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# 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:**
7/7 - 7/24/2014
**Test Site/Location:**
PCTEST Lab, Columbia, MD, USA
**Test Report Serial No.:**
0Y1407071350.A3L

| | |
|---|---|
| **FCC ID:** | **A3LSMG901F** |
| **APPLICANT:** | **Samsung Electronics, Co. Ltd.** |

| | |
|---|---|
| **Application Type:** | Certification |
| **Model:** | SM-G901F |
| **EUT Type:** | Portable Handset |
| **Max. RF Output Power:** | 1.414 mW (1.51 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 |

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


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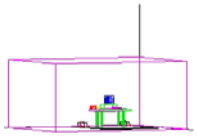

# MEASUREMENT REPORT
## FCC Part 15.247

## § 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 15.247 |
| **BASE MODEL:** | SM-G901F |
| **FCC ID:** | A3LSMG901F |
| **FCC CLASSIFICATION:** | Digital Transmission System (DTS) |
| **Test Device Serial No.:** | 7JULY-4, 7JULY-5 ☐ Production ☒ Pre-Production ☐ Engineering |
| **DATE(S) OF TEST:** | 7/7 - 7/24/2014 |
| **TEST REPORT S/N:** | 0Y1407071350.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 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.

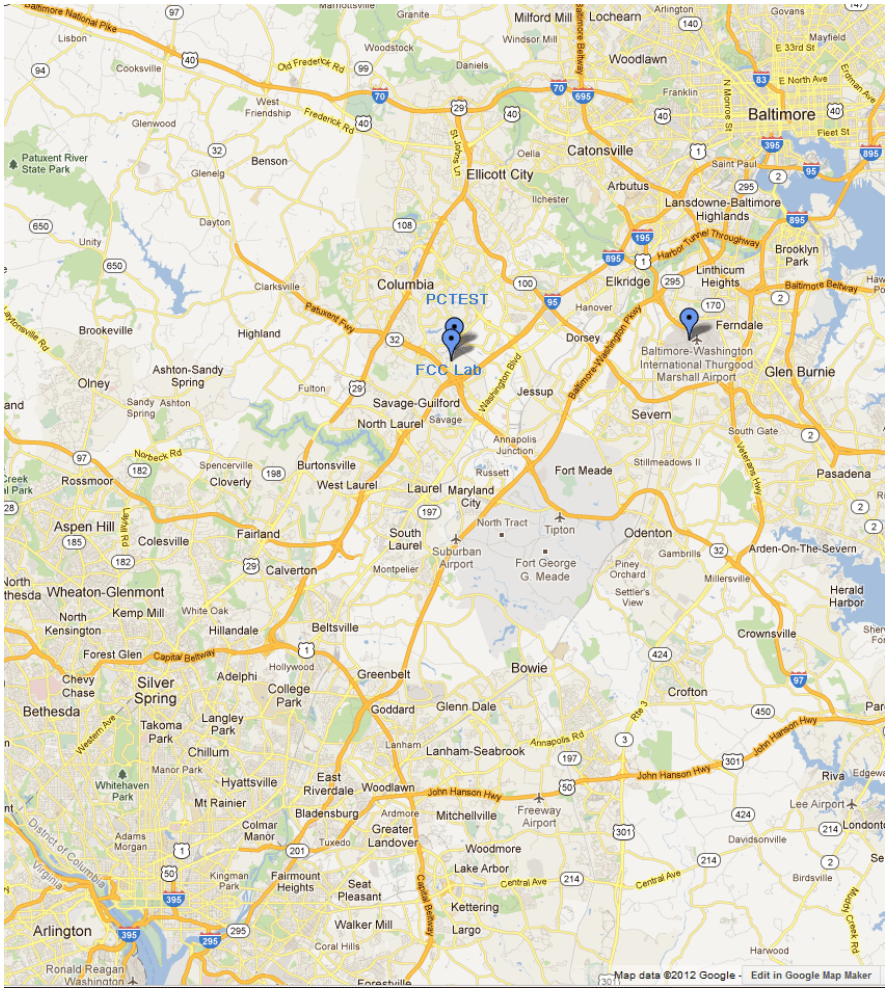


**Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area**


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# 2.0 PRODUCT INFORMATION

## 2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Portable Handset FCC ID: A3LSMG901F**. 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, 802.11a/b/g/n/ac WLAN, 802.11a/n/ac UNII, Bluetooth (1x, EDR, LE), NFC, ANT+

## 2.3 Test Configuration

The Samsung Portable Handset FCC ID: A3LSMG901F 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, 3.3, and 6.1 of this test report for a description of the AC line conducted emissions, radiated emissions, and antenna port conducted emissions test setups, respectively.

## 2.4 EMI Suppression Device(s)/Modifications

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

## 2.5 Labeling Requirements

<u>Per 15.19; Docket 95-19</u>

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphlet supplied to the user and be readily visible to the purchaser at the time of purchase. However, when the device is so small wherein placement of the label with specified statement is not practical, only the trade name and FCC ID must be displayed on the device per Section 15.19(a)(5). Please see attachment for FCC ID label and label location.


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# 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 Portable Handset FCC ID: A3LSMG901F.**

**Deviation from measurement procedure…….....None**

## 3.2 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 6.9. Automated test software was used to perform the AC line conducted emissions testing. Automated measurement software utilized is Rohde & Schwarz EMC32, Version 8.51.0.


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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. For the EUT positioning, "H" is defined with the EUT lying flat on the test surface, "H2" is defined with the EUT standing up on its side, and "V" is defined with the EUT standing upright.


