



Test Report

Date : 2023-05-30
No. : HMD23040027

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Applicant : The Singing Machine Company, inc.
6301 NW 5th Way, Suite 2900, Fort Lauderdale, FL 33309, USA

Supplier / Manufacturer : ZHUHAI FULLWING ELECTRONIC CO., LTD ZHONGSHAN BRANCH.
4/F & 5/F, No 10, Xingye Road, Xinxu, San Xiang, Zhongshan, Guangdong, China

Description of Sample(s) : Submitted sample(s) said to be
Product: SINGCAST HOME STAGE MINI
Brand Name: Singing Machine
Model No.: SMC2020
FCC ID: 2AAXO-SMC2020

Date Samples Received : 2023-04-25

Date Tested : 2023-04-25 to 2023-05-18

Investigation Requested : Perform Electro Magnetic Interference measurement in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15 and ANSI C63.10:2013 for FCC Certification.

Conclusions : The submitted product COMPLIED with the requirements of Federal Communications Commission [FCC] Rules and Regulations Part 15. The tests were performed in accordance with the standards described above and on Section 2.2 in this Test Report.

Remarks : Bluetooth FHSS (GFSK / $\pi/4$ -DQPSK/ 8DPSK)
For additional model(s) details, please see page 3.

Test by : Susu


Dr.CHAN Kwok Hung, Brian
Authorized Signatory



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1.0 General Details

1.1 Test Laboratory

The Hong Kong Standards and Testing Centre Ltd.
EMC Laboratory
10 Dai Wang Street, Taipo Industrial Estate, New Territories, Hong Kong
Telephone: 852 2666 1888
Fax: 852 2664 4353

1.2 Equipment Under Test [EUT]

Description of Sample(s)

Product: SINGCAST HOME STAGE MINI
Manufacturer: ZHUHAI FULLWING ELECTRONIC CO., LTD
ZHONGSHAN BRANCH
4/F&5/F, No 10, Xingye Road, Xinxu, San Xiang, Zhongshan,
Guangdong, China
Brand Name: Singing Machine
Model Number: SMC2020
Additional Model Number: SMC2024, SMC2027
Rating: 12Vd.c. by adapter
The AC/DC adapter was provided by the applicant with following details:
Brand name: REYIPOWER; Model no.: RY24D120125US
Input: 100-240Va.c. 50-60Hz 1.0A MAX, Output: 12Vd.c. 1250mA

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is a SINGCAST HOME STAGE MINI. The transmission signal is digital modulated with channel frequency range 2402-2480MHz. The R.F. signal was modulated by IC; the type of modulation used was frequency hopping spread spectrum Modulation.

1.3 Date of Order

2023-04-25

1.4 Submitted Sample(s):

1 Sample

1.5 Test Duration

2023-04-25 to 2023-05-18

1.6 Country of Origin

China

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1.7 RF Module Details

Module Model Number: N/A
Module FCC ID: N/A
Module Transmission Type: Bluetooth 5.0 BR+EDR
Modulation: FHSS (GFSK / $\pi/4$ -DQPSK/ 8DPSK)
Data Rates: 1Mbps: GFSK
2 Mbps: $\pi/4$ -DQPSK
3 Mbps: 8DPSK
Frequency Range: 2400-2483.5MHz
Carrier Frequencies: 2402MHz – 2480MHz

Module Specification (specification provided by manufacturer)

1.8 Antenna Details

Antenna Type: PCB antenna
Antenna Gain: -0.58 dBi

1.9 Channel List

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|
| 0 | 2402 | 42 | 2444 |
| 1 | 2403 | 43 | 2445 |
| 2 | 2404 | 44 | 2446 |
| 3 | 2405 | 45 | 2447 |
| 4 | 2406 | 46 | 2448 |
| 5 | 2407 | 47 | 2449 |
| 6 | 2408 | 48 | 2450 |
| 7 | 2409 | ... | ... |
| 8 | 2410 | 67 | 2469 |
| 9 | 2411 | 68 | 2470 |
| ... | ... | 69 | 2471 |
| 33 | 2435 | 70 | 2472 |
| 34 | 2436 | 71 | 2473 |
| 35 | 2437 | 72 | 2474 |
| 36 | 2438 | 73 | 2475 |
| 37 | 2439 | 74 | 2476 |
| 38 | 2440 | 75 | 2477 |
| 39 | 2441 | 76 | 2478 |
| 40 | 2442 | 77 | 2479 |
| 41 | 2443 | 78 | 2480 |

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2.0 Technical Details

2.1 Investigations Requested

Perform Electromagnetic Interference measurements in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15 Regulations and ANSI C63.10:2013 for FCC Certification.
The device was realized by test software and the RF power select "0".



The screenshot shows the MV FrequencyTools v0.3.2 software interface. The window has a light blue background and standard Windows window controls (minimize, maximize, close) in the top right corner. The interface is divided into several sections:

- Top Left:** Contains an information icon and a download icon, with links for "About" and "QuickStartGuide".
- COM Port:** A dropdown menu showing "COM3" and a "Close" button below it.
- Connect Select:** A dropdown menu showing "NonConnect_BT" and a "Connect" button.
- Generate and Send CMD:** This section includes:
 - 1. Hopping Type:** A dropdown menu showing "Single Frequency".
 - 2. Frequency:** A dropdown menu showing "2480" followed by "MHz".
 - 3. Package Type:** A dropdown menu showing "3DH5".
 - Mode Select in NonConnect:** Two radio buttons, "BT-TX" (selected) and "BT-RX".
 - MAX TX Power:** A dropdown menu showing "0dBm".
 - SEND:** A large button on the right side of this section.
- Connect_BLE_Tester:** This section includes:
 - BLE Mode:** Two radio buttons, "BLE-TX" and "BLE-RX" (selected).
 - Frequency (BLE Tester):** A dropdown menu.
 - Received Packet Number:** A text input field.
 - START:** A button on the right side of this section.
- Bottom:** A green checkmark icon followed by the text "Send Data:Successful!" and "FCC Ver:1.5.4" on the right.



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2.2 Test Standards and Results Summary Tables

| EMISSION | | | | | | |
|-------------------------------------|------------------------------------|-------------------|------------------|-------------------------------------|--------------------------|--------------------------|
| Results Summary | | | | | | |
| Test Condition | Test Requirement | Test Method | Class / Severity | Test Result | | |
| | | | | Pass | Failed | N/A |
| Maximum Peak Conducted Output Power | FCC 47CFR 15.247(b)(1) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Radiated Spurious Emissions | FCC 47CFR 15.209, FCC 47CFR 15.205 | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| AC Mains Conducted Emissions | FCC 47CFR 15.207 | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Conducted Spurious Emissions | FCC 47CFR 15.247(d) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Number of Hopping Frequency | FCC 47CFR 15.247 (b)(1) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 20dB Bandwidth | FCC 47CFR 15.247(a)(2) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Hopping Channel Separation | FCC 47CFR 15.247(a)(1) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Band-edge measurement (Radiated) | FCC 47CFR 15.247(d) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Pseudorandom Hopping Algorithm | FCC 47CFR 15.247(a)(1) | N/A | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Time of Occupancy (Dwell Time) | FCC 47CFR 15.247(a)(1)(iii) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Antenna requirement | FCC 47CFR 15.203 | N/A | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Note: N/A - Not Applicable



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2.3 Table for Test Modes

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate in the table below is the worst case rate with respect to the specific test item.

Investigation has been done on all the possible configurations for searching the worst cases.

The following table is a list of the test modes shown in this test report.

| Test Items | Mode | Data Rate |
|--|-------------------------------|-----------------------|
| Maximum Peak Conducted Output Power | GFSK / $\pi/4$ -DQPSK / 8DPSK | 1MBps / 2MBps / 3MBps |
| Hopping Channel Separation | GFSK / $\pi/4$ -DQPSK / 8DPSK | 1MBps / 2MBps / 3MBps |
| Number of Hopping Frequency | GFSK / $\pi/4$ -DQPSK / 8DPSK | 1MBps / 2MBp / 3MBps |
| Time of Occupancy(Dwell Time) | 8DPSK (3DH1 / 3DH3 / 3DH5) | 3MBps |
| Radiated Spurious Emissions | GFSK / $\pi/4$ -DQPSK / 8DPSK | 1MBps / 2MBps / 3MBps |
| Band-edge compliance of Conducted Emission | GFSK / $\pi/4$ -DQPSK / 8DPSK | 1MBps / 2MBps / 3MBps |

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3.0 Test Results

3.1 Emission

3.1.1 Maximum Peak Conducted Output Power

| | |
|--------------------|-------------------------|
| Test Requirement: | FCC 47CFR 15.247(b) (1) |
| Test Method: | ANSI C63.10: 2013 |
| Test Date: | 2023-04-28 |
| Mode of Operation: | Tx mode |

| | | |
|---------------------------|------------------------|-------------------------------|
| Ambient Temperature: 25°C | Relative Humidity: 51% | Atmospheric Pressure: 101 kPa |
|---------------------------|------------------------|-------------------------------|

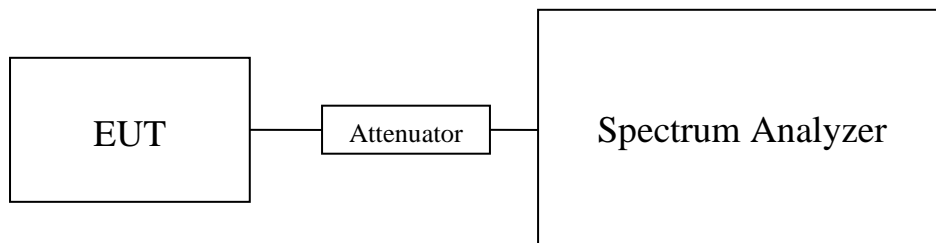
Test Method:

A temporary antenna connector was soldered to the RF output. The RF output of the EUT was connected to the spectrum analyzer. All the attenuation or cable loss will be added to the measured maximum output power. The results are recorded in Watt.

Spectrum Analyzer Setting:

RBW = 3 MHz, VBW= 3MHz, Sweep = Auto, Span: Approximately five times the 20 dB bandwidth
Detector = Peak, Trace = Max. hold

Test Setup:



Note: a temporary antenna connector was soldered to the RF output.



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Limits for Maximum Peak Conducted Output Power [FCC 47CFR 15.247]:

The maximum peak output power shall not exceed the following limits:
For frequency hopping systems employing at least 75 hopping channels: 1 Watt
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 Watts
For Digital Transmission systems in 2400-2483.5 MHz Band: 1 Watt

Results of Bluetooth Communication mode (GFSK) (Fundamental Power): Pass

| Channel | Frequency (MHz) | Conducted power(dBm) | Antenna Gain(dBi) | E.I.R.P(dBm) | E.I.R.P (Watt) |
|---------|-----------------|----------------------|-------------------|--------------|----------------|
| 0 | 2402 | -1.026 | -0.58 | -1.606 | 0.000691 |
| 39 | 2441 | -0.600 | -0.58 | -1.180 | 0.000762 |
| 78 | 2480 | -3.967 | -0.58 | -4.547 | 0.000351 |

Results of Bluetooth Communication mode (PI/4DQPSK) (Fundamental Power): Pass

| Channel | Frequency (MHz) | Conducted power(dBm) | Antenna Gain(dBi) | E.I.R.P(dBm) | E.I.R.P (Watt) |
|---------|-----------------|----------------------|-------------------|--------------|----------------|
| 0 | 2402 | -1.011 | -0.58 | -1.591 | 0.000693 |
| 39 | 2441 | -0.565 | -0.58 | -1.145 | 0.000768 |
| 78 | 2480 | -3.972 | -0.58 | -4.552 | 0.000351 |

Results of Bluetooth Communication mode (8DPSK) (Fundamental Power): Pass

| Channel | Frequency (MHz) | Conducted power(dBm) | Antenna Gain(dBi) | E.I.R.P(dBm) | E.I.R.P (Watt) |
|---------|-----------------|----------------------|-------------------|--------------|----------------|
| 0 | 2402 | -1.034 | -0.58 | -1.614 | 0.000690 |
| 39 | 2441 | -0.597 | -0.58 | -1.177 | 0.000763 |
| 78 | 2480 | -3.957 | -0.58 | -4.537 | 0.000352 |

Calculated measurement uncertainty : 30MHz to 1GHz 1.7dB
1GHz to 18GHz 1.7dB

Remark:

1. All test data for each data rate were verified, but only the worst case was reported.
2. The EUT is programmed to transmit signals continuously for all testing.

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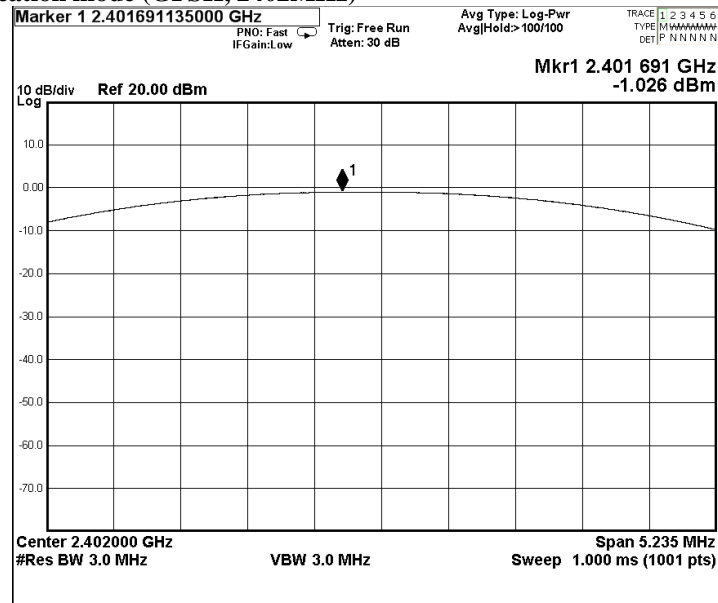
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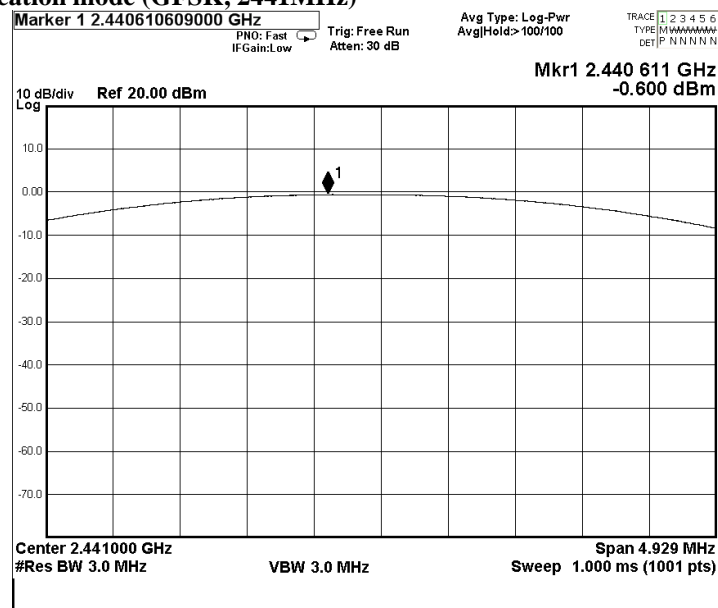
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Test plot of Maximum Peak Conducted Output Power:

Bluetooth Communication mode (GFSK, 2402MHz)



Bluetooth Communication mode (GFSK, 2441MHz)



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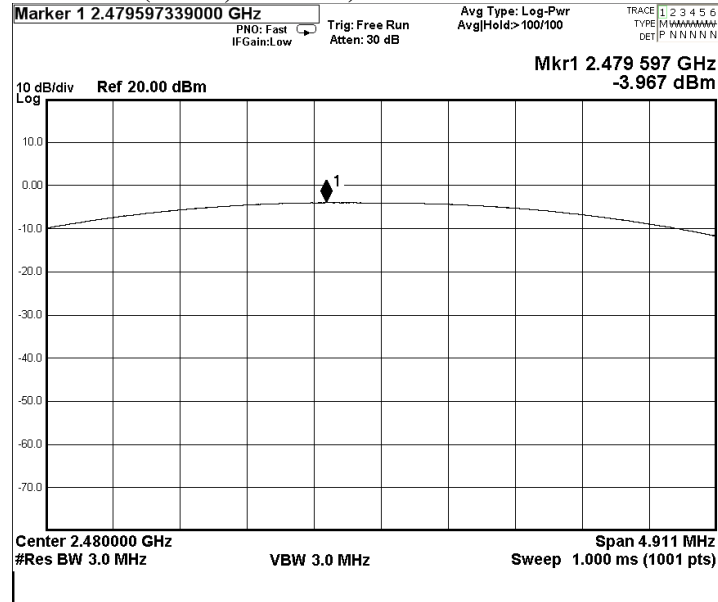


Test Report

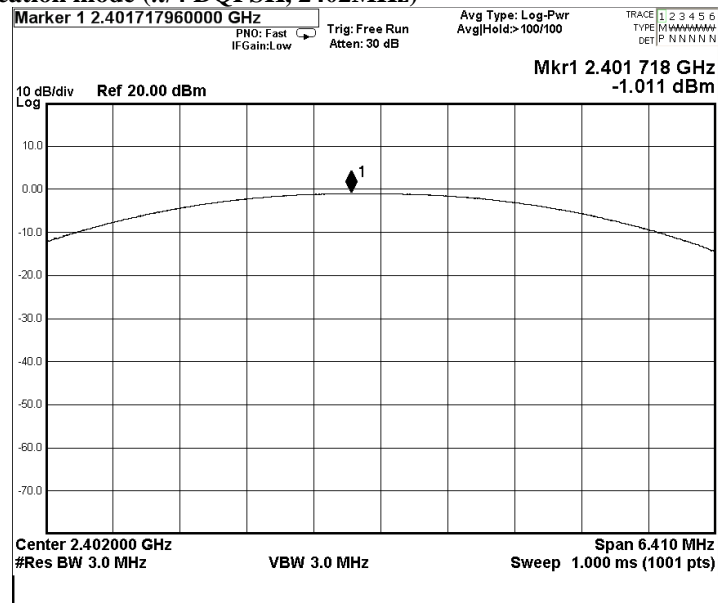
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Bluetooth Communication mode (GFSK, 2480MHz)



Bluetooth Communication mode ($\pi/4$ DQPSK, 2402MHz)



