



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: January 31, 2025

Certificate Number: 2357.10

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1,7}:

I. Dimensional

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Micrometers – Inside, Outside, & Depth ³	Up to 4 in (4 to 12) in (12 to 48) in	(7.9 + 2.8L) µin (22 + 4.7L) µin (12 + 5.6L) µin	Gage Blocks
Flatness	Up to 1 in	5.3 µin	Optical flat
Parallelism	Up to 0.001 in	6.6 µin	Gage blocks, surface plate
Calipers ³	Up to 4 in (4 to 12) in (12 to 48) in	(30 + 1.3L) µin (285 + 1.3L) µin (267 + 2.8L) µin	Gage blocks
Height Gages ³	Up to 12 in (12 to 48) in	(57 + 1.3L) µin (36 + 3.0L) µin	Gage blocks & surface plate
Indicators	Up to 4 in	21 µin	Gage blocks
Depth Gages	(0.005 to 0.05) in (0.05 to 4) in (4 to 12) in (12 to 48) in	59 µin (58 + 0.25L) µin (43 + 4L) µin (55 + 3L) µin	Gage blocks

II. Electrical – DC / Low Frequency

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Voltage – Generate ³	0 V	67 nV	Copper Short
	(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	7.9 μV/V + 0.39 μV 4.8 μV/V + 0.62 μV 3.2 μV/V + 2.3 μV 3.2 μV/V + 3.9 μV 4.8 μV/V + 39 μV 6.4 μV/V + 0.39 mV	Fluke 5730A
	(10 to 120) kV	1.2 mV/V	Ross 120 kV divider w/ 34401A
DC Voltage – Measure ³	0 V	67 nV	Copper short
	Up to 100 mV (0.1 to 1.2) V (1.2 to 10) V (10 to 100) V (100 to 1000) V	6.6 μV/V + 0.23 μV 2.4 μV/V + 0.23 μV 2.4 μV/V + 0.39 μV 3.9 μV/V + 23 μV 4.1 μV/V + 78 μV	HP 3458A, opt 002
	(1.1 to 120) kV	1.2 mV/V	Ross 120 kV divider w/ 34401A
DC Current – Generate ³	0 A	2.2 pA	Open
	Up to 220 μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) 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 0.28 mA/A + 0.37 mA	Fluke 5730A
	(11 to 20.5) A	0.81 mA/A + 0.58 mA	Fluke 5730A w/ 5725A
	(20.5 to 100) A	0.36 %	Fluke 5522A
	With Shunts	(20 to 50) A (50 to 100) A (100 to 300) A	0.4 mA/A + 390 mA 0.4 mA/A + 780 mA 0.41 mA/A + 230 mA
Clamp-On Only	(16.5 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/ coil

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Resistance – Generate	(0 to 10.9999) Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω (0.33 to 1.099 999) kΩ (1.1 to 3.299 999) kΩ (3.3 to 10.999 99) kΩ (11 to 32.999 99) kΩ (33 to 109.9999) kΩ (110 to 329.9999) kΩ (0.33 to 1.099 999) MΩ (1.1 to 3.299 999) MΩ (3.3 to 10.999 99) MΩ (11 to 32.999 99) MΩ (33 to 109.9999) MΩ (110 to 329.9999) MΩ (330 to 1100) MΩ	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 5522A
	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 0.12 mΩ 0.16 mΩ 0.21 mΩ 0.42 mΩ 0.97 mΩ 1.8 mΩ 6.4 mΩ 12 mΩ 64 mΩ 0.12 Ω 0.82 Ω 1.9 Ω 13 Ω 57 Ω 0.89 kΩ 1.7 kΩ 20 kΩ	Fluke 5730A
DC Current – Measure ³	0 A Up to 1 pA (1 to 10) pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 to 100) nA (0.1 to 1) μA	2.2 pA 13 fA/pA + 8.1 fA 6 fA/pA + 8.1 fA 2 fA/pA + 35 fA 0.6 pA/nA + 230 fA 0.6 pA/nA + 2.3 pA 0.6 pA/nA + 23 pA 0.6 nA/pA + 350 nA	3458A, open Keithley 6430
	0 to 200 μA (0.2 to 2) mA (2 to 20) mA	13 μA/A + 0.40 nA 14 μA/A + 4.0 nA 14 μA/A + 40 nA	Fluke 8508A

