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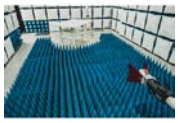

# MEASUREMENT REPORT
## FCC PART 15.247 / ISED RSS-247 Bluetooth (Low Energy)

**Applicant Name:**
Samsung Electronics Co., Ltd.
129, Samsung-ro,
Yeongtong-gu, Suwon-si
Gyeonggi-do, 16677, Korea

**Date of Testing:**
05/22 - 07/10/2019
**Test Site/Location:**
PCTEST Lab. Columbia, MD, USA
**Test Report Serial No.:**
1M1905220084-11.A3L

| | |
|---|---|
| **FCC ID:** | **A3LSMN970U** |
| **IC:** | **649E-SMN970U** |
| **APPLICANT:** | **Samsung Electronics Co., Ltd.** |

| | |
|---|---|
| **Application Type:** | Certification |
| **Model:** | SM-N970U |
| **Additional Model(s):** | SM-N970U1, SM-N970XU, SM-N970W |
| **HVIN:** | SM-N970W |
| **EUT Type:** | Portable Handset |
| **Max. RF Output Power:** | 8.466 mW (9.28 dBm) Peak Conducted |
| **Frequency Range:** | 2402 – 2480MHz |
| **FCC Classification:** | Digital Transmission System (DTS) |
| **FCC Rule Part(s):** | Part 15 Subpart C (15.247) |
| **ISED Specification:** | RSS-247 Issue 2 |
| **Test Procedure(s):** | ANSI C63.10-2013, KDB 558074 D01 v05r02, KDB 648474 D03 v01r04 |

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013 and KDB 558074 D01 v05r02. 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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# 1.0 INTRODUCTION

## 1.1 Scope

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

## 1.2 PCTEST Test Location

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

## 1.3 Test Facility / Accreditations

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

- PCTEST is an ISO 17025-2005 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- PCTEST facility is a registered (2451B) test laboratory with the site description on file with ISED.




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# 2.0 PRODUCT INFORMATION

## 2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Portable Handset FCC ID: A3LSMN970U**. 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.

**Test Device Serial No.:** 8786B, 8778B, 1202M, 1210M, 1445M

## 2.2 Device Capabilities

This device contains the following capabilities:

800/850/1900 CDMA/EvDO Rev0/A, 1x Advanced (BC0, BC1, BC10), 850/1900 GSM/GPRS/EDGE, 850/1700/1900 WCDMA/HSPA, Multi-band LTE, 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, Bluetooth (1x, EDR, LE), NFC, ANT+, Wireless Power Transfer

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

**Table 2-1. Frequency / Channel Operations**

## 2.3 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013 and KDB 558074 D01 v05r02. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups, and 7.2, 7.3, 7.4, 7.5, and 7.6 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 v01r04. Additional radiated spurious emission measurements were performed with the EUT lying flat on an authorized wireless charging pad (WCP) Model: EP-N5100 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.



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# 3.0 DESCRIPTION OF TESTS

## 3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 v05r02 were used in the measurement of the EUT**.**

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

## 3.2 AC Line Conducted Emissions

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

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

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

Line conducted emissions test results are shown in Section 7.9. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.




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## 3.3 Radiated Emissions

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

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

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

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 474788 D01.

## 3.4 Environmental Conditions

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



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# 4.0 ANTENNA REQUIREMENTS

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

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

**Conclusion:**

The EUT complies with the requirement of §15.203.



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# 5.0 MEASUREMENT UNCERTAINTY

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

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




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# 6.0 TEST EQUIPMENT CALIBRATION DATA

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

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| - | WL25-1 | Conducted Cable Set (25GHz) | 10/31/2018 | Annual | 10/31/2019 | WL25-1 |
| - | WL25-2 | Conducted Cable Set (25GHz) | 8/23/2018 | Annual | 8/23/2019 | WL25-2 |
| Agilent | N9038A | MXE EMI Receiver | 7/11/2018 | Annual | 7/11/2019 | MY51210133 |
| Agilent | N9030A | PXA Signal Analyzer (44GHz) | 6/12/2018 | Annual | 6/12/2020 | MY52350166 |
| Anritsu | MA2411B | Pulse Power Sensor | 8/22/2018 | Annual | 8/22/2019 | 1315051 |
| Anritsu | ML2495A | Power Meter | 10/5/2018 | Annual | 10/5/2019 | 1328004 |
| Anritsu | ML2496A | Power Meter | 7/18/2018 | Annual | 7/18/2019 | 1405003 |
| Anritsu | MA2411B | Pulse Power Sensor | 9/27/2018 | Annual | 9/27/2019 | 1339026 |
| Com-Power | PAM-103 | Pre-Amplifier (1-1000MHz) | 8/8/2018 | Annual | 8/8/2019 | 441128 |
| Com-Power | AL-130 | 9kHz - 30MHz Loop Antenna | 10/10/2017 | Biennial | 10/10/2019 | 121034 |
| Com-Power | PAM-103 | Pre-Amplifier (1-1000MHz) | 9/17/2018 | Annual | 9/17/2019 | 441119 |
| Emco | 3115 | Horn Antenna (1-18GHz) | 3/28/2018 | Biennial | 3/28/2020 | 9704-5182 |
| Emco | 3116 | Horn Antenna (18 - 40GHz) | 6/7/2018 | Triennial | 6/7/2021 | 9203-2178 |
| Emco | 3160-09 | Small Horn (18 - 26.5GHz) | 8/9/2018 | Biennial | 8/9/2020 | 00135427 |
| ETS-Lindgren | 3816/2NM | Line Impedance Stabilization Network | 6/18/2018 | Biennial | 6/18/2020 | 114451 |
| Huber + Suhner | Sucoflex 102A | 40GHz Radiated Cable Set | 8/23/2018 | Annual | 8/23/2019 | 251425001 |
| Pasternack | NMLC-2 | Line Conducted Emissions Cable (NM) | 8/23/2018 | Annual | 8/23/2019 | NMLC-2 |
| Rohde & Schwarz | TS-PR26 | 18-26.5 GHz Pre-Amplifier | 9/19/2018 | Annual | 9/19/2019 | 100040 |
| Rohde & Schwarz | ESU26 | EMI Test Receiver (26.5GHz) | 6/5/2019 | Annual | 06/05/2020 | 100342 |
| Rohde & Schwarz | ESU40 | EMI Test Receiver (40GHz) | 8/9/2018 | Annual | 8/9/2019 | 100348 |
| Rohde & Schwarz | SFUNIT-Rx | Shielded Filter Unit | 7/18/2018 | Annual | 7/18/2019 | 102134 |
| Solar Electronics | 8012-50-R-24-BNC | Line Impedance Stabilization Network | 8/14/2017 | Biennial | 8/14/2019 | 310233 |
| Sunol | JB5 | Bi-Log Antenna (30M - 5GHz) | 4/19/2018 | Biennial | 4/19/2020 | A051107 |

**Table 6-1. Annual Test Equipment Calibration Schedule**

**Note:**

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




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# 7.0 TEST RESULTS

## 7.1 Summary

Company Name: Samsung Electronics Co., Ltd.

FCC ID: A3LSMN970U

FCC Classification: Digital Transmission System (DTS)

Number of Channels: 40

| FCC Part Section(s) | RSS Section(s) | Test Description | Test Limit | Test Condition | Test Result | Reference |
|---|---|---|---|---|---|---|
| 15.247(a)(2) | RSS-247 [5.2] | 6dB Bandwidth | > 500kHz | CONDUCTED | PASS | Section 7.2 |
| 15.247(b)(3) | RSS-247 [5.4(4)] | Transmitter Output Power | < 1 Watt | | PASS | Sections 7.3 |
| 15.247(e) | RSS-247 [5.2] | Transmitter Power Spectral Density | < 8dBm / 3kHz Band | | PASS | Section 7.4 |
| 15.247(d) | RSS-247 [5.5] | Band Edge / Out-of-Band Emissions | ≥ 20dBc | | PASS | Sections 7.5, 7.6 |
| 15.205 15.209 | RSS-Gen [8.9] | General Field Strength Limits (Restricted Bands and Radiated Emission Limits) | Emissions in restricted bands must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9]) | RADIATED | PASS | Sections 7.7, 7.8 |
| 15.207 | RSS-Gen [8.8] | AC Conducted Emissions 150kHz – 30MHz | < FCC 15.207 limits (RSS-Gen[8.8]) | LINE CONDUCTED | PASS | Section 7.9 |

**Table 7-1. Summary of Test Results**

**Notes:**

1. All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.
2. The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3. All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
4. For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Bluetooth LE Automation," Version 3.1.
5. For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Chamber Automation," Version 0.2.16.




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## 7.2 6dB Bandwidth Measurement – Bluetooth (LE)

**§15.247(a.2); RSS-247 [5.2]**

### Test Overview and Limit

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

***The minimum permissible 6dB bandwidth is 500 kHz.***

### Test Procedure Used

ANSI C63.10-2013 – Section 11.8.2 Option 2
KDB 558074 D01 v05r01 – Section 8.2

### 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 7-1. Test Instrument & Measurement Setup**

### Test Notes

None




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| Frequency [MHz] | Data Rate | Channel No. | Bluetooth Mode | Measured Bandwidth [kHz] | Minimum Bandwidth [kHz] | Pass / Fail |
|---|---|---|---|---|---|---|
| 2402 | 125 kbps | 0 | LE | 704.0 | 500 | Pass |
| 2440 | 125 kbps | 19 | LE | 704.9 | 500 | Pass |
| 2480 | 125 kbps | 39 | LE | 708.6 | 500 | Pass |
| 2402 | 500 kbps | 0 | LE | 748.8 | 500 | Pass |
| 2440 | 500 kbps | 19 | LE | 749.9 | 500 | Pass |
| 2480 | 500 kbps | 39 | LE | 744.9 | 500 | Pass |
| 2402 | 1 Mbps | 0 | LE | 684.6 | 500 | Pass |
| 2440 | 1 Mbps | 19 | LE | 692.6 | 500 | Pass |
| 2480 | 1 Mbps | 39 | LE | 692.0 | 500 | Pass |
| 2402 | 2 Mbps | 0 | LE | 659.3 | 500 | Pass |
| 2440 | 2 Mbps | 19 | LE | 656.6 | 500 | Pass |
| 2480 | 2 Mbps | 39 | LE | 657.6 | 500 | Pass |

**Table 7-2. Conducted Bandwidth Measurements**




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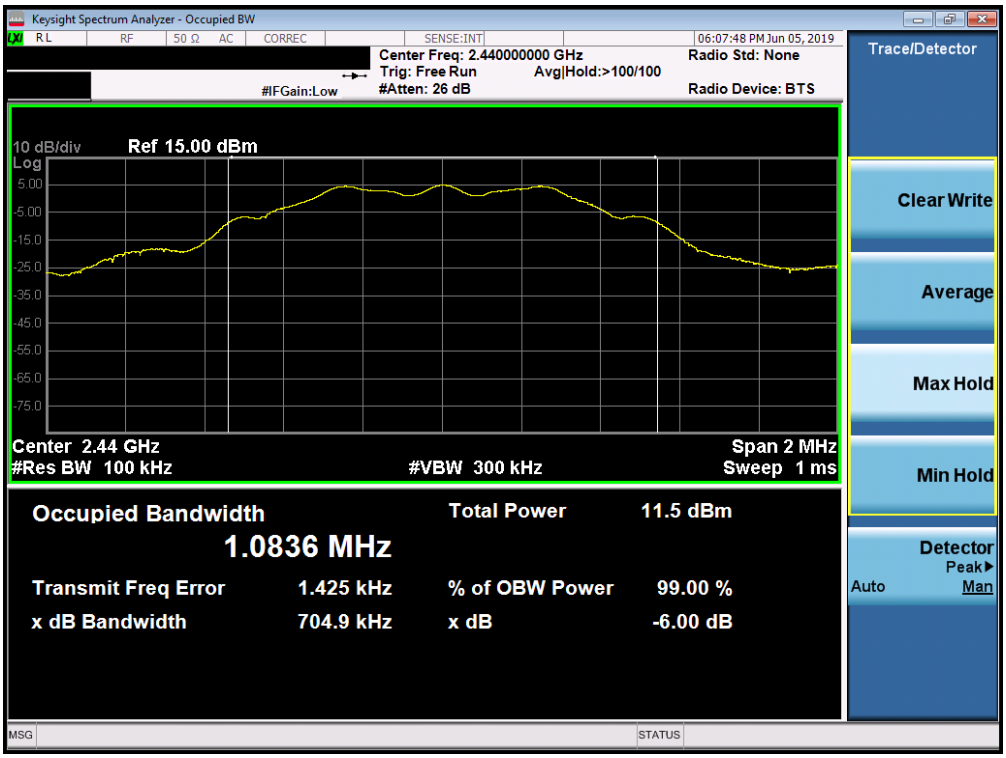
**Plot 7-1. 6dB Bandwidth Plot (Bluetooth (LE), 125kbps – Ch. 0)**




**Plot 7-2. 6dB Bandwidth Plot (Bluetooth (LE), 125kbps – Ch. 19)**

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**Plot 7-3. 6dB Bandwidth Plot (Bluetooth (LE), 125kbps – Ch. 39)**

**Plot 7-4. 6dB Bandwidth Plot (Bluetooth (LE), 500kbps – Ch. 0)**




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**Plot 7-5. 6dB Bandwidth Plot (Bluetooth (LE), 500kbps – Ch. 19)**

**Plot 7-6. 6dB Bandwidth Plot (Bluetooth (LE), 500kbps – Ch. 39)**



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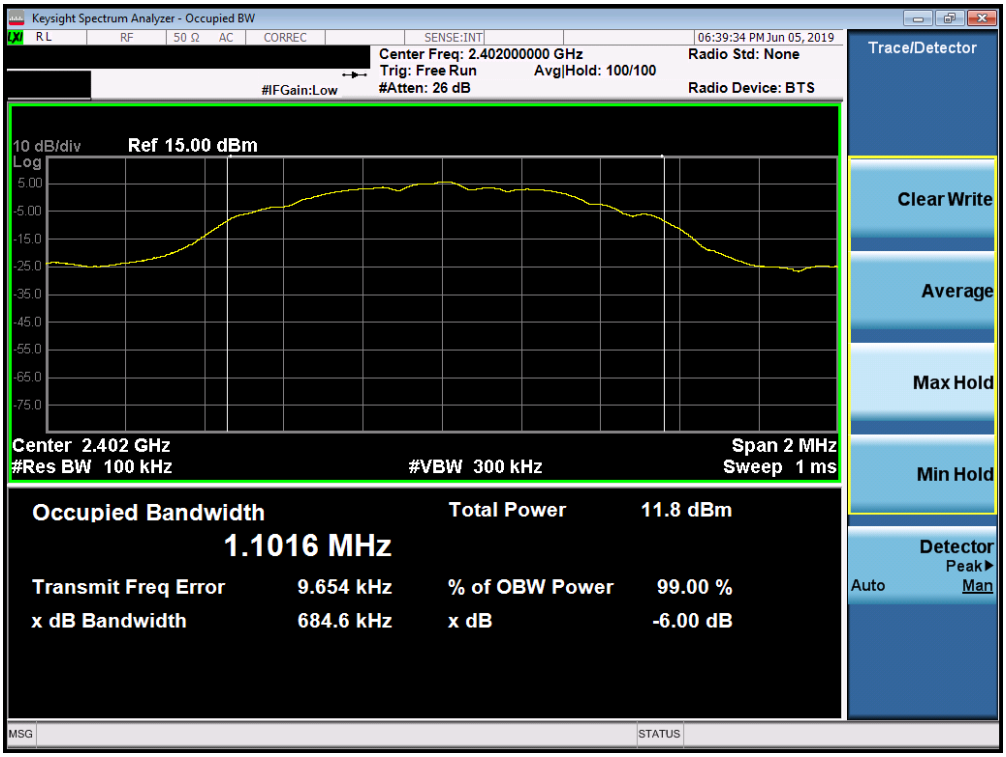
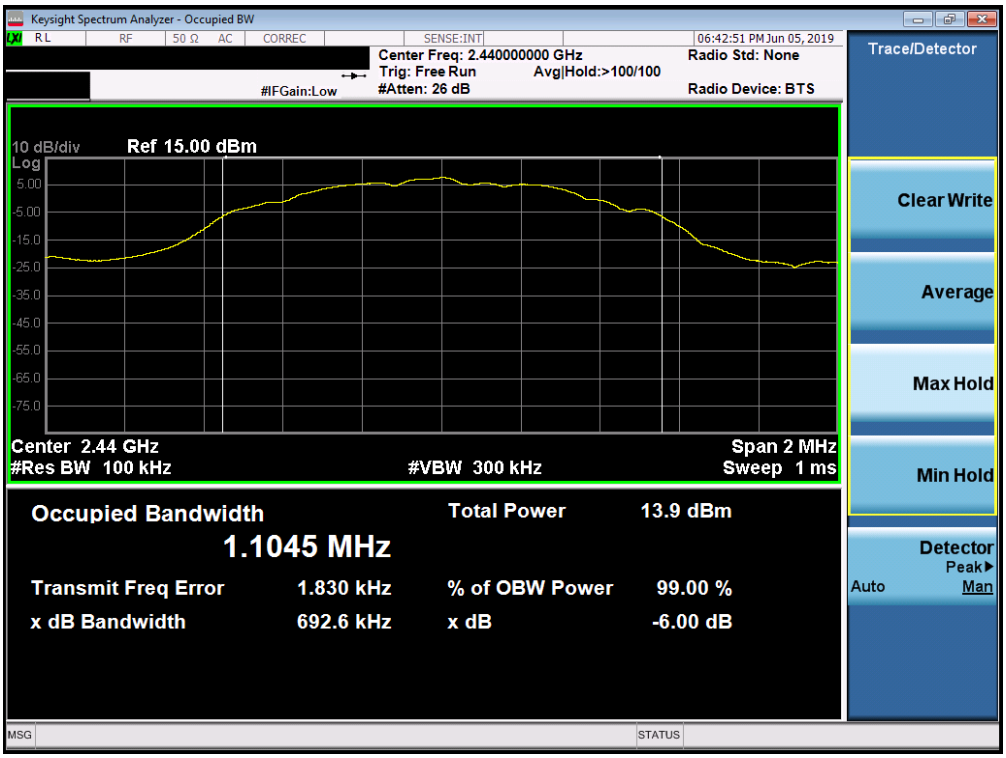



