



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994

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CALIBRATION

Valid to: January 31, 2020

Certificate Number: 3295.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Voltage – Generate	(0 to 0.22) V	6.0 μV/V + 0.40 μV	Multifunction calibrator
	(0.22 to 2.2) V	3.5 μV/V + 0.70 μV	
Fixed Points	(2.2 to 11) V	2.5 μV/V + 2.5 μV	Low thermal EMF short Zener reference group/reference divider
	(11 to 22) V	2.5 μV/V + 4 μV	
	(22 to 220) V	3.5 μV/V + 40 μV	
	(220 to 1100) V	4.5 μV/V + 400 μV	
	0 V	20 nV	
	0.1 V	1.0 μV/V	
	1 V	0.53 μV/V	
10 V	0.50 μV/V		
100 V	0.53 μV/V		
1 kV	0.64 μV/V		
DC Voltage – Measure	(0 to 0.20) V	4.5 μV/V + 0.10 μV	Reference DMM
	(0.20 to 2.0) V	3.0 μV/V + 0.40 μV	
	(2.0 to 20) V	3.0 μV/V + 4 μV	
	(20 to 200) V	4.5 μV/V + 40 μV	
	(200 to 1000) V	4.5 μV/V + 500 μV	

Parameter/Equipment	Range	CMC ^{2,3} (±)	Comments
DC Voltage – Measure (cont)			
Fixed Points	10 V	0.50 $\mu\text{V/V}$	Zener reference group/volt reference
Fixed Points ⁴	0.1 V 1 V 100 V 1 kV	1.0 $\mu\text{V/V}$ 0.53 $\mu\text{V/V}$ 0.53 $\mu\text{V/V}$ 0.64 $\mu\text{V/V}$	Zener reference group/reference divider/null detector
DC Current – Generate	(0 to 1) μA (1 to 10) μA	25 $\mu\text{A/A} + 0.04 \text{ nA}$ 25 $\mu\text{A/A} + 0.10 \text{ nA}$	DMM using current source
	(10 to 100) μA 100 μA to 1 mA 1 mA to 1 A (1 to 10) A	20 $\mu\text{A/A}$ 10 $\mu\text{A/A}$ 60 $\mu\text{A/A}$ 0.012 %	DMM/DC shunts using current source
DC Current – Measure	(0 to 1) μA (1 to 10) μA (10 to 200) μA 200 μA to 2 mA (2 to 20) mA (20 to 100) mA 100 mA to 1 A (1 to 2) A (2 to 20) A	19 $\mu\text{A/A} + 31 \text{ pA}$ 19 $\mu\text{A/A} + 78 \text{ pA}$ 12 $\mu\text{A/A} + 0.4 \text{ nA}$ 12 $\mu\text{A/A} + 4 \text{ nA}$ 13 $\mu\text{A/A} + 40 \text{ nA}$ 40 $\mu\text{A/A} + 0.5 \mu\text{A}$ 115 $\mu\text{A/A} + 10 \mu\text{A}$ 170 $\mu\text{A/A} + 16 \mu\text{A}$ 380 $\mu\text{A/A} + 0.4 \text{ mA}$	Reference DMM
	(10 to 100) μA 100 μA to 1 mA 1 mA to 1 A (1 to 10) A	20 $\mu\text{A/A}$ 10 $\mu\text{A/A}$ 60 $\mu\text{A/A}$ 0.012 %	DMM/DC shunts

Parameter/Range	Frequency	CMC ^{2, 3, 4} (±)	Comments
AC Voltage – Generate			
100 μV to 2.2 mV	(10 to 20) Hz	0.13 % + 1.0 μV	Reference AC voltmeter and sources
	(20 to 40) Hz	0.057 % + 1.0 μV	
	40 Hz to 20 kHz	0.033 % + 1.0 μV	
	(20 to 50) kHz	0.063 % + 1.6 μV	
	(50 to 100) kHz	0.093 % + 1.9 μV	
	(100 to 300) kHz	0.18 % + 3.1 μV	
	(300 to 500) kHz	0.19 % + 6.2 μV	
(2.2 to 7) mV	500 kHz to 1 MHz	0.27 % + 6.2 μV	
	(10 to 20) Hz	0.066 % + 1.0 μV	
	(20 to 40) Hz	0.029 % + 1.0 μV	
	40 Hz to 20 kHz	0.016 % + 1.0 μV	
	(20 to 50) kHz	0.031 % + 1.6 μV	
	(50 to 100) kHz	0.047 % + 1.9 μV	
	(100 to 300) kHz	0.093 % + 3.1 μV	
(7 to 22) mV	(300 to 500) kHz	0.10 % + 6.2 μV	
	500 kHz to 1 MHz	0.18 % + 6.2 μV	
	(10 to 20) Hz	0.022 % + 1.0 μV	
	(20 to 40) Hz	0.015 % + 1.0 μV	
	40 Hz to 20 kHz	85 μV/V + 1.0 μV	
	(20 to 50) kHz	0.016 % + 1.6 μV	
	(50 to 100) kHz	0.024 % + 1.9 μV	
(22 to 70) mV	(100 to 300) kHz	0.063 % + 3.1 μV	
	(300 to 500) kHz	0.069 % + 6.2 μV	
	500 kHz to 1 MHz	0.13 % + 6.2 μV	
	(10 to 20) Hz	0.019 % + 1.2 μV	
	(20 to 40) Hz	93 μV/V + 1.2 μV	
	40 Hz to 20 kHz	50 μV/V + 1.2 μV	
	(20 to 50) kHz	0.010 % + 1.6 μV	
(70 to 220) mV	(50 to 100) kHz	0.020 % + 1.9 μV	
	(100 to 300) kHz	0.040 % + 3.1 μV	
	(300 to 500) kHz	0.052 % + 6.2 μV	
	500 kHz to 1 MHz	0.085 % + 6.2 μV	
	(10 to 20) Hz	0.016 % + 1.2 μV	
	(20 to 40) Hz	66 μV/V + 1.2 μV	
	40 Hz to 20 kHz	29 μV/V + 1.2 μV	
	(20 to 50) kHz	53 μV/V + 1.6 μV	
	(50 to 100) kHz	0.012 % + 1.9 μV	
	(100 to 300) kHz	0.019 % + 3.1 μV	
	(300 to 500) kHz	0.029 % + 6.2 μV	
	500 kHz to 1 MHz	0.078 % + 6.2 μV	

