



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: October 31, 2027

Certificate Number: 2354.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the organization's compliance with R205 – A2LA's Calibration Program Requirements), accreditation is granted to this laboratory to perform the following calibrations^{1, 8}:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
DC Voltage – Measure ³	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 500) V (500 to 1000) V	7.9 μV/V 4.6 μV/V 4.2 μV/V 4.4 μV/V 12 μV/V 8.2 μV/V	HP 3458A, Fluke 8508A
DC Voltage – Generate ³	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V	7.5 μV/V 4.5 μV/V 3.0 μV/V 4.2 μV/V 5.2 /μV/V	Fluke 5730A/5725A (5-digit DUT)
DC Current – Measure ³	Up to 100 μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (1 to 11) A	10 μA/A 11 μA/A 13 μA/A 40 μA/A 140 μA/A 380 μA/A	HP 3458A, Fluke 8508A



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Resistance – Measure ³	Up to 100 kΩ (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ	8.5 μΩ/Ω 8.7 μΩ/Ω 7.5 μΩ/Ω 7.5 μΩ/Ω 7.5 μΩ/Ω 8 μΩ/Ω 8.1 μΩ/Ω 22 μΩ/Ω	HP 3458A, Fluke 8508A

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Measure ³ (1 to 10) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	610 μV/V 320 μV/V 430 μV/V 1.2 mV/V 620 μV/V 40 mV/V 13 mV/V 71 mV/V	HP 3458A, Fluke 8508A
(10 to 100) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 500 kHz to 1MHz	80 μV/V 61 μV/V 96 μV/V 120 μV/V 460 μV/V 1.2 mV/V 3.5 mV/V 3.5 mV/V	
100 mV to 1 V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 500 kHz to 1MHz	68 μV/V 50 μV/V 74 μV/V 130 μV/V 180 μV/V 1.0 mV/V 3.4 mV/V 3.7 mV/V	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Measure ³ (cont)			
(1 to 10) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 500 kHz to 1MHz	65µV/V 50µV/V 74µV/V 85µV/V 300 µv/V 330 µV/V 3.5 mV/V 3.6 mV/V	HP 3458A, Fluke 8508A
(10 to 100) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	110 µV/V 90 µV/V 94 µV/V 140 µV/V 420 µV/V 430 µV/V	
(100 to 700) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	83 µV/V 160 µV/V 27 µV/V 560 µV/V	
(700 to 1000) V	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	140 µV/V 130 µV/V 150 µV/V	
AC Voltage – Generate ³			
Up to 10 mV	(10 to 20) Hz (20 to 40) Hz (40 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	660 µV/V 520 µV/V 290 µv/V 590 µV/V 990 µV/V 1.9 mV/V 3.3 mV/V 7.5 mV/V	Fluke 5730A/5725A
(10 to 100) 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	730 µV/V 330 µV/V 290 µv/V 420 µV/V 970 µV/V 1.5 mv/V 3.9 mv/V 6.1 mV/V	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate ³ (cont)			
100 mV to 1 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 1MHz	140 µV/V 31 µV/V 31 µV/V 56 µV/V 71 µV/V 200 µV/V 710 µV/V 940 µV/V	Fluke 5730A/5725A
(1 to 10) 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 1MHz	480 µV/V 48 µV/V 35 µV/V 44 µV/V 51 µV/V 250 µV/V 350 µV/V 1.9 mV/V	
(10 to 100) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	140 µV/V 53 µV/V 45 µV/V 52 µV/V 220 µV/V	
(200 to 1000) V	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	110 µV/V 33 µV/V 130 µV/V	
AC Current – Measure ³			
(10 to 100) µA	(10 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	15 µA/A 12 µA/A 21 µA/A 31 µA/A 150 µA/A	HP 3458A, Fluke 8508A
100 µA to 1 mA	(10 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	33 µA/A 23 µA/A 21 µA/A 11 µA/A 30 µA/A	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Current – Measure ³ (cont)			
(1 to 10) mA	(10 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	21 µA/A 17 µA/A 25 µA/A 28 µA/A 17 µA/A	HP 3458A, Fluke 8508A
(10 to 100) mA	(10 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	22 µA/A 16 µA/A 32 µA/A 25 µA/A 59 µA/A	
100 mA to 1 A	(10 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	41 µA/A 35 µA/A 68 µA/A 100 µA/A 52 µA/A	
(1 to 5) A	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	15 µA/A 17 µA/A 17 µA/A 18 µA/A	
(5 to 11) A	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	28 µA/A 28 µA/A 13 µA/A 31 µA/A	

