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MEASUREMENT REPORT
FCC PART 15.247 Bluetooth

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro, Maetan dong,
Yeongtong-gu, Suwon-si
Gyeonggi-do 443-742, Korea

Date of Testing:
01/14-02/19/2015
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
0Y1501190148.A3L

FCC ID:	**A3LSMG920R4**
APPLICANT:	**Samsung Electronics Co., Ltd.**

Application Type:	Certification
Model(s):	SM-G920R4
EUT Type:	Portable Handset
Max. RF Output Power:	10.428 mW (10.18 dBm) Peak Conducted
Frequency Range:	2402 – 2480MHz (Bluetooth for US)
Type of Modulation:	GFSK, π/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):	DA 00-705, KDB 648474 D03 v01r02

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 DA 00-705. 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

ACCREDITED
TESTING CERT#2041.01

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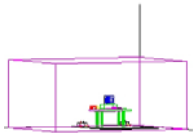
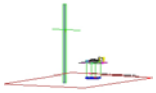


MEASUREMENT REPORT
FCC Part 15.247



§ 2.1033 General Information

APPLICANT:	Samsung Electronics Co., Ltd.
APPLICANT ADDRESS:	129, Samsung-ro, Maetan dong, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-742, Korea
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:	SM-G920R4
FCC ID:	A3LSMG920R4
FCC CLASSIFICATION:	FCC Part 15 Spread Spectrum Transmitter (DSS)
Test Device Serial No.:	08F8F, 08C70, 08DBB, SPARE ☐ Production ☒ Pre-Production ☐ Engineering
Method/System:	Frequency Hopping Spread Spectrum (FHSS)
DATE(S) OF TEST:	01/14-02/19/2015
TEST REPORT S/N:	0Y1501190148.A3L

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 Internt'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 C63.4-2009 on February 15, 2012.

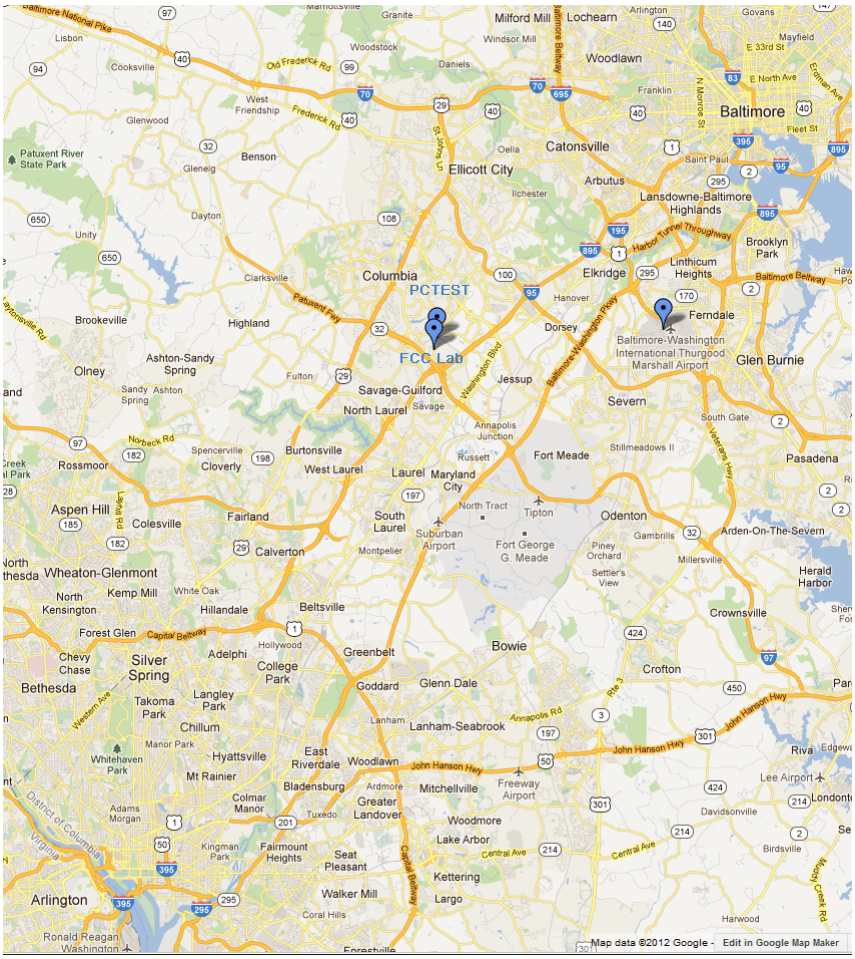

Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Portable Handset FCC ID: A3LSMG920R4**. 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:

850/1900 CDMA/EvDO Rev0/A (BC0, BC1), 850/1900 GSM/GPRS/EDGE, 850/1900 WCDMA/HSPA, Multi-band LTE, 802.11b/g/n WLAN, 802.11a/n/ac UNII, Bluetooth (1x, EDR, LE), NFC, ANT+

2.3 Test Configuration

The Samsung Portable Handset FCC ID: A3LSMG920R4 was tested per the guidance of ANSI C63.10-2009 and DA 00-705. ANSI C63.10-2009 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 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, and 6.8 for antenna port conducted emissions test setups.

This device supports wireless charging capability and, thus, is subject to the test requirements of KDB 648474 D03 v01r02. Additional radiated spurious emission measurements were performed with the EUT lying flat on a certified wireless charging pad while operating under normal conditions in a simulated call or data transmission configuration. The worst case radiated emissions data is shown in this report.

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 TEST

3.1 Evaluation Procedure

The measurement procedure described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2009) and the "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems" (DA 00-705) were used in the measurement of the **Samsung Portable Handset FCC ID: A3LSMG920R4.**

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 6.12. 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 Clause 5, Figure 5.7 of ANSI C63.4-2009. 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, the absorbers are removed. An ETS Lindgren Model 2188 raised turntable is used for radiated measurement. It is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. A 78cm high PVC support structure is placed on top of the turntable. A ¾" (~1.9cm) sheet of high density polyethylene 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 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 0.8 meter high, 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 antennas of the Samsung Portable Handset are **permanently attached.**
- There are no provisions for connection to an external antenna.

Conclusion:

The **Samsung Portable Handset FCC ID: A3LSMG920R4** 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 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
-	BT2	Bluetooth Cable Set	10/15/2014	Annual	10/15/2015	N/A
-	RE1	Radiated Emissions Cable Set (UHF/EHF)	10/24/2014	Annual	10/24/2015	N/A
Agilent	N4010A	Wireless Connectivity Test Set	N/A			GB46170464
Agilent	N9020A	MXA Signal Analyzer	10/27/2014	Annual	10/27/2015	US46470561
Agilent	N9030A	PXA Signal Analyzer (44GHz)	5/8/2014	Annual	5/8/2015	MY52350166
Agilent	N9038A	MXE EMI Receiver	3/3/2014	Annual	3/3/2015	MY51210133
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	6/26/2013	Biennial	6/26/2015	121034
Emco	3115	Horn Antenna (1-18GHz)	1/30/2014	Biennial	1/30/2016	9704-5182
ETS Lindgren	3117	1-18 GHz DRG Horn (Medium)	4/8/2014	Biennial	4/8/2016	125518
ETS Lindgren	3160-09	18-26.5 GHz Standard Gain Horn	6/17/2014	Biennial	6/17/2016	135427
K & L	11SH10-3075/U18000	High Pass Filter	12/1/2014	Annual	12/1/2015	2
Pasternack	NMLC-1	Line Conducted Emissions Cable (NM)	10/17/2014	Annual	10/17/2015	N/A
Rohde & Schwarz	CMU200	Base Station Simulator	N/A			836536/0005
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	3/27/2014	Annual	3/27/2015	100342
Rohde & Schwarz	TS-PR18	1-18 GHz Pre-Amplifier	3/5/2014	Annual	3/5/2015	100071
Rohde & Schwarz	TS-PR26	18-26.5 GHz Pre-Amplifier	3/12/2014	Annual	3/12/2015	100040
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/18/2014	Biennial	3/18/2016	N/A
Solar Electronics	8012-50-R-24-BNC	Line Impedance Stabilization Network	6/20/2013	Biennial	6/20/2015	310233
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	1/28/2014	Biennial	1/28/2016	A051107
VWR	62344-734	Thermometer with Clock	2/20/2014	Biennial	2/20/2016	140140420

Table 5-1. Annual Test Equipment Calibration Schedule

Note:

Equipment with a calibration date of "N/A" shown in this list was not used to make direct calibrated measurements.

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6.0 TEST RESULTS

6.1 Summary

Company Name: Samsung Electronics Co., Ltd.

FCC ID: A3LSMG920R4

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	< 1 MHz only if using less than 15 non-overlapping channels	CONDUCTED	PASS	Section 6.2
15.247(b)(1)	Peak Transmitter Output Power	< 1 Watt if ≥ 75 non-overlapping channels used		PASS	Section 6.3
15.247(a)(1)	Channel Separation	> 2/3 of 20 dB BW for systems with Output Power < 125mW		PASS	Section 6.5
15.247(a)(1)(iii)	Number of Channels	> 15 Channels		PASS	Section 6.7
15.247(a)(1)(iii)	Time of Occupancy	< 0.4 sec in 31.6 sec period		PASS	Section 6.6
15.247(d)	Band Edge / Out-of-Band Emissions	Conducted > 20dBc		PASS	Section 6.4, Section 6.8
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 (RSS-210 table 3 limits)	RADIATED	PASS	Section 6.9, Section 6.10, Section 6.11
15.207	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits or < RSS-Gen table 2 limits	LINE CONDUCTED	PASS	Section 6.12

Table 6-1. 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 2.6.

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6.2 20dB Bandwidth Measurement

§15.247 (a.1.iii)

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. ***The maximum permissible 20dB bandwidth is 1 MHz, unless more than 15 non-overlapping channels are employed.***

Frequency [MHz]	Data Rate [Mbps]	Channel No.	20dB Bandwidth Test Results	
			Measured Bandwidth [kHz]	Pass/Fail
2402	1.0	0	1021.00	Pass
2441	1.0	39	997.50	Pass
2480	1.0	78	950.70	Pass
2402	2.0	0	1349.00	Pass
2441	2.0	39	1354.00	Pass
2480	2.0	78	1348.00	Pass
2402	3.0	0	1326.00	Pass
2441	3.0	39	1338.00	Pass
2480	3.0	78	1330.00	Pass

Table 6-2. Conducted 20dB Bandwidth Measurements

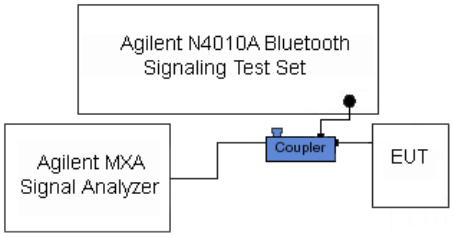

Figure 6-1. Test Instrument & Measurement Setup

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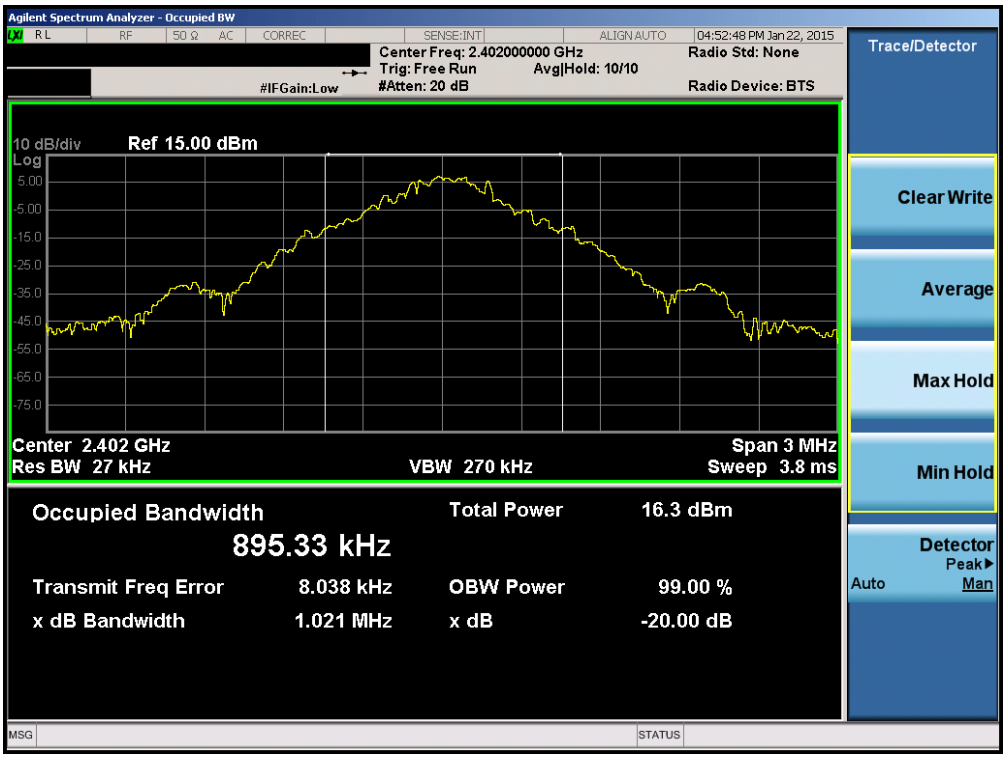
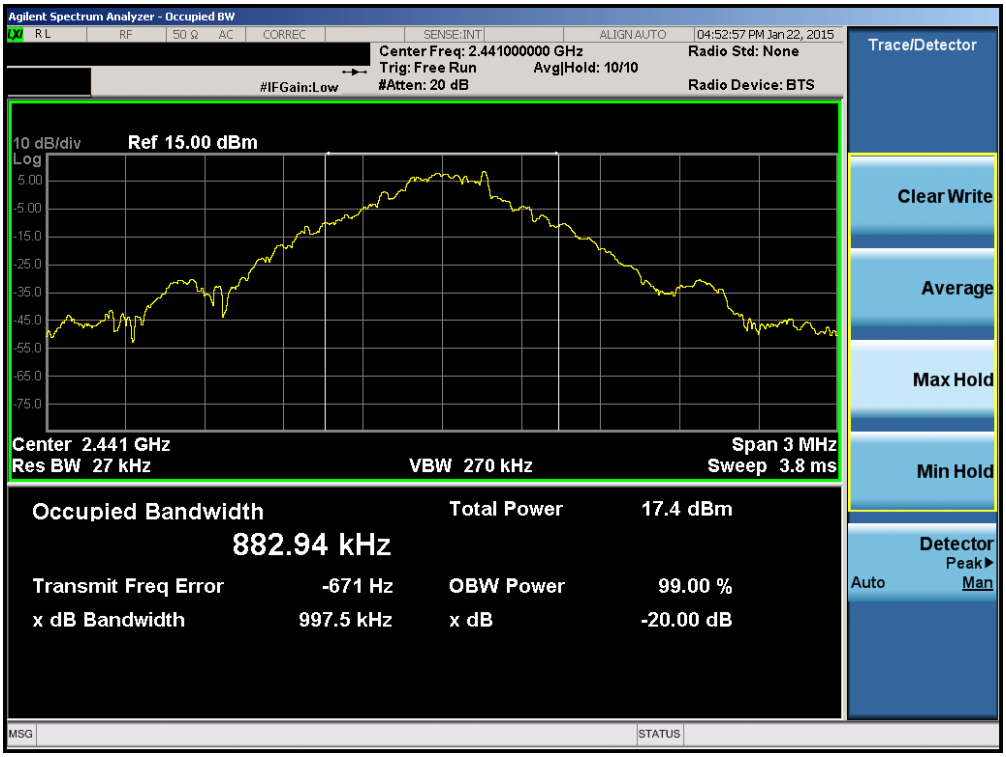


Plot 6-1. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 0)



Plot 6-2. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 39)

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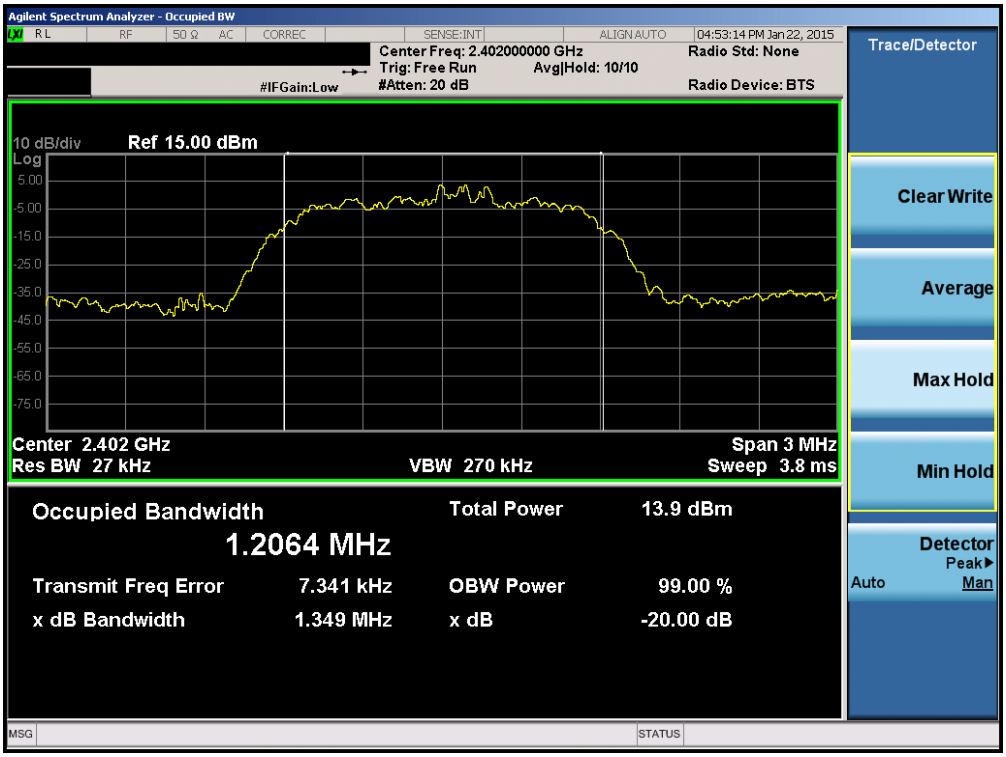
Plot 6-3. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 78)



Plot 6-4. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 0)