**Plot 7-7. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps – Ch. 0)**




**Plot 7-8. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps – Ch. 19)**



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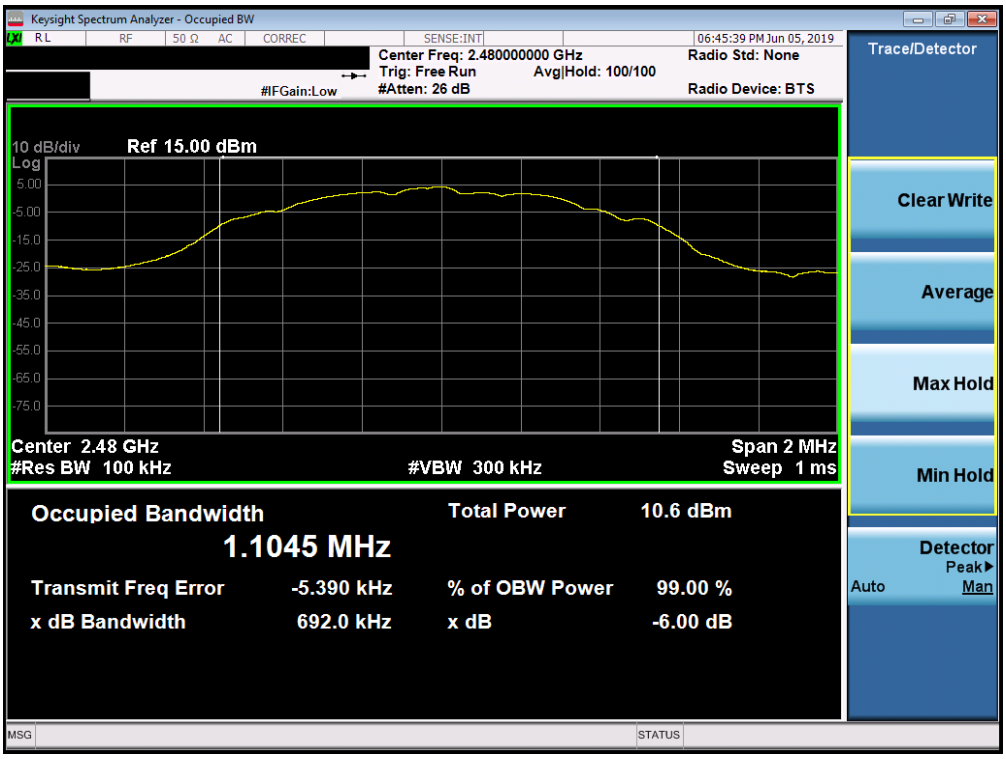
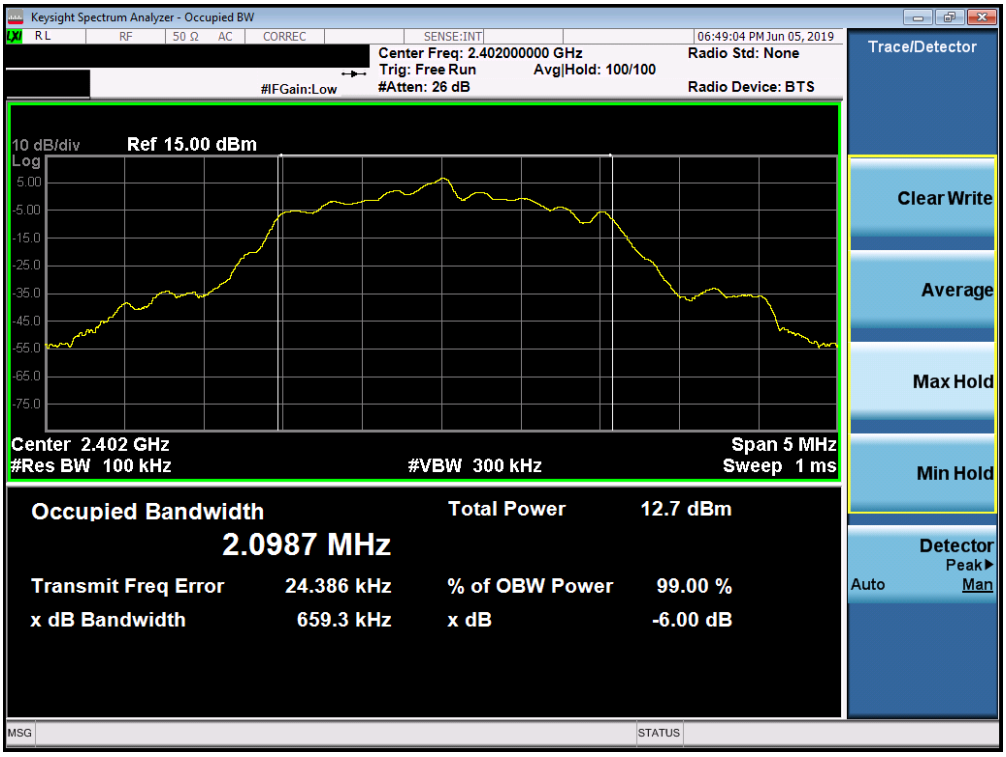



**Plot 7-9. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps – Ch. 39)**




**Plot 7-10. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps – Ch. 0)**

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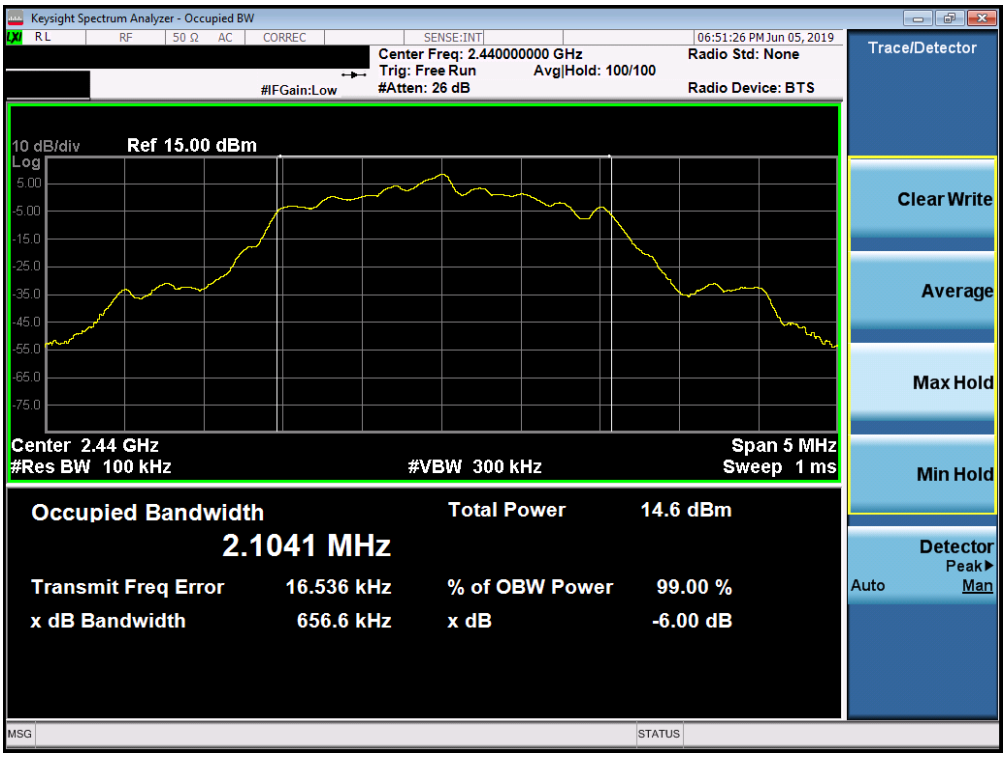
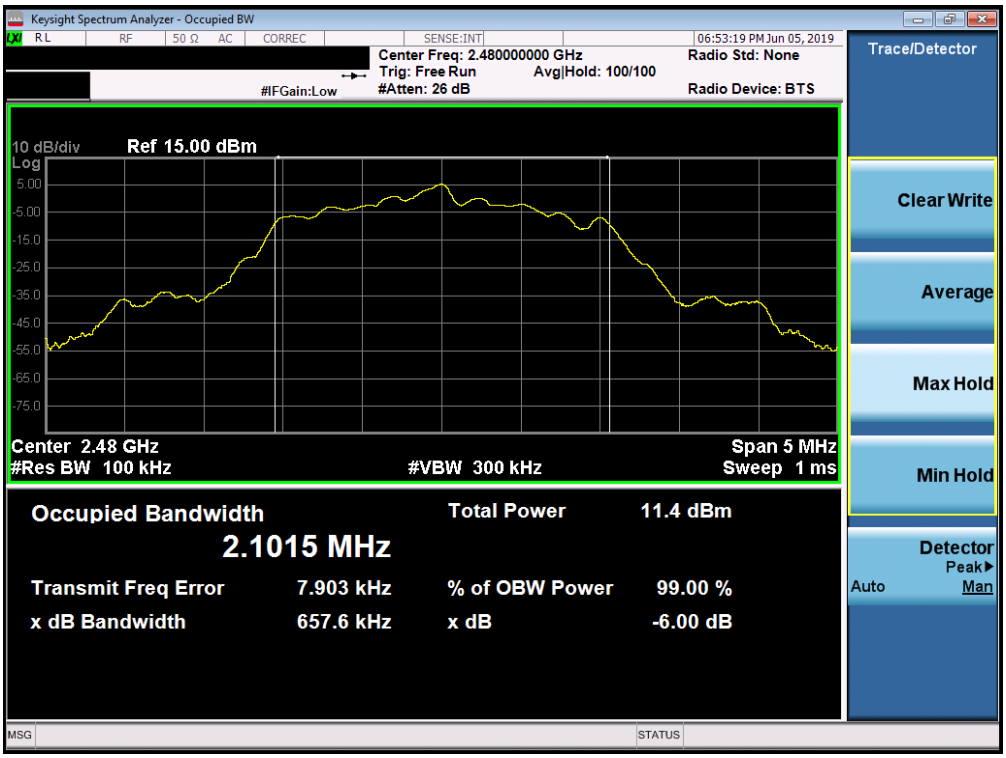



**Plot 7-11. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps – Ch. 19)**




**Plot 7-12. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps – Ch. 39)**



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## 7.3 Output Power Measurement – Bluetooth (LE)

**§15.247(b.3); RSS-247 [5.4(4)]**

### Test Overview and Limits

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

***The maximum permissible conducted output power is 1 Watt.***

### Test Procedure Used

ANSI C63.10-2013 – Section 11.9.1.1
KDB 558074 D01 v05r01 – Section 8.3.1.1

### 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 7-2. Test Instrument & Measurement Setup**

### Test Notes

None




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| Frequency [MHz] | Data Rate [Mbps] | Channel No. | Bluetooth Mode | Peak Conducted Power | |
|---|---|---|---|---|---|
| | | | | [dBm] | [mW] |
| 2402 | 125 kbps | 0 | LE | 7.28 | 5.347 |
| 2440 | 125 kbps | 19 | LE | 7.01 | 5.023 |
| 2480 | 125 kbps | 39 | LE | 8.17 | 6.566 |
| 2402 | 500 kbps | 0 | LE | 7.25 | 5.311 |
| 2440 | 500 kbps | 19 | LE | 7.00 | 5.011 |
| 2480 | 500 kbps | 39 | LE | 8.16 | 6.542 |
| 2402 | 1 Mbps | 0 | LE | 7.38 | 5.470 |
| 2440 | 1 Mbps | 19 | LE | 7.16 | 5.200 |
| 2480 | 1 Mbps | 39 | LE | 8.08 | 6.427 |
| 2402 | 2 Mbps | 0 | LE | 8.90 | 7.761 |
| 2440 | 2 Mbps | 19 | LE | 9.28 | 8.466 |
| 2480 | 2 Mbps | 39 | LE | 9.12 | 8.170 |

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




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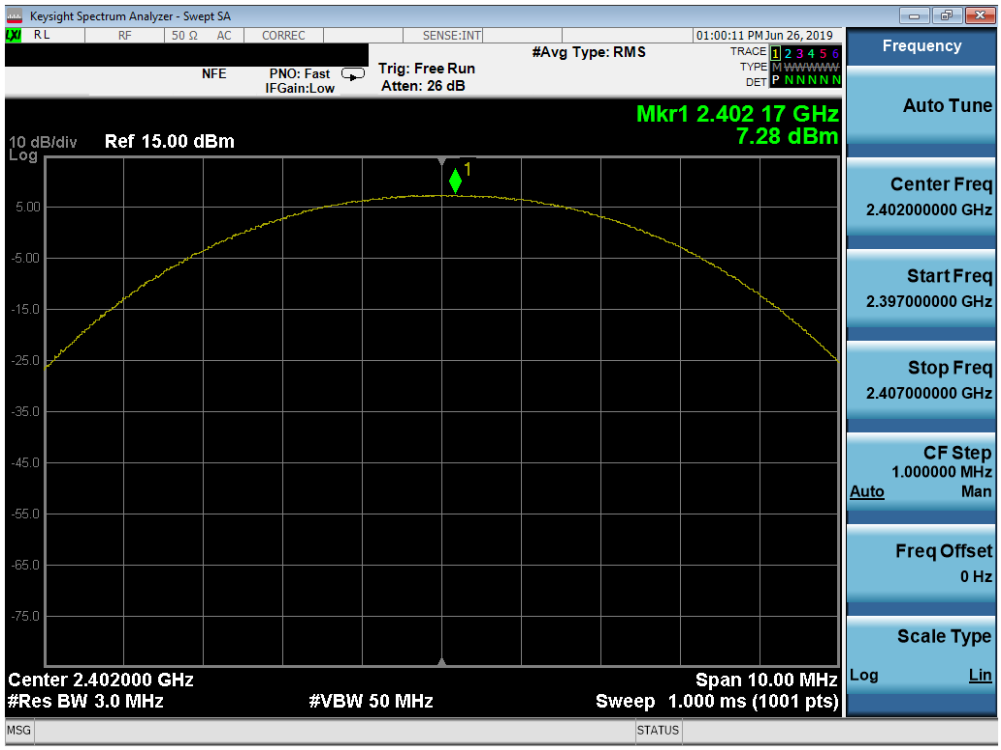
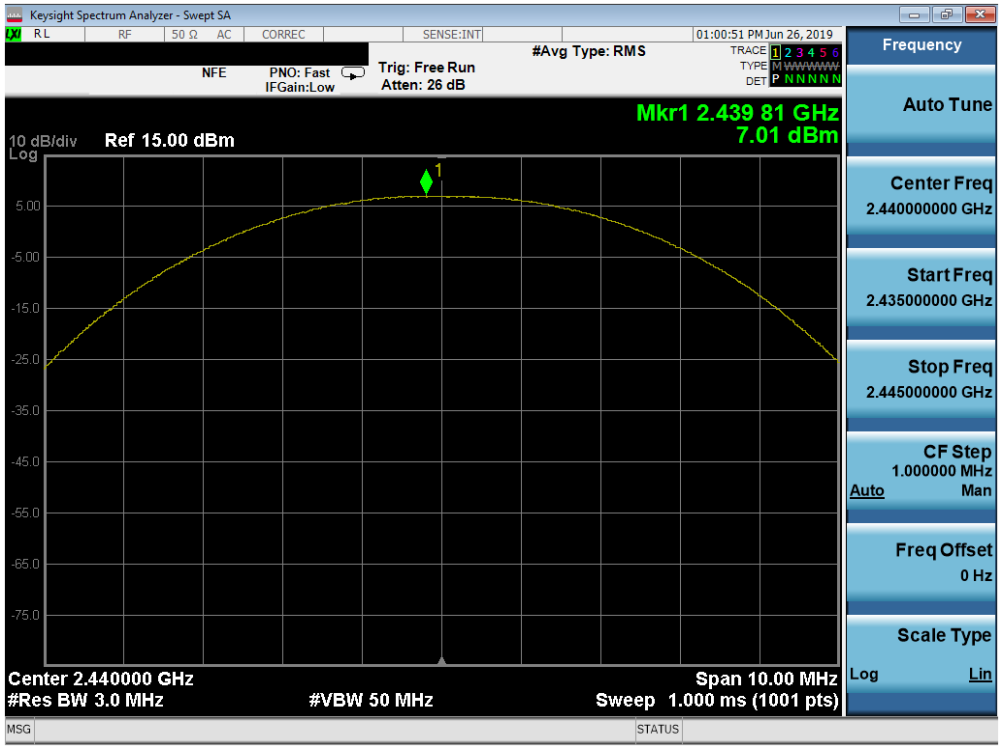



