



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

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CALIBRATION

Valid To: March 31, 2024

Certificate Number: 2357.20

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1,7</sup>:

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Calipers <sup>3</sup>	Up to 4 in (>4 to 12) in (>12 to 48) in	(58 + 0.25L) μin (53 + 1.9L) μin (47 + 2.4L) μin	Gage blocks
Height Gages <sup>3</sup>	Up to 4 in (>4 to 12) in (>12 to 48) in	(58 + 0.25L) μin (53 + 1.9L) μin (47 + 2.4L) μin	Gage blocks
Micrometers – Inside, Outside, Depth <sup>3</sup> –			
Length	Up to 4 in (>4 to 12) in (>12 to 48) in	(8.0 + 1.5L) μin (22 + 2.9L) μin (15 + 3.4L) μin	Gage blocks
Flatness	Up to 1 in	5.2 μin	Optical parallel
Parallelism	Up to 1 in	10 μin	

Parameter/Equipment	Range	CMC <sup>2, 5</sup> ( $\pm$ )	Comments
UMM – Universal Measuring Machines, Horizontal Metroscopes <sup>3</sup>			
Length	Up to 4 in	$(7.2 + 1.7L) \mu\text{in}$	Gage blocks
Flatness	Up to 1 in	5.2 $\mu\text{in}$	Optical parallel
Parallelism	Up to 1 in	10 $\mu\text{in}$	
Tailstock Force	Up to 40 ozf	$(0.17 + 0.010F) \text{ ozf}$	Load cell * <i>F</i> is for force in ozf
Plain Plug & Pin Gages	Up to 1 in	28 $\mu\text{in}$	Universal measuring machine
Indicators <sup>3</sup>	Up to 6 in (>6 in to 12) in (>12 to 48) in	$(13 + 1.5L) \mu\text{in}$ $(9.6 + 3.2L) \mu\text{in}$ $(14 + 2.8L) \mu\text{in}$	Gage blocks
	Up to 6 in	38 $\mu\text{in}$	Universal measuring machine
	Up to 6 in	69 $\mu\text{in}$	Starrett 716

## II. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC <sup>2, 4</sup> ( $\pm$ )	Comments
AC Current – Generate <sup>3</sup>			
Up to 220 $\mu\text{A}$	(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 0.10 mA/A + 7.8 nA 0.27 mA/A + 12 nA 1.0 mA/A + 62 nA	Fluke 5730A
(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 0.10 mA/A + 31 nA 0.20 mA/A + 0.10 $\mu\text{A}$ 1.0 mA/A + 0.62 $\mu\text{A}$	

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
AC Current – Generate <sup>3</sup> (cont)			
(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 µA 0.16 mA/A + 0.31 µA 0.10 mA/A + 0.31 µA 0.19 mA/A + 0.54 µA 1.0 mA/A + 4.7 µA	Fluke 5730A
(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 µA 0.16 mA/A + 3.1 µA 0.10 mA/A + 2.3 µA 0.19 mA/A + 3.1 µA 1.0 mA/A + 9.3 µA	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.24 mA/A + 31 µA 0.40 mA/A + 78 µA 6.2 mA/A + 0.16 mA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.40 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 (0.1 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
Up to 329.99 µA (0.33 to 3.2999) mA (3.3 to 32.999) mA (33 to 329.99) mA (0.33 to 1.099 99) A (1.1 to 2.999 99) A	(10 to 30) kHz (10 to 30) kHz (10 to 30) kHz (10 to 30) kHz (10 to 45) Hz (10 to 45) Hz	12 mA/A + 0.31 µA 7.8 mA/A + 0.47 µA 3.3 mA/A + 3.1 µA 3.1 mA/A + 0.16 mA 1.4 mA/A + 78 µA 1.4 mA/A + 78 µA	
Clamp-On Ammeters			
Toroidal (16.5 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.38 % 0.84 %	Fluke 5520A w/ coil
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.37 % 0.83 %	
Non-Toroidal (16.5 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.76 % 1.2 %	
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	1.2 % 1.6 %	

