



TEST REPORT

Applicant Name : Astera LED-Technology GmbH
Address : Stahlgruberring 36, Munich, Germany 81829
Report Number : SZNS210923-49580E-RF-00C
FCC ID: X55FP-BTB

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type: Titan Tube BTB
Model No.: FP1-BTB
Multiple Model(s) No.: FP2-BTB (Please refer to DOS for Model difference)
Trade Mark: ASTERA
Date Received: 2021/09/23
Date of Test: 2021/10/21~2022/02/17
Report Date: 2022/02/17

| | |
|--------------|-------|
| Test Result: | Pass* |
|--------------|-------|

* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Ting Lv
EMC Engineer

Approved By:

Robert Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" .

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

| | |
|-------------------------------------|--|
| Frequency Range | FHSS: 917-922.2MHz |
| Maximum conducted Peak output power | FHSS: 9.11dBm |
| Modulation Technique | FHSS: GFSK |
| Antenna Specification* | PCB Antenna: 2.0dBi (provided by the applicant) |
| Voltage Range | DC14.4V From Battery or DC 24V from adapter |
| Sample serial number | SZNS210923-49580E-RF-S1 (Assigned by ATC) |
| Sample/EUT Status | Good condition |

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission rules.

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

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

| Parameter | | Uncertainty |
|------------------------------------|--------------|-------------|
| Occupied Channel Bandwidth | | 5% |
| RF output power, conducted | | 0.73dB |
| Unwanted Emission, conducted | | 1.6dB |
| AC Power Lines Conducted Emissions | | 2.72dB |
| Emissions, Radiated | 9kHz - 30MHz | 2.66dB |
| | 30MHz - 1GHz | 4.28dB |
| | 1GHz - 18GHz | 4.98dB |
| Temperature | | 1°C |
| Humidity | | 6% |
| Supply voltages | | 0.4% |

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. 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.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISED), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

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

channel list:

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|
| 0 | 917.00 | 27 | 919.70 |
| 1 | 917.10 | 28 | 919.80 |
| 2 | 917.20 | 29 | 919.90 |
| 3 | 917.30 | 30 | 920.00 |
| 4 | 917.40 | 31 | 920.10 |
| 5 | 917.50 | 32 | 920.20 |
| 6 | 917.60 | 33 | 920.30 |
| 7 | 917.70 | 34 | 920.40 |
| 8 | 917.80 | 35 | 920.50 |
| 9 | 917.90 | 36 | 920.60 |
| 10 | 918.00 | 37 | 920.70 |
| 11 | 918.10 | 38 | 920.80 |
| 12 | 918.20 | 39 | 920.90 |
| 13 | 918.30 | 40 | 921.00 |
| 14 | 918.40 | 41 | 921.10 |
| 15 | 918.50 | 42 | 921.20 |
| 16 | 918.60 | 43 | 921.30 |
| 17 | 918.70 | 44 | 921.40 |
| 18 | 918.80 | 45 | 921.50 |
| 19 | 918.90 | 46 | 921.60 |
| 20 | 919.00 | 47 | 921.70 |
| 21 | 919.10 | 48 | 921.80 |
| 22 | 919.20 | 49 | 921.90 |
| 23 | 919.30 | 50 | 922.00 |
| 24 | 919.40 | 51 | 922.10 |
| 25 | 919.50 | 52 | 922.20 |
| 26 | 919.60 | / | / |

Channel 0, 26, 52 were tested.

EUT Exercise Software

“AsterApp_9.96”* software was used to test.

The device was tested with the Power level is default*.

The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

| Manufacturer | Description | Model | Serial Number |
|--------------|--------------|--------|---------------|
| ASTERA | AsteraBox | ART7-U | 025-0918819 |
| Nubia | Mobile Phone | NX549J | NX549J |

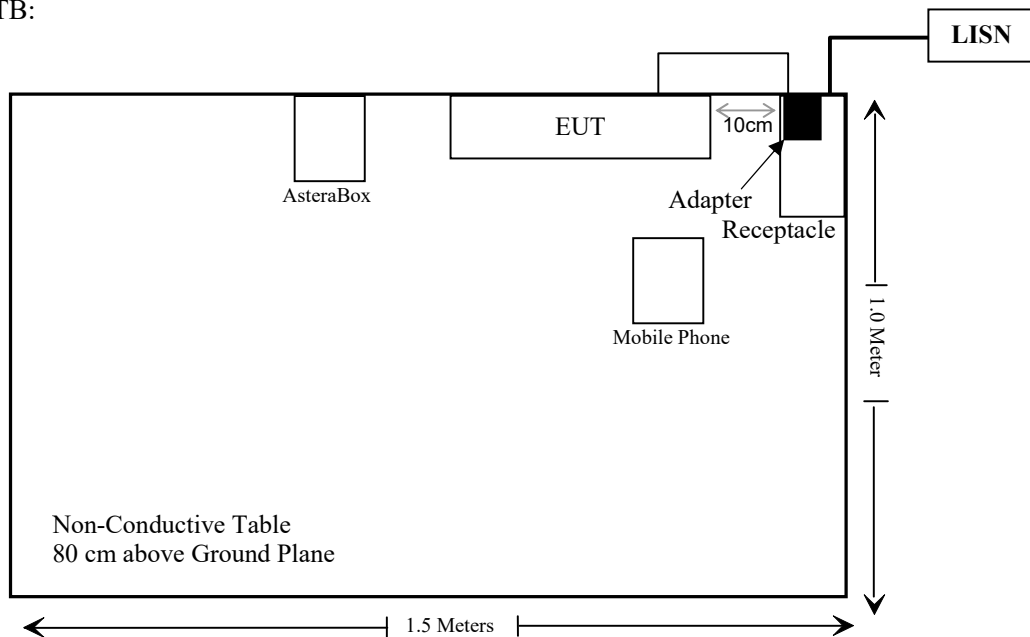
External I/O Cable

| Cable Description | Length (m) | From Port | To |
|--------------------------------------|------------|-----------|-----|
| Un-shielding Un-Detachable USB Cable | 1.5 | Adapter | EUT |

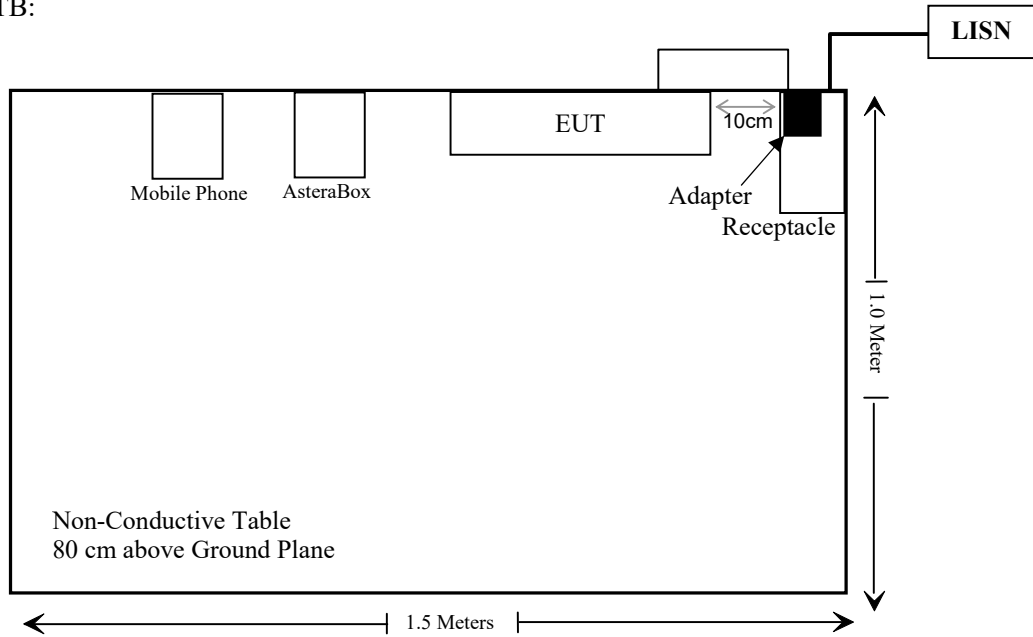
Block Diagram of Test Setup

For Conducted emission:

For FP1-BTB:

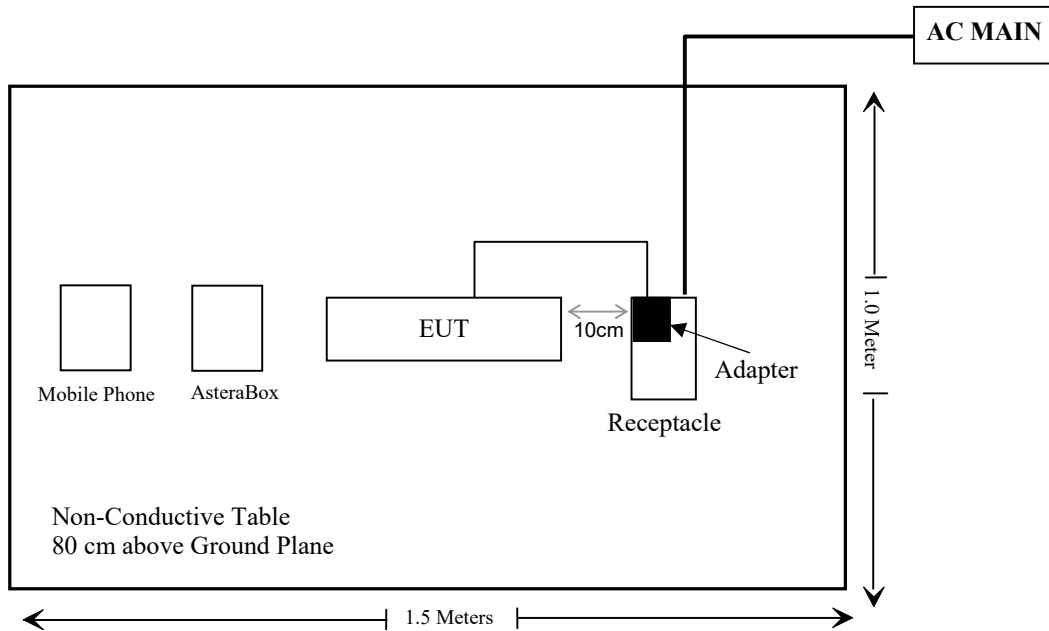


For FP2-BTB:

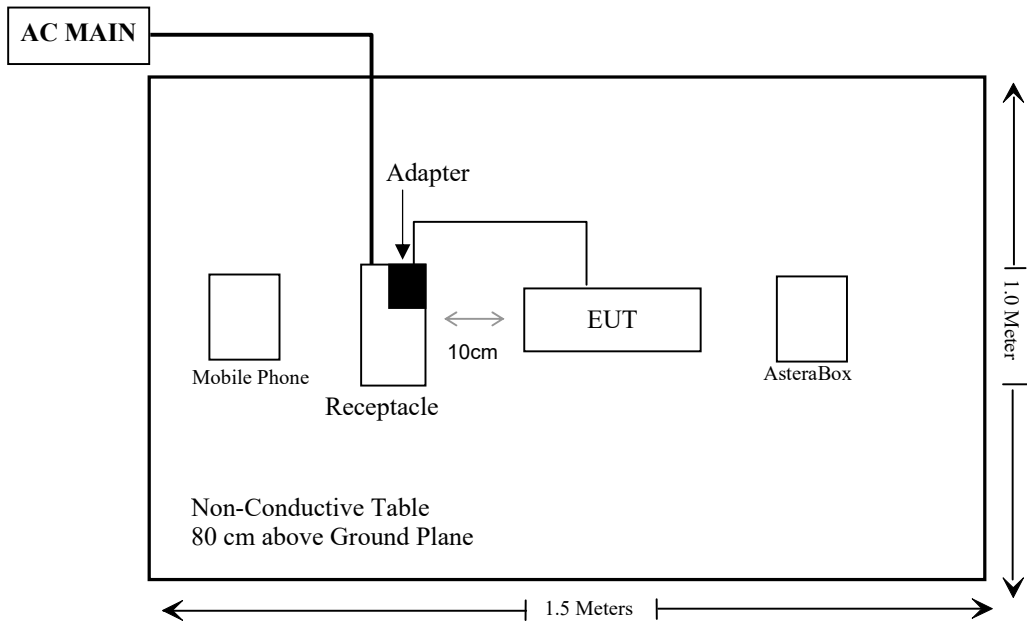


For Radiate emission: (below 1GHz)

