NVLAP Lab Code 200087-0

**Rogers Labs, a division of The Compatibility Center LLC**

*7915 Nieman Rd.*
*Lenexa, KS 66214*
*Phone / Fax (913) 660-0666*

47CFR, PART 15C - Intentional Radiators
47CFR Paragraph 15.247 and
Industry Canada RSS-247 Issue 3 and RSS-GEN Issue 5

# Application For Grant of Certification

# Model: A04684

2402-2480 and 2412-2462 MHz Digital Transmission System (DTS)

## FCC ID: IPH-04684
## IC: 1792A-04684

# Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062
Tim Olson
Senior Compliance Engineer

Test Report Number: 230821A
Test Date: August 21, 2023

Authorized Signatory:

Patrick Powell
Rogers Labs, a division of The Compatibility Center LLC
FCC Designation: US5305
ISED Registration: 3041A

## Revisions

Revision 1 Issued June 19, 2024

Revision 2 Issued June 26, 2024 – Clarified EUT duty cycle in the Equipment Function section.

## Executive Summary

The following information is submitted for consideration in obtaining Grant of Certification for License Exempt Digital Transmission System Intentional Radiator operating under Code of Federal Regulations Title 47 (47CFR) Part 15C paragraph 15.247, Industry Canada RSS-247 Issue 3, and RSS-GEN Issue 5, operation in the 2400 – 2483.5 MHz band.

Name of Applicant: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

PMN: A04684

FCC ID: IPH-04684 IC: 1792A-04684

Operating Frequency Range: 2402-2480 MHz

A04684 was chosen for transmitter configuration testing and used for final measurements.

Operational communication modes 1 through 4

| Mode | Power (Watts) | 99% OBW (kHz) | 6-dB OBW (kHz) |
|---|---|---|---|
| Mode 1, BT BLE (GMSK) | 0.002 | 1,054.5 | 709.5 |
| Mode 2, 802.11b | 0.041 | 11,647.5 | 8,360.0 |
| Mode 3, 802.11g | 0.030 | 16,950.0 | 16,004.6 |
| Mode 4, 802.11n | 0.026 | 18,050.0 | 16,520.0 |

This report addresses EUT Operations as Digital Transmission System using transmitter modulations in modes 1 through 4. Note, the production device utilizes a non-user accessible integral antenna system with 2.2 dBi gain.

## Opinion / Interpretation of Results

| Tests Performed | Margin (dB) | Results |
|---|---|---|
| Emissions 15.205, RSS-GEN, RSS-247 | -2.5 | Complies |
| Emissions as per 47CFR 15.207, RSS-GEN 8.8 | -7.75 | Complies |
| Radiated Emissions 47 CFR 15.209, RSS-GEN 8.9 | -19.3 | Complies |
| Harmonic Emissions per 47CFR 15.247, RSS-247 | -0.7 | Complies |
| Power Spectral Density per 47CFR 15.247, RSS-247 | -12.9 | Complies |

Tests performed include
47CFR
15.247 (a) (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.
(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one-Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time

interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

RSS-247 Issue 3

**5.2 Digital transmission systems**

DTS's include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz

a)The minimum 6 dB bandwidth shall be 500 kHz.

b)The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d),(i.e., the power spectral density shall be determined using the same method as is used to determine the conducted output power).

**5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.) requirements**

d) For DTS's employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

**5.5 Unwanted emissions**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

## Equipment Tested

Model: A04684

Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

| Equipment | Model / PN | Serial Number |
|---|---|---|
| EUT General Emissions #1 | A04684 | 3444728073 |
| EUT Tx Radiated #2 | A04684 | 3459196260 |
| EUT Antenna Port Conducted #1 | A04684 | 3448985366 |
| EUT Antenna Port Conducted #2 | A04684 | 3459196235 |
| 8m power cable | 320-01325-20 | N/A |
| 4m power cable | 320-01325-10 | N/A |
| 1.5m USB/power cable | 320-01325-00 | N/A |
| Dual USB PWR Adaptor | 013-00797-01 | M1812004b |
| Quick Power Adaptor | 320-01425-10 | N/A |
| Parking mode Cable | 320-00845-04 | F19000070 |
| DC Power Supply | BK 1745 | 209C13 |
| Laptop Computer | Latitude 7480 | EFSPSN2 |
| USB Printer | Dell 0N5819 | 5D1SL61 |

Test results in this report relate only to the items tested. Worst-case configuration data recorded in this report.

Software (FVIN): 1.04 or higher; Antennas: 2.4 GHz PIFA (2.2 dBi), 5 GHz PIFA (4.5 dBi)

## *Equipment Operational Modes*

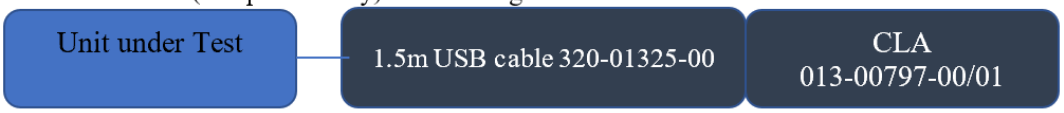
| Mode | Transmitter Operation |
|---|---|
| 1 | BT BLE (GMSK) |
| 2 | 802.11b |
| 3 | 802.11g |
| 4 | 802.11n |
| 5 | U-NII-1 802.11a |
| 6 | U-NII-1 802.11n |
| 7 | U-NII-1 802.11n40 |
| 8 | U-NII-1 802.11ac80 |
| 9 | U-NII-3 802.11a |
| 10 | U-NII-3 802.11n |
| 11 | U-NII-3 802.11n40 |
| 12 | U-NII-3 802.11ac80 |

### *Equipment Function*

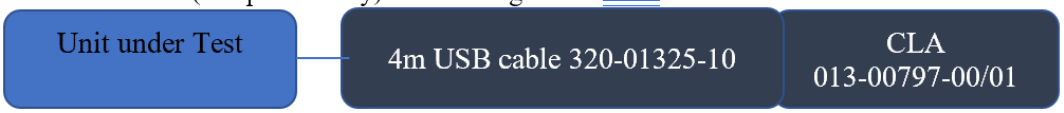
The EUT is a mobile mounted, digital recording device incorporating wireless data transfer. The device incorporates camera sensor and associated circuitry to record images within the lens view angle. The design incorporates transmitter circuitry operating in the 2402-2480, 5150-5250, and 5725-5850 MHz frequency bands. The product operates from internal battery or external direct current power provided over the micro USB interface port. Power is provided through compatible USB interface cable options and power sources. The design provides a Micro SD Card slot and USB-C interface port as presented below and wireless communications with compatible equipment. The EUT was arranged as described by the manufacturer emulating typical user configurations for testing purposes. The EUT offers no other interface connections than those presented in the configuration options as described by the manufacturer and presented below. During testing, the test system was configured to operate in a manufacturer defined mode. The software provided the ability to operate the transmitters at near 100% duty cycle for testing purposes. The testing mode of operation exceeds typical duty cycle operation of production equipment. As requested by the manufacturer, the equipment was tested for emissions compliance using the available configurations with the worst-case data presented. Test results in this report relate only to the products described in this report.

## *Equipment Configuration*

1) Unit connected to (and powered by) CLA through USB cable




2) Unit connected to (and powered by) CLA through USB cable



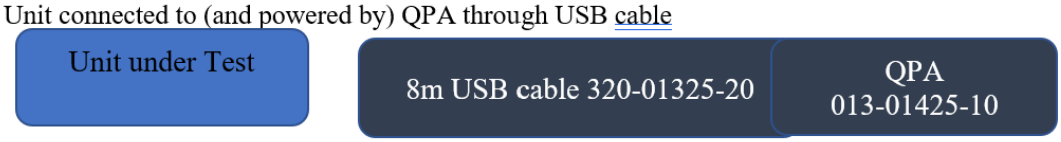

3) Unit connected to (and powered by) CLA through USB cable


4) Unit connected to (and powered by) Computer through USB cable

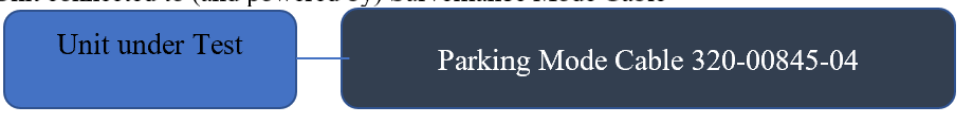

5) Unit connected to (and powered by) QPA through USB cable


6) Unit connected to (and powered by) QPA through USB cable


7) Unit connected to (and powered by) QPA through USB cable




8) Unit connected to (and powered by) Surveillance Mode Cable



## Application for Certification

(1) Manufacturer: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

(2) Identification: HVIN: A04684
FCC ID: IPH-04684 IC: 1792A-04684

(3) Instruction Book:
Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:
Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:
Refer to Exhibit of Operational Description.

(6) Report of Measurements:
Report of measurements follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:
Refer to Exhibit for photographs of equipment.

(8) List of Peripheral Equipment Necessary for operation. The equipment operates from external direct current power provided from installation vehicle. The EUT provides interface ports for power, loads and communications as presented in this filing.

(9) Transition Provisions of 47CFR 15.37 are not requested.

(10) Not Applicable. The unit is not a scanning receiver.

(11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

(13) Applications for certification of U-NII devices in the 5.15-5.35 GHz and the 5.47-5.85 GHz bands must include a high-level operational description of the security procedures that control the radio frequency operating parameters and ensure that unauthorized modifications cannot be made. This requirement is not applicable to his DTS device.

(14) Contain at least one drawing or photograph showing the test set-up for each of the required types of tests applicable to the device for which certification is requested. These drawings or photographs must show enough detail to confirm other information contained in the test report. Any photographs used must be focused originals without glare or dark spots and must clearly show the test configuration used. This information is provided in this report and Test Setup Exhibits provided with the application filing.

## Applicable Standards

The following information is submitted in accordance with the eCFR (electronic Title 47 Code of Federal Regulations) (47CFR), dated August 4, 2023: Part 2, Subpart J, Part 15C Paragraph 15.247, RSS-247 Issue 3, and RSS-GEN Issue 5. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.10-2013. This report documents compliance for the EUT operations as Digital Transmission Systems operation.

# Test Procedures

### *AC Line Conducted Emission Test Procedure*

Testing for the AC line-conducted emissions were performed as required in CFR47 15B, RSS-GEN, and directed in ANSI C63.4-2014. The test setup, including the EUT, was arranged in the test configurations as presented during testing. The test configuration was placed on a 1 x 1.5-meter bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50-µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to diagram one showing typical test arrangement and photographs in the test setup exhibit for EUT placement used during testing.

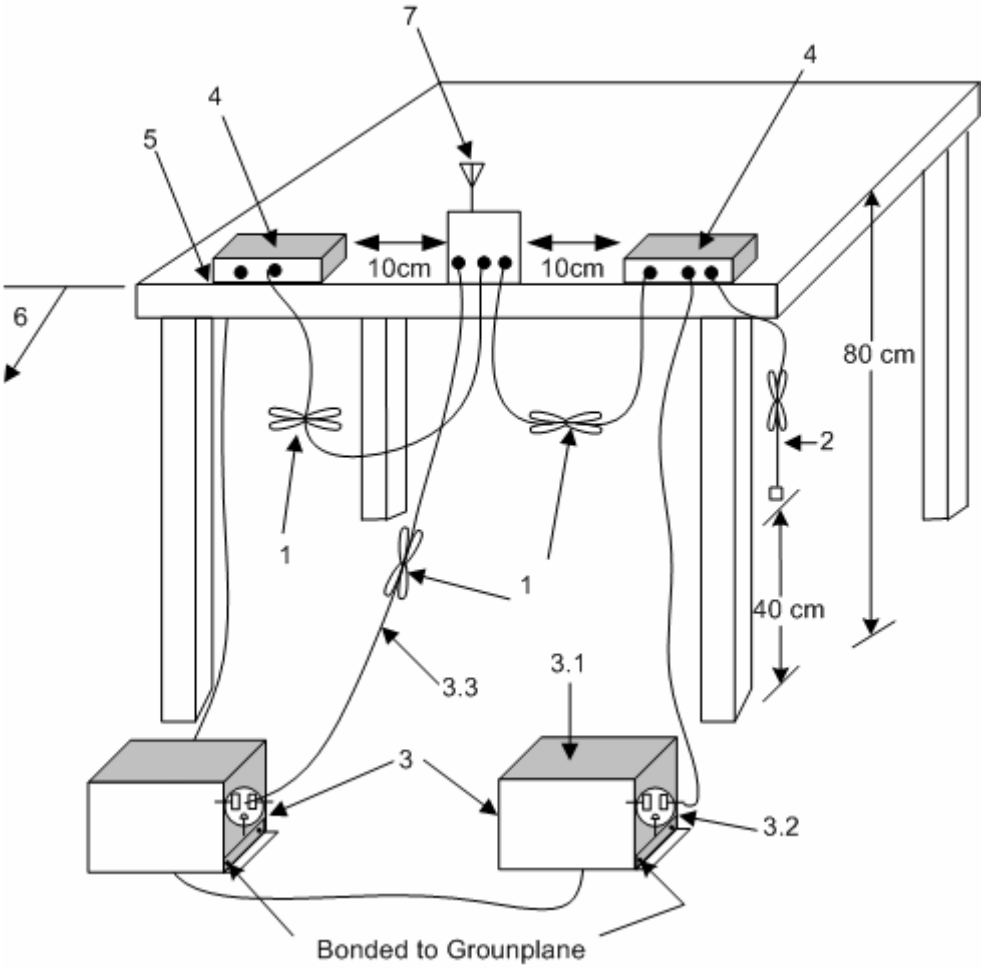
### *Radiated Emission Procedure*

Radiated emissions testing was performed as required in 47CFR 15C, RSS-247 Issue 3, RSS-GEN and specified in ANSI C63.10-2013. The EUT was placed on a rotating 0.9 x 1.2-meter platform, elevated as required above the ground plane at a distance of 3 meters from the FSM antenna. EMI energy was maximized by equipment placement permitting orientation in three orthogonal axes, raising, and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken and recorded. The frequency spectrum from 9 kHz to 25,000 MHz was searched for emissions during preliminary investigation. Refer to diagrams two and three showing typical test setup. Refer to photographs in the test setup exhibits for specific EUT placement during testing.

### *Antenna Port Conducted Emission Test Procedure*

The EUT was assembled as required for operation placed on a benchtop. This configuration provided the ability to connect test equipment to the provided test antenna port Antenna Port conducted emissions testing was performed presented in the regulations and specified in ANSI C63.10-2013. Testing was completed on a laboratory bench in a shielded room. The active antenna port of the device was connected to appropriate attenuation and the spectrum analyzer. Refer to diagram 4 showing typical test arrangement and photographs in the test setup exhibits for specific EUT placement during testing.

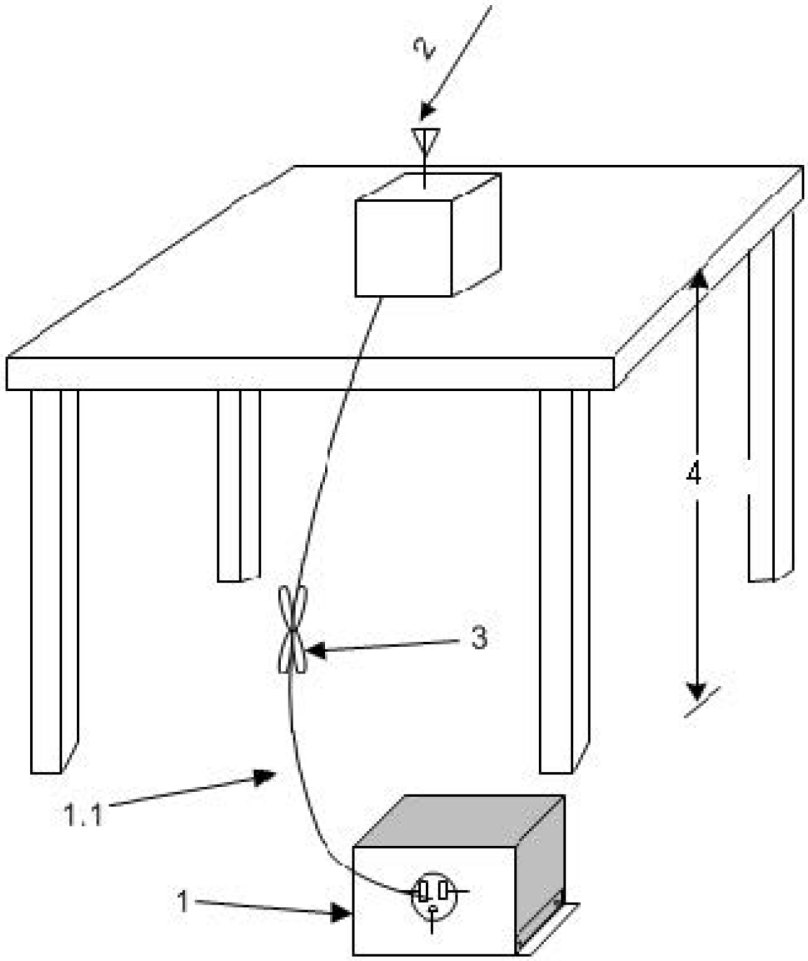
***Diagram 1 Test arrangement for power-line conducted emissions***




1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.1).
2. I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.2.2).
3. EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
   3.1 All other equipment powered from additional LISN(s).
   3.2 Multiple-outlet strip can be used for multiple power cords of non-EUT equipment.
   3.3 LISN at least 80 cm from nearest part of EUT chassis.
4. Non-EUT components of EUT system being tested.
5. Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.3.1).
6. Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).

7. Antenna may be integral or detachable. If detachable, the antenna shall be attached for this test

***Diagram 2 Test arrangement for radiated emissions of tabletop equipment***

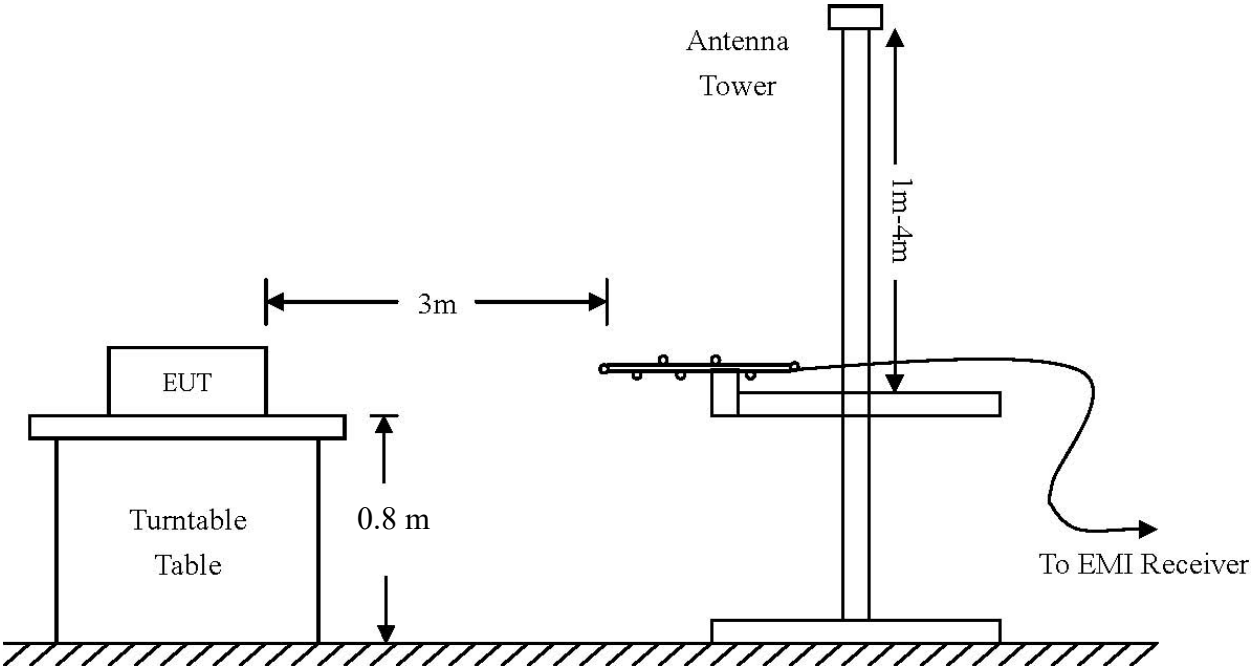



1—A LISN is optional for radiated measurements between 30 MHz and 1000 MHz but not allowed for measurements
below 30 MHz and above 1000 MHz (see 6.3.1). If used, then connect EUT to one LISN. Unused LISN measuring port
connectors shall be terminated in 50 Ω loads. The LISN may be placed on top of, or immediately beneath, the reference
ground plane (see 6.2.2 and 6.2.3.2).
1.1—LISN spaced at least 80 cm from the nearest part of the EUT chassis.
2—Antenna can be integral or detachable, depending on the EUT (see 6.3.1).
3—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center
forming a bundle 30 cm to 40 cm long (see 6.3.1).
4—For emission measurements at or below 1 GHz, the table height shall be 80 cm. For emission measurements above

1 GHz, the table height shall be 1.5 m for measurements, except as otherwise specified (see 6.3.1 and 6.6.3.1)..

***Diagram 3 Test arrangement for radiated emissions tested in Semi-Anechoic Chamber (SAC) and Outdoor Area Test Site (OATS)***

