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# TEST REPORT

FCC/ISED DTS Test for VT231SNAN&VT231SNKN

**APPLICANT**
HYUNDAI MOBIS CO., LTD.

**REPORT NO.**
HCT-RF-2202-FI003

**DATE OF ISSUE**
February 11, 2022

**Tested by**
Jin Gwan Lee

**Technical Manager**
Jong Seok Lee

HCT CO., LTD.
BongJai Huh / CEO

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# TEST REPORT

FCC/ISED DTS Test for VT231SNAN& VT231SNKN

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Additional Model
-

| | |
|---|---|
| Applicant | **HYUNDAI MOBIS CO., LTD.**<br>203, Teheran-ro, Gangnam-gu, Seoul, 135-977, South Korea |
| Eut Type | CAR AUDIO SYSTEM |
| FCC Model Name | VT231SNAN |
| ISED Model Name | VT231SNKN |
| FCC ID | TQ8-VT231SNAN |
| IC | 5074A-VT231SNKN |
| Max. RF Output Power | 802.11b : 13.22 dBm / 802.11g : 16.85 dBm / 802.11n(HT20) : 16.32 dBm |
| Modulation type | CCK/DSSS/OFDM |
| FCC Classification | Digital Transmission System(DTS) |
| FCC Rule Part(s) | Part 15.247 |
| ISED Rule Part(s) | RSS-247 Issue 2 (February 2017)<br>RSS-Gen Issue 5_Amendment 1 (March 2019) |

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test results were applied only to the test methods required by the standard.

## REVISION HISTORY

The revision history for this test report is shown in table.

| Revision No. | Date of Issue | Description |
|---|---|---|
| 0 | February 11, 2022 | Initial Release |

Engineering Statement:
The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC / ISED Rules under normal use and maintenance

If this report is required to confirmation of authenticity, please contact to www.hct.co.kr

## CONTENTS

## 1. EUT DESCRIPTION

| | |
|---|---|
| FCC Model | VT231SNAN |
| ISED Model | VT231SNKN |
| FCC Additional Model | - |
| ISED Additional Model | - |
| EUT Type | CAR AUDIO SYSTEM |
| Power Supply | DC 9 V ~ 16 V |
| Frequency Range | 2 412 MHz ~ 2 462 MHz |
| Max. RF Output Power | **Peak Power**<br>802.11b : 13.22 dBm<br>802.11g : 16.85 dBm<br>802.11n(HT20) : 16.32 dBm<br>**Average Power**<br>802.11b : 7.27 dBm<br>802.11g : 8.98 dBm<br>802.11n(HT20) : 8.11 dBm |
| Modulation Type | DSSS/CCK : 802.11b<br>OFDM : 802.11g, 802.11n |
| Number of Channels | 11 Channels |
| Antenna Specification | Antenna type: Dual Bands Wi-Fi ANT<br>Peak Gain : -1.19 dBi |
| Date(s) of Tests | January 03, 2022 ~ February 11, 2022 |
| PMN<br>(Product Marketing Number) | VT231SNKN |
| HVIN<br>(Hardware Version Identification Number) | VT231SNKN |
| FVIN<br>(Firmware Version Identification Number) | QX_23. USA.0000.V041.001.210914 |
| HMN<br>(Host Marketing Name) | N/A |
| EUT serial numbers | Conducted : 96560-K2370MDD (FCC), 96560-K2360MDD (ISED)<br>Radiated : 96560-K2370MDD (FCC), 96560-K2360MDD (ISED) |

## 2. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05r02 dated April 02, 2019 entitled “guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices and the measurement procedure described in ANSI C63.10(Version : 2013) ‘the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices’.

### 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.

### EUT EXERCISE

The EUT was operated in the engineering 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. / RSS-Gen issue 5, RSS-247 issue 2.

### GENERAL TEST PROCEDURES

**Conducted Emissions**

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and average detector modes.

**Radiated Emissions**

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1 GHz. Above 1 GHz with 1.5m using absorbers between the EUT and receive antenna. 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 max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 6.6.5 of ANSI C63.10. (Version: 2013)

### DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

## 3. 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 equipment, which is traceable to recognized national standards.
Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

## 4. FACILITIES AND ACCREDITATIONS

### FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.
Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032).
For ISED, test facility was accepted dated January 26, 2021 (CAB identifier: KR0032).

### 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 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.”

## 5. ANTENNA REQUIREMENTS

**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."

(1) The antennas of this E.U.T are permanently attached.

(2) The E.U.T Complies with the requirement of § 15.203

## 6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of

ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

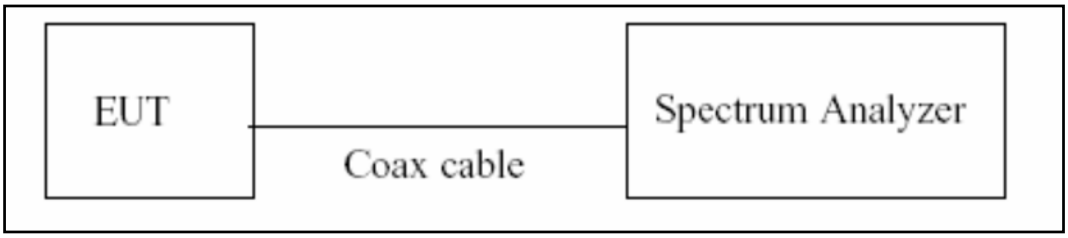
The measurement data shown herein meets or exceeds the $U_{CISPR}$ measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

| Parameter | Expanded Uncertainty (±dB) |
|---|---|
| Conducted Disturbance (150 kHz ~ 30 MHz) | 1.82 (Confidence level about 95 %, k=2) |
| Radiated Disturbance (9 kHz ~ 30 MHz) | 3.40 (Confidence level about 95 %, k=2) |
| Radiated Disturbance (30 MHz ~ 1 GHz) | 4.80 (Confidence level about 95 %, k=2) |
| Radiated Disturbance (1 GHz ~ 18 GHz) | 5.70 (Confidence level about 95 %, k=2) |
| Radiated Disturbance (18 GHz ~ 40 GHz) | 5.05 (Confidence level about 95 %, k=2) |

# 7. DESCRIPTION OF TESTS

## 7.1. Duty Cycle

**Test Configuration**




**Test Procedure**

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method.

The largest available value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/ *T*.

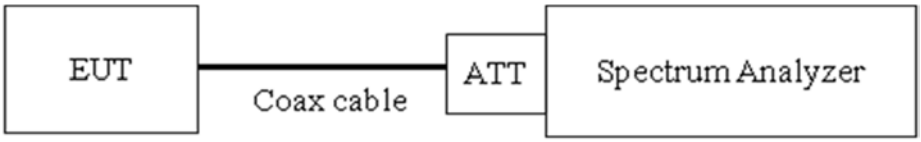
1. RBW = 8 MHz (the largest available value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure $T_{total}$ and $T_{on}$
8. Calculate Duty Cycle = $T_{on}$/ $T_{total}$ and Duty Cycle Factor = 10log(1/Duty Cycle)

### 7.2. 6 dB Bandwidth & 99 % Bandwidth

**Limit**

The minimum permissible 6 dB bandwidth is 500 kHz.

**Test Configuration**




**Test Procedure**

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 11.8.1 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Detector = Peak
4) Trace mode = Max hold
5) Sweep = auto couple
6) Allow the trace to stabilize
7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

**Test Procedure (99 % Bandwidth for ISED)**

The transmitter output is connected to the spectrum analyzer.

RBW = 1 % ~ 5 % of the occupied bandwidth

VBW ≒ 3 x RBW

Detector = Peak

Trace mode = Max hold

Sweep = auto couple

Allow the trace to stabilize

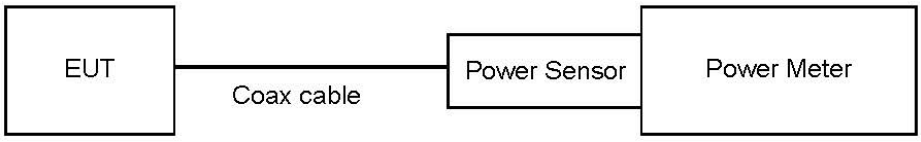
Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

## 7.3. Output Power

### Limit

The maximum permissible conducted output power is 1 Watt.

### Test Configuration




### Test Procedure

The transmitter output is connected to the Power Meter.

- Peak Power (Procedure 11.9.1.3 in ANSI 63.10-2013)
  : Measure the peak power of the transmitter.

- Average Power (Procedure 11.9.2.3 in ANSI 63.10-2013)
  1) Measure the duty cycle.
  2) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
  3) Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

### Sample Calculation

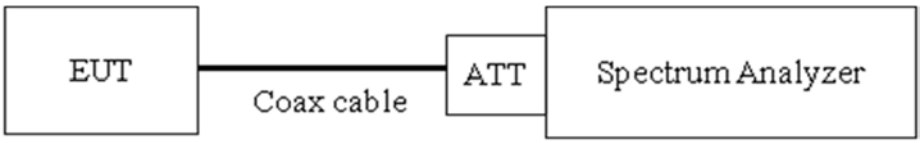
- Conducted Output Power(Peak) = Measured Level + ATT loss + Cable loss
- Conducted Output Power(Average) = Measured Level + ATT loss + Cable loss + Duty Cycle Factor

## 7.4. Power Spectral Density

### Limit

The transmitter power density average over 1-second interval shall not be greater than 8 dBm in any 3 kHz BW.

### Test Configuration




### Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05r02, Procedure 11.10.2 in ANSI 63.10-2013.

The spectrum analyzer is set to :

1) Set analyzer center frequency to DTS channel center frequency.
2) Span = 1.5 times the DTS channel bandwidth.
3) RBW = 3 kHz ≤ RBW ≤ 100 kHz.
4) VBW ≥ 3 x RBW.
5) Sweep = auto couple
6) Detector = peak
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.
   If Measured Level exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### Sample Calculation

- Power Spectral Density = Measured Level + ATT loss + Cable loss

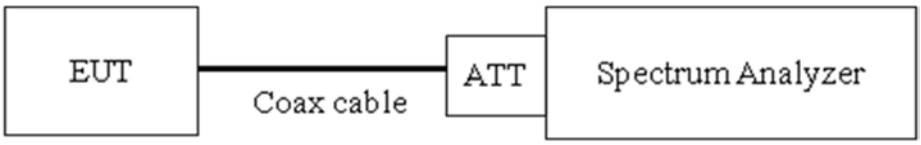
## 7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

**Limit**

The maximum conducted (Average) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

[ Conducted > 20 dBc ]

**Test Configuration**




**Test Procedure**

The transmitter output is connected to the spectrum analyzer.

(Procedure 11.11 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Set span to encompass the spectrum to be examined
4) Detector = Peak
5) Trace Mode = Max hold
6) Sweep time = auto couple
7) Ensure that the number of measurement points ≥ 2 x Span/RBW
8) Allow trace to fully stabilize.
9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.

Factors for frequency

| Freq(MHz) | Factor(dB) |
|---|---|
| 30 | 20.55 |
| 100 | 20.60 |
| 200 | 20.64 |
| 300 | 20.69 |
| 400 | 20.75 |
| 500 | 20.75 |
| 600 | 20.76 |
| 700 | 20.77 |
| 800 | 20.78 |
| 900 | 20.80 |
| 1000 | 20.85 |
| 2000 | 21.00 |
| 2400 | 21.03 |
| 2412 | 21.05 |
| 2437 | 21.05 |
| 2462 | 21.05 |
| 2500 | 21.54 |
| 3000 | 21.84 |
| 4000 | 21.92 |
| 5000 | 21.99 |
| 5700 | 22.00 |
| 5800 | 22.07 |
| 6000 | 22.08 |
| 7000 | 22.21 |
| 8000 | 22.21 |
| 9000 | 22.29 |
| 10000 | 22.39 |
| 11000 | 22.48 |
| 12000 | 22.57 |
| 13000 | 22.58 |
| 14000 | 22.61 |
| 15000 | 22.71 |
| 16000 | 22.79 |
| 17000 | 23.00 |
| 18000 | 23.13 |
| 19000 | 23.05 |
| 20000 | 22.72 |
| 21000 | 22.85 |
| 22000 | 22.84 |
| 23000 | 22.85 |
| 24000 | 22.86 |
| 25000 | 22.96 |

Note : 1. 2400 ~ 2500 MHz is fundamental frequency range.

2. Factor = Attenuator loss + Cable loss

## 7.6. Radiated Test

### Limit

**FCC**

| Frequency (MHz) | Field Strength (μV/m) | Measurement Distance (m) |
|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30 | 30 | 30 |

**ISED**

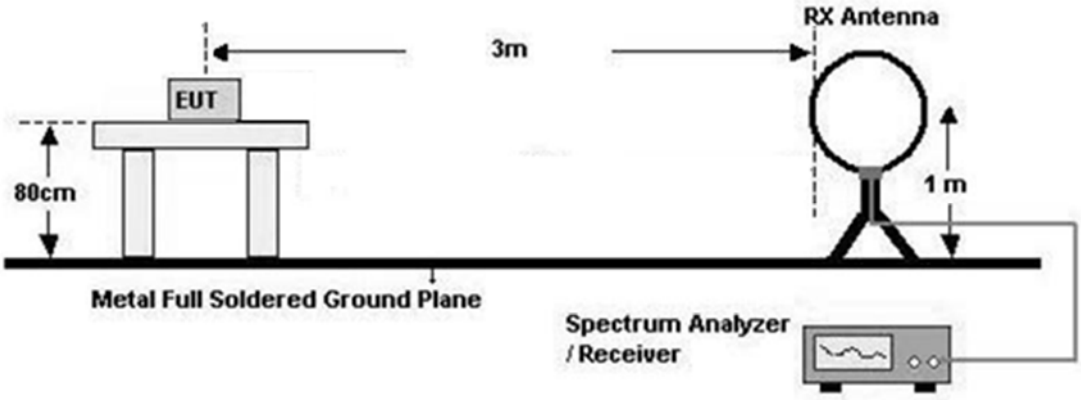
| Frequency (MHz) | Field Strength (uA/m) | Measurement Distance (m) |
|---|---|---|
| 0.009 – 0.490 | 6.37/F(kHz) | 300 |
| 0.490 – 1.705 | 63.7/F(kHz) | 30 |
| 1.705 – 30 | 0.08 | 30 |

