

**MEASUREMENT REPORT**
FCC PART 15.247 Bluetooth**Company Name:**H&D Wireless AB
Färögatan 33
SE-164 51 Kista
Sweden**Date of Testing:**

4/7 - 6/17/2016

Test Site/Location:

PCTEST Lab. Columbia, MD, USA

Test Report Serial No.:

0Y1604070740.XO2

FCC ID:**XO2SPB209A****APPLICANT:****H&D Wireless AB****Application Type:**

Certification

Model(s):

SPB209A

EUT Type:

Wifi/BT/NFC Module

Max. RF Output Power:

4.53 mW (6.56 dBm) Peak Conducted

Frequency Range:

2402 – 2480MHz (Bluetooth for US)

Type of Modulation:GFSK, $\pi/4$ -DQPSK, 8DPSK**FCC Classification:**

FCC Part 15 Spread Spectrum Transmitter (DSS)

FCC Rule Part(s):

Part 15 Subpart C (15.247)

Test Procedure(s):

ANSI C63.10-2013

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. 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: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 1 of 60

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MEASUREMENT REPORT

FCC Part 15.247



§ 2.1033 General Information

COMPANY: H&D Wireless AB
COMPANY ADDRESS: Färögatan 33
 SE-164 51 Kista, Sweden
TEST SITE: PCTEST ENGINEERING LABORATORY, INC.
TEST SITE ADDRESS: 7185 Oakland Mills Road, Columbia, MD 21046 USA
FCC RULE PART(S): Part 15 Subpart C (15.247)
BASE MODEL: SPB209A
FCC CLASSIFICATION: FCC Part 15 Spread Spectrum Transmitter (DSS)
Method/System: Frequency Hopping Spread Spectrum (FHSS)
DATE(S) OF TEST: 4/7 - 6/17/2016
TEST REPORT S/N: 0Y1604070740.XO2

Test Facility / Accreditations

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



- PCTEST facility is an FCC registered (PCTEST Reg. No. 159966) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (2451B-1).
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing Aid Compatibility (HAC) testing, CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.
- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (2451B-1) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS, CDMA, and EvDO wireless devices and for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO, and CDMA 1xRTT.

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1.0 INTRODUCTION

1.1 Scope

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

1.2 PCTEST Test Location

The map below shows the location of the PCTEST LABORATORY, its proximity to the FCC Laboratory, the Columbia vicinity, the Baltimore-Washington Intern't'l (BWI) airport, the city of Baltimore and the Washington, DC area. (See Figure 1-1).

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The site coordinates are 39° 10'23" N latitude and 76° 49'50" W longitude. The facility is 0.4 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4-2014 on January 22, 2012.

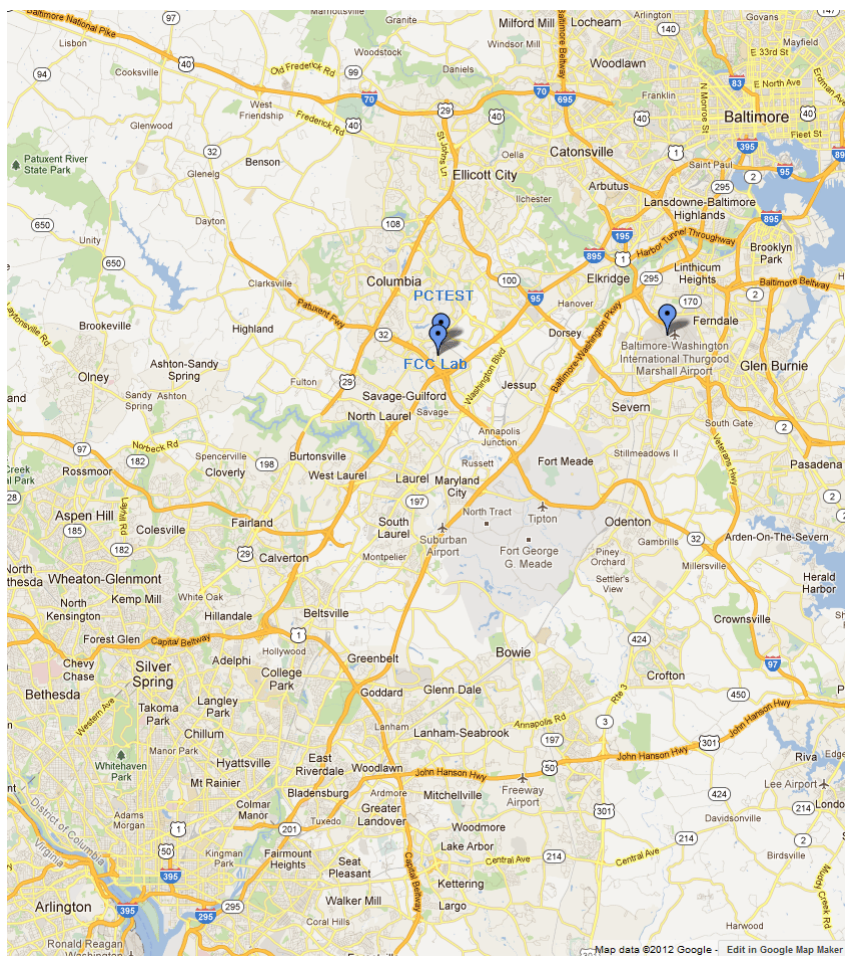


Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **H&D Wireless AB Wifi/BT/NFC Module FCC ID: XO2SPB209A**. The test data contained in this report pertains only to the emissions due to the EUT's Bluetooth transmitter.

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
 - A) The hopping sequence is pseudorandom
 - B) All channels are used equally on average
 - C) The receiver input bandwidth equals the transmit bandwidth
 - D) The receiver hops in sequence with the transmit signal
- 15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.
- 15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.
- 15.247(h): The EUT employs Adaptive Frequency Hopping (AFH) which identifies sources of interference namely devices operating in 802.11 WLAN and excludes them from the list of available channels. The process of re-mapping reduces the number of test channels from 79 channels to a minimum number of 20 channels.

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n/a/ac WLAN/UNII, Bluetooth (1x, EDR, LE), NFC, Master AP

2.3 Test Configuration

The H&D Wireless AB Wifi/BT/NFC Module FCC ID: XO2SPB209A was tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was also 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, 7.6, 7.7, 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 no modifications were made during testing.

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3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedure described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013) was used in the measurement of the **H&D Wireless AB Wifi/BT/NFC Module** FCC ID: XO2SPB209A.

Deviation from measurement procedure.....None

3.2 AC Line Conducted Emissions

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

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

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was also maximized by varying: power lines, the mode of operation or resolution, clock or data exchange speed, scrolling H pattern to the EUT and/or support equipment whichever determined the worst-case 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 7.12. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.

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3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. For measurements above 1GHz 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 below 1GHz, a 72.4cm high PVC support structure is placed on top of the turntable. A 3" (~7.6cm) sheet of high density polystyrene is used as the table top and is placed on top of the PVC supports to bring the total height of the table to 80cm. For measurements above 1GHz, a high density expanded polystyrene block 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(b)(1) 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, clock speed, mode of operation or video resolution, if applicable, 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).

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4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

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

- The antenna of the H&D Wireless AB Wifi/BT/NFC Module is **permanently attached**.
- Antenna connections uses unique coupling to the intentional radiator.

Conclusion:

The **H&D Wireless AB Wifi/BT/NFC Module FCC ID: XO2SPB209A** unit complies with the requirement of §15.203.

Ch.	Frequency (MHz)
00	2402
:	:
39	2441
:	:
78	2480

Table 4-1. Frequency/ Channel Operations

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5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95% level of confidence. The measurement data shown herein 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
Conducted Disturbance	3.09
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST).

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	RE1	Radiated Emissions Cable Set (UHF/EHF)	3/4/2016	Annual	3/4/2017	RE1
-	WL25-1	Conducted Cable Set (25GHz)	4/11/2016	Annual	4/11/2017	WL25-1
Agilent	8447D	Broadband Amplifier	6/12/2015	Annual	6/12/2016	2443A01900
Agilent	N9020A	MXA Signal Analyzer	11/5/2015	Annual	11/5/2016	US46470561
Agilent	N9038A	MXE EMI Receiver	4/21/2016	Annual	4/21/2017	MY51210133
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	7/30/2015	Biennial	7/30/2017	121034
Com-Power	PAM-103	Pre-Amplifier (1-1000MHz)	2/26/2016	Annual	2/26/2017	441119
Emco	3115	Horn Antenna (1-18GHz)	3/10/2016	Biennial	3/10/2018	9704-5182
Espec	ESX-2CA	Environmental Chamber	3/4/2016	Annual	3/4/2017	17620
ETS Lindgren	3160-09	18-26.5 GHz Standard Gain Horn	6/17/2014	Biennial	6/17/2016	135427
ETS Lindgren	3160-10	26.5-40 GHz Standard Gain Horn	6/17/2014	Biennial	6/17/2016	130993
ETS-Lindgren	3816/2NM	Line Impedance Stabilization Network	11/11/2014	Biennial	11/11/2016	114451
Huber+Suhner	Sucoflex 102A	40GHz Radiated Cable	4/26/2016	Annual	4/26/2017	251425001
K & L	11SH10-3075/U18000	High Pass Filter	7/18/2015	Annual	7/18/2016	11SH10-3075/U18000-2
K & L	11SH10-3075/U18000	High Pass Filter	7/18/2015	Annual	7/18/2016	11SH10-3075/U18000-1
Rhode & Schwarz	TS-PR18	Pre-Amplifier	3/7/2016	Annual	3/7/2017	101622
Rohde & Schwarz	TS-PR18	1-18 GHz Pre-Amplifier	3/7/2016	Annual	3/7/2017	100071
Rohde & Schwarz	TS-PR26	18-26.5 GHz Pre-Amplifier	3/7/2016	Annual	3/7/2017	100040
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	5/16/2016	Annual	5/16/2017	100342
Rohde & Schwarz	TS-PR40	26.5-40 GHz Pre-Amplifier	3/7/2016	Annual	3/7/2017	100037
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	7/17/2015	Annual	7/17/2016	100348
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/2/2016	Biennial	3/2/2018	N/A
Solar Electronics	8012-50-R-24-BNC	Line Impedance Stabilization Network	7/30/2015	Biennial	7/30/2017	310233
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	3/14/2016	Biennial	3/14/2018	A051107

Table 6-1. Annual Test Equipment Calibration Schedule

Note:

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

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7.0 TEST RESULTS

7.1 Summary

Company Name: H&D Wireless AB
 FCC ID: XO2SPB209A
 Method/System: Frequency Hopping Spread Spectrum (FHSS)
 Number of Channels: 79

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
TRANSMITTER MODE (Tx)					
15.247(a)(1)(iii)	20dB Bandwidth	N/A	CONDUCTED	PASS	Section 7.2
15.247(b)(1)	Peak Transmitter Output Power	< 1 Watt if ≥ 75 non-overlapping channels used		PASS	Section 7.3
15.247(a)(1)	Channel Separation	> 2/3 of 20 dB BW for systems with Output Power < 125mW		PASS	Section 7.5
15.247(a)(1)(iii)	Number of Channels	> 15 Channels		PASS	Section 7.7
15.247(a)(1)(iii)	Time of Occupancy	< 0.4 sec in 31.6 sec period		PASS	Section 7.6
15.247(d)	Band Edge / Out-of-Band Emissions	Conducted > 20dBc		PASS	Section 7.4, Section 7.8
15.205 15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209	RADIATED	PASS	Section 7.9, Section 7.10, Section 7.11
15.207	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits	LINE CONDUCTED	PASS	Section 7.12

Table 7-1. Summary of Test Results

Notes:

- 1) All modes of operation and data rates 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, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT 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, attenuators, and couplers.
- 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 "BT Auto," Version 3.0.
- 5) For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Chamber Automation," Version 1.1.2.

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7.2 20dB Bandwidth Measurement

§15.247 (a.1.iii)

Test Overview and Limit

The bandwidth at 20dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

Test Procedure Used

ANSI C63.10-2013 – Section 6.9.2

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 20dB bandwidth measurement. The "X" dB bandwidth parameter was set to $X = 20$. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. $RBW = 1 - 5\% \text{ OBW}$
3. $VBW \geq 3 \times RBW$
4. Reference level set to keep signal from exceeding maximum input mixer level for linear operation.
5. Detector = Peak
6. Trace mode = max hold
7. Sweep = auto couple
8. The trace was allowed to stabilize

Test Setup

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

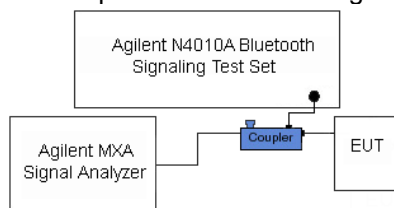


Figure 7-1. Test Instrument & Measurement Setup

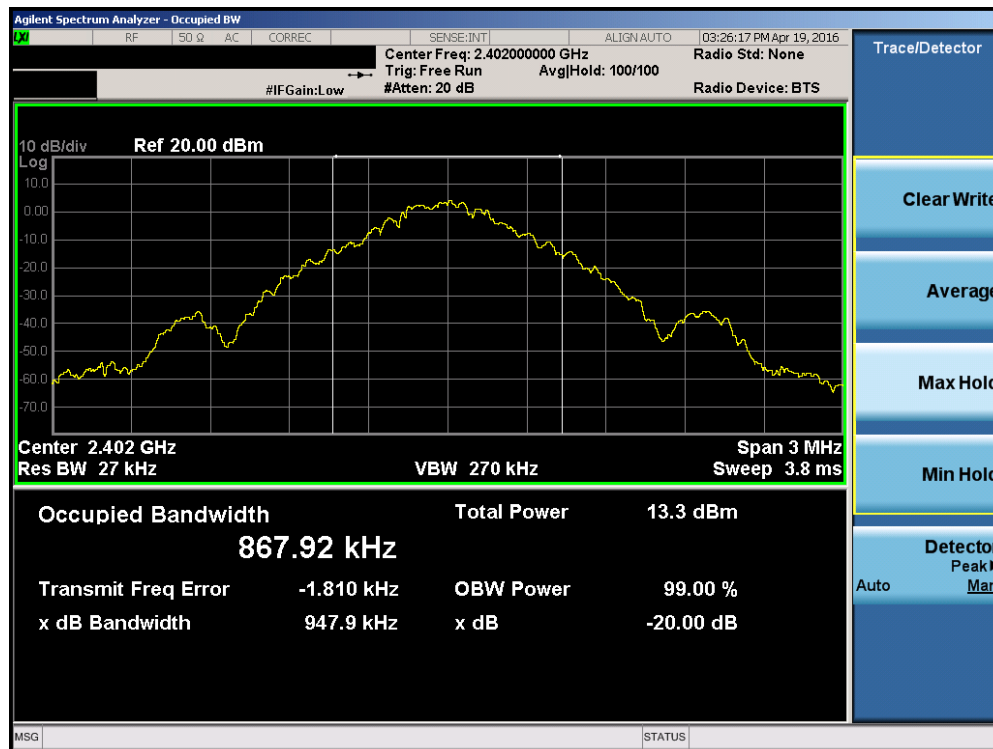
Test Notes

None

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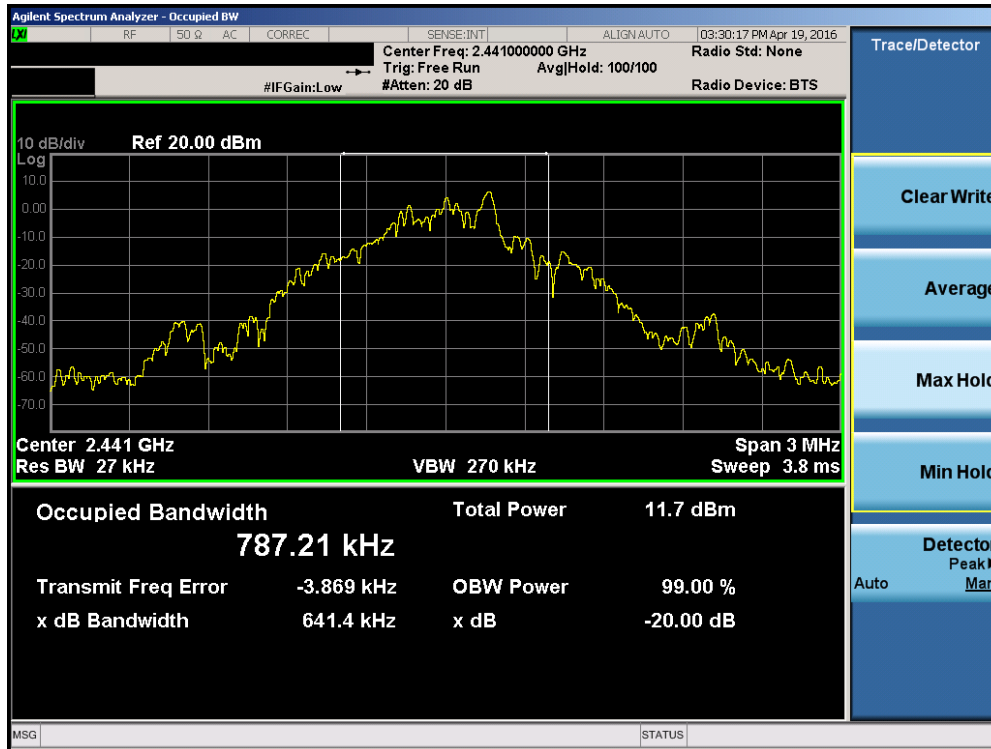
Frequency [MHz]	Data Rate [Mbps]	Channel No.	20dB Bandwidth Test Results	
			Measured Bandwidth [kHz]	Pass/Fail
2402	1.0	0	947.9	Pass
2441	1.0	39	641.4	Pass
2480	1.0	78	670.4	Pass
2402	2.0	0	1310	Pass
2441	2.0	39	1345	Pass
2480	2.0	78	1333	Pass
2402	3.0	0	1295	Pass
2441	3.0	39	1315	Pass
2480	3.0	78	1307	Pass

Table 7-2. Conducted 20dB Bandwidth Measurements



Plot 7-1. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 0)

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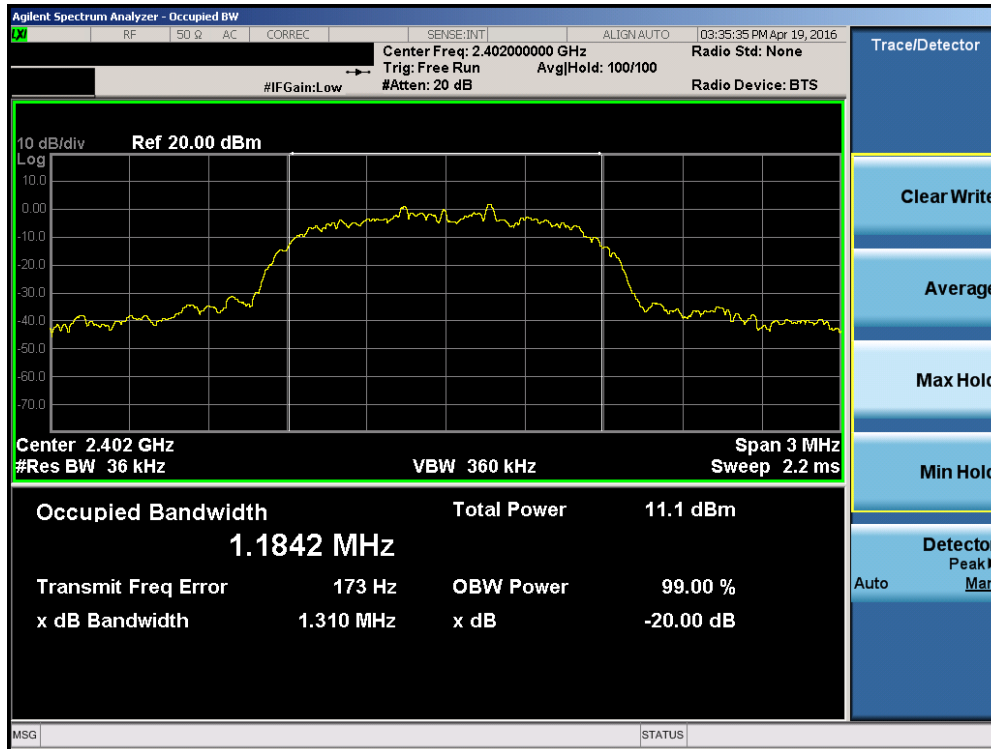


