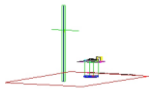
PCTEST ENGINEERING LABORATORY, INC.
7185 Oakland Mills Road, Columbia, MD 21046 USA
Tel. 410.290.6652 / Fax 410.290.6654
http://www.pctestlab.com



MEASUREMENT REPORT
FCC PART 15.247 Bluetooth (Low Energy)

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

Date of Testing:
1/27 - 2/25/2015
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Test Report Serial No.:
0Y1501300312.A3L

FCC ID:	**A3LSMG920A**
APPLICANT:	**Samsung Electronics Co., Ltd.**

Application Type:	Certification
Model:	SM-G920A
EUT Type:	Portable Handset
Max. RF Output Power:	7.867 mW (8.96 dBm) Peak Conducted
Frequency Range:	2402 - 2480 MHz
FCC Classification:	Digital Transmission System (DTS)
FCC Rule Part(s):	Part 15.247
Test Procedure(s):	KDB 558074 v03r02, 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 KDB 558074 v03r02. 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

© 2015 PCTEST Engineering Laboratory, Inc.

TABLE OF CONTENTS

FCC PART 15.247 MEASUREMENT REPORT 3

1.0 INTRODUCTION 4

1.1 SCOPE 4

1.2 PCTEST TEST LOCATION 4

2.0 PRODUCT INFORMATION 5

2.1 EQUIPMENT DESCRIPTION 5

2.2 DEVICE CAPABILITIES 5

2.3 TEST CONFIGURATION 5

2.4 EMI SUPPRESSION DEVICE(S)/MODIFICATIONS 5

3.0 DESCRIPTION OF TEST 6

3.1 EVALUATION PROCEDURE 6

3.2 AC LINE CONDUCTED EMISSIONS 6

3.3 RADIATED EMISSIONS 7

3.4 ENVIRONMENTAL CONDITIONS 7

4.0 ANTENNA REQUIREMENTS 8

5.0 TEST EQUIPMENT CALIBRATION DATA 9

6.0 TEST RESULTS 10

6.1 SUMMARY 10

6.2 6DB BANDWIDTH MEASUREMENT – BLUETOOTH (LE) 11

6.3 OUTPUT POWER MEASUREMENT – BLUETOOTH (LE) 14

6.4 POWER SPECTRAL DENSITY – BLUETOOTH (LE) 17

6.5 CONDUCTED EMISSIONS AT THE BAND EDGE 20

6.6 CONDUCTED SPURIOUS EMISSIONS 22

6.7 RADIATED SPURIOUS EMISSION MEASUREMENTS – ABOVE 1GHZ 27

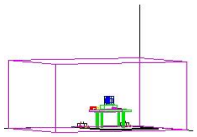
6.8 RADIATED RESTRICTED BAND EDGE MEASUREMENTS 36

6.9 RADIATED SPURIOUS EMISSIONS MEASUREMENTS – BELOW 1GHZ 38

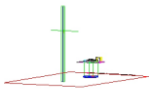
6.10 LINE-CONDUCTED TEST DATA 41

7.0 CONCLUSION 43

© 2015 PCTEST Engineering Laboratory, Inc.



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 15.247
BASE MODEL:	SM-G920A
FCC ID:	A3LSMG920A
FCC CLASSIFICATION:	Digital Transmission System (DTS)
Test Device Serial No.:	1163A, 0F8F0, 11646 ☐ Production ☒ Pre-Production ☐ Engineering
DATE(S) OF TEST:	1/27 - 2/25/2015
TEST REPORT S/N:	0Y1501300312.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.

© 2015 PCTEST Engineering Laboratory, Inc.

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 are, 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.

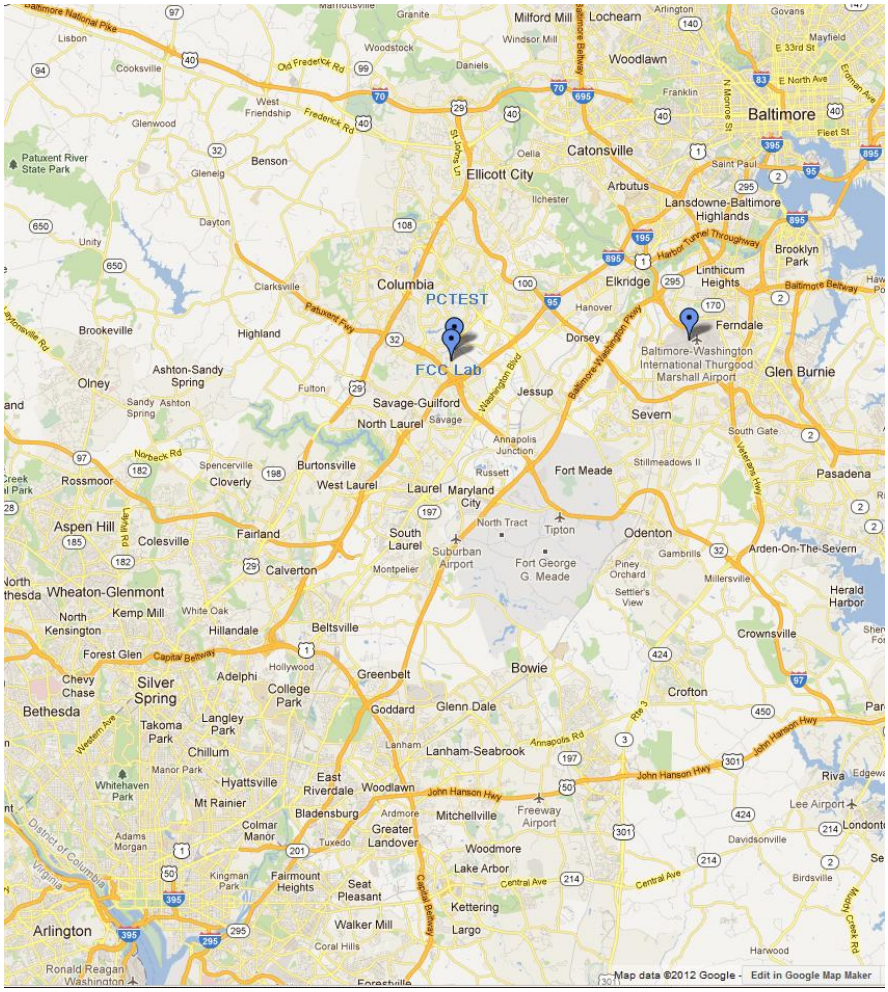


Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

© 2015 PCTEST Engineering Laboratory, Inc.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Electronics Co., Ltd. Portable Handset FCC ID: A3LSMG920A**. The data found in this test report was taken with the EUT operating in Bluetooth low energy mode. While in low energy mode, the Bluetooth transmitter hops pseudo-randomly between 40 channels, three of which are “advertising channels”. When the transmitter is hopping only between the three advertising channels, the EUT does not fall under the category of a “hopper” as defined in 15.247(a)(iii) which states that a “frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.” As operation on only the advertising channels does not qualify the EUT as a hopper, the EUT is certified as a DTS device in this mode. The data found in this report is representative of the device when it transmits on its advertising channels. Typical Bluetooth operation is covered under the DSS report found with this application.

2.2 Device Capabilities

This device contains the following capabilities:

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 Electronics Co., Ltd. Portable Handset FCC ID: A3LSMG920A was tested per the guidance of KDB 558074 v03r02. 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, and 6.6 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/or no modifications were made during testing.

© 2015 PCTEST Engineering Laboratory, Inc.

3.0 DESCRIPTION OF TEST

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2009), and the guidance provided in KDB 558074 v03r02 were used in the measurement of the **Samsung Electronics Co., Ltd. Portable Handset FCC ID: A3LSMG920A.**

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. 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.

Line conducted emissions test results are shown in Section 6.10. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.

© 2015 PCTEST Engineering Laboratory, Inc.

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).

© 2015 PCTEST Engineering Laboratory, Inc.

4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

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

Conclusion:

The **Samsung Electronics Co., Ltd. Portable Handset FCC ID: A3LSMG920A** unit complies with the requirement of §15.203.

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

Table 4-1. Frequency / Channel Operations

© 2015 PCTEST Engineering Laboratory, Inc.

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
-	RE3	Radiated Emissions Cable Set	10/17/2014	Annual	10/17/2015	N/A
-	WL25-1	Conducted Cable Set (25GHz)	10/14/2014	Annual	10/14/2015	N/A
Agilent	8447D	Broadband Amplifier	5/30/2014	Annual	5/30/2015	2443A01900
Agilent	8449B	(1-26.5GHz) Pre-Amplifier	5/11/2014	Annual	5/11/2015	3008A00985
Agilent	E4448A	PSA (3Hz-50GHz) Spectrum Analyzer	4/16/2014	Annual	4/16/2015	US42510244
Agilent	N9020A	MXA Signal Analyzer	10/27/2014	Annual	10/27/2015	US46470561
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
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
Huber+Suhner	Sucoflex 102A	40GHz Radiated Cable	10/15/2014	Annual	10/15/2015	251425001
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
Rhode & Schwarz	TS-PR18	Pre-Amplifier	6/12/2014	Annual	6/12/2015	101622
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	5/21/2014	Annual	5/21/2015	100348
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	140140336

Table 5-1. Annual Test Equipment Calibration Schedule

© 2015 PCTEST Engineering Laboratory, Inc.

6.0 TEST RESULTS

6.1 Summary

Company Name: Samsung Electronics Co., Ltd.

FCC ID: A3LSMG920A

FCC Classification: Digital Transmission System (DTS)

Number of Channels: 40

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
TRANSMITTER MODE (TX)					
15.247(a)(2)	6dB Bandwidth	> 500kHz	CONDUCTED	PASS	Section 6.2
15.247(b)(3)	Transmitter Output Power	< 1 Watt		PASS	Sections 6.3
15.247(e)	Transmitter Power Spectral Density	< 8dBm / 3kHz Band		PASS	Section 6.4
15.247(d)	Band Edge / Out-of-Band Emissions	≥ 20dBc		PASS	Sections 6.5, 6.6
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	Sections 6.7, 6.8, 6.9
15.207	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits or < RSS-Gen table 2 limits	LINE CONDUCTED	PASS	Section 6.10

Table 6-1. Summary of Test Results

Notes:

1. All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.
2. The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3. All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
4. For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Bluetooth LE Automation", Version 2.2.

© 2015 PCTEST Engineering Laboratory, Inc.

6.2 6dB Bandwidth Measurement – Bluetooth (LE)

§15.247(a.2)

Test Overview and Limit

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

The minimum permissible 6dB bandwidth is 500 kHz.

Test Procedure Used

KDB 558074 v03r02 – Section 8.2 Option 2

Test Settings

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

Test Setup

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

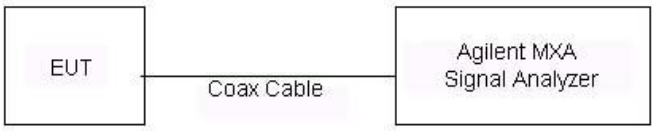


Figure 6-1. Test Instrument & Measurement Setup

Test Notes

None

© 2015 PCTEST Engineering Laboratory, Inc.

Frequency [MHz]	Channel No.	Bluetooth Mode	Measured Bandwidth [kHz]	Minimum Bandwidth [kHz]	Pass / Fail
2402	0	LE	684.2	500	Pass
2440	19	LE	677.6	500	Pass
2480	39	LE	684.8	500	Pass

Table 6-2. Conducted Bandwidth Measurements

Plot 6-1. 6dB Bandwidth Plot (Bluetooth (LE) – Ch. 0)

© 2015 PCTEST Engineering Laboratory, Inc.

