



Test Report

Date : 2018-05-15
No. : HM18040022

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Applicant: Kokoon Technology Ltd
Unit M1, 245a Coldharbour Lane, London, SW9 8RR, UK

Manufacturer: Kokoon Technology Ltd
Unit M1, 245a Coldharbour Lane, London, SW9 8RR, UK

Description of Sample(s): Product: Kokoon Relax
Brand Name: Kokoon
Model Number: K1V0W
FCC ID: 2A0P8-K1V0W

Date Sample(s) Received: 2018-04-24

Date Tested: 2018-04-27 to 2018-05-02

Investigation Requested: Perform ElectroMagnetic Interference measurement in accordance with FCC 47 CFR [Codes of Federal Regulations] Part 15: 2017 and ANSI C63.10: 2013 for FCC Certification.

Conclusion(s): 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.

Remark(s): Bluetooth FHSS (GFSK/ π/4-DQPSK/ 8DPSK)




CHEUNG Chi, Kenneth
Authorized Signatory
ElectroMagnetic Compatibility Department
For and on behalf of
The Hong Kong Standards and Testing Centre Ltd.

The Hong Kong Standards and Testing Centre Limited

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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

Telephone: (852) 26661888
Fax: (852) 26644353

1.2 Equipment Under Test [EUT]

Description of Sample(s)

| | |
|---------------|--|
| Product: | Kokoon Relax |
| Manufacturer: | Kokoon Technology Ltd Unit M1, 245a Coldharbour Lane, London, SW9 8RR, UK |
| Brand Name: | Kokoon |
| Model Number: | K1V0W |
| Rating: | 5.0Vd.c. Powered by USB port/ 3.7 Vd.c. (1*3.7Vd.c. Rechargeable battery) |

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is a Bluetooth Headphones. 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

2018-04-24

1.4 Submitted Sample(s):

2 Samples

1.5 Test Duration

2018-04-27 to 2018-05-02

1.6 Country of Origin

China

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1.7 Antenna Details

Antenna Type (Bluetooth): Monopole Antenna
Antenna Gain (Bluetooth): 0.0dBi

1.8 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: 2017 Regulations. ANSI C63.10:2013 for FCC Certification.

2.2 Test Standards and Results Summary Tables

| EMISSION (BLUETOOTH) Results Summary | | | | | |
|---|----------------------------|-------------------|------------------|-------------------------------------|--------------------------|
| Test Condition | Test Requirement | Test Method | Class / Severity | Test Result | |
| | | | | Pass | Fail |
| Maximum Peak Conducted Output Power | FCC 47CFR 15.247(b)(1) | ANSI C63.10:2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Radiated Spurious Emissions | FCC 47CFR 15.209 | ANSI C63.10:2013 | N/A | <input checked="" 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"/> |
| Number of Hopping Frequency | FCC 47CFR 15.247 (b)(1) | ANSI C63.10:2013 | N/A | <input checked="" 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"/> |
| Hopping Channel Separation | FCC 47CFR 15.247(a)(1) | ANSI C63.10: 2013 | N/A | <input checked="" 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"/> |
| Pseudorandom Hopping Algorithm | FCC 47CFR 15.247(a)(1) | N/A | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Time of Occupancy (Dwell Time) | FCC 47CFR 15.247(a)(1)(ii) | ANSI C63.10: 2013 | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Antenna requirement | FCC 47CFR 15.203 | N/A | N/A | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| RF Exposure | FCC 47CFR 15.247(i) | N/A | N/A | <input checked="" 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

| | |
|-------------------------------------|------------------------------|
| Maximum Peak Conducted Output Power | GFSK / $\pi/4$ -DQPSK/ 8DPSK |
| Hopping Channel Separation | GFSK / $\pi/4$ -DQPSK/ 8DPSK |
| Number of Hopping Frequency | GFSK / $\pi/4$ -DQPSK/ 8DPSK |
| Time of Occupancy(Dwell Time) | 8DPSK (DH1 / DH3 / DH5) |
| Radiated Spurious Emissions | GFSK / $\pi/4$ -DQPSK/ 8DPSK |

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3.0 Test Results

3.1 Emission

3.1.1 Maximum Peak Output Power (EIRP)

Ambient temperature 25°C Relative humidity 57%

Test Requirement: FCC 47CFR 15.247(b)(2)

Test Method: ANSI C63.10:2013

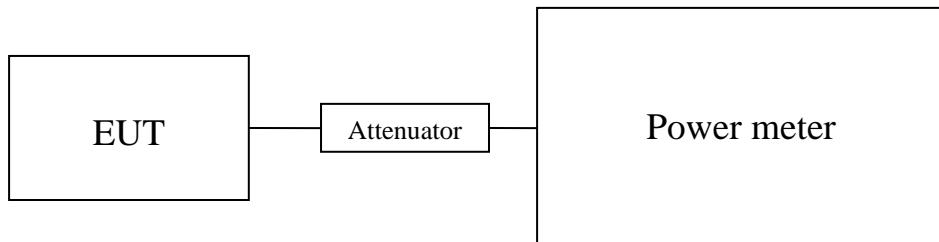
Test Date: 2018-04-27

Mode of Operation: Tx mode

Test Method:

The RF output of the EUT was connected to the power meter. All the attenuation or cable loss will be added to the measured maximum output power. The results are recorded in Watt.

Test Setup:



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



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Limits for Maximum Peak Output Power (EIRP) [FCC 47CFR 15.247]:

2400–2483.5 MHz band:

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

Maximum output power (EIRP)

| Channel | Frequency(M Hz) | Output Power(dBm) | Antenna Gain(dBi) | EIRP(dBm) | EIRP(Watt) |
|---------|-----------------|-------------------|-------------------|-----------|------------|
| 0 | 2402 | 7.62 | 0 | 7.62 | 0.00578 |
| 39 | 2441 | 7.81 | 0 | 7.81 | 0.00604 |
| 78 | 2480 | 7.73 | 0 | 7.73 | 0.00593 |

Results of Bluetooth Communication mode ($\pi/4$ -DQPSK) (Fundamental Power): Pass Maximum output power (EIRP)

| Channel | Frequency(M Hz) | Output Power(dBm) | Antenna Gain(dBi) | EIRP(dBm) | EIPR(Watt) |
|---------|-----------------|-------------------|-------------------|-----------|------------|
| 0 | 2402 | 6.34 | 0 | 6.34 | 0.00431 |
| 39 | 2441 | 6.46 | 0 | 6.46 | 0.00443 |
| 78 | 2480 | 6.32 | 0 | 6.32 | 0.00429 |

Results of Bluetooth Communication mode (8DPSK) (Fundamental Power): Pass Maximum output power (EIRP)

| Channel | Frequency(M Hz) | Output Power(dBm) | Antenna Gain(dBi) | EIRP(dBm) | EIRP(Watt) |
|---------|-----------------|-------------------|-------------------|-----------|------------|
| 0 | 2402 | 6.54 | 0 | 6.54 | 0.00451 |
| 39 | 2441 | 6.66 | 0 | 6.66 | 0.00463 |
| 78 | 2480 | 6.61 | 0 | 6.61 | 0.00458 |

| | | |
|------------------------------------|---------------|-------|
| 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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3.1.2 Conducted Emissions (0.15MHz to 30MHz)

Ambient temperature 25°C

Relative humidity 57%

Test Requirement: FCC 47CFR 15.207

Test Method: ANSI C63.10:2013

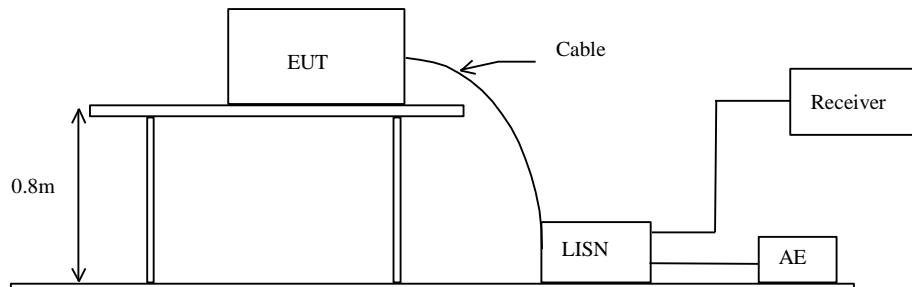
Test Date: 2018-04-30

Mode of Operation: Bluetooth Communication mode with charging function

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.

Test Setup:



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Limit for Conducted Emissions (FCC 47CFR 15.207):

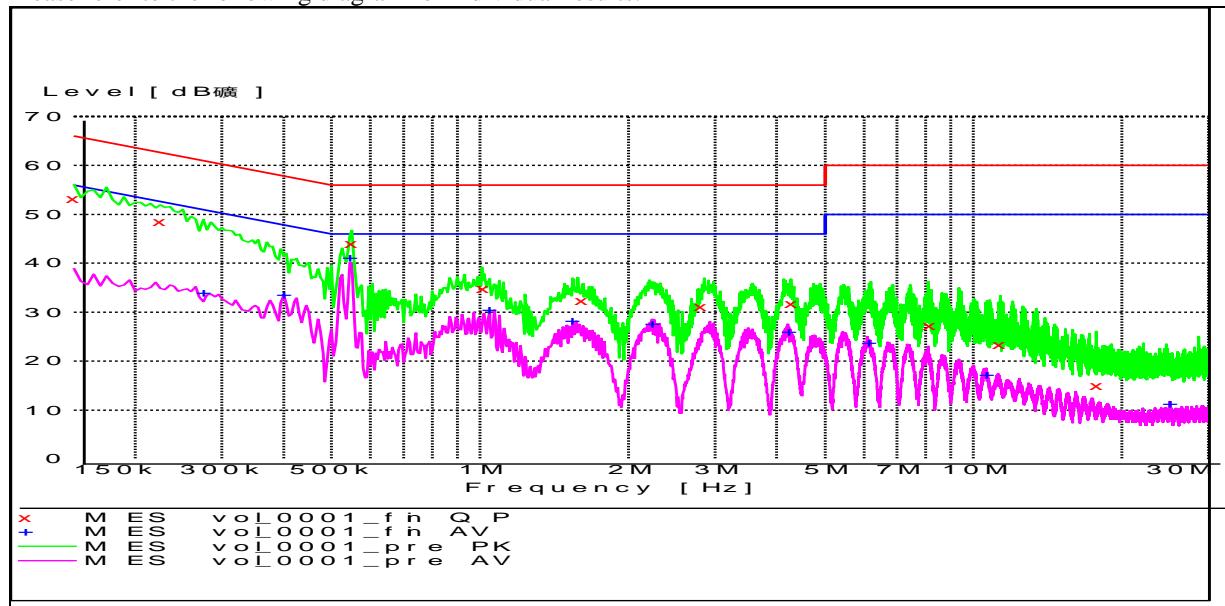
| Frequency Range [MHz] | Quasi-Peak Limits [dB μ V] | Average [dB μ V] |
|--------------------------|-----------------------------------|-------------------------|
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5.0 | 56 | 46 |
| 5.0-30.0 | 60 | 50 |

* Decreases with the logarithm of the frequency.

Limits for Conducted Emissions Test, please refer to limit lines (Quasi-Peak and Average) in the following diagram.

Results of Bluetooth Communication mode with charging function (L & N): PASS

Please refer to the following diagram for individual results.



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Results of Bluetooth Communication mode with charging function (L & N): PASS

MEASUREMENT RESULT: "vol_0001_fin_QP"

| Frequency MHz | Level dB μ V | Transd dB | Limit dB μ V | Margin dB | Line | PE |
|------------------|---------------------|--------------|---------------------|--------------|------|-----|
| 0.150000 | 53.10 | 9.9 | 66 | 12.9 | N | GND |
| 0.225000 | 48.50 | 9.9 | 63 | 14.1 | L1 | GND |
| 0.550000 | 44.00 | 10.0 | 56 | 12.0 | N | GND |
| 1.015000 | 34.80 | 9.8 | 56 | 21.2 | N | GND |
| 1.610000 | 32.40 | 10.0 | 56 | 23.6 | L1 | GND |
| 2.805000 | 31.20 | 10.3 | 56 | 24.8 | N | GND |
| 4.285000 | 31.80 | 10.5 | 56 | 24.2 | N | GND |
| 8.175000 | 27.30 | 10.5 | 60 | 32.7 | L1 | GND |
| 11.310000 | 23.40 | 10.5 | 60 | 36.6 | N | GND |
| 17.805000 | 15.00 | 10.7 | 60 | 45.0 | N | GND |

MEASUREMENT RESULT: "vol_0001_fin_AV"

| Frequency MHz | Level dB μ V | Transd dB | Limit dB μ V | Margin dB | Line | PE |
|------------------|---------------------|--------------|---------------------|--------------|------|-----|
| 0.275000 | 33.90 | 9.9 | 51 | 17.0 | N | GND |
| 0.400000 | 33.50 | 10.0 | 48 | 14.3 | N | GND |
| 0.545000 | 41.10 | 10.0 | 46 | 4.9 | L1 | GND |
| 1.045000 | 30.50 | 9.8 | 46 | 15.5 | L1 | GND |
| 1.540000 | 28.30 | 10.0 | 46 | 17.7 | N | GND |
| 2.235000 | 27.60 | 10.2 | 46 | 18.4 | N | GND |
| 4.235000 | 26.00 | 10.5 | 46 | 20.0 | N | GND |
| 6.145000 | 23.80 | 10.6 | 50 | 26.2 | N | GND |
| 10.630000 | 17.20 | 10.4 | 50 | 32.8 | N | GND |
| 25.060000 | 11.40 | 10.8 | 50 | 38.6 | N | GND |

Remarks:

Calculated measurement uncertainty (0.15MHz – 30MHz): 3.2dB

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

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3.1.3 Radiated Spurious Emissions

Ambient temperature 25°C Relative humidity 57%

Test Requirement: FCC 47CFR 15.209
Test Method: ANSI C63.10:2013
Test Date: 2018-05-02
Mode of Operation: Tx mode :GFSK/ $\pi/4$ -DQPSK/8DPSK

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, 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.

*

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Spectrum Analyzer Setting:

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9KHz – 30MHz (Pk & Av)

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

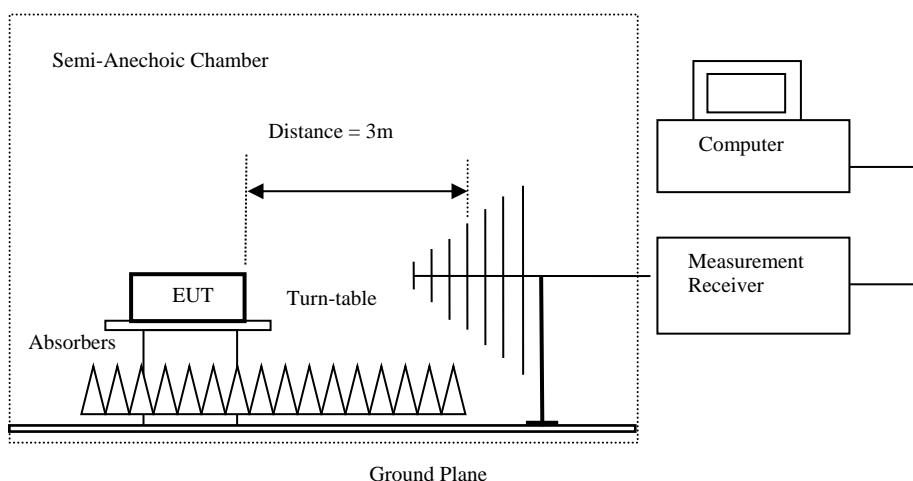
30MHz – 1GHz (QP)

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

Above 1GHz (Pk & Av)

RBW: 1MHz
 VBW: 3MHz
 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 15.209 Class B]:

| Frequency Range [MHz] | Quasi-Peak Limits [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.

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Result of Tx mode (2402.0 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 Limits | | | | | | |

Result of Tx mode (2402.0 MHz) (GFSK) (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 dBuV/m | E-Field Polarity |
| 2402.0 | 75.0 | 27.9 | 102.9 | N/A | N/A | Horizontal |
| 4804.0 | 5.1 | 32.1 | 37.2 | 74.0 | 36.8 | Horizontal |
| 7206.0 | 3.2 | 38.6 | 41.8 | 74.0 | 32.2 | Horizontal |
| 9608.0 | -1.3 | 41.3 | 40.0 | 74.0 | 34.0 | Vertical |
| 12010.0 | -2.9 | 43.5 | 40.6 | 74.0 | 33.4 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2402.0 | 64.8 | 27.9 | 92.7 | N/A | N/A | Horizontal |
| 4804.0 | -6.4 | 32.1 | 25.7 | 54.0 | 28.3 | Horizontal |
| 7206.0 | -3.7 | 38.6 | 34.9 | 54.0 | 19.1 | Horizontal |
| 9608.0 | -8.1 | 41.3 | 33.2 | 54.0 | 20.8 | Vertical |
| 12010.0 | -8.7 | 43.5 | 34.8 | 54.0 | 19.2 | Vertical |

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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 Limits | | | | | | |

Result of Tx mode (2441.0 MHz) (GFSK) (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 dBuV/m | E-Field Polarity |
| 2441.0 | 75.3 | 27.9 | 103.2 | N/A | N/A | Horizontal |
| 4882.0 | 4.2 | 32.1 | 36.3 | 74.0 | 37.7 | Horizontal |
| 7323.0 | 2.9 | 38.6 | 41.5 | 74.0 | 32.5 | Horizontal |
| 9764.0 | -1.5 | 41.3 | 39.8 | 74.0 | 34.2 | Vertical |
| 12205.0 | -3.4 | 43.5 | 40.1 | 74.0 | 33.9 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2441.0 | 65.8 | 27.9 | 93.7 | N/A | N/A | Horizontal |
| 4882.0 | -2.6 | 32.1 | 29.5 | 54.0 | 24.5 | Horizontal |
| 7323.0 | -3.1 | 38.6 | 35.5 | 54.0 | 18.5 | Horizontal |
| 9764.0 | -5.1 | 41.3 | 36.2 | 54.0 | 17.8 | Vertical |
| 12205.0 | -4.8 | 43.5 | 38.7 | 54.0 | 15.3 | Vertical |

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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 Limits | | | | | | |

Result of Tx mode (2480.0 MHz) (GFSK) (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 dBuV/m | E-Field Polarity |
| 2480.0 | 75.1 | 27.9 | 103.0 | N/A | N/A | Horizontal |
| 4960.0 | 4.8 | 32.2 | 37.0 | 74.0 | 37.0 | Horizontal |
| 7440.0 | 3.6 | 38.6 | 42.2 | 74.0 | 31.8 | Horizontal |
| 9920.0 | 1.1 | 42.1 | 43.2 | 74.0 | 30.8 | Vertical |
| 12400.0 | -4.2 | 44.1 | 39.9 | 74.0 | 34.1 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2480.0 | 65.4 | 27.9 | 93.3 | N/A | N/A | Horizontal |
| 4960.0 | -2.7 | 32.2 | 29.5 | 54.0 | 24.5 | Horizontal |
| 7440.0 | -3.1 | 38.6 | 35.5 | 54.0 | 18.5 | Horizontal |
| 9920.0 | -4.1 | 42.1 | 38.0 | 54.0 | 16.0 | Vertical |
| 12400.0 | -4.7 | 44.1 | 39.4 | 54.0 | 14.6 | Vertical |

