TESTING LABORATORY
CERTIFICATE #4820.01

# FCC PART 15.247

# RSS-GEN, ISSUE 4, NOVEMBER 2014

# RSS-247, ISSUE 2, FEBRUARY 2017

# TEST REPORT

For

## Flyability SA

Flyability SA, Avenue de Sevelin 20, Lausanne, Switzerland, CH-1004

**FCC ID: 2AL7M-MAGICREX**
**IC: 22887-MAGICREX**

| **Report Type:** | **Product Name:** |
|---|---|
| Original Report | Range Extender (REx) |

| | |
|---|---|
| **Report Number:** | RDG180328002-00A |
| **Report Date:** | 2018-05-02 |
| **Reviewed By:** | Jerry Zhang<br>EMC Manager |
| **Test Laboratory:** | Bay Area Compliance Laboratories Corp. (Dongguan)<br>No.69 Pulongcun, Puxinhu Industry Area,<br>Tangxia, Dongguan, Guangdong, China<br>Tel: +86-769-86858888<br>Fax: +86-769-86858891<br>www.baclcorp.com.cn |

# TABLE OF CONTENTS

# GENERAL INFORMATION

## Product Description for Equipment under Test (EUT)

| | |
|---|---|
| **EUT Name:** | Range Extender (REx) |
| **EUT Model:** | No.2 |
| **FCC ID:** | 2AL7M-MAGICREX |
| **IC:** | 22887-MAGICREX |
| **Rated Input Voltage:** | Remote Controller:<br>DC 7.4V from lithium rechargeable battery or DC 17.4V from adapter<br>Antenna Module:<br>DC 11.1V from lithium rechargeable battery |
| **Serial Number:** | 180328002 |
| **EUT Received Date:** | 2018.03.28 |

## Objective

This report is prepared on behalf of ***Flyability SA*** in accordance with Part 2, Subpart J, Part 15, Subparts A, and C of the Federal Communications Commission's rules and RSS-247, Issue 2, February 2017, RSS-Gen Issue 4, November 2014 of the Innovation, Science and Economic Development Canada.

The tests were performed in order to determine the compliance of the EUT with FCC Rules Part 15-Subpart C, section 15.203, 15.205, 15.209, 15.247 rules and RSS-247, Issue 2, February 2017, RSS-Gen Issue 4, November 2014 of the Innovation, Science and Economic Development Canada.

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

FCC submissions with Part 15C DXX, FCC ID: 2AL7M- MAGICREX.
ISEDC submissions with RSS-210, IC: 22887-MAGICREX

## Test Methodology

All measurements detailed in this Test Report were performed in accordance with ANSI C63.10-2013 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices", RSS-247, Issue 2, February 2017, RSS-Gen Issue 4, November 2014 of the Innovation, Science and Economic Development Canada, and KDB 558074 D01 DTS Meas Guidance v04.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Dongguan).

## Measurement Uncertainty

| Parameter | Measurement Uncertainty |
|---|---|
| Occupied Channel Bandwidth | ±5 % |
| RF output power, conducted | ±0.61dB |
| Power Spectral Density, conducted | ±0.61 dB |
| Unwanted Emissions, radiated | 30M~200MHz: 4.58 dB for Horizontal, 4.59 dB for Vertical<br>200M~1GHz: 4.83 dB for Horizontal, 5.85 dB for Vertical<br>1G~6GHz: 4.45 dB, 6G~26.5GHz: 5.23 dB |
| Unwanted Emissions, conducted | ±1.5 dB |
| Temperature | ±1℃ |
| Humidity | ±5% |
| DC and low frequency voltages | ±0.4% |
| Duty Cycle | 1% |
| AC Power Lines Conducted Emission | 3.12 dB (150 kHz to 30 MHz) |

## Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, 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. : 897218,the FCC Designation No. : CN1220.

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

# SYSTEM TEST CONFIGURATION

## Description of Test Configuration

The system was configured for testing in testing mode, which was provided by manufacturer.

The Range Extender system is composed of different elements: Remote Controller(RC), Antenna Module, RC Cable, Adaptor, and Module Cable. Please refer to the user manual for detailly.

All antenna Conducted test performed at the RF output port of the antenna module.

For 2.4GHz band, the remote controller employed 39 channels as below:

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---|---|---|---|
| 1 | 2404 | 21 | 2444 |
| 2 | 2406 | … | … |
| … | … | … | … |
| … | … | … | … |
| .. | … | 38 | 2478 |
| 20 | 2442 | 39 | 2480 |

3channels were tested: 2404MHz, 2442MHz, 2480 MHz

## Equipment Modifications

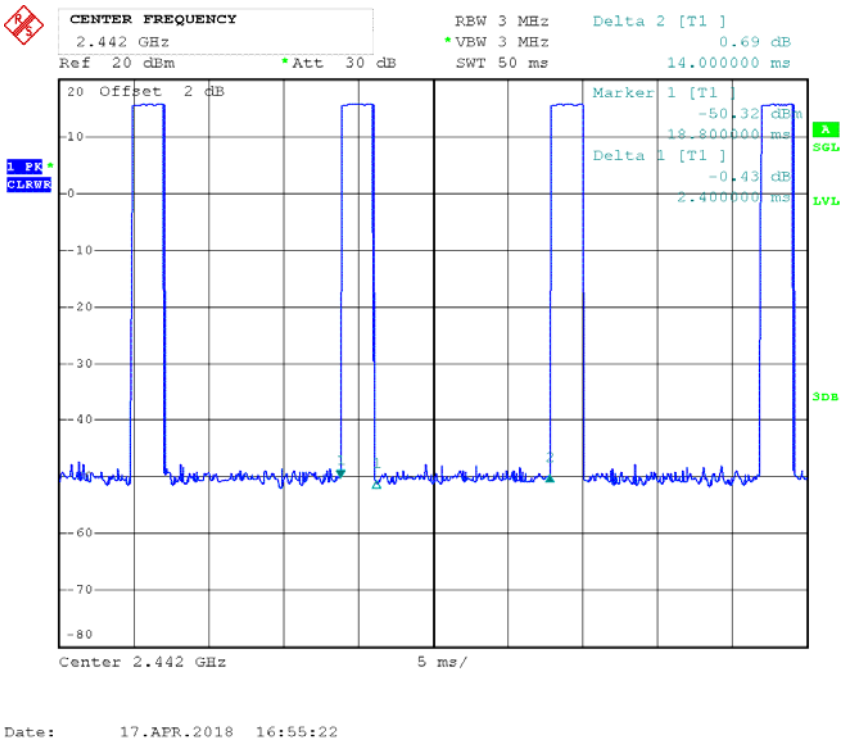
No modification was made to the EUT tested.

## EUT Exercise Software

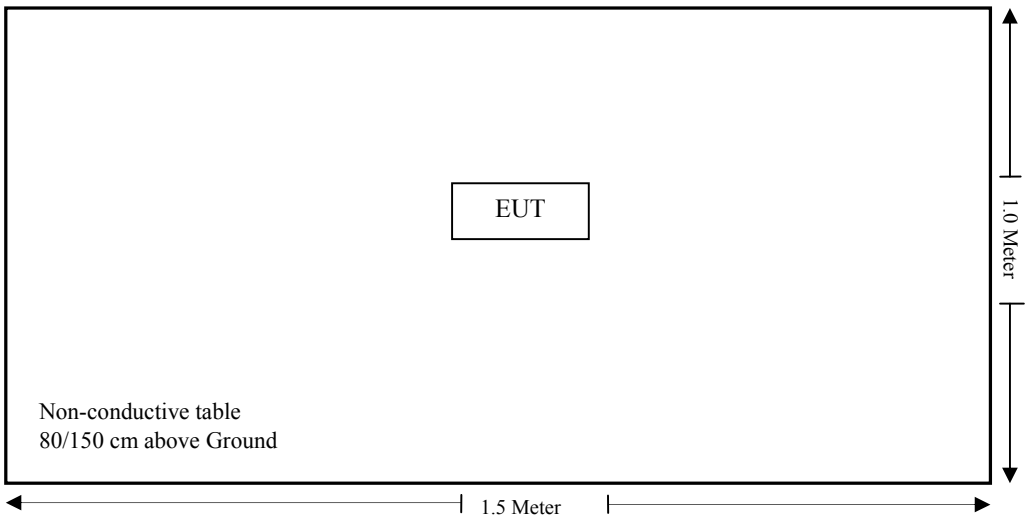
The software: SScom32 was used in the test. The system configured maximum power as default setting and switched the channel by software commands.

