

Radio Testing of the

Spot LLC

Sat-Fi2 Remote Antenna Station Model: SF2 RAS

In accordance with FCC Part 15 Subpart C
§15.247 and IC RSS-247 Issue 2 February 2017

Spot LLC
1351 Holiday Square Blvd.
Covington, LA 70433 USA



COMMERCIAL-IN-CONFIDENCE

Date: October 2019
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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Alex Chang	October 08, 2019	<i>Alex Chang</i>

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY

A sample of this product was tested and found to be in compliance with FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 2 February 2017.

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REPORT ON Radio Testing of the
Spot LLC
Model SF2 RAS Sat-Fi2 Remote Antenna Station

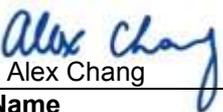
TEST REPORT NUMBER 7215019B

TEST REPORT DATE October 2019

PREPARED FOR Spot LLC
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DATED October 08, 2019



Revision History

7215019B Spot LLC Model SF2 RAS Sat-Fi2 Remote Antenna Station					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
10/08/2019	—	Initial Release			Alex Chang



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SECTION 1

1 REPORT SUMMARY

Radio Testing of the
Spot LLC
SF2 RAS Sat-Fi2 Remote Antenna Station



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Spot LLC SF2 RAS Sat-Fi2 Remote Antenna Station to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 2 February 2017.

Objective	To perform Radio testing to determine the Equipment Under Test's (EUT's) compliance with the test specification, for the series of tests carried out.
Manufacturer	Spot LLC
EUT	Sat-Fi2 Remote Antenna Station
Trade Name	SF2 RAS
Model Name	SF2 RAS
FCC ID	L2V-SF2RAS
IC Number	3989A-SF2RAS
FCC Classification	Low power Communications Device Transmitter (DTS)
Serial Number(s)	N/A
Number of Samples Tested	1
Test Specification/Issue/Date	<ul style="list-style-type: none">• FCC Part 15 Subpart C §15.247 (October 1, 2018).• RSS-247–Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices (Issue 2, February 2017).• RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 5, Amendment 1 March 2019).
Start of Test	September 10, 2019
Finish of Test	October 05, 2019
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	<ul style="list-style-type: none">• ANSI C63.10-2013. American National Standard of Procedures for Compliance testing of Unlicensed Wireless Devices.• KDB 558074 D01 15.247 v05r02 Guidance for compliance measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices operating under Section 15.247 of the FCC rules.• Supporting documents for EUT certification are separate exhibits.



1.2 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 2 February 2017 with cross-reference to the corresponding IC RSS standard are shown below.

Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments /Base Standard
2.1	§15.247(b)(3)	RSS-247 5.4(d)	Peak Output Power	Compliant	
2.2	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	Compliant	
2.3	-	RSS-Gen 6.7	99% Emission Bandwidth	Compliant	
2.4	§15.247(a)(2)	RSS-247 5.2(a)	Minimum 6 dB RF Bandwidth	Compliant	
2.5	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	Compliant	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.7	§15.247(d)	RSS-247 5.5	Radiated Spurious Emissions	Compliant	
	-	RSS-Gen 7.3 and 7.4	Receiver Spurious Emissions	N/A*	
2.8	§15.247(e)	RSS-247 5.2(b)	Power Spectral Density for Digitally Modulated Device	Compliant	

N/A* Not required as per RSS-Gen 5.3 The EUT does not fall into any category defined as Receiver under RSS-Gen.



1.3 Product Information

1.3.1 Technical Description

The Equipment Under Test (EUT) is a Spot LLC SF2 RAS Sat-Fi2 Remote Antenna Station. The EUT consists of a self-contained electronics housing, RF cables, an active GPS antenna, and an active satellite antenna. The EUT Wi-Fi modem is an Azure Wave AW300 based on the Marvell MW300 chipset. It is configured in this application to only work on Channel 1 in order to reduce the possibility of interference with Globalstar’s receive band.

1.3.2 EUT General Description

EUT Description	Sat-Fi2 Remote Antenna Station
Trade Name	SF2 RAS
Model Name	SF2 RAS
Rated Voltage	12-24VDC
Mode Verified	802.11b/g 2412 MHz
Capability	802.11b/g 2412 MHz and 1610.73 – 1620.57 MHz in the 1610.0-1626.5 MHz L-Band Mobile Satellite Service
Primary Unit (EUT)	<input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production <input type="checkbox"/> Engineering
Antenna Type	Omni-directional antenna
Manufacturer	Pulse Electronics
Antenna Model	P/N W1027
Maximum Antenna Gain	3.2 dBi

1.3.3 Maximum Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
802.11b	2412	14.54	28.44
802.11g	2412	15.20	33.11



1.4 EUT Test configuration

1.4.1 Test Configuration Description

Test Configuration	Description
A	Antenna Conducted Port Test Setup. Antenna port connected directly to the TS8997 Test System with 20dB external attenuator. RF configurations are done via USB connection and PuTTY.
B	Radiated Test Setup (Cabinet Spurious Emissions). Identical configuration as above with the antenna port terminated with a 50Ω load

1.4.2 EUT Exercise Software

The EUT is connected to the support laptop via USB. PuTTY was used to communicate with the EUT. The manufacturer provided command lines to configure EUT for each test case.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
HP	Laptop ProBook 440 G2	Model: HSTNN-C83C
HP	Laptop Power Supply	Part No.: 744481-0002
N/A	USB EUT to Laptop	1-meter, hardwired USB cable
Xinsu Global Electronics	AC DC Adapter	Model: XSG 1202000
Protek	DC Power Supply	SDGE09075
RF Precision Cables	50Ω Attenuation	Model: ATX3396-30, 30Db, 50W
JFW	50Ω Load	Model: 5ot-054, 30W

1.4.4 Worst Case Configuration

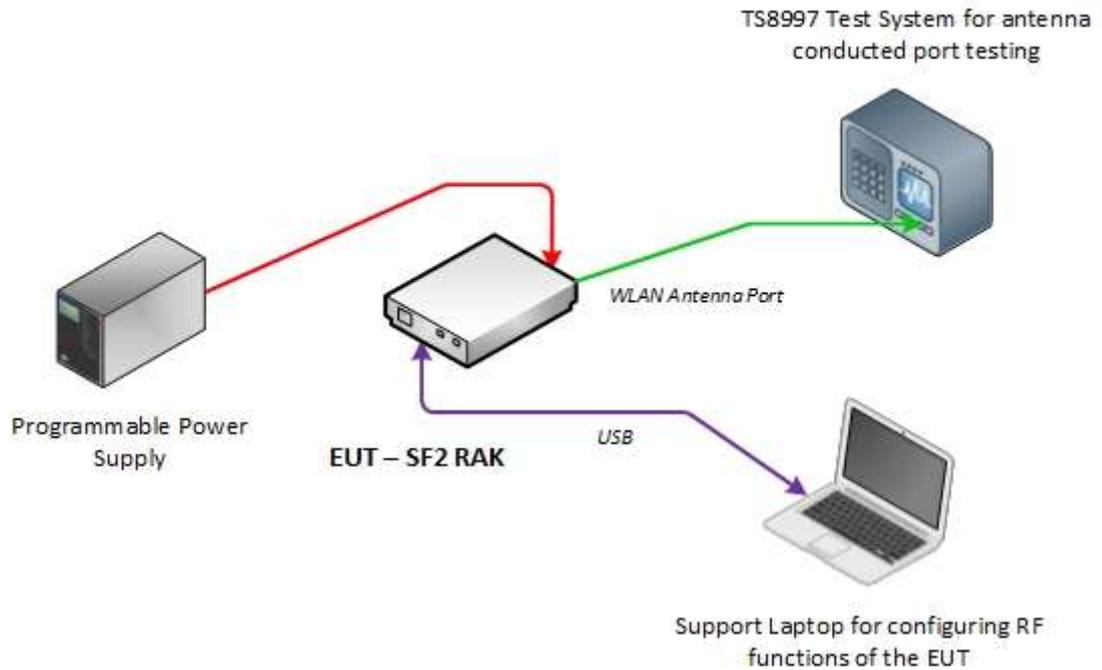
Worst-case configuration used in this test report as per maximum conducted output power measurements:

Mode	Channel	Data Rate
802.11b	1 (Low Channel)	5.5 Mbps
802.11g	1 (Low Channel)	18 Mbps

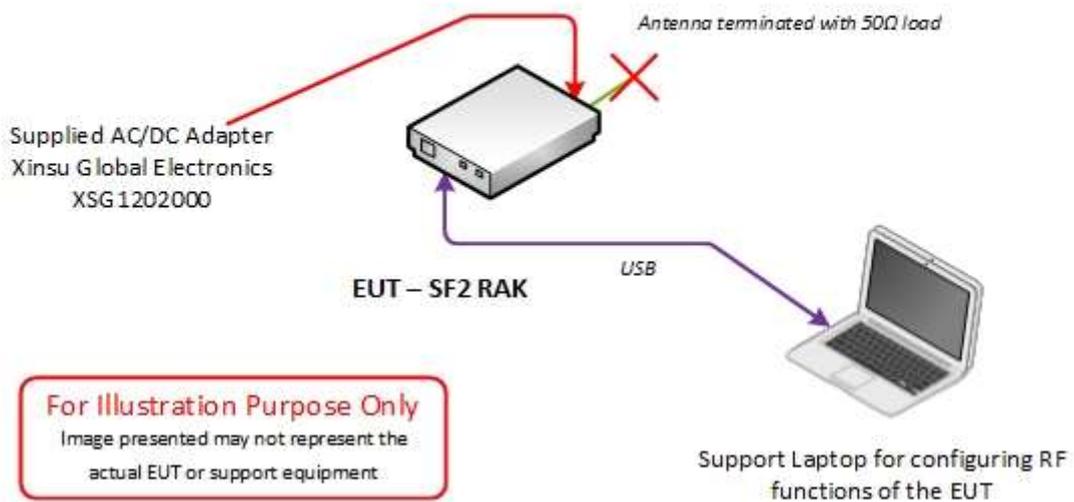
The EUT is a mobile device. For radiated measurements, X, Y and Z were not verified as the EUT is primarily designed as a table top equipment. The EUT was verified using standard axis configuration as recommended.

1.4.5 Simplified Test Configuration Diagram

Antenna Conducted Port Test Configuration



Cabinet Spurious Emissions Test Configuration





1.5 Deviations from the Standard

No deviations from the applicable test standards or test plan were made during testing.

1.6 Modification Record

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: N/A		
None	—	—

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.10-2013. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 Test Facility Location

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400
 FAX: 858 546 0364

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

16936 Via Del Campo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 678 1400
 Fax: 858 546 0364.

1.9 Test Facility Registration

1.9.1 FCC – Designation No.: US1146

TÜV SÜD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Designation is US1146.



1.9.2 Innovation, Science and Economic Development Canada (IC) Registration No.: 3067A-1 & 22806-1

The 10m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Rancho Bernardo) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A-1.

The 3m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Mira Mesa) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 22806-1.

1.9.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)

TÜV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

1.9.4 NCC (National Communications Commission - US0102)

TÜV SÜD America Inc. (San Diego) is listed as a Foreign Recognized Telecommunication Equipment Testing Laboratory and is accredited to ISO/IEC 17025 (A2LA Certificate No.2955.13) which under APEC TEL MRA Phase 1 was designated as a Conformity Assessment Body competent to perform testing of equipment subject to the Technical Regulations covered under its scope of accreditation including RTTE01, PLMN01 and PLMN08 for TTE type of testing and LP002 for Low-Power RF Device type of testing.

