Wagz, Inc.

Report of FCC and ISED Canada Intentional Radiator Testing

Prepared For:	***Dale Goodman***
Company	***Wagz, Inc.*** ***230 Commerce Way, Suite 325*** ***Portsmouth, NH 03801***
Applicable Models	***Explore Smart Collar***
Test Laboratory	***Core Compliance Testing Services, LLC*** ***79 River Road*** ***Hudson, NH 03051***
Test Dates	**March 26 – April 2, 2019**
Tested & Reviewed By	***Ken MacGrath, Manager*** ***George Correia, Test Engineer*** ***Ed Ramshaw, Test Engineer***
Signature, Manager	
Signature, Test Engineers	 

Table of Contents

1.0 GENERAL INFORMATION 4
1.1 Product Description 4
1.2 Applicable Documents and Standards 5
1.3 Test Dates 5
1.4 Test Methodology 5
1.5 Test Facility 5
1.6 Test Equipment List 6
Table 1: Test Equipment 6
1.7 Measurement Uncertainty 7
1.8 Equipment Modifications 7
2.0 SYSTEM TEST CONFIGURATION 7
2.1 EUT Configuration 7
2.2 EUT Exercise 7
3.0 SUMMARY OF TEST RESULTS 10
Table 2: Test Summary 10
4.0 PEAK OUTPUT POWER MEASUREMENT 11
4.1 Applicable Standards 11
4.2 Measurement Procedure 11
4.3 Measurement Notes 11
4.4 Peak Output Power Test Results 11
5.0 6dB BANDWIDTH 16
5.1 Applicable Standards 16
5.2 Measurement Procedure 16
5.3 Measurement Results Summary 16
5.4 6dB Bandwidth Test Results 16
5.5 6dB Bandwidth Measurement Conclusion 20
6.0 100kHz BAND EDGE MEASUREMENTS 21
6.1 Applicable Standards 21
6.2 Measurement Procedure 21
6.3 100kHz Band Edge Measurement Test Results 21
6.4 100kHz Band Edge Measurement Conclusion 28
7.0 PEAK POWER SPECTRAL DENSITY 29
7.1 Applicable Standards 29
7.2 Measurement Procedure 29
7.3 Peak Power Spectral Density Measurement Results 29
7.4 Peak Power Spectral Density Measurement Conclusion 33
8.0 UNINTENTIONAL/SPURIOUS RADIATED EMISSION TEST 34
8.1 Radiated Emissions 34
8.2 Prescan Radiated Emissions 34
8.3 Prescan Measurement Procedure 34

8.4 Prescan Measurement Results 34
8.5 Radiated Emissions Applicable Standards 39
8.6 Radiated Emissions EUT Setup 39
8.7 Radiated Emissions Measurement Procedure 39
8.8 Radiated Emissions Test Setup Photos 40
8.9 Field Strength Calculation 40
8.10 Limit Extrapolation Method for Frequencies Below 30MHz 40
8.13 Measurement Result – Radiated Emissions Data Tables 41
8.14 Unintentional/Spurious Radiated Emissions Measurement Conclusion 48
9.0 ANTENNA REQUIREMENT 48
9.1 Applicable Standards 48
9.2 Antenna Connected Construction 48
9.3 Antenna Requirement Conclusion 48
10.0 MAXIMUM PERMISSIBLE EXPOSURE 49
10.1 Applicable Standards 49
10.2 MPE Calculations 49
10.3 MPE Conclusion 51
11.0 Conducted Emissions Tests 52
11.1 Object of Conducted Emissions 52
11.2 Conducted Emissions Test Procedure 52
11.3 Conducted Emissions Terms and Calculation 53
11.4 Deviations from Test Method: 53
11.5 Measurement Result – Conducted Emissions Data Tables (continued) 54
11.6 Conducted Emissions Limits 54
11.7 Conducted Emissions Test Summary 54
11.8 Results: 54
11.9 Modifications: None 54
11.10 Measurement Result – Conducted Emissions Data Tables 55
12.0 PHOTOGRAPHS 59

1.0 GENERAL INFORMATION

1.1 Product Description

Equipment Under Test (EUT): Explore Smart Collar

Manufacturer:	Wagz, Inc.
Applicable Models:	Explore Smart Collar
Serial Number:	1852190012
Power Supply:	(2) Lithium Ion batteries, 3.7V, 500mAh, 1.85Wh

EUT Technical Specifications:

A) Channels, Operating Frequency and Modulation:
Refer to Section 2.2 for all operating modes tested.

B) Rated output power:

BLE	0.834 milliwatts (-0.79 dBm). Refer to section 4.0 of this report.
WiFi	4.142 milliwatts (6.17 dBm). Refer to section 4.0 of this report.
LTE	218 milliwatts based on Sequans Communications module, FCC Grant, FCC ID: 2AAGMUS130Q

C) Antenna Designation: PulseLarsen, P/N W3095, ceramic chip, non-user replaceable (fixed), 2.5dBi.

D) This report documents the results for the Wagz Explore Smart Collar which is a “smart” collar for dogs which contains Bluetooth, WiFi, and LTE cellular communications capabilities.

E) FCC ID: 2ASHHEXPLORE01
IC ID: N/A

F) Maximum Permissible Exposure (MPE): The EUT meets the MPE requirements by exclusion with reference to FCC Part 2.1091 for mobile devices, FCC KDB 447498 D01 General RF Exposure Guidance v06, FCC KDB 865664 D02 RF Exposure Reporting v01r02, and ISED RSS-102, Issue 5, Section 2.5.

1.2 Applicable Documents and Standards

This test report is based on the following standards.

- FCC CFR47, Part 15, Subpart C, Section 15.247
- FCC CFR47, Part 15, Subpart C, Section 15.207 and 15.209
- Industry Canada RSS-247, Issue 2, February 2017, Spectrum Management and Telecommunications, Radio Standards Specification, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
- RSS-GEN, Issue 5, March 2019, Amendment 1, Spectrum Management and Telecommunications, Radio Standards Specification, General Requirements for Compliance of Radio Apparatus
- ANSI C63.10: 2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- ANSI C63.4: 2014

Maximum Permissible Exposure

- FCC Part 2.1091, Radiofrequency radiation exposure evaluation: mobile devices
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 865664 D02 RF Exposure Reporting v01r02
- ISED RSS-102, Issue 5, Section 2.5

1.3 Test Dates

March 26 – April 2, 2019

1.4 Test Methodology

Testing was done according to the standards listed in section 1.2. Radiated testing was performed at an antenna-to-EUT distance of 3-meters.

1.5 Test Facility

The Alternative Open Area Test Site (OATS) and ferrite lined shielded chamber used to collect the radiated emissions data is located at Core Compliance Testing Services, 79 River Road, Hudson, NH. Radiated prescans are done in the ferrite lined shielded chamber and all final radiated emissions testing is done in the OATS which conforms to the site attenuation characteristics defined by ANSI C63.4-2014, MP5 and OST-55. The test facility is A2LA accredited to ISO 17025 (certificate # 2778.01) and is an ISED Canada registered wireless test site (site # 11794A-1).

1.6 Test Equipment List

All equipment used in the testing process has up to date calibrations traceable to the National Institute of Standards and Technology (NIST). Refer to the Table 1 below for a complete list of equipment used during the test.

Table 1: Test Equipment

Asset #	Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
3	Preamplifier 8447F OPT H64	Agilent/HP	8447F-H64	3113A07400	1/2/2018	1/2/2020
6	EMI Receiver/RF Filter Sytem	HP	8546A	3942A00506/3704A00463	12/3/2018	12/3/2019
15	Horn Antenna	EMCO	3115	9906-5841	N/A	N/A
17	Antenna, Bilog (Green)	Schaffner-Chase	CBL6112B	2602	1/17/2019	1/17/2021
17a	Attenuator, 4db Pad	Huber-Suhner	6804.17. A	1001701788		
18	Antenna, Bilog (Yellow)	Chase	CBL6140	1041	N/A	N/A
19	Pre-amplifier	HP/Agilent	08449B	3008A01322	12/13/2017	12/13/2019
20	Cable, 8 Meters	Andrew	ETS1-50T-S01	00a1108339	12/13/17	12/13/19
21	Cable, 25 meters with 2 Wurth Ferrites @ each end of the cable	A.H. Systems	SC-18G-25	1306	1/02/18	1/02/20
30	Semi-Anechoic chamber	Keene Ray Proof	N/A	8298	7/9/2018	7/9/2019
84	Spectrum Analyzer	Agilent	E4407B	US41192608	1/2/18	1/2/20
103	Loop Antenna	Com-Power	AL-130	121056	5/1/18	5/1/20
109	Alternative Open Area Test Site	Strongwell	10 Meter	None	10/26/2018	10/26/2020
114	Humidity Alert	Control Company	4040	122171578	8/21/2018	8/21/2019
126	DRG Horn Antenna 700M-18GHz	A.H. Systems	SAS-571	782	4/27/18	4/27/20
133	Horn Antenna 15-26.5 GHz	Schwarzbeck	BBHA9170	9170	7/13/16	7/13/19
138	Preamplifier	Miteq	NSP1001200-NF-S	701275	1/02/18	1/02/20
144	EMI Test Receiver	Rohde & Schwarz	ESMI	848926/003 - 849182/001	4/23/18	4/23/19
148	SMA Cable	Thermax	DCA5573-12	None	7/31/18	7/31/19

All equipment used for testing has been calibrated according to methods and procedures defined by the National Institute of Standards and Technology (NIST).

1.7 Measurement Uncertainty

Radiated Emissions up to 1GHz, Expanded Uncertainty	4.19
Radiated Emissions 1-18GHz, Expanded Uncertainty	4.14
Conducted Emissions up to 30MHz, Expanded Uncertainty	1.83
Telco Conducted Emissions up to 30MHz, Expanded Uncertainty	1.85

The measurement uncertainty of radiated emissions data is based on the test equipment used and the OATS site attenuation data. The measurement uncertainty of conducted emissions and Telco conducted emissions data is based on the test equipment used.

1.8 Equipment Modifications

The unit was put into continuous transmit at maximum power with modulation applied at the BLE and WiFi operating modes as given in section 2.2.

2.0 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing was based on the requirements as given in the applicable standards and was operated in a manner which intends to maximize its emissions characteristics in a continuous transmit application as detailed in section 2.2.

2.2 EUT Exercise

The EUT has been tested under operating conditions and was programmed to allow it to remain in continuous transmitting mode.

The testing was done with the batteries fully charged for all testing.

2.2 EUT Exercise (continued)

The EUT was operated as follows:

BLE Transmit Channel	Transmit Freq. (MHz)	Transmit Power Level (dBm)	Test Mode	Modulation
1	2402	+4	BLE mode	GFSK
2	2440	+4	BLE mode	GFSK
3	2480	+4	BLE mode	GFSK

WiFi 802.11b Transmit Channel	Transmit Freq. (MHz)	Transmit Power Level (dBm)	Data Rate (Mbps)	Modulation
1	2412	+18	1	DBPSK
6	2437	+18	1	DBPSK
11	2462	+18	1	DBPSK

WiFi 802.11g Transmit Channel	Transmit Freq. (MHz)	Transmit Power Level (dBm)	Data Rate (Mbps)	Modulation
1	2412	+15	6	BPSK
6	2437	+15	6	BPSK
11	2462	+15	6	BPSK

WiFi 802.11n 20MHz Transmit Channel	Transmit Freq. (MHz)	Transmit Power Level (dBm)	Data Rate (Mbps)	Modulation
1	2412	+14	6.5	BPSK
6	2437	+14	6.5	BPSK
11	2462	+14	6.5	BPSK

WiFi 802.11n 40MHz Transmit Channel	Transmit Freq. (MHz)	Transmit Power Level (dBm)	Data Rate (Mbps)	Modulation
3	2422	+12.5	13.5	BPSK
6	2437	+12.5	13.5	BPSK
9	2452	+12.5	13.5	BPSK

2.2 EUT Exercise (continued)

The following table was provided by the customer to further detail the test mode operating conditions.

SCPC Power Control Settings Table for Regulatory Setting					
Standard	SCPC	Data Rate	CH	Frequ. (MHz)	Meas. Con.Max.Pwr (dBm)
			1	2412	17.68
			6	2437	17.71
802.11b	**18 dBm**	1 Mbps	11	2462	17.29
			1	2412	7.83
			2	2417	11.45
			3	2422	14.53
			4	2427	14.61
			5	2432	14.22
			6	2437	14.79
			7	2442	14.54
			8	2447	14.59
			9	2452	14.53
			10	2457	10.52
802.11g	**15 dBm**	6 Mbps	11	2462	6.99
			1	2412	8.84
			2	2417	12.39
			3	2422	13.56
			4	2427	13.68
			5	2432	13.25
			6	2437	13.86
			7	2442	13.49
			8	2447	13.58
			9	2452	13.62
802.11n		MCS0	10	2457	9.58
20 MHz	**14 dBm**	6.5 Mbps	11	2462	6.56
			3	2422	5.99
			4	2427	6.06
			5	2432	6.98
			6	2437	7.59
			7	2442	7.19
802.11n		MCS0	8	2447	6.31
40 MHz	**12.5 dBm**	13.5 Mbps	9	2452	6.56

3.0 SUMMARY OF TEST RESULTS

Table 2: Test Summary

Rules	Description Of Test	Test Report Section	Result
FCC 15.247 (b) (3) RSS-247, 5.4 (d)	Peak Output Power (1 W)	4.0	*Pass*
FCC 15.247 (a) (2) RSS-247, 5.2 (a)	6dB Bandwidth (≥500kHz)	5.0	*Pass*
FCC 15.247 (d) RSS-247, 5.5	100 kHz Band Edge Measurements	6.0	*Pass*
FCC 15.247 (e) RSS-247, 5.2 (b)	Peak Power Spectral Density (8dBm/3kHz)	7.0	*Pass*
FCC 15.209 (a) - (f) RSS-GEN, 8.9	Unintentional/Spurious Emissions	8.0	*Pass*
FCC 15.203 FCC 15.247 (4) (i) RSS-GEN, 6.8 RSS-247, 5.4 (f) (ii)	Antenna Requirement	9.0	*Pass*
FCC Part 2.1091 FCC KDB 447498 D01	Maximum Permissible Exposure (MPE)	10.0	*Pass*
FCC 15.207 (a) RSS-GEN, 8.8	Conducted Emissions	11.0	*Pass*

4.0 PEAK OUTPUT POWER MEASUREMENT

4.1 Applicable Standards

FCC 15.247 (b) (3), RSS-247, 5.4 (d). For systems using digital modulation techniques in the 2400 – 2483.5 MHz band, the maximum peak conducted output power is 1.0 Watt.

4.2 Measurement Procedure

Place the EUT on a 1.5m high polystyrene stand and set it into transmitting mode. Measurements were made with typical modulation applied.

Utilizing the radiated emissions method, the EUT was set up on a three meter OATS. The field strength was maximized by rotating the turntable and adjusting the antenna height. Measurements were further optimized for vertical and horizontal polarization of the receive antenna.

The peak field strength for each transmit frequency was recorded.

To convert field strength at 3 meters to power in Watts, the following formula was

Used: $P = (E \times d)^2 / (30 \times G)$

Where:
P = Power in Watts
E = Field strength in V/m
d = Measurement distance in meters
G = Numerical Gain of Antenna

Repeat the above procedures for each of the low, mid, and high frequency channels.

4.3 Measurement Notes

The antenna is an integral part of the EUT so EIRP data was used in the power calculations.

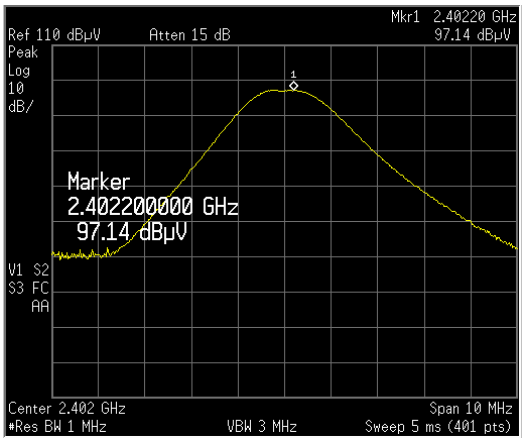
4.4 Peak Output Power Test Results

The peak output power plots and test results are shown on the following pages.

