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Des-Case Corporation TEST REPORT

SCOPE OF WORK
EMC TESTING – ISOLOGIC MODULE

REPORT NUMBER
103397344LEX-003.1

ISSUE DATE	**[REVISED DATE]**
3/16/2018	3/22/2018

PAGES
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DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 103397344LEX-003.1
Project Number: G103397344

Report Issue Date: 3/22/2018

Model(s) Tested: IsoLogic Module
IsoLogic VentGuard Cartridge Size 1 (VG-1)
IsoLogic VentGuard Cartridge Size 4 (VG-4)

Standards: Title 47 CFR Part 15.247
RSS-247 Issue 2
RSS-Gen Issue 4

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

Client:
Des-Case Corporation
675 N Main Street
Coodlettsville, TN 37072
USA

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 2.0 were performed on the product constructed as described in section 4.0. 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 **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
6	Receiver Spurious Emissions (ANSI C63.4: 2014)	Pass
7	Transmitter Spurious Emissions (FCC Part 15.247(d), RSS-247 Issue 2 § 5.5)	Pass
8	Output Power (FCC Part 15.247(b)(1), RSS-247 Issue 2 § 5.4(b))	Pass
9	Occupied Bandwidth (FCC Part 15.247, RSS-247 Issue 2 § 5.2(a))	Pass
10	Channel Separation (FCC Part 15.247(a)(1), RSS-247 Issue 2 § 5.1(b))	Pass
11	Number of Hopping Channels (FCC Part 15.247(a)(1)(iii), RSS-247 Issue 2 § 5.1(d))	Pass
12	Time of Occupancy (FCC Part 15.247(a)(1)(iii), RSS-247 Issue 2 § 5.1(d))	Pass
13	Power Spectral Density (FCC Part 15.247(e), RSS-247 Issue 2 § 5.2(b))	Pass
14	Antenna Requirement (FCC Part 15.203, RSS-Gen Issue 4 § 8.3)	Pass
-	Conducted Emissions (ANSI C63.4: 2014)	NA[1]

[1] Test it not applicable. Unit is battery powered and does not connect directly or indirectly to AC Mains.

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Des-Case Corporation
Address:	675 N Main Street Coodlettsville, TN 37072 USA
Contact:	Jay Cooper
Telephone:	+1 (615) 672-8800
Email:	Jay.cooper@descase.com
Manufacturer Information	
Manufacturer Name:	Des-Case Corporation
Manufacturer Address:	675 N Main Street Coodlettsville, TN 37072 USA

4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	IsoLogic Module
Model Number	10000000
Serial Number	10019523
Receive Date	2/12/2018
Test Start Date	2/12/2018
Test End Date	2/23/2018
Device Received Condition	Good
Test Sample Type	Production
Rated Voltage	4.5V (3x AAA batteries)
Rated Current	60mA max, 1mA average
Rated Frequency	-
Number of Phases	-
Software Used By EUT	None
Frequency Band(s)	RFID: 13.56MHz BLE: 2400-2483.5MHz
Modulation Type(s)	RFID: AM BLE: GFSK
Test Channel(s)	RFID: N/A BLE: 0 (2402MHz), 19 (2440MHz), 39 (2480MHz)
Maximum Antenna Gain (dBi)	RFID: 0.5 (from datasheet) BLE: 2.2 (from datasheet)
Maximum Output Power (dBm)	RFID: 17.4 (from datasheet) BLE: 4 (from datasheet)
Description of Equipment Under Test (provided by client)	
IsoLogic Module: Breather Module that houses the batteries and hardware (BLE and RFID) IsoLogic VentGuard Cartridge Size 1 (VG-1): Breather Filter Cartridge that houses hardware (sensor board and RFID coil) IsoLogic VentGuard Cartridge Size 4 (VG-4): Breather Filter Cartridge that houses hardware (sensor board and RFID coil)	

4.1 Variant Models:

There were no variant models covered by this evaluation.

5 System Setup and Method

5.1 Method:

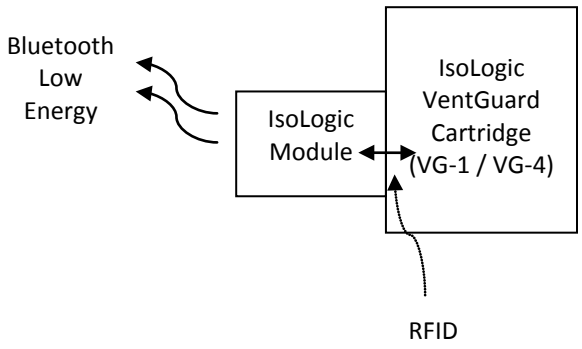
Configuration as required by ANSI C63.4: 2014 and ANSI C63.10:2013

No.	Descriptions of EUT Exercising
1	Transmitting a Bluetooth Low Energy (BLE) signal or low, middle, or high channel
2	Transmitting a Bluetooth Low Energy (BLE) signal with frequency hopping enabled

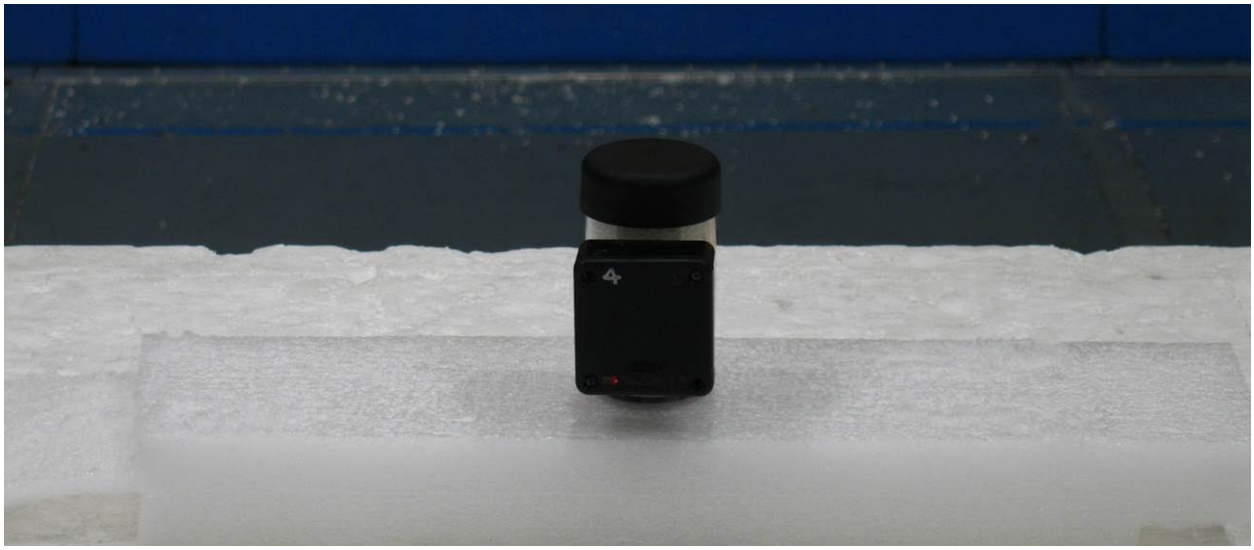
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination

Support Equipment			
Description	Manufacturer	Model Number	Serial Number

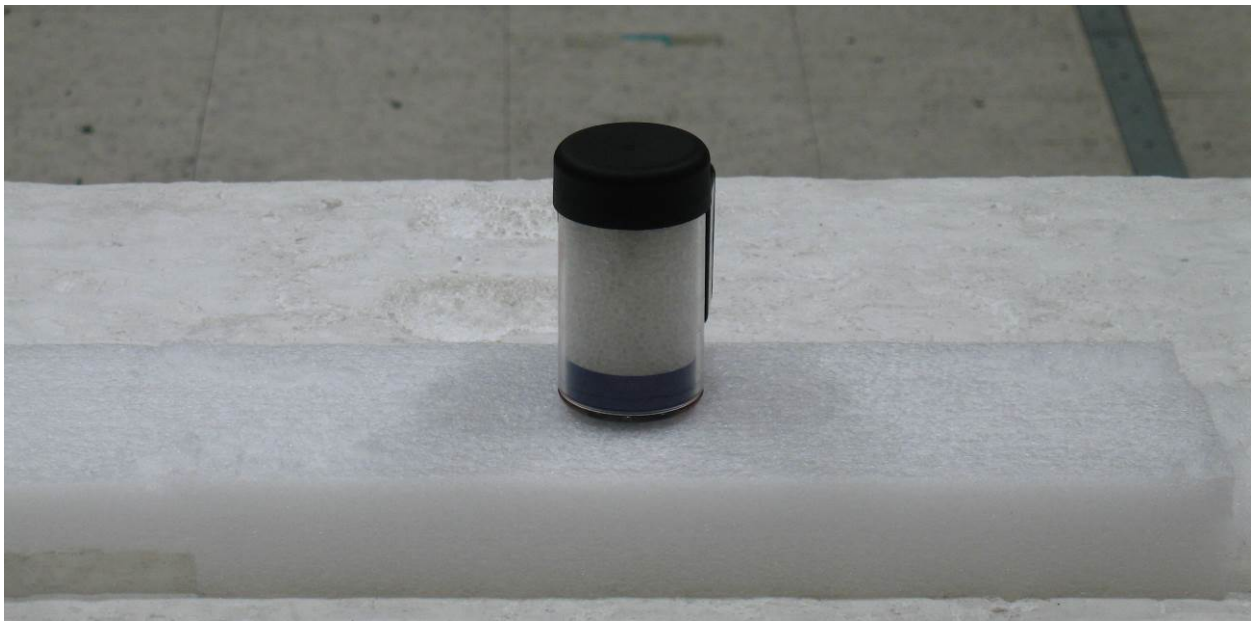
5.2 EUT Block Diagram:



