



TESTING LABORATORY
CERTIFICATE#4323.01



FCC PART 15.247

TEST REPORT

For

Shanghai HowayGIS Co., Ltd

RM230, Fawkes Building, No. 1985, Road Chunshen, Shanghai, China

FCC ID: 2AAZD-TGU1-S3

| | |
|--|---|
| Report Type: Original Report | Product Type: High Precision Mobile GNSS Receiver |
| Test Engineer: Hope Zhang | <i>Hope Zhang</i> |
| Report Number: RKSA171222002-00B | |
| Report Date: 2018-10-17 | |
| Reviewed By: Oscar Ye RF Leader | <i>Oscar Ye</i> |
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FUNNIAL

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

| | |
|--------------|---|
| Applicant | Shanghai HowayGIS Co., Ltd |
| Tested Model | TG-U2 |
| Series Model | TG-U1, TG-U3, X1 |
| Product Type | High Precision Mobile GNSS Receiver |
| Dimension | 210 mm(L)×60 mm(W)×110 mm(H) |
| Power Supply | DC 7.2V from battery and DC 12V charging by adapter |

Adapter Information:

Model: A122-1201000ID

Input: AC100-240 V 50/60Hz 0.4A

Output: 12V, 1000mA

Note: The differences between the tested model and series models were explained in the declaration letter.

**All measurement and test data in this report was gathered from production sample serial number: 20171222002. (Assigned by the BACL. The EUT supplied by the applicant was received on 2017-12-22)*

Objective

This report is prepared on behalf of *Shanghai HowayGIS Co., Ltd* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

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

Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS and Part 15B JBP submittals with FCC ID: 2AAZD-TGU1-S3.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC 558074 D01 15.247 Meas Guidance v05.

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

Measurement Uncertainty

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

Test Facility

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

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

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel List for BLE mode:

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

EUT was tested with channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

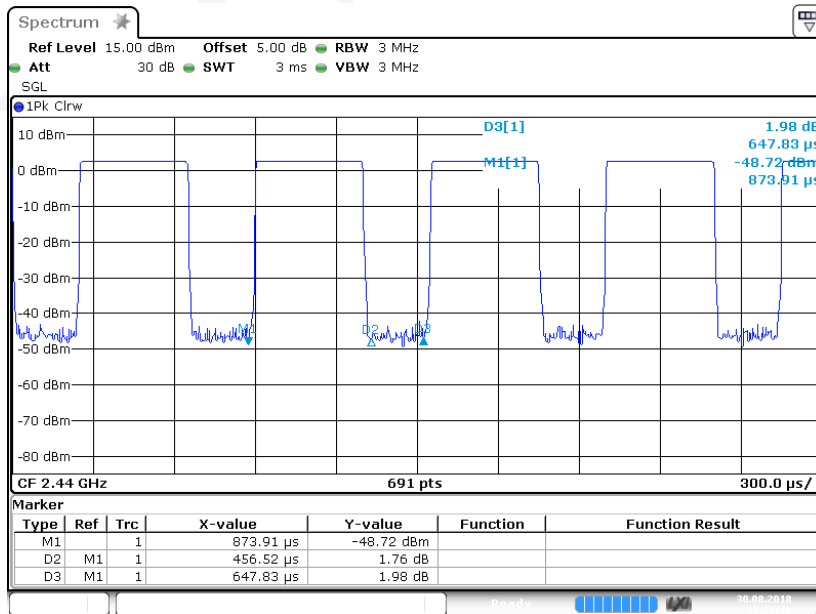
EUT Exercise Software

RF test tool: Blue Test 3

Power Level: 50

Duty Cycle:

Middle Channel



Date: 30 AUG 2018 17:23:46

| Mode | Duty Cycle (%) | T(us) | 1/T(kHz) | 10log(1/x) |
|------|----------------|-------|----------|------------|
| BLE | 70.52 | 457 | 2.19 | 1.52 |

Note: “x” means the Duty Cycle.

Support Equipment List and Details

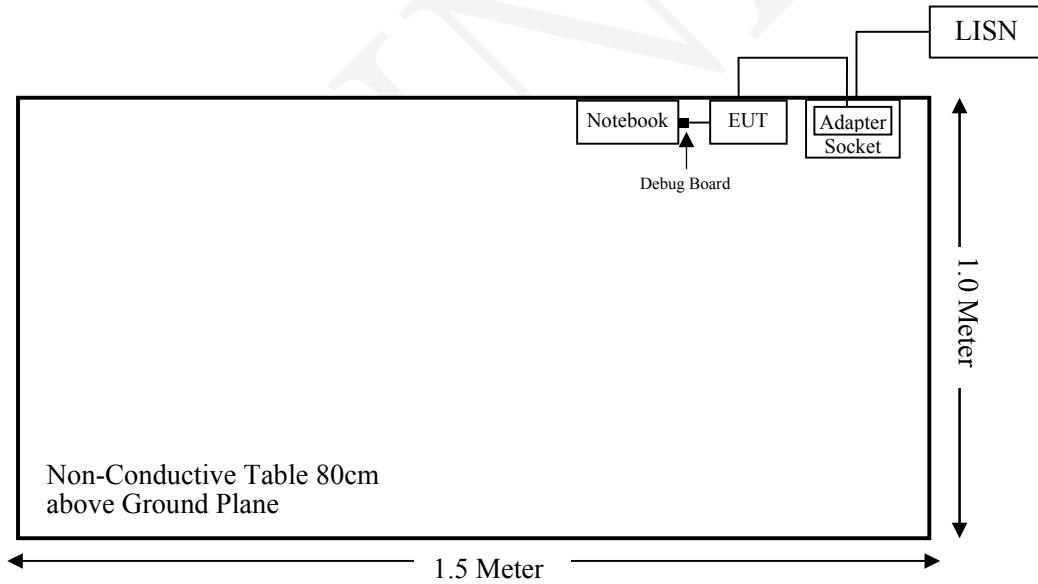
| Manufacturer | Description | Model | Serial Number |
|-------------------|-------------|-------|---------------|
| DELL | Notebook | GX620 | D65874152 |
| Shanghai HowayGIS | Debug Board | / | / |

External I/O Cable

| Cable Description | Length (m) | From Port | To |
|-------------------|------------|-------------|---------|
| Data Cable | 0.2 | Debug Board | EUT |
| Power Cable | 1.5 | EUT | Adapter |

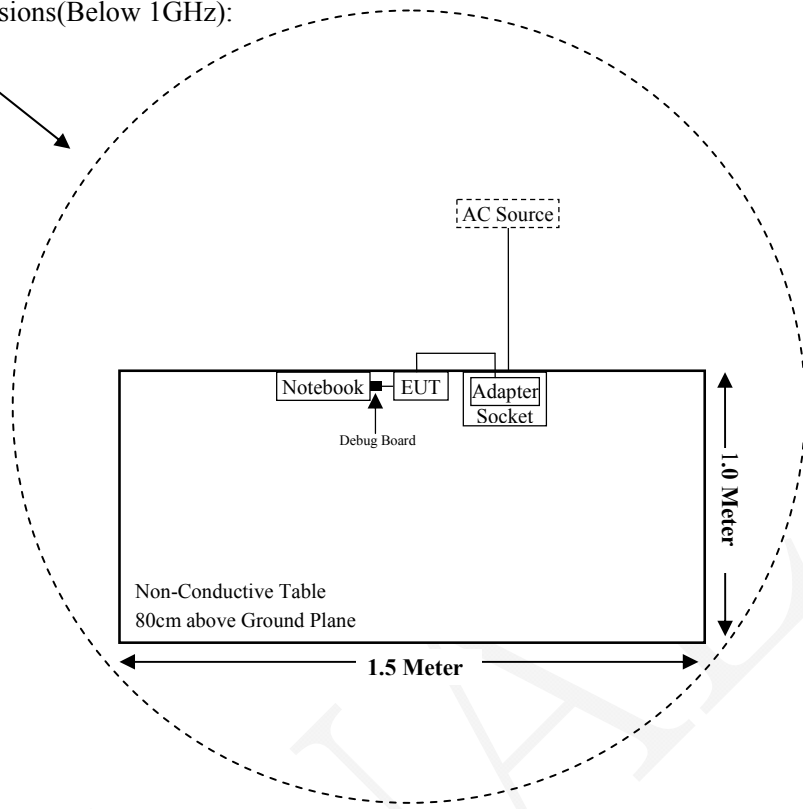
Block Diagram of Test Setup

For Conducted Emissions:



