



## FCC PART 15.247

### TEST REPORT

For

## Guangdong BYD Energy-saving Technology Co., Ltd.

BYD Industrial Park, Xiangshui River, Daya Bay, Huizhou City, Guangdong Province, China

**FCC ID: 2AX63FF-CDP001-P2**

|                                                                                                                                                                                                                                                                                                                             |                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>Report Type:</b><br>Original Report                                                                                                                                                                                                                                                                                      | <b>Product Type:</b><br>Led roof display                                                           |
| <b>Report Number:</b> RSH201124050-00A                                                                                                                                                                                                                                                                                      |                                                                                                    |
| <b>Report Date:</b> 2021-01-13                                                                                                                                                                                                                                                                                              |                                                                                                    |
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## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

|                                     |                                                                                        |
|-------------------------------------|----------------------------------------------------------------------------------------|
| Product                             | Led roof display                                                                       |
| Tested Model                        | FF-CDP001-P2                                                                           |
| Frequency Range                     | Wi-Fi: 2412-2462MHz                                                                    |
| Maximum Conducted Peak Output Power | 16.24dBm(802.11b), 15.56dBm(802.11g)<br>14.93dBm(802.11n-HT20), 13.38dBm(802.11n-HT40) |
| Modulation Technique                | Wi-Fi: DSSS, OFDM                                                                      |
| Antenna Specification*              | 5.0dBi(provided by the applicant)                                                      |
| Voltage Range                       | DC 12.0 from Battery                                                                   |
| Date of Test                        | 2020-12-14 to 2020-12-25                                                               |
| Sample serial number                | RSH201124050-RF-S1(Assigned by BACL, Shenzhen)                                         |
| Received date                       | 2020-11-24                                                                             |
| Sample/EUT Status                   | Good condition                                                                         |

### Objective

This test report is 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.

### 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 KDB 558074 D01 15.247 Meas Guidance v05r02.

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

**Measurement Uncertainty**

| Parameter                          |            | Uncertainty |
|------------------------------------|------------|-------------|
| Occupied Channel Bandwidth         |            | ±5%         |
| RF Output Power with Power meter   |            | ±0.73dB     |
| RF conducted test with spectrum    |            | ±1.6dB      |
| AC Power Lines Conducted Emissions |            | ±1.95dB     |
| Emissions,<br>Radiated             | Below 1GHz | ±4.75dB     |
|                                    | Above 1GHz | ±4.88dB     |
| Temperature                        |            | ±1 °C       |
| Humidity                           |            | ±6%         |
| Supply voltages                    |            | ±0.4%       |

*Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. 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. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

For 802.11b, 802.11g, 802.11n-HT20 and 802.11n-HT40 mode, 11 channels are provided to testing:

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

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

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

### Equipment Modifications

No modification was made to the EUT tested.

### EUT Exercise Software

“blade\_test” exercise software was used. The software and power level was provided by the applicant.

The device was tested with the worst case was performed as below:

| Mode         | Data rate | Power level* |                |              |
|--------------|-----------|--------------|----------------|--------------|
|              |           | Low channel  | Middle channel | High channel |
| 802.11b      | Mbps      | 12           | 12             | 12           |
| 802.11g      | Mbps      | 10           | 10             | 10           |
| 802.11n-HT20 | MCS       | 05           | 05             | 05           |
| 802.11n-HT40 | MCS       | 07           | 07             | 07           |

### Duty cycle

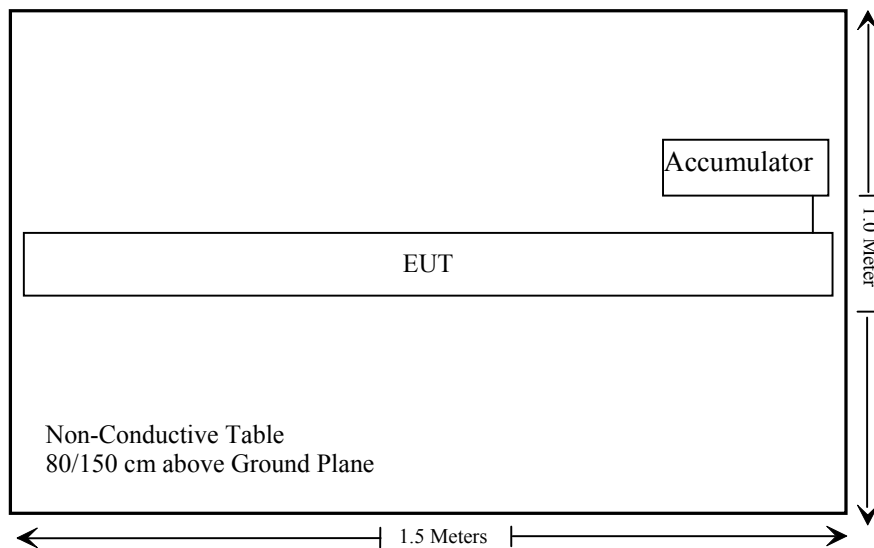
Test Result: Compliant. Please refer to the Append.

**Support Equipment List and Details**

| Manufacturer | Description | Model        | Serial Number |
|--------------|-------------|--------------|---------------|
| VARTA        | Accumulator | 6-QW-70(600) | D13464646     |

**External I/O Cable**

| Cable Description                   | Length (m) | From Port | To          |
|-------------------------------------|------------|-----------|-------------|
| Un-shielding Un-Detachable DC Cable | 0.3        | EUT       | Accumulator |

**Block Diagram of Test Setup**

**SUMMARY OF TEST RESULTS**

| FCC Rules                       | Description of Test                      | Result         |
|---------------------------------|------------------------------------------|----------------|
| §15.247 (i), §2.1091            | Maximum Permissible Exposure(MPE)        | Compliance     |
| §15.203                         | Antenna Requirement                      | Compliance     |
| §15.207 (a)                     | AC Line Conducted Emissions              | Not Applicable |
| §15.205, §15.209,<br>§15.247(d) | Spurious Emissions                       | Compliance     |
| §15.247 (a)(2)                  | 6 dB Emission Bandwidth                  | Compliance     |
| §15.247(b)(3)                   | Maximum Conducted Output Power           | Compliance     |
| §15.247(d)                      | 100 kHz Bandwidth of Frequency Band Edge | Compliance     |
| §15.247(e)                      | Power Spectral Density                   | Compliance     |

Not Applicable: The EUT intend for use in vehicle and powered by vehicle battery.

**TEST EQUIPMENT LIST**

| Manufacturer                  | Description                  | Model                   | Serial Number  | Calibration Date | Calibration Due Date |
|-------------------------------|------------------------------|-------------------------|----------------|------------------|----------------------|
| <b>Radiated Emission Test</b> |                              |                         |                |                  |                      |
| R&S                           | EMI Test Receiver            | ESR3                    | 102455         | 2020/08/04       | 2021/08/03           |
| Sonoma instrument             | Pre-amplifier                | 310 N                   | 186238         | 2020/08/04       | 2021/08/03           |
| Sunol Sciences                | Broadband Antenna            | JB1                     | A040904-1      | 2017/12/22       | 2020/12/21           |
| Unknown                       | Cable 2                      | RF Cable 2              | F-03-EM197     | 2020/11/29       | 2021/11/28           |
| Unknown                       | Cable                        | Chamber Cable 1         | F-03-EM236     | 2020/11/29       | 2021/11/28           |
| Rohde & Schwarz               | Auto test software           | EMC 32                  | V9.10          | NCR              | NCR                  |
| Rohde & Schwarz               | Spectrum Analyzer            | FSV40-N                 | 102259         | 2020/7/22        | 2021/7/21            |
| COM-POWER                     | Pre-amplifier                | PA-122                  | 181919         | 2020/11/29       | 2021/11/28           |
| Quinstar                      | Amplifier                    | QLW-18405536-J0         | 15964001002    | 2020/11/29       | 2021/11/28           |
| Sunol Sciences                | Horn Antenna                 | DRH-118                 | A052604        | 2017/12/22       | 2020/12/21           |
| Insulated Wire Inc.           | RF Cable                     | SPS-2503-3150           | 02222010       | 2020/11/29       | 2021/11/28           |
| Unknow                        | RF Cable                     | W1101-EQ1 OUT           | F-19-EM005     | 2020/11/29       | 2021/11/28           |
| SNSD                          | Band Reject filter           | BSF2402-2480MN-0898-001 | 2.4G filter    | 2020/04/20       | 2021/04/20           |
| Ducommun Technologies         | Horn antenna                 | ARH-4223-02             | 1007726-021304 | 2018/12/06       | 2021/12/05           |
| <b>RF Conducted Test</b>      |                              |                         |                |                  |                      |
| Tonscend Corporation          | RF control Unit              | JS0806-2                | 19D8060154     | 2020/7/10        | 2021/7/9             |
| Rohde & Schwarz               | Signal and Spectrum Analyzer | FSV40                   | 101473         | 2020/7/22        | 2021/7/21            |
| Unknown                       | RF Cable                     | Unknown                 | 2301 276       | 2020/11/29       | 2021/11/28           |

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) 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) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

### Applicable Standard

According to subpart 15.247 (i) and subpart 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

| Limits for General Population/Uncontrolled Exposure |                               |                               |                                     |                          |
|-----------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| Frequency Range (MHz)                               | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density (mW/cm <sup>2</sup> ) | Averaging Time (Minutes) |
| 0.3-1.34                                            | 614                           | 1.63                          | *(100)                              | 30                       |
| 1.34-30                                             | 824/f                         | 2.19/f                        | *(180/f <sup>2</sup> )              | 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

### Result

#### Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>)

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)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

| Mode         | Frequency (MHz) | Antenna Gain |           | Max Tune Up Conducted Power |       | Evaluation Distance (cm) | Power Density (mW/cm <sup>2</sup> ) | MPE Limit (mW/cm <sup>2</sup> ) |
|--------------|-----------------|--------------|-----------|-----------------------------|-------|--------------------------|-------------------------------------|---------------------------------|
|              |                 | (dBi)        | (numeric) | (dBm)                       | (mW)  |                          |                                     |                                 |
| Wi-Fi        | 2412-2462       | 5.0          | 3.16      | 16.5                        | 44.67 | 20                       | 0.028                               | 1.0                             |
| WCDMA Band 2 | 1850-1910       | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 1.0                             |
| WCDMA Band 4 | 1710-1755       | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 1.0                             |
| WCDMA Band 5 | 824-849         | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 0.549                           |
| LTE Band 2   | 1850-1910       | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 1.0                             |
| LTE Band 4   | 1710-1755       | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 1.0                             |
| LTE Band 5   | 824-849         | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 0.549                           |
| LTE Band 7   | 2500-2570       | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 1.0                             |
| LTE Band 12  | 699-716         | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 0.466                           |
| LTE Band 13  | 777-787         | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 0.518                           |
| LTE Band 17  | 704-716         | 0            | 1.0       | 23.0                        | 200   | 20                       | 0.040                               | 0.469                           |

Note: 1. the tune up conducted power was declared by the applicant  
 2. the Wi-Fi, WCDMA/LTE can transmit at the same time.

So the worst simultaneous transmitting consideration:

The ratio= $MPE_{Wi-Fi}/limit + MPE_{LTE}/limit = 0.028/1.0 + 0.040/0.466 = 0.114 < 1.0$

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

**Result: Compliance**

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## **FCC §15.203 - ANTENNA REQUIREMENT**

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### **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 one internal antenna arrangement which was permanently attached and the antenna gain is 5.0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

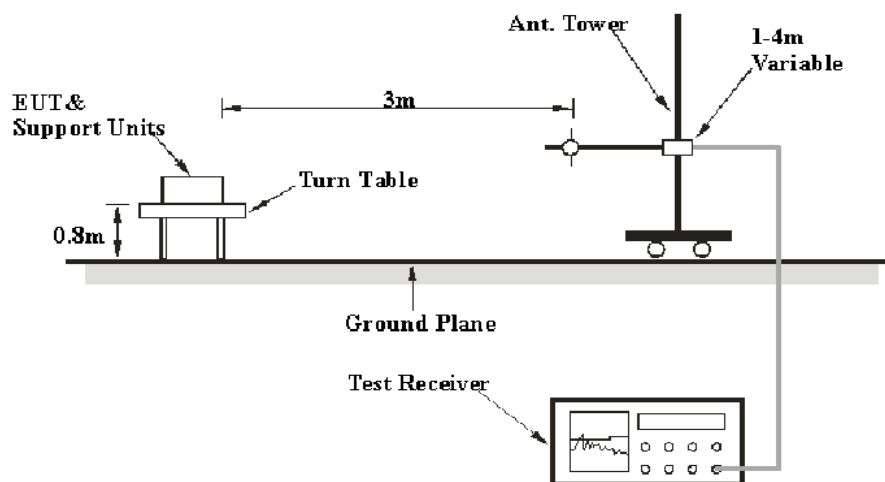
**Result:** Compliance.

**FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS****Applicable Standard**

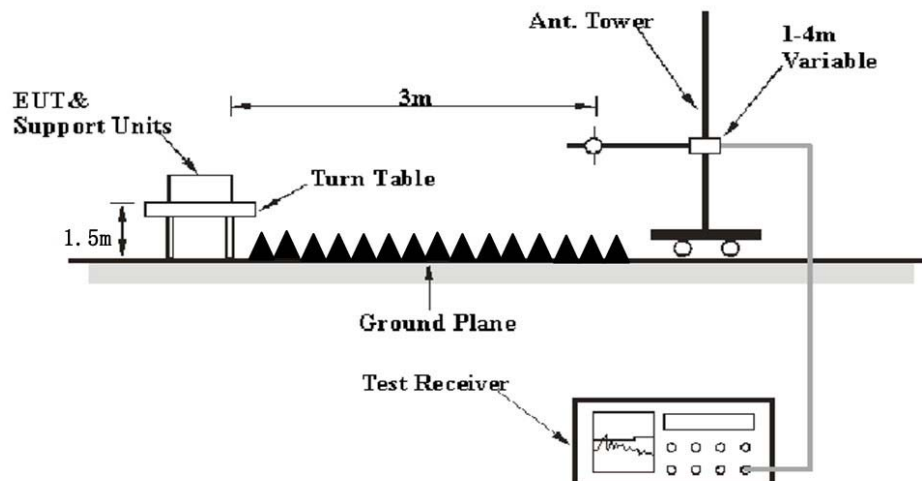
FCC §15.247 (d); §15.209; §15.205;

**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 & Spectrum Analyzer Setup

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

| Frequency Range   | RBW     | Video B/W               | IF B/W  | Measurement |
|-------------------|---------|-------------------------|---------|-------------|
| 30 MHz – 1000 MHz | 100 kHz | 300 kHz                 | 120 kHz | QP          |
| Above 1 GHz       | 1MHz    | 3 MHz                   | /       | PK          |
|                   | 1MHz    | 10 Hz <sup>Note 1</sup> | /       | Average     |
|                   | 1MHz    | > 1/T <sup>Note 2</sup> | /       | Average     |

Note 1: when duty cycle is no less than 98%

Note 2: when duty cycle is less than 98%

## Test Procedure

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 modes for frequencies above 1 GHz.

## Corrected Amplitude & Margin Calculation

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:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Data

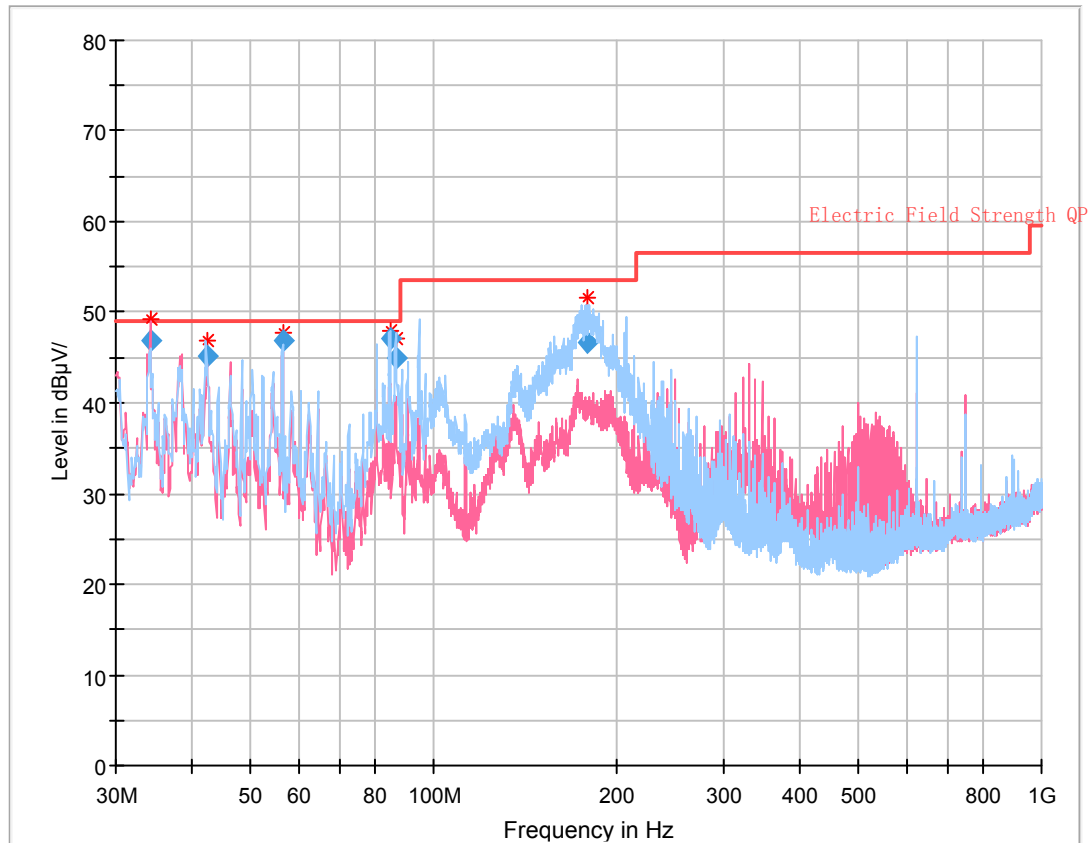
### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25~28.1°C |
| <b>Relative Humidity:</b> | 44~52 %   |
| <b>ATM Pressure:</b>      | 101 kPa   |

*The testing was performed by Harris He on 2020-12-14 for below 1GHz and Leven Gan on 2020-12-14 for above 1GHz.*

*EUT operation mode: Transmitting*

**30 MHz~1 GHz: (worst case at 802.11b mode, low channel)**



## Final Result

| Frequency (MHz) | QuasiPeak (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|----------------------|------------------|-------------|-------------|-----|---------------|------------|
| 34.297500       | 46.88                | 76.47*           | 29.59       | 110.0       | V   | 62.0          | -7.0       |
| 42.300250       | 45.17                | 86.96*           | 41.79       | 386.0       | H   | 191.0         | -12.2      |
| 56.461000       | 46.80                | 86.96*           | 40.16       | 378.0       | H   | 76.0          | -16.9      |
| 84.670750       | 47.18                | 86.96*           | 39.78       | 400.0       | H   | 351.0         | -16.4      |
| 86.719875       | 44.96                | 86.96*           | 42.00       | 393.0       | H   | 0.0           | -16.2      |
| 178.797875      | 46.75                | 86.96*           | 40.21       | 156.0       | H   | 211.0         | -12.0      |

Note: The above plot represents the worst case for all supported operating modes, there were no spurious emission in the range 30MHz -1GHz over the limit in §15.209 caused by radio, the emission list at above table was investigated and was not caused by the radio, the emission was present when the radio was not transmitting. Those emissions comply with the FCC Part 15, Subpart B-Unintentional radiators §15.109(b) limit set for Class A digital device as the EUT is a Class A equipment according the user manual.

Note \*: The limit was driven from §15.247(d), i.e. 20dB below fundamental.

**1 GHz-25 GHz (Wi-Fi):****802.11b Mode:**

| Frequency<br>(MHz)       | Receiver          |            | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB/m) | Corrected<br>Amplitude<br>(dBμV/m) | Limit<br>(dBμV/m) | Margin<br>(dB) |
|--------------------------|-------------------|------------|---------------------|---------------|----------------|-------------------------------|------------------------------------|-------------------|----------------|
|                          | Reading<br>(dBμV) | PK/QP/Ave. |                     | Height<br>(m) | Polar<br>(H/V) |                               |                                    |                   |                |
| Low Channel (2412 MHz)   |                   |            |                     |               |                |                               |                                    |                   |                |
| 2412.00                  | 74.99             | PK         | 186                 | 1.7           | H              | 31.97                         | 106.96                             | /                 | /              |
| 2412.00                  | 70.40             | AV         | 186                 | 1.7           | H              | 31.97                         | 102.37                             | /                 | /              |
| 2412.00                  | 64.50             | PK         | 30                  | 1.1           | V              | 31.97                         | 96.47                              | /                 | /              |
| 2412.00                  | 59.68             | AV         | 30                  | 1.1           | V              | 31.97                         | 91.65                              | /                 | /              |
| 2331.24                  | 29.10             | PK         | 211                 | 1.5           | H              | 31.64                         | 60.74                              | 74                | 13.26          |
| 2331.24                  | 15.37             | Ave.       | 211                 | 1.5           | H              | 31.64                         | 47.01                              | 54                | 6.99           |
| 2493.47                  | 29.44             | PK         | 216                 | 1.1           | H              | 32.13                         | 61.57                              | 74                | 12.43          |
| 2493.47                  | 15.48             | Ave.       | 216                 | 1.1           | H              | 32.13                         | 47.61                              | 54                | 6.39           |
| 4824.00                  | 44.37             | PK         | 244                 | 1.2           | H              | 6.28                          | 50.65                              | 74                | 23.35          |
| 4824.00                  | 30.17             | Ave.       | 244                 | 1.2           | H              | 6.28                          | 36.45                              | 54                | 17.55          |
| Middle Channel (2437MHz) |                   |            |                     |               |                |                               |                                    |                   |                |
| 4874.00                  | 45.05             | PK         | 292                 | 2.0           | H              | 6.76                          | 51.81                              | 74                | 22.19          |
| 4874.00                  | 30.27             | Ave.       | 292                 | 2.0           | H              | 6.76                          | 37.03                              | 54                | 16.97          |
| High Channel (2462 MHz)  |                   |            |                     |               |                |                               |                                    |                   |                |
| 2355.79                  | 29.72             | PK         | 66                  | 1.1           | H              | 31.77                         | 61.49                              | 74                | 12.51          |
| 2355.79                  | 15.20             | Ave.       | 66                  | 1.1           | H              | 31.77                         | 46.97                              | 54                | 7.03           |
| 2481.30                  | 29.35             | PK         | 45                  | 1.4           | H              | 32.13                         | 61.48                              | 74                | 12.52          |
| 2481.30                  | 15.31             | Ave.       | 45                  | 1.4           | H              | 32.13                         | 47.44                              | 54                | 6.56           |
| 4924.00                  | 44.86             | PK         | 247                 | 2.3           | H              | 6.76                          | 51.62                              | 74                | 22.38          |
| 4924.00                  | 31.28             | Ave.       | 247                 | 2.3           | H              | 6.76                          | 38.04                              | 54                | 15.96          |

**802.11g Mode:**

| Frequency<br>(MHz)       | Receiver          |            | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB/m) | Corrected<br>Amplitude<br>(dBμV/m) | Limit<br>(dBμV/m) | Margin<br>(dB) |
|--------------------------|-------------------|------------|---------------------|---------------|----------------|-------------------------------|------------------------------------|-------------------|----------------|
|                          | Reading<br>(dBμV) | PK/QP/Ave. |                     | Height<br>(m) | Polar<br>(H/V) |                               |                                    |                   |                |
| Low Channel (2412 MHz)   |                   |            |                     |               |                |                               |                                    |                   |                |
| 2310.87                  | 28.80             | PK         | 13                  | 1.4           | H              | 31.64                         | 60.44                              | 74                | 13.56          |
| 2310.87                  | 15.37             | Ave.       | 13                  | 1.4           | H              | 31.64                         | 47.01                              | 54                | 6.99           |
| 2496.72                  | 29.96             | PK         | 215                 | 1.3           | H              | 32.13                         | 62.09                              | 74                | 11.91          |
| 2496.72                  | 15.42             | Ave.       | 215                 | 1.3           | H              | 32.13                         | 47.55                              | 54                | 6.45           |
| 4824.00                  | 44.83             | PK         | 33                  | 1.3           | H              | 6.28                          | 51.11                              | 74                | 22.89          |
| 4824.00                  | 30.11             | Ave.       | 33                  | 1.3           | H              | 6.28                          | 36.39                              | 54                | 17.61          |
| Middle Channel (2437MHz) |                   |            |                     |               |                |                               |                                    |                   |                |
| 4874.00                  | 44.95             | PK         | 160                 | 2.4           | H              | 6.76                          | 51.71                              | 74                | 22.29          |
| 4874.00                  | 30.50             | Ave.       | 160                 | 2.4           | H              | 6.76                          | 37.26                              | 54                | 16.74          |
| High Channel (2462 MHz)  |                   |            |                     |               |                |                               |                                    |                   |                |
| 2389.94                  | 28.57             | PK         | 165                 | 1.4           | H              | 31.87                         | 60.44                              | 74                | 13.56          |
| 2389.94                  | 15.43             | Ave.       | 165                 | 1.4           | H              | 31.87                         | 47.30                              | 54                | 6.70           |
| 2497.08                  | 28.17             | PK         | 79                  | 2.2           | H              | 32.13                         | 60.30                              | 74                | 13.70          |
| 2497.08                  | 15.21             | Ave.       | 79                  | 2.2           | H              | 32.13                         | 47.34                              | 54                | 6.66           |
| 4924.00                  | 44.18             | PK         | 38                  | 2.4           | H              | 6.76                          | 50.94                              | 74                | 23.06          |
| 4924.00                  | 30.20             | Ave.       | 38                  | 2.4           | H              | 6.76                          | 36.96                              | 54                | 17.04          |

