# TEST REPORT

| | |
|---|---|
| **Application No.:** | SZEM2007006280CR |
| **Applicant:** | SKULLCANDY, INC. |
| **Address of Applicant:** | 6301 N Landmark Dr Park City UT 84098, Utah United States of America |
| **Manufacturer:** | SKULLCANDY, INC. |
| **Address of Manufacturer:** | 6301 N Landmark Dr Park City UT 84098, Utah United States of America |
| **Equipment Under Test (EUT):** | |
| **EUT Name:** | Hesh EVO |
| **Model No.:** | S6HVW |
| **Trade mark:** | Skullcandy |
| **FCC ID:** | Y22-S6HVW |
| **Standard(s)** : | 47 CFR Part 15, Subpart C 15.247 |
| **Date of Receipt:** | 2020-07-09 |
| **Date of Test:** | 2020-07-13 to 2020-08-20 |
| **Date of Issue:** | 2020-08-20 |
| **Test Result:** | **Pass*** |

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

Keny Xu
EMC Laboratory Manager

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| Revision Record | | | | |
|---|---|---|---|---|
| ***Version*** | ***Chapter*** | ***Date*** | ***Modifier*** | ***Remark*** |
| *01* | | *2020-08-20* | | *Original* |
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|---|---|---|---|---|
| **Authorized for issue by:** | | | | |
| | | Benson Wang<br>**Benson Wang /Project Engineer** | | |
| | | Eric Fu<br>**Eric Fu /Reviewer** | | |

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# 2 Test Summary

| Radio Spectrum Technical Requirement | | | | |
|---|---|---|---|---|
| **Item** | **Standard** | **Method** | **Requirement** | **Result** |
| Antenna Requirement | 47 CFR Part 15, Subpart C 15.247 | N/A | 47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4) | Pass |

| Radio Spectrum Matter Part | | | | |
|---|---|---|---|---|
| **Item** | **Standard** | **Method** | **Requirement** | **Result** |
| Conducted Peak Output Power | 47 CFR Part 15, Subpart C 15.247 | ANSI C63.10 (2013) Section 11.9.1 | 47 CFR Part 15, Subpart C 15.247(b)(3) | Pass |
| Minimum 6dB Bandwidth | 47 CFR Part 15, Subpart C 15.247 | ANSI C63.10 (2013) Section 11.8.1 | 47 CFR Part 15, Subpart C 15.247a(2) | Pass |
| Power Spectrum Density | 47 CFR Part 15, Subpart C 15.247 | ANSI C63.10 (2013) Section 11.10.2 | 47 CFR Part 15, Subpart C 15.247(e) | Pass |
| Conducted Band Edges Measurement | 47 CFR Part 15, Subpart C 15.247 | ANSI C63.10 (2013) Section 11.13.3.2 | 47 CFR Part 15, Subpart C 15.247(d) | Pass |
| Conducted Spurious Emissions | 47 CFR Part 15, Subpart C 15.247 | ANSI C63.10 (2013) Section 11.11 | 47 CFR Part 15, Subpart C 15.247(d) | Pass |
| Radiated Emissions which fall in the restricted bands | 47 CFR Part 15, Subpart C 15.247 | ANSI C63.10 (2013) Section 6.10.5 | 47 CFR Part 15, Subpart C 15.205 & 15.209 | Pass |
| Radiated Spurious Emissions | 47 CFR Part 15, Subpart C 15.247 | ANSI C63.10 (2013) Section 6.4,6.5,6.6 | 47 CFR Part 15, Subpart C 15.205 & 15.209 | Pass |

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# 4 General Information

## 4.1 Details of E.U.T.

| | |
|---|---|
| Battery: | Rechargeable battery: 3.7V 500mAh (Charged by adapter) |
| Cable: | USB cable: 58cm unshielded<br>Aux in cable: 125cm unshielded |
| Operation Frequency: | 2402MHz to 2480MHz |
| Bluetooth Version: | V5.0 Dual mode |
| Data Rate: | Only support 1M/bit |
| Modulation Type: | GFSK |
| Number of Channels: | 40 |
| Channel Spacing: | 2MHz |
| Antenna Type: | Integral Antenna |
| Antenna Gain: | 3.83dBi |

## 4.2 Description of Support Units

The EUT has been tested as an independent unit.

## 4.3 Measurement Uncertainty

| Test Item | Measurement Uncertainty |
|---|---|
| Conducted Peak Output Power | ± 0.75dB |
| Minimum 6dB Bandwidth | ± 3% |
| Power Spectrum Density | ± 2.84dB |
| Conducted Band Edges Measurement | ± 0.75dB |
| Conducted Spurious Emissions | ± 0.75dB |
| Radiated Emissions which fall in the restricted bands | ± 4.5dB (Below 1GHz);± 4.8dB (Above 1GHz) |
| Radiated Spurious Emissions | ± 4.5dB (Below 1GHz);± 4.8dB (Above 1GHz) |

Remark:
The $U_{lab}$ (lab Uncertainty) is less than $U_{cispr}$ (CISPR Uncertainty), so the test results
– compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit;
– non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.

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## 4.4 Test Location

All tests were performed at:

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Tel: +86 755 2601 2053 Fax: +86 755 2671 0594

No tests were sub-contracted.

## 4.5 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

**• A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

**• VCCI**

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

**• FCC –Designation Number: CN1178**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

**• Innovation, Science and Economic Development Canada**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0006.

IC#: 4620C.

## 4.6 Deviation from Standards

None

## 4.7 Abnormalities from Standard Conditions

None

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# 5 Equipment List

| Radiated Emissions and Radiated Emission which fall in the restricted bands | | | | | |
|---|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model No** | **Inventory No** | **Cal Date** | **Cal Due Date** |
| 3m Semi-Anechoic Chamber | AUDIX | N/A | SEM001-02 | 2018-03-13 | 2021-03-12 |
| Measurement Software | AUDIX | e3 V8.2014-6-27 | N/A | N/A | N/A |
| Coaxial Cable | SGS | N/A | SEM026-01 | 2020-07-09 | 2021-07-08 |
| EXA Spectrum Analyzer | AgilentTechnologies Inc | N9010A | SEM004-12 | 2020-04-09 | 2021-04-08 |
| Horn Antenna | Rohde & Schwarz | HF907 | SEM003-07 | 2018-04-13 | 2021-04-12 |
| Horn Antenna | Schwarzbeck | BBHA 9170 | SEM003-15 | 2017-10-17 | 2020-10-16 |
| Pre-Amplifier | Compliance Directions Systems Inc. | PAP-0126 | SEM004-11 | 2019-09-24 | 2020-09-23 |
| Pre-amplifier | Rohde & Schwarz | CH14-H052 | SEM005-17 | 2020-04-01 | 2021-03-31 |
| Pre-amplifier | Compliance Directions Systems Inc. | PAP-2640-50 | SEM005-08 | 2020-04-01 | 2021-03-31 |
| DC Power Supply | Zhao Xin | KXN-6020D | SEM011-08 | 2019-09-24 | 2020-09-23 |
| Active Loop Antenna | ETS-Lindgren | 6502 | SEM003-08 | 2017-08-22 | 2020-08-21 |

| Radiated Emissions | | | | | |
|---|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model No** | **Inventory No** | **Cal Date** | **Cal Due Date** |
| 10m Semi-Anechoic Chamber | SAEMC | FSAC1018 | SEM001-03 | 2018-03-31 | 2021-03-30 |
| EMI Test Receiver (9kHz-7GHz) | Rohde&Schwarz | ESR | SEM004-03 | 2020-03-24 | 2021-03-23 |
| Trilog-Broadband Antenna(25MHz-2GHz) | Schwarzbeck | VULB9168 | SEM003-18 | 2019-08-08 | 2022-08-07 |
| Pre-amplifier (9kHz-1GHz) | Sonoma Instrument Co | 310N | SEM005-04 | 2020-04-09 | 2021-04-08 |
| Measurement Software | AUDIX | e3 V8.2014-6-27 | N/A | N/A | N/A |
| Coaxial Cable | SGS | N/A | SEM029-01 | 2020-07-10 | 2021-07-09 |

| RF conducted | | | | | |
|---|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model No** | **Inventory No** | **Cal Date** | **Cal Due Date** |
| Shielding Room | SAEMC | MSR733 | SEM001-09 | 2019-06-13 | 2022-06-12 |
| DC Power Supply | Rohde & Schwarz | NGSM 32/10 | SEM011-04 | 2020-03-24 | 2021-03-23 |
| Spectrum Analyzer | Rohde & Schwarz | FSP | SEM004-06 | 2019-09-24 | 2020-09-23 |

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| | | | | | |
|---|---|---|---|---|---|
| Measurement Software | JS Tonscend | JS1120-2 BT/WIFI V2. | N/A | N/A | N/A |
| Coaxial Cable | SGS | N/A | SEM031-02 | 2020-07-09 | 2021-07-08 |
| Attenuator | Weinschel Associates | WA41 | SEM021-09 | N/A | N/A |
| Signal Generator | KEYSIGHT | N5173B | SEM006-05 | 2019-09-24 | 2020-09-23 |
| Power Meter | Rohde & Schwarz | NRVS | SEM014-02 | 2019-09-24 | 2020-09-23 |
| Electric and Magnetic Field Analyzer | Narda | EHP-50F | SEM022-05 | 2019-11-28 | 2020-11-27 |
| Electric Field Probe | WANDEL & GOLTERMANN | EMR-20 | EMC0907 | 2020-05-20 | 2021-05-19 |
| EMF Tester | Narda | ELT-400 | SZE039-4 | 2020-07-07 | 2021-07-06 |

| **General used equipment** | | | | | |
|---|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model No** | **Inventory No** | **Cal Date** | **Cal Due Date** |
| Humidity/ Temperature Indicator | Shanghai Meteorological Industry Factory | ZJ1-2B | SEM002-03 | 2019-09-26 | 2020-09-25 |
| Humidity/ Temperature Indicator | Shanghai Meteorological Industry Factory | ZJ1-2B | SEM002-04 | 2019-09-26 | 2020-09-25 |
| Humidity/ Temperature Indicator | Mingle | N/A | SEM002-08 | 2019-09-26 | 2020-09-25 |
| Barometer | Changchun Meteorological Industry Factory | DYM3 | SEM002-01 | 2019-04-07 | 2021-04-06 |
| Barometer | Changchun Meteorological Industry Factory | DYM3 | SEM002-01 | 2020-04-07 | 2021-04-06 |

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# 6 Radio Spectrum Technical Requirement

## 6.1 Antenna Requirement

### 6.1.1 Test Requirement:

47 CFR Part 15, Subpart C 15.247

### 6.1.2 Conclusion

Standard Requirement:

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, 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.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna:

The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 3.83dBi.

Antenna location: Refer to internal photo.

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# 7 Radio Spectrum Matter Test Results

## 7.1 Conducted Peak Output Power

Test Requirement 47 CFR Part 15, Subpart C 15.247
Test Method: ANSI C63.10 (2013) Section 11.9.1

Limit:

| Frequency range(MHz) | Output power of the intentional radiator(watt) |
|---|---|
| 902-928 | 1 for ≥50 hopping channels |
| | 0.25 for 25≤ hopping channels <50 |
| | 1 for digital modulation |
| 2400-2483.5 | 1 for ≥75 non-overlapping hopping channels |
| | 0.125 for all other frequency hopping systems |
| | 1 for digital modulation |
| 5725-5850 | 1 for frequency hopping systems and digital modulation |

### 7.1.1 E.U.T. Operation

Operating Environment:
Temperature: 23.5 °C Humidity: 53.5 % RH Atmospheric Pressure: 1060 mbar

### 7.1.2 Test Mode Description

| Pre-scan / Final test | Mode Code | Description |
|---|---|---|
| Final test | 03 | TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation. |

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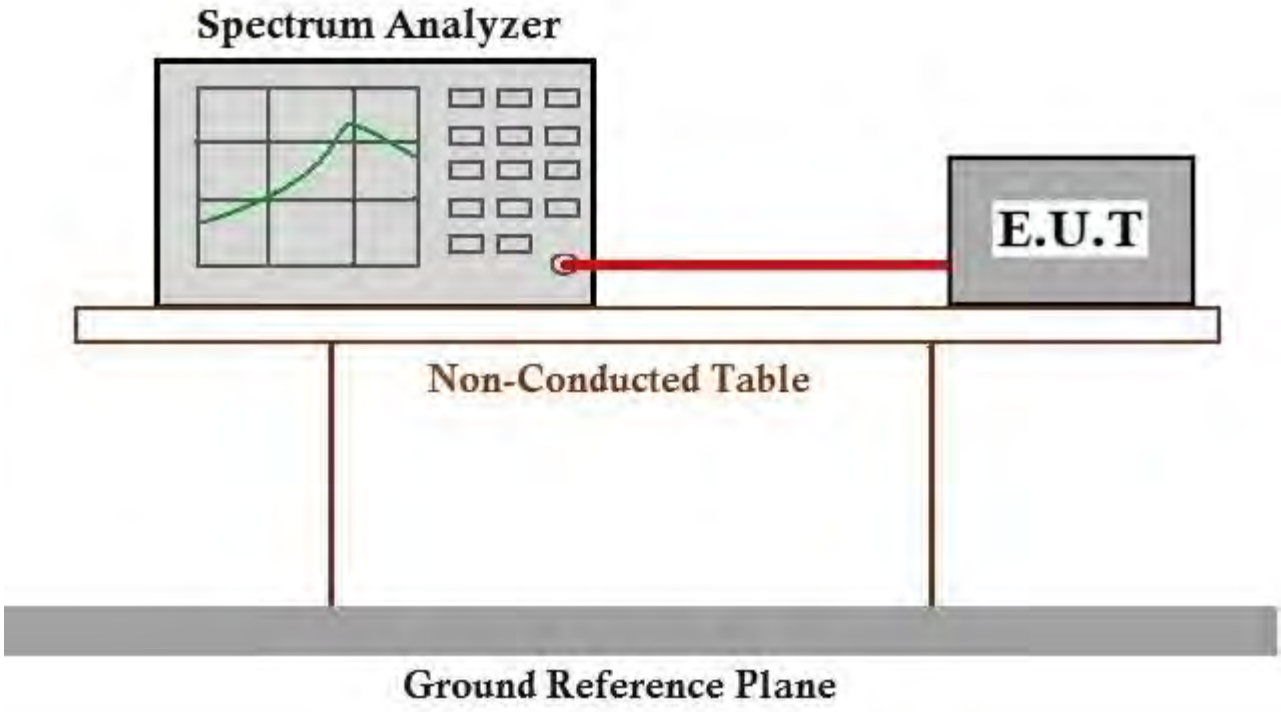
### 7.1.3 Test Setup Diagram




### 7.1.4 Measurement Procedure and Data

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## 7.2 Minimum 6dB Bandwidth

Test Requirement 47 CFR Part 15, Subpart C 15.247
Test Method: ANSI C63.10 (2013) Section 11.8.1
Limit: ≥500 kHz

