# FCC Part 15.247

# TEST REPORT

For

# I/O INTERCONNECT INC.

**5F, No.19-3, Sanchong Rd., Nangang District, Taipei 115, Taiwan**

## FCC ID: 2ACNORA843

| **Report Type:** | **Product Type:** |
|---|---|
| Original Report | Wireless Charging Pad+Dock |

**Report Producer :** Kaylee Chiang

**Report Number :** RXZ181116001-00B

**Report Date :** 2018-12-12

**Reviewed By:** Jerry Chang

**Prepared By:** Bay Area Compliance Laboratories Corp.(Taiwan)
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# Revision History

| Revision | No. | Report Number | Issue Date | Description | Author/ Revised by |
|---|---|---|---|---|---|
| 1.0 | RXZ181116001 | RXZ181116001-00B | 2018.12.12 | Original Report | Kaylee |

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# 1 General Information

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

| | |
|---|---|
| Applicant | I/O INTERCONNECT INC. |
| | 5F, No.19-3, Sanchong Rd., Nangang District, Taipei 115, Taiwan |
| Manufacturer | ShengHua Electronics (DongGuan) Co., LTD. |
| | No. 4, Third road, High New Technology Industrial Zone, Tang xia Town, Dong Guan City, Guangdong Province, China 523716 |
| Brand(Trade) Name | MediaGear |
| Product (Equipment) | Wireless Charging Pad$^{+}$Dock |
| Main Model Name | RA843 |
| Frequency Range | 2402 ~ 2480 MHz |
| Transmit Power | BLE Mode: -2.63 dBm (0.0006W) |
| Modulation Technique | BLE Mode: GFSK |
| Transmit Data Rate | BLE Mode: 1 Mbps |
| Number of Channels | BLE Mode: 40 Channels |
| Antenna Specification | Chip Antenna / 1.72 dBi |
| Power Operation (Voltage Range) | ☒ AC 120V/60Hz<br>☒ Adapter I/P: 100-240Vac, 50/60Hz, 1.5A; O/P: 19Vdc, 3.42A<br>☐ By AC Power Cord<br>☐ PoE |
| | ☐ DC Type<br>☐ Battery<br>☐ DC Power Supply<br>☐ External from USB Cable<br>☐ External DC Adapter |
| | ☐ Host System |
| Received Date | Nov 16, 2018 |
| Date of Test | Dec 04, 2018 ~ Dec 07, 2018 |

**All measurement and test data in this report was gathered from production sample serial number: 181116001 (Assigned by BACL, Taiwan).*

## 1.2 Objective

This report is prepared on behalf of *I/O INTERCONNECT INC.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.

The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

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

FCC Part 15.247 DCD submission with FCC ID: 2ACNORA843.

## 1.4 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.

## 1.5 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Taiwan) to collect test data is located on

☒70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

☐68-3, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

Bay Area Compliance Laboratories Corp. (Taiwan) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3180) and the FCC designation No.TW3180 under the Mutual Recognition Agreement (MRA) in FCC Test. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.10.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 974454. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

# 2 System Test Configuration

## 2.1 Description of Test Configuration

For BT BLE mode, there are totally 40 channels.

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---|---|---|---|
| 1 | 2402 | 21 | 2442 |
| 2 | 2404 | -- | -- |
| 3 | 2406 | -- | -- |
| 4 | 2408 | 38 | 2476 |
| -- | -- | 39 | 2478 |
| 20 | 2440 | 40 | 2480 |

For BLE Modes were tested with channel 1, 20 and 40.

## 2.2 Equipment Modifications

No modification was made to the EUT.

## 2.3 EUT Exercise Software

The software was used “SmartRF Studio 7 2.11.0”.

## 2.4 Support Equipment List and Details

| Description | Manufacturer | Model Number | BSMI | FCC ID | S/N |
|---|---|---|---|---|---|
| Mobile Phone | SAMSUNG | SM-G930V | N/A | N/A | R38H50YSZ6M |
| NB | DELL | E6410 | N/A | PD98260NGU | 10912240367 |
| USB Dongle*3 | Kingston | SE9 G2 USB3.0 16G | N/A | N/A | N/A |
| Monitor | DELL | S2817Q | R43004 | DOC | CN-0GD45P-WS200-77B-092I-A01 |
| Earphone | KINYO | N/A | N/A | N/A | N/A |
| SD Card | Transcend | Transcend 4GB | N/A | N/A | N/A |
| Switching Adapter (For ferrite core) | DEE VAN ENTERPRISE CO., LTD. | DSA-65PFB-19 FUS | N/A | N/A | N/A |

## 2.5 External Cable List and Details

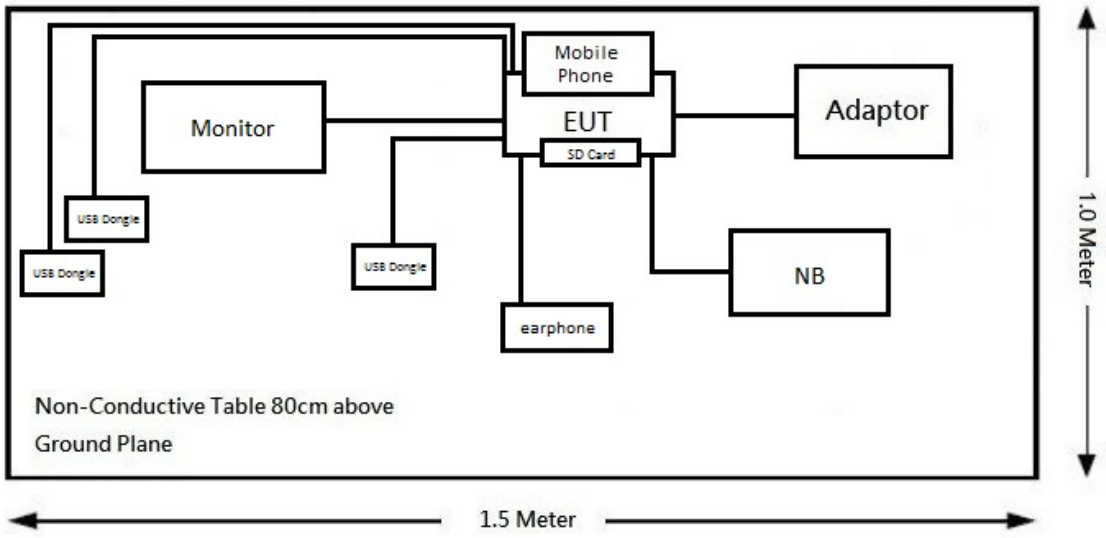
| Cable Description | Length (m) | From | To |
|---|---|---|---|
| USB Cable | 0.4 | NB | EUT |
| USB Cable*3 | 1.2 | USB Dongle | EUT |
| HDMI Cable | 1.8 | Monitor | EUT |
| Audio Cable | 1.2 | Earphone | EUT |

## 2.6 Block Diagram of Test Setup

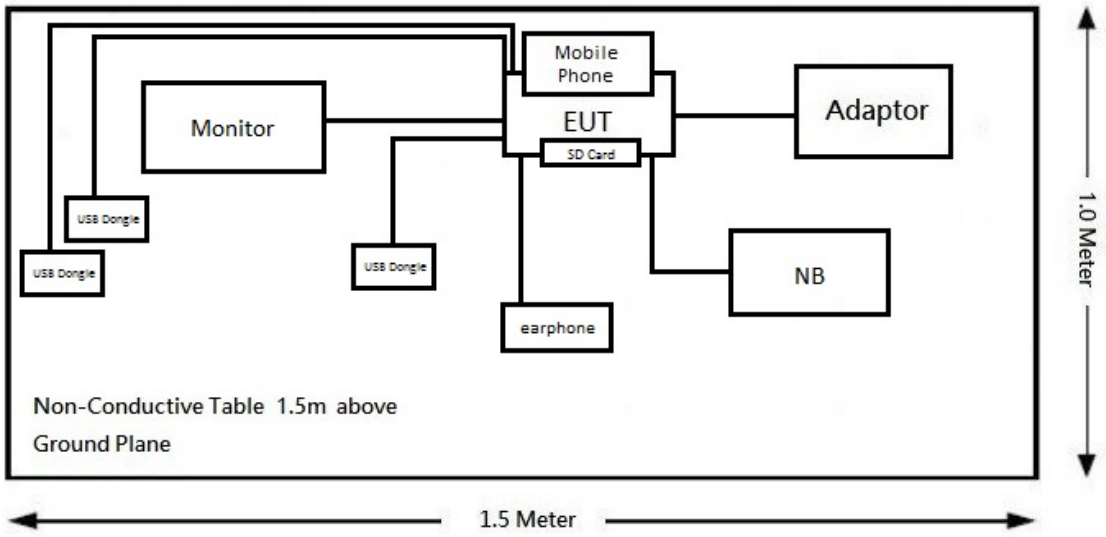
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