**FCC&ISED**

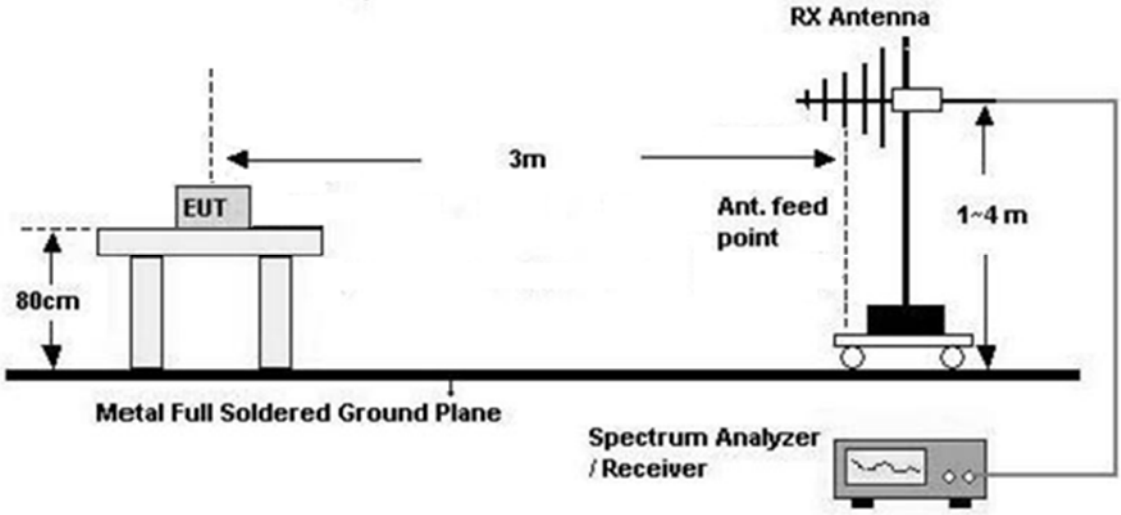
| Frequency (MHz) | Field Strength (μV/m) | Measurement Distance (m) |
|---|---|---|
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

## Test Configuration

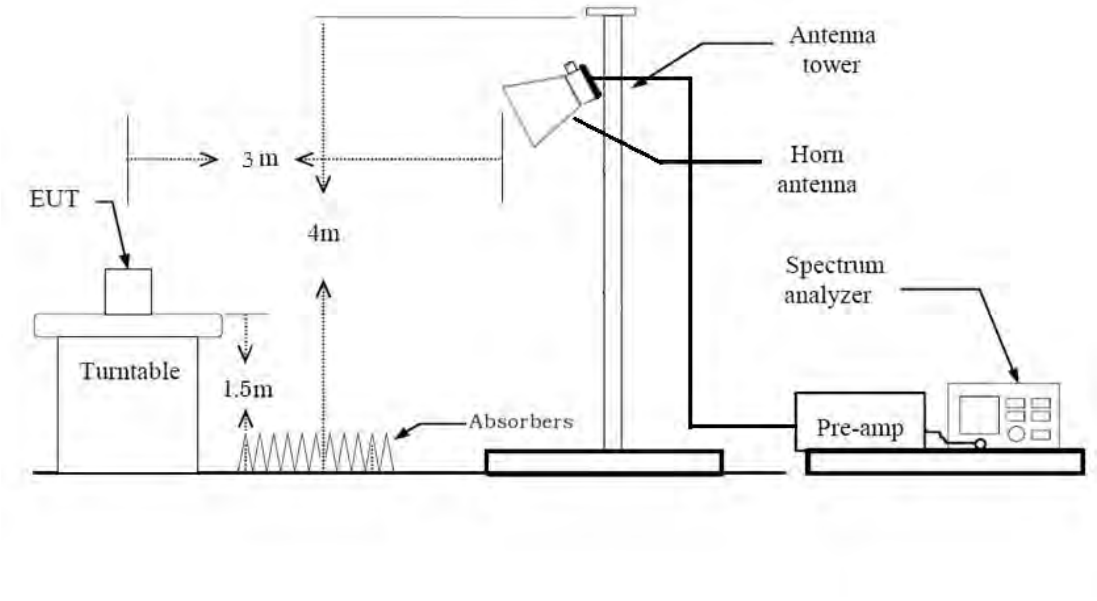
Below 30 MHz




30 MHz - 1 GHz



Above 1 GHz




**Test Procedure of Radiated spurious emissions(Below 30 MHz)**

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3 m from the EUT
3. The EUT is placed on a turntable, which is 0.8 m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor(0.009 MHz – 0.490 MHz) = 40log(3 m/300 m) = - 80 dB
   Measurement Distance : 3 m
7. Distance Correction Factor(0.490 MHz – 30 MHz) = 40log(3 m/30 m) = - 40 dB
   Measurement Distance : 3 m
8. Spectrum Setting
   - Frequency Range = 9 kHz ~ 30 MHz
   - Detector = Peak
   - Trace = Max hold
   - RBW = 9 kHz
   - VBW ≥ 3 x RBW
9. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

**KDB 414788 OFS and Chamber Correlation Justification**

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

**Test Procedure of Radiated spurious emissions(Below 1 GHz)**

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8 m above ground plane.
3. The Hybrid antenna was placed at a location 3 m from the EUT, which is varied from 1 m to 4 m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = Max hold
      - RBW = 100 kHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Quasi-peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Quasi-Peak
      - RBW = 120 kHz

   ※In general, (1) is used mainly
7. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L)
8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

**Test Procedure of Radiated spurious emissions (Above 1 GHz)**

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. 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.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Spectrum Setting (Method 8.6 in KDB 558074 v05r02, Procedure 11.12 in ANSI 63.10-2013)

(1) Measurement Type(Peak):
- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW ≥ 3 x RBW

(2) Measurement Type(Average): Duty cycle ≥ 98 %
- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW ≥ 3 x RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle < 98 %, duty cycle variations are less than ±2 %
- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW ≥ 3 x RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).
- 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.
- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
9. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
10. Total(Measurement Type : Peak)
= Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average, Duty cycle ≥ 98 %)
= Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average, Duty cycle < 98 %)
= Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)
+ Duty Cycle Factor

**Test Procedure of Radiated Restricted Band Edge**

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. 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.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
      - Detector = Peak
      - Trace = Max hold
      - RBW = 1 MHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Average): Duty cycle ≥ 98 %,
      - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
      - Detector = RMS
      - Averaging type = power (*i.e.*, RMS)
      - RBW = 1 MHz
      - VBW ≥ 3 x RBW
      - Sweep time = auto.
      - Trace mode = average (at least 100 traces).
   (3) Measurement Type(Average): Duty cycle < 98 %, duty cycle variations are less than ±2 %
      - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
      - Detector = RMS

- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW ≥ 3 x RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).
- 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.
- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
9. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
10. Total(Measurement Type : Peak)
= Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F) – Amp Gain(A.G)

Total(Measurement Type : Average, Duty cycle ≥ 98 %)
= Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F) – Amp Gain(A.G)

Total(Measurement Type : Average, Duty cycle < 98 %)
= Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)
+ Duty Cycle Factor – Amp Gain(A.G)

## 7.7. Receiver Spurious Emissions

**Limit**

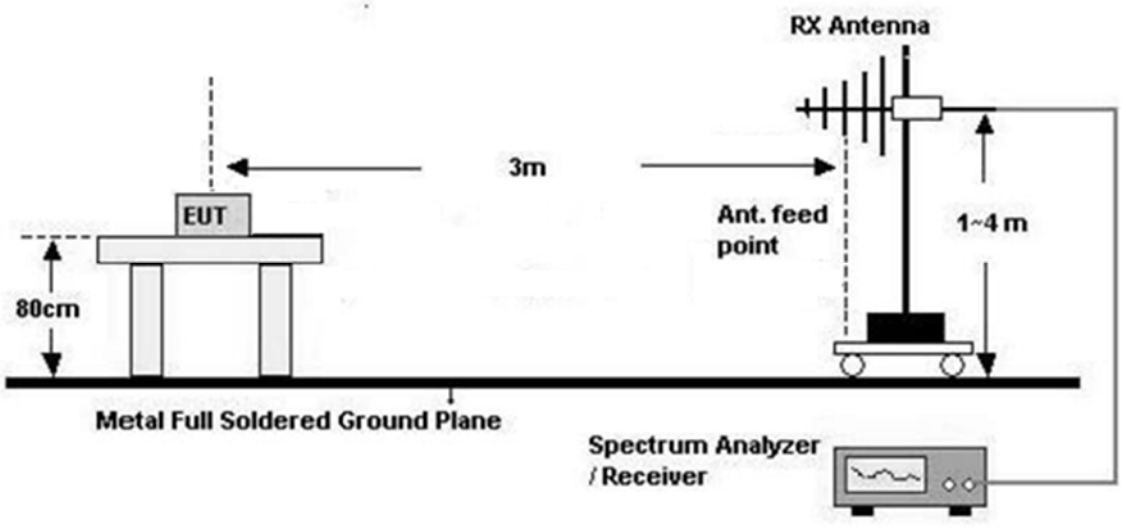
| Frequency (MHz) | Field Strength (μV/m) | Measurement Distance (m) |
|---|---|---|
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

Note:

Measurements for compliance with the limits in table may be performed at distances other than 3 metres.

**Test Configuration**

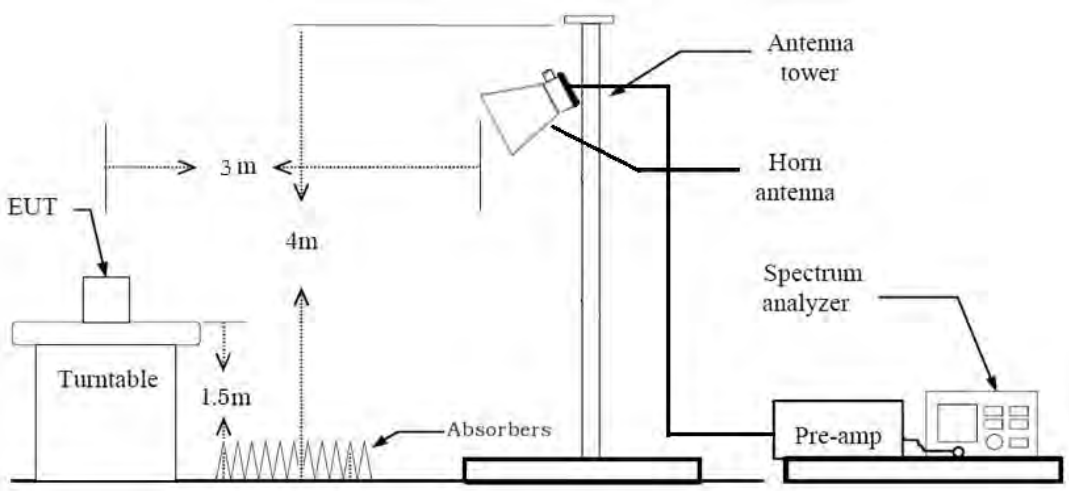
30 MHz - 1 GHz



**Test Procedure of Receiver Spurious Emissions (Below 1 GHz)**

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8 m above ground plane.
3. The Hybrid antenna was placed at a location 3 m from the EUT, which is varied from 1 m to 4 m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = Max hold
      - RBW = 100 kHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Quasi-peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Quasi-Peak
      - RBW = 120 kHz
7. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L)

Above 1 GHz




**Test Procedure of Radiated spurious emissions (Above 1 GHz)**

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. 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.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 1 GHz – 25 GHz
      - Detector = Peak
      - Trace = Max hold
      - RBW = 1 MHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Average):

- We performed using a reduced video BW method was done with the analyzer in linear mode
- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW ≥ 3 x RBW

8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
9. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)

### 7.8. Worst case configuration and mode

**Radiated test**

1. All modes of operation were investigated and the worst case configuration results are reported.
   - Mode : Stand alone , Stand alone + Shark Antenna
   - Mode : Stand alone + Shark Antenna
2. EUT Axis
   - Radiated Spurious Emissions : X
   - Radiated Restricted Band Edge : X
3. All data rate of operation were investigated and the worst case data rate results are reported
   - 802.11b : 11 Mbps
   - 802.11g : 6 Mbps
   - 802.11n : MCS3
4. All position of loop antenna were investigated and the test result is a no critical peak found at all positions.

- Position : Horizontal, Vertical, Parallel to the ground plane

**AC Power line Conducted Emissions**

1. We don’t perform powerline conducted emission test. Because this EUT is used DC.

**Conducted test**

1. The EUT was configured with data rate of highest power.

## 8. SUMMARY TEST OF RESULTS

FCC Part

| Test Description | FCC Part Section(s) | Test Limit | Test Condition | Test Result |
|---|---|---|---|---|
| 6 dB Bandwidth | § 15.247(a)(2) | > 500 kHz | Conducted | PASS |
| Conducted Maximum Output Power | § 15.247(b)(3) | < 1 Watt | | PASS |
| Power Spectral Density | § 15.247(e) | < 8 dBm / 3 kHz Band | | PASS |
| Band Edge (Out of Band Emissions) | § 15.247(d) | Conducted > 20 dBc | | PASS |
| AC Power line Conducted Emissions | § 15.207 | cf. Section 7.7 | | N/A (#Note1) |
| Radiated Spurious Emissions | § 15.247(d), 15.205, 15.209 | cf. Section 7.6 | Radiated | PASS |
| Radiated Restricted Band Edge | § 15.247(d), 15.205, 15.209 | cf. Section 7.6 | | PASS |

#Note1 : Not Tested

**ISED Part**

| Test Description | ISED Part Section(s) | Test Limit | Test Condition | Test Result |
|---|---|---|---|---|
| 6 dB Bandwidth | RSS-247, 5.2 | > 500 kHz | Conducted | PASS |
| 99 % Bandwidth | RSS-GEN, 6.7 | N/A | | PASS |
| Conducted Maximum Peak Output Power And e.i.r.p. | RSS-247, 5.4. | < 1 Watt<br><4 Watt(e.i.r.p.) | | PASS |
| Power Spectral Density | RSS-247, 5.2 | < 8 dBm / 3 kHz Band | | PASS |
| Band Edge(Out of Band Emissions) | RSS-247, 5.5 | Conducted > 20 dBc | | PASS |
| AC Power line Conducted Emissions | RSS-GEN, 8.8 | cf. Section 7.7 | | N/A (#Note1) |
| Radiated Spurious Emissions | RSS-GEN, 8.9 | cf. Section 7.6 | Radiated | PASS |
| Receiver Spurious Emissions | RSS-GEN, 7 | cf. Section 7.8 | | PASS |
| Radiated Restricted Band Edge | RSS-GEN, 8.10 | cf. Section 7.6 | | PASS |