The duty cycle as below:

| $T_{on}$ (ms) | $T_{on+off}$ (ms) | Duty Cycle (%) |
|---|---|---|
| 2.400 | 14.000 | 17.14 |




## Block Diagram of Test Setup



# SUMMARY OF TEST RESULTS

| Rules | Description of Test | Result |
|---|---|---|
| FCC §15.247 (i) & §1.1310 & §2.1091 | Maximum Permissible Exposure(MPE) | Compliance |
| RSS-102 §2.5.2 | Exemption limits for Routine Evaluation – RF EXPOSURE Evaluation | Compliance |
| FCC§15.203<br>RSS-GEN§8.3 | Antenna Requirement | Compliance |
| §15.207 (a)<br>RSS-Gen §8.8 | AC Line Conducted Emissions | Not Applicable |
| §15.205, §15.209, §15.247(d)<br>RSS-247 §5.5<br>RSS-Gen §8.10 | Spurious Emissions | Compliance |
| §15.247 (a)(2)<br>RSS-247 §5.2 a) | 6 dB Emission Bandwidth And 99% Occupied Bandwidth | Compliance |
| §15.247(b)(3)<br>RSS-247 §5.4 d) | Maximum conducted output power | Compliance |
| §15.247(d)<br>RSS-247 §5.5 | 100 kHz Bandwidth of Frequency Band Edge | Compliance |
| §15.247 (e)<br>RSS-247 §5.2 b) | Power Spectral Density | Compliance |

Note:
Not Applicable: the device powered by battery.

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

## Applicable Standard

According to§15.247(i) and §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

| (B) Limits for General Population/Uncontrolled Exposure | | | | |
|---|---|---|---|---|
| Frequency Range (MHz) | **Electric Field Strength (V/m)** | **Magnetic Field Strength (A/m)** | **Power Density ($mW/cm^2$)** | **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;

According to §1.1310 and §2.1091 RF exposure is calculated.

**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:**

| **Frequency Range (MHz)** | **Antenna Gain** | | **Max. Target Power including Tolerance** | | **Evaluation Distance (cm)** | **Power Density ($mW/cm^2$)** | **MPE Limit ($mW/cm^2$)** |
|---|---|---|---|---|---|---|---|
| | **(dBi)** | **(numeric)** | **(dBm)** | **(mW)** | | | |
| 2404-2480 | 3.5 | 2.24 | 18 | 63.10 | 20.00 | 0.028 | 1.0 |

Note: the Max. Target Power including Tolerance was declared by manufacturer.
The 2.4GHz and 5.8GHz can`t transmit simultaneously.

**Result: Compliance,** The device meets MPE requirement for Devices Used by the General Public (Uncontrolled Environment) at distance ≥20 cm.

# RSS-102 § 2.5.2 - EXEMPTION LIMITS FOR ROUTINE EVALUATION – RF EXPOSURE EVALUATION

Applicable Standard

According to RSS-102 § (2.5.2):

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

• below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);

• at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where $f$ is in MHz;

• at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);

• at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where $f$ is in MHz;

• at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

**Calculated Data:**

The maximum power including tune-up tolerance is 18dBm@ 2.4GHz band, the maximum antenna gain is 3.5dBi, so the maximum e.r.i.p. is 21.5dBm (0.141W)

Exemption from Routine Evaluation Limit is:
$1.31 \times 10^{-2} f^{0.6834} = 1.31 \times 10^{-2} \times 2404^{0.6834} = 2.68 > 0.141$W

So the device is compliance exemption from Routine Evaluation Limits –RF exposure Evaluation.

**Result:** Compliance

# FCC §15.203, RSS-GEN§8.3 - 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.

According to RSS-Gen §8.3, The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.
Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level.9 When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

*This radio transmitter (identify the device by certification number or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.*

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

## Antenna Information And Connector Construction

All RF connector are RP-SMA connector, fulfill the requirement of the item. Please refer to the EUT photos. The antenna gains for the two antennas in the Antenna Module are 3.5 dBi. One of the antenna for transmitting, the other one only for receiving,

**Result:** Compliance.

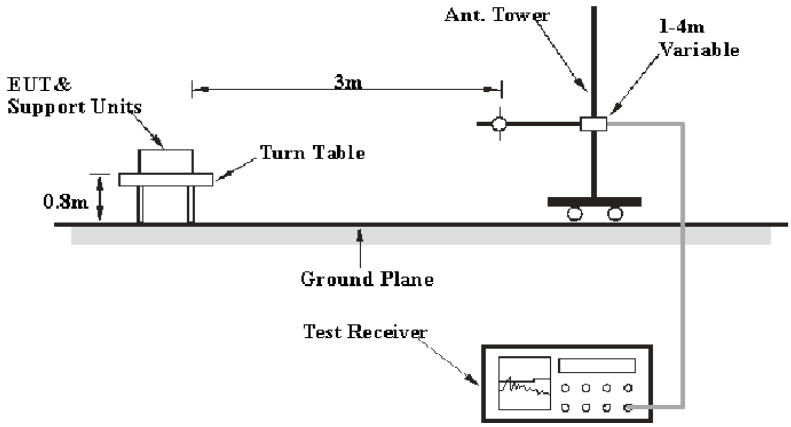
# FCC §15.209, §15.205, §15.247(d) & RSS-247 §5.5&RSS-GEN§8.10-SPURIOUS EMISSIONS

## Applicable Standard

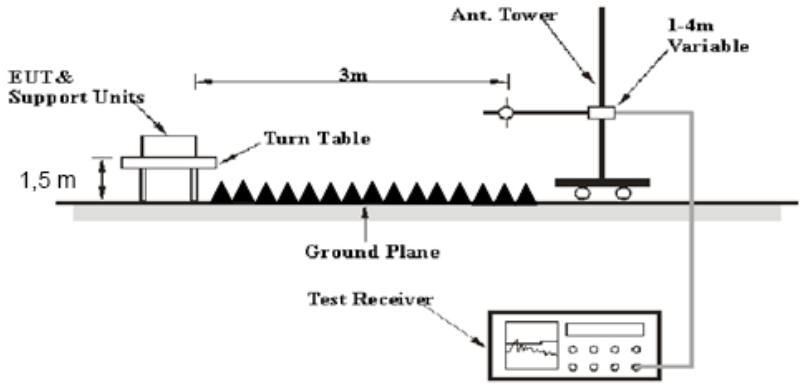
FCC §15.247 (d); §15.209; §15.205; and RSS-247 §5.5, RSS-GEN §8.10

## EUT Setup

**Below 1GHz:**




**Above 1GHz:**




The radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 and RSS-247 §5.5, RSS-Gen §8.10 limits.

The spacing between the peripherals was 10 cm.

## EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

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

30-1000MHz:

| Measurement | RBW | Video B/W | IF B/W |
|---|---|---|---|
| QP | 120 kHz | 300 kHz | 120kHz |

1GHz- 25GHz:

| Measurement | Duty cycle | RBW | Video B/W |
|---|---|---|---|
| PK | Any | 1MHz | 3 MHz |
| Ave. | >98% | 1MHz | 10 Hz |
| | <98% | 1MHz | 1/T |

## 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.

All emissions under the average limit and under the noise floor have not recorded in the report.

