TESTING LABORATORY
CERTIFICATE#4323.01

# FCC PART 15.247

# TEST REPORT

For

## M5Stack Technology Co.,Ltd

106,1st Floor,Building 1,Bright Technology Park,88Zhuguang North Road,XiliTaoyuan Street,Nanshan District,Shenzhen,Guangdong,China

## FCC ID: 2AN3WATOM

| **Report Type:** | **Product Type:** |
|---|---|
| Original Report | ATOM |

| | |
|---|---|
| **Test Engineer:** | Lee Li |
| **Report Number:** | RSHD200103001-00B |
| **Report Date:** | 2020-02-21 |
| **Reviewed By:** | Oscar Ye<br>EMC Manager |
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# GENERAL INFORMATION

## Product Description for Equipment under Test (EUT)

| | |
|---|---|
| Applicant: | M5Stack Technology Co.,Ltd |
| Product Type: | ATOM |
| Tested Model: | ATOM-1 |
| Series Model: | ATOM-2 |
| Power Supply: | DC 5.0V |
| RF Function: | 2.4G Wi-Fi, BLE(1Mbps) |
| Operating Band/Frequency: | 2.4G Wi-Fi: 2412-2462MHz<br>BLE(1Mbps): 2402-2480MHz |
| Channel Number: | 2.4G Wi-Fi: 11, BLE(1Mbps): 40 |
| Channel Separation: | 2.4G Wi-Fi: 5MHz, BLE(1Mbps): 2MHz |
| Modulation Type: | BLE(1Mbps): GFSK; Wi-Fi: OFDM,DSSS |
| Antenna Type: | Wi-Fi/BLE: PIFA Antenna |
| Maximum Antenna Gain: | Wi-Fi/BLE: 2dBi |

**All measurement and test data in this report was gathered from production sample serial number: 20200103001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2020-01-03)*

## Objective

This report is prepared on behalf of *M5Stack Technology Co.,Ltd* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine Compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

## Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS submissions with FCC ID: 2AN3WATOM

## Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

## Measurement Uncertainty

| Item | | Uncertainty |
|---|---|---|
| AC Power Lines Conducted Emissions | | 3.19dB |
| RF conducted test with spectrum | | 0.9dB |
| RF Output Power with Power meter | | 0.5dB |
| Radiated emission | 30MHz~1GHz | 6.11dB |
| | 1GHz~6GHz | 4.45dB |
| | 6GHz~18GHz | 5.23dB |
| | 18GHz~40GHz | 5.65dB |
| Occupied Bandwidth | | 0.5kHz |
| Temperature | | 1.0℃ |
| Humidity | | 6% |

Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

## Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01), the FCC designation No. CN1185 under the FCC KDB 974614 D01 and CAB identifier CN0004 under the ISED requirement. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014

# SYSTEM TEST CONFIGURATION

## Description of Test Configuration

Test channel list is as below:

For 802.11b, 802.11g and 802.11n-HT20 mode, EUT was tested with Channel 1, 6 and 11;

For 802.11n-HT40 mode, EUT was tested with Channel 3, 6 and 9;

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---|---|---|---|
| 1 | 2412 | 7 | 2442 |
| 2 | 2417 | 8 | 2447 |
| 3 | 2422 | 9 | 2452 |
| 4 | 2427 | 10 | 2457 |
| 5 | 2432 | 11 | 2462 |
| 6 | 2437 | / | / |

For BLE mode, EUT was tested with channel 0, 19 and 39.

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---|---|---|---|
| 0 | 2402 | 20 | 2442 |
| 1 | 2404 | … | … |
| … | … | … | … |
| … | … | … | … |
| 18 | 2438 | 38 | 2478 |
| 19 | 2440 | 39 | 2480 |

## Equipment Modifications

No modification was made to the EUT tested.

## EUT Exercise Software

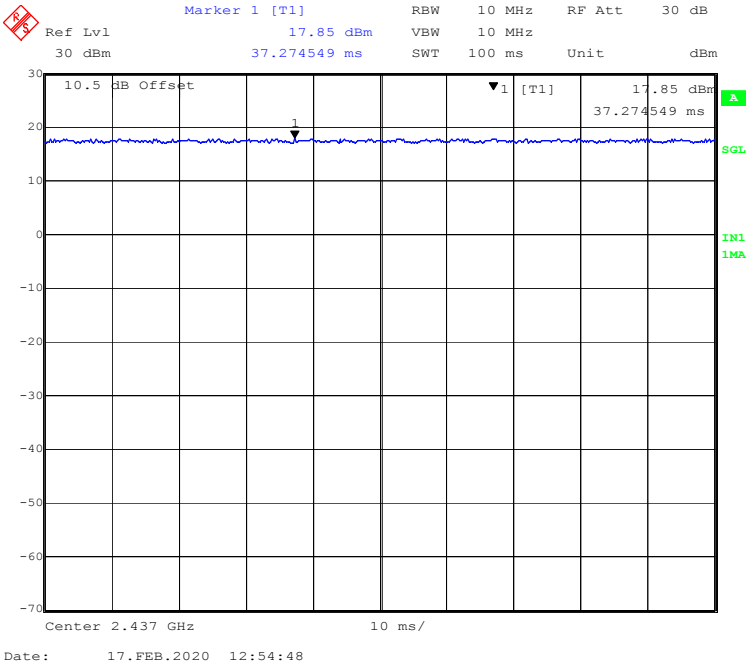
RF test software: espRFTool

Pre-scan with all the data rates, and the worst case was performed as below:

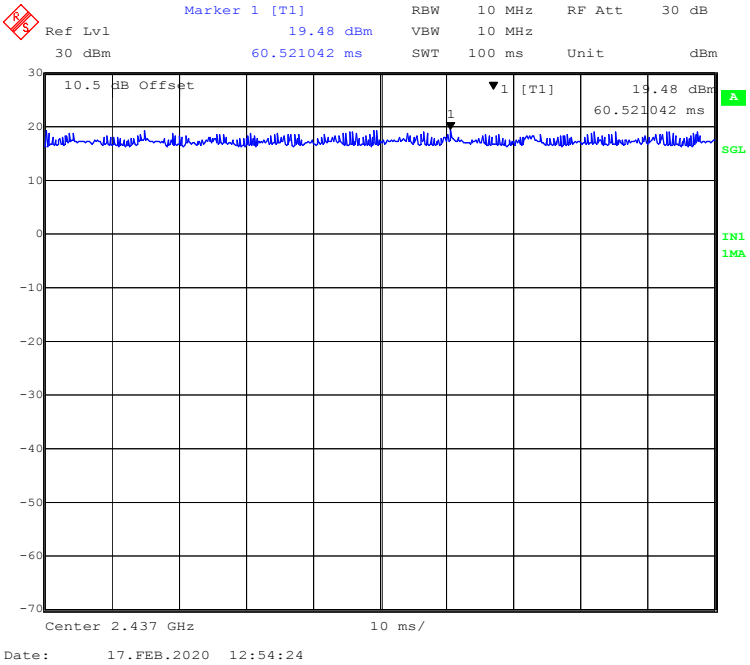
| Mode | Data Rate | Power Level |
|---|---|---|
| 802.11b | 1 Mbps | 8 |
| 802.11g | 6 Mbps | 8 |
| 802.11n-HT20 | MCS0 | 8 |
| 802.11n-HT40 | MCS0 | 16 |
| BLE | 1Mbps | 5 |

**Duty Cycle:**

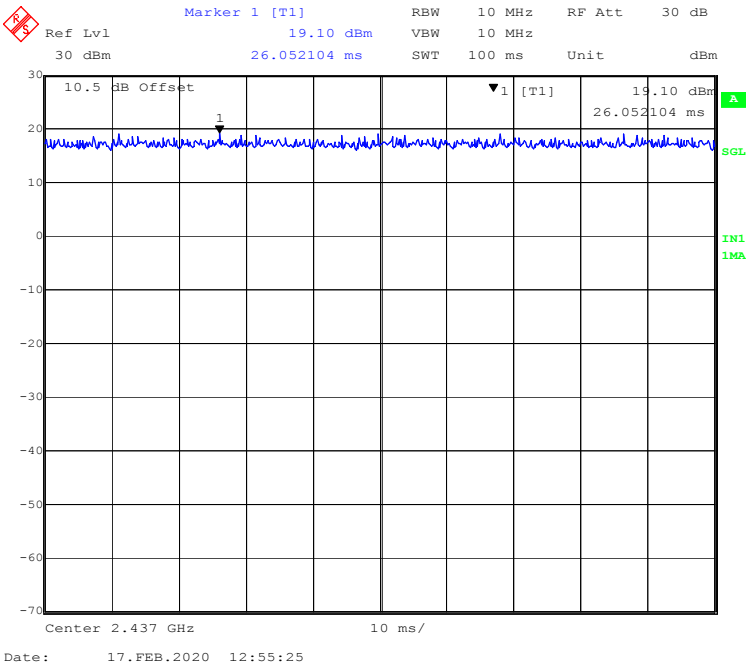
**802.11b Mode Middle Channel**



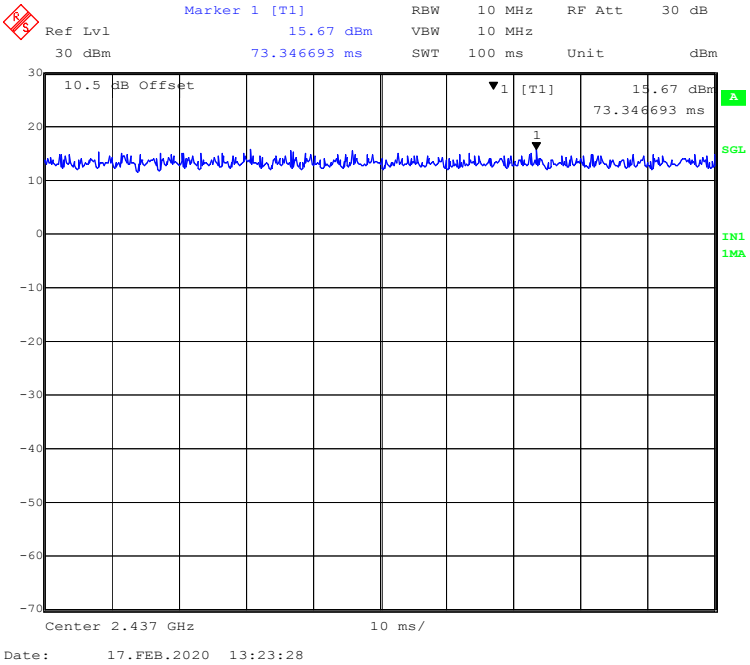
## 802.11g Mode Middle Channel



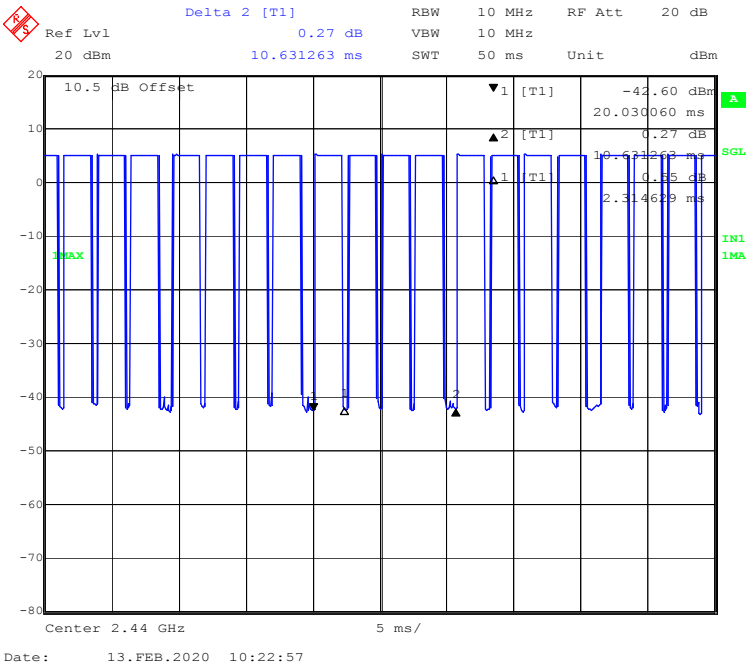

## 802.11n-HT20 Mode Middle Channel



## 802.11n-HT40 Mode Middle Channel




## BLE Mode Middle Channel



| Mode | Duty Cycle (%) | T(ms) | 1/T(kHz) | 10log(1/x) |
|---|---|---|---|---|
| 802.11b | 100.00 | / | / | 0.00 |
| 802.11g | 100.00 | / | / | 0.00 |
| 802.11n-HT20 | 100.00 | / | / | 0.00 |
| 802.11n-HT40 | 100.00 | / | / | 0.00 |
| BLE | 20.08 | 2.315 | 0.43 | 6.97 |

**Note**: "x" means the Duty Cycle.

## Support Equipment List and Details

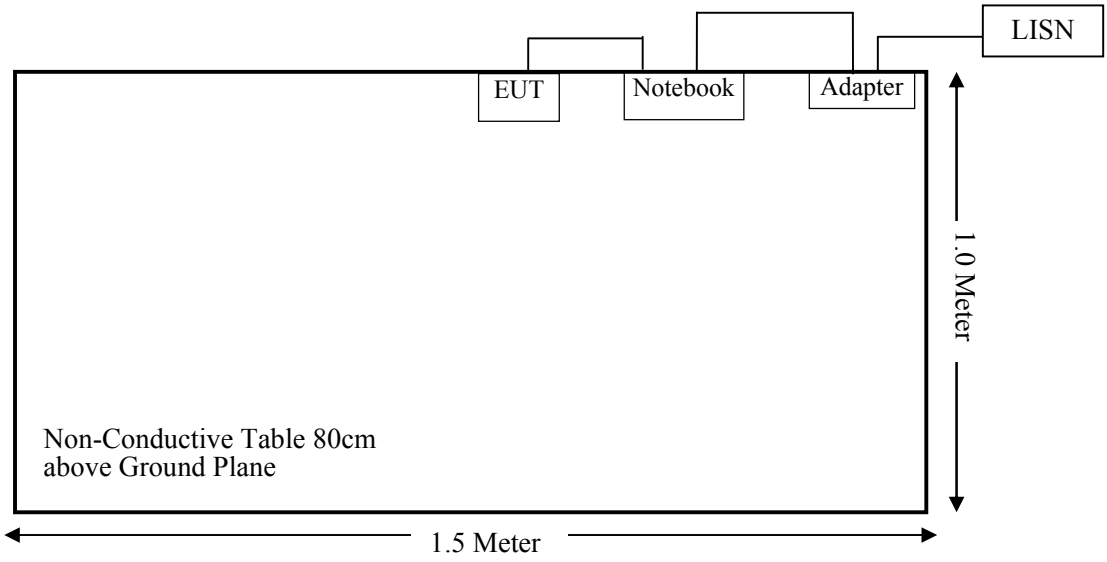
| Manufacturer | Description | Model | Serial Number |
|---|---|---|---|
| DELL | Notebook | GX620 | D65874152 |
| DELL | Adapter | LA65NS0-00 | DF263 |

## External I/O Cable

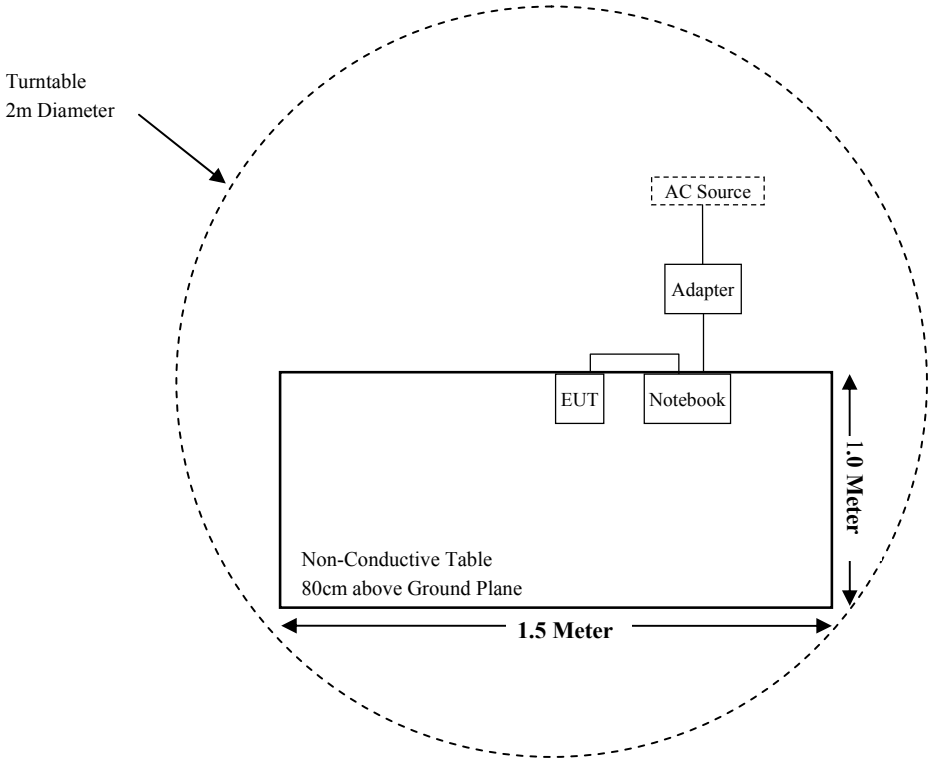
| Cable Description | Shielding Type | Length (m) | From Port | To |
|---|---|---|---|---|
| USB Cable | Un-shielding | 0.3 | Notebook | EUT |

## Block Diagram of Test Setup

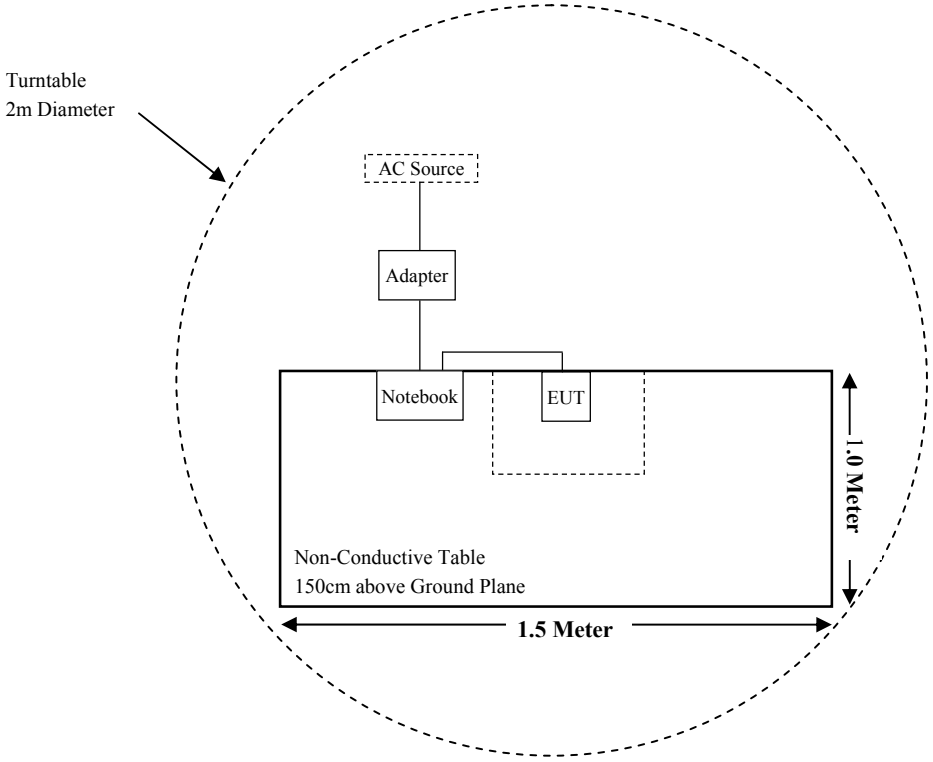
For Conducted Emissions:



For Radiated Emissions (Below 1GHz):




For Radiated Emissions (Above 1GHz):



# SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test | Result |
|---|---|---|
| §15.247 (I), §1.1310 & §2.1091 | MAXIMUM PERMISSIBLE EXPOSURE (MPE) | Compliant |
| §15.203 | Antenna Requirement | Compliant |
| §15.207 (a) | AC Line Conducted Emissions | Compliant |
| §15.247(d) | Spurious Emissions at Antenna Port | Compliant |
| §15.205, §15.209, §15.247(d) | Spurious Emissions | Compliant |
| §15.247 (a)(2) | 6 dB Emission Bandwidth | Compliant |
| §15.247(b)(3) | Maximum Conducted Output Power | Compliant |
| §15.247(d) | Band Edge | Compliant |
| §15.247(e) | Power Spectral Density | Compliant |

# TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| **Radiated Emission Test（Chamber 1#）** | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESCI | 100195 | 2019-11-12 | 2020-11-11 |
| Sunol Sciences | Broadband Antenna | JB3 | A090413-1 | 2019-12-26 | 2022-12-25 |
| Sonoma Instrunent | Pre-amplifier | 310N | 171205 | 2019-08-15 | 2020-08-14 |
| Audix | Test Software | e3 | V9 | -- | -- |
| MICRO-COAX | Coaxial Cable | Cable-8 | 008 | 2019-08-15 | 2020-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-9 | 009 | 2019-08-15 | 2020-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-10 | 010 | 2019-08-15 | 2020-08-14 |
| **Radiated Emission Test（Chamber 2#）** | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESU40 | 100207 | 2019-08-27 | 2020-08-26 |
| ETS-LINDGREN | Horn Antenna | 3115 | 6229 | 2019-01-11 | 2022-01-10 |
| ETS-LINDGREN | Horn Antenna | 3116 | 00084159 | 2019-10-18 | 2022-10-17 |
| A.H.Systems, inc | Amplifier | 2641-1 | 466 | 2019-09-11 | 2020-09-10 |
| EM Electronics Corporation | Amplifier | EM18G40G | 060726 | 2019-03-22 | 2020-03-21 |
| MICRO-TRONICS | Band Reject Filter | BRM50702 | G024 | 2019-08-05 | 2020-08-04 |
| Narda | Attenuator | 10dB | 010 | 2019-08-15 | 2020-08-14 |
| Rohde & Schwarz | Auto test Software | EMC32 | 100361 | / | / |
| MICRO-COAX | Coaxial Cable | Cable-6 | 006 | 2019-08-15 | 2020-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-11 | 011 | 2019-08-15 | 2020-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-12 | 012 | 2019-08-15 | 2020-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-13 | 013 | 2019-08-15 | 2020-08-14 |
| **RF Conducted Test** | | | | | |
| Rohde & Schwarz | Signal Analyzer | FSIQ26 | 836131/009 | 2019-11-12 | 2020-11-11 |
| Narda | Attenuator | 10dB | 010 | 2019-08-15 | 2020-08-14 |
| Agilent | Power Meter | N1912A | MY5000492 | 2019-11-18 | 2020-11-17 |
| Agilent | Power Sensor | N1921A | MY54210024 | 2019-11-18 | 2020-11-17 |
| M5Stack Technology Co.,Ltd | RF Cable | 01 | M5Stack Technology Co.,Ltd C01 | Each Time | / |
| **Conducted Emission Test** | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESR | 1316.3003K03-101746-zn | 2019-07-11 | 2020-07-10 |
| Rohde & Schwarz | LISN | ENV216 | 3560655016 | 2019-11-30 | 2020-11-29 |
| Audix | Test Software | e3 | V9 | -- | -- |
| Rohde & Schwarz | Pulse limiter | ESH3-Z2 | 0357.8810.54 | 2019-08-10 | 2020-08-09 |
| MICRO-COAX | Coaxial Cable | Cable-15 | 015 | 2019-08-15 | 2020-08-14 |

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

# FCC §15.247 (I) & §1.1310 & §2.1091 - MAXIMUM PERMISSIBLE EXPOSURE (MPE)

## Applicable Standard

According to subpart 15.247 (i) and subpart 1.1310, 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

| Limits for General Population/Uncontrolled Exposure | | | | |
|---|---|---|---|---|
| **Frequency Range (MHz)** | **Electric Field Strength (V/m)** | **Magnetic Field Strength (A/m)** | **Power Density (mW/cm²)** | **Averaging Time (minutes)** |
| 0.3-1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34-30 | 824/f | 2.19/f | *(180/f²) | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | / | | f/1500 | 30 |
| 1500-100,000 | / | | 1.0 | 30 |

f = frequency in MHz; * = Plane-wave equivalent power density

## Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. $mW/cm^2$);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

## Calculated Data:

| Mode | Frequency Range (MHz) | Maximum Antenna Gain | | Tune-up Conducted Power | | Evaluation Distance (cm) | Power Density ($mW/cm^2$) | MPE Limit ($mW/cm^2$) |
|---|---|---|---|---|---|---|---|---|
| | | (dBi) | (numeric) | (dBm) | (mW) | | | |
| 802.11b | 2412-2462 | 2.00 | 1.58 | 21.5 | 141.25 | 20 | 0.0444 | 1.0 |
| 802.11g | | 2.00 | 1.58 | 21.0 | 125.89 | 20 | 0.0396 | 1.0 |
| 802.11n-HT20 | | 2.00 | 1.58 | 21.5 | 141.25 | 20 | 0.0444 | 1.0 |
| 802.11n-HT40 | 2422-2452 | 2.00 | 1.58 | 20.0 | 100.00 | 20 | 0.0314 | 1.0 |
| BLE | 2402-2480 | 2.00 | 1.58 | 5.0 | 3.16 | 20 | 0.0010 | 1.0 |
| BT 3.0 | 2402-2480 | 2.00 | 1.58 | 7.5 | 5.62 | 20 | 0.0018 | 1.0 |

**Note:** 1. For the above tune up power were declared by the manufacturer.
2. All modes can't transmit simultaneously.

**Result:** The device meet FCC MPE at 20 cm distance.

# FCC §15.203 - ANTENNA REQUIREMENT

## Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine Compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

## Antenna Connector Construction

The EUT has an internal PIFA antenna for WIFI&BLE, which the antenna gain is 2.0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

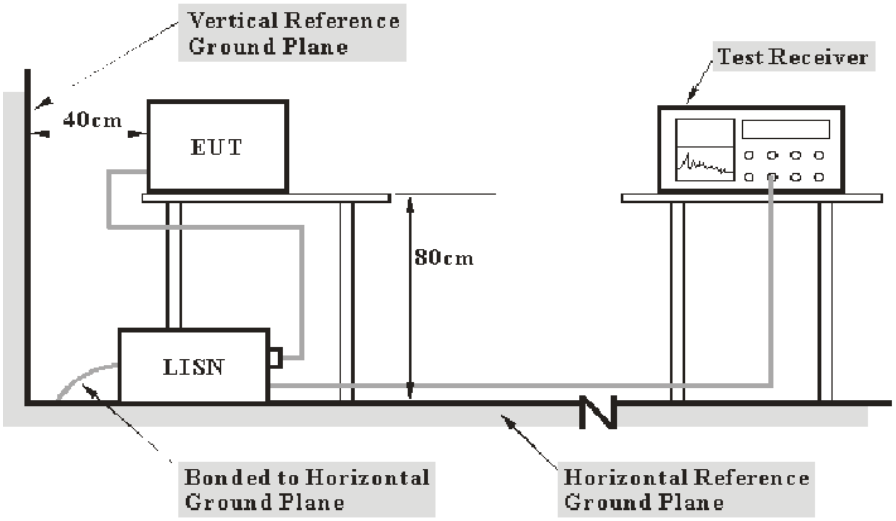
**Result:** Compliant.

# FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

## Applicable Standard

FCC §15.207(a)

## EUT Setup




Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

## EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

| Frequency Range | IF B/W |
|---|---|
| 150 kHz – 30 MHz | 9 kHz |

## Test Procedure

ANSI C63.10-2013 clause 6.2

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

## Factor & Over Limit Calculation

The Factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Attenuator. The basic equation is as follows:

Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Attenuator (dB)

The "**Over Limit**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over Limit of 7 dB means the emission is 7 dB above the limit. The equation for Over Limit calculation is as follows:

Over Limit (dB) = Read level (dBμV) + Factor (dB) - Limit (dBμV)

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 21.4~22.5 ℃ |
| **Relative Humidity:** | 51~53 % |
| **ATM Pressure:** | 100.7~101.5 kPa |

*The testing was performed by Lee Li 2020-01-09 to 2020-02-18.*

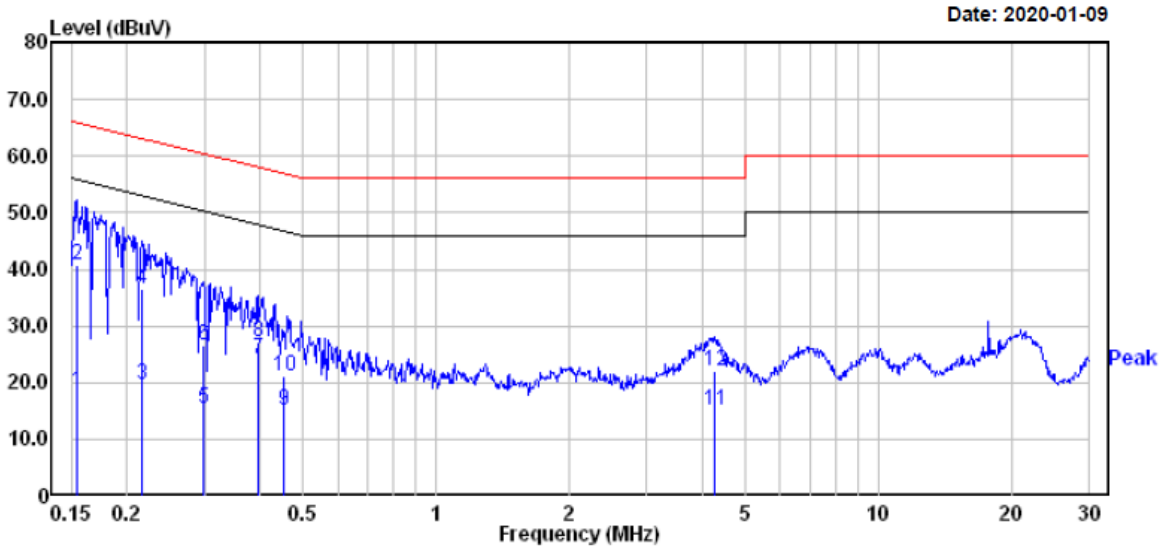
**Test Result:** Compliant.