**Radiation:**

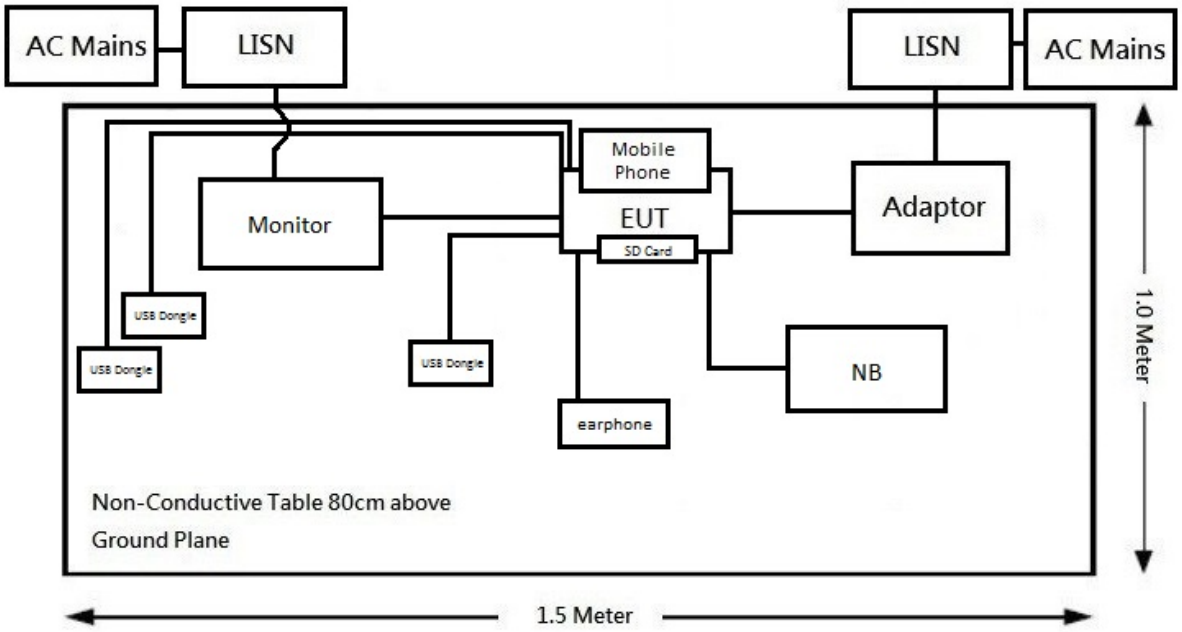
Below 1GHz:



Above 1GHz:




**Conduction:**



## 2.7 Duty Cycle

According to KDB 558074 D01 15.247 Meas Guidance v05 section 6.0:

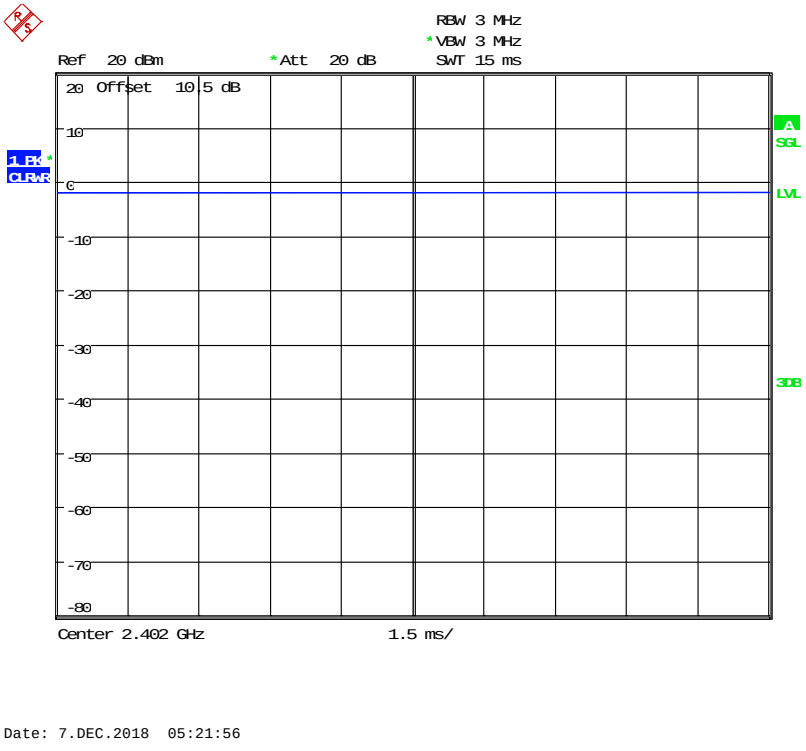
All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximumpower transmission duration, T, are required for each tested mode of operation.

| Radio Mode | On Time (ms) | Period (ms) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) |
|---|---|---|---|---|
| BLE | 15 | 15 | 100 | 0 |

Note: Duty Cycle Correction Factor = 10*log(1/duty cycle)

Please refer to the following plots.

**BLE Mode**



# 3 Summary of Test Results

| FCC Rules | Description of Test | Results |
|---|---|---|
| §15.247(i), §1.1310, §2.1091 | Maximum Permissible Exposure (MPE) | Compliance |
| §15.203 | Antenna Requirement | Compliance |
| §15.207(a) | AC Line Conducted Emissions | Compliance |
| §15.205, §15.209, §15.247(d) | Spurious Emissions | Compliance |
| §15.247(a)(2) | 6 dB Emission Bandwidth | Compliance |
| §15.247(b)(3) | Maximum Peak Output Power | Compliance |
| §15.247(d) | 100 kHz Bandwidth of Frequency Band Edge | Compliance |
| §15.247(e) | Power Spectral Density | Compliance |

# 4 Test Equipment List and Details

| Description | Manufacturer | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| AC Line Conduction Room (CON-A) | | | | | |
| LISN | Rohde & Schwarz | ENV216 | 101612 | 2018/02/22 | 2019/02/21 |
| LISN | Rohde & Schwarz | ENV216 | 101248 | 2018/06/27 | 2019/06/26 |
| EMI Test Receiver | Rohde & Schwarz | ESR7 | 101419 | 2018/10/23 | 2019/10/22 |
| Pulse Limiter | Rohde & Schwarz | ESH3Z2 | TXZEM104 | 2018/08/03 | 2019/08/02 |
| RF Cable | EMEC | EM-CB5D | 001 | 2018/07/02 | 2019/07/01 |
| Software | AUDIX | E3 | V9.150826k | N.C.R | N.C.R |
| Radiated Room (966-A) | | | | | |
| Bilog Antenna with 6 dB Attenuator | SUNOL SCIENCES & MINI-CIRCUITS | JB6/UNAT-6+ | A050115/15542_01 | 2017/12/20 | 2018/12/19 |
| Horn Antenna | EMCO | 3115 | 9311-4158 | 2018/04/20 | 2019/04/19 |
| Horn Antenna | ETS-Lindgren | 3116 | 62638 | 2018/08/29 | 2019/08/28 |
| Preamplifier | Sonoma | 310N | 130602 | 2018/07/04 | 2019/07/03 |
| Preamplifier | EM Electronics Corp. | EM01G18G | 060657 | 2017/12/14 | 2018/12/13 |
| Microware Preamplifier | EM Electronics Corporation | EM18G40G | 060656 | 2018/01/15 | 2019/01/14 |
| EMI Test Receiver | Rohde & Schwarz | ESR7 | 101419 | 2018/10/23 | 2019/10/22 |
| Spectrum Analyzer | Rohde & Schwarz | FSV40 | 101435 | 2018/02/12 | 2019/02/13 |
| Micro flex Cable | UTIFLEX | FSCM 64639 / (2M) | 93D0127 | 2018/07/31 | 2019/07/30 |
| Micro flex Cable | UTIFLEX | UFA210A-1-3149-300300 | MFR64639 226389-001 | 2018/11/16 | 2019/11/15 |
| Micro flex Cable | ROSNOL | K1K50-UP0264-K1K50-450CM | 160309-1 | 2018/03/05 | 2019/03/04 |
| Micro flex Cable | ROSNOL | K1K50-UP0264-K1K50-80CM | 160309-2 | 2018/01/17 | 2019/01/16 |
| Turn Table | Champro | TT-2000 | 060772-T | N.C.R | N.C.R |
| Antenna Tower | Champro | AM-BS-4500-B | 060772-A | N.C.R | N.C.R |
| Controller | Champro | EM1000 | 60772 | N.C.R | N.C.R |
| Software | Farad | EZ_EMC | BACL-03A1 | N.C.R | N.C.R |

| Description | Manufacturer | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| Conducted Room | | | | | |
| Spectrum Analyzer | Rohde & Schwarz | FSU26 | 200268 | 2018/05/04 | 2019/05/03 |
| Cable | WOKEN | SFL402 | S02-160323-07 | 2018/02/12 | 2019/02/11 |
| Attenuator | MINI-CIRCUITS | BW-S10W5+ | N/A | 2018/03/08 | 2019/03/07 |
| Power Sensor | KEYSIGHT | U2021XA | MY54080018 | 2018/03/07 | 2019/03/06 |

***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements*

# 5 FCC §15.247(i), §1.1310, § 2.1091 - Maximum Permissible Exposure (MPE)

## 5.1 Applicable Standard

According to subpart 15.247(i)and subpart §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/$f^2$) | 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);

## 5.2 RF Exposure Evaluation Result

**MPE evaluation:**

| Mode | Frequency Range (MHz) | Antenna Gain | | Target Power | | Evaluation Distance (cm) | Power Density ($mW/cm^2$) | MPE Limit ($mW/cm^2$) |
|---|---|---|---|---|---|---|---|---|
| | | (dBi) | (numeric) | (dBm) | (mW) | | | |
| BLE | 2402-2480 | 1.72 | 1.49 | -2.5 | 0.56 | 20 | 0.0002 | 1 |

BLE module with QI module will not be launched at the same time, so there will be no co-located.

**Result:** MPE evaluation meet 20 cm the requirement of standard.

# 6 FCC §15.203 – Antenna Requirements

## 6.1 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.

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 does not exceed 6dBi.

## 6.2 Measurement Uncertainty

| Manufacturer | Type | Antenna Gain | Result |
|---|---|---|---|
| INPAQ Technology Co., LTD | Chip Antenna | 1.72 dBi | Compliance |

The EUT has one integral antenna arrangement, which was permanently attached; fulfill the requirement of this section.

