



MEASUREMENT REPORT

FCC PART 15.407 UNII 802.11a/n/ac

Applicant Name:

Sirius XM Radio Inc.
 1500 Eckington Place, NE
 Washington, DC 20002
 United States
 Attn: Beejay Jolayemi

Date of Testing:

11/04 - 11/21/2019

Test Site/Location:

PCTEST Lab. Columbia, MD, USA

Test Report Serial No.:

1M1911040180-02.RS2

FCC ID:
RS2LBEE5HY1MW
APPLICANT:
Sirius XM Radio Inc.
Application Type:

Class II Permissive Change

Model:

LBEE5HY1MW

EUT Type:

BT/WiFi Module

Frequency Range:

5180 – 5825MHz

FCC Classification:

Unlicensed National Information Infrastructure (UNII)

FCC Rule Part(s):

Part 15 Subpart E (15.407)

Test Procedure(s):

ANSI C63.10-2013, KDB 789033 D02 v02r01

Class II Permissive Change:

Please see FCC change document

Original Grant Date:

12/23/2019

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013 and KDB 789033 D02 v02r01. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.



 Randy Ortanez
 President


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1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission.

1.2 PCTEST Test Location

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.

- PCTEST is an ISO 17025-2005 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).
- PCTEST facility is a registered (2451B) test laboratory with the site description on file with ISED.

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Sirius XM BT/WiFi Module FCC ID: RS2LBEE5HY1MW**. The test data contained in this report pertains only to the emissions due to the EUT's UNII transmitter.

The EUT is integrated into a host device certified under FCC ID: RS2SXWB1.

Test Device Serial No.: 89337

2.2 Device Capabilities

This device contains the following capabilities:

2.4GHz WiFi, 5GHz UNII, Bluetooth, Bluetooth LE

Band 1		Band 2A		Band 2C		Band 3	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
36	5180	52	5260	100	5500	149	5745
:	:	:	:	:	:	:	:
42	5210	56	5280	116		157	5785
:	:	:	:	:	:	:	:
48	5240	64	5320	140	5700	165	5825

Table 2-1. 802.11a (20MHz) Frequency / Channel Operations

2.3 Test Configuration

The EUT was tested per the guidance of KDB 789033 D02 v02r01. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups, and 7.2 for antenna port conducted emissions test setups.

2.4 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

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3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 789033 D02 v02r01 were used in the measurement of the EUT.

Deviation from measurement procedure.....**None**

3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 10'x16'x9' shielded enclosure. The shielded enclosure is manufactured by ETS Lindgren RF Enclosures. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-5. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50µH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is an ETS Lindgren Model LPRX-4X30 (100dB Attenuation, 14kHz-18GHz) and the two EMI/RFI filters are ETS Lindgren Model LRW-2030-S1 (100dB Minimum Insertion Loss, 14kHz – 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference groundplane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.5. Automated test software was used to perform the AC line conducted emissions testing.

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3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33 depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 474788 D01.

3.4 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

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4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

- The antennas of the EUT are **permanently attached**.
- There are no provisions for connection to an external antenna.

Conclusion:

The EUT complies with the requirement of §15.203.

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5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (\pm dB)
Conducted Bench Top Measurements	1.13
Line Conducted Disturbance	3.09
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Keysight	N9030A	PXA Signal Analyzer (26.5GHz)	9/13/2019	Annual	9/13/2020	MY54490576
Emco	3115	Horn Antenna (1-18GHz)	3/28/2018	Biennial	3/28/2020	9704-5182
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	6/5/2019	Annual	6/5/2020	100342
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	7/11/2019	Annual	7/11/2020	102134
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	4/19/2018	Biennial	4/19/2020	A051107
Agilent	N9038A	MXE EMI Receiver	7/17/2019	Annual	7/17/2020	MY51210133
ETS-Lindgren	3816/2NM	Line Impedance Stabilization Network	6/18/2018	Biennial	6/18/2020	114451

Table 6-1. Annual Test Equipment Calibration Schedule

Note:

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

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7.0 TEST RESULTS

7.1 Summary

Company Name: Sirius XM Radio Inc.
 FCC ID: RS2LBEE5HY1MW
 FCC Classification: Unlicensed National Information Infrastructure (UNII)

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.407 (a.1.iv), (a.2), (a.3)	Maximum Conducted Output Power	Maximum conducted powers must meet the limits detailed in 15.407 (a)	CONDUCTED	PASS	Section 7.2
15.407(b.1), (2), (3), (4)	Undesirable Emissions	Undesirable emissions must meet the limits detailed in 15.407(b)	RADIATED	PASS	Section 7.3
15.205, 15.407(b.1), (4), (5), (6)	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209		PASS	Section 7.3, 7.4
15.407	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits	LINE CONDUCTED	PASS	Section 7.5

Table 7-1. Summary of Test Results

Notes:

- 1) All channels, modes, and modulations/data rates were investigated among all UNII bands. The test results shown in the following sections represent the worst case emissions.
- 2) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
- 3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
- 4) For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "UNII Automation," Version 4.7.
- 5) For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Chamber Automation," Version 1.3.1.

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7.2 UNII Output Power Measurement – 802.11a/n/ac

§15.407(a.1.iv) §15.407(a.2) §15.407(a.3);

Test Overview and Limits

A transmitter antenna terminal of the EUT is connected to the input of an RF pulse power sensor. Measurement is made using a broadband average power meter while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, and at the appropriate frequencies.

In the 5.15 – 5.25GHz band, the maximum permissible conducted output power is 250mW (23.98dBm). The maximum e.i.r.p. shall not exceed the lesser of 200 mW or 10 + 10 log10B, dBm.

In the 5.25 – 5.35GHz band, the maximum permissible conducted output power is the lesser of 250mW (23.98dBm) or 11 dBm + 10log₁₀(26dB BW) = 11 dBm + 10log₁₀(20.89) = 24.20dBm. The maximum e.i.r.p. shall not exceed the lesser of 1.0 W or 17 + 10 log10B, dBm.

In the 5.47 – 5.725GHz band, the maximum permissible conducted output power is the lesser of 250mW (23.98dBm) or 11 dBm + 10log₁₀(26dB BW) = 11 dBm + 10log₁₀(20.98) = 24.22dBm. The maximum e.i.r.p. shall not exceed the lesser of 1.0 W or 17 + 10 log10B, dBm.

In the 5.725 – 5.850GHz band, the maximum permissible conducted output power is 1W (30dBm). The maximum e.i.r.p. is 36 dBm.

Test Procedure Used

ANSI C63.10-2013 – Section 12.3.3.2 Method PM-G
KDB 789033 D02 v02r01 – Section E)3(b) Method PM-G

Test Settings

Average power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power.

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-1. Test Instrument & Measurement Setup

Test Notes

The conducted powers were measured for the purpose of ensuring that the powers are equivalent to the powers of the original certified module (FCC ID: VPYLBEE5HY1MW).

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5GHz (20MHz Bandwidth)	Freq [MHz]	Channel	Detector	IEEE Transmission Mode			Conducted Power Limit [dBm]	Conducted Power Margin [dB]
				802.11a	802.11n	802.11ac		
5180	36	AVG	11.91	11.40	11.42	23.98	-12.07	
5200	40	AVG	11.93	11.54	11.54	23.98	-12.05	
5240	48	AVG	14.54	12.82	14.31	23.98	-9.44	
5260	52	AVG	14.69	14.15	14.28	23.98	-9.29	
5280	56	AVG	12.03	14.33	14.40	23.98	-9.58	
5320	64	AVG	12.14	11.73	11.81	23.98	-11.84	
5500	100	AVG	11.73	11.24	11.26	23.98	-12.25	
5600	120	AVG	14.39	11.78	14.29	23.98	-9.59	
5720	144	AVG	11.85	11.52	11.50	23.98	-12.13	
5745	149	AVG	11.68	11.21	10.98	30.00	-18.32	
5785	157	AVG	14.01	13.41	13.53	30.00	-15.99	
5825	165	AVG	11.33	10.90	10.71	30.00	-18.67	

Table 7-2. 20MHz BW (UNII) Maximum Conducted Output Power

5GHz (40MHz Bandwidth)	Freq [MHz]	Channel	Detector	IEEE Transmission Mode		Conducted Power Limit [dBm]	Conducted Power Margin [dB]
				802.11n	802.11ac		
5190	38	AVG	9.29	9.38	23.98	-14.60	
5230	46	AVG	13.59	13.47	23.98	-10.39	
5270	54	AVG	13.41	13.58	23.98	-10.40	
5310	62	AVG	9.51	9.61	23.98	-14.37	
5510	102	AVG	9.29	9.35	23.98	-14.63	
5630	126	AVG	14.20	14.38	23.98	-9.60	
5710	142	AVG	9.62	9.47	23.98	-14.36	
5755	151	AVG	9.03	9.11	30.00	-20.89	
5795	159	AVG	9.13	9.24	30.00	-20.76	