**802.11n-HT20 Mode:**

| Frequency<br>(MHz)       | Receiver          |            | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB/m) | Corrected<br>Amplitude<br>(dBμV/m) | Limit<br>(dBμV/m) | Margin<br>(dB) |
|--------------------------|-------------------|------------|---------------------|---------------|----------------|-------------------------------|------------------------------------|-------------------|----------------|
|                          | Reading<br>(dBμV) | PK/QP/Ave. |                     | Height<br>(m) | Polar<br>(H/V) |                               |                                    |                   |                |
| Low Channel (2412 MHz)   |                   |            |                     |               |                |                               |                                    |                   |                |
| 2389.51                  | 29.29             | PK         | 267                 | 1.5           | H              | 31.87                         | 61.16                              | 74                | 12.84          |
| 2389.51                  | 15.33             | Ave.       | 267                 | 1.5           | H              | 31.87                         | 47.20                              | 54                | 6.80           |
| 2484.17                  | 28.42             | PK         | 118                 | 2.2           | H              | 32.13                         | 60.55                              | 74                | 13.45          |
| 2484.17                  | 14.98             | Ave.       | 118                 | 2.2           | H              | 32.13                         | 47.11                              | 54                | 6.89           |
| 4824.00                  | 44.01             | PK         | 208                 | 2.4           | H              | 6.28                          | 50.29                              | 74                | 23.71          |
| 4824.00                  | 30.42             | Ave.       | 208                 | 2.4           | H              | 6.28                          | 36.70                              | 54                | 17.30          |
| Middle Channel (2437MHz) |                   |            |                     |               |                |                               |                                    |                   |                |
| 4874.00                  | 43.89             | PK         | 121                 | 1.5           | H              | 6.76                          | 50.65                              | 74                | 23.35          |
| 4874.00                  | 30.27             | Ave.       | 121                 | 1.5           | H              | 6.76                          | 37.03                              | 54                | 16.97          |
| High Channel (2462 MHz)  |                   |            |                     |               |                |                               |                                    |                   |                |
| 2388.47                  | 28.45             | PK         | 285                 | 1.6           | H              | 31.87                         | 60.32                              | 74                | 13.68          |
| 2388.47                  | 15.27             | Ave.       | 285                 | 1.6           | H              | 31.87                         | 47.14                              | 54                | 6.86           |
| 2484.16                  | 28.29             | PK         | 191                 | 1.3           | H              | 32.13                         | 60.42                              | 74                | 13.58          |
| 2484.16                  | 15.43             | Ave.       | 191                 | 1.3           | H              | 32.13                         | 47.56                              | 54                | 6.44           |
| 4924.00                  | 44.12             | PK         | 215                 | 2.4           | H              | 6.76                          | 50.88                              | 74                | 23.12          |
| 4924.00                  | 30.52             | Ave.       | 215                 | 2.4           | H              | 6.76                          | 37.28                              | 54                | 16.72          |

**802.11n-HT40 Mode:**

| Frequency<br>(MHz)       | Receiver          |            | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB/m) | Corrected<br>Amplitude<br>(dBμV/m) | Limit<br>(dBμV/m) | Margin<br>(dB) |
|--------------------------|-------------------|------------|---------------------|---------------|----------------|-------------------------------|------------------------------------|-------------------|----------------|
|                          | Reading<br>(dBμV) | PK/QP/Ave. |                     | Height<br>(m) | Polar<br>(H/V) |                               |                                    |                   |                |
| Low Channel (2422 MHz)   |                   |            |                     |               |                |                               |                                    |                   |                |
| 2387.42                  | 29.03             | PK         | 229                 | 2.3           | H              | 31.87                         | 60.90                              | 74                | 13.10          |
| 2387.42                  | 15.47             | Ave.       | 229                 | 2.3           | H              | 31.87                         | 47.34                              | 54                | 6.66           |
| 2484.53                  | 28.83             | PK         | 330                 | 2.0           | H              | 32.13                         | 60.96                              | 74                | 13.04          |
| 2484.53                  | 15.44             | Ave.       | 330                 | 2.0           | H              | 32.13                         | 47.57                              | 54                | 6.43           |
| 4844.00                  | 44.47             | PK         | 340                 | 1.4           | H              | 6.28                          | 50.75                              | 74                | 23.25          |
| 4844.00                  | 30.24             | Ave.       | 340                 | 1.4           | H              | 6.28                          | 36.52                              | 54                | 17.48          |
| Middle Channel (2437MHz) |                   |            |                     |               |                |                               |                                    |                   |                |
| 4874.00                  | 44.35             | PK         | 274                 | 1.4           | H              | 6.76                          | 51.11                              | 74                | 22.89          |
| 4874.00                  | 30.31             | Ave.       | 274                 | 1.4           | H              | 6.76                          | 37.07                              | 54                | 16.93          |
| High Channel (2452 MHz)  |                   |            |                     |               |                |                               |                                    |                   |                |
| 2388.17                  | 29.21             | PK         | 232                 | 1.6           | H              | 31.87                         | 61.08                              | 74                | 12.92          |
| 2388.17                  | 15.50             | Ave.       | 232                 | 1.6           | H              | 31.87                         | 47.37                              | 54                | 6.63           |
| 2484.32                  | 28.91             | PK         | 348                 | 1.6           | H              | 32.13                         | 61.04                              | 74                | 12.96          |
| 2484.32                  | 15.54             | Ave.       | 348                 | 1.6           | H              | 32.13                         | 47.67                              | 54                | 6.33           |
| 4904.00                  | 44.28             | PK         | 358                 | 1.5           | H              | 6.76                          | 51.04                              | 74                | 22.96          |
| 4904.00                  | 30.37             | Ave.       | 358                 | 1.5           | H              | 6.76                          | 37.13                              | 54                | 16.87          |

**Note:**

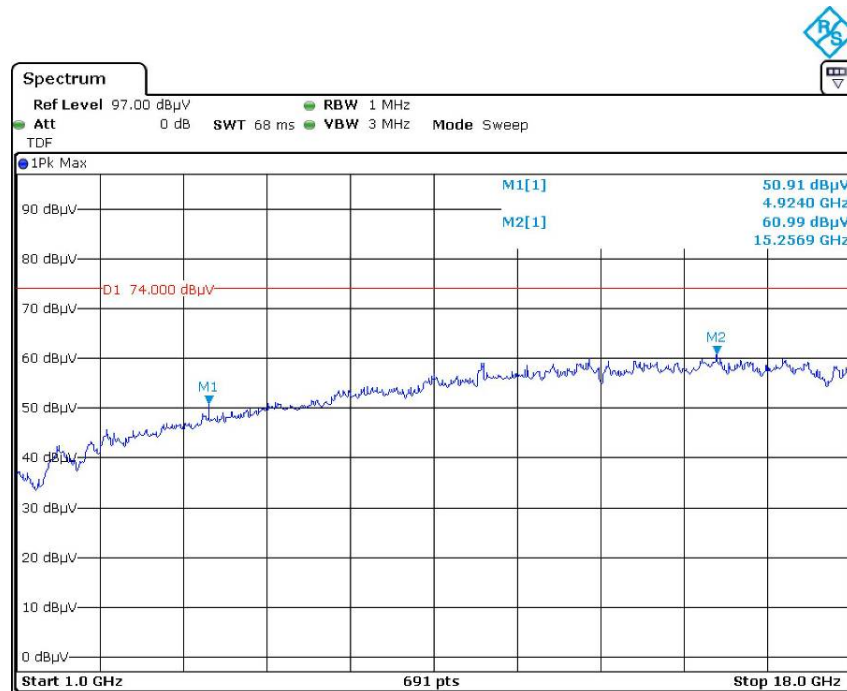
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

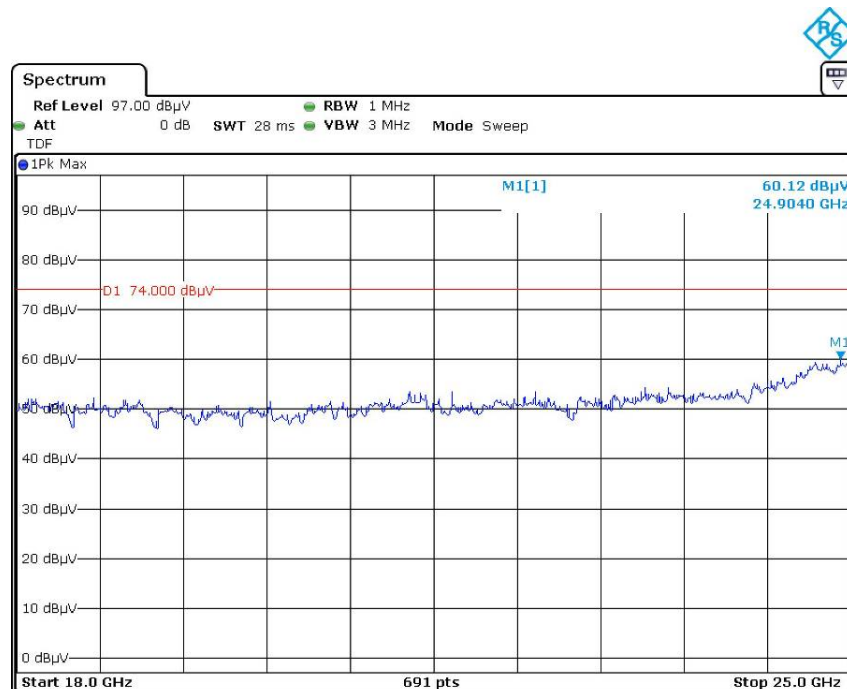
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

**Pre-scan with Wi-Fi High channel in 802.11b mode**  
**Horizontal**

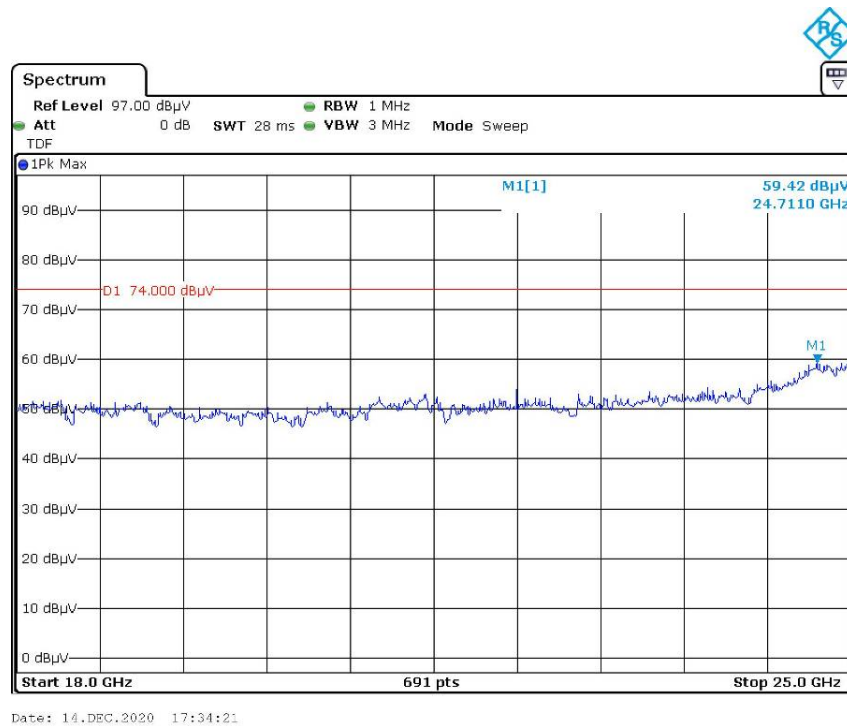
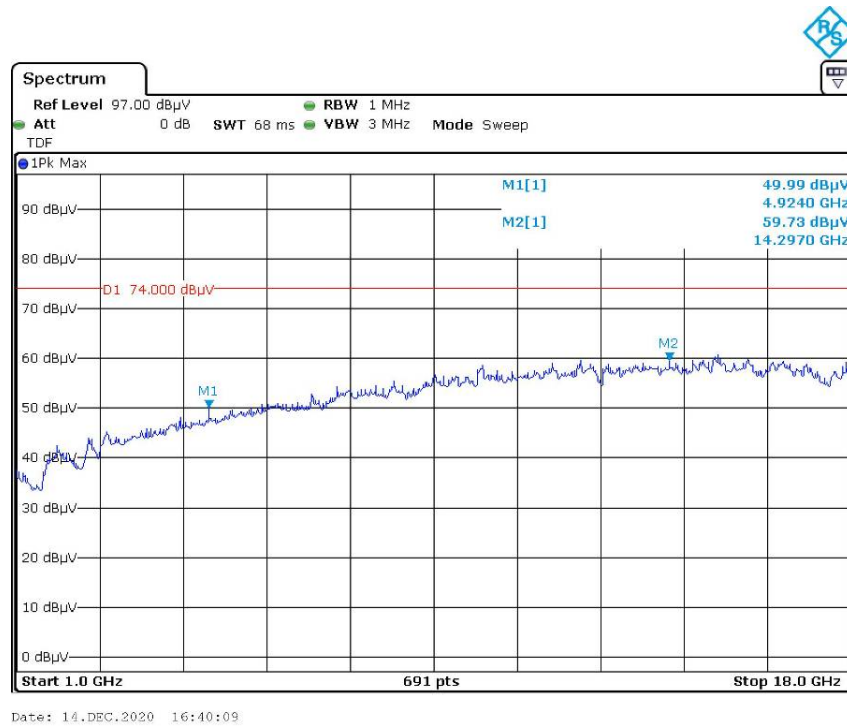