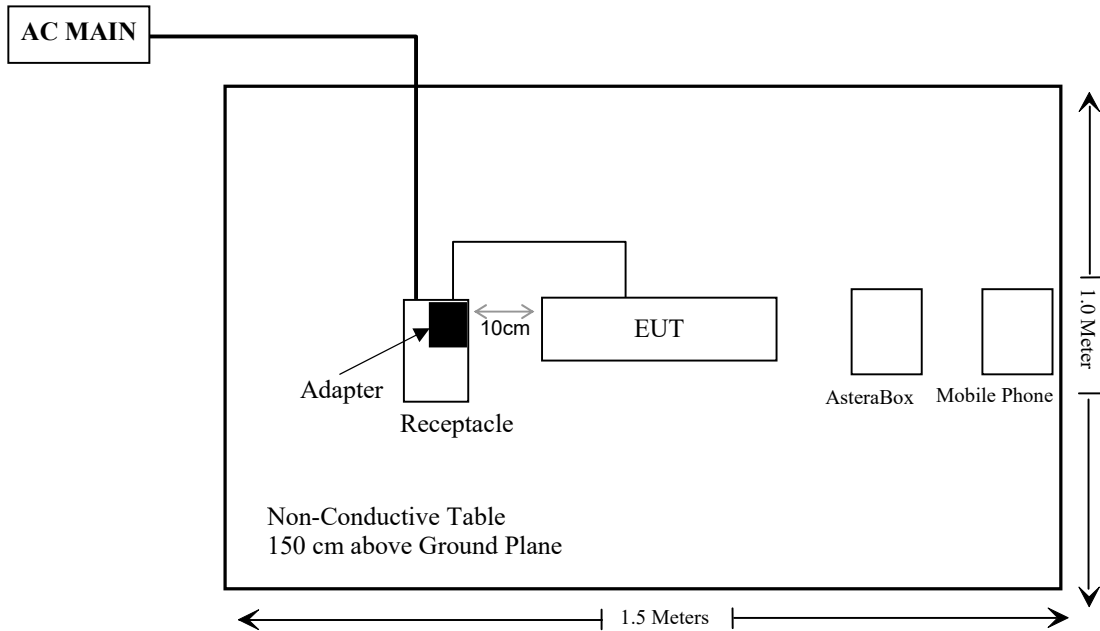
For FP1-BTB:



For FP2-BTB:



For Radiate emission: (above 1GHz)



SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test | Result |
|-------------------------------|---|---------------|
| FCC §15.247 (i), §2.1091 | Maximum Permissible Exposure(MPE) | Compliant |
| §15.203 | Antenna Requirement | Compliant |
| §15.207(a) | AC Line Conducted Emissions | Compliant |
| §15.205, §15.209 & §15.247(d) | Radiated Emissions | Compliant |
| §15.247(a)(1) | 20 dB Emission Bandwidth & 99% Occupied Bandwidth | Compliant |
| §15.247(a)(1) | Channel Separation Test | Compliant |
| §15.247(a)(1)(iii) | Time of Occupancy (Dwell Time) | Compliant |
| §15.247(a)(1)(iii) | Quantity of hopping channel Test | Compliant |
| §15.247(b)(1) | Peak Output Power Measurement | Compliant |
| §15.247(d) | Band edges | Compliant |

TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|--|------------------------------|-------------------|-----------------|------------------|----------------------|
| Conducted emission test | | | | | |
| Rohde& Schwarz | EMI Test Receiver | ESCI | 100784 | 2021/12/13 | 2022/12/12 |
| Rohde & Schwarz | L.I.S.N. | ENV216 | 101314 | 2021/12/13 | 2022/12/12 |
| Anritsu Corp | 50 Coaxial Switch | MP59B | 6100237248 | 2021/12/13 | 2022/12/12 |
| Conducted Emission Test Software: e3 19821b (V9) | | | | | |
| Radiated emission test | | | | | |
| Rohde& Schwarz | Test Receiver | ESR | 102725 | 2021/12/13 | 2022/12/12 |
| Rohde&Schwarz | Spectrum Analyzer | FSV40 | 101949 | 2021/05/18 | 2022/05/17 |
| SONOMA INSTRUMENT | Amplifier | 310 N | 186131 | 2021/11/09 | 2022/11/08 |
| A.H. Systems, inc. | Preamplifier | PAM-0118P | 135 | 2021/11/09 | 2022/11/08 |
| Schwarzbeck | Bilog Antenna | VULB9163 | 9163-323 | 2021/07/06 | 2024/07/05 |
| Schwarzbeck | Horn Antenna | BBHA9120D | 9120D-1067 | 2020/01/05 | 2023/01/04 |
| Wainwright | High Pass Filter | HPM-1.2/18G-60 | 110 | 2020/12/14 | 2021/12/13 |
| Wainwright | High Pass Filter | HPM-1.2/18G-60 | 110 | 2021/12/14 | 2022/12/13 |
| Radiated Emission Test Software: e3 19821b (V9) | | | | | |
| RF conducted test | | | | | |
| Rohde & Schwarz | Spectrum Analyzer | FSV-40 | 101495 | 2020/12/13 | 2021/12/12 |
| Rohde & Schwarz | Spectrum Analyzer | FSV-40 | 101495 | 2021/12/13 | 2022/12/12 |
| Rohde & Schwarz | Open Switch and Control Unit | OSP120 + OSP-B157 | 101244 + 100866 | 2020/12/13 | 2021/12/12 |
| Rohde & Schwarz | Open Switch and Control Unit | OSP120 + OSP-B157 | 101244 + 100866 | 2021/12/13 | 2022/12/12 |
| Unknown | RF Cable | Unknown | Unknown | Each time | / |

* **Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

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

Applicable Standard

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

Limits for General Population/Uncontrolled Exposure

| Limits for General Population/Uncontrolled Exposure | | | | |
|--|--------------------------------------|--------------------------------------|--|---------------------------------|
| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density (mW/cm²) | 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

Result

Calculated Formulary:

Predication of MPE limit at a given distance

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

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

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

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

| Mode | Frequency (MHz) | Antenna Gain | | Tune up conducted power | | Evaluation Distance (cm) | Power Density (mW/cm ²) | MPE Limit (mW/cm ²) |
|-------|-----------------|--------------|-----------|-------------------------|--------|--------------------------|-------------------------------------|---------------------------------|
| | | (dBi) | (numeric) | (dBm) | (mW) | | | |
| BT | 2402-2480 | 7.35 | 5.43 | 7.0 | 5.01 | 20 | 0.005 | 1 |
| BLE | 2402-2480 | 7.35 | 5.43 | 4.5 | 2.82 | 20 | 0.003 | 1 |
| Wi-Fi | 2412-2462 | 7.35 | 5.43 | 21.0 | 125.89 | 20 | 0.136 | 1 |
| UHF | 917-922.2 | 2.0 | 1.58 | 9.5 | 8.91 | 20 | 0.003 | 0.611 |

- Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
 2. The BT/BLE/Wi-Fi can transmit at the same time with the UHF, and the BT, BLE and Wi-Fi can not transmitting simultaneously.

Simultaneous transmitting consideration (worst case):

$$\text{The ratio} = \text{MPE}_{\text{Wi-Fi}} / \text{limit} + \text{MPE}_{\text{UHF}} / \text{limit} = 0.136/1 + 0.003/0.611 = 0.141 < 1.0$$

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

Result: Compliant.

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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 use of a standard antenna jack or electrical connector is prohibited.

Antenna Connector Construction

The EUT has one internal antenna arrangement, which was permanently attached to the EUT and the antenna gain is 2.0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

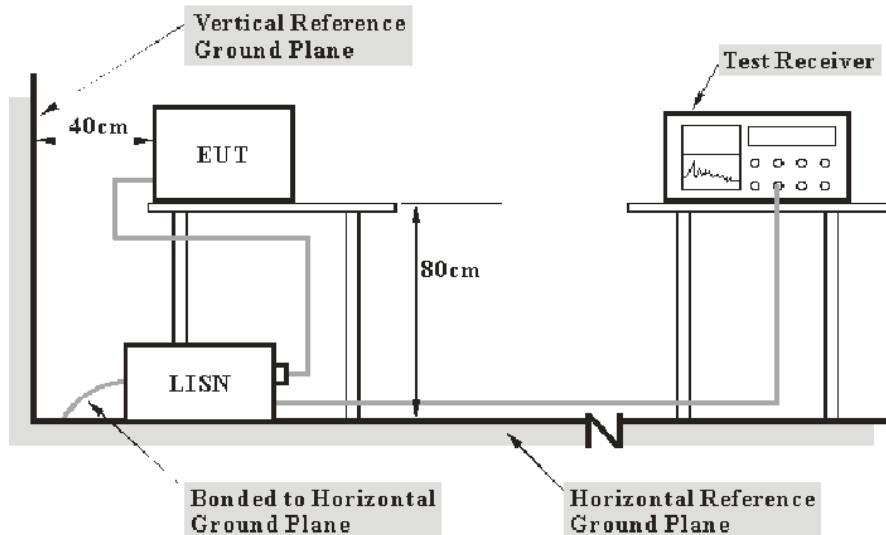
Result: Compliant.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



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

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

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

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

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

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

Test Procedure

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.

Transd Factor & Margin Calculation

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

$$\text{Transd Factor} = \text{LISN VDF} + \text{Cable Loss}$$

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 margin calculation is as follows:

$$\begin{aligned} \text{Over limit} &= \text{Level} - \text{Limit} \\ \text{Level} &= \text{Reading level} + \text{Transd Factor} \end{aligned}$$

Test Data

Environmental Conditions

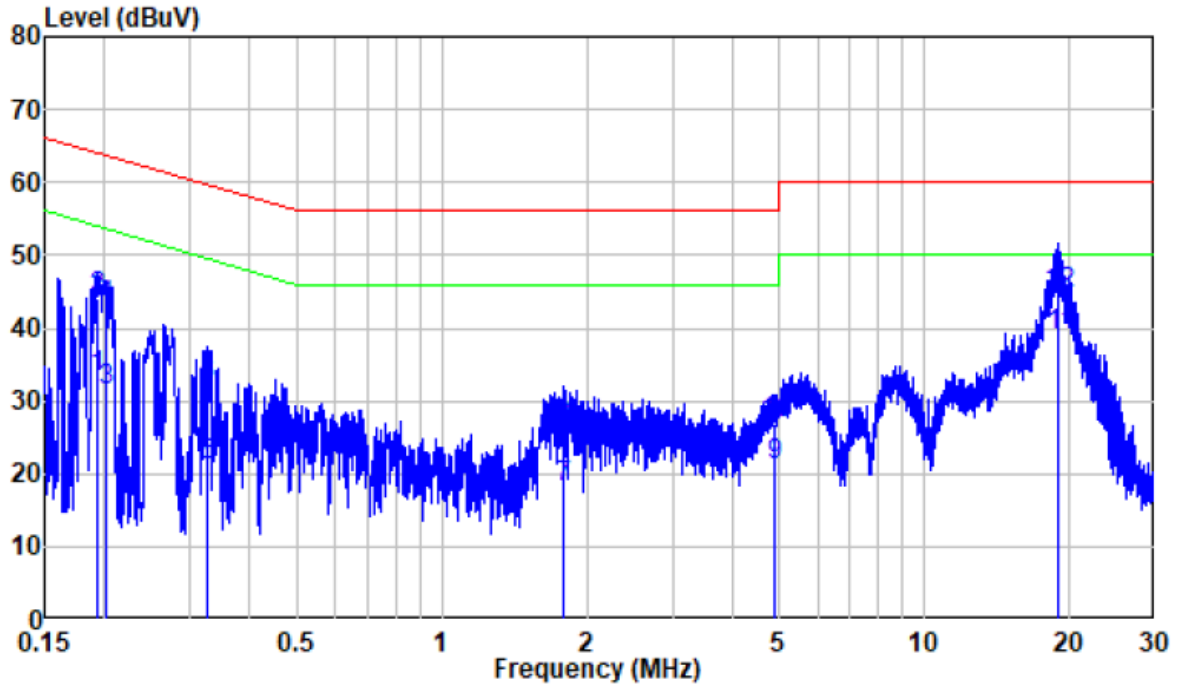
| | |
|---------------------------|-----------|
| Temperature: | 23 °C |
| Relative Humidity: | 54~60 % |
| ATM Pressure: | 101.0 kPa |

The testing was performed by Bin Deng on 2021-12-22 and 2022-01-07.