5.3 EUT Photo (Front):



5.4 EUT Photo (Back):



6 Receiver Spurious Emissions

6.1 Test Method

Tests are performed in accordance with ANSI C63.4: 2014

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.9dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.0dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.7dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.7dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

6.2 Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG

Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

6.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde&Schwarz	ESU40	9/20/2017	9/20/2018
Bilog Antenna	3133	ETS Lindgren	3142C	4/6/2017	4/6/2018
Horn Antenna	3780	ETS Lindgren	3117	6/1/2017	6/1/2018
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/29/2017	11/29/2018
3m Cable Preamplifier	3918	TS-PR18	122005	11/29/2017	11/29/2018
3m Cable Preamp→Chamber	2588			11/29/2017	11/29/2018
3m Cable Chamber→Control Room	2593			11/29/2017	11/29/2018
3m Cable Control Room→Receiver	2592			11/29/2017	11/29/2018
10m Cable Antenna→Preamp	3339			11/29/2017	11/29/2018

6.4 Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

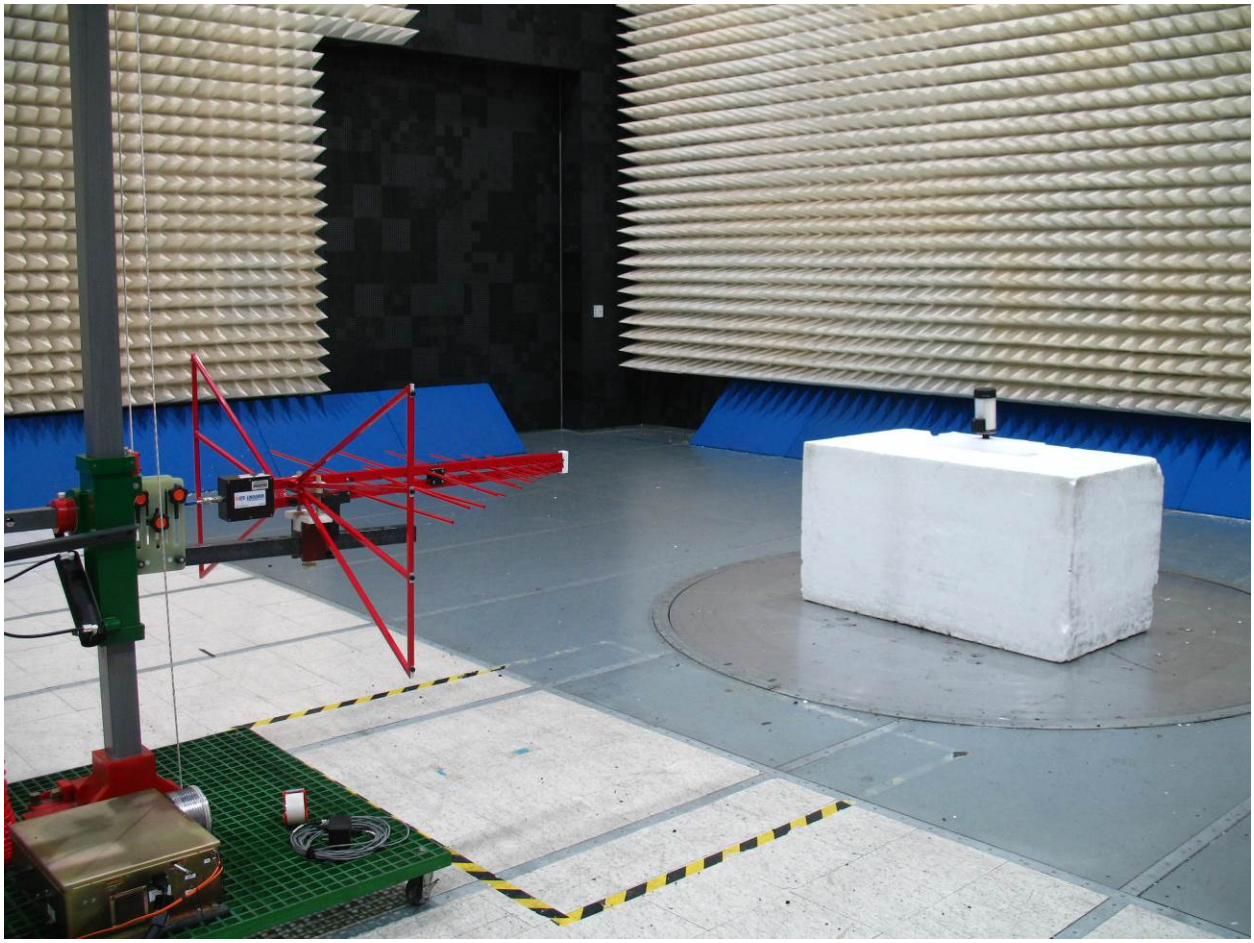
6.5 Test Results

The sample tested was found to be **compliant**.

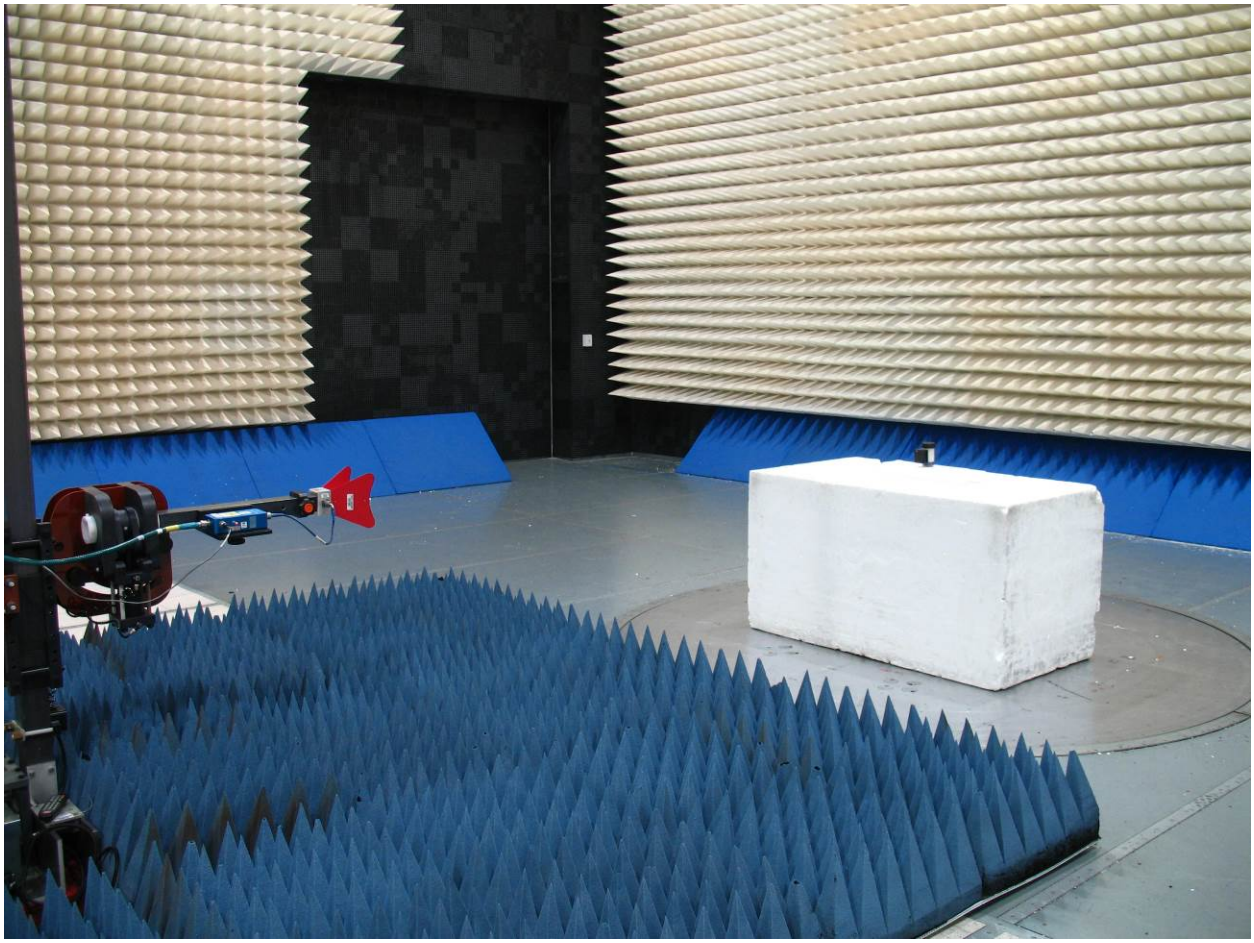
6.6 Test Conditions

Test Personnel:	B. Lackey	Test Date:	2/12/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	16.9C
Input Voltage:	Battery	Relative Humidity:	33.6%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

