



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: April 30, 2024

Certificate Number: 2357.18

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1, 10}:

I. Dimensional

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
Micrometers and Depth Gages ³ –			
Length	Up to 12 in (12 to 72) in	(30 + 1.7L) μin (28 + 1.8L) μin	Grade 2 gage blocks
Flatness	Up to 1 in	4.3 μin	Optical flats
Parallelism	Up to 1 in	8.8 μin	Gage blocks, surface plates
Height Gages ³	(0.05 to 4) in (4 to 12) in (12 to 48) in	(82 + 0.25L) μin (78 + 1.4L) μin (62 + 2.7L) μin	Grade 2 gage blocks and surface plates
Gage Blocks	(0.01 to 1) in (1 to 4) in (4 to 14) in	(3.2 + 0.9L) μin (2.5 + 1.8L) μin (9.1 + 2.8L) μin	Grade 00 gage blocks and Labmaster™
Calipers ³	Up to 4 in (4 to 12) in (12 to 72) in	(58 + 2.3L) μin (60 + 1.6L) μin (73 + 2L) μin	Grade 2 gage blocks, master rings, surface plate

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Inside Diameter Measuring Instruments	(0.15 to 8) in	(25 + 7L) μin	Comparison to ring gages
Indicators ³	Up to 0.05 in (0.05 to 4) in	6.5 μin (60 + 1.3L) μin	Labmaster™ and Grade 2 gage blocks
Pin and Plug Gages	Up to 2 in	(6.7 + 1D) μin	Grade 00 gage blocks and Labmaster™
Precision Rules and Glass Scales	Up to 4 in	120 μin	Nikon MM11 microscope
Rulers and Tape Measures	Up to 36 ft	0.002 in/ft	Video measurement system
Ring Gages	(0.04 to 14) in	(6.6 + 2.7L) μin	Labmaster™ and Master ring gages
Length Standards	Up to 14 in	(16 + 3.2L) μin	Labmaster™ w/ gage blocks
	(14 to 40) in	(19 + 1.6L) μin	Mahr 828 w/ gage blocks
Protractors and Levels ³ –	(0.25 to 160) °	21 arc seconds	Sine plate, gage blocks, surface plate
Angle Generation	Up to 1000 arc seconds	0.36 arc seconds	Brunson 470 small angle generator

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
DC Voltage ³ – Generate	0 V	7.6 nV	Copper short
	(0 to 219.999 99) 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 99) V (220 to 1100) V	6.9 μV/V + 0.40 μV 3.2 μV/V + 0.70 μV 2.4 μV/V + 2.5 μV 2.4 μV/V + 4.0 μV 3.2 μV/V + 40 μV 4.7 μV/V + 0.40 mV	5720A 90-day spec
	1 V 1.018 V 10 V	1.4 μV/V 1.2 μV/V 1.2 μV/V	Fluke 732B
	100 mV to 1000 V ⁹ 100 mV ⁹ 100 V ⁹ 1000 V ⁹	1.5 μV/V 1.5 μV/V 1.4 μV/V 1.5 μV/V	Fluke 732B w/720A, 845 AR, 5720A, and 752A
DC Current ³ – Generate (Ohms Law Method)	0 A	1.5 pA	OPEN
	Up to 2 pA	5.3 fA/pA + 12 fA	Keithley 263
	(2 to 20) pA	4.3 fA/pA + 12 fA	
	(20 to 200) pA	2.9 fA/pA + 35 fA	
	(0.2 to 2) nA	0.74 pA/nA + 0.12 pA	
	(2 to 20) nA	0.74 pA/nA + 1.2 pA	
	(20 to 200) nA	0.41 pA/nA + 12 pA	
	(0.2 to 2) μA	0.29 nA/μA + 0.12 nA	
	(2 to 20) μA	0.3 nA/μA + 1.2 nA	
	(20 to 200) μA	0.29 nA/μA + 12 nA	
	(0.2 to 2) mA	0.29 μA/mA + 0.12 μA	
	(2 to 20) mA	1.7 μA/mA + 1.2 μA	



Parameter/Equipment	Range	CMC ^{2,5,6} (±)	Comments
DC Current ³ – Generate (Ohms Law Method) (cont)	Up to 10 pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 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 ⁹ (10 to 100) mA ⁹ (0.1 to 1) A ⁹ (1 to 10) A ⁹ (10 to 20) A (20 to 100) A (100 to 300) A (300 to 600) A	0.13 % 0.13 % 920 µA/A 920 µA/A 70 µA/A 55 µA/A 11 µA/A 9.9 µA/A 6.8 µA/A 7.1 µA/A 6.7 µA/A 6.7 µA/A 10 µA/A 35 µA/A 100 µA/A 510 µA/A 0.14 %	Voltage drop method 8508 w/: Keithley 100 GΩ Keithley 10 GΩ Keithley 1 GΩ Keithley 100 MΩ Guildline 10 MΩ Guildline 1 MΩ Guildline 100 kΩ Guidline 9211 shunt Rubicon shunt
Clamp-On Only	(16.5 to 149.999) A (150 to 1025) A	3.9 mA/A + 0.11 mA 4.0 mA/A + 0.39 mA	5520A w/ coil
DC Current ³ – Measure (Ohms Law Method)	Zero Up to 1 pA (1 to 10) pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 to 100) nA (0.1 to 1) µA (0 to 200) µA (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A	1.5 pA 13 fA/pA + 8.1 fA 6 fA/pA + 8.1 fA 2 fA/pA + 35 fA 0.6 pA/nA + 230 fA 0.6 pA/nA + 2.3 pA 0.6 pA/nA + 23 pA 0.6 nA/pA + 350 nA 1 µA/A + 0.4 nA 13 µA/A + 4 nA 12 µA/A + 40 nA 12 µA/A + 0.80 µA 20 µA/A + 16 µA 0.13 mA/A + 0.40 mA	Fluke 8508, open Keithley 6430 Fluke 8508A

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
DC Current ³ – Measure (Ohms Law Method) (cont)	Up to 10 pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 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 ⁹ (10 to 100) mA ⁹ (0.1 to 1) A ⁹ (1 to 10) A ⁹ (10 to 20) A (20 to 100) A (100 to 300) A (300 to 650) A	0.13 % 0.13 % 920 μA/A 920 μA/A 70 μA/A 55 μA/A 11 μA/A 9.9 μA/A 6.8 μA/A 7.1 μA/A 6.7 μA/A 6.7 μA/A 10 μA/A 35 μA/A 100 μA/A 510 μA/A 0.14 %	Voltage drop methods 8508 w/: Keithley 100 GΩ Keithley 10 GΩ Keithley 1 GΩ Keithley 100 MΩ Guildline 10MΩ Guildline 1MΩ Guildline 100kΩ Fluke 742A-10k IET SRL-1K Guildline 100Ω Fluke 742A-10 IET SRL 0.1 L&N 0.01Ω Fluke Y5020 Guildline 9211A Rubicon shunt
DC Power ³ – Generate	0.01 mW to 337 W (0.01 to 3060) W (3060 to 20 910) W (20 to 100) kW	0.24 mW/W 0.17 mW/W 0.56 mW/W 0.29 % + 30 W	Fluke 5520A Two phase locked Fluke 57XX w/2555 and 9211
DC Voltage ³ – Measure	Zero (0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1050) V 1 mV to 1000 V	7.6 nV 6.0 μV/V + 0.10 μV 3.6 μV/V + 0.40 μV 3.6 μV/V + 4.0 μV 5.5 μV/V + 40 μV 5.5 μV/V + 0.53 mV 1.5 μV/V	Fluke 8508A w/ short Fluke 8508A 732B w/ 720A, 845AR, 5720A, and 752A
Generate Only	(1 to 60) kV (60 to 100) kV	0.35 mV/V 0.017 %	Ross VD60 Hipotronics KVM100

Parameter/Equipment	Range	CMC ^{2, 5, 6} (\pm)	Comments
DC Resistance ³ – Generate	(0 to 10.9999) Ω	33 Ω/Ω + 0.78 m Ω	Fluke 5520A
	(11 to 32.9999) Ω	24 $\mu\Omega/\Omega$ + 1.2 m Ω	
	(33 to 109.9999) Ω	22 $\mu\Omega/\Omega$ + 1.1 m Ω	
	(110 to 329.9999) Ω	23 $\mu\Omega/\Omega$ + 1.6 m Ω	
	(0.33 to 1.099 999) k Ω	22 $\mu\Omega/\Omega$ + 1.6 m Ω	
	(1.1 to 3.299 999) k Ω	23 $\mu\Omega/\Omega$ + 16 m Ω	
	(3.3 to 10.999 99) k Ω	23 $\mu\Omega/\Omega$ + 16 m Ω	
	(11 to 32.999 99) k Ω	23 $\mu\Omega/\Omega$ + 0.16 Ω	
	(33 to 109.9999) k Ω	23 $\mu\Omega/\Omega$ + 0.16 Ω	
	(110 to 329.9999) k Ω	26 $\mu\Omega/\Omega$ + 1.6 Ω	
	(0.33 to 1.099 999) M Ω	26 $\mu\Omega/\Omega$ + 1.6 Ω	
	(1.1 to 3.299 999) M Ω	48 $\mu\Omega/\Omega$ + 23 Ω	
	(3.3 to 10.999 99) M Ω	0.1 m Ω/Ω + 39 Ω	
	(11 to 32.999 99) M Ω	0.21 m Ω/Ω + 1.9 k Ω	
	(33 to 109.9999) M Ω	0.4 m Ω/Ω + 2.3 k Ω	
	(110 to 329.9999) M Ω	2.4 m Ω/Ω + 78 k Ω	
(330 to 1100) M Ω	12 m Ω/Ω + 0.39 M Ω		
	(0.1 to 1) G Ω	2.5 m Ω/Ω	Megadek 72-6346-1
	(1 to 10) G Ω	5.8 m Ω/Ω	
	(10 to 100) G Ω	17 m Ω/Ω	
	(0.1 to 1) T Ω	1.2 %	IET Labs HRRS-B-3-1G-5 kV
	(1 to 10) M Ω ; 1M Steps	32 $\mu\Omega/\Omega$	SR1050 1M
	(10 to 100) M Ω ; 10 M Steps	32 $\mu\Omega/\Omega$	SR1050 10M
DC Resistance ³ – Generate, Fixed Values	Zero	0.20 $\mu\Omega$	Copper short
	10 $\mu\Omega$	250 $\mu\Omega/\Omega$	Empro E500050 shunt Rubicon shunt
	100 $\mu\Omega$	120 $\mu\Omega/\Omega$	
	333 $\mu\Omega$	120 $\mu\Omega/\Omega$	Guildline 9211A
	1 m Ω	140 $\mu\Omega/\Omega$	
	0.01 Ω	3.2 $\mu\Omega/\Omega$	L&N 0.01 Ω
	0.1 Ω	1.9 $\mu\Omega/\Omega$	IET SRL 0.1
	1.0 Ω	2.0 $\mu\Omega/\Omega$	Fluke 742A-1
	1.9 Ω	1.9 $\mu\Omega/\Omega$	IET SRL 1.9
	10 Ω	2.0 $\mu\Omega/\Omega$	Fluke 742A-10
	19 Ω	19 $\mu\Omega/\Omega$	Fluke 5720A
	100 Ω	4.0 $\mu\Omega/\Omega$	Guildline 100 Ω
	190 Ω	8.5 $\mu\Omega/\Omega$	Fluke 5720A
	1 k Ω	1.8 $\mu\Omega/\Omega$	IET SRL-1k
	1.9 k Ω	7.0 $\mu\Omega/\Omega$	Fluke 5720A