EUT operation mode: BT+UHF Transmitting

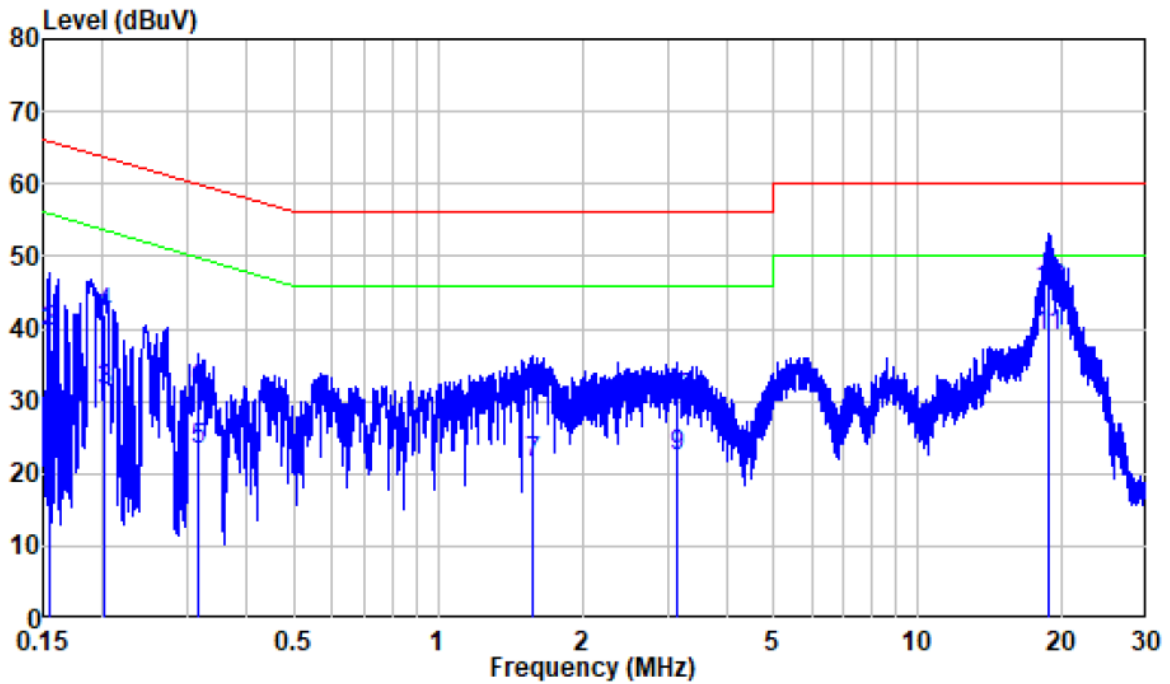
For FPI-BTB

AC 120V/60 Hz, Line



| | Freq | Factor | Read Level | Limit Level | Over Limit | Remark |
|----|--------|--------|------------|-------------|------------|----------------|
| | MHz | dB | dBuV | dBuV | dBuV | dB |
| 1 | 0.193 | 9.81 | 23.43 | 33.24 | 53.92 | -20.68 Average |
| 2 | 0.193 | 9.81 | 34.34 | 44.15 | 63.92 | -19.77 QP |
| 3 | 0.200 | 9.80 | 21.66 | 31.46 | 53.60 | -22.14 Average |
| 4 | 0.200 | 9.80 | 33.20 | 43.00 | 63.60 | -20.60 QP |
| 5 | 0.327 | 9.80 | 11.24 | 21.04 | 49.54 | -28.50 Average |
| 6 | 0.327 | 9.80 | 22.23 | 32.03 | 59.54 | -27.51 QP |
| 7 | 1.782 | 9.90 | 8.14 | 18.04 | 46.00 | -27.96 Average |
| 8 | 1.782 | 9.90 | 16.37 | 26.27 | 56.00 | -29.73 QP |
| 9 | 4.893 | 9.99 | 11.19 | 21.18 | 46.00 | -24.82 Average |
| 10 | 4.893 | 9.99 | 16.77 | 26.76 | 56.00 | -29.24 QP |
| 11 | 18.958 | 10.17 | 28.75 | 38.92 | 50.00 | -11.08 Average |
| 12 | 18.958 | 10.17 | 34.48 | 44.65 | 60.00 | -15.35 QP |

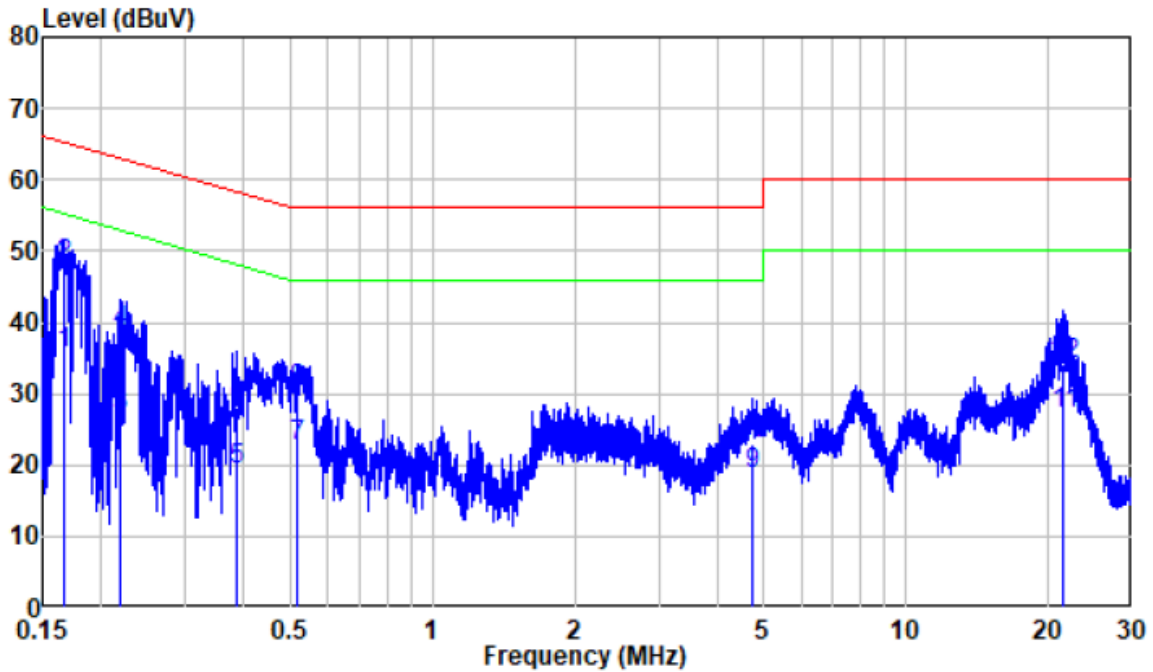
AC 120V/60 Hz, Neutral



| | Freq | Factor | Read Level | Limit Level | Limit Line | Over Limit | Remark |
|----|--------|--------|------------|-------------|------------|------------|---------|
| | MHz | dB | dBuV | dBuV | dBuV | dB | |
| 1 | 0.154 | 9.91 | 8.72 | 18.63 | 55.76 | -37.13 | Average |
| 2 | 0.154 | 9.91 | 29.64 | 39.55 | 65.76 | -26.21 | QP |
| 3 | 0.202 | 10.00 | 21.28 | 31.28 | 53.52 | -22.24 | Average |
| 4 | 0.202 | 10.00 | 31.98 | 41.98 | 63.52 | -21.54 | QP |
| 5 | 0.315 | 9.95 | 13.32 | 23.27 | 49.84 | -26.57 | Average |
| 6 | 0.315 | 9.95 | 21.54 | 31.49 | 59.84 | -28.35 | QP |
| 7 | 1.577 | 9.92 | 11.61 | 21.53 | 46.00 | -24.47 | Average |
| 8 | 1.577 | 9.92 | 20.97 | 30.89 | 56.00 | -25.11 | QP |
| 9 | 3.138 | 9.99 | 12.47 | 22.46 | 46.00 | -23.54 | Average |
| 10 | 3.138 | 9.99 | 20.28 | 30.27 | 56.00 | -25.73 | QP |
| 11 | 18.733 | 10.17 | 28.83 | 39.00 | 50.00 | -11.00 | Average |
| 12 | 18.733 | 10.17 | 35.25 | 45.42 | 60.00 | -14.58 | QP |

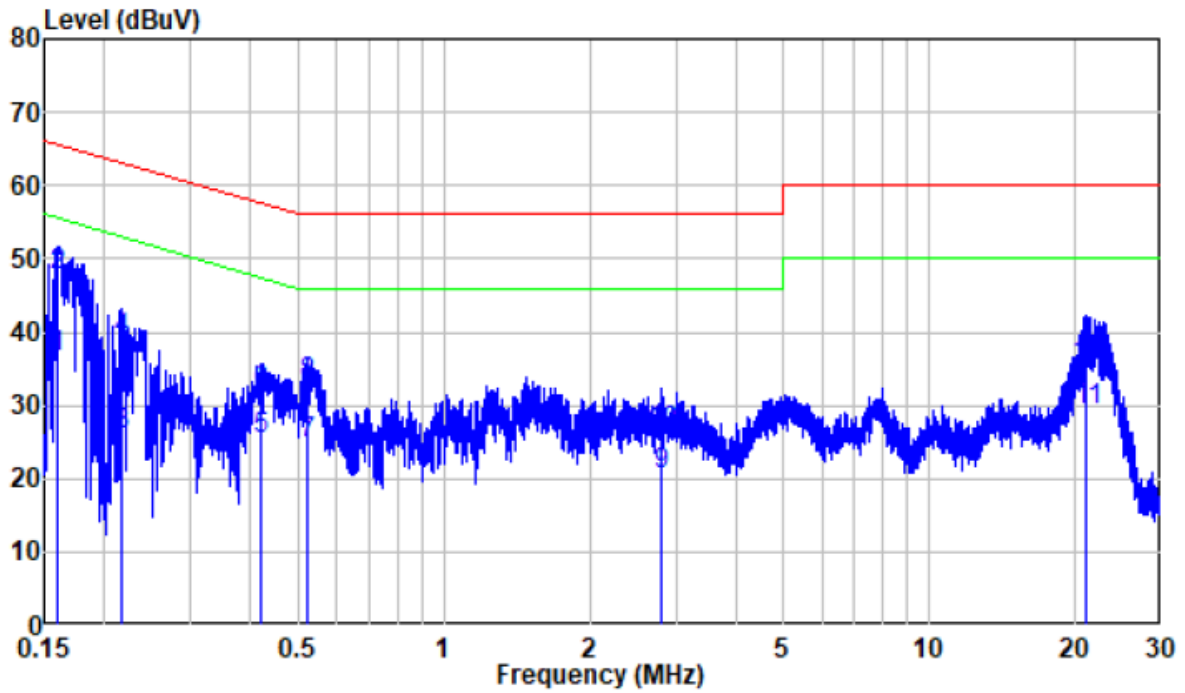
For FP2-BTB

AC 120V/60 Hz, Line



| | Freq | Factor | Read Level | Limit Level | Limit Line | Over Limit | Remark |
|----|--------|--------|------------|-------------|------------|------------|---------|
| | MHz | dB | dBuV | dBuV | dBuV | dB | |
| 1 | 0.166 | 9.86 | 25.80 | 35.66 | 55.16 | -19.50 | Average |
| 2 | 0.166 | 9.86 | 38.19 | 48.05 | 65.16 | -17.11 | QP |
| 3 | 0.220 | 9.80 | 17.06 | 26.86 | 52.82 | -25.96 | Average |
| 4 | 0.220 | 9.80 | 28.85 | 38.65 | 62.82 | -24.17 | QP |
| 5 | 0.385 | 9.80 | 9.58 | 19.38 | 48.16 | -28.78 | Average |
| 6 | 0.385 | 9.80 | 18.27 | 28.07 | 58.16 | -30.09 | QP |
| 7 | 0.520 | 9.81 | 12.84 | 22.65 | 46.00 | -23.35 | Average |
| 8 | 0.520 | 9.81 | 20.57 | 30.38 | 56.00 | -25.62 | QP |
| 9 | 4.750 | 9.98 | 8.73 | 18.71 | 46.00 | -27.29 | Average |
| 10 | 4.750 | 9.98 | 13.01 | 22.99 | 56.00 | -33.01 | QP |
| 11 | 21.543 | 10.26 | 16.76 | 27.02 | 50.00 | -22.98 | Average |
| 12 | 21.543 | 10.26 | 23.94 | 34.20 | 60.00 | -25.80 | QP |