Plot 6-2. 6dB Bandwidth Plot (Bluetooth (LE) – Ch. 19)

Plot 6-3. 6dB Bandwidth Plot (Bluetooth (LE) – Ch. 39)

© 2015 PCTEST Engineering Laboratory, Inc.

6.3 Output Power Measurement – Bluetooth (LE)

§15.247(b.3)

Test Overview and Limits

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

The maximum permissible conducted output power is 1 Watt.

Test Procedure Used

KDB 558074 v03r02 – Section 9.1.1

Test Settings

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

Test Setup

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

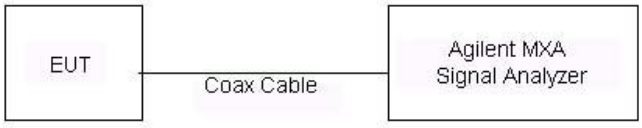


Figure 6-2. Test Instrument & Measurement Setup

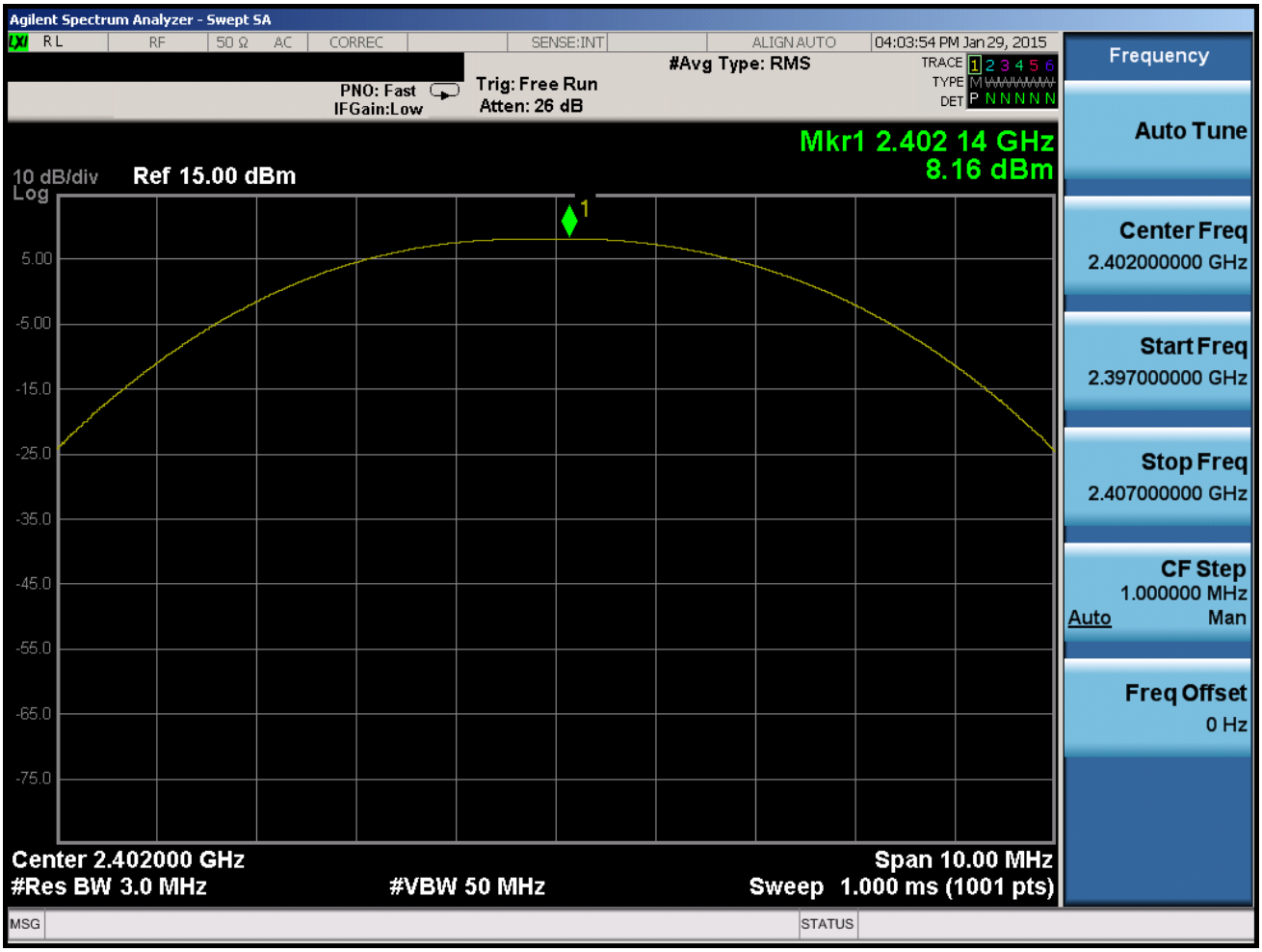
Test Notes

None

© 2015 PCTEST Engineering Laboratory, Inc.

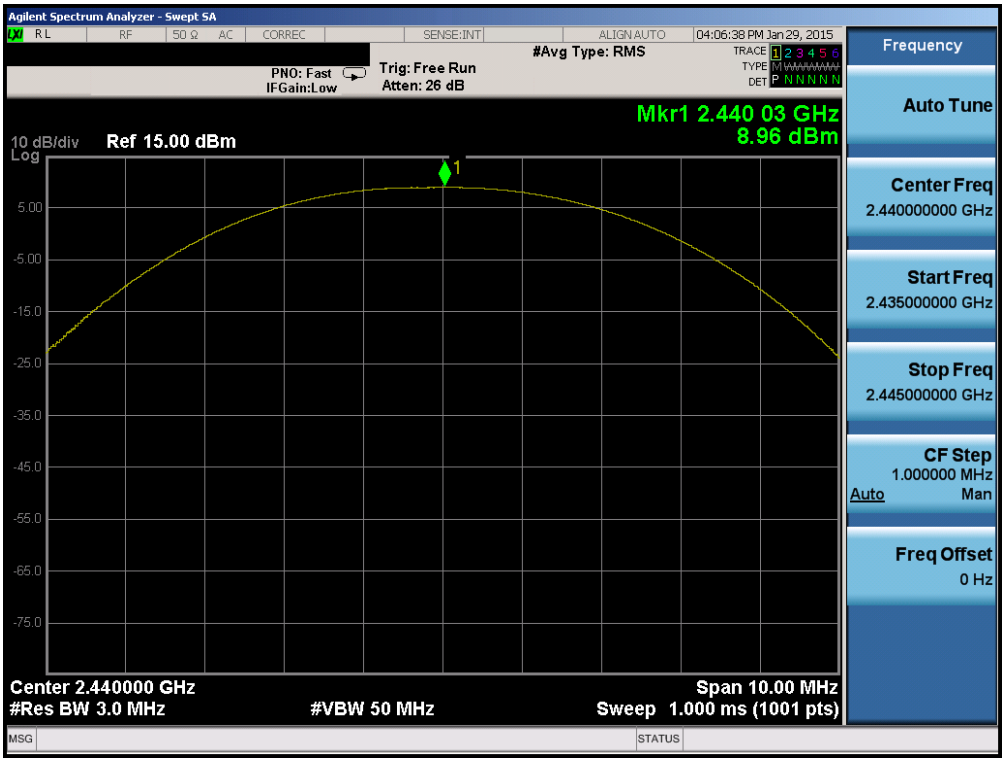
Frequency [MHz]	Channel No.	Bluetooth Mode	Peak Conducted Power	
			[dBm]	[mW]
2402	0	LE	8.16	6.548
2440	19	LE	8.96	7.867
2480	39	LE	7.32	5.389

Table 6-3. Conducted Output Power Measurements (Bluetooth (LE))

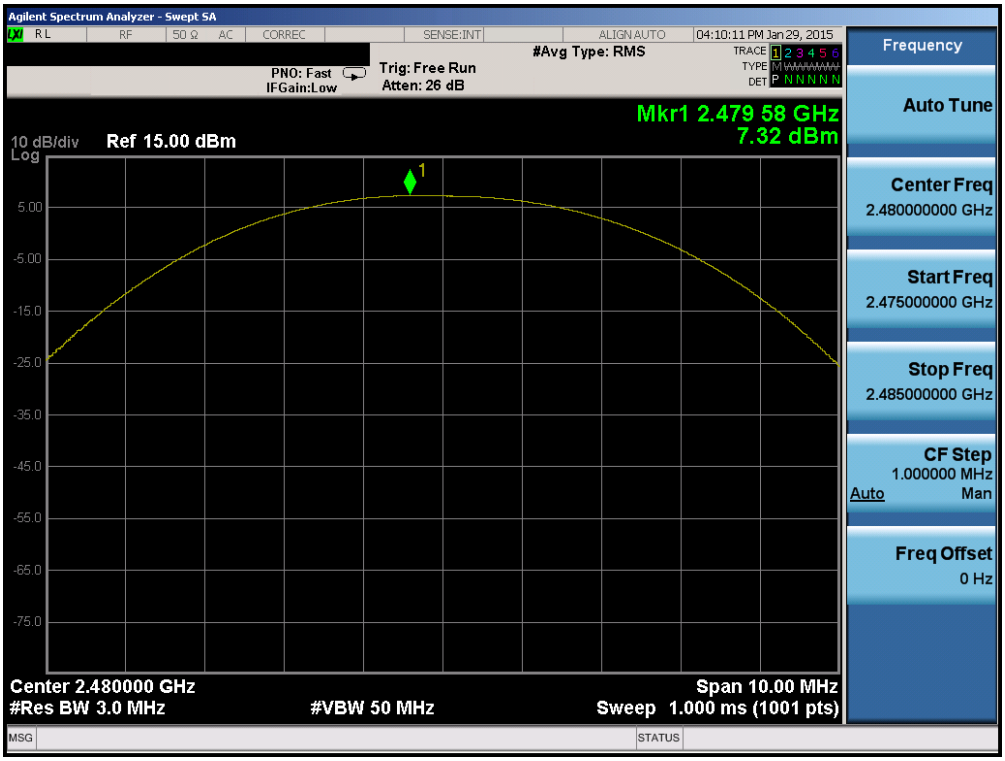


Plot 6-4. Peak Power Plot (Bluetooth (LE) – Ch. 0)

© 2015 PCTEST Engineering Laboratory, Inc.



Plot 6-5. Peak Power Plot (Bluetooth (LE) – Ch. 19)



Plot 6-6. Peak Power Plot (Bluetooth (LE) – Ch. 39)

© 2015 PCTEST Engineering Laboratory, Inc.

