to 1000) °C (1000 to 1800) °C (1800 to 2000) °C (2000 to 2316) °C	0.16 °C 0.23 °C 0.27 °C 0.36 °C	
Type E	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 600) °C (600 to 1000) °C	0.25 °C 0.12 °C 0.091 °C 0.082 °C 0.1 °C	
Type J	(-210 to -100) °C (-100 to 800) °C (800 to 1200) °C	0.14 °C 0.091 °C 0.11 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Thermocouple – Indicating Systems & Measure ³ (cont)			
Type K	(-250 to -200) °C (-200 to -100) °C (-100 to 500) °C (500 to 800) °C (800 to 1372) °C	0.46 °C 0.16 °C 0.1 °C 0.1 °C 0.14 °C	Fluke 7526A
Type L	(-200 to -100) °C (-100 to 900) °C	0.1 °C 0.092 °C	
Type N	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 100) °C (100 to 800) °C (800 to 1300) °C	0.73 °C 0.23 °C 0.12 °C 0.11 °C 0.1 °C 0.13 °C	
Type R	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1000) °C (1000 to 1600) °C (1600 to 1767) °C	0.55 °C 0.45 °C 0.39 °C 0.28 °C 0.22 °C 0.21 °C 0.2 °C 0.24 °C	
Type S	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1000) °C (1000 to 1600) °C (1600 to 1767) °C	0.51 °C 0.43 °C 0.38 °C 0.29 °C 0.23 °C 0.22 °C 0.22 °C 0.27 °C	
Type T	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 200) °C (200 to 400) °C	0.35 °C 0.16 °C 0.14 °C 0.12 °C 0.12 °C	
Type U	(-200 to 0) °C (0 to 200) °C (200 to 600) °C	0.23 °C 0.1 °C 0.1 °C	

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} ($\pm$)	Comments
Amplitude Modulation ³ – Measure (5 to 99) % depth (5 to 20) % depth (20 to 99) % depth (5 to 20) % depth (20 to 99) % depth	100 kHz to 10 MHz 10 MHz to 3 GHz (3 to 26.5) GHz	0.86 % of depth 2.6 % of depth 0.78 % of depth 4.6 % of depth 1.7 % of depth	Agilent E4440A
Frequency Modulation ³ – Measure Modulation rate: 20 Hz to 10 kHz Deviation: 200 Hz to 40 kHz Modulation rate: 50 Hz to 200 kHz Deviation: 250 Hz to 400 kHz	250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.5 % 1.5 % 2.5 % 3.8 %	Agilent E4440A
Phase Modulation ³ – Measure (0.3 to $\leq$ 0.7) rad > 0.7 rad (0.6 to $\leq$ 2.0) rad 2.0 rad (1.2 to $\leq$ 4.0) rad > 4.0 rad	100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	3 % 1.1 % 3 % 1.1 % 3 % 1.1 %	Agilent E4440A

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} (±)	Comments
Relative Power ³ – 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 (-120 to -130) dB	100 kHz to 26.5 GHz	0.031 dB 0.035 dB 0.039 dB 0.058 dB 0.06 dB 0.064 dB 0.077 dB 0.082 dB 0.086 dB 0.096 dB 0.1 dB 0.11 dB 0.12 dB	Agilent E4440A
Absolute Power – Measure ³ (-20 to +30) dBm (-60 to +20) dBm (-70 to +20) dBm (-20 to +30) dBm	100 kHz to 4.2 GHz 9 kHz to 6 GHz 50 MHz to 3 GHz (3 to 9.2) GHz (9.2 to 13.5) GHz (13.5 to 22) GHz (22 to 26.5) GHz 50 MHz to 3 GHz (3 to 9.2) GHz (9.2 to 13.5) GHz (13.5 to 22) GHz (22 to 26.5) GHz	3.7 % 3.7 % 3.8 % 3.9 % 4.1 % 4.4 % 4.7 % 3.8 % 3.9 % 4.1 % 4.4 % 4.7 %	N1914A w/: N5532B E9304A E4413A N5532A
Attenuation – 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 -100) dB (-100 to -110) dB (-110 to -120) dB (-120 to -127) dB	10 MHz to 26.5 GHz	0.039 dB 0.042 dB 0.045 dB 0.062 dB 0.064 dB 0.068 dB 0.081 dB 0.085 dB 0.089 dB 0.099 dB 0.11 dB 0.11 dB 0.13 dB	Agilent E4440A