1.9.5 VCCI – Registration No. A-0280 and A-0281

TÜV SÜD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.

1.9.6 RRA – Identification No. US0102

TÜV SÜD America Inc. (San Diego) is National Radio Research Agency (RRA) recognized laboratory under Phase I of the APEC Tel MRA.

1.9.7 OFCA – U.S. Identification No. US0102

TÜV SÜD America Inc. (San Diego) is recognized by Office of the Communications Authority (OFCA) under Appendix B, Phase I of the APEC Tel MRA.



SECTION 2

2 TEST DETAILS

Radio Testing of the
Spot LLC
Sat-Fi2 Remote Antenna Station



2.1 Peak Output Power

2.1.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(b)(3)
RSS-247, Clause 5.4 (d)

2.1.2 Standard Applicable

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands, the maximum peak conducted output shall not exceed 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

2.1.3 Equipment Under Test and Modification State

Serial No: N/A / Test Configuration A

2.1.4 Date of Test/Initial of test personnel who performed the test

September 29, 2019 / FSC

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.1 °C
Relative Humidity	53.6 %
ATM Pressure	99.1 kPa

2.1.7 Additional Observations

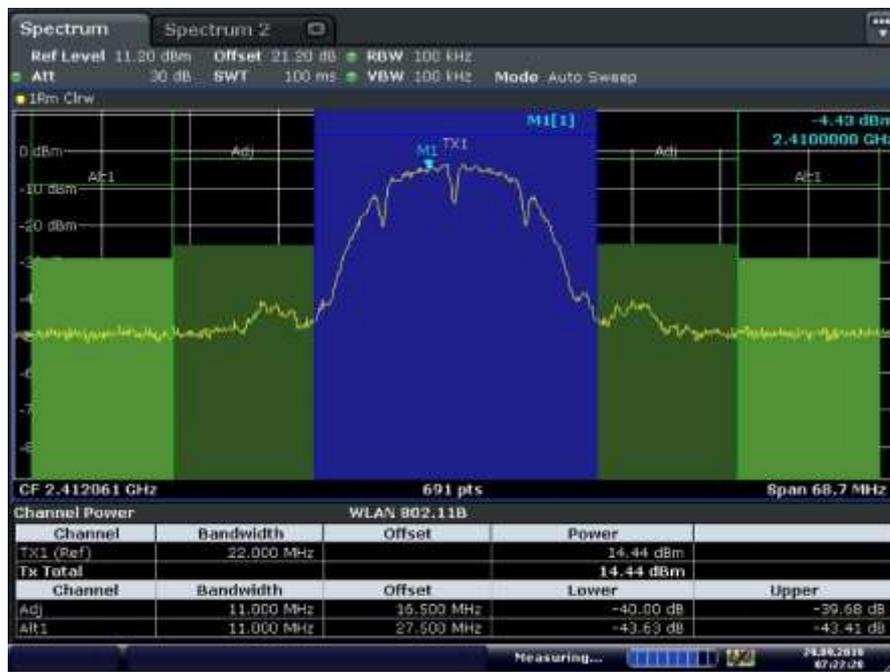
- This is a conducted test using direct connection to the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is according to FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.9.2.3.2.



2.1.8 Test Results

WLAN Mode	Channel	Data Rates (Mbps)	Maximum Conducted Output Power (dBm)
802.11b	1 (2412 MHz)	1	14.44
		2	14.46
		5.5	14.54
		11	14.46
802.11g	1 (2412 MHz)	6	15.04
		9	15.08
		12	15.07
		18	15.20
		24	15.06
		36	15.03
		48	15.03
		54	15.02

2.1.9 Sample Test Plots



Date: 28 SEP 2018 07:22:28

802.11b 1Mbps



Date: 29-SEP-2019 07:23:05

802.11b 2Mbps



Date: 29-SEP-2019 07:23:35

802.11b 5.5Mbps



Date: 29-SEP-2019 07:23:58

802.11b 11Mbps



Date: 29-SEP-2019 07:25:38

802.11g 6Mbps



Date: 29-SEP-2019 07:25:57

802.11g 9Mbps



Date: 29-SEP-2019 07:26:13

802.11g 12Mbps



Date: 29-SEP-2019 07:28:32

802.11g 18Mbps



Date: 29-SEP-2019 07:28:58

802.11g 24Mbps



Date: 29-SEP-2019 07:27:19

802.11g 48Mbps



Date: 29-SEP-2019 07:27:37

802.11g 54Mbps



2.2 Conducted Emissions

2.2.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.207(a)
 RSS-GEN, Clause 8.8

2.2.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

**Decreases with the logarithm of the frequency.*

2.2.3 Equipment Under Test and Modification State

Serial No: N/A / Test Configuration A

2.2.4 Date of Test/Initial of test personnel who performed the test

October 05, 2019 / FSC

2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature 24.0 °C
 Relative Humidity 37.9 %
 ATM Pressure 99.1 kPa

2.2.7 Additional Observations

Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.2.8 for sample computation.



2.2.8 Sample Computation (Conducted Emission – Quasi Peak)

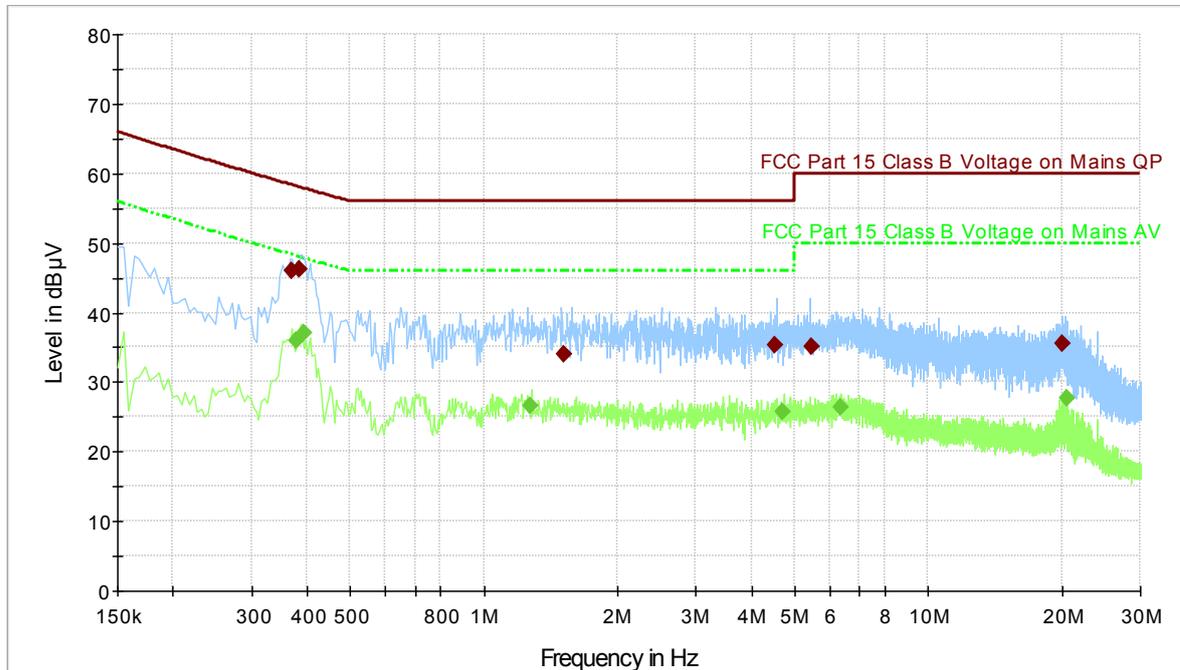
Measuring equipment raw measurement (db μ V) @ 150kHz		5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9
	Asset# 1177 (cable)	0.15
	Asset# 1176 (cable)	0.35
	Asset# 7568 (LISN)	0.30
Reported QuasiPeak Final Measurement (dbμV) @ 150kHz		26.2

2.2.9 Test Results

Compliant. See attached plots and tables.



2.2.10 SF2-RAK (Line 1 on the supplied AC/DC Adapter)



- FCC Part 15 Class B Voltage on Mains QP [..\EMI conducted\]
- - - FCC Part 15 Class B Voltage on Mains AV [..\EMI conducted\]
- Preview Result 1-PK+ [Preview Result 1.Result:1]
- Preview Result 2-AVG [Preview Result 2.Result:2]
- ◆ Final Result 1-QPK [Final Result 1.Result:1]
- ◆ Final Result 2-AVG [Final Result 2.Result:1]

Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.370500	46.0	1000.0	9.000	Off	L1	20.0	12.3	58.3
0.384000	46.3	1000.0	9.000	Off	L1	20.0	11.7	58.1
1.513500	34.1	1000.0	9.000	Off	L1	19.7	21.9	56.0
4.528500	35.3	1000.0	9.000	Off	L1	20.4	20.7	56.0
5.446500	35.2	1000.0	9.000	Off	L1	20.4	24.8	60.0
19.959000	35.5	1000.0	9.000	Off	L1	20.6	24.5	60.0

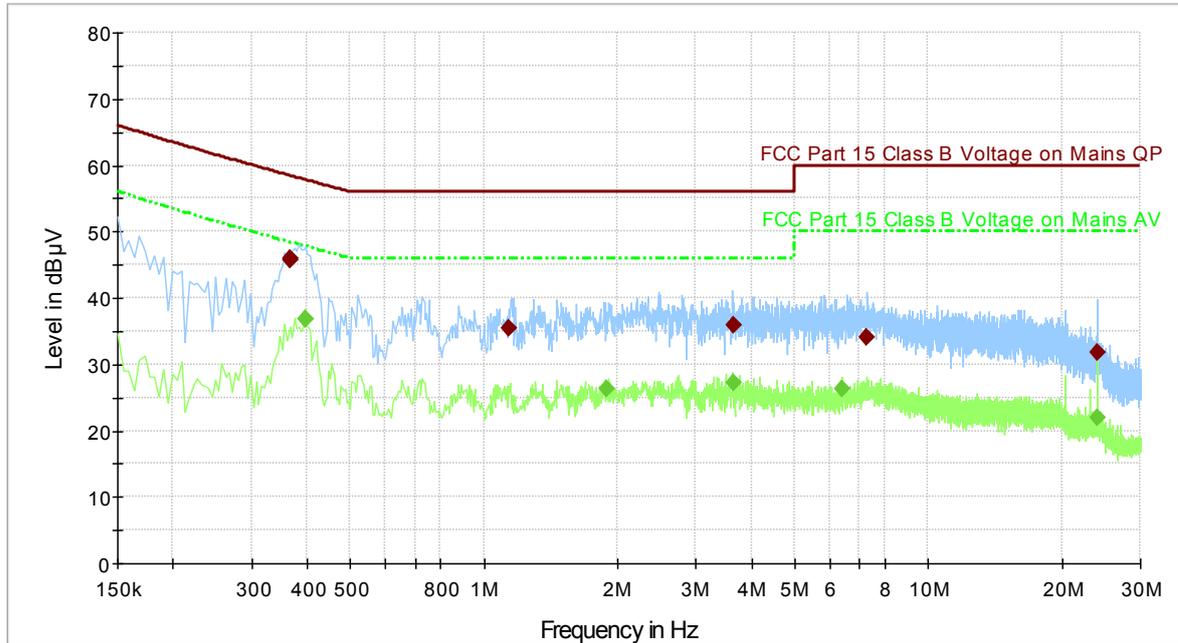
Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.379500	36.0	1000.0	9.000	Off	L1	20.0	12.1	48.1
0.393000	37.1	1000.0	9.000	Off	L1	19.9	10.8	47.8
1.270500	26.7	1000.0	9.000	Off	L1	19.9	19.3	46.0
4.690500	25.6	1000.0	9.000	Off	L1	20.5	20.4	46.0
6.333000	26.4	1000.0	9.000	Off	L1	20.4	23.6	50.0
20.440500	27.7	1000.0	9.000	Off	L1	20.6	22.3	50.0