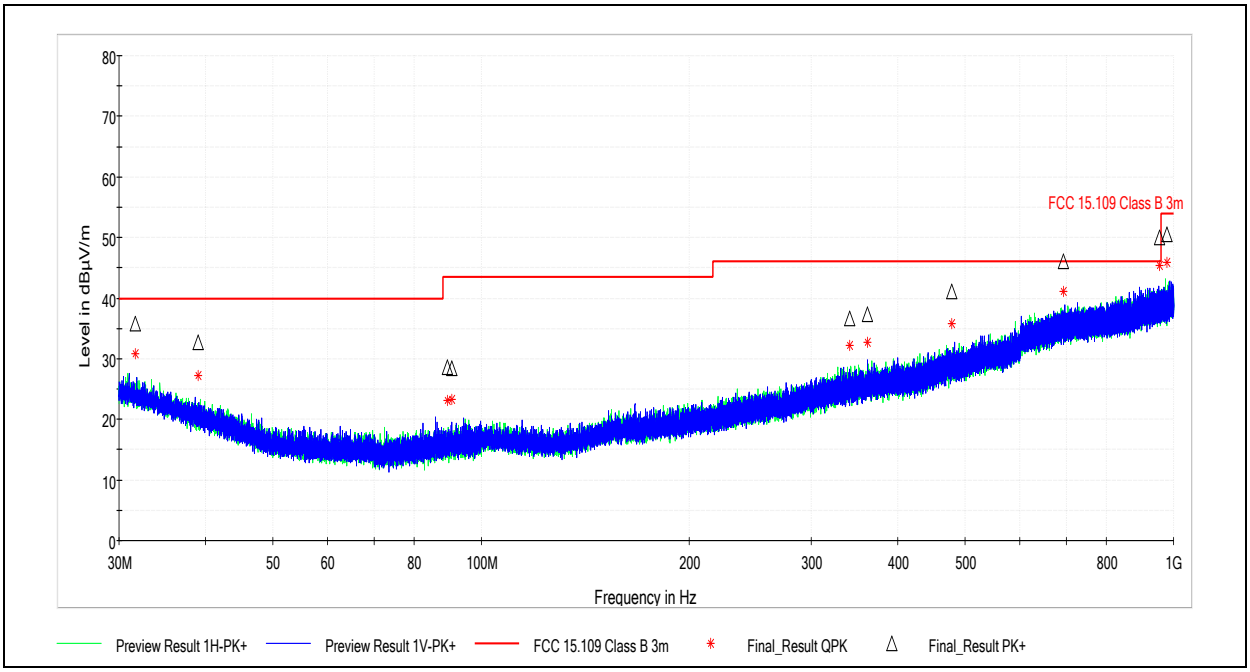
6.7 Setup Photographs: 30MHz – 1GHz



6.8 Setup Photographs: 1GHz – 18GHz



6.9 Test Data: 30MHz – 1GHz

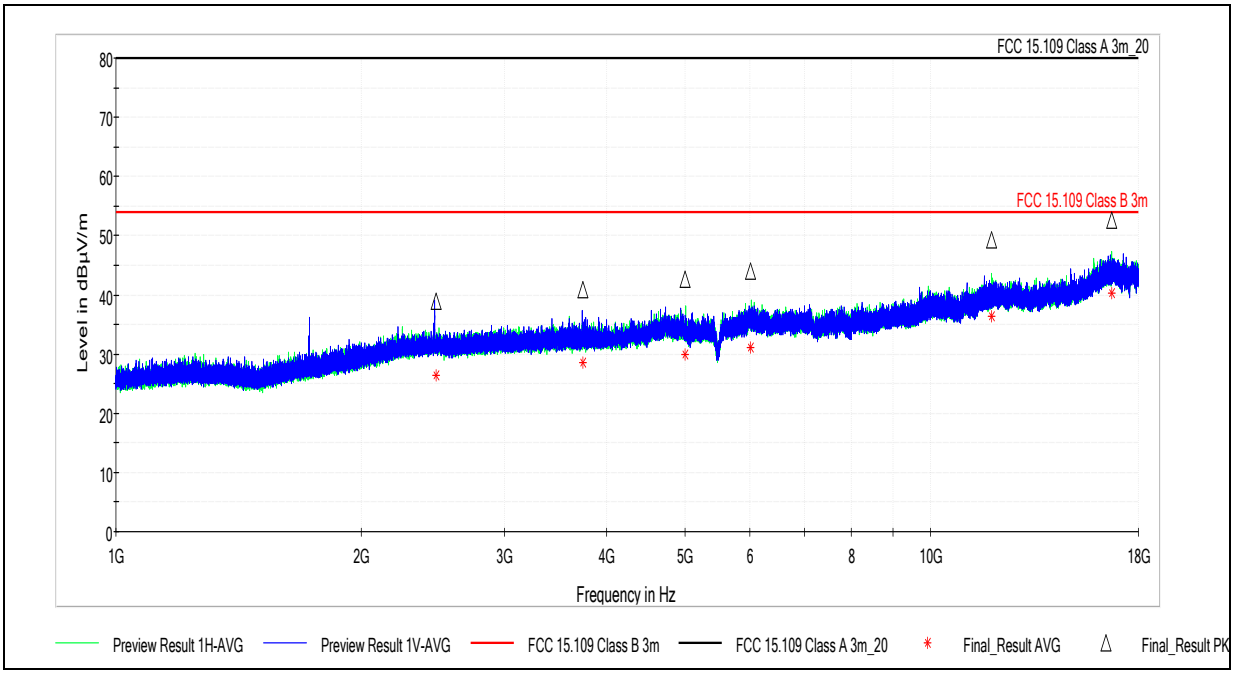


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.680000	35.87	60.00	24.13	120.000	140.0	H	120.0	23.9
39.071000	32.66	60.00	27.34	120.000	353.4	H	347.0	20.7
89.410000	28.64	63.52	34.88	120.000	397.1	V	239.0	16.7
90.775000	28.49	63.52	35.03	120.000	354.2	V	176.0	16.8
340.440000	36.68	66.02	29.34	120.000	377.9	H	339.0	25.1
361.520000	37.39	66.02	28.63	120.000	139.7	V	201.0	25.6
478.560000	41.07	66.02	24.95	120.000	283.2	V	230.0	28.6
694.050000	46.02	66.02	20.00	120.000	126.0	V	209.0	33.4
953.820000	49.95	66.02	16.07	120.000	309.5	V	295.0	36.4
978.340000	50.58	74.00	23.42	120.000	390.0	H	330.0	36.9

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.680000	30.76	40.00	9.24	120.000	140.0	H	120.0	23.9
39.071000	27.32	40.00	12.68	120.000	353.4	H	347.0	20.7
89.410000	23.06	43.52	20.46	120.000	397.1	V	239.0	16.7
90.775000	23.22	43.52	20.30	120.000	354.2	V	176.0	16.8
340.440000	32.20	46.02	13.82	120.000	377.9	H	339.0	25.1
361.520000	32.72	46.02	13.30	120.000	139.7	V	201.0	25.6
478.560000	35.75	46.02	10.27	120.000	283.2	V	230.0	28.6
694.050000	41.12	46.02	4.90	120.000	126.0	V	209.0	33.4
953.820000	45.41	46.02	0.61	120.000	309.5	V	295.0	36.4
978.340000	45.91	54.00	8.09	120.000	390.0	H	330.0	36.9

Deviations, Additions, or Exclusions: None

6.10 Test Data: 1GHz – 18GHz



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2473.722000	38.92	80.00	41.08	1000.000	178.0	V	-10.0	3.9
3743.680500	40.81	80.00	39.19	1000.000	184.0	V	37.0	6.0
5000.325000	42.57	80.00	37.43	1000.000	173.0	V	37.0	7.1
6019.412000	44.04	80.00	35.96	1000.000	188.0	H	50.0	9.4
11889.739500	49.24	80.00	30.76	1000.000	125.0	V	24.0	17.0
16681.301500	52.56	80.00	27.44	1000.000	176.0	V	26.0	21.7

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2473.722000	26.46	54.00	27.54	1000.000	178.0	V	-10.0	3.9
3743.680500	28.54	54.00	25.46	1000.000	184.0	V	37.0	6.0
5000.325000	29.97	54.00	24.03	1000.000	173.0	V	37.0	7.1
6019.412000	31.13	54.00	22.87	1000.000	188.0	H	50.0	9.4
11889.739500	36.39	54.00	17.61	1000.000	125.0	V	24.0	17.0
16681.301500	40.38	54.00	13.62	1000.000	176.0	V	26.0	21.7

Deviations, Additions, or Exclusions: None

7 Transmitter Spurious Emissions

7.1 Test Limits

FCC Part 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)).