Parameter/Range	Frequency	CMC <sup>2, 4</sup> (±)	Comments
AC Current – Measure <sup>3</sup>			
(5 to 100) µA	10 to 20) Hz (20 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	Agilent 3458A opt 002
100 µA to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.3 mA/A + 0.16 µA 1.2 mA/A + 0.16 µA 0.51 mA/A + 0.16 µA 0.24 mA/A + 0.16 µA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.3 mA/A + 1.6 µA 1.2 mA/A + 1.6 µA 0.48 mA/A + 1.6 µA 0.24 mA/A + 1.6 µA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.3 mA/A + 16 µA 1.2 mA/A + 16 µA 0.49 mA/A + 16 µA 0.25 mA/A + 16 µA	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	3.3 mA/A + 0.16 mA 1.3 mA/A + 0.16 mA 0.66 mA/A + 0.16 mA 0.81 mA/A + 0.16 mA	
(1 to 20) A	40 Hz to 1 kHz (1 to 5) kHz	0.11 mA/A 0.16 mA/A	Fluke Y5020 w/ HP 3458A opt 002
(20 to 300) A	(45 to 65) Hz	16 mA/A	Agilent/HP 34330A w/HP 3458A
AC Voltage – Generate <sup>3</sup>			
Up to 2.2 mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.41 mV/V + 3.9 µV 0.34 mV/V + 3.9 µV 0.35 mV/V + 3.9 µV 0.39 mV/V + 3.9 µV 0.63 mV/V + 4.7 µV 1.1 mV/V + 9.3 µV 1.5 mV/V + 19 µV 2.8 mV/V + 19 µV	Fluke 5730A
(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 µV 0.11 mV/V + 3.9 µV 0.10 mV/V + 3.9 µV 0.20 mV/V + 3.9 µV 0.47 mV/V + 4.7 µV 1.0 mV/V + 9.3 µV 1.3 mV/V + 19 µV 2.7 mV/V + 19 µV	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup>			
(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 μV 92 μV/V + 6.2 μV 58 μV/V + 6.2 μV 0.12 mV/V + 6.2 μV 0.31 mV/V + 16 μV 0.62 mV/V + 19 μV 1.3 mV/V + 23 μV 2.6 mV/V + 47 μV	Fluke 5730A
(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 μV 87 μV/V + 16 μV 39 μV/V + 7.8 μV 63 μV/V + 9.3 μV 0.11 mV/V + 31 μV 0.32 mV/V + 78 μV 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 μV/V + 0.16 mV 39 μV/V + 54 μV 63 μV/V + 93 μV 79 μV/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 μV/V + 1.6 mV 53 μV/V + 0.54 mV 79 μV/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 μV/V + 3.1 mV	
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	78 μV/V + 3.1 mV 0.13 mV/V + 4.7 mV 0.47 mV/V + 8.5 mV	Fluke 5730A w/5725A
(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	Ross VD120-6.2Y Divider w/ HP 34401A
(1 to 85) kV	60 Hz	5.9 mV/V	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (cont)			
Absolute: (0 to 1.1) mV (1.1 to 3) mV (3 to 11) mV (11 to 33) mV (33 to 110) mV (110 to 330) mV (0.33 to 1.1) V (1.1 to 3.5) V	30 Hz to 500 kHz	6.5 mV/V + 1.6 μV 5.5 mV/V + 2.3 μV 5.4 mV/V + 6.2 μV 4.7 mV/V + 12 μV 4.7 mV/V + 31 μV 3.9 mV/V + 78 μV 3.9 mV/V + 0.31 mV 3.1 mV/V + 0.39 mV	Fluke 5730A wideband
Flatness: Up to 1.1 mV	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.4 mV/V 1.0 mV/V 1.8 mV/V + 2.3 μV 3.5 mV/V + 2.3 μV 5.5 mV/V + 2.3 μV 13 mV/V + 12 μV 23 mV/V + 12 μV	
(>1.1 to 3) mV	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.4 mV/V 0.81 mV/V 0.81 mV/V + 2.3 μV 2.3 mV/V + 2.3 μV 4.0 mV/V + 2.3 μV 12 mV/V + 2.3 μV 23 mV/V + 2.3 μV	
(>3.3 to 11) mV	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.6 mV/V 0.78 mV/V 0.80 mV/V + 2.3 μV 1.6 mV/V + 2.3 μV 3.2 mV/V + 2.3 μV 7.8 mV/V + 2.3 μV 16 mV/V + 2.3 μV	
(>11 to 33) mV	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.3 mV/V 0.80 mV/V 0.80 mV/V + 2.3 μV 1.6 mV/V + 2.3 μV 3.2 mV/V + 2.3 μV 7.8 mV/V + 2.3 μV 16 mV/V + 2.3 μV	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (cont)			
Flatness: (>33 to 110) mV	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.3 mV/V 0.79 mV/V 0.79 mV/V + 2.3 μV 1.6 mV/V + 2.3 μV 3.2 mV/V + 2.3 μV 7.8 mV/V + 2.3 μV 16 mV/V + 2.3 μV	Fluke 5700A/EP
(>110 to 330) mV	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.3 mV/V 0.8 mV/V 0.8 mV/V + 2.3 μV 1.6 mV/V + 2.3 μV 3.2 mV/V + 2.3 μV 7.8 mV/V + 2.3 μV 16 mV/V + 2.3 μV	
>330 mV to 1.1 V	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.3 mV/V 0.79 mV/V 0.79 mV/V + 2.3 μV 1.6 mV/V + 2.3 μV 3.2 mV/V + 2.3 μV 7.8 mV/V + 2.3 μV 16 mV/V + 2.3 μV	
(1.1 to 3.5) V	(10 to 30) Hz 30 Hz to 119.99 kHz (0.12 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz (30 to 50) MHz	2.3 mV/V 0.79 mV/V 0.79 mV/V + 2.3 μV 1.6 mV/V + 2.3 μV 3.2 mV/V + 2.3 μV 7.8 mV/V + 2.3 μV 16 mV/V + 2.3 μV	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup>			
(0 to 2.2) mV	(1 to 10) Hz (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	0.27 mV/V + 2.3 μV 0.27 mV/V + 2.3 μV 0.58 mV/V + 1.0 μV 0.18 mV/V + 0.85 μV 0.78 mV/V + 0.85 μV 0.94 mV/V + 1.9 μV 1.8 mV/V + 3.1 μV 1.9 mV/V + 6.2 μV 2.7 mV/V + 6.2 μV	Agilent 3458 OPT 002 or Fluke 5790A
(2.2 to 7) mV	(1 to 10) Hz (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	0.27 mV/V + 2.3 μV 0.27 mV/V + 2.3 μV 0.29 mV/V + 1.0 μV 0.17 mV/V + 1.0 μV 0.32 mV/V + 1.6 μV 0.48 mV/V + 1.9 μV 0.95 mV/V + 3.1 μV 1 mV/V + 6.2 μV 1.8 mV/V + 6.2 μV	
(7 to 22) mV	(1 to 10) Hz (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	0.13 mV/V + 3.1 μV 0.13 mV/V + 3.1 μV 0.16 mV/V + 1.0 μV 95 μV/V + 1.0 μV 0.17 mV/V + 1.6 μV 0.26 mV/V + 1.9 μV 0.65 mV/V + 3.1 μV 0.74 mV/V + 6.2 μV 1.4 mV/V + 6.2 μV	
(22 to 70) mV	(1 to 10) Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz	0.13 mV/V + 3.1 μV 0.13 mV/V + 3.1 μV 0.10 mV/V + 1.2 μV 63 μV/V + 1.2 μV	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (cont)			
(22 to 70) mV	(20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.11 mV/V + 1.6 µV 0.22 mV/V + 1.9 µV 0.43 mV/V + 3.1 µV 0.57 mV/V + 6.2 µV 0.91 mV/V + 6.2 µV	Agilent 3458 OPT 002 or Fluke 5790A
(70 to 200) mV	(1 to 10) Hz (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	0.28 mV/V + 31 µV 0.17 mV/V + 1.2 µV 74 µV/V + 1.2 µV 34 µV/V + 1.2 µV 60 µV/V + 1.6 µV 0.13 mV/V + 1.9 µV 0.21 mV/V + 3.1 µV 0.32 mV/V + 6.2 µV 0.80 mV/V + 6.2 µV	
(200 to 700) mV	(1 to 10) Hz (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	0.28 mV/V + 31 µV 0.17 mV/V + 1.2 µV 63 µV/V + 1.2 µV 28 µV/V + 1.2 µV 41 µV/V + 1.6 µV 64 µV/V + 1.9 µV 0.14 mV/V + 3.1 µV 0.24 mV/V + 6.2 µV 0.75 mV/V + 6.2 µV	
(0.7 to 1) V	(1 to 10) Hz (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	0.28 mV/V + 31 µV 0.16 mV/V 56 µV/V 21 µV/V 37 µV/V 56 µV/V 0.13 mV/V 0.20 mV/V 0.70 mV/V	
(1 to 2) V	(1 to 10) Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.28 mV/V + 0.31 mV 0.16 mV/V 56 µV/V 21 µV/V 37 µV/V 56 µV/V	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (cont)			
(1 to 2) V	(100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.13 mV/V 0.20 mV/V 0.70 mV/V	Agilent 3458 OPT 002 or Fluke 5790A
(2 to 7) V	(1 to 10) Hz (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	0.28 mV/V + 0.31 mV 0.16 mV/V 58 µV/V 20 µV/V 39 µV/V 65 µV/V 0.15 mV/V 0.31 mV/V 0.93 mV/V	
(7 to 10) V	(1 to 10) Hz (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	0.28 mV/V + 0.31 mV 0.16 mV/V 57 µV/V 24 µV/V 42 µV/V 67 µV/V 0.15 mV/V 0.31 mV/V 0.93 mV/V	
(10 to 20) V	(1 to 10) Hz (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	0.31 mV/V + 3.1 mV 0.16 mV/V 57 µV/V 24 µV/V 42 µV/V 67 µV/V 0.15 mV/V 0.31 mV/V 0.93 mV/V	
(20 to 70) V	(1 to 10) Hz (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	0.31 mV/V + 3.1 mV 0.16 mV/V 58 µV/V 27 µV/V 46 µV/V 74 µV/V 0.16 mV/V 0.32 mV/V 0.93 mV/V	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (cont)			
(70 to 100) V	(1 to 10) Hz (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	0.31 mV/V + 3.1 mV 0.16 mV/V 58 µV/V 26 µV/V 55 µV/V 78 µV/V 0.17 mV/V 0.39 mV/V 12 mV/V + 7.8 mV	Agilent 3458 OPT 002 or Fluke 5790A
(100 to 200) V	(1 to 10) Hz (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	0.50 mV/V + 31 mV 0.16 mV/V 58 µV/V 26 µV/V 55 µV/V 78 µV/V 0.17 mV/V 0.39 mV/V	
(200 to 700) V	(1 to 10) Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.50 mV/V + 31 mV 0.16 mV/V 79 µV/V 37 µV/V 0.10 mV/V 0.39 mV/V	
(700 to 1000) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.16 mV/V 80 µV/V 37 µV/V 0.10 mV/V 0.39 mV/V	
(1 to 10) kV	(15 to 200) Hz (200 to 450) Hz (450 to 600) Hz	0.11 % + 0.12 V 0.43 % + 0.12 V 0.84 % + 0.12 V	Vitrk 4700
(1 to 85) kV	60 Hz	5.9 mV/V	Ross VD120-6.2Y divider w/ HP 34401A