**Plot 7-13. Peak Power Plot (Bluetooth (LE), 125kbps – Ch. 0)**




**Plot 7-14. Peak Power Plot (Bluetooth (LE), 125kbps – Ch. 19)**

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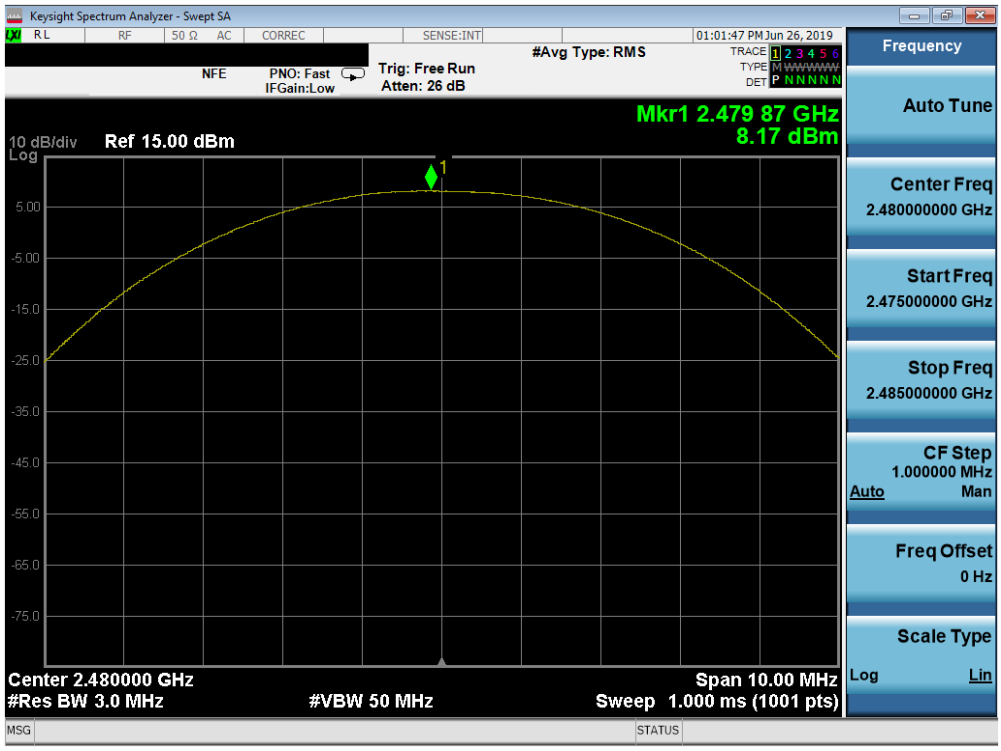
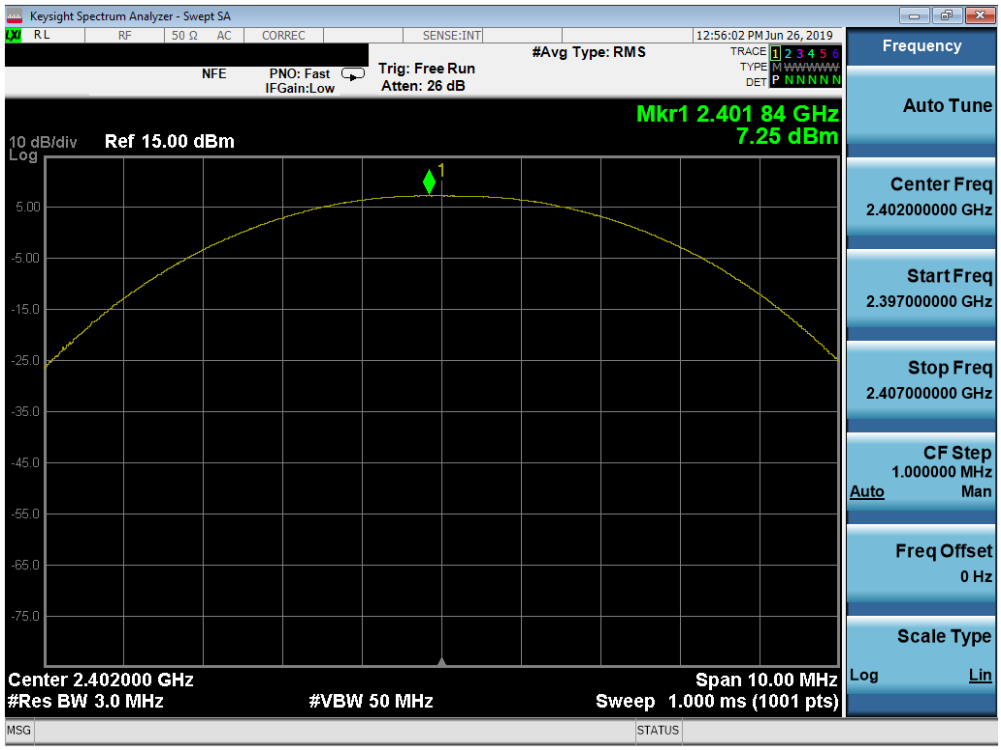



**Plot 7-15. Peak Power Plot (Bluetooth (LE), 125kbps – Ch. 39)**




**Plot 7-16. Peak Power Plot (Bluetooth (LE), 500kbps – Ch. 0)**

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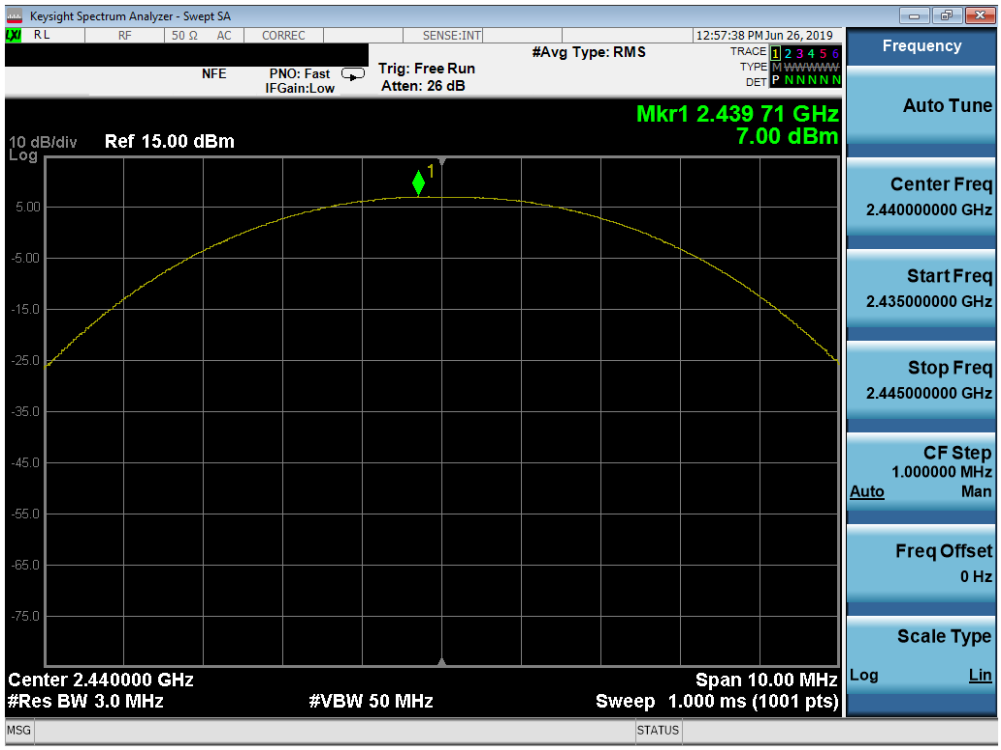
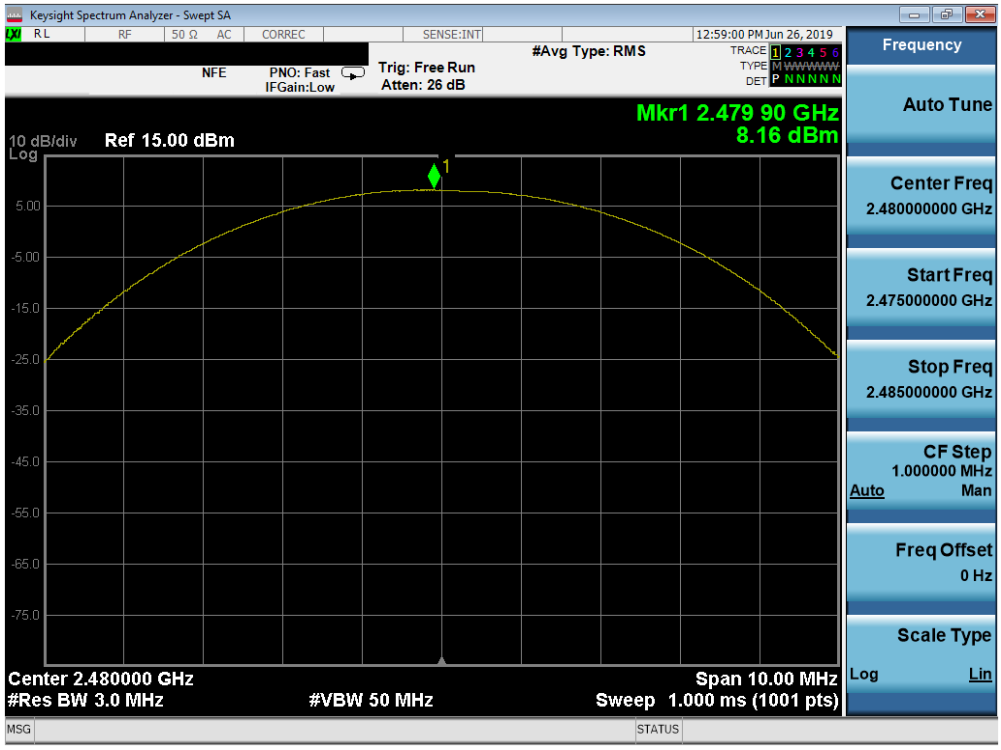



**Plot 7-17. Peak Power Plot (Bluetooth (LE), 500kbps – Ch. 19)**




**Plot 7-18. Peak Power Plot (Bluetooth (LE), 500kbps – Ch. 39)**

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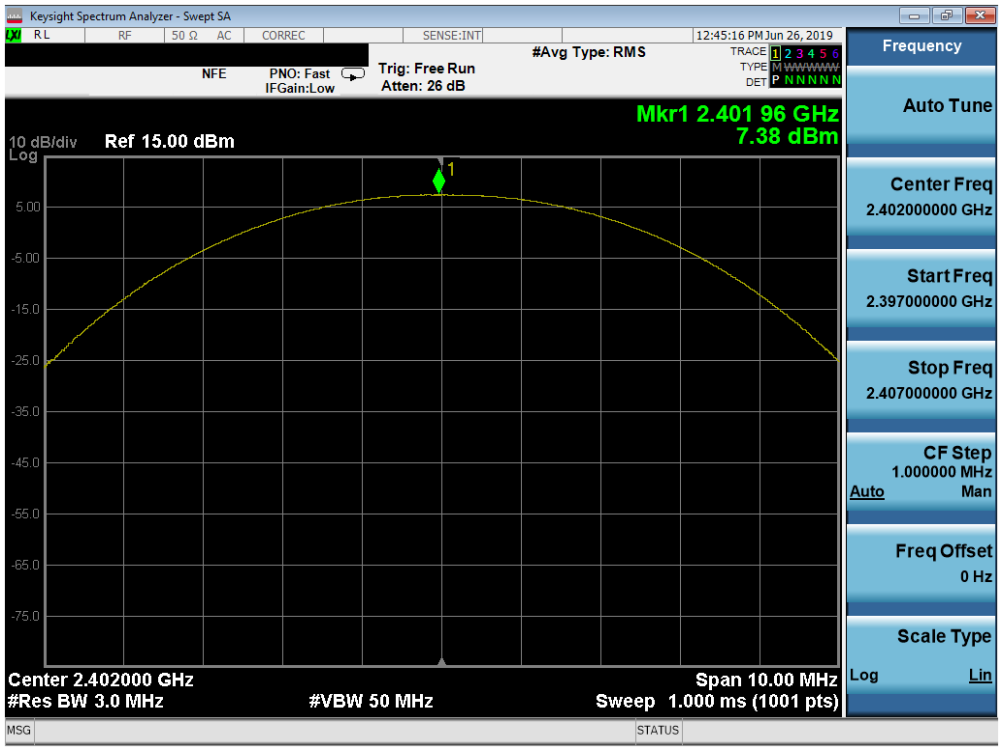
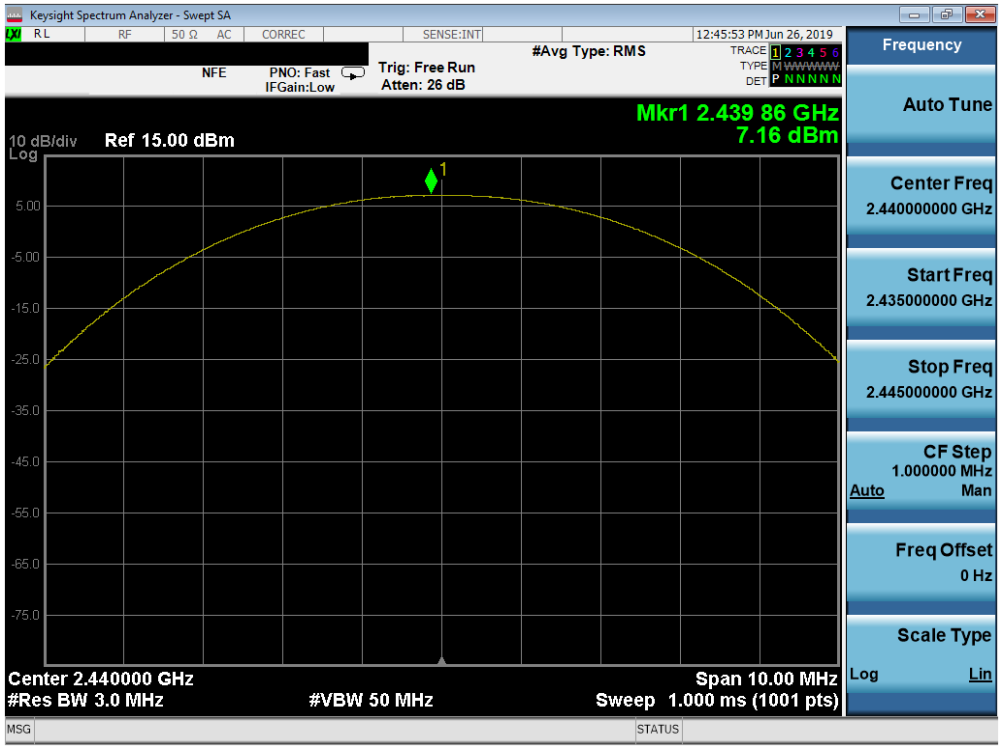