#Note1 : Not Tested

# 9. TEST RESULT

## 9.1 DUTY CYCLE

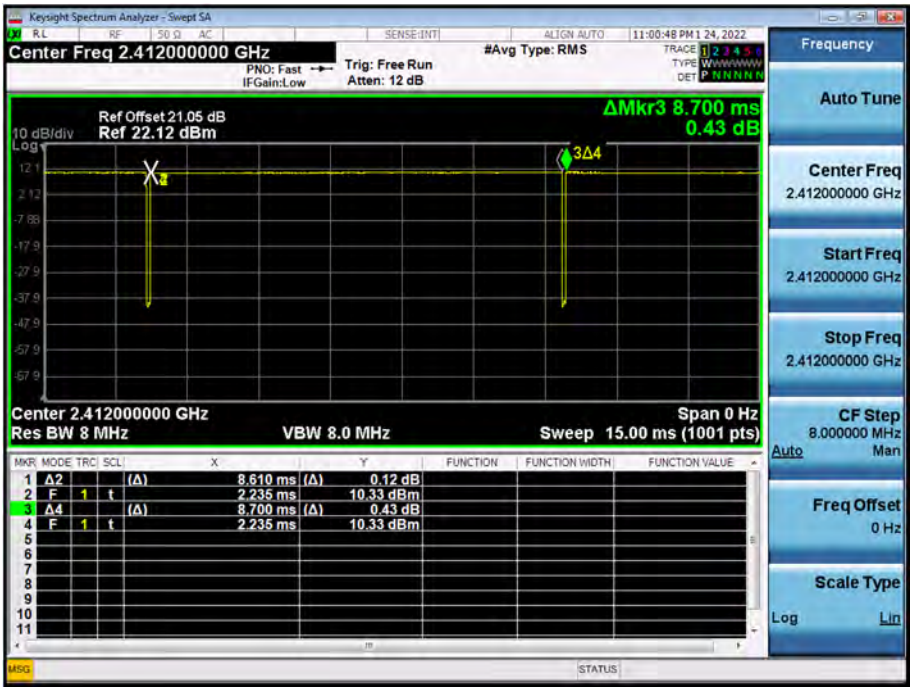
| Mode | Data Rate (Mbps) | $T_{on}$ (ms) | $T_{total}$ (ms) | Duty Cycle | Duty Cycle Factor (dB) |
|---|---|---|---|---|---|
| 802.11b | 1 | 8.617 | 8.708 | 0.990 | 0.045 |
| | 2 | 4.301 | 4.395 | 0.979 | 0.094 |
| | 5.5 | 1.625 | 1.719 | 0.946 | 0.243 |
| | 11 | 0.861 | 0.956 | 0.901 | 0.453 |
| 802.11g | 6 | 1.428 | 1.529 | 0.934 | 0.298 |
| | 9 | 0.960 | 1.061 | 0.905 | 0.433 |
| | 12 | 0.725 | 0.826 | 0.878 | 0.565 |
| | 18 | 0.492 | 0.594 | 0.829 | 0.816 |
| | 24 | 0.372 | 0.474 | 0.786 | 1.046 |
| | 36 | 0.256 | 0.358 | 0.716 | 1.448 |
| | 48 | 0.196 | 0.297 | 0.658 | 1.816 |
| | 54 | 0.180 | 0.281 | 0.640 | 1.935 |
| 802.11n (HT20) | 6.5 (MCS0) | 1.336 | 1.438 | 0.929 | 0.321 |
| | 13 (MCS1) | 0.688 | 0.790 | 0.871 | 0.600 |
| | 19.5 (MCS2) | 0.472 | 0.573 | 0.824 | 0.842 |
| | 26 (MCS3) | 0.364 | 0.465 | 0.783 | 1.064 |
| | 39 (MCS4) | 0.257 | 0.358 | 0.718 | 1.441 |
| | 52 (MCS5) | 0.200 | 0.302 | 0.664 | 1.776 |
| | 58.5 (MCS6) | 0.184 | 0.285 | 0.644 | 1.912 |
| | 65 (MCS7) | 0.168 | 0.269 | 0.624 | 2.047 |

**Note:**

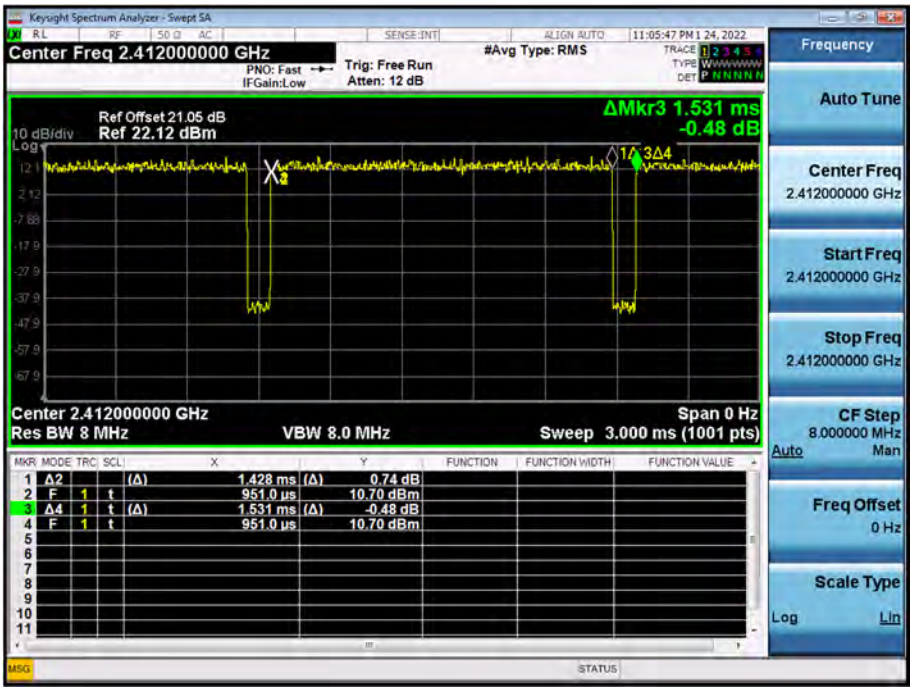
1. Duty Cycle Factor = 10log(1/Duty Cycle). where, Duty Cycle = $T_{on}$ / $T_{total}$

## ▣ Test Plots

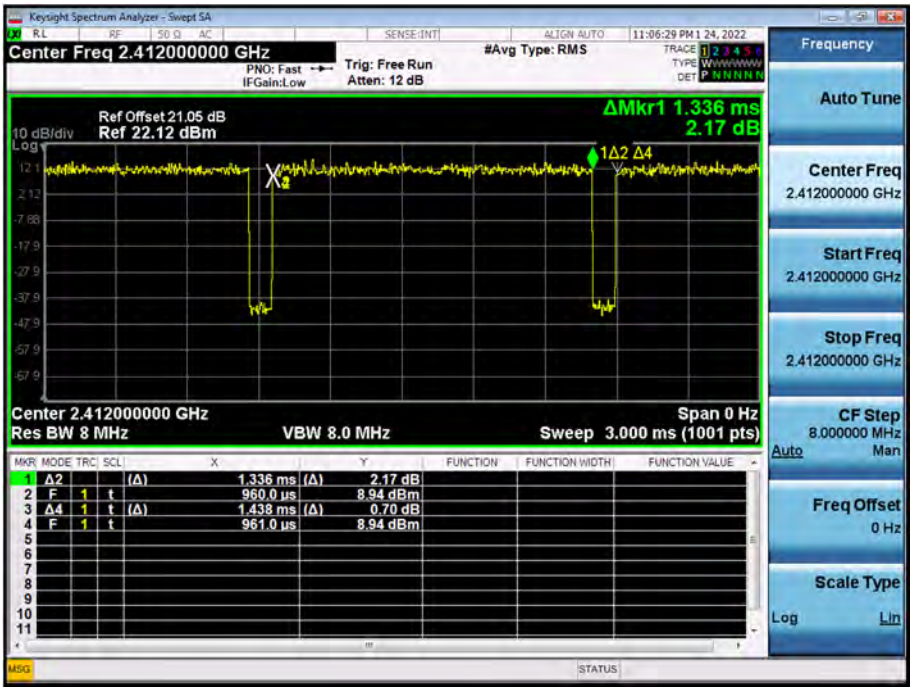
Duty cycle plot (802.11b(1 Mbps))




Duty cycle plot (802.11g(6 Mbps))



Duty cycle plot (802.11n(HT20)(MCS0))




**Note:**

In order to simplify the report, attached plots were only the most lowest data rate.

## 9.2 6dB BANDWIDTH & 99 % BANDWIDTH

FCC

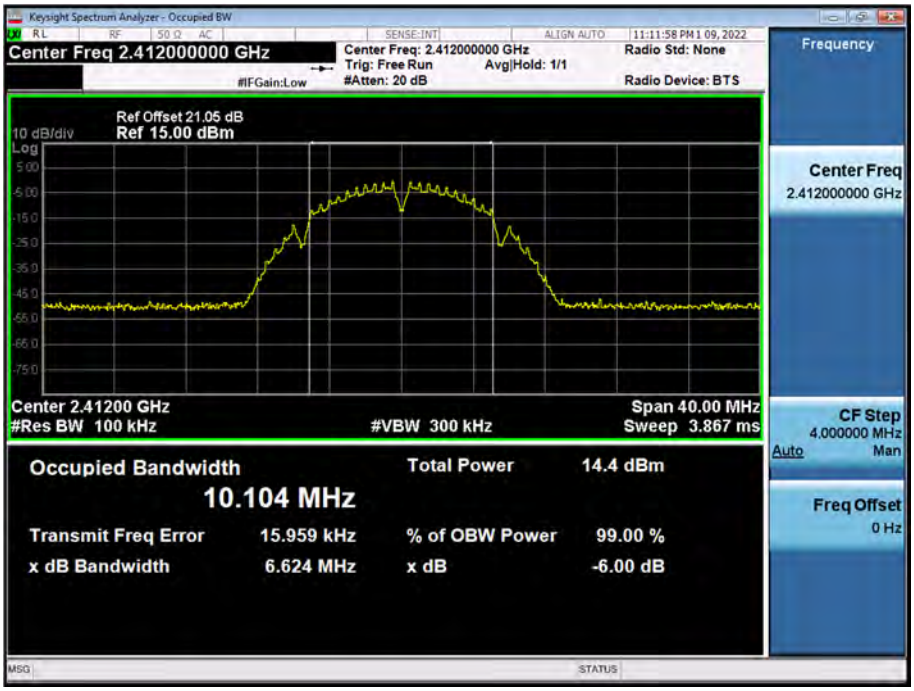
| 802.11b Mode | | Measured Bandwidth [MHz] | Minimum Bandwidth [MHz] |
|---|---|---|---|
| Frequency [MHz] | Channel No. | | |
| 2412 | 1 | 6.624 | > 0.5 |
| 2437 | 6 | 7.111 | > 0.5 |
| 2462 | 11 | 7.098 | > 0.5 |

| 802.11g Mode | | Measured Bandwidth [MHz] | Minimum Bandwidth [MHz] |
|---|---|---|---|
| Frequency [MHz] | Channel No. | | |
| 2412 | 1 | 16.06 | > 0.5 |
| 2437 | 6 | 16.33 | > 0.5 |
| 2462 | 11 | 16.10 | > 0.5 |

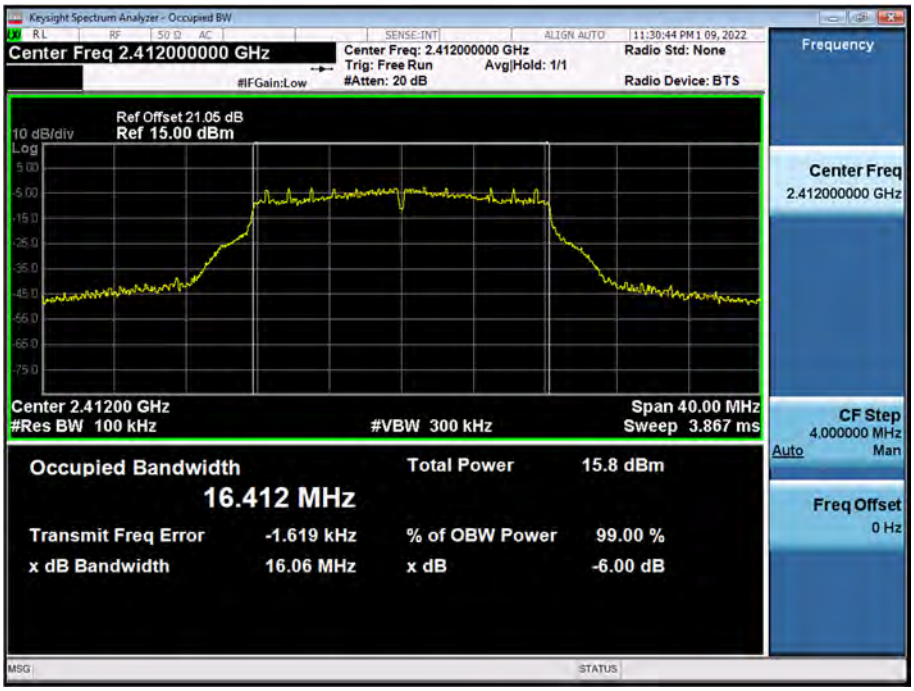
| 802.11n(HT20) Mode | | Measured Bandwidth [MHz] | Minimum Bandwidth [MHz] |
|---|---|---|---|
| Frequency [MHz] | Channel No. | | |
| 2412 | 1 | 17.07 | > 0.5 |
| 2437 | 6 | 16.69 | > 0.5 |
| 2462 | 11 | 17.32 | > 0.5 |

▣ Test Plots

6 dB Bandwidth plot (802.11b-CH 1)




6 dB Bandwidth plot (802.11g-CH 1)



6 dB Bandwidth plot (802.11n_HT20-CH 6)


**Note:**

In order to simplify the report, attached plots were only the most narrow 6 dB BW channel.

**99 % Bandwidth Measurements(ISED)**

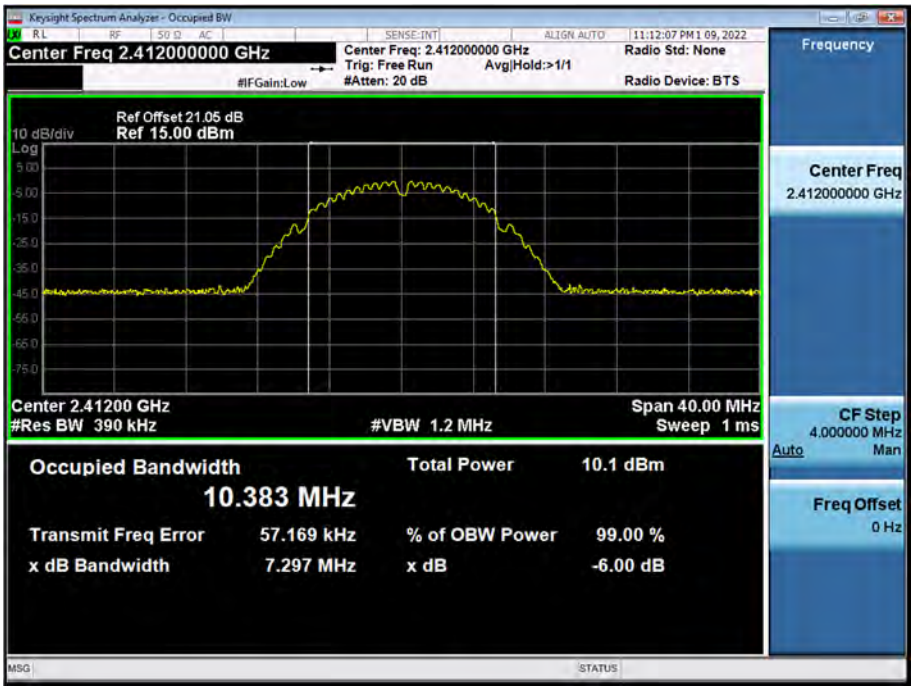
| 802.11b Mode | | OBW Bandwidth [MHz] | Limit [MHz] |
|---|---|---|---|
| Frequency [MHz] | Channel No. | | |
| 2412 | 1 | 10.383 | N/A |
| 2437 | 6 | 10.377 | N/A |
| 2462 | 11 | 10.363 | N/A |

| 802.11g Mode | | OBW Bandwidth [MHz] | Limit [MHz] |
|---|---|---|---|
| Frequency [MHz] | Channel No. | | |
| 2412 | 1 | 17.147 | N/A |
| 2437 | 6 | 17.137 | N/A |
| 2462 | 11 | 17.144 | N/A |

| 802.11n(HT20) Mode | | OBW Bandwidth [MHz] | Limit [MHz] |
|---|---|---|---|
| Frequency [MHz] | Channel No. | | |
| 2412 | 1 | 18.099 | N/A |
| 2437 | 6 | 18.131 | N/A |
| 2462 | 11 | 18.154 | N/A |

## ▣ Test Plots

99 % Bandwidth plot (802.11b-CH 1)




99 % Bandwidth plot (802.11g-CH 1)

99 % Bandwidth plot (802.11n_HT20-CH 11)


**Note:**

In order to simplify the report, attached plots were only the most wide 99 % Bandwidth channel.