# 7 FCC §15.207(a) – AC Line Conducted Emissions

## 7.1 Applicable Standard

According to §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

| Frequency of Emission (MHz) | Conducted Limit (dBuV) | |
|---|---|---|
| | Quasi-Peak | Average |
| 0.15-0.5 | 66 to 56 Note 1 | 56 to 46 Note 2 |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

*Note 1: Decreases with the logarithm of the frequency.*

*Note 2: A linear average detector is required*

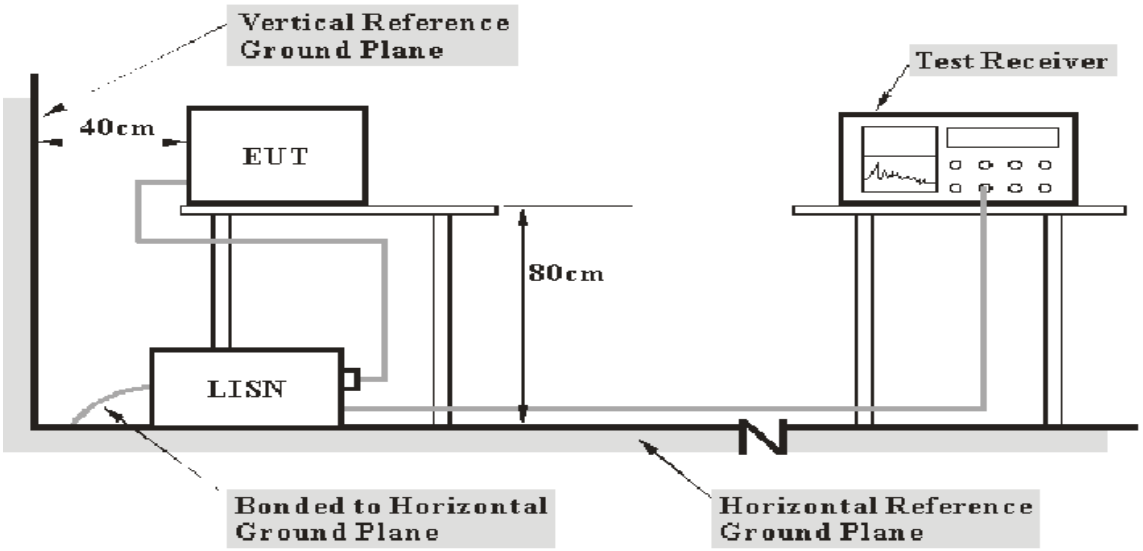
## 7.2 Measurement Uncertainty

Input quantities to be considered for conducted disturbance measurements maybe receiver reading, attenuation of the connection between LISN/ISN and receiver, LISN/ISN voltage division factor, LISN/ISN VDF frequency interpolation and receiver related input quantities, etc.

Based on CISPR 16-4-2:2011, the expended combined standard uncertainty of conducted disturbance test at Bay Area Compliance Laboratories Corp. (Taiwan) is shown as below. And the uncertainty will not be taken into consideration for the test data recorded in the report

| Port | Expanded Measurement uncertainty |
|---|---|
| AC Mains | 2.71 dB (k=2, 95% level of confidence) |

## 7.3 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.

## 7.4 EMI Test Receiver Setup

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

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

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

## 7.5 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 data was recorded in the Quasi-peak and average detection mode.

## 7.6 Corrected Factor & Margin Calculation

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

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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

Over Limit = Level – Limit Line

## 7.7 Environmental Conditions

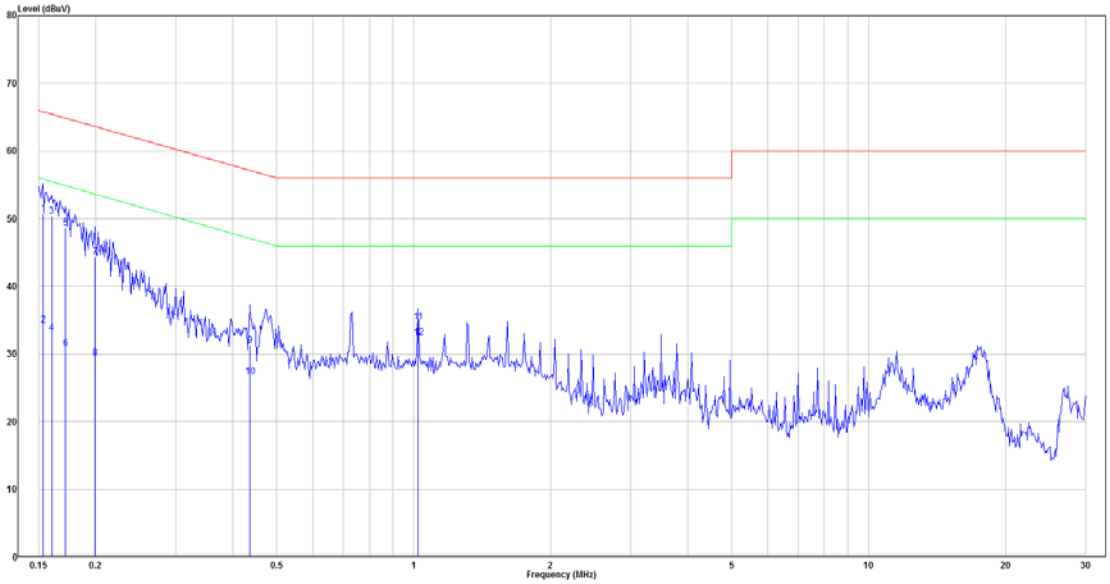
| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 1010 hPa |

*The testing was performed by Tom Hsu on 2018-12-06.*

## 7.8 Test Results

*Test Mode: Transmitting*

**Main: AC120 V, 60 Hz, Line**




| No. | Frequency | Reading | Correct | Result | Limit | Over limit | Remark |
|---|---|---|---|---|---|---|---|
| | (MHz) | (dBµV) | Factor(dB) | (dBµV) | (dBµV) | (dB) | |
| 1 | 0.153 | 31.20 | 19.45 | 50.65 | 65.83 | -15.18 | QP |
| 2 | 0.153 | 14.85 | 19.45 | 34.30 | 55.83 | -21.53 | Average |
| 3 | 0.160 | 30.96 | 19.45 | 50.41 | 65.46 | -15.05 | QP |
| 4 | 0.160 | 13.66 | 19.45 | 33.11 | 55.46 | -22.35 | Average |
| 5 | 0.172 | 29.13 | 19.45 | 48.58 | 64.88 | -16.30 | QP |
| 6 | 0.172 | 11.38 | 19.45 | 30.84 | 54.88 | -24.05 | Average |
| 7 | 0.199 | 24.87 | 19.46 | 44.33 | 63.64 | -19.31 | QP |
| 8 | 0.199 | 9.94 | 19.46 | 29.40 | 53.64 | -24.24 | Average |
| 9 | 0.436 | 11.78 | 19.47 | 31.25 | 57.14 | -25.89 | QP |
| 10 | 0.436 | 7.14 | 19.47 | 26.62 | 47.14 | -20.53 | Average |
| 11 | 1.022 | 15.21 | 19.49 | 34.71 | 56.00 | -21.29 | QP |
| 12 | 1.022 | 12.94 | 19.49 | 32.43 | 46.00 | -13.57 | Average |

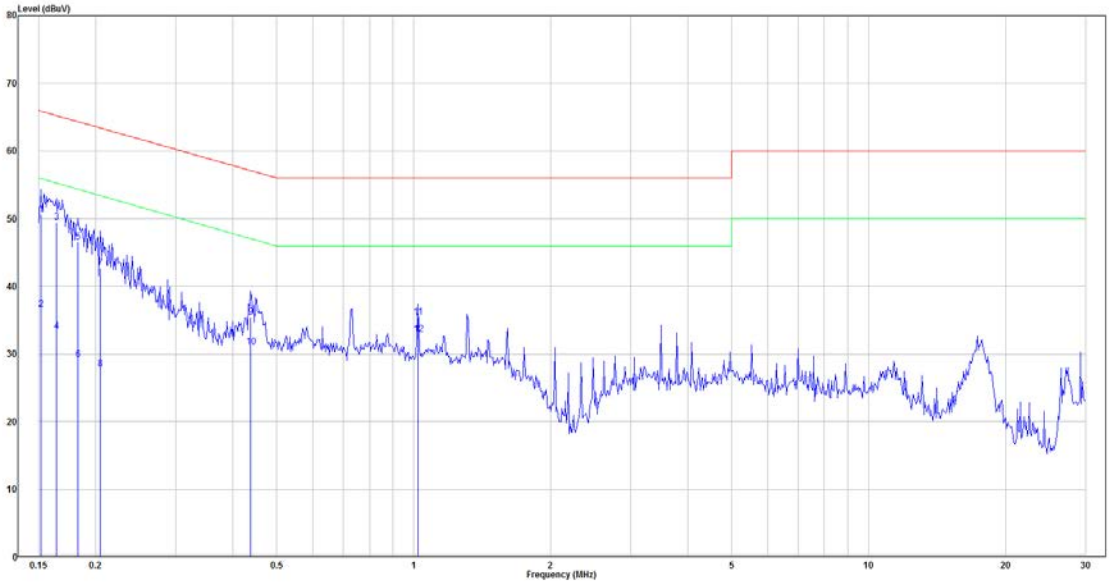
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

