



PCTEST ENGINEERING LABORATORY, INC.

7185 Oakland Mills Road, Columbia, MD 21046 USA

Tel. 410.290.6652 / Fax 410.290.6654

<http://www.pctest.com>



MEASUREMENT REPORT FCC PART 15.247 Bluetooth (Low Energy)

Applicant Name:

OnPoint Systems, LLC
292 Route 101
Bedford, NH 03110
USA

Date of Testing:

4/25-5/21/2018

Test Site/Location:

PCTEST Lab. Columbia, MD, USA

Test Report Serial No.:

1M1803230052-02.2AP

FCC ID:

2APPWSO1

APPLICANT:

OnPoint Systems, LLC

Application Type:

Certification

Model:

VSF 001-1

EUT Type:

Integrated Device, wearable (Pet Collar)

Max. RF Output Power:

2.489 mW (3.96 dBm) Peak Conducted

Frequency Range:

2402 – 2480MHz

FCC Classification:

Digital Transmission System (DTS)

FCC Rule Part(s):

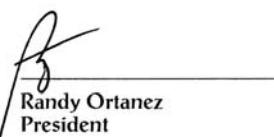
Part 15 Subpart C (15.247)

Test Procedure(s):

ANSI C63.10-2013, KDB 558074 D01 v04

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013 and KDB 558074 D01 v04. Test results reported herein relate only to the item(s) tested.

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



Randy Ortanez
President



FCC ID: 2APPWSO1	PCTEST Engineering Laboratory, Inc.		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 1 of 65

T A B L E O F C O N T E N T S

1.0	INTRODUCTION	3
1.1	Scope	3
1.2	PCTEST Test Location	3
1.3	Test Facility / Accreditations	3
2.0	PRODUCT INFORMATION.....	4
2.1	Equipment Description	4
2.2	Device Capabilities	4
2.3	Test Configuration	4
2.4	EMI Suppression Device(s)/Modifications	4
3.0	DESCRIPTION OF TESTS	5
3.1	Evaluation Procedure	5
3.2	AC Line Conducted Emissions	5
3.3	Radiated Emissions.....	6
3.4	Environmental Conditions.....	6
4.0	ANTENNA REQUIREMENTS	7
5.0	MEASUREMENT UNCERTAINTY	8
6.0	TEST EQUIPMENT CALIBRATION DATA	9
7.0	TEST RESULTS.....	10
7.1	Summary	10
7.2	6dB Bandwidth Measurement – Bluetooth (LE).....	11
7.3	Output Power Measurement – Bluetooth (LE).....	17
7.4	Power Spectral Density – Bluetooth (LE)	23
7.5	Conducted Emissions at the Band Edge	29
7.6	Carrier Frequency Separation	33
7.7	Number of Hopping Channels	35
7.8	Conducted Spurious Emissions.....	37
7.9	Radiated Spurious Emission Measurements.....	48
7.10	Radiated Restricted Band Edge Measurements.....	55
7.11	Radiated Spurious Emissions Measurements – Below 1GHz	57
7.12	Line-Conducted Test Data.....	62
8.0	CONCLUSION.....	65

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 2 of 65

1.0 INTRODUCTION

1.1 Scope

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

1.2 PCTEST Test Location

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

1.3 Test Facility / Accreditations

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

- PCTEST is an ISO 17025-2005 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).
- PCTEST facility is a registered (2451B) test laboratory with the site description on file with ISED.

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 3 of 65

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **OnPoint Systems Integrated Device, wearable (Pet Collar)** **FCC ID: 2APPWSO1**. The data found in this test report was taken with the EUT operating in Bluetooth low energy mode. While in low energy mode, the Bluetooth transmitter hops pseudo-randomly between 40 channels, three of which are “advertising channels”. When the transmitter is hopping only between the three advertising channels, the EUT does not fall under the category of a “hopper” as defined in 15.247(a)(iii) which states that a “frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.” As operation on only the advertising channels does not qualify the EUT as a hopper, the EUT is certified as a DTS device in this mode. The data found in this report is representative of the device when it transmits on its advertising channels.

Test Device Serial No.: 000B0002, 000B0007

2.2 Device Capabilities

This device contains the following capabilities:

Bluetooth (LE)

Ch.	Frequency (MHz)
0	2402
:	:
19	2440
:	:
39	2480

Table 2-1. Frequency / Channel Operations

2.3 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013 and KDB 558074 D01 v04. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups, and 7.2, 7.3, 7.4, 7.5, and 7.8 for antenna port conducted emissions test setups.

2.4 EMI Suppression Device(s)/Modifications

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

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 4 of 65

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 v04 were used in the measurement of the EUT.

Deviation from measurement procedure.....None

3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 7m x 3.66m x 2.7m shielded enclosure. The shielded enclosure is manufactured by AP Americas. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-5. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50µH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is an ETS Lindgren Model LPRX-4X30 (100dB Attenuation, 14kHz-18GHz) and the two EMI/RFI filters are ETS Lindgren Model LRW-2030-S1 (100dB Minimum Insertion Loss, 14kHz – 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

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

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

Line conducted emissions test results are shown in Section 7.11. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 5 of 65

3.3 Radiated Emissions

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

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

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

3.4 Environmental Conditions

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

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 6 of 65

4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

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

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

Conclusion:

The EUT complies with the requirement of §15.203.

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 7 of 65

5.0 MEASUREMENT UNCERTAINTY

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

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

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 8 of 65

6.0 TEST EQUIPMENT CALIBRATION DATA

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

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	WL25-1	Conducted Cable Set (25GHz)	6/14/2017	Annual	6/14/2018	WL25-1
Agilent	N9020A	MXA Signal Analyzer	1/24/2018	Annual	1/24/2019	US46470561
Agilent	N9038A	MXE EMI Receiver	6/26/2017	Annual	6/26/2018	MY51210133
COM-Power	AL-130R	Active Loop Antenna	6/5/2017	Annual	6/5/2018	121085
Emco	3115	Horn Antenna (1-18GHz)	3/28/2018	Biennial	3/28/2020	9704-5182
EMCO	3160-09	Small Horn (18 - 26.5GHz)	8/23/2016	Biennial	8/23/2018	135427
ETS Lindgren	3117	1-18 GHz DRG Horn (Medium)	12/1/2016	Biennial	12/1/2018	125518
ETS-Lindgren	3164-05	Quad Ridge Horn (Small) 2 - 18GHz	5/31/2016	Biennial	5/31/2018	208255
Huber+Suhner	Sucoflex 102A	40GHz Radiated Cable	5/19/2017	Annual	5/19/2018	251425001
Pasternack	NMLC-1	Line Conducted Emissions Cable (NM)	5/31/2017	Annual	5/31/2018	NMLC-1
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	7/31/2017	Annual	7/31/2018	100348
Rohde & Schwarz	FSW67	Signal / Spectrum Analyzer	8/11/2017	Annual	8/11/2018	103200
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	7/3/2017	Annual	7/3/2018	102134
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	7/3/2017	Annual	7/3/2018	102133
Rohde & Schwarz	TS-PR26	18-26.5 GHz Pre-Amplifier	5/11/2017	Annual	5/11/2018	100040
Solar Electronics	8012-50-R-24-BNC	Line Impedance Stabilization Network	8/14/2017	Biennial	8/14/2019	310233
Sunol	DRH-118	Horn Antenna (1-18GHz)	8/11/2017	Biennial	8/11/2019	A050307
Sunol Sciences	JB6	JB6 Antenna	9/27/2016	Biennial	9/27/2018	A082816

Table 6-1. Annual Test Equipment Calibration Schedule

Note:

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

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 9 of 65	

7.0 TEST RESULTS

7.1 Summary

Company Name: OnPoint Systems, LLC
 FCC ID: 2APPWSO1
 FCC Classification: Digital Transmission System (DTS)
 Number of Channels: 40

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	RSS-247 [5.2]	6dB Bandwidth	> 500kHz	CONDUCTED	PASS	Section 7.2
15.247(b)(3)	RSS-247 [5.4(4)]	Transmitter Output Power	< 1 Watt		PASS	Sections 7.3
15.247(e)	RSS-247 [5.2]	Transmitter Power Spectral Density	< 8dBm / 3kHz Band		PASS	Section 7.4
15.247(d)	RSS-247 [5.5]	Band Edge / Out-of-Band Emissions	≥ 20dBc		PASS	Sections 7.5, 0
15.205 15.209	RSS-Gen [8.9]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9])	RADIATED	PASS	Sections 7.9, 7.10
15.207	RSS-Gen [8.8]	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits (RSS-Gen[8.8])	LINE CONDUCTED	PASS	Section 7.11

Table 7-1. Summary of Test Results

Notes:

1. All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.
2. The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3. All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
4. For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Bluetooth LE Automation," Version 3.1.
5. For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Chamber Automation," Version 0.2.8.

FCC ID: 2APPWSO1		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 10 of 65

7.2 6dB Bandwidth Measurement – Bluetooth (LE)

§15.247(a.2); RSS-247 [5.2]

Test Overview and Limit

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the transmitter antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible 6dB bandwidth is 500 kHz.

Test Procedure Used

ANSI C63.10-2013 – Section 11.8.2 Option 2
KDB 558074 D01 v04 – Section 8.2 Option 2

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100kHz
3. VBW $\geq 3 \times$ RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize

Test Setup

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



Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 11 of 65

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Bluetooth Mode	Measured Bandwidth [kHz]	Minimum Bandwidth [kHz]	Pass / Fail
2402	0.25	0	LE	527.3	500	Pass
2440	0.25	19	LE	532.5	500	Pass
2480	0.25	39	LE	537.4	500	Pass
2402	1.0	0	LE	527.8	500	Pass
2440	1.0	19	LE	542.0	500	Pass
2480	1.0	39	LE	535.6	500	Pass
2402	2.0	0	LE	802.8	500	Pass
2440	2.0	19	LE	865.1	500	Pass
2480	2.0	39	LE	822.0	500	Pass

Table 7-2. Conducted Bandwidth Measurements



Plot 7-1. 6dB Bandwidth Plot (Bluetooth (LE), 250kbps – Ch. 0)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 12 of 65	



Plot 7-2. 6dB Bandwidth Plot (Bluetooth (LE), 250kbps – Ch. 19)



Plot 7-3. 6dB Bandwidth Plot (Bluetooth (LE), 250kbps – Ch. 39)

FCC ID: 2APPWSO1	PCTEST® ENGINEERING LABORATORY, INC.		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 13 of 65

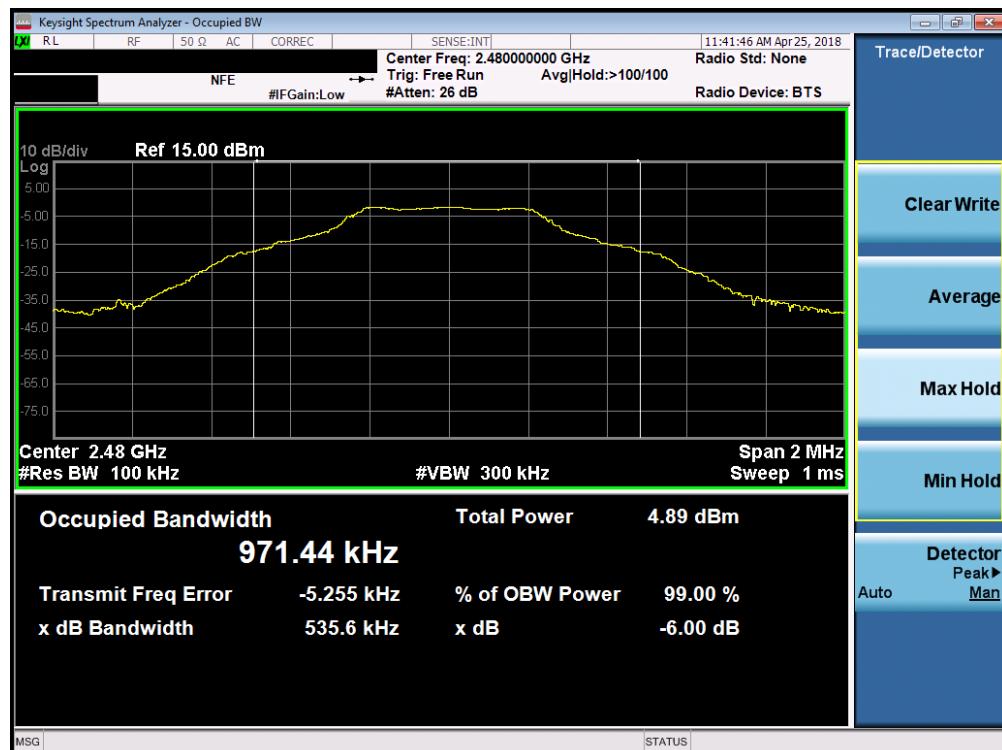


Plot 7-4. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps – Ch. 0)



Plot 7-5. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps – Ch. 19)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 14 of 65



Plot 7-6. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps – Ch. 39)



Plot 7-7. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps – Ch. 0)

FCC ID: 2APPWSO1	PCTEST ENGINEERING LABORATORY, INC.		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 15 of 65



Plot 7-8. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps – Ch. 19)



Plot 7-9. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps – Ch. 39)

FCC ID: 2APPWSO1	PCTEST ENGINEERING LABORATORY, INC.		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 16 of 65

7.3 Output Power Measurement – Bluetooth (LE)

§15.247(b.3); RSS-247 [5.4(4)]

Test Overview and Limits

The transmitter antenna terminal of the EUT is connected to the input of a spectrum analyzer. Measurements are made while the EUT is operating at maximum power and at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt.

Test Procedure Used

ANSI C63.10-2013 – Section 11.9.1.1
KDB 558074 D01 v04 – Section 9.1.1

Test Settings

1. RBW = 3MHz
2. VBW = 50MHz
3. Span \geq 3 x RBW
4. Sweep = auto couple
5. Detector = Peak
6. Trace mode = max hold
7. The trace was allowed to stabilize

Test Setup

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

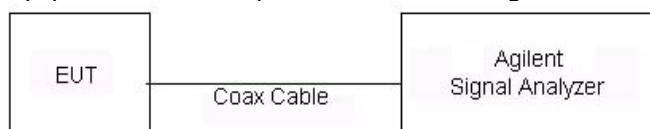


Figure 7-2. Test Instrument & Measurement Setup

Test Notes

None

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 17 of 65

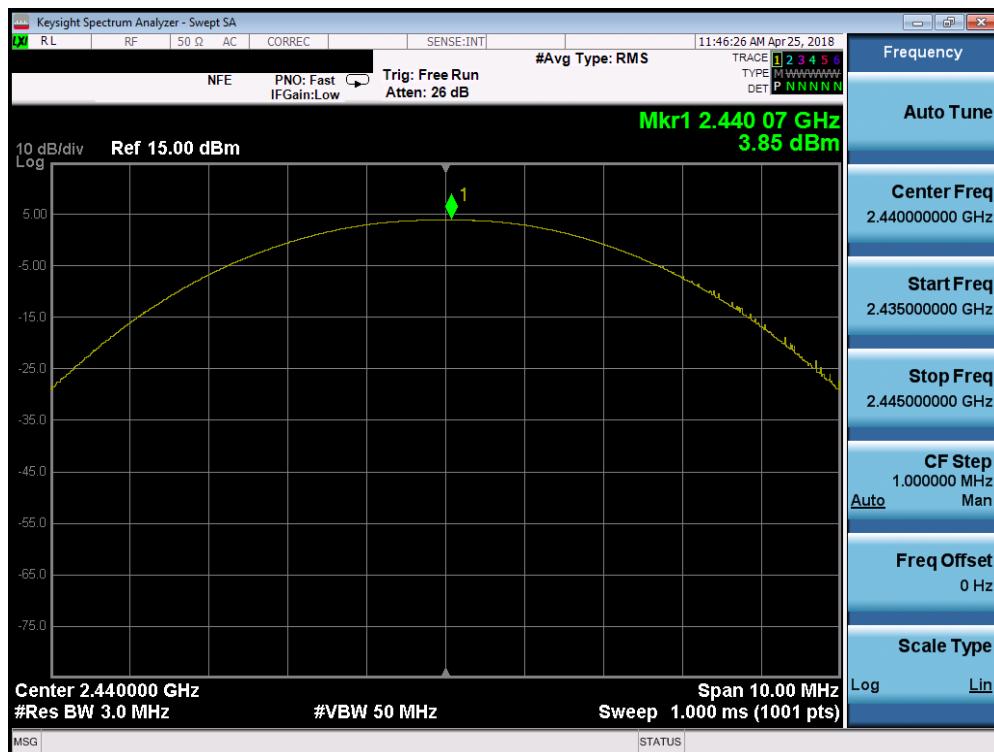
Frequency [MHz]	Data Rate [Mbps]	Channel No.	Bluetooth Mode	Peak Conducted Power	
				[dBm]	[mW]
2402	0.25	0	LE	3.87	2.435
2440	0.25	19	LE	3.85	2.428
2480	0.25	39	LE	3.45	2.214
2402	1.0	0	LE	3.84	2.421
2440	1.0	19	LE	3.88	2.443
2480	1.0	39	LE	3.45	2.213
2402	2.0	0	LE	3.96	2.489
2440	2.0	19	LE	3.92	2.467
2480	2.0	39	LE	3.45	2.214

Table 7-3. Peak Conducted Output Power Measurements (Bluetooth (LE))