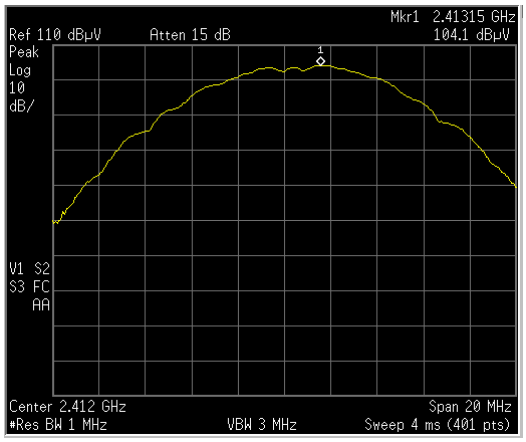
4.4 Peak Output Power Test Results (continued)

Peak Power Output Data Plot (Low Channel)

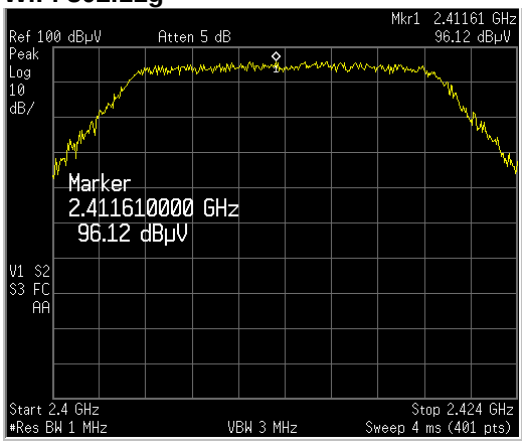
BLE mode



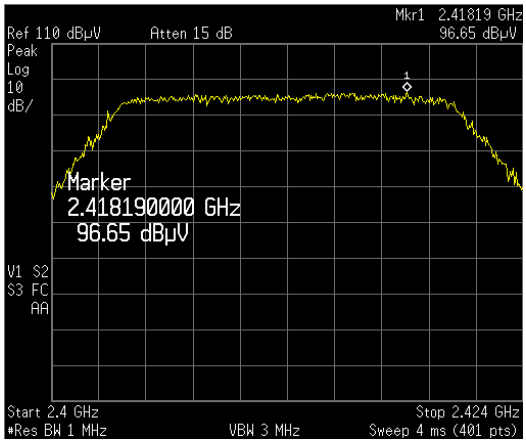
WiFi 802.11b



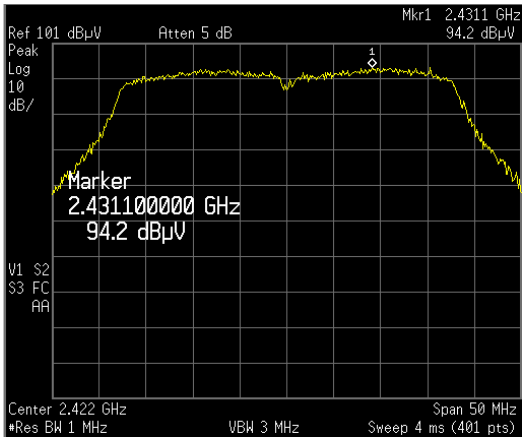
WiFi 802.11g



WiFi 802.11n 20MHz



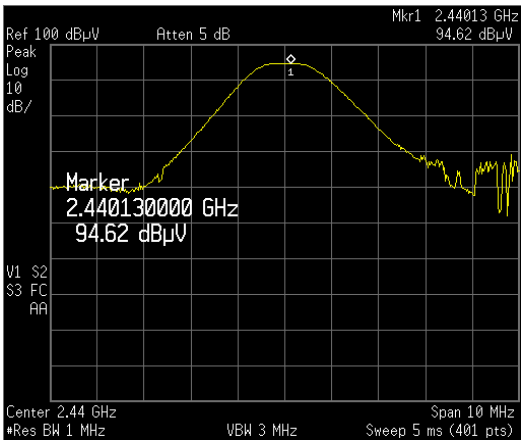
WiFi 802.11n 40MHz



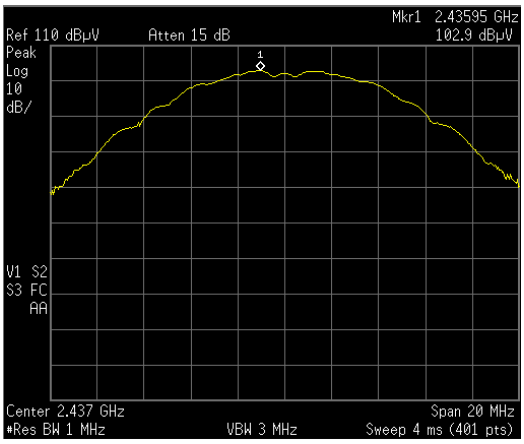
4.4 Peak Output Power Test Results (continued)

Peak Power Output Data Plot (Mid Channel)

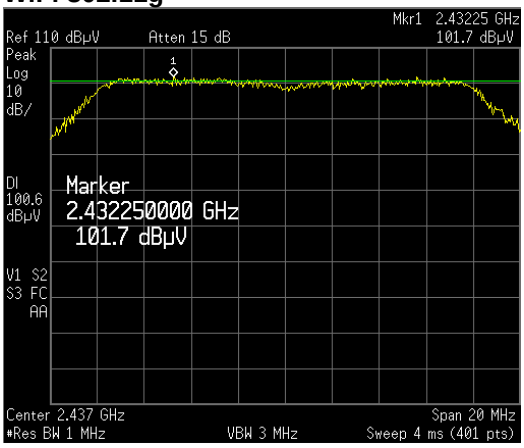
BLE mode



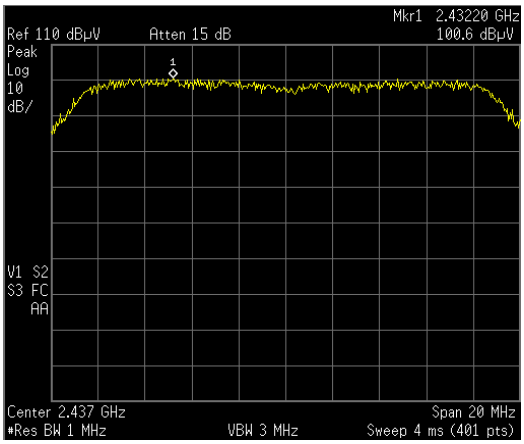
WiFi 802.11b



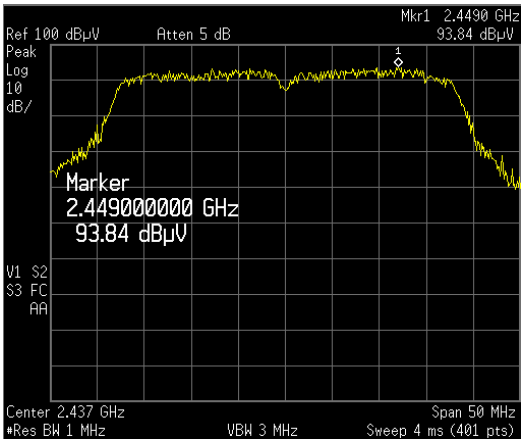
WiFi 802.11g



WiFi 802.11n 20MHz



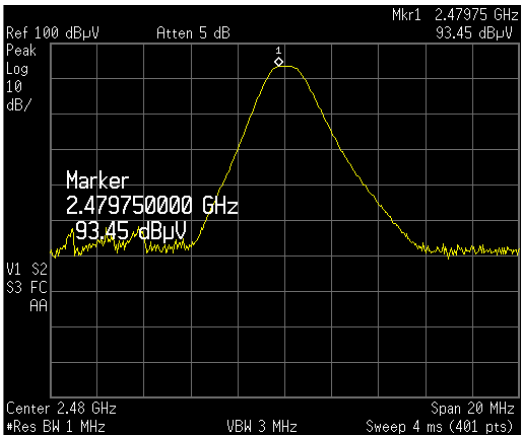
WiFi 802.11n 40MHz



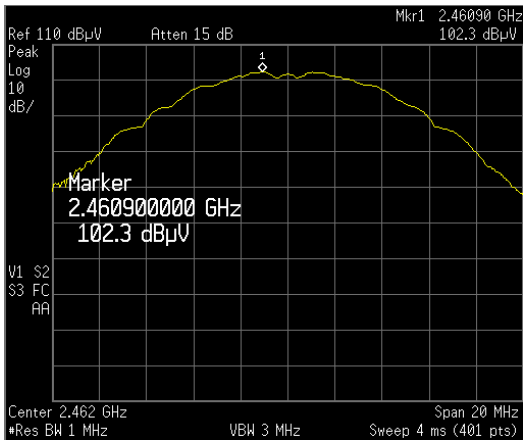
4.4 Peak Output Power Test Results (continued)

Peak Power Output Data Plot (High Channel)

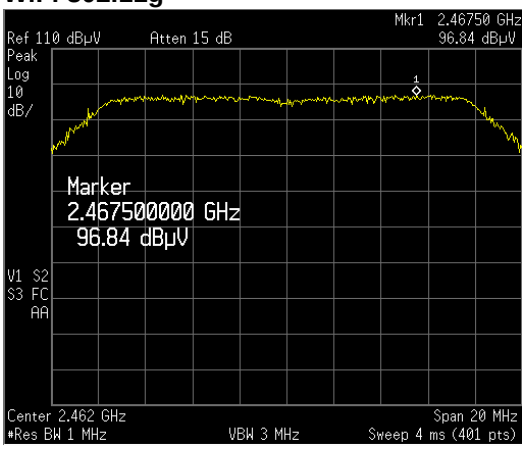
BLE mode



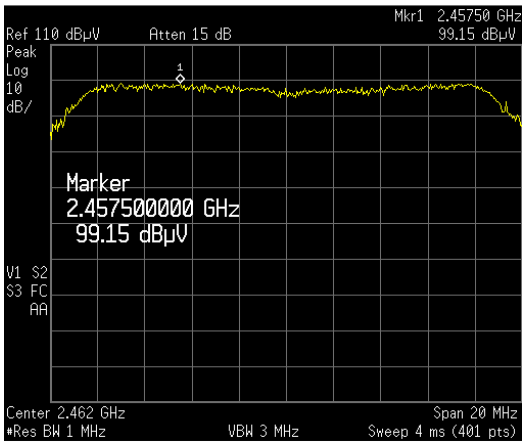
WiFi 802.11b



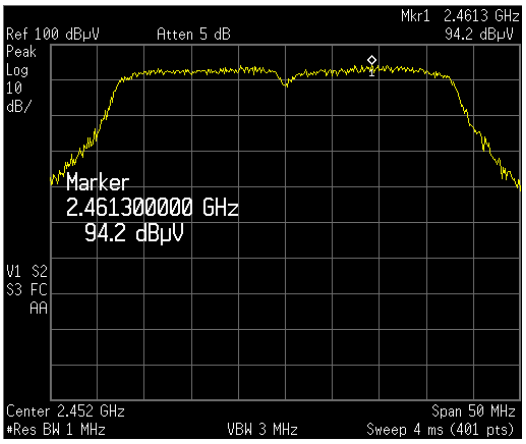
WiFi 802.11g



WiFi 802.11n 20MHz



WiFi 802.11n 40MHz



4.4 Peak Output Power Test Results (continued)

Peak Power Output Data Plot (Low Channel)

Operating Mode	Channel	Frequency (MHz)	Reading (dBµV)	Cable Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Power Calculation (mW)	[2]EIRP (dBm)
WiFi b	Low, 1	2412.000	104.1	8.7	37.6	28.7	103.9	156675	1.8	4.141804	6.17
WiFi g	Low, 1	2412.000	96.1	8.7	37.6	28.7	95.9	62517	1.8	0.659462	-1.81
WiFi n 20M	Low, 1	2412.000	96.7	8.7	37.6	28.7	96.5	66451	1.8	0.745057	-1.28
WiFi n 40M	Low, 3	2422.000	94.2	8.7	37.6	28.8	94.1	50699	1.8	0.433700	-3.63
BLE	Low	2402.000	97.1	8.7	37.6	28.7	96.9	70307	1.8	0.834045	-0.79

Peak Power Output Data Plot (Mid Channel)

Operating Mode	Channel	Frequency (MHz)	Reading (dBµV)	Cable Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Power Calculation (mW)	[2]EIRP (dBm)
WiFi b	Mid, 6	2437.000	102.9	8.8	37.6	28.8	102.9	139637	1.8	3.289952	5.17
WiFi g	Mid, 6	2437.000	101.7	8.8	37.6	28.8	101.7	121619	1.8	2.495683	3.97
WiFi n 20M	Mid, 6	2437.000	100.6	8.8	37.6	28.8	100.6	107152	1.8	1.937267	2.87
WiFi n 40M	Mid, 6	2437.000	93.8	8.8	37.6	28.8	93.8	49204	1.8	0.408498	-3.89
BLE	Mid	2440.000	94.6	8.8	37.6	28.8	94.6	53827	1.8	0.488866	-3.11

Peak Power Output Data Plot (High Channel)

Operating Mode	Channel	Frequency (MHz)	Reading (dBµV)	Cable Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Power Calculation (mW)	[2]EIRP (dBm)
WiFi b	High, 11	2462.000	102.3	8.8	37.6	28.9	102.4	131826	1.8	2.932172	4.67
WiFi g	High, 11	2462.000	96.8	8.8	37.6	28.9	96.9	70307	1.8	0.834045	-0.79
WiFi n 20M	High, 11	2462.000	99.2	8.8	37.6	28.9	99.3	91728	1.8	1.419677	1.52
WiFi n 40M	High, 9	2452.000	94.2	8.8	37.6	28.9	94.3	51880	1.8	0.454140	-3.43
BLE	High	2480.000	93.5	8.9	37.6	29.0	93.8	48697	1.8	0.400119	-3.98

[1]Antenna Numerical Gain (dBi = 10 log G)
[2]EIRP calculation of maximum peak conducted output power; ref: section 4.2 of this report

4.5 Maximum Peak Conducted Output Power Measurement Conclusion

The EUT meets the maximum peak conducted output power requirement of FCC 15.247 (b) (3) and RSS-247, 5.4 (d). The maximum peak conducted output power was 4.142 mW (+6.17 dBm) which is under the 1.0 Watt limit (+30 dBm).

5.0 6dB BANDWIDTH

5.1 Applicable Standards

FCC 15.247 (a) (2), RSS-247, 5.2 (a). For systems using digital modulation techniques in the 2400 – 2483.5 MHz band, the minimum 6 dB bandwidth shall be at least 500 kHz.

5.2 Measurement Procedure

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points that are attenuated by 6 dB, relative to the peak of the fundamental frequency.

These measurements were performed at the low, mid, and high channel frequencies.

5.3 Measurement Results Summary

Channel	Bandwidth (kHz)
Low	740
Mid	700
High	740

Note that the worst-case 6dB bandwidth results are given above and these occurred when in BLE mode.

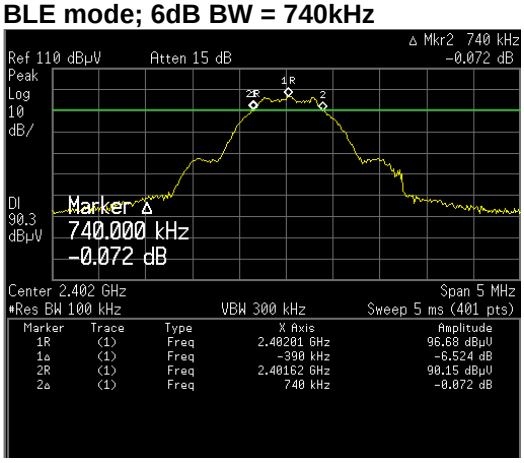
5.4 6dB Bandwidth Test Results

The 6dB bandwidth plots are shown on the following pages.

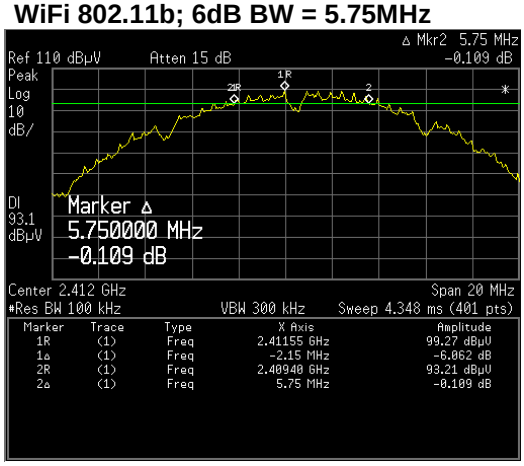
5.4 6dB Bandwidth Test Results (continued)

6dB Bandwidth Data Plot (Low Channel)

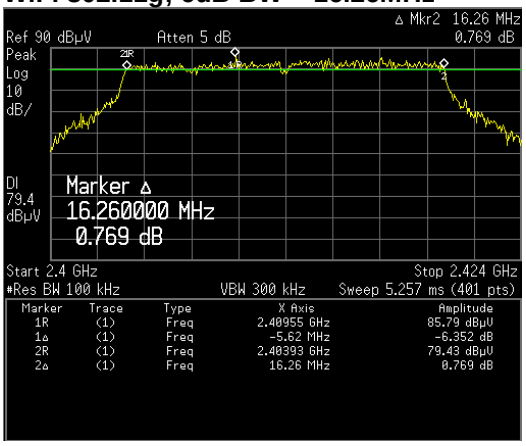
BLE mode; 6dB BW = 740kHz



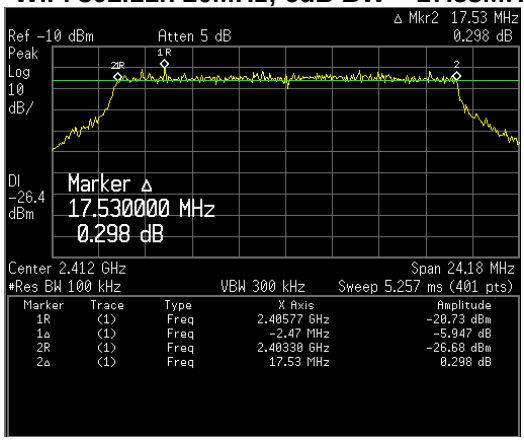
WiFi 802.11b; 6dB BW = 5.75MHz



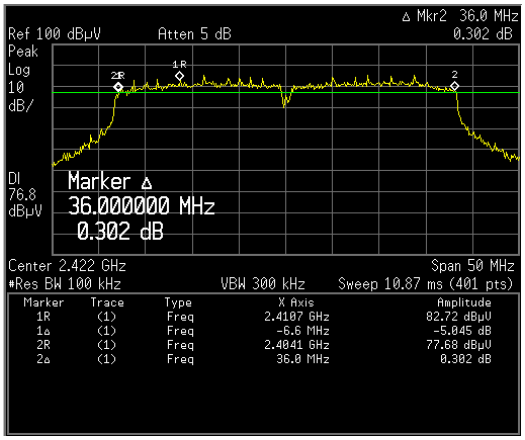
WiFi 802.11g; 6dB BW = 16.26MHz



WiFi 802.11n 20MHz; 6dB BW = 17.53MHz



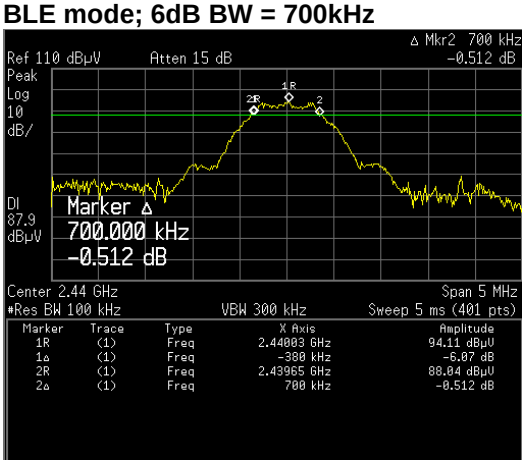
WiFi 802.11n 40MHz; 6dB BW = 36.0MHz



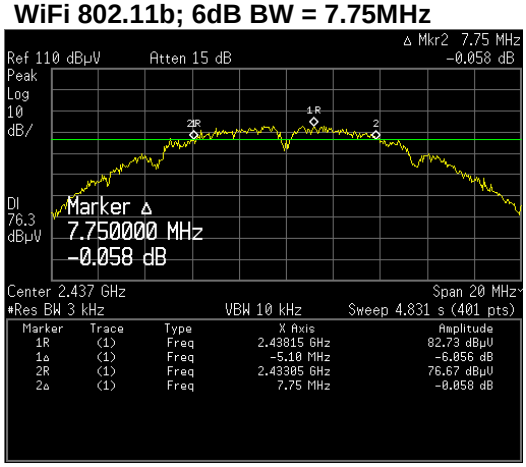
5.4 6dB Bandwidth Test Results (continued)