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Current – Measure ³ (cont)	(20 to 200) mA (0.2 to 2) A (2 to 20) A (20 to 50) A (50 to 100) A (100 to 300) A	48 µA/A + 0.80 µA 0.18 mA/A + 16 µA 0.41 mA/A + 0.4 mA 0.40 mA/A + 0.39 A 0.40 mA/A + 0.78 A 0.41 mA/A + 0.23 A	3458A w/ various shunts
DC Resistance – Measure ³			Fluke 8508A
True Ohms Mode	Up to 2 Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ	19 µΩ/Ω + 4 µΩ 10 µΩ/Ω + 14 µΩ 8.8 µΩ/Ω + 50 µΩ 8.7 µΩ/Ω + 0.5 mΩ	
Normal Mode	(2 to 20) kΩ (2 to 200) kΩ (0.2 to 2) MΩ	8.7 µΩ/Ω + 5 mΩ 8.9 µΩ/Ω + 50 mΩ 11 µΩ/Ω + 1 Ω	
High Voltage Mode	(2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	21 µΩ/Ω + 10 Ω 68 µΩ/Ω + 1 kΩ 0.19 mΩ/Ω + 0.1 MΩ 1.5 mΩ/Ω + 10 MΩ	
AC Voltage – Generate ³			
(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 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 w/ Fluke 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 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 ^{2,4} (±)	Comments
AC Voltage – Generate ³ (cont)			
(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 w/ Fluke 5725A
(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	
(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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate ³ (cont)			
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 μV 3.7 mV/V + 2.3 μV 5.5 mV/V + 2.3 μV 13 mV/V + 12 μV	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 μV 2.2 mV/V + 2.3 μV 4.9 mV/V + 2.3 μV 13 mV/V + 2.3 μV	
(3 to 11) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.4 mV/V 0.94 mV/V 1.12 mV/V + 2.3 μV 2.0 mV/V + 2.3 μV 3.9 mV/V + 2.3 μV 8.6 mV/V + 2.3 μV	
(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 μV 2.0 mV/V + 2.3 μV 3.8 mV/V + 2.3 μV 8.5 mV/V + 2.3 μV	
(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 μV 2.0 mV/V + 2.3 μV 3.8 mV/V + 2.3 μV 8.1 mV/V + 2.3 μV	
(110 to 330) mV	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.84 mV/V 1.1 mV/V + 2.3 μV 2.0 mV/V + 2.3 μV 3.8 mV/V + 2.3 μV 8.5 mV/V + 2.3 μV	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate ³ (cont)			
Wideband Output 330 mV to 1.1 V	(10 to 30) Hz 30 Hz to 120 kHz (0.12 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.3 mV/V 0.84 mV/V 1.0 mV/V + 2.3 μV 2.0 mV/V + 2.3 μV 3.8 mV/V + 2.3 μV 8.5 mV/V + 2.3 μV	Fluke 5720A
(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 μV 2.0 mV/V + 2.3 μV 3.8 mV/V + 2.3 μV 8.5 mV/V + 2.3 μV	
(1 to 85) kV	60 Hz	5.9 mV/V	Ross 120 kV divider w/ 34401A
AC Current – Generate ³			Fluke 5730A
(1 to 220) μA	(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	
(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 μA 1.0 mA/A + 0.62 μA	
(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	
(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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Generate ³ (cont)			
(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	Fluke 5730A
(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
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 1.09999 A 1.1 to 2.99999 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	Fluke 5522A
(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	
Clamp-On Only (10 to 149.999) A	(45 to 65) Hz (65 to 440) Hz	0.31 % 0.81 %	Fluke 5522A w/coil
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	0.33 % 0.82 %	
AC Voltage – Measure			
Up to 199.99 mV	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.35 mV/V + 14 µV 0.16 mV/V + 4.0 µV 0.12 mV/V + 4.0 µV 0.12 mV/V + 2.0 µV 0.14 mV/V + 4.0 µV 0.35 mV/V + 8.0 µV 0.77 mV/V + 20 µV	Fluke 8508A
(0.2 to 1.9999) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.50 mV/V + 0.12 mV 0.12 mV/V + 20 µV 0.11 mV/V + 20 µV 79 µV/V + 20 µV 0.11 mV/V + 20 µV 0.23 mV/V + 40 µV 0.59 mV/V + 0.20 mV 3.0 mV/V + 2.0 mV 10 mV/V + 20 mV	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Measure (cont)			
(2 to 19.999) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.36 mV/V + 1.2 mV 0.13 mV/V + 0.20 mV 95 μV/V + 0.20 mV 85 μV/V + 0.20 mV 0.11 mV/V + 0.20 mV 0.22 mV/V + 0.40 mV 0.58 mV/V + 2.0 mV 3.0 mV/V + 20 mV 10 mV/V + 0.20 V	Fluke 8508A
(20 to 199.99) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.43 mV/V + 12 mV 0.13 mV/V + 2.0 mV 98 μV/V + 2.0 mV 83 μV/V + 2.0 mV 0.12 mV/V + 2.0 mV 0.22 mV/V + 4.0 mV 0.58 mV/V + 20 mV 1.6 mV/V + 0.2 V 5.2 mV/V + 2.0 V	
(100 to 1050) V	(1 to 10) Hz (10 to 40) Hz (40 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.50 mV/V + 10 mV 0.13 mV/V + 20 mV 0.16 mV/V + 20 mV 0.38 mV/V + 40 mV 0.66 mV/V + 0.20 V	
(1 to 85) kV	60 Hz	5.9 mV/V	Ross 120 kV divider w/ 34401A
AC Current – Measure ³			
Up to 199.99 μA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.58 mA/A + 20 nA 0.52 mA/A + 20 nA 0.65 mA/A + 20 nA 3.1 mA/A + 20 nA	Fluke 8508A
(0.2 to 1.9999) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.42 mA/A + 0.20 μA 0.31 mA/A + 0.20 μA 0.63 mA/A + 0.20 μA 3.1 mA/A + 0.20 μA	
(2 to 19.999) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.41 mA/A + 2.0 μA 0.31 mA/A + 2.0 μA 0.63 mA/A + 2.0 μA 3.7 mA/A + 2.0 μA	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Measure ³ (cont)			
(20 to 199.99) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.42 mA/A + 20 µA 0.30 mA/A + 20 µA 0.68 mA/A + 20 µA	Fluke 8508A
(0.2 to 1.9999) A	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.57 mA/A + 0.20 mA 0.85 mA/A + 0.20 mA 2.4 mA/A + 0.20 mA	
(20 to 19.999) A	10 Hz to 2 kHz (2 to 10) kHz	0.74 mA/A + 0.20 mA 2.1 mA/A + 0.20 mA	
With Shunts (20 to 100) A (100 to 300) A	60 Hz 60 Hz	0.40 µA/A + 390 mA 0.41 mA/A + 230 mA	3458A w/ various shunts
Capacitance – Generate ³			
(0.19 to 1.0999) nF	10 Hz to 10 kHz	4.0 mF/F + 7.8 pF	Fluke 5522A
(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	
AC Level Flatness ³ –			
0.5, 1, 3 Vrms Thermal Converter	10 Hz to < 30 kHz (30 to < 100) kHz (0.1 to < 1) MHz (1 to < 3) MHz (3 to < 8) MHz	0.12 % 0.23 % 0.29 % 0.58 % 0.70 %	By comparison to thermal voltage converters w/ HP 3458A OPT 002