## 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:

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - 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:

Margin = Limit –Corrected Amplitude

## Test Equipment List and Details

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| Sunol Sciences | Antenna | JB3 | A060611-1 | 2017-11-10 | 2020-11-10 |
| R&S | EMI Test Receiver | ESCI | 100224 | 2017-12-11 | 2018-12-11 |
| HP | Amplifier | 8447D | 2727A05902 | 2017-09-05 | 2018-09-05 |
| Unknown | Coaxial Cable | C-NJNJ-50 | C-0400-01 | 2017-09-05 | 2018-09-05 |
| Unknown | Coaxial Cable | C-NJNJ-50 | C-0075-01 | 2017-09-05 | 2018-09-05 |
| Unknown | Coaxial Cable | C-NJNJ-50 | C-1000-01 | 2017-09-05 | 2018-09-05 |
| ETS-Lindgren | Horn Antenna | 3115 | 000 527 35 | 2016-01-05 | 2019-01-04 |
| E-Microwave | Band-stop Filters | OBSF-2400-2483.5-S | OE01601525 | 2017-06-16 | 2018-06-16 |
| Micro-tronics | High Pass Filter | HPM50111 | S/N-G217 | 2017-06-16 | 2018-06-16 |
| Ducommun Technolagies | Horn Antenna | ARH-4223-02 | 1007726-01 1304 | 2016-11-18 | 2019-11-18 |
| Unknown | Coaxial Cable | C-SJSJ-50 | C-0800-01 | 2017-09-05 | 2018-09-05 |
| Unknown | Coaxial Cable | C-2.4J2.4J-50 | C-0700-02 | 2017-06-27 | 2018-06-27 |
| MITEQ | Amplifier | AFS42-00101800-25-S-42 | 2001271 | 2017-09-05 | 2018-09-05 |
| Agilent | Spectrum Analyzer | E4440A | SG43360054 | 2017-12-08 | 2018-12-08 |
| Quinstar | Amplifier | QLW-18405536-JO | 15964001001 | 2017-06-27 | 2018-06-27 |
| Farad | Test Software | EZ-EMC | V1.1.4.2 | N/A | N/A |

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

## Test Data

### Environmental Conditions

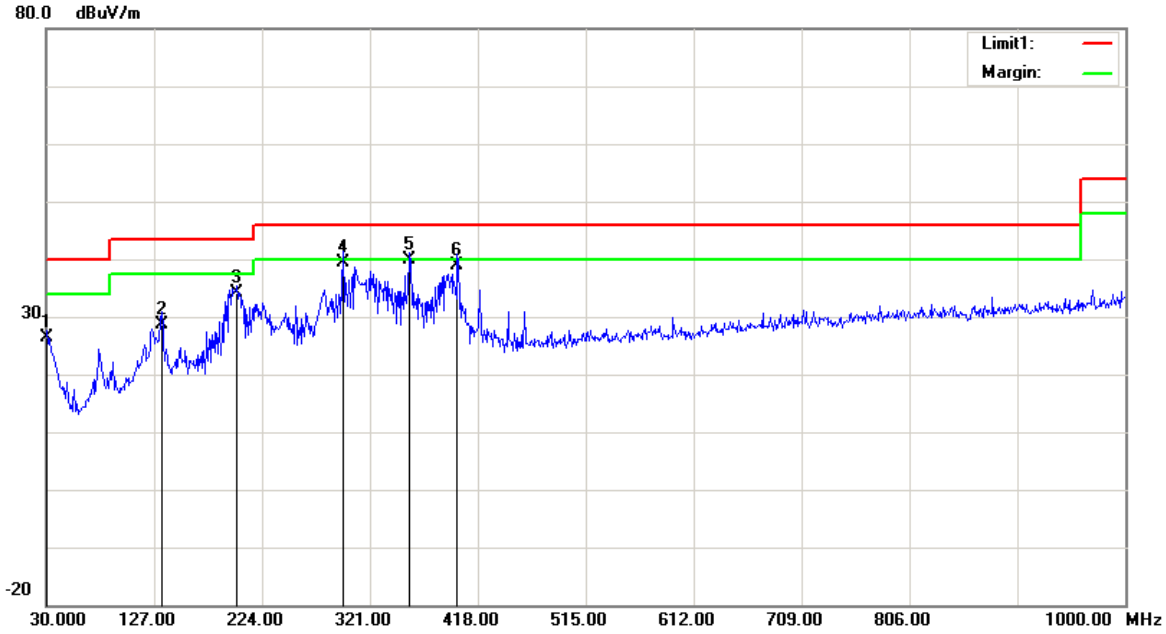
| | |
|---|---|
| **Temperature:** | 23.5 °C |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 101 kPa |

*The testing was performed by Sunny Cen and Blake Yang on 2018-04-19.*

*Test Mode: Transmitting*

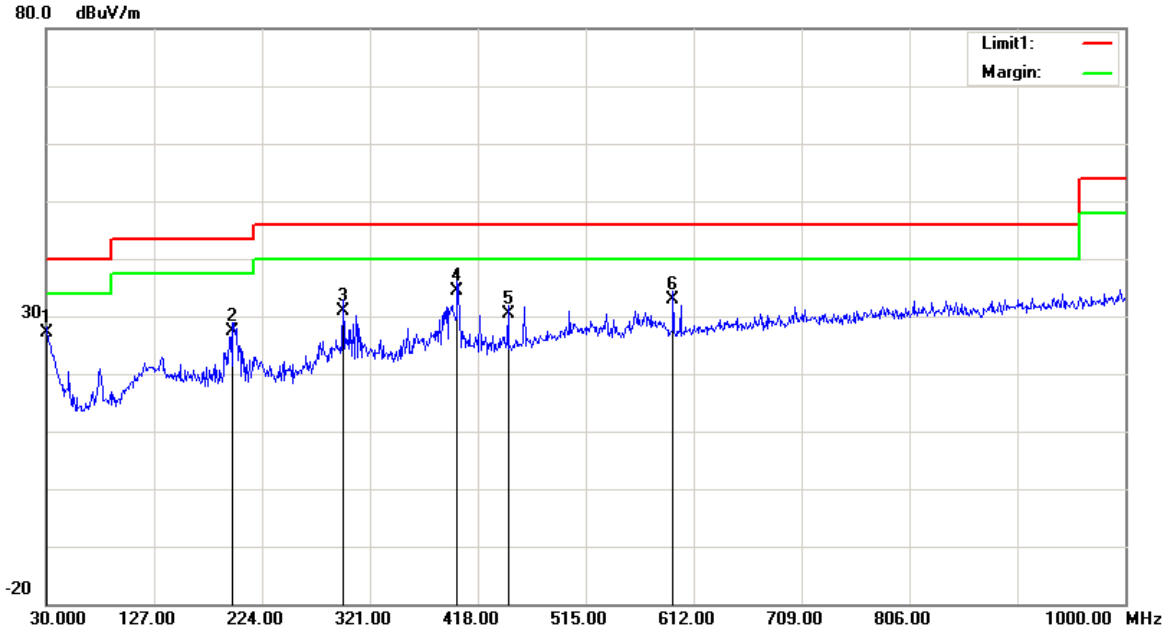
**1) 30MHz-1GHz(Middle channel was the worst)**:

**Horizontal:**




| Frequency (MHz) | Receiver Reading (dBµV) | Detector | Correction Factor (dB/m) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 30.9700 | 25.59 | QP | 0.81 | 26.40 | 40.00 | 13.60 |
| 133.7900 | 33.83 | QP | -5.13 | 28.70 | 43.50 | 14.80 |
| 201.6900 | 40.12 | QP | -6.02 | 34.10 | 43.50 | 9.40 |
| 296.7500 | 43.49 | QP | -4.09 | 39.40 | 46.00 | 6.60 |
| 356.8900 | 42.75 | QP | -2.95 | 39.80 | 46.00 | 6.20 |
| 399.5700 | 40.93 | QP | -2.03 | 38.90 | 46.00 | 7.10 |