6dB Bandwidth Data Plot (Mid Channel)

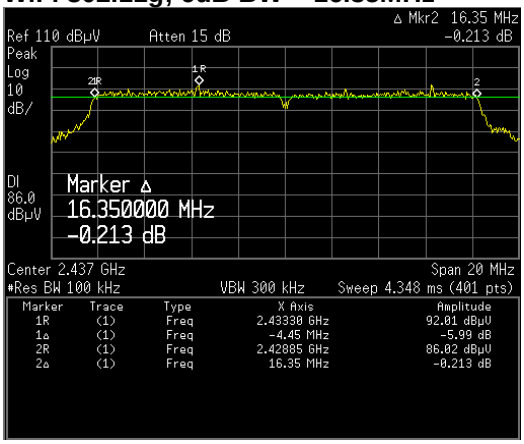
BLE mode; 6dB BW = 700kHz



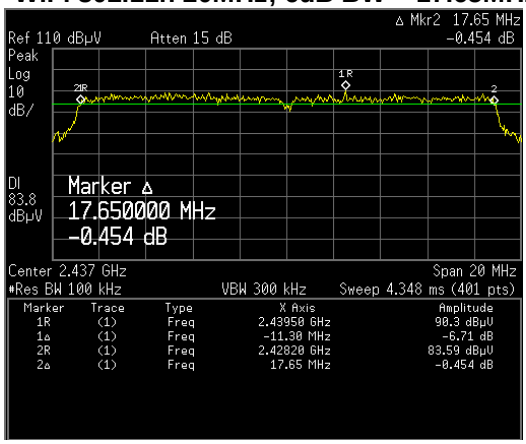
WiFi 802.11b; 6dB BW = 7.75MHz



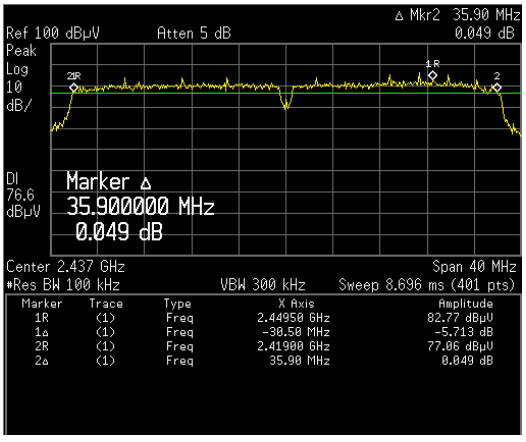
WiFi 802.11g; 6dB BW = 16.35MHz



WiFi 802.11n 20MHz; 6dB BW = 17.65MHz



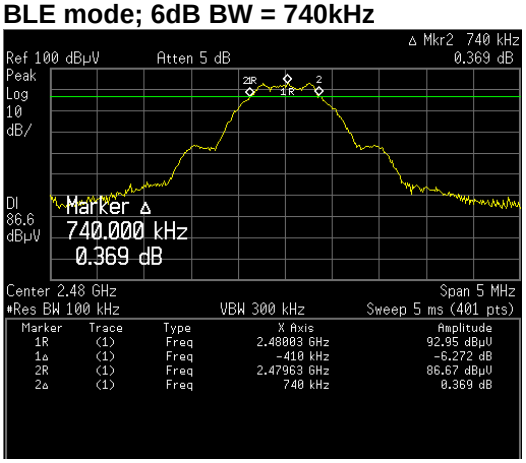
WiFi 802.11n 40MHz; 6dB BW = 35.9MHz



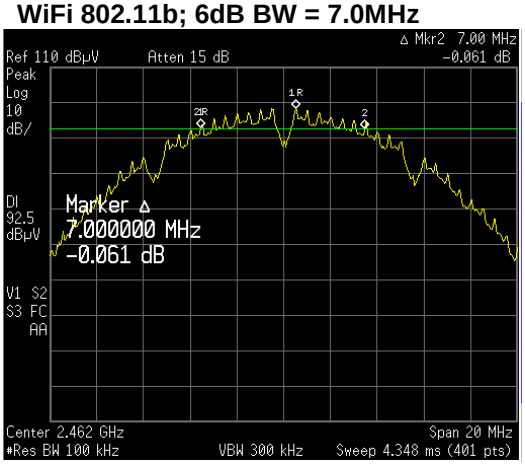
5.4 6dB Bandwidth Test Results (continued)

6dB Bandwidth Data Plot (High Channel)

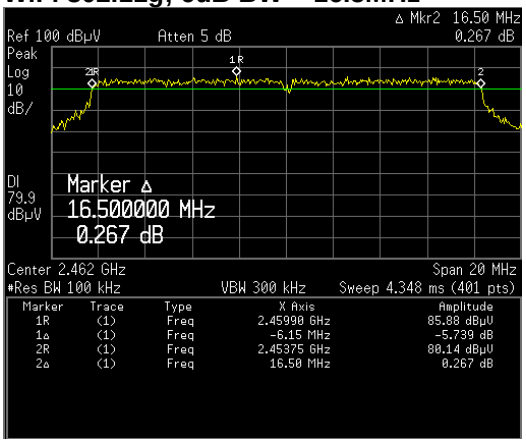
BLE mode; 6dB BW = 740kHz



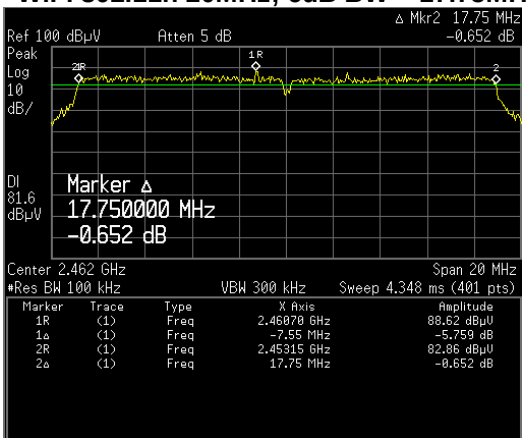
WiFi 802.11b; 6dB BW = 7.0MHz



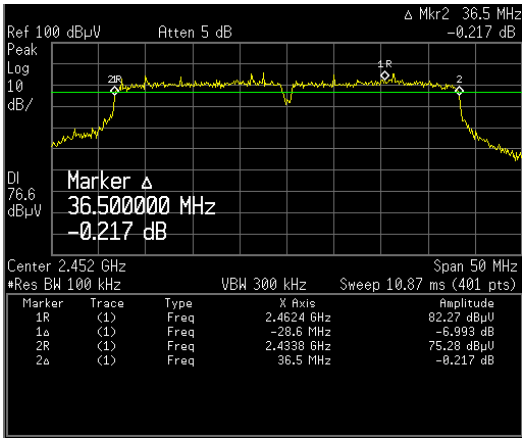
WiFi 802.11g; 6dB BW = 16.5MHz



WiFi 802.11n 20MHz; 6dB BW = 17.75MHz



WiFi 802.11n 40MHz; 6dB BW = 36.5MHz



5.5 6dB Bandwidth Measurement Conclusion

The EUT meets the 6dB bandwidth requirements of FCC 15.247 (a) (2) and RSS-247, 5.2 (a). The worst-case 6dB bandwidth of the EUT occurred in BLE mode and was 700kHz which meets the 500kHz minimum bandwidth requirement.

6.0 100kHz BAND EDGE MEASUREMENTS

6.1 Applicable Standards

FCC 15.247 (d), RSS-247, 5.5. In any 100kHz bandwidth outside the frequency bands in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions, which fall in the restricted bands, as defined in FCC 15.205 (a) and RSS-GEN, 8.10, must also comply with the radiated emission limits specified in FCC 15.209 (a) and RSS-GEN, 8.9.

6.2 Measurement Procedure

- Place the EUT on a 1.5m high polystyrene stand and set it in transmitting mode with modulation.
- Set the center frequency of the spectrum analyzer to the operating frequency.
- Set the spectrum analyzer RBW= 100kHz, VBW=300KHz, Span=10MHz, Sweep Auto
- Mark the peak of the Low channel and record the maximum level. The lower band edge is 2.400GHz.
- Mark the peak of the High channel and record the maximum level. The upper band edge is 2.4835 GHz.
- Set the delta marker to the next lower frequency of spurious emission outside of the band and record the peak.

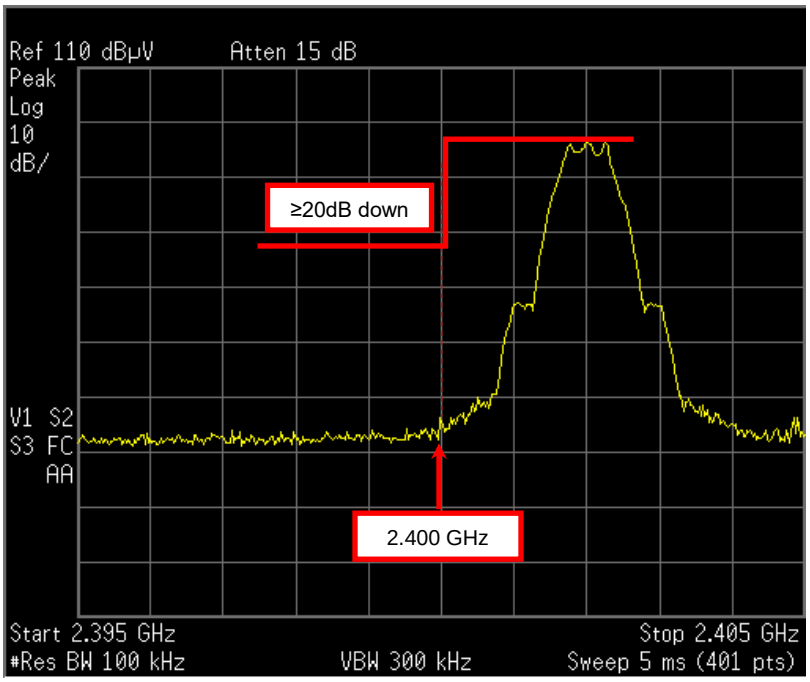
6.3 100kHz Band Edge Measurement Test Results

The 100kHz band edge measurement plots are shown on the following pages.

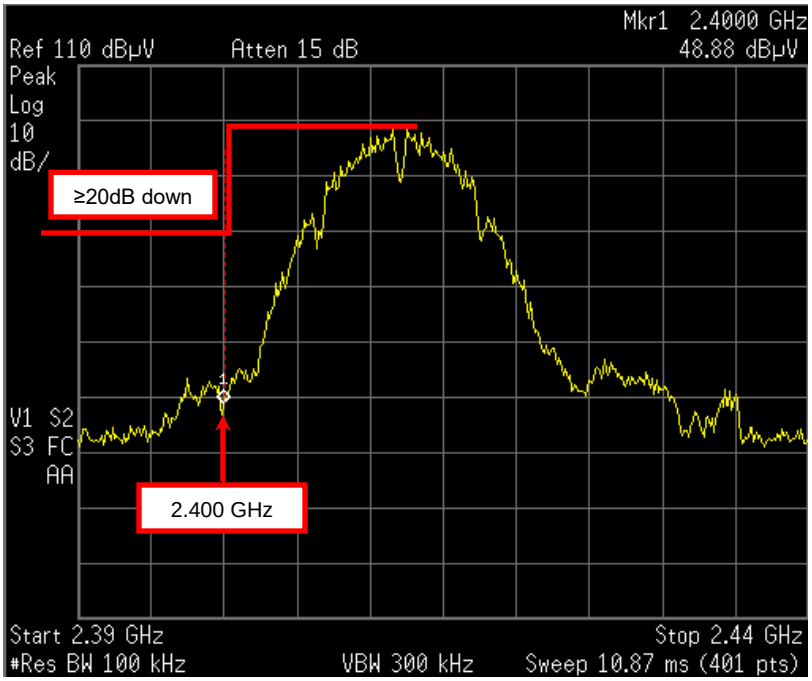
6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (Low Channel)

BLE mode



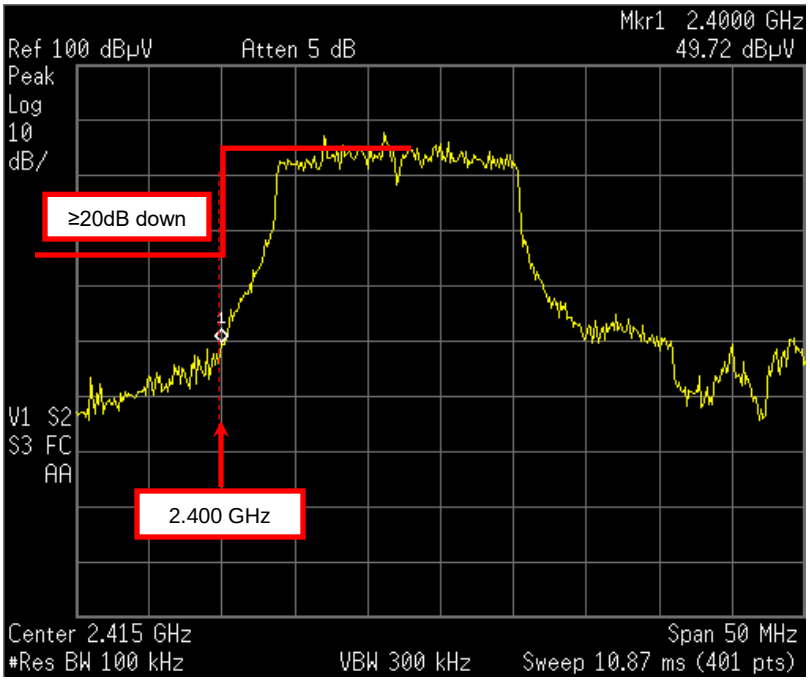
WiFi 802.11b



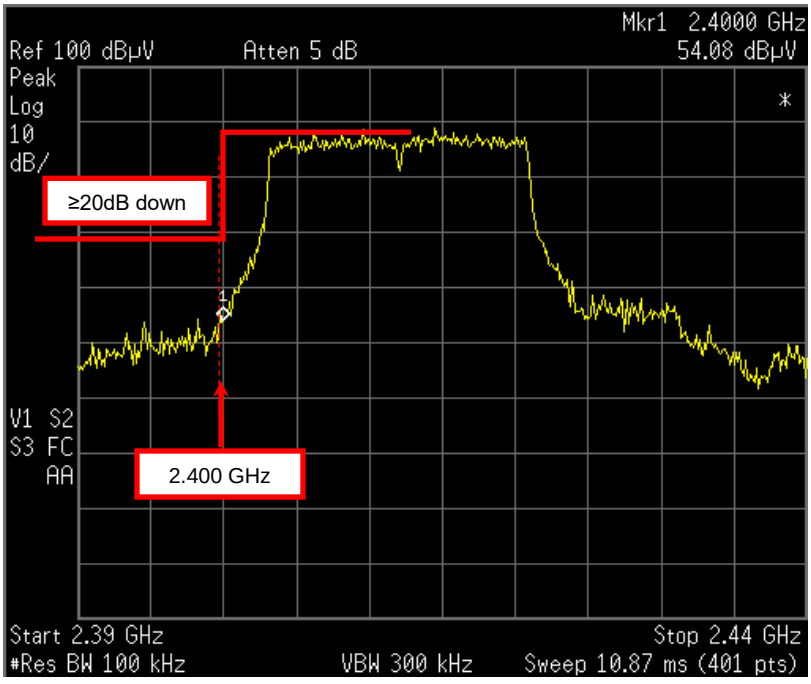
6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (Low Channel)

