



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, 2026

Certificate Number: 2357.18

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory at the location above as well as the satellite laboratory listed below to perform the following calibrations^{1, 10}:

I. Dimensional

Parameter/Equipment	Range	CMC ^{2,4} ($\pm$)	Comments
Micrometers & Depth Gages ³ – Length Flatness Parallelism	Up to 12 in (12 to 72) in Up to 1 in Up to 1 in	$(30 + 1.7L) \mu\text{in}$ $(28 + 1.8L) \mu\text{in}$ 4.3 μin 8.8 μin	Grade 2 gage blocks Optical flats Gage blocks
Height Gages ³	(0.05 to 4) in (4 to 12) in (12 to 48) in	$(82 + 0.25L) \mu\text{in}$ $(78 + 1.4L) \mu\text{in}$ $(62 + 2.7L) \mu\text{in}$	Grade 2 gage blocks & surface plates
Gage Blocks	(0.01 to 1) in (1 to 4) in (4 to 14) in	$(1.9 + 1.2L) \mu\text{in}$ $(2.5 + 1.8L) \mu\text{in}$ $(9.1 + 2.8L) \mu\text{in}$	Master blocks & Labmaster TM
Calipers ³	Up to 4 in (4 to 12) in (12 to 72) in	$(58 + 2.3L) \mu\text{in}$ $(60 + 1.6L) \mu\text{in}$ $(73 + 2L) \mu\text{in}$	Grade 2 gage blocks, master rings, surface plate

Parameter/Equipment	Range	CMC ^{2,4} ($\pm$)	Comments
Inside Diameter Measuring Instruments	(0.08 to 8) in	60 μ in	Comparison to ring gages
Indicators ³	Up to 0.05 in (0.05 to 4) in	6.5 μ in (60 + 1.3L) μ in	Labmaster™ & Grade 2 gage blocks
Pin & Plug Gages	Up to 2 in	(6.7 + 1D) μ in	Grade 00 gage blocks & Labmaster™
Precision Rules & Glass Scales	Up to 4 in	120 μ in	Nikon MM11 microscope
Rulers & Tape Measures	Up to 100 ft	0.002 in/ft	Video measurement system
Ring Gages	(0.04 to 14) in	(11 + 4.2L) μ in	Labmaster™ & Master ring gages
Length Standards	Up to 14 in	(16 + 3.2L) μ in	Labmaster™ w/ gage blocks
	(14 to 40) in	(19 + 1.6L) μ in	Mahr 828 w/ gage blocks
Protractors & 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

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 6} ($\pm$)	Comments
DC Voltage ³ – Generate	0 V (0 to 219.999 99) mV (0.22 to 2.199 999 9) V (2.2 to 10.999 999) V (11 to 21.999 999) V (22 to 219.999 99) V (220 to 1100) V 1 V 1.018 V 10 V 100 mV to 1000 V ⁹ 100 mV ⁹ 100 V ⁹ 1000 V ⁹	58 pV 6.9 μ V/V + 0.40 μ V 3.2 μ V/V + 0.70 μ V 2.4 μ V/V + 2.5 μ V 2.4 μ V/V + 4.0 μ V 3.2 μ V/V + 40 μ V 4.7 μ V/V + 0.40 mV 1.4 μ V/V 1.2 μ V/V 1.2 μ V/V 1.5 μ V/V 1.5 μ V/V 1.4 μ V/V 1.5 μ V/V	Copper short 5720A 90-day spec Fluke 732B Fluke 732B w/ 752A, 34420A, & 5720A
DC Current ³ – Generate	0 A Up to 2 pA (2 to 20) pA (20 to 200) pA (0.2 to 2) nA (2 to 20) nA (20 to 200) nA (0.2 to 2) μ A (2 to 20) μ A (20 to 200) μ A (0.2 to 2) mA (2 to 20) mA	0.29 fA 5.3 mA/A + 12 fA 4.3 mA/A + 12 fA 2.9 mA/A + 35 fA 0.74 mA/A + 0.12 pA 0.74 mA/A + 1.2 pA 0.41 mA/A + 12 pA 0.29 mA/A + 0.12 nA 0.3 mA/A + 1.2 nA 0.29 mA/A + 12 nA 0.29 mA/A + 0.12 μ A 1.7 mA/A + 1.2 μ A	OPEN Keithley 263

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 1000) 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 Fluke 57XX's w/2555 & 9211
DC Voltage ³ – Measure	0 V (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 (1 to 60) kV (60 to 100) kV	58 pV 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 0.35 mV/V 0.017 %	Agilent 34420A w/ short Fluke 8508A 732B with 752A, 34420A, & 5720A 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	0 Ω	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 $\mu\Omega/\Omega$	
	1 m Ω	140 $\mu\Omega/\Omega$	Guildline 9211A L&N 0.01 Ω
	0.01 Ω	3.2 $\mu\Omega/\Omega$	
	0.1 Ω	1.9 $\mu\Omega/\Omega$	
	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} ($\pm$)	Comments
DC Resistance ³ – Generate, Fixed Values (cont)	10 k Ω 19 k Ω 100 k Ω 190 k Ω 1.0 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω 10 T Ω	1.9 $\mu\Omega/\Omega$ 1.8 $\mu\Omega/\Omega$ 3.1 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 3.2 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 3.3 $\mu\Omega/\Omega$ 5.9 $\mu\Omega/\Omega$ 78 $\mu\Omega/\Omega$ 45 $\mu\Omega/\Omega$ 1.1 m Ω/Ω 1.1 m Ω/Ω 1.3 m Ω/Ω 2.9 m Ω/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) k Ω (2 to 20) k Ω (20 to 200) k Ω (0.2 to 2) M Ω (2 to 20) M Ω (20 to 200) M Ω (0.2 to 2) G Ω (2 to 20) G Ω (0.1 to 1) m Ω (1 to 10) m Ω (1 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	4.1 $\mu\Omega/\Omega$ 8.7 $\mu\Omega/\Omega$ 1.0 $\mu\Omega/\Omega$ 1.1 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 1.4 $\mu\Omega/\Omega$ 3.6 $\mu\Omega/\Omega$ 4.1 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 70 $\mu\Omega/\Omega$ 1100 $\mu\Omega/\Omega$ 91 $\mu\Omega/\Omega$ 9.9 $\mu\Omega/\Omega$ 5.5 $\mu\Omega/\Omega$ 5.1 $\mu\Omega/\Omega$ 5.4 $\mu\Omega/\Omega$ 5.4 $\mu\Omega/\Omega$ 6 $\mu\Omega/\Omega$ 6 $\mu\Omega/\Omega$ 6.1 $\mu\Omega/\Omega$	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	0.14 % + 0.31 kΩ 0.14 % + 3.0 kΩ 0.17 % + 37 kΩ 0.25 % + 0.55 MΩ 0.26 % + 5.8 MΩ 0.40 % + 0.11 GΩ 0.58 % + 3.0 GΩ 1.1 % + 63 GΩ	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	Fluke 5720A w/ 5790A 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	Fluke 5720A w/ 5790A 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 %	Fluke 5720A w/ 5790A 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 & Generate			
2 mV	10 Hz 20 Hz 40 Hz 1 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	350 µV/V 330 µV/V 340 µV/V 360 µV/V 350 µV/V 320 µV/V 430 µV/V 530 µV/V 620 µV/V 1200 µV/V	Fluke 792A & Fluke 8508
10 mV	1 kHz 20 kHz	76 µV/V 73 µV/V	
20 mV	10 Hz 20 Hz 40 Hz 1 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	120 µV/V 78 µV/V 61 µV/V 64 µV/V 62 µV/V 81 µV/V 140 µV/V 220 µV/V 320 µV/V 420 µV/V	
30 mV	10 Hz 45 Hz 1 kHz 10 kHz 20 kHz	120 µV/V 85 µV/V 70 µV/V 70 µV/V 71 µV/V	
33 mV	45 Hz 10 kHz	81 µV/V 69 µV/V	
100 mV	20 Hz 55 Hz 1 kHz 10 kHz 20 kHz	25 µV/V 13 µV/V 13 µV/V 13 µV/V 12 µV/V	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
AC Voltage – Measure & Generate (cont)			
200 mV	10 Hz 20 Hz 40 Hz 1 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	26 µV/V 20 µV/V 11 µV/V 10 µV/V 10 µV/V 20 µV/V 40 µV/V 75 µV/V 110 µV/V 180 µV/V	Fluke 792A & Fluke 8508
300 mV	10 Hz	35 µV/V	
500 mV	40 Hz 1 kHz 20 kHz 100 kHz 300 kHz 1 MHz	12 µV/V 12 µV/V 12 µV/V 48 µV/V 79 µV/V 790 µV/V	
1 V	20 Hz 40 Hz 1 kHz 20 kHz 100 kHz 300 kHz 1 MHz	17 µV/V 6.2 µV/V 5.7 µV/V 13 µV/V 14 µV/V 21 µV/V 48 µV/V	
2 V	10 Hz 20 Hz 40 Hz 1 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	26 µV/V 25 µV/V 6.9 µV/V 5.8 µV/V 11 µV/V 13 µV/V 14 µV/V 22 µV/V 30 µV/V 45 µV/V	
3 V	10 Hz	36 µV/V	
10 V	10 Hz 20 Hz 40 Hz 1 kHz	28 µV/V 16 µV/V 5.3 µV/V 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 & 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} (±)	Comments
AC Current ³ – Measure & Generate			
Up to 33 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz	350 µA/A 280 µA/A 260 µA/A 880 µA/A	Fluke 5720A w/ metal film resistors
(33 to 330) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz	220 µA/A 110 µA/A 87 µA/A 300 µA/A	
(0.33 to 5) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz	270 µA/A 90 µA/A 59 µA/A 210 µA/A	
(5 to 50) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 µA/A 96 µA/A 65 µA/A 100 µA/A	Fluke 5720A w/ 5790A & AC shunts
(50 to 260) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 µA/A 97 µA/A 67 µA/A 110 µA/A	
(125 to 650) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 µA/A 96 µA/A 67 µA/A 110 µA/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 µA/A 99 µA/A 78 µA/A 140 µA/A	
(1.25 to 6) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	220 µA/A 110 µA/A 97 µA/A 190 µA/A	Fluke 5720A w/ 5725A monitored by 5790A with AC shunts
(2.5 to 13) A	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	230 µA/A 120 µA/A 110 µA/A 170 µA/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	AC Current Source monitored with AC shunts & a Fluke 5790A
(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} ($\pm$)	Comments
AC Resistance ³ – Measure (0.01 to 100) k Ω (0.1 to 10) M Ω 0.1 Ω 1.0 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 0.1 Ω 1.0 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω	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
AC Level Flatness ³			
0.5 V Thermal Converter	(10 to <100) Hz	0.12 %	Agilent 3458A w/ thermal converters Reference to 1 kHz
	(0.1 to <1) kHz	0.12 %	
	(1 to <10) kHz	0.12 %	
	(10 to <30) kHz	0.12 %	
	(30 to <100) kHz	0.23 %	
	(100 to <300) kHz	0.29 %	
	(0.3 to <1) MHz	0.29 %	
	(1 to <3) MHz	0.58 %	
	(3 to <8) MHz	0.70 %	
	(8 to <10) MHz	0.71 %	
	(10 to <20) MHz	0.71 %	
	(20 to <30) MHz	0.76 %	
	(30 to <50) MHz	1.8 %	
	(50 to <70) MHz	2.8 %	
	(70 to <80) MHz	3.6 %	
	(80 to <100) MHz	3.9 %	
	100 MHz	4.8 %	
1 V Thermal Converter	(10 to <100) Hz	0.12 %	
	(0.1 to <1) kHz	0.12 %	
	(1 to <10) kHz	0.12 %	
	(10 to <30) kHz	0.12 %	
	(30 to <100) kHz	0.23 %	
	(100 to <300) kHz	0.29 %	
	(0.3 to <1) MHz	0.29 %	
	(1 to <3) MHz	0.58 %	
	(3 to <8) MHz	0.70 %	
	(8 to <10) MHz	0.71 %	
	(10 to <20) MHz	0.71 %	
	(20 to <30) MHz	0.76 %	
	(30 to <50) MHz	1.8 %	
	(50 to <70) MHz	2.8 %	
	(70 to <80) MHz	3.6 %	
	(80 to <100) MHz	3.9 %	
	100 MHz	4.8 %	
3 V Thermal Converter	(10 to <100) Hz	0.12 %	
	(0.1 to <1) kHz	0.12 %	
	(1 to <10) kHz	0.12 %	
	(10 to <30) kHz	0.12 %	
	(30 to <100) kHz	0.23 %	
	(100 to <300) kHz	0.29 %	
	(0.3 to <1) MHz	0.29 %	
	(1 to <3) MHz	0.58 %	
	(3 to <8) MHz	0.70 %	
	(8 to <10) MHz	0.71 %	
	(10 to <20) MHz	0.71 %	
	(20 to <30) MHz	0.76 %	
	(30 to <50) MHz	1.8 %	
	(50 to <70) MHz	2.8 %	
	(70 to <80) MHz	3.6 %	
	(80 to <100) MHz	3.9 %	
	100 MHz	4.8 %	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
Inductance ³ – Generate			
3 µH 10 µH 100 µH ⁹	100 Hz to 1 kHz	81 nH 0.12 µH 0.55 µH	Western Elec D-179XXX
200 µH ⁹ 300 µH 500 µH 1 mH 2 mH 5 mH 10 mH 20 mH 100 mH 1 H 5 H 10 H		48 nH 0.99 µH 0.12 µH 0.28 µH 0.48 µH 1.2 µH 4.5 µH 4.8 µH 25 µH 0.41 mH 1.5 mH 2.4 mH	GenRad 1482X Western Elec D-179XXX
1 mH to 10 H		0.021 %	GenRad 1491-D monitored w/ IET 1689 (CMC valid at 1 kHz only)
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 10 µH 100 µH ⁹ 200 µH 300 µH 500 µH 1 mH	(0.1 to 1) MHz	0.10 % 0.05 % 0.05 % 0.06 % 0.07 % 0.06 % 0.07 %	Agilent E4980A
3 µH 10 µH 100 µH 200 µH	(1 to 2) MHz	0.10 % 0.10 % 0.10 % 0.17 %	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
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		0.02 %	
(25 to 100) µF		0.03 %	
(0.1 to 1) mF		0.21 %	
1 pF	(0.1 to 1) MHz	0.19 %	Agilent E4980A
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	
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	