Table 7-5. 40MHz BW (UNII) Maximum Conducted Output Power

FCC ID: RS2LBEE5HY1MW	 PCTEST® Engineering Laboratory, Inc.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
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5GHz (80MHz Bandwidth)	Freq [MHz]	Channel	Detector	IEEE Transmission Mode	Conducted Power Limit [dBm]	Conducted Power Margin [dB]
				802.11ac		
	5210	42	AVG	9.19	23.98	-14.79
	5290	58	AVG	9.41	23.98	-14.57
	5530	106	AVG	9.17	23.98	-14.81
	5610	122	AVG	9.38	23.98	-14.60
	5690	138	AVG	9.58	23.98	-14.40
	5775	155	AVG	8.97	30.00	-21.03

Table 7-6. 80MHz BW (UNII) Maximum Conducted Output Power

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7.3 Radiated Spurious Emission Measurements – Above 1GHz

§15.407(b) §15.205 §15.209

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013 and KDB 789033 D02 v02r01, and at the appropriate frequencies. All channels, modes (e.g. 802.11a, 802.11n (20MHz BW), 802.11n (40MHz BW), and 802.11ac (80MHz)), and modulations/data rates were investigated among all UNII bands. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

For transmitters operating in the 5.15-5.25 GHz and 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an EIRP of -27 dBm/MHz.

For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-3 per Section 15.209.

Frequency	Field Strength [μ V/m]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 7-3. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Sections 12.7.7.2, 12.7.6, 12.7.5
 KDB 789033 D02 v02r01 – Section G

Test Settings

Average Measurements above 1GHz (Method AD)

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = power average (RMS)
5. Number of measurement points = 1001 (Number of points must be $\geq 2 \times$ span/RBW)
6. Averaging type = power (RMS)
7. Sweep time = auto couple
8. Trace was averaged over 100 sweeps

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Peak Measurements above 1GHz

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Peak Measurements below 1GHz

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Span was set greater than 1MHz
3. RBW = 120kHz
4. Detector = CISPR quasi-peak
5. Sweep time = auto couple
6. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

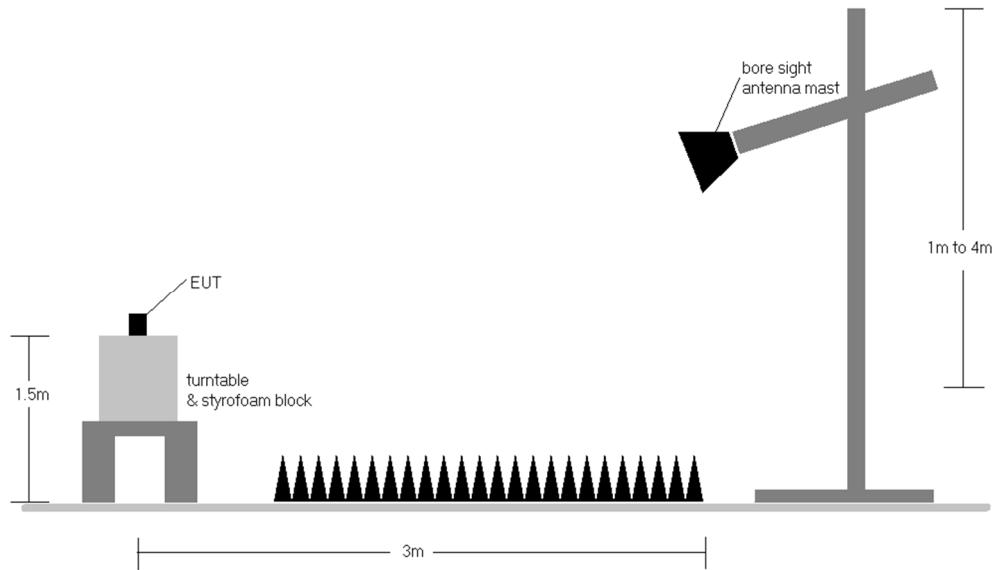


Figure 7-2. Test Instrument & Measurement Setup

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SiriusXM SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 15 of 37

Test Notes

1. All emissions that lie in the restricted bands (denoted by a * next to the frequency) specified in §15.205 are below the limit shown in Table 7-3.
2. All spurious emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-3. All spurious emissions that do not lie in a restricted band are subject to a peak limit of -27dBm/MHz. At a distance of 3 meters, the field strength limit in dB μ V/m can be determined by adding a "conversion" factor of 95.2dB to the EIRP limit of -27dBm/MHz to obtain the limit for out of band spurious emissions of 68.2dB μ V/m.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested while powered by a 12V DC power source (battery).
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
6. Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section.
8. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

Sample Calculations

Determining Spurious Emissions Levels

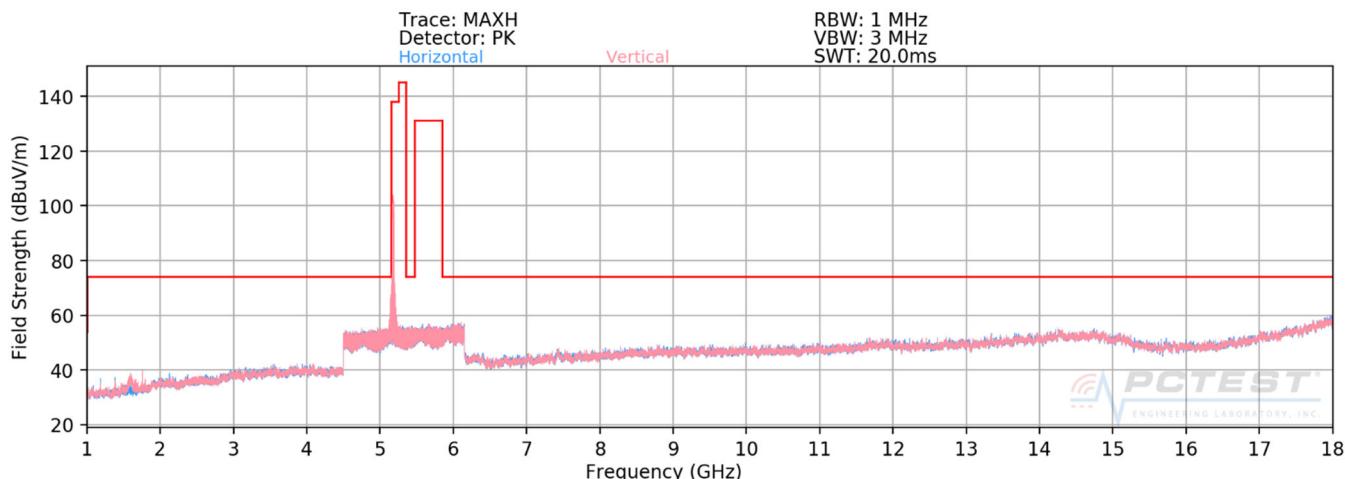
- Field Strength Level [dB μ V/m] = Analyzer Level [dBm] + 107 + AFCL [dB/m]
- AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB]
- Margin [dB] = Field Strength Level [dB μ V/m] – Limit [dB μ V/m]

Radiated Band Edge Measurement Offset

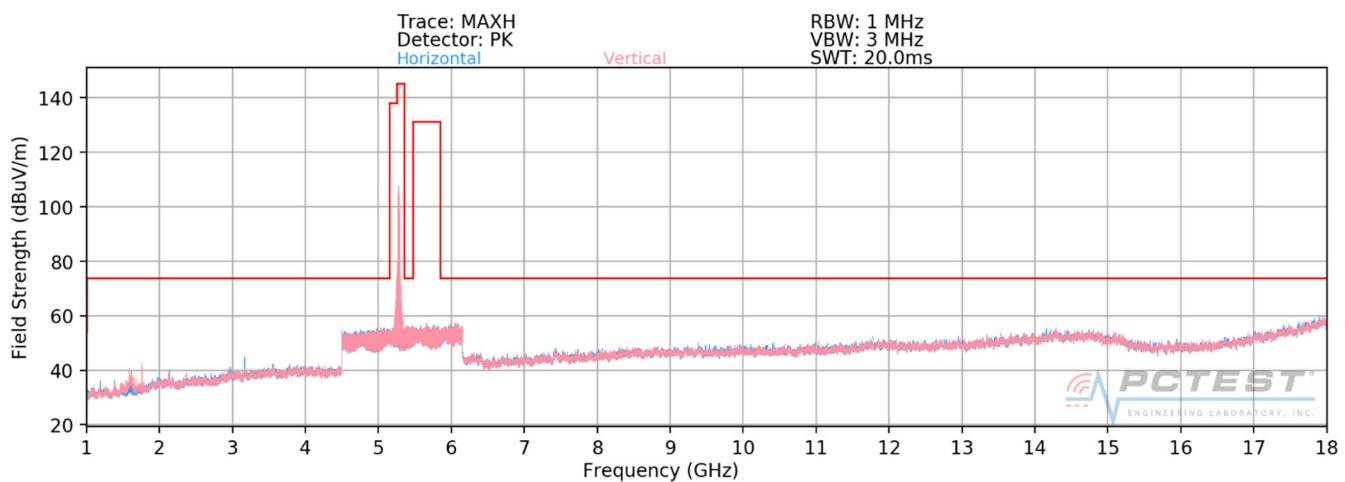
- The amplitude offset shown in the radiated restricted band edge plots was calculated using the formula:
Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain

FCC ID: RS2LBEE5HY1MW	 PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SiriusXM SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 16 of 37

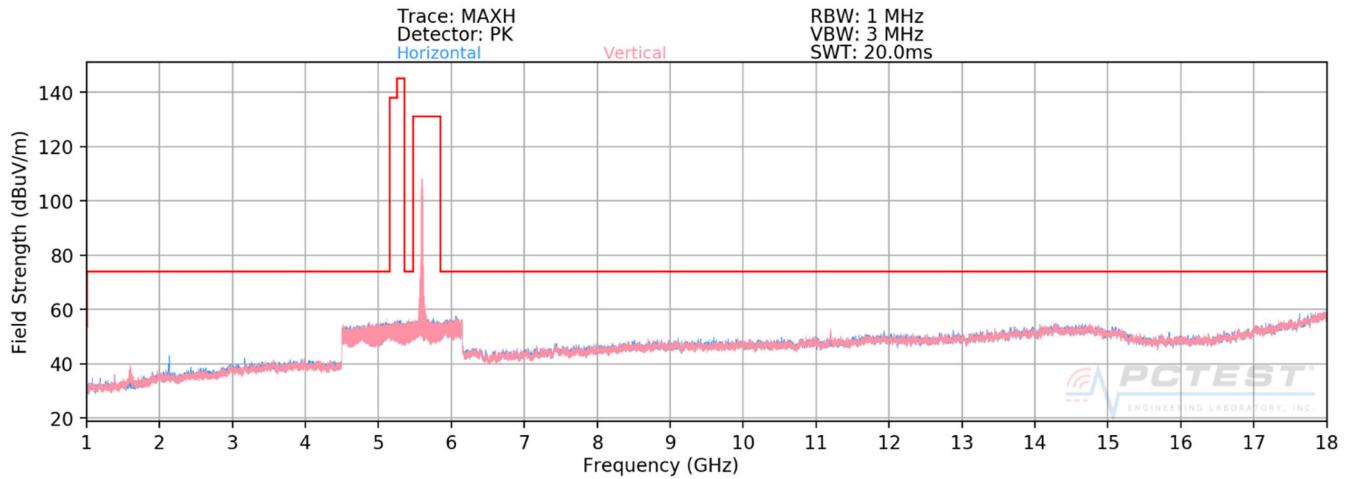
Radiated Spurious Emission Measurements



Plot 7-1. Radiated Spurious Plot above 1GHz (802.11a – U1 Ch. 40)

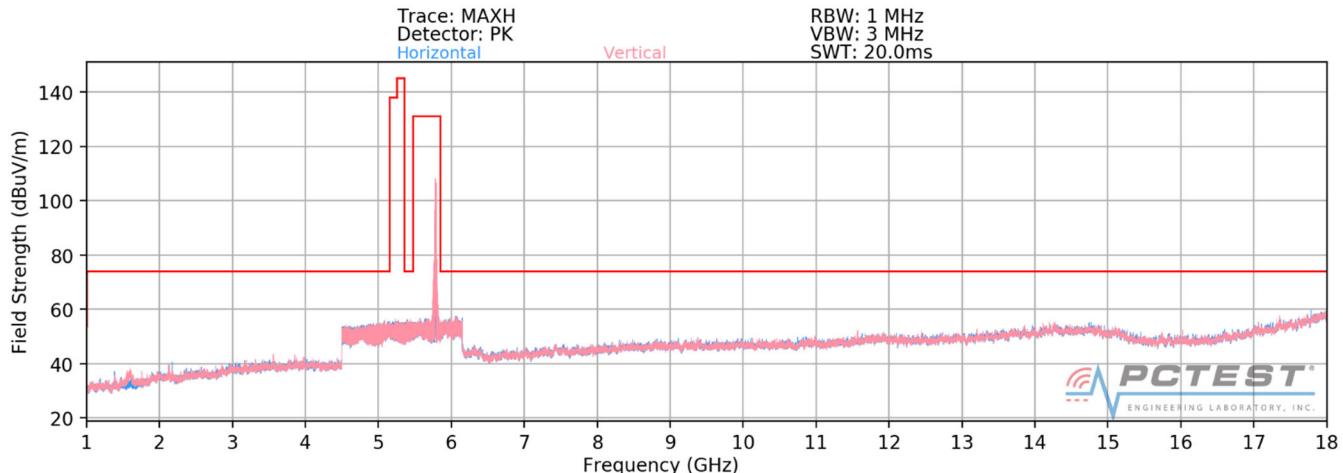


Plot 7-2. Radiated Spurious Plot above 1GHz (802.11a – U2A Ch. 56)



Plot 7-3. Radiated Spurious Plot above 1GHz (802.11a – U2C Ch. 120)

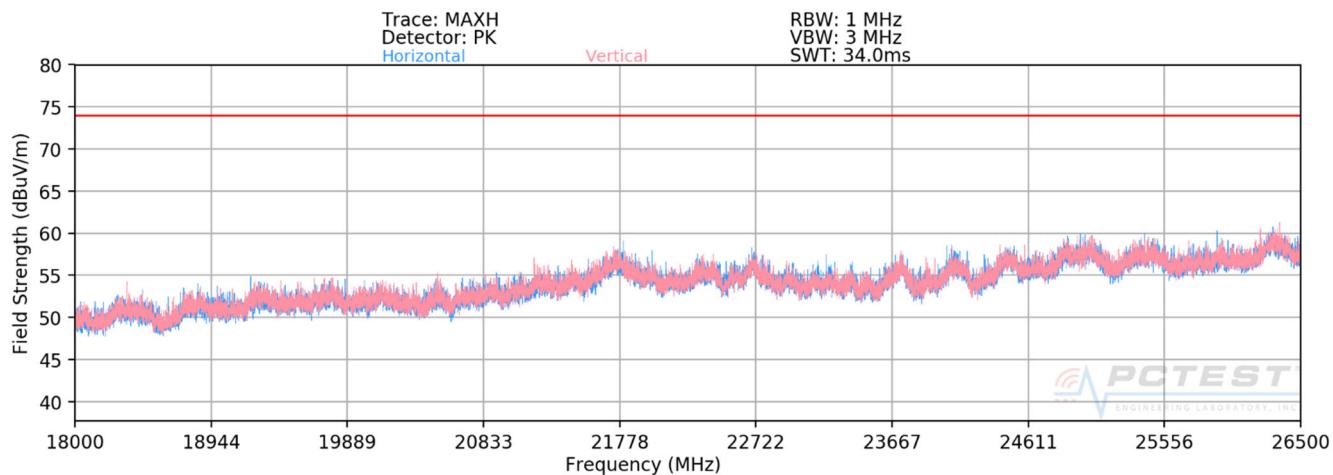
FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 17 of 37