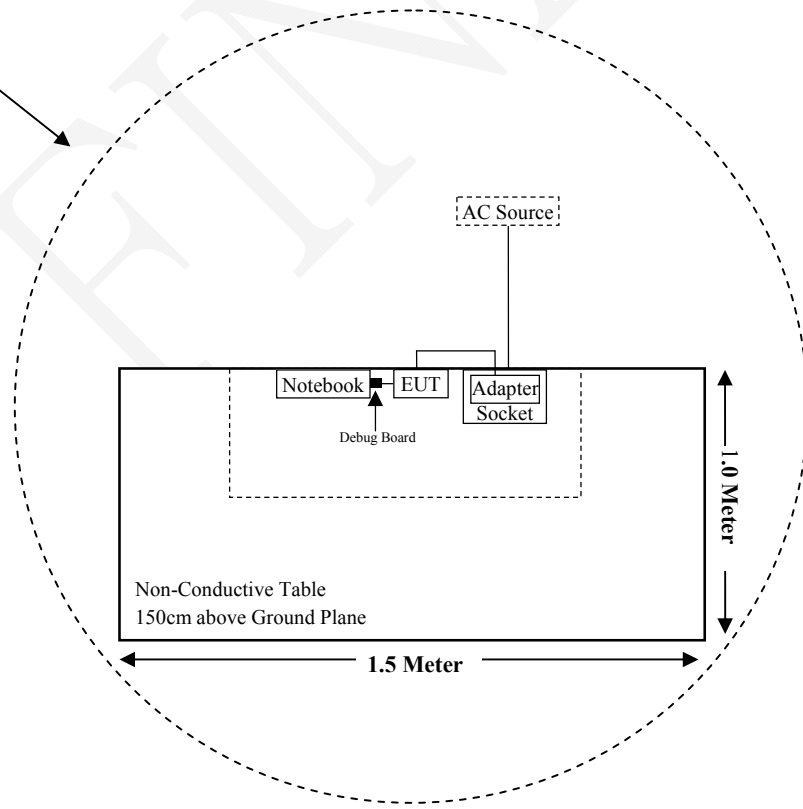
For Radiated Emissions(Below 1GHz):

Turntable
2m Diameter



For Radiated Emissions(Above 1GHz):

Turntable
2m Diameter



SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test | Result |
|------------------------------|------------------------------------|-----------|
| §1.1310 & §2.1093 | RF EXPOSURE | Compliant |
| §15.203 | Antenna Requirement | Compliant |
| §15.207 (a) | AC Line Conducted Emissions | Compliant |
| §15.247(d) | Spurious Emissions at Antenna Port | Compliant |
| §15.205, §15.209, §15.247(d) | Spurious Emissions | Compliant |
| §15.247 (a)(2) | 6 dB Emission Bandwidth | Compliant |
| §15.247(b)(3) | Maximum Conducted Output Power | Compliant |
| §15.247(d) | Band Edge | Compliant |
| §15.247(e) | Power Spectral Density | Compliant |

TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|--|--------------------|-------------|---------------|------------------|----------------------|
| Radiated Emission Test (Chamber 1#) | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESCI | 100195 | 2017-11-12 | 2018-11-11 |
| Sunol Sciences | Broadband Antenna | JB3 | A090413-1 | 2016-12-26 | 2019-12-25 |
| Sonoma Instrument | Pre-amplifier | 310N | 171205 | 2018-08-15 | 2019-08-14 |
| Rohde & Schwarz | Auto test Software | EMC32 | 100361 | / | / |
| MICRO-COAX | Coaxial Cable | Cable-8 | 008 | 2018-08-15 | 2019-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-9 | 009 | 2018-08-15 | 2019-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-10 | 010 | 2018-08-15 | 2019-08-14 |
| Radiated Emission Test (Chamber 2#) | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESU40 | 100207 | 2018-08-27 | 2019-08-26 |
| ETS-LINDGREN | Horn Antenna | 3115 | 6229 | 2016-01-11 | 2019-01-10 |
| ETS-LINDGREN | Horn Antenna | 3116 | 00084159 | 2016-10-18 | 2019-10-17 |
| Mini-Circuits | Amplifier | ZVA-183W-S+ | 220701818 | 2018-05-20 | 2019-05-19 |
| EM Electronics Corporation | Amplifier | EM18G40G | 060726 | 2018-03-22 | 2019-03-21 |
| MICRO-TRONICS | Band notch Filter | BRM50702 | G024 | 2018-08-05 | 2019-08-04 |
| Narda | Attenuator/10dB | 10dB | 010 | 2018-08-15 | 2019-08-14 |
| Rohde & Schwarz | Auto test Software | EMC32 | 100361 | / | / |
| MICRO-COAX | Coaxial Cable | Cable-6 | 006 | 2018-08-15 | 2019-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-11 | 011 | 2018-08-15 | 2019-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-12 | 012 | 2018-08-15 | 2019-08-14 |
| MICRO-COAX | Coaxial Cable | Cable-13 | 013 | 2018-08-15 | 2019-08-14 |
| RF Conducted Test | | | | | |
| Rohde & Schwarz | Signal Analyzer | FSV40 | 101116 | 2018-07-23 | 2019-07-22 |
| Narda | Attenuator/10dB | 10dB | 010 | 2018-08-15 | 2019-08-14 |
| Shanghai HowayGIS | RF Cable | HowayGISC01 | C01 | Each Time | / |
| Conducted Emission Test | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESCS30 | 834115/007 | 2017-11-12 | 2018-11-11 |
| Rohde & Schwarz | LISN | ESH3-Z5 | 862770/011 | 2017-11-12 | 2018-11-11 |
| BACL | Auto test Software | BACL-EMC | CE001 | / | / |
| Narda | Attenuator/6dB | 10690812-2 | 26850-6 | 2018-01-10 | 2019-01-09 |
| MICRO-COAX | Coaxial Cable | Cable-15 | 015 | 2018-08-15 | 2019-08-14 |

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

FCC §15.247 (I) & §1.1310 & §2.1093 - RF EXPOSURE

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 ensure that the public is not exposed to radio frequency energy level in excess of the Commission’s guideline.

According to KDB447498 D01 General RF Exposure Guidance v06:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

Measurement Result

| Mode | Frequency Range (MHz) | Target Output Power | | Minimum test separation distance required for the exposure conditions (mm) |
|-------|-----------------------|---------------------|------|--|
| | | (dBm) | (mW) | |
| BT3.0 | 2402-2480 | 4.50 | 2.82 | 5.00 |
| BLE | 2402-2480 | 4.60 | 2.88 | 5.00 |

Note: The target output power was declared by the manufacturer.

Result:

BT3.0: $[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] = 2.82 / 5 \cdot \sqrt{2.48} = 0.9 < 3.0$

BLE: $[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] = 2.88 / 5 \cdot \sqrt{2.48} = 0.9 < 3.0$

So the stand-alone SAR evaluation is not necessary.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

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

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

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has an internal ceramic antenna for Bluetooth and the antenna gain is 1dBi, which was permanently attached; fulfill the requirement of this section. Please refer to the EUT photos.

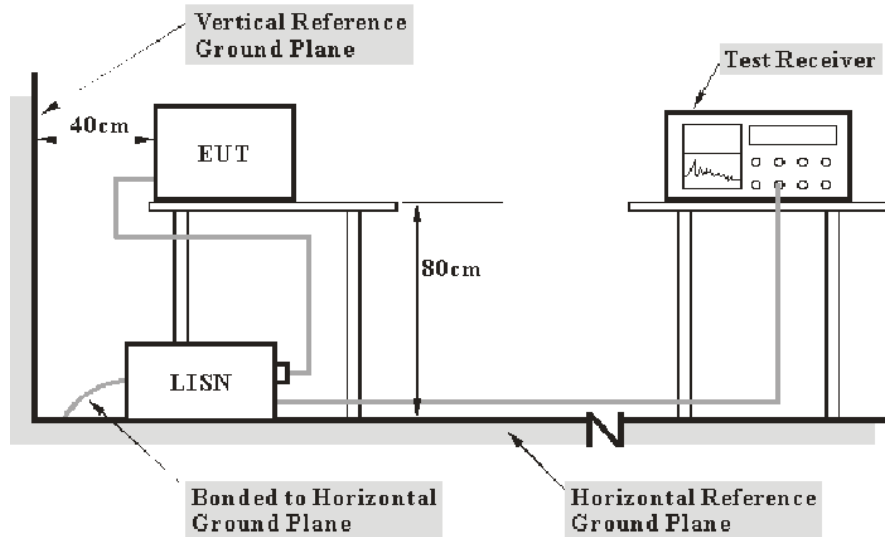
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



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

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

EMI Test Receiver Setup

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

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

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

Test Procedure

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

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

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

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Corrected Factor (dB)} = \text{LISN VDF (dB)} + \text{Cable Loss (dB)} + \text{Transient Limiter Attenuation (dB)}$$

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

$$\text{Margin (dB)} = \text{Limit (dB}\mu\text{V)} - \text{Corrected Amplitude (dB}\mu\text{V)}$$

Test Results Summary

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

Test Data

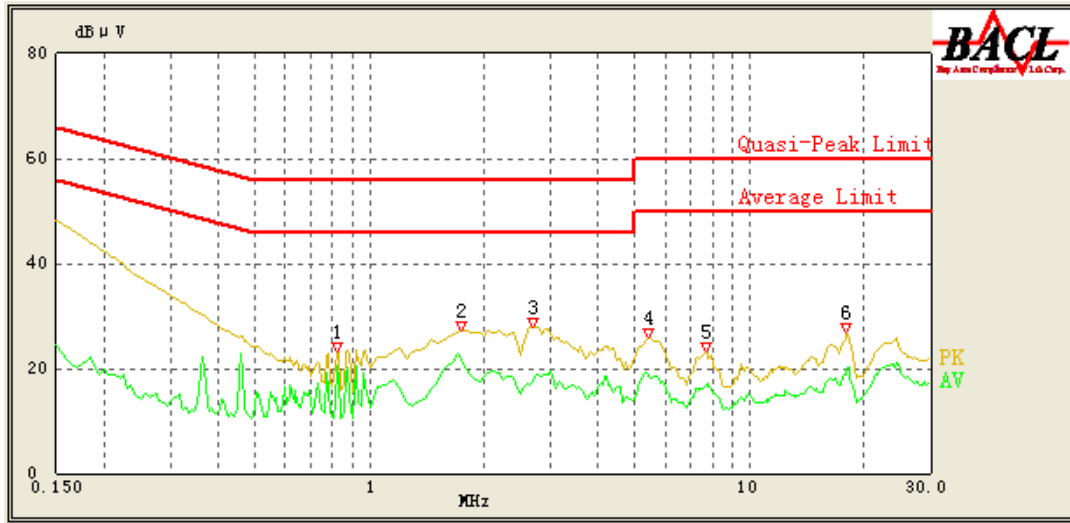
Environmental Conditions

| | |
|---------------------------|----------|
| Temperature: | 24.1 °C |
| Relative Humidity: | 50 % |
| ATM Pressure: | 101.2kPa |

The testing was performed by Hope Zhang on 2018-09-01.