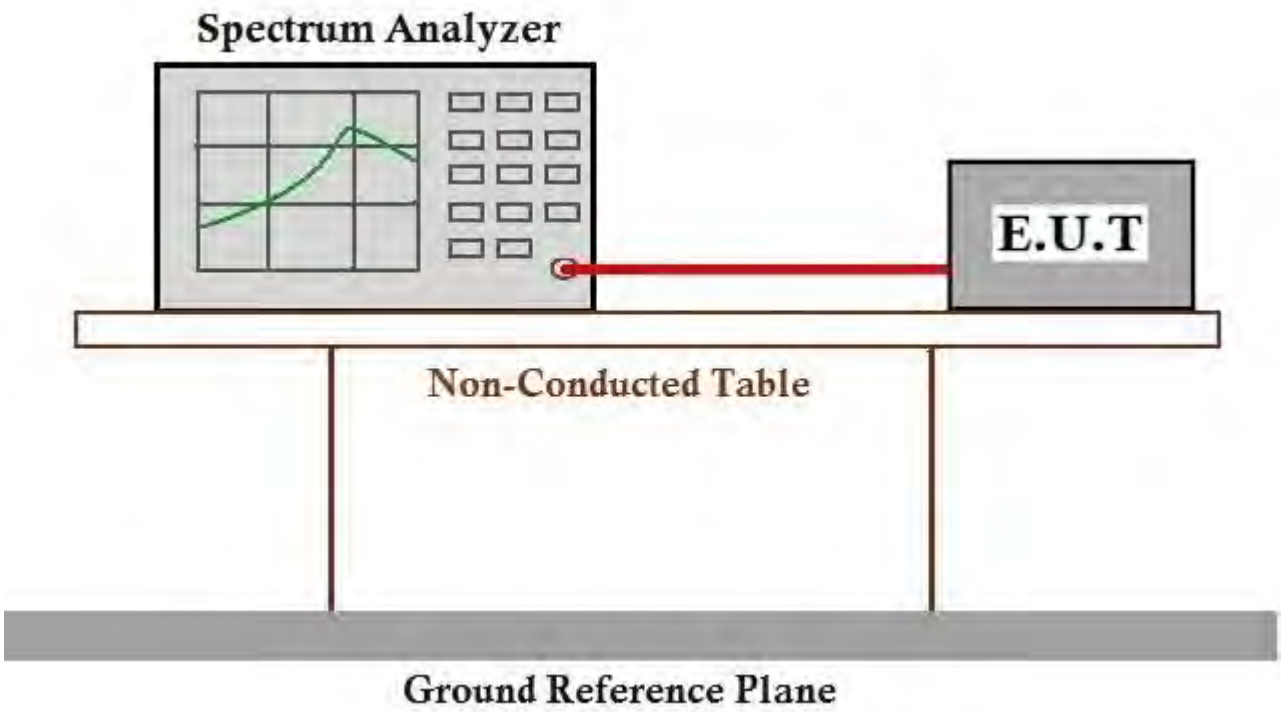
### 7.2.1 E.U.T. Operation

Operating Environment:
Temperature: 23.5 °C Humidity: 53.5 % RH Atmospheric Pressure: 1060 mbar

### 7.2.2 Test Mode Description

| Pre-scan / Final test | Mode Code | Description |
|---|---|---|
| Final test | 03 | TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation. |

### 7.2.3 Test Setup Diagram




### 7.2.4 Measurement Procedure and Data

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## 7.3 Power Spectrum Density

Test Requirement 47 CFR Part 15, Subpart C 15.247
Test Method: ANSI C63.10 (2013) Section 11.10.2
Limit: ≤8dBm in any 3 kHz band during any time interval of continuous transmission

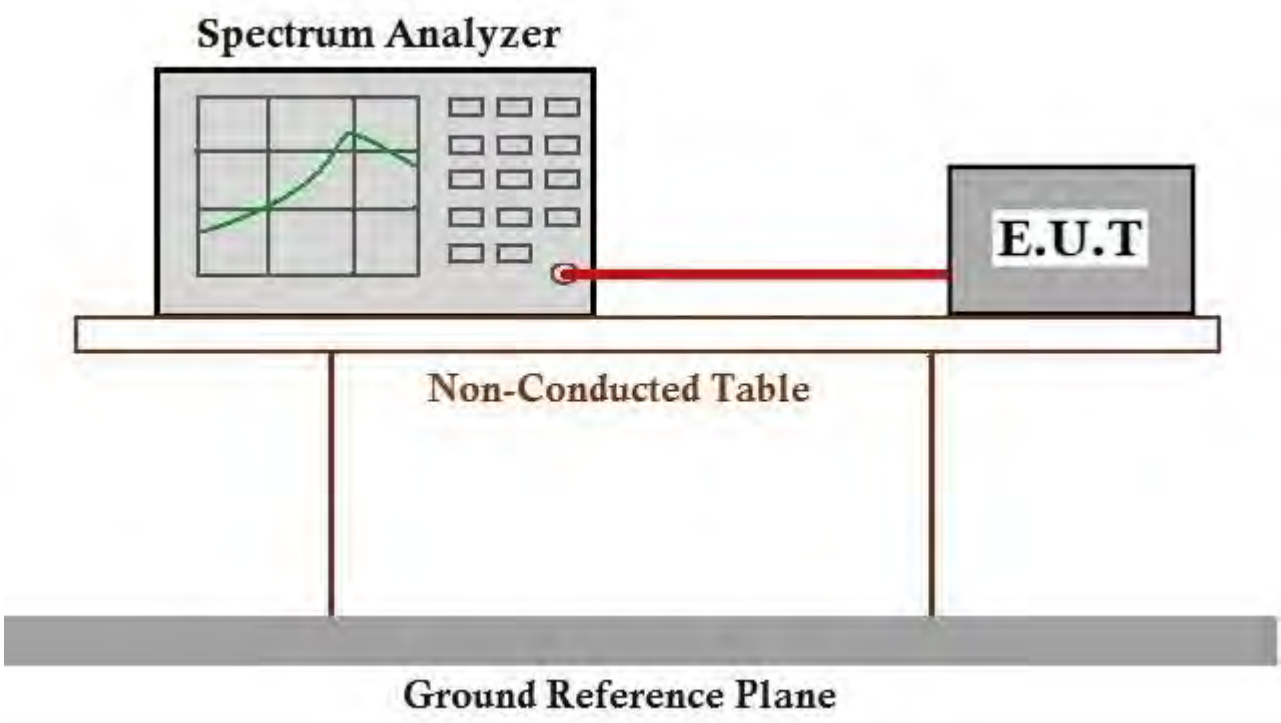
### 7.3.1 E.U.T. Operation

Operating Environment:
Temperature: 23.5 °C Humidity: 53.5 % RH Atmospheric Pressure: 1060 mbar

### 7.3.2 Test Mode Description

| Pre-scan / Final test | Mode Code | Description |
|---|---|---|
| Final test | 03 | TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation. |

### 7.3.3 Test Setup Diagram




### 7.3.4 Measurement Procedure and Data

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## 7.4 Conducted Band Edges Measurement

Test Requirement 47 CFR Part 15, Subpart C 15.247
Test Method: ANSI C63.10 (2013) Section 11.13.3.2

Limit:

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).

### 7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 23.5 °C Humidity: 53.5 % RH Atmospheric Pressure: 1060 mbar

### 7.4.2 Test Mode Description

| Pre-scan / Final test | Mode Code | Description |
|---|---|---|
| Final test | 03 | TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation. |

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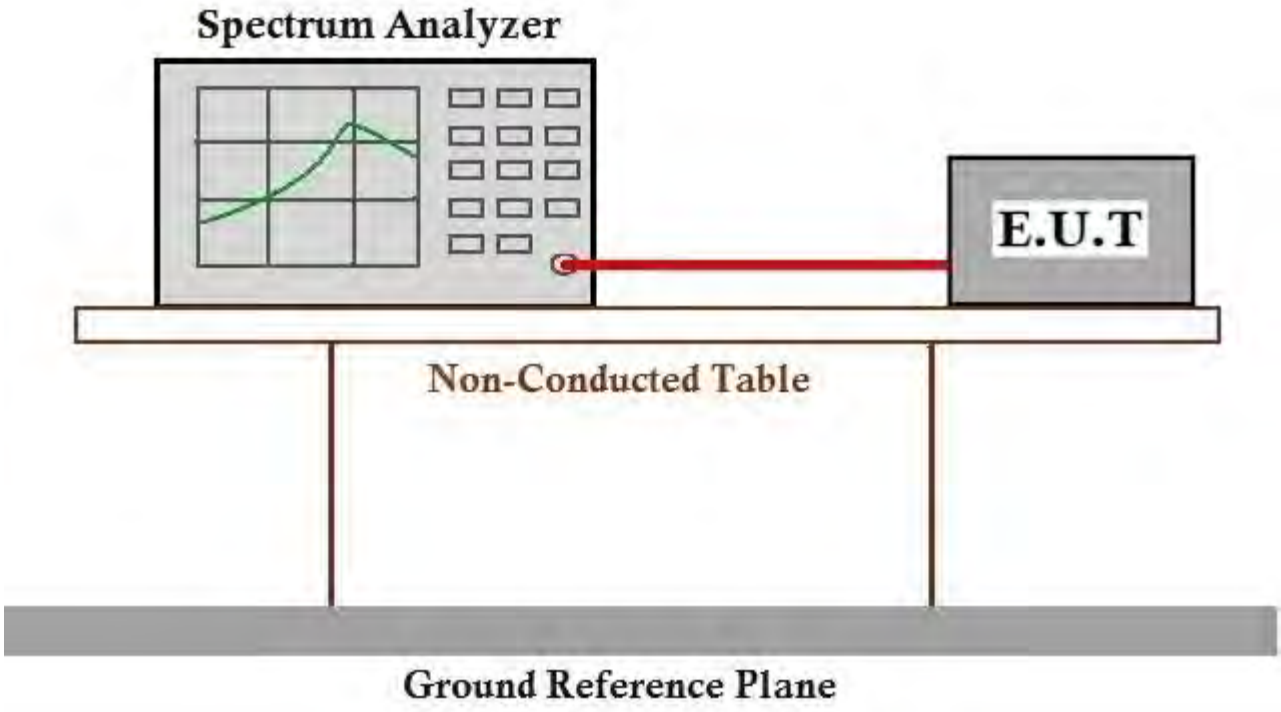
### 7.4.3 Test Setup Diagram




### 7.4.4 Measurement Procedure and Data

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## 7.5 Conducted Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.247
Test Method: ANSI C63.10 (2013) Section 11.11

Limit:

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).

### 7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 23.5 °C Humidity: 53.5 % RH Atmospheric Pressure: 1060 mbar

### 7.5.2 Test Mode Description

| Pre-scan / Final test | Mode Code | Description |
|---|---|---|
| Final test | 03 | TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation. |

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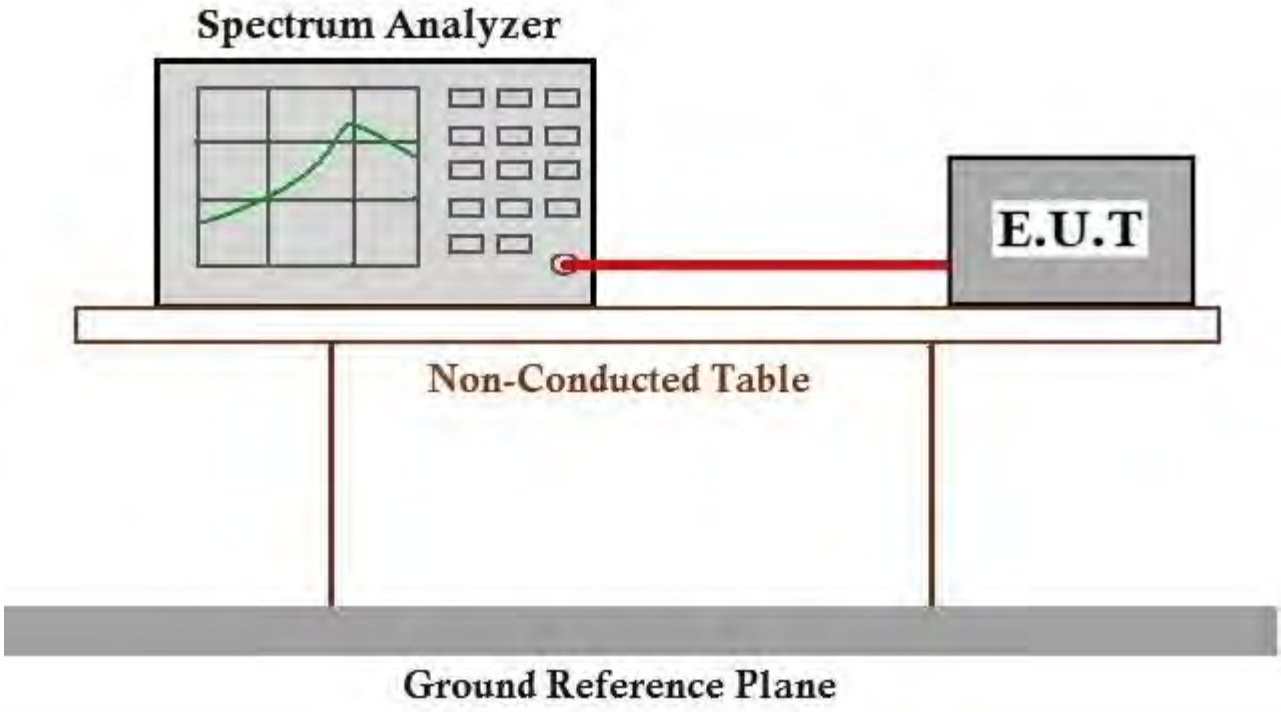
### 7.5.3 Test Setup Diagram




### 7.5.4 Measurement Procedure and Data

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## 7.6 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15, Subpart C 15.247

Test Method: ANSI C63.10 (2013) Section 6.10.5

Measurement Distance: 3m

Limit:

| Frequency(MHz) | Field strength(microvolts/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 |
| Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. | | |

### 7.6.1 E.U.T. Operation

Operating Environment:

Temperature: 22.8 °C Humidity: 54.9 % RH Atmospheric Pressure: 1005 mbar

### 7.6.2 Test Mode Description

| Pre-scan / Final test | Mode Code | Description |
|---|---|---|
| Final test | 03 | TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation. |

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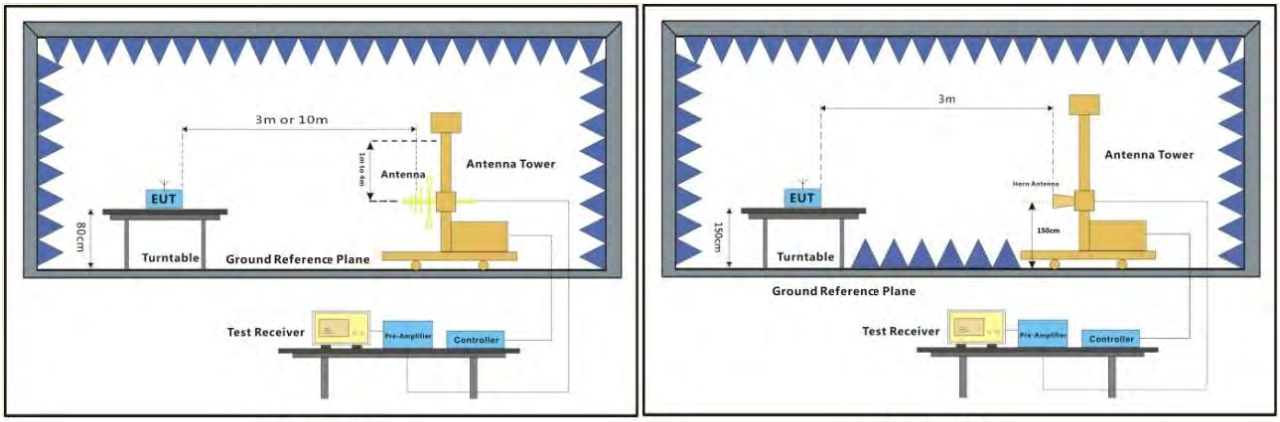
### 7.6.3 Test Setup Diagram