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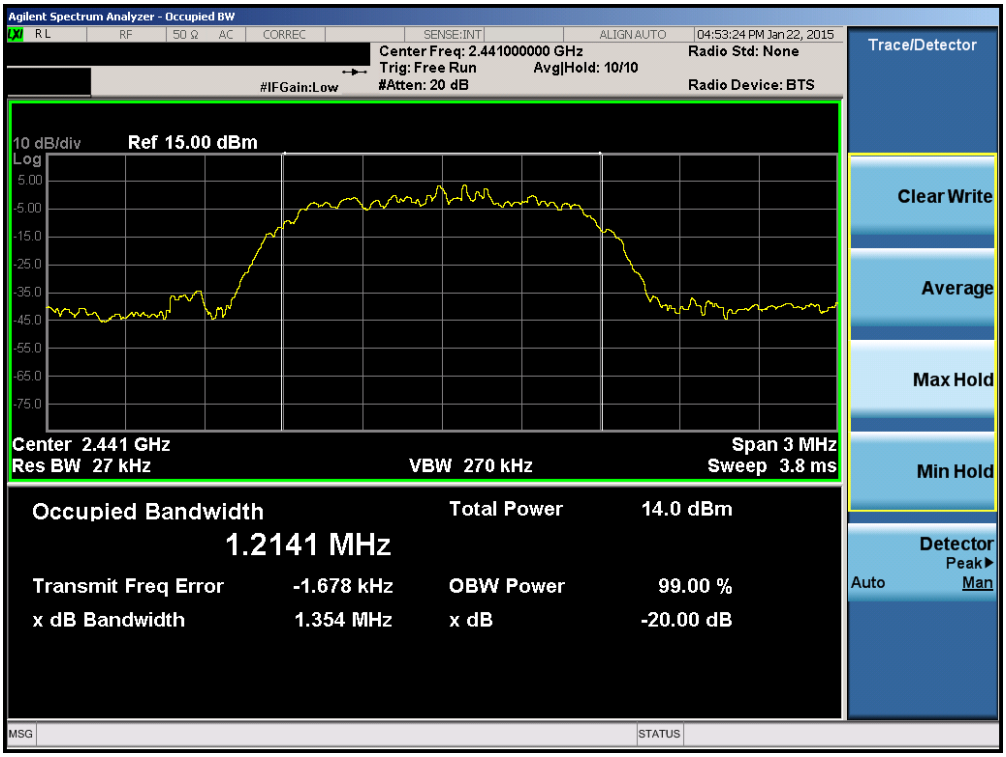
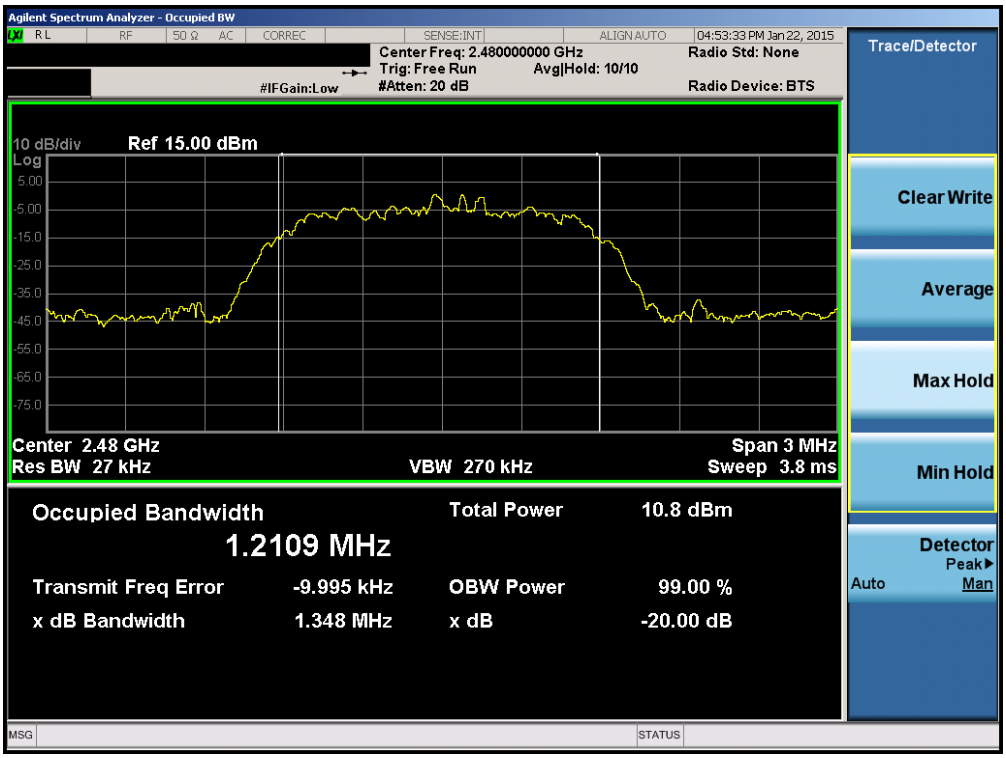


Plot 6-5. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 39)



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

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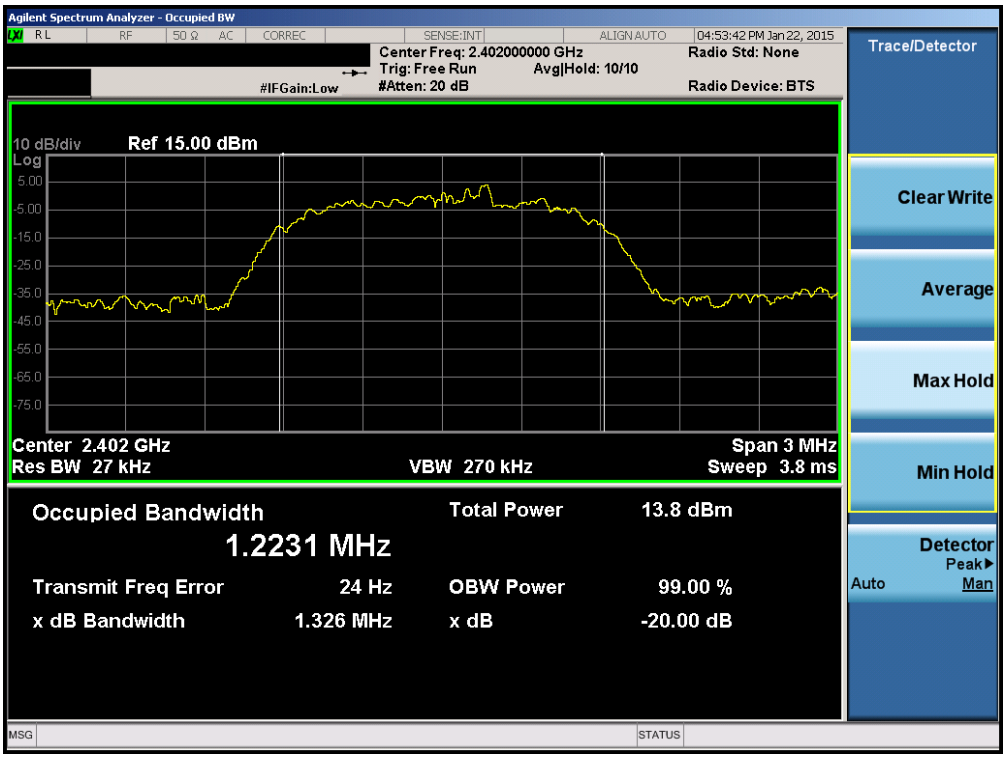
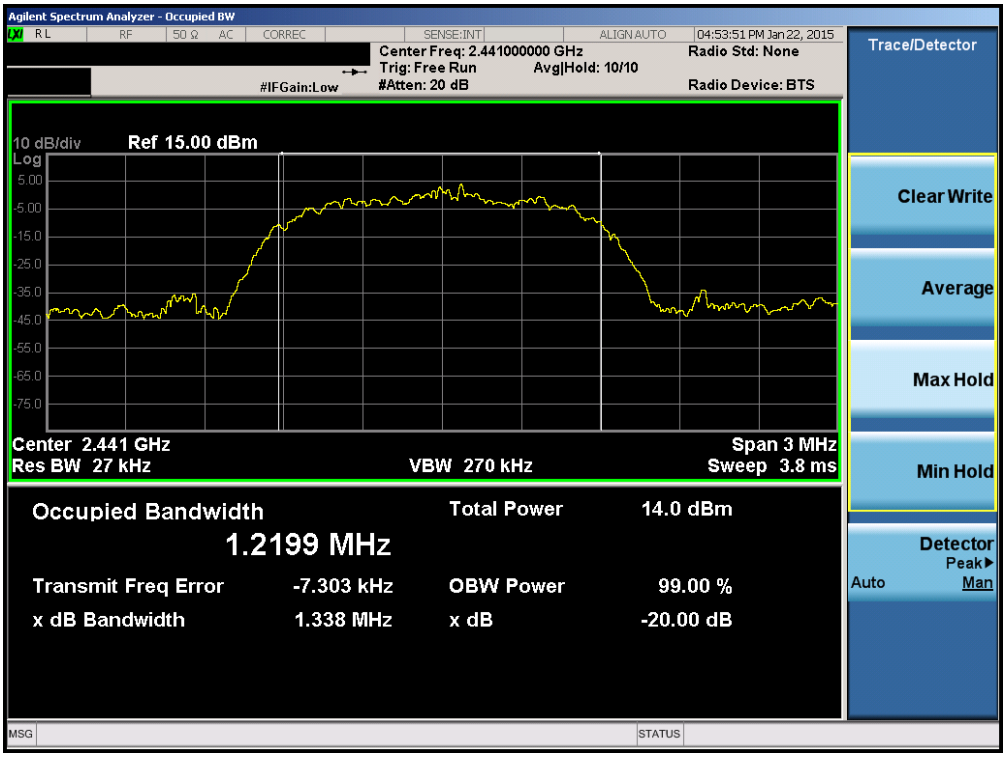


Plot 6-7. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 0)



Plot 6-8. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 39)

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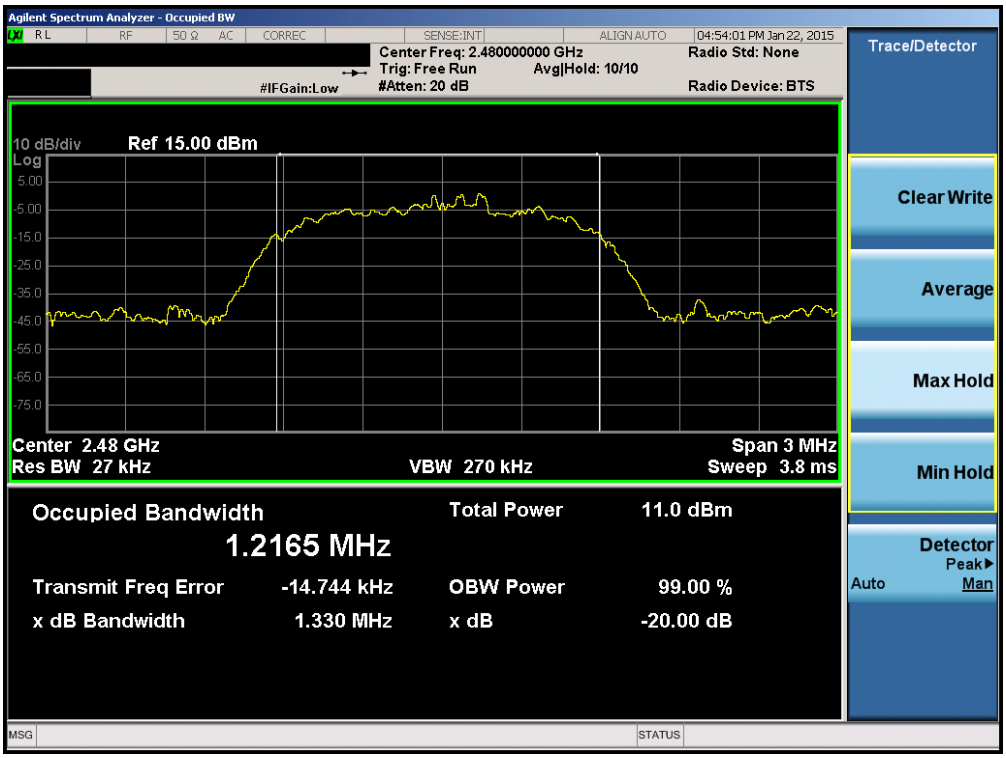

Plot 6-9. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 78)

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6.3 Output Power Measurement

§15.247 (b.1)

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. Peak power measurements are performed in the analyzers' swept spectrum mode using a peak detector with RBW = 3MHz and VBW ≥ RBW. 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 burst set to maximum power and measures the maximum average power over the on-time. ***The maximum permissible output power is 1 Watt.***

This unit was tested with all possible data rates and the highest peak power is reported with the unit transmitting at 1Mbps.

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Peak Conducted Power		Avg Conducted Power	
			[dBm]	[mW]	[dBm]	[mW]
2402	1.0	0	9.23	8.368	9.11	8.141
2441	1.0	39	10.18	10.428	10.06	10.135
2480	1.0	78	6.14	4.108	6.04	4.020
2402	2.0	0	8.15	6.536	5.82	3.818
2441	2.0	39	8.69	7.403	6.37	4.337
2480	2.0	78	5.26	3.357	2.99	1.989
2402	3.0	0	8.42	6.955	6.10	4.076
2441	3.0	39	9.07	8.069	6.48	4.446
2480	3.0	78	5.43	3.491	3.04	2.014

Table 6-3. Conducted Output Power Measurements

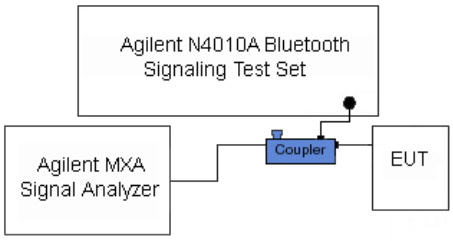

Figure 6-2. Test Instrument & Measurement Setup

Note

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

Output Power (dBm) = Raw Analyzer Level (dBm) + Cable Loss (dB) + Loss in Directional Coupler/Insertion Loss (dB)

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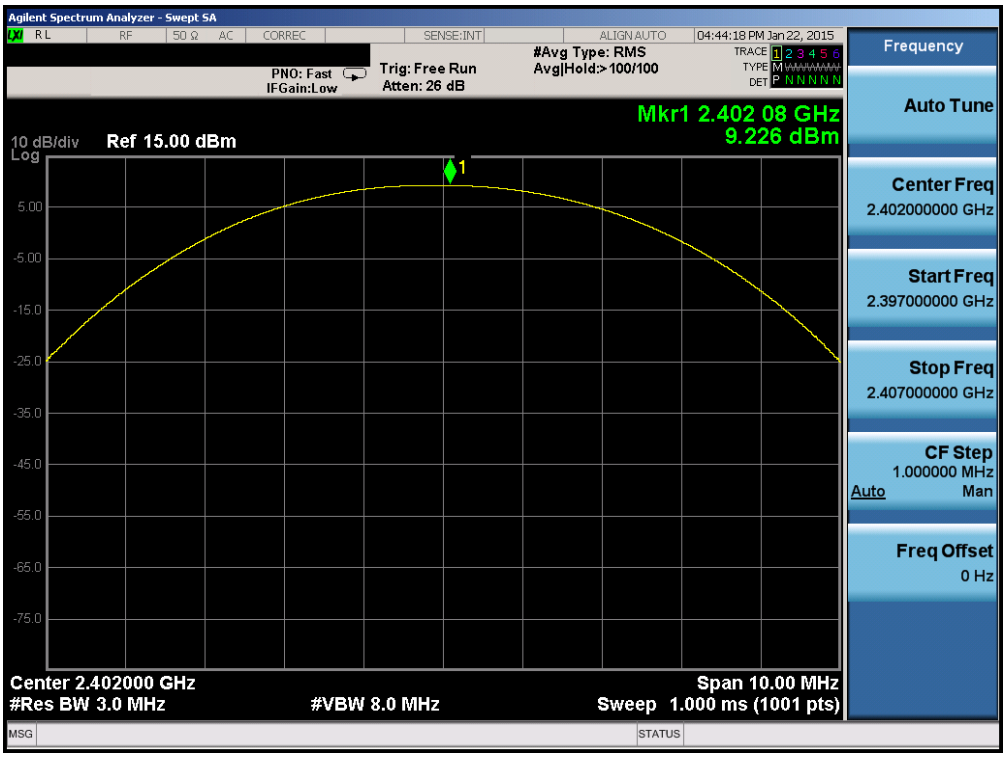
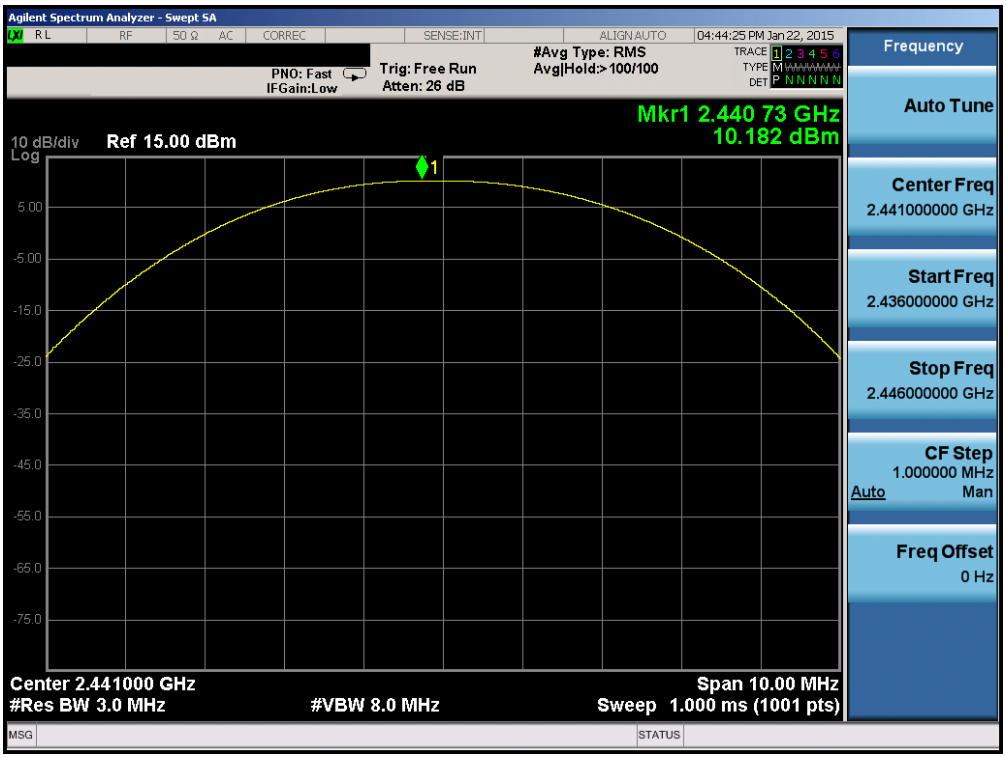


Plot 6-10. Peak Conducted Power (1Mbps – Ch. 0)



Plot 6-11. Peak Conducted Power (1Mbps – Ch. 39)