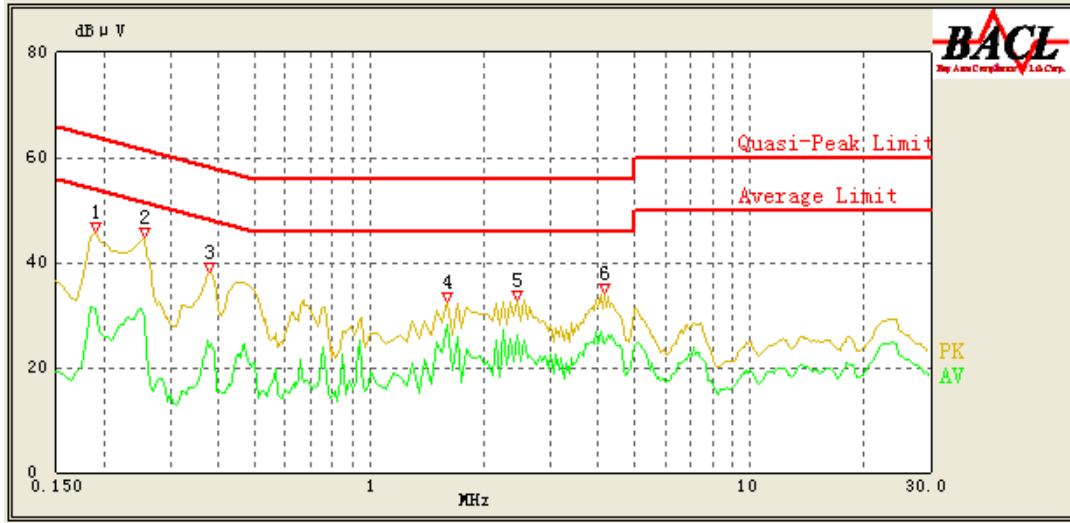
EUT operation mode: Transmitting in high channel. (Worst case)

AC 120V/60 Hz, Line



| Frequency (MHz) | Corrected Amplitude (dBμV) | Detector (PK/AV/QP) | Bandwidth (kHz) | Line | Corrected Factor (dB) | Limit (dBμV) | Margin (dB) | Comment |
|-----------------|----------------------------|---------------------|-----------------|------|-----------------------|--------------|-------------|------------|
| 0.825 | 23.09 | QP | 9.000 | L1 | 15.92 | 56.00 | 32.91 | Compliance |
| 0.825 | 20.56 | AV | 9.000 | L1 | 15.92 | 46.00 | 25.44 | Compliance |
| 1.750 | 27.15 | QP | 9.000 | L1 | 15.86 | 56.00 | 28.85 | Compliance |
| 1.750 | 21.84 | AV | 9.000 | L1 | 15.86 | 46.00 | 24.16 | Compliance |
| 2.700 | 27.93 | QP | 9.000 | L1 | 15.85 | 56.00 | 28.07 | Compliance |
| 2.700 | 17.39 | AV | 9.000 | L1 | 15.85 | 46.00 | 28.61 | Compliance |
| 5.400 | 25.95 | QP | 9.000 | L1 | 15.88 | 60.00 | 34.05 | Compliance |
| 5.400 | 18.67 | AV | 9.000 | L1 | 15.88 | 50.00 | 31.33 | Compliance |
| 7.650 | 23.06 | QP | 9.000 | L1 | 16.00 | 60.00 | 36.94 | Compliance |
| 7.650 | 16.93 | AV | 9.000 | L1 | 16.00 | 50.00 | 33.07 | Compliance |
| 17.950 | 26.72 | QP | 9.000 | L1 | 16.35 | 60.00 | 33.28 | Compliance |
| 18.000 | 19.76 | AV | 9.000 | L1 | 16.35 | 50.00 | 30.24 | Compliance |

AC 120V/60 Hz, Neutral



| Frequency (MHz) | Corrected Amplitude (dBμV) | Detector (PK/AV/QP) | Bandwidth (kHz) | Line | Corrected Factor (dB) | Limit (dBμV) | Margin (dB) | Comment |
|-----------------|----------------------------|---------------------|-----------------|------|-----------------------|--------------|-------------|------------|
| 0.190 | 45.80 | QP | 9.000 | N | 16.05 | 64.04 | 18.24 | Compliance |
| 0.190 | 31.16 | AV | 9.000 | N | 16.05 | 54.04 | 22.88 | Compliance |
| 0.255 | 44.75 | QP | 9.000 | N | 16.06 | 61.59 | 16.84 | Compliance |
| 0.255 | 29.38 | AV | 9.000 | N | 16.06 | 51.59 | 22.21 | Compliance |
| 0.380 | 38.20 | QP | 9.000 | N | 16.09 | 58.28 | 20.08 | Compliance |
| 0.380 | 23.86 | AV | 9.000 | N | 16.09 | 48.28 | 24.42 | Compliance |
| 1.600 | 32.64 | QP | 9.000 | N | 15.92 | 56.00 | 23.36 | Compliance |
| 1.600 | 28.18 | AV | 9.000 | N | 15.92 | 46.00 | 17.82 | Compliance |
| 2.450 | 32.88 | QP | 9.000 | N | 15.90 | 56.00 | 23.12 | Compliance |
| 2.450 | 26.12 | AV | 9.000 | N | 15.90 | 46.00 | 19.88 | Compliance |
| 4.150 | 34.15 | QP | 9.000 | N | 15.88 | 56.00 | 21.85 | Compliance |
| 4.150 | 24.45 | AV | 9.000 | N | 15.88 | 46.00 | 21.55 | Compliance |

Note:

- 1) Corrected Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Transient Limiter Attenuation (dB)
- 2) Margin (dB) = Limit (dBμV) - Corrected Amplitude (dBμV)

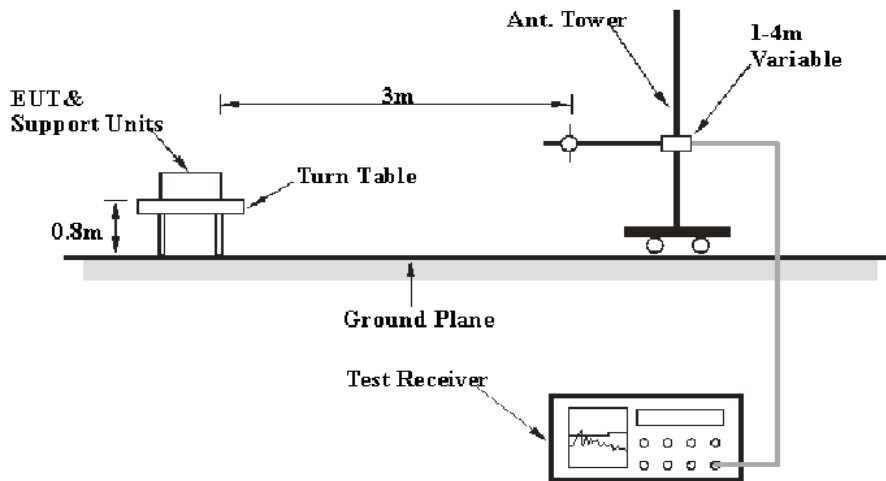
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

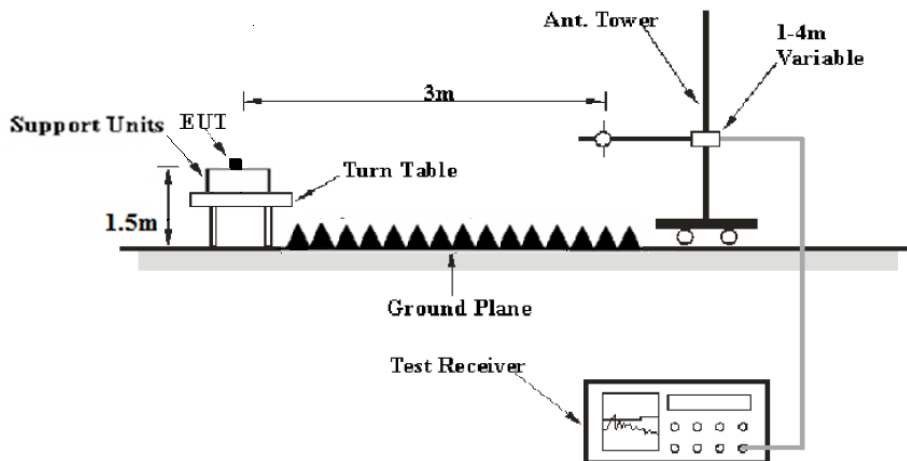
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1 GHz:



Above 1GHz:



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

EMI Test Receiver Setup

The system was investigated from 30 MHz to 25 GHz.