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
DC Resistance ³ – Generate, Fixed Values (cont)	10 kΩ 19 kΩ 100 kΩ 190 kΩ 1.0 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ 10 TΩ	1.9 μΩ/Ω 1.8 μΩ/Ω 3.1 μΩ/Ω 8.5 μΩ/Ω 3.2 μΩ/Ω 15 μΩ/Ω 3.3 μΩ/Ω 5.9 μΩ/Ω 78 μΩ/Ω 0.12 mΩ/Ω 1.1 mΩ/Ω 1.1 mΩ/Ω 1.3 mΩ/Ω 2.9 mΩ/Ω	Fluke 742A-10k IET SRL-19k Guildline 100k 5720A Guildline 1M 5720A Guildline 10M IET SRL 19M 5720A Fluke 8508A-7000K Keithley 5155-10 Keithley 5155-11 Keithley 5155-12 Keithley 5155-13
DC Resistance ³ – Measure	Up to 2 Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ (0.1 to 1) mΩ (1 to 10) mΩ (1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ	4.1 μΩ/Ω 8.7 μΩ/Ω 1.0 μΩ/Ω 1.1 μΩ/Ω 1.3 μΩ/Ω 1.4 μΩ/Ω 3.6 μΩ/Ω 4.1 μΩ/Ω 13 μΩ/Ω 70 μΩ/Ω 1100 μΩ/Ω 91 μΩ/Ω 9.9 μΩ/Ω 5.5 μΩ/Ω 5.1 μΩ/Ω 5.4 μΩ/Ω 5.4 μΩ/Ω 6 μΩ/Ω 6 μΩ/Ω 6.1 μΩ/Ω	Fluke 8508A opt 1 – transfer method Fluke 8508, opt 1 – high voltage mode transfer Fluke 8508A w/ fixed resistors



Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
DC Resistance ³ – Measure (cont) (Ohms Law Method)	(0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ (20 to 200) GΩ (0.2 to 2) TΩ (2 to 20) TΩ	0.0016 MΩ 0.016 MΩ 0.17 MΩ 0.0026 GΩ 0.026 GΩ 0.44 GΩ 0.012 TΩ 0.15 TΩ	Keithley 6517A

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
AC Voltage ³ – Measure & Generate 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	1.3 mV/V + 1.0 μV 0.58 mV/V + 1.0 μV 0.34 mV/V + 1.0 μV 0.64 mV/V + 1.6 μV 0.94 mV/V + 2.5 μV 1.8 mV/V + 3.1 μV 1.9 mV/V + 6.2 μV 2.5 mV/V + 6.2 μV	Fluke 5720A w/ 5790A
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.64 mV/V + 0.78 μV 0.84 mV/V + 0.78 μV 1.7 mV/V + 0.78 μV 3.1 mV/V + 0.78 μV 6.0 mV/V + 1.6 μV	Note: uncertainty of wideband is for flatness relative to 1 kHz
(2.2 to 7) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.66 mV/V + 1.0 μV 0.29 mV/V + 1.0 μV 0.17 mV/V + 1.0 μV 0.31 mV/V + 1.6 μV 0.47 mV/V + 2.5 μV 0.95 mV/V + 3.1 μV 1.0 mV/V + 6.2 μV 1.8 mV/V + 6.2 μV	Fluke 5720A w/ 5790A

Parameter/Range	Frequency	CMC ^{2, 6} (\pm)	Comments
AC Voltage ³ - Measure & Generate (cont)			
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.60 mV/V + 0.78 μ V 0.73 mV/V + 0.78 μ V 1.2 mV/V + 0.78 μ V 2.2 mV/V + 0.78 μ V 3.4 mV/V + 0.78 μ V	Note: uncertainty of wideband is for flatness relative to 1 kHz
(7 to 22) mV	(9 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 + 1.0 μ V 0.16 mV/V + 1.0 μ V 94 μ V/V + 1.0 μ V 0.16 mV/V + 1.6 μ V 0.25 mV/V + 2.5 μ V 0.65 mV/V + 3.1 μ V 0.73 mV/V + 6.2 μ V 1.4 mV/V + 6.2 μ V	Fluke 5720A w/ 5790A
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.58 mV/V 0.72 mV/V 1.1 mV/V 2.2 mV/V 3.4 mV/V	Note: uncertainty of wideband is for flatness relative to 1 kHz
(22 to 70) mV	(9 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	0.19 mV/V + 1.0 μ V 0.10 mV/V + 1.0 μ V 63 μ V/V + 1.0 μ V 0.11 mV/V + 1.6 μ V 0.22 mV/V + 2.5 μ V 0.42 mV/V + 3.1 μ V 0.56 mV/V + 6.2 μ V 0.90 mV/V + 6.2 μ V	Fluke 5720A w/ 5790A
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.44 mV/V 0.60 mV/V 1.1 mV/V 2.1 mV/V 3.3 mV/V	

Parameter/Range	Frequency	CMC ^{2, 6} (\pm)	Comments
AC Voltage ³ – Measure & Generate (cont)			
(70 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.17 mV/V + 1.0 μ V 75 μ V/V + 1.0 μ V 33 μ V/V + 1.0 μ V 61 μ V/V + 1.6 μ V 0.13 mV/V + 2.5 μ V 0.21 mV/V + 3.1 μ V 0.31 mV/V + 6.2 μ V 0.80 mV/V + 6.2 μ V	Fluke 5720A w/ 5790A
Wideband	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.43 mV/V 0.60 mV/V 1.1 mV/V 2.1 mV/V 3.3 mV/V	Note: uncertainty of wideband is for flatness relative to 1 kHz
(220 to 700) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.17 mV/V + 1.0 μ V 62 μ V/V + 1.0 μ V 28 μ V/V + 1.0 μ V 41 μ V/V + 1.6 μ V 64 μ V/V + 2.5 μ V 0.14 mV/V + 3.1 μ V 0.23 mV/V + 6.2 μ V 0.75 mV/V + 6.2 μ V	
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.43 mV/V 0.60 mV/V 1.1 mV/V 2.1 mV/V 3.2 mV/V	
(0.7 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	0.16 mV/V 55 μ V/V 20 μ V/V 36 μ V/V 56 μ V/V 0.13 mV/V 0.20 mV/V 0.70 mV/V	Fluke 5720A w/ 5790A