**Vertical:**



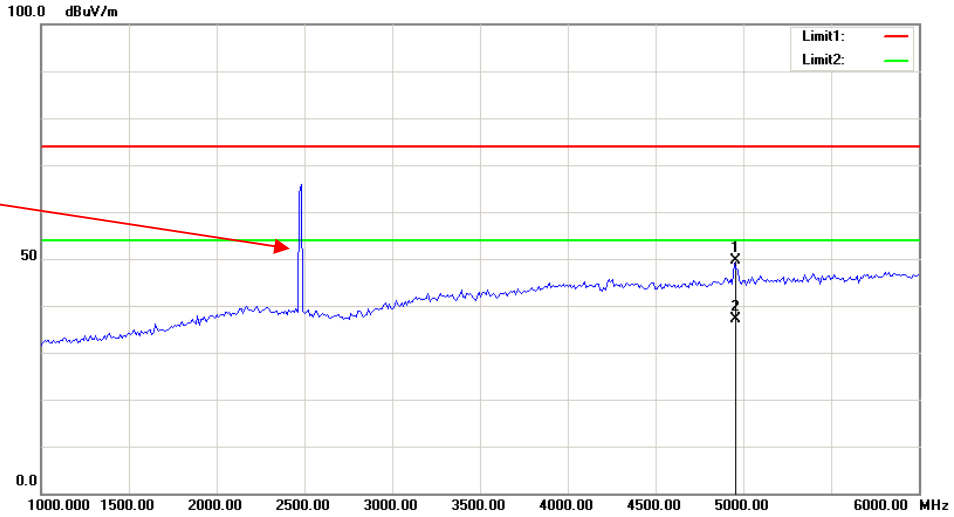

| Frequency (MHz) | Receiver Reading (dBµV) | Detector t | Correction Factor (dB/m) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 30.0000 | 25.66 | QP | 1.54 | 27.20 | 40.00 | 12.80 |
| 197.8100 | 33.73 | QP | -6.43 | 27.30 | 43.50 | 16.20 |
| 296.7500 | 34.89 | QP | -4.09 | 30.80 | 46.00 | 15.20 |
| 399.5700 | 36.53 | QP | -2.03 | 34.50 | 46.00 | 11.50 |
| 445.1600 | 31.77 | QP | -1.27 | 30.50 | 46.00 | 15.50 |
| 593.5700 | 32.06 | QP | 0.74 | 32.80 | 46.00 | 13.20 |

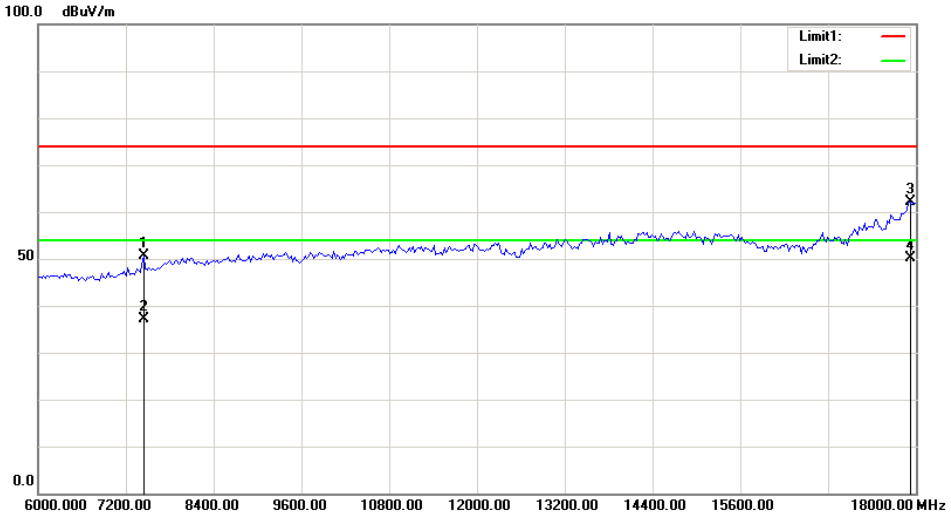
**2) 1-25GHz:**

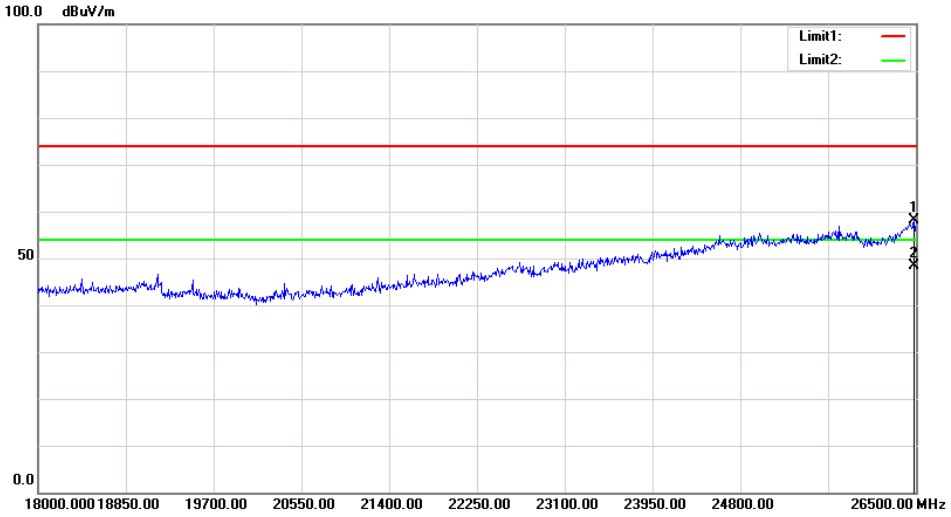
| Frequency (MHz) | Receiver | | Rx Antenna | | Cable loss (dB) | Amplifier Gain (dB) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBμV) | Detector (PK/QP/AV) | Polar (H/V) | Factor (dB) | | | | | |
| Low Channel: 2404 MHz | | | | | | | | | |
| 2404.00 | 73.96 | PK | H | 28.11 | 1.80 | 0.00 | 103.87 | N/A | N/A |
| 2404.00 | 60.36 | AV | H | 28.11 | 1.80 | 0.00 | 90.27 | N/A | N/A |
| 2404.00 | 75.24 | PK | V | 28.11 | 1.80 | 0.00 | 105.15 | N/A | N/A |
| 2404.00 | 64.37 | AV | V | 28.11 | 1.80 | 0.00 | 94.28 | N/A | N/A |
| 2390.00 | 28.64 | PK | V | 28.08 | 1.80 | 0.00 | 58.52 | 74.00 | 15.48 |
| 2390.00 | 15.47 | AV | V | 28.08 | 1.80 | 0.00 | 45.35 | 54.00 | 8.65 |
| 4808.00 | 53.01 | PK | V | 32.92 | 3.17 | 37.20 | 51.90 | 74.00 | 22.10 |
| 4808.00 | 38.41 | AV | V | 32.92 | 3.17 | 37.20 | 37.30 | 54.00 | 16.70 |
| 7212.00 | 52.31 | PK | V | 35.75 | 4.81 | 37.24 | 55.63 | 74.00 | 18.37 |
| 7212.00 | 37.52 | AV | V | 35.75 | 4.81 | 37.24 | 40.84 | 54.00 | 13.16 |
| Middle Channel: 2442 MHz | | | | | | | | | |
| 2442.00 | 71.42 | PK | H | 28.18 | 1.82 | 0.00 | 101.42 | N/A | N/A |
| 2442.00 | 57.55 | AV | H | 28.18 | 1.82 | 0.00 | 87.55 | N/A | N/A |
| 2442.00 | 72.89 | PK | V | 28.18 | 1.82 | 0.00 | 102.89 | N/A | N/A |
| 2442.00 | 58.87 | AV | V | 28.18 | 1.82 | 0.00 | 88.87 | N/A | N/A |
| 4884.00 | 52.14 | PK | V | 33.07 | 3.28 | 37.21 | 51.28 | 74.00 | 22.72 |
| 4884.00 | 37.82 | AV | V | 33.07 | 3.28 | 37.21 | 36.96 | 54.00 | 17.04 |
| 7326.00 | 56.66 | PK | V | 36.05 | 4.61 | 37.38 | 59.94 | 74.00 | 14.06 |
| 7326.00 | 42.44 | AV | V | 36.05 | 4.61 | 37.38 | 45.72 | 54.00 | 8.28 |
| High Channel: 2480 MHz | | | | | | | | | |
| 2480.00 | 68.58 | PK | H | 28.26 | 1.84 | 0.00 | 98.68 | N/A | N/A |
| 2480.00 | 54.59 | AV | H | 28.26 | 1.84 | 0.00 | 84.69 | N/A | N/A |
| 2480.00 | 71.60 | PK | V | 28.26 | 1.84 | 0.00 | 101.70 | N/A | N/A |
| 2480.00 | 59.42 | AV | V | 28.26 | 1.84 | 0.00 | 89.52 | N/A | N/A |
| 2483.50 | 28.26 | PK | V | 28.27 | 1.84 | 0.00 | 58.37 | 74.00 | 15.63 |
| 2483.50 | 15.87 | AV | V | 28.27 | 1.84 | 0.00 | 45.98 | 54.00 | 8.02 |
| 4960.00 | 54.77 | PK | V | 33.22 | 3.23 | 37.25 | 53.97 | 74.00 | 20.03 |
| 4960.00 | 40.61 | AV | V | 33.22 | 3.23 | 37.25 | 39.81 | 54.00 | 14.19 |
| 7440.00 | 58.41 | PK | V | 36.34 | 4.41 | 37.52 | 61.64 | 74.00 | 12.36 |
| 7440.00 | 41.58 | AV | V | 36.34 | 4.41 | 37.52 | 44.81 | 54.00 | 9.19 |