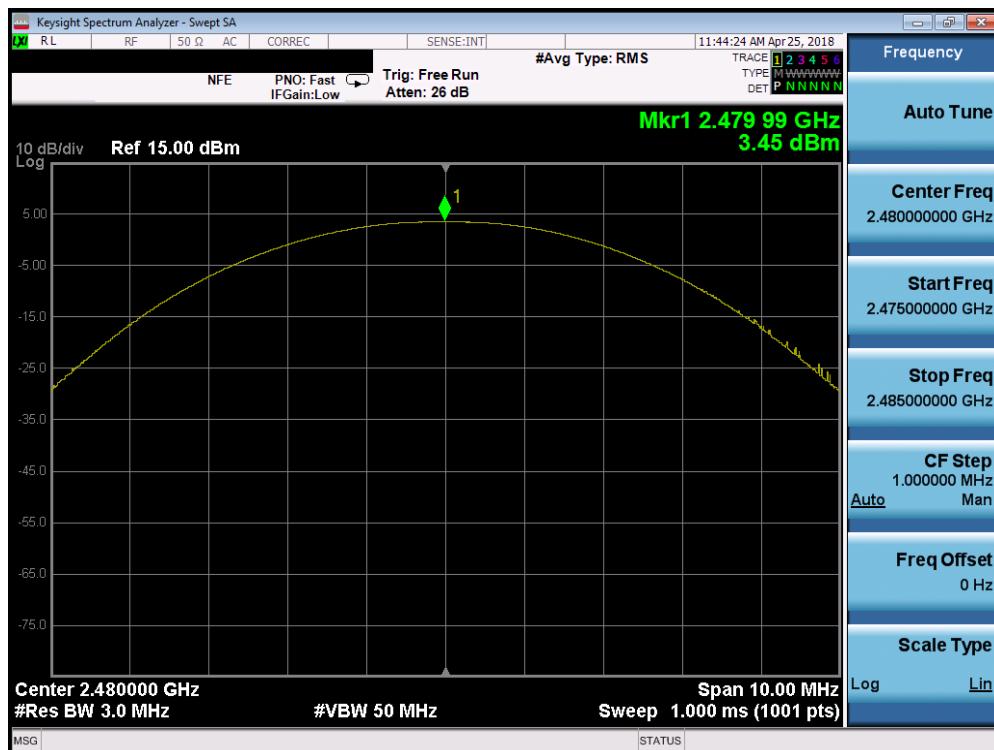


Plot 7-10. Peak Power Plot (Bluetooth (LE), 250kbps – Ch. 0)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 18 of 65	

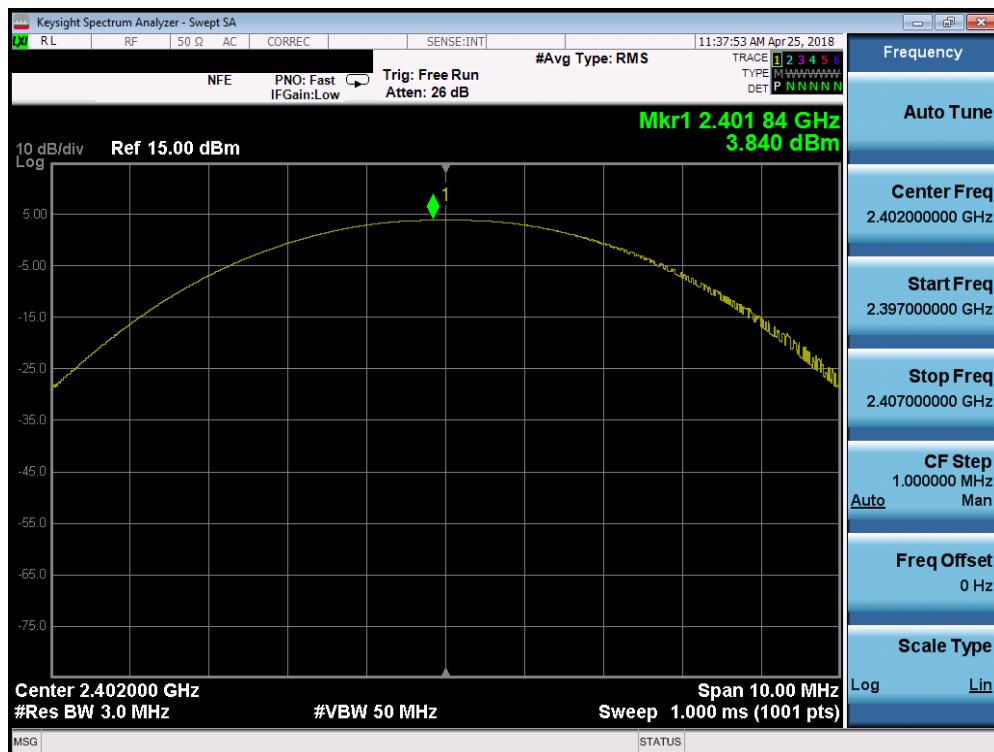


Plot 7-11. Peak Power Plot (Bluetooth (LE), 250kbps – Ch. 19)

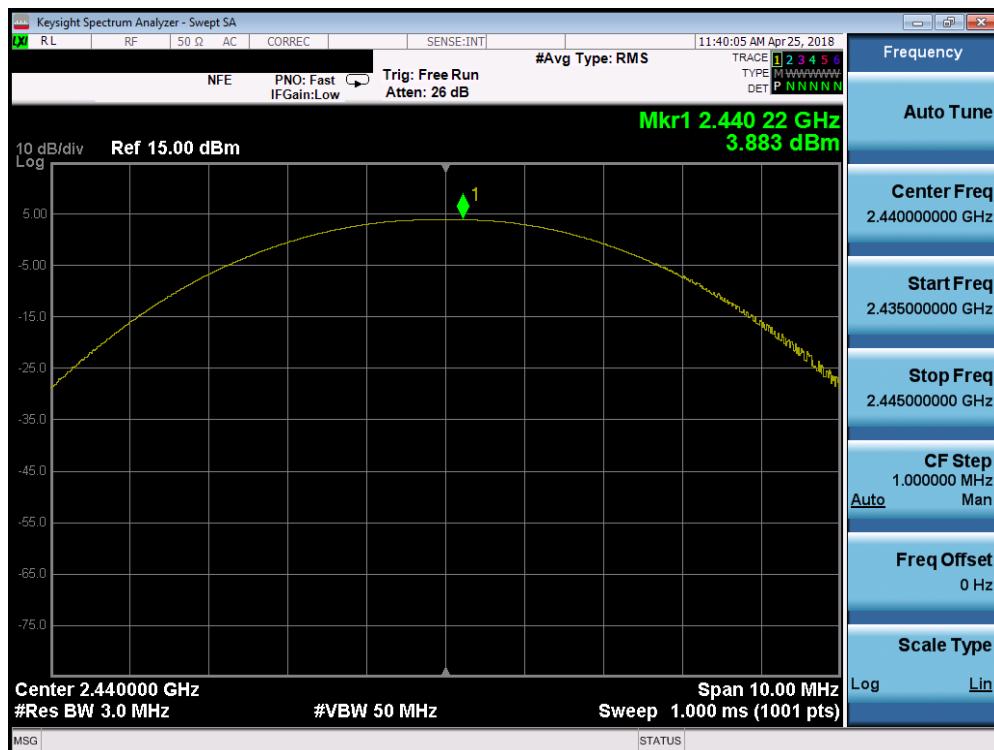


Plot 7-12. Peak Power Plot (Bluetooth (LE), 250kbps – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 19 of 65

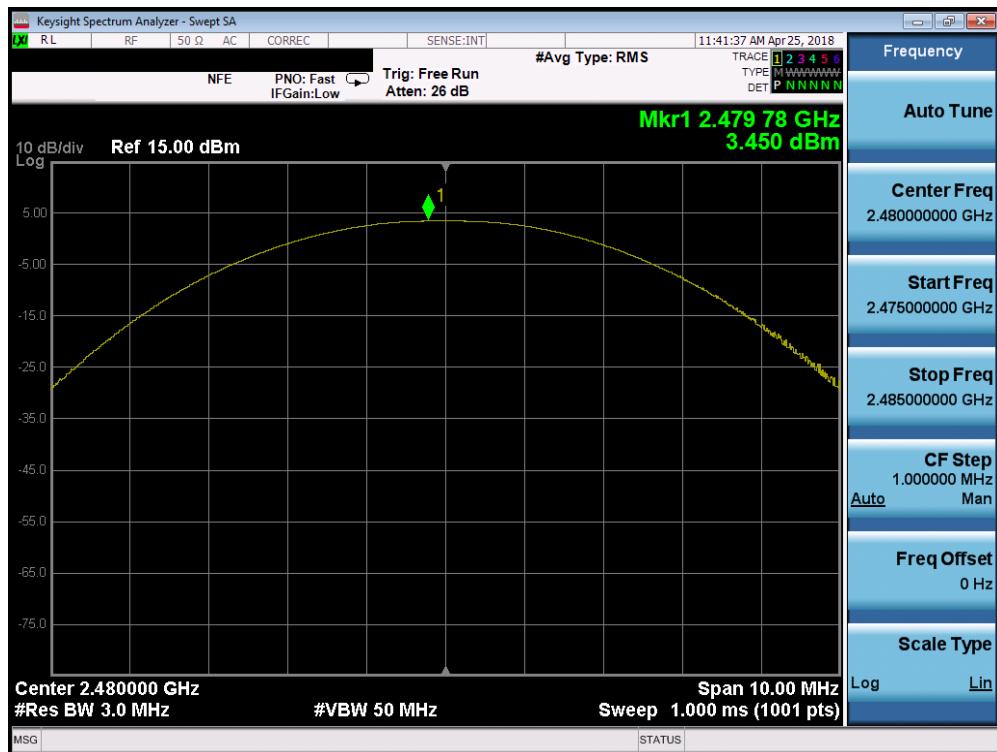


Plot 7-13. Peak Power Plot (Bluetooth (LE), 1Mbps – Ch. 0)

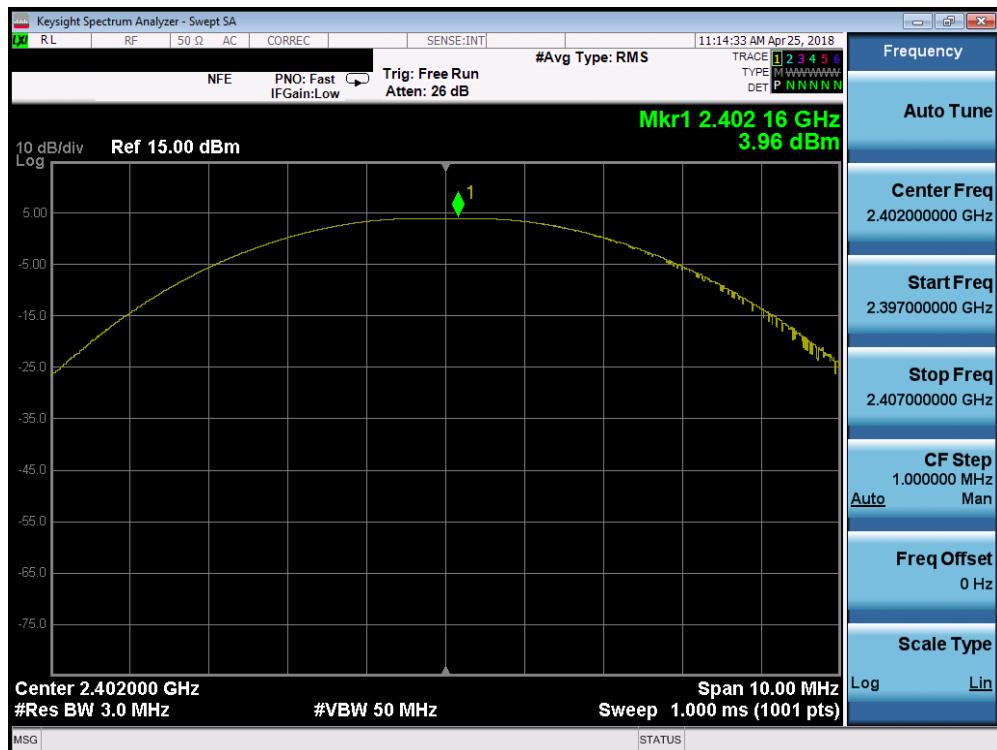


Plot 7-14. Peak Power Plot (Bluetooth (LE), 1Mbps – Ch. 19)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 20 of 65

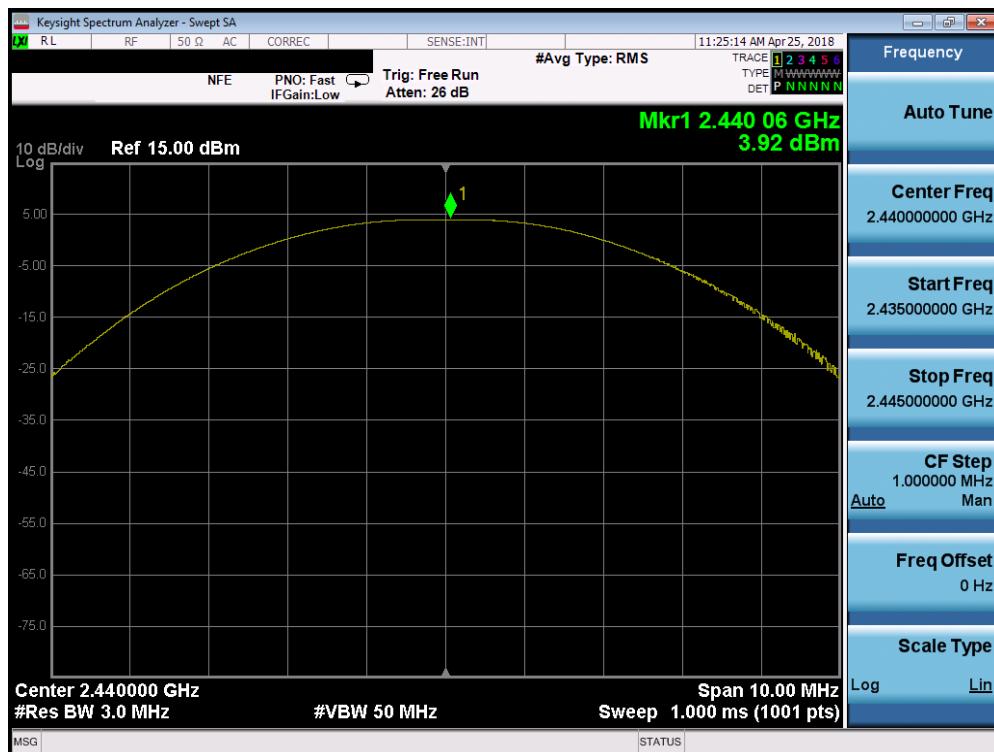


Plot 7-15. Peak Power Plot (Bluetooth (LE), 1Mbps – Ch. 39)



Plot 7-16. Peak Power Plot (Bluetooth (LE), 2Mbps – Ch. 0)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 21 of 65



Plot 7-17. Peak Power Plot (Bluetooth (LE), 2Mbps – Ch. 19)



Plot 7-18. Peak Power Plot (Bluetooth (LE), 2Mbps – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 22 of 65	

7.4 Power Spectral Density – Bluetooth (LE)

§15.247(e); RSS-247 [5.2]

Test Overview and Limit

The peak power density is measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies.

The maximum permissible power spectral density is 8 dBm in any 3 kHz band.

Test Procedure Used

ANSI C63.10-2013 – Section 11.10.2 Method PKPSD
KDB 558074 D01 v04 – Section 10.2 Method PKPSD

Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 3kHz
4. VBW = 1MHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

Test Setup

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



Figure 7-3. Test Instrument & Measurement Setup

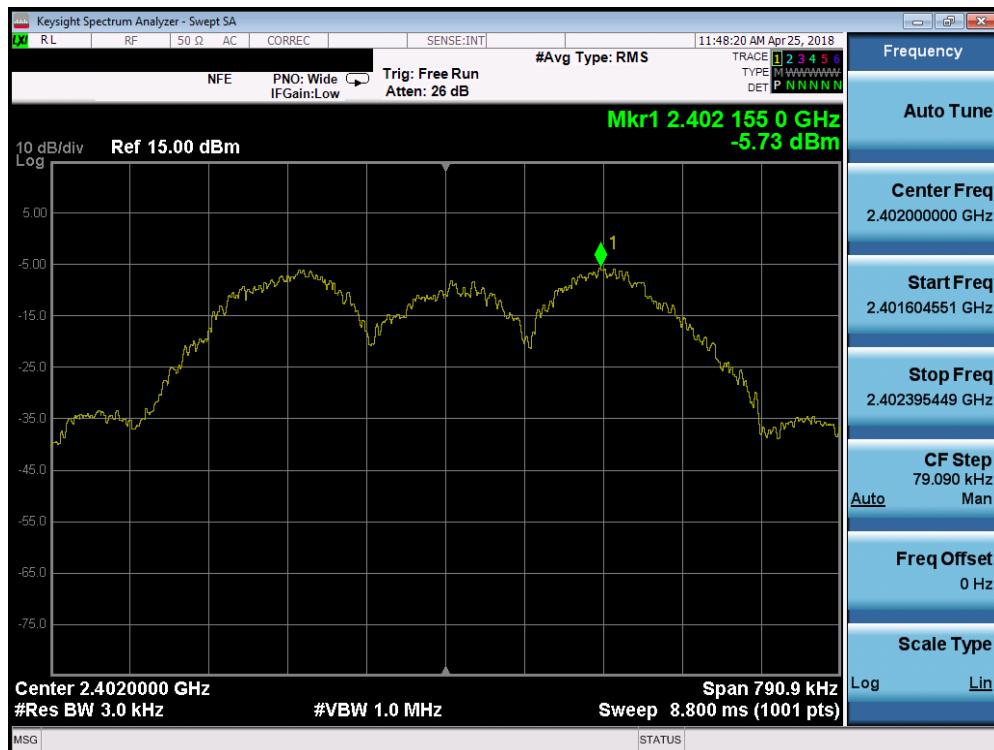
Test Notes

None

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 23 of 65

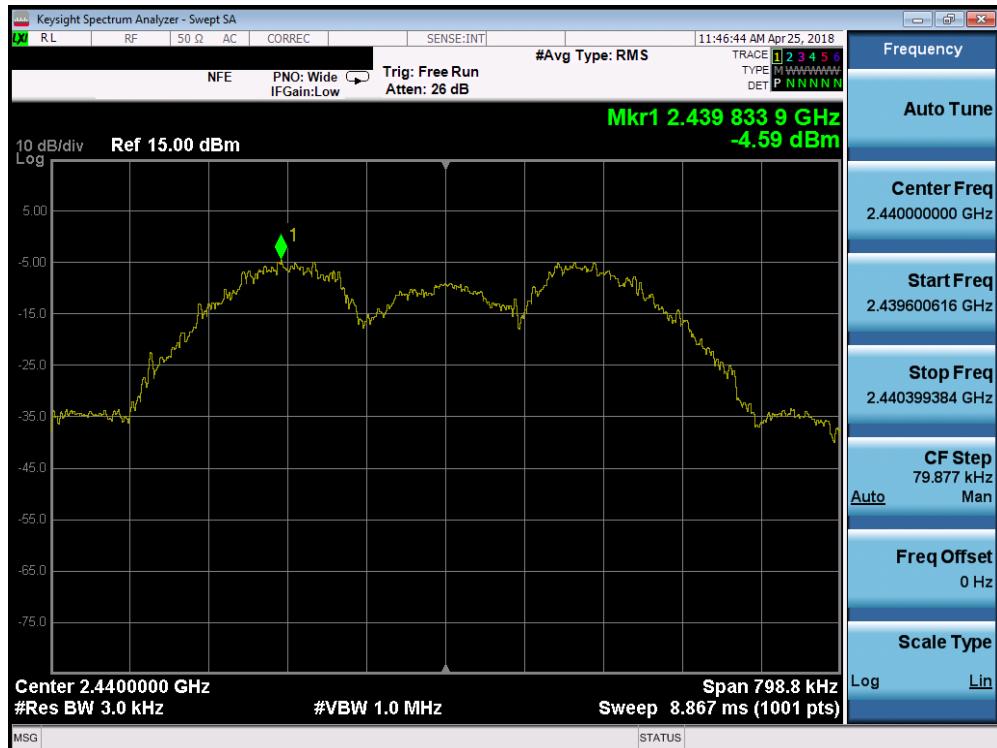
Frequency [MHz]	Data Rate [Mbps]	Channel No.	Bluetooth Mode	Measured Power Spectral Density [dBm]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
2402	0.25	0	LE	-5.73	8.0	-13.73
2440	0.25	19	LE	-4.59	8.0	-12.59
2480	0.25	39	LE	-5.09	8.0	-13.09
2402	1.0	0	LE	-6.59	8.0	-14.59
2440	1.0	19	LE	-6.42	8.0	-14.42
2480	1.0	39	LE	-7.40	8.0	-15.40
2402	2.0	0	LE	-9.23	8.0	-17.23
2440	2.0	19	LE	-13.88	8.0	-21.88
2480	2.0	39	LE	-9.13	8.0	-17.13