Parameter/Range	Frequency	CMC ^{2, 3, 4} (±)	Comments
AC Voltage – Generate (cont)			
(220 to 700) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.016 % + 1.2 μV 59 μV/V + 1.2 μV 26 μV/V + 1.2 μV 39 μV/V + 1.6 μV 61 μV/V + 1.3 μV 0.014 % + 3.1 μV 0.023 % + 6.2 μV 0.075 % + 6.2 μV	Reference AC voltmeter and sources
700 mV 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 500 kHz to 1 MHz	0.016 % 51 μV/V 19 μV/V 36 μV/V 55 μV/V 0.013 % 0.020 % 0.070 %	
(2.2 to 7.0) 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 500 kHz to 1 MHz	0.016 % 52 μV/V 19 μV/V 37 μV/V 63 μV/V 0.015 % 0.031 % 0.093 %	
(7.0 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 500 kHz to 1 MHz	0.016 % 52 μV/V 21 μV/V 37 μV/V 63 μV/V 0.015 % 0.031 % 0.093 %	
(22 to 70) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.016 % 53 μV/V 25 μV/V 44 μV/V 73 μV/V 0.016 % 0.032 % 0.093 %	

Parameter/Range	Frequency	CMC ^{2, 3, 4} (±)	Comments
AC Voltage – Generate (cont)			
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.016 % 54 μV/V 24 μV/V 53 μV/V 76 μV/V 0.017 % 0.039 %	Reference AC voltmeter and sources
(220 to 250) V	(15 to 20) Hz (20 to 40) Hz (40 to 50) Hz	0.016 % 77 μV/V 32 μV/V	
(220 to 700) V	50 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	32 μV/V 0.010 % 0.039 %	
(700 to 750) V	50 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	30 μV/V 0.010 % 0.039 %	
(750 to 1000) V	50 Hz to 20 kHz (20 to 30) kHz	30 μV/V 0.010 %	
AC Voltage – Measure			
100 μV 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 500 kHz to 1 MHz	0.13 % + 1.0 μV 0.057 % + 1.0 μV 0.033 % + 1.0 μV 0.063 % + 1.6 μV 0.093 % + 1.9 μV 0.18 % + 3.1 μV 0.19 % + 6.2 μV 0.27 % + 6.2 μV	AC measurement standard
(2.2 to 7) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.066 % + 1.0 μV 0.029 % + 1.0 μV 0.016 % + 1.0 μV 0.031 % + 1.6 μV 0.047 % + 1.9 μV 0.093 % + 3.1 μV 0.10 % + 6.2 μV 0.18 % + 6.2 μV	

Parameter/Range	Frequency	CMC ^{2, 3, 4} (±)	Comments
AC Voltage – Measure			
(7 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 500 kHz to 1 MHz	0.022 % + 1.0 μV 0.015 % + 1.0 μV 85 μV/V + 1.0 μV 0.016 % + 1.6 μV 0.024 % + 1.9 μV 0.063 % + 3.1 μV 0.069 % + 6.2 μV 0.13 % + 6.2 μV	AC measurement standard
(22 to 70) 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 500 kHz to 1 MHz	0.019 % + 1.2 μV 93 μV/V + 1.2 μV 50 μV/V + 1.2 μV 0.010 % + 1.6 μV 0.020 % + 1.9 μV 0.040 % + 3.1 μV 0.052 % + 6.2 μV 0.085 % + 6.2 μV	
(70 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.016 % + 1.2 μV 66 μV/V + 1.2 μV 29 μV/V + 1.2 μV 53 μV/V + 1.6 μV 0.012 % + 1.9 μV 0.019 % + 3.1 μV 0.029 % + 6.2 μV 0.078 % + 6.2 μV	
(220 to 700) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.016 % + 1.2 μV 59 μV/V + 1.2 μV 26 μV/V + 1.2 μV 39 μV/V + 1.6 μV 61 μV/V + 1.9 μV 0.014 % + 3.1 μV 0.023 % + 6.2 μV 0.075 % + 6.2 μV	
700 mV 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 500 kHz to 1 MHz	0.016 % 51 μV/V 19 μV/V 36 μV/V 55 μV/V 0.013 % 0.020 % 0.070 %	

Parameter/Range	Frequency	CMC ^{2, 3, 4} (±)	Comments
AC Voltage – Measure (cont)			
(2.2 to 7.0) 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 500 kHz to 1 MHz	0.016 % 52 μV/V 19 μV/V 37 μV/V 63 μV/V 0.015 % 0.031 % 0.093 %	AC measurement standard
(7.0 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 500 kHz to 1 MHz	0.016 % 52 μV/V 21 μV/V 37 μV/V 63 μV/V 0.015 % 0.031 % 0.093 %	
(22 to 70) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.016 % 53 μV/V 25 μV/V 44 μV/V 73 μV/V 0.016 % 0.032 % 0.093 %	
(70 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.016 % 53 μV/V 24 μV/V 54 μV/V 76 μV/V 0.017 % 0.039 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.016 % 77 μV/V 32 μV/V 0.010 % 0.039 %	
(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	0.016 % 77 μV/V 30 μV/V 0.010 % 0.039 %	

