

RF TEST REPORT

Test item : DIGITAL CAR AVN SYSTEM
Model No. : ATC41F2AN
Order No. : DTNC1505-02549
Date of receipt : 2015-05-22
Test duration : 2015-06-02 ~ 2015-06-09
Date of issue : 2015-06-17
Use of report : FCC Original Grant

Applicant : HYUNDAI MOBIS CO., LTD.
203 Teheran-ro, Gangnam-gu, Seoul, Korea, 135-977

Test laboratory : DT&C Co., Ltd.
42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935

Test specification : FCC Part 15 Subpart C 247
Test environment : See appended test report
Test result : Pass Fail

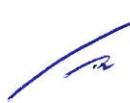
The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DT&C Co., Ltd.

Tested by:



Engineer
InHee Bae

Reviewed by:



Technical Manager
Geunki Son

Test Report Version

| Test Report No. | Date | Description |
|------------------------|---------------|--------------------|
| DRTFCC1506-0114 | Jun. 17, 2015 | Initial issue |
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1. GENERAL INFORMATION

Applicant : HYUNDAI MOBIS CO., LTD.
Address : 203 Teheran-ro, Gangnam-gu, Seoul, Korea, 135-977
FCC ID : TQ8-ATC41F2AN
EUT : DIGITAL CAR AVN SYSTEM
Model : ATC41F2AN
Additional Model(s) : N/A
Date of Test : 2015-06-02 ~ 2015-06-09
Contact person : Seung Hoon Choe

2. EUT DESCRIPTION

| | |
|------------------------------|---|
| Product | DIGITAL CAR AVN SYSTEM |
| Model Name | ATC41F2AN |
| Power Supply | DC 14.4 V |
| Hardware version | GEN 4.0. |
| Software version | 1.0. |
| Frequency Range | 2.4GHz Band ▪ 802.11b/g/n(20 MHz) : 2412 MHz ~ 2462 MHz |
| Max. RF Output Power | 2.4GHz Band ▪ 802.11b : 17.98 dBm ▪ 802.11g : 20.73 dBm ▪ 802.11n (HT20) : 20.01 dBm |
| Modulation Type | 802.11b : DSSS/CCK 802.11g/n : OFDM |
| Antenna Specification | External Antenna (1TX ,1RX) ▪ 2.4GHz Band Max. peak gain : 2.64 dBi |

3. SUMMARY OF TESTS

| FCC Part Section(s) | Parameter | Limit | Test Condition | Status Note 1 |
|--|---|--------------------------|-------------------|---------------------|
| 15.247(a) | 6 dB Bandwidth | > 500 kHz | Conducted | C |
| 15.247(b) | Transmitter Output Power | < 1 Watt | | C |
| 15.247(d) | Out of Band Emissions / Band Edge | 20 dBc in any 100 kHz BW | | C |
| 15.247(e) | Transmitter Power Spectral Density | < 8 dBm/3 kHz | | C |
| 15.205 15.209 | General Field Strength Limits (Restricted Bands and Radiated Emission Limits) | FCC 15.209 limits | Radiated | C Note 2 |
| 15.207 | AC Conducted Emissions | FCC 15.207 limits | AC Line Conducted | NA Note 3 |
| 15.203 | Antenna Requirements | FCC 15.203 limits | - | C |
| <p>Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable</p> <p>Note 2: This test item was performed in each axis and the worst case data was reported.</p> <p>Note 3: This device is installed in a car. Therefore the power source is a battery of car.</p> | | | | |

4. TEST METHODOLOGY

Generally the tests were performed according to the KDB558074 v03r03. And ANSI C63.10-2013 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing.

4.1 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

4.2 EUT EXERCISE

The EUT was operated in the test mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

4.3 GENERAL TEST PROCEDURES

Conducted Emissions

The power-line conducted emission test procedure is not described on the KDB 558074. So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10.

The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and Average detector.

Radiated Emissions

Basically the radiated tests were performed with KDB 558074. But some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10 as stated on section 12.1 of the KDB 558074.

The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the highest emission, the relative positions of the EUT were rotated through three orthogonal axes.

4.4 DESCRIPTION OF TEST MODES

The EUT has been tested with all modes of operating conditions to determine the worst case emission characteristics. A test program is used to control the EUT for staying in continuous transmitting mode.

5. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards.

6. FACILITIES AND ACCREDITATIONS

6.1 FACILITIES

The open area test site (OATS) or semi anechoic chamber and conducted measurement facility used to collect the radiated and conducted test data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935. The site is constructed in conformance with the requirements.

- Semi anechoic chamber registration Number: 165783(FCC)

6.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and peak, quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

7. ANTENNA REQUIREMENTS

7.1 According to FCC 47 CFR §15.203:

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 external antennas used a unique coupling to the intentional radiator.

Therefore this E.U.T Complies with the requirement of §15.203.

8. TEST RESULT

8.1 6 dB Bandwidth

Test Requirements and limit, §15.247(a)

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6 dB bandwidth is 500 kHz.

■ TEST CONFIGURATION

Refer to the APPENDIX I.

■ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB558074**

1. Set resolution bandwidth (RBW) = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
(RBW : 100 kHz / VBW : 300 kHz)
3. Detector = **Peak**.
4. Trace mode = **max hold**.
5. Sweep = **auto couple**.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

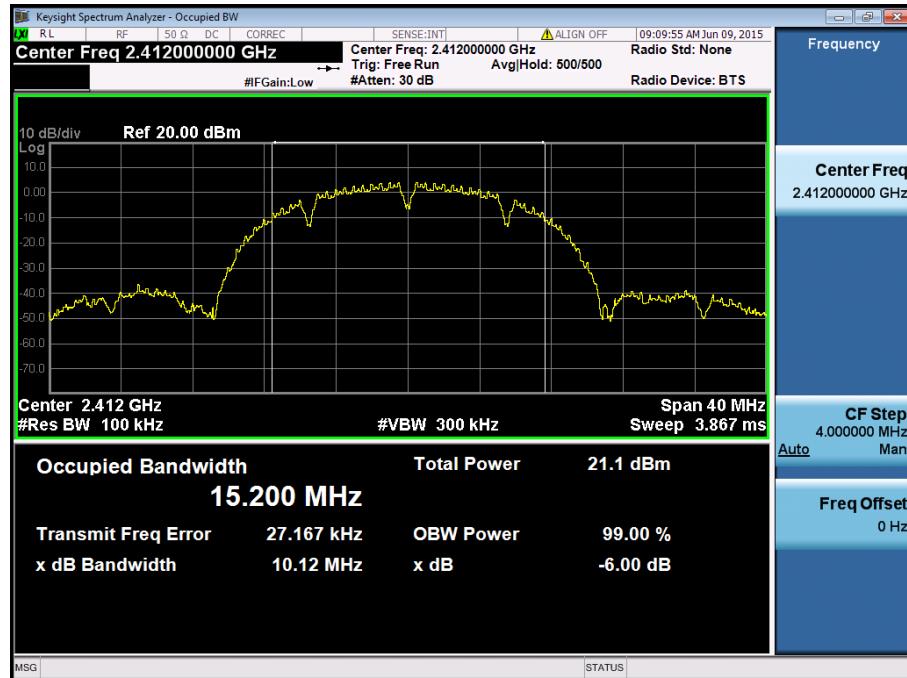
■ TEST RESULTS: **Comply**

| Test Mode | Data Rate | Frequency [MHz] | Test Results [MHz] |
|---------------------|-----------|-----------------|--------------------|
| 802.11b | 1 Mbps | 2412 | 10.120 |
| | | 2437 | 10.120 |
| | | 2462 | 10.120 |
| 802.11g | 6 Mbps | 2412 | 16.330 |
| | | 2437 | 16.340 |
| | | 2462 | 16.350 |
| 802.11n (20 MHz) | MCS 0 | 2412 | 17.040 |
| | | 2437 | 17.080 |
| | | 2462 | 16.910 |