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Level Flatness ³ – (cont)			
0.5, 1, 3 Vrms Thermal Converter	(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	0.71 % 0.76 % 1.8 % 2.8 % 3.6 % 3.9 % 4.8 %	By comparison to thermal voltage converters w/ HP 3458A OPT 002
Oscilloscopes –			
Amplitude DC Signal 50 Ω Load 1 MΩ Load	0 V to ± 6.6 V 0 V to ± 130 V	1.9 mV/V + 31 μV 0.39 mV/V + 31 μV	Fluke 5522A
Amplitude Square Wave 10 Hz to 10 kHz			
50 Ω Load	1 mV to ± 6.0 V _{p-p} 10 Hz to 10 kHz	2.1 mV/V + 31 μV	
1 MΩ Load	1 mV to ± 200 V _{p-p} 10 Hz to 10 kHz	0.78 mV/V + 31 μV	
Bandwidth / Level Sine Flatness ³	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 %	Power meter & sensor with signal generator
Time Marker	1 ns to 20 ms 50 ms to 5 s Non-cardinal point	2.5 μs/s (19 + 38t) μs/s 39 μs/s	Fluke 5522A 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	
Resistance	(40 to 60) Ω (0.6 to 1.5) MΩ	0.79 mΩ/Ω 0.79 mΩ/Ω	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ –			
Type B	(600 to 800) °C (800 to 1550) °C (1550 to 1820) °C	0.29 °C 0.24 °C 0.20 °C	Fluke 7526A
Type C	(0 to 1000) °C (1000 to 1800) °C (1800 to 2000) °C (2000 to 2316) °C	0.16 °C 0.21 °C 0.22 °C 0.29 °C	
Type E	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 600) °C (600 to 1000) °C	0.22 °C 0.14 °C 0.12 °C 0.12 °C 0.13 °C	
Type J	(-210 to -100) °C (-100 to 800) °C (800 to 1200) °C	0.20 °C 0.13 °C 0.13 °C	
Type K	(-250 to -200) °C (-200 to -100) °C (-100 to 500) °C (500 to 800) °C (800 to 1372) °C	0.37 °C 0.16 °C 0.13 °C 0.13 °C 0.14 °C	
Type L	(-200 to -100) °C (-100 to 900) °C	0.13 °C 0.12 °C	
Type N	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 100) °C (100 to 800) °C (800 to 1300) °C	0.57 °C 0.21 °C 0.14 °C 0.13 °C 0.13 °C 0.14 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ – (cont)			
Type R	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1000) °C (1000 to 1600) °C (1600 to 1767) °C	0.44 °C 0.37 °C 0.32 °C 0.24 °C 0.20 °C 0.19 °C 0.18 °C 0.21 °C	Fluke 7526A
Type S	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1000) °C (1000 to 1600) °C (1600 to 1767) °C	0.41 °C 0.37 °C 0.31 °C 0.25 °C 0.21 °C 0.20 °C 0.20 °C 0.23 °C	
Type T	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 200) °C (200 to 400) °C	0.30 °C 0.16 °C 0.13 °C 0.12 °C 0.12 °C	
Type U	(-200 to 0) °C (0 to 200) °C (200 to 600) °C	0.17 °C 0.13 °C 0.13 °C	
Electrical Calibration of RTDs ³ –			Fluke 7526A
PT 385, 100 Ω	(-200 to -800) °C	0.044 °C	
Pt 3926, 100 Ω	(-200 to 630) °C	0.044 °C	
Pt 3916, 100 Ω	(-200 to 630) °C (JIS)	0.044 °C	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of RTDs ³ – (cont)			
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	Fluke 5520A
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	(-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	
DC Power – Generate ³ 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 5522A