Parameter/Range	Frequency	CMC ^{2, 5, 6} ($\pm$)	Comments
Capacitance ³ – Generate (cont)			Agilent 1638XX capacitors
1 nF	100 Hz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.35 pF 0.38 pF 0.45 pF 0.56 pF 0.71 pF 1.9 pF 2.8 pF	
10 nF	(100 to 120) Hz 120 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.62 pF 0.71 pF 0.71 pF 0.44 pF	
100 nF	(100 to 120) Hz 120 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	7.1 pF 7.1 pF 7.1 pF 9.1 pF	
1 μ F	(100 to 120) Hz 120 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	76 pF 70 pF 70 pF 0.58 nF	
(1 to 10) μ F	50 Hz to 1 kHz	0.081 %	GenRad 1424-A
1 pF to 1 μ F	1 kHz	140 μ F/F	GenRad 1413
(1 to 1.4) μ F	1 kHz	800 μ F/F	Arco SS-32
(10 to 200) μ F	1 kHz	5 %	HARS-10-2-10UF-450V
(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) μ F	(10 to 600) Hz	2.3 nF/ μ F + 0.78 nF	
(1.1 to 3.29) μ F	(10 to 300) Hz	2.3 nF/ μ F + 2.3 nF	
(3.29 to 10.09) μ F	(10 to 150) Hz	2.3 nF/ μ F + 7.8 nF	
(11 to 32.9) μ F	(10 to 120) Hz	3.4 nF/ μ F + 23 nF	
(33 to 109.9) μ F	(10 to 80) Hz	3.7 nF/ μ F + 78 nF	
(110 to 329.9) μ F	(10 to 50) Hz	3.5 nF/ μ F + 0.23 μ F	
(0.33 to 1.09) mF	(10 to 20) Hz	3.5 μ F/mF + 0.78 μ F	
(1.1 to 3.29) mF	DC to 6 Hz	3.5 μ F/mF + 2.3 μ F	
(3.3 to 10.9) mF	DC to 2 Hz	3.5 μ F/mF + 7.8 μ F	
(11 to 32.9) mF	DC to 0.6 Hz	5.8 μ F/mF + 23 μ F	
(33 to 110) mF	DC to 0.2 Hz	8.5 μ F/mF + 78 μ F	

Parameter/Range	Frequency	CMC ^{2, 6} ($\pm$)	Comments
Dissipation Factor – Generate			
1 pF	Up to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.000 022 δ 0.000 031 δ 0.000 061 δ 0.000 14 δ 0.000 17 δ 0.000 22 δ 0.000 58 δ 0.000 84 δ	Keysight 16380A
10 pF	Up to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.000 021 δ 0.000 021 δ 0.000 021 δ 0.000 079 δ 0.000 079 δ 0.000 081 δ 0.000 099 δ 0.000 11 δ	
100 pF	Up to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.000 11 δ 0.000 11 δ 0.000 11 δ 0.000 079 δ 0.000 087 δ 0.000 092 δ 0.000 17 δ 0.000 25 δ	
1000 pF	Up to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.000 13 δ 0.000 13 δ 0.000 14 δ 0.000 12 δ 0.000 16 δ 0.000 22 δ 0.000 58 δ 0.000 85 δ	
0.01 μ F	Up to 120 Hz (0.12 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.000 035 δ 0.000 035 δ 0.000 035 δ 0.000 035 δ	Keysight 16380C
0.1 μ F	Up to 120 Hz (0.12 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.000 041 δ 0.000 035 δ 0.000 035 δ 0.000 041 δ	
1 μ F	Up to 120 Hz (0.12 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.000 049 δ 0.000 035 δ 0.000 041 δ 0.000 049 δ	

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} ($\pm$)	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	50 kHz to 100 MHz	2.9 %	Note: uncertainty of flatness is relative to 50 kHz
	(100 to 300) MHz	3.1 %	
	(300 to 600) MHz	4.1 %	
	(600 to 1100) MHz	4.7 %	
	>1 kHz to 100 MHz	0.61 %	Fluke 96270A Note: uncertainty of flatness is relative to 100 kHz. VSWR = 1.0
	(>0.1 to 2.4) GHz	0.82 %	
	(>2.4 to 8) GHz	1.3 %	
	(>8 to 12.4) GHz	1.3 %	
	(>12.4 to 18) GHz	1.7 %	
	(>18 to 26.5) GHz	2.1 %	
	(26.5 to 50) GHz	7.2 %	Power Meter & Sensor with Signal Generator
Time Mark	1 ns to 20 ms	2.1 μ s/s	Fluke 5522A <i>t</i> is the time in seconds
Into 50 Ω	20 ms to 5 s	(19 + 39 <i>t</i>) μ s/s	
Frequency	1 kHz to 10 MHz	2.5 μ s/s	
Rise Time – Generate	Positive Side – Nominal 16 ps	11 ps	Tektronix 067-1338-00
	Negative Side – Nominal 16 ps	12 ps	
Rise Time – Measure	6 ps to 1 μ s	10 ps	Tektronix SD-32
Impedance – Measure	(40 to 60) Ω	0.79 m Ω / Ω	Fluke 5522A/SC1100
	(0.6 to 1.5) M Ω	0.79 m Ω / Ω	
	(5 to 50) pF	0.42 mF/F + 0.21 μ F	

Parameter/Equipment	Range	CMC ^{2, 6} ($\pm$)	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
Power Supplies – Measure ³			
Ripple / Noise RMS – CV Ripple/Noise RMS – CC	Up to 1000 V Up to 300 A	59 μ V/V 59 μ A/A	Tektronix MDO3014 with programmable DC load
Transient Response Time Voltage	Up to 5 ms Up to 1 V	12 ms/s 8.3 mV/V	