2.2.11 SF2-RAK (Line 2 on the supplied AC/DC Adapter)

TUV SR7 Line 2



- FCC Part 15 Class B Voltage on Mains QP [..\EMI conducted\]
- - - FCC Part 15 Class B Voltage on Mains AV [..\EMI conducted\]
- Preview Result 1-PK+ [Preview Result 1.Result:1]
- Preview Result 2-AVG [Preview Result 2.Result:2]
- ◆ Final Result 1-QPK [Final Result 1.Result:1]
- ◆ Final Result 2-AVG [Final Result 2.Result:1]

Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.366000	45.8	1000.0	9.000	Off	N	19.9	12.6	58.4
0.366000	45.8	1000.0	9.000	Off	N	19.9	12.7	58.4
1.135500	35.5	1000.0	9.000	Off	N	19.8	20.5	56.0
3.646500	35.8	1000.0	9.000	Off	N	20.3	20.2	56.0
7.278000	34.0	1000.0	9.000	Off	N	20.4	26.0	60.0
23.986500	31.8	1000.0	9.000	Off	N	20.7	28.2	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.397500	36.7	1000.0	9.000	Off	N	19.8	11.1	47.8
0.397500	36.8	1000.0	9.000	Off	N	19.8	11.0	47.8
1.891500	26.2	1000.0	9.000	Off	N	19.9	19.8	46.0
3.646500	27.1	1000.0	9.000	Off	N	20.3	18.9	46.0
6.387000	26.2	1000.0	9.000	Off	N	20.4	23.8	50.0
24.031500	22.0	1000.0	9.000	Off	N	20.7	28.0	50.0



2.3 99% Emission Bandwidth

2.3.1 Specification Reference

RSS-Gen Clause 6.7

2.3.2 Standard Applicable

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth. When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: N/A / Test Configuration A

2.3.4 Date of Test/Initial of test personnel who performed the test

September 29, 2019 / FSC

2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.1 °C
Relative Humidity	53.6 %
ATM Pressure	99.1 kPa



2.3.7 Additional Observations

- This is a conducted test using direct connection to the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is per Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1.
- Only the worst-case data rate presented.

2.3.8 Sample Measurement Settings (802.11b)

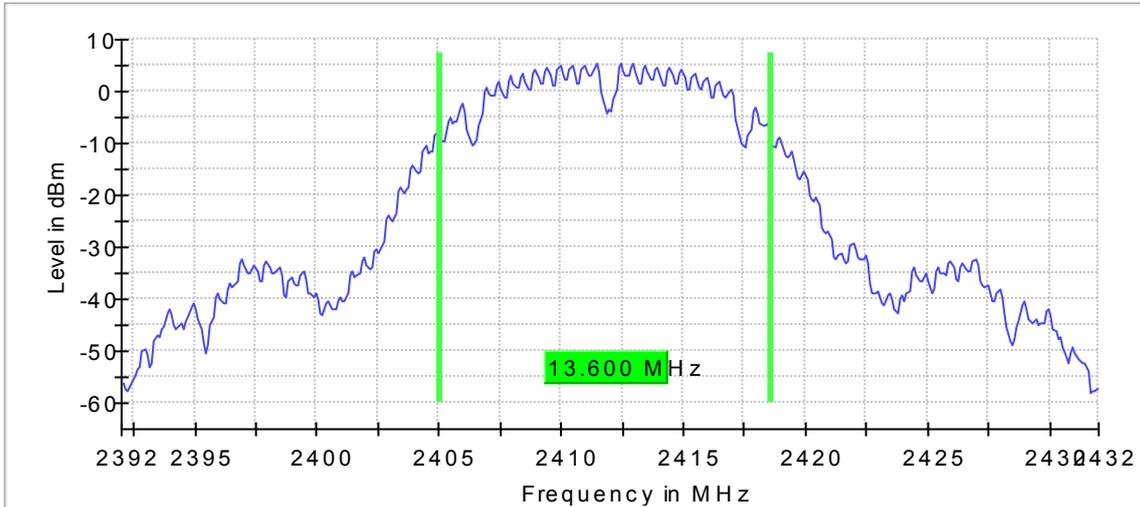
Setting	Instrument Value	Target Value
Start Frequency	2.39200 GHz	2.39200 GHz
Stop Frequency	2.43200 GHz	2.43200 GHz
Span	40.000 MHz	40.000 MHz
RBW	200.000 kHz	>= 200.000 kHz
VBW	1.000 MHz	>= 600.000 kHz
Sweep Points	400	~ 400
Sweeptime	28.477 µs	AUTO
Reference Level	-10.000 dBm	-20.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.19 dB	0.30 dB

2.3.9 Test Results (For reporting purposes only)

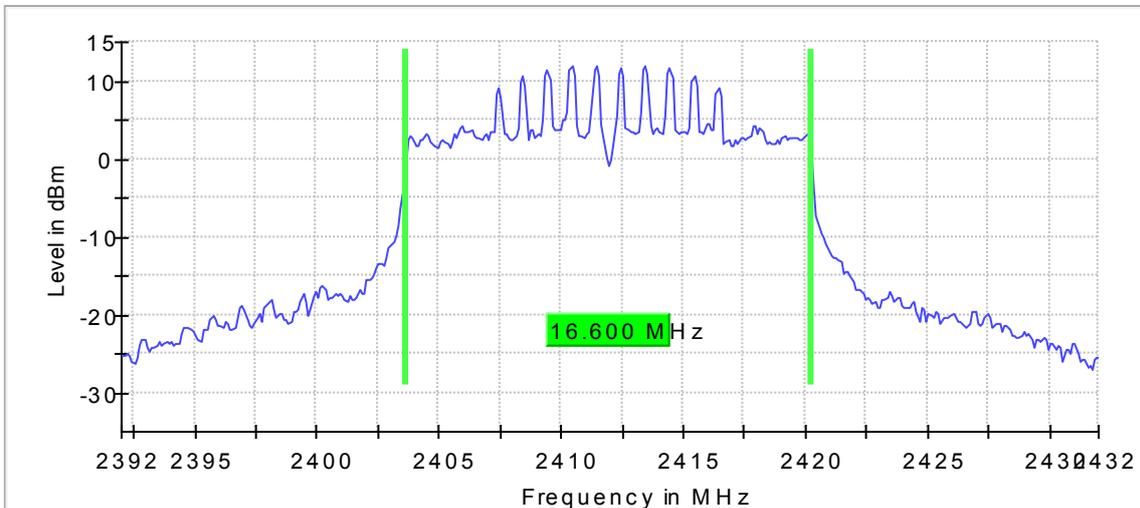
Mode	DUT Frequency (MHz)	Bandwidth (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Result
802.11b	2412.000000	13.600000	2405.050000	2418.650000	PASS
802.11g	2412.000000	16.600000	2403.650000	2420.250000	PASS



2.3.10 Test Results Plots



802.11b Low Channel



802.11g Low Channel



2.4 Minimum 6 dB RF Bandwidth

2.4.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(a)(2)
RSS-247, Clause 5.2 (a)

2.4.2 Standard Applicable

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.4.3 Equipment Under Test and Modification State

Serial No: N/A / Test Configuration A

2.4.4 Date of Test/Initial of test personnel who performed the test

September 29, 2019 / FSC

2.4.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.1 °C
Relative Humidity	53.6 %
ATM Pressure	99.1 kPa

2.4.7 Additional Observations

- This is a conducted test using direct connection to the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is per Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1.
- Only the worst-case data rate presented.



2.4.8 Sample Measurement Settings (802.11g)

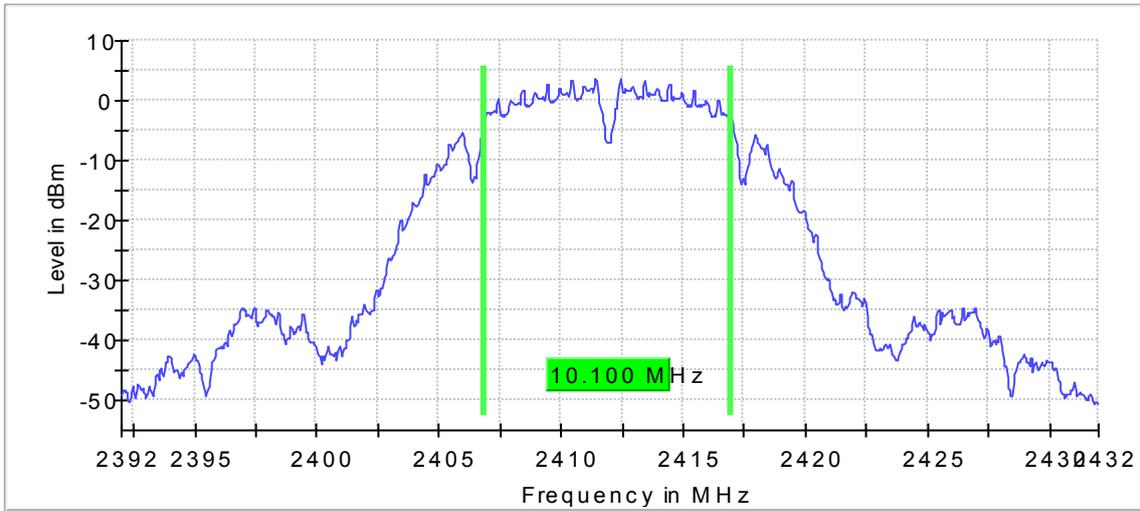
Setting	Instrument Value	Target Value
Start Frequency	2.39200 GHz	2.39200 GHz
Stop Frequency	2.43200 GHz	2.43200 GHz
Span	40.000 MHz	40.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	800	~ 800
Sweeptime	56.836 μ s	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	26 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.29 dB	0.50 dB

2.4.9 Test Results

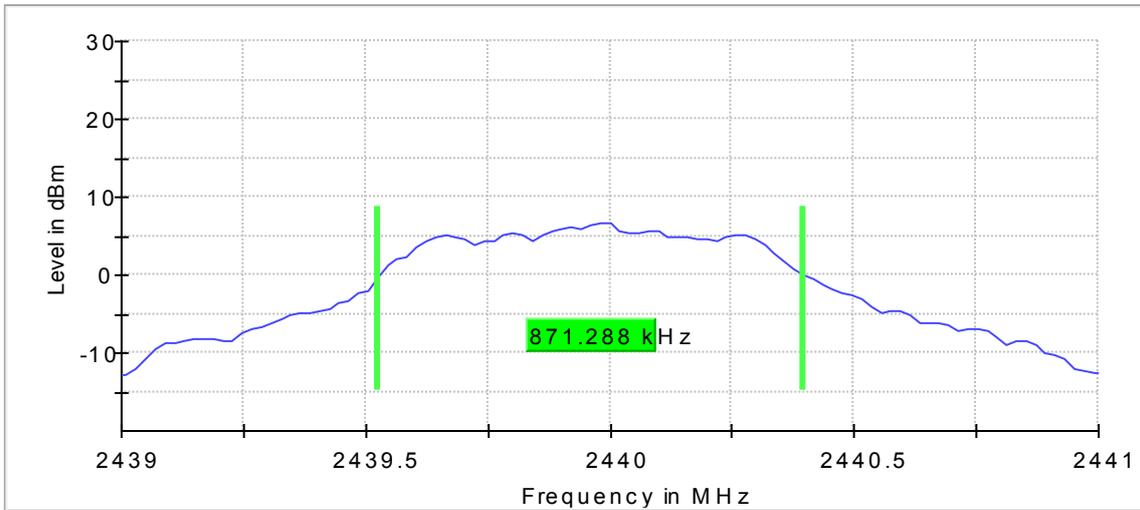
Mode	DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Result
802.11b	2412.000000	10.100000	0.500000	2406.875000	2416.975000	PASS
802.11g	2412.000000	16.600000	0.500000	2403.625000	2420.225000	PASS