Plot 7-2. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 39)

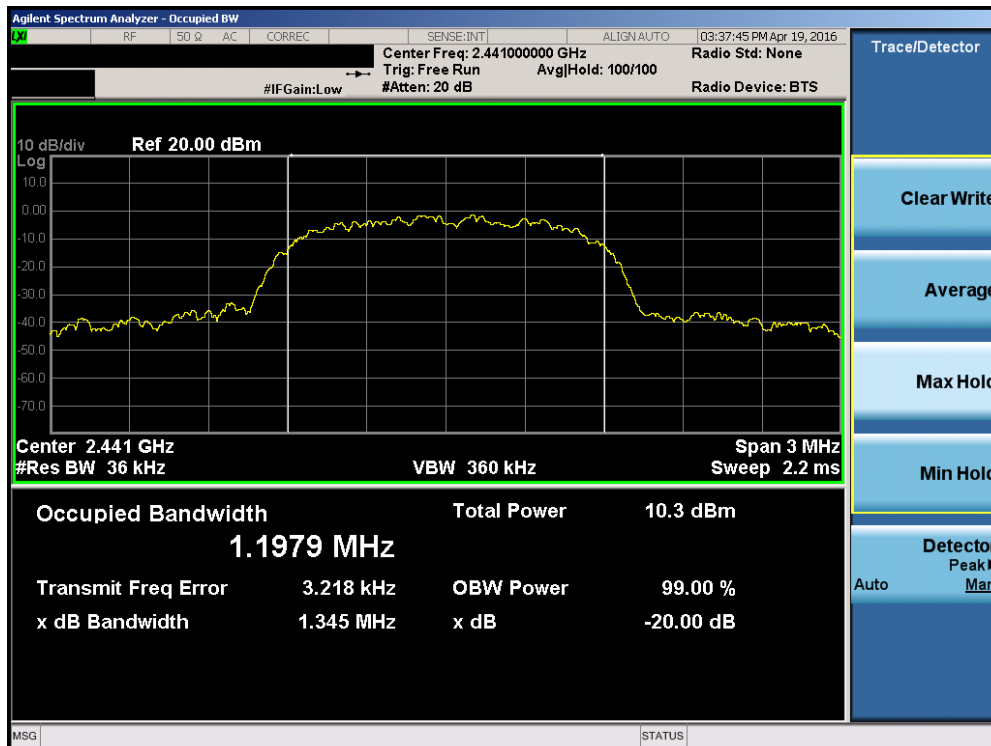


Plot 7-3. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 78)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 14 of 60

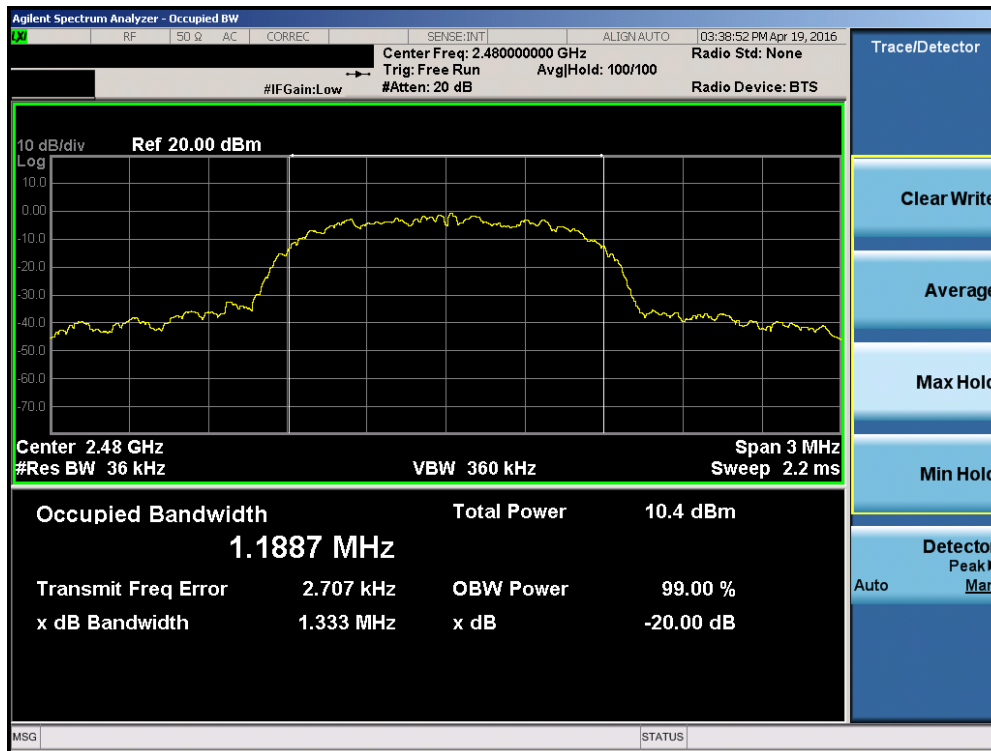


Plot 7-4. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 0)

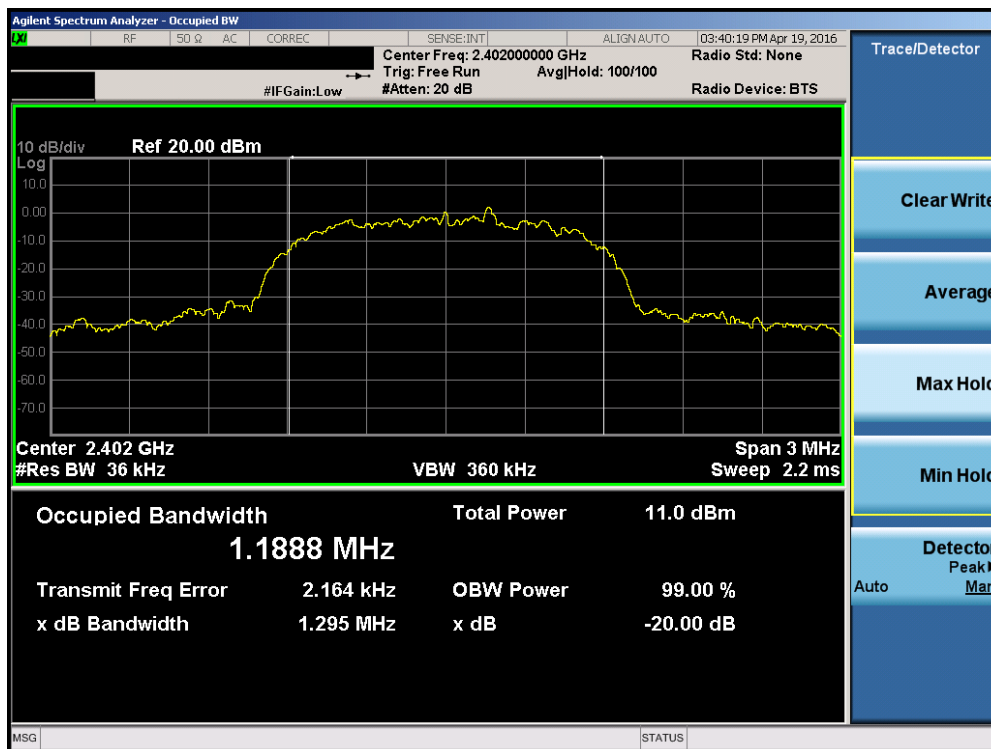


Plot 7-5. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 39)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 15 of 60

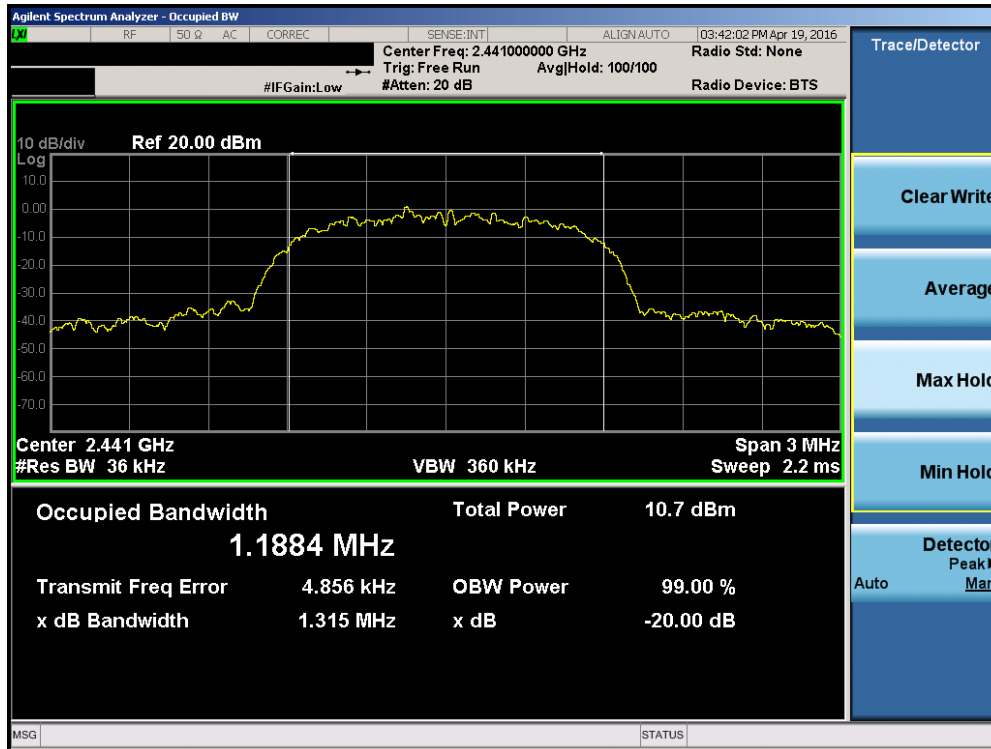


Plot 7-6. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 78)

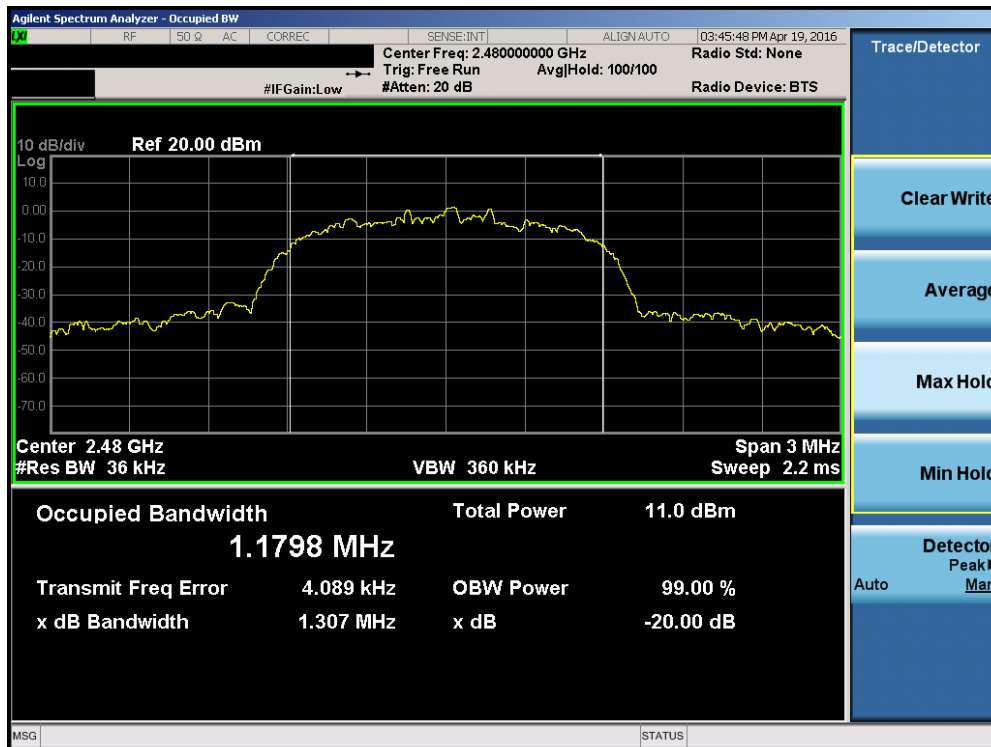


Plot 7-7. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 0)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 16 of 60



Plot 7-8. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 39)



Plot 7-9. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 78)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 17 of 60

7.3 Output Power Measurement

§15.247 (b.1)

Test Overview and Limits

Measurement is made while the EUT is operating in non-hopping transmission mode. The powers shown below were measured using a spectrum analyzer with a Bluetooth signaling test set (Agilent Model: N4010A) used only to maintain a Bluetooth link with the EUT. Average power data is provided to determine the need for Bluetooth SAR testing according to KDB 447498 D01 v05r02. Average power measurements are performed using the analyzer's "burst power" function with RBW = 3MHz. The burst power function triggers on a single set burst set to maximum power and measures the maximum average power on the on-time.

The maximum permissible output power is 1 Watt.

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.5

Test Settings

Peak Power Measurement

1. Span = approximately 5x 20dB bandwidth, centered on hopping channel
2. RBW > 20dB bandwidth of emission being measured
3. VBW ≥ RBW
4. Sweep = auto
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.

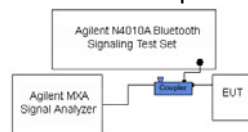


Figure 7-2. Test Instrument & Measurement Setup

Note

This unit was tested with all possible data rates and the highest peak power is reported with the unit transmitting at 3Mbps.

Final results were obtained using calibrated couplers, attenuators and cables. The following formula was used:

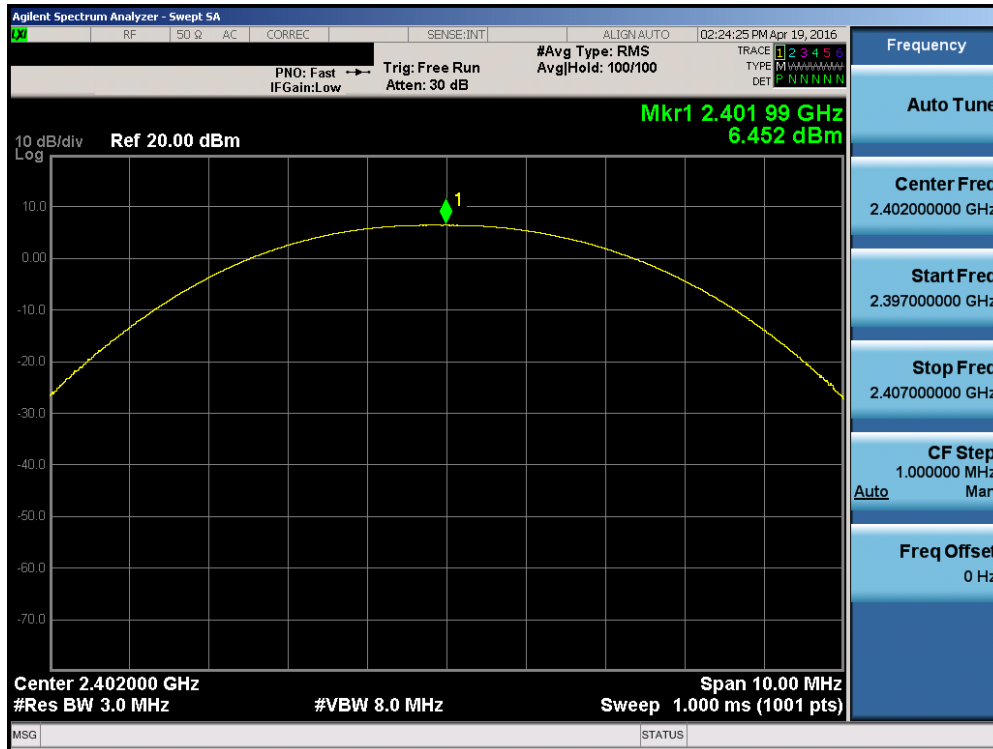
$$\text{Output Power (dBm)} = \text{Raw Analyzer Level (dBm)} + \text{Cable Loss (dB)} + \text{Loss in Directional Coupler/Insertion Loss (dB)}$$

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 18 of 60

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Peak Conducted Power		Avg Conducted Power	
			[dBm]	[mW]	[dBm]	[mW]
2402	1.0	0	6.45	4.418	6.40	4.362
2441	1.0	39	6.37	4.330	6.32	4.282
2480	1.0	78	6.34	4.308	6.25	4.217
2402	2.0	0	6.43	4.396	3.71	2.351
2441	2.0	39	6.43	4.396	3.46	2.216
2480	2.0	78	6.23	4.200	3.25	2.111
2402	3.0	0	6.56	4.530	3.69	2.337
2441	3.0	39	6.40	4.362	3.46	2.220
2480	3.0	78	6.22	4.191	3.25	2.112

Table 7-3. Conducted Output Power Measurements

FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module	Page 19 of 60	

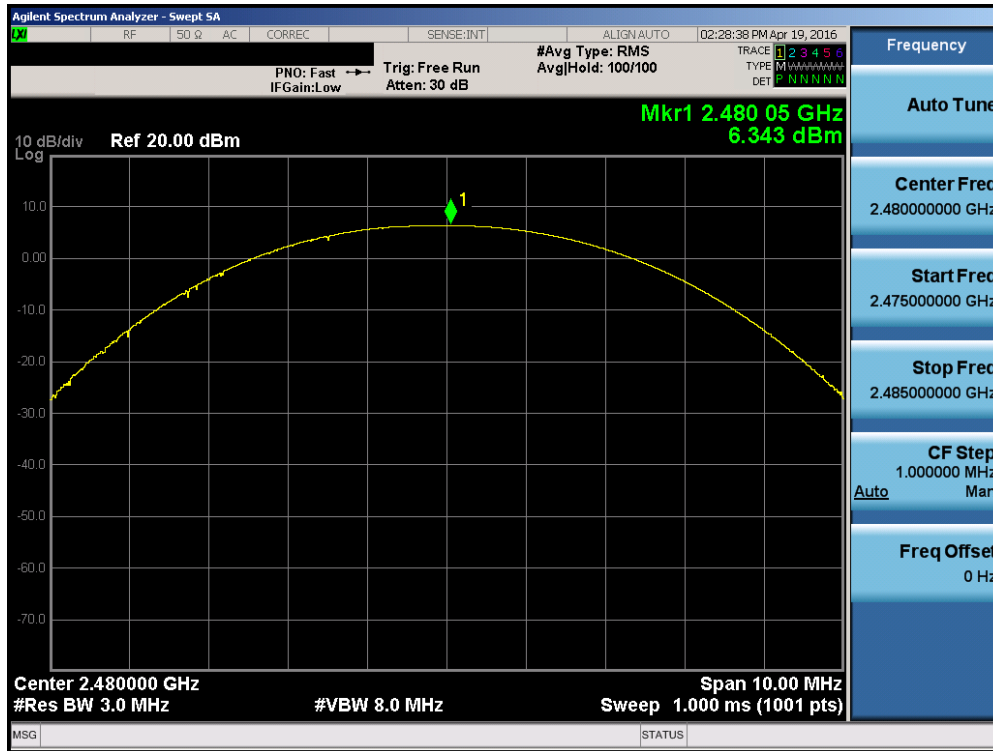


Plot 7-10. Peak Conducted Power (1Mbps – Ch. 0)