Parameter/Range	Frequency	CMC <sup>2, 4, 5, 6</sup> ( $\pm$ )	Comments
AC Resistance – Measure <sup>3</sup> 10 m $\Omega$ to 100 k $\Omega$	12 Hz to 200 kHz	(0.32 + 0.23R) m $\Omega$	GenRad 1689M (CMC valid at 1 kHz only) <sup>10</sup>
AC Resistance – Generate 0.1 $\Omega$ 1 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$	DC to 1 MHz DC to 1 MHz DC to 1 MHz DC to 1 MHz DC to 1 MHz DC to 1 MHz DC to 1 MHz	0.19 % 0.026 % 0.011 % 0.028 % 0.012 % (0.013 + 0.013f) % (0.037 + 2.3f) %	HP 16074A       f = Frequency in MHz
AC Resistance – Measure <sup>3</sup> 10 m $\Omega$ to 100 k $\Omega$	12 Hz to 200 kHz	(0.32 + 0.23R) m $\Omega$	GenRad 1689M (CMC valid at 1 kHz) <sup>10</sup>
Inductance – Generate <sup>3</sup> 1 mH 10 mH 100 mH 1 H	100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz	1.2 $\mu$ H 6.4 $\mu$ H 53 $\mu$ H 0.94 mH	GenRad 1482 series
Inductance – Measure <sup>3</sup> 100 $\mu$ H to 10 H	12 Hz to 100 kHz	1.2 mH/H	GenRad 1689M (CMC valid at 1 kHz only) <sup>10</sup>

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Capacitance – Generate <sup>3</sup>			
0 F		2.4 pF	OPEN
1 pF	100 Hz to 1 kHz	0.39 fF	HP 16380A
	1 kHz to 1 MHz	0.40 fF	
	(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 kHz	3.5 fF	
	1 kHz to 1 MHz	3.5 fF	
	(1 to 2) MHz	3.8 fF	
	(2 to 3) MHz	3.8 fF	
	(3 to 4) MHz	3.5 fF	
	(4 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	64 fF	
1 nF	100 Hz to 1 kHz	0.35 pF	
	1 kHz 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	0.72 pF	
	(5 to 10) MHz	2.0 pF	
	(10 to 13) MHz	2.9 pF	
10 nF	(100 to 120) Hz	0.62 pF	
	120 Hz to 1 kHz	0.71 pF	
	(1 to 10) kHz	0.71 pF	
	(10 to 100) kHz	0.73 pF	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Capacitance – Generate <sup>3</sup> (cont)			
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	HP 16380A
1 μF	(100 to 120) Hz 120 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	76 pF 70 pF 70 pF 0.58 nF	
1 nF	100 Hz to 10 kHz	0.29 pF	GenRad 1409 series
10 nF	100 Hz to 10 kHz	2.4 pF	
100 nF	100 Hz to 10 kHz	24 pF	
1 μF	100 Hz to 10 kHz	0.25 nF	
10 pF	100 Hz to 10 kHz	0.24 fF	GenRad 1404 series
1000 pF	100 Hz to 10 kHz	24 fF	
(0.19 to 1.0999) nF	10 Hz to 10 kHz	4.0 mF/F + 7.8 pF	Fluke 5520A
(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 + 77.5 pF	
(110 to 329.999) nF	10 Hz to 1 kHz	2.0 mF/F + 0.23 nF	
(0.33 to 1.099 99) μF	(10 to 600) Hz	2.1 mF/F + 0.78 nF	
(1.1 to 3.299 99) μF	(10 to 300) Hz	2.1 mF/F + 2.3 nF	
(3.3 to 10.9999) μF	(10 to 150) Hz	2.1 mF/F + 7.8 nF	
(11 to 32.9999) μF	(10 to 120) Hz	3.2 mF/F + 23 nF	
(33 to 109.999) μF	(10 to 80) Hz	3.6 mF/F + 78 nF	
(110 to 329.999) μF	DC to 50 Hz	3.5 mF/F + 0.23 μF	
(0.33 to 1.099 99) mF	DC to 20 Hz	3.5 mF/F + 0.78 μF	
(1.1 to 3.2999) mF	DC to 6 Hz	3.5 mF/F + 2.3 μF	
(3.3 to 10.9999) mF	DC to 2 Hz	3.5 mF/F + 7.8 μF	
(11 to 32.9999) mF	DC to 0.6 Hz	5.8 mF/F + 23 μF	
(33 to 110) mF	DC to 0.2 Hz	8.5 mF/F + 78 μF	
Capacitance – Measure <sup>3</sup>			
0 F		2.4 pF	GenRad 1689M, OPEN
(0.1 to 100) pF	12 Hz to 100 kHz	4.8 mF/F	GenRad 1689M
100 pF to 25 μF	12 Hz to 100 kHz	0.24 mF/F	
(25 to 100) μF	12 Hz to 100 kHz	0.25 mF/F	
100 μF to 1 mF	12 Hz to 100 kHz	2.5 mF/F	(CMC valid at 1 kHz only) <sup>10</sup>