RSS-247 Issue 2 § 5.5:

> In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

7.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde&Schwarz	ESU40	9/20/2017	9/20/2018
Bilog Antenna	3133	ETS Lindgren	3142C	4/6/2017	4/6/2018
Horn Antenna	3780	ETS Lindgren	3117	6/1/2017	6/1/2018
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/29/2017	11/29/2018
3m Cable Preamplifier	3918	TS-PR18	122005	11/29/2017	11/29/2018
3m Cable Preamp→Chamber	2588			11/29/2017	11/29/2018
3m Cable Chamber→Control Room	2593			11/29/2017	11/29/2018
3m Cable Control Room→Receiver	2592			11/29/2017	11/29/2018
10m Cable Antenna→Preamp	3339			11/29/2017	11/29/2018

7.4 Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

7.5 Test Results

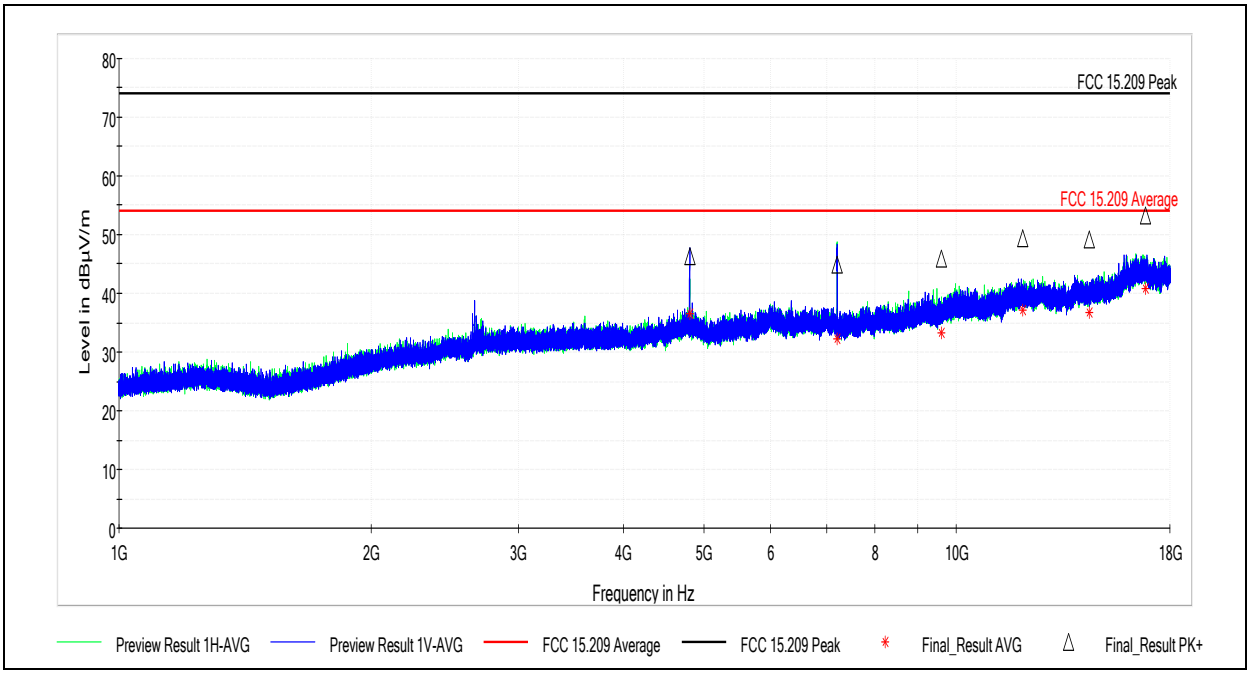
The sample tested was found to be **compliant**.

7.6 Test Conditions

Test Personnel:	B. Lackey	Test Date:	2/14/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	19.6C
Input Voltage:	Battery	Relative Humidity:	41.0%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	982.0mbar

7.7 Test Data

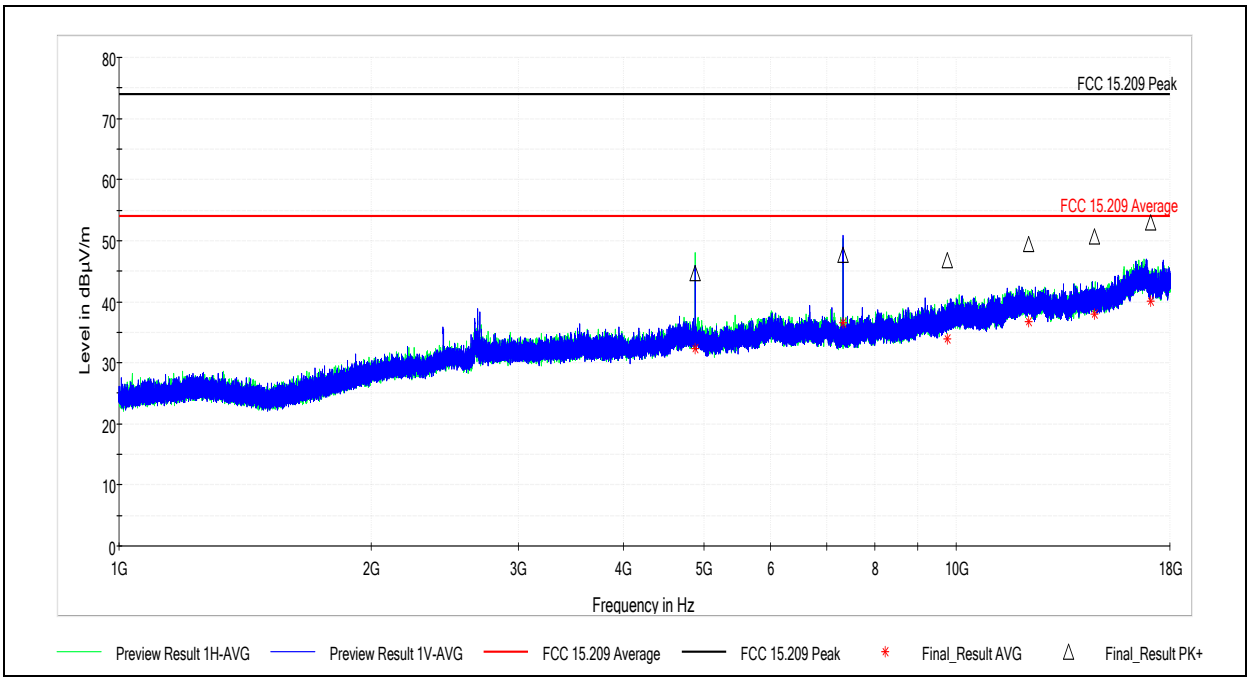
BLE Channel 0 (2402MHz) Spurious Emissions:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4804.000000	46.34	74.00	27.66	1000.000	302.0	V	124.0	7.8
7205.200000	44.87	74.00	29.13	1000.000	259.0	H	142.0	10.2
9606.800000	46.00	74.00	28.00	1000.000	378.0	H	135.0	13.5
12011.600000	49.37	74.00	24.63	1000.000	410.0	V	294.0	17.2
14410.000000	49.23	74.00	24.77	1000.000	410.0	H	298.0	17.2
16816.400000	53.35	74.00	20.65	1000.000	322.0	V	306.0	21.8

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4804.000000	36.51	54.00	17.49	1000.000	302.0	V	124.0	7.8
7205.200000	32.26	54.00	21.74	1000.000	259.0	H	142.0	10.2
9606.800000	33.31	54.00	20.69	1000.000	378.0	H	135.0	13.5
12011.600000	37.19	54.00	16.81	1000.000	410.0	V	294.0	17.2
14410.000000	36.70	54.00	17.30	1000.000	410.0	H	298.0	17.2
16816.400000	40.84	54.00	13.16	1000.000	322.0	V	306.0	21.8

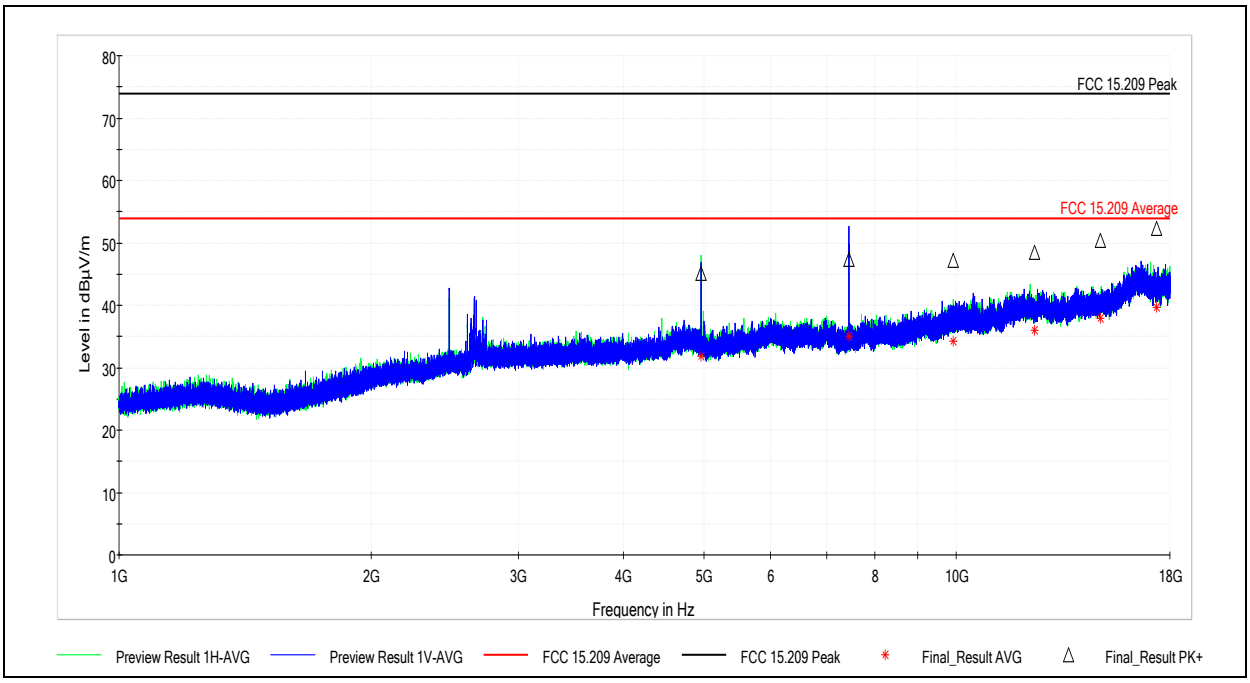
BLE Channel 19 (2440MHz) Spurious Emissions:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4880.000000	44.69	74.00	29.31	1000.000	216.0	V	104.0	7.4
7320.800000	47.65	74.00	26.35	1000.000	410.0	H	139.0	10.5
9758.800000	46.86	74.00	27.14	1000.000	391.0	H	306.0	13.7
12201.600000	49.53	74.00	24.47	1000.000	288.0	V	313.0	17.0
14642.000000	50.72	74.00	23.28	1000.000	350.0	V	326.0	17.4
17088.000000	52.98	74.00	21.02	1000.000	200.0	H	201.0	21.3