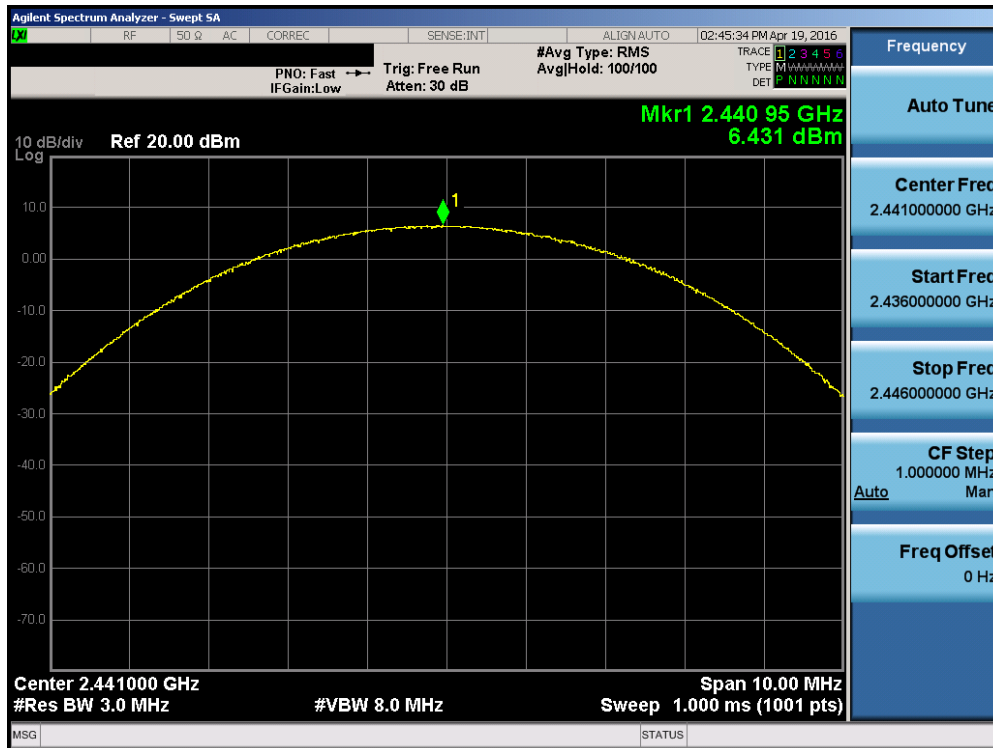


Plot 7-11. Peak Conducted Power (1Mbps – Ch. 39)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 20 of 60

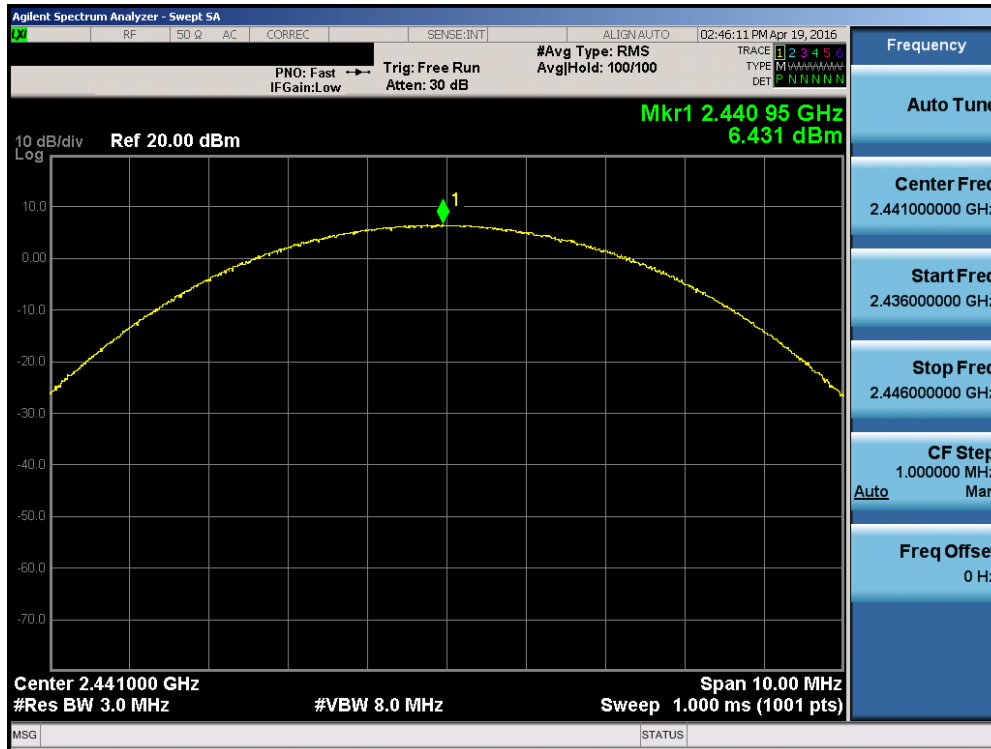


Plot 7-12. Peak Conducted Power (1Mbps – Ch. 78)

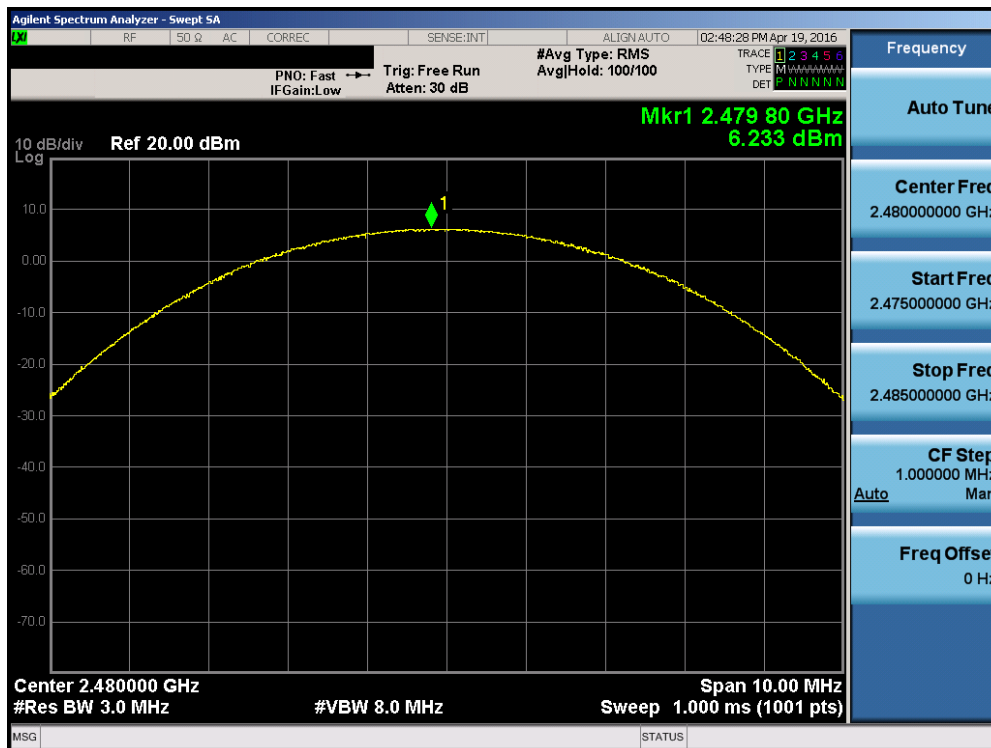


Plot 7-13. Peak Conducted Power (2Mbps – Ch. 0)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 21 of 60

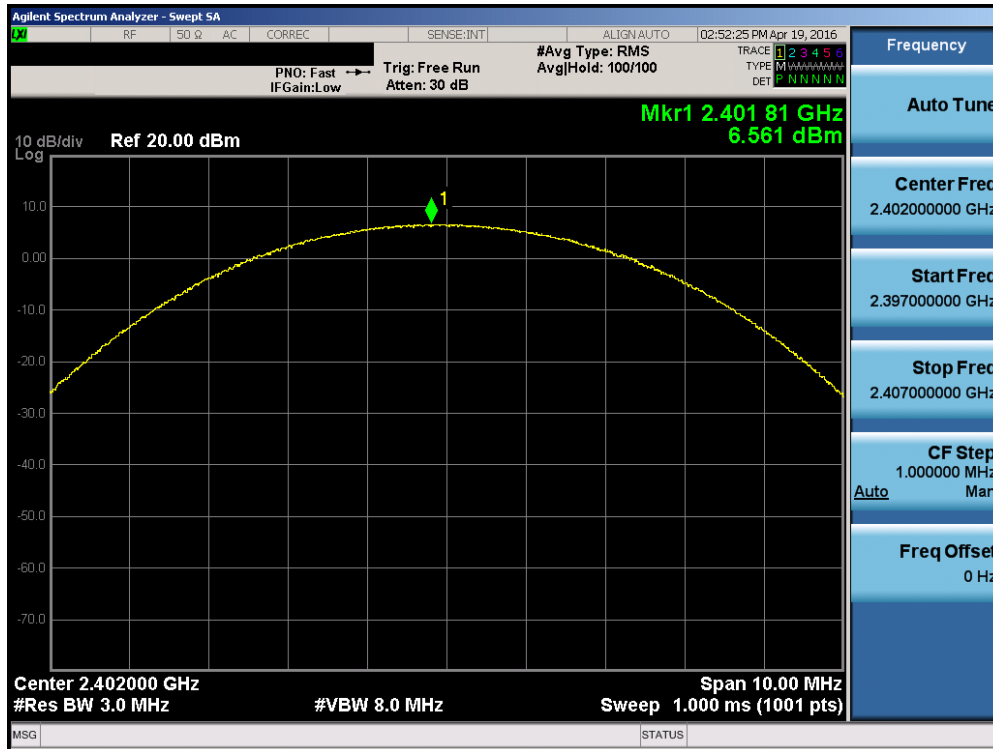


Plot 7-14. Peak Conducted Power (2Mbps – Ch. 39)

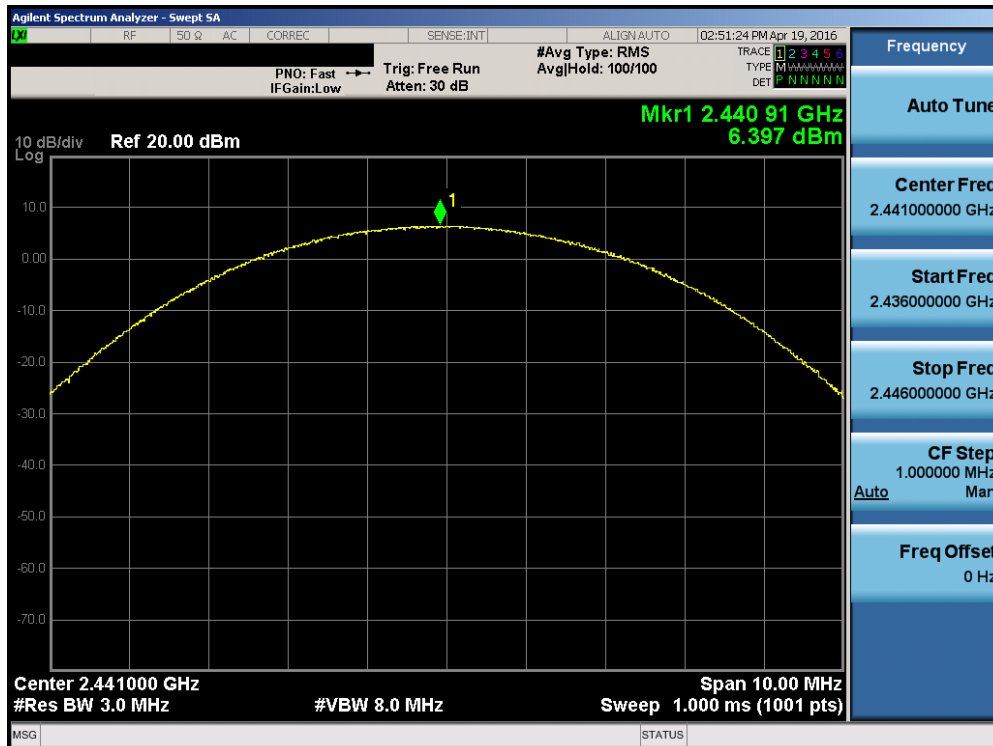


Plot 7-15. Peak Conducted Power (2Mbps – Ch. 78)

FCC ID: XO2SPB209A	 FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION) 		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module	Page 22 of 60

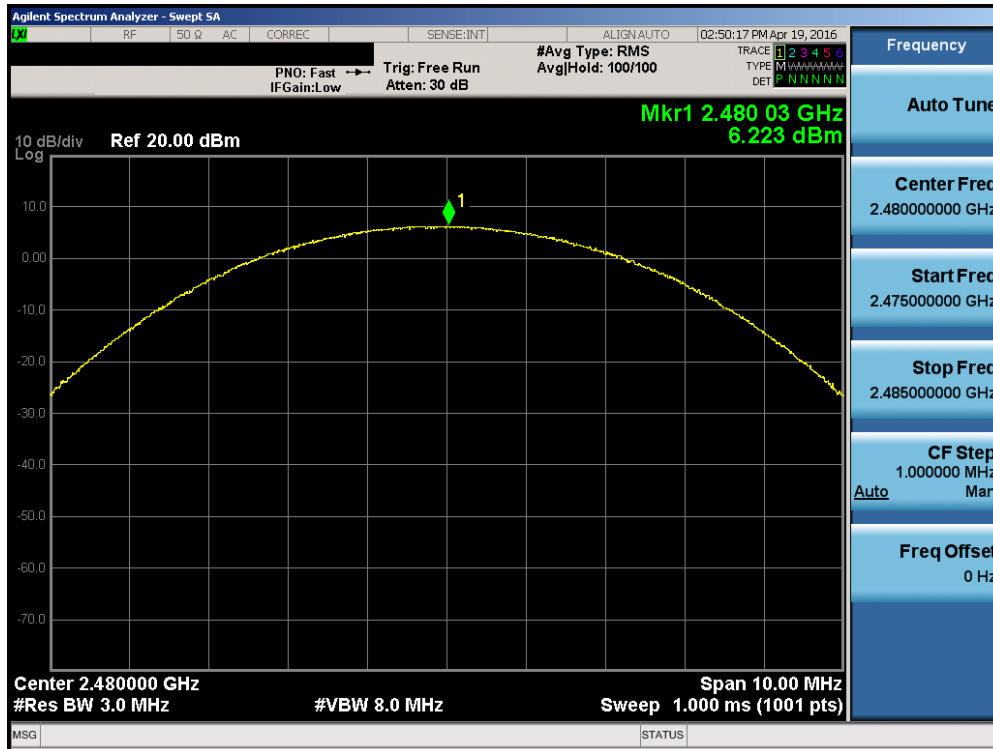


Plot 7-16. Peak Conducted Power (3Mbps – Ch. 0)

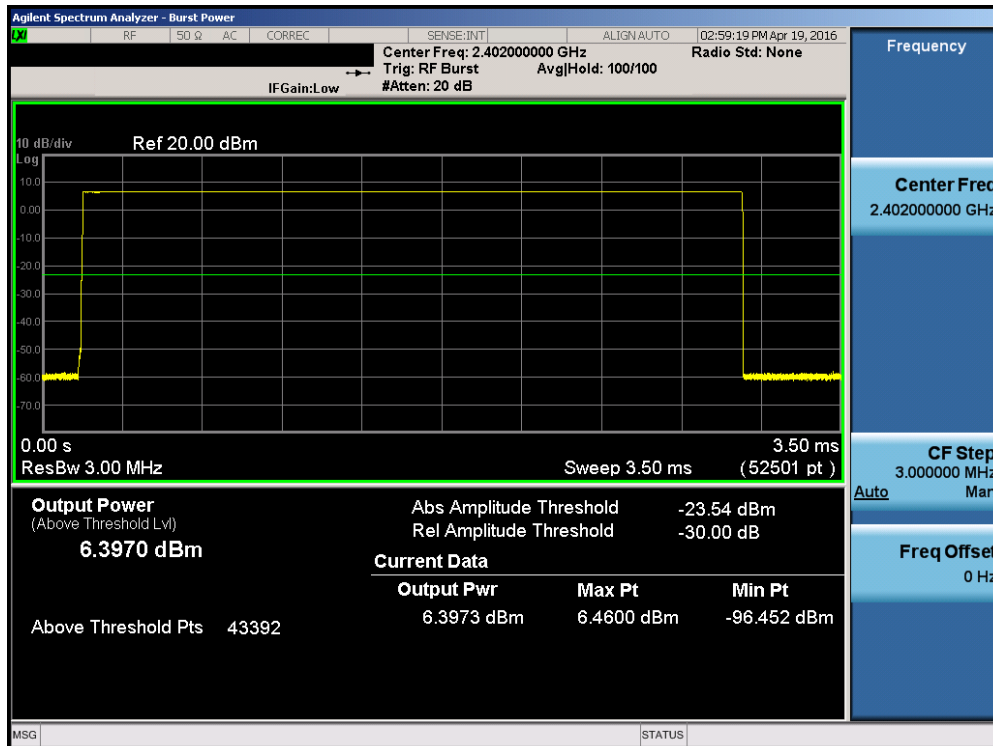


Plot 7-17. Peak Conducted Power (3Mbps – Ch. 39)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 23 of 60

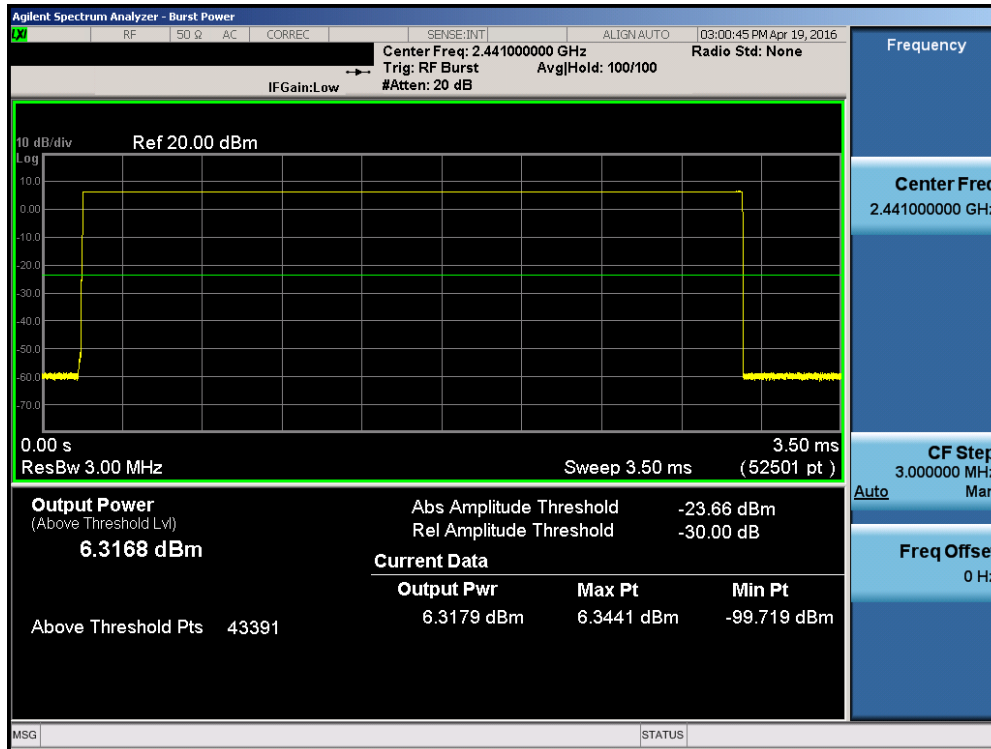


Plot 7-18. Peak Conducted Power (3Mbps – Ch. 78)