RESULT PLOTS

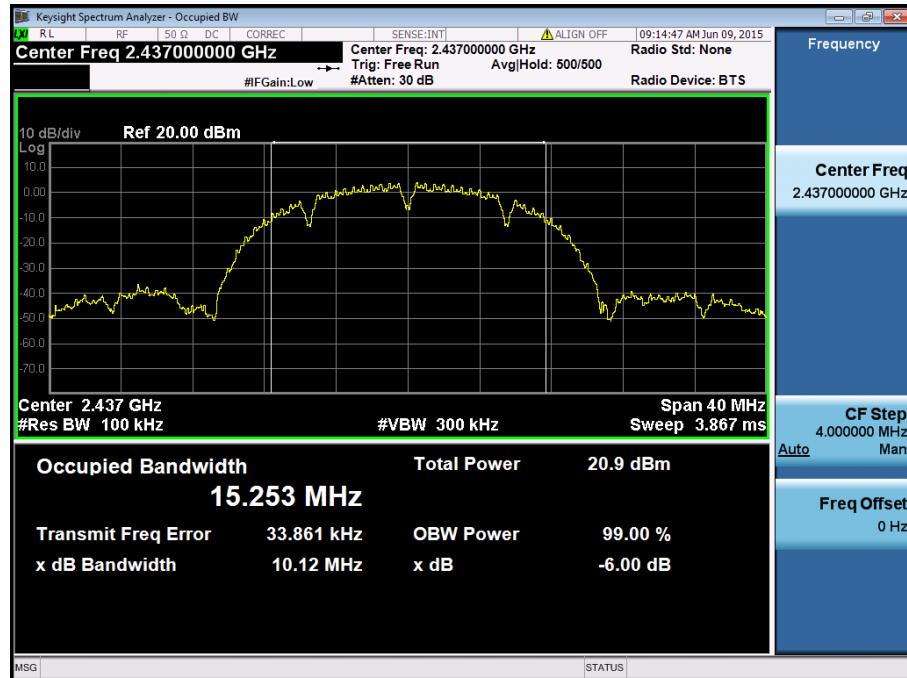
6 dB Bandwidth

Test Mode: 802.11b & 1 Mbps & 2412 MHz



6 dB Bandwidth

Test Mode: 802.11b & 1 Mbps & 2437 MHz



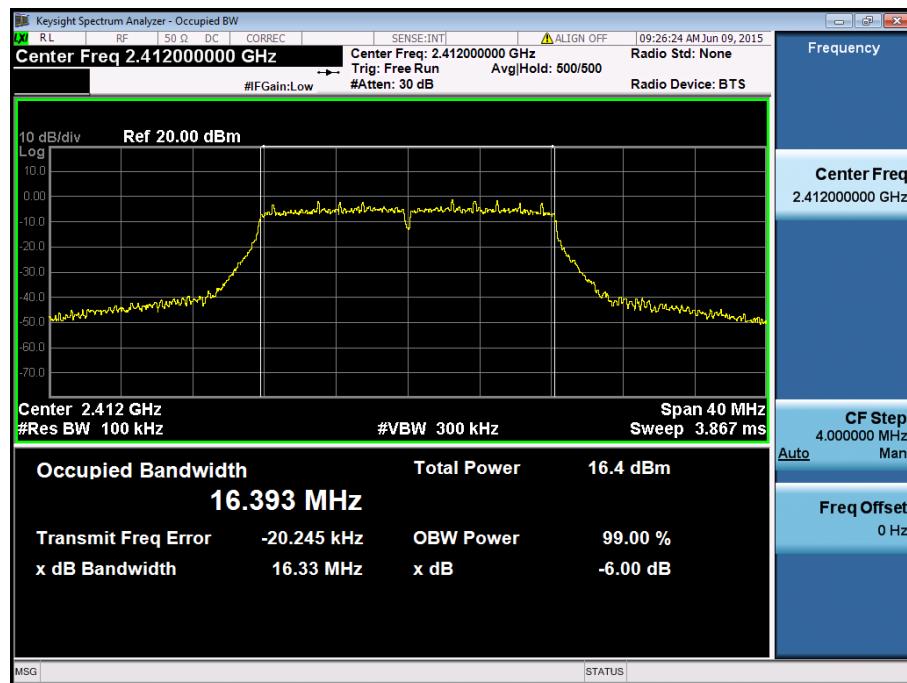
6 dB Bandwidth

Test Mode: 802.11b & 1 Mbps & 2462 MHz

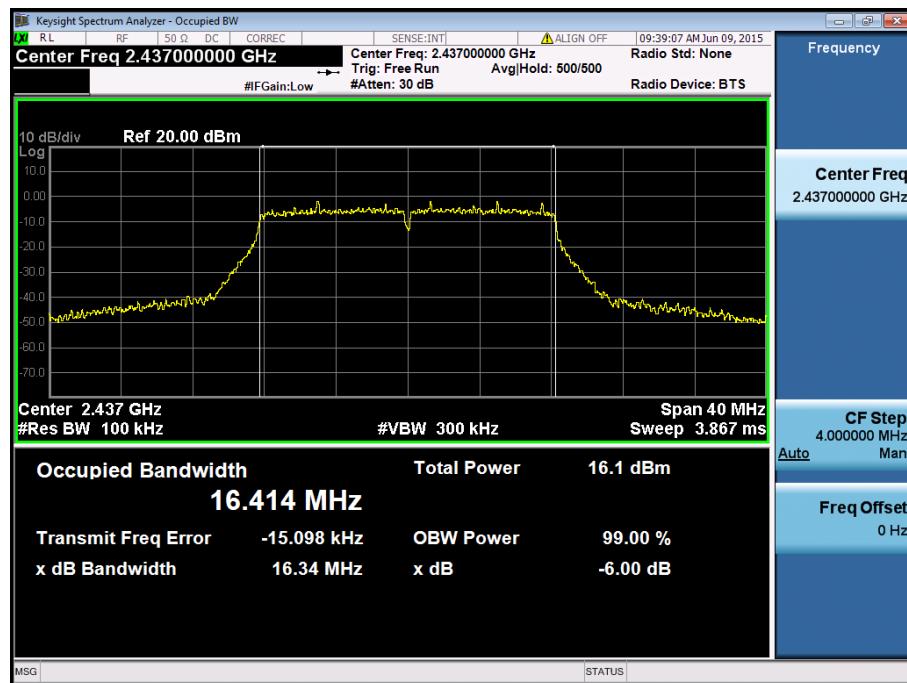


6 dB Bandwidth

Test Mode: 802.11g & 6 Mbps & 2412 MHz

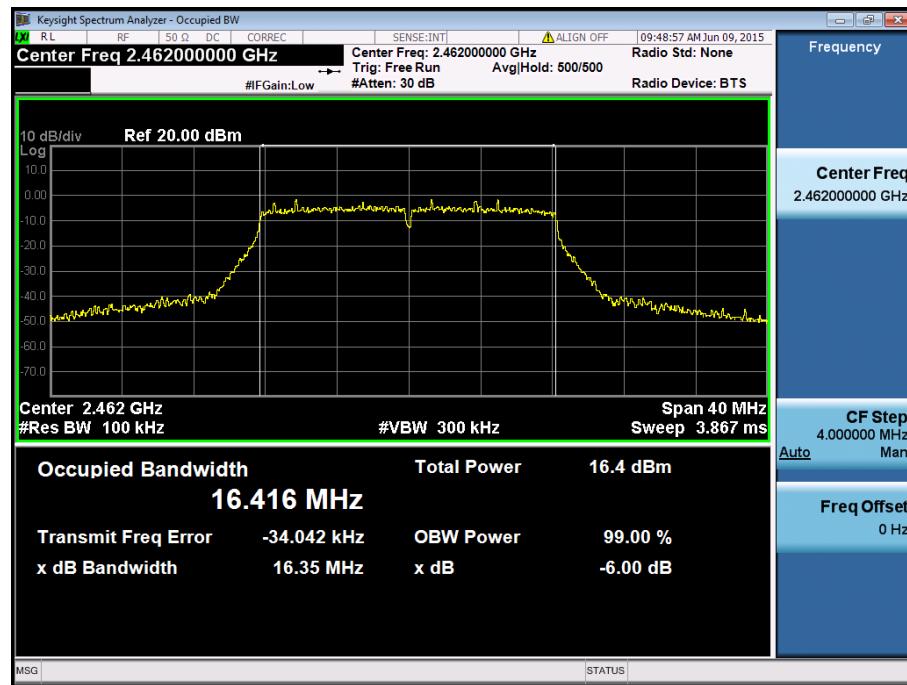
**6 dB Bandwidth**

Test Mode: 802.11g & 6 Mbps & 2437 MHz



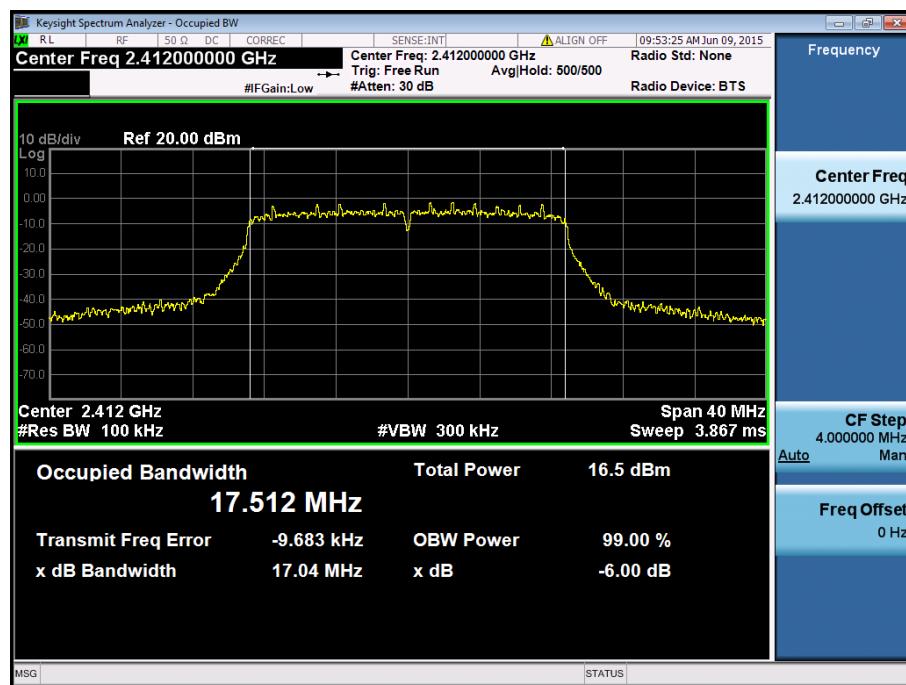
6 dB Bandwidth

Test Mode: 802.11g & 6 Mbps & 2462 MHz

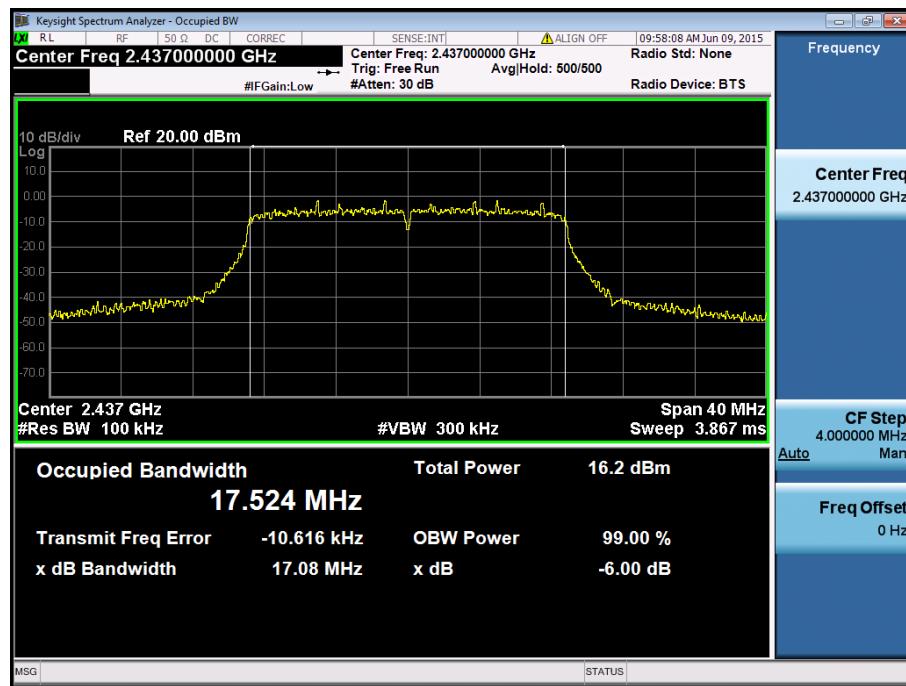


6 dB Bandwidth

Test Mode: 802.11n & MCS 0 & 2412 MHz

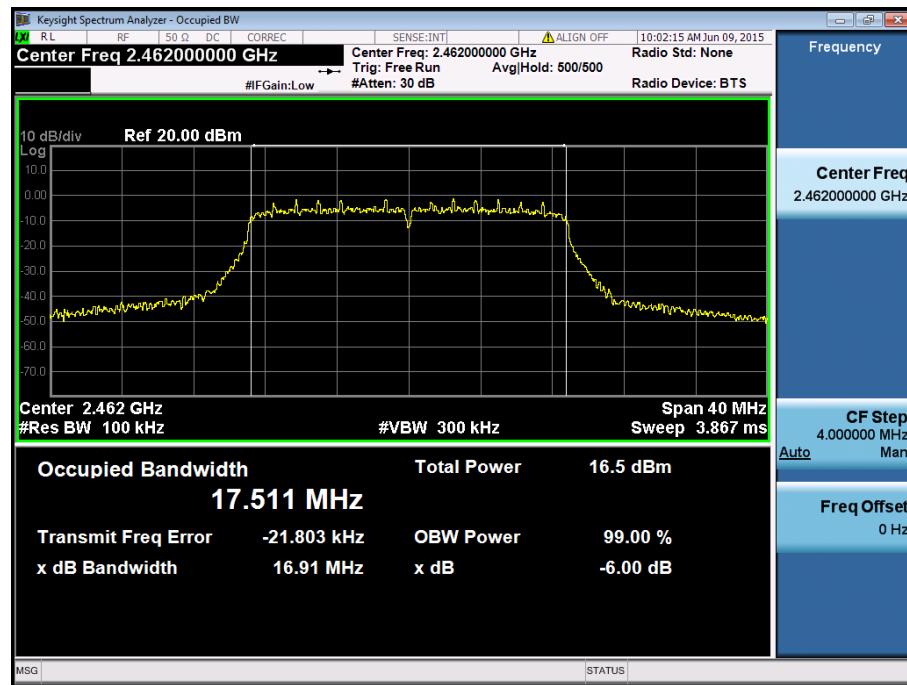
**6 dB Bandwidth**

Test Mode: 802.11n & MCS 0 & 2437 MHz



6 dB Bandwidth

Test Mode: 802.11n & MCS 0 & 2462 MHz

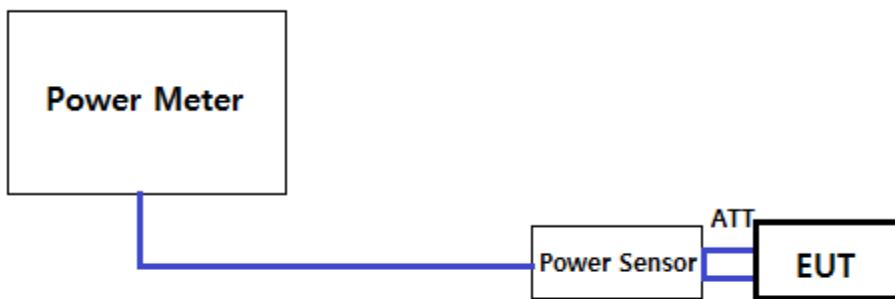


8.2 Maximum Peak Conducted Output Power

Test Requirements and limit, §15.247(b)

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

■ TEST CONFIGURATION



■ TEST PROCEDURE:

1. PKPM1 Peak power meter method of KDB558074

The maximum conducted output powers were measured using a broadband peak RF power meter which has greater video bandwidth than DUT's DTS bandwidth and utilize a fast-responding diode detector.

2. Method AVGPM-G (Measurement using a gated RF average power meter) of KDB558074

The average conducted output powers were measured using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

TEST RESULTS: Comply**- Measurement Data:****- Test Results**

| Mode | Channel | Frequency [MHz] | Detector | Test Result [dBm] | | | | | | | |
|---------|---------|-----------------|----------|-------------------|-------|-------|-------|----|----|----|----|
| | | | | DATA RATE [Mbps] | | | | | | | |
| | | | | 1 | 2 | 5.5 | 11 | NA | NA | NA | NA |
| 802.11b | 1 | 2412 | PK | 17.98 | 17.35 | 17.77 | 17.51 | - | - | - | - |
| | | | AV | 16.11 | 15.89 | 15.91 | 15.64 | - | - | - | - |
| | 6 | 2437 | PK | 17.81 | 17.76 | 17.80 | 17.78 | - | - | - | - |
| | | | AV | 15.87 | 15.78 | 15.83 | 15.81 | - | - | - | - |
| | 11 | 2462 | PK | 17.96 | 17.94 | 17.90 | 17.89 | - | - | - | - |
| | | | AV | 15.92 | 15.89 | 15.85 | 15.87 | - | - | - | - |

| Mode | Channel | Frequency [MHz] | Detector | Test Result [dBm] | | | | | | | |
|---------|---------|-----------------|----------|-------------------|-------|-------|-------|-------|-------|-------|-------|
| | | | | DATA RATE [Mbps] | | | | | | | |
| | | | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11g | 1 | 2412 | PK | 20.73 | 20.68 | 20.41 | 20.46 | 20.49 | 20.33 | 20.36 | 20.30 |
| | | | AV | 11.52 | 11.47 | 11.09 | 11.27 | 11.34 | 11.25 | 11.26 | 11.22 |
| | 6 | 2437 | PK | 20.61 | 20.55 | 20.28 | 20.35 | 20.38 | 20.30 | 20.33 | 20.27 |
| | | | AV | 11.46 | 11.41 | 11.29 | 11.21 | 11.26 | 11.22 | 11.25 | 11.18 |
| | 11 | 2462 | PK | 20.18 | 20.16 | 20.11 | 20.08 | 20.14 | 20.07 | 20.13 | 20.19 |
| | | | AV | 10.86 | 10.83 | 10.76 | 10.80 | 10.82 | 10.76 | 10.78 | 10.72 |

| Mode | Channel | Frequency [MHz] | Detector | Test Result [dBm] | | | | | | | |
|----------------|---------|-----------------|----------|-------------------|-------|-------|-------|-------|-------|-------|-------|
| | | | | DATA RATE [Mbps] | | | | | | | |
| | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 802.11n (HT20) | 1 | 2412 | PK | 20.01 | 19.89 | 19.75 | 19.82 | 19.44 | 19.87 | 19.90 | 19.92 |
| | | | AV | 10.64 | 10.52 | 10.58 | 10.61 | 10.54 | 10.63 | 10.58 | 10.52 |
| | 6 | 2437 | PK | 19.87 | 19.58 | 19.75 | 19.68 | 19.55 | 19.59 | 19.77 | 19.74 |
| | | | AV | 10.73 | 10.68 | 10.66 | 10.70 | 10.64 | 10.69 | 10.55 | 10.62 |
| | 11 | 2462 | PK | 19.80 | 19.78 | 19.69 | 19.66 | 19.71 | 19.66 | 19.74 | 19.76 |
| | | | AV | 10.72 | 10.64 | 10.57 | 10.55 | 10.60 | 10.48 | 10.53 | 10.55 |

8.3 Maximum Power Spectral Density

Test requirements and limit, §15.247(e)

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.

■ TEST CONFIGURATION

Refer to the APPENDIX I.

■ Test Procedure : KDB 558074

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to **1.5 times** the DTS bandwidth.
3. Set the RBW to : **3 kHz ≤ RBW ≤ 100 kHz**
4. Set the VBW $\geq 3 \times \text{RBW}$
5. Detector = **peak**
6. Sweep time = **auto couple**
7. Trace mode = **max hold**.
8. Allow trace to fully stabilize.
9. Use the **peak marker function** to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

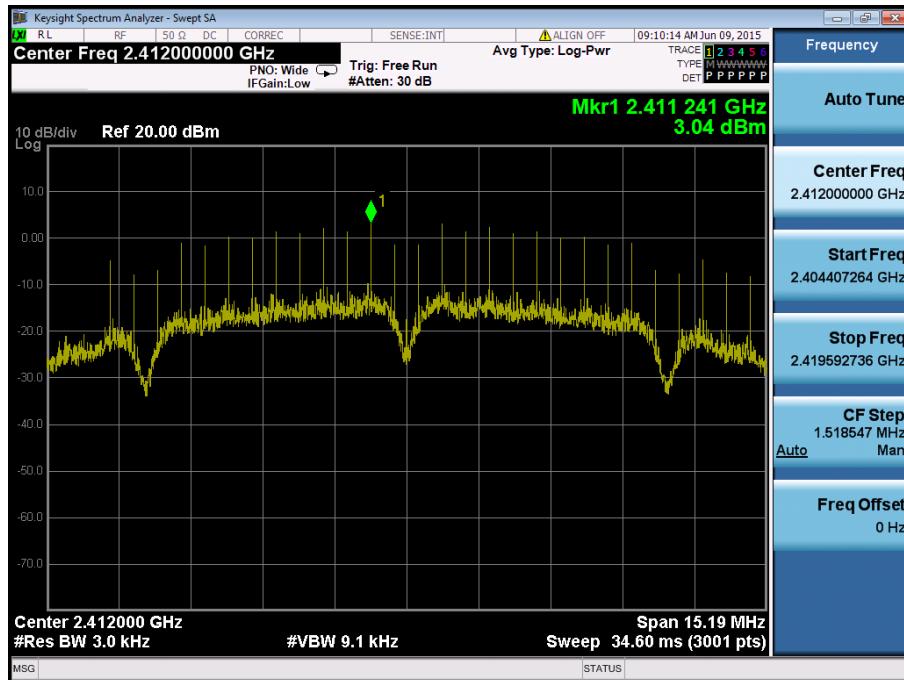
■ TEST RESULTS: **Comply**

| Test Mode | Data Rate | Frequency [MHz] | RBW | PKPSD [dBm] |
|--------------|-----------|-----------------|-------|-------------|
| 802.11b | 1 Mbps | 2412 | 3 kHz | 3.04 |
| | | 2437 | 3 kHz | 2.78 |
| | | 2462 | 3 kHz | 2.88 |
| 802.11g | 6 Mbps | 2412 | 3 kHz | -15.90 |
| | | 2437 | 3 kHz | -15.72 |
| | | 2462 | 3 kHz | -15.35 |
| 802.11n HT20 | MCS 0 | 2412 | 3 kHz | -16.06 |
| | | 2437 | 3 kHz | -16.02 |
| | | 2462 | 3 kHz | -15.27 |