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
RF Power – Generate & Measure ³ e.g., Generator, Power Meter			
(-100 to <-80) dBm	(8 to <100) kHz	0.079 dB	R&S@UCS2010 measuring system: power sensor w/ receiver
(-130 to <-80) dBm	100 kHz to 100 MHz	0.079 dB	
	>100 MHz to 2.4 GHz	0.081 dB	
	(>2.4 to 8) GHz	0.083 dB	
	(>8 to 20) GHz	0.11 dB	
(-120 to <-80) dBm	(>20 to 40) GHz	0.12 dB	
(-100 to <-80) dBm	(>40 to 50) GHz	0.14 dB	
	(>50 to 67) GHz	0.19 dB	
(-80 to <-20) dBm	>8 kHz to 100 MHz	0.057 dB	
	>100 MHz to 2.4 GHz	0.060 dB	
	(>2.4 to 8) GHz	0.062 dB	
	(>8 to 20) GHz	0.094 dB	
	(>20 to 40) GHz	0.10 dB	
	(>40 to 50) GHz	0.13 dB	
	(>50 to 67) GHz	0.18 dB	
Generate ³ e.g., Generator			
(-20 to 20) dBm	1 kHz to 100 MHz	0.016 dB	R&S@NRP18T
	>100 MHz to 2 GHz	0.024 dB	
	(>2 to 8) GHz	0.030 dB	
	(>8 to 12.4) GHz	0.037 dB	
	(>12.4 to 18) GHz	0.049 dB	
	(>18 to 26.5) GHz	0.064 dB	R&S@NRP67T
	(26.5 to 33) GHz	0.080 dB	
	(33 to 40) GHz	0.085 dB	
	(>40 to 50) GHz	0.12 dB	
	(>50 to 67) GHz	0.17 dB	
	(>67 to 70) GHz	0.21 dB	
	(>70 to 90) GHz	0.34 dB	
(>20 to 40) dBm	>1 kHz to 100 MHz	0.048 dB	R&S@NRP110T
	100 MHz to 6 GHz	0.059 dB	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
RF Power – Generate & Measure ³ (cont)			
Generate			
(>20 to 35) dBm	(>6 to 8) GHz (>8 to 12.5) GHz (12.5 to 18) GHz	0.064 dB 0.081 dB 0.095 dB	R&S®NRP18T w/ 20 dB attenuator
(>20 to 30) dBm	(>18 to 26.5) GHz (>26.5 to 40) GHz (>40 to 50) GHz (>50 to 67) GHz	0.11 dB 0.12 dB 0.15 dB 0.19 dB	R&S®NRP67T w/ 20 dB attenuator
(0 to 70) dB (>70 to 120) dB	8 kHz to 67 GHz	0.05 dB 0.10 dB	R&S®FSW67 w/ preamplifier
RF Power – Generate ³ Absolute, DUT: Power Meter			Material measure Direct RF power comparison
(-40 to -20) dBm	>DC to 100 MHz >100 MHz to 2.4 GHz (>2.4 to 4) GHz (>4 to 8) GHz (>8 to 12.4) GHz (>12.4 to 18) GHz (>18 to 26.5) GHz (>26.5 to 33) GHz (>33 to 40) GHz	0.025 dB 0.029 dB 0.034 dB 0.041 dB 0.055 dB 0.063 dB 0.064 dB 0.076 dB 0.082 dB	R&S®NRPC18 R&S®NRPC33 R&S®NRPC40 R&S®NRPC67
(-20 to 20) dBm	>DC to 1 MHz (>1 to 100) MHz >100 MHz to 2.4 GHz (>2.4 to 8) GHz (>8 to 12.4) GHz (>12.4 to 18) GHz (>18 to 26.5) GHz (>26.5 to 33) GHz (>33 to 40) GHz (>40 to 50) GHz (>50 to 67) GHz (>67 to 90) GHz	0.012 dB 0.015 dB 0.021 dB 0.029 dB 0.036 dB 0.047 dB 0.050 dB 0.060 dB 0.063 dB 0.095 dB 0.15 dB 0.44 dB	R&S®NRPC18 R&S®NRPC33 R&S®NRPC40 R&S®NRPC50 R&S®NRPC67 R&S®NRP110T w/ R&S® SMZ90 (mismatch uncertainty not included)

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
Tuned RF Power – Measure ³ Relative DUT: Generator, Step Attenuator (0 to -0.1) dB (-0.1 to -20) dB (-20 to -40) dB (-40 to -60) dB (-60 to -80) dB (-80 to -90) dB	(10 to 200) MHz	0.007 dB 0.010 dB 0.014 dB 0.016 dB 0.019 dB 0.023 dB	Indicating measuring instrument direct RF power comparison (e.g.: R&S® FSWP8) UCS display linearity - MS: spectrum analyzer - DUT: step attenuator
Tuned RF Power – Generate ³ Relative DUT: Power Meter (0 to -0.1) dB (-0.1 to -20) dB (-20 to -40) dB (-40 to -60) dB (-60 to -80) dB (-80 to -90) dB (0 to 0.1) dB (>0.1 to 21) dB (>21 to 30) dB (>30 to 40) dB (>40 to 50) dB (>50 to 60) dB (>60 to 70) dB (>70 to 80) dB (>80 to 90) dB (>90 to 100) dB (>100 to 110) dB (>110 to 120) dB	(10 to 200) MHz 50 MHz to 1 GHz	0.010 dB 0.020 dB 0.023 dB 0.024 dB 0.027 dB 0.036 dB 0.001 dB 0.005 dB 0.010 dB 0.012 dB 0.013 dB 0.014 dB 0.015 dB 0.016 dB 0.017 dB 0.018 dB 0.019 dB 0.020 dB	Material measure direct RF power comparison R&S® RSC step attenuator; R&S® UCS2120 R&S®NRPC-LS, w/ R&S®RSC