6.4 Power Spectral Density – Bluetooth (LE)

§15.247(e)

Test Overview and Limit

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

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

Test Procedure Used

KDB 558074 v03r02 – Section 10.2 Method PKPSD

Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 10kHz
4. VBW = 1MHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

Test Setup

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

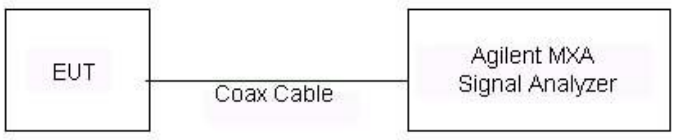


Figure 6-3. Test Instrument & Measurement Setup

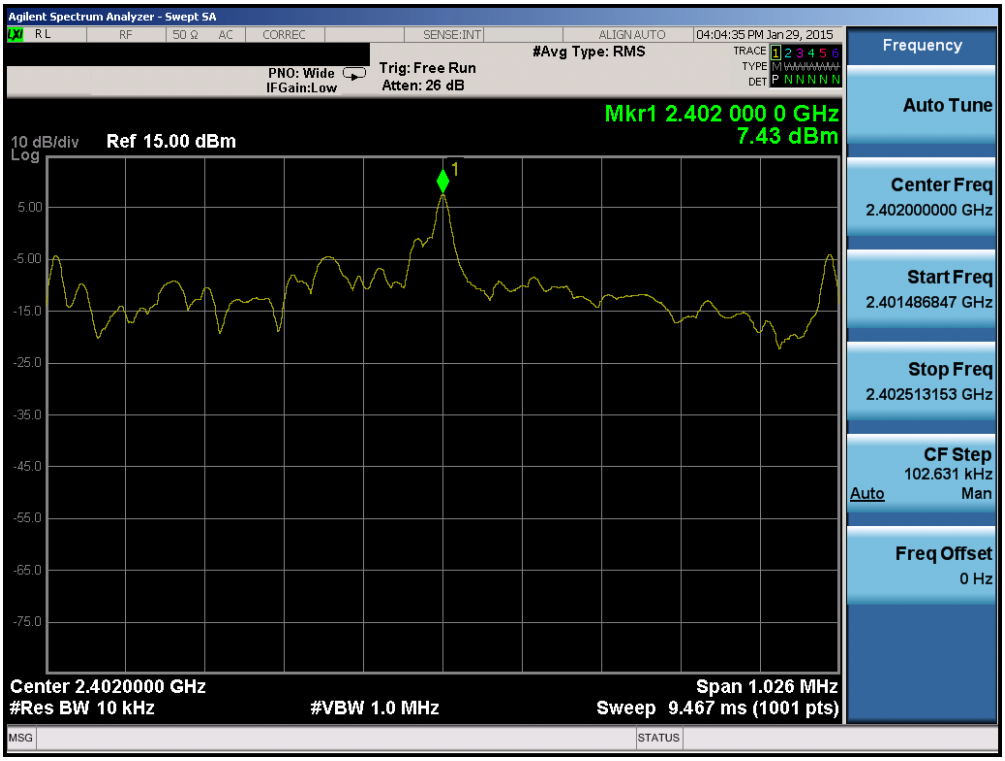
Test Notes

None

© 2015 PCTEST Engineering Laboratory, Inc.

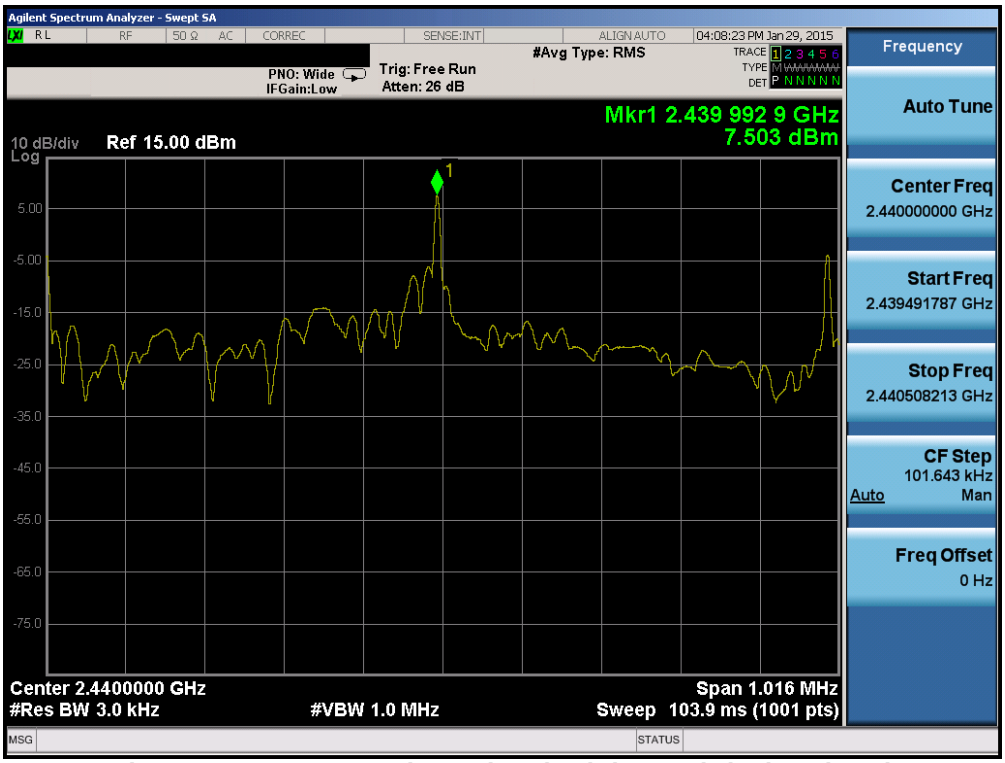
Frequency [MHz]	Channel No.	Bluetooth Mode	Measured Power Spectral Density [dBm]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
2402	0	LE	7.43	8.0	-0.57
2440	19	LE	7.50	8.0	-0.50
2480	39	LE	6.47	8.0	-1.53

Table 6-4. Conducted Power Density Measurements

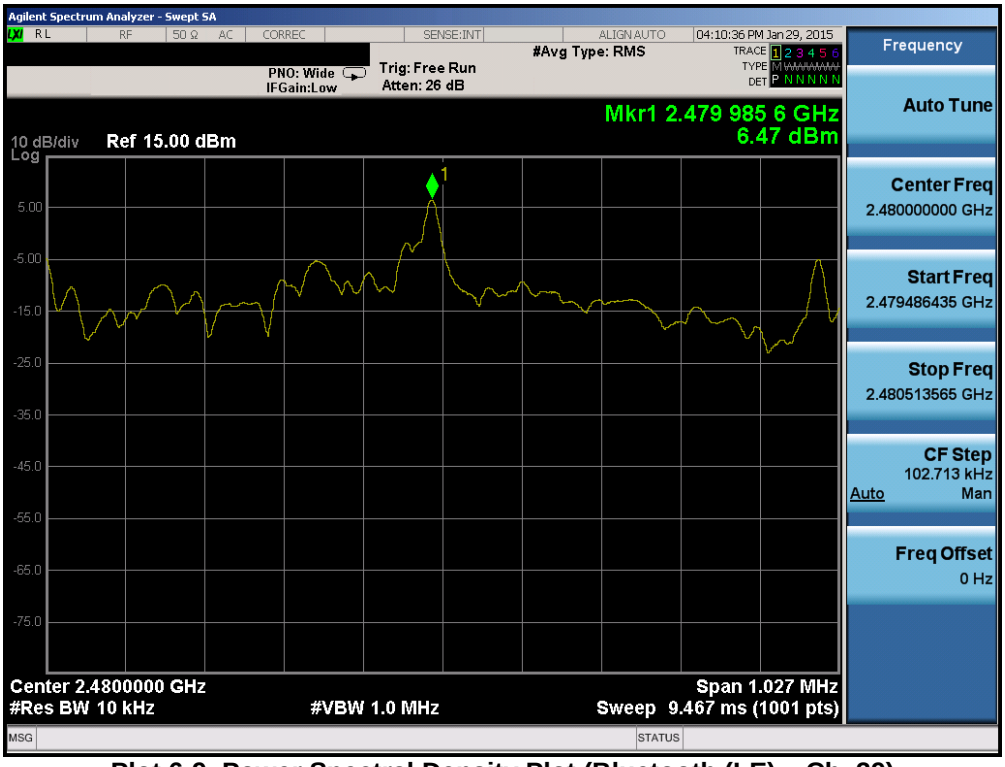


Plot 6-7. Power Spectral Density Plot (Bluetooth (LE) – Ch. 0)

© 2015 PCTEST Engineering Laboratory, Inc.



Plot 6-8. Power Spectral Density Plot (Bluetooth (LE) – Ch. 19)



Plot 6-9. Power Spectral Density Plot (Bluetooth (LE) – Ch. 39)

© 2015 PCTEST Engineering Laboratory, Inc.

6.5 Conducted Emissions at the Band Edge

§15.247(d)

Test Overview and Limit

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

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

Test Procedure Used

KDB 558074 v03r02 – Section 11.3

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100kHz
4. VBW = 300kHz
5. Detector = Peak
6. Number of sweep points ≥ 2 x 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.

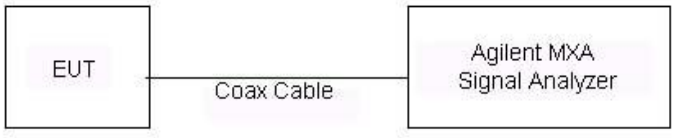
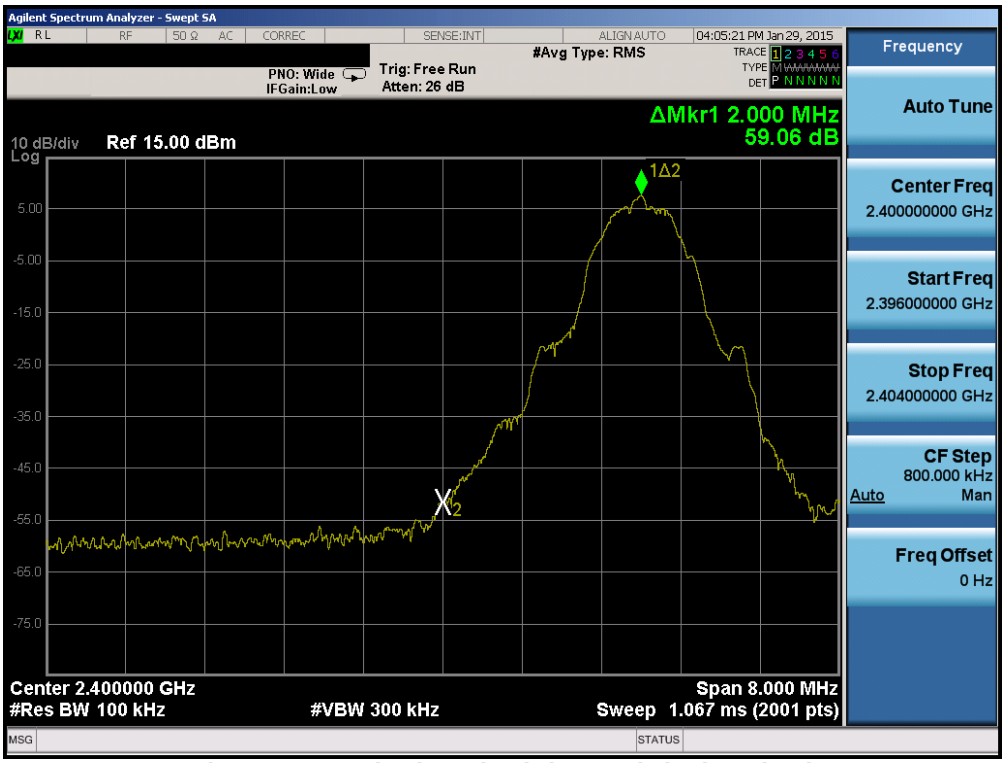


Figure 6-4. Test Instrument & Measurement Setup

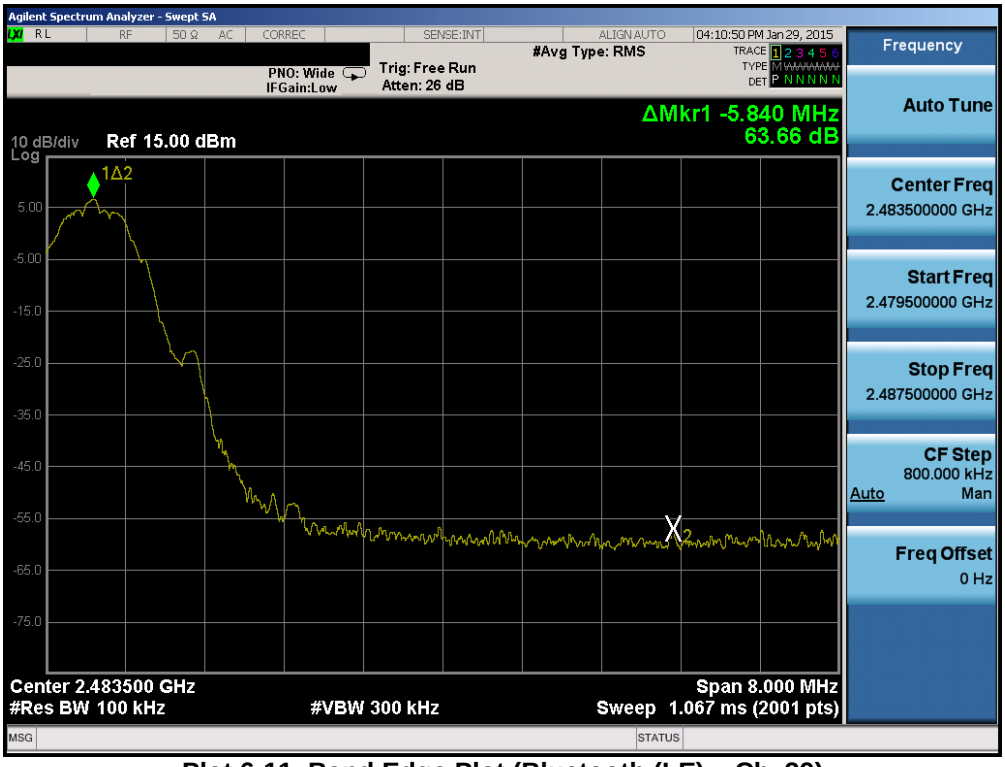
Test Notes

None

© 2015 PCTEST Engineering Laboratory, Inc.