RESULT PLOTS

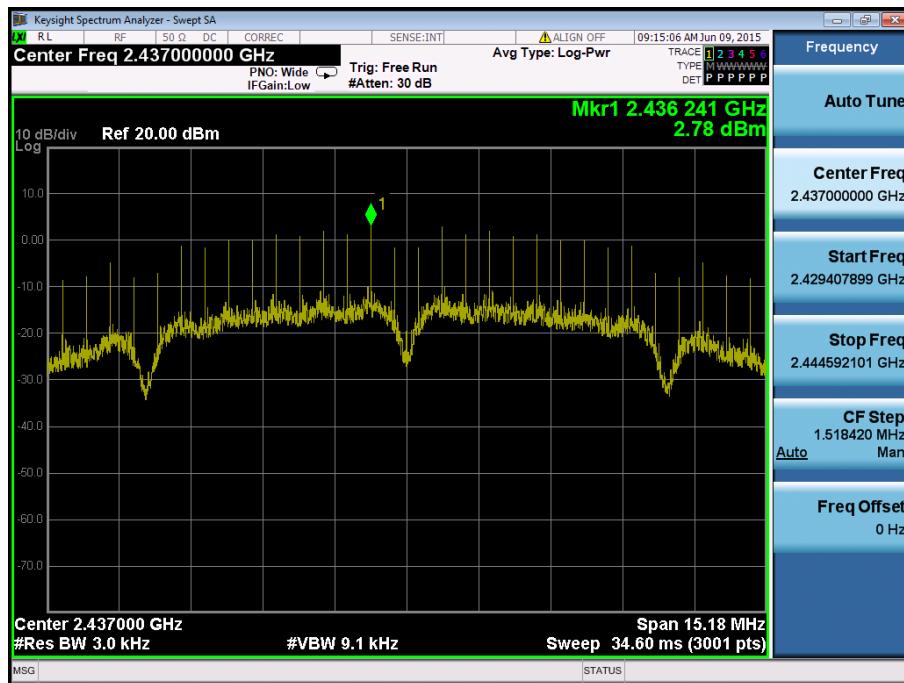
Maximum PKPSD

Test Mode: 802.11b & 1 Mbps & 2412 MHz



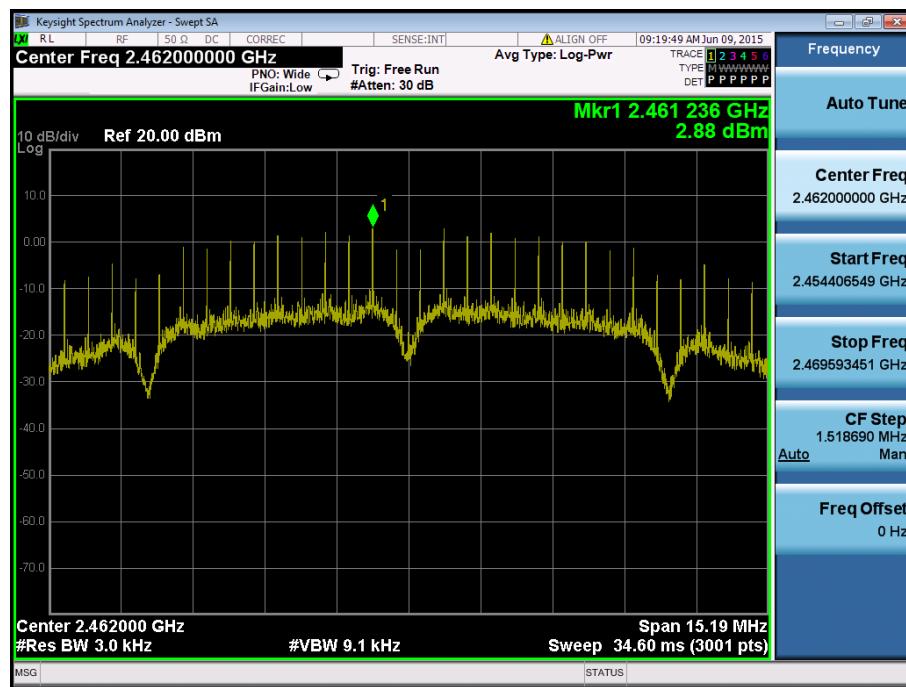
Maximum PKPSD

Test Mode: 802.11b & 1 Mbps & 2437 MHz



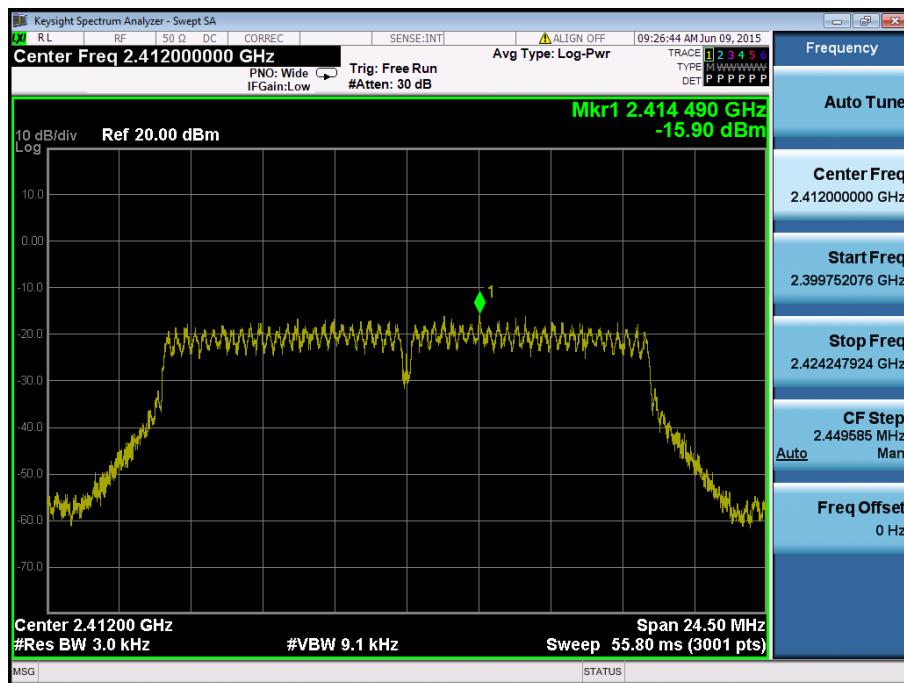
Maximum PKPSD

Test Mode: 802.11b & 1 Mbps & 2462 MHz

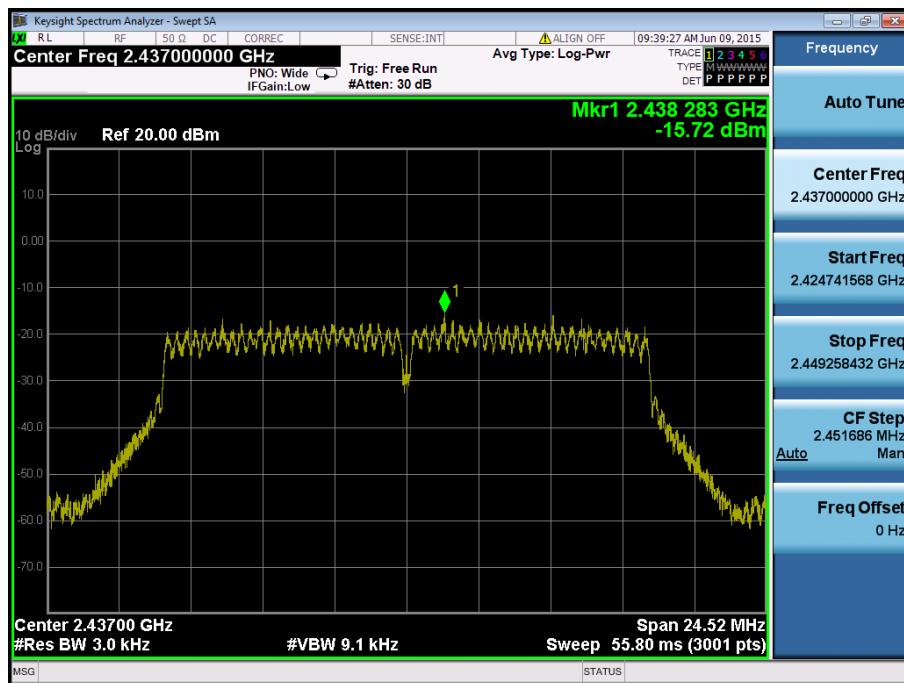


Maximum PKPSD

Test Mode: 802.11g & 6 Mbps & 2412 MHz

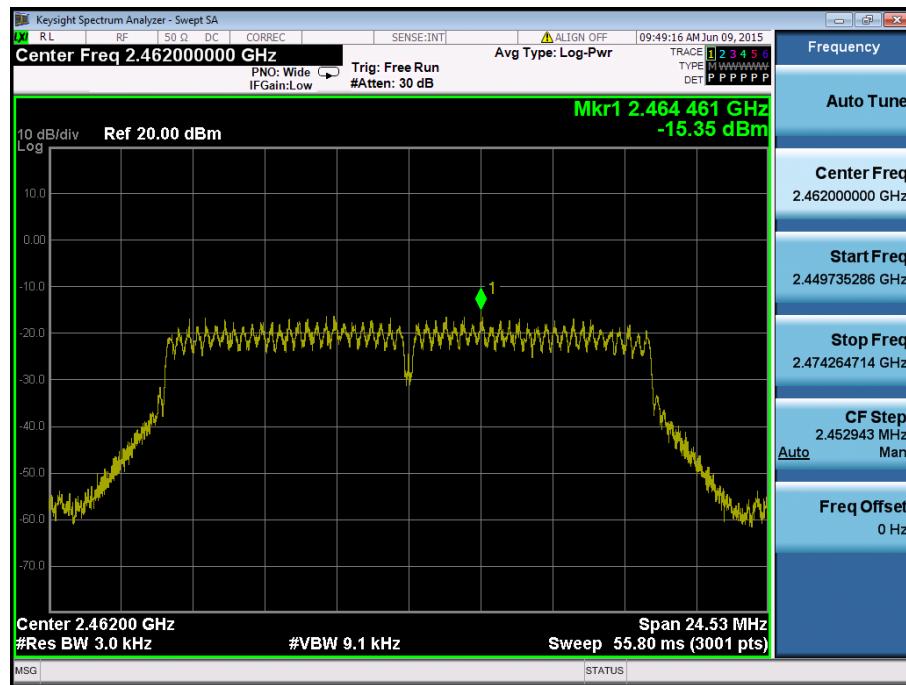
**Maximum PKPSD**

Test Mode: 802.11g & 6 Mbps & 2437 MHz



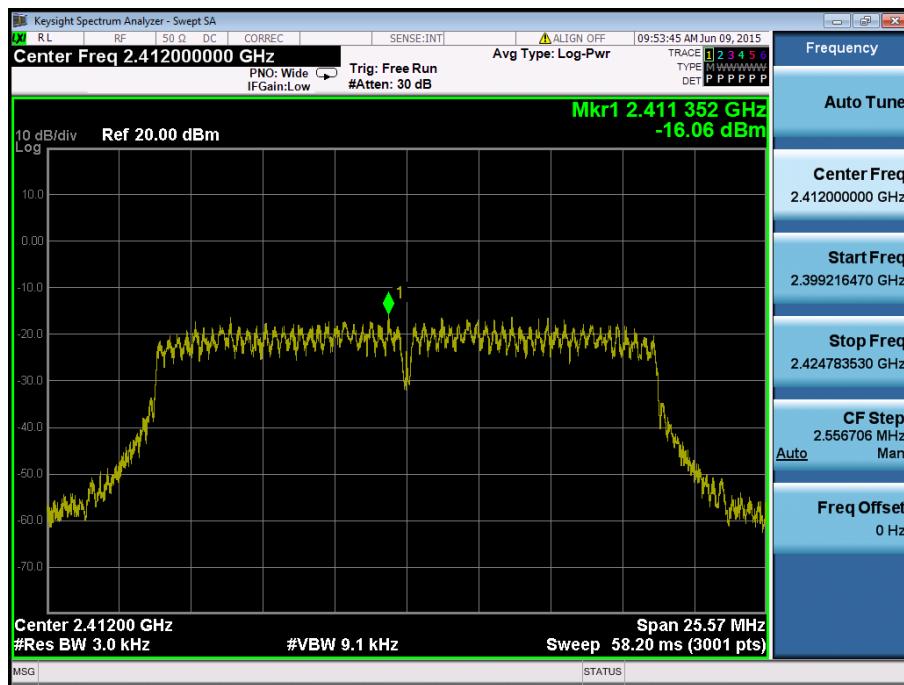
Maximum PKPSD

Test Mode: 802.11g & 6 Mbps & 2462 MHz



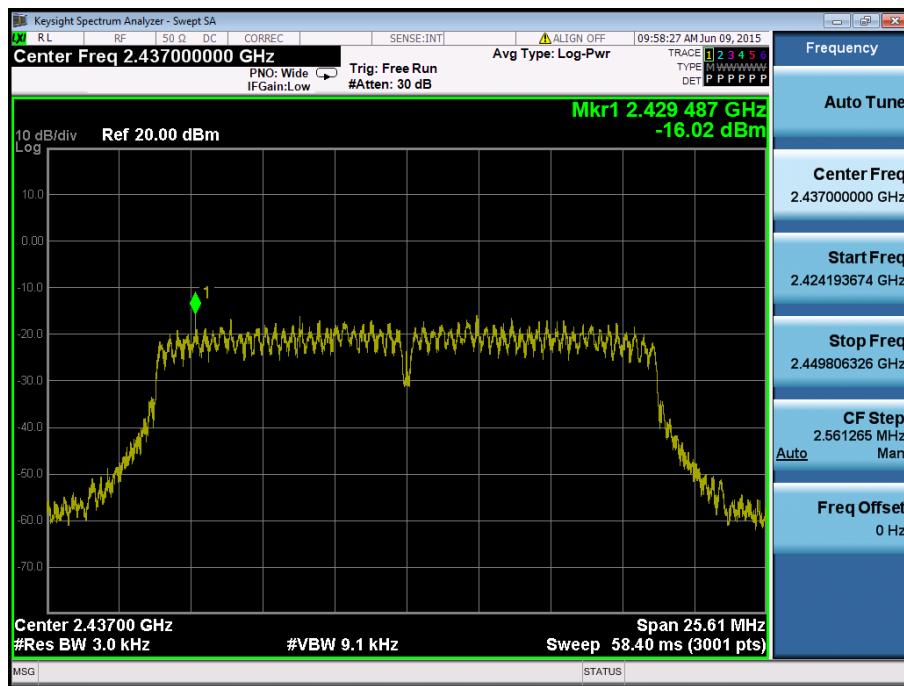
Maximum PKPSD

Test Mode: 802.11n(HT20) & MCS 0 & 2412 MHz



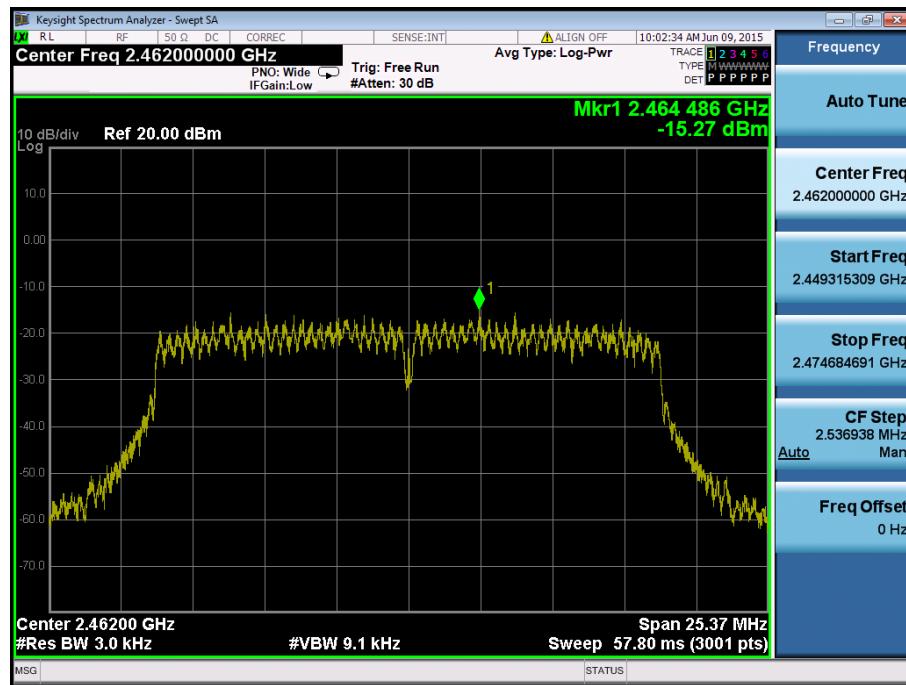
Maximum PKPSD

Test Mode: 802.11n(HT20) & MCS 0 & 2437 MHz



Maximum PKPSD

Test Mode: 802.11n(HT20) & MCS 0 & 2462 MHz



8.4 Out of Band Emissions at the Band Edge / Conducted Spurious Emissions

Test requirements and limit, §15.247(d)

§15.247(d) specifies that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions :

If **the peak output power procedure** is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the peak conducted output power measured within any 100 kHz outside of the authorized frequency band shall be attenuated **by at least 20 dB** relative to the maximum measured in-band peak PSD level.

If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured inband average PSD level.

In either case, attenuation to levels below the general emission limits specified in **§15.209(a)** is not required.

■ TEST CONFIGURATION

Refer to the APPENDIX I.

■ TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer.

- Measurement Procedure 1 – Reference Level

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to ≥ 1.5 times the DTS bandwidth.
3. Set the RBW = 100 kHz.
4. Set the VBW $\geq 3 \times$ RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum PSD level.

- Measurement Procedure 2 - Unwanted Emissions

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = **100 kHz**. (**Actual 1 MHz**, See below note)
3. Set the VBW $\geq 3 \times$ RBW. (**Actual 3 MHz**, See below note)
4. Detector = **peak**.
5. Ensure that the number of measurement points \geq span/RBW.
6. Sweep time = **auto couple**.
7. Trace mode = **max hold**.
8. **Allow the trace to stabilize.** (this may take some time, depending on the extent of the span)
9. Use the peak marker function to determine the maximum amplitude level.

Note : The conducted spurious emission was tested with below settings.

Frequency range: 9 kHz ~ 30 MHz

RBW = 100 kHz, VBW = 300 kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

Frequency range: 30 MHz ~ 10 GHz, 10 GHz ~25 GHz

RBW = 1 MHz, VBW = 3 MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

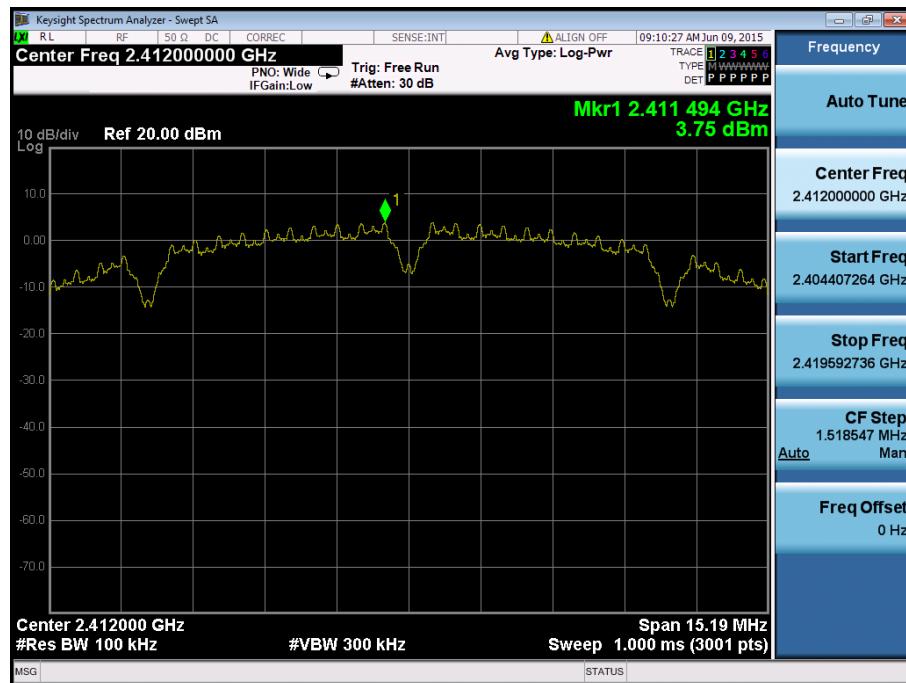
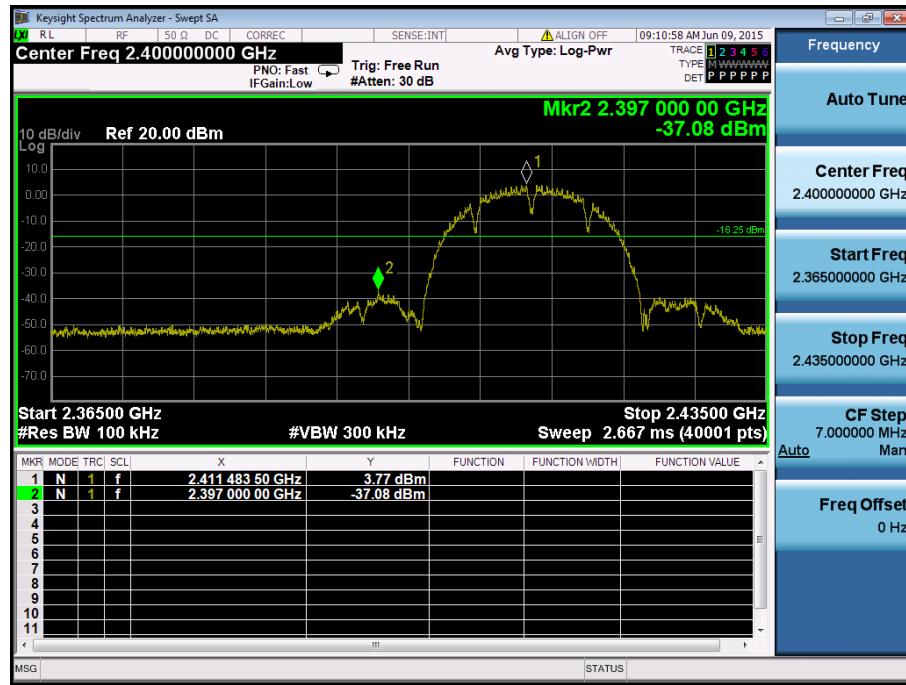
LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.

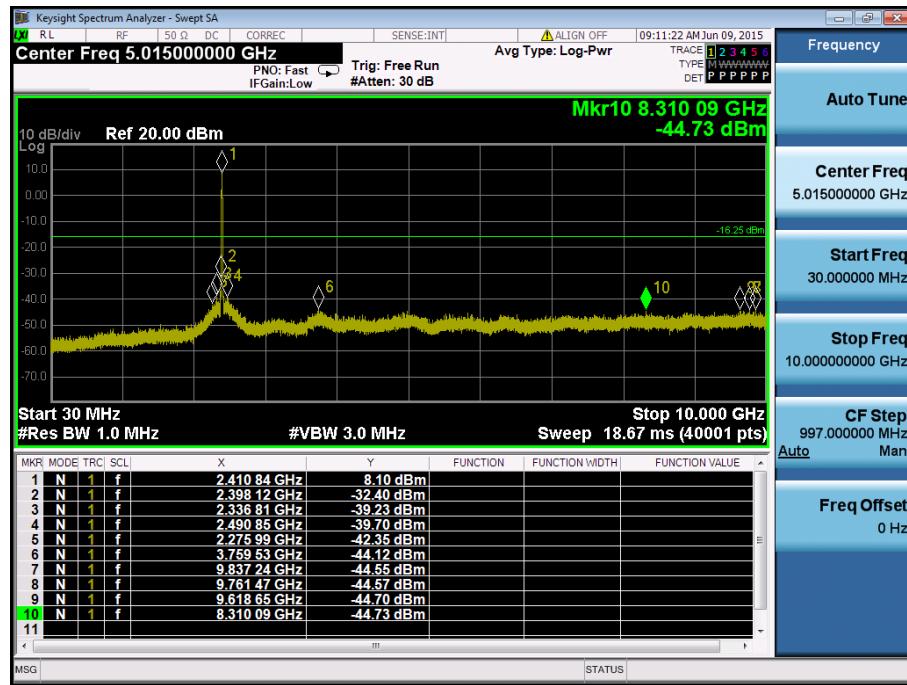
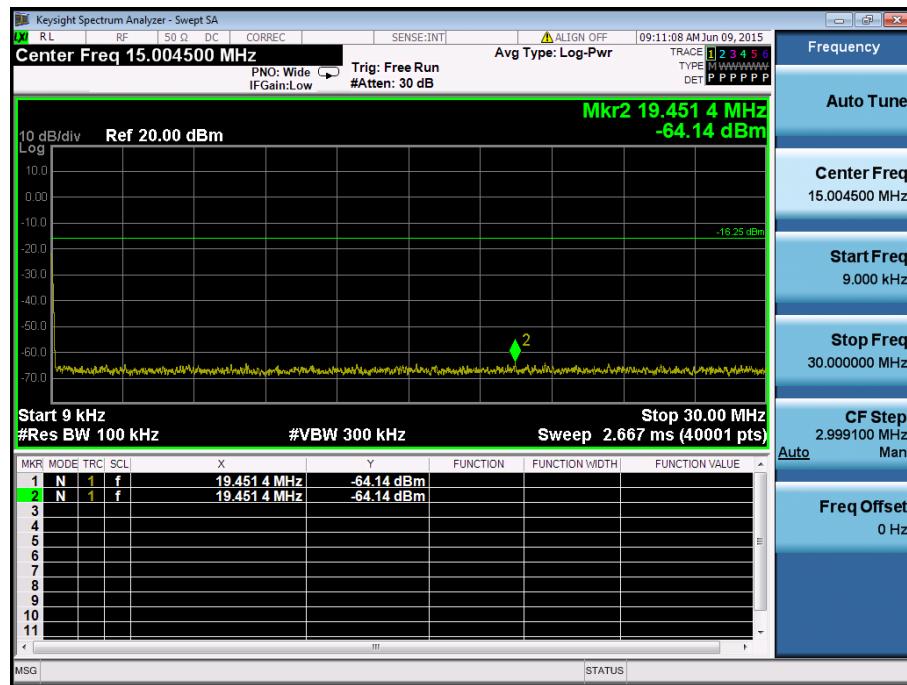
Also the path loss for conducted measurement setup was used as described on the Appendix I of this test report.