***Model: ATOM-1***

***For Wi-Fi Mode:***

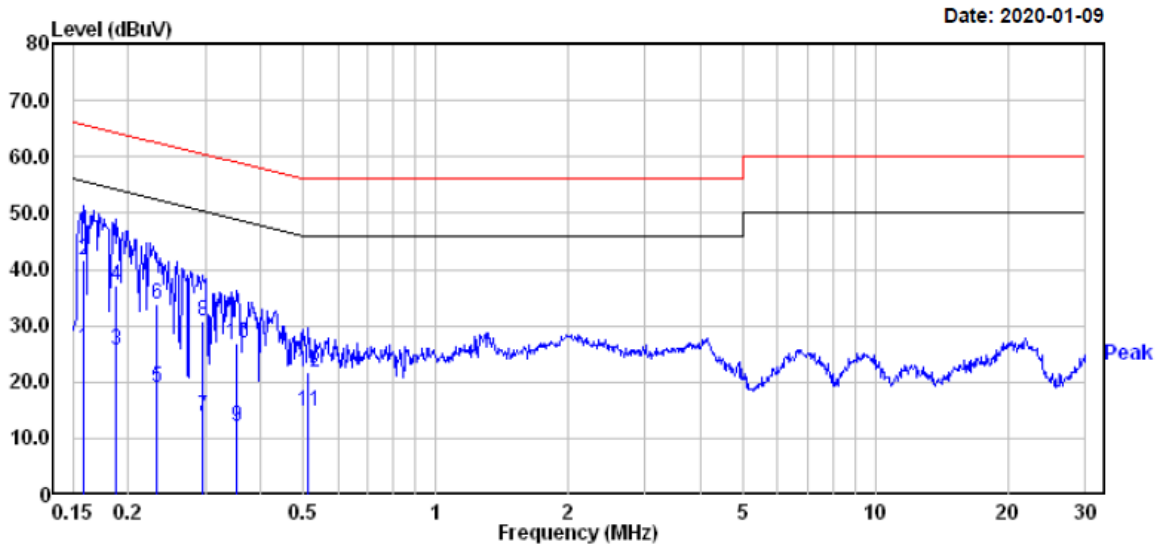
*EUT operation mode: Transmitting in 802.11b mode low channel (worst case)*

**AC 120V/60 Hz, Line**




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.154 | -1.30 | 19.82 | 18.52 | 55.78 | -37.26 | Average |
| 2 | 0.154 | 20.80 | 19.82 | 40.62 | 65.78 | -25.16 | QP |
| 3 | 0.216 | -0.10 | 19.82 | 19.72 | 52.96 | -33.24 | Average |
| 4 | 0.216 | 16.70 | 19.82 | 36.52 | 62.96 | -26.44 | QP |
| 5 | 0.297 | -4.30 | 19.83 | 15.53 | 50.32 | -34.79 | Average |
| 6 | 0.297 | 6.80 | 19.83 | 26.63 | 60.32 | -33.69 | QP |
| 7 | 0.396 | 4.29 | 19.75 | 24.04 | 47.95 | -23.91 | Average |
| 8 | 0.396 | 7.29 | 19.75 | 27.04 | 57.95 | -30.91 | QP |
| 9 | 0.451 | -4.60 | 19.75 | 15.15 | 46.85 | -31.70 | Average |
| 10 | 0.451 | 1.50 | 19.75 | 21.25 | 56.85 | -35.60 | QP |
| 11 | 4.269 | -4.49 | 19.47 | 14.98 | 46.00 | -31.02 | Average |
| 12 | 4.269 | 2.51 | 19.47 | 21.98 | 56.00 | -34.02 | QP |

**AC 120V/60 Hz, Neutral**

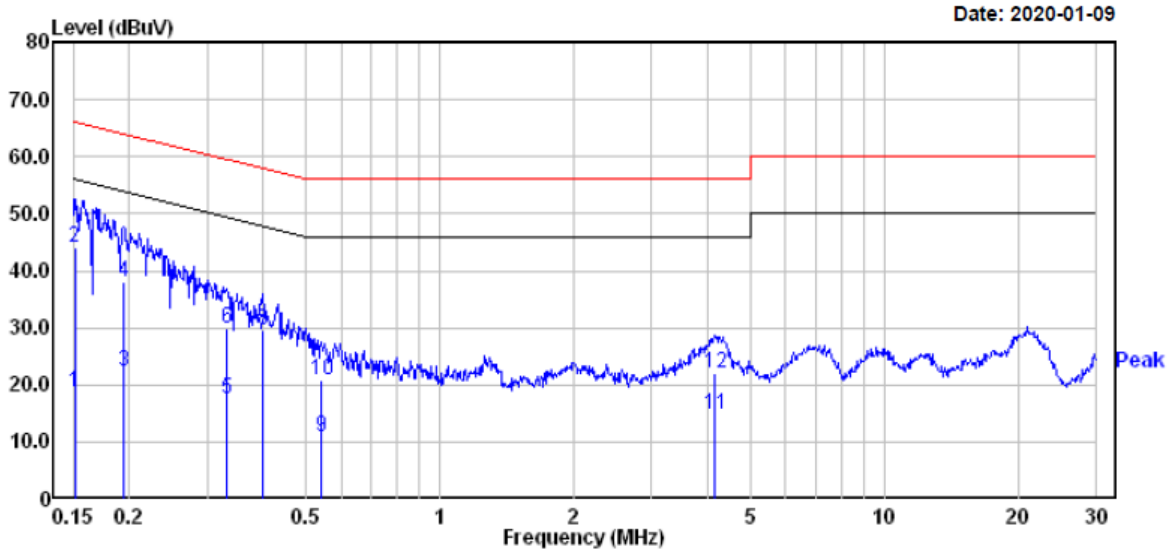



| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.158 | 6.00 | 19.82 | 25.82 | 55.56 | -29.74 | Average |
| 2 | 0.158 | 21.80 | 19.82 | 41.62 | 65.56 | -23.94 | QP |
| 3 | 0.187 | 5.81 | 19.82 | 25.63 | 54.15 | -28.52 | Average |
| 4 | 0.187 | 17.21 | 19.82 | 37.03 | 64.15 | -27.12 | QP |
| 5 | 0.233 | -0.80 | 19.82 | 19.02 | 52.35 | -33.33 | Average |
| 6 | 0.233 | 14.00 | 19.82 | 33.82 | 62.35 | -28.53 | QP |
| 7 | 0.296 | -5.80 | 19.83 | 14.03 | 50.37 | -36.34 | Average |
| 8 | 0.296 | 11.00 | 19.83 | 30.83 | 60.37 | -29.54 | QP |
| 9 | 0.354 | -7.70 | 19.80 | 12.10 | 48.87 | -36.77 | Average |
| 10 | 0.354 | 7.00 | 19.80 | 26.80 | 58.87 | -32.07 | QP |
| 11 | 0.513 | -5.00 | 19.76 | 14.76 | 46.00 | -31.24 | Average |
| 12 | 0.513 | 2.00 | 19.76 | 21.76 | 56.00 | -34.24 | QP |

***For BLE Mode:***

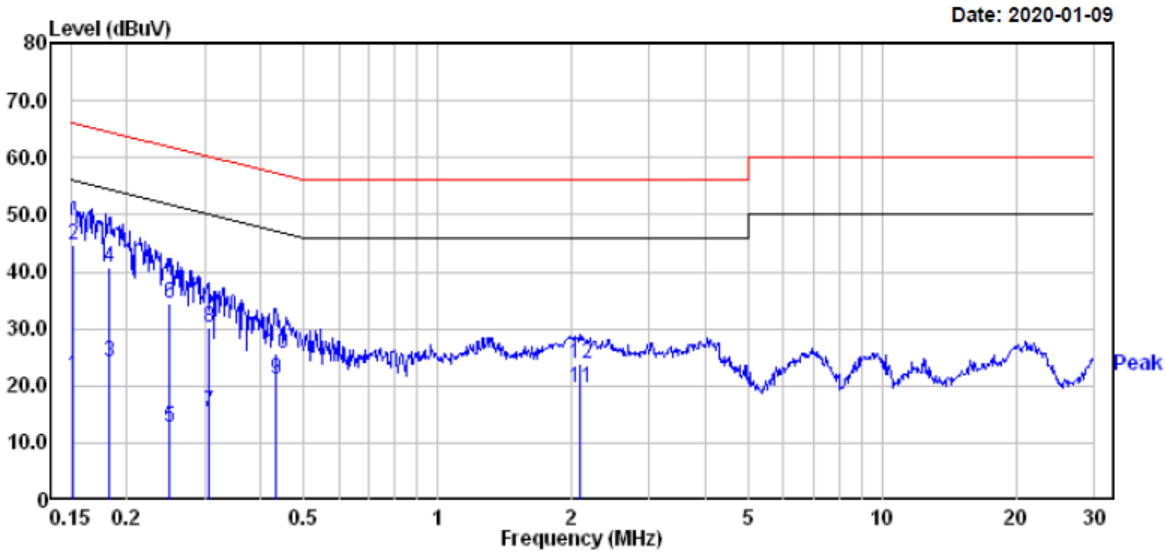
*EUT operation mode: Transmitting in middle channel (worst case)*

**AC 120V/60 Hz, Line**




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.151 | -1.10 | 19.82 | 18.72 | 55.96 | -37.24 | Average |
| 2 | 0.151 | 24.20 | 19.82 | 44.02 | 65.96 | -21.94 | QP |
| 3 | 0.194 | 2.50 | 19.82 | 22.32 | 53.84 | -31.52 | Average |
| 4 | 0.194 | 18.20 | 19.82 | 38.02 | 63.84 | -25.82 | QP |
| 5 | 0.332 | -2.21 | 19.82 | 17.61 | 49.40 | -31.79 | Average |
| 6 | 0.332 | 9.99 | 19.82 | 29.81 | 59.40 | -29.59 | QP |
| 7 | 0.400 | 9.00 | 19.74 | 28.74 | 47.86 | -19.12 | Average |
| 8 | 0.400 | 9.80 | 19.74 | 29.54 | 57.86 | -28.32 | QP |
| 9 | 0.541 | -8.99 | 19.75 | 10.76 | 46.00 | -35.24 | Average |
| 10 | 0.541 | 1.01 | 19.75 | 20.76 | 56.00 | -35.24 | QP |
| 11 | 4.158 | -4.70 | 19.47 | 14.77 | 46.00 | -31.23 | Average |
| 12 | 4.158 | 2.50 | 19.47 | 21.97 | 56.00 | -34.03 | QP |

**AC 120V/60 Hz, Neutral**



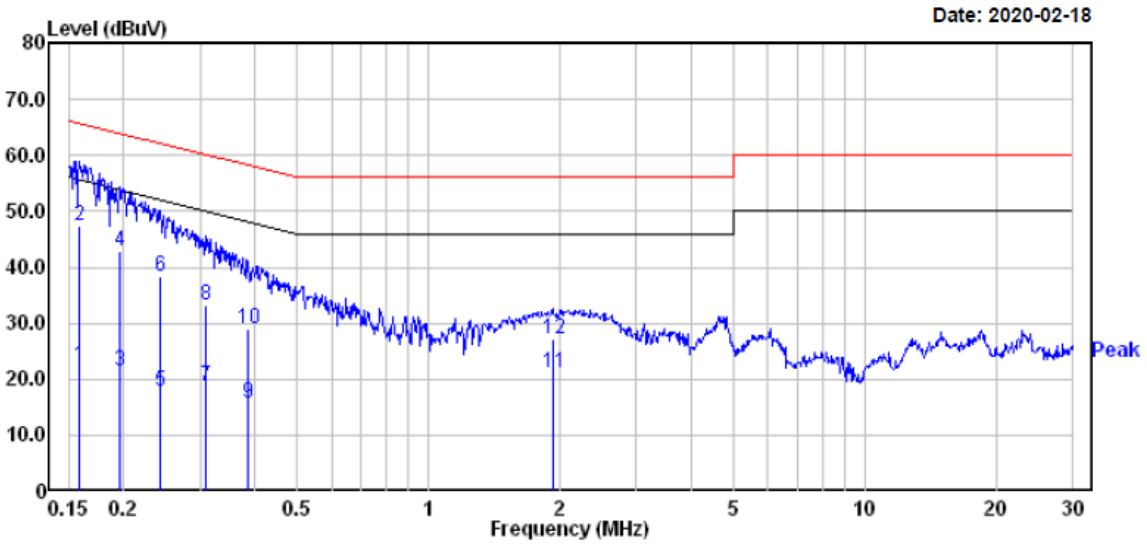

| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.152 | 1.90 | 19.82 | 21.72 | 55.91 | -34.19 | Average |
| 2 | 0.152 | 25.00 | 19.82 | 44.82 | 65.91 | -21.09 | QP |
| 3 | 0.182 | 4.20 | 19.83 | 24.03 | 54.37 | -30.34 | Average |
| 4 | 0.182 | 21.00 | 19.83 | 40.83 | 64.37 | -23.54 | QP |
| 5 | 0.249 | -7.10 | 19.82 | 12.72 | 51.78 | -39.06 | Average |
| 6 | 0.249 | 14.70 | 19.82 | 34.52 | 61.78 | -27.26 | QP |
| 7 | 0.305 | -4.51 | 19.83 | 15.32 | 50.10 | -34.78 | Average |
| 8 | 0.305 | 10.49 | 19.83 | 30.32 | 60.10 | -29.78 | QP |
| 9 | 0.433 | 1.50 | 19.75 | 21.25 | 47.20 | -25.95 | Average |
| 10 | 0.433 | 5.80 | 19.75 | 25.55 | 57.20 | -31.65 | QP |
| 11 | 2.099 | 0.00 | 19.75 | 19.75 | 46.00 | -26.25 | Average |
| 12 | 2.099 | 4.10 | 19.75 | 23.85 | 56.00 | -32.15 | QP |

***Model: ATOM-2***

***For Wi-Fi Mode:***

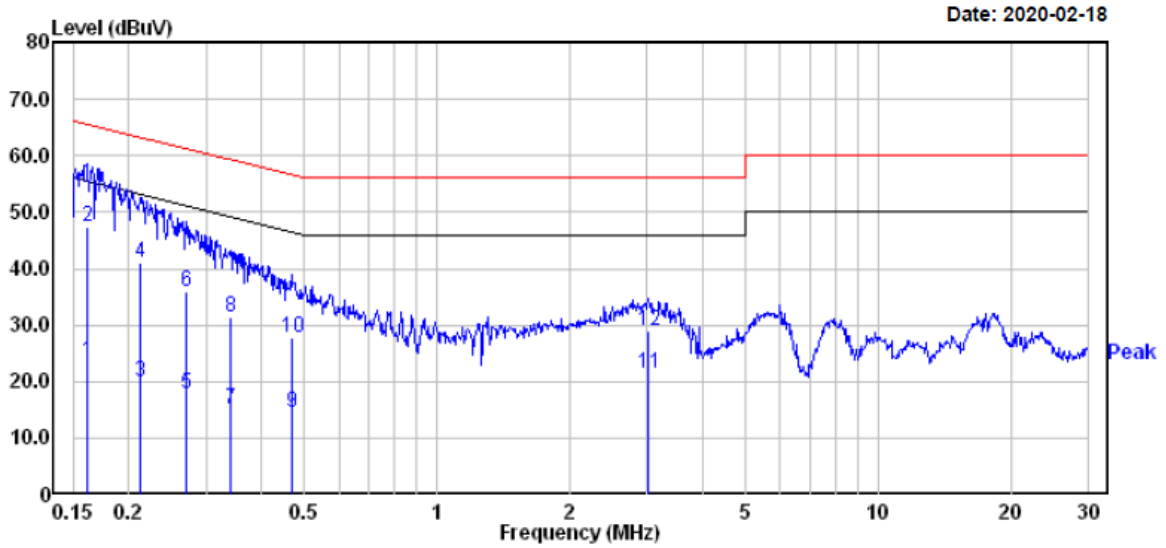
*EUT operation mode: Transmitting in 802.11b mode low channel (worst case)*

**AC 120V/60 Hz, Line**




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.158 | 2.40 | 19.82 | 22.22 | 55.56 | -33.34 | Average |
| 2 | 0.158 | 27.60 | 19.82 | 47.42 | 65.56 | -18.14 | QP |
| 3 | 0.196 | 1.60 | 19.82 | 21.42 | 53.80 | -32.38 | Average |
| 4 | 0.196 | 23.10 | 19.82 | 42.92 | 63.80 | -20.88 | QP |
| 5 | 0.243 | -1.90 | 19.82 | 17.92 | 52.00 | -34.08 | Average |
| 6 | 0.243 | 18.40 | 19.82 | 38.22 | 62.00 | -23.78 | QP |
| 7 | 0.310 | -1.11 | 19.83 | 18.72 | 49.97 | -31.25 | Average |
| 8 | 0.310 | 13.29 | 19.83 | 33.12 | 59.97 | -26.85 | QP |
| 9 | 0.385 | -4.00 | 19.76 | 15.76 | 48.17 | -32.41 | Average |
| 10 | 0.385 | 9.10 | 19.76 | 28.86 | 58.17 | -29.31 | QP |
| 11 | 1.928 | 1.40 | 19.83 | 21.23 | 46.00 | -24.77 | Average |
| 12 | 1.928 | 7.30 | 19.83 | 27.13 | 56.00 | -28.87 | QP |

**AC 120V/60 Hz, Neutral**

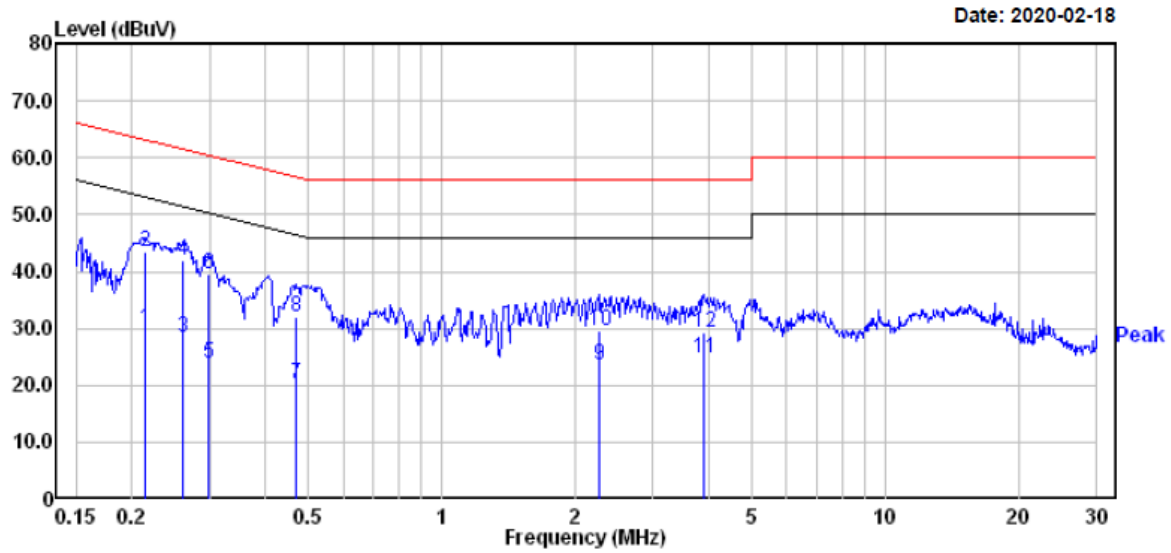



| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.161 | 3.80 | 19.83 | 23.63 | 55.43 | -31.80 | Average |
| 2 | 0.161 | 27.50 | 19.83 | 47.33 | 65.43 | -18.10 | QP |
| 3 | 0.213 | 0.20 | 19.82 | 20.02 | 53.10 | -33.08 | Average |
| 4 | 0.213 | 21.20 | 19.82 | 41.02 | 63.10 | -22.08 | QP |
| 5 | 0.270 | -1.90 | 19.82 | 17.92 | 51.12 | -33.20 | Average |
| 6 | 0.270 | 16.20 | 19.82 | 36.02 | 61.12 | -25.10 | QP |
| 7 | 0.341 | -4.60 | 19.81 | 15.21 | 49.18 | -33.97 | Average |
| 8 | 0.341 | 11.60 | 19.81 | 31.41 | 59.18 | -27.77 | QP |
| 9 | 0.469 | -5.39 | 19.75 | 14.36 | 46.54 | -32.18 | Average |
| 10 | 0.469 | 7.91 | 19.75 | 27.66 | 56.54 | -28.88 | QP |
| 11 | 3.025 | 2.00 | 19.46 | 21.46 | 46.00 | -24.54 | Average |
| 12 | 3.025 | 9.40 | 19.46 | 28.86 | 56.00 | -27.14 | QP |

***For BLE Mode:***

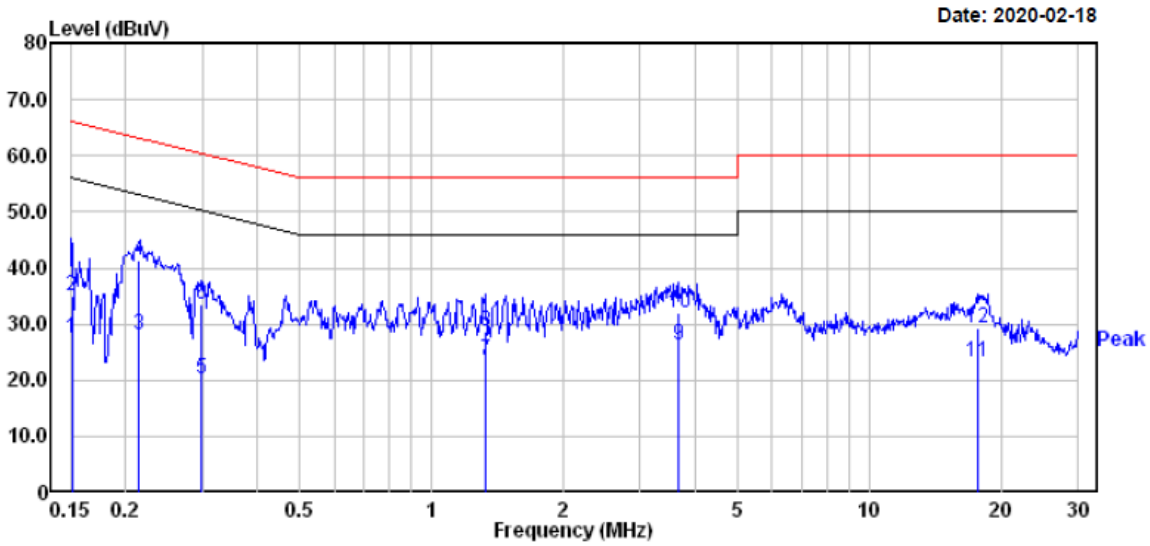
*EUT operation mode: Transmitting in middle channel (worst case)*

**AC 120V/60 Hz, Line**




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.214 | 10.20 | 19.82 | 30.02 | 53.05 | -23.03 | Average |
| 2 | 0.214 | 23.70 | 19.82 | 43.52 | 63.05 | -19.53 | QP |
| 3 | 0.260 | 8.60 | 19.82 | 28.42 | 51.42 | -23.00 | Average |
| 4 | 0.260 | 22.10 | 19.82 | 41.92 | 61.42 | -19.50 | QP |
| 5 | 0.299 | 3.90 | 19.83 | 23.73 | 50.28 | -26.55 | Average |
| 6 | 0.299 | 19.60 | 19.83 | 39.43 | 60.28 | -20.85 | QP |
| 7 | 0.471 | 0.51 | 19.75 | 20.26 | 46.49 | -26.23 | Average |
| 8 | 0.471 | 12.11 | 19.75 | 31.86 | 56.49 | -24.63 | QP |
| 9 | 2.261 | 3.80 | 19.63 | 23.43 | 46.00 | -22.57 | Average |
| 10 | 2.261 | 10.10 | 19.63 | 29.73 | 56.00 | -26.27 | QP |
| 11 | 3.901 | 5.40 | 19.47 | 24.87 | 46.00 | -21.13 | Average |
| 12 | 3.901 | 9.80 | 19.47 | 29.27 | 56.00 | -26.73 | QP |

**AC 120V/60 Hz, Neutral**




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dBuV | dBuV | dB | |
| 1 | 0.151 | 7.70 | 19.82 | 27.52 | 55.96 | -28.44 | Average |
| 2 | 0.151 | 15.20 | 19.82 | 35.02 | 65.96 | -30.94 | QP |
| 3 | 0.214 | 8.20 | 19.82 | 28.02 | 53.05 | -25.03 | Average |
| 4 | 0.214 | 21.60 | 19.82 | 41.42 | 63.05 | -21.63 | QP |
| 5 | 0.297 | 0.30 | 19.83 | 20.13 | 50.32 | -30.19 | Average |
| 6 | 0.297 | 13.70 | 19.83 | 33.53 | 60.32 | -26.79 | QP |
| 7 | 1.324 | 3.61 | 19.82 | 23.43 | 46.00 | -22.57 | Average |
| 8 | 1.324 | 8.71 | 19.82 | 28.53 | 56.00 | -27.47 | QP |
| 9 | 3.661 | 6.90 | 19.47 | 26.37 | 46.00 | -19.63 | Average |
| 10 | 3.661 | 12.60 | 19.47 | 32.07 | 56.00 | -23.93 | QP |
| 11 | 17.661 | 3.30 | 19.81 | 23.11 | 50.00 | -26.89 | Average |
| 12 | 17.661 | 9.40 | 19.81 | 29.21 | 60.00 | -30.79 | QP |

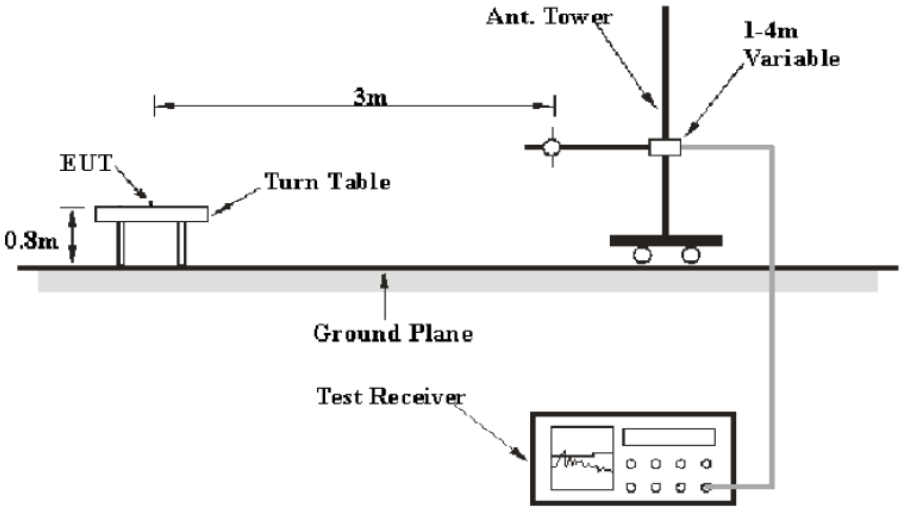
# FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

## Applicable Standard

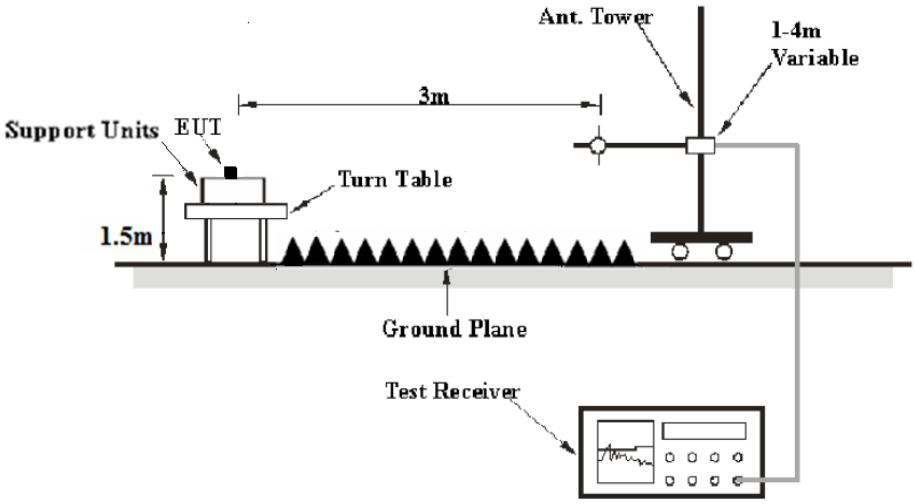
FCC §15.247 (d); §15.209; §15.205;

## EUT Setup

**Below 1 GHz:**




**Above 1GHz:**




The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

## EMI Test Receiver Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver Setup was set with the following configurations:

| Frequency Range | RBW | Video B/W | IF B/W | Detector |
|---|---|---|---|---|
| 30 MHz – 1000 MHz | 120 kHz | 300 kHz | 120 kHz | QP |
| Above 1GHz | 1MHz | 3 MHz | / | PK |
| | 1MHz | 3 MHz | / | Ave. |

## Test Procedure

According to ANSI C63.10-2013 clause 6.5, 6.6 and 6.7.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection mode for frequencies above 1 GHz.