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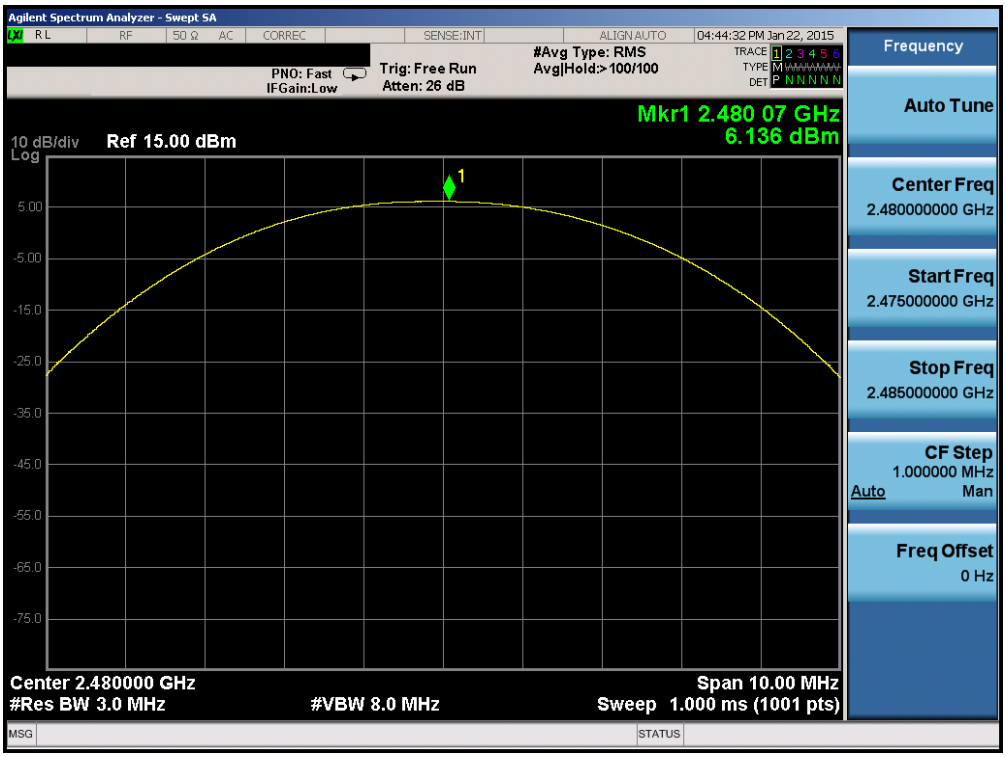
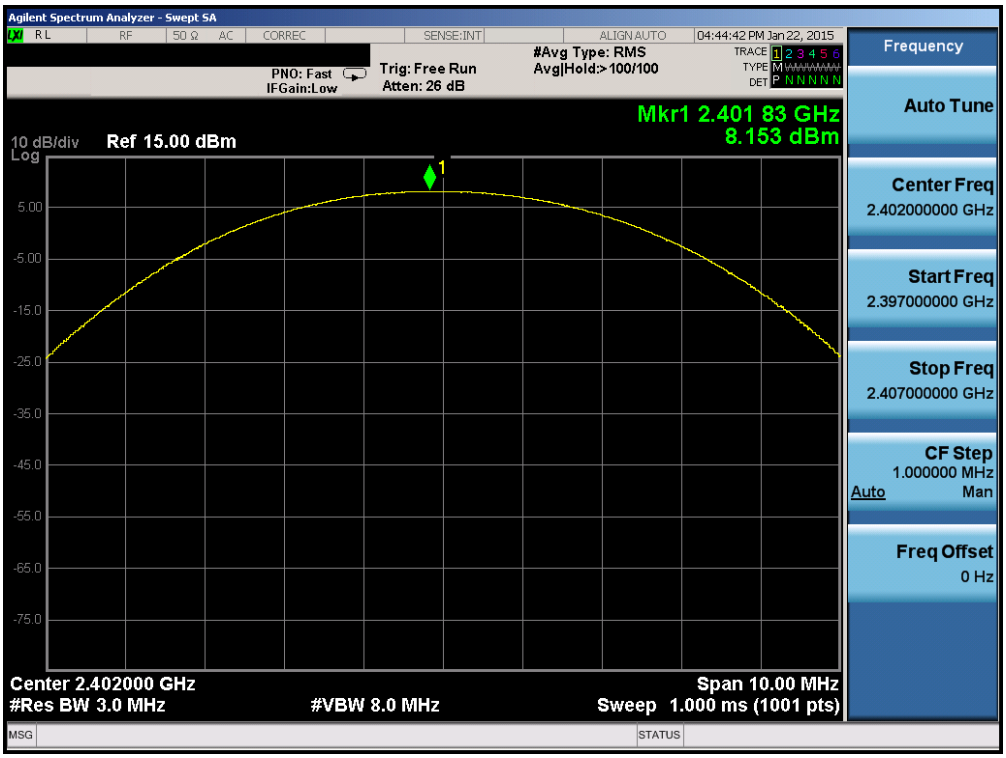


Plot 6-12. Peak Conducted Power (1Mbps – Ch. 78)



Plot 6-13. Peak Conducted Power (2Mbps – Ch. 0)

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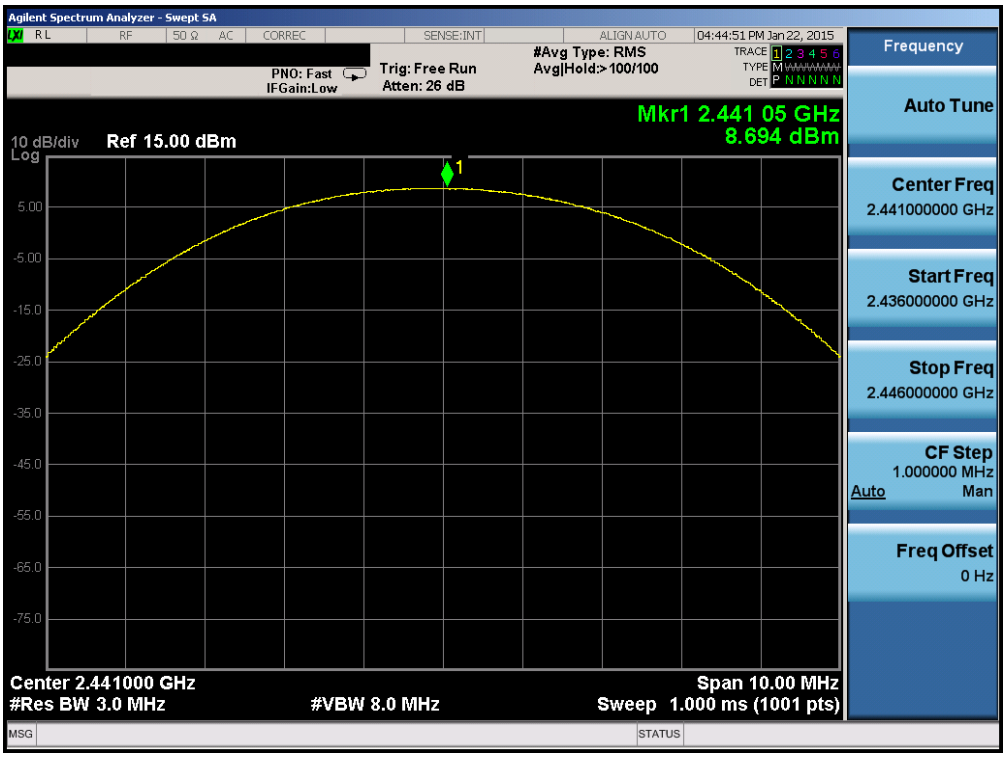
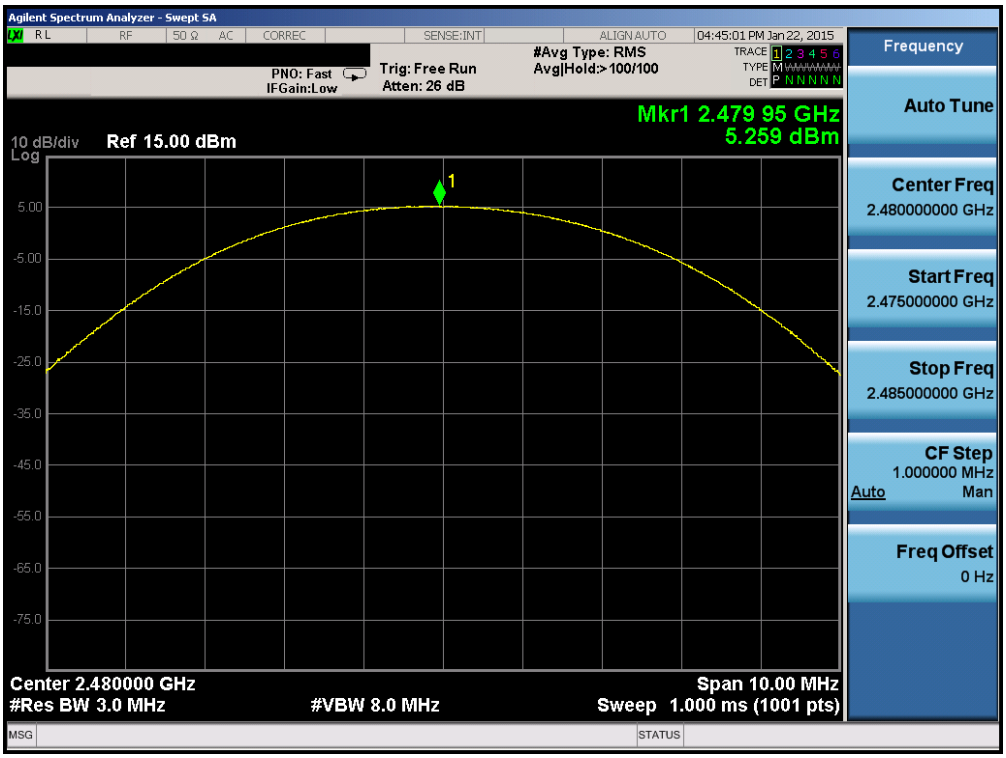


Plot 6-14. Peak Conducted Power (2Mbps – Ch. 39)



Plot 6-15. Peak Conducted Power (2Mbps – Ch. 78)

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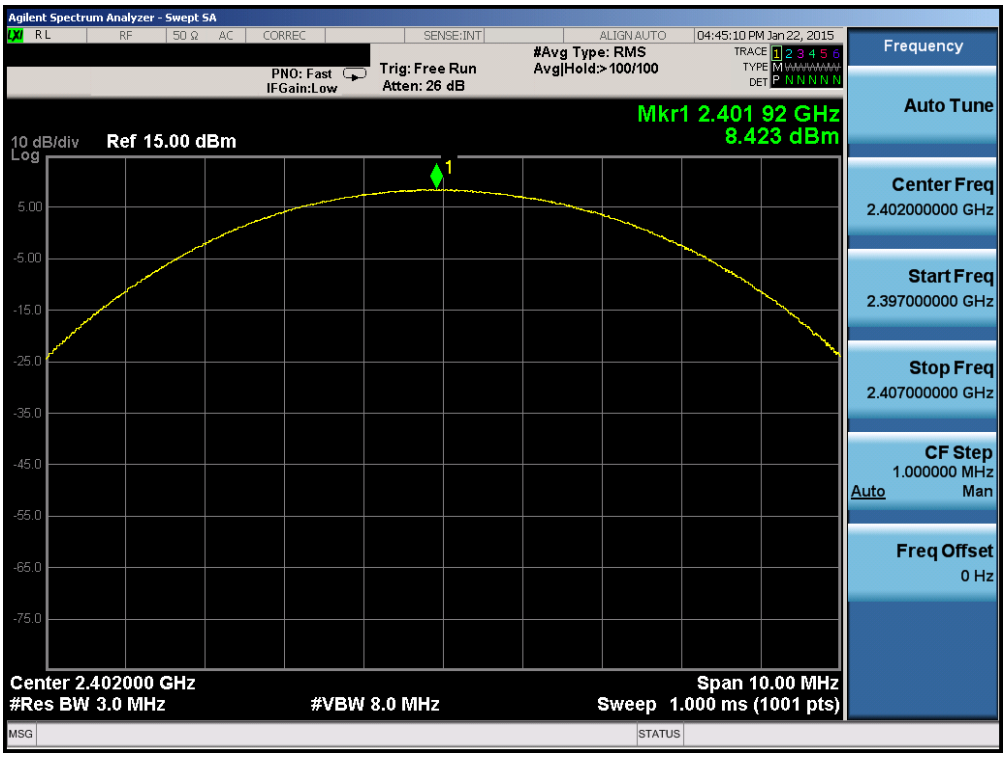
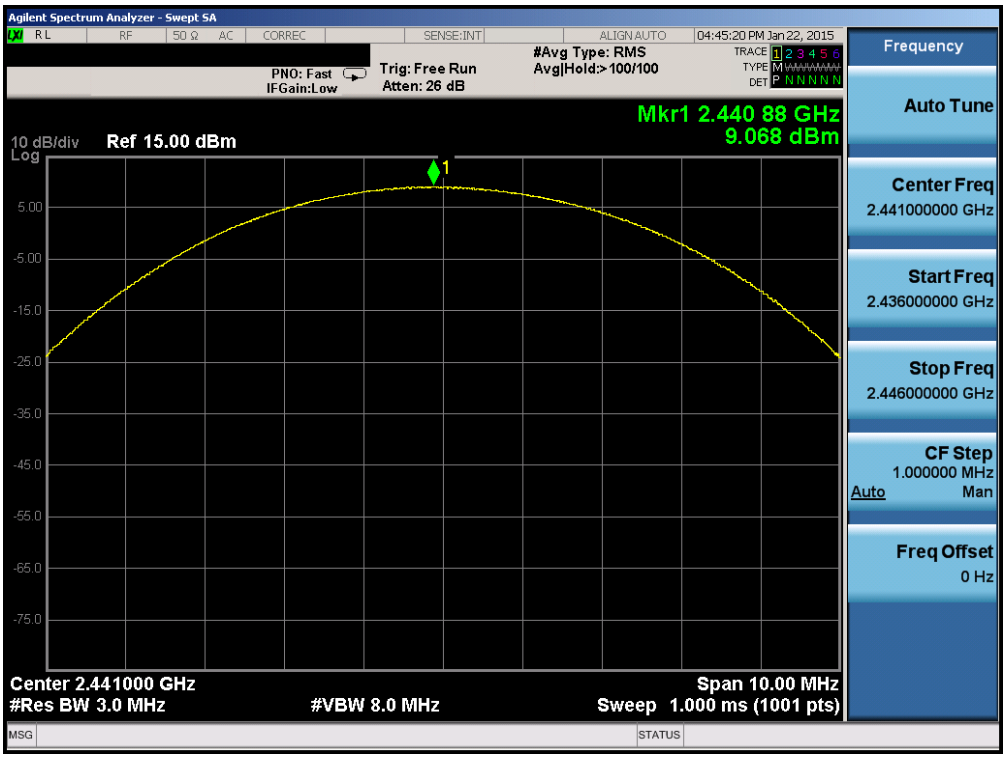


Plot 6-16. Peak Conducted Power (3Mbps – Ch. 0)



Plot 6-17. Peak Conducted Power (3Mbps – Ch. 39)

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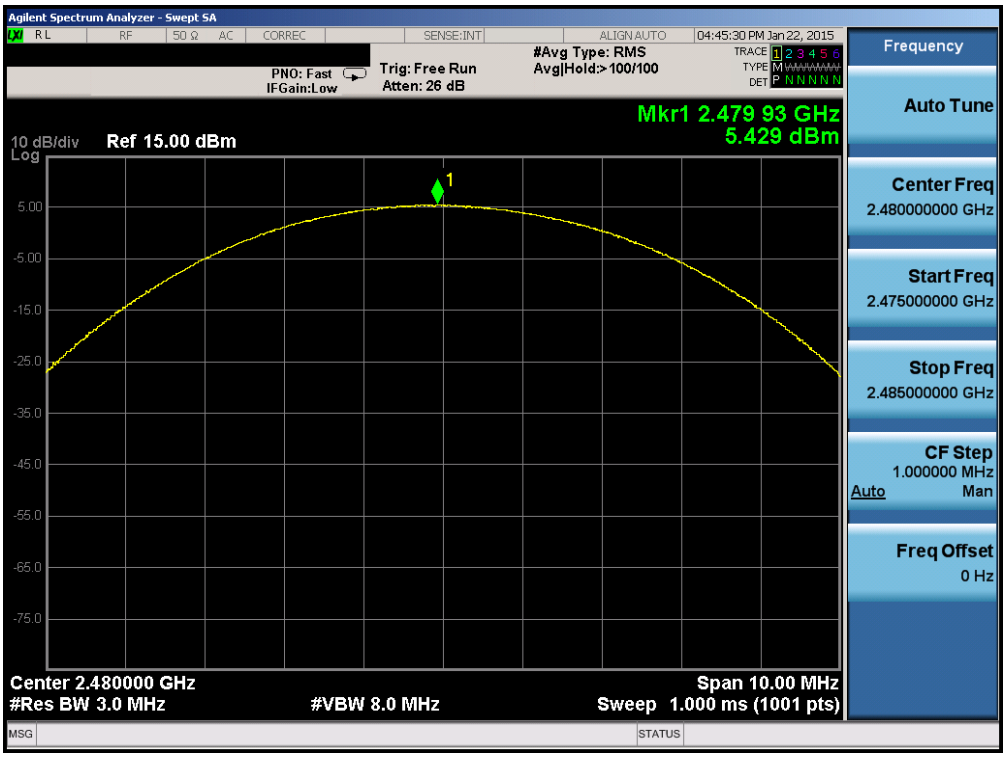
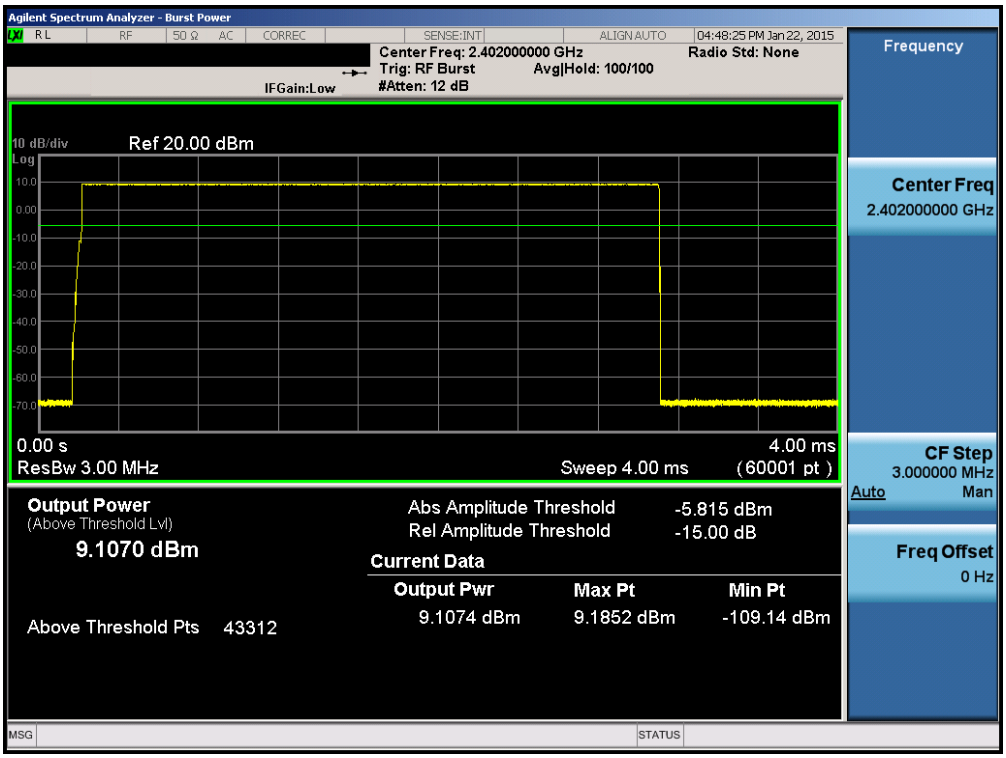