30MHz-1GHz　　Above 1GHz

### 7.6.4 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark 1: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

Remark 2: For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

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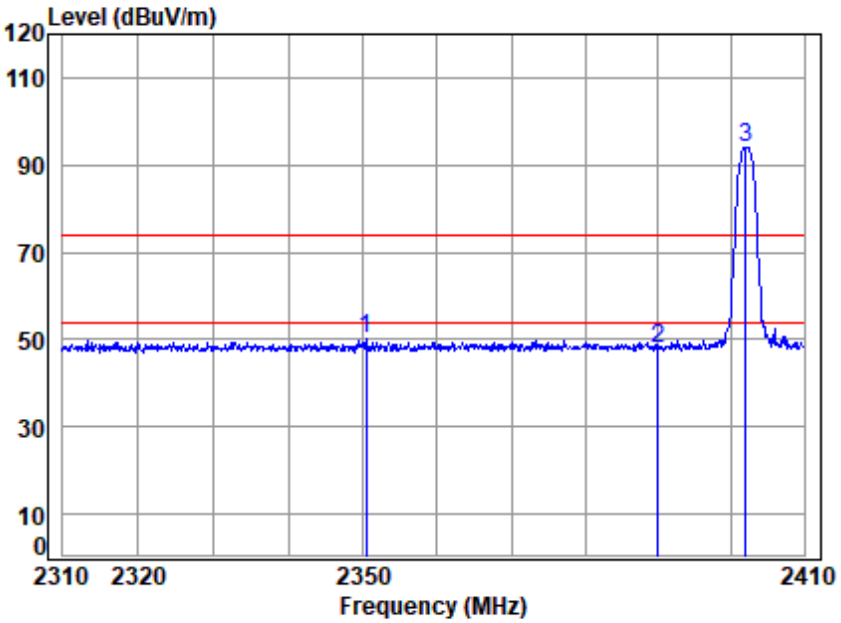
Mode:03: Polarization:Horizontal; Modulation:GFSK; Channel:Low




Site : chamber
Condition: 3m HORIZONTAL
Job No : 06280CR/06281CR
Mode : 2402 Band edge
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 2350.388 | 4.28 | 28.45 | 40.96 | 58.37 | 50.14 | 74.00 | -23.86 | peak |
| 2 | 2390.000 | 4.34 | 28.52 | 40.97 | 55.85 | 47.74 | 74.00 | -26.26 | peak |
| 3 * | 2402.000 | 4.36 | 28.54 | 40.98 | 102.20 | 94.12 | 74.00 | 20.12 | peak |

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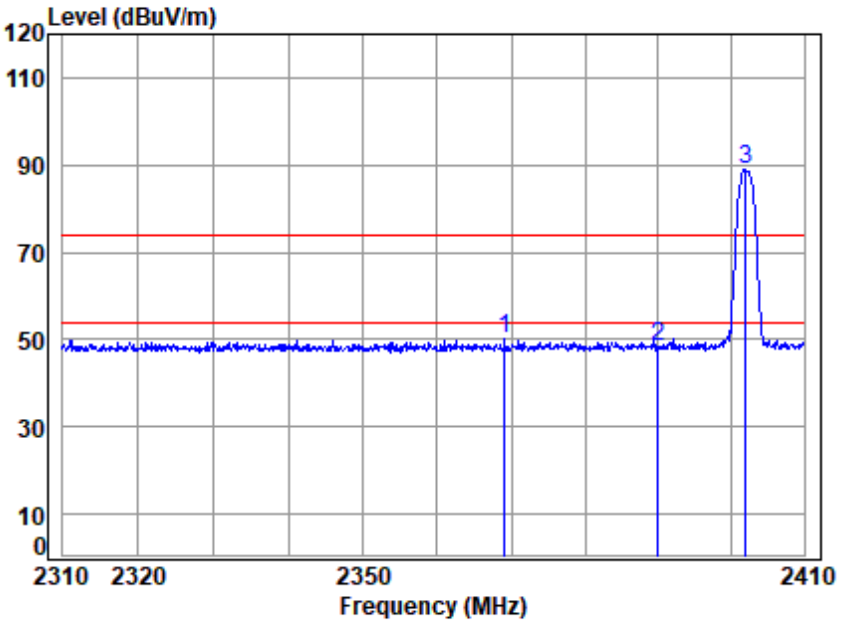
Mode:03: Polarization:Vertical; Modulation:GFSK; Channel:Low




Site : chamber
Condition: 3m VERTICAL
Job No : 06280CR/06281CR
Mode : 2402 Band edge
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 2369.089 | 4.31 | 28.48 | 40.96 | 58.43 | 50.26 | 74.00 | -23.74 | peak |
| 2 | 2390.000 | 4.34 | 28.52 | 40.97 | 56.65 | 48.54 | 74.00 | -25.46 | peak |
| 3 * | 2402.000 | 4.36 | 28.54 | 40.98 | 96.89 | 88.81 | 74.00 | 14.81 | peak |

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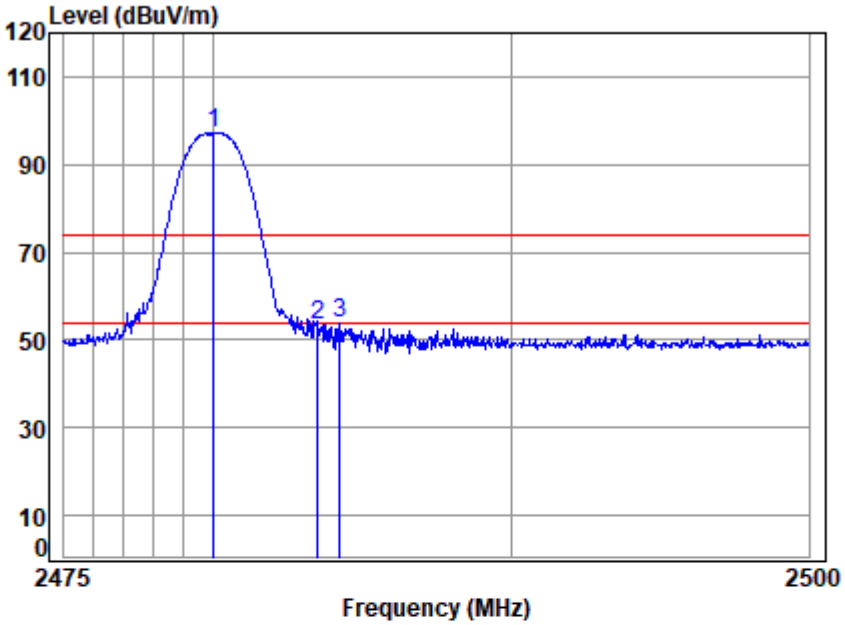
Mode:03: Polarization:Horizontal; Modulation:GFSK; Channel:High




Site : chamber
Condition: 3m HORIZONTAL
Job No : 06280CR/06281CR
Mode : 2480 Band edge
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 * | 2480.000 | 4.49 | 28.67 | 41.01 | 104.91 | 97.06 | 74.00 | 23.06 | peak |
| 2 | 2483.500 | 4.49 | 28.67 | 41.01 | 61.39 | 53.54 | 74.00 | -20.46 | peak |
| 3 | 2484.221 | 4.50 | 28.67 | 41.01 | 61.50 | 53.66 | 74.00 | -20.34 | peak |

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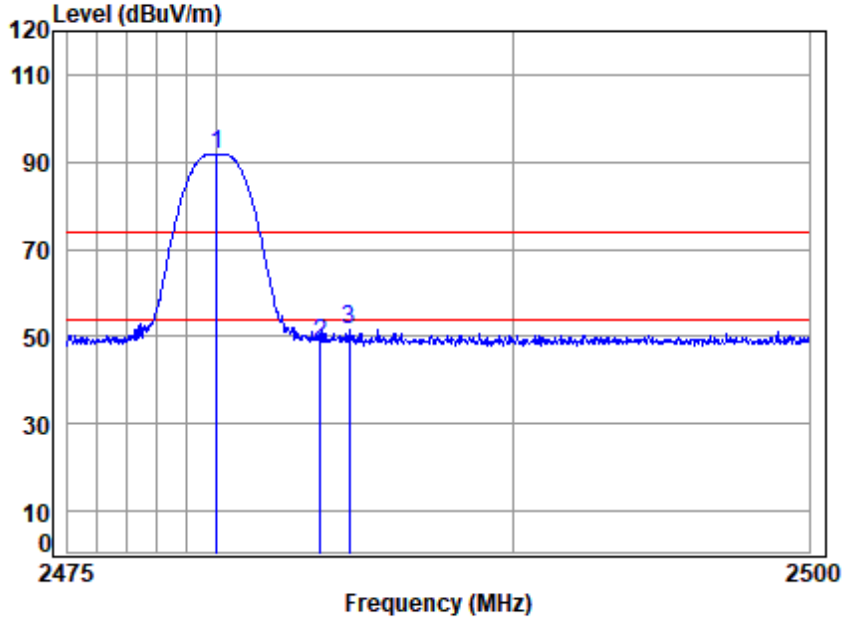
Mode:03: Polarization:Vertical; Modulation:GFSK; Channel:High




Site : chamber
Condition: 3m VERTICAL
Job No : 06280CR/06281CR
Mode : 2480 Band edge
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 * | 2480.000 | 4.49 | 28.67 | 41.01 | 99.72 | 91.87 | 74.00 | 17.87 | peak |
| 2 | 2483.500 | 4.49 | 28.67 | 41.01 | 56.24 | 48.39 | 74.00 | -25.61 | peak |
| 3 | 2484.470 | 4.50 | 28.67 | 41.01 | 59.26 | 51.42 | 74.00 | -22.58 | peak |

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## 7.7 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.247
Test Method: ANSI C63.10 (2013) Section 6.4,6.5,6.6
Measurement Distance: 10m (Below 1GHz) and 3m (Above 1GHz)

Limit:

| Frequency(MHz) | Field strength(microvolts/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 |
| Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. | | |

### 7.7.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 45 % RH Atmospheric Pressure: 1060 mbar

### 7.7.2 Test Mode Description

| Pre-scan / Final test | Mode Code | Description |
|---|---|---|
| Final test | 03 | TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation. |

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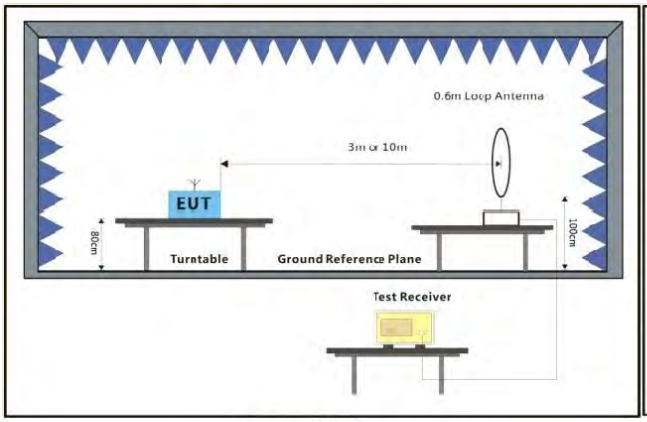
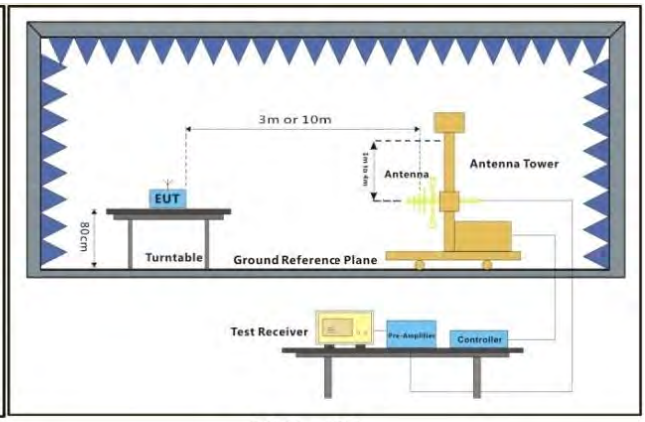
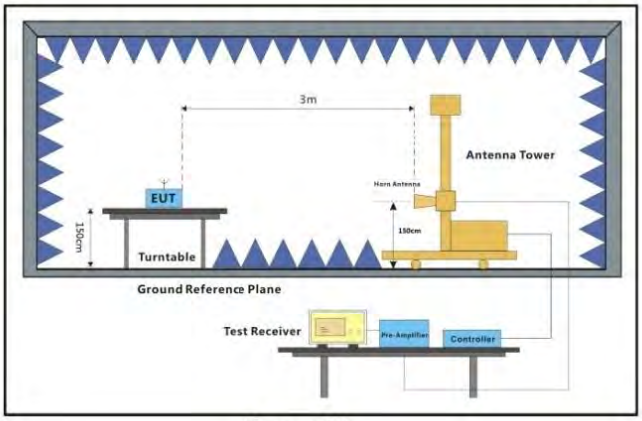
### 7.7.3 Test Setup Diagram




Below 30MHz




30MHz-1GHz




Above 1GHz

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### 7.7.4 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark:

1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.