## Corrected Factor & Over Limit Calculation (For Below 1 GHz)

The Corrected Factor is calculated by adding Antenna Factor, Cable Loss and Amplifier Gain. The basic equation is as follows:

Factor (dB) = Antenna Factor (dB/m) + Cable Loss (dB) + Amplifier Gain (dB)

The "**Over Limit**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of 7 dB means the emission is 7 dB above the limit. The equation for margin calculation is as follows:

Over Limit (dB) = Read level (dBμV) + Factor (dB) - Limit (dBμV)

## Corrected Amplitude & Margin Calculation (For Above 1 GHz)

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude (dBμV /m) = Meter Reading (dBμV) + Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB)

The "**Margin**" column of the following data tables indicates the degree of Compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV /m)

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

# Test Data

## Environmental Conditions

| | |
|---|---|
| **Temperature:** | 21.8-22.5℃ |
| **Relative Humidity:** | 49-53% |
| **ATM Pressure:** | 101.0-101.2kPa |

*The testing was performed by Lee Li from 2020-01-08 to 2020-02-20.*

**Test Result:** Compliant.

*EUT operation mode: Transmitting*

***Model: ATOM-1***

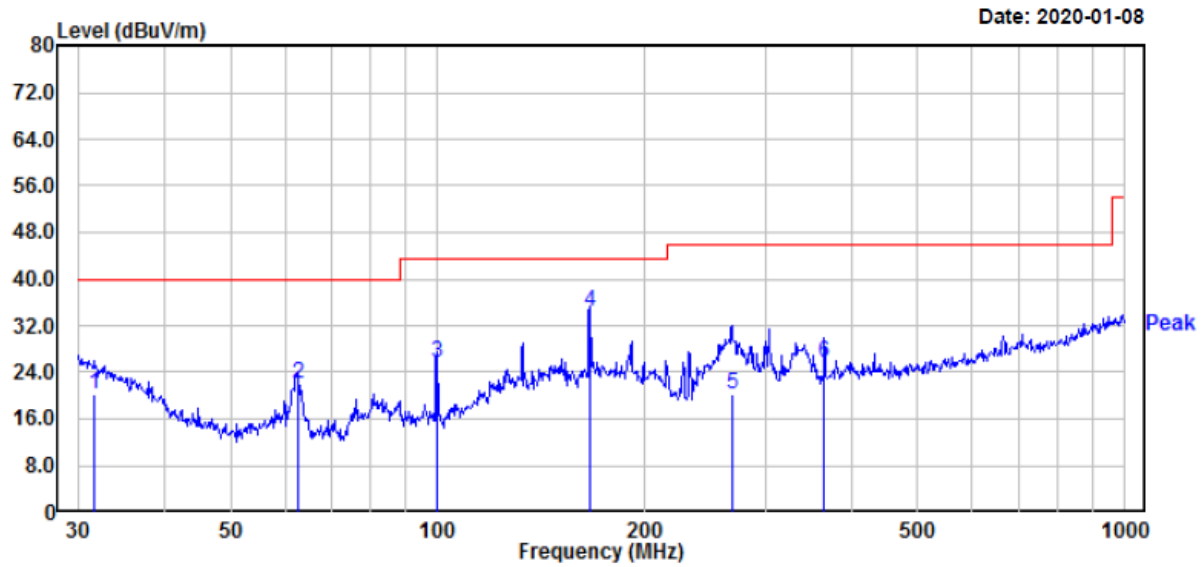
***For Wi-Fi Mode:***

## Spurious Emission Test:

### 30MHz-1GHz:

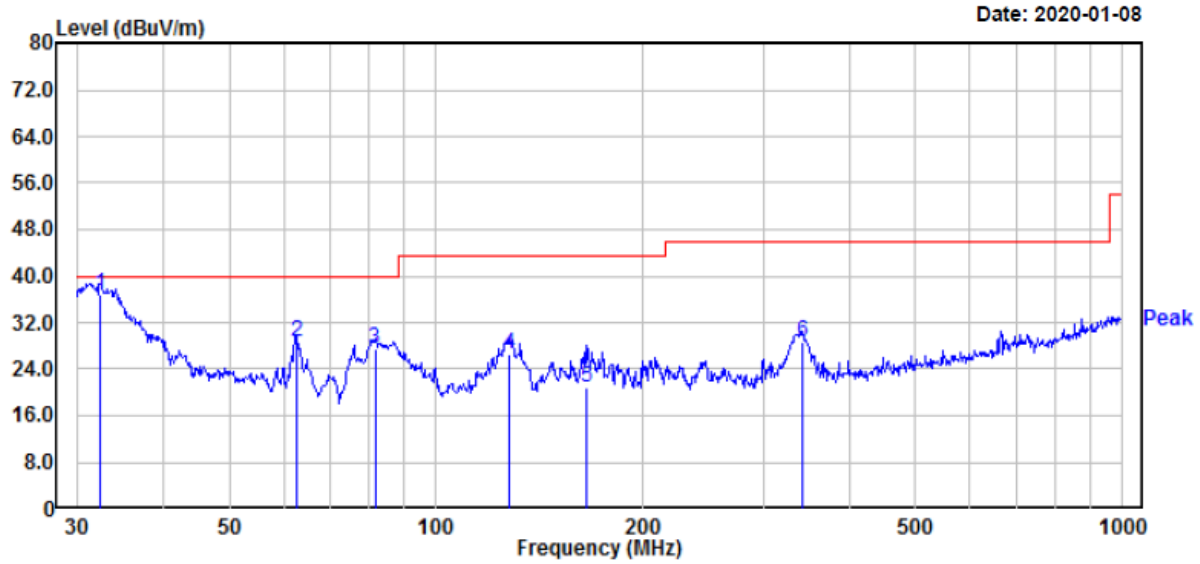
***Horizontal:***

*Pre-scan with 802.11b, 802.11g, 802.11n-HT20 and 802.11n-HT40 modes of operation in the X,Y and Z axes of orientation, the worst case* ***low channel of 802.11b mode in Z-axis of orientation*** *was recorded*




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 31.73 | 24.71 | -4.58 | 20.13 | 40.00 | -19.87 | 200 | 229 | QP |
| 2 | 62.65 | 39.40 | -17.38 | 22.02 | 40.00 | -17.98 | 200 | 151 | QP |
| 3 | 99.88 | 40.30 | -14.65 | 25.65 | 43.50 | -17.85 | 200 | 276 | QP |
| 4 | 166.65 | 46.70 | -12.37 | 34.33 | 43.50 | -9.17 | 200 | 305 | QP |
| 5 | 268.49 | 31.40 | -11.19 | 20.21 | 46.00 | -25.79 | 100 | 241 | QP |
| 6 | 365.54 | 34.30 | -8.68 | 25.62 | 46.00 | -20.38 | 100 | 109 | QP |

***Vertical:***




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 32.41 | 42.01 | -5.14 | 36.87 | 40.00 | -3.13 | 100 | 84 | QP |
| 2 | 62.65 | 46.10 | -17.38 | 28.72 | 40.00 | -11.28 | 100 | 163 | QP |
| 3 | 81.50 | 44.81 | -17.19 | 27.62 | 40.00 | -12.38 | 100 | 113 | QP |
| 4 | 128.11 | 37.80 | -11.12 | 26.68 | 43.50 | -16.82 | 100 | 45 | QP |
| 5 | 166.07 | 33.29 | -12.33 | 20.96 | 43.50 | -22.54 | 100 | 215 | QP |
| 6 | 341.98 | 38.09 | -9.28 | 28.81 | 46.00 | -17.19 | 100 | 154 | QP |

***Model: ATOM-2***

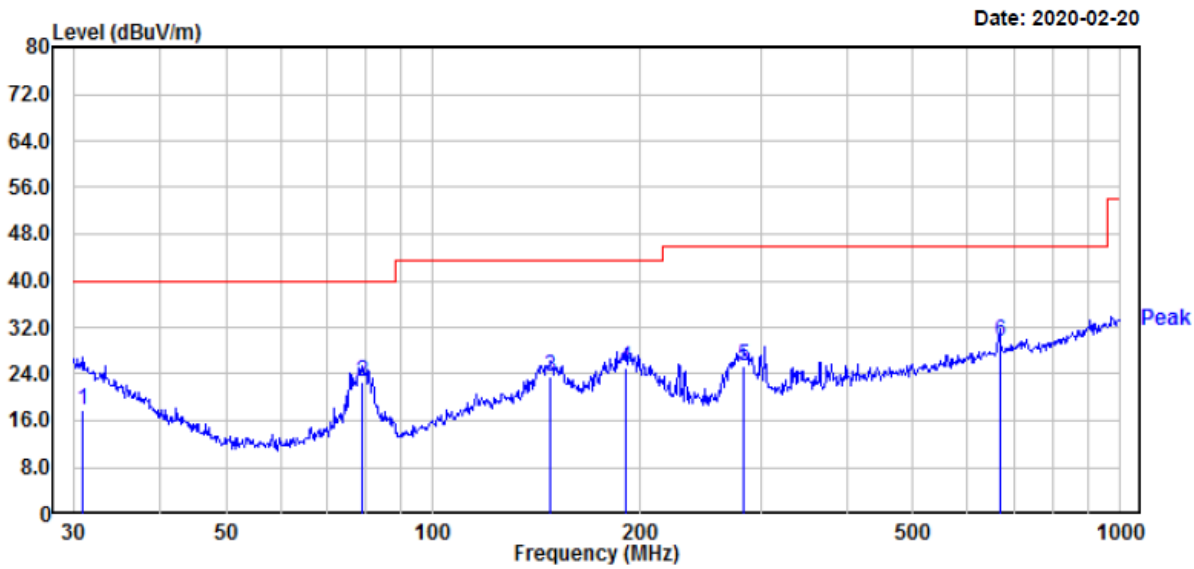
***For Wi-Fi Mode:***

## Spurious Emission Test:

### 30MHz-1GHz:

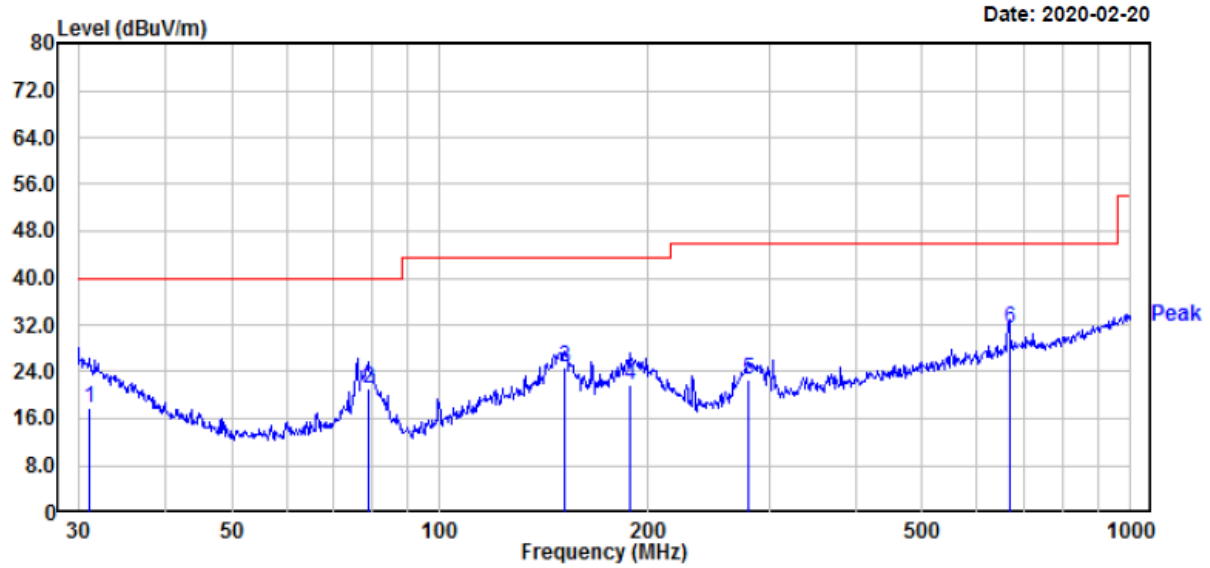
***Horizontal:***

*Pre-scan with 802.11b, 802.11g, 802.11n-HT20 and 802.11n-HT40 modes of operation in the X,Y and Z axes of orientation, the worst case* ***low channel of 802.11b mode in Z-axis of orientation*** *was recorded*




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 30.96 | 21.70 | -3.93 | 17.77 | 40.00 | -22.23 | 100 | 291 | QP |
| 2 | 78.69 | 39.90 | -17.13 | 22.77 | 40.00 | -17.23 | 200 | 30 | QP |
| 3 | 147.92 | 35.50 | -11.86 | 23.64 | 43.50 | -19.86 | 200 | 85 | QP |
| 4 | 190.41 | 37.40 | -12.26 | 25.14 | 43.50 | -18.36 | 100 | 44 | QP |
| 5 | 283.98 | 36.00 | -10.52 | 25.48 | 46.00 | -20.52 | 100 | 89 | QP |
| 6 | 668.14 | 32.30 | -2.71 | 29.59 | 46.00 | -16.41 | 100 | 2 | QP |

***Vertical:***



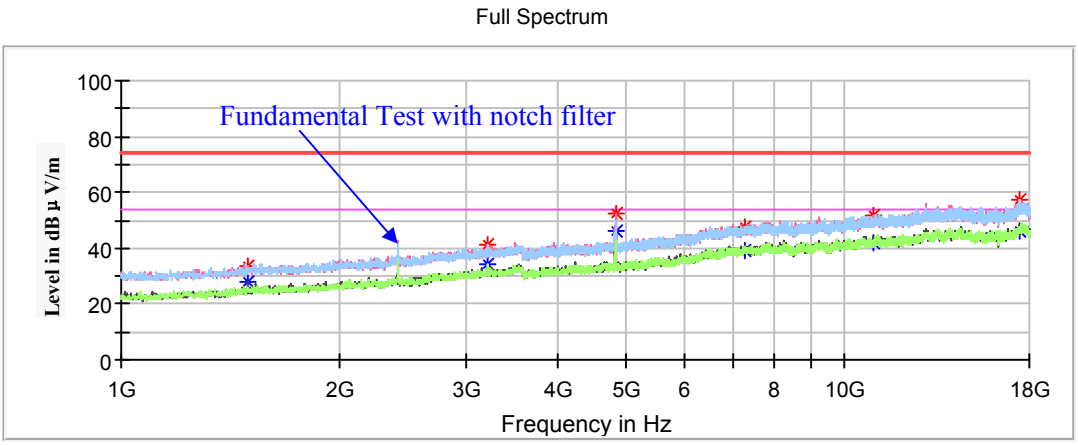

| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 31.18 | 21.90 | -4.11 | 17.79 | 40.00 | -22.21 | 100 | 72 | QP |
| 2 | 78.69 | 38.40 | -17.13 | 21.27 | 40.00 | -18.73 | 100 | 114 | QP |
| 3 | 151.60 | 36.70 | -11.91 | 24.79 | 43.50 | -18.71 | 100 | 299 | QP |
| 4 | 188.41 | 34.19 | -12.40 | 21.79 | 43.50 | -21.71 | 100 | 239 | QP |
| 5 | 280.02 | 33.10 | -10.59 | 22.51 | 46.00 | -23.49 | 200 | 359 | QP |
| 6 | 668.14 | 34.20 | -2.71 | 31.49 | 46.00 | -14.51 | 100 | 66 | QP |

**1GHz-18GHz:**

**802.11b Mode:**
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded)*

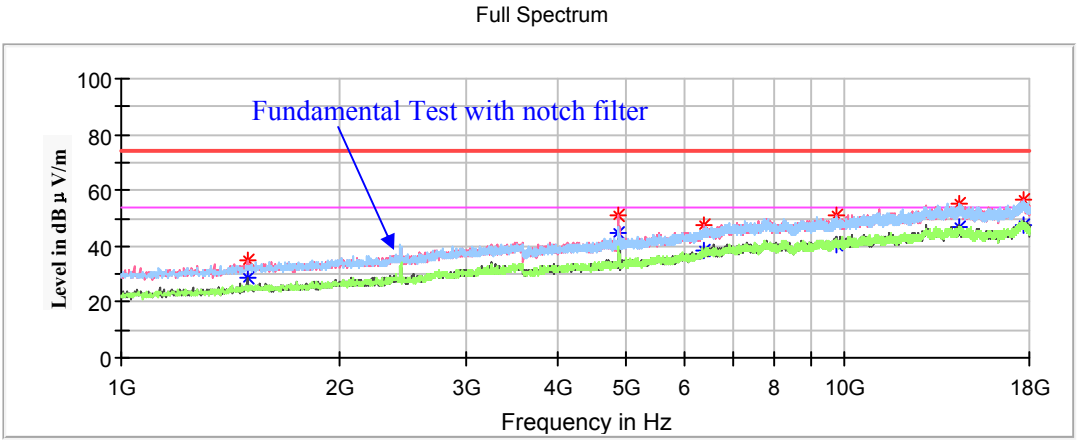
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
   Corrected Amplitude (dBµV /m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV /m)

**Low Channel: 2412MHz**



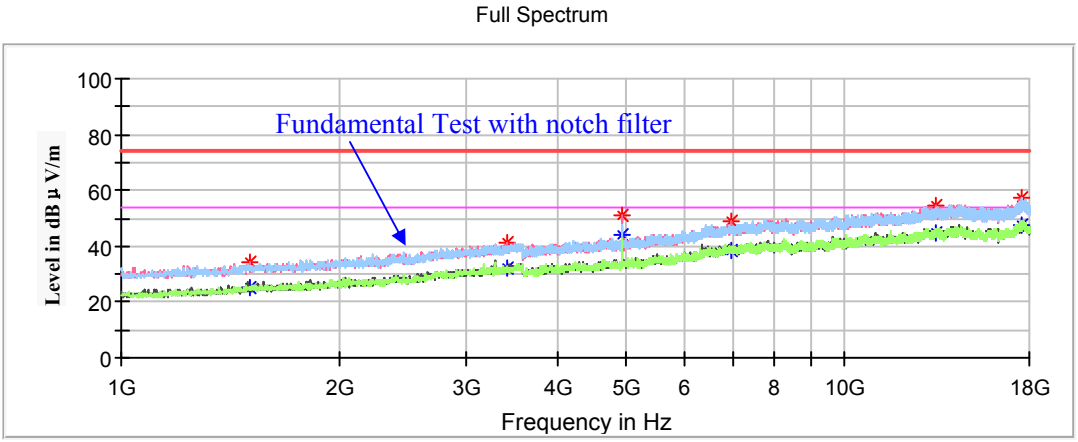

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1498.10 | --- | 27.94 | 200.0 | V | 312.0 | -9.9 | 54.00 | 26.06 |
| 1498.10 | 33.74 | --- | 200.0 | V | 312.0 | -9.9 | 74.00 | 40.26 |
| 3215.10 | --- | 34.25 | 150.0 | H | 115.0 | -4.0 | 54.00 | 19.75 |
| 3215.10 | 41.22 | --- | 150.0 | H | 115.0 | -4.0 | 74.00 | 32.78 |
| 4824.00 | --- | 46.48 | 150.0 | V | 58.0 | -0.5 | 54.00 | 7.52 |
| 4824.00 | 52.42 | --- | 150.0 | V | 58.0 | -0.5 | 74.00 | 21.58 |
| 7236.00 | --- | 39.29 | 200.0 | V | 188.0 | 5.8 | 54.00 | 14.71 |
| 7236.00 | 47.77 | --- | 200.0 | V | 188.0 | 5.8 | 74.00 | 26.23 |
| 10990.90 | --- | 42.19 | 200.0 | V | 358.0 | 9.7 | 54.00 | 11.81 |
| 10990.90 | 51.61 | --- | 200.0 | V | 358.0 | 9.7 | 74.00 | 22.39 |
| 17403.30 | --- | 45.83 | 150.0 | H | 0.0 | 13.8 | 54.00 | 8.17 |
| 17403.30 | 57.13 | --- | 150.0 | H | 0.0 | 13.8 | 74.00 | 16.87 |

**Middle Channel: 2437MHz**




| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1493.00 | --- | 28.82 | 200.0 | V | 217.0 | -10.0 | 54.00 | 25.18 |
| 1493.00 | 35.10 | --- | 200.0 | V | 217.0 | -10.0 | 74.00 | 38.90 |
| 4874.00 | --- | 44.75 | 200.0 | V | 280.0 | -0.5 | 54.00 | 9.25 |
| 4874.00 | 51.40 | --- | 200.0 | V | 280.0 | -0.5 | 74.00 | 22.60 |
| 6377.10 | --- | 38.15 | 150.0 | V | 348.0 | 3.9 | 54.00 | 15.85 |
| 6377.10 | 47.54 | --- | 150.0 | V | 348.0 | 3.9 | 74.00 | 26.46 |
| 9717.60 | --- | 40.38 | 150.0 | V | 173.0 | 7.9 | 54.00 | 13.62 |
| 9717.60 | 51.26 | --- | 150.0 | V | 173.0 | 7.9 | 74.00 | 22.74 |
| 14441.90 | --- | 46.69 | 200.0 | V | 306.0 | 12.7 | 54.00 | 7.31 |
| 14441.90 | 55.54 | --- | 200.0 | V | 306.0 | 12.7 | 74.00 | 18.46 |
| 17658.30 | --- | 47.61 | 150.0 | V | 203.0 | 14.0 | 54.00 | 6.39 |
| 17658.30 | 56.53 | --- | 150.0 | V | 203.0 | 14.0 | 74.00 | 17.47 |

**High Channel: 2462MHz**

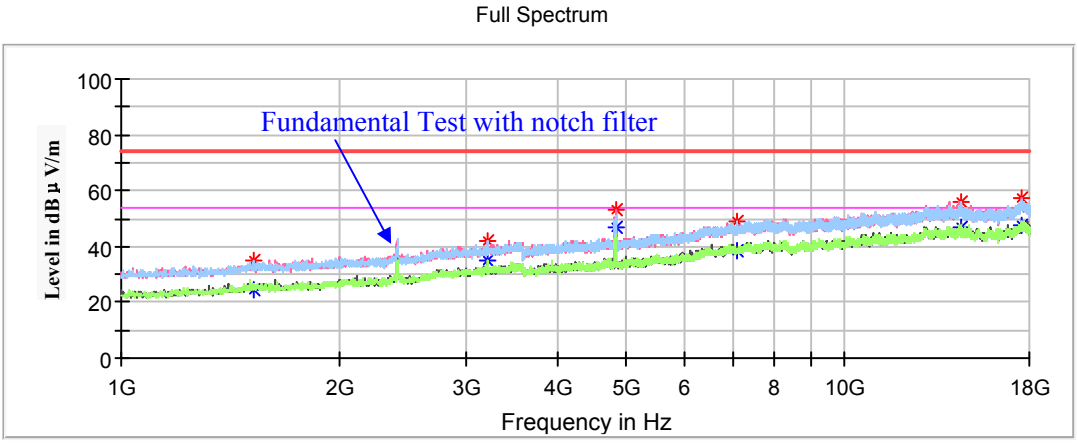



| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1508.30 | --- | 24.96 | 150.0 | V | 338.0 | -9.9 | 54.00 | 29.04 |
| 1508.30 | 34.31 | --- | 150.0 | V | 338.0 | -9.9 | 74.00 | 39.69 |
| 3417.40 | 41.44 | --- | 200.0 | V | 109.0 | -3.7 | 74.00 | 32.56 |
| 3417.40 | --- | 32.08 | 200.0 | V | 109.0 | -3.7 | 54.00 | 21.92 |
| 4924.00 | --- | 43.85 | 200.0 | V | 258.0 | -0.4 | 54.00 | 10.15 |
| 4924.00 | 50.75 | --- | 200.0 | V | 258.0 | -0.4 | 74.00 | 23.25 |
| 6984.00 | --- | 38.31 | 200.0 | V | 109.0 | 5.3 | 54.00 | 15.69 |
| 6984.00 | 49.22 | --- | 200.0 | V | 109.0 | 5.3 | 74.00 | 24.78 |
| 13377.70 | --- | 45.02 | 150.0 | V | 50.0 | 12.0 | 54.00 | 8.98 |
| 13377.70 | 54.68 | --- | 150.0 | V | 50.0 | 12.0 | 74.00 | 19.32 |
| 17569.90 | --- | 47.48 | 150.0 | H | 278.0 | 14.2 | 54.00 | 6.52 |
| 17569.90 | 57.01 | --- | 150.0 | H | 278.0 | 14.2 | 74.00 | 16.99 |

**802.11g Mode:**
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded)*

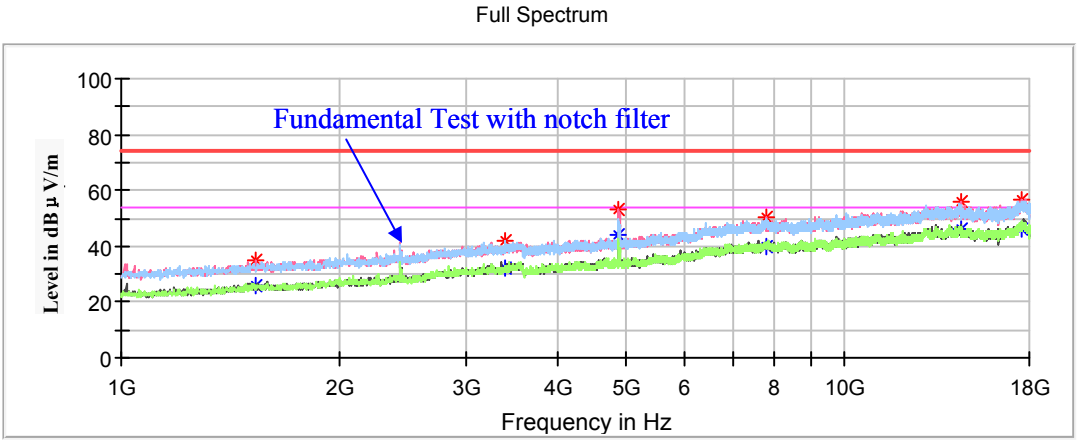
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
   Corrected Amplitude (dBµV /m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV /m)

**Low Channel: 2412MHz**



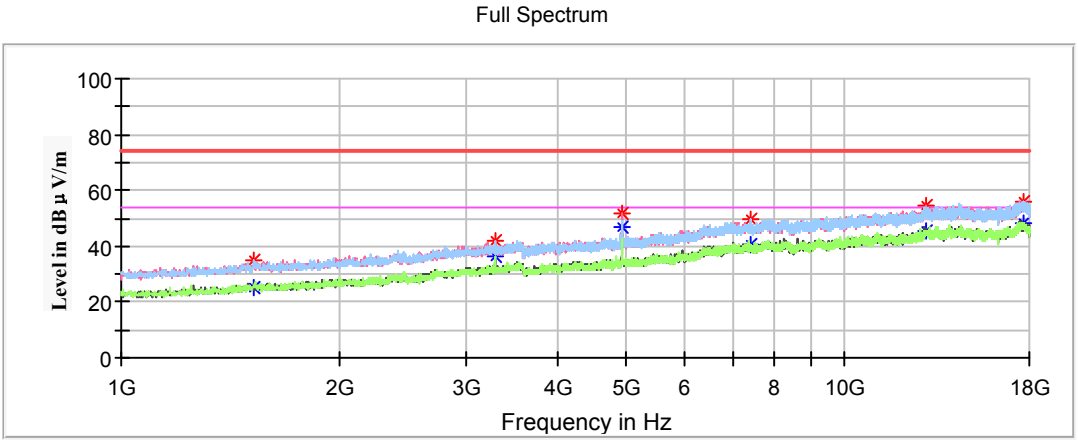

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1520.20 | --- | 24.47 | 200.0 | H | 350.0 | -9.9 | 54.00 | 29.53 |
| 1520.20 | 34.99 | --- | 200.0 | H | 350.0 | -9.9 | 74.00 | 39.01 |
| 3215.10 | --- | 34.71 | 150.0 | H | 144.0 | -4.0 | 54.00 | 19.29 |
| 3215.10 | 42.28 | --- | 150.0 | H | 144.0 | -4.0 | 74.00 | 31.72 |
| 4824.00 | --- | 47.06 | 150.0 | V | 330.0 | -0.5 | 54.00 | 6.94 |
| 4824.00 | 53.34 | --- | 150.0 | V | 330.0 | -0.5 | 74.00 | 20.66 |
| 7104.70 | --- | 38.51 | 200.0 | H | 327.0 | 5.5 | 54.00 | 15.49 |
| 7104.70 | 48.73 | --- | 200.0 | H | 327.0 | 5.5 | 74.00 | 25.27 |
| 14448.70 | --- | 47.19 | 200.0 | H | 205.0 | 12.7 | 54.00 | 6.81 |
| 14448.70 | 56.20 | --- | 200.0 | H | 205.0 | 12.7 | 74.00 | 17.80 |
| 17568.20 | --- | 47.59 | 150.0 | V | 209.0 | 14.2 | 54.00 | 6.41 |
| 17568.20 | 57.27 | --- | 150.0 | V | 209.0 | 14.2 | 74.00 | 16.73 |

**Middle Channel: 2437MHz**




| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1538.90 | 34.69 | --- | 150.0 | V | 308.0 | -9.8 | 74.00 | 39.31 |
| 1538.90 | --- | 25.93 | 150.0 | V | 308.0 | -9.8 | 54.00 | 28.07 |
| 3386.80 | 42.14 | --- | 200.0 | H | 310.0 | -3.7 | 74.00 | 31.86 |
| 3386.80 | --- | 32.24 | 200.0 | H | 310.0 | -3.7 | 54.00 | 21.76 |
| 4874.00 | --- | 44.00 | 150.0 | V | 294.0 | -0.5 | 54.00 | 10.00 |
| 4874.00 | 53.33 | --- | 150.0 | V | 294.0 | -0.5 | 74.00 | 20.67 |
| 7791.50 | --- | 40.14 | 200.0 | V | 91.0 | 6.7 | 54.00 | 13.86 |
| 7791.50 | 50.31 | --- | 200.0 | V | 91.0 | 6.7 | 74.00 | 23.69 |
| 14465.70 | --- | 46.41 | 200.0 | V | 232.0 | 12.7 | 54.00 | 7.59 |
| 14465.70 | 56.06 | --- | 200.0 | V | 232.0 | 12.7 | 74.00 | 17.94 |
| 17575.00 | --- | 46.29 | 150.0 | V | 50.0 | 14.2 | 54.00 | 7.71 |
| 17575.00 | 56.75 | --- | 150.0 | V | 50.0 | 14.2 | 74.00 | 17.25 |