WiFi 802.11g



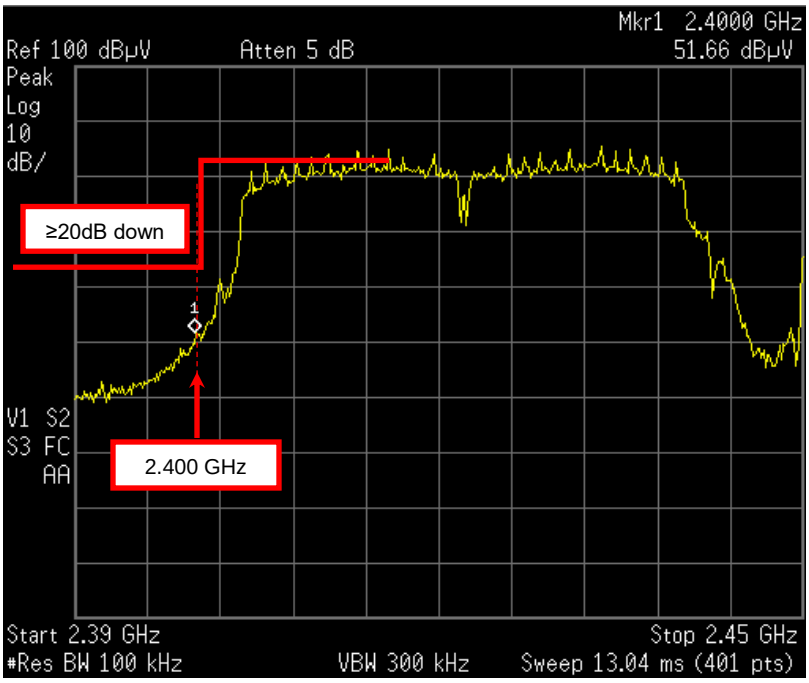
WiFi 802.11n 20MHz



6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (Low Channel)

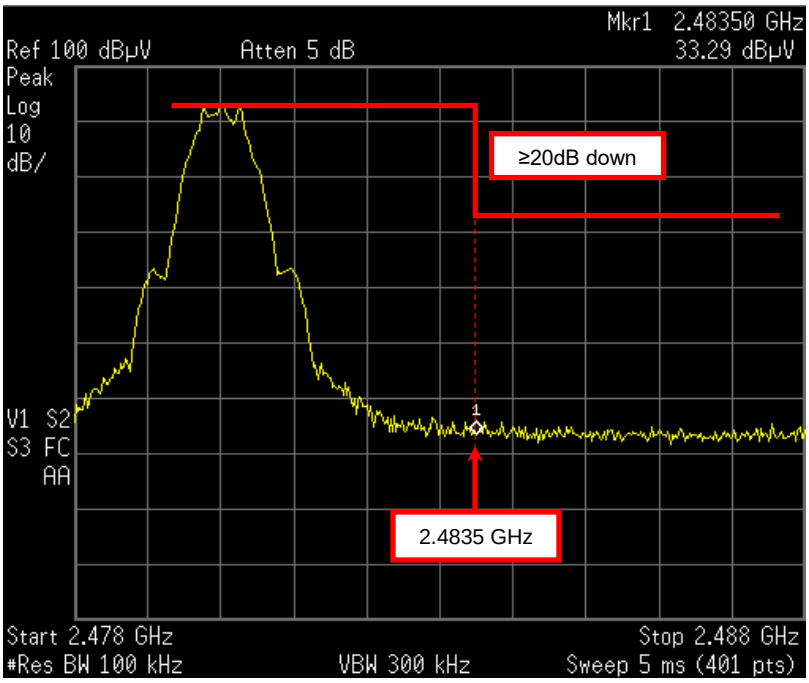
WiFi 802.11n 40MHz



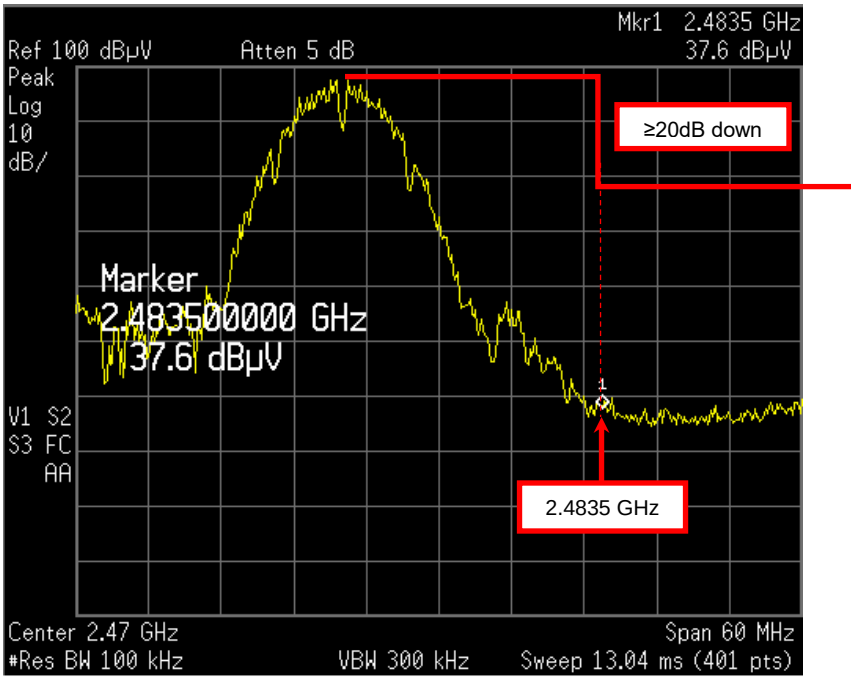
6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (High Channel)

BLE mode



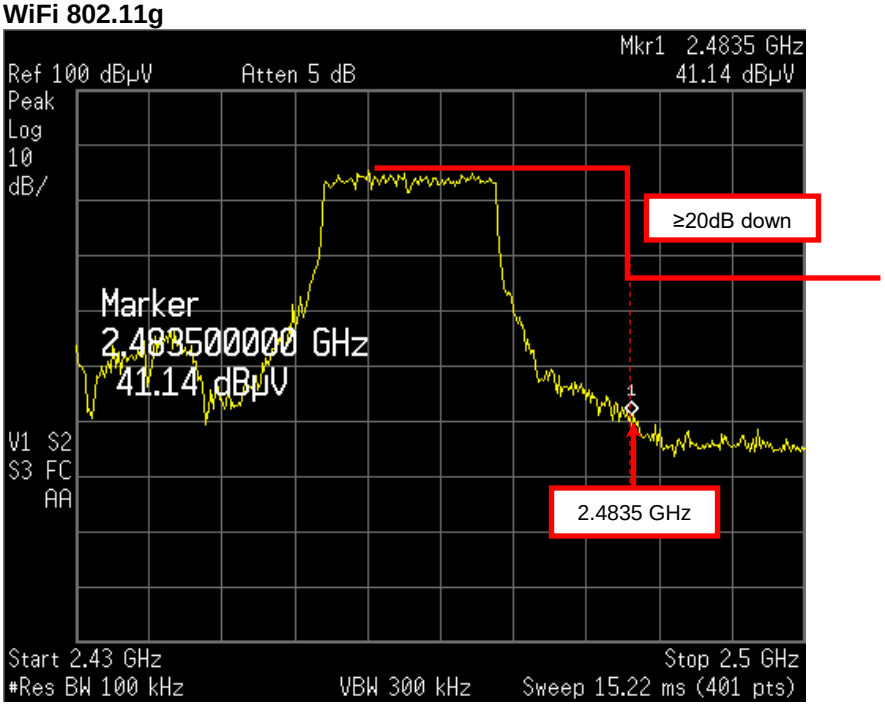
WiFi 802.11b



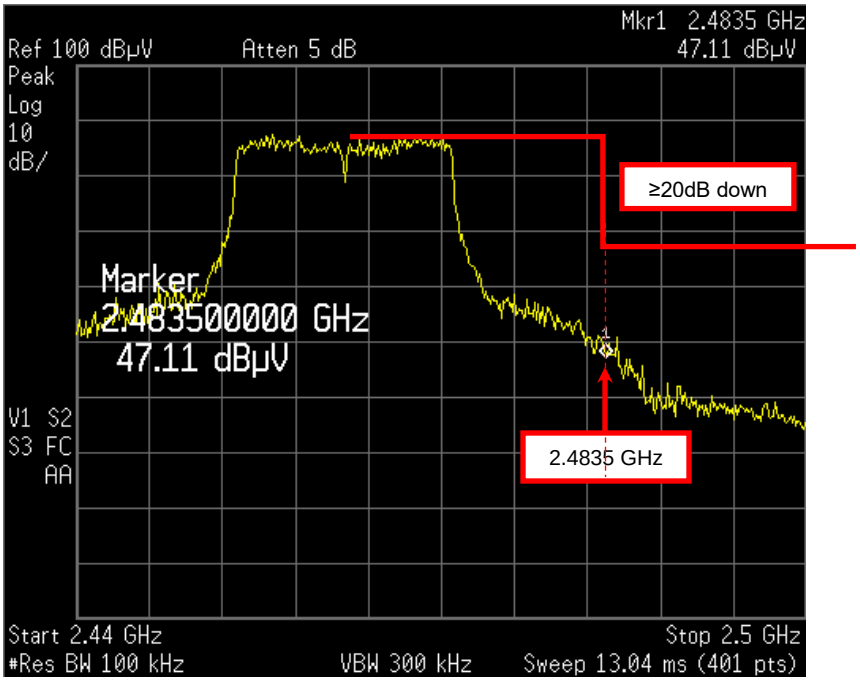
6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (High Channel)

WiFi 802.11g



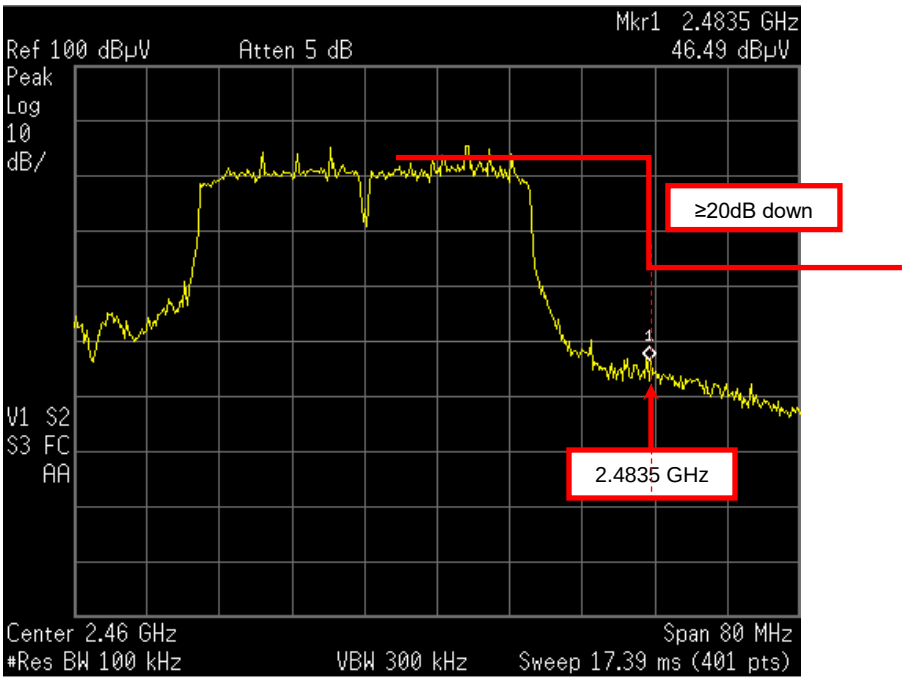
WiFi 802.11n 20MHz



6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (High Channel)

WiFi 802.11n 40MHz



6.4 100kHz Band Edge Measurement Conclusion

The EUT meets the 100kHz band edge measurement requirements of FCC 15.247 (d) and RSS-247, 5.5.

7.0 PEAK POWER SPECTRAL DENSITY

7.1 Applicable Standards

FCC 15.247 (e), RSS-247, 5.2 (b). For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3kHz band during any time of continuous transmission.

7.2 Measurement Procedure

- Place the EUT on a 1.5m high polystyrene stand and set it in continuous transmit mode with modulation.
- Set the spectrum analyzer RBW = 3kHz, VBW = 10kHz, Span = as needed, Sweep = Auto.
- Record the maximum reading.
- Repeat above procedures for the low, mid, and high frequency channels.

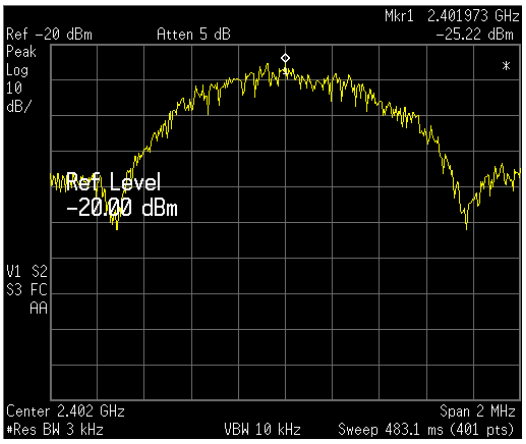
7.3 Peak Power Spectral Density Measurement Results

The peak power spectral density plots and test results are given on the following pages.

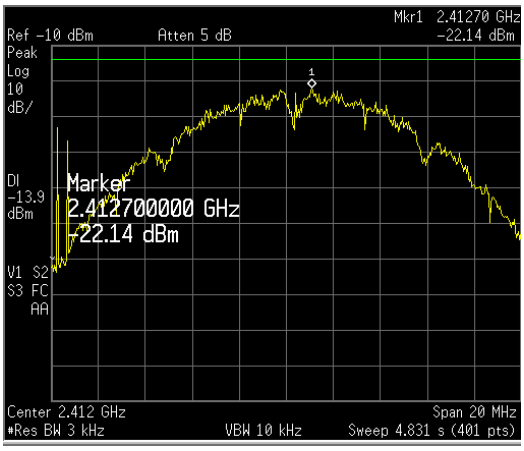
7.3 Peak Power Spectral Density Measurement Results (continued)

Power Spectral Density Test Plot (Low Channel)

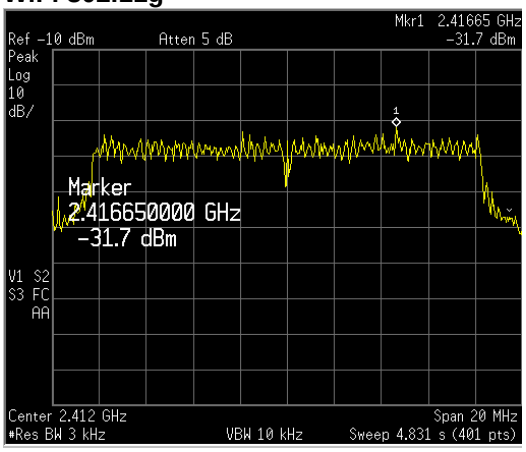
BLE mode



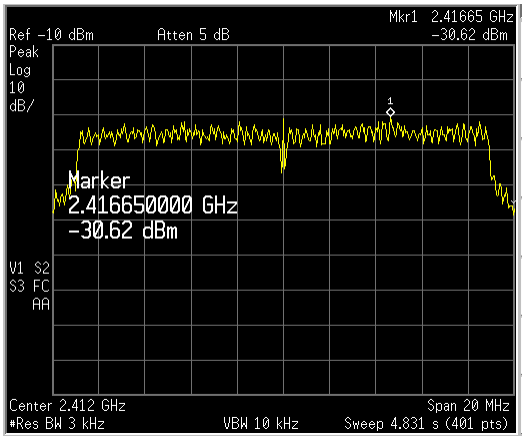
WiFi 802.11b



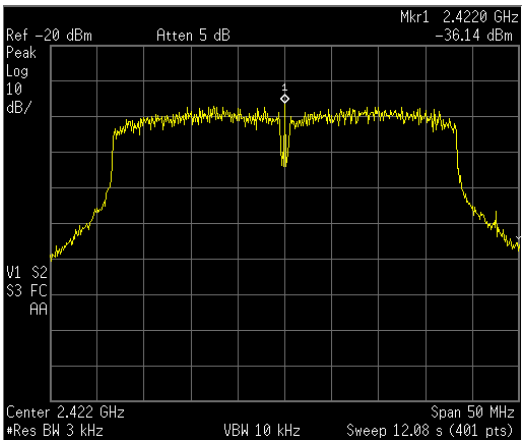
WiFi 802.11g



WiFi 802.11n 20MHz



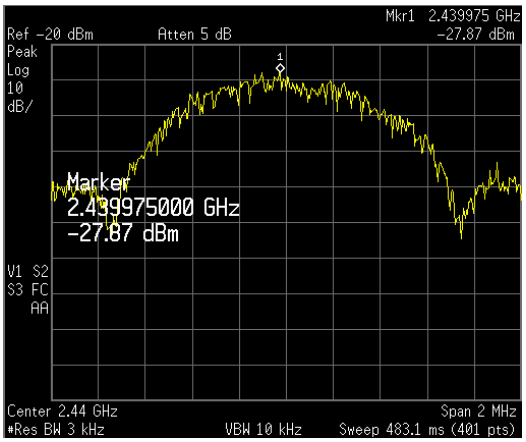
WiFi 802.11n 40MHz



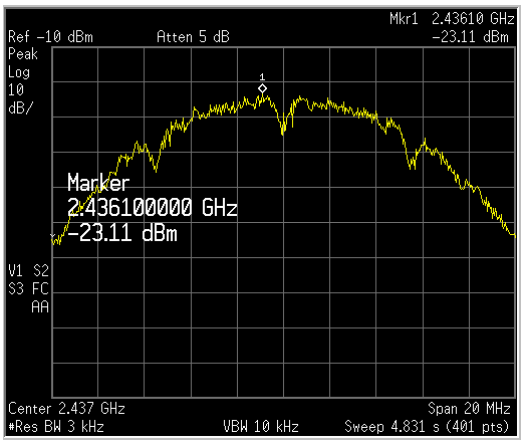
7.3 Peak Power Spectral Density Measurement Results (continued)