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# 4.0 ANTENNA REQUIREMENTS

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

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

**Conclusion:**

The **Samsung Portable Handset FCC ID: A3LSMG901F** unit complies with the requirement of §15.203.

| Ch. | Frequency (MHz) |
|---|---|
| 0 | 2402 |
| : | : |
| 19 | 2440 |
| : | : |
| 39 | 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 |
|---|---|---|---|---|---|---|
| - | RE1 | Radiated Emissions Cable Set (UHF/EHF) | 5/29/2014 | Annual | 5/29/2015 | N/A |
| - | WL25-1 | Conducted Cable Set (25GHz) | 1/29/2014 | Annual | 1/29/2015 | N/A |
| Agilent | 8447D | Broadband Amplifier | 5/30/2014 | Annual | 5/30/2015 | 2443A01900 |
| Agilent | E4448A | PSA (3Hz-50GHz) Spectrum Analyzer | 4/16/2014 | Annual | 4/16/2015 | US42510244 |
| Agilent | N9020A | MXA Signal Analyzer | 10/29/2013 | Annual | 10/29/2014 | US46470561 |
| 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 |
| Huber+Suhner | Sucoflex 102A | 40GHz Radiated Cable | 1/30/2014 | Annual | 1/30/2015 | 251425001 |
| K & L | 11SH10-3075/U18000 | High Pass Filter | 5/2/2014 | Annual | 5/2/2015 | 2 |
| Pasternack | NMLC-1 | Line Conducted Emissions Cable (NM) | 1/28/2014 | Annual | 1/28/2015 | N/A |
| 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 |
| Rohde & Schwarz | ESU26 | EMI Test Receiver (26.5GHz) | 1/27/2014 | Annual | 1/27/2015 | 100342 |
| 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**


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# 6.0 TEST RESULTS

## 6.1 Summary

Company Name: Samsung Electronics, Co. Ltd.

FCC ID: A3LSMG901F

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 |
| 15.207 | AC Conducted Emissions 150kHz – 30MHz | < FCC 15.207 limits or < RSS-Gen table 2 limits | LINE CONDUCTED | PASS | Section 6.9 |

**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.


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## 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.

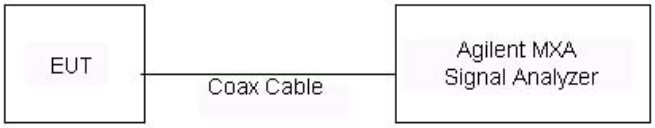


**Figure 6-1. Test Instrument & Measurement Setup**

**Test Notes**

None


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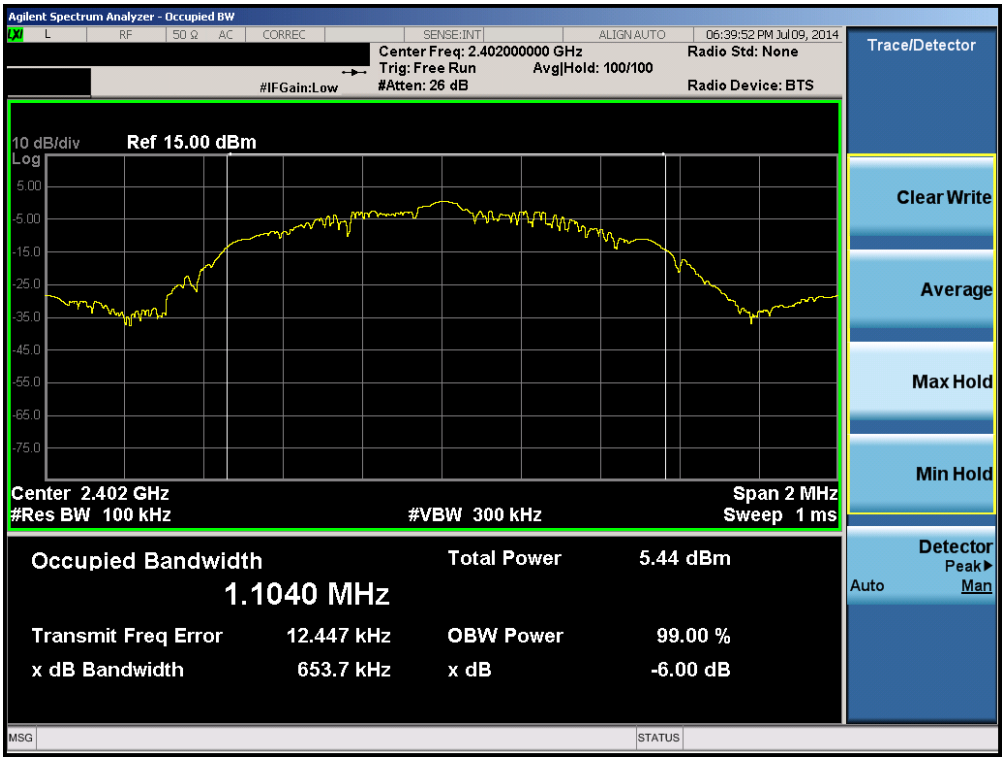
| Frequency [MHz] | Channel No. | Bluetooth Mode | Measured Bandwidth [kHz] | Minimum Bandwidth [kHz] | Pass / Fail |
|---|---|---|---|---|---|
| 2402 | 0 | LE | 653.7 | 500 | Pass |
| 2440 | 19 | LE | 660.5 | 500 | Pass |
| 2480 | 39 | LE | 655.7 | 500 | Pass |