**Main: AC120 V, 60 Hz, Neutral**




| No. | Frequency | Reading | Correct | Result | Limit | Over limit | Remark |
|---|---|---|---|---|---|---|---|
| | (MHz) | (dBµV) | Factor(dB) | (dBµV) | (dBµV) | (dB) | |
| 1 | 0.152 | 31.14 | 19.44 | 50.58 | 65.92 | -15.33 | QP |
| 2 | 0.152 | 17.14 | 19.44 | 36.58 | 55.92 | -19.34 | Average |
| 3 | 0.164 | 29.96 | 19.45 | 49.41 | 65.25 | -15.84 | QP |
| 4 | 0.164 | 13.90 | 19.45 | 33.35 | 55.25 | -21.91 | Average |
| 5 | 0.183 | 27.12 | 19.45 | 46.57 | 64.34 | -17.77 | QP |
| 6 | 0.183 | 9.70 | 19.45 | 29.15 | 54.34 | -25.19 | Average |
| 7 | 0.204 | 23.26 | 19.46 | 42.72 | 63.43 | -20.71 | QP |
| 8 | 0.204 | 8.30 | 19.46 | 27.76 | 53.43 | -25.68 | Average |
| 9 | 0.438 | 15.92 | 19.46 | 35.38 | 57.10 | -21.72 | QP |
| 10 | 0.438 | 11.57 | 19.46 | 31.03 | 47.10 | -16.07 | Average |
| 11 | 1.022 | 15.96 | 19.48 | 35.44 | 56.00 | -20.56 | QP |
| 12 | 1.022 | 13.46 | 19.48 | 32.94 | 46.00 | -13.06 | Average |

Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

# 8 FCC §15.209, §15.205 , §15.247(d) – Spurious Emissions

## 8.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1MHz.

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090 – 0.110<br>0.495 – 0.505<br>2.1735 – 2.1905<br>4.125 – 4.128<br>4.17725 – 4.17775<br>4.20725 – 4.20775<br>6.215 – 6.218<br>6.26775 – 6.26825<br>6.31175 – 6.31225<br>8.291 – 8.294<br>8.362 – 8.366<br>8.37625 – 8.38675<br>8.41425 – 8.41475<br>12.29 – 12.293<br>12.51975 – 12.52025<br>12.57675 – 12.57725<br>13.36 – 13.41 | 16.42 – 16.423<br>16.69475 – 16.69525<br>25.5 – 25.67<br>37.5 – 38.25<br>73 – 74.6<br>74.8 – 75.2<br>108 – 121.94<br>123 – 138<br>149.9 – 150.05<br>156.52475 – 156.52525<br>156.7 – 156.9<br>162.0125 –167.17<br>167.72 – 173.2<br>240 – 285<br>322 – 335.4<br>399.9 – 410<br>608 – 614 | 960 – 1240<br>1300 – 1427<br>1435 – 1626.5<br>1645.5 – 1646.5<br>1660 – 1710<br>1718.8 – 1722.2<br>2200 – 2300<br>2310 – 2390<br>2483.5 – 2500<br>2690 – 2900<br>3260 – 3267<br>3.332 – 3.339<br>3 3458 – 3 358<br>3.600 – 4.400 | 4. 5 – 5. 15<br>5. 35 – 5. 46<br>7.25 – 7.75<br>8.025 – 8.5<br>9.0 – 9.2<br>9.3 – 9.5<br>10.6 – 12.7<br>13.25 – 13.4<br>14.47 – 14.5<br>15.35 – 16.2<br>17.7 – 21.4<br>22.01 – 23.12<br>23.6 – 24.0<br>31.2 – 31.8<br>36.43 – 36.5<br>Above 38.6 |

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency (MHz) | Field Strength (micro volts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009 - 0.490 | 2400/F(kHz) | 300 |
| 0.490 - 1.705 | 24000/F(kHz) | 30 |
| 1.705 - 30.0 | 30 | 30 |
| 30 - 88 | 100** | 3 |
| 88 - 216 | 150** | 3 |
| 216 - 960 | 200** | 3 |
| Above 960 | 500 | 3 |

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per 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).

## 8.2 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

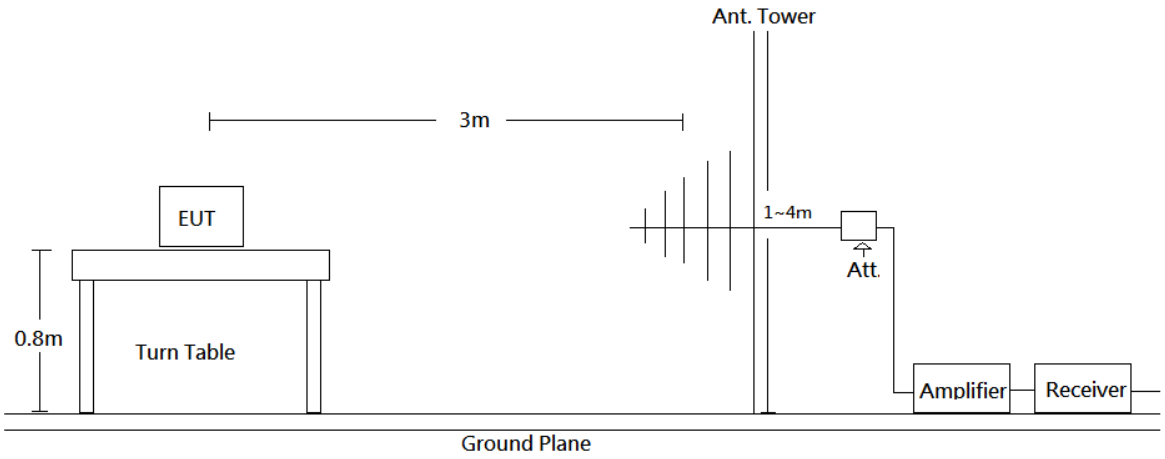
Based on CISPR 16-4-2:2011, the expended combined standard uncertainty of radiation emissions at Bay Area Compliance Laboratories Corp. (Taiwan) is shown in below table. And the uncertainty will not be taken into consideration for the test data recorded in the report.

| Frequency | Measurement uncertainty |
|---|---|
| 30 MHz~200 MHz | 3.75 dB (k=2, 95% level of confidence) |
| 200 MHz~1 GHz | 4.21 dB (k=2, 95% level of confidence) |
| 1 GHz~6 GHz | 4.83 dB (k=2, 95% level of confidence) |
| 6 GHz~18 GHz | 5.18 dB (k=2, 95% level of confidence) |
| 18 GHz~26 GHz | 4.55 dB (k=2, 95% level of confidence) |
| 26 GHz~40 GHz | 4.67 dB (k=2, 95% level of confidence) |

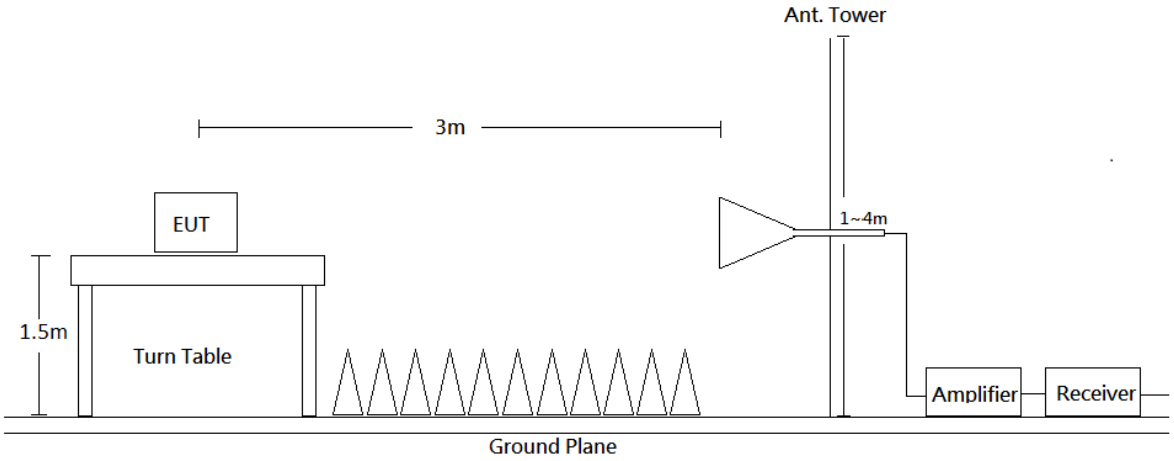
 

## 8.3 EUT Setup

Below 1 GHz:




Above 1 GHz:




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 Part 15.209 and FCC 15.247 Limits.

## 8.4 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

| Frequency Range | RBW | VBW | Detector | Duty cycle | Measurement method |
|---|---|---|---|---|---|
| 30-1000 MHz | 120 kHz | / | QP | | QP |
| Above 1 GHz | 1 MHz | 3 MHz | PK | | PK |
| | 1 MHz | 3 MHz | RMS | >98% | Ave |
| | 1 MHz | 1/T | PK | <98% | Ave |

## 8.5 Test Procedure

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

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

## 8.6 Corrected Factor & Margin Calculation

The Correct Factor 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:

Correct Factor = 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 -7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Result – Limit

## 8.7 Test Results Summary

According to the data in the following table, the EUT complied with the FCC §15.209 Limit.