2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Factor - Preamplifier Factor

3) Scan from 9kHz to 25GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

4) For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

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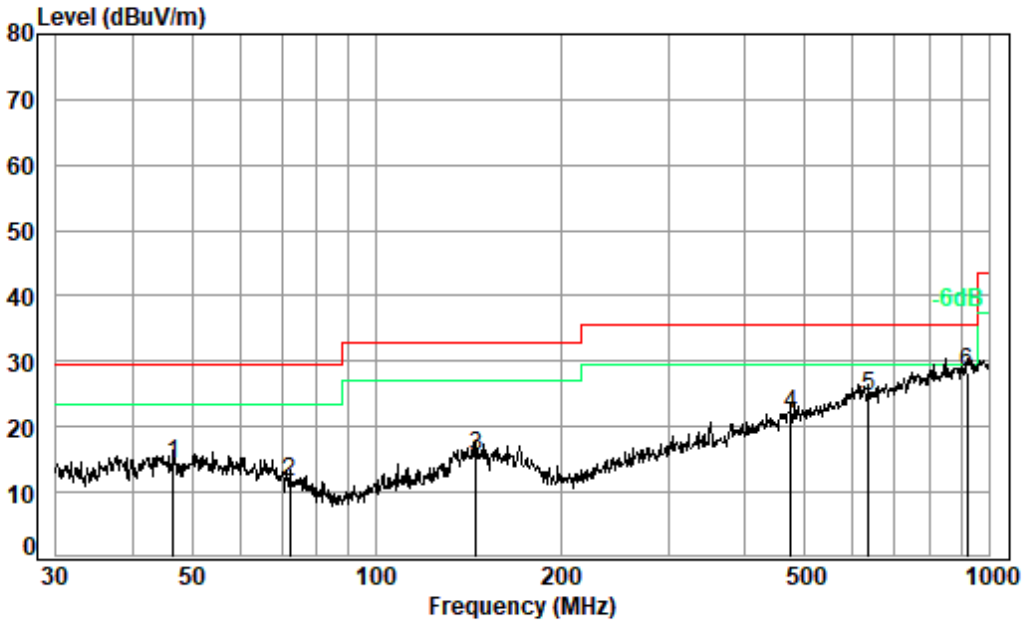
**Radiated emission below 1GHz**

Mode:03: Polarization:Horizontal




Condition: 10m HORIZONTAL
Job No. : 06280CR
Test Mode: 03

| | Freq | Ant Factor | Preamp Factor | Cable Loss | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB/m | dB | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 46.666 | 20.40 | 32.45 | 0.97 | 25.43 | 14.35 | 29.50 | -15.15 | QP |
| 2 | 72.338 | 16.81 | 32.38 | 1.10 | 25.92 | 11.45 | 29.50 | -18.05 | QP |
| 3 | 145.351 | 19.97 | 32.30 | 1.46 | 26.46 | 15.59 | 33.00 | -17.41 | QP |
| 4 | 475.499 | 23.70 | 32.38 | 2.82 | 27.65 | 21.79 | 35.60 | -13.81 | QP |
| 5 | 636.134 | 26.26 | 32.11 | 3.19 | 27.18 | 24.52 | 35.60 | -11.08 | QP |
| 6 pp | 922.516 | 29.80 | 31.40 | 3.45 | 26.54 | 28.39 | 35.60 | -7.21 | QP |

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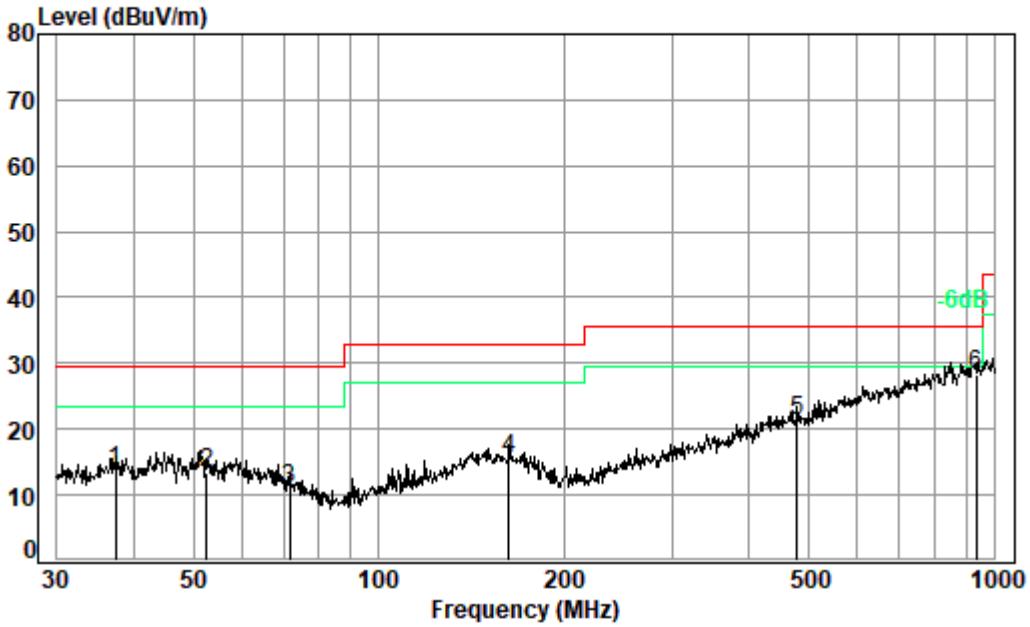
Mode:03: Polarization:Vertical




Condition: 10m VERTICAL
Job No. : 06280CR
Test Mode: 03

| | Freq | Ant Factor | Preamp Factor | Cable Loss | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB/m | dB | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 37.416 | 19.86 | 32.42 | 0.90 | 25.33 | 13.67 | 29.50 | -15.83 | QP |
| 2 | 52.575 | 19.96 | 32.45 | 1.00 | 24.98 | 13.49 | 29.50 | -16.01 | QP |
| 3 | 71.832 | 16.96 | 32.38 | 1.10 | 25.26 | 10.94 | 29.50 | -18.56 | QP |
| 4 | 162.611 | 19.67 | 32.30 | 1.51 | 26.78 | 15.66 | 33.00 | -17.34 | QP |
| 5 | 478.846 | 23.70 | 32.40 | 2.84 | 27.21 | 21.35 | 35.60 | -14.25 | QP |
| 6 pp | 935.546 | 29.80 | 31.33 | 3.47 | 26.32 | 28.26 | 35.60 | -7.34 | QP |

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The test was performed at a 10m test site. According to below formulate and the test data at 10m test distance,

$L_3 / L_{10} = D_{10} / D_3$

Note:

$L_3$: Level @ 3m distance. Unit: uV/m;

$L_{10}$: Level @ 10m distance. Unit: uV/m;

$D_3$: 3m distance. Unit: m

$D_{10}$: 10m distance. Unit: m

The level at 3m test distance is below:

| Frequency (MHz) | Level @ 10m (dBuV/m) | Level @ 10m (uV/m) | Level @ 3m (uV/m) | Level @ 3m (dBuV/m) | Limit @ 3m (dBuV/m) | Margin (dB) | Ant. Polarization |
|---|---|---|---|---|---|---|---|
| 37.416 | 13.67 | 4.83 | 16.08 | 24.13 | 40.00 | -15.87 | V |
| 52.575 | 13.49 | 4.73 | 15.75 | 23.95 | 40.00 | -16.05 | V |
| 71.832 | 10.94 | 3.52 | 11.75 | 21.40 | 40.00 | -18.60 | V |
| 162.611 | 15.66 | 6.07 | 20.22 | 26.12 | 43.50 | -17.38 | V |
| 478.846 | 21.35 | 11.68 | 38.94 | 31.81 | 46.00 | -14.19 | V |
| 935.546 | 28.26 | 25.88 | 86.27 | 38.72 | 46.00 | -7.28 | V |
| 46.666 | 14.35 | 5.22 | 17.39 | 24.81 | 40.00 | -15.19 | H |
| 72.338 | 11.45 | 3.74 | 12.46 | 21.91 | 40.00 | -18.09 | H |
| 145.351 | 15.59 | 6.02 | 20.06 | 26.05 | 43.50 | -17.45 | H |
| 475.499 | 21.79 | 12.29 | 40.96 | 32.25 | 46.00 | -13.75 | H |
| 636.134 | 24.52 | 16.83 | 56.09 | 34.98 | 46.00 | -11.02 | H |
| 922.516 | 28.39 | 26.27 | 87.57 | 38.85 | 46.00 | -7.15 | H |

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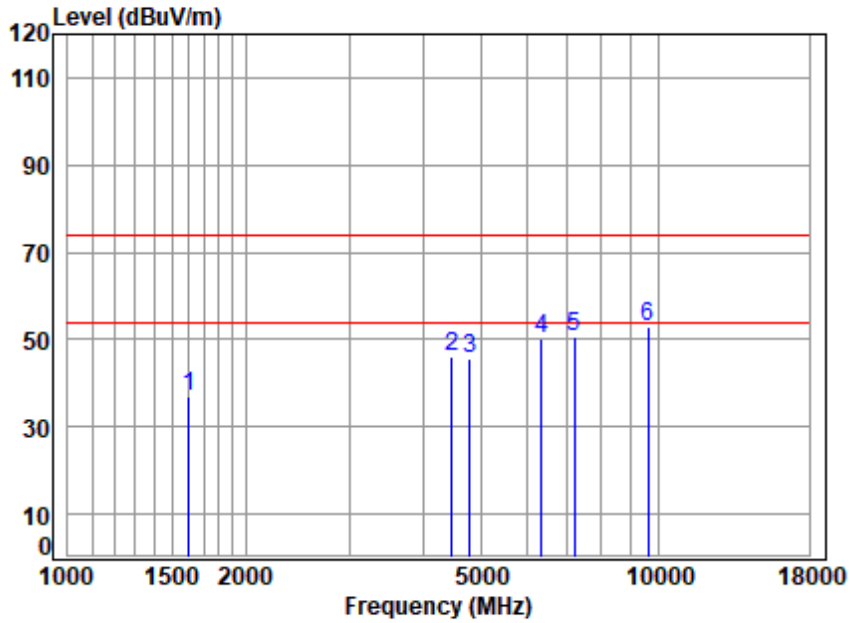
**Above 1GHz**

Mode:03: Polarization:Horizontal; Modulation:GFSK; Channel:Low




Site : chamber
Condition: 3m HORIZONTAL
Job No : 06280CR/06281CR
Mode : 2402 TX SE
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 1601.804 | 3.35 | 26.26 | 40.57 | 47.95 | 36.99 | 74.00 | -37.01 | peak |
| 2 | 4469.214 | 6.73 | 33.55 | 42.53 | 48.40 | 46.15 | 74.00 | -27.85 | peak |
| 3 | 4804.000 | 7.10 | 33.97 | 42.77 | 47.17 | 45.47 | 74.00 | -28.53 | peak |
| 4 | 6340.436 | 8.27 | 35.44 | 42.04 | 48.49 | 50.16 | 74.00 | -23.84 | peak |
| 5 | 7206.000 | 8.74 | 36.07 | 41.58 | 47.32 | 50.55 | 74.00 | -23.45 | peak |
| 6 | 9608.000 | 10.81 | 37.67 | 38.57 | 42.86 | 52.77 | 74.00 | -21.23 | peak |

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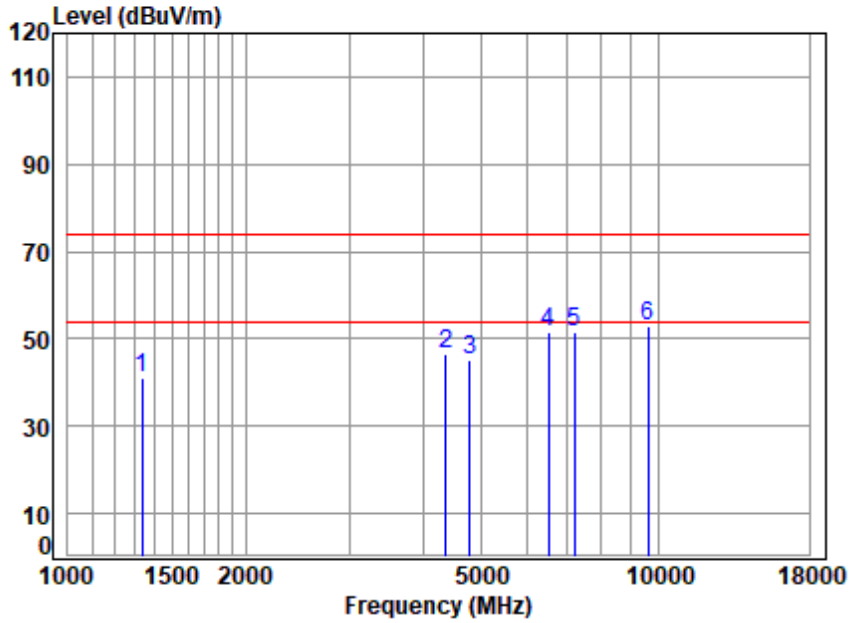
Mode:03: Polarization:Vertical; Modulation:GFSK; Channel:Low




Site : chamber
Condition: 3m VERTICAL
Job No : 06280CR/06281CR
Mode : 2402 TX SE
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 1335.141 | 3.00 | 25.17 | 40.39 | 53.06 | 40.84 | 74.00 | -33.16 | peak |
| 2 | 4367.058 | 6.64 | 33.37 | 42.45 | 48.94 | 46.50 | 74.00 | -27.50 | peak |
| 3 | 4804.000 | 7.10 | 33.97 | 42.77 | 46.97 | 45.27 | 74.00 | -28.73 | peak |
| 4 | 6507.536 | 8.28 | 35.60 | 41.95 | 49.55 | 51.48 | 74.00 | -22.52 | peak |
| 5 | 7206.000 | 8.74 | 36.07 | 41.58 | 48.15 | 51.38 | 74.00 | -22.62 | peak |
| 6 | 9608.000 | 10.81 | 37.67 | 38.57 | 42.90 | 52.81 | 74.00 | -21.19 | peak |

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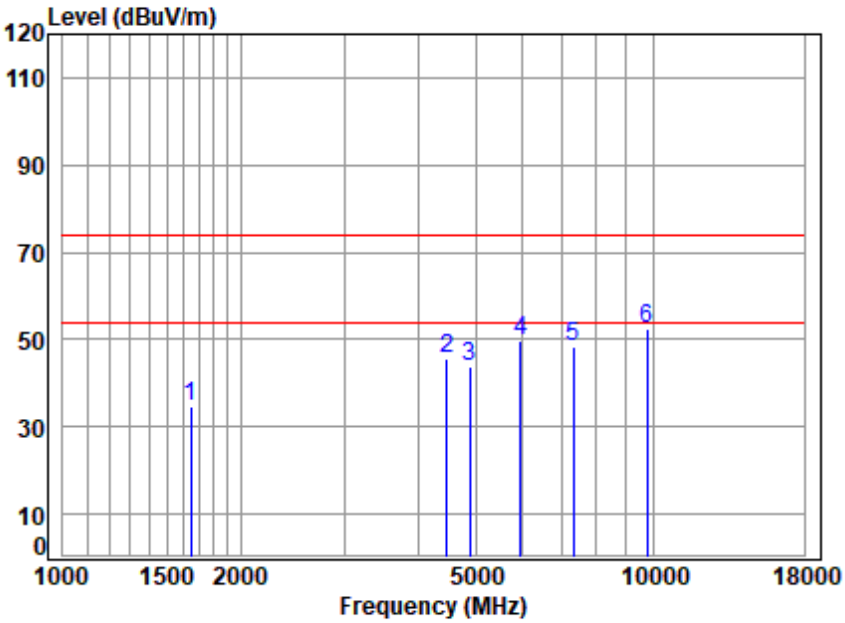
Mode:03: Polarization:Horizontal; Modulation:GFSK; Channel:Middle




Site : chamber
Condition: 3m HORIZONTAL
Job No : 06280CR/06281CR
Mode : 2440 TX SE
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 1648.778 | 3.39 | 26.46 | 40.60 | 45.58 | 34.83 | 74.00 | -39.17 | peak |
| 2 | 4469.214 | 6.73 | 33.55 | 42.53 | 47.87 | 45.62 | 74.00 | -28.38 | peak |
| 3 | 4880.000 | 7.18 | 34.06 | 42.82 | 45.39 | 43.81 | 74.00 | -30.19 | peak |
| 4 | 5967.033 | 8.25 | 35.07 | 42.26 | 48.76 | 49.82 | 74.00 | -24.18 | peak |
| 5 | 7323.000 | 8.85 | 36.16 | 41.52 | 44.88 | 48.37 | 74.00 | -25.63 | peak |
| 6 | 9764.000 | 10.76 | 37.76 | 38.34 | 42.08 | 52.26 | 74.00 | -21.74 | peak |

