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BLUETOOTH TEST REPORT

Report Number:	**103291273LEX-016.2**
Project Number:	**G103291273**
Report Issue Date:	**5/17/2018**
Product Name:	**External Pulse Generator**
Standards:	**Title 47 CFR Part 15 Subpart C** **RSS-247 Issue 2**

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Drive
Lexington, KY 40510

Client:
SPR Therapeutics, Inc.
22901 Millcrek Blvd, Suite 110
Cleveland, OH 44122

Report prepared by

Brian Lackey, Project Engineer

Report reviewed by

Bryan Taylor, Team Leader

TABLE OF CONTENTS

1 Introduction and Conclusion

The tests indicated in section 2 were performed on the product constructed as described in section 3. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test method, a list of the actual test equipment used, documentation photos, results and raw data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested complied with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

The INTERTEK-Lexington is located at 731 Enterprise Drive, Lexington Kentucky, 40510. The radiated emission test site is a 10-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1 and ANSI C63.4. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters. The test site is listed with the FCC under registration number 485103. The test site is listed with Industry Canada under site number IC 2042M-1.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
6	Peak Output Power	§ 15.247(b)(1)	RSS-247 § 5.4(b)	Pass
9	Occupied Bandwidth	§ 15.247(a)(1)	RSS-247 § 5.2(a)	Pass
13	Time of Occupancy	§ 15.247(a)(1)(iii)	RSS-247 § 5.1(d)	Pass
16	Conducted Spurious Emissions	§ 15.247(d)	RSS-Gen § 7.1.3	Pass
19	Power Spectral Density	§ 15.247(e)	RSS-247 § 5.2(b)	Pass
19	Radiated Spurious Emissions (Transmitter)	§ 15.247(d), § 15.209, and § 15.205	RSS-247 § 5.5	Pass
30	Radiated Spurious Emissions (Receiver)	§ 15.109	RSS-Gen § 7.1.2	Pass
-	AC Mains Conducted Emissions	§ 15.107, § 15.207	RSS-Gen § 8.8	NA[1]
34	Antenna Requirement per FCC Part 15.203	§ 15.203	RSS-Gen § 8.3	Pass

[1] Test is not applicable. Device does not connect to AC mains.

3 Description of Equipment Under Test

Equipment Under Test	
Manufacturer	SPR Therapeutics, Inc.
Model Number	9610
Serial Number	17440002
Receive Date	11/10/2017
Test Start Date	11/10/2017
Test End Date	11/17/2017
Device Received Condition	Good
Test Sample Type	Production
Frequency Band	2402 – 2480MHz
Mode(s) of Operation	Bluetooth Low Energy (BTLE)
Modulation Type	DTS
Transmission Control	Test Commands
Maximum Output Power	8.44dBm
Test Channels	0, 19, 39
Antenna Type (15.203)	Internal
Operating Voltage	Battery

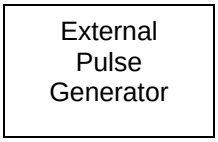
Description of Equipment Under Test
This is the body worn 2-channel pulse generator that provides stimulus current to 1 or 2 MicroLeads (Percutaneous Electrodes).

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Bluetooth low energy (BTLE) transmitting on low, mid, and high channels
2	Receive / idle mode

4 System setup including cable interconnection details, support equipment and simplified block diagram

4.1 EUT Block Diagram:



4.2 Cables:

No cables were used in this test configuration.

4.3 Support Equipment:

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Laptop	HP	-	-

5 Peak Output Power

5.1 Test Limits

§ 15.247(b): The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

5.2 Test Procedure

ANSI C63.10: 2013. The peak output power was measured using the marker to peak function of the spectrum analyzer.

5.3 Test Equipment Used

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

5.4 Test Results

The device was found to be **compliant**. The output power was less than the limit.

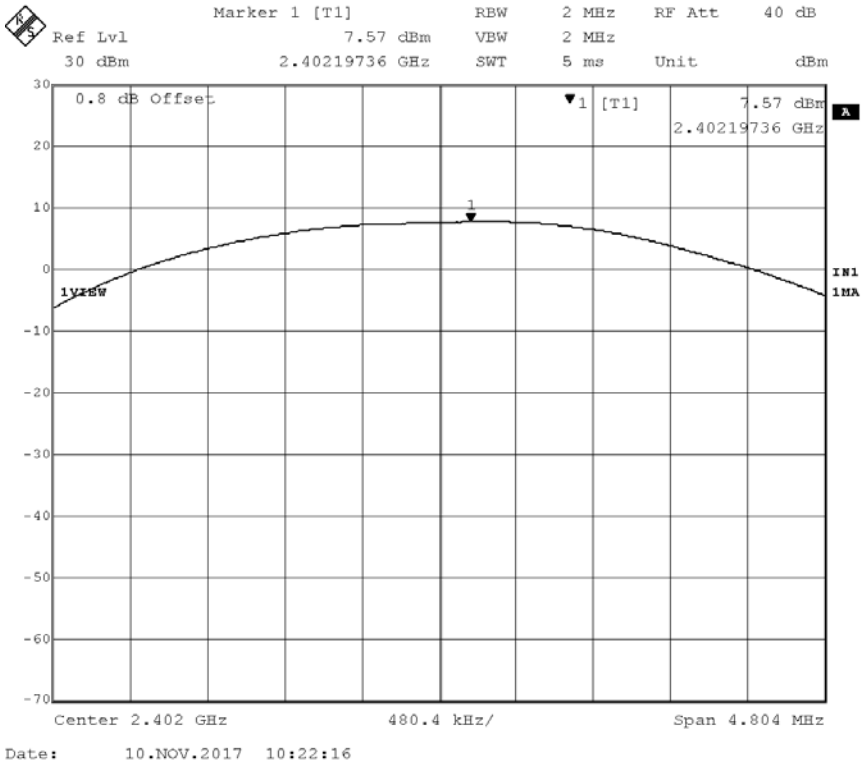
5.5 Test Conditions

Test Personnel:	Brian Lackey	Test Date:	11/10/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Ambient Temperature:	22.1C
Input Voltage:	Battery	Relative Humidity:	35.2%
		Atmospheric Pressure:	992.0mbar

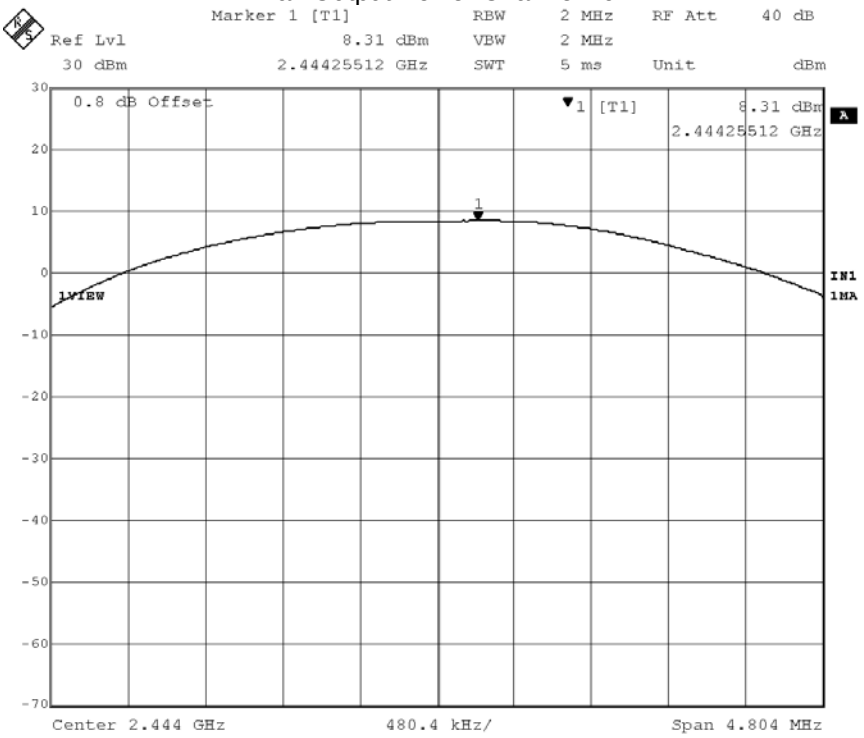
5.6 Test Data

Channel	Frequency (MHz)	Output Power (mW)	Limit (mW)	Pass / Fail
0	2402	5.71	125	Pass
19	2440	6.78	125	Pass
39	2480	6.98	125	Pass