Plot 6-18. Peak Conducted Power (3Mbps – Ch. 78)



Plot 6-19. Average Conducted Power (1Mbps – Ch. 0)

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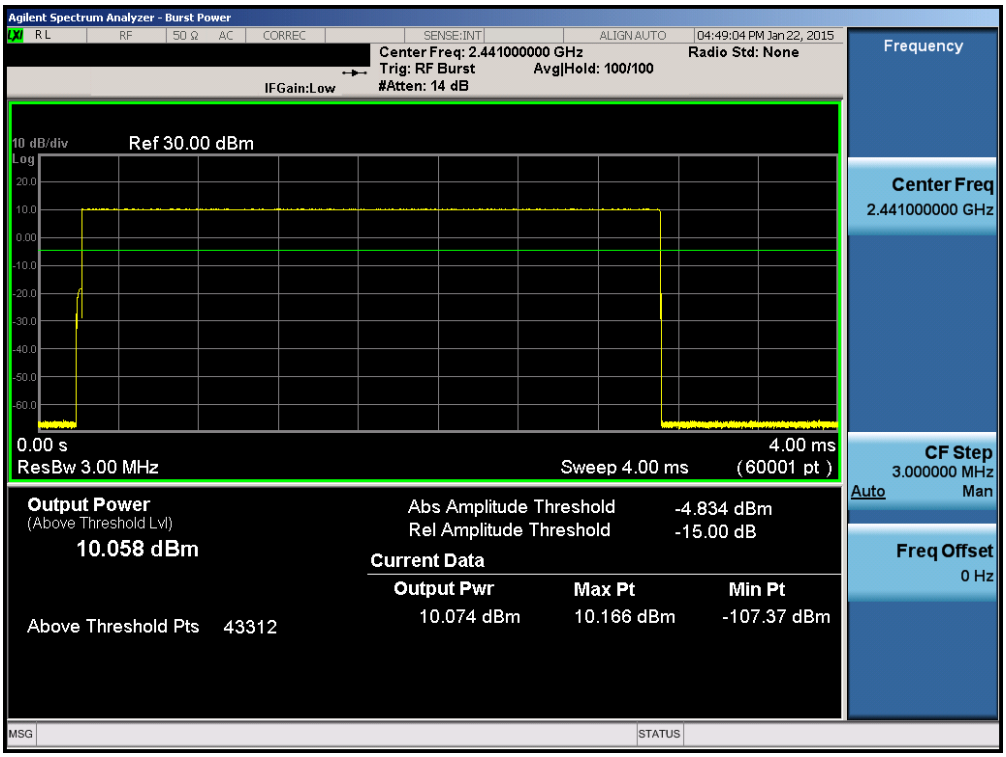
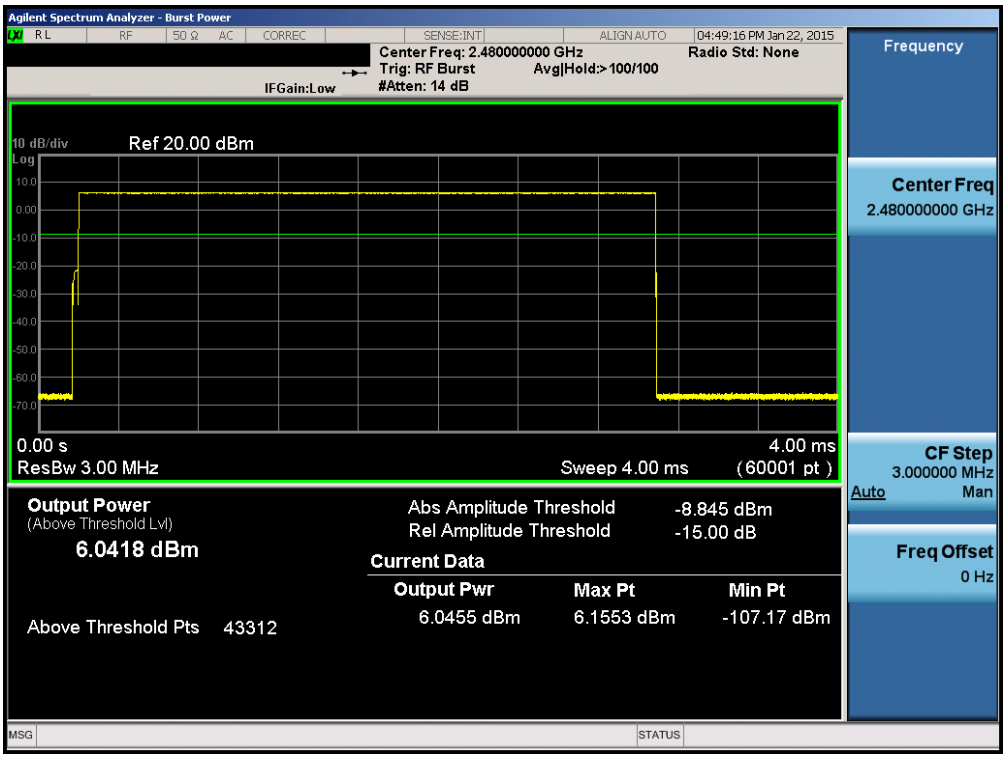


Plot 6-20. Average Conducted Power (1Mbps – Ch. 39)



Plot 6-21. Average Conducted Power (1Mbps – Ch. 78)

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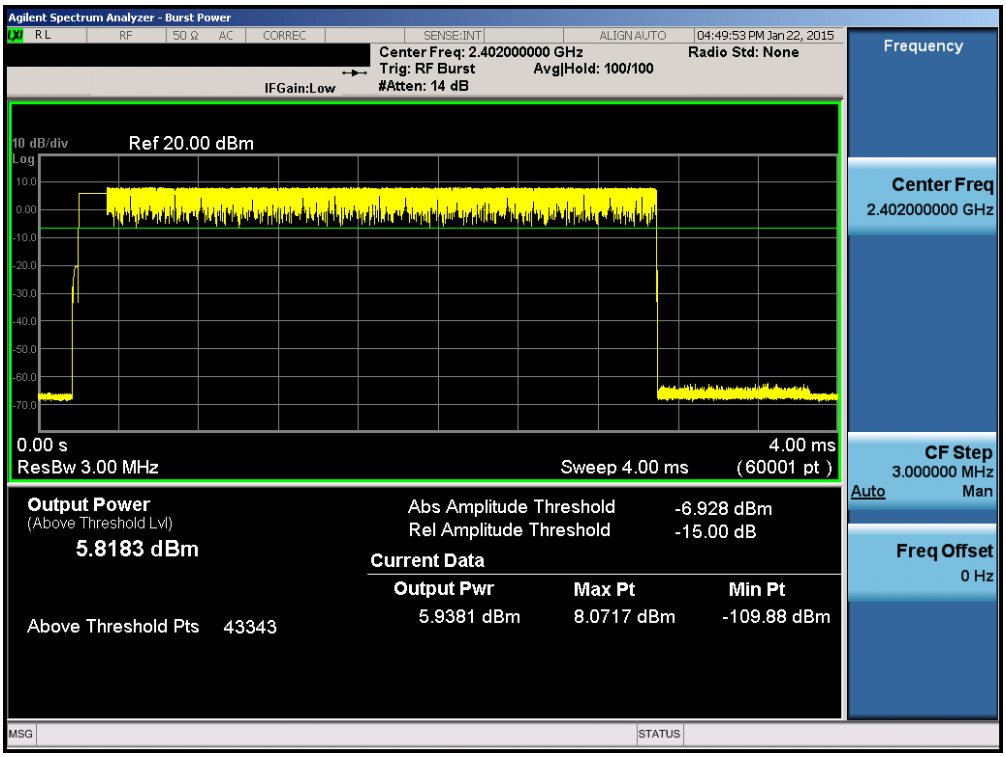
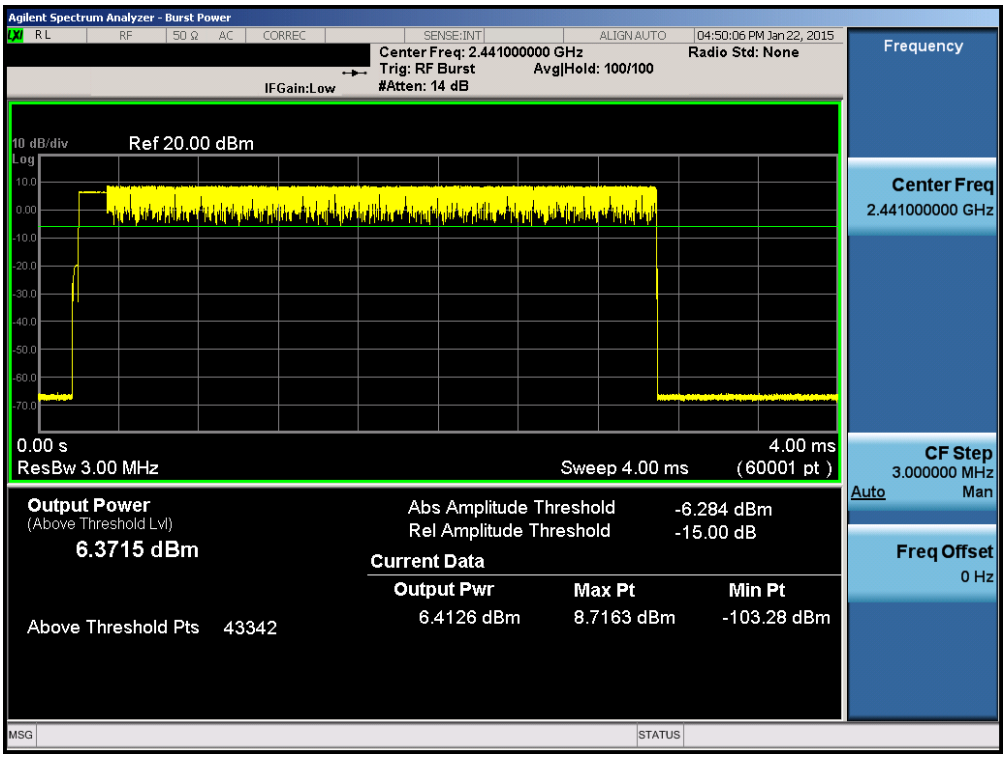


Plot 6-22. Average Conducted Power (2Mbps – Ch. 0)



Plot 6-23. Average Conducted Power (2Mbps – Ch. 39)

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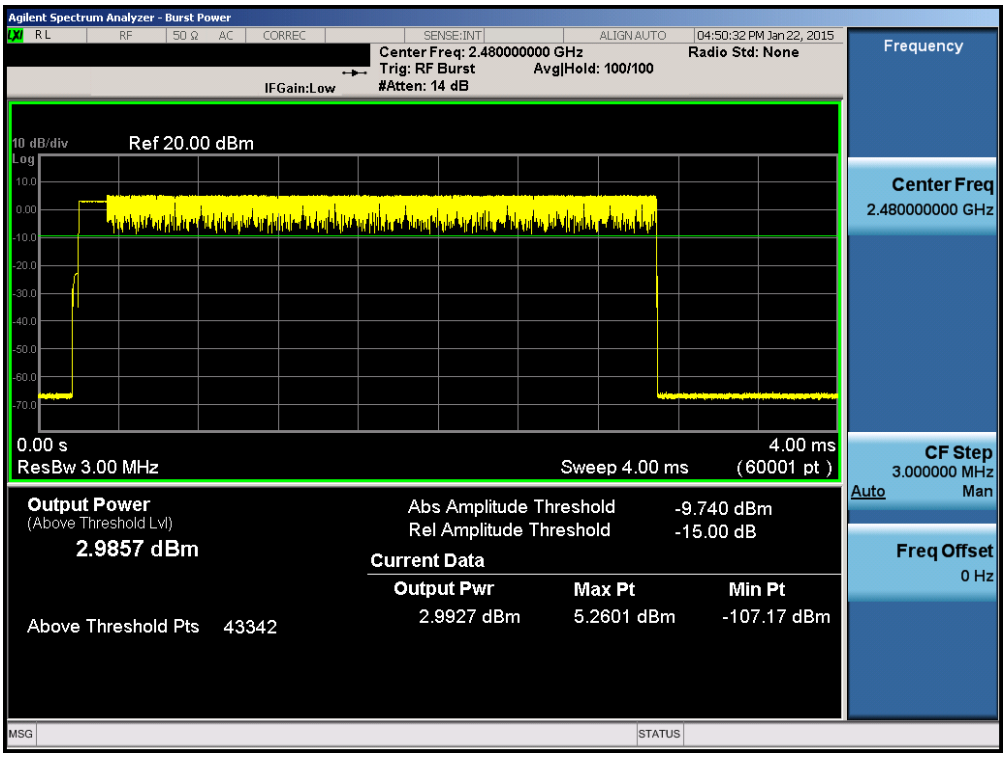
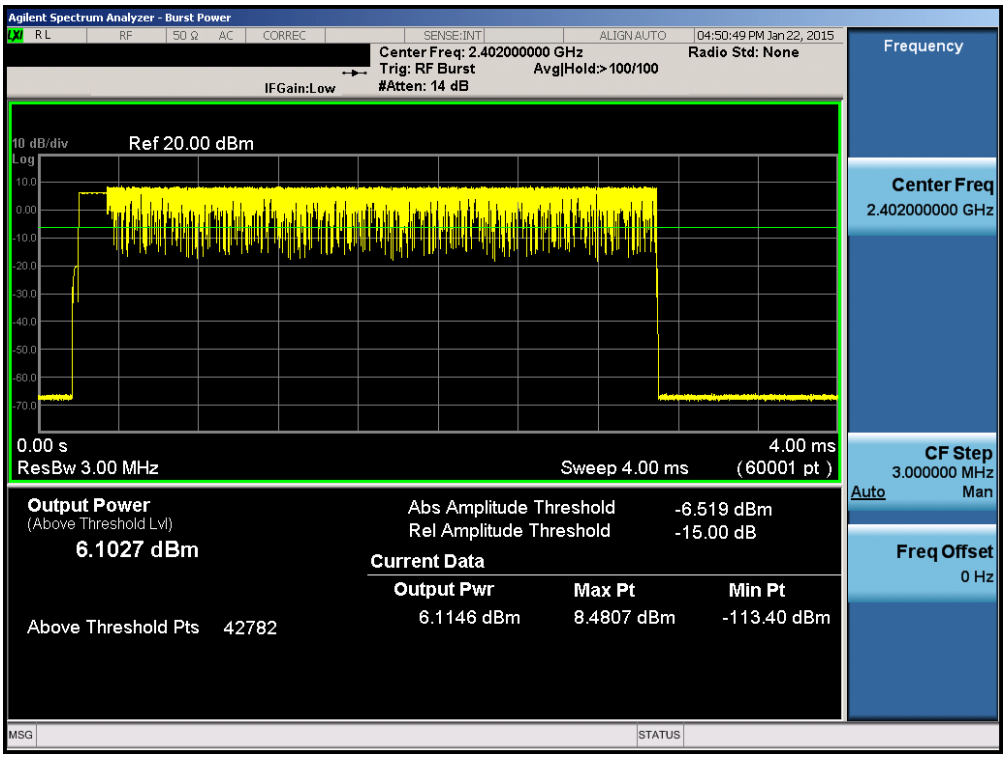


Plot 6-24. Average Conducted Power (2Mbps – Ch. 78)



Plot 6-25. Average Conducted Power (3Mbps – Ch. 0)

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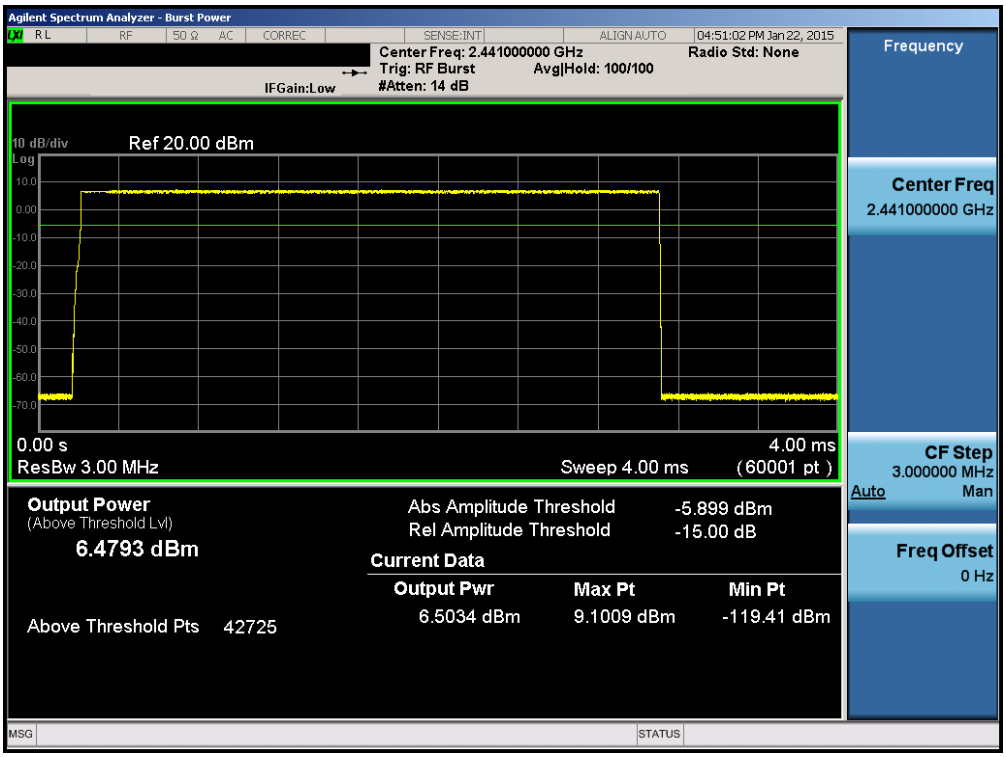
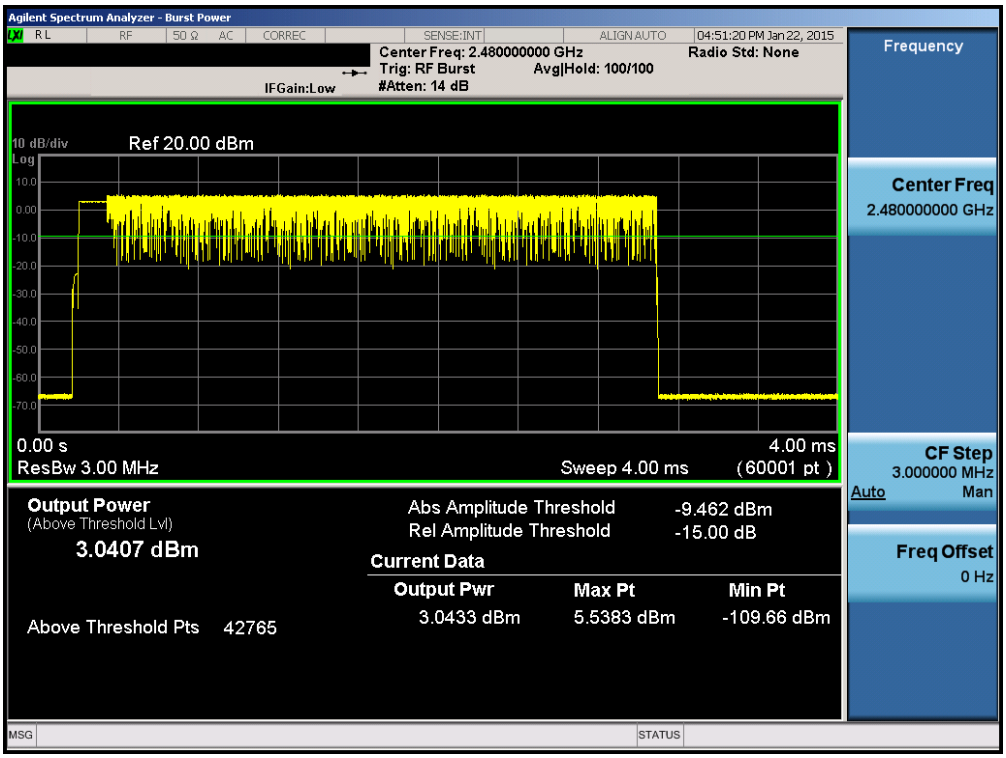