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4880.000000	32.23	54.00	21.77	1000.000	216.0	V	104.0	7.4
7320.800000	36.48	54.00	17.52	1000.000	410.0	H	139.0	10.5
9758.800000	33.96	54.00	20.04	1000.000	391.0	H	306.0	13.7
12201.600000	36.65	54.00	17.35	1000.000	288.0	V	313.0	17.0
14642.000000	37.96	54.00	16.04	1000.000	350.0	V	326.0	17.4
17088.000000	40.01	54.00	13.99	1000.000	200.0	H	201.0	21.3

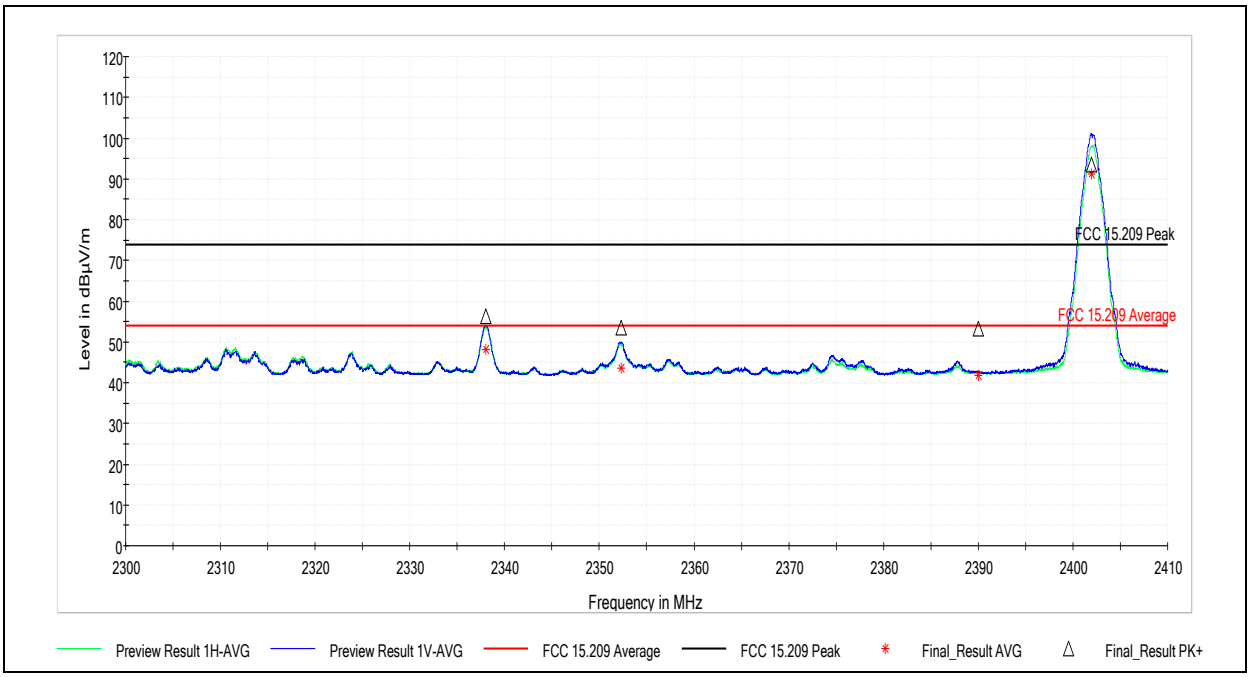
BLE Channel 39 (2480MHz) Spurious Emissions:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4960.000000	45.07	74.00	28.93	1000.000	374.0	H	121.0	7.2
7439.200000	47.36	74.00	26.64	1000.000	374.0	H	139.0	10.7
9918.800000	47.23	74.00	26.77	1000.000	410.0	H	320.0	14.0
12401.600000	48.48	74.00	25.52	1000.000	242.0	V	154.0	16.5
14882.000000	50.36	74.00	23.64	1000.000	371.0	V	320.0	18.3
17351.200000	52.40	74.00	21.60	1000.000	350.0	V	172.0	20.6

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4960.000000	31.91	54.00	22.09	1000.000	374.0	H	121.0	7.2
7439.200000	35.09	54.00	18.91	1000.000	374.0	H	139.0	10.7
9918.800000	34.21	54.00	19.79	1000.000	410.0	H	320.0	14.0
12401.600000	36.00	54.00	18.00	1000.000	242.0	V	154.0	16.5
14882.000000	37.90	54.00	16.10	1000.000	371.0	V	320.0	18.3
17351.200000	39.61	54.00	14.39	1000.000	350.0	V	172.0	20.6

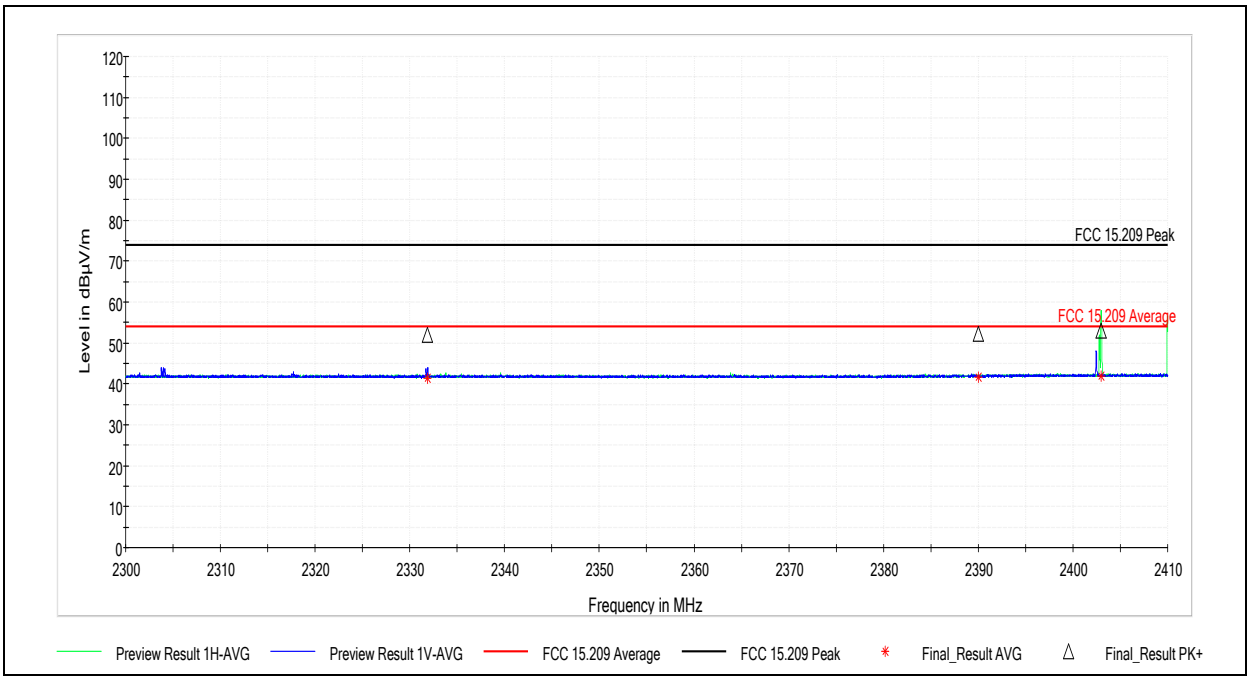
Emissions at the low band edge, hopping disabled:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2338.027000	56.25	74.00	17.75	1000.000	311.0	V	150.0	37.7
2352.294000	53.50	74.00	20.50	1000.000	315.0	H	217.0	37.7
2390.000000	53.14	74.00	20.86	1000.000	272.0	V	150.0	37.8

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2338.027000	48.07	54.00	5.93	1000.000	311.0	V	150.0	37.7
2352.294000	43.67	54.00	10.33	1000.000	315.0	H	217.0	37.7
2390.000000	41.77	54.00	12.23	1000.000	272.0	V	150.0	37.8