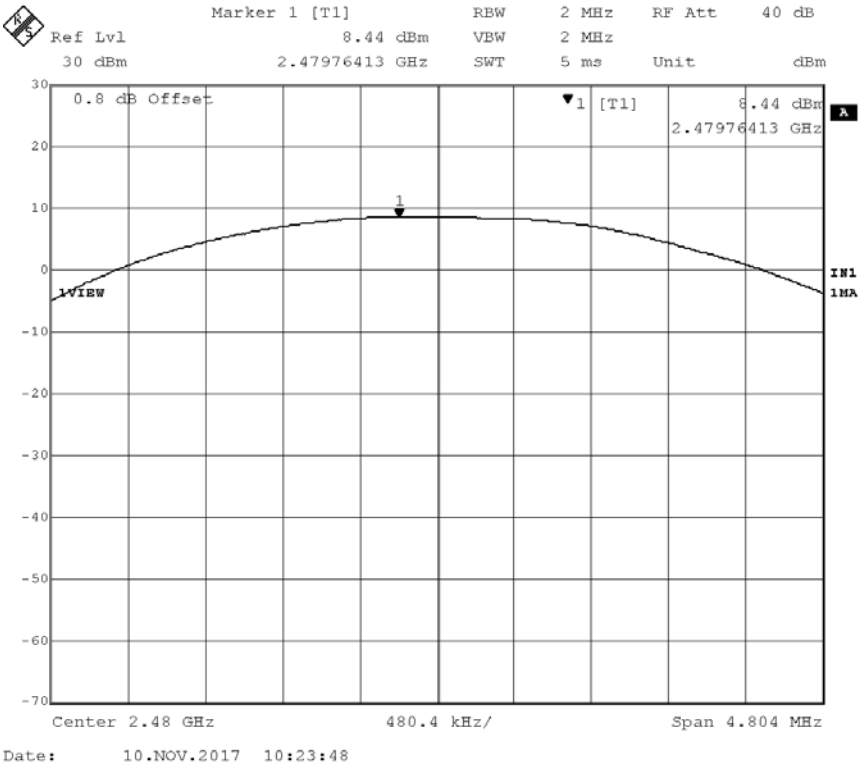
Max Output Power Channel 0



Max Output Power Channel 19



Max Output Power Channel 39



6 Occupied Bandwidth

6.1 Test Limits

§ 15.247(a): Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

6.2 Test Procedure

ANSI C63.10: 2013.

6.3 Test Equipment Used

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

6.4 Test Results

The 20dB bandwidth measurements are shown below. A 99% bandwidth measurement was also performed.

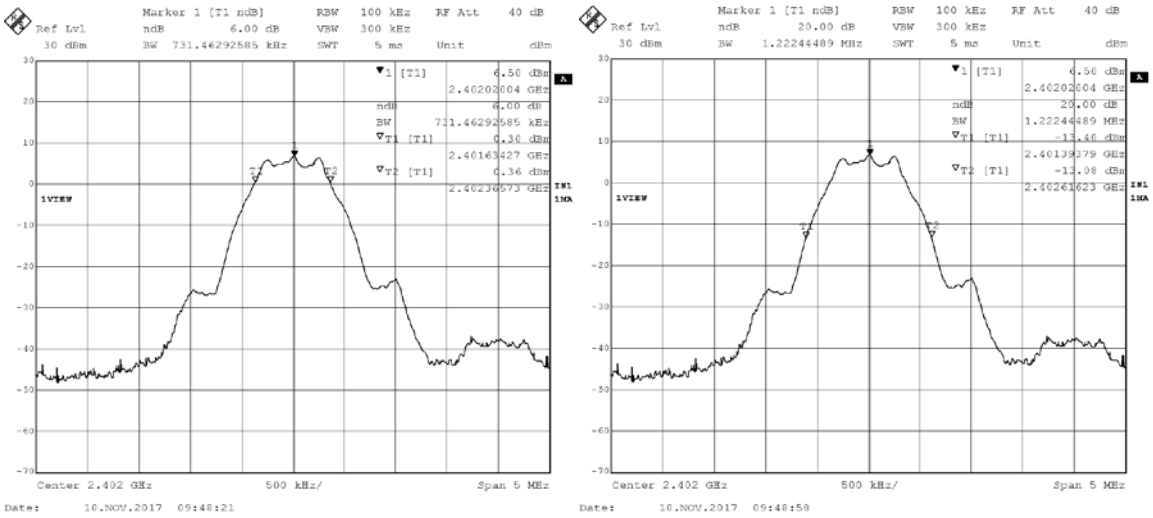
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	20dB Bandwidth (MHz)
0	2402	0.731	1.222
19	2440	0.731	1.222
39	2480	0.721	1.212

6.5 Test Conditions

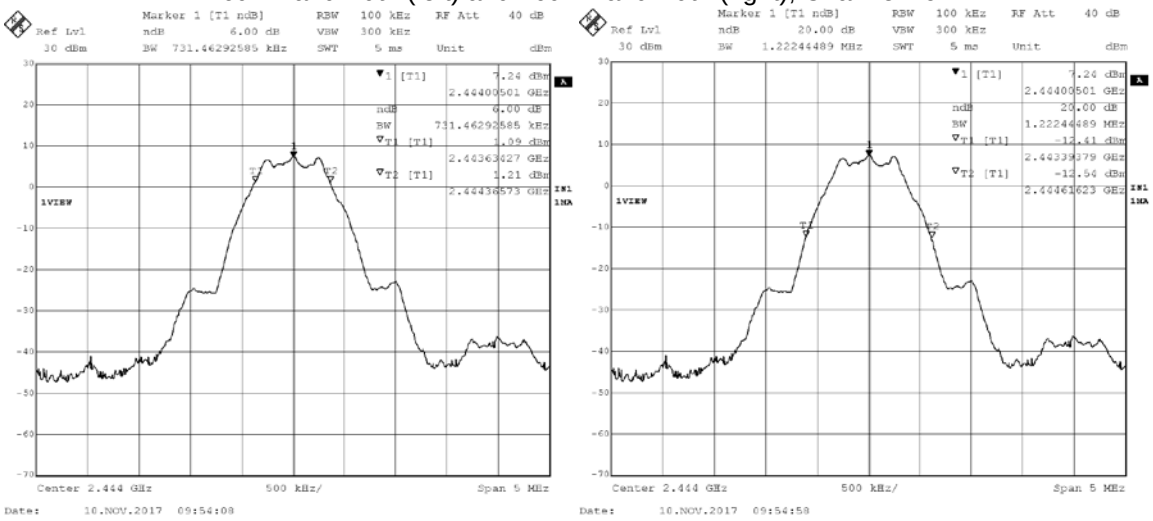
Test Personnel:	Brian Lackey	Test Date:	11/10/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Ambient Temperature:	22.1C
Input Voltage:	Battery	Relative Humidity:	35.2%
		Atmospheric Pressure:	992.0mbar

6.6 Test Data

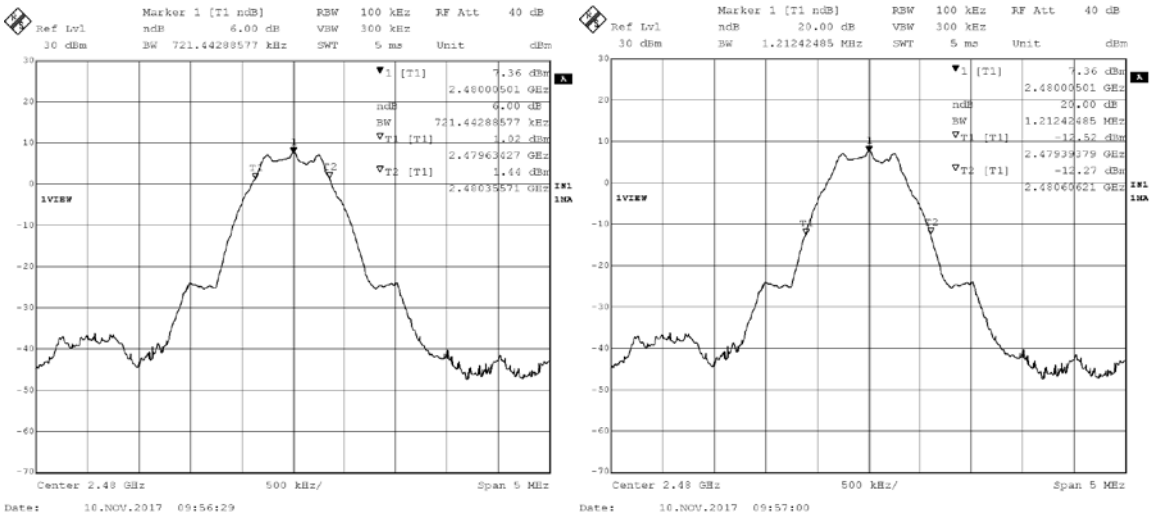
6dB Bandwidth (left) and 20dB Bandwidth (right), Channel 0