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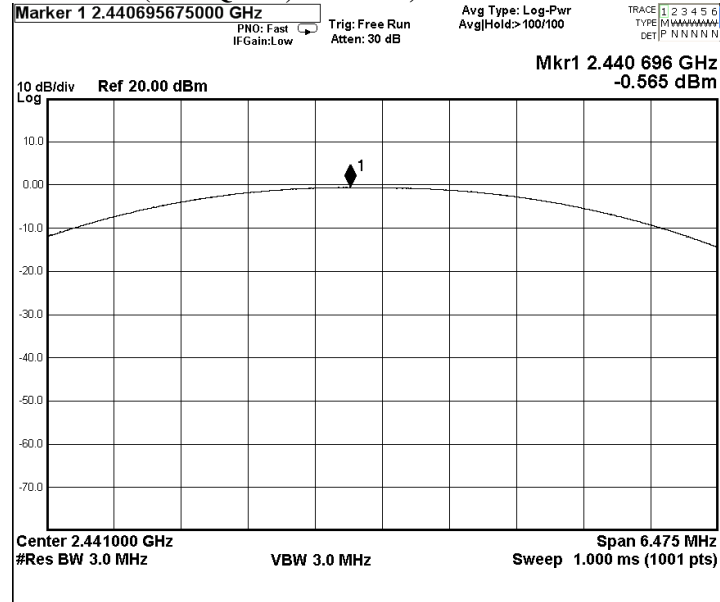
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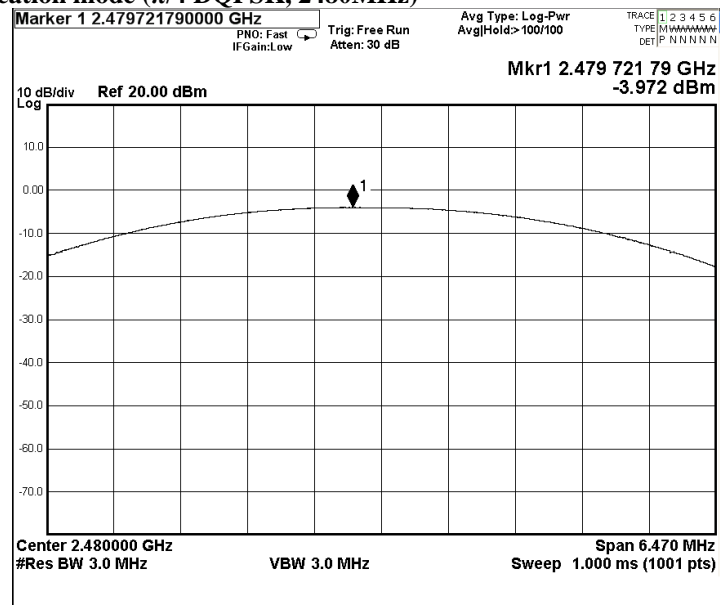
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Bluetooth Communication mode ($\pi/4$ DQPSK, 2441MHz)



Bluetooth Communication mode ($\pi/4$ DQPSK, 2480MHz)



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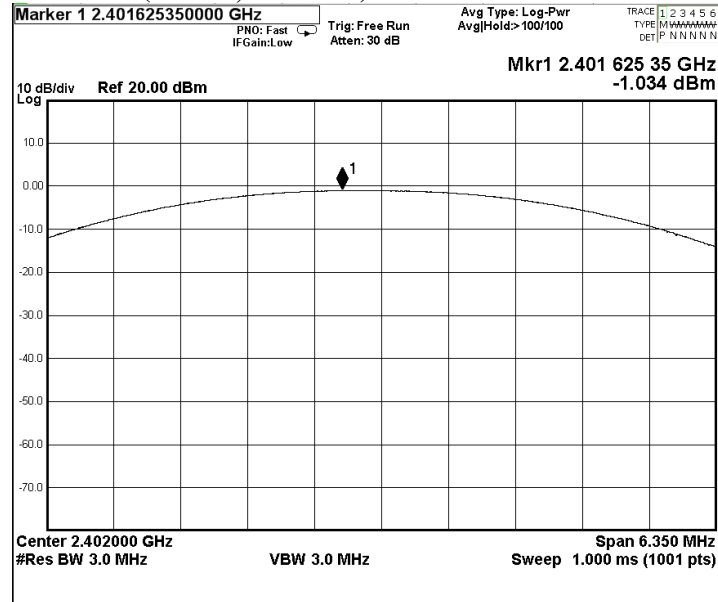


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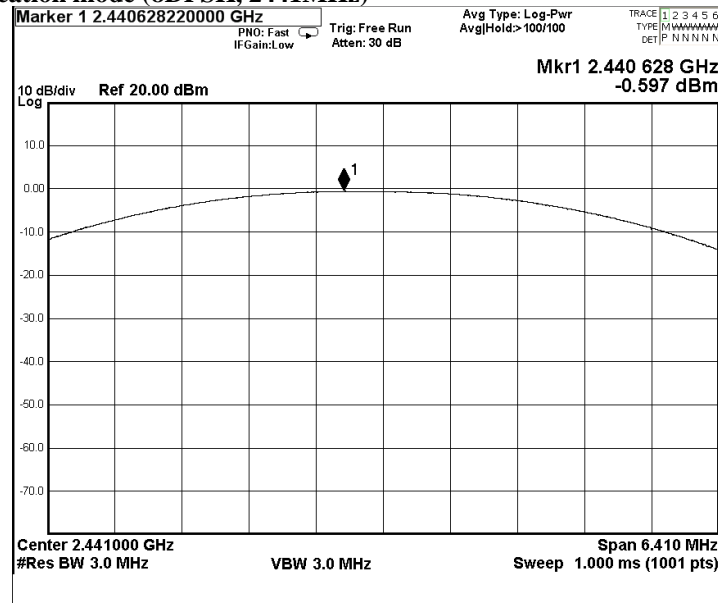
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Bluetooth Communication mode (8DPSK, 2402MHz)



Bluetooth Communication mode (8DPSK, 2441MHz)



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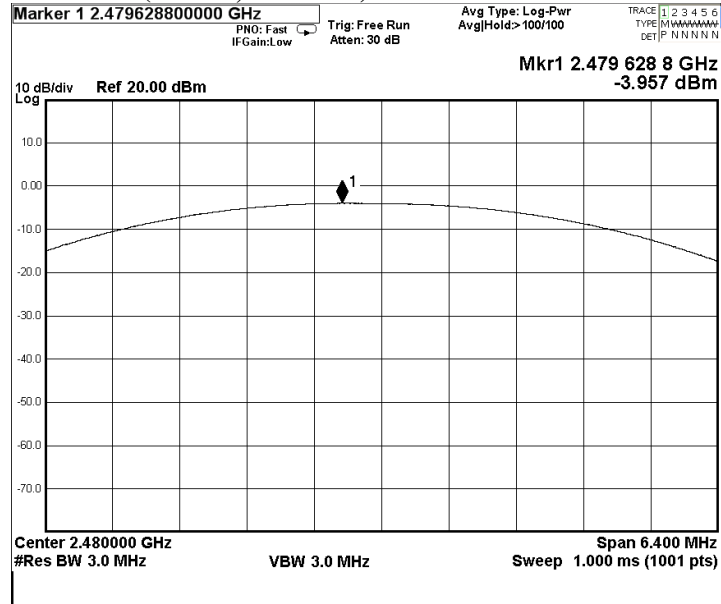


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Bluetooth Communication mode (8DPSK, 2480MHz)



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3.1.2 Radiated Spurious Emissions

| | |
|--------------------|--------------------------------------|
| Test Requirement: | FCC 47CFR 15.209 |
| Test Method: | ANSI C63.10:2013 |
| Test Date: | 2023-04-26 to 2023-04-28 |
| Mode of Operation: | Tx mode / Bluetooth play mode (GFSK) |

Ambient Temperature: 26.8°C Relative Humidity: 43.9% Atmospheric Pressure: 100.8 kPa

Test Method:

For emission measurements at or below 1 GHz, the sample was placed 0.8m above the ground plane of semi-anechoic Chamber*. For emission measurements above 1 GHz, the sample was placed 1.5m above the ground plane of semi-anechoic Chamber*. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.

* Semi-Anechoic chamber located on the G/F of The Hong Kong Standards and Testing Centre Ltd. with
Registration Number: HK0001
Test Firm Registration Number: 367672

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Spectrum Analyzer Setting:

9KHz – 30MHz (Pk & AVG)

RBW: 10kHz
VBW: 30kHz
Sweep: Auto
Span: Fully capture the emissions being measured
Trace: Max. hold

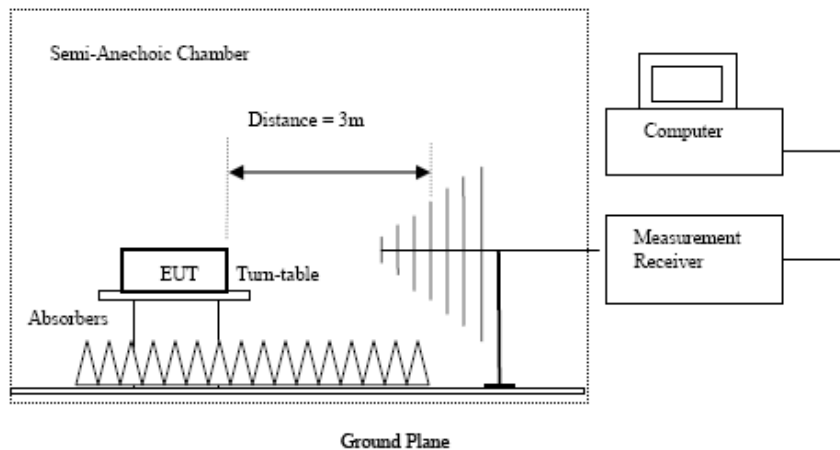
30MHz – 1GHz (QP)

RBW: 120kHz
VBW: 120kHz
Sweep: Auto
Span: Fully capture the emissions being measured
Trace: Max. hold

Above 1GHz (Pk & AVG)

RBW: 1MHz
VBW: 1MHz
Sweep: Auto
Span: Fully capture the emissions being measured
Trace: Max. hold

Test Setup:



- Absorbers placed on top of the ground plane are for measurements above 1000MHz only.
- Measurements between 30MHz to 1000MHz made with Bi-log antennas, above 1000MHz horn antennas are used, 9kHz to 30MHz loop antennas are used.



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Limits for Radiated Emissions FCC 47 CFR 15.247 Class B):

| Frequency Range | Quasi-Peak Limits |
|-----------------|-------------------|
| [MHz] | [μ V/m] |
| 0.009-0.490 | 2400/F (kHz) |
| 0.490-1.705 | 24000/F (kHz) |
| 1.705-30 | 30 |
| 30-88 | 100 |
| 88-216 | 150 |
| 216-960 | 200 |
| Above 960 | 500 |

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Result of Tx mode (2402.0 MHz) (GFSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------------|------------------------------|-----------------------------------|--------------------------------|--------------------|---------------------|
| Frequency MHz | Measured Level dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Field Strength μ V/m | Limit μ V/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2402.0 MHz) (GFSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 4804.0 | 57.4 | 0.8 | 58.3 | 74.0 | 15.7 | Vertical |
| 4804.0 | 57.0 | 0.5 | 57.5 | 74.0 | 16.5 | Horizontal |
| 7206.0 | 49.5 | 7.0 | 56.5 | 74.0 | 17.5 | Vertical |
| 7206.0 | 49.6 | 6.5 | 56.1 | 74.0 | 17.9 | Horizontal |
| 9608.0 | 46.3 | 8.5 | 54.8 | 74.0 | 19.2 | Vertical |
| 9608.0 | 46.5 | 8.3 | 54.8 | 74.0 | 19.2 | Horizontal |
| 12010.0 | 45.3 | 10.9 | 56.2 | 74.0 | 17.8 | Vertical |
| 12010.0 | 45.3 | 10.8 | 56.1 | 74.0 | 18.0 | Horizontal |

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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 4804.0 | 41.2 | 0.8 | 42.0 | 54.0 | 12.0 | Vertical |
| 4804.0 | 41.4 | 0.5 | 41.9 | 54.0 | 12.1 | Horizontal |
| 7206.0 | 35.2 | 7.0 | 42.2 | 54.0 | 11.8 | Vertical |
| 7206.0 | 34.1 | 6.5 | 40.6 | 54.0 | 13.4 | Horizontal |
| 9608.0 | 31.5 | 8.5 | 40.0 | 54.0 | 14.0 | Vertical |
| 9608.0 | 32.2 | 8.3 | 40.5 | 54.0 | 13.5 | Horizontal |
| 12010.0 | 30.1 | 10.9 | 41.0 | 54.0 | 13.0 | Vertical |
| 12010.0 | 30.0 | 10.8 | 40.8 | 54.0 | 13.2 | Horizontal |

Result of Tx mode (2441.0 MHz) (GFSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2441.0 MHz) (GFSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 4882.0 | 57.1 | 0.8 | 57.9 | 74.0 | 16.1 | Vertical |
| 4882.0 | 57.0 | 0.5 | 57.5 | 74.0 | 16.5 | Horizontal |
| 7223.0 | 50.0 | 7.0 | 57.0 | 74.0 | 17.0 | Vertical |
| 7223.0 | 50.6 | 6.5 | 57.1 | 74.0 | 16.9 | Horizontal |
| 9764.0 | 48.2 | 8.5 | 56.7 | 74.0 | 17.3 | Vertical |
| 9764.0 | 47.9 | 8.3 | 56.2 | 74.0 | 17.8 | Horizontal |
| 12205.0 | 45.1 | 10.9 | 56.0 | 74.0 | 18.0 | Vertical |
| 12205.0 | 45.5 | 10.8 | 56.3 | 74.0 | 17.7 | Horizontal |

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| Field Strength of Spurious Emissions | | | | | | |
|--------------------------------------|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Average Value | | | | | | |
| Frequency MHz | Measured Level @3m dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dB | E-Field Polarity |
| 4882.0 | 41.7 | 0.8 | 42.5 | 54.0 | 11.5 | Vertical |
| 4882.0 | 41.6 | 0.5 | 42.1 | 54.0 | 11.9 | Horizontal |
| 7323.0 | 35.5 | 7.0 | 42.5 | 54.0 | 11.5 | Vertical |
| 7323.0 | 35.6 | 6.5 | 42.1 | 54.0 | 11.9 | Horizontal |
| 9764.0 | 33.3 | 8.5 | 41.8 | 54.0 | 12.2 | Vertical |
| 9764.0 | 32.6 | 8.3 | 40.9 | 54.0 | 13.1 | Horizontal |
| 12205.0 | 30.5 | 10.9 | 41.4 | 54.0 | 12.6 | Vertical |
| 12205.0 | 30.1 | 10.8 | 40.9 | 54.0 | 13.1 | Horizontal |

Result of Tx mode (2480.0 MHz) (GFSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2480.0 MHz) (GFSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions | | | | | | |
|--------------------------------------|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 4960.0 | 55.8 | 0.8 | 56.6 | 74.0 | 17.4 | Vertical |
| 4960.0 | 55.3 | 0.5 | 55.8 | 74.0 | 18.2 | Horizontal |
| 7440.0 | 48.5 | 7.0 | 55.5 | 74.0 | 18.5 | Vertical |
| 7440.0 | 48.9 | 6.5 | 55.4 | 74.0 | 18.6 | Horizontal |
| 9920.0 | 47.2 | 8.5 | 55.7 | 74.0 | 18.3 | Vertical |
| 9920.0 | 47.3 | 8.3 | 55.6 | 74.0 | 18.4 | Horizontal |
| 12400.0 | 45.1 | 10.9 | 56.0 | 74.0 | 18.0 | Vertical |
| 12400.0 | 45.3 | 10.8 | 56.1 | 74.0 | 17.9 | Horizontal |

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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBμV | Correction Factor dB/m | Field Strength dBμV/m | Limit @3m dBμV/m | Margin dB | E-Field Polarity |
| 4960.0 | 41.1 | 0.8 | 41.9 | 54.0 | 12.1 | Vertical |
| 4960.0 | 41.2 | 0.5 | 41.7 | 54.0 | 12.3 | Horizontal |
| 7440.0 | 34.6 | 7.0 | 41.6 | 54.0 | 12.4 | Vertical |
| 7440.0 | 35.2 | 6.5 | 41.7 | 54.0 | 12.3 | Horizontal |
| 9920.0 | 33.3 | 8.5 | 41.8 | 54.0 | 12.2 | Vertical |
| 9920.0 | 31.1 | 8.3 | 39.4 | 54.0 | 14.6 | Horizontal |
| 12400.0 | 30.1 | 10.9 | 41.0 | 54.0 | 13.0 | Vertical |
| 12400.0 | 30.4 | 10.8 | 41.2 | 54.0 | 12.8 | Horizontal |

Result of Tx mode (2402.0 MHz) ($\pi/4$ -DQPSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2402.0 MHz) ($\pi/4$ -DQPSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBμV | Correction Factor dB/m | Field Strength dBμV/m | Limit @3m dBμV/m | Margin dB | E-Field Polarity |
| 4804.0 | 57.2 | 0.8 | 58.0 | 74.0 | 16.0 | Vertical |
| 4804.0 | 57.3 | 0.5 | 57.8 | 74.0 | 16.2 | Horizontal |
| 7206.0 | 50.1 | 7.0 | 57.1 | 74.0 | 16.9 | Vertical |
| 7206.0 | 50.4 | 6.5 | 56.9 | 74.0 | 17.1 | Horizontal |
| 9608.0 | 46.6 | 8.5 | 55.1 | 74.0 | 18.9 | Vertical |
| 9608.0 | 47.5 | 8.3 | 55.8 | 74.0 | 18.2 | Horizontal |
| 12010.0 | 45.1 | 10.9 | 56.0 | 74.0 | 18.0 | Vertical |
| 12010.0 | 45.5 | 10.8 | 56.3 | 74.0 | 17.8 | Horizontal |



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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 4804.0 | 41.4 | 0.8 | 42.2 | 54.0 | 11.8 | Vertical |
| 4804.0 | 41.4 | 0.5 | 41.9 | 54.0 | 12.1 | Horizontal |
| 7206.0 | 35.1 | 7.0 | 42.1 | 54.0 | 11.9 | Vertical |
| 7206.0 | 35.2 | 6.5 | 41.7 | 54.0 | 12.3 | Horizontal |
| 9608.0 | 32.5 | 8.5 | 41.0 | 54.0 | 13.0 | Vertical |
| 9608.0 | 33.1 | 8.3 | 41.4 | 54.0 | 12.6 | Horizontal |
| 12010.0 | 30.8 | 10.9 | 41.7 | 54.0 | 12.3 | Vertical |
| 12010.0 | 31.1 | 10.8 | 41.9 | 54.0 | 12.1 | Horizontal |

Result of Tx mode (2441.0 MHz) ($\pi/4$ -DQPSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2441.0 MHz) ($\pi/4$ -DQPSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dB | E-Field Polarity |
| 4882.0 | 57.1 | 0.8 | 57.9 | 74.0 | 16.1 | Vertical |
| 4882.0 | 57.2 | 0.5 | 57.7 | 74.0 | 16.3 | Horizontal |
| 7323.0 | 50.3 | 7.0 | 57.3 | 74.0 | 16.7 | Vertical |
| 7323.0 | 50.4 | 6.5 | 56.9 | 74.0 | 17.1 | Horizontal |
| 9764.0 | 48.2 | 8.5 | 56.7 | 74.0 | 17.3 | Vertical |
| 9764.0 | 47.5 | 8.3 | 55.8 | 74.0 | 18.2 | Horizontal |
| 12205.0 | 45.1 | 10.9 | 56.0 | 74.0 | 18.0 | Vertical |
| 12205.0 | 45.3 | 10.8 | 56.1 | 74.0 | 18.0 | Horizontal |