Power Spectral Density Test Plot (Mid Channel)

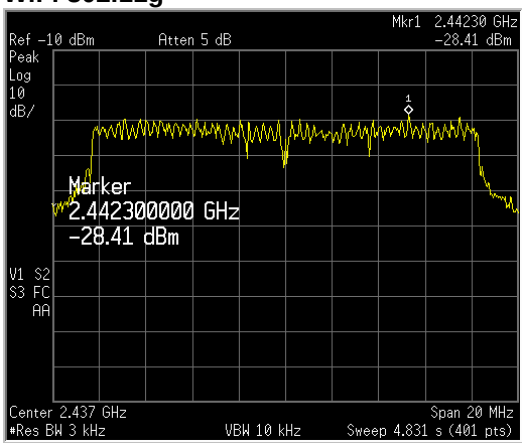
BLE mode



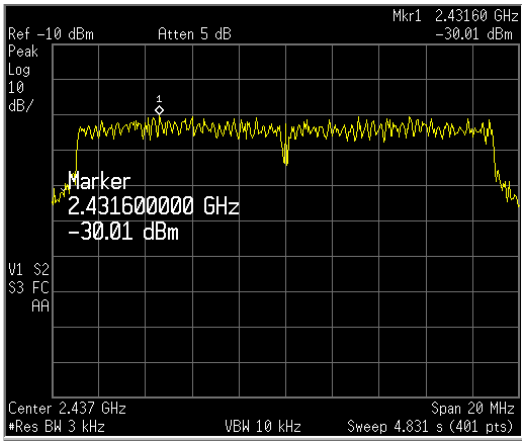
WiFi 802.11b



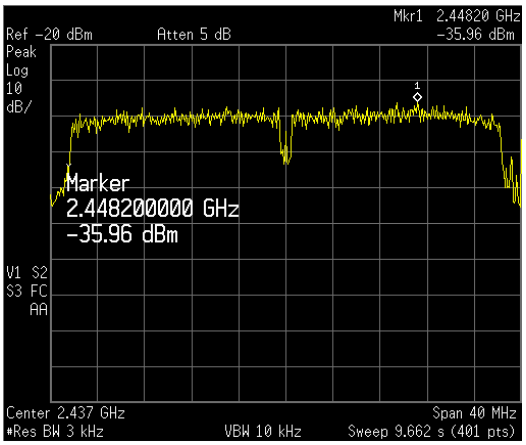
WiFi 802.11g



WiFi 802.11n 20MHz



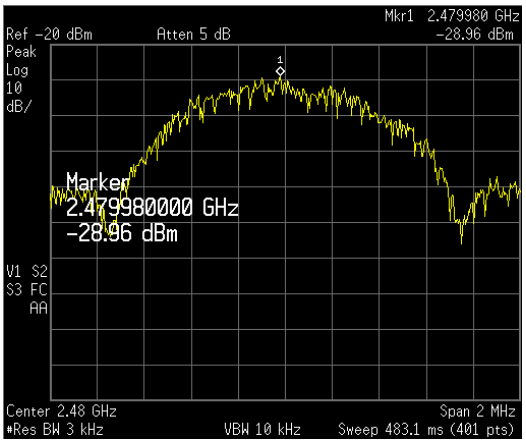
WiFi 802.11n 40MHz



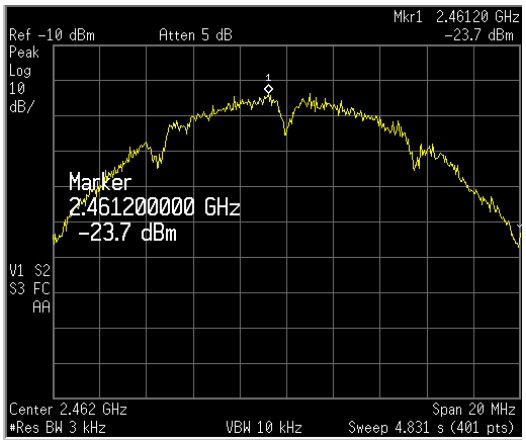
7.3 Peak Power Spectral Density Measurement Results (continued)

Power Spectral Density Test Plot (High Channel)

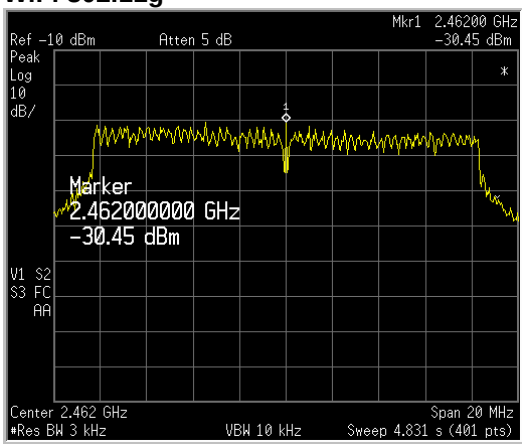
BLE mode



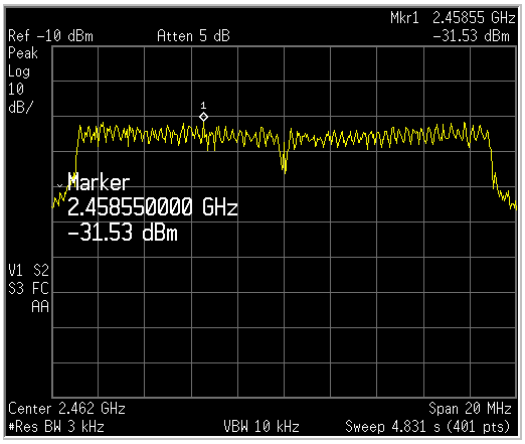
WiFi 802.11b



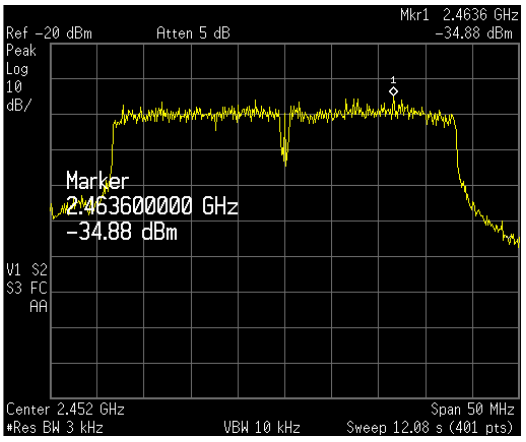
WiFi 802.11g



WiFi 802.11n 20MHz



WiFi 802.11n 40MHz



7.3 Peak Power Spectral Density Measurement Results (continued)

Channel	Operating Mode	Frequency (MHz)	Reading (dBm)	Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBm/m)	Field Strength (µV/m)	[1]Antenna Numerical	Calculation (mW)	[2]EIRP (dBm/MHz)	Limit (dBm/MHz)
Low	BLE	2402.0	-25.2	8.7	37.6	28.7	-25.4	11995	1.778	0.024	-16.1	8.0
Low, 1	WiFi 802.11b	2412.0	-22.1	8.7	37.6	28.7	-22.3	17100	1.778	0.049	-13.1	8.0
Low, 1	WiFi 802.11g	2412.0	-31.7	8.7	37.6	28.7	-31.9	5689	1.778	0.005	-22.6	8.0
Low, 1	WiFi 802.11n 20	2412.0	-30.6	8.7	37.6	28.7	-30.8	6442	1.778	0.007	-21.5	8.0
Low, 3	WiFi 802.11n 40	2422.0	-36.1	8.7	37.6	28.8	-36.2	3451	1.778	0.002	-27.0	8.0
Mid	BLE	2440.0	-27.9	8.8	37.6	28.8	-27.9	9047	1.778	0.014	-18.6	8.0
Mid, 6	WiFi 802.11b	2437.0	-23.1	8.8	37.6	28.8	-23.1	15649	1.778	0.041	-13.8	8.0
Mid, 6	WiFi 802.11g	2437.0	-28.4	8.8	37.6	28.8	-28.4	8502	1.778	0.012	-19.1	8.0
Mid, 6	WiFi 802.11n 20	2437.0	-30.0	8.8	37.6	28.8	-30.0	7071	1.778	0.008	-20.7	8.0
Mid, 6	WiFi 802.11n 40	2437.0	-36.0	8.8	37.6	28.8	-36.0	3565	1.778	0.002	-26.7	8.0
High	BLE	2480.0	-29.0	8.9	37.6	29.0	-28.7	8260	1.778	0.012	-19.4	8.0
High, 11	WiFi 802.11b	2462.0	-23.7	8.8	37.6	28.9	-23.6	14791	1.778	0.037	-14.3	8.0
High, 11	WiFi 802.11g	2462.0	-30.5	8.8	37.6	28.9	-30.4	6800	1.778	0.008	-21.1	8.0
High, 11	WiFi 802.11n 20	2462.0	-31.5	8.8	37.6	28.9	-31.4	6005	1.778	0.006	-22.2	8.0
High, 9	WiFi 802.11n 40	2452.0	-34.9	8.8	37.6	28.9	-34.8	4083	1.778	0.003	-25.5	8.0

[1]Antenna Numerical Gain (dBi = 10 log G)
[2]EIRP calculation of maximum peak conducted output power; ref: section 4.2 of this report

7.4 Peak Power Spectral Density Measurement Conclusion

The EUT meets the peak power spectral density requirements of FCC 15.247 (e) and RSS-247, 5.2 (b). The maximum power spectral density measured was -13.1 dBm which is under the 8 dBm limit.

8.0 UNINTENTIONAL/SPURIOUS RADIATED EMISSION TEST

8.1 Radiated Emissions

Preliminary testing was done in a ferrite lined shielded enclosure for frequency identification from the EUT. These scans are exploratory emission tests only that are voluntarily submitted. All final measurements were done on the OATS.

For the OATS testing, the EUT was placed on a turntable per ANSI C63.10, clause 6.3.1. The turntable was rotated 360 degrees to determine the position of maximum emission level. The EUT is set 3m away from the receiving antenna which was varied from 1m to 4m in height during the final OATS measurements, to find the highest emissions level. Each frequency of emission was maximized by changing the polarization of the receiving antenna both horizontal and vertical. In order to find out the maximum emissions, the relative positions of the transmitter (EUT) was rotated through three orthogonal axes according to the requirements in ANSI C63.10, clause 5.10.1.

8.2 Prescan Radiated Emissions

The radiated emissions prescan testing was performed in the 3 meter ferrite lined shielded chamber.

The EUT was placed on a 0.8m high polystyrene table for all measurements.

8.3 Prescan Measurement Procedure

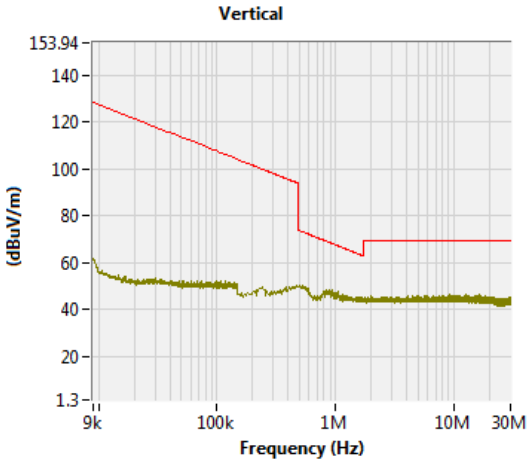
- Prescans from 9kHz to 26GHz were done in the ferrite-lined shielded chamber for EUT frequency identification. These scans are exploratory emission tests only that are voluntarily submitted.

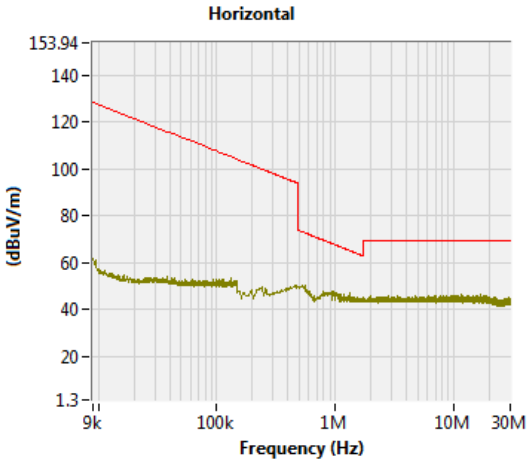
8.4 Prescan Measurement Results

The following plots show a summary of the prescan data that was collected.

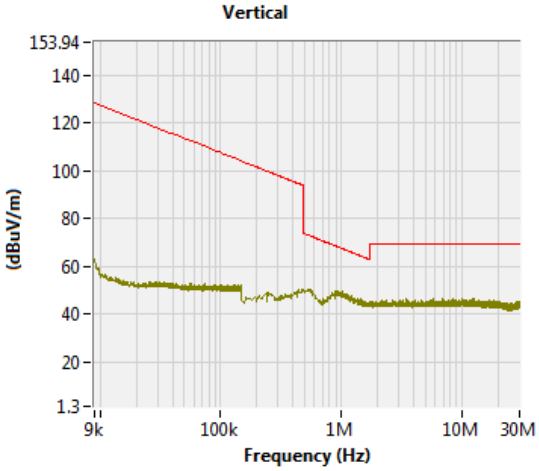
8.4 Pre-scan Measurement Results

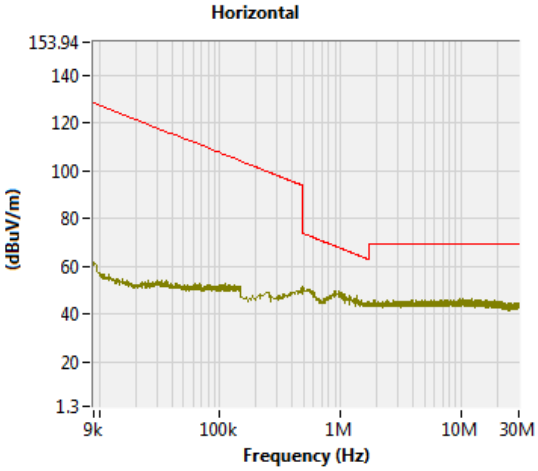
RE Prescan 9 kHz - 30 MHz Frequency - BLE mode





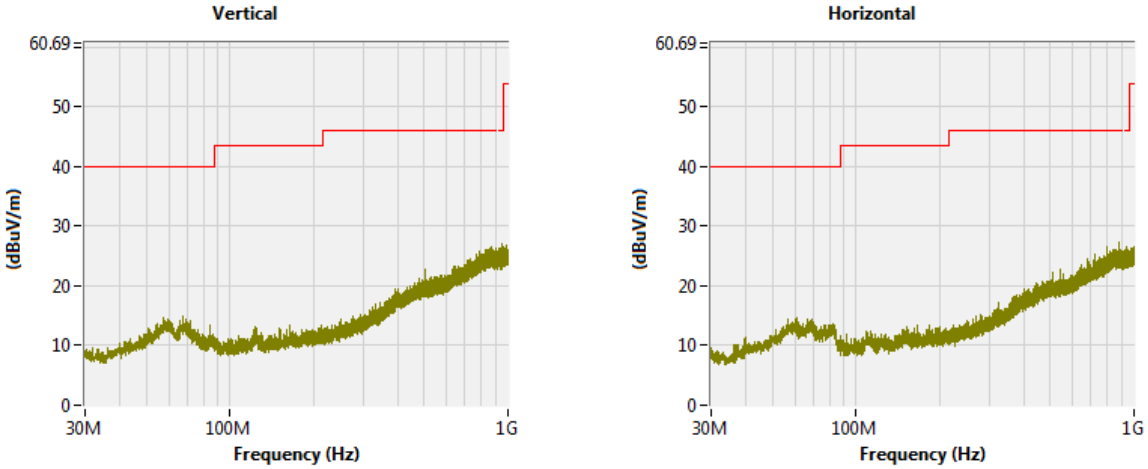
RE Prescan 9 kHz - 30 MHz Frequency - WiFi mode