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Reflection Γ S_{11}/S_{22} – Measure ³ Magnitude Unit Linear:			Γ : reflection magnitude Type-N (50 Ω), 3.5 mm, 2.92 mm 2.4 mm, 1.85 m
(>0.2 to 1) lin (0 to 0.2) lin	9 kHz to 10 GHz	(0.0035 + 0.0039 · Γ^2) lin 0.0035 lin	R&S@ZNB8
(>0.2 to 1) lin (0 to 0.2) lin	(>10 to 18) GHz	(0.0041 + 0.0040 · Γ^2) lin 0.0041 lin	R&S@ZVA67
(>0.2 to 1) lin (0 to 0.2) lin	(>18 to 30) GHz	(0.0059 + 0.0055 · Γ^2) lin 0.0059 lin	R&S@ZV-Z270
(>0.2 to 1) lin (0 to 0.2) lin	(>30 to 40) GHz	(0.0070 + 0.0050 · Γ^2) lin 0.0070 lin	R&S@ZV-Z235
(>0.2 to 1) lin (0 to 0.2) lin	(>40 to 50) GHz	(0.0092 + 0.0088 · Γ^2) lin 0.0092 lin	R&S@ZN-Z229
(>0.2 to 1) lin (0 to 0.2) lin	(>50 to 60) GHz	(0.012 + 0.011 · Γ^2) lin 0.012 lin	R&S@ZV-Z224
(>0.2 to 1) lin (0 to 0.2) lin	(>60 to 67) GHz	(0.012 + 0.014 · Γ^2) lin 0.012 lin	R&S@ZV-Z218
Reflection Γ S_{11}/S_{22} – Measure ³ Phase:			R&S@ZNB8 w/CalKit Phase uncertainty: If $U_{Mag} > \Gamma $, If $U_{Mag} < \Gamma $
(0 to 1)	9 kHz to 67 GHz	180°	Γ : reflection magnitude U_{Mag} : magnitude uncertainty in unit 1 U_{Deg} : phase uncertainty in unit degree
(0 to 1)	9 kHz to 67 GHz	$U_{Deg} = \arcsin(U_{Mag}/ \Gamma)$ $\times 180^\circ/\pi$	

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
Transmission S ₂₁ /S ₁₂ – Measure ³			A: Attenuation in dB
(0 to 30) dB (>30 to 40) dB (>40 to 50) dB (>50 to 60) dB (>60 to 80) dB	(9 to 100) kHz	0.05 dB, 0.4° 0.07 dB, 0.5° 0.12 dB, 0.8° 0.32 dB, 2.1° 0.32 dB + 0.13(A - 60 dB)	R&S®ZNB8 R&S®ZV-Z270
(0 to 30) dB (>30 to 40) dB (>40 to 50) dB (>50 to 60) dB (>60 to 80) dB	>100 kHz to 50 MHz	0.05 dB, 0.4° 0.06 dB, 0.4° 0.09 dB, 0.6° 0.19 dB, 1.3° 0.19 dB + 0.076(A - 60 dB)	
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB	(>50 to 200) MHz	0.05 dB, 0.4° 0.06 dB, 0.4° 0.08 dB, 0.6° 0.32 dB, 2.1° 1.0 dB	
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB	200 MHz to 20 GHz	0.04 dB, 0.9° 0.06 dB, 0.9° 0.07 dB, 0.9° 0.15 dB, 1.3° 0.32 dB	R&S®ZVA67 R&S®ZV-Z218
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB	(20 to 40) GHz	0.06 dB, 1.3° 0.08 dB, 1.3° 0.09 dB, 1.3° 0.33 dB, 2.5° 0.96 dB	R&S®ZVA67 R&S®ZV-Z218
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB	(40 to 50) GHz	0.11 dB, 1.7° 0.12 dB, 1.7° 0.13 dB, 1.7° 0.34 dB, 2.7° 0.96 dB	
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 90) dB	(50 to 67) GHz	0.15 dB, 2.2° 0.16 dB, 2.3° 0.20 dB, 2.4° 0.20 dB + 0.09(A - 60 dB)	