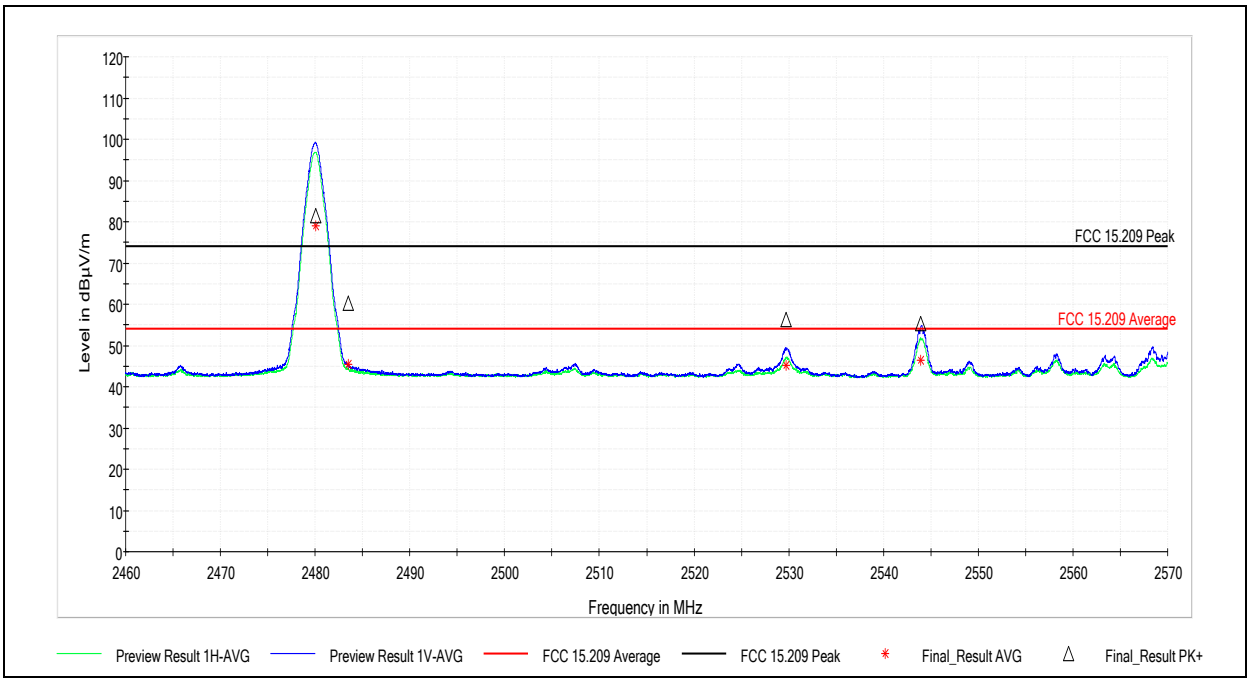
Emissions at the low band edge, hopping enabled:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2331.889000	52.10	74.00	21.90	1000.000	283.0	V	178.0	37.7
2390.000000	52.14	74.00	21.86	1000.000	378.0	H	235.0	37.8

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2331.889000	41.37	54.00	12.63	1000.000	283.0	V	178.0	37.7
2390.000000	41.63	54.00	12.37	1000.000	378.0	H	235.0	37.8

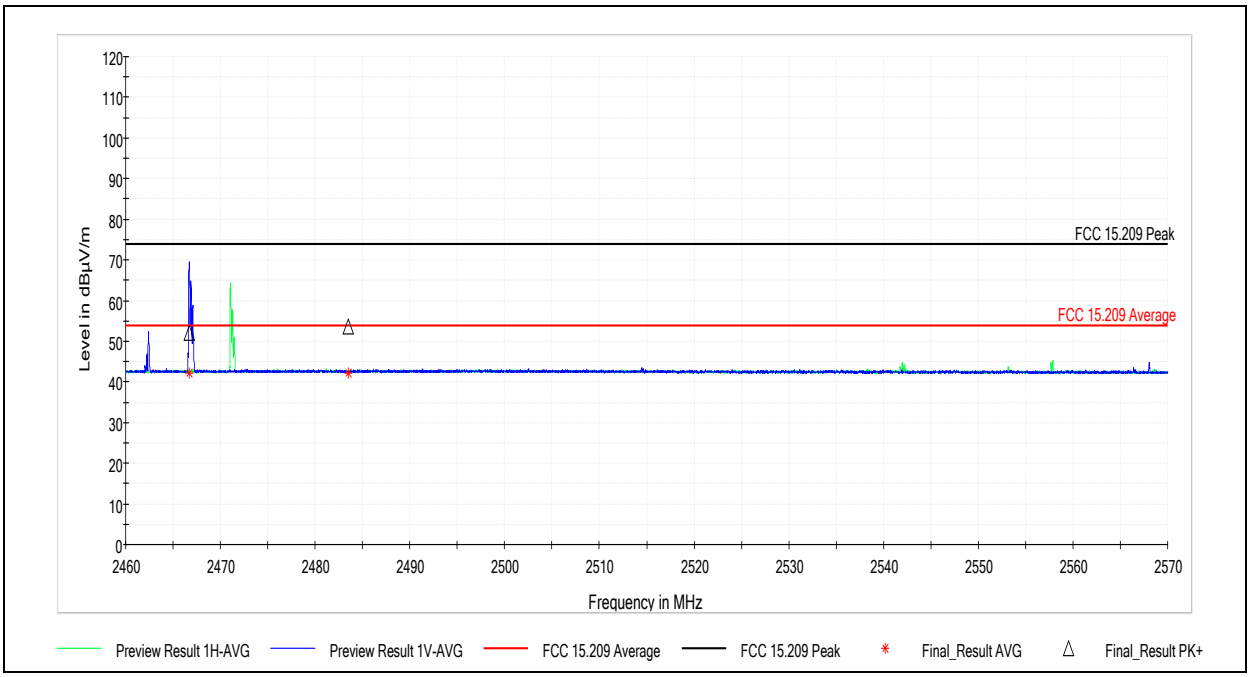
Emissions at the high band edge, hopping disabled:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	60.31	74.00	13.69	1000.000	369.0	H	0.0	37.8
2529.740000	56.23	74.00	17.77	1000.000	236.0	V	132.0	37.9
2543.952000	55.20	74.00	18.80	1000.000	246.0	V	124.0	37.9

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	45.42	54.00	8.58	1000.000	369.0	H	0.0	37.8
2529.740000	45.18	54.00	8.82	1000.000	236.0	V	132.0	37.9
2543.952000	46.48	54.00	7.52	1000.000	246.0	V	124.0	37.9

Emissions at the high band edge, hopping enabled:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	53.57	74.00	20.43	1000.000	237.0	H	228.0	37.8

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	42.20	54.00	11.80	1000.000	237.0	H	228.0	37.8

8 Output Power

8.1 Test Limits

FCC Part 15.247(b)(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.

RSS-247 Issue 2 § 5.4(b):

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

8.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

8.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde&Schwarz	ESU40	9/20/2017	9/20/2018
Bilog Antenna	3133	ETS Lindgren	3142C	4/6/2017	4/6/2018
Horn Antenna	3780	ETS Lindgren	3117	6/1/2017	6/1/2018
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/29/2017	11/29/2018
3m Cable Preamplifier	3918	TS-PR18	122005	11/29/2017	11/29/2018
3m Cable Preamp→Chamber	2588			11/29/2017	11/29/2018
3m Cable Chamber→Control Room	2593			11/29/2017	11/29/2018
3m Cable Control Room→Receiver	2592			11/29/2017	11/29/2018
10m Cable Antenna→Preamp	3339			11/29/2017	11/29/2018

8.4 Test Results

The device was found to be **compliant**. The output power was less than 0.125W.

8.5 Test Conditions

Test Personnel:	B. Lackey	Test Date:	2/23/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	25.3C
Input Voltage:	Battery	Relative Humidity:	46.7%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	988.8mbar

8.6 Test Data

Channel	Frequency (MHz)	Field Strength (dBuV/m)	EIRP (dBm)	Antenna Gain (dBi)	Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	100.1	4.84	2.2	2.64	1.837	125
19	2440	99.8	4.54	2.2	2.34	1.714	125
39	2480	99.1	3.84	2.2	1.64	1.459	125

Deviations, Additions, or Exclusions: Converted field strength to dBm EIRP per ANSI C63.26:2015 using a correction factor of $20 \cdot \log_{10}(D)$ - 104.8dB, where D is the measurement distance in meters. At a distance of 3 meters, this correction factor is -95.26dB.

9 Occupied Bandwidth

9.1 Test Limits

FCC Part 15.247(a)(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.

RSS-247 Issue 2 § 5.2(a):

The minimum 6 dB bandwidth shall be 500 kHz.

9.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

9.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	10/18/2017	10/18/2018

9.4 Test Results

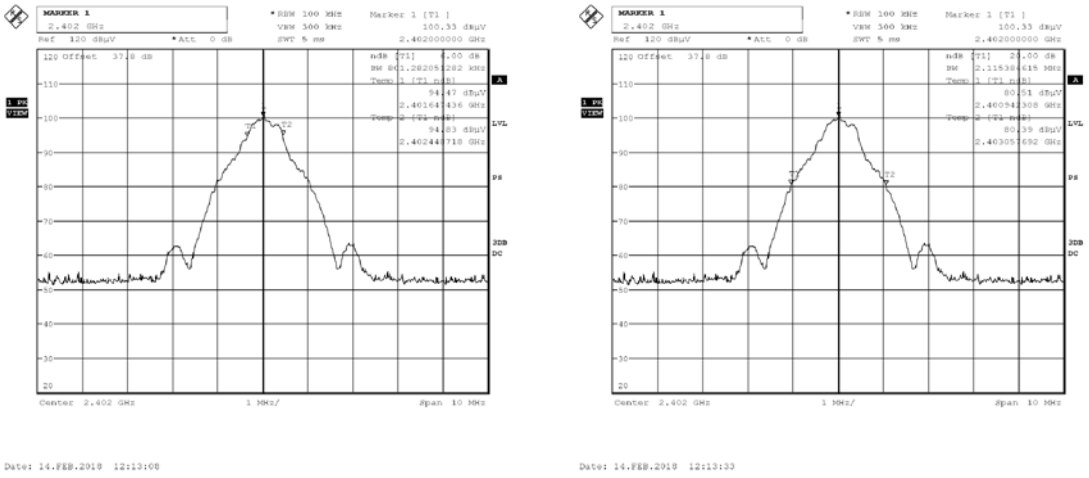
The device was found to be **compliant**. The 6dB bandwidth was at least 500kHz.