Parameter/Equipment	Range	CMC ^{2,3} (±)	Comments
Resistance – Generate, Fixed Points	0 Ω	100 nΩ	Low thermal EMF shunt
	0.1 Ω	3.5 μΩ/Ω	Temperature stabilized resistance standard
	1 Ω	2.2 μΩ/Ω	
	10 Ω	2.1 μΩ/Ω	
	100 Ω	2.2 μΩ/Ω	
	1 kΩ	2.1 μΩ/Ω	
	10 kΩ	0.6 μΩ/Ω	
	100 kΩ	5.1 μΩ/Ω	
	1 MΩ	7.0 μΩ/Ω	
	10 MΩ	8.0 μΩ/Ω	
	100 MΩ	25 μΩ/Ω	
	1 GΩ	35 μΩ/Ω	Air resistance standards
	5 GΩ	0.018 %	
	1.9 Ω	80 μΩ/Ω	Multifunction calibrator
	19 Ω	21 μΩ/Ω	
	190 Ω	9.0 μΩ/Ω	
	1.9 kΩ	7.5 μΩ/Ω	
	19 kΩ	7.5 μΩ/Ω	
	190 kΩ	9.0 μΩ/Ω	
	1.9 MΩ	16 μΩ/Ω	
19 MΩ	39 μΩ/Ω		
Resistance – Measure	(0 to 2) Ω	15 μΩ/Ω + 4 μΩ	Reference DMM
	(2 to 20) Ω	9 μΩ/Ω + 14 μΩ	
	(20 to 200) Ω	7.5 μΩ/Ω + 50 μΩ	
	(200 to 2000) Ω	7.5 μΩ/Ω + 0.5 mΩ	
	(2 to 20) kΩ	7.5 μΩ/Ω + 5 mΩ	
	(20 to 200) kΩ	7.5 μΩ/Ω + 50 mΩ	
	(200 to 2000) kΩ	8.5 μΩ/Ω + 1 Ω	
	(2 to 20) MΩ	15 μΩ/Ω + 10 Ω	
	(20 to 200) MΩ	60 μΩ/Ω + 1 kΩ	
	2 MΩ to 2 GΩ	150 μΩ/Ω + 0.1 MΩ	
	(2 to 20) GΩ	530 μΩ/Ω + 10 MΩ	
	(0 to 2) Ω	3.1 μΩ/Ω + 0.50 μΩ	Transfer method
(2 to 20) Ω	3.0 μΩ/Ω + 13 μΩ		
(20 to 200) Ω	2.3 μΩ/Ω + 15 μΩ	Temperature stabilized resistance standard transfer using reference DMM	
200 Ω to 2 kΩ	2.2 μΩ/Ω + 0.15 mΩ		
(2 to 20) kΩ	2.2 μΩ/Ω + 1.2 mΩ		
(20 to 200) kΩ	5.2 μΩ/Ω + 30 mΩ		
200 kΩ to 2 MΩ	6.5 μΩ/Ω + 0.50 Ω		

Parameter/Equipment	Range	CMC ^{2,3} (±)	Comments
Resistance – Measure (cont)	(2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 1 GΩ (2 to 5) GΩ	8.2 μΩ/Ω 25 μΩ/Ω 37 μΩ/Ω 0.024 %	Temperature stabilized resistance standard transfer using reference DMM
	10 kΩ	0.70 μΩ/Ω + 1.4 mΩ	Transfer method 1:1

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
AC Current – Measure			
10 μA to 1 mA	(10 to 20) Hz	0.022 %	DMM/AC current shunts
	(20 to 40) Hz	75 μA/A	
	(40 to 100) Hz	40 μA/A	
	100 Hz to 1 kHz	(0.03f + 35) μA/A	
	(1 to 5) kHz	(0.002f + 65) μA/A	
	(5 to 20) kHz	80 μA/A	
	(20 to 30) kHz	90 μA/A	
	(30 to 100) kHz	(1.1 x 10 ⁻³ f + 65) μA/A	
(1.0 to 10) mA	(10 to 20) Hz	0.022 %	
	(20 to 40) Hz	70 μA/A	
	(40 to 500) Hz	35 μA/A	
	500 Hz to 20 kHz	40 μA/A	
	(20 to 50) kHz	55 μA/A	
	(50 to 100) kHz	80 μA/A	
(10 to 20) mA	(10 to 20) Hz	0.022 %	
	(20 to 40) Hz	70 μA/A	
	(40 to 500) Hz	35 μA/A	
	500 Hz to 20 kHz	40 μA/A	
	(20 to 50) kHz	55 μA/A	
	(50 to 100) kHz	80 μA/A	
(20 to 50) mA	(10 to 20) Hz	0.020 %	
	(20 to 40) Hz	70 μA/A	
	40 Hz to 20 kHz	35 μA/A	
	(20 to 50) kHz	55 μA/A	
	(50 to 100) kHz	80 μA/A	

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
AC Current – Measure (cont)			
(50 to 100) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.022 % 70 µA/A 35 µA/A 55 µA/A 80 µA/A	DMM/AC current shunts
(100 to 200) mA	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.022 % 75 µA/A 35 µA/A 40 µA/A 60 µA/A 85 µA/A	
(200 to 500) mA	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.022 % 75 µA/A 35 µA/A 40 µA/A 60 µA/A 80 µA/A	
(0.5 to 1.0) A	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.022 % 70 µA/A 35 µA/A 40 µA/A 60 µA/A 80 µA/A	
(1.0 to 2.0) A	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.022 % 75 µA/A 35 µA/A 40 µA/A 60 µA/A 0.010 %	
(2.0 to 5.0) A	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.022 % 70 µA/A 36 µA/A 44 µA/A 70 µA/A 0.010 %	

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
AC Current – Measure (cont)			
(5.0 to 10.0) A	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 10 kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz	0.022 % 75 μA/A 40 μA/A (0.002f + 45) μA/A 65 μA/A 80 μA/A 90 μA/A 0.012 %	DMM/AC current shunts
(10 to 20) A	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 10 kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz	0.022 % 80 μA/A 40 μA/A 50 μA/A 60 μA/A 70 μA/A (7 x 10 ⁻⁴ f + 65) μA/A (5 x 10 ⁻⁴ f + 90) μA/A	
AC Current – Generate			
10 μA to 1 mA	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.022 % 75 μA/A 40 μA/A (0.03f + 35) μA/A (0.002f + 65) μA/A 80 μA/A	AC current source w/ DMM/AC current shunts
(1.0 to 10) mA	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 10 kHz	0.022 % 70 μA/A 35 μA/A 40 μA/A	
(10 to 20) mA	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 10 kHz	0.022 % 70 μA/A 35 μA/A 40 μA/A	
(20 to 50) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz	0.022 % 70 μA/A 35 μA/A	
(50 to 100) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz	0.022 % 70 μA/A 35 μA/A	