Parameter/Equipment	Range	CMC ^{2,4,6} (±)	Comments
AC Power – Generate ³ PF = (0 to 1)			Fluke 5522A
(10 to 45) Hz	(33 to 329.99) mV		
(0.1089 to 2.9696) mW	(3.3 to 8.999) mA	0.15 %	
(0.297 to 10.8893) mW	(9 to 32.999) mA	0.15 %	
(1.089 to 29.6958) mW	(33 to 89.99) mA	0.040 %	
(2.97 to 108.8934) mW	(90 to 329.99) mA	0.040 %	
(10.89 to 296.958) mW	(330 to 899.9) mA	0.049 %	
(29.7 to 725.945) mW	(0.9 to 2.1999) A	0.052 %	
(72.6 to 1484.922) mW	(2.2 to 4.4999) A	0.064 %	
148.5 mW to 6.7648 W	(4.5 to 20.5) A	0.11 %	
	330 mV to 1020 V		
1.089 mW to 9.179 W	(3.3 to 8.999) mA	0.15 %	
2.97 mW to 33.659 W	(9 to 32.999) mA	0.15 %	
10.89 mW to 91.7898 W	(33 to 89.99) mA	0.044 %	
(0.0297 to 336.5898) W	(90 to 329.99) mA	0.044 %	
(0.1089 to 917.898) W	(330 to 899.9) mA	0.053 %	
(0.297 to 2243.898) W	(0.9 to 2.1999) A	0.056 %	
(0.726 to 4589.898) W	(2.2 to 4.4999) A	0.067 %	
1.485 W to 20.91 kW	(4.5 to 20.5) A	0.12 %	
(45 to 65) Hz	33 to 329.999 mV		
(0.109 to 3.0) mW	(3.3 to 8.999) mA	0.23 %	
(0.297 to 10.89) mW	(9 to 32.999) mA	0.14 %	
(1.09 to 29.7) mW	(33 to 89.99) mA	0.11 %	
(3.0 to 108.9) mW	(90 to 329.99) mA	0.13 %	
(10.9 to 297) mW	(330 to 899.9) mA	0.1 %	
(29.7 to 726) mW	(0.9 to 2.1999) A	0.1 %	
72.6 mW to 1.5 W	(2.2 to 4.4999) A	0.11 %	
148.5 mW to 6.8 W	(4.5 to 20.5) A	0.1 %	
	330 mV to 1020 V		
1.09 mW to 9.2 W	(3.3 to 8.999) mA	0.34 %	
2.97 mW to 33.6 W	(9 to 32.999) mA	0.062 %	
10.9 mW to 91.8 W	(33 to 89.99) mA	0.094 %	
29.7 mW to 336.6 W	(90 to 329.99) mA	0.062 %	
108.9 mW to 918 W	(330 to 899.9) mA	0.086 %	
297 mW to 2244 W	(0.9 to 2.1999) A	0.071 %	
72.6 mW to 4590 W	(2.2 to 4.4999) A	0.094 %	
(1.49 W to 20 910) W	(4.5 to 20.5) A	0.077 %	
65 Hz to 1 kHz	(33 to 329.99) mV		
(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 %	