**High Channel: 2462MHz**

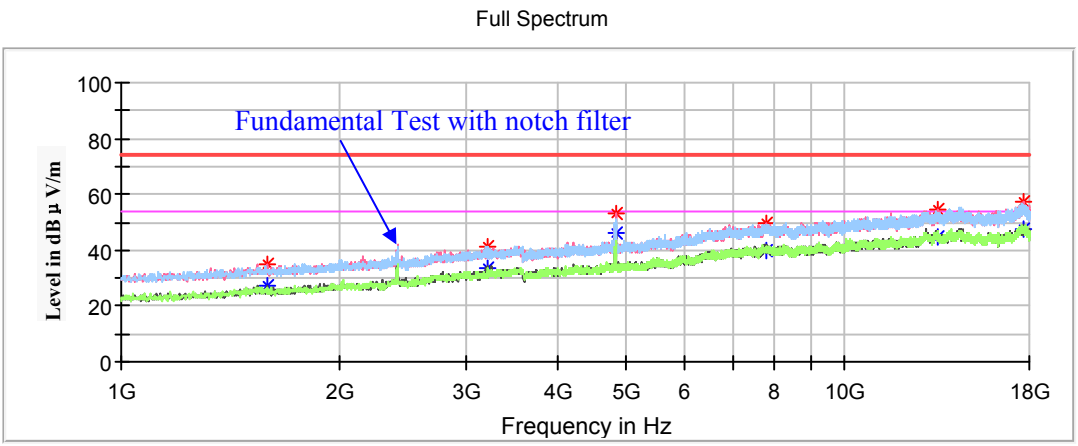



| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1525.30 | --- | 25.25 | 150.0 | H | 181.0 | -9.8 | 54.00 | 28.75 |
| 1525.30 | 34.74 | --- | 150.0 | H | 181.0 | -9.8 | 74.00 | 39.26 |
| 3281.40 | --- | 36.04 | 150.0 | H | 241.0 | -3.9 | 54.00 | 17.96 |
| 3281.40 | 42.03 | --- | 150.0 | H | 241.0 | -3.9 | 74.00 | 31.97 |
| 4924.00 | --- | 46.78 | 200.0 | V | 328.0 | -0.4 | 54.00 | 7.22 |
| 4924.00 | 51.61 | --- | 200.0 | V | 328.0 | -0.4 | 74.00 | 22.39 |
| 7386.00 | --- | 40.31 | 200.0 | H | 311.0 | 6.0 | 54.00 | 13.69 |
| 7386.00 | 49.38 | --- | 200.0 | H | 311.0 | 6.0 | 74.00 | 24.62 |
| 12949.30 | --- | 45.41 | 200.0 | V | 342.0 | 11.9 | 54.00 | 8.59 |
| 12949.30 | 54.23 | --- | 200.0 | V | 342.0 | 11.9 | 74.00 | 19.77 |
| 17665.10 | --- | 48.19 | 150.0 | V | 97.0 | 14.0 | 54.00 | 5.81 |
| 17665.10 | 56.07 | --- | 150.0 | V | 97.0 | 14.0 | 74.00 | 17.93 |

**802.11n-HT20 Mode:**
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded)*

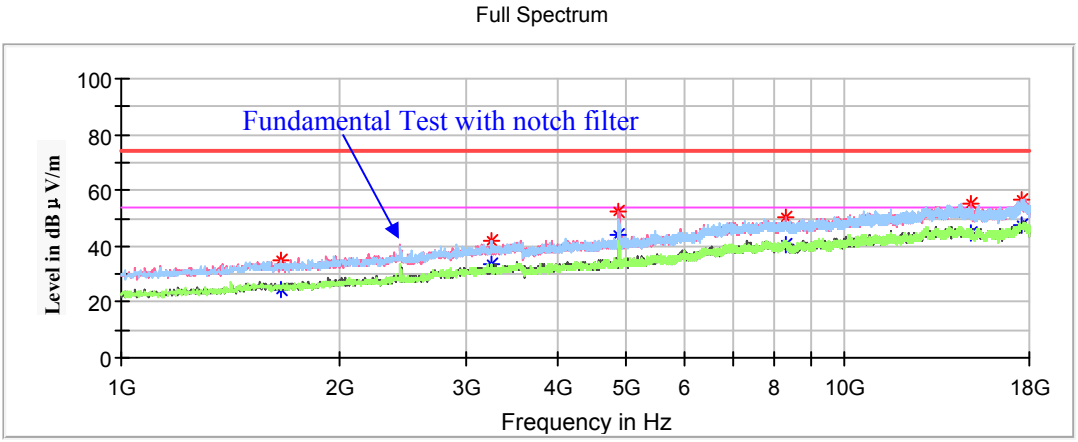
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
   Corrected Amplitude (dBµV /m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV /m)

**Low Channel : 2412MHz**



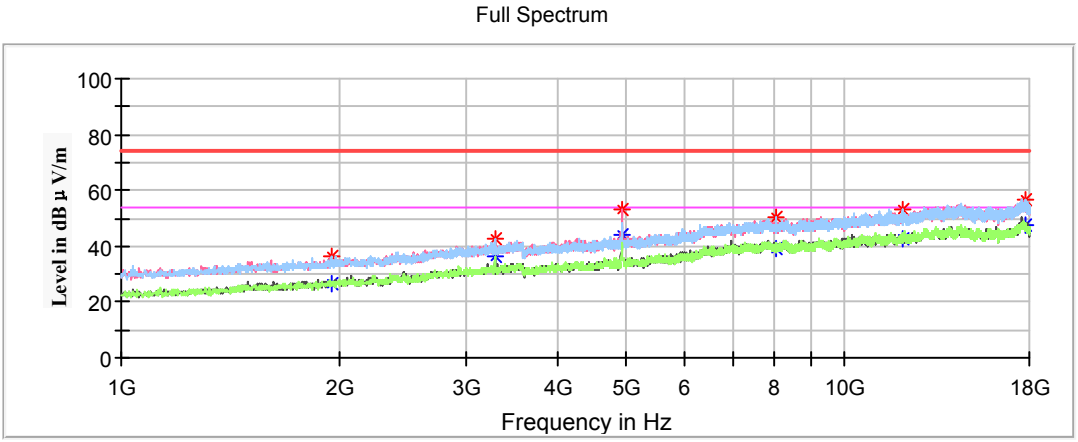

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1588.20 | 35.06 | --- | 200.0 | V | 141.0 | -9.6 | 74.00 | 38.94 |
| 1588.20 | --- | 27.31 | 200.0 | V | 141.0 | -9.6 | 54.00 | 26.69 |
| 3215.10 | --- | 33.79 | 150.0 | H | 111.0 | -4.0 | 54.00 | 20.21 |
| 3215.10 | 41.58 | --- | 150.0 | H | 111.0 | -4.0 | 74.00 | 32.42 |
| 4824.00 | --- | 45.95 | 200.0 | V | 351.0 | -0.5 | 54.00 | 8.05 |
| 4824.00 | 53.27 | --- | 200.0 | V | 351.0 | -0.5 | 74.00 | 20.73 |
| 7767.70 | --- | 39.98 | 150.0 | V | 24.0 | 6.6 | 54.00 | 14.02 |
| 7767.70 | 49.63 | --- | 150.0 | V | 24.0 | 6.6 | 74.00 | 24.37 |
| 13420.20 | --- | 44.85 | 150.0 | V | 299.0 | 12.0 | 54.00 | 9.15 |
| 13420.20 | 54.81 | --- | 150.0 | V | 299.0 | 12.0 | 74.00 | 19.19 |
| 17656.60 | --- | 47.65 | 200.0 | V | 95.0 | 14.0 | 54.00 | 6.35 |
| 17656.60 | 57.14 | --- | 200.0 | V | 95.0 | 14.0 | 74.00 | 16.86 |

**Middle Channel: 2437MHz**




| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1657.90 | --- | 24.71 | 200.0 | H | 283.0 | -9.4 | 54.00 | 29.29 |
| 1657.90 | 34.77 | --- | 200.0 | H | 283.0 | -9.4 | 74.00 | 39.23 |
| 3249.10 | --- | 33.51 | 150.0 | H | 138.0 | -4.0 | 54.00 | 20.49 |
| 3249.10 | 41.94 | --- | 150.0 | H | 138.0 | -4.0 | 74.00 | 32.06 |
| 4874.00 | --- | 43.94 | 200.0 | V | 307.0 | -0.5 | 54.00 | 10.06 |
| 4874.00 | 52.34 | --- | 200.0 | V | 307.0 | -0.5 | 74.00 | 21.66 |
| 8276.00 | --- | 40.54 | 200.0 | V | 249.0 | 6.6 | 54.00 | 13.46 |
| 8276.00 | 50.25 | --- | 200.0 | V | 249.0 | 6.6 | 74.00 | 23.75 |
| 14924.70 | --- | 44.70 | 150.0 | H | 9.0 | 11.7 | 54.00 | 9.30 |
| 14924.70 | 55.06 | --- | 150.0 | V | 9.0 | 11.7 | 74.00 | 18.94 |
| 17575.00 | --- | 47.78 | 200.0 | H | 20.0 | 14.2 | 54.00 | 6.22 |
| 17575.00 | 56.81 | --- | 200.0 | H | 20.0 | 14.2 | 74.00 | 17.19 |

**High Channel : 2462MHz**

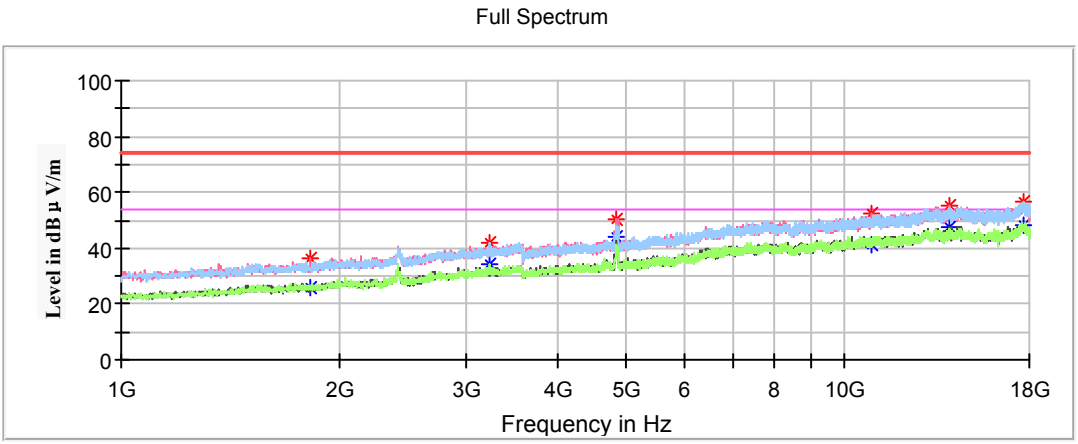



| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1948.60 | --- | 26.53 | 150.0 | H | 49.0 | -8.4 | 54.00 | 27.47 |
| 1948.60 | 36.66 | --- | 150.0 | H | 49.0 | -8.4 | 74.00 | 37.34 |
| 3281.40 | --- | 36.59 | 150.0 | H | 245.0 | -3.9 | 54.00 | 17.41 |
| 3281.40 | 42.39 | --- | 150.0 | H | 245.0 | -3.9 | 74.00 | 31.61 |
| 4924.00 | --- | 43.80 | 200.0 | V | 261.0 | -0.4 | 54.00 | 10.20 |
| 4924.00 | 53.32 | --- | 200.0 | V | 261.0 | -0.4 | 74.00 | 20.68 |
| 8019.30 | --- | 39.10 | 150.0 | H | 153.0 | 7.0 | 54.00 | 14.90 |
| 8019.30 | 50.67 | --- | 150.0 | H | 153.0 | 7.0 | 74.00 | 23.33 |
| 12017.70 | --- | 42.50 | 200.0 | H | 241.0 | 10.1 | 54.00 | 11.50 |
| 12017.70 | 53.44 | --- | 200.0 | H | 241.0 | 10.1 | 74.00 | 20.56 |
| 17755.20 | --- | 47.76 | 200.0 | H | 23.0 | 13.9 | 54.00 | 6.24 |
| 17755.20 | 56.84 | --- | 200.0 | H | 23.0 | 13.9 | 74.00 | 17.16 |

**802.11n-HT40 Mode:**
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded)*

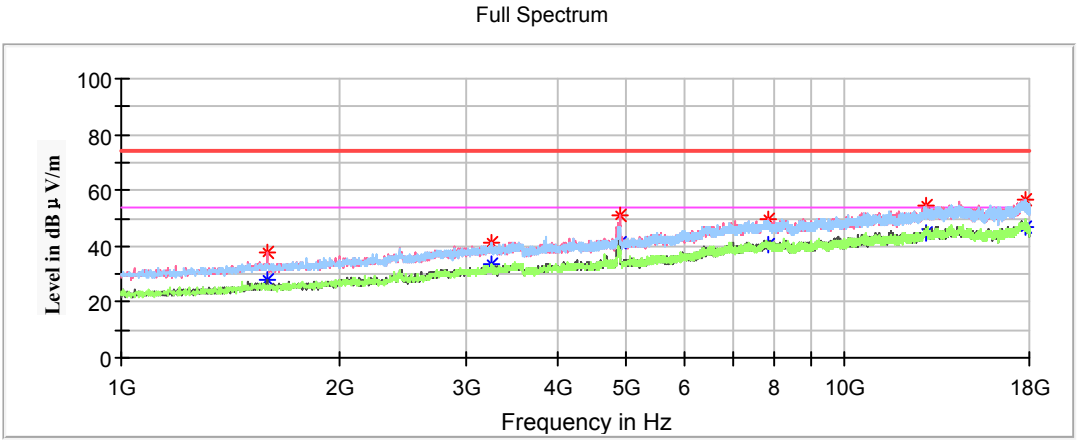
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
   Corrected Amplitude (dBµV /m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV /m)

**Low Channel : 2422MHz**



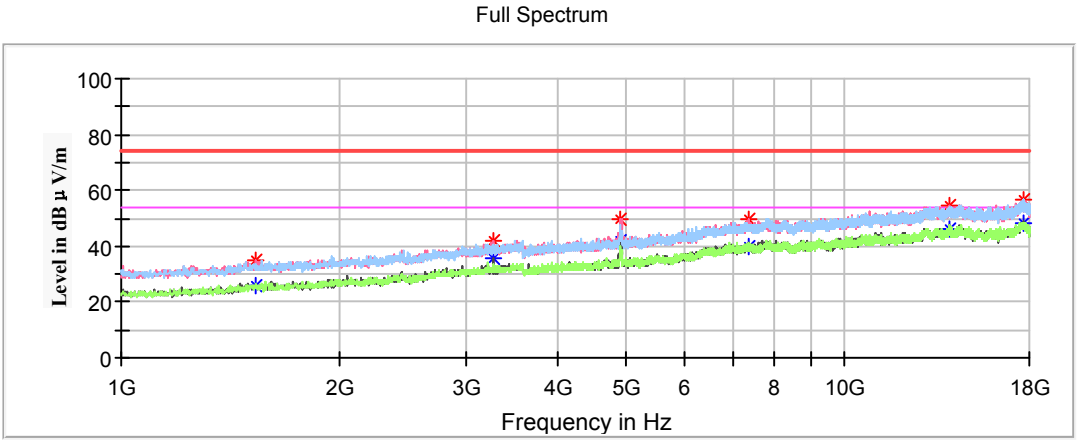

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1822.80 | --- | 26.07 | 200.0 | V | 264.0 | -8.8 | 54.00 | 27.93 |
| 1822.80 | 36.17 | --- | 200.0 | V | 264.0 | -8.8 | 74.00 | 37.83 |
| 3228.70 | --- | 34.12 | 150.0 | H | 247.0 | -4.0 | 54.00 | 19.88 |
| 3228.70 | 41.63 | --- | 150.0 | H | 247.0 | -4.0 | 74.00 | 32.37 |
| 4844.00 | --- | 44.30 | 150.0 | V | 66.0 | -0.5 | 54.00 | 9.70 |
| 4844.00 | 50.07 | --- | 150.0 | V | 66.0 | -0.5 | 74.00 | 23.93 |
| 10866.80 | --- | 41.47 | 150.0 | V | 21.0 | 9.6 | 54.00 | 12.53 |
| 10866.80 | 52.65 | --- | 150.0 | V | 21.0 | 9.6 | 74.00 | 21.35 |
| 13965.90 | --- | 47.36 | 150.0 | V | 82.0 | 12.5 | 54.00 | 6.64 |
| 13965.90 | 55.31 | --- | 150.0 | V | 82.0 | 12.5 | 74.00 | 18.69 |
| 17687.20 | 56.65 | --- | 200.0 | H | 170.0 | 14.0 | 74.00 | 17.35 |
| 17688.90 | --- | 47.93 | 200.0 | H | 170.0 | 14.0 | 54.00 | 6.07 |

**Middle Channel: 2437MHz**




| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1593.30 | --- | 27.98 | 150.0 | V | 286.0 | -9.6 | 54.00 | 26.02 |
| 1593.30 | 37.70 | --- | 150.0 | V | 286.0 | -9.6 | 74.00 | 36.30 |
| 3249.10 | --- | 33.57 | 200.0 | V | 277.0 | -4.0 | 54.00 | 20.43 |
| 3249.10 | 41.39 | --- | 200.0 | H | 227.0 | -4.0 | 74.00 | 32.61 |
| 4874.00 | --- | 41.49 | 200.0 | V | 278.0 | -0.4 | 54.00 | 12.51 |
| 4874.00 | 51.03 | --- | 200.0 | V | 278.0 | -0.4 | 74.00 | 22.97 |
| 7828.90 | --- | 40.69 | 200.0 | V | 81.0 | 6.7 | 54.00 | 13.31 |
| 7828.90 | 49.73 | --- | 200.0 | V | 81.0 | 6.7 | 74.00 | 24.27 |
| 12979.90 | --- | 44.70 | 200.0 | V | 310.0 | 12.0 | 54.00 | 9.30 |
| 12979.90 | 54.61 | --- | 200.0 | V | 310.0 | 12.0 | 74.00 | 19.39 |
| 17802.80 | --- | 46.76 | 150.0 | H | 7.0 | 13.8 | 54.00 | 7.24 |
| 17802.80 | 56.88 | --- | 150.0 | H | 7.0 | 13.8 | 74.00 | 17.12 |

**High Channel : 2452MHz**

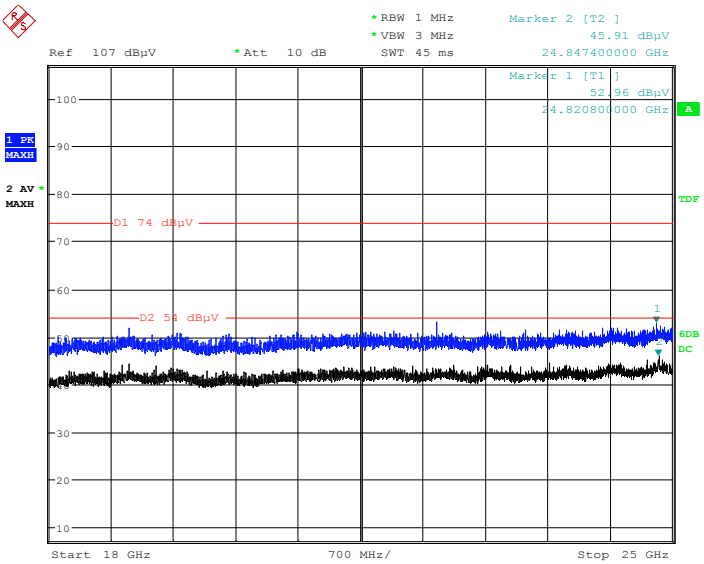



| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1535.50 | --- | 25.66 | 150.0 | V | 190.0 | -9.8 | 54.00 | 28.34 |
| 1535.50 | 34.95 | --- | 150.0 | V | 190.0 | -9.8 | 74.00 | 39.05 |
| 3267.80 | --- | 35.44 | 150.0 | V | 322.0 | -3.9 | 54.00 | 18.56 |
| 3267.80 | 42.14 | --- | 150.0 | V | 322.0 | -3.9 | 74.00 | 31.86 |
| 4904.00 | --- | 42.20 | 200.0 | V | 337.0 | -0.4 | 54.00 | 11.80 |
| 4904.00 | 49.35 | --- | 200.0 | V | 337.0 | -0.4 | 74.00 | 24.65 |
| 7386.00 | --- | 39.90 | 200.0 | V | 1.0 | 5.9 | 54.00 | 14.10 |
| 7386.00 | 49.47 | --- | 200.0 | V | 1.0 | 5.9 | 74.00 | 24.53 |
| 13921.70 | --- | 46.47 | 200.0 | V | 5.0 | 12.4 | 54.00 | 7.53 |
| 13921.70 | 54.62 | --- | 200.0 | V | 5.0 | 12.4 | 74.00 | 19.38 |
| 17646.40 | --- | 48.26 | 150.0 | H | 42.0 | 14.0 | 54.00 | 5.74 |
| 17646.40 | 56.52 | --- | 150.0 | H | 42.0 | 14.0 | 74.00 | 17.48 |

## 18GHz-25GHz:

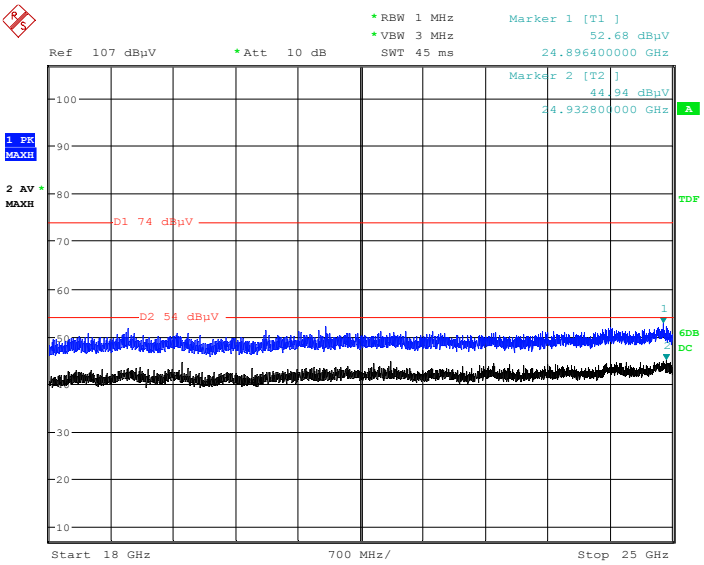
*Pre-scan with 802.11b, 802.11g and 802.11n-HT20 modes of operation in the X,Y and Z axes of orientation, the worst case* ***low channel of 802.11b mode in Z-axis of orientation*** *was recorded*

### Horizontal




Date: 10.JAN.2020 08:41:34

### Vertical




Date: 10.JAN.2020 08:28:06

**Restricted Bands Emissions Test:**

Note:
1. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
   Corrected Amplitude (dBµV/m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV/m)

***802.11b Mode:*** *(Pre-scan in the X, Y and Z axes of orientation, the worst case X-axis of orientation was recorded)*

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV/m) | Average (dBµV/m) | Height (cm) | Polar (H/V) | | | | |
| Low Channel: 2412MHz | | | | | | | | |
| 2390.00 | --- | 43.47 | 150.0 | V | 0.0 | 2.8 | 54.00 | 10.53 |
| 2390.00 | 50.43 | --- | 150.0 | V | 0.0 | 2.8 | 74.00 | 23.57 |
| High Channel: 2462MHz | | | | | | | | |
| 2483.50 | --- | 42.77 | 200.0 | V | 359.0 | 3.0 | 54.00 | 11.23 |
| 2483.50 | 50.80 | --- | 200.0 | V | 359.0 | 3.0 | 74.00 | 23.20 |

***802.11g Mode:*** *(Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)*

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV/m) | Average (dBµV/m) | Height (cm) | Polar (H/V) | | | | |
| Low Channel: 2412MHz | | | | | | | | |
| 2390.00 | 51.58 | --- | 200.0 | V | 247.0 | 2.8 | 74.00 | 22.42 |
| 2390.00 | --- | 43.78 | 200.0 | V | 247.0 | 2.8 | 54.00 | 10.22 |
| High Channel: 2462MHz | | | | | | | | |
| 2483.50 | --- | 44.61 | 200.0 | V | 330.0 | 3.0 | 54.00 | 9.39 |
| 2483.50 | 52.09 | --- | 200.0 | V | 330.0 | 3.0 | 74.00 | 21.91 |

***802.11n-HT20 Mode:*** *(Pre-scan in the X,Y and Z axes of orientation, the worst case Z-axis of orientation was recorded)*

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV/m) | Average (dBµV/m) | Height (cm) | Polar (H/V) | | | | |
| Low Channel: 2412MHz | | | | | | | | |
| 2390.00 | --- | 43.13 | 200.0 | V | 317.0 | 2.8 | 54.00 | 10.87 |
| 2390.00 | 50.65 | --- | 200.0 | V | 317.0 | 2.8 | 74.00 | 23.35 |
| High Channel: 2462MHz | | | | | | | | |
| 2483.50 | 52.49 | --- | 200.0 | V | 263.0 | 3.0 | 74.00 | 21.51 |
| 2483.50 | --- | 44.48 | 200.0 | V | 263.0 | 3.0 | 54.00 | 9.52 |

***802.11n-HT40 Mode:*** *(Pre-scan in the X,Y and Z axes of orientation, the worst case Z-axis of orientation was recorded)*

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV/m) | Average (dBµV/m) | Height (cm) | Polar (H/V) | | | | |
| Low Channel: 2422MHz | | | | | | | | |
| 2390.00 | 52.30 | --- | 200.0 | V | 313.0 | 2.8 | 74.00 | 21.70 |
| 2390.00 | --- | 45.69 | 200.0 | V | 313.0 | 2.8 | 54.00 | 8.31 |
| High Channel: 2452MHz | | | | | | | | |
| 2483.50 | --- | 48.65 | 200.0 | V | 317.0 | 3.0 | 54.00 | 5.35 |
| 2483.50 | 55.73 | --- | 200.0 | V | 317.0 | 3.0 | 74.00 | 18.27 |

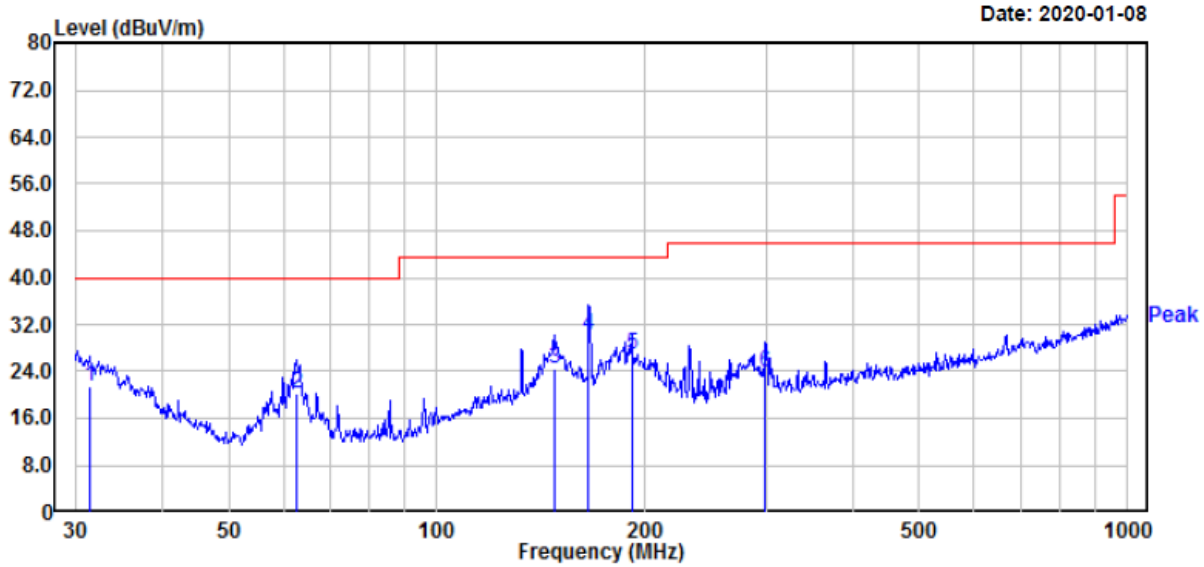
***Model: ATOM-1***

***For BLE Mode:***

**Spurious Emission Test:**

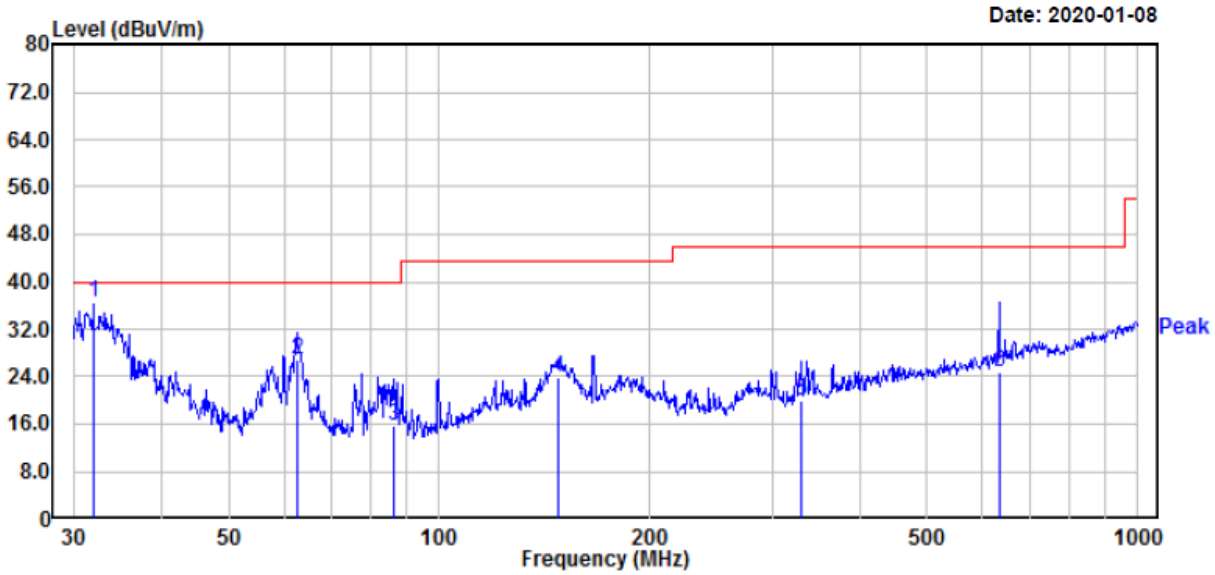
***Horizontal:***

**30MHz-1GHz**
*(The worst case **low channel of operation in the Z axis of orientation** was recorded)*




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 31.40 | 25.60 | -4.29 | 21.31 | 40.00 | -18.69 | 200 | 215 | QP |
| 2 | 62.87 | 37.50 | -17.37 | 20.13 | 40.00 | -19.87 | 200 | 138 | QP |
| 3 | 147.92 | 36.40 | -11.86 | 24.54 | 43.50 | -18.96 | 200 | 98 | QP |
| 4 | 166.07 | 42.49 | -12.33 | 30.16 | 43.50 | -13.34 | 200 | 147 | QP |
| 5 | 191.75 | 38.90 | -12.17 | 26.73 | 43.50 | -16.77 | 200 | 175 | QP |
| 6 | 299.32 | 34.20 | -10.29 | 23.91 | 46.00 | -22.09 | 100 | 295 | QP |