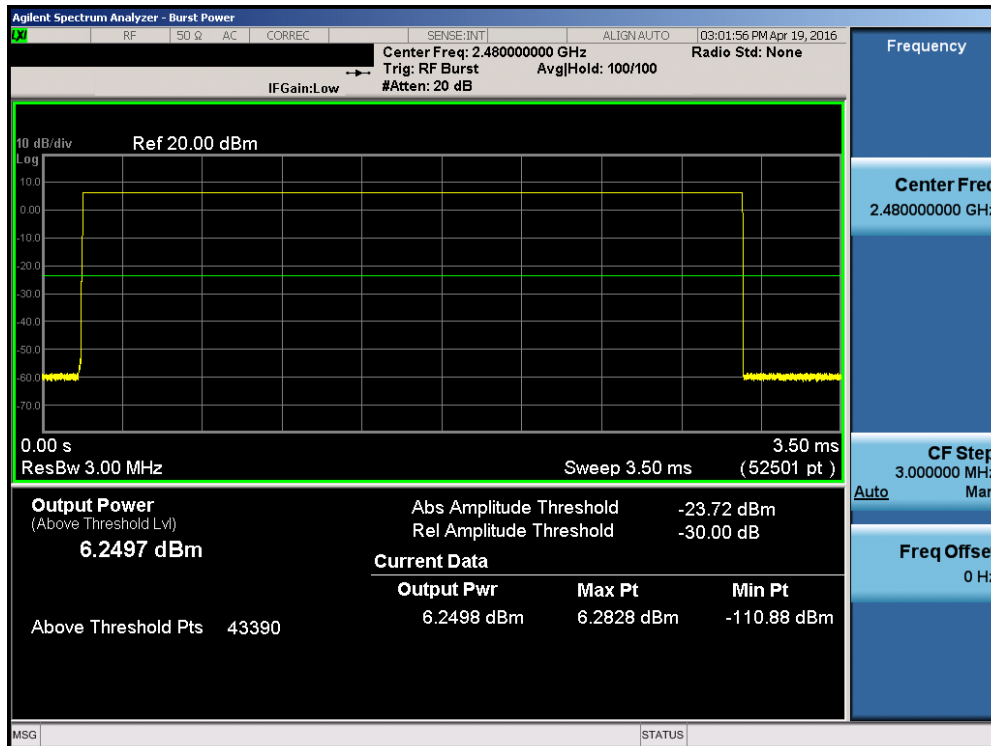


Plot 7-19. Average Conducted Power (1Mbps – Ch. 0)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 24 of 60

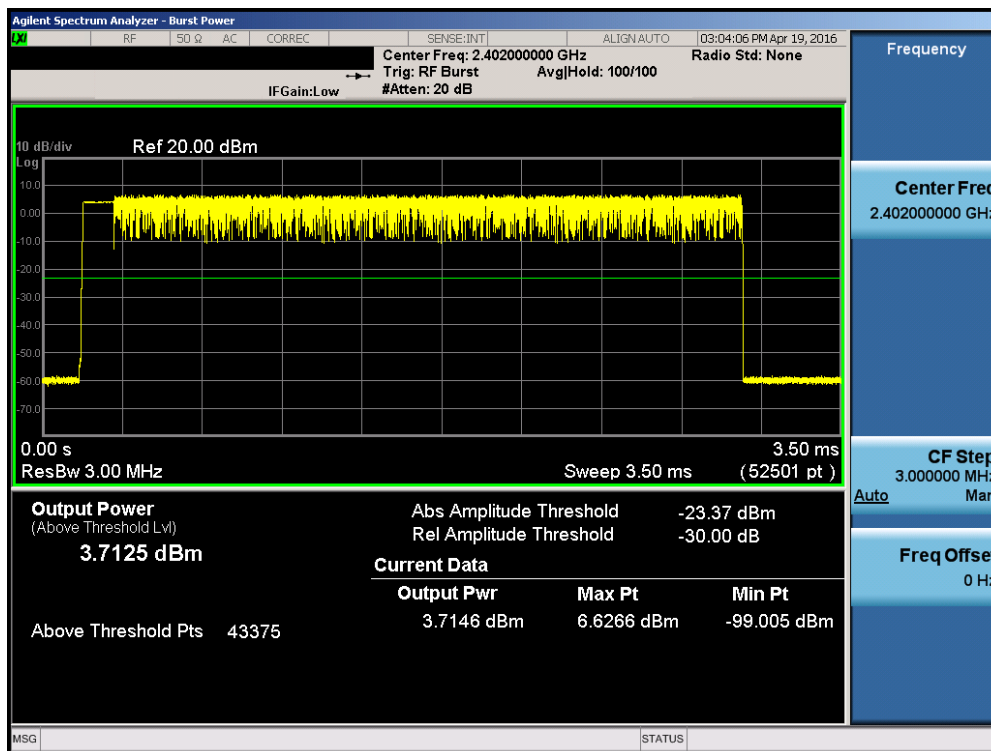


Plot 7-20. Average Conducted Power (1Mbps – Ch. 39)

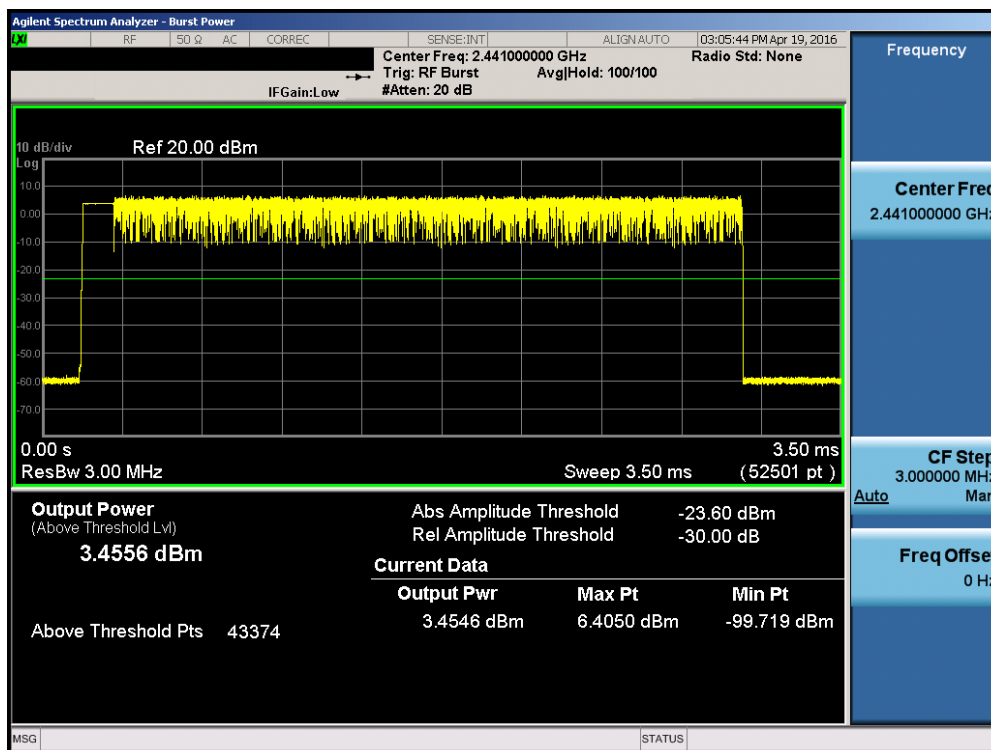


Plot 7-21. Average Conducted Power (1Mbps – Ch. 78)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 25 of 60

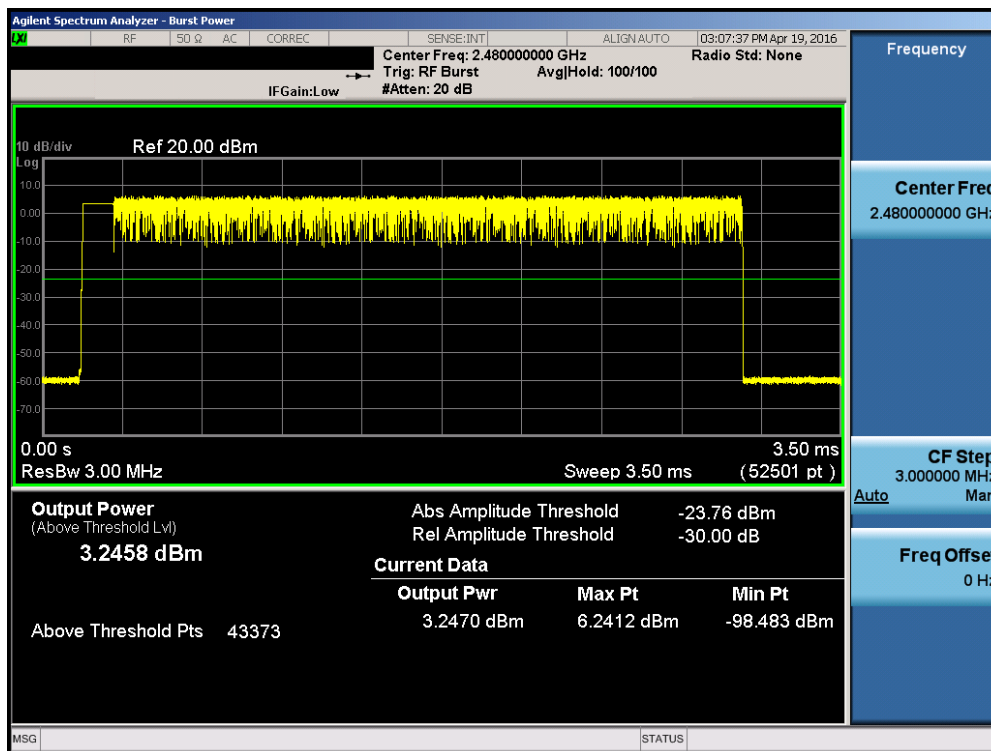


Plot 7-22. Average Conducted Power (2Mbps – Ch. 0)

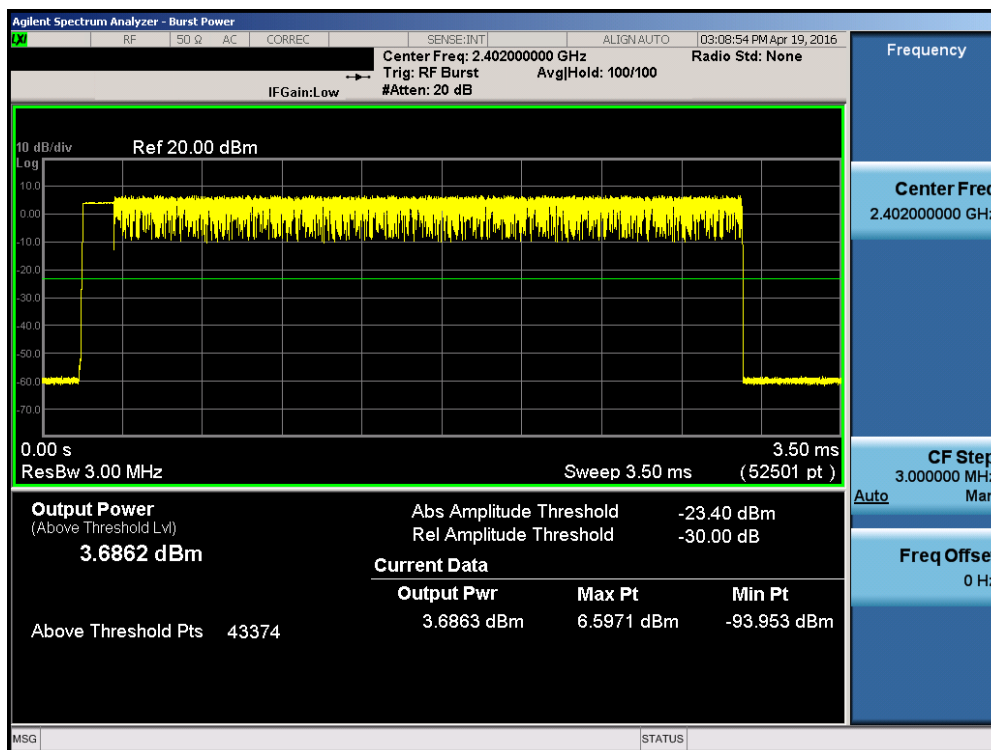


Plot 7-23. Average Conducted Power (2Mbps – Ch. 39)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 26 of 60

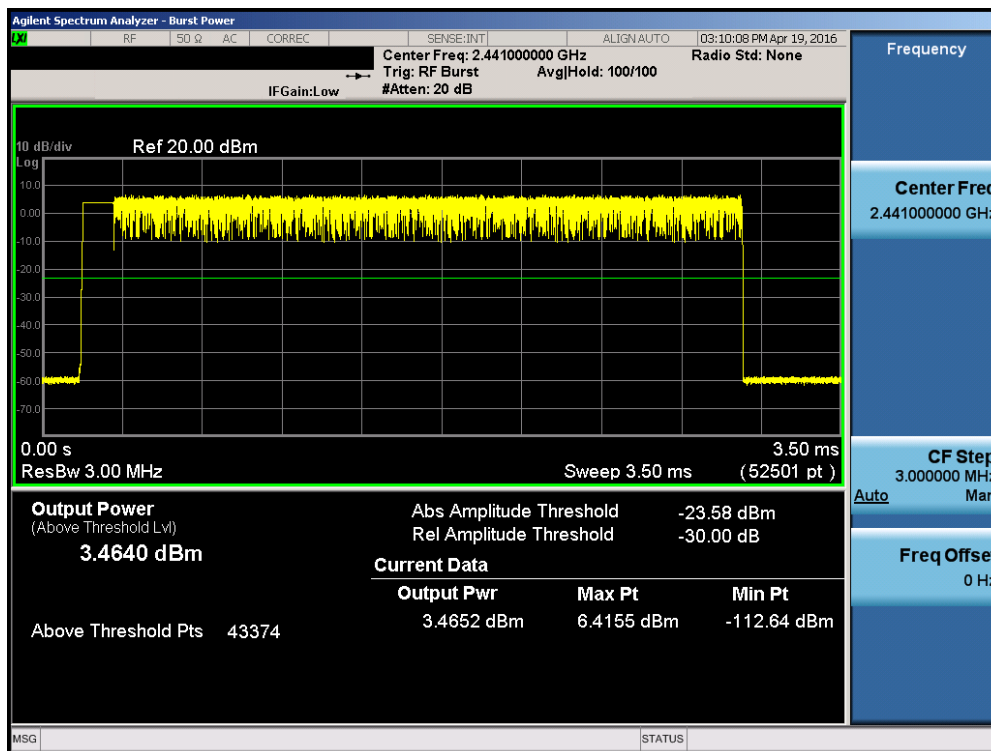


Plot 7-24. Average Conducted Power (2Mbps – Ch. 78)

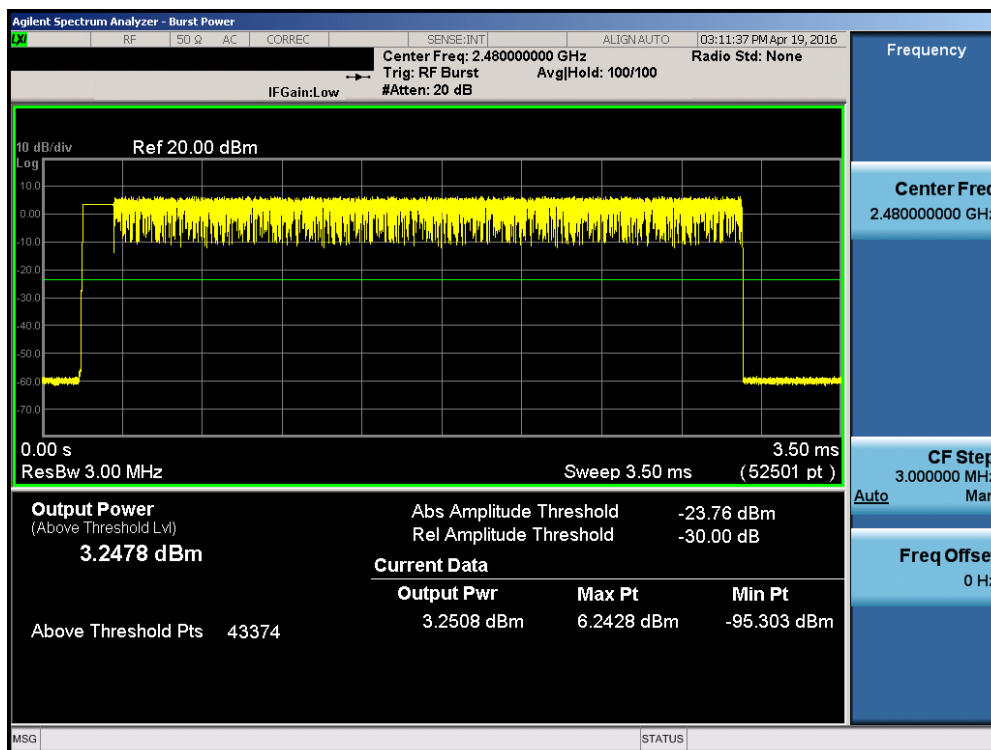


Plot 7-25. Average Conducted Power (3Mbps – Ch. 0)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 27 of 60



Plot 7-26. Average Conducted Power (3Mbps – Ch. 39)



Plot 7-27. Average Conducted Power (3Mbps – Ch. 78)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 28 of 60

7.4 Band Edge Compliance

§15.247 (d)

Test Overview and Limits

EUT operates in hopping and non-hopping transmission mode. Measurement is taken at the highest point located outside of the emission bandwidth. **The maximum permissible out-of-band emission level is 20 dBc.**

Test Procedure Used

ANSI C63.10-2013 – Section 6.10.4

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 $\geq 2 \times \text{Span/RBW}$
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.