III. Electrical – RF/Microwave Device Specific Parameters

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
<p>CISPR Pulse Characteristic – Absolute Measure DUT: Pulse Generator</p> <p>Band A 13.5 μVs; 25 Hz</p> <p>Band B 0.316 μVs; 100 Hz</p> <p>Band C/D 0.044 μVs; 100 Hz</p>	<p>(9 to 150) kHz</p> <p>150 kHz to 30 MHz</p> <p>(30 to 1000) MHz</p>	<p>0.25 dB</p> <p>0.25 dB</p> <p>0.26 dB</p>	<p>Indicating measuring instrument, direct pulse comparison R&S®FSWP8 CISPR 16-1-1</p> <p>UCS CISPR: pulse level, MS: spectrum analyzer, DUT: EMI pulse generator</p>
<p>CISPR Detector Absolute – Generate DUT: Test Receiver</p> <p>Band A 13.5 μVs; 25 Hz</p> <p>Band B 0.316 μVs; 100 Hz</p> <p>Band C/D 0.044 μVs; 100 Hz</p> <p>Band E (Pulse Modulated Carrier)</p>	<p>(9 to 150) kHz</p> <p>150 kHz to 30 MHz</p> <p>(30 to 1000) MHz</p> <p>(1 to 4) GHz (4 to 8) GHz (8 to 18) GHz</p>	<p>0.30 dB</p> <p>0.30 dB</p> <p>0.31 dB</p> <p>0.10 dB 0.11 dB 0.13 dB</p>	<p>Material measure, direct pulse comparison (e.g.: Schwarzbeck® IGUU 2918) CISPR 16-1-1</p> <p>Absolute pulse response (Band E) MS: pulsed RF generator, DUT: receiver R&S® SMA100B</p>
<p>CISPR Pulse Repetition Rate – Measure DUT: Pulse Generator</p> <p>Band A</p> <p>Band B</p> <p>Band C/D</p>	<p>(9 to 150) kHz</p> <p>150 kHz to 30 MHz</p> <p>(30 to 1000) MHz</p>	<p>0.01 %</p> <p>0.01 %</p> <p>0.01 %</p>	<p>Indicating measuring, instrument direct measurement (e.g.: R&S® HM8123) CISPR 16-1-1</p> <p>UCS: pulse repetition rate, MS: frequency counter, DUT: EMI pulse generator</p>

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
CISPR Detector – Relative: Response Variation with Repetition Frequency Generate ³ DUT: Test Receiver Band A (0.1 to 100) Hz Band B 0.1 Hz to 4 kHz Band C/D 0.1 Hz to 50 kHz	 (9 to 150) kHz 150 kHz to 30 MHz (30 to 1000) MHz	 0.05 dB 0.05 dB 0.05 dB	Material measure, direct pulse comparison (e.g.: Schwarzbeck® IGUU 2918) CISPR 16-1-1 UCS: pulse repetition rate, MS: pulse generator, DUT: receiver
CISPR Detector – Absolute Generate ³ DUT: Test Receiver Band E (Pulse Modulated Carrier) 100 Hz to 400 kHz	 (1 to 18) GHz	 0.05 dB	Material measure direct comparison pulse to modulated carrier (e.g.: R&S® SMA100B) CISPR 16-1-1 Absolute pulse response (Band E) MS: pulsed RF generator, DUT: receiver
Phase Noise – Measure	100 MHz to 16 GHz Carrier	0.67 dB	R&S LPN
Resolution Bandwidth Bandwidth Switching – Measure ³	100 Hz to 80 MHz (RBW)	0.010 dB	R&S NRP18A
Amplitude Modulation – Generate & Measure ³ 0.01 to 1.0	$>DC, f_{mod} \leq 100 \text{ kHz}$ $100 \text{ kHz} < f_{mod} \leq 1 \text{ MHz}$ $1 \text{ MHz} < f_{mod} \leq 10 \text{ MHz}$	$0.001m + k_{AM}$ $0.002m + k_{AM}$ $0.007m + k_{AM}$	m : Modulation index f_{mod} : modulation frequency R&S®FSW k_{AM} : residual influence depends on demodulation bandwidth

Parameter/Range	Frequency	CMC ^{2, 4} (\pm)	Comments
Frequency Modulation – Generate & Measure ³ 10 Hz to 16 MHz	$10 \text{ Hz} < f_{\text{mod}} \leq 100 \text{ kHz}$ $100 \text{ kHz} < f_{\text{mod}} \leq 200 \text{ kHz}$ $200 \text{ kHz} < f_{\text{mod}} \leq 10 \text{ MHz}$	$0.001\Delta f + k_{\text{FM}}$ $0.002\Delta f + k_{\text{FM}}$ $0.005\Delta f + k_{\text{FM}}$	Δf : frequency deviation R&S®FSW k_{FM} : residual influence depends on demodulation bandwidth
Phase Modulation – Generate & Measure ³ 10 Hz/ f_{mod} in rad to 16 MHz/ f_{mod} in rad	$10 \text{ Hz } f_{\text{mod}} \leq 100 \text{ kHz}$ $100 \text{ kHz} < f_{\text{mod}} \leq 200 \text{ kHz}$ $200 \text{ kHz} < f_{\text{mod}} \leq 10 \text{ MHz}$	$0.001\Delta\phi + k_{\text{FM}}$ $0.002\Delta\phi + k_{\text{FM}}$ $0.005\Delta\phi + k_{\text{FM}}$	$\Delta\phi$: phase deviation R&S®FSW k_{PM} : residual influence depends on demodulation
Digital Modulation – Generate & Measure ³ Carrier: 2 MHz to 6 GHz Error Vector Magnitude (RMS) for Modulation Types: MSK, GMSK, BPSK, DQPSK, $\pi/4$ DQPSK, 8 PSK, 16 QAM & 32 QAM, QPSK Phase Error (RMS) for Modulation Types: MSK, GMSK, BPSK, DQPSK, $\pi/4$ DQPSK, 8 PSK, 16 QAM & 32 QAM, QPSK	$(20 \text{ to } 1500) \text{ MHz}$ $(>1500 \text{ to } 2600) \text{ MHz}$ $(>2600 \text{ to } 6000) \text{ MHz}$ $(20 \text{ to } 1500) \text{ MHz}$ $(>1500 \text{ to } 2600) \text{ MHz}$ $(>2600 \text{ to } 6000) \text{ MHz}$	0.018 % RMS 0.019 % RMS 0.046 % RMS 0.0099° RMS 0.011° RMS 0.026° RMS	R&S FSWP