AC 120V/60 Hz, Neutral



| | Freq | Factor | Read Level | Limit Level | Limit Line | Over Limit | Remark |
|----|--------|--------|------------|-------------|------------|------------|---------|
| | MHz | dB | dBuV | dBuV | dBuV | dB | |
| 1 | 0.160 | 9.92 | 26.66 | 36.58 | 55.46 | -18.88 | Average |
| 2 | 0.160 | 9.92 | 37.81 | 47.73 | 65.46 | -17.73 | QP |
| 3 | 0.216 | 9.99 | 16.10 | 26.09 | 52.97 | -26.88 | Average |
| 4 | 0.216 | 9.99 | 28.99 | 38.98 | 62.97 | -23.99 | QP |
| 5 | 0.421 | 9.92 | 15.48 | 25.40 | 47.42 | -22.02 | Average |
| 6 | 0.421 | 9.92 | 21.88 | 31.80 | 57.42 | -25.62 | QP |
| 7 | 0.522 | 9.91 | 14.90 | 24.81 | 46.00 | -21.19 | Average |
| 8 | 0.522 | 9.91 | 23.03 | 32.94 | 56.00 | -23.06 | QP |
| 9 | 2.805 | 9.98 | 10.69 | 20.67 | 46.00 | -25.33 | Average |
| 10 | 2.805 | 9.98 | 16.28 | 26.26 | 56.00 | -29.74 | QP |
| 11 | 21.063 | 10.22 | 19.08 | 29.30 | 50.00 | -20.70 | Average |
| 12 | 21.063 | 10.22 | 24.96 | 35.18 | 60.00 | -24.82 | QP |

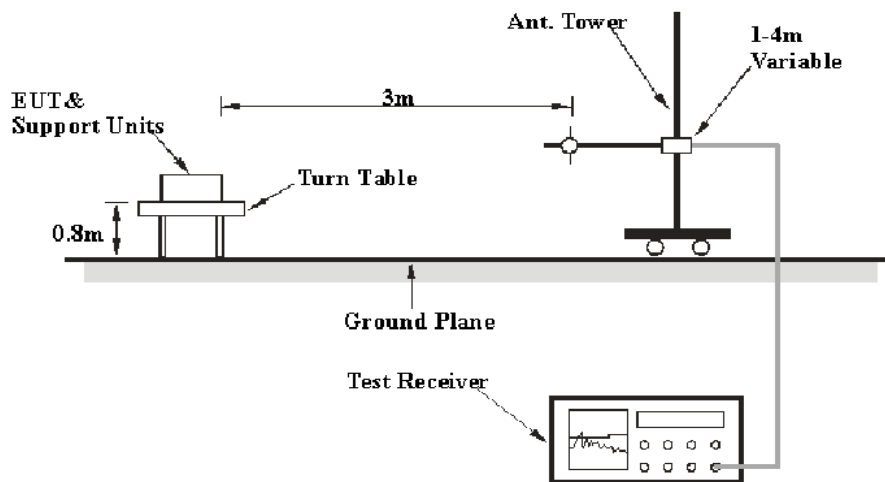
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

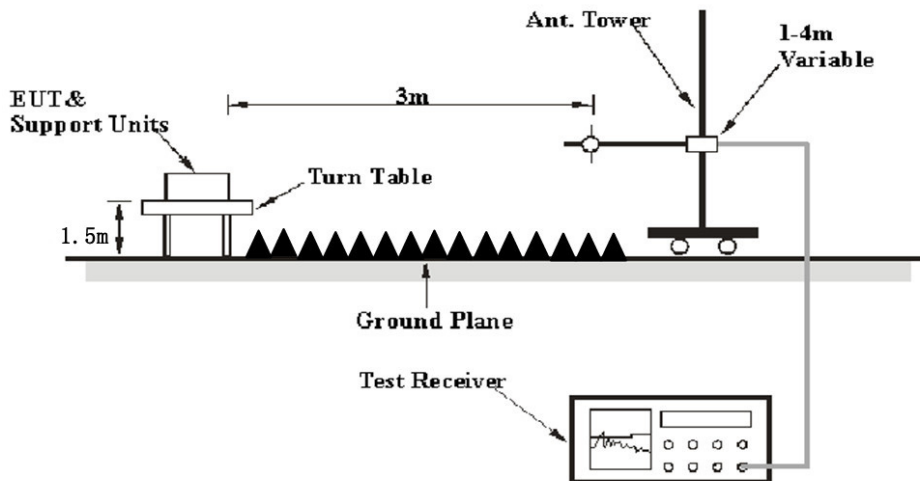
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



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

EMI Test Receiver & Spectrum Analyzer Setup

The EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

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

Test Procedure

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

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

Factor & Margin Calculation

The 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:

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

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

$$\begin{aligned} \text{Margin/Over limit} &= \text{Level/Corrected Amplitude} - \text{Limit} \\ \text{Level/Corrected Amplitude} &= \text{Reading} + \text{Factor} \end{aligned}$$

Test Data

Environmental Conditions

| | |
|---------------------------|------------|
| Temperature: | 20~25.8 °C |
| Relative Humidity: | 50~62 % |
| ATM Pressure: | 101.2 kPa |

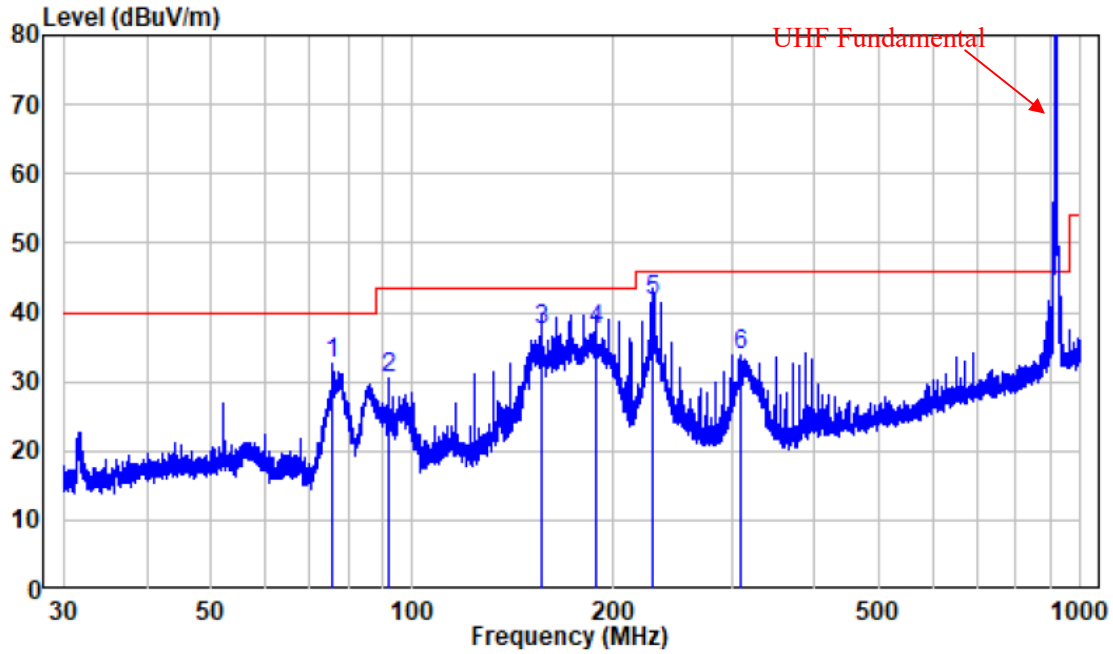
The testing was performed by Chao Mo on 2021-12-23 and 2022-01-06 for below 1GHz and by Caro hu on 2021-12-02, Bin Deng on 2021-12-22 for above 1GHz.

EUT operation mode: Transmitting(Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

30MHz-1GHz: (BT+UHF Transmitting)

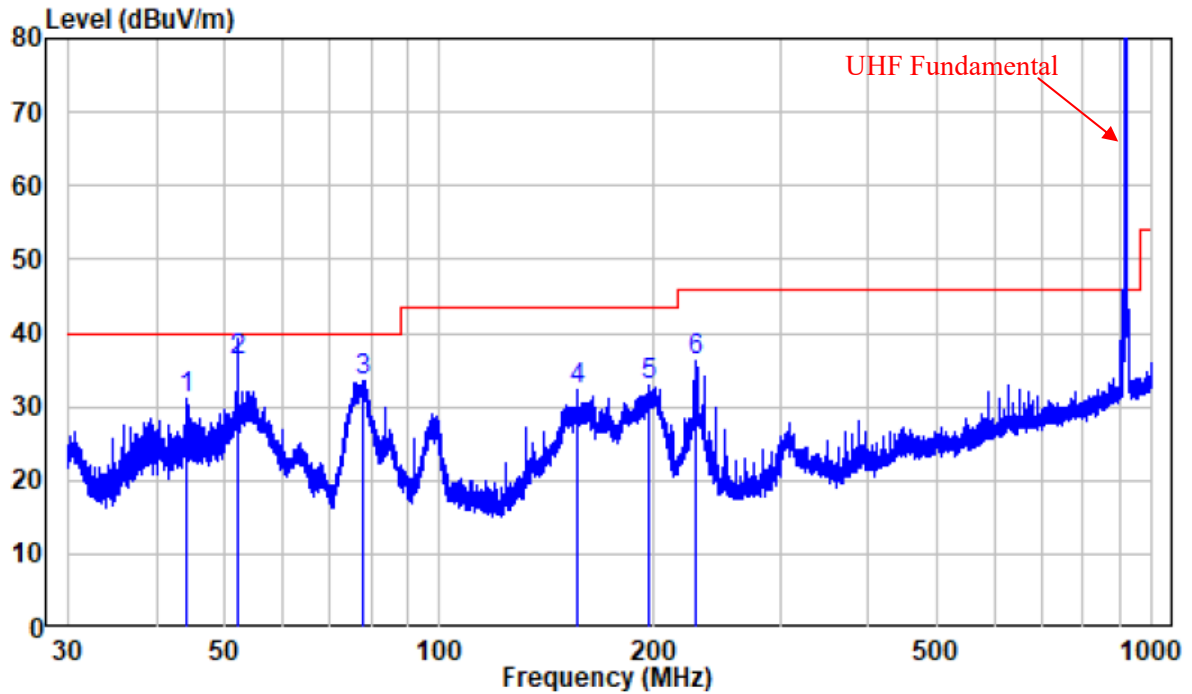
For FPI-BTB

Horizontal:



| | Freq | Factor | Read Level | Limit Level | Limit Line | Over Limit | Remark |
|---|--------|--------|------------|-------------|------------|------------|--------|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 75.98 | -16.42 | 48.97 | 32.55 | 40.00 | -7.45 | Peak |
| 2 | 92.02 | -13.29 | 43.88 | 30.59 | 43.50 | -12.91 | Peak |
| 3 | 155.98 | -14.82 | 52.30 | 37.48 | 43.50 | -6.02 | QP |
| 4 | 188.00 | -11.82 | 49.40 | 37.58 | 43.50 | -5.92 | QP |
| 5 | 227.99 | -11.17 | 52.69 | 41.52 | 46.00 | -4.48 | QP |
| 6 | 310.00 | -8.89 | 42.84 | 33.95 | 46.00 | -12.05 | Peak |

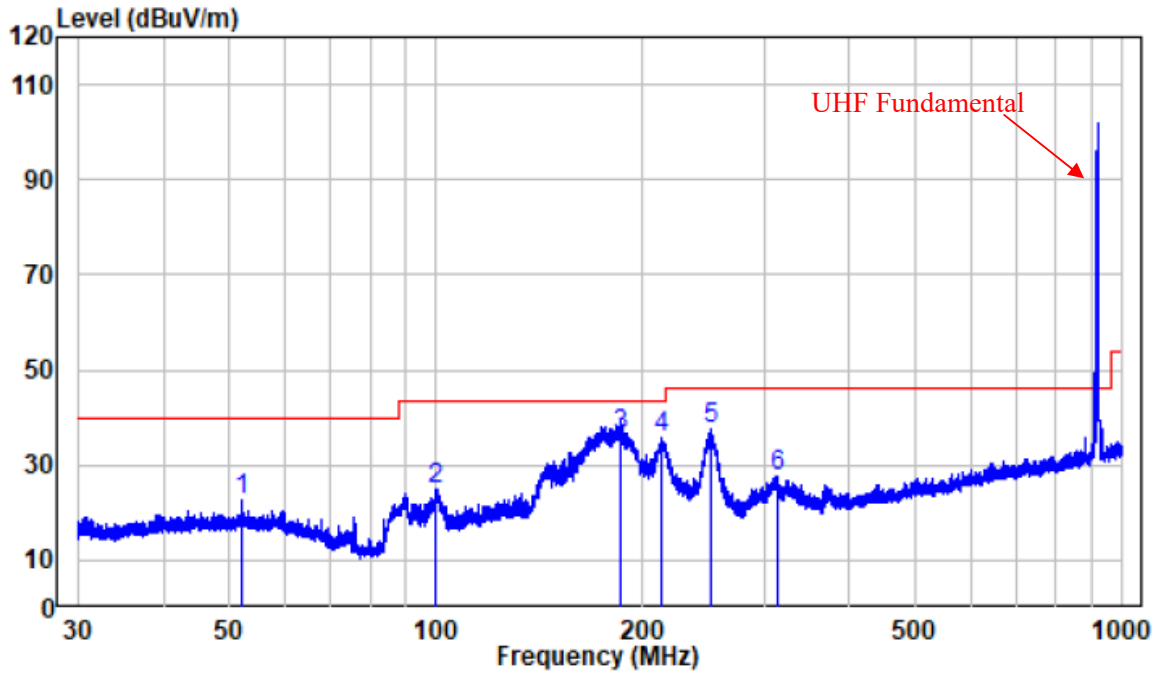
Vertical



| | Freq | Factor | Read Level | Limit Level | Limit Line | Over Limit | Remark |
|---|--------|--------|------------|-------------|------------|------------|--------|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 44.02 | -9.90 | 40.87 | 30.97 | 40.00 | -9.03 | Peak |
| 2 | 52.00 | -9.97 | 46.14 | 36.17 | 40.00 | -3.83 | Peak |
| 3 | 77.83 | -16.59 | 50.06 | 33.47 | 40.00 | -6.53 | QP |
| 4 | 155.98 | -14.82 | 47.08 | 32.26 | 43.50 | -11.24 | Peak |
| 5 | 195.99 | -11.57 | 44.40 | 32.83 | 43.50 | -10.67 | Peak |
| 6 | 227.99 | -11.17 | 47.37 | 36.20 | 46.00 | -9.80 | Peak |