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

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

Test Procedure

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:

$$\text{Corrected Amplitude (dB}\mu\text{V /m)} = \text{Meter Reading (dB}\mu\text{V)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Amplifier Gain (dB)}$$

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

$$\text{Margin (dB)} = \text{Limit (dB}\mu\text{V/m)} - \text{Corrected Amplitude (dB}\mu\text{V /m)}$$

Test Results Summary

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

Test Data

Environmental Conditions

| | |
|---------------------------|-----------------|
| Temperature: | 23.3-23.4 °C |
| Relative Humidity: | 49-50 % |
| ATM Pressure: | 101.1-101.2 kPa |

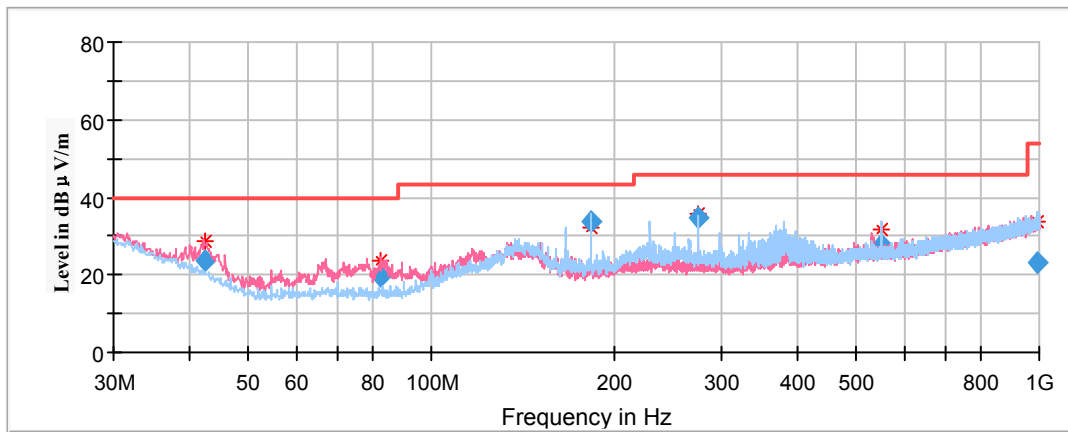
Radiated emission test was performed by Hope Zhang on 2018-09-14 & 2018-10-17;
 RF conducted test was performed by Hope Zhang on 2018-08-30.

EUT operation mode: Transmitting

Spurious Emission Test:

30MHz-1GHz

(Pre-scan with low, middle and high channels of operation in the X,Y and Z axes of orientation, the worst case **high** channel of operation in **Y-axis** of orientation was recorded)



| Frequency (MHz) | Corrected Amplitude QuasiPeak (dBµV/m) | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|-----------------|--|-------------|-------------|------------------|-------------------------|----------------|-------------|
| | | Height (cm) | Polar (H/V) | | | | |
| 42.451750 | 28.68 | 100.0 | V | 93.0 | -12.2 | 40.00 | 11.32 |
| 82.618350 | 23.71 | 100.0 | V | 202.0 | -17.7 | 40.00 | 16.29 |
| 183.229700 | 32.15 | 200.0 | H | 144.0 | -13.4 | 43.50 | 11.35 |
| 274.933900 | 35.72 | 100.0 | H | 0.0 | -11.3 | 46.00 | 10.28 |
| 550.054850 | 31.79 | 100.0 | H | 298.0 | -5.6 | 46.00 | 14.21 |
| 990.723150 | 33.94 | 100.0 | H | 1.0 | 2.1 | 53.90 | 19.96 |

1GHz-18GHz

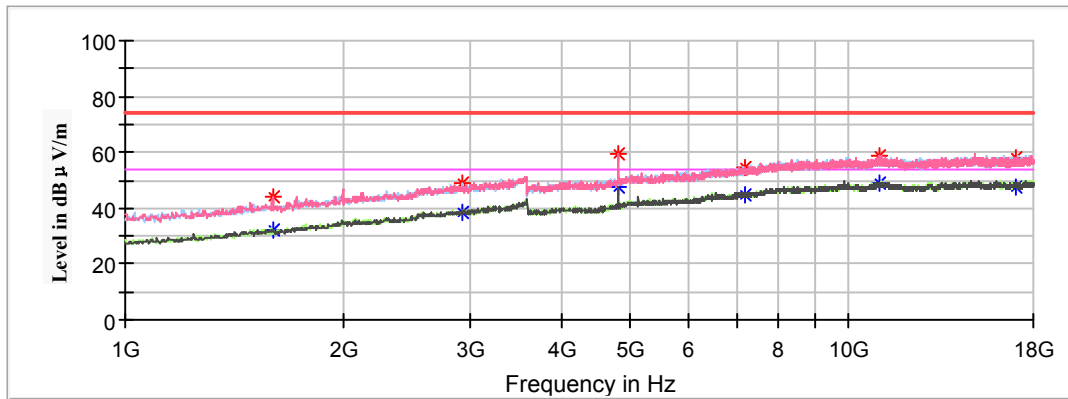
(Pre-scan in the X, Y and Z axes of orientation, the worst case Y-axis of orientation was recorded.)

Note:

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

Low Channel: 2402MHz

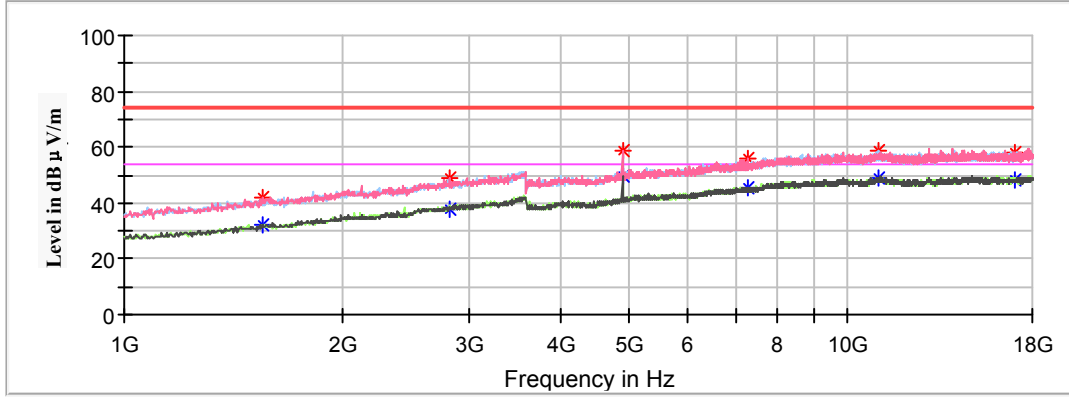
Full Spectrum



| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|-----------------|---------------------|-------------------|-------------|-------------|------------------|-------------------------|----------------|-------------|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1598.400000 | 43.99 | --- | 100.0 | V | 99.0 | -0.6 | 74.00 | 30.01 |
| 1598.400000 | --- | 31.84 | 100.0 | V | 99.0 | -0.6 | 54.00 | 22.16 |
| 2931.200000 | 48.78 | --- | 150.0 | H | 146.0 | 5.6 | 74.00 | 25.22 |
| 2931.200000 | --- | 38.41 | 150.0 | H | 146.0 | 5.6 | 54.00 | 15.59 |
| 4804.000000 | 59.17 | --- | 250.0 | V | 99.0 | 10.7 | 74.00 | 14.83 |
| 4804.000000 | --- | 47.62 | 250.0 | V | 99.0 | 10.7 | 54.00 | 6.38 |
| 7206.000000 | --- | 45.03 | 150.0 | V | 257.0 | 15.2 | 54.00 | 8.97 |
| 7206.000000 | 54.70 | --- | 150.0 | V | 257.0 | 15.2 | 74.00 | 19.30 |
| 11019.800000 | --- | 48.81 | 200.0 | V | 358.0 | 19.0 | 54.00 | 5.19 |
| 11019.800000 | 58.93 | --- | 200.0 | V | 358.0 | 19.0 | 74.00 | 15.07 |
| 17058.200000 | --- | 47.76 | 100.0 | V | 12.0 | 18.1 | 54.00 | 6.24 |
| 17058.200000 | 58.10 | --- | 100.0 | V | 12.0 | 18.1 | 74.00 | 15.90 |