Plot 6-10. Band Edge Plot (Bluetooth (LE) – Ch. 0)



Plot 6-11. Band Edge Plot (Bluetooth (LE) – Ch. 39)

© 2015 PCTEST Engineering Laboratory, Inc.

6.6 Conducted Spurious Emissions

§15.247(d)

Test Overview and Limit

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

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 11.1 of KDB 558074 v03r02.

Test Procedure Used

KDB 558074 v03r02 – Section 11.3

Test Settings

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

Test Setup

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

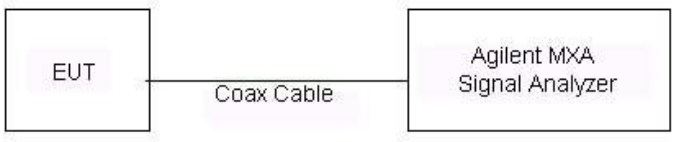


Figure 6-5. Test Instrument & Measurement Setup

© 2015 PCTEST Engineering Laboratory, Inc.

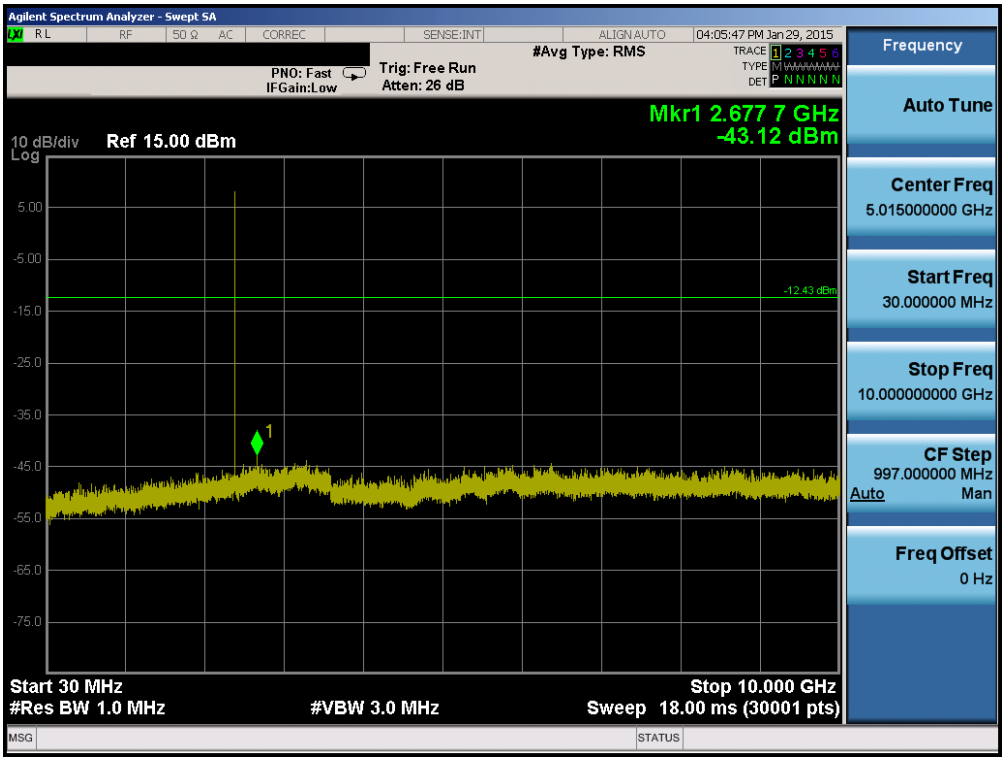
Test Notes

1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.

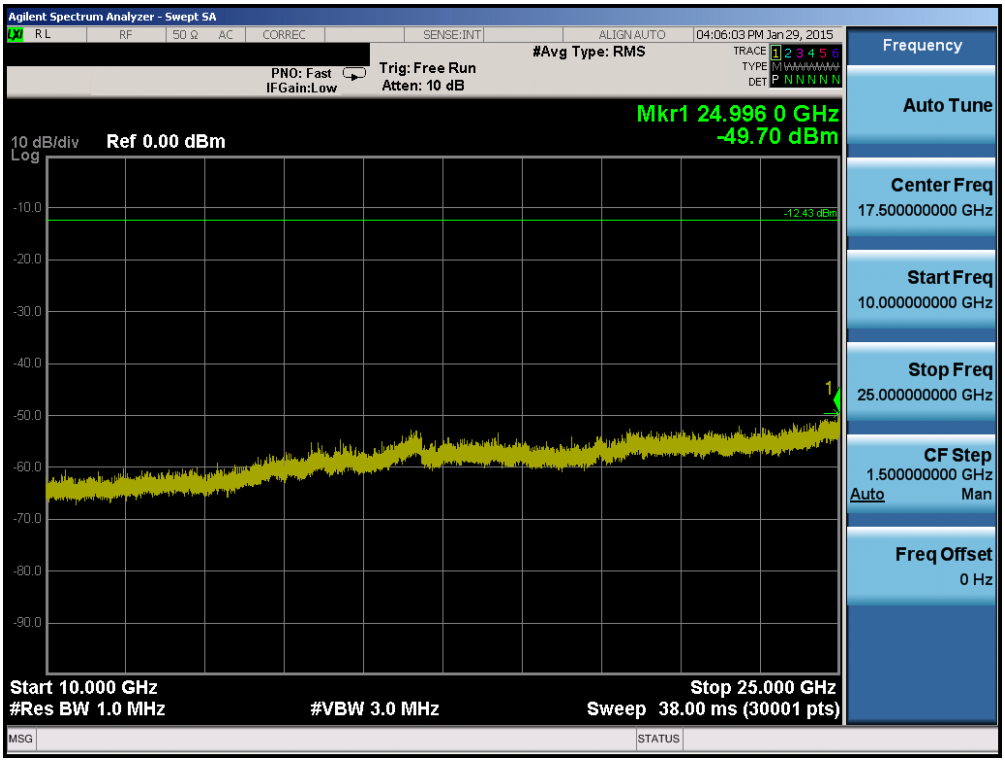
2. The display line shown in the following plots denotes the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.

3. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.

© 2015 PCTEST Engineering Laboratory, Inc.

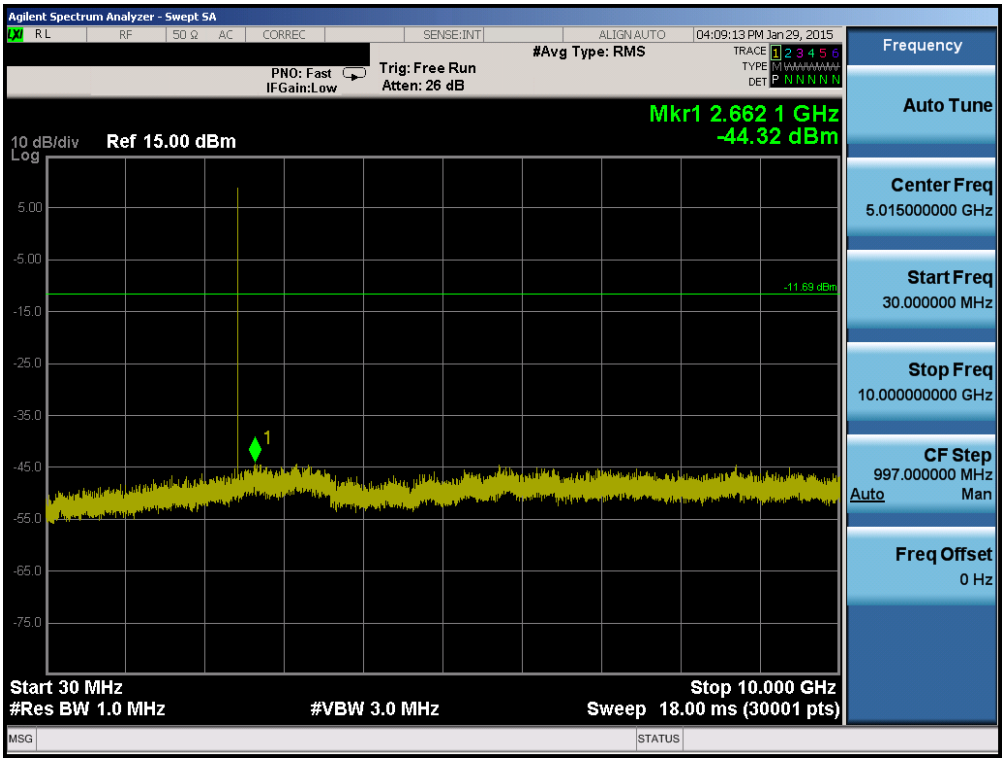


Plot 6-12. Conducted Spurious Plot (Bluetooth (LE) – Ch. 0)

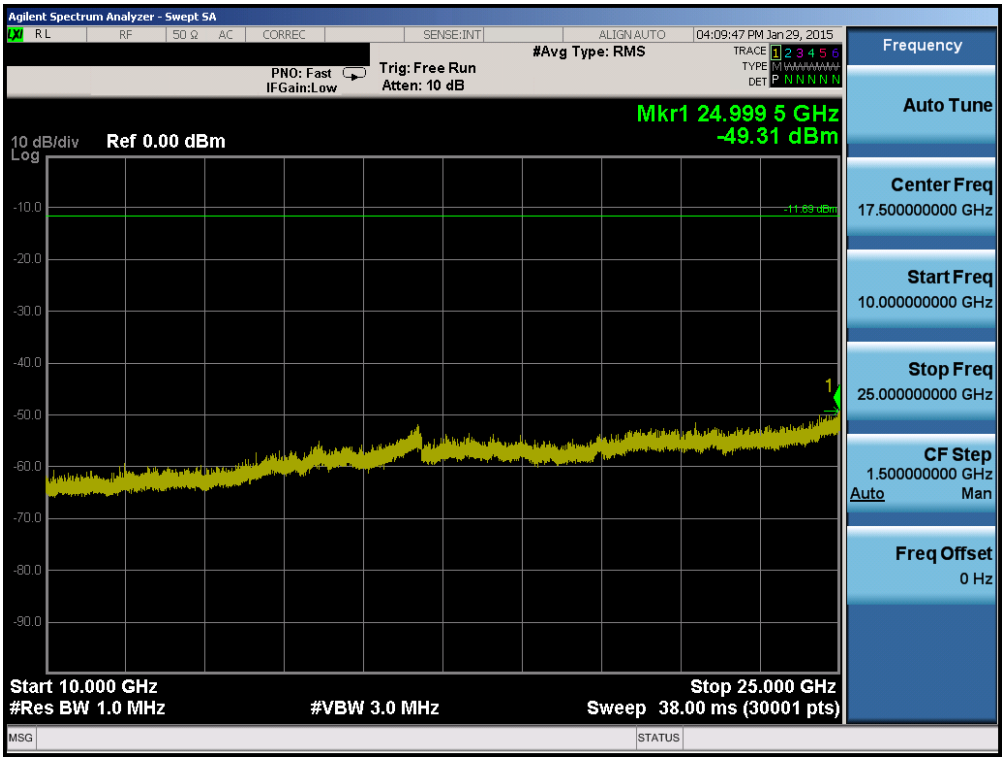


Plot 6-13. Conducted Spurious Plot (Bluetooth (LE) – Ch. 0)

© 2015 PCTEST Engineering Laboratory, Inc.