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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dB | E-Field Polarity |
| 4882.0 | 41.1 | 0.8 | 41.9 | 54.0 | 12.1 | Vertical |
| 4882.0 | 41.2 | 0.52 | 41.7 | 54.0 | 12.3 | Horizontal |
| 7323.0 | 35.1 | 7 | 42.1 | 54.0 | 11.9 | Vertical |
| 7323.0 | 35.0 | 6.5 | 41.5 | 54.0 | 12.5 | Horizontal |
| 9764.0 | 32.8 | 8.5 | 41.3 | 54.0 | 12.7 | Vertical |
| 9764.0 | 33.5 | 8.3 | 41.8 | 54.0 | 12.2 | Horizontal |
| 12205.0 | 31.0 | 10.9 | 41.9 | 54.0 | 12.1 | Vertical |
| 12205.0 | 30.6 | 10.8 | 41.4 | 54.0 | 12.6 | Horizontal |

Result of Tx mode (2480.0 MHz) ($\pi/4$ -DQPSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2480.0 MHz) ($\pi/4$ -DQPSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dB | E-Field Polarity |
| 4960.0 | 56.3 | 0.8 | 57.1 | 74.0 | 16.9 | Vertical |
| 4960.0 | 56.0 | 0.5 | 56.5 | 74.0 | 17.5 | Horizontal |
| 7440.0 | 49.1 | 7.0 | 56.1 | 74.0 | 17.9 | Vertical |
| 7440.0 | 50.0 | 6.5 | 56.5 | 74.0 | 17.5 | Horizontal |
| 9920.0 | 47.1 | 8.5 | 55.6 | 74.0 | 18.4 | Vertical |
| 9920.0 | 47.2 | 8.3 | 55.5 | 74.0 | 18.5 | Horizontal |
| 12400.0 | 45.0 | 10.9 | 55.9 | 74.0 | 18.1 | Vertical |
| 12400.0 | 45.3 | 10.8 | 56.1 | 74.0 | 17.9 | Horizontal |

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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBμV | Correction Factor dB/m | Field Strength dBμV/m | Limit @3m dBμV/m | Margin dB | E-Field Polarity |
| 4960.0 | 41.1 | 0.8 | 41.9 | 54.0 | 12.1 | Vertical |
| 4960.0 | 40.5 | 0.5 | 41.0 | 54.0 | 13.0 | Horizontal |
| 7440.0 | 34.4 | 7.0 | 41.4 | 54.0 | 12.6 | Vertical |
| 7440.0 | 35.0 | 6.5 | 41.5 | 54.0 | 12.5 | Horizontal |
| 9920.0 | 33.0 | 8.5 | 41.5 | 54.0 | 12.5 | Vertical |
| 9920.0 | 32.1 | 8.3 | 40.4 | 54.0 | 13.6 | Horizontal |
| 12400.0 | 30.4 | 10.9 | 41.3 | 54.0 | 12.7 | Vertical |
| 12400.0 | 30.4 | 10.8 | 41.2 | 54.0 | 12.8 | Horizontal |

Result of Tx mode (2402.0 MHz) (8DPSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2402.0 MHz) (8DPSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBμV | Correction Factor dB/m | Field Strength dBμV/m | Limit @3m dBμV/m | Margin dB | E-Field Polarity |
| 4804.0 | 56.4 | 0.8 | 57.2 | 74.0 | 16.8 | Vertical |
| 4804.0 | 56.2 | 0.5 | 56.7 | 74.0 | 17.3 | Horizontal |
| 7206.0 | 48.9 | 7.0 | 55.9 | 74.0 | 18.1 | Vertical |
| 7206.0 | 49.6 | 6.5 | 56.1 | 74.0 | 17.9 | Horizontal |
| 9608.0 | 47.0 | 8.5 | 55.5 | 74.0 | 18.5 | Vertical |
| 9608.0 | 47.4 | 8.3 | 55.7 | 74.0 | 18.3 | Horizontal |
| 12010.0 | 45.3 | 10.9 | 56.2 | 74.0 | 17.8 | Vertical |
| 12010.0 | 45.0 | 10.8 | 55.8 | 74.0 | 18.2 | Horizontal |

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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBμV | Correction Factor dB/m | Field Strength dBμV/m | Limit @3m dBμV/m | Margin dB | E-Field Polarity |
| 4804.0 | 41.1 | 0.8 | 41.9 | 54.0 | 12.1 | Vertical |
| 4804.0 | 41.0 | 0.5 | 41.5 | 54.0 | 12.5 | Horizontal |
| 7206.0 | 34.3 | 7.0 | 41.3 | 54.0 | 12.7 | Vertical |
| 7206.0 | 35.2 | 6.5 | 41.7 | 54.0 | 12.3 | Horizontal |
| 9608.0 | 32.3 | 8.5 | 40.8 | 54.0 | 13.2 | Vertical |
| 9608.0 | 33.0 | 8.3 | 41.3 | 54.0 | 12.7 | Horizontal |
| 12010.0 | 31.1 | 10.9 | 42.0 | 54.0 | 12.0 | Vertical |
| 12010.0 | 30.5 | 10.8 | 41.3 | 54.0 | 12.7 | Horizontal |

Result of Tx mode (2441.0 MHz) (8DPSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2441.0 MHz) (8DPSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBμV | Correction Factor dB/m | Field Strength dBμV/m | Limit @3m dBμV/m | Margin dB | E-Field Polarity |
| 4882.0 | 57.2 | 0.8 | 58.0 | 74.0 | 16.0 | Vertical |
| 4882.0 | 57.3 | 0.5 | 57.8 | 74.0 | 16.2 | Horizontal |
| 7223.0 | 49.2 | 7.0 | 56.2 | 74.0 | 17.8 | Vertical |
| 7223.0 | 49.1 | 6.5 | 55.6 | 74.0 | 18.4 | Horizontal |
| 9764.0 | 47.5 | 8.5 | 56.0 | 74.0 | 18.0 | Vertical |
| 9764.0 | 47.4 | 8.3 | 55.7 | 74.0 | 18.3 | Horizontal |
| 12205.0 | 45.0 | 10.9 | 55.9 | 74.0 | 18.1 | Vertical |
| 12205.0 | 45.2 | 10.8 | 56.0 | 74.0 | 18.0 | Horizontal |

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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dB | E-Field Polarity |
| 4882.0 | 41.0 | 0.8 | 41.8 | 54.0 | 12.2 | Vertical |
| 4882.0 | 41.2 | 0.5 | 41.7 | 54.0 | 12.3 | Horizontal |
| 7323.0 | 34.4 | 7.0 | 41.4 | 54.0 | 12.6 | Vertical |
| 7323.0 | 35.1 | 6.5 | 41.6 | 54.0 | 12.4 | Horizontal |
| 9764.0 | 33.0 | 8.5 | 41.5 | 54.0 | 12.5 | Vertical |
| 9764.0 | 33.0 | 8.3 | 41.3 | 54.0 | 12.7 | Horizontal |
| 12205.0 | 30.2 | 10.9 | 41.1 | 54.0 | 12.9 | Vertical |
| 12205.0 | 30.5 | 10.8 | 41.3 | 54.0 | 12.7 | Horizontal |

Result of Tx mode (2480.0 MHz) (8FPSK) (9kHz – 30MHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|---|---------------------------|------------------------------|-----------------------------|---------------------------|---------------|---------------------|
| Frequency MHz | Measured Level dBuV | Correction Factor dB/m | Field Strength dBuV/m | Field Strength uV/m | Limit uV/m | E-Field Polarity |
| Emissions detected are more than 20 dB below the FCC Limits | | | | | | |

Result of Tx mode (2480.0 MHz) (8DPSK) (Above 1GHz): Pass

| Field Strength of Spurious Emissions Peak Value | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 4960.0 | 56.0 | 0.8 | 56.8 | 74.0 | 17.2 | Vertical |
| 4960.0 | 56.1 | 0.5 | 56.6 | 74.0 | 17.4 | Horizontal |
| 7440.0 | 49.0 | 7.0 | 56.0 | 74.0 | 18.0 | Vertical |
| 7440.0 | 49.3 | 6.5 | 55.8 | 74.0 | 18.2 | Horizontal |
| 9920.0 | 47.1 | 8.5 | 55.6 | 74.0 | 18.4 | Vertical |
| 9920.0 | 47.2 | 8.3 | 55.5 | 74.0 | 18.5 | Horizontal |
| 12400.0 | 45.0 | 10.9 | 55.9 | 74.0 | 18.1 | Vertical |
| 12400.0 | 45.3 | 10.8 | 56.1 | 74.0 | 17.9 | Horizontal |

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| Field Strength of Spurious Emissions Average Value | | | | | | |
|---|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 4960.0 | 41.1 | 0.8 | 41.9 | 54.0 | 12.1 | Vertical |
| 4960.0 | 41.0 | 0.5 | 41.5 | 54.0 | 12.5 | Horizontal |
| 7440.0 | 34.2 | 7.0 | 41.2 | 54.0 | 12.8 | Vertical |
| 7440.0 | 35.1 | 6.5 | 41.6 | 54.0 | 12.4 | Horizontal |
| 9920.0 | 31.8 | 8.5 | 40.3 | 54.0 | 13.7 | Vertical |
| 9920.0 | 32.4 | 8.3 | 40.7 | 54.0 | 13.3 | Horizontal |
| 12400.0 | 30.5 | 10.9 | 41.4 | 54.0 | 12.6 | Vertical |
| 12400.0 | 30.9 | 10.8 | 41.7 | 54.0 | 12.3 | Horizontal |

Remarks:

No additional spurious emissions found between lowest internal used/generated frequency and 30 MHz

* Denotes restricted band of operation.

Measurements were made using a peak detector. Any emission less than 1000MHz and falling within the restricted bands of FCC Rules Part 15 Section 15.205 and the limits of FCC Rules Part 15 Section 15.209 were applied.

Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty
(9kHz-30MHz): 2.0dB
(30MHz -1GHz): 4.9dB
(1GHz -6GHz): 4.02dB
(6GHz -26.5GHz): 4.03dB

Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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Radiated Emissions Measurement:

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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).

Result: RF Radiated Emissions (Lowest)-GFSK

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2390.0 | 48.2 | -4.8 | 43.4 | 74.0 | 30.6 | Vertical |
| 2390.0 | 48.0 | -4.7 | 43.3 | 74.0 | 30.7 | Horizontal |

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Average Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2390.0 | 42.5 | -4.8 | 37.7 | 54.0 | 16.3 | Vertical |
| 2390.0 | 42.3 | -4.7 | 37.6 | 54.0 | 16.4 | Horizontal |

Result: RF Radiated Emissions (Highest) -GFSK

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2483.5 | 55.8 | -4.8 | 51.0 | 74.0 | 23.0 | Vertical |
| 2483.5 | 54.4 | -4.7 | 49.7 | 74.0 | 24.3 | Horizontal |

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| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Average Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2483.5 | 44.0 | -4.8 | 39.2 | 54.0 | 14.8 | Vertical |
| 2483.5 | 44.6 | -4.7 | 39.9 | 54.0 | 14.1 | Horizontal |

Result: RF Radiated Emissions (Lowest)- $\pi/4$ -DQPSK

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2390.0 | 48.3 | -4.8 | 43.5 | 74.0 | 30.5 | Vertical |
| 2390.0 | 48.1 | -4.7 | 43.4 | 74.0 | 30.6 | Horizontal |

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Average Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2390.0 | 42.7 | -4.8 | 37.9 | 54.0 | 16.1 | Vertical |
| 2390.0 | 42.5 | -4.7 | 37.8 | 54.0 | 16.2 | Horizontal |

Result: RF Radiated Emissions (Highest) - $\pi/4$ -DQPSK

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2483.5 | 56.8 | -4.8 | 52.0 | 74.0 | 22.0 | Vertical |
| 2483.5 | 56.4 | -4.7 | 51.7 | 74.0 | 22.3 | Horizontal |

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Average Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2483.5 | 44.2 | -4.8 | 39.4 | 54.0 | 14.6 | Vertical |
| 2483.5 | 44.5 | -4.7 | 39.8 | 54.0 | 14.2 | Horizontal |

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Result: RF Radiated Emissions (Lowest)- 8DPSK

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2390.0 | 48.0 | -4.8 | 43.2 | 74.0 | 30.8 | Vertical |
| 2390.0 | 48.1 | -4.7 | 43.4 | 74.0 | 30.6 | Horizontal |

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Average Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2390.0 | 43.5 | -4.8 | 38.7 | 54.0 | 15.3 | Vertical |
| 2390.0 | 43.1 | -4.7 | 38.4 | 54.0 | 15.6 | Horizontal |

Result: RF Radiated Emissions (Highest) -8DPSK

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Peak Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2483.5 | 56.8 | -4.8 | 52.0 | 74.0 | 22.0 | Vertical |
| 2483.5 | 55.9 | -4.7 | 51.2 | 74.0 | 22.8 | Horizontal |

| Field Strength of Band-edge Compliance | | | | | | |
|--|-------------------------------------|------------------------------|-----------------------------------|------------------------------|--------------|---------------------|
| Average Value | | | | | | |
| Frequency MHz | Measured Level @3m dB μ V | Correction Factor dB/m | Field Strength dB μ V/m | Limit @3m dB μ V/m | Margin dB | E-Field Polarity |
| 2483.5 | 45.4 | -4.8 | 40.6 | 54.0 | 13.4 | Vertical |
| 2483.5 | 45.3 | -4.7 | 40.6 | 54.0 | 13.4 | Horizontal |

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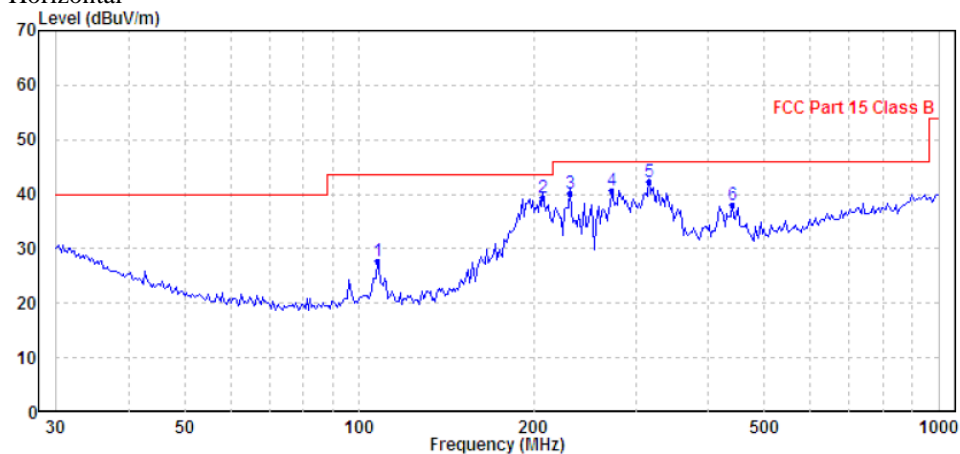
Limits for Radiated Emissions FCC 47 CFR 15.247 Class B):

| Frequency Range | Quasi-Peak Limits |
|-----------------|-------------------|
| [MHz] | [μ V/m] |
| 0.009-0.490 | 2400/F (kHz) |
| 0.490-1.705 | 24000/F (kHz) |
| 1.705-30 | 30 |
| 30-88 | 100 |
| 88-216 | 150 |
| 216-960 | 200 |
| Above960 | 500 |

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Results of Bluetooth mode (GFSK 2402.0 MHz) (30MHz – 1GHz): Pass

Horizontal



Ambient Temperature: 25C
Relative Humidity : 50%

| | Freq | Level | Limit | Over | | |
|---|---------|--------|-------|--------|--------|------------|
| | MHz | dBuV/m | Line | Limit | Remark | Pol/Phase |
| 1 | 107.510 | 27.76 | 43.50 | -15.74 | QP | Horizontal |
| 2 | 207.850 | 39.25 | 43.50 | -4.25 | QP | Horizontal |
| 3 | 230.907 | 40.14 | 46.00 | -5.86 | QP | Horizontal |
| 4 | 273.234 | 40.77 | 46.00 | -5.23 | QP | Horizontal |
| 5 | 316.589 | 42.39 | 46.00 | -3.61 | QP | Horizontal |
| 6 | 440.196 | 38.07 | 46.00 | -7.93 | QP | Horizontal |

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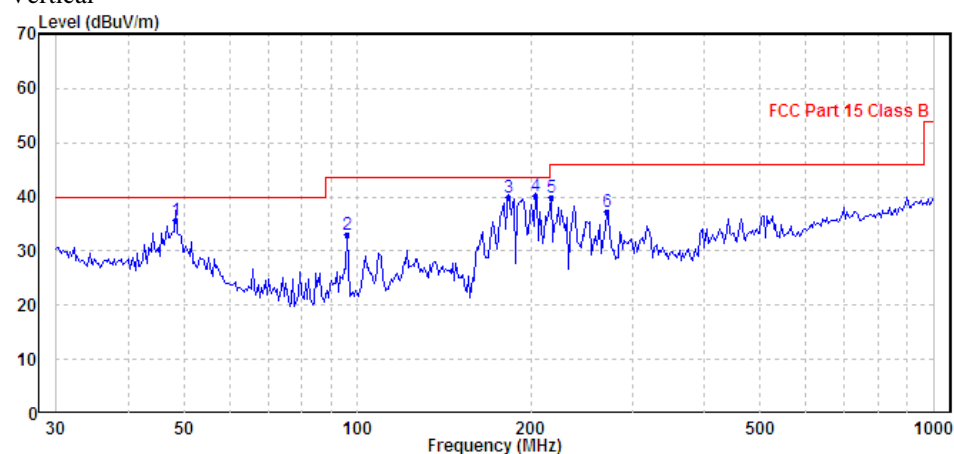
Limits for Radiated Emissions FCC 47 CFR 15.247 Class B]:

| Frequency Range | Quasi-Peak Limits |
|-----------------|-------------------|
| [MHz] | [μ V/m] |
| 0.009-0.490 | 2400/F (kHz) |
| 0.490-1.705 | 24000/F (kHz) |
| 1.705-30 | 30 |
| 30-88 | 100 |
| 88-216 | 150 |
| 216-960 | 200 |
| Above 960 | 500 |

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Results of Bluetooth mode (GFSK 2402.0 MHz) (30MHz – 1GHz): Pass

Vertical



Ambient Temperature: 25C
Relative Humidity : 50%

| | Freq | Level | Limit | Over | Remark | Pol/Phase |
|---|---------|--------|--------|--------|--------|-----------|
| | MHz | dBuV/m | dBuV/m | dB | | |
| 1 | 48.332 | 35.78 | 40.00 | -4.22 | QP | Vertical |
| 2 | 96.099 | 32.94 | 43.50 | -10.56 | QP | Vertical |
| 3 | 183.201 | 39.92 | 43.50 | -3.58 | QP | Vertical |
| 4 | 203.523 | 40.23 | 43.50 | -3.27 | QP | Vertical |
| 5 | 216.783 | 39.88 | 46.00 | -6.12 | QP | Vertical |
| 6 | 271.325 | 37.15 | 46.00 | -8.85 | QP | Vertical |

Remarks: Calculated measurement uncertainty (30MHz – 1GHz): 4.9dB

Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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3.1.3 AC Mains Conducted Emissions (0.15MHz to 30MHz)

| | |
|--------------------|------------------|
| Test Requirement: | FCC 47CFR 15.207 |
| Test Method: | ANSI C63.10:2013 |
| Test Date: | 2023-05-13 |
| Mode of Operation: | TX mode |
| Test Voltage: | 120V a.c. 60Hz |

| | | |
|---------------------------|------------------------|-------------------------------|
| Ambient Temperature: 25°C | Relative Humidity: 51% | Atmospheric Pressure: 101 kPa |
|---------------------------|------------------------|-------------------------------|

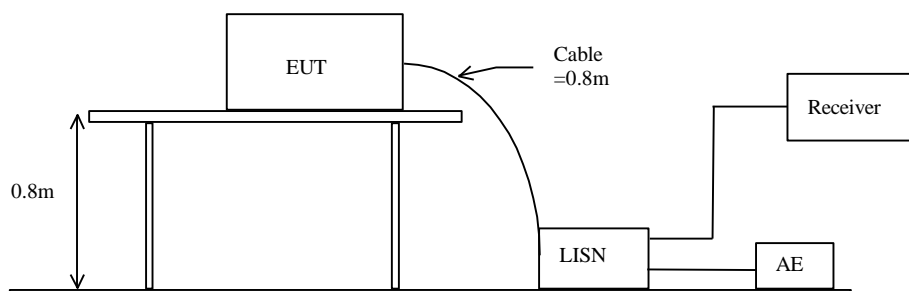
Test Method:

The test was performed in accordance with ANSI C63.10:2013, with the following: an initial measurement was performed in peak and average detection mode on the live line, any emissions recorded within 30dB of the relevant limit line were re-measured using quasi-peak and average detection on the live and neutral lines with the worst case recorded in the table of results.