## 9.3 OUTPUT POWER

**Peak Power**

1. Power Meter offset = Attenuator loss(20 dB) + Cable loss(1ea) + EUT Cable(For Conducted)
2. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.
So, 21.05 dB is offset for 2.4 GHz Band

| 802.11b Mode | | Rate (Mbps) | Measured Power(dBm) | Limit (dBm) |
|---|---|---|---|---|
| Frequency[MHz] | Channel No. | | | |
| 2412 | 1 | 1 | 9.19 | 30.00 |
| | | 2 | 9.41 | 30.00 |
| | | 5.5 | 11.02 | 30.00 |
| | | 11 | 12.74 | 30.00 |
| 2437 | 6 | 1 | 9.23 | 30.00 |
| | | 2 | 9.32 | 30.00 |
| | | 5.5 | 10.77 | 30.00 |
| | | 11 | 12.55 | 30.00 |
| 2462 | 11 | 1 | 9.78 | 30.00 |
| | | 2 | 10.02 | 30.00 |
| | | 5.5 | 11.56 | 30.00 |
| | | 11 | 13.22 | 30.00 |

| 802.11g Mode | | Rate (Mbps) | Measured Power(dBm) | Limit (dBm) |
|---|---|---|---|---|
| Frequency[MHz] | Channel No. | | | |
| 2412 | 1 | 6 | 16.52 | 30.00 |
| | | 9 | 16.42 | 30.00 |
| | | 12 | 16.26 | 30.00 |
| | | 18 | 15.87 | 30.00 |
| | | 24 | 15.99 | 30.00 |
| | | 36 | 16.22 | 30.00 |
| | | 48 | 16.12 | 30.00 |
| | | 54 | 16.19 | 30.00 |
| 2437 | 6 | 6 | 16.32 | 30.00 |
| | | 9 | 16.21 | 30.00 |
| | | 12 | 16.06 | 30.00 |
| | | 18 | 15.54 | 30.00 |
| | | 24 | 15.89 | 30.00 |
| | | 36 | 15.95 | 30.00 |
| | | 48 | 16.01 | 30.00 |
| | | 54 | 15.77 | 30.00 |
| 2462 | 11 | 6 | 16.85 | 30.00 |
| | | 9 | 16.79 | 30.00 |
| | | 12 | 16.58 | 30.00 |
| | | 18 | 16.18 | 30.00 |
| | | 24 | 16.34 | 30.00 |
| | | 36 | 16.31 | 30.00 |
| | | 48 | 16.38 | 30.00 |
| | | 54 | 16.35 | 30.00 |

| 802.11n(HT20) Mode | | MCS Index | Measured Power(dBm) | Limit (dBm) |
|---|---|---|---|---|
| Frequency[MHz] | Channel No. | | | |
| 2412 | 1 | 0 | 15.49 | 30.00 |
| | | 1 | 15.59 | 30.00 |
| | | 2 | 15.48 | 30.00 |
| | | 3 | 15.68 | 30.00 |
| | | 4 | 15.63 | 30.00 |
| | | 5 | 15.64 | 30.00 |
| | | 6 | 15.53 | 30.00 |
| | | 7 | 15.41 | 30.00 |
| 2437 | 6 | 0 | 15.10 | 30.00 |
| | | 1 | 15.25 | 30.00 |
| | | 2 | 15.15 | 30.00 |
| | | 3 | 15.52 | 30.00 |
| | | 4 | 15.49 | 30.00 |
| | | 5 | 15.30 | 30.00 |
| | | 6 | 15.37 | 30.00 |
| | | 7 | 15.20 | 30.00 |
| 2462 | 11 | 0 | 15.94 | 30.00 |
| | | 1 | 15.98 | 30.00 |
| | | 2 | 15.97 | 30.00 |
| | | 3 | 16.32 | 30.00 |
| | | 4 | 16.14 | 30.00 |
| | | 5 | 16.22 | 30.00 |
| | | 6 | 16.13 | 30.00 |
| | | 7 | 15.97 | 30.00 |

**Average Power**

1. Power Meter offset = Attenuator loss(20 dB) + Cable loss(1ea) + EUT Cable(For Conducted)
2. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.
   So, 21.05 dB is offset for 2.4 GHz Band.

| 802.11b Mode | | Rate (Mbps) | Measured Power (dBm) | Duty Cycle Factor | Measured Power(dBm) + Duty Cycle Factor | Limit (dBm) |
|---|---|---|---|---|---|---|
| Frequency [MHz] | Channel No. | | | | | |
| 2412 | 1 | 1 | 6.81 | 0.045 | 6.85 | 30.00 |
| | | 2 | 6.70 | 0.094 | 6.79 | 30.00 |
| | | 5.5 | 6.58 | 0.243 | 6.82 | 30.00 |
| | | 11 | 6.43 | 0.453 | 6.89 | 30.00 |
| 2437 | 6 | 1 | 6.58 | 0.045 | 6.62 | 30.00 |
| | | 2 | 6.41 | 0.094 | 6.50 | 30.00 |
| | | 5.5 | 6.28 | 0.243 | 6.53 | 30.00 |
| | | 11 | 6.05 | 0.453 | 6.50 | 30.00 |
| 2462 | 11 | 1 | 7.22 | 0.045 | 7.27 | 30.00 |
| | | 2 | 7.02 | 0.094 | 7.12 | 30.00 |
| | | 5.5 | 6.87 | 0.243 | 7.12 | 30.00 |
| | | 11 | 6.69 | 0.453 | 7.14 | 30.00 |

| 802.11g Mode | | Rate (Mbps) | Measured Power (dBm) | Duty Cycle Factor | Measured Power(dBm) + Duty Cycle Factor | Limit (dBm) |
|---|---|---|---|---|---|---|
| Frequency [MHz] | Channel No. | | | | | |
| 2412 | 1 | 6 | 8.36 | 0.298 | 8.66 | 30.00 |
| | | 9 | 8.31 | 0.433 | 8.75 | 30.00 |
| | | 12 | 8.22 | 0.565 | 8.78 | 30.00 |
| | | 18 | 7.50 | 0.816 | 8.31 | 30.00 |
| | | 24 | 7.19 | 1.046 | 8.23 | 30.00 |
| | | 36 | 6.93 | 1.448 | 8.38 | 30.00 |
| | | 48 | 6.56 | 1.816 | 8.37 | 30.00 |
| | | 54 | 6.41 | 1.935 | 8.35 | 30.00 |
| 2437 | 6 | 6 | 8.04 | 0.298 | 8.34 | 30.00 |
| | | 9 | 7.94 | 0.433 | 8.38 | 30.00 |
| | | 12 | 7.83 | 0.565 | 8.40 | 30.00 |
| | | 18 | 6.94 | 0.816 | 7.76 | 30.00 |
| | | 24 | 6.90 | 1.046 | 7.95 | 30.00 |
| | | 36 | 6.46 | 1.448 | 7.90 | 30.00 |
| | | 48 | 6.27 | 1.816 | 8.09 | 30.00 |
| | | 54 | 5.94 | 1.935 | 7.87 | 30.00 |
| 2462 | 11 | 6 | 8.58 | 0.298 | 8.88 | 30.00 |
| | | 9 | 8.53 | 0.433 | 8.96 | 30.00 |
| | | 12 | 8.41 | 0.565 | 8.98 | 30.00 |
| | | 18 | 7.70 | 0.816 | 8.52 | 30.00 |
| | | 24 | 7.54 | 1.046 | 8.59 | 30.00 |
| | | 36 | 6.98 | 1.448 | 8.43 | 30.00 |
| | | 48 | 6.81 | 1.816 | 8.63 | 30.00 |
| | | 54 | 6.64 | 1.935 | 8.58 | 30.00 |

| 802.11n Mode | | MCS Index | Measured Power (dBm) | Duty Cycle Factor | Measured Power(dBm) + Duty Cycle Factor | Limit (dBm) |
|---|---|---|---|---|---|---|
| Frequency [MHz] | Channel No. | | | | | |
| 2412 | 1 | 0 | 7.21 | 0.321 | 7.54 | 30.00 |
| | | 1 | 6.92 | 0.600 | 7.52 | 30.00 |
| | | 2 | 6.74 | 0.842 | 7.58 | 30.00 |
| | | 3 | 6.24 | 1.064 | 7.30 | 30.00 |
| | | 4 | 5.81 | 1.441 | 7.25 | 30.00 |
| | | 5 | 5.47 | 1.776 | 7.25 | 30.00 |
| | | 6 | 5.27 | 1.912 | 7.18 | 30.00 |
| | | 7 | 5.12 | 2.047 | 7.17 | 30.00 |
| 2437 | 6 | 0 | 6.94 | 0.321 | 7.26 | 30.00 |
| | | 1 | 6.75 | 0.600 | 7.35 | 30.00 |
| | | 2 | 6.49 | 0.842 | 7.34 | 30.00 |
| | | 3 | 6.12 | 1.064 | 7.18 | 30.00 |
| | | 4 | 5.70 | 1.441 | 7.14 | 30.00 |
| | | 5 | 5.24 | 1.776 | 7.02 | 30.00 |
| | | 6 | 5.17 | 1.912 | 7.08 | 30.00 |
| | | 7 | 5.00 | 2.047 | 7.05 | 30.00 |
| 2462 | 11 | 0 | 7.72 | 0.321 | 8.05 | 30.00 |
| | | 1 | 7.51 | 0.600 | 8.11 | 30.00 |
| | | 2 | 7.26 | 0.842 | 8.10 | 30.00 |
| | | 3 | 6.75 | 1.064 | 7.82 | 30.00 |
| | | 4 | 6.35 | 1.441 | 7.79 | 30.00 |
| | | 5 | 6.02 | 1.776 | 7.79 | 30.00 |
| | | 6 | 5.74 | 1.912 | 7.66 | 30.00 |
| | | 7 | 5.64 | 2.047 | 7.68 | 30.00 |

## 9.4 POWER SPECTRAL DENSITY

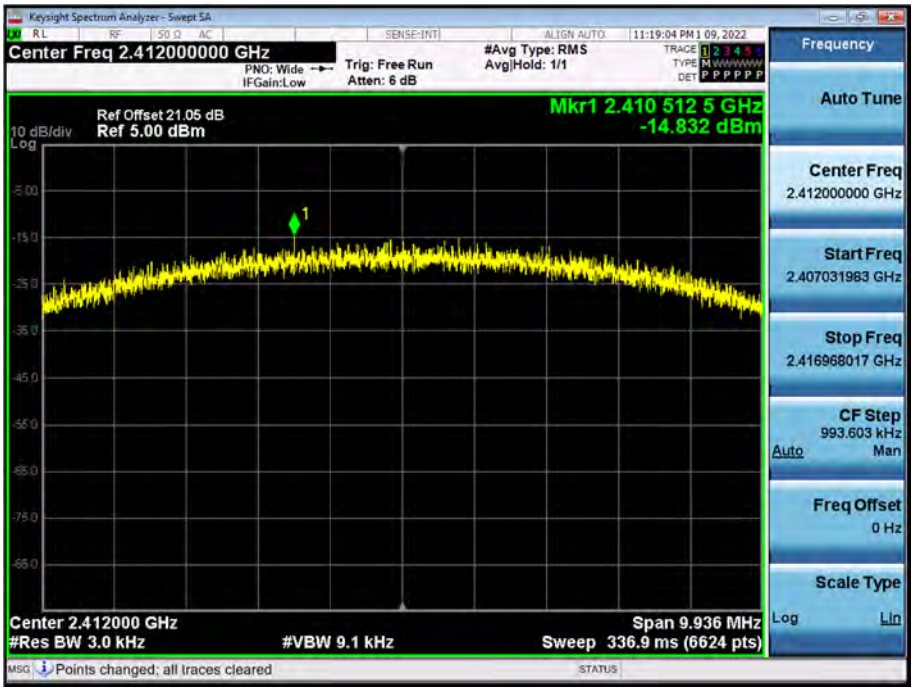
| Mode | Frequency (MHz) | Channel No. | Test Result | |
|---|---|---|---|---|
| | | | PSD (dBm/3 kHz) | Limit (dBm/3 kHz) |
| 802.11b | 2412 | 1 | -14.832 | 8 |
| | 2437 | 6 | -15.732 | |
| | 2462 | 11 | -14.866 | |
| 802.11g | 2412 | 1 | -14.218 | |
| | 2437 | 6 | -14.904 | |
| | 2462 | 11 | -14.341 | |
| 802.11n(HT20) | 2412 | 1 | -18.985 | |
| | 2437 | 6 | -19.200 | |
| | 2462 | 11 | -17.227 | |

**Note :**

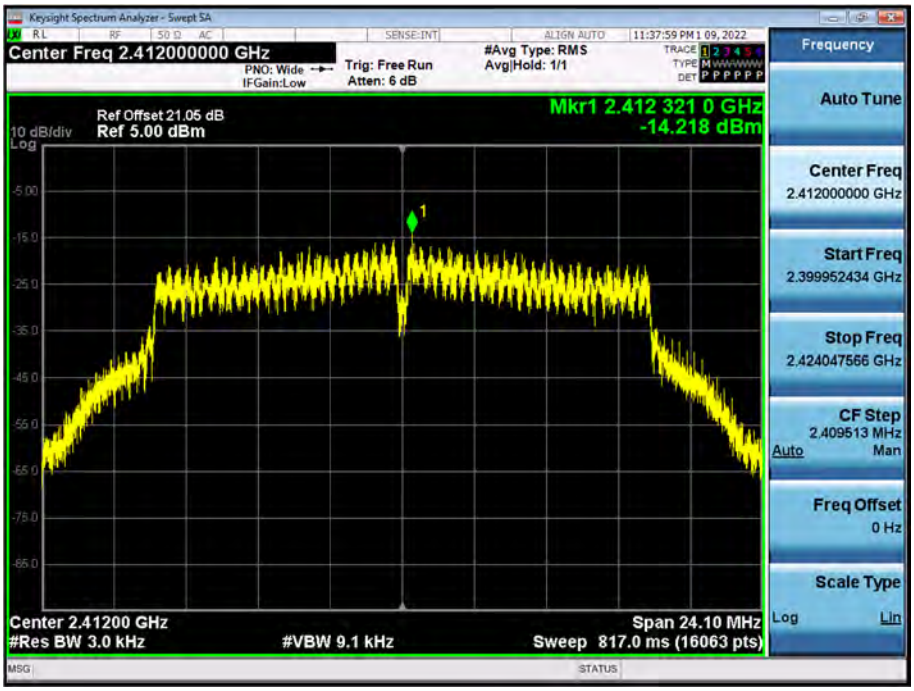
1. Spectrum Measured Levels are not plot data.
   The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss(20 dB) + Cable loss(1ea)
3. 21.05 dB is offset for 2.4 GHz Band.