**Plot 7-19. Peak Power Plot (Bluetooth (LE), 1Mbps – Ch. 0)**




**Plot 7-20. Peak Power Plot (Bluetooth (LE), 1Mbps – Ch. 19)**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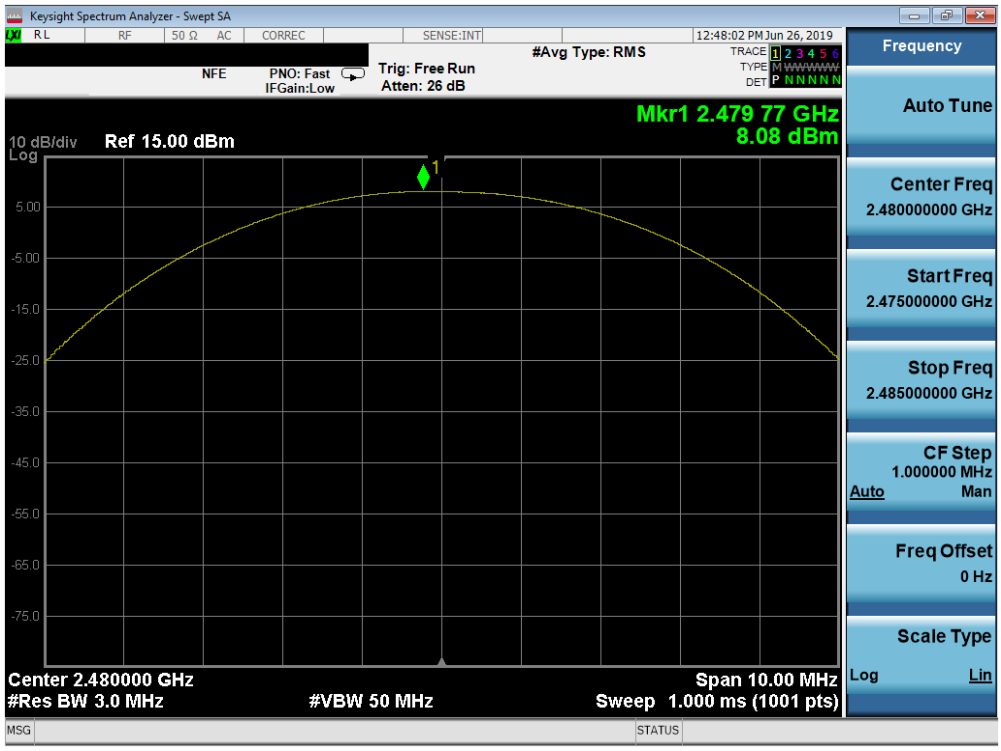
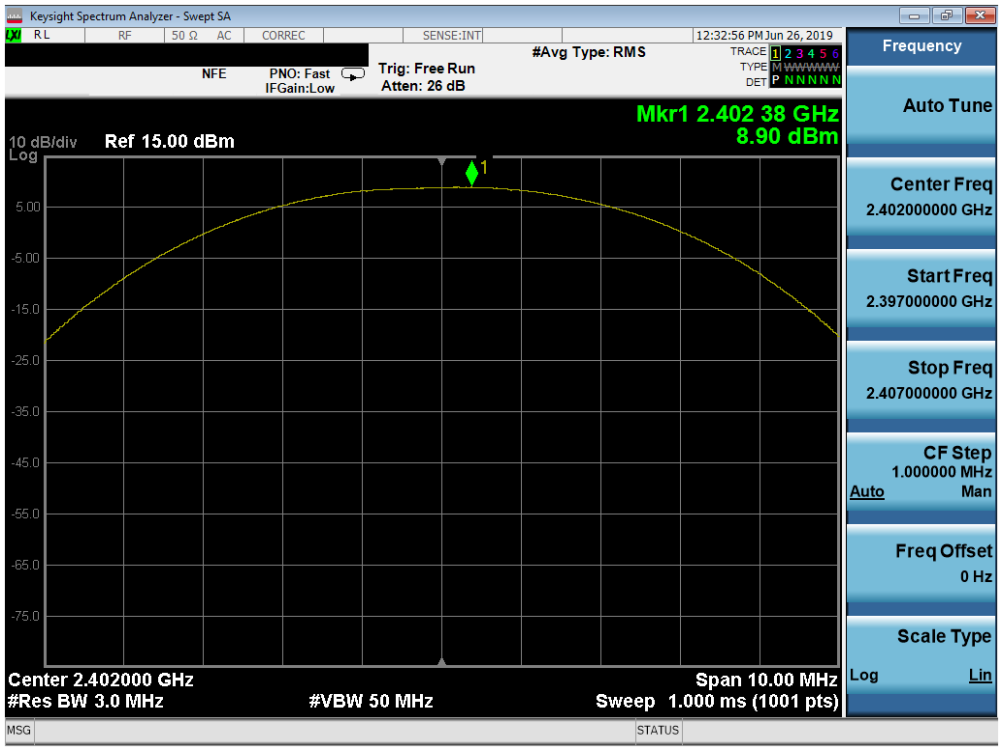



**Plot 7-21. Peak Power Plot (Bluetooth (LE), 1Mbps – Ch. 39)**




**Plot 7-22. Peak Power Plot (Bluetooth (LE), 2Mbps – Ch. 0)**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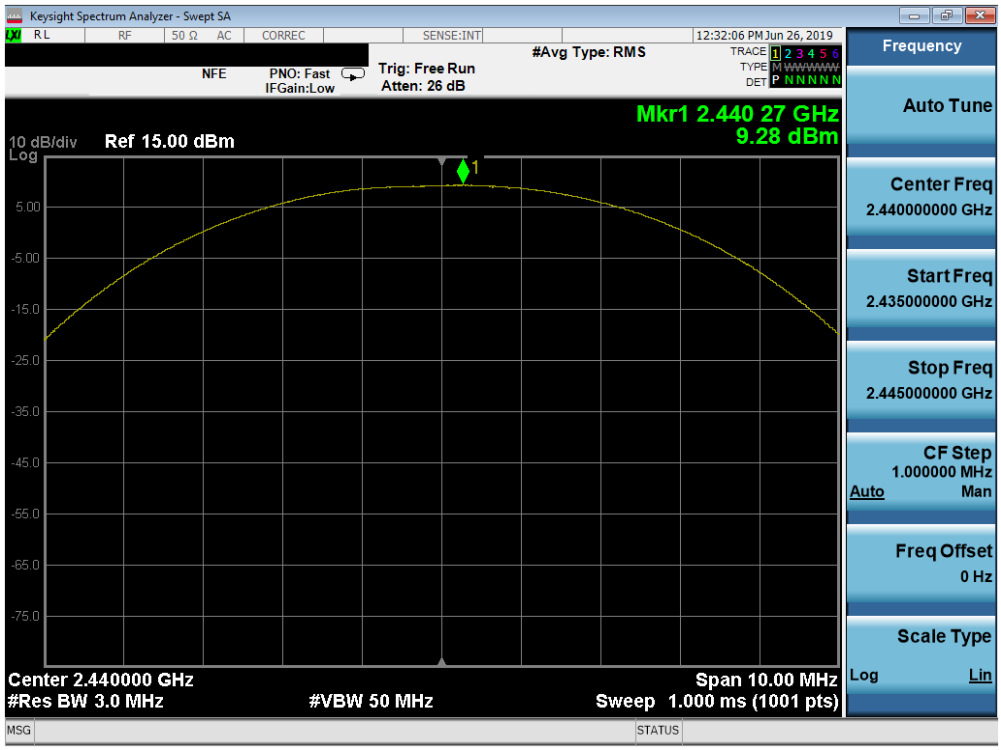
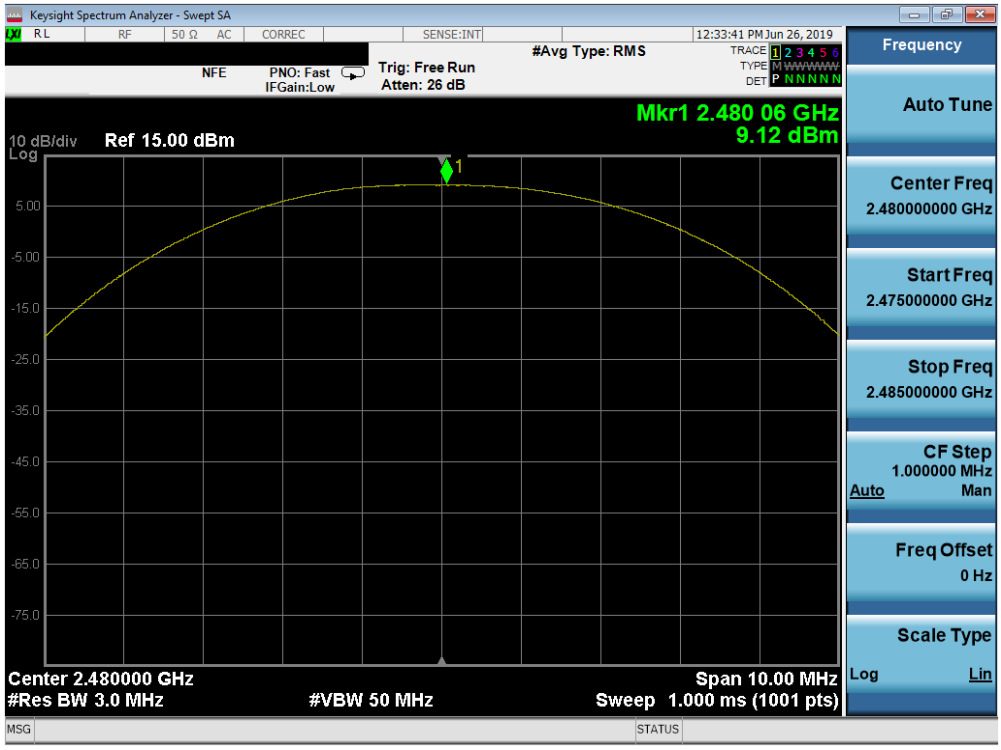



**Plot 7-23. Peak Power Plot (Bluetooth (LE), 2Mbps – Ch. 19)**




**Plot 7-24. Peak Power Plot (Bluetooth (LE), 2Mbps – Ch. 39)**



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## 7.4 Power Spectral Density – Bluetooth (LE)

**§15.247(e); RSS-247 [5.2]**

### Test Overview and Limit

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

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

### Test Procedure Used

ANSI C63.10-2013 – Section 11.10.2 Method PKPSD
KDB 558074 D01 v05r01 – Section 8.4 DTS Maximum Power Spectral Density level in the fundamental emission

### Test Settings

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

### Test Setup

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

**Figure 7-3. Test Instrument & Measurement Setup**

### Test Notes

None




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| Frequency [MHz] | Data Rate [Mbps] | Channel No. | Bluetooth Mode | Measured Power Spectral Density [dBm] | Maximum Permissible Power Density [dBm / 3kHz] | Margin [dB] |
|---|---|---|---|---|---|---|
| 2402 | 125 kbps | 0 | LE | -0.07 | 8.0 | -8.07 |
| 2440 | 125 kbps | 19 | LE | 2.02 | 8.0 | -5.98 |
| 2480 | 125 kbps | 39 | LE | -1.35 | 8.0 | -9.35 |
| 2402 | 500 kbps | 0 | LE | 4.17 | 8.0 | -3.83 |
| 2440 | 500 kbps | 19 | LE | 6.23 | 8.0 | -1.77 |
| 2480 | 500 kbps | 39 | LE | 2.96 | 8.0 | -5.04 |
| 2402 | 1 Mbps | 0 | LE | 4.86 | 8.0 | -3.14 |
| 2440 | 1 Mbps | 19 | LE | 6.84 | 8.0 | -1.16 |
| 2480 | 1 Mbps | 39 | LE | 3.55 | 8.0 | -4.45 |
| 2402 | 2 Mbps | 0 | LE | 2.31 | 8.0 | -5.69 |
| 2440 | 2 Mbps | 19 | LE | 4.14 | 8.0 | -3.86 |
| 2480 | 2 Mbps | 39 | LE | 0.90 | 8.0 | -7.10 |

**Table 7-4. Conducted Power Density Measurements**




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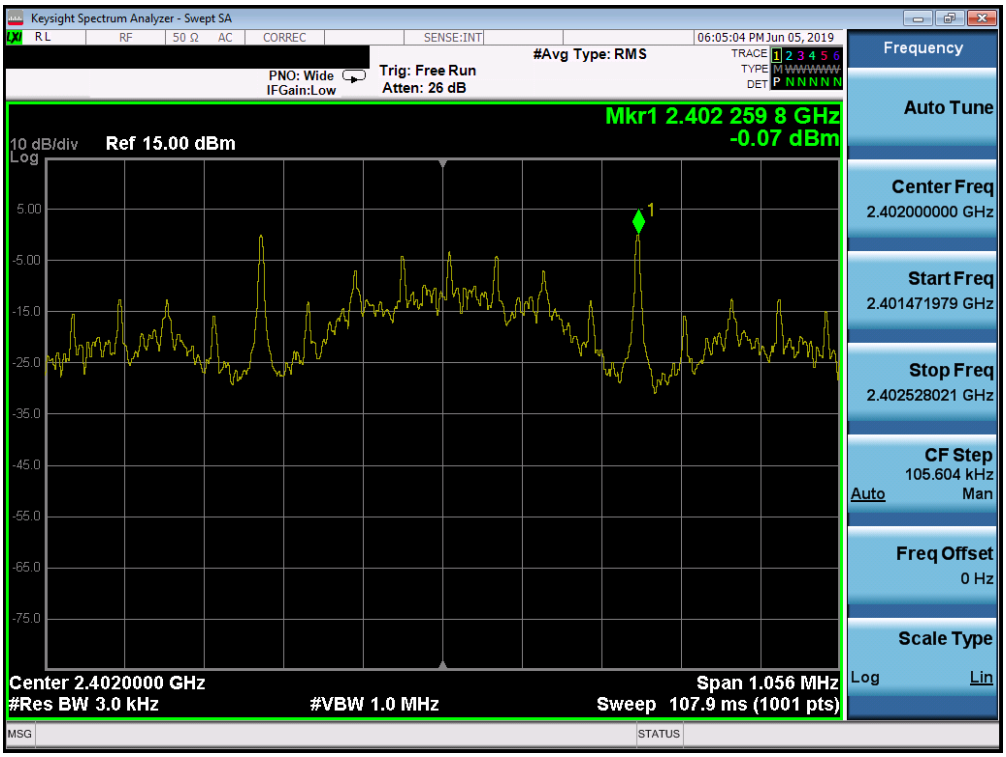
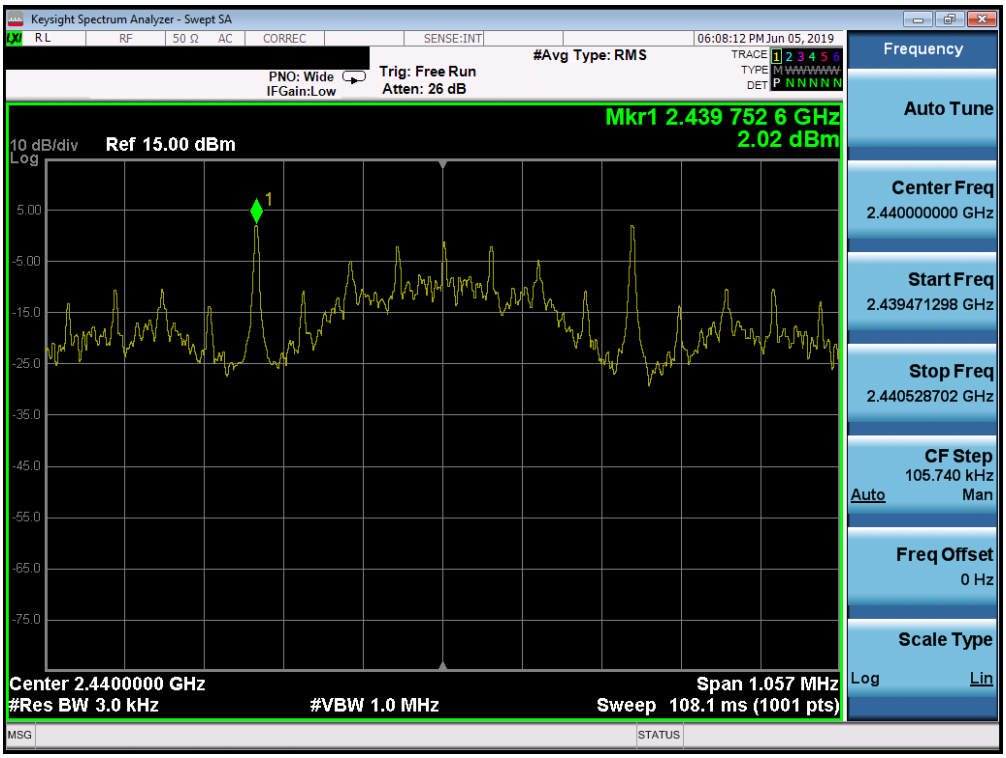



**Plot 7-25. Power Spectral Density Plot (Bluetooth (LE), 125kbps – Ch. 0)**




**Plot 7-26. Power Spectral Density Plot (Bluetooth (LE), 125kbps – Ch. 19)**

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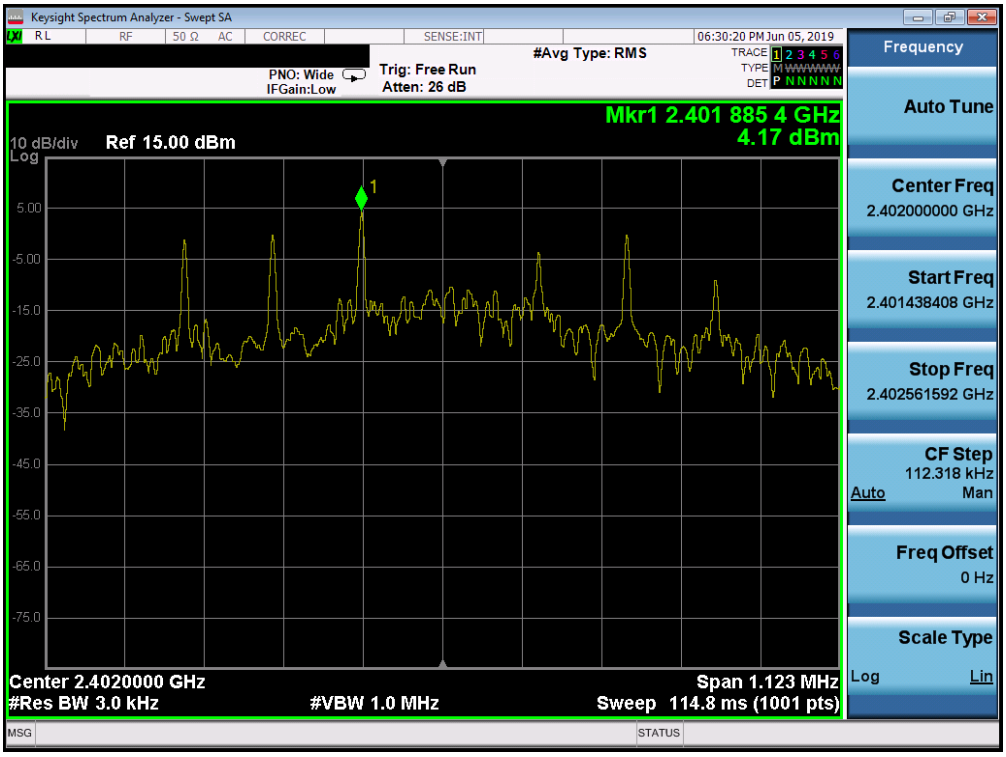
**Plot 7-27. Power Spectral Density Plot (Bluetooth (LE), 125kbps – Ch. 39)**