Below 1 GHz




Above 1 GHz:

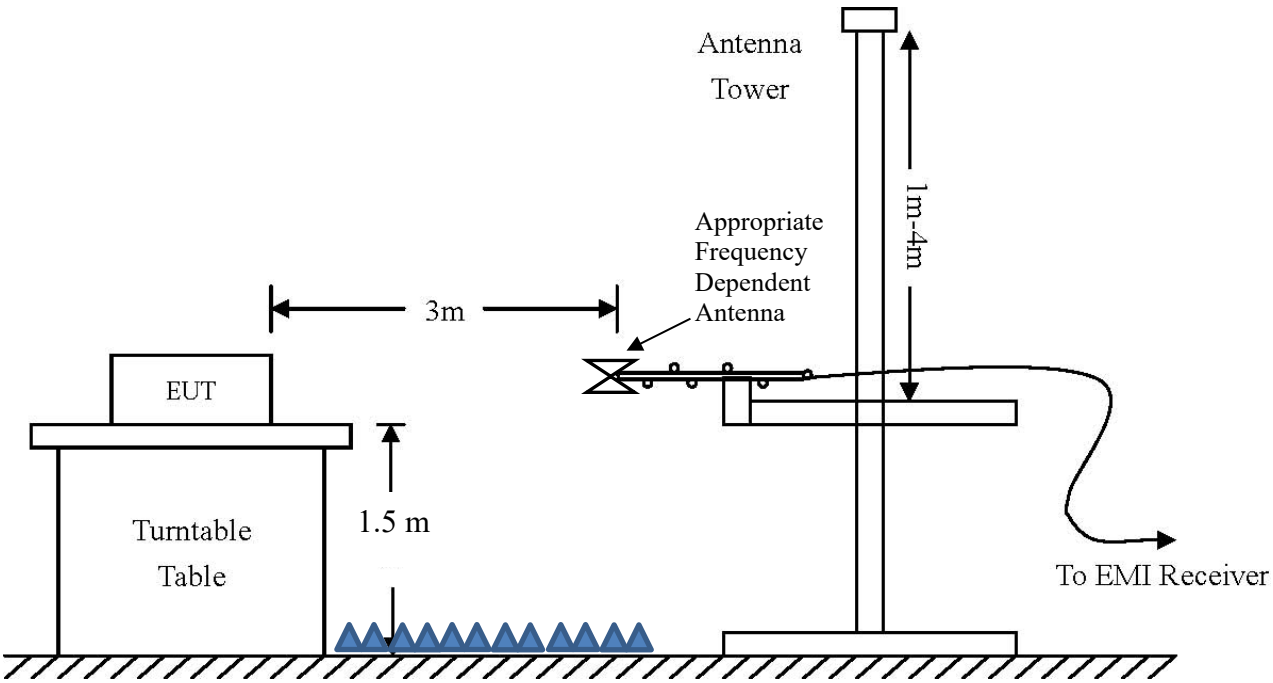
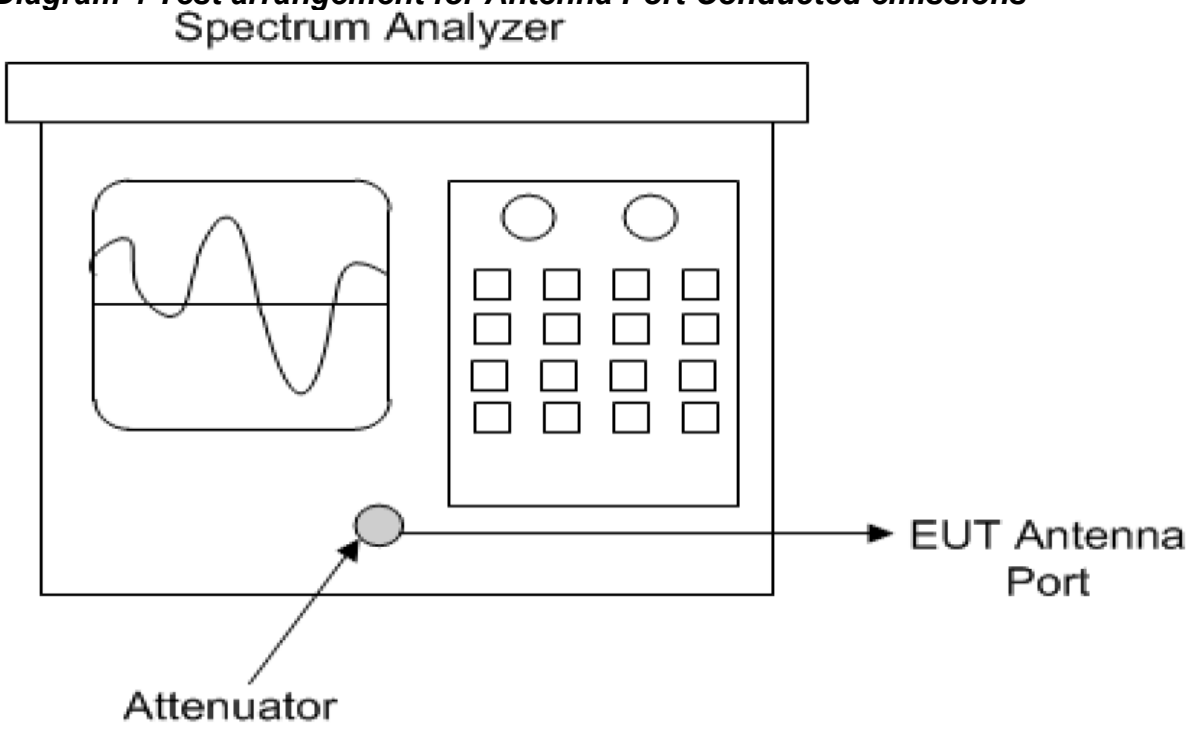



***Diagram 4 Test arrangement for Antenna Port Conducted emissions***



## Test Site Locations

| | |
|---|---|
| Conducted EMI | AC line conducted emissions testing performed in a shielded screen room located at Rogers Labs, a division of The Compatibility Center LLC, 7915 Nieman Rd., Lenexa, KS (or satellite location). |
| Antenna port | Antenna port conducted emissions testing was performed in a shielded screen room located at Rogers Labs, a division of The Compatibility Center LLC, 7915 Nieman Rd., Lenexa, KS (or satellite location). |
| Radiated EMI | The radiated emissions tests were performed at the 3 meters Semi-Anechoic Chamber (SAC) located at Rogers Labs, a division of The Compatibility Center LLC, 7915 Nieman Rd., Lenexa, KS or at the 3 meters Outdoor Area Test Site (OATS) in the satellite location. |
| Registered Site information: | FCC Site: US5305, ISED: 3041A, CAB Identifier: US0096 |
| NVLAP Accreditation | Lab code 200087-0 |

## Units of Measurements

| | |
|---|---|
| Conducted EMI | Data presented in dBµV; dB referenced to one microvolt |
| Antenna port Conducted | Data is in dBm; dB referenced to one milliwatt |
| Radiated EMI | Data presented in dBµV/m; dB referenced to one microvolt per meter |

Note: The limit is expressed for a measurement in dBµV/m when the measurement is taken at a distance of 3 or 10 meters. Data taken for this report was taken at distance of 3 meters. Sample calculation demonstrates corrected field strength reading for Semi-Anechoic Chamber using the measurement reading and correcting for receive antenna factor, cable losses, and amplifier gains.

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured

A.F. = Receive antenna factor, Losses = attenuators/cable losses, Gain = amplification gains

RFS (dBµV/m @ 3m) = FSM (dBµV) + A.F. (dB/m) + Losses (dB) - Gain (dB)

| Frequency: 9 kHz-30 MHz | Frequency: 30 MHz- 1 GHZ | Frequency: Above 1 GHz |
|---|---|---|
| Loop Antenna | Broadband Biconilog | Horn |
| RBW = 9 kHz | RBW = 120 kHz | RBW = 1 MHz |
| VBW = 30 kHz | VBW = 500 kHz | VBW = 3 MHz |
| Sweep time = Auto | Sweep time = Auto | Sweep time = Auto |
| Detector = PK, QP | Detector = PK, QP | Detector = PK, AV |
| Antenna Height 1m | Antenna Height 1-4m | Antenna Height 1-4m |

## Environmental Conditions

Ambient Temperature 19.4° C

Relative Humidity 32.0 %

Atmospheric Pressure 1028.1 mb

## Statement of Modifications and Deviations

No modifications to the EUT were required for the equipment to demonstrate compliance with the 47CFR Part 15C, Industry Canada RSS-247 Issue 3, and RSS-GEN Issue 5 emission requirements. There were no deviations to the specifications.

# Intentional Radiators

The following information is submitted supporting compliance with the requirements of 47CFR, Subpart C, paragraph 15.247, Industry Canada RSS-247 Issue 3, and RSS-GEN Issue 5.

## *Antenna Requirements*

The EUT incorporates integral non-user accessible system. Production equipment offers no provision for connection to alternate antenna system. The antenna connection point complies with the unique antenna connection requirements. There are no deviations or exceptions to the specification.

## *Restricted Bands of Operation*

Spurious emissions falling in the restricted frequency bands of operation were measured at the SAC. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were investigated at the SAC, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. Peak and average amplitudes of frequencies above 1000 MHz were compared to the required limits with worst-case data presented below. Test procedures of ANSI C63.10-2013 were used during testing. No other significant emission was observed which fell into the restricted bands of operation. Computed emission values consider the received radiated field strength, receive antenna correction factor, amplifier gain stage, and test system cable losses.

**Table 1 Radiated Emissions in Restricted Frequency Bands Data Mode 1, BT BLE (GMSK)**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 53.7 | 39.5 | 53.0 | 39.5 | 54.0 | -14.5 | -14.5 |
| 2483.5 | 54.8 | 40.5 | 54.5 | 40.5 | 54.0 | -13.5 | -13.5 |
| 4804.0 | 51.4 | 37.8 | 51.3 | 37.7 | 54.0 | -16.2 | -16.3 |
| 4880.0 | 51.7 | 37.6 | 52.0 | 37.6 | 54.0 | -16.4 | -16.4 |
| 4960.0 | 51.3 | 37.6 | 50.9 | 37.5 | 54.0 | -16.4 | -16.5 |
| 7206.0 | 55.3 | 41.7 | 55.5 | 41.6 | 54.0 | -12.3 | -12.4 |
| 7320.0 | 55.4 | 41.7 | 55.5 | 41.7 | 54.0 | -12.3 | -12.3 |
| 7440.0 | 56.7 | 41.8 | 55.3 | 41.7 | 54.0 | -12.2 | -12.3 |
| 12010.0 | 61.8 | 47.7 | 61.1 | 47.6 | 54.0 | -6.3 | -6.4 |
| 12200.0 | 62.1 | 48.3 | 61.6 | 48.4 | 54.0 | -5.7 | -5.6 |
| 12400.0 | 62.2 | 48.5 | 61.7 | 48.5 | 54.0 | -14.5 | -14.5 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 2 Radiated Emissions in Restricted Frequency Bands Data Mode 2, 802.11b**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 59.5 | 45.3 | 60.3 | 45.6 | 54.0 | -8.7 | -8.4 |
| 2483.5 | 56.8 | 42.8 | 58.2 | 44.6 | 54.0 | -11.2 | -9.4 |
| 4824.0 | 51.0 | 37.3 | 51.8 | 37.6 | 54.0 | -16.7 | -16.4 |
| 4874.0 | 51.0 | 37.3 | 51.4 | 37.7 | 54.0 | -16.7 | -16.3 |
| 4924.0 | 51.2 | 37.4 | 53.0 | 38.4 | 54.0 | -16.6 | -15.6 |
| 7236.0 | 55.6 | 41.9 | 55.6 | 42.0 | 54.0 | -12.1 | -12.0 |
| 7311.0 | 55.3 | 41.7 | 57.2 | 43.4 | 54.0 | -12.3 | -10.6 |
| 7386.0 | 55.8 | 42.1 | 55.6 | 41.9 | 54.0 | -11.9 | -12.1 |
| 12060.0 | 61.5 | 48.2 | 62.2 | 48.3 | 54.0 | -5.8 | -5.7 |
| 12185.0 | 60.8 | 47.2 | 60.3 | 47.1 | 54.0 | -6.8 | -6.9 |
| 12310.0 | 61.4 | 47.8 | 61.5 | 47.7 | 54.0 | -6.2 | -6.3 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 3 Radiated Emissions in Restricted Frequency Bands Data Mode 3, 802.11g**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 71.0 | 49.3 | 72.4 | 51.3 | 54.0 | -4.7 | -2.7 |
| 2483.5 | 67.8 | 46.5 | 68.9 | 48.1 | 54.0 | -7.5 | -5.9 |
| 4824.0 | 50.9 | 37.2 | 51.4 | 37.3 | 54.0 | -16.8 | -16.7 |
| 4874.0 | 50.9 | 37.3 | 50.8 | 37.4 | 54.0 | -16.7 | -16.6 |
| 4924.0 | 51.4 | 37.4 | 51.2 | 37.4 | 54.0 | -16.6 | -16.6 |
| 7236.0 | 55.5 | 41.5 | 55.0 | 41.5 | 54.0 | -12.5 | -12.5 |
| 7311.0 | 55.2 | 41.7 | 55.5 | 42.2 | 54.0 | -12.3 | -11.8 |
| 7386.0 | 55.3 | 41.8 | 55.0 | 41.7 | 54.0 | -12.2 | -12.3 |
| 12060.0 | 62.4 | 48.6 | 61.8 | 48.5 | 54.0 | -5.4 | -5.5 |
| 12185.0 | 60.8 | 47.2 | 60.4 | 47.2 | 54.0 | -6.8 | -6.8 |
| 12310.0 | 61.1 | 47.8 | 61.8 | 47.8 | 54.0 | -6.2 | -6.2 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 4 Radiated Emissions in Restricted Frequency Bands Data Mode 4, 802.11n**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 71.0 | 49.4 | 72.4 | 50.9 | 54.0 | -4.6 | -3.1 |
| 2483.5 | 71.2 | 49.4 | 73.0 | 51.5 | 54.0 | -4.6 | -2.5 |
| 4824.0 | 51.1 | 37.3 | 51.0 | 37.4 | 54.0 | -16.7 | -16.6 |
| 4874.0 | 51.2 | 37.3 | 51.0 | 37.4 | 54.0 | -16.7 | -16.6 |
| 4924.0 | 51.2 | 37.3 | 51.2 | 37.3 | 54.0 | -16.7 | -16.7 |
| 7236.0 | 54.9 | 41.7 | 56.2 | 42.2 | 54.0 | -12.3 | -11.8 |
| 7311.0 | 55.5 | 41.9 | 55.5 | 42.0 | 54.0 | -12.1 | -12.0 |
| 7386.0 | 55.5 | 41.9 | 55.4 | 41.8 | 54.0 | -12.1 | -12.2 |
| 12060.0 | 62.1 | 48.4 | 61.7 | 48.3 | 54.0 | -5.6 | -5.7 |
| 12185.0 | 60.5 | 47.1 | 60.6 | 47.1 | 54.0 | -6.9 | -6.9 |
| 12310.0 | 60.8 | 47.7 | 61.1 | 47.7 | 54.0 | -6.3 | -6.3 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

### *Summary of Results for Radiated Emissions in Restricted Bands*

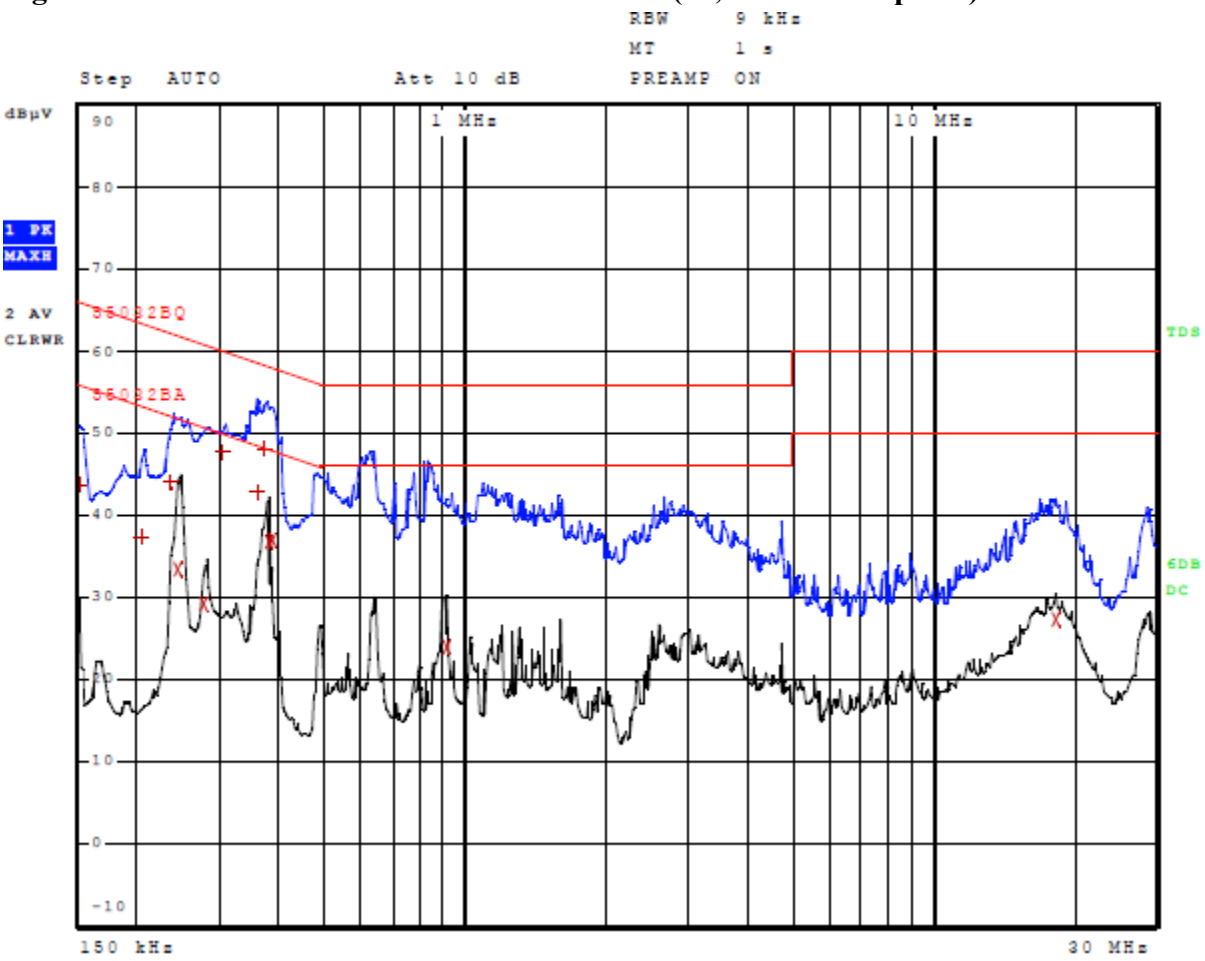
The EUT demonstrated compliance with the radiated emissions requirements of 47CFR Part 15C and RSS-247 Issue 3 Intentional Radiator requirements. The EUT demonstrated a worst-case minimum margin of -2.5 dB below the emissions requirements in restricted frequency bands. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

## *AC Line Conducted EMI Procedure*

The EUT was arranged in typical equipment configurations as offered by manufacturer and presented above in equipment configuration. AC Line Conducted emission testing was performed with the EUT placed on a 1 x 1.5-meter bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. Testing for the AC line-conducted emissions followed the procedures of ANSI C63.10-2013. The EUT was configured as presented in the AC Line conducted configurations as directed by the manufacture and presented above in equipment configuration. The AC adapter for the EUT was connected to the LISN for AC line-conducted emissions testing. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the test configuration. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 μF capacitor, internal to the LISN. Power line conducted emissions testing was carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequencies of each of the emissions, which demonstrated the highest amplitudes. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz and data recorded.