Date: 14.DEC.2020 16:30:40

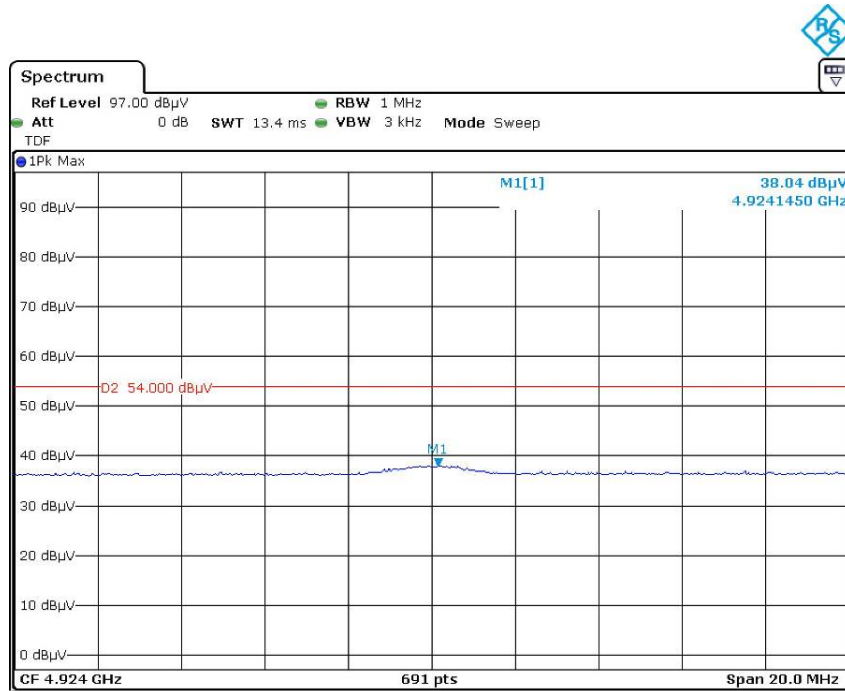


Date: 14.DEC.2020 17:25:39

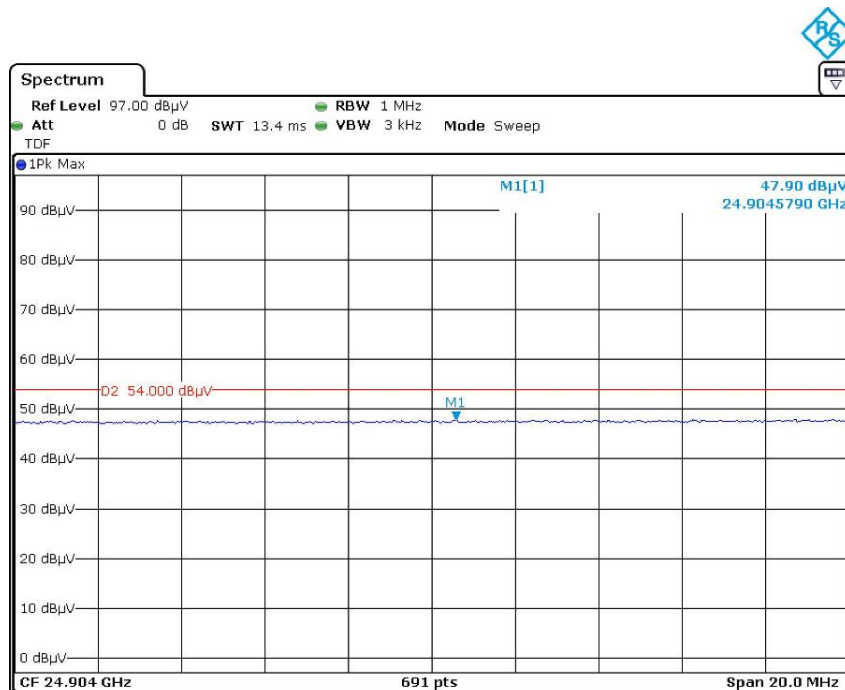
# Vertical



# Average Horizontal

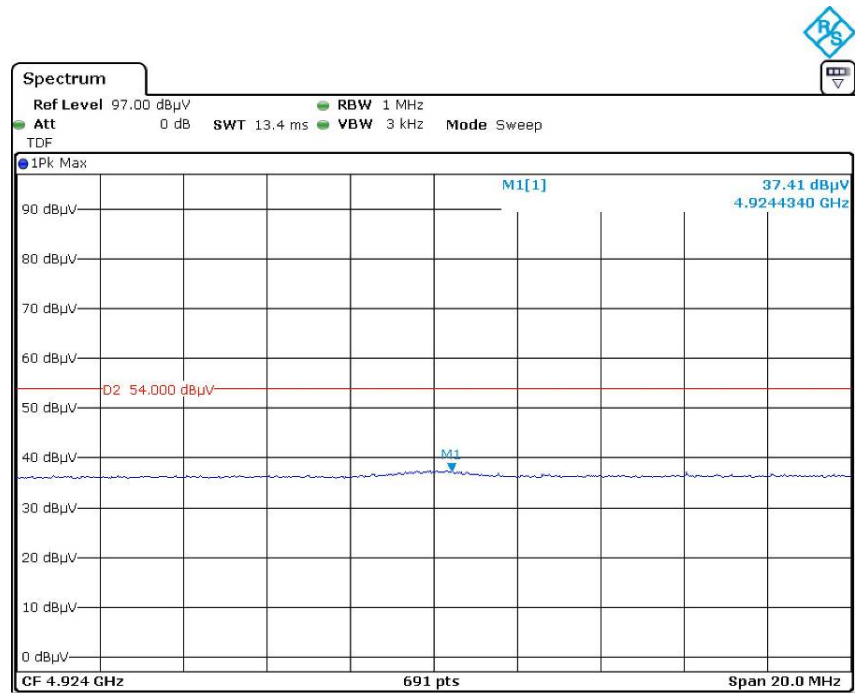


Date: 14.DEC.2020 16:35:34

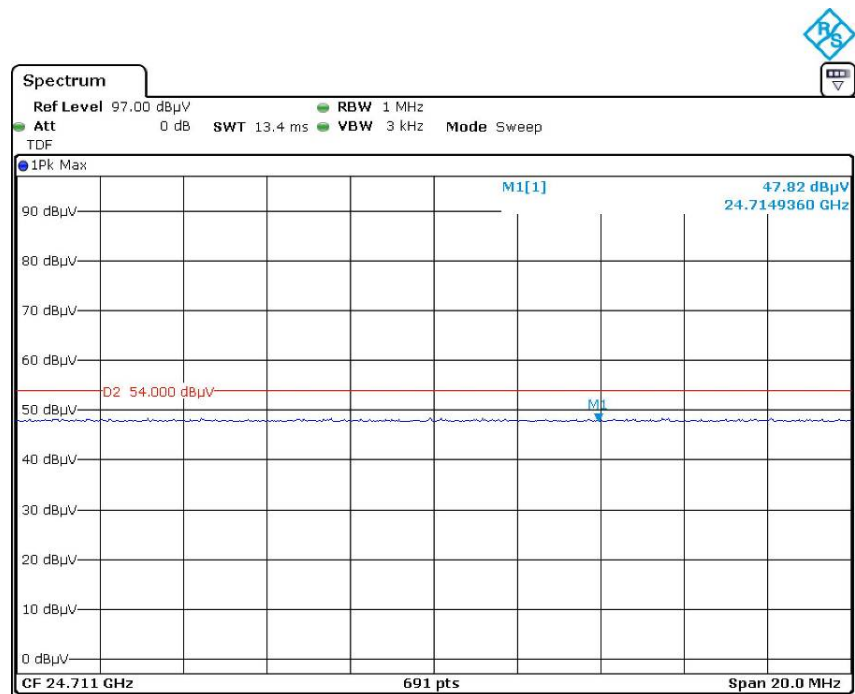


Date: 14.DEC.2020 17:29:01

# Vertical



Date: 14.DEC.2020 16:45:09



Date: 14.DEC.2020 17:37:51

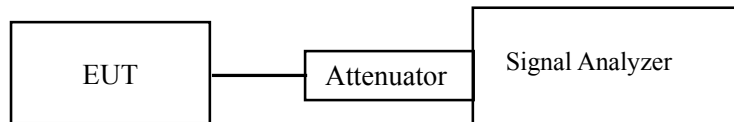
## FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

### 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

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 it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.



### Test Data

#### Environmental Conditions

|                    |               |
|--------------------|---------------|
| Temperature:       | 23.6-24.6 °C  |
| Relative Humidity: | 45-55 %       |
| ATM Pressure:      | 100.8-101 kPa |

*The testing was performed by Zero Yan from 2020-12-20 to 2020-12-25.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

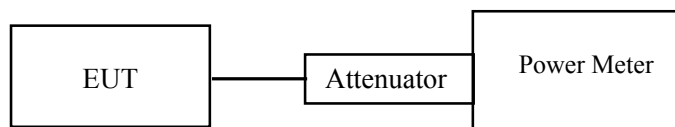
## FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

### 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

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



### Test Data

#### Environmental Conditions

|                    |               |
|--------------------|---------------|
| Temperature:       | 23.6-24.6 °C  |
| Relative Humidity: | 45-55 %       |
| ATM Pressure:      | 100.8-101 kPa |

*The testing was performed by Zero Yan from 2020-12-20 to 2020-12-25.*

*EUT operation mode: Transmitting*

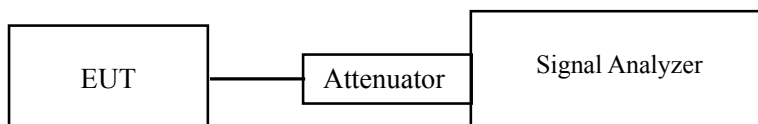
Test Result: Compliant. Please refer to the Appendix.

**FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY 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**

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**

|                           |               |
|---------------------------|---------------|
| <b>Temperature:</b>       | 23.6-24.6 °C  |
| <b>Relative Humidity:</b> | 45-55 %       |
| <b>ATM Pressure:</b>      | 100.8-101 kPa |

*The testing was performed by Zero Yan from 2020-12-20 to 2020-12-25.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

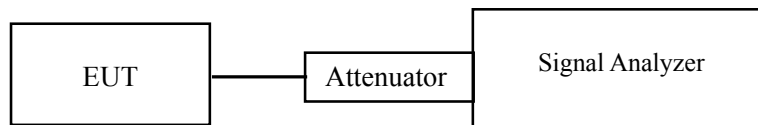
## FCC §15.247(e) - POWER SPECTRAL DENSITY

### 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

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to:  $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$ .
3. Set the VBW  $\geq 3 \times \text{RBW}$ .
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



### Test Data

#### Environmental Conditions

|                    |               |
|--------------------|---------------|
| Temperature:       | 23.6-24.6 °C  |
| Relative Humidity: | 45-55 %       |
| ATM Pressure:      | 100.8-101 kPa |

*The testing was performed by Zero Yan from 2020-12-20 to 2020-12-25.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

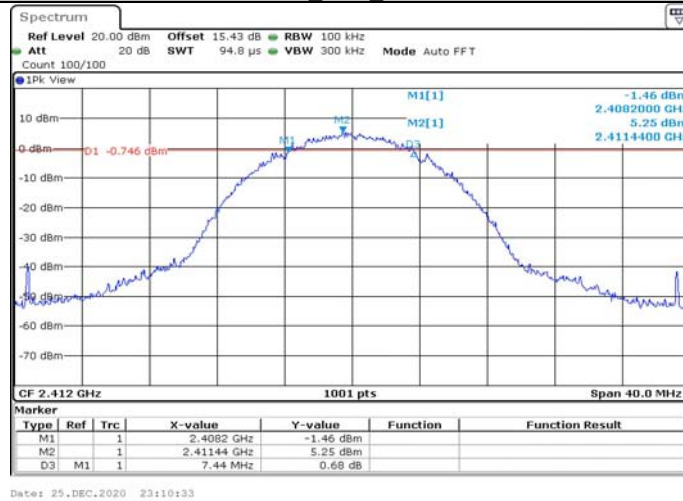
## APPENDIX

### Appendix A: DTS Bandwidth Test Result

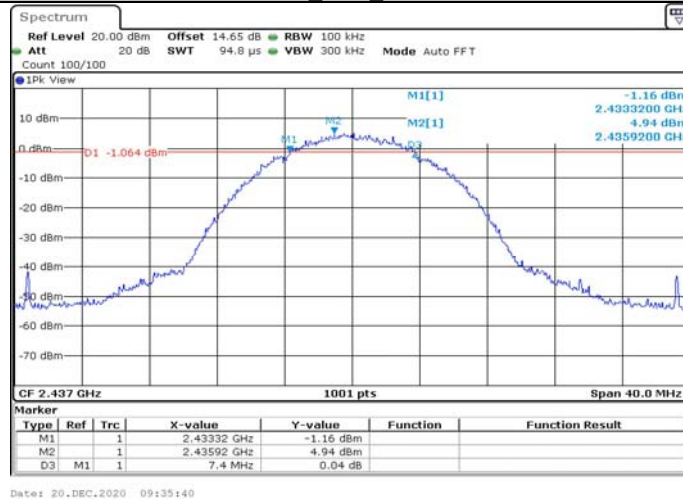
| TestMode  | Antenna | Channel | DTS BW [MHz] | Limit[MHz] | Verdict |
|-----------|---------|---------|--------------|------------|---------|
| 11B       | Ant1    | 2412    | 7.440        | 0.5        | PASS    |
|           |         | 2437    | 7.400        | 0.5        | PASS    |
|           |         | 2462    | 6.960        | 0.5        | PASS    |
| 11G       | Ant1    | 2412    | 16.400       | 0.5        | PASS    |
|           |         | 2437    | 16.600       | 0.5        | PASS    |
|           |         | 2462    | 16.480       | 0.5        | PASS    |
| 11N20SISO | Ant1    | 2412    | 17.720       | 0.5        | PASS    |
|           |         | 2437    | 17.760       | 0.5        | PASS    |
|           |         | 2462    | 17.760       | 0.5        | PASS    |
| 11N40SISO | Ant1    | 2422    | 36.400       | 0.5        | PASS    |
|           |         | 2437    | 35.920       | 0.5        | PASS    |
|           |         | 2452    | 35.600       | 0.5        | PASS    |