Receiver Setting:

Bandw. = 9 kHz, Meas. Time= 10.0 ms, Step Width = 5.0kHz
 Detector = MaxPeak and CISPR AV

Test Setup:



Limits for Conducted Emissions (FCC 47 CFR 15.207):

| Frequency Range [MHz] | Quasi-Peak Limits [dBμV] | Average [dBμV] |
|--------------------------|-----------------------------|-------------------|
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5.0 | 56 | 46 |
| 5.0-30.0 | 60 | 50 |

* Decreases with the logarithm of the frequency.

Remarks:

Calculated measurement uncertainty (0.15MHz – 30MHz): 3.25dB

-*- Emission(s) that is far below the corresponding limit line.



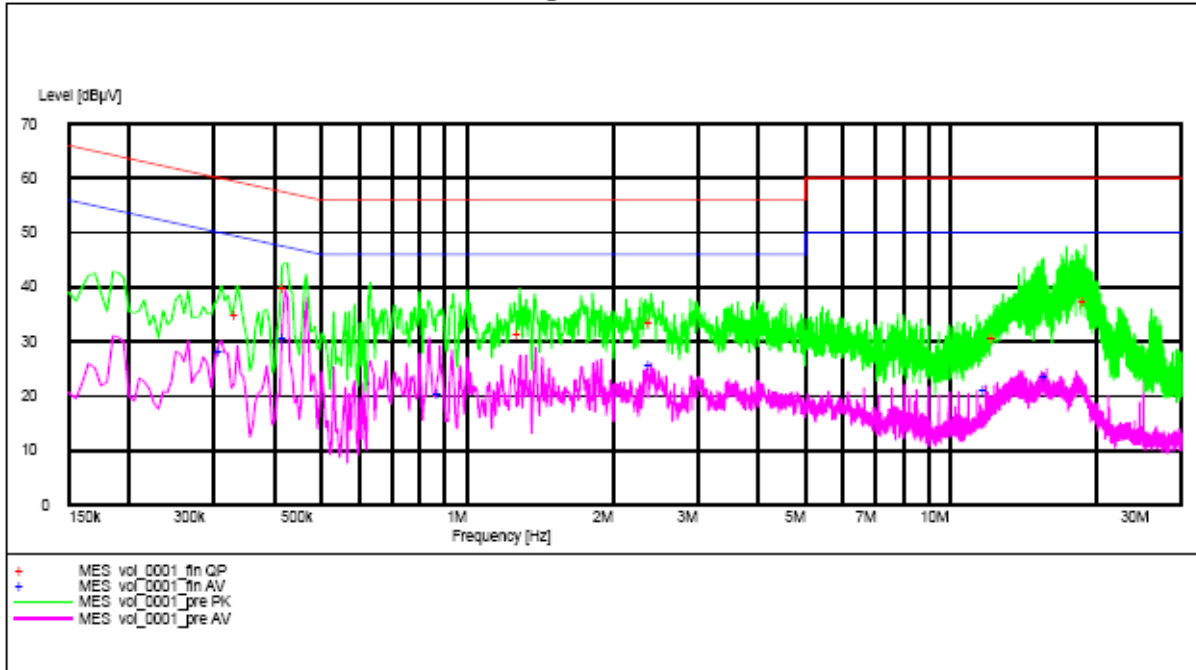
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Results of Bluetooth mode (L): PASS

Please refer to the following diagram for individual results.



MEASUREMENT RESULT: "vol_0001_fin QP"

5/13/2023 1:59PM

| Frequency MHz | Level dBμV | Transd dB | Limit dBμV | Margin dB | Line | PE |
|------------------|---------------|--------------|---------------|--------------|------|-----|
| 0.335000 | 35.00 | 9.7 | 59 | 24.3 | L1 | GND |
| 0.420000 | 39.90 | 9.7 | 57 | 17.5 | L1 | GND |
| 1.285000 | 31.30 | 9.7 | 56 | 24.7 | L1 | GND |
| 2.400000 | 33.50 | 9.8 | 56 | 22.5 | L1 | GND |
| 12.300000 | 30.70 | 10.1 | 60 | 29.3 | L1 | GND |
| 18.965000 | 37.40 | 10.3 | 60 | 22.6 | L1 | GND |

MEASUREMENT RESULT: "vol_0001_fin AV"

5/13/2023 1:59PM

| Frequency MHz | Level dBμV | Transd dB | Limit dBμV | Margin dB | Line | PE |
|------------------|---------------|--------------|---------------|--------------|------|-----|
| 0.310000 | 28.10 | 9.7 | 50 | 21.9 | L1 | GND |
| 0.420000 | 30.80 | 9.7 | 47 | 16.6 | L1 | GND |
| 0.880000 | 20.50 | 9.7 | 46 | 25.5 | L1 | GND |
| 2.400000 | 25.90 | 9.8 | 46 | 20.1 | L1 | GND |
| 11.825000 | 21.00 | 10.1 | 50 | 29.0 | L1 | GND |
| 15.795000 | 23.70 | 10.3 | 50 | 26.3 | L1 | GND |

5/13/2023 1:59PM vol_0001

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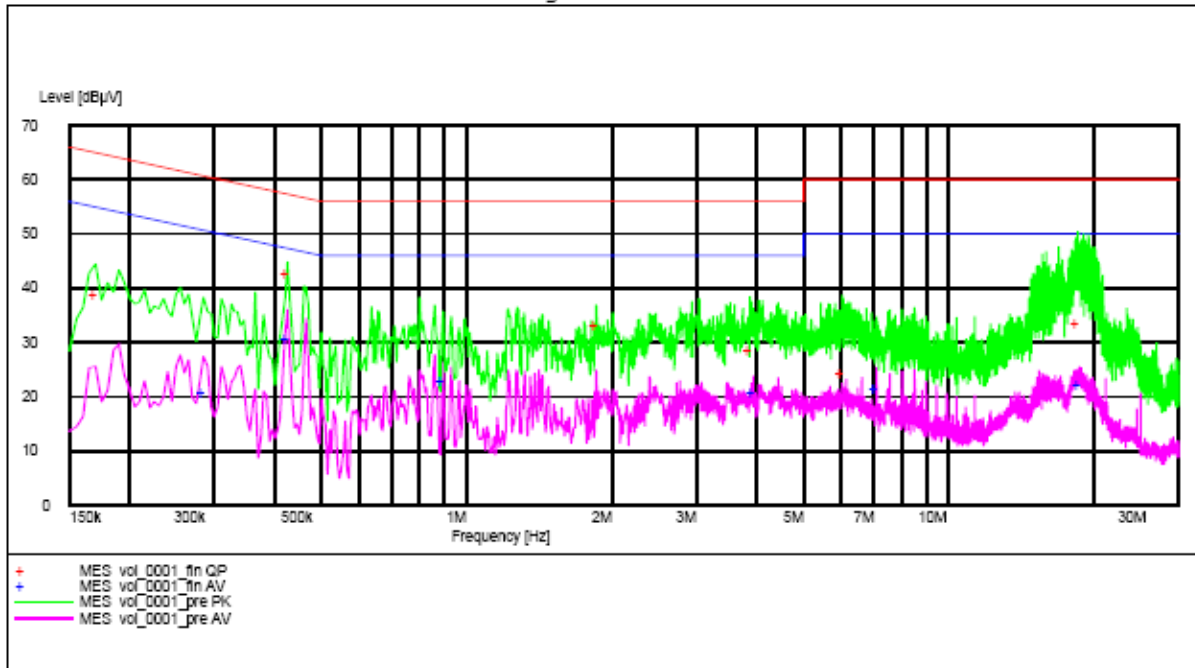
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Results of Bluetooth mode (N): PASS

Please refer to the following diagram for individual results.



5/13/2023 1:56PM

| Frequency MHz | Level dBμV | Transd dB | Limit dBμV | Margin dB | Line | PE |
|------------------|---------------|--------------|---------------|--------------|------|-----|
| 0.170000 | 38.60 | 9.7 | 65 | 26.4 | N | GND |
| 0.425000 | 42.50 | 9.7 | 57 | 14.9 | N | GND |
| 1.860000 | 33.00 | 9.8 | 56 | 23.0 | N | GND |
| 3.870000 | 28.60 | 9.8 | 56 | 27.4 | N | GND |
| 6.020000 | 24.20 | 9.9 | 60 | 35.8 | N | GND |
| 18.565000 | 33.30 | 10.3 | 60 | 26.7 | N | GND |

MEASUREMENT RESULT: "vol_0001_fin AV"

5/13/2023 1:56PM

| Frequency MHz | Level dBμV | Transd dB | Limit dBμV | Margin dB | Line | PE |
|------------------|---------------|--------------|---------------|--------------|------|-----|
| 0.285000 | 20.70 | 9.7 | 51 | 29.9 | N | GND |
| 0.425000 | 30.60 | 9.7 | 47 | 16.7 | N | GND |
| 0.895000 | 22.70 | 9.7 | 46 | 23.3 | N | GND |
| 3.935000 | 20.60 | 9.8 | 46 | 25.4 | N | GND |
| 7.090000 | 21.50 | 9.9 | 50 | 28.5 | N | GND |
| 18.725000 | 22.00 | 10.3 | 50 | 28.0 | N | GND |

5/13/2023 1:56PM vol_0001



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3.1.4 Number of Hopping Frequency

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Limit of Number of Hopping Frequency

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels

Test Method:

The RF output of the EUT was connected to the spectrum analyzer by a low loss cable.

Spectrum Analyzer Setting:

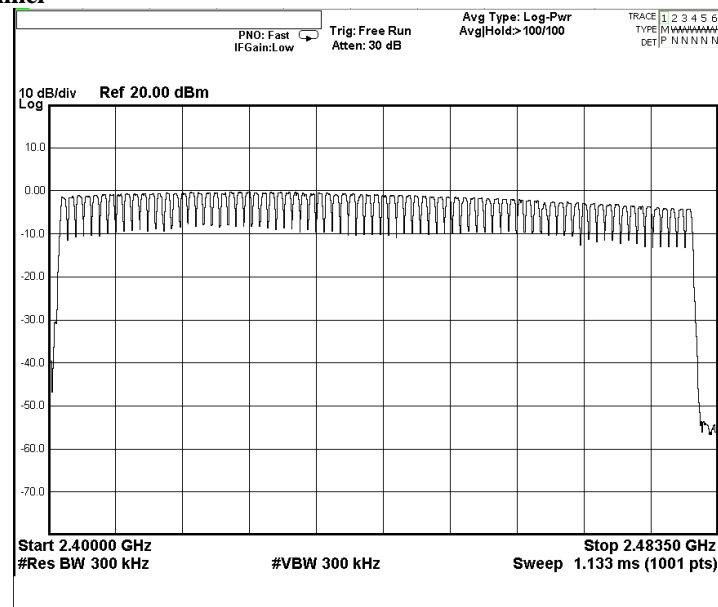
RBW = 300kHz, VBW \geq RBW, Sweep = Auto, Span = the frequency band of operation
Detector = Peak, Trace = Max. hold

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

Measurement Data:

GFSK: 79 of 79 Channel



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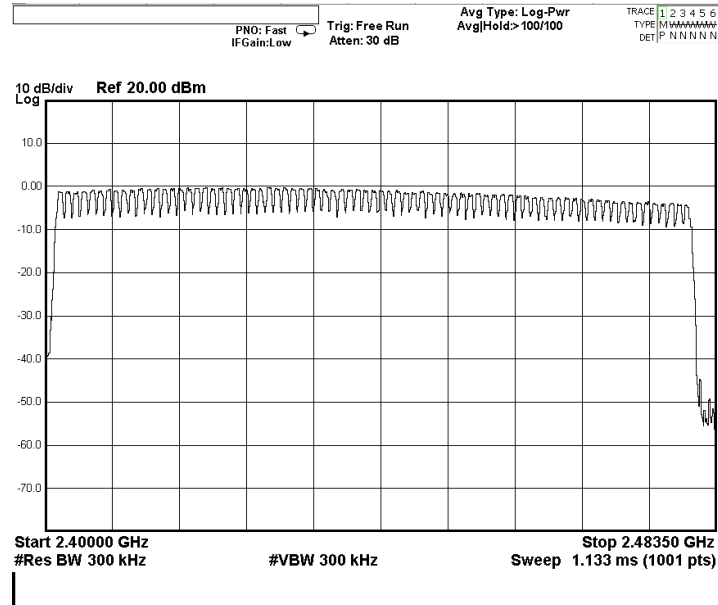


Test Report

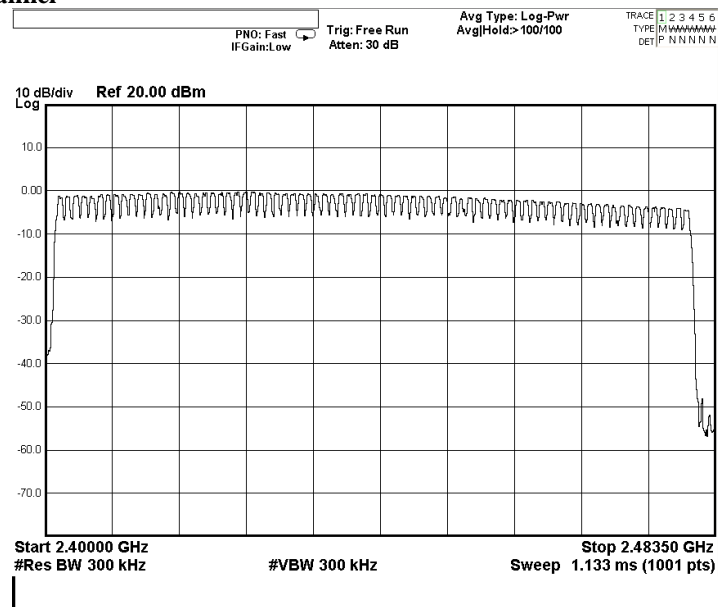
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$\pi/4$ -DQPSK: 79 of 79 Channel



8DPSK: 79 of 79 Channel



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3.1.5 20dB Bandwidth

Test Requirement: FCC 47CFR 15.247(a)(1)
Test Method: ANSI C63.10:2013
Test Date: 2023-04-27
Mode of Operation: Tx mode

Ambient Temperature: 25°C Relative Humidity: 51% Atmospheric Pressure: 101 kPa

Remark:

The result has been done on all the possible configurations for searching the worst cases.

Test Method:

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signal to produce the worst-case (i.e. the widest) bandwidth.

Spectrum Analyzer Setting:

RBW = 30kHz, VBW \geq RBW, Sweep = Auto, Span = two times and five times the OBW
Detector = Peak, Trace = Max. hold

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

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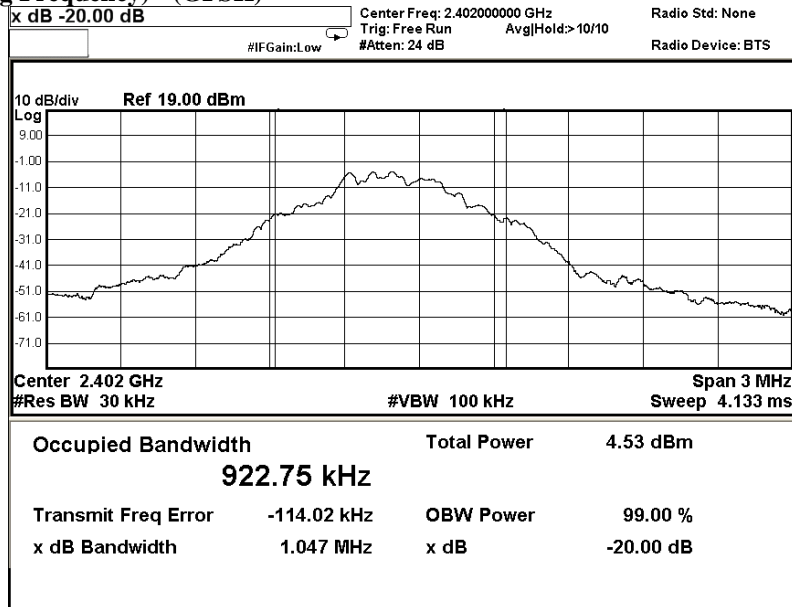
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2402 | 1.047 | Within 2400-2483.5 |

(Lowest Operating Frequency) - (GFSK)



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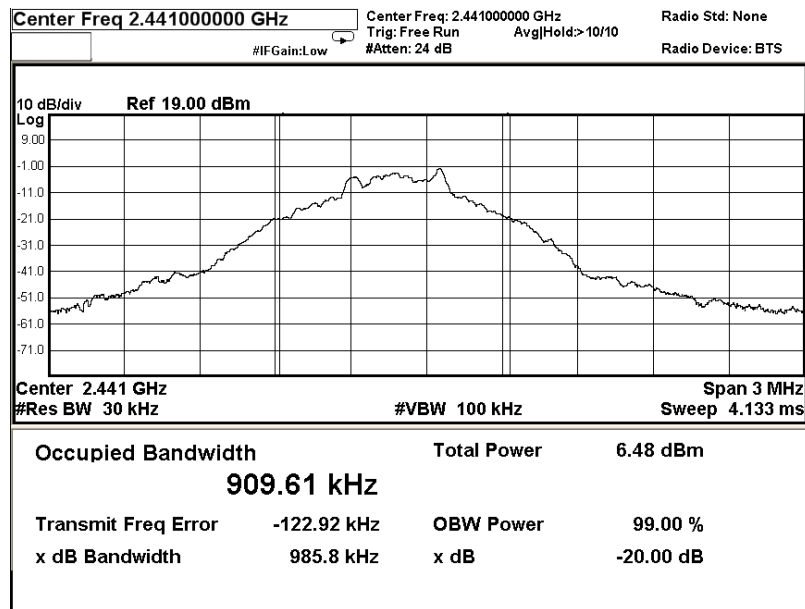
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2441 | 0.9858 | Within 2400-2483.5 |