Plot 6-26. Average Conducted Power (3Mbps – Ch. 39)



Plot 6-27. Average Conducted Power (3Mbps – Ch. 78)

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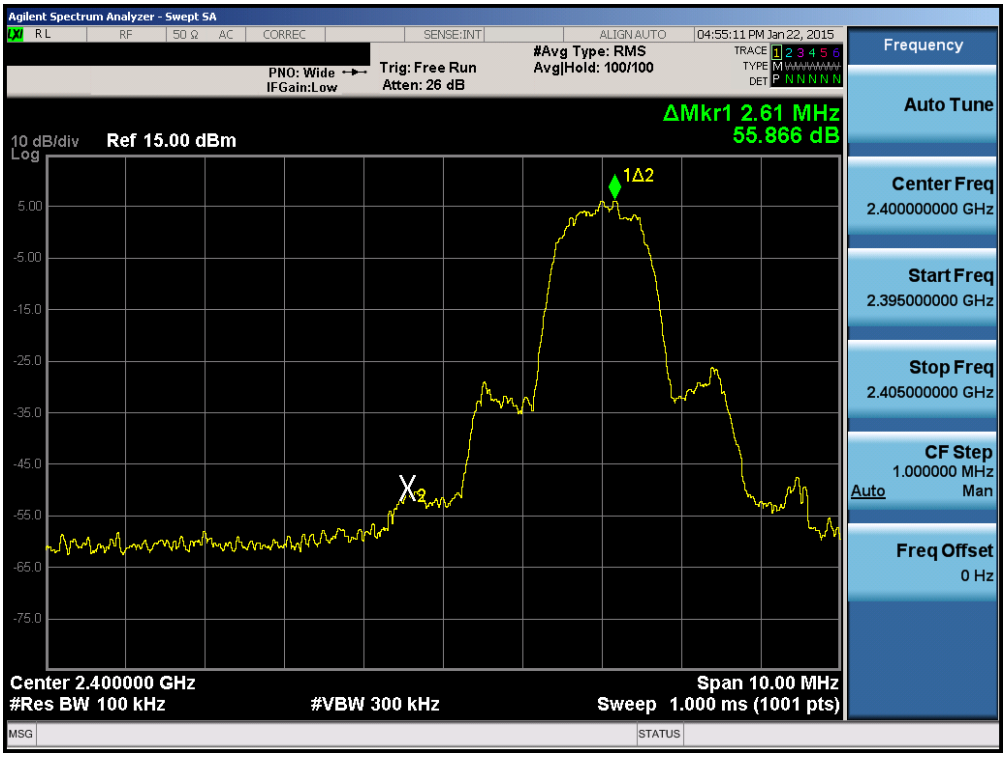
6.4 Band Edge Compliance

§15.247 (d)

Measurement is taken at the highest point located outside of the emission bandwidth. ***The maximum permissible emission level is 20 dBc. Any emission lying outside of the emission bandwidth and in a restricted band is subject to a field strength limit specified in Section 15.209 of the Title 47 CFR.***

Out of band conducted spurious emissions at the band edge were investigated for all data rates and 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.



Plot 6-28. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 0)

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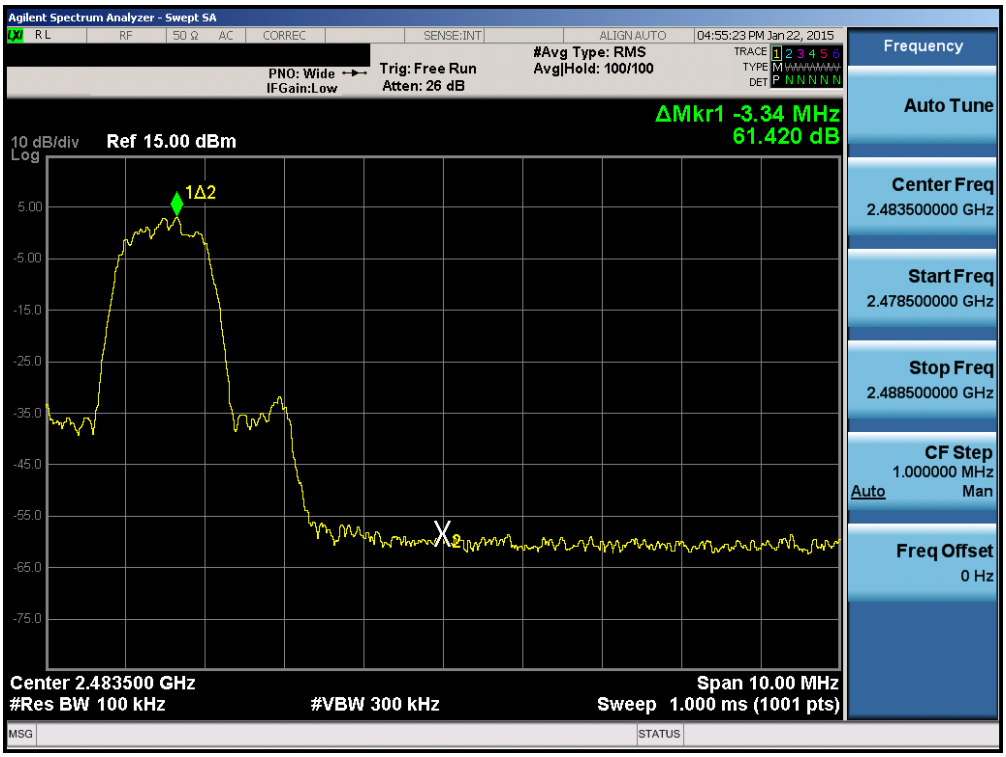
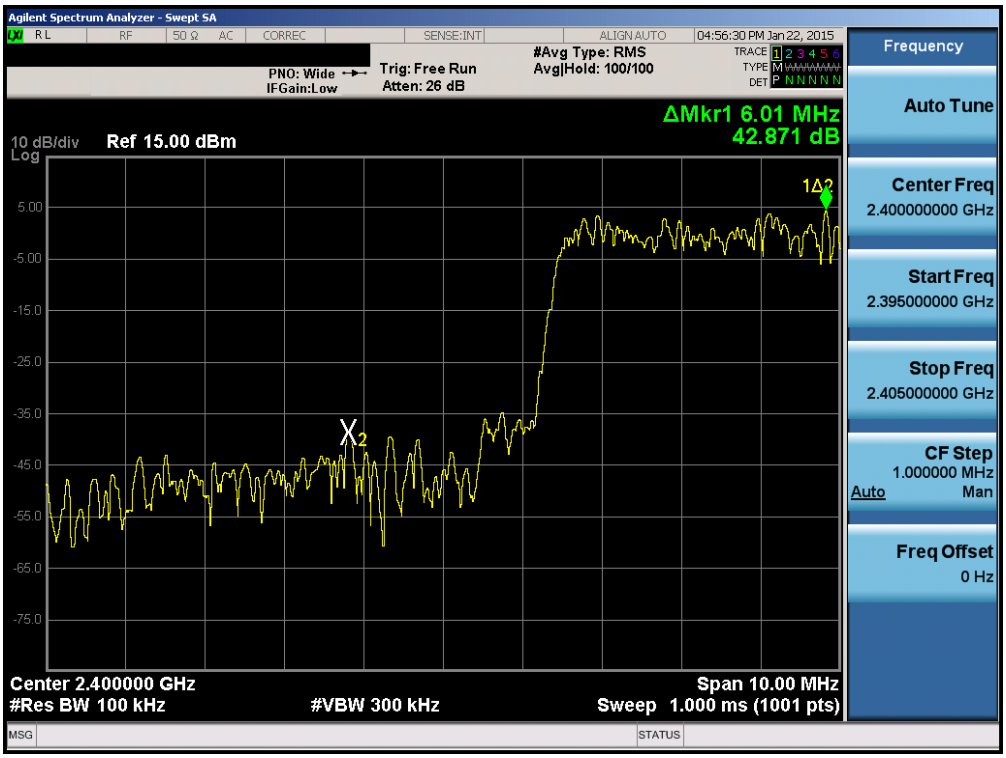


Plot 6-29. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 78)



Plot 6-30. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps)

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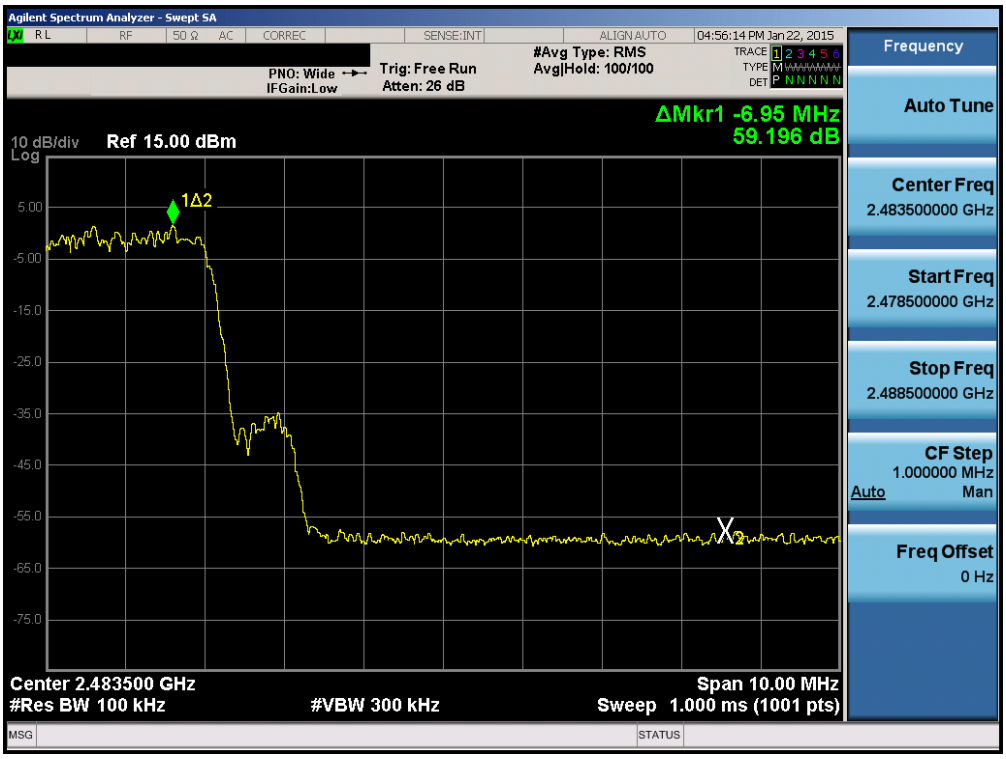

Plot 6-31. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps)

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6.5 Carrier Frequency Separation

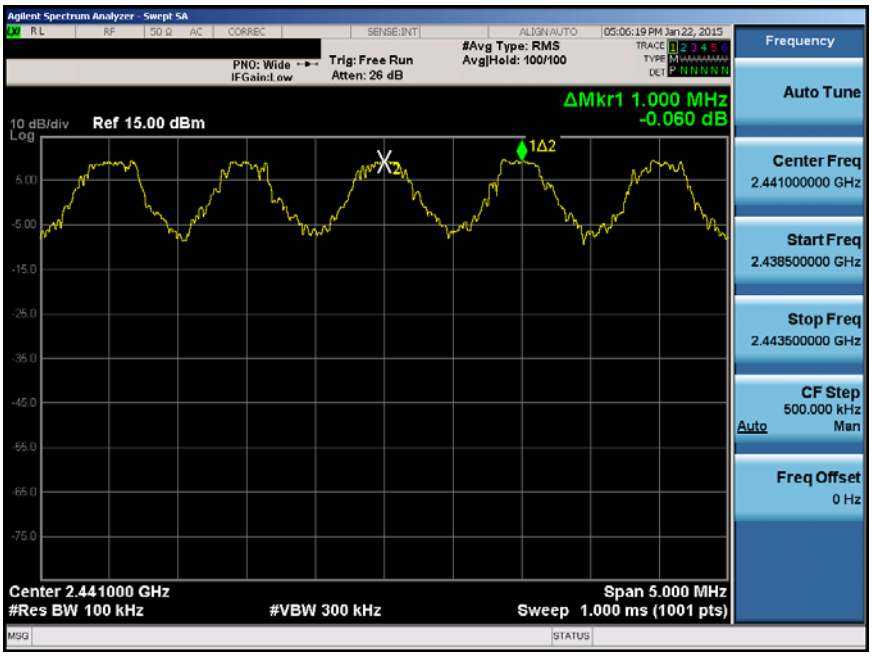
§15.247 (a.1)

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.***

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.

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Min. Channel Separation [MHz]
2402	1.0	0	0.681
2441	1.0	39	0.665
2480	1.0	78	0.634
2402	2.0	0	0.899
2441	2.0	39	0.903
2480	2.0	78	0.899
2402	3.0	0	0.884
2441	3.0	39	0.892
2480	3.0	78	0.887

Table 6-4. Minimum Channel Separation



Plot 6-32. Channel Spacing Plot (Bluetooth)

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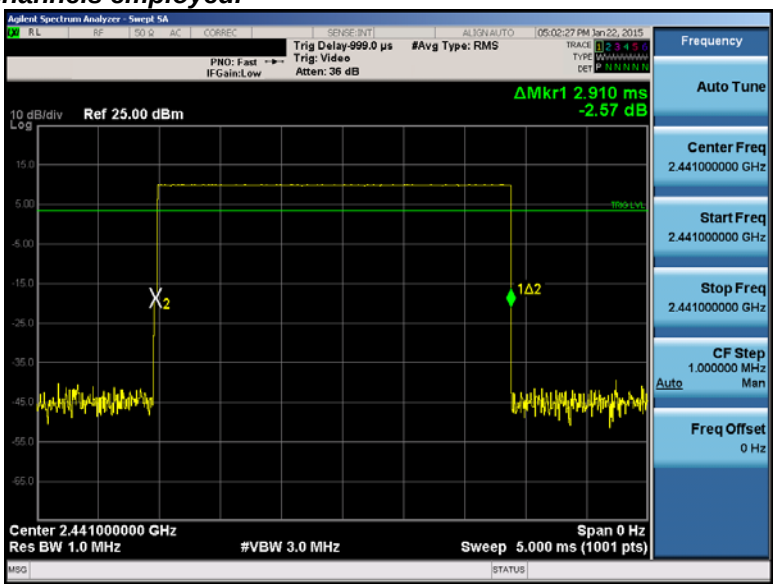
6.6 Time of Occupancy

§15.247 (a.1.iii)

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.***



Plot 6-33. 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

- 400ms x 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 hops/second / 79 channels = 3.38 hops/second (# of hops/second on one channel)
- 3.38 hops/second/channel x 31.6 seconds = 106.67 hops (# hops over a 31.6 second period)
- 106.67 hops x 2.910 ms/channel = 310.40 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

- 400ms x 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 hops/s / 20 channels = 6.67 hops/second (# of hops/second on one channel)
- 6.67 hops/s / channel x 8 seconds = 53.34 hops (# hops over a 8 second period)
- 53.34 hops x 2.910 ms/channel = 155.21 ms (worst case dwell time for one channel in AFH mode)

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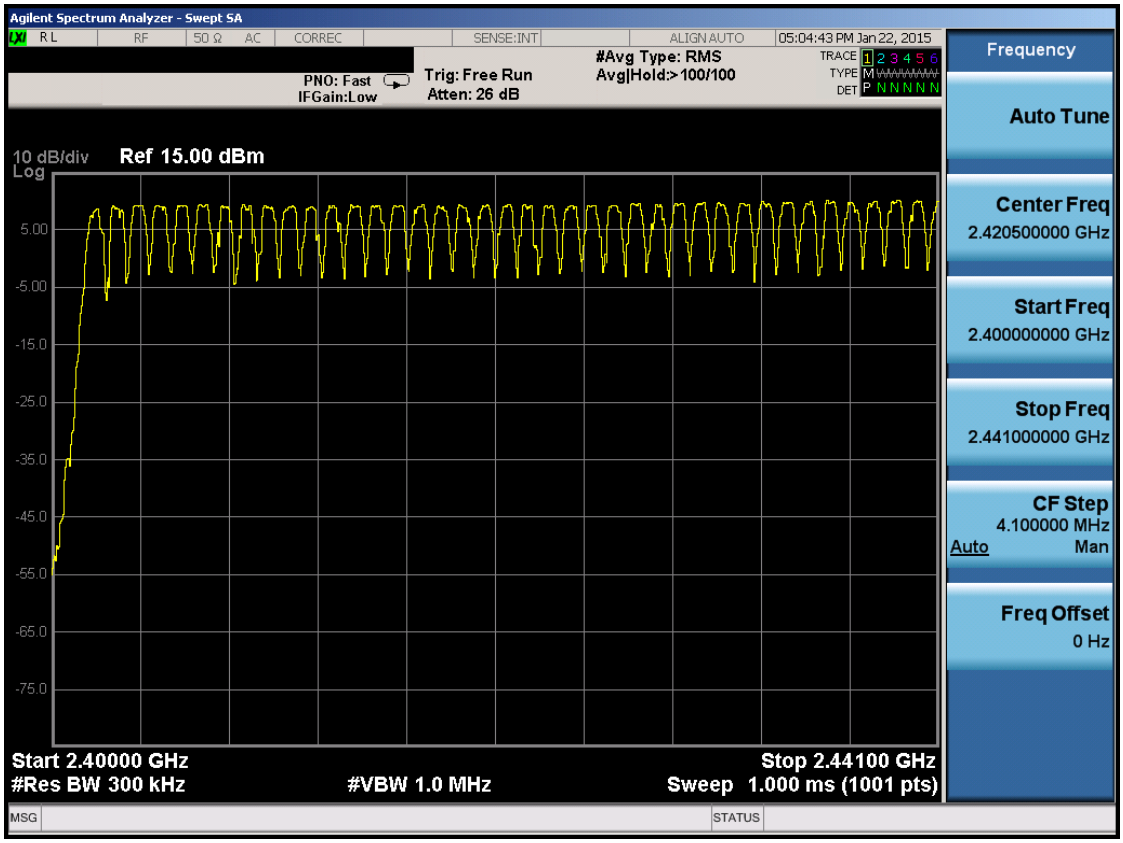
6.7 Number of Hopping Channels

§15.247 (a.1.iii)

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

In AFH mode, this device operates using 20 channels so the requirement for minimum number of hopping channels is satisfied.