Table 7-4. Conducted Power Density Measurements



Plot 7-19. Power Spectral Density Plot (Bluetooth (LE), 250kbps – Ch. 0)

FCC ID: 2APPWSO1	MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 24 of 65	



Plot 7-20. Power Spectral Density Plot (Bluetooth (LE), 250kbps – Ch. 19)



Plot 7-21. Power Spectral Density Plot (Bluetooth (LE), 250kbps – Ch. 39)

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 25 of 65



Plot 7-22. Power Spectral Density Plot (Bluetooth (LE), 1Mbps – Ch. 0)

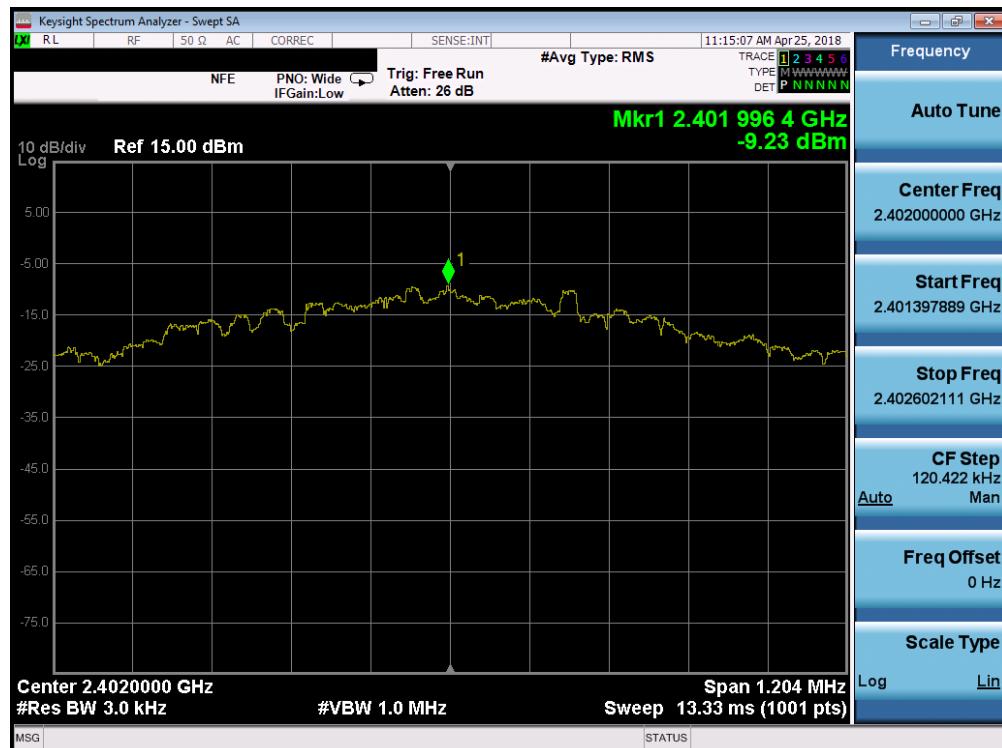


Plot 7-23. Power Spectral Density Plot (Bluetooth (LE), 1Mbps – Ch. 19)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 26 of 65



Plot 7-24. Power Spectral Density Plot (Bluetooth (LE), 1Mbps – Ch. 39)



Plot 7-25. Power Spectral Density Plot (Bluetooth (LE), 2Mbps – Ch. 0)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 27 of 65



Plot 7-26. Power Spectral Density Plot (Bluetooth (LE), 2Mbps – Ch. 19)



Plot 7-27. Power Spectral Density Plot (Bluetooth (LE), 2Mbps – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 28 of 65

7.5 Conducted Emissions at the Band Edge

§15.247(d); RSS-247 [5.5]

Test Overview and Limit

For the following out of band conducted spurious emissions plots at the band edge, the EUT was set to transmit at maximum power with the largest packet size available. These settings produced the worst-case emissions.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth.

Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v04 – Section 11.3

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100kHz
4. VBW = 300kHz
5. Detector = Peak
6. Number of sweep points $\geq 2 \times$ Span/RBW
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Test Setup

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

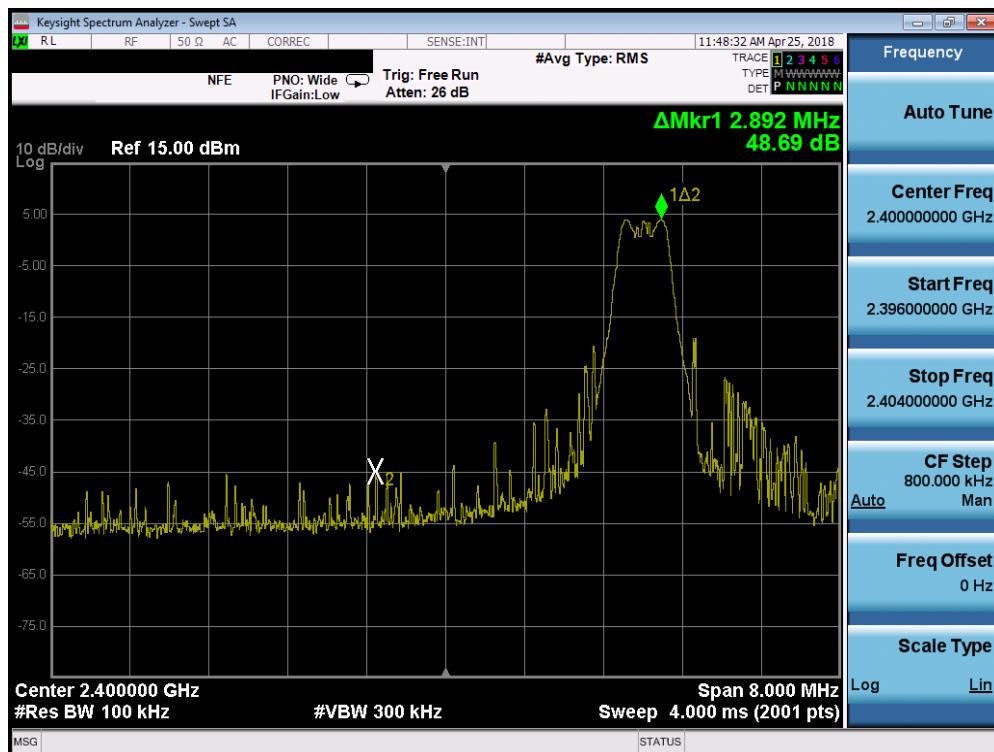


Figure 7-4. Test Instrument & Measurement Setup

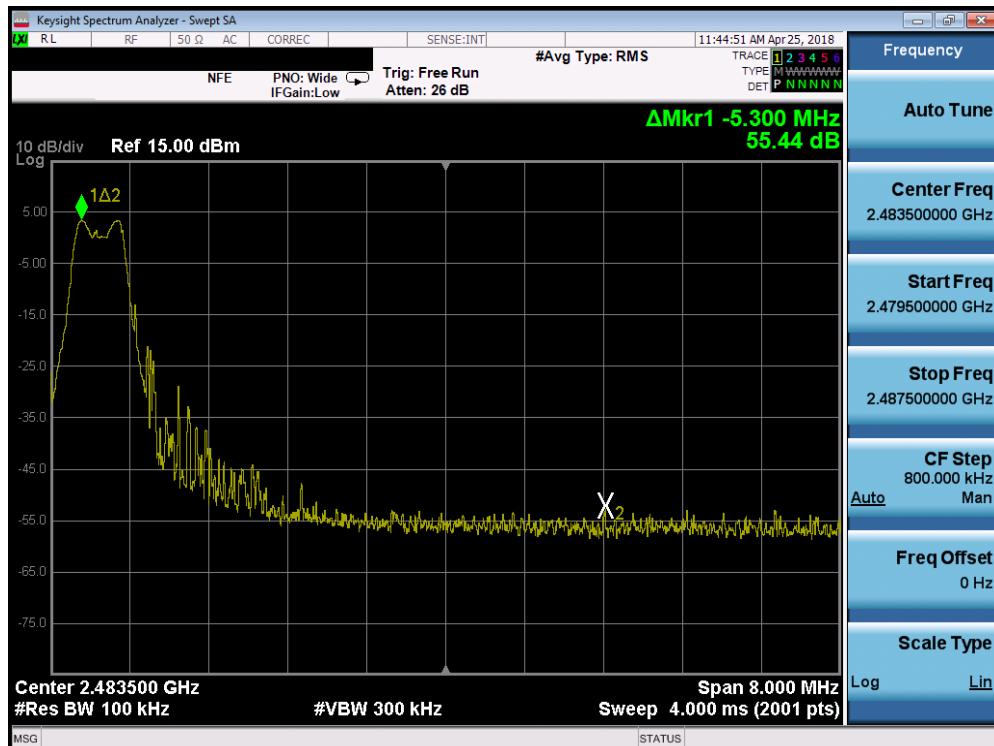
Test Notes

None

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 29 of 65

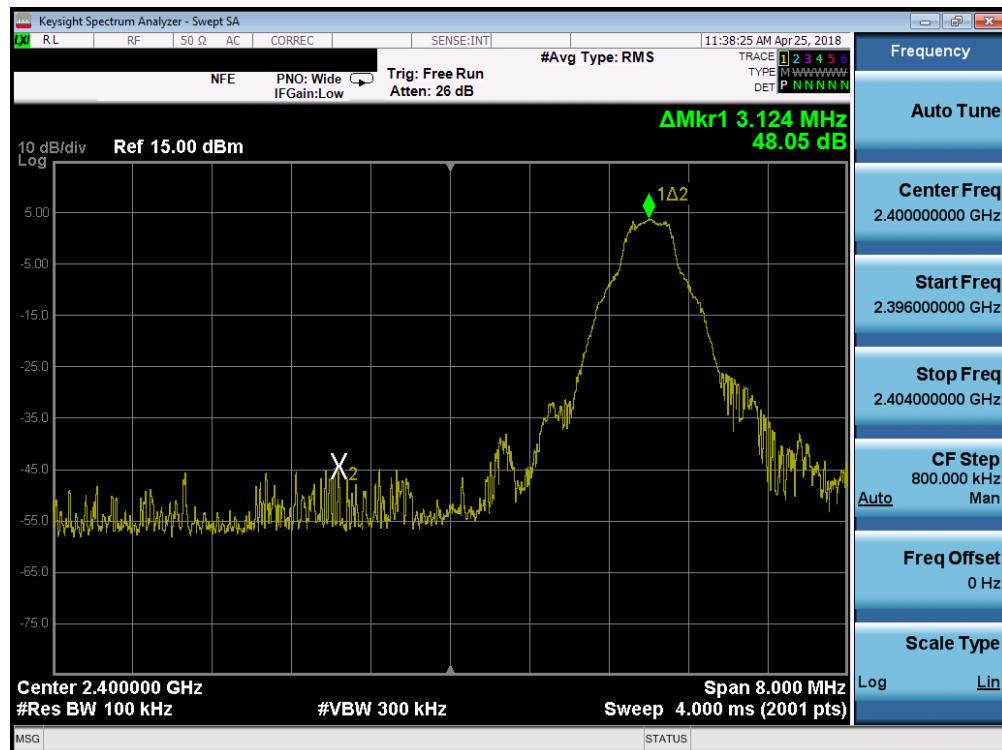


Plot 7-28. Band Edge Plot (Bluetooth (LE), 250kbps – Ch. 0)

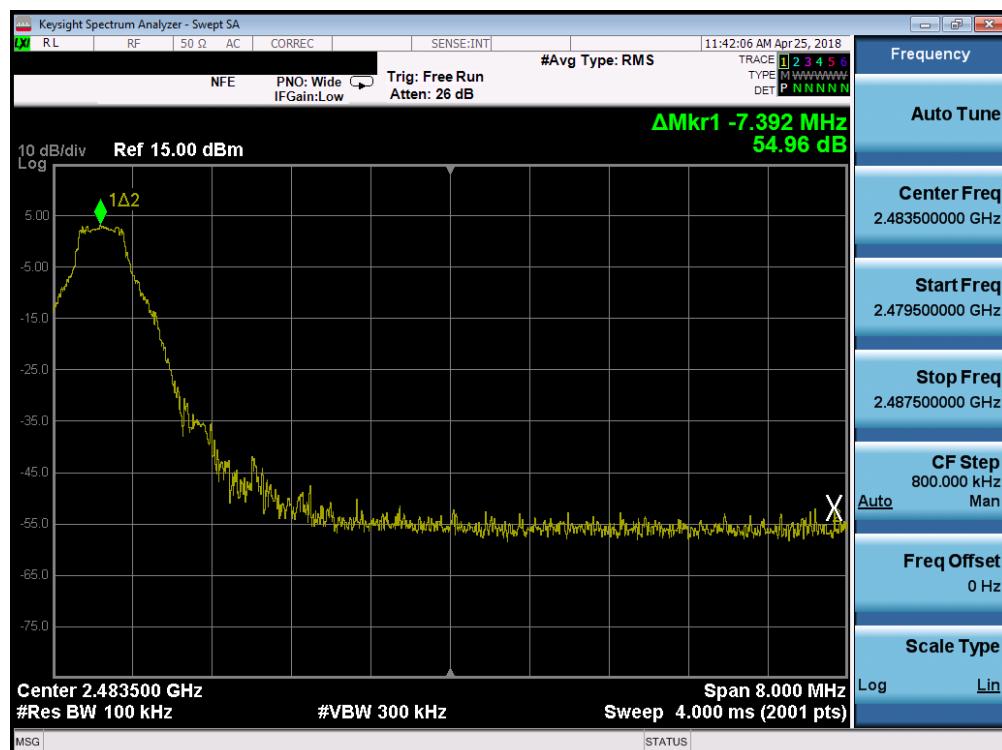


Plot 7-29. Band Edge Plot (Bluetooth (LE), 250kbps – Ch. 39)

FCC ID: 2APPWSO1	PCTEST ENGINEERING LABORATORY, INC.		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 30 of 65	

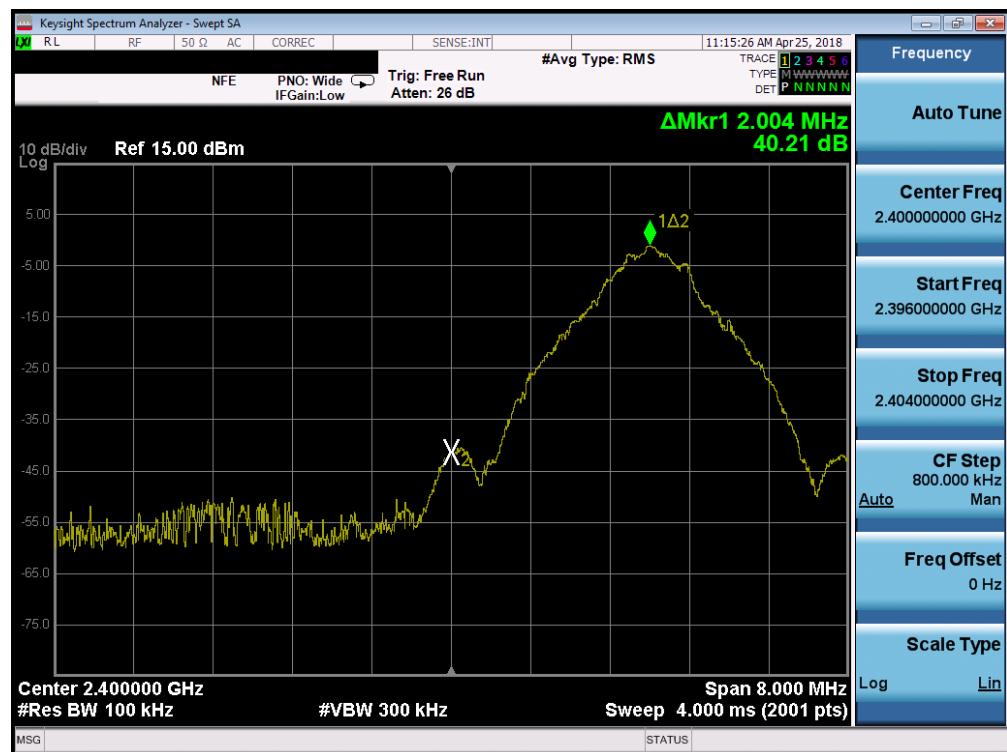


Plot 7-30. Band Edge Plot (Bluetooth (LE), 1Mbps – Ch. 0)