(Middle Operating Frequency) - (GFSK)



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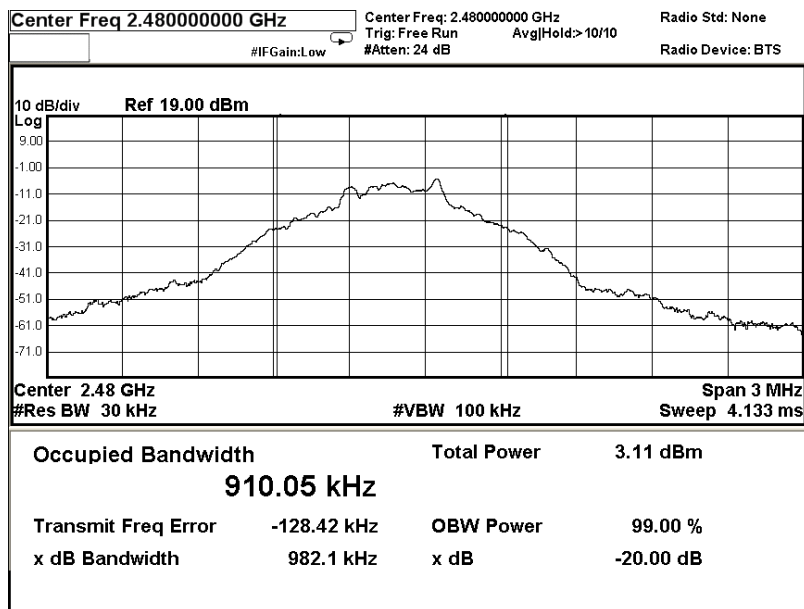
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2480 | 0.9821 | Within 2400-2483.5 |

(Highest Operating Frequency) - (GFSK)



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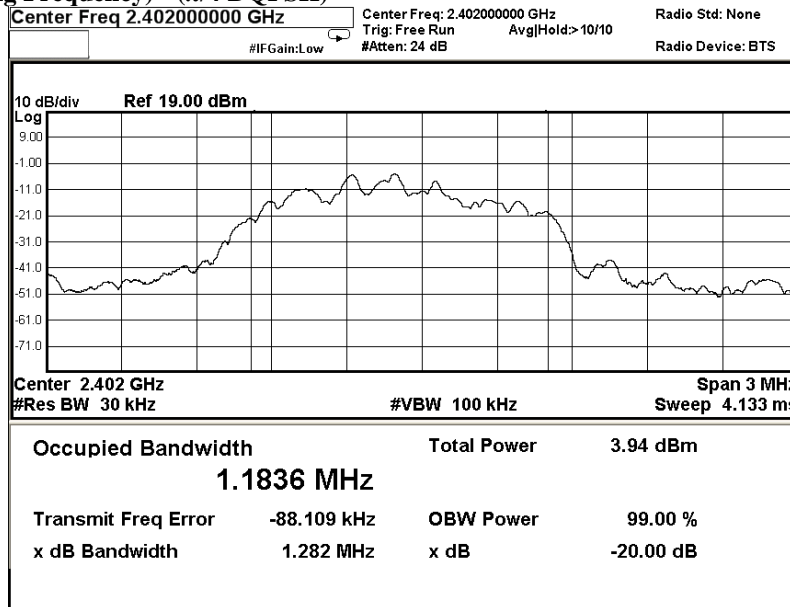
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2402 | 1.282 | Within 2400-2483.5 |

(Lowest Operating Frequency) - ($\pi/4$ DQPSK)



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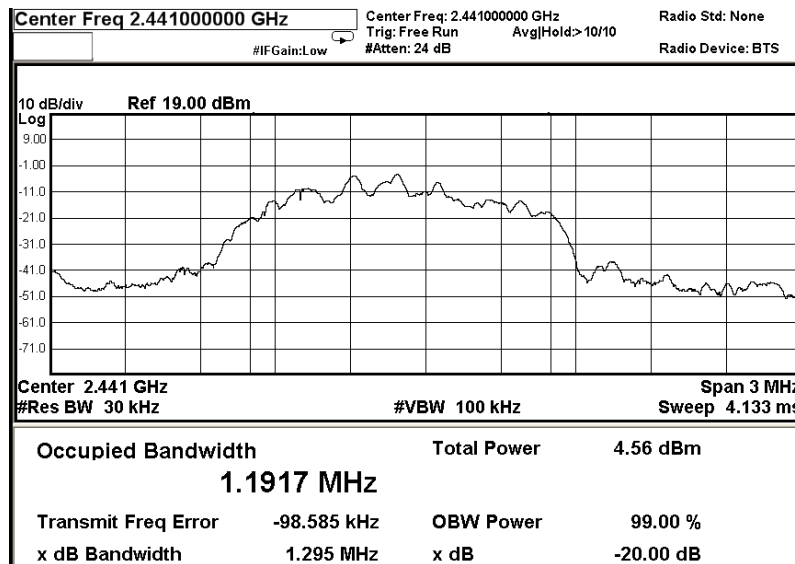
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2441 | 1.295 | Within 2400-2483.5 |

(Middle Operating Frequency) - ($\pi/4$ DQPSK)



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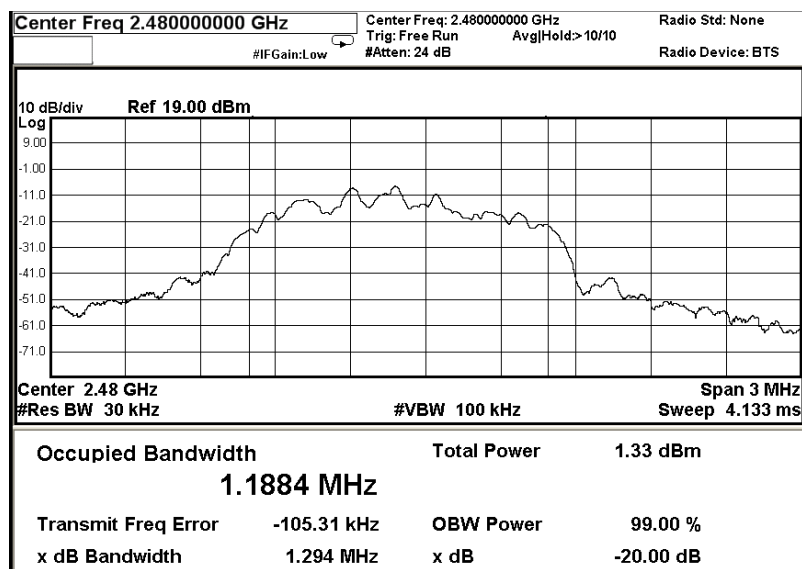
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2480 | 1.294 | Within 2400-2483.5 |

(Highest Operating Frequency) - ($\pi/4$ DQPSK)



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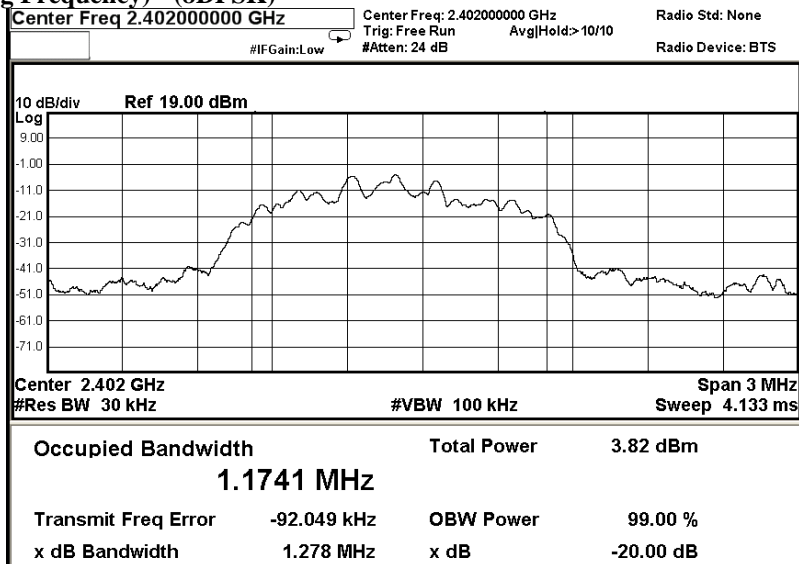
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2402 | 1.278 | Within 2400-2483.5 |

(Lowest Operating Frequency) - (8DPSK)



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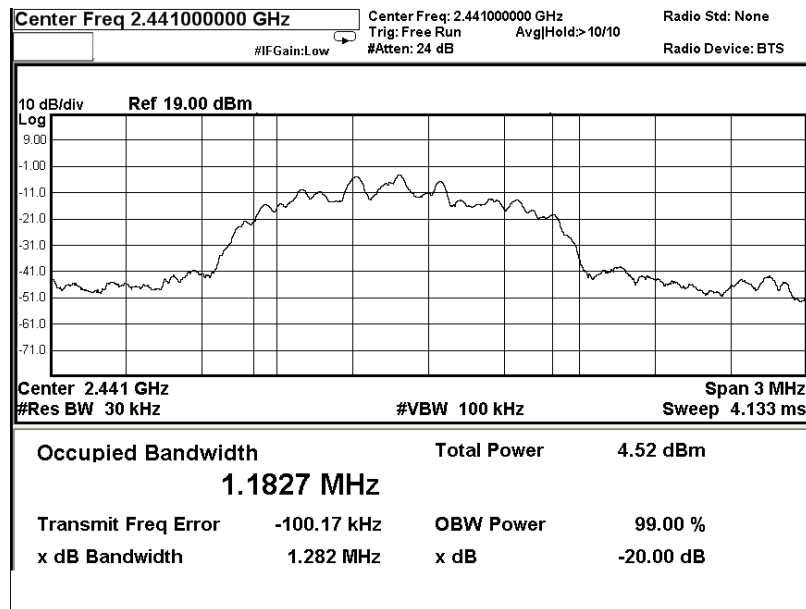
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2441 | 1.282 | Within 2400-2483.5 |

(Middle Operating Frequency) - (8DPSK)



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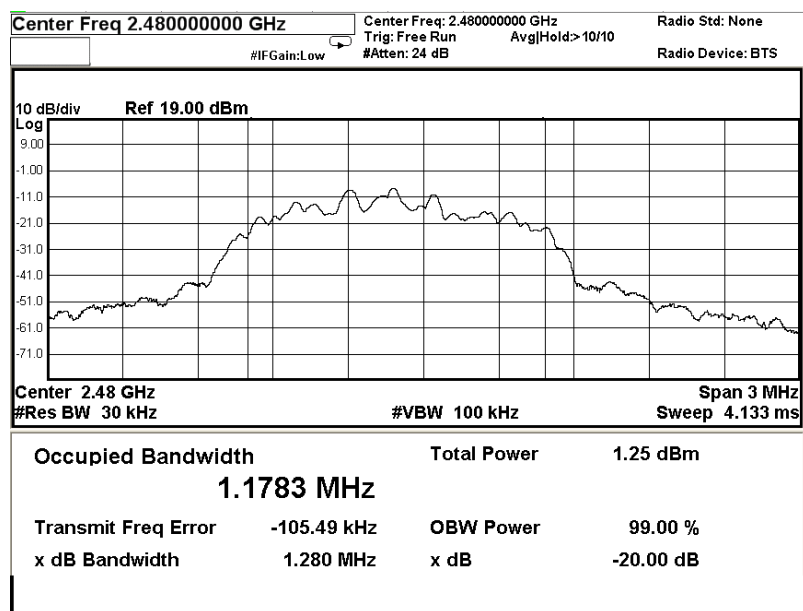
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2480 | 1.280 | Within 2400-2483.5 |

(Highest Operating Frequency) - (8DPSK)



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3.1.6 Hopping Channel Separation

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Requirements:

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.

Spectrum Analyzer Setting:

RBW = 300kHz, VBW \geq RBW, Sweep = Auto,
Span = Wide enough to capture the peaks of two adjacent channels
Detector = Peak, Trace = Max. hold

Limit:

The measured maximum bandwidth=1295 kHz

The measured maximum bandwidth * 2/3 = 1295KHz * 2/3 = 863.33kHz

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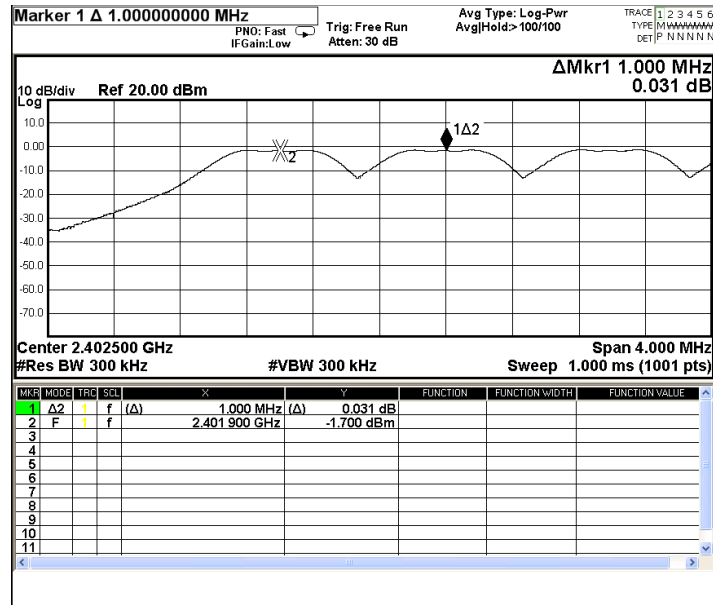
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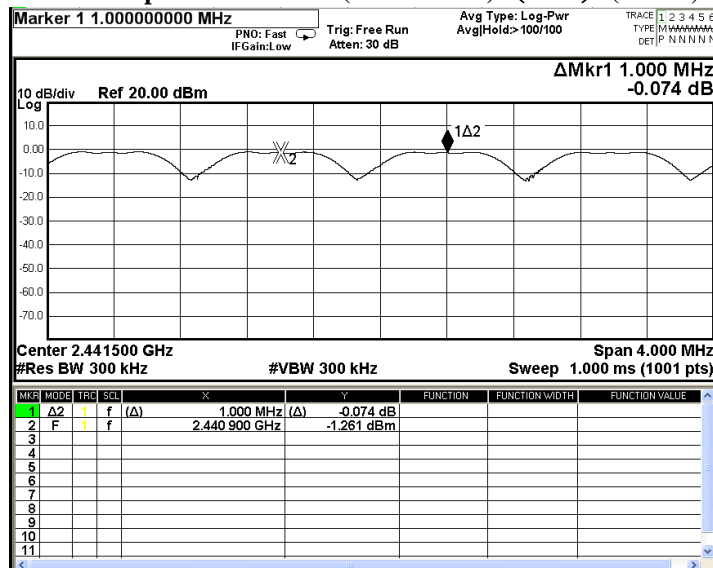
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Channel separation = 1MHz (>863.33kHz) (Lowest) (GFSK)



Channel separation = 1MHz(>863.33kHz) (Mid) (GFSK)



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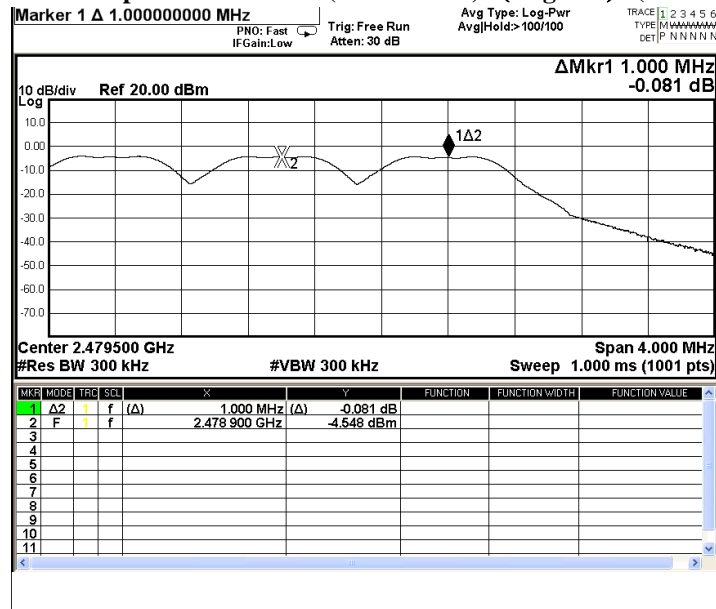


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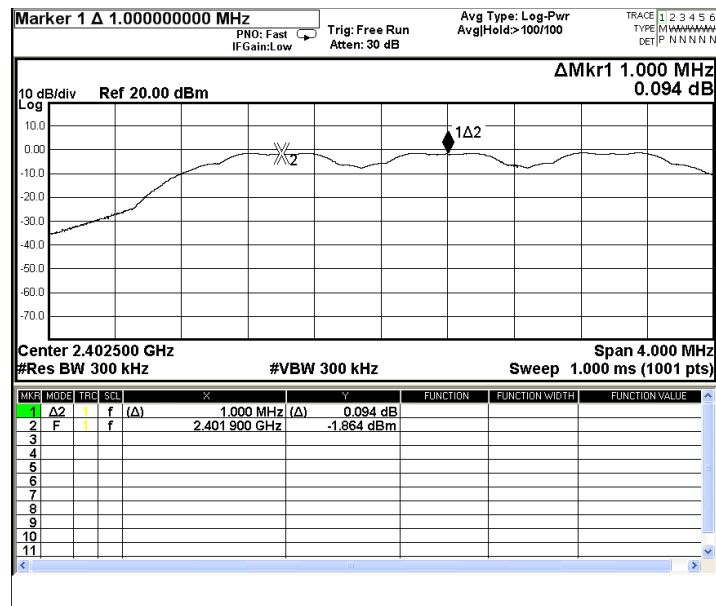
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Channel separation = 1MHz (>863.33kHz) (Highest) (GFSK)



Channel separation = 1MHz (>863.33kHz) (Lowest) ($\pi/4$ DQPSK)



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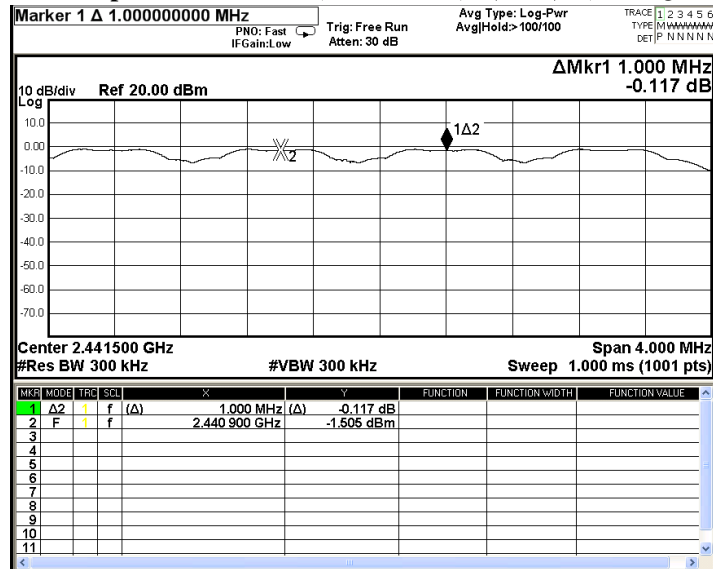