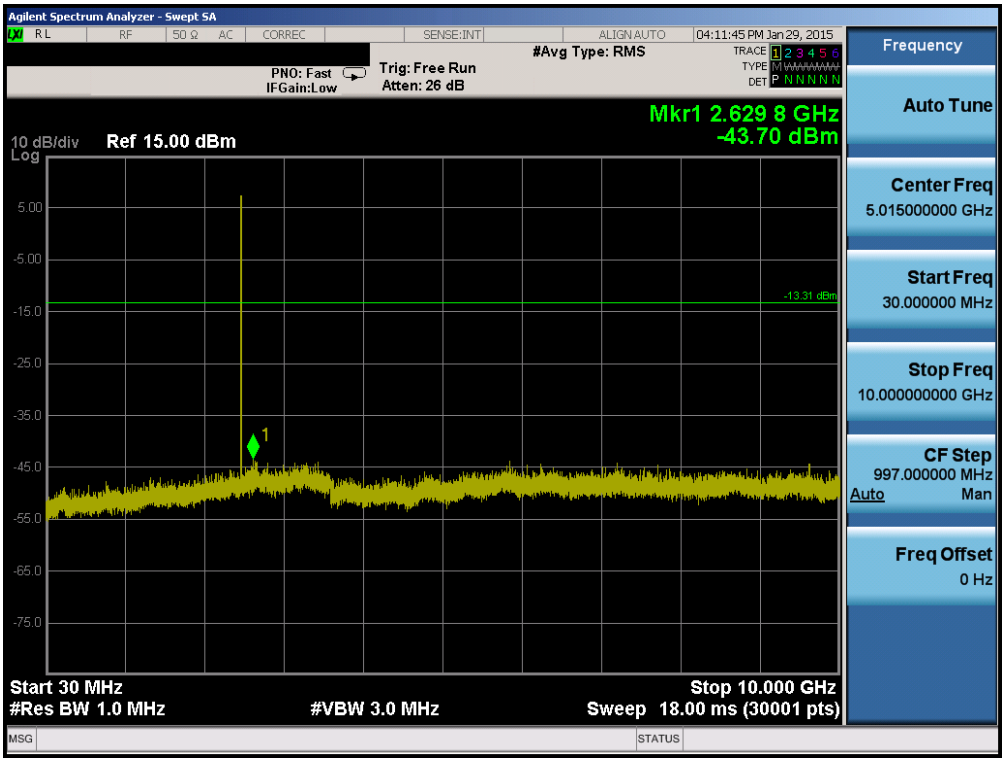


Plot 6-14. Conducted Spurious Plot (Bluetooth (LE) – Ch. 19)



Plot 6-15. Conducted Spurious Plot (Bluetooth (LE) – Ch. 19)

© 2015 PCTEST Engineering Laboratory, Inc.



Plot 6-16. Conducted Spurious Plot (Bluetooth (LE) – Ch. 39)

Plot 6-17. Conducted Spurious Plot (Bluetooth (LE) – Ch. 39)

© 2015 PCTEST Engineering Laboratory, Inc.

6.7 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 6-5 per Section 15.209.

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

Table 6-5. Radiated Limits

Test Procedures Used

KDB 558074 v03r02 – Section 12.1, 12.2.7

Test Settings

Average Field Strength Measurements per Section 12.2.5.3 of KDB 558074 v03r02

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

© 2015 PCTEST Engineering Laboratory, Inc.

Peak Field Strength Measurements per Section 12.2.4 of KDB 558074 v03r02

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

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

Table 6-6. RBW as a Function of Frequency

Test Setup

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

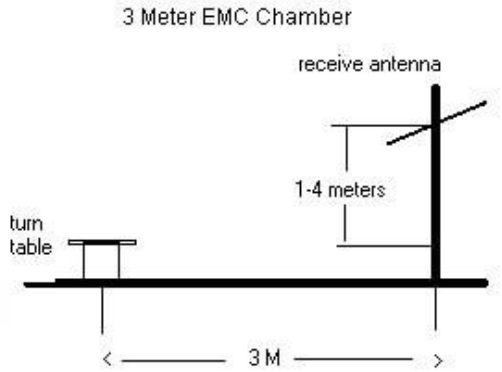


Figure 6-6. Test Instrument & Measurement Setup

Test Notes

1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of KDB 558074 v03r02 were not used to evaluate this device for compliance to radiated limits. All radiated spurious emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 6-5.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.

© 2015 PCTEST Engineering Laboratory, Inc.

4. This unit was tested with its standard battery.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
6. Average measurements were recorded using a VBW of 3kHz, per Section 12.2.4.3 of KDB 558074 v03r02, since 1/T is equal to just under 3kHz. This method was used because the EUT could not be configured to operate with a duty cycle > 98%. Both average and peak measurements were made using a peak detector
7. Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
8. No significant radiated band edge emissions were found in the 2310 – 2390MHz restricted band.
9. The 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.

Sample Calculations

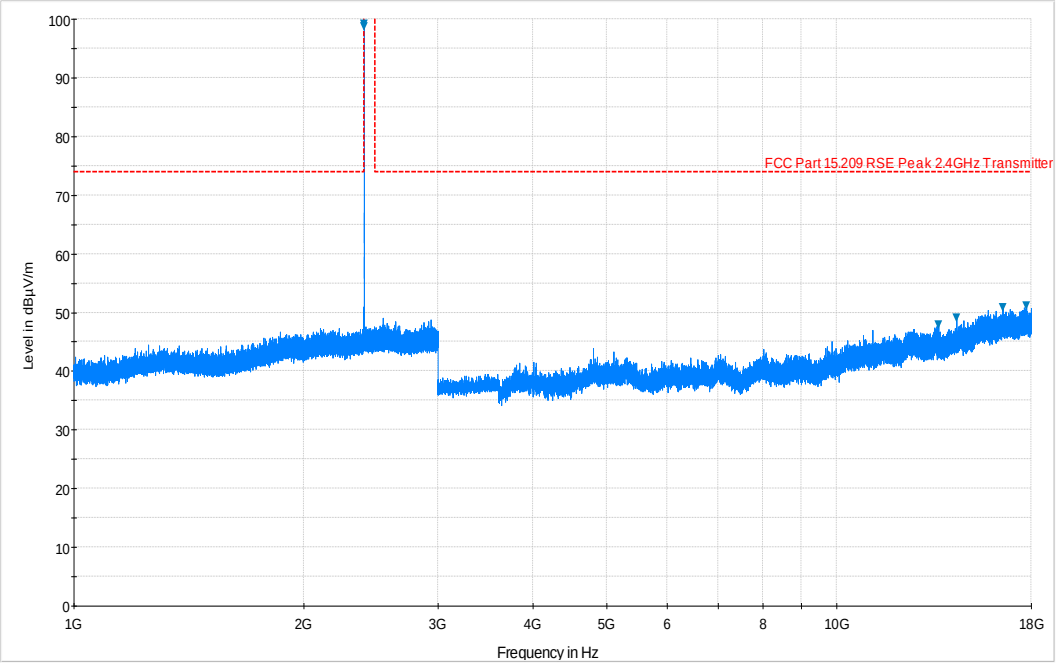
Determining Spurious Emissions Levels

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

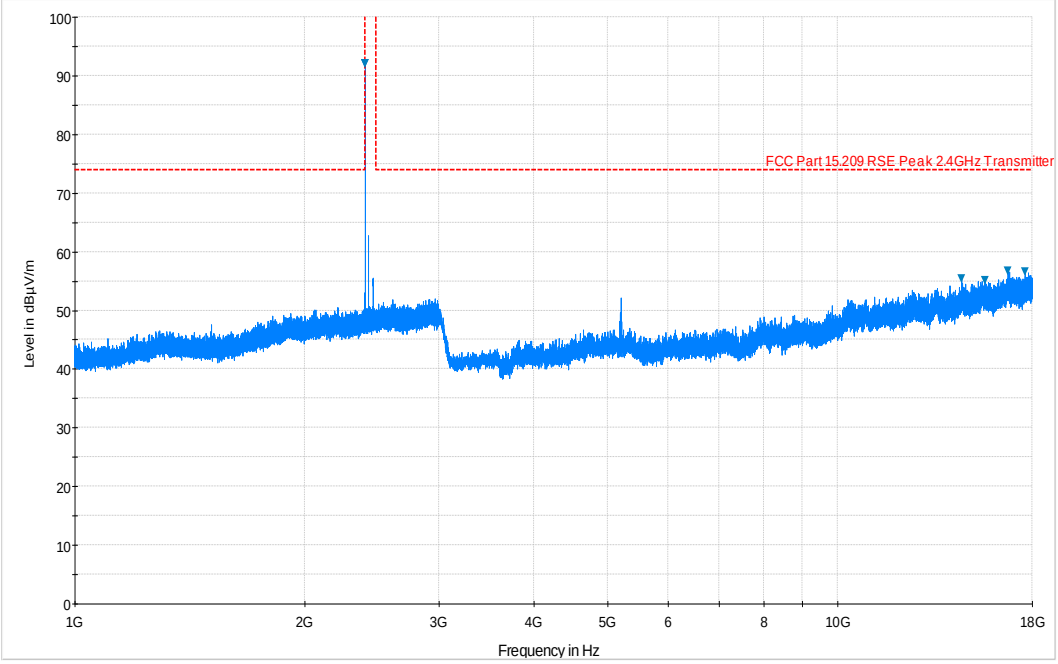
Radiated Band Edge Measurement Offset

- The amplitude offset shown in the radiated restricted band edge plots in Section 6.8 was calculated using the formula:
  Offset (dB) = (Antenna Factor + Cable Loss + 10 dB Attenuator) – Preamplifier Gain

© 2015 PCTEST Engineering Laboratory, Inc.