RESULT PLOTS

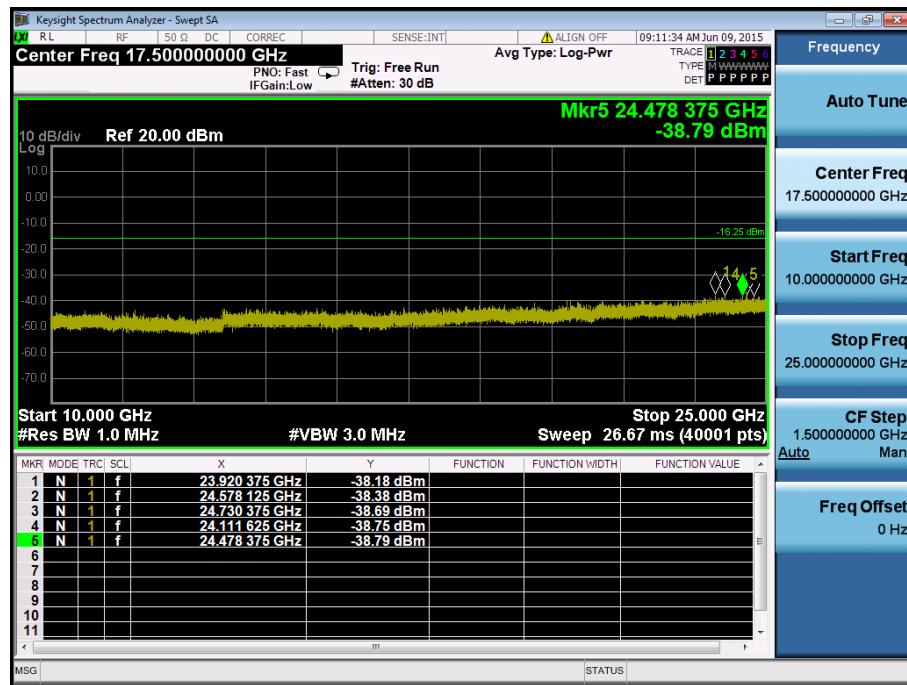
802.11b & 1 Mbps & 2412 MHz

Reference**Low Band-edge**

Conducted Spurious Emissions

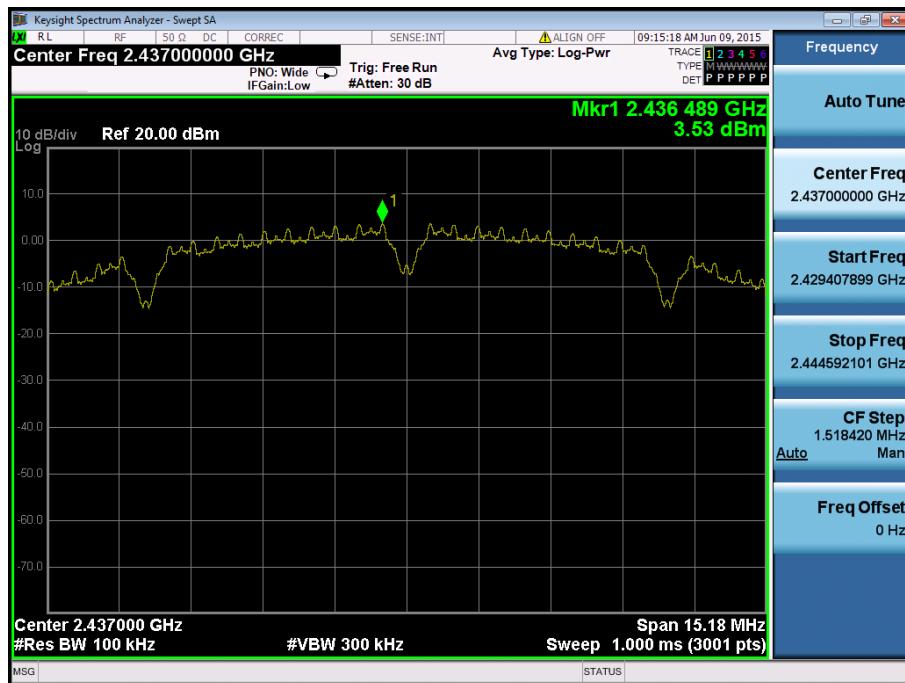


Conducted Spurious Emissions

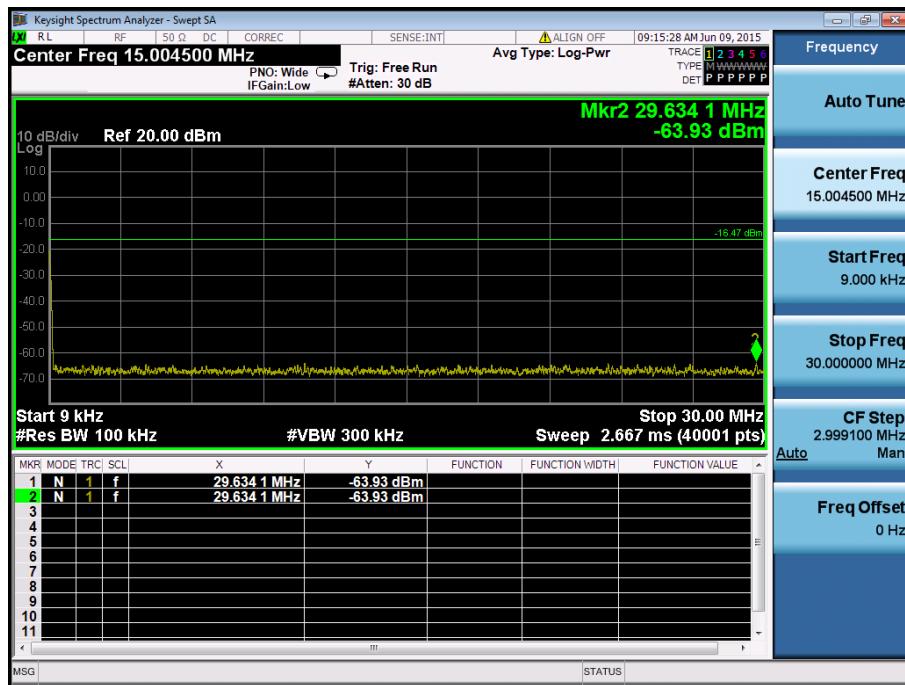


802.11b & 1 Mbps & 2437 MHz

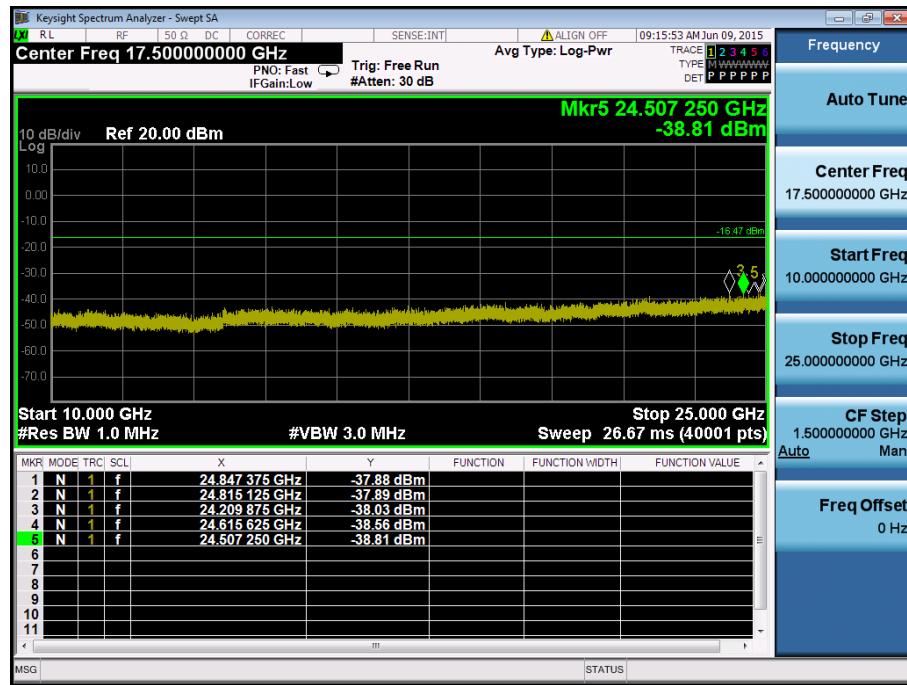
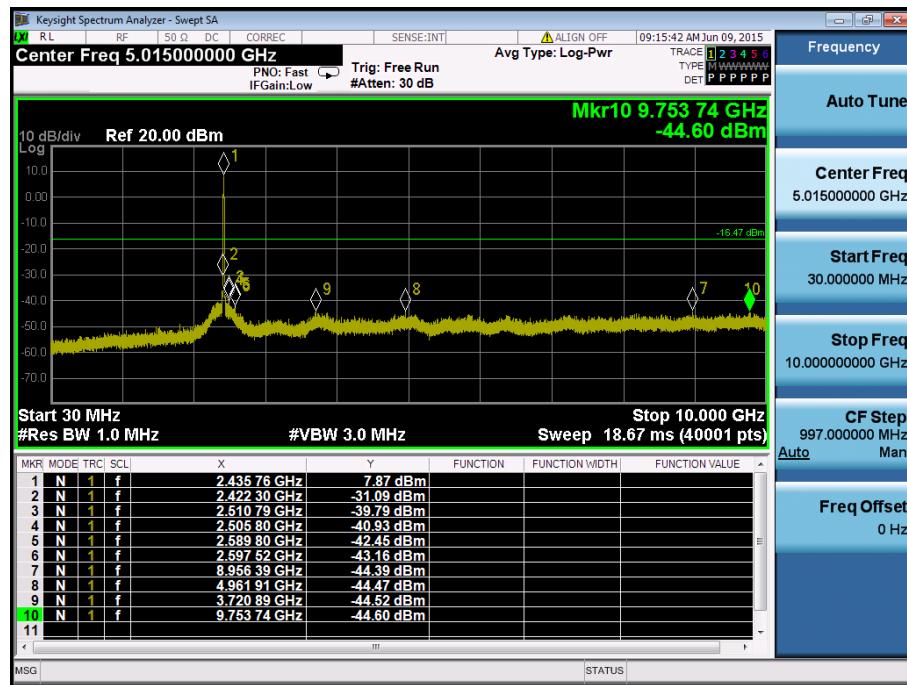
Reference



Conducted Spurious Emissions

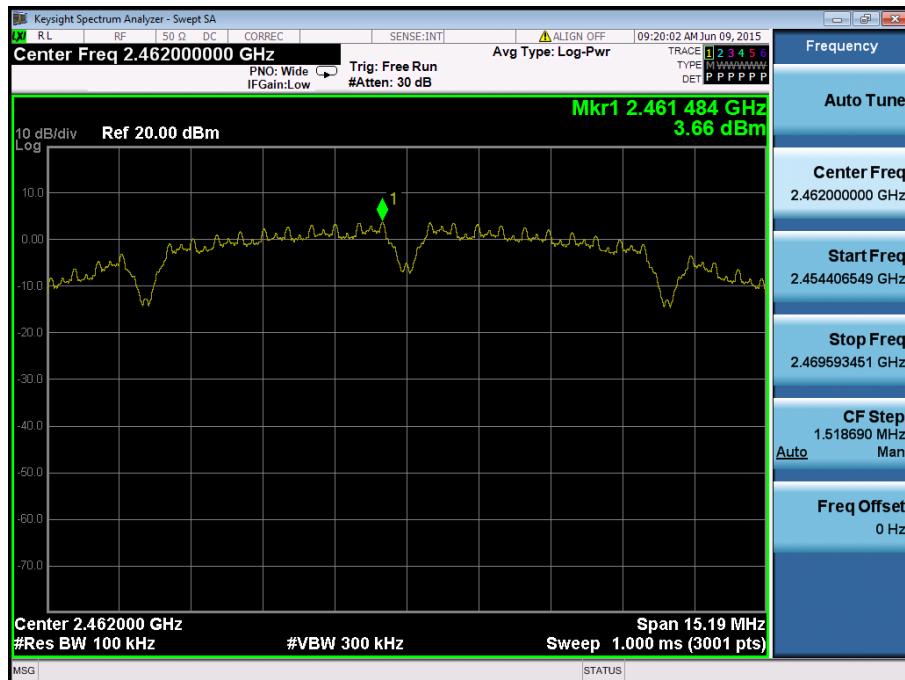


Conducted Spurious Emissions

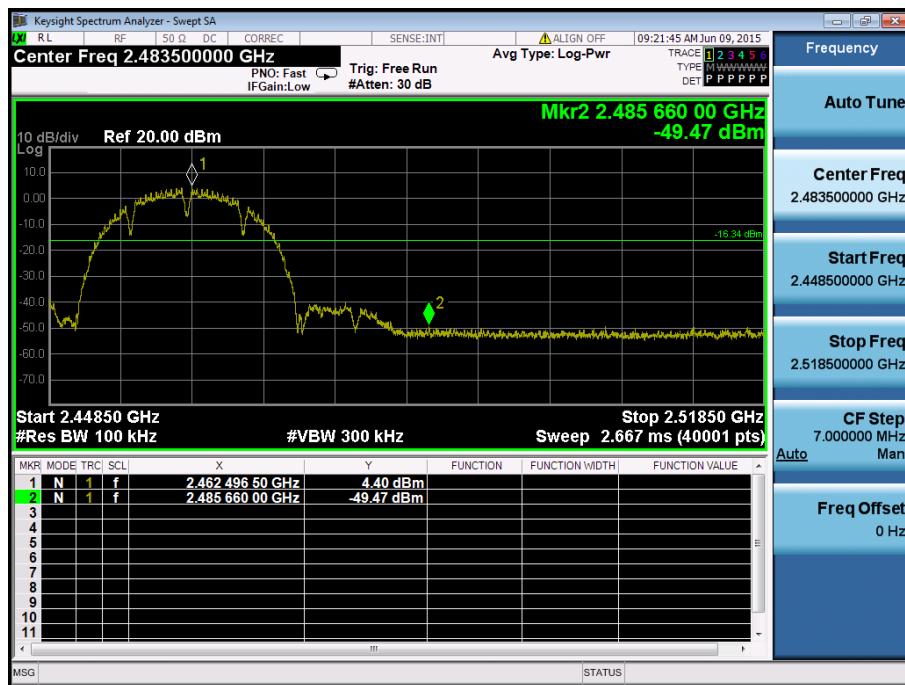


802.11b & 1 Mbps & 2462 MHz

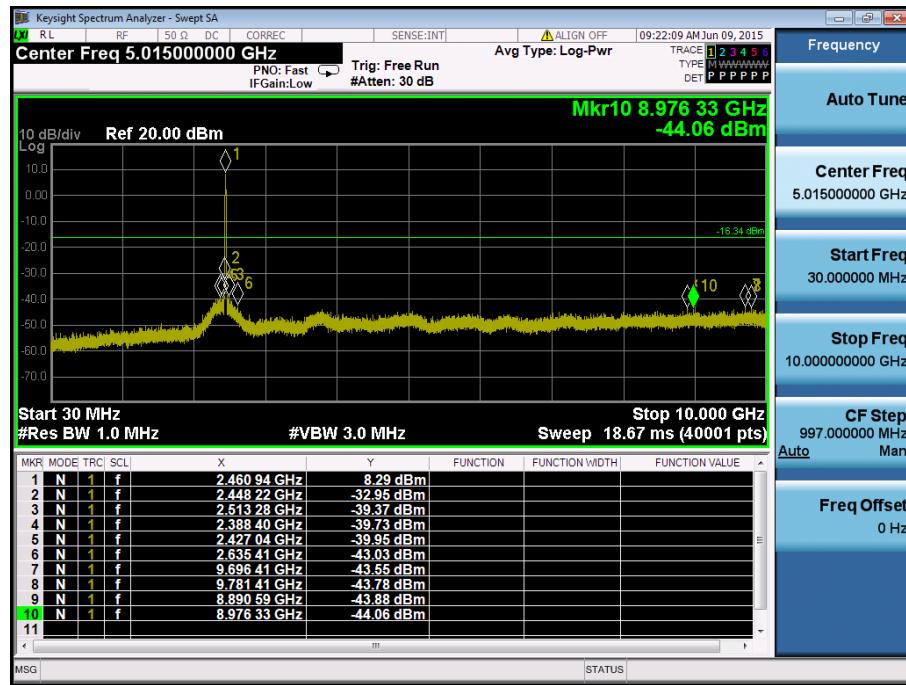
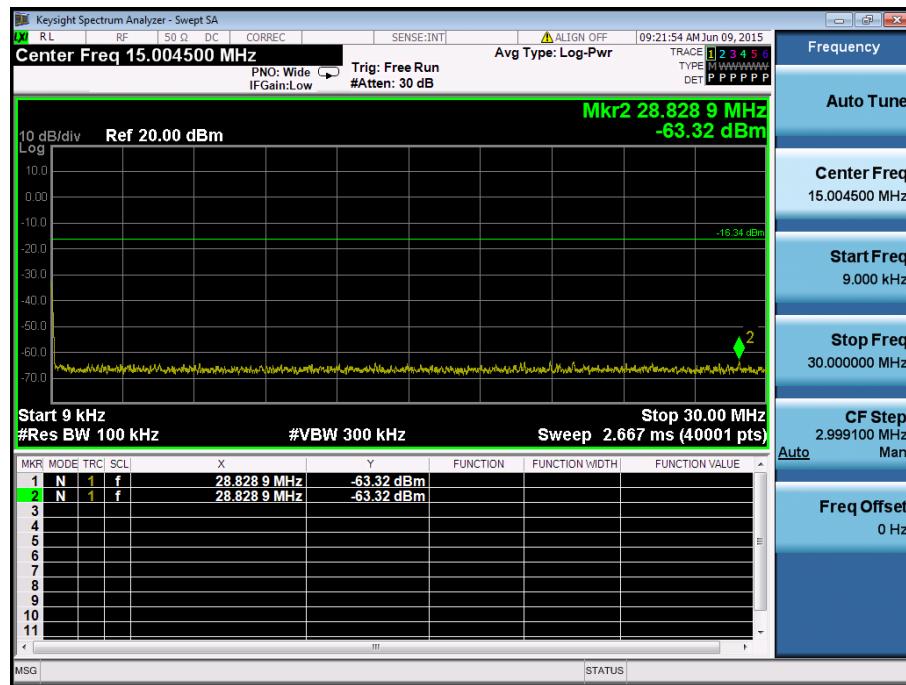
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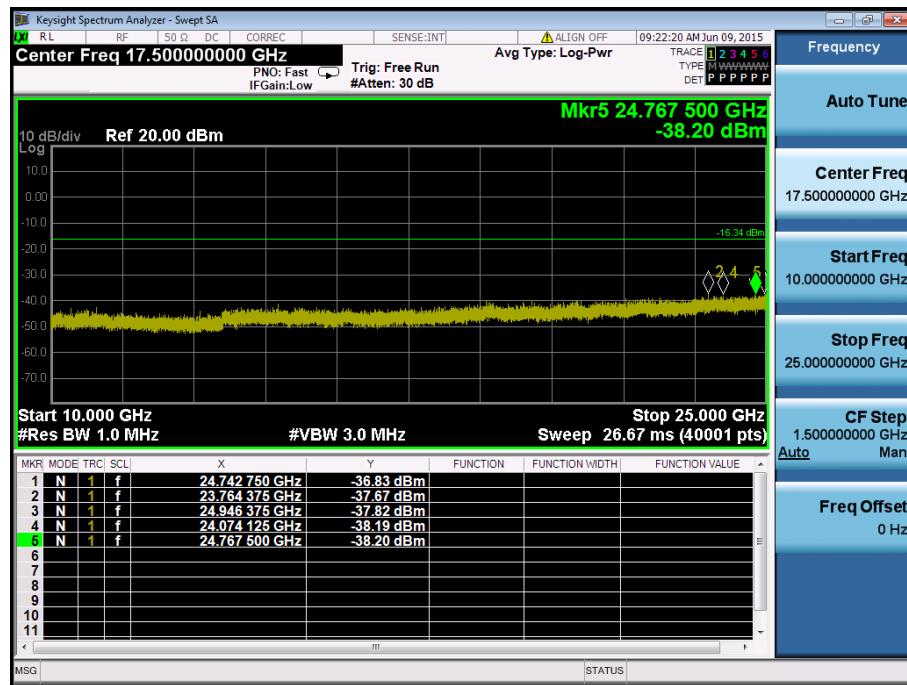
High Band-edge