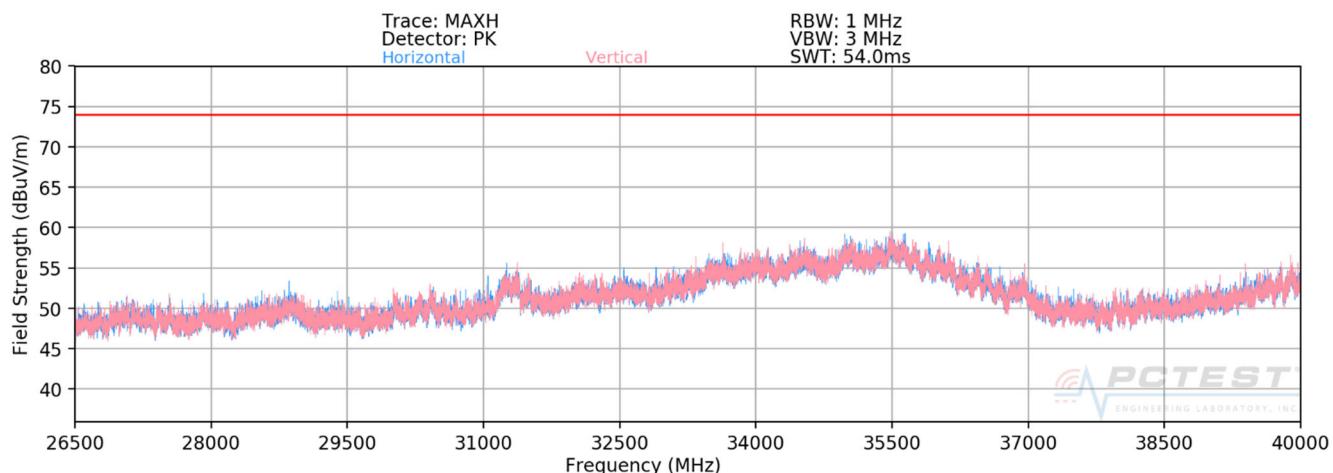
Plot 7-4. Radiated Spurious Plot above 1GHz (802.11a – U3 Ch. 157)

MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)			Approved by: Quality Manager
FCC ID: RS2LBEE5HY1MW Test Report S/N: 1M1911040180-02.RS2	PCTEST® ENGINEERING LABORATORY, INC. Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module	SiriusXM SATELLITE RADIO Page 18 of 37

Radiated Spurious Emissions Measurements (Above 18GHz)



Plot 7-5. Radiated Spurious Plot 18GHz - 26.5GHz (802.11a)



Plot 7-6. Radiated Spurious Plot 26.5GHz - 40GHz (802.11a)

FCC ID: RS2LBEE5HY1MW	 PCTEST® <small>ENGINEERING LABORATORY, INC.</small>	MEASUREMENT REPORT <small>(CLASS II PERMISSIVE CHANGE)</small>	 SiriusXM <small>SATELLITE RADIO</small>	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 19 of 37

Radiated Spurious Emission Measurements

§15.407(b) §15.205 & §15.209:

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5180MHz
Channel:	36

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
10360.00	Peak	V	121	170	-69.07	11.61	49.54	68.20	-18.66
* 15540.00	Average	V	-	-	-81.89	13.79	38.90	53.98	-15.08
* 15540.00	Peak	V	-	-	-69.83	13.79	50.96	73.98	-23.02

Table 7-4. Radiated Measurements ANT1

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5200MHz
Channel:	40

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
10400.00	Peak	V	118	192	-69.08	11.62	49.54	68.20	-18.66
* 15600.00	Average	V	-	-	-81.95	12.99	38.04	53.98	-15.94
* 15600.00	Peak	V	-	-	-69.79	12.99	50.20	73.98	-23.78

Table 7-5. Radiated Measurements ANT1

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 20 of 37

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5240MHz
Channel:	48

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
10480.00	Peak	V	131	207	-68.28	11.91	50.63	68.20	-17.57
* 15720.00	Average	V	-	-	-81.73	14.48	39.75	53.98	-14.23
* 15720.00	Peak	V	-	-	-69.57	14.48	51.91	73.98	-22.07

Table 7-6. Radiated Measurements ANT1

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5260MHz
Channel:	52

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
10520.00	Peak	V	219	5	-66.18	11.17	51.99	68.20	-16.21
* 15780.00	Average	V	-	-	-81.92	13.34	38.42	53.98	-15.55
* 15780.00	Peak	V	-	-	-69.85	13.34	50.49	73.98	-23.48

Table 7-7. Radiated Measurements ANT1

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 21 of 37

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5280MHz
Channel:	56

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
10560.00	Peak	V	161	142	-67.78	11.69	50.91	68.20	-17.29
* 15840.00	Average	V	-	-	-81.71	15.07	40.36	53.98	-13.62
* 15840.00	Peak	V	-	-	-69.93	15.07	52.14	73.98	-21.84

Table 7-8. Radiated Measurements ANT1

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5320MHz
Channel:	64

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
* 10640.00	Average	V	150	139	-80.61	12.99	39.38	53.98	-14.60
* 10640.00	Peak	V	150	139	-67.67	12.99	52.32	73.98	-21.66
* 15960.00	Average	V	-	-	-82.22	13.86	38.64	53.98	-15.34
* 15960.00	Peak	V	-	-	-69.74	13.86	51.12	73.98	-22.86

Table 7-9. Radiated Measurements ANT1

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 22 of 37

Worst Case Mode: 802.11a
 Worst Case Transfer Rate: 6Mbps
 Distance of Measurements: 1 & 3 Meters
 Operating Frequency: 5500MHz
 Channel: 100

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
* 11000.00	Average	V	130	140	-79.04	12.34	40.30	53.98	-13.68
* 11000.00	Peak	V	130	140	-65.58	12.34	53.76	73.98	-20.22
16500.00	Peak	V	-	-	-70.18	15.07	51.89	68.20	-16.31

Table 7-10. Radiated Measurements ANT1

Worst Case Mode: 802.11a
 Worst Case Transfer Rate: 6Mbps
 Distance of Measurements: 1 & 3 Meters
 Operating Frequency: 5745MHz
 Channel: 149

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
* 11490.00	Average	V	159	164	-78.99	13.90	41.91	53.98	-12.07
* 11490.00	Peak	V	159	164	-66.09	13.90	54.81	73.98	-19.17
17235.00	Peak	V	-	-	-69.15	17.99	55.84	68.20	-12.36

Table 7-11. Radiated Measurements ANT1

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)			 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module				Page 23 of 37

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5785MHz
Channel:	157

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
* 11570.00	Average	V	147	164	-76.07	12.91	43.84	53.98	-10.14
* 11570.00	Peak	V	147	164	-63.04	12.91	56.87	73.98	-17.11
17355.00	Peak	V	143	169	-67.98	18.74	57.76	68.20	-10.44

Table 7-12. Radiated Measurements ANT1

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5825MHz
Channel:	165

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
* 11650.00	Average	V	141	163	-79.25	13.29	41.04	53.98	-12.94
* 11650.00	Peak	V	141	163	-66.64	13.29	53.65	73.98	-20.33
17475.00	Peak	V	-	-	-69.45	19.70	57.25	68.20	-10.95

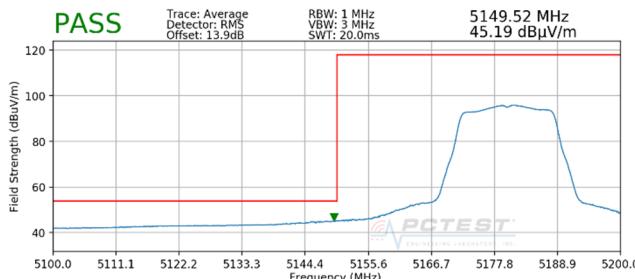
Table 7-13. Radiated Measurements ANT1

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 24 of 37

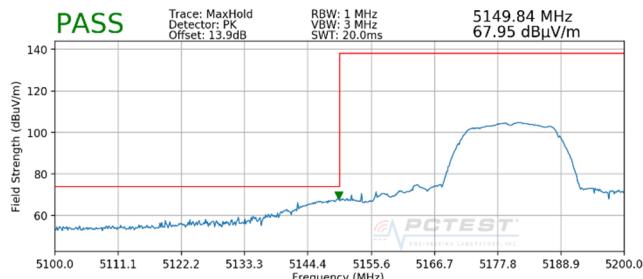
Radiated Band Edge Measurements (20MHz BW)

§15.407(b.1)(b.2) §15.205 §15.209

Worst Case Mode: 802.11a
Worst Case Transfer Rate: 6Mbps
Distance of Measurements: 3 Meters
Operating Frequency: 5180MHz
Channel: 36

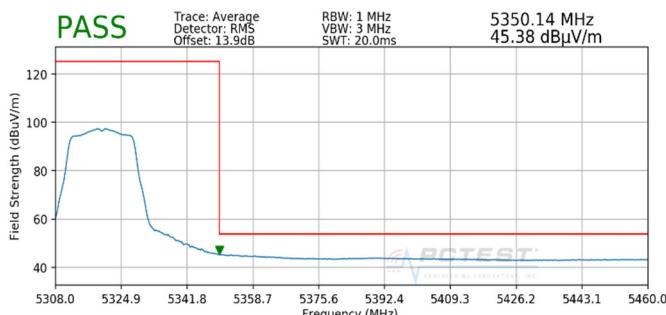


Plot 7-7. Radiated Lower Band Edge Plot (Average – UNII Band 1)