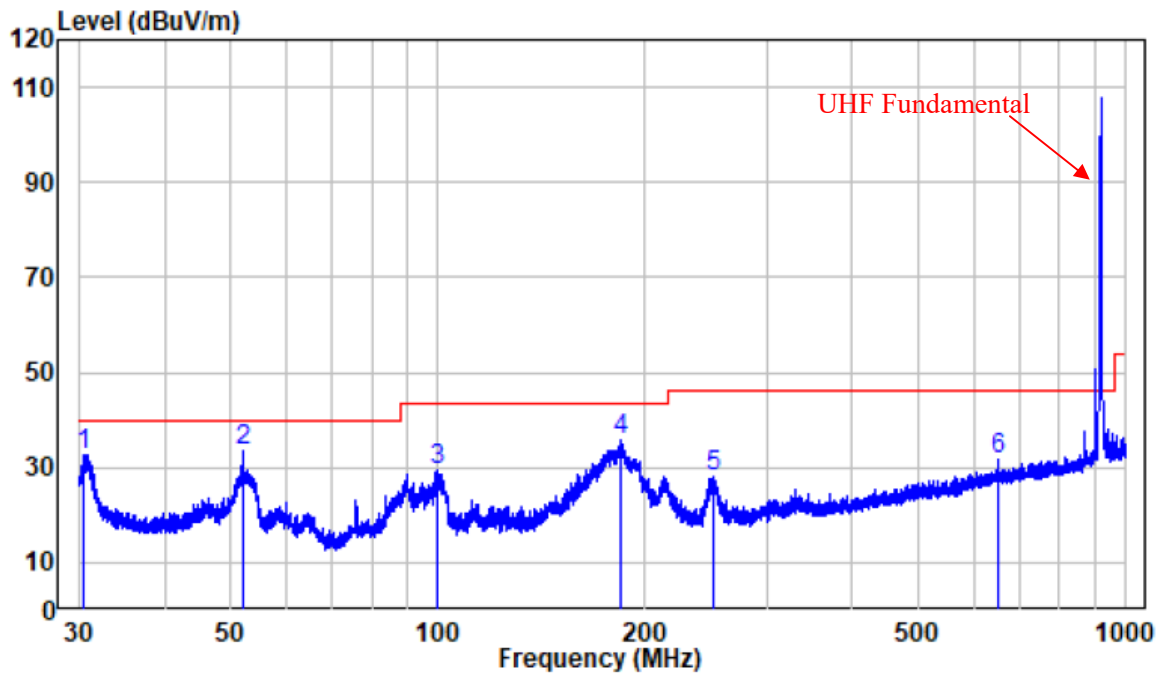
For FP2-BTB

Horizontal:



| | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---------|--------|------------|--------|------------|------------|--------|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 52.002 | -9.97 | 32.42 | 22.45 | 40.00 | -17.55 | Peak |
| 2 | 100.009 | -11.80 | 36.82 | 25.02 | 43.50 | -18.48 | Peak |
| 3 | 185.300 | -12.15 | 48.24 | 36.09 | 43.50 | -7.41 | QP |
| 4 | 213.295 | -11.73 | 47.35 | 35.62 | 43.50 | -7.88 | Peak |
| 5 | 251.511 | -10.71 | 48.16 | 37.45 | 46.00 | -8.55 | Peak |
| 6 | 313.413 | -8.77 | 36.51 | 27.74 | 46.00 | -18.26 | Peak |

Vertical



| | Freq | Factor | Read Level | Limit Level | Limit Line | Over Limit | Remark |
|---|---------|--------|------------|-------------|------------|------------|--------|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 30.531 | -12.34 | 44.83 | 32.49 | 40.00 | -7.51 | Peak |
| 2 | 52.025 | -9.98 | 43.66 | 33.68 | 40.00 | -6.32 | Peak |
| 3 | 99.878 | -11.83 | 41.10 | 29.27 | 43.50 | -14.23 | Peak |
| 4 | 184.814 | -12.20 | 48.00 | 35.80 | 43.50 | -7.70 | Peak |
| 5 | 251.401 | -10.71 | 38.67 | 27.96 | 46.00 | -18.04 | Peak |
| 6 | 649.945 | -1.74 | 33.34 | 31.60 | 46.00 | -14.40 | Peak |

Above 1GHz:

| Frequency (MHz) | Receiver | | Turntable Degree | Rx Antenna | | Corrected Factor (dB/m) | Corrected Amplitude (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
|-----------------|----------------------|------------|------------------|------------|-------------|-------------------------|------------------------------------|----------------------|-------------|
| | Reading (dB μ V) | PK/QP/Ave. | | Height (m) | Polar (H/V) | | | | |
| Low Channel | | | | | | | | | |
| 1834 | 52.63 | PK | 8 | 1.8 | H | -8.5 | 44.13 | 74 | -29.87 |
| 1834 | 50.05 | PK | 192 | 1.6 | V | -8.5 | 41.55 | 74 | -32.45 |
| 2751 | 48.49 | PK | 192 | 1.6 | H | -6.6 | 41.89 | 74 | -32.11 |
| 2751 | 46.69 | PK | 1 | 1.0 | V | -6.6 | 40.09 | 74 | -33.91 |
| 3668 | 45.14 | PK | 192 | 1.6 | H | -5.81 | 39.33 | 74 | -34.67 |
| 3668 | 49.31 | PK | 1 | 1.0 | V | -5.81 | 43.5 | 74 | -30.5 |
| Middle Channel | | | | | | | | | |
| 1839.2 | 54.48 | PK | 240 | 1.9 | H | -8.47 | 46.01 | 74 | -27.99 |
| 1839.2 | 65.38 | PK | 28 | 1.0 | V | -8.47 | 56.91 | 74 | -17.09 |
| 1839.2 | 43.43 | AVG | 28 | 1.0 | V | -8.47 | 34.96 | 54 | -19.04 |
| 2758.8 | 50.56 | PK | 128 | 1.5 | H | -6.54 | 44.02 | 74 | -29.98 |
| 2758.8 | 46.87 | PK | 311 | 2.1 | V | -6.54 | 40.33 | 74 | -33.67 |
| 3678.4 | 46.96 | PK | 28 | 1.0 | H | -5.77 | 41.19 | 74 | -32.81 |
| 3678.4 | 50.91 | PK | 311 | 2.1 | V | -5.77 | 45.14 | 74 | -28.86 |
| High Channel | | | | | | | | | |
| 1844.4 | 55.78 | PK | 103 | 1.0 | H | -8.42 | 47.36 | 74 | -26.64 |
| 1844.4 | 58.85 | PK | 138 | 1.3 | V | -8.42 | 50.43 | 74 | -23.57 |
| 2766.6 | 50.59 | PK | 138 | 1.3 | H | -6.48 | 44.11 | 74 | -29.89 |
| 2766.6 | 47.65 | PK | 290 | 1.1 | V | -6.48 | 41.17 | 74 | -32.83 |
| 3688.8 | 46.6 | PK | 138 | 1.3 | H | -5.74 | 40.86 | 74 | -33.14 |
| 3688.8 | 51.04 | PK | 290 | 1.1 | V | -5.74 | 45.3 | 74 | -28.7 |

Note:

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

Corrected Amplitude = Corrected Factor + Reading

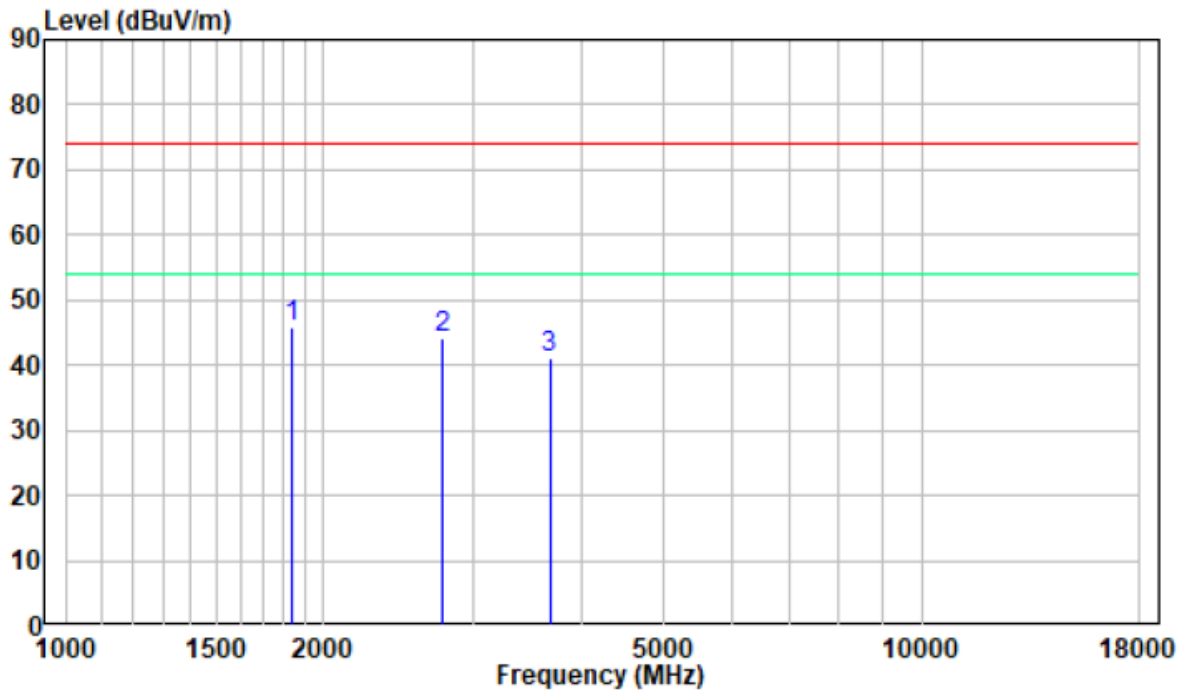
Margin = Corrected. Amplitude - Limit

The other spurious emission which is in the noise floor level was not recorded.

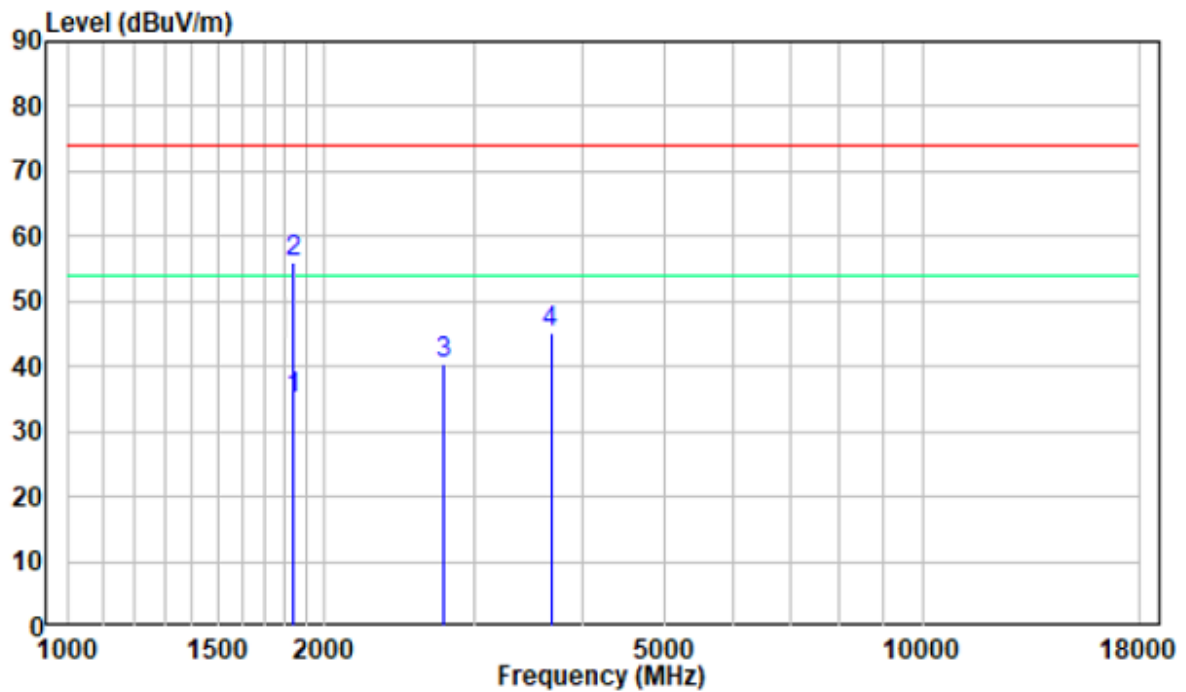
When the test result of peak was less than the limit of average, just peak value were recorded.