## 8.8 Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 1010 hPa |

*The Radiation Spurious Emissions testing was performed by Tom Hsu on 2018-12-04 ~ 2018-12-05.*

*The Conducted Spurious Emissions testing was performed by Tom Hsu on 2018-12-07.*

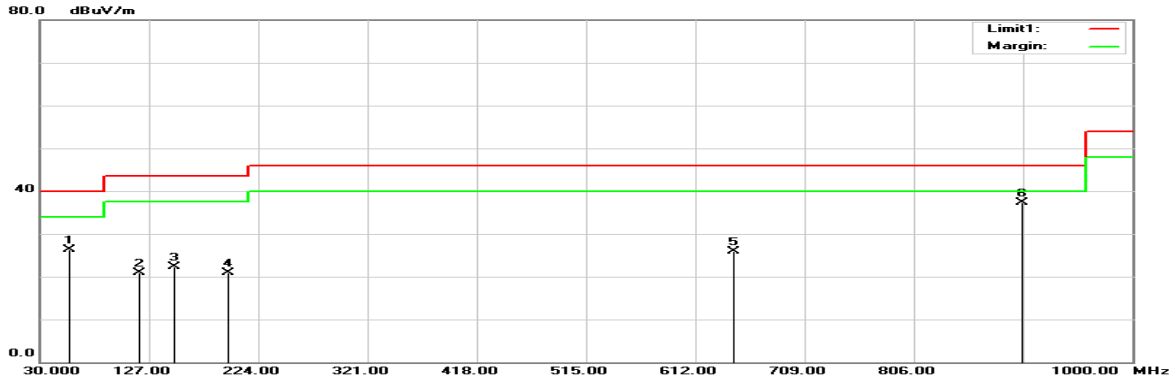
## 8.9 Test Results

*Test Mode: Transmitting*

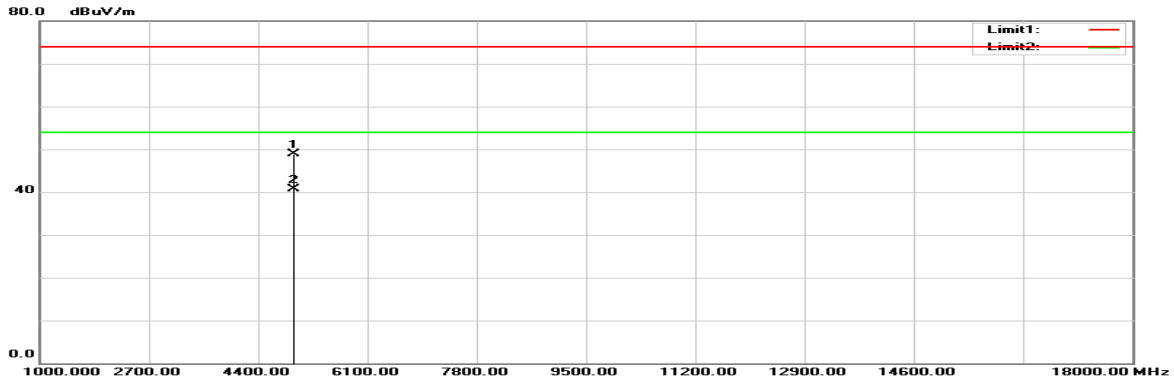
**BLE Mode** *(Pre-scan with three orthogonal axis, and worse case as Y axis.)*

**Horizontal** (*worst case is BLE mode high channel*)

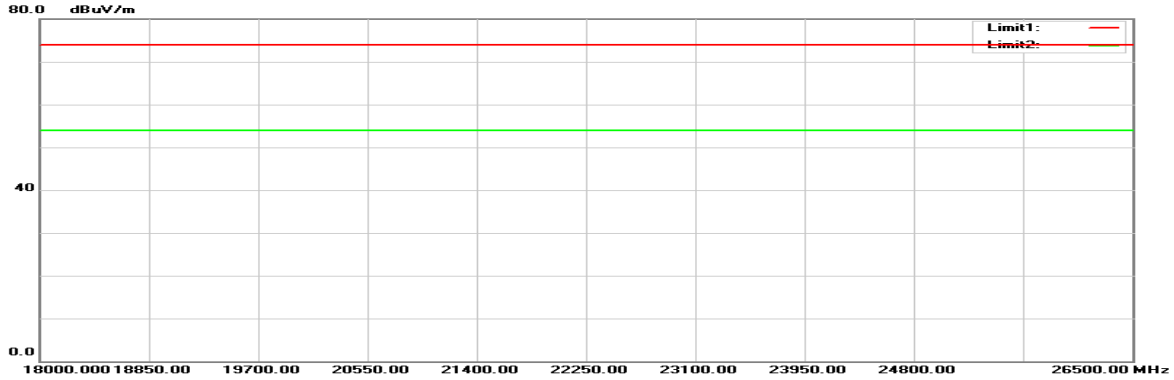
30MHz-1GHz:




1GHz-18GHz:

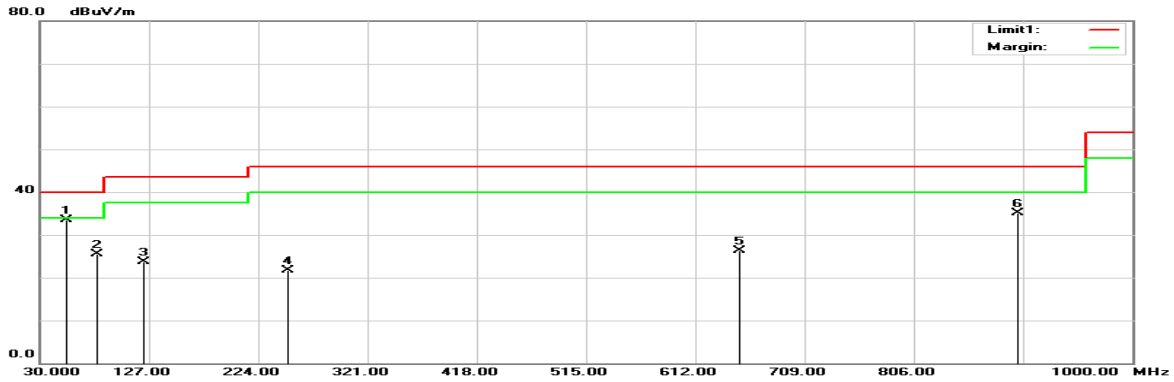



18GHz-26.5GHz:

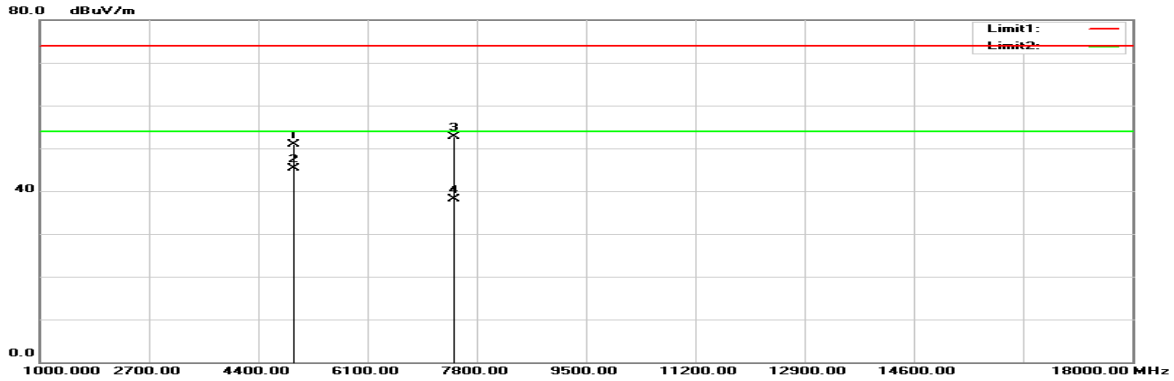


**Vertical** (*worst case is BLE mode high channel*)

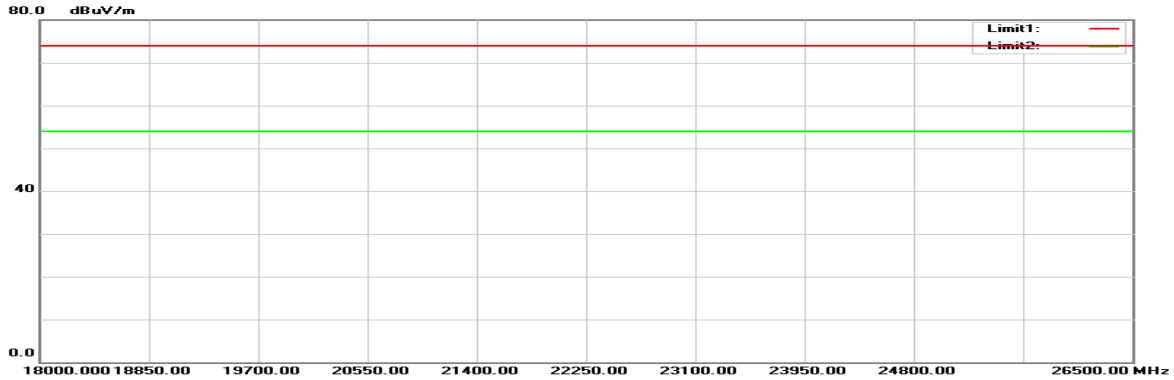
30MHz-1GHz:




1GHz-18GHz:




18GHz-26.5GHz:



## Below 1GHz

## Horizontal

| Frequency (MHz) | Reading (dBµV) | Correct Factor(dB/m) | Result (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Degree ( ° ) | Remark |
|---|---|---|---|---|---|---|---|---|
| 56.1900 | 42.58 | -16.34 | 26.24 | 40.00 | -13.76 | 100 | 48 | QP |
| 118.2700 | 30.34 | -9.48 | 20.86 | 43.50 | -22.64 | 100 | 248 | QP |
| 149.3100 | 32.00 | -9.62 | 22.38 | 43.50 | -21.12 | 100 | 260 | QP |
| 197.8100 | 30.19 | -9.24 | 20.95 | 43.50 | -22.55 | 100 | 0 | QP |
| 645.9500 | 28.85 | -2.90 | 25.95 | 46.00 | -20.05 | 100 | 167 | QP |
| 902.0300 | 36.48 | 0.77 | 37.25 | 46.00 | -8.75 | 100 | 181 | QP |