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 6} ($\pm$)	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} (±)	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
RF Power ³ – Generate (-100 to 24) dBm (-100 to 20) dBm (-100 to 18) dBm	 Up to 100 MHz (0.1 to 1.4) GHz (1.4 to 2.4) GHz (2.4 to 8) GHz (8 to 12) GHz (12 to 18) GHz (18 to 20) GHz (20 to 22) GHz (22 to 26.5) GHz	 0.43 % 0.57 % 0.70 % 0.88 % 1.0 % 1.2 % 1.6 % 1.6 % 2.5 %	 Fluke 96270A – microwave output
RF Power ³ – Measure (-30 to +30) dBm (-70 to -30) dBm (+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm (+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm (+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm (+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm (-30 to -20) dBm (-70 to -30) dBm (+20 to +30) dBm (-30 to 20) dBm	 (3 Hz to 100 kHz) 100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz 10 MHz to 18 GHz 100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz 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	 0.021 dB 0.072 dB 0.14 dB 0.051 dB 0.061 dB 0.14 dB 0.05 dB 0.061 dB 0.16 dB 0.1 dB 0.1 dB 0.17 dB 0.12 dB 0.12 dB 0.07 dB 0.05 dB 0.15 dB 0.17 dB 0.19 dB 0.22 dB 0.060 dB 0.064 dB 0.082 dB 0.10 dB 0.12 dB 0.16 dB	 Fluke 8508A-01 Agilent E441XB power meter w/ 8482A 8481A 8485A 8487A 8481D 8482A w/ attenuator 8481A w/ attenuator 8485A w/ attenuator 8487A w/ attenuator NRP-Z55, VSWR = 1.15

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
RF Power ³ – Measure (cont)			
(-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 to -60) dBm (-140 to -100) dBm	100 kHz to 50 GHz 100 kHz to 50 GHz 100 kHz to 50 GHz	0.64 dB 0.82 dB 0.84 dB	FSMR
1 mW reference	50 MHz	0.26 %	HP 478A-H76 w/ 432A & 3458A
RF Power – Generate & Measure			Signal generator monitored by an NRP- Z56 power sensor
(-35 to 20) dBm	DC 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 (26.5 to 40) GHz (40 to 50) GHz	0.027 dBm 0.042 dBm 0.064 dBm 0.082 dBm 0.11 dBm 0.098 dBm 0.11 dBm 0.14 dBm	
RF Attenuation 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 95) dB (95 to 100) dB (100 to 105) dB (105 to 110) dB (110 to 115) dB (115 to 120) dB (120 to 125) dB	(0.100 to 10) MHz	0.018 dB 0.024 dB 0.029 dB 0.035 dB 0.041 dB 0.047 dB 0.052 dB 0.058 dB 0.064 dB 0.071 dB 0.075 dB 0.086 dB 0.094 dB 0.13 dB 0.21 dB 0.27 dB	FSMR & 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	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	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
RF Attenuation ³ – Measure (cont)			
(100 to 105) dB (105 to 110) dB (110 to 115) dB (115 to 120) dB (120 to 130) dB (130 to 135) dB	0 MHz to 22 GHz	0.082 dB 0.092 dB 0.094 dB 0.22 dB 0.47 dB 1.3 dB	FSMR & 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	0.22 dB 0.28 dB 0.35 dB 0.30 dB 0.31 dB 0.41 dB 0.35 dB 0.32 dB 0.51 dB 0.27 dB 0.34 dB 0.31 dB 0.30 dB 0.31 dB 0.45 dB 0.31 dB 2.9 dB 1.3 dB	
(0 to 5) dB (5 to 20) dB (20 to 25) dB (25 to 30) dB (30 to 35) dB (35 to 40) dB (40 to 45) dB (45 to 50) dB (50 to 55) dB (55 to 60) dB (60 to 65) dB (65 to 70) dB (70 to 75) dB (75 to 80) dB (80 to 85) dB (85 to 90) dB (90 to 95) dB (95 to 100) dB (100 to 105) dB (105 to 110) dB (110 to 115) dB (115 to 120) dB (120 to 125) dB	(26.5 to 40) GHz	0.26 dB 0.25 dB 0.39 dB 0.29 dB 0.22 dB 0.44 dB 0.31 dB 0.45 dB 0.61 dB 0.41 dB 0.51 dB 0.41 dB 0.29 dB 0.41 dB 0.42 dB 0.41 dB 0.42 dB 0.40 dB 0.38 dB 0.47 dB 0.55 dB 0.18 dB 0.26 dB	FSMR & NRP-Z56

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
RF Attenuation ³ – Measure (cont)			
(0 to 5) dB (5 to 10) dB (10 to 20) dB (20 to 25) dB (25 to 30) dB (30 to 35) dB (35 to 40) dB (40 to 45) dB (45 to 50) dB (50 to 55) dB (55 to 65) dB (65 to 70) dB (70 to 75) dB (75 to 80) dB (80 to 85) dB (85 to 90) dB (90 to 95) dB (95 to 100) dB (100 to 105) dB (105 to 110) dB (110 to 115) dB	(40 to 50) GHz	0.36 dB 0.31 dB 0.45 dB 0.50 dB 0.52 dB 0.51 dB 0.55 dB 0.43 dB 0.49 dB 0.30 dB 0.36 dB 0.44 dB 0.35 dB 0.42 dB 0.36 dB 0.41 dB 0.37 dB 0.38 dB 0.39 dB 0.37 dB 0.35 dB	FSMR & NRP-Z56
RF Attenuation ³ – Generate (Relative)			
(0 to 55) dB (55 to 64) dB (64 to 74) dB (74 to 100) dB (100 to 120) dB	100 kHz to 128 MHz	0.019 dB 0.026 dB 0.043 dB 0.061 dB 0.23 dB	Fluke 96270A
(0 to 10) dB (10 to 20) dB (20 to 30) dB (30 to 40) dB (40 to 50) dB (50 to 60) dB (60 to 70) dB (70 to 80) dB (80 to 90) dB (90 to 95) dB (95 to 100) dB (100 to 105) dB	(0.100 to 10) MHz	0.018 dB 0.024 dB 0.029 dB 0.035 dB 0.041 dB 0.047 dB 0.052 dB 0.058 dB 0.064 dB 0.071 dB 0.075 dB 0.086 dB	Fluke 96270 A w/ FSMR & NRP-Z37

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 0.47 dB 1.3 dB	Fluke 96270 A w/ FSMR & 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	0.22 dB 0.28 dB 0.35 dB 0.30 dB 0.31 dB 0.41 dB 0.35 dB 0.32 dB 0.51 dB 0.27 dB 0.34 dB 0.31 dB 0.30 dB 0.31 dB 0.45 dB 0.31 dB 2.9 dB 1.3 dB	Keysight E8257D w/ FSMR & 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 & 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		0.38 dB	
(105 to 110) dB		0.47 dB	
(110 to 115) dB		0.55 dB	
(115 to 120) dB		0.18 dB	
(120 to 125) dB		0.26 dB	
(0 to 5) dB	(40 to 50) GHz	0.36 dB	
(5 to 10) dB		0.31 dB	
(10 to 20) dB		0.45 dB	
(20 to 25) dB		0.50 dB	
(25 to 30) dB		0.52 dB	
(30 to 35) dB		0.51 dB	
(35 to 40) dB		0.55 dB	
(40 to 45) dB		0.43 dB	
(45 to 50) dB		0.49 dB	
(50 to 55) dB		0.30 dB	
(55 to 60) dB		0.36 dB	
(65 to 70) dB		0.44 dB	
(70 to 75) dB		0.35 dB	
(75 to 80) dB		0.42 dB	
(80 to 85) dB		0.36 dB	
(85 to 90) dB		0.41 dB	
(90 to 95) dB		0.37 dB	
(95 to 100) dB		0.38 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} ($\pm$)	Comments
Frequency Modulation ³ – Generate Pk Deviation <12.5 kHz Rate: <100 kHz Rate: $\leq$ 200 kHz Pk Deviation <100 kHz Rate: <100 kHz Rate: $\leq$ 200 kHz Pk Deviation <400 kHz Rate: <100 kHz Rate: $\leq$ 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: $\leq$ 6 rad Rate: $\leq$ 50 kHz Pk Deviation: $\leq$ 1 rad Rate: $\leq$ 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} ($\pm$)	Comments
Amplitude Modulation ³ – Generate (cont)			
Rate: 1 Hz to 220 kHz Depth: (0.1 to 99) %	50 kHz to 4 GHz	1.7 %	Fluke 96270A
Rate: 1 Hz to 220 kHz Depth: (0.1 to 99) %	50 kHz to 4 GHz	3.8 %	
Frequency Modulation ³ – Measure			
Pk Deviation $\leq$ 50 kHz Rate: (0.01 to 10) kHz	100 kHz to 10 MHz	1.2 %	RS FSMR
Pk Deviation $\leq$ 500 kHz Rate: (0.01 to 100) kHz Rate: (0.1 to 200) kHz	100 kHz to 50 GHz	1.2 % 3.5 %	
Amplitude Modulation ³ – Measure			
Rate: (0.01 to 10) kHz Depth: (5 to 99) %	100 kHz to 10 MHz	1.5 %	RS FSMR
Rate (0.01 to 50) kHz Depth: (5 to 99) %	10 MHz to 50 GHz	1 %	
Rate: (50 to 100) kHz Depth: (5 to 99) %	10 MHz to 50 GHz	1.5 %	
Rate: (90 to 150) Hz Depth: (5 to 99) %	10 MHz to 50 GHz	0.42 %	
Phase Modulation ³ – Measure			
Rate: 200 Hz to 10 kHz	f_c (0.15 to 10) MHz	1 %	RS FSMR
Rate: 200 Hz to 20 kHz	f_c (0.01 to 26.5) GHz	1 %	