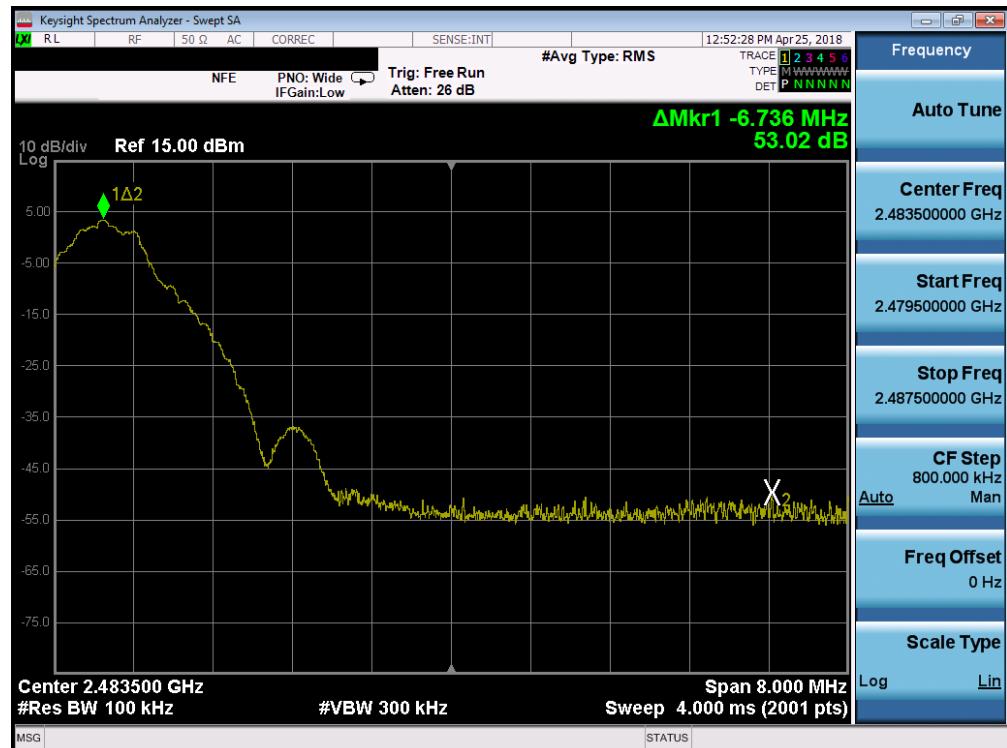


Plot 7-31. Band Edge Plot (Bluetooth (LE), 1Mbps – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 31 of 65



Plot 7-32. Band Edge Plot (Bluetooth (LE), 2Mbps – Ch. 0)



Plot 7-33. Band Edge Plot (Bluetooth (LE), 2Mbps – Ch. 39)

FCC ID: 2APPWSO1	MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 32 of 65

7.6 Carrier Frequency Separation

§15.247 (a.1); RSS-247 [5.1(2)]

Test Overview and Limit

Measurement is made with EUT operating in hopping mode. ***The minimum permissible channel separation for this system is 2/3 the value of the 20dB BW.***

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.2

Test Settings

1. Span = Wide enough to capture peaks of two adjacent channels
2. RBW = 30% of channel spacing. Adjust as necessary to best identify center of each individual channel
3. VBW \geq RBW
4. Sweep = Auto
5. Detector = Peak
6. Trace mode = max hold
7. The trace was allowed to stabilize.
8. Marker-delta function used to determine separation between peaks of the adjacent channels

Test Setup

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



Figure 7-5. Test Instrument & Measurement Setup

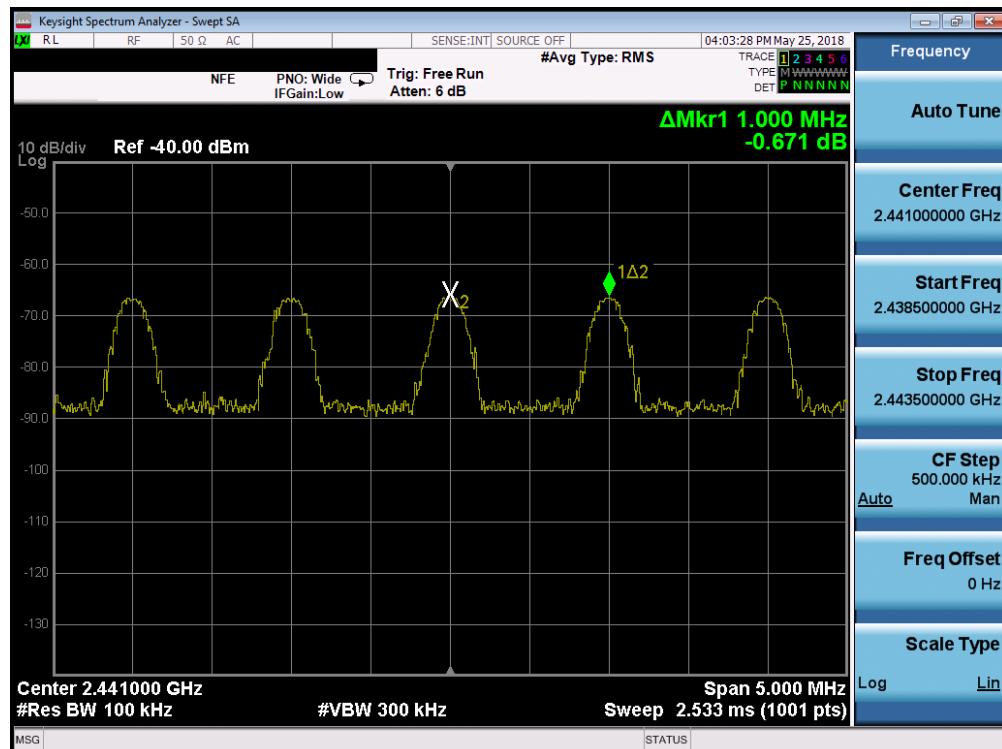
Test Notes

The EUT complies with the minimum channel separation requirement when it is operating in 1x/EDR mode using 79 channels and when operating in AFH mode using 20 channels.

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 33 of 65

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Min. Channel Separation [MHz]
2402	0.3	0	0.352
2441	0.3	39	0.355
2480	0.3	78	0.358
2402	2.0	0	0.352
2441	2.0	39	0.361
2480	2.0	78	0.357
2402	3.0	0	0.535
2441	3.0	39	0.577
2480	3.0	78	0.548

Table 7-5. Minimum Channel Separation



Plot 7-34. Channel Spacing Plot (Bluetooth)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 34 of 65	

7.7 Number of Hopping Channels

§15.247 (a.1.iii); RSS-247 [5.1(4)]

Test Overview and Limit

Measurement is made while EUT is operating in hopping mode. ***This frequency hopping system must employ a minimum of 15 hopping channels.***

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.3

Test Settings

1. Span = frequency of band of operation (divided into two plots)
2. RBW < 30% of channel spacing or 20dB bandwidth, whichever is smaller.
3. VBW \geq RBW
4. Sweep = auto
5. Detector = peak
6. Trace mode = max hold
7. Trace was allowed to stabilize

Test Setup

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

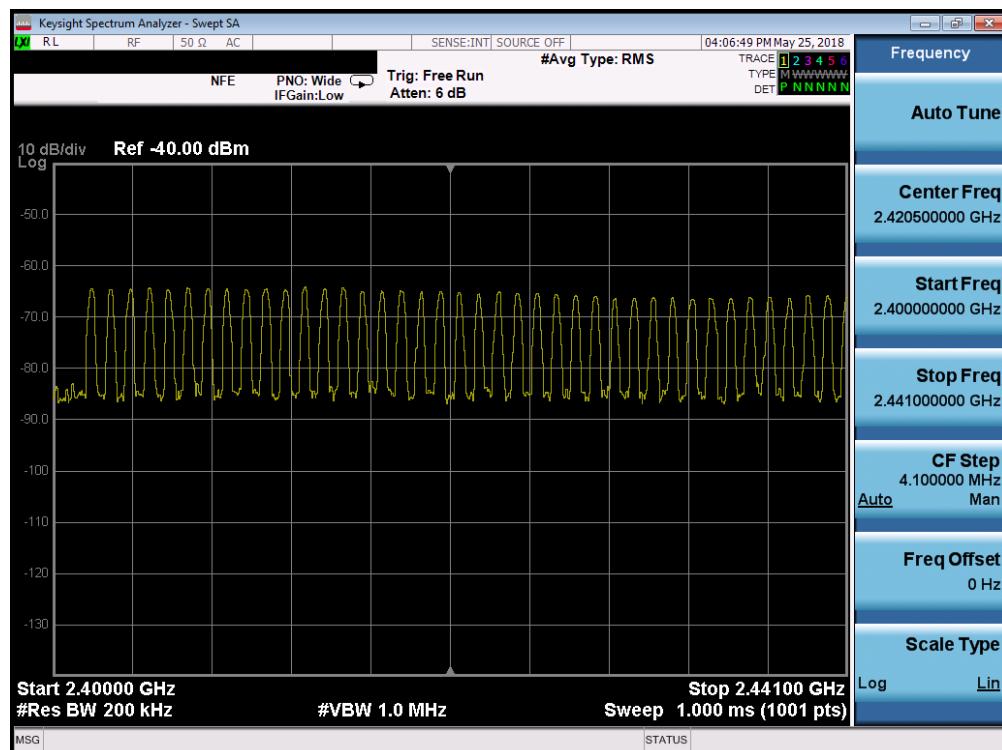


Figure 7-6. Test Instrument & Measurement Setup

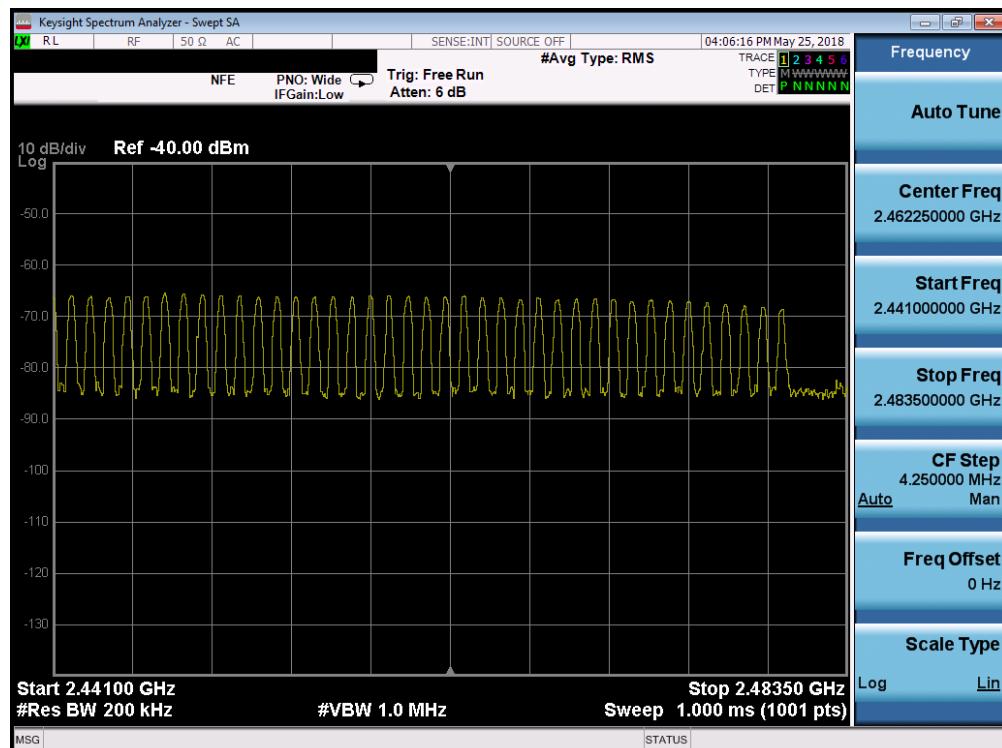
Test Notes

The frequency spectrum was broken up into two sub-ranges to clearly show all of the hopping frequencies. In AFH mode, this device operates using 20 channels so the requirement for minimum number of hopping channels is satisfied.

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 35 of 65



Plot 7-35. Low End Spectrum Channel Hopping Plot (Bluetooth)



Plot 7-36. High End Spectrum Channel Hopping Plot (Bluetooth)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 36 of 65	

7.8 Conducted Spurious Emissions

§15.247(d); RSS-247 [5.5]

Test Overview and Limit

For the following out of band conducted spurious emissions plots, the EUT was set to transmit at maximum power with the largest packet size available. The worst case spurious emissions were found in this configuration.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 11.1 of KDB 558074 D01 v04 and Section 11.11.3 of ANSI C63.10-2013.

Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v04 – Section 11.3

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

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



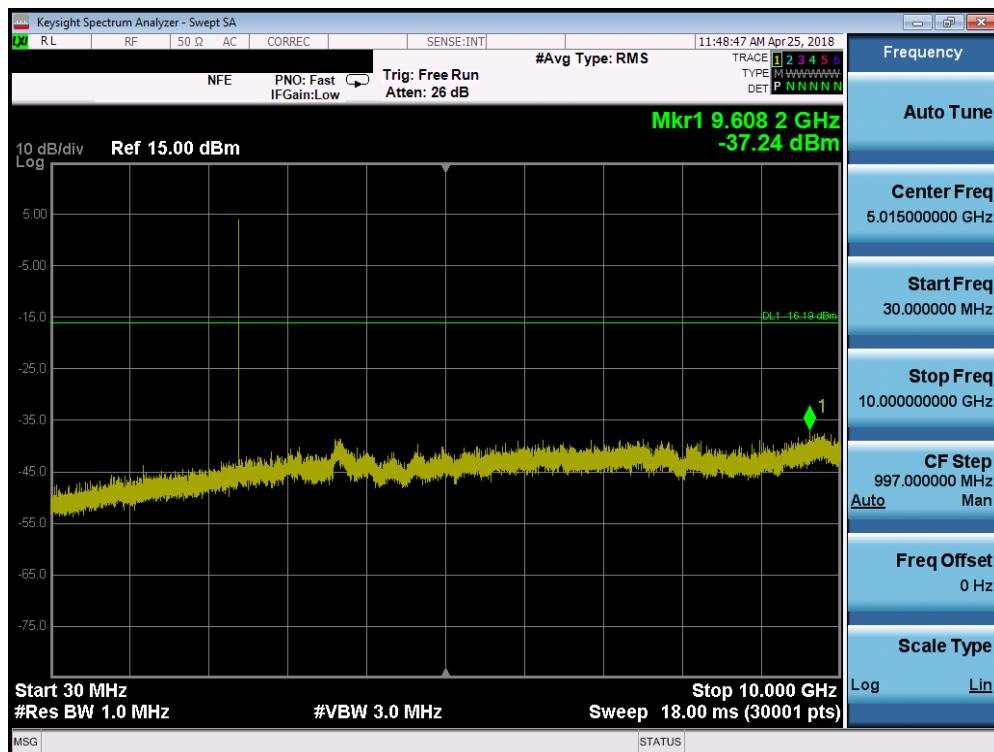
Figure 7-7. Test Instrument & Measurement Setup

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 37 of 65

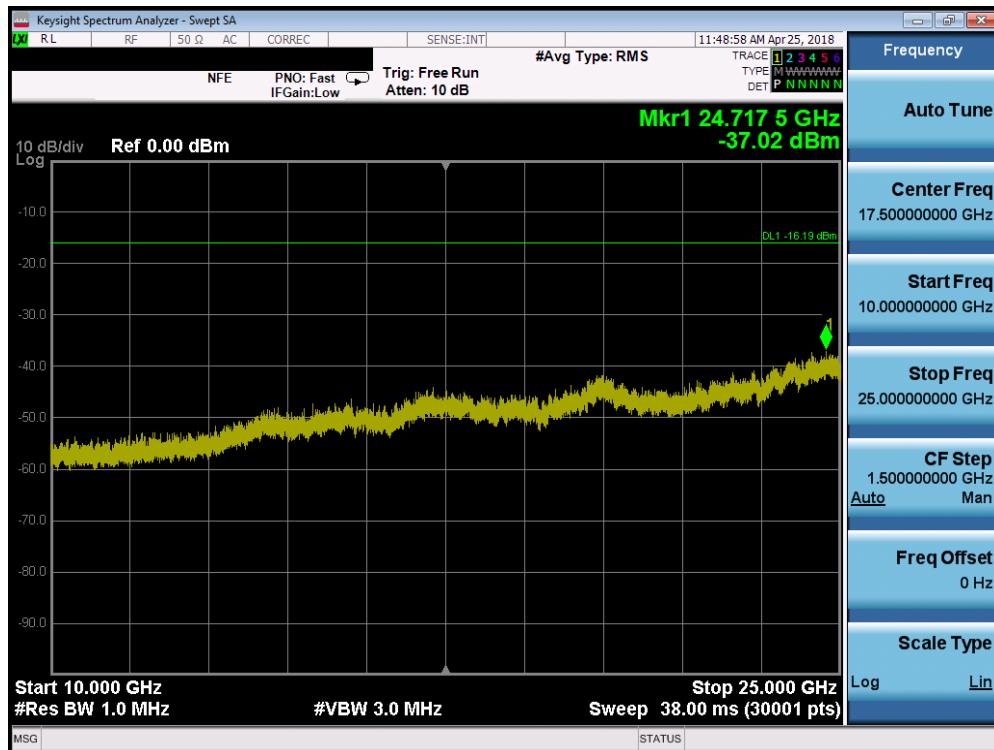
Test Notes

1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.
2. The display line shown in the following plots denotes the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.
3. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 38 of 65