# Test Graphs

11B\_Ant1\_2412



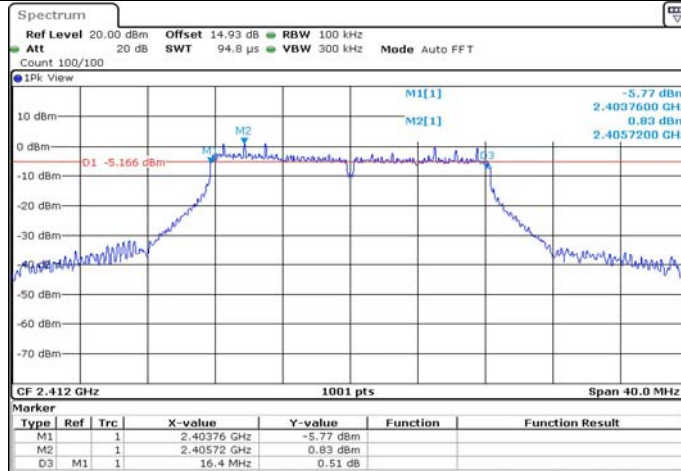
11B\_Ant1\_2437



11B\_Ant1\_2462

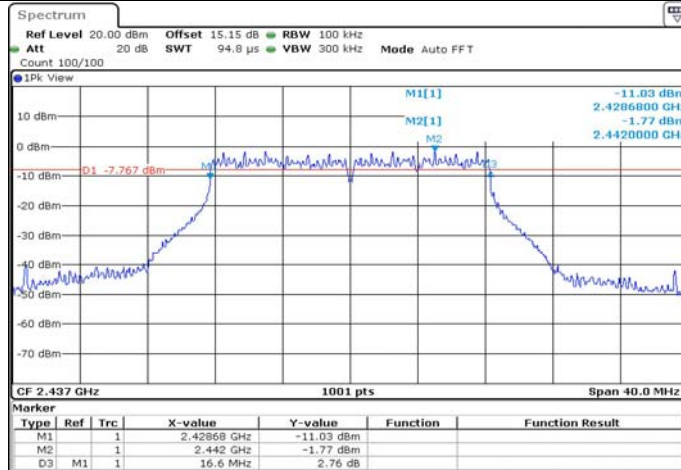


## 11G\_Ant1\_2412



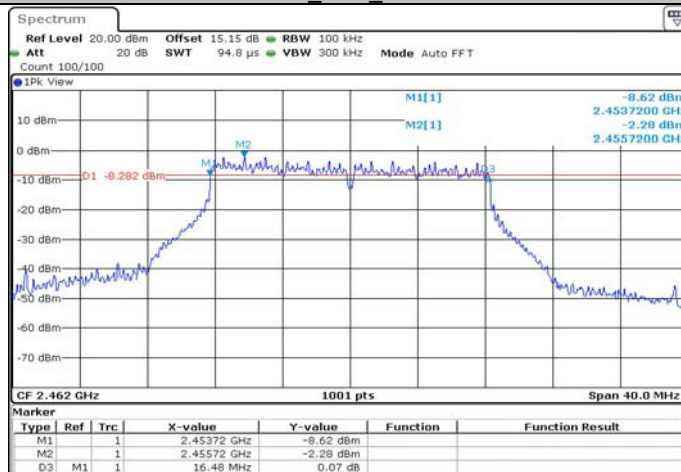
Date: 20.DEC.2020 10:18:06

## 11G\_Ant1\_2437

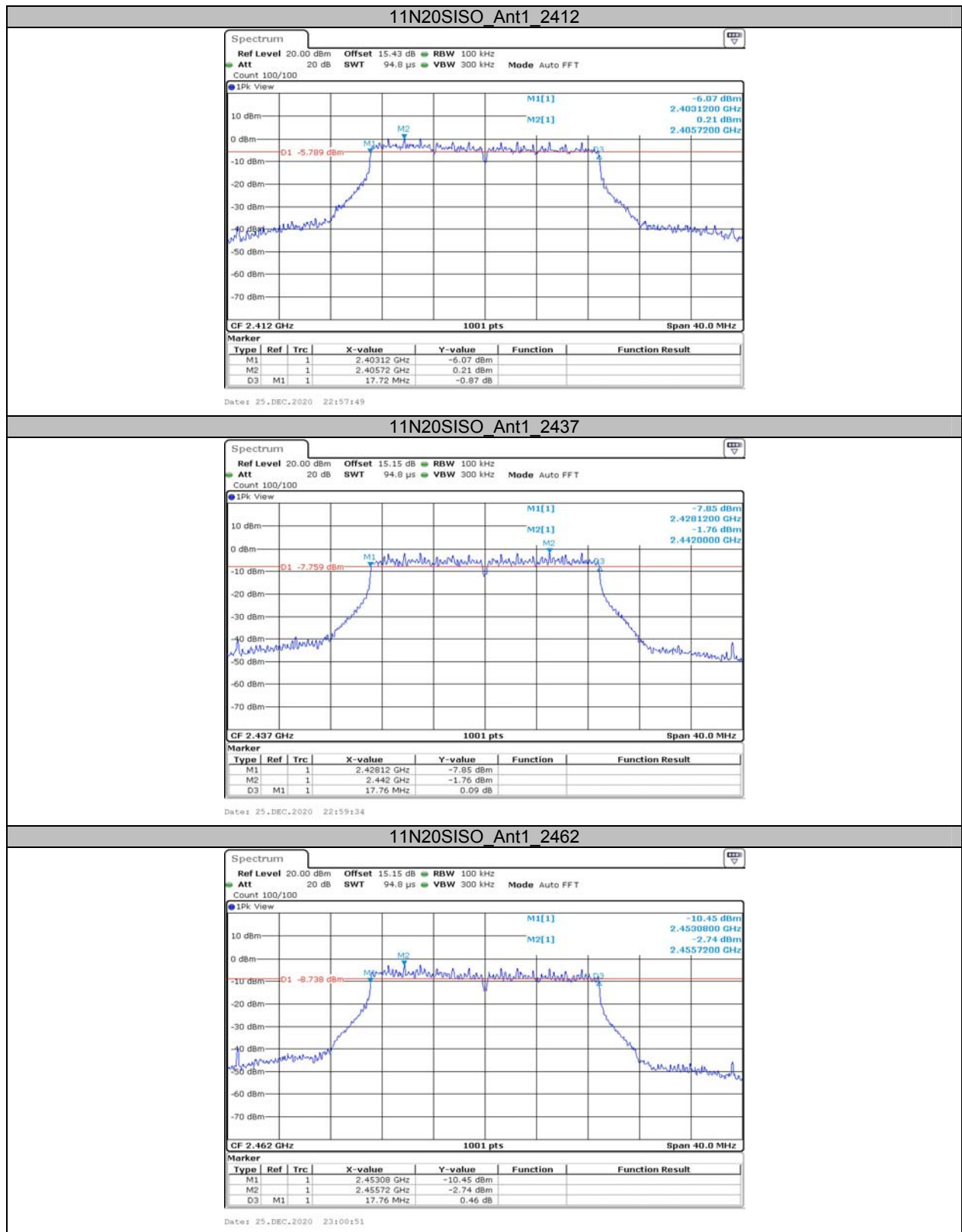


Date: 25.DEC.2020 23:07:08

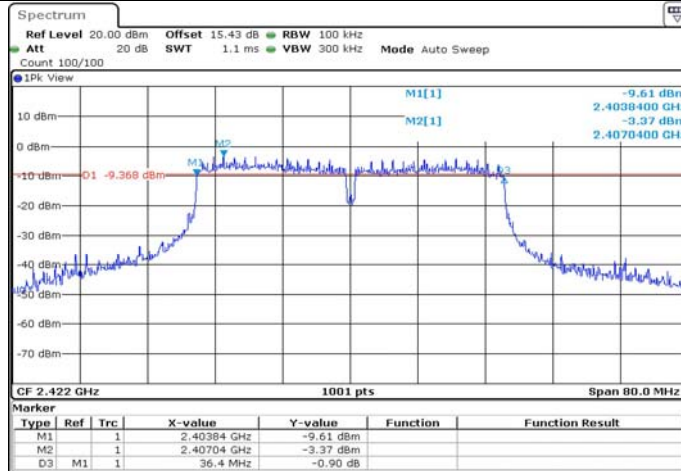
## 11G\_Ant1\_2462



Date: 25.DEC.2020 23:08:19

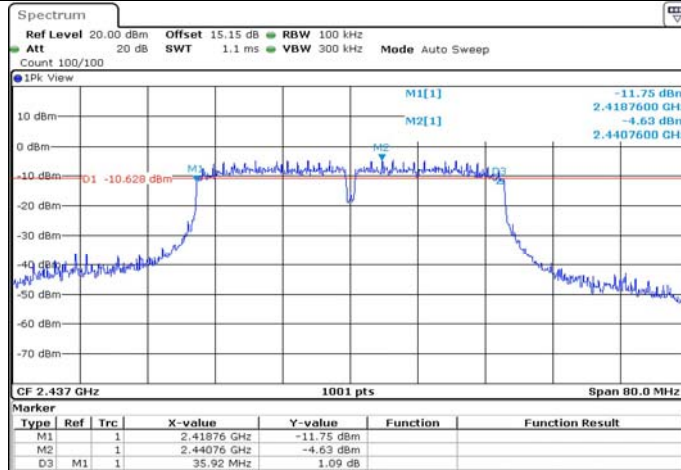


## 11N40SISO\_Ant1\_2422



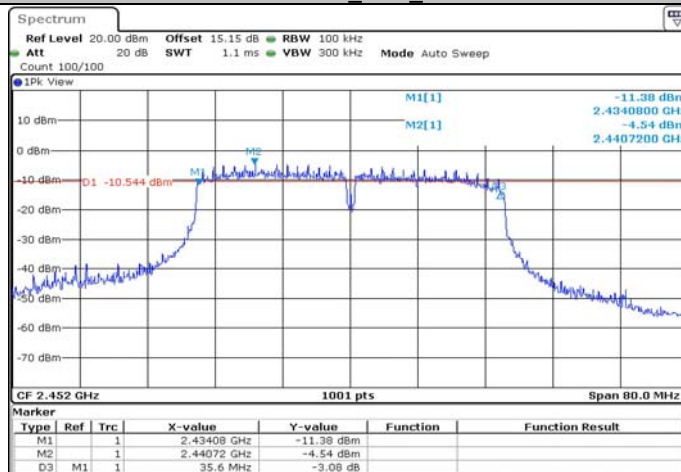
Date: 25, DEC, 2020 22:34:34

## 11N40SISO\_Ant1\_2437



Date: 25, DEC, 2020 22:46:17

## 11N40SISO\_Ant1\_2452



Date: 25, DEC, 2020 22:44:02

**Appendix B: Occupied Channel Bandwidth  
Test Result**

| TestMode  | Antenna | Channel | OCB [MHz] | Limit[MHz] | Verdict |
|-----------|---------|---------|-----------|------------|---------|
| 11B       | Ant1    | 2412    | 12.188    | ---        | PASS    |
|           |         | 2437    | 12.068    | ---        | PASS    |
|           |         | 2462    | 11.988    | ---        | PASS    |
| 11G       | Ant1    | 2412    | 18.022    | ---        | PASS    |
|           |         | 2437    | 17.343    | ---        | PASS    |
|           |         | 2462    | 17.463    | ---        | PASS    |
| 11N20SISO | Ant1    | 2412    | 18.342    | ---        | PASS    |
|           |         | 2437    | 18.302    | ---        | PASS    |
|           |         | 2462    | 18.302    | ---        | PASS    |
| 11N40SISO | Ant1    | 2422    | 36.843    | ---        | PASS    |
|           |         | 2437    | 36.603    | ---        | PASS    |
|           |         | 2452    | 36.284    | ---        | PASS    |

## Test Graphs

11B\_Ant1\_2412



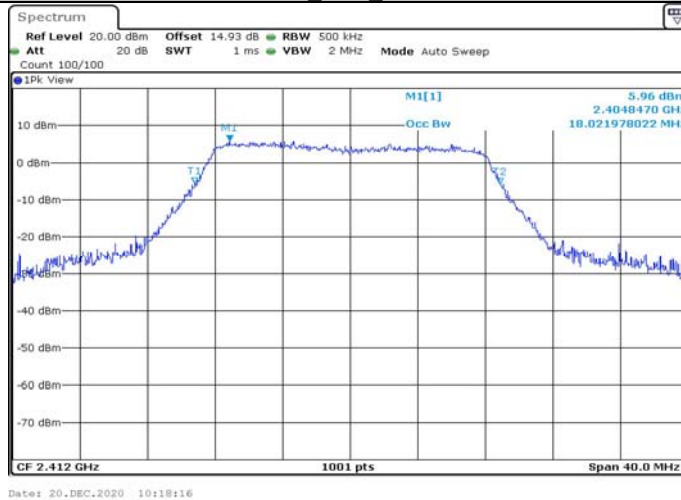
11B\_Ant1\_2437



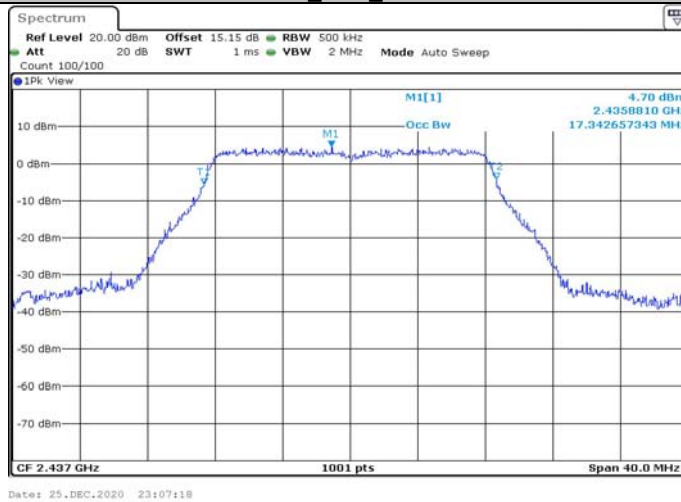
11B\_Ant1\_2462



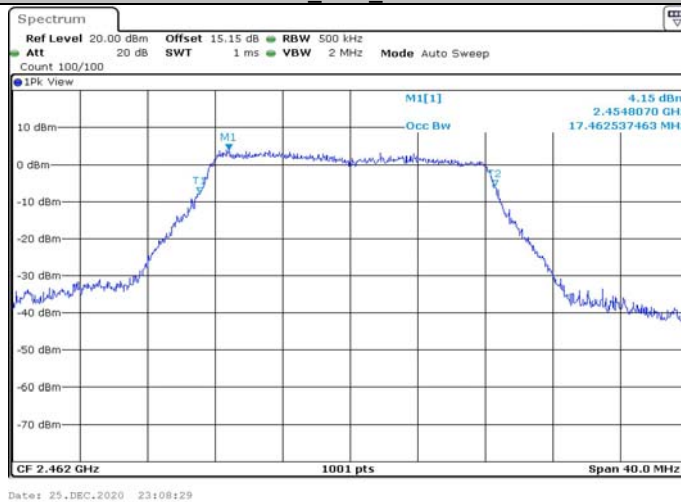
## 11G\_Ant1\_2412



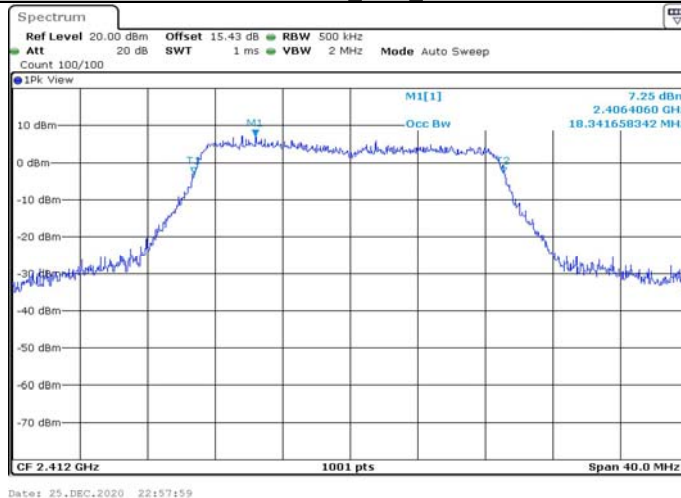
## 11G\_Ant1\_2437



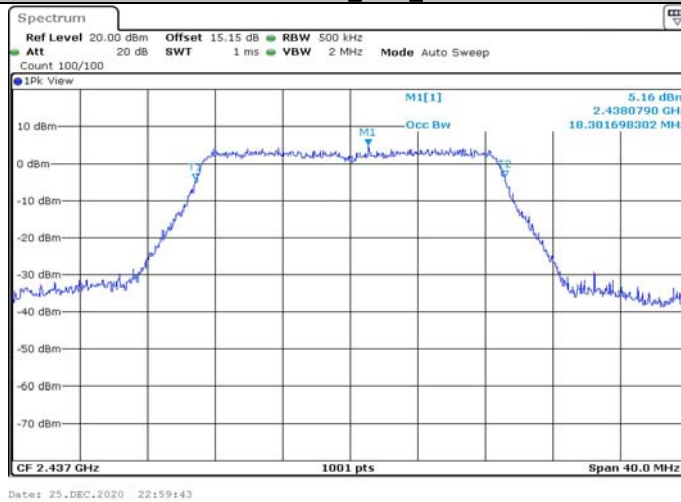
## 11G\_Ant1\_2462



## 11N20SISO\_Ant1\_2412



## 11N20SISO\_Ant1\_2437



## 11N20SISO\_Ant1\_2462



## 11N40SISO\_Ant1\_2422



## 11N40SISO\_Ant1\_2437



## 11N40SISO\_Ant1\_2452



### Appendix C: Maximum conducted output power PK Test Result

| TestMode  | Antenna | Channel | Result[dBm] | Limit[dBm] | Verdict |
|-----------|---------|---------|-------------|------------|---------|
| 11B       | Ant1    | 2412    | 16.24       | <=30       | PASS    |
|           |         | 2437    | 16.01       | <=30       | PASS    |
|           |         | 2462    | 15.74       | <=30       | PASS    |
| 11G       | Ant1    | 2412    | 15.56       | <=30       | PASS    |
|           |         | 2437    | 15.06       | <=30       | PASS    |
|           |         | 2462    | 13.75       | <=30       | PASS    |
| 11N20SISO | Ant1    | 2412    | 14.93       | <=30       | PASS    |
|           |         | 2437    | 14.51       | <=30       | PASS    |
|           |         | 2462    | 13.40       | <=30       | PASS    |
| 11N40SISO | Ant1    | 2422    | 13.38       | <=30       | PASS    |
|           |         | 2437    | 13.03       | <=30       | PASS    |
|           |         | 2452    | 12.15       | <=30       | PASS    |

### Appendix C: Maximum conducted output power AV Test Result

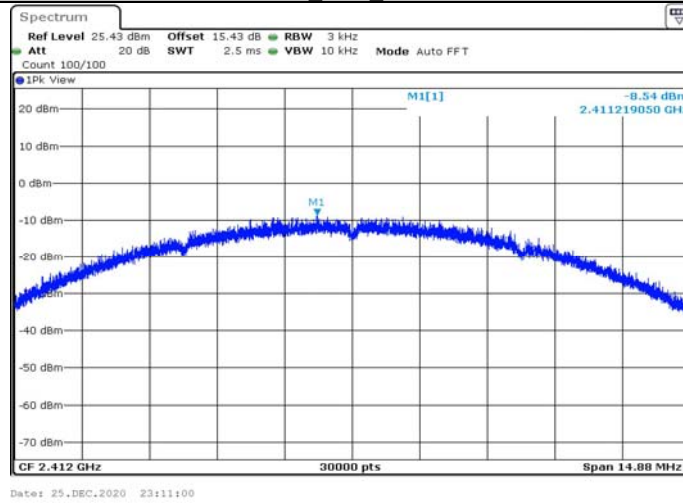
| TestMode  | Antenna | Channel | Result[dBm] | Limit[dBm] | Verdict |
|-----------|---------|---------|-------------|------------|---------|
| 11B       | Ant1    | 2412    | 15.58       | <=30       | PASS    |
|           |         | 2437    | 14.16       | <=30       | PASS    |
|           |         | 2462    | 13.08       | <=30       | PASS    |
| 11G       | Ant1    | 2412    | 12.24       | <=30       | PASS    |
|           |         | 2437    | 10.41       | <=30       | PASS    |
|           |         | 2462    | 9.32        | <=30       | PASS    |
| 11N20SISO | Ant1    | 2412    | 11.31       | <=30       | PASS    |
|           |         | 2437    | 10.29       | <=30       | PASS    |
|           |         | 2462    | 8.62        | <=30       | PASS    |
| 11N40SISO | Ant1    | 2422    | 10.98       | <=30       | PASS    |
|           |         | 2437    | 10.58       | <=30       | PASS    |
|           |         | 2452    | 9.36        | <=30       | PASS    |

**Appendix D: Maximum power spectral density  
Test Result**

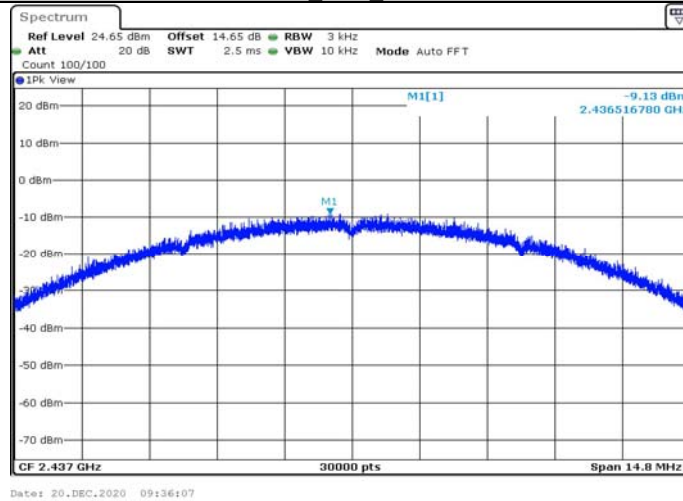
| TestMode  | Antenna | Channel | Result[dBm/3kHz] | Limit[dBm/3kHz] | Verdict |
|-----------|---------|---------|------------------|-----------------|---------|
| 11B       | Ant1    | 2412    | -8.54            | <=8             | PASS    |
|           |         | 2437    | -9.13            | <=8             | PASS    |
|           |         | 2462    | -8.97            | <=8             | PASS    |
| 11G       | Ant1    | 2412    | -13.07           | <=8             | PASS    |
|           |         | 2437    | -16.39           | <=8             | PASS    |
|           |         | 2462    | -16.98           | <=8             | PASS    |
| 11N20SISO | Ant1    | 2412    | -15.27           | <=8             | PASS    |
|           |         | 2437    | -16.6            | <=8             | PASS    |
|           |         | 2462    | -17.64           | <=8             | PASS    |
| 11N40SISO | Ant1    | 2422    | -20.05           | <=8             | PASS    |
|           |         | 2437    | -20.73           | <=8             | PASS    |
|           |         | 2452    | -20.83           | <=8             | PASS    |