## Vertical

| Frequency (MHz) | Reading (dBµV) | Correct Factor(dB/m) | Result (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Degree ( ° ) | Remark |
|---|---|---|---|---|---|---|---|---|
| 54.2500 | 49.71 | -16.12 | 33.59 | 40.00 | -6.41 | 100 | 171 | QP |
| 80.4400 | 41.02 | -15.59 | 25.43 | 40.00 | -14.57 | 100 | 3 | QP |
| 122.1500 | 33.03 | -9.24 | 23.79 | 43.50 | -19.71 | 100 | 246 | QP |
| 250.1900 | 31.94 | -10.15 | 21.79 | 46.00 | -24.21 | 100 | 360 | QP |
| 650.8000 | 29.06 | -2.84 | 26.22 | 46.00 | -19.78 | 100 | 173 | QP |
| 898.1500 | 34.49 | 0.70 | 35.19 | 46.00 | -10.81 | 100 | 273 | QP |

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

## Above 1GHz

## Horizontal

| Frequency (MHz) | Reading (dBμV) | Correct Factor(dB/m) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Height (cm) | Degree ( ° ) | Remark |
|---|---|---|---|---|---|---|---|---|
| Low channel | | | | | | | | |
| 2390.000 | 67.29 | -3.88 | 63.41 | 74.00 | -10.59 | 300 | 297 | peak |
| 2390.000 | 52.84 | -3.88 | 48.96 | 54.00 | -5.04 | 300 | 297 | AVG |
| 2402.000 | 103.11 | -3.86 | 99.25 | N/A | N/A | 300 | 56 | peak |
| 2402.000 | 102.20 | -3.86 | 98.34 | N/A | N/A | 300 | 56 | AVG |
| 4804.000 | 46.67 | 1.81 | 48.48 | 74.00 | -25.52 | 100 | 94 | peak |
| 4804.000 | 38.27 | 1.81 | 40.08 | 54.00 | -13.92 | 100 | 94 | AVG |
| Middle channel | | | | | | | | |
| 2440.000 | 103.51 | -3.76 | 99.75 | N/A | N/A | 300 | 58 | peak |
| 2440.000 | 102.75 | -3.76 | 98.99 | N/A | N/A | 300 | 58 | AVG |
| 4880.000 | 44.48 | 2.06 | 46.54 | 74.00 | -27.46 | 100 | 325 | peak |
| 4880.000 | 31.25 | 2.06 | 33.31 | 54.00 | -20.69 | 100 | 325 | AVG |
| 7320.000 | 45.75 | 8.89 | 54.64 | 74.00 | -19.36 | 100 | 120 | peak |
| 7320.000 | 34.64 | 8.89 | 43.53 | 54.00 | -10.47 | 100 | 120 | AVG |
| High channel | | | | | | | | |
| 2480.000 | 98.48 | -3.66 | 94.82 | N/A | N/A | 300 | 57 | peak |
| 2480.000 | 97.65 | -3.66 | 93.99 | N/A | N/A | 300 | 57 | AVG |
| 2483.500 | 66.23 | -3.64 | 62.59 | 74.00 | -11.41 | 300 | 358 | peak |
| 2483.500 | 54.52 | -3.64 | 50.88 | 54.00 | -3.12 | 300 | 358 | AVG |
| 4960.000 | 46.62 | 2.32 | 48.94 | 74.00 | -25.06 | 100 | 89 | peak |
| 4960.000 | 38.48 | 2.32 | 40.80 | 54.00 | -13.20 | 100 | 89 | AVG |

## Vertical

| Frequency (MHz) | Reading (dBμV) | Correct Factor(dB/m) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Height (cm) | Degree ( ° ) | Remark |
|---|---|---|---|---|---|---|---|---|
| Low channel | | | | | | | | |
| 2390.000 | 67.48 | -3.88 | 63.60 | 74.00 | -10.40 | 100 | 0 | peak |
| 2390.000 | 52.72 | -3.88 | 48.84 | 54.00 | -5.16 | 100 | 0 | AVG |
| 2402.000 | 99.73 | -3.86 | 95.87 | N/A | N/A | 100 | 16 | peak |
| 2402.000 | 98.94 | -3.86 | 95.08 | N/A | N/A | 100 | 16 | AVG |
| 4804.000 | 48.80 | 1.81 | 50.61 | 74.00 | -23.39 | 100 | 66 | peak |
| 4804.000 | 43.41 | 1.81 | 45.22 | 54.00 | -8.78 | 100 | 66 | AVG |
| Middle channel | | | | | | | | |
| 2440.000 | 98.06 | -3.76 | 94.30 | N/A | N/A | 100 | 20 | peak |
| 2440.000 | 97.19 | -3.76 | 93.43 | N/A | N/A | 100 | 20 | AVG |
| 4880.000 | 49.93 | 2.06 | 51.99 | 74.00 | -22.01 | 100 | 58 | peak |
| 4880.000 | 45.21 | 2.06 | 47.27 | 54.00 | -6.73 | 100 | 58 | AVG |
| 7320.000 | 46.46 | 8.88 | 55.34 | 74.00 | -18.66 | 100 | 53 | peak |
| 7320.000 | 34.92 | 8.88 | 43.80 | 54.00 | -10.20 | 100 | 53 | AVG |
| High channel | | | | | | | | |
| 2480.000 | 94.98 | -3.66 | 91.32 | N/A | N/A | 100 | 20 | peak |
| 2480.000 | 94.08 | -3.66 | 90.42 | N/A | N/A | 100 | 20 | AVG |
| 2483.500 | 65.35 | -3.64 | 61.71 | 74.00 | -12.29 | 100 | 184 | peak |
| 2483.500 | 53.06 | -3.64 | 49.42 | 54.00 | -4.58 | 100 | 184 | AVG |
| 4960.000 | 48.55 | 2.32 | 50.87 | 74.00 | -23.13 | 100 | 65 | peak |
| 4960.000 | 42.95 | 2.32 | 45.27 | 54.00 | -8.73 | 100 | 65 | AVG |
| 7440.000 | 43.30 | 9.40 | 52.70 | 74.00 | -21.30 | 100 | 180 | peak |
| 7440.000 | 28.61 | 9.40 | 38.01 | 54.00 | -15.99 | 100 | 180 | AVG |

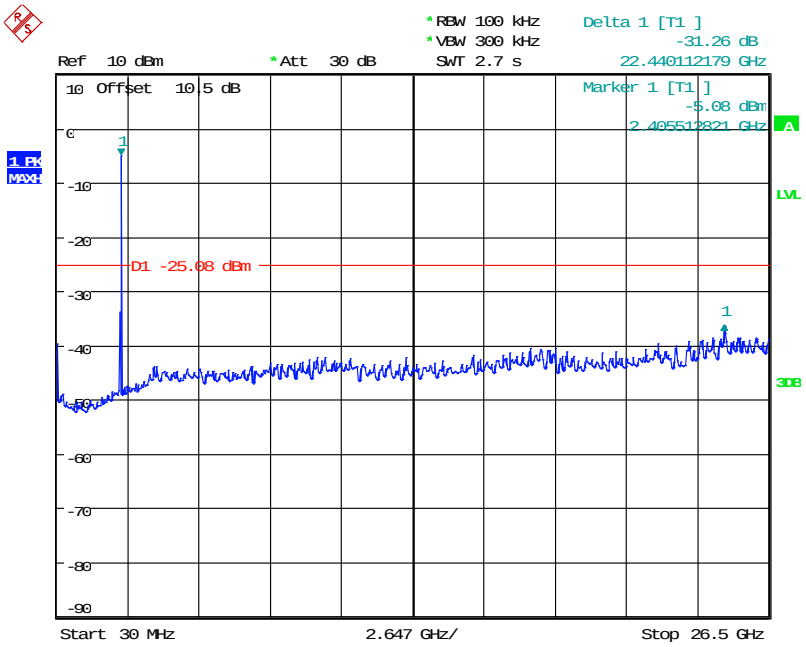
Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

## Conducted Spurious Emissions:

| Channel | Frequency (MHz) | Delta Peak to Band Emission (dBc) | Limit (dBc) | Result |
|---|---|---|---|---|
| Low | 2402 | 31.26 | ≥ 20 | PASS |
| Mid | 2440 | 31.67 | ≥ 20 | PASS |
| High | 2480 | 32.62 | ≥ 20 | PASS |