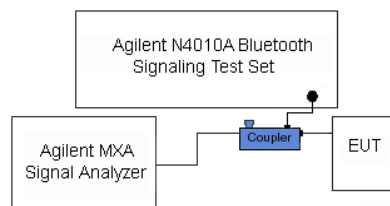
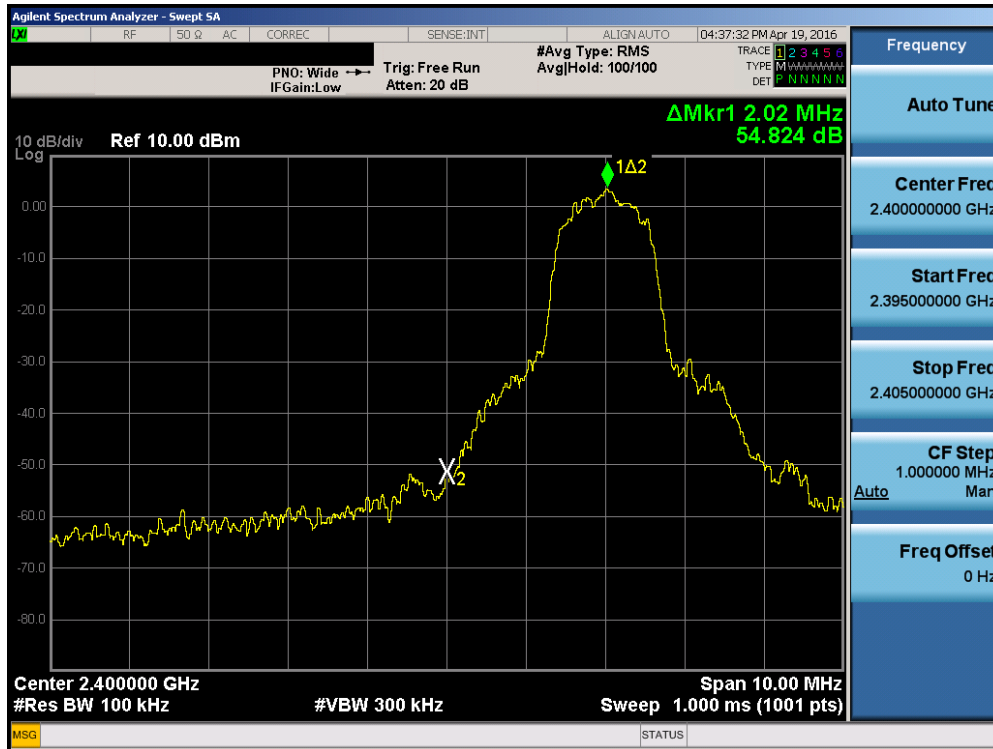


Figure 7-3. Test Instrument & Measurement Setup

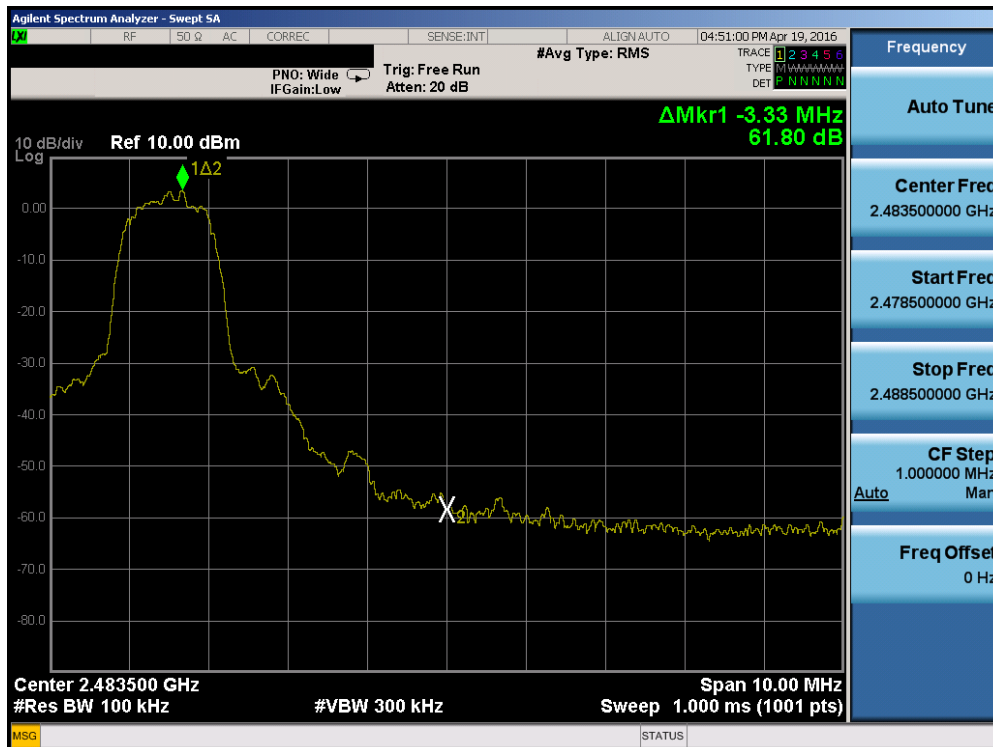
Test Notes

Out of band conducted spurious emissions at the band edge were investigated for all data rates in hopping and non-hopping modes. The worst case emissions were found with the EUT transmitting at 3 Mbps. Band edge emissions were also investigated with the EUT transmitting in all data rates. Plots of the worst case emissions are shown below.

FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Plot 7-28. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 0)



Plot 7-29. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 78)

FCC ID: XO2SPB209A	 FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION) 		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module	Page 30 of 60



Plot 7-30. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps)



Plot 7-31. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 31 of 60

7.5 Carrier Frequency Separation

§15.247 (a.1)

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.

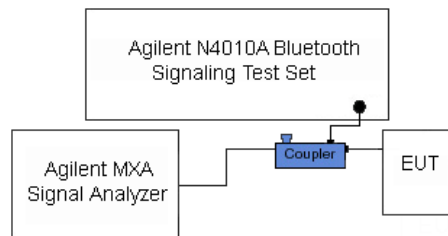


Figure 7-4. Test Instrument & Measurement Setup

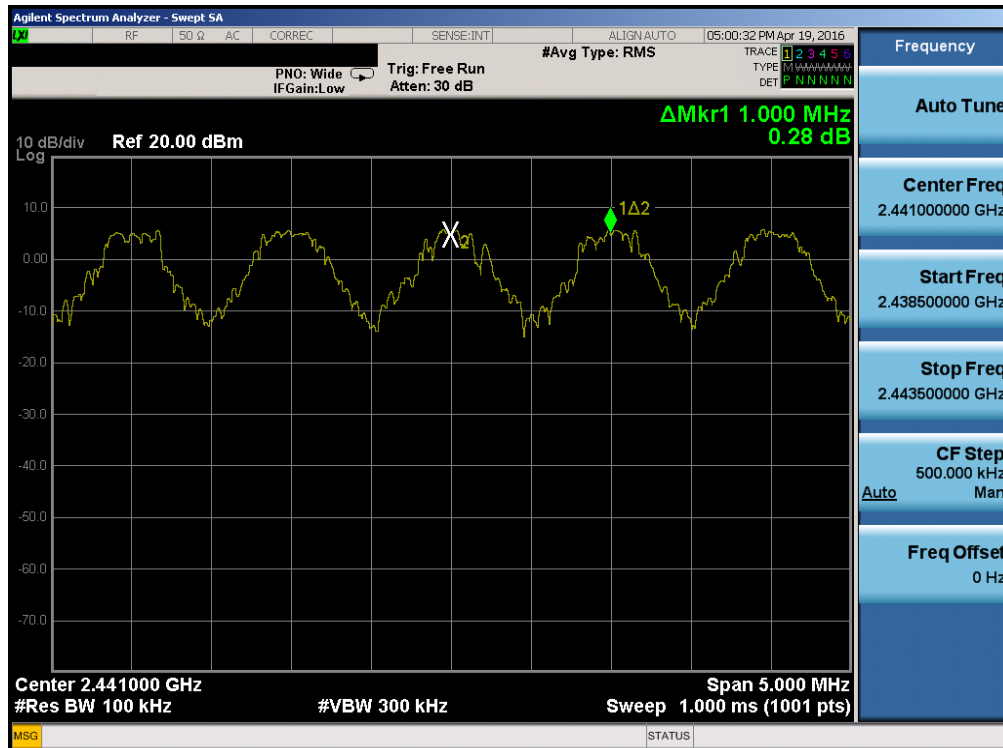
Test Notes

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: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 32 of 60

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Min. Channel Separation [MHz]
2402	1.0	0	0.632
2441	1.0	39	0.428
2480	1.0	78	0.447
2402	2.0	0	0.873
2441	2.0	39	0.897
2480	2.0	78	0.889
2402	3.0	0	0.863
2441	3.0	39	0.877
2480	3.0	78	0.871

Table 7-4. Minimum Channel Separation



Plot 7-32. Channel Spacing Plot (Bluetooth)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 33 of 60

7.6 Time of Occupancy

§15.247 (a.1.iii)

Test Overview and Limit

Measurement is made while EUT is operating in hopping mode with the spectrum analyzer set to zero span. **The maximum permissible time of occupancy is 400 ms within a period of 400ms multiplied by the number of hopping channels employed.**

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.4

Test Settings

1. Span = zero span, centered on a hopping channel
2. RBW $\leq$ channel spacing and $\gg 1/T$, where T is expected dwell time per channel
3. Sweep = as necessary to capture entire dwell time. Second plot may be required to demonstrate two successive hops on a channel
4. Trigger is set with appropriate trigger delay to place pulse near the center of the plot
5. Detector = peak
6. Trace mode = max hold
7. Marker-delta function used to determine transmit time per hop

Test Setup

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

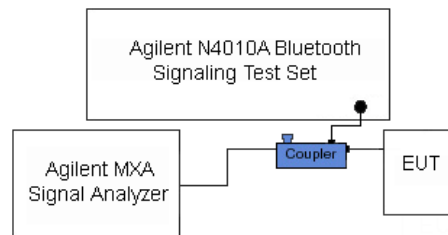
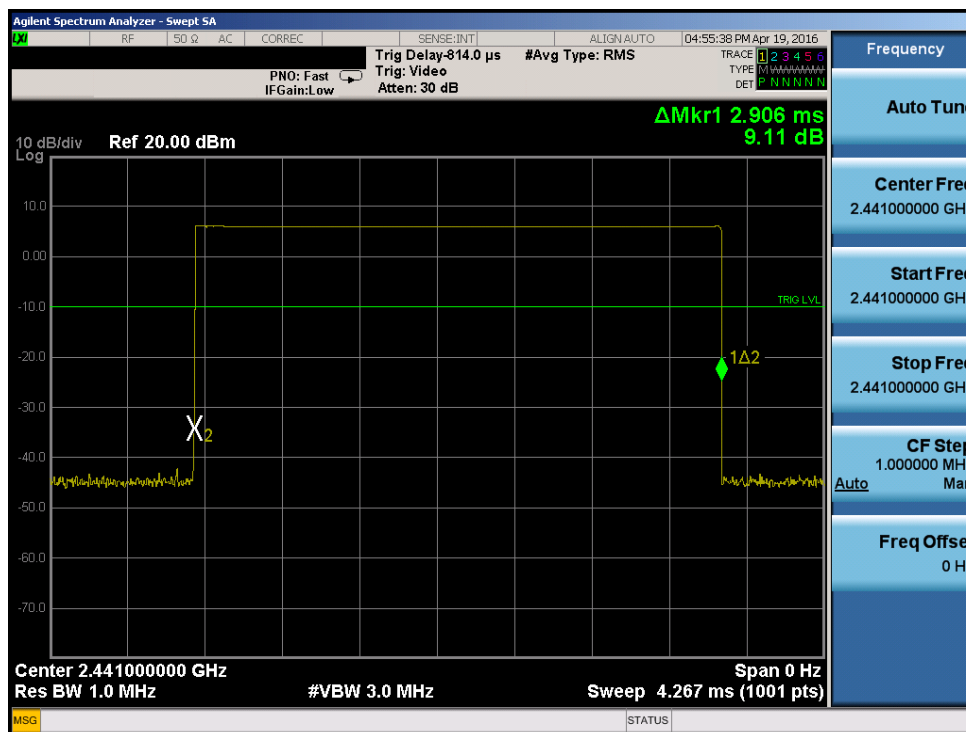


Figure 7-5. Test Instrument & Measurement Setup

Test Notes

None

FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Plot 7-33. Time of Occupancy Plot (Bluetooth)

Bluetooth Time of Occupancy Calculation

Typically, Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s. Since 1x/EDR modes use 5 transmit and 1 receive slot, for a total of 6 slots, the Bluetooth transmitter is actually hopping at a rate of $1600 / 6 = 266.67$ hops/s/slot

- $400\text{ms} \times 79$ hopping channels = 31.6 sec (Time of Occupancy Limit)
- Worst case BT has 266.67 hops/second (for 1x/EDR modes with DH5 operation)
- $266.67 \text{ hops/second} / 79 \text{ channels} = 3.38 \text{ hops/second}$ (# of hops/second on one channel)
- $3.38 \text{ hops/second/channel} \times 31.6 \text{ seconds} = 106.67 \text{ hops}$ (# hops over a 31.6 second period)
- $106.67 \text{ hops} \times 2.906 \text{ ms/channel} = 309.98 \text{ ms}$ (worst case dwell time for one channel in 1x/EDR modes)

With AFH, the number of channels is reduced to a minimum of 20 channels and the channel hopping rate is reduced by 50% to 800 hops/s. AFH mode also uses 6 total slots so the Bluetooth transmitter hops at a rate of $800 / 6 = 133.3$ hops/s/slot

- $400\text{ms} \times 20$ hopping channels = 8 sec (Time of Occupancy Limit)
- Worst case BT has 133.3 hops/second/slot (for AFH mode with DH5 operation)
- $133.3 \text{ hops/s} / 20 \text{ channels} = 6.67 \text{ hops/second}$ (# of hops/second on one channel)
- $6.67 \text{ hops/s} / \text{channel} \times 8 \text{ seconds} = 53.34 \text{ hops}$ (# hops over a 8 second period)
- $53.34 \text{ hops} \times 2.906 \text{ ms/channel} = 155.0 \text{ ms}$ (worst case dwell time for one channel in AFH mode)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
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7.7 Number of Hopping Channels

§15.247 (a.1.iii)

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 ≥ 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.

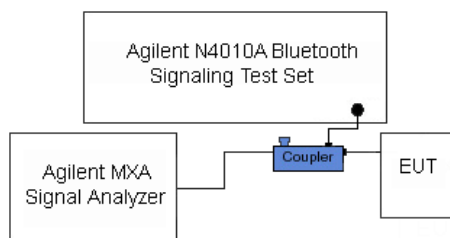
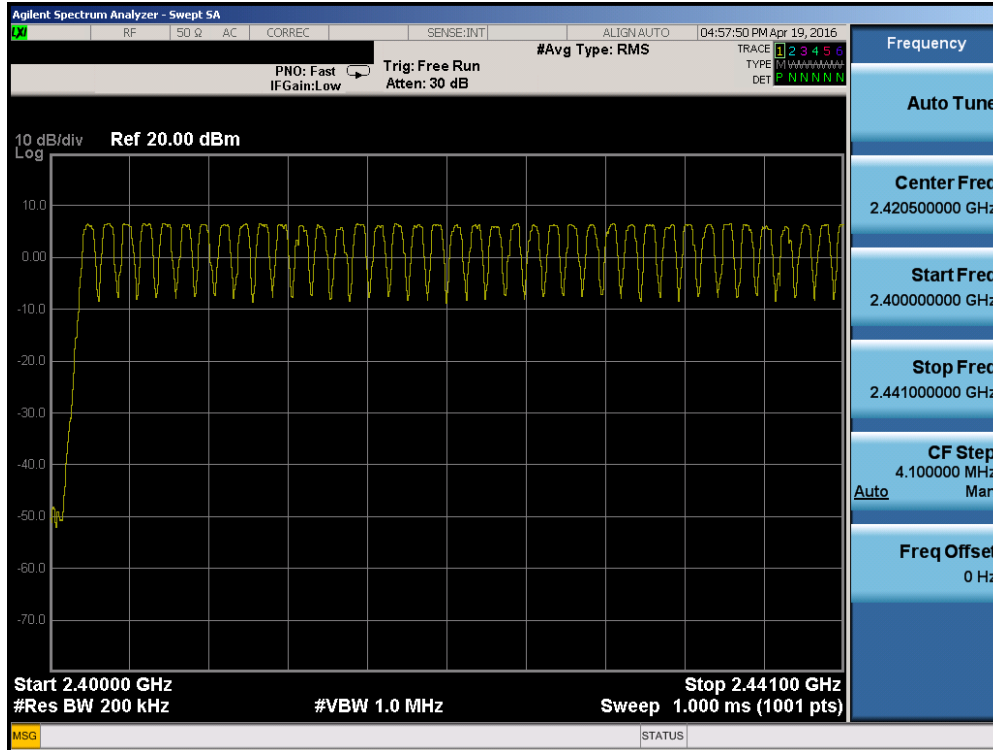


Figure 7-6. Test Instrument & Measurement Setup

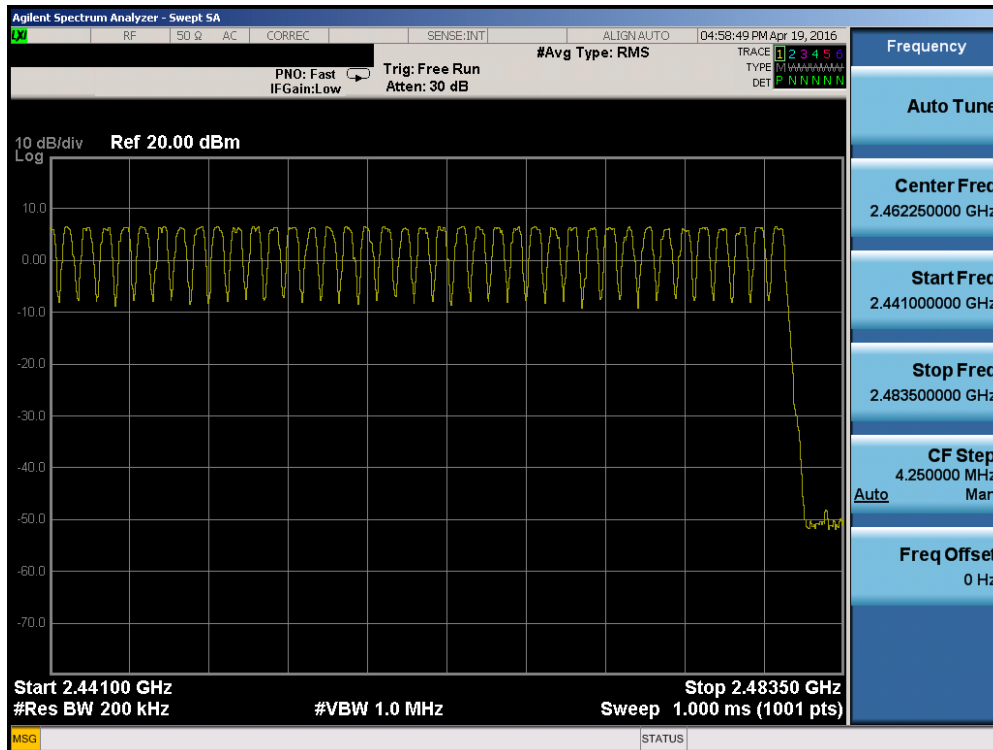
Test Notes

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.

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Plot 7-34. Low End Spectrum Channel Hopping Plot (Bluetooth)



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

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7.8 Conducted Spurious Emissions

§15.247 (d)

Test Overview and Limit

Conducted out-of-band spurious emissions were investigated from 30MHz up to 25GHz to include the 10th harmonic of the fundamental transmit frequency. **The maximum permissible out-of-band emission level is 20 dBc.**

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.8

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* (See note below)
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.