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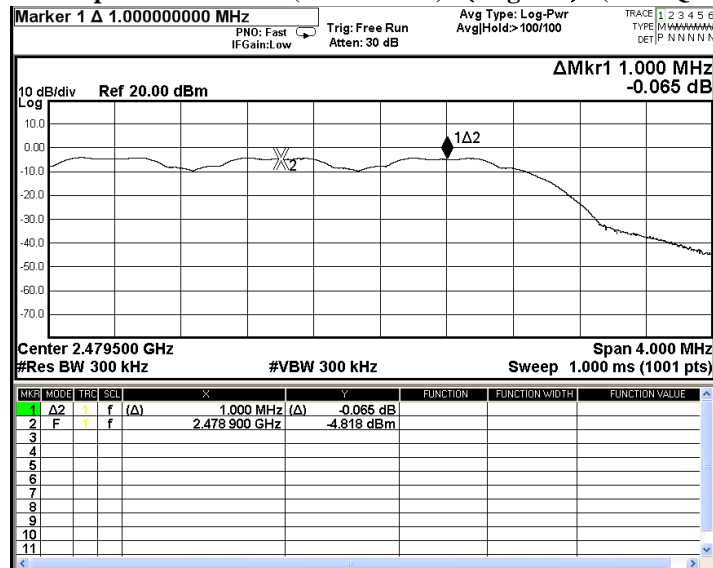
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Channel separation = 1MHz (>863.33kHz) (Mid) ($\pi/4$ DQPSK)



Channel separation = 1MHz(>863.33kHz) (Highest) ($\pi/4$ DQPSK)



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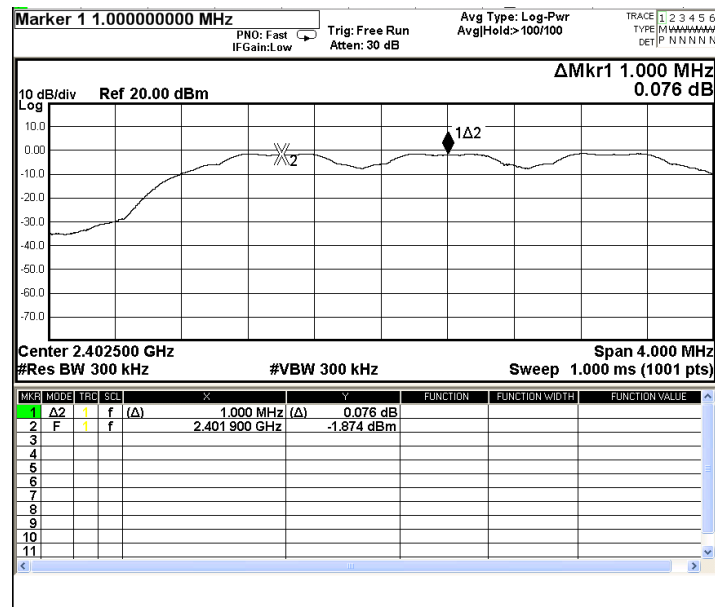


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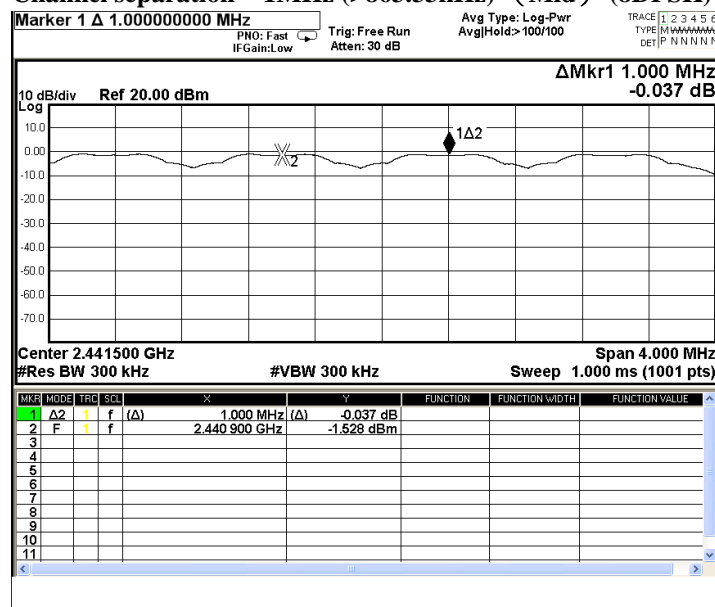
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Channel separation = 1MHz (>863.33kHz) (Lowest) (8DPSK)



Channel separation = 1MHz (>863.33kHz) (Mid) (8DPSK)



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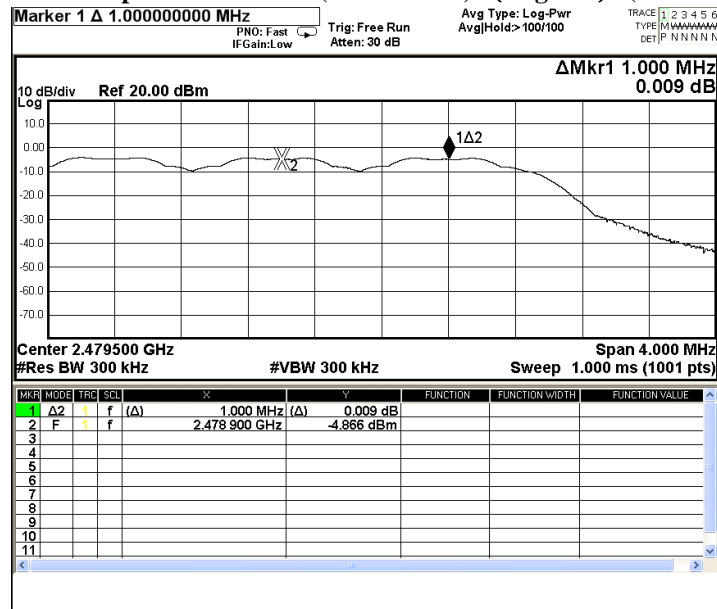


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Channel separation = 1MHz(>863.33kHz) (Highest) (8DPSK)



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3.1.7 Band-edge Compliance of RF Conducted Emissions Measurement:

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

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. Attenuation below the general limits specified in Section 15.209(a) is not required.

According to the test method DA 00-705.

Spectrum Analyzer Setting:

RBW = 100kHz, VBW = 300kHz, Sweep = Coupled,

Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

Detector = Peak, Trace = Max. hold

Remark: Emissions under the fixed frequency mode and hopping mode have been investigated, the worst-case measurement results were recorded in the test report

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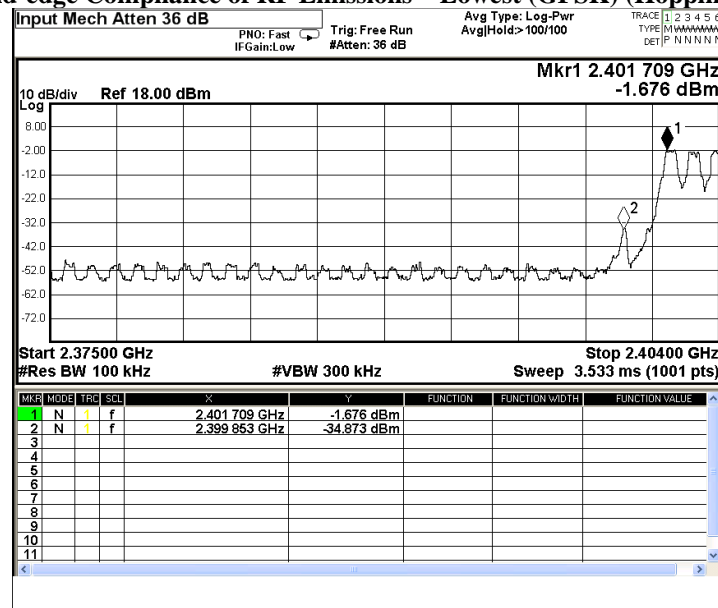
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|----------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2400 – Lowest Fundamental (2402) | -1.676 | -21.676 | -34.873 | PASS |

Band-edge Compliance of RF Emissions – Lowest (GFSK) (Hopping on)



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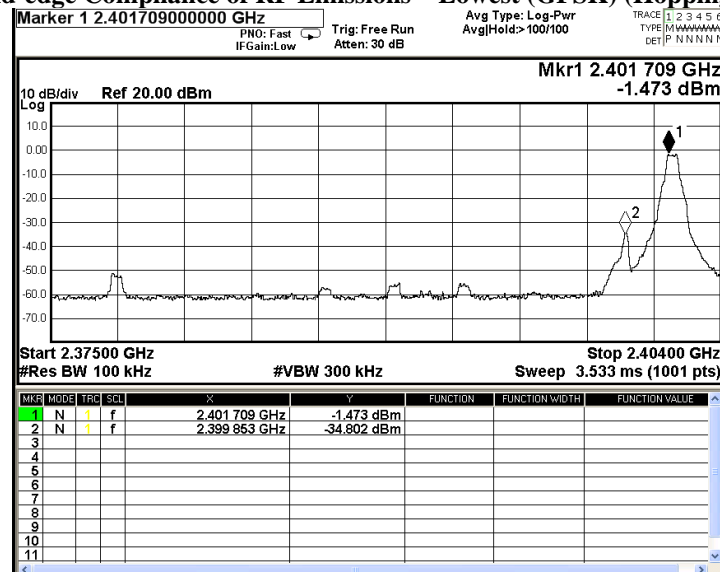
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|----------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2400 – Lowest Fundamental (2402) | -1.473 | -21.473 | -34.802 | PASS |

Band-edge Compliance of RF Emissions – Lowest (GFSK) (Hopping off)



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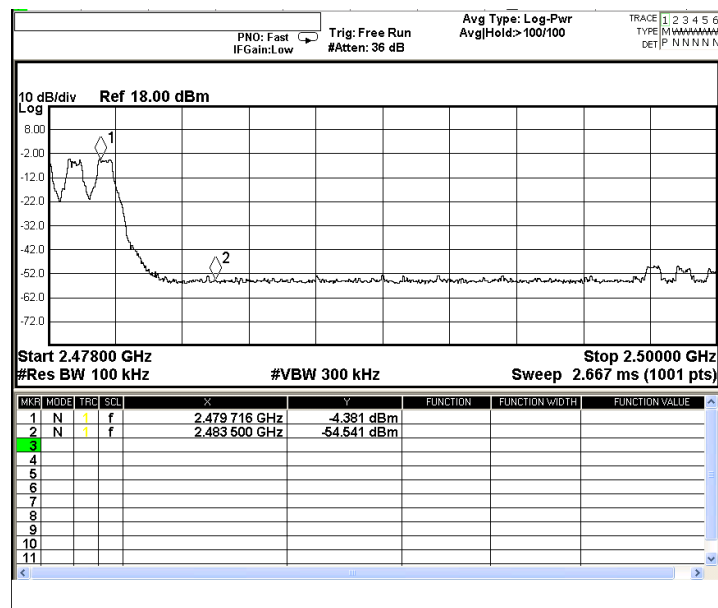
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|-------------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2483.5 - Highest Fundamental (2480) | -4.381 | -24.381 | -54.541 | PASS |

Band-edge Compliance of RF Emissions – Highest (GFSK) (Hopping on)



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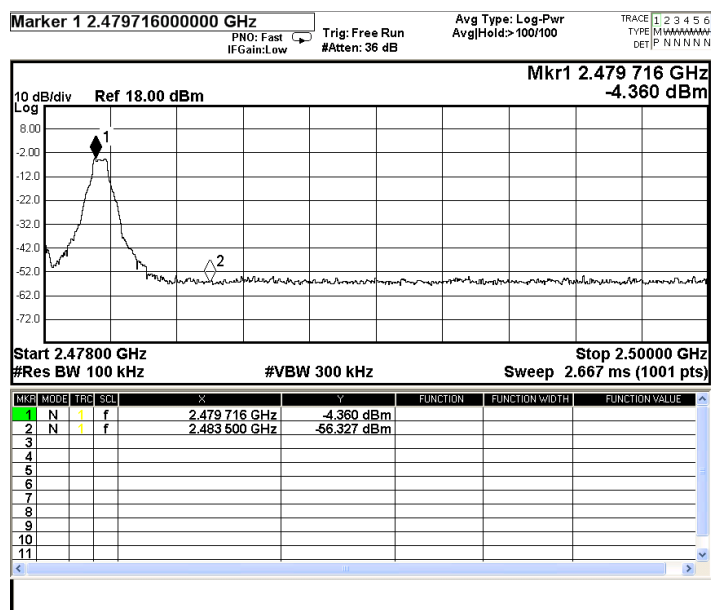
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|-------------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2483.5 - Highest Fundamental (2480) | -4.360 | -24.360 | -56.327 | PASS |

Band-edge Compliance of RF Emissions – Highest (GFSK) (Hopping off)



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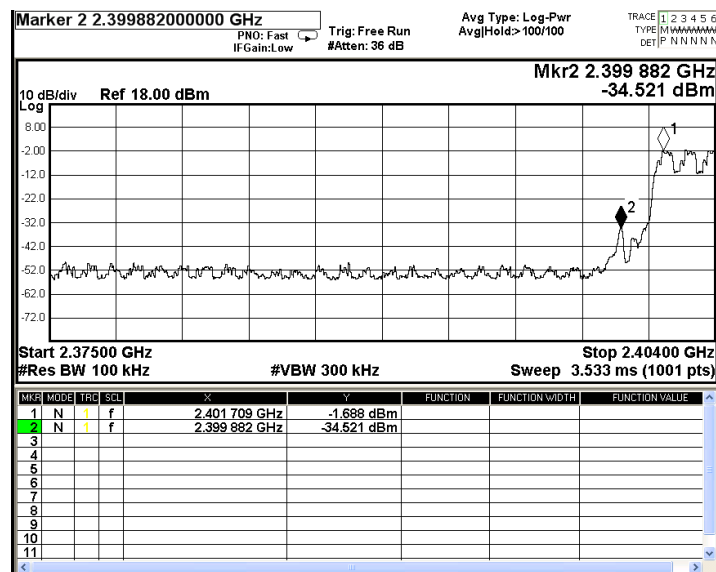
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|----------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2400 – Lowest Fundamental (2402) | -1.688 | -21.688 | -34.521 | PASS |

Band-edge Compliance of RF Emissions – Lowest ($\pi/4$ DQPSK) (Hopping on)



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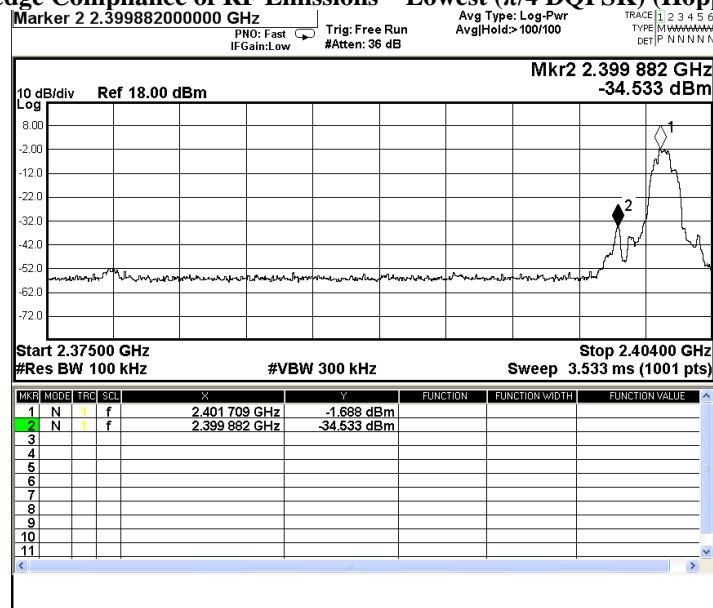
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|----------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2400 – Lowest Fundamental (2402) | -1.688 | -21.688 | -34.533 | PASS |

Band-edge Compliance of RF Emissions – Lowest ($\pi/4$ DQPSK) (Hopping off)



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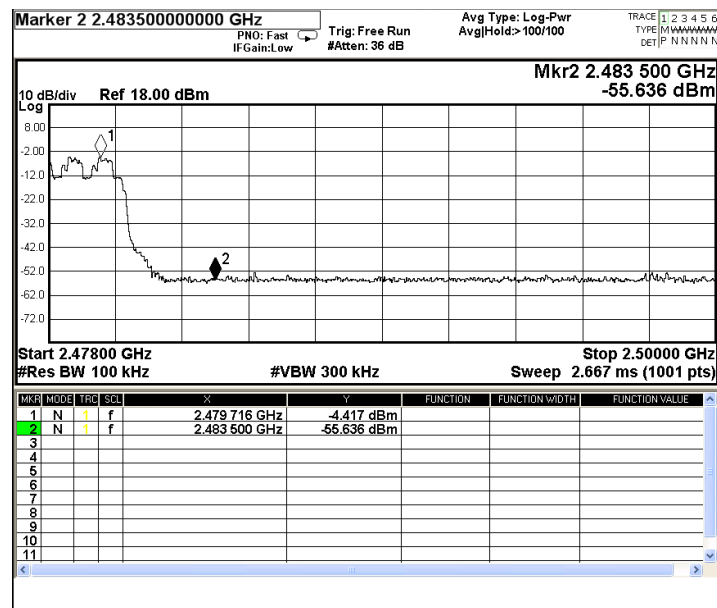
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|-------------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2483.5 - Highest Fundamental (2480) | -4.417 | -24.417 | -55.636 | PASS |

Band-edge Compliance of RF Emissions – Highest ($\pi/4$ DQPSK) (Hopping on)



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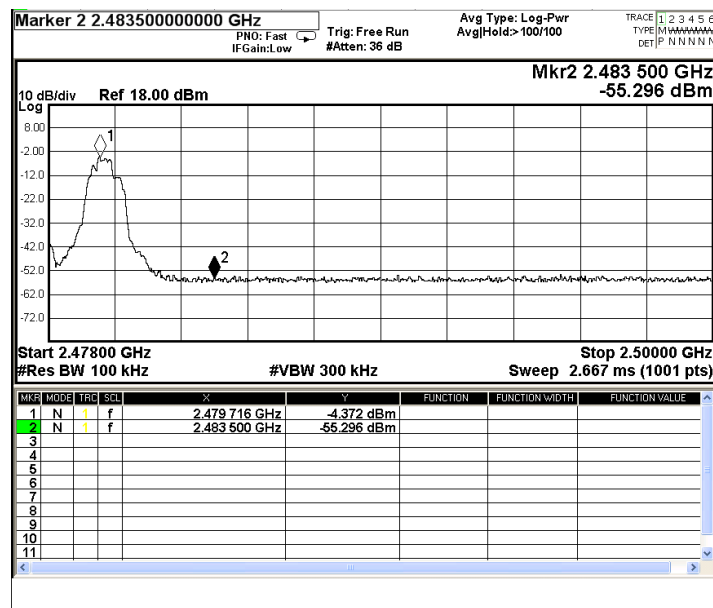
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|-------------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2483.5 - Highest Fundamental (2480) | -4.372 | -24.372 | -55.296 | PASS |