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Current – Generate <sup>3</sup>	0 A	2.2 pA	OPEN
	Up to 220 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	40 µA/A + 5.4 nA 32 µA/A + 6.2 nA 32 µA/A + 39 nA 40 µA/A + 0.62 µA 72 µA/A + 12 µA	Fluke 5730A
	(2.2 to 11) A	0.28 mA/A + 0.37 mA	Fluke 5730A w/ 5725A
	(11 to 20.5) A	0.81 mA/A + 0.58 mA	Fluke 5522A
	(20 to 149.999) 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 – Measure <sup>3</sup>	0 A	2.2 pA	HP 3458A, OPEN
	Up to 20 pA (>20 to 200) pA (>0.2 to 2) nA	12 mA/A + 3.5 fA 12 mA/A + 5.8 fA 2.5 mA/A + 0.35 pA	Keithley 6517B
	(>2 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	0.20 mA/A + 31 pA 38 µA/A + 31 pA 17 µA/A + 78 pA 16 µA/A + 0.62 nA 16 µA/A + 3.9 nA 17 µA/A + 39 nA 28 µA/A + 0.39 µA 87 µA/A + 7.8 µA	HP 3458A
	(1 to 20) A	31 µA/A	Fluke Y5020A w/ HP 3458A opt 002
	(20 to 300) A	0.57 mA/A	L&N 4363 w/ HP 3458A opt 002
DC Resistance – Measure <sup>3</sup>	(0 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 (10 to 100) MΩ (0.1 to 1.2) GΩ	12 µΩ/Ω + 39 µΩ 9.4 µΩ/Ω + 0.39 mΩ 7.9 µΩ/Ω + 0.39 mΩ 7.9 µΩ/Ω + 3.9 mΩ 9.4 µΩ/Ω + 39 mΩ 14 µΩ/Ω + 1.6 Ω 51 µΩ/Ω + 78 Ω 0.40 mΩ/Ω + 0.78 kΩ 4.6 mΩ/Ω + 7.8 kΩ	HP 3458A opt 002

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Resistance – Generate <sup>3</sup>	(0 to 10.9999) Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω (330 to 1099.999) Ω (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 (330 to 1099.999) kΩ (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 1099.999) MΩ	38 μΩ/Ω + 0.78 mΩ 27 μΩ/Ω + 1.2 mΩ 23 μΩ/Ω + 1.1 mΩ 23 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 16 mΩ 22 μΩ/Ω + 16 mΩ 23 μΩ/Ω + 0.16 Ω 23 μΩ/Ω + 0.16 Ω 27 μΩ/Ω + 1.6 Ω 27 μΩ/Ω + 1.6 Ω 59 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
	(1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ (10 to 100) GΩ	1.2 mΩ/Ω 1.3 mΩ/Ω 2.4 mΩ/Ω 5.8 mΩ/Ω 18 mΩ/Ω	Megadek 72-6346-1
DC Resistance – Generate <sup>3</sup> Fixed Points	0 Ω	20 μΩ	Copper short
	1 mΩ 10 mΩ 100 mΩ	72 μΩ/Ω 3.7 μΩ/Ω 31 μΩ/Ω	Yokogawa 279201 Yokogawa 279202 Yokogawa 279203
	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	49 μΩ 0.11 mΩ 0.16 mΩ 0.21 mΩ 0.40 mΩ 0.95 mΩ 1.8 mΩ 6.5 mΩ 12 mΩ 64 mΩ 0.12 Ω 0.79 Ω 1.8 Ω 12 Ω 33 Ω 0.36 kΩ 0.89 kΩ 9.7 kΩ	Fluke 5730A



Parameter/Equipment	Range	CMC <sup>2,4,6</sup> ( $\pm$ )	Comments	
DC Voltage – Measure <sup>3</sup>	0 V  (0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1100) V  (1 to 120) kV	67 nV  6.6 $\mu$ V/V + 0.23 $\mu$ V 2.4 $\mu$ V/V + 0.23 $\mu$ V 2.4 $\mu$ V/V + 0.39 $\mu$ V 3.9 $\mu$ V/V + 23 $\mu$ V 4.1 $\mu$ V/V + 78 $\mu$ V  1.2 mV/V	HP 3458A w/ short  HP 3458A-HFL    Ross VD120-6.2Y Divider w/ HP 34401A	
DC Voltage – Generate <sup>3</sup>	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  (1.1 to 10) kV  (10 to 120) kV	67 nV  7.9 $\mu$ V/V + 0.39 $\mu$ V 4.8 $\mu$ V/V + 0.62 $\mu$ V 3.2 $\mu$ V/V + 2.3 $\mu$ V 3.2 $\mu$ V/V + 3.9 $\mu$ V 4.8 $\mu$ V/V + 39 $\mu$ V 6.4 $\mu$ V/V + 0.39 mV  0.027 % + 40 mV  1.2 mV/V	Copper short  Fluke 5730A     Vitretek 4700  Ross VD120-6.2Y Divider w/ HP 34401A	
Distortion– Measure Fundamental Frequency <sup>3</sup>	20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	(-80 to 0) dB (-70 to 0) dB (-65 to 0) dB	1.2 dB 2.3 dB 2.3 dB	HP 8903B
Amplitude Modulation Distortion – Measure	Depth of modulation: (5 to 99) %	Carrier Frequency: 100 kHz to 10 MHz $\geq$ 10 MHz	0.36 % 0.44 %	R&S FSMR50
Frequency Modulation Distortion – Measure	Deviation < 10 kHz Deviation < 50 kHz  Deviation < 100 kHz Deviation < 500 kHz	200 kHz to 10 MHz  $\geq$ 10 MHz	0.19 % 0.38 %  0.20 % 0.38 %	R&S FSMR50

Parameter/Equipment	Range	CMC <sup>2,4,6</sup> (±)	Comments
Phase Modulation Distortion – Measure	200 kHz to 10 MHz ≥ 10 MHz	0.18 % 0.18 %	R&S FSMR50
Distortion – Audio Input (-100 to 0) dB	100 Hz to 100 kHz	0.60 dB	R&S FSMR50
Electrical Calibration of Thermocouple Indicators <sup>3</sup> –			
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 5520A
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 1000) °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 1200) °C	0.25 °C 0.13 °C 0.12 °C 0.14 °C 0.18 °C	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Calibration of Thermocouple Indicators <sup>3</sup> – (cont)			
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	Fluke 5520A
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.29 °C 0.20 °C 0.14 °C	
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	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Simulation of RTD Indicators <sup>3</sup> –			
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.085 °C 0.12 °C 0.12 °C 0.11 °C 0.097 °C 0.11 °C 0.20 °C	Fluke 5520A
Pt 3926, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.064 °C 0.076 °C 0.075 °C 0.089 °C 0.095 °C 0.17 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.21 °C 0.060 °C 0.068 °C 0.070 °C 0.077 °C 0.084 °C 0.090 °C 0.13 °C 0.19 °C	
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	0.036 °C 0.043 °C 0.044 °C 0.051 °C 0.066 °C	

Parameter/Equipment	Range	CMC <sup>2,4,6</sup> (±)	Comments
Electrical Simulation of RTD Indicators <sup>3</sup> – (cont)			
Pt 385, 500 Ω	(300 to 400) °C (400 to 600) °C (600 to 630) °	0.066 °C 0.073 °C 0.088 °C	Fluke 5520A
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	
AC Voltage Flatness – Measure			
(0.5, 1, 3) V Thermal Converter	10 Hz to <30 kHz (30 to <100) kHz (0.1 to <1) MHz (1 to <3) MHz (3 to <8) MHz (8 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 % 0.23 % 0.29 % 0.58 % 0.70 % 0.71 % 0.76 % 1.8 % 2.8 % 3.6 % 3.9 % 4.8 %	By comparison to thermal voltage converters w/ HP 3458A, opt 002