## ▣ Test Plots

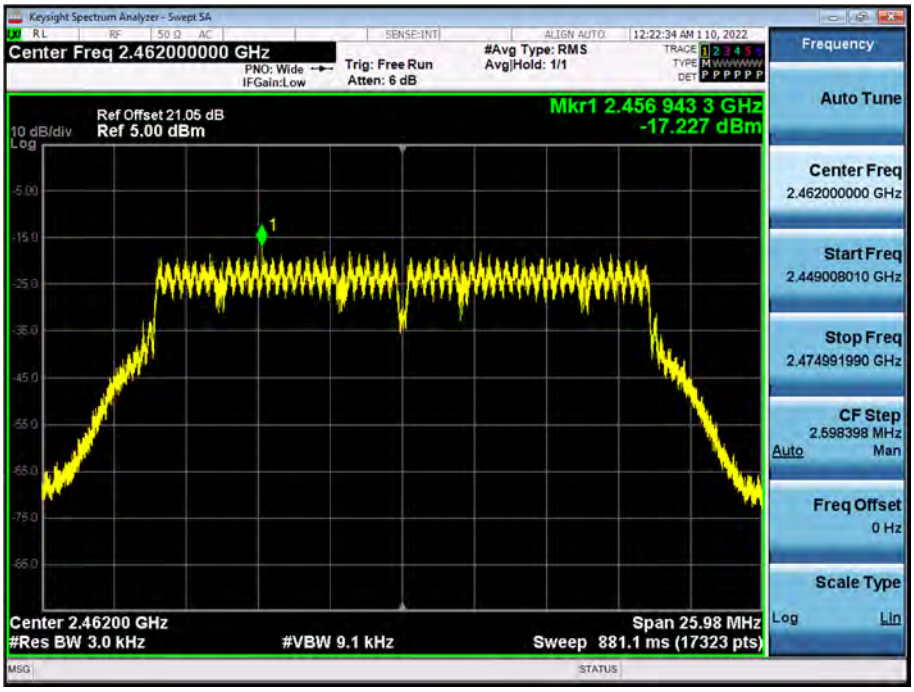
Power Spectral Density (802.11b-CH 1)




Power Spectral Density (802.11g-CH 1)



Power Spectral Density (802.11n_HT20 –CH 11)




**Note :**

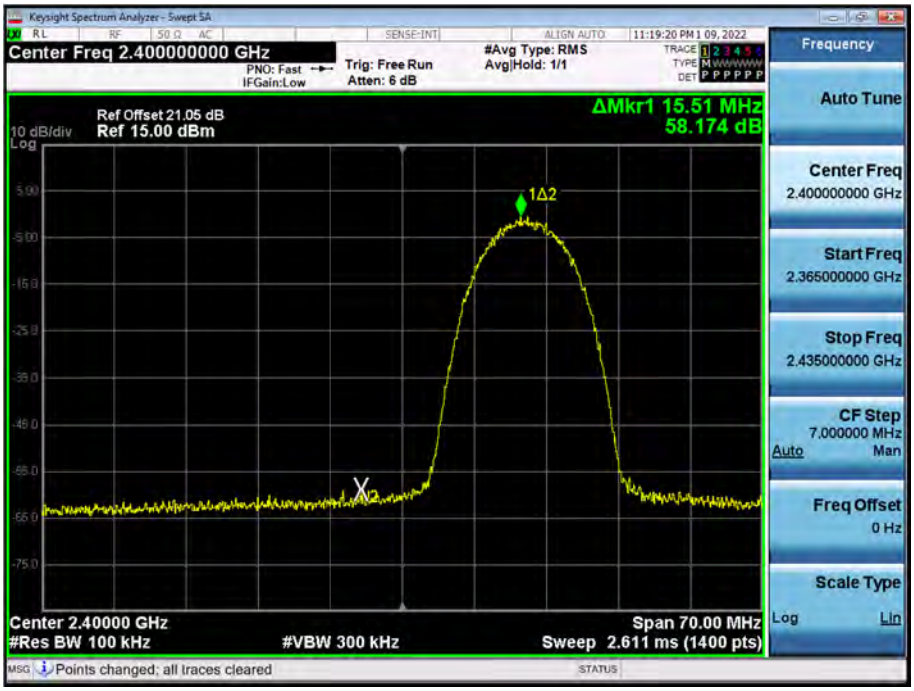
In order to simplify the report, attached plots were only the worst case PSD channel.

## 9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

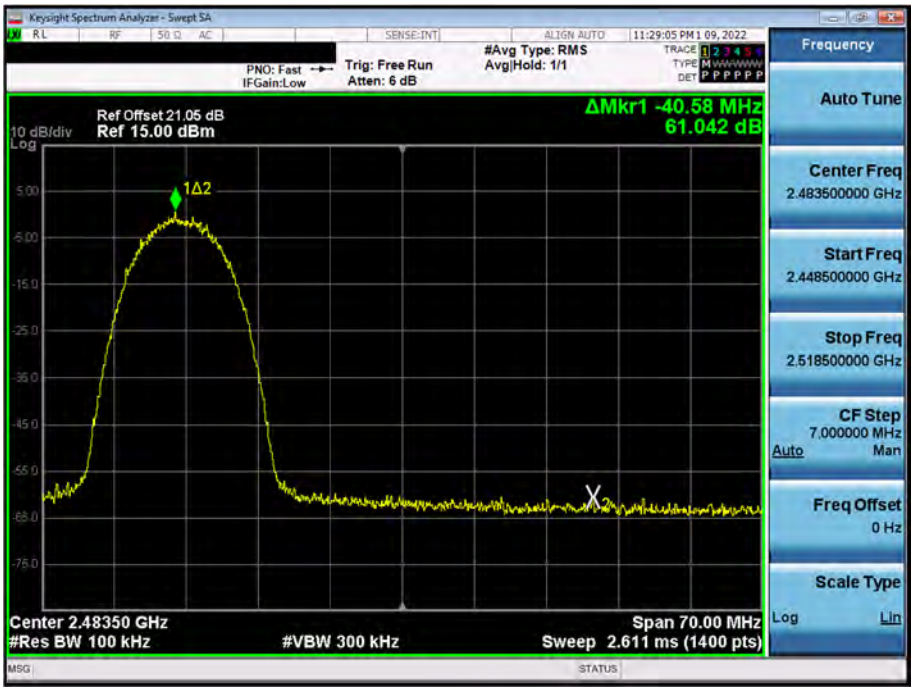
Test Result : please refer to the plot below.
In order to simplify the report, attached plots were only the worst case channel and data rate.

## ▣ Test Plots(BandEdge)

Band Edge (802.11b-CH1)



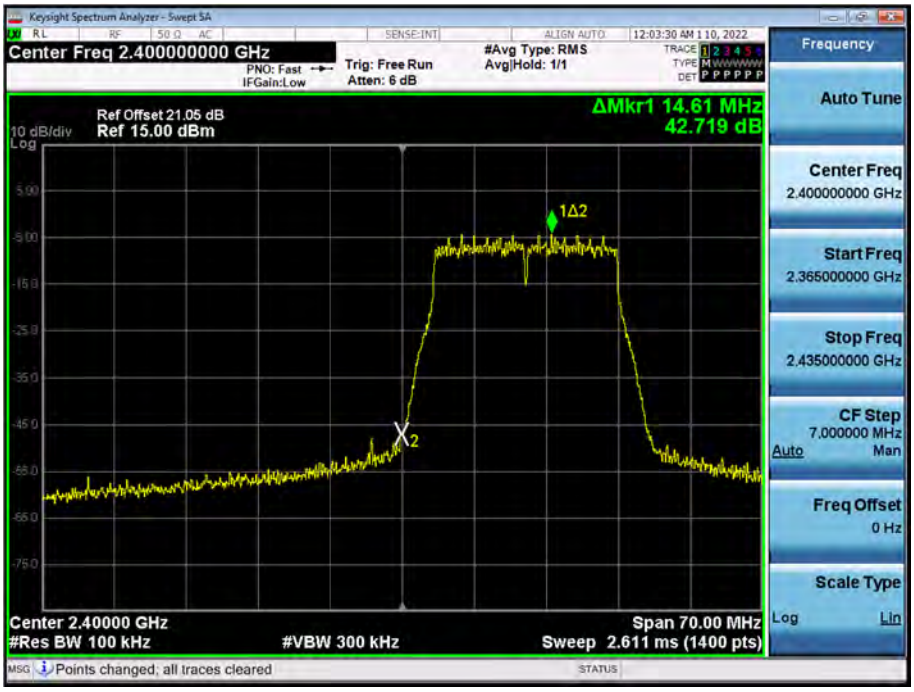

Band Edge (802.11b-CH11)



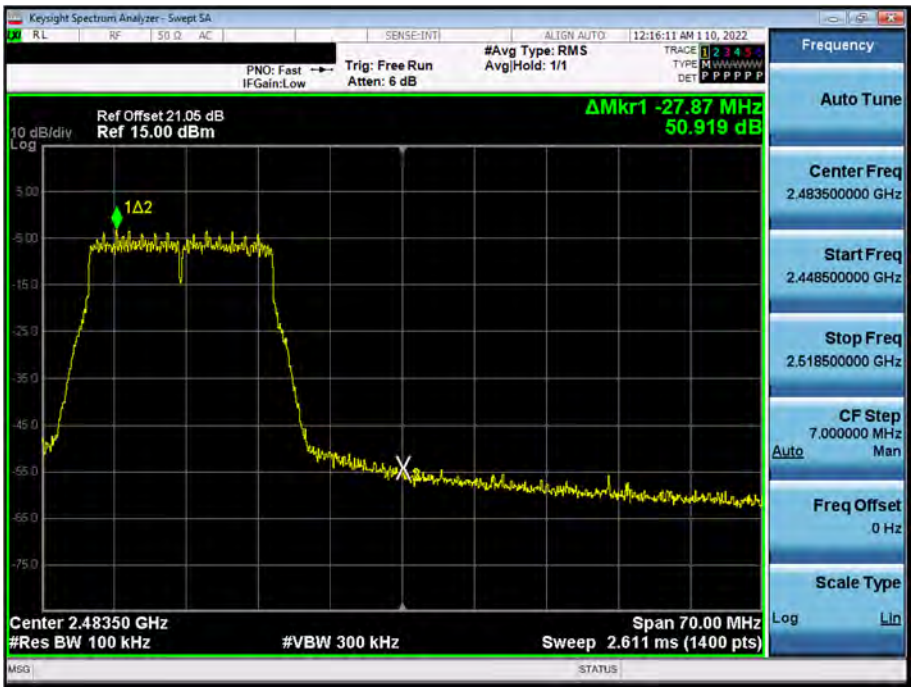
Band Edge (802.11g-CH1)


Band Edge (802.11g-CH11)

Band Edge (802.11n_HT20 -CH1)



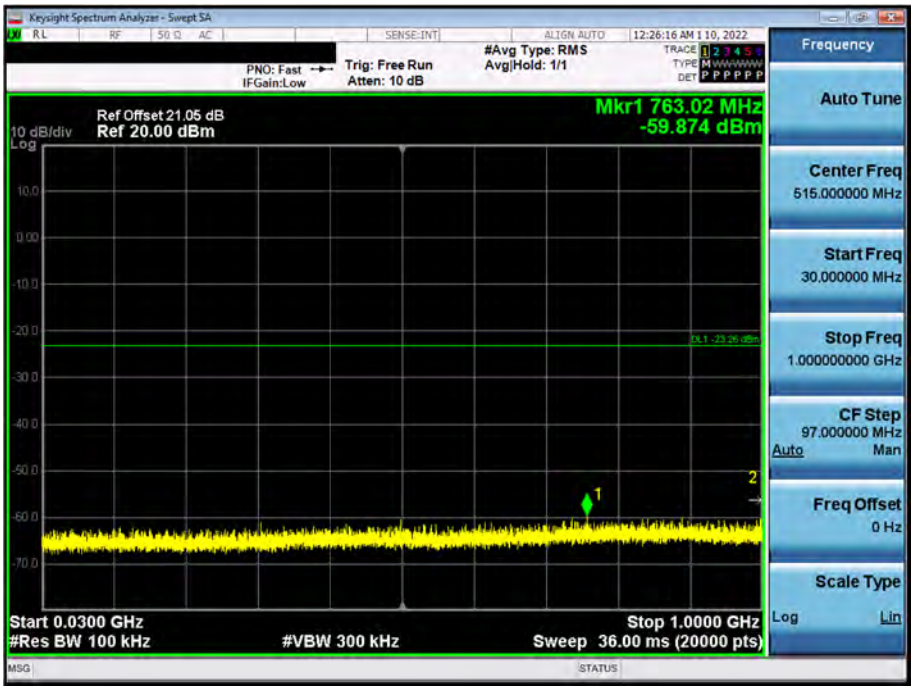

Band Edge (802.11n_HT20 -CH11)



## ▣ Test Plots(Conducted Spurious Emission)

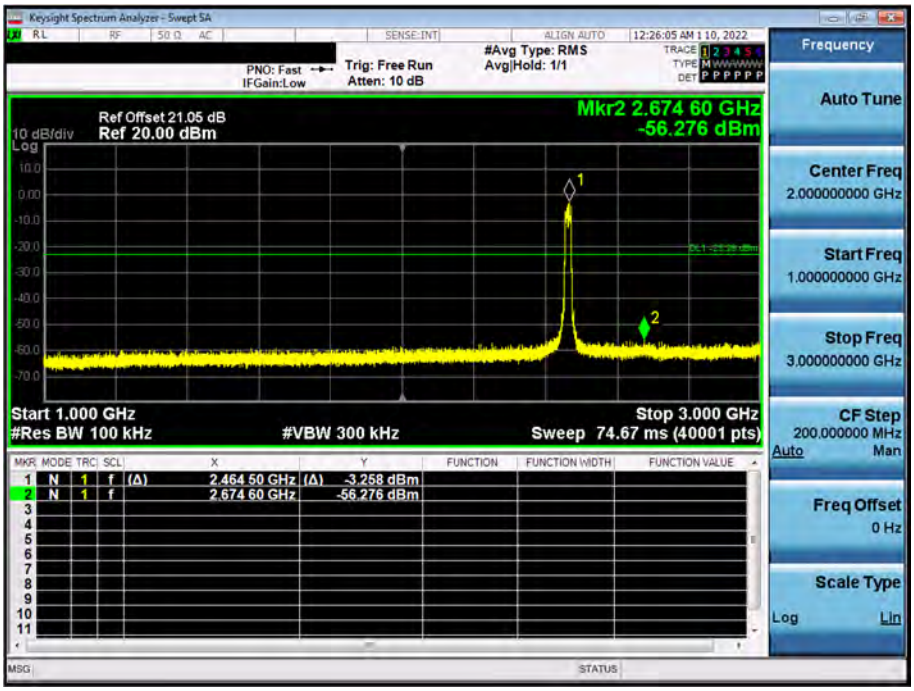
30 MHz ~ 1 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