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} ($\pm$)	Comments
Attenuation – Generate ³ (1 to 11) dB (10 to 60) dB (70 to 110) dB (110 to 121) dB	DC to 4 GHz	0.21 dB 0.3 dB 0.31 dB 0.32 dB	8494G & 8496G step attenuators
Displayed Average Noise Level (-160 to -50) dBm	45 MHz to $\leq$ 2 GHz (2 to $\leq$ 3) GHz (3 to $\leq$ 6) GHz (6 to $\leq$ 9) GHz	0.73 dB 0.85 dB 0.92 dB 1.1 dB	Agilent 85032F 50 Ω termination
Return Loss (VSWR) ³ $\leq$ 10 dB ($\geq$ 1.9 VSWR) (10 to $\leq$ 14) dB ($\geq$ 1.5 to 1.9) VSWR (14 to $\leq$ 17.5) dB ($\geq$ 1.3 to 1.5) VSWR (17.5 to $\leq$ 26) dB ($\geq$ 1.1 to 1.3) VSWR $\geq$ 26 dB (< 1.1 VSWR) Up to 60 dB (up to 1:1 VSWR)	5 MHz to 2 GHz (2 to 12.4) GHz (12.4 to 18) GHz (18 to 26.5) GHz	2 dB 1.9 dB 1.2 dB 1 dB 0.92 dB 1.4 dB 1.8 dB 2.8 dB	8902A, 60NF50 SWR bridges 8902A, directional coupler
Single Side-Band Phase Noise ³ – Measure Carrier: 1 MHz to 26.5 GHz System noise floor limits measurements below: (1 to 10) MHz: -150 dBm 10 MHz to 1.2 GHz: -154 dBm (1.2 to 2.1) GHz: -153 dBm (2.1 to 6.6) GHz: -153 dBm (6.6 to 13.2) GHz: -152 dBm (13.2 to 20) GHz: -147 dBm (20 to 26.5) GHz: -143 dBm	At offsets: 10 Hz 100 Hz 1 kHz 10 kHz 20 kHz 100 kHz 1 MHz 10 MHz	2.7 dB 2.7 dB 2.5 dB 2.4 dB 2.4 dB 2.4 dB 2.4 dB 2.4 dB	Agilent E4440A

IV. Mechanical

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
Balances ³ When $R =$ 0.0001 g 0.001 g 0.01 g 0.1 g 1 g & 10 g	 ≤ 500 mg > 500 mg to 10 g > 10 g to 14 kg ≤ 50 g (> 50 to 100) g (> 100 to 200) g > 200 g to 14 kg ≤ 500 g 500 g to 14 kg ≤ 2 kg (> 2 to 14) kg ≤ 14 kg	 0.82R 0.91R 1.2R 0.83R 0.87R 1.0R 1.2R 0.83R 0.87R 0.82R 1.0R 0.82R	Class 1 weights
Scales	Up to 800 lbs (360 kg)	0.82R	Class F & 6 weights
Force, Compression & Tension – Measuring Equipment ³	Up to 800 lbf	0.0023 %	Deadweight using Class F & 6 weights
Force, Compression & Tension - Measure ³	(40 to 1000) lbf (1000 to 5000) lbf (5000 to 10 000) lbf (10 000 to 25 000) lbf	0.027 % 0.038 % 0.038 % 0.034 %	Standard load cells

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Torque – Measure Tools	(4 to 8) ozf·in	1.2 %	Mountz BMX40Z
	(8 to 40) ozf·in	0.58 %	
	(5 to 50) lbf·in	0.59 %	TL-50i
	(20 to 200) lbf·in	0.33 %	AKO TSD011/020
	(50 to 100) lbf·in	1.2 %	BMX500I
	(100 to 500) lbf·in	0.6 %	
	(25 to 50) lbf·ft	1.2 %	BMX250F
	(50 to 250) lbf·ft	0.59 %	
	(30 to 300) lbf·ft	0.13 %	AKO TSD321BT
Pressure – Measure & Generate	(5 to 50) lbf·in	0.3 %	CDI 2000-400-02
	(40 to 400) lbf·in	0.3 %	
	(100 to 1000) lbf·in	0.31 %	
	(25 to 250) lbf·ft	0.3 %	
	(60 to 600) lbf·ft	0.31 %	CDI 2000-12-02
Hydraulic	(10 to 10 000) psig	0.018 %	Ametek DM-T-150 DWT
Pneumatic	(0 to 5) inH ₂ O	0.096 %	Ashcroft AQS-1
	(0 to 10) inH ₂ O	0.099 %	Ashcroft HQS-1
	(0 to 25) inH ₂ O	0.082 %	Ashcroft AM2-1
	(0 to 60) psia	0.078 %	Ashcroft AQS-2
	(8 to 17) psia	0.023 %	Mensor CPC4000
	(-15 to 83) psig	0.019 psi	
	(83 to 150) psig	0.023 %	
	(-15 to 758) psig	0.18 psi	
	(758 to 1500) psig	0.023 %	