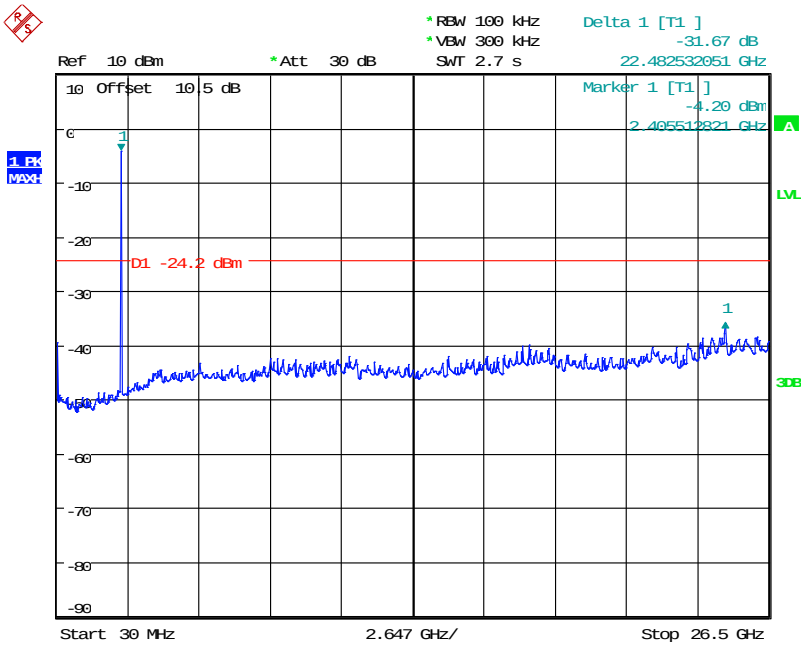
### BLE Mode

### Low Channel



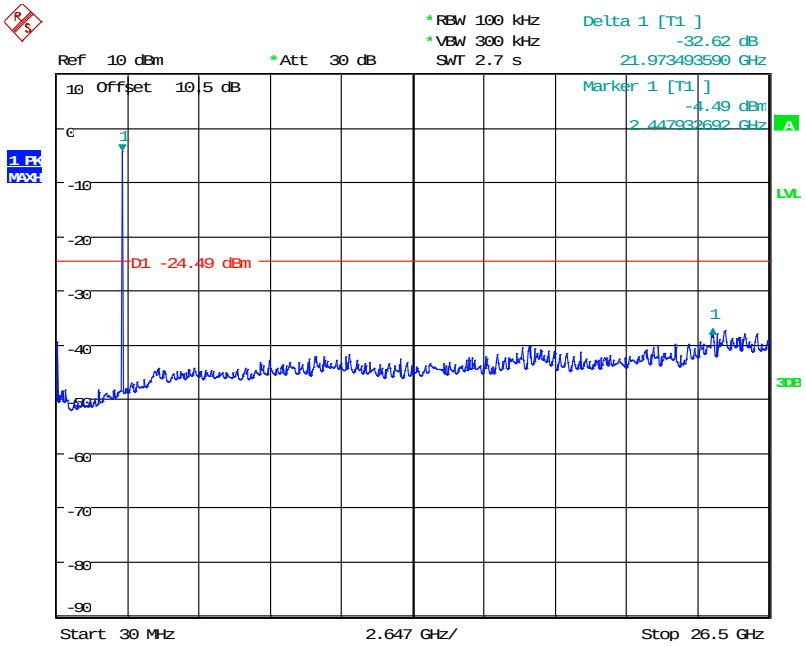

Date: 7.DEC.2018 05:10:04

## Middle Channel




Date: 7.DEC.2018 05:14:03

## High Channel




Date: 7.DEC.2018 05:16:18

# 9 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

## 9.1 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 kHz.

## 9.2 Test Procedure

The steps for the first option are as follows:

a) Set RBW = 100 kHz.

b) Set the 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.

## 9.3 Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 1010 hPa |

*The testing was performed by Tom Hsu on 2018-12-07.*

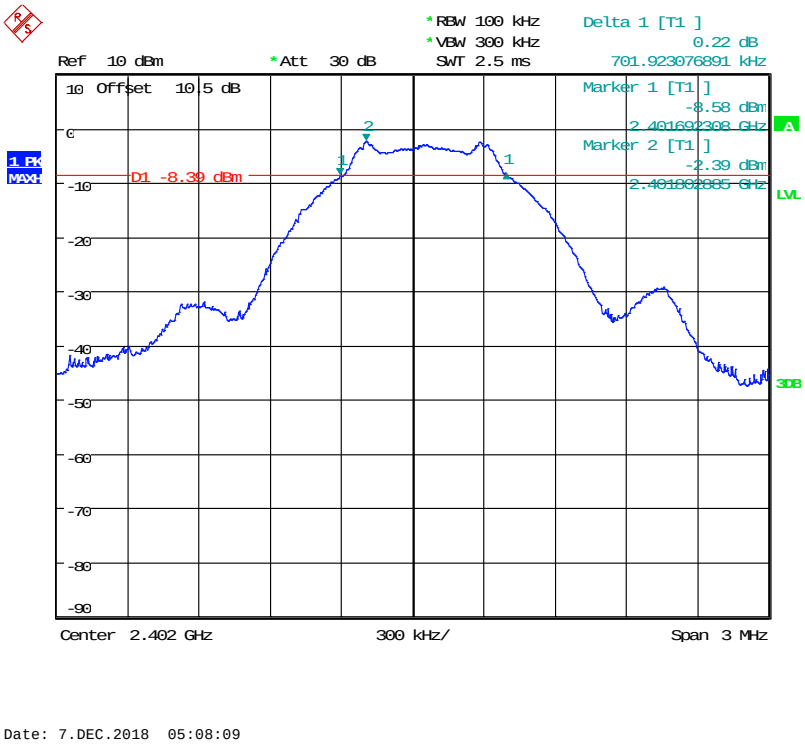
## 9.4 Test Results

| Channel | Frequency (MHz) | 6 dB Emission Bandwidth (kHz) | Limit (kHz) | Result |
|---|---|---|---|---|
| Low | 2402 | 702 | > 500 | Compliance |
| Middle | 2440 | 702 | > 500 | Compliance |
| High | 2480 | 692 | > 500 | Compliance |

Please refer to the following plots

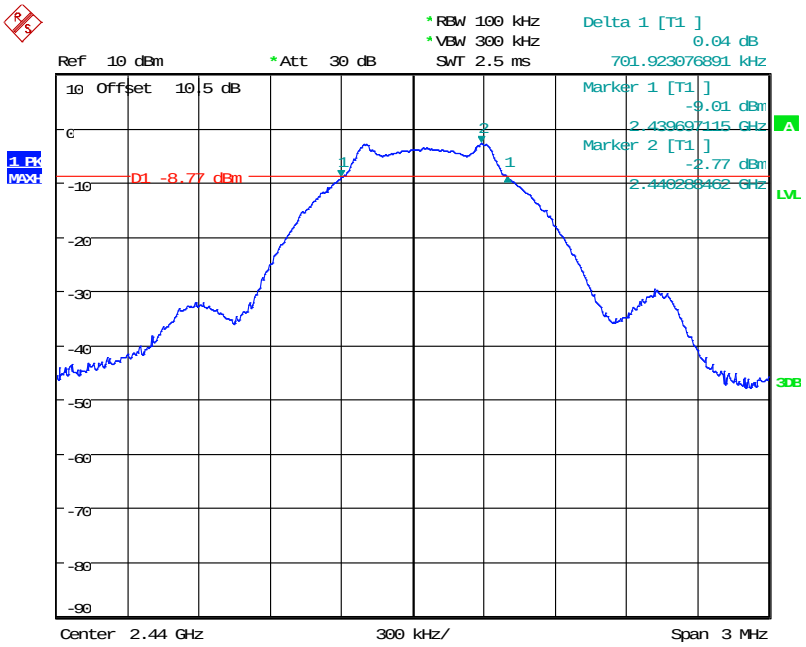
**BLE Mode**

**Low Channel**



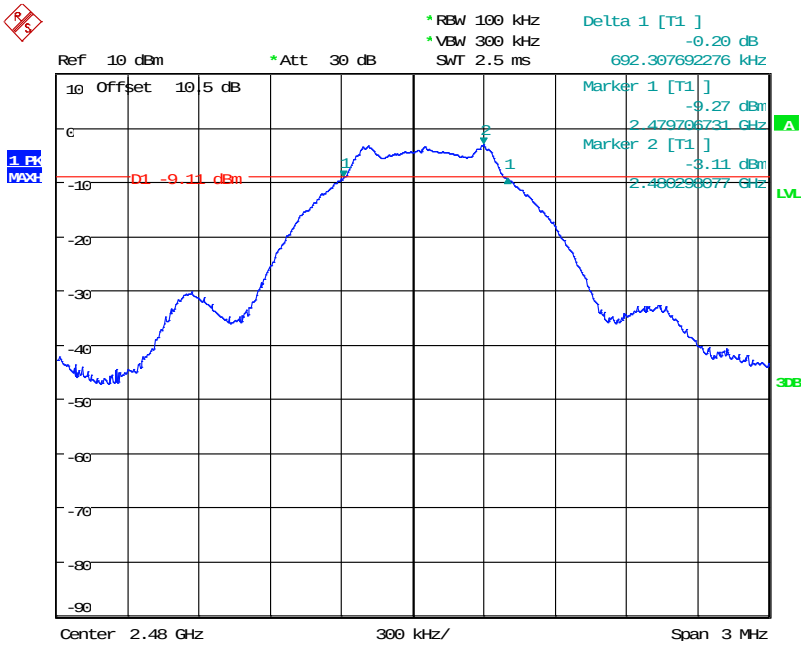

Date: 7.DEC.2018 05:08:09

## Middle Channel




Date: 7.DEC.2018 05:11:04

## High Channel




Date: 7.DEC.2018 05:14:52

# 10 FCC §15.247(b)(3) – Maximum Output Power

## 10.1 Applicable Standard

According to FCC §15.247(b) (3).

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.