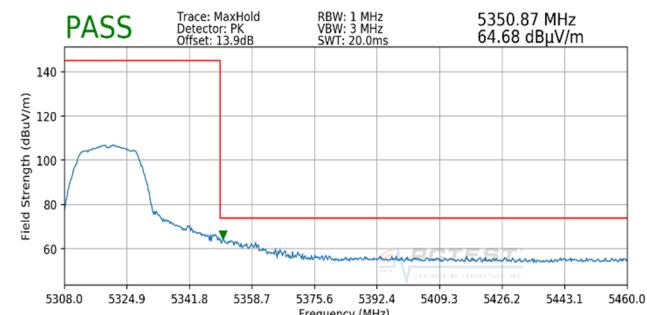


Plot 7-8. Radiated Lower Band Edge Plot (Peak – UNII Band 1)

Worst Case Mode: 802.11a
Worst Case Transfer Rate: 6Mbps
Distance of Measurements: 3 Meters
Operating Frequency: 5320MHz
Channel: 64



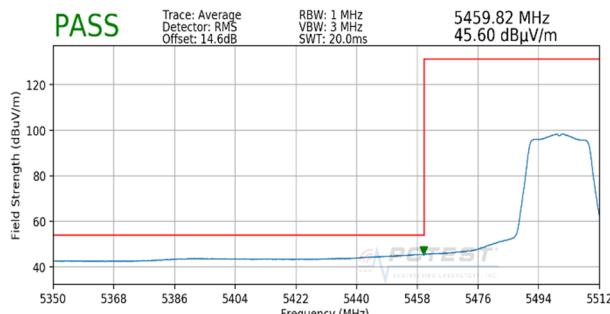
Plot 7-33. Radiated Lower Band Edge Plot (Average – UNII Band 2A)



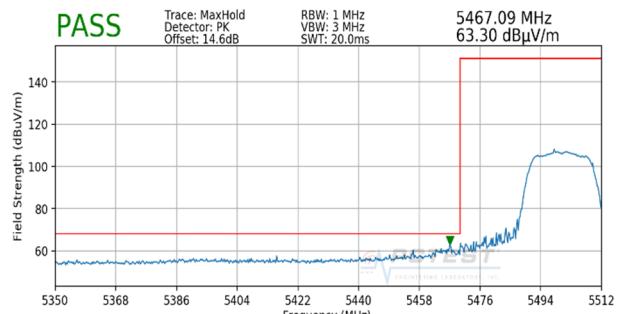
Plot 7-34. Radiated Lower Band Edge Plot (Peak – UNII Band 2A)

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 25 of 37

Worst Case Mode: 802.11n
Worst Case Transfer Rate: MCS0
Distance of Measurements: 3 Meters
Operating Frequency: 5500MHz
Channel: 100

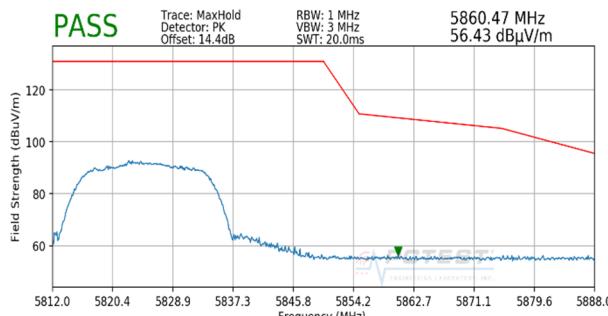


Plot 7-35. Radiated Lower Band Edge Plot (Average – UNII Band 2C)



Plot 7-36. Radiated Lower Band Edge Plot (Peak – UNII Band 2C)

Worst Case Mode: 802.11n
Worst Case Transfer Rate: MSC0
Distance of Measurements: 3 Meters
Operating Frequency: 5825MHz
Channel: 165



Plot 7-9. Radiated Upper Band Edge Plot (Peak – UNII Band 3)

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SIRIUSXM SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 26 of 37

7.4 Radiated Spurious Emissions Measurements – Below 1GHz

§15.209

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-14 per Section 15.209.

Frequency	Field Strength [μ V/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-14. Radiated Limits

Test Procedures Used

ANSI C63.10-2013

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 27 of 37

Test Setup

The EUT and measurement equipment were set up as shown in the diagrams below.

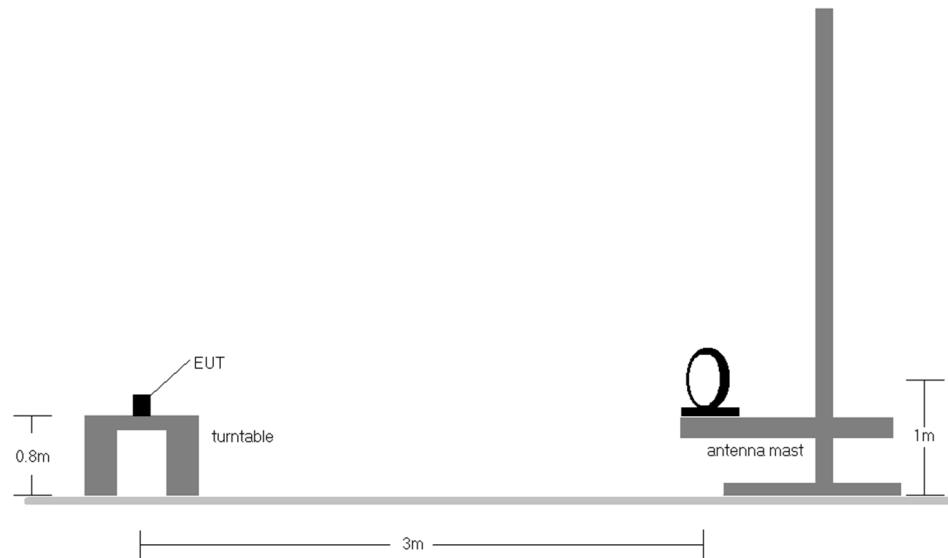


Figure 7-3. Radiated Test Setup < 30MHz

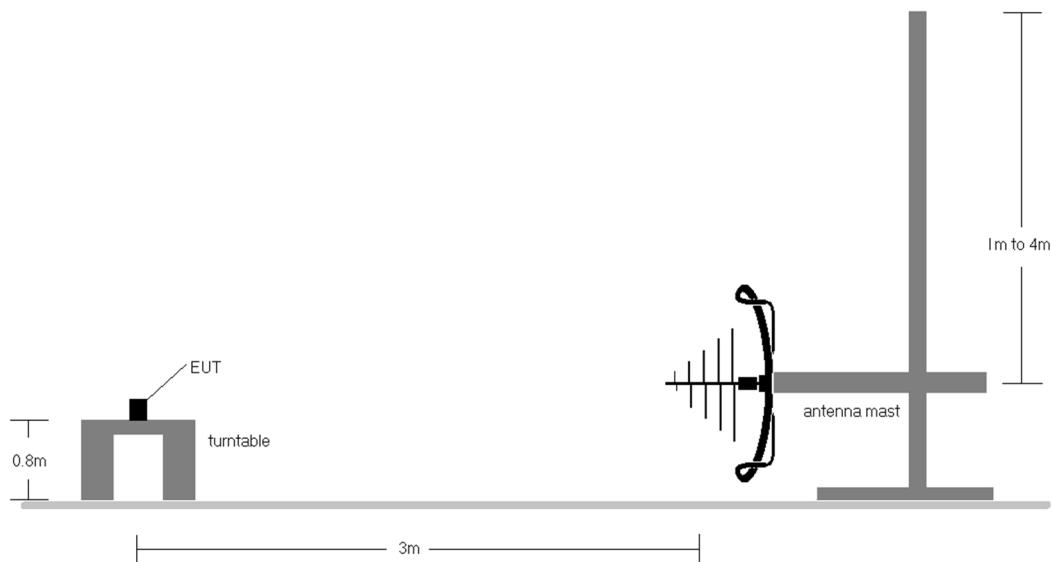


Figure 7-4. Radiated Test Setup < 1GHz

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SiriusXM SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 28 of 37