**Plot 7-28. Power Spectral Density Plot (Bluetooth (LE), 500kbps – Ch. 0)**

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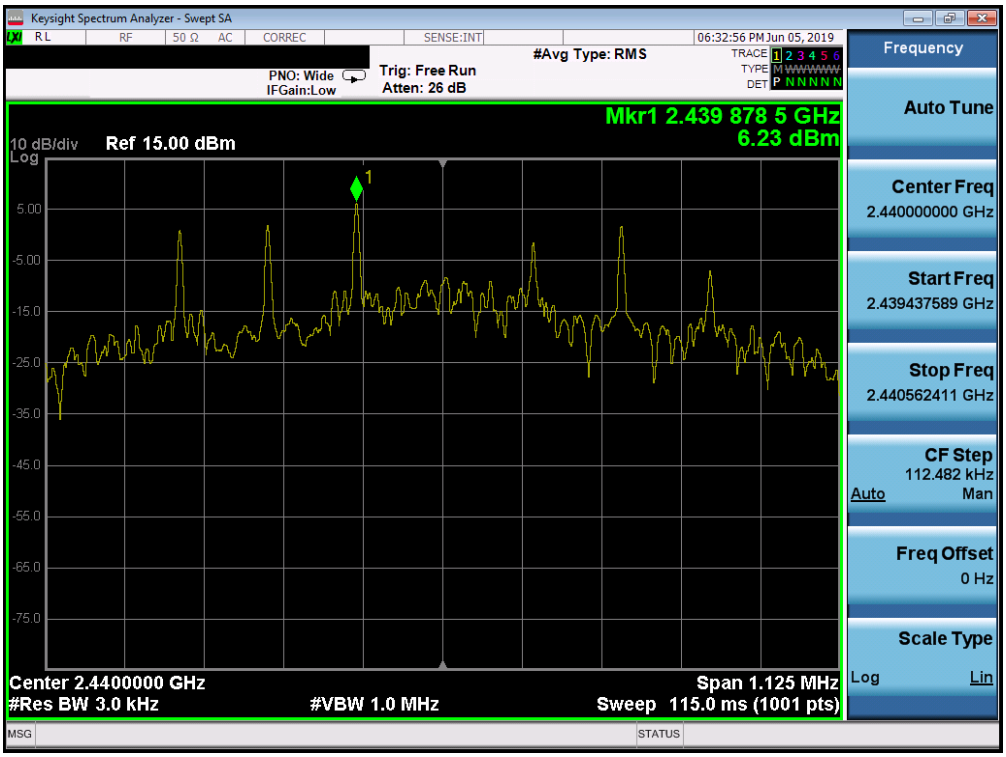
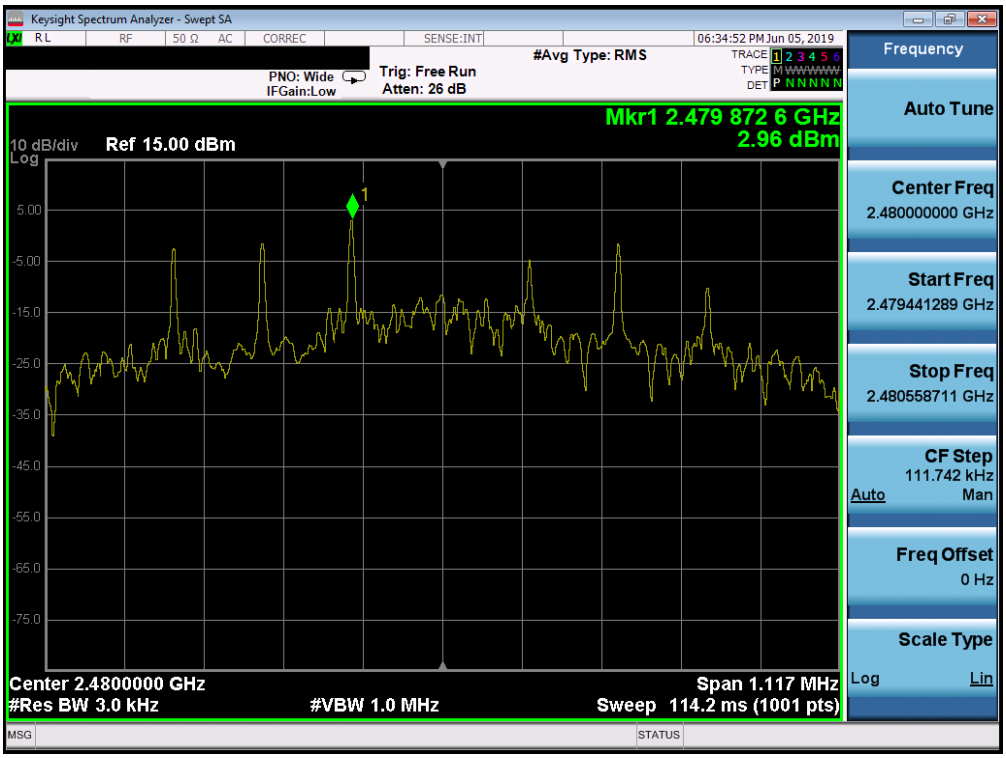



**Plot 7-29. Power Spectral Density Plot (Bluetooth (LE), 500kbps – Ch. 19)**




**Plot 7-30. Power Spectral Density Plot (Bluetooth (LE), 500kbps – Ch. 39)**

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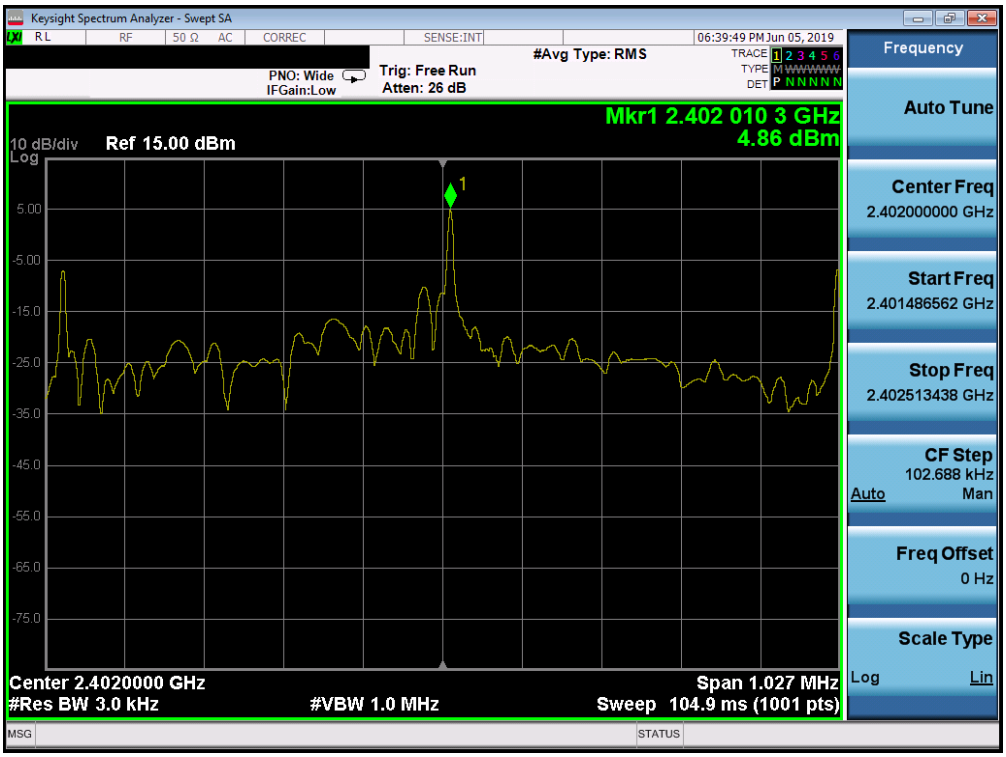
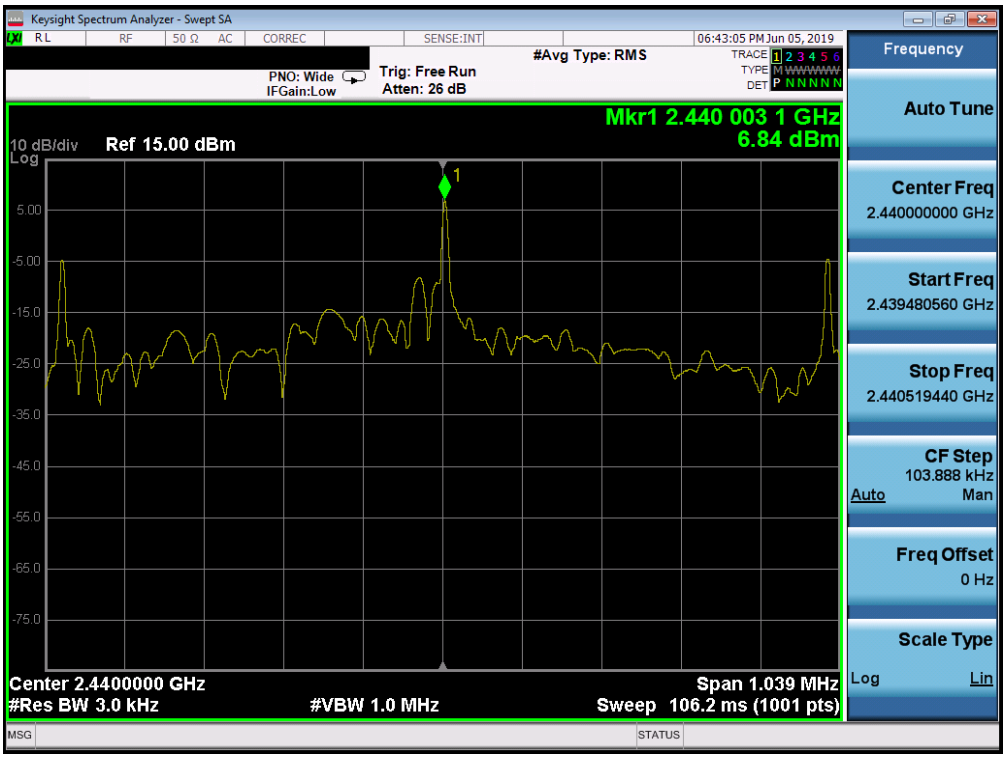



**Plot 7-31. Power Spectral Density Plot (Bluetooth (LE), 1Mbps – Ch. 0)**




**Plot 7-32. Power Spectral Density Plot (Bluetooth (LE), 1Mbps – Ch. 19)**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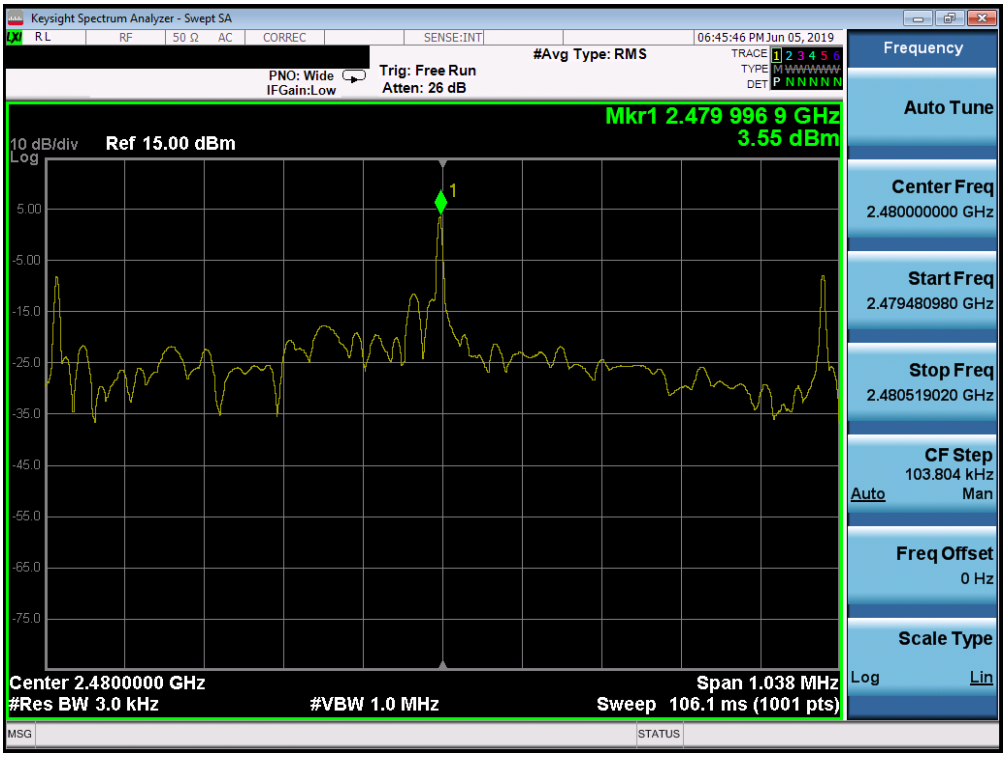
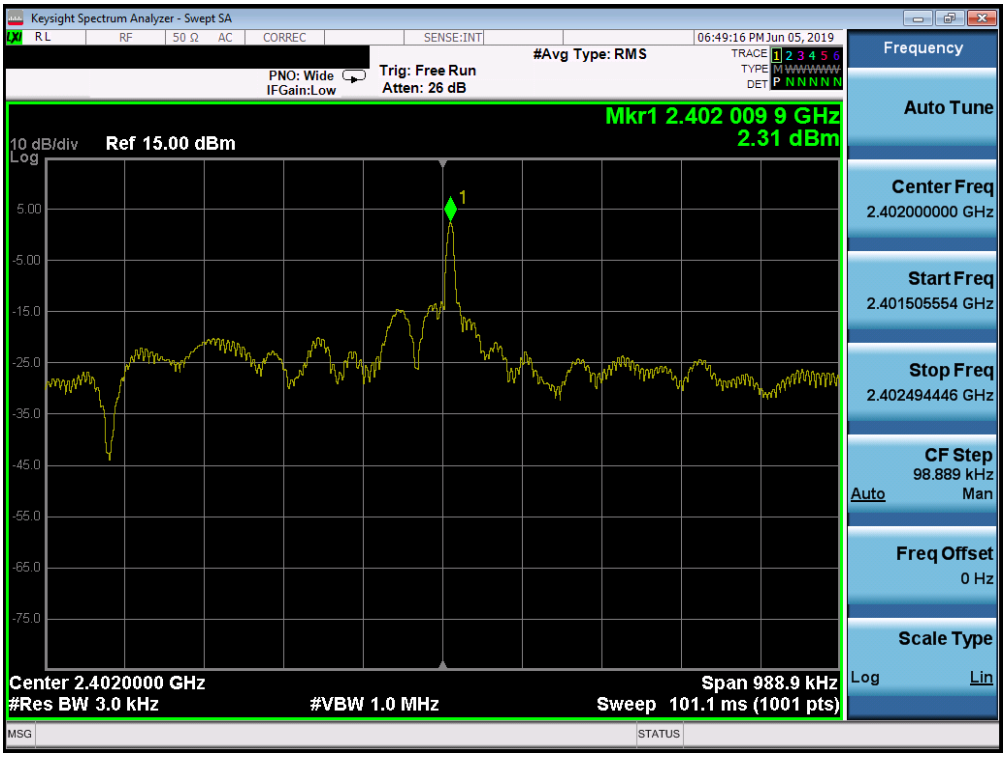