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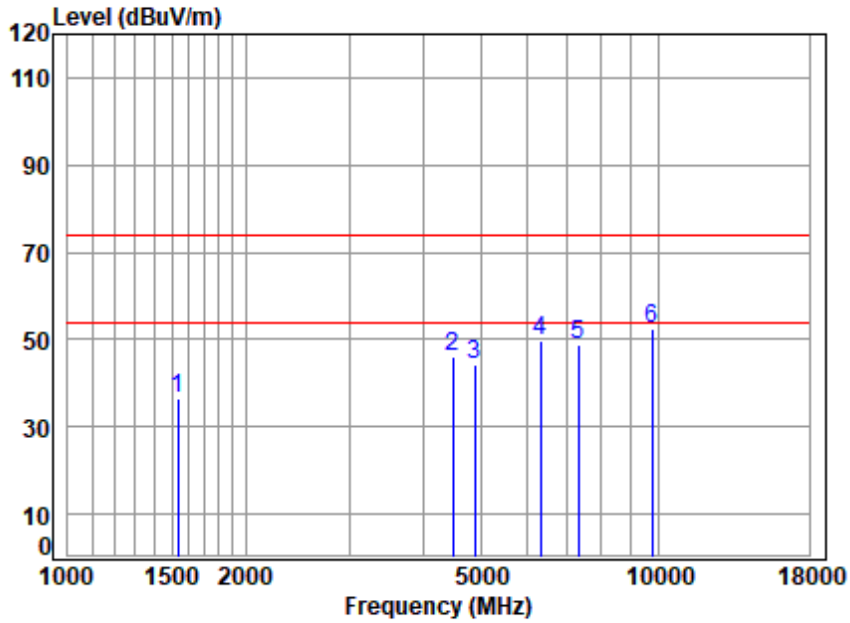
Mode:03: Polarization:Vertical; Modulation:GFSK; Channel:Middle




Site : chamber
Condition: 3m VERTICAL
Job No : 06280CR/06281CR
Mode : 2440 TX SE
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 1538.281 | 3.29 | 25.98 | 40.53 | 47.78 | 36.52 | 74.00 | -37.48 | peak |
| 2 | 4482.150 | 6.74 | 33.57 | 42.54 | 48.48 | 46.25 | 74.00 | -27.75 | peak |
| 3 | 4880.000 | 7.18 | 34.06 | 42.82 | 45.73 | 44.15 | 74.00 | -29.85 | peak |
| 4 | 6322.136 | 8.27 | 35.43 | 42.05 | 47.98 | 49.63 | 74.00 | -24.37 | peak |
| 5 | 7323.000 | 8.85 | 36.16 | 41.52 | 45.22 | 48.71 | 74.00 | -25.29 | peak |
| 6 | 9764.000 | 10.76 | 37.76 | 38.34 | 42.45 | 52.63 | 74.00 | -21.37 | peak |

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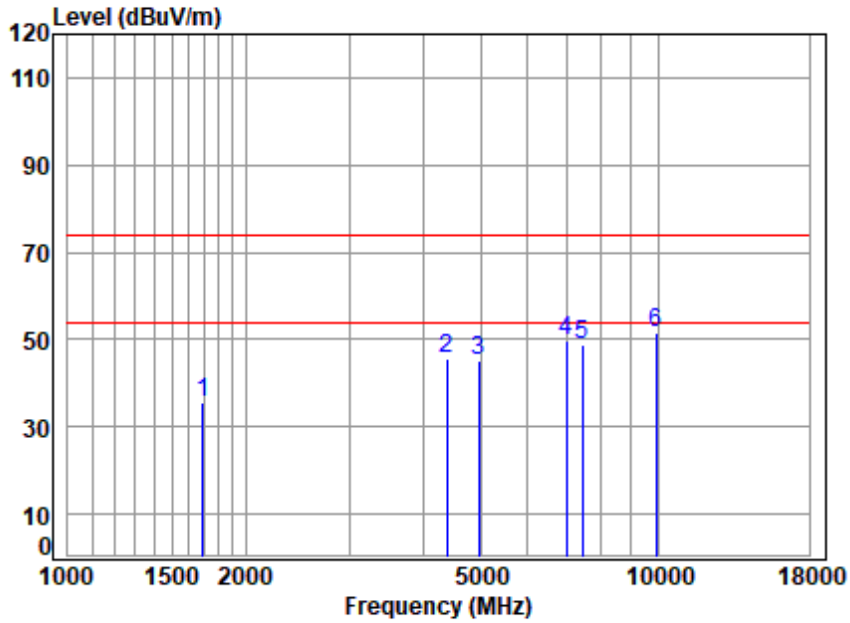
Mode:03: Polarization:Horizontal; Modulation:GFSK; Channel:High




Site : chamber
Condition: 3m HORIZONTAL
Job No : 06280CR/06281CR
Mode : 2480 TX SE
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 1692.231 | 3.42 | 26.64 | 40.63 | 46.24 | 35.67 | 74.00 | -38.33 | peak |
| 2 | 4379.699 | 6.65 | 33.39 | 42.46 | 48.21 | 45.79 | 74.00 | -28.21 | peak |
| 3 | 4960.000 | 7.26 | 34.15 | 42.87 | 46.45 | 44.99 | 74.00 | -29.01 | peak |
| 4 | 6995.172 | 8.54 | 35.90 | 41.69 | 47.16 | 49.91 | 74.00 | -24.09 | peak |
| 5 | 7440.000 | 8.96 | 36.25 | 41.46 | 45.01 | 48.76 | 74.00 | -25.24 | peak |
| 6 | 9920.000 | 10.71 | 37.85 | 38.12 | 41.04 | 51.48 | 74.00 | -22.52 | peak |

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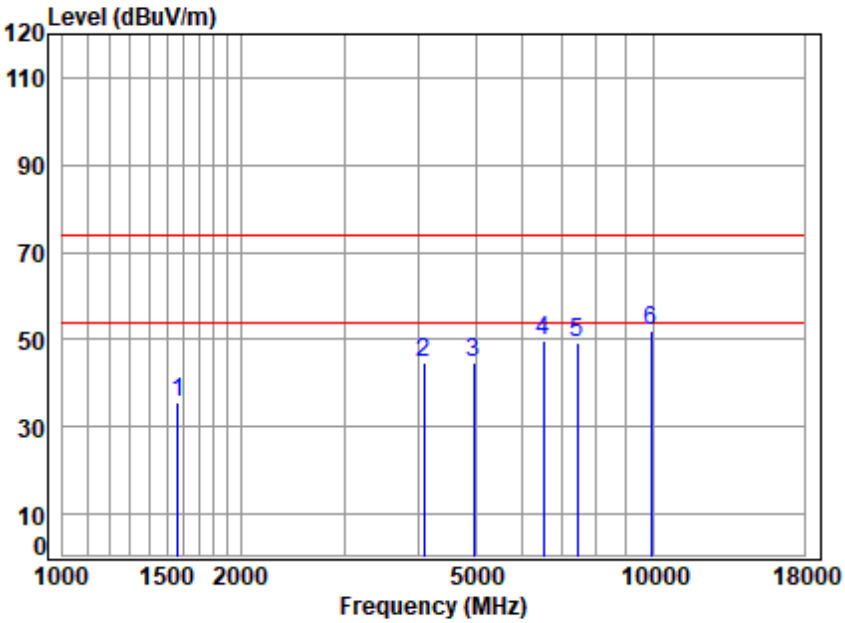


Site : chamber
Condition: 3m VERTICAL
Job No : 06280CR/06281CR
Mode : 2480 TX SE
Note : BLE

| | Freq | Cable Loss | Ant Factor | Preamp Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | MHz | dB | dB/m | dB | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 1565.191 | 3.32 | 26.10 | 40.55 | 46.51 | 35.38 | 74.00 | -38.62 | peak |
| 2 | 4086.182 | 6.37 | 32.86 | 42.23 | 47.92 | 44.92 | 74.00 | -29.08 | peak |
| 3 | 4960.000 | 7.26 | 34.15 | 42.87 | 46.30 | 44.84 | 74.00 | -29.16 | peak |
| 4 | 6507.536 | 8.28 | 35.60 | 41.95 | 47.88 | 49.81 | 74.00 | -24.19 | peak |
| 5 | 7440.000 | 8.96 | 36.25 | 41.46 | 45.52 | 49.27 | 74.00 | -24.73 | peak |
| 6 | 9920.000 | 10.71 | 37.85 | 38.12 | 41.63 | 52.07 | 74.00 | -21.93 | peak |

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# 8 Test Setup Photo

Please refer to setup photos.

# 9 EUT Constructional Details (EUT Photos)

Please Refer to external and internal photos for details.

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# 10 Appendix

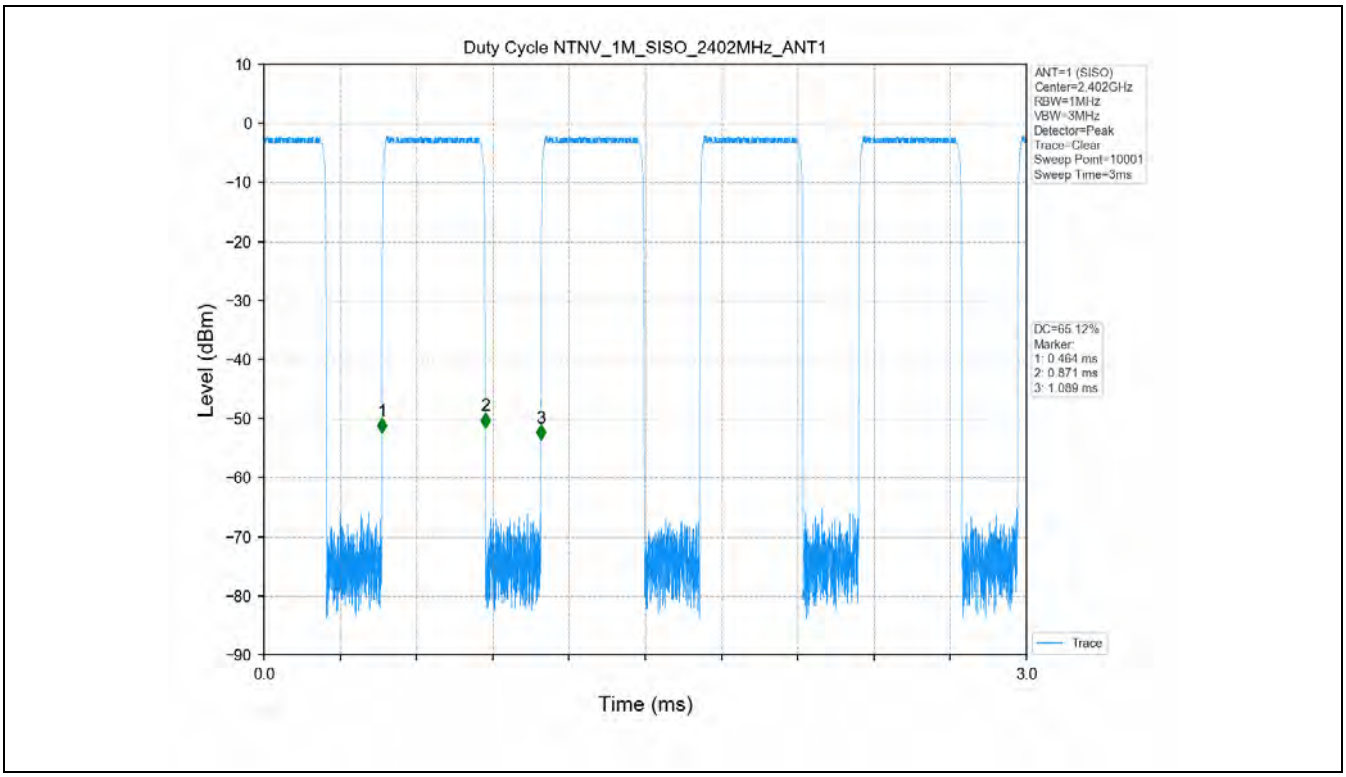
## Appendix for 15.247

## 1. Duty Cycle

### 1.1 Test Result

| Test Mode | Channel Frequency(MHz) | TX Type | ANT No. | T_on (ms) | Period (ms) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) |
|---|---|---|---|---|---|---|---|
| 1M | 2402 | SISO | 1 | 0.407 | 0.625 | 65.12 | 1.86 |
| | 2440 | SISO | 1 | 0.407 | 0.625 | 65.12 | 1.86 |
| | 2480 | SISO | 1 | 0.408 | 0.626 | 65.18 | 1.86 |

### 1.2 Test Graph

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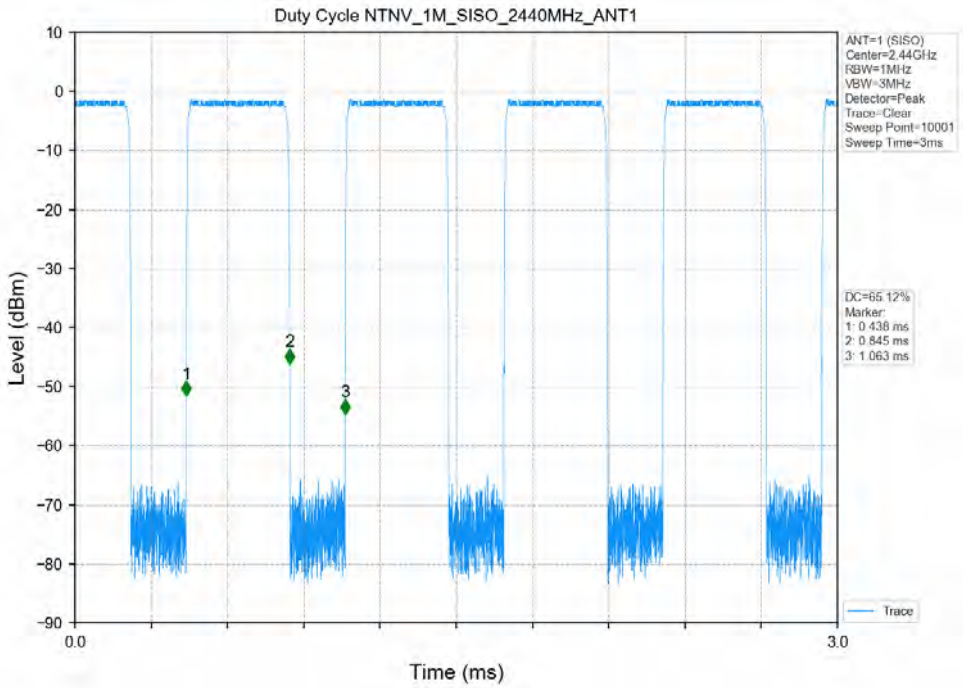