## Test Graphs

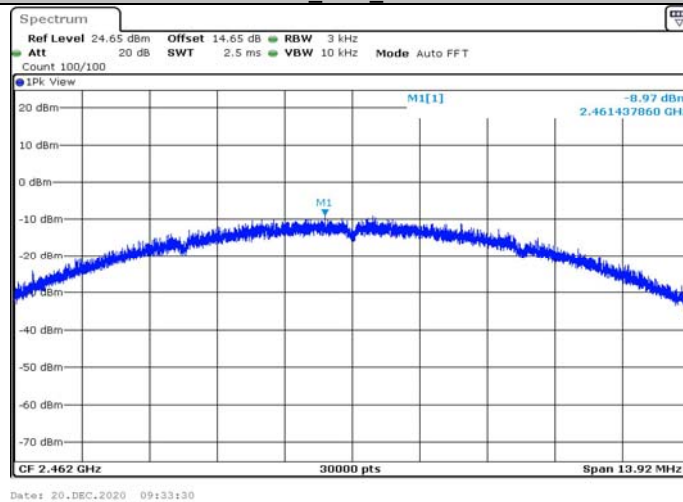
11B\_Ant1\_2412



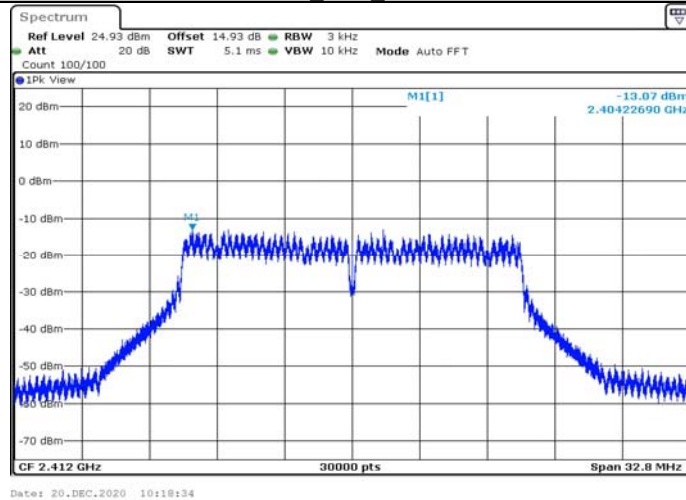
11B\_Ant1\_2437



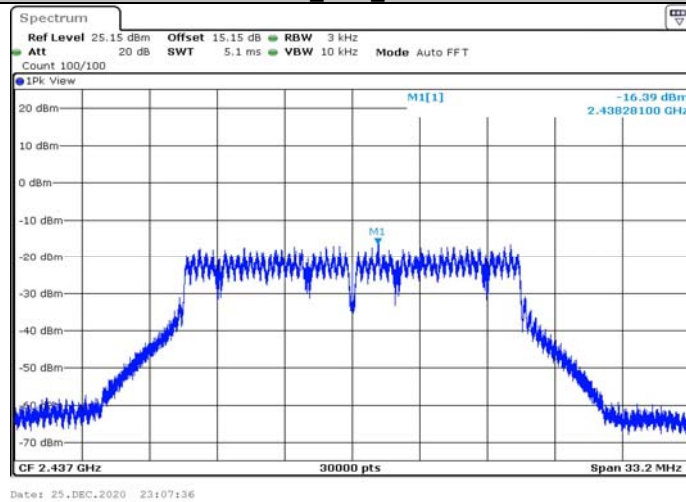
11B\_Ant1\_2462



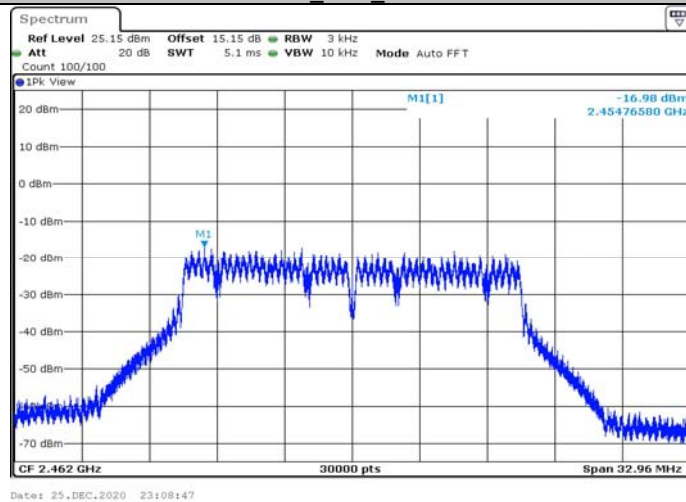
## 11G\_Ant1\_2412



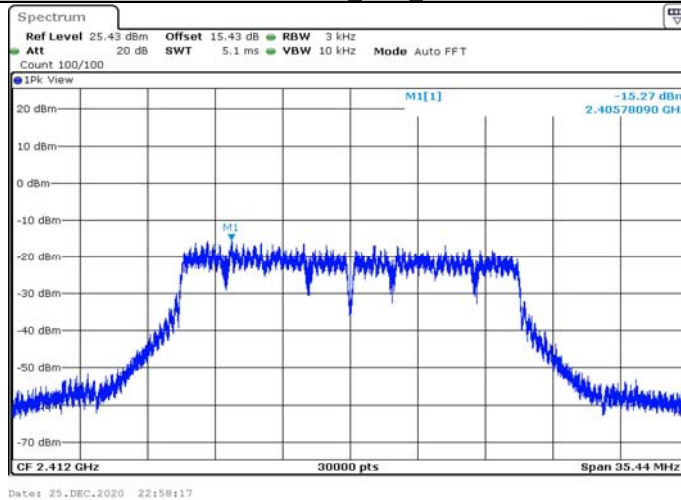
## 11G\_Ant1\_2437



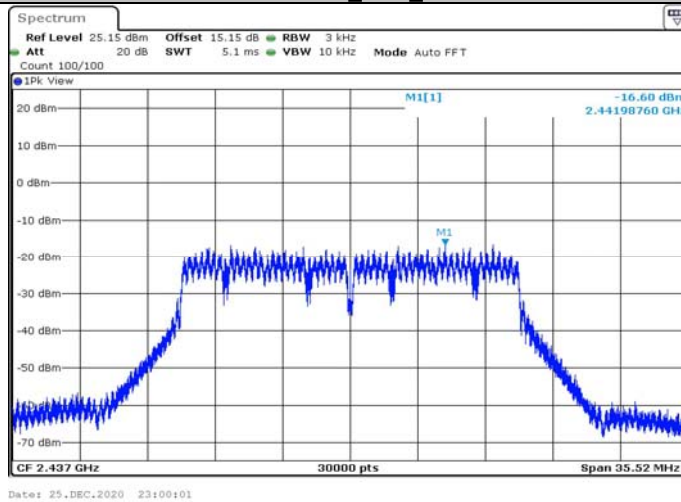
## 11G\_Ant1\_2462



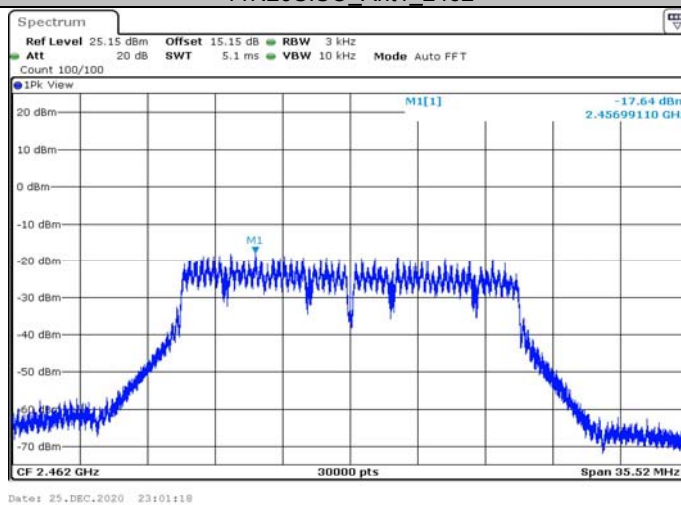
## 11N20SISO\_Ant1\_2412

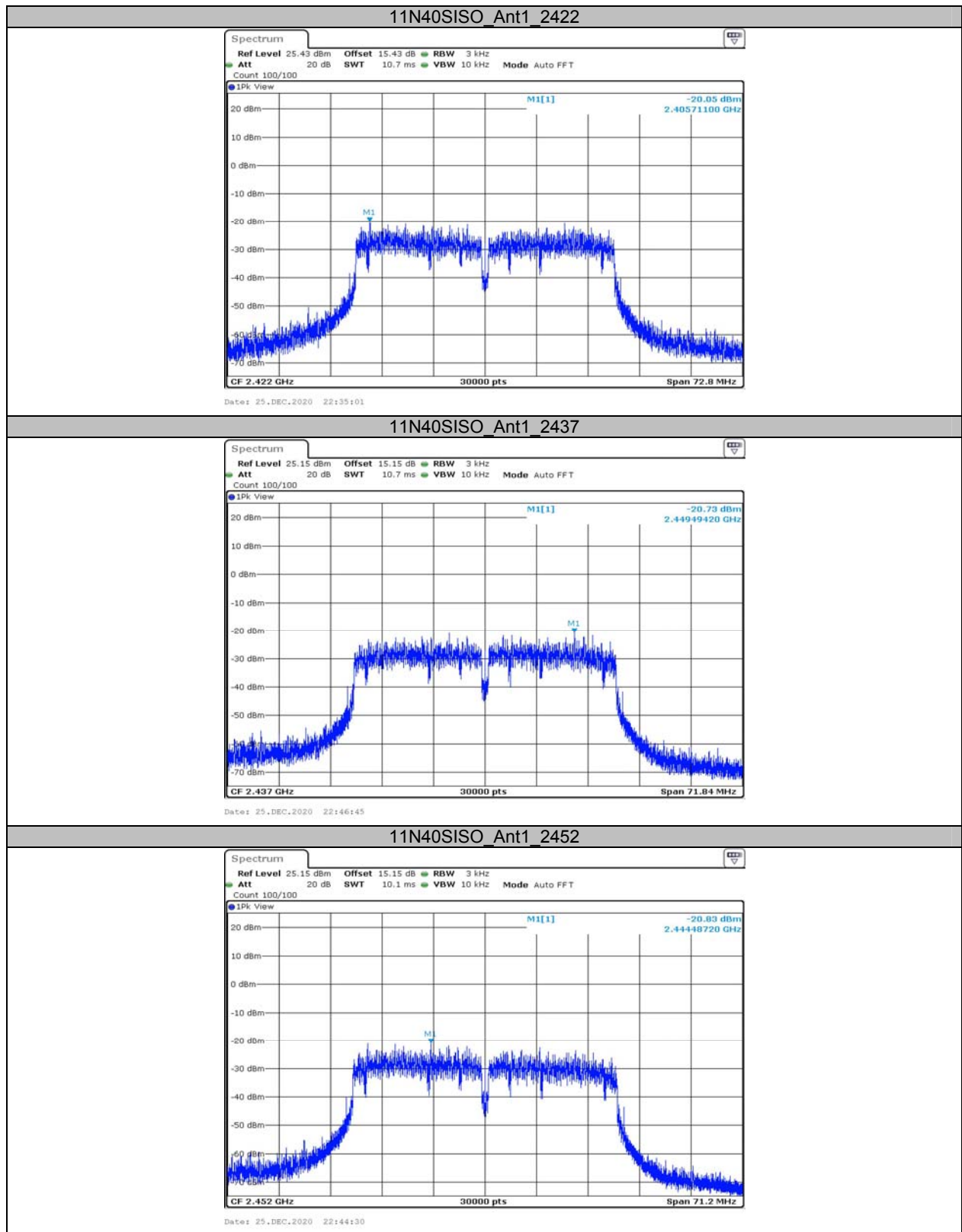


## 11N20SISO\_Ant1\_2437



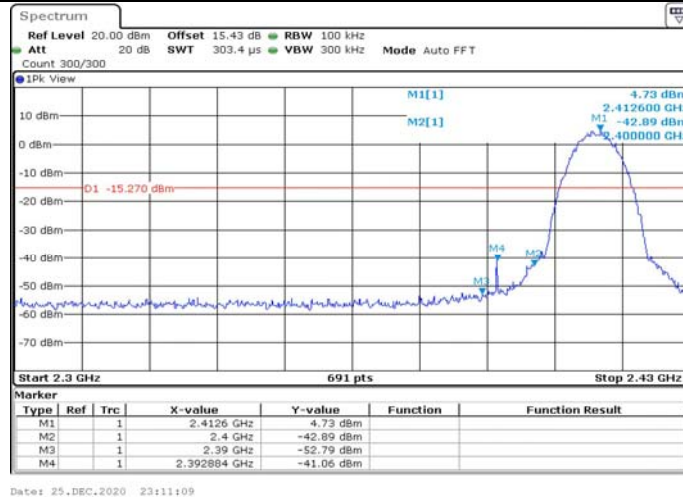
## 11N20SISO\_Ant1\_2462



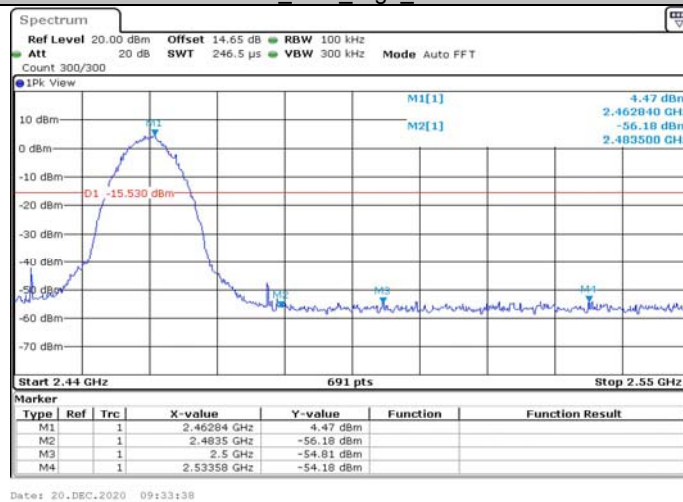


## Appendix E: Band edge measurements Test Graphs

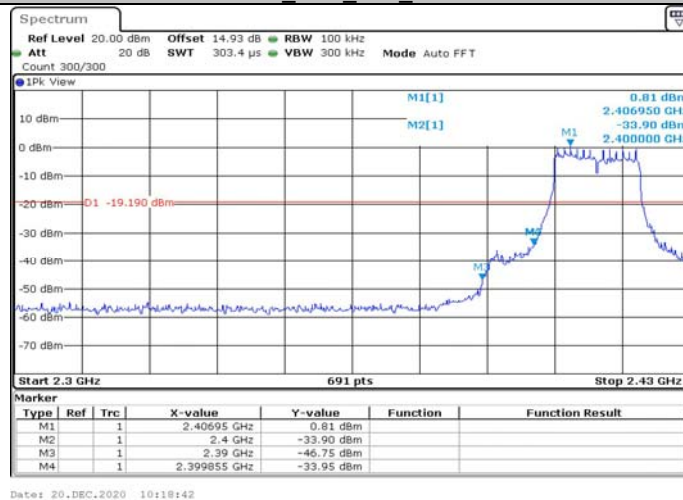
11B\_Ant1\_Low\_2412



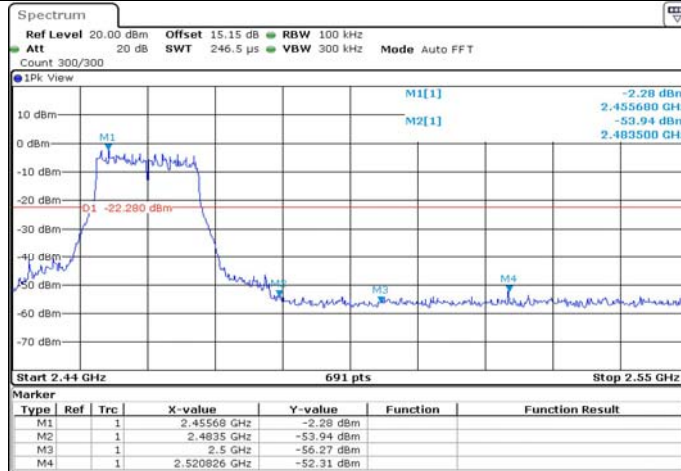
11B\_Ant1\_High\_2462



11G\_Ant1\_Low\_2412



## 11G Ant1\_High\_2462



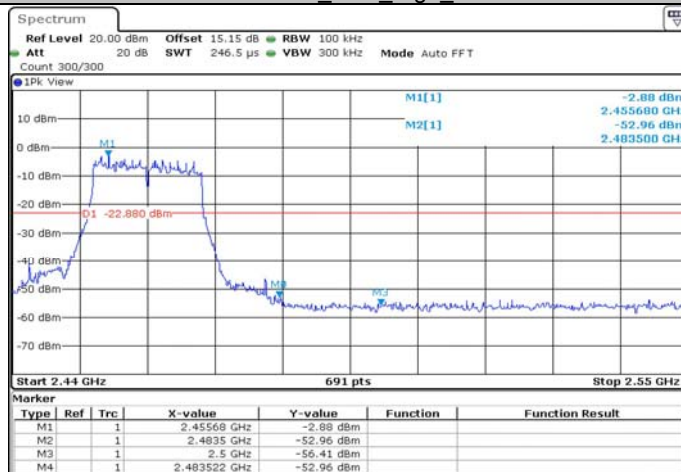
Date: 25, DEC, 2020 23:08:55