**Plot 7-33. Power Spectral Density Plot (Bluetooth (LE), 1Mbps – Ch. 39)**




**Plot 7-34. Power Spectral Density Plot (Bluetooth (LE), 2Mbps – Ch. 0)**



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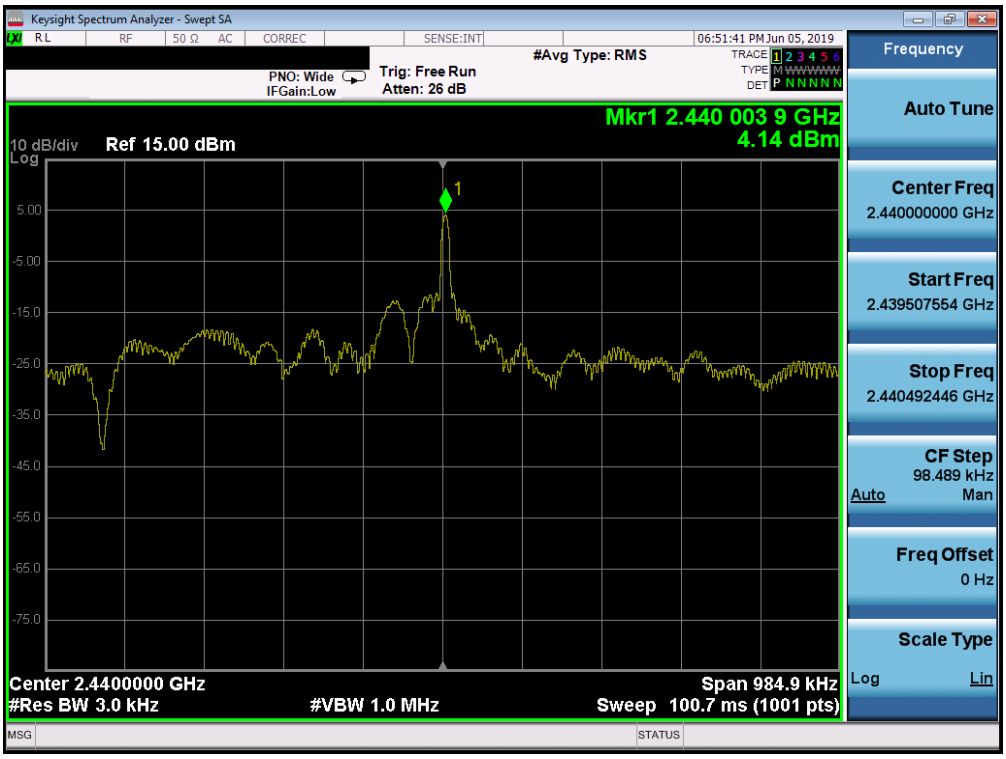
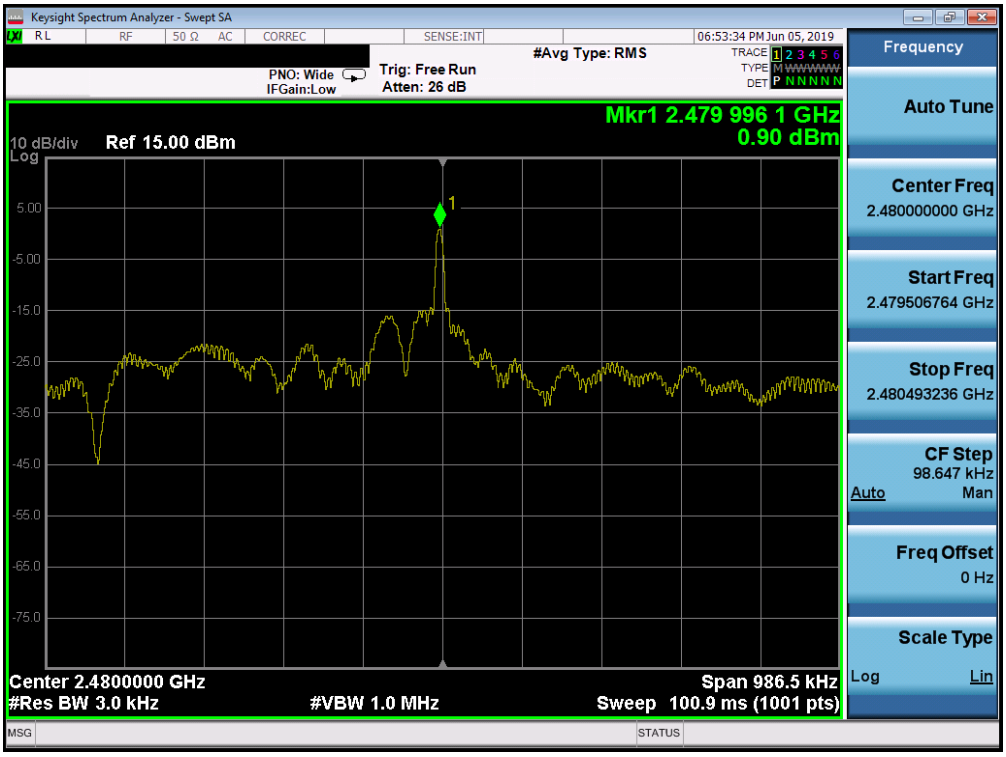



**Plot 7-35. Power Spectral Density Plot (Bluetooth (LE), 2Mbps – Ch. 19)**




**Plot 7-36. Power Spectral Density Plot (Bluetooth (LE), 2Mbps – Ch. 39)**

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## 7.5 Conducted Emissions at the Band Edge

**§15.247(d); RSS-247 [5.5]**

### Test Overview and Limit

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

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

### Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v05r01 – Section 8.7.2

### 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 7-4. Test Instrument & Measurement Setup**

### Test Notes

None




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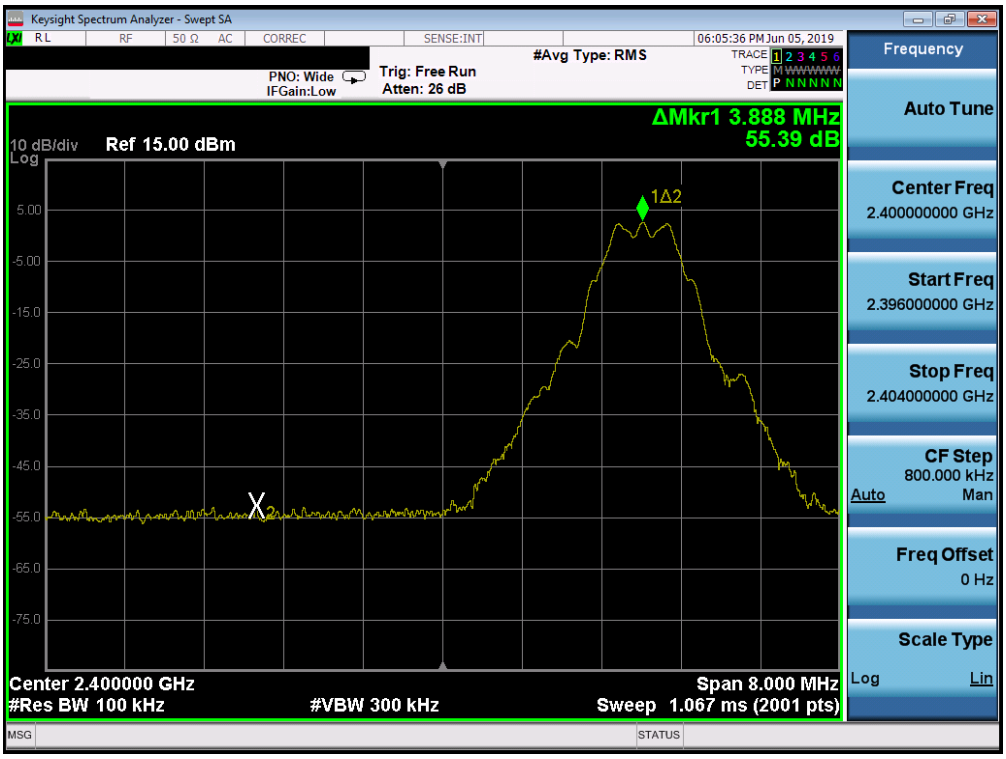
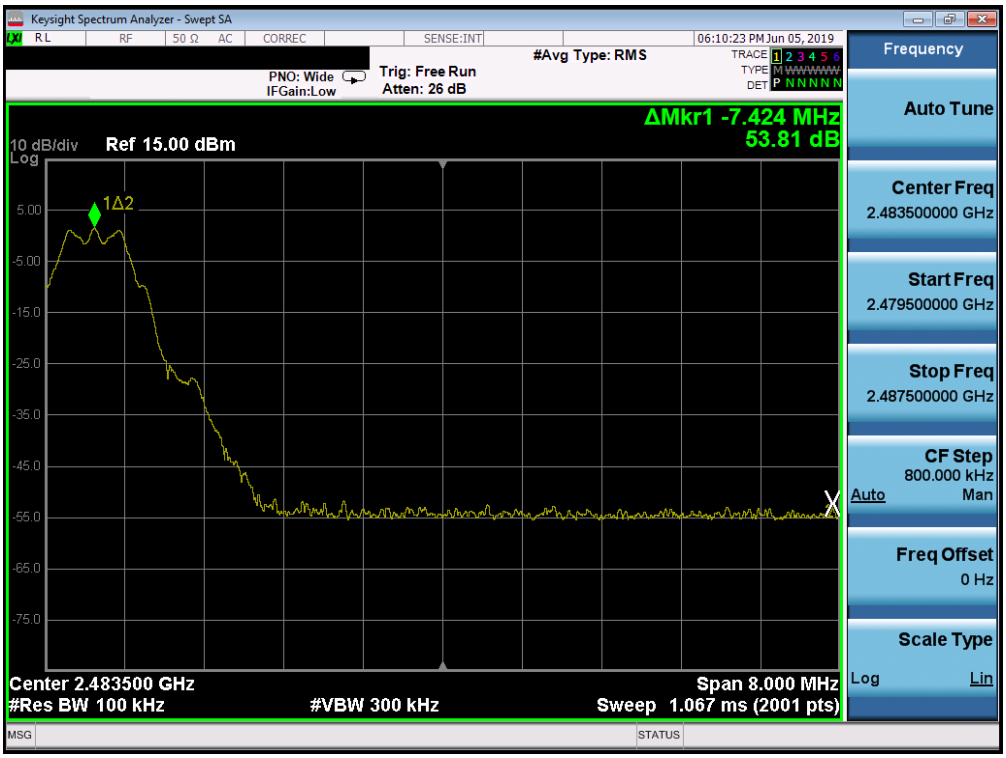



**Plot 7-37. Band Edge Plot (Bluetooth (LE), 125kbps – Ch. 0)**




**Plot 7-38. Band Edge Plot (Bluetooth (LE), 125kbps – Ch. 39)**

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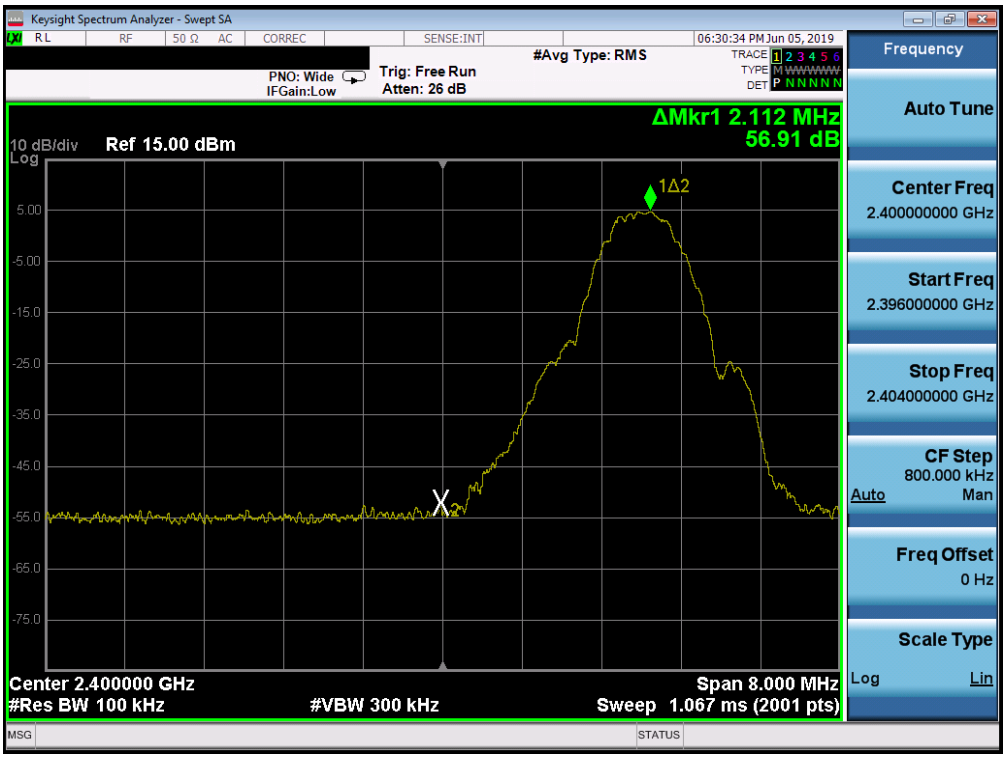
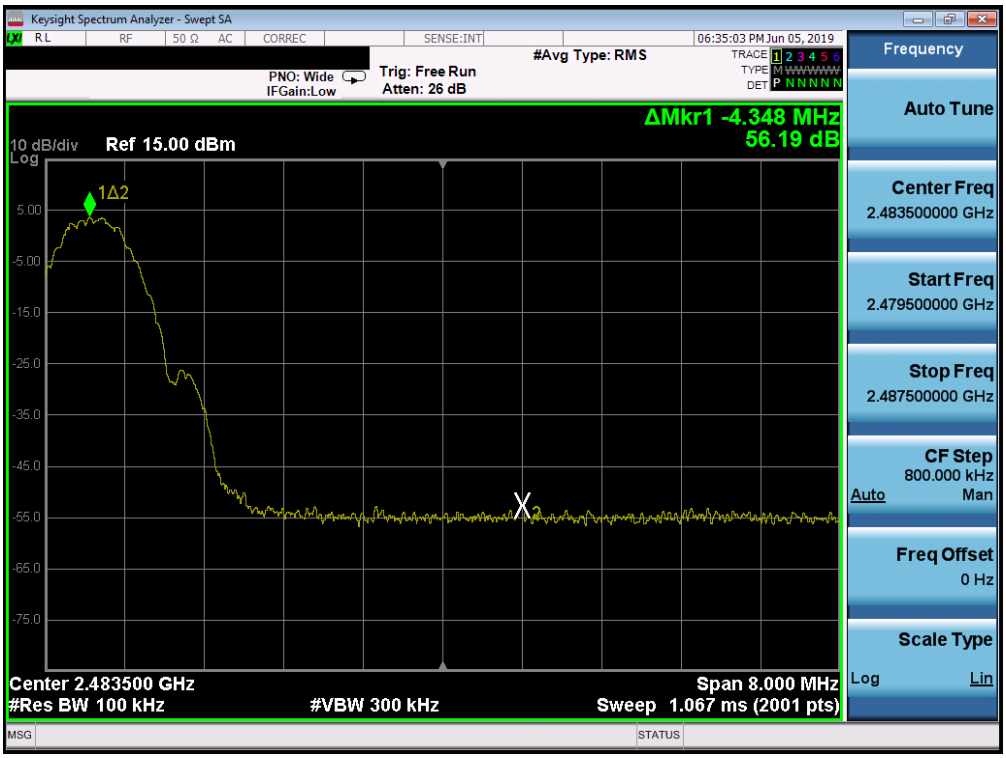