**Table 6-2. Conducted Bandwidth Measurements**




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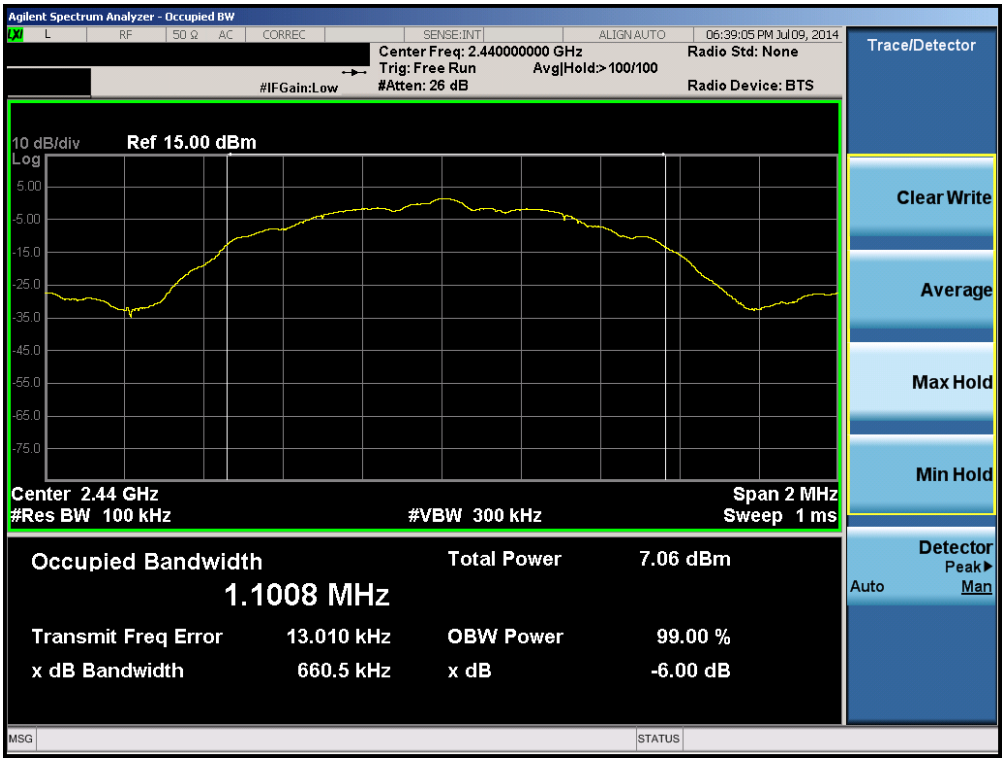
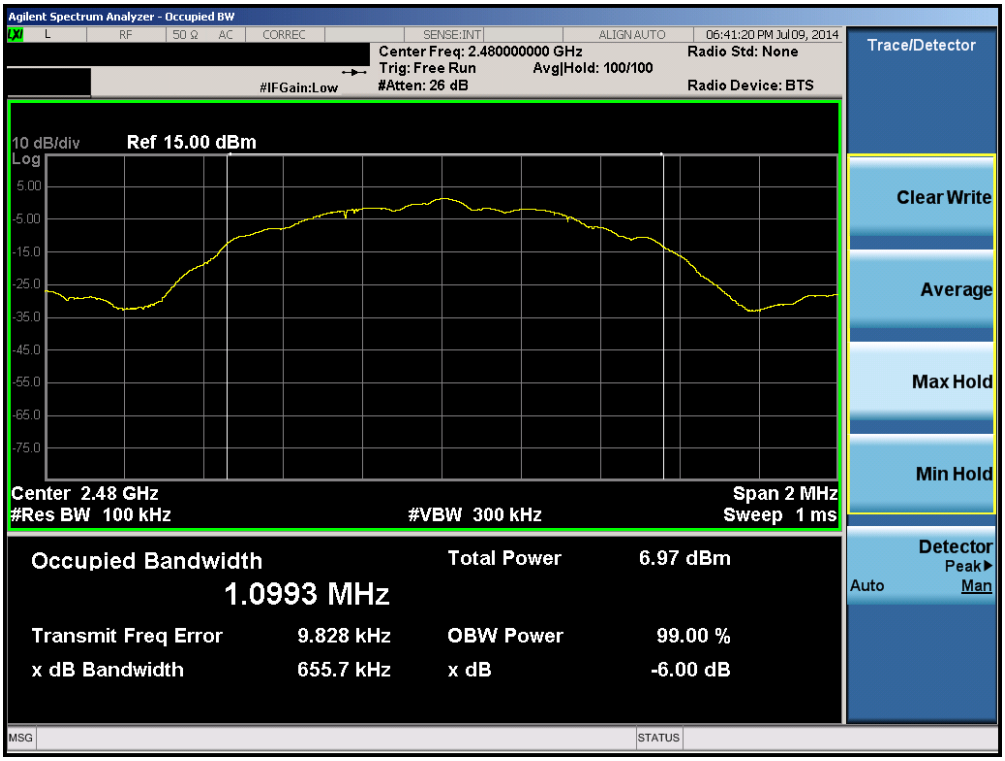



**Plot 6-2. 6dB Bandwidth Plot (Bluetooth (LE) – Ch. 19)**




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

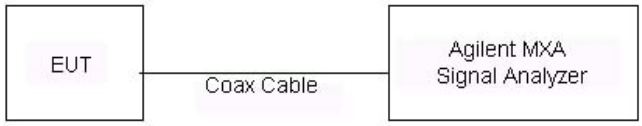


**Figure 6-2. Test Instrument & Measurement Setup**

**Test Notes**

None


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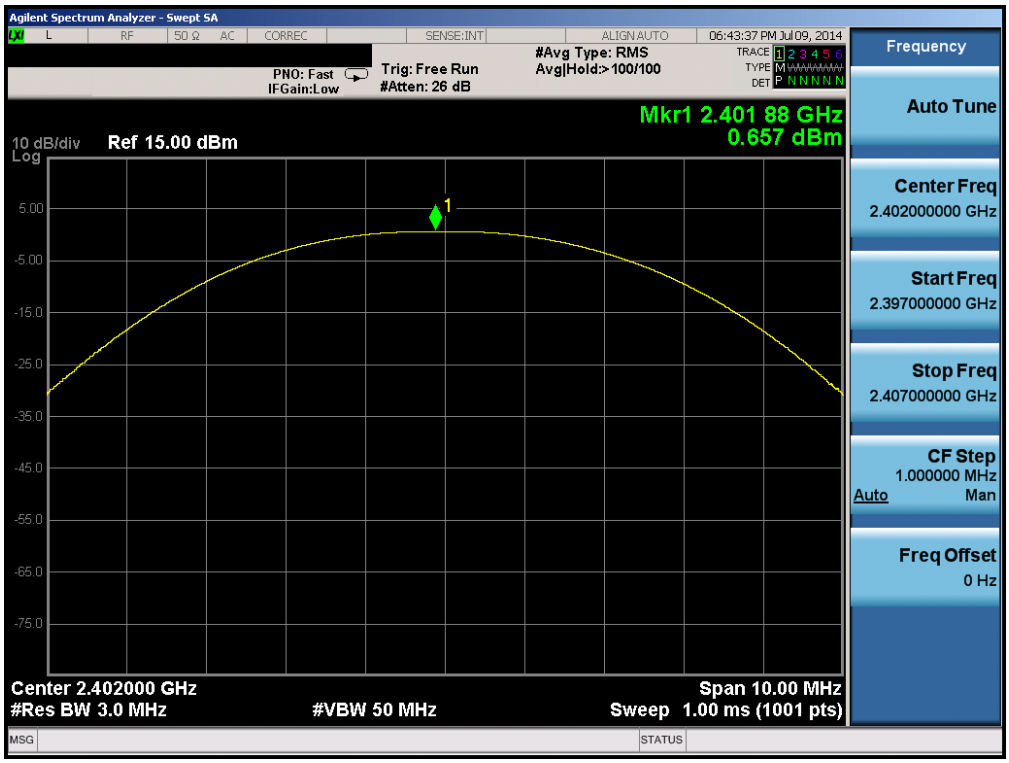
| Frequency [MHz] | Channel No. | Bluetooth Mode | Peak Conducted Power | |
|---|---|---|---|---|
| | | | [dBm] | [mW] |
| 2402 | 0 | LE | 0.66 | 1.163 |
| 2440 | 19 | LE | 1.51 | 1.414 |
| 2480 | 39 | LE | 1.45 | 1.397 |