Middle Channel: 2440MHz

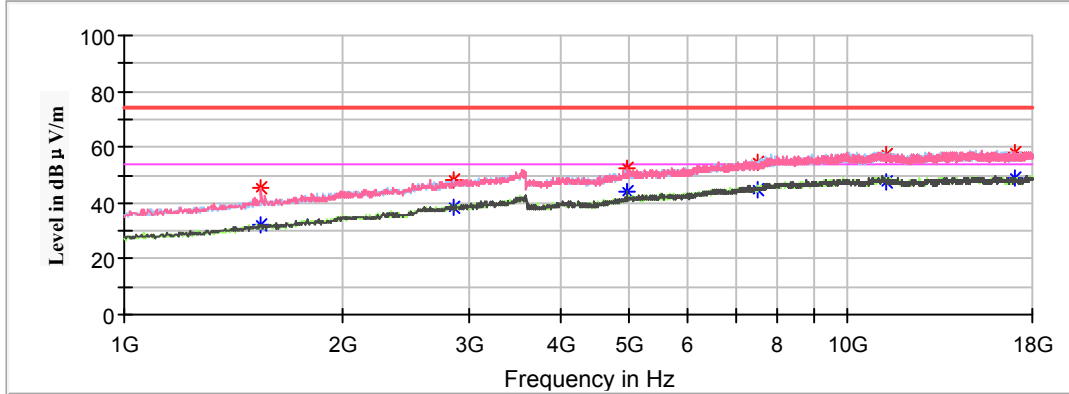
Full Spectrum



| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|-----------------|---------------------|-------------------|-------------|-------------|------------------|-------------------------|----------------|-------------|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1554.200000 | 42.15 | --- | 250.0 | V | 185.0 | -0.9 | 74.00 | 31.85 |
| 1554.200000 | --- | 32.01 | 250.0 | V | 185.0 | -0.9 | 54.00 | 21.99 |
| 2819.000000 | 48.61 | --- | 100.0 | V | 209.0 | 5.0 | 74.00 | 25.39 |
| 2819.000000 | --- | 38.11 | 100.0 | V | 209.0 | 5.0 | 54.00 | 15.89 |
| 4880.000000 | 58.42 | --- | 100.0 | V | 209.0 | 11.1 | 74.00 | 15.58 |
| 4880.000000 | --- | 49.83 | 100.0 | V | 209.0 | 11.1 | 54.00 | 4.17 |
| 7320.000000 | --- | 45.23 | 250.0 | V | 276.0 | 15.4 | 54.00 | 8.77 |
| 7320.000000 | 55.73 | --- | 250.0 | V | 276.0 | 15.4 | 74.00 | 18.27 |
| 11016.400000 | --- | 48.83 | 100.0 | H | 75.0 | 19.0 | 54.00 | 5.17 |
| 11016.400000 | 58.39 | --- | 100.0 | H | 75.0 | 19.0 | 74.00 | 15.61 |
| 16973.200000 | --- | 48.16 | 200.0 | H | 207.0 | 18.1 | 54.00 | 5.84 |
| 16973.200000 | 58.07 | --- | 200.0 | H | 207.0 | 18.1 | 74.00 | 15.93 |

High Channel: 2480MHz

Full Spectrum

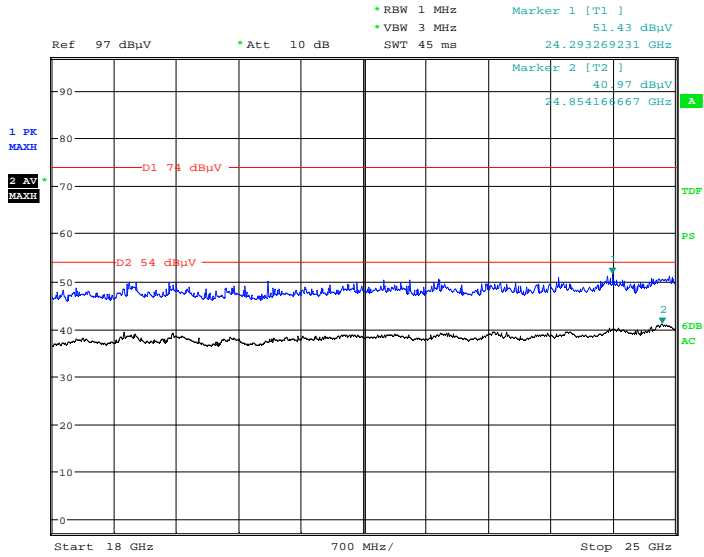


| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|-----------------|---------------------|-------------------|-------------|-------------|------------------|-------------------------|----------------|-------------|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| 1547.400000 | --- | 32.20 | 250.0 | V | 108.0 | -0.9 | 54.00 | 21.80 |
| 1547.400000 | 45.66 | --- | 250.0 | V | 108.0 | -0.9 | 74.00 | 28.34 |
| 2856.400000 | --- | 38.32 | 100.0 | H | 79.0 | 5.2 | 54.00 | 15.68 |
| 2856.400000 | 48.49 | --- | 100.0 | H | 79.0 | 5.2 | 74.00 | 25.51 |
| 4960.000000 | --- | 44.37 | 200.0 | V | 41.0 | 11.5 | 54.00 | 9.63 |
| 4960.000000 | 52.69 | --- | 200.0 | V | 41.0 | 11.5 | 74.00 | 21.31 |
| 7440.000000 | --- | 44.64 | 200.0 | V | 219.0 | 15.6 | 54.00 | 9.36 |
| 7440.000000 | 54.72 | --- | 200.0 | V | 219.0 | 15.6 | 74.00 | 19.28 |
| 11281.600000 | --- | 47.70 | 100.0 | V | 269.0 | 18.7 | 54.00 | 6.30 |
| 11281.600000 | 57.66 | --- | 100.0 | V | 269.0 | 18.7 | 74.00 | 16.34 |
| 17065.000000 | --- | 48.71 | 200.0 | V | 93.0 | 18.1 | 54.00 | 5.29 |
| 17065.000000 | 57.79 | --- | 200.0 | V | 93.0 | 18.1 | 74.00 | 16.21 |

18GHz - 25GHz

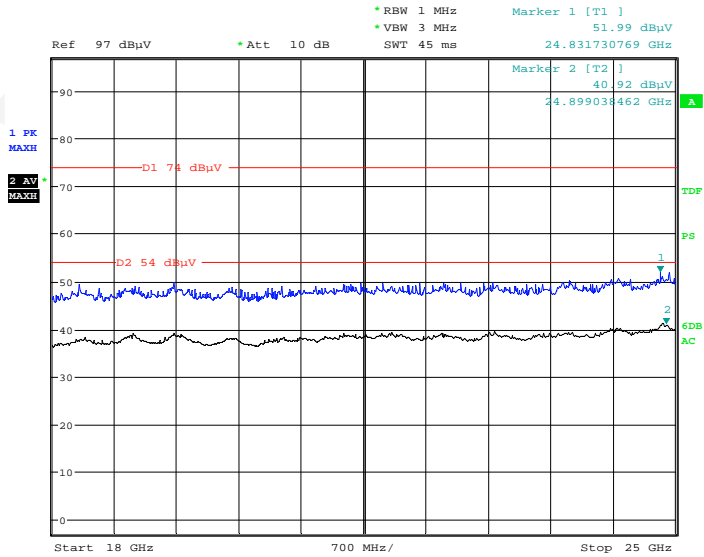
(Pre-scan with low, middle and high channels of operation in the X,Y and Z axes of orientation, the worst case **high** channel of operation in Y-axis of orientation was recorded)

Horizontal



Date: 17.OCT.2018 16:46:55

Vertical



Date: 17.OCT.2018 17:06:30

Fundamental Test & Restricted Bands Emissions Test:

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

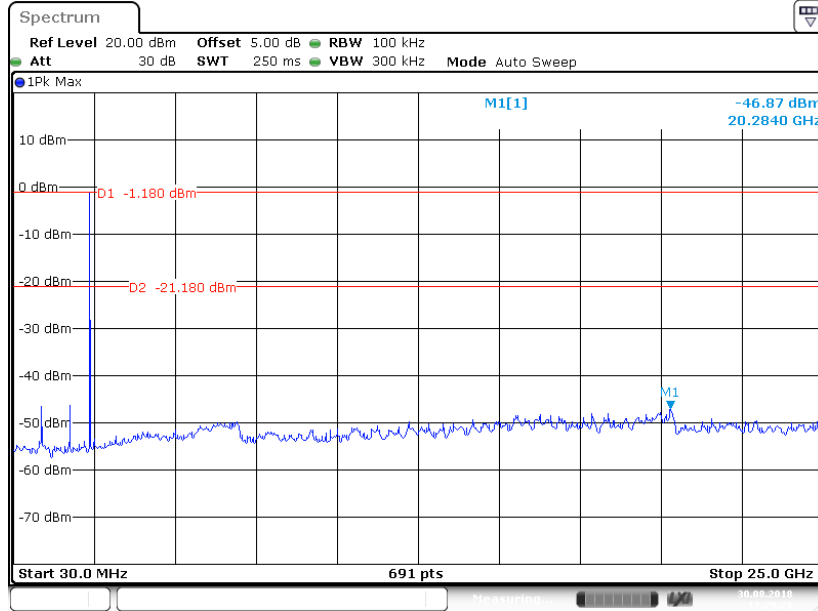
Note:

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

| Frequency (MHz) | Corrected Amplitude | | Rx Antenna | | Turntable Degree | Corrected Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|--------------------------------|---------------------|-------------------|-------------|-------------|------------------|-------------------------|----------------|-------------|
| | MaxPeak (dBµV /m) | Average (dBµV /m) | Height (cm) | Polar (H/V) | | | | |
| Low Channel: 2402MHz | | | | | | | | |
| 2402.000000 | 94.51 | --- | 150.0 | V | 122.0 | 2.9 | / | / |
| 2402.000000 | --- | 92.25 | 150.0 | V | 122.0 | 2.9 | / | / |
| 2402.000000 | 92.39 | --- | 250.0 | H | 22.0 | 2.9 | / | / |
| 2402.000000 | --- | 90.11 | 250.0 | H | 22.0 | 2.9 | / | / |
| 2390.000000 | 49.74 | --- | 250.0 | V | 67.0 | 2.8 | 74.00 | 24.26 |
| 2390.000000 | --- | 40.29 | 250.0 | V | 67.0 | 2.8 | 54.00 | 13.71 |
| Middle Channel: 2440MHz | | | | | | | | |
| 2440.000000 | 98.14 | --- | 250.0 | V | 113.0 | 3.0 | / | / |
| 2440.000000 | --- | 95.81 | 250.0 | V | 113.0 | 3.0 | / | / |
| 2440.000000 | 96.06 | --- | 150.0 | H | 210.0 | 3.0 | / | / |
| 2440.000000 | --- | 93.78 | 150.0 | H | 210.0 | 3.0 | / | / |
| High Channel: 2480MHz | | | | | | | | |
| 2480.000000 | 98.02 | --- | 200.0 | V | 2.0 | 3.0 | / | / |
| 2480.000000 | --- | 95.67 | 200.0 | V | 2.0 | 3.0 | / | / |
| 2480.000000 | 95.96 | --- | 200.0 | H | 301.0 | 3.0 | / | / |
| 2480.000000 | --- | 93.73 | 200.0 | H | 301.0 | 3.0 | / | / |
| 2483.500000 | 50.68 | --- | 200.0 | V | 297.0 | 3.0 | 74.00 | 23.32 |
| 2483.500000 | --- | 39.96 | 200.0 | V | 297.0 | 3.0 | 54.00 | 14.04 |

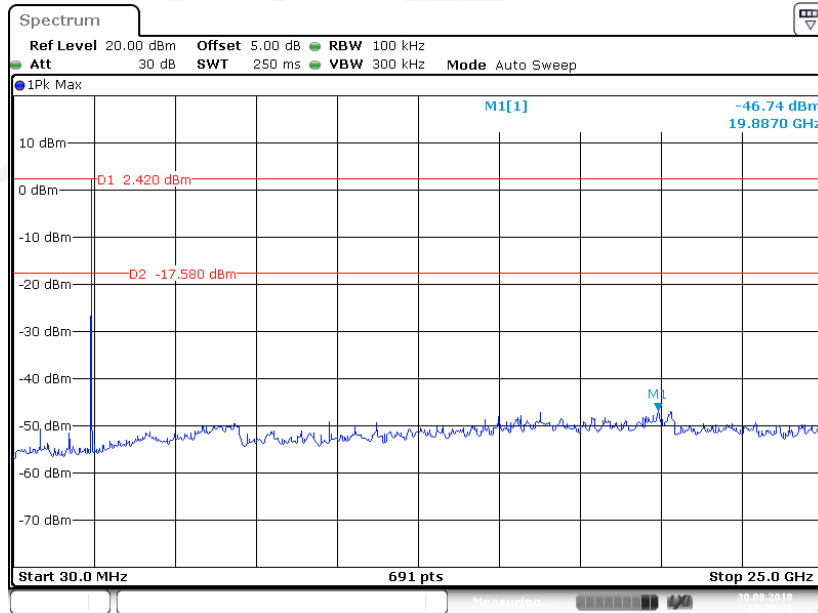
Conducted Spurious Emissions at Antenna Port:

Low Channel



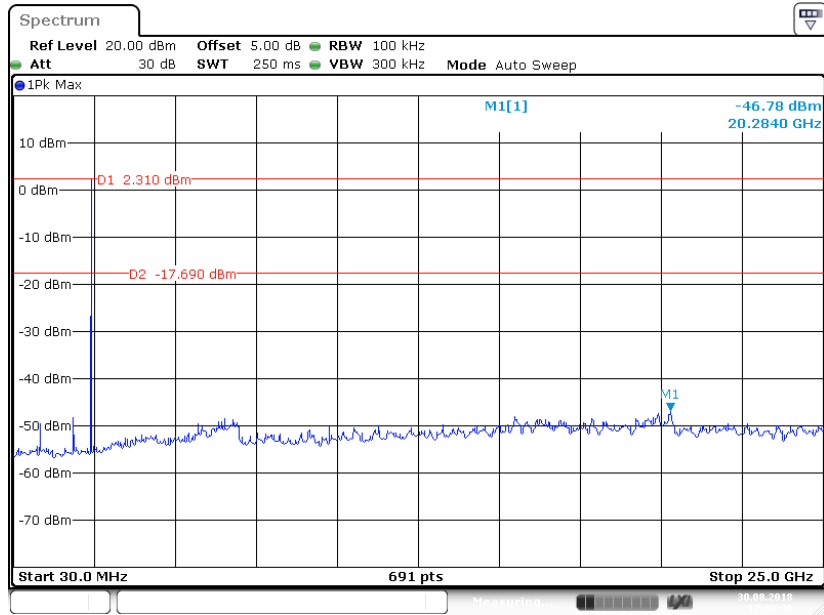
Date: 30.AUG.2018 17:29:29

Middle Channel



Date: 30.AUG.2018 17:28:19

High Channel



Date: 30.AUG.2018 17:30:38

FCC §15.247(a) (2) - 6 dB EMISSION BANDWIDTH

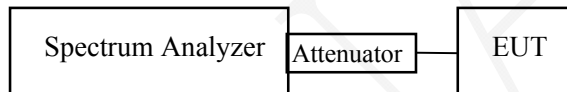
Applicable Standard

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

Test Procedure

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

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



Test Data

Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 24.2°C |
| Relative Humidity: | 51 % |
| ATM Pressure: | 101.2 kPa |

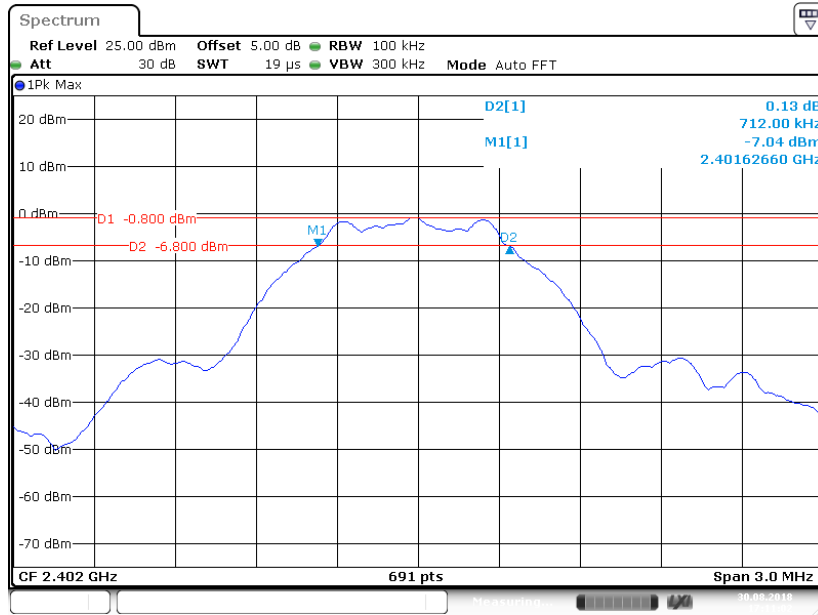
The testing was performed by Hope Zhang on 2018-08-30.

Test Result: Pass.