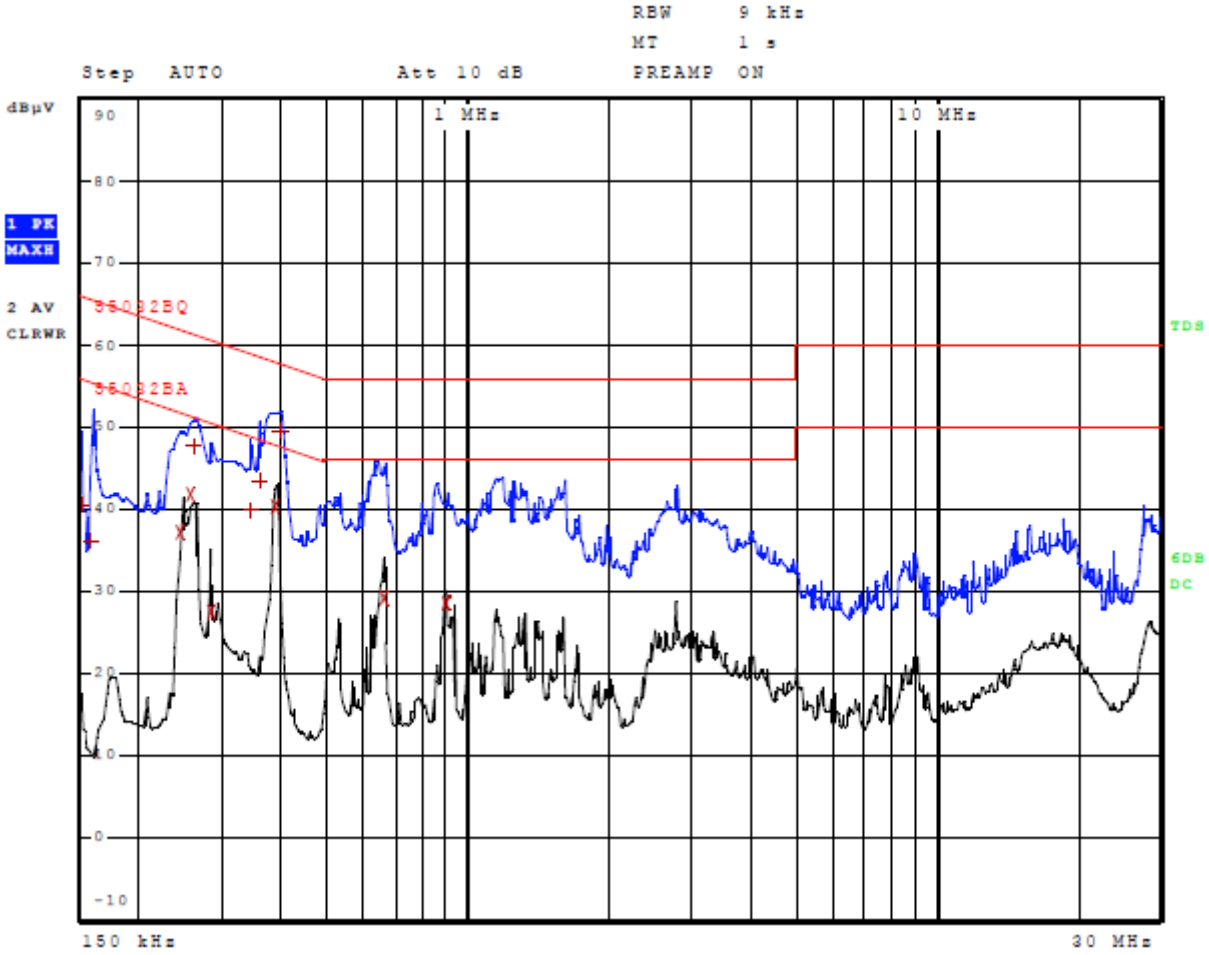
Refer to figures one and two for plots of the Configuration #4 EUT – USB Computer interface AC Line conducted emissions.

**Figure 1 AC Line Conducted Emissions Data L1 (#4, EUT – Computer)**




Other emissions present had amplitudes at least 20 dB below the limit.

**Figure 2 AC Line Conducted Emissions Data L2 (#4, EUT – Computer)**




Other emissions present had amplitudes at least 20 dB below the limit.

**Table 5 AC Line Conducted Emissions Data L1 (#4, EUT – Computer)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 150.000000000 kHz | 43.61 | Quasi Peak | -22.39 |
| 1 | 206.000000000 kHz | 37.31 | Quasi Peak | -26.05 |
| 1 | 238.000000000 kHz | 44.09 | Quasi Peak | -18.08 |
| 2 | 246.000000000 kHz | 33.42 | Average | -18.47 |
| 2 | 278.000000000 kHz | 29.10 | Average | -21.77 |
| 1 | 306.000000000 kHz | 47.76 | Quasi Peak | -12.31 |
| 1 | 358.000000000 kHz | 42.82 | Quasi Peak | -15.96 |
| 1 | 374.000000000 kHz | 48.12 | Quasi Peak | -10.29 |
| 2 | 378.000000000 kHz | 36.73 | Average | -11.59 |
| 2 | 386.000000000 kHz | 37.03 | Average | -11.12 |
| 2 | 910.000000000 kHz | 23.86 | Average | -22.14 |
| 2 | 18.399900000 MHz | 27.28 | Average | -22.72 |

Other emissions present had amplitudes at least 20 dB below the limit.

**Table 6 AC Line Conducted Emissions Data L2 (#4, EUT – Computer)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 150.000000000 kHz | 40.62 | Quasi Peak | -25.38 |
| 1 | 158.000000000 kHz | 36.17 | Quasi Peak | -29.39 |
| 2 | 246.000000000 kHz | 37.07 | Average | -14.82 |
| 2 | 258.000000000 kHz | 41.85 | Average | -9.65 |
| 1 | 262.000000000 kHz | 47.74 | Quasi Peak | -13.63 |
| 2 | 282.000000000 kHz | 27.58 | Average | -23.18 |
| 1 | 342.000000000 kHz | 39.81 | Quasi Peak | -19.34 |
| 1 | 358.000000000 kHz | 43.41 | Quasi Peak | -15.36 |
| 2 | 390.000000000 kHz | 40.31 | Average | -7.75 |
| 1 | 394.000000000 kHz | 49.50 | Quasi Peak | -8.48 |
| 2 | 658.000000000 kHz | 29.27 | Average | -16.73 |
| 2 | 898.000000000 kHz | 28.51 | Average | -17.49 |

Other emissions present had amplitudes at least 20 dB below the limit.

### *Summary of Results for AC Line Conducted Emissions*

The EUT demonstrated compliance with the AC Line Conducted Emissions requirements of 47CFR Part 15C, RSS-247 and RSS-Gen. The EUT configuration #4 demonstrated a minimum margin of -7.75 dB below the requirement. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.

### *General Radiated Emissions Procedure*

Testing for the radiated emissions were performed as specified in CFR47 15B, RSS-GEN, and directed in ANSI C63.4-2014. For testing purposes, the EUT was arranged as presented in the applicable configuration diagrams above and operated through all modes as presented.

Exploratory radiated emissions measurements were performed in the SAC chamber or screen room, finding maximized emissions over frequency, EUT orientation, antenna height and polarity. This data is then used to focus the final radiated emissions measurements on these maximized points.

Final radiated emissions data were taken with the EUT located in the OATS or SAC at distance of 3 meters between the EUT and the receiving antenna. The frequency spectrum from 9 kHz to 6,000 MHz was searched for radiated emissions. Measured emission levels were maximized by EUT placement on the table, changing cable location, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Loop, Biconical, Broadband Biconilog, Log Periodic, and Double Ridge or Pyramidal Horns and mixers above 1 GHz.

**Table 7 General Radiated Emissions Data**

| Frequency (MHz) | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dBm) | Vertical Margin (dBm) |
|---|---|---|---|---|---|---|---|
| 167.0 | 20.2 | 14.4 | 21.0 | 15.8 | 40.0 | -25.6 | -24.2 |
| 160.5 | 32.4 | 16.3 | 21.3 | 14.9 | 40.0 | -23.7 | -25.1 |
| 82.6 | 26.5 | 16.2 | 26.5 | 20.7 | 40.0 | -23.8 | -19.3 |
| 84.4 | 23.0 | 17.2 | 26.6 | 21.3 | 40.0 | -29.8 | -25.7 |
| 217.1 | 19.7 | 13.6 | 19.5 | 13.5 | 40.0 | -33.4 | -33.5 |
| 192.0 | 20.9 | 15.1 | 21.1 | 15.4 | 47.0 | -31.9 | -31.6 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

### *Summary of Results for General Radiated Emissions*

The EUT demonstrated compliance with the radiated emissions requirements of 47CFR Part 15C paragraph 15.209, RSS-247 Issue 3, and RSS-GEN Issue 5 Intentional Radiators. The EUT configuration demonstrated a minimum margin of -19.3 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.

### *Operation in the Band 2400 – 2483.5 MHz*

Test procedures of ANSI C63.10-2013 paragraph 6, and KDB 558074 were used during transmitter testing. Test sample EUT Antenna Port Conducted #1 was provided for testing antenna port conducted emissions. This sample was modified by replacing the internal antenna with a 50-ohm antenna port connector and attenuator for testing purposes. The transmitter peak and average power was measured at the antenna port using a wideband RF power meter as described in KDB 558074 and ANSI C63.10-2013. Average power measured did not include any time intervals during which the transmitter was off or transmitting at a reduced power level. The peak Power Spectral Density (PKPSD) was measured as defined in KDB 558074 and ANSI C63.10-2013. DTS Emission bandwidth was measured as described in KDB 558074 and ANSI C63.10-2013. The amplitude of each harmonic and general radiated emission was measured on the SAC at distance of 3 meters from the FSM antenna (radiated emission testing was performed on sample #1 representative of production equipment with integral antenna). The EUT was positioned on supporting turntable elevated as required above the ground plane, at a distance of 3 meters from the FSM antenna. Radiated emission investigations were performed from 9 kHz to 25,000 MHz. Each radiated emission was maximized by varying the FSM antenna height and polarization, and by rotating the turntable. The worst-case amplitude of each emission was then recorded from the analyzer display. The peak and quasi-peak amplitude of frequencies below 1000 MHz were measured using a spectrum analyzer. The peak and average amplitude of frequencies above 1000 MHZ were measured using a spectrum analyzer. A Loop antenna was used for measuring emissions from 0.009 to 30 MHz, Biconilog Antenna for 30 to 1000 MHz, Double-Ridge, and/or Pyramidal Horn Antennas from 1 GHz to 25 GHz. Radiated Emissions were measured in dBµV/m @ 3 meters. Plots were taken of transmitter performance (using EUT Antenna Port Conducted #1) for reference in this and other documentation.

Refer to figures three through eleven showing plots taken of the 2402-2480 MHz BT BR (GFSK) Frequency Hopping Spread Spectrum operation displaying compliance with the specifications.