**Plot 7-39. Band Edge Plot (Bluetooth (LE), 500kbps – Ch. 0)**




**Plot 7-40. Band Edge Plot (Bluetooth (LE), 500kbps – Ch. 39)**



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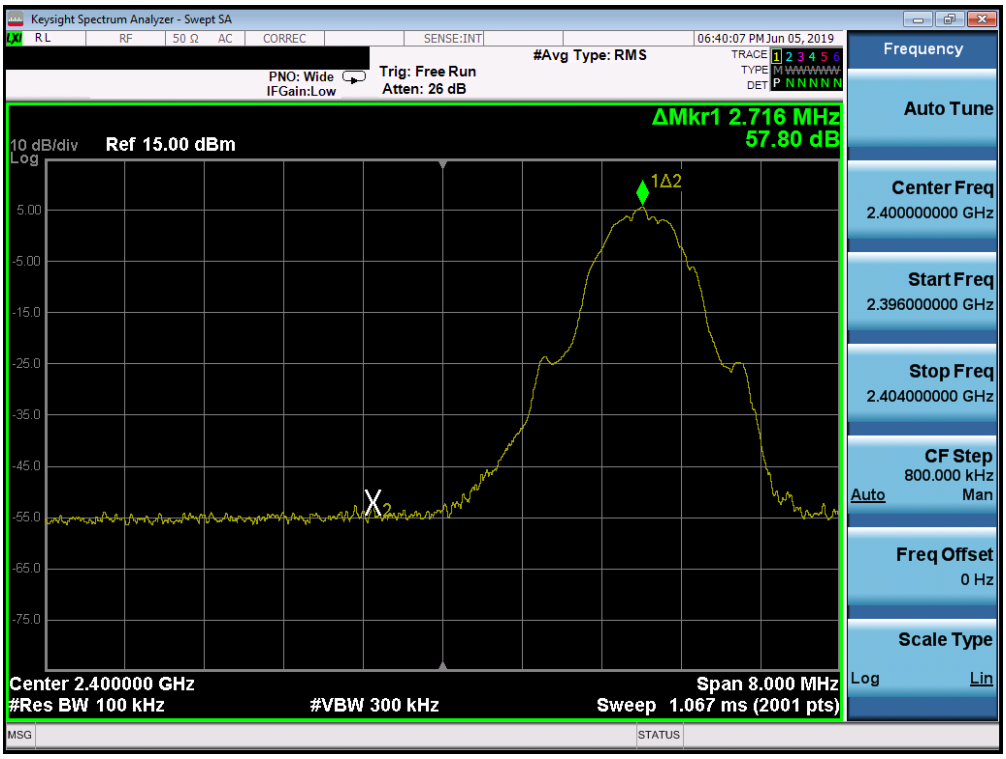
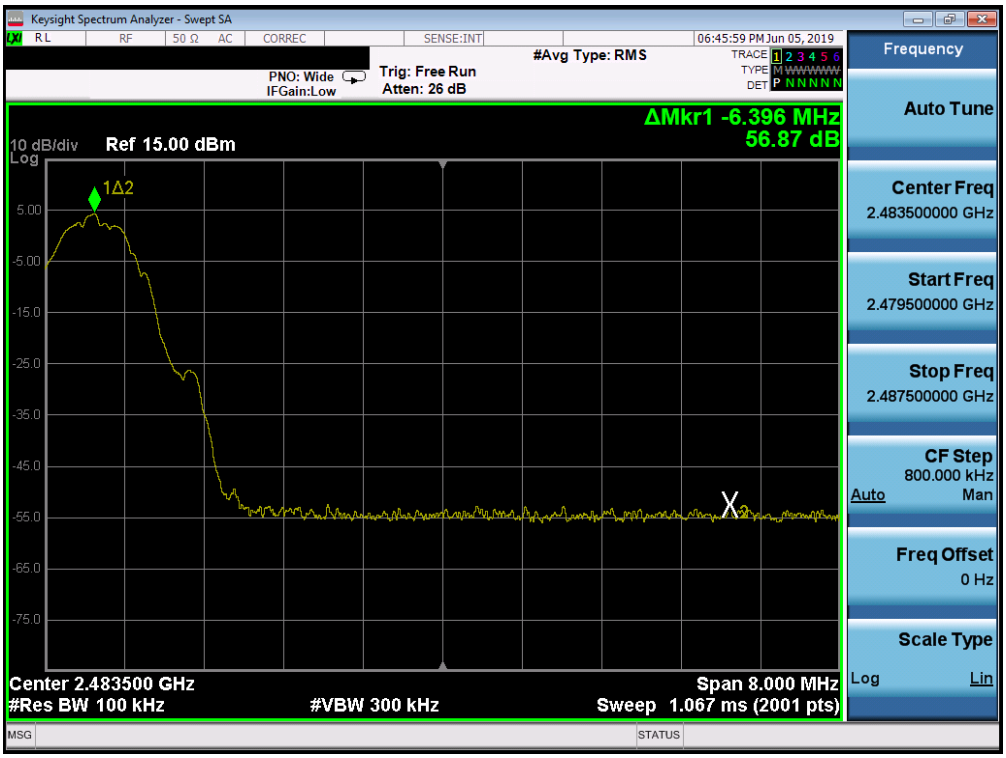



**Plot 7-41. Band Edge Plot (Bluetooth (LE), 1Mbps – Ch. 0)**




**Plot 7-42. Band Edge Plot (Bluetooth (LE), 1Mbps – Ch. 39)**



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**Plot 7-43. Band Edge Plot (Bluetooth (LE), 2Mbps – Ch. 0)**

**Plot 7-44. Band Edge Plot (Bluetooth (LE), 2Mbps – Ch. 39)**




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## 7.6 Conducted Spurious Emissions

**§15.247(d); RSS-247 [5.5]**

### Test Overview and Limit

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

***The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 8.5 of KDB 558074 D01 v05r02 and Section 11.11.3 of ANSI C63.10-2013.***

### Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v05r01 – Section 8.5

### Test Settings

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

### Test Setup

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

**Figure 7-5. 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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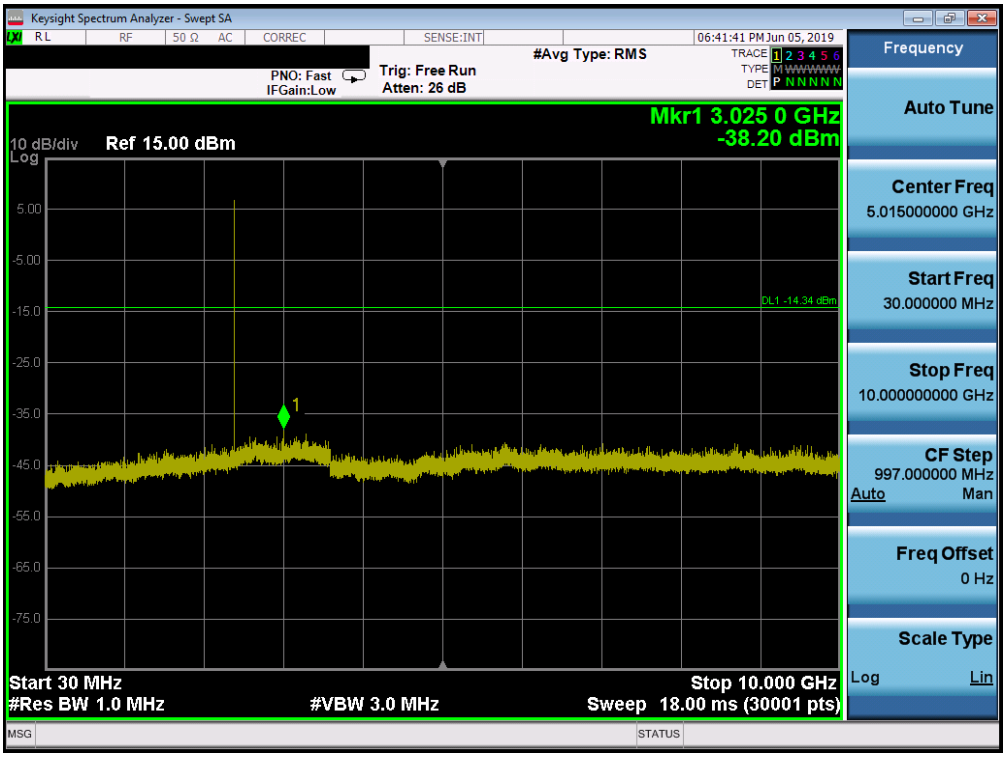


**Plot 7-45. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 0)**

**Plot 7-46. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 0)**




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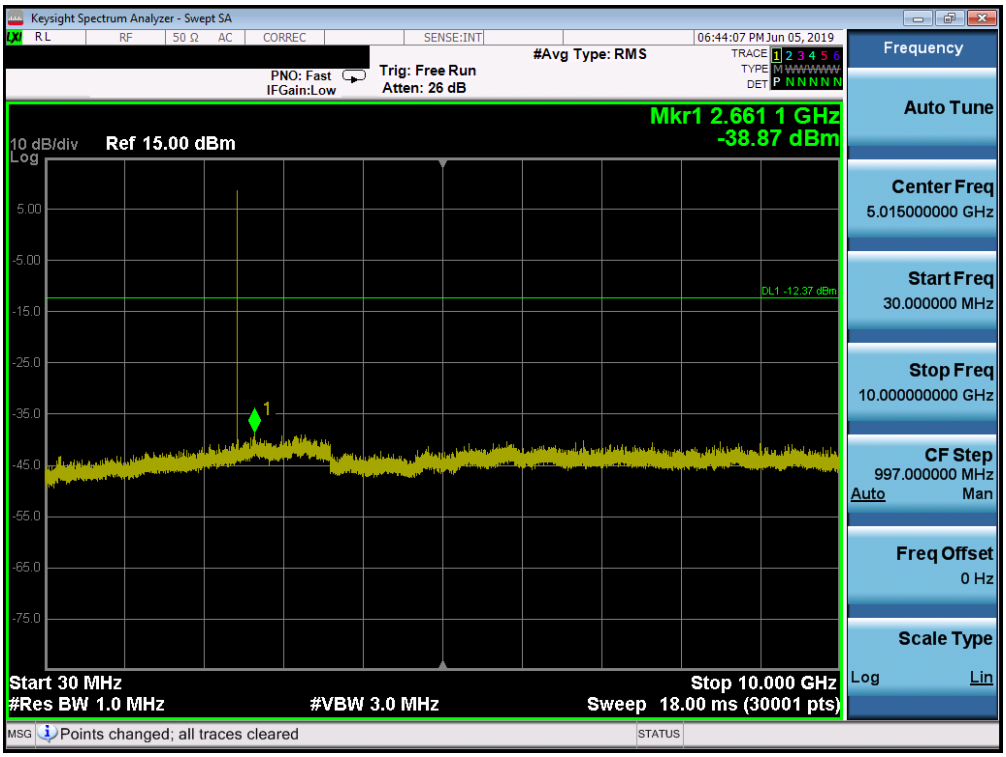


**Plot 7-47. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 19)**

**Plot 7-48. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 19)**




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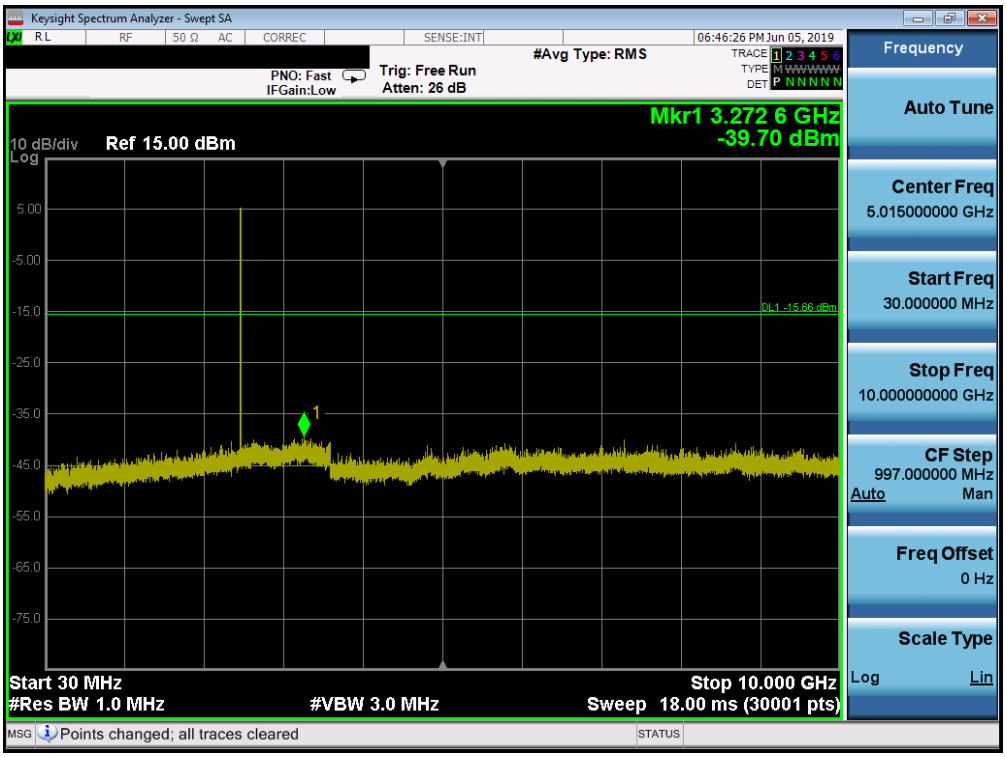


**Plot 7-49. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 39)**

**Plot 7-50. Conducted Spurious Plot (Bluetooth (LE), 1Mbps – Ch. 39)**



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## 7.7 Radiated Spurious Emission Measurements

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

### Test Overview and Limit

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

***All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-5 per Section 15.209 and RSS-Gen (8.9).***

| 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 7-5. Radiated Limits**

### Test Procedures Used

ANSI C63.10-2013 – Section 6.6.4.3

KDB 558074 D01 v05r01 – Section 8.6, 8.7

### Test Settings

#### Average Field Strength Measurements

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




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## Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW is set depending on measurement frequency, as specified in Table 7-6 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 7-6. RBW as a Function of Frequency**

## Test Setup

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

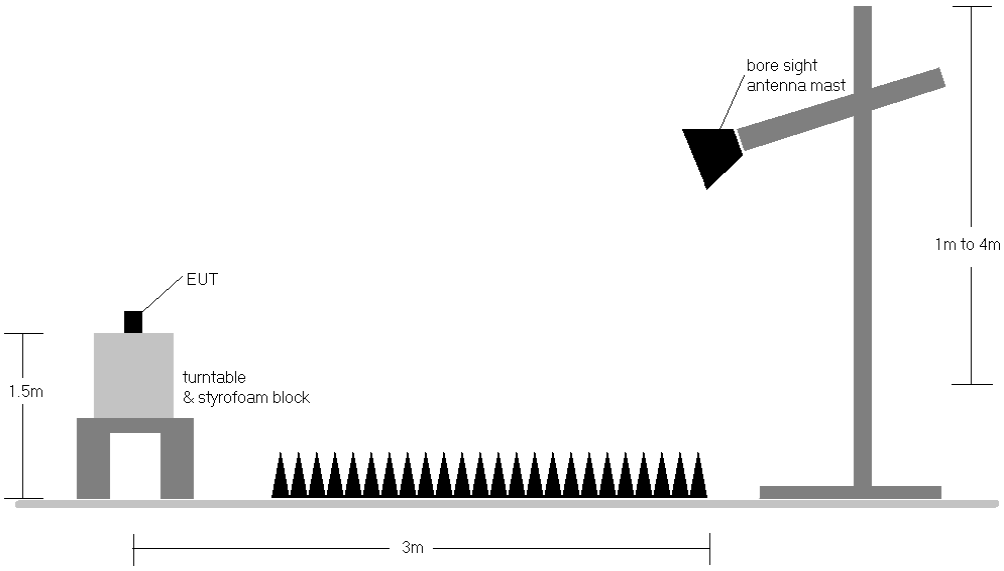


**Figure 7-6. Radiated Test Setup >1GHz**




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## Test Notes

1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of KDB 558074 D01 v05r02 were not used to evaluate this device for compliance to radiated limits. All radiated spurious emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-5.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested with its standard battery.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
6. Average measurements were recorded using a VBW of 3kHz, per Section 4.1.4.2.3 of ANSI C63.10-2013, since 1/T is equal to just under 3kHz. This method was used because the EUT could not be configured to operate with a duty cycle > 98%. Both average and peak measurements were made using a peak detector
7. Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
8. No significant radiated band edge emissions were found in the 2310 – 2390MHz restricted band.
9. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

## Sample Calculations

### Determining Spurious Emissions Levels

- Field Strength Level $_{[dB\mu V/m]}$ = 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 7.8 was calculated using the formula:
  Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain



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## Radiated Spurious Emission Measurements

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

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

| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | Avg | V | - | - | -78.26 | 6.20 | 34.94 | 53.98 | -19.04 |
| 4804.00 | Peak | V | - | - | -66.23 | 6.20 | 46.97 | 73.98 | -27.01 |
| 12010.00 | Avg | V | - | - | -80.54 | 17.94 | 44.40 | 53.98 | -9.58 |
| 12010.00 | Peak | V | - | - | -68.89 | 17.94 | 56.05 | 73.98 | -17.93 |

**Table 7-7. Radiated Measurements @ 3 meters**

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

| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 4880.00 | Avg | V | - | - | -78.54 | 6.79 | 35.25 | 53.98 | -18.73 |
| 4880.00 | Peak | V | - | - | -66.49 | 6.79 | 47.30 | 73.98 | -26.68 |
| 7320.00 | Avg | V | - | - | -79.57 | 12.03 | 39.46 | 53.98 | -14.52 |
| 7320.00 | Peak | V | - | - | -66.68 | 12.03 | 52.35 | 73.98 | -21.63 |
| 12200.00 | Avg | V | - | - | -80.48 | 18.27 | 44.79 | 53.98 | -9.19 |
| 12200.00 | Peak | V | - | - | -68.26 | 18.27 | 57.01 | 73.98 | -16.97 |

**Table 7-8. Radiated Measurements @ 3 meters**



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# Radiated Spurious Emission Measurements

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

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

| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | Avg | V | - | - | -78.69 | 6.70 | 35.01 | 53.98 | -18.97 |
| 4960.00 | Peak | V | - | - | -67.21 | 6.70 | 46.49 | 73.98 | -27.49 |
| 7440.00 | Avg | V | - | - | -79.64 | 12.23 | 39.59 | 53.98 | -14.39 |
| 7440.00 | Peak | V | - | - | -67.63 | 12.23 | 51.60 | 73.98 | -22.38 |
| 12400.00 | Avg | V | - | - | -81.16 | 18.53 | 44.37 | 53.98 | -9.61 |
| 12400.00 | Peak | V | - | - | -69.52 | 18.53 | 56.01 | 73.98 | -17.97 |

**Table 7-9. Radiated Measurements @ 3 meters**



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## 7.8 Radiated Restricted Band Edge Measurements

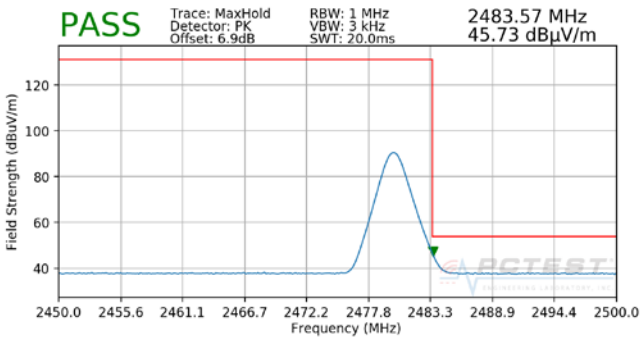
**§15.205 §15.209; RSS-Gen [8.9]**

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

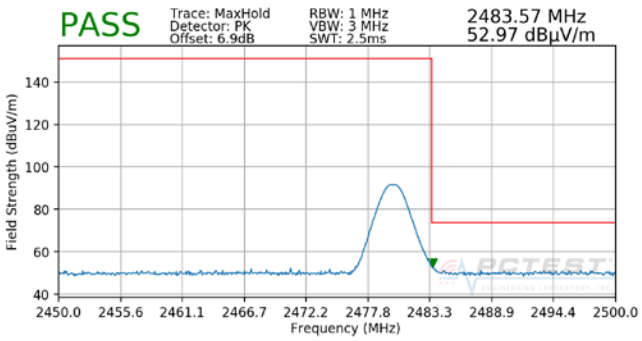
The amplitude offset shown in the following plots for average measurements was calculated using the formula:

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

| | |
|---|---|
| Bluetooth Mode: | LE |
| Data Rate | 1Mbps |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 39 |




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




**Plot 7-52. Radiated Restricted Upper Band Edge Measurement (Peak)**

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## 7.9 Line-Conducted Test Data

**§15.207; RSS-Gen [8.8]**

**Test Overview and Limit**

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

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

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

**Table 7-10. Conducted Limits**

*Decreases with the logarithm of the frequency.