Pre-scan for Middle channel

Horizontal:



Vertical:



FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 27.5 °C |
| Relative Humidity: | 56 % |
| ATM Pressure: | 101.0 kPa |

The testing was performed by Fan Yang on 2021-10-21.

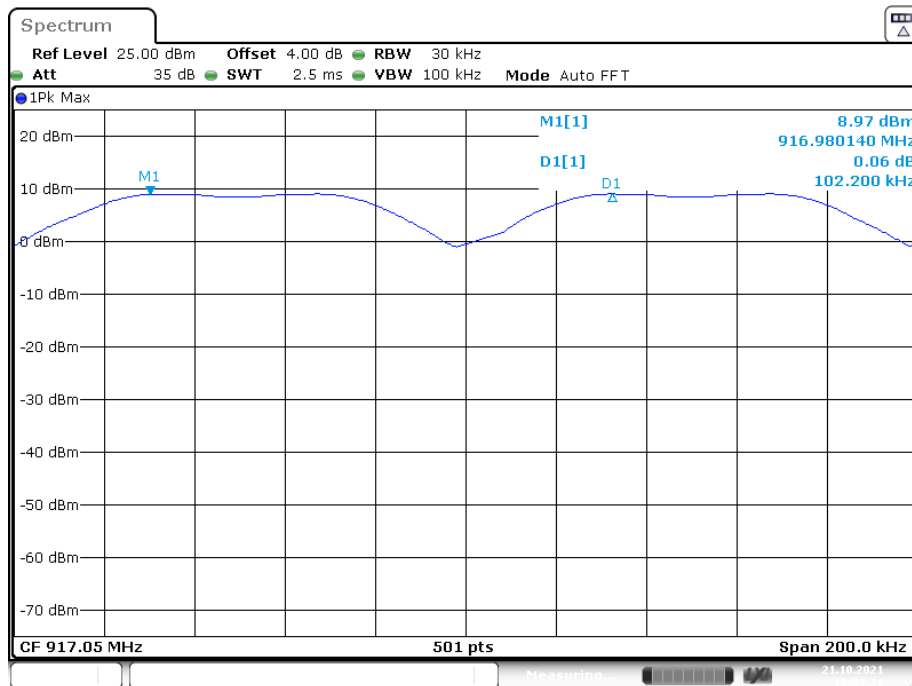
EUT operation mode: Transmitting

Test Result: Compliant.

| Channel | Channel Separation (MHz) | 20dB Bandwidth (kHz) | Result |
|---------|--------------------------|----------------------|--------|
| Low | 0.102 | 69.06 | Pass |
| Middle | 0.102 | 69.46 | Pass |
| High | 0.101 | 63.10 | Pass |

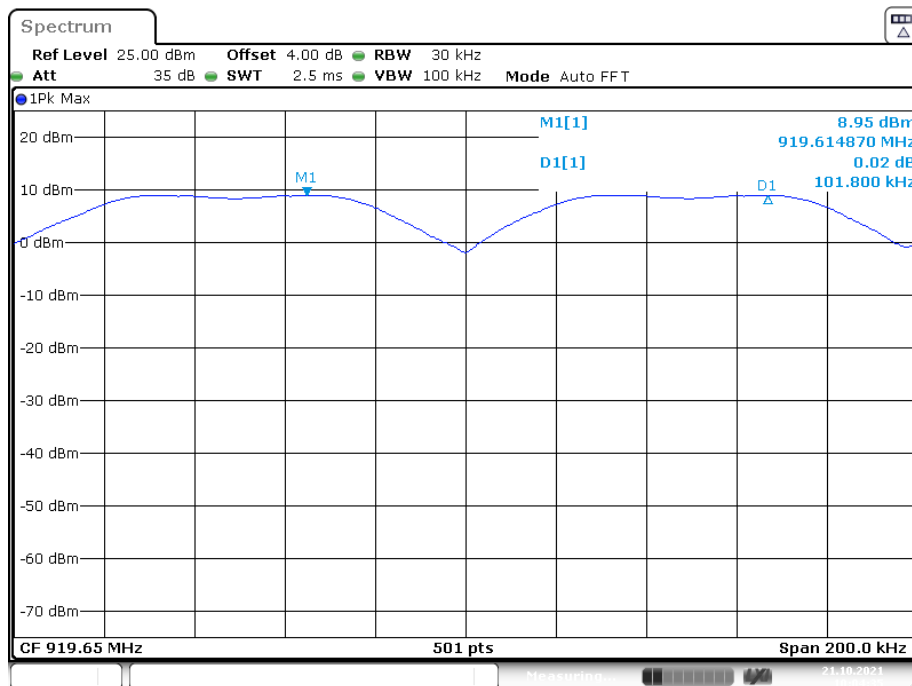
Note: The limit > 20 dB bandwidth

Low Channel



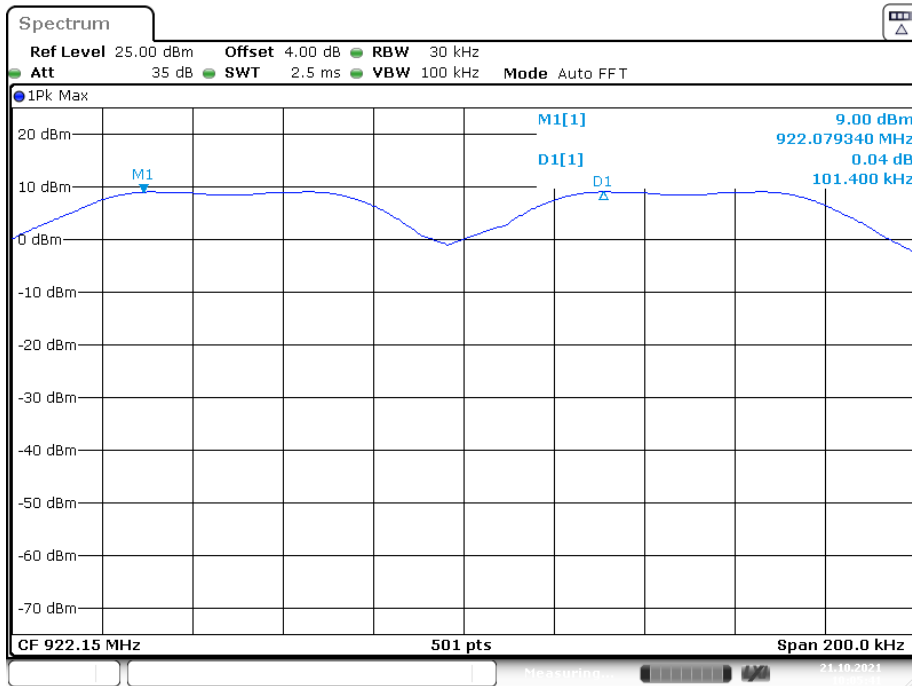
Date: 21.OCT.2021 10:03:21

Middle Channel



Date: 21.OCT.2021 10:04:35

High Channel



Date: 21.OCT.2021 10:05:42

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

According to §15.247(a) (1) (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

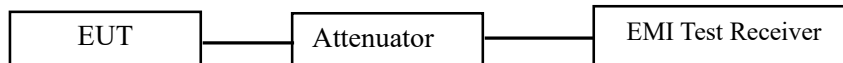
Test Procedure

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 27.5 °C |
| Relative Humidity: | 56 % |
| ATM Pressure: | 101.0 kPa |

The testing was performed by Fan Yang on 2021-10-21 and 2022-02-17.

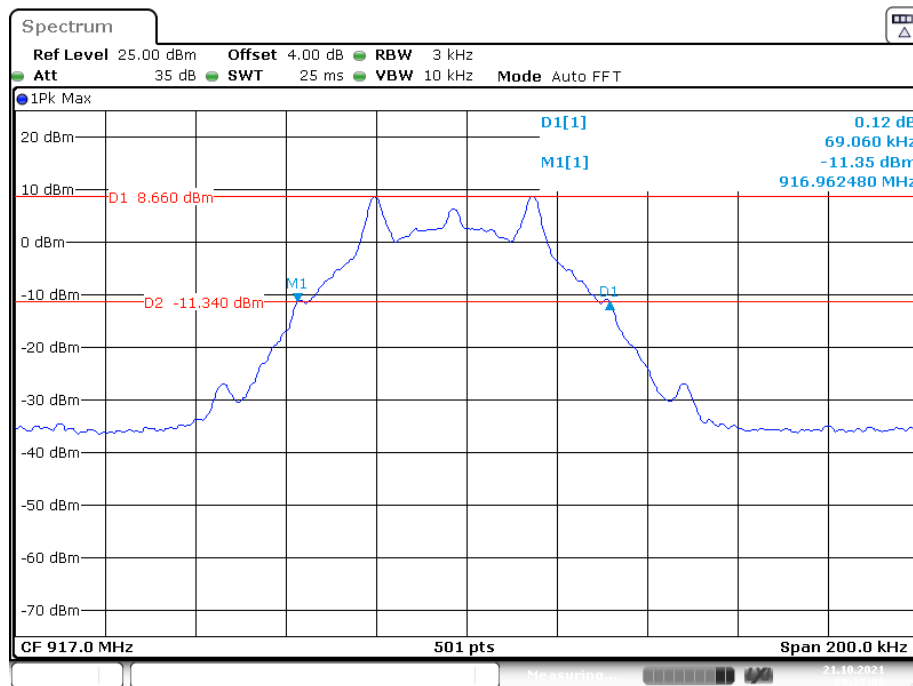
EUT operation mode: Transmitting

Test Result: Compliant.

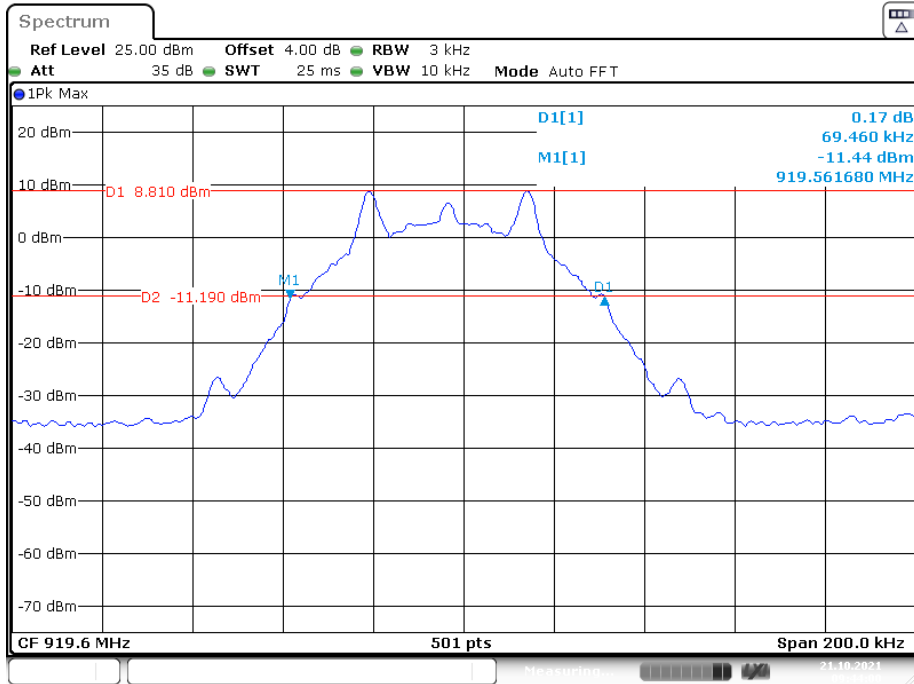
| Channel | Channel Frequency (MHz) | 20dB Bandwidth (kHz) |
|--------------|-------------------------|----------------------|
| Low Channel | 917.0 | 69.06 |
| Mid Channel | 919.6 | 69.46 |
| High Channel | 922.2 | 63.10 |