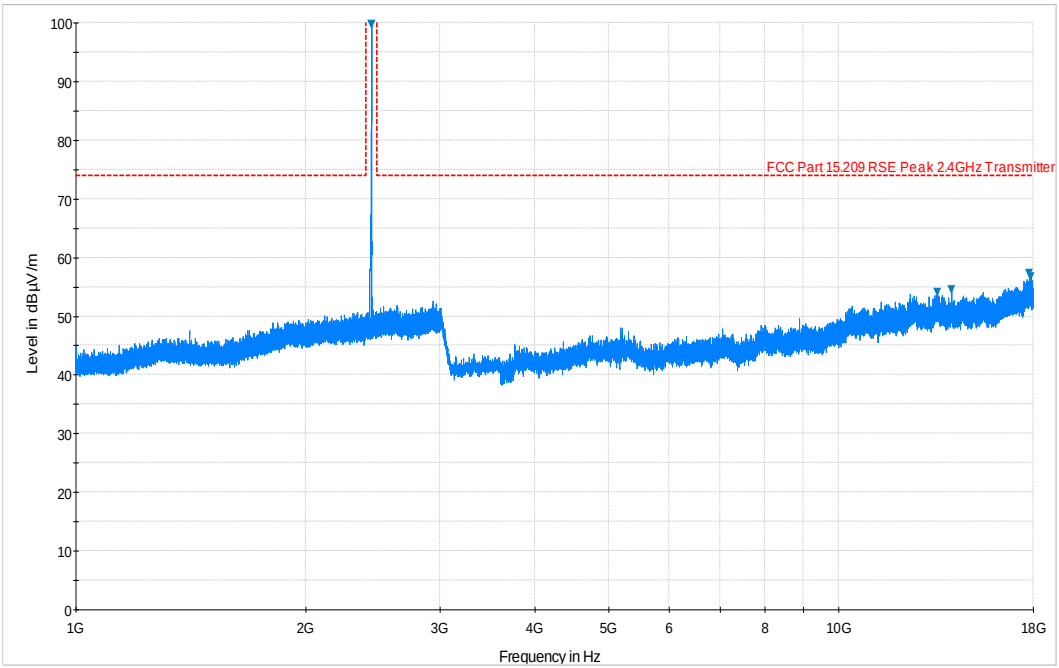


Plot 6-18. Radiated Spurious Plot above 1GHz (BTLE – Ch. 0, Ant. Pol. H)

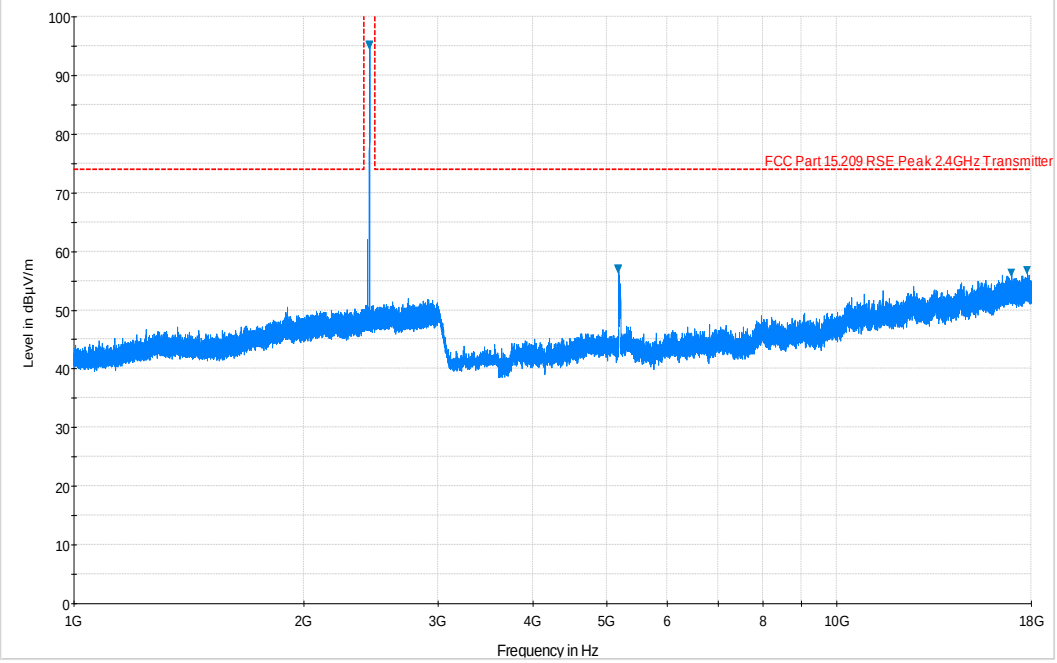


Plot 6-19. Radiated Spurious Plot above 1GHz (BTLE – Ch. 0, Ant. Pol. V)

© 2015 PCTEST Engineering Laboratory, Inc.

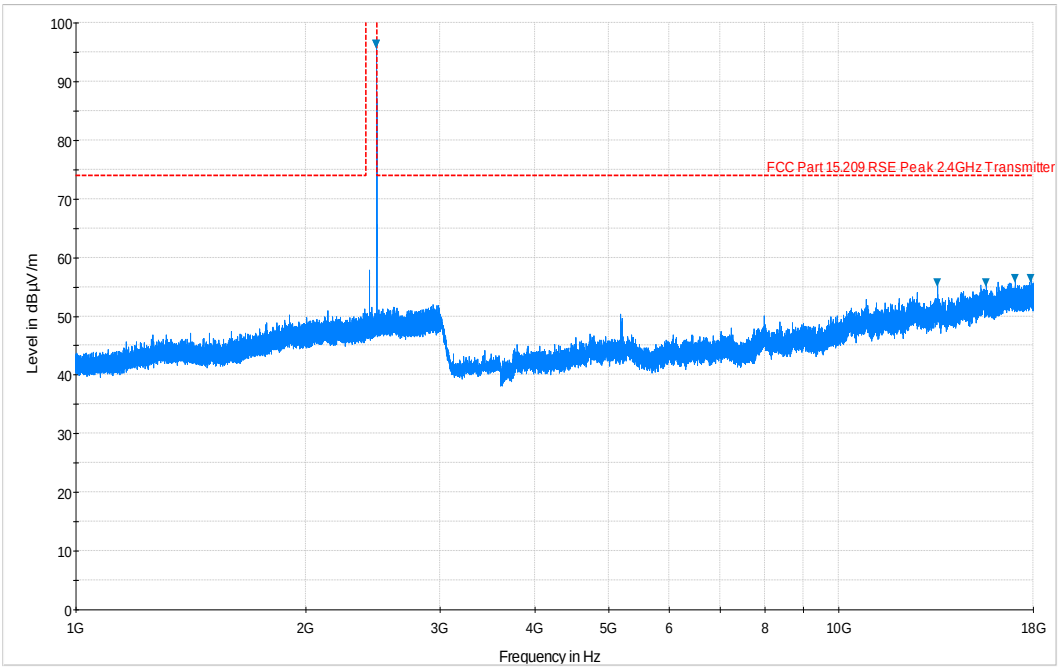


Plot 6-20. Radiated Spurious Plot above 1GHz (BTLE – Ch. 19, Ant. Pol. H)

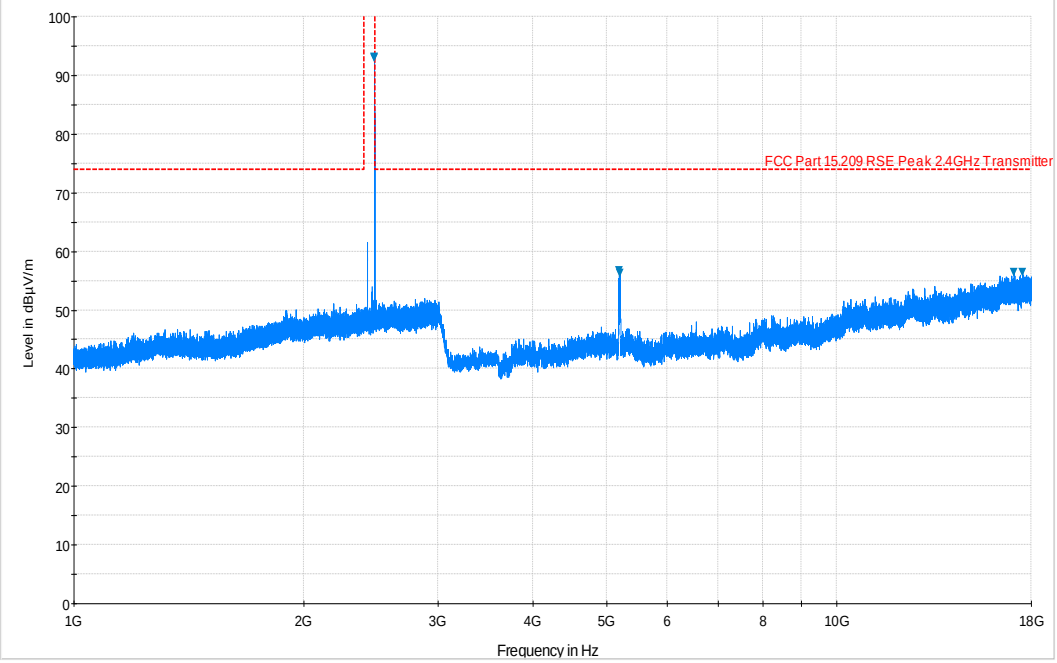


Plot 6-21. Radiated Spurious Plot above 1GHz (BTLE – Ch. 19, Ant. Pol. V)

© 2015 PCTEST Engineering Laboratory, Inc.



Plot 6-22. Radiated Spurious Plot above 1GHz (BTLE – Ch. 39, Ant. Pol. H)

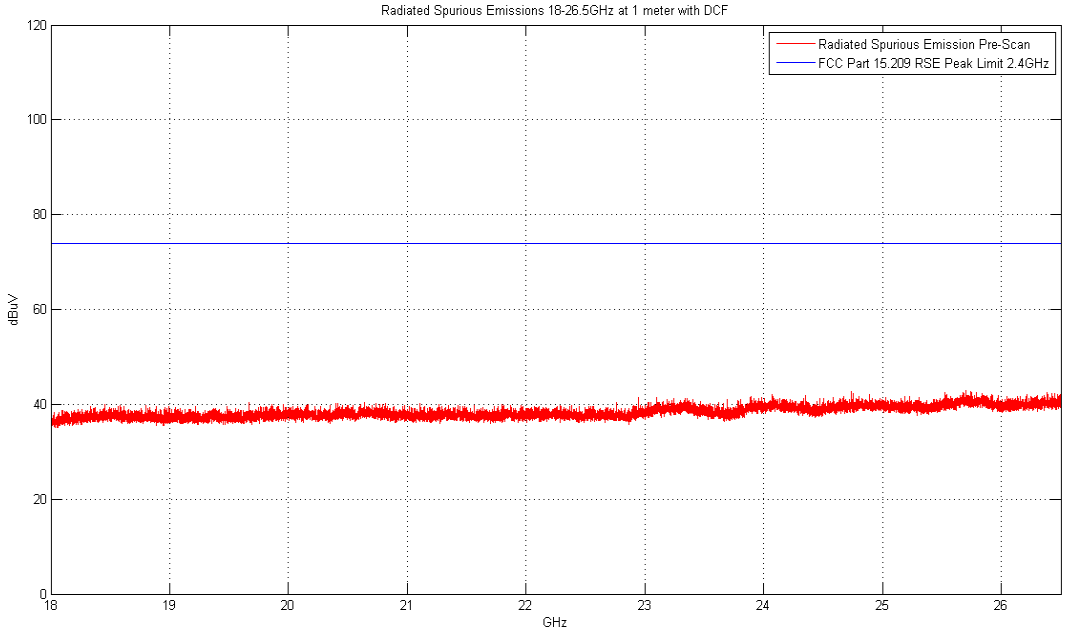


Plot 6-23. Radiated Spurious Plot above 1GHz (BTLE – Ch. 39, Ant. Pol. V)

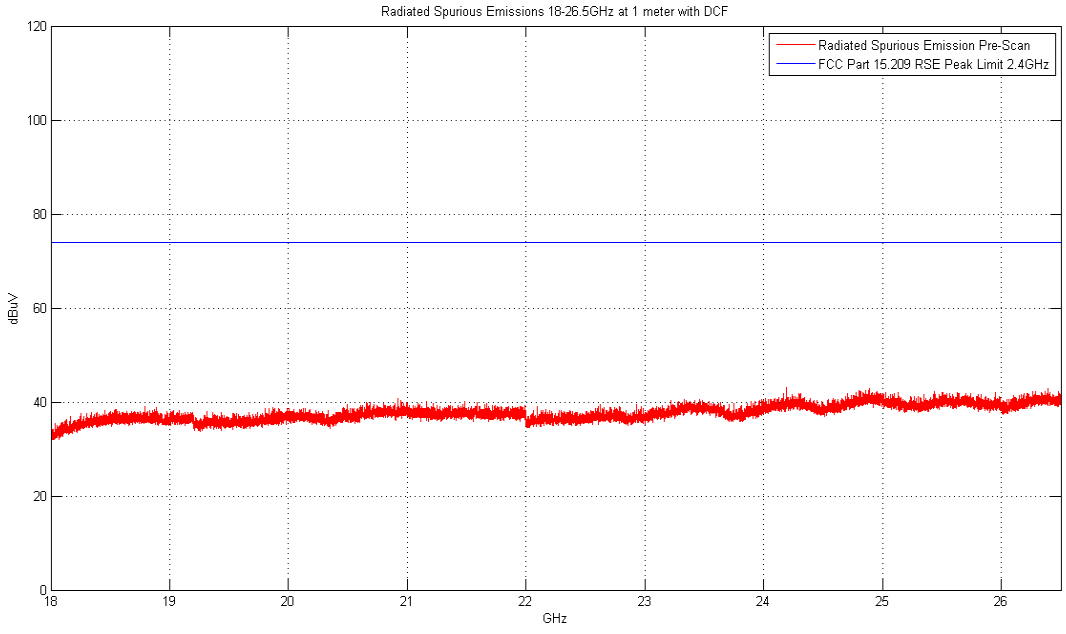
© 2015 PCTEST Engineering Laboratory, Inc.