**Figure 3 Plot of Transmitter Operation in 2402-2480 MHz Mode 1, BT BLE (GMSK)**

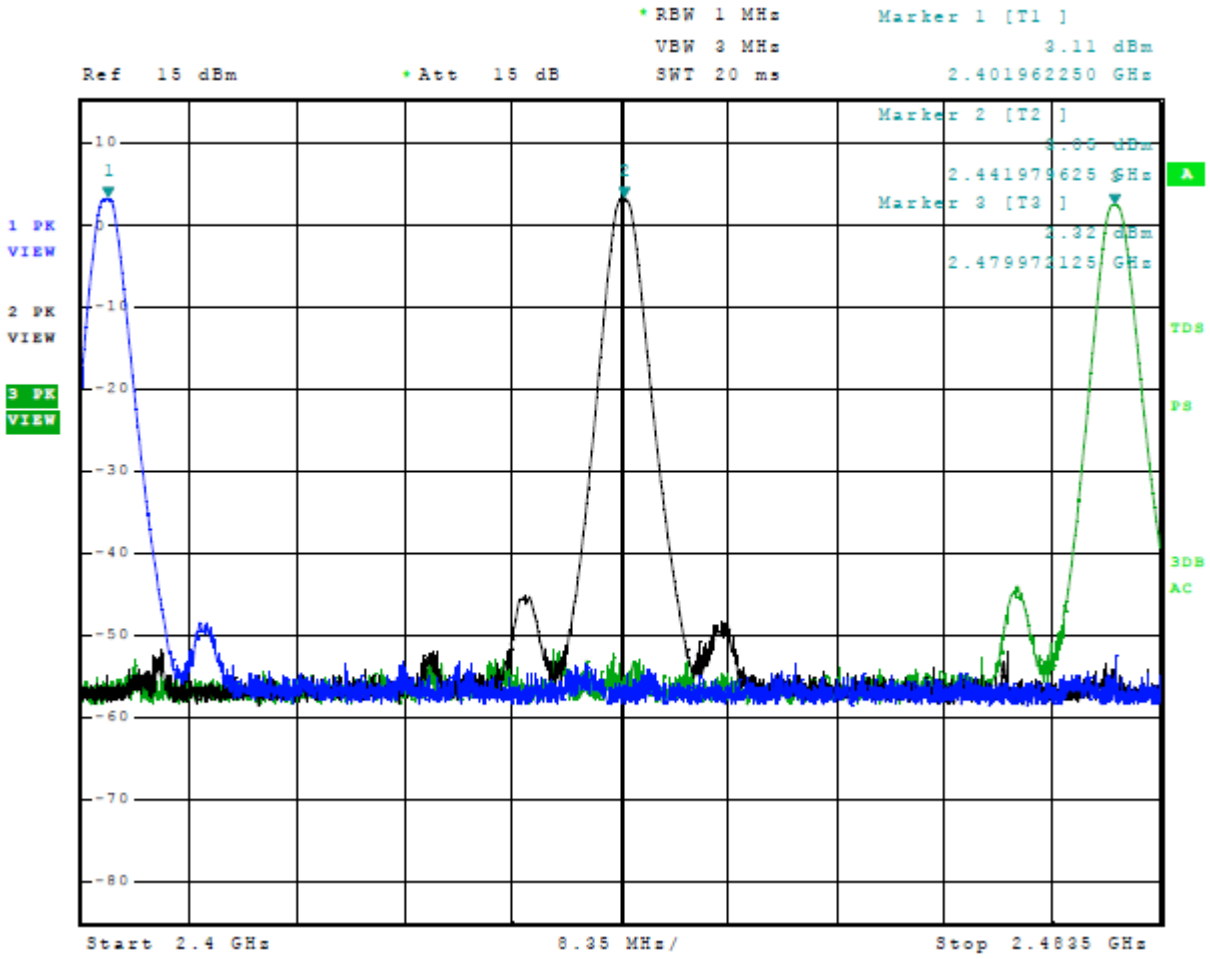


**Figure 4 Plot of Transmitter Operation in 2402-2480 MHz Mode 2, 802.11b**

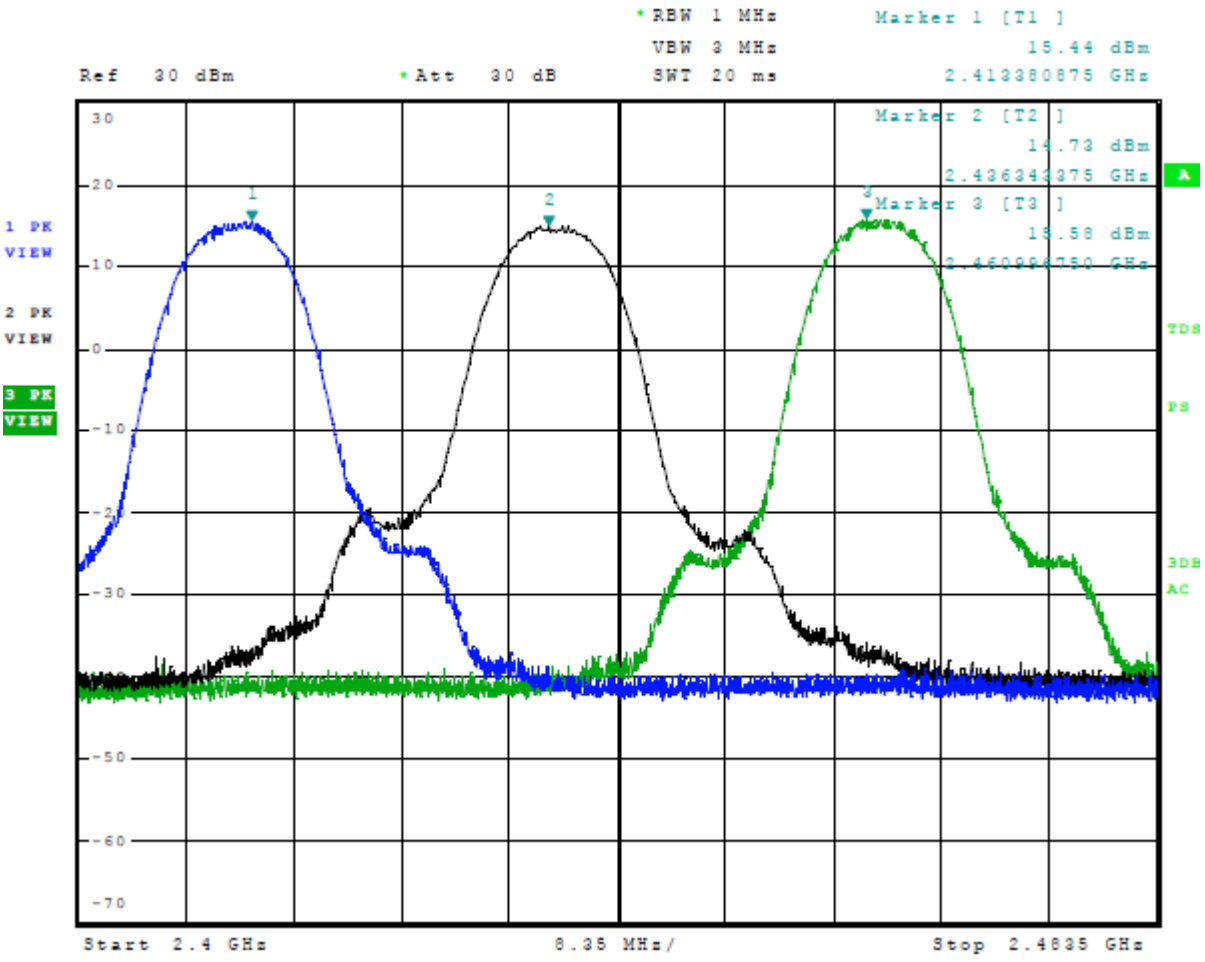


**Figure 5 Plot of Transmitter Operation in 2402-2480 MHz Mode 3, 802.11g**

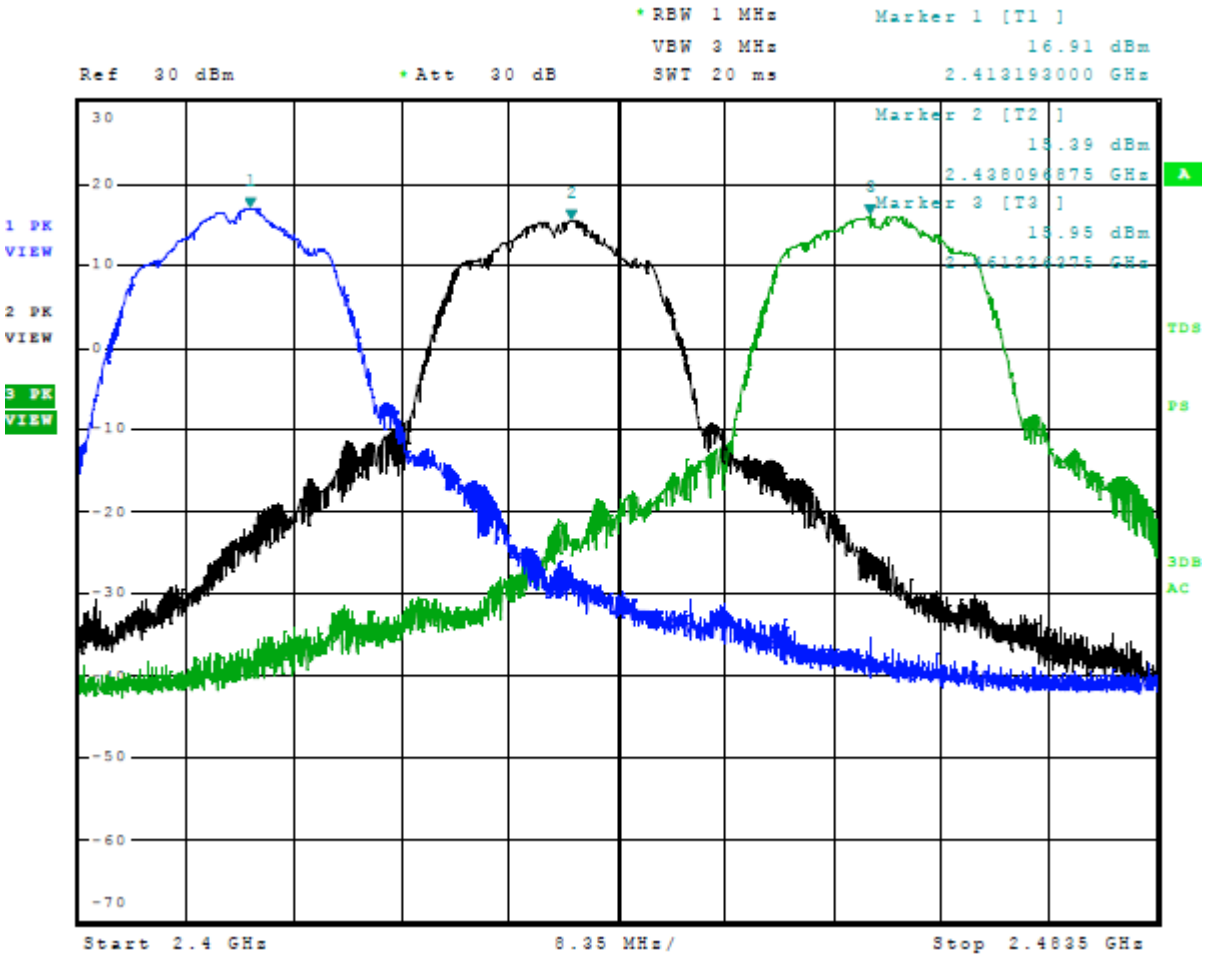


**Figure 6 Plot of Transmitter Operation in 2402-2480 MHz Mode 3, 802.11n**

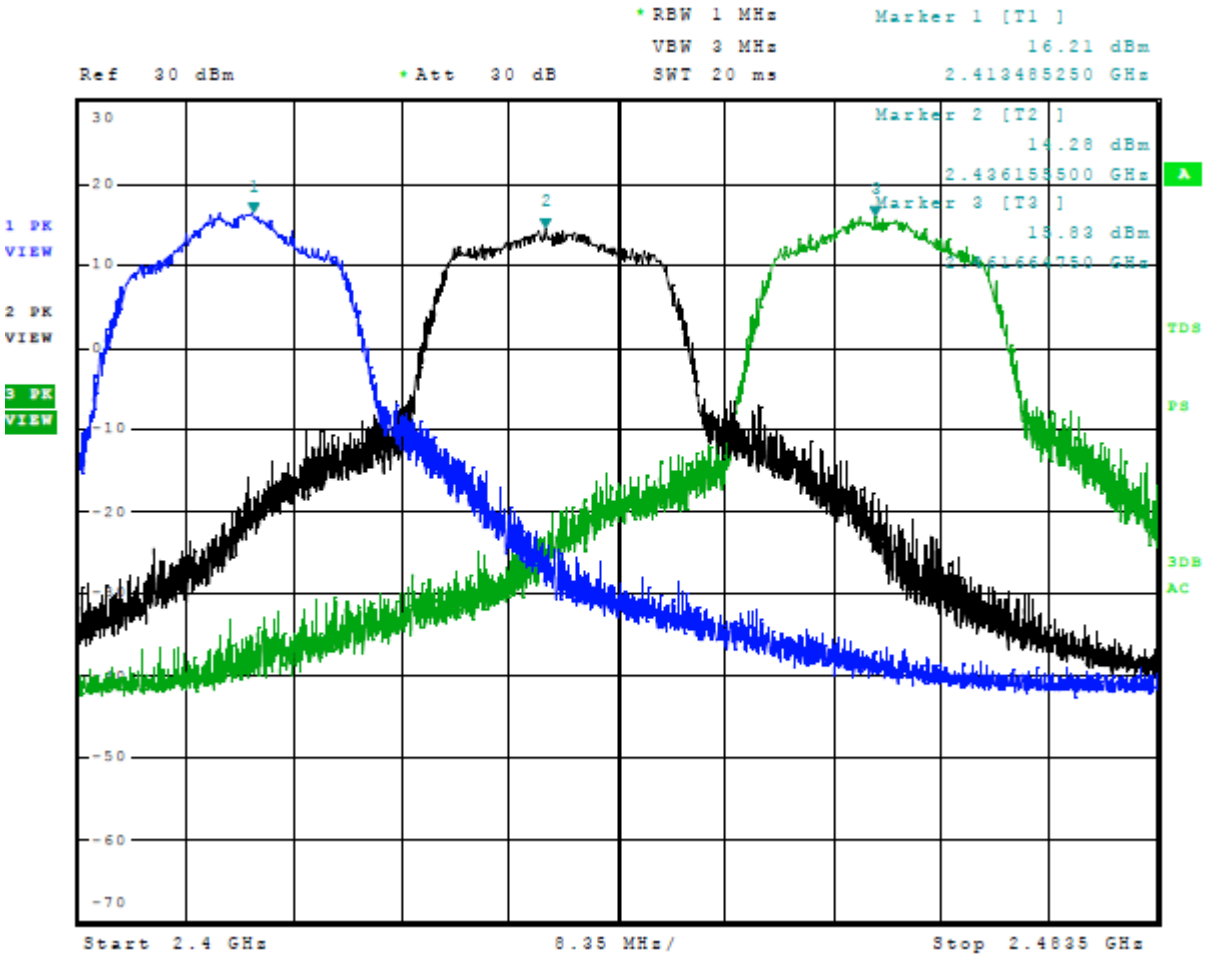


**Figure 7 Plot of Emissions Low Band Edge Mode 1, BT BLE (GMSK)**

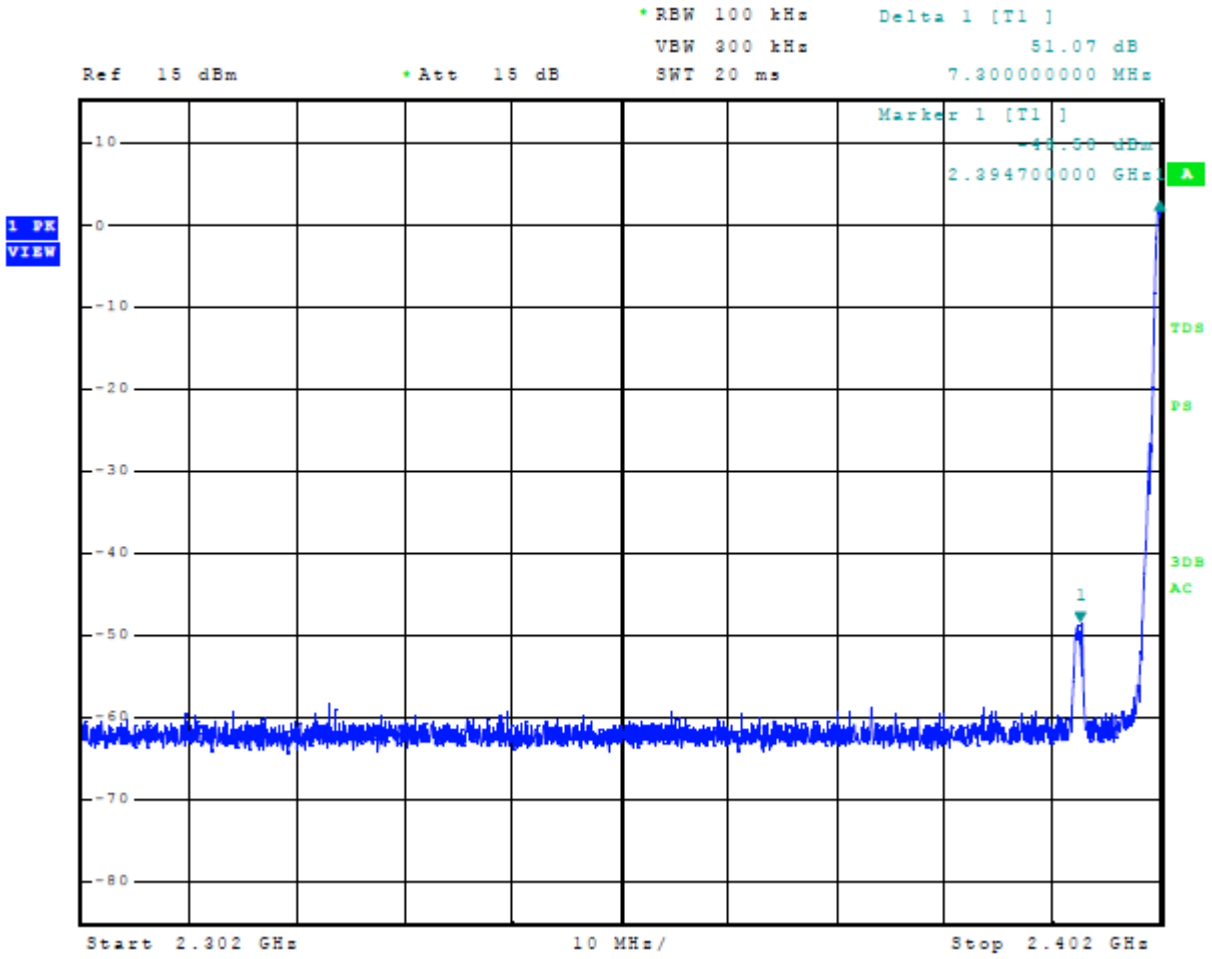


**Figure 8 Plot of Emissions Low Band Edge Mode 2, 802.11b**

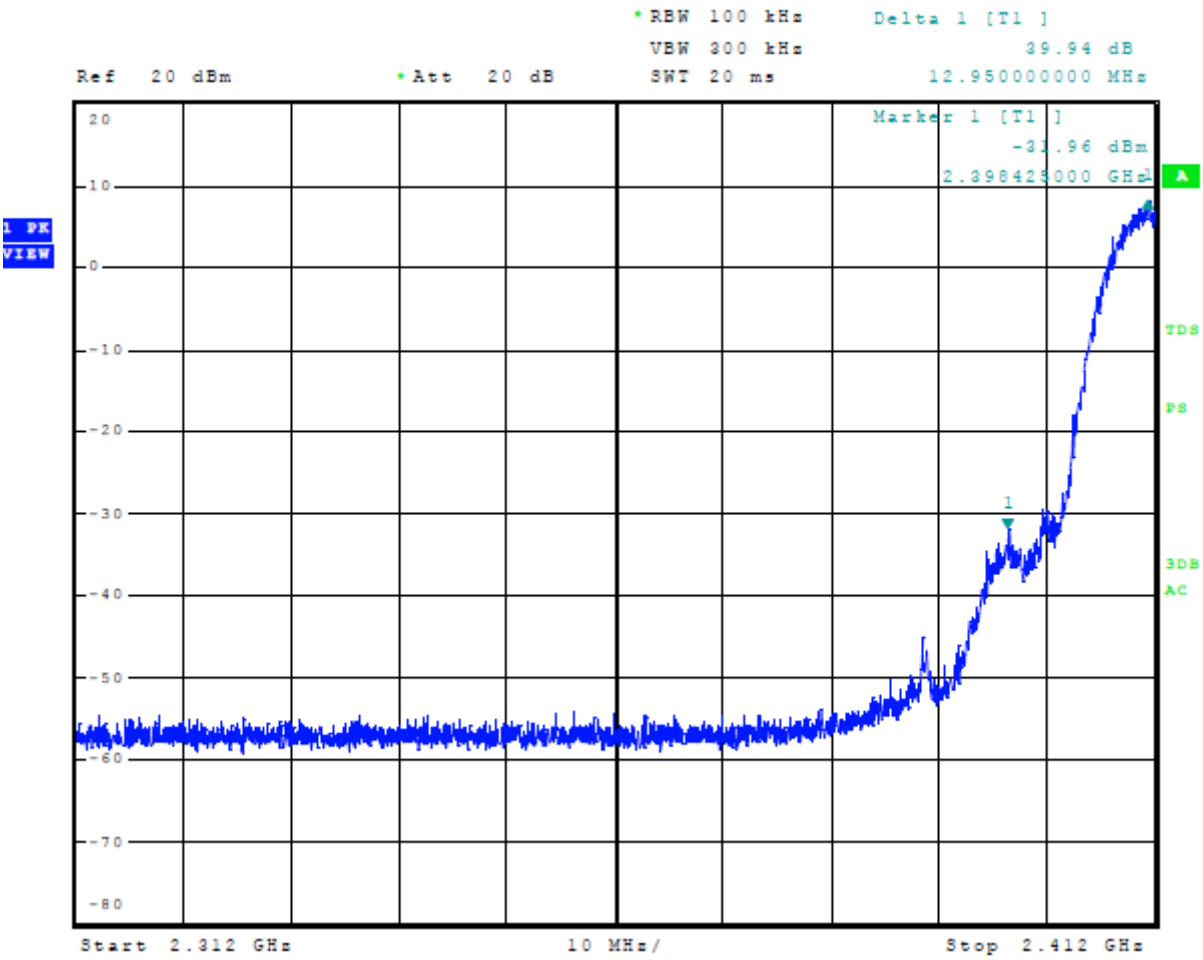


**Figure 9 Plot of Emissions Low Band Edge Mode 3, 802.11g**

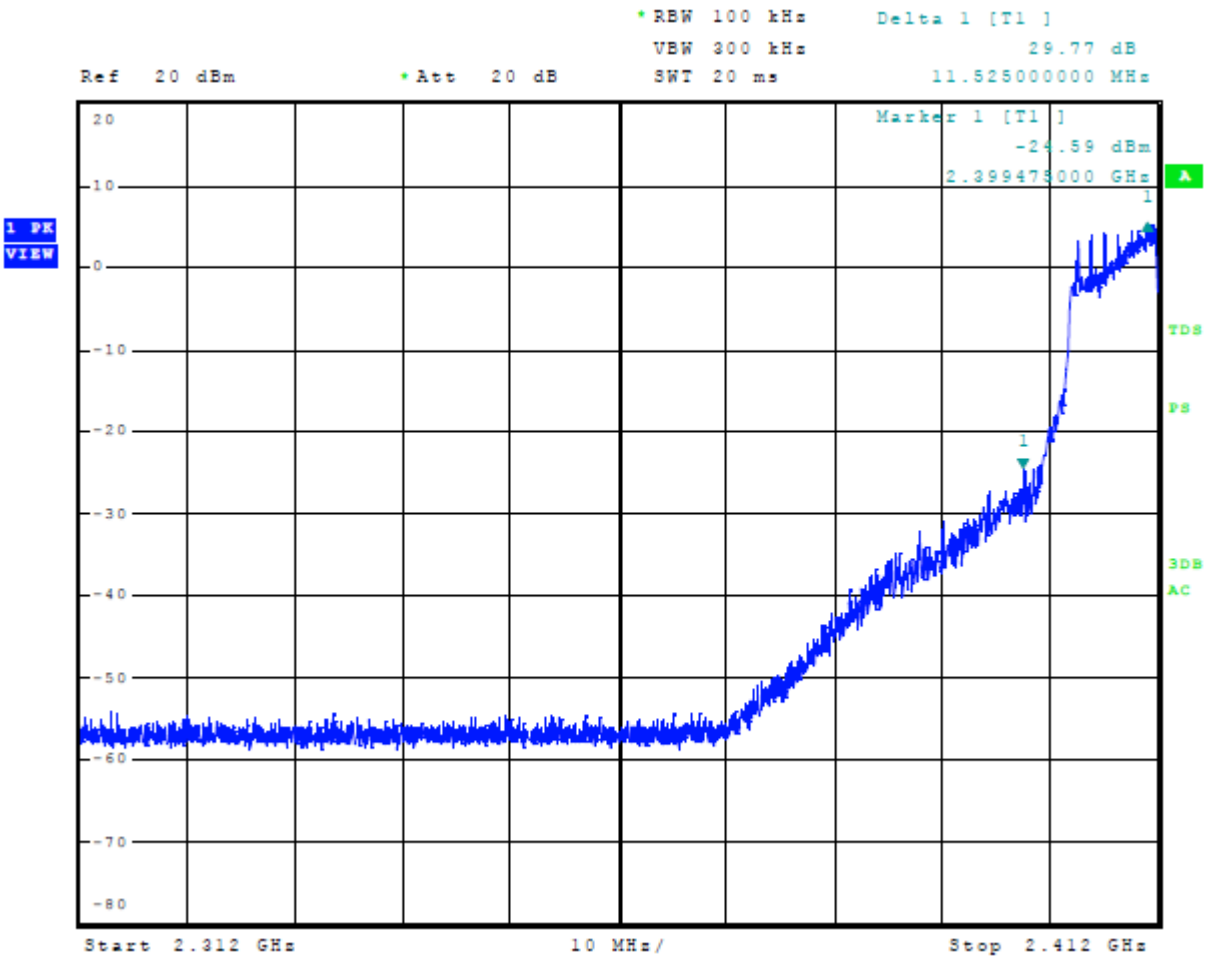


**Figure 10 Plot of Emissions Low Band Edge Mode 4, 802.11n**

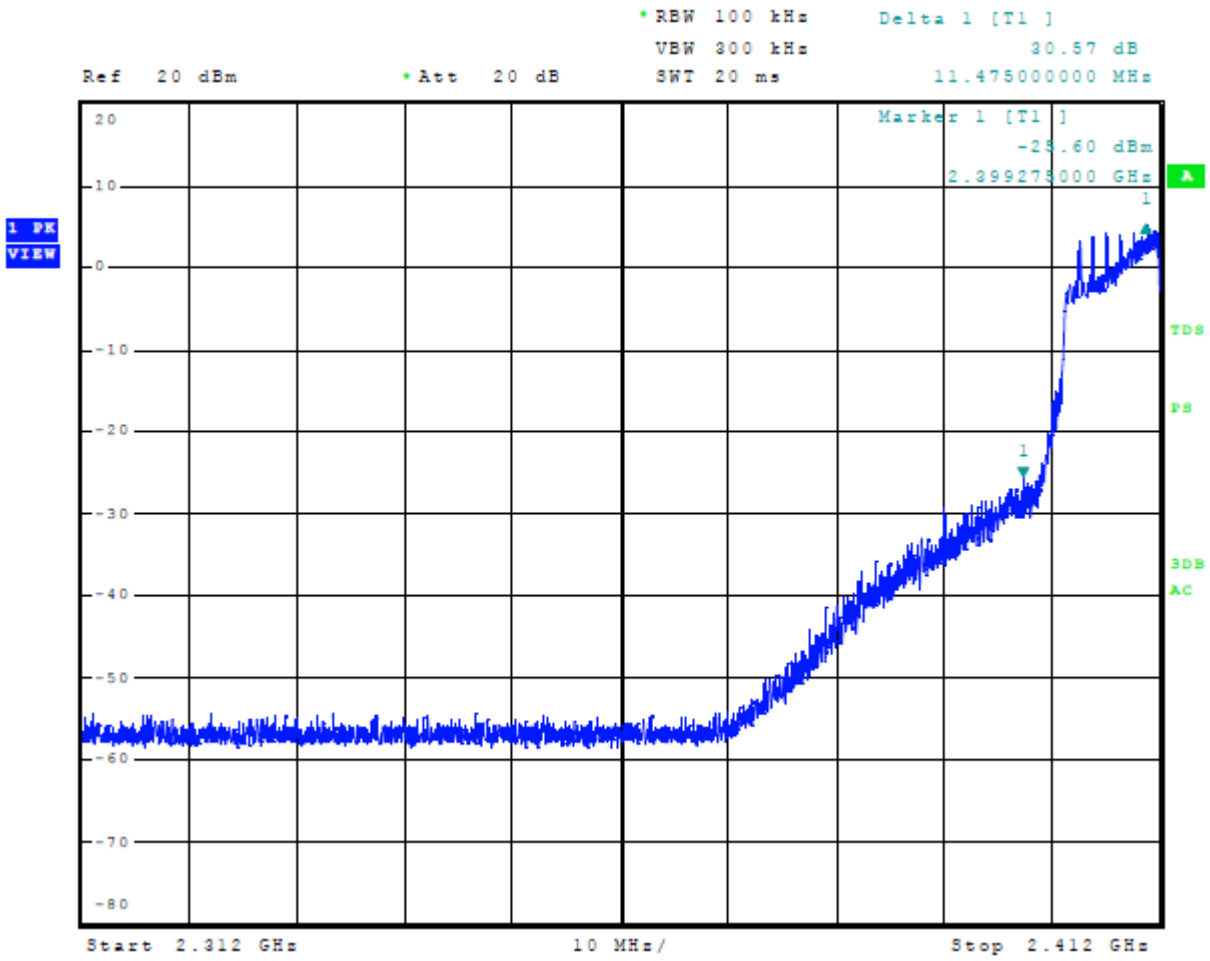


**Figure 11 Plot of Transmitter Emissions High Band Edge Mode 1, BT BLE (GMSK)**

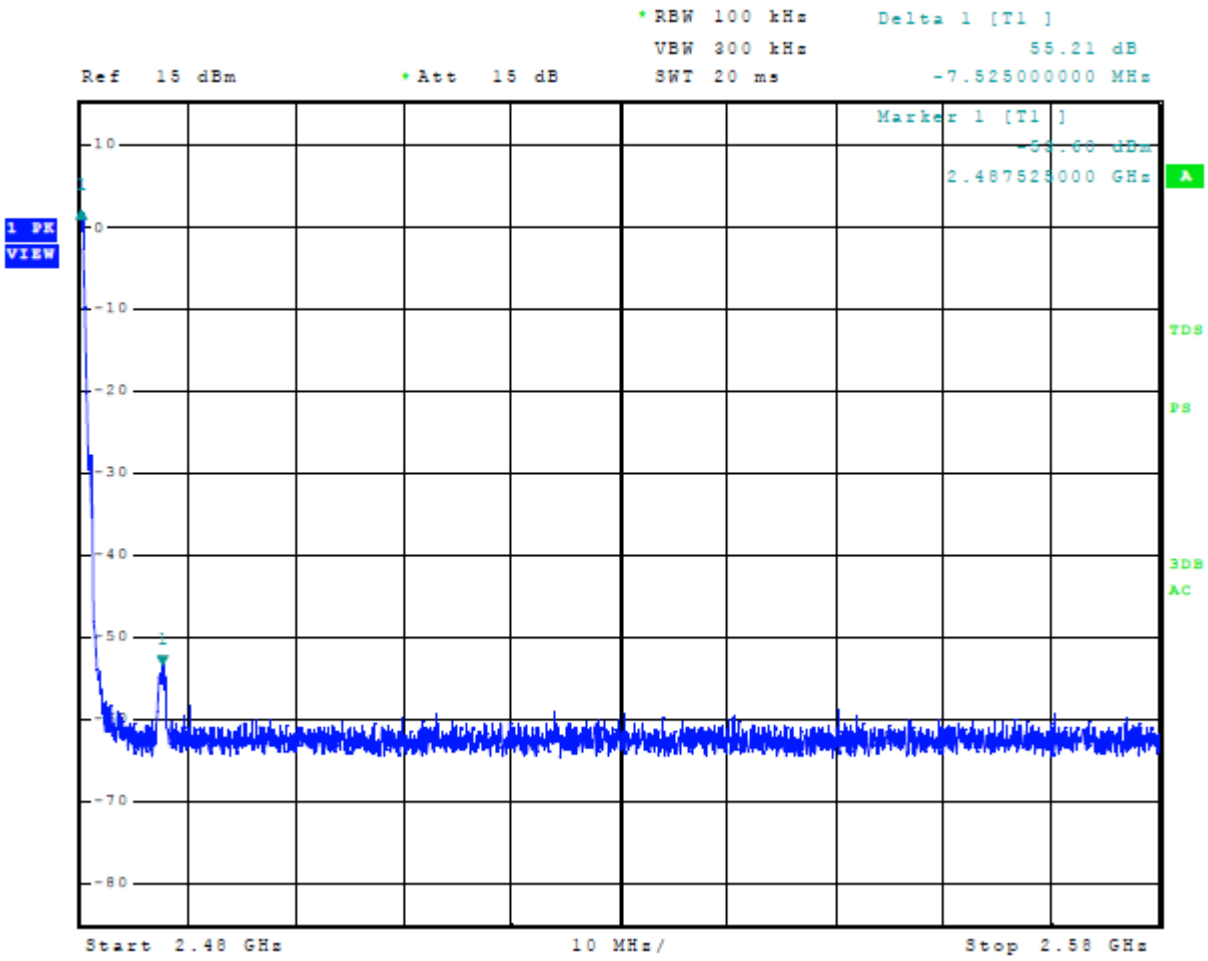


**Figure 12 Plot of Transmitter Emissions High Band Edge Mode 2, 802.11b**

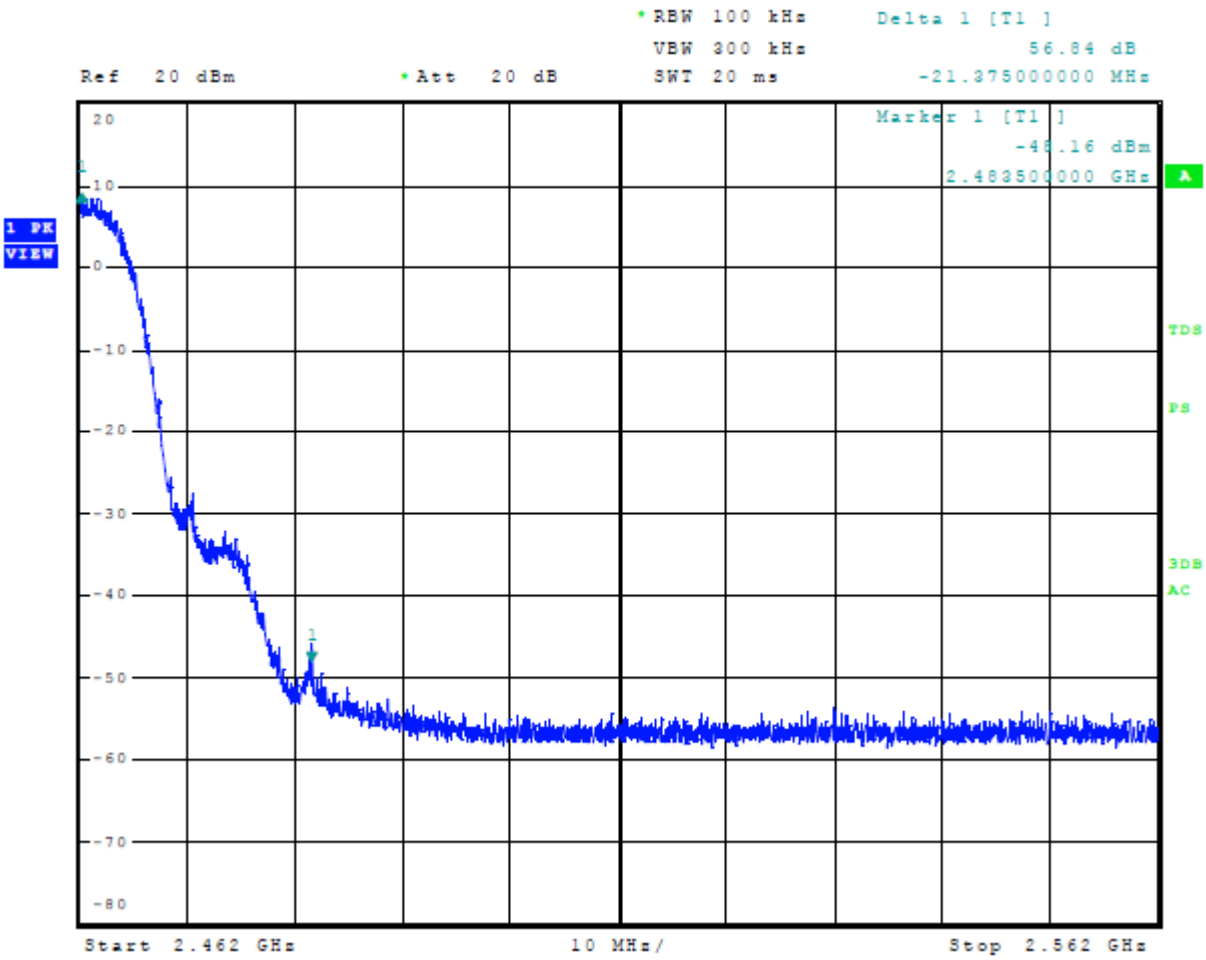


**Figure 13 Plot of Transmitter Emissions High Band Edge Mode 3, 802.11g**

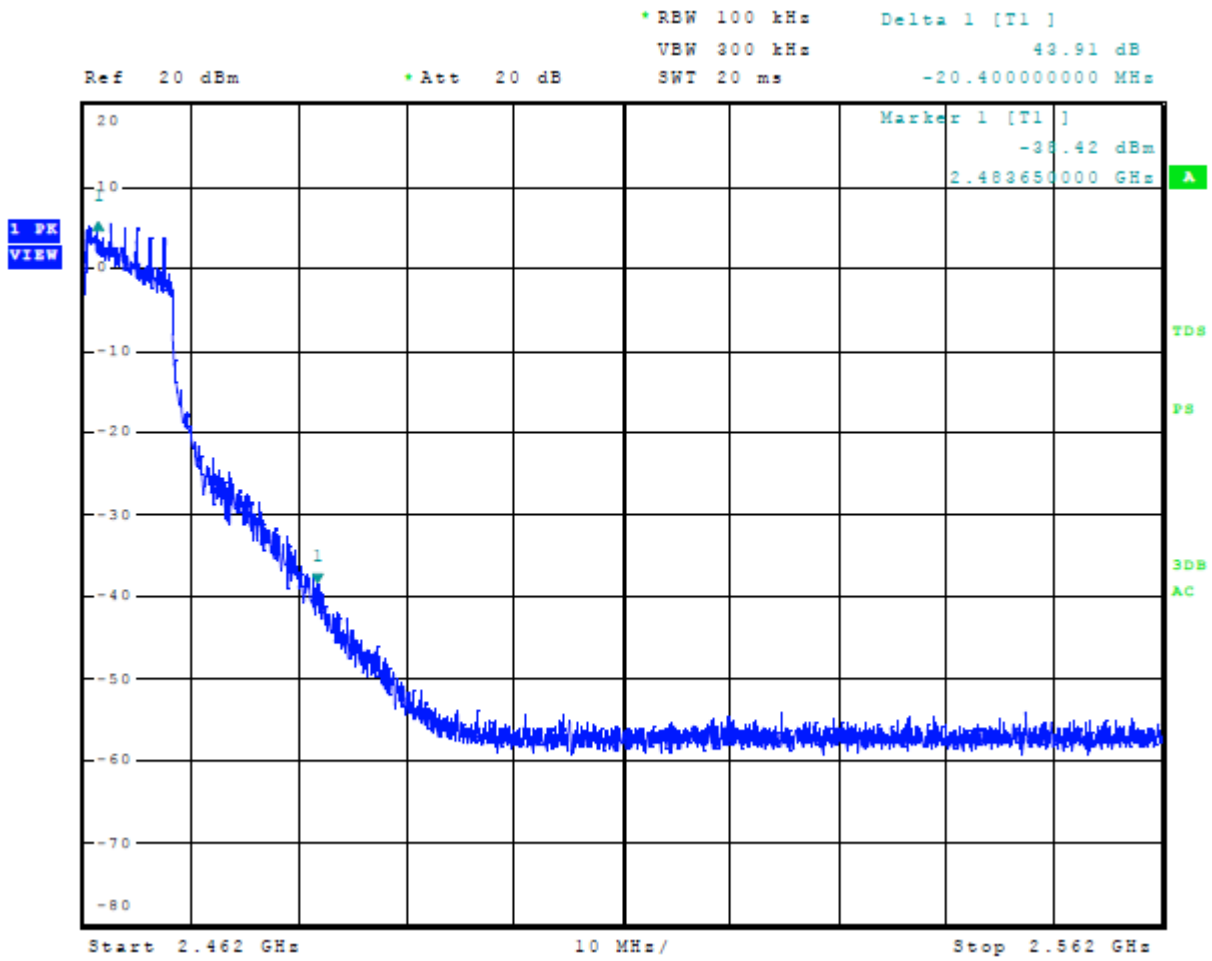


**Figure 14 Plot of Transmitter Emissions High Band Edge Mode 4, 802.11n**

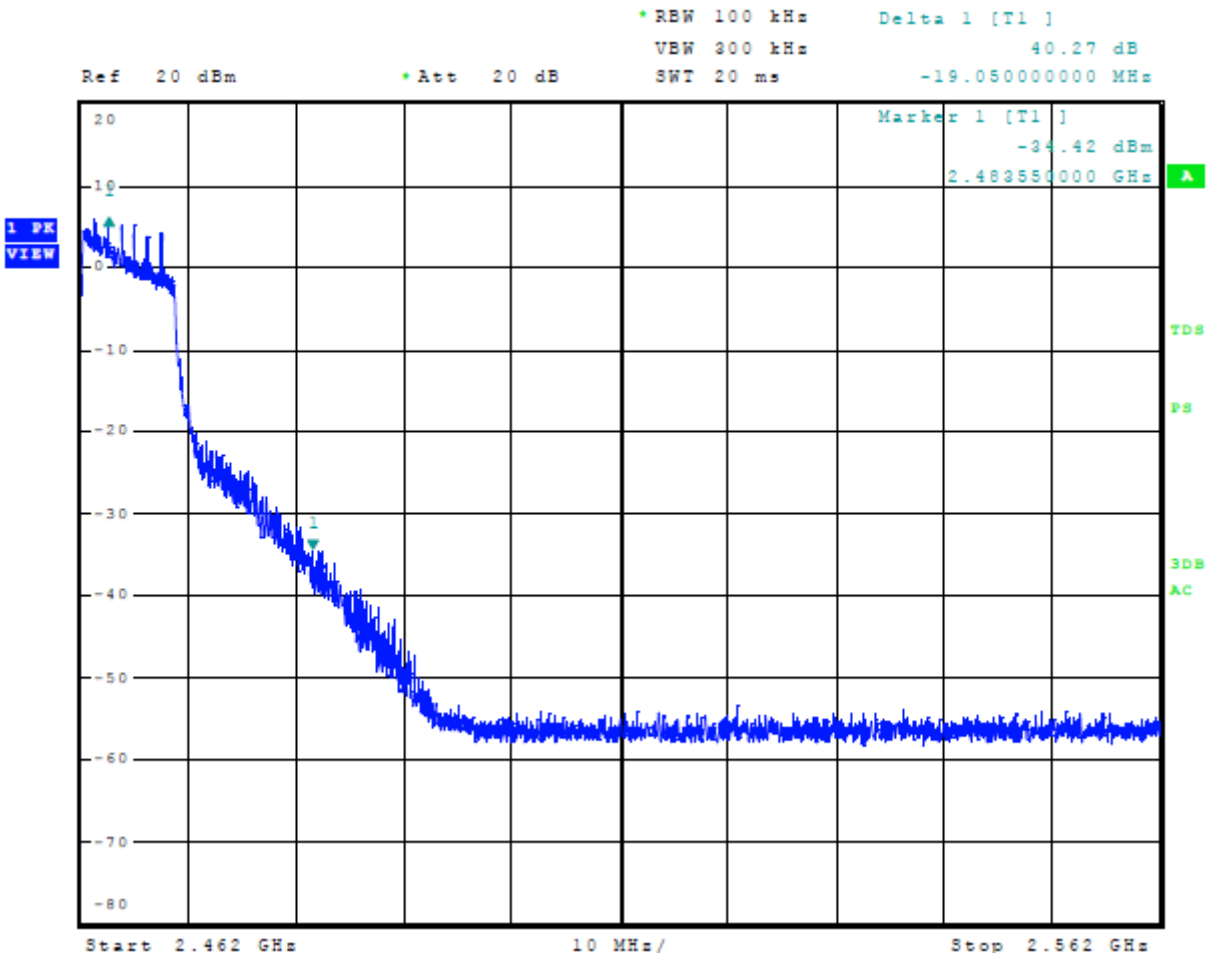


**Figure 15 Plot of 6-dB Occupied Bandwidth Mode 1, BT BLE (GMSK)**

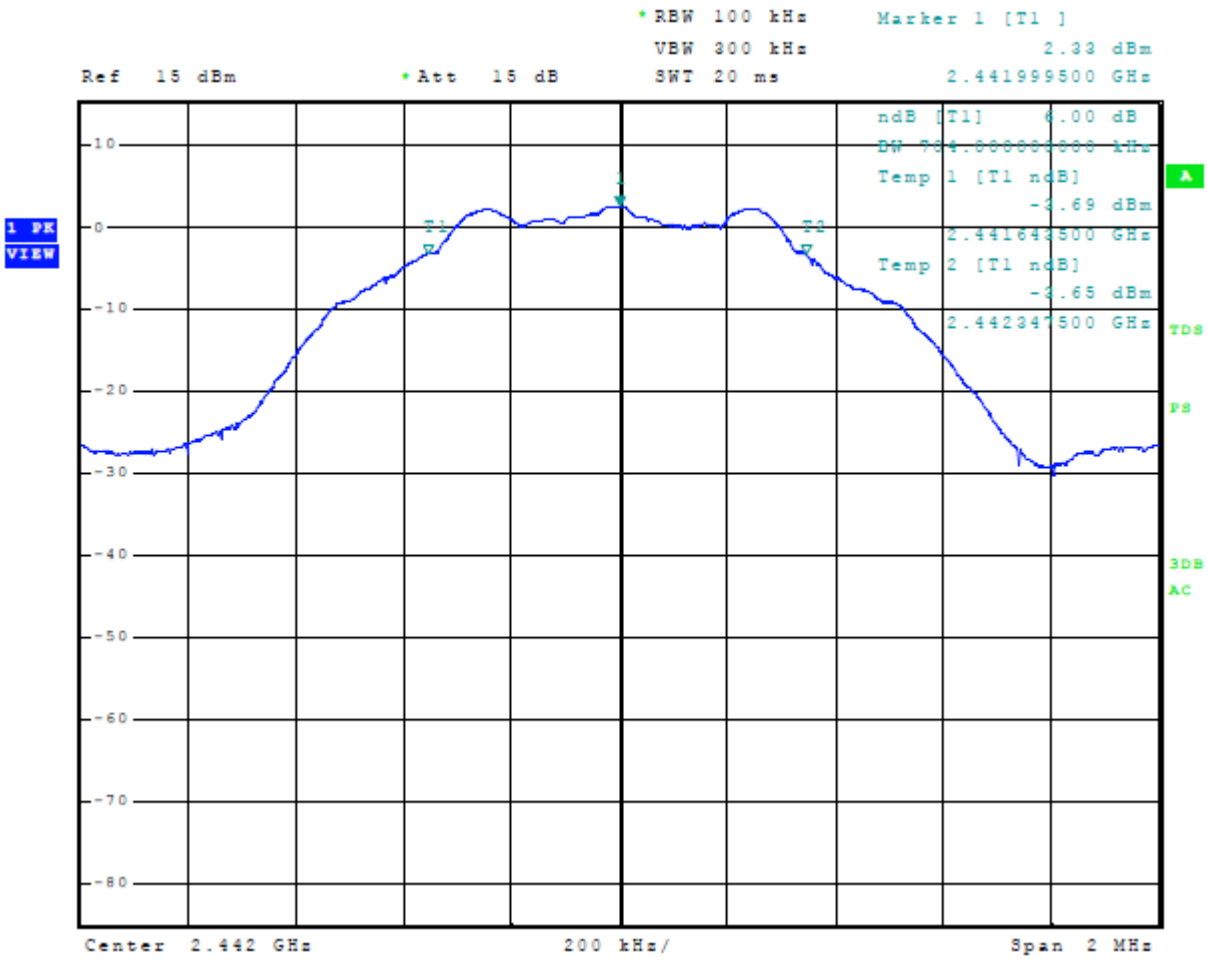


**Figure 16 Plot of 99% Occupied Bandwidth Mode 1, BT BLE (GMSK)**

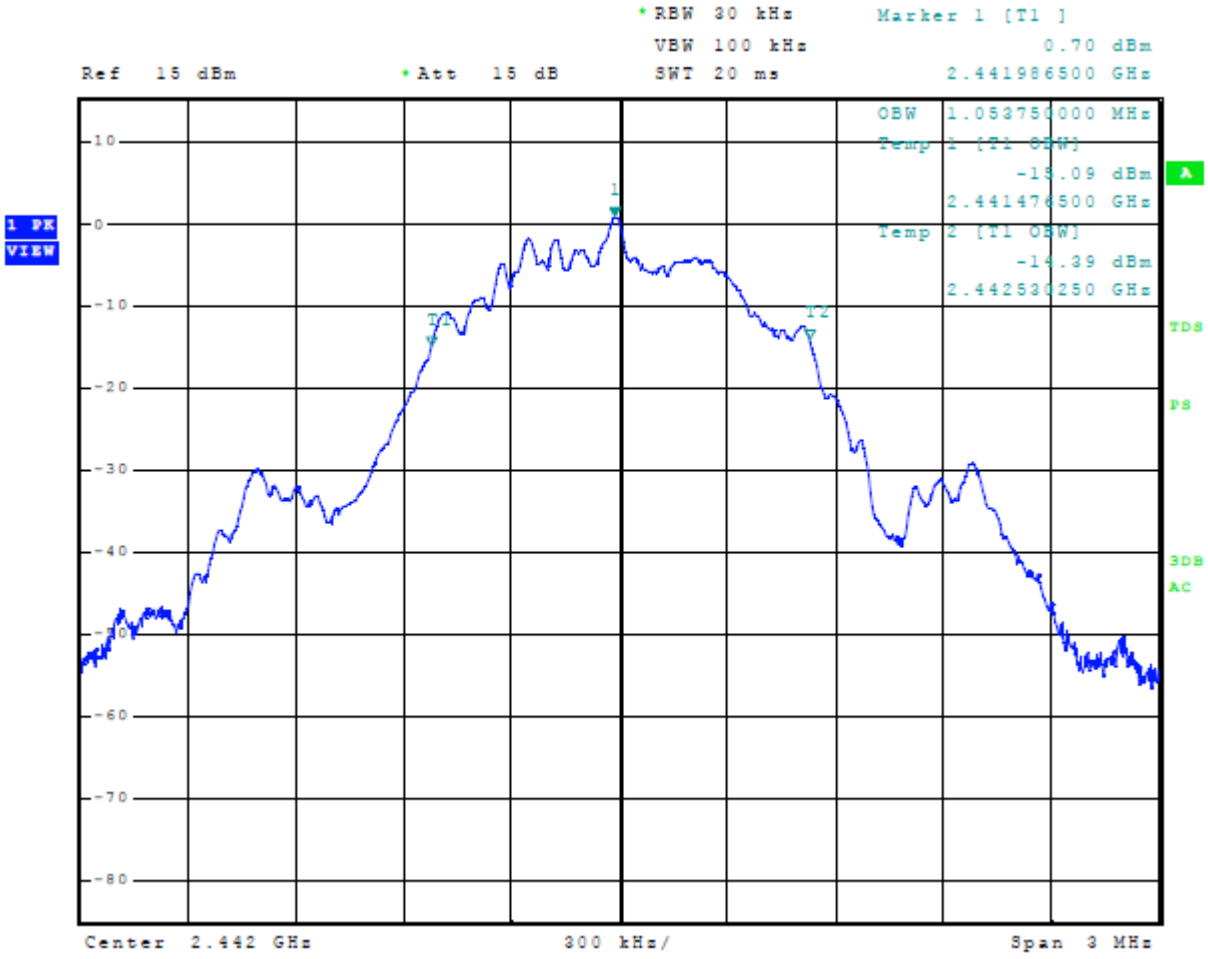


**Figure 17 Plot of 6-dB Occupied Bandwidth Mode 2, 802.11b**

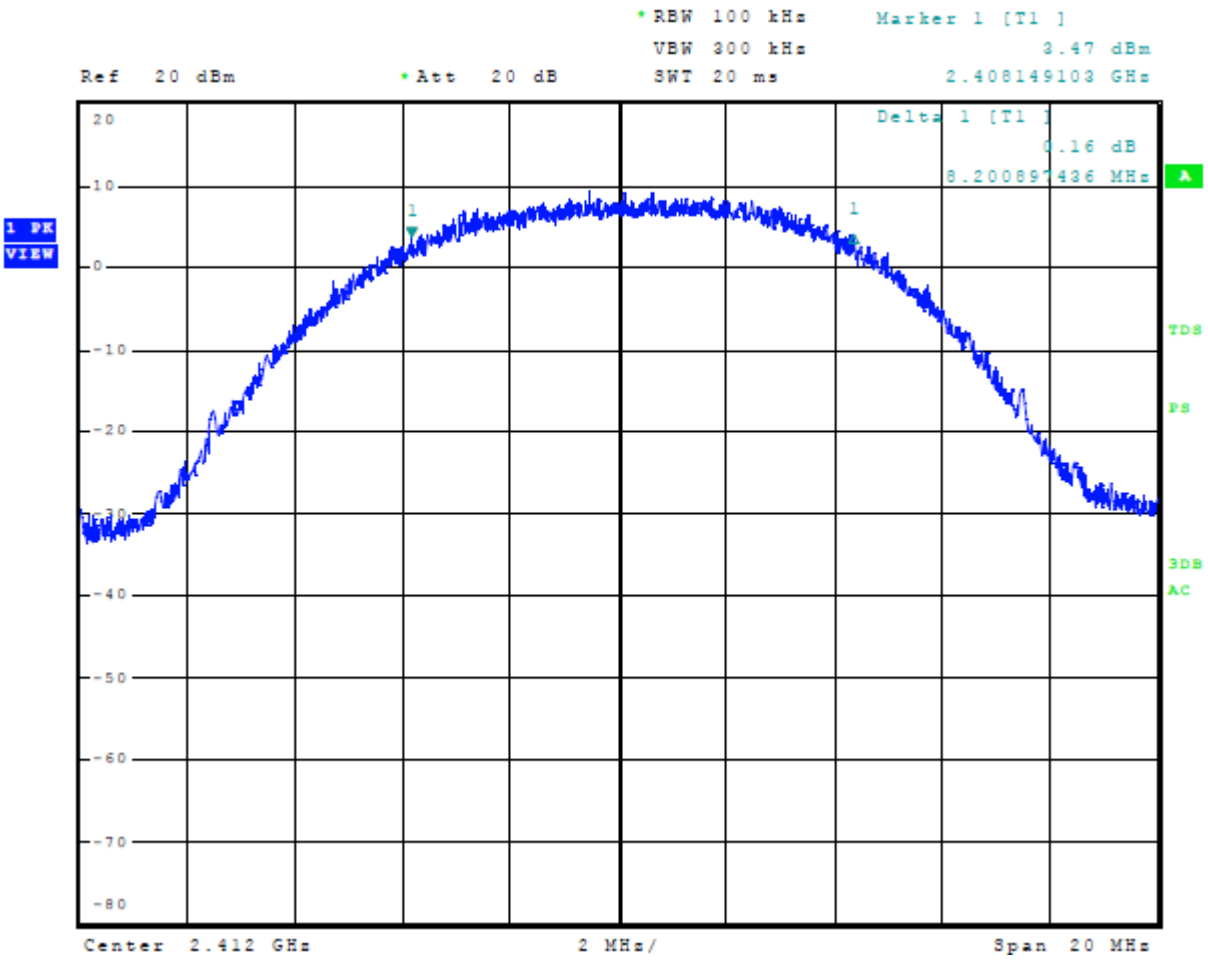


**Figure 18 Plot of 99% Occupied Bandwidth Mode 2, 802.11b**

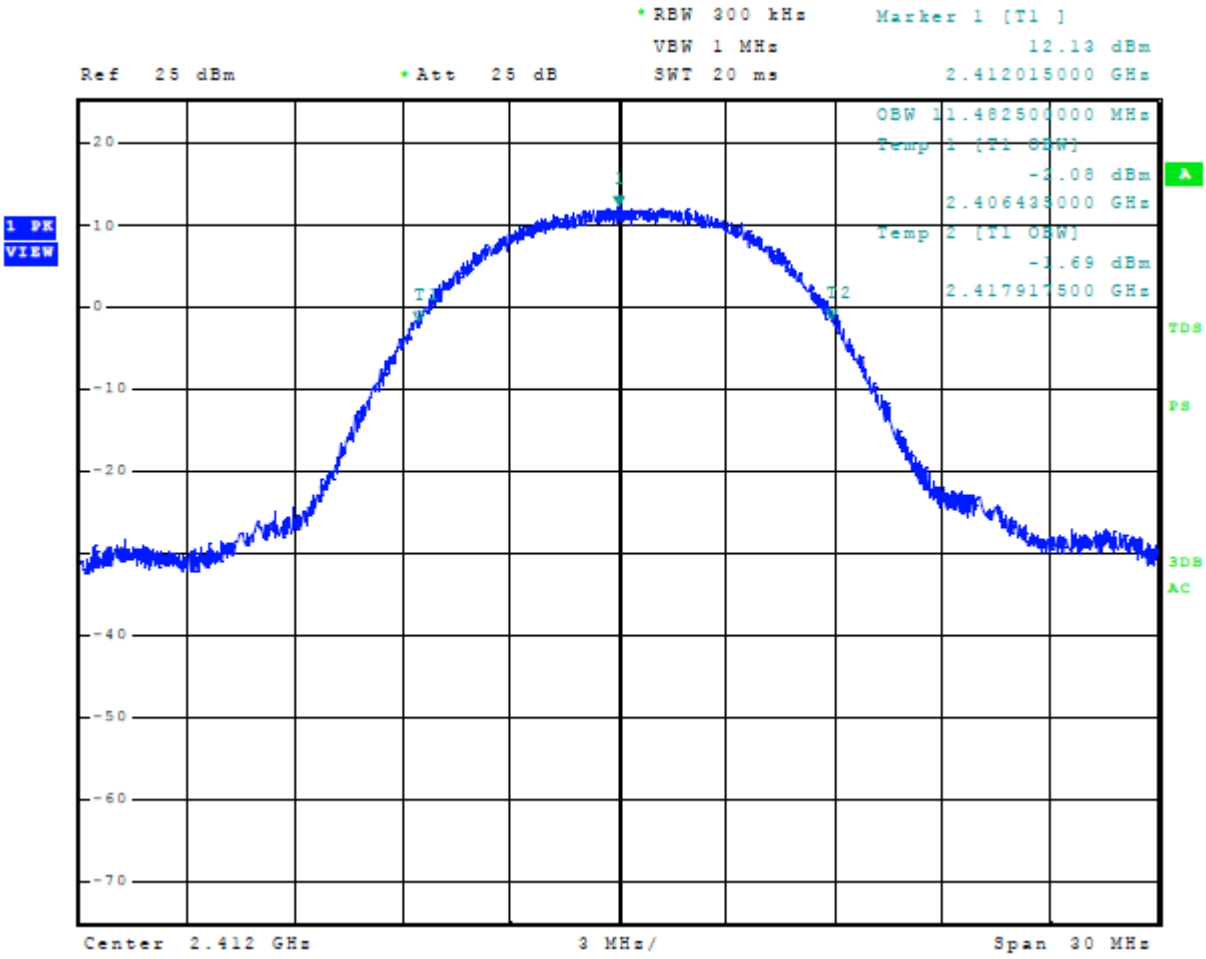


**Figure 19 Plot of 6-dB Occupied Bandwidth Mode 3, 802.11g**

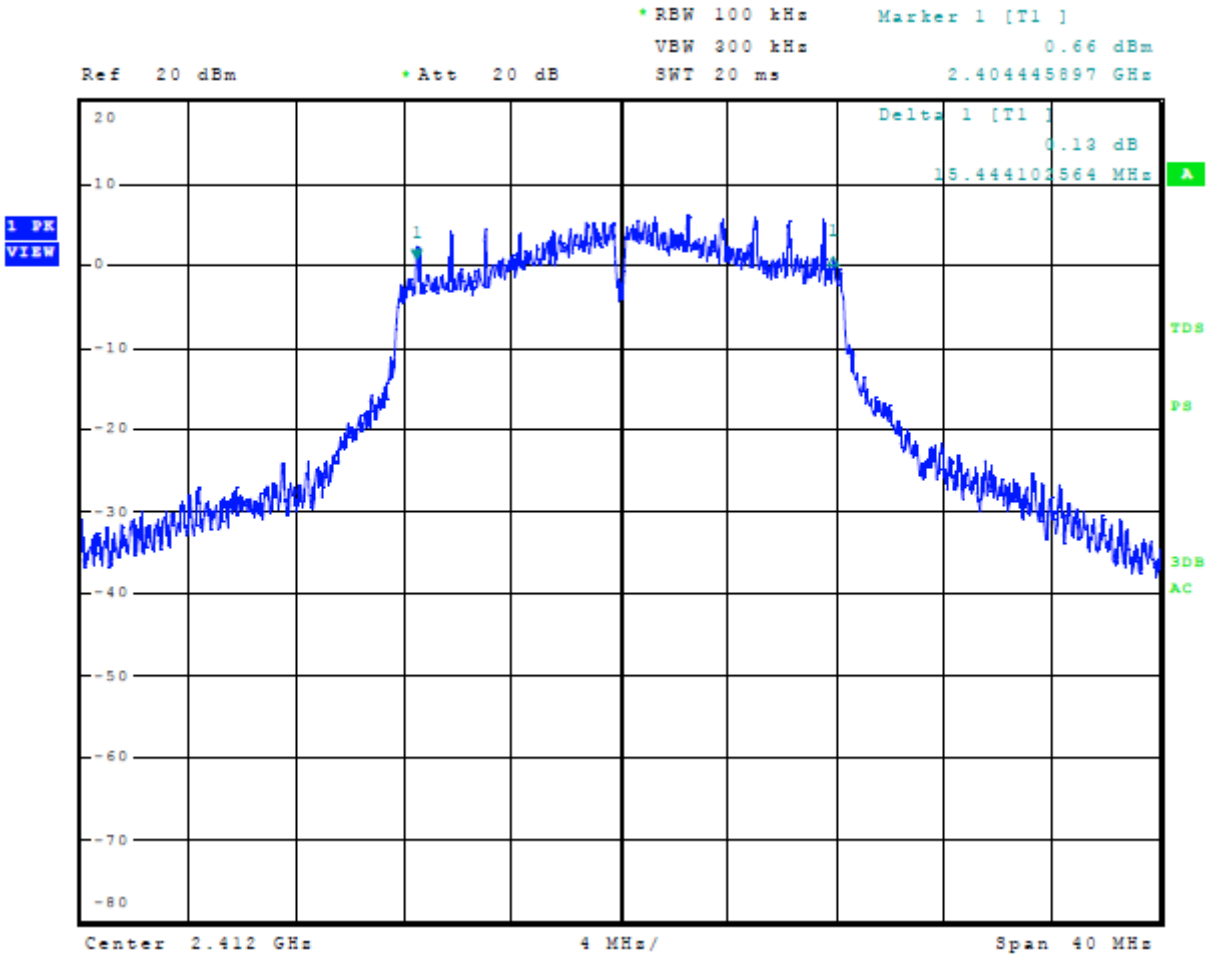


**Figure 20 Plot of 99% Occupied Bandwidth Mode 3, 802.11g**

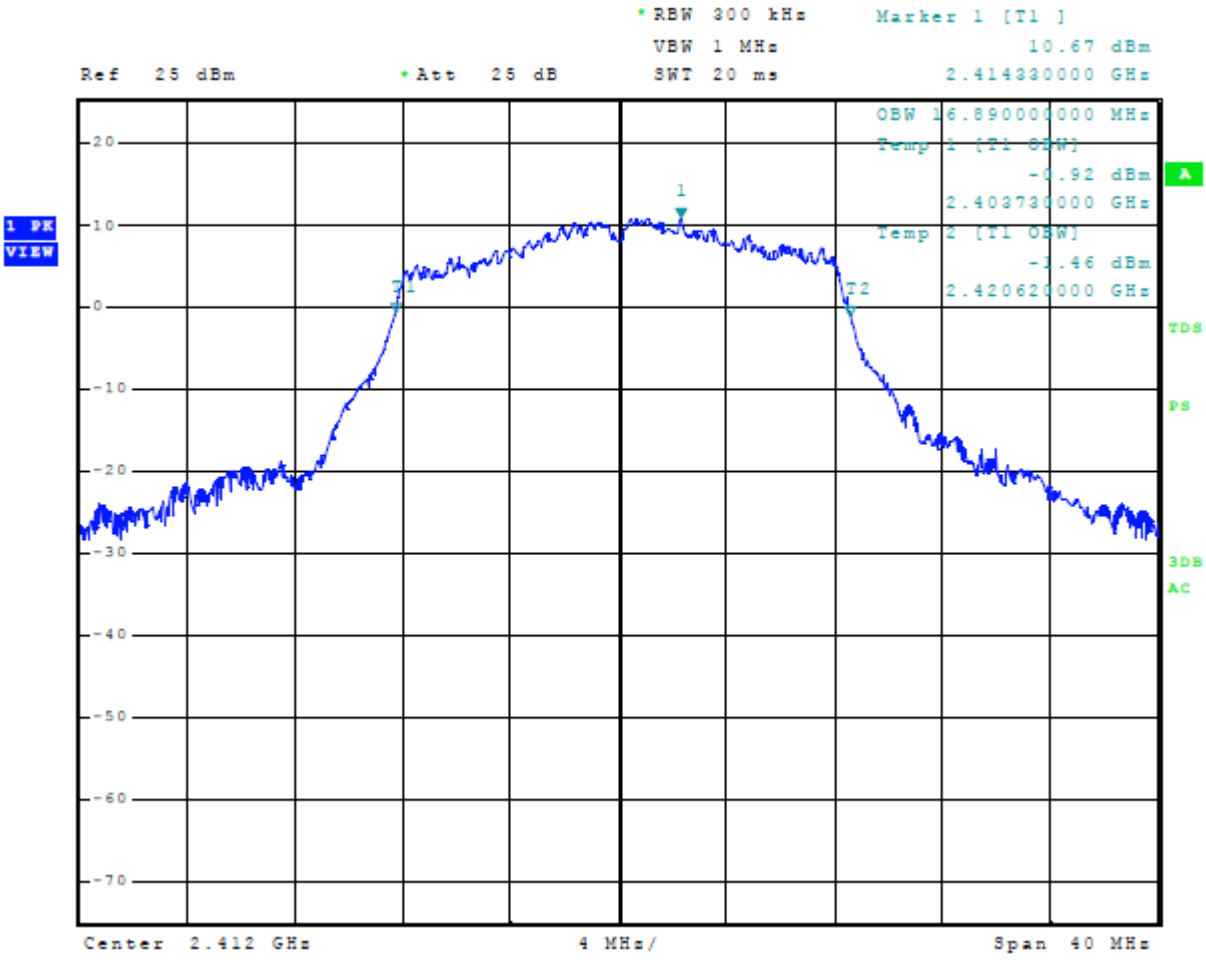


**Figure 21 Plot of 6-dB Occupied Bandwidth Mode 4, 802.11n**

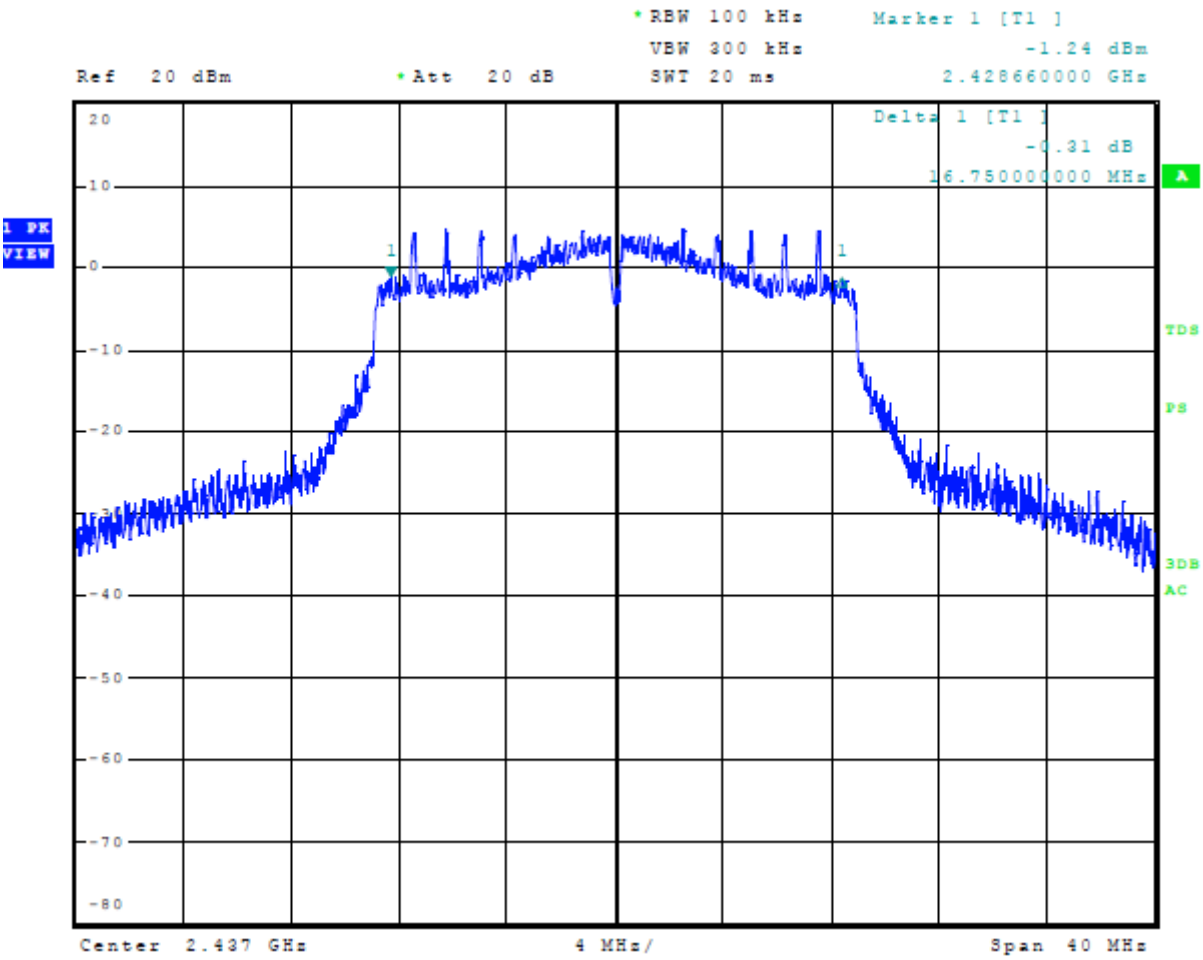