Plot 6-34. Low End Spectrum Channel Hopping Plot (Bluetooth)

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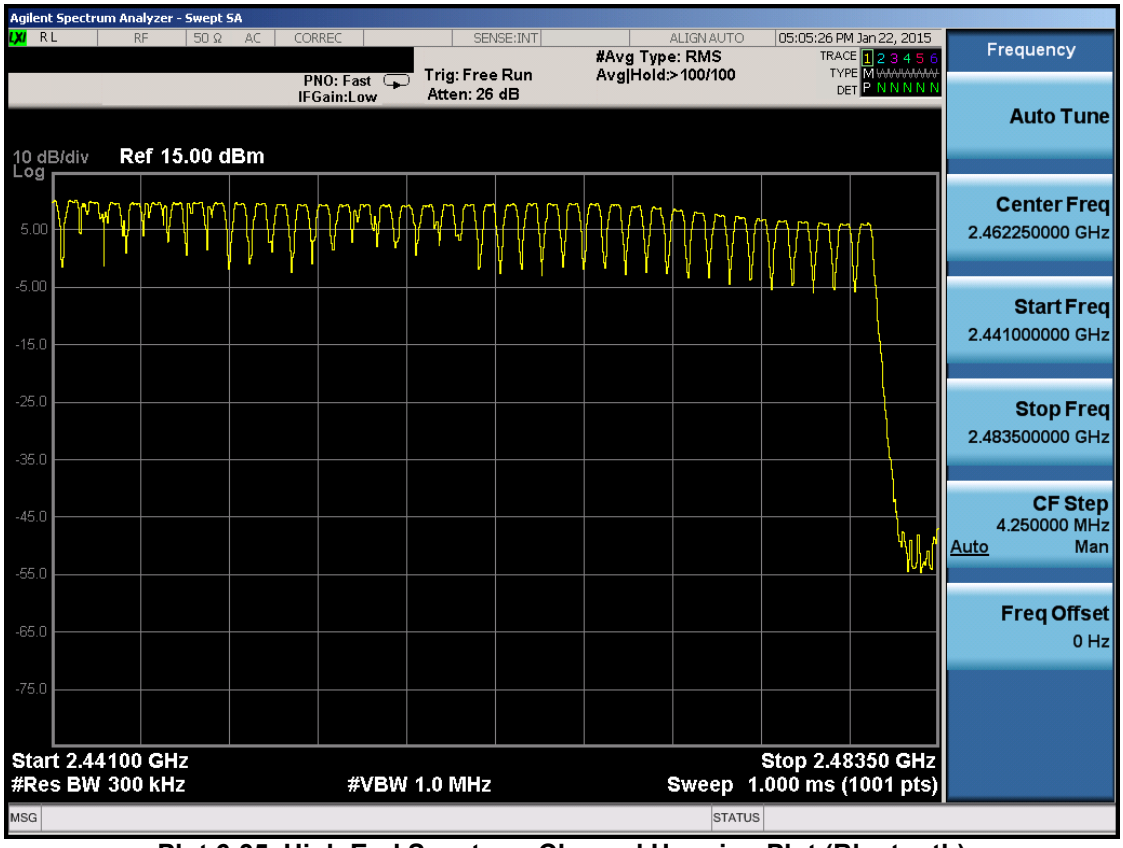

Plot 6-35. High End Spectrum Channel Hopping Plot (Bluetooth)

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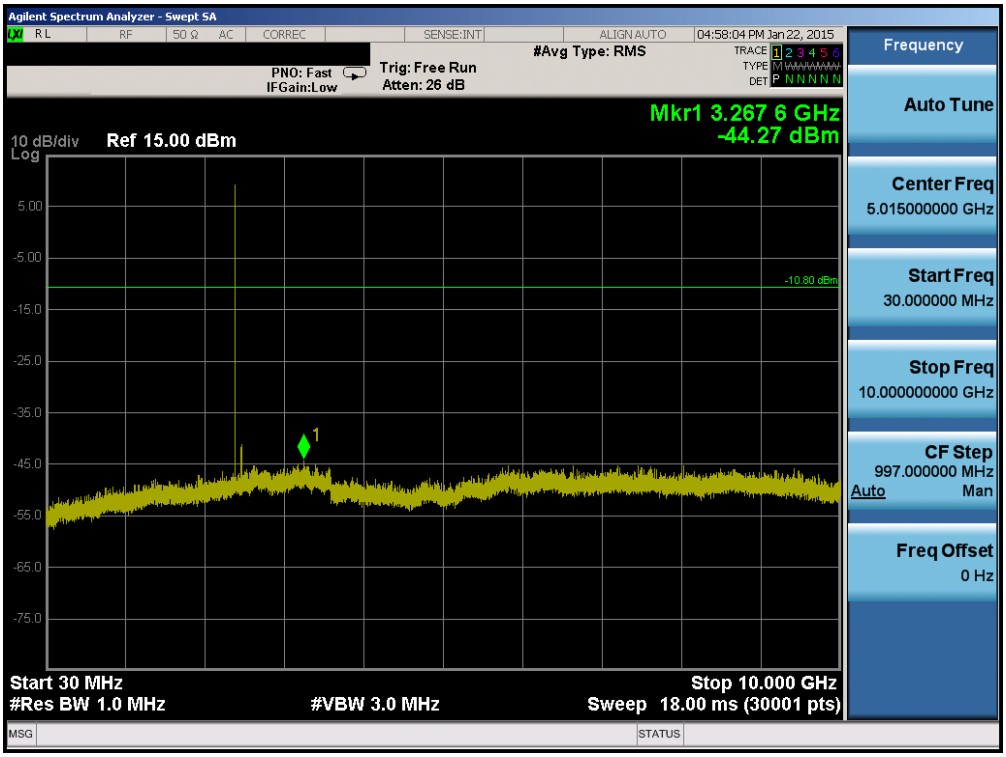
6.8 Conducted Spurious Emissions

§15.247 (d)

Out of band conducted spurious emissions were investigated for all data rates and the worst case emissions were found with the EUT transmitting at 1Mbps. Plots of the worst case emissions are shown below.

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.



Plot 6-36. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 0)

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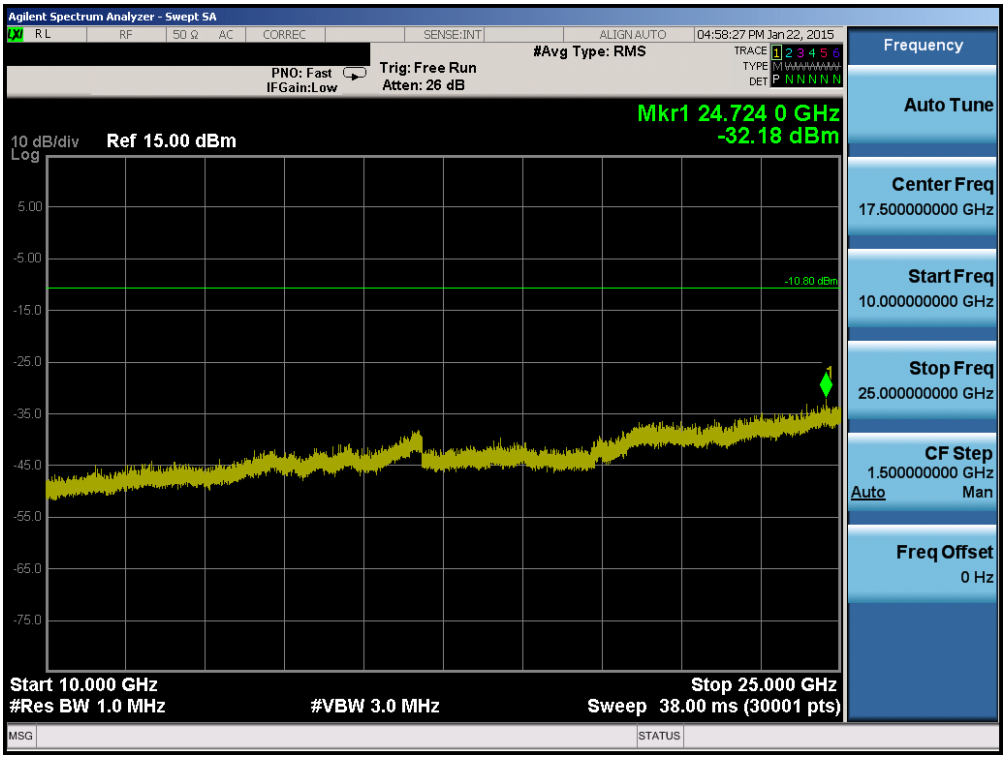
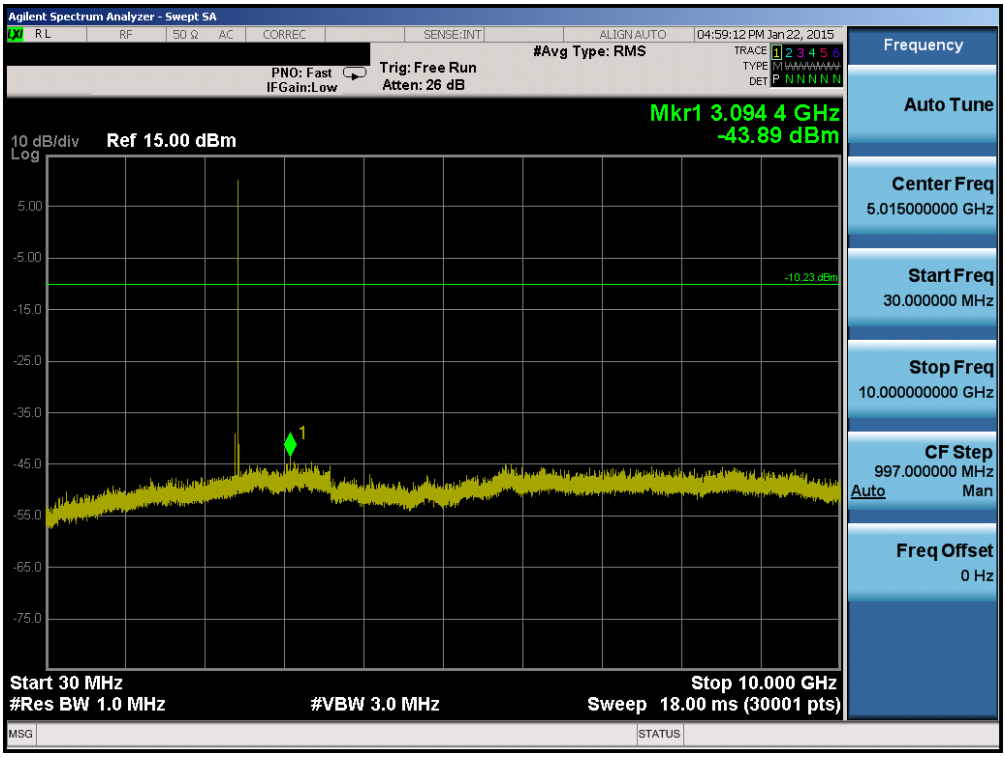


Plot 6-37. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 0)



Plot 6-38. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 39)

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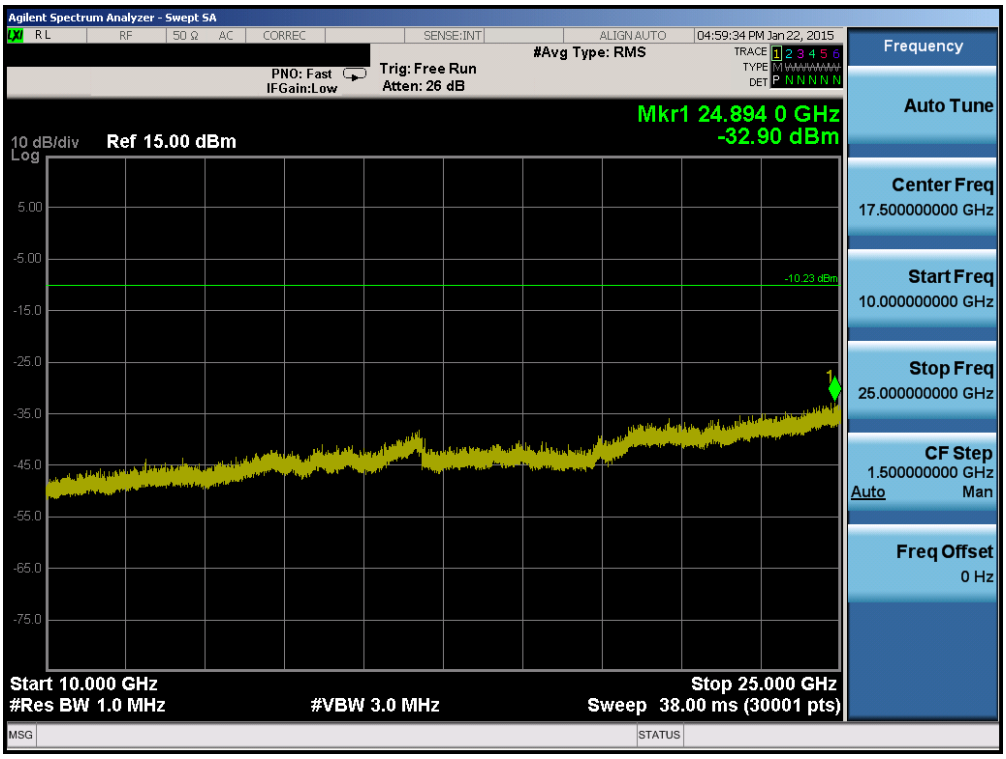
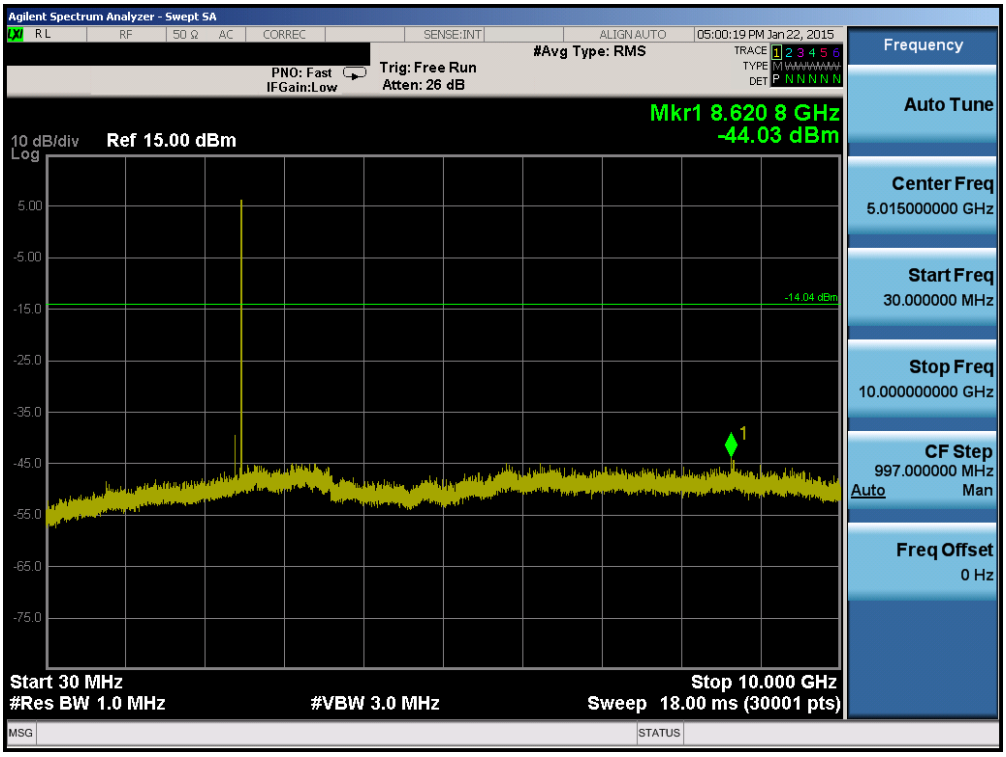


Plot 6-39. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 39)



Plot 6-40. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 78)

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Plot 6-41. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 78)

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6.9 Radiated Spurious Emission Measurements – Above 1GHz

§15.205 §15.209 §15.247 (d)

Frequency	Field Strength [μV/m]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 6-5. Radiated Limits

Sample Calculation

- Field Strength Level $_{[dB\mu V/m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB/m]}$ + Duty Cycle Correction $_{[dB]}$
- AFCL $_{[dB/m]}$ = Antenna Factor $_{[dB/m]}$ + Cable Loss $_{[dB]}$
- Margin $_{[dB]}$ = Field Strength Level $_{[dB\mu V/m]}$ – 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 hops/second = 7.50 ms
- Time to cycle through all channels = 7.50 x 20 channels = 150 ms
- Number of times transmitter hits on one channel = 100 ms / 150 ms = 1 time(s)
- Worst case dwell time = 7.5 ms
- Duty cycle correction factor = $20\log_{10}$(7.5ms/100ms) = -22.5 dB

Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 6-5.
2. No significant radiated emissions were found in the 2310 - 2390MHz restricted band.
3. Average measurements > 1GHz using RBW = 1MHz and VBW = 3kHz $\geq 1/\tau$ Hz, where τ = pulse width in seconds. Peak measurements > 1GHz using RBW = 1MHz and VBW = 3MHz. Both average and peak measurements were made using a peak detector.
4. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
5. This unit was tested with its standard battery.
6. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported.
7. The duty cycle correction factor was not applied to noise floor measurements.
8. 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.