## 10.2 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 measuring equipment.

## 10.3 Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 1010 hPa |

*The testing was performed by Tom Hsu on 2018-12-07.*

## 10.4 Test Results

| Channel | Frequency | Maximum peak Conducted Output Power | | Limit | Result |
|---|---|---|---|---|---|
| | (MHz) | (dBm) | (W) | (W) | |
| **BLE Mode** | | | | | |
| Low | 2402 | -2.63 | 0.0006 | 1 | PASS |
| Middle | 2440 | -3.15 | 0.0005 | 1 | PASS |
| High | 2480 | -3.57 | 0.0004 | 1 | PASS |

# 11 FCC§15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

## 11.1 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)).

## 11.2 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.

## 11.3 Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 1010 hPa |

*The testing was performed by Tom Hsu on 2018-12-07.*

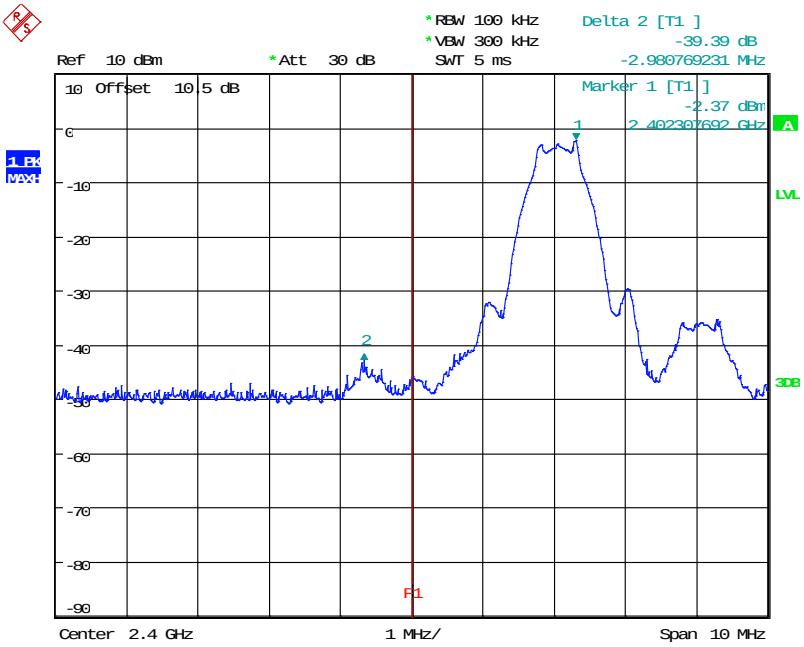
## 11.4 Test Results

| Channel | Frequency (MHz) | Delta Peak to Band Emission (dBc) | Limit (dBc) | Result |
|---|---|---|---|---|
| Low | 2402 | 39.39 | ≥ 20 | PASS |
| High | 2480 | 42.60 | ≥ 20 | PASS |

Please refer to the following plots

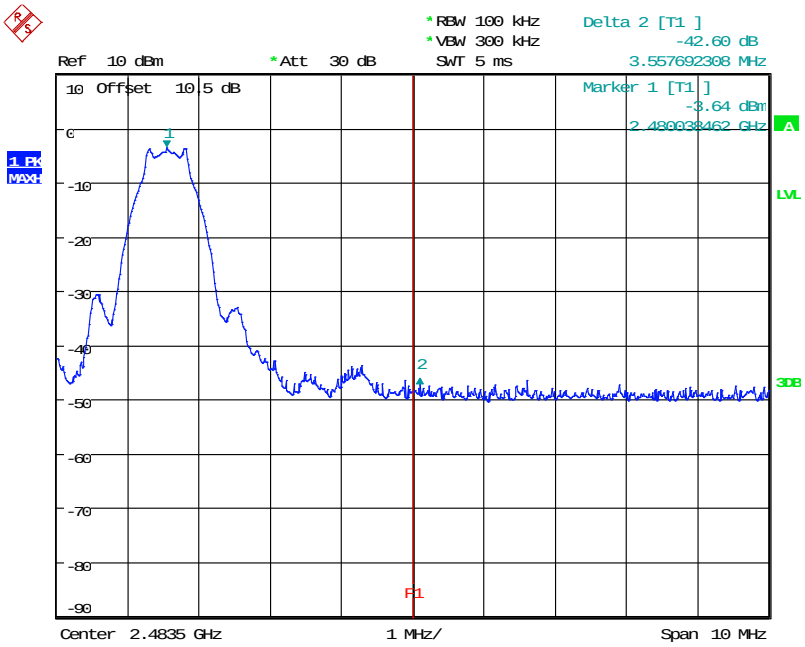
**BLE Mode**

**Band Edge, Left Side**




Date: 7.DEC.2018 05:08:55

## Band Edge, Right Side




Date: 7.DEC.2018 05:15:38

# 12 FCC §15.247(e) – Power Spectral Density

## 12.1 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.

## 12.2 Test Procedure

According to ANSI C63.10-2013

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 = peak.

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 requirement, then reduce RBW (but no less than 3 kHz) and repeat

## 12.3 Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 55 % |
| **ATM Pressure:** | 1010 hPa |

*The testing was performed by Tom Hsu on 2018-12-07.*

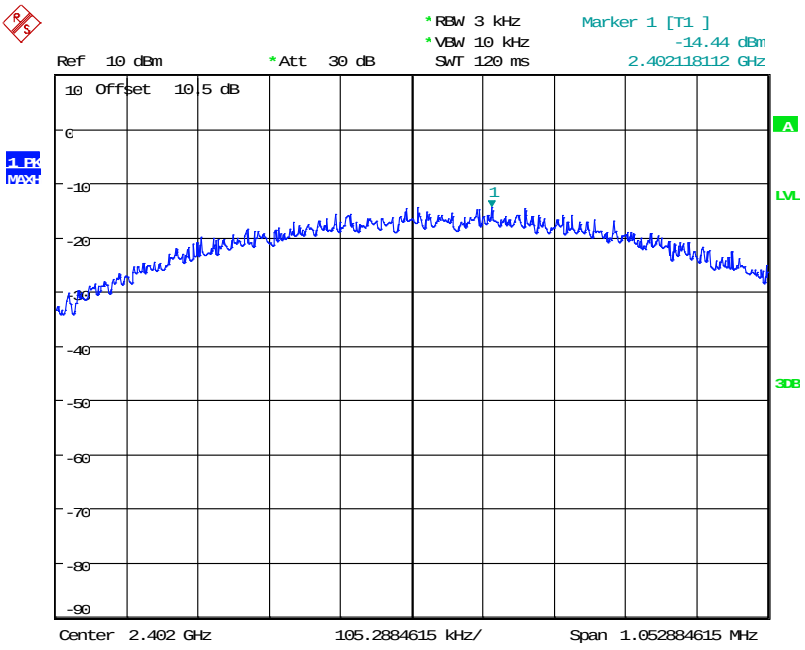
## 12.4 Test Results

| Channel | Frequency (MHz) | Power Spectral Density (dBm/3 kHz) | Limit (dBm/3 kHz) | Result |
|---|---|---|---|---|
| Low | 2402 | -14.44 | 8 | Compliance |
| Middle | 2440 | -15.12 | 8 | Compliance |
| High | 2480 | -15.33 | 8 | Compliance |

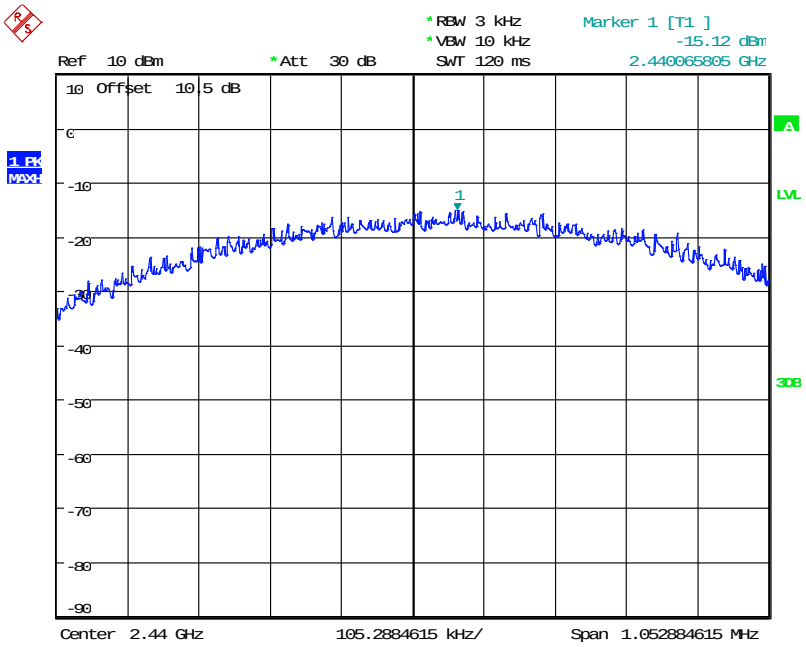
Please refer to the following plots

**BLE Mode**

**Low Channel**



## Middle Channel

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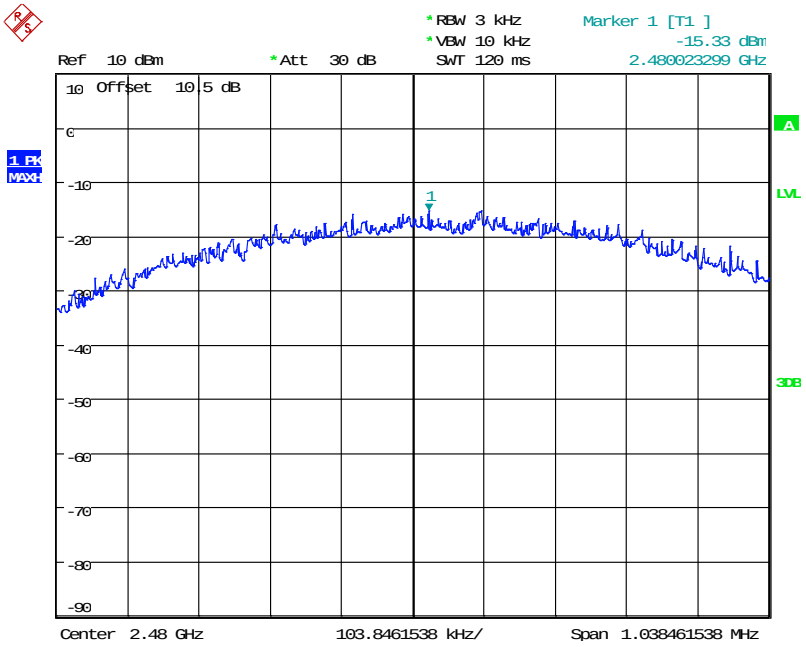
## High Channel

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