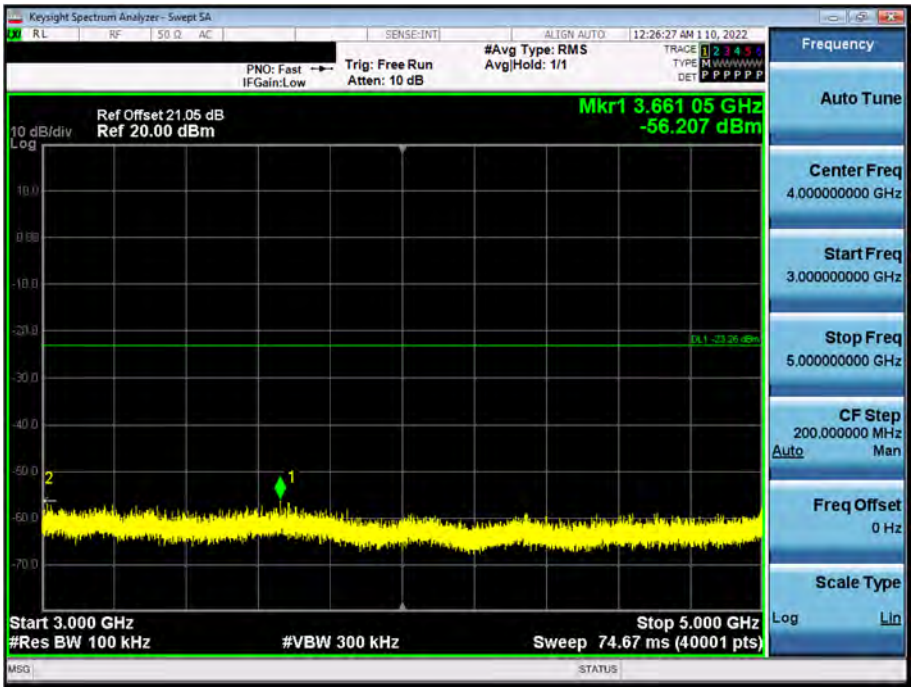

1 GHz ~ 3 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



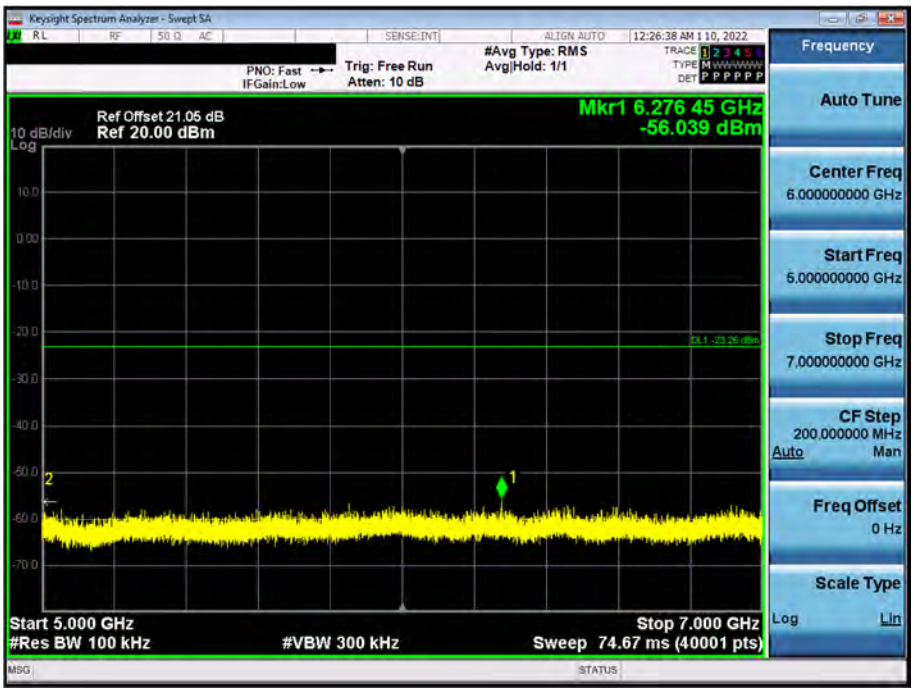
3 GHz ~ 5 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



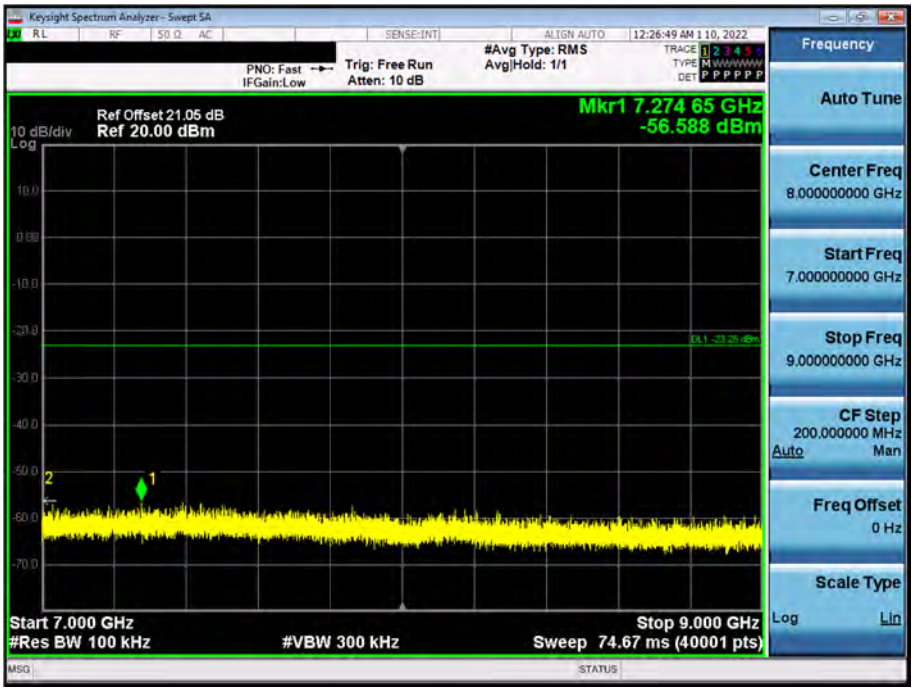

5 GHz ~ 7 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



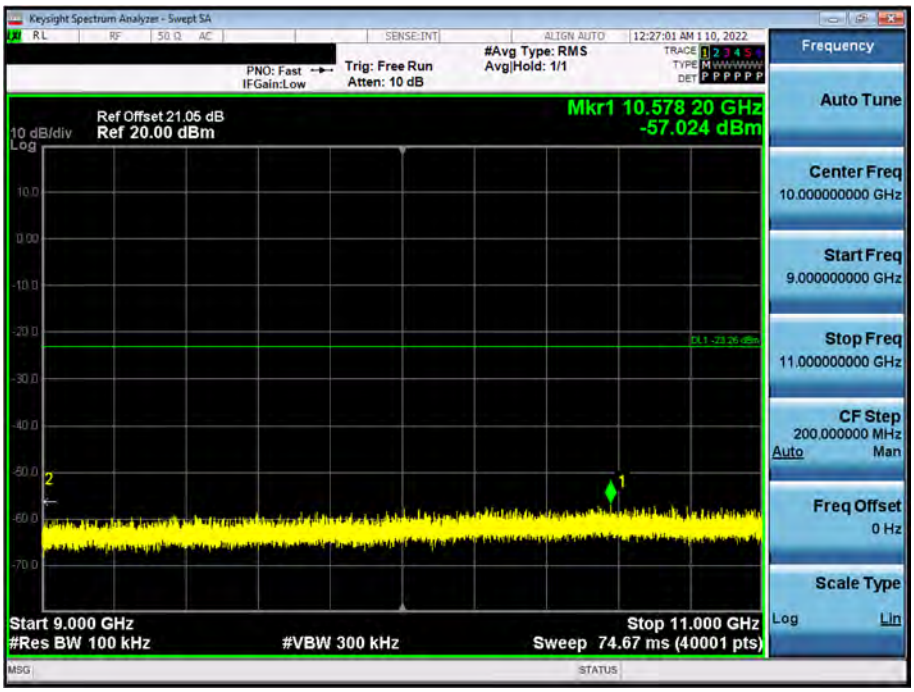
7 GHz ~ 9 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



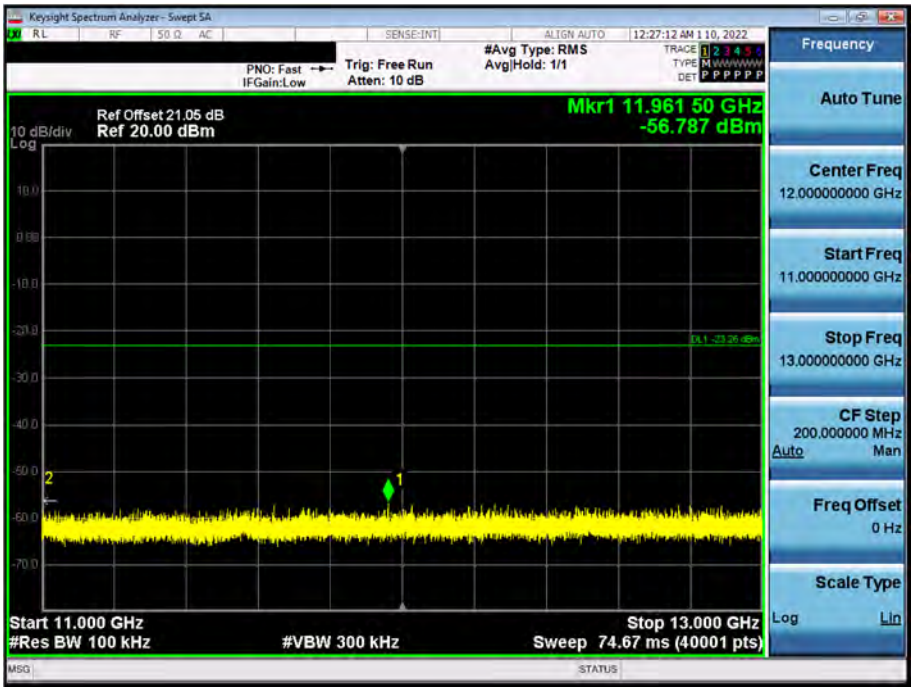

9 GHz ~ 11 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



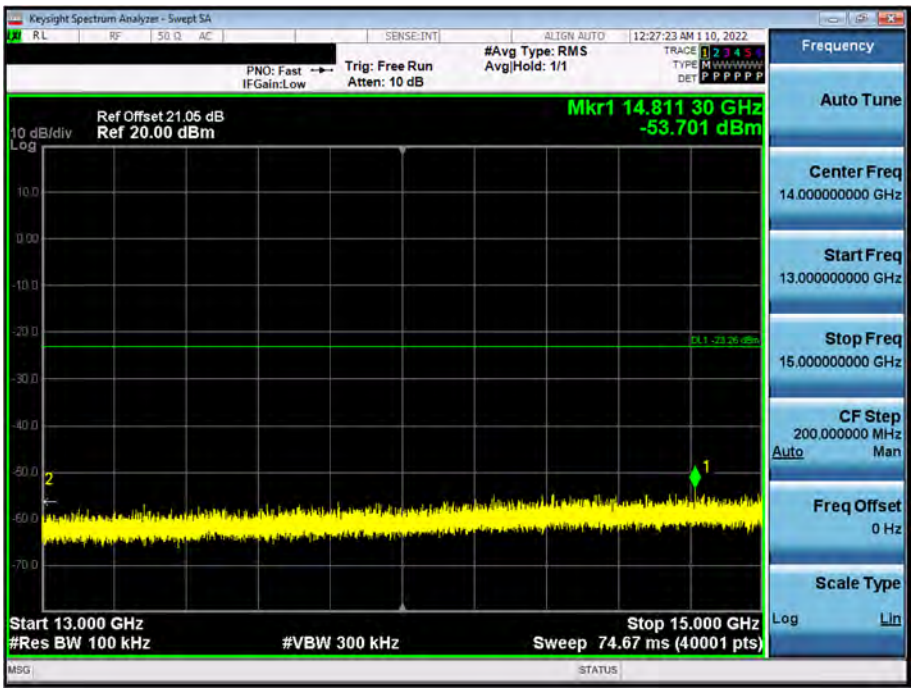
11 GHz ~ 13 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



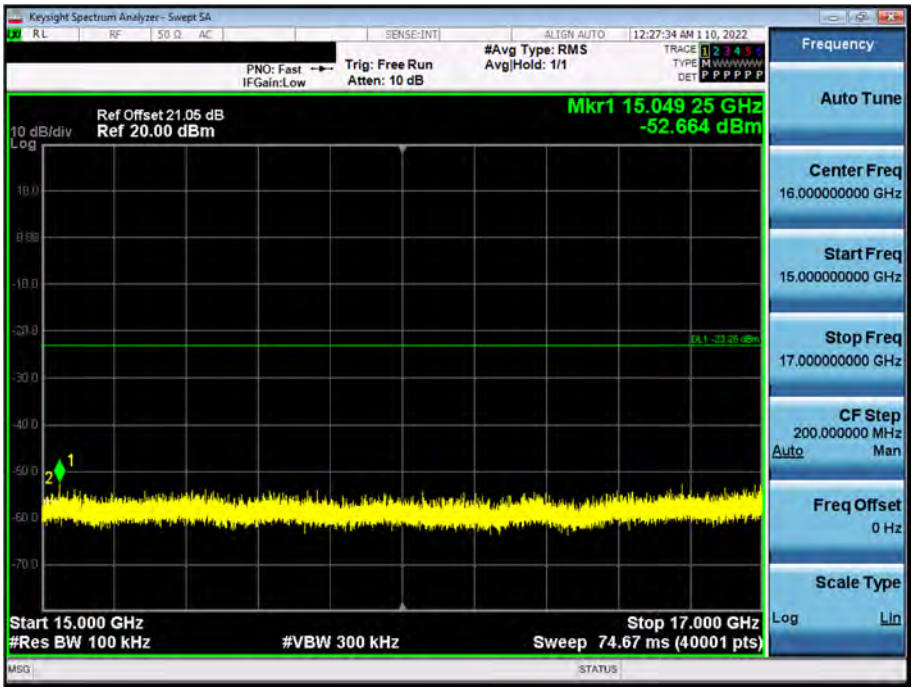

13 GHz ~ 15 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



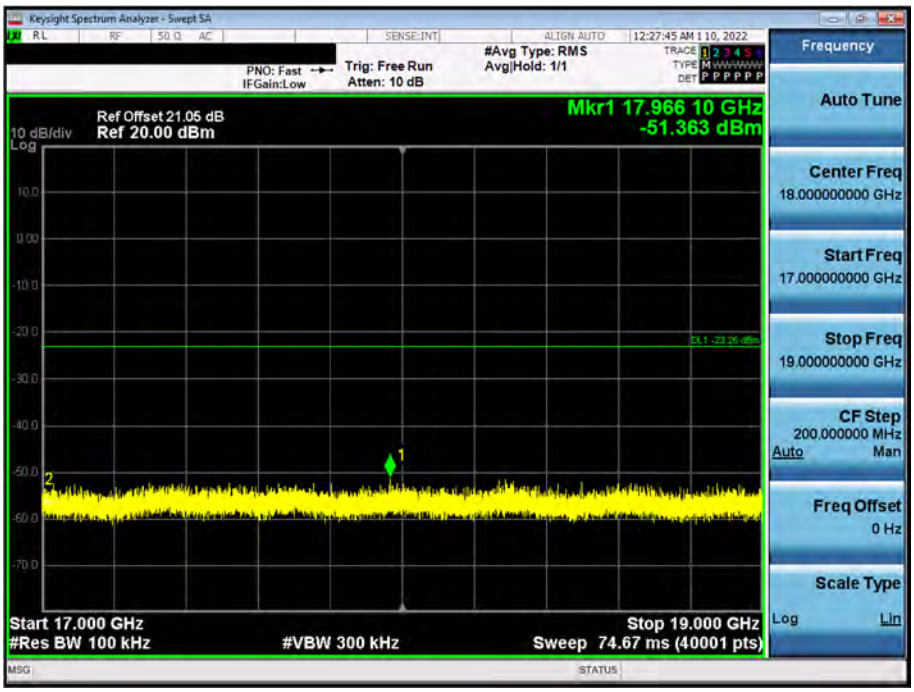
15 GHz ~ 17 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