**Figure 22 Plot of 99% Occupied Bandwidth Mode 4, 802.11n**

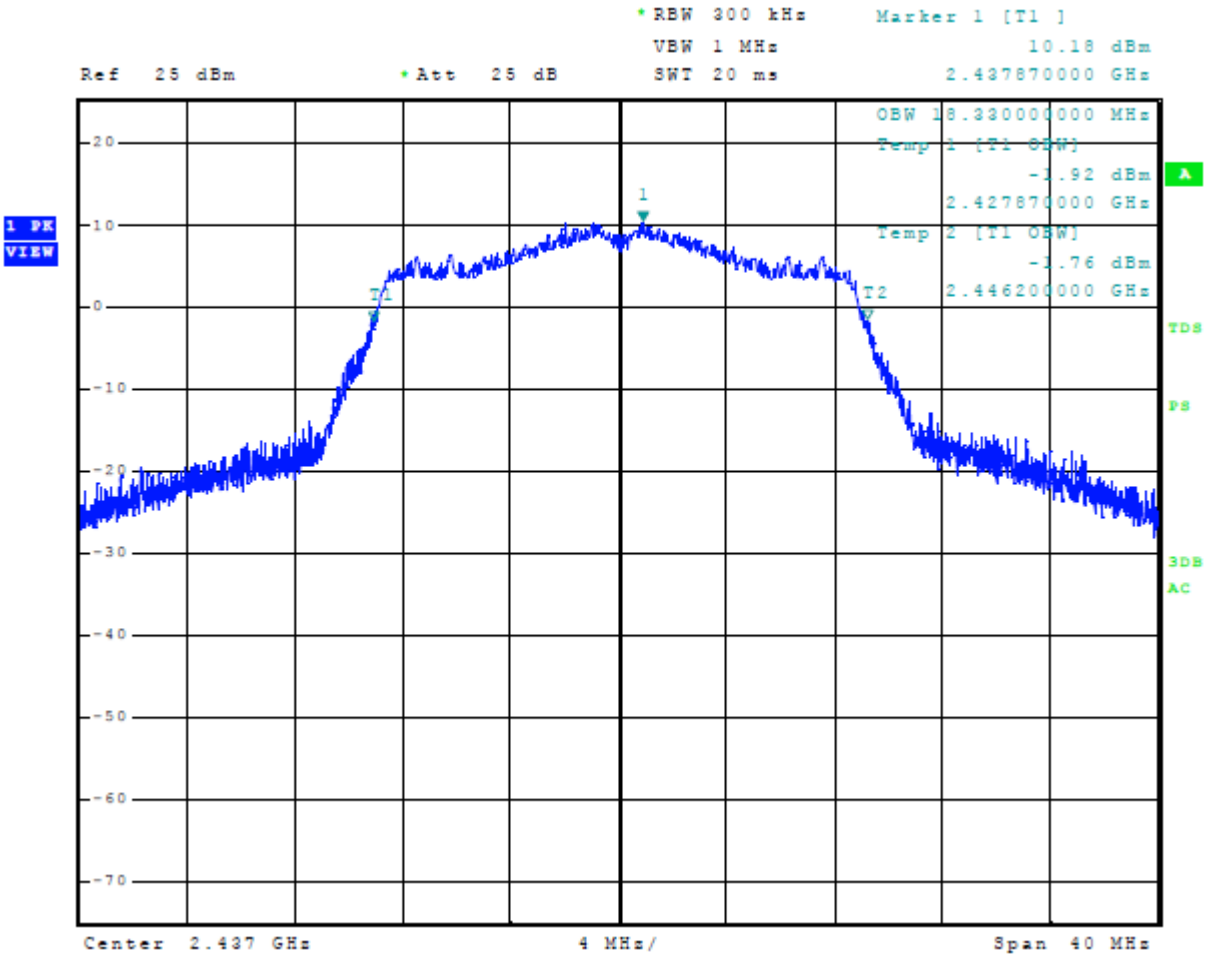


**Figure 23 Plot of Transmitter Power Spectral Density Mode 1, BT BLE (GMSK)**

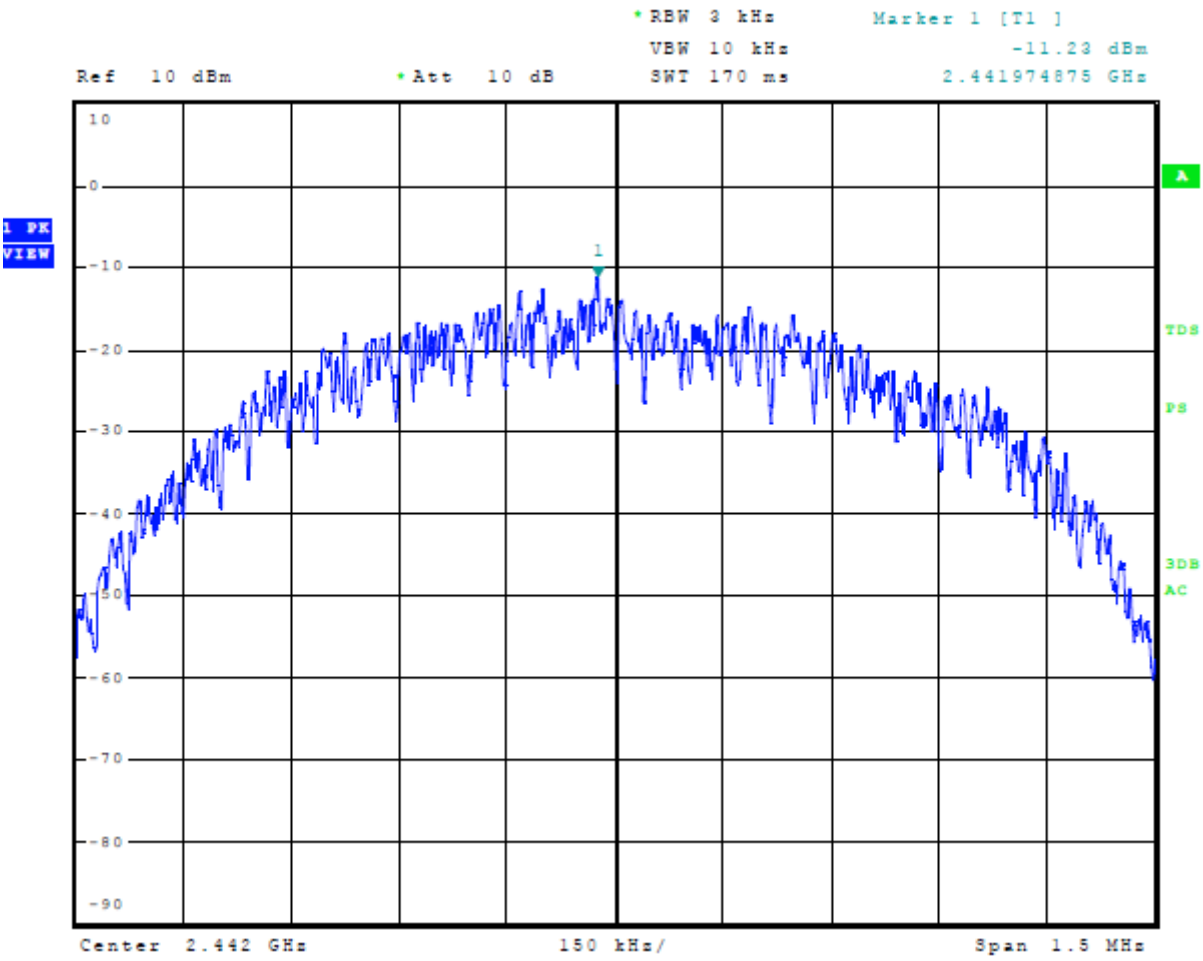


**Figure 24 Plot of Transmitter Power Spectral Density Mode 2, 802.11b**

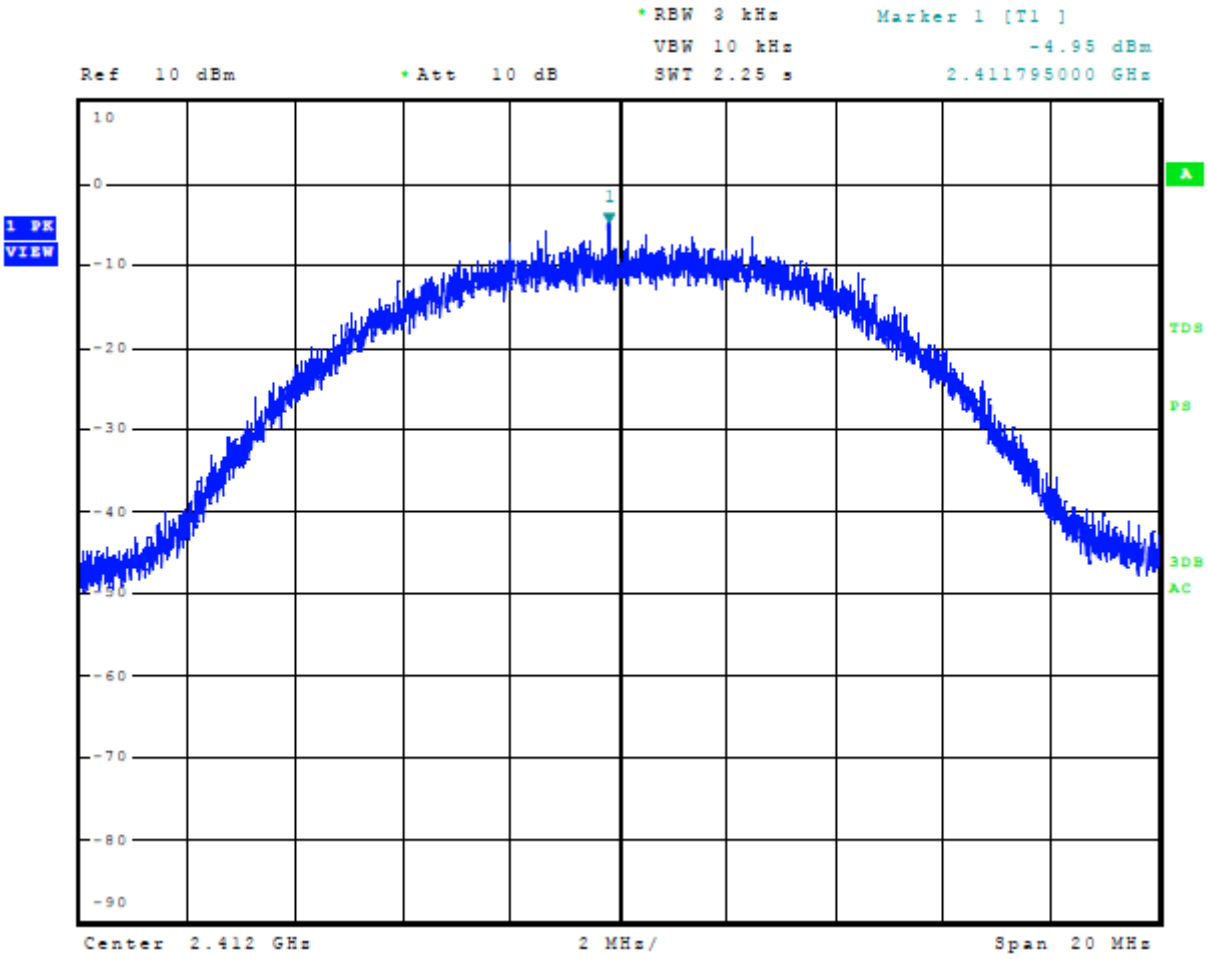


**Figure 25 Plot of Transmitter Power Spectral Density Mode 3, 802.11g**

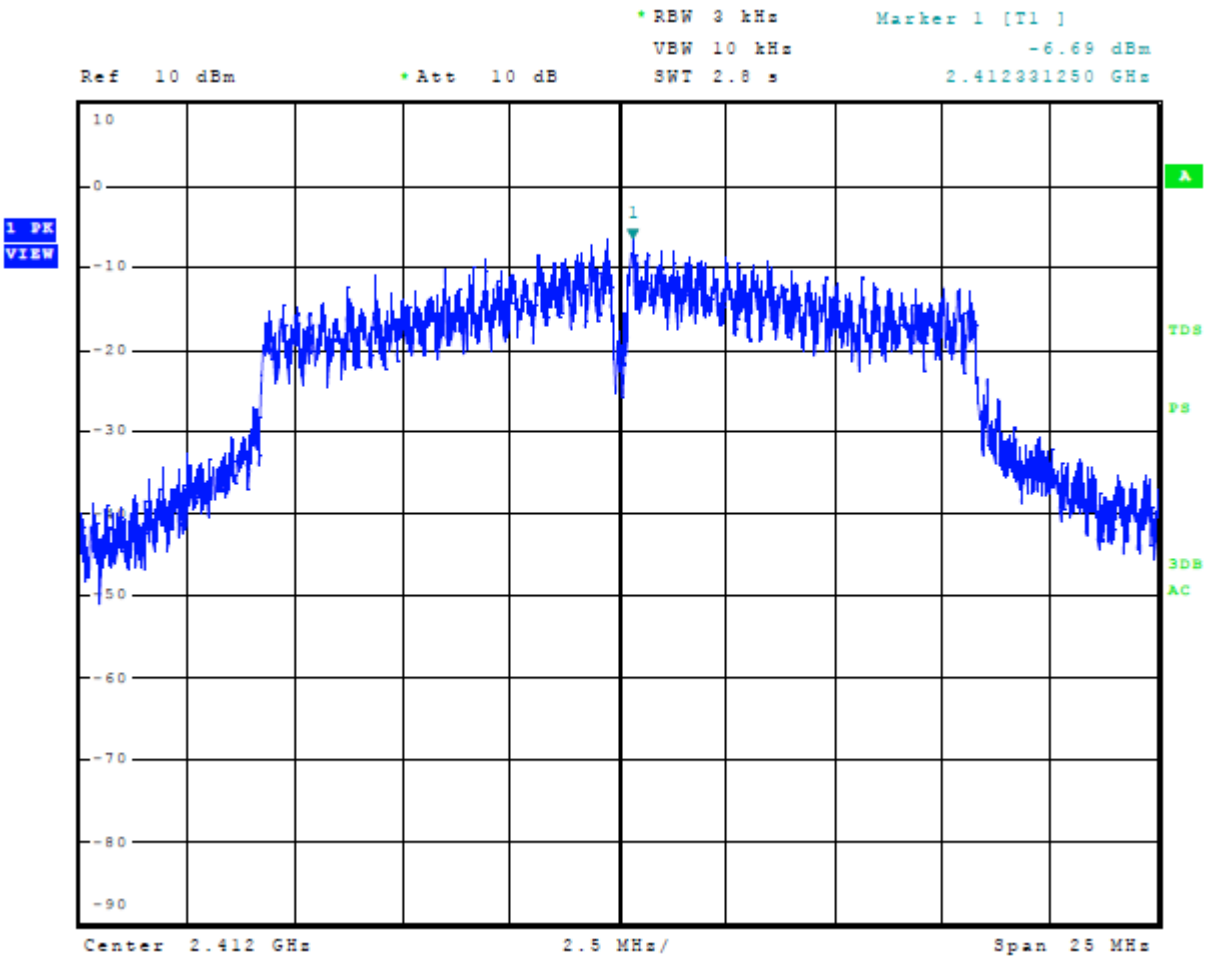
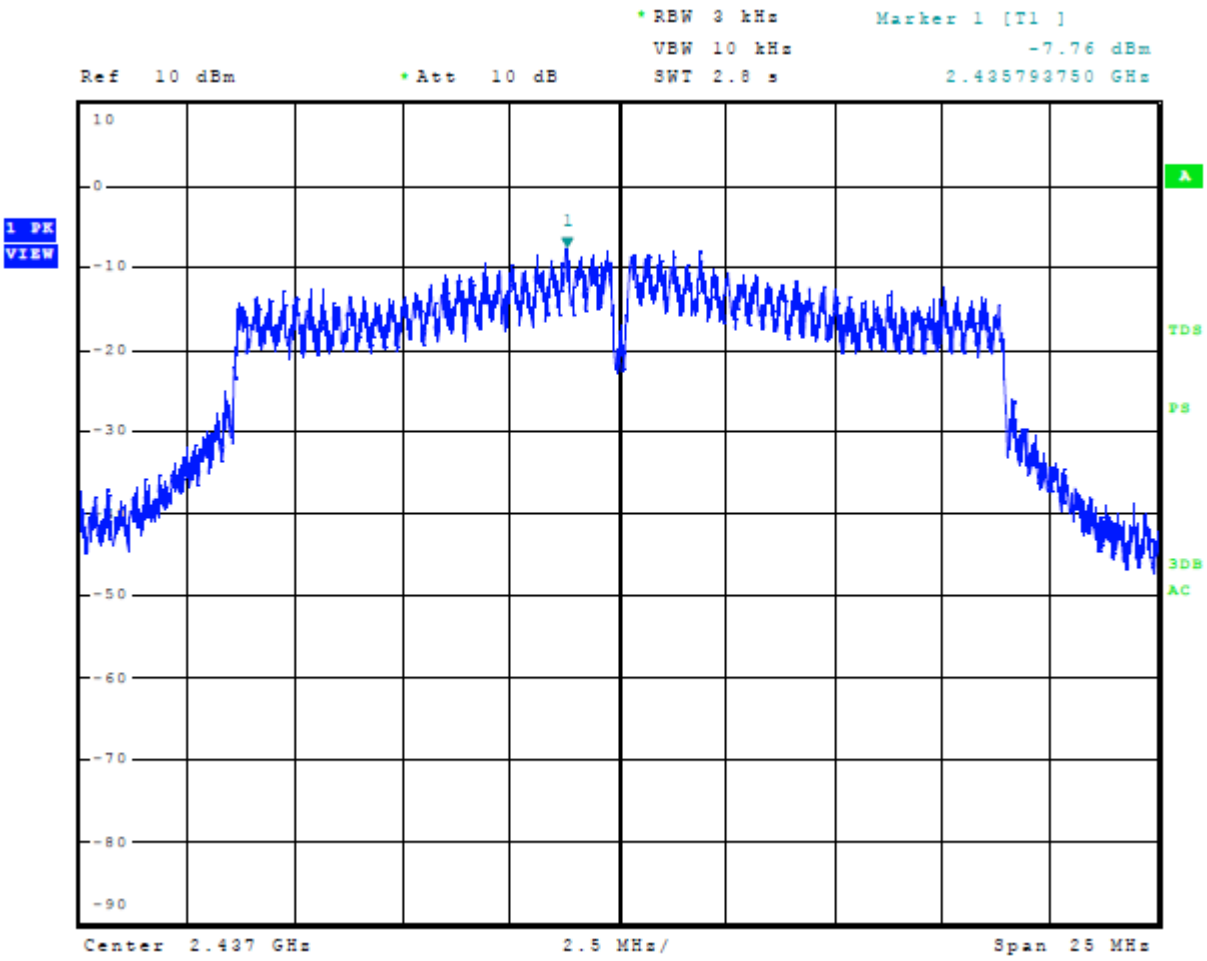


**Figure 26 Plot of Transmitter Power Spectral Density Mode 4, 802.11n**



## *Transmitter Emissions Data*

**Table 8 Transmitter Radiated Emissions Mode 1, BT BLE (GMSK)**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2402.0 | -- | -- | -- | -- | -- | -- | -- |
| 4804.0 | 51.4 | 37.8 | 51.3 | 37.7 | 54.0 | -16.2 | -16.3 |
| 7206.0 | 55.3 | 41.7 | 55.5 | 41.6 | 54.0 | -12.3 | -12.4 |
| 9608.0 | 58.8 | 45.1 | 58.7 | 45.1 | 54.0 | -8.9 | -8.9 |
| 12010.0 | 61.8 | 47.7 | 61.1 | 47.6 | 54.0 | -6.3 | -6.4 |
| 14412.0 | 60.8 | 47.5 | 60.6 | 47.3 | 54.0 | -6.5 | -6.7 |
| 16814.0 | 66.7 | 53.3 | 66.3 | 53.2 | 54.0 | -0.7 | -0.8 |
| 2440.0 | -- | -- | -- | -- | -- | -- | -- |
| 4880.0 | 51.7 | 37.6 | 52.0 | 37.6 | 54.0 | -16.4 | -16.4 |
| 7320.0 | 55.4 | 41.7 | 55.5 | 41.7 | 54.0 | -12.3 | -12.3 |
| 9760.0 | 58.3 | 44.6 | 58.7 | 44.6 | 54.0 | -9.4 | -9.4 |
| 12200.0 | 62.1 | 48.3 | 61.6 | 48.4 | 54.0 | -5.7 | -5.6 |
| 14640.0 | 62.9 | 49.5 | 63.1 | 49.6 | 54.0 | -4.5 | -4.4 |
| 17080.0 | 66.2 | 52.8 | 66.9 | 53.0 | 54.0 | -1.2 | -1.0 |
| 2480.0 | -- | -- | -- | -- | -- | -- | -- |
| 4960.0 | 51.3 | 37.6 | 50.9 | 37.5 | 54.0 | -16.4 | -16.5 |
| 7440.0 | 56.7 | 41.8 | 55.3 | 41.7 | 54.0 | -12.2 | -12.3 |
| 9920.0 | 58.8 | 45.5 | 59.2 | 45.4 | 54.0 | -8.5 | -8.6 |
| 12400.0 | 62.2 | 48.5 | 61.7 | 48.5 | 54.0 | -5.5 | -5.5 |
| 14880.0 | 62.3 | 49.2 | 62.8 | 49.0 | 54.0 | -4.8 | -5.0 |
| 17360.0 | 66.8 | 53.1 | 66.4 | 52.9 | 54.0 | -0.9 | -1.1 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 9 Transmitter Radiated Emissions Mode 2, 802.11b**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2412.0 | -- | -- | -- | -- | -- | -- | -- |