Band-edge Compliance of RF Emissions – Highest ($\pi/4$ DQPSK) (Hopping off)



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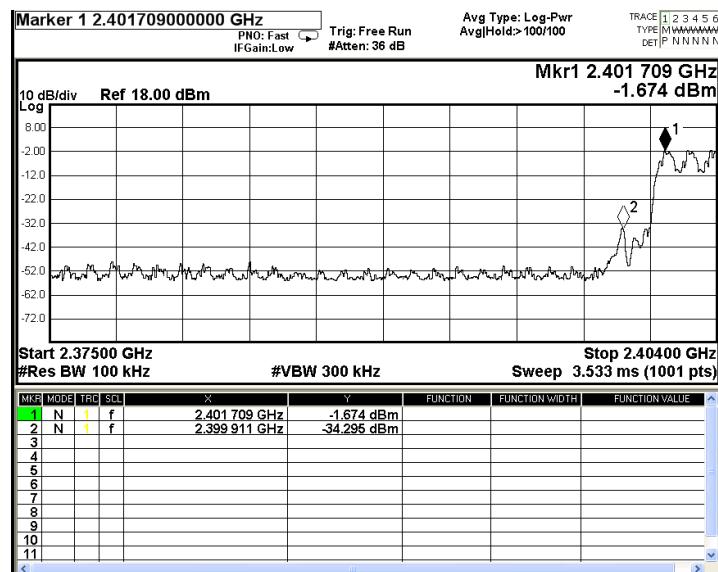
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|----------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2400 – Lowest Fundamental (2402) | -1.674 | -21.674 | -34.295 | PASS |

Band-edge Compliance of RF Emissions – Lowest (8DPSK) (Hopping on)



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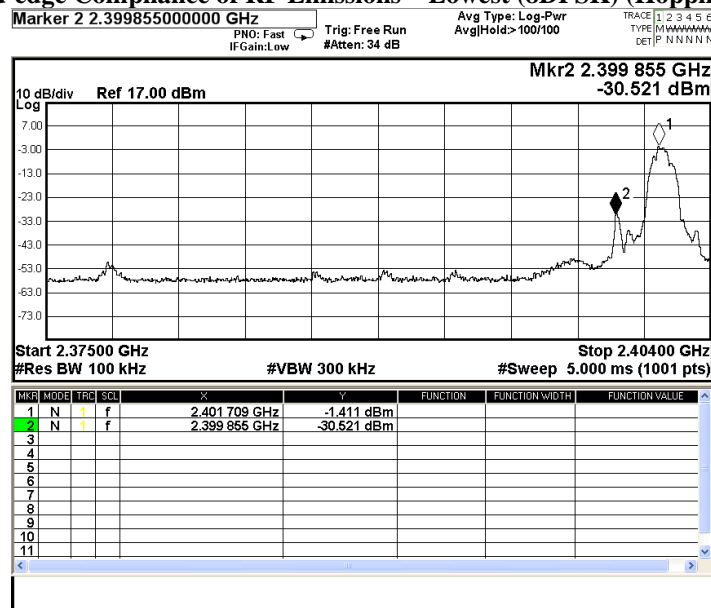
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|----------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2400 – Lowest Fundamental (2402) | -1.411 | -21.411 | -30.521 | PASS |

Band-edge Compliance of RF Emissions – Lowest (8DPSK) (Hopping off)



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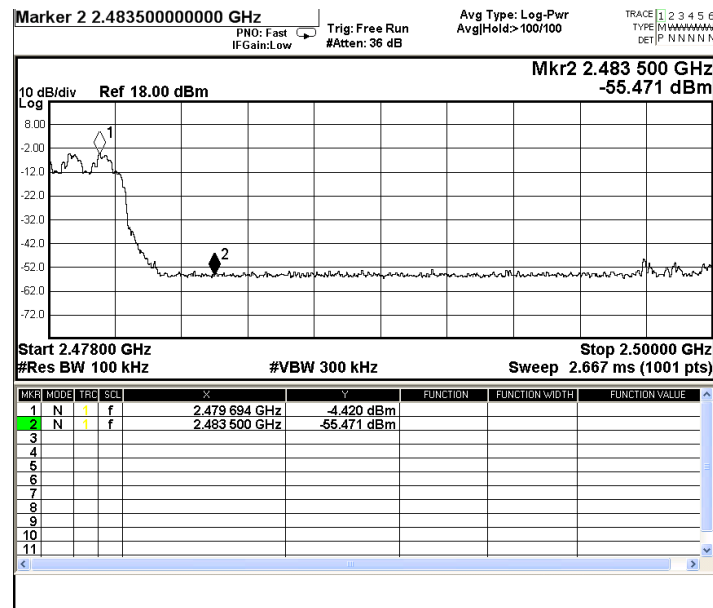
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|-------------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2483.5 - Highest Fundamental (2480) | -4.420 | -24.420 | -55.471 | PASS |

Band-edge Compliance of RF Emissions – Highest (8DPSK) (Hopping on)



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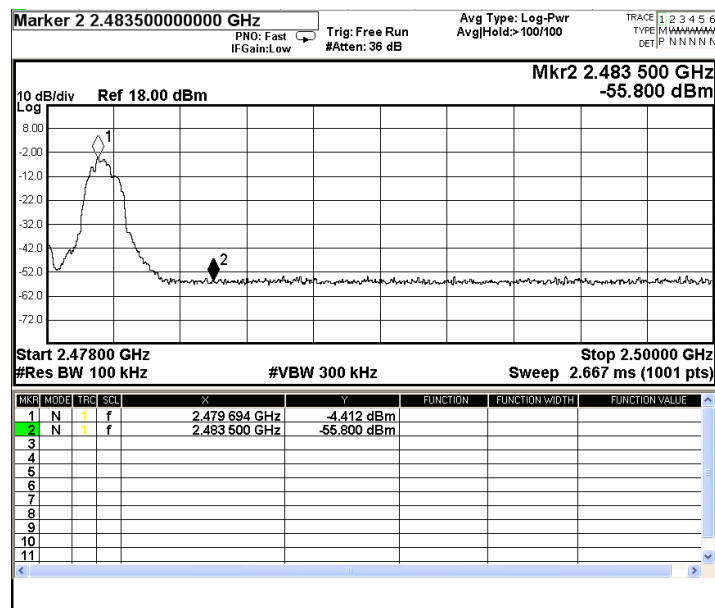
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Band-edge Compliance of RF Conducted Emissions Measurement:

| Frequency Range | Reference level | Limit | The highest conducted band edge emission | Result |
|-------------------------------------|-----------------|---------|--|--------|
| [MHz] | [dBm] | [dBm] | [dBm] | |
| 2483.5 - Highest Fundamental (2480) | -4.412 | -24.412 | -55.800 | PASS |

Band-edge Compliance of RF Emissions – Highest (8DPSK) (Hopping off)



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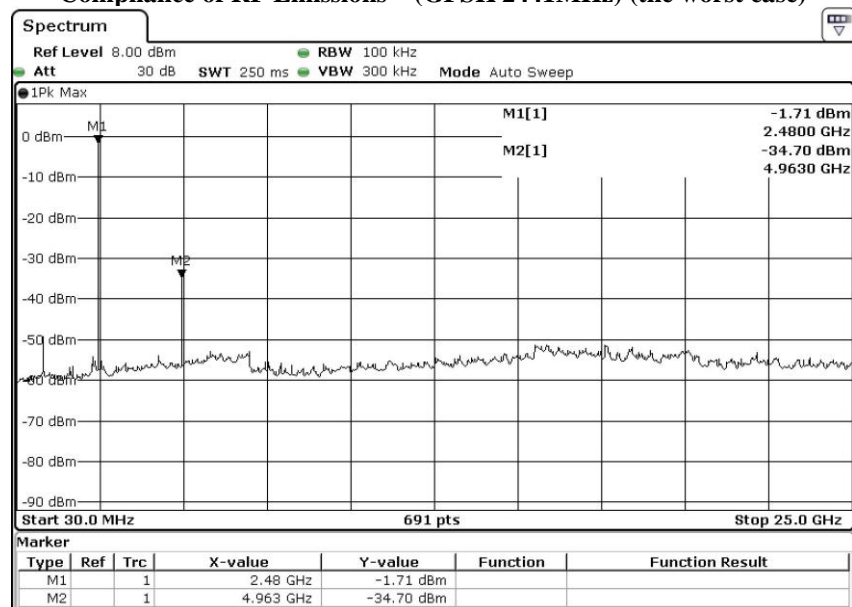
Compliance of RF Conducted Emissions Measurement:

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. Attenuation below the general limits specified in Section 15.209(a) is not required.

Remark: Emissions under the fixed frequency mode and hopping mode have been investigated, the worst-case measurement results were recorded in the test report

Compliance of RF Emissions – (GFSK 2441MHz) (the worst case)



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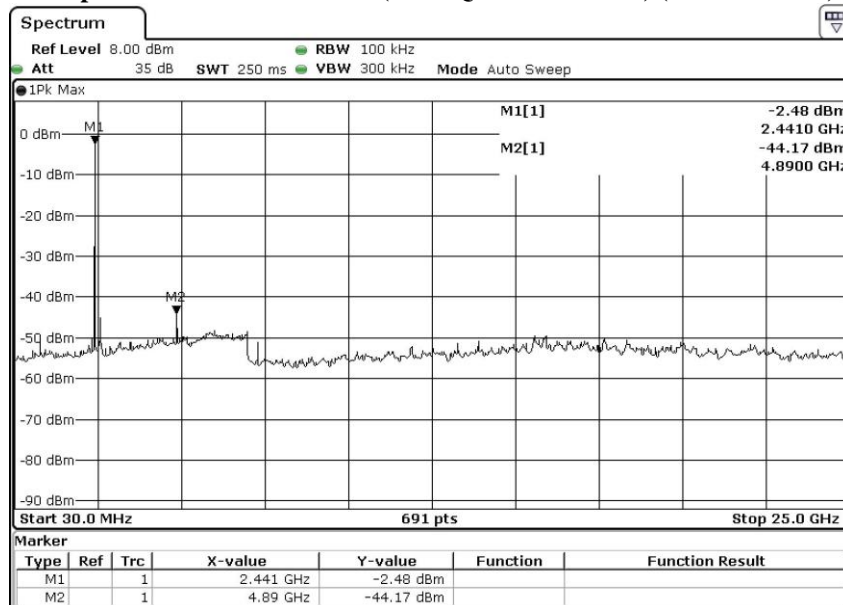


Test Report

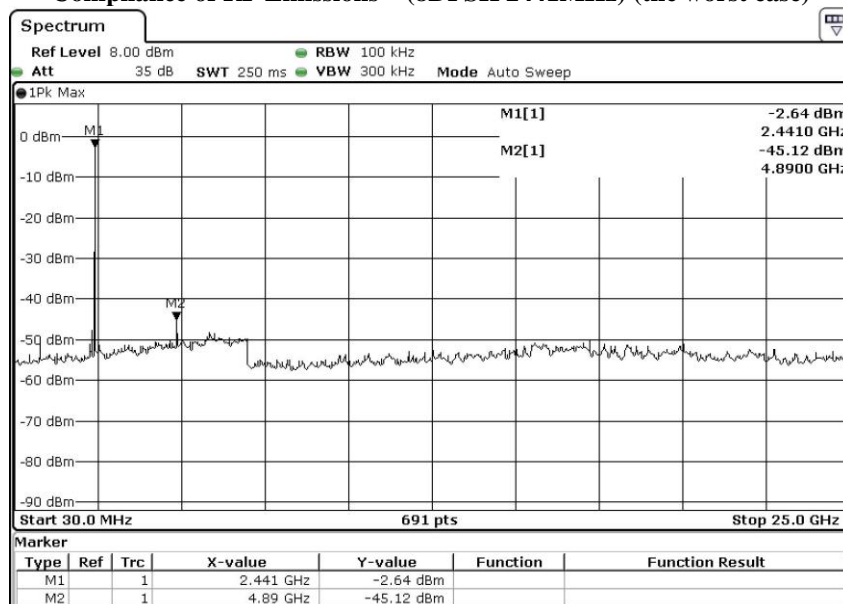
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Compliance of RF Emissions – ($\pi/4$ -DQPSK 2441MHz) (the worst case)



Compliance of RF Emissions – (8DPSK 2441MHz) (the worst case)



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3.1.8 Time of Occupancy (Dwell Time)

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Requirements:

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channel employed.

No requirements for Digital Transmission System.

Spectrum Analyzer Setting:

RBW = 300kHz, VBW ≥ RBW,

Sweep = A longer sweep time to show two successive hops on a channel,

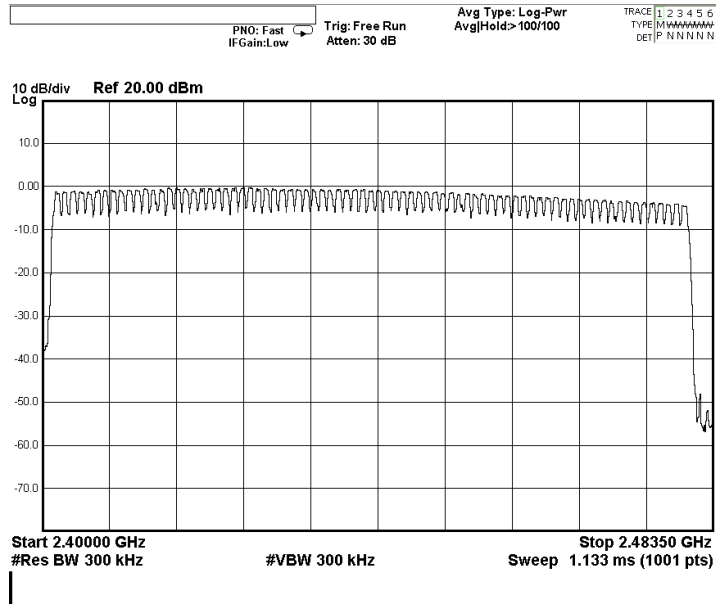
Span = Zero, Detector = Peak, Trace = Max. hold

Dwell Time = Pulse Duration * hop rate / number of channel * observation duration

Observed duration: 0.4s x 79 = 31.6s

Measurement Data:

Channel Occupied in GFSK: 79 of 79 Channel



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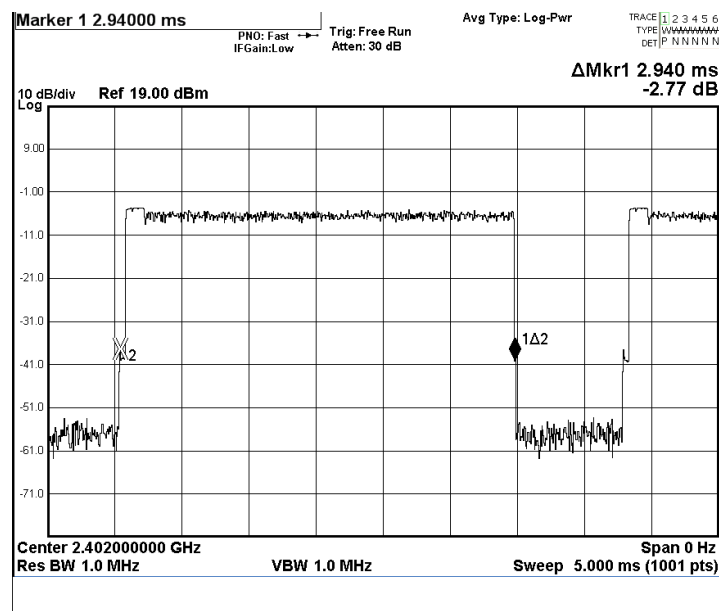
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3DH5 Packet:

3DH5 Packet permit maximum $1600/79/6 = 3.37$ hops per second in each channel (5 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times $3.37 \times 31.6 = 106.6$ within 31.6 seconds

Fig. A
[Pulse duration of Lowest Channel]



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Fig. B

[Pulse duration of Middle Channel]

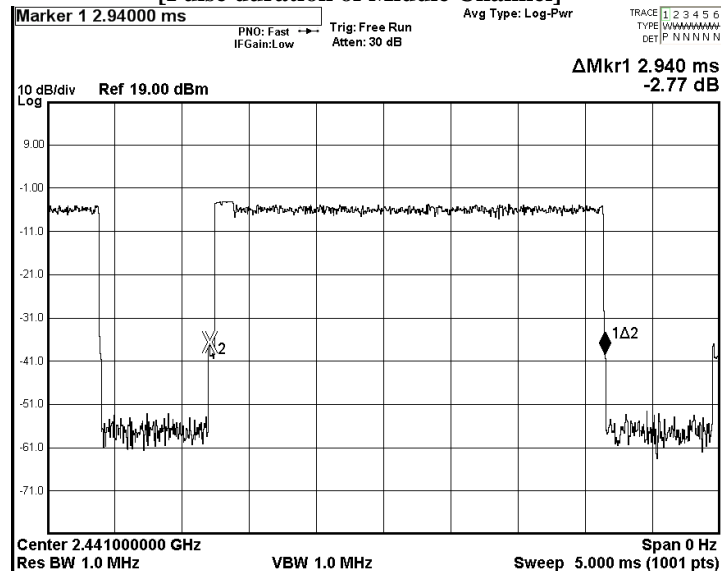
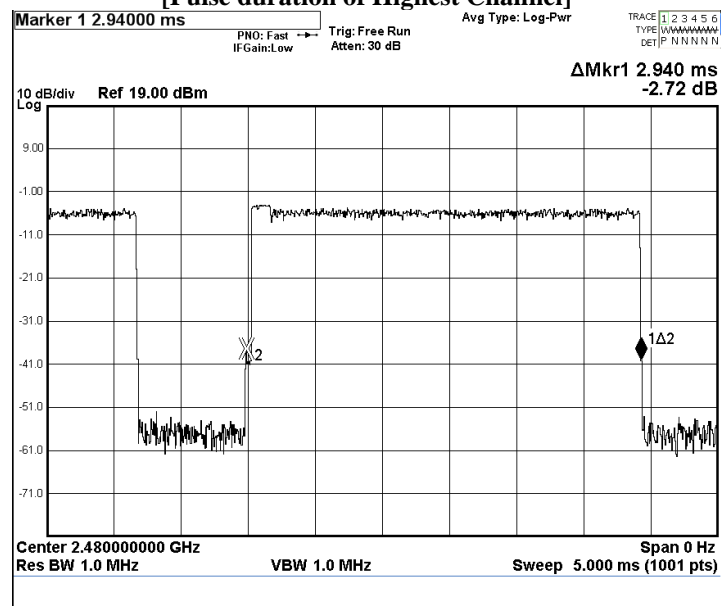


Fig. C

[Pulse duration of Highest Channel]