9.5 Test Conditions

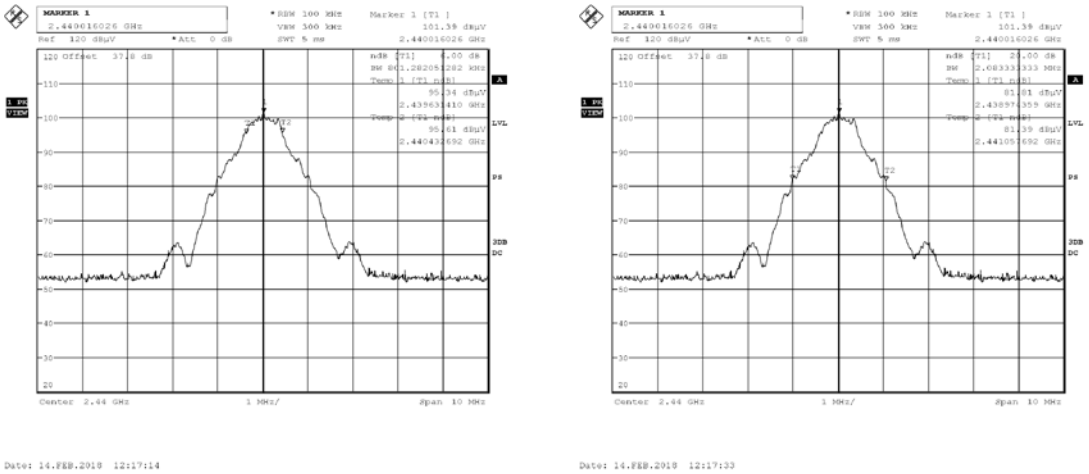
Test Personnel:	B. Lackey	Test Date:	2/21/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	23.8C
Input Voltage:	Battery	Relative Humidity:	46.4%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	988.8mbar

9.6 Test Data

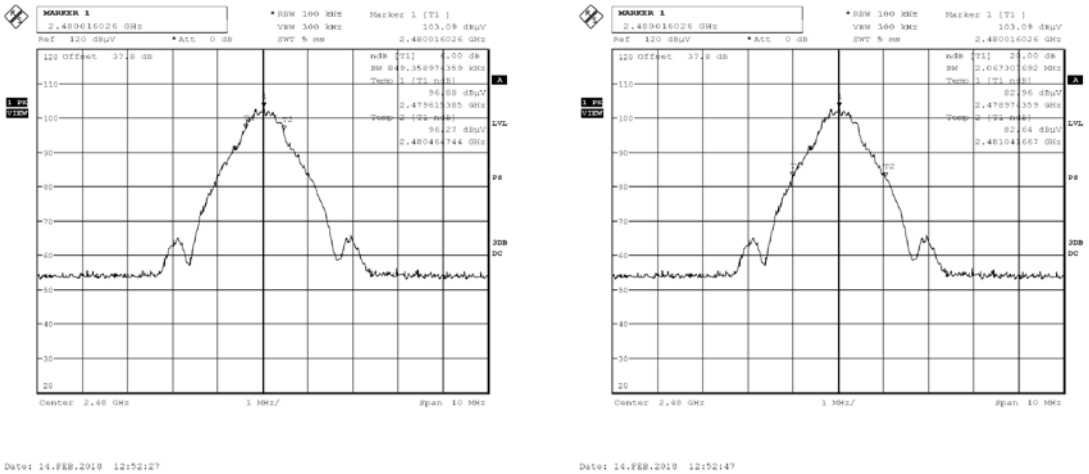
Channel	Frequency (MHz)	6dB BW	20dB BW	99% BW
0	2402	801.282kHz	2.115MHz	1.891MHz
19	2440	801.282kHz	2.083MHz	1.859MHz
39	2480	849.359kHz	2.067MHz	1.859MHz



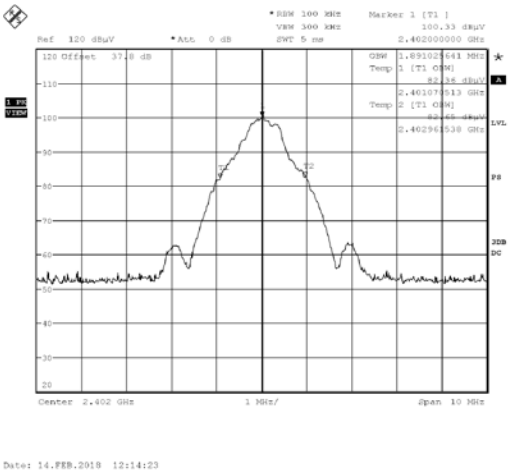
Channel 0 (2402MHz) 6dB BW (left) and 20dB BW (right)



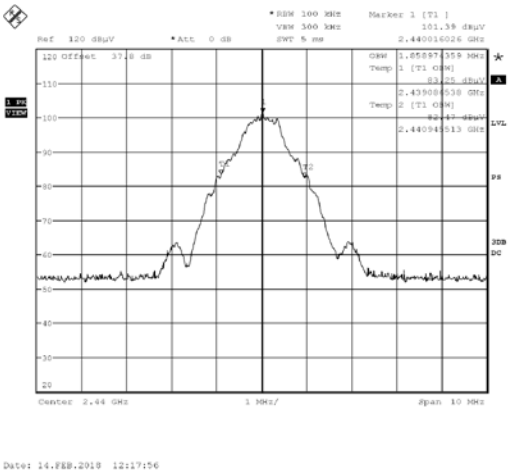
Channel 19 (2440MHz) 6dB BW (left) and 20dB BW (right)



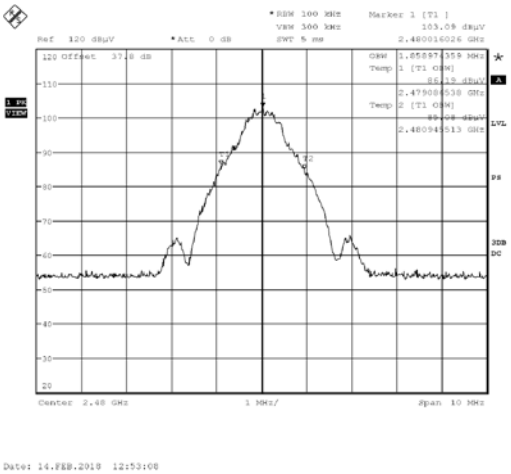
Channel 39 (2480MHz) 6dB BW (left) and 20dB BW (right)



Channel 0 (2402MHz) 99% BW



Channel 19 (2440MHz) 99% BW



Channel 39 (2480MHz) 99% BW

Deviations, Additions, or Exclusions: None

10 Channel Separation

10.1 Test Limits

FCC Part 15.247(a)(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.

RSS-247 Issue 2 § 5.1(b):

> FHSs 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

10.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

10.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	10/18/2017	10/18/2018

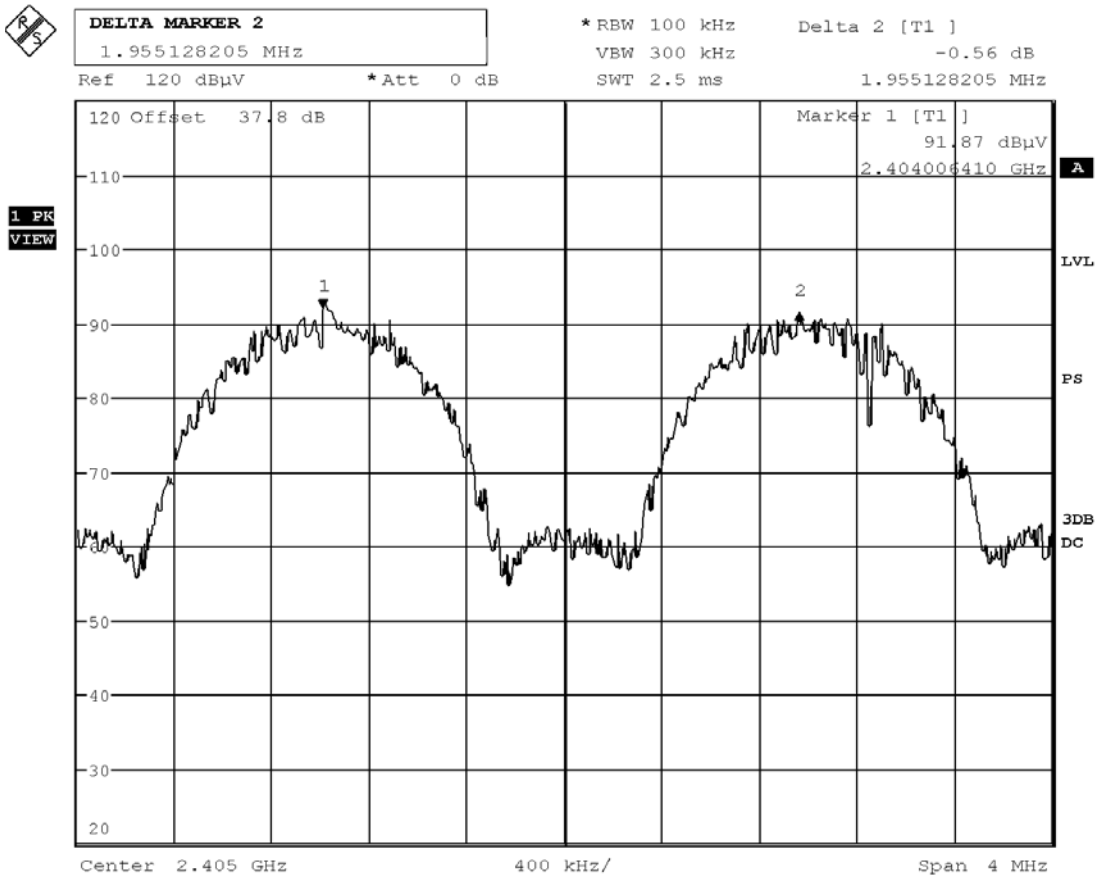
10.4 Test Results

The device was found to be **compliant**. Adjacent channels were separated by at least the 20dB bandwidth of the hopping channel.