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




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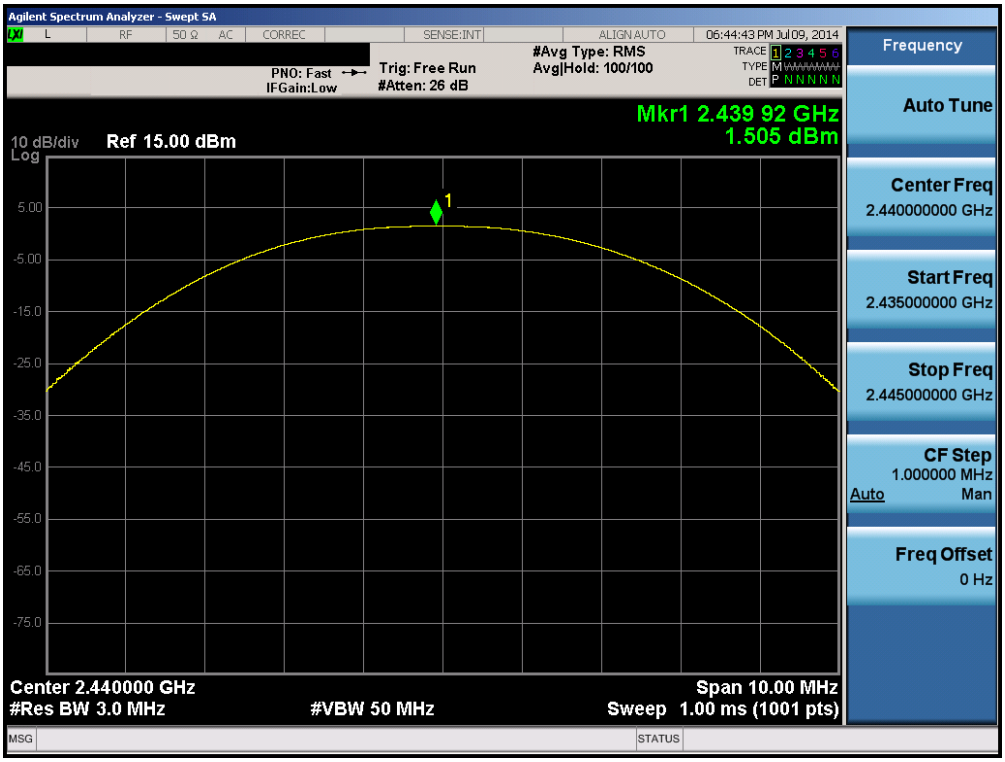
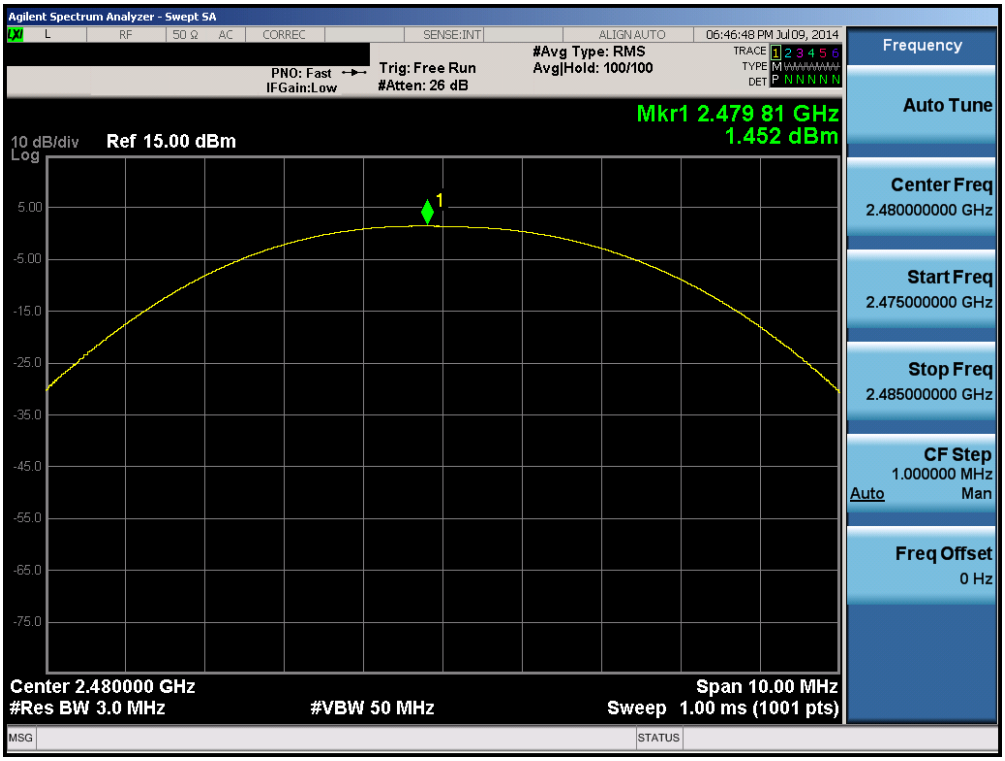



**Plot 6-5. Peak Power Plot (Bluetooth (LE) – Ch. 19)**




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

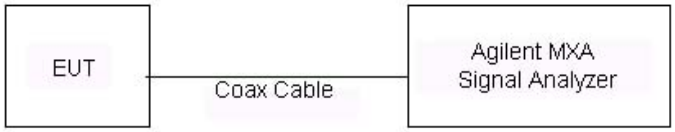


**Figure 6-3. Test Instrument & Measurement Setup**

**Test Notes**

None


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| Frequency [MHz] | Channel No. | Bluetooth Mode | Measured Power Spectral Density [dBm] | Maximum Permissible Power Density [dBm / 3kHz] | Margin [dB] |
|---|---|---|---|---|---|
| 2402 | 0 | LE | -0.11 | 8.0 | -8.11 |
| 2440 | 19 | LE | 0.77 | 8.0 | -7.23 |
| 2480 | 39 | LE | 0.67 | 8.0 | -7.33 |

**Table 6-4. Conducted Power Density Measurements**

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


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

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


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## 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.