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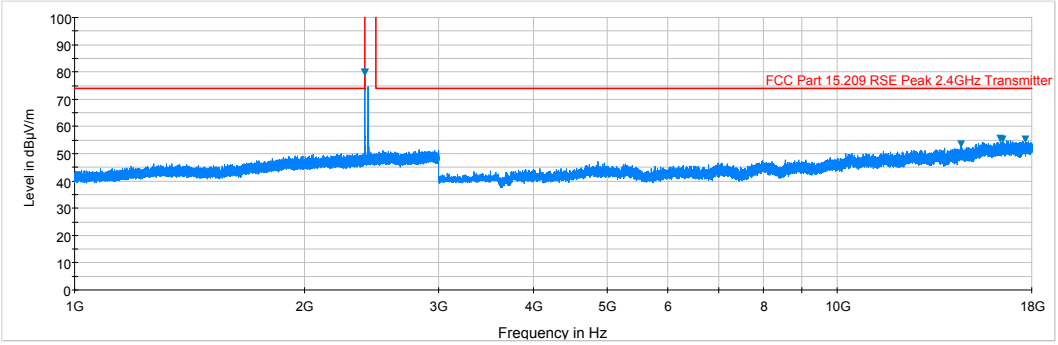
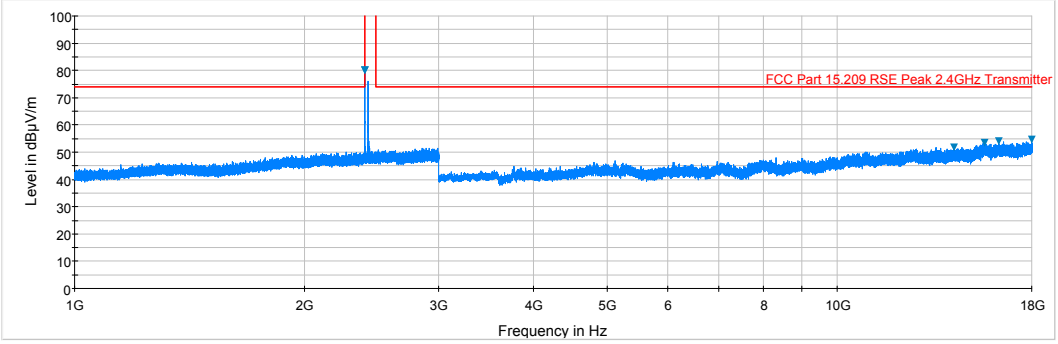
Radiated Spurious Emission Measurements

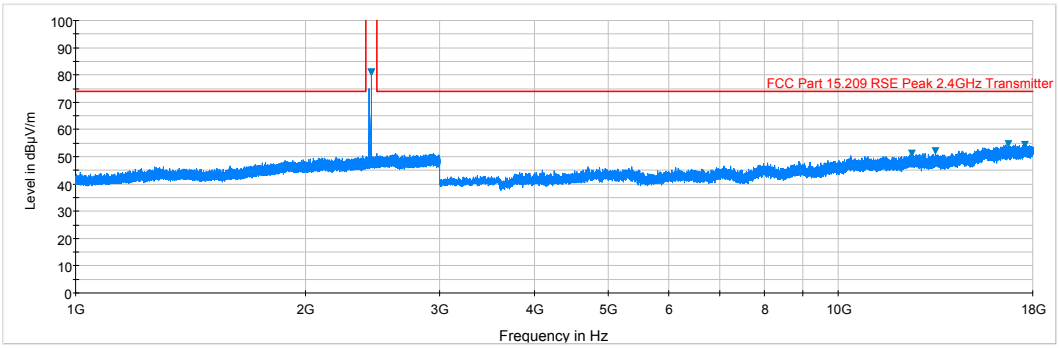
§15.205 §15.209 §15.247 (d)



Plot 6-42. Radiated Spurious Plot above 1GHz (BT – Ch. 0, Ant. Pol. H)



Plot 6-43. Radiated Spurious Plot above 1GHz (BT – Ch. 0, Ant. Pol. V)



Plot 6-44. Radiated Spurious Plot above 1GHz (BT – Ch. 39, Ant. Pol. H)

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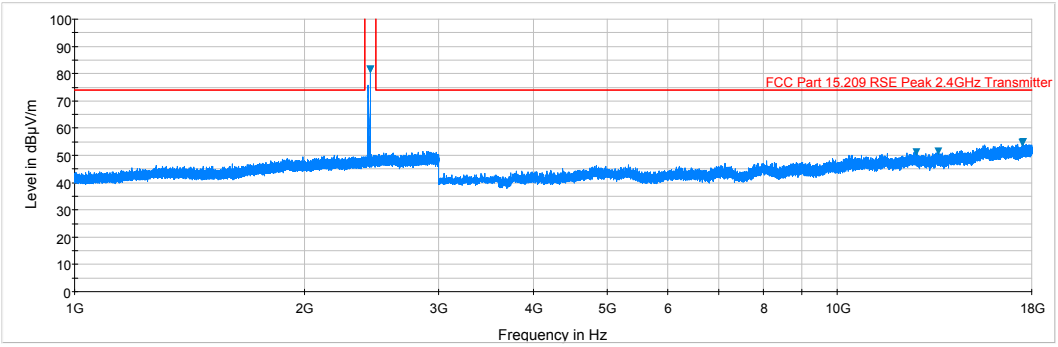
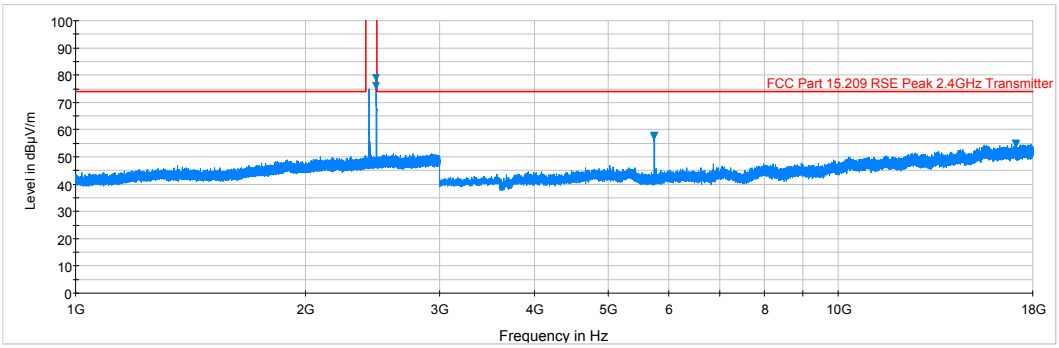
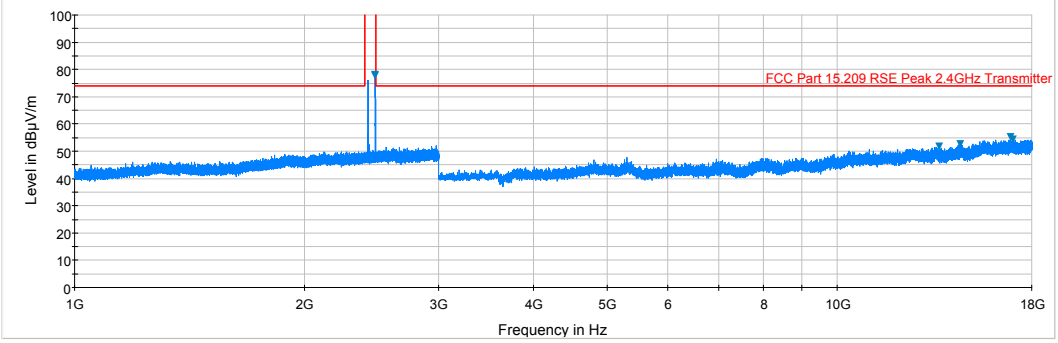


Plot 6-45. Radiated Spurious Plot above 1GHz (BT – Ch. 39, Ant. Pol. V)



Plot 6-46. Radiated Spurious Plot above 1GHz (BT – Ch. 78, Ant. Pol. H)



Plot 6-47. Radiated Spurious Plot above 1GHz (BT – Ch. 78, Ant. Pol. V)

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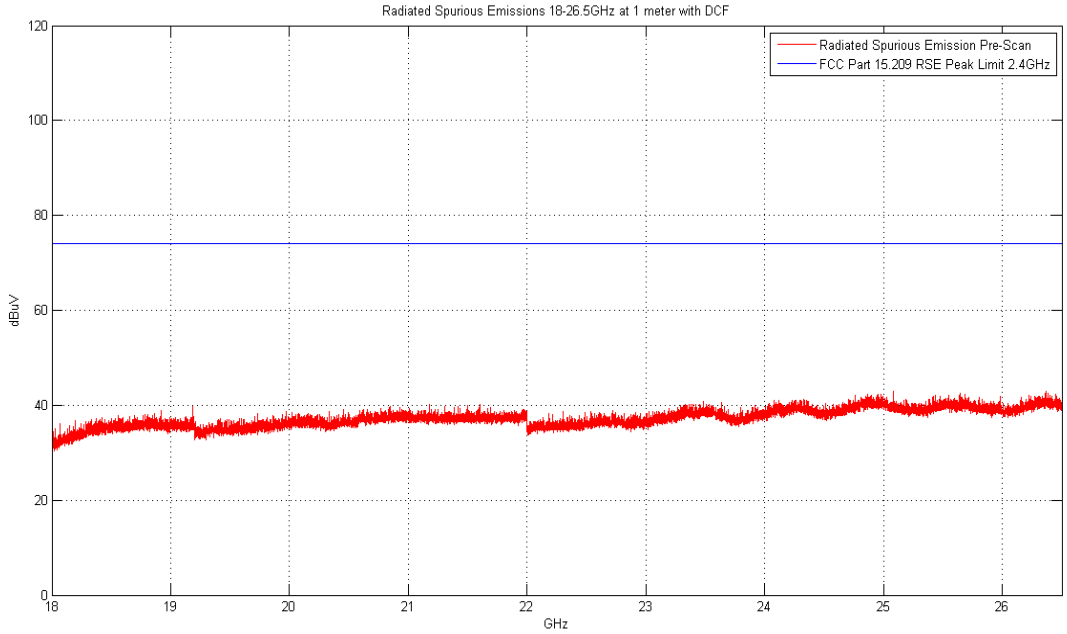
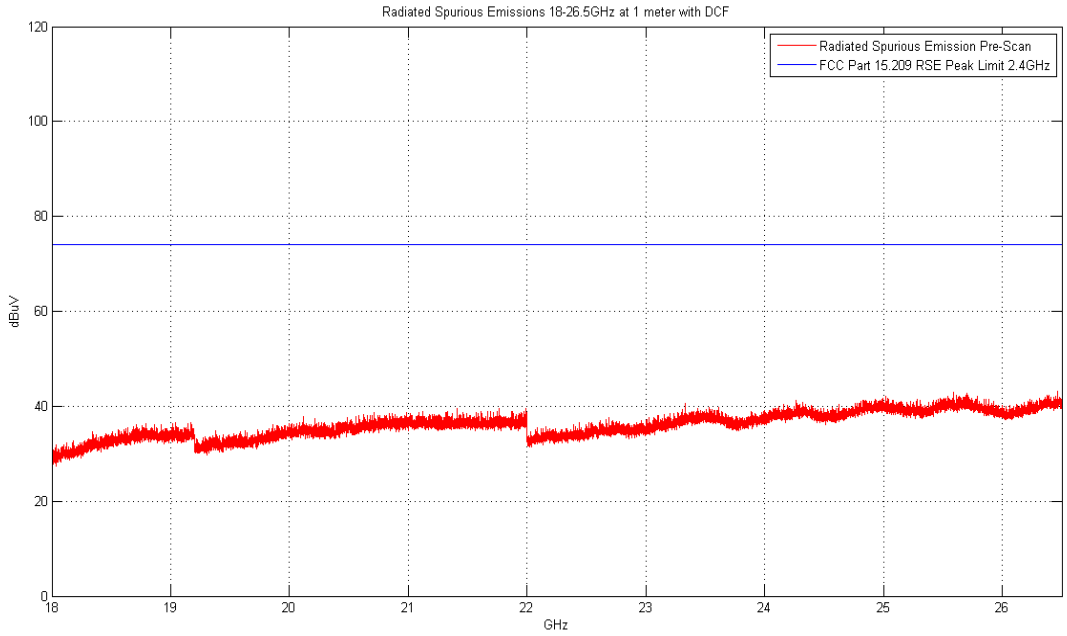
Radiated Spurious Emissions Measurements (Above 18GHz)
§15.209



Plot 6-48. Radiated Spurious Plot above 18GHz (Pol. H)



Plot 6-49. Radiated Spurious Plot above 18GHz (Pol. V)

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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]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	-103.17	Avg	H	38.29	-22.50	19.62	53.98	-34.36
4804.00	-96.99	Peak	H	38.29	0.00	48.30	73.98	-25.68
12010.00	-116.98	Avg	H	49.01	0.00	39.04	53.98	-14.94
12010.00	-104.25	Peak	H	49.01	0.00	51.77	73.98	-22.21

Table 6-6. Radiated Measurements

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

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	-104.11	Avg	H	38.60	-22.50	18.99	53.98	-34.98
4882.00	-97.90	Peak	H	38.60	0.00	47.70	73.98	-26.28
7323.00	-105.84	Avg	H	43.80	-22.50	22.46	53.98	-31.52
7323.00	-98.85	Peak	H	43.80	0.00	51.95	73.98	-22.03
12205.00	-117.10	Avg	H	48.76	0.00	38.67	53.98	-15.31
12205.00	-104.64	Peak	H	48.76	0.00	51.13	73.98	-22.85

Table 6-7. Radiated Measurements

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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: 2480MHz
Channel: 78

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	-112.03	Avg	H	38.91	-22.50	11.38	53.98	-42.60
4960.00	-100.42	Peak	H	38.91	0.00	45.49	73.98	-28.49
7440.00	-107.41	Avg	H	43.92	-22.50	21.01	53.98	-32.97
7440.00	-100.51	Peak	H	43.92	0.00	50.41	73.98	-23.57
12400.00	-116.40	Avg	H	48.82	0.00	39.41	53.98	-14.57
12400.00	-103.44	Peak	H	48.82	0.00	52.37	73.98	-21.61

Table 6-8. Radiated Measurements

Worst Case Mode: Bluetooth
Worst Case Data Rate: 1 Mbps
Measurement Distance: 3 Meters
Operating Frequency: 2402MHz
Channel: 0

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	-106.40	Avg	H	38.29	-22.50	16.39	53.98	-37.59
4804.00	-98.95	Peak	H	38.29	0.00	46.34	73.98	-27.64
12010.00	-118.24	Avg	H	49.01	0.00	37.78	53.98	-16.20
12010.00	-104.52	Peak	H	49.01	0.00	51.50	73.98	-22.48

Table 6-9. Radiated Measurements with WCP

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6.10 Radiated Restricted Band Edge Measurements

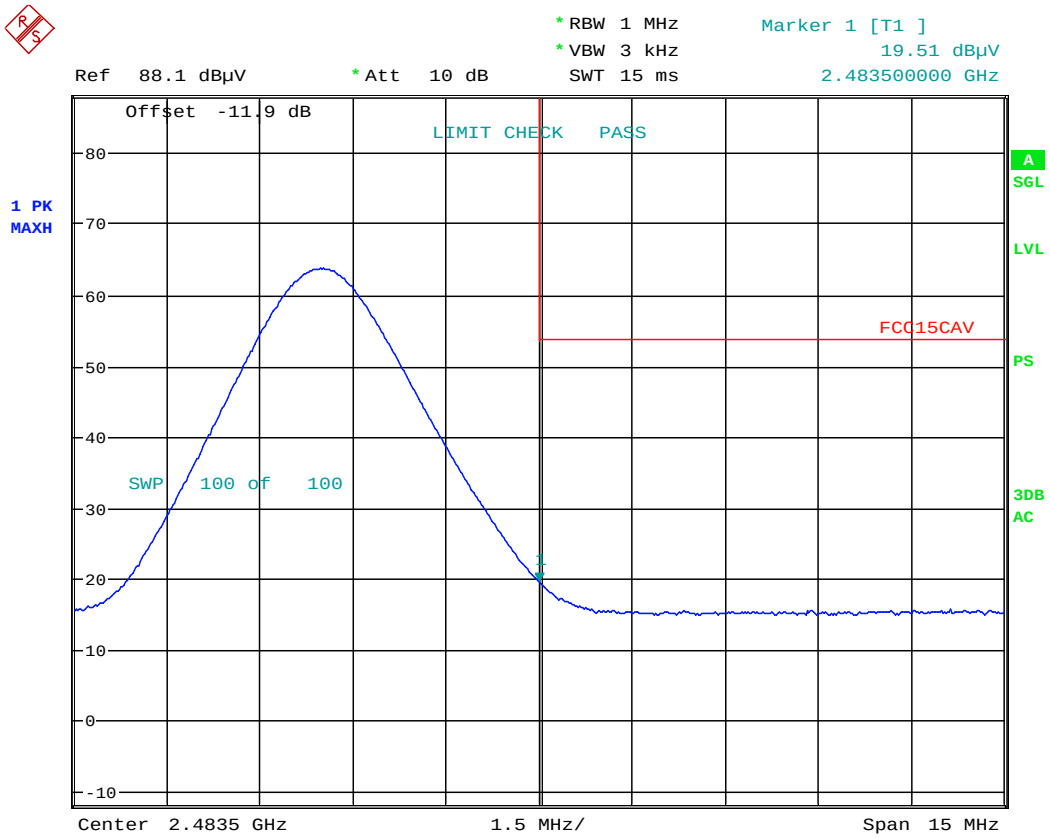
§15.205 §15.209 §15.247 (d)

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:

Offset (dB) = (Antenna Factor + Cable Loss + 10 dB Attenuator) – Preamplifier Gain + DCCF

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



Date: 27.JAN.2015 00:18:14

Plot 6-50. Radiated Restricted Upper Band Edge Measurement (Average)

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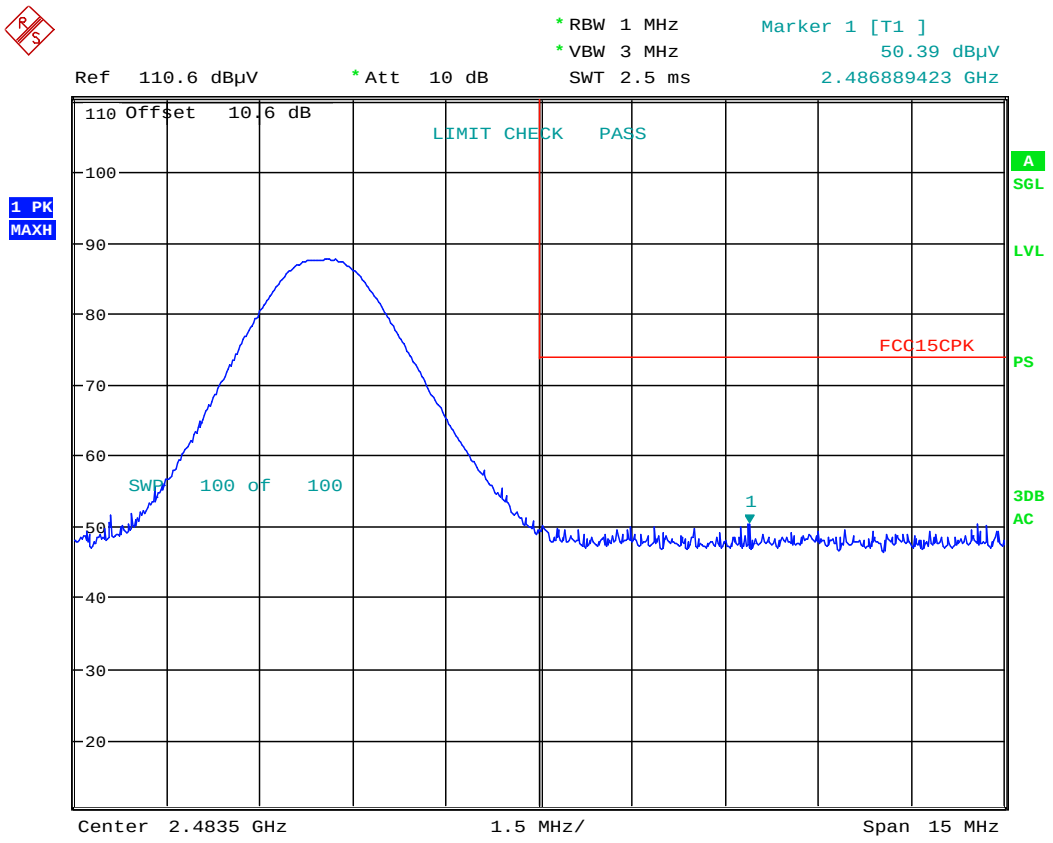
Radiated Restricted Band Edge Measurements
§15.205 §15.209 §15.247 (d)

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

Offset (dB) = (Antenna Factor + Cable Loss + 10 dB Attenuator) – Preamplifier Gain



Date: 27.JAN.2015 00:19:02

Plot 6-51. Radiated Restricted Upper Band Edge Measurement (Peak)

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6.11 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 6-10 per Section 15.209.