Parameter/Equipment	Range	CMC ^{2,4,6} (±)	Comments
AC Power – Generate ³ PF = (0 to 1) (cont)			Fluke 5522A
65 Hz to 1 kHz	(33 to 329.99) mV		
(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 %	
(0.1089 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) mV		
(0.1089 to 2.9696) mW	(3.3 to 8.999) mA	0.10 %	
(0.297 to 10.8893) mW	(9 to 32.999) mA	0.10 %	
(1.089 to 29.6958) mW	(33 to 89.99) mA	0.12 %	
(2.97 to 108.8934) mW	(90 to 329.99) mA	0.12 %	
(10.89 to 296.958) mW	(330 to 899.9) mA	0.54 %	
(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	0.12 %	
148.5 mW to 6.7648 W	(4.5 to 20.5) A	0.16 %	
	330 mV to 1020 V		
1.089 mW to 9.179 W	(3.3 to 8.999) mA	0.10 %	
2.97 mW to 33.659 W	(9 to 32.999) mA	0.10 %	
10.89 mW to 91.7898 W	(33 to 89.99) mA	0.12 %	
(0.0297 to 336.5898) W	(90 to 329.99) mA	0.12 %	
(0.1089 to 917.898) W	(330 to 899.9) mA	0.54 %	
(0.297 to 2243.898) W	(0.9 to 2.1999) A	0.50 %	
(0.726 to 4589.898) W	(2.2 to 4.4999) A	0.12 %	
1.485 W to 20.91 kW	(4.5 to 20.5) A	0.16 %	
(5 to 10) kHz	(33 to 329.99) mV		
(0.1089 to 2.9696) mW	(3.3 to 8.999) mA	0.34 %	
(0.297 to 10.8893) mW	(9 to 32.999) mA	0.34 %	
(1.089 to 29.6958) mW	(33 to 89.99) mA	0.35 %	
(2.97 to 108.8934) mW	(90 to 329.99) mA	0.34 %	
(10.89 to 296.958) mW	(330 to 899.9) mA	0.61 %	
(29.7 to 725.945) mW	(0.9 to 2.1999) A	0.57 %	
(72.6 to 989.9667) mW	(2.2 to 2.999 99) A	0.57 %	

Parameter/Equipment	Range	CMC ^{2, 4, 6} (±)	Comments
AC Power – Generate ³ PF = (0 to 1) (cont)			Fluke 5522A
(5 to 10) kHz 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	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	0.33 % 0.34 % 0.34 % 0.36 % 0.35 % 0.61 % 0.57 %	
(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	(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	1.2 % 1.2 % 1.2 % 1.2 %	
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	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	1.2 % 1.2 % 1.3 % 1.3 %	
Power Supplies – Measure ³			
Ripple / Noise RMS - CV Ripple / Noise RMS - CC	Up to 1000 V Up to 5) A	59 μV/V 59 μA/A	Tektronix MDO3014 with load
Transient Response Time Voltage	Up to 5 ms Up to 1 V	2 ms/s 8.3 mV/V	Tektronix MDO3014 with load