| 4824.0 | 51.0 | 37.3 | 51.8 | 37.6 | 54.0 | -16.7 | -16.4 |
| 7236.0 | 55.6 | 41.9 | 55.6 | 42.0 | 54.0 | -12.1 | -12.0 |
| 9648.0 | 59.3 | 45.4 | 59.0 | 45.5 | 54.0 | -8.6 | -8.5 |
| 12060.0 | 61.5 | 48.2 | 62.2 | 48.3 | 54.0 | -5.8 | -5.7 |
| 14472.0 | 63.0 | 49.1 | 63.0 | 49.2 | 54.0 | -4.9 | -4.8 |
| 16884.0 | 65.7 | 52.4 | 65.9 | 52.5 | 54.0 | -1.6 | -1.5 |
| 2437.0 | -- | -- | -- | -- | -- | -- | -- |
| 4874.0 | 51.0 | 37.3 | 51.4 | 37.7 | 54.0 | -16.7 | -16.3 |
| 7311.0 | 55.3 | 41.7 | 57.2 | 43.4 | 54.0 | -12.3 | -10.6 |
| 9748.0 | 58.3 | 44.9 | 59.0 | 45.0 | 54.0 | -9.1 | -9.0 |
| 12185.0 | 60.8 | 47.2 | 60.3 | 47.1 | 54.0 | -6.8 | -6.9 |
| 14622.0 | 62.1 | 49.0 | 62.6 | 48.8 | 54.0 | -5.0 | -5.2 |
| 17059.0 | 67.1 | 52.3 | 65.9 | 51.9 | 54.0 | -1.7 | -2.1 |
| 2462.0 | -- | -- | -- | -- | -- | -- | -- |
| 4924.0 | 51.2 | 37.4 | 53.0 | 38.4 | 54.0 | -16.6 | -15.6 |
| 7386.0 | 55.8 | 42.1 | 55.6 | 41.9 | 54.0 | -11.9 | -12.1 |
| 9848.0 | 59.3 | 45.6 | 59.1 | 45.6 | 54.0 | -8.4 | -8.4 |
| 12310.0 | 61.4 | 47.8 | 61.5 | 47.7 | 54.0 | -6.2 | -6.3 |
| 14772.0 | 62.3 | 49.0 | 62.9 | 48.9 | 54.0 | -5.0 | -5.1 |
| 17234.0 | 66.6 | 52.7 | 66.9 | 52.6 | 54.0 | -1.3 | -1.4 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 10 Transmitter Radiated Emissions Mode 3, 802.11g**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2412.0 | -- | -- | -- | -- | -- | -- | -- |
| 4824.0 | 50.9 | 37.2 | 51.4 | 37.3 | 54.0 | -16.8 | -16.7 |
| 7236.0 | 55.5 | 41.5 | 55.0 | 41.5 | 54.0 | -12.5 | -12.5 |
| 9648.0 | 58.6 | 45.5 | 59.4 | 45.5 | 54.0 | -8.5 | -8.5 |
| 12060.0 | 62.4 | 48.6 | 61.8 | 48.5 | 54.0 | -5.4 | -5.5 |
| 14472.0 | 62.8 | 49.4 | 63.0 | 49.5 | 54.0 | -4.6 | -4.5 |
| 16884.0 | 66.3 | 52.9 | 66.5 | 52.9 | 54.0 | -1.1 | -1.1 |
| 2437.0 | -- | -- | -- | -- | -- | -- | -- |
| 4874.0 | 50.9 | 37.3 | 50.8 | 37.4 | 54.0 | -16.7 | -16.6 |
| 7311.0 | 55.2 | 41.7 | 55.5 | 42.2 | 54.0 | -12.3 | -11.8 |
| 9748.0 | 59.0 | 44.9 | 58.3 | 45.0 | 54.0 | -9.1 | -9.0 |