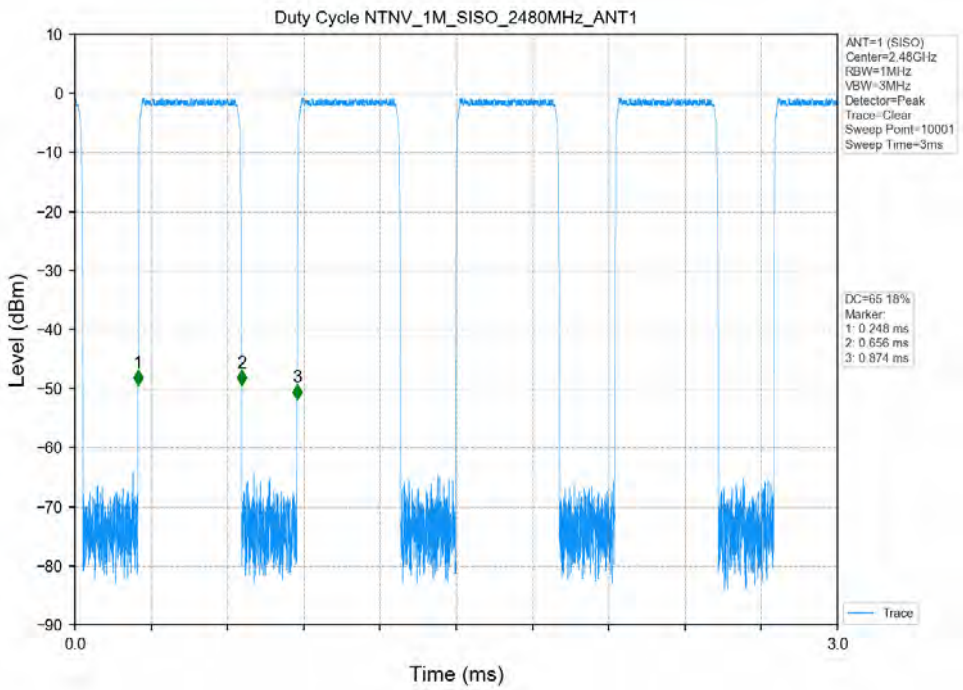


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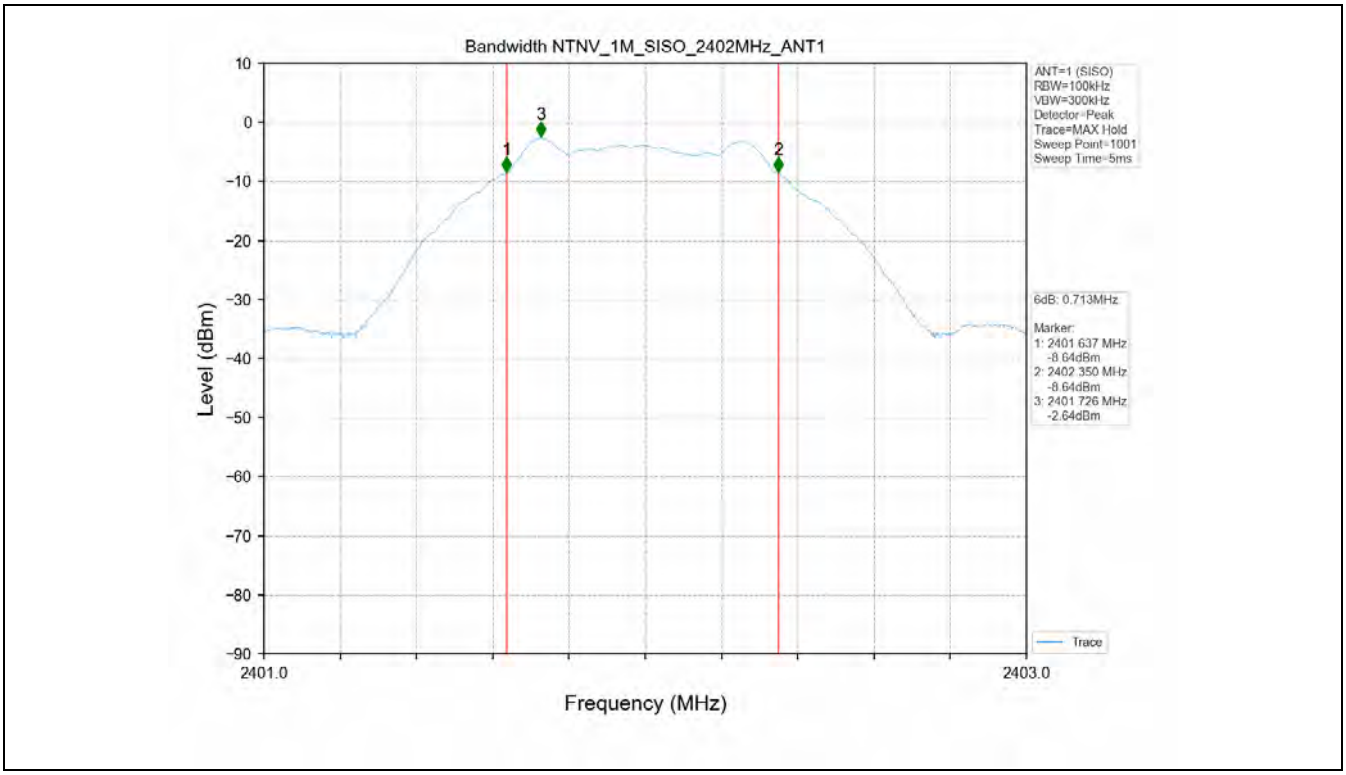
## 2. Bandwidth

### 2.1 Test Result

| Test Mode | Frequency (MHz) | TX Type | ANT No. | 6dB Bandwidth Test Result (MHz) | Verdict |
|---|---|---|---|---|---|
| 1M | 2402 | SISO | 1 | 0.713 | PASS |
| | 2440 | SISO | 1 | 0.716 | PASS |
| | 2480 | SISO | 1 | 0.717 | PASS |

| Test Mode | Frequency (MHz) | TX Type | ANT No. | 99% Occupied Bandwidth Test Result (MHz) | |
|---|---|---|---|---|---|
| 1M | 2402 | SISO | 1 | 1.025 | Only for Report Use |
| | 2440 | SISO | 1 | 1.025 | Only for Report Use |
| | 2480 | SISO | 1 | 1.025 | Only for Report Use |

### 2.2 Test Graph - 6dB Bandwidth

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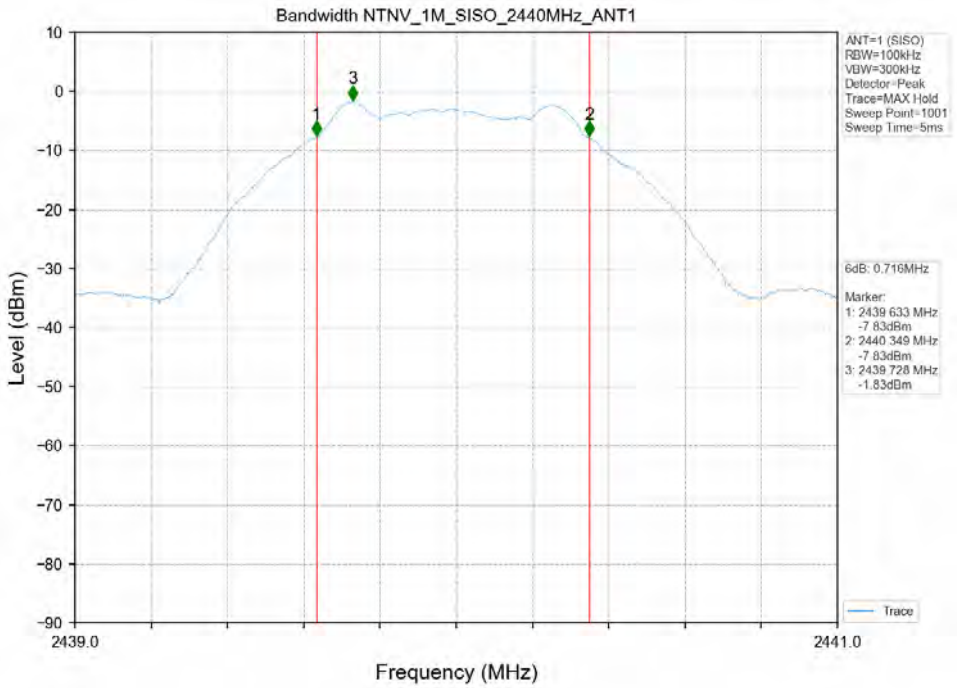


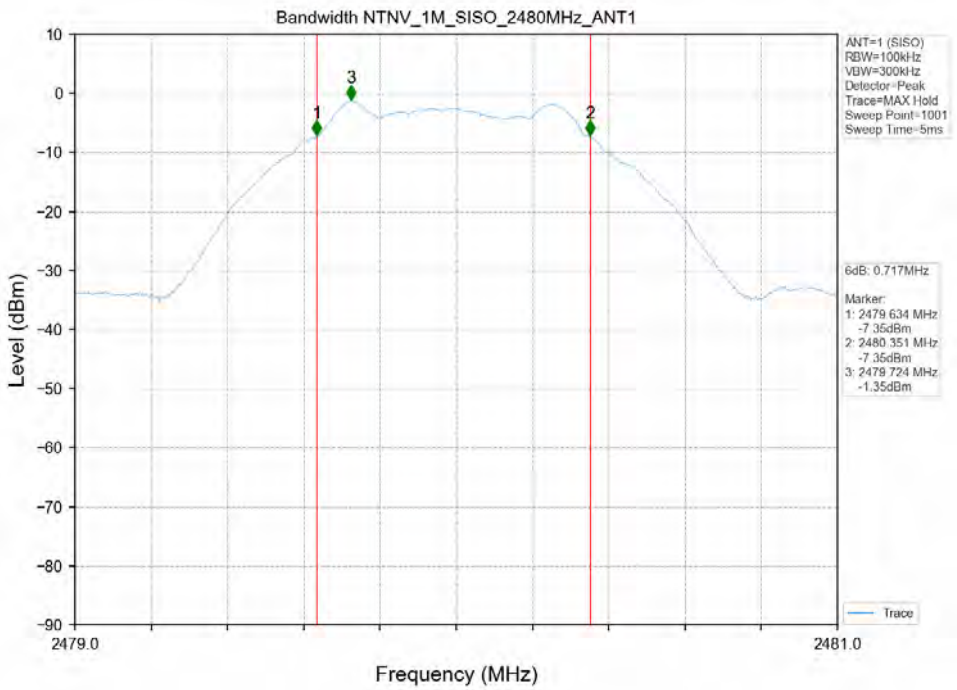


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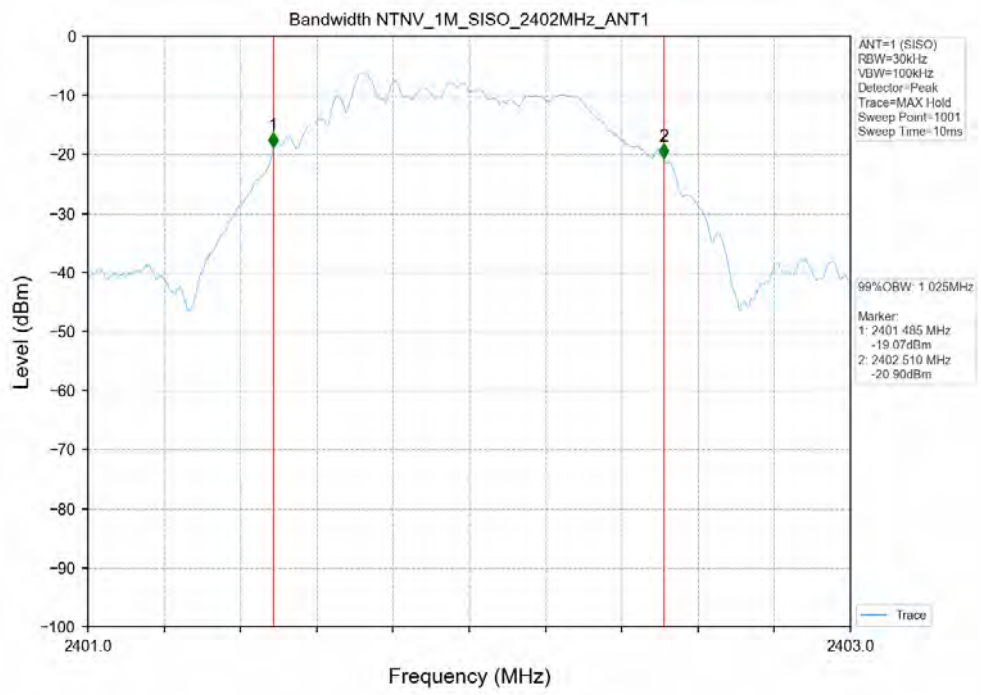
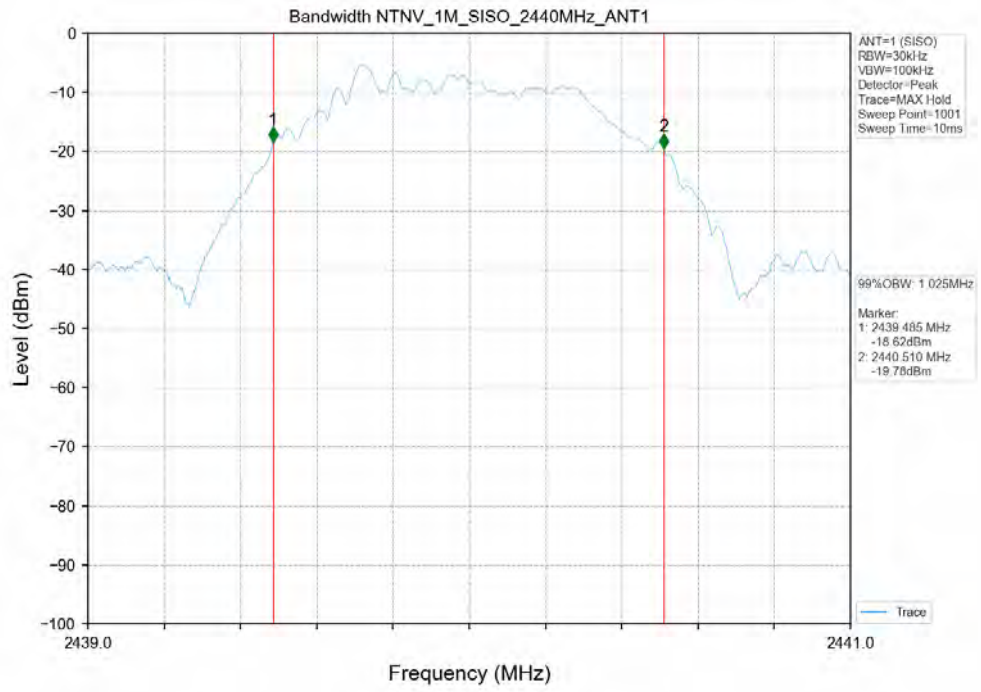
### 2.3 Test Graph - 99% Occupied Bandwidth