III. Electrical – RF / Microwave

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
RF Power – Measure ³ 1 mW Power Meter Reference	50 MHz	0.26 %	HP 478A-H76 w/ HP 432A & DMM
RF Power – Generate & Measure ³ (-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 & 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
(-35 to + 20) dBm	0.1 MHz to 100 MHz 100 MHz to 2.4 GHz 2.4 GHz to 8.0 GHz 8.0 GHz to 12.4 GHz 12.4 GHz to 18.0 GHz 18.0 GHz to 26.5 GHz 26.5 GHz to 33.0 GHz 33.0 GHz to 40.0 GHz 40.0 GHz to 44.0 GHz 44.0 GHz to 50.0 GHz	0.027 dBm 0.042 dBm 0.064 dBm 0.082 dBm 0.11 dBm 0.098 dBm 0.11 dBm 0.11 dBm 0.14 dBm 0.14 dBm	NRP50T w/ power Meter
RF Power – Generate ³ (-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
(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	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
RF Power – Generate ³ (cont)			
(-7 to 3) dBm	(0.2 to 100) kHz	0.024 dB	Fluke 96270A/LL/FF w/leveling head
	(0.1 to 300) MHz	0.052 dB	
	(0.3 to 1.4) GHz	0.17 dB	
	(1.4 to 4.0) GHz	0.26 dB	
(-47 to -17) dBm	(0.2 to 100) kHz	0.024 dB	
	(0.1 to 300) MHz	0.052 dB	
	(0.3 to 1.4) GHz	0.17 dB	
	(1.4 to 3.5) GHz	0.26 dB	
	(3.5 to 4.0) GHz	0.41 dB	
(-66 to -47) dBm	(0.1 to 10) MHz	0.16 dB	
	(10 to 300) MHz	0.089 dB	
	(0.3 to 1.4) GHz	0.33 dB	
	(1.4 to 4) GHz	0.44 dB	
(-85 to -66) dBm	(0.1 to 10) MHz	0.40 dB	
	(10 to 150) MHz	0.10 dB	
	(0.15 to 1.5) GHz	0.42 dB	
	(1.5 to 4) GHz	0.80 dB	
(-124 to -84) dBm	(10 to 100) MHz	0.62 dB	
	(0.1 to 1.4) GHz	1.5 dB	
RF Power – Generate (Microwave Output)	Up to 100 MHz	0.43 %	Fluke 96270A/LL/FF w/leveling head
	(0.1 to 1) GHz	0.57 %	
	(1 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 22 GHz)	1.6 %	
	(22 to 26.5) GHz	2.5 %	

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Attenuation – Tuned RF Power Measure ³			
(0 to -10) dB	100 kHz to 10 MHz	0.018 dB	Rohde & Schwarz R&S FSMR3050
(-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 ^{2,4} (±)	Comments
RF Attenuation – Tuned RF Power Measure ³ (cont)			
(0 to -5) dB	(22 to 26.5) GHz	0.22 dB	Rohde & Schwarz R&S FSMR3050
(-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	
(-85 to -90) dB		0.41 dB	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
RF Attenuation – Tuned RF Power Measure ³ (cont)			
(-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	0.42 dB 0.40 dB 0.38 dB 0.47 dB 0.55 dB 0.18 dB 0.26 dB	Rohde & Schwarz R&S FSMR3050
(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 (-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	(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 0.36 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	
Amplitude Modulation – Generate/Measure ³			
Rate: 10 Hz to 10 kHz Depth: (5 to 99) %	(0.1 to 10) MHz	1.5 %	HP 83650B monitored by Rohde & Schwarz R&S FSMR3050
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 %	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
Frequency Modulation – Measure ³ 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 %	R&S FSMR3050
Frequency Modulation – Generate ³ 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
Phase Modulation – Measure ³ Rate: 10 Hz to 10 kHz Rate: 10 Hz to 5 MHz	200 kHz to 10 MHz 10 MHz to 50 GHz	1.0 % 1.0 %	R&S FSMR3050
Phase Noise – Measure ³ Carrier Frequency (1 to 10) MHz (-40 to -176) dBc	1 Hz Offset 10 Hz Offset 100 Hz Offset 1 kHz Offset 10 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 4.0 dB	R&S FSMR3050

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Phase Noise – Measure ³			R&S FSMR3050
(10 to 100) MHz (-66 to -175) dBc	1 Hz Offset	3.7 dB	
	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 (-46 to -173) dBc	1 Hz Offset	3.2 dB	
	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		
(1 to 3) GHz (+10 to -170) dBc	1 Hz Offset	4.2 dB	
	10 Hz Offset	2.0 dB	
	100 Hz Offset	1.6 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.8 dB	
	10 MHz Offset	4.4 dB	
>30 MHz Offset	4.1 dB		
(3 to 7) GHz (+17 to -166) dBc	1 Hz Offset	4.4 dB	
	10 Hz Offset	2.6 dB	
	100 Hz Offset	1.7 dB	
	1 kHz Offset	1.6 dB	
	10 kHz Offset	1.6 dB	
	100 kHz Offset	1.6 dB	
	1 MHz Offset	3.3 dB	
	10 MHz Offset	3.9 dB	
>30 MHz Offset	4.6 dB		

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
Phase Noise – Measure ³ (cont)			
(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	R&S FSMR3050
(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	
(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	
Average Noise & Residuals (DANL) ³			50 Ω load
(-30 to -170) dBm	20 Hz to 50 GHz	0.78 dB	
3rd Order Intermodulation ³			Fluke 96270A, Agilent 83650B
(0 to -120) dB	200 Hz to 50 MHz	2.1 dB	
(0 to -120) dB	50 MHz to 50 GHz	3.0 dB	