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Phase Noise ³ – Measure			
(1 to 10) MHz (-50 to -140) dBc/Hz	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 20 kHz Offset 100 kHz Offset 1 MHz Offset	2.7 dB 2.5 dB 1.6 dB 1.6 dB 1.6 dB 1.6 dB 1.6 dB 4.0 dB	RS FSWP
(10 to 100) MHz (-50 to -140) dBc/Hz	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 20 kHz Offset 100 kHz Offset 1 MHz Offset	3.7 dB 2.8 dB 1.6 dB 1.5 dB 1.6 dB 1.6 dB 1.6 dB 2.7 dB	
(0.1 to 1) GHz (-50 to -140) dBc/Hz	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 20 kHz Offset 100 kHz Offset 1 MHz Offset	3.2 dB 2.4 dB 1.7 dB 1.7 dB 1.6 dB 1.6 dB 1.7 dB 3.9 dB	
(1 to 3) GHz (-50 to -140) dBc/Hz	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 20 kHz Offset 100 kHz Offset 1 MHz Offset	4.2 dB 2.0 dB 1.6 dB 1.6 dB 1.6 dB 1.6 dB 1.6 dB 3.8 dB	
(3 to 7) GHz (-50 to -140) dBc/Hz	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 20 kHz Offset 100 kHz Offset 1 MHz Offset	4.4 dB 2.6 dB 1.7 dB 1.6 dB 1.6 dB 1.6 dB 1.6 dB 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, 12} ($\pm$)	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			
(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, 5, 6, 12} ($\pm$)	Comments
Transmission Magnitude – Into 50 Ω (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	
(0 to -3) dB (-3 to -6) dB (-6 to -10) dB (-10 to -20) dB (-20 to -30) dB	45 MHz to 50 GHz 45 MHz to 50 GHz 45 MHz to 50 GHz 45 MHz to 50 GHz 45 MHz to 50 GHz	0.12 dB 0.12 dB 0.12 dB 0.12 dB 0.12 dB	
(-30 to -40) dB	(45 to 200) MHz (0.2 to 34) GHz (34 to 36) GHz (36 to 40) GHz (40 to 50) GHz	0.14 dB 0.12 dB (0.12 to 0.13) dB 0.12 dB (0.12 to 0.14) dB	
(-40 to -50) dB	(45 to 200) MHz (0.2 to 1) GHz (1 to 19) GHz (19 to 20) GHz (20 to 33) GHz (33 to 34) GHz (34 to 40) GHz (40 to 41) GHz (41 to 44) GHz (44 to 50) GHz	(0.28 to 0.15) dB (0.15 to 0.12) dB 0.12 dB (0.12 to 0.13) dB 0.13 dB (0.13 to 0.14) dB 0.14 dB (0.14 to 0.22) dB 0.22 dB (0.22 to 0.23) dB	
(-50 to -60) dB	(45 to 200) MHz (0.2 to 1) GHz (1 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 41) GHz (41 to 50) GHz	(0.80 to 0.29) dB (0.29 to 0.14) dB (0.14 to 0.16) dB (0.16 to 0.21) dB (0.21 to 0.22) dB (0.22 to 0.59) dB (0.58 to 0.63) dB	

Parameter/Range	Frequency	CMC ^{2, 5, 6, 12} ($\pm$)	Comments
Transmission Phase (0 to -3) dB (-3 to -6) dB (-6 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB	45 MHz to 50 GHz	(0.73 to 11.3) ° (0.73 to 11.3) ° (0.73 to 11.3) ° (0.73 to 11.3) ° (0.73 to 11.3) ° (0.75 to 11.3) ° (0.90 to 11.4) ° (1.8 to 12) °	R&S ZNA ¹²
Reflection Coefficient – Into 50 Ω $0 < \Gamma \leq 1$ $0 < \Gamma \leq 0.5$ $0.5 \leq \Gamma \leq 0.75$ $0.75 \leq \Gamma \leq 1$ $0 < \Gamma \leq 1$	30 kHz to 6 GHz 50 MHz to 20 GHz (20 to 26.5) GHz 50 MHz to 20 GHz (20 to 26.5) GHz 50 MHz to 20 GHz (20 to 26.5) GHz 45 MHz to 50 GHz	0.004 ρ 0.016 ρ 0.021 ρ 0.013 ρ 0.021 ρ 0.017 ρ 0.030 ρ (0.004 to 0.015) ρ	HP 8753D w/85032F HP 8722ES w/ 85032F, 85052D R&S ZNA ¹²
Reflection Phase $0 < \Gamma \leq 0.1$ $0.1 \leq \Gamma \leq 1$	45 MHz to 50 GHz	(2.1 to 5.4) ° (0.45 to 3) °	R&S ZNA ¹²
Spectrum Analyzers – Average Noise & Residuals (DANL) ³ (-30 to -170) dBm	20 Hz to 50 GHz	0.78 dBm	50 Ω Load
Reference Level – Generate ³ Log Scale (0 to -100) dB Linear Scale (0 to -100) dB	50 MHz 50 MHz	0.13 dB 0.16 dB	Fluke 96270A Keysight E8257D
BW Switching – Generate ³ (-20 to 20) dB	20 Hz to 50 MHz 50 MHz to 50 GHz	0.18 dB 2.0 dB	Fluke 96270A Keysight E8257D
BW Accuracy – Generate ³	20 Hz to 50 MHz 50 MHz to 50 GHz	7.4 nHz/Hz 0.58 nHz/Hz	Keysight E8257D

Parameter/Range	Frequency	CMC ^{2, 6, 12} (±)	Comments
2 nd Harmonic Distortion ³ (0 to -120) dB	200 Hz to 50 MHz	2.8 dB	Fluke 96270A
	50 MHz to 50 GHz	3.8 dB	Keysight E8257D
3 rd Order Intermodulation ³ (0 to -120) dB	200 Hz to 50 MHz	2.1 dB	Fluke 96270A
	50 MHz to 50 GHz	3.0 dB	Keysight E8257D
Noise/System Sidebands ³ (0 to -120) dB	200 Hz to 50 MHz	0.56 dB	Fluke 96270A
	50 MHz to 50 GHz	0.87 dB	Keysight E8257D
Frequency Response ³ (20 to -30) dB	9 kHz to 18 GHz	0.69 dB	Agilent E9304
	50 MHz to 50 GHz	0.38 dB	Agilent N8487A
Gain Compression ³ (20 to -20) dB	200 Hz to 50 MHz	0.24 dB	Fluke 96270A
	50 MHz to 50 GHz	0.11 dB	Keysight E8257D

Parameter/Equipment	Range	CMC ^{2, 6, 12} (±)	Comments
Attenuator Check ³	(0 to 100) dB	0.11 dB	Fluke 96270A
Log Fidelity ³	20 to -100 dB	0.87 dB	Fluke 96270A
Linear Fidelity ³	(20 to -100) dB	0.12 dB	Fluke 96270A

Parameter/Range	Frequency	CMC ^{2, 5, 6, 12} ($\pm$)	Comments
Distortion – Measure ³	Fundamental Frequency		
(-80 to 0) dB	20 Hz to 20 kHz	1.2 dB	HP 8903B
(-70 to 0) dB	(20 to 50) kHz	2.3 dB	
(-65 to 0) dB	(50 to 100) kHz	2.3 dB	
Amplitude Modulation Distortion	Carrier Frequency:		R&S FSMR
Depth of Modulation: 5 % to 99 %	100 kHz to 10 MHz	0.36 %	
	≥ 10 MHz to 4 GHz	0.44 %	
Frequency Modulation Distortion			
Deviation <10 kHz	200 kHz to 10 MHz	0.19 %	
Deviation <50 kHz		0.38 %	
Deviation <100 kHz	≥ 10 MHz to 4 GHz	0.20 %	
Deviation <500 kHz		0.38 %	
Phase Modulation Distortion	200 kHz to 10 MHz	0.18 %	
	≥ 10 MHz to 4 GHz	0.18 %	
Distortion – Audio Input (-100 to 0) dB	100 Hz to 100 kHz	0.60 dB	

IV. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5, 11} ($\pm$)	Comments
Pressure ³ – Measure & Measuring Equipment			
Pneumatic	Up to 3 in·H ₂ O (3 to 30) in·H ₂ O	0.016 % + 0.000 16 in·H ₂ O 0.013 %	Ruska 7250LP 10/30
Pneumatic Absolute	(0 to 15) psia (15 to 30) psia Up to 75 psia (75 to 150) psia Up to 300 psia (300 to 600) psia Up to 1500 psia (1500 to 3000) psia Up to 10 000 psia	0.0036 psi 0.012 % 0.018 psi 0.013 % 0.039 psi 0.013 % 0.39 psi 0.013 % 0.013 % + 0.43 psi	Mensor CPR6050 Fluke RPM4 A70Ms
Pneumatic Gage	(-14.5 to 0) psig (0 to 15) psig Up to 75 psig (75 to 150) psig Up to 300 psig (300 to 600) psig Up to 1500 psig (1500 to 3000) psig Up to 10 000 psig	0.0036 psi 0.012 % + 0.0014 psi 0.018 psi 0.013 % 0.039 psi 0.013 % 0.39 psi 0.013 % 0.013 % + 0.43 psi	Mensor CPR6050 Fluke RPM4 A70Ms
Hydraulic Gage	(1 to 30 000) psig	0.010 %	DHI PG7202
Torque ³ – Measuring Equipment	(1 to 10) ozf·in (5 to 50) ozf·in (8 to 80) ozf·in 5 lbf·in to 1000 lbf·ft	0.30 % 0.58 % 0.30 % 0.30 %	Mountz MTX10z CDI 2000-04-02 Mountz BMX80z CDI 2000-400-02, CDI 2000-12-02 & CDI 2000-13-02
Scales & 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 & Balances ³ (cont)	(0.25 to 0.5) lb (113.398 g to 226.796 g) (0.5 to 1) lb (226.796 g to 453.592 g) (1 to 2) lb (453.592 g to 907.185 g) (2 to 5) (907.185 g to 2267.96 g) (5 to 10) lb (2267.96 g to 4.53592 kg) (10 to 20) lb (4.53592 kg to 9.07185 kg) (20 to 50) lb (9.07185 kg to 22.6796 kg) (50 to 100) lb (22.6796 kg to 45.3592 kg) (100 to 250) lb (45.3592 kg to 113.398 kg) (250 to 500) lb (113.398 kg to 226.796 kg) (500 to 1000) lb (226.796 kg to 453.592 kg)	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 & comparators
Force Gages & Load Cells ³	Up 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 ASTM E74 calibrated 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 & temperature sources
Temperature ³ – Measure	(-200 to 660) °C	0.016 °C	Fluke 5626 PRT w/ Chubb E4 & temperature sources
Relative Humidity – Measuring Equipment	(10 to 35) % RH (35 to 50) % RH (50 to 70) % RH (70 to 95) % RH	0.52 % RH 0.53 % RH 0.54 % RH 0.55 % 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 Timometer

Parameter/Equipment	Range	CMC ^{2, 4, 5, 11} ($\pm$)	Comments
Frequency – Generate ³	10 MHz DC to 1 kHz 1 kHz to 20 MHz 10 MHz to 26.5 GHz 10 MHz to 50 GHz	5.8 mHz + 0.6 <i>R</i> 0.17 nHz/Hz 0.18 nHz/Hz 64 pHz/Hz 0.58 nHz/Hz	HP 3325B w/ GPS Tektronix AFG2021 w/ GPS Fluke 96270 w/ GPS Keysight E8257D w/ GPS
Frequency – Measure	DC to 1 kHz (1 to 1000) kHz (1 to 225) MHz 225 MHz to 3 GHz (3 to 50) GHz	54 μ Hz/Hz 0.34 nHz/Hz 0.21 nHz/Hz 0.21 nHz/Hz 58 pHz/Hz	5313X w/ GPS 5313X Opt 003 w/ GPS FSMR w/ GPS
Tachometers – Non-contact	(10 to 100 000) rpm	0.0023 rpm	LED w/ 3325B & GPS