Radiated Spurious Emissions Measurements (Above 18GHz)

§15.209



Plot 6-24. Radiated Spurious Plot above 18GHz (Pol. H)



Plot 6-25. Radiated Spurious Plot above 18GHz (Pol. V)

© 2015 PCTEST Engineering Laboratory, Inc.

Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d)

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

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	-105.81	Avg	H	38.29	39.48	53.98	-14.50
4804.00	-97.83	Peak	H	38.29	47.46	73.98	-26.52
12010.00	-117.50	Avg	H	49.01	38.52	53.98	-15.46
12010.00	-104.50	Peak	H	49.01	51.52	73.98	-22.46

Table 6-7. Radiated Measurements @ 3 meters

Bluetooth Mode: LE
Distance of Measurements: 3 Meters
Operating Frequency: 2440MHz
Channel: 19

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4880.00	-108.38	Avg	H	38.60	37.21	53.98	-16.76
4880.00	-99.06	Peak	H	38.60	46.53	73.98	-27.44
7320.00	-112.52	Avg	H	43.79	38.27	53.98	-15.71
7320.00	-101.06	Peak	H	43.79	49.73	73.98	-24.25
12200.00	-117.88	Avg	H	48.76	37.88	53.98	-16.10
12200.00	-104.40	Peak	H	48.76	51.36	73.98	-22.62

Table 6-8. Radiated Measurements @ 3 meters

© 2015 PCTEST Engineering Laboratory, Inc.

Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d)

Bluetooth Mode: LE
Distance of Measurements: 3 Meters
Operating Frequency: 2480MHz
Channel: 39

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	-110.19	Avg	H	38.91	35.72	53.98	-18.26
4960.00	-99.82	Peak	H	38.91	46.09	73.98	-27.89
7440.00	-115.07	Avg	H	43.92	35.85	53.98	-18.13
7440.00	-102.68	Peak	H	43.92	48.24	73.98	-25.74
12400.00	-117.30	Avg	H	48.82	38.51	53.98	-15.47
12400.00	-103.91	Peak	H	48.82	51.90	73.98	-22.08

Table 6-9. Radiated Measurements @ 3 meters

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

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	-107.14	Avg	H	38.29	38.15	53.98	-15.83
4804.00	-98.40	Peak	H	38.29	46.89	73.98	-27.09
12010.00	-117.64	Avg	H	49.01	38.38	53.98	-15.60
12010.00	-103.75	Peak	H	49.01	52.27	73.98	-21.71

Table 6-10. Radiated Measurements with WCP @ 3 meters

© 2015 PCTEST Engineering Laboratory, Inc.

6.8 Radiated Restricted Band Edge Measurements

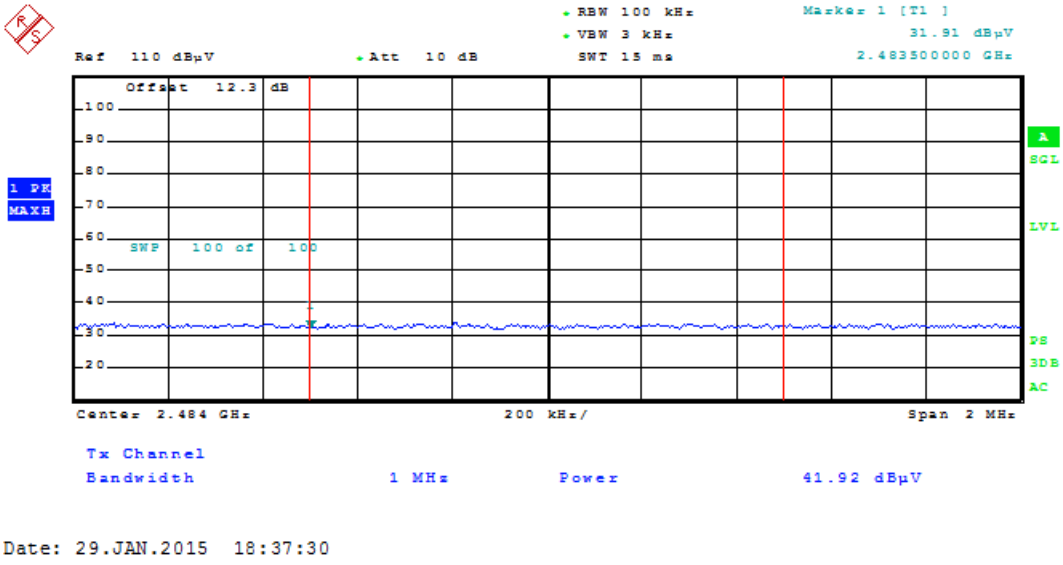
§15.205 §15.209

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

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

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

Bluetooth Mode:	LE
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	39



Plot 6-26. Radiated Restricted Upper Band Edge Measurement (Average)

Note:

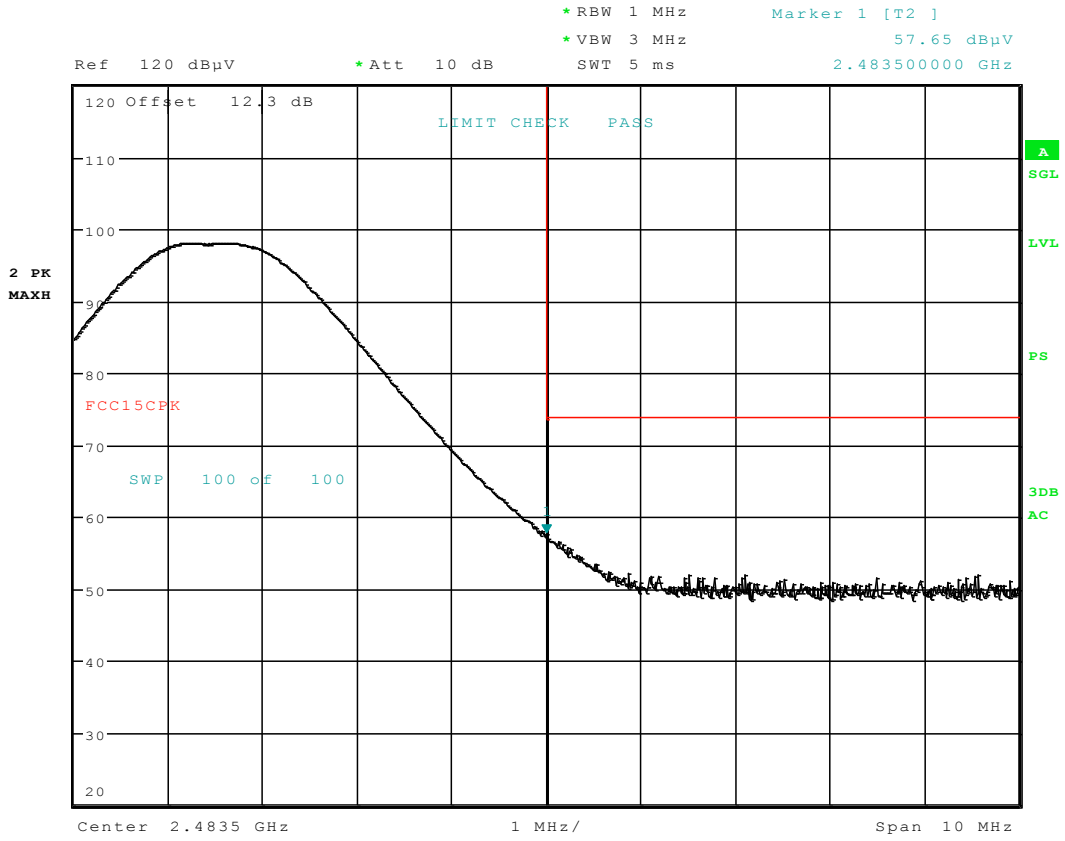
A channel integration method was used to determine compliance with the out of band average radiated spurious emissions limit in the 2483.5 – 2500MHz band. Per KDB 558074 Section 13.3.3, a measurement was performed using a RBW of 100kHz at the 2483.5MHz band edge. The results were integrated up to the 1MHz reference bandwidth to show compliance with the 15.209 radiated limit for emissions greater than 1GHz.

© 2015 PCTEST Engineering Laboratory, Inc.

Radiated Restricted Band Edge Measurements
§15.205 §15.209

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



Date: 29.JAN.2015 18:34:11

Plot 6-27. Radiated Restricted Upper Band Edge Measurement (Peak)

© 2015 PCTEST Engineering Laboratory, Inc.

6.9 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 6-11 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 6-11. 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

© 2015 PCTEST Engineering Laboratory, Inc.

Test Setup

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

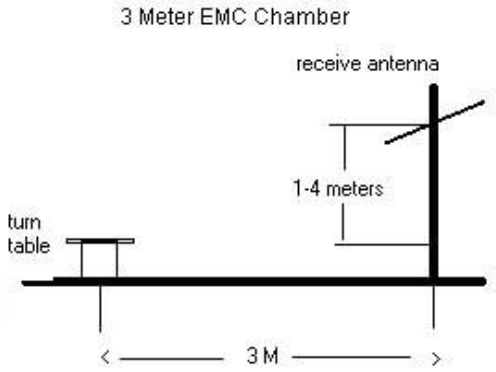


Figure 6-7. Test Instrument & Measurement Setup

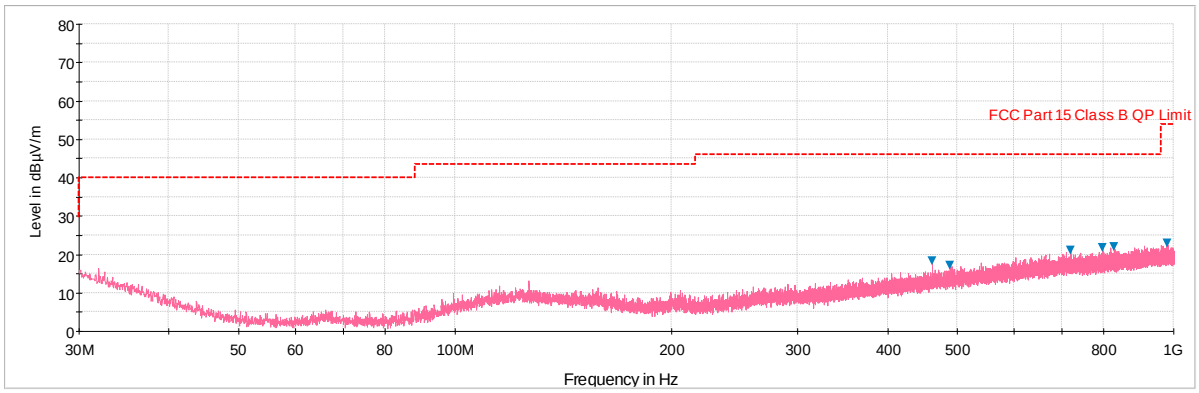
Test Notes

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.