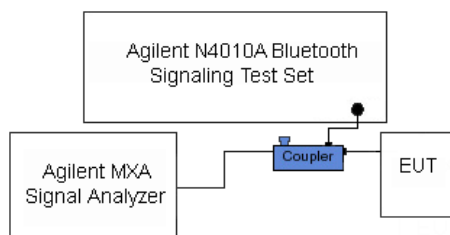
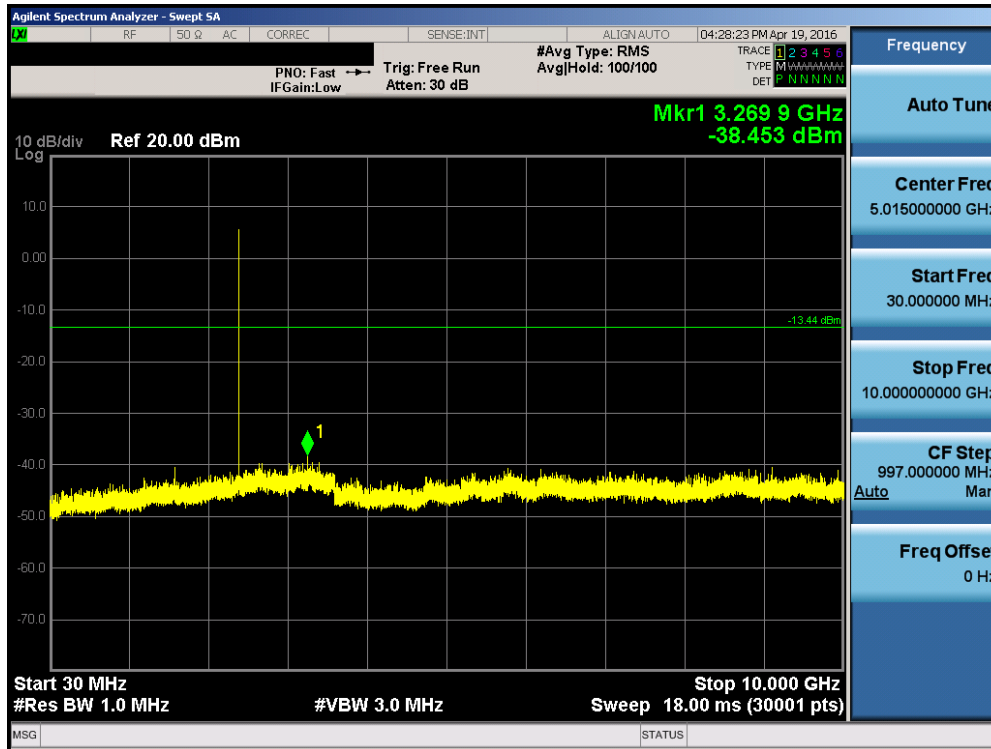


Figure 7-7. Test Instrument & Measurement Setup

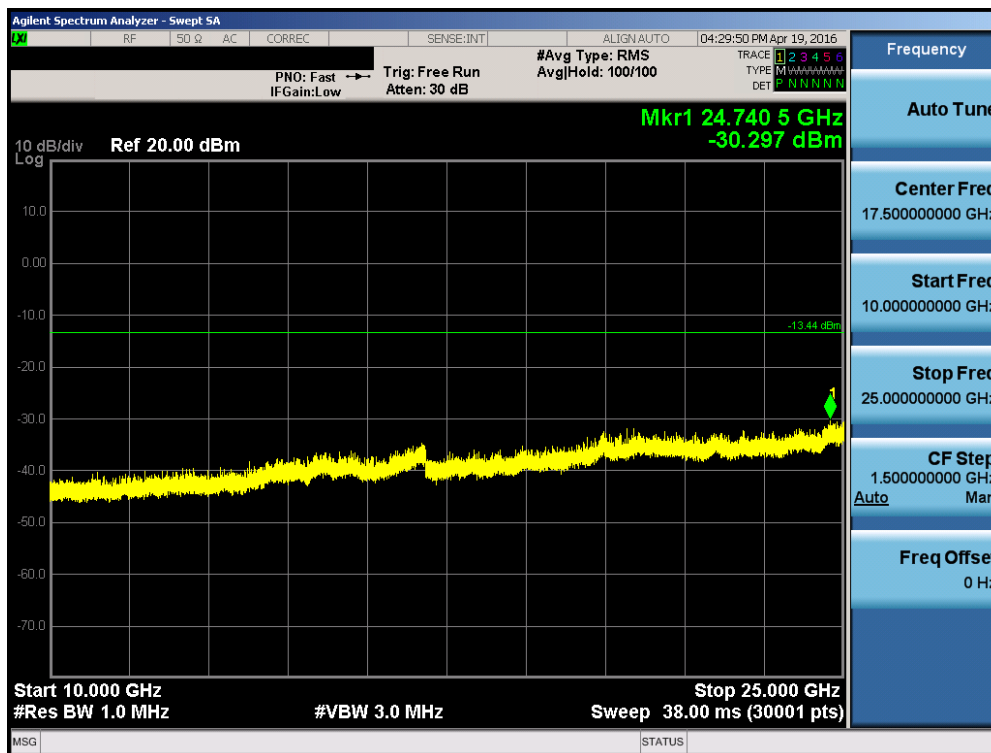
Test Notes

Out-of-band conducted spurious emissions were investigated for all data rates and the worst case emissions were found with the EUT transmitting at 3Mbps. The display line shown in the following plots is the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, the traces in the following plots are measured with a 1MHz RBW to reduce test time, so the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.

FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 38 of 60

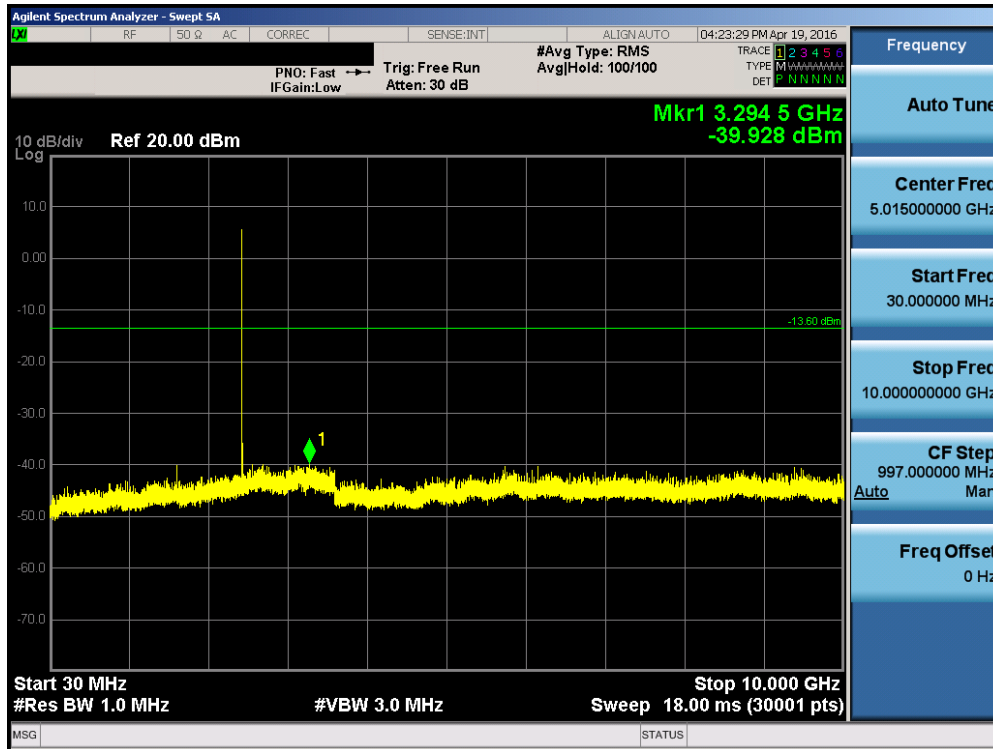


Plot 7-36. Conducted Spurious Plot (Bluetooth, 3Mbps – Ch. 0)

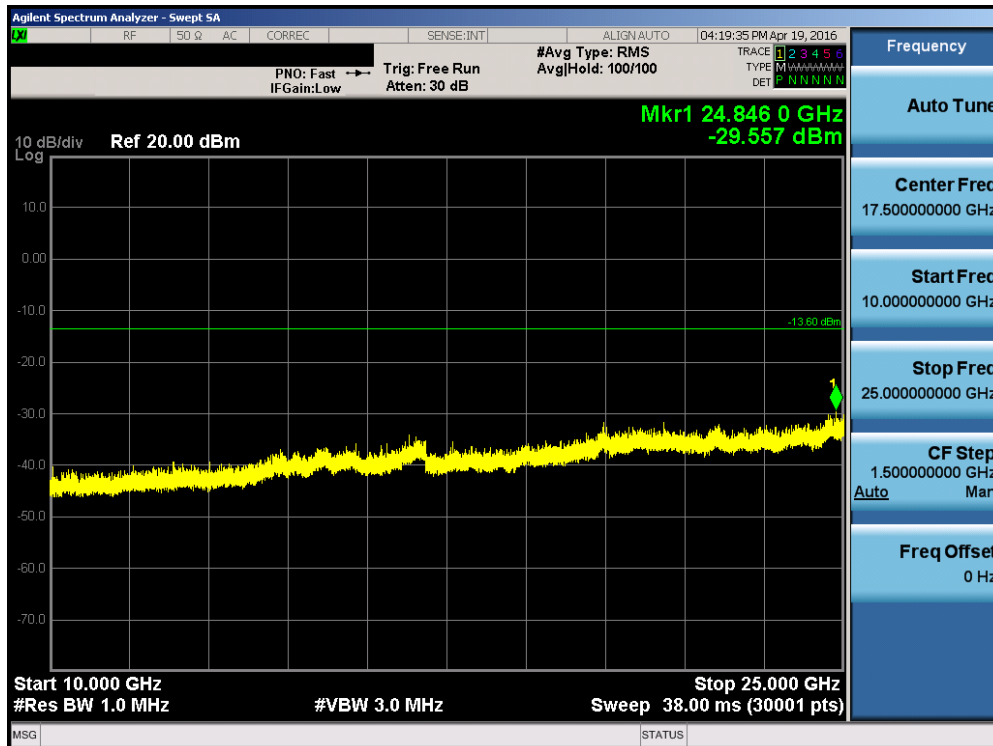


Plot 7-37. Conducted Spurious Plot (Bluetooth, 3Mbps – Ch. 0)

FCC ID: XO2SPB209A	 FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION) 		Reviewed by: Quality Manager
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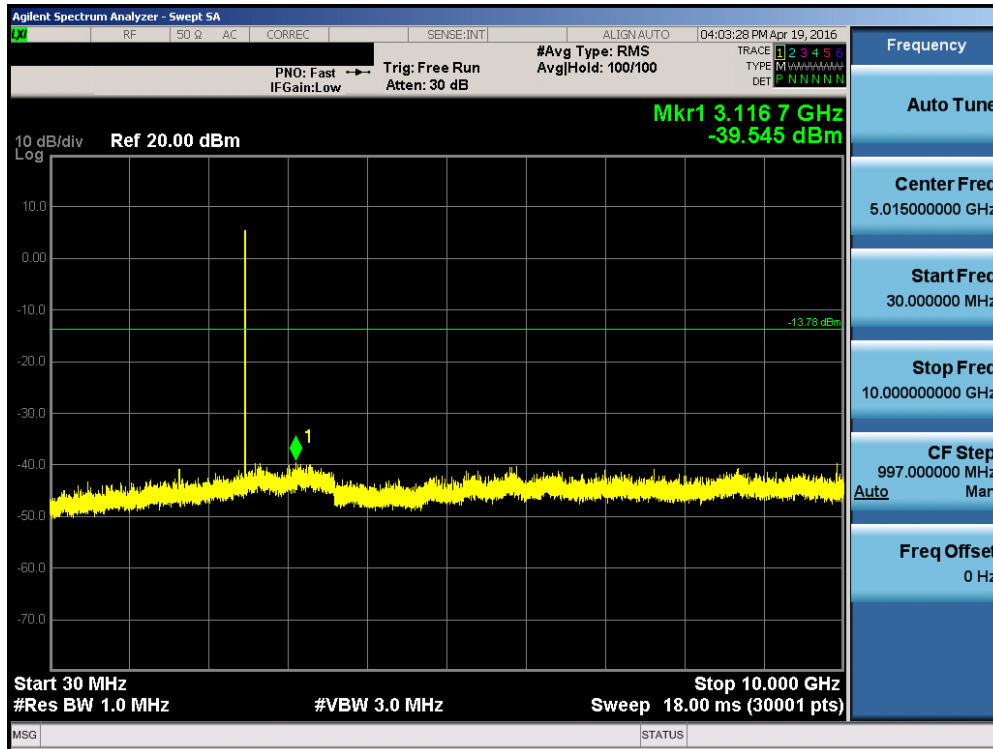


Plot 7-38. Conducted Spurious Plot (Bluetooth, 3Mbps – Ch. 39)

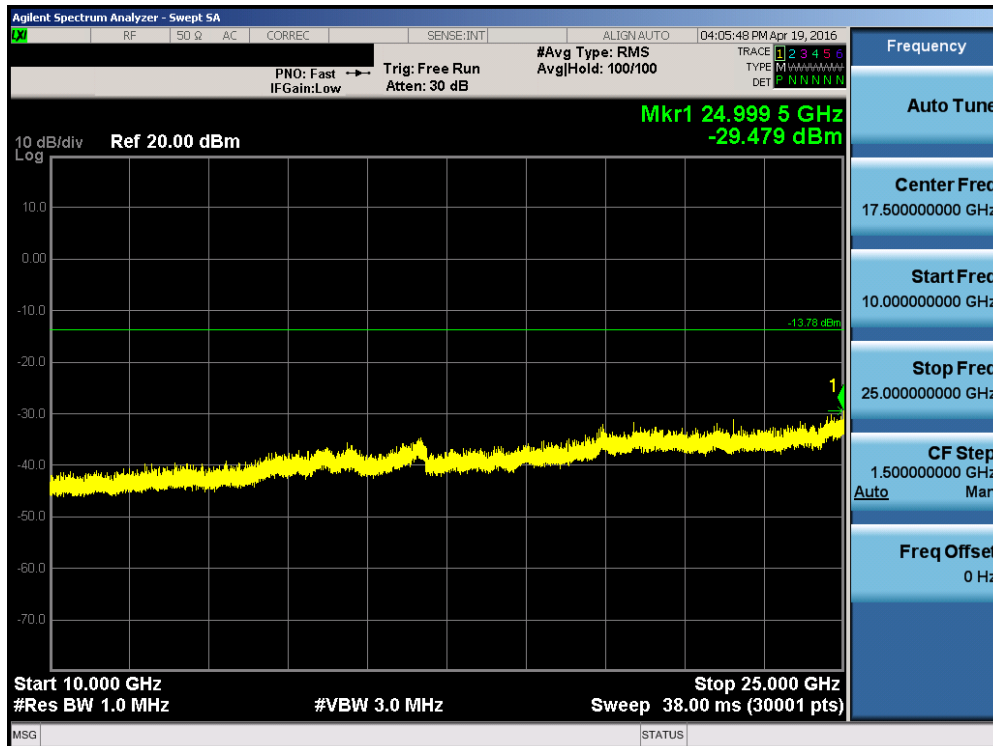


Plot 7-39. Conducted Spurious Plot (Bluetooth, 3Mbps – Ch. 39)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 40 of 60



Plot 7-40. Conducted Spurious Plot (Bluetooth, 3Mbps – Ch. 78)



Plot 7-41. Conducted Spurious Plot (Bluetooth, 3Mbps – Ch. 78)

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Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 41 of 60

7.9 Radiated Spurious Emission Measurements – Above 1GHz

§15.205 §15.209 §15.247 (d)

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 must not exceed the limits shown in Table 7-5 per Section 15.209.

Frequency	Field Strength [$\mu\text{V/m}$]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 7-5. Radiated Limits

Test Procedure Used

ANSI C63.10-2013 – Section 6.6.4.3

Test Settings

Average Field Strength Measurements per Section 4.1.4.2.3 of ANSI C63.10-2013

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 1kHz $\geq 1/\tau$ Hz, where τ = pulse width in seconds
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 stabilize

Peak Field Strength Measurements per Section 4.1.4.2.2 of ANSI C63.10-2013

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 7-6 below
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

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

Table 7-6. RBW as a Function of Frequency

Test Setup

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

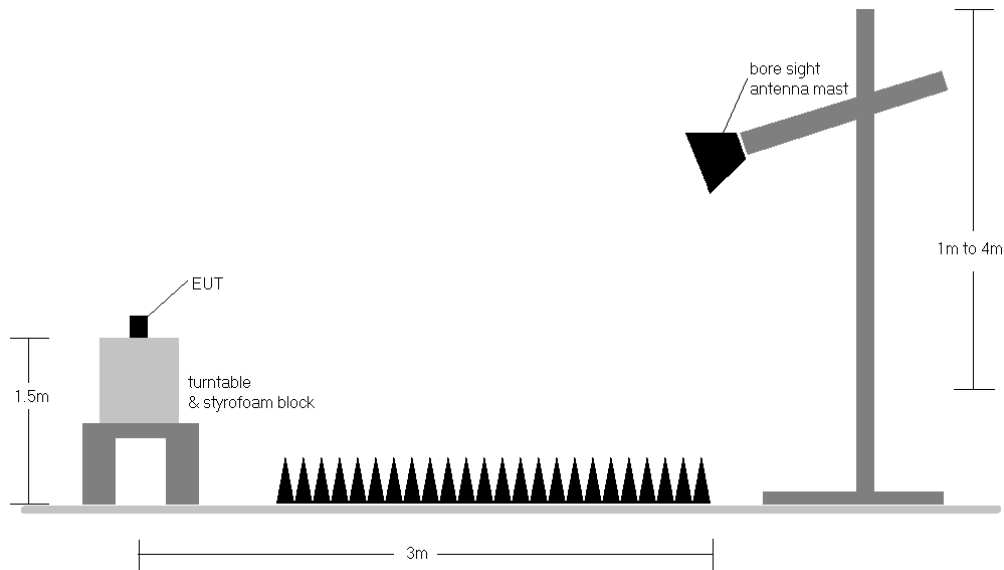


Figure 7-8. Radiated Test Setup >1GHz

Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-5.
2. No significant radiated emissions were found in the 2310 - 2390MHz restricted band.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested while powered by an DC power source.
5. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported.
6. The duty cycle correction factor was not applied to noise floor measurements.
7. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section.