Frequency	Field Strength [μV/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 6-10. Radiated Limits

Test Procedures Used

ANSI C63.4-2009

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

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Test Setup

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

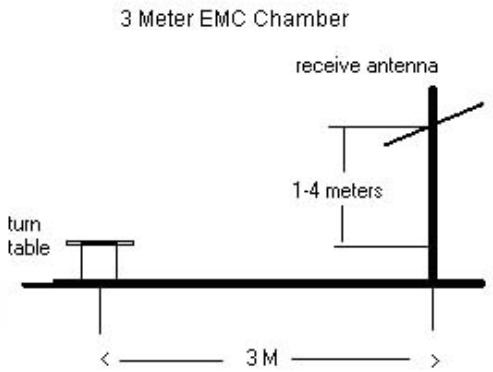

Figure 6-3. Test Instrument & Measurement Setup

Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 6-10.
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 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.

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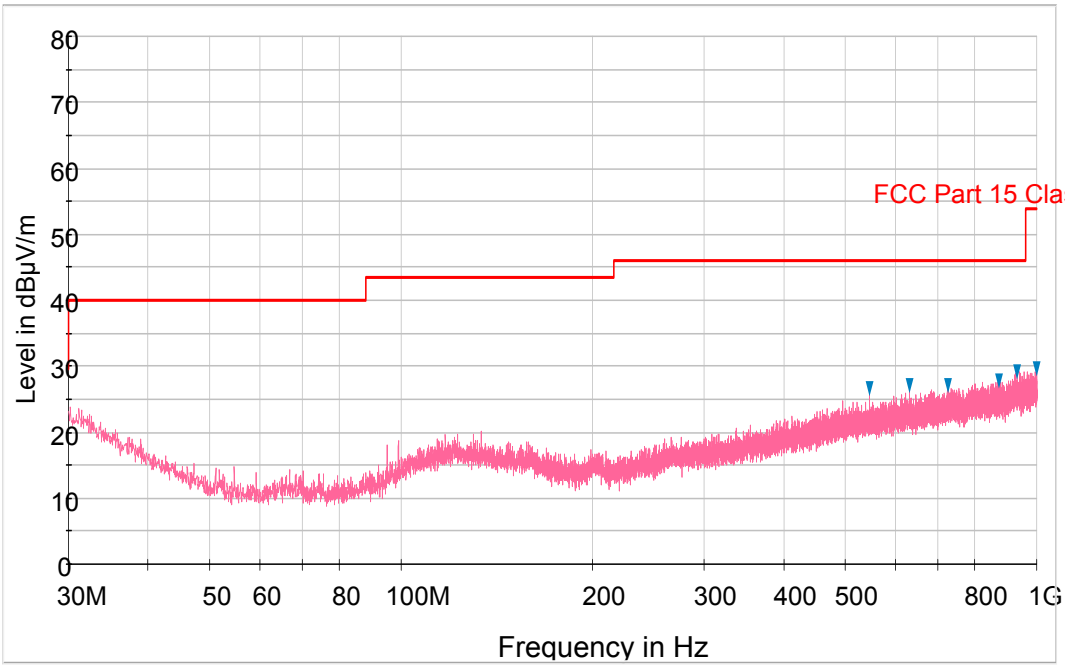
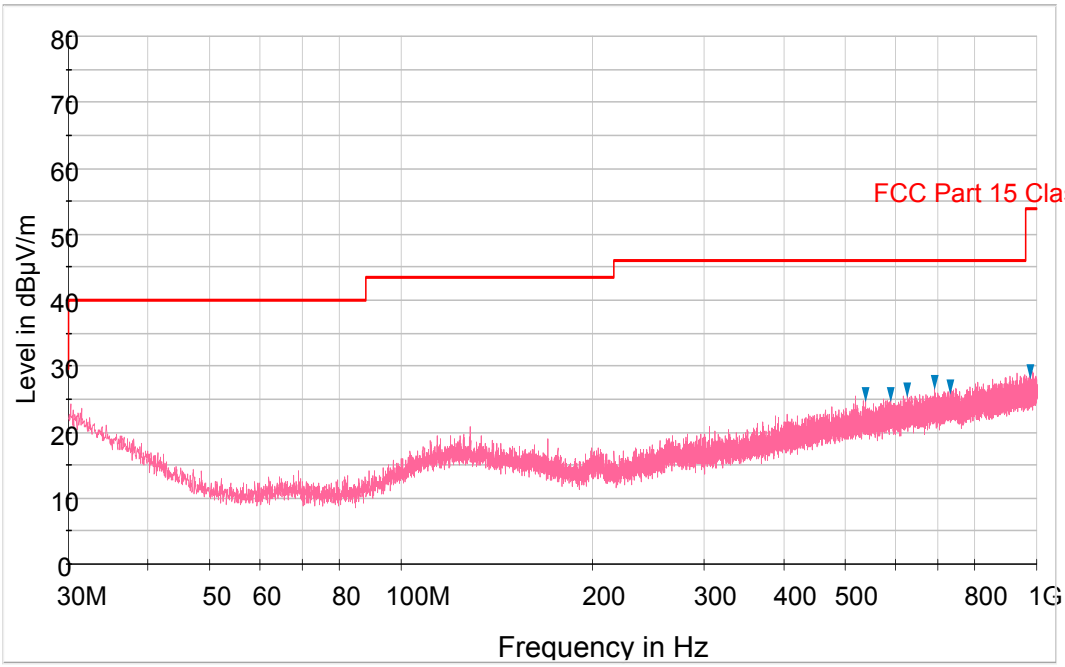
Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209



Plot 6-52. Radiated Spurious Plot below 1GHz (Pol. H)



Plot 6-53. Radiated Spurious Plot below 1GHz (Pol. V)

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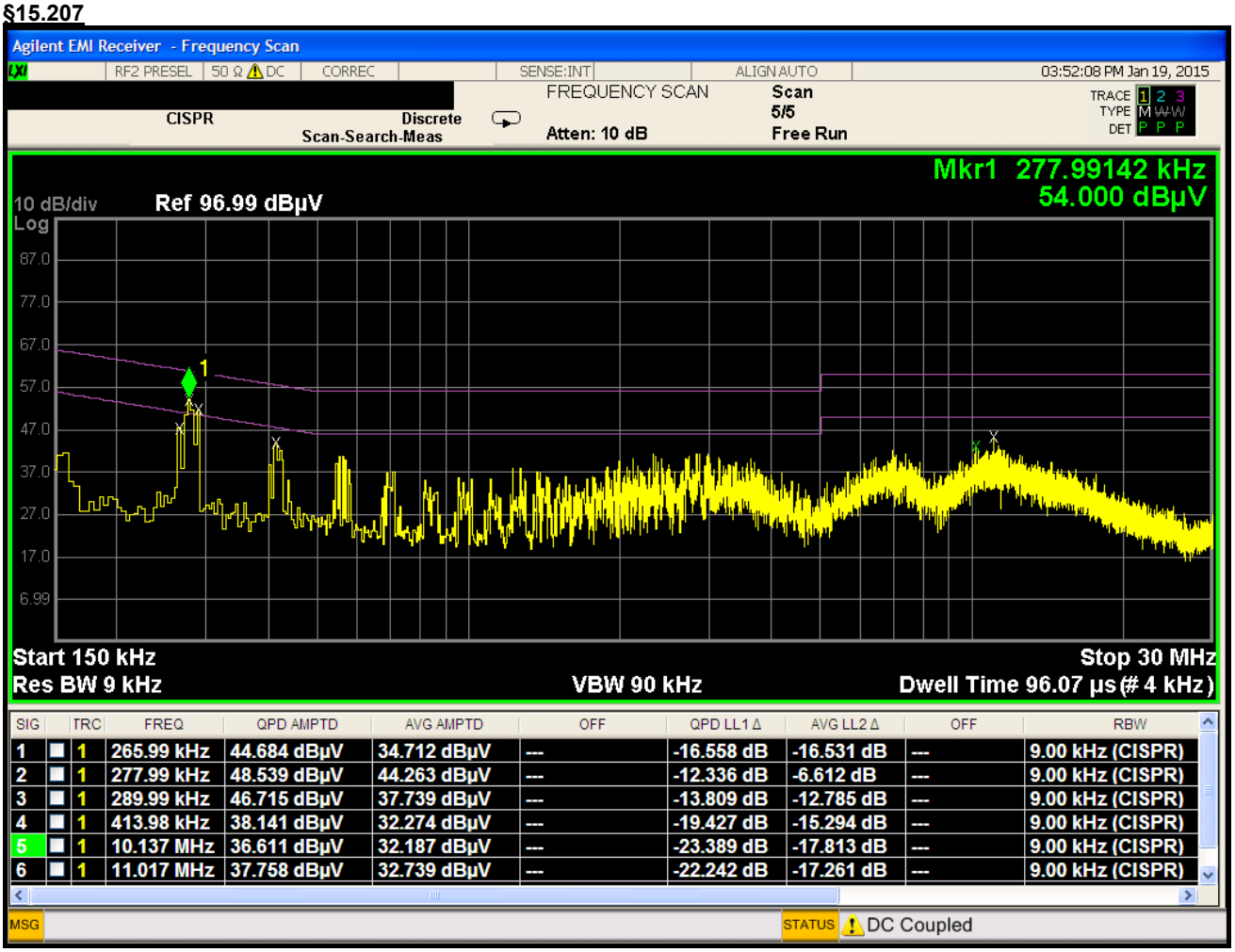
6.12 Line Conducted Measurement Data

§15.207



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	OFF	QPD LL1 Δ	AVG LL2 Δ	OFF	RBW
1	1	265.99 kHz	44.684 dBµV	34.712 dBµV	---	-16.558 dB	-16.531 dB	---	9.00 kHz (CISPR)
2	1	277.99 kHz	48.539 dBµV	44.263 dBµV	---	-12.336 dB	-6.612 dB	---	9.00 kHz (CISPR)
3	1	289.99 kHz	46.715 dBµV	37.739 dBµV	---	-13.809 dB	-12.785 dB	---	9.00 kHz (CISPR)
4	1	413.98 kHz	38.141 dBµV	32.274 dBµV	---	-19.427 dB	-15.294 dB	---	9.00 kHz (CISPR)
5	1	10.137 MHz	36.611 dBµV	32.187 dBµV	---	-23.389 dB	-17.813 dB	---	9.00 kHz (CISPR)
6	1	11.017 MHz	37.758 dBµV	32.739 dBµV	---	-22.242 dB	-17.261 dB	---	9.00 kHz (CISPR)

Plot 6-54. Line-Conducted Test Plot (L1)

Notes:

1. All modes of operation, data rates, and test channels were investigated and the worst-case emissions are reported in BT BDR mode using 1Mbps on Channel 39. 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 Section 15.207 of the Title 47 CFR.
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (dBµV) = QP/AV Analyzer/Receiver Level (dBµV) + Corr. (dB)
5. Margin (dB) = QP/AV Limit (dBµV) - QP/AV Level (dBµV)
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.

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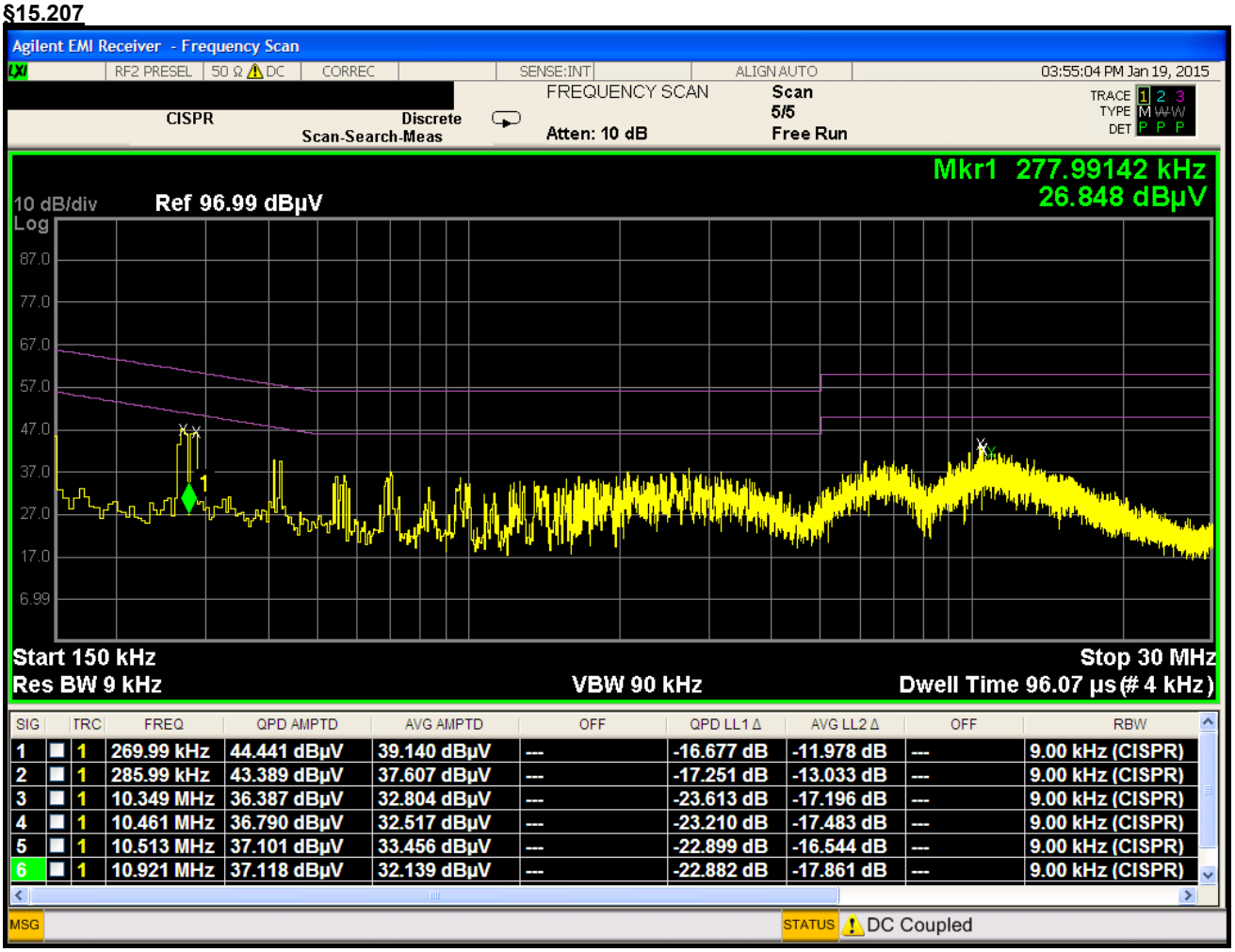
Line Conducted Measurement Data

§15.207



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	OFF	QPD LL1 Δ	AVG LL2 Δ	OFF	RBW
1	1	269.99 kHz	44.441 dBµV	39.140 dBµV	---	-16.677 dB	-11.978 dB	---	9.00 kHz (CISPR)
2	1	285.99 kHz	43.389 dBµV	37.607 dBµV	---	-17.251 dB	-13.033 dB	---	9.00 kHz (CISPR)
3	1	10.349 MHz	36.387 dBµV	32.804 dBµV	---	-23.613 dB	-17.196 dB	---	9.00 kHz (CISPR)
4	1	10.461 MHz	36.790 dBµV	32.517 dBµV	---	-23.210 dB	-17.483 dB	---	9.00 kHz (CISPR)
5	1	10.513 MHz	37.101 dBµV	33.456 dBµV	---	-22.899 dB	-16.544 dB	---	9.00 kHz (CISPR)
6	1	10.921 MHz	37.118 dBµV	32.139 dBµV	---	-22.882 dB	-17.861 dB	---	9.00 kHz (CISPR)

Plot 6-55. Line-Conducted Test Plot (N)

Notes:

1. All modes of operation, data rates, and test channels were investigated and the worst-case emissions are reported in BT BDR mode using 1Mbps on Channel 39. 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 Section 15.207 of the Title 47 CFR.
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (dBµV) = QP/AV Analyzer/Receiver Level (dBµV) + Corr. (dB)
5. Margin (dB) = QP/AV Limit (dBµV) - QP/AV Level (dBµV)
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.

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7.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Samsung Portable Handset FCC ID: A3LSMG920R4** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.

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