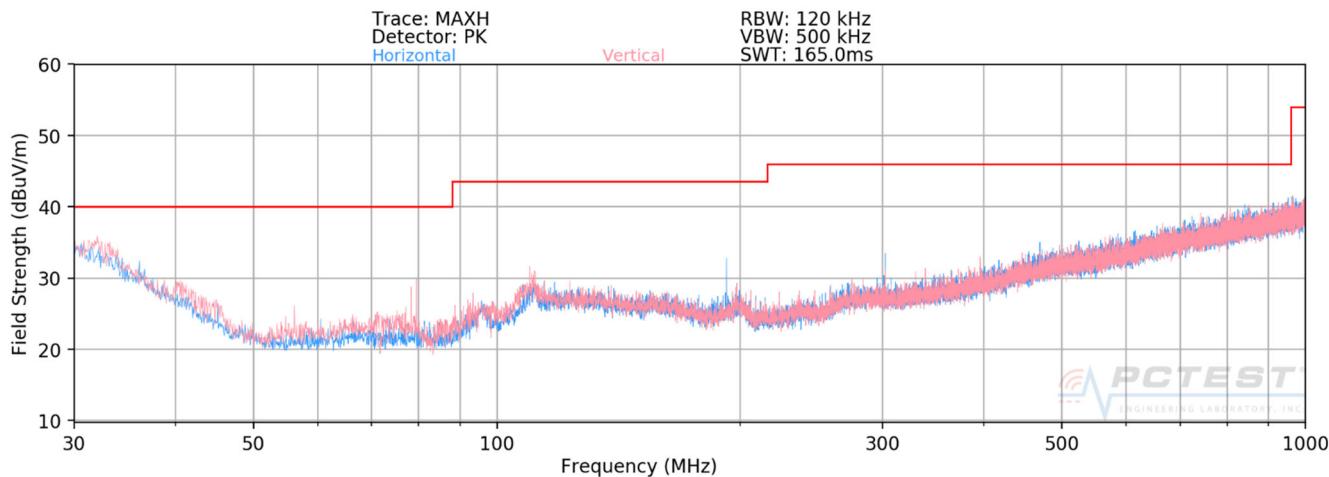
Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-14.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes.
3. This unit was tested while powered by a 12V DC power source (battery).
4. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
5. Emissions were measured at a 3 meter test distance.
6. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
7. No spurious emissions were detected within 20dB of the limit below 30MHz.
8. The results recorded using the broadband antenna is known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
9. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. There were no emissions detected in the 30MHz – 1GHz frequency range, as shown in the subsequent plots.

FCC ID: RS2LBEE5HY1MW		 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SiriusXM SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module			Page 29 of 37

Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209



Plot 7-10. Radiated Spurious Plot below 1GHz (802.11a – U3 Ch. 157)

Frequency [MHz]	Detector	Ant. Pol. [H/V]	EUT Pol. [X/Y/Z]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
56.54	Quasi-Peak	V	X	-96.51	13.59	24.08	40.00	-15.92
89.40	Quasi-Peak	V	X	-89.82	14.60	31.78	43.52	-11.74
118.23	Quasi-Peak	H	X	-94.32	20.51	33.19	43.52	-10.33
192.09	Quasi-Peak	H	X	-92.78	18.73	32.95	43.52	-10.57
302.11	Quasi-Peak	H	X	-94.68	21.26	33.58	46.02	-12.44

Table 7-15. Radiated Spurious Measurements

FCC ID: RS2LBEE5HY1MW	 PCTEST® ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CLASS II PERMISSIVE CHANGE)	 SATELLITE RADIO	Approved by: Quality Manager
Test Report S/N: 1M1911040180-02.RS2	Test Dates: 11/04 - 11/21/2019	EUT Type: BT/WiFi Module		Page 30 of 37

7.5 Line-Conducted Test Data

§15.407

Test Overview and Limit

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

All conducted emissions must not exceed the limits shown in the table below, per Section 15.207.

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

Table 7-16. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2013, Section 6.2

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = RMS
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

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Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

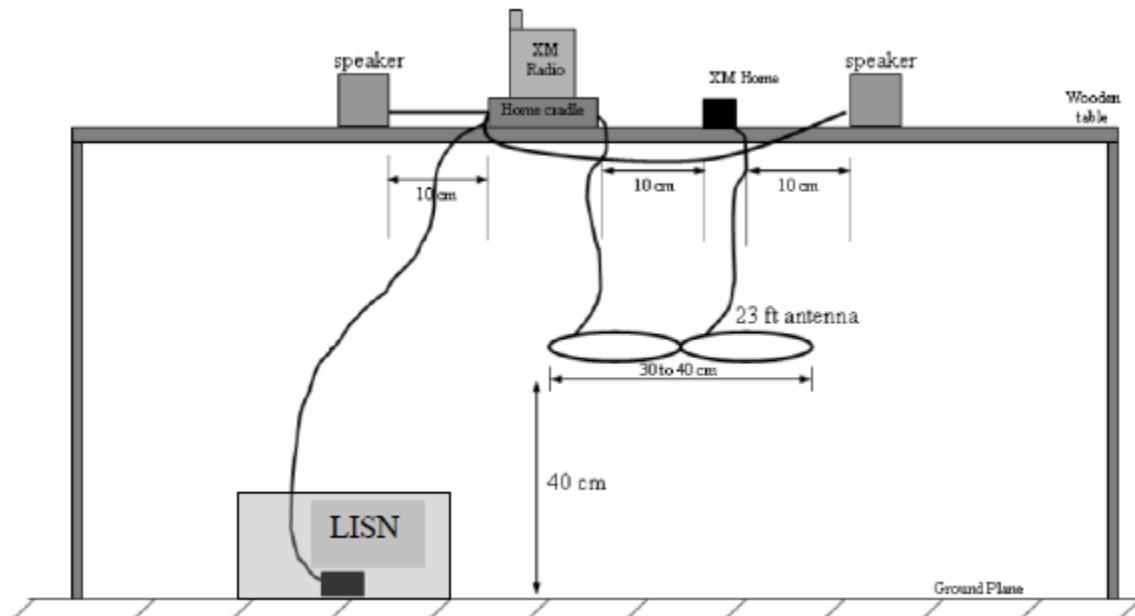
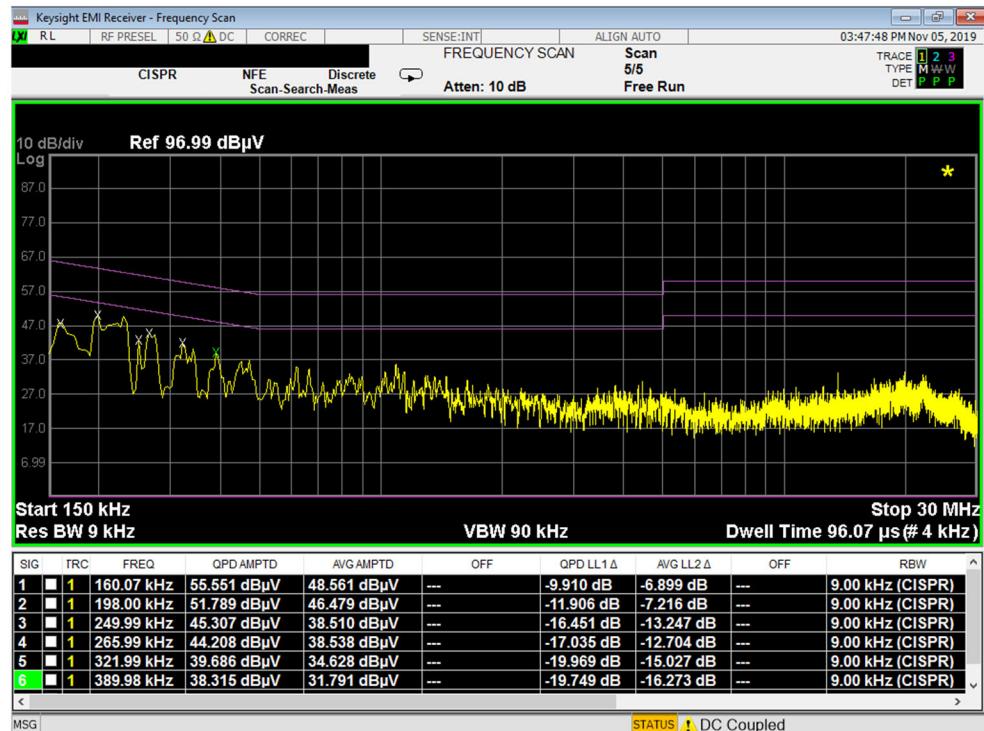