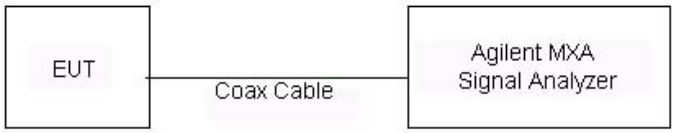


**Figure 6-4. Test Instrument & Measurement Setup**

**Test Notes**

None


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

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


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## 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.

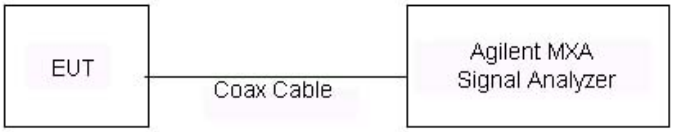


**Figure 6-5. Test Instrument & Measurement Setup**


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## 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.


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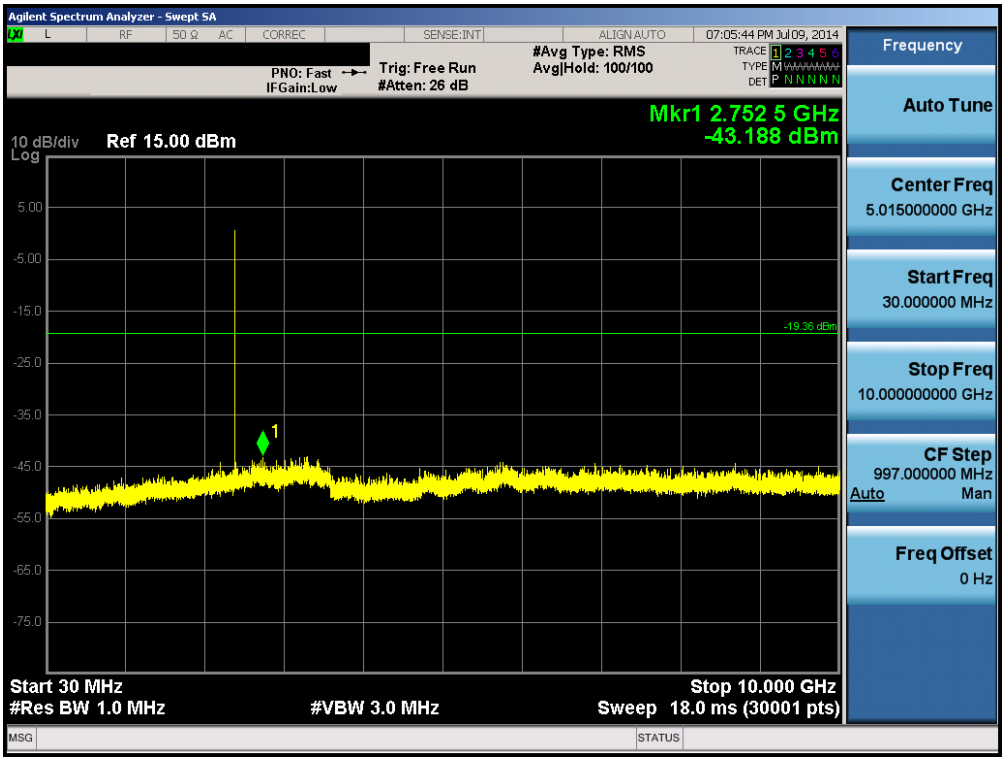


**Plot 6-12. Conducted Spurious Plot (Bluetooth (LE) – Ch. 0)**

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


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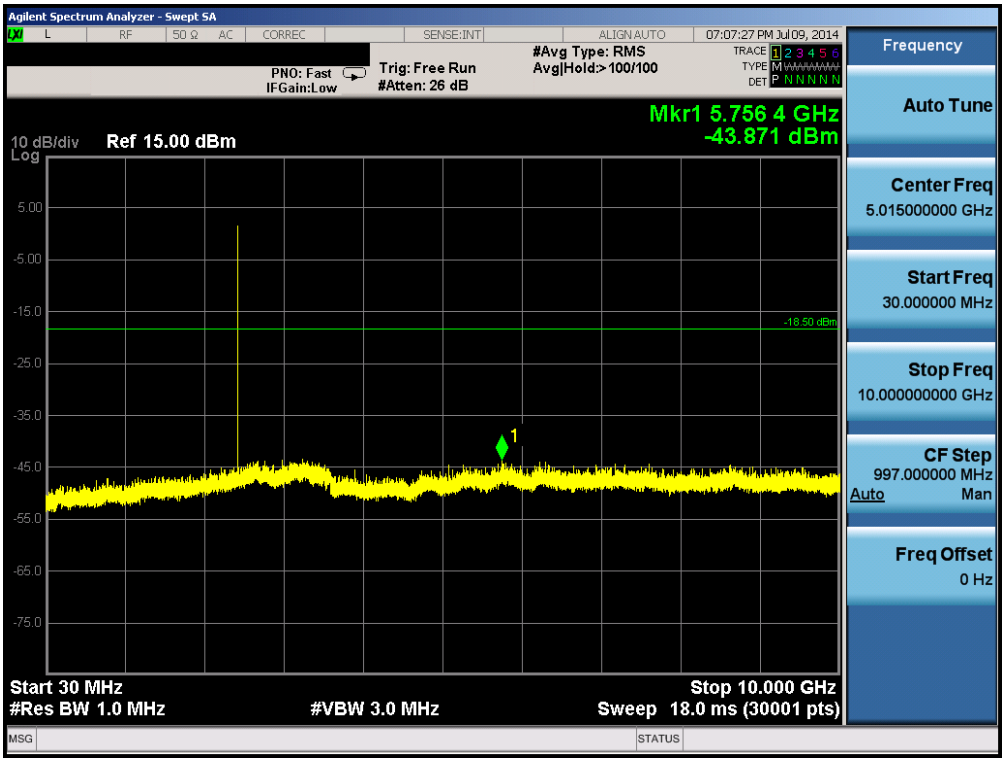