SATELLITE FACILITY

TEKTRONIX INC.
12500 TI Blvd
Dallas, TX 75243
Steven Housley-Follis Phone: 972 871 4718

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 6} ($\pm$)	Comments
DC Voltage ³ – Generate	0 V (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	58 pV 7.9 μ V/V + 0.39 μ V 4.8 μ V/V + 0.62 μ V 3.2 μ V/V + 2.3 μ V 3.2 μ V/V + 3.9 μ V 4.8 μ V/V + 39 μ V 6.4 μ V/V + 0.39 mV	Copper short Fluke 5730A (90 Day Spec)
DC Voltage ³ – Measure	Up to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	7.1 μ V/V + 0.23 μ V 3.6 μ V/V + 0.23 μ V 3.6 μ V/V + 0.39 μ V 4.8 μ V/V + 23 μ V 4.9 μ V/V + 78 μ V	3458A Opt 002
DC Current ³ – Generate	Up to 220 μ A (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 (11 to 20.5) A (20.5 to 100) A	40 μ A/A + 5.4 nA 32 μ A/A + 6.2 nA 32 μ A/A + 39 nA 40 μ A/A + 0.62 μ A 72 μ A/A + 12 μ A 0.28 mA/A + 0.37 mA 0.81 mA/A + 0.58 mA 0.36 %	Fluke 5730A w/ Fluke 5725A Fluke 5522A Fluke 5730A w/ Valhalla 2555A
Clamp-On Only	(16.5 to 150) A (150 to 1025) A	4.4 mA/A + 0.11 mA 4.6 mA/A + 0.39 mA	Fluke 5522A w/ 5500A Coil
DC Current ³ – Measure	0 A Up to 100 nA (0.1 to 1) μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	2.2 pA 0.20 mA/A + 31 pA 38 μ A/A + 31 pA 18 μ A/A + 78 pA 17 μ A/A + 0.62 nA 18 μ A/A + 3.9 nA 19 μ A/A + 39 nA 30 μ A/A + 390 nA 87 μ A/A + 7.8 μ A	Open Keysight 3458A

Parameter/Equipment	Range	CMC ^{2, 6} ($\pm$)	Comments
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 (100 to 1200) M Ω	15 $\mu\Omega/\Omega$ + 39 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.39 m Ω 11 $\mu\Omega/\Omega$ + 0.39 $\mu\Omega$ 9.1 $\mu\Omega/\Omega$ + 3.9 m Ω 11 $\mu\Omega/\Omega$ + 39 m Ω 17 $\mu\Omega/\Omega$ + 1.6 Ω 42 $\mu\Omega/\Omega$ + 78 Ω 0.4 m Ω/Ω + 0.78 k Ω 4.6 m Ω/Ω + 7.8 k Ω	Keysight 3458A
DC Power ³ – Generate 33 mV to 1020 V	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 Fluke 57XX's w/2555 & 9211
Electrical Calibration of Thermocouple Indicators ³			Fluke 5522A
Type B	(600 to 800) $^{\circ}\text{C}$ (800 to 1000) $^{\circ}\text{C}$ (1000 to 1550) $^{\circ}\text{C}$ (1550 to 1820) $^{\circ}\text{C}$	0.34 $^{\circ}\text{C}$ 0.27 $^{\circ}\text{C}$ 0.24 $^{\circ}\text{C}$ 0.26 $^{\circ}\text{C}$	
Type C	(0 to 150) $^{\circ}\text{C}$ (150 to 650) $^{\circ}\text{C}$ (650 to 1000) $^{\circ}\text{C}$ (1000 to 1800) $^{\circ}\text{C}$ (1800 to 2316) $^{\circ}\text{C}$	0.24 $^{\circ}\text{C}$ 0.21 $^{\circ}\text{C}$ 0.25 $^{\circ}\text{C}$ 0.39 $^{\circ}\text{C}$ 0.65 $^{\circ}\text{C}$	
Type E	(-250 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 350) $^{\circ}\text{C}$ (350 to 650) $^{\circ}\text{C}$ (650 to 1000) $^{\circ}\text{C}$	0.39 $^{\circ}\text{C}$ 0.13 $^{\circ}\text{C}$ 0.11 $^{\circ}\text{C}$ 0.13 $^{\circ}\text{C}$ 0.17 $^{\circ}\text{C}$	
Type J	(-210 to -100) $^{\circ}\text{C}$ (-100 to -30) $^{\circ}\text{C}$ (-30 to 150) $^{\circ}\text{C}$ (150 to 760) $^{\circ}\text{C}$ (760 to 1200) $^{\circ}\text{C}$	0.25 $^{\circ}\text{C}$ 0.13 $^{\circ}\text{C}$ 0.12 $^{\circ}\text{C}$ 0.14 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$	
Type K	(-200 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 120) $^{\circ}\text{C}$ (120 to 1000) $^{\circ}\text{C}$ (1000 to 1372) $^{\circ}\text{C}$	0.26 $^{\circ}\text{C}$ 0.14 $^{\circ}\text{C}$ 0.13 $^{\circ}\text{C}$ 0.20 $^{\circ}\text{C}$ 0.31 $^{\circ}\text{C}$	
Type L	(-200 to -100) $^{\circ}\text{C}$ (-100 to 800) $^{\circ}\text{C}$ (800 to 900) $^{\circ}\text{C}$	0.29 $^{\circ}\text{C}$ 0.20 $^{\circ}\text{C}$ 0.14 $^{\circ}\text{C}$	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ (cont)			Fluke 5522A
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.31 °C 0.17 °C 0.15 °C 0.14 °C 0.21 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.45 °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	
Electrical Simulation of RTDs ³			Fluke 5522A
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.085 °C 0.12 °C 0.12 °C 0.11 °C 0.097 °C 0.11 °C 0.20 °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	0.064 °C 0.076 °C 0.075 °C 0.089 °C 0.095 °C 0.17 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.21 °C 0.060 °C 0.068 °C 0.070 °C 0.077 °C 0.084 °C 0.090 °C 0.13 °C 0.19 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of RTDs ³ (cont)			Fluke 5522A
Pt 385, 200 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.041 °C 0.043 °C 0.044 °C 0.051 °C 0.098 °C 0.11 °C 0.11 °C 0.13 °C	
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.036 °C 0.043 °C 0.044 °C 0.051 °C 0.066 °C 0.066 °C 0.073 °C 0.088 °C	
Pt 385, 1000 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.029 °C 0.029 °C 0.036 °C 0.042 °C 0.050 °C 0.18 °C 0.057 °C 0.18 °C	
PtNi 385, 120 Ω (Ni120)	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.081 °C 0.11 °C 0.11 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.69 °C	
Power Supplies – Measure ³			
Ripple / Noise RMS – CV Ripple/Noise RMS – CC	Up to 1000 V Up to 300 A	59 μV/V 59 μA/A	Tektronix MDO3014 with programmable DC load
Transient Response Time Voltage	Up to 5 ms Up to 1 V	12 ms/s 8.3 mV/V	

Parameter/Range	Frequency	CMC ^{2,6} ($\pm$)	Comments
AC Voltage ³ – Generate			
(0.2 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.41 mV/V + 3.9 μ V 0.34 mV/V + 3.9 μ V 0.35 mV/V + 3.9 μ V 0.39 mV/V + 3.9 μ V 0.63 mV/V + 4.7 μ V 1.1 mV/V + 9.3 μ V 1.5 mV/V + 19 μ V 2.8 mV/V + 19 μ V	Fluke 5730A w/ 5725A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.24 mV/V + 3.9 μ V 0.11 mV/V + 3.9 μ V 0.10 mV/V + 3.9 μ V 0.20 mV/V + 3.9 μ V 0.47 mV/V + 4.7 μ V 1.0 mV/V + 9.3 μ V 1.3 mV/V + 19 μ V 2.7 mV/V + 19 μ 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	0.36 mV/V + 12 μ V 92 μ V/V + 6.2 μ V 58 μ V/V + 6.2 μ V 0.12 mV/V + 6.2 μ V 0.31 mV/V + 16 μ V 0.62 mV/V + 19 μ V 1.3 mV/V + 23 μ V 2.6 mV/V + 47 μ 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	0.49 mV/V + 39 μ V 87 μ V/V + 16 μ V 39 μ V/V + 7.8 μ V 63 μ V/V + 9.3 μ V 0.11 mV/V + 31 μ V 0.32 mV/V + 78 μ V 0.94 mV/V + 0.19 mV 1.6 mV/V + 0.31 mV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.37 mV/V + 0.39 mV 92 μ V/V + 0.16 mV 39 μ V/V + 54 μ V 63 μ V/V + 93 μ V 79 μ V/V + 0.19 mV 0.23 mV/V + 0.62 mV 0.93 mV/V + 1.9 mV 1.4 mV/V + 3.1 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.43 mV/V + 3.9 mV 88 μ V/V + 1.6 mV 53 μ V/V + 0.54 mV 79 μ V/V + 0.93 mV 0.14 mV/V + 2.3 mV 0.85 mV/V + 16 mV 4.2 mV/V + 39 mV 7.8 mV/V + 78 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.28 mV/V + 16 mV 69 μ V/V + 3.1 mV	