Conducted Spurious Emissions

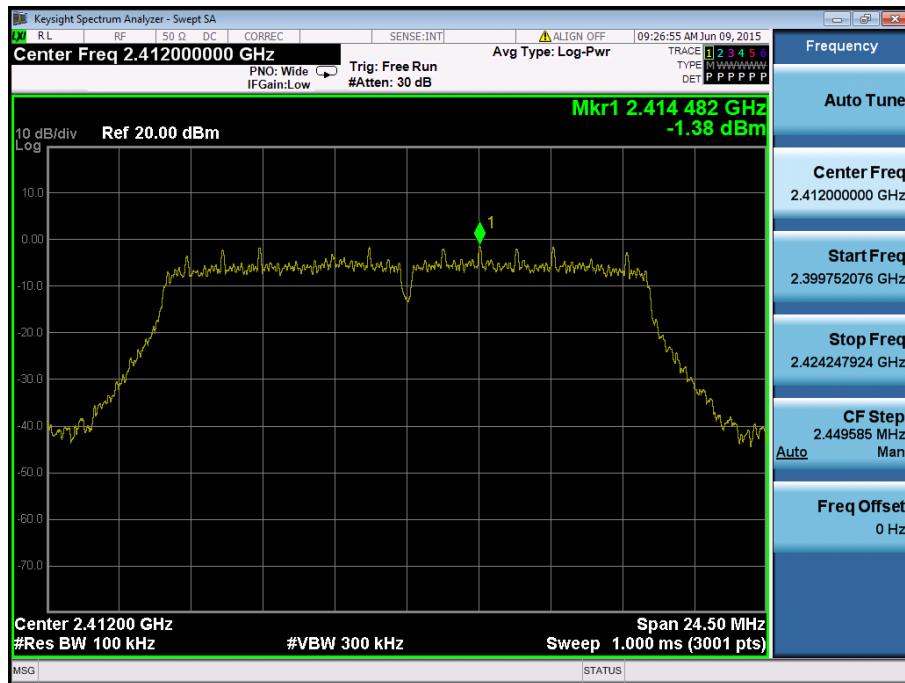


Conducted Spurious Emissions

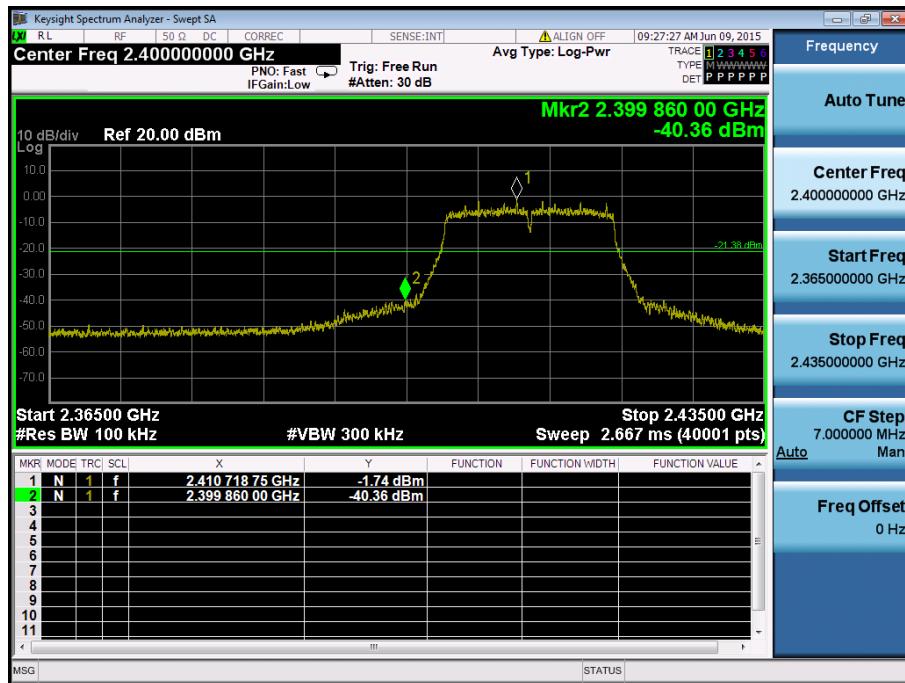


802.11g & 6 Mbps & 2412 MHz

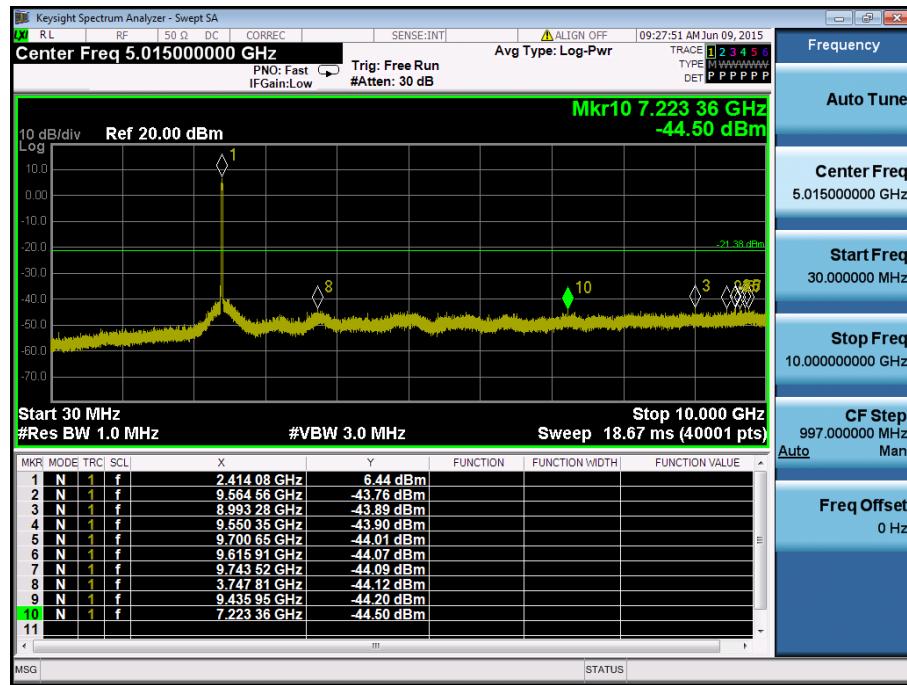
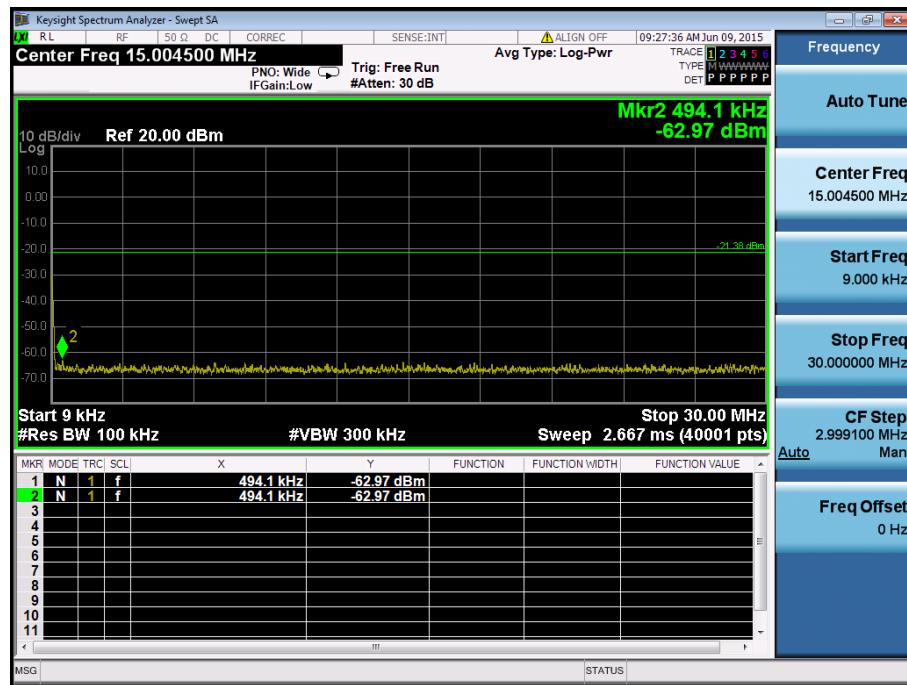
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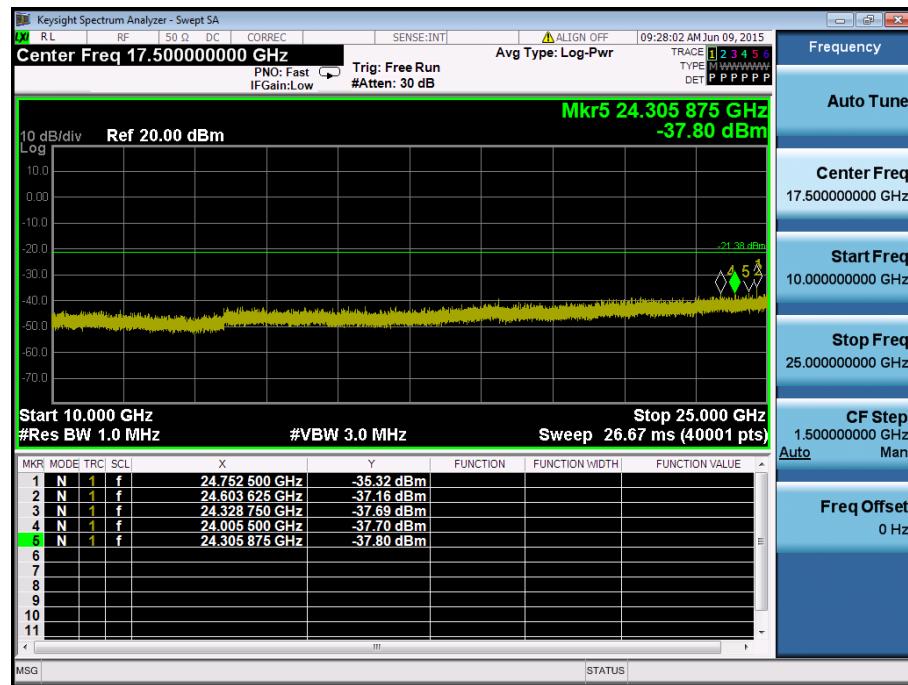
Low Band-edge



Conducted Spurious Emissions



Conducted Spurious Emissions

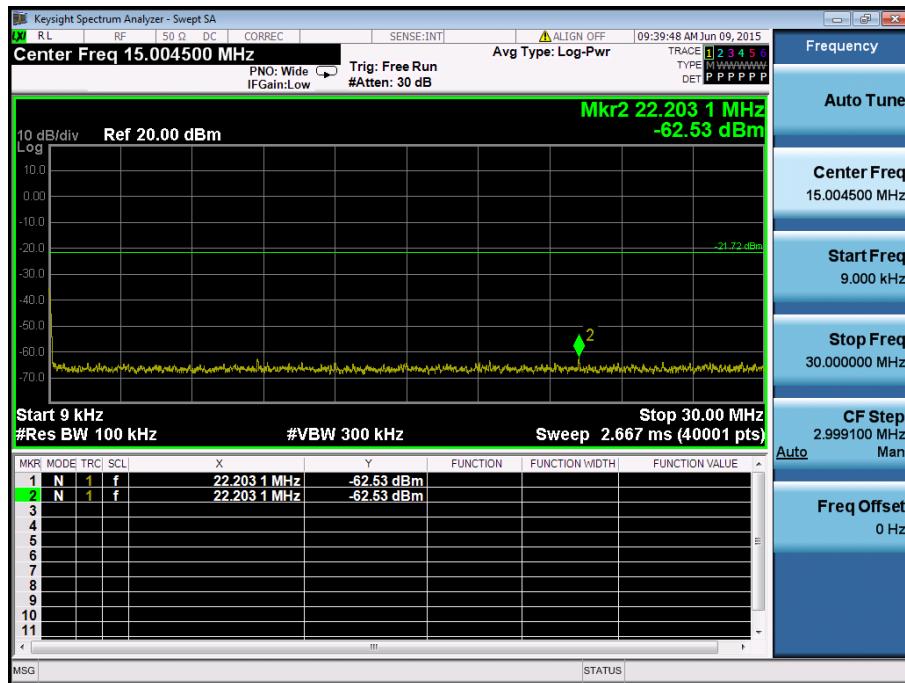


802.11g & 6 Mbps & 2437 MHz

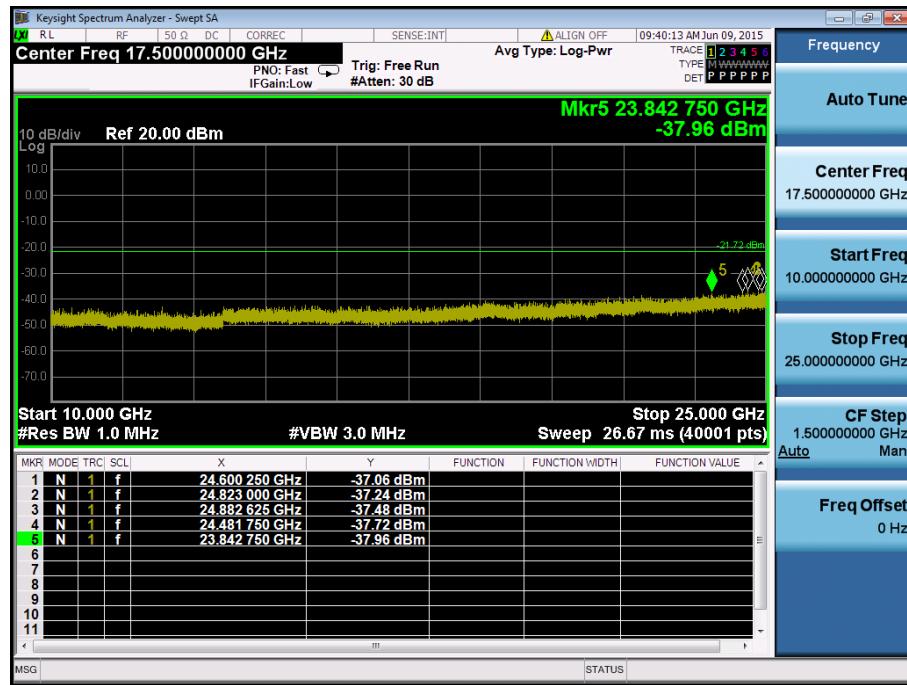
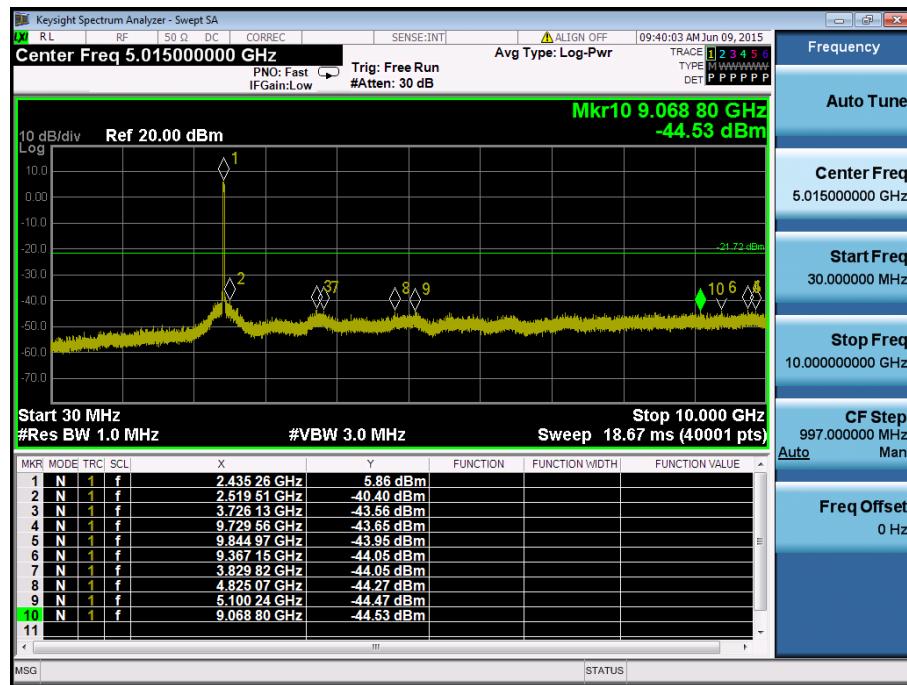
Reference