Please refer to the below plots:

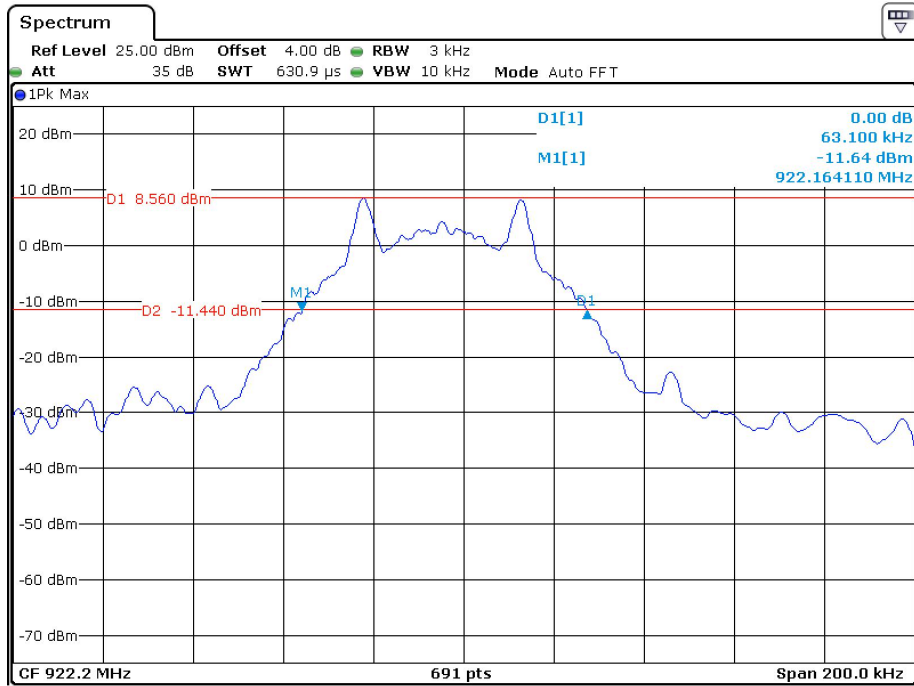
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

According to §15.247(a) (1) (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

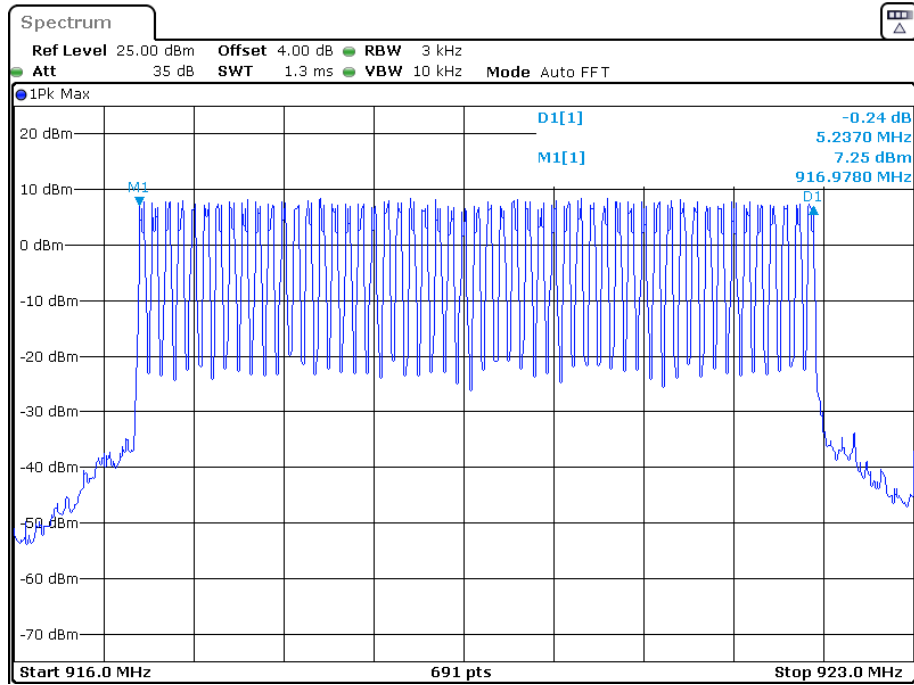
| | |
|---------------------------|-----------|
| Temperature: | 27.5 °C |
| Relative Humidity: | 56 % |
| ATM Pressure: | 101.0 kPa |

The testing was performed by Fan Yang on 2022-01-12.

EUT operation mode: Transmitting

Test Result: Compliant.

| Frequency Range MHz | Hopping Channels | Limit |
|--------------------------------|-------------------------|--------------|
| 902-928 | 53 | ≥50 |



Date: 12.JAN.2022 09:58:36

FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

According to §15.247(a) (1) (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 10kHz.
3. Set the VBW $\geq 3 \times$ RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

Test Data

Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 27.5 °C |
| Relative Humidity: | 56 % |
| ATM Pressure: | 101.0 kPa |

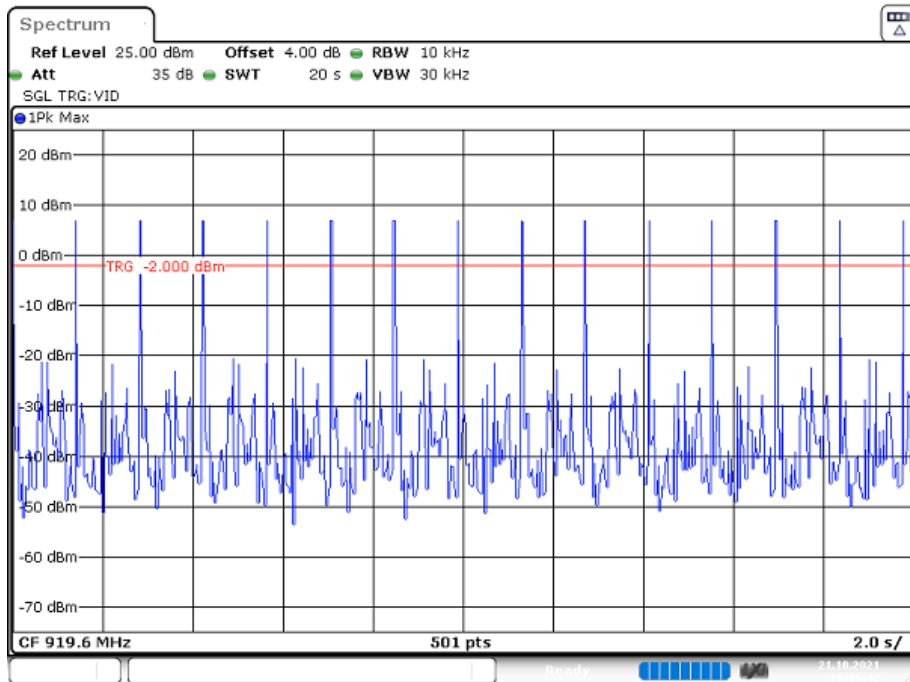
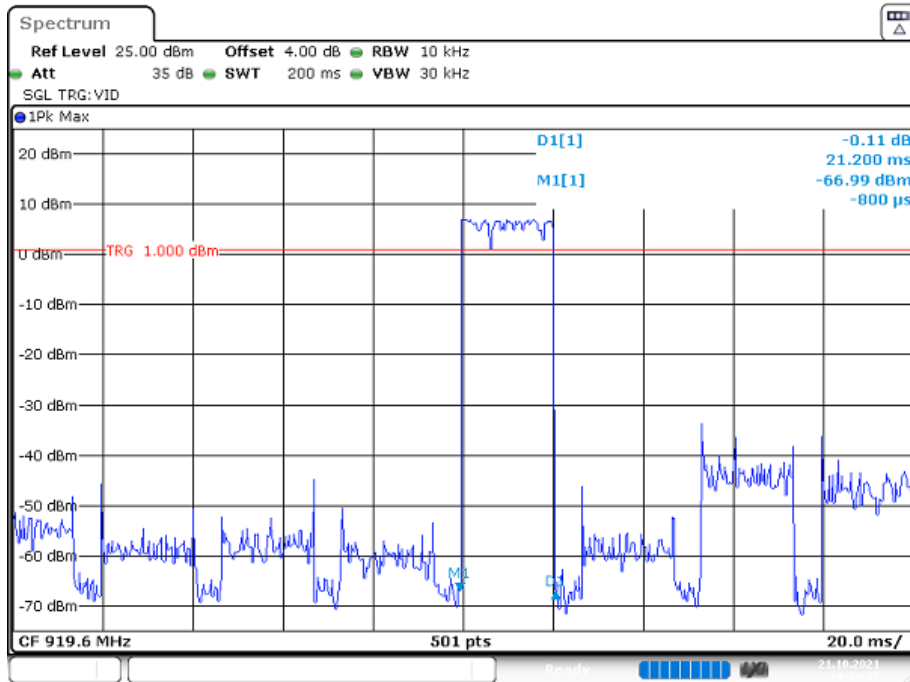
The testing was performed by Fan Yang on 2021-10-21.

EUT operation mode: Transmitting

Test Result: Compliant.

| Frequency (MHz) | Pulse Time (ms) | Hopping Number | Period Time (s) | Total of Dwell (ms) | Limit (ms) | Result |
|------------------------|------------------------|-----------------------|------------------------|----------------------------|-------------------|---------------|
| 919.6 | 21.200 | 15 | 20 | 318 | <400 | Pass |

Hop



FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to FCC §15.247(b) (2), For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Test Procedure

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

Test Data

Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 27.5 °C |
| Relative Humidity: | 56 % |
| ATM Pressure: | 101.0 kPa |

The testing was performed by Fan Yang on 2021-10-21.

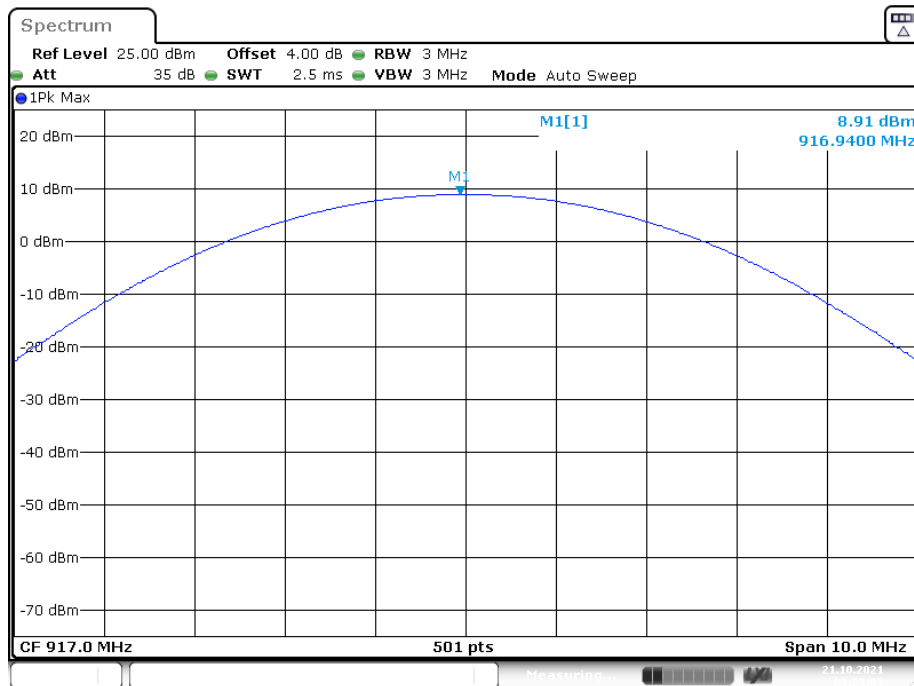
EUT operation mode: Transmitting

Test Result: Compliant.

| Mode | Channel | Frequency (MHz) | Reading power (dBm) | Limit (dBm) |
|------|---------|-----------------|---------------------|-------------|
| GFSK | Low | 917.0 | 8.91 | 30 |
| | Middle | 919.6 | 9.06 | 30 |
| | High | 922.2 | 9.11 | 30 |

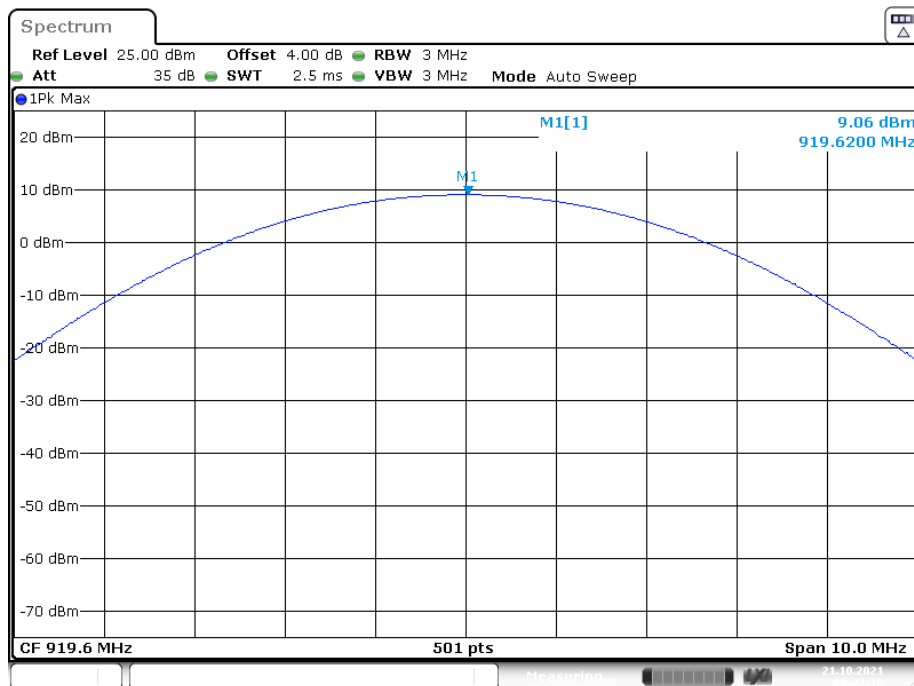
Note: The data above was tested in conducted mode.