IV. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 7} (\pm)	Comments
Frequency – Measure & Measuring Equipment ³	20 Hz to 100 MHz 100 MHz to 67 GHz 10 MHz (at 24 hours)	0.01 Hz 0.10 nHz/Hz 3.9 pHz/Hz (3.9 parts in 10 ¹²)	Fluke 910R, spectrum analyzer, generator (e.g.: R&S® SMA100B)
Time – Measure	100 ns	3.9 ps/s (3.9 parts in 10 ¹²)	Fluke 910R w/ Fluke 6690 counter
Rise-Time (RF pulse) – Measure ³	(0.5 to 10) ns	160 ps	R&S®RTO2000

SATELLITE FACILITY

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I. Electrical – RF/Microwave

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Power – Generate ³ Absolute, DUT: Power Meter			Material measure Direct RF power comparison
(-40 to -20) dBm	>DC to 100 MHz	0.025 dB	R&S®NRP-Z55
	>100 MHz to 2.4 GHz	0.029 dB	
	(>2.4 to 4) GHz	0.034 dB	
	(>4 to 8) GHz	0.041 dB	
	(>8 to 12.4) GHz	0.055 dB	
	(>12.4 to 18) GHz	0.063 dB	
	(>18 to 26.5) GHz	0.064 dB	
	(>26.5 to 33) GHz	0.076 dB	
(-20 to 20) dBm	>DC to 1 MHz	0.012 dB	R&S®NRPC18 R&S®NRPC33 R&S®NRPC40 R&S®NRPC50 R&S®NRPC67
	(>1 to 100) MHz	0.015 dB	
	>100 MHz to 2.4 GHz	0.021 dB	
	(>2.4 to 8) GHz	0.029 dB	
	(>8 to 12.4) GHz	0.036 dB	
	(>12.4 to 18) GHz	0.047 dB	
	(>18 to 26.5) GHz	0.050 dB	
	(>26.5 to 33) GHz	0.060 dB	
	(>33 to 40) GHz	0.063 dB	
	(>40 to 50) GHz	0.095 dB	
	(>50 to 67) GHz	0.15 dB	
	(>67 to 90) GHz	0.44 dB	



Parameter/Equipment	Range	CMC ^{2,4} (\pm)	Comments
Reflection Γ S_{11}/S_{22} – Measure ³ Magnitude Unit Linear: (>0.2 to 1) lin (0 to 0.2) lin	9 kHz to 10 GHz (>10 to 18) GHz (>18 to 30) GHz (>30 to 40) GHz	(0.0035 + 0.0039 · Γ^2) lin 0.0035 lin (0.0041 + 0.0040 · Γ^2) lin 0.0041 lin (0.0059 + 0.0055 · Γ^2) lin 0.0059 lin (0.0070 + 0.0050 · Γ^2) lin 0.0070 lin	Γ : reflection magnitude Type-N (50 Ω), 3.5 mm, 2.92 mm 2.4 mm, 1.85 mm R&S®ZNB8 R&S®ZVA67 R&S®ZV-Z270 R&S®ZV-Z235
Transmission S_{21}/S_{12} – Measure ³ (0 to 30) dB (>30 to 40) dB (>40 to 50) dB (>50 to 60) dB (>60 to 80) dB (0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB (0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB (0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB	>100 kHz to 50 MHz (>50 to 200) MHz 200 MHz to 20 GHz (20 to 40) GHz	0.05 dB, 0.4° 0.06 dB, 0.4° 0.09 dB, 0.6° 0.19 dB, 1.3° 0.19 dB + 0.076(A - 60 dB) 0.05 dB, 0.4° 0.06 dB, 0.4° 0.08 dB, 0.6° 0.32 dB, 2.1° 1.0 dB 0.04 dB, 0.9° 0.06 dB, 0.9° 0.07 dB, 0.9° 0.15 dB, 1.3° 0.32 dB 0.06 dB, 1.3° 0.08 dB, 1.3° 0.09 dB, 1.3° 0.33 dB, 2.5° 0.96 dB	A : Attenuation in dB R&S®ZNB8 R&S®ZV-Z270 R&S®ZVA67 R&S®ZV-Z218



II. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
Frequency – Measure & Measuring Equipment ³	20 Hz to 100 MHz 100 MHz to 67 GHz 10 MHz	0.01 Hz 0.10 nHz/Hz 3.9 pHz/Hz (3.9 parts in 10 ¹²)	Fluke 910R w/ FSQ spectrum analyzer, generator (e.g.: R&S® SMA100B)