Parameter/Range	Frequency	CMC ^{2, 6} (\pm)	Comments
AC Voltage ³ – Measure & Generate (cont)			
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.46 mV/V 0.63 mV/V 1.2 mV/V 2.1 mV/V 3.3 mV/V	Note: uncertainty of wideband is for flatness relative to 1kHz
(2.2 to 7) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.16 mV/V 57 μ V/V 20 μ V/V 40 μ V/V 67 μ V/V 0.15 mV/V 0.31 mV/V 0.93 mV/V	Fluke 5720A w/ 5790A
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.44 mV/V 0.62 mV/V 1.1 mV/V 2.1 mV/V 3.3 mV/V	
(7 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.16 mV/V 56 μ V/V 24 μ V/V 44 μ V/V 69 μ V/V 0.15 mV/V 0.31 mV/V 0.93 mV/V	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (\pm)	Comments
AC Voltage ³ – Measure & Generate (cont)			
Wide Band	(1 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.04 % 0.04 % 0.08 % 0.12 % 0.27 %	Note: uncertainty of wideband is for flatness relative to 1kHz
(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	0.16 mV/V 57 μ V/V 27 μ V/V 45 μ V/V 74 μ V/V 0.16 mV/V 0.32 mV/V 0.93 mV/V	Fluke 5720A w/ 5790A
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.16 mV/V 57 μ V/V 27 μ V/V 45 μ V/V 75 μ V/V 0.16 mV/V 0.32 mV/V	
(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	0.16 mV/V 78 μ V/V 34 μ V/V 0.10 mV/V 0.39 mV/V	
(700 to 1020) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 30) kHz (50 to 100) kHz	0.16 mV/V 79 μ V/V 35 μ V/V 0.10 mV/V 0.39 mV/V	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Voltage – Measure and Generate			
2 mV	10 Hz	350 µV/V	Fluke 792A and Fluke 8508
	20 Hz	330 µV/V	
	40 Hz	340 µV/V	
	1 kHz	360 µV/V	
	20 kHz	350 µV/V	
	50 kHz	320 µV/V	
	100 kHz	430 µV/V	
	300 kHz	530 µV/V	
	500 kHz	620 µV/V	
	1 MHz	1200 µV/V	
	10 mV	1 kHz	
20 kHz		73 µV/V	
20 mV	10 Hz	120 µV/V	
	20 Hz	78 µV/V	
	40 Hz	61 µV/V	
	1 kHz	64 µV/V	
	20 kHz	62 µV/V	
	50 kHz	81 µV/V	
	100 kHz	140 µV/V	
	300 kHz	220 µV/V	
	500 kHz	320 µV/V	
	1 MHz	420 µV/V	
30 mV	10 Hz	120 µV/V	
	45 Hz	85 µV/V	
	1 kHz	70 µV/V	
	10 kHz	70 µV/V	
	20 kHz	71 µV/V	
33 mV	45 Hz	81 µV/V	
	10 kHz	69 µV/V	
100 mV	20 Hz	25 µV/V	
	55 Hz	13 µV/V	
	1 kHz	13 µV/V	
	10 kHz	13 µV/V	
	20 kHz	12 µV/V	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
AC Voltage – Measure & Generate (cont)			
200 mV	10 Hz	26 μV/V	Fluke 792A and Fluke 8508
	20 Hz	20 μV/V	
	40 Hz	11 μV/V	
	1 kHz	10 μV/V	
	20 kHz	10 μV/V	
	50 kHz	20 μV/V	
	100 kHz	40 μV/V	
	300 kHz	75 μV/V	
	500 kHz	110 μV/V	
	1 MHz	180 μV/V	
300 mV	10 Hz	35 μV/V	
500 mV	40 Hz	12 μV/V	
	1 kHz	12 μV/V	
	20 kHz	12 μV/V	
	100 kHz	48 μV/V	
	300 kHz	79 μV/V	
	1 MHz	790 μV/V	
1 V	20 Hz	17 μV/V	
	40 Hz	6.2 μV/V	
	1 kHz	5.7 μV/V	
	20 kHz	13 μV/V	
	100 kHz	14 μV/V	
	300 kHz	21 μV/V	
	1 MHz	48 μV/V	
2 V	10 Hz	26 μV/V	
	20 Hz	25 μV/V	
	40 Hz	6.9 μV/V	
	1 kHz	5.8 μV/V	
	20 kHz	11 μV/V	
	50 kHz	13 μV/V	
	100 kHz	14 μV/V	
	300 kHz	22 μV/V	
	500 kHz	30 μV/V	
	1 MHz	45 μV/V	
3 V	10 Hz	36 μV/V	
10 V	10 Hz	28 μV/V	
	20 Hz	16 μV/V	
	40 Hz	5.3 μV/V	
	1 kHz	5.2 μV/V	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Voltage – Measure & Generate (cont)			
19 V	1 kHz	6 µV/V	Fluke 792A and Fluke 8508
20 V	10 Hz	26 µV/V	
	20 Hz	15 µV/V	
	40 Hz	6.8 µV/V	
	1 kHz	6.1 µV/V	
	20 kHz	6.3 µV/V	
	50 kHz	7.2 µV/V	
	100 kHz	10 µV/V	
	300 kHz	20 µV/V	
	500 kHz	29 µV/V	
	1 MHz	42 µV/V	
22 V	1 MHz	59 µV/V	
30 V	10 Hz	36 µV/V	
50 V	300 kHz	36 µV/V	
100 V	20 Hz	16 µV/V	
	55 Hz	8.6 µV/V	
	1 kHz	6.1 µV/V	
200 V	10 Hz	37 µV/V	
	20 Hz	15 µV/V	
	40 Hz	8.1 µV/V	
	1 kHz	8.1 µV/V	
	20 kHz	8.6 µV/V	
	50 kHz	12 µV/V	
	100 kHz	18 µV/V	
250 V	15 Hz	57 µV/V	
300 V	50 kHz	20 µV/V	
500 V	50 Hz	14 µV/V	
	1 kHz	14 µV/V	
	30 kHz	20 µV/V	
1000 V	50 Hz	16 µV/V	
	1 kHz	11 µV/V	
	30 kHz	11 µV/V	
(1 to 40) kV	50/60 Hz	4.1 mV/V	Ross YD60 divider w/ meter
(40 to 100) kV Measure Only	50/60 Hz	14 mV/V	Hipotronics KVM100

Parameter/Range	Frequency	CMC ^{2,6} (\pm)	Comments
AC Current ³ – Measure & Generate			
Up to 33 μ A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz	350 μ A/A 280 μ A/A 260 μ A/A 880 μ A/A	Fluke 5720A w/ metal film resistors
(33 to 330) μ A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz	220 μ A/A 110 μ A/A 87 μ A/A 300 μ A/A	
(0.33 to 5) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz	270 μ A/A 90 μ A/A 59 μ A/A 210 μ A/A	
(5 to 50) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 μ A/A 96 μ A/A 65 μ A/A 100 μ A/A	Fluke 5720A w/ 5790A and AC shunts
(50 to 260) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 μ A/A 97 μ A/A 67 μ A/A 110 μ A/A	
(125 to 650) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 μ A/A 96 μ A/A 67 μ A/A 110 μ A/A	
(0.5 to 2.6) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 μ A/A 99 μ A/A 78 μ A/A 140 μ A/A	
(1.25 to 6) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 μ A/A 110 μ A/A 97 μ A/A 190 μ A/A	
(2.5 to 13) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	230 μ A/A 120 μ A/A 110 μ A/A 170 μ A/A	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (\pm)	Comments
AC Current ³ – Measure & Generate (cont)			
(5 to 26) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	250 μ A/A 160 μ A/A 170 μ A/A 210 μ A/A	Fluke 5720A w/ 5790A and AC shunts
(26 to 1200) A	Up to 1 kHz	520 μ A/A	w/ Weston 327 type 2 current transformer
Generate Only (16.5 to 149.999) A	(45 to 65) Hz (65 to 440) Hz	0.31 % 0.81 %	Fluke 5520A w/ 5500-coil
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.33 % 0.82 %	
AC Resistance ³ – Generate			
10 Ω	DC 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	4.1 m Ω 5.1 m Ω 5.1 m Ω 6.1 m Ω 7.1 m Ω 20 m Ω 40 m Ω	Agilent 42030 set
100 Ω	DC 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	42 m Ω 42 m Ω 46 m Ω 46 m Ω 44 m Ω 84 m Ω 93 m Ω	
1 k Ω	DC to 3 MHz (3 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.43 Ω 0.42 Ω 2 Ω 3 Ω	
10 k Ω	DC to 1 MHz	3.3 Ω	
100 k Ω	DC to 1 MHz	46 Ω	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Resistance ³ – Measure (0.01 to 100) kΩ (0.1 to 10) MΩ 0.1 Ω 1.0 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 0.1 Ω 1.0 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	12 Hz to 100 kHz (0.1 to 1) MHz (1 to 2) MHz	0.021 % 0.26 % 0.53 % 0.34 % 0.11 % 0.05 % 0.05 % 0.10 % 0.16 % 0.63 % 0.34 % 0.21 % 0.10 % 0.10 % 0.21 % 0.32 %	IET 1689 – CMC valid at 1 kHz only ⁸ Agilent E4980A
AC Power ³ – Generate (0.01 to 0.1) W (0.1 to 890) W (0.89 to 3) kW (3 to 11) kW (11 to 20.5) kW (20.5 to 100) kW	(0.04 to 1) kHz; PF = 1 (10 to 100) Hz (100 to 400) Hz (0.4 to 1) kHz	0.23 % 0.14 % 0.13 % 0.15 % 0.13 % 0.66 % + 0.15 kW 0.66 % + 0.20 kW 0.67 % + 0.30 kW	Fluke 5520A Two Fluke 57XX phase locked w/ Valhalla 2555A