2.4.10 Test Results Plots



802.11b Low Channel



802.11g Low Channel



2.5 Out-of-band Emissions - Conducted

2.5.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
RSS-247, Clause 5.5

2.5.2 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.5.3 Equipment Under Test and Modification State

Serial No: N/A / Test Configuration A

2.5.4 Date of Test/Initial of test personnel who performed the test

September 29, 2019 / FSC

2.5.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.1 °C
Relative Humidity	53.6 %
ATM Pressure	99.1 kPa



2.5.7 Additional Observations

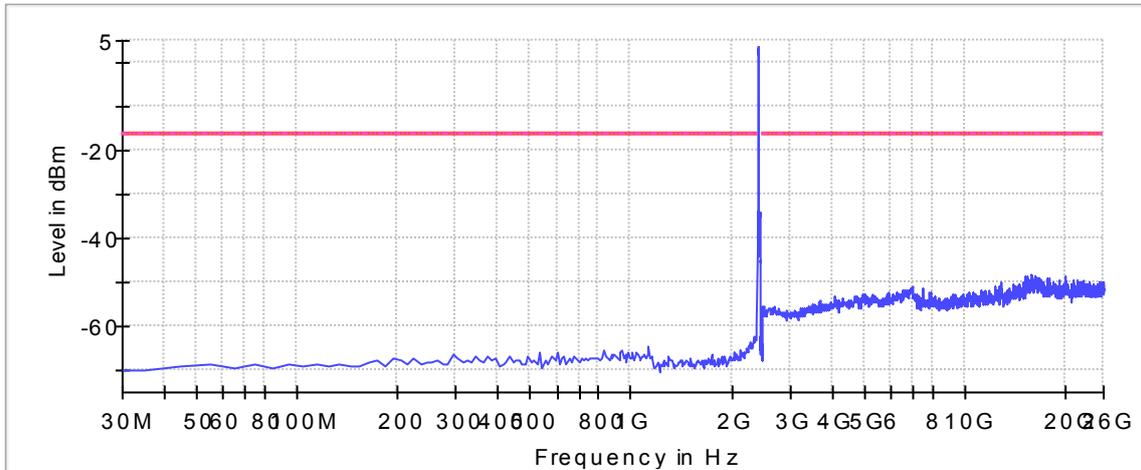
- This is a conducted test using direct connection to the Spectrum Analyzer being controlled by the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is per Test according to FCC title 47 part 15 §15.247(d), KDB 558074 D01 DTS Meas Guidance v05 8.5 and ANSI C63.10-2013 11.11.2 & 11.11.3.
- Only the worst-case data rate presented.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d) by applying the formula per Clause 12.7.2(d) of ANSI C63.10-2013 ($E(\text{dB}\mu\text{V}/\text{m}) = \text{EIRP}(\text{dBm}) + 95.2$).
- EUT **complies**. Observed margin from the limit is >20dB.

2.5.8 Pre Measurement Settings

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	238	~ 238
SweepTime	23.700 ms	AUTO
Reference Level	-10.000 dBm	-30.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	3	3
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	5 / max. 40	max. 40
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

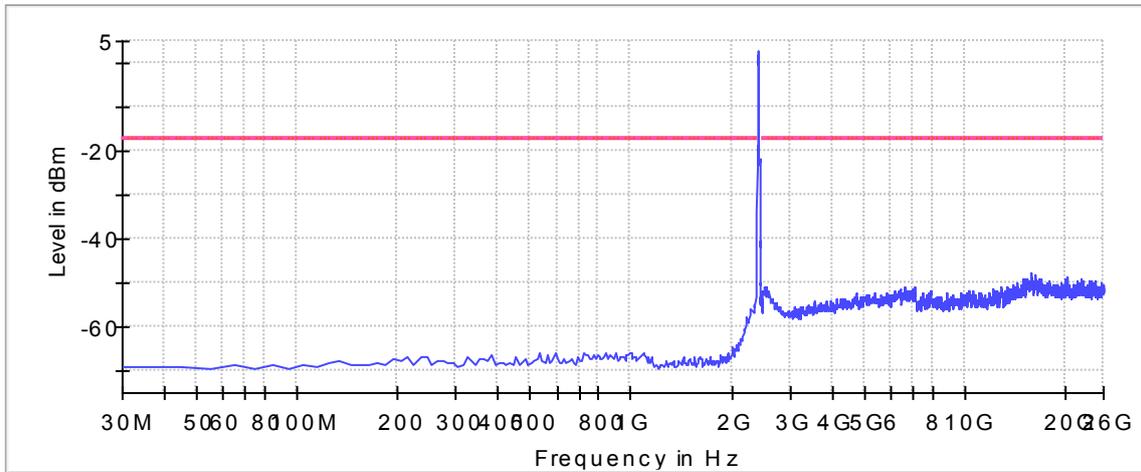


2.5.9 Test Results Plots



— Limit — Sum Level - - - Threshold × Critical × Final Critical

802.11b Low Channel



— Limit — Sum Level - - - Threshold × Critical × Final Critical

802.11g Low Channel



2.6 Band-Edge Compliance of RF Conducted Emissions

2.6.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
FCC 47 CFR Part 15, Clause 15.205
RSS-247, Clause 5.5

2.6.2 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.6.3 Equipment Under Test and Modification State

Serial No: N/A / Test Configuration A

2.6.4 Date of Test/Initial of test personnel who performed the test

September 29, 2019 / FSC

2.6.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.1 °C
Relative Humidity	53.6 %
ATM Pressure	99.1 kPa

2.6.7 Additional Observations

- This is a conducted test using direct connection to the Spectrum Analyzer being controlled by the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is per Test according to FCC title 47 part 15 §15.247(d), KDB 558074 D01 DTS Meas Guidance v05 8.7 and ANSI C63.10-2013.
- Only the worst-case data rate presented.
- The EUT only uses 2412MHz, only Band Edge Low presented.



2.6.8 Sample Measurement Settings (Measurement 2)

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	94.727 μ s	AUTO
Reference Level	-10.000 dBm	-20.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.37 dB	0.50 dB

2.6.9 Test Results (Lower Band Edge 802.11b)

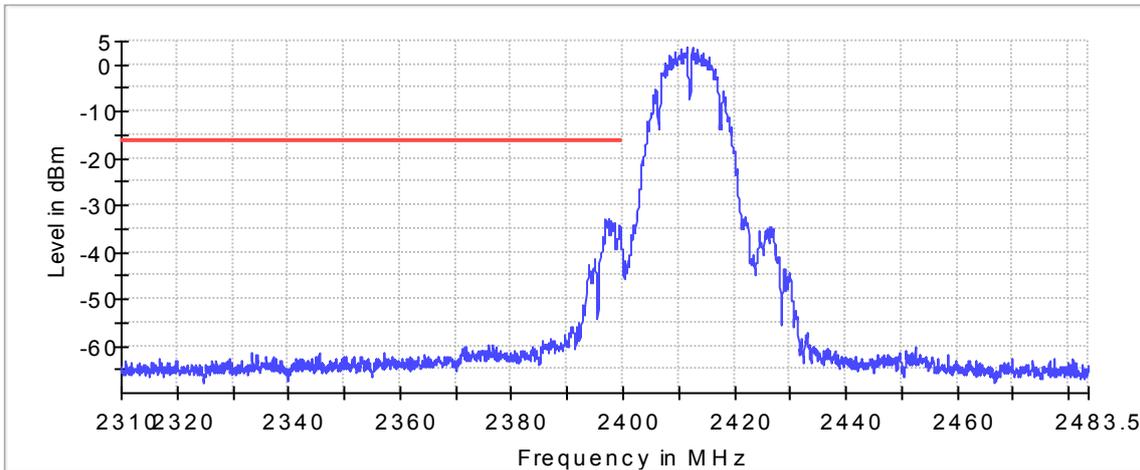
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2396.925000	-33.1	16.7	-16.3	PASS
2397.425000	-33.1	16.8	-16.3	PASS
2396.975000	-33.2	16.9	-16.3	PASS
2397.475000	-33.3	17.0	-16.3	PASS
2397.925000	-33.5	17.2	-16.3	PASS
2397.975000	-33.7	17.3	-16.3	PASS
2398.425000	-33.7	17.4	-16.3	PASS
2397.025000	-33.8	17.5	-16.3	PASS
2398.475000	-33.9	17.6	-16.3	PASS
2397.075000	-34.0	17.6	-16.3	PASS
2398.025000	-34.0	17.7	-16.3	PASS
2397.125000	-34.1	17.8	-16.3	PASS
2397.375000	-34.1	17.8	-16.3	PASS
2398.075000	-34.2	17.9	-16.3	PASS
2396.875000	-34.2	17.9	-16.3	PASS



2.6.10 Test Results (Lower Band Edge 802.11g)

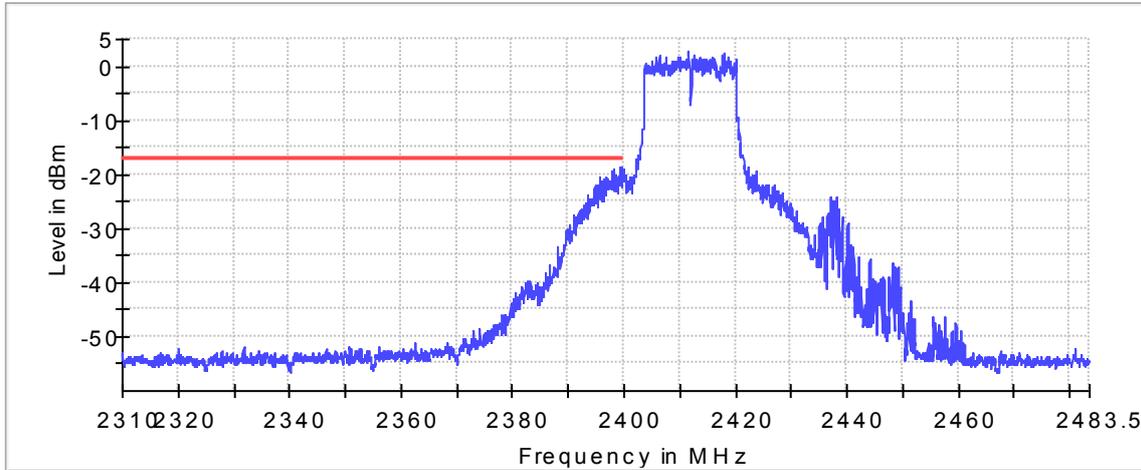
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.425000	-18.5	1.3	-17.3	PASS
2399.475000	-18.8	1.5	-17.3	PASS
2399.975000	-19.0	1.7	-17.3	PASS
2399.925000	-19.1	1.8	-17.3	PASS
2399.375000	-19.2	1.9	-17.3	PASS
2398.175000	-19.2	1.9	-17.3	PASS
2397.875000	-19.2	1.9	-17.3	PASS
2397.925000	-19.3	2.0	-17.3	PASS
2398.125000	-19.4	2.1	-17.3	PASS
2399.125000	-20.0	2.8	-17.3	PASS
2399.875000	-20.1	2.8	-17.3	PASS
2398.475000	-20.1	2.9	-17.3	PASS
2398.225000	-20.3	3.0	-17.3	PASS
2395.725000	-20.3	3.1	-17.3	PASS
2398.425000	-20.4	3.1	-17.3	PASS

2.6.11 Test Plots



— Limit — Sum Level × Fail

802.11b Low Band Edge 2400MHz



802.11g Low Band Edge 2400MHz



2.7 Radiated Spurious Emissions

2.7.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
RSS-247, Clause 5.5

2.7.2 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.7.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

2.7.4 Date of Test/Initial of test personnel who performed the test

September 10, 2019 / FSC

2.7.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.7.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	26.2 °C
Relative Humidity	42.1 %
ATM Pressure	98.6 kPa

2.7.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only the worst-case mode (802.11g) presented for below 1GHz. There are no significant differences in emissions between modes.
- Only noise floor measurements observed above 18GHz.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.