**Plot 6-14. Conducted Spurious Plot (Bluetooth (LE) – Ch. 19)**

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


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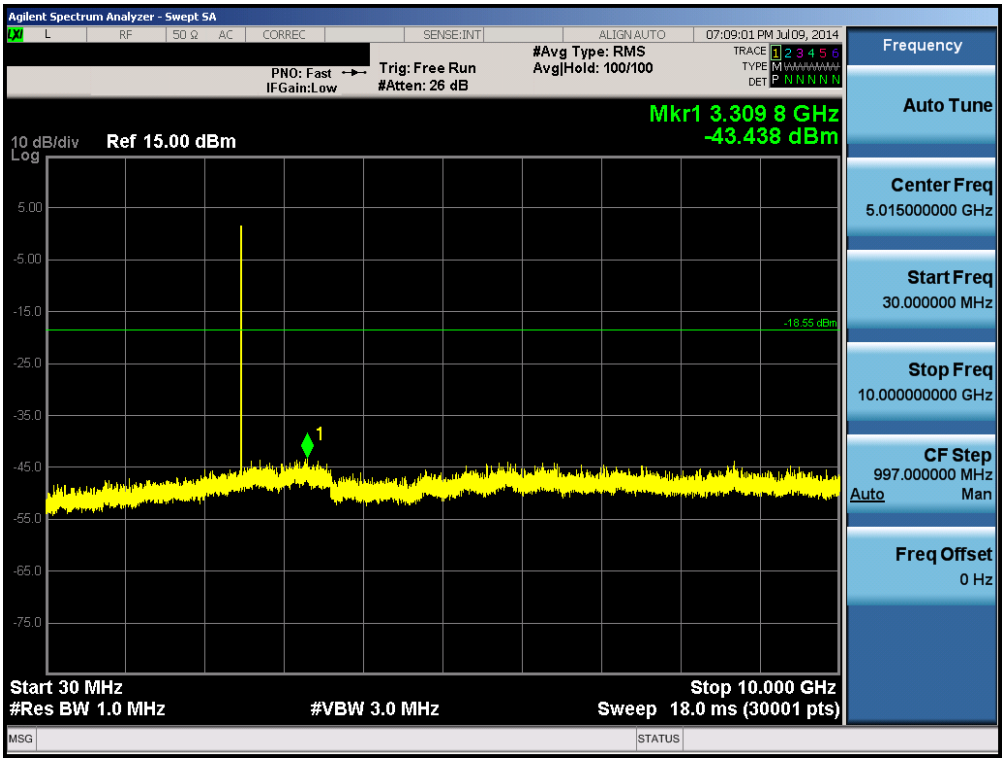


**Plot 6-16. Conducted Spurious Plot (Bluetooth (LE) – Ch. 39)**

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


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## 6.7 Radiated Spurious Emission Measurements

**§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] |
|---|---|---|
| 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 6-5. Radiated Limits**

**Test Procedures Used**

KDB 558074 v03r02 – Section 12.1, 12.7

**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


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**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.

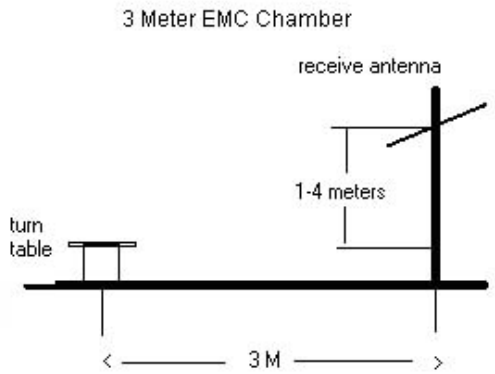


**Figure 6-6. Test Instrument & Measurement Setup**

**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.


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4. The EUT is supplied with a new/fully-recharged battery. The battery for this model contains an embedded NFC antenna.
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.

## 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


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## 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] | EUT Pol. [H/H2/V] | AFCL [dB] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|
| 4804.00 | -114.74 | Avg | H | H | 40.94 | 33.20 | 53.98 | -20.78 |
| 4804.00 | -101.54 | Peak | H | H | 40.94 | 46.40 | 73.98 | -27.58 |
| 12010.00 | -117.59 | Avg | H | H | 45.51 | 34.91 | 53.98 | -19.06 |
| 12010.00 | -103.85 | Peak | H | H | 45.51 | 48.65 | 73.98 | -25.32 |

**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] | EUT Pol. [H/H2/V] | AFCL [dB] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|
| 4880.00 | -114.31 | Avg | H | H | 40.96 | 33.65 | 53.98 | -20.33 |
| 4880.00 | -102.06 | Peak | H | H | 40.96 | 45.90 | 73.98 | -28.08 |
| 7320.00 | -112.84 | Avg | H | H | 41.17 | 35.33 | 53.98 | -18.65 |
| 7320.00 | -102.45 | Peak | H | H | 41.17 | 45.72 | 73.98 | -28.26 |
| 12200.00 | -117.75 | Avg | H | H | 45.82 | 35.07 | 53.98 | -18.91 |
| 12200.00 | -103.78 | Peak | H | H | 45.82 | 49.04 | 73.98 | -24.94 |

**Table 6-8. Radiated Measurements @ 3 meters**


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## 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] | EUT Pol. [H/H2/V] | AFCL [dB] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|
| 4960.00 | -115.83 | Avg | H | H | 40.93 | 32.10 | 53.98 | -21.88 |
| 4960.00 | -103.04 | Peak | H | H | 40.93 | 44.89 | 73.98 | -29.09 |
| 7440.00 | -116.57 | Avg | H | H | 40.89 | 31.32 | 53.98 | -22.66 |
| 7440.00 | -100.88 | Peak | H | H | 40.89 | 47.01 | 73.98 | -26.97 |
| 12400.00 | -118.71 | Avg | H | H | 46.01 | 34.30 | 53.98 | -19.67 |
| 12400.00 | -105.16 | Peak | H | H | 46.01 | 47.85 | 73.98 | -26.12 |

**Table 6-9. Radiated Measurements @ 3 meters**


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## 6.8 Radiated Restricted Band Edge Measurements