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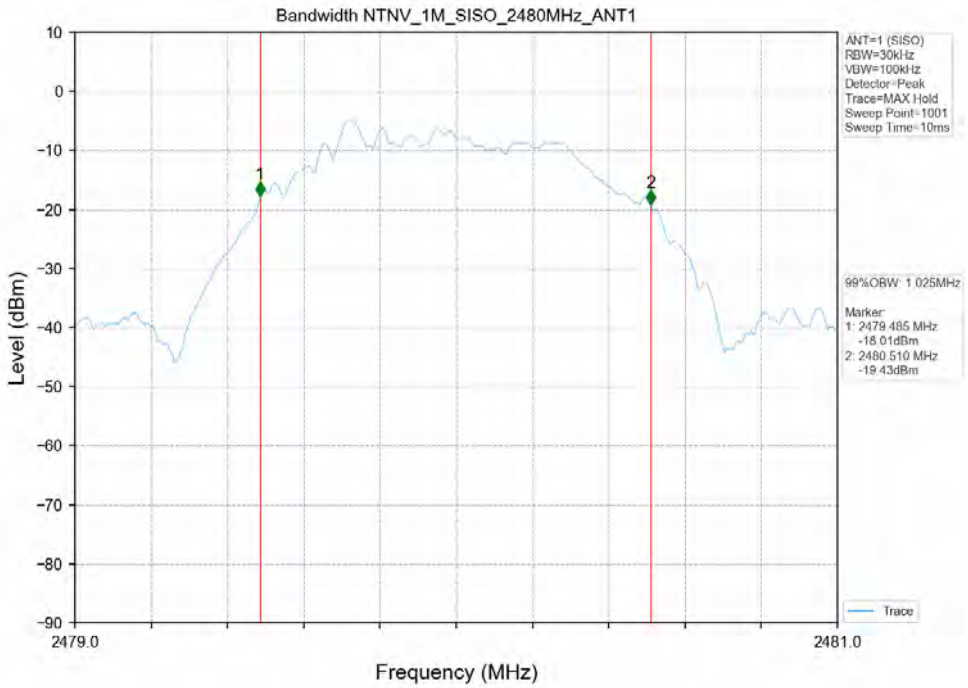


## 3. Maximum Conducted Output Power

### 3.1 Test Result

| Test Mode | Frequency (MHz) | Tx Type | Measured Peak Output Power (dBm) | Limits (dBm) | Verdict |
|---|---|---|---|---|---|
| | | | Ant 1 | | |
| 1M | 2402 | SISO | -2.13 | 30 | PASS |
| | 2440 | SISO | -1.23 | 30 | PASS |
| | 2480 | SISO | -0.71 | 30 | PASS |

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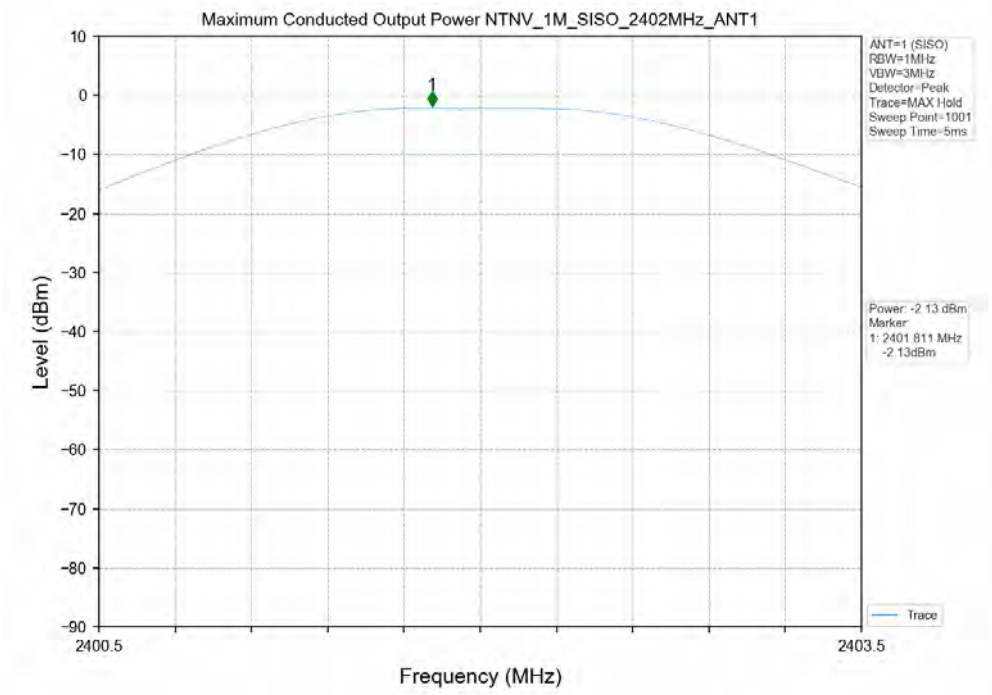
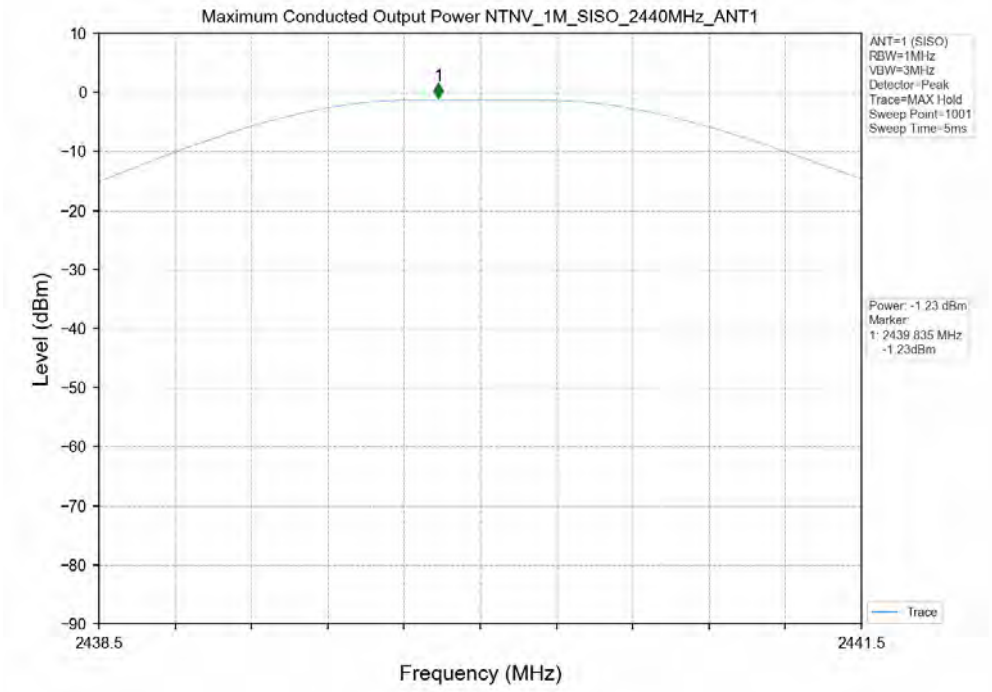
### 3.2 Test Graph

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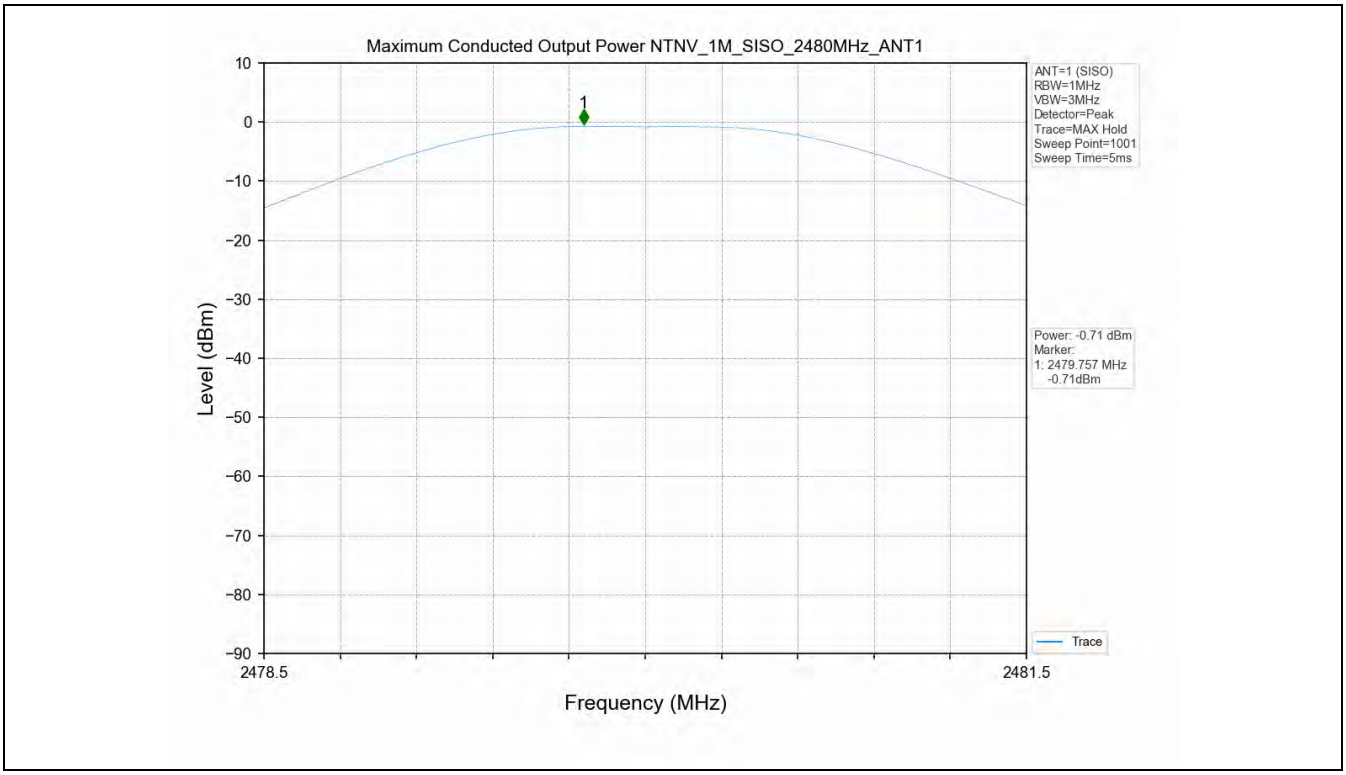


## 4. Maximum Power Spectral Density (PSD)

### 4.1 Test Result

| Test Mode | Frequency (MHz) | Tx Type | Maximum Power Spectral Density (dBm/3KHz) | Limits (dBm/3kHz) | Verdict |
|---|---|---|---|---|---|
| | | | Ant 1 | | |
| 1M | 2402 | SISO | -17.46 | ≤8 | PASS |
| | 2440 | SISO | -16.65 | ≤8 | PASS |
| | 2480 | SISO | -16.15 | ≤8 | PASS |

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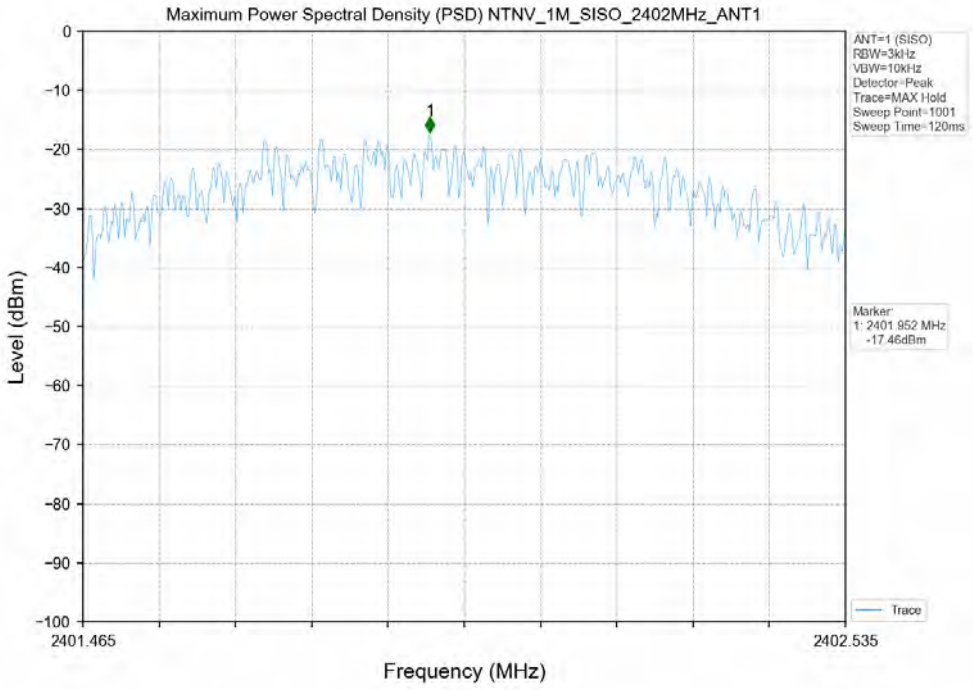
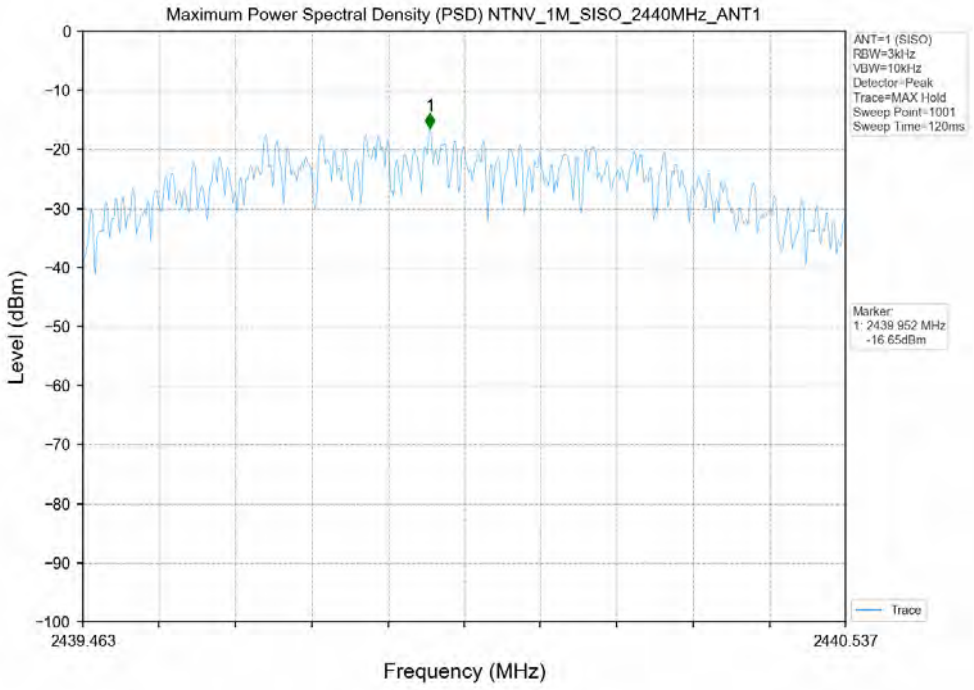
**4.2 Test Graph**