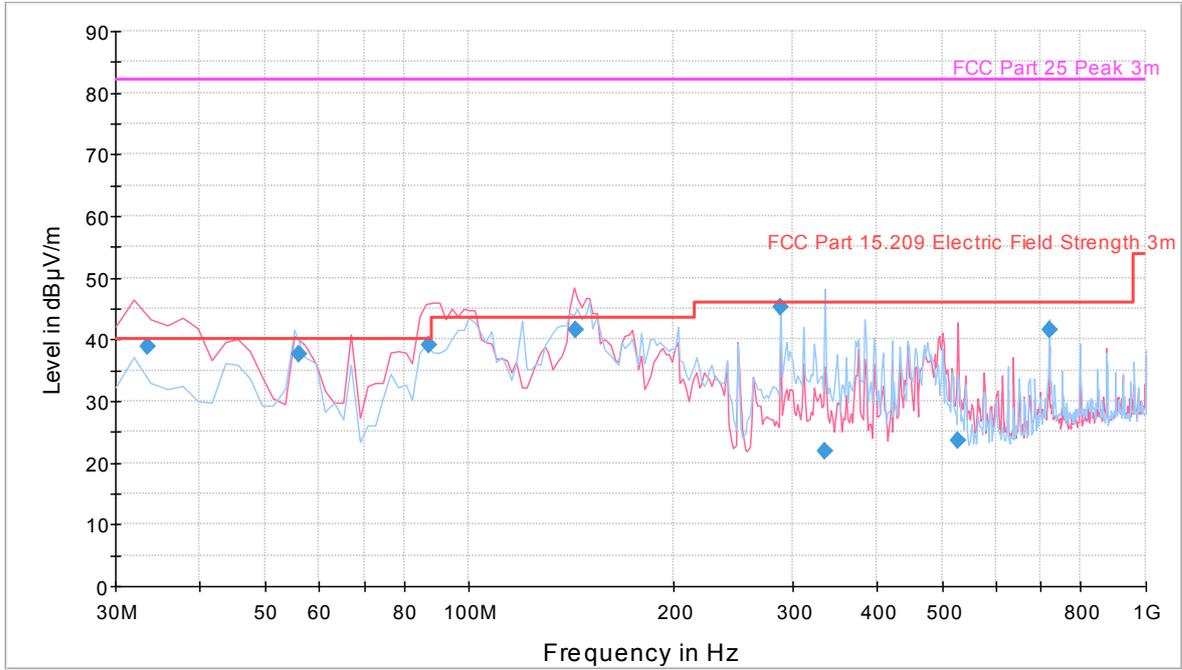
2.7.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (db μ V) @ 30 MHz		24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3
	Asset# 1172 (cable)	0.3
	Asset# 1016 (preamplifier)	-30.7
	Asset# 1175(cable)	0.3
	Asset# 1002 (antenna)	17.2
Reported QuasiPeak Final Measurement (dbμV/m) @ 30MHz		11.8



2.7.9 Below 1GHz Radiated Emission Test (Intermodulation, both Satellite and WLAN modems active)

Continuous Rotation TUV 3m Radiated 30 to 1000MHz



- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- ◆ Final Result 1-QPK [Final Result 1.Result:1]
- FCC Part 15.209 Electric Field Strength 3m [.\EMI Radiated\]
- FCC Part 25 Peak 3m [.\EMI Radiated\]

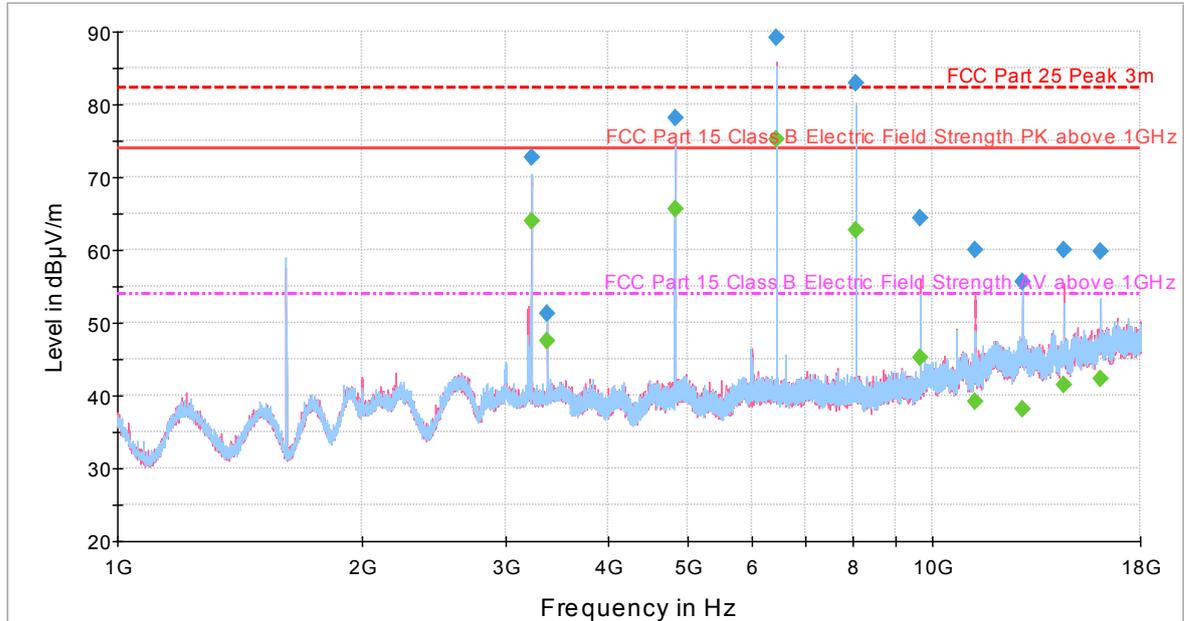
Quasi-Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
33.400000	38.9	1000.0	120.000	100.0	V	210.0	-9.3	0.1	40.0
55.870541	37.6	1000.0	120.000	355.0	H	189.0	-16.0	2.4	40.0
86.932745	39.2	1000.0	120.000	100.0	V	122.0	-15.7	0.8	40.0
143.305491	41.5	1000.0	120.000	100.0	V	0.0	-14.0	2.0	43.5
288.017074	45.3	1000.0	120.000	100.0	H	22.0	-7.8	0.7	46.0
335.870381	21.9	1000.0	120.000	240.0	H	96.0	-5.8	24.1	46.0
527.835271	23.6	1000.0	120.000	250.0	V	140.0	-1.0	22.4	46.0
719.760160	41.6	1000.0	120.000	100.0	H	152.0	2.8	4.4	46.0



2.7.10 Above 1GHz Radiated Emission Test (Intermodulation, both Satellite and WLAN modems active, 802.11b)

Continuous Rotation TUV 3m Radiated 1000 to 18000MHz



- FCC Part 15 Class B Electric Field Strength PK above 1GHz [..\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [..\EMI Radiated\]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- - - FCC Part 25 Peak 3m [..\EMI Radiated\]
- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- ◆ Final Result 1-PK+ [Final Result 1.Result:1]
- ◆ Final Result 2-AVG [Final Result 2.Result:1]

Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
3220.60000	72.6	1000.0	1000.000	167.6	H	164.0	1.1	1.3	73.9
3373.56666	51.2	1000.0	1000.000	301.2	H	184.0	0.9	22.7	73.9
4833.33333	78.0	1000.0	1000.000	331.1	V	128.0	3.7	-4.1	73.9
6444.56666	89.3	1000.0	1000.000	326.2	V	135.0	6.1	-15.4	73.9
8052.00000	82.9	1000.0	1000.000	135.7	H	177.0	6.8	-9.0	73.9
9665.83333	64.3	1000.0	1000.000	383.0	V	152.0	8.8	9.6	73.9
11273.2333	60.0	1000.0	1000.000	353.1	V	-11.0	12.3	13.9	73.9
12884.1666	55.6	1000.0	1000.000	146.7	H	99.0	13.7	18.3	73.9
14493.8333	60.1	1000.0	1000.000	315.2	V	116.0	15.4	13.8	73.9
16103.9000	59.8	1000.0	1000.000	235.4	H	143.0	16.6	14.1	73.9



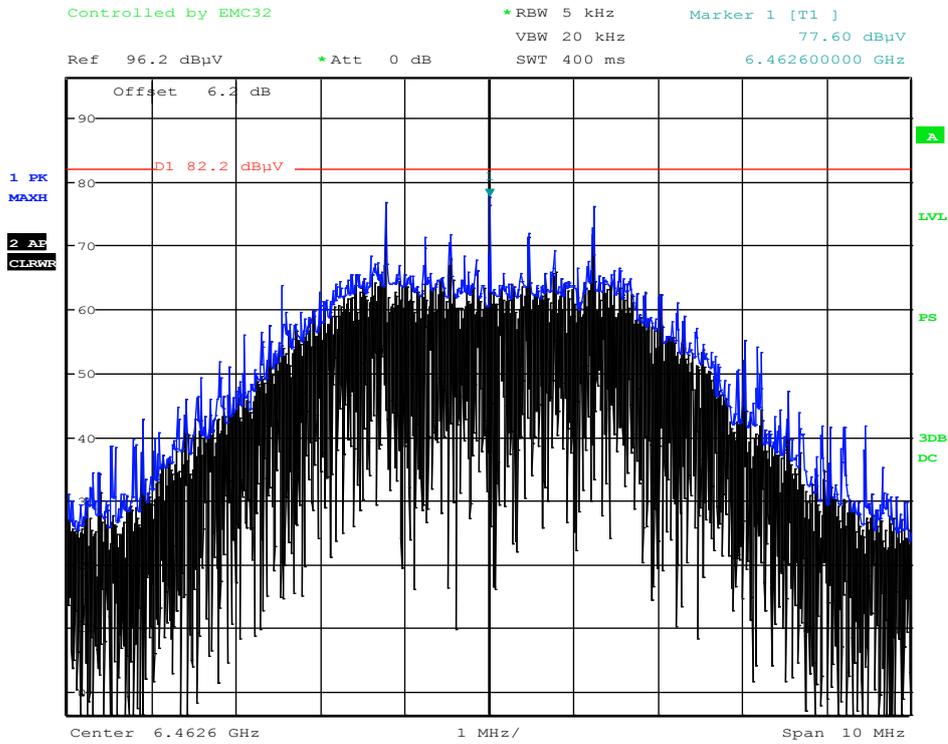
Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
3220.60000	63.9	1000.0	1000.000	167.6	H	164.0	1.1	-10.0	53.9
3373.56666	47.5	1000.0	1000.000	301.2	H	184.0	0.9	6.4	53.9
4833.33333	65.7	1000.0	1000.000	331.1	V	128.0	3.7	-11.8	53.9
6444.56666	75.2	1000.0	1000.000	326.2	V	135.0	6.1	-21.3	53.9
8052.00000	62.7	1000.0	1000.000	135.7	H	177.0	6.8	-8.8	53.9
9665.83333	45.1	1000.0	1000.000	383.0	V	152.0	8.8	8.8	53.9
11273.2333	39.1	1000.0	1000.000	353.1	V	-11.0	12.3	14.8	53.9
12884.1666	38.2	1000.0	1000.000	146.7	H	99.0	13.7	15.7	53.9
14493.8333	41.4	1000.0	1000.000	315.2	V	116.0	15.4	12.5	53.9
16103.9000	42.3	1000.0	1000.000	235.4	H	143.0	16.6	11.6	53.9