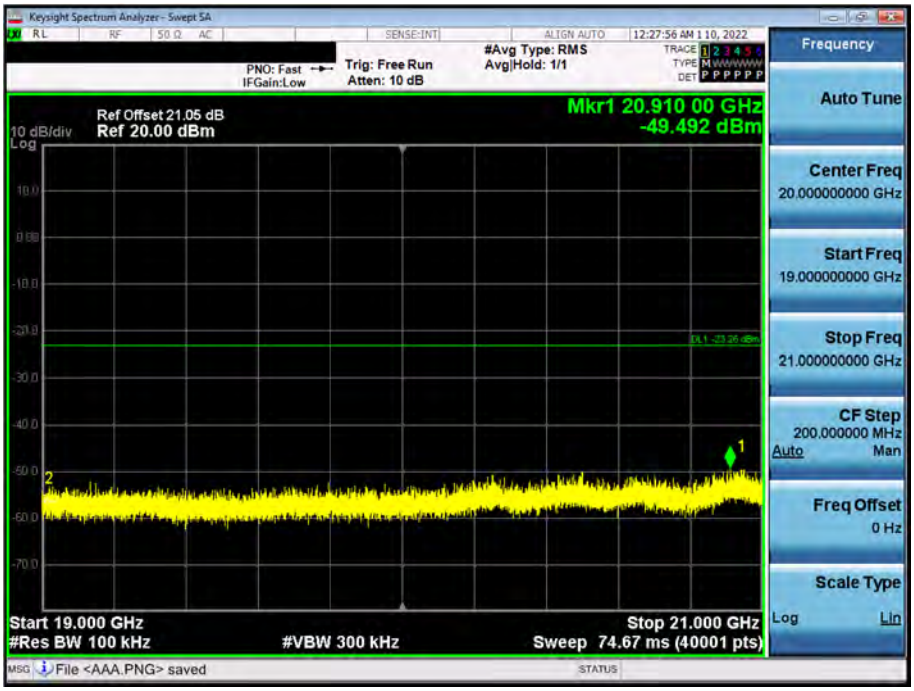

17 GHz ~ 19 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



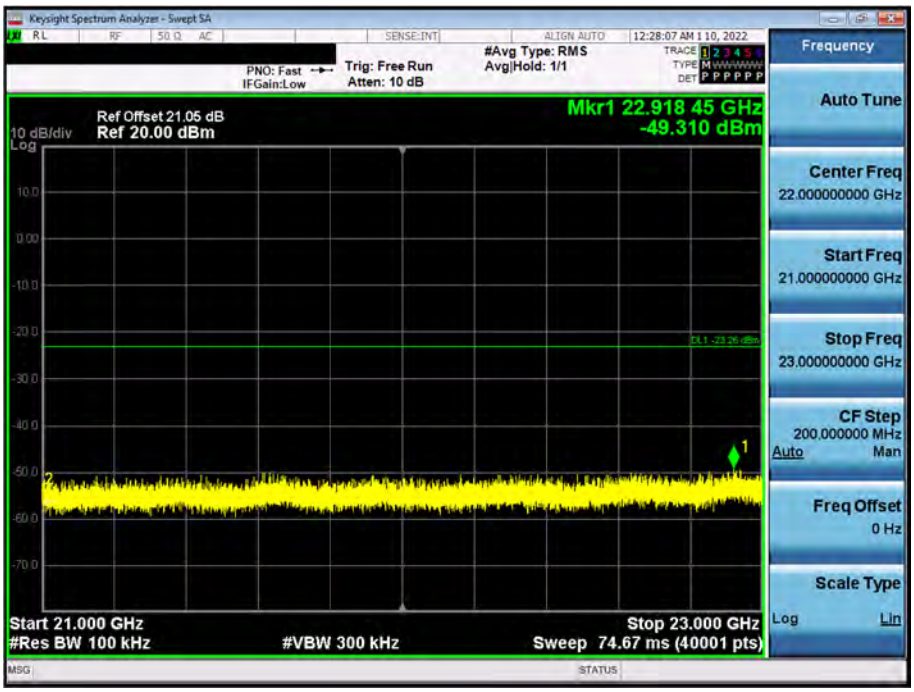
19 GHz ~ 21 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



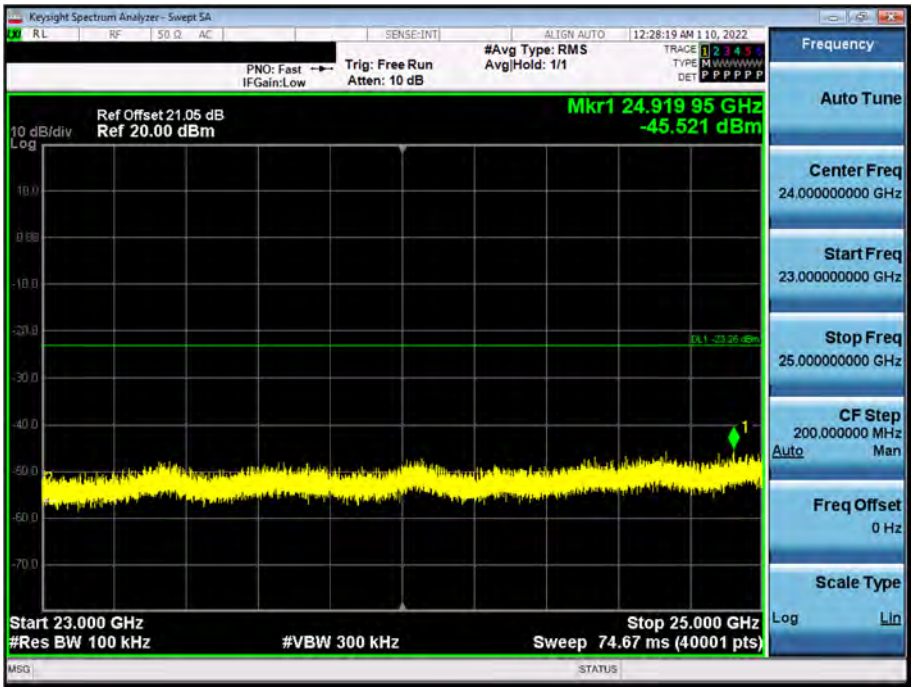

21 GHz ~ 23 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)



23 GHz ~ 25 GHz

Conducted Spurious Emission (802.11g_Ch.11_6 Mbps)




**Note:**

Limit : -23.26 dBm

## 9.6 RADIATED SPURIOUS EMISSIONS

**Frequency Range : 9 kHz – 30 MHz**

| Frequency | Measured Level | Ant. factor | Cable loss | Ant. POL | Total | Limit | Margin |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBm/m | dBm | (H/V) | dBµV/m | dBµV/m | dB |
| No Critical peaks found | | | | | | | |

**Note:**

1. The Measured Level of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
2. Distance extrapolation factor = 40log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBµV) + Distance extrapolation factor

**Frequency Range : Below 1 GHz**

| Frequency | Measured Level | Ant. factor | Cable loss | Ant. POL | Total | Limit | Margin |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBm/m | dBm | (H/V) | dBµV/m | dBµV/m | dB |
| No Critical peaks found | | | | | | | |

**Note:**

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

**Frequency Range : Above 1 GHz**

| | |
|---|---|
| Operation Mode: | 802.11b |
| Transfer Rate: | 1 Mbps |
| Operating Frequency | 2412 |
| Channel No. | 01 Ch |

| Frequency | Measured Level | AF+CL+DF-AG | ANT. POL | Total | Limit | Margin | Measurement Type |
|---|---|---|---|---|---|---|---|
| [MHz] | [dBμV] | [dB/m] | [H/V] | [dBμV/m] | [dBμV/m] | [dB] | |
| 4824 | 43.12 | 3.48 | V | 46.60 | 73.98 | 27.38 | PK |
| 4824 | 31.29 | 3.48 | V | 34.77 | 53.98 | 19.21 | AV |
| 7236 | 45.54 | 8.67 | V | 54.21 | 73.98 | 19.77 | PK |
| 7236 | 37.93 | 8.67 | V | 46.60 | 53.98 | 7.38 | AV |
| 4824 | 43.05 | 3.48 | H | 46.53 | 73.98 | 27.45 | PK |
| 4824 | 31.21 | 3.48 | H | 34.69 | 53.98 | 19.29 | AV |
| 7236 | 44.99 | 8.67 | H | 53.66 | 73.98 | 20.32 | PK |
| 7236 | 37.08 | 8.67 | H | 45.75 | 53.98 | 8.23 | AV |

| | |
|---|---|
| Operation Mode: | 802.11b |
| Transfer Rate: | 1 Mbps |
| Operating Frequency | 2437 |
| Channel No. | 06 Ch |

| Frequency | Measured Level | AF+CL+DF-AG | ANT. POL | Total | Limit | Margin | Measurement Type |
|---|---|---|---|---|---|---|---|
| [MHz] | [dBμV] | [dB/m] | [H/V] | [dBμV/m] | [dBμV/m] | [dB] | |
| 4874 | 42.48 | 3.19 | V | 45.67 | 73.98 | 28.31 | PK |
| 4874 | 30.15 | 3.19 | V | 33.34 | 53.98 | 20.64 | AV |
| 7311 | 43.29 | 9.41 | V | 52.70 | 73.98 | 21.28 | PK |
| 7311 | 32.07 | 9.41 | V | 41.48 | 53.98 | 12.50 | AV |
| 4874 | 42.34 | 3.19 | H | 45.53 | 73.98 | 28.45 | PK |
| 4874 | 30.11 | 3.19 | H | 33.30 | 53.98 | 20.68 | AV |
| 7311 | 43.43 | 9.41 | H | 52.84 | 73.98 | 21.14 | PK |
| 7311 | 32.24 | 9.41 | H | 41.65 | 53.98 | 12.33 | AV |

| | |
|---|---|
| Operation Mode: | 802.11b |
| Transfer MCS Index: | 1 Mbps |
| Operating Frequency | 2462 |
| Channel No. | 11 Ch |

| Frequency | Measured Level | AF+CL+DF-AG | ANT. POL | Total | Limit | Margin | Measurement Type |
|---|---|---|---|---|---|---|---|
| [MHz] | [dBµV] | [dB/m] | [H/V] | [dBµV/m] | [dBµV/m] | [dB] | |
| 4924 | 42.16 | 2.54 | V | 44.70 | 73.98 | 29.28 | PK |
| 4924 | 30.01 | 2.54 | V | 32.55 | 53.98 | 21.43 | AV |
| 7386 | 42.95 | 10.04 | V | 52.99 | 73.98 | 20.99 | PK |
| 7386 | 33.12 | 10.04 | V | 43.16 | 53.98 | 10.82 | AV |
| 4924 | 42.09 | 2.54 | H | 44.63 | 73.98 | 29.35 | PK |
| 4924 | 29.83 | 2.54 | H | 32.37 | 53.98 | 21.61 | AV |
| 7386 | 40.99 | 10.04 | H | 51.03 | 73.98 | 22.95 | PK |
| 7386 | 32.28 | 10.04 | H | 42.32 | 53.98 | 11.66 | AV |

**Note:**

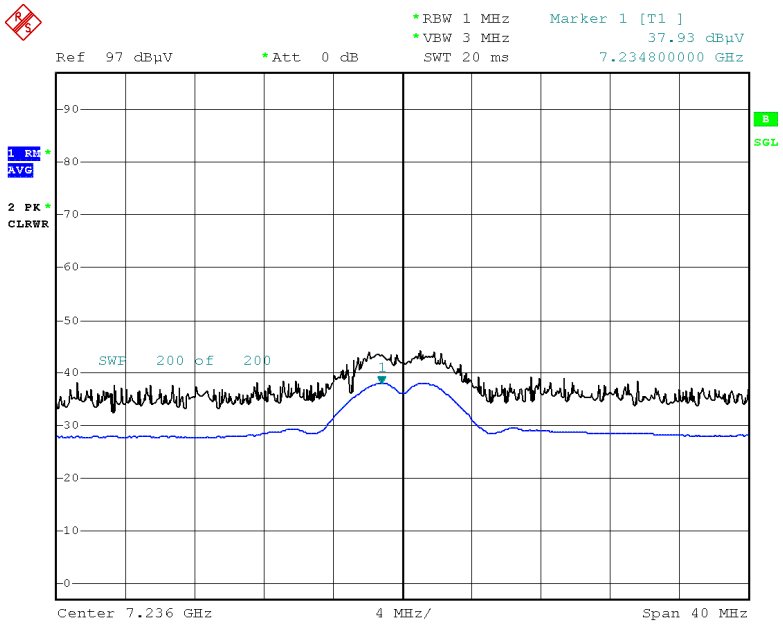
All Modes of operation were investigated and the worst case configuration results are reported.