| 12185.0 | 60.8 | 47.2 | 60.4 | 47.2 | 54.0 | -6.8 | -6.8 |
| 14622.0 | 62.8 | 48.9 | 62.6 | 49.0 | 54.0 | -5.1 | -5.0 |
| 17059.0 | 65.2 | 52.2 | 65.9 | 52.2 | 54.0 | -1.8 | -1.8 |
| 2462.0 | -- | -- | -- | -- | -- | -- | -- |
| 4924.0 | 51.4 | 37.4 | 51.2 | 37.4 | 54.0 | -16.6 | -16.6 |
| 7386.0 | 55.3 | 41.8 | 55.0 | 41.7 | 54.0 | -12.2 | -12.3 |
| 9848.0 | 58.9 | 45.6 | 59.5 | 45.6 | 54.0 | -8.4 | -8.4 |
| 12310.0 | 61.1 | 47.8 | 61.8 | 47.8 | 54.0 | -6.2 | -6.2 |
| 14772.0 | 62.2 | 48.9 | 62.2 | 48.9 | 54.0 | -5.1 | -5.1 |
| 17234.0 | 66.3 | 52.6 | 66.1 | 52.7 | 54.0 | -1.4 | -1.3 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 11 Transmitter Radiated Emissions Mode 4, 802.11n**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) | Horizontal Margin (dB) | Vertical Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2412.0 | -- | -- | -- | -- | -- | -- | -- |
| 4824.0 | 51.1 | 37.3 | 51.0 | 37.4 | 54.0 | -16.7 | -16.6 |
| 7236.0 | 54.9 | 41.7 | 56.2 | 42.2 | 54.0 | -12.3 | -11.8 |
| 9648.0 | 59.4 | 45.5 | 58.8 | 45.5 | 54.0 | -8.5 | -8.5 |
| 12060.0 | 62.1 | 48.4 | 61.7 | 48.3 | 54.0 | -5.6 | -5.7 |
| 14472.0 | 63.6 | 49.2 | 62.9 | 49.2 | 54.0 | -4.8 | -4.8 |
| 16884.0 | 66.0 | 52.4 | 67.1 | 52.5 | 54.0 | -1.6 | -1.5 |
| 2437.0 | -- | -- | -- | -- | -- | -- | -- |
| 4874.0 | 51.2 | 37.3 | 51.0 | 37.4 | 54.0 | -16.7 | -16.6 |
| 7311.0 | 55.5 | 41.9 | 55.5 | 42.0 | 54.0 | -12.1 | -12.0 |
| 9748.0 | 58.3 | 44.9 | 58.1 | 44.9 | 54.0 | -9.1 | -9.1 |
| 12185.0 | 60.5 | 47.1 | 60.6 | 47.1 | 54.0 | -6.9 | -6.9 |
| 14622.0 | 62.2 | 48.8 | 61.7 | 48.8 | 54.0 | -5.2 | -5.2 |
| 17059.0 | 65.5 | 51.8 | 65.4 | 51.8 | 54.0 | -2.2 | -2.2 |
| 2462.0 | -- | -- | -- | -- | -- | -- | -- |
| 4924.0 | 51.2 | 37.3 | 51.2 | 37.3 | 94.0 | -16.7 | -16.7 |
| 7386.0 | 55.5 | 41.9 | 55.4 | 41.8 | 54.0 | -12.1 | -12.2 |
| 9848.0 | 59.0 | 45.6 | 58.8 | 45.6 | 54.0 | -8.4 | -8.4 |
| 12310.0 | 60.8 | 47.7 | 61.1 | 47.7 | 54.0 | -6.3 | -6.3 |
| 14772.0 | 62.3 | 48.9 | 62.4 | 48.8 | 54.0 | -5.1 | -5.2 |
| 17234.0 | 66.0 | 52.5 | 66.2 | 52.6 | 54.0 | -1.5 | -1.4 |