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
AC Current – Generate (cont)			
(100 to 200) mA	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 10 kHz	0.022 % 75 µA/A 35 µA/A 40 µA/A	AC current source w/ DMM/AC current shunts
(200 to 500) mA	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 10 kHz	0.022 % 75 µA/A 35 µA/A 40 µA/A	
(0.5 to 1.0) A	(10 to 20) Hz (20 to 40) Hz (40 to 500) Hz 500 Hz to 10 kHz	0.022 % 70 µA/A 35 µA/A 40 µA/A	
(1.0 to 2.0) A	(10 to 20) Hz (20 to 500) Hz 500 Hz to 10 kHz	75 µA/A 35 µA/A 40 µA/A	
(2.0 to 5.0) A	(40 to 500) Hz 500 Hz to 10 kHz	36 µA/A 44 µA/A	
(5.0 to 10.0) A	(40 to 500) Hz 500 Hz to 10 kHz	40 µA/A (0.002f + 45) µA/A	
(10 to 11) A	(40 to 500) Hz 500 Hz to 10 kHz	40 µA/A 50 µA/A	
Capacitance – Generate, Fixed Points			Standard capacitors and reference capacitance bridge
0.5 pF to 1 µF	(0.05 to 20) kHz	See table 1 below	Standard capacitors
10 µF	100 Hz 1 kHz	0.040 % 0.027 %	
100 µF	100 Hz 1 kHz	0.035 % 0.026 %	
1 mF	(91 and 100) Hz	0.065 %	
10 µF	(70 to 300) Hz 300 Hz to 1 kHz	0.041 % 0.030 %	
100 µF	(70 to 300) Hz 300 Hz to 1 kHz	0.039 % 0.032 %	
1 mF	20 Hz to 1 kHz	0.070 %	

Parameter/Range	Frequency	CMC ^{2,3} (\pm)	Comments
Capacitance – Generate, Fixed Points 100 pF	100 Hz 1 kHz 10 kHz	5.0 μ F/F 1.1 μ F/F 3.1 μ F/F	Silver mica standard capacitor
Capacitance – Measure Fixed Points 1 pF 10 pF 100 pF 1 nF 10 nF 100 nF 1 μ F 10 μ F 100 μ F 1 mF Continuous (1 to 10) pF (10 to 100) pF 100 pF to 1 nF (1 to 10) nF (10 to 100) nF 100 nF to 1 μ F (1 to 10) μ F (10 to 100) μ F 100 μ F to 1 mF 0.5 pF to 1 μ F	 (1 to 10) kHz (1 to 10) kHz (1 to 10) kHz 90 Hz to 10 kHz 90 Hz to 10 kHz 90 Hz to 10 kHz 90 Hz to 10 kHz 90 Hz to 1 kHz 90 Hz to 1 kHz (90 to 100) Hz (1 to 10) kHz (1 to 10) kHz (1 to 10) kHz 90 Hz to 10 kHz 90 Hz to 10 kHz 90 Hz to 10 kHz 90 Hz to 10 kHz 90 Hz to 1 kHz 90 Hz to 1 kHz (0.05 to 20) kHz	 0.070 % 0.063 % 0.021 % 0.017 % 0.017 % 0.017 % 0.018 % 0.046 % 0.076 % 0.096 % 0.070 % 0.063 % 0.021 % 0.017 % 0.017 % 0.017 % 0.018 % 0.046 % 0.076 % See table 1 below	 Transfer method 1:1 standard capacitors and RLC bridge Transfer method 1:10 standard capacitors and RLC bridge Direct method capacitance bridge
Inductance – Generate/Measure (5 to 1) H >1 H to 500 μ H (>500 to 100) μ H (>100 to 10) μ H	 (0.05 to 10) kHz (0.05 to 15) kHz (0.05 to 20) kHz (0.05 to 20) kHz	 3.5 % 3.5 % 3.8 % 4.5 %	 Standard inductance and reference inductance bridge

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
RF Absolute Power – Measure			
1 mW	50 MHz	0.36 %	Thermistor mount power standard and power meter
(1 to 10) mW	100 kHz to 1.25 MHz (>1.25 to 10) MHz (>10 to 80) MHz (>80 to 1600) MHz (>1.6 to 4.6) GHz (>4.6 to <12) GHz (12 to 14.75) GHz (>14.75 to 17.25) GHz (>17.25 to 18) GHz	0.40 $f^{-0.12}$ % 0.38 % $1.4 \times 10^{-3} f + 0.33$ % 0.37 % 0.42 % 0.47 % 0.61 % 0.52 % 0.61 %	Type N thermistor mount power standard and power meter taking into consideration a DUT VSWR = 1.1
	(10 to 40) MHz (> 40 to 10 00) MHz (> 1 to 2.5) GHz (> 2.5 to 18) GHz (> 18 to 22) GHz (> 22 to 25) GHz (> 25 to 26.5) GHz	$3.7 f^{-0.53}$ % 0.50 % 0.60 % $5.2 \times 10^{-5} f + 0.50$ % 1.7 % 2.1 % 2.4 %	Type 2.92 mm connector thermistor mount power standard and power meter taking into consideration a DUT VSWR = 1.1
RF Absolute Power – Generate			
(1 to 10) mW	(100 to 500) kHz (>0.5 to 40) MHz (>40 to < 90) MHz (90 to 1600) MHz (>1.6 to 4.6) GHz (>4.6 to 12) GHz (>12 to <15) GHz (15 to 17.5) GHz (>17.5 to 18) GHz	0.41 $f^{-0.12}$ % 0.44 % 0.47 % 0.42 % 0.45 % 0.51 % 0.65 % 0.56 % 0.63 %	Type N RF transfer standard and power meter, taking into consideration a DUT VSWR = 1.1
	(10 to 50) MHz (>50 to 10 00) MHz (>1 to 2.9) GHz (>2.9 to 18) GHz (>18 to 22) GHz (>22 to 26.5) GHz	$3.0 f^{-0.44}$ % 0.60 % 0.65 % $5.5 \times 10^{-5} f + 0.50$ % 1.8 % 2.5 %	Type 2.92 mm connector thermistor mount power standard and power meter taking into consideration a DUT VSWR = 1.1