Parameter/Range	Frequency	CMC ^{2, 6} ($\pm$)	Comments
AC Voltage ³ – Generate (cont)			Fluke 5730A w/ 5725A
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	78 μ V/V + 3.1 mV 0.13 mV/V + 4.7 mV 0.47 mV/V + 8.5 mV	
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.47 mV/V + 8.5 mV 1.8 mV/V + 35 mV	
AC Voltage – Generate ³ Wideband Output Up to 1.1 mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.98 mV/V 2.2 mV/V + 2.3 μ V 3.7 mV/V + 2.3 μ V 5.5 mV/V + 2.3 μ V 13 mV/V + 12 μ V	Fluke 5730A
(1.1 to 3) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.94 mV/V 1.3 mV/V + 2.3 μ V 2.2 mV/V + 2.3 μ V 4.9 mV/V + 2.3 μ V 13 mV/V + 2.3 μ V	
(3 to 11) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.94 mV/V 1.1 mV/V + 2.3 μ V 2.0 mV/V + 2.3 μ V 3.9 mV/V + 2.3 μ V 8.6 mV/V + 2.3 μ V	
(11 to 33) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.91 mV/V 1.0 mV/V + 2.3 μ V 2.0 mV/V + 2.3 μ V 3.8 mV/V + 2.3 μ V 8.5 mV/V + 2.3 μ V	
(33 to 110) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.87 mV/V 1.1 mV/V + 2.3 μ V 2.0 mV/V + 2.3 μ V 3.8 mV/V + 2.3 μ V 8.1 mV/V + 2.3 μ V	
(110 to 330) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.84 mV/V 1.1 mV/V + 2.3 μ V 2.0 mV/V + 2.3 μ V 3.8 mV/V + 2.3 μ V 8.5 mV/V + 2.3 μ V	

Parameter/Range	Frequency	CMC ^{2,6} ($\pm$)	Comments
AC Voltage – Generate ³ (cont)			Fluke 5730A
Wideband Output (0.33 to 1.1) V	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.84 mV/V 1.0 mV/V + 2.3 μ V 2.0 mV/V + 2.3 μ V 3.8 mV/V + 2.3 μ V 8.5 mV/V + 2.3 μ V	
(1.1 to 3.5) V	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.84 mV/V 1.0 mV/V + 2.3 μ V 2.0 mV/V + 2.3 μ V 3.8 mV/V + 2.3 μ V 8.5 mV/V + 2.3 μ V	
AC Voltage – Measure ³			Keysight 3458A
Up to 10 mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz	0.39 mV/V + 3 μ V 0.3 mV/V + 1.1 μ V 0.36 mV/V + 1.1 μ V 1.0 mV/V + 1.1 μ V 5 mV/V + 1.1 μ V 12 mV/V + 5 μ V 70 mV/V + 7 μ V 0.2 V/V + 8 μ 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 300 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz	0.15 mV/V + 4 μ V 93 μ V/V + 2 μ V 0.15 mV/V + 2 μ V 0.3 mV/V + 2 μ V 0.8 mV/V + 2 μ V 3 mV/V + 10 μ V 11 mV/V + 10 μ V 40 mV/V + 70 μ V 40 mV/V + 80 μ V 0.15 V/V + 100 μ V	
(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 300 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz	0.07 mV/V + 40 μ V 74 μ V/V + 20 μ V 0.14 mV/V + 20 μ V 0.3 mV/V + 20 μ V 0.8 mV/V + 20 μ V 3 mV/V + 100 μ V 10 mV/V + 100 μ V 40 mV/V + 0.7 mV 40 mV/V + 0.8 mV 0.15 V/V + 1 mV	

Parameter/Range	Frequency	CMC ^{2, 6} ($\pm$)	Comments
AC Voltage – Measure ³ (cont)			Keysight 3458A
(1 to 10) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz	0.09 mV/V + 0.4 mV 73 μ V/V + 0.2 mV 0.14 mV/V + 0.2 mV 0.3 mV/V + 0.2 mV 0.8 mV/V + 0.2 mV 3 mV/V + 1 mV 10 mV/V + 1 mV 40 mV/V + 7 mV 40 mV/V + 8 mV 0.15 V/V + 10 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 300 kHz to 1 MHz	0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.2 mV/V + 2 mV 0.35 mV/V + 2 mV 1.2 mV/V + 2 mV 4 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	0.41 mV/V + 40 mV 0.4 mV/V + 20 mV 0.6 mV/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	
AC Current – Generate ³			Fluke 5730A w/ 5725A
Up 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	0.24 mA/A + 16 nA 0.16 mA/A + 9.3 nA 0.1 mA/A + 7.8 nA 0.27 mA/A + 12 nA 1 mA/A + 62 nA	
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.24 mA/A + 39 nA 0.16 mA/A + 31 nA 0.1 mA/A + 31 nA 0.2 mA/A + 0.10 μ A 1 mA/A + 0.62 μ A	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.24 mA/A + 0.39 μ A 0.16 mA/A + 0.31 μ A 0.1 mA/A + 0.31 μ A 0.19 mA/A + 0.54 μ A 1 mA/A + 4.7 μ A	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.24 mA/A + 3.9 μ A 0.16 mA/A + 3.1 μ A 0.1 mA/A + 2.3 μ A 0.19 mA/A + 3.1 μ A 1 mA/A + 9.3 μ A	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.24 mA/A + 31 μ A 0.4 mA/A + 78 μ A 6.2 mA/A + 0.16 mA	

Parameter/Range	Frequency	CMC ^{2, 5, 6} ($\pm$)	Comments
AC Current – Generate ³ (cont)			
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.4 mA/A + 0.13 mA 0.76 mA/A + 0.29 mA 2.8 mA/A + 0.58 mA	Fluke 5730A w/ 5725A
(11 to 20.5) A	45 to 100 Hz 100 Hz to 1 kHz 1 to 5 kHz	0.95 mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	Fluke 5522A/SC1100
Clamp-on Only (10 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.31 % 0.81 %	Fluke 5522A w/ 5500A coil
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.33 % 0.82 %	
AC Current – Measure ³			
Up to 100 μ A	(10 to 20) Hz (20 Hz to 45) Hz 45 Hz to 5 kHz	3.1 mA/A + 23 nA 1.2 mA/A + 23 nA 0.47 mA/A + 23 nA	Keysight 3458A
(0.1 to 1) mA	(10 to 20) Hz (20 Hz to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.4 mA/A + 0.16 μ A 1.3 mA/A + 0.16 μ A 0.54 mA/A + 0.16 μ A 0.26 mA/A + 0.16 μ A	
(1 to 10) mA	(10 to 20) Hz (20 Hz to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.4 mA/A + 1.6 μ A 1.3 mA/A + 1.6 μ A 0.51 mA/A + 1.6 μ A 0.26 mA/A + 1.6 μ A	
(10 to 100) mA	(10 to 20) Hz (20 Hz to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.4 mA/A + 16 μ A 1.3 mA/A + 16 μ A 0.5 mA/A + 16 μ A 0.25 mA/A + 16 μ A	
(0.1 to 1) A	(10 to 20) Hz (20 Hz to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.3 mA/A + 0.16 mA 1.4 mA/A + 0.16 mA 0.68 mA/A + 0.16 mA 0.84 mA/A + 0.16 mA	
Up to 20 A	55 Hz to 1 kHz (1 to 5) kHz	0.42 % 0.92 %	Keysight 3458A with Y5020

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
AC Power – Generate ³	(10 to 45) Hz PF=1		Fluke 5522A
(33 to 329.99) mV	(0.1 to 3) mW	0.15 %	
	(0.3 to 10.9) mW	0.15 %	
	(1 to 30) mW	0.040 %	
	(3 to 109) mW	0.040 %	
	(10.9 to 300) mW	0.049 %	
	(30 to 725) mW	0.052 %	
	(72.6 to 1500) mW	0.064 %	
	148 mW to 6.77 W	0.11 %	
330 mV to 1020 V	1 mW to 9 W	0.15 %	
	3 mW to 33W	0.15 %	
	10.9 mW to 90 W	0.044 %	
	(0.03 to 335) W	0.044 %	
	(0.1 to 1000) W	0.053 %	
	(0.3 to 2250) W	0.056 %	
	(0.7 to 4600) W	0.067 %	
	1.5 W to 20.91 kW	0.12 %	
	65 Hz to 1 kHz PF=1		
(33 to 329.99) mV	(0.1 to 3) mW	0.040 %	
	(0.3 to 10.9) mW	0.040 %	
	(1.09 to 30) mW	0.042 %	
	(3 to 109) mW	0.039 %	
	(10.9 to 300) mW	0.54 %	
	(30 to 726) mW	0.053 %	
	(72.6 to 1500) mW	0.094 %	
	148 mW to 6.77 W	0.14 %	
330 mV to 1020 V	1 mW to 9 W	0.043 %	
	3 mW to 33 W	0.043 %	
	10.9 mW to 90 W	0.045 %	
	(0.03 to 336) W	0.042 %	
	(0.1 to 1000) W	0.54 %	
	(0.3 to 2250) W	0.055 %	
	(0.7 to 4600) W	0.095 %	
	1.5 W to 20.91 kW	0.14 %	
	(1 to 5) kHz PF=1		
(33 to 329.99) mV	(0.1 to 3) mW	0.13 %	
	(0.3 to 10.9) mW	0.13 %	
	(1.09 to 30) mW	0.15 %	
	(3 to 109) mW	0.15 %	
	(10.9 to 300) mW	0.55 %	
	(30 to 726) mW	0.50 %	
	(72.6 to 1500) mW	0.15 %	
	148 mW to 6.77 W	0.18 %	