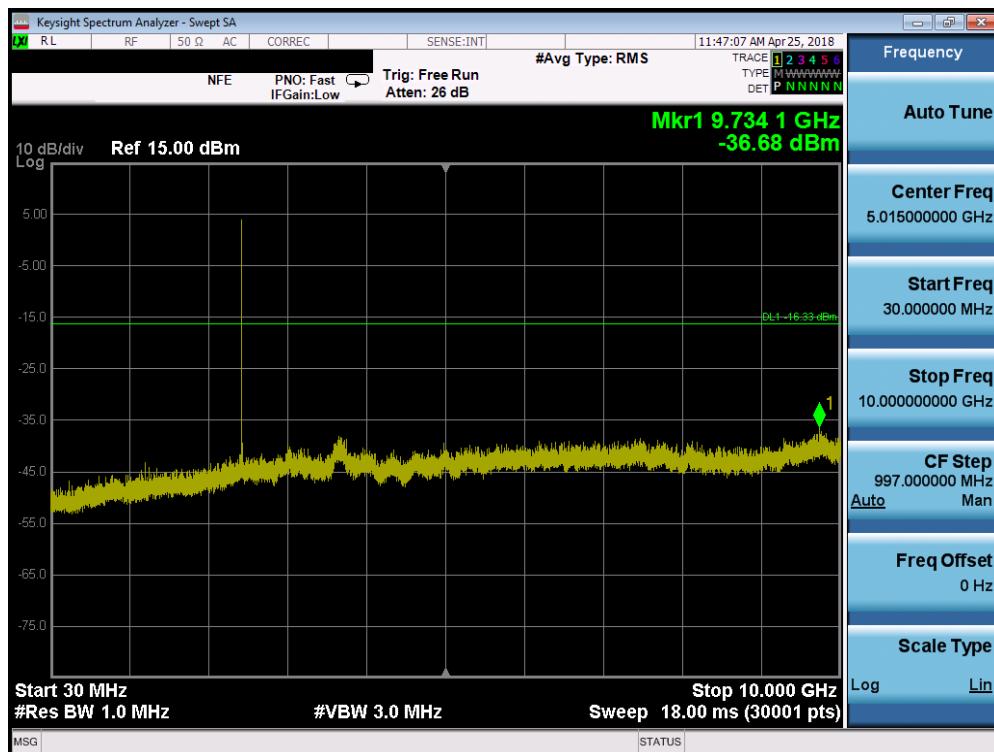


Plot 7-37. Conducted Spurious Plot (Bluetooth (LE), 250kbps – Ch. 0)

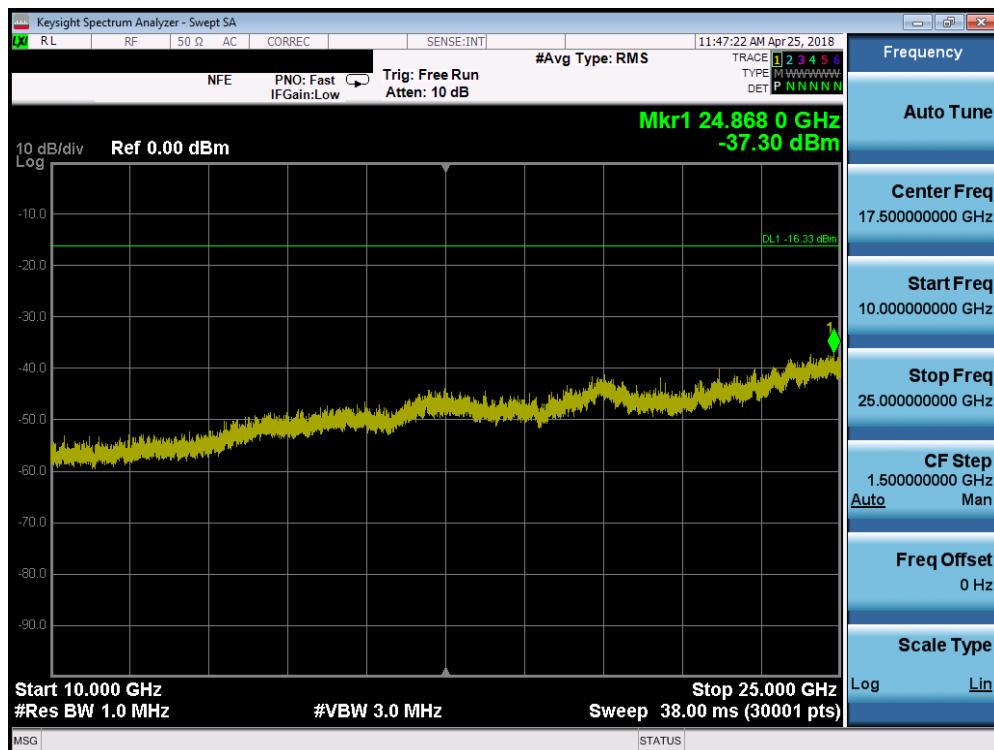


Plot 7-38. Conducted Spurious Plot (Bluetooth (LE), 250kbps – Ch. 0)

FCC ID: 2APPWSO1	PCTEST ENGINEERING LABORATORY, INC.			MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)			Page 39 of 65

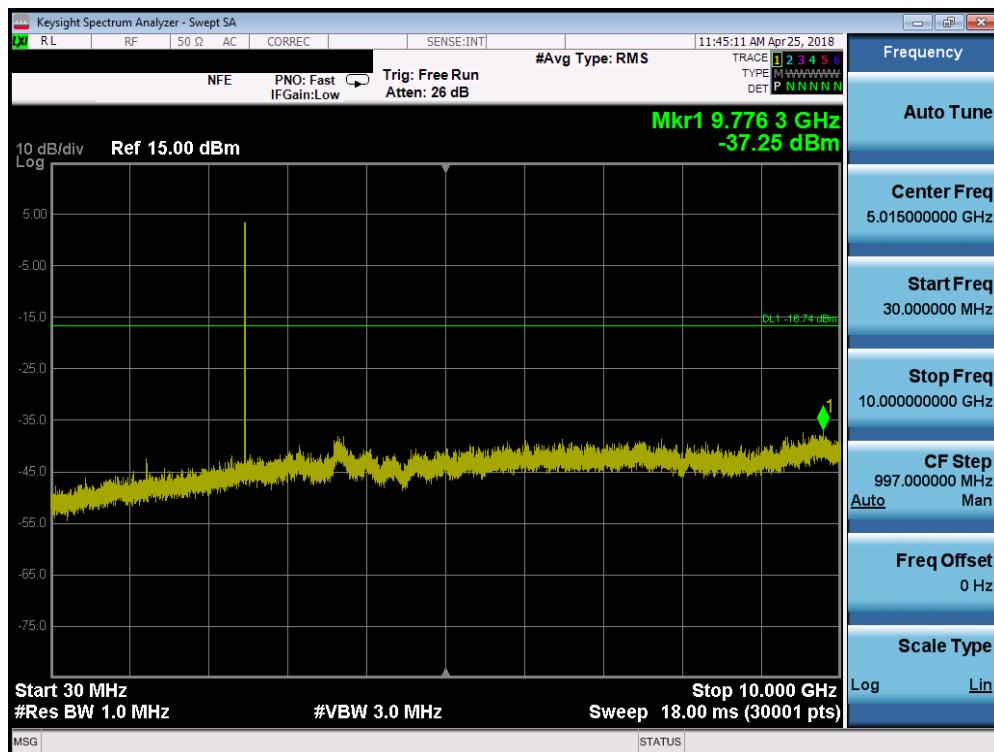


Plot 7-39. Conducted Spurious Plot (Bluetooth (LE), 250kbps – Ch. 19)

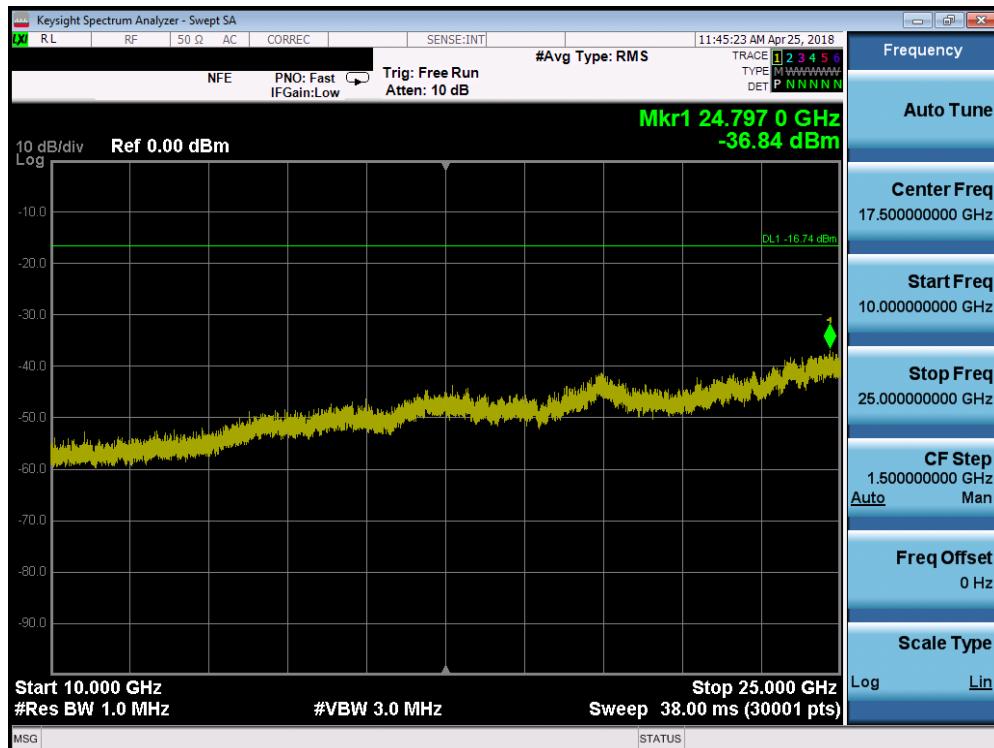


Plot 7-40. Conducted Spurious Plot (Bluetooth (LE), 250kbps – Ch. 19)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 40 of 65

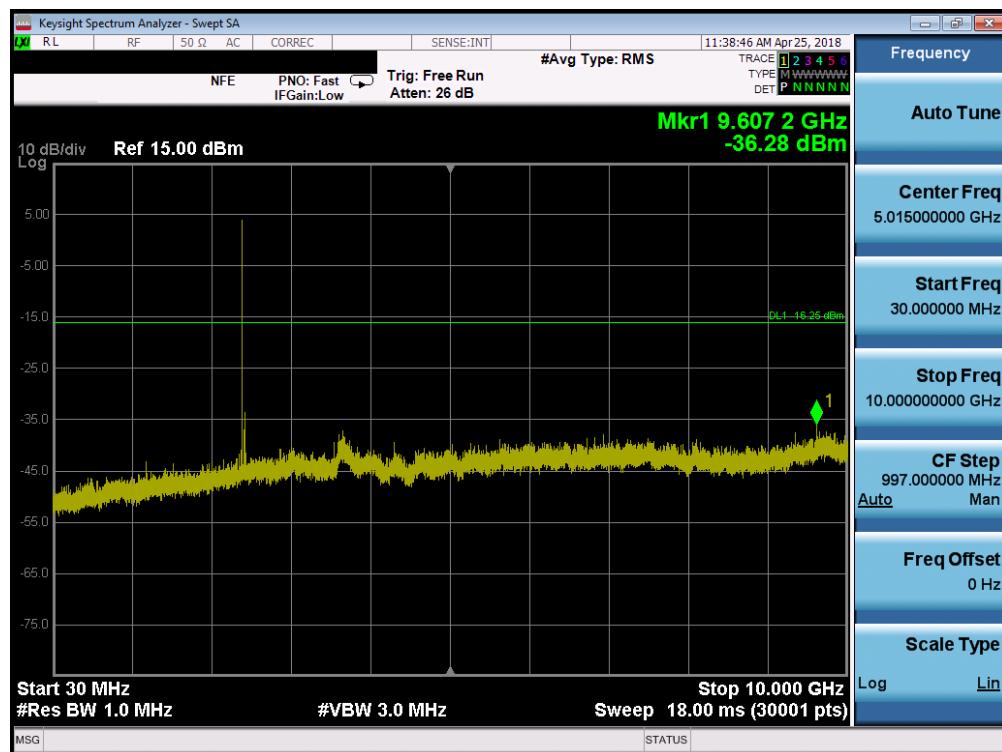


Plot 7-41. Conducted Spurious Plot (Bluetooth (LE), 250kbps – Ch. 39)

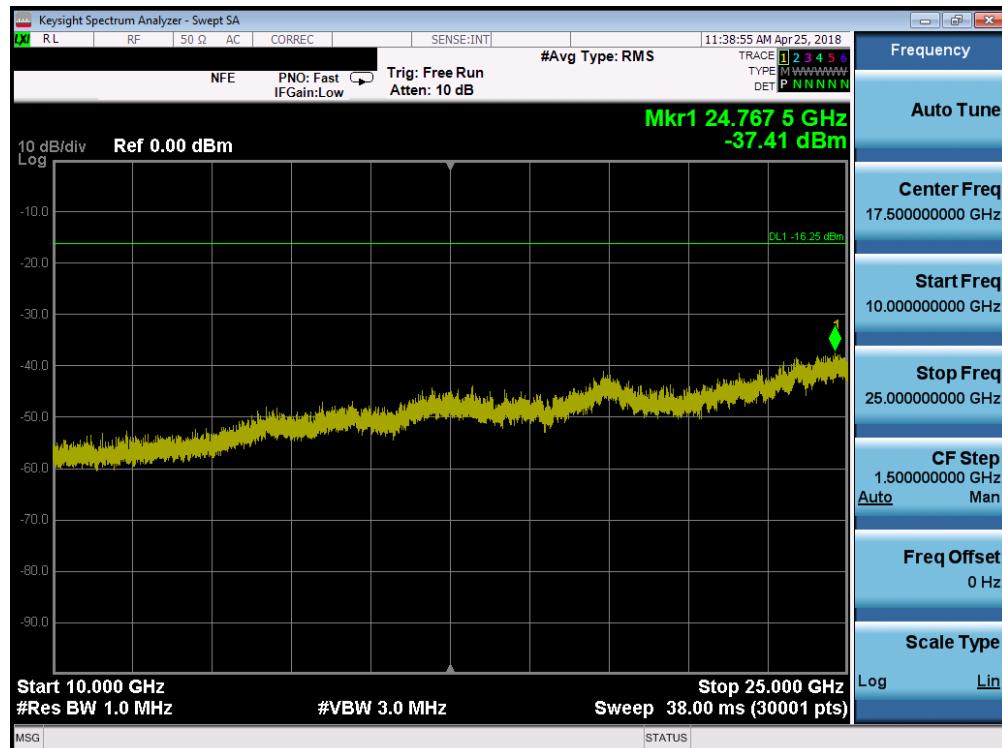


Plot 7-42. Conducted Spurious Plot (Bluetooth (LE), 250kbps – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 41 of 65	

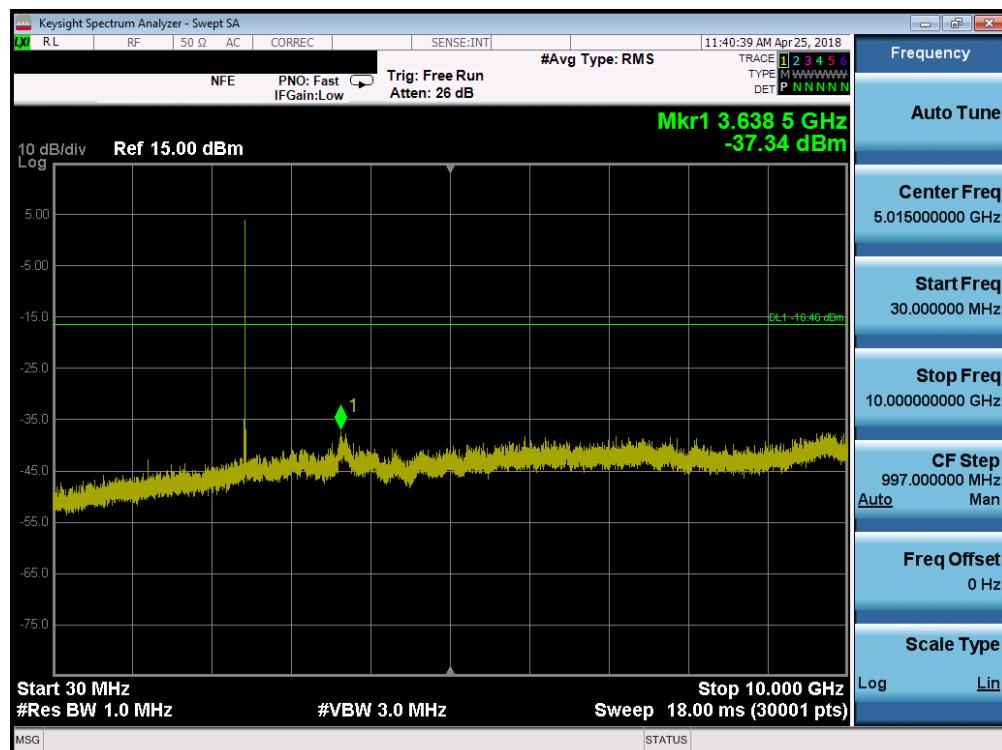


Plot 7-43. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 0)

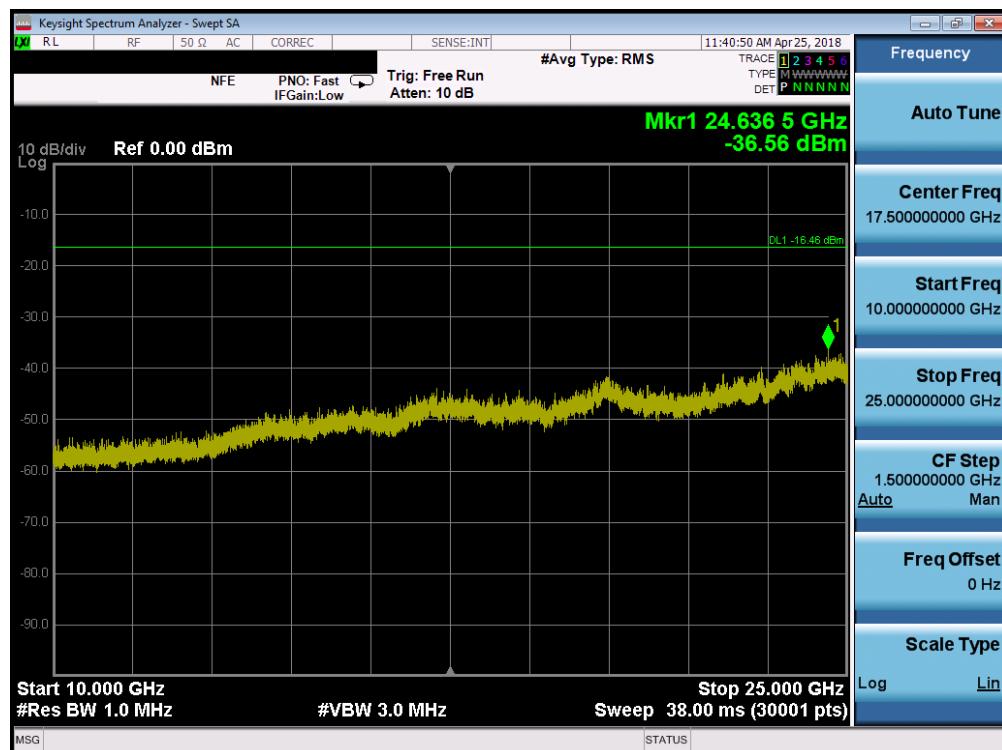


Plot 7-44. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 0)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 42 of 65