SATELLITE FACILITY

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I. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
RF Power – Generate & Measure ³ e.g., Generator, Power Meter			
(-100 to <-80) dBm	(8 to <100) kHz	0.079 dB	R&S@UCS2010 measuring system: power sensor w/ receiver
(-130 to <-80) dBm	100 kHz to 100 MHz	0.079 dB	
	>100 MHz to 2.4 GHz	0.081 dB	
	(>2.4 to 8) GHz	0.083 dB	
	(>8 to 20) GHz	0.11 dB	
	(>20 to 40) GHz	0.12 dB	
(-120 to <-80) dBm			
(-100 to <-80) dBm	(>40 to 50) GHz	0.14 dB	
	(>50 to 67) GHz	0.19 dB	
(-80 to <-20) dBm	>8 kHz to 100 MHz	0.057 dB	
	>100 MHz to 2.4 GHz	0.060 dB	
	(>2.4 to 8) GHz	0.062 dB	
	(>8 to 20) GHz	0.094 dB	
	(>20 to 40) GHz	0.10 dB	
	(>40 to 50) GHz	0.13 dB	
	(>50 to 67) GHz	0.18 dB	



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
RF Power – Generate & Measure ³ (cont)			
Generate ³ e.g., Generator			
(-20 to 20) dBm	1 kHz to 100 MHz >100 MHz to 2 GHz (>2 to 8) GHz (>8 to 12.4) GHz (>12.4 to 18) GHz (>18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (>40 to 50) GHz (>50 to 67) GHz (>67 to 70) GHz (>70 to 90) GHz	0.016 dB 0.024 dB 0.030 dB 0.037 dB 0.049 dB 0.064 dB 0.080 dB 0.085 dB 0.12 dB 0.17 dB 0.21 dB 0.34 dB	R&S@NRP18T R&S@NRP67T
(>20 to 40) dBm	>1 kHz to 100 MHz 100 MHz to 6 GHz	0.048 dB 0.059 dB	R&S@NRP110T R&S@NRP18T w/ 20 dB attenuator
(>20 to 35) dBm	(>6 to 8) GHz (>8 to 12.5) GHz (12.5 to 18) GHz	0.064 dB 0.081 dB 0.095 dB	
(>20 to 30) dBm	(>18 to 26.5) GHz (>26.5 to 40) GHz (>40 to 50) GHz (>50 to 67) GHz	0.11 dB 0.12 dB 0.15 dB 0.19 dB	R&S@NRP67T w/ 20 dB attenuator
(0 to 70) dB (>70 to 120) dB	8 kHz to 67 GHz	0.05 dB 0.10 dB	R&S@FSW67 w/ preamplifier
RF Power – Generate ³ Absolute, DUT: Power Meter			Material measure Direct RF power comparison
(-40 to -20) dBm	>DC to 100 MHz >100 MHz to 2.4 GHz (>2.4 to 4) GHz (>4 to 8) GHz (>8 to 12.4) GHz (>12.4 to 18) GHz (>18 to 26.5) GHz (>26.5 to 33) GHz (>33 to 40) GHz	0.025 dB 0.029 dB 0.034 dB 0.041 dB 0.055 dB 0.063 dB 0.064 dB 0.076 dB 0.082 dB	R&S@NRPC18 R&S@NRPC33 R&S@NRPC40 R&S@NRPC67

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
RF Power – Generate ³ Absolute, DUT: Power Meter (cont) (-20 to 20) dBm	>DC to 1 MHz (>1 to 100) MHz >100 MHz to 2.4 GHz (>2.4 to 8) GHz (>8 to 12.4) GHz (>12.4 to 18) GHz (>18 to 26.5) GHz (>26.5 to 33) GHz (>33 to 40) GHz (>40 to 50) GHz (>50 to 67) GHz (>67 to 90) GHz	0.012 dB 0.015 dB 0.021 dB 0.029 dB 0.036 dB 0.047 dB 0.050 dB 0.060 dB 0.063 dB 0.095 dB 0.15 dB 0.44 dB	R&S®NRPC18 R&S®NRPC33 R&S®NRPC40 R&S®NRPC50 R&S®NRPC67 R&S®NRP110T w/ R&S® SMZ90
Tuned RF Power – Measure ³ Relative DUT: Generator, Step Attenuator (0 to -0.1) dB (-0.1 to -20) dB (-20 to -40) dB (-40 to -60) dB (-60 to -80) dB (-80 to -90) dB	(10 to 200) MHz	0.007 dB 0.010 dB 0.014 dB 0.016 dB 0.019 dB 0.023 dB	Indicating measuring instrument direct RF power comparison (e.g.: R&S® FSWP8) UCS display linearity - MS: spectrum analyzer - DUT: step attenuator
Tuned RF Power – Generate ³ Relative DUT: Power Meter (0 to -0.1) dB (-0.1 to -20) dB (-20 to -40) dB (-40 to -60) dB (-60 to -80) dB (-80 to -90) dB	(10 to 200) MHz	0.010 dB 0.020 dB 0.023 dB 0.024 dB 0.027 dB 0.036 dB	Material measure direct RF power comparison R&S® RSC step attenuator; R&S® UCS2120