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
AC Power – Generate ³ (cont)	(1 to 5) kHz PF=1		
330 mV to 1020 V	1 mW to 9 W 3 mW to 33 W 10.9 mW to 90 W (0.03 to 336) W (0.1 to 1000) W (0.3 to 2250) W (0.7 to 4600) W 1.5 W to 20.91 kW	0.14 % 0.14 % 0.15 % 0.15 % 0.55 % 0.51 % 0.15 % 0.18 %	
(33 to 329.99) mV	(5 to 10) kHz PF=1 (0.1 to 3) mW (0.3 to 11) mW (1.09 to 30) mW (3 to 109) mW (10.9 to 300) mW (30 to 725) mW (72.6 to 990) mW	0.47 % 0.47 % 0.48 % 0.47 % 0.69 % 0.66 % 0.66 %	
330 mV to 1020 V	1 mW to 9 W 3 mW to 33 W 10.9 mW to 92 W 30 mW to 335 W (0.1 to 920) W (0.3 to 2250) W (0.7 to 3060) W	0.46 % 0.47 % 0.47 % 0.48 % 0.47 % 0.69 % 0.66 %	
(33 to 329.99) mV	(10 to 30) kHz PF=1 (0.1 to 3) mW (0.3 to 10.9) mW (1.09 to 30) mW (3 to 109) mW	1.8 % 1.8 % 1.8 % 1.8 %	
330 mV to 1020 V	1.09 mW to 9 W 3 mW to 33 W 10.9 mW to 92 W 30 mW to 337 W	1.8 % 1.8 % 1.8 % 1.8 %	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Level Flatness ³			
0.5 V Thermal Converter	(10 to <100) Hz (0.1 to <1) kHz (1 to <10) kHz (10 to <30) kHz (30 to <100) kHz (100 to <300) kHz (0.3 to <1) MHz (1 to <3) MHz (3 to <8) MHz (8 to <10) MHz (10 to <20) MHz (20 to <30) MHz (30 to <50) MHz (50 to <70) MHz (70 to <80) MHz (80 to <100) MHz 100 MHz	0.12 % 0.12 % 0.12 % 0.12 % 0.23 % 0.29 % 0.29 % 0.58 % 0.70 % 0.71 % 0.71 % 0.76 % 1.8 % 2.8 % 3.6 % 3.9 % 4.8 %	Agilent 3458A w/ thermal converters Reference to 1 kHz
1 V Thermal Converter	(10 to <100) Hz (0.1 to <1) kHz (1 to <10) kHz (10 to <30) kHz (30 to <100) kHz (100 to <300) kHz (0.3 to <1) MHz (1 to <3) MHz (3 to <8) MHz (8 to <10) MHz (10 to <20) MHz (20 to <30) MHz (30 to <50) MHz (50 to <70) MHz (70 to <80) MHz (80 to <100) MHz 100 MHz	0.12 % 0.12 % 0.12 % 0.12 % 0.23 % 0.29 % 0.29 % 0.58 % 0.70 % 0.71 % 0.71 % 0.76 % 1.8 % 2.8 % 3.6 % 3.9 % 4.8 %	
3 V Thermal Converter	(10 to <100) Hz (0.1 to <1) kHz (1 to <10) kHz (10 to <30) kHz (30 to <100) kHz (100 to <300) kHz (0.3 to <1) MHz (1 to <3) MHz (3 to <8) MHz (8 to <10) MHz (10 to <20) MHz (20 to <30) MHz (30 to <50) MHz (50 to <70) MHz (70 to <80) MHz (80 to <100) MHz 100 MHz	0.12 % 0.12 % 0.12 % 0.12 % 0.23 % 0.29 % 0.29 % 0.58 % 0.70 % 0.71 % 0.71 % 0.76 % 1.8 % 2.8 % 3.6 % 3.9 % 4.8 %	

Parameter/Range	Frequency	CMC ^{2, 6} ($\pm$)	Comments
Capacitance – Generate ³			Fluke 5522A
(0.19 to 1.0999) nF	10 Hz to 10 kHz	4.0 mF/F + 7.8 pF	
(1.1 to 3.2999) nF	10 Hz to 3 kHz	4.0 mF/F + 7.8 pF	
(3.3 to 10.9999) nF	10 Hz to 1 kHz	2.1 mF/F + 7.8 pF	
(11 to 109.999) nF	10 Hz to 1 kHz	2.1 mF/F + 78 pF	
(110 to 329.999) nF	10 Hz to 1 kHz	2.0 mF/F + 0.23 nF	
(0.33 to 1.099 99) μ F	(10 to 600) Hz	2.1 mF/F + 0.78 nF	
(1.1 to 3.299 99) μ F	(10 to 300) Hz	2.1 mF/F + 2.3 nF	
(3.3 to 10.9999) μ F	(10 to 150) Hz	2.1 mF/F + 7.8 nF	
(11 to 32.9999) μ F	(10 to 120) Hz	3.2 mF/F + 23 nF	
(33 to 109.999) μ F	(10 to 80) Hz	3.6 mF/F + 78 nF	
(110 to 329.999) μ F	(DC to 50) Hz	3.5 mF/F + 0.23 μ F	
(0.33 to 1.099 99) mF	(DC to 20) Hz	3.5 mF/F + 0.78 μ F	
(1.1 to 3.2999) mF	(DC to 6) Hz	3.5 mF/F + 2.3 μ F	
(3.3 to 10.9999) mF	(DC to 2) Hz	3.5 mF/F + 7.8 μ F	
(11 to 32.9999) mF	(DC to 0.6) Hz	5.8 mF/F + 23 μ F	
(33 to 110) mF	(DC to 0.2) Hz	8.5 mF/F + 78 μ F	

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 5522A/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	1 mV to 6.6 V	1.6 mV/V + 31 μ V	
Into 50 Ω Load	1 mV to 130 V _{p-p}	0.78 mV/V + 31 μ V	
Into 1 M Ω Load			
Leveled Sine Wave Flatness	50 kHz to 100 MHz	2.9 %	Note: uncertainty of flatness is relative to 50 kHz
	(100 to 300) MHz	3.1 %	
	(300 to 600) MHz	4.1 %	
	(600 to 1100) MHz	4.7 %	
	>1 kHz to 10MHz	0.61 %	Fluke 96270A
	(>0.1 to 2.4) GHz	0.82 %	Note: uncertainty of flatness is relative to 100 kHz. VSWR = 1.0
	(>2.4 to 8) GHz	1.3 %	
	(>8 to 12.4) GHz	1.3 %	
	(>12.4 to 18) GHz	1.7 %	
	(>18 to 26.5) GHz	2.1 %	
Time Mark			
Into 50 Ω	1 ns to 20 ms	2.1 μ s/s	Fluke 5520A
	20 ms to 5 s	(19 + 39 <i>t</i>) μ s/s	<i>t</i> is the time in seconds
Frequency	1 kHz to 10 MHz	2.5 μ s/s	

Parameter/Equipment	Range	CMC ^{2, 6} ($\pm$)	Comments
Oscilloscopes ³ – (cont)			
Impedance – Measure	(40 to 60) Ω (0.6 to 1.5) M Ω (5 to 50) pF	0.79 m Ω/Ω 0.79 m Ω/Ω 420 μ F/F + 0.21 pF	Fluke 5522A/SC1100
Rise Time – Generate	1 kHz to 2 MHz, (200 to 300) ps (2 to 10) MHz, (200 to 350) ps	19 ps 19 ps	

II. Electrical RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 5, 6} ($\pm$)	Comments
RF Power ³ – Measure			
0 mW Reference	50 MHz	0.26 %	HP 478A w/ 432A & 3458A DMM
			E4418B with:
(+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm	100 kHz to 4.2 GHz	0.14 dB 0.051 dB 0.061 dB	8482A
(+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm	4.2 GHz to 18 GHz	0.14 dB 0.05 dB 0.065 dB	8481A
(+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm	18 GHz to 26.5 GHz	0.16 dB 0.1 dB 0.1 dB	8485A
(+10 to +20) dBm (-10 to +10) dBm (-20 to -10) dBm	26.5 GHz to 50 GHz	0.17 dB 0.12 dB 0.12 dB	8487A
(-30 to -20) dBm (-70 to -30) dBm	10 MHz to 18 GHz	0.07 dB 0.05 dB	8481D
(+20 to +30) dBm (+20 to +30) dBm (+20 to +30) dBm (+20 to +30) dBm	100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	0.15 dB 0.17 dB 0.19 dB 0.22 dB	8482A/Atten 8481A/Atten 8485A/Atten 8487A/Atten
(-60 to -30) dBm (-100 to -60) dBm (-140 to -100) dBm	20 Hz to 50 GHz	0.64 dB 0.82 dB 0.84 dB	FSMR

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
RF Power ³ – Generate			
(16 to 24) 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	
(-124 to -84) dBm	(10 to 100) MHz (0.1 to 1.4) GHz	0.60 dB 1.4 dB	
RF Power ³ – Generate			Fluke 96270A – microwave output
(-100 to 24) dBm	Up to 100 MHz	0.43 %	
(-100 to 20) dBm	(0.1 to 1.4) GHz	0.57 %	
	(1.4 to 2.4) GHz	0.70 %	
	(2.4 to 8) GHz	0.88 %	
	(8 to 12) GHz	1.0 %	
	(12 to 18) GHz	1.2 %	
	(18 to 20) GHz	1.6 %	
(-100 to 18) dBm	(20 to 22) GHz	1.6 %	
	(22 to 26.5) GHz	2.5 %	
RF Power ³ – Generate & Measure			Signal generator monitored by an NRP-Z56 Power Sensor
(-35 to 20) dBm	DC to 100 MHz	0.027 dBm	
	(0.2 to 2.4) GHz	0.042 dBm	
	(2.4 to 8) GHz	0.064 dBm	
	(8 to 12.4) GHz	0.082 dBm	
	(12.4 to 18) GHz	0.11 dBm	
	(18 to 26.5) GHz	0.098 dBm	
	(26.5 to 40) GHz	0.11 dBm	
	(40 to 50) GHz	0.14 dBm	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Attenuation ³ – Tuned RF Level Generate & Measure			
(0 to 10) dB	(0.1 to 10) MHz	0.018 dB	R&S FSMR
(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	(0.01 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		0.47 dB	
(130 to 135) dB		1.3 dB	
(0 to 5) dB	(22 to 26.5) GHz	0.22 dB	
(5 to 10) dB		0.28 dB	
(10 to 15) dB		0.35 dB	
(15 to 20) dB		0.34 dB	
(20 to 25) dB		0.30 dB	
(25 to 30) dB		0.21 dB	
(30 to 35) dB		0.31 dB	
(35 to 40) dB		0.26 dB	
(40 to 45) dB		0.35 dB	
(45 to 50) dB		0.41 dB	
(50 to 55) dB		0.35 dB	
(55 to 60) dB		0.32 dB	
(60 to 65) dB		0.51 dB	
(65 to 70) dB		0.38 dB	
(70 to 75) dB		0.23 dB	
(75 to 80) dB		0.27 dB	
(80 to 85) dB		0.34 dB	
(85 to 90) dB		0.31 dB	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Attenuation ³ – Tuned RF Level Generate & Measure (cont)			R&S FSMR
(90 to 95) dB (95 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	0.30 dB 0.27 dB 0.27 dB 0.31 dB 0.45 dB 0.31 dB 2.9 dB 1.3 dB	
(0 to 5) dB (5 to 20) dB (20 to 25) dB (25 to 30) dB (30 to 35) dB (35 to 40) dB (40 to 45) dB (45 to 50) dB (50 to 55) dB (55 to 60) dB (60 to 65) dB (65 to 70) dB (70 to 75) dB (75 to 80) dB (80 to 85) dB (85 to 90) dB (90 to 95) dB (95 to 100) dB (100 to 105) dB (105 to 110) dB (110 to 115) dB (115 to 120) dB (120 to 125) dB	(26.5 to 40) GHz	0.26 dB 0.25 dB 0.39 dB 0.29 dB 0.22 dB 0.44 dB 0.31 dB 0.45 dB 0.61 dB 0.41 dB 0.51 dB 0.41 dB 0.29 dB 0.41 dB 0.42 dB 0.41 dB 0.42 dB 0.40 dB 0.38 dB 0.47 dB 0.55 dB 0.18 dB 0.26 dB	
(0 to 5) dB (5 to 10) dB (10 to 15) dB (15 to 20) dB (20 to 25) dB (25 to 30) dB (30 to 35) dB (35 to 40) dB (40 to 45) dB (45 to 50) dB (50 to 55) dB (55 to 65) dB (65 to 70) dB (70 to 75) dB (75 to 80) dB (80 to 85) dB (85 to 90) dB (90 to 95) dB (95 to 100) dB (100 to 105) dB (105 to 110) dB (110 to 115) dB	(40 to 50) GHz	0.36 dB 0.31 dB 0.45 dB 0.44 dB 0.50 dB 0.52 dB 0.51 dB 0.55 dB 0.43 dB 0.49 dB 0.30 dB 0.36 dB 0.44 dB 0.35 dB 0.42 dB 0.36 dB 0.41 dB 0.37 dB 0.38 dB 0.39 dB 0.37 dB 0.35 dB	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
Amplitude Modulation – Generate & Measure ³			
Rate: 10 Hz to 10 kHz Depth: (5 to 99) %	(0.1 to 10) MHz	1.5 %	R&S FSMR
Rate: 10 Hz to 50 kHz Depth: (5 to 99) %	(0.01 to 50) GHz	1.0 %	
Rate: 50 kHz to 100 kHz Depth: (5 to 99) %	(0.01 to 50) GHz	1.5 %	
Rate: 90 Hz to 150 Hz Depth: (5 to 99) %	(0.01 to 50) GHz	0.42 %	
Frequency Modulation – Generate & Measure ³			
Rate: 10 Hz to 10 kHz Dev: ≤50 kHz peak	(0.1 to 10) MHz	1.2 %	R&S FSMR
Rate: 10 Hz to 100 kHz Dev: ≤500 kHz peak	(0.01 to 50) GHz	1.2 %	
Rate: (100 to 200) kHz Dev: ≤500 kHz peak	(0.01 to 50) GHz	3.5 %	
Phase Modulation – Generate & Measure ³			
Rate: 50 Hz to 10 kHz Depth: (5 to 99) %	(0.2 to 10) MHz	1 %	R&S FSMR
Rate: 50 Hz to 10 kHz Depth: (5 to 99) %	(0.01 to 50) GHz	1 %	
Digital Modulation – Measure ^{3,7}	Carrier: 2 MHz to 50 GHz		R&S FSMR
Error Vector Magnitude for Modulation	Symbol Rate ≤1 MHz ≤10 MHz ≤15 MHz	0.53 % 1.1 % 2.1 %	
Phase Error for Modulation	Mod Freq Span ≤100 kHz ≤1 MHz ≤10 MHz >10 MHz	0.32° 0.42° 0.64° 1.3 °	