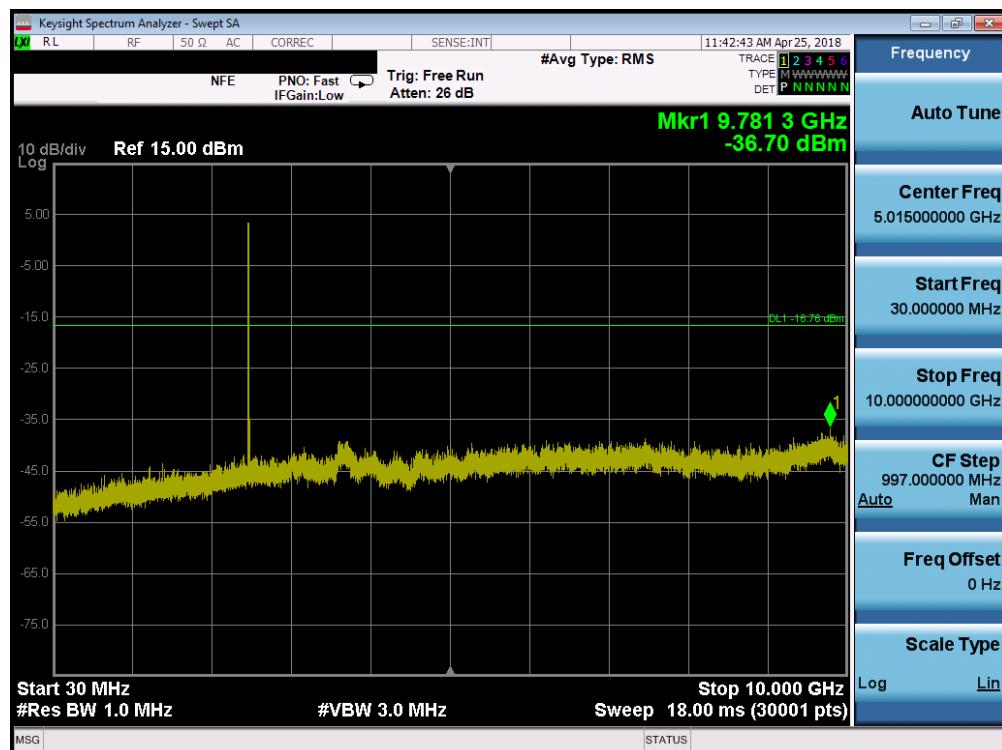


Plot 7-45. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 19)

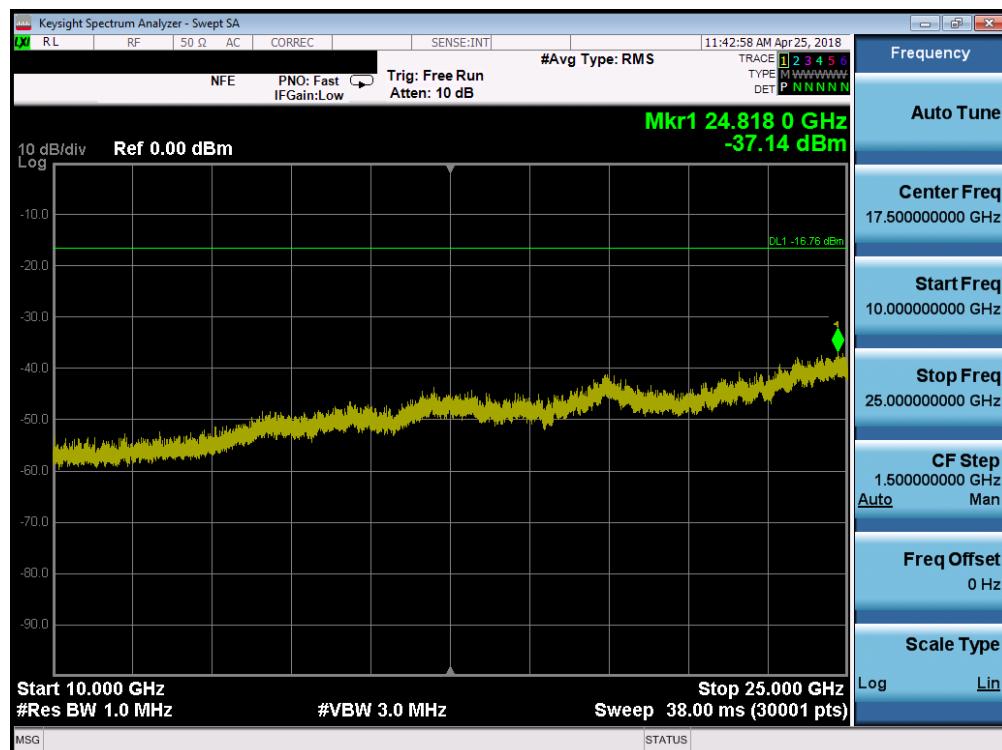


Plot 7-46. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 19)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 43 of 65

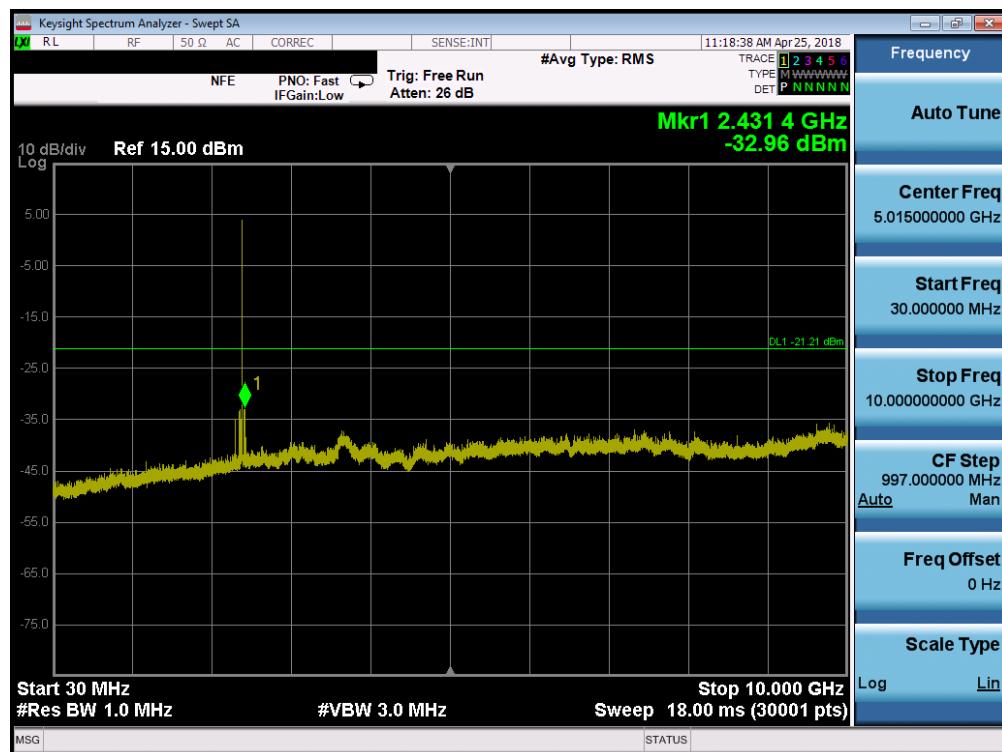


Plot 7-47. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 39)

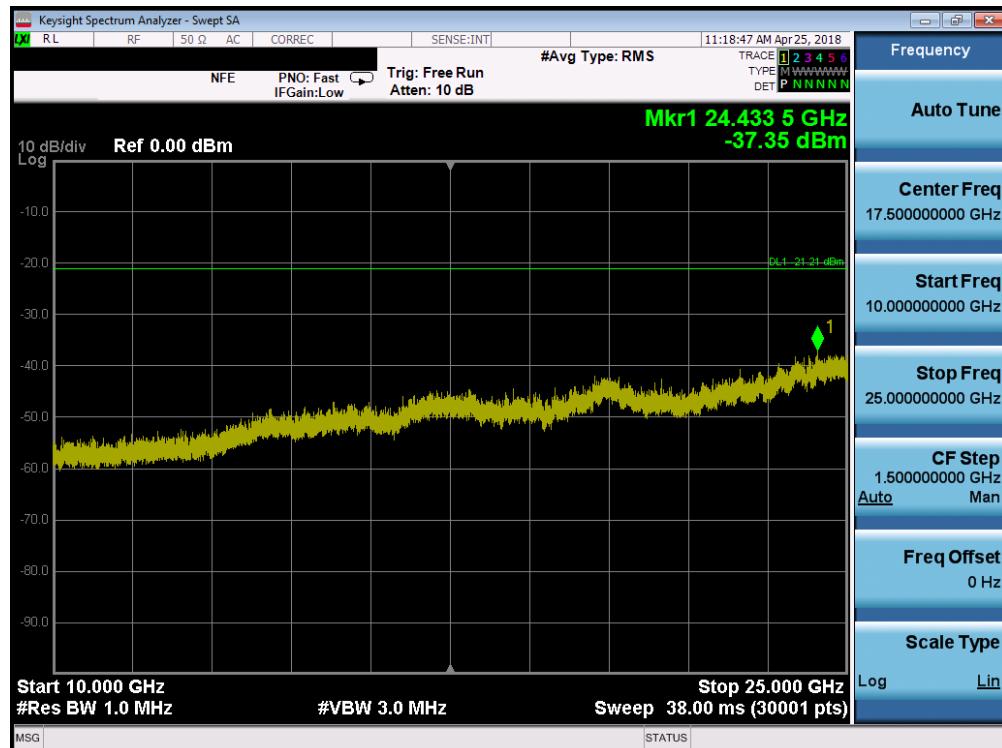


Plot 7-48. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 44 of 65

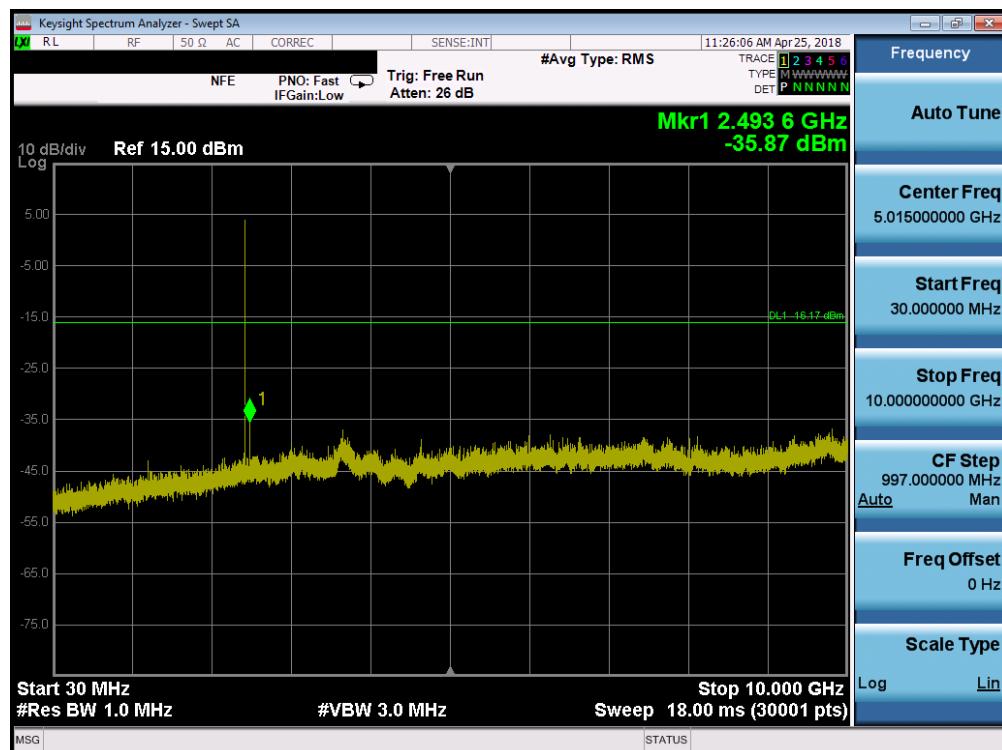


Plot 7-49. Conducted Spurious Plot (Bluetooth (LE), 2Mbps – Ch. 0)

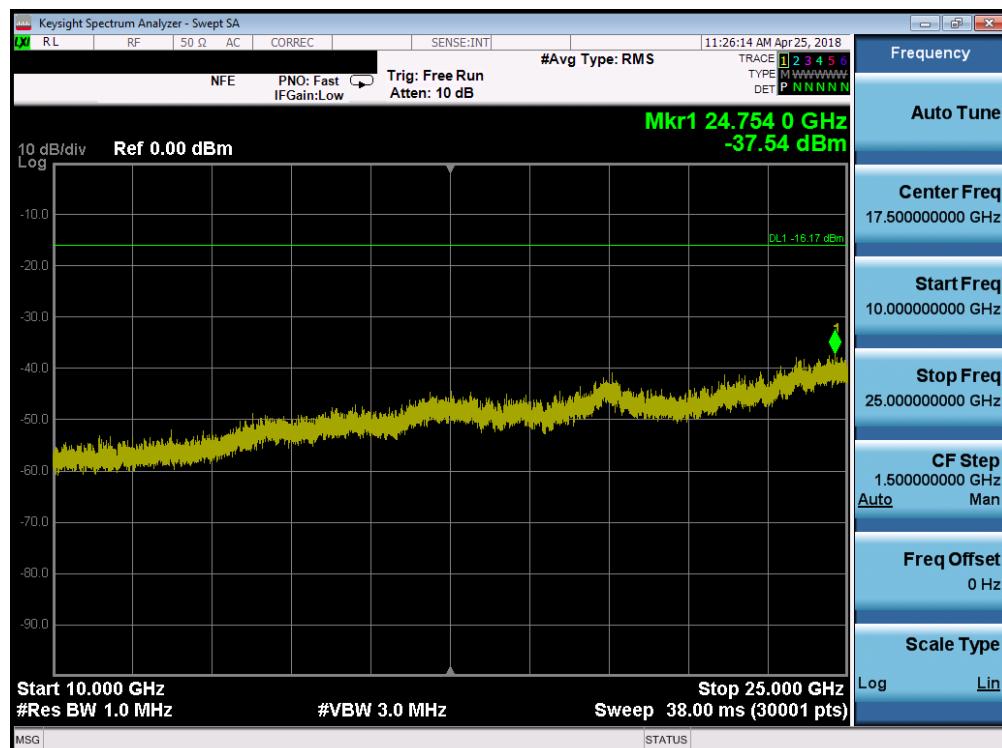


Plot 7-50. Conducted Spurious Plot (Bluetooth (LE), 2Mbps – Ch. 0)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 45 of 65	

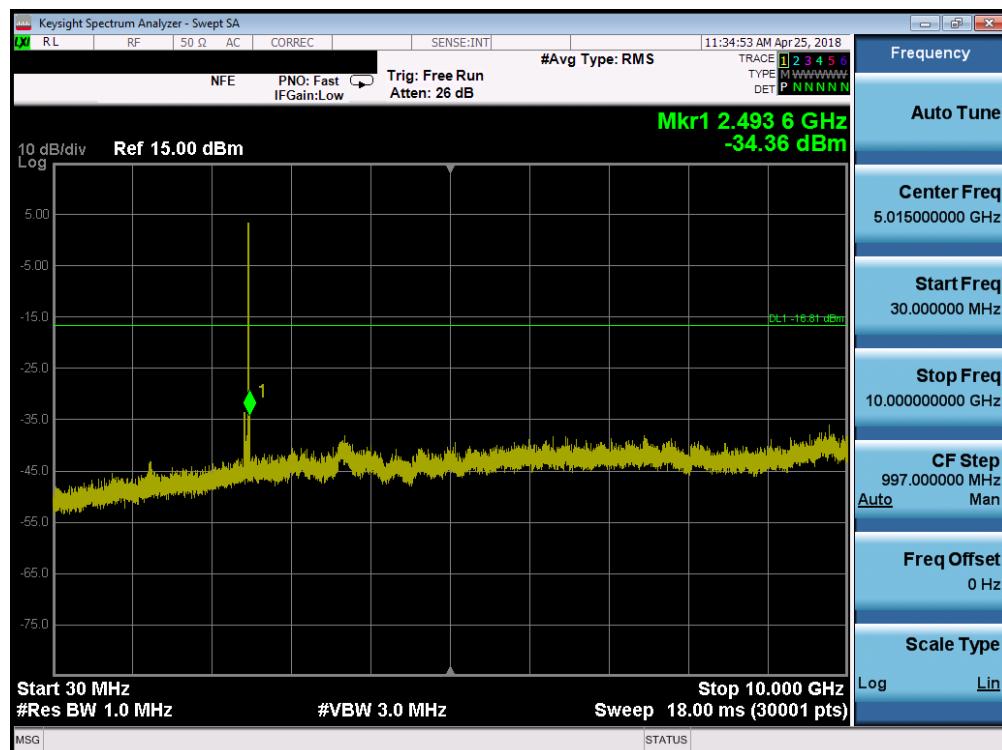


Plot 7-51. Conducted Spurious Plot (Bluetooth (LE), 2Mbps – Ch. 19)

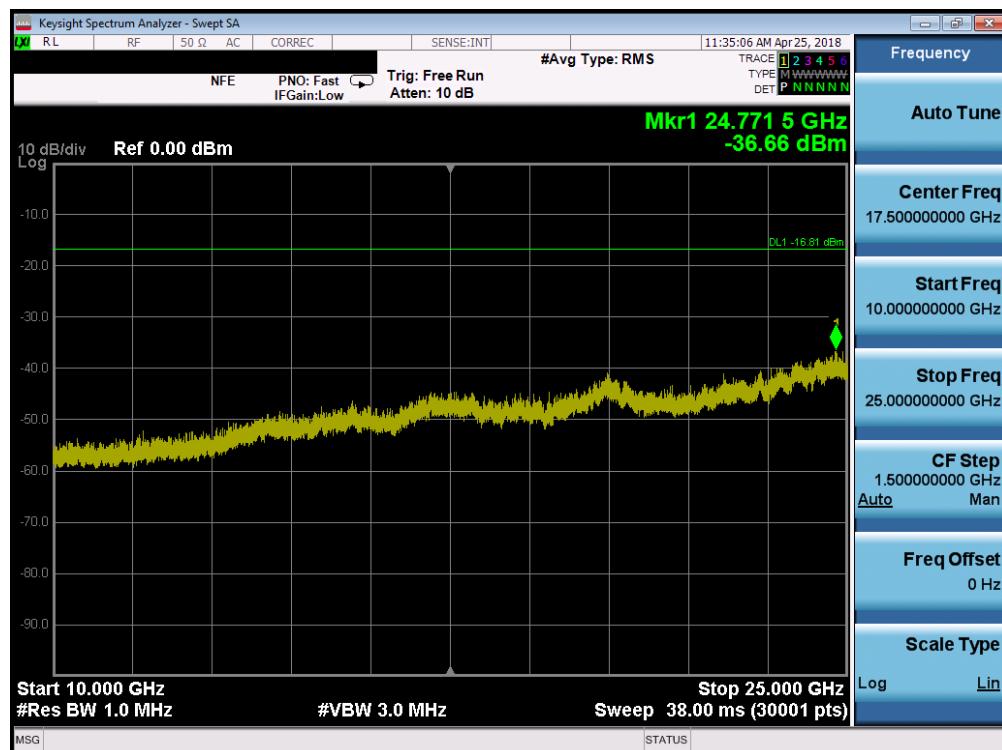


Plot 7-52. Conducted Spurious Plot (Bluetooth (LE), 2Mbps – Ch. 19)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 46 of 65



Plot 7-53. Conducted Spurious Plot (Bluetooth (LE), 2Mbps – Ch. 39)



Plot 7-54. Conducted Spurious Plot (Bluetooth (LE), 2Mbps – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 47 of 65

7.9 Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d); RSS-Gen [8.9]

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-6 per Section 15.209 and RSS-Gen (8.9).