EUT operation mode: Transmitting

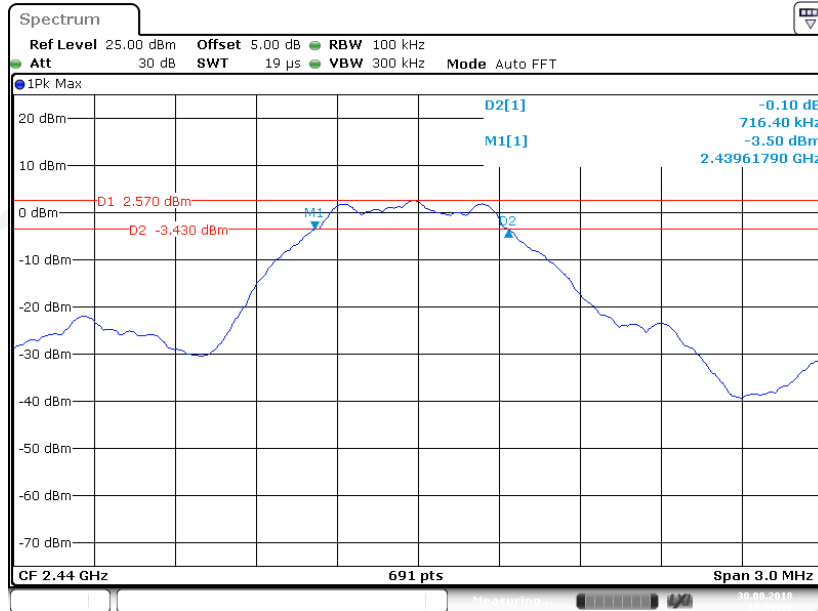
| Channel | Frequency (MHz) | 6 dB Emission Bandwidth (MHz) | Limit (MHz) |
|---------|-----------------|-------------------------------|-------------|
| Low | 2402 | 0.712 | ≥ 0.5 |
| Middle | 2440 | 0.716 | ≥ 0.5 |
| High | 2480 | 0.725 | ≥ 0.5 |

Low Channel



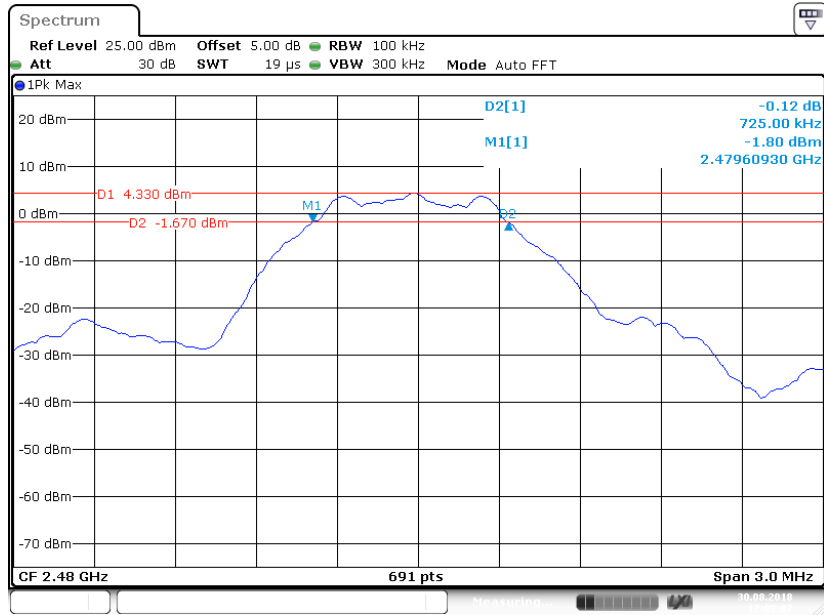
Date: 30.AUG.2018 17:11:02

Middle Channel



Date: 30.AUG.2018 17:09:36

High Channel



Date: 30.AUG.2018 17:08:07

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

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

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



Test Data

Environmental Conditions

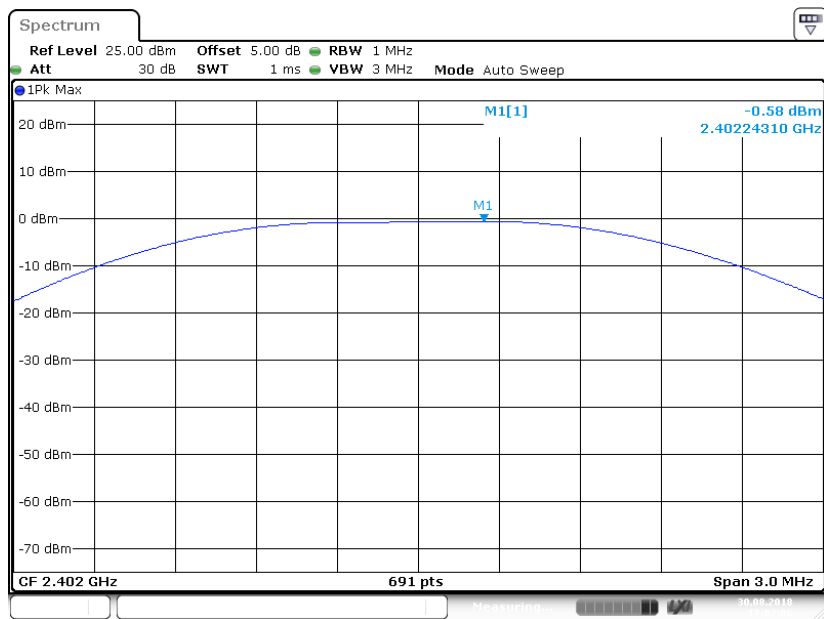
| | |
|---------------------------|-----------|
| Temperature: | 24.2°C |
| Relative Humidity: | 51 % |
| ATM Pressure: | 101.2 kPa |

The testing was performed by Hope Zhang on 2018-08-30.

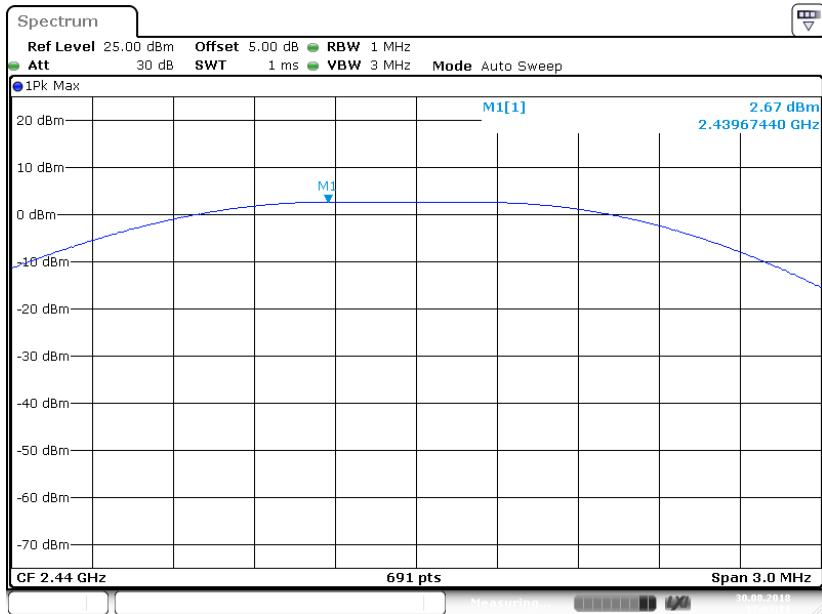
EUT operation mode: Transmitting

| Channel | Frequency (MHz) | Max Conducted Peak Output Power (dBm) | Limit (dBm) | Result |
|---------|-----------------|---------------------------------------|-------------|--------|
| Low | 2402 | -0.58 | ≤ 30 | Pass |
| Middle | 2440 | 2.67 | ≤ 30 | Pass |
| High | 2480 | 4.51 | ≤ 30 | Pass |