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Tuned RF Power – Generate ³ Relative DUT: Power Meter (cont) (0 to 0.1) dB (>0.1 to 21) dB (>21 to 30) dB (>30 to 40) dB (>40 to 50) dB (>50 to 60) dB (>60 to 70) dB (>70 to 80) dB (>80 to 90) dB (>90 to 100) dB (>100 to 110) dB (>110 to 120) dB	50 MHz to 1 GHz	0.001 dB 0.005 dB 0.010 dB 0.012 dB 0.013 dB 0.014 dB 0.015 dB 0.016 dB 0.017 dB 0.018 dB 0.019 dB 0.020 dB	R&S®NRPC-LS, w/ R&S®RSC
Reflection Γ S ₁₁ /S ₂₂ – Measure ³ Magnitude Unit Linear:			Γ : reflection magnitude
(>0.2 to 1) lin (0 to 0.2) lin	9 kHz to 10 GHz	(0.0035 + 0.0039 · Γ^2) lin 0.0035 lin	Type-N (50 Ω), 3.5 mm, 2.92 mm 2.4 mm, 1.85 mm R&S®ZNB8
(>0.2 to 1) lin (0 to 0.2) lin	(>10 to 18) GHz	(0.0041 + 0.0040 · Γ^2) lin 0.0041 lin	R&S®ZVA67
(>0.2 to 1) lin (0 to 0.2) lin	(>18 to 30) GHz	(0.0059 + 0.0055 · Γ^2) lin 0.0059 lin	R&S®ZV-Z270
(>0.2 to 1) lin (0 to 0.2) lin	(>30 to 40) GHz	(0.0070 + 0.0050 · Γ^2) lin 0.0070 lin	R&S®ZV-Z235
(>0.2 to 1) lin (0 to 0.2) lin	(>40 to 50) GHz	(0.0092 + 0.0088 · Γ^2) lin 0.0092 lin	R&S®ZN-Z229
(>0.2 to 1) lin (0 to 0.2) lin	(>50 to 60) GHz	(0.012 + 0.011 · Γ^2) lin 0.012 lin	R&S®ZV-Z224
(>0.2 to 1) lin (0 to 0.2) lin	(>60 to 67) GHz	(0.012 + 0.014 · Γ^2) lin 0.012 lin	R&S®ZV-Z218

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Transmission S ₂₁ /S ₁₂ – Measure ³ (cont)			<i>A</i> : Attenuation in dB
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB	(20 to 40) GHz	0.06 dB, 1.3° 0.08 dB, 1.3° 0.09 dB, 1.3° 0.33 dB, 2.5° 0.96 dB	R&S®ZVA67 R&S®ZV-Z218
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 80) dB (>80 to 90) dB	(40 to 50) GHz	0.11 dB, 1.7° 0.12 dB, 1.7° 0.13 dB, 1.7° 0.34 dB, 2.7° 0.96 dB	
(0 to 30) dB (>30 to 40) dB (>40 to 60) dB (>60 to 90) dB	(50 to 67) GHz	0.15 dB, 2.2° 0.16 dB, 2.3° 0.20 dB, 2.4° 0.20 dB + 0.09(<i>A</i> - 60 dB)	

II. Electrical – RF/Microwave Device Specific Parameters

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
CISPR Pulse Characteristic – Absolute Measure DUT: Pulse Generator			Indicating measuring instrument, direct pulse comparison R&S®FSWP8 CISPR 16-1-1
Band A 13.5 μVs; 25 Hz	(9 to 150) kHz	0.25 dB	
Band B 0.316 μVs; 100 Hz	150 kHz to 30 MHz	0.25 dB	UCS CISPR: pulse level, MS: spectrum analyzer,
Band C/D 0.044 μVs; 100 Hz	(30 to 1000) MHz	0.26 dB	DUT: EMI pulse generator

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} (±)	Comments
CISPR Detector Absolute – Generate DUT: Test Receiver Band A 13.5 µVs; 25 Hz Band B 0.316 µVs; 100 Hz Band C/D 0.044 µVs; 100 Hz Band E (Pulse Modulated Carrier)	(9 to 150) kHz 150 kHz to 30 MHz (30 to 1000) MHz (1 to 4) GHz (4 to 8) GHz (8 to 18) GHz	0.30 dB 0.30 dB 0.31 dB 0.10 dB 0.11 dB 0.13 dB	Material measure, direct pulse comparison (e.g.: Schwarzbeck® IGUU 2918) CISPR 16-1-1 Absolute pulse response (Band E) MS: pulsed RF generator, DUT: receiver R&S® SMA100B
CISPR Pulse Repetition Rate – Measure DUT: Pulse Generator Band A Band B Band C/D	(9 to 150) kHz 150 kHz to 30 MHz (30 to 1000) MHz	0.02 % 0.02 % 0.01 %	Indicating measuring, instrument direct measurement (e.g.: R&S® HM8123) CISPR 16-1-1 UCS: pulse repetition rate, MS: frequency counter, DUT: EMI pulse generator
CISPR Detector – Relative: Response Variation with Repetition Frequency Generate ³ DUT: Test Receiver Band A (0.1 to 100) Hz Band B 0.1 Hz to 4 kHz Band C/D 0.1 Hz to 50 kHz	(9 to 150) kHz 150 kHz to 30 MHz (30 to 1000) MHz	0.05 dB 0.05 dB 0.05 dB	Material measure, direct pulse comparison (e.g.: Schwarzbeck® IGUU 2918) CISPR 16-1-1 UCS: pulse repetition rate, MS: pulse generator, DUT: receiver