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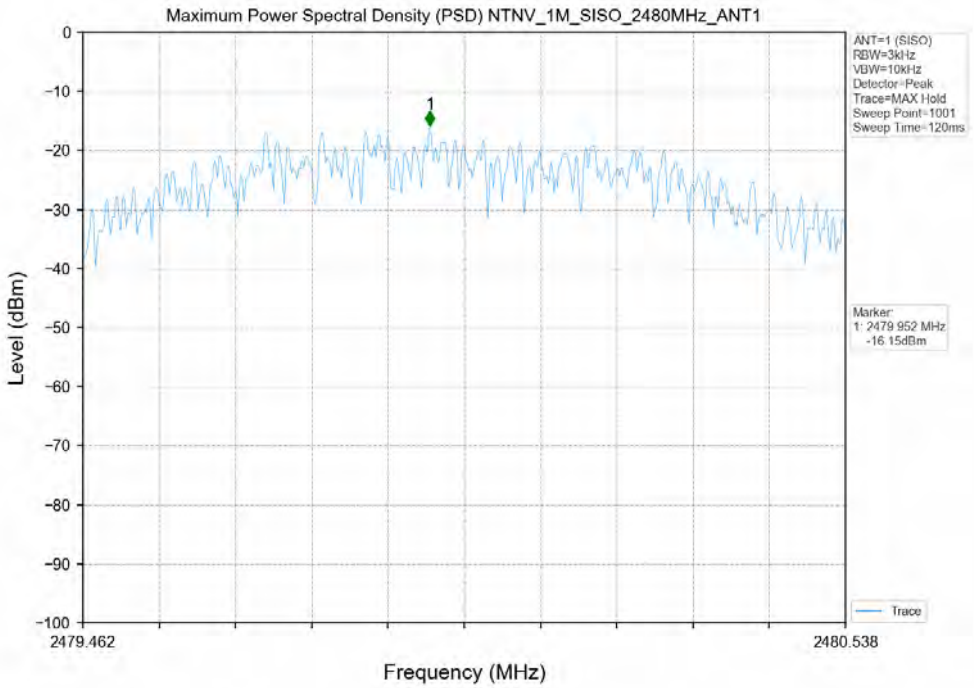


## 5. Unwanted Emissions in Non-restricted Frequency Bands

### 5.1 Test Result

| Test Mode | Frequency (MHz) | TX Type | ANT No. | Spurious Conducted Emission (dBm) | Limits (dBm) | Verdict |
|---|---|---|---|---|---|---|
| 1M | 2402 | SISO | 1 | Refer to test graph | -21.35 | PASS |
| | 2440 | SISO | 1 | Refer to test graph | -21.35 | PASS |
| | 2480 | SISO | 1 | Refer to test graph | -21.35 | PASS |

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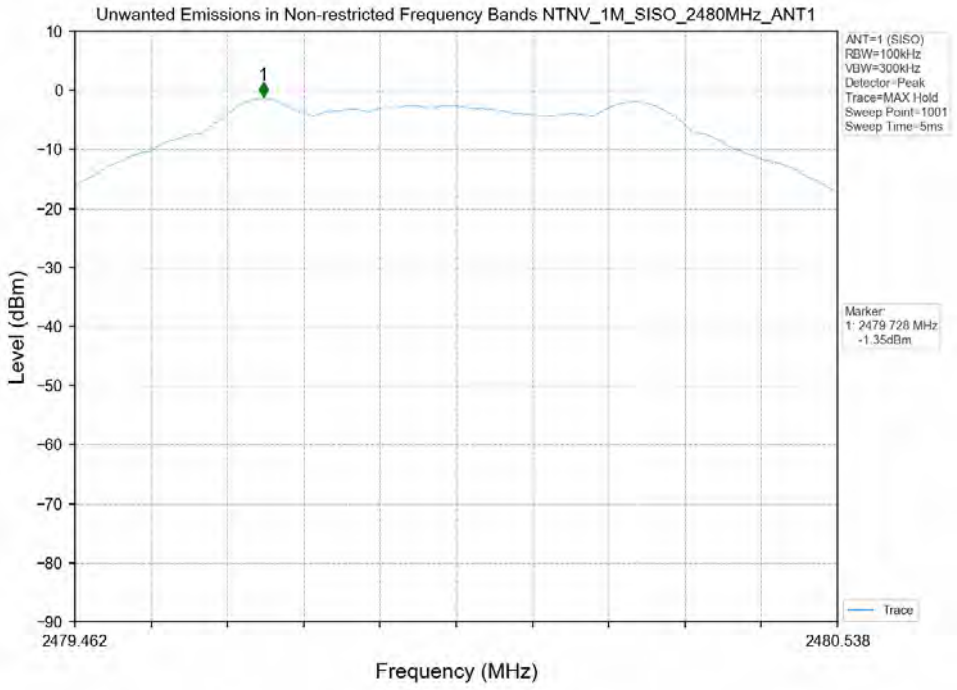
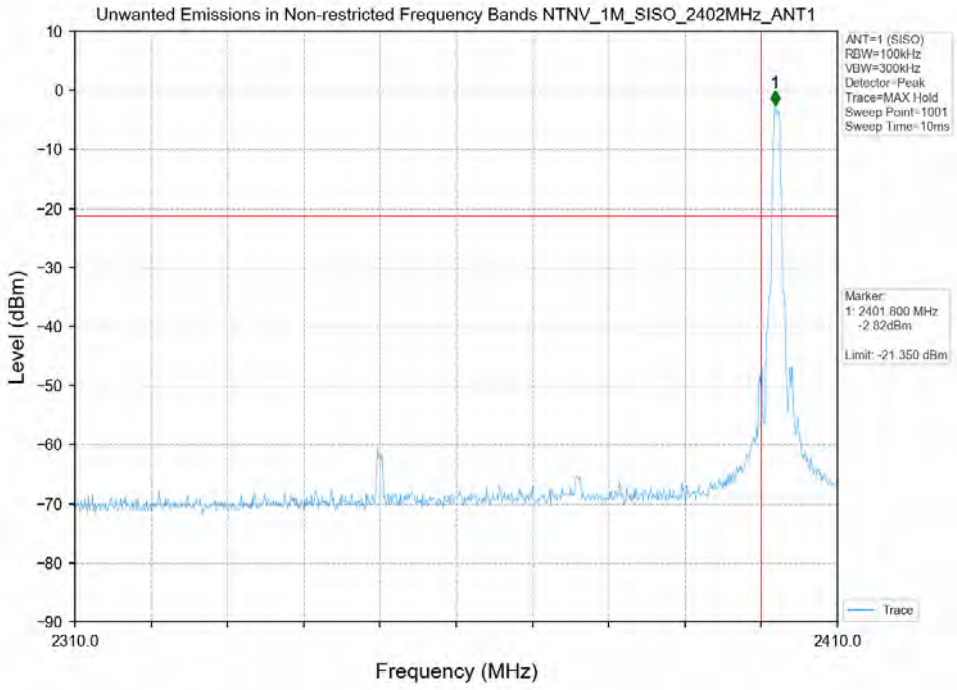
**5.2 Test Graph**

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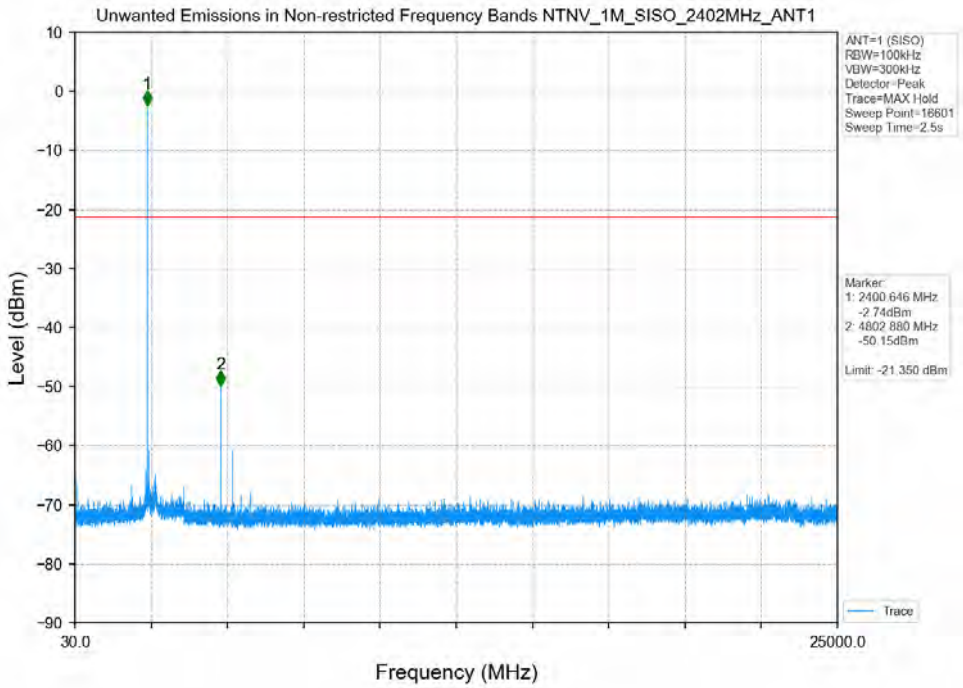


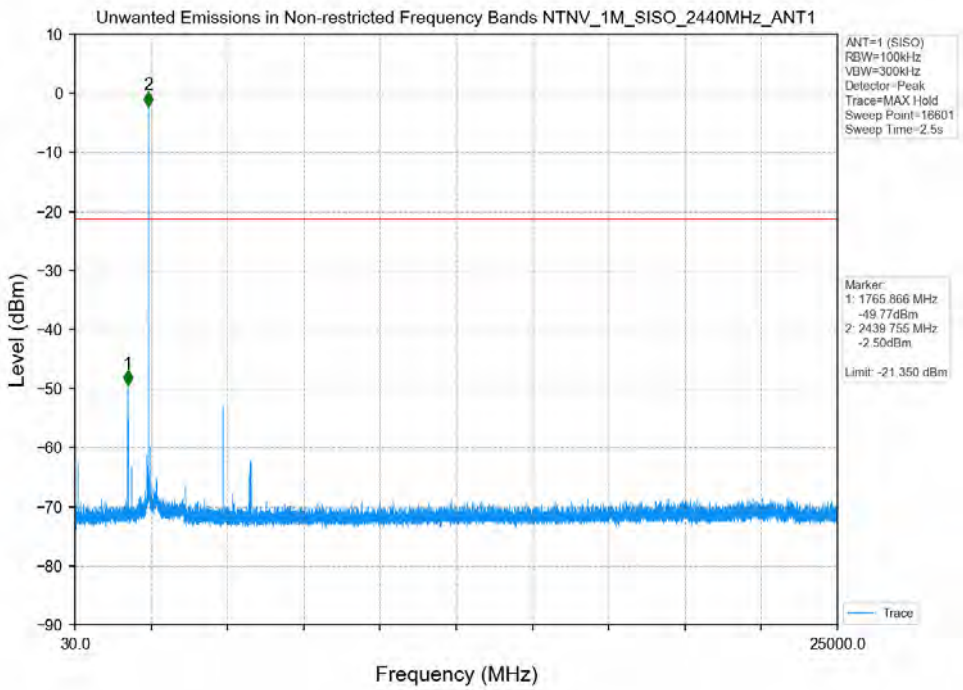


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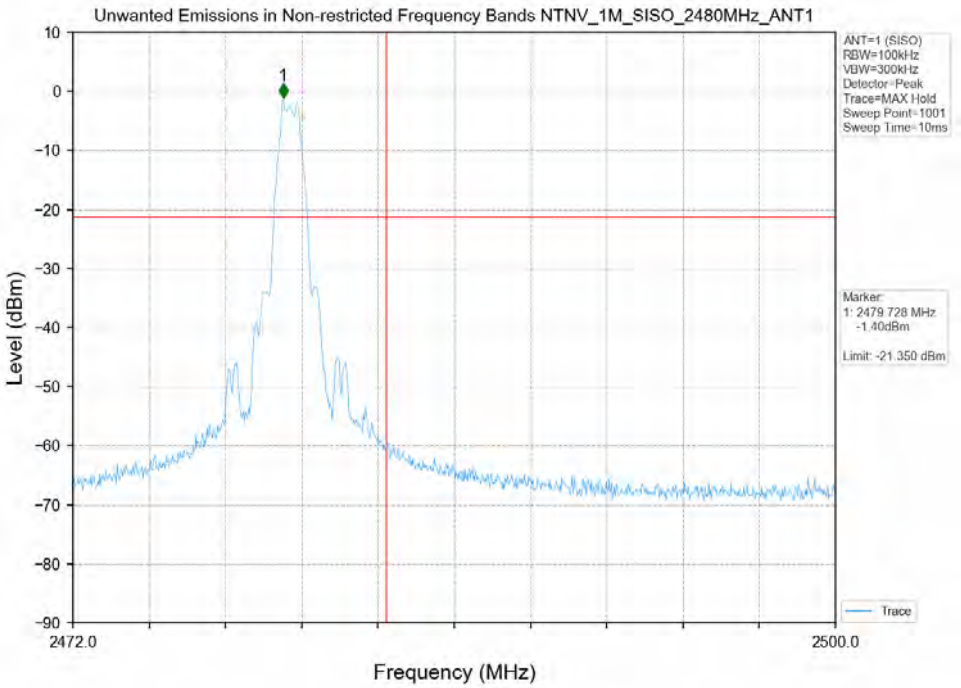


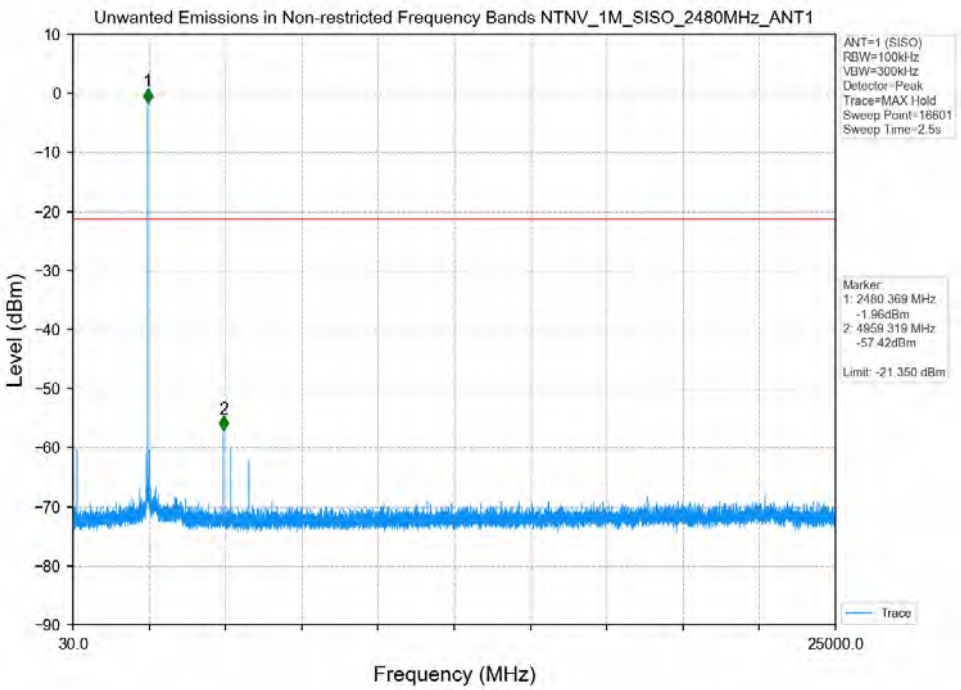


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