**Worst plots(Middle channel)**
**Horizontal**

Fundamental Test with Band Rejection Filter

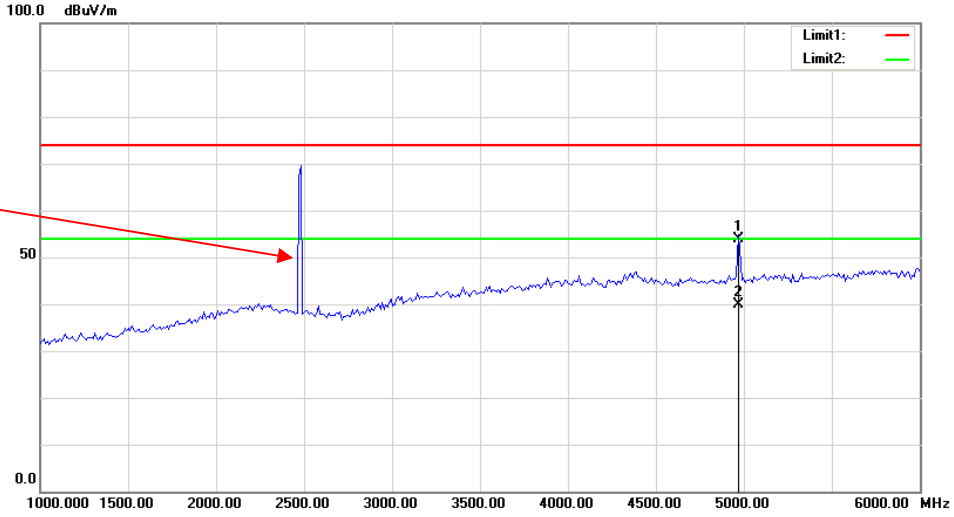


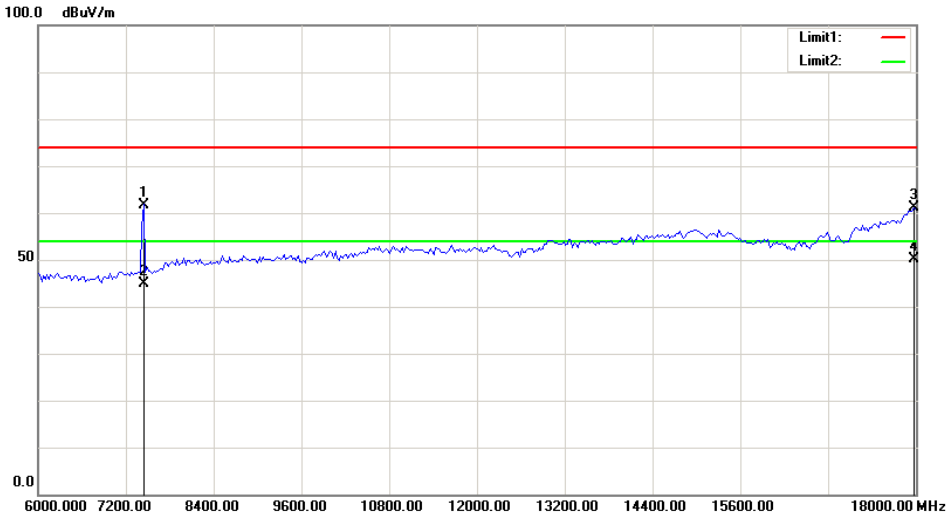



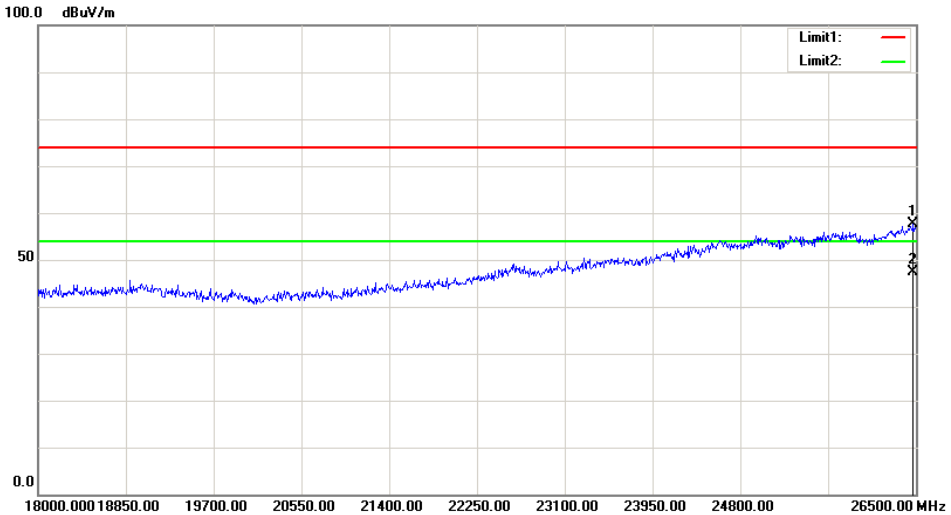



**Vertical**

Fundamental Test with Band Rejection Filter



# FCC §15.247(a) (2) & RSS-247 §5.2 a) &RSS-247 §5.2 a) &RSS-GEN§6.6–6 dB EMISSION BANDWIDTH AND 99% OCCUPIED BANDWIDTH

## Applicable Standard

According to FCC §15.247(a) (2)

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

According to RSS-247 §5.2 a)

The minimum 6 dB bandwidth shall be 500 kHz.

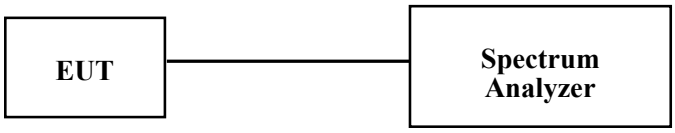
According to RSS-Gen §6.6

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

## Test Procedure

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3×RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) 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.
h) Measure the 99% bandwidth use OBW test function.



## Test Equipment List and Details

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| R&S | EMI Test Receiver | ESPI | 100120 | 2017-12-11 | 2018-12-11 |
| Unknown | Coaxial Cable | C-SJ00-0010 | C0010/01 | Each time | N/A |

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

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 24.9 °C |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 101.3 kPa |