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

**Table 11 Transmitter Antenna Port Conducted Data modes 1, 2, 3 and 4**

| Frequency MHz | Antenna Port Average Output Power (Watts) | 99% Occupied Bandwidth (kHz) | 6-dB Occupied Bandwidth (kHz) | Peak Power Spectral Density (dBm) |
|---|---|---|---|---|
| Mode 1, BT BLE (GMSK) | | | | |
| 2402 | 0.002 | 1,053.8 | 702.5 | -11.1 |
| 2442 | 0.002 | 1,053.8 | 704.0 | -11.2 |
| 2480 | 0.002 | 1,054.5 | 709.5 | -12.0 |
| Mode 2, 802.11b | | | | |
| 2412 | 0.037 | 11,482.5 | 8,200.9 | -5.0 |
| 2437 | 0.037 | 11,730.0 | 8,320.0 | -6.7 |
| 2462 | 0.041 | 11,512.0 | 8,390 | -4.9 |
| Mode 3, 802.11g | | | | |
| 2412 | 0.028 | 16,900.0 | 15,768.2 | -9.2 |
| 2437 | 0.027 | 16,950.0 | 16,010.0 | -8.8 |
| 2462 | 0.030 | 16,800.0 | 15,960.0 | -8.4 |
| Mode 4, 802.11n | | | | |
| 2412 | 0.025 | 17,970.0 | 16,520.0 | -9.9 |
| 2437 | 0.024 | 18,050.0 | 15,490.0 | -9.1 |
| 2462 | 0.026 | 17,900.0 | 16,250.0 | -8.9 |

***Summary of Results for Transmitter Radiated Emissions of Intentional Radiator***

The EUT demonstrated compliance with the radiated and conducted emission requirements of 47CFR Subpart 15C Paragraph 15.247, RSS-247 Issue 3 and RSS-GEN Issue 5 emission requirements for Digital Transmission Systems. The highest average output power measured at the antenna port for modes 1, 2, 3, and 4 was 0.041 Watts. The highest peak power spectral density measured at the antenna port for modes 1, 2, 3, and 4 presented a minimum margin of -12.9 dB below the requirements. The EUT demonstrated a minimum margin of -0.7 dB below the harmonic emissions requirements. There were no other significantly measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. There were no other deviations or exceptions to the requirements.

## Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Test Equipment
- Annex C Rogers Qualifications
- Annex D Laboratory Certificate of Accreditation

## *Annex A Measurement Uncertainty Calculations*

The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4. Result of measurement uncertainty calculations are recorded below. Component and process variability of production devices similar to those tested may result in additional deviations. The manufacturer has the sole responsibility of continued compliance.

| Measurement | Expanded Measurement Uncertainty $U_{(lab)}$ |
|---|---|
| 3 Meter Horizontal 0.009-1000 MHz Measurements | 4.16 |
| 3 Meter Vertical 0.009-1000 MHz Measurements | 4.33 |
| 3 Meter Measurements 1-18 GHz | 5.46 |
| 3 Meter Measurements 18-40 GHz | 5.16 |
| 10 Meter Horizontal Measurements 0.009-1000 MHz | 4.15 |
| 10 Meter Vertical Measurements 0.009-1000 MHz | 4.32 |
| AC Line Conducted | 1.75 |
| Antenna Port Conducted power | 1.17 |
| Frequency Stability | 1.00E-11 |
| Temperature | 1.6˚C |
| Humidity | 3% |

## *Annex B Test Equipment*

| Equipment | Manufacturer | Model (SN) | Band | Cal Date(m/d/y) | Due |
|---|---|---|---|---|---|
| ☒ LISN | FCC | FCC-LISN-50-25-10(1PA) (160611) | .15-30MHz | 3/28/2023 | 3/28/2024 |
| ☒ LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08 | | | | 3/28/2023 | 3/28/2024 |
| ☒ Cable | Huber & Suhner Inc. | Sucoflex102ea(L10M)(303073) | 9kHz-40 GHz | 10/11/2022 | 10/11/2023 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(1.5M)(303069) | 9kHz-40 GHz | 10/11/2022 | 10/11/2023 |
| ☒ Cable | Huber & Suhner Inc. | Sucoflex102ea(1.5M)(303070) | 9kHz-40 GHz | 10/11/2022 | 10/11/2023 |
| ☐ Cable | Belden | RG-58 (L1-CAT3-11509) | 9kHz-30 MHz | 10/11/2022 | 10/11/2023 |
| ☐ Cable | Belden | RG-58 (L2-CAT3-11509) | 9kHz-30 MHz | 10/11/2022 | 10/11/2023 |
| ☒ Antenna | Com Power | AL-130 (121055) | .001-30 MHz | 10/11/2022 | 10/11/2023 |
| ☐ Antenna: | EMCO | 6509 | .001-30 MHz | 10/14/2020 | 10/11/2023 |
| ☐ Antenna | ARA | BCD-235-B (169) | 20-350MHz | 10/11/2022 | 10/11/2023 |
| ☒ Antenna | Sunol | JB-6 (A100709) | 30-1000 MHz | 10/11/2022 | 10/11/2023 |
| ☐ Antenna | ETS-Lindgren | 3147 (40582) | 200-1000MHz | 10/11/2022 | 10/11/2024 |
| ☒ Antenna | ETS-Lindgren | 3117 (200389) | 1-18 GHz | 3/28/2022 | 3/29/2024 |
| ☐ Antenna | Com Power | AH-118 (10110) | 1-18 GHz | 10/11/2022 | 10/11/2024 |
| ☒ Antenna | Com Power | AH-840 (101046) | 18-40 GHz | 3/27/2023 | 3/27/2025 |
| ☒ Analyzer | Rohde & Schwarz | ESU40 (100108) | 20Hz-40GHz | 6/26/2023 | 6/26/2024 |
| ☒ Analyzer | Rohde & Schwarz | ESW44 (101534) | 20Hz-44GHz | 1/25/2023 | 1/25/2024 |
| ☐ Analyzer | Rohde & Schwarz | FS-Z60, 90, 140, and 220 | 40GHz-220GHz | 12/22/2017 | 12/22/2027 |
| ☒ Amplifier | Com-Power | PA-010 (171003) | 100Hz-30MHz | 10/11/2022 | 10/11/2023 |
| ☒ Amplifier | Com-Power | CPPA-102 (01254) | 1-1000 MHz | 10/11/2022 | 10/11/2023 |
| ☒ Amplifier | Com-Power | PAM-118A (551014) | 0.5-18 GHz | 10/11/2022 | 10/11/2023 |
| ☒ Amplifier | Com-Power | PAM-840A (461328) | 18-40 GHz | 10/11/2022 | 10/11/2023 |
| ☐ Pwr Sensor | Rohde & Schwarz | NRP33T | 0.05-33 GHz | 8/31/2022 | 8/31/2023 |
| ☐ Power Meter | Agilent | N1911A with N1921A | 0.05-40 GHz | 3/28/2023 | 3/28/2025 |
| ☐ Generator | Rohde & Schwarz | SMB100A6 (100150) | 20Hz-6 GHz | 3/28/2023 | 3/28/2024 |
| ☐ Generator | Rohde & Schwarz | SMBV100A6 (260771) | 20Hz-6 GHz | 3/28/2023 | 3/28/2024 |
| ☐ RF Filter | Micro-Tronics | BRC50722 (009).9G notch | 30-18000 MHz | 3/28/2023 | 3/28/2025 |
| ☐ RF Filter | Micro-Tronics | HPM50114 (017)1.5G HPF | 30-18000 MHz | 3/28/2023 | 3/28/2025 |
| ☐ RF Filter | Micro-Tronics | HPM50117 (063) 3G HPF | 30-18000 MHz | 3/28/2023 | 3/28/2025 |
| ☐ RF Filter | Micro-Tronics | HPM50105 (059) 6G HPF | 30-18000 MHz | 3/28/2023 | 3/28/2025 |
| ☒ RF Filter | Micro-Tronics | BRM50702 (172) 2G notch | 30-18000 MHz | 3/28/2023 | 3/28/2025 |
| ☐ RF Filter | Micro-Tronics | BRC50703 (G102) 5G notch | 30-18000 MHz | 3/28/2023 | 3/28/2025 |
| ☐ RF Filter | Micro-Tronics | BRC50705 (024) 5G notch | 30-18000 MHz | 3/28/2023 | 3/28/2025 |
| ☒ Attenuator | Mini-Circuits | VAT-3W2+ (1436) | 30-6000 MHz | 3/28/2023 | 3/28/2024 |
| ☐ Attenuator | Mini-Circuits | VAT-3W2+ (1445) | 30-6000 MHz | 3/28/2023 | 3/28/2024 |
| ☐ Attenuator | Mini-Circuits | VAT-3W2+ (1735) | 30-6000 MHz | 3/28/2023 | 3/28/2024 |
| ☐ Attenuator | Mini-Circuits | VAT-6W2+ (1438) | 30-6000 MHz | 3/28/2023 | 3/28/2024 |
| ☐ Attenuator | Mini-Circuits | VAT-6W2+ (1736) | 30-6000 MHz | 3/28/2023 | 3/28/2024 |
| ☒ Weather station | Davis | 6312 (A81120N075) | | 10/11/2022 | 10/11/2023 |

| List of Test Equipment | | | Calibration Date (m/d/y) | Due |
|---|---|---|---|---|
| ☐ Frequency Counter: Leader LDC-825 (8060153 | | | 3/28/2023 | 3/28/2025 |
| ☐ ISN: | Com-Power Model ISN T-8 | | 3/28/2023 | 3/28/2024 |
| ☐ LISN | Compliance Design | FCC-LISN-2.Mod.cd,(126) .15-30MHz | 10/11/2022 | 10/11/2024 |
| ☐ LISN: | Com-Power Model LI-220A | | 3/29/2023 | 3/29/2025 |
| ☐ LISN: | Com-Power Model LI-550C | | 10/11/2022 | 10/11/2024 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(1.5M)(303072) 9kHz-40 GHz | 10/11/2022 | 10/11/2023 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(L1M)(281183) 9kHz-40 GHz | 10/11/2022 | 10/11/2023 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(L4M)(281184) 9kHz-40 GHz | 10/11/2022 | 10/11/2023 |
| ☐ Cable | Huber & Suhner Inc. | Sucoflex102ea(L10M)(317546)9kHz-40 GHz | 10/11/2022 | 10/11/2023 |
| ☐ Cable | Time Microwave | 4M-750HF290-750 (4M) 9kHz-24 GHz | 10/11/2022 | 10/11/2023 |
| ☐ RF Filter | Micro-Tronics | BRC17663 (001) 9.3-9.5 notch 30-1800 MHz | 3/28/2023 | 3/28/2025 |
| ☐ RF Filter | Micro-Tronics | BRC19565 (001) 9.2-9.6 notch 30-1800 MHz | 3/28/2023 | 3/28/2025 |
| ☐ Analyzer | HP | 8562A (3051A05950) 9kHz-125GHz | 3/28/2023 | 3/28/2024 |
| ☐ Wave Form Generator Keysight | | 33512B (MY57400128) | 3/29/2022 | 3/29/2024 |
| ☐ Antenna: | Solar 9229-1 & 9230-1 | | 2/18/2023 | 2/18/2024 |
| ☐ CDN: | Com-Power Model CDN325E | | 10/11/2022 | 10/11/2024 |
| ☐ Oscilloscope Scope: Tektronix MDO 4104 | | | 2/18/2023 | 2/18/2024 |
| ☐ EMC Transient Generator HVT TR 3000 | | | 2/18/2023 | 2/18/2024 |
| ☐ AC Power Source (Ametech, California Instruments) | | | 2/18/2023 | 2/18/2024 |
| ☐ Field Intensity Meter: EFM-018 | | | 2/18/2023 | 2/18/2024 |
| ☐ ESD Simulator: MZ-15 | | | 2/18/2023 | 2/18/2024 |
| ☐ Injection Clamp Luthi Model EM101 | | | not required | |
| ☐ R.F. Power Amp ACS 230-50W | | | not required | |
| ☐ R.F. Power Amp EIN Model: A301 | | | not required | |
| ☐ R.F. Power Amp A.R. Model: 10W 1010M7 | | | not required | |
| ☐ R.F. Power Amp A.R. Model: 50U1000 | | | not required | |
| ☐ Temperature Chamber | | | not required | |
| ☒ Shielded Room | | | not required | |

## *Annex C Qualifications*

***Patrick Powell, Engineer***

**Rogers Labs, a division of The Compatibility Center LLC**

Mr. Powell has approximately 40 years' experience in the field of electronics. Working experience includes automated test engineering in Military electronics; design & development in medical electronics; and application engineering / small business ownership in the semiconductor and display technology spaces.

Positions Held:

| | |
|---|---|
| Test Engineer: | McDonnell Douglas (now Boeing) |
| | Allied Signal Aerospace (now Honeywell) |
| Electrical Engineer: | PPG Biomedical Systems |
| | Nellcor, Inc. |
| Applications Engineer / small business owner: | |
| | Sharp Electronics |
| | Lattice Semiconductor |
| EMC Test Engineering: | The Compatibility Center LLC (current) |

Educational Background:

Bachelor of Science Degree in Electrical Engineering from Kansas State University

NVLAP Lab Code 200087-0

## *Annex D Laboratory Certificate of Accreditation*

3/18/24 through 3/31/25:

United States Department of Commerce
National Institute of Standards and Technology

**Certificate of Accreditation to ISO/IEC 17025:2017**

**NVLAP LAB CODE: 200087-0**

**Rogers Labs, a division of The Compatibility Center LLC**
Lenexa, KS

*is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:*

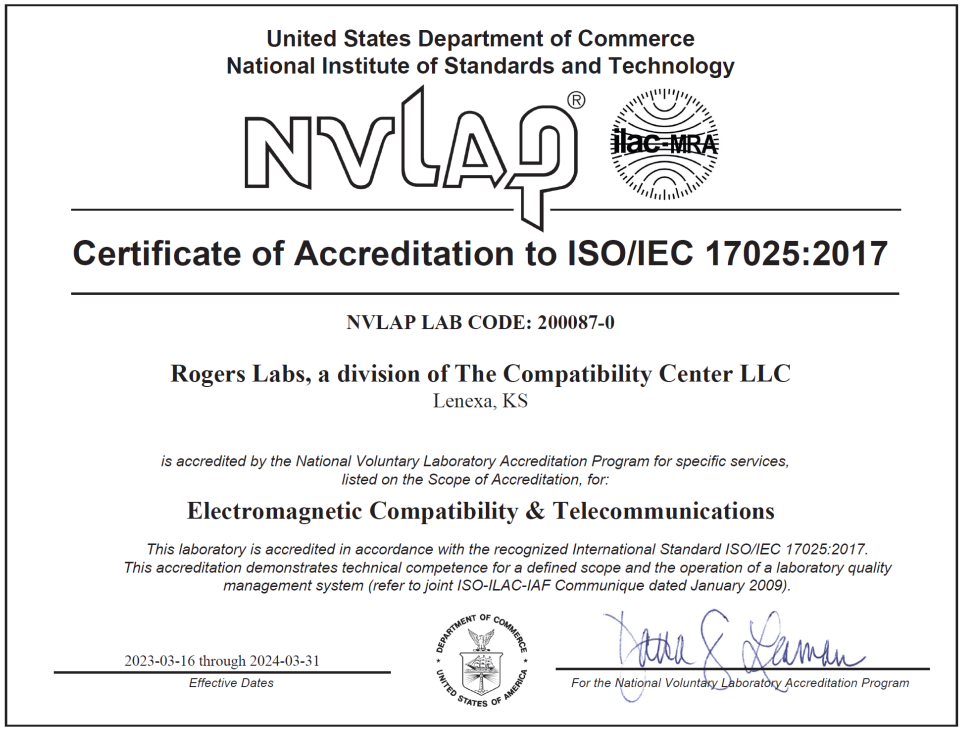
**Electromagnetic Compatibility & Telecommunications**

*This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).*

2024-03-18 through 2025-03-31
*Effective Dates*

*For the National Voluntary Laboratory Accreditation Program*

3/16/23 through 3/31/24:



United States Department of Commerce
National Institute of Standards and Technology

**Certificate of Accreditation to ISO/IEC 17025:2017**

**NVLAP LAB CODE: 200087-0**

**Rogers Labs, a division of The Compatibility Center LLC**
Lenexa, KS

*is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:*

**Electromagnetic Compatibility & Telecommunications**

*This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).*

2023-03-16 through 2024-03-31
*Effective Dates*

*For the National Voluntary Laboratory Accreditation Program*