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
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Sample Calculation

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

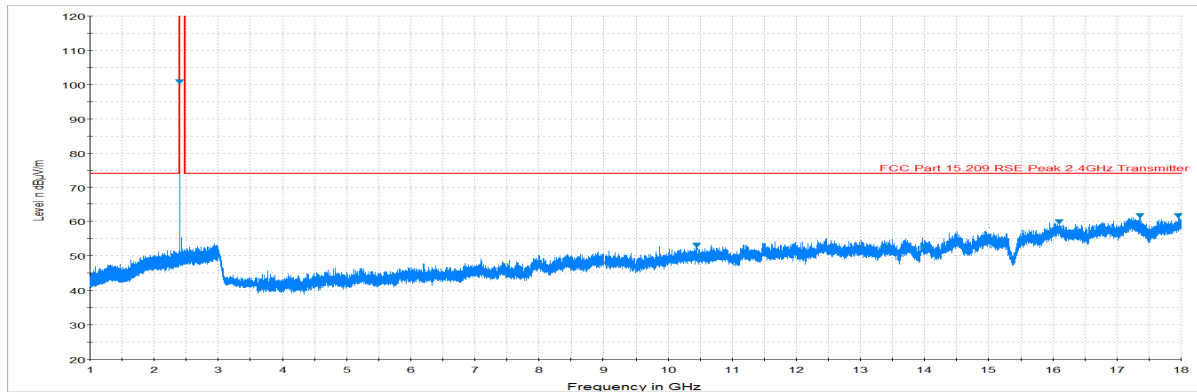
Duty Cycle Correction Factor Calculation

- Channel hop rate = 800 hops/second (AFH Mode)
- Adjusted channel hop rate for DH5 mode = 133.33 hops/second
- Time per channel hop = $1 / 133.33 \text{ hops/second} = 7.50 \text{ ms}$
- Time to cycle through all channels = $7.50 \times 20 \text{ channels} = 150 \text{ ms}$
- Number of times transmitter hits on one channel = $100 \text{ ms} / 150 \text{ ms} = 1 \text{ time(s)}$
- Worst case dwell time = 7.5 ms
- Duty cycle correction factor = $20\log_{10}(7.5\text{ms}/100\text{ms}) = -22.5 \text{ dB}$

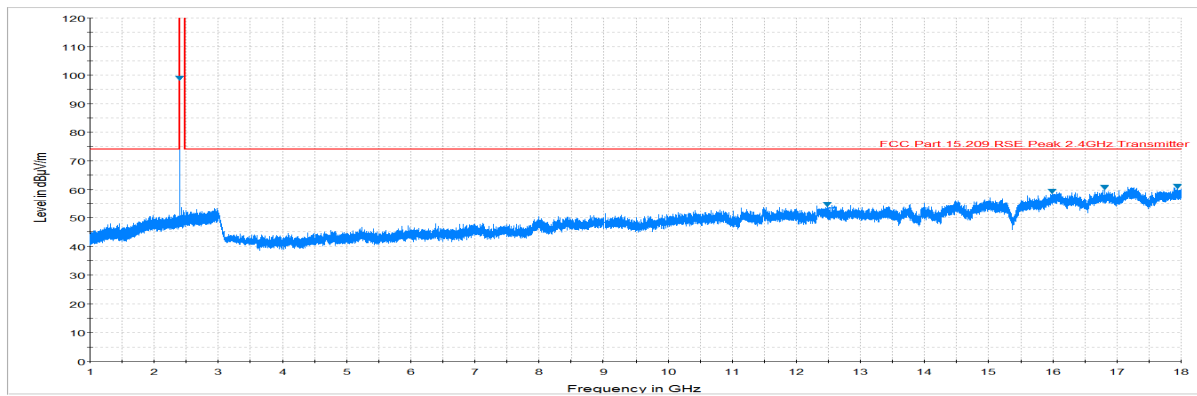
FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 44 of 60

Radiated Spurious Emission Measurements

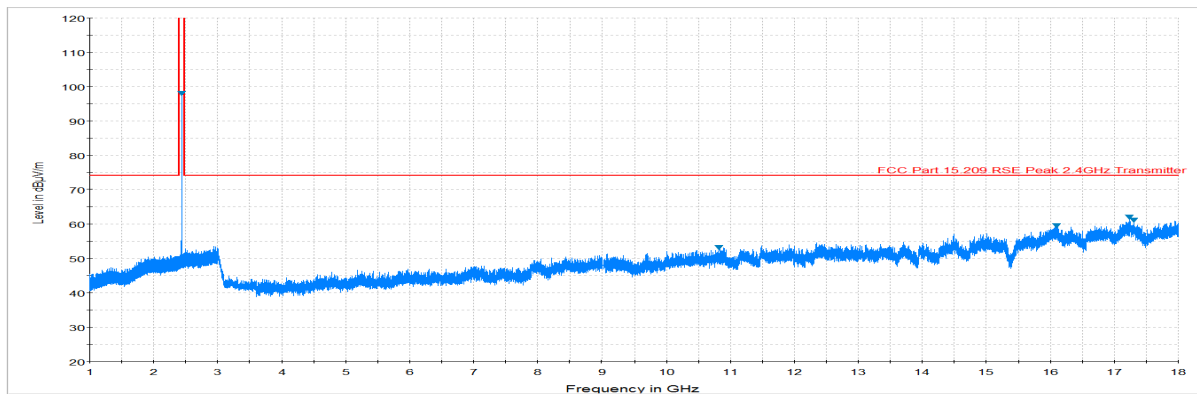
§15.205 §15.209 §15.247 (d)



Plot 7-42. Radiated Spurious Plot above 1GHz (BT – Ch. 0, Ant. Pol. H)

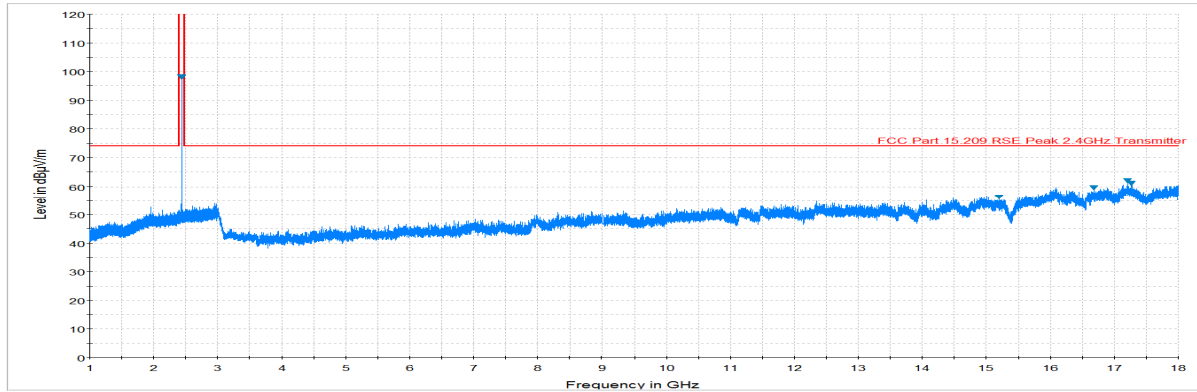


Plot 7-43. Radiated Spurious Plot above 1GHz (BT – Ch. 0, Ant. Pol. V)

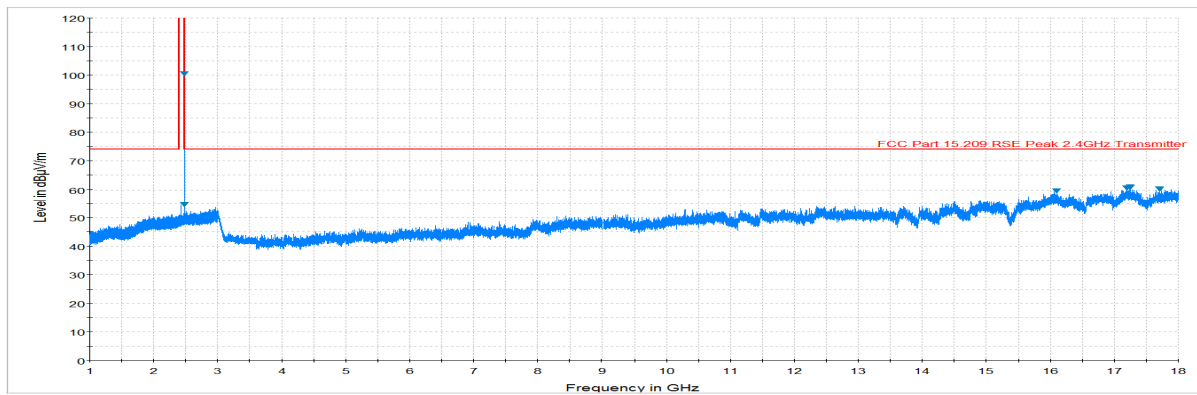


Plot 7-44. Radiated Spurious Plot above 1GHz (BT – Ch. 39, Ant. Pol. H)

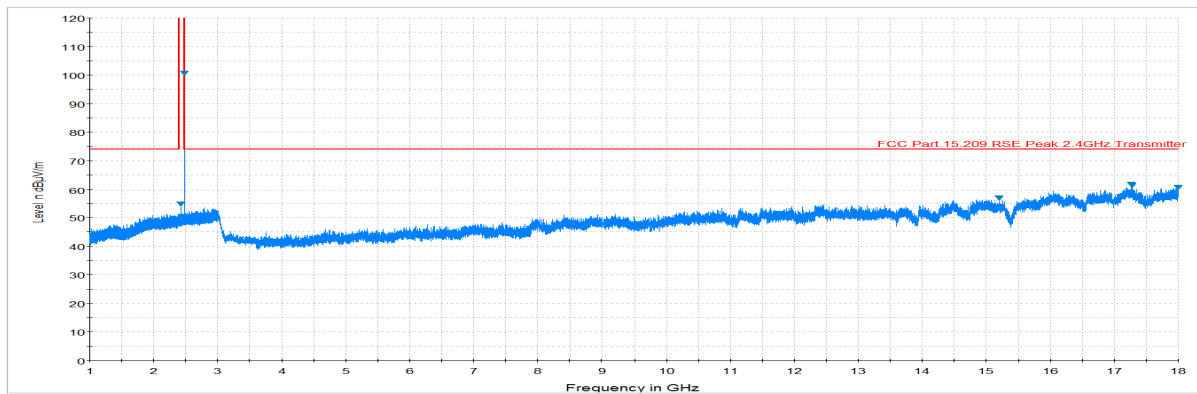
FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 45 of 60



Plot 7-45. Radiated Spurious Plot above 1GHz (BT – Ch. 39, Ant. Pol. V)



Plot 7-46. Radiated Spurious Plot above 1GHz (BT – Ch. 78, Ant. Pol. H)

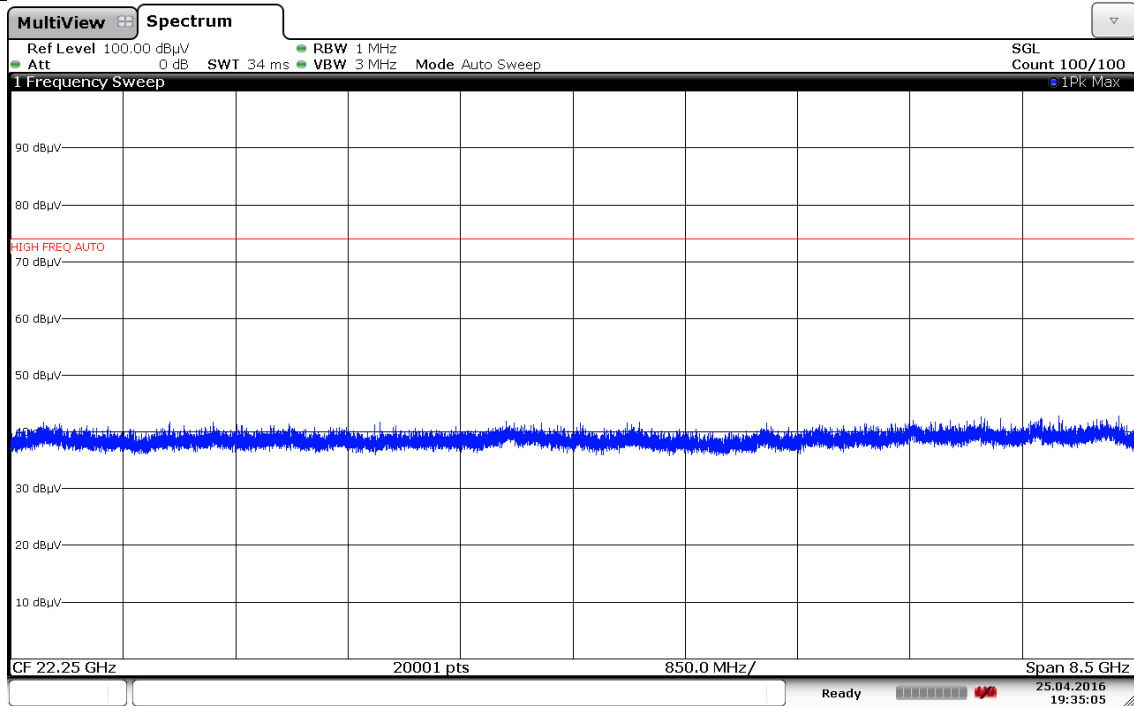


Plot 7-47. Radiated Spurious Plot above 1GHz (BT – Ch. 78, Ant. Pol. V)

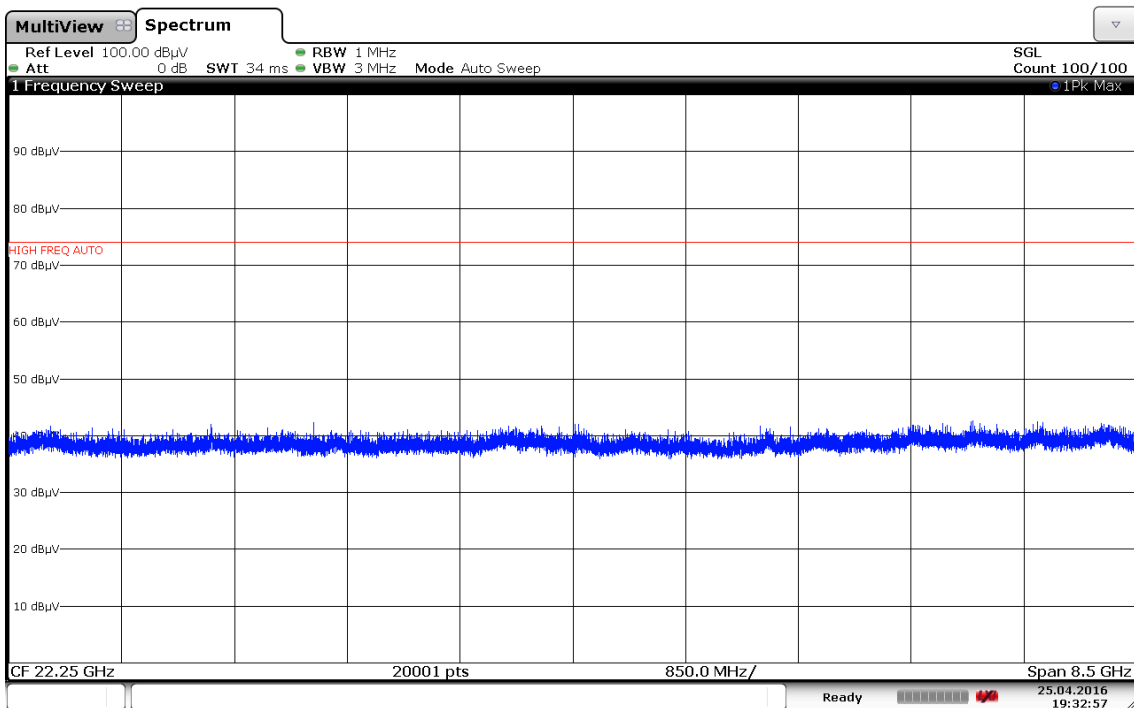
FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.X02	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 46 of 60

Radiated Spurious Emissions Measurements (Above 18GHz)

\$15.209



Plot 7-48. Radiated Spurious Plot above 18GHz (Pol. H)



Plot 7-49. Radiated Spurious Plot above 18GHz (Pol. V)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 47 of 60

Radiated Spurious Emission Measurements

\$15.205 \$15.209 \$15.247 (d)

Worst Case Mode: Bluetooth
Worst Case Data Rate: 1 Mbps
Measurement Distance: 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]	Field Strength [dBμV/m]	Limit [dBμV/m]	Margin [dB]
4804.00	Avg	H	-	-	-112.31	40.43	35.12	53.98	-18.86
4804.00	Peak	H	-	-	-98.55	40.43	48.88	73.98	-25.10
12010.00	Avg	H	-	-	-111.97	51.20	46.22	53.98	-7.75
12010.00	Peak	H	-	-	-99.61	51.20	58.58	73.98	-15.39

Table 7-7. Radiated Measurements

Worst Case Mode: Bluetooth
Worst Case Data Rate: 1 Mbps
Measurement Distance: 3 Meters
Operating Frequency: 2441MHz
Channel: 39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB]	Field Strength [dBμV/m]	Limit [dBμV/m]	Margin [dB]
4882.00	Avg	H	-	-	-111.61	39.94	35.33	53.98	-18.65
4882.00	Peak	H	-	-	-99.23	39.94	47.71	73.98	-26.27
7323.00	Avg	H	-	-	-112.17	43.81	38.63	53.98	-15.35
7323.00	Peak	H	-	-	-99.00	43.81	51.80	73.98	-22.18
12205.00	Avg	H	-	-	-111.94	51.21	46.27	53.98	-7.71
12205.00	Peak	H	-	-	-98.90	51.21	59.31	73.98	-14.67

Table 7-8. Radiated Measurements

FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Radiated Spurious Emission Measurements

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Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	78

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB]	Field Strength [dBμV/m]	Limit [dBμV/m]	Margin [dB]
4960.00	Avg	H	-	-	-111.96	40.02	35.06	53.98	-18.92
4960.00	Peak	H	-	-	-98.91	40.02	48.11	73.98	-25.87
7440.00	Avg	H	-	-	-112.51	44.42	38.90	53.98	-15.07
7440.00	Peak	H	-	-	-98.88	44.42	52.53	73.98	-21.44
12400.00	Avg	H	-	-	-112.15	51.65	46.50	53.98	-7.48
12400.00	Peak	H	-	-	-98.78	51.65	59.87	73.98	-14.11

Table 7-9. Radiated Measurements

FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.X02	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 49 of 60

7.10 Radiated Restricted Band Edge Measurements

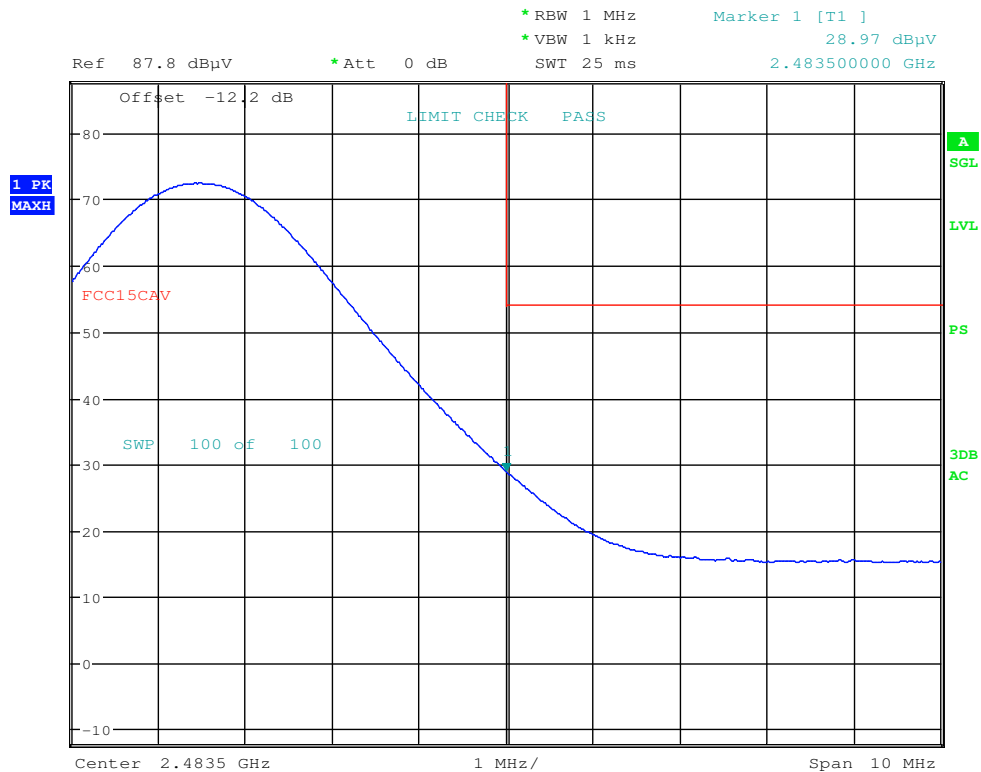
\$15.205 \$15.209 \$15.247 (d)

The radiated restricted band edge measurements are measured with an EMI test receiver connected to the receive antenna while the EUT is transmitting. Two different amplitude offsets were used depending on whether peak or average measurements were measured. The average measurements use a duty cycle correction factor (DCCF).