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

Table 7-6. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Section 6.6.4.3

KDB 558074 D01 v04 – Section 12.1, 12.2.7

Test Settings

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3kHz > 1/T
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times (1/duty cycle) traces

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 48 of 65

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW is set depending on measurement frequency, as specified in Table 7-7 below
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Frequency	RBW
9 – 150kHz	200 – 300Hz
0.15 – 30MHz	9 – 10kHz
30 – 1000MHz	100 – 120kHz
> 1000MHz	1MHz

Table 7-7. RBW as a Function of Frequency

Test Setup

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

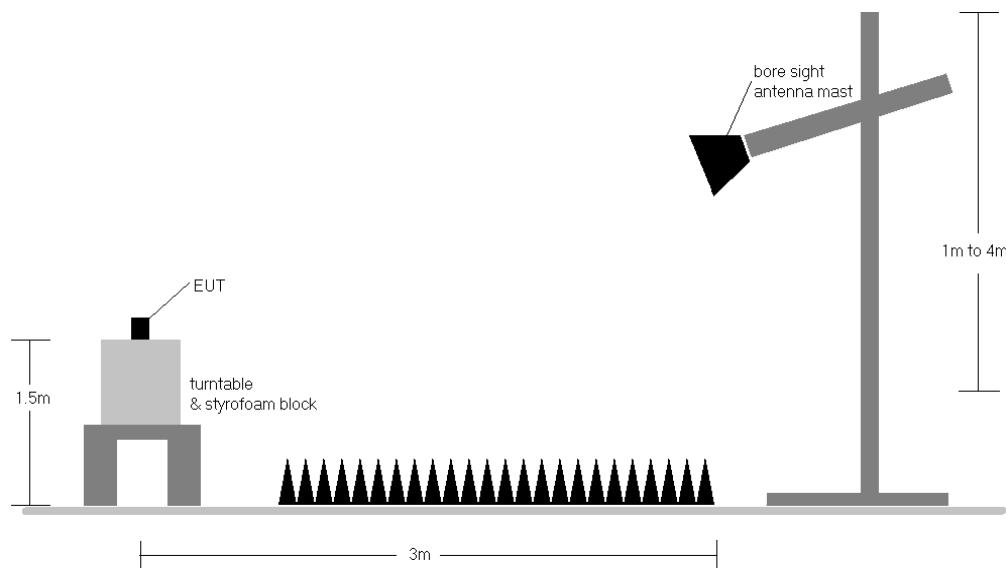


Figure 7-8. Radiated Test Setup >1GHz

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 49 of 65

Test Notes

1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of KDB 558074 D01 v04 were not used to evaluate this device for compliance to radiated limits. All radiated spurious emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-6.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested with its standard battery.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
6. Average measurements were recorded using a VBW of 3kHz, per Section 12.2.5.3 of KDB 558074 D01 v04 and Section 4.1.4.2.3 of ANSI C63.10-2013, since $1/T$ is equal to just under 3kHz. This method was used because the EUT could not be configured to operate with a duty cycle $> 98\%$. Both average and peak measurements were made using a peak detector
7. Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
8. No significant radiated band edge emissions were found in the 2310 – 2390MHz restricted band.
9. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

Sample Calculations

Determining Spurious Emissions Levels

- Field Strength Level $[\text{dB}_{\mu\text{V/m}}]$ = Analyzer Level $[\text{dBm}] + 107 + \text{AFCL} [\text{dB/m}]$
- AFCL $[\text{dB/m}]$ = Antenna Factor $[\text{dB/m}] + \text{Cable Loss} [\text{dB}]$
- Margin $[\text{dB}]$ = Field Strength Level $[\text{dB}_{\mu\text{V/m}}] - \text{Limit} [\text{dB}_{\mu\text{V/m}}]$

Radiated Band Edge Measurement Offset

- The amplitude offset shown in the radiated restricted band edge plots in Section 7.10 was calculated using the formula:

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + \text{Attenuator}) - \text{Preamplifier Gain}$$

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 50 of 65

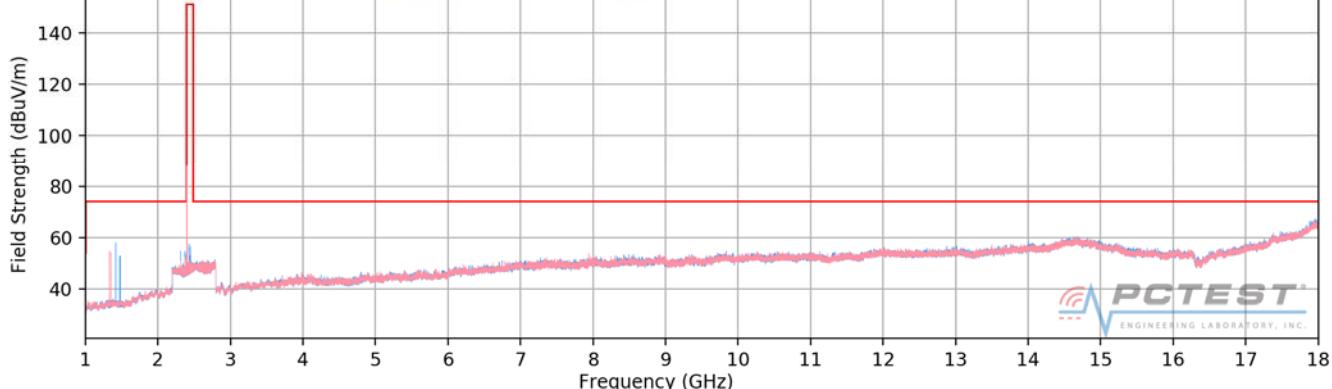
Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d); RSS-Gen [8.9]

PASS

Trace: MAXH
Detector: POS
Horizontal Vertical

RBW: 1 MHz
VBW: 3 MHz
SWT: 5.0ms

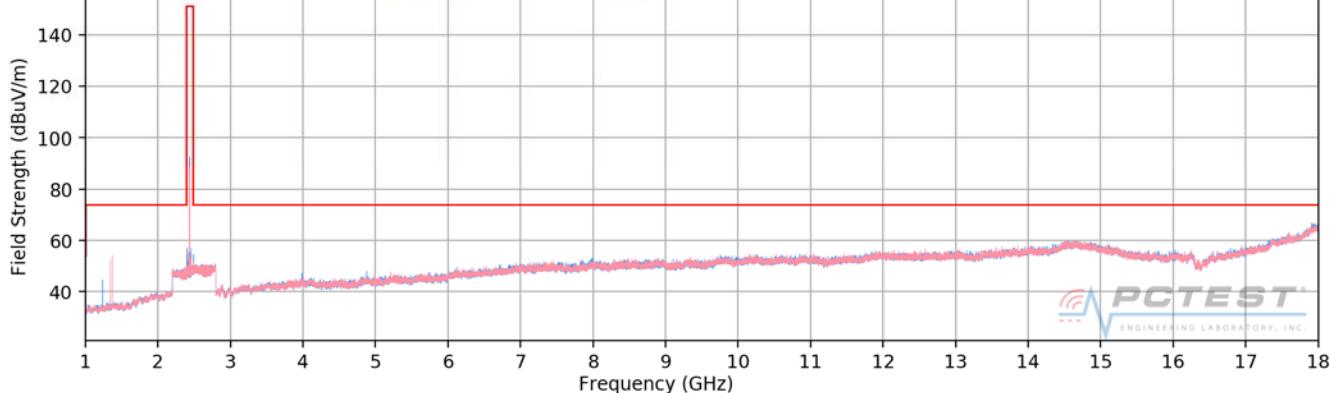


Plot 7-55. Radiated Spurious Plot above 1GHz (Bluetooth LE – Ch. 0)

PASS

Trace: MAXH
Detector: POS
Horizontal Vertical

RBW: 1 MHz
VBW: 3 MHz
SWT: 5.0ms

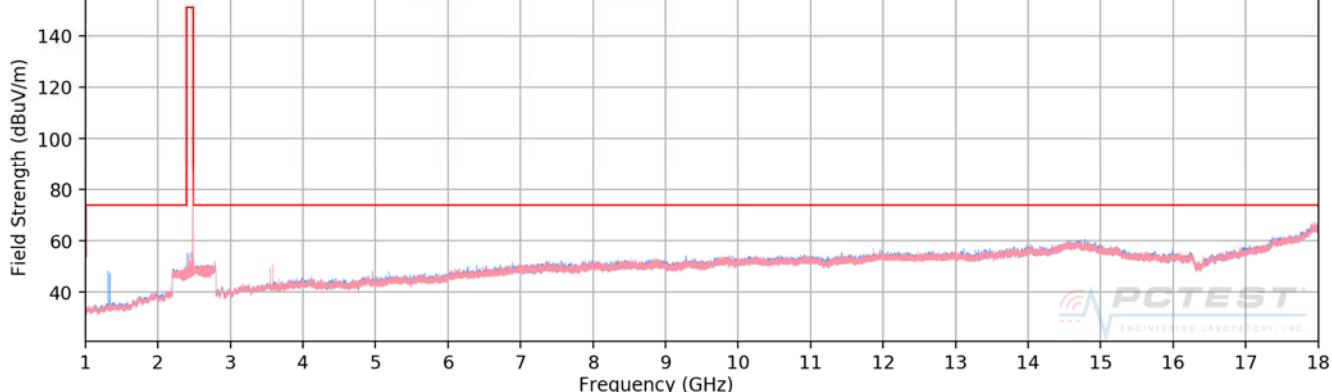


Plot 7-56. Radiated Spurious Plot above 1GHz (Bluetooth LE – Ch. 19)

PASS

Trace: MAXH
Detector: POS
Horizontal Vertical

RBW: 1 MHz
VBW: 3 MHz
SWT: 5.0ms



Plot 7-57. Radiated Spurious Plot above 1GHz (Bluetooth LE – Ch. 39)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 51 of 65

Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d); RSS-Gen [8.9]

Bluetooth Mode: LE
 Data Rate: 2 Mbps
 Distance of Measurements: 3 Meters
 Operating Frequency: 2402MHz
 Channel: 0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
4804.00	Avg	H	154	347	-79.27	2.42	30.15	53.98	-23.82
4804.00	Peak	H	154	347	-67.46	2.42	41.96	73.98	-32.01
12010.00	Avg	H	-	-	-82.92	13.48	37.56	53.98	-16.42
12010.00	Peak	H	-	-	-70.27	13.48	50.21	73.98	-23.77

Table 7-8. Radiated Measurements @ 3 meters

Bluetooth Mode: LE
 Data Rate: 2 Mbps
 Distance of Measurements: 3 Meters
 Operating Frequency: 2440MHz
 Channel: 19

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
4880.00	Avg	H	116	349	-76.84	3.27	33.43	53.98	-20.55
4880.00	Peak	H	116	349	-65.85	3.27	44.42	73.98	-29.56
7320.00	Avg	H	237	3	-81.47	9.70	35.23	53.98	-18.75
7320.00	Peak	H	237	3	-69.89	9.70	46.81	73.98	-27.17
12200.00	Avg	H	-	-	-82.84	14.01	38.17	53.98	-15.81
12200.00	Peak	H	-	-	-70.73	14.01	50.28	73.98	-23.70

Table 7-9. Radiated Measurements @ 3 meters

FCC ID: 2APPWSO1	 PCTEST ENGINEERING LABORATORY, INC.	MEASUREMENT REPORT (CERTIFICATION)				Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)				

Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d); RSS-Gen [8.9]

Bluetooth Mode: LE
 Data Rate: 2 Mbps
 Distance of Measurements: 3 Meters
 Operating Frequency: 2480MHz
 Channel: 39

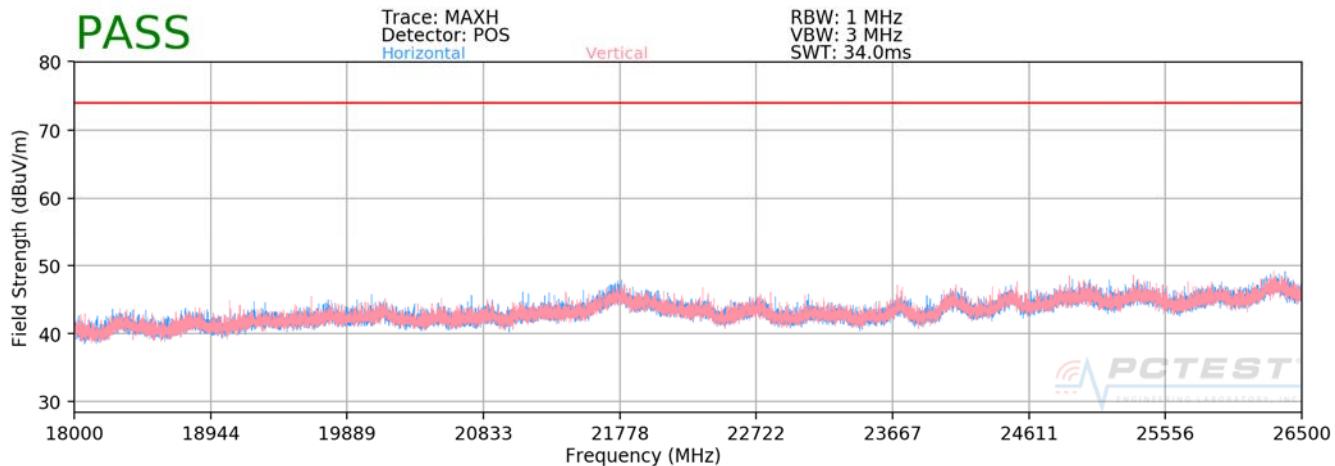
Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
4960.00	Avg	H	106	338	-75.25	2.62	34.37	53.98	-19.61
4960.00	Peak	H	106	338	-63.33	2.62	46.29	73.98	-27.69
7440.00	Avg	H	111	314	-80.09	9.48	36.39	53.98	-17.59
7440.00	Peak	H	111	314	-68.87	9.48	47.61	73.98	-26.37
12400.00	Avg	H	-	-	-83.20	12.93	36.73	53.98	-17.25
12400.00	Peak	H	-	-	-70.60	12.93	49.33	73.98	-24.65

Table 7-10. Radiated Measurements @ 3 meters

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 53 of 65	

Radiated Spurious Emissions Measurements (Above 18GHz)

§15.209; RSS-Gen [8.9]



Plot 7-58. Radiated Spurious Plot above 18GHz

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 54 of 65

7.10 Radiated Restricted Band Edge Measurements

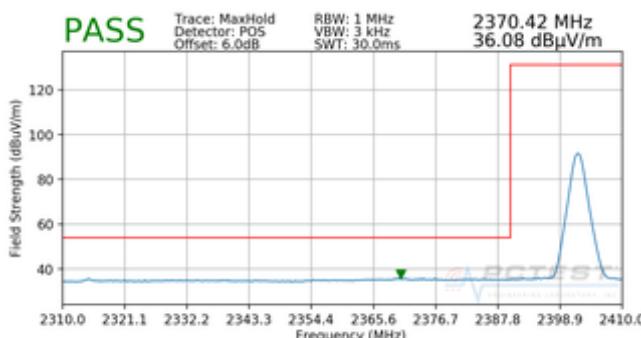
§15.205 §15.209; RSS-Gen [8.9]

The radiated restricted band edge measurements are measured with an EMI test receiver connected to the receive antenna while the EUT is transmitting.