Parameter/Range	Frequency	CMC <sup>2,4</sup> ( $\pm$ )	Comments
AC Voltage Flatness – Measure (cont)			
(0 to 2.2) mV	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.45 mV/V 0.45 mV/V 0.60 mV/V + 0.78 $\mu$ V 0.59 mV/V + 0.78 $\mu$ V 0.61 mV/V + 0.78 $\mu$ V 1.4 mV/V + 0.78 $\mu$ V 2.5 mV/V + 0.78 $\mu$ V 5.7 mV/V + 1.6 $\mu$ V	Fluke 5790A, opt 003, wideband input
(2.2 to 7) mV	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.41 mV/V 0.41 mV/V 0.56 mV/V + 0.78 $\mu$ V 0.56 mV/V + 0.78 $\mu$ V 0.58 mV/V + 0.78 $\mu$ V 0.91 mV/V + 0.78 $\mu$ V 1.6 mV/V + 0.78 $\mu$ V 3.4 mV/V + 0.78 $\mu$ V	
(7 to 22) mV	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.40 mV/V 0.40 mV/V 0.56 mV/V 0.56 mV/V 0.58 mV/V 0.9 mV/V 1.6 mV/V 3.4 mV/V	
(22 to 70) mV	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.42 mV/V 0.41 mV/V 0.41 mV/V 0.42 mV/V 0.44 mV/V 0.90 mV/V 69 mV/V 85 mV/V	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage Flatness – Measure (cont)			
(70 to 220) mV	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	59 mV/V 31 mV/V 27 mV/V 59 mV/V 31 mV/V 27 mV/V 39 mV/V 33 mV/V	Fluke 5790A, OPT 003, wideband input
(220 to 700) mV	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	31 mV/V 37 mV/V 23 mV/V 31 mV/V 37 mV/V 23 mV/V 51 mV/V 35 mV/V	
(0.7 to 2.2) V	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.25 mV/V 0.25 mV/V 0.26 mV/V 0.41 mV/V 0.43 mV/V 0.9 mV/V 1.4 mV/V 3.2 mV/V	
(2.2 to 7) V	120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.25 mV/V 0.25 mV/V 0.26 mV/V 0.41 mV/V 0.43 mV/V 0.9 mV/V 1.4 mV/V 3.2 mV/V	

Parameter/Equipment	Range	CMC <sup>2,4,6</sup> ( $\pm$ )	Comments
Oscilloscopes <sup>3</sup> –			
Amplitude DC Signal			
50 $\Omega$ Load	0 V to $\pm$ 6.6 V	1.9 mV/V + 31 $\mu$ V	Wavetek 9500B w/9530 head
1 M $\Omega$ Load	0 V to $\pm$ 130 V	0.39 mV/V + 31 $\mu$ V	
Amplitude Square Wave 10 Hz to 10 kHz:			
50 $\Omega$ Load	1 mV to $\pm$ 6.0 V <sub>p-p</sub> 10 Hz to 10 kHz	2.1 mV/V + 31 $\mu$ V	Fluke 5522A
1 M $\Omega$ Load	1 mV to $\pm$ 200 V <sub>p-p</sub> 10 Hz to 10 kHz	0.78 mV/V + 31 $\mu$ V	
Bandwidth / Level Sine Flatness <sup>3</sup>	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz  (1.1 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	2.9 % 3.1 % 4.1 % 4.7 %  4.0 % 4.1 % 7.2 %	
Time Marker	1 ns to 20 ms 50 ms to 5 s Non-cardinal point	2.5 $\mu$ s/s (19 + 38t) $\mu$ s/s 39 $\mu$ s/s	Power meter and sensor with signal generator, t = time in seconds
Rise Time – Generate	1 kHz to 2 MHz, (200 to 300) ps  (2 to 10) MHz, (200 to 350) ps	19 ps  19 ps	Fluke 5522A
Resistance	(40 to 60) $\Omega$ (0.6 to 1.5) M $\Omega$	0.79 m $\Omega$ / $\Omega$ 0.79 m $\Omega$ / $\Omega$	
DC Power – Generate <sup>3</sup> , PF = 1	0.01 mW to 337 W (0.01 to 3060) W (3060 to 20 910) W	0.018 % 0.017 % 0.057 %	Fluke 5520A



Parameter/Equipment	Range	CMC <sup>2,4,6</sup> (±)	Comments
AC Power – Generate <sup>3</sup> PF = (0 to 1) <sup>11</sup>			
(10 to 45) Hz (0.1089 to 2.9696) mW (0.297 to 10.8893) mW (1.089 to 29.6958) mW (2.97 to 108.8934) mW (10.89 to 296.958) mW (29.7 to 725.945) mW (72.6 to 1484.922) mW 148.5 mW to 6.7648 W	(33 to 329.99) mV: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA (330 to 899.9) mA (0.9 to 2.1999) A (2.2 to 4.4999) A (4.5 to 20.5) A	0.15 % 0.15 % 0.040 % 0.040 % 0.049 % 0.052 % 0.064 % 0.11 %	Fluke 5522A
1.089 mW to 9.179 W 2.97 mW to 33.659 W 10.89 mW to 91.7898 W (0.0297 to 336.5898) W (0.1089 to 917.898) W (0.297 to 2243.898) W (0.726 to 4589.898) W 1.485 W to 20.91 kW	330 mV to 1020 V: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA (330 to 899.9) mA (0.9 to 2.1999) A (2.2 to 4.4999) A (4.5 to 20.5) A	0.15 % 0.15 % 0.044 % 0.044 % 0.053 % 0.056 % 0.067 % 0.12 %	
(45 to 65) Hz (0.109 to 3.0) mW (0.297 to 10.89) mW (1.09 to 29.7) mW (3.0 to 108.9) mW (10.9 to 297) mW (29.7 to 726) mW 72.6 mW to 1.5 W 148.5 mW to 6.8 W	(33 to 329.999) mV: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA (330 to 899.9) mA (0.9 to 2.1999) A (2.2 to 4.4999) A (4.5 to 20.5) A	0.23 % 0.14 % 0.11 % 0.13 % 0.10 % 0.10 % 0.11 % 0.10 %	
1.09 mW to 9.2 W 2.97 mW to 33.6 W 10.9 mW to 91.8 W 29.7 mW to 336.6 W 108.9 mW to 918 W 297 mW to 2244 W 72.6 mW to 4590 W (1.49 to 20 910) W	330 mV to 1020 V: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA (330 to 899.9) mA (0.9 to 2.1999) A (2.2 to 4.4999) A (4.5 to 20.5) A	0.34 % 0.062 % 0.094 % 0.062 % 0.086 % 0.071 % 0.094 % 0.077 %	