Conducted Spurious Emissions



Conducted Spurious Emissions

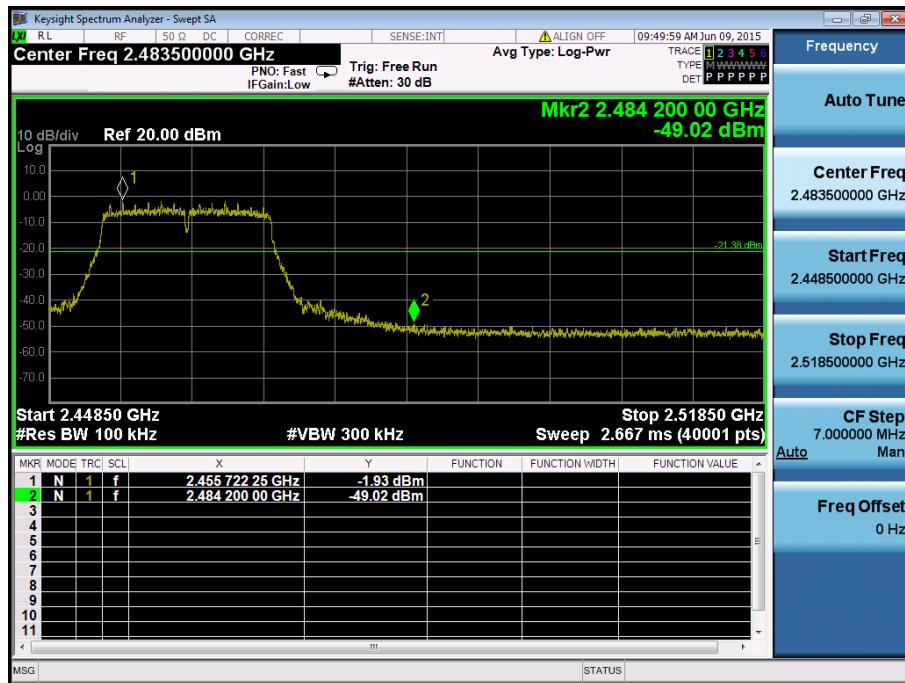


802.11g & 6 Mbps & 2462 MHz

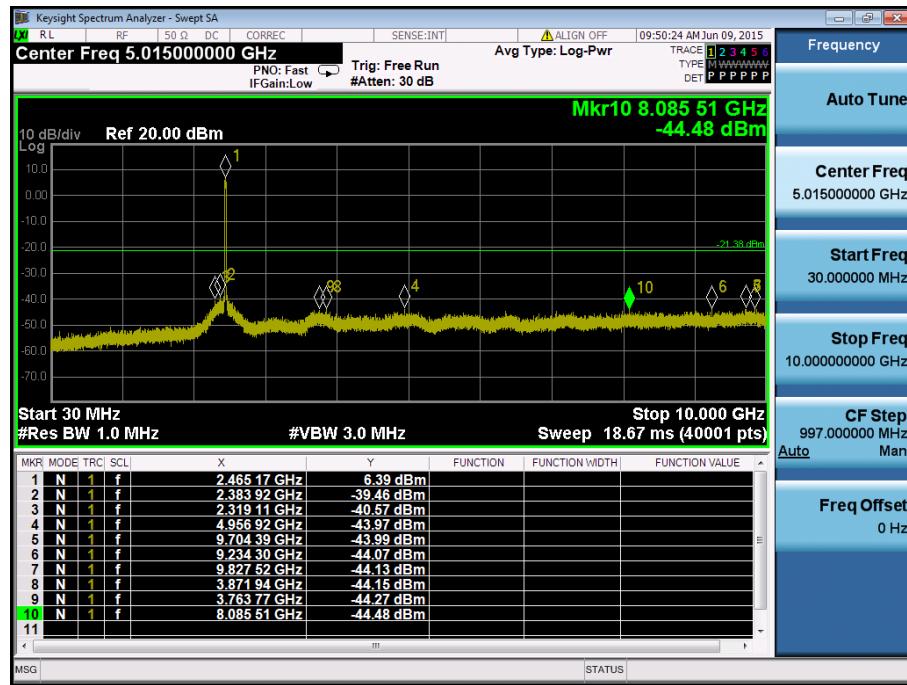
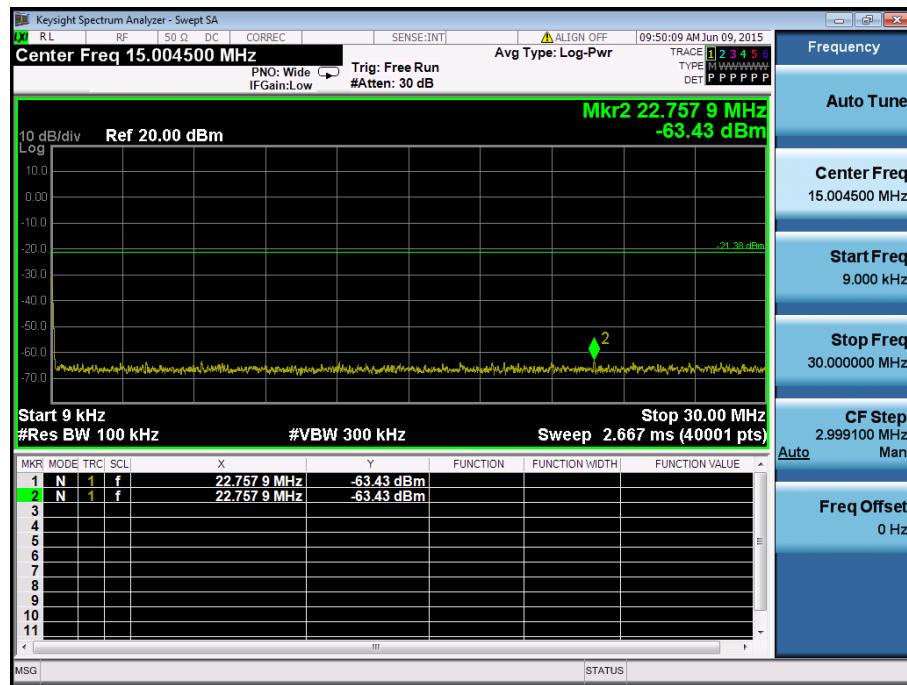
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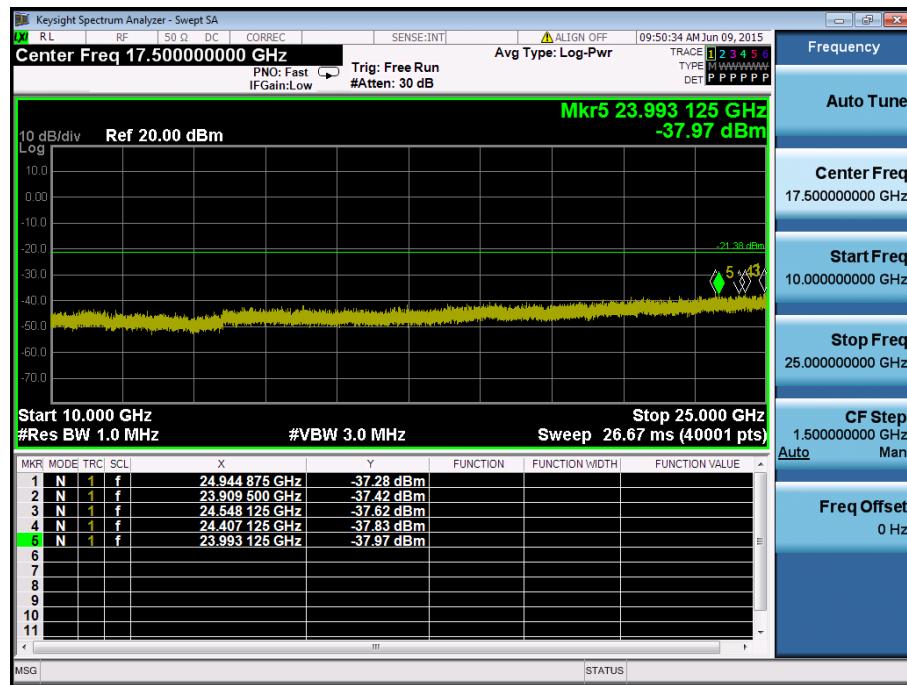
High Band-edge



Conducted Spurious Emissions

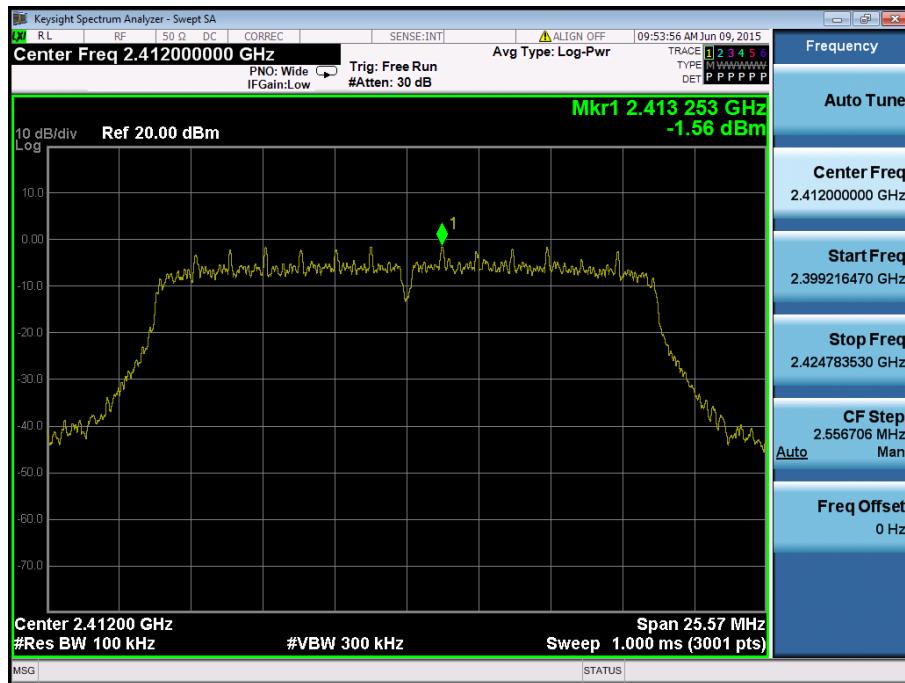


Conducted Spurious Emissions

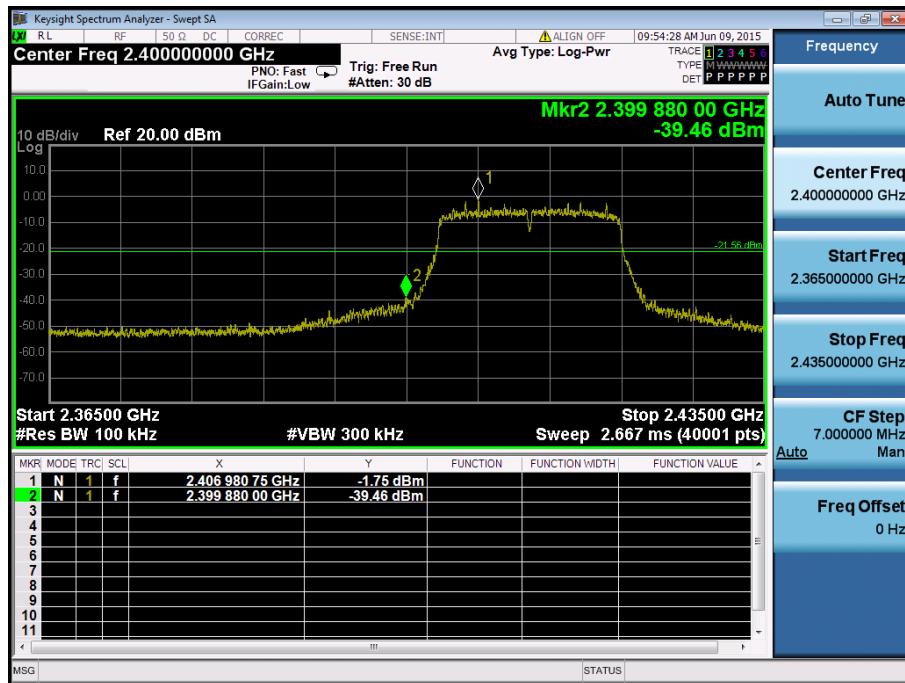


802.11n(HT20) & MCS 0 & 2412 MHz

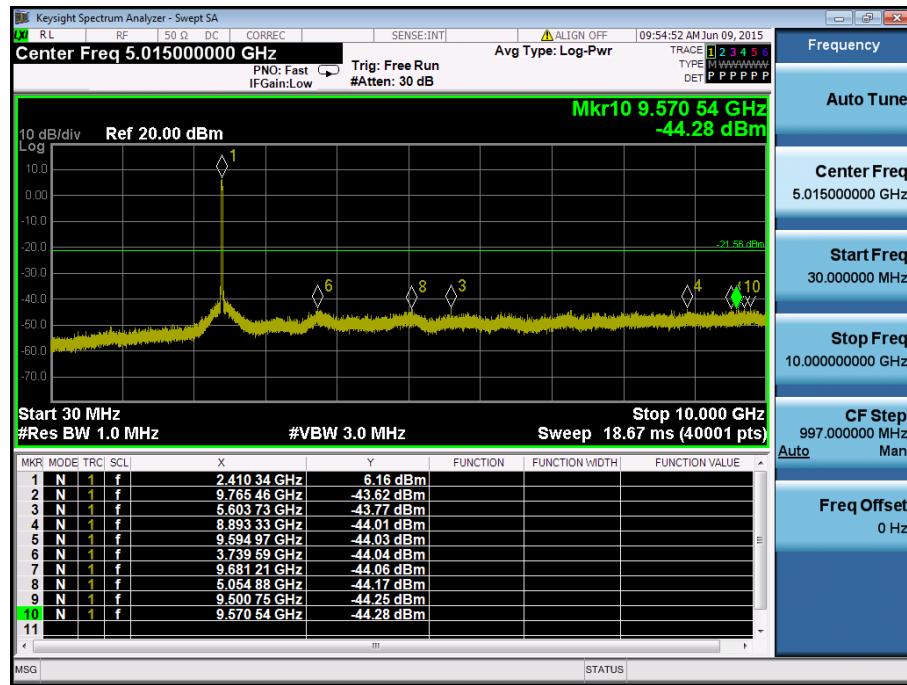
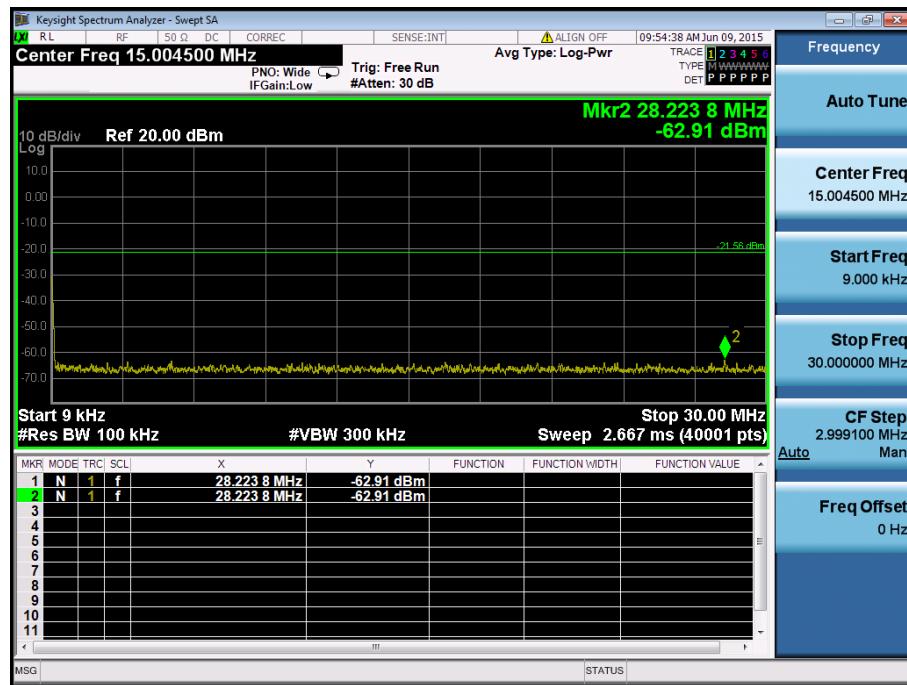
Reference