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
Inductance ³ – Measure			
100 µH to 10 H ⁹	12 Hz to 100 kHz	0.021 %	IET 1689 – CMC valid at 1 kHz only ⁸
3 µH	(0.1 to 1) MHz	0.10 %	Agilent E4980A
10 µH		0.05 %	
100 µH ⁹		0.05 %	
200 µH		0.06 %	
300 µH		0.07 %	
500 µH		0.06 %	
1 mH		0.07 %	
3 µH	(1 to 2) MHz	0.10 %	
10 µH		0.10 %	
100 µH		0.10 %	
200 µH		0.17 %	
Capacitance ³ – Measure			
(1 to 10) pF	100 Hz to 100 kHz	0.41 %	IET 1689 - CMC valid at 1 kHz only ⁸
(10 to 100) pF	12 Hz to 100 kHz	0.05 %	
100 pF to 25 µF	(0.1 to 1) MHz	0.02 %	Agilent E4980A
(25 to 100) µF		0.03 %	
(0.1 to 1) mF		0.21 %	
1 pF		0.19 %	
10 pF		0.11 %	
100 pF		0.05 %	
1 nF		0.05 %	
10 nF	0.10 %		
100 nF	0.15 %		
1 µF	0.41 %		
1 pF	(1 to 2) MHz	0.28 %	
10 pF		0.11 %	
100 pF		0.10 %	
1 nF		0.10 %	
10 nF		0.21 %	
100 nF		0.35 %	
1 µF		0.81 %	
Up to 1.099 99 mF	DC	0.14 mF/F	Fluke 5720A w/ Keysight 3458A
(1.1 to 3.299 99) mF	DC	0.13 mF/F	
(3.3 to 10.9999) mF	DC	0.13 mF/F	
(11 to 32.9999) mF	DC	0.17 mF/F	
(33 to 110) mF	DC	0.33 mF/F	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
Capacitance ³ – Generate			
1 pF	100 Hz to 1 MHz	0.40 fF	Agilent 1638XX capacitors
	(1 to 2) MHz	0.45 fF	
	(2 to 3) MHz	0.57 fF	
	(3 to 4) MHz	0.73 fF	
	(4 to 5) MHz	1.5 fF	
	(5 to 10) MHz	2.5 fF	
	(10 to 13) MHz	4.1 fF	
10 pF	100 Hz to 1 MHz	3.5 fF	
	(1 to 3) MHz	3.8 fF	
	(3 to 5) MHz	3.5 fF	
	(5 to 10) MHz	4.1 fF	
	(10 to 13) MHz	4.3 fF	
100 pF	100 Hz to 1 kHz	43 fF	
	1 kHz to 1 MHz	35 fF	
	(1 to 2) MHz	36 fF	
	(2 to 3) MHz	37 fF	
	(3 to 4) MHz	38 fF	
	(4 to 5) MHz	39 fF	
	(5 to 10) MHz	52 fF	
	(10 to 13) MHz	63 fF	
1 nF	100 Hz to 1 MHz	0.35 pF	
	(1 to 2) MHz	0.38 pF	
	(2 to 3) MHz	0.45 pF	
	(3 to 4) MHz	0.56 pF	
	(4 to 5) MHz	0.71 pF	
	(5 to 10) MHz	1.9 pF	
	(10 to 13) MHz	2.8 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	0.44 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	
1 μF	(100 to 120) Hz	76 pF	
	120 Hz to 1 kHz	70 pF	
	(1 to 10) kHz	70 pF	
	(10 to 100) kHz	0.58 nF	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
Capacitance ³ – Generate (cont)			
(1 to 10) μF	50 Hz to 1 kHz	0.081 %	GenRad 1424-A
1 pF to 1 μF	1 kHz	140 μF/F	GenRad 1413
1 μF to 1.4 μF	1 kHz	800 μF/F	Arco SS-32
(0.19 to 1.09) nF	10 Hz to 10 kHz	4.1 pF/nF + 7.8 pF	Fluke 5520A
(1.1 to 3.29) nF	10 Hz to 3 kHz	4.0 pF/nF + 7.8 pF	
(3.3 to 10.09) nF	10 Hz to 1 kHz	2.3 pF/nF + 7.8 pF	
(11 to 109.9) nF	10 Hz to 1 kHz	2.3 pF/nF + 78 pF	
(110 to 329.9) nF	10 Hz to 1 kHz	2.3 pF/nF + 0.23 nF	
(0.33 to 1.09) μF	(10 to 600) Hz	2.3 nF/μF + 0.78 nF	
(1.1 to 3.29) μF	(10 to 300) Hz	2.3 nF/μF + 2.3 nF	
(3.29 to 10.09) μF	(10 to 150) Hz	2.3 nF/μF + 7.8 nF	
(11 to 32.9) μF	(10 to 120) Hz	3.4 nF/μF + 23 nF	
(33 to 109.9) μF	(10 to 80) Hz	3.7 nF/μF + 78 nF	
(110 to 329.9) μF	(10 to 50) Hz	3.5 nF/μF + 0.23 μF	
(0.33 to 1.09) mF	(10 to 20) Hz	3.5 μF/mF + 0.78 μF	
(1.1 to 3.29) mF	DC to 6 Hz	3.5 μF/mF + 2.3 μF	
(3.3 to 10.9) mF	DC to 2 Hz	3.5 μF/mF + 7.8 μF	
(11 to 32.9) mF	DC to 0.6 Hz	5.8 μF/mF + 23 μF	
(33 to 110) mF	DC to 0.2 Hz	8.5 μF/mF + 78 μF	
Phase ³ – Generate			
(-180 to 180) °	1 mHz to 20 MHz	0.17°	HP 3325A and reference signal
Phase ³ – Measure			
(0 to 360) °	10 Hz to 225 MHz	0.025°	Agilent 53132A

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicators ³			
Type B	(600 to 1820) °C	0.092 °C	Keysight 3458, Fluke 5720A, thermal reference probe, and ice point
Type C	(0 to 2316) °C	0.092 °C	
Type E	(-250 to 1000) °C	0.91 °C	
Type J	(-210 to 1200) °C	0.92 °C	
Type K	(-200 to 1372) °C	0.092 °C	
Type R	(0 to 1767) °C	0.24 °C	
Type S	(0 to 1767) °C	0.24 °C	
Type T	(-250 to 400) °C	0.14 °C	
Type U	(-200 to 600) °C	0.14 °C	
Type N	(-200 to -100) °C	0.31 °C	Fluke 5520A
	(-100 to -25) °C	0.17 °C	
	(-25 to 120) °C	0.15 °C	
	(120 to 410) °C	0.14 °C	
	(410 to 1300) °C	0.21 °C	
Electrical calibration of RTDs –			
Pt 385, 100 Ω	(-200 to 0) °C	0.06 °C	Fluke 5520A
	(0 to 100) °C	0.08 °C	
	(100 to 400) °C	0.10 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
Pt 385, 200 Ω	(-200 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
Pt 385, 500 Ω	(-200 to 260) °C	0.06 °C	
	(260 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical calibration of RTDs – (cont)			
Pt 385, 1 kΩ	(-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 0.23 °C	Fluke 5520A
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.08 °C 0.09 °C 0.14 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 °C to 0) °C (0 °C to 100) °C (100 °C to 260) °C (260 °C to 300) °C (300 °C to 400) °C (400 °C to 600) °C (600 °C to 630) °C	0.25 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.11 °C 0.23 °C	
Pt 3926, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.05 °C 0.06 °C 0.07 °C 0.09 °C 0.10 °C 0.13 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.30 °C	

Parameter/Equipment	Range	CMC ^{2, 5, 6} (\pm)	Comments
Oscilloscopes ³ –			
DC Signal			
Into 50 Ω Load	(0 to 6.6) V	1.9 mV/V + 31 μ V	Fluke 5520A/SC1100
Into 1 M Ω Load	(0 to 130) V	0.39 mV/V + 31 μ V	
Amplitude Square Wave			
10 Hz to 10 kHz			
Into 50 Ω Load	1 mV to 6.6 V	1.6 mV/V + 31 μ V	
Into 1 M Ω Load	1 mV to 130 V _{p-p}	0.78 mV/V + 31 μ V	
Leveled Sine Wave Flatness			
5 mV to 5.5 V	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.5 % + 78 μ V 1.8 % + 78 μ V 3.4 % + 78 μ V	Note: uncertainty of flatness is relative to 50 kHz
Leveled Sine Wave Flatness			
Up to 3.5 V	> 1 kHz to 100 MHz (> 0.1 to 2.4) GHz (> 2.4 to 8) GHz (> 8 to 12.4) GHz (> 12.4 to 18) GHz (> 18 to 26.5) GHz	0.61 % 0.82 % 1.3 % 1.3 % 1.7 % 2.1 %	Fluke 96270A Note: uncertainty of flatness is relative to 100 kHz. VSWR = 1.0
Time Mark			
Into 50 Ω	1 ns to 20 ms 20 ms to 5 s	2.1 μ s/s (19 + 39 <i>t</i>) μ s/s	Fluke 5520A <i>t</i> is the time in seconds
Frequency	1 kHz to 10 MHz	2.5 μ s/s	
Rise Time – Generate	Positive Side – Nominal 16 ps Negative Side – Nominal 16 ps	11 ps 12 ps	Tektronix 067-1338-00
Rise Time – Measure	6 ps to 1 μ s	10 ps	Tektronix SD-32

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Distortion ³ – Measure			
(0 to 100) % Distortion	20 Hz to 20 kHz (20 to 100) kHz	1.3 dB 2.4 dB	HP 8903B
(0 to 100) % Distortion	100 Hz to 100 kHz	0.61 dB	FSMR

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
RF Power ³ – Generate			
(16 to 20) dBm	(0.2 to 100) kHz (0.1 to 125) MHz	0.023 dB 0.045 dB	Fluke 96270A – leveling head output
(3 to 16) dBm	(0.2 to 100) kHz (0.1 to 150) MHz (0.25 to 1.4) GHz	0.023 dB 0.043 dB 0.16 dB	
(-7 to 3) dBm	(0.2 to 100) kHz (0.1 to 300) MHz (0.3 to 1.4) GHz (1.4 to 4.0) GHz	0.024 dB 0.047 dB 0.16 dB 0.26 dB	
(-47 to -17) dBm	(0.2 to 100) kHz (0.1 to 300) MHz (0.3 to 1.4) GHz (1.4 to 3.5) GHz (3.5 to 4.0) GHz	0.024 dB 0.047 dB 0.16 dB 0.24 dB 0.40 dB	
(-66 to -47) dBm	(0.1 to 10) MHz (10 to 300) MHz (0.3 to 1.4) GHz (1.4 to 4) GHz	0.16 dB 0.083 dB 0.31 dB 0.41 dB	
(-85 to -66) dBm	(0.1 to 10) MHz (10 to 150) MHz (0.15 to 1.5) GHz (1.5 to 4) GHz	0.56 dB 0.41 dB 0.82 dB 0.80 dB	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (\pm)	Comments
RF Power ³ – Generate (cont)			
(-124 to -94) dBm	(10 to 100) MHz (0.1 to 1.4) GHz	0.60 dB 1.4 dB	Fluke 96270A – leveling head output
(-120 to 24) dBm	Up to 100 MHz (0.1 to 1) GHz (1 to 2.4) GHz (2.4 to 8) GHz (8 to 12) GHz (12 to 18) GHz (18 to 22) GHz (22 to 26.5) GHz	0.43 % 0.57 % 0.70 % 0.88 % 1.0 % 1.2 % 1.6 % 2.5 %	
RF Power ³ – Measure			
(-30 to 20) dBm	100 kHz to 100 MHz 100 MHz to 2.0 GHz (2.0 to 12.0) GHz (12.0 to 18.0) GHz (18.0 to 26.5) GHz (26.5 to 40.0) GHz	0.060 dB 0.064 dB 0.082 dB 0.10 dB 0.12 dB 0.16 dB	NRP-Z55, VSWR = 1.15
(-30 to 20) dBm	(40 to 44) GHz (44 to 50) GHz	0.16 dB 0.16 dB	NRP-Z56, VSWR=1.15
(-60 to -30) dBm	100 kHz to 50 GHz	0.64 dB	FSMR
(-100 to -60) dBm	100 kHz to 50 GHz	0.82 dB	
(-140 to -100) dBm	100 kHz to 50 GHz	0.84 dB	
1 mW reference	50 MHz	0.68 %	HP 478A-H76 w/ 432A and 3458A