***Vertical:***




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 31.95 | 41.40 | -4.76 | 36.64 | 40.00 | -3.36 | 100 | 96 | QP |
| 2 | 62.65 | 44.30 | -17.38 | 26.92 | 40.00 | -13.08 | 200 | 104 | QP |
| 3 | 86.20 | 32.99 | -17.21 | 15.78 | 40.00 | -24.22 | 100 | 115 | QP |
| 4 | 147.92 | 35.60 | -11.86 | 23.74 | 43.50 | -19.76 | 100 | 172 | QP |
| 5 | 330.19 | 29.70 | -9.63 | 20.07 | 46.00 | -25.93 | 100 | 162 | QP |
| 6 | 633.91 | 28.00 | -3.36 | 24.64 | 46.00 | -21.36 | 200 | 35 | QP |

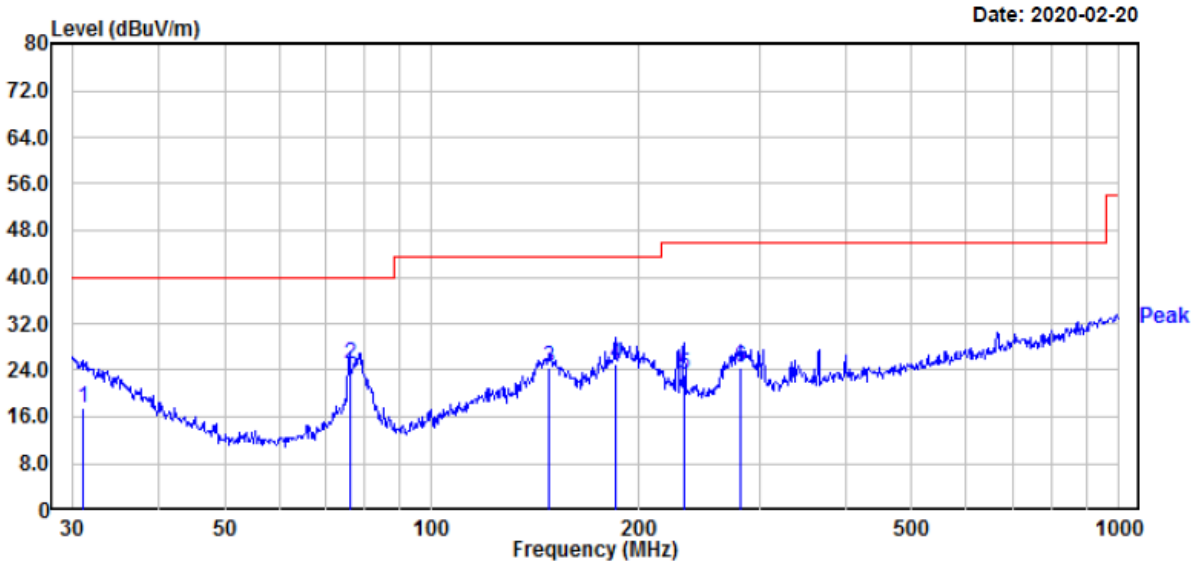
***Model: ATOM-2***

***For BLE Mode:***

**Spurious Emission Test:**

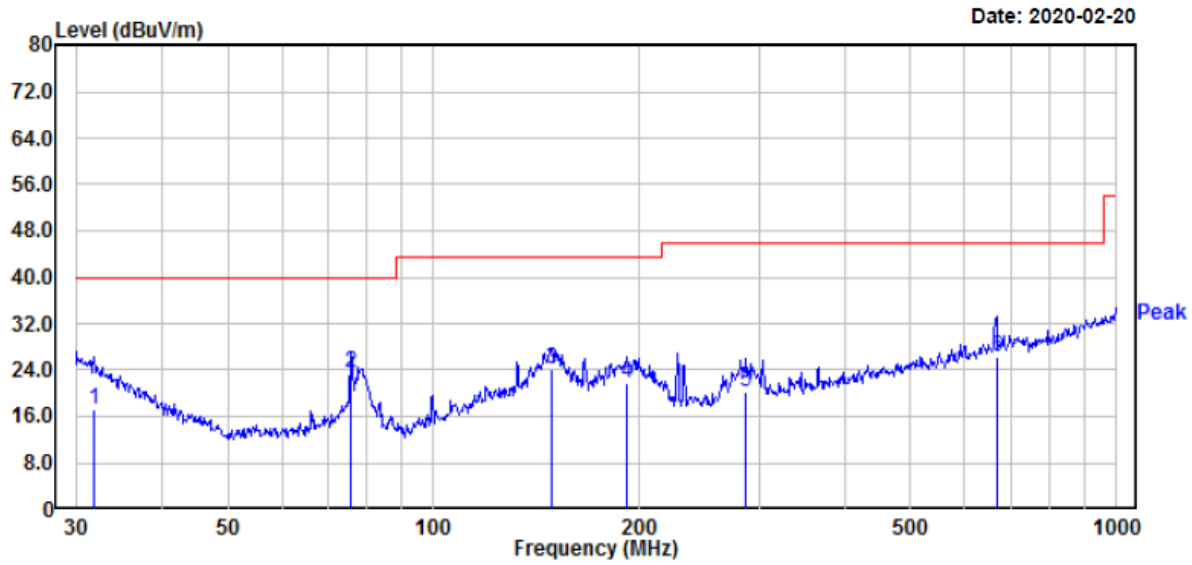
***Horizontal:***

**30MHz-1GHz**
*(The worst case **low channel of operation in the Z axis of orientation** was recorded)*




| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 31.18 | 21.50 | -4.11 | 17.39 | 40.00 | -22.61 | 100 | 324 | QP |
| 2 | 75.98 | 42.00 | -17.06 | 24.94 | 40.00 | -15.06 | 200 | 40 | QP |
| 3 | 147.92 | 36.40 | -11.86 | 24.54 | 43.50 | -18.96 | 200 | 80 | QP |
| 4 | 185.14 | 37.70 | -12.64 | 25.06 | 43.50 | -18.44 | 200 | 40 | QP |
| 5 | 233.35 | 36.20 | -13.01 | 23.19 | 46.00 | -22.81 | 200 | 3 | QP |
| 6 | 282.00 | 34.90 | -10.55 | 24.35 | 46.00 | -21.65 | 100 | 88 | QP |

***Vertical:***



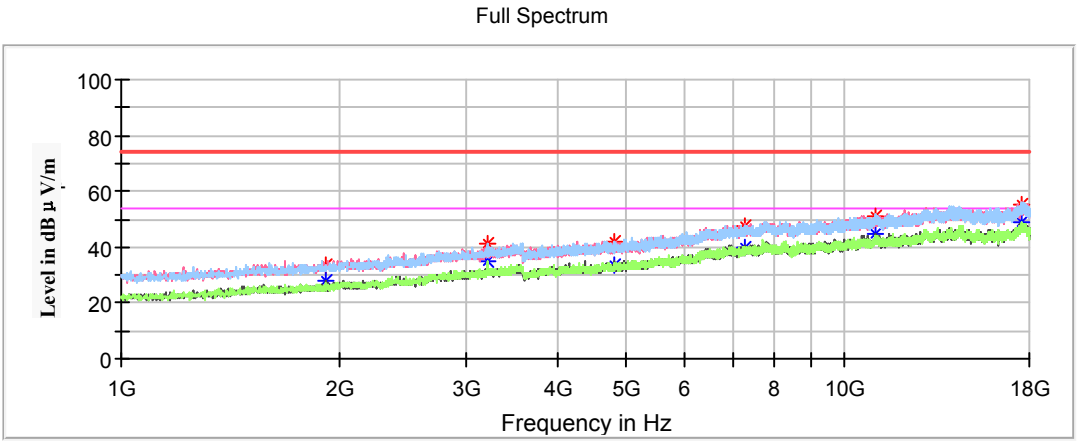

| | Freq | Read Level | Factor | Level | Limit Line | Over Limit | APos | TPos | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | cm | deg | |
| 1 | 31.84 | 21.81 | -4.67 | 17.14 | 40.00 | -22.86 | 100 | 279 | QP |
| 2 | 75.71 | 40.70 | -17.05 | 23.65 | 40.00 | -16.35 | 100 | 121 | QP |
| 3 | 148.96 | 36.10 | -11.88 | 24.22 | 43.50 | -19.28 | 100 | 304 | QP |
| 4 | 191.75 | 33.80 | -12.17 | 21.63 | 43.50 | -21.87 | 100 | 360 | QP |
| 5 | 286.98 | 30.70 | -10.46 | 20.24 | 46.00 | -25.76 | 200 | 13 | QP |
| 6 | 668.14 | 29.00 | -2.71 | 26.29 | 46.00 | -19.71 | 100 | 52 | QP |

**1GHz-18GHz**

*(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded)*

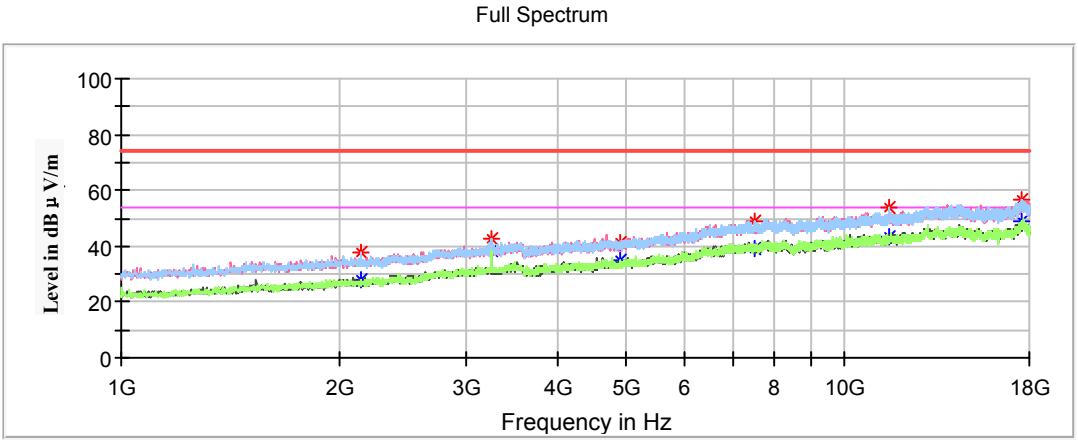
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
   Corrected Amplitude (dBµV /m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV /m)

**Low Channel: 2402MHz**



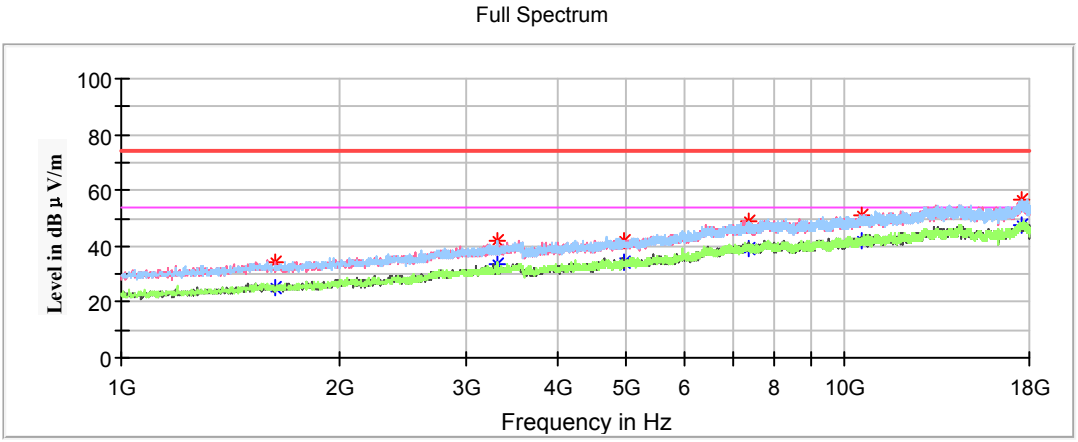

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1918.00 | --- | 27.65 | 150.0 | V | 77.0 | -8.5 | 54.00 | 26.35 |
| 1918.00 | 33.80 | --- | 150.0 | V | 77.0 | -8.5 | 74.00 | 40.20 |
| 3204.90 | --- | 34.72 | 200.0 | H | 215.0 | -4.0 | 54.00 | 19.28 |
| 3204.90 | 41.39 | --- | 200.0 | H | 215.0 | -4.0 | 74.00 | 32.61 |
| 4804.00 | --- | 33.70 | 150.0 | H | 349.0 | -0.6 | 54.00 | 20.30 |
| 4804.00 | 41.87 | --- | 150.0 | H | 349.0 | -0.6 | 74.00 | 32.13 |
| 7290.00 | --- | 39.71 | 200.0 | V | 106.0 | 5.8 | 54.00 | 14.29 |
| 7290.00 | 47.83 | --- | 200.0 | V | 106.0 | 5.8 | 74.00 | 26.17 |
| 11026.60 | --- | 45.07 | 150.0 | V | 77.0 | 9.8 | 54.00 | 8.93 |
| 11026.60 | 51.26 | --- | 150.0 | V | 77.0 | 9.8 | 74.00 | 22.74 |
| 17546.10 | 55.09 | --- | 150.0 | H | 215.0 | 14.2 | 74.00 | 18.91 |
| 17546.10 | --- | 49.11 | 150.0 | H | 215.0 | 14.2 | 54.00 | 4.89 |

**Middle Channel: 2440MHz**




| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 2147.50 | --- | 28.02 | 200.0 | H | 358.0 | -7.9 | 54.00 | 25.98 |
| 2147.50 | 37.58 | --- | 200.0 | H | 358.0 | -7.9 | 74.00 | 36.42 |
| 3252.50 | --- | 38.11 | 200.0 | H | 129.0 | -4.0 | 54.00 | 15.89 |
| 3252.50 | 42.33 | --- | 200.0 | H | 129.0 | -4.0 | 74.00 | 31.67 |
| 4880.00 | 41.11 | --- | 150.0 | V | 0.0 | -0.4 | 74.00 | 32.89 |
| 4880.00 | --- | 35.15 | 150.0 | V | 0.0 | -0.4 | 54.00 | 18.85 |
| 7504.20 | --- | 39.11 | 200.0 | H | 188.0 | 6.1 | 54.00 | 14.89 |
| 7504.20 | 48.86 | --- | 200.0 | H | 188.0 | 6.1 | 74.00 | 25.14 |
| 11550.20 | --- | 43.14 | 200.0 | H | 295.0 | 9.8 | 54.00 | 10.86 |
| 11550.20 | 53.75 | --- | 200.0 | H | 295.0 | 9.8 | 74.00 | 20.25 |
| 17508.70 | --- | 49.02 | 200.0 | H | 159.0 | 14.3 | 54.00 | 4.98 |
| 17508.70 | 56.72 | --- | 200.0 | H | 159.0 | 14.3 | 74.00 | 17.28 |

**High Channel: 2480MHz**

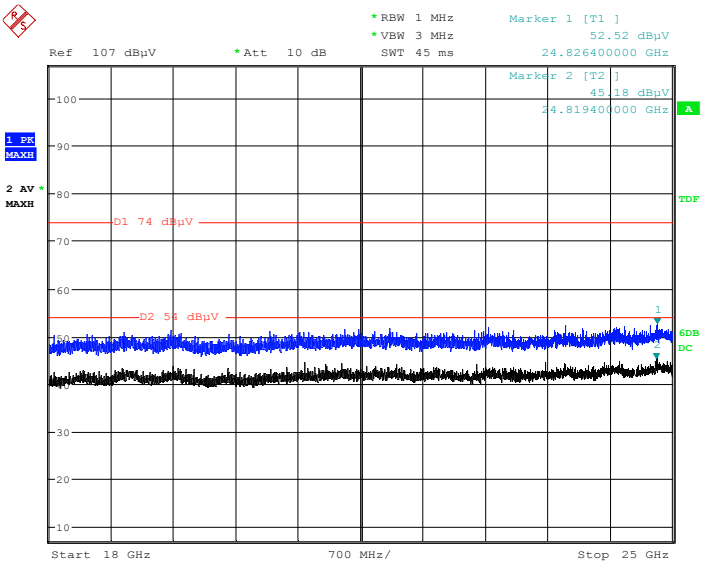



| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1630.70 | --- | 25.02 | 150.0 | V | 21.0 | -9.5 | 54.00 | 28.98 |
| 1630.70 | 34.58 | --- | 150.0 | V | 21.0 | -9.5 | 74.00 | 39.42 |
| 3305.20 | --- | 33.80 | 150.0 | H | 237.0 | -3.9 | 54.00 | 20.20 |
| 3305.20 | 41.81 | --- | 150.0 | H | 237.0 | -3.9 | 74.00 | 32.19 |
| 4960.00 | --- | 34.34 | 150.0 | V | 79.0 | -0.3 | 54.00 | 19.66 |
| 4960.00 | 41.97 | --- | 150.0 | V | 79.0 | -0.3 | 74.00 | 32.03 |
| 7346.10 | --- | 39.02 | 200.0 | H | 296.0 | 5.9 | 54.00 | 14.98 |
| 7346.10 | 49.20 | --- | 200.0 | H | 296.0 | 5.9 | 74.00 | 24.80 |
| 10545.50 | --- | 41.90 | 200.0 | V | 37.0 | 9.1 | 54.00 | 12.10 |
| 10545.50 | 51.21 | --- | 200.0 | V | 37.0 | 9.1 | 74.00 | 22.79 |
| 17609.00 | --- | 47.81 | 150.0 | H | 251.0 | 14.1 | 54.00 | 6.19 |
| 17609.00 | 56.60 | --- | 150.0 | H | 251.0 | 14.1 | 74.00 | 17.40 |

**18GHz-25GHz**

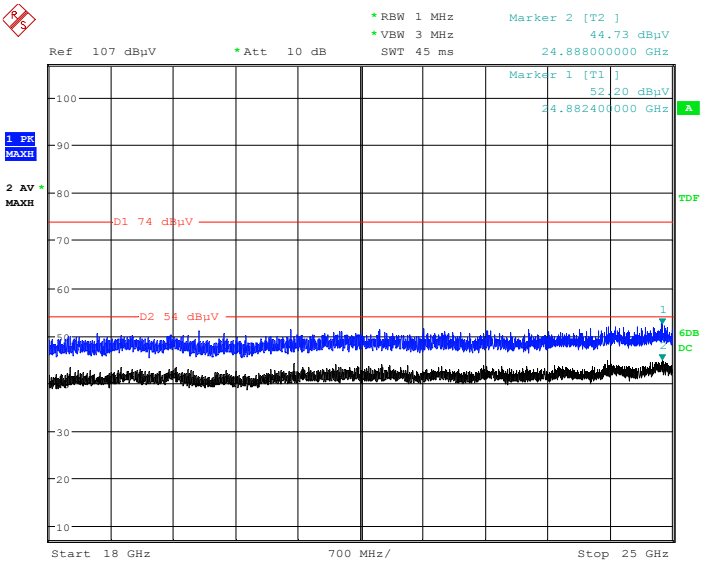
*(The worst case **middle channel of operation in the Z axis of orientation** was recorded)*

**Horizontal**




Date: 10.JAN.2020 09:56:10

**Vertical**




Date: 10.JAN.2020 09:24:54

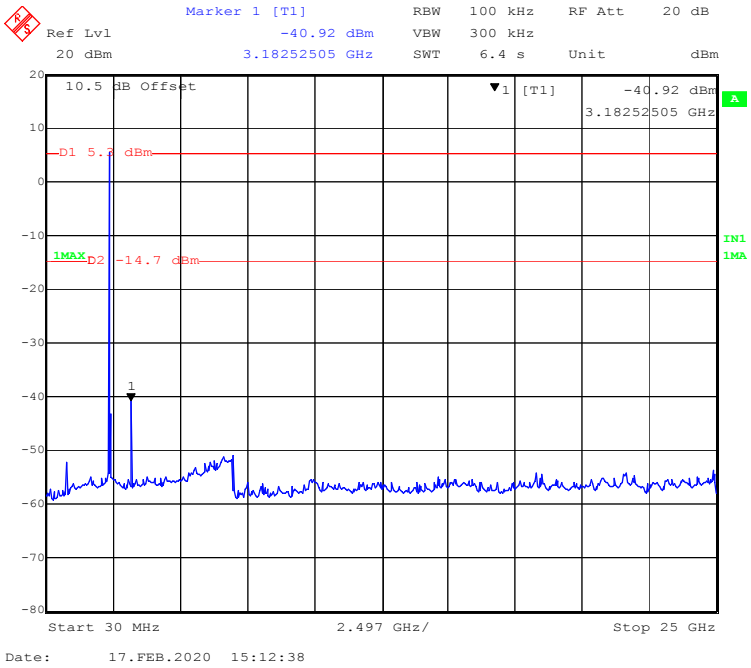
**Restricted Bands Emissions Test:**
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded)*

Note:
1. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
   Corrected Amplitude (dBµV/m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV/m)

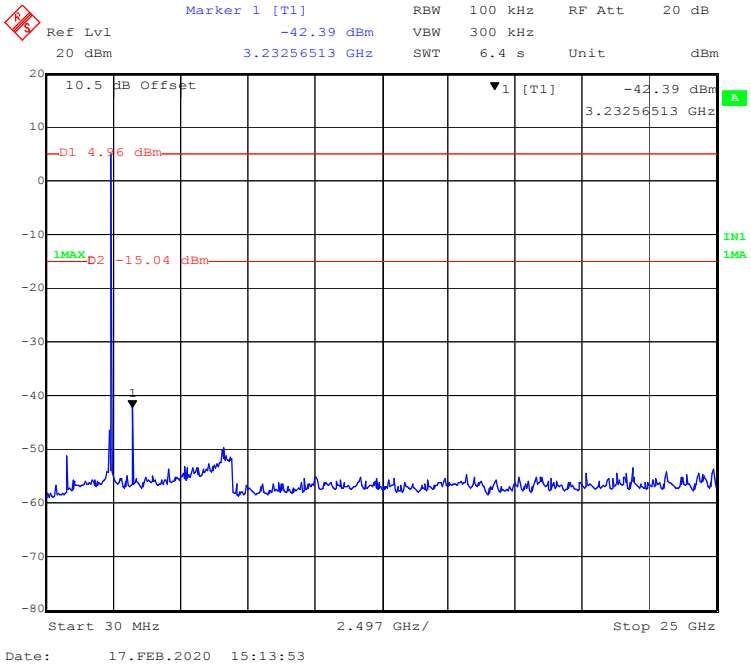
| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| | MaxPeak (dBµV/m) | Average (dBµV/m) | Height (cm) | Polar (H/V) | | | | |
| Low Channel: 2402MHz | | | | | | | | |
| 2390.00 | --- | 41.24 | 200.0 | H | 0.0 | 2.8 | 54.00 | 12.76 |
| 2390.00 | 51.17 | --- | 200.0 | H | 0.0 | 2.8 | 74.00 | 22.83 |
| High Channel: 2480MHz | | | | | | | | |
| 2483.50 | --- | 40.76 | 200.0 | H | 249.0 | 3.1 | 54.00 | 13.24 |
| 2483.50 | 52.16 | --- | 200.0 | H | 249.0 | 3.1 | 74.00 | 21.84 |