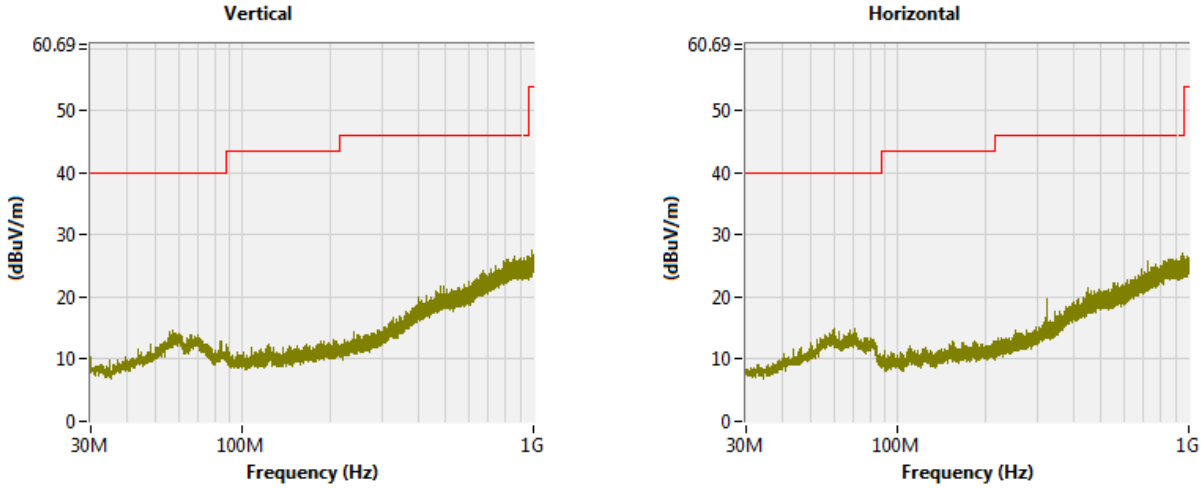


8.4 Pre-scan Measurement Results (continued)

RE Prescan 30M-1GHz - BLE mode

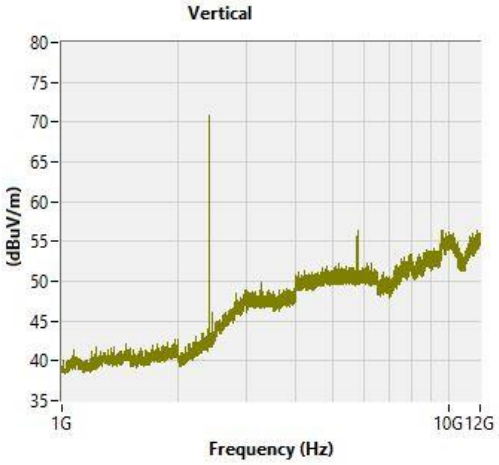


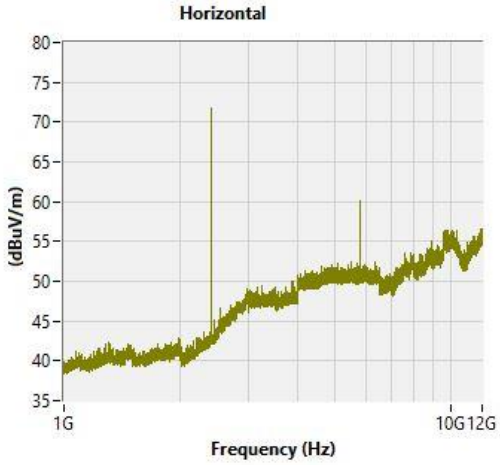
RE Prescan 30M-1GHz - WiFi mode



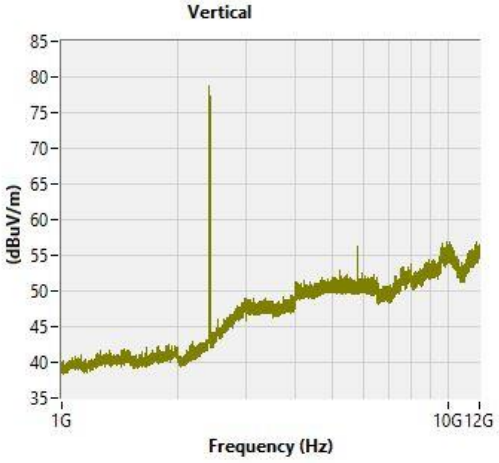
8.4 Pre-scan Measurement Results (continued)

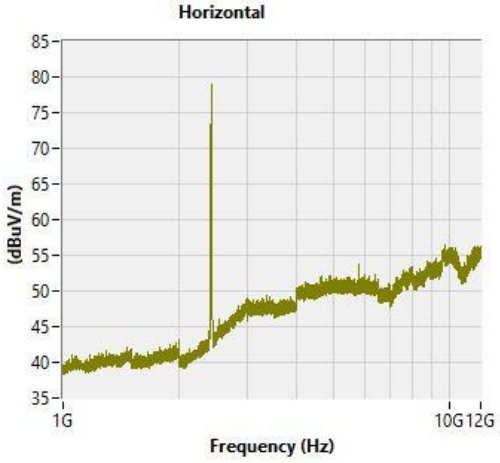
RE 1-12GHz Wagz Collar - BLE mode





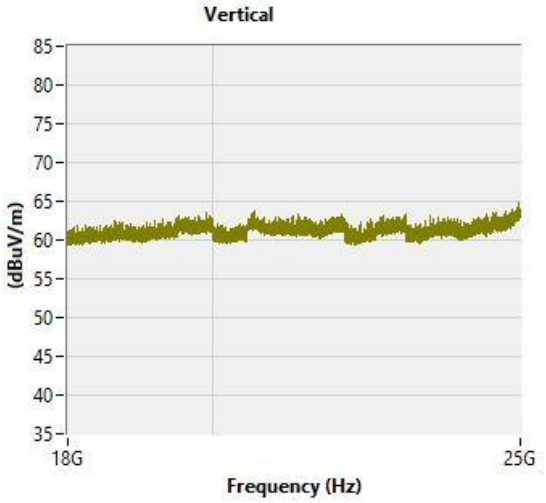
RE 1-12GHz Wagz Collar - WiFi mode

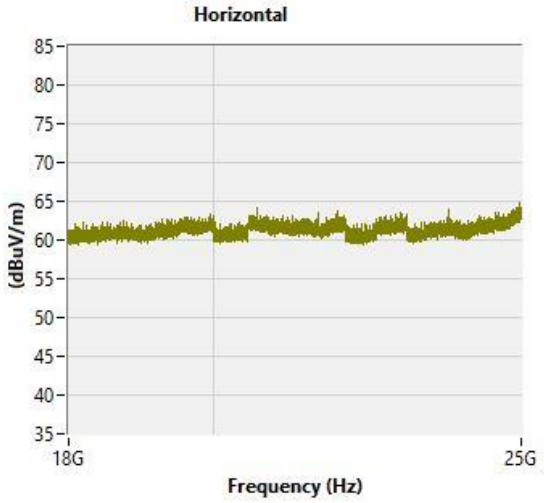




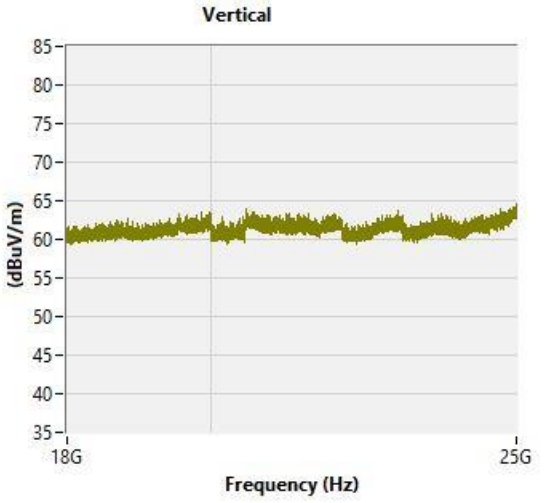
8.4 Pre-scan Measurement Results (continued)

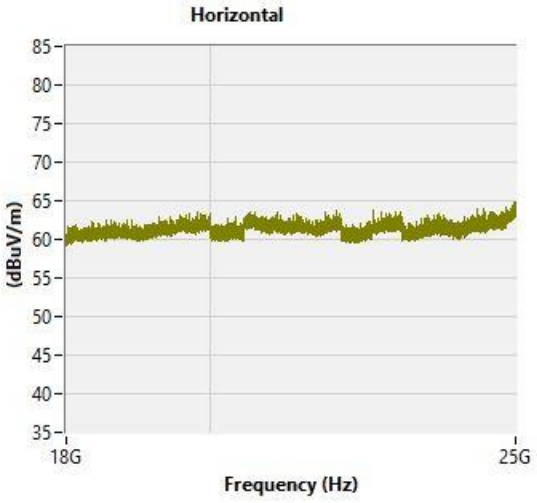
RE 18-25GHz Wagz Collar - BLE mode





RE 18-25GHz Wagz Collar - WiFi mode





8.5 Radiated Emissions Applicable Standards

FCC 15.209 (a) – (f), RSS-GEN, 8.9. Emissions outside the authorized bands shall not exceed the radiated emission limits specified in FCC 15.209(a) – (f) and RSS-GEN, 8.9, and according to FCC 15.33(a)(1) and ANSI C63.10, section 5.5, for an intentional radiator operating below 10GHz, the frequency range of measurements shall encompass from the lowest frequency generated in the device or at least 30MHz to the tenth harmonic of the highest fundamental frequency or 40GHz, whichever is lower.

8.6 Radiated Emissions EUT Setup

The radiated emission tests were performed on the 3 meter open area test site.

The EUT was placed on an 80cm polystyrene table for measurements up to and including 1GHz and it was placed on a 1.5m high polystyrene stand for measurements above 1GHz.

8.7 Radiated Emissions Measurement Procedure

- The 80cm polystyrene table and 1.5m stand, when used, was placed on a turntable which is flush with the ground plane.
- The turntable was rotated 360 degrees to determine the position of maximum emission level.
- The EUT was 3m away from the receiving antenna which was varied from 1m to 4m to obtain the maximum emissions level.
- The data was recorded for at least the six highest emissions to ensure EUT compliance.
- Each emission was maximized by changing the polarization of the receiving antenna both horizontal and vertical.
- Emissions were measured with the EUT transmitting at the low, mid, and high frequencies with modulation applied.

8.8 Radiated Emissions Test Setup Photos

Refer to photos in the Tsup document.

8.9 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CL - AG$$

Where:
FS = Field Strength
RA = Reading Amplitude
AF = Antenna Factor
CL = Cable Attenuation Factor (Cable Loss)
AG = Amplifier Gain

8.10 Limit Extrapolation Method for Frequencies Below 30MHz

For radiated emissions results below 30MHz, the limit was adjusted based on a 40dB/decade extrapolation factor for distance (Reference: FCC Part 15.31 f 2). The field strength limit is calculated and converted to dBµV/m and then the 3m Limit Adjustment was added to this to get the 3 meter limit shown in the 9kHz - 30MHz results tables.

Frequency (MHz)	Field strength limit (microvolts/meter)	Measurement distance (meters)	3m Limit Adjustment (dB)	3m Limit (dBµV/m)
0.009-0.490	2400/F(kHz)	300	80	128.5 - 93.8
0.490-1.705	24000/F(kHz)	30	40	73.8 – 62.9
1.705-30.0	30	30	40	69.5 – 69.5
30.0	100	3	N/A	40.0

For example: At 32 kHz, the field strength limit is 2400/32 = 75 µV/m. This converts to 37.5 dBµV/m. To this is added the 3m Limit Adjustment of 80dB. Therefore, the 3m limit at 32 kHz is 117.5 dBµV/m.

8.12 Worst-case mode and orientation determination

The worst-case BLE and worst-case WiFi modes were tested for spurious and unintentional emissions. These operating modes gave the highest intentional transmitted emissions at the transmit frequencies. These modes were as follows:
BLE transmitting on Channel 1, 2402MHz
WiFi transmitting on Channel 1, 2412MHz

The worst-case orientation is with the collar standing up as shown in the Test Setup.

8.13 Measurement Result – Radiated Emissions Data Tables

The data tables on the following page show the Radiated Emissions test results.

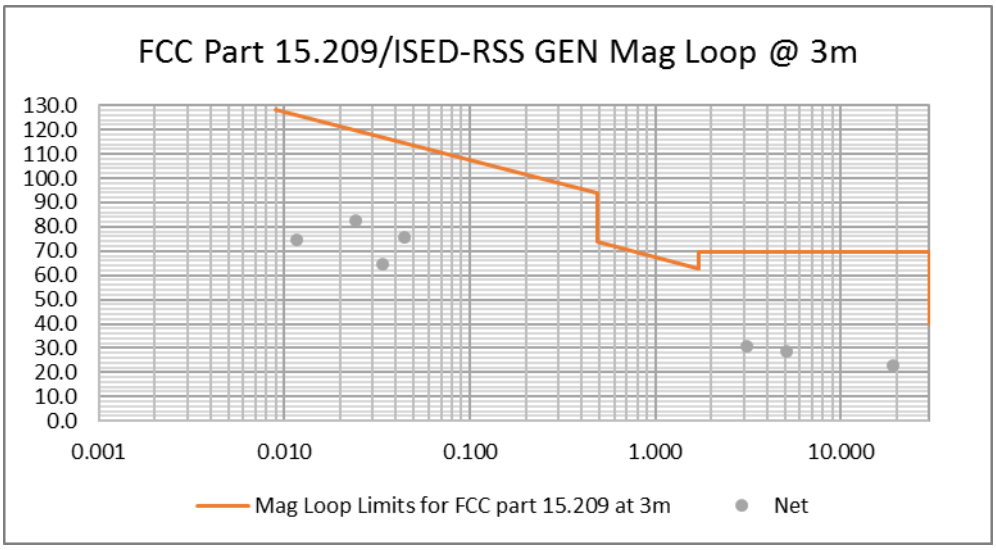
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

3-Meter Magnetic Loop Radiated Emissions Results

Date:	3/31/2019
Test Engineer:	KM
Customer:	Swanson Assoc.
Product:	Wagz Smart Collar
Configuration:	BLE Channel 0 2402 Mhzwith USB adapter
EUT Voltage:	Battery
Temperature (°C):	20.6
Relative Humidity (%):	44
Test Distance:	**3 meters**
Frequency Range:	**9kHz-30MHz**
Antenna Asset #:	**103**
Detector used:	**Quasi-peak (QP) for all except as follows: Average (AVG) 9-90kHz and 110-490kHz**
Antenna Polarity:	**V=plane of loop perpendicular to EUT face; H=plane of loop parallel to EUT face**

Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Frequency (MHz)	Detector (QP or AV)	Reading (dBµV)	Mag Loop E Factor (dB)	25m Cable Factor (dB)	Net (dBµV/m)	FCC 15.209 Limit (dBµV/m)	FCC 15.209 Margin (dBµV/m)	ISED RSS-GEN Limit (dBµV/m)	ISED RSS-GEN Margin (dBµV/m)
315.0	1.0	V	0.012	AV	59.7	15.2	0.0	74.9	126.2	-51.3	126.2	-51.3
22.5	1.0	V	0.024	AV	67.6	14.8	0.0	82.5	120.0	-37.5	120.0	-37.5
0.0	1.0	V	0.034	AV	49.7	15.1	0.0	64.8	117.0	-52.2	117.0	-52.2
315.0	1.0	V	0.044	AV	61.2	14.5	0.0	75.8	114.7	-38.9	114.7	-38.9
270.0	1.0	H	3.102	QP	16.1	14.2	0.2	30.5	69.5	-39.0	69.5	-39.0
45.0	1.0	H	5.090	QP	14.1	14.3	0.2	28.6	69.5	-40.9	69.5	-40.9
315.0	1.0	H	19.000	QP	7.9	14.5	0.5	22.9	69.5	-46.6	69.5	-46.6

Scanned: 9kHz-30MHz



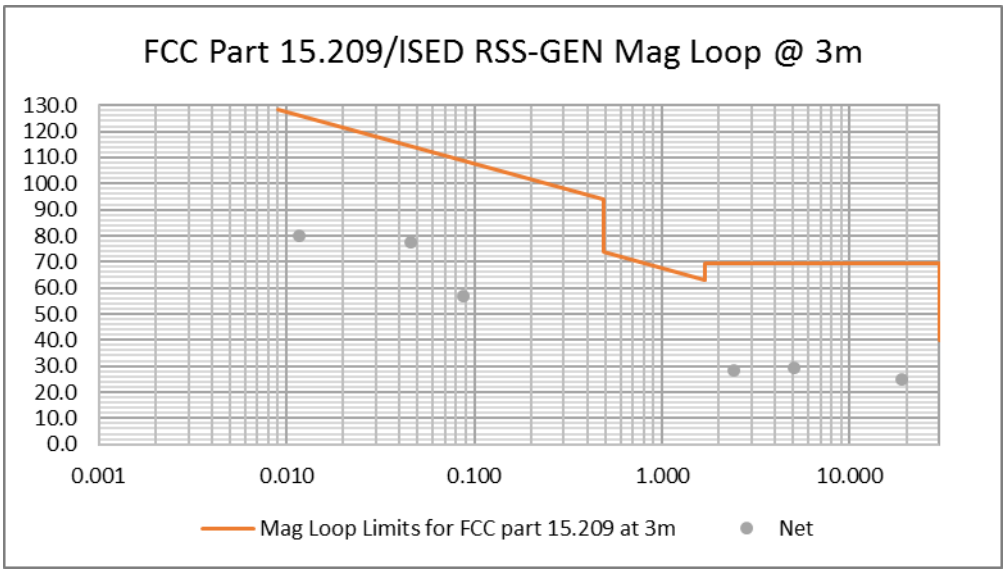
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

3-Meter Magnetic Loop Radiated Emissions Results

Date:	3/31/2019
Test Engineer:	KM
Customer:	Swanson Assoc.
Product:	Wagz Smart Collar
Configuration:	802.11B Channel 1, 2412
EUT Voltage:	Battery
Temperature (°C):	20.6
Relative Humidity (%):	44
Test Distance:	**3 meters**
Frequency Range:	**9kHz-30MHz**
Antenna Asset #:	**103**
Detector used:	**Quasi-peak (QP) for all except as follows: Average (AVG) 9-90kHz and 110-490kHz**
Antenna Polarity:	**V=plane of loop perpendicular to EUT face; H=plane of loop parallel to EUT face**

Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Frequency (MHz)	Detector (QP or AV)	Reading (dBµV)	Mag Loop E Factor (dB)	25m Cable Factor (dB)	Net (dBµV/m)	FCC 15.209 Limit (dBµV/m)	FCC 15.209 Margin (dBµV/m)	ISED RSS-GEN Limit (dBµV/m)	ISED RSS-GEN Margin (dBµV/m)
90.0	1.0	V	0.012	AV	64.6	15.2	0.0	79.8	126.2	-46.4	126.2	-46.4
90.0	1.0	V	0.046	AV	63.1	14.5	0.0	77.6	114.4	-36.8	114.4	-36.8
315.0	1.0	V	0.088	AV	42.7	14.2	0.0	56.9	108.7	-51.8	108.7	-51.8
270.0	1.0	V	2.418	QP	13.8	14.3	0.2	28.3	69.5	-41.3	69.5	-41.3
270.0	1.0	H	5.090	QP	14.7	14.3	0.2	29.2	69.5	-40.3	69.5	-40.3
315.0	1.0	H	19.000	QP	9.8	14.5	0.5	24.8	69.5	-44.7	69.5	-44.7

Scanned: 9kHz-30MHz



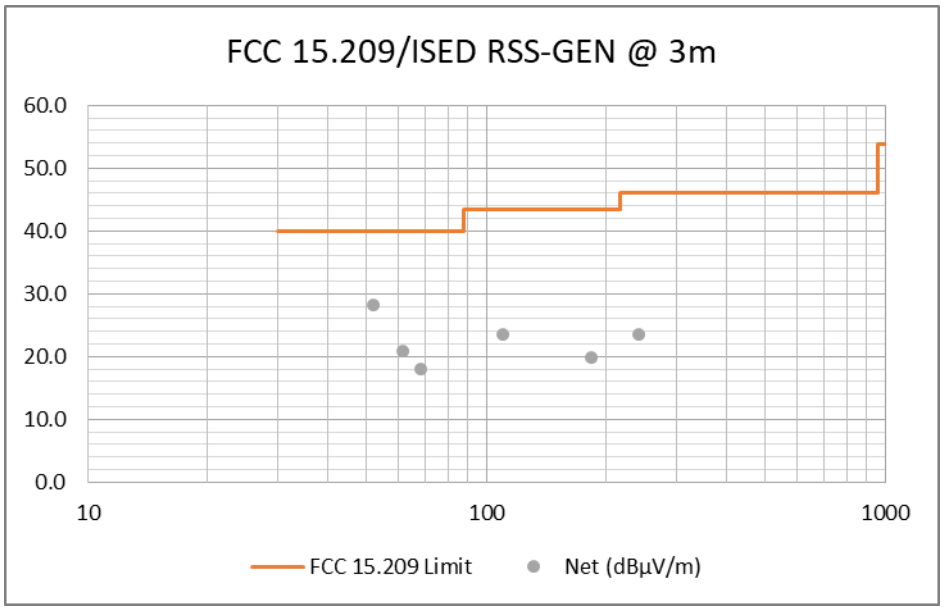
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

3-Meter Radiated Emissions Results

Date: 3/31/2019
Test Engineer: KM
Customer: Wagz
Product: Smart Collar
Configuration: BLE, Channel 0, 2402MHz
EUT Voltage: Internal batteries
Temperature (°C): 19.6
Relative Humidity (%): 55
Test Distance: **3 meters**
Frequency Range: **30-1000MHz**
Antenna Asset #: **17**

Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Frequency (MHz)	QP Reading (dBµV)	3m Antenna Factor (dB)	25m Cable Factor (dB)	Net (dBµV/m)	FCC Class B QP Limit (dBµV/m)	FCC Part 15.209 QP Limit (dBµV/m)	FCC Part 15.209 QP Margin (dBµV/m)	ISED RSS-GEN QP Limit (dBµV/m)	ISED RSS-GEN QP Margin (dBµV/m)
135.0	1.0	V	52.1	15.4	12.1	0.8	28.3	40.0	40.0	-11.7	40.0	-11.7
22.5	1.0	V	61.6	9.9	10.1	0.9	21.0	40.0	40.0	-19.0	40.0	-19.0
315.0	1.0	V	68.5	6.7	10.3	1.0	17.9	40.0	40.0	-22.1	40.0	-22.1
157.5	1.0	V	109.8	6.2	16.2	1.2	23.6	43.5	43.5	-19.9	43.5	-19.9
22.5	1.0	V	183.0	5.0	13.4	1.5	19.9	43.5	43.5	-23.6	43.5	-23.6
90.0	1.7	V	241.5	5.7	16.0	1.8	23.5	46.0	46.0	-22.5	46.0	-22.5

NOTES:
RBW=120kHz
Scanned 30-1000 MHz



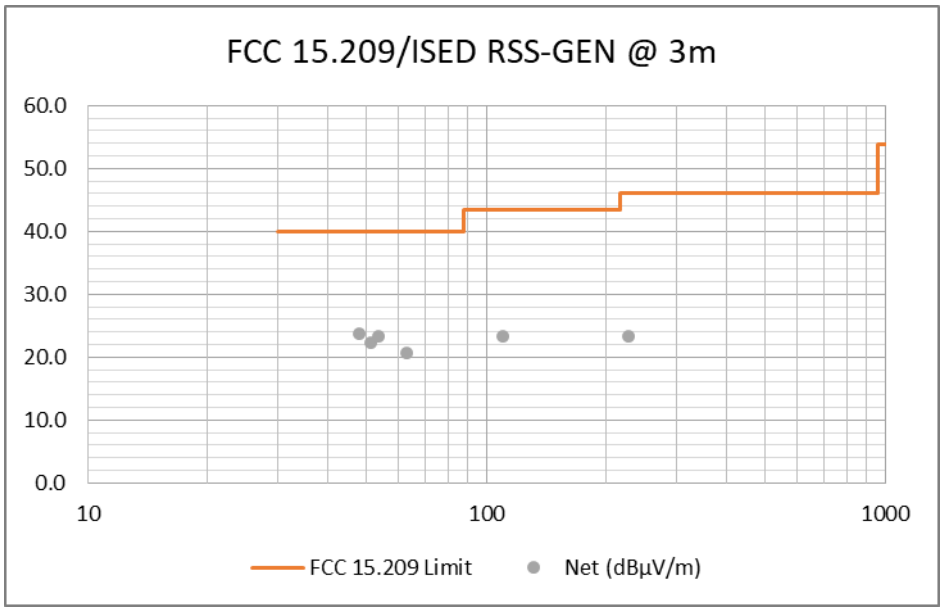
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

3-Meter Radiated Emissions Results

Date: 3/31/2019
Test Engineer: KM
Customer: Wagz
Product: Smart Collar
Configuration: WiFi 802.11b, Low Channel 1, 2412MHz
EUT Voltage: Internal batteries
Temperature (°C): 20.6
Relative Humidity (%): 46
Test Distance: **3 meters**
Frequency Range: **30-1000MHz**
Antenna Asset #: **17**

Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Frequency (MHz)	QP Reading (dBµV)	3m Antenna Factor (dB)	25m Cable Factor (dB)	Net (dBµV/m)	FCC Part 15.209 QP Limit (dBµV/m)	FCC Part 15.209 QP Margin (dBµV/m)	ISED RSS-GEN QP Limit (dBµV/m)	ISED RSS-GEN QP Margin (dBµV/m)
135.0	1.0	V	47.9	9.2	13.8	0.8	23.7	40.0	-16.3	40.0	-16.3
270.0	1.0	V	51.3	9.1	12.4	0.8	22.3	40.0	-17.7	40.0	-17.7
315.0	1.0	V	53.5	10.8	11.7	0.8	23.3	40.0	-16.7	40.0	-16.7
315.0	1.0	V	63.0	9.7	10.1	0.9	20.7	40.0	-19.3	40.0	-19.3
90.0	1.0	V	109.8	5.9	16.2	1.2	23.3	43.5	-20.2	43.5	-20.2
202.5	1.8	H	226.5	6.8	14.7	1.7	23.3	46.0	-22.7	46.0	-22.7

NOTES:
RBW=120kHz
Scanned 30-1000 MHz



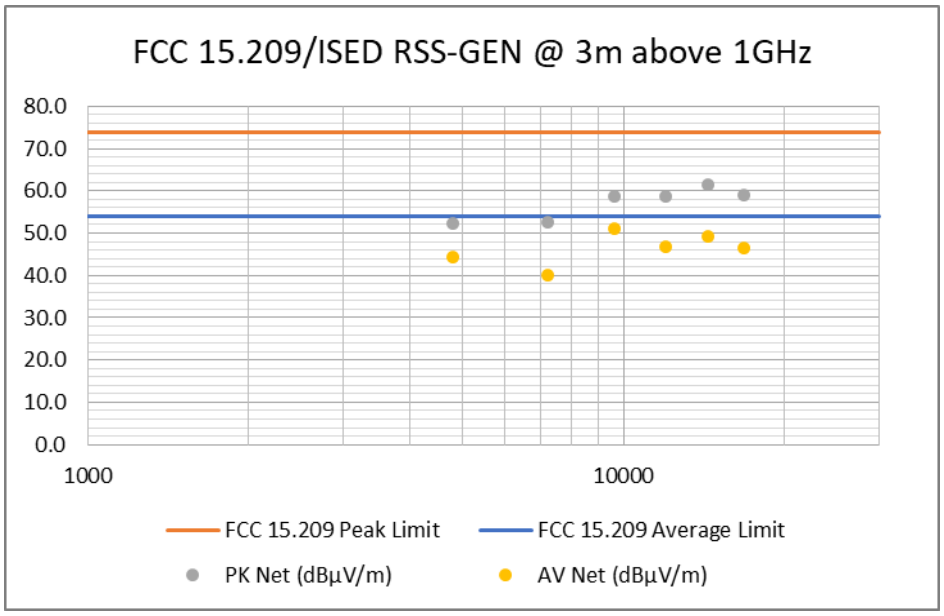
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

3-Meter Radiated Emissions Results 1-25GHz

Date: 3/28/2019
Test Engineer: GC
Customer: Wagz
Product: Smart Collar
Configuration: BLE, Channel 1, 2402MHz
EUT Voltage: Internal batteries
Temperature (°C): 20.4
Relative Humidity (%): 33
Test Distance: 3 meters
Frequency Range: >1.0 GHz
Antenna Asset #: 126 and 133

Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Frequency (MHz)	PK Reading (dBµV)	AV Reading (dBµV)	3m Antenna Factor (dB)	25m Cable Factor (dB)	8m Cable Factor (dB)	HP8449B Factor (dB)	PK Net (dBµV/m)	AV Net (dBµV/m)	FCC Part 15.209 PK Limit (dBµV/m)	FCC Part 15.209 PK Margin (dBµV/m)	FCC Part 15.209 AV Limit (dBµV/m)	FCC Part 15.209 AV Margin (dBµV/m)	ISED RSS-GEN PK Limit (dBµV/m)	ISED RSS-GEN PK Margin (dBµV/m)	ISED RSS-GEN AV Limit (dBµV/m)	ISED RSS-GEN AV Margin (dBµV/m)
0.0	1.8	V	4803.8	43.8	36.0	32.9	8.6	4.3	37.4	52.2	44.4	73.9	-21.7	53.9	-9.5	73.9	-21.7	53.9	-9.5
0.0	1.8	V	7205.9	35.7	23.2	38.5	10.5	5.5	37.6	52.5	40.0	73.9	-21.4	53.9	-13.9	73.9	-21.4	53.9	-13.9
225.0	1.5	V	9607.8	40.0	32.6	37.8	12.4	6.5	38.1	58.6	51.2	73.9	-15.3	53.9	-2.7	73.9	-15.3	53.9	-2.7
225.0	1.5	V	12009.8	34.8	22.9	39.5	14.1	7.6	37.4	58.6	46.7	73.9	-15.3	53.9	-7.2	73.9	-15.3	53.9	-7.2
225.0	1.8	V	14411.9	31.5	19.3	41.5	16.2	8.3	36.1	61.4	49.2	73.9	-12.5	53.9	-4.7	73.9	-12.5	53.9	-4.7
0.0	1.5	V	16813.8	26.3	13.9	41.5	17.8	9.3	36.0	58.9	46.5	73.9	-15.0	53.9	-7.4	73.9	-15.0	53.9	-7.4

NOTES:
RBW=1MHz
Scanned 1 to 25 GHz
8m Cable Factor using Asset #154, dark green 8m cable.



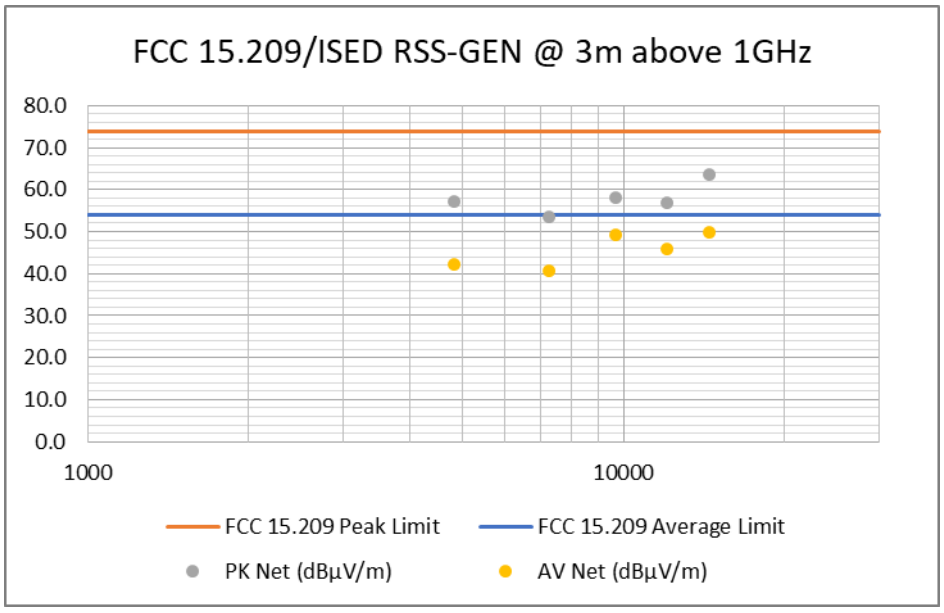
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

3-Meter Radiated Emissions Results 1-25GHz

Date: 3/29/2019
Test Engineer: ER
Customer: Wagz
Product: Smart Collar S/N 1904190139
Configuration: WiFi 802.11b, Low Channel 1, 2412MHz
EUT Voltage: Internal batteries
Temperature (°C): 21.9
Relative Humidity (%): 38
Test Distance: 3 meters
Frequency Range: >1.0 GHz
Antenna Asset #: 126 and 133

Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Frequency (MHz)	PK Reading (dBµV)	AV Reading (dBµV)	3m Antenna Factor (dB)	25m Cable Factor (dB)	8m Cable Factor (dB)	HP8449B Factor (dB)	PK Net (dBµV/m)	AV Net (dBµV/m)	FCC Part 15.209 PK Limit (dBµV/m)	FCC Part 15.209 PK Margin (dBµV/m)	FCC Part 15.209 AV Limit (dBµV/m)	FCC Part 15.209 AV Margin (dBµV/m)	ISED RSS-GEN PK Limit (dBµV/m)	ISED RSS-GEN PK Margin (dBµV/m)	ISED RSS-GEN AV Limit (dBµV/m)	ISED RSS-GEN AV Margin (dBµV/m)
135.0	1.7	V	4824.0	48.6	33.8	33.0	8.6	4.3	37.4	57.1	42.3	73.9	-16.8	53.9	-11.6	73.9	-16.8	53.9	-11.6
135.0	1.6	V	7244.4	36.4	23.8	38.6	10.5	5.5	37.7	53.4	40.8	73.9	-20.5	53.9	-13.1	73.9	-20.5	53.9	-13.1
135.0	1.4	V	9648.0	39.4	30.6	37.8	12.4	6.5	38.1	58.0	49.2	73.9	-15.9	53.9	-4.7	73.9	-15.9	53.9	-4.7
0.0	1.0	V	12060.0	32.7	21.9	39.5	14.2	7.6	37.3	56.7	45.9	73.9	-17.2	53.9	-8.0	73.9	-17.2	53.9	-8.0
0.0	1.3	V	14472.7	33.3	19.7	41.7	16.3	8.3	36.1	63.4	49.8	73.9	-10.5	53.9	-4.1	73.9	-10.5	53.9	-4.1

NOTES:
RBW=1MHz
Scanned 1 to 25 GHz
8m Cable Factor using Asset #154, dark green 8m cable.



8.14 Unintentional/Spurious Radiated Emissions Measurement Conclusion

The EUT meets the unintentional/spurious radiated emissions requirements of FCC 15.209 (a) through (f) and RSS-GEN, 8.9. The worst-case unintentional/spurious radiated emission measured was 51.2 dBµV/m (AV) at 9607.8MHz. The FCC/RSS-GEN limit at that frequency is 53.9 dBµV/m (500.0 microvolts/meter).

9.0 ANTENNA REQUIREMENT

9.1 Applicable Standards

FCC 15.203, 15.247 (4) (i), RSS-GEN, 6.8, RSS-247, 5.4 (f) (ii). An intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

Systems operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

9.2 Antenna Connected Construction

The directional gain of the antenna used for transmitting is 2.5dBi (max), and the antenna is permanently mounted to the EUT with no consideration of replacement.

9.3 Antenna Requirement Conclusion

The EUT antenna meets the requirements of FCC 15.203, 15.247 (4) (i), RSS-GEN, 6.8, and RSS-247, 5.4 (f) (ii).

10.0 MAXIMUM PERMISSIBLE EXPOSURE

10.1 Applicable Standards

FCC Part 2.1091, KDB 447498 D01 General RF Exposure Guidance v06
ISED RSS-102, Issue 5, Section 2.5
An intentional radiator shall be evaluated for radiofrequency radiation exposure to persons. This EUT is considered a mobile device in that it is intended to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure and the body of the user or nearby persons.