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
RF Absolute Power – Generate ⁴ (cont) (0.01 to 100) mW	9 kHz to 1 MHz (>1 to 100) MHz (>0.1 to 2.25) GHz (>2.25 to 8) GHz (>8 to 12) GHz (>12 to 18) GHz	0.28 % 0.33 % 0.51 % 0.67 % 0.84 % 1.1 %	R&S NRPC18
RF Absolute Power – Measure and Generate (0.5 to 10) mW	100 kHz to 100 MHz >100 MHz to 2 GHz (>2 to 8) GHz (>8 to 12) GHz (>12 to 18) GHz (>18 to 26.5) GHz (>26.5 to 40) GHz	0.60 % 0.85 % 1.0 % 1.3 % 1.7 % 1.4 % 1.5 %	2.92 mm connector RF transfer standard and power meter, taking into consideration a DUT VSWR = 1.0
Tuned RF Absolute Power ⁴ – Measure (26 to 20) dBm	20 Hz to 2 GHz (2 to 8) GHz (8 to 9) GHz (9 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 14.5) GHz (14.5 to 15) GHz (15 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 22.5) GHz (22.5 to 23) GHz (23 to 23.5) GHz (23.5 to 24.5) GHz (24.5 to 25) GHz (25 to 26) GHz (26 to 26.5) GHz	0.055 dB 0.060 dB 0.065 dB 0.070 dB 0.080 dB 0.095 dB 0.085 dB 0.090 dB 0.085 dB 0.095 dB 0.11 dB 0.10 dB 0.095 dB 0.11 dB 0.095 dB 0.10 dB 0.090 dB 0.095 dB	Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Absolute Power – Measure (cont)			Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1
	(20 to -5) dBm	20 Hz to 5 MHz 5 MHz to 2 GHz (2 to 8) GHz (8 to 9) GHz (9 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 14.5) GHz (14.5 to 15) GHz (15 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 22.5) GHz (22.5 to 23) GHz (23 to 23.5) GHz (23.5 to 24.5) GHz (24.5 to 25) GHz (25 to 26) GHz (26 to 26.5) GHz	
(-5 to -10) dBm	20 Hz to 5 MHz 5 MHz to 2 GHz (2 to 8) GHz (8 to 9) GHz (9 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 14.5) GHz (14.5 to 15) GHz (15 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 22.5) GHz (22.5 to 23) GHz (23 to 23.5) GHz (23.5 to 24.5) GHz (24.5 to 25) GHz (25 to 26) GHz (26 to 26.5) GHz	0.050 dB 0.055 dB 0.060 dB 0.065 dB 0.070 dB 0.080 dB 0.095 dB 0.085 dB 0.090 dB 0.085 dB 0.095 dB 0.11 dB 0.10 dB 0.095 dB 0.12 dB 0.095 dB 0.10 dB 0.090 dB 0.095 dB	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Absolute Power – Measure (cont)			
(-10 to -20) dBm	20 Hz to 2 GHz	0.055 dB	Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1
	(2 to 8) GHz	0.060 dB	
	(8 to 9) GHz	0.065 dB	
	(9 to 12) GHz	0.070 dB	
	(12 to 12.5) GHz	0.080 dB	
	(12.5 to 14) GHz	0.095 dB	
	(14 to 14.5) GHz	0.085 dB	
	(14.5 to 15) GHz	0.090 dB	
	(15 to 18.5) GHz	0.085 dB	
	(18.5 to 21.5) GHz	0.095 dB	
	(21.5 to 22) GHz	0.11 dB	
	(22 to 22.5) GHz	0.10 dB	
	(22.5 to 23) GHz	0.095 dB	
	(23 to 23.5) GHz	0.12 dB	
	(23.5 to 24.5) GHz	0.095 dB	
	(24.5 to 25) GHz	0.10 dB	
	(25 to 26) GHz	0.090 dB	
(26 to 26.5) GHz	0.095 dB		
(-20 to -30) dBm	20 Hz to 5 MHz	0.055 dB	
	5 MHz to 2 GHz	0.060 dB	
	(2 to 8) GHz	0.065 dB	
	(8 to 9) GHz	0.065 dB	
	(9 to 12) GHz	0.070 dB	
	(12 to 12.5) GHz	0.080 dB	
	(12.5 to 14) GHz	0.095 dB	
	(14 to 14.5) GHz	0.085 dB	
	(14.5 to 15) GHz	0.095 dB	
	(15 to 18.5) GHz	0.085 dB	
	(18.5 to 21.5) GHz	0.095 dB	
	(21.5 to 22) GHz	0.11 dB	
	(22 to 22.5) GHz	0.10 dB	
	(22.5 to 23) GHz	0.095 dB	
	(23 to 23.5) GHz	0.11 dB	
	(23.5 to 24.5) GHz	0.095 dB	
	(24.5 to 25) GHz	0.10 dB	
(25 to 26) GHz	0.090 dB		
(26 to 26.5) GHz	0.095 dB		

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Absolute Power – Measure (cont)			
(-30 to -40) dBm	20 Hz to 2 GHz	0.060 dB	Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1
	(2 to 8) GHz	0.065 dB	
	(8 to 12) GHz	0.070 dB	
	(12 to 12.5) GHz	0.085 dB	
	(12.5 to 14) GHz	0.095 dB	
	(14 to 14.5) GHz	0.090 dB	
	(14.5 to 15) GHz	0.095 dB	
	(15 to 18.5) GHz	0.085 dB	
	(18.5 to 21.5) GHz	0.10 dB	
	(21.5 to 22) GHz	0.11 dB	
	(22 to 23) GHz	0.10 dB	
	(23 to 23.5) GHz	0.11 dB	
	(23.5 to 25) GHz	0.10 dB	
	(25 to 26) GHz	0.095 dB	
(26 to 26.5) GHz	0.10 dB		
(-40 to -43.5) dBm	20 Hz to 5 MHz	0.060 dB	
	5 MHz to 2 GHz	0.065 dB	
	(2 to 9) GHz	0.070 dB	
	(9 to 12) GHz	0.075 dB	
	(12 to 12.5) GHz	0.085 dB	
	(12.5 to 14) GHz	0.10 dB	
	(14 to 14.5) GHz	0.090 dB	
	(14.5 to 15) GHz	0.095 dB	
	(15 to 18.5) GHz	0.090 dB	
	(18.5 to 21.5) GHz	0.10 dB	
	(21.5 to 22) GHz	0.11 dB	
	(22 to 22.5) GHz	0.10 dB	
	(22.5 to 23) GHz	0.10 dB	
	(23 to 23.5) GHz	0.11 dB	
(23.5 to 25) GHz	0.10 dB		
(25 to 26) GHz	0.095 dB		
(26 to 26.5) GHz	0.10 dB		