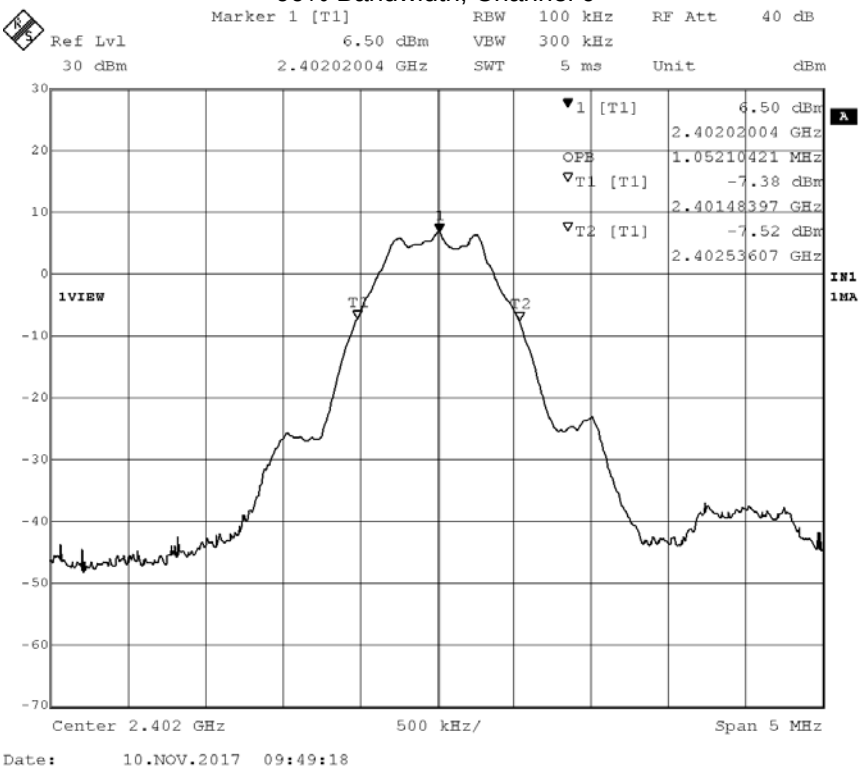
6dB Bandwidth (left) and 20dB Bandwidth (right), Channel 19



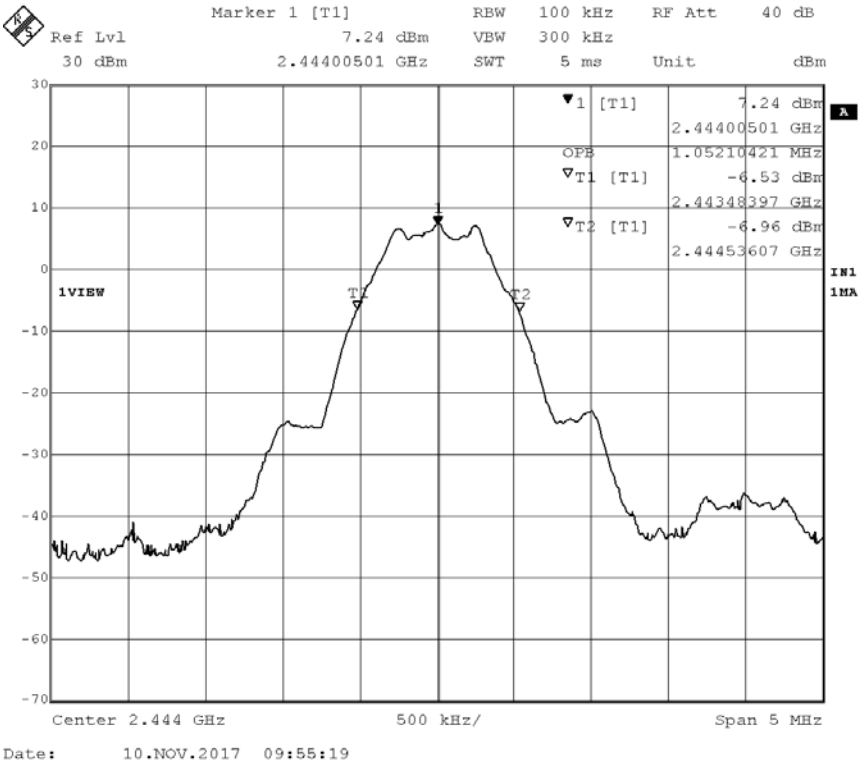
6dB Bandwidth (left) and 20dB Bandwidth (right), Channel 39



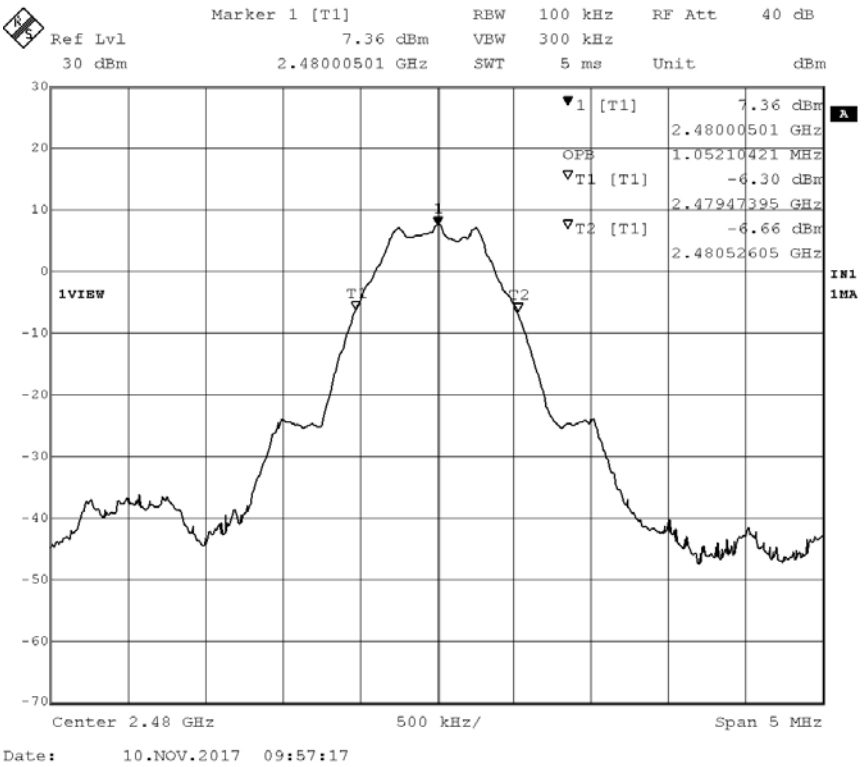
99% Bandwidth, Channel 0



99% Bandwidth, Channel 19



99% Bandwidth, Channel 39



7 Time of Occupancy

7.1 Test Limits

§ 15.247(a): Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1)(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used

7.2 Test Procedure

ANSI C63.10: 2013.

7.3 Test Equipment Used

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

7.4 Test Results

The device was found to be **compliant**. The time of occupancy was less than the limit.

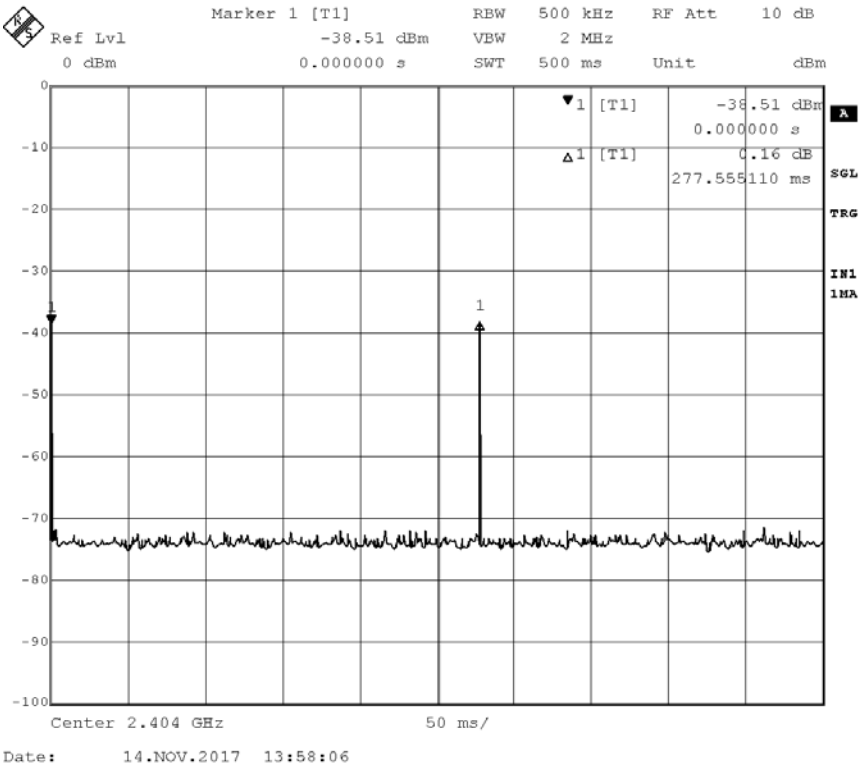
7.5 Test Conditions

Test Personnel:	Brian Lackey	Test Date:	11/14/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Ambient Temperature:	21.2C
Input Voltage:	Battery	Relative Humidity:	29.7%
		Atmospheric Pressure:	985.4mbar