Parameter/Range	Frequency	CMC ^{2, 6} (\pm)	Comments
2 nd Harmonic Distortion ³ (0 to -120) dB (0 to -120) dB	200 Hz to 50 MHz 50 MHz to 50 GHz	2.8 dB 3.8 dB	Fluke 96270A, Agilent 83650B
Digital Modulation – Measure ³ Carrier: 2 MHz to 50 GHz Error Vector Magnitude for Modulation Phase Error for Modulation	Symbol Rate ≤ 1 MHz ≤ 10 MHz ≤ 15 MHz Mod Freq Span ≤ 100 kHz ≤ 1 MHz ≤ 10 MHz > 10 MHz	0.53 % 1.1 % 2.1 % 0.32 ° 0.42 ° 0.64 ° 1.3 °	Rohde & Schwarz R&S FSMR3050 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
Distortion– Measure Fundamental Frequency ³ 20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz Amplitude Modulation Distortion Depth of Modulation: 5 % to 99 % Frequency Modulation Distortion Deviation < 10 kHz Deviation < 50 kHz Deviation < 100 kHz Deviation < 500 kHz Phase Modulation Distortion Distortion - Audio Input (-100 to 0) dB	(-80 to 0) dB (-70 to 0) dB (-65 to 0) dB Carrier Frequency: 100 kHz to 10 MHz ≥ 10 MHz to 4 GHz 200 kHz to 10 MHz ≥ 10 MHz to 4 GHz 200 kHz to 10 MHz ≥ 10 MHz to 4 GHz 100 Hz to 100 kHz	1.2 dB 2.3 dB 2.3 dB 0.36 % 0.44 % 0.19 % 0.38 % 0.20 % 0.38 % 0.18 % 0.18 % 0.60 dB	HP 8903B R&S FSMR3050

IV. Mechanical

Parameter/Equipment	Range	CMC ^{2,8} (±)	Comments
Scales & Balances ³	5 to 10 mg	16 µg	Class S1 weights
	10 to 20 mg	16 µg	
	20 to 50 mg	16 µg	
	50 to 100 mg	29 µg	
	100 to 200 mg	29 µg	
	0.2 to 0.5 g	29 µg	
	0.5 to 1 g	65 µg	
	1 to 2 g	65 µg	
	2 to 3 g	130 µg	
	3 to 5 g	73 µg	
	5 to 10 g	87 µg	
	10 to 50 g	0.15 mg	
	50 to 100 g	0.3 mg	
	100 to 200 g	0.65 mg	
	200 to 300 g	0.98 mg	
	300 to 500 g	1.6 mg	
	0.5 to 1 kg	2.9 mg	
	1 to 2 kg	6.1 mg	
	2 to 3 kg	9.1 mg	
	3 to 3.5 kg	14 mg	
	(0.25 to 1) lb (113.398 g to 453.592 g)	44 mg	Class F weights
	(1 to 10) lb (453.592 g to 4535.92 g)	0.44 g	
	(10 to 25) lb (4535.92 g to 11.3398 kg)	0.65 g	
(25 to 50) lb (11.3398 kg to 22.6796 kg)	26 g		
(50 to 100) lb (22.6796 kg to 45.3952 kg)	27 g		
(100 to 250) lb (45.3592 kg to 113.398 kg)	29 g		
(250 to 500) lb (113.398 kg to 226.796 kg)	35 g		
(1 to 20) mg	14 µg	Class S1 weights using comparison method	
30 mg	14 µg		
(50 to 200) mg	14 µg		
300 mg	14 µg		
500 mg	14 µg		
1 g	41 µg		
2 g	41 µg		
3 g	42 µg		
5 g	41 µg		
10 g	60 µg		
20 g	87 µg		
30 g	88 µg		
50 g	0.14 mg		
100 g	0.30 mg		