**Test Procedures Used**

ANSI C63.10-2013, Section 6.2

**Test Settings**

**Quasi-Peak Field Strength Measurements**

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

**Average Field Strength Measurements**

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




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## Test Setup

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

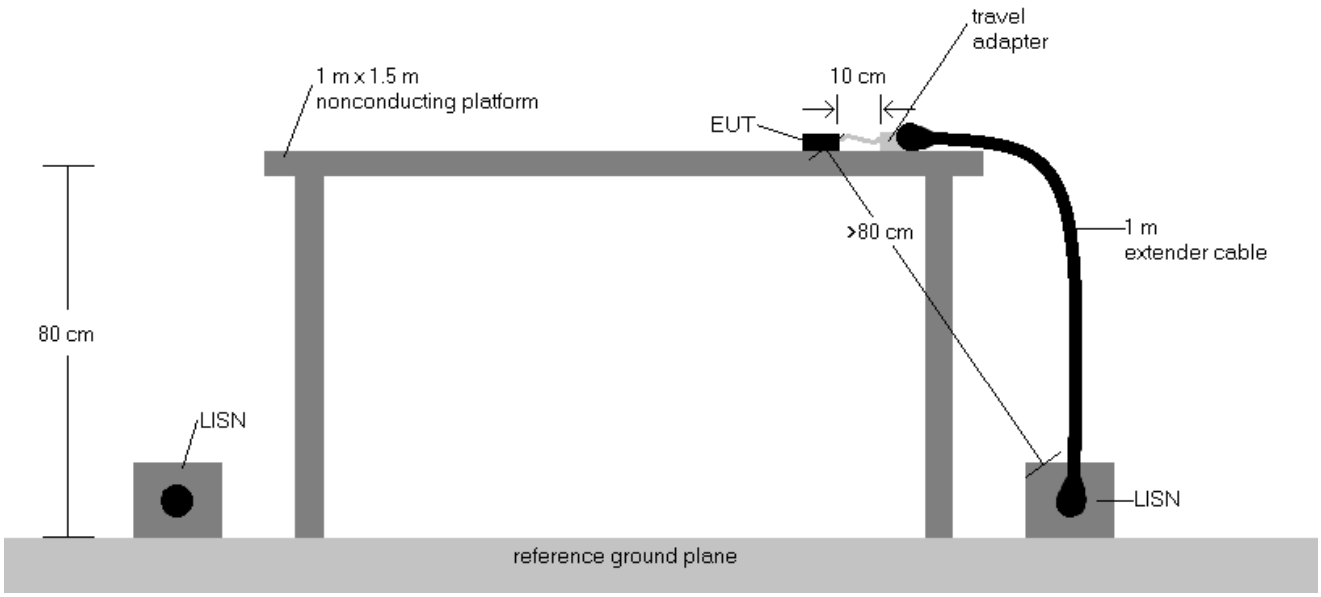


**Figure 7-7. Test Instrument & Measurement Setup**

## Test Notes

1. All modes of operation were investigated and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in Part 15.207 and RSS-Gen (8.8).
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (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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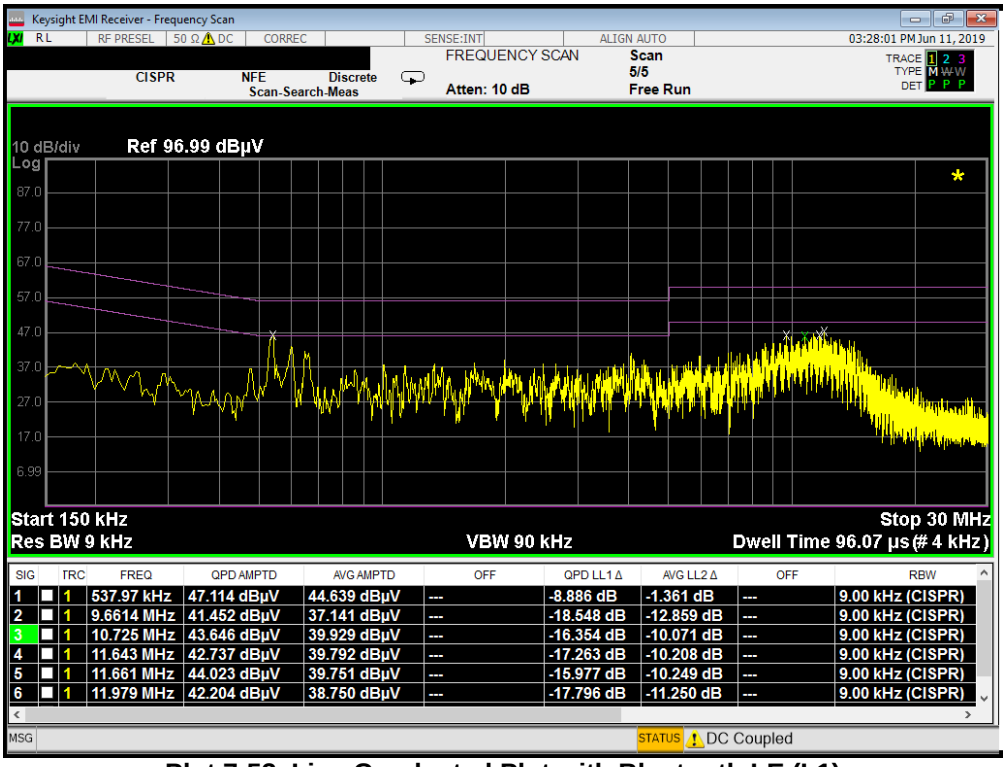
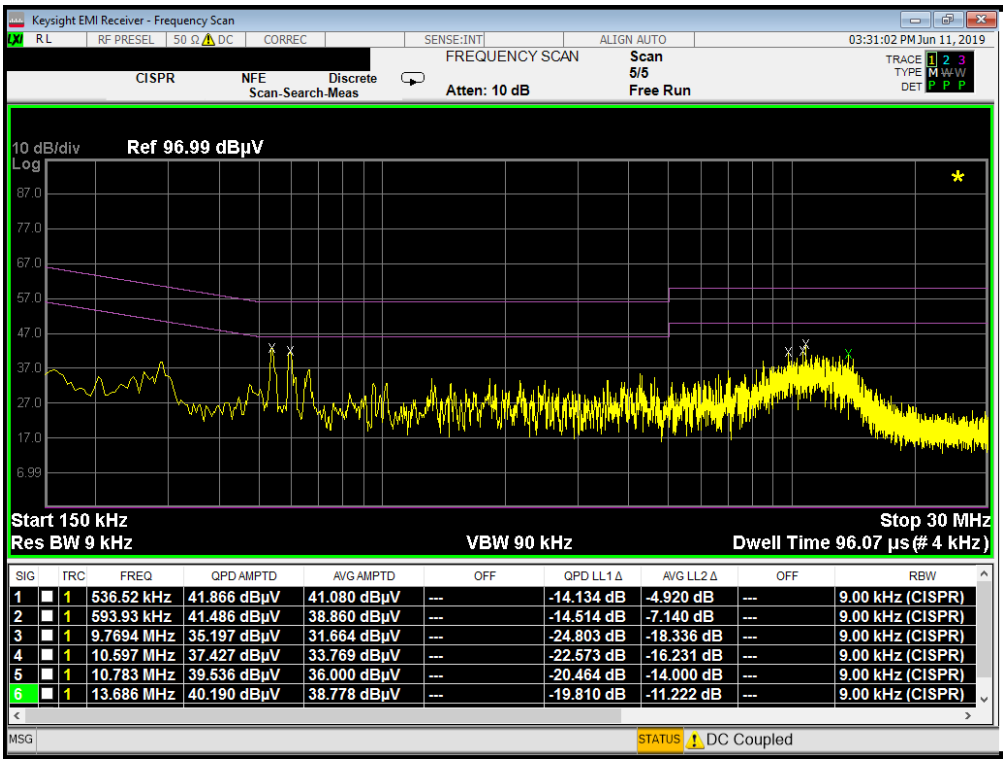



| SIG | TRC | FREQ | QPD AMPTD | AVG AMPTD | OFF | QPD LL1 Δ | AVG LL2 Δ | OFF | RBW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 537.97 kHz | 47.114 dBµV | 44.639 dBµV | --- | -8.886 dB | -1.361 dB | --- | 9.00 kHz (CISPR) |
| 2 | 1 | 9.6614 MHz | 41.452 dBµV | 37.141 dBµV | --- | -18.548 dB | -12.859 dB | --- | 9.00 kHz (CISPR) |
| 3 | 1 | 10.725 MHz | 43.646 dBµV | 39.929 dBµV | --- | -16.354 dB | -10.071 dB | --- | 9.00 kHz (CISPR) |
| 4 | 1 | 11.643 MHz | 42.737 dBµV | 39.792 dBµV | --- | -17.263 dB | -10.208 dB | --- | 9.00 kHz (CISPR) |
| 5 | 1 | 11.661 MHz | 44.023 dBµV | 39.751 dBµV | --- | -15.977 dB | -10.249 dB | --- | 9.00 kHz (CISPR) |
| 6 | 1 | 11.979 MHz | 42.204 dBµV | 38.750 dBµV | --- | -17.796 dB | -11.250 dB | --- | 9.00 kHz (CISPR) |

**Plot 7-53. Line Conducted Plot with Bluetooth LE (L1)**




| SIG | TRC | FREQ | QPD AMPTD | AVG AMPTD | OFF | QPD LL1 Δ | AVG LL2 Δ | OFF | RBW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 536.52 kHz | 41.866 dBµV | 41.080 dBµV | --- | -14.134 dB | -4.920 dB | --- | 9.00 kHz (CISPR) |
| 2 | 1 | 593.93 kHz | 41.486 dBµV | 38.860 dBµV | --- | -14.514 dB | -7.140 dB | --- | 9.00 kHz (CISPR) |
| 3 | 1 | 9.7694 MHz | 35.197 dBµV | 31.664 dBµV | --- | -24.803 dB | -18.336 dB | --- | 9.00 kHz (CISPR) |
| 4 | 1 | 10.597 MHz | 37.427 dBµV | 33.769 dBµV | --- | -22.573 dB | -16.231 dB | --- | 9.00 kHz (CISPR) |
| 5 | 1 | 10.783 MHz | 39.536 dBµV | 36.000 dBµV | --- | -20.464 dB | -14.000 dB | --- | 9.00 kHz (CISPR) |
| 6 | 1 | 13.686 MHz | 40.190 dBµV | 38.778 dBµV | --- | -19.810 dB | -11.222 dB | --- | 9.00 kHz (CISPR) |

**Plot 7-54. Line Conducted Plot with Bluetooth LE (N)**

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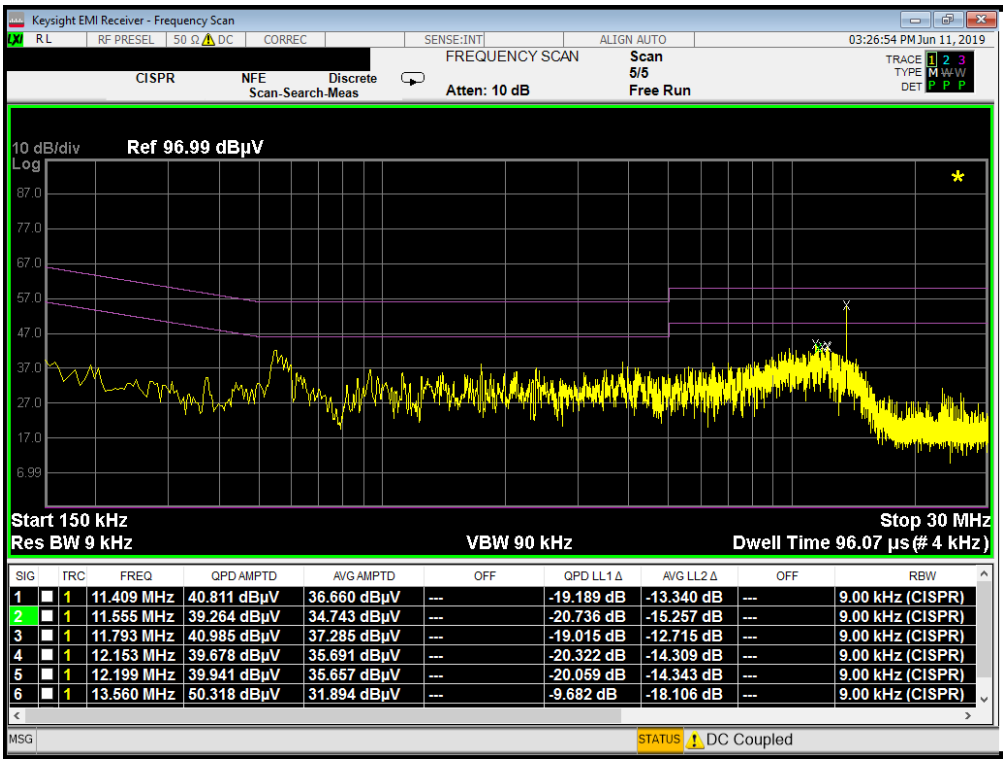
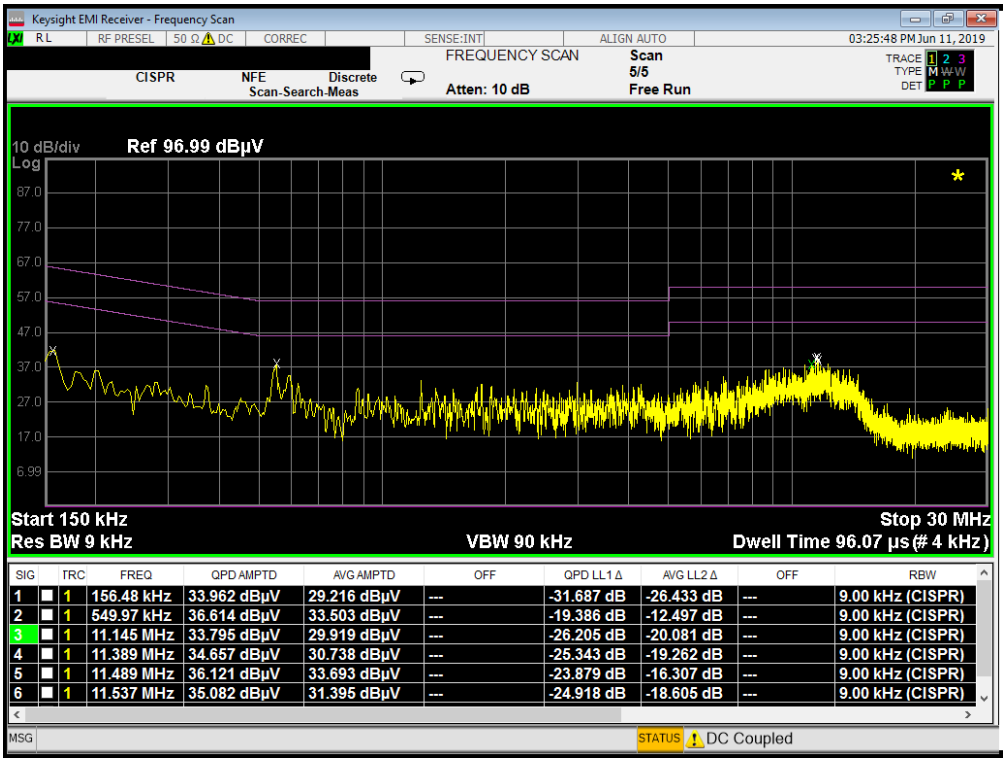



**Plot 7-55. Line Conducted Plot with Bluetooth LE with WCP (L1)**




**Plot 7-56. Line Conducted Plot with Bluetooth LE with WCP (N)**



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# 8.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **Samsung Portable Handset FCC ID: A3LSMN970U** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules and RSS-247 of the Innovation, Science and Economic Development Canada Rules.




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