



Test Report

Date : 2017-10-19

No. : HM170844

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Applicant: Como Audio LLC
21 Drydock Avenue, Suite 760W, Boston, Massachusetts 02210

Manufacturer: Jwoodaudio Industry Co. Ltd.
No. 4 Industrial District, Liuwu Village, Yuanzhou Town, Huizhou City, Guangdong Province, P.R.C, 516123

Description of Sample(s):

Product:	CD/Internet/FM/Digital Radio with Bluetooth and Spotify/Deezer/Tidal/Napster
Brand Name:	Como Audio
Model Number:	Musica
FCC ID:	2AMWRMUSICA

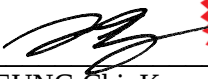
Date Sample(s) Received: 2017-07-19

Date Tested: 2017-08-07 to 2017-08-11

Investigation Requested: Perform ElectroMagnetic Interference measurement in accordance with FCC 47 CFR [Codes of Federal Regulations] Part 15: 2015 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/ $\pi/4$ -DQPSK/ 8DPSK)
This Laboratory Report supersedes our previous Test Report No. HM170844 issued on 2017-08-28 which is hereby deemed null and void.


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





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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: CD/Internet/FM/Digital Radio with Bluetooth and
Spotify/Deezer/Tidal/Napster
Manufacturer: Jwoodaudio Industry Co. Ltd.
No. 4 Industrial District, Liuwu Village, Yuanzhou Town,
Huizhou City, Guangdong Province, P.R.C, 516123
Brand Name: Como Audio
Model Number: Musica
Rating: Input: 100 - 240Va.c

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is Internet/FM Digital Radio with Bluetooth and Spotify, which is able to connect to the Internet through WiFi. 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

2017-07-19

1.4 Submitted Sample(s):

1 Sample

1.5 Test Duration

2017-08-07 to 2017-08-11

1.6 Country of Origin

China

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1.7 Antenna Details

Antenna Type (Bluetooth): PIFA
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: 2016 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	N/A
Maximum Peak Conducted Output Power	FCC 47CFR 15.247(b)(1)	ANSI C63.10:2013	N/A	☒	☐	☐
Radiated Spurious Emissions	FCC 47CFR 15.209	ANSI C63.10:2013	N/A	☒	☐	☐
AC Mains Conducted Emissions	FCC 47CFR 15.207	ANSI C63.10:2013	N/A	☒	☐	☐
Number of Hopping Frequency	FCC 47CFR 15.247 (b)(1)	ANSI C63.10:2013	N/A	☒	☐	☐
20dB Bandwidth	FCC 47CFR 15.247(a)(2)	ANSI C63.10: 2013	N/A	☒	☐	☐
Hopping Channel Separation	FCC 47CFR 15.247(a)(1)	ANSI C63.10: 2013	N/A	☒	☐	☐
Band-edge measurement (Radiated)	FCC 47CFR 15.247(d)	ANSI C63.10: 2013	N/A	☒	☐	☐
Pseudorandom Hopping Algorithm	FCC 47CFR 15.247(a)(1)	N/A	N/A	☒	☐	☐
Time of Occupancy (Dwell Time)	FCC 47CFR 15.247(a)(1)(iii)	ANSI C63.10: 2013	N/A	☒	☐	☐
Antenna requirement	FCC 47CFR 15.203	N/A	N/A	☒	☐	☐
RF Exposure	FCC 47CFR 15.247(i)	N/A	N/A	☒	☐	☐

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

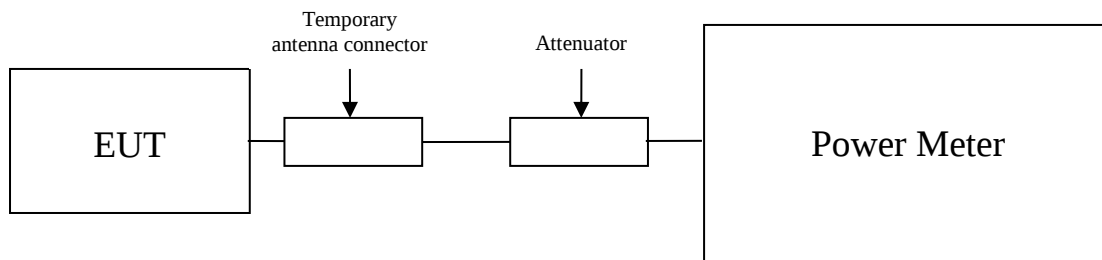
3.1.1 Maximum Peak Conducted Output Power

Test Requirement: FCC 47CFR 15.247(b)(2)
Test Method: ANSI C63.10:2013
Test Date: 2017-08-07
Mode of Operation: Tx mode :GFSK/ π /4-DQPSK/ 8DPSK

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 dBm.

Test Setup:



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Limits for Maximum Peak Conducted Output Power [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 conducted output power

Channel	Frequency(MHz)	Output Power(Watt)
0	2402	0.00107
39	2441	0.00116
78	2480	0.00136

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

Channel	Frequency(MHz)	Output Power(Watt)
0	2402	0.00097
39	2441	0.00075
78	2480	0.00067

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

Channel	Frequency(MHz)	Output Power(Watt)
0	2402	0.00098
39	2441	0.00078
78	2480	0.00071

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)

Test Requirement: FCC 47CFR 15.207

Test Method: ANSI C63.10:2013

Test Date: 2017-08-08

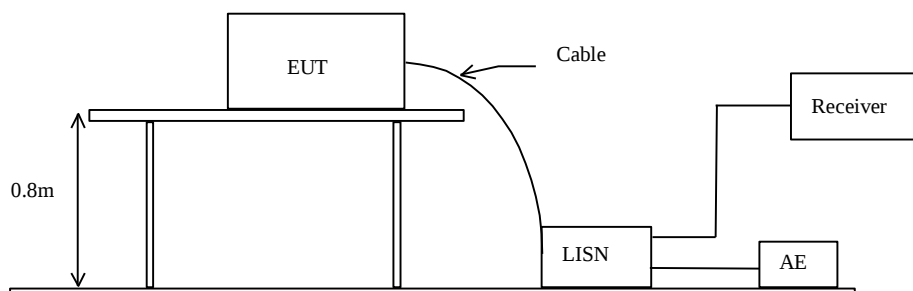
Mode of Operation: Tx mode/ FM mode/ DAB mode/ Internet Radio mode/ CD Play mode and Aux-in Mode connected to iPod**

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.

** Only results Tx mode will be shown in the report, since that is worst cases found.

Test Setup:



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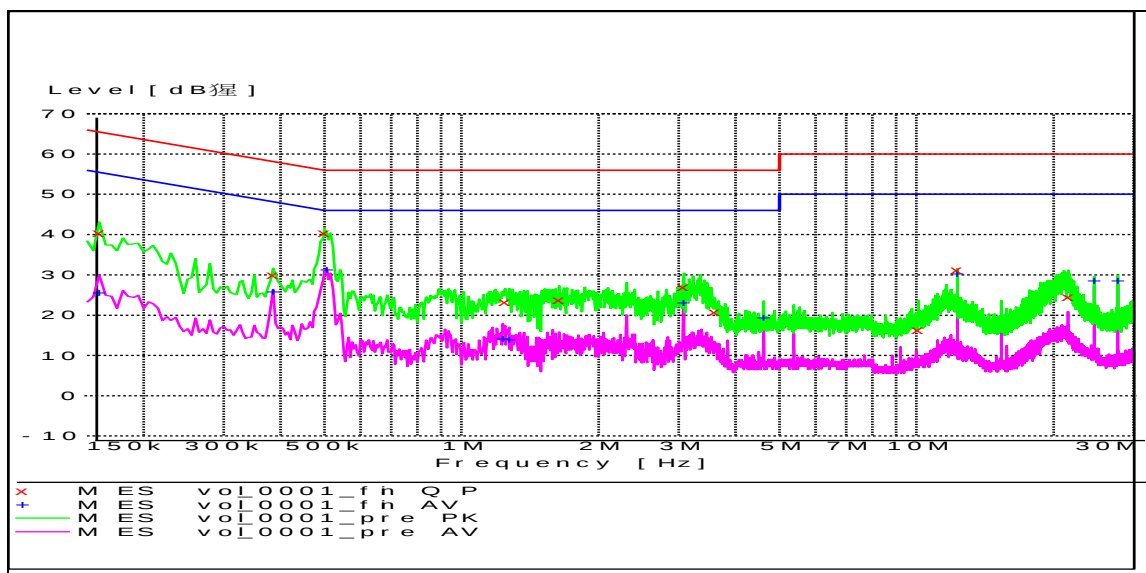
Limit for Conducted Emissions (FCC 47CFR 15.207):

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.

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

Results of Tx mode – Live and Neutral: PASS



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MEASUREMENT RESULT: "vol_0001_fin QP"

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Line	PE
0.160000	40.40	9.9	66	25.1	N	GND
0.385000	30.00	10.0	58	28.1	L1	GND
0.500000	40.40	10.0	56	15.6	L1	GND
1.245000	23.20	9.9	56	32.8	L1	GND
1.635000	23.80	10.0	56	32.2	L1	GND
3.075000	26.90	10.4	56	29.1	N	GND
3.605000	20.90	10.4	56	35.1	L1	GND
10.075000	16.30	10.3	60	43.7	N	GND
12.290000	31.20	10.6	60	28.8	N	GND
21.525000	24.50	10.8	60	35.5	L1	GND

MEASUREMENT RESULT: "vol_0001_fin AV"

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Line	PE
0.160000	25.40	9.9	56	30.1	L1	GND
0.385000	25.90	10.0	48	22.2	L1	GND
0.505000	31.10	10.0	46	14.9	L1	GND
1.230000	14.00	9.9	46	32.0	L1	GND
1.270000	13.90	9.9	46	32.1	L1	GND
3.075000	23.00	10.4	46	23.0	N	GND
4.610000	19.30	10.5	46	26.7	L1	GND
12.290000	30.20	10.6	50	19.8	N	GND
24.575000	28.50	10.9	50	21.5	N	GND
27.650000	28.40	10.7	50	21.6	N	GND

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3.1.3 Radiated Spurious Emissions

Test Requirement:	FCC 47CFR 15.209
Test Method:	ANSI C63.10:2013
Test Date:	2017-08-09
Mode of Operation:	Tx mode :GFSK/ π /4-DQPSK/8DPSK / FM mode/ DAB mode/ Internet Radio mode/ CD Play mode and Aux-in Mode connected to iPod**

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.

* Semi-anechoic chamber located on the G/F of “The Hong Kong Standards and Testing Centre Ltd.” with a metal ground plane filed with the FCC pursuant to section 2.948 of the FCC rules, with Registration Number: 607756.

** Only results of Tx mode will be shown in the report, since that are worst cases found.

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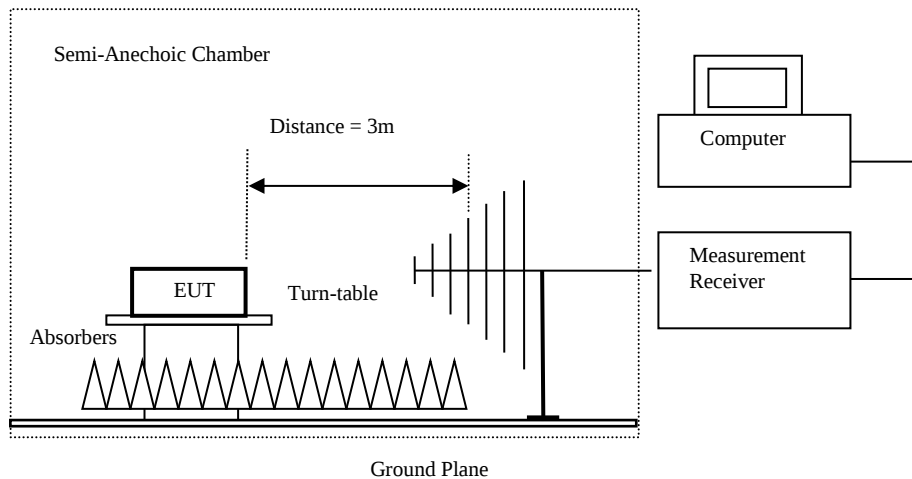
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Spectrum Analyzer Setting:

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]:

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.

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Result of Tx mode (GFSK: 2402.0 MHz) (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 (GFSK: 2402.0 MHz) (30MHz – 1GHz): Pass

Field Strength of Spurious Emissions Quasi-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 (GFSK: 2402.0 MHz) (1GHz - 26.5GHz): 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
4804.0	7.3	42.4	49.7	74.0	24.3	Vertical
7206.0	3.4	46.7	50.1	74.0	23.9	Vertical
9608.0	2.7	48.4	51.1	74.0	22.9	Vertical
12010.0	1.5	53.1	54.6	74.0	19.4	Vertical

Result of Tx mode (GFSK: 2402.0 MHz) (1GHz - 26.5GHz): Pass

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
4804.0	-6.3	42.4	36.1	54.0	17.9	Vertical
7206.0	-10.2	46.7	36.5	54.0	17.5	Vertical
9608.0	-11.4	48.4	37.0	54.0	17.0	Vertical
12010.0	-12.1	53.1	41.0	54.0	13.0	Vertical

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Result of Tx mode (GFSK: 2441.0 MHz) (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						

Results of Tx mode (GFSK: 2441.0 MHz) (30MHz – 1000MHz): PASS

Field Strength of Spurious Emissions Quasi-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 (GFSK: 2441.0 MHz) (1GHz - 26.5GHz): 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
4882.0	7.1	42.5	49.6	74.0	24.4	Vertical
7323.0	4.8	47.1	51.9	74.0	22.1	Vertical
9764.0	2.8	49.3	52.1	74.0	21.9	Vertical
12205.0	1.8	53.1	54.9	74.0	19.1	Vertical

Result of Tx mode (GFSK: 2441.0 MHz) (1GHz - 26.5GHz): Pass

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
4882.0	-5.3	42.5	37.2	54.0	16.8	Vertical
7323.0	-7.3	47.1	39.8	54.0	14.2	Vertical
9764.0	-10.3	49.3	39.0	54.0	15.0	Vertical
12205.0	-11.2	53.1	41.9	54.0	12.1	Vertical

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Result of Tx mode (GFSK: 2480.0 MHz) (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						

Results of Tx mode (GFSK: 2480.0 MHz) (30MHz – 1000MHz): PASS

Field Strength of Spurious Emissions Quasi-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 (GFSK: 2480.0 MHz) (1GHz - 26.5GHz): 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
4960.0	7.7	43.2	50.9	74.0	23.1	Vertical
7440.0	4.3	46.2	50.5	74.0	23.5	Vertical
9920.0	2.3	50.9	53.2	74.0	20.8	Vertical
12400.0	0.9	54.3	55.2	74.0	18.8	Vertical

Result of Tx mode (GFSK: 2480.0 MHz) (1GHz - 26.5GHz): Pass

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
4944.0	-8.1	43.2	35.1	54.0	18.9	Vertical
7416.0	-11.2	46.2	35.0	54.0	19.0	Vertical
9888.0	-11.7	50.9	39.2	54.0	14.8	Vertical
12360.0	-12.3	54.3	42.0	54.0	12.0	Vertical

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Result of Tx mode ($\pi/4$ -DQPSK: 2402.0 MHz) (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 ($\pi/4$ -DQPSK: 2402.0 MHz) (30MHz – 1GHz): Pass

Field Strength of Spurious Emissions Quasi-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 ($\pi/4$ -DQPSK: 2402.0 MHz) (1GHz - 26.5GHz): 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
4804.0	6.8	42.4	49.2	74.0	24.8	Vertical
7206.0	3.1	46.7	49.8	74.0	24.2	Vertical
9608.0	2.7	48.4	51.1	74.0	22.9	Vertical
12010.0	1.3	53.1	54.4	74.0	19.6	Vertical

Result of Tx mode ($\pi/4$ -DQPSK: 2402.0 MHz) (1GHz - 26.5GHz): Pass

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
4804.0	-6.5	42.4	35.9	54.0	18.1	Vertical
7206.0	-10.3	46.7	36.4	54.0	17.6	Vertical
9608.0	-11.3	48.4	37.1	54.0	16.9	Vertical
12010.0	-11.9	53.1	41.2	54.0	12.8	Vertical

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

Results of Tx mode ($\pi/4$ -DQPSK: 2441.0 MHz) (30MHz – 1000MHz): PASS

Field Strength of Spurious Emissions Quasi-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 ($\pi/4$ -DQPSK: 2441.0 MHz) (1GHz - 26.5GHz): 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
4882.0	7.1	42.5	49.6	74.0	24.4	Vertical
7323.0	4.6	47.1	51.7	74.0	22.3	Vertical
9764.0	2.3	49.3	51.6	74.0	22.4	Vertical
12205.0	1.4	53.1	54.5	74.0	19.5	Vertical

Result of Tx mode ($\pi/4$ -DQPSK: 2441.0 MHz) (1GHz - 26.5GHz): Pass

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
4882.0	-4.9	42.5	37.6	54.0	16.4	Vertical
7323.0	-7.5	47.1	39.6	54.0	14.4	Vertical
9764.0	-10.5	49.3	38.8	54.0	15.2	Vertical
12205.0	-11.6	53.1	41.5	54.0	12.5	Vertical

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

Results of Tx mode ($\pi/4$ -DQPSK: 2480.0 MHz) (30MHz – 1000MHz): PASS

Field Strength of Spurious Emissions Quasi-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 ($\pi/4$ -DQPSK: 2480.0 MHz) (1GHz - 26.5GHz): 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
4960.0	6.4	43.2	49.6	74.0	24.4	Vertical
7440.0	3.3	46.2	49.5	74.0	24.5	Vertical
9920.0	2.5	50.9	53.4	74.0	20.6	Vertical
12400.0	1.6	54.3	55.9	74.0	18.1	Vertical

Result of Tx mode ($\pi/4$ -DQPSK: 2480.0 MHz) (1GHz - 26.5GHz): Pass

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
4960.0	-7.7	43.2	35.5	54.0	18.5	Vertical
7440.0	-9.5	46.2	36.7	54.0	17.3	Vertical
9920.0	-11.1	50.9	39.8	54.0	14.2	Vertical
12400.0	-11.5	54.3	42.8	54.0	11.2	Vertical

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Result of Tx mode (8DPSK: 2402.0 MHz) (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 (8DPSK: 2402.0 MHz) (30MHz – 1GHz): Pass

Field Strength of Spurious Emissions Quasi-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 (8DPSK: 2402.0 MHz) (1GHz - 26.5GHz): 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
4804.0	6.5	42.4	48.9	74.0	25.1	Vertical
7206.0	3.2	46.7	49.9	74.0	24.1	Vertical
9608.0	2.5	48.4	50.9	74.0	23.1	Vertical
12010.0	1.5	53.1	54.6	74.0	19.4	Vertical

Result of Tx mode (8DPSK: 2402.0 MHz) (1GHz - 26.5GHz): Pass

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
4804.0	-7.7	42.4	34.7	54.0	19.3	Vertical
7206.0	-9.3	46.7	37.4	54.0	16.6	Vertical
9608.0	-10.5	48.4	37.9	54.0	16.1	Vertical
12010.0	-12.1	53.1	41.0	54.0	13.0	Vertical

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Result of Tx mode (8DPSK: 2441.0 MHz) (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						

Results of Tx mode (8DPSK: 2441.0 MHz) (30MHz – 1000MHz): PASS

Field Strength of Spurious Emissions Quasi-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 (8DPSK: 2441.0 MHz) (1GHz - 26.5GHz): 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
4882.0	6.8	42.5	49.3	74.0	24.7	Vertical
7323.0	4.1	47.1	51.2	74.0	22.8	Vertical
9764.0	2.3	49.3	51.6	74.0	22.4	Vertical
12205.0	1.6	53.1	54.7	74.0	19.3	Vertical

Result of Tx mode (8DPSK: 2441.0 MHz) (1GHz - 26.5GHz): Pass

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
4882.0	-8.1	42.5	34.4	54.0	19.6	Vertical
7323.0	-9.9	47.1	37.2	54.0	16.8	Vertical
9764.0	-10.9	49.3	38.4	54.0	15.6	Vertical
12205.0	-11.9	53.1	41.2	54.0	12.8	Vertical

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Result of Tx mode (8DPSK: 2480.0 MHz) (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						

Results of Tx mode (8DPSK: 2480.0 MHz) (30MHz – 1000MHz): PASS

Field Strength of Spurious Emissions Quasi-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 (8DPSK: 2480.0 MHz) (1GHz - 26.5GHz): 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
4960.0	7.1	43.2	50.3	74.0	23.7	Vertical
7440.0	5.1	46.2	51.3	74.0	22.7	Vertical
9920.0	2.6	50.9	53.5	74.0	20.5	Vertical
12400.0	1.6	54.3	55.9	74.0	18.1	Vertical

Result of Tx mode (8DPSK: 2480.0 MHz) (1GHz - 26.5GHz): Pass

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
4960.0	-7.1	43.2	36.1	54.0	17.9	Vertical
7440.0	-10.3	46.2	35.9	54.0	18.1	Vertical
9920.0	-11.5	50.9	39.4	54.0	14.6	Vertical
12400.0	-12.1	54.3	42.2	54.0	11.8	Vertical

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Limits for Radiated Emissions [FCC 47 CFR 15.209]:

Frequency Range [MHz]	Quasi-Peak Limits [μV/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 Tx mode, (9kHz – 30MHz): PASS

Emissions detected are more than 20 dB below the FCC Limits

Result of Tx mode, (30MHz – 1GHz): PASS

Field Strength of Fundamental and Harmonics Emissions Quasi-Peak Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
41.4	26.8	10.0	36.8	69.2	100	Vertical
76.0	23.5	7.2	30.7	34.3	150	Horizontal
110.2	18.1	8.7	26.8	21.9	150	Horizontal
153.6	22.8	10.0	32.8	43.7	200	Horizontal
305.0	30.8	13.9	44.7	171.8	200	Horizontal
577.1	10.4	20.0	30.4	33.1	200	Horizontal

Result of Tx mode, (1GHz – 18GHz): PASS

Emissions detected are more than 20 dB below the FCC Limits

Remarks:

Frequencies not listed are more than 20 dB below the Limits

* 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

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:

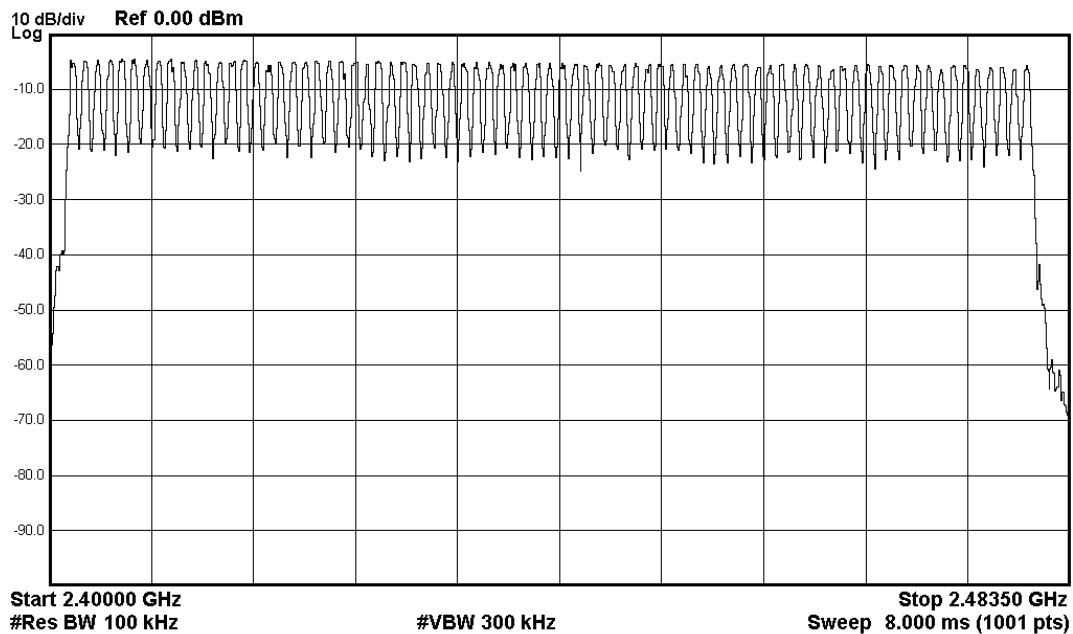
RBW = 300kHz, VBW $\geq$ RBW, Sweep = Auto, Span = the frequency band of operation
Detector = Peak, Trace = Max. hold

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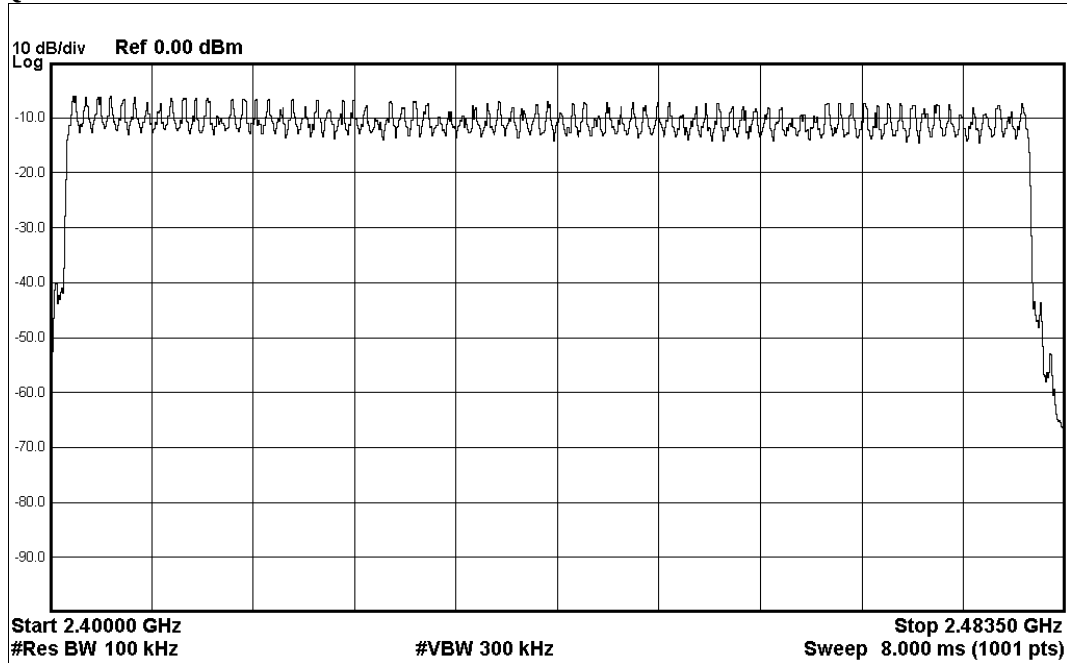
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