## Conducted Spurious Emissions at Antenna Port

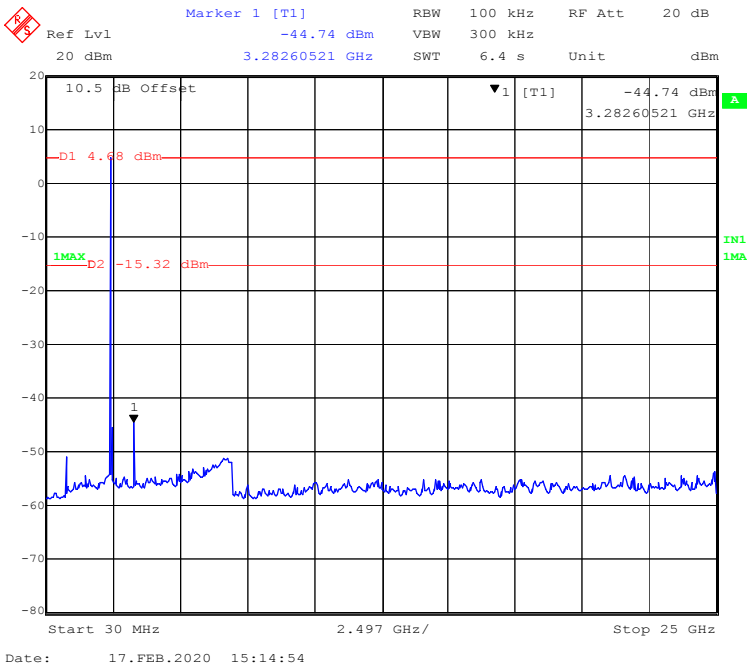
### 802.11b Mode Low Channel



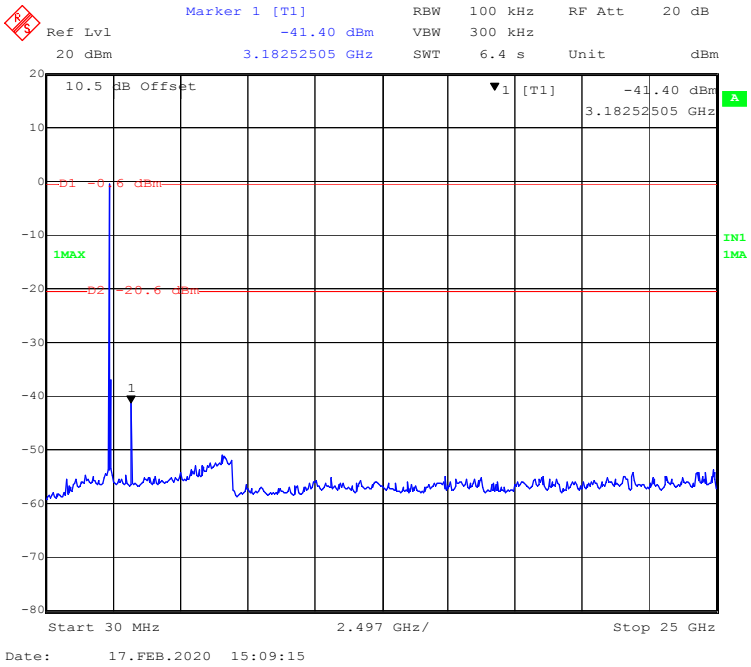

### 802.11b Mode Middle Channel



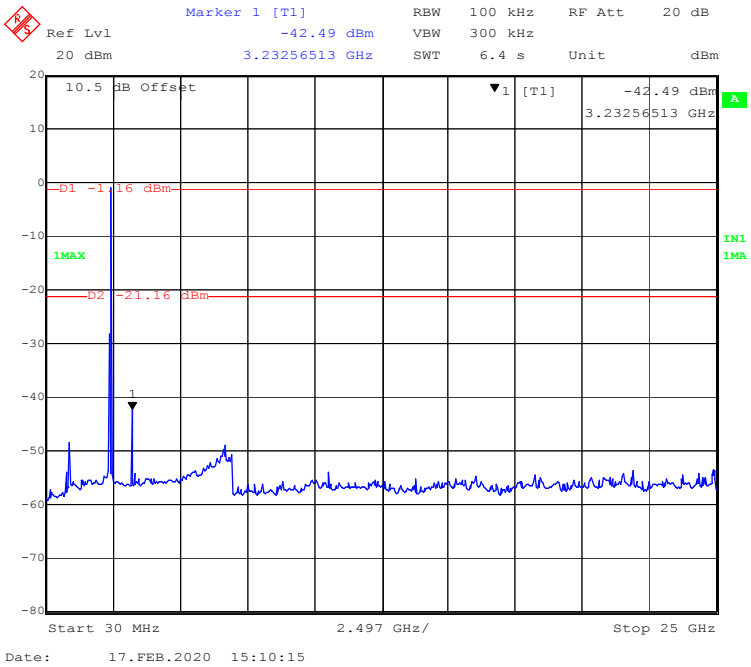
## 802.11b Mode High Channel



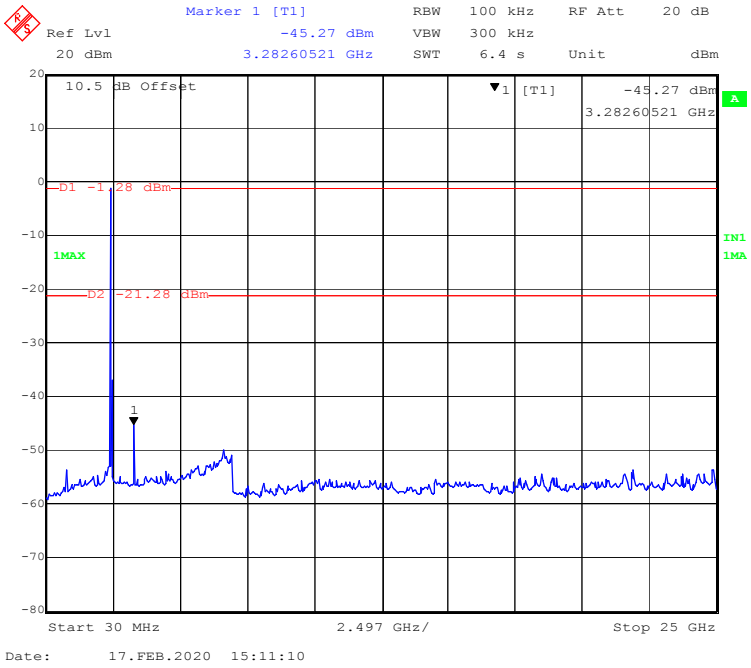

## 802.11g Mode Low Channel



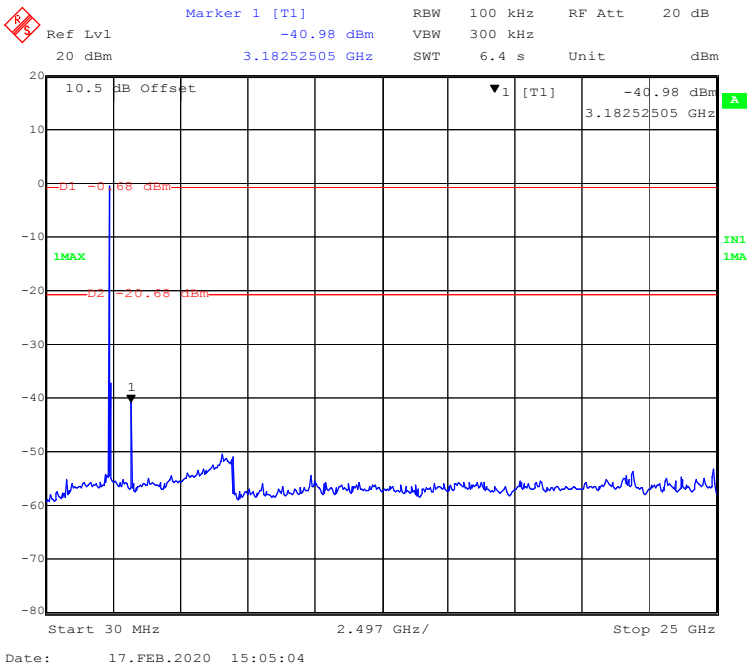
## 802.11g Mode Middle Channel



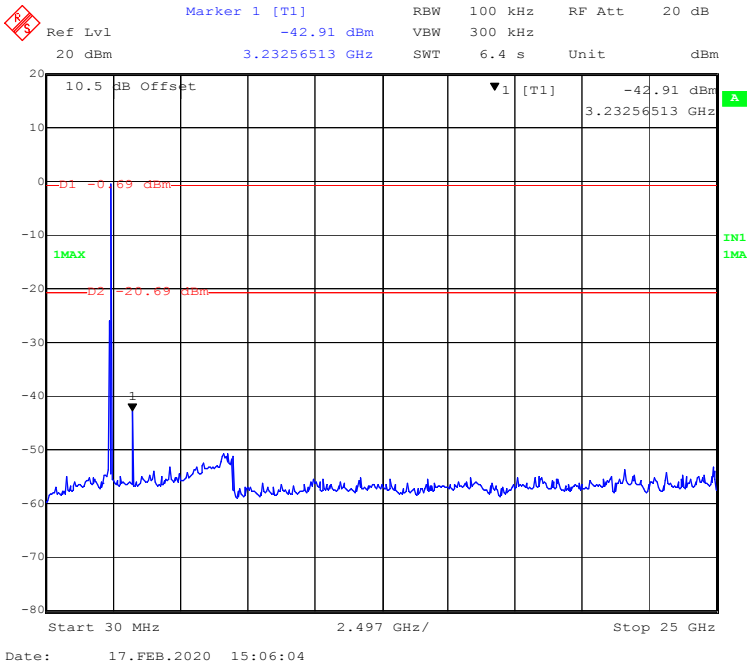

## 802.11g Mode High Channel



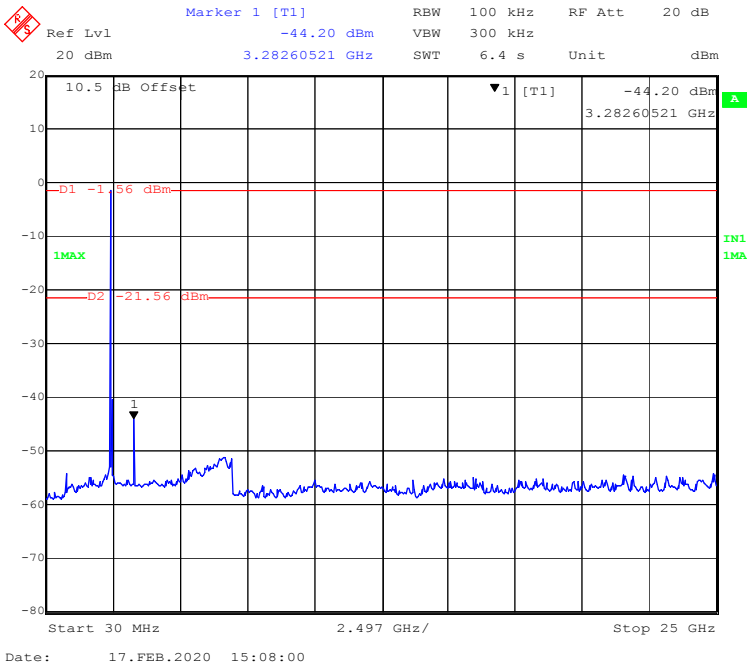
## 802.11n-HT20 Mode Low Channel



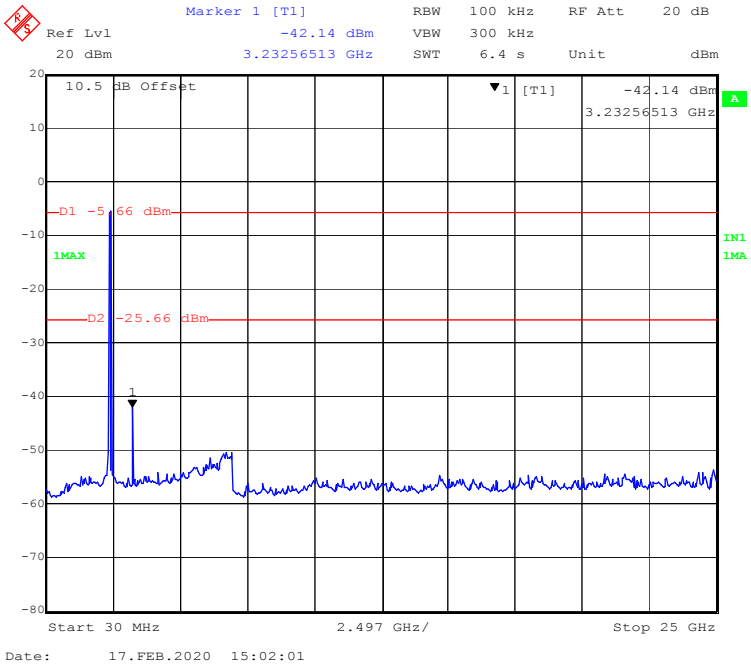

## 802.11n-HT20 Mode Middle Channel



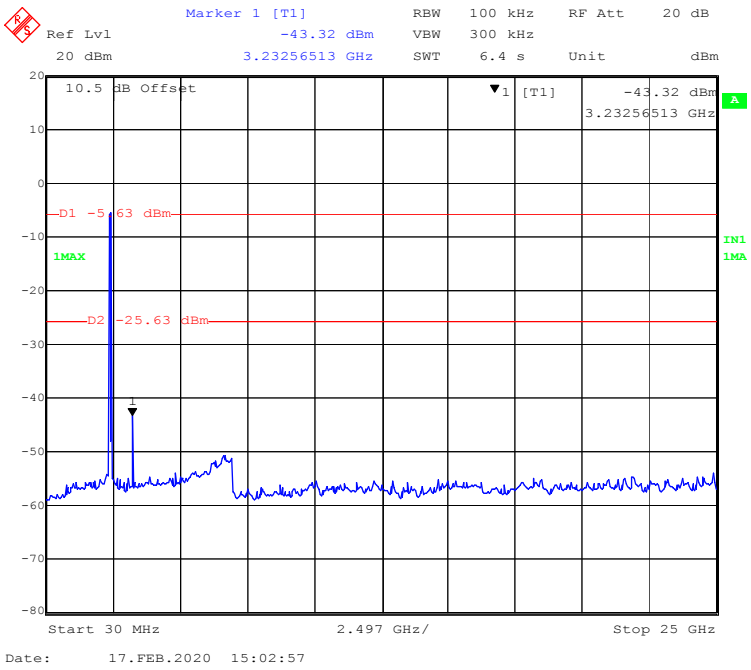
## 802.11n-HT20 Mode High Channel



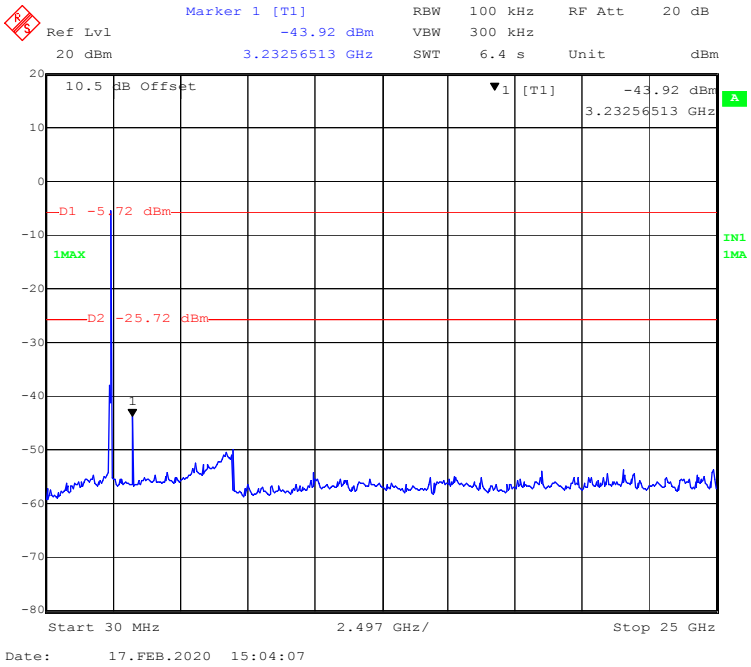

## 802.11n-HT40 Mode Low Channel



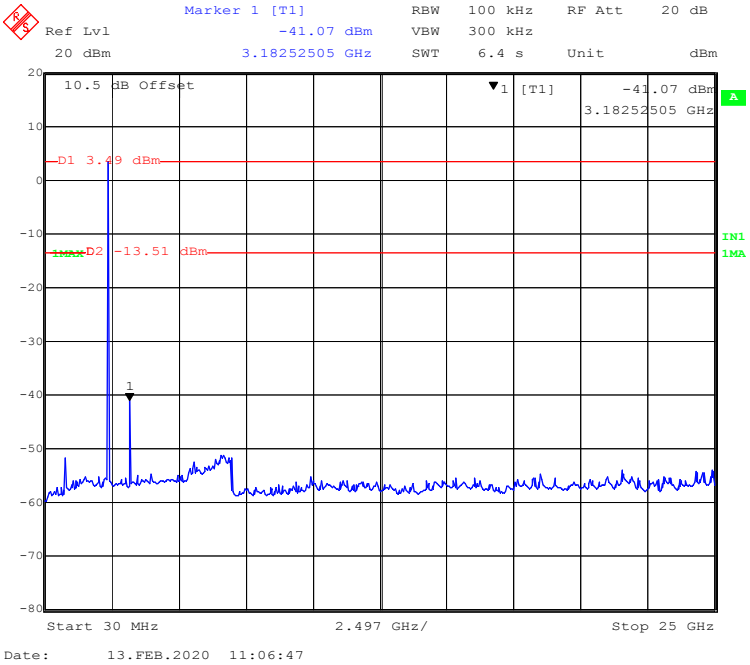
## 802.11n-HT40 Mode Middle Channel



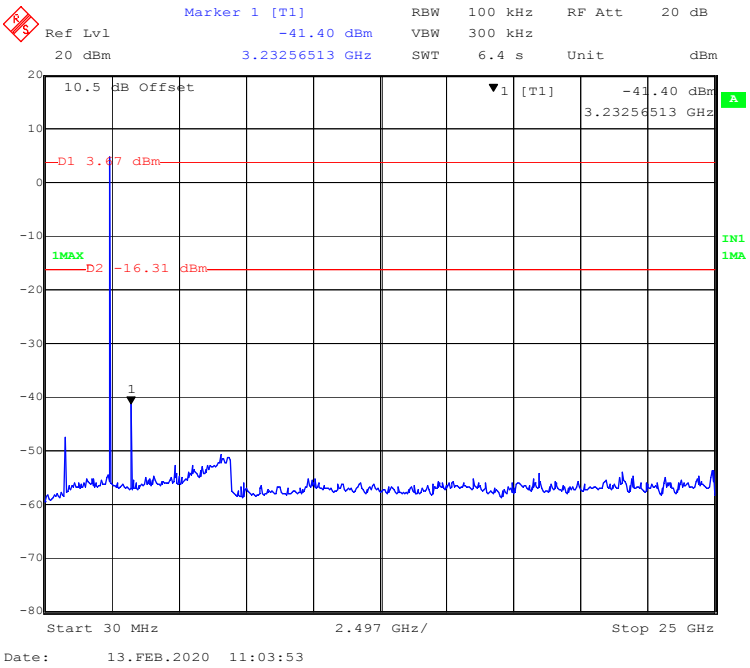

## 802.11n-HT40 Mode High Channel



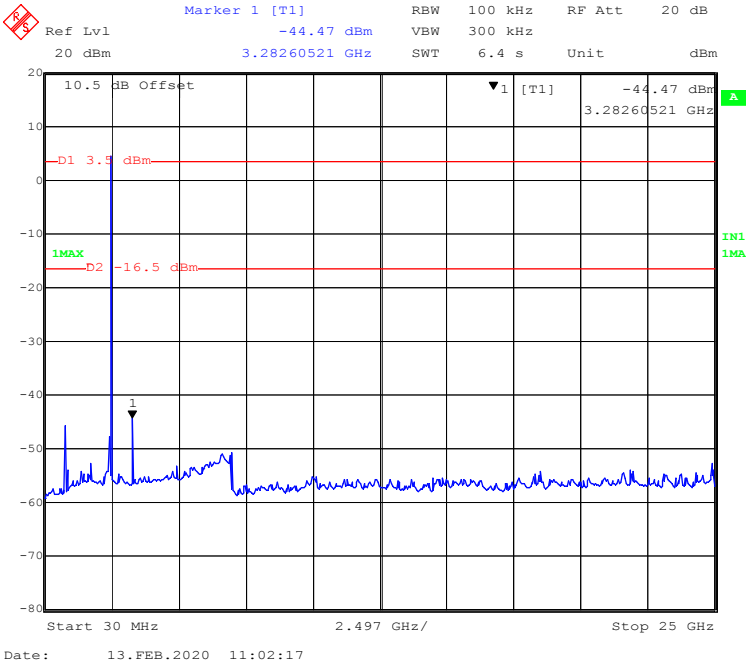
## BLE Mode Low Channel




## BLE Mode Middle Channel



## BLE Mode High Channel



# FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

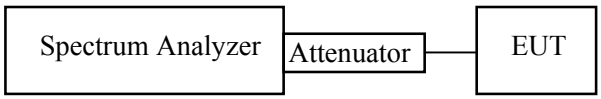
## Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

## Test Procedure

According to ANSI C63.10-2013 sub-clause 11.8.1

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
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 frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.




## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 21.3℃~22.6 ℃ |
| **Relative Humidity:** | 50 %~51 % |
| **ATM Pressure:** | 101.2kPa~102.1kPa |

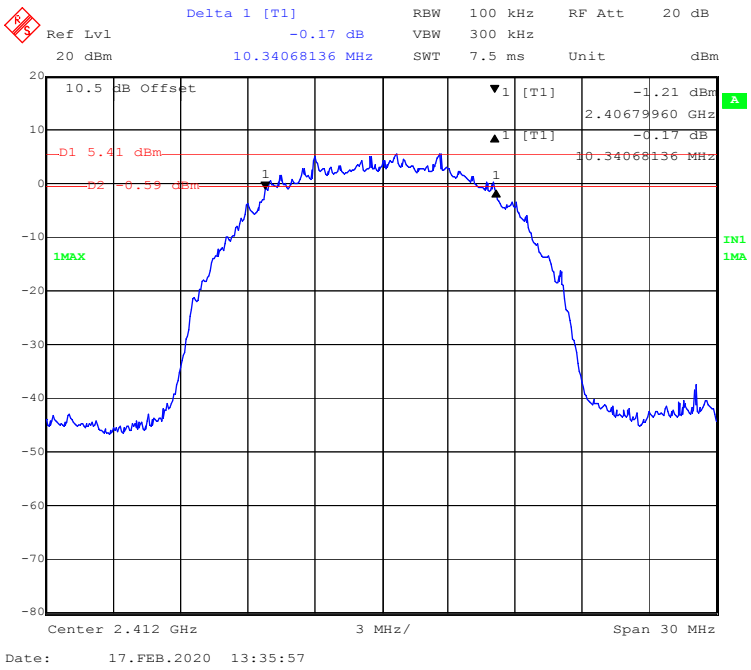
*The testing was performed by Lee Li from 2020-02-13 to 2020-02-17.*

**Test Result:** Compliant.

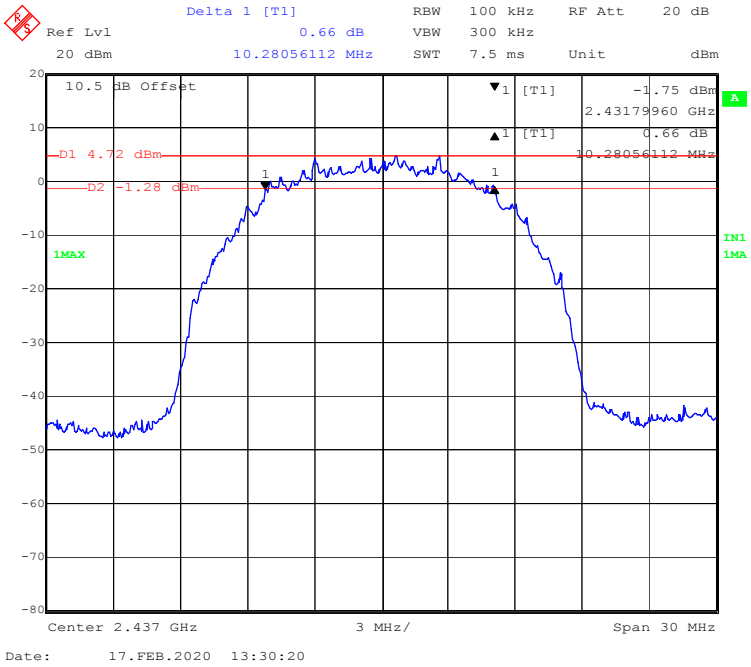
*EUT operation mode: Transmitting*

| Channel | Frequency (MHz) | 6 dB Emission Bandwidth (MHz) | Limit (MHz) |
|---|---|---|---|
| 802.11b Mode | | | |
| Low | 2412 | 10.341 | ≥0.5 |
| Middle | 2437 | 10.281 | ≥0.5 |
| High | 2462 | 10.341 | ≥0.5 |
| 802.11g Mode | | | |
| Low | 2412 | 16.533 | ≥0.5 |
| Middle | 2437 | 16.533 | ≥0.5 |
| High | 2462 | 16.533 | ≥0.5 |
| 802.11n-HT20 Mode | | | |
| Low | 2412 | 17.675 | ≥0.5 |
| Middle | 2437 | 17.675 | ≥0.5 |
| High | 2462 | 17.675 | ≥0.5 |
| 802.11n-HT40 Mode | | | |
| Low | 2422 | 36.673 | ≥0.5 |
| Middle | 2437 | 36.673 | ≥0.5 |
| High | 2452 | 36.673 | ≥0.5 |
| BLE Mode | | | |
| Low | 2402 | 0.7034 | ≥0.5 |
| Middle | 2440 | 0.7034 | ≥0.5 |
| High | 2480 | 0.7034 | ≥0.5 |