*The testing was performed by Kami Zhou on 2018-04-17.*

*Test Mode: Transmitting*

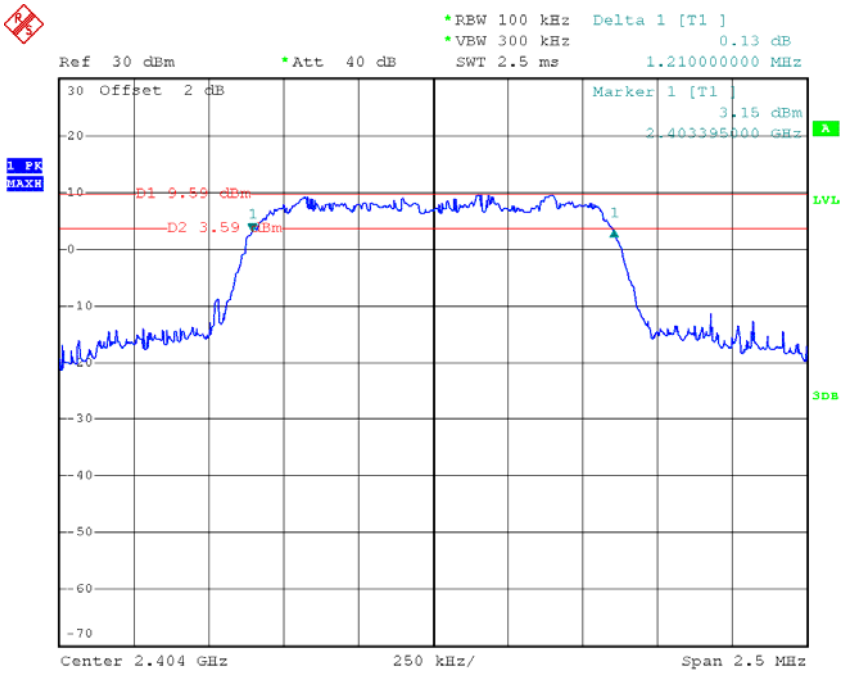
*Test Result: Compliant.*

*Please refer to the following table and plots.*

| Channel | Frequency (MHz) | 6 dB Emission Bandwidth (MHz) | 99% Occupied bandwidth (MHz) | Limit (MHz) |
|---|---|---|---|---|
| Low | 2404 | 1.210 | 1.205 | ≥0.5 |
| Middle | 2442 | 1.205 | 1.230 | ≥0.5 |
| High | 2480 | 1.200 | 1.210 | ≥0.5 |

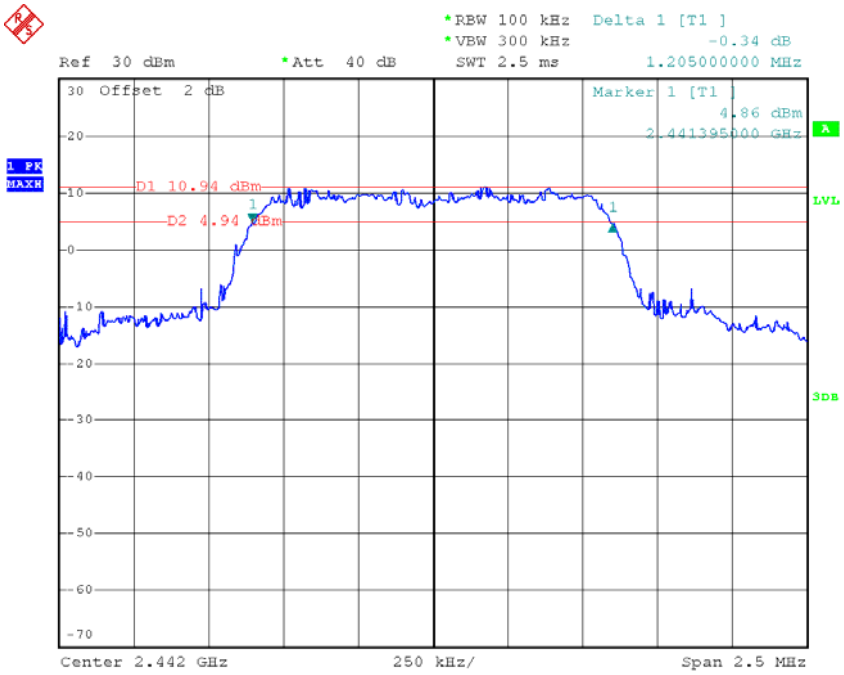
**6dB Bandwidth:**

**Low Channel**




Date: 17.APR.2018 13:48:42

**Middle Channel**

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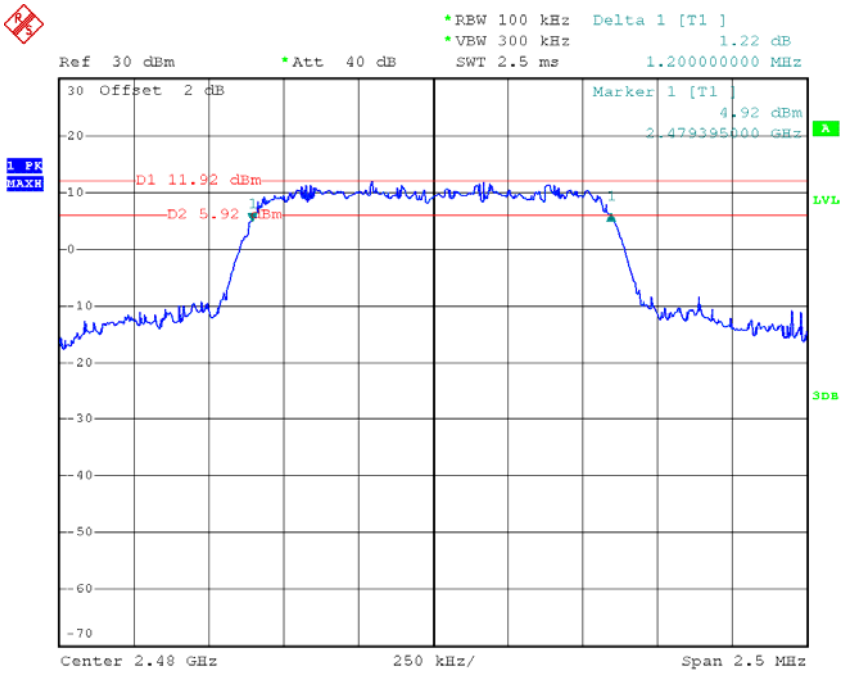
**High Channel**

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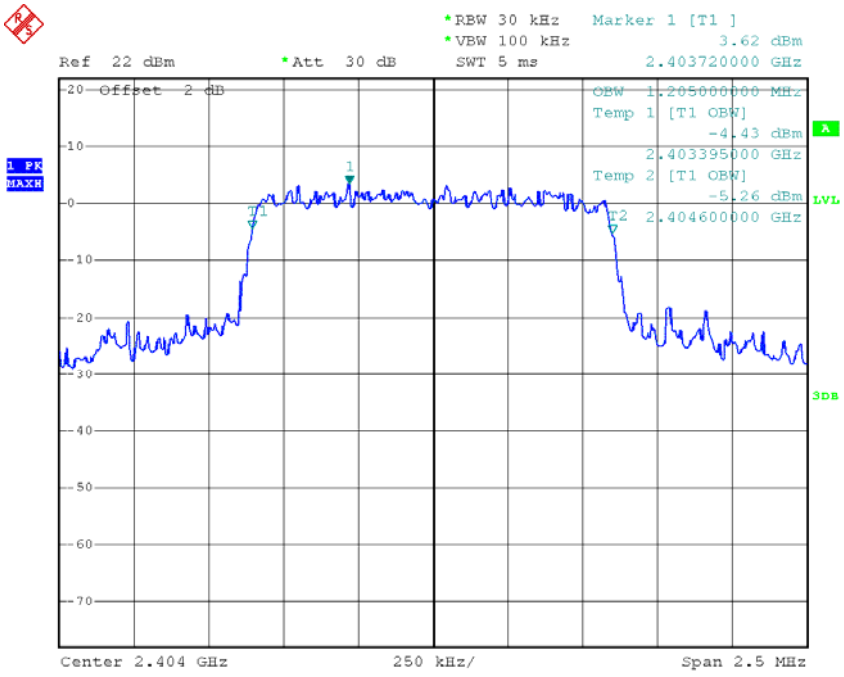
**99% Occupied Bandwidth:**