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
CISPR Detector – Absolute Generate ³ DUT: Test Receiver Band E (Pulse Modulated Carrier) 100 Hz to 400 kHz	(1 to 18) GHz	0.05 dB	Material measure direct comparison pulse to modulated carrier (e.g.: R&S® SMA100B) CISPR 16-1-1 Absolute pulse response (Band E) MS: pulsed RF generator, DUT: receiver
Phase Noise – Measure	100 MHz to 16 GHz Carrier	0.67 dB	R&S LPN
Resolution Bandwidth Bandwidth Switching – Measure ³	100 Hz to 80 MHz (RBW)	0.010 dB	R&S NRP18A
Amplitude Modulation – Generate & Measure ³ 0.01 to 1.0	>DC $f_{\text{mod}} \leq 100$ kHz 100 kHz $<f_{\text{mod}} \leq 1$ MHz 1 MHz $<f_{\text{mod}} \leq 10$ MHz	$0.001m + k_{\text{AM}}$ $0.002m + k_{\text{AM}}$ $0.007m + k_{\text{AM}}$	m : Mmodulation index f_{mod} : modulation frequency R&S®FSW k_{AM} : residual influence depends on demodulation bandwidth
Frequency Modulation – Generate & Measure ³ 10 Hz to 16 MHz	10 Hz $<f_{\text{mod}} \leq 100$ kHz 100 kHz $<f_{\text{mod}} \leq 200$ kHz 200 kHz $<f_{\text{mod}} \leq 10$ MHz	$0.001\Delta f + k_{\text{FM}}$ $0.002\Delta f + k_{\text{FM}}$ $0.005\Delta f + k_{\text{FM}}$	Δf : frequency deviation R&S®FSW k_{FM} : residual influence depends on demodulation bandwidth

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Phase Modulation – Generate & Measure ³ 10 Hz/ f_{mod} in rad to 16 MHz/ f_{mod} in rad	10 Hz $f_{\text{mod}} \leq 100$ kHz 100 kHz $< f_{\text{mod}} \leq 200$ kHz 200 kHz $< f_{\text{mod}} \leq 10$ MHz	0.001 $\Delta\phi + k_{\text{FM}}$ 0.002 $\Delta\phi + k_{\text{FM}}$ 0.005 $\Delta\phi + k_{\text{FM}}$	$\Delta\phi$: phase deviation R&S®FSW k_{PM} : residual influence depends on demodulation
Digital Modulation – Generate & Measure ³ Carrier: 2 MHz to 6 GHz Error Vector Magnitude (RMS) for Modulation Types: MSK, GMSK, BPSK, DQPSK, $\pi/4$ DQPSK, 8 PSK, 16 QAM & 32QAM, QPSK Phase Error (RMS) for Modulation Types: MSK, GMSK, BPSK, DQPSK, $\pi/4$ DQPSK, 8 PSK, 16 QAM & 32 QAM, QPSK	(20 to 1500) MHz (>1500 to 2600) MHz (>2600 to 6000) MHz (20 to 1500) MHz (>1500 to 2600) MHz (>2600 to 6000) MHz	0.018 % RMS 0.019 % RMS 0.046 % RMS 0.0099° RMS 0.011° RMS 0.026° RMS	R&S FSQ

III. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Frequency – Measure & Measuring Equipment ³	20 Hz to 100 MHz 100 MHz to 67 GHz 10 MHz	0.01 Hz 0.10 nHz/Hz 3.9 pHz/Hz (3.9 parts in 10 ¹²)	Fluke 910R w/ FSQ spectrum analyzer, generator (e.g.: R&S® SMA100B)

Parameter/Equipment	Range	CMC ^{2,7} (\pm)	Comments
Time – Measure	100 ns	3.9 ps/s (3.9 parts in 10 ¹²)	Fluke 910R w/ Fluke 6690 counter
Rise-Time (RF pulse) – Measure ³	(0.5 to 10) ns	1 ns	Krytar®704A w/ R&S®RTO2000

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, % refers to a percent of reading unless otherwise noted.

⁶ Calibration of EMI Test Receivers according to CISPR 16-1-1.

⁷ 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.

⁸ This scope meets A2LA's *PI12 Flexible Scope Policy*.



Accredited Laboratory

A2LA has accredited

ROHDE & SCHWARZ USA, INC.

Columbia, MD

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/NC SL Z540-1-1994 and the requirements of ANSI/NC SL 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 2nd day of December 2025.

A blue ink signature of Mr. Trace McInturff.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2354.01
Valid to October 31, 2027

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