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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 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 dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dBuV/m | E-Field Polarity |
| 2402.0 | 73.7 | 27.9 | 101.6 | N/A | N/A | Horizontal |
| 4804.0 | 4.2 | 32.1 | 36.3 | 74.0 | 37.7 | Horizontal |
| 7206.0 | 2.4 | 38.6 | 41.0 | 74.0 | 33.0 | Horizontal |
| 9608.0 | -1.1 | 41.3 | 40.2 | 74.0 | 33.8 | Vertical |
| 12010.0 | -2.8 | 43.5 | 40.7 | 74.0 | 33.3 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2402.0 | 62.8 | 27.9 | 90.7 | N/A | N/A | Horizontal |
| 4804.0 | -3.4 | 32.1 | 28.7 | 54.0 | 25.3 | Horizontal |
| 7206.0 | -2.5 | 38.6 | 36.1 | 54.0 | 17.9 | Horizontal |
| 9608.0 | -5.3 | 41.3 | 36.0 | 54.0 | 18.0 | Vertical |
| 12010.0 | -4.6 | 43.5 | 38.9 | 54.0 | 15.1 | Vertical |

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

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| 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 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 dBuV/m | E-Field Polarity |
| 2441.0 | 73.8 | 27.9 | 101.7 | N/A | N/A | Horizontal |
| 4882.0 | 3.6 | 32.1 | 35.7 | 74.0 | 38.3 | Horizontal |
| 7323.0 | 3.1 | 38.6 | 41.7 | 74.0 | 32.3 | Horizontal |
| 9764.0 | -2.1 | 41.3 | 39.2 | 74.0 | 34.8 | Vertical |
| 12205.0 | -3.9 | 43.5 | 39.6 | 74.0 | 34.4 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2441.0 | 62.8 | 27.9 | 90.7 | N/A | N/A | Horizontal |
| 4882.0 | -2.2 | 32.1 | 29.9 | 54.0 | 24.1 | Horizontal |
| 7323.0 | -1.9 | 38.6 | 36.7 | 54.0 | 17.3 | Horizontal |
| 9764.0 | -4.7 | 41.3 | 36.6 | 54.0 | 17.4 | Vertical |
| 12205.0 | -5.1 | 43.5 | 38.4 | 54.0 | 15.6 | Vertical |

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

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| 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 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 dBuV/m | E-Field Polarity |
| 2480.0 | 73.6 | 27.9 | 101.5 | N/A | N/A | Horizontal |
| 4960.0 | 3.9 | 32.2 | 36.1 | 74.0 | 37.9 | Horizontal |
| 7440.0 | 2.1 | 38.6 | 40.7 | 74.0 | 33.3 | Horizontal |
| 9920.0 | -1.7 | 42.1 | 40.4 | 74.0 | 33.6 | Vertical |
| 12400.0 | -3.3 | 44.1 | 40.8 | 74.0 | 33.2 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2480.0 | 62.4 | 27.9 | 90.3 | N/A | N/A | Horizontal |
| 4960.0 | -2.9 | 32.2 | 29.3 | 54.0 | 24.7 | Horizontal |
| 7440.0 | -3.1 | 38.6 | 35.5 | 54.0 | 18.5 | Horizontal |
| 9920.0 | -4.8 | 42.1 | 37.3 | 54.0 | 16.7 | Vertical |
| 12400.0 | -5.6 | 44.1 | 38.5 | 54.0 | 15.5 | Vertical |

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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 Limits | | | | | | |

Result of Tx mode (2402.0 MHz) (8DPSK) (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 dBuV/m | E-Field Polarity |
| 2402.0 | 74.0 | 27.9 | 101.9 | N/A | N/A | Horizontal |
| 4804.0 | 2.9 | 32.1 | 35.0 | 74.0 | 39.0 | Horizontal |
| 7206.0 | 1.8 | 38.6 | 40.4 | 74.0 | 33.6 | Horizontal |
| 9608.0 | -1.5 | 41.3 | 39.8 | 74.0 | 34.2 | Vertical |
| 12010.0 | -3.3 | 43.5 | 40.2 | 74.0 | 33.8 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2402.0 | 62.5 | 27.9 | 90.4 | N/A | N/A | Horizontal |
| 4804.0 | -3.3 | 32.1 | 28.8 | 54.0 | 25.2 | Horizontal |
| 7206.0 | -4.1 | 38.6 | 34.5 | 54.0 | 19.5 | Horizontal |
| 9608.0 | -6.4 | 41.3 | 34.9 | 54.0 | 19.1 | Vertical |
| 12010.0 | -5.9 | 43.5 | 37.6 | 54.0 | 16.4 | Vertical |

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

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| 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 Limits | | | | | | |

Result of Tx mode (2441.0 MHz) (8DPSK) (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 dBuV/m | E-Field Polarity |
| 2441.0 | 74.2 | 27.9 | 102.1 | N/A | N/A | Horizontal |
| 4882.0 | 3.1 | 32.1 | 35.2 | 74.0 | 38.8 | Horizontal |
| 7323.0 | 2.1 | 38.6 | 40.7 | 74.0 | 33.3 | Horizontal |
| 9764.0 | -1.5 | 41.3 | 39.8 | 74.0 | 34.2 | Vertical |
| 12205.0 | -3.7 | 43.5 | 39.8 | 74.0 | 34.2 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2441.0 | 62.8 | 27.9 | 90.7 | N/A | N/A | Horizontal |
| 4882.0 | -1.8 | 32.1 | 30.3 | 54.0 | 23.7 | Horizontal |
| 7323.0 | -3.3 | 38.6 | 35.3 | 54.0 | 18.7 | Horizontal |
| 9764.0 | -5.8 | 41.3 | 35.5 | 54.0 | 18.5 | Vertical |
| 12205.0 | -6.4 | 43.5 | 37.1 | 54.0 | 16.9 | Vertical |

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

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| 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 Limits | | | | | | |

Result of Tx mode (2480.0 MHz) (8DPSK) (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 dBuV/m | E-Field Polarity |
| 2480.0 | 74.1 | 27.9 | 102.0 | N/A | N/A | Horizontal |
| 4960.0 | 3.4 | 32.2 | 35.6 | 74.0 | 38.4 | Horizontal |
| 7440.0 | 2.4 | 38.6 | 41.0 | 74.0 | 33.0 | Horizontal |
| 9920.0 | -1.5 | 42.1 | 40.6 | 74.0 | 33.4 | Vertical |
| 12400.0 | -4.2 | 44.1 | 39.9 | 74.0 | 34.1 | Vertical |

| 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 dBuV/m | E-Field Polarity |
| 2480.0 | 62.4 | 27.9 | 90.3 | N/A | N/A | Horizontal |
| 4960.0 | -1.1 | 32.2 | 31.1 | 54.0 | 22.9 | Horizontal |
| 7440.0 | -2.7 | 38.6 | 35.9 | 54.0 | 18.1 | Horizontal |
| 9920.0 | -3.3 | 42.1 | 38.8 | 54.0 | 15.2 | Vertical |
| 12400.0 | -5.1 | 44.1 | 39.0 | 54.0 | 15.0 | Vertical |

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Result of Tx mode (8DPSK: 2480.0 MHz) (9kHz – 30MHz): Pass
Limits for Radiated Emissions [FCC 47 CFR 15.209 Class B]:

| Frequency Range [MHz] | Quasi-Peak Limits [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 |

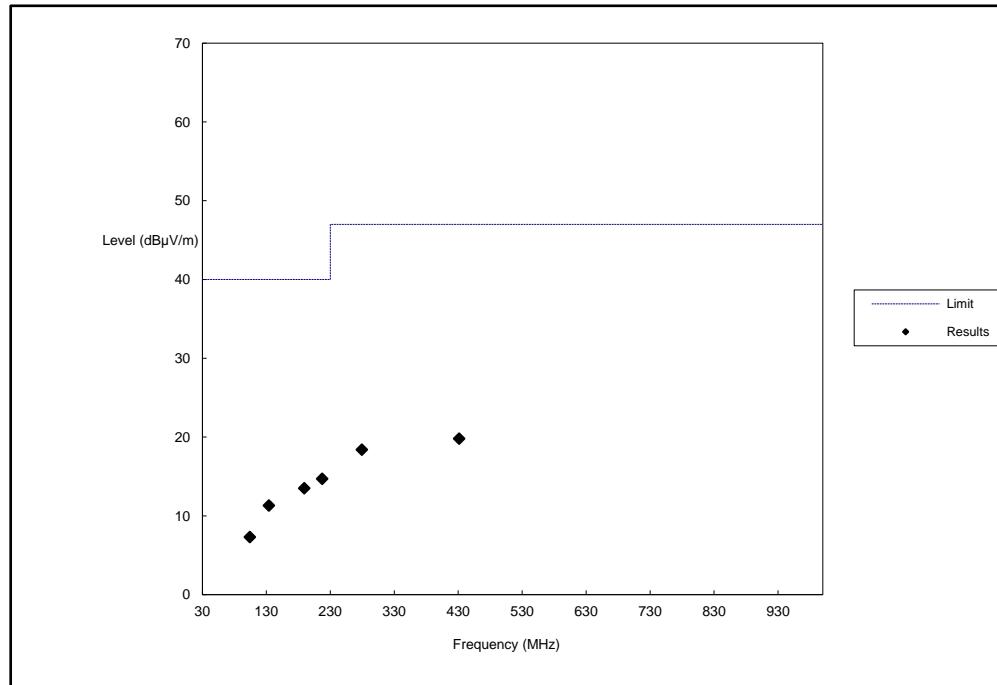
The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Result of Bluetooth communication mode, (9kHz – 30MHz): PASS

Emissions detected are more than 20 dB below the FCC Limits

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

Please refer to the following table for result details(The data is the worst cases)



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| Radiated Emissions Quasi-Peak | | | | | |
|----------------------------------|---------------------|------------------------------|------------------------------|---------------------------|---------------------------|
| Emission Frequency MHz | E-Field Polarity | Level @3m dB μ V/m | Limit @3m dB μ V/m | Level @3m μ V/m | Limit @3m μ V/m |
| 67.8 | Vertical | 18.9 | 40.0 | 8.8 | 150 |
| 147.3 | Horizontal | 13.7 | 43.5 | 4.8 | 150 |
| 195.7 | Horizontal | 16.7 | 43.5 | 6.8 | 150 |
| 205.3 | Horizontal | 18.7 | 43.5 | 8.6 | 200 |
| 299.7 | Horizontal | 19.4 | 46.0 | 9.3 | 200 |
| 445.3 | Horizontal | 23.4 | 46.0 | 14.8 | 200 |

Result of Bluetooth communication mode, (1GHz – 26GHz): PASS

Emissions detected are more than 20 dB below the FCC Limits

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 3.3dB
30MHz -1GHz 4.6dB
1GHz -26GHz 4.4dB

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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3.1.4 Number of Hopping Frequency

Ambient temperature 26°C

Relative humidity 57%

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:

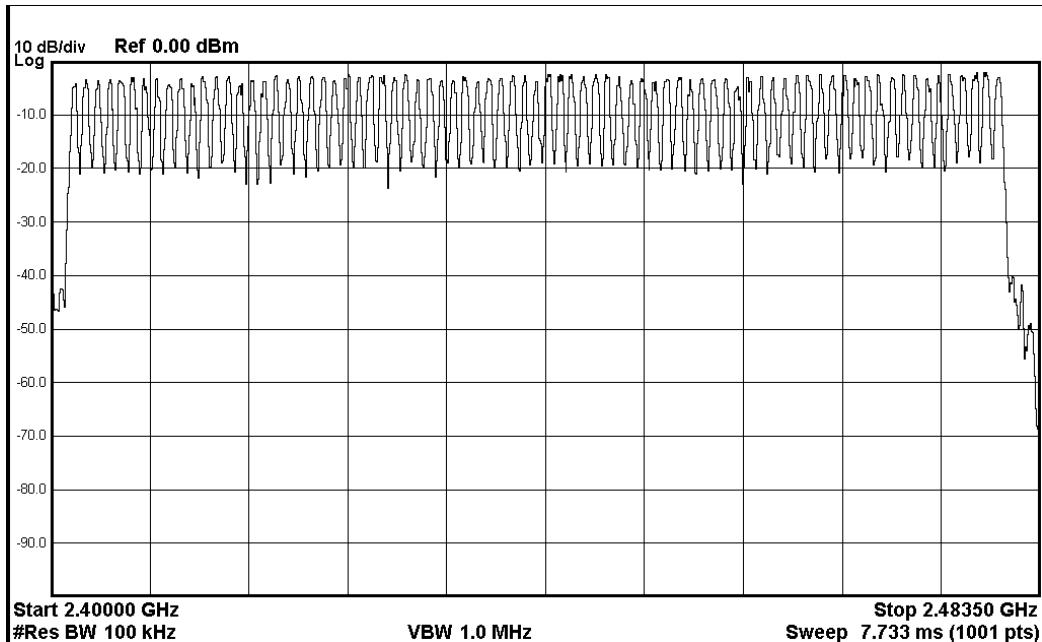
RBW = 100kHz, VBW \geq RBW, Sweep = Auto, Span = the frequency band of operation
Detector = Peak, Trace = Max. hold

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

Measurement Data:

GFSK: 79 of 79 Channel



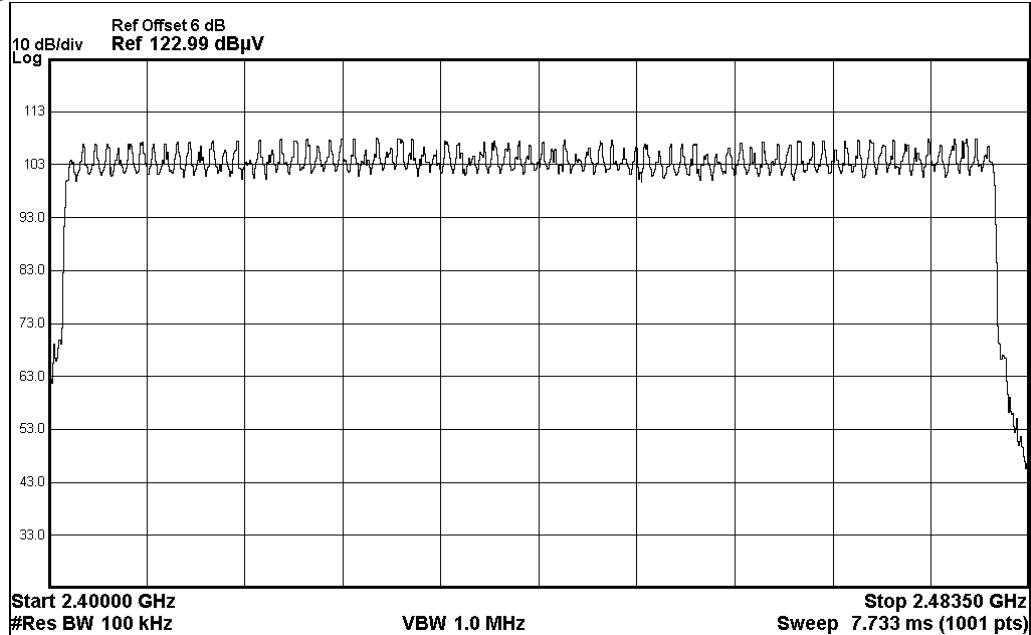
Test Report

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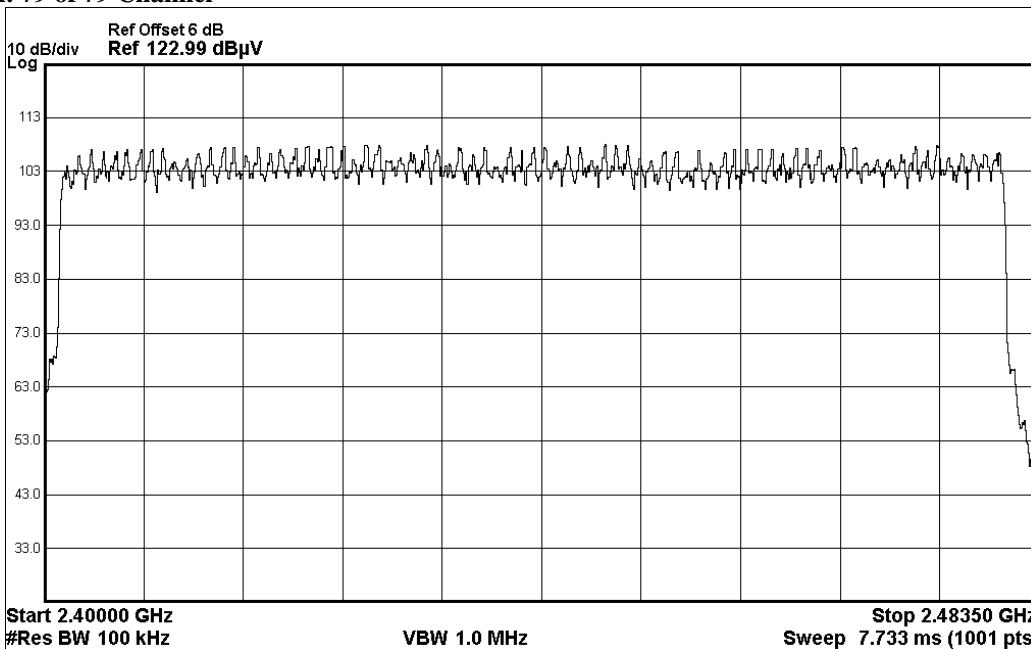
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$\pi/4$ -DQPSK: 79 of 79 Channel

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8DPSK: 79 of 79 Channel



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Test Report

Date : 2018-05-15

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3.1.5 20dB Bandwidth

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Ambient temperature 25°C

Relative humidity 57%

Test Requirement: FCC 47CFR 15.247(a)(1)

Test Method: ANSI C63.10:2013

Test Date: 2018-05-02

Mode of Operation: Tx mode :GFSK/ π /4-DQPSK/8DPSK

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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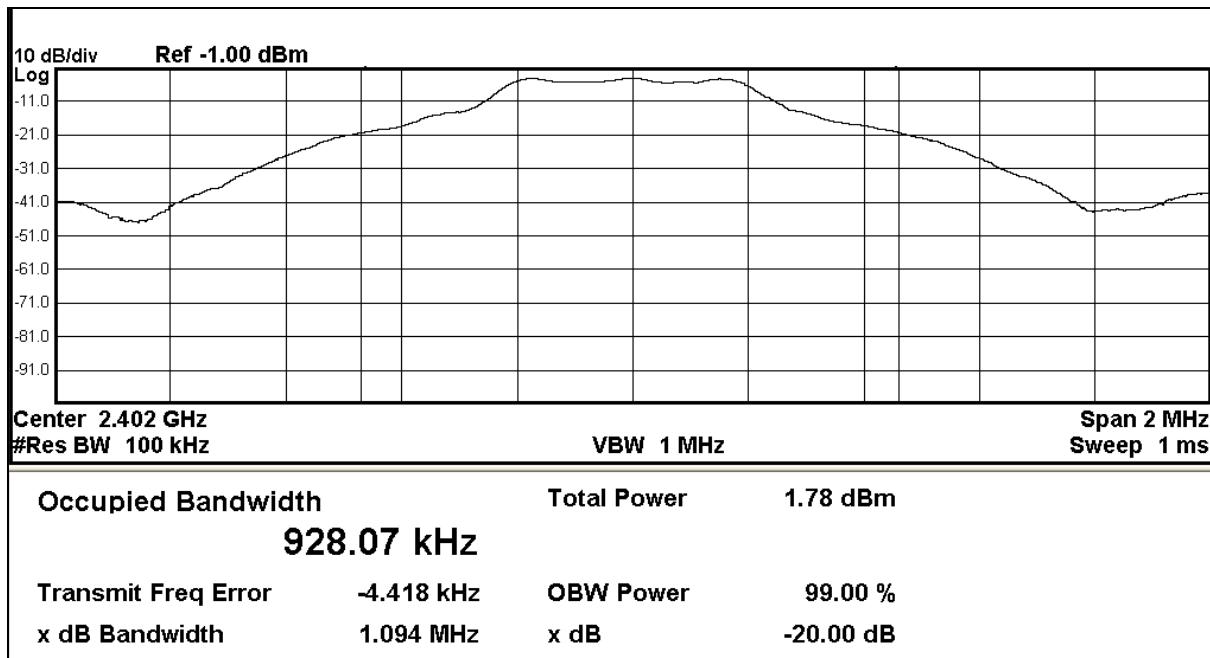
Date : 2018-05-15

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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2402 | 1.09 | Within 2400-2483.5 |

(Lowest Operating Frequency) - (GFSK)



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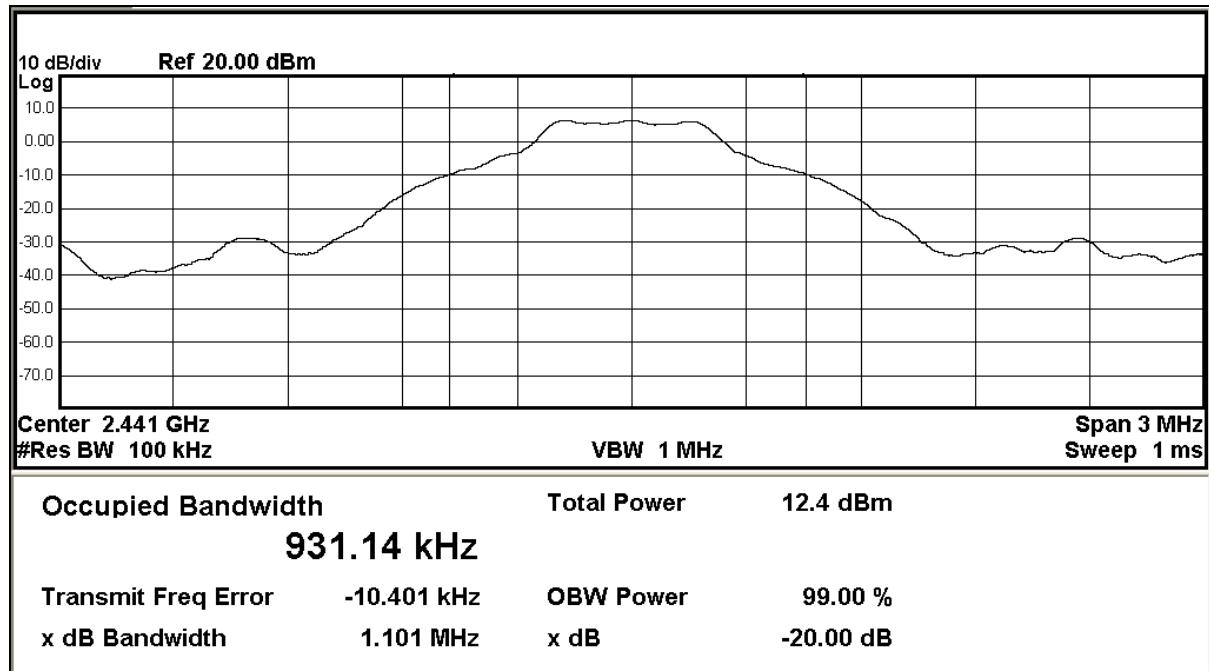
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2441 | 1.10 | Within 2400-2483.5 |

(Middle Operating Frequency) - (GFSK)



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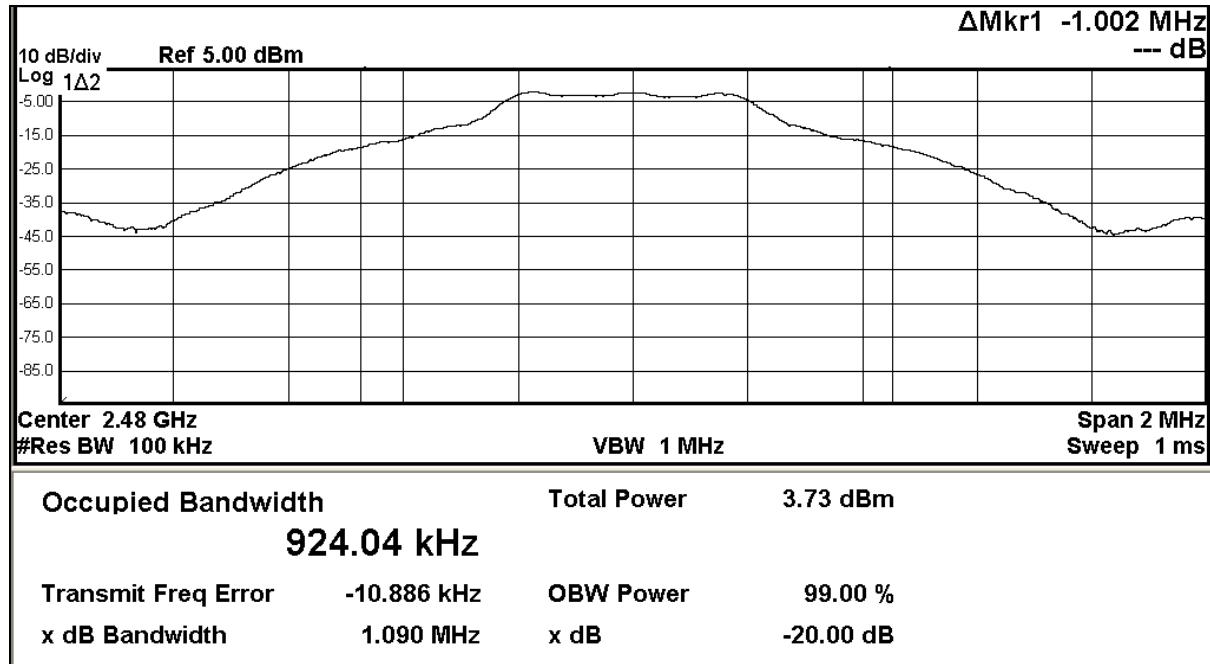
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| Fundamental Frequency [MHz] | 20dB Bandwidth [KHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2480 | 1.09 | Within 2400-2483.5 |

(Highest Operating Frequency) - (GFSK)



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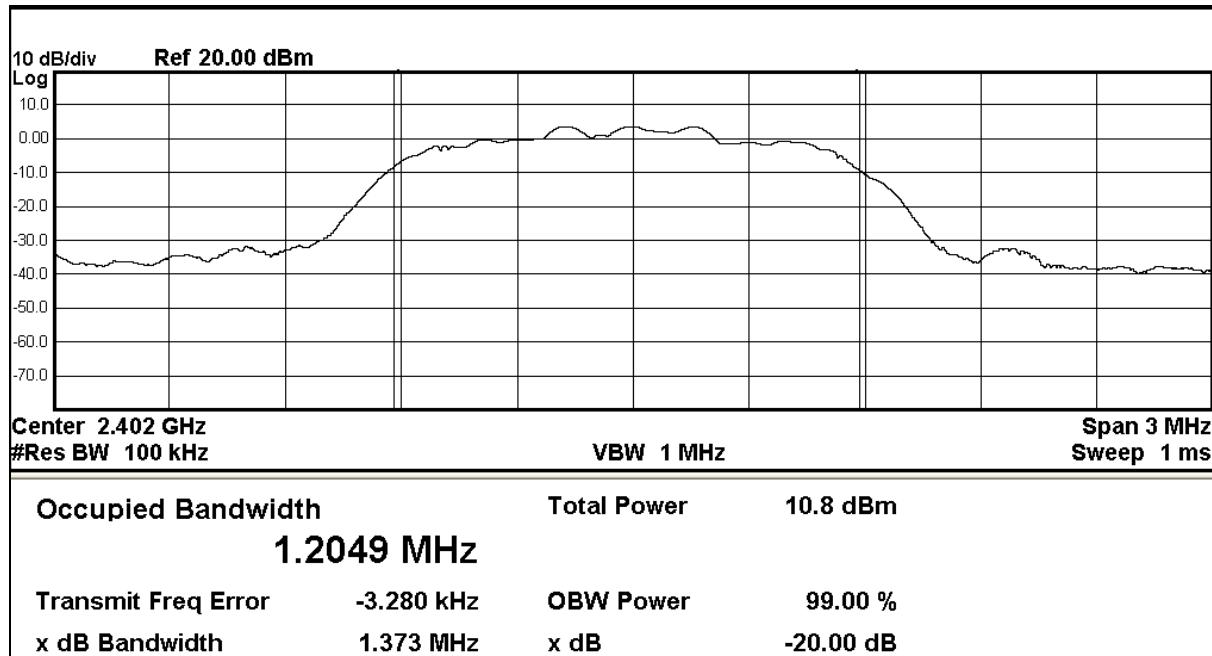
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2402 | 1.37 | Within 2400-2483.5 |

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



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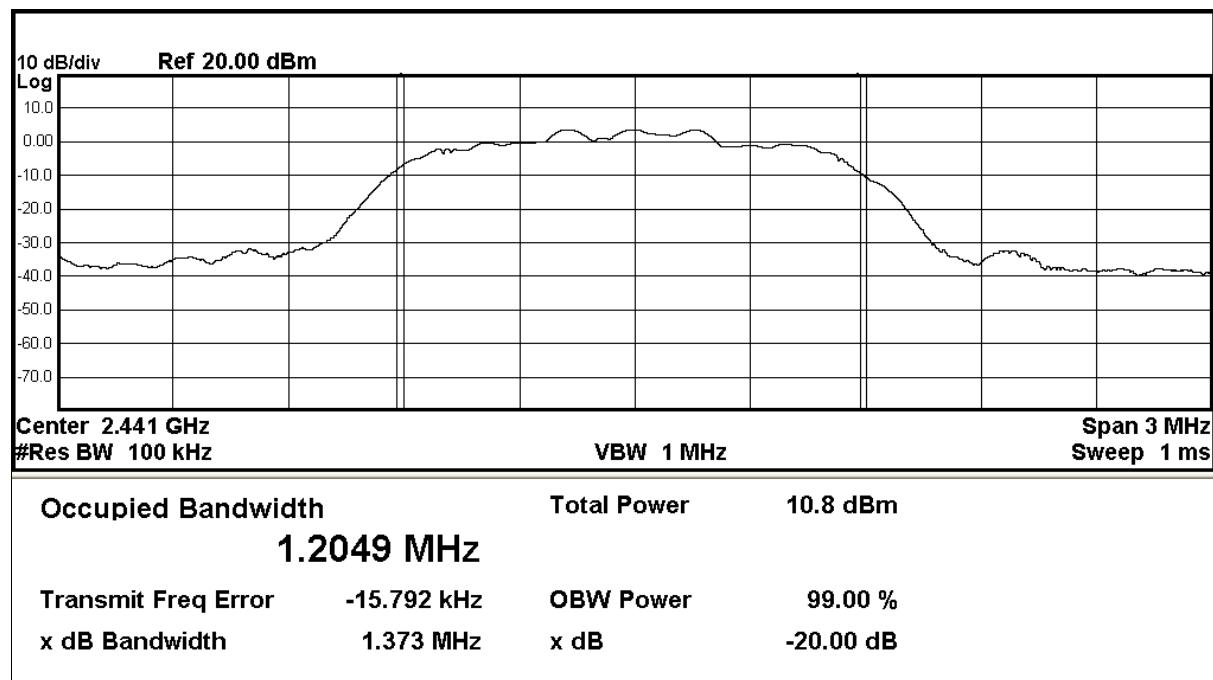
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2441 | 1.37 | Within 2400-2483.5 |

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



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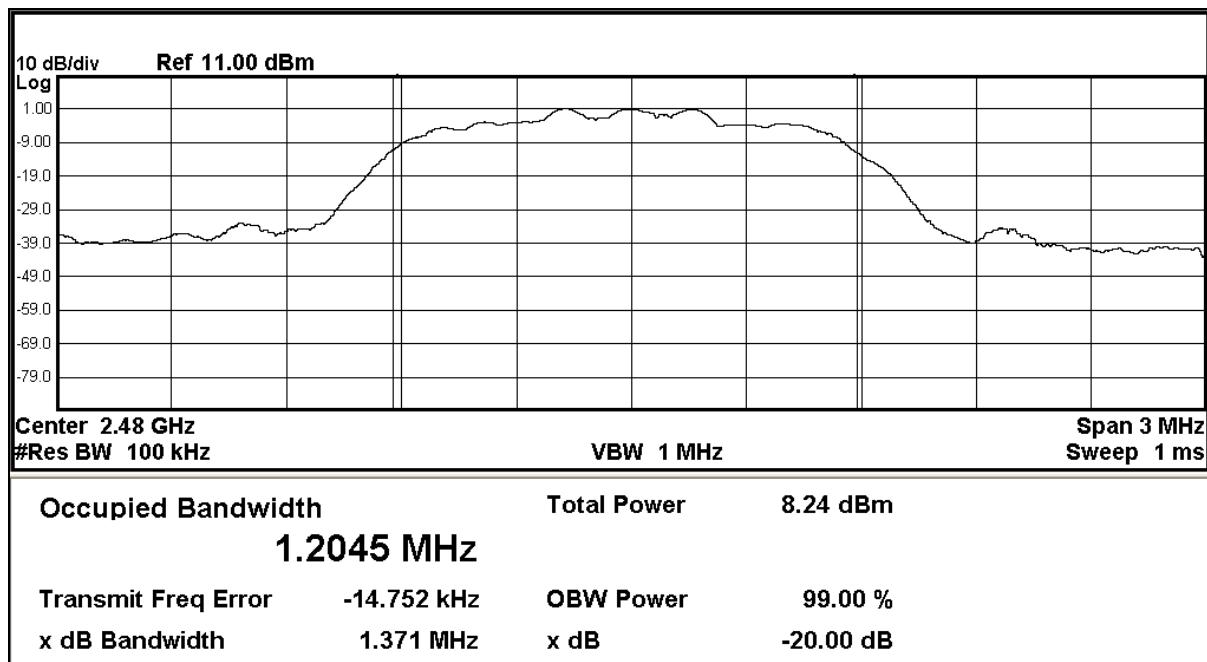
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2480 | 1.37 | Within 2400-2483.5 |

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



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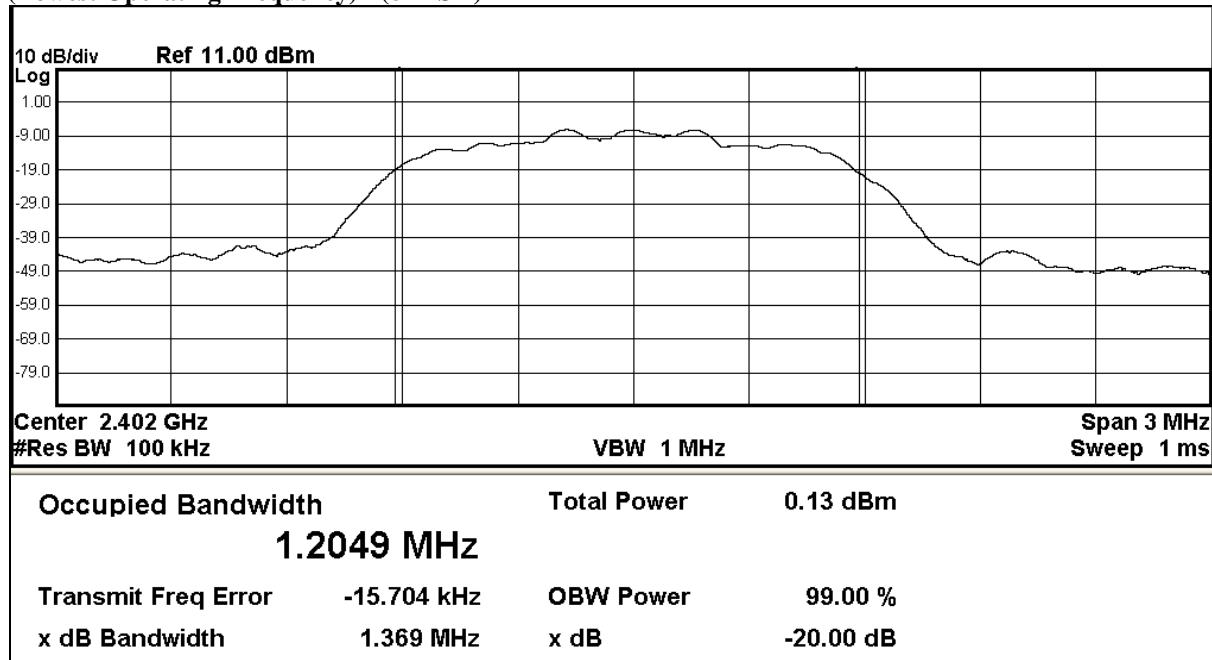
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2402 | 1.37 | Within 2400-2483.5 |

(Lowest Operating Frequency) - (8DPSK)



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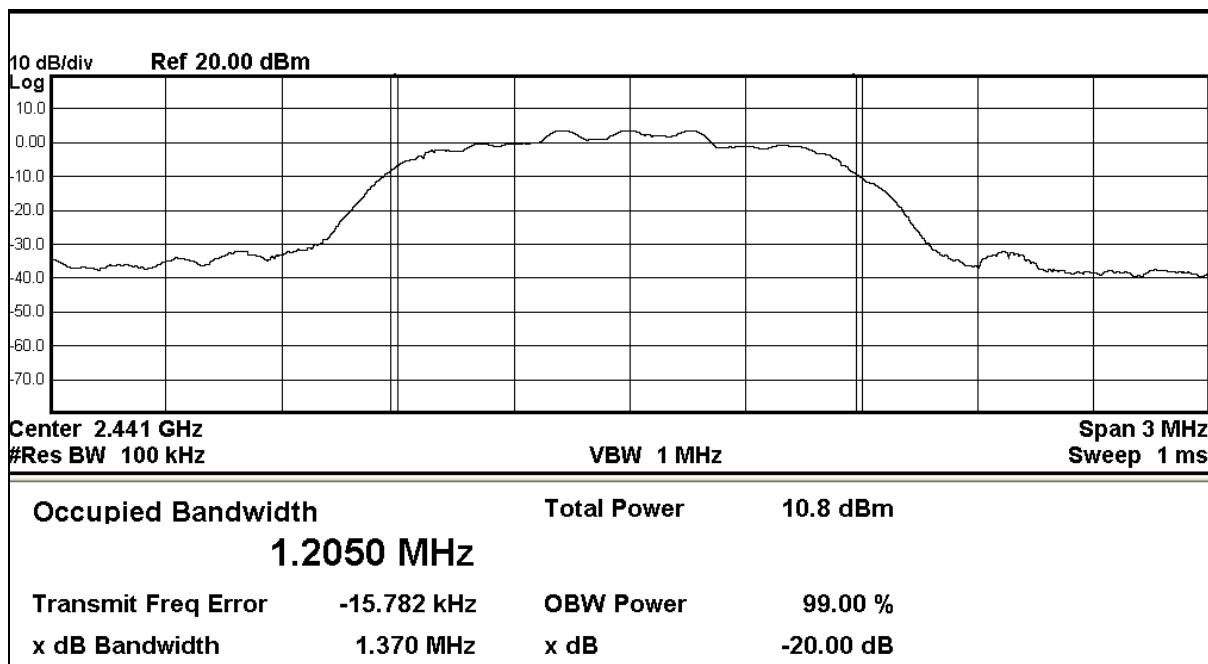
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2441 | 1.37 | Within 2400-2483.5 |

(Middle Operating Frequency) - (8DPSK)



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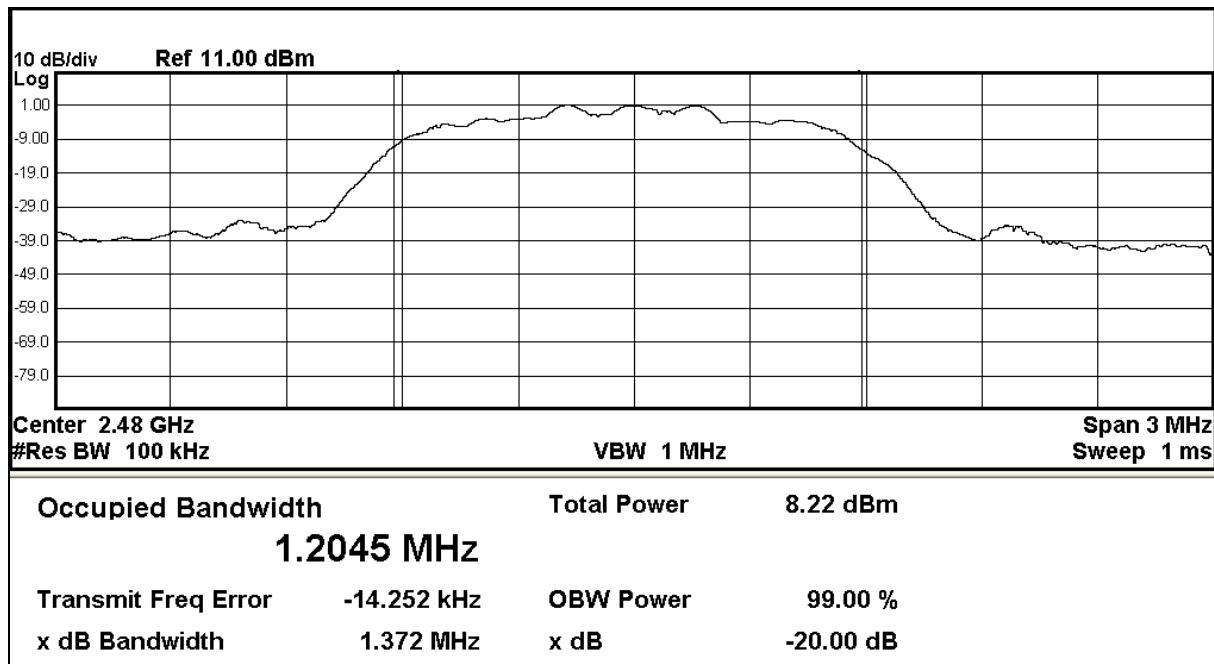
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| Fundamental Frequency [MHz] | 20dB Bandwidth [MHz] | FCC Limits [MHz] |
|--------------------------------|-------------------------|---------------------|
| 2480 | 1.37 | Within 2400-2483.5 |

(Highest Operating Frequency) - (8DPSK)



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3.1.6 Hopping Channel Separation

Ambient temperature 25°C

Relative humidity 57%

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 = 30kHz, VBW \geq RBW, Sweep = Auto,
Span = Wide enough to capture the peaks of two adjacent channels
Detector = Peak, Trace = Max. hold

Limit:

GFSK: The measured maximum bandwidth * 2/3 = 1.10MHz * 2/3 = 733.3kHz

$\pi/4$ DQPSK: The measured maximum bandwidth * 2/3 = 1.37MHz * 2/3 = 913.3kHz

8DPSK: The measured maximum bandwidth * 2/3 = 1.37MHz * 2/3 = 913.3MHz

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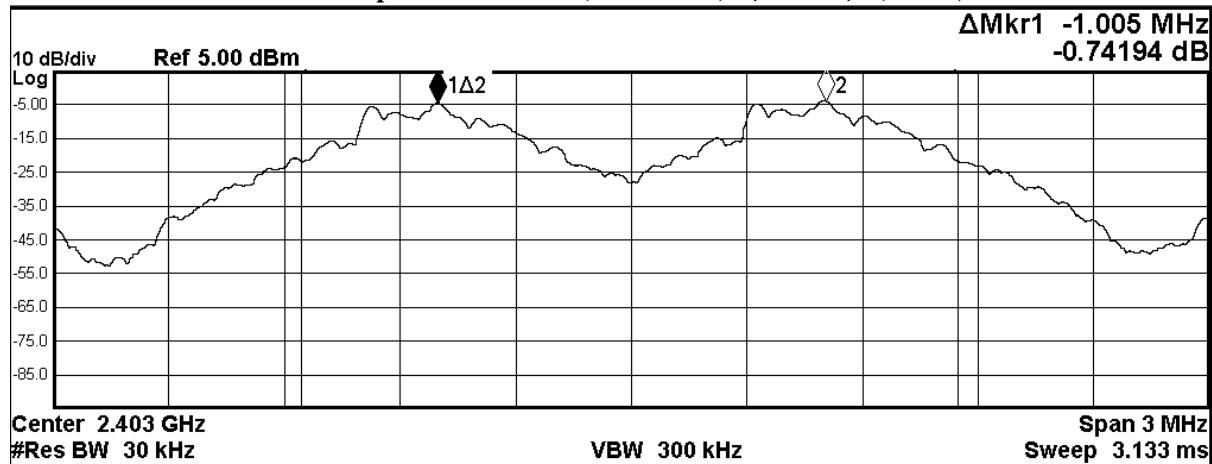
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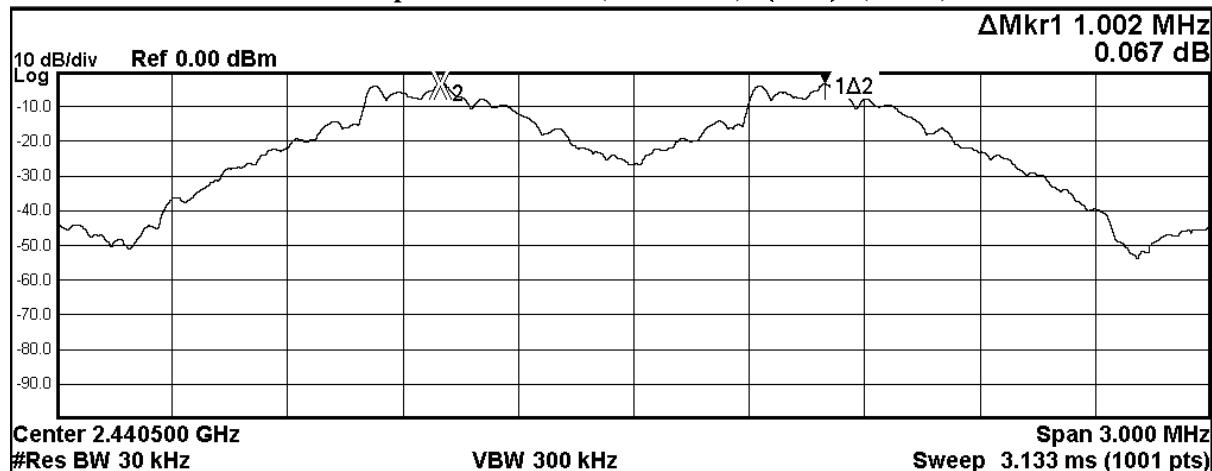
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Channel separation = 1MHz (>2/3 of BW) (Lowest) (GFSK)



Channel separation = 1MHz (>2/3 of BW) (Mid) (GFSK)



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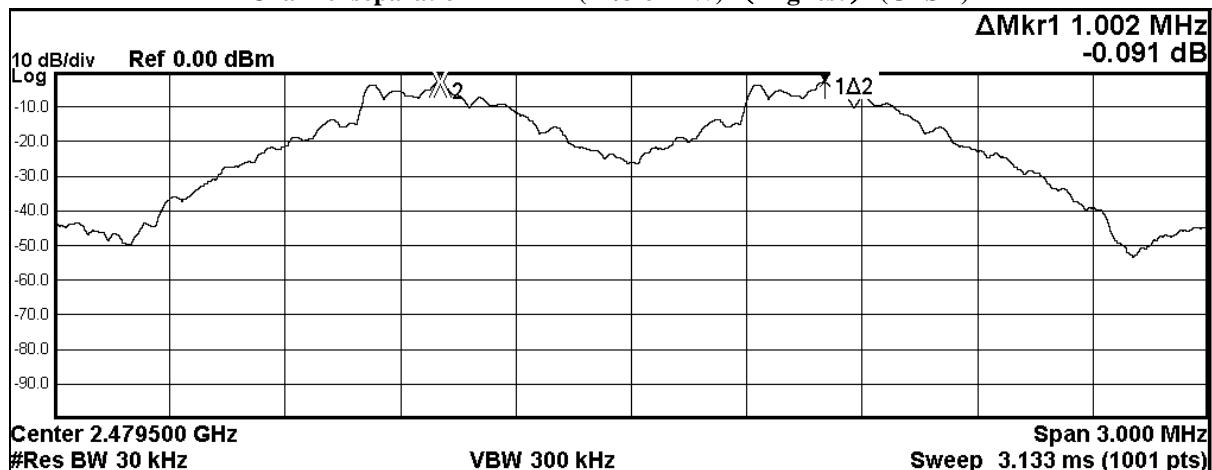
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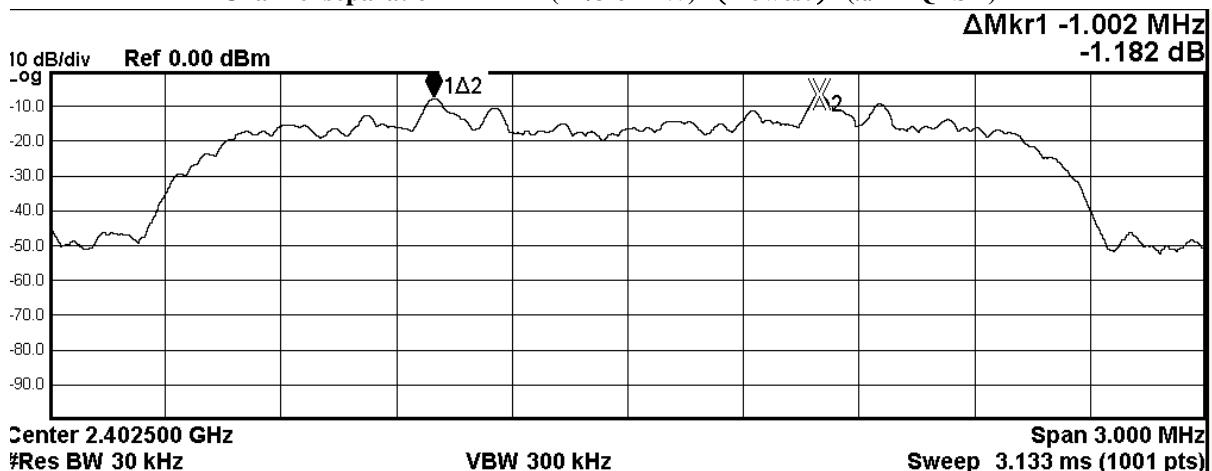
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Channel separation = 1MHz (>2/3 of BW) (Highest) (GFSK)



Channel separation = 1MHz (>2/3 of BW) (Lowest) ($\pi/4$ DQPSK)



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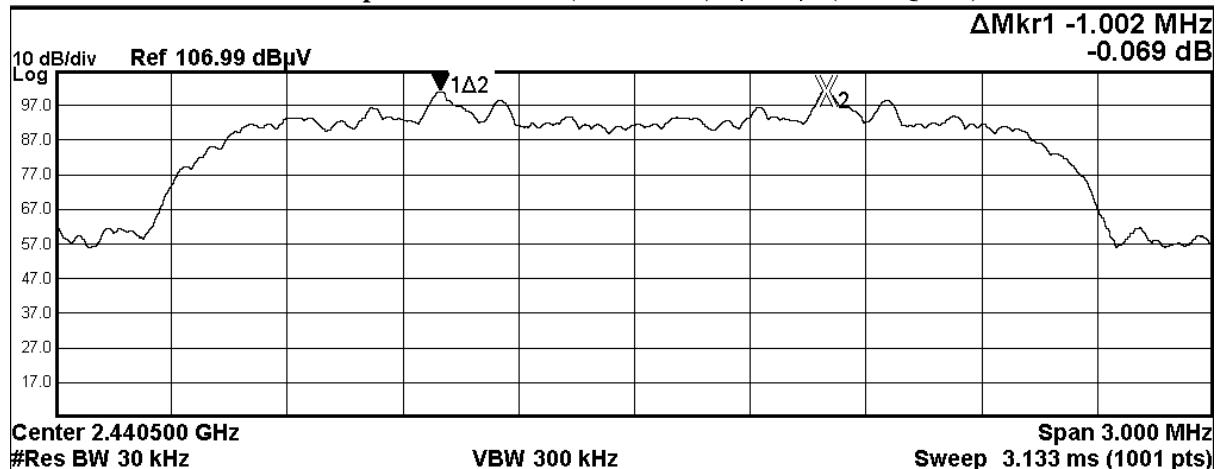
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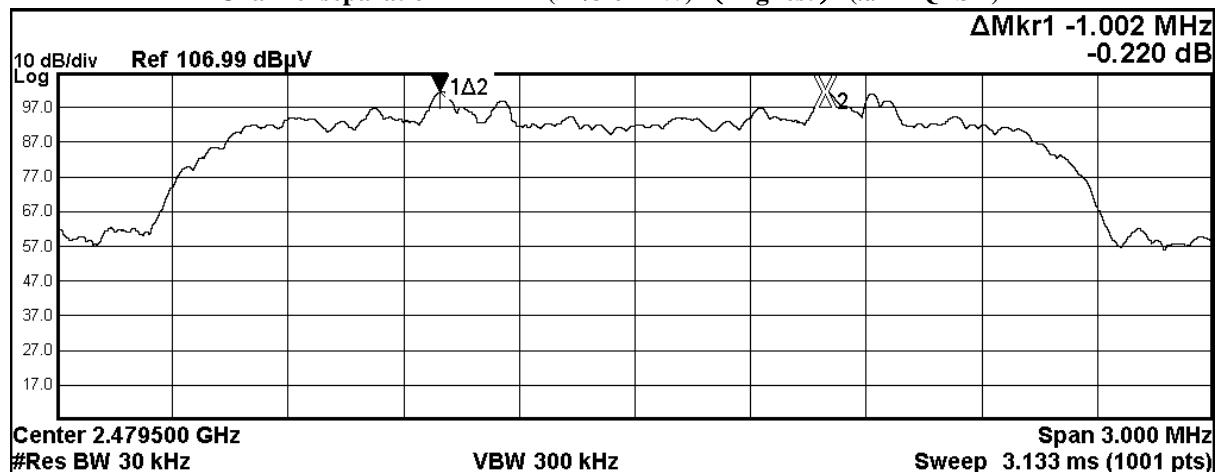
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Channel separation = 1MHz (>2/3 of BW) (Mid) ($\pi/4$ DQPSK)



Channel separation = 1MHz (>2/3 of BW) (Highest) ($\pi/4$ DQPSK)



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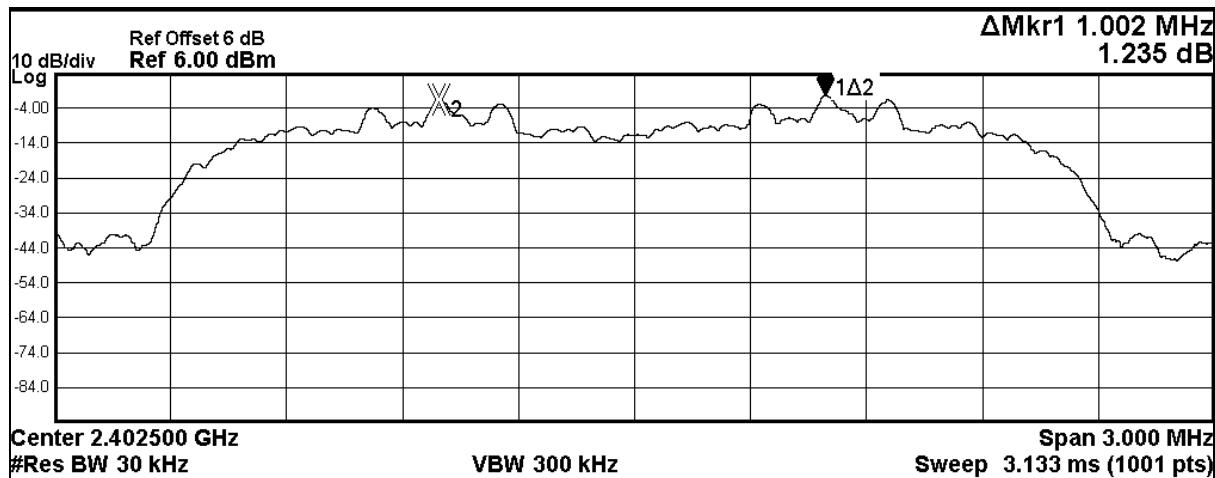
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Date : 2018-05-15

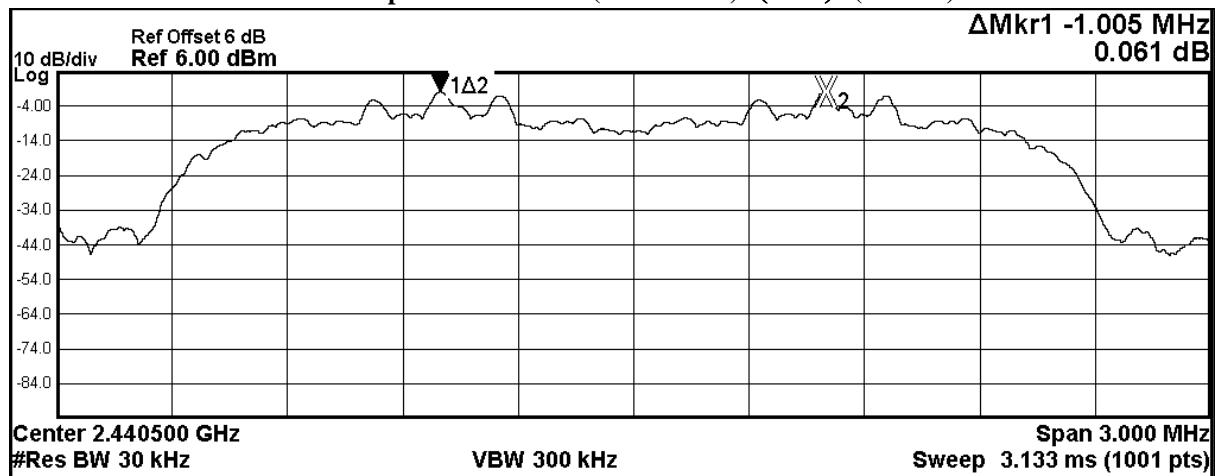
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Channel separation = 1MHz (>2/3 of BW) (Lowest) (8DPSK)



Channel separation = 1MHz (>2/3 of BW) (Mid) (8DPSK)



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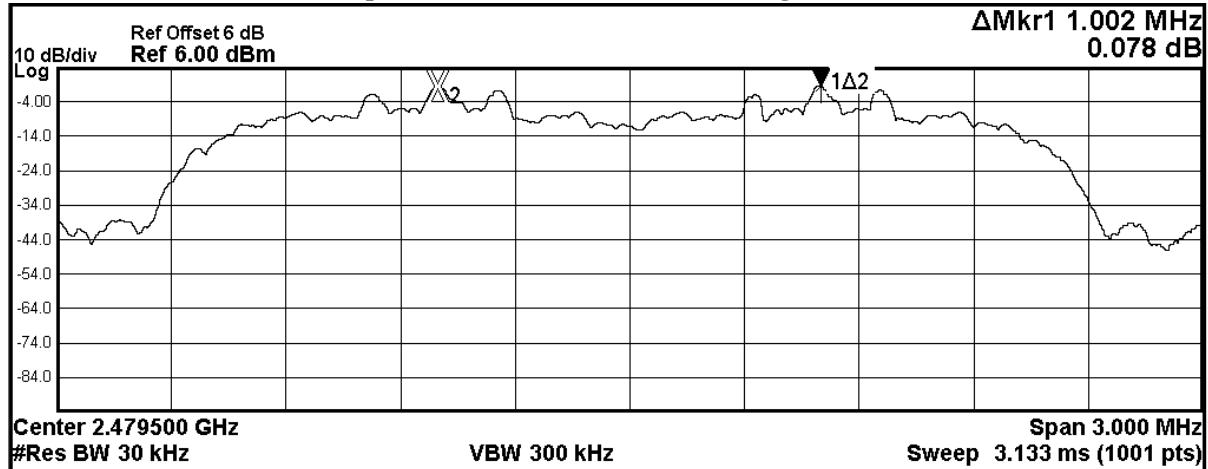
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Channel separation = 1MHz (>2/3 of BW) (Highest) (8DPSK)



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3.1.7 Band-edge Emissions Measurement:

Ambient temperature 25°C

Relative humidity 57%

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.

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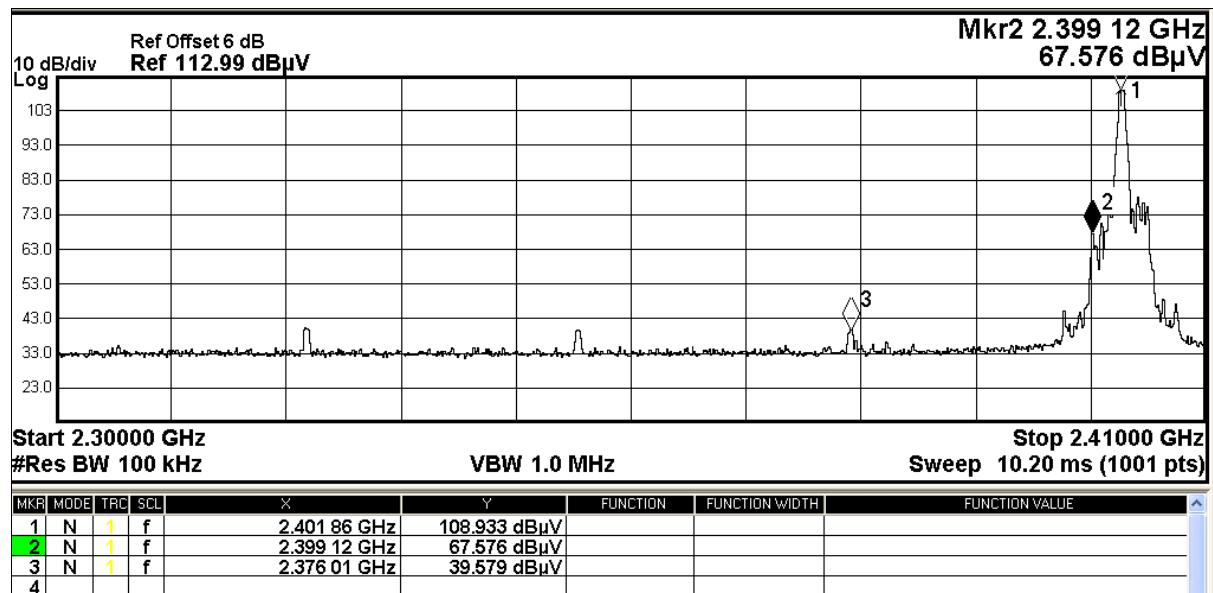
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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|----------------------------------|--|
| 2400 – Lowest Fundamental (2402) | 41.4 |

Conducted Band-edge Compliance Measurement, GFSK (Hopping Off) – Lower Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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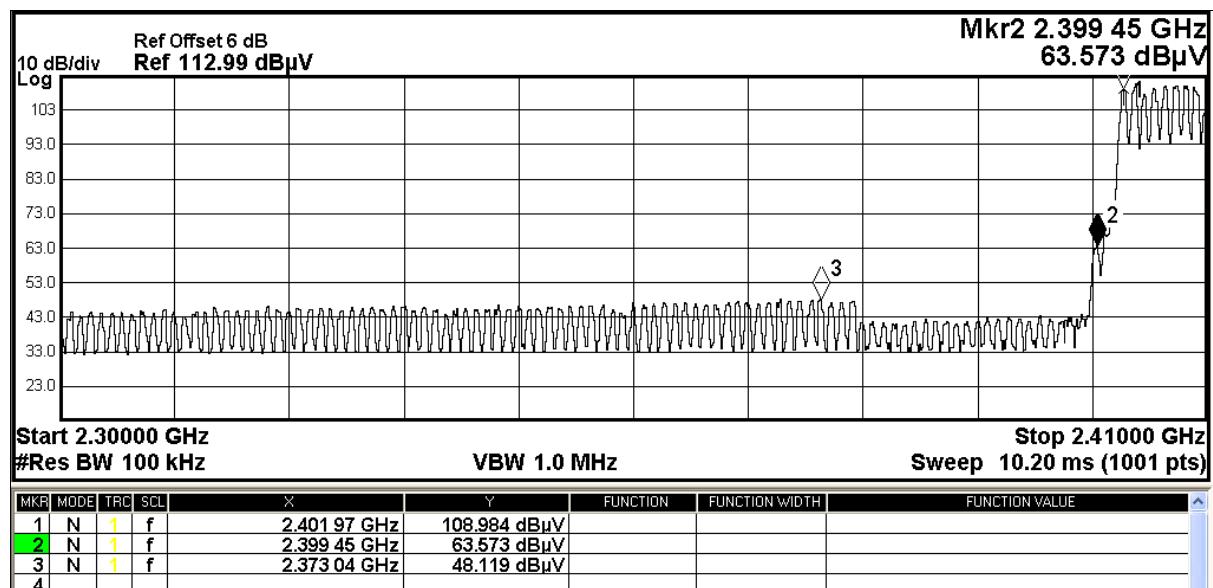
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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|----------------------------------|--|
| 2400 – Lowest Fundamental (2402) | 45.4 |

Conducted Band-edge Compliance Measurement, GFSK (Hopping On) – Lower Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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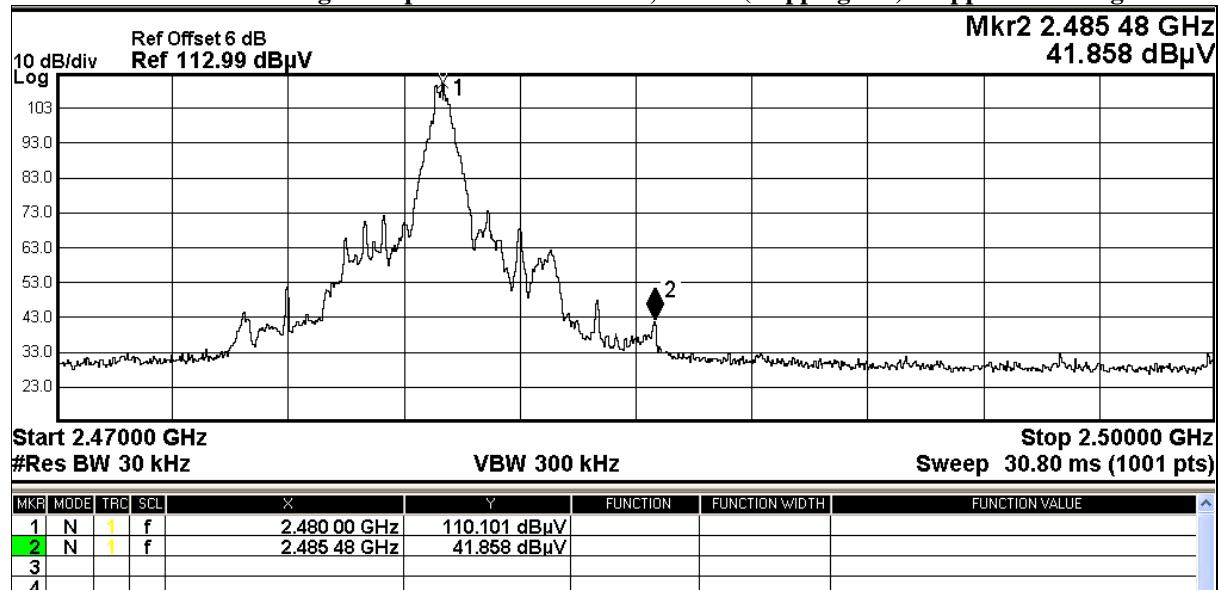
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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|-------------------------------------|--|
| 2483.5 - Highest Fundamental (2480) | 68.2 |

Conducted Band-edge Compliance Measurement, GFSK (Hopping Off) – Upper Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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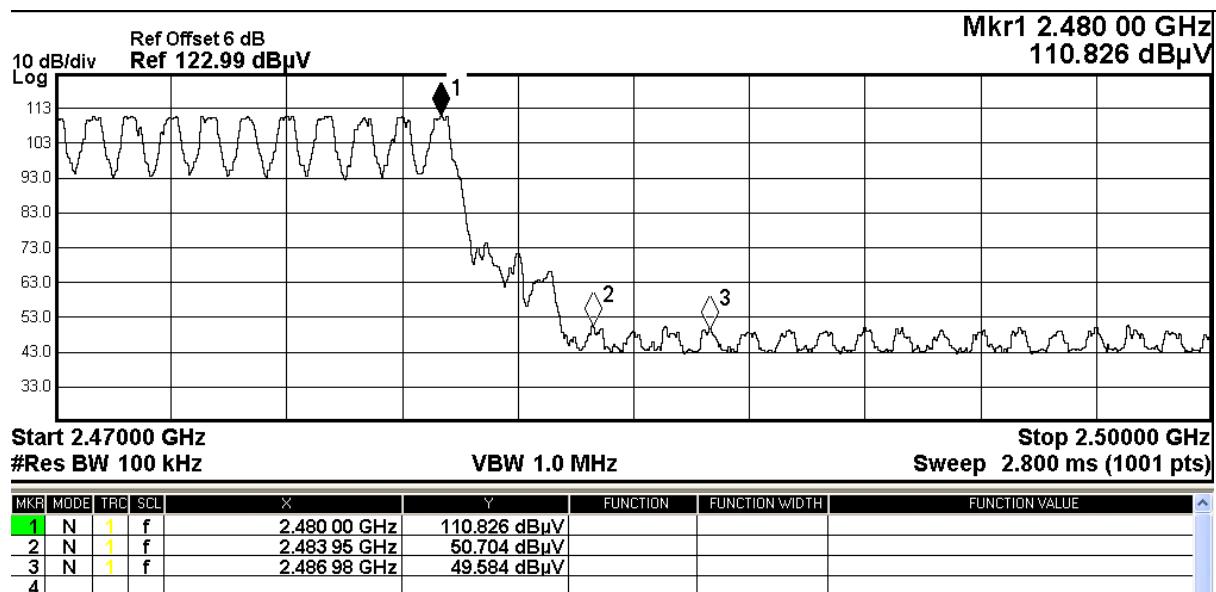
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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|-------------------------------------|--|
| 2483.5 - Highest Fundamental (2480) | 60.1 |

Conducted Band-edge Compliance Measurement, GFSK (Hopping On) – Upper Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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Date : 2018-05-15

No. : HM18040022

Band-edge Emissions Measurement:

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Result: Radiated Emissions Band-edge and Restricted Band - GFSK

| Field Strength of Band-edge Compliance 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 |
| 2376.0 | 10.4 | 27.9 | 38.3 | 74.0 | 35.7 | Horizontal |
| 2373.0 | 16.7 | 27.9 | 44.6 | 74.0 | 29.4 | Horizontal |
| 2485.5 | 9.7 | 27.9 | 37.6 | 74.0 | 36.4 | Horizontal |
| 2487.0 | 16.8 | 27.9 | 44.7 | 74.0 | 29.3 | Horizontal |

| Field Strength of Band-edge Compliance 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 |
| 2376.0 | 4.3 | 27.9 | 32.2 | 54.0 | 21.8 | Horizontal |
| 2373.0 | 6.7 | 27.9 | 34.6 | 54.0 | 19.4 | Horizontal |
| 2485.5 | 3.7 | 27.9 | 31.6 | 54.0 | 22.4 | Horizontal |
| 2487.0 | 6.8 | 27.9 | 34.7 | 54.0 | 19.3 | Horizontal |

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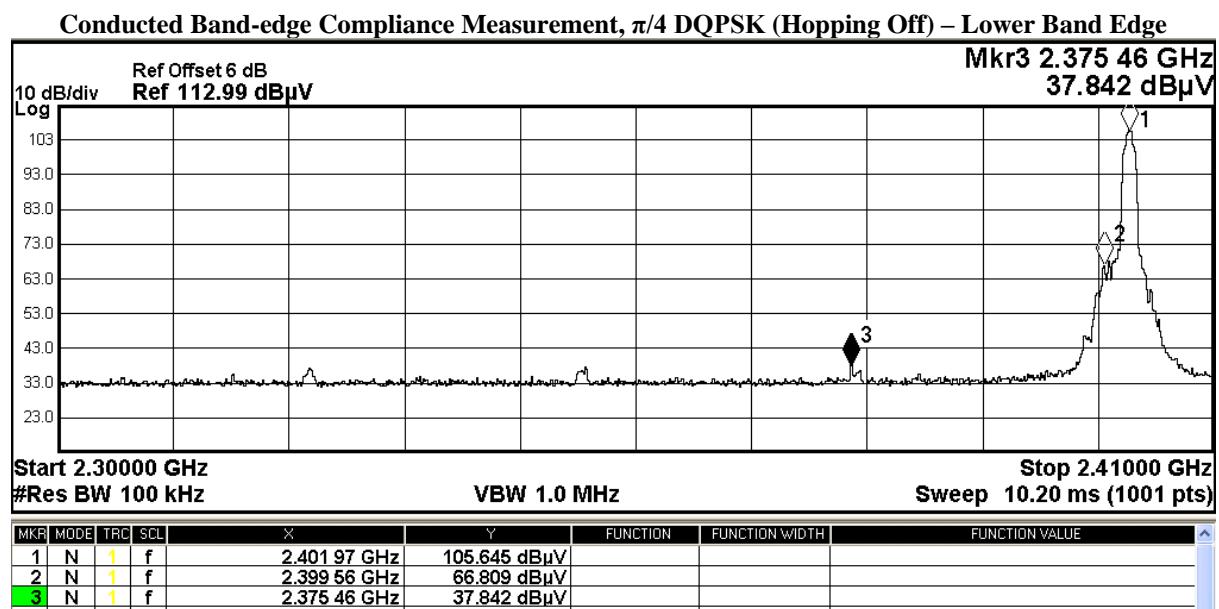


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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|----------------------------------|--|
| 2400 – Lowest Fundamental (2402) | 38.8 |



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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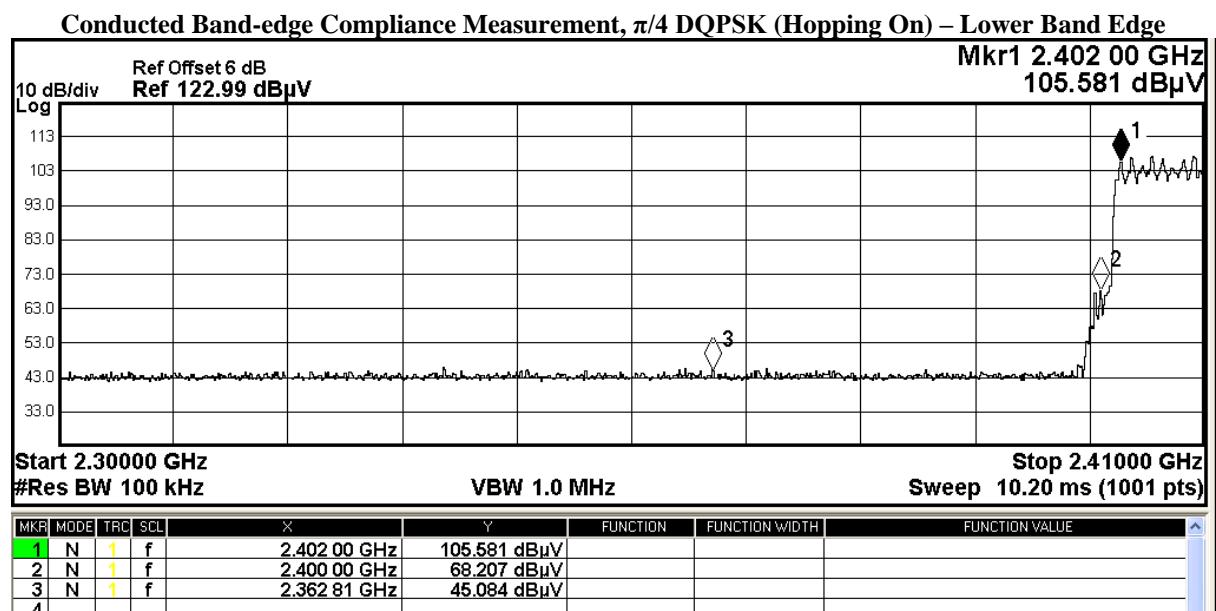


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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|----------------------------------|--|
| 2400 – Lowest Fundamental (2402) | 37.4 |



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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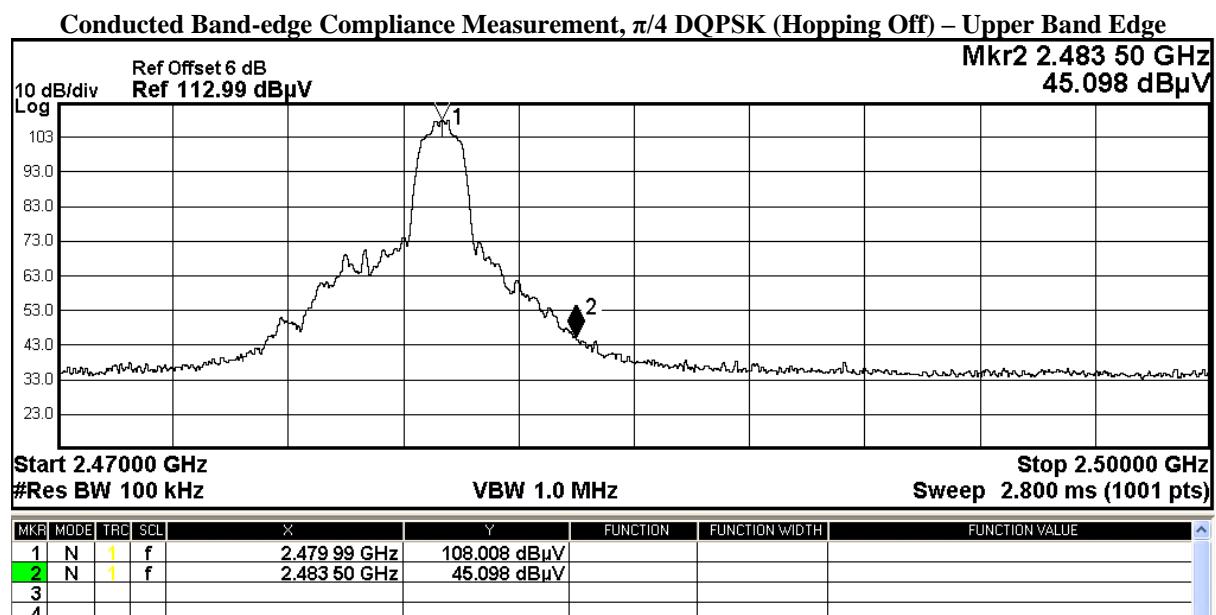


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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|-------------------------------------|--|
| 2483.5 - Highest Fundamental (2480) | 62.9 |



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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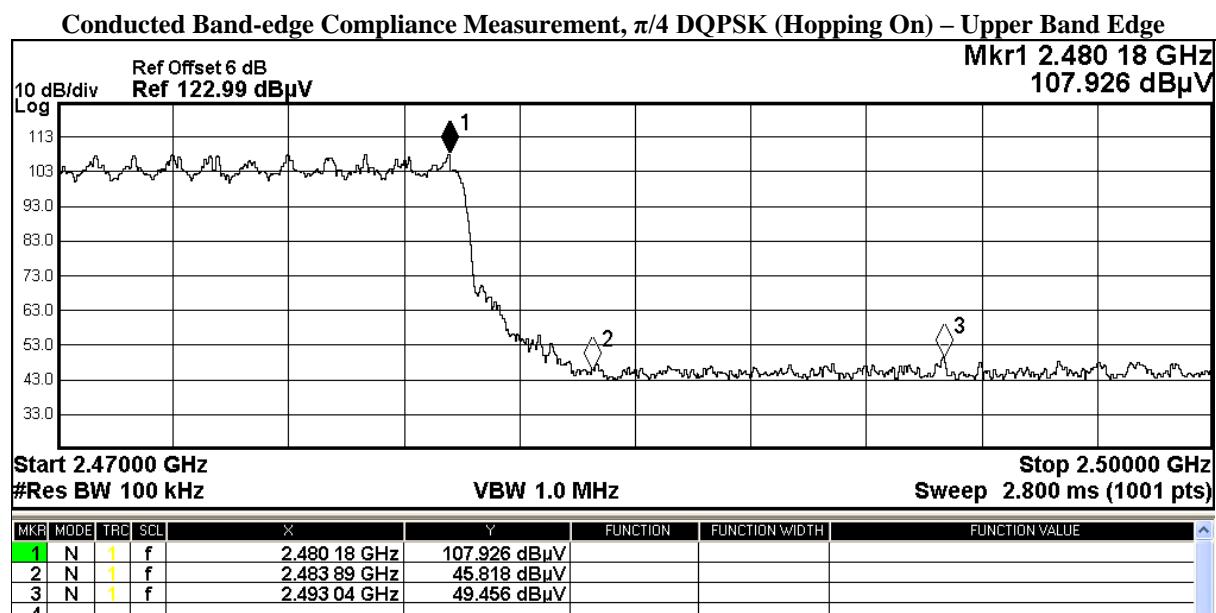


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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|-------------------------------------|--|
| 2483.5 - Highest Fundamental (2480) | 62.1 |



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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Test Report

Date : 2018-05-15

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Band-edge Emissions Measurement:

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Result: Radiated Emissions Band-edge and Restricted Band - $\pi/4$ DQPSK

| Field Strength of Band-edge Compliance 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 |
| 2375.5 | 8.3 | 27.9 | 36.2 | 74.0 | 37.8 | Horizontal |
| 2362.8 | 14.5 | 27.9 | 42.4 | 74.0 | 31.6 | Horizontal |
| 2483.5 | 13.7 | 27.9 | 41.6 | 74.0 | 32.4 | Horizontal |
| 2493.0 | 18.8 | 27.9 | 46.7 | 74.0 | 27.3 | Horizontal |

| Field Strength of Band-edge Compliance AverageValue | | | | | | |
|--|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dB | E-Field Polarity |
| 2375.5 | 2.8 | 27.9 | 30.7 | 54.0 | 23.3 | Horizontal |
| 2362.8 | 4.2 | 27.9 | 32.1 | 54.0 | 21.9 | Horizontal |
| 2483.5 | 5.3 | 27.9 | 33.2 | 54.0 | 20.8 | Horizontal |
| 2493.0 | 8.7 | 27.9 | 36.6 | 54.0 | 17.4 | Horizontal |

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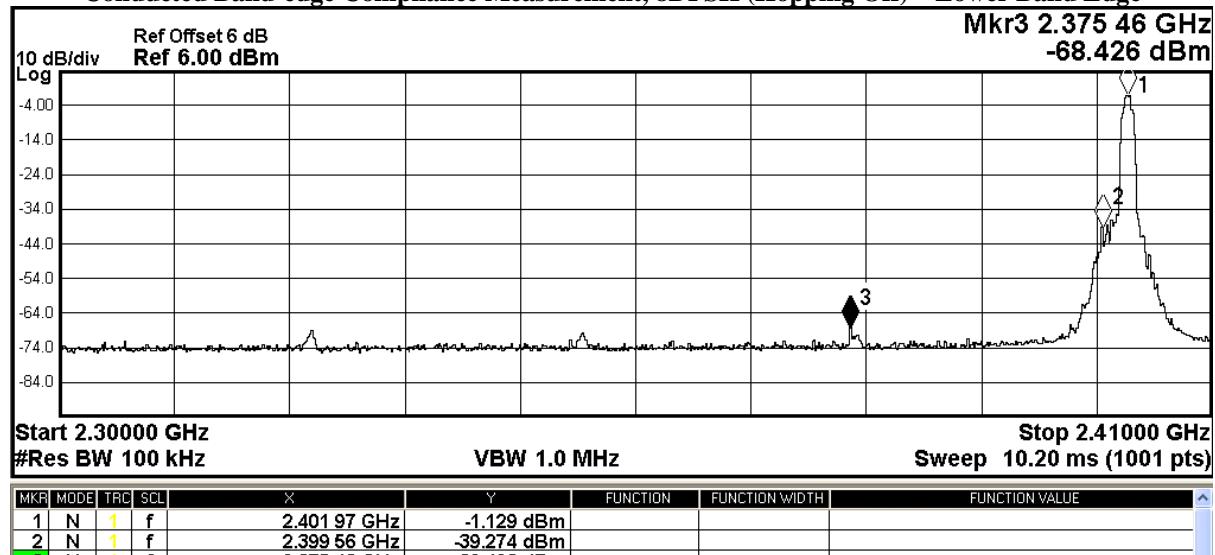
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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|----------------------------------|--|
| 2400 – Lowest Fundamental (2402) | 38.1 |

Conducted Band-edge Compliance Measurement, 8DPSK (Hopping Off) – Lower Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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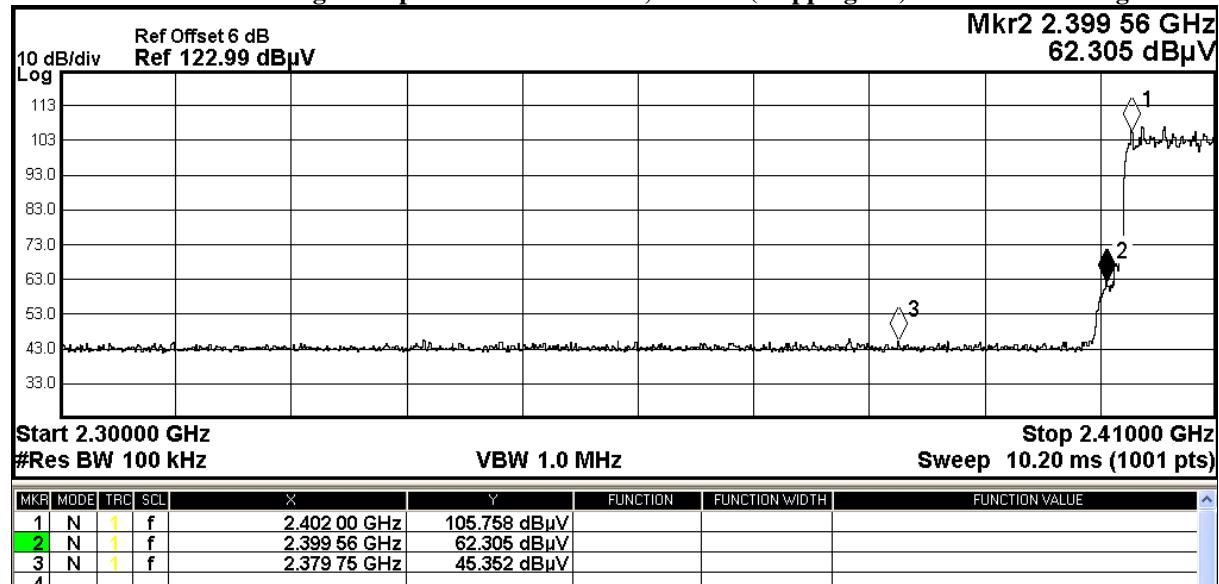
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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|----------------------------------|--|
| 2400 – Lowest Fundamental (2402) | 43.5 |

Conducted Band-edge Compliance Measurement, 8DPSK (Hopping On) – Lower Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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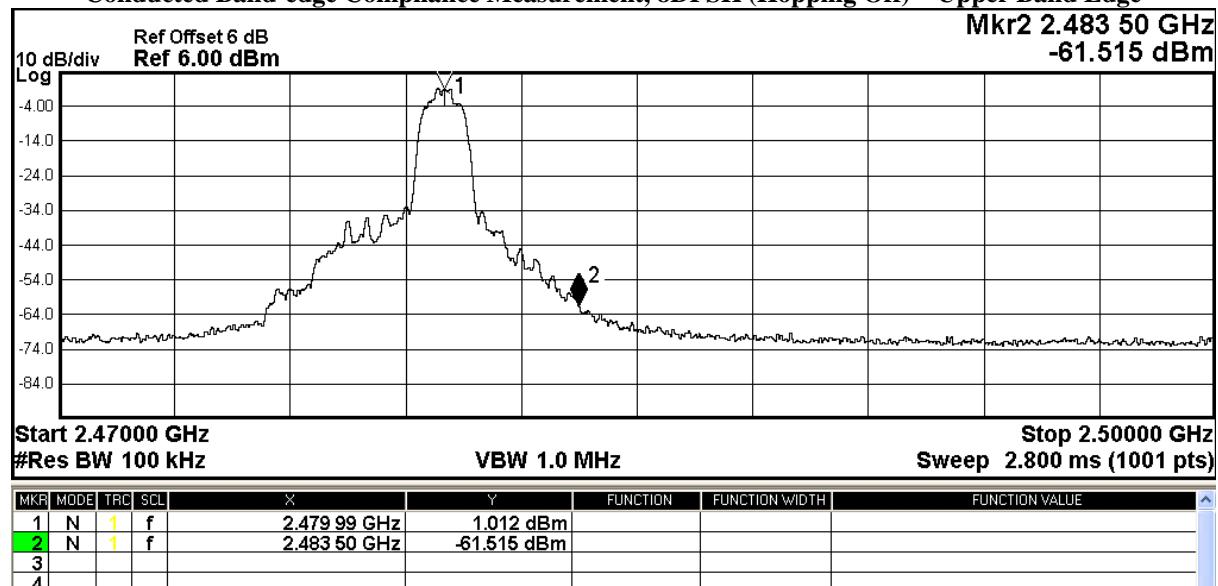
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| Frequency Range [MHz] | Conducted Emission Attenuate below the Fundamental [dB] |
|-------------------------------------|--|
| 2483.5 - Highest Fundamental (2480) | 62.5 |

Conducted Band-edge Compliance Measurement, 8DPSK (Hopping Off) – Upper Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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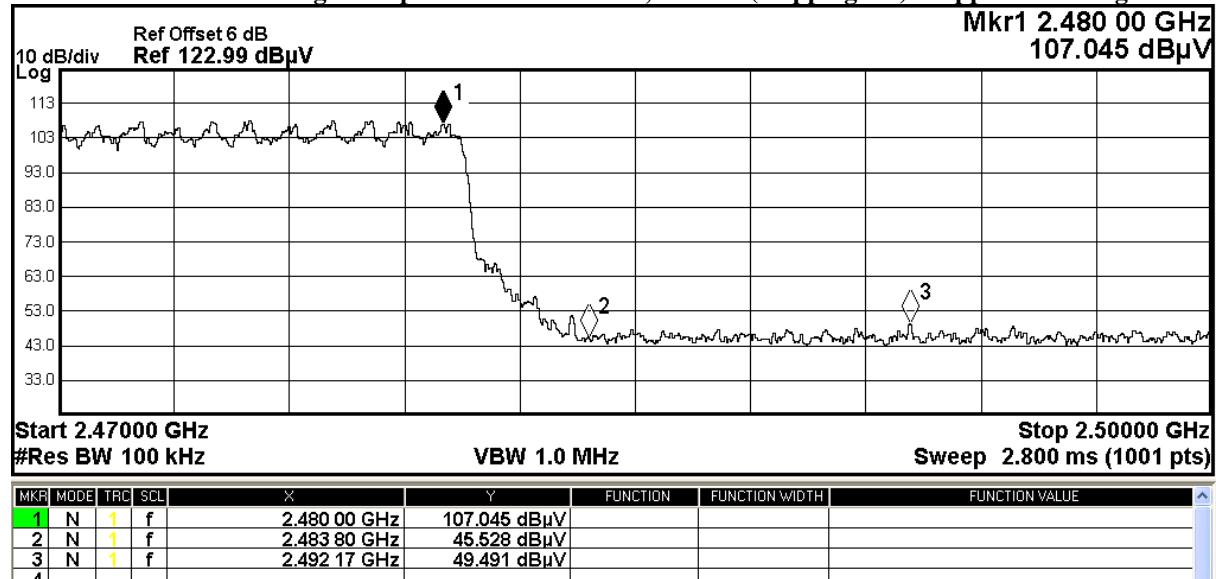
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| Frequency Range [MHz] | Conducted Emission Attenuated below the Fundamental [dB] |
|-------------------------------------|--|
| 2483.5 - Highest Fundamental (2480) | 61.5 |

Conducted Band-edge Compliance Measurement, 8DPSK (Hopping On) – Upper Band Edge



Remark: The 6dB offset of the received level was set improperly, the measured level should be minus 6dB.

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Band-edge Emissions Measurement:

Result: Radiated Emissions Band-edge and Restricted Band- 8DPSK

| Field Strength of Band-edge Compliance 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 |
| 2375.5 | 21.4 | 27.9 | 45.2 | 74.0 | 28.8 | Horizontal |
| 2379.8 | 18.7 | 27.9 | 42.6 | 74.0 | 31.4 | Horizontal |
| 2483.5 | 18.1 | 27.9 | 42.1 | 74.0 | 31.9 | Horizontal |
| 2492.2 | 23.4 | 27.9 | 46.8 | 74.0 | 27.2 | Horizontal |

| Field Strength of Band-edge Compliance AverageValue | | | | | | |
|--|-------------------------------|------------------------------|-----------------------------|------------------------|--------------|---------------------|
| Frequency MHz | Measured Level @3m dBuV | Correction Factor dB/m | Field Strength dBuV/m | Limit @3m dBuV/m | Margin dB | E-Field Polarity |
| 2375.5 | 7.4 | 27.9 | 35.3 | 54.0 | 18.7 | Horizontal |
| 2379.8 | 6.2 | 27.9 | 34.1 | 54.0 | 19.9 | Horizontal |
| 2483.5 | 5.8 | 27.9 | 33.7 | 54.0 | 20.3 | Horizontal |
| 2492.2 | 10.1 | 27.9 | 38.0 | 54.0 | 16.0 | Horizontal |

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3.1.8 Time of Occupancy (Dwell Time)

Ambient temperature 25°C

Relative humidity 57%

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 \geq RBW,

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

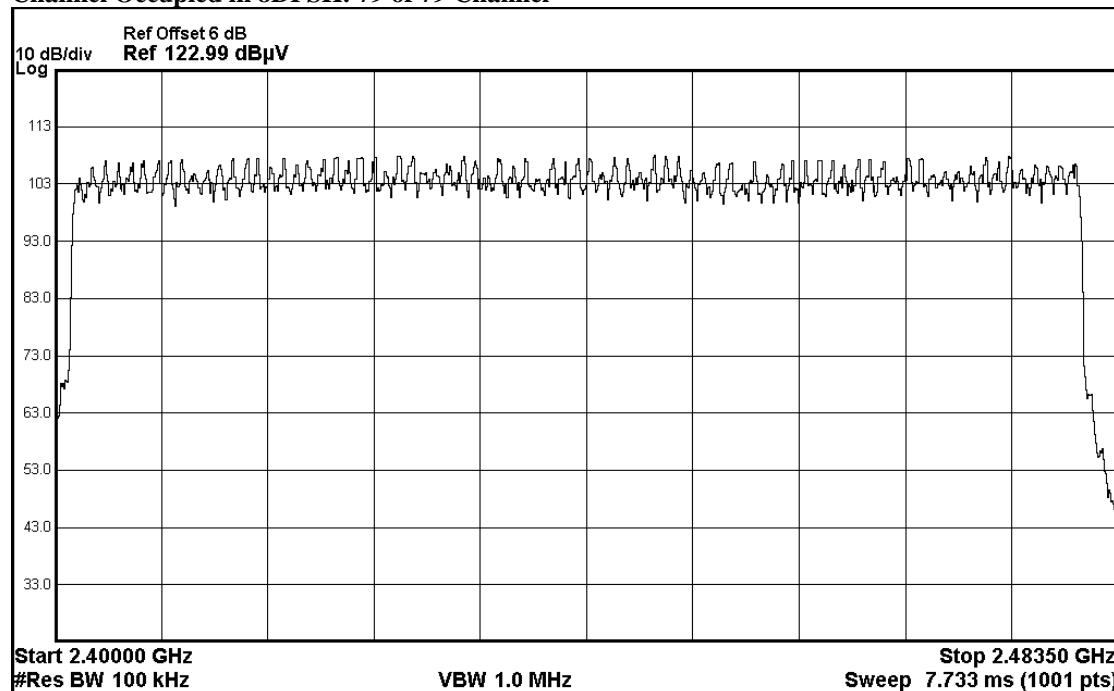
Span = Zero, Detector = Peak, Trace = Max. hold

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

Observed duration: 0.4s x 79 = 31.6s

Measurement Data:

Channel Occupied in 8DPSK: 79 of 79 Channel



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DH5 Packet:

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DH5 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]

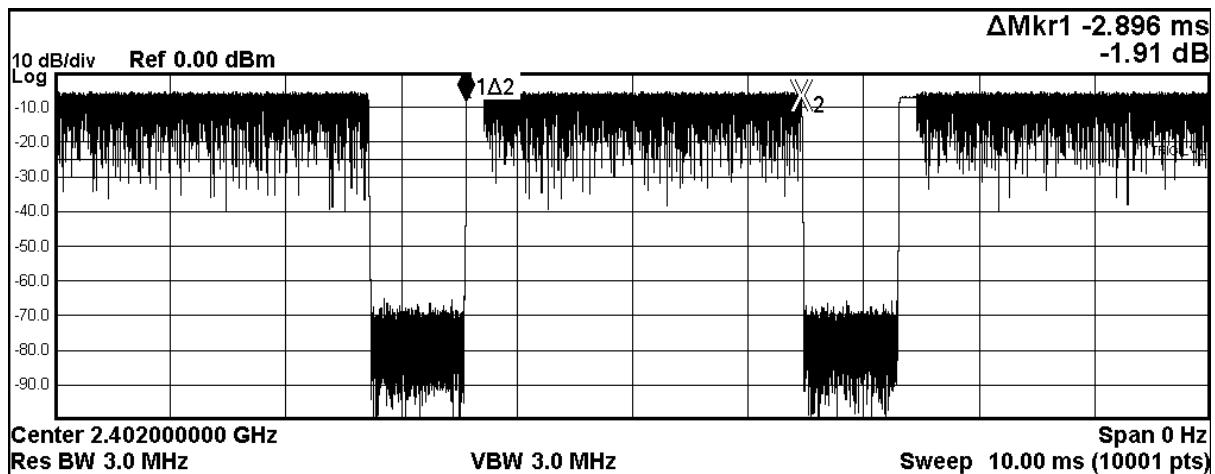
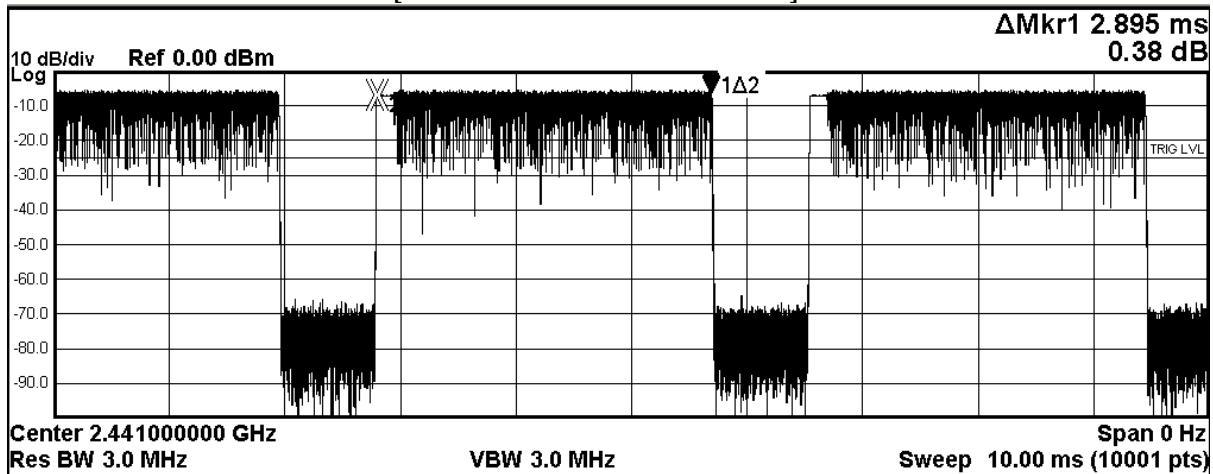


Fig. B
[Pulse duration of Middle Channel]



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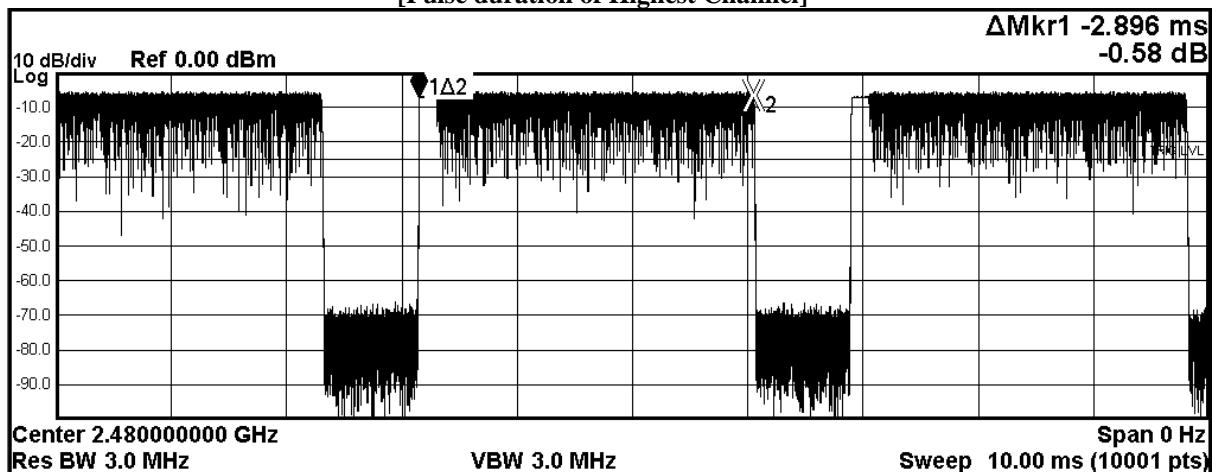


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Fig. C
[Pulse duration of Highest Channel]



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DH3 Packet:

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DH3 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]

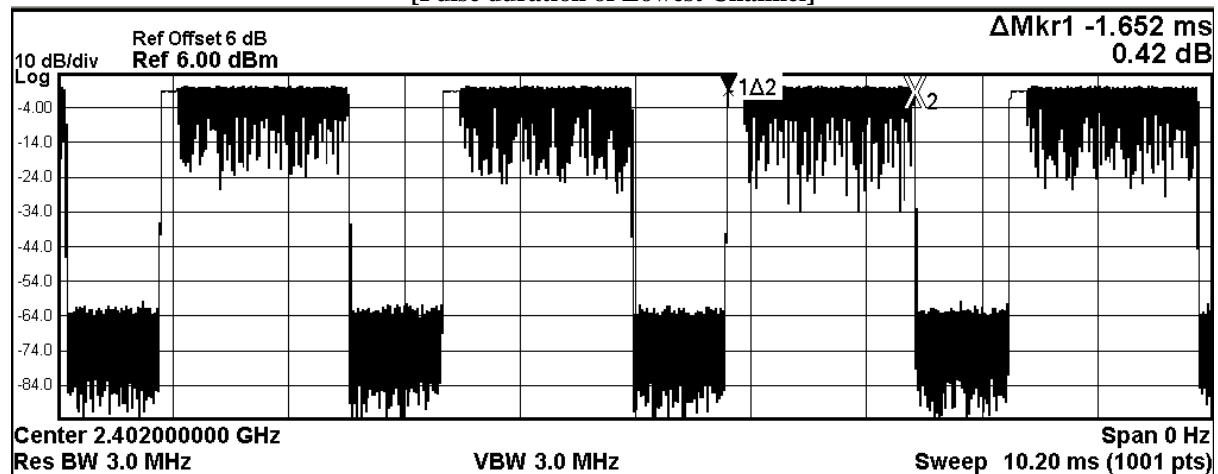
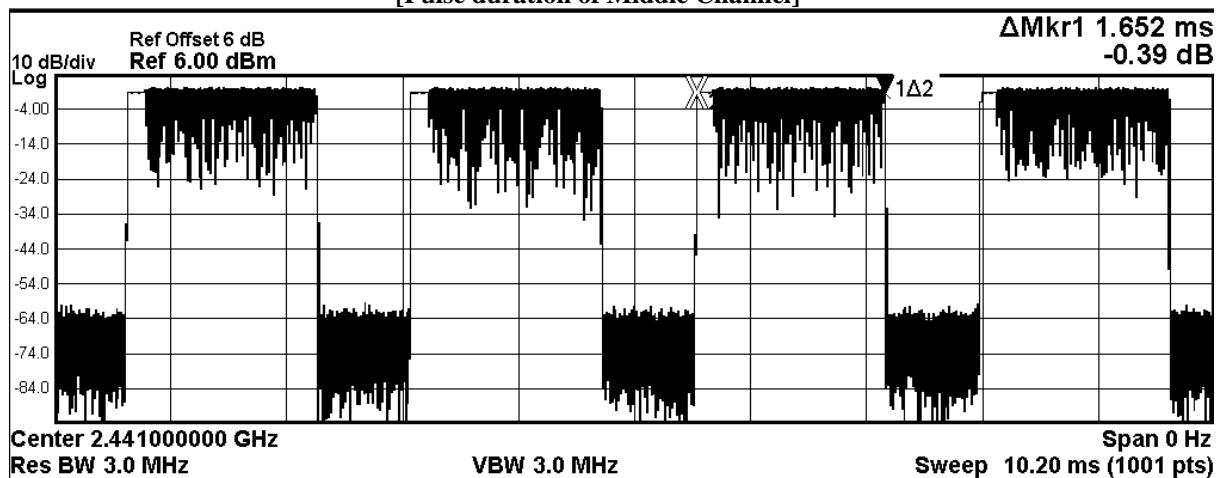


Fig. E
[Pulse duration of Middle Channel]



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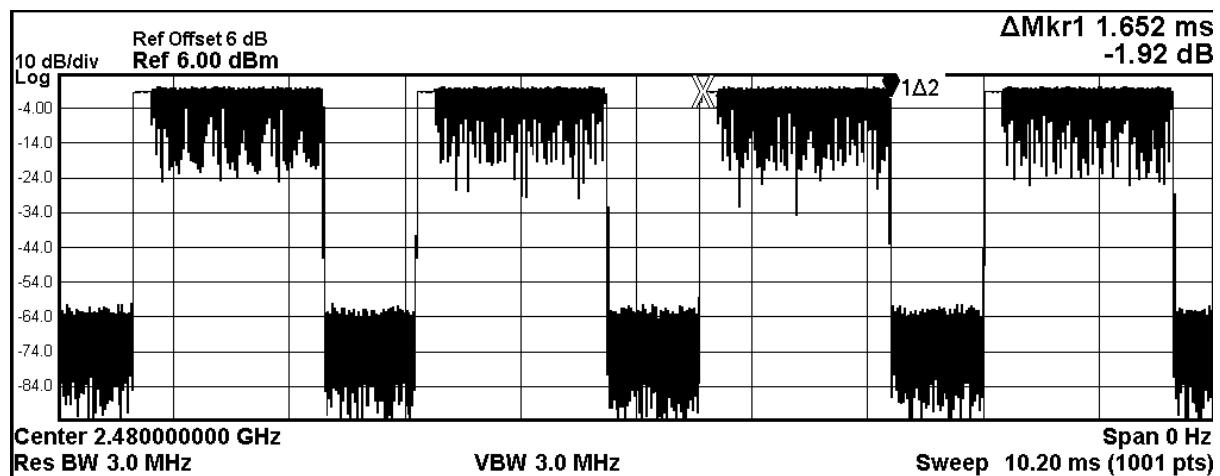


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Fig. F
[Pulse duration of Highest Channel]



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DH1 Packet:

DH1 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]

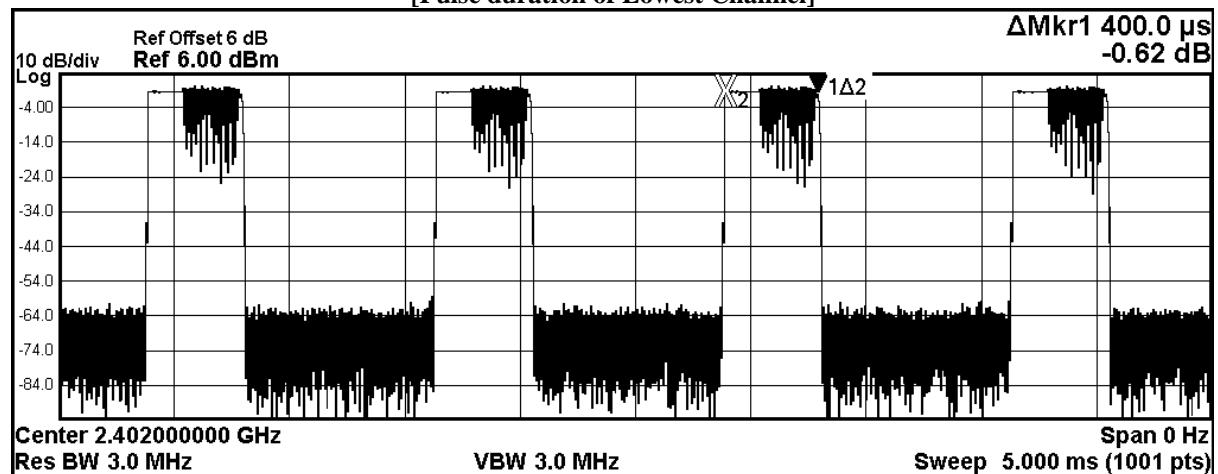
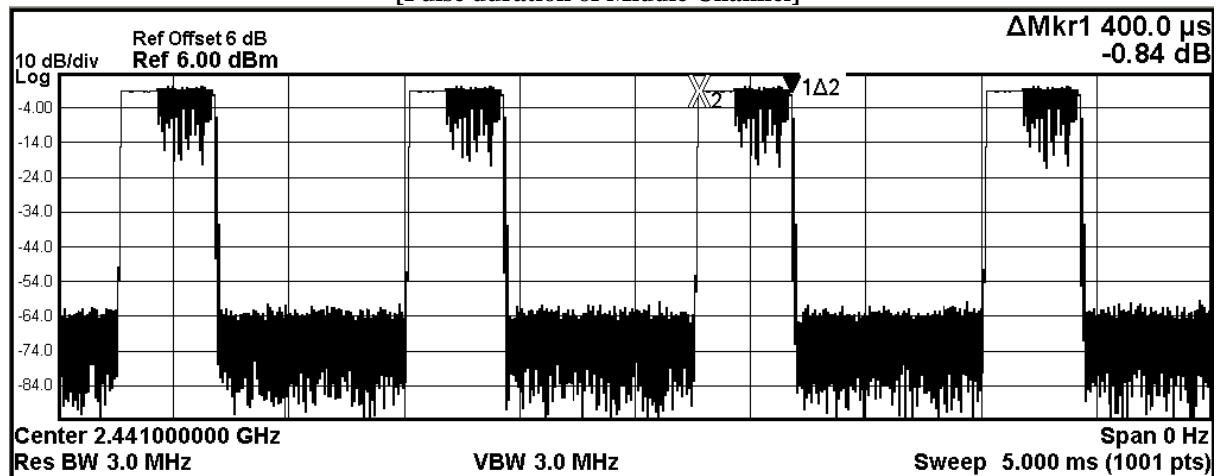


Fig. H
[Pulse duration of Middle Channel]



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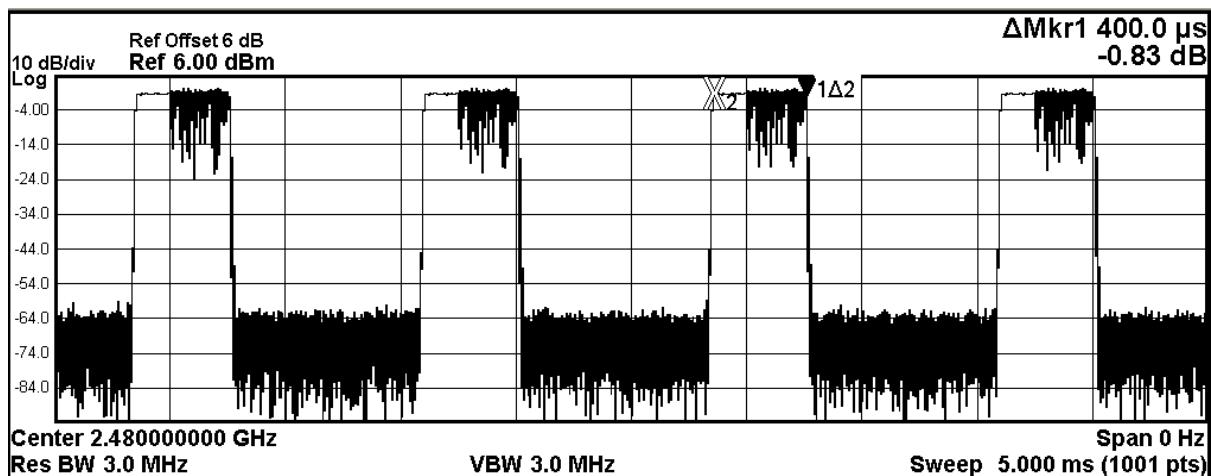
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Fig. I
 [Pulse duration of Highest Channel]



Time of occupancy (Dwell Time):

| Data Packet | Frequency (MHz) | Pulse Duration (ms) | Dwell Time (s) | Limits (s) | Test Results |
|-------------|-----------------|---------------------|----------------|------------|--------------|
| DH5 | 2402 | 2.896 | 0.308 | 0.400 | Complies |
| DH5 | 2441 | 2.895 | 0.308 | 0.400 | Complies |
| DH5 | 2480 | 2.896 | 0.308 | 0.400 | Complies |
| DH3 | 2402 | 1.652 | 0.264 | 0.400 | Complies |
| DH3 | 2441 | 1.652 | 0.264 | 0.400 | Complies |
| DH3 | 2480 | 1.652 | 0.264 | 0.400 | Complies |
| DH1 | 2402 | 0.400 | 0.128 | 0.400 | Complies |
| DH1 | 2441 | 0.400 | 0.128 | 0.400 | Complies |
| DH1 | 2480 | 0.400 | 0.128 | 0.400 | Complies |

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3.1.9 Channel Centre Frequency

Ambient temperature 25°C

Relative humidity 57%

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 = 1,...,79 (Channel separation = 1MHz)

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3.1.10 Pseudorandom Hopping Algorithm

Ambient temperature 25°C

Relative humidity 57%

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 57%

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 Circuit printed meander line antenna. There is no external antenna, the antenna gain = 0.0dBi. 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 | -- | 2018/01/24 | 2019/01/24 |
| EM356 | ANTENNA POSITIONING TOWER | ETS-LINDGREN | 2171B | 00150346 | N/A | N/A |
| EM354 | BICONILOG ANTENNA | ETS-LINDGREN | 3143B | 00142073 | 2018/03/29 | 2020/03/29 |
| EM229 | EMI TEST RECEIVER | R&S | ESIB40 | 100248 | 2018/06/01 | 2019/06/01 |
| EM276 | BROADBAND HORN ANTENNA | A-INFOMW | JXTXLB-10180-SF | J203109090300 | 2018/04/27 | 2020/04/27 |
| EM300 | PYRAMIDAL STANDARD GAIN HORN ANTENNA | ETS-LINDGREN | 3160-09 | 00130130 | 2018/05/13 | 2019/05/13 |
| EM301 | PYRAMIDAL STANDARD GAIN HORN ANTENNA | ETS-LINDGREN | 3160-10 | 00130988 | 2018/05/13 | 2019/05/13 |
| EM302 | PRECISION OMNIDIRECTIONAL DIPOLE (1 – 6GHZ) | SEIBERSDORF LABORATORIES | POD 16 | 161806/L | 2018/05/11 | 2020/05/11 |
| EM303 | PRECISION OMNIDIRECTIONAL DIPOLE (6 – 18GHZ) | SEIBERSDORF LABORATORIES | POD 618 | 6181908/L | 2018/05/11 | 2020/05/11 |
| EM353 | LOOP ANTENNA | ETS_LINDGREN | 6502 | 00206533 | 2018/04/16 | 2020/04/16 |
| EM045 | POWER METER | ROHDE & SCHWARZ | NRVD | 843246/028 | 2017/10/14 | 2018/10/14 |

Line Conducted

| EQP NO. | DESCRIPTION | MANUFACTURER | MODEL NO. | SERIAL NO. | LAST CAL | DUE CAL |
|---------|-------------------------------------|-------------------------------|-----------|-----------------|------------|------------|
| EM119 | LISN | R & S | ESH3-Z5 | 0831.5518.52 | 2017/11/29 | 2018/11/29 |
| EM145 | EMI TEST RECEIVER | R & S | ESCS 30 | 830245/021 | 2018/06/01 | 2019/06/01 |
| EM179 | IMPULSE LIMITER | ROHDE & SCHWARZ | ESH3-Z2 | 357-8810.52/54 | 2018/01/11 | 2019/01/11 |
| EM154 | SHIELDING ROOM | SIEMENS MATSUSHITA COMPONENTS | N/A | 803-740-057-99A | 2017/02/02 | 2022/02/02 |
| N/A | MEASUREMENT AND EVALUATION SOFTWARE | ROHDE & SCHWARZ | BSIB-K1 | V1.20 | N/A | N/A |

Remarks:-

CM Corrective Maintenance
N/A Not Applicable or Not Available
TBD To Be Determined

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Appendix B

Photographs of EUT

Front View of the product



Rear View of the product



Rear View of the product



Rear View of the product



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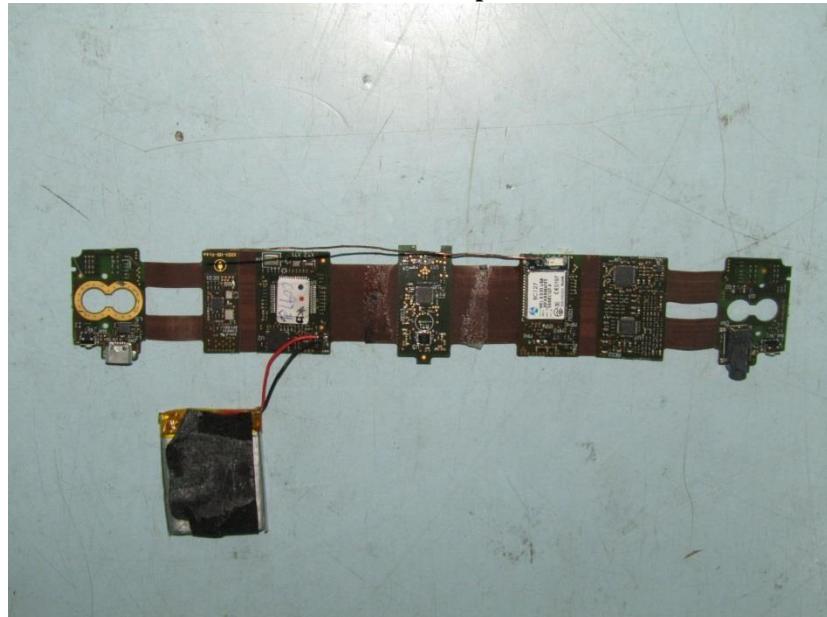
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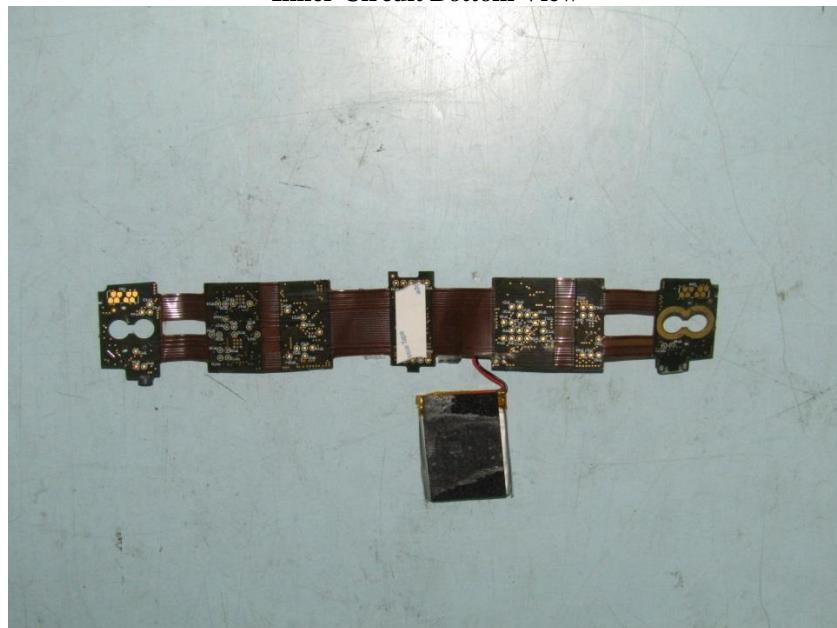
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Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



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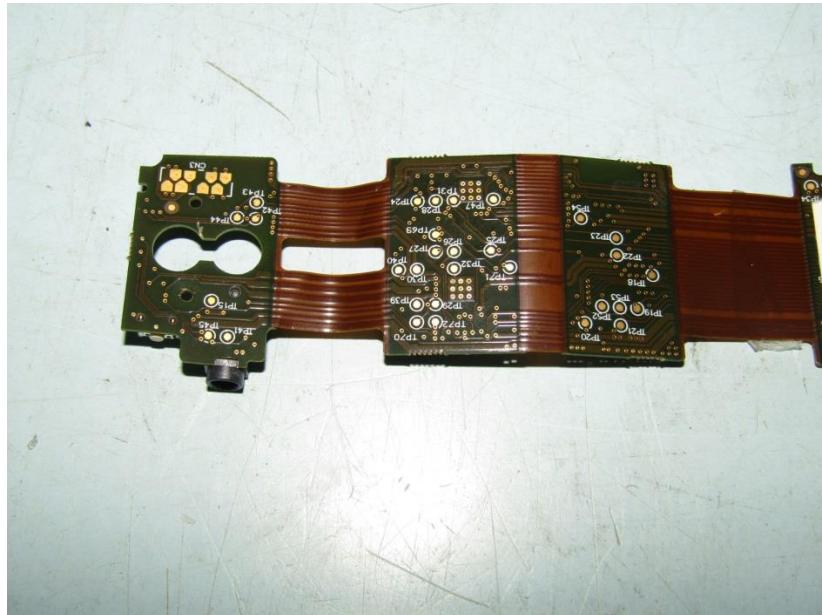
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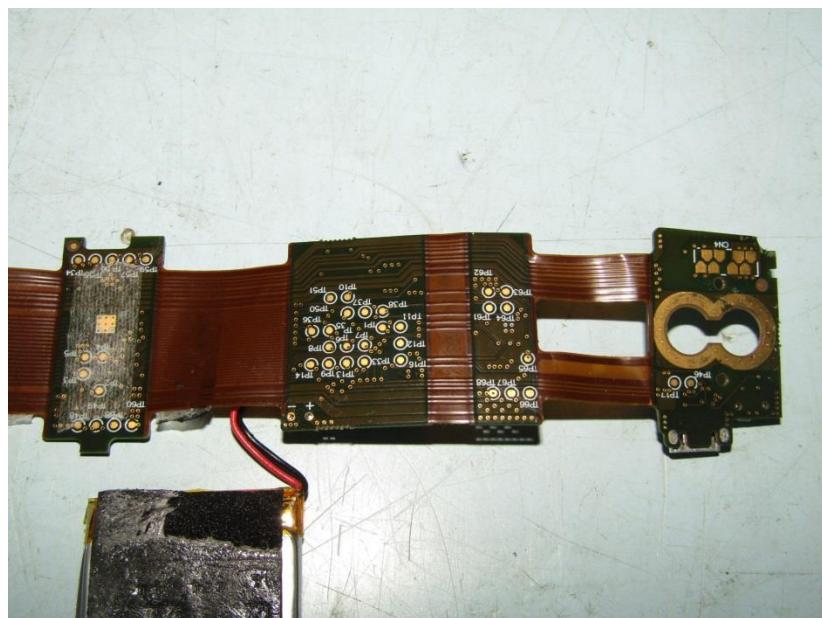
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Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



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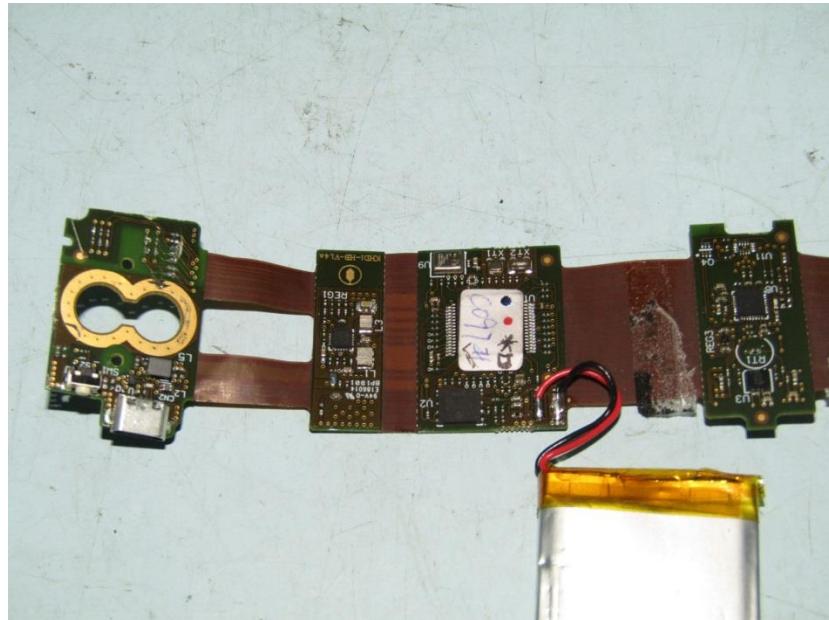
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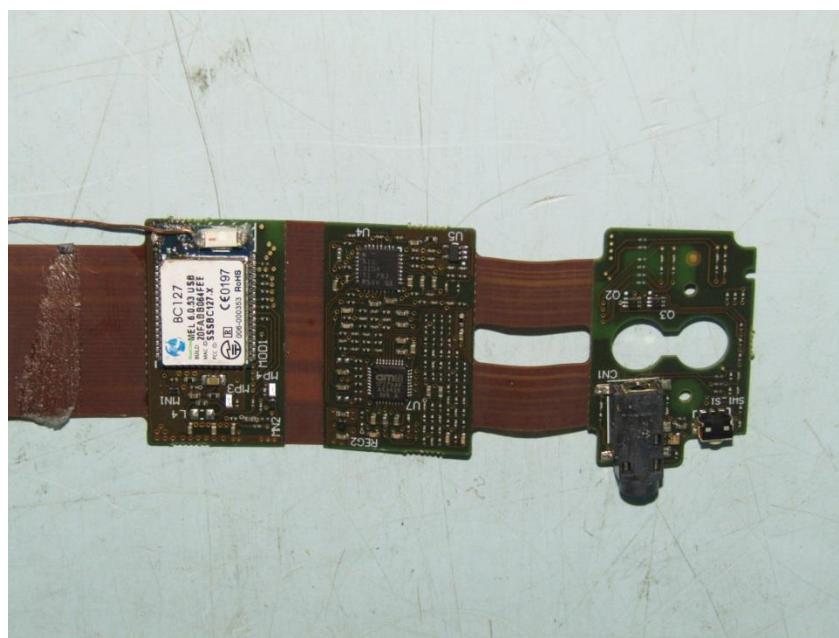
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Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



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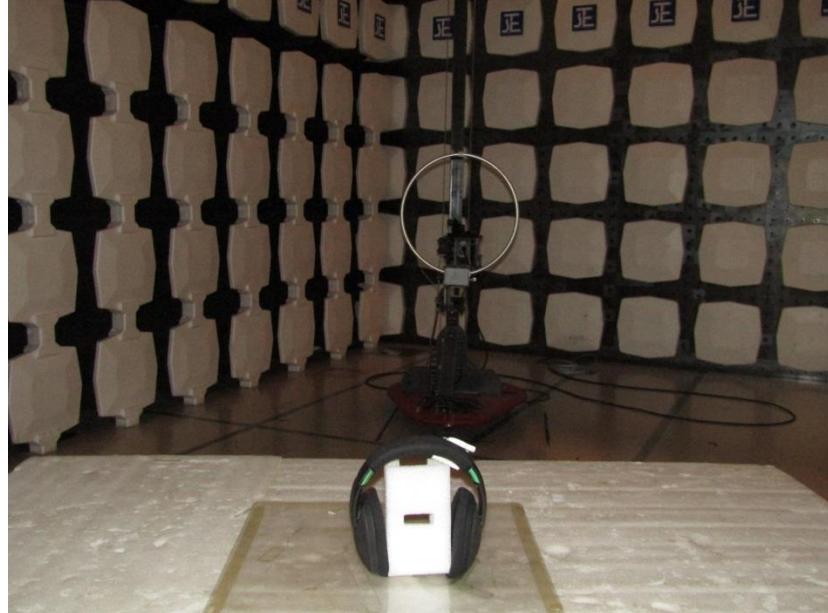
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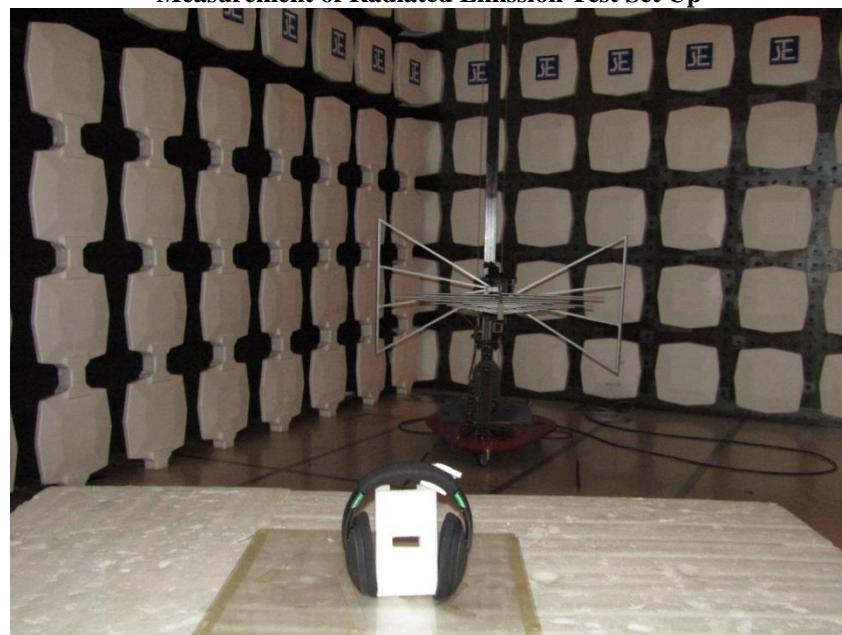
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Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Radiated Emission Test Set Up



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Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Conducted Emission Test Set Up



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

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