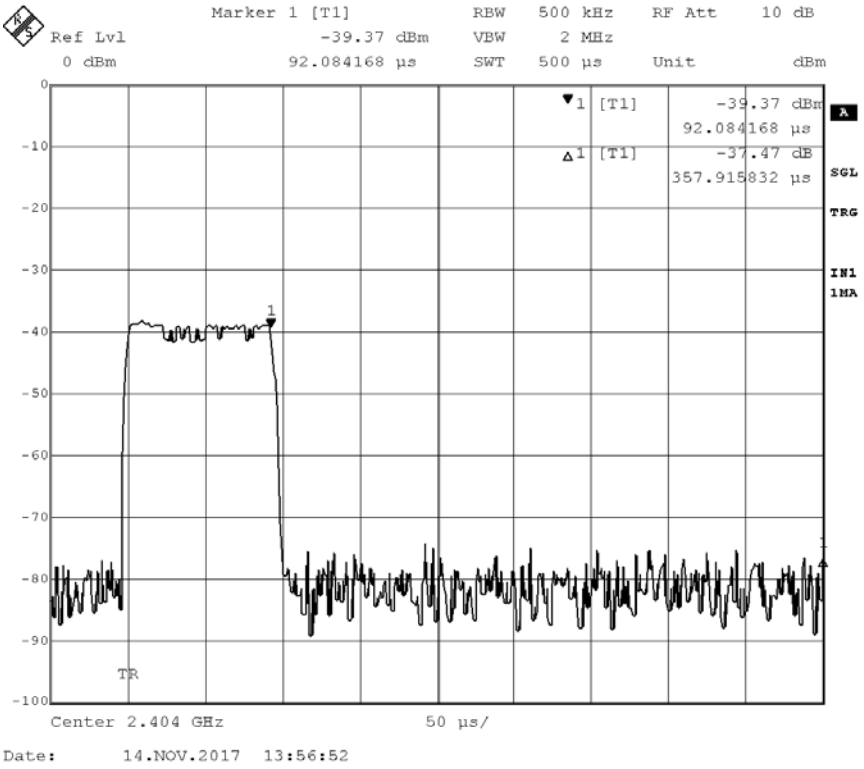
7.6 Test Data

Mode	Number of Transmissions in a 16s Frame (80 Hopping Ch x 0.4s)	Transmission Time (ms)	Result (ms)	Limit (ms)
BTLE	2 (times in 0.4sec) * (16sec / 0.4sec) = 80	0.0921	7.368	400
Time of occupancy = Transmission Time x Number of Transmissions				

Dwell Time, BTLE



Dwell Time (Single Pulse)



8 Conducted Spurious Emissions

8.1 Test Limits

§ 15.247(d): 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.

8.2 Test Procedure

ANSI C63.10: 2013.

8.3 Test Equipment Used

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

8.4 Test Results

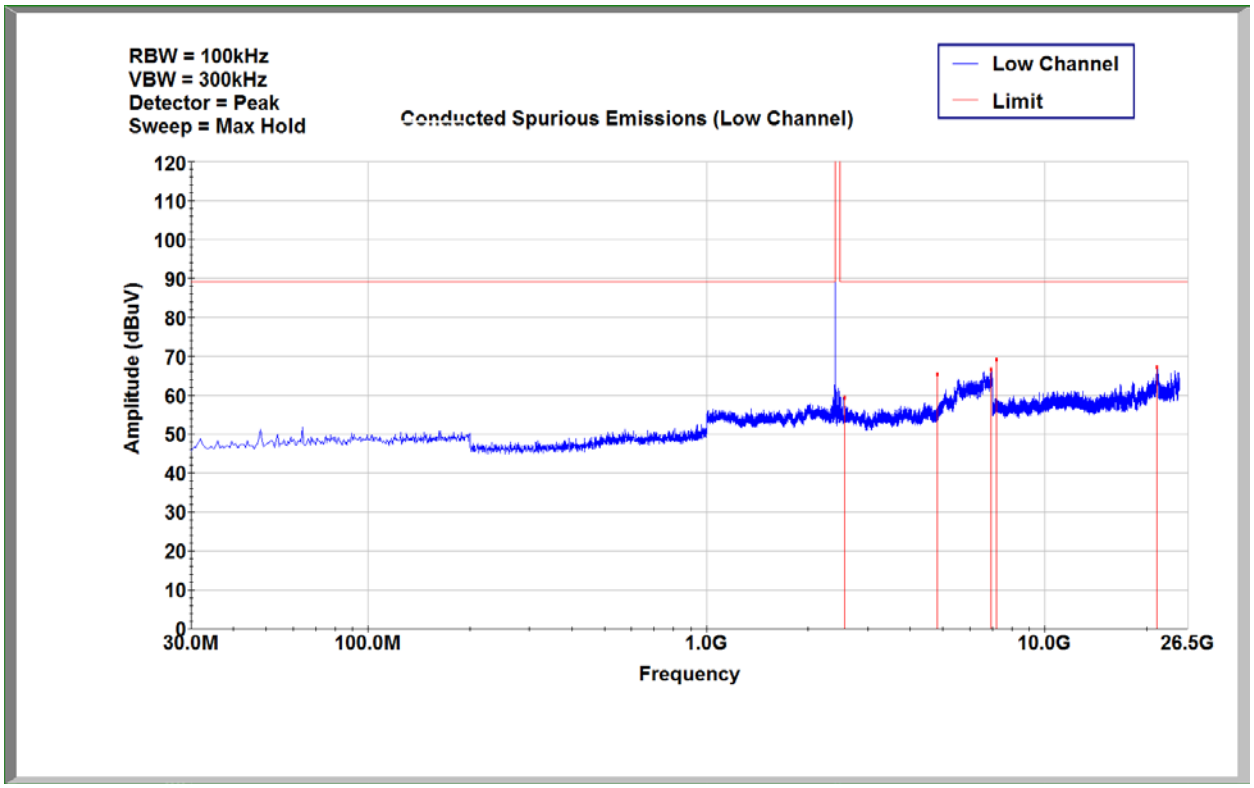
The device was found to be **compliant**. The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria. Plots are also presented showing the band edge compliance.

8.5 Test Conditions

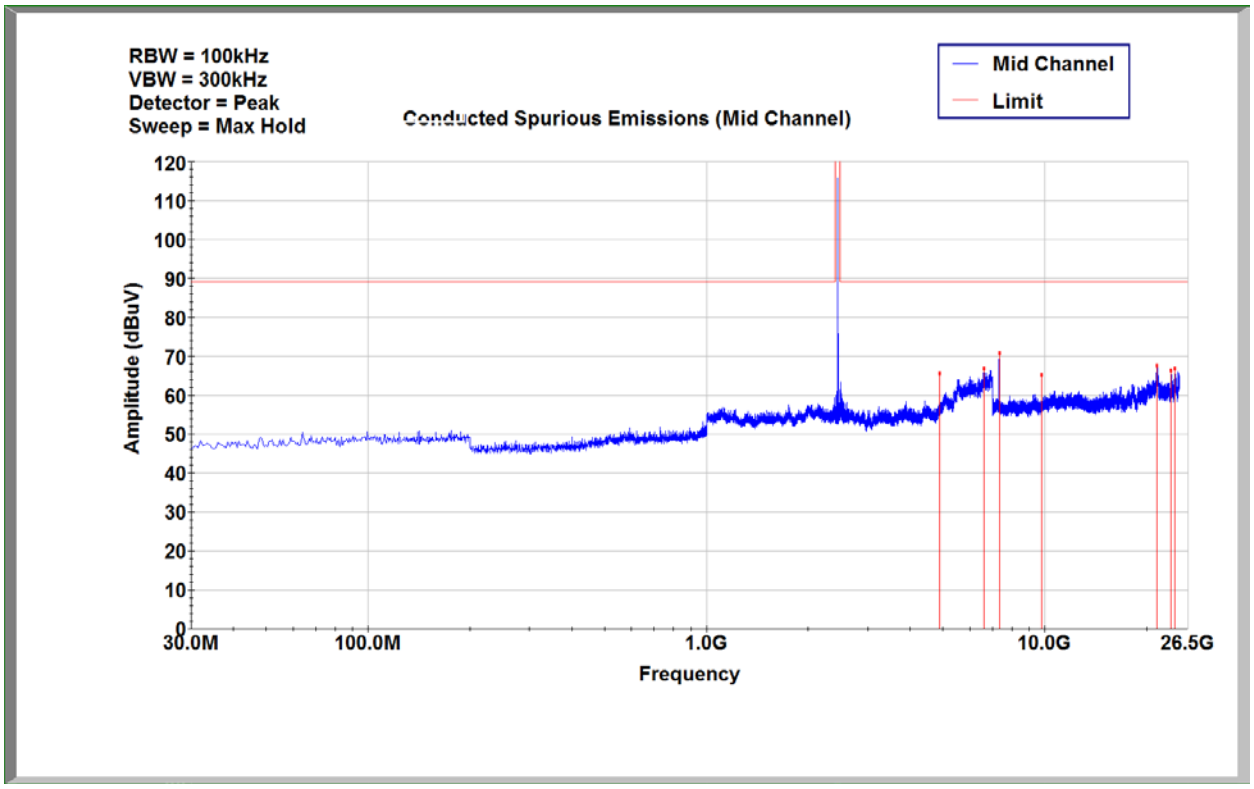
Test Personnel:	Brian Lackey	Test Date:	11/10/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Ambient Temperature:	22.1C
Input Voltage:	Battery	Relative Humidity:	35.2%
		Atmospheric Pressure:	992.0mbar