Figure 7-5. Test Instrument & Measurement Setup

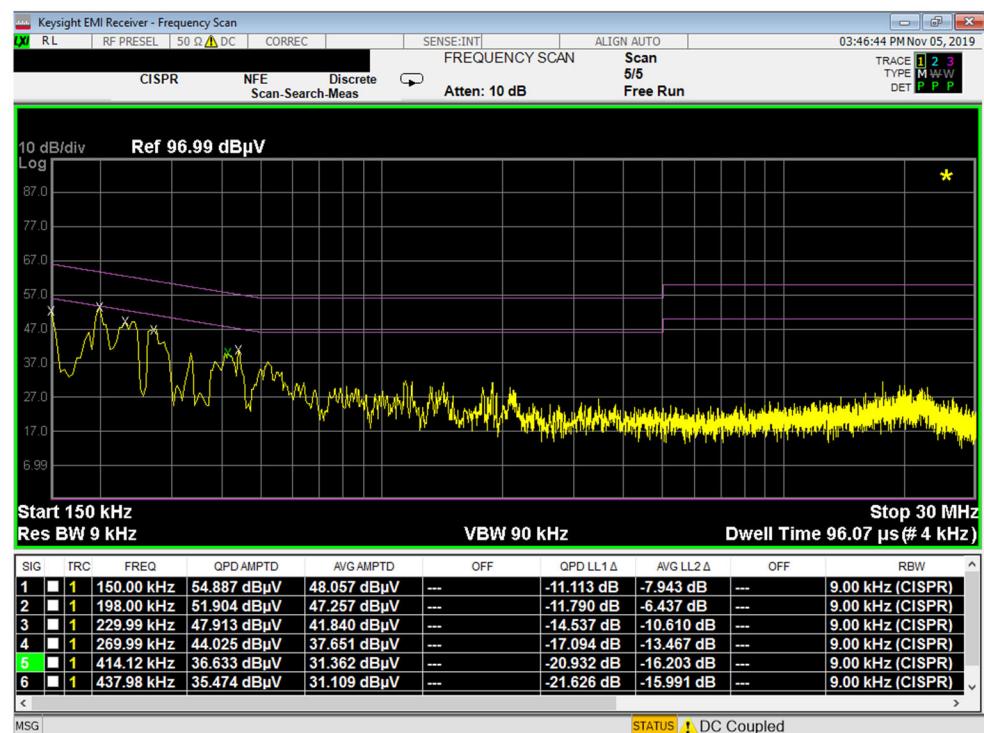
Test Notes

1. All modes of operation were investigated and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in 15.207.
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (dB μ V) = QP/AV Analyzer/Receiver Level (dB μ V) + Corr. (dB)
5. Margin (dB) = QP/AV Limit (dB μ V) - QP/AV Level (dB μ V)
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.

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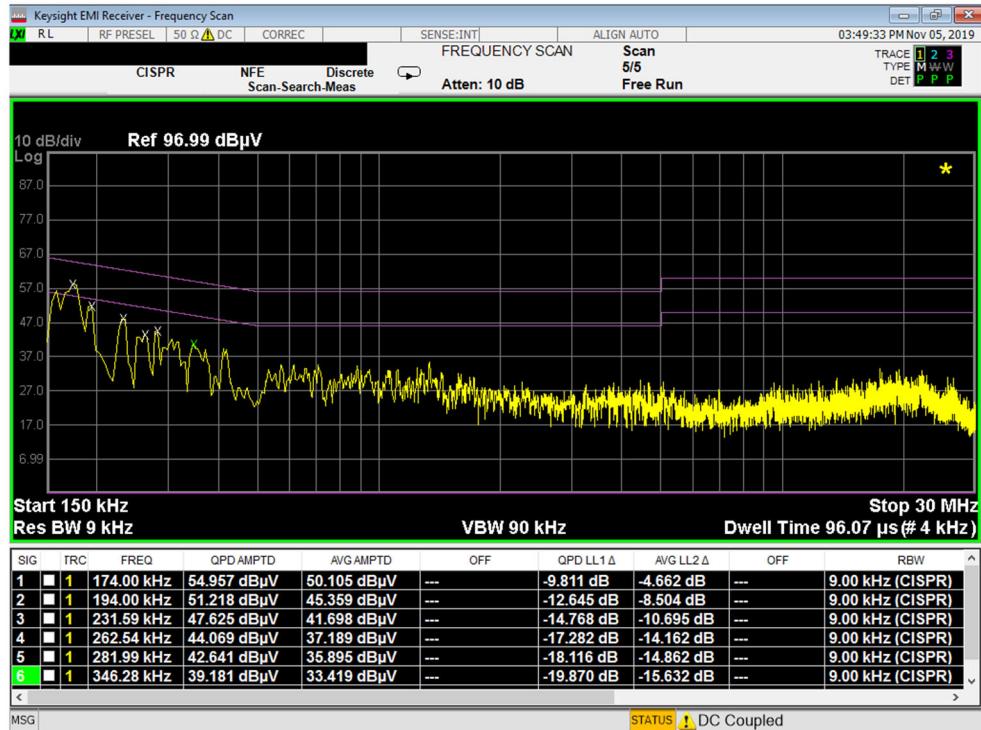


Plot 7-11. Line Conducted Plot with 802.11a UNII Band 1 (L1)

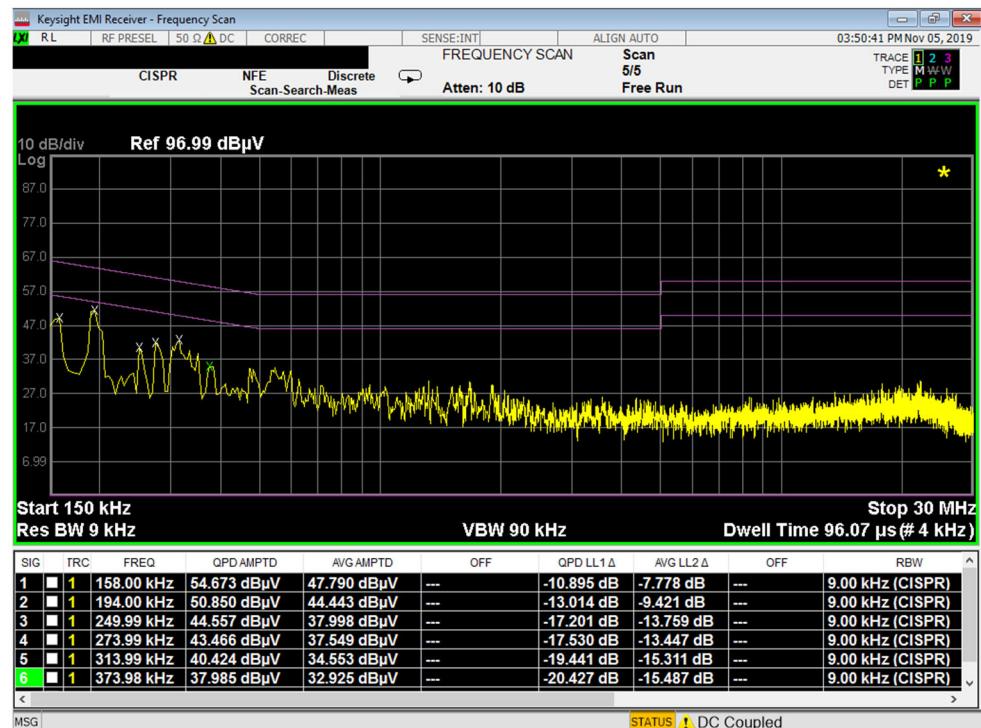


Plot 7-12. Line Conducted Plot with 802.11a UNII Band 1 (N)

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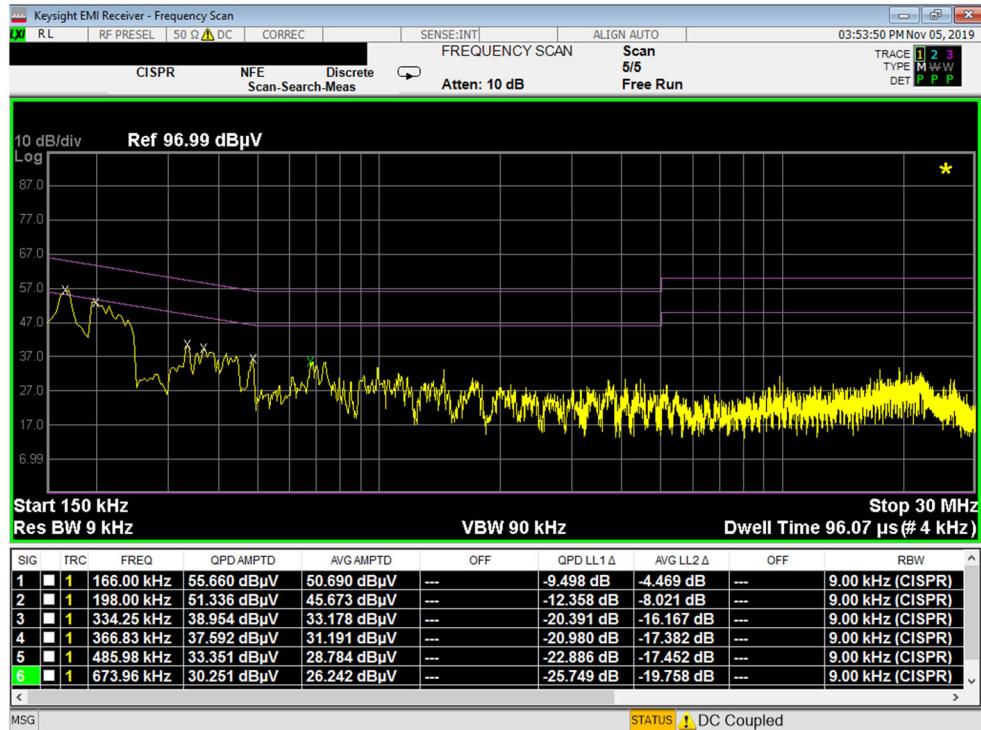