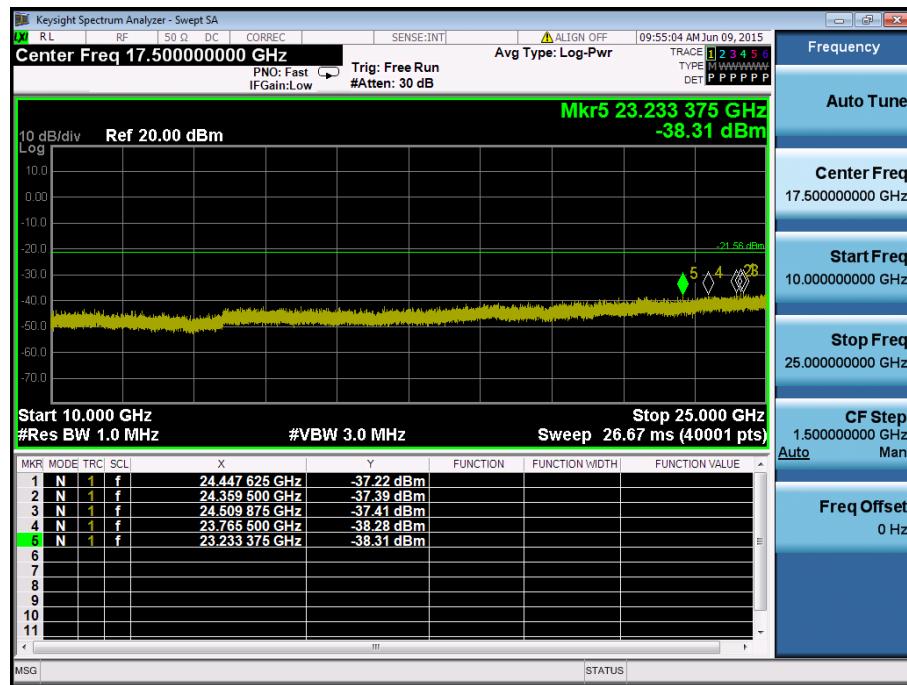
Low Band-edge



Conducted Spurious Emissions

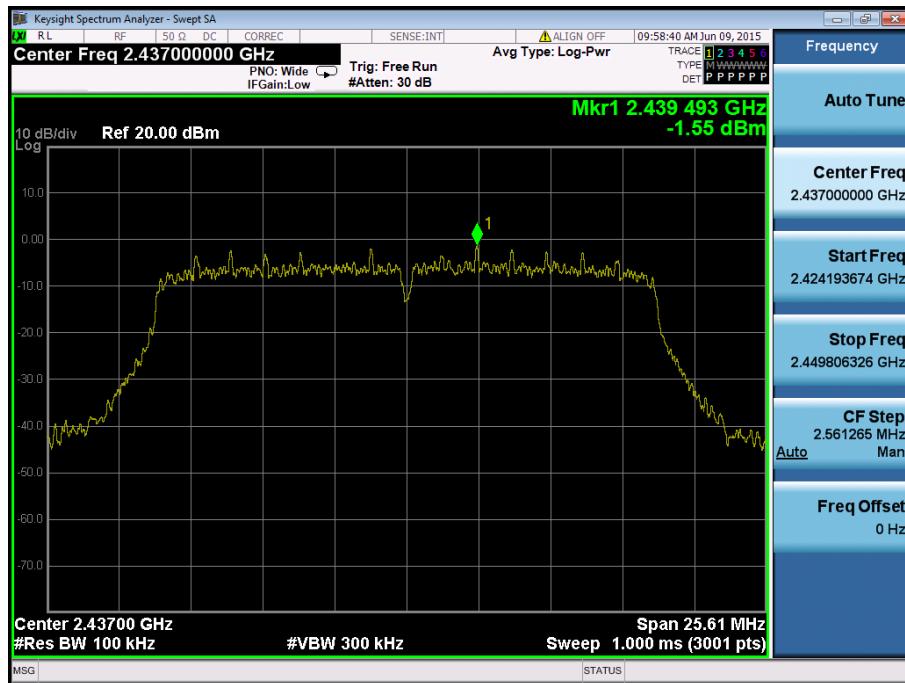


Conducted Spurious Emissions

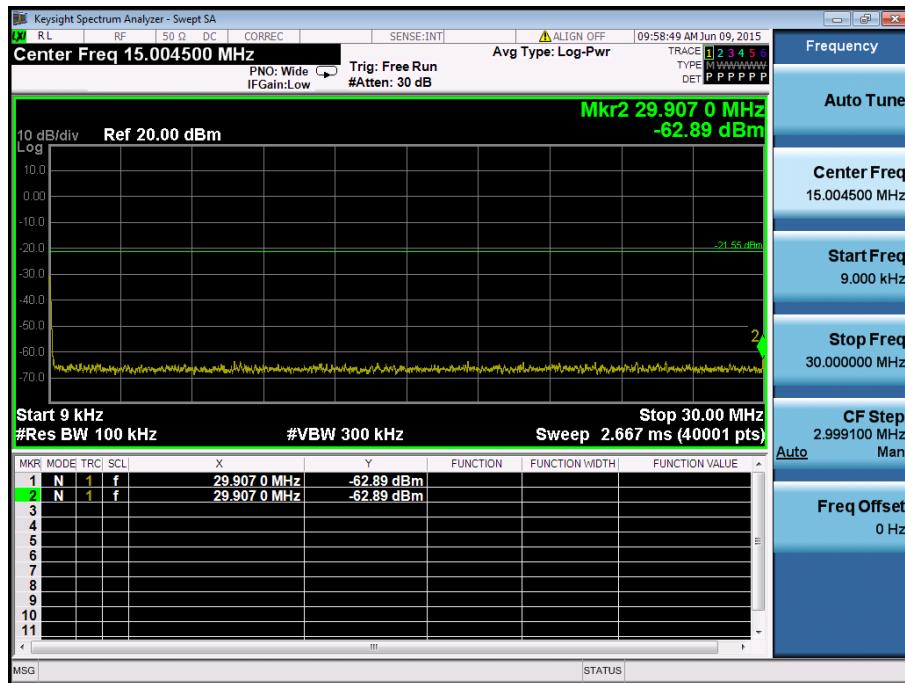


802.11n(HT20) & MCS 0 & 2437 MHz

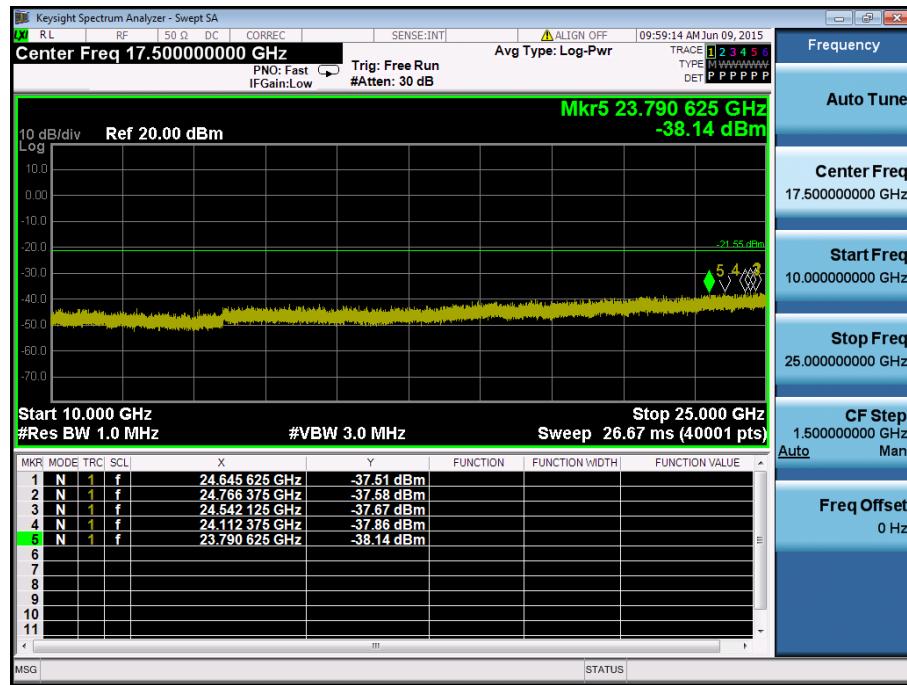
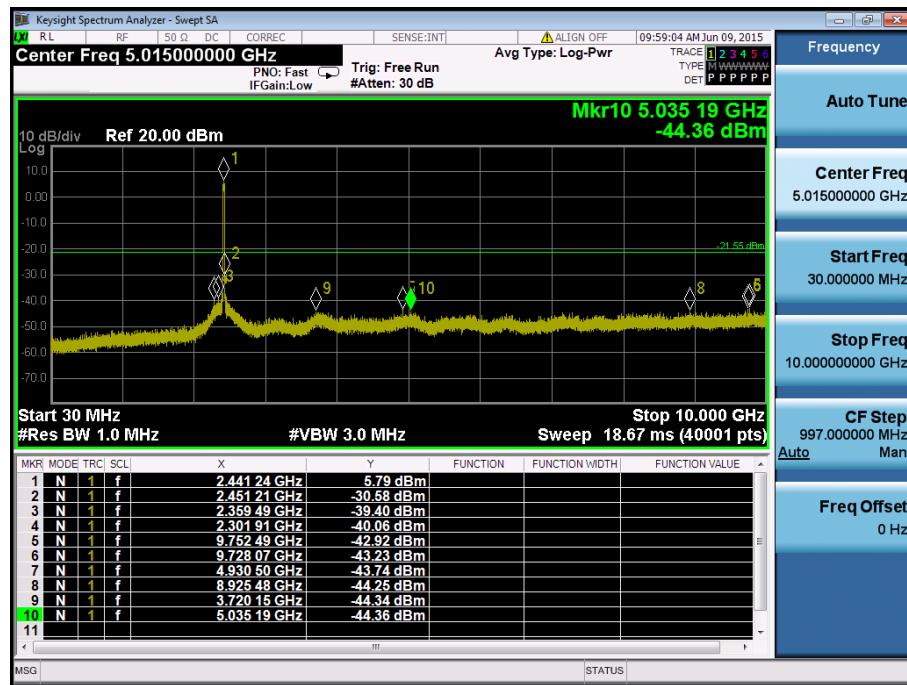
Reference



Conducted Spurious Emissions

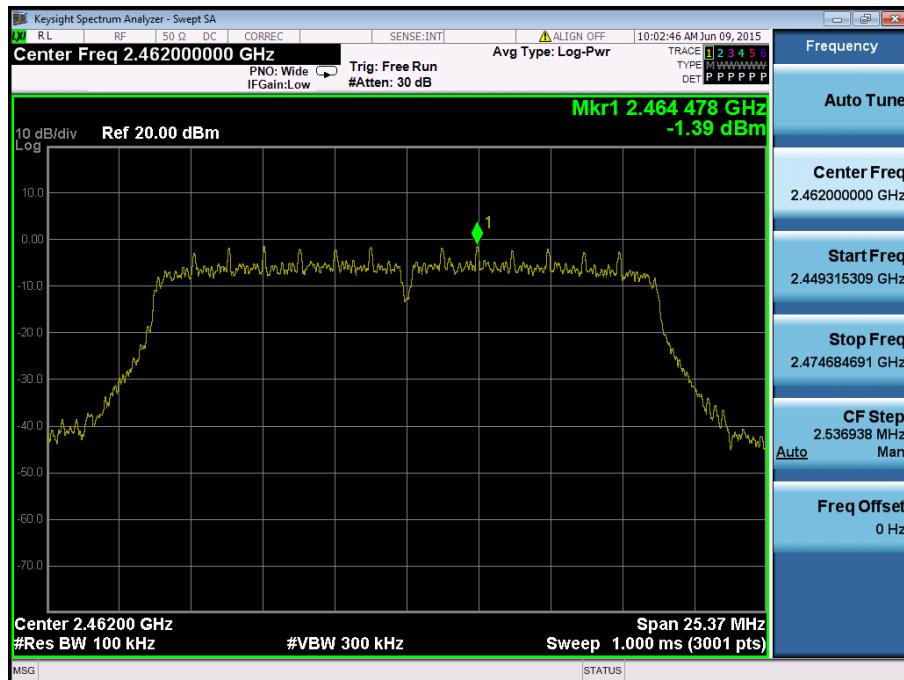


Conducted Spurious Emissions

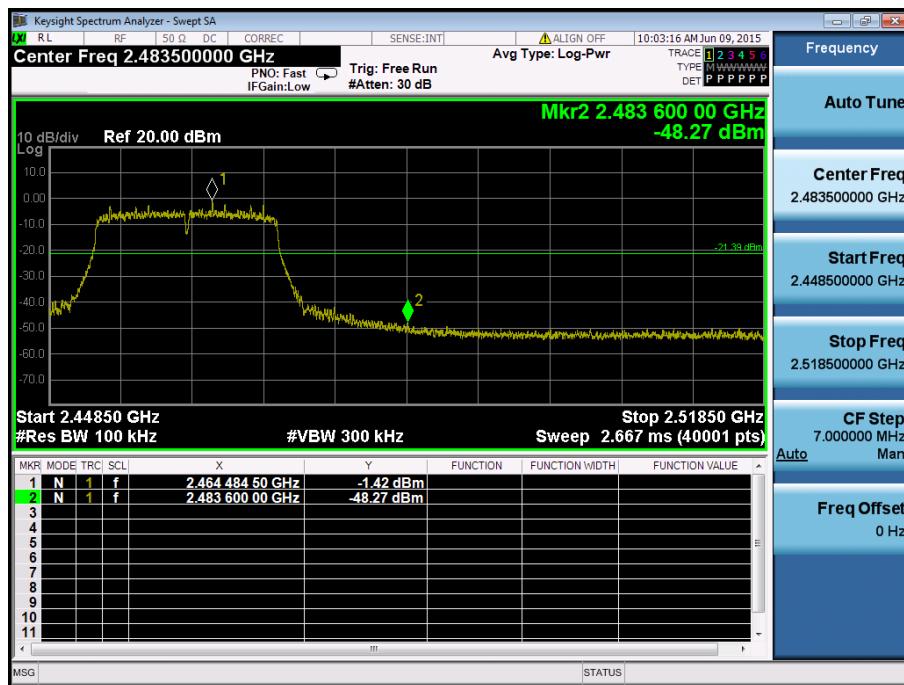


802.11n(HT20) & MCS 0 & 2462 MHz

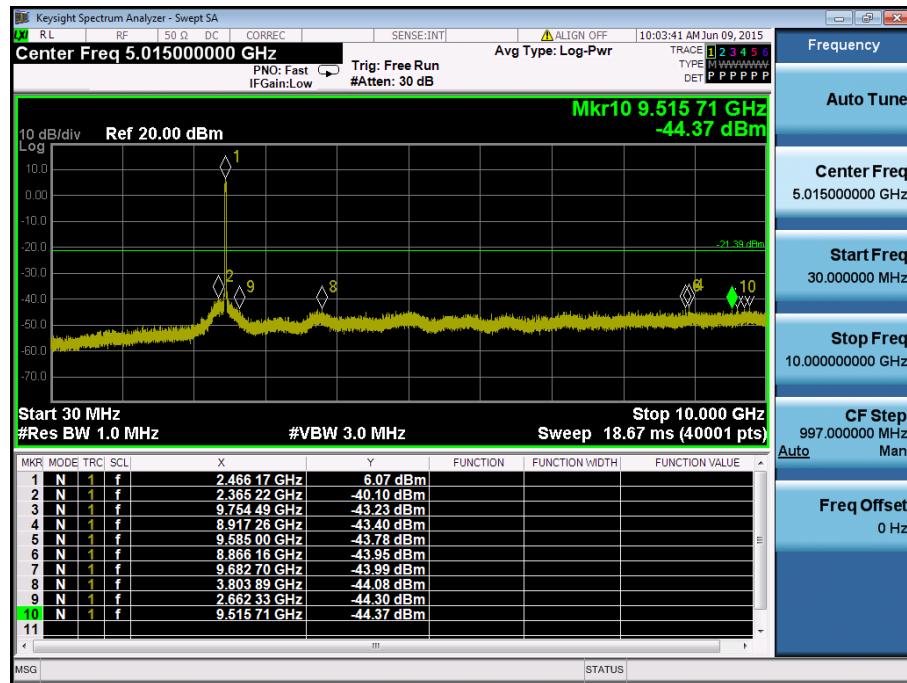
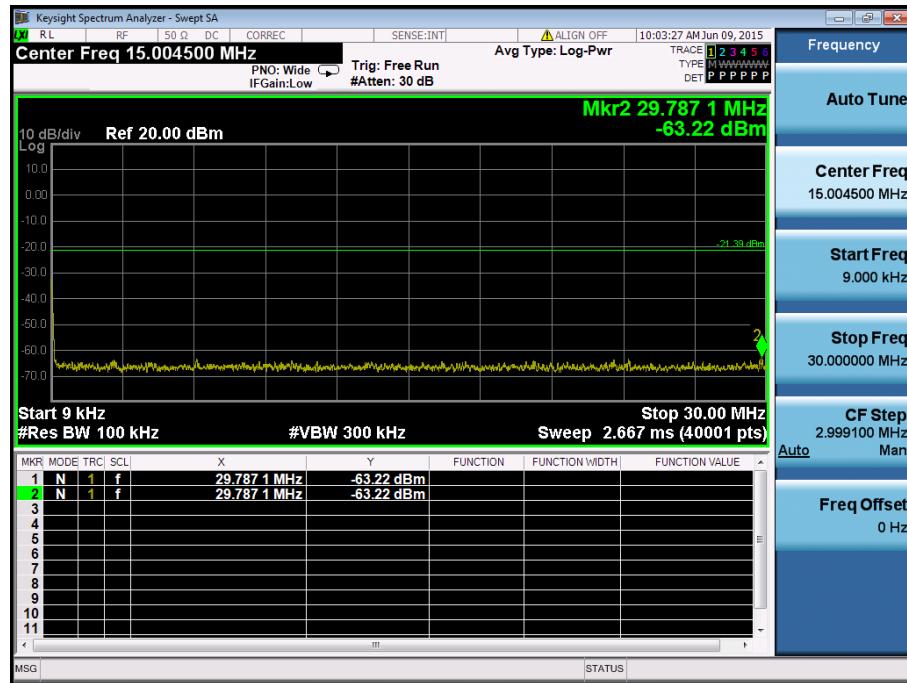
Reference



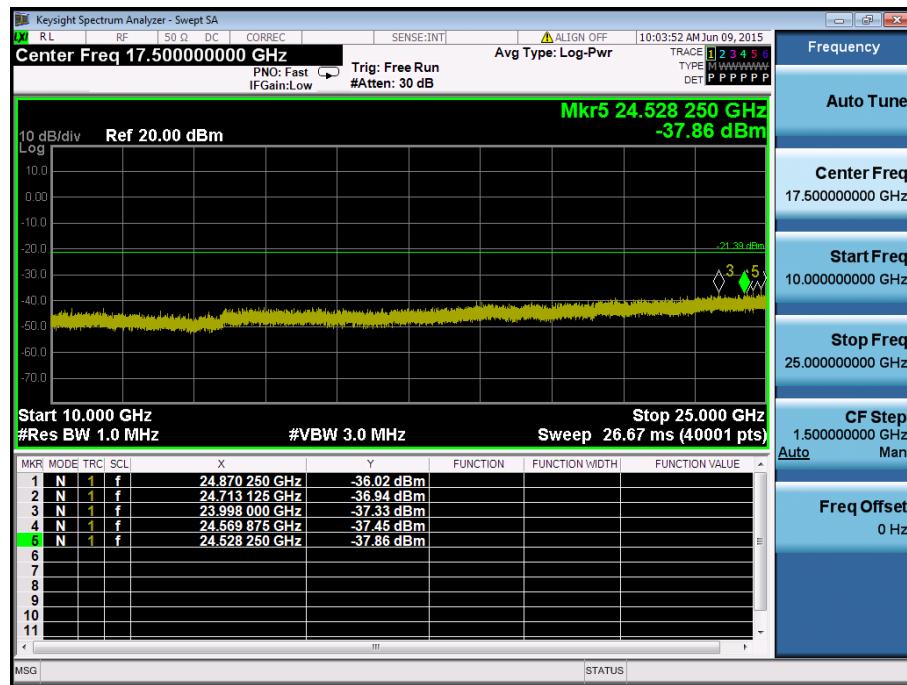
High Band-edge



Conducted Spurious Emissions



Conducted Spurious Emissions



8.5 Radiated Spurious Emissions

Test Requirements and limit,

§15.247(d), §15.205, §15.209

In any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table below has to be followed

• FCC Part 15.209(a) and (b)

| Frequency (MHz) | Limit (uV/m) | Measurement Distance (meter) |
|-----------------|---------------|------------------------------|
| 0.009 – 0.490 | 2400/F (KHz) | 300 |
| 0.490 – 1.705 | 24000/F (KHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 ~ 88 | 100 ** | 3 |
| 88 ~ 216 | 150 ** | 3 |
| 216 ~ 960 | 200 ** | 3 |
| Above 960 | 500 | 3 |

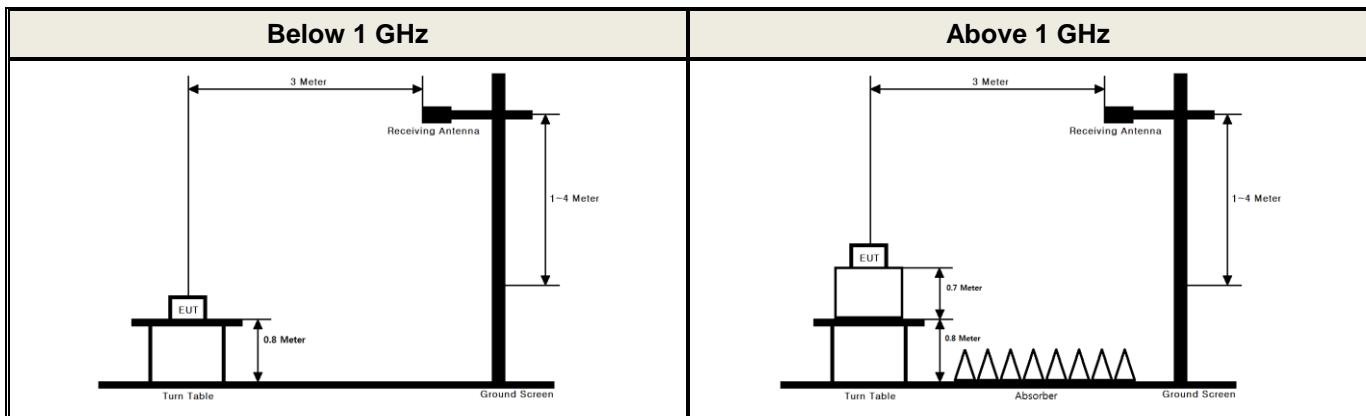
** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

• FCC Part 15.205 (a): Only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | MHz | GHz | GHz |
|-------------------|-------------------|-------------------|-----------------|--------------|---------------|
| 0.009 ~ 0.110 | 8.41425 ~ 8.41475 | 108 ~ 121.94 | 1300 ~ 1427 | 4.5 ~ 5.15 | 14.47 ~ 14.5 |
| 0.495 ~ 0.505 | 12.29 ~ 12.293 | 123 ~ 138 | 1435 ~ 1626.5 | 5.35 ~ 5.46 | 15.35 ~ 16.2 |
| 2.1735 ~ 2.1905 | 12.51975 ~ | 149.9 ~ 150.05 | 1645.5 ~ 1646.5 | 7.25 ~ 7.75 | 17.7 ~ 21.4 |
| 4.125 ~ 4.128 | 12.52025 | 156.52475 ~ | 1660 ~ 1710 | 8.025 ~ 8.5 | 22.01 ~ 23.12 |
| 4.17725 ~ 4.17775 | 12.57675 ~ | 156.52525 | 1718.8 ~ 1722.2 | 9.0 ~ 9.2 | 23.6 ~ 24.0 |
| 4.20725 ~ 4.20775 | 12.57725 | 156.7 ~ 156.9 | 2200 ~ 2300 | 9.3 ~ 9.5 | 31.2 ~ 31.8 |
| 6.215 ~ 6.218 | 13.36 ~ 13.41 | 162.0125 ~ 167.17 | 2310 ~ 2390 | 10.6 ~ 12.7 | 36.43 ~ 36.5 |
| 6.26775 ~ 6.26825 | 16.42 ~ 16.423 | 167.72 ~ 173.2 | 2483.5 ~ 2500 | 13.25 ~ 13.4 | Above 38.6 |
| 6.31175 ~ 6.31225 | 16.69475 ~ | 240 ~ 285 | 2655 ~ 2900 | | |
| 8.291 ~ 8.294 | 16.69525 | 322 ~ 335.4 | 3260 ~ 3267 | | |
| 8.362 ~ 8.366 | 16.80425 ~ | 399.90 ~ 410 | 3332 ~ 3339 | | |
| 8.37625 ~ 8.38675 | 16.80475 | 608 ~ 614 | 3345.8 ~ 3358 | | |
| | 25.5 ~ 25.67 | 960 ~ 1240 | 3600 ~ 4400 | | |
| | 37.5 ~ 38.25 | | | | |
| | 73 ~ 74.6 | | | | |
| | 74.8 ~ 75.2 | | | | |

• FCC Part 15.205(b): The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

Test Configuration



TEST PROCEDURE

1. The EUT is placed on a non-conductive table, emission measurements at below 1 GHz, the table height is 80 cm and above 1 GHz, the table height is 1.5 m.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

Measurement Instrument Setting for Radiated Emission Measurements.