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

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + 10 \text{ dB Attenuator}) - \text{Preamplifier Gain} + \text{DCCF}$$

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	78



Date: 26.APR.2016 00:54:05

Plot 7-50. Radiated Restricted Upper Band Edge Measurement (Average)

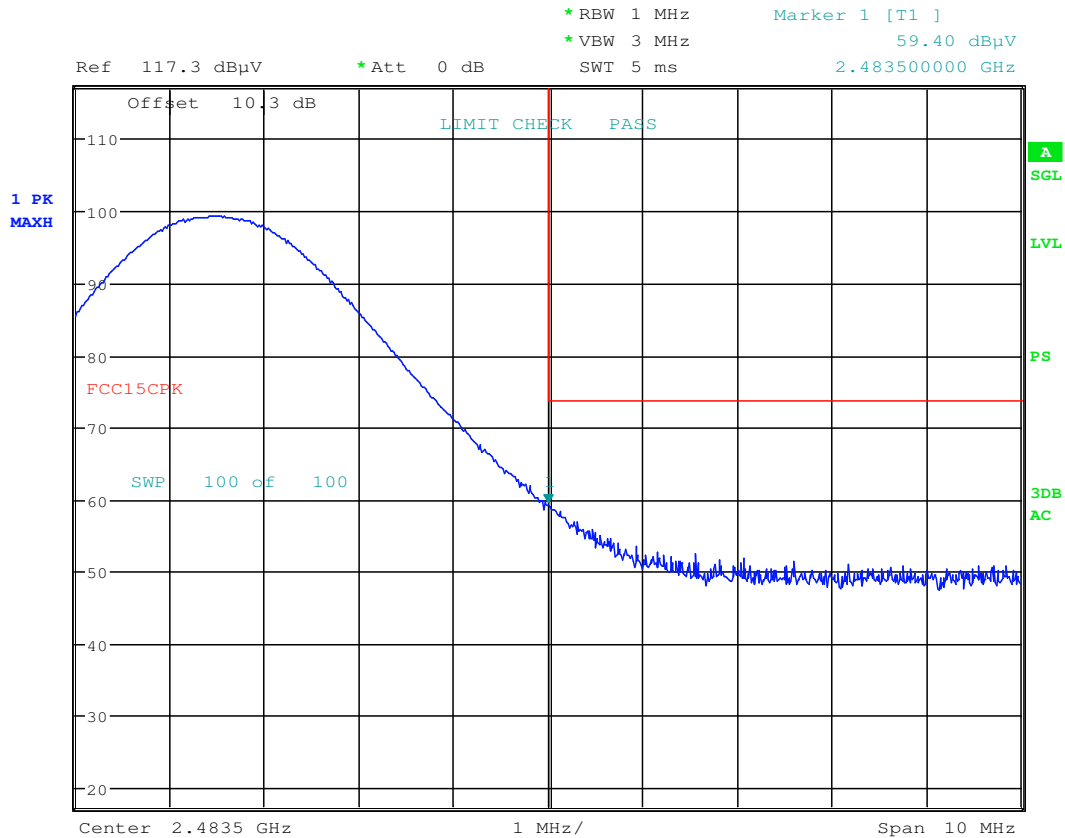
FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 50 of 60

Radiated Restricted Band Edge Measurements

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

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + 10 \text{ dB Attenuator}) - \text{Preamplifier Gain}$$



Date: 26.APR.2016 00:57:35

Plot 7-51. Radiated Restricted Upper Band Edge Measurement (Peak)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 51 of 60

7.11 Radiated Spurious Emissions Measurements – Below 1GHz

§15.209

Test Overview and Limit

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

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-10 per Section 15.209.

Frequency	Field Strength [$\mu\text{V/m}$]	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 7-10. 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: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 52 of 60

Test Setup

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

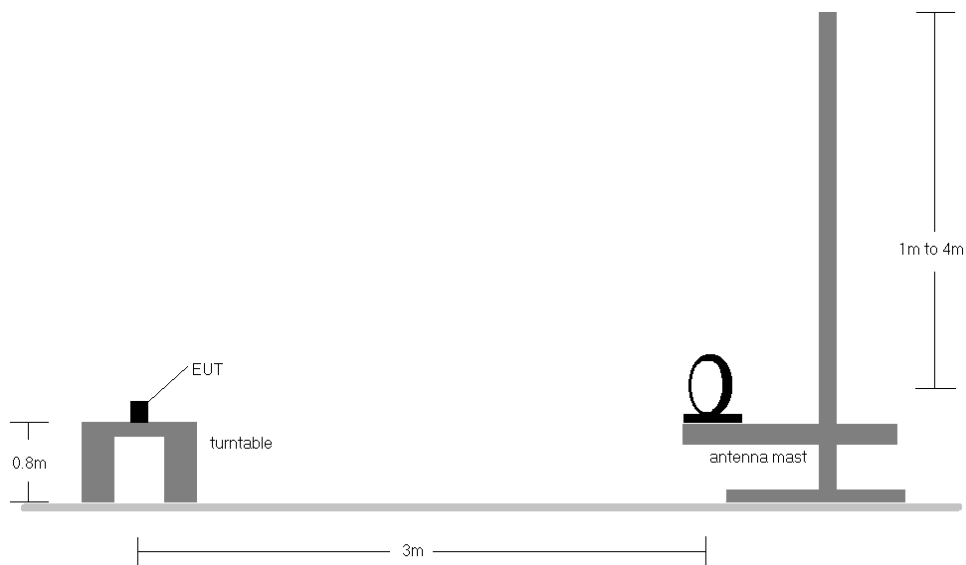


Figure 7-9. Radiated Test Setup < 30Mhz

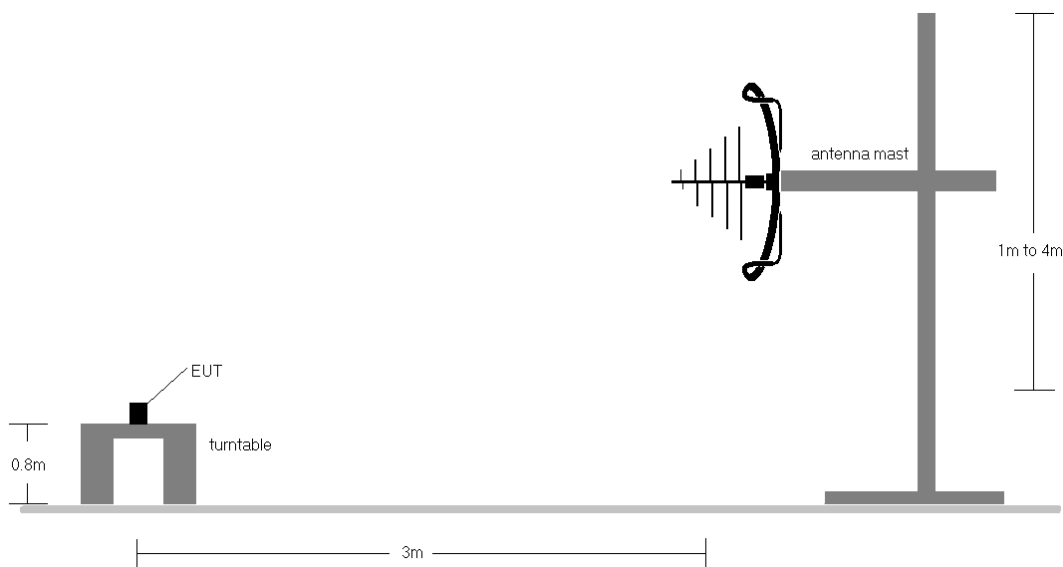


Figure 7-10. Radiated Test Setup < 1GHz

FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 53 of 60

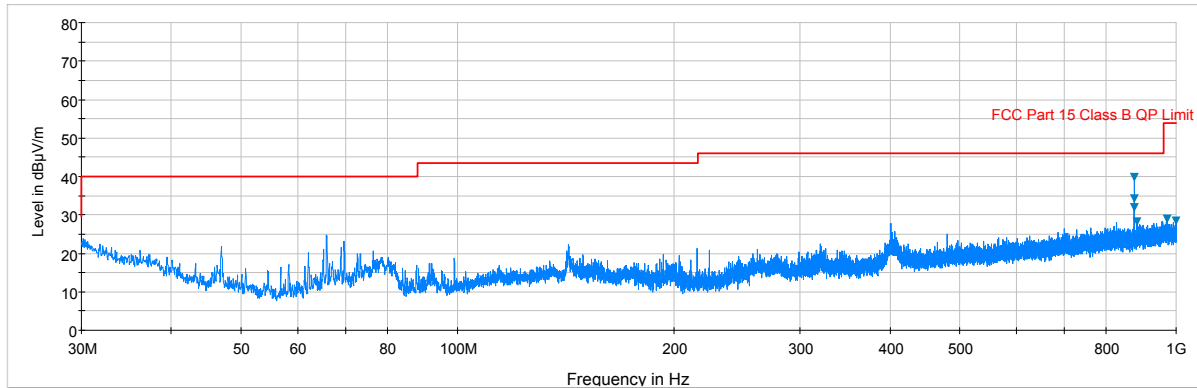
Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-10.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes.
3. This unit was tested while powered by an DC power source.
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.

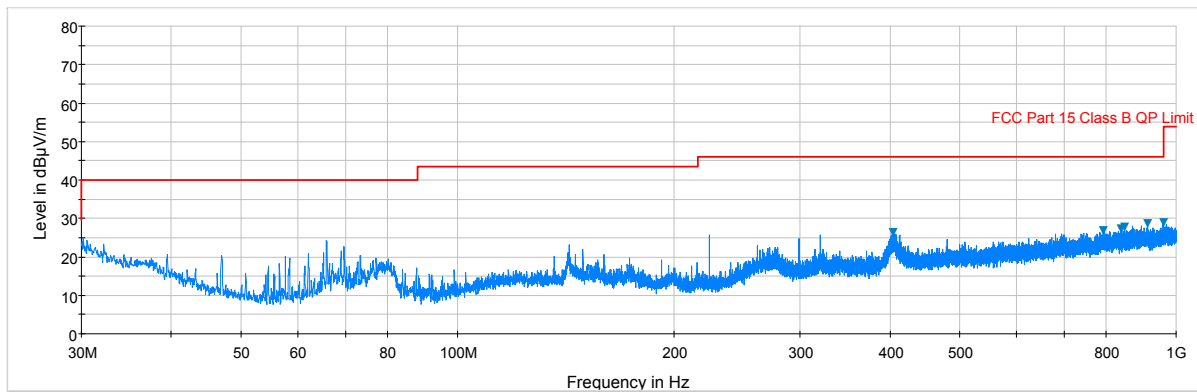
FCC ID: XO2SPB209A		FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 54 of 60

Radiated Spurious Emissions Measurements (Below 1GHz)

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Plot 7-52. Radiated Spurious Plot below 1GHz (Pol. H)



Plot 7-53. Radiated Spurious Plot below 1GHz (Pol. V)

FCC ID: XO2SPB209A	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 BLUETOOTH TEST REPORT (CERTIFICATION)	H&D Wireless	Reviewed by: Quality Manager
Test Report S/N: 0Y1604070740.XO2	Test Dates: 4/7 - 6/17/2016	EUT Type: Wifi/BT/NFC Module		Page 55 of 60

7.12 Line Conducted Measurement Data

§15.207

Test Overview and Limit

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

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

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

Table 7-11. 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

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

Average Field Strength Measurements

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

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Test Setup

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

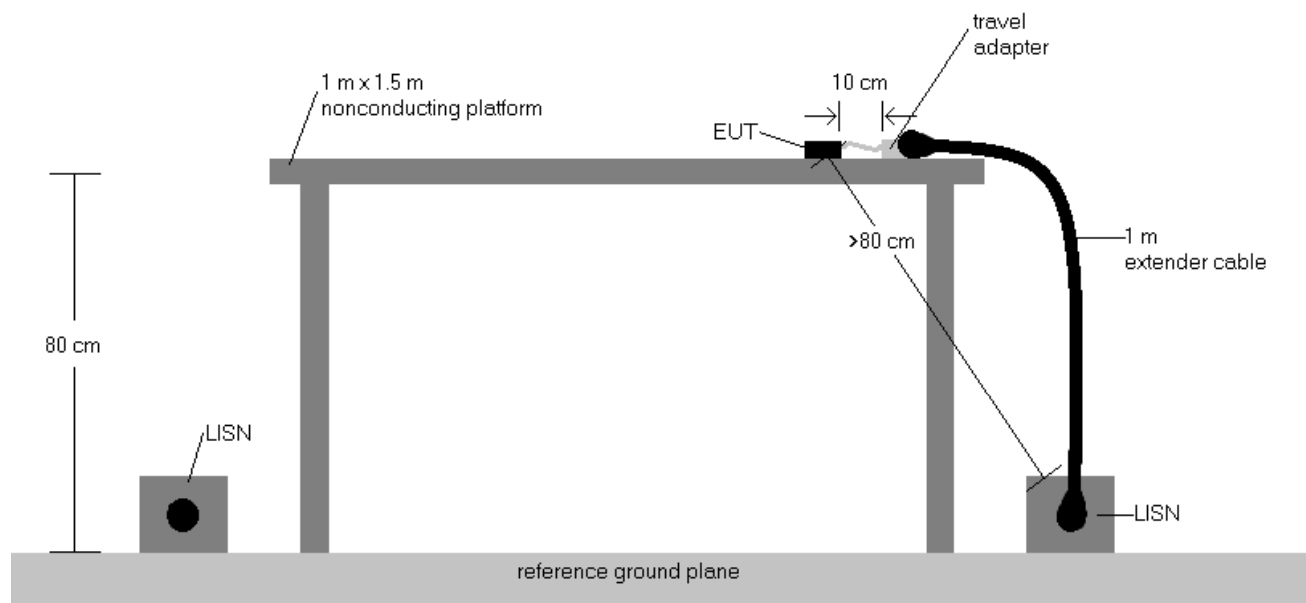


Figure 7-11. Test Instrument & Measurement Setup

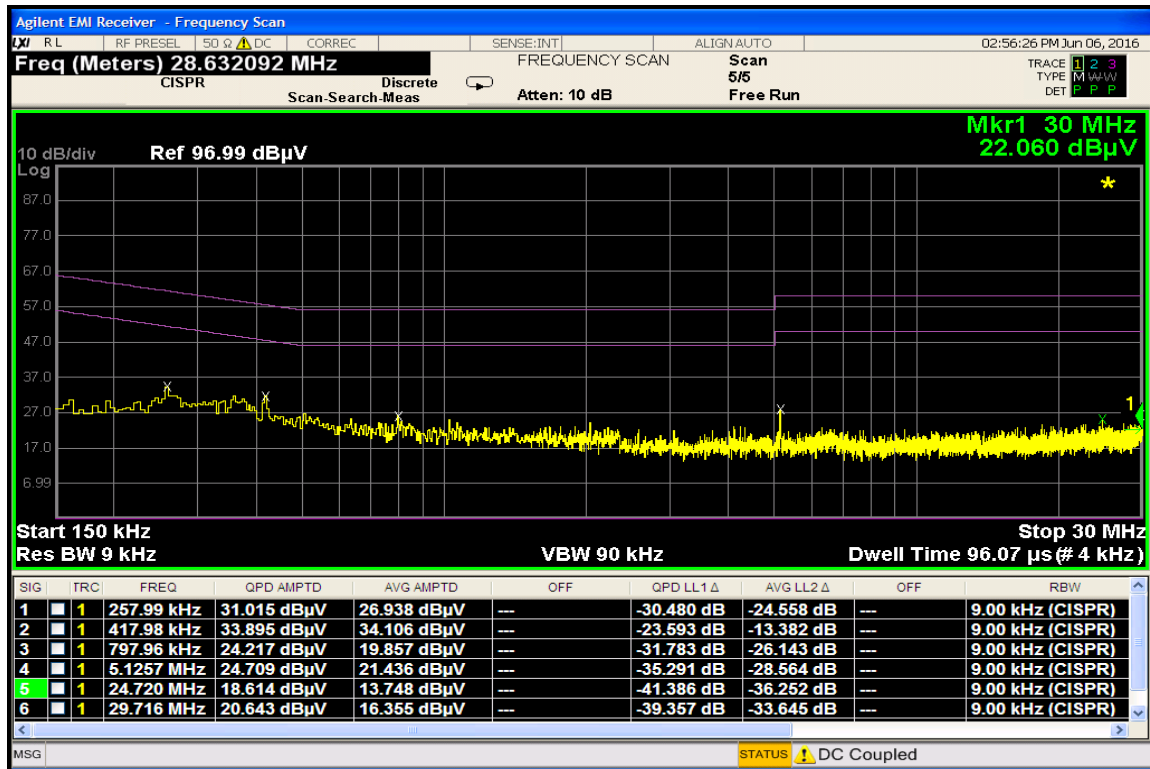
Test Notes

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 15.207.
3. $\text{Corr. (dB)} = \text{Cable loss (dB)} + \text{LISN insertion factor (dB)}$
4. $\text{QP/AV Level (dB}\mu\text{V)} = \text{QP/AV Analyzer/Receiver Level (dB}\mu\text{V)} + \text{Corr. (dB)}$
5. $\text{Margin (dB)} = \text{QP/AV Limit (dB}\mu\text{V)} - \text{QP/AV Level (dB}\mu\text{V)}$
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.

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Line Conducted Measurement Data

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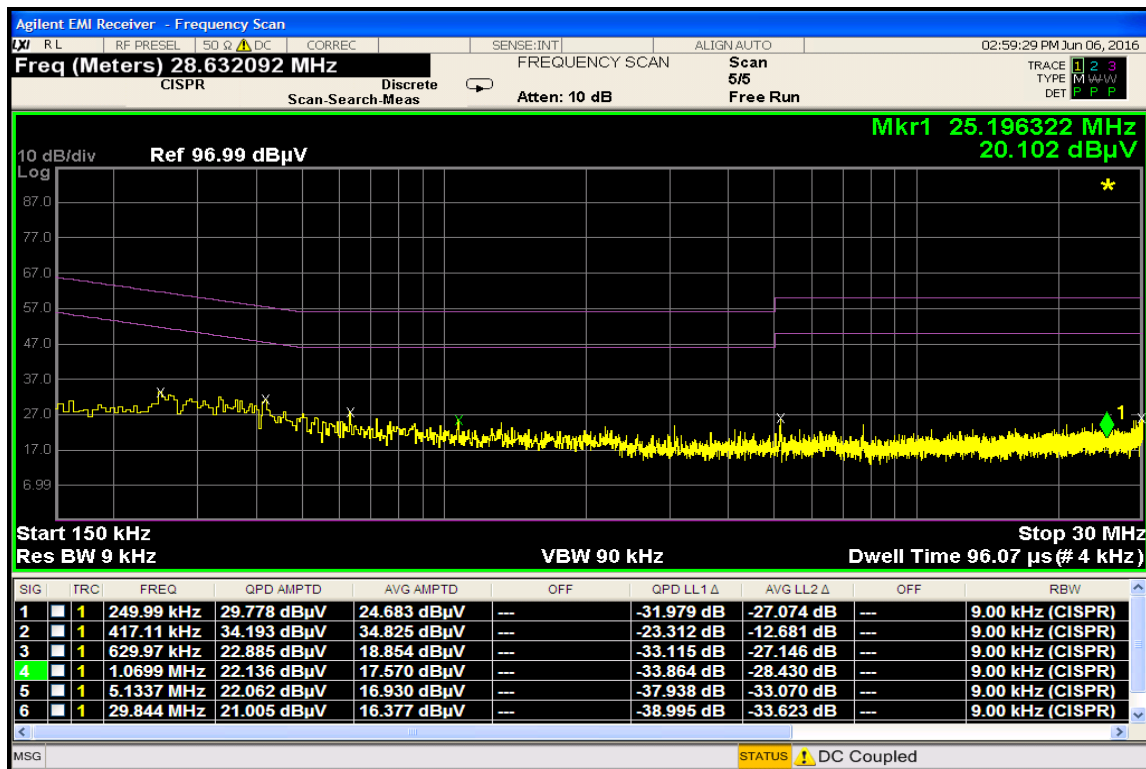


Plot 7-54. Line-Conducted Test Plot (L1)

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Line Conducted Measurement Data

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Plot 7-55. Line-Conducted Test Plot (N)

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8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **H&D Wireless AB Wifi/BT/NFC Module** **FCC ID: XO2SPB209A** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.

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