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Absolute Power – Measure (cont)			
(-43.5 to -50) dBm	20 Hz to 2 GHz	0.065 dB	Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1
	(2 to 8) GHz	0.070 dB	
	(8 to 9) GHz	0.075 dB	
	(9 to 12) GHz	0.075 dB	
	(12 to 12.5) GHz	0.085 dB	
	(12.5 to 14) GHz	0.10 dB	
	(14 to 14.5) GHz	0.095 dB	
	(14.5 to 15) GHz	0.10 dB	
	(15 to 18.5) GHz	0.090 dB	
	(18.5 to 21.5) GHz	0.10 dB	
	(21.5 to 22.5) GHz	0.11 dB	
	(22.5 to 23) GHz	0.10 dB	
	(23 to 23.5) GHz	0.11 dB	
	(23.5 to 25) GHz	0.10 dB	
(25 to 26) GHz	0.095 dB		
(26 to 26.5) GHz	0.10 dB		
(-50 to -60) dBm	20 Hz to 5 MHz	0.065 dB	
	5 MHz to 2 GHz	0.070 dB	
	(2 to 9) GHz	0.075 dB	
	(9 to 12) GHz	0.080 dB	
	(12 to 12.5) GHz	0.090 dB	
	(12.5 to 14) GHz	0.10 dB	
	(14 to 14.5) GHz	0.095 dB	
	(14.5 to 15) GHz	0.10 dB	
	(15 to 18.5) GHz	0.095 dB	
	(18.5 to 21.5) GHz	0.10 dB	
	(21.5 to 22) GHz	0.12 dB	
	(22 to 22.5) GHz	0.11 dB	
	(22.5 to 23) GHz	0.10 dB	
	(23 to 23.5) GHz	0.11 dB	
(23.5 to 24.5) GHz	0.10 dB		
(24.5 to 25) GHz	0.11 dB		
(25 to 26.5) GHz	0.10 dB		

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments	
Tuned RF Absolute Power – Measure (cont)				
	(-60 to -70) dBm	20 Hz to 5 MHz 5 MHz to 8 GHz (8 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 14.5) GHz (14.5 to 15) GHz (15 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 22.5) GHz (22.5 to 23) GHz (23 to 23.5) GHz (23.5 to 24.5) GHz (24.5 to 25) GHz (25 to 26) GHz (26 to 26.5) GHz	0.070 dB 0.075 dB 0.080 dB 0.090 dB 0.10 dB 0.095 dB 0.10 dB 0.095 dB 0.10 dB 0.12 dB 0.11 dB 0.10 dB 0.12 dB 0.10 dB 0.11 dB 0.10 dB 0.11 dB	Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1
	(-70 to -80) dBm	20 Hz to 2 GHz (2 to 8) GHz (9 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 23) GHz (23 to 23.5) GHz (23.5 to 25) GHz (25 to 26) GHz (26 to 26.5) GHz	0.075 dB 0.080 dB 0.085 dB 0.095 dB 0.11 dB 0.10 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.11 dB 0.10 dB 0.11 dB	
(-80 to -90) dBm	20 Hz to 2 GHz (2 to 9) GHz (9 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 14.5) GHz (14.5 to 15) GHz (15 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 23) GHz (23 to 23.5) GHz (23.5 to 26.5) GHz	0.080 dB 0.085 dB 0.090 dB 0.10 dB 0.11 dB 0.10 dB 0.11 dB 0.10 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.11 dB		

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments	
Tuned RF Absolute Power – Measure (cont)				
	(-90 to -100) dBm	20 Hz to 5 MHz 5 MHz to 8 GHz (8 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 14.5) GHz (14.5 to 15) GHz (15 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22.5) GHz (22.5 to 23) GHz (23 to 23.5) GHz (23.5 to 24.5) GHz (24.5 to 25) GHz (25 to 26.5) GHz	0.080 dB 0.085 dB 0.090 dB 0.10 dB 0.11 dB 0.10 dB 0.11 dB 0.10 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.11 dB	Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1
	(-100 to -110) dBm	20 Hz to 5 MHz 5 MHz to 8 GHz (8 to 12) GHz (12 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 22.5) GHz (22.5 to 23) GHz (23 to 23.5) GHz (23.5 to 24.5) GHz (24.5 to 25) GHz (25 to 26) GHz (26 to 26.5) GHz	0.085 dB 0.090 dB 0.095 dB 0.11 dB 0.12 dB 0.13 dB 0.12 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB	
(-110 to -120) dBm	20 Hz to 2 GHz (2 to 9) GHz (9 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 23) GHz (23 to 23.5) GHz (23.5 to 25) GHz (25 to 26) GHz (26 to 26.5) GHz	0.090 dB 0.095 dB 0.10 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.13 dB 0.12 dB 0.13 dB 0.12 dB 0.11 dB 0.12 dB		