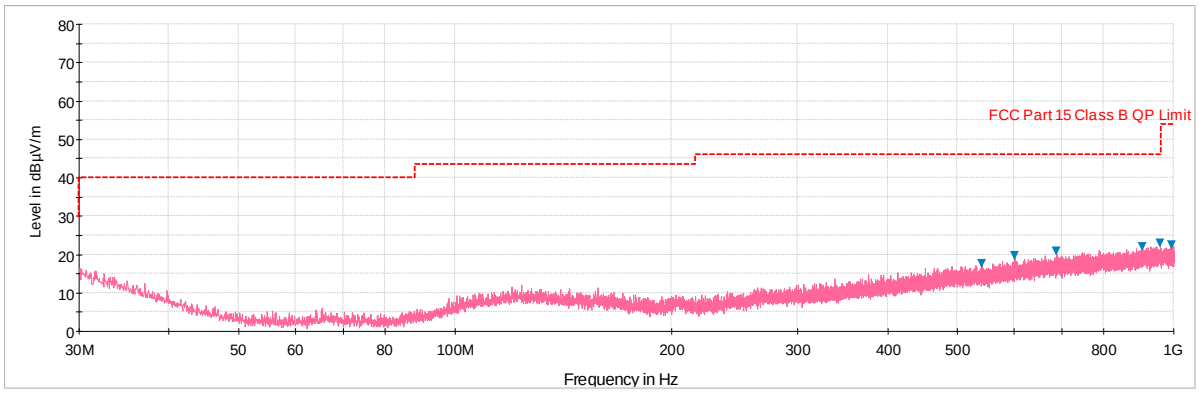
© 2015 PCTEST Engineering Laboratory, Inc.

Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209



Plot 6-28. Radiated Spurious Plot below 1GHz (Pol. H)

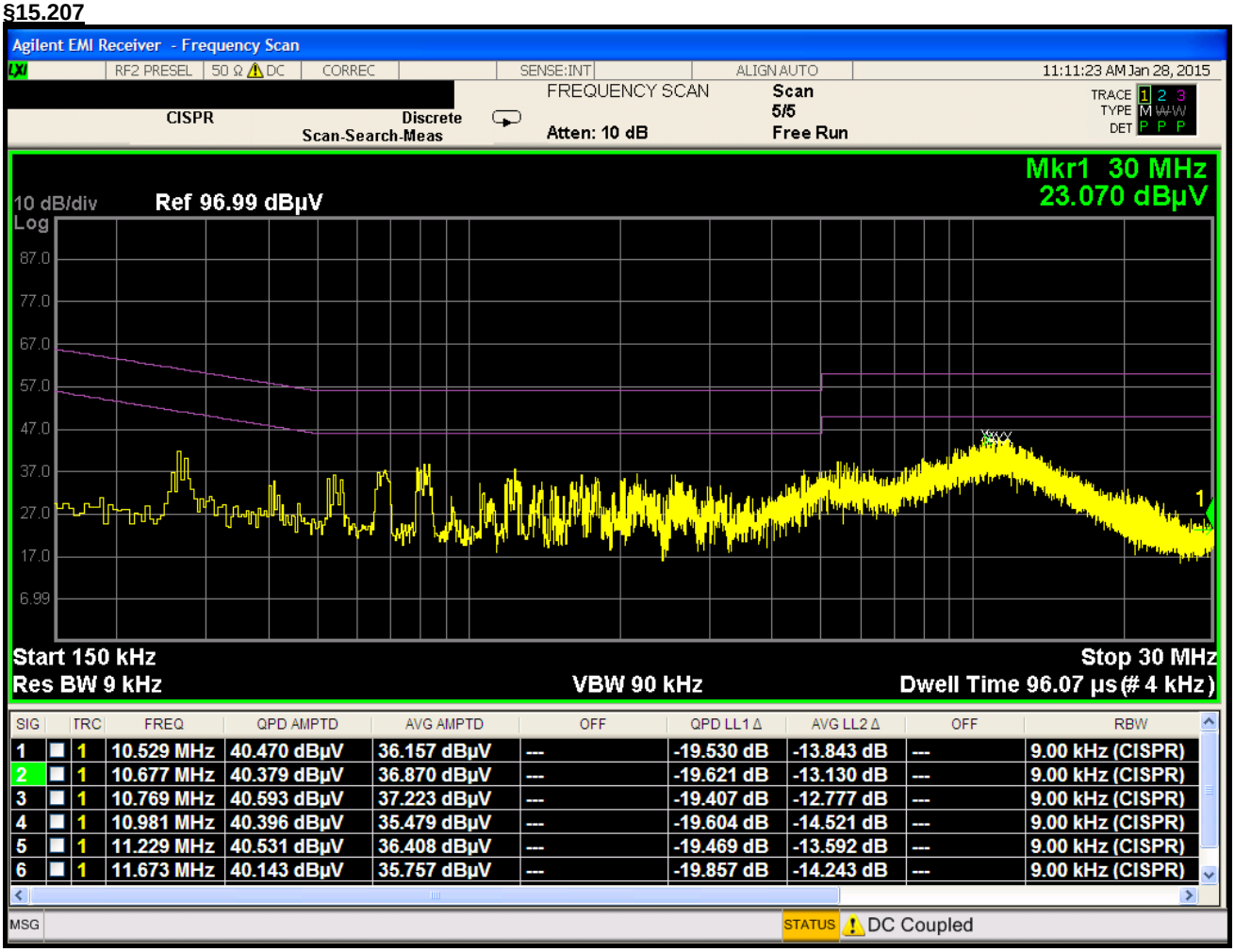


Plot 6-29. Radiated Spurious Plot below 1GHz (Pol. V)

© 2015 PCTEST Engineering Laboratory, Inc.

6.10 Line-Conducted Test Data

§15.207



Plot 6-30. Line Conducted Plot with Bluetooth LE (L1)

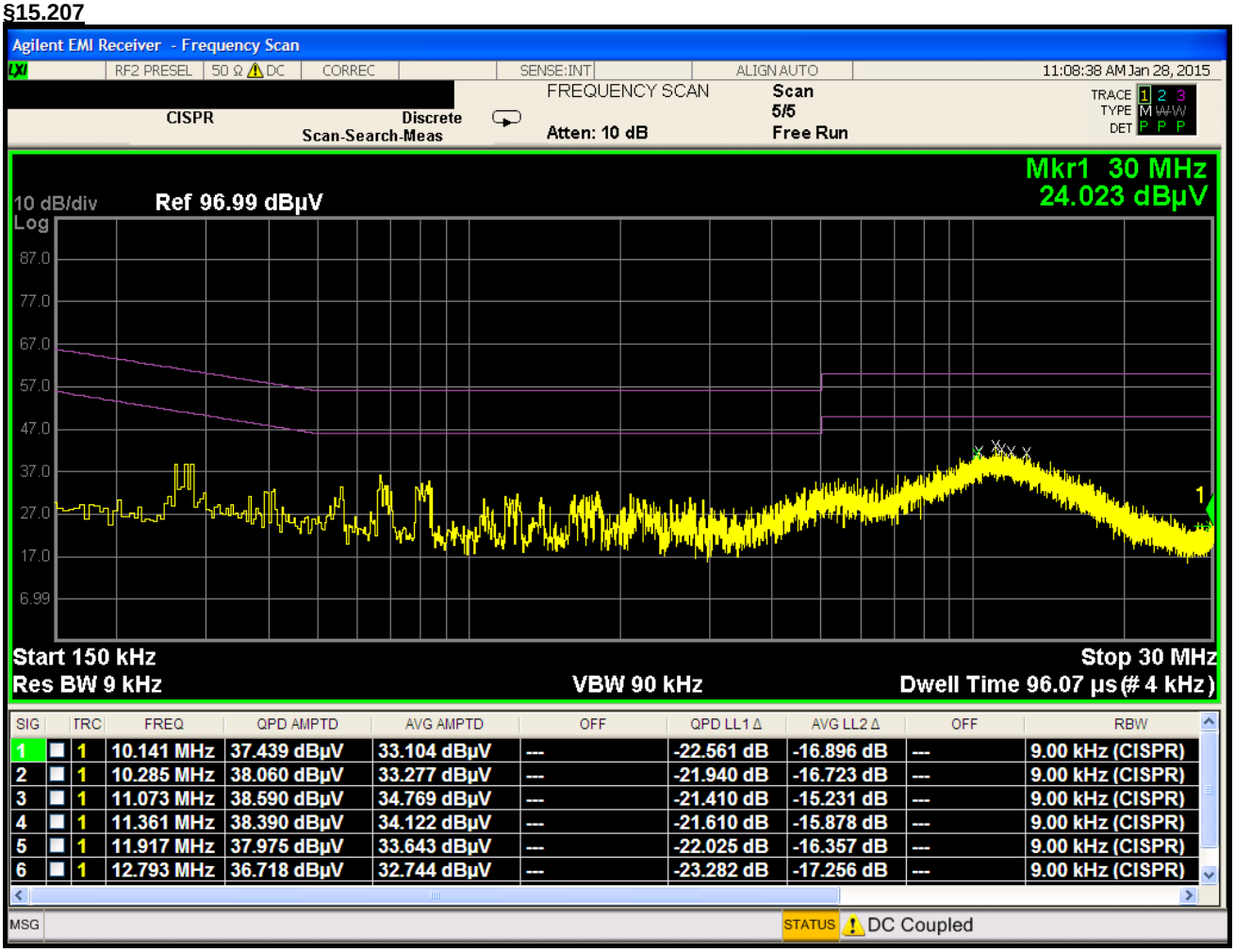
Notes:

1. All modes of operation were investigated and the worst-case emissions are reported using channel 19. The emissions found were not affected by the choice of channel used during testing.
2. The limit for Class B device(s) 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.

© 2015 PCTEST Engineering Laboratory, Inc.

Line-Conducted Test Data

§15.207



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	OFF	QPD LL1 Δ	AVG LL2 Δ	OFF	RBW
1	1	10.141 MHz	37.439 dBµV	33.104 dBµV	---	-22.561 dB	-16.896 dB	---	9.00 kHz (CISPR)
2	1	10.285 MHz	38.060 dBµV	33.277 dBµV	---	-21.940 dB	-16.723 dB	---	9.00 kHz (CISPR)
3	1	11.073 MHz	38.590 dBµV	34.769 dBµV	---	-21.410 dB	-15.231 dB	---	9.00 kHz (CISPR)
4	1	11.361 MHz	38.390 dBµV	34.122 dBµV	---	-21.610 dB	-15.878 dB	---	9.00 kHz (CISPR)
5	1	11.917 MHz	37.975 dBµV	33.643 dBµV	---	-22.025 dB	-16.357 dB	---	9.00 kHz (CISPR)
6	1	12.793 MHz	36.718 dBµV	32.744 dBµV	---	-23.282 dB	-17.256 dB	---	9.00 kHz (CISPR)

Plot 6-31. Line Conducted Plot with Bluetooth LE (N)

Notes:

1. All modes of operation were investigated and the worst-case emissions are reported using channel 19. The emissions found were not affected by the choice of channel used during testing.
2. The limit for Class B device(s) 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.

© 2015 PCTEST Engineering Laboratory, Inc.

7.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **Samsung Electronics Co., Ltd. Portable Handset FCC ID: A3LSMG920A** is in compliance with Part 15C of the FCC Rules.

© 2015 PCTEST Engineering Laboratory, Inc.