**Low Channel**

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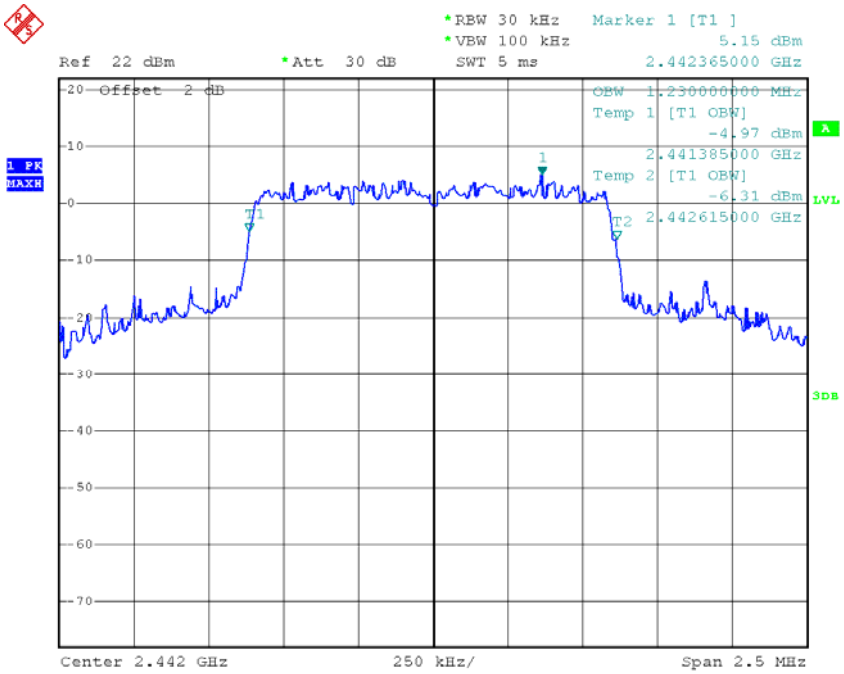
**Middle Channel**

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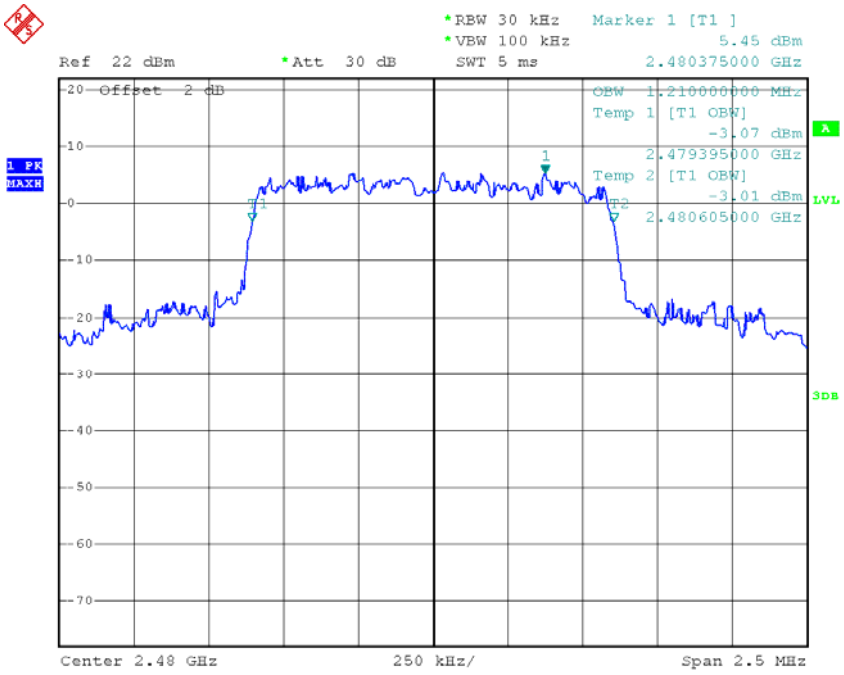
**High Channel**

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# FCC §15.247(b) (3) &RSS-247 §5.4 d)- 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.

According to RSS-247§5.4 d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(e), the e.i.r.p. shall not exceed 4 W.
As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling 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 transmitting at a reduced power level. If multiple modes of operation are implemented, 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 test equipment.
3. Add a correction factor to the display.

## Test Equipment List and Details

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| Agilent | Wideband Power Sensor | N1921A | MY54210016 | 2017-11-03 | 2018-11-03 |
| Agilent | P-Series Power Meter | N1912A | MY5000448 | 2017-11-03 | 2018-11-03 |
| Unknown | Coaxial Cable | C-SJ00-0010 | C0010/01 | Each Time | / |

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

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 24.9 °C |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 101.3 kPa |

*The testing was performed by Kami Zhou on 2018-04-17.*

*Test Mode: Transmitting*

*Test Result: Compliant. Please refer to the following table.*

| Frequency (MHz) | Max Conducted Peak Output Power (dBm) | Limit (dBm) | EIRP (dBm) |
|---|---|---|---|
| 2404 | 16.76 | 30 | 20.26 |
| 2442 | 16.94 | 30 | 20.44 |
| 2480 | 17.13 | 30 | 20.63 |

| Frequency (MHz) | Max Conducted RMS channel power (dBm) | Limit (dBm) | EIRP (dBm) |
|---|---|---|---|
| 2404 | 12.96 | 30 | 16.46 |
| 2442 | 12.93 | 30 | 16.43 |
| 2480 | 13.33 | 30 | 16.83 |

Note: the antenna gain is 3.5dBi, RSS-247 requried EIRP less than 36dBm

# FCC§15.247(d) &RSS-247 §5.5– 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

## Applicable Standard

According to FCC§15.247(d):In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

According to RSS-247 §5.5:

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

## 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 Equipment List and Details

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| R&S | EMI Test Receiver | ESPI | 100120 | 2017-12-11 | 2018-12-11 |
| Unknown | Coaxial Cable | C-SJ00-0010 | C0010/01 | Each time | N/A |

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

## Test Data

### Environmental Conditions

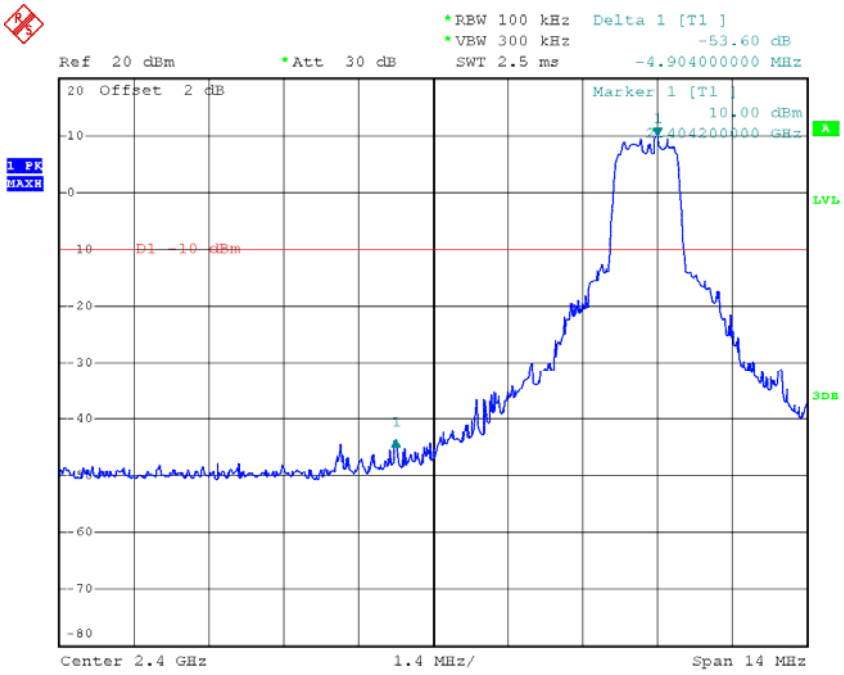
| | |
|---|---|
| **Temperature:** | 24.9 °C |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 101.3 kPa |