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Absolute Power – Measure (cont)			
(-120 to -125) dBm	20 Hz to 2 GHz (2 to 12) GHz (12 to 12.5) GHz (12.5 to 14) GHz (14 to 14.5) GHz (14.5 to 15) GHz (15 to 18.5) GHz (18.5 to 21.5) GHz (21.5 to 22) GHz (22 to 23) GHz (23 to 23.5) GHz (23.5 to 26.5) GHz	0.095 dB 0.10 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.11 dB 0.12 dB 0.13 dB 0.12 dB 0.13 dB 0.12 dB	Thermoelectric power sensor and measurement receiver taking into consideration a DUT VSWR = 1.1
Tuned RF Relative Power – Measure			
(25 to 20) dB	20 Hz to 11 GHz (11 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.025 dB 0.030 dB 0.040 dB 0.11 dB	Measurement receiver taking into consideration a DUT VSWR = 1.1
(20 to 10) dBm	20 Hz to 11 GHz (11 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.020 dB 0.030 dB 0.040 dB 0.11 dB	
(10 to -3) dBm	20 Hz to 11 GHz (11 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.020 dB 0.025 dB 0.040 dB 0.11 dB	
(-3 to -10) dBm	20 Hz to 11 GHz (11 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.020 dB 0.030 dB 0.040 dB 0.12 dB	
(-10 to -20) dBm	20 Hz to 20 GHz (20 to 40) GHz (40 to 50) GHz	0.030 dB 0.040 dB 0.12 dB	
(-20 to -30) dBm	20 Hz to 11 GHz (11 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.025 dB 0.035 dB 0.045 dB 0.13 dB	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Relative Power – Measure (cont)			
(-30 to -40) dBm	20 Hz to 11 GHz	0.025 dB	Measurement receiver taking into consideration a DUT VSWR = 1.1
	(11 to 20) GHz	0.040 dB	
	(20 to 40) GHz	0.045 dB	
	(40 to 50) GHz	0.13 dB	
(-40 to -43) dBm	20 Hz to 11 GHz	0.040 dB	
	(11 to 20) GHz	0.045 dB	
	(20 to 40) GHz	0.050 dB	
	(40 to 50) GHz	0.13 dB	
(-43 to -50) dBm	20 Hz to 11 GHz	0.045 dB	
	(11 to 20) GHz	0.050 dB	
	(20 to 40) GHz	0.055 dB	
	(40 to 50) GHz	0.16 dB	
(-50 to -60) dB	20 Hz to 20 GHz	0.050 dB	
	(20 to 40) GHz	0.060 dB	
	(40 to 50) GHz	0.16 dB	
(-60 to -70) dB	20 Hz to 20 GHz	0.055 dB	
	(20 to 40) GHz	0.060 dB	
	(40 to 50) GHz	0.17 dB	
(-70 to -80) dB	20 Hz to 20 GHz	0.060 dB	
	(20 to 40) GHz	0.065 dB	
	(40 to 50) GHz	0.17 dB	
(-80 to -90) dB	20 Hz to 20 GHz	0.065 dB	
	(20 to 40) GHz	0.070 dB	
	(40 to 50) GHz	0.17 dB	
(-90 to -100) dB	20 Hz to 11 GHz	0.065 dB	
	(11 to 20) GHz	0.070 dB	
	(20 to 40) GHz	0.075 dB	
	(40 to 50) GHz	0.18 dB	
(-100 to -110) dB	20 Hz to 11 GHz	0.070 dB	
	(11 to 20) GHz	0.075 dB	
	(20 to 40) GHz	0.080 dB	
	(40 to 50) GHz	0.18 dB	
(-110 to -120) dB	20 Hz to 11 GHz	0.075 dB	
	(11 to 20) GHz	0.080 dB	
	(20 to 40) GHz	0.085 dB	
	(40 to 50) GHz	0.19 dB	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Relative Power – Measure (cont) (-120 to -130) dB	20 Hz to 11 GHz (11 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.080 dB 0.085 dB 0.090 dB 0.18 dB	Measurement receiver taking into consideration a DUT VSWR = 1.1
Reflection S ₁₁ /S ₂₂ – Measure Reflection Coefficient (0 to 1)	50 kHz to 10 MHz 10 MHz to 2.5 GHz (2.5 to 20) GHz (20 to 40) GHz (40 to 65) GHz (65 to 67) GHz (67 to 70) GHz	0.011 lin ± 0.74° 0.011 lin ± 0.63° 0.006 lin ± 0.73° 0.007 lin ± 0.41° 0.011 lin ± 0.36° 0.011 lin ± 0.62° 0.012 lin ± 0.31°	Vector network analyzer
Reflection Coefficient (0 to 1) ⁴	9 kHz to 8.5 GHz 9 kHz to 50 MHz 50 MHz to 4 GHz (4 to 8.5) GHz	0.0051e ^{1.3* Γ} lin 2° 6° 17°	Vector network analyzer R&S ZNB8

Parameter/Range	Frequency	CMC ² (±)	Comments
Transmission S ₁₂ /S ₂₁ – Measure Transmission Coefficient (0 to 1)	50 kHz to 10 MHz 10 MHz to 2.5 GHz (2.5 to 20) GHz (20 to 40) GHz (40 to 65) GHz (65 to 67) GHz (67 to 70) GHz	0.005 lin ± 0.13° 0.005 lin ± 0.13° 0.004 lin ± 0.27° 0.009 lin ± 0.28° 0.013 lin ± 0.39° 0.013 lin ± 0.39° 0.016 lin ± 0.47°	Vector network analyzer
Transition Time – Measure (10 to 90) %	100 Hz to 10 GHz t > 12 ps	5.0 ps	High BW sampling scope
Phase Noise Measurement ⁴ – 1 MHz to 26.5 GHz	(1 to 100) Hz offset 100 Hz to 10 MHz offset (10 to 30) MHz offset	3.0 dB 1.0 dB 3.0 dB	PLL method with cross-correlation measurement system

III. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,3} (±)	Comments
Temperature – Measure	(-200 to -80) °C (-80 to -38.8) °C (-38.8 to 232) °C (232 to 660) °C	15 mK (-0.073t + 9.2) mK 12 mK (0.019t + 7.5) mK	PRT probe w/ readout
Temperature – Measuring Equipment	(-10 to 0.01) °C (0.01 to 120) °C	30 mK 25 mK	PRT probe and dry well

IV. Time & Frequency

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
Frequency – Measure	1 mHz to 10 Hz 10 Hz to 100 kHz 100 kHz to 10 MHz 10 MHz to 20 GHz	1.6 µHz 3.0 µHz $2.6 \times 10^{-12}f + 2.5 \mu\text{Hz}$ 3.0 pHz/Hz	Counter externally locked to GPS disciplined rubidium oscillator
Frequency – Measuring Equipment			
Fixed Point	10 MHz	1.2 pHz/Hz	GPS disciplined rubidium oscillator
	1 mHz to 10 Hz 10 Hz to 100 kHz 100 kHz to 10 MHz 10 MHz to 20 GHz	1.6 µHz 3.0 µHz $2.6 \times 10^{-12}f + 2.5 \mu\text{Hz}$ 3.0 pHz/Hz	Sources monitored by counter externally locked to GPS disciplined rubidium oscillator

¹ Commercial calibration service is sometimes available for this laboratory.