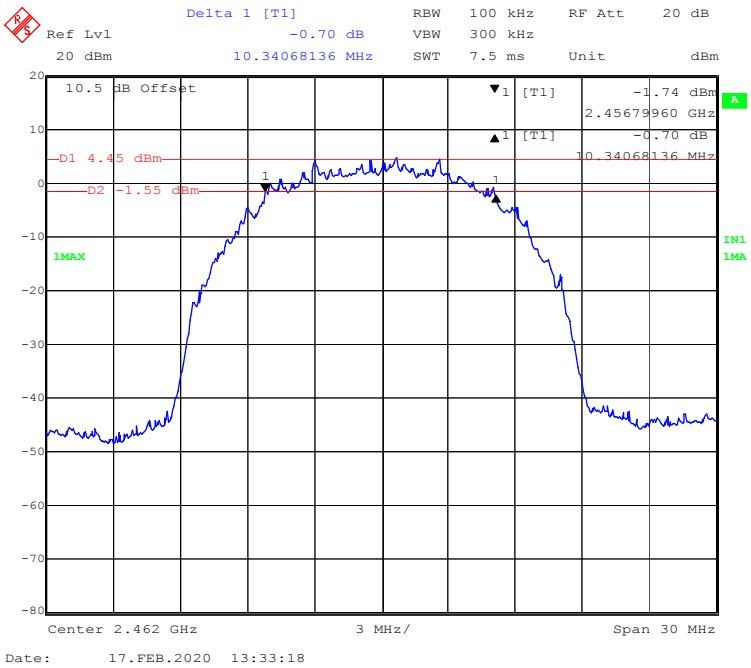
## 802.11b Mode Low Channel




## 802.11b Mode Middle Channel

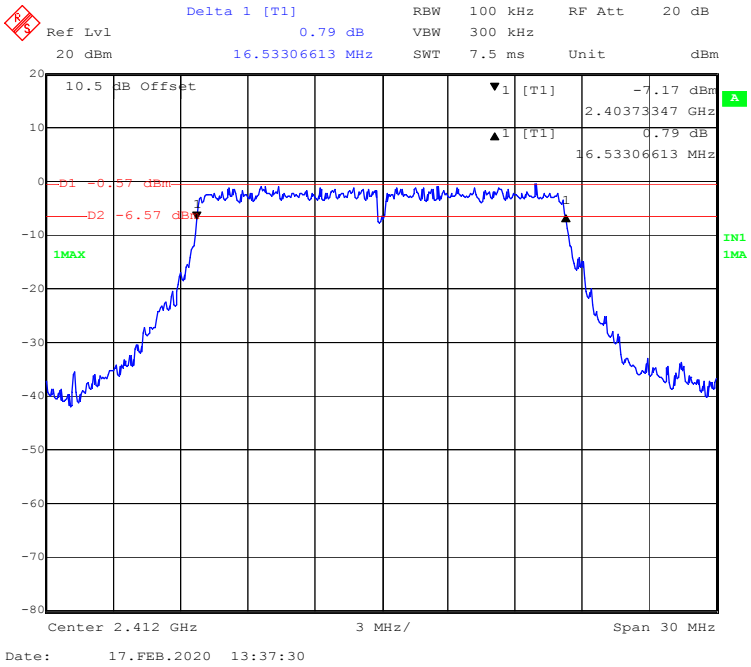


## 802.11b Mode High Channel



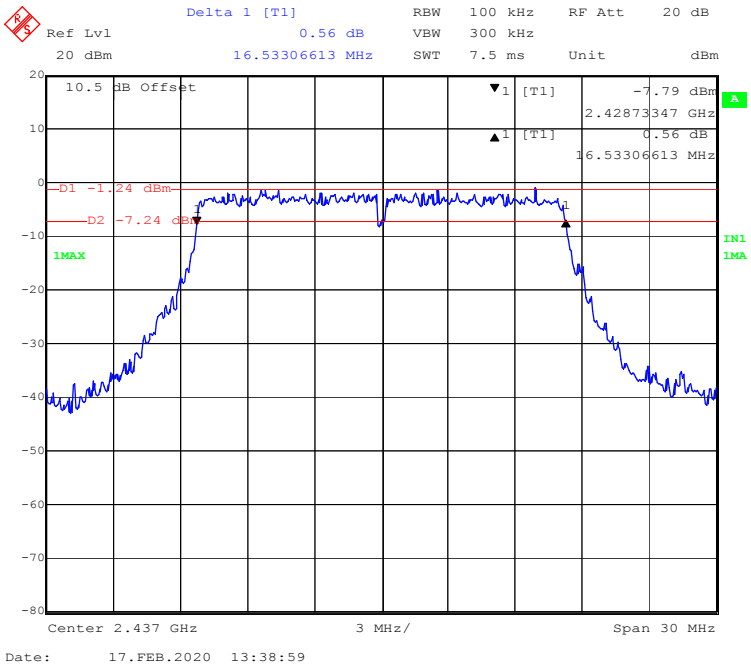

Date: 17.FEB.2020 13:33:18

## 802.11g Mode Low Channel

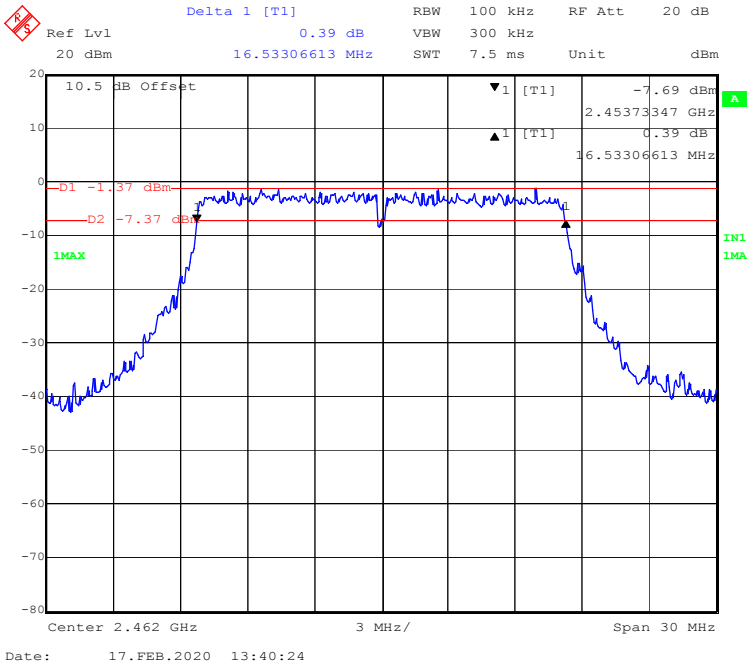



Date: 17.FEB.2020 13:37:30

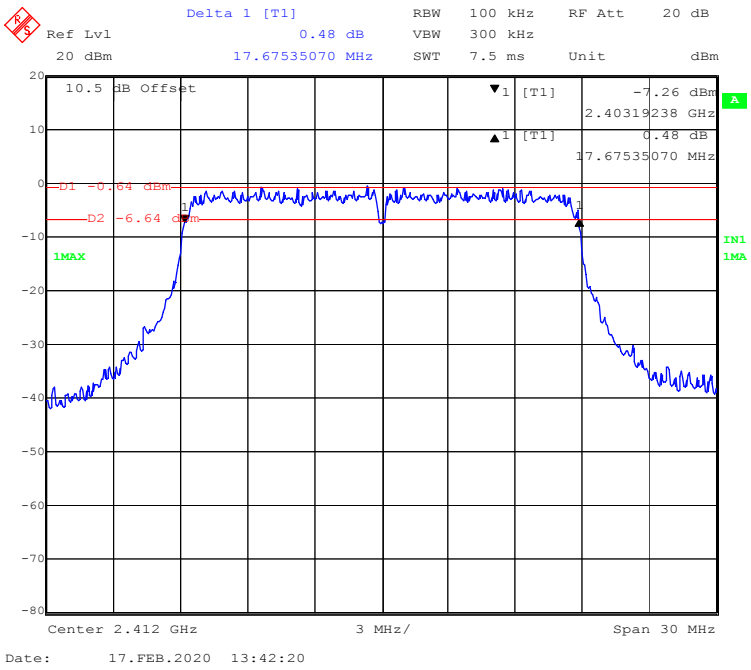
## 802.11g Mode Middle Channel



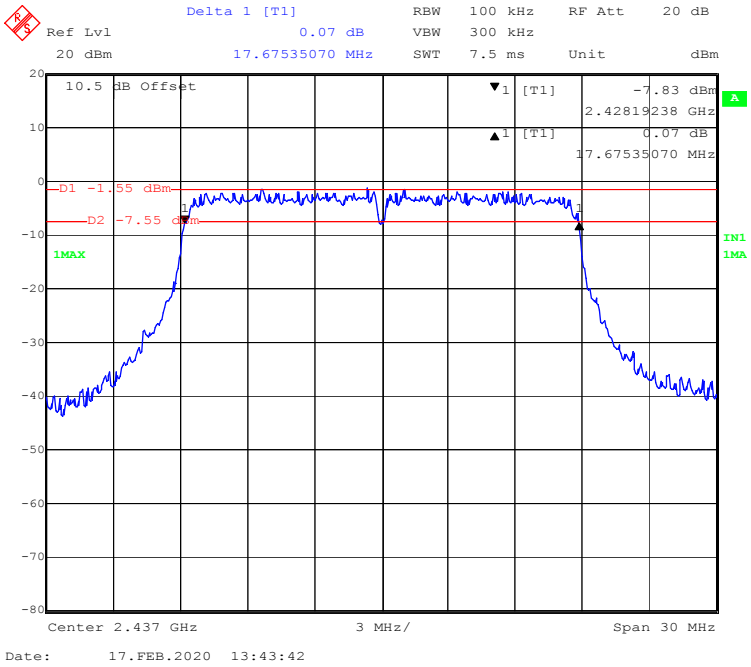

## 802.11g Mode High Channel



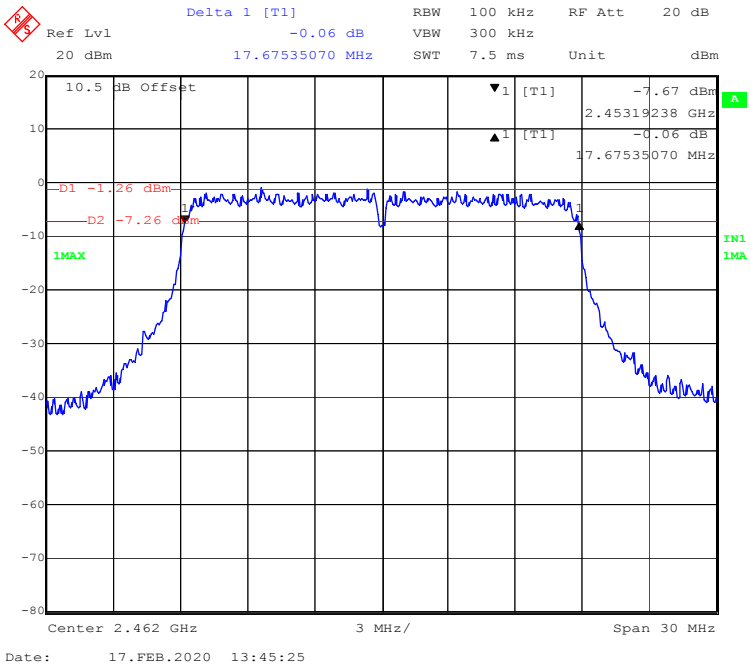
## 802.11n-HT20 Mode Low Channel



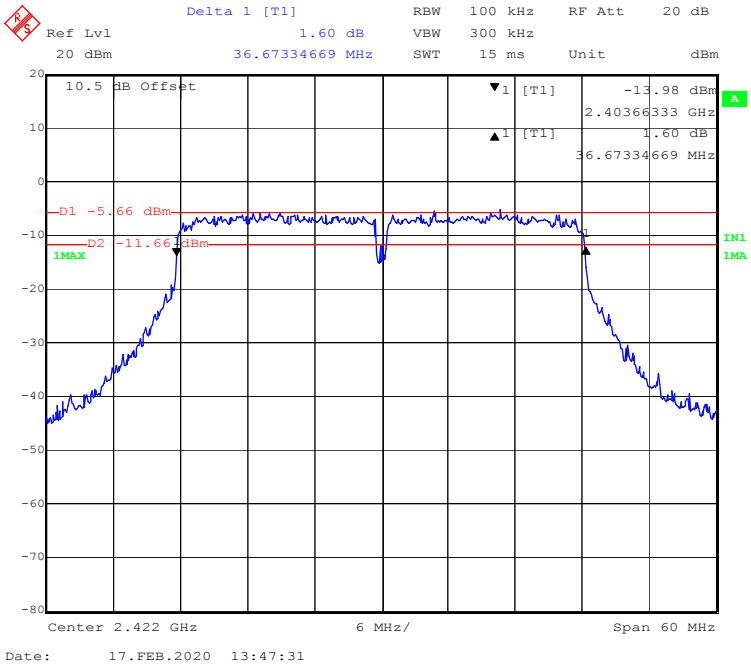

## 802.11n-HT20 Mode Middle Channel



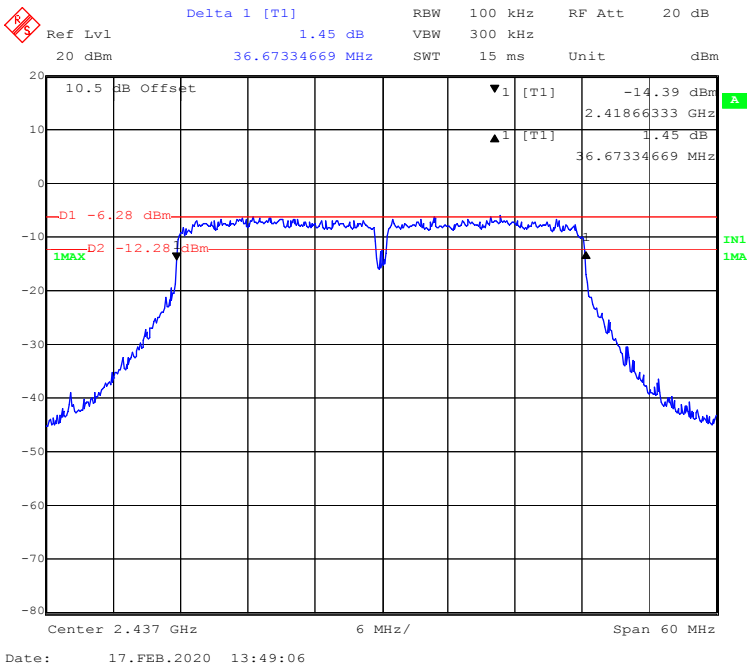
## 802.11n-HT20 Mode High Channel



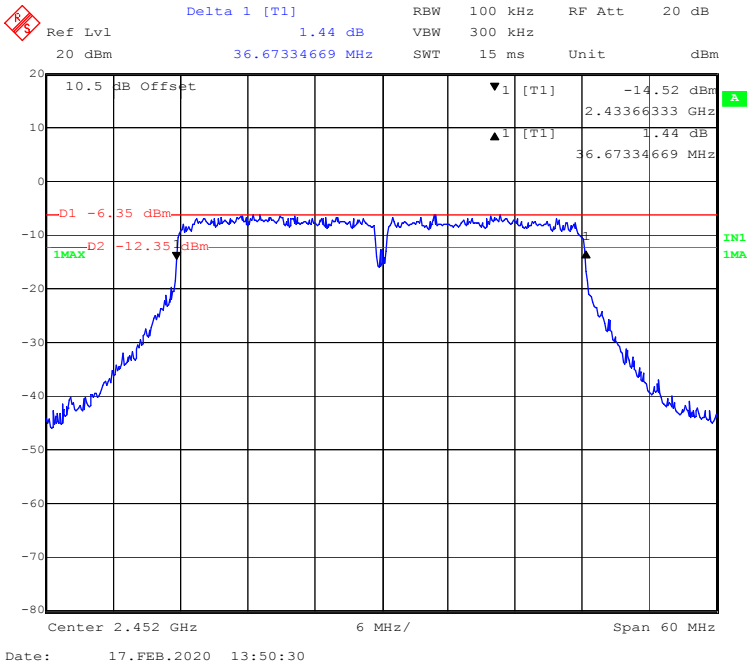

## 802.11n-HT40 Mode Low Channel



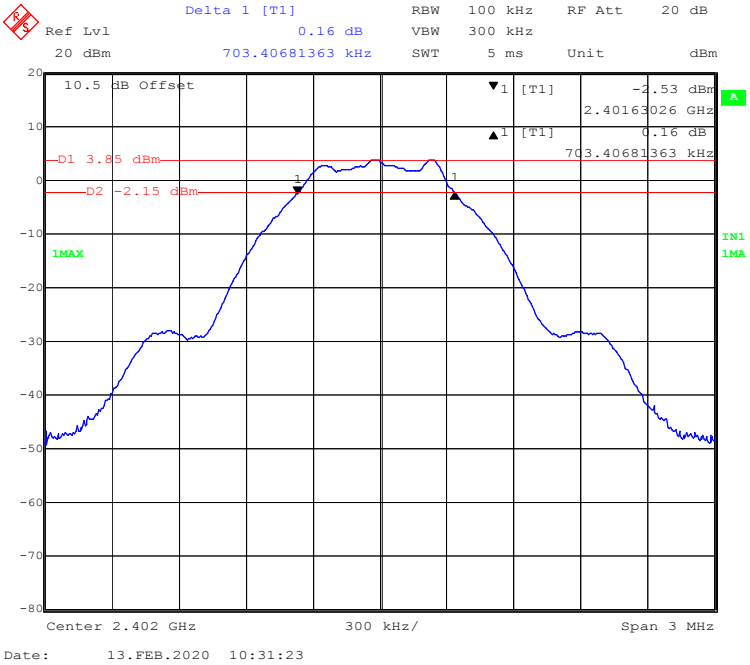
## 802.11n-HT40 Mode Middle Channel



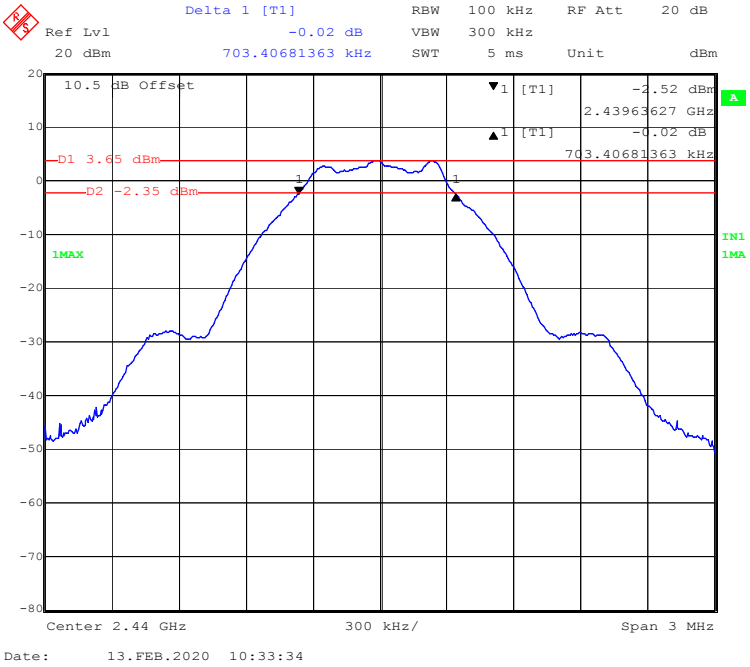

## 802.11n-HT40 Mode High Channel



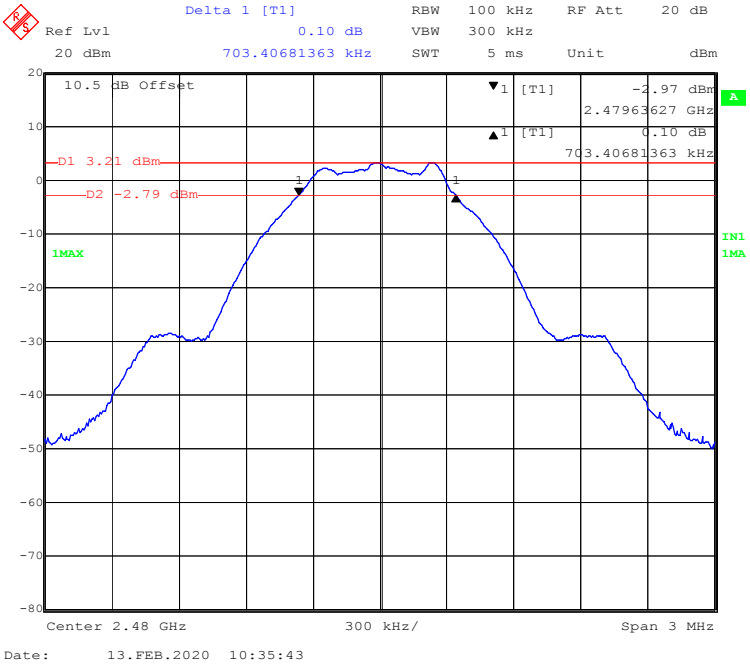
## BLE Mode Low Channel




## BLE Mode Middle Channel



## BLE Mode High Channel



# FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

## Applicable Standard

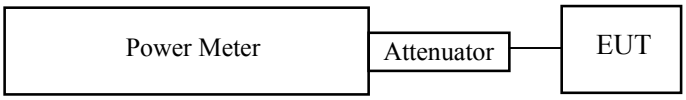
According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, Compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

## Test Procedure

**For Wi-Fi:**

According to ANSI C63.10-2013 sub-clause 11.9.1.3

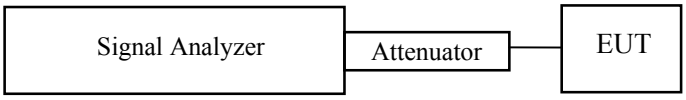
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.




**For BLE:**

According to ANSI C63.10-2013 sub-clause 11.9.1.1

1. Set the RBW ≥ DTS bandwidth.
2. Set VBW ≥ 3 x RBW.
3. Set span ≥ 3 x RBW
4. Sweep time = auto couple.
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.



## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 21.3℃~22.6 ℃ |
| **Relative Humidity:** | 50 %~51 % |
| **ATM Pressure:** | 101.2kPa~102.1kPa |

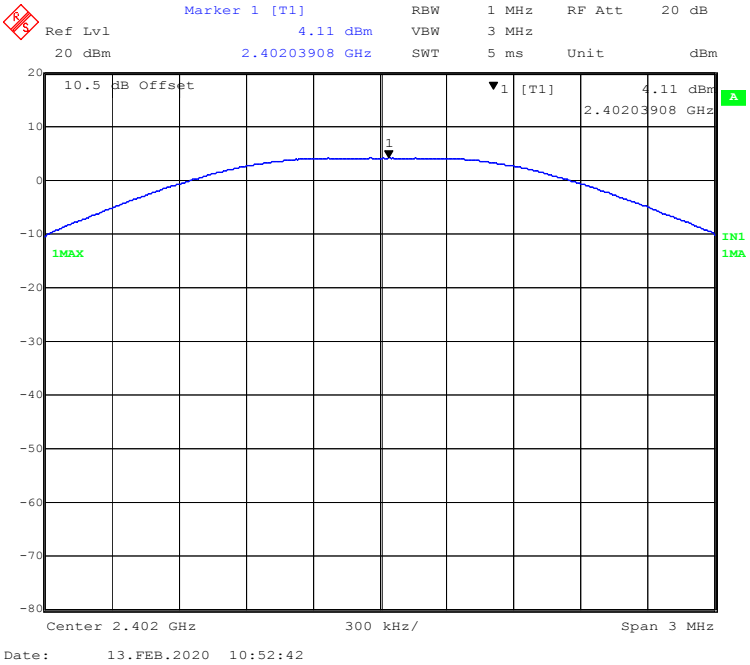
*The testing was performed by Lee Li from 2020-02-13 to 2020-02-17.*

**Test Result:** Compliant.

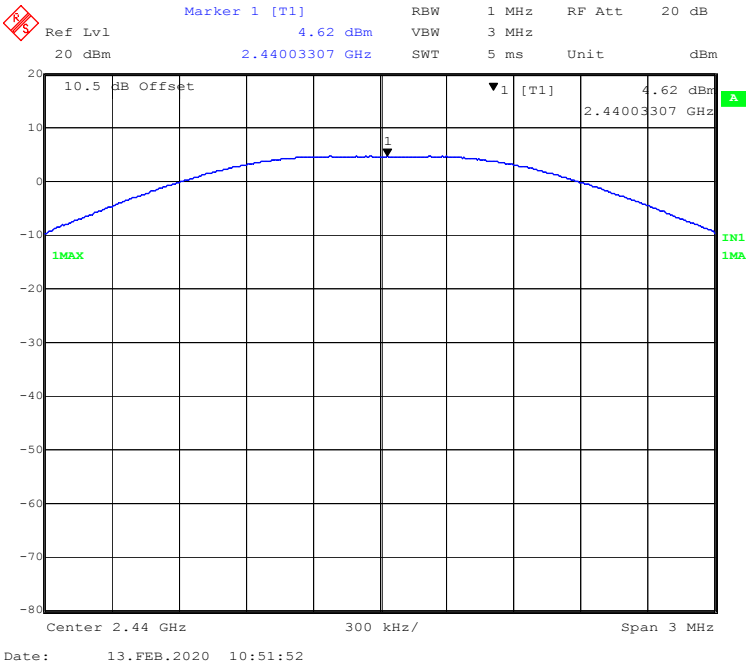
*EUT operation mode: Transmitting*

| Channel | Frequency (MHz) | Max Conducted Peak Output Power (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|
| 802.11b Mode | | | | |
| Low | 2412 | 21.30 | 30 | Pass |
| Middle | 2437 | 20.52 | 30 | Pass |
| High | 2462 | 20.46 | 30 | Pass |
| 802.11g Mode | | | | |
| Low | 2412 | 20.84 | 30 | Pass |
| Middle | 2437 | 20.11 | 30 | Pass |
| High | 2462 | 20.18 | 30 | Pass |
| 802.11n-HT20 Mode | | | | |
| Low | 2412 | 21.05 | 30 | Pass |
| Middle | 2437 | 20.38 | 30 | Pass |
| High | 2462 | 20.33 | 30 | Pass |
| 802.11n-HT40 Mode | | | | |
| Low | 2422 | 19.68 | 30 | Pass |
| Middle | 2437 | 19.21 | 30 | Pass |
| High | 2452 | 19.23 | 30 | Pass |
| BLE Mode | | | | |
| Low | 2402 | 4.11 | 30 | Pass |
| Middle | 2440 | 4.62 | 30 | Pass |
| High | 2480 | 4.32 | 30 | Pass |

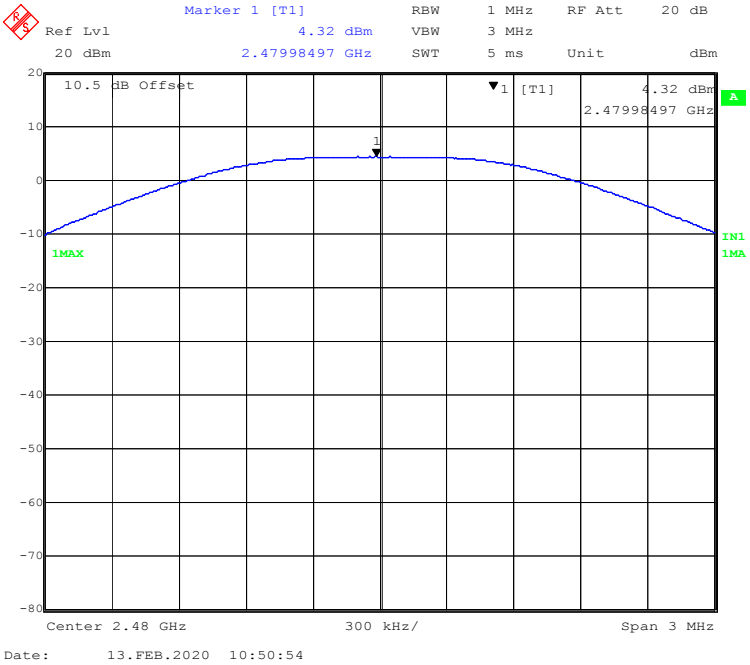
## BLE Mode Low Channel




## BLE Mode Middle Channel



## BLE Mode High Channel



# FCC §15.247(d) – BAND EDGE

## Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates Compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

## Test Procedure

According to ANSI C63.10-2013 sub-clause 6.10.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

## Test Data

### Environmental Conditions

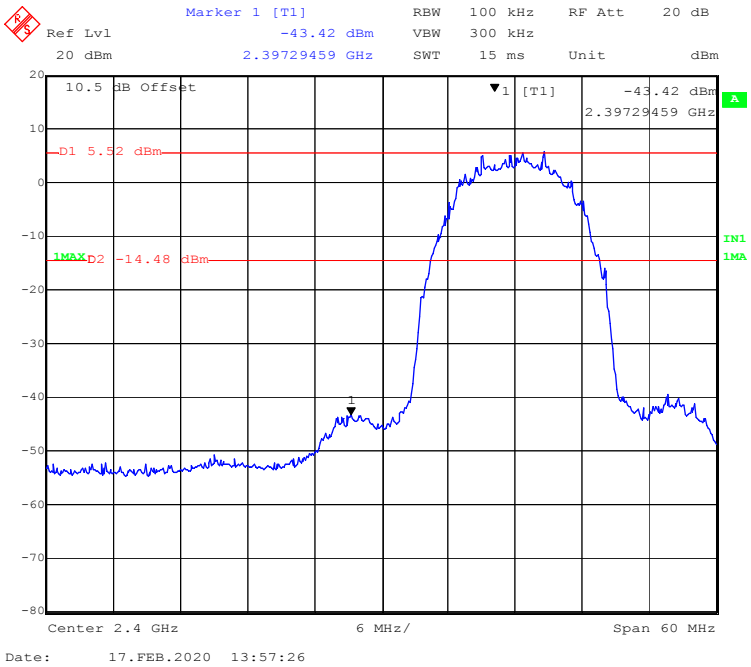
| | |
|---|---|
| **Temperature:** | 21.3℃~22.6 ℃ |
| **Relative Humidity:** | 50 %~51 % |
| **ATM Pressure:** | 101.2kPa~102.1kPa |

*The testing was performed by Lee Li from 2020-02-13 to 2020-02-17.*

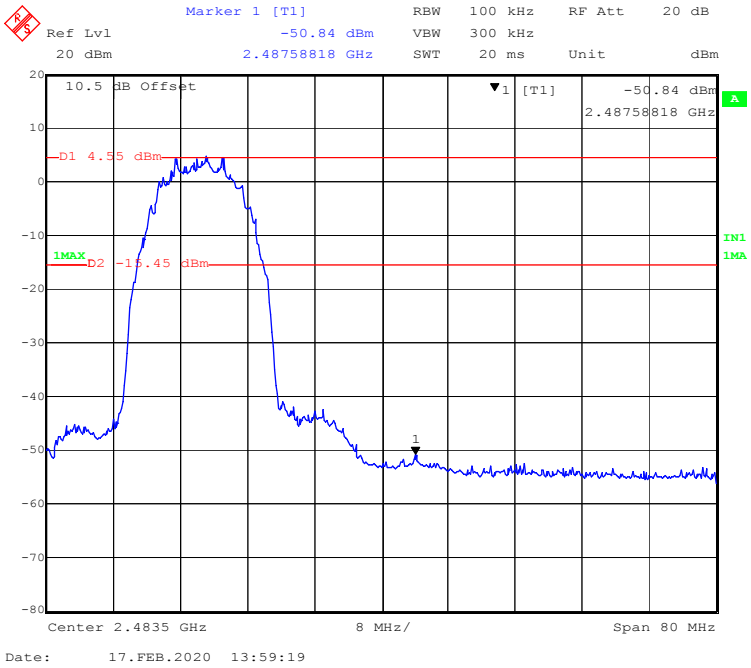
**Test Result:** Compliant.