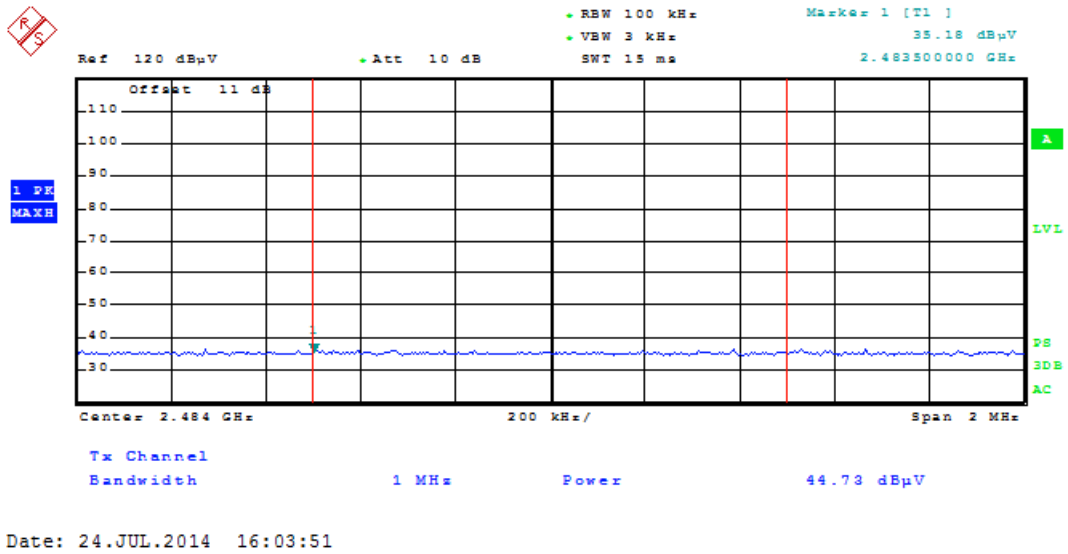
**§15.205 §15.209**

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 6-18. 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 13.3.4, 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.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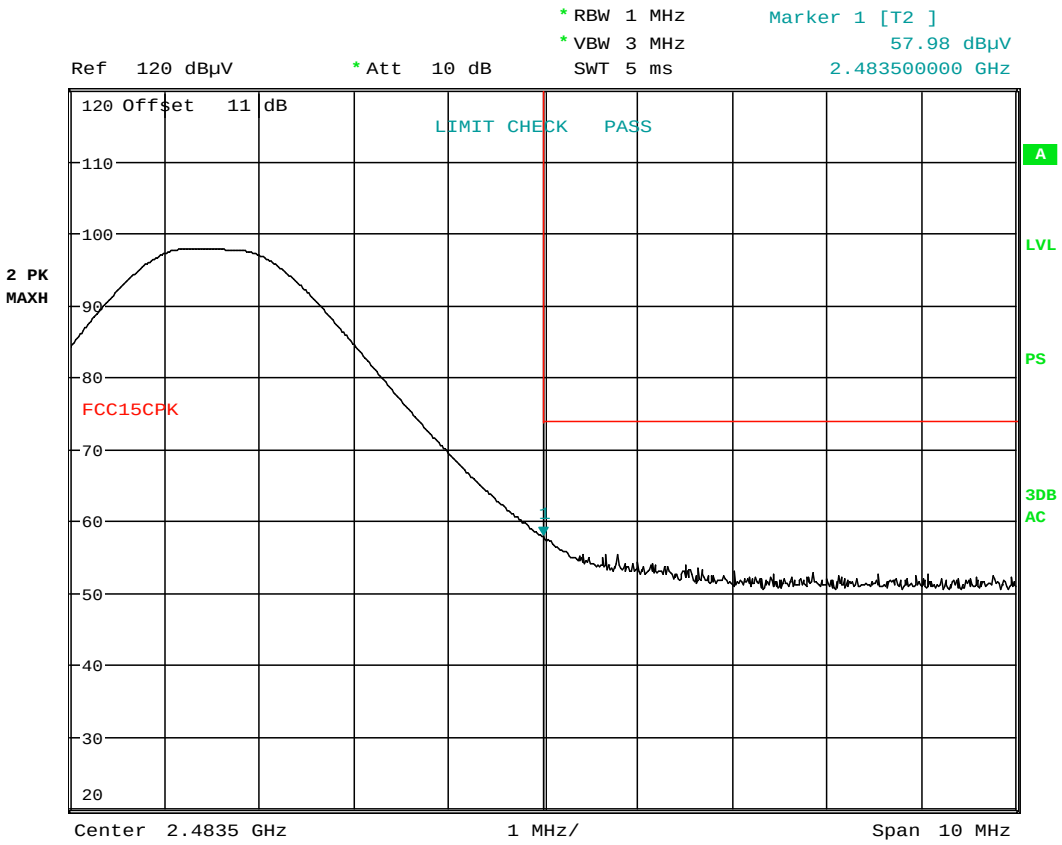
## Radiated Restricted Band Edge Measurements
**§15.205 §15.209**

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: 24.JUL.2014 15:49:52

**Plot 6-19. Radiated Restricted Upper Band Edge Measurement (Peak)**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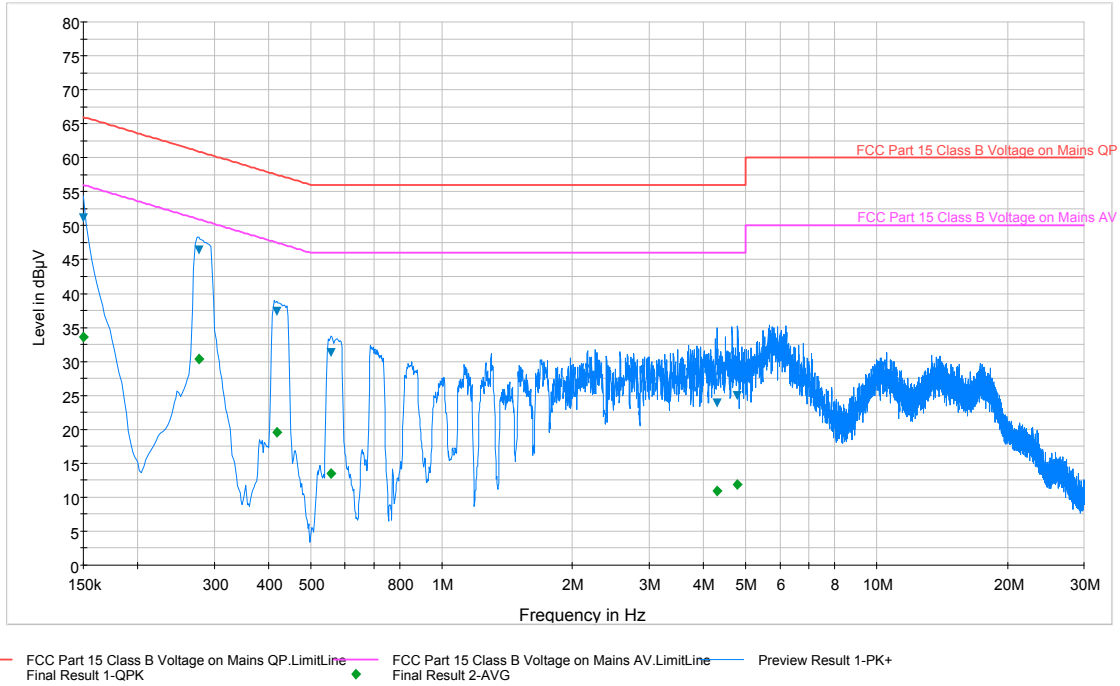
## 6.9 Line-Conducted Test Data