*The testing was performed by Kami Zhou on 2018-04-17.*

*Test mode: Transmitting*

*Test Result: Compliant. Please refer to following plots.*

**Band Edge, Left Side**

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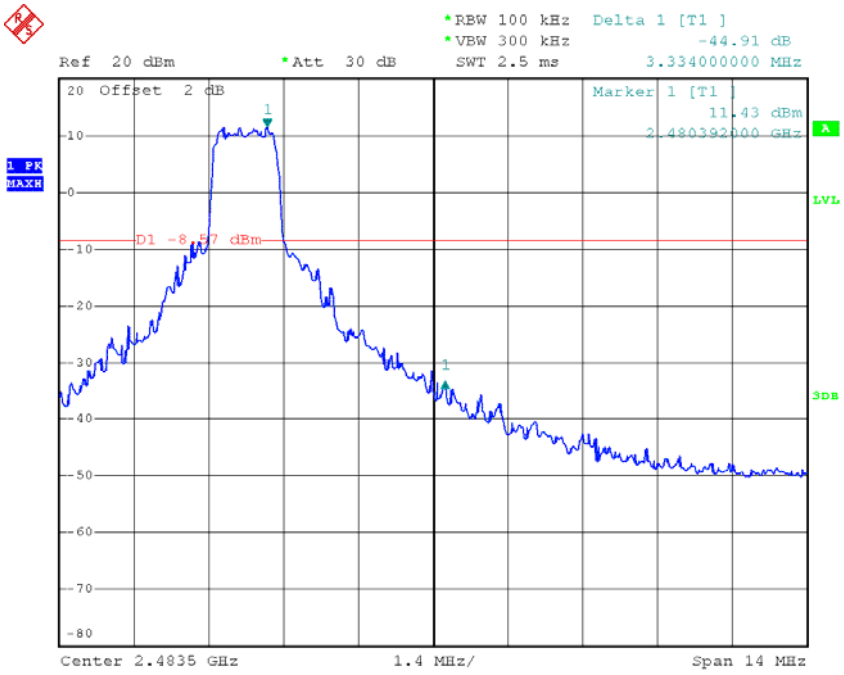
**Band Edge, Right Side**

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# FCC §15.247(e) &RSS-247 §5.2 b) - POWER SPECTRAL DENSITY

## Applicable Standard

According to FCC§15.247(e):For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

According to RSS-247 §5.2 b):

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

## Test Procedure

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3×RBW.
e) Detector = RMS.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

## Test Equipment List and Details

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| R&S | EMI Test Receiver | ESPI | 100120 | 2017-12-11 | 2018-12-11 |
| Unknown | Coaxial Cable | C-SJ00-0010 | C0010/01 | Each time | N/A |

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

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 24.9 °C |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 101.3 kPa |

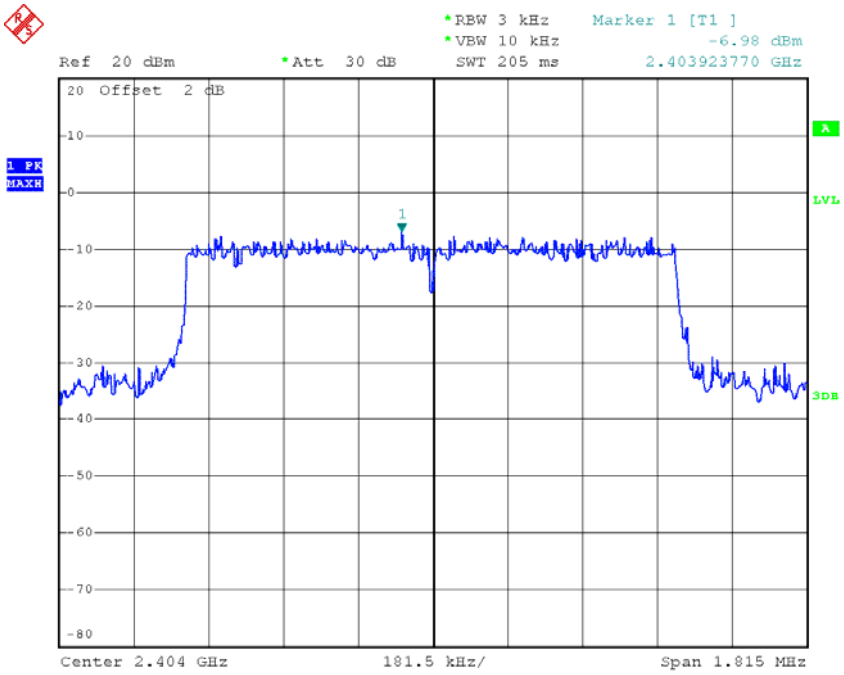
*The testing was performed by Kami Zhou on 2018-04-17.*

*Test Mode: Transmitting*

*Test Result: Compliant. Please refer to the following table and plots*

| Channel | Frequency (MHz) | Reading (dBm/3kHz) | Limit (dBm/3kHz) |
|---|---|---|---|
| Low | 2404 | -6.98 | ≤8.0 |
| Middle | 2442 | -5.47 | ≤8.0 |
| High | 2480 | -4.77 | ≤8.0 |

**Power Spectral Density, Low Channel**

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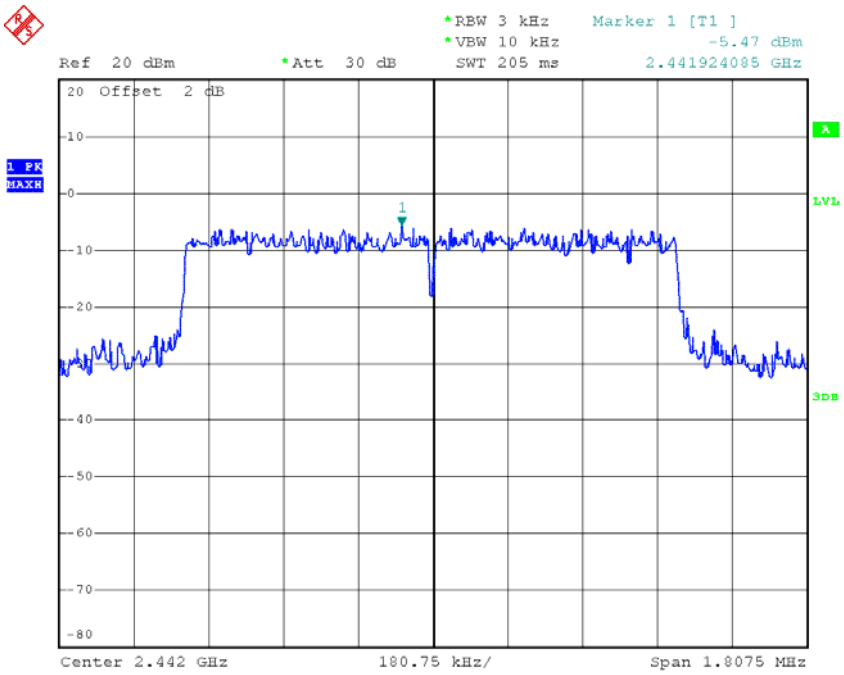
**Power Spectral Density, Middle Channel**

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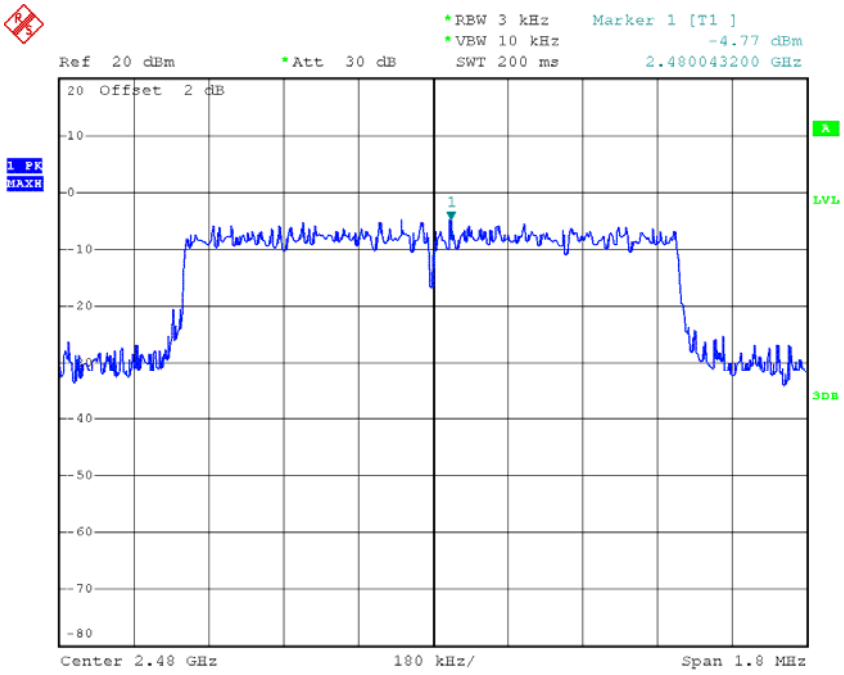
**Power Spectral Density, High Channel**

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