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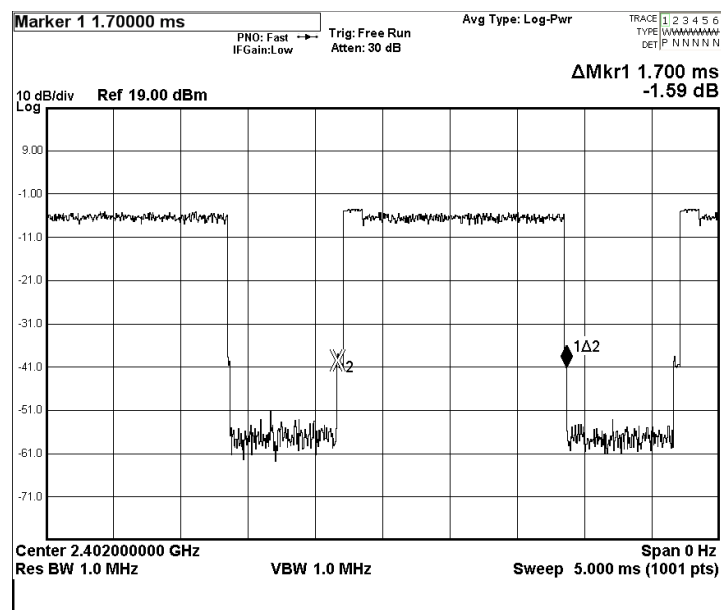
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3DH3 Packet:

3DH3 Packet permit maximum $1600/79/4 = 5.06$ hops per second in each channel (3 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times $5.06 \times 31.6 = 160$ within 31.6 seconds

Fig. D
[Pulse duration of Lowest Channel]



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Fig. E
[Pulse duration of Middle Channel]

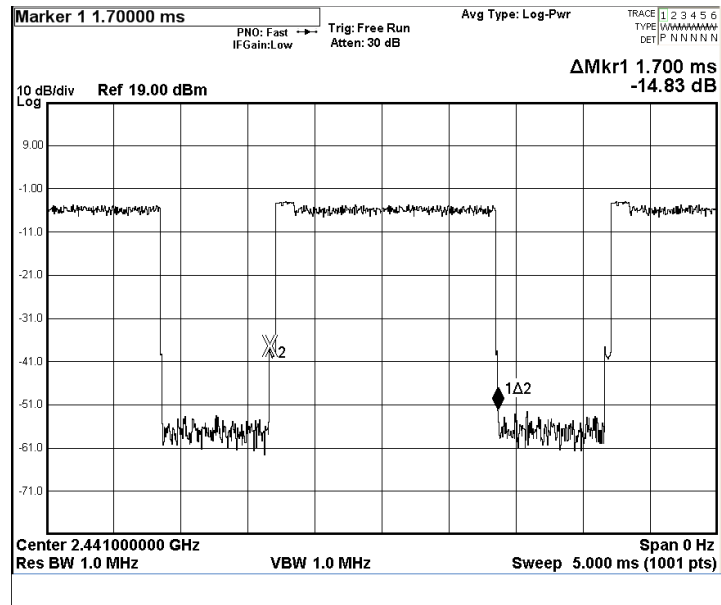
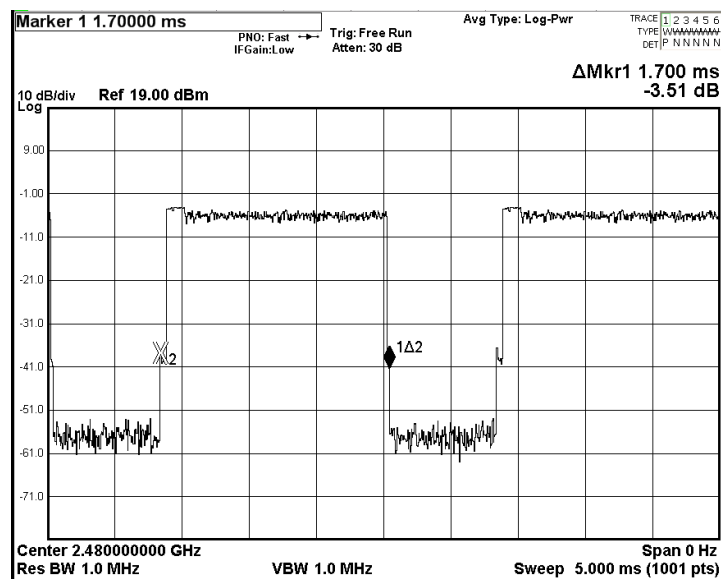


Fig. F
[Pulse duration of Highest Channel]



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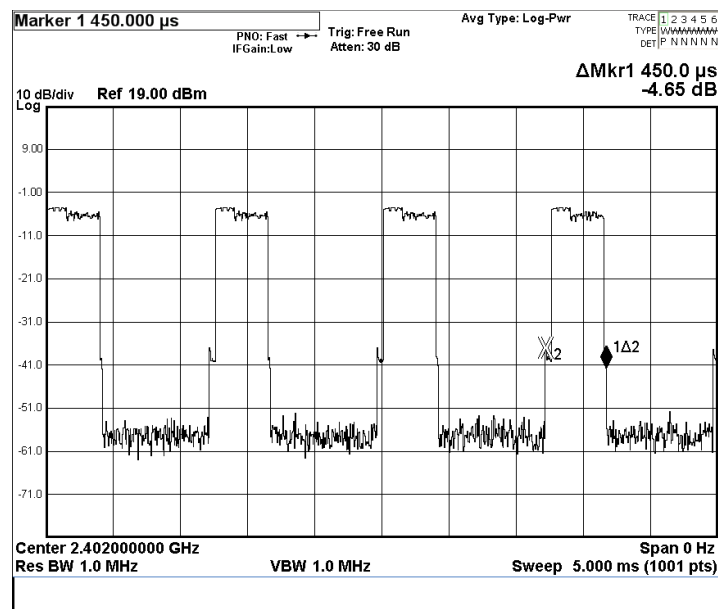
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3DH1 Packet:

3DH1 Packet permit maximum $1600/79/2 = 10.12$ hops per second in each channel (3 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times $10.12 \times 31.6 = 320$ within 31.6 seconds

Fig. G
[Pulse duration of Lowest Channel]



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Fig. H
[Pulse duration of Middle Channel]

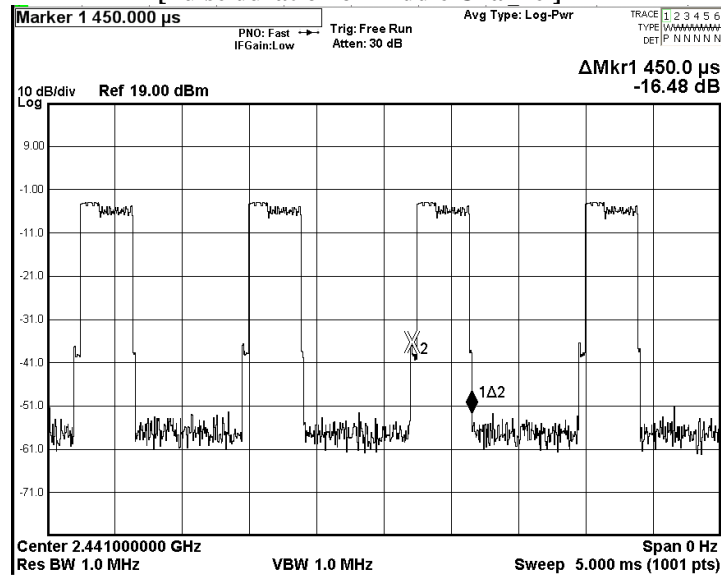
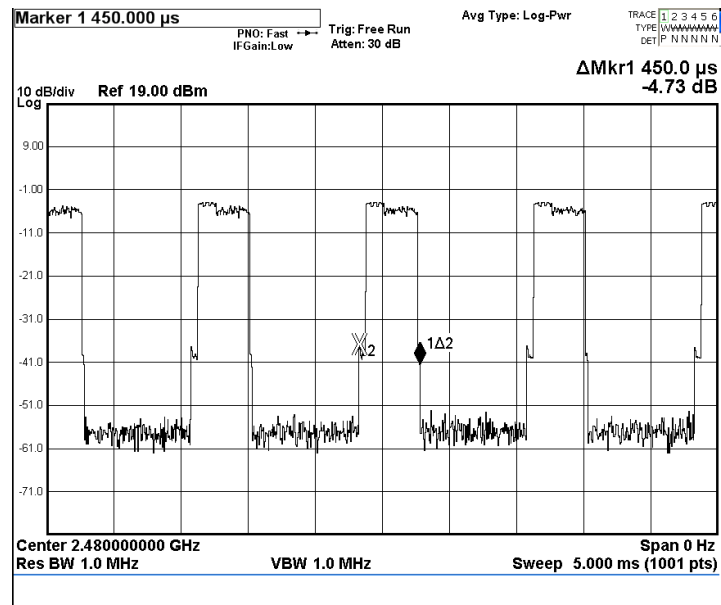


Fig. I
[Pulse duration of Highest Channel]



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Time of occupancy (Dwell Time):

| Data Packet | Frequency (MHz) | Pulse Duration (ms) | Dwell Time (s) | Limits (s) | Test Results |
|-------------|--------------------|------------------------|-------------------|---------------|--------------|
| 3DH5 | 2402 | 2.940 | 0.313 | 0.400 | Complies |
| 3DH5 | 2441 | 2.940 | 0.313 | 0.400 | Complies |
| 3DH5 | 2480 | 2.940 | 0.313 | 0.400 | Complies |
| 3DH3 | 2402 | 1.700 | 0.272 | 0.400 | Complies |
| 3DH3 | 2441 | 1.700 | 0.272 | 0.400 | Complies |
| 3DH3 | 2480 | 1.700 | 0.272 | 0.400 | Complies |
| 3DH1 | 2402 | 0.450 | 0.144 | 0.400 | Complies |
| 3DH1 | 2441 | 0.450 | 0.144 | 0.400 | Complies |
| 3DH1 | 2480 | 0.450 | 0.144 | 0.400 | Complies |

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3.1.9 Channel Centre Frequency

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Requirements:

Frequency hopping system in the 2400-2483.5MHz band shall use at least 79 (Channel 1 to 79) non-overlapping channels.

The EUT operates in according with the Bluetooth system specification within the 2400 - 2483.5 MHz frequency band.

RF channels for Bluetooth systems are spaced 1 MHz and are ordered in channel number k. In order to comply with out-of-band regulations, a lower frequency guard band of 2.0 MHz and a higher frequency guard band of 3.5MHz is used.

The operating frequencies of each channel are as follows:

First RF channel start from 2400MHz + 2MHz guard band = 2402MHz

Frequency of RF Channel = 2402+k MHz, k = 0,...,78 (Channel separation = 1MHz)

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3.1.10 Pseudorandom Hopping Algorithm

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Requirements:

The channel frequencies shall be selected from a pseudorandom ordered list of hopping frequencies. Each frequency must be used equally by the transmitter.

EUT Pseudorandom Hopping Algorithm

The EUT is a Bluetooth device, the Pseudo-random hopping pattern; hopping characteristics and algorithm are based on the Bluetooth specification.

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3.1.11 Antenna Requirement

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Test Requirements: § 15.203

Test Specification:

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.

Test Results:

This is PCB antenna. There is no external antenna, the antenna gain = -0.58 dBi. User is unable to remove or changed the Antenna.

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Appendix A

List of Measurement Equipment

Radiated Emission

| EQP NO. | DESCRIPTION | MANUFACTURER | MODEL NO. | SERIAL NO. | LAST CAL | DUE CAL |
|---------|--------------------------------------|----------------------|-----------|------------|------------|------------|
| EM215 | MULTIDEVICE CONTROLLER | EMCO | 2090 | 00024676 | N/A | N/A |
| EM217 | ELECTRIC POWERED TURNTABLE | EMCO | 2088 | 00029144 | N/A | N/A |
| EM218 | ANECHOIC CHAMBER | ETS-LINDGREN | FACT-3 | -- | 2019/04/16 | 2024/04/16 |
| EM356 | ANTENNA POSITIONING TOWER | ETS-LINDGREN | 2171B | 00150346 | N/A | N/A |
| EM293 | SPECTRUM ANALYZER | AGILENT TECHNOLOGIES | N9020A | MY50510152 | 2022/11/25 | 2024/11/25 |
| EM299 | BROADBAND HORN ANTENNA | ETS-LINDGREN | 3115 | 00114120 | 2022/11/24 | 2024/11/24 |
| EM300 | PYRAMIDAL STANDARD GAIN HORN ANTENNA | ETS-LINDGREN | 3160-09 | 00130130 | 2022/11/25 | 2024/11/25 |
| EM301 | PYRAMIDAL STANDARD GAIN HORN ANTENNA | ETS-LINDGREN | 3160-10 | 00130988 | 2022/11/25 | 2024/11/25 |
| EM353 | LOOP ANTENNA | ETS_LINDGREN | 6502 | 00206533 | 2022/06/10 | 2024/09/10 |
| EM355 | Biconilog Antenna | ETS-Lindgren | 3143B | 00094856 | 2022/06/17 | 2024/09/17 |
| EM200 | DUAL CHANNEL POWER METER | R & S | NRVD | 100592 | 2022/10/11 | 2025/10/11 |
| EM012 | PRE-AMPLIFIER | HP | HP8448B | 3008A00262 | 2022/11/08 | 2025/11/08 |
| EM215 | MULTIDEVICE CONTROLLER | EMCO | 2090 | 00024676 | N/A | N/A |

Line Conducted

| EQP NO. | DESCRIPTION | MANUFACTURER | MODEL NO. | SERIAL NO. | LAST CAL | DUE CAL |
|---------|-------------------------------------|-------------------------------|-----------|-----------------|------------|------------|
| EM232 | LISN | SCHAFFNER | NNB41 | 04/100082 | 2022/07/20 | 2023/07/20 |
| EM181 | EMI TEST RECEIVER | ROHDE & SCHWARZ | ESIB7 | 100072 | 2022/05/30 | 2023/05/30 |
| EM179 | PULSE LIMITER | ROHDE & SCHWARZ | ESH3-Z2 | 357.8810.52/54 | 2023/03/17 | 2025/03/17 |
| EM154 | SHIELDING ROOM | SIEMENS MATSUSHITA COMPONENTS | N/A | 803-740-057-99A | 2022/02/02 | 2027/02/02 |
| N/A | MEASUREMENT AND EVALUATION SOFTWARE | ROHDE & SCHWARZ | BSIB-K1 | V1.20 | N/A | N/A |

Remarks:-

CM CORRECTIVE MAINTENANCE
N/A NOT APPLICABLE
TBD TO BE DETERMINED

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Appendix B

Photographs of EUT

View of the product



View of the product



Inner circuit view



View of battery



Inner circuit top view



Inner circuit bottom view



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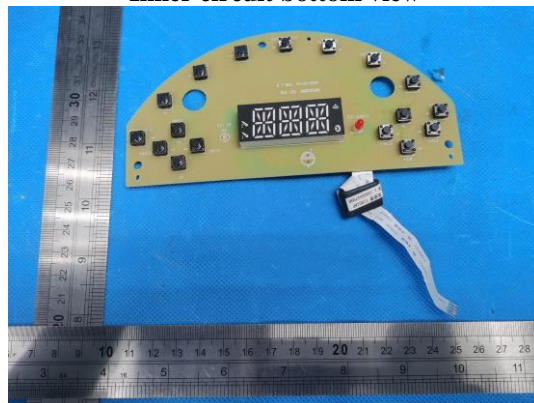
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Photographs of EUT

Inner circuit top view



Inner circuit bottom view



Inner circuit top view



Inner circuit top view



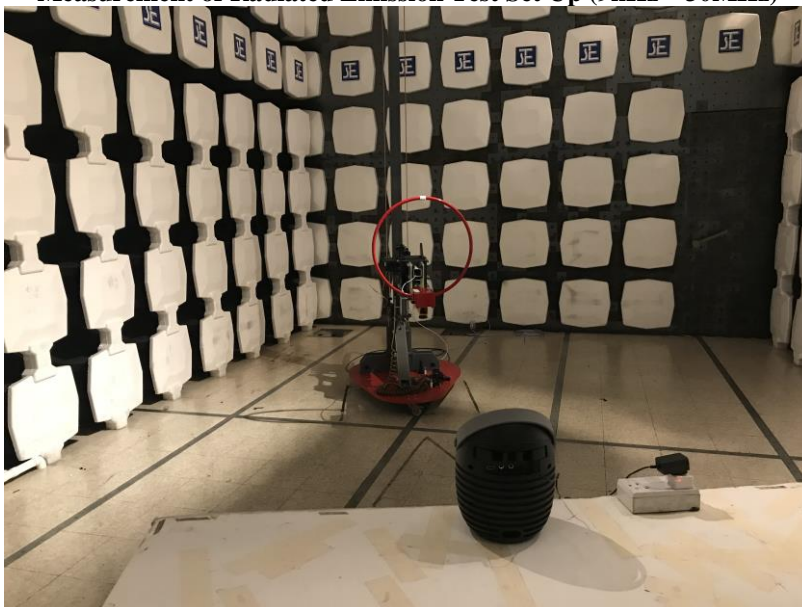
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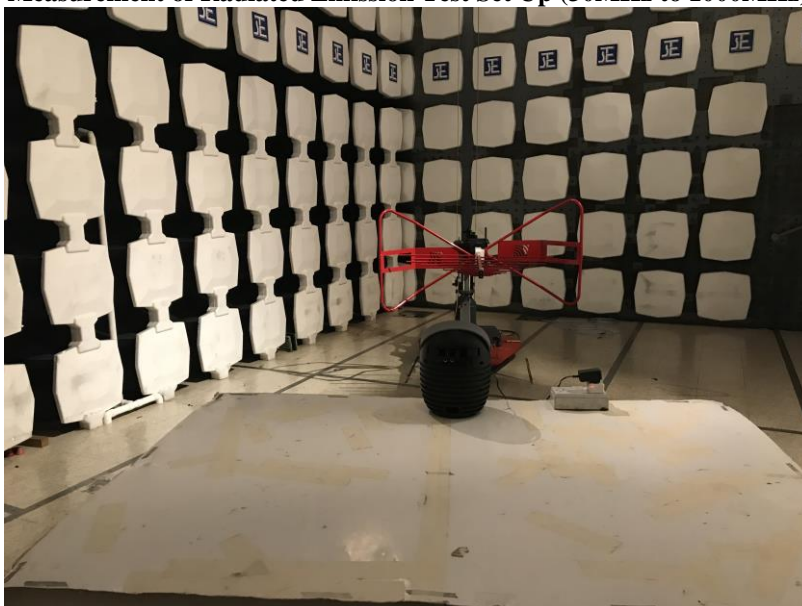
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Photographs of EUT

Measurement of Radiated Emission Test Set Up (9kHz – 30MHz)



Measurement of Radiated Emission Test Set Up (30MHz to 1000MHz)



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Photographs of EUT

Measurement of Radiated Emission Test Set Up (Above 1000MHz)



Measurement of Conducted Emission Test Set Up



******* End of Test Report *******

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