**§15.207; RSS-Gen [7.2.2]**




**Plot 6-20. Line Conducted Plot with Bluetooth LE (L1)**

| Frequency MHz | Line | Corr. dB | QuasiPeak dBµV | Limit dBµV | Margin dB | Average dBµV | Limit dBµV | Margin dB |
|---|---|---|---|---|---|---|---|---|
| 0.150 | L1 | 0.2 | 51.10 | 66.00 | 14.90 | 33.60 | 56.00 | 22.40 |
| 0.276 | L1 | 0.1 | 46.40 | 60.90 | 14.50 | 30.40 | 50.90 | 20.60 |
| 0.418 | L1 | 0.1 | 37.40 | 57.50 | 20.10 | 19.50 | 47.50 | 28.00 |
| 0.557 | L1 | 0.1 | 31.30 | 56.00 | 24.70 | 13.50 | 46.00 | 32.50 |
| 4.297 | L1 | 0.2 | 23.90 | 56.00 | 32.10 | 10.90 | 46.00 | 35.10 |
| 4.796 | L1 | 0.2 | 25.00 | 56.00 | 31.00 | 11.90 | 46.00 | 34.10 |

**Table 6-10. Line Conducted Data 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.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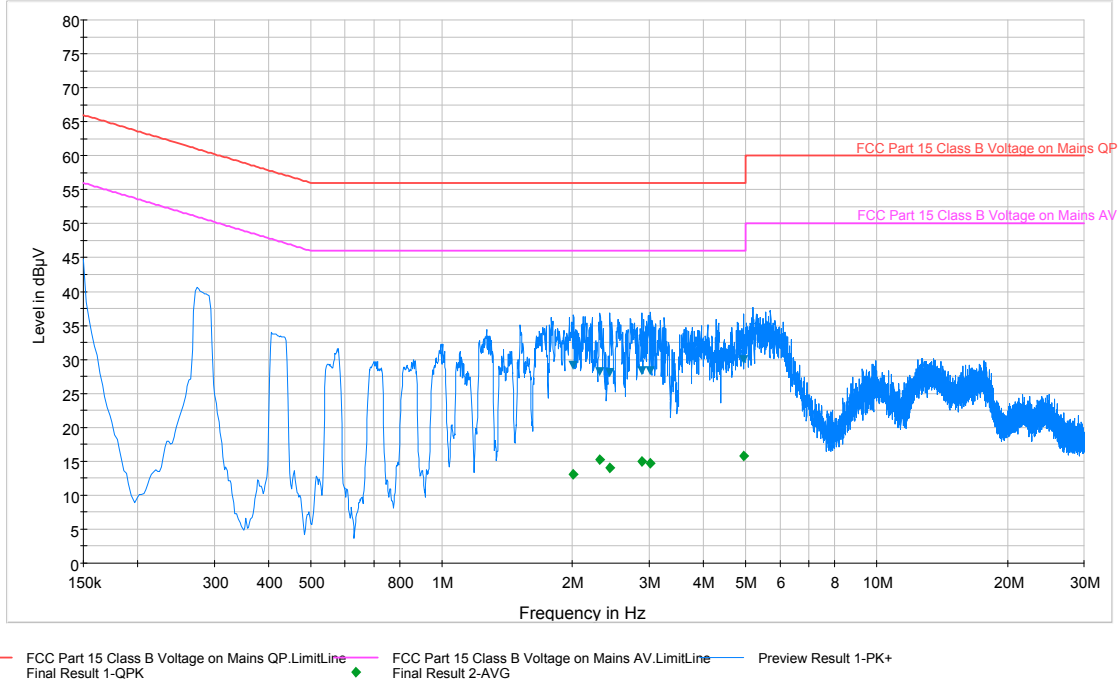
# Line-Conducted Test Data

**§15.207; RSS-Gen [7.2.2]**




**Plot 6-21. Line Conducted Plot with Bluetooth LE (N)**

| Frequency MHz | Line | Corr. dB | QuasiPeak dBµV | Limit dBµV | Margin dB | Average dBµV | Limit dBµV | Margin dB |
|---|---|---|---|---|---|---|---|---|
| 2.011 | N | 0.2 | 29.20 | 56.00 | 26.80 | 13.20 | 46.00 | 32.80 |
| 2.315 | N | 0.2 | 28.20 | 56.00 | 27.80 | 15.20 | 46.00 | 30.80 |
| 2.438 | N | 0.2 | 28.10 | 56.00 | 27.90 | 14.10 | 46.00 | 31.90 |
| 2.886 | N | 0.2 | 28.40 | 56.00 | 27.60 | 15.00 | 46.00 | 31.00 |
| 3.023 | N | 0.2 | 28.40 | 56.00 | 27.60 | 14.70 | 46.00 | 31.30 |
| 4.954 | N | 0.2 | 29.90 | 56.00 | 26.10 | 15.80 | 46.00 | 30.20 |

**Table 6-11. Line Conducted Data 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.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# 7.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **Samsung Portable Handset FCC ID: A3LSMG901F** is in compliance with Part 15C of the FCC Rules.


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