8.6 Test Data

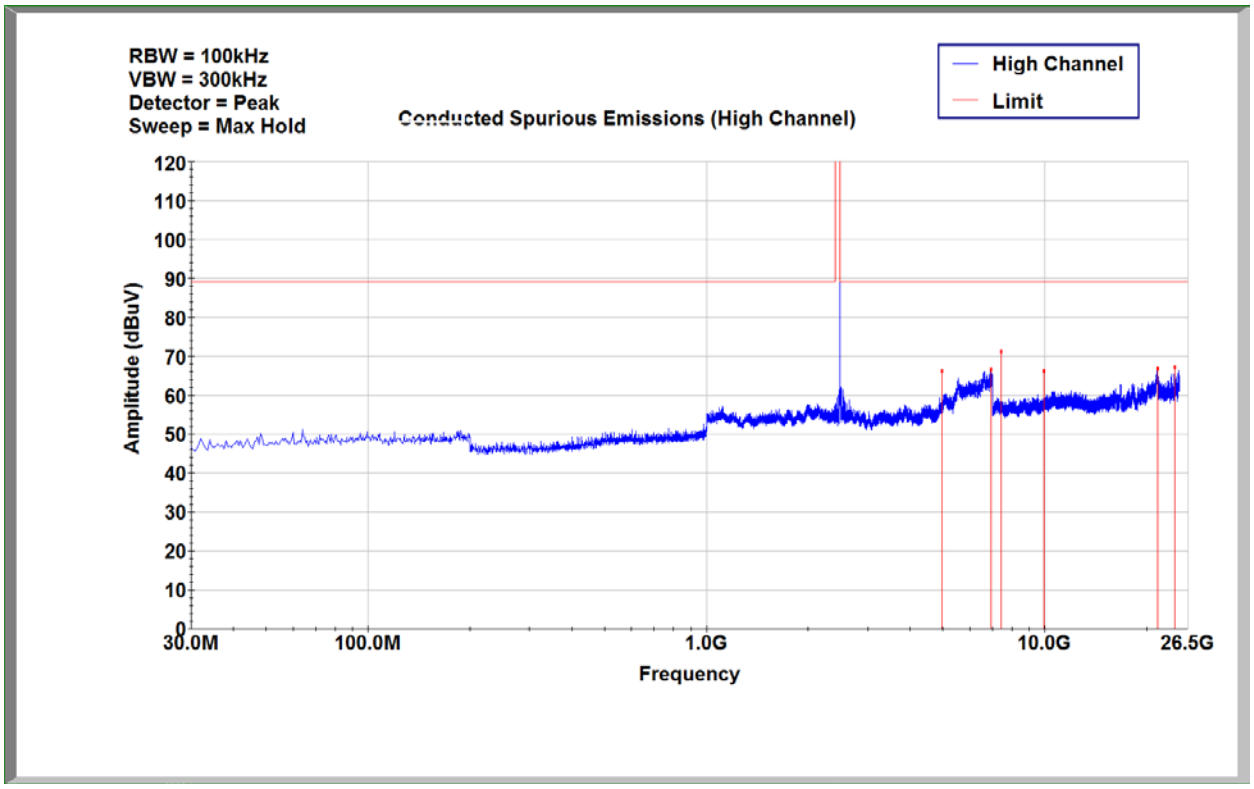
Conducted Spurious Emissions at Antenna Port Channel 0



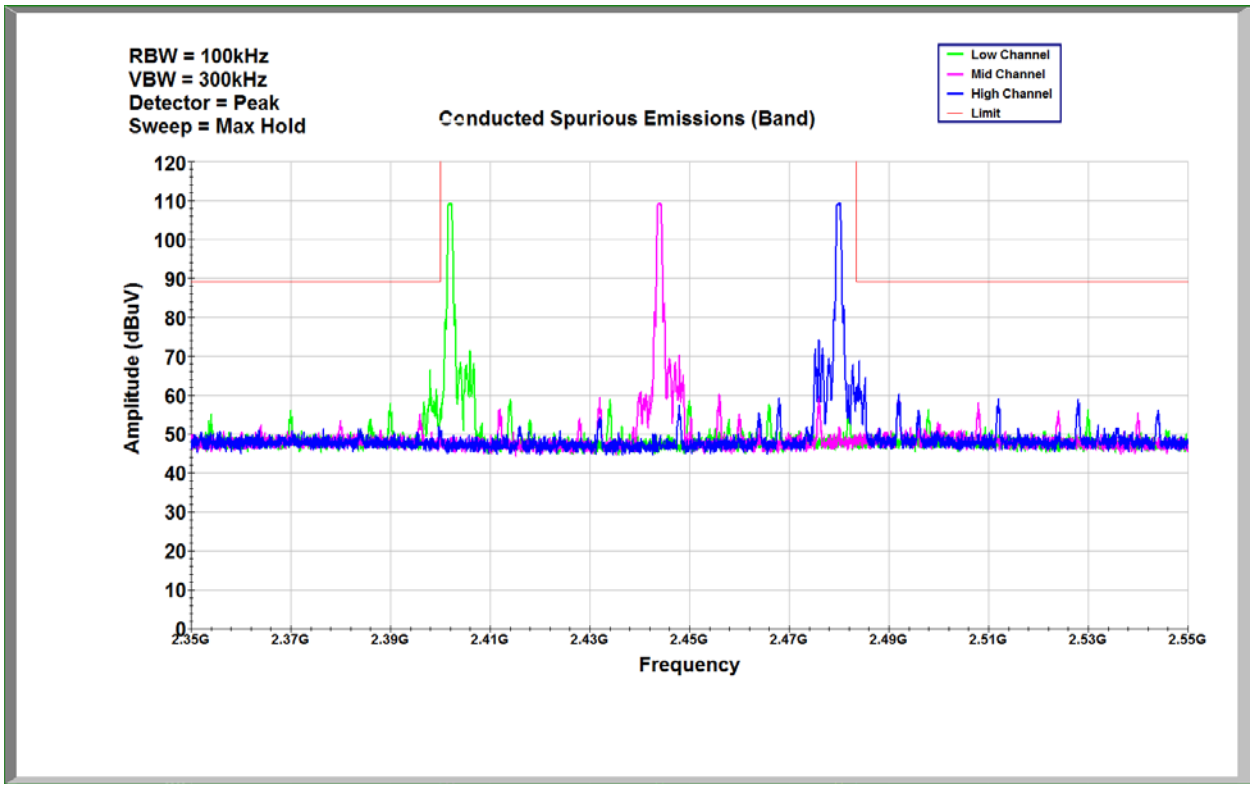
Conducted Spurious Emissions at Antenna Port Channel 19



Conducted Spurious Emissions at Antenna Port Channel 39



Band Edge Plot



9 Power Spectral Density

9.1 Test Limits

§ 15.247(e): 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.

9.2 Test Procedure

ANSI C63.10: 2013.

9.3 Test Equipment Used

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

9.4 Test Results

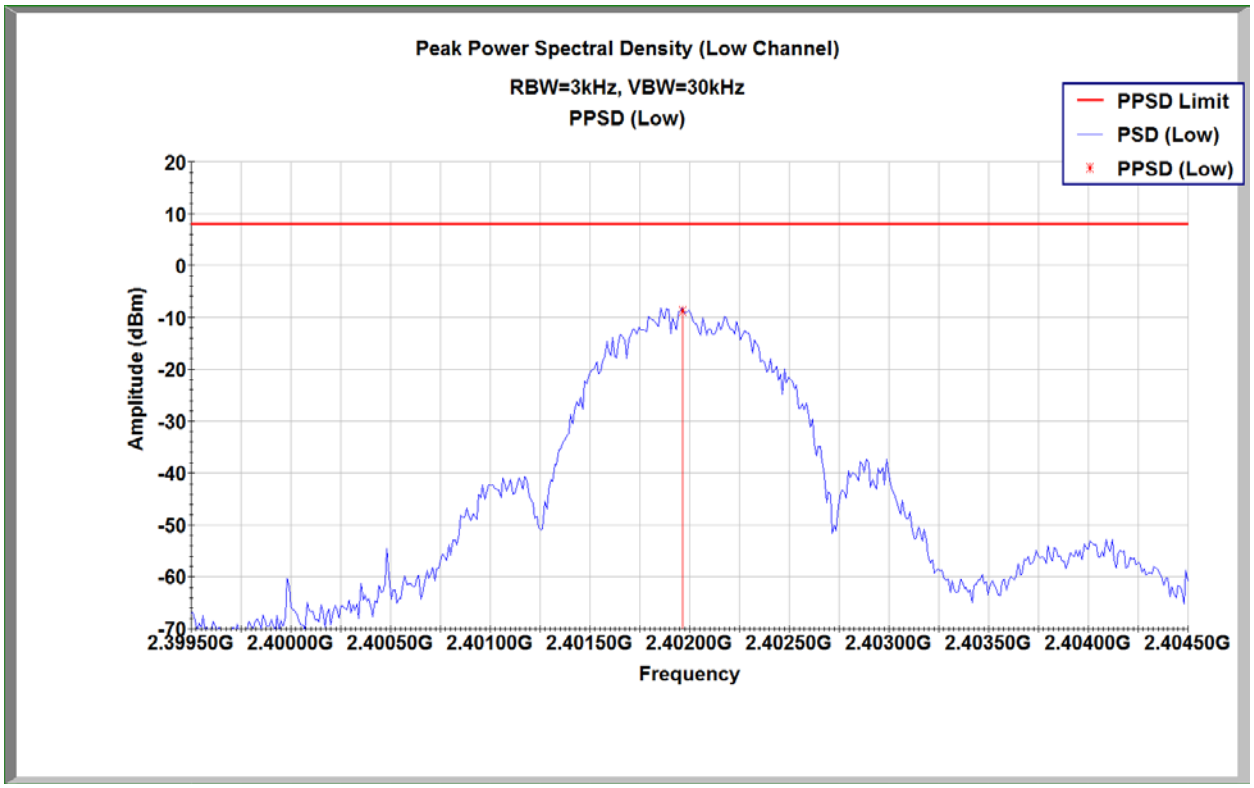
The device was found to be **compliant**. The peak power spectral density was less than the limit.