Test Notes: All emissions presented were verified to comply with their corresponding limits (Satellite to Part 25 and WLAN to Part 15.205/Part 15.247). Secondary verifications using 4kHz RBW for Part 25 spurious emissions are normally performed. See sample verification on the following page.



2.7.11 Sample Part 25 Spurious Verification Using 5KHz RBW



Date: 2.OCT.2019 10:36:31

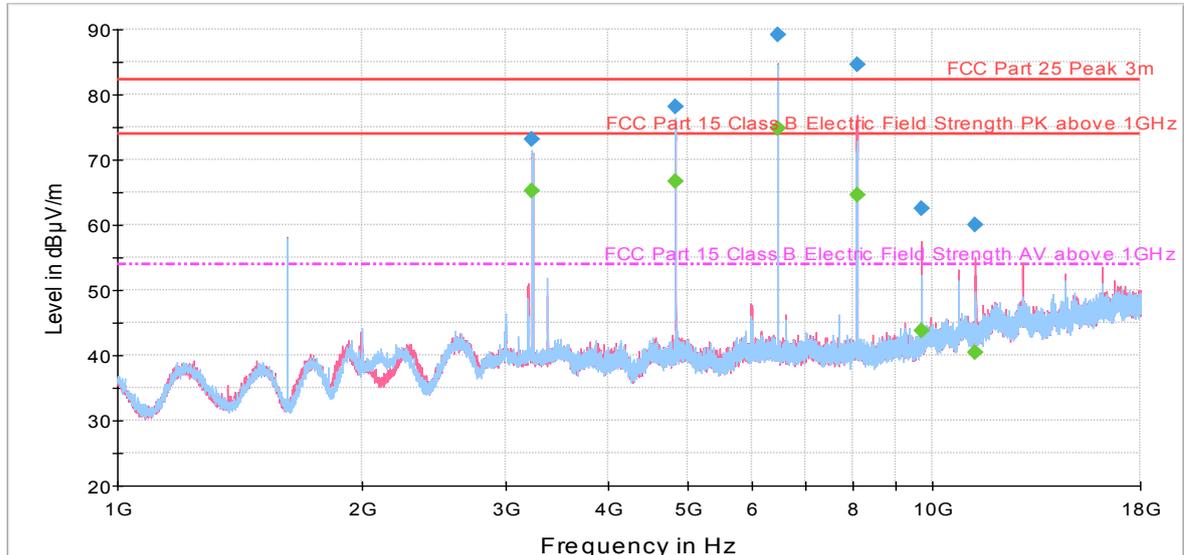
- Once the emission is maximized (turntable azimuth and receive antenna height), the RBW setting of the Receiver was changed from 1MHz to 5KHz (SA limitation).
- Offset was programmed using the calculated correction factor from EMC32.
- Only the worst spur presented (Mid Channel).
- The maximum detectable emission (field strength) was converted to equivalent power level and was compared to FCC Part 25 limit of -13 dBm for emissions >±250% OBW offset from the center frequency:

$$\begin{aligned}
 \text{EIRP (dBm)} &= E \text{ (dB}\mu\text{V/m)} + 20\log(D) - 104.8, \text{ where } D \text{ is 3 meters (measurement distance)} \\
 &= 77.6 \text{ dB}\mu\text{V/m} + 9.54 - 104.8 \\
 &= -17.66 \text{ dBm (Complies)}
 \end{aligned}$$



2.7.12 Above 1GHz Radiated Emission Test (Intermodulation, both Satellite and WLAN modems active, 802.11g)

Continuous Rotation TUV 3m Radiated 1000 to 18000MHz



- FCC Part 15 Class B Electric Field Strength PK above 1GHz [.\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [.\EMI Radiated\]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- ◆ Final Result 1-PK+ [Final Result 1.Result:1]
- ◆ Final Result 2-AVG [Final Result 2.Result:1]
- FCC Part 25 Peak 3m [.\EMI Radiated\]

Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
3230.60000	73.0	1000.0	1000.000	149.6	H	163.0	1.1	0.9	73.9
4847.86666	78.1	1000.0	1000.000	130.7	H	148.0	3.7	-4.2	73.9
6464.20000	89.2	1000.0	1000.000	186.5	V	130.0	6.2	-15.3	73.9
8076.73333	84.5	1000.0	1000.000	179.5	V	116.0	6.8	-10.6	73.9
9691.90000	62.6	1000.0	1000.000	401.1	V	133.0	8.8	11.3	73.9
11307.3000	60.1	1000.0	1000.000	154.6	V	131.0	12.2	13.8	73.9

Average Data

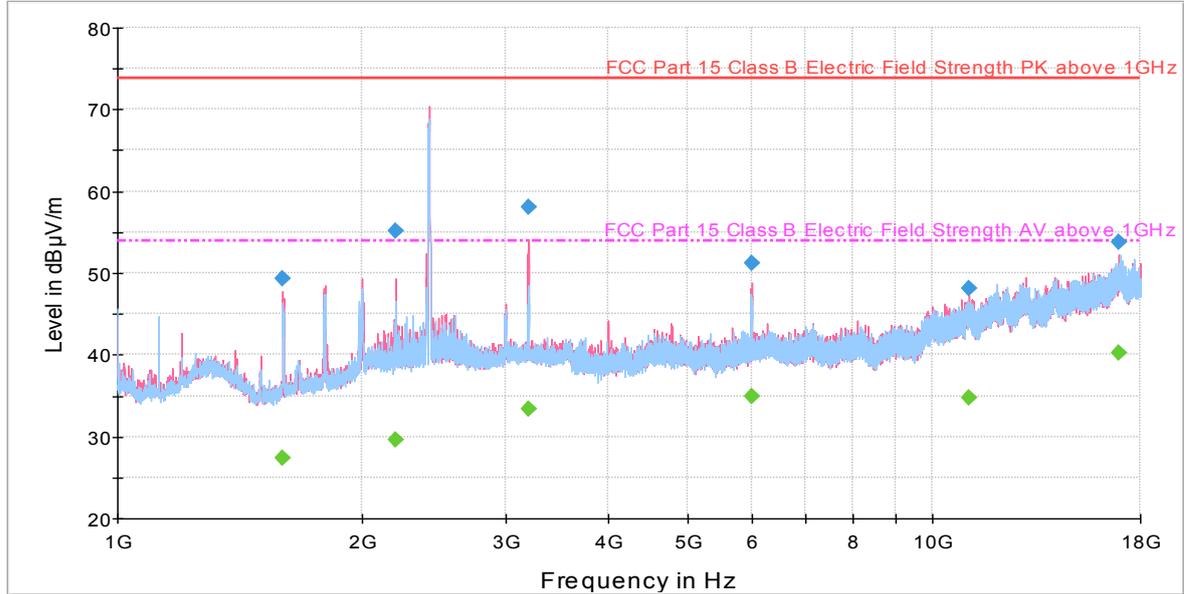
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
3230.60000	65.1	1000.0	1000.000	149.6	H	163.0	1.1	-11.2	53.9
4847.86666	66.6	1000.0	1000.000	130.7	H	148.0	3.7	-12.7	53.9
6464.20000	74.8	1000.0	1000.000	186.5	V	130.0	6.2	-20.9	53.9
8076.73333	64.6	1000.0	1000.000	179.5	V	116.0	6.8	-10.7	53.9
9691.90000	43.8	1000.0	1000.000	401.1	V	133.0	8.8	10.1	53.9
11307.3000	40.4	1000.0	1000.000	154.6	V	131.0	12.2	13.5	53.9

Test Notes: All emissions presented were verified to comply with their corresponding limits (Satellite to Part 25 and WLAN to Part 15.205/Part 15.247).



2.7.13 Above 1GHz to 18GHz Radiated Emission Test (WLAN Transmit Mode, 802.11b)

Continuous Rotation TUV 3m Radiated 1000 to 18000MHz



- FCC Part 15 Class B Electric Field Strength PK above 1GHz [..\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [..\EMI Radiated\]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- ◆ Final Result 1-PK+ [Final Result 1.Result:1]
- ◆ Final Result 2-AVG [Final Result 2.Result:1]

Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1594.56666	49.4	1000.0	1000.000	365.1	V	207.0	-5.8	24.5	73.9
2195.70000	55.2	1000.0	1000.000	235.4	V	76.0	-1.7	18.7	73.9
3193.76666	58.1	1000.0	1000.000	376.1	V	270.0	1.0	15.8	73.9
5998.56666	51.3	1000.0	1000.000	134.7	V	261.0	5.7	22.6	73.9
11109.7333	48.0	1000.0	1000.000	201.3	V	215.0	12.2	25.9	73.9
16961.5000	53.8	1000.0	1000.000	300.6	V	252.0	17.9	20.1	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1594.56666	27.3	1000.0	1000.000	365.1	V	207.0	-5.8	26.6	53.9
2195.70000	29.6	1000.0	1000.000	235.4	V	76.0	-1.7	24.3	53.9
3193.76666	33.4	1000.0	1000.000	376.1	V	270.0	1.0	20.5	53.9
5998.56666	34.9	1000.0	1000.000	134.7	V	261.0	5.7	19.0	53.9
11109.7333	34.8	1000.0	1000.000	201.3	V	215.0	12.2	19.1	53.9
16961.5000	40.2	1000.0	1000.000	300.6	V	252.0	17.9	13.7	53.9

Test Notes: Satellite modem not active for this test. This is to show compliance of the EUT to the requirement of cabinet spurious emissions of Part 15.247 including Part 15.205.



2.8 Power Spectral Density

2.8.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(e)
RSS-247, Clause 5.2(2)

2.8.2 Standard Applicable

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

2.8.3 Equipment Under Test and Modification State

Serial No: N/A / Test Configuration A

2.8.4 Date of Test/Initial of test personnel who performed the test

September 29, 2019 / FSC

2.8.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.8.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.1 °C
Relative Humidity	53.6 %
ATM Pressure	99.1 kPa

2.8.7 Additional Observations

- This is a conducted test using direct connection to the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is per Test according to FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013.
- Only the worst-case data rate presented.