Parameter/Equipment	Range	CMC <sup>2,4,6</sup> (±)	Comments
AC Power – Generate <sup>3</sup> PF = (0 to 1) <sup>11</sup> (cont)			
65 Hz to 1 kHz	(33 to 329.99) mV:		Fluke 5522A
(0.109 to 3.0) mW	(3.3 to 8.999) mA	0.040 %	
(0.297 to 10.89) mW	(9 to 32.999) mA	0.040 %	
(1.09 to 29.7) mW	(33 to 89.99) mA	0.042 %	
(3.0 to 108.9) mW	(90 to 329.99) mA	0.039 %	
(10.9 to 297) mW	(330 to 899.9) mA	0.54 %	
(29.7 to 726) mW	(0.9 to 2.1999) A	0.053 %	
72.6 mW to 1.5 W	(2.2 to 4.4999) A	0.094 %	
148.5 mW to 6.8 W	(4.5 to 20.5) A	0.14 %	
	330 mV to 1020 V:		
1.089 mW to 9.179 W	(3.3 to 8.999) mA	0.043 %	
2.97 mW to 33.659 W	(9 to 32.999) mA	0.043 %	
10.89 mW to 91.7898 W	(33 to 89.99) mA	0.045 %	
(0.0297 to 336.5898) W	(90 to 329.99) mA	0.042 %	
(0.0189 to 917.898) W	(330 to 899.9) mA	0.54 %	
(0.297 to 2243.898) W	(0.9 to 2.1999) A	0.055 %	
(0.726 to 4589.898) W	(2.2 to 4.4999) A	0.095 %	
1.485 W to 20.91 kW	(4.5 to 20.5) A	0.14 %	
(1 to 5) kHz	(33 to 329.99) mW:		
(0.1089 to 2.9696) mW	(3.3 to 8.999) mA	0.13 %	
(0.297 to 10.8893) mW	(9 to 32.999) mA	0.13 %	
(1.089 to 29.6958) mW	(33 to 89.99) mA	0.15 %	
(2.97 to 108.8934) mW	(90 to 329.99) mA	0.15 %	
(10.89 to 296.958) mW	(330 to 899.9) mA	0.55 %	
(29.7 to 725.945) mW	(0.9 to 2.1999) A	0.50 %	
(72.6 to 1484.922) mW	(2.2 to 4.4999) A	0.15 %	
148.5 mW to 6.7648 W	(4.5 to 20.5) A	0.18 %	
	330 mV to 1020 V:		
1.089 mW to 9.179 W	(3.3 to 8.999) mA	0.14 %	
2.97 mW to 33.659 W	(9 to 32.999) mA	0.14 %	
10.89 mW to 91.7898 W	(33 to 89.99) mA	0.15 %	
(0.0297 to 336.5898) W	(90 to 329.99) mA	0.15 %	
(0.1089 to 917.898) W	(330 to 899.9) mA	0.55 %	
(0.297 to 2243.898) W	(0.9 to 2.1999) A	0.51 %	
(0.726 to 4589.898) W	(2.2 to 4.4999) A	0.15 %	
1.485 W to 20.91 kW	(4.5 to 20.5) A	0.18 %	

Parameter/Equipment	Range	CMC <sup>2,4,6</sup> (±)	Comments
AC Power – Generate <sup>3</sup> PF = (0 to 1) <sup>11</sup> (cont)  (5 to 10) kHz (0.1089 to 2.9696) mW (0.297 to 10.8893) mW (1.089 to 29.6958) mW (2.97 to 108.8934) mW (10.89 to 296.958) mW (29.7 to 725.945) mW (72.6 to 989.9667) mW  1.089 mW to 9.179 W 2.97 mW to 33.659 W 10.89 mW to 91.7898 W 29.7 mW to 336.5898 W (0.1089 to 917.898) W (0.297 to 2243.898) W (0.726 to 3059.9898) W  (10 to 30) kHz (0.1089 to 2.9696) mW (0.297 to 10.8893) mW (1.089 to 29.6958) mW (2.97 to 108.8934) mW  1.089 mW to 9.179 W 2.97 mW to 33.659 W 10.89 mW to 91.7898 W 29.7 mW to 336.5898 W	(33 to 329.99) mV: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA (330 to 899.9) mA (0.9 to 2.1999) A (2.2 to 2.999 99) A  330 mV to 1020 V: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA (330 to 899.9) mA (0.9 to 2.1999) A (2.2 to 2.999 99) A  (33 to 329.99) mV: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA  330 mV to 1020 V: (3.3 to 8.999) mA (9 to 32.999) mA (33 to 89.99) mA (90 to 329.99) mA	0.47 % 0.47 % 0.48 % 0.47 % 0.69 % 0.66 % 0.66 %  0.46 % 0.47 % 0.47 % 0.48 % 0.47 % 0.69 % 0.66 %  1.8 % 1.8 % 1.8 % 1.8 %  1.8 % 1.8 % 1.8 % 1.8 %	Fluke 5522A
Power Supplies <sup>3</sup> –  Ripple / Noise RMS - CV Ripple / Noise RMS - CC  Transient Response Time Voltage	Up to 1000 V Up to 50 A  Up to 5 ms Up to 1 V	59 μV/V 59 μV/V  12 mS/S 8.3 mV/V	Tektronix MDO3014 w/ load  Tektronix MDO3014 w/ load

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
RF Power – Measure <sup>3</sup>  1 mW Power Meter Reference	50 MHz	0.30 %	HP 478A-H76 w/ HP 432A and DMM
RF Power – Generate & Measure <sup>3</sup>  (-30 to +30) dBm (-70 to -30) dBm	3 Hz to 100 kHz	0.060 dB 0.091 dB	HP 33250A / 3458A
(-10 to +20) dBm (-20 to -10) dBm	100 kHz to 4.2 GHz	0.081 dB 0.080 dB	Signal generator and power meter w/ power sensor: 8482A
(-10 to +20) dBm (-20 to -10) dBm	(4.2 to 18) GHz	0.078 dB 0.083 dB	8481A
(-20 to +20) dBm	(18 to 26.5) GHz	0.080 dB	8485A
(-35 to + 20) dBm	DC to 100 MHz (>0.10 to 2.4) GHz (>2.4 to 8) GHz (>8 to 12.4) GHz (>12.4 to 26.5) GHz (>26.5 to 40) GHz (>40 to 50) GHz	0.016 dB 0.042 dB 0.064 dB 0.080 dB 0.097 dB 0.12 dB 0.14 dB	NRP50T w/ power meter
(-70 to -20) dBm	(18 to 26.5) GHz	0.15 dB	8485D
(+20 to +24) dBm	10 MHz to 18 GHz (18 to 26.5) GHz	0.16 dB 0.17 dB	8481A/8485A
RF Power – Generate <sup>3</sup>  (-56 to 27) dBm	DC to 5 MHz (> 5 to 20) MHz	0.19 dB 0.35 dB	Tektronix AFG2021
(16 to 24) dBm	(0.2 to 100) kHz (0.1 to 125) MHz	0.023 dB 0.049 dB	Fluke 96270A/LL/FF w/leveling head