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 In the statement of CMC, percentages are defined as the percentage of reading; f represents the frequency of the measurement in MHz; t represents temperature measured in °C. Γ represents the linear reflection coefficient.

⁴ CMC components that can be reasonably attributed to the unit under test have not been utilized in the calculation of the CMC value for this measurement parameter.

	Table 1															CMC in (μF/F)	
Cap. [F]	0.5-0.8	0.8-1.5	1.5-3	3-7	7-15	15-40	40 - 2000	2-4	4-6.6	6.6-16.6	16.6-56	56-90	90-150	150-250	250-400	400-600	0.6 - 1.6
Frequency (Hz)	(pF)	(pF)	(pF)	(pF)	(pF)	(pF)	(pF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(μF)
50	20	17	16	15	15	15	15	15	14	120	220	320	320	420	420	420	620
60	17	15	14	13	13	13	13	13	13	96	180	260	260	350	350	350	520
70	15	14	13	12	12	12	12	12	12	83	160	230	230	300	300	300	440
80	14	12	11	11	11	11	11	11	11	74	140	200	200	260	260	260	390
100	12	11	10	9.6	9.5	9.4	9.4	9.4	9.4	60	110	160	160	210	210	210	310
120	11	9.8	9.2	8.8	8.6	8.5	8.5	8.5	8.5	51	93	140	140	180	180	180	260
140	10	9.1	8.5	8.1	8.0	7.9	7.9	7.9	7.9	44	81	120	120	150	150	150	230
160	9.7	8.5	8.0	7.7	7.6	7.5	7.5	7.5	7.5	39	72	100	100	140	140	140	200
200	8.8	7.8	7.3	7.0	6.9	6.8	6.8	6.8	6.8	33	59	85	85	110	110	110	160
240	8.2	7.3	6.9	6.6	6.5	6.4	6.4	6.4	6.4	28	51	73	73	95	95	95	140
300	7.7	6.8	6.4	6.2	6.1	6.0	6.0	6.0	6.0	24	42	61	61	79	79	79	120
400	7.2	6.4	6.0	5.8	5.9	5.7	5.7	5.7	5.6	20	35	49	49	64	64	64	93
500	7.0	6.2	5.8	5.6	5.7	5.5	5.4	5.4	5.4	18	30	43	43	56	56	56	81
600	6.9	6.1	5.7	5.5	5.5	5.3	5.3	5.3	5.3	17	28	39	39	51	51	51	74
700	6.9	6.0	5.6	5.4	5.5	5.3	5.3	5.3	5.3	16	27	37	37	48	48	49	70
800	6.9	6.0	5.6	5.4	5.4	5.2	5.2	5.2	5.2	15	26	36	36	47	47	47	69
1.00E+03	7.1	6.1	5.7	5.4	5.4	5.2	5.2	5.2	5.2	15	25	35	36	46	46	47	68
1.20E+03	7.3	6.3	5.8	5.5	5.5	5.3	5.2	5.2	5.2	15	26	36	36	47	47	48	71

	Table 1															CMC in (μF/F)	
Cap. [F]	0.5-0.8	0.8-1.5	1.5-3	3-7	7-15	15-40	40 - 2000	2-4	4-6.6	6.6-16.6	16.6-56	56-90	90-150	150-250	250-400	400-600	0.6 - 1.6
Frequency (Hz)	(pF)	(pF)	(pF)	(pF)	(pF)	(pF)	(pF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(nF)	(μF)
1.40E+03	7.7	6.5	5.9	5.6	5.5	5.3	5.3	5.3	5.3	16	27	37	38	49	50	51	76
1.60E+03	8.1	6.7	6.1	5.7	5.7	5.4	5.4	5.4	5.4	17	28	39	40	52	53	55	82
2.00E+03	9.1	7.4	6.5	6.0	5.9	5.6	5.6	5.6	5.6	18	31	44	45	59	61	64	98
2.40E+03	10	8.1	7.1	6.4	6.2	5.9	5.8	5.8	5.9	20	34	50	51	68	70	76	120
3.00E+03	12	9.5	8.0	7.0	6.7	6.3	6.2	6.3	6.3	23	40	59	61	82	87	97	160
4.00E+03	17	12	10	8.4	7.8	7.0	6.9	7.1	7.2	29	51	76	80	110	120	140	230
5.00E+03	23	16	12	10	9.1	7.9	7.6	8.0	8.2	35	63	95	100	150	160	200	340
6.00E+03	30	20	15	12	10	8.9	8.5	9.2	9.5	41	75	120	130	190	210	270	470
7.00E+03	39	25	18	14	12	10	9	10	11	48	88	140	160	230	270	360	630
8.00E+03	48	31	22	16	14	11	10	12	13	55	100	160	190	290	340	460	830
1.00E+04	71	44	31	22	18	14	13	15	17	69	130	220	260	410	510	720	1320
1.20E+04	99	61	41	28	23	17	15	19	21	85	160	280	350	570	730	1000	2000
1.40E+04	130	80	53	35	28	20	18	24	27	100	200	360	460	760	1000	1500	2800
1.60E+04	170	100	67	44	34	24	21	29	34	120	240	440	580	990	1300	2000	3800
20000	260	150	99	64	48	32	28	43	52	160	320	640	890	1500	2100	3300	6400



Accredited Laboratory

A2LA has accredited

NATIONAL INSTRUMENTS CORPORATE METROLOGY LABORATORY

Austin, TX

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSLI Z540-1-1994 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 8 January 2009).



Presented this 9th day of January 2018.

A handwritten signature in black ink, appearing to read "L. J. ...", positioned above a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 3295.01
Valid to January 31, 2020
Revised January 19, 2018

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