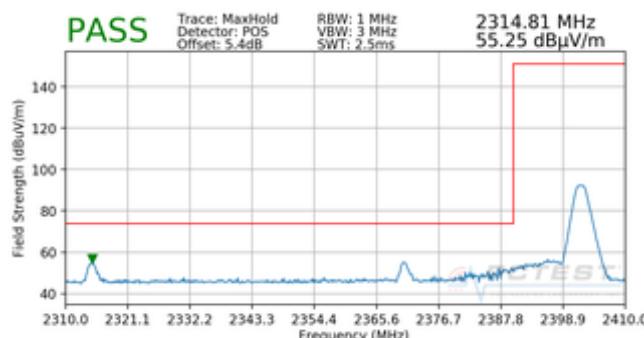
The amplitude offset shown in the following plots for average measurements was calculated using the formula:

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + \text{Attenuator}) - \text{Preamplifier Gain}$$

Bluetooth Mode: LE
 Measurement Distance: 3 Meters
 Operating Frequency: 2402MHz
 Channel: 0



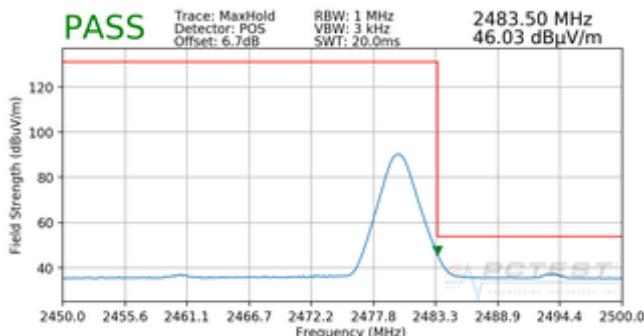
Plot 7-59. Radiated Restricted Lower Band Edge Measurement (Average)



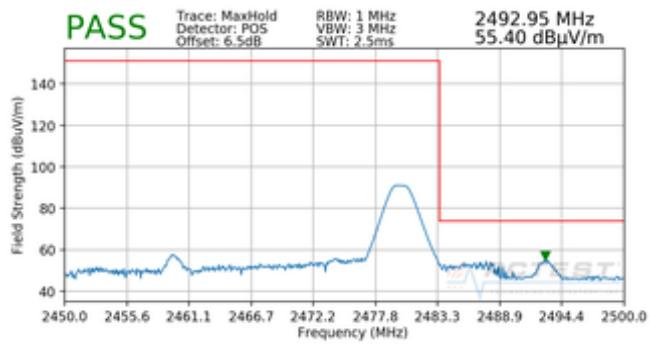
Plot 7-60. Radiated Restricted Lower Band Edge Measurement (Peak)

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 55 of 65

Bluetooth Mode: LE
 Measurement Distance: 3 Meters
 Operating Frequency: 2402MHz
 Channel: 39



Plot 7-61. Radiated Restricted Upper Band Edge Measurement (Average)



Plot 7-62. Radiated Restricted Upper Band Edge Measurement (Peak)

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 56 of 65

7.11 Radiated Spurious Emissions Measurements – Below 1GHz

§15.209; RSS-Gen [8.9]

Test Overview and Limit

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

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-11 per Section 15.209 and RSS-Gen (8.9).

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

Table 7-11. Radiated Limits

Test Procedures Used

ANSI C63.10-2013

Test Settings

Quasi-Peak Field Strength Measurements

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

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 57 of 65

Test Setup

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

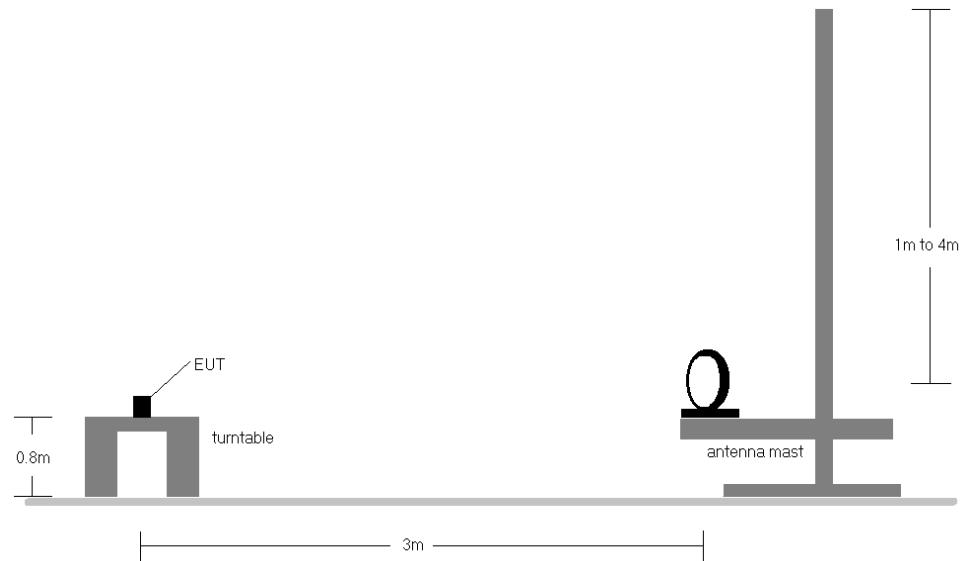


Figure 7-9. Radiated Test Setup < 30Mhz

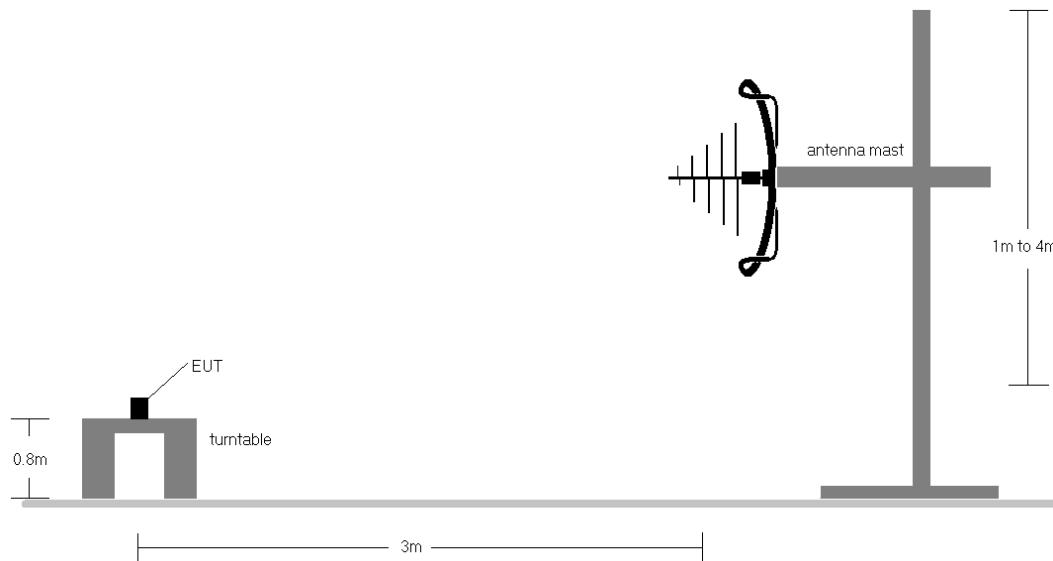


Figure 7-10. Radiated Test Setup < 1GHz

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 58 of 65

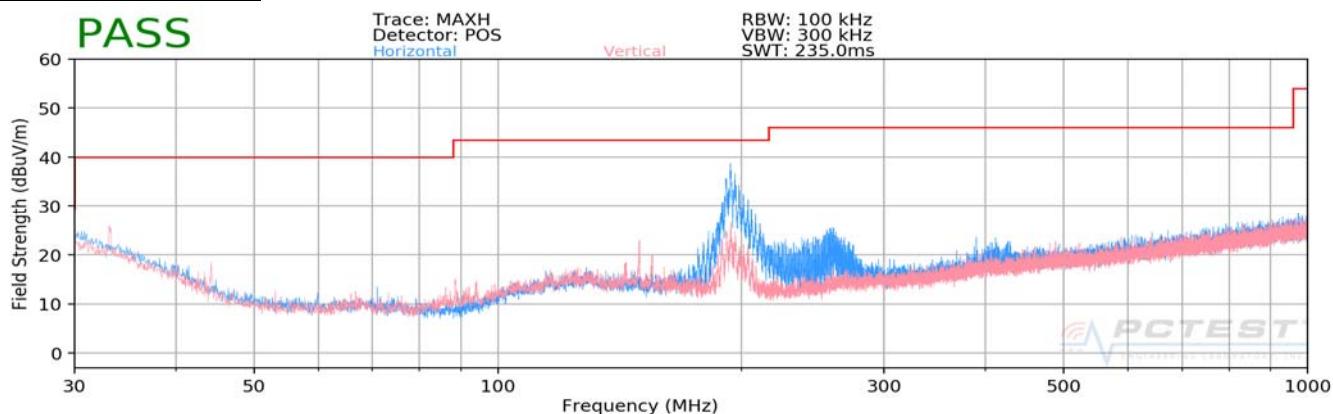
Test Notes

1. All emissions lying in restricted bands specified in §15.205 and RSS-Gen (8.10) are below the limit shown in Table 7-11.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes.
3. This unit was tested with its standard battery.
4. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
5. Emissions were measured at a 3 meter test distance.
6. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
7. No spurious emissions were detected within 20dB of the limit below 30MHz.
8. The results recorded using the broadband antenna is known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
9. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. There were no emissions detected in the 30MHz – 1GHz frequency range, as shown in the subsequent plots.

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 59 of 65

Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209; RSS-Gen [8.9]



Plot 7-63. Radiated Spurious Plot below 1GHz

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 60 of 65

Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209; RSS-Gen [8.9]

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
149.00	Quasi-Peak	H	187	228	-69.42	-17.04	20.54	43.52	-22.98
189.00	Quasi-Peak	H	187	228	-54.94	-18.07	33.99	43.52	-9.53
194.00	Quasi-Peak	H	187	228	-55.08	-17.36	34.56	43.52	-8.96
229.00	Quasi-Peak	H	187	228	-66.67	-17.98	22.35	46.02	-23.67
259.00	Quasi-Peak	H	187	228	-67.24	-17.16	22.60	46.02	-23.42
271.00	Quasi-Peak	H	187	228	-70.37	-15.95	20.68	46.02	-25.34

Table 7-12. Radiated Spurious Emissions Below 1GHz

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 61 of 65	

7.12 Line-Conducted Test Data

§15.207; RSS-Gen [8.8]

Test Overview and Limit

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

All conducted emissions must not exceed the limits shown in the table below, per Section 15.207 and RSS-Gen (8.8).

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

Table 7-13. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2013, Section 6.2

Test Settings

Quasi-Peak Field Strength Measurements

7. Analyzer center frequency was set to the frequency of the spurious emission of interest
8. RBW = 9kHz (for emissions from 150kHz – 30MHz)
9. Detector = quasi-peak
10. Sweep time = auto couple
11. Trace mode = max hold
12. Trace was allowed to stabilize

Average Field Strength Measurements

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

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 62 of 65

Test Setup

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

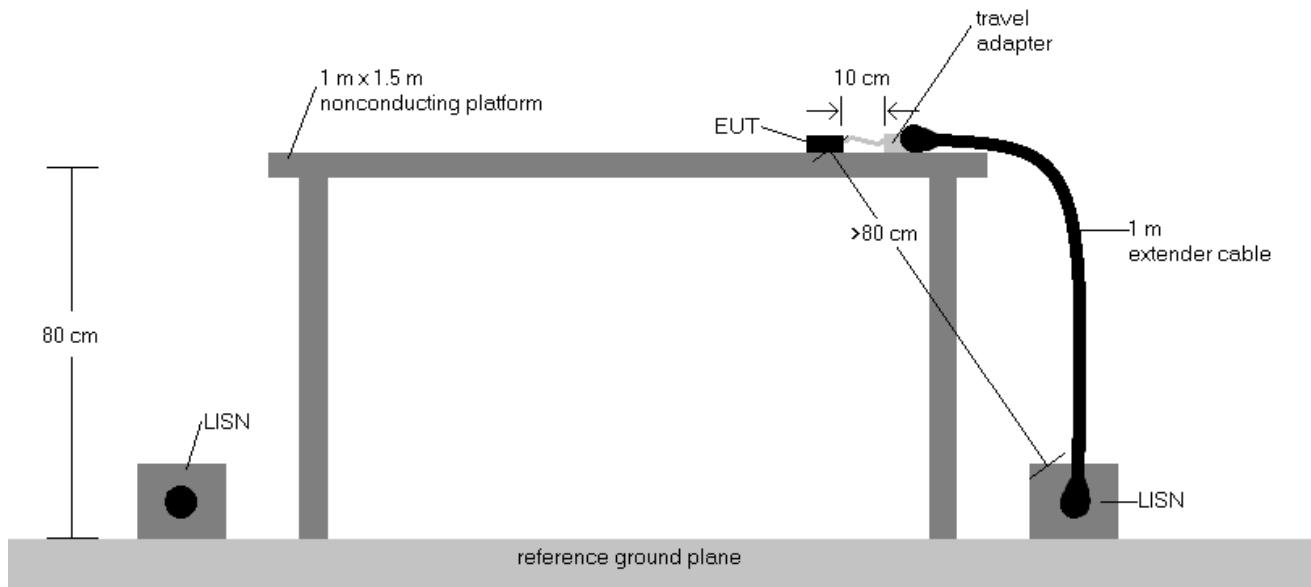
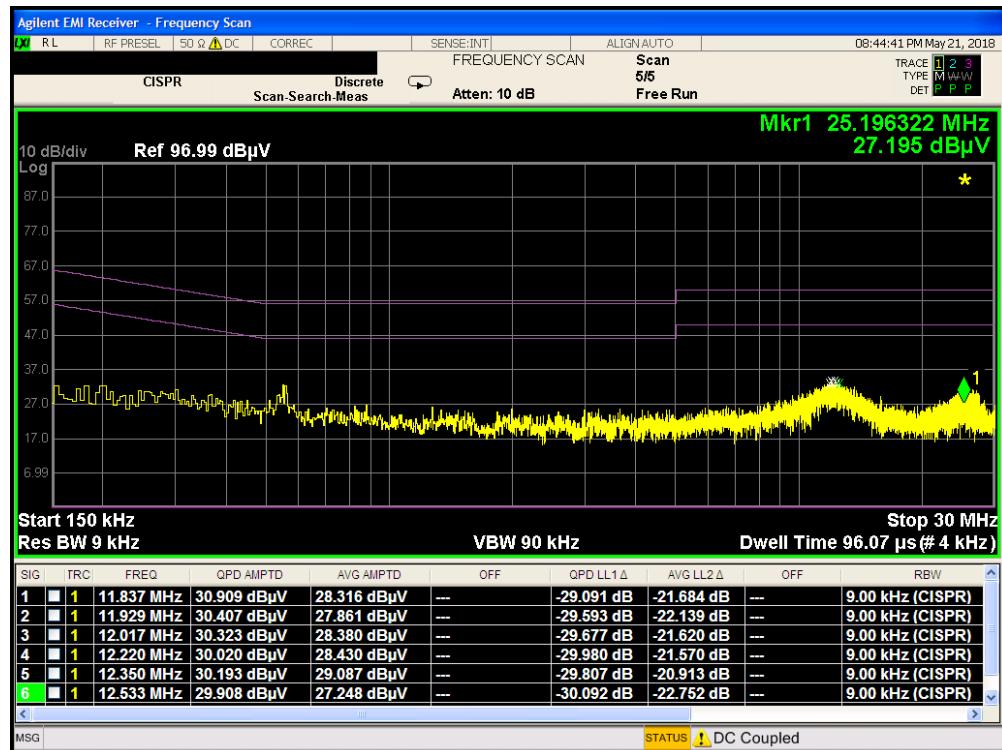


Figure 7-11. Test Instrument & Measurement Setup

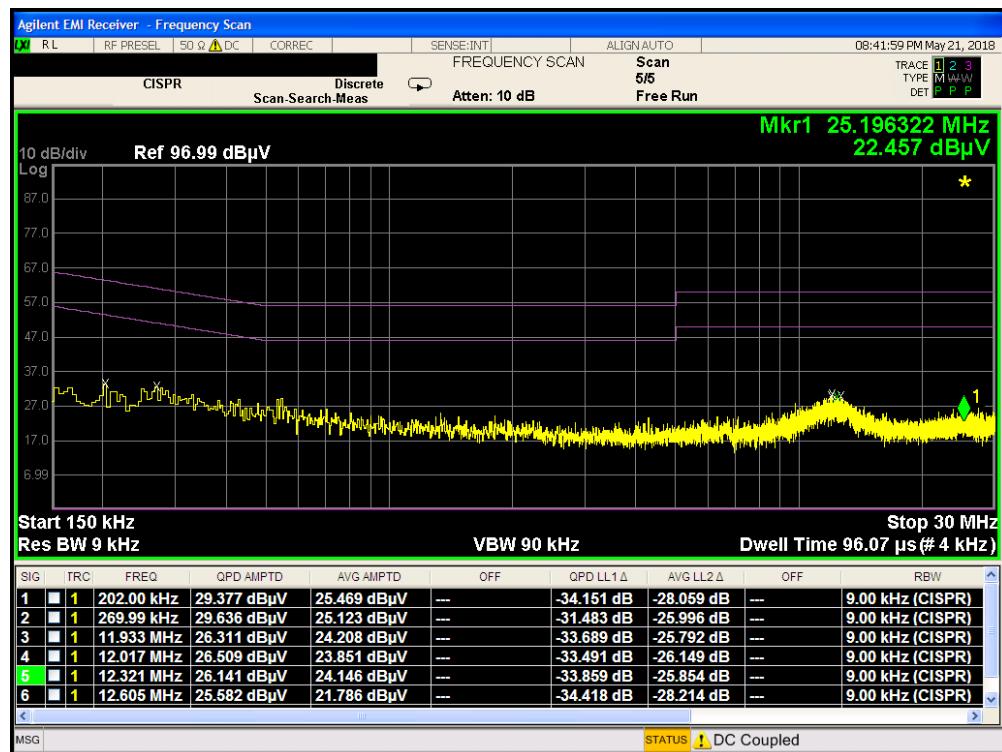
Test Notes

1. All modes of operation were investigated and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in Part 15.207 and RSS-Gen (8.8).
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (dB μ V) = QP/AV Analyzer/Receiver Level (dB μ V) + Corr. (dB)
5. Margin (dB) = QP/AV Limit (dB μ V) - QP/AV Level (dB μ V)
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.

FCC ID: 2APPWS01	PCTEST ENGINEERING LABORATORY, INC.		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)		Page 63 of 65



Plot 7-64. Line Conducted Plot with Bluetooth LE (L1)



Plot 7-65. Line Conducted Plot with Bluetooth LE (N)

FCC ID: 2APPWS01	 MEASUREMENT REPORT (CERTIFICATION)			Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 64 of 65	

8.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **OnPoint Systems Integrated Device, wearable (Pet Collar) FCC ID: 2APPWSO1** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.

FCC ID: 2APPWSO1	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1803230052-02 2AP	Test Dates: 4/25-5/21/2018	EUT Type: Integrated Device, wearable (Pet Collar)	Page 65 of 65