9.5 Test Conditions

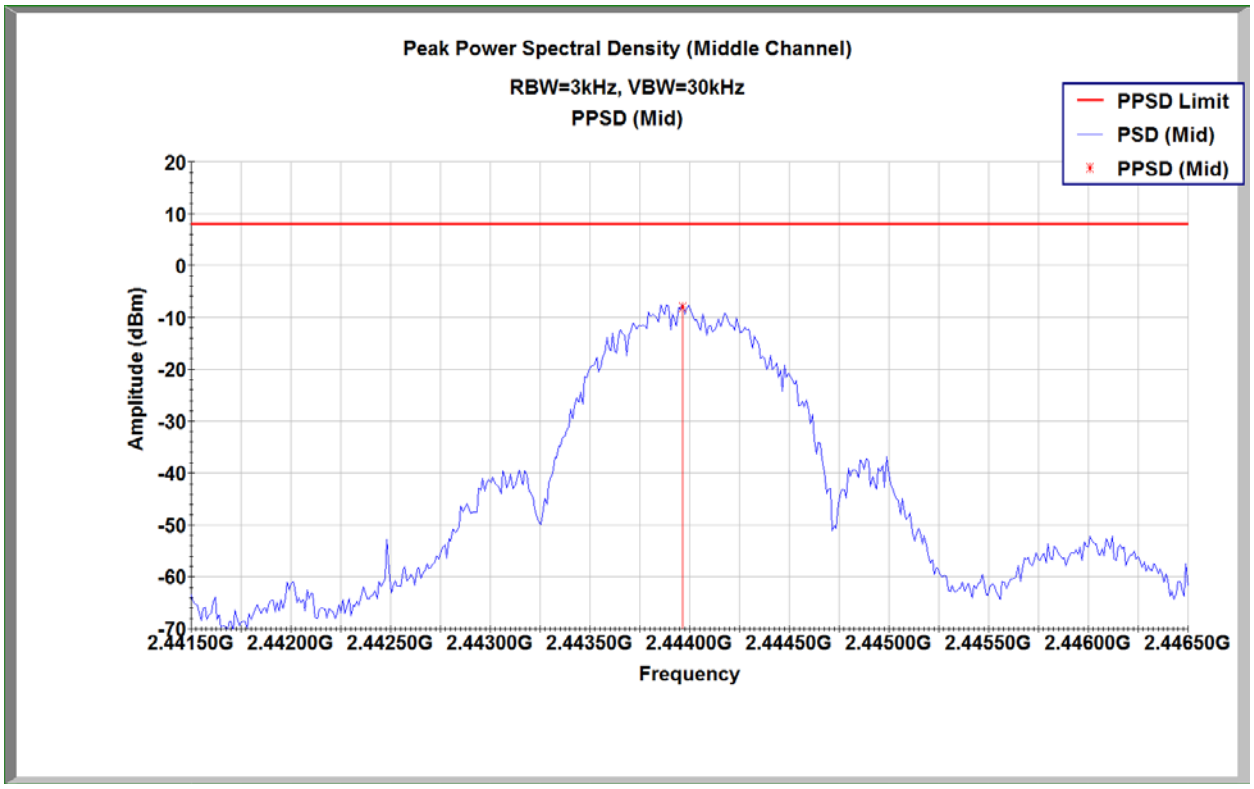
Test Personnel:	Brian Lackey	Test Date:	11/10/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Ambient Temperature:	22.1C
Input Voltage:	Battery	Relative Humidity:	35.2%
		Atmospheric Pressure:	992.0mbar

9.6 Test Data

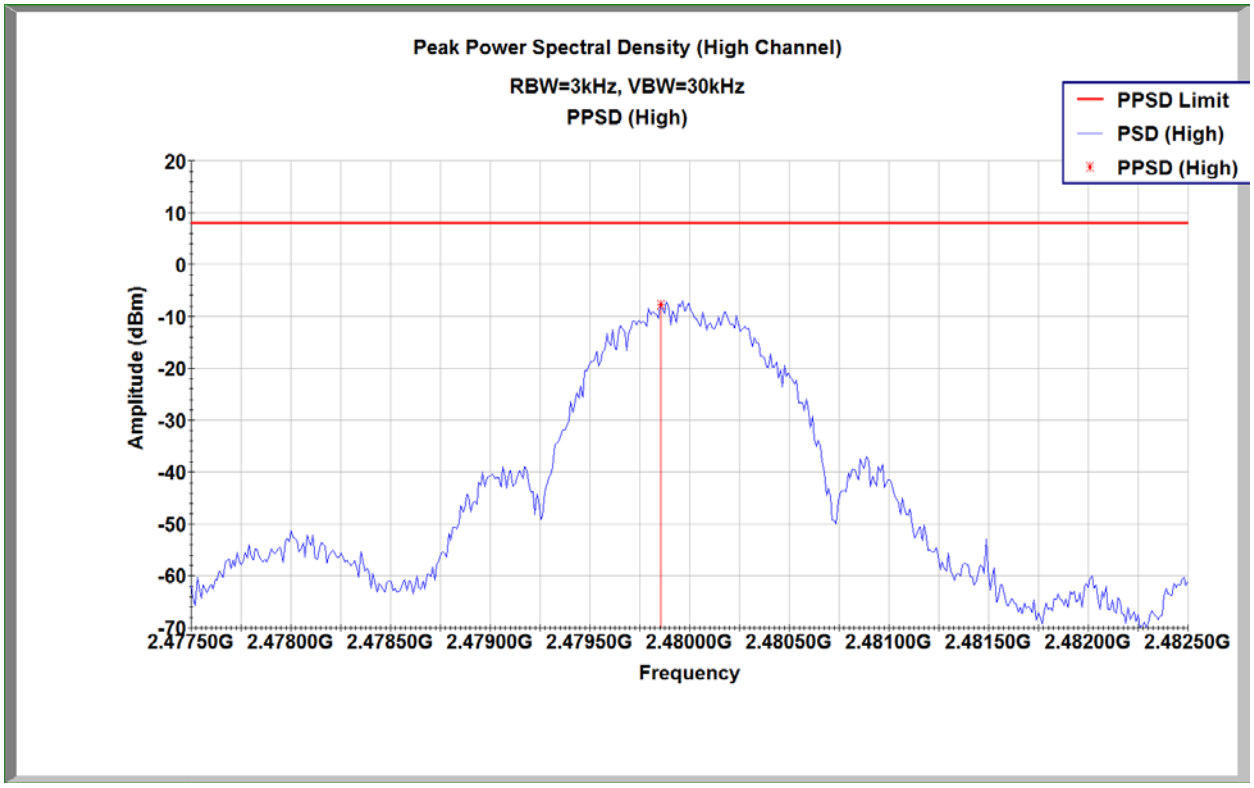
Mode	Channel Number	Frequency (MHz)	PSD in 3kHz BW (dBm)	Limit (dBm)	Margin (dBm)	Result
BLE	0	2402	-8.771	8	16.771	Pass
BLE	19	2440	-8.096	8	16.096	Pass
BLE	39	2480	-7.700	8	15.700	Pass



Power Spectral Density – Channel 0



Power Spectral Density – Channel 19



Power Spectral Density – Channel 39

10 Radiated Spurious Emissions (Transmitter)

10.1 Test Limits

§ 15.247(d): 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)).

Part 15.205(a): Restricted Bands of Operations

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Part 15.209(a): Field Strength Limits for Restricted Bands of Operation

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

10.2 Test Procedure

ANSI C63.10: 2013.

10.3 Example of Field Strength Calculation Method

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBμV/m
RA = Receiver Amplitude in dBμV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBμV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBμV/m
Level in μV/m = Common Antilogarithm [(38.78 dBμV/m)/20] = 86.89 μV/m

10.4 Test Equipment Used

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018
Preamplifier	122005	Rohde&Schwarz	TS-PR18	11/17/2016	11/17/2017
Biconnilog Antenna	9610-1102	ETS	3142	2/25/2016	2/25/2018
Horn Antenna (1 GHz – 18GHz)	154521	ETS	3117	11/14/2016	11/14/2017
Horn Antenna (18 GHz – 40GHz)	3779	ETS	3116c	6/5/2017	6/5/2018
Preamplifier	3921	Rohde&Schwarz	TS-PR40	12/1/2017	12/1/2018
System Controller	121701-1	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/17/2016	11/17/2017
3m Cable Preamp→Chamber	2588			11/17/2016	11/17/2017
3m Cable Chamber→Control Room	2593			11/17/2016	11/17/2017
3m Cable Control Room→Receiver	2592			11/17/2016	11/17/2017
10m Cable Antenna→Preamp	3339			11/17/2016	11/17/2017
10m Cable Preamp→Chamber	3172			11/17/2016	11/17/2017
10m Cable Chamber→Control Room	2590			11/17/2016	11/17/2017
10m Cable Control Room→Receiver	2589			11/17/2016	11/17/2017

10.5 Test Results

The device was found to be **compliant**. All spurious emissions were attenuated by at least 20dB below the level of the fundamental as required by Part 15.247(d). Additionally, all emissions falling within restricted bands of operation and at the band edges were found to be below the limit specified in Part 15.209(a). The spurious emissions listed in the following table are the worst case emissions.