Low Channel



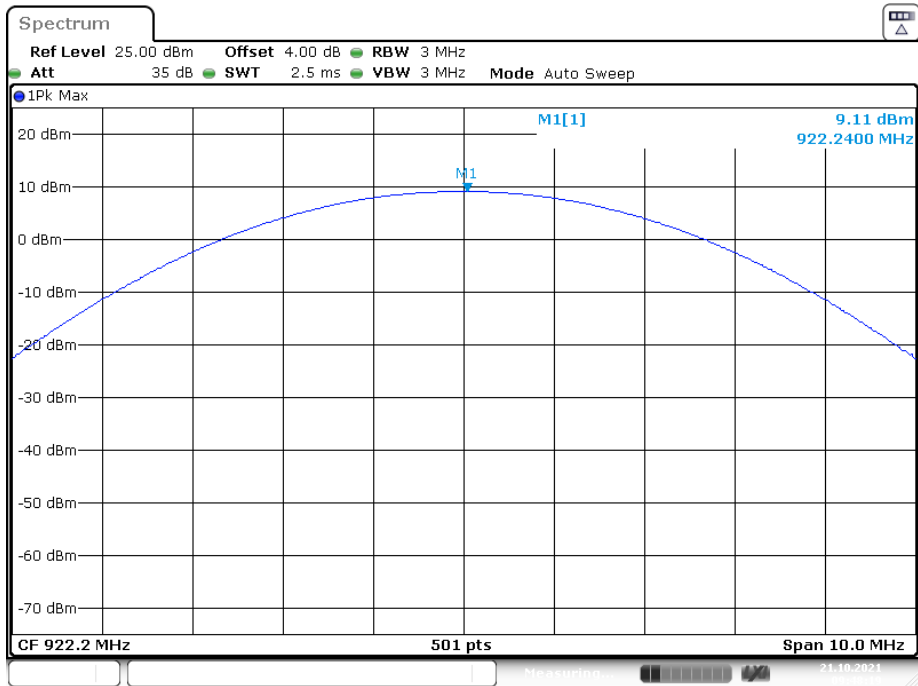
Date: 21.OCT.2021 09:25:05

Middle Channel



Date: 21.OCT.2021 09:42:18

High Channel



Date: 21.OCT.2021 09:48:19

FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

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

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 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: | 27.5 °C |
| Relative Humidity: | 56 % |
| ATM Pressure: | 101.0 kPa |

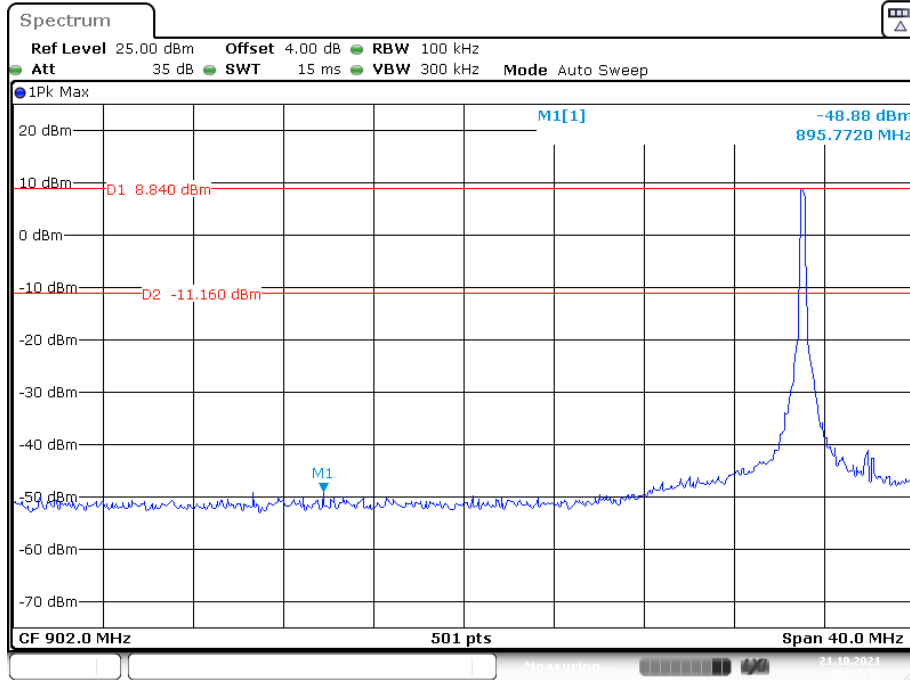
The testing was performed by Fan Yang on 2021-10-21.

EUT operation mode: Transmitting

Test Result: Compliant.

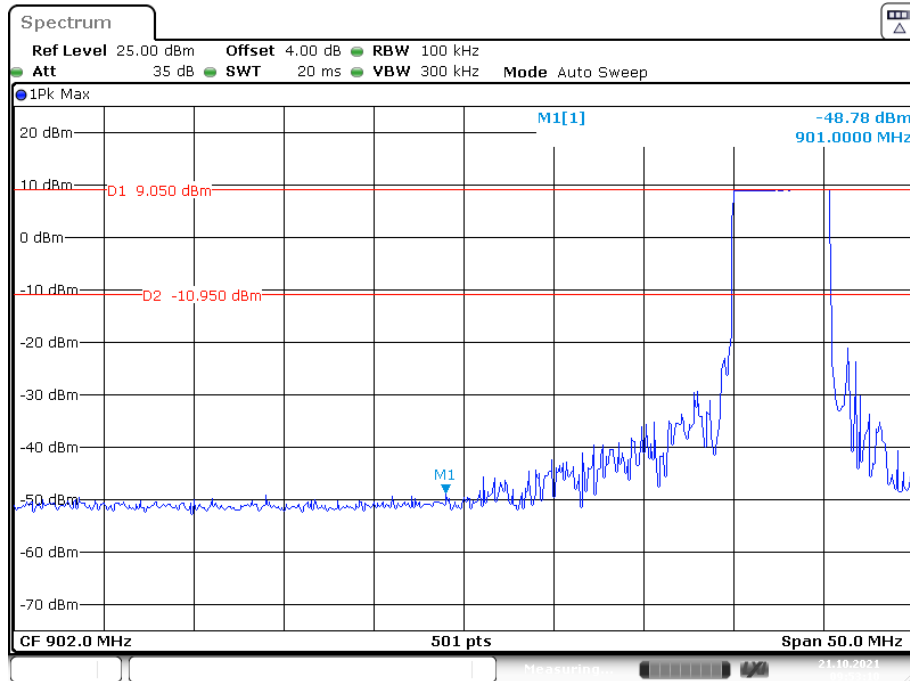
Conducted Band Edge Result:

Low Channel



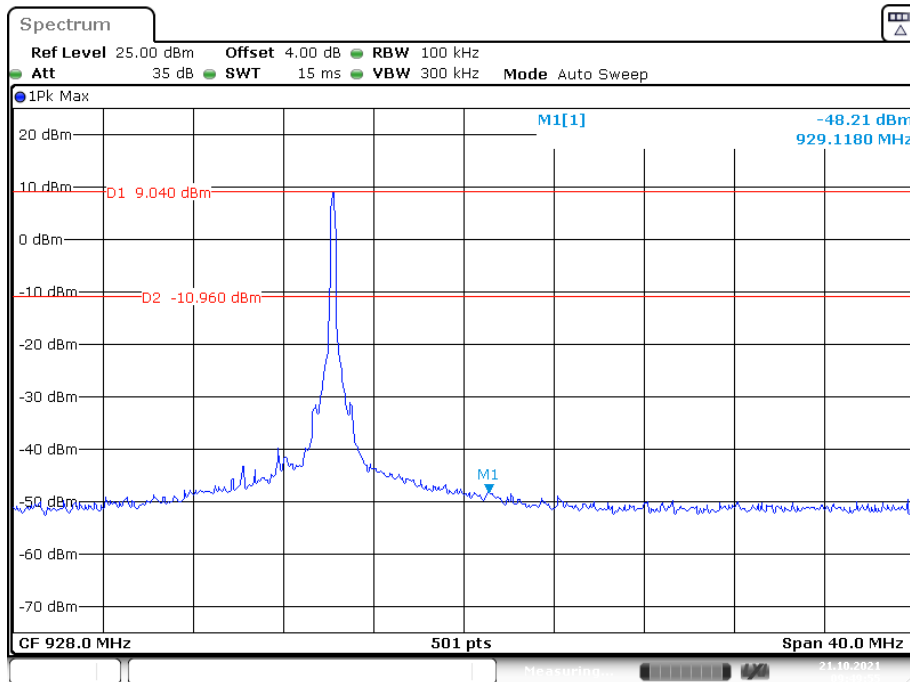
Date: 21.OCT.2021 09:29:36

Hop_Low Channel



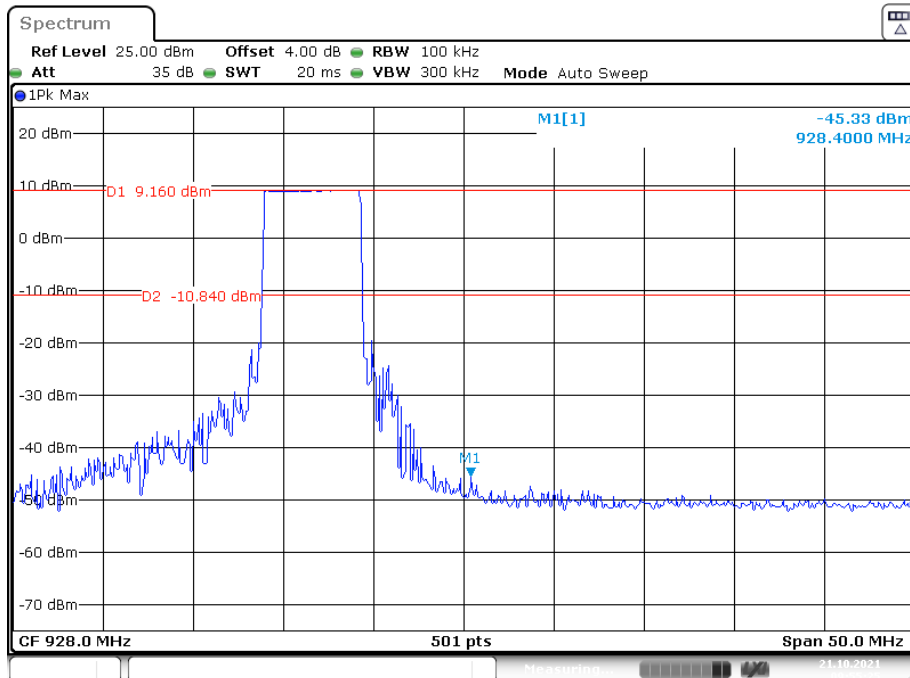
Date: 21.OCT.2021 09:53:10

High Channel



Date: 21.OCT.2021 09:49:56

Hop_High Channel



Date: 21.OCT.2021 09:55:25

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