Low Channel

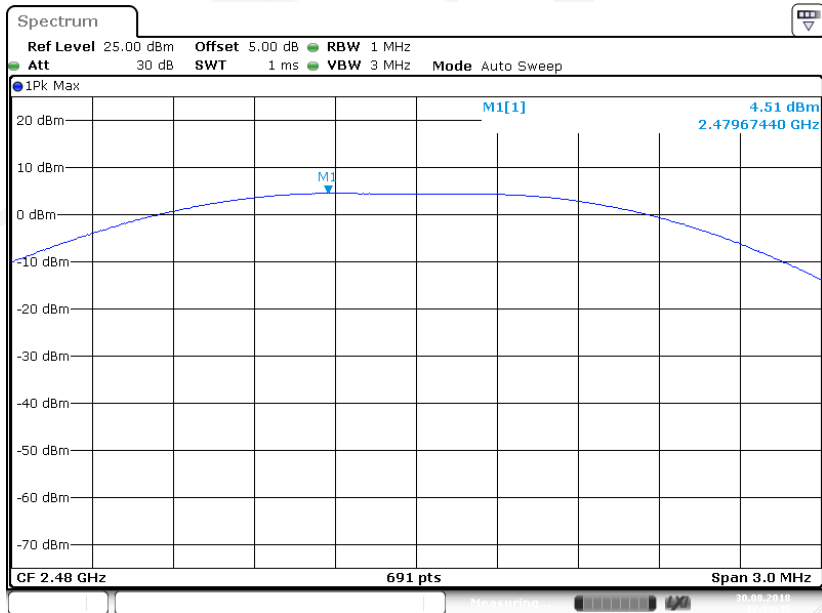


Middle Channel



Date: 30.AUG.2018 17:03:11

High Channel



Date: 30.AUG.2018 17:03:45

FCC §15.247(d) - BAND EDGE

Applicable Standard

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

Test Procedure

According to ANSI C63.10-2013 clause 6.10

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

Test Data

Environmental Conditions

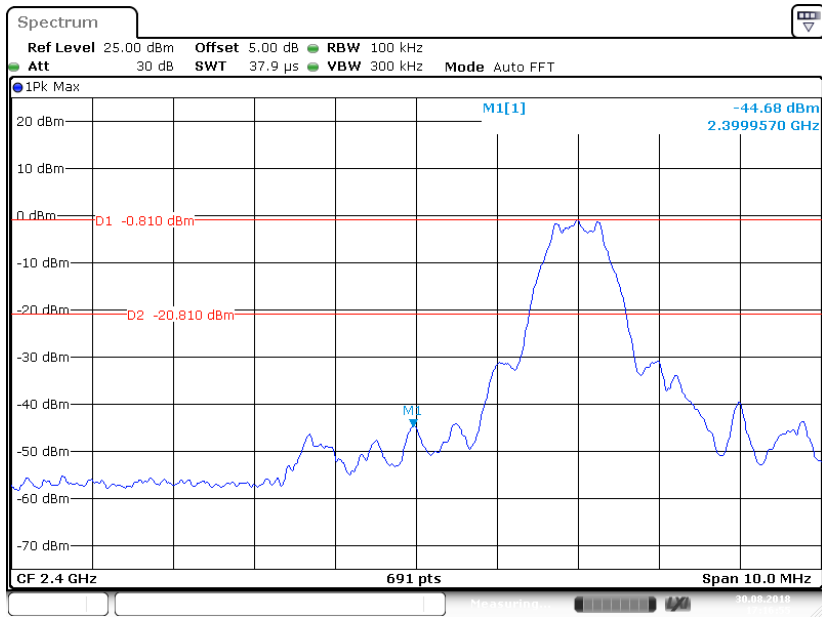
| | |
|--------------------|-----------|
| Temperature: | 24.2°C |
| Relative Humidity: | 51 % |
| ATM Pressure: | 101.2 kPa |

The testing was performed by Hope Zhang on 2018-08-30.

EUT operation mode: Transmitting

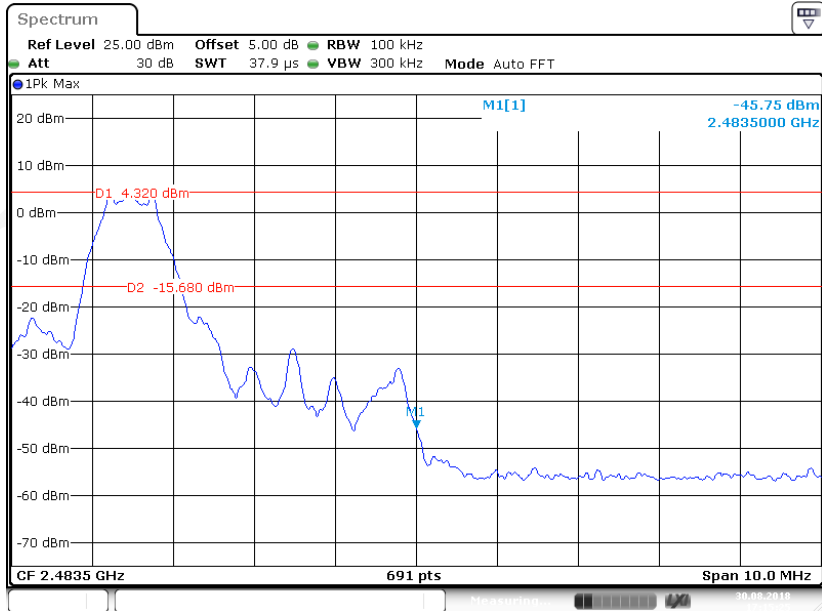
Test Result: *Compliance*

Left Side



Date: 30.AUG.2018 17:16:55

Right Side



Date: 30.AUG.2018 17:15:25

FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

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

Test Procedure

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

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

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

Test Data

Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 24.2°C |
| Relative Humidity: | 51 % |
| ATM Pressure: | 101.2 kPa |

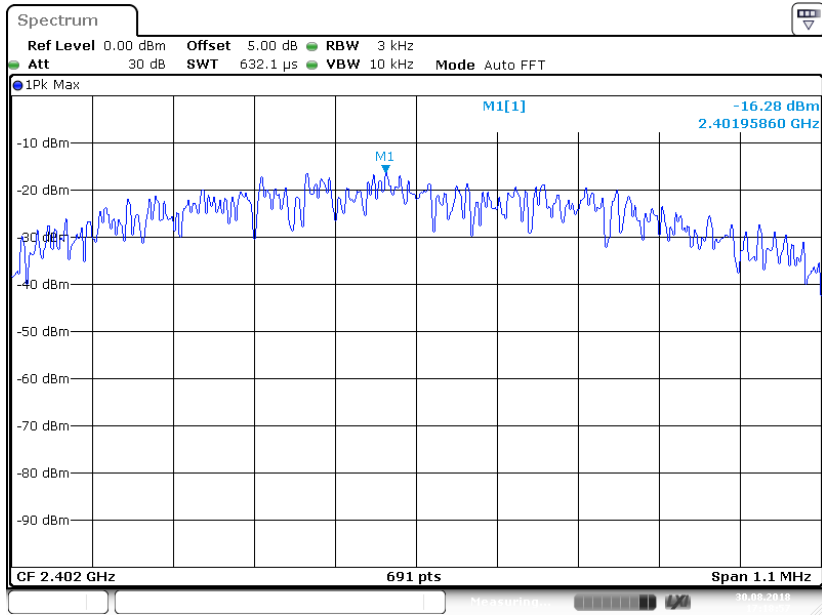
The testing was performed by Hope Zhang on 2018-08-30.

EUT operation mode: Transmitting

Test Result: Pass

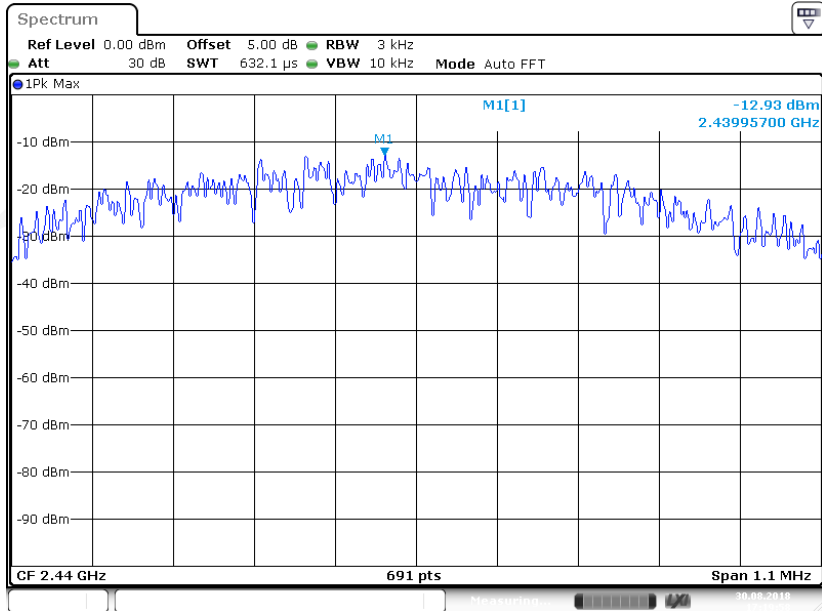
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) |
|---------|-----------------|----------------|------------------|
| Low | 2402 | -16.28 | ≤ 8 |
| Middle | 2440 | -12.93 | ≤ 8 |
| High | 2480 | -11.33 | ≤ 8 |

Low Channel



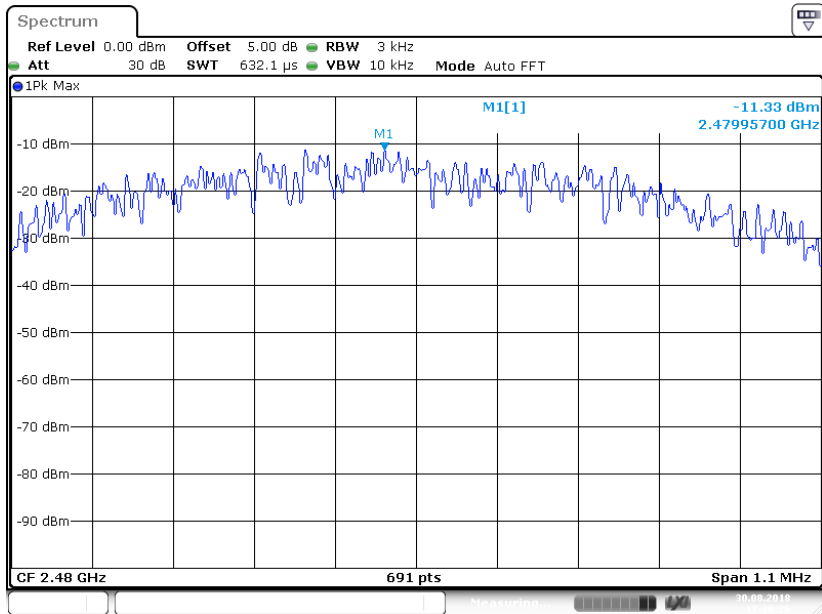
Date: 30.AUG.2018 17:18:57

Middle Channel



Date: 30.AUG.2018 17:19:58

High Channel



Date: 30.AUG.2018 17:20:26

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