10.6 Test Conditions

Test Personnel:	Brian Lackey	Test Date:	11/10/2017
Supervising/Reviewing Engineer:			
(Where Applicable)	NA	Ambient Temperature:	21.4C
Input Voltage:	Battery	Relative Humidity:	26.6%
		Atmospheric Pressure:	998.0mbar

10.7 Test Data

Worst Case Spurious Measurements

*Emissions were investigated with the test sample in its worst operating position across 3 orthogonal axes.

Bluetooth Channel 0 (2402MHz) Spurious Emissions

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4803.878500	49.20	74.00	24.80	1000.000	162.0	H	0.0	7.5
7200.708000	43.92	74.00	30.08	1000.000	154.0	H	0.0	10.4
9611.943500	47.08	74.00	26.92	1000.000	144.0	V	22.0	13.6
12011.272000	49.90	74.00	24.10	1000.000	129.0	V	38.0	17.4
14417.293500	49.01	74.00	24.99	1000.000	176.0	V	34.0	17.0
16808.195000	53.65	74.00	20.35	1000.000	166.0	V	50.0	21.5

Average

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4803.878500	39.38	54.00	14.62	1000.000	162.0	H	0.0	7.5
7200.708000	31.52	54.00	22.48	1000.000	154.0	H	0.0	10.4
9611.943500	34.02	54.00	19.98	1000.000	144.0	V	22.0	13.6
12011.272000	36.99	54.00	17.01	1000.000	129.0	V	38.0	17.4
14417.293500	36.31	54.00	17.69	1000.000	176.0	V	34.0	17.0
16808.195000	40.79	54.00	13.21	1000.000	166.0	V	50.0	21.5

Bluetooth Channel 19 (2440MHz) Spurious Emissions

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4887.538000	48.34	74.00	25.66	1000.000	186.0	H	0.0	7.4
7332.658500	48.30	74.00	25.70	1000.000	189.0	H	25.0	10.5
9775.961000	46.21	74.00	27.79	1000.000	165.0	V	50.0	13.8
12221.135500	49.62	74.00	24.38	1000.000	132.0	V	37.0	17.2
14670.412500	49.67	74.00	24.33	1000.000	176.0	H	50.0	17.4
17105.282000	51.99	74.00	22.01	1000.000	200.0	V	50.0	21.2

Average

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4887.538000	36.94	54.00	17.06	1000.000	186.0	H	0.0	7.4
7332.658500	35.21	54.00	18.79	1000.000	189.0	H	25.0	10.5
9775.961000	33.69	54.00	20.31	1000.000	165.0	V	50.0	13.8
12221.135500	36.98	54.00	17.02	1000.000	132.0	V	37.0	17.2
14670.412500	36.74	54.00	17.26	1000.000	176.0	H	50.0	17.4
17105.282000	39.59	54.00	14.41	1000.000	200.0	V	50.0	21.2

Bluetooth Channel 39 (2480MHz) Spurious Emissions

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4959.461500	49.60	74.00	24.40	1000.000	161.0	V	24.0	7.2
7440.706500	51.99	74.00	22.01	1000.000	176.0	H	36.0	10.9
9926.732000	47.12	74.00	26.88	1000.000	135.0	H	38.0	14.0
12401.102500	49.11	74.00	24.89	1000.000	131.0	V	17.0	16.9
14880.955500	50.03	74.00	23.97	1000.000	200.0	V	50.0	18.2
17360.496500	52.71	74.00	21.29	1000.000	165.0	V	26.0	20.6

Average

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4959.461500	38.28	54.00	15.72	1000.000	161.0	V	24.0	7.2
7440.706500	39.61	54.00	14.39	1000.000	176.0	H	36.0	10.9
9926.732000	34.13	54.00	19.87	1000.000	135.0	H	38.0	14.0
12401.102500	36.75	54.00	17.25	1000.000	131.0	V	17.0	16.9
14880.955500	37.35	54.00	16.65	1000.000	200.0	V	50.0	18.2
17360.496500	39.83	54.00	14.17	1000.000	165.0	V	26.0	20.6

Bluetooth Low Band Edge, Transmitting on Channel 0 (2402MHz)

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	51.78	74.00	22.22	1000.000	397.0	H	120.0	37.7

Average

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	41.51	54.00	12.49	1000.000	397.0	H	120.0	37.7

Bluetooth Low Band Edge, Frequency Hopping Enabled

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	52.43	74.00	21.57	1000.000	226.0	H	256.0	37.7

Average

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	41.73	54.00	12.27	1000.000	226.0	H	256.0	37.7

Bluetooth High Band Edge, Transmitting on Channel 39 (2480MHz)

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	52.67	74.00	21.33	1000.000	327.0	H	144.0	37.8

Average

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	42.79	54.00	11.21	1000.000	327.0	H	144.0	37.8

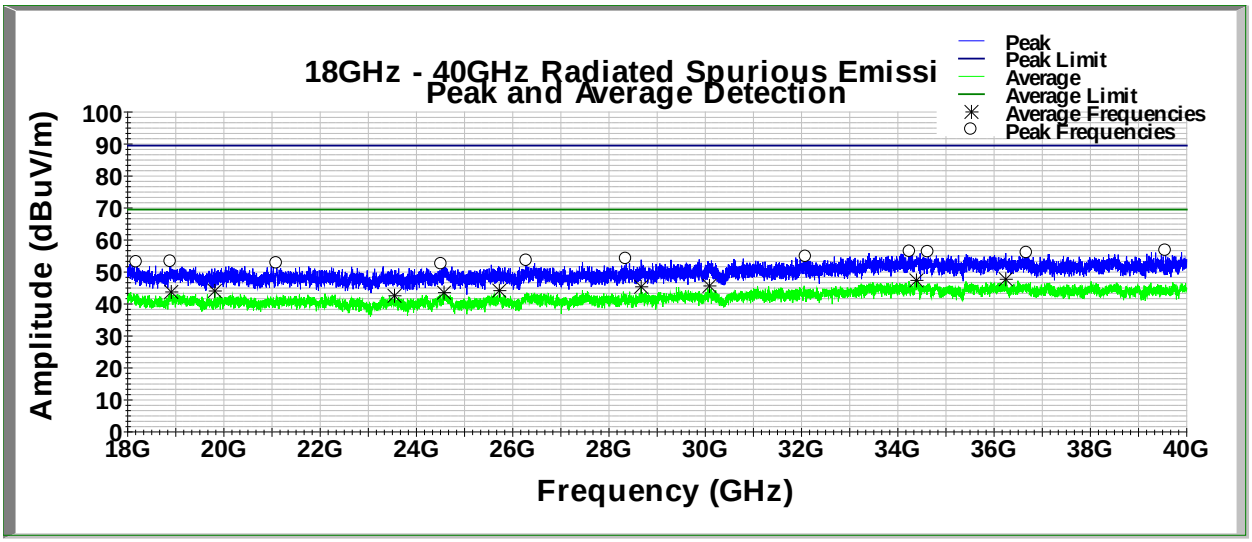
Bluetooth High Band Edge, Frequency Hopping Enabled

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	54.14	74.00	19.86	1000.000	410.0	H	273.0	37.8

Average

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	42.45	54.00	11.55	1000.000	410.0	H	273.0	37.8



18-40GHz spurious emissions data, representative of the worst case of all transmission modes measured in 3 orthogonal axes.

11 Radiated Spurious Emissions (Receiver)

11.1 Test Limits

§ 15.109: Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBuV/m)
30–88	100	40
88–216	150	43.5
216–960	200	46
Above 960	500	54

These limits are identical to those in RSS-GEN

11.2 Test Procedure

ANSI C63.4: 2014

11.3 Example of Field Strength Calculation Method

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBμV/m
RA = Receiver Amplitude in dBμV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBμV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBμV/m
Level in μV/m = Common Antilogarithm [(38.78 dBμV/m)/20] = 86.89 μV/m

11.4 Test Equipment Used

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018
Preamplifier	122005	Rohde&Schwarz	TS-PR18	11/17/2016	11/17/2017
Biconnilog Antenna	9610-1102	ETS	3142	2/25/2016	2/25/2018
Horn Antenna	154521	ETS	3117	11/14/2016	11/14/2017
System Controller	121701-1	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/17/2016	11/17/2017
3m Cable Preamp→Chamber	2588			11/17/2016	11/17/2017
3m Cable Chamber→Control Room	2593			11/17/2016	11/17/2017
3m Cable Control Room→Receiver	2592			11/17/2016	11/17/2017
10m Cable Antenna→Preamp	3339			11/17/2016	11/17/2017
10m Cable Preamp→Chamber	3172			11/17/2016	11/17/2017
10m Cable Chamber→Control Room	2590			11/17/2016	11/17/2017
10m Cable Control Room→Receiver	2589			11/17/2016	11/17/2017