Parameter/Range	Frequency	CMC ^{2, 5, 6} ($\pm$)	Comments
Distortion – Measure ³			
(-80 to 0) dB	Fundamental Frequency		HP 8903B
(-70 to 0) dB	20 Hz to 20 kHz	1.2 dB	
(-65 to 0) dB	(20 to 50) kHz	2.3 dB	
	(50 to 100) kHz	2.3 dB	
Amplitude Modulation Distortion	Carrier Frequency:		R&S FSMR
Depth of Modulation			
5 % to 99 %	100 kHz to 10 MHz	0.36 %	
	≥ 10 MHz to 4 GHz	0.44 %	
Frequency Modulation Distortion			
Deviation <10 kHz	200 kHz to 10 MHz	0.19 %	
Deviation <50 kHz		0.38 %	
Deviation <100 kHz	≥ 10 MHz to 4 GHz	0.20 %	
Deviation <500 kHz		0.38 %	
Phase Modulation Distortion	200 kHz to 10 MHz	0.18 %	
	≥ 10 MHz to 4 GHz	0.18 %	
Distortion – Audio Input	100 Hz to 100 kHz	0.60 dB	
(-100 to 0) dB			
Phase Noise – Measure ³			
Carrier Frequency			R&S FSMR
(1 to 10) MHz	1 Hz Offset	2.7 dB	
(-40 to -176) dBc	10 Hz Offset	2.5 dB	
	100 Hz Offset	1.6 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	4.0 dB	
(10 to 100) MHz	1 Hz Offset	3.7 dB	
(-66 to -175) dBc	10 Hz Offset	2.8 dB	
	100 Hz Offset	1.6 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	2.7 dB	
	10 MHz Offset	3.3 dB	
	>30 MHz Offset	4.0 dB	
100 MHz to 1 GHz	1 Hz Offset	3.2 dB	
(-46 to -173) dBc	10 Hz Offset	2.4 dB	
	100 Hz Offset	1.7 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.9 dB	
	10 MHz Offset	4.0 dB	
	>30 MHz Offset	4.0 dB	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
Phase Noise – Measure ³ (cont)			R&S FSMR
Carrier Frequency (1 to 3) GHz (+10 to -170) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 100 kHz Offset 1 MHz Offset 10 MHz Offset >30 MHz Offset	4.2 dB 2.0 dB 1.6 dB 1.6 dB 1.6 dB 1.6 dB 3.8 dB 4.4 dB 4.1 dB	
(3 to 7) GHz (+17 to -166) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 100 kHz Offset 1 MHz Offset 10 MHz Offset >30 MHz Offset	4.4 dB 2.6 dB 1.7 dB 1.6 dB 1.6 dB 1.6 dB 3.3 dB 3.9 dB 4.6 dB	
(7 to 10) GHz (+20 to -175) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 100 kHz Offset 1 MHz Offset 10 MHz Offset >30 MHz Offset	4.4 dB 2.7 dB 1.8 dB 1.6 dB 1.6 dB 1.6 dB 3.5 dB 3.3 dB 4.6 dB	
(10 to 16) GHz (+24 to -171) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 100 kHz Offset 1 MHz Offset 10 MHz Offset >30 MHz Offset	3.2 dB 2.7 dB 1.7 dB 1.6 dB 1.6 dB 1.6 dB 3.3 dB 4.1 dB 4.0 dB	
(16 to 26.5) GHz (+28 to -167) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 100 kHz Offset 1 MHz Offset 10 MHz Offset >30 MHz Offset	4.1 dB 2.7 dB 1.7 dB 1.6 dB 1.6 dB 1.6 dB 3.6 dB 4.2 dB 4.0 dB	

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
Phase Noise – Measure ³ (cont) Carrier Frequency (26.5 to 50) GHz (+34 to -161) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 100 kHz Offset 1 MHz Offset 10 MHz Offset >30 MHz Offset	4.1 dB 2.0 dB 1.8 dB 1.6 dB 1.6 dB 1.6 dB 3.7 dB 3.6 dB 4.4 dB	R&S FSMR
Average Noise & Residuals (DANL) ³ (-30 to -170) dBm	20 Hz to 50 GHz	0.78 dBm	50 Ω Load
Reference Level – Generate ³ Log Scale (0 to -100) dB Linear Scale (0 to -100) dB	50 MHz 50 MHz	0.13 dB 0.16 dB	Fluke 96270A Keysight E8257D
BW Switching – Generate ³ (-20 to 20) dB	20 Hz to 50 MHz 50 MHz to 50 GHz	0.18 dB 2.0 dB	Fluke 96270A Keysight E8257D
BW Accuracy – Generate ³	20 Hz to 50 MHz 50 MHz to 50 GHz	7.4 nHz/Hz 0.58 nHz/Hz	Keysight E8257D
2 nd Harmonic Distortion ³ (0 to -120) dB	200 Hz to 50 MHz 50 MHz to 50 GHz	2.8 dB 3.8 dB	Fluke 96270A Keysight E8257D

Parameter/Range	Frequency	CMC ^{2, 6} (±)	Comments
3 rd Order Intermodulation ³ (0 to -120) dB	200 Hz to 50 MHz	2.1 dB	Fluke 96270A
	50 MHz to 50 GHz	3.0 dB	Keysight E8257D
Noise/System Sidebands ³ (0 to -120) dB	200 Hz to 50 MHz	0.56 dB	Fluke 96270A
	50 MHz to 50 GHz	0.87 dB	Keysight E8257D
Frequency Response ³ (20 to -30) dB	9 kHz to 18 GHz	0.69 dB	Agilent E9304
	50 MHz to 50 GHz	0.38 dB	Agilent N8487A
Gain Compression ³ (20 to -20) dB	200 Hz to 50 MHz	0.24 dB	Fluke 96270A
	50 MHz to 50 GHz	0.11 dB	Keysight E8257D

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Attenuator Check ³	(0 to 100) dB	0.11 dB	Fluke 96270A
Log Fidelity ³	(20 to -100) dB	0.87 dB	Fluke 96270A
Linear Fidelity ³	(20 to -100) dB	0.12 dB	Fluke 96270A

III. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 5, 11} ($\pm$)	Comments
Frequency – Generate ³	10 MHz	5.8 mHz + 0.6 <i>R</i>	HP 3325B w/ GPS
	DC to 1 kHz	0.17 nHz/Hz	Tektronix AFG2021 w/ GPS
	1 kHz to 20 MHz	0.18 nHz/Hz	
	10 MHz to 26.5 GHz	64 pHz/Hz	Fluke 96270 w/ GPS
	10 MHz to 50 GHz	0.58 nHz/Hz	Keysight E8257D w/ GPS
Frequency – Measure	DC to 1 kHz	54 μ Hz/Hz	5313X w/ GPS
	(1 to 1000) kHz	0.34 nHz/Hz	
	(1 to 225) MHz	0.21 nHz/Hz	5313X Opt 003 w/ GPS FSMR w/ GPS
	225 MHz to 3 GHz	0.21 nHz/Hz	
	(3 to 50) GHz	58 pHz/Hz	

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.

¹² The laboratory uses METAS™ proprietary software to calculate uncertainties across the range.



Accredited Laboratory

A2LA has accredited

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 28th day of February 2024.

A blue ink signature of Trace McInturff, written over a horizontal line.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2357.18
Valid to April 30, 2026

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