Plot 7-13. Line Conducted Plot with 802.11a UNII Band 2A (L1)

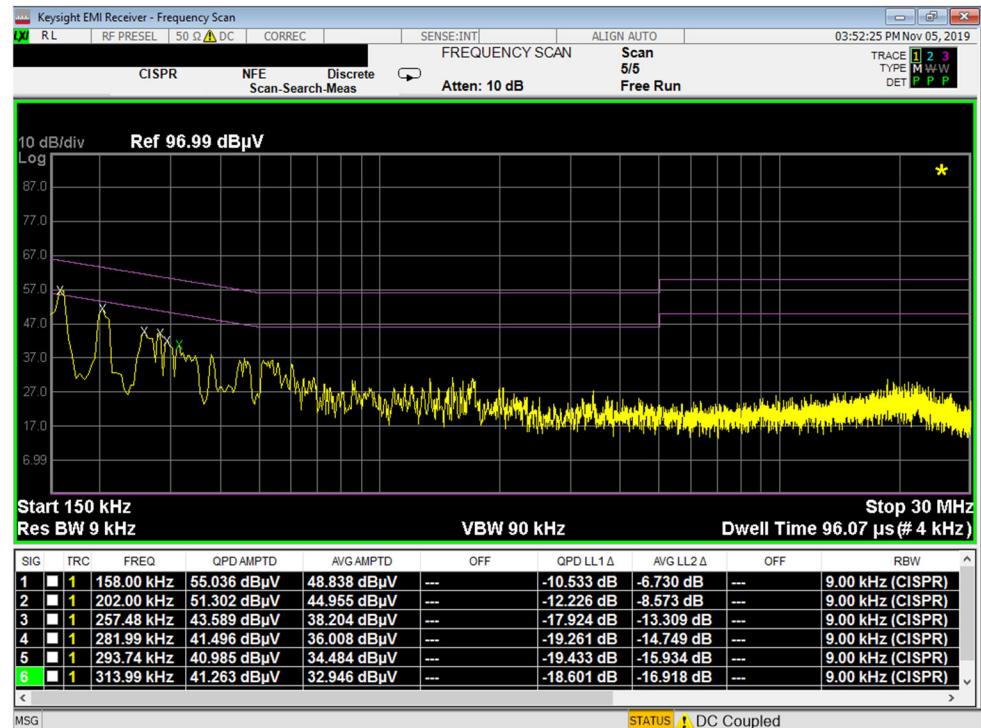


Plot 7-14. Line Conducted Plot with 802.11a UNII Band 2A (N)

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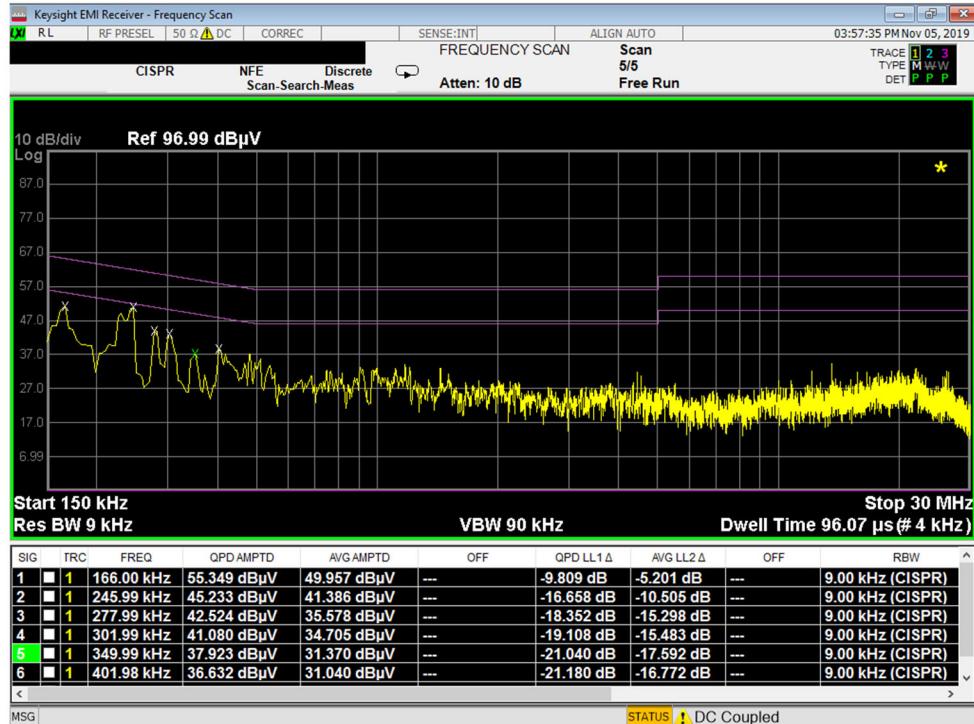


Plot 7-15. Line Conducted Plot with 802.11a UNII Band 2C (L1)

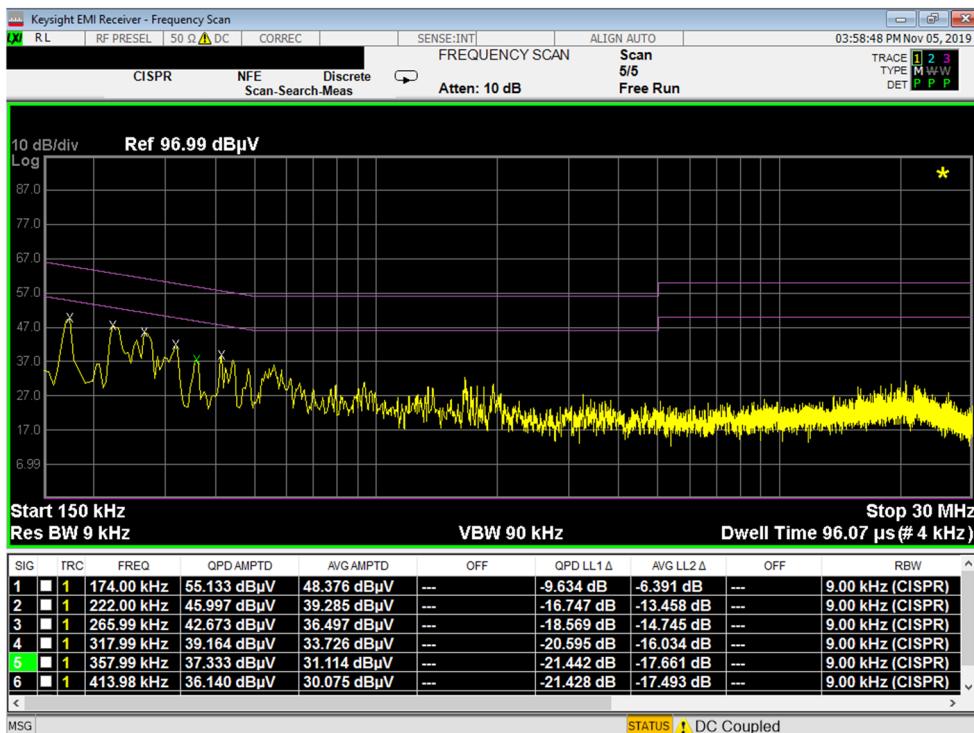


Plot 7-16. Line Conducted Plot with 802.11a UNII Band 2C (N)

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Plot 7-17. Line Conducted Plot with 802.11a UNII Band 3 (L1)



Plot 7-18. Line Conducted Plot with 802.11a UNII Band 3 (N)

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8.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **Sirius XM BT/WiFi Module** **FCC ID: RS2LBEE5HY1MW** is in compliance with Part 15 Subpart E (15.407) of the FCC Rules.

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