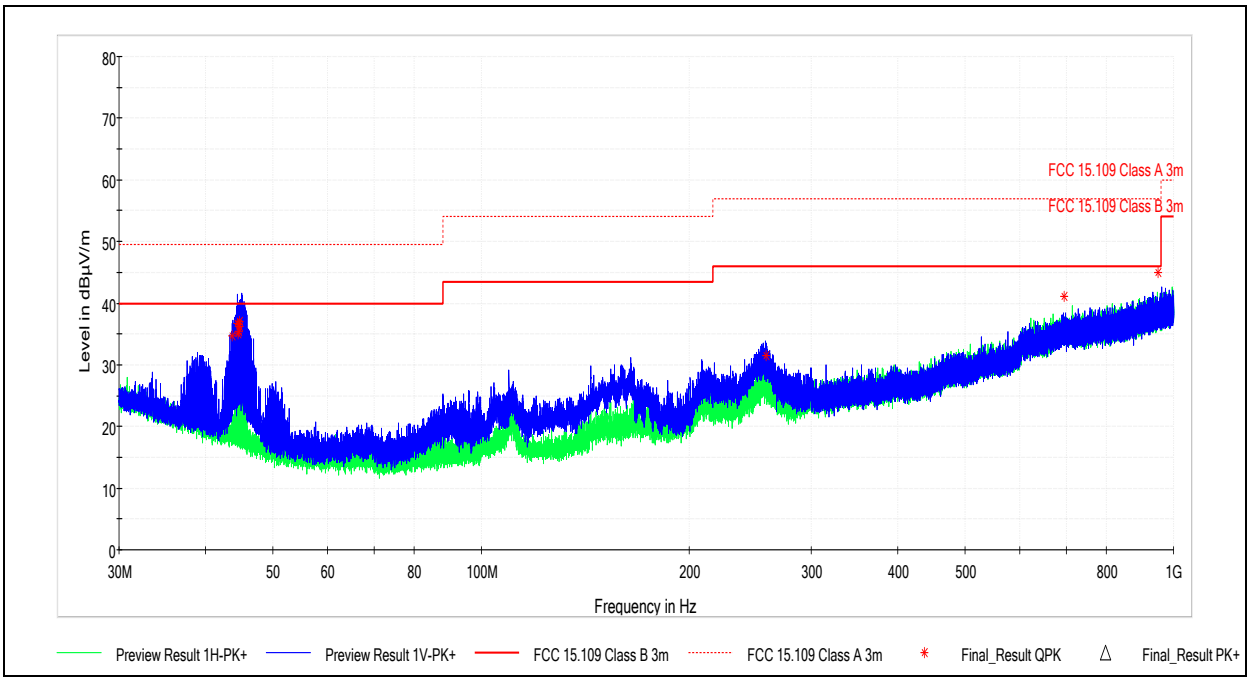
11.5 Test Results

All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.109 for a class B digital device and RSS-GEN Section 6.1. All peak detected emissions were at least 15dB below the limit.

11.6 Test Conditions

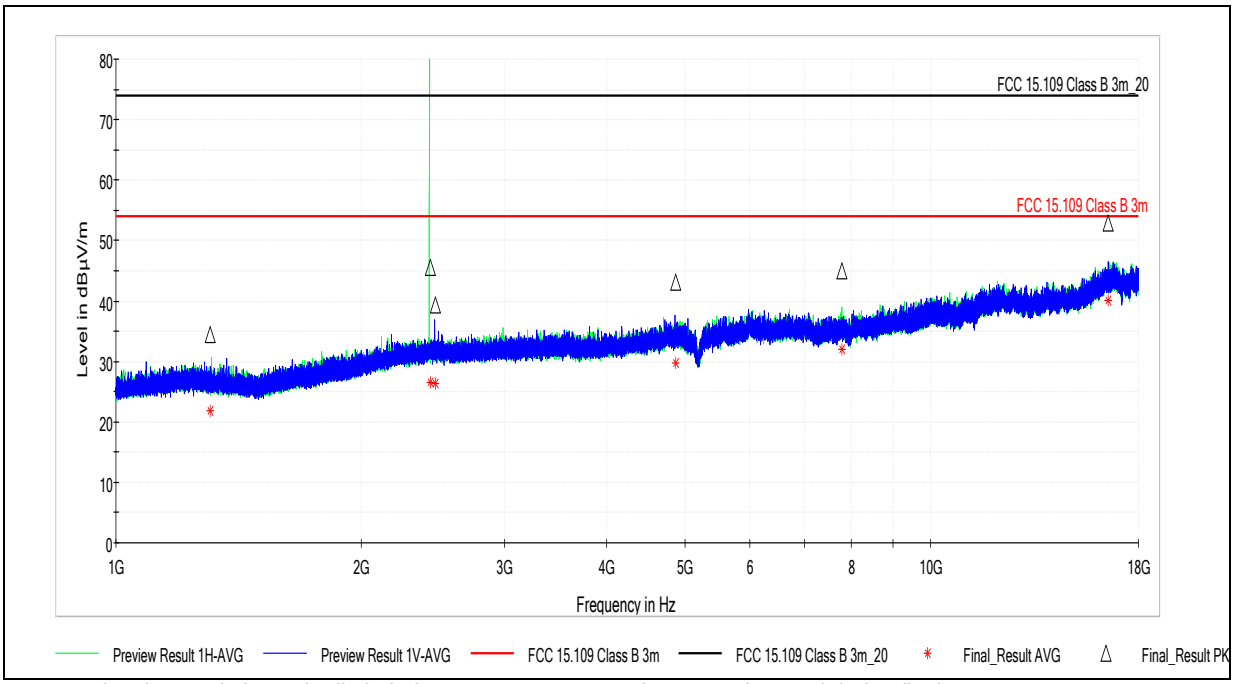
Test Personnel: Brian Lackey
Test Date: 11/13/2017
Supervising/Reviewing Engineer:
(Where Applicable) NA
Ambient Temperature: 20.6C
Input Voltage: Battery
Relative Humidity: 36.1%
Atmospheric Pressure: 988.8mbar

11.7 Test Data



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
43.732000	34.73	40.00	5.27	120.000	105.7	V	320.0	18.7
44.501000	36.76	40.00	3.24	120.000	109.7	V	292.0	18.4
44.604000	34.99	40.00	5.01	120.000	110.5	V	228.0	18.4
44.696000	35.42	40.00	4.58	120.000	114.7	V	37.0	18.3
44.730000	36.52	40.00	3.48	120.000	99.6	V	290.0	18.3
44.774000	36.99	40.00	3.01	120.000	105.4	V	238.0	18.3
44.784000	36.23	40.00	3.77	120.000	114.8	V	313.0	18.3
258.100000	31.45	46.02	14.57	120.000	142.6	V	154.0	22.0
695.320000	41.10	46.02	4.92	120.000	106.0	V	0.0	33.4
949.520000	45.03	46.02	0.99	120.000	109.3	H	192.0	36.2



Note: Peaks observed above the limit during prescan were transients not observed during final measurement.

Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1304.677500	34.48	74.00	39.52	1000.000	134.0	H	50.0	-1.2
2430.875000	45.53	74.00	28.47	1000.000	180.0	H	0.0	3.9
2466.402500	39.38	74.00	34.62	1000.000	200.0	V	50.0	3.9
4867.466000	43.12	74.00	30.88	1000.000	170.0	H	28.0	7.4
7785.408500	44.96	74.00	29.04	1000.000	184.0	H	38.0	11.1
16538.475000	52.81	74.00	21.19	1000.000	155.0	H	23.0	21.0

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1304.677500	21.79	54.00	32.21	1000.000	134.0	H	50.0	-1.2
2430.875000	26.46	54.00	27.54	1000.000	180.0	H	0.0	3.9
2466.402500	26.44	54.00	27.56	1000.000	200.0	V	50.0	3.9
4867.466000	29.82	54.00	24.18	1000.000	170.0	H	28.0	7.4
7785.408500	31.91	54.00	22.09	1000.000	184.0	H	38.0	11.1
16538.475000	40.17	54.00	13.83	1000.000	155.0	H	23.0	21.0

12 Antenna Requirement per FCC Part 15.203

12.1 Test Limits

§ 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

12.2 Test Results

The sample tested met the antenna requirement. The antenna used was internal to the sample and permanently attached to the PCB.

12.3 Test Conditions

Test Personnel:	Brian Lackey	Test Date:	11/13/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Ambient Temperature:	20.6C
Input Voltage:	Battery	Relative Humidity:	36.1%
		Atmospheric Pressure:	988.8mbar

13 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of k = 2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty	Notes
Radiated emissions, 30 to 1000 MHz	±3.9dB	
Radiated emissions, 1 to 18 GHz	±4.2dB	
Radiated emissions, 18 to 40 GHz	±4.3dB	
Power Port Conducted emissions, 150kHz to 30 MHz	±2.8dB	

14 Revision History

Revision Level	Date	Report Number	Notes
0	11/27/2017	103291273LEX-016	Original Issue
1	5/9/2018	103291273LEX-016.1	Added 18-40GHz radiated emissions data.
2	5/17/2018	103291273LEX-016.2	Removed FHSS data. Added 6dB Bandwidth.