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
RF Attenuation ³ – Measure			
(0 to 10) dB	(0.100 to 10) MHz	0.018 dB	FSMR and NRP-Z37
(10 to 20) dB		0.024 dB	
(20 to 30) dB		0.029 dB	
(30 to 40) dB		0.035 dB	
(40 to 50) dB		0.041 dB	
(50 to 60) dB		0.047 dB	
(60 to 70) dB		0.052 dB	
(70 to 80) dB		0.058 dB	
(80 to 90) dB		0.064 dB	
(90 to 95) dB		0.071 dB	
(95 to 100) dB		0.075 dB	
(100 to 105) dB		0.086 dB	
(105 to 110) dB		0.094 dB	
(110 to 115) dB		0.13 dB	
(115 to 120) dB	0.21 dB		
(120 to 125) dB	0.27 dB		
(0 to 5) dB	10 MHz to 22 GHz	0.018 dB	
(5 to 10) dB		0.019 dB	
(10 to 20) dB		0.024 dB	
(20 to 30) dB		0.029 dB	
(30 to 40) dB		0.035 dB	
(40 to 50) dB		0.041 dB	
(50 to 60) dB		0.047 dB	
(60 to 70) dB		0.053 dB	
(70 to 80) dB		0.059 dB	
(80 to 85) dB		0.065 dB	
(85 to 90) dB		0.068 dB	
(90 to 100) dB		0.074 dB	
(100 to 105) dB		0.082 dB	
(105 to 110) dB		0.092 dB	
(110 to 115) dB	0.094 dB		
(115 to 120) dB	0.22 dB		
(120 to 130) dB	0.047 dB		
(130 to 135) dB	1.2 dB		

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Attenuation ³ – Measure (cont)			
(0 to 5) dB	(22 to 26.5) GHz	0.018 dB	FSMR and NRP-Z37
(5 to 10) dB		0.019 dB	
(10 to 20) dB		0.024 dB	
(20 to 30) dB		0.029 dB	
(30 to 40) dB		0.035 dB	
(40 to 50) dB		0.041 dB	
(50 to 60) dB		0.047 dB	
(60 to 70) dB		0.053 dB	
(70 to 80) dB		0.059 dB	
(80 to 85) dB		0.065 dB	
(85 to 90) dB		0.068 dB	
(90 to 100) dB		0.074 dB	
(100 to 105) dB		0.082 dB	
(105 to 110) dB		0.092 dB	
(110 to 115) dB		0.094 dB	
(115 to 120) dB		0.22 dB	
(120 to 130) dB		0.47 dB	
(130 to 135) dB		1.3 dB	
(0 to 5) dB	(26.5 to 40) GHz	0.26 dB	
(5 to 20) dB		0.25 dB	
(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 115) dB		0.55 dB	
(115 to 120) dB		0.018 dB	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Attenuation ³ – Generate (Relative) (cont)			
(0 to 5) dB (5 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 115) dB (115 to 120) dB (120 to 130) dB (130 to 135) dB	10 MHz to 22 GHz	0.018 dB 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 0.068 dB 0.074 dB 0.082 dB 0.092 dB 0.094 dB 0.22 dB 0.047 dB 1.3 dB	Fluke 96270 A w/ FSMR and NRP-Z37
(0 to 5) dB (5 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 115) dB (115 to 120) dB (120 to 130) dB (130 to 135) dB	(22 to 26.5) GHz	0.018 dB 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 0.068 dB 0.074 dB 0.082 dB 0.092 dB 0.094 dB 0.22 dB 0.47 dB 1.3 dB	Keysight E8257D w/ FSMR and NRP-Z56
(0 to 5) dB (5 to 20) dB (20 to 25) dB (25 to 30) dB (30 to 35) dB	(26.5 to 40) GHz	0.26 dB 0.25 dB 0.39 dB 0.29 dB 0.22 dB	



Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Attenuation ³ – Generate (Relative) (cont)			
(35 to 40) dB	(26.5 to 40) GHz	0.44 dB	Keysight E8257D w/ FSMR and NRP-Z56
(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		0.42 dB	
(100 to 105) dB		0.40 dB	
(105 to 110) dB		0.38 dB	
(110 to 115) dB		0.47 dB	
(115 to 120) dB	0.55 dB		
(120 to 125) dB	0.018 dB		
(0 to 5) dB	(40 to 50) GHz	0.36 dB	
(5 to 10) dB		0.31 dB	
(10 to 15) dB		0.45 dB	
(20 to 25) dB		0.44 dB	
(25 to 30) dB		0.50 dB	
(30 to 35) dB		0.52 dB	
(35 to 40) dB		0.51 dB	
(40 to 45) dB		0.55 dB	
(45 to 50) dB		0.43 dB	
(50 to 55) dB		0.49 dB	
(55 to 60) dB		0.30 dB	
(65 to 70) dB		0.36 dB	
(70 to 75) dB		0.44 dB	
(75 to 80) dB		0.35 dB	
(80 to 85) dB		0.42 dB	
(85 to 90) dB		0.36 dB	
(90 to 95) dB	0.41 dB		
(95 to 100) dB	0.37 dB		
(100 to 105) dB	0.39 dB		
(105 to 110) dB	0.37 dB		
(110 to 115) dB	0.35 dB		

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
Frequency Modulation ³ – Generate Pk Deviation < 12.5 kHz Rate: < 100 kHz Rate: ≤ 200 kHz Pk Deviation < 100 kHz Rate: < 100 kHz Rate: ≤ 200 kHz Pk Deviation < 400 kHz Rate: < 100 kHz Rate: ≤ 200 kHz	 (11 to 13.5) MHz (11 to 13.5) MHz (88 to 108) MHz (88 to 108) MHz (352 to 432) MHz (352 to 432) MHz	 0.39 % 0.38 % 0.38 % 0.38 % 0.38 % 0.53 %	 HP 11715A w/ 3335A
Phase Modulation ³ – Generate Pk Deviation: ≤ 6 rad Rate: ≤ 50 kHz Pk Deviation: ≤ 1 rad Rate: ≤ 300 kHz	 9 MHz to 4 GHz 9 MHz to 4 GHz	 1 % + 0.24 rad 3.6 %	 Fluke 96270A
Amplitude Modulation ³ – Generate Rate: (0.05 to 50) kHz Depth: (0 to 99) % Rate: (0.02 to 100) kHz Depth: (0 to 99) %	 (11 to 13.5) MHz (12 to 13.5) MHz	 0.20 % 0.33 %	 HP 11715A w/ 3335A

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
Amplitude Modulation ³ – Generate (cont) Rate: 1 Hz to 220 kHz Depth: (0.1 to 99) % Rate: 1 Hz to 220 kHz Depth: (0.1 to 99) %	50 kHz to 4 GHz 50 kHz to 4 GHz	1.7 % 3.8 %	Fluke 96270A
Frequency Modulation ³ – Measure Pk Deviation ≤ 50 kHz Rate: (0.01 to 10) kHz Pk Deviation ≤ 500 kHz Rate: (0.01 to 100) kHz Rate: (0.1 to 200) kHz	100 kHz to 10 MHz 100 kHz to 50 GHz	1.2 % 1.2 % 3.5 %	RS FSMR
Amplitude Modulation ³ – Measure Rate: (0.01 to 10) kHz Depth: (5 to 99) % Rate (0.01 to 50) kHz Depth: (5 to 99) % Rate: (50 to 100) kHz Depth: (5 to 99) % Rate: (90 to 150) Hz Depth: (5 to 99) %	100 kHz to 10 MHz 10 MHz to 50 GHz 10 MHz to 50 GHz 10 MHz to 50 GHz	1.5 % 1 % 1.5 % 0.42 %	RS FSMR
Phase Modulation ³ – Measure Rate: 200 Hz to 10 kHz Rate: 200 Hz to 20 kHz	f _c (0.15 to 10) MHz f _c (0.01 to 26.5) GHz	1 % 1 %	RS FSMR