Parameter/Equipment	Range	CMC ^{2, 6, 8} (\pm)	Comments
Mass (cont)	200 g 300 g 500 g 1 kg 2 kg 3 kg 5 kg 20 lb (9.07185 kg) 50 lb (22.6796 kg)	0.60 mg 0.89 mg 1.4 mg 2.9 mg 5.9 mg 8.7 mg 15 mg 22 mg 60 mg	Class S1 weights using comparison method
Tachometers	(60 to 100 000) RPM	0.0023 RPM + 0.6R	Datum 9390 w/3325B
Torque – Measuring Equipment ³	(10 to 100) ozf·in (5 to 50) ozf·in (40 to 400) ozf·in (100 to 1000) lbf·in (25 to 250) lbf·ft (60 to 600) lbf·ft (200 to 2000) lbf·ft	0.59 % 0.30 % 0.30 % 0.30 % 0.30 % 0.29 % 0.31 %	1001-O-DTT CDI 5000 ST w/ 2000-400-02 2000-12-02 2000-14-02
Torque Transducers	(2 to 200) ozf·in (4 to 110) lbf·in (9 to 275) lbf·ft (275 to 2000) lbf·ft (2000 to 4000) lbf·ft	0.045 % 0.046 % 0.052 % 0.046 % 0.061 %	Torque arms & wheels w/ NIST Class F weights
Pressure	(0 to 1) in·H ₂ O (1 to 5) in·H ₂ O (5 to 10) in·H ₂ O (10 to 20) in·H ₂ O (20 to 30) in·H ₂ O (1 to 5) psi (5 to 15) psi (15 to 100) psi (100 to 200) psi (200 to 300) psi (300 to 400) psi (400 to 500) psi (500 to 1000) psi (1000 to 1250) psi (1250 to 1500) psi (1500 to 1750) psi (1750 to 2500) psi (-29 to 0) in·Hg	0.000 24 in·H ₂ O 0.000 50 in·H ₂ O 0.000 97 in·H ₂ O 0.0020 in·H ₂ O 0.0029 in·H ₂ O 0.000 59 psi 0.0018 psi 0.0078 psi 0.013 psi 0.019 psi 0.025 psi 0.032 psi 0.065 psi 0.078 psi 0.094 psi 0.11 psi 0.16 psi 0.0019 in·Hg	Ruska 7250 lp Mensor 2500 w/ manual piston Ruska 7250 xi Ruska 7250 xi

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Pressure & Vacuum ³	(300 to 10 000) psi	0.03 %	Ametek TQ-100-1
Gas Flow – Measuring Equipment	Up to 10 sccm (10 to 25) sccm (25 to 50) sccm (50 to 75) sccm (75 to 100) sccm (100 to 250) sccm (250 to 500) sccm (500 to 750) sccm (750 to 1 000) sccm Up to 5 slm (5 to 10) slm (10 to 20) slm (20 to 30) slm (30 to 40) slm (40 to 50) slm (50 to 100) slm (100 to 150) slm (150 to 200) slm (200 to 300) slm	0.04 sccm 0.1 sccm 0.19 sccm 0.28 sccm 0.37 sccm 0.96 sccm 1.9 sccm 2.8 sccm 3.8 sccm 0.02 slm 0.03 slm 0.08 slm 0.11 slm 0.15 slm 0.19 slm 0.37 slm 0.56 slm 0.75 slm 1.1 slm	Fluke Molbloc/Molbox mass flow system

V. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Temperature – Measure	-196 to 0°C 0 to 200°C 200 to 420°C 420 to 660°C	0.061°C 0.061°C 0.11°C 0.12°C	Fluke 1595A w/5699 SPRT using comparison method
Temperature – Measuring Equipment	-196 °C (-80 to -38) °C (-38 to 0.0) °C (0.0 to 50.0) °C (50 to 150) °C (150 to 300) °C (300 to 660) °C	26 m°C 17 m°C 17 m°C 17 m°C 4.8 m°C 28 m°C 50 m°C	Fluke 1595A w/ 5699 & various baths & dry wells
Relative Humidity – Measuring Equipment	(10 to 95) %	0.53 % RH	Thunder Scientific 2500
Relative Humidity – Measuring Equipment ³	(10 to 95) %	1.2 % RH	Rotronic HP 23A w/ HC 2-S probe

VI. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 8} (\pm)	Comments
Frequency – Measuring Equipment	(0.001 to 1000) Hz 1000 Hz to 20 MHz	0.17 nHz/Hz 0.18 nHz/Hz	GPS disciplined oscillator, Tektronix AFG2021
	10 MHz to 50 GHz	0.17 nHz/Hz	GPS disciplined
Frequency – Measure	DC to 1.0 kHz (1.0 to 1000) kHz (1.0 to 225) MHz (0.225 to 12.4) GHz	0.12 mHz 0.29 nHz/Hz 38 pHz/Hz 39 pHz/Hz	Datum 9390 & 53132A
	(0.5 to 40.0) GHz	1.2 Hz/GHz	Datum 9390 & 5352B
Rise Time – Measure	20 ps to 1 ns	21 ps	83487A (RT = 0.35/BW)

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

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

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

⁴ 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.

⁵ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches.

⁶ All CMC's listed in % are percent of reading of input unless otherwise stated.

⁷ This scope meets A2LA's *P112 Flexible Scope Policy*.

⁸ The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.



Accredited Laboratory

A2LA has accredited

TEKTRONIX, INC.

Covina, CA

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/NCSLI Z540-1-1994, 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 23rd day of January 2023.

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

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2357.10
Valid to January 31, 2025

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