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
RF Power – Generate <sup>3</sup> (cont)			
(3 to 16) dBm	(0.2 to 100) kHz (0.1 to 150) MHz (0.25 to 1.4) GHz	0.023 dB 0.050 dB 0.20 dB	Fluke 96270A/LL/FF w/leveling head
(-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 0.052 dB 0.17 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 0.052 dB 0.17 dB 0.26 dB 0.41 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 0.089 dB 0.33 dB 0.44 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	0.40 dB 0.10 dB 0.42 dB 0.80 dB	
(-124 to -84) dBm	(10 to 100) MHz (0.1 to 1.4) GHz	0.62 dB 1.5 dB	
RF Power Generate (Microwave Output)			
(-35 to 18) dB	1 kHz to 100 MHz (0.1 to 1.4) GHz	0.11 dB 0.12 dB	
(-35 to 14) dB	(1.4 to 2.4) GHz (2.4 to 8) GHz (8 to 12.4) GHz (12.4 to 18) GHz (18 to 20) GHz	0.14 dB 0.17 dB 0.17 dB 0.23 dB 0.26 dB	
(-35 to 12) dB	(20 to 26.5) GHz	0.34 dB	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
RF Attenuation – Tuned RF Power Measure <sup>3</sup>			
(0 to -10) dB	100 kHz to 10 MHz	0.018 dB	Rohde and Schwarz FSMR50
(-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		0.47 dB	
(-130 to -135) dB		1.3 dB	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
RF Attenuation – Tuned RF Power Measure <sup>3</sup> (cont)			
(0 to -5) dB	(22 to 26.5) GHz	0.22 dB	Rohde and Schwarz FSMR50
(-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	
(-90 to -95) dB		0.30 dB	
(-95 to -100) dB		0.27 dB	
(-100 to -105) dB		0.27 dB	
(-105 to -110) dB		0.31 dB	
(-110 to -115) dB		0.45 dB	
(-115 to -120) dB		0.31 dB	
(-120 to -130) dB		2.9 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	
(-10 to -15) dB		0.25 dB	
(-15 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	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
RF Attenuation – Tuned RF Power Measure <sup>3</sup> (cont)			
(-85 to -90) dB	(26.5 to 40) GHz	0.41 dB	Rohde and Schwarz FSMR50
(-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		0.18 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 -15) dB		0.45 dB	
(-15 to -20) dB		0.44 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 -65) dB		0.36 dB	
(-60 to -65) 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/Range	Frequency	CMC <sup>2,4,6</sup> (±)	Comments
Amplitude Modulation – Generate/Measure <sup>3</sup>  Rate: 10 Hz to 10 kHz Depth: (5 to 99) %  Rate: 10 Hz 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) %	(0.1 to 10) MHz  (0.01 to 50) GHz  (0.01 to 50) GHz  (0.01 to 50) GHz	1.5 %  1.0 %  1.5 %  0.42 %	HP 83650B monitored by Rohde and Schwarz FSMR 50
Frequency Modulation – Generate/Measure <sup>3</sup>  Rate: 10 Hz to 10 kHz Dev: ≤ 50 kHz peak  Rate: 10 Hz to 100 kHz Dev: ≤ 500 kHz peak  Rate: (100 to 200) kHz Dev: ≤ 500 kHz peak	(0.1 to 10) MHz  (0.01 to 50) GHz  (0.01 to 50) GHz	1.2 %  1.2 %  3.5 %	Rohde and Schwarz FSMR 50
Frequency Modulation – Generate <sup>3</sup>  Rate: DC to 100 kHz Rate: (100 to 200) kHz Dev.: ≤ 12.5 kHz peak  Rate: DC to 100 kHz Rate: (100 to 200) kHz Dev.: ≤ 100 kHz peak  Rate: DC to 100 kHz Rate: (100 to 200) kHz Dev.: ≤ 400 kHz peak	(11 to 13.5) MHz  (88 to 108) MHz  (352 to 432) MHz	0.44 % 0.43 %  0.43 % 0.43 %  0.43 % 0.56 %	HP 11715A

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> (±)	Comments
Phase Modulation – Measure <sup>3</sup>			
Rate: 50 Hz to 10 kHz	200 kHz to 10 MHz	1.0 %	Rohde and Schwarz FSMR 50
Rate: 50 Hz to 100 kHz	10 MHz to 50 GHz	1.0 %	
Phase Noise – Measure <sup>3</sup>			
Carrier Frequency: (1 to 10) MHz (-40 to 0176) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 kHz Offset 100 kHz Offset 1 MHz Offset	2.7 dBc 2.5 dBc 1.6 dBc 1.6 dBc 1.6 dBc 1.6 dBc 4.0 dBc	Rohde and Schwarz FSWP50
(10 to 100) MHz (-66 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	3.7 dBc 2.8 dBc 1.6 dBc 1.6 dBc 1.6 dBc 1.6 dBc 2.7 dBc 3.3 dBc 4.0 dBc	
100 MHz to 1 GHz (-46 to -173) 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 dBc 2.4 dBc 1.7 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.9 dBc 4.0 dBc 4.0 dBc	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Phase Noise – Measure <sup>3</sup> (cont)			
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 dBc 2.0 dBc 1.6 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.8 dBc 4.4 dBc 4.1 dBc	Rohde and Schwarz FSWP50
(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 dBc 2.6 dBc 1.7 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.3 dBc 3.9 dBc 4.6 dBc	
(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 dBc 2.7 dBc 1.8 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.5 dBc 3.3 dBc 4.6 dBc	
(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 dBc 2.7 dBc 1.7 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.3 dBc 4.1 dBc 4.0 dBc	

Parameter/Range	Frequency	CMC <sup>2, 4, 6</sup> ( $\pm$ )	Comments
Phase Noise – Measure <sup>3</sup> (cont)			
Carrier Frequency: (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 dBc 2.7 dBc 1.7 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.6 dBc 4.2 dBc 4.0 dBc	Rohde and Schwarz FSWP50
(26.5 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 dBc 2.0 dBc 1.8 dBc 1.6 dBc 1.6 dBc 1.6 dBc 3.7 dBc 3.6 dBc 4.4 dBc	
Digital Modulation – Measure <sup>3</sup>			
Carrier: 2 MHz to 50 GHz			Rohde and Schwarz FSMR50
Error Vector Magnitude for Modulation	Symbol Rate $\leq 1$ MHz $\leq 10$ MHz $\leq 15$ MHz	0.53 % 1.1 % 2.1 %	Types: 2FSK & 4FSK (include GFSK), BPSK, QPSK (3GPP WCDMA, CDMA2000®), OQPSK, DQPSK, $\pi/4$ DQPSK, 8PSK, D8PSK, 3 $\pi/8$ , 8PSK (EDGE), 16QAM, 32QAM, 64QAM, 128QAM, 256 QAM, D16QAM, D32QAM, D64QAM, D128QAM, D256QAM, 8VSB, GSM, NADC, PDC, PHS, Bluetooth®, DECT, TETRA
Phase Error for Modulation	Mod Freq Span $\leq 100$ kHz $\leq 1$ MHz $\leq 10$ MHz > 10 MHz	0.32 ° 0.42 ° 0.64 ° 1.3 °	