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Phase Noise ³ – Measure			
(1 to 10) MHz (-50 to -140) dBc/Hz	1 Hz Offset	2.7 dB	RS FSWP
	10 Hz Offset	2.5 dB	
	100 Hz Offset	1.6 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	4.0 dB	
	(10 to 100) MHz (-50 to -140) dBc/Hz	1 Hz Offset	
10 Hz Offset		2.8 dB	
100 Hz Offset		1.6 dB	
1 kHz Offset		1.5 dB	
10 kHz Offset		1.6 dB	
20 kHz Offset		1.6 dB	
100 kHz Offset		1.6 dB	
1 MHz Offset		2.7 dB	
(0.1 to 1) GHz (-50 to -140) dBc/Hz	1 Hz Offset	3.2 dB	
	10 Hz Offset	2.4 dB	
	100 Hz Offset	1.7 dB	
	1 kHz Offset	1.7 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.7 dB	
	1 MHz Offset	3.9 dB	
(1 to 3) GHz (-50 to -140) dBc/Hz	1 Hz Offset	4.2 dB	
	10 Hz Offset	2.0 dB	
	100 Hz Offset	1.6 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.8 dB	
(3 to 7) GHz (-50 to -140) dBc/Hz	1 Hz Offset	4.4 dB	
	10 Hz Offset	2.6 dB	
	100 Hz Offset	1.7 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.3 dB	

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Phase Noise ³ – Measure (cont)			
(7 to 10) GHz (-50 to -140) dBc/Hz	1 Hz Offset	4.4 dB	RS FSWP
	10 Hz Offset	2.7 dB	
	100 Hz Offset	1.8 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.5 dB	
(10 to 16) GHz (-50 to -140) dBc/Hz	1 Hz Offset	3.2 dB	
	10 Hz Offset	2.7 dB	
	100 Hz Offset	1.7 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.3 dB	
(16 to 26) GHz (-50 to -140) dBc/Hz	1 Hz Offset	4.1 dB	
	10 Hz Offset	2.0 dB	
	100 Hz Offset	1.7 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.6 dB	
(26 to 50) GHz (-50 to -140) dBc/Hz	1 Hz Offset	4.1 dB	
	10 Hz Offset	2.0 dB	
	100 Hz Offset	1.7 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	20 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.6 dB	

Parameter/Range	Frequency	CMC ^{2, 5, 6, 7} (±)	Comments
Digital Modulation – Measure			
Error Vector Magnitude	≤ 1 MHz ≤ 10 MHz ≤ 15 MHz	0.53 % 1.1 % 2.1 %	RS FSMR
Phase Error Up to 180°	≤ 100 kHz ≤ 1 MHz ≤ 10 MHz ≥ 10 MHz	0.32 deg 0.42 deg 0.64 deg 1.3 deg	
Power Sensor ³ – Calibration Factors			% = % of assigned calibration factor
0 dBm	(0.01 to 0.05) GHz (0.05 to 2) GHz (2 to 4) GHz (4 to 6) GHz (6 to 8) GHz (8 to 12) GHz (12 to 13) GHz (13 to 14) GHz (14 to < 18) GHz 18 GHz	1.5 % 1.5 % 1.7 % 1.8 % 1.9 % 1.9 % 2.2 % 2.2 % 2.2 % 2 %	Fluke 96270A – characterized microwave output w/ splitter VSWR = 1.0, Reference power sensors – HP 8481A
0 dBm	(10 to 30) MHz 30 MHz to 4 GHz (4 to 6) GHz (6 to 8) GHz (8 to 10) GHz (10 to 12) GHz (12 to 14) GHz (14 to 15) GHz (15 to 18) GHz	2.5 % 2.0 % 2.1 % 2.1 % 2.1 % 2.3 % 2.4 % 2.4 % 2.5 %	Reference power sensors – HP8481D

Parameter/Range	Frequency	CMC ^{2, 5, 6} (\pm)	Comments
Power Sensor ³ – Calibration Factors (cont)			
0 dBm	(100 to 500) kHz 500 kHz to 1 MHz (1 to 2) MHz (2 to 50) MHz (50 to 100) MHz (0.1 to 2) GHz (2 to 4) GHz (4 to 4.2) GHz	1.7 % 1.7 % 1.5 % 1.5 % 1.4 % 1.5 % 1.9 % 1.9 %	Fluke 96270A – characterized microwave output w/ splitter VSWR = 1.0, Reference power sensors – HP 8482A
0 dBm	50 MHz to 12 GHz (12 to 18) GHz (18 to 26.5) GHz	2.4 % 2.9 % 3.4 %	Reference power sensors – HP 8485A
Transmission Magnitude – Into 50 Ω , (S12, S21)			
(10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB	30 kHz to 1.3 GHz	0.069 dB 0.031 dB 0.042 dB 0.042 dB 0.042 dB	HP 8753D w/85032F
(10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB	(1.3 to 3) GHz	0.069 dB 0.036 dB 0.045 dB 0.045 dB 0.045 dB	
(10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB	(3 to 6) GHz	0.10 dB 0.059 dB 0.065 dB 0.065 dB 0.065 dB	
(10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB	50 MHz to 2 GHz	0.048 dB 0.038 dB 0.060 dB 0.071 dB 0.28 dB	HP 8722ES w/ 85032F, 85052D

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
Transmission Magnitude – Into 50 Ω, (S12, S21) (cont)			
(10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB	(2 to 8) GHz	0.06 dB 0.056 dB 0.079 dB 0.082 dB 0.094 dB	HP 8722ES w/ 85032F, 85052D
(10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB	(8 to 20) GHz	0.071 dB 0.062 dB 0.088 dB 0.11 dB 0.095 dB	
(10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB	(20 to 26.5) GHz	0.15 dB 0.14 dB 0.14 dB 0.15 dB 0.20 dB	
Reflection Coefficient – Into 50 Ω, (S11, S22)			
(0 to 1)	30 kHz to 6 GHz	0.004 ρ	HP 8753D w/85032F
(0 to 0.5)	50 MHz to 20 GHz (20 to 26.5) GHz	0.016 ρ 0.021 ρ	HP 8722ES w/ 85032F, 85052D
(0.5 to 0.75)	50 MHz to 20 GHz (20 to 26.5) GHz	0.013 ρ 0.021 ρ	
(0.75 to 1)	50 MHz to 20 GHz (20 to 26.5) GHz	0.017 ρ 0.030 ρ	

IV. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5, 11} (±)	Comments
Pressure ³ – Measure and Measuring Equipment			
Pneumatic	(0 to 1) in·H ₂ O (1 to 35) in·H ₂ O	0.000 17 in·H ₂ O 0.01 %	Ruska 7250LP PK 654-WC
	(0 to 15) psia (-14.5 to 15) psig Up to 75 psia (75 to 150) psia Up to 300 psia (300 to 600) psia Up to 1500 psia (1500 to 3000) psia	0.0021 psia 0.0018 psig 0.0089 psia 0.013 % 0.042 psia 0.012 % 0.18 psia 0.012 %	Mensor CPC6050
Hydraulic	(1 to 30) kpsig	0.010 %	DHI PG7202
Torque ³ – Measuring Equipment	5 lbf·in to 250 lbf·ft	0.30 %	CDI 2000-400-02, CDI 2000-12-02 and CDI 2000-13-0
Scales and Balances ³	(1 to 500) mg (0.5 to 2) g (2 to 3) g (3 to 5) g (5 to 10) g (10 to 50) g (50 to 100) g (100 to 200) g (200 to 300) g (300 to 500) g (0.5 to 1) kg (1 to 2) kg (2 to 3) kg (3 to 10) kg	12 µg 44 µg 47 µg 54 µg 61 µg 0.15 mg 0.30 mg 0.61 mg 0.63 mg 1.4 mg 2.9 mg 5.9 mg 9.7 mg 12 mg	Class 1 weights

Parameter/Equipment	Range	CMC ^{2, 5, 11} (±)	Comments
Scales and Balances ³ (cont)	(0.25 to 0.5) lb (0.5 to 1) lb (1 to 2) lb (2 to 5) lb (5 to 10) lb (10 to 20) lb (20 to 50) lb (50 to 100) lb (100 to 250) lb (250 to 500) lb (500 to 1000) lb	23 mg 35 mg 58 mg 230 mg 0.35 g 0.59 g 2.3 g 3.3 g 5.2 g 5.8 g 11 g	Class 1 weights Class F weights
Mass – Measure	(10 to 20) kg (5 to 10) kg (3 to 5) kg (2 to 3) kg (1 to 2) kg (0.2 to 1) kg (50 to 100) g (30 to 50) g (20 to 30) g (5 to 20) g (1 to 5) g (0.001 to 1) g	21 mg 9 mg 6.1 mg 5.5 mg 1.7 mg 0.24 mg 0.14 mg 49 µg 32 µg 18 µg 11 µg 3.4 µg	Class 1 weights and comparators
Force Gages and Load Cells ³	(0 to 100) lbf (100 to 500) lbf (500 to 1000) lbf (20 to 500) lbf (500 to 1000) lbf (1000 to 5000) lbf (5000 to 10 000) lbf (10 000 to 25 000) lbf (25 000 to 50 000) lbf (50 000 to 100 000) lbf	0.012 lbf 0.082 lbf 0.13 lbf 0.018 % 0.018 % 0.018 % 0.018 % 0.018 % 0.021 % 0.017 %	Class F weights Interface gold 1600 series load cells w/ GSSYS software

V. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 5, 11} (\pm)	Comments
Temperature ³ – Measuring Equipment	(-30 to 140) °C (50 to 660) °C	0.021 °C 0.041 °C	Fluke 5626 PRT w/ Chubb E4 and temperature sources
Temperature ³ – Measure	(-200 to 660) °C	0.016 °C	Fluke 5626 PRT w/ Chubb E4 and temperature sources
Relative Humidity ³ – Measuring Equipment	(10 to 95) % RH	0.59 % RH	Thunder Scientific 2500
Relative Humidity ³ – Measure	(20 to 80) % RH	1.1 RH	Humidity probe
Infrared Temperature – Measuring Equipment ³	(-30 to -20) °C (-20 to 35) °C (35 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 500) °C (500 to 982) °C	1.9 °C 0.9 °C 0.44 °C 0.57 °C 0.72 °C 1.1 °C 1.2 % + 1 °C	Hart 9133 $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$ Fluke 4181 $\epsilon = (0.9 \text{ to } 1), \lambda =$ $(8 \text{ to } 14) \mu\text{m}$ Omega BB-4A $\epsilon = 0.99, \lambda = (8 \text{ to } 14) \mu\text{m}$