10.5 Test Conditions

Test Personnel:	B. Lackey	Test Date:	2/14/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	23.8C
Input Voltage:	Battery	Relative Humidity:	46.4%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	988.8mbar

10.6 Test Data



Adjacent channels showing separation greater than the 20dB bandwidth

Deviations, Additions, or Exclusions: None

11 Number of Hopping Channels

11.1 Test Limits

FCC Part 15.247(a)(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.

RSS-247 Issue 2 § 5.1(d):

> FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

11.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

11.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	10/18/2017	10/18/2018

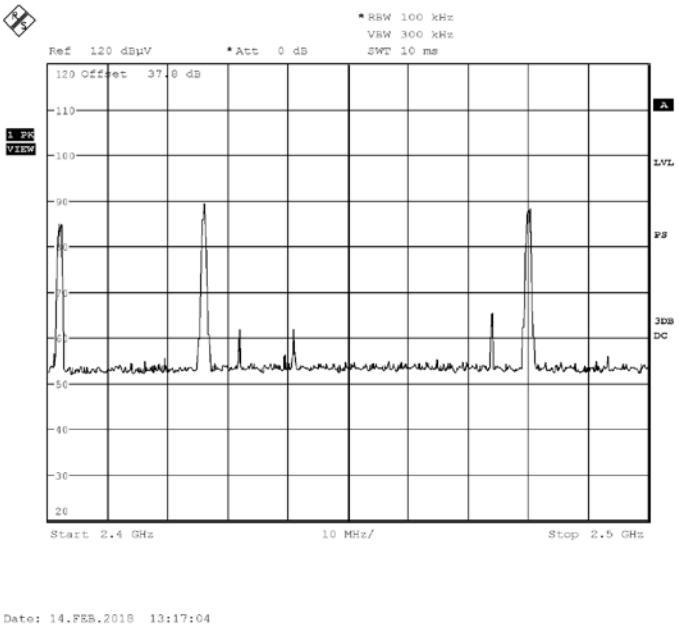
11.4 Test Results

The device was found to be **compliant**. The device used a total of 40 hopping channels between 2 modes of operation.

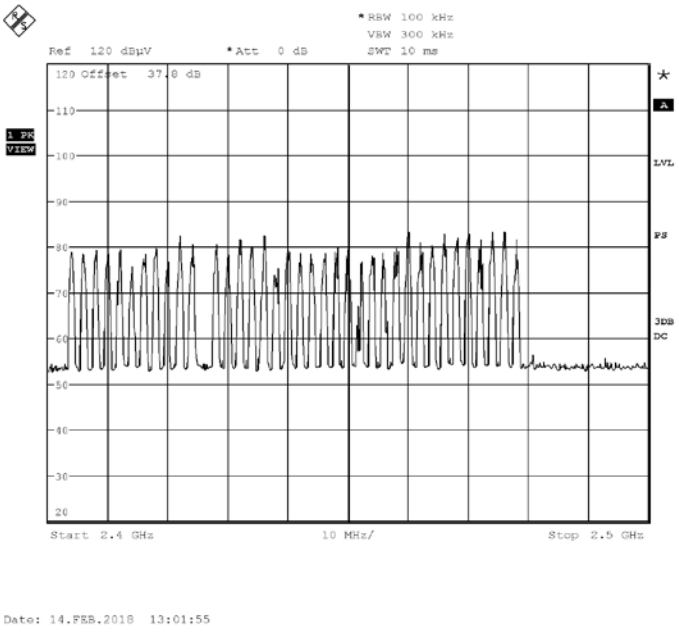
11.5 Test Conditions

Test Personnel:	B. Lackey	Test Date:	2/14/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	23.8C
Input Voltage:	Battery	Relative Humidity:	46.4%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	988.8mbar

11.6 Test Data



Total number of hopping channels during acquisition = 3



Total number of hopping channels during normal operation = 37

Deviations, Additions, or Exclusions: None

12 Time of Occupancy

12.1 Test Limits

FCC Part 15.247(a)(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.

RSS-247 Issue 2 § 5.1(d):

> FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

12.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

12.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	10/18/2017	10/18/2018

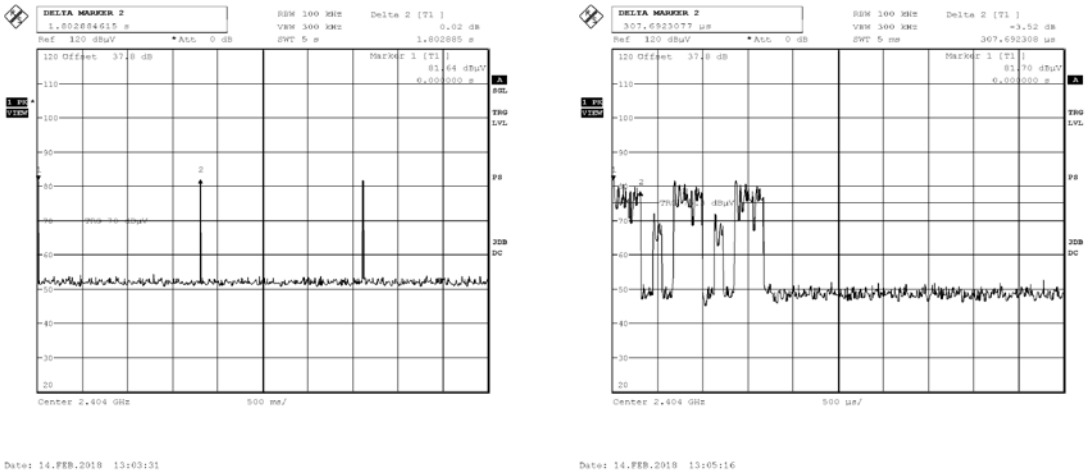
12.4 Test Results

The device was found to be **compliant**. The total time of occupancy per channel was found to be X in a period of 16 seconds (0.4 seconds x 40 hopping channels).

12.5 Test Conditions

Test Personnel:	B. Lackey	Test Date:	2/14/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	23.8C
Input Voltage:	Battery	Relative Humidity:	46.4%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	988.8mbar

12.6 Test Data



Time between occupancies (left) and transmit time per occupancy (right) on a single channel

Observation period = (0.4 s) · (40 channels) = 16s

Time between occupancies on a single channel = 1.802s
Number of occupancies on a single channel in 16 seconds = (16s) / (1.802s) = 8.879 → 8 occupancies

Total transmit time per occupancy on a single channel = 0.923ms
Total transmit time in 16 seconds = (8 occupancies) · (0.923 ms/occupancy) = 7.384ms = 0.007384s

0.007384s < 0.4s, so the device is deemed to comply with the limit.

Deviations, Additions, or Exclusions: None

13 Power Spectral Density

13.1 Test Limits

FCC Part 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.

RSS-247 Issue 2 § 5.2(b):

The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

13.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

13.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde&Schwarz	ESU40	9/20/2017	9/20/2018
Bilog Antenna	3133	ETS Lindgren	3142C	4/6/2017	4/6/2018
Horn Antenna	3780	ETS Lindgren	3117	6/1/2017	6/1/2018
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/29/2017	11/29/2018
3m Cable Preamplifier	3918	TS-PR18	122005	11/29/2017	11/29/2018
3m Cable Preamp→Chamber	2588			11/29/2017	11/29/2018
3m Cable Chamber→Control Room	2593			11/29/2017	11/29/2018
3m Cable Control Room→Receiver	2592			11/29/2017	11/29/2018
10m Cable Antenna→Preamp	3339			11/29/2017	11/29/2018

13.4 Test Results

The device was found to be **compliant**. The peak power spectral density was less than 8dBm.

13.5 Test Conditions

Test Personnel:	B. Lackey	Test Date:	2/14/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	23.8C
Input Voltage:	Battery	Relative Humidity:	46.4%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	988.8mbar

13.6 Test Data

Channel	Frequency (MHz)	RBW (kHz)	Field Strength (dBuV/m)	PPSD (dBm EIRP)	Limit (dBm EIRP)	Result
0	2402	3	89.40	-5.86	8	Pass
19	2440	3	89.34	-5.92	8	Pass
39	2480	3	89.60	-5.66	8	Pass

Deviations, Additions, or Exclusions: Converted field strength to dBm EIRP per ANSI C63.26:2015 using a correction factor of $20 \cdot \log_{10}(D)$ - 104.8dB, where D is the measurement distance in meters. At a distance of 3 meters, this correction factor is -95.26dB.

14 Antenna Requirement

14.1 Test Limits

FCC Part 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, 15.221, or §15.236. 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.

RSS-Gen Issue 4 § 8.3:

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

14.2 Test Results

The device was found to be **compliant**. The device has an internal, permanently affixed antenna.

15 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	3/16/2018	103397344LEX-003	BL	BCT	Original Issue
1	3/22/2018	103397344LEX-003.1	BL	BCT	Updated contact information