10.2 MPE Calculations

FCC Part 2.1091, KDB 447498 D01 General RF Exposure Guidance v06
SAR test exclusion guidance is given in KDB 447498 D01 General RF Exposure Guidance v06. It states that for 100 MHz to 6 GHz and test separation distances > 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

KDB 447498 D01, 4.3.1, b), 2):
{[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm) X 10]} mW, for > 1500 MHz and ≤ 6 GHz

- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is > 50 mm, and for transmission frequencies between 100 MHz and 6 GHz.

The above equation was used to determine the 1-g and 10-g SAR exclusion thresholds. The worst-case peak power measurements were used. A worst-case separation distance of 200 mm was used in the above equation.

10.2 MPE Calculations (continued)

RSS-102, Issue 5, section 2.5.1
SAR test exclusion guidance is given in RSS-102, Issue 5, section 2.5.1, Table 1. Using the column for test separation distances ≥ 50 mm, and using linear interpolation to determine the exemption limit, the following was determined:

- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The worst-case peak power measurements were used. A worst-case separation distance of 200 mm was used.

10.2 MPE Calculations (continued)

FCC Part 2.1091, KDB 447498 D01 General RF Exposure Guidance v06

Operating Mode	Channel	Frequency (MHz)	Output Power (mW)	Test Separation Distance (mm)	SAR Test Exclusion Thresholds (mW)	Result
BLE	Mid	2440	1	200.00	1596	EXCLUDED
WiFi b	Low, 1	2412	4	200.00	1597	EXCLUDED
LTE		1720-1745	218	200.00	1614	EXCLUDED

RSS-102, Issue 5, section 2.5.1

Operating Mode	Channel	Frequency (MHz)	Output Power (mW)	Test Separation Distance (mm)	SAR Test Exemption Limit (mW)	Result
BLE	Mid	2440	1	≥50mm	311	EXCLUDED
WiFi b	Low, 1	2412	4	≥50mm	317	EXCLUDED
LTE		1720-1745	218	≥50mm	380	EXCLUDED

10.3 MPE Conclusion

Since the worst-case output power is below the SAR test exclusion power thresholds, the EUT is excluded from the SAR evaluation.

11.0 Conducted Emissions Tests

11.1 Object of Conducted Emissions

The purpose of this test is to measure the conducted electromagnetic emissions on the AC power lines, pursuant to FCC Part 15.207 and ISED RSS-GEN, Issue 5, section 8.0 requirements.

11.2 Conducted Emissions Test Procedure

The EUT was tested as described ANSI C63.10. Testing is performed at a workstation with the EUT placed on a table 80 cm in height that is positioned 40 cm from a vertical coupling plane. Each individual current-carrying power lead is individually connected through a 50Ω/50µH Line Impedance Stabilization Network (LISN). The EUT is set into operation such that all parts of the system are exercised, while the RF voltages across the 50Ω measuring port of the LISN are recorded. The test is repeated for each current-carrying power line of the EUT.

11.3 Conducted Emissions Terms and Calculation

The following is a description of terms and a sample calculation, as appears in the Conducted Emissions Data Table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading: This is the reading obtained on the receiver in dBµV. Any external attenuators used are taken into account through internal analyzer settings.

Limit: This is the Conducted Emission limit (in units of dBµV).

Margin: This is the margin of compliance below the limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.
Below is an example of an emission measuring 45 dBµV on the receiver at 5.14 MHz.
Note: This example shows a passing result (i.e. a negative margin).

Example only:

Frequency	Reading	LISN Factor	Cable Factor	Limit	Margin
0.4MHz	45dBµV	9.83dB	0.01dB	66.0dBµV	-11.2dBµV

11.4 Deviations from Test Method:

None

11.5 Measurement Result – Conducted Emissions Data Tables (continued)

11.6 Conducted Emissions Limits

Frequency (MHz)	Quasi-Peak (dBμV)	Average (dBμV)
0.150 to 0.50	66 to 56	56 to 46
.50 to 5.0	56	46
5.0 to 30	60	50

Notes: For the table shown above, the stricter limit applies at the frequency transition points.

11.7 Conducted Emissions Test Summary

Type	Input Voltage/Frequency	Results
Mains	120V/60Hz	Passed

11.8 Results:

The EUT met the FCC Part 15.207 and ISED RSS-GEN, Issue 5, section 8.0 Conducted Emissions requirements. See Section 11.10 for data tables.

Worst-case emissions measured:

Modifications	Class Conducted Emissions
None	Passed: 36.4dBμV at 0.652 MHz Line Voltage: 120V, 60Hz Configuration: Line

The above results pertain only to the specific item submitted for testing, identified by the product's model and serial numbers.

11.9 Modifications: None

11.10 Measurement Result – Conducted Emissions Data Tables

FCC Part 15.207 / ISED RSS-GEN Conducted Emissions Results

Date: 4/1/2019
Test Engineer: KM
Customer: Swanson Assoc.
Product: Wagz Smart Collar with Samsung AC adapter
Configuration: BLE Channel 0
EUT Voltage: *See below.*
LISN USED: Teseq (Asset #135)
Temperature (°C): 19.7
Relative Humidity (%): 30.5

Mains Voltage:	120Vac
Frequency:	60Hz
Line Under Test:	L1

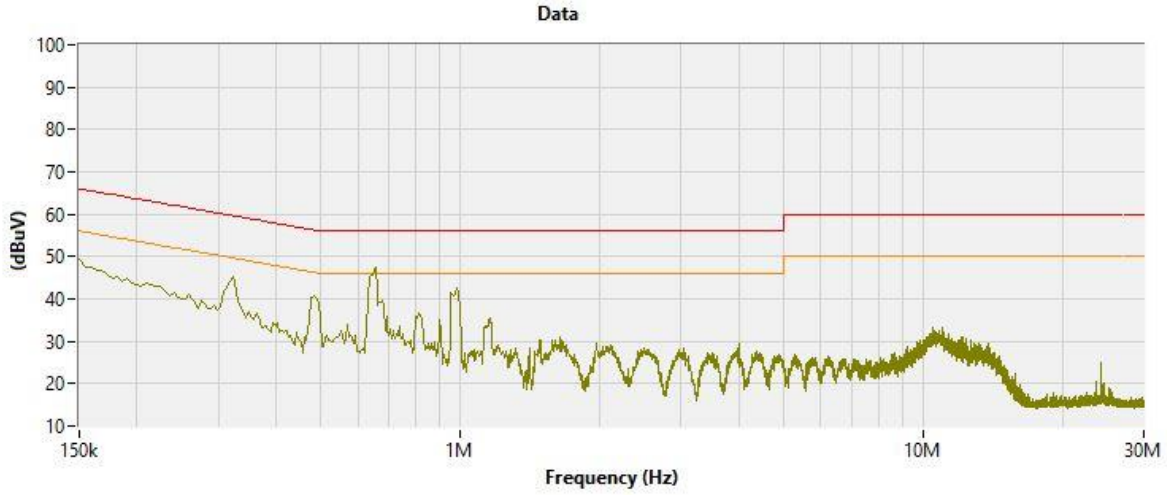
Freq. (MHz)	Peak (dBuV)	Quasi-Peak (dBuV)	Average (dBuV)	LISN Factors	Cable Factors	QP Net (dBuV)	AV Net (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.327	31.3	29.0	26.1	9.83	0.01	38.84	35.94	59.5	-20.7	49.5	-13.6
0.490	26.5	24.2	20.1	9.83	0.01	34.04	29.94	56.2	-22.1	46.2	-16.2
0.652	32.2	30.8	26.5	9.84	0.02	40.66	36.36	56.0	-15.3	46.0	-9.6
0.979	29.4	27.1	20.4	9.85	0.03	36.98	30.28	56.0	-19.0	46.0	-15.7
1.147	20.0	16.8	5.0	9.86	0.03	26.69	14.89	56.0	-29.3	46.0	-31.1
10.990	14.0	8.9	2.2	10.39	0.05	19.34	12.64	60.0	-40.7	50.0	-37.4

Mains Voltage:	120Vac
Frequency:	60Hz
Line Under Test:	N (L0)

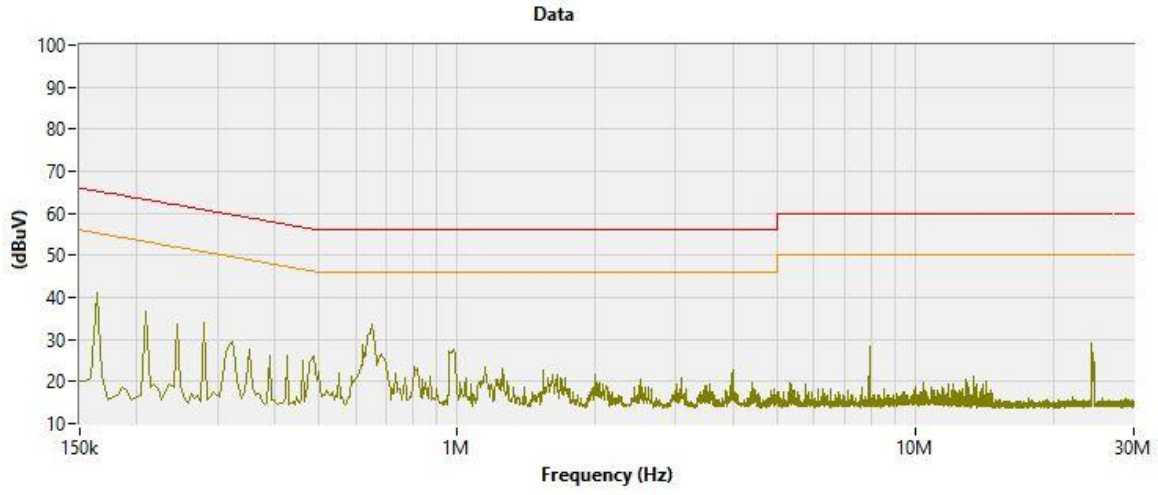
Freq. (MHz)	Peak (dBuV)	Quasi-Peak (dBuV)	Average (dBuV)	LISN Factors	Cable Factors	QP Net (dBuV)	AV Net (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.158	31.7	14.8	6.5	10.51	0.01	25.32	17.02	65.6	-40.2	55.6	-38.5
0.208	30.3	12.1	11.4	10.27	0.01	22.38	21.68	63.3	-40.9	53.3	-31.6
0.493	17.0	13.6	6.3	9.83	0.01	23.44	16.14	56.1	-32.7	46.1	-30.0
0.642	24.0	21.0	16.6	9.84	0.02	30.85	26.45	56.0	-25.1	46.0	-19.5
0.965	18.1	16.3	9.4	9.85	0.03	26.18	19.28	56.0	-29.8	46.0	-26.7
1.134	16.2	8.1	0.7	9.86	0.03	17.99	10.59	56.0	-38.0	46.0	-35.4

11.10 Measurement Result – Conducted Emissions Data Tables (continued)

Wagz Collar BLE Channel 0 120V 60 Hz Line



Wagz Collar BLE Channel 0 120V 60 Hz Neutral



11.10 Measurement Result – Conducted Emissions Data Tables (continued)

FCC Part 15.207 / ISED RSS-GEN Conducted Emissions Results

Date: 4/1/2019
Test Engineer: KM
Customer: Swanson Assoc.
Product: Wagz Smart Collar with Samsung AC adapter
Configuration: Wifi Channel 1 2412MHz
EUT Voltage: *See below.*
LISN USED: Teseq (Asset #135)
Temperature (°C): 19.7
Relative Humidity (%): 30.5

Mains Voltage:	120Vac
Frequency:	60Hz
Line Under Test:	N (L0)

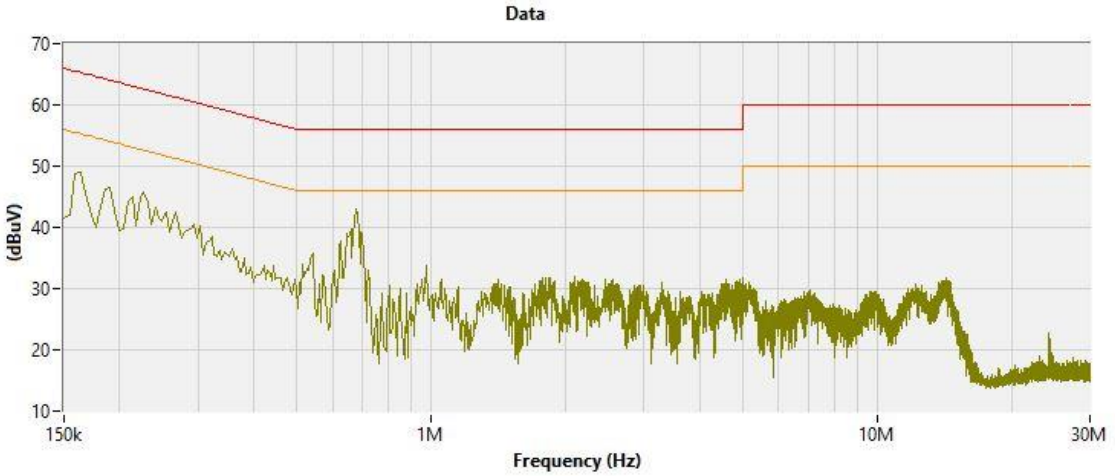
Freq. (MHz)	Peak (dBuV)	Quasi-Peak (dBuV)	Average (dBuV)	LISN Factors	Cable Factors	QP Net (dBuV)	AV Net (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.173	41.9	40.6	25.7	10.44	0.01	51.05	36.15	64.8	-13.8	54.8	-18.7
0.202	39.3	36.6	19.2	10.30	0.01	46.91	29.51	63.5	-16.6	53.5	-24.0
0.222	37.7	36.8	21.6	10.20	0.01	47.01	31.81	62.7	-15.7	52.7	-20.9
0.670	31.2	29.3	21.0	9.84	0.02	39.16	30.86	56.0	-16.8	46.0	-15.1
0.690	28.7	24.5	15.8	9.84	0.02	34.36	25.66	56.0	-21.6	46.0	-20.3
1.370	20.5	18.3	12.0	9.87	0.03	28.20	21.90	56.0	-27.8	46.0	-24.1

Mains Voltage:	120Vac
Frequency:	60Hz
Line Under Test:	N (L0)

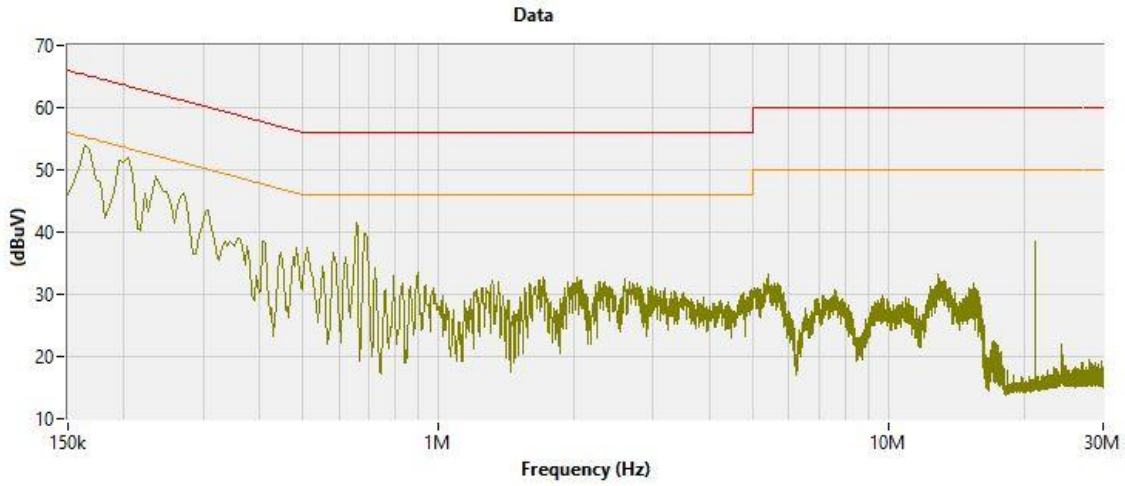
Freq. (MHz)	Peak (dBuV)	Quasi-Peak (dBuV)	Average (dBuV)	LISN Factors	Cable Factors	QP Net (dBuV)	AV Net (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.158	40.0	38.8	21.9	10.51	0.01	49.32	32.42	65.6	-16.2	55.6	-23.1
0.202	37.8	35.9	21.0	10.30	0.01	46.21	31.31	63.5	-17.3	53.5	-22.2
0.222	34.3	30.5	14.3	10.20	0.01	40.71	24.51	62.7	-22.0	52.7	-28.2
0.670	30.8	26.8	18.3	9.84	0.02	36.66	28.16	56.0	-19.3	46.0	-17.8
0.690	31.1	25.4	11.7	9.84	0.02	35.26	21.56	56.0	-20.7	46.0	-24.4
1.370	20.3	16.7	7.9	9.87	0.03	26.60	17.80	56.0	-29.4	46.0	-28.2

11.10 Measurement Result – Conducted Emissions Data Tables (continued)

Wagz Collar WiFi 11g 2412 Channel 1 120V 60 Hz Line



Wagz Collar WiFi 11g 2412 Channel 1 120V 60 Hz Neutral



12.0 PHOTOGRAPHS

Wagz, Inc.

Explore Smart Collar

Photographs can be found in separate documents:

2ASHHEXPLORE01 Tsup.pdf
2ASHHEXPLORE01 Intpho.pdf
2ASHHEXPLORE01 Extpho.pdf.

END OF TEST REPORT