III. Mechanical

Parameter/Equipment	Range	CMC <sup>2, 6, 8</sup> ( $\pm$ )	Comments
Pressure <sup>3</sup> –			
Hydraulic	(2 to 500) psig (200 to 10 000) psig	(0.040 + 0.000 076 <i>P</i> ) psi (0.0040 + 0.000 072 <i>P</i> ) psi	Pressurements W2200-3
Pneumatic	(3 to 500) psig (-14.5 to 0) psig (15 to 150) in·H <sub>2</sub> O	(0.0062 + 0.000 068 <i>P</i> ) psi (0.00059 + 0.000 049 <i>P</i> ) psi 0.019 %	Pressurements T-3500/3 Pressurements T9000
	(-13.2 to 35) psia (-5 to 300) psia (0 to 3000) psia	0.010 % + 0.0041 psi 0.010 % + 0.026 psi 0.010 % + 0.24 psi	Fluke PM600 modules
	(0 to 1) in·H <sub>2</sub> O (1 to 10) in·H <sub>2</sub> O	(0.000 43 + 0.0024 <i>P</i> ) in·H <sub>2</sub> O (0.0053 + 0.00085 <i>P</i> ) in·H <sub>2</sub> O	Ashcroft AQS-1 modules <i>P</i> is applied pressure
Scales & Balances <sup>3</sup>	(1 to 50) mg (50 to 100) 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 3.5) kg	16 $\mu$ g 29 $\mu$ g 65 $\mu$ g 0.13 mg 73 $\mu$ g 87 $\mu$ g 0.15 mg 0.30 mg 0.65 mg 0.93 mg 1.6 mg 2.9 mg 6.1 mg 9.1 mg 14 mg	Class S weights

Parameter/Equipment	Range	CMC <sup>2, 6, 8</sup> ( $\pm$ )	Comments
Scales & Balances <sup>3</sup> (cont)	Up to 1 lb (1 to 10) lb (10 to 25) lb (25 to 100) lb (100 to 250) lb (250 to 500) lb	0.000 90 lb 0.0009 lb 0.0013 lb 0.054 lb 0.059 lb 0.072 lb	Class F weights
Tachometers –  Optical  Mechanical	(55 to 200 000) RPM  (55 to 100) RPM (> 100 to 1000) RPM (> 1000 to 30 000) RPM	0.0023 RPM  0.013 RPM (0.0069 + 0.000 031 <i>R</i> ) RPM (0.54 + 0.000 022 <i>R</i> ) RPM	HP 3325 w/ LED  GEC H8224-837837 monitored w/5335A & GPS; <i>R</i> is for the measured RPM
Torque Measure – Torque Wrenches & Tools <sup>3</sup>	(5 to 50) lbf·in (40 to 400) lbf·in (100 to 1000) lbf·in (25 to 250) lbf·ft (60 to 600) lbf·ft (5 to 50) ozf·in (15 to 200) ozf·in  (0.5 to 10) ozf·in (6 to 43) ozf·in	0.30 % 0.31 % 0.46 % 0.43 % 0.65 % 0.61 % 0.32 %  0.27 % 0.30 %	CDI Display w/ 2000-400-02  CDI 2000-12-02 CDI 2000-04-02 CDI 2000-05-02  Waters Mfg 6500-T4

IV. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2, 8</sup> (±)	Comments
Relative Humidity – Measuring Equipment	(10 to 50) % RH (>50 to 95) % RH	0.54 % RH 0.64 % RH	Thunder Scientific 2500 ST-LT
Relative Humidity – Measure <sup>3</sup>	(10 to 90) % RH (90 to 95) % RH	1.3 % RH 2.4 % RH	Vaisala HMI-41 RH meter w/ HMP 46 probe
Temperature – Measuring Equipment <sup>3</sup>	(-30 to -5) °C (-5 to 100) °C (100 to 200) °C (200 to 660) °C  (0 to 100) °C	0.087 °C 0.077 °C 0.074 °C 0.27 °C  0.020 °C	RTD Hart 5628 w/readout: Hart 9011 Hart 7102 Hart 6102 Hart 9011  Thermistor 5665 w/readout, thermal bath
Temperature – Measure <sup>3</sup>	(-200 to 200) °C (200 to 420) °C (420 to 660) °C  (0 to 100) °C	0.060 °C 0.076 °C 0.12 °C  0.020 °C	RTD Hart 5628 w/readout  Thermistor 5665 w/readout
Infrared Temperature – Measuring Equipment <sup>3, 9</sup>	(10 to 100) °C (100 to 120) °C  35 °C (> 35 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 500) °C	0.56 °C 0.65 °C  0.45 °C 0.57 °C 0.86 °C 1.4 °C 1.9 °C	Fluke 4180  Fluke 4181

## V. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2,8</sup> ( $\pm$ )	Comments
Frequency – Measuring Equipment <sup>3</sup>	(0.001 to 1000) Hz 1000 Hz to 20 MHz	0.17 mHz/Hz 0.18 nHz/Hz	GPS disciplined oscillator, Tektronix AFG2021
	10 MHz to 50 GHz	0.17 nHz/Hz	GPS disciplined oscillator, HP 83650
Frequency – Measure <sup>3</sup>	0.001 Hz to 1 kHz (1 to 1000) kHz (1 to 225) MHz 225 MHz to 3 GHz	54 $\mu$ Hz/Hz 0.34 nHz/Hz 0.21 nHz/Hz 0.21 nHz/Hz	Agilent 5313XA OPT 3 w/GPS
Stopwatches & Timers <sup>3</sup>	(0 to 19.99) s/day	0.040 s/day	Timometer 4500

<sup>1</sup> This laboratory offers commercial and field calibration service.

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

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

<sup>4</sup> The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

<sup>5</sup> In the statement of CMC,  $L$  is the numerical value of the nominal length of the device measured in inches;  $R$  is the resolution of the unit under test.

<sup>6</sup> In the statement of CMC, percentages are to be read as percent of reading, unless indicated otherwise.

<sup>7</sup> This scope meets A2LA's *P112 Flexible Scope Policy*.



<sup>8</sup> 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.

<sup>9</sup> Measurements made on calibrated blackbody source with an emissivity of 0.95 within the (8 to 14)  $\mu\text{m}$  spectral band.

<sup>10</sup> Measurement uncertainty at intermediate values is calculated using the Manufacturers Limits of Error Calculator

<sup>11</sup> Measurement uncertainty at PF other than 1 is calculated using the Manufacturers Guide in the Service Manual stating "Overall uncertainty for power output in Watts (or VARs) is based on the root sum square (rss) of the individual uncertainties in percent for the selected voltage, current, and power factor parameters.



# Accredited Laboratory

A2LA has accredited

**TEKTRONIX, INC.**

Charlotte, NC

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/NCSLI 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 20<sup>th</sup> day of December 2021.

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

Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 2357.20  
Valid to March 31, 2024

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