[Worst case]

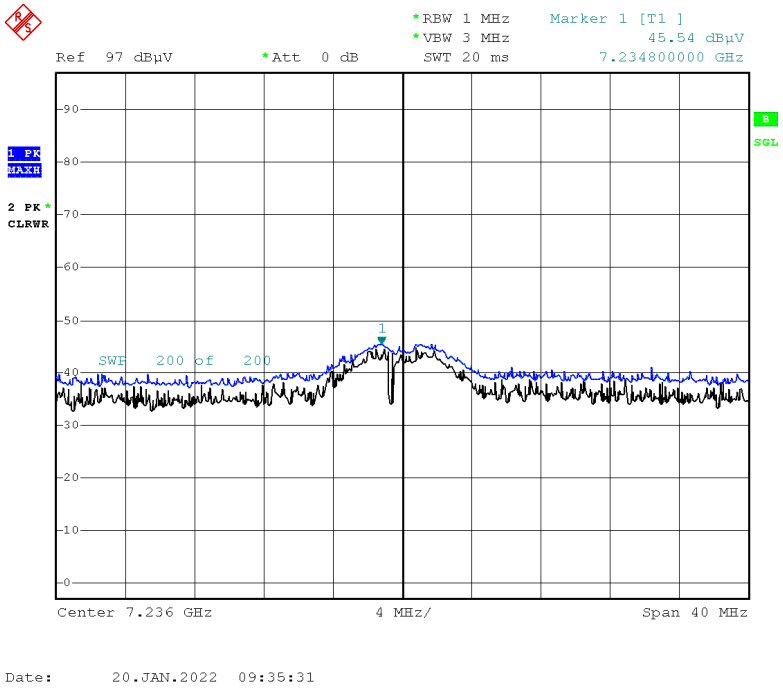
- Worstcase : 802.11b

## ▣ Test Plots (Worst case : X-V)

Radiated Spurious Emissions plot – Average Result (802.11b, Ch.1 3rd Harmonic)




Radiated Spurious Emissions plot – Peak Result (802.11b, Ch.1 3rd Harmonic)




**Note:**

Plot of worst case are only reported.

## 9.7 RADIATED RESTRICTED BAND EDGES

| | |
|---|---|
| Operation Mode: | 802.11b |
| Transfer Rate: | 1 Mbps |
| Operating Frequency | 2412 MHz, 2462 MHz |
| Channel No. | 01 Ch, 11 Ch |

| Frequency | Measured Level | AF+CL+DF-AG | ANT. POL | Total | Limit | Margin | Measurement |
|---|---|---|---|---|---|---|---|
| [MHz] | [dBµV] | [dB/m] | [H/V] | [dBµV/m] | [dBµV/m] | [dB] | Type |
| 2390.0 | 47.86 | 0.75 | H | 48.61 | 73.98 | 25.37 | PK |
| 2390.0 | 36.38 | 0.75 | H | 37.13 | 53.98 | 16.85 | AV |
| 2390.0 | 48.09 | 0.75 | V | 48.84 | 73.98 | 25.14 | PK |
| 2390.0 | 36.40 | 0.75 | V | 37.15 | 53.98 | 16.83 | AV |
| 2483.5 | 47.93 | 1.34 | H | 49.27 | 73.98 | 24.71 | PK |
| 2483.5 | 36.21 | 1.34 | H | 37.55 | 53.98 | 16.43 | AV |
| 2483.5 | 48.09 | 1.34 | V | 49.43 | 73.98 | 24.55 | PK |
| 2483.5 | 36.23 | 1.34 | V | 37.57 | 53.98 | 16.41 | AV |

| | |
|---|---|
| Operation Mode: | 802.11g |
| Transfer Rate: | 6 Mbps |
| Operating Frequency | 2412 MHz, 2462 MHz |
| Channel No. | 01 Ch, 11 Ch |

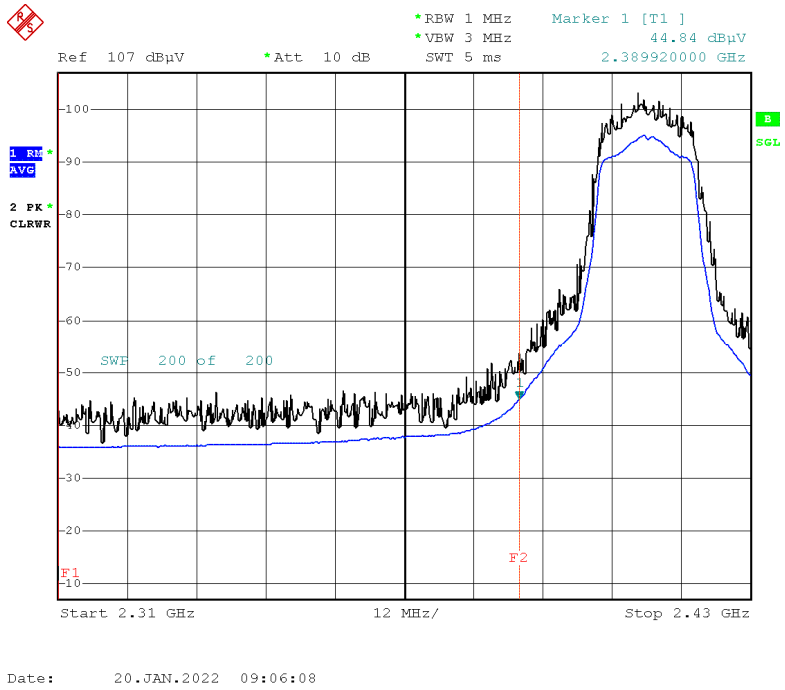
| Frequency | Measured Level | Duty Cycle Factor | AF+CL+DF-AG | ANT. POL | Total | Limit | Margin | Measurement Type |
|---|---|---|---|---|---|---|---|---|
| [MHz] | [dBµV] | [dB] | [dB/m] | [H/V] | [dBµV/m] | [dBµV/m] | [dB] | |
| 2390.0 | 58.32 | 0.000 | 0.75 | H | 59.07 | 73.98 | 14.91 | PK |
| 2390.0 | 43.08 | 0.298 | 0.75 | H | 44.12 | 53.98 | 9.86 | AV |
| 2390.0 | 58.59 | 0.000 | 0.75 | V | 59.34 | 73.98 | 14.64 | PK |
| 2390.0 | 44.84 | 0.298 | 0.75 | V | 45.88 | 53.98 | 8.10 | AV |
| 2483.5 | 54.28 | 0.000 | 1.34 | H | 55.62 | 73.98 | 18.36 | PK |
| 2483.5 | 41.08 | 0.298 | 1.34 | H | 42.72 | 53.98 | 11.26 | AV |
| 2483.5 | 55.67 | 0.000 | 1.34 | V | 57.01 | 73.98 | 16.97 | PK |
| 2483.5 | 42.92 | 0.298 | 1.34 | V | 44.56 | 53.98 | 9.42 | AV |

| | |
|---|---|
| Operation Mode: | 802.11n (HT20) |
| Transfer Rate: | MCS0 |
| Operating Frequency | 2412 MHz, 2462 MHz |
| Channel No. | 01 Ch, 11 Ch |

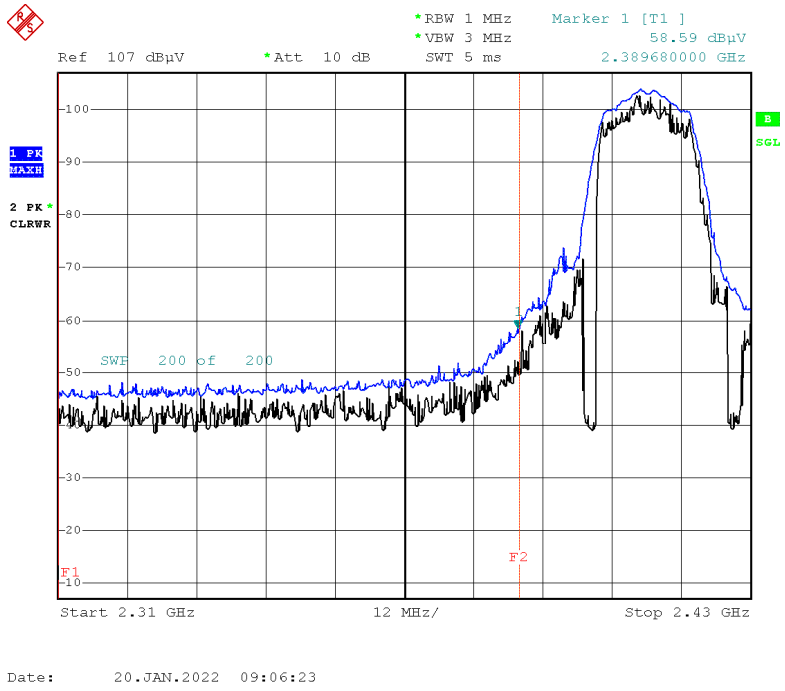
| Frequency | Measured Level | Duty Cycle Factor | AF+CL+DF-AG | ANT. POL | Total | Limit | Margin | Measurement Type |
|---|---|---|---|---|---|---|---|---|
| [MHz] | [dBµV] | [dB] | [dB/m] | [H/V] | [dBµV/m] | [dBµV/m] | [dB] | |
| 2390.0 | 60.57 | 0.000 | 0.75 | H | 61.32 | 73.98 | 12.66 | PK |
| 2390.0 | 42.99 | 0.321 | 0.75 | H | 44.06 | 53.98 | 9.92 | AV |
| 2390.0 | 61.30 | 0.000 | 0.75 | V | 62.05 | 73.98 | 11.93 | PK |
| 2390.0 | 44.72 | 0.321 | 0.75 | V | 45.79 | 53.98 | 8.19 | AV |
| 2483.5 | 54.11 | 0.000 | 1.34 | H | 55.45 | 73.98 | 18.53 | PK |
| 2483.5 | 40.98 | 0.321 | 1.34 | H | 42.64 | 53.98 | 11.34 | AV |
| 2483.5 | 56.75 | 0.000 | 1.34 | V | 58.09 | 73.98 | 15.89 | PK |
| 2483.5 | 42.33 | 0.321 | 1.34 | V | 43.99 | 53.98 | 9.99 | AV |

## ▣ Test Plots

Radiated Restricted Band Edges plot – Average Result (802.11g Ch.1, X-V)




Radiated Restricted Band Edges plot – Peak Result (802.11g Ch.1, X-V)




**Note:**

Plot of worst case are only reported.

## 9.8 RECEIVER SPURIOUS EMISSIONS

**Frequency Range : Below 1 GHz**

| Frequency | Measured Level | Ant. factor | Cable loss | Ant. POL | Total | Limit | Margin |
|---|---|---|---|---|---|---|---|
| MHz | dBμV/m | dBm/m | dBm | (H/V) | dBμV/m | dBμV/m | dB |
| No Critical peaks found | | | | | | | |

**Note:**

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

**Frequency Range : Above 1 GHz**

| Frequency | Measured Level | Ant. factor | Cable loss | Ant. POL | Total | Limit | Margin |
|---|---|---|---|---|---|---|---|
| MHz | dBμV/m | dBm/m | dBm | (H/V) | dBμV/m | dBμV/m | dB |
| No Critical peaks found | | | | | | | |

## 10. LIST OF TEST EQUIPMENT

**Conducted Test**

| Equipment | Model | Manufacturer | Serial No. | Due to Calibration | Calibration Interval |
|---|---|---|---|---|---|
| LISN | ENV216 | Rohde & Schwarz | 102245 | 08/23/2022 | Annual |
| Test Receiver | ESCI | Rohde & Schwarz | 100033 | 06/15/2022 | Annual |
| Temperature Chamber | SU-642 | ESPAC | 0093008124 | 03/15/2022 | Annual |
| Signal Analyzer | N9020A | Agilent | MY52440870 | 09/02/2022 | Annual |
| Signal Analyzer | N9030A | Agilent | MY49431210 | 01/11/2023 | Annual |
| Power Meter | N1911A | Agilent | MY45100523 | 04/08/2022 | Annual |
| Power Sensor | N1921A | Agilent | MY57820067 | 04/08/2022 | Annual |
| Directional Coupler | 87300B | Agilent | 3116A03621 | 11/02/2022 | Annual |
| Power Splitter | 11667B | Hewlett Packard | 05001 | 05/20/2022 | Annual |
| DC Power Supply | E3632A | Hewlett Packard | KR75303960 | 06/10/2022 | Annual |
| Attenuator (10 dB) | 5910-N-50-010 | H+S | 00801 | 10/29/2022 | Annual |
| Software | EMC32 | Rohde & Schwarz | N/A | N/A | N/A |
| FCC WLAN&BT&BLE Conducted Test Software v3.0 | FCC WLAN&BT&BLE Conducted Test Software v3.0 | HCT CO., LTD. | N/A | N/A | N/A |
| Bluetooth Tester | CBT | Rohde & Schwarz | 100422 | 05/04/2022 | Annual |

**Note:**

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

**Radiated Test**

| Equipment | Model | Manufacturer | Serial No. | Due to Calibration | Calibration Interval |
|---|---|---|---|---|---|
| Controller (Antenna mast) | CO3000 | Innco system | CO3000-4p | N/A | N/A |
| Antenna Position Tower | MA4640/800-XP-EP | Innco system | N/A | N/A | N/A |
| Controller | 2090 | Emco | 060520 | N/A | N/A |
| Turn Table | Turn Table | Ets | N/A | N/A | N/A |
| Loop Antenna | Loop Antenna | Rohde & Schwarz | 1513-333 | 03/19/2022 | Biennial |
| Hybrid Antenna | VULB 9168 | Schwarzbeck | 9168-0895 | 09/04/2022 | Biennial |
| Horn Antenna | BBHA 9120D | Schwarzbeck | 9120D-1191 | 11/18/2023 | Biennial |
| Horn Antenna (15 GHz ~ 40 GHz) | BBHA9170 | Schwarzbeck | BBHA9170541 | 11/16/2023 | Biennial |
| Spectrum Analyzer | FSP (9 kHz ~ 30 GHz) | Rohde & Schwarz | 836650/016 | 09/13/2022 | Annual |
| Spectrum Analyzer | FSV40-N | Rohde & Schwarz | 101068-SZ | 09/15/2022 | Annual |
| Band Reject Filter | WRCJV2400/2483.5-2370/2520-60/12SS | Wainwright Instruments | 1 | 06/29/2022 | Annual |
| Band Reject Filter | WRCJV5100/5850-40/50-8EEK | Wainwright Instruments | 1 | 02/07/2023 | Annual |
| Attenuator (10 dB)<br>56-10 | CBLU1183540B-01<br>56-10 | CERNEX<br>WEINSCHEL | N/A | 12/22/2022 | Annual |
| Broadband Low Noise Amplifier<br>Attenuator (3 dB) | CBL06185030<br>18B-03 | CERNEX<br>Api tech. | N/A | 12/22/2022 | Annual |
| High Pass Filter | WHKX10-2700-3000-18000-40SS | Wainwright Instruments | N/A | 12/22/2022 | Annual |
| High Pass Filter | WHKX8-6090-7000-18000-40SS | Wainwright Instruments | N/A | 12/22/2022 | Annual |
| Thru | COAXIAL ATTENUATOR | T&M SYSTEM | N/A | 12/22/2022 | Annual |
| Power Amplifier | CBL18265035 | CERNEX | 22966 | 12/02/2022 | Annual |
| Power Amplifier | CBL26405040 | CERNEX | 25956 | 03/23/2022 | Annual |
| Bluetooth Tester | TC-3000C | TESCOM | 3000C000276 | 03/09/2022 | Annual |

**Note:**

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.
3. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5(Version : 2017).

## 11. ANNEX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

| No. | Description |
|---|---|
| 1 | HCT-RF-2202-FI003-P |