*EUT operation mode: Transmitting*

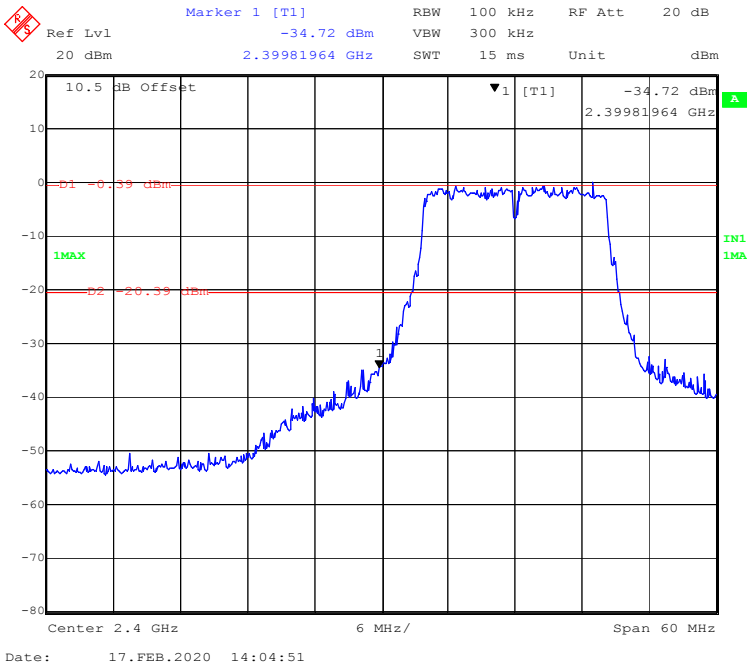
## 802.11b Mode Left Side



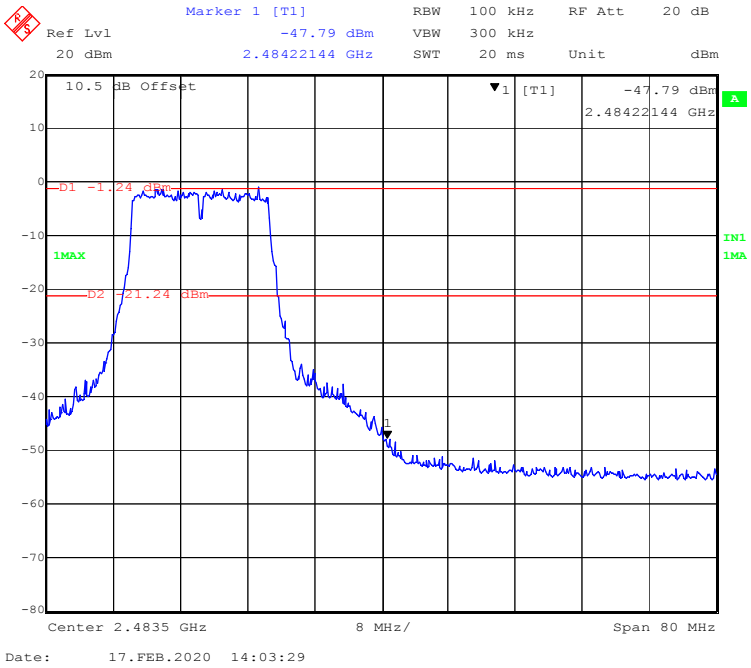

## 802.11b Mode Right Side



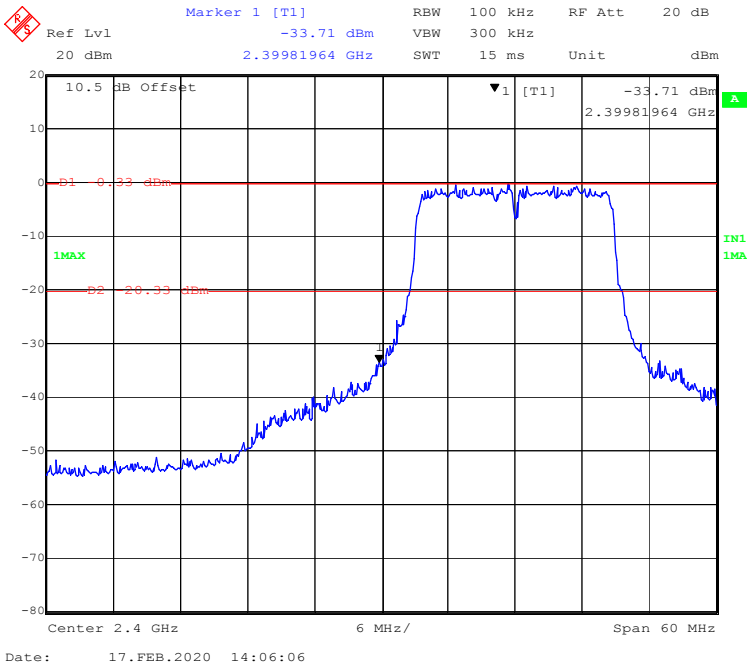
## 802.11g Mode Left Side



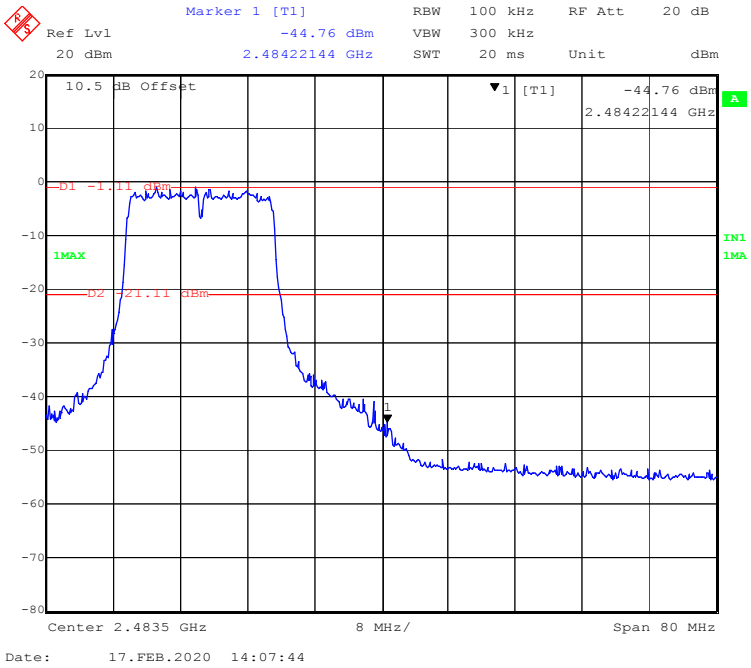

## 802.11g Mode Right Side



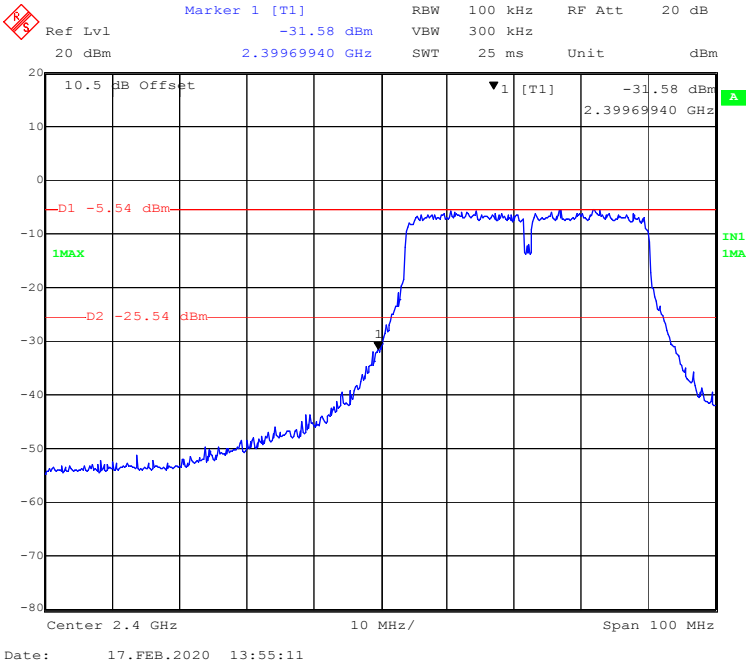
## 802.11n-HT20 Mode Left Side



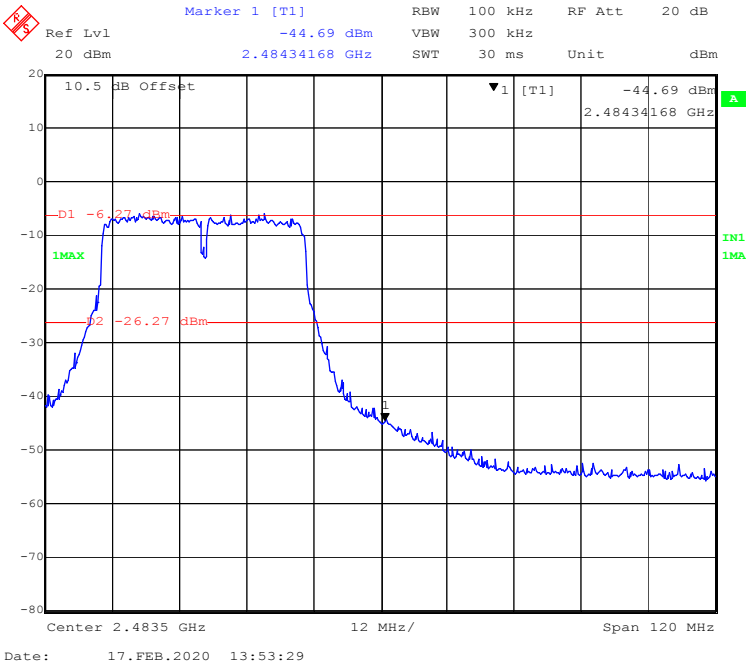

## 802.11n-HT20 Mode Right Side



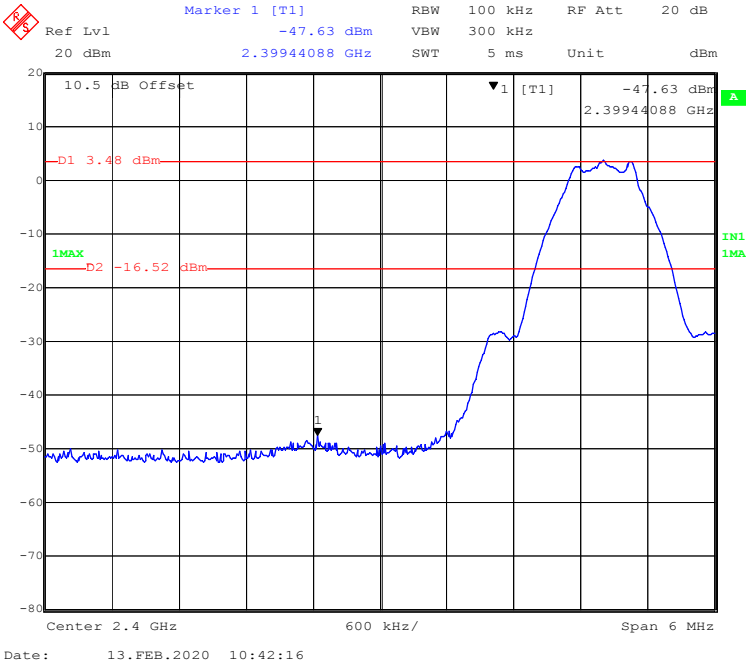
## 802.11n-HT40 Mode Left Side



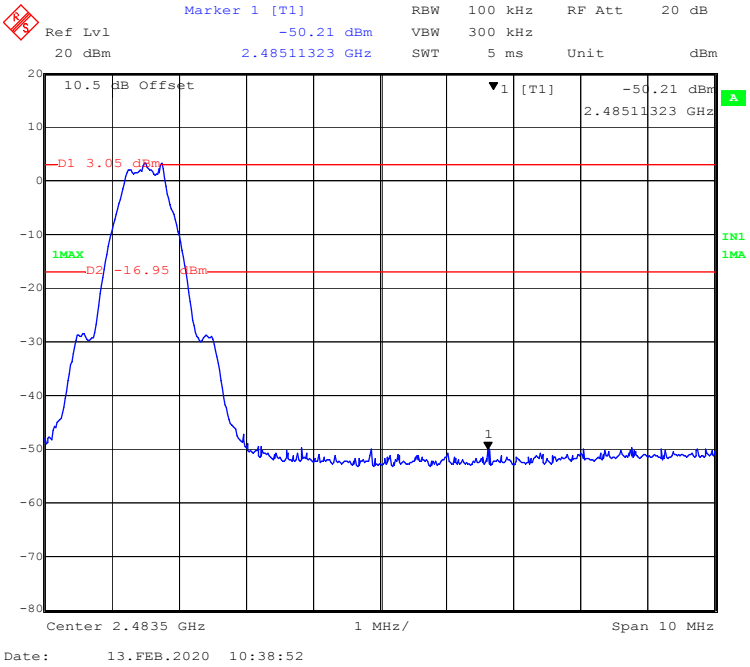

## 802.11n-HT40 Mode Right Side



## BLE Mode Left Side




## BLE Mode Right Side



# FCC §15.247(e) - POWER SPECTRAL DENSITY

## Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

## Test Procedure

According to ANSI C63.10-2013 sub-clause 11.10.2

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

1. Set the RBW to: 3kHz≤ RBW≤100 kHz.
2. Set the VBW ≥ [3xRBW].
3. Set the span to 1.5 times the DTS bandwidth.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level within the RBW.
9. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 21.3℃~22.6 ℃ |
| **Relative Humidity:** | 50 %~51 % |
| **ATM Pressure:** | 101.2kPa~102.1kPa |

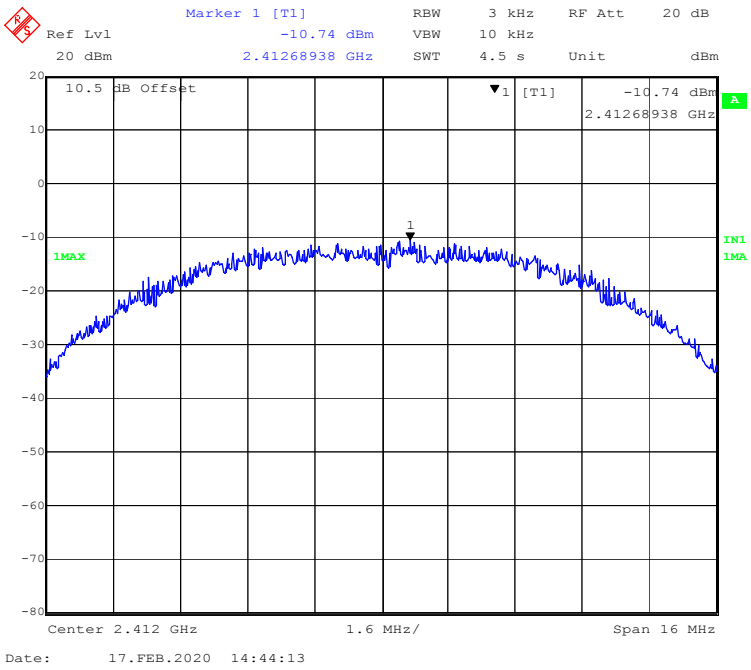
*The testing was performed by Lee Li from 2020-02-13 to 2020-02-17.*

**Test Result:** Compliant.

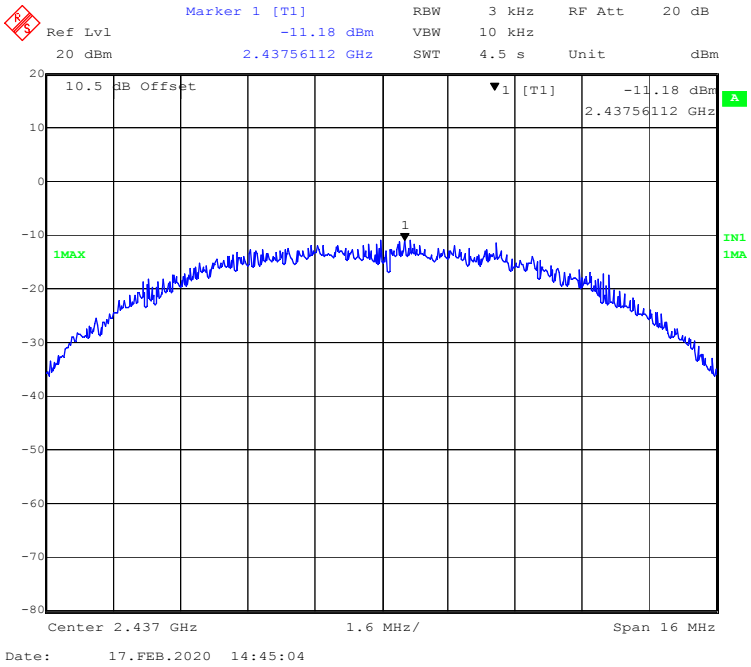
*EUT operation mode: Transmitting*

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) |
|---|---|---|---|
| 802.11b mode | | | |
| Low | 2412 | -10.74 | ≤8 |
| Middle | 2437 | -11.18 | ≤8 |
| High | 2462 | -11.03 | ≤8 |
| 802.11g mode | | | |
| Low | 2412 | -15.73 | ≤8 |
| Middle | 2437 | -16.41 | ≤8 |
| High | 2462 | -16.34 | ≤8 |
| 802.11n-HT20 mode | | | |
| Low | 2412 | -14.64 | ≤8 |
| Middle | 2437 | -15.78 | ≤8 |
| High | 2462 | -15.84 | ≤8 |
| 802.11n-HT40 mode | | | |
| Low | 2422 | -19.45 | ≤8 |
| Middle | 2437 | -18.84 | ≤8 |
| High | 2452 | -19.77 | ≤8 |
| BLE mode | | | |
| Low | 2402 | -11.31 | ≤8 |
| Middle | 2440 | -11.23 | ≤8 |
| High | 2480 | -11.57 | ≤8 |

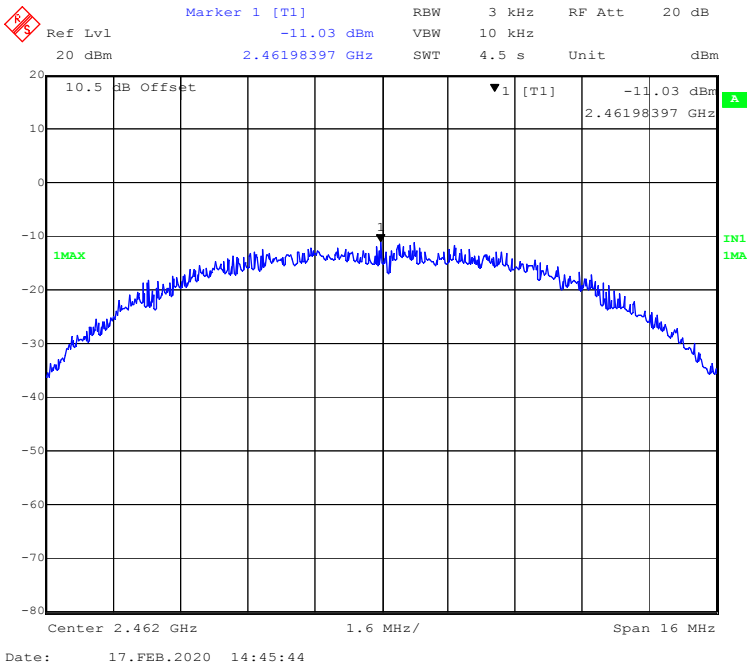
## 802.11b Mode Low Channel



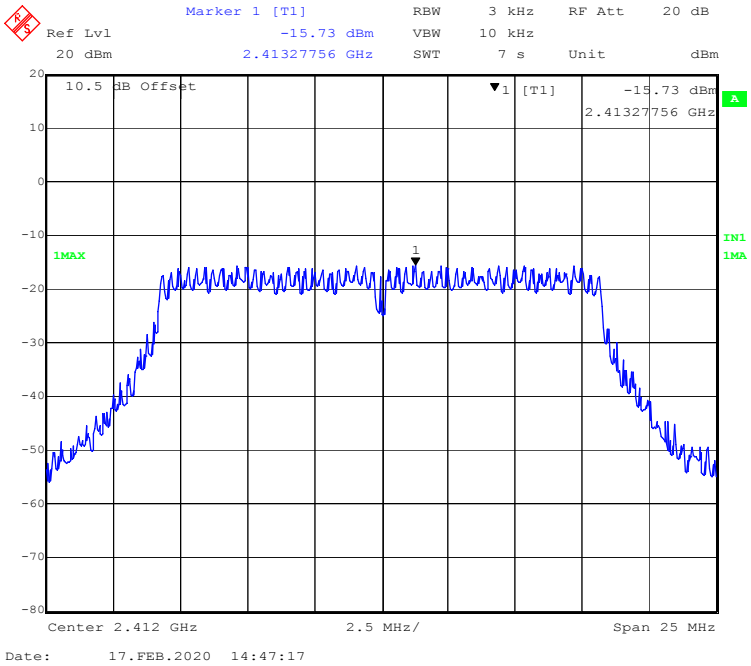

## 802.11b Mode Middle Channel



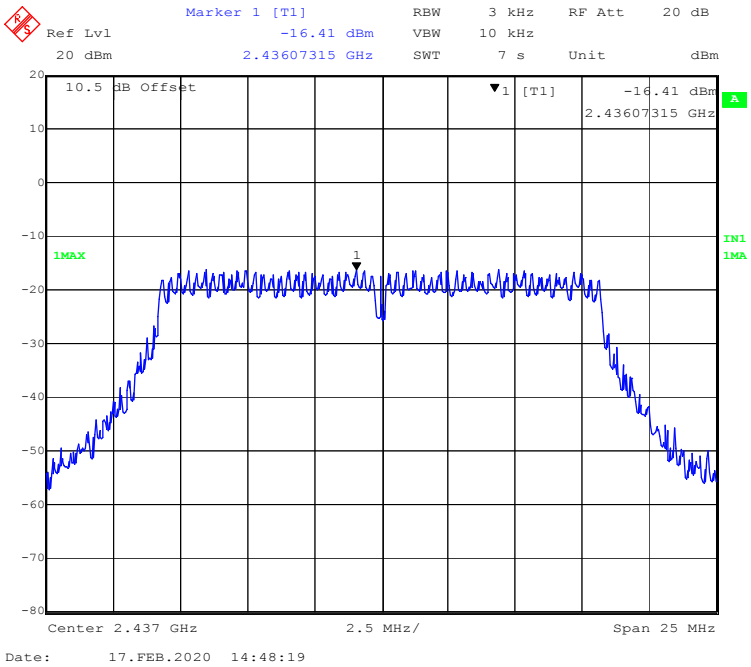
## 802.11b Mode High Channel



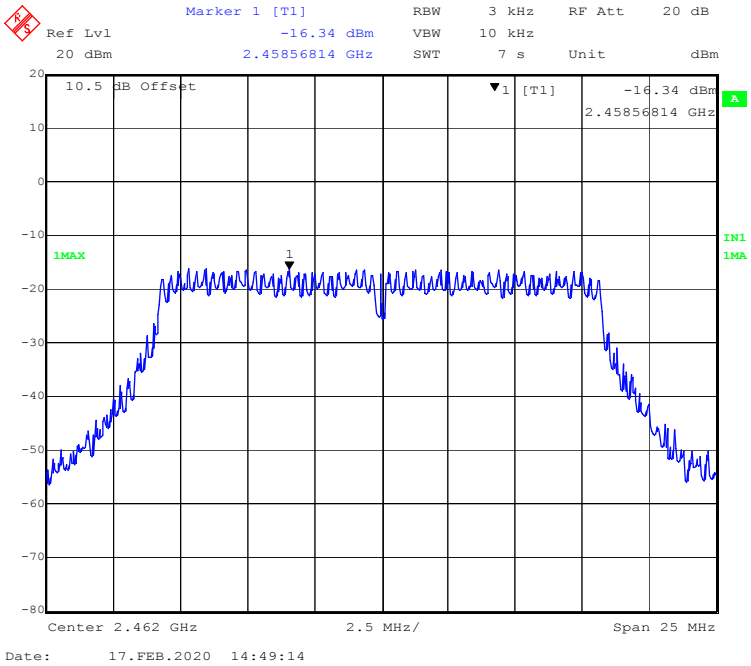

## 802.11g Mode Low Channel



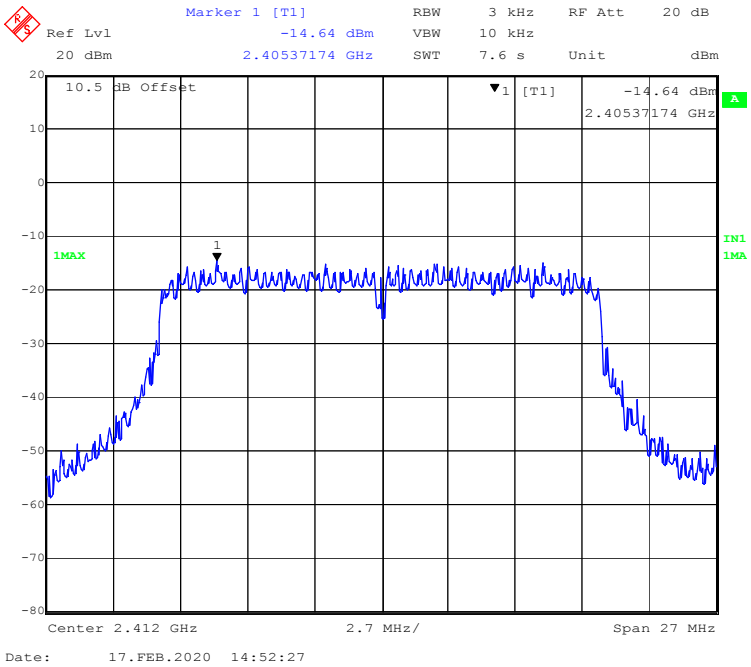
## 802.11g Mode Middle Channel



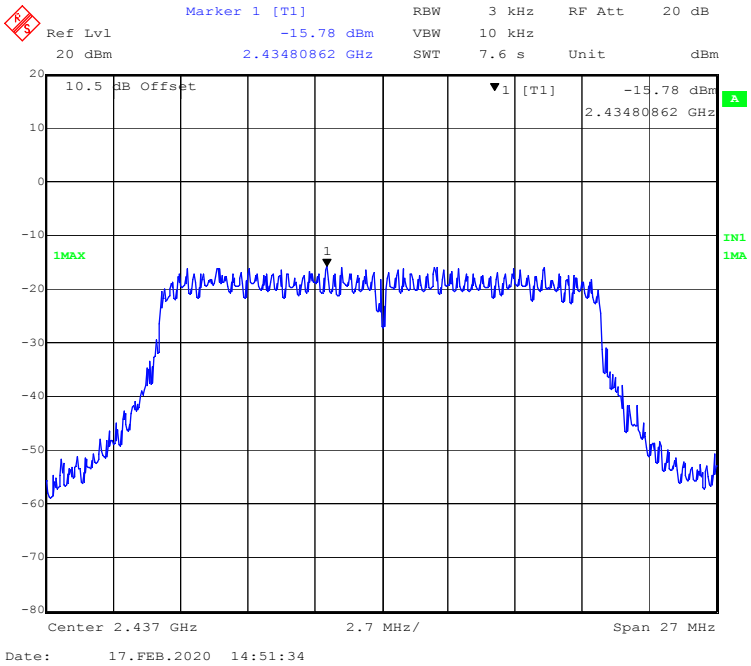

## 802.11g Mode High Channel



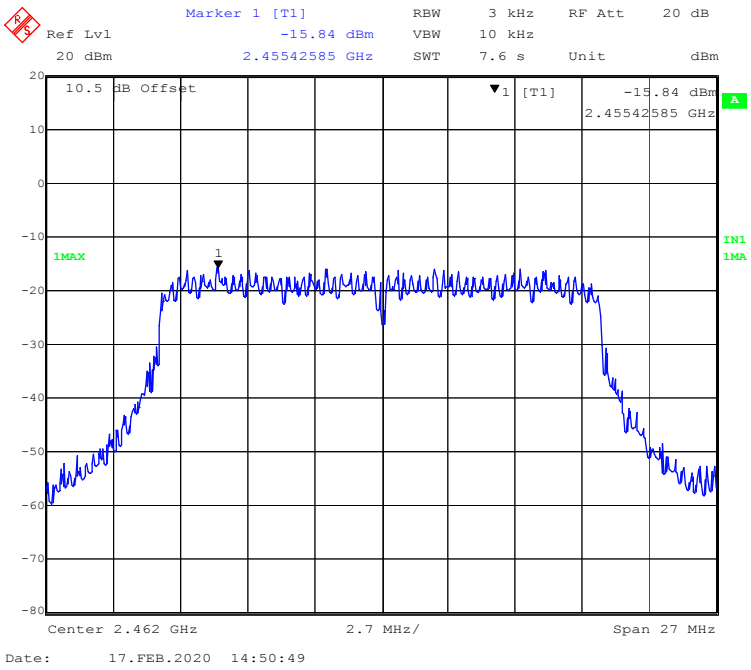
## 802.11n-HT20 Mode Low Channel



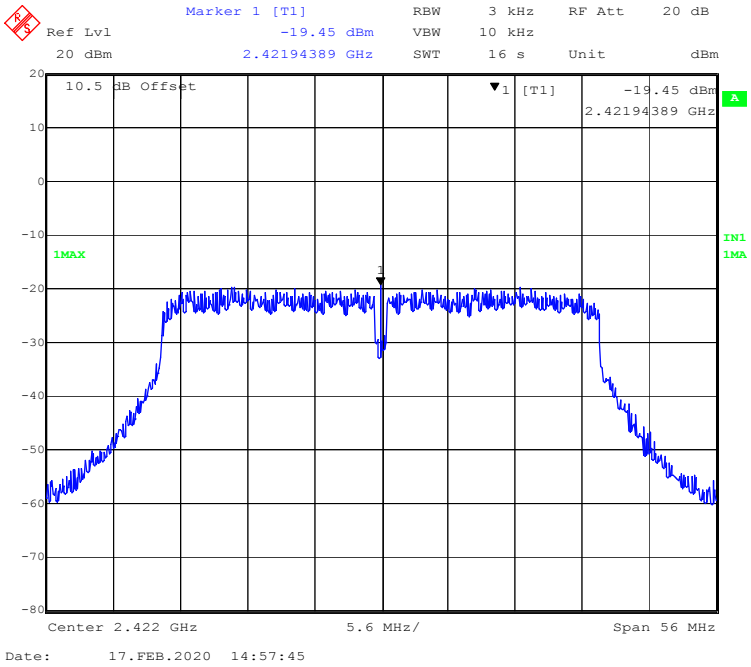

## 802.11n-HT20 Mode Middle Channel



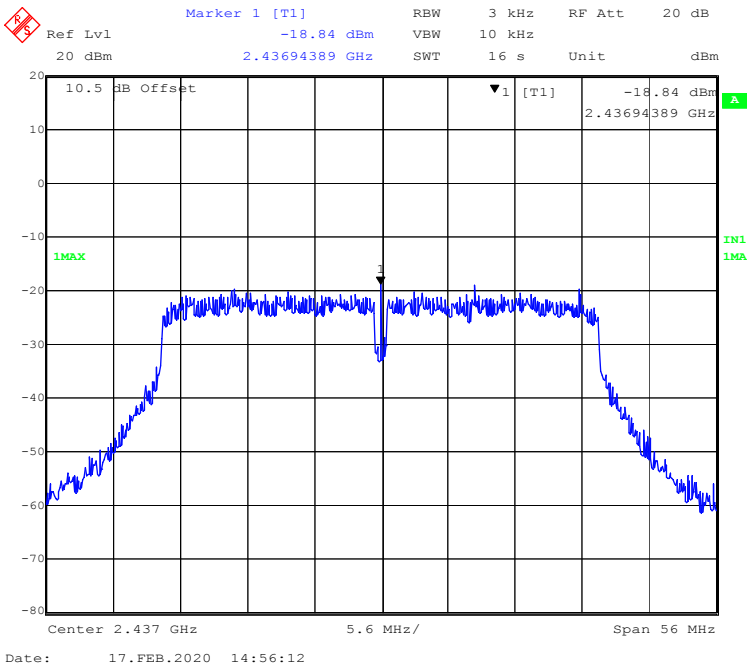
## 802.11n-HT20 Mode High Channel



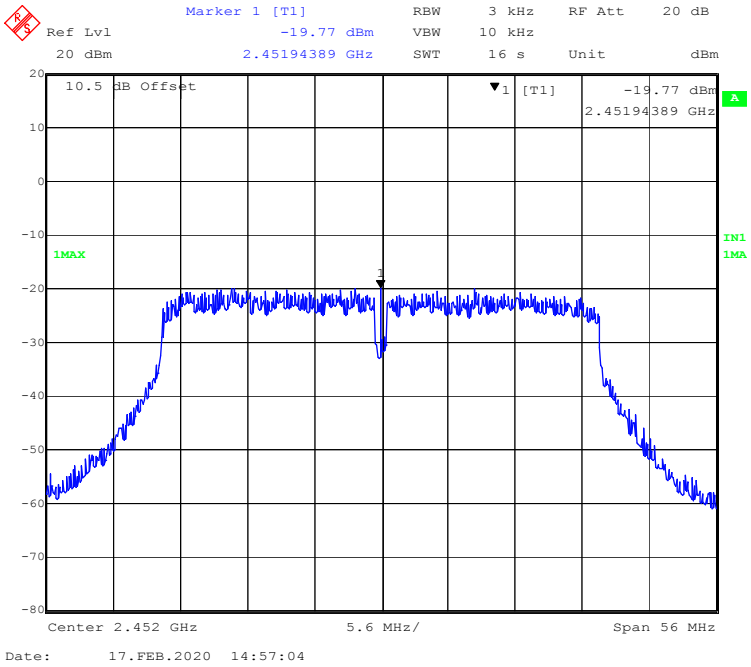

## 802.11n-HT40 Mode Low Channel



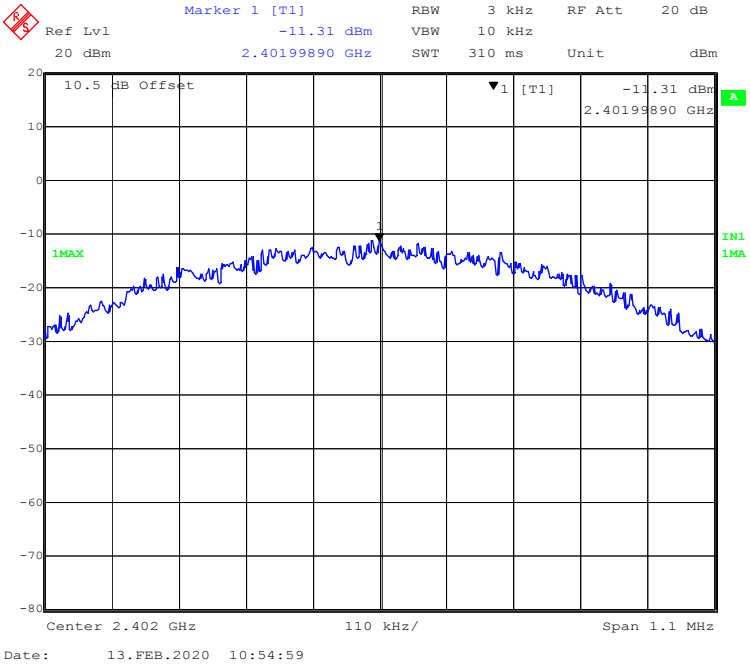
## 802.11n-HT40 Mode Middle Channel



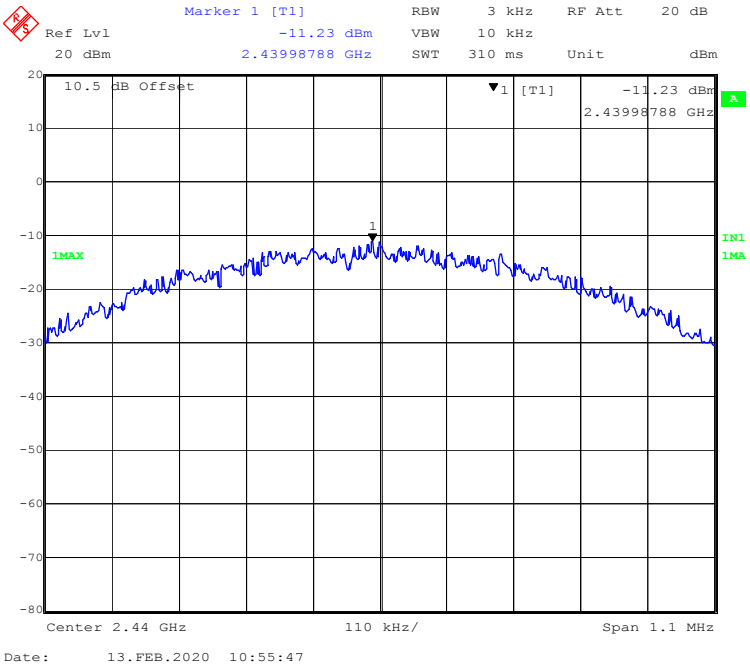

## 802.11n-HT40 Mode High Channel



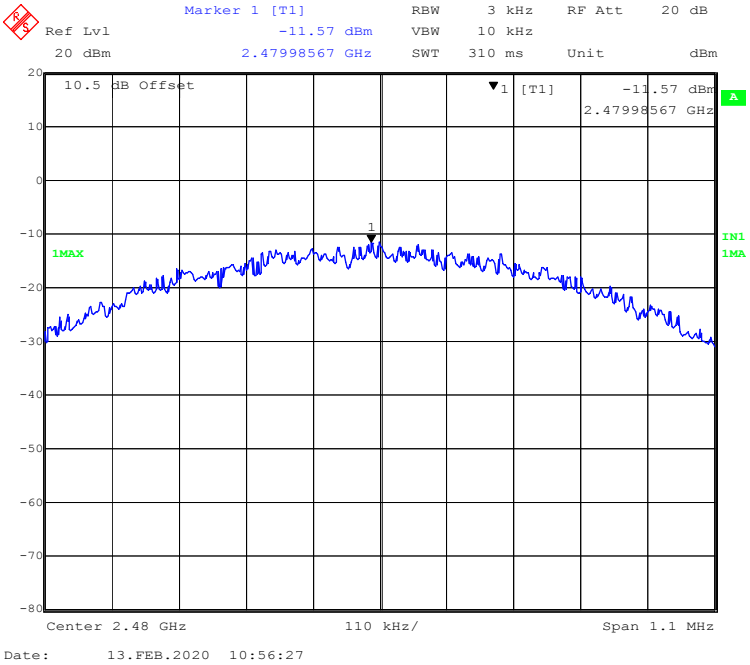
## BLE Mode Low Channel




## BLE Mode Middle Channel



## BLE Mode High Channel




******* END OF REPORT *******