## 11N20SISO\_Ant1\_Low\_2412

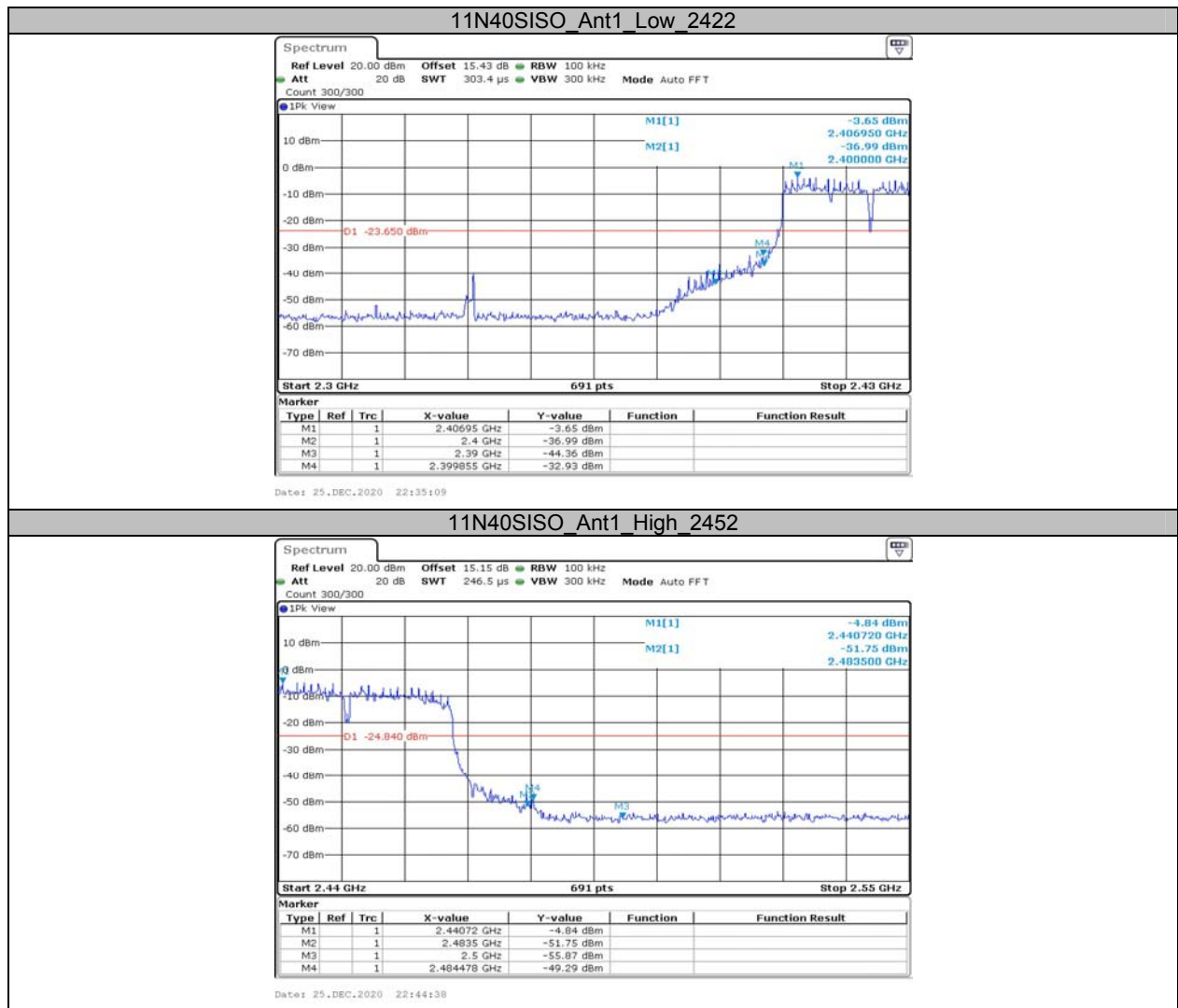


Date: 25, DEC, 2020 22:58:25

## 11N20SISO\_Ant1\_High\_2462



Date: 25, DEC, 2020 23:01:26

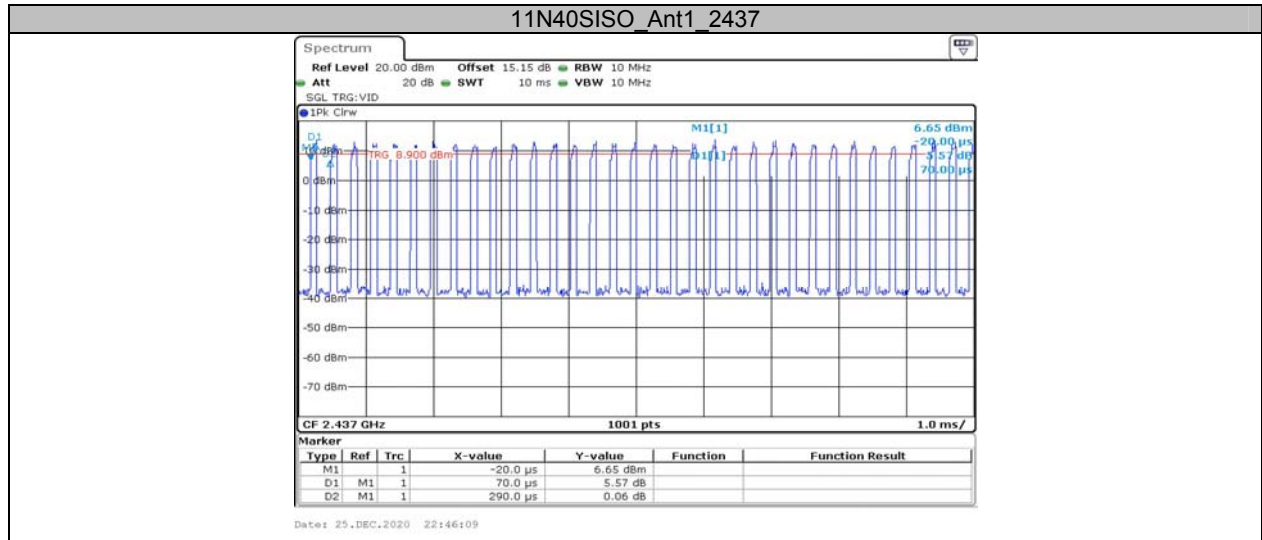


**Appendix F: Duty Cycle  
Test Result**

| TestMode  | Antenna | Channel | Transmission<br>Duration [ms] | Transmission<br>Period [ms] | Duty Cycle [%] |
|-----------|---------|---------|-------------------------------|-----------------------------|----------------|
| 11B       | Ant1    | 2437    | 0.78                          | 1.02                        | 76.47          |
| 11G       | Ant1    | 2437    | 0.15                          | 0.37                        | 40.54          |
| 11N20SISO | Ant1    | 2437    | 0.14                          | 0.35                        | 40.00          |
| 11N40SISO | Ant1    | 2437    | 0.07                          | 0.29                        | 24.14          |

## Test Graphs





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