VI. Time & Frequency

Parameter/Equipment	Range	CMC ² (\pm)	Comments
Stopwatches & Timers ³	Up to 19.99 s/day	0.061 s/day	Helmut Klein 4500 Tinometer

Parameter/Equipment	Range	CMC ^{2, 4, 5, 11} (\pm)	Comments
Frequency – Generate ³	10 MHz	0.11 Hz + 0.6R	HP 3325B w/ GPS
	DC to 1 kHz (0.1 to 20) MHz 10 MHz to 26.5 GHz (0.2 to 26.5) GHz	67 nHz/Hz 0.6 nHz/Hz 64 pHz/Hz 11 nHz/Hz	HP 3325B w/ GPS Fluke 96270 w/ GPS
Frequency – Measure	DC to 1000 Hz (1 to 1000) kHz (1 to 225) MHz (0.2 to 26.5) GHz (26.5 to 50) GHz	5.8 μ Hz/Hz 280 pHz/Hz 5 pHz/Hz 82 pHz/Hz + 0.6R 58 pHz/Hz	5313X w/ GPS 5351B w/ GPS FSMR w/ GPS
Tachometers –			
Contact	(55 to 40 000) rpm	0.018 %	General dynamics H8224 and frequency counter
Non-contact	(10 to 100 000) rpm	0.0023 rpm	LED w/ 3325B and GPS

Satellite Facility

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I. Dimensional

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
Micrometers – Length Flatness Parallelism	Up to 12 in (12 to 72) in Up to 1 in Up to 1 in	 (30 + 1.7L) μin (28 + 1.8L) μin 4.3 μin 8.8 μin	 Grade 2 gage blocks Optical flats Gage blocks, surface plates
Calipers ³	Up to 4 in (4 to 12) in (12 to 48) in	(58 + 2.3L) μin (67 + 5.4L) μin (110 + 8.0L) μin	Grade 2 gage blocks

II. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Current – Generate ³ (29 to 329.99) μA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	1.6 nA/μA + 78 nA 1.2 nA/μA + 78 nA 0.98 nA/μA + 78 nA 2.3 nA/μA + 0.12 μA 6.2 nA/μA + 0.16 μA 12 nA/μA + 0.31 μA	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Current – Generate ³ (cont)			
(0.33 to 3.2999) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	1.6 μA/mA + 0.12 μA 1.0 μA/mA + 0.12 μA 0.79 μA/mA + 0.12 μA 1.6 μA/mA + 0.16 μA 4.0 μA/mA + 0.23 μA 7.8 μA/mA + 0.47 μA	Fluke 5520A
(3.3 to 32.999) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	1.4 μA/mA + 1.6 μA 0.71 μA/mA + 1.6 μA 0.35 μA/mA + 1.6 μA 0.64 μA/mA + 1.6 μA 1.6 μA/mA + 2.3 μA 3.5 μA/mA + 3.1 μA	
(33 to 329.99) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	1.5 μA/mA + 16 μA 0.71 μA/mA + 16 μA 0.34 μA/mA + 16 μA 0.79 μA/mA + 39 μA 1.6 μA/mA + 78 μA 3.2 μA/mA + 0.16 mA	
(0.33 to 1.099 99) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	1.4 mA/A + 0.078 mA 0.41 mA/A + 0.078 mA 4.7 mA/A + 0.78 mA 19 mA/A + 3.9 mA	
(1.1 to 2.999 99) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	1.4 mA/A + 78 μA 0.56 mA/A + 78 μA 4.7 mA/A + 0.78 mA 19 mA/A + 3.9 mA	
(3 to 10.9999) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.52 mA/A + 1.6 mA 0.81 mA/A + 1.6 mA 23 mA/A + 1.6 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.96 mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
AC Voltage – Generate ³			
(1.0 to 32.999) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.63 mV/V + 4.7 μ V 0.15 mV/V + 4.7 μ V 0.19 mV/V + 4.7 μ V 0.80 mV/V + 4.7 μ V 2.7 mV/V + 9.3 μ V 6.2 mV/V + 39 μ V	Fluke 5520A
(33 to 329.999) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.23 mV/V + 6.2 μ V 0.12 mV/V + 6.2 μ V 0.13 mV/V + 6.2 μ V 0.28 mV/V + 6.2 μ V 0.63 mV/V + 25 μ V 1.6 mV/V + 54 μ V	
(0.33 to 3.299 99) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.23 mV/V + 39 μ V 0.12 mV/V + 47 μ V 0.15 mV/V + 47 μ V 0.24 mV/V + 39 μ V 0.55 mV/V + 97 μ V 1.9 mV/V + 0.47 mV	
(3.3 to 32.9999) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.23 mV/V + 0.50 mV 0.12 mV/V + 0.47 mV 0.19 mV/V + 0.47 mV 0.27 mV/V + 0.47 mV 0.7 mV/V + 1.2 mV	
(33 to 329.999) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.15 mV/V + 1.6 mV 0.16 mV/V + 4.7 mV 0.44 mV/V + 4.7 mV 0.25 mV/V + 4.7 mV 1.6 mV/V + 39 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mV/V + 7.8 mV 0.20 mV/V + 7.8 mV 0.23 mV/V + 7.8 mV	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
AC Voltage – Generate ³ (cont)			
(33 to 329.999) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.23 mV/V + 6.2 μV 0.12 mV/V + 6.2 μV 0.13 mV/V + 6.2 μV 0.28 mV/V + 6.2 μV 0.63 mV/V + 25 μV 1.6 mV/V + 54 μV	Fluke 5522A
(0.33 to 3.299 99) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.23 mV/V + 39 μV 0.12 mV/V + 47 μV 0.15 mV/V + 47 μV 0.24 mV/V + 39 μV 0.55 mV/V + 97 μV 1.9 mV/V + 0.47 mV	
(3.3 to 32.9999) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.23 mV/V + 0.50 mV 0.12 mV/V + 0.47 mV 0.19 mV/V + 0.47 mV 0.27 mV/V + 0.47 mV 0.7 mV/V + 1.2 mV	
(33 to 329.999) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.15 mV/V + 1.6 mV 0.16 mV/V + 4.7 mV 0.44 mV/V + 4.7 mV 0.25 mV/V + 4.7 mV 1.6 mV/V + 39 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mV/V + 7.8 mV 0.20 mV/V + 7.8 mV 0.23 mV/V + 7.8 mV	
Capacitance – Generate ³			
(220 to 399.9) pF (0.4 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.9999) nF (11 to 32.9999) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) μF (1.1 to 3.299 99) μF (3.3 to 10.9999) μF (11 to 32.9999) μF (33 to 109.999) μF (110 to 329.999) μF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz DC to 50 Hz	5.6 fF/pF + 7.8 pF 4.3 pF/nF + 7.8 pF 4.1 pF/nF + 7.8 pF 2.0 pF/nF + 7.8 pF 2.0 pF/nF + 78 pF 2.0 pF/nF + 78 pF 2.1 pF/nF + 0.23 nF 2.0 nF/μF + 0.78 nF 2.0 nF/μF + 2.3 nF 2.1 nF/μF + 7.8 nF 3.2 nF/μF + 23 nF 3.7 nF/μF + 78 nF 3.7 nF/μF + 0.23 μF	Fluke 5522A



Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
Capacitance – Generate ³ (cont)			
(0.33 to 1.099 99) mF	DC to 20 Hz	3.7 μF/mF + 0.78 μF	Fluke 5522A
(1.1 to 3.299 99) mF	DC to 6 Hz	3.5 μF/mF + 2.3 μF	
(3.3 to 10.9999) mF	DC to 2 Hz	3.5 μF/mF + 7.8 μF	
(11 to 32.9999) mF	DC to 0.6 Hz	5.8 μF/mF + 23 μF	
(33 to 110) mF	DC to 0.2 Hz	8.5 μF/mF + 78 μF	

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
DC Current – Generate ³	(0 to 329.999) μA (0 to 3.299 99) mA (0 to 32.9999) mA (0 to 329.999) mA (0 to 1.099 99) A (1.1 to 2.999 99) A (0 to 10.9999) A (11 to 20.5) A	120 μA/A + 16 nA 78 μA/A + 39 nA 78 μA/A + 0.19 μA 80 μA/A + 1.9 μA 0.16 mA/A + 31 μA 0.3 mA/A + 31 μA 0.39 mA/A + 0.39 mA 0.78 mA/A + 0.58 mA	Fluke 5520A
DC Voltage – Generate ³	(0 to 329.9999) mV (0 to 3.299 999) V (0 to 32.999 99) V (30 to 329.9999) V (100 to 1000.000) V	18 μV/V + 0.78 μV 12 μV/V + 1.6 μV 12 μV/V + 16 μV 16 μV/V + 0.12 mV 16 μV/V + 1.2 mV	Fluke 5520A
DC Resistance – Generate ³	(0 to 10.9999) Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω (0.33 to 1.0999 99) kΩ (1.1 to 3.299 999) kΩ (3.3 to 10.999 99) kΩ (11 to 32.999 99) kΩ (33 to 109.9999) kΩ (110 to 329.9999) kΩ (0.33 to 1.099 999) MΩ (1.1 to 3.299 999) MΩ (3.3 to 10.999 99) MΩ (11 to 32.999 99) MΩ (33 to 109.9999) MΩ (110 to 329.9999) MΩ (330 to 1100) MΩ	33 μΩ/Ω + 0.78 mΩ 24 μΩ/Ω + 1.2 mΩ 22 μΩ/Ω + 1.1 mΩ 23 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 1.6 mΩ 23 μΩ/Ω + 16 mΩ 23 μΩ/Ω + 16 mΩ 23 μΩ/Ω + 0.16 Ω 23 μΩ/Ω + 0.16 Ω 26 μΩ/Ω + 1.6 Ω 26 μΩ/Ω + 1.6 Ω 48 μΩ/Ω + 23 Ω 0.10 mΩ/Ω + 39 Ω 0.21 mΩ/Ω + 1.9 kΩ 0.40 mΩ/Ω + 2.3 kΩ 2.4 mΩ/Ω + 78 kΩ 12 mΩ/Ω + 0.39 MΩ	Fluke 5520A



Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.34 °C 0.27 °C 0.24 °C 0.26 °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	0.24 °C 0.21 °C 0.25 °C 0.39 °C 0.65 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C	0.39 °C 0.13 °C 0.11 °C 0.13 °C 0.17 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °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	0.26 °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 1 300) °C	0.31 °C 0.17 °C 0.15 °C 0.14 °C 0.21 °C	

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Electrical Calibration of Thermocouple Indicators ³ (cont)			Fluke 5522A
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.45 °C 0.28 °C 0.26 °C 0.32 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.38 °C 0.28 °C 0.29 °C 0.36 °C	
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	
Type U	(-200 to 0) °C (0 to 600) °C	0.44 °C 0.21 °C	
Oscilloscope –			Fluke 552XA SC1100
Voltage – DC 50 Ω 1 M Ω	(0 to 6.6) V (0 to 130) V	1.9 mV/V + 24 μ V 0.37 mV/V + 24 μ V	
Squarewave @ 1 kHz 50 Ω 1 M Ω	1 mV to 6.6 V 1 mV to 130 V	1.9 mV/V + 24 μ V 0.78 mV/V + 24 μ V	
Bandwidth ³	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	3.0 % + 78 μ V 3.4 % + 78 μ V 4.3 % + 78 μ V 4.9 % + 78 μ V	
Time Marker	50 ms to 5 s 1 ns to 20 ms Non-Cardinal Points	7.8 ms/s + 0.0019 % 6.2 μ s/s 39 μ s/s	

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Oscilloscope – (cont)			
Rise Time – Generate Transition Time w/Rep Rate < 2 MHz	(200 to 300) ps Actual Value from Calibration Report	19 ps	Fluke 552XA SC1100
Transition Time w/Rep Rate (2 to 10) MHz	(250 to 350) ps Actual Value from Calibration Report	19 ps	
Input Resistance – Measure	(40 to 90) Ω (0.6 to 1.5) M Ω	0.79 m Ω/Ω 0.79 m Ω/Ω	
DC Voltage – Measure ³	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1100) V	5.9 $\mu\text{V}/\text{V} + 0.23 \mu\text{V}$ 3.5 $\mu\text{V}/\text{V} + 0.23 \mu\text{V}$ 3.4 $\mu\text{V}/\text{V} + 0.39 \mu\text{V}$ 4.9 $\mu\text{V}/\text{V} + 23 \mu\text{V}$ 5.0 $\mu\text{V}/\text{V} + 78 \mu\text{V}$	HP 3458A OPT 002
DC Resistance – Measure ³	Up 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	15 $\mu\Omega/\Omega + 50 \mu\Omega$ 12 $\mu\Omega/\Omega + 0.50 \text{m}\Omega$ 10 $\mu\Omega/\Omega + 0.50 \text{m}\Omega$ 10 $\mu\Omega/\Omega + 5.0 \text{m}\Omega$ 11 $\mu\Omega/\Omega + 50 \text{m}\Omega$ 16 $\mu\Omega/\Omega + 2.0 \Omega$ 51 $\mu\Omega/\Omega + 100 \Omega$ 0.51 m $\Omega/\Omega + 1.0 \text{k}\Omega$ 5.6 m $\Omega/\Omega + 10 \text{k}\Omega$	HP 3458A
DC Current – Measure ³	(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 20) A	67 $\mu\text{A}/\text{A} + 40 \text{pA}$ 34 $\mu\text{A}/\text{A} + 40 \text{pA}$ 20 $\mu\text{A}/\text{A} + 0.10 \text{nA}$ 22 $\mu\text{A}/\text{A} + 0.80 \text{nA}$ 23 $\mu\text{A}/\text{A} + 5.0 \text{nA}$ 22 $\mu\text{A}/\text{A} + 50 \text{nA}$ 42 $\mu\text{A}/\text{A} + 500 \text{nA}$ 110 $\mu\text{A}/\text{A} + 10 \mu\text{A}$ 56 $\mu\text{A}/\text{A}$	HP 3458A Y5020 w/3458A

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Voltage – Measure ³			
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 kHz to 1 MHz	0.43 μV/mV + 3.0 μV 0.22 μV/mV + 1.1 μV 0.32 μV/mV + 1.1 μV 1.0 μV/mV + 1.1 μV 5.0 μV/mV + 1.1 μV 40 μV/mV + 5.0 μV	HP 3458A, synchronous sub-sampled mode
(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	0.30 μV/mV + 4.0 μV 0.10 μV/mV + 2.0 μV 0.15 μV/mV + 2.0 μV 0.32 μV/mV + 2.0 μV 0.81 μV/mV + 2.0 μV 3.0 μV/mV + 10 μV 10 μV/mV + 10 μV	
(0.1 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	0.28 mV/V + 40 μV 87 μV/V + 20 μV 0.15 mV/V + 20 μV 0.32 mV/V + 20 μV 0.81 mV/V + 20 μV 3.0 mV/V + 0.10 mV 10 mV/V + 0.10 mV	
(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	0.28 mV/V + 0.40 mV 86 μV/V + 0.20 mV 0.15 mV/V + 0.20 mV 0.32 mV/V + 0.20 mV 0.81 mV/V + 0.20 mV 3.0 mV/V + 1.0 mV 10 mV/V + 1.0 mV	
(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	0.34 mV/V + 4.0 mV 0.21 mV/V + 2.0 mV 0.21 mV/V + 2.0 mV 0.37 mV/V + 2.0 mV 1.2 mV/V + 2.0 mV 4.0 mV/V + 10 mV 15 mV/V + 10 mV	
(100 to 700) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.49 mV/V + 40 mV 0.40 mV/V + 20 mV 0.60 mV/V + 20 mV 1.2 mV/V + 20 mV 3.0 mV/V + 20 mV	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Current – Measure ³			
(10 to 100) μA	(10 to 20) Hz (20 to 45) Hz (45 to 5) kHz	3.1 nA/μA + 23 nA 1.2 nA/μA + 23 nA 0.49 nA/μA + 23 nA	HP 3458A
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	3.1 μA/mA + 0.16 μA 1.2 μA/mA + 0.16 μA 0.52 μA/mA + 0.16 μA 0.28 μA/mA + 0.16 μA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	3.1 μA/mA + 1.6 μA 1.2 μA/mA + 1.6 μA 0.49 μA/mA + 1.6 μA 0.28 μA/mA + 1.6 μA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	3.1 μA/mA + 16 μA 1.2 μA/mA + 16 μA 0.49 μA/mA + 16 μA 0.28 μA/mA + 16 μA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	3.1 mA/A + 0.16 mA 1.3 mA/A + 0.16 mA 0.69 mA/A + 0.16 mA 0.83 mA/A + 0.16 mA	
(1 to 20) A	55 Hz to 1 kHz (1 to 5) kHz	0.42 mA/A 0.92 mA/A	Y5020 w/ 3458A

III. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 11} (±)	Comments
Frequency – Measure	0.001 Hz to 1 kHz (1 to 1000) kHz (1 to 225) MHz	0.01 mHz/Hz 0.29 nHz/Hz 38 pHz/Hz	HP 53132A, GPS
	225 MHz to 26.5 GHz	1.2 nHz/Hz	HP 5351B, GPS
Frequency – Measuring Equipment	0.1 Hz to 80 MHz	0.11 μHz/Hz	HP 33250A w/ 53132A, GPS
	10 MHz to 26.5 GHz	64 pHz/Hz	HP 83650B, GPS

-
- ¹ This laboratory offers commercial calibration and field calibration service.
- ² Calibration and Measurement Capability Uncertainty 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 of 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 CMC of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device, to the environment and to influences from the circumstances of the specific calibration.
- ³ Field calibration service is available for this calibration. Please note the uncertainties achievable on a customer's site can normally be expected to be larger than the Calibration and Measurement Capability Uncertainty (CMC) that the accredited laboratory has been assigned 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 uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the calibration uncertainty 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 diameter of the device in inches; R is the resolution of the unit under test.
- ⁵ In the statement of CMC, percentages are to be read as percent of reading unless otherwise noted.
- ⁶ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.
- ⁷ Vector error magnitude and phase error are for modulation types: MSK, GMSK, BPSK, DQPSK, $\Pi/4$ DQPSK, 8PSK, 16QAM, 32QAM, 64QAM, 128QAM, and 256QAM unless otherwise stated.
- ⁸ CMC uncertainties at frequencies other than 1 kHz are calculated using the 1689 Limits of Error Calculation Tool (www.ietlabs.com)
- ⁹ The CMC uncertainty claim is smaller than that of the expanded CMC uncertainty claim by NIST as listed in the BIPM KCDB. A2LA has evaluated the laboratory CMC uncertainty claim and has verified this information to be correct and appropriate.
- ¹⁰ This scope meets A2LA's *P112 Flexible Scope Policy*.
- ¹¹ 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

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TEKTRONIX, INC.

Irving, TX

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 15th day of June 2022.

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

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2357.18
Valid to April 30, 2024

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