The radiated emission was tested according to the section 6.3, 6.4, 6.5 and 6.6 of the ANSI C63.10-2013 with following settings.

Peak Measurement:

RBW = As specified in below table , VBW \geq 3 x RBW, Sweep = Auto, Detector = Peak, Trace mode = Max Hold until the trace stabilizes.

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

Average Measurement:

1. RBW = 1 MHz (unless otherwise specified).
2. VBW \geq 3 x RBW.
3. Detector = RMS (Number of points \geq 2 x Span / RBW)
4. Averaging type = power. (i.e., RMS)
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.
7. A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

- 1) If power averaging (RMS) mode was used in step 4, then the applicable correction factor is $10 \log(1/x)$, where x is the duty cycle.
- 2) If linear voltage averaging mode was used in step 4, then the applicable correction factor is $20 \log(1/x)$, where x is the duty cycle.
- 3) If a specific emission is demonstrated to be continuous (\geq 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Duty Cycle Corrections (Refer to appendix II for duty cycle measurement procedure and plots)

| Band | Duty Cycle (%) | T _{on} (ms) | T _{on} + T _{off} (ms) | DCF = 10log(1/Duty) (dB) |
|---------------|----------------|----------------------|---|--------------------------|
| 802.11b | 100.00 | - | - | 0.00 |
| 802.11g | 98.74 | 3.130 | 3.170 | 0.06 |
| 802.11n(HT20) | 98.64 | 2.910 | 2.950 | 0.06 |
| - | - | - | - | - |

9 kHz ~ 25 GHz Data(802.11b & 1 Mbps)

▪ Lowest Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 2387.04 | V | Z | PK | 61.50 | 2.88 | N/A | N/A | 64.38 | 74.00 | 9.62 |
| 2386.78 | V | Z | AV | 47.32 | 2.88 | N/A | N/A | 50.20 | 54.00 | 3.80 |
| 4823.98 | H | Z | PK | 45.27 | 10.36 | N/A | N/A | 55.63 | 74.00 | 18.37 |
| 4824.10 | H | Z | AV | 36.50 | 10.36 | N/A | N/A | 46.86 | 54.00 | 7.14 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

▪ Middle Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 4874.18 | H | Z | PK | 46.22 | 10.96 | N/A | N/A | 57.18 | 74.00 | 16.82 |
| 4873.96 | H | Z | AV | 37.48 | 10.96 | N/A | N/A | 48.44 | 54.00 | 5.56 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

▪ Highest Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 2486.90 | V | Z | PK | 64.44 | 3.36 | N/A | N/A | 67.80 | 74.00 | 6.20 |
| 2484.04 | V | Z | AV | 46.47 | 3.36 | N/A | N/A | 49.83 | 54.00 | 4.17 |
| 4924.12 | H | Z | PK | 47.03 | 10.68 | N/A | N/A | 57.71 | 74.00 | 16.29 |
| 4924.00 | H | Z | AV | 39.95 | 10.68 | N/A | N/A | 50.63 | 54.00 | 3.37 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

Note.

1. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
So Distance Correction Factor : - $9.54 \text{ dB} = 20 \times \log(1 \text{ m} / 3 \text{ m})$
2. No other spurious and harmonic emissions were found greater than listed emissions on above table.
3. The band edge test has performed between 2310-2390 MHz for low channel and 2483.5-2500 MHz for high channel.
The worst results were reported in the table.
4. Sample Calculation.

Margin = Limit - Result / Result = Reading + T.F + DCF + Distance Factor / T.F = AF + CL - AG
Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
DCF = Duty Cycle Correction Factor.

9 kHz ~ 25 GHz Data(802.11g & 6 Mbps)

▪ Lowest Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 2388.62 | V | Z | PK | 59.29 | 2.88 | N/A | N/A | 62.17 | 74.00 | 11.83 |
| 2389.66 | V | Z | AV | 46.43 | 2.88 | N/A | N/A | 49.31 | 54.00 | 4.69 |
| 4825.13 | H | Z | PK | 44.47 | 10.36 | N/A | N/A | 54.83 | 74.00 | 19.17 |
| 4825.07 | H | Z | AV | 34.24 | 10.36 | N/A | N/A | 44.60 | 54.00 | 9.40 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

▪ Middle Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 4875.17 | H | Z | PK | 45.28 | 10.96 | N/A | N/A | 56.24 | 74.00 | 17.76 |
| 4874.66 | H | Z | AV | 34.37 | 10.96 | N/A | N/A | 45.33 | 54.00 | 8.67 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

▪ Highest Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 2483.88 | V | Z | PK | 59.56 | 3.36 | N/A | N/A | 62.92 | 74.00 | 11.08 |
| 2483.65 | V | Z | AV | 46.26 | 3.36 | N/A | N/A | 49.62 | 54.00 | 4.38 |
| 4924.71 | H | Z | PK | 45.08 | 10.68 | N/A | N/A | 55.76 | 74.00 | 18.24 |
| 4924.55 | H | Z | AV | 34.41 | 10.68 | N/A | N/A | 45.09 | 54.00 | 8.91 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

Note.

1. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
So Distance Correction Factor : - 9.54 dB = $20 \times \log(1 \text{ m} / 3 \text{ m})$
2. No other spurious and harmonic emissions were found greater than listed emissions on above table.
3. The band edge test has performed between 2310-2390 MHz for low channel and 2483.5-2500 MHz for high channel.
The worst results were reported in the table.
4. Sample Calculation.

Margin = Limit – Result / Result = Reading + T.F + DCF + Distance Factor / T.F = AF + CL – AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

DCF = Duty Cycle Correction Factor.

9 kHz ~ 25 GHz Data(802.11n HT20 & MCS 0)

▪ Lowest Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 2389.96 | V | Z | PK | 59.46 | 2.88 | N/A | N/A | 62.34 | 74.00 | 11.66 |
| 2389.96 | V | Z | AV | 46.72 | 2.88 | N/A | N/A | 49.60 | 54.00 | 4.40 |
| 4823.69 | H | Z | PK | 45.27 | 10.36 | N/A | N/A | 55.63 | 74.00 | 18.37 |
| 4823.51 | H | Z | AV | 34.38 | 10.36 | N/A | N/A | 44.74 | 54.00 | 9.26 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

▪ Middle Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 4874.86 | H | Z | PK | 45.36 | 10.96 | N/A | N/A | 56.32 | 74.00 | 17.68 |
| 4874.27 | H | Z | AV | 34.41 | 10.96 | N/A | N/A | 45.37 | 54.00 | 8.63 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

▪ Highest Channel

| Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCF (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|---------------------|---------------|----------------|------------|----------|---------------------|-----------------|----------------|-------------|
| 2483.60 | V | Z | PK | 59.96 | 3.36 | N/A | N/A | 63.32 | 74.00 | 10.68 |
| 2483.67 | V | Z | AV | 46.44 | 3.36 | N/A | N/A | 49.80 | 54.00 | 4.20 |
| 4924.84 | H | Z | PK | 45.16 | 10.68 | N/A | N/A | 55.84 | 74.00 | 18.16 |
| 4923.10 | H | Z | AV | 34.52 | 10.68 | N/A | N/A | 45.20 | 54.00 | 8.80 |
| - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - |

Note.

1. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
So Distance Correction Factor : - $9.54 \text{ dB} = 20 \times \log(1 \text{ m} / 3 \text{ m})$
2. No other spurious and harmonic emissions were found greater than listed emissions on above table.
3. The band edge test has performed between 2310-2390 MHz for low channel and 2483.5-2500 MHz for high channel.
The worst results were reported in the table.
4. Sample Calculation.

Margin = Limit – Result / Result = Reading + T.F + DCF + Distance Factor / T.F = AF + CL – AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

DCF = Duty Cycle Correction Factor.

8.6 Power-line conducted emissions

Test Requirements and limit, §15.207

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

| Frequency Range (MHz) | Conducted Limit (dBuV) | |
|--------------------------|------------------------|------------|
| | Quasi-Peak | Average |
| 0.15 ~ 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 ~ 5 | 56 | 46 |
| 5 ~ 30 | 60 | 50 |

* Decreases with the logarithm of the frequency

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

□ TEST PROCEDURE

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to the test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

□ Test Results: **NA**

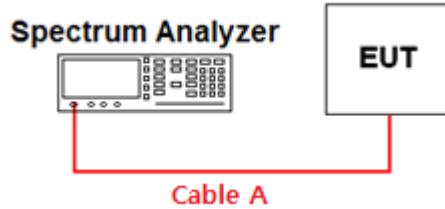
9. LIST OF TEST EQUIPMENT

| Type | Manufacturer | Model | Cal.Date (yy/mm/dd) | Next.Cal.Date (yy/mm/dd) | S/N |
|-------------------------------|----------------------|------------------------------|------------------------|-----------------------------|--------------------|
| Spectrum Analyzer | Agilent Technologies | N9030A | 14/10/21 | 15/10/21 | MY53310140 |
| Dynamic Measurement DC Source | Agilent Technologies | 66332A | 14/09/11 | 15/09/11 | MY43000211 |
| Power Meter | Anritsu | ML2495A MA2490A | 15/03/26 | 16/03/26 | 1306007 1249001 |
| Thermohygrometer | BODYCOM | BJ5478 | 15/02/26 | 16/02/26 | 1209 |
| Multimeter | Agilent Technologies | 34401A | 15/01/06 | 16/01/06 | MY41037027 |
| Signal Generator | Rohde Schwarz | SMF100A | 14/07/01 | 15/07/01 | 102341 |
| Vector Signal Generator | Rohde Schwarz | SMBV100A | 15/01/06 | 16/01/06 | 255571 |
| Power Splitter | Anritsu | K241B | 15/02/25 | 16/02/25 | 1301181 |
| 50W 10dB ATT | SMAJK | SMAJK-50-10 | 14/10/21 | 15/10/21 | 2-50-10 |
| High-pass filter | Wainwright | WCHKX12-2580-3000-18000-80SS | 14/09/11 | 15/09/11 | 3 |
| Low Noise Pre Amplifier | TSJ | MLA-010K01-B01-27 | 15/04/09 | 16/04/09 | 1844538 |
| Amplifier | Agilent | 8449B | 14/11/06 | 15/11/06 | 3008A02478 |
| Loop Antenna | Schwarzbeck | FMZB1513 | 14/04/29 | 16/04/29 | 1513-128 |
| TRILOG Broadband Test-Antenna | SCHWARZBECK | VULB 9160 | 14/04/04 | 16/04/04 | 3357 |
| HORN ANT | ETS | 3115 | 15/02/09 | 17/02/09 | 24797 |
| HORN ANT | A.H.Systems | SAS-574 | 15/04/30 | 17/04/30 | 154 |
| EMI TEST RECEIVER | R&S | ESR7 | 14/10/21 | 15/10/21 | 101109 |
| EMI TEST RECEIVER | R&S | ESCI | 15/02/25 | 16/02/25 | 100364 |
| FREQUENCY CONVERTER | Taejin Electronic | CVCF | 14/09/11 | 15/09/11 | ZU0033 |
| ARTIFICIAL MAINS NETWORK | Narda S.T.S. / PMM | PMM L2-16B | 14/06/26 | 15/06/26 | 000WX20305 |

APPENDIX I

Conducted Test set up Diagram & Path loss Information

Conducted Measurement



Path loss information

| Frequency (GHz) | Path Loss (dB) | Frequency (GHz) | Path Loss (dB) |
|--------------------|----------------|-----------------|----------------|
| 0.03 | 0.48 | 15 | 5.48 |
| 1 | 1.52 | 20 | 6.18 |
| 2412 & 2441 & 2462 | 1.99 | 25 | 6.89 |
| 5 | 3.02 | - | - |
| 10 | 3.89 | - | - |

Note. 1: The path loss from EUT to Spectrum analyzer was measured and used for test.

Path loss (S/A's offset value) = Cable A (Attenuator, Applied only when it was used externally)

APPENDIX II

Duty cycle plots

TEST PROCEDURE

Duty Cycle measured using section 6.0 b) of KDB558074

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

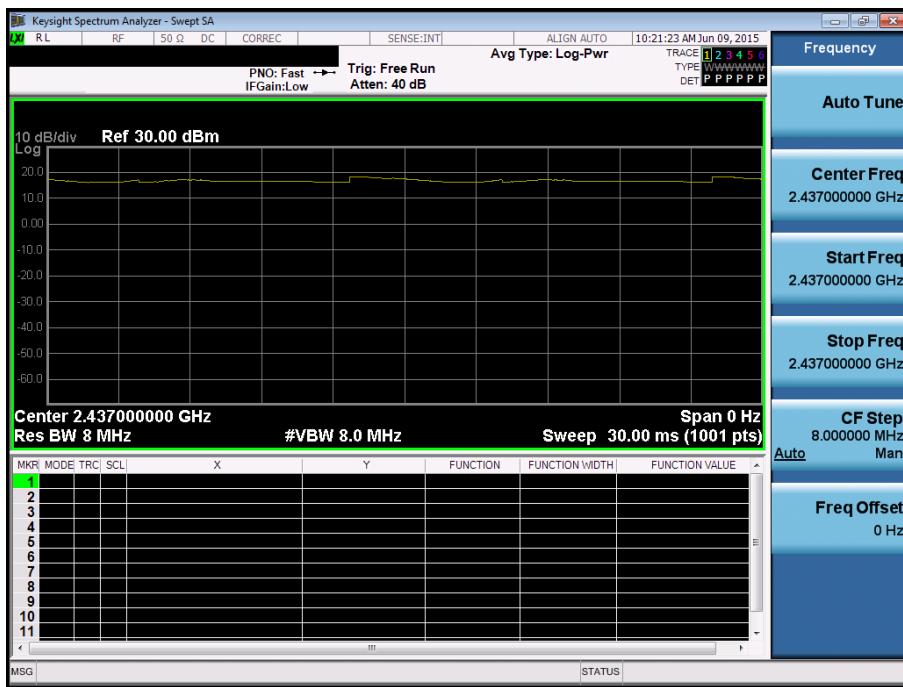
Set the center frequency of the instrument to the center frequency of the transmission. Set $RBW \geq OBW$ if possible; otherwise, set RBW to the largest available value. Set $VBW \geq RBW$. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are $> 50/T$ and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if $T \leq 16.7$ microseconds.)

Test Plots :

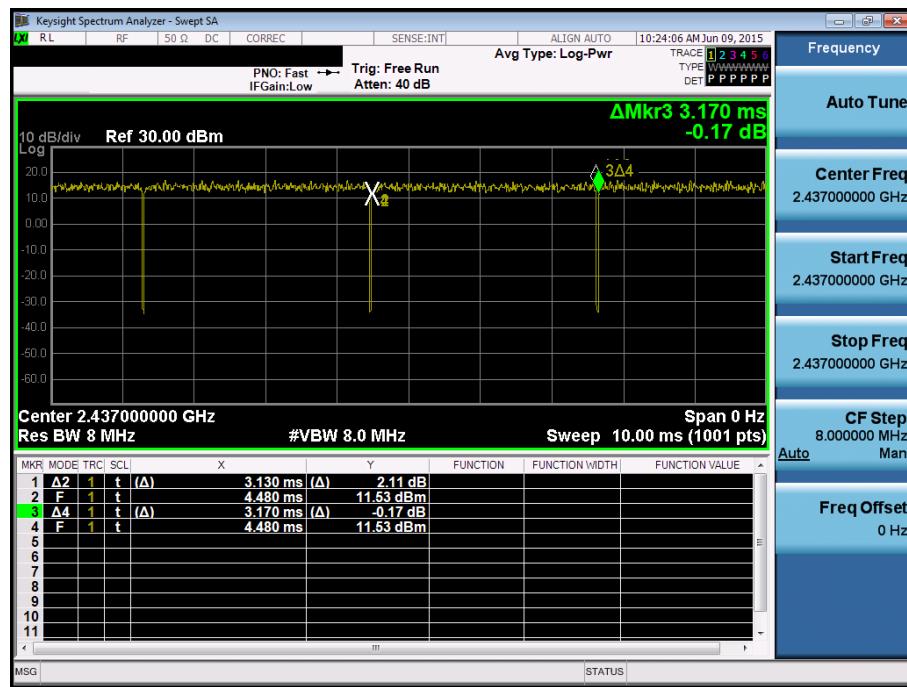
Duty Cycle

Test Mode: 802.11b & 1 Mbps & 2437 MHz



Duty Cycle

Test Mode: 802.11g & 6 Mbps & 2437 MHz

**Duty Cycle**

Test Mode: 802.11n & MCS 0 & 2437 MHz