Parameter/Equipment	Range	CMC ² (±)	Comments
Indirect Verification of Rockwell Hardness Testers ³	HRA: High Middle Low HRBW: High Middle Low HRC: High Middle Low HREW: High Middle Low HRRW: High Middle HR15N: High Middle Low HR15T: High Middle Low HR30N: High Middle Low HR30TW: High Middle Low HR45N: High Middle Low	0.37 HRA 0.37 HRA 0.27 HRA 0.64 HRBW 0.34 HRBW 0.46 HRBW 0.44 HRC 0.34 HRC 0.33 HRC 0.69 HREW 0.31 HREW 0.62 HREW 0.24 HRRW 0.51 HRRW 0.51 HR15N 0.54 HR15N 0.47 HR15N 0.44 HR15T 0.4 HR15T 0.41 HR15T 0.47 HR30N 0.57 HR30N 0.57 HR30N 0.71 HR30TW 0.7 HR30TW 0.71 HR30TW 0.59 HR45N 0.4 HR45N 0.27 HR45N	ASTM E18 w/ traceable blocks

V. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 4, 5, 6} ($\pm$)	Comments
Temperature – Measure ³	(-197 to -140) °C (-140 to -60) °C (-60 to 0) °C	0.028 °C 0.024 °C 0.019 °C	Fluke 5614 & 1502A
Temperature – Measuring Equipment ³	-78 °C (-45 to 140) °C (35 to 420) °C (420 to 600) °C (-30 to 125) °C (35 to 200) °C	0.074 °C 0.065 °C 0.065 °C + 0.000 067 °C/°C 0.092 °C + 0.000 14 °C/°C 0.046 °C + 0.000 18 °C/°C 0.038 °C + 0.000 088 °C/°C	Fluke 5614 & 1502A dry wells, dry ice bath
Infrared Temperature – Measuring Equipment	(-15 to 12) °C (-12 to -9) °C (-9 to -6) °C (-6 to -2) °C (-2 to 0) °C (0 to 120) °C (35 to 500) °C	1.2 °C 1.1 °C 1 °C 0.94 °C 0.82 °C 0.87 °C + 0.01 °C/°C 0.62 °C + 0.017 °C/°C	Fluke 4180 Fluke 4181
Relative Humidity – Measuring Equipment ³	(15 to 80) % RH (> 80 to 95) % RH	1.4 % RH 2.1 % RH	Kaymont 2000
Relative Humidity – Measure ³	(20 to 90) % RH (90 to 95) % RH	1.4 % RH 2.1 % RH	Vaisala MI70 & HMP77

VI. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 5, 6} ($\pm$)	Comments
Frequency	10 MHz	67 μ Hz	Rubidium oscillator

Parameter/Equipment	Range	CMC ^{2, 5, 6} ($\pm$)	Comments
Frequency – Measuring Equipment ³	1 mHz to 21 MHz 21 MHz to 26.5 GHz	0.58 μ Hz + 28 pHz/Hz 0.14 mHz + 6.7 pHz/Hz	Rubidium oscillator, function generator, signal generator
Frequency – Measure ³	1 mHz to 3 GHz (3 to 26.5) GHz	58 pHz + 59 pHz/Hz 0.18 Hz + 59 pHz/Hz	Rubidium oscillator, frequency counters
Stopwatches & Timers	Up to 24 hours	5.8 ms + 0.61 μ s/s 32 ms	NIST 960-12 Timometer Rubidium oscillator, function generator, frequency counter
Tachometers – Optical	(1 to 100 000) rpm	0.000 044 rpm + 0.000 038 rpm/rpm	Function generator & LED
Stroboscopes	10 mHz to 2 kHz (1 to 100 000) FPM	12 nHz + 1.2 μ Hz/Hz 0.000 0066 FPM + 0.000 12 %	Frequency counter, pickup

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

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

³ Field calibration service is available for this calibration. 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; D is the numerical value of the nominal diameter of the device measured in inches; Di is the numerical value of the nominal diagonal of the plate measured in feet; R is the numerical value of the resolution of the device in its respective units; F is the applied frequency in kHz; and percentages are percentage of reading unless otherwise indicated.

⁵ 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.

⁶ CMC components that can be reasonably attributed to the Unit Under Test have not been utilized in the calculation of the CMC value for this measurement parameter.

⁷ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

⁸ This scope meets A2LA's *P112 Flexible Scope Policy*



Accredited Laboratory

A2LA has accredited

TRESCAL, INC.

Arlington Heights, 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, 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 5th day of December 2022.

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

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1022.03
Valid to May 31, 2024

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