2.8.8 Sample Measurement Settings

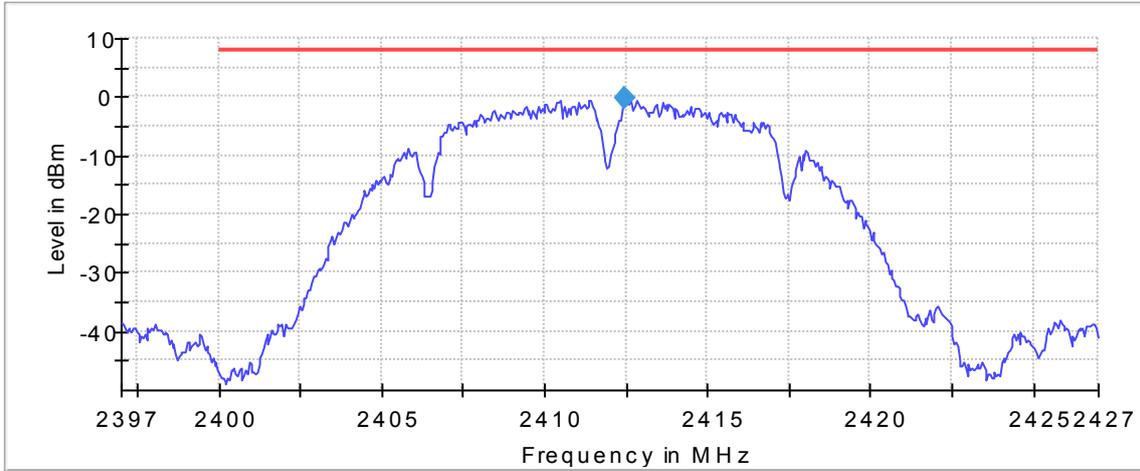
Setting	Instrument Value	Target Value
Start Frequency	2.39700 GHz	2.39700 GHz
Stop Frequency	2.42700 GHz	2.42700 GHz
Span	30.000 MHz	30.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	600	~ 600
Sweeptime	12.000 ms	12.000 ms
Reference Level	-10.000 dBm	-20.000 dBm
Attenuation	10.000 dB	AUTO
Detector	RMS	RMS
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	18 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.48 dB	0.50 dB

2.8.9 Test Results Summary

Mode	DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
802.11b	2412.000000	2412.475000	-0.217	8.0	PASS
802.11g	2412.000000	2408.925000	3.757	8.0	PASS

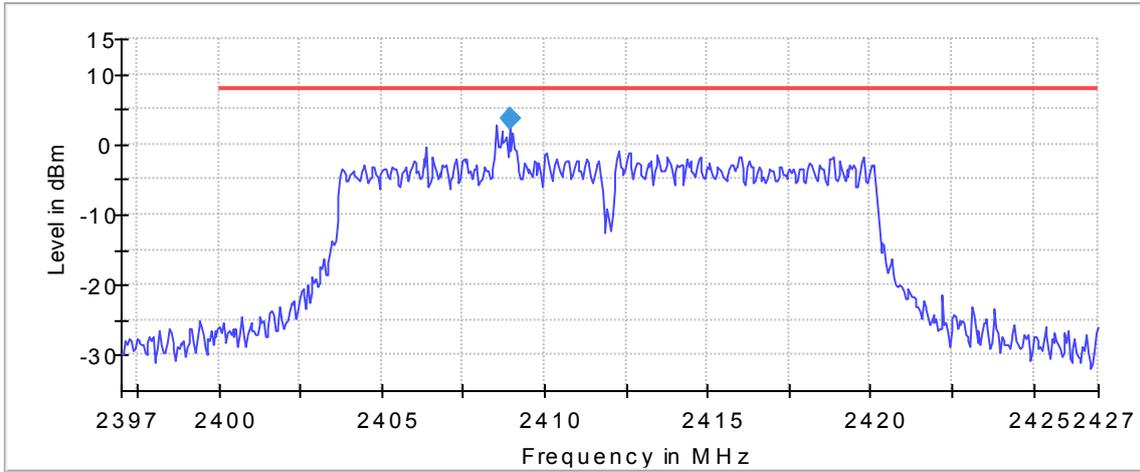


2.8.10 Test Results Plots



— Limit — Sum Level ◆ PSD

802.11b Low Channel



— Limit — Sum Level ◆ PSD

802.11g Low Channel



SECTION 3

3 TEST EQUIPMENT USED



3.1 Test Equipment Used

List of absolute measuring and other principal items of test equipment.

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Emissions						
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/18/18	10/18/19
7567	LISN	FCC-LISN-50-25-2-10	120304	Fisher Custom Comm	01/14/19	01/02/20
8822	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/05/19	03/05/20
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/05/19	03/05/20
Conducted Port Setup						
7643	Signal/Spectrum Analyzer	FSV30	1321.3008K3 0/103166	Rhode & Schwarz	04/04/18	04/04/20
7655	Vector Signal Generator	SMBV100A	260734	Rhode & Schwarz	11/19/18	11/19/19
7654	Signal Generator	SMB 100A	175750	Rhode & Schwarz	11/16/18	11/16/19
7656	OSP with B157	OSP120	101310	Rhode & Schwarz	01/23/19	01/23/20
8825	20dB Attenuator	46-20-34	BK5773	Weinschel Corp.	Verified by 7643 and 7654	
8832	20dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 7643 and 7654	
Radiated Emission						
1033	Bilog Antenna	3142C	00044556	EMCO	11/06/18	11/06/20
7631	Double-ridged waveguide horn	3117	00205418	ETS-Lindgren	08/20/18	08/20/20
8628	Pre-amplifier	QLI-01182835-JO	8986002	Quinstar	03/07/19	03/07/20
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 7643 and 7654	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 7643 and 7654	
8816	2.4GHz Notch Filter	BRM 50702	N/A	Micro-Tronics	Verified by 7643 and 7654	
8809	2.0GHz High Pass Filter	HPM50110	072	Micro-Tronics	Verified by 7643 and 7654	
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/15/18	10/15/19
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/18/18	10/18/19
1016	Pre-Amplifier	PAM-0202	187	PAM	03/08/19	03/08/20
Miscellaneous						
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	11312	04/16/19	04/16/20
-	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	



3.2 Measurement Uncertainty

Calculation of Measurement Uncertainty per CISPR 16-4-2:2011 with Corr. 1

3.2.1 Antenna Conducted Port Measurements

	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	Cable attenuation	1.00 dB	Normal, k=2	2.000	0.50	0.25
3	Receiver sinewave accuracy	0.08 dB	Normal, k=2	2.000	0.04	0.00
4	Receiver pulse amplitude	0.00 dB	Rectangular	1.732	0.00	0.00
5	Receiver pulse repetition rate	0.00 dB	Rectangular	1.732	0.00	0.00
6	Noise floor proximity	0.00 dB	Rectangular	1.732	0.00	0.00
7	Frequency interpolation	0.10 dB	Rectangular	1.732	0.06	0.00
8	Mismatch	0.07 dB	U-shaped	1.414	0.05	0.00
Combined standard uncertainty					Normal	0.52 dB
Expanded uncertainty					Normal, k=2	1.03 dB

3.2.2 AC Conducted Emissions Measurements

	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	LISN-receiver attenuation	0.10 dB	Normal, k=2	2.000	0.05	0.00
3	LISN voltage division factor	0.30 dB	Normal, k=2	2.000	0.15	0.02
4	Receiver sinewave accuracy	0.36 dB	Normal, k=2	2.000	0.18	0.03
5	Receiver pulse amplitude	1.50 dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50 dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.00 dB	Rectangular	1.732	0.00	0.00
8	AMN VDF frequency interpolation	0.10 dB	Rectangular	1.732	0.06	0.00
9	Mismatch	0.07 dB	U-shaped	1.414	0.05	0.00
10	LISN impedance	2.65 dB	Triangular	2.449	1.08	1.17
11	Effect of mains disturbance	0.00 dB			0.00	0.00
12	Effect of the environment					
Combined standard uncertainty					Normal	1.66 dB
Expanded uncertainty					Normal, k=2	3.31 dB



3.2.3 Radiated Measurements (Below 1GHz)

	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20 dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75 dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.45 dB	Normal, k=2	2.000	0.23	0.05
5	Receiver pulse amplitude	1.50 dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50 dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50 dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95 dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30 dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10 dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12 dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00 dB	Rectangular	1.732	0.58	0.33
13	Cross-polarization	0.90 dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00 dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.76 dB	Triangular	2.449	1.54	2.36
16	Separation distance at 3 m	0.30 dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77 dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10 dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00 dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00 dB				0.00
Combined standard uncertainty				Normal	2.95 dB	
Expanded uncertainty				Normal, k=2	5.90 dB	



3.2.4 Radiated Emission Measurements (Above 1GHz)

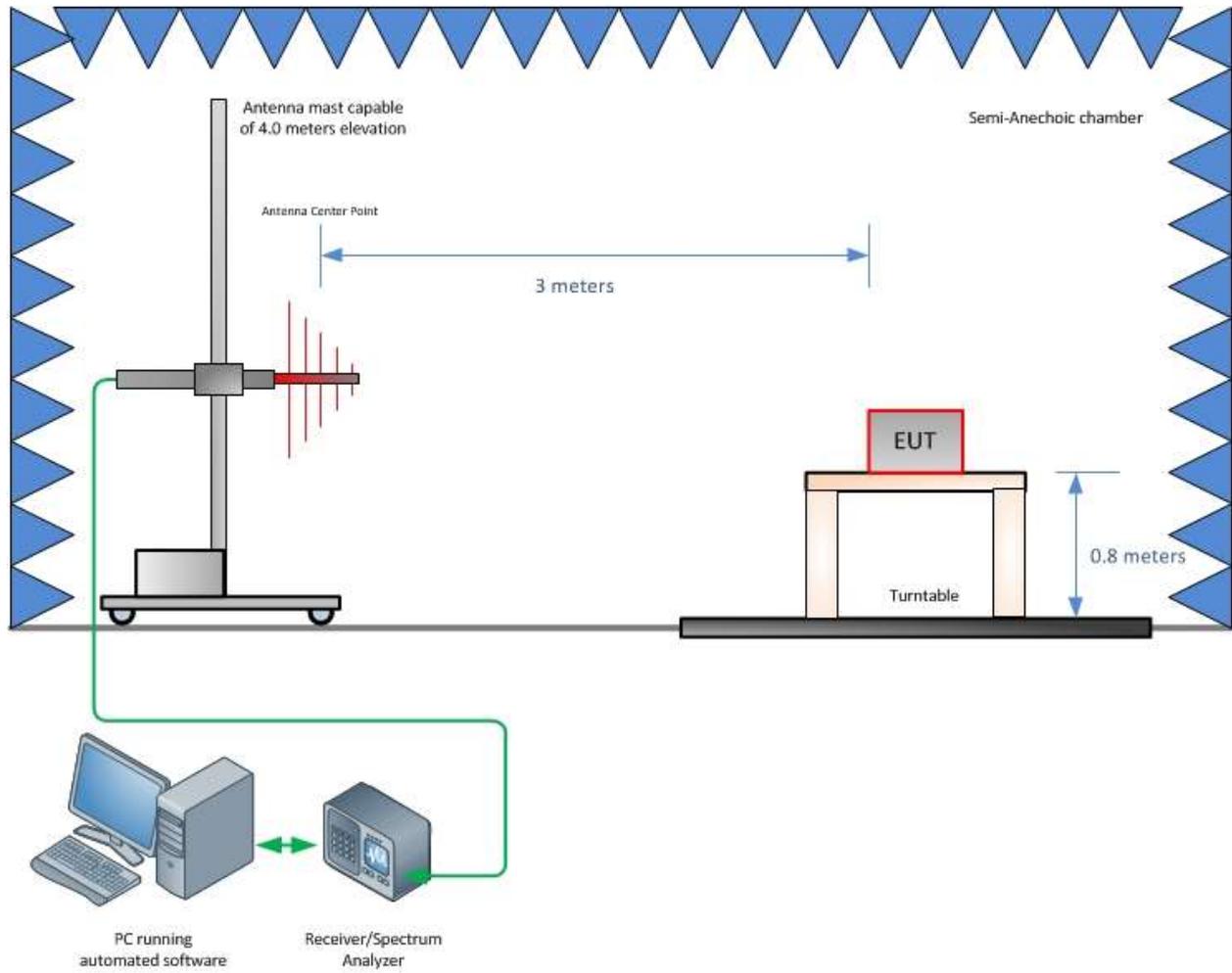
	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$						
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01						
2	Attenuation: antenna-receiver	0.20 dB	Normal, k=2	2.000	0.10	0.01						
3	Antenna factor AF	0.75 dB	Normal, k=2	2.000	0.38	0.14						
4	Receiver sinewave accuracy	0.45 dB	Normal, k=2	2.000	0.23	0.05						
5	Receiver pulse amplitude	1.50 dB	Rectangular	1.732	0.87	0.75						
6	Receiver pulse repetition rate	1.50 dB	Rectangular	1.732	0.87	0.75						
7	Noise floor proximity	0.50 dB	Rectangular	1.732	0.29	0.08						
8	Mismatch: antenna-receiver	0.95 dB	U-shaped	1.414	0.67	0.45						
9	AF frequency interpolation	0.30 dB	Rectangular	1.732	0.17	0.03						
10	AF height deviations	0.10 dB	Rectangular	1.732	0.06	0.00						
11	Directivity difference at 3 m	3.12 dB	Rectangular	1.732	1.80	3.24						
12	Phase center location at 3 m	1.00 dB	Rectangular	1.732	0.58	0.33						
13	Cross-polarization	0.90 dB	Rectangular	1.732	0.52	0.27						
14	Balance	0.00 dB	Rectangular	1.732	0.00	0.00						
15	Site imperfections	3.25 dB	Triangular	2.449	1.33	1.76						
16	Separation distance at 3 m	0.30 dB	Rectangular	1.732	0.17	0.03						
17	Effect of setup table material	0.77 dB	Rectangular	1.732	0.44	0.20						
18	Table height at 3 m	0.10 dB	Normal, k=2	2.000	0.05	0.00						
19	Near-field effects	0.00 dB	Triangular	2.449	0.00	0.00						
20	Effect of ambient noise on OATS	0.00 dB				0.00						
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Combined standard uncertainty</td> <td style="width: 20%; text-align: center;">Normal</td> <td style="width: 30%; text-align: center;">2.85 dB</td> </tr> <tr> <td>Expanded uncertainty</td> <td style="text-align: center;">Normal, k=2</td> <td style="text-align: center;">5.70 dB</td> </tr> </table>							Combined standard uncertainty	Normal	2.85 dB	Expanded uncertainty	Normal, k=2	5.70 dB
Combined standard uncertainty	Normal	2.85 dB										
Expanded uncertainty	Normal, k=2	5.70 dB										



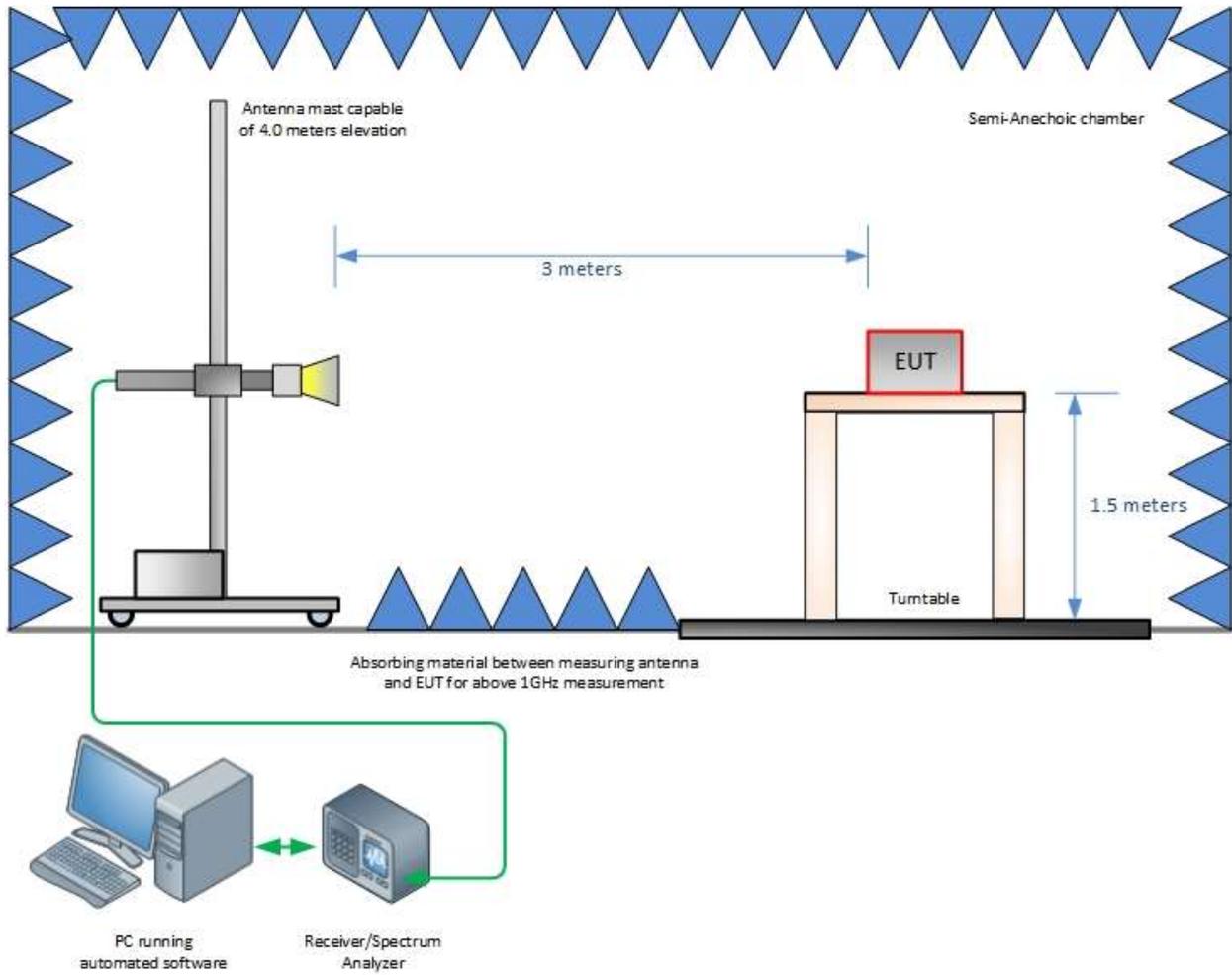
SECTION 4

4 Diagram of Test Setup

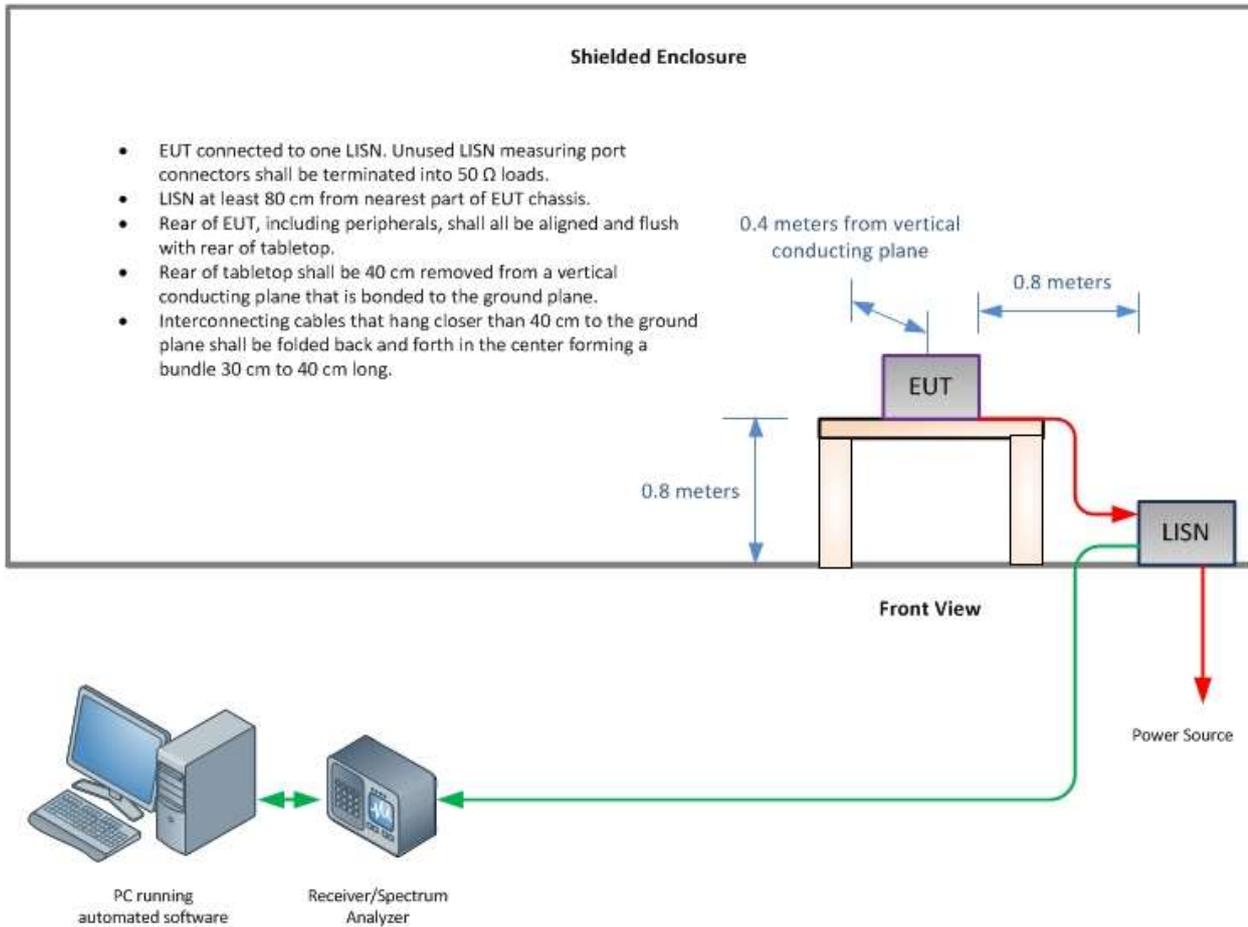
4.1 Test Setup Diagram



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)





SECTION 5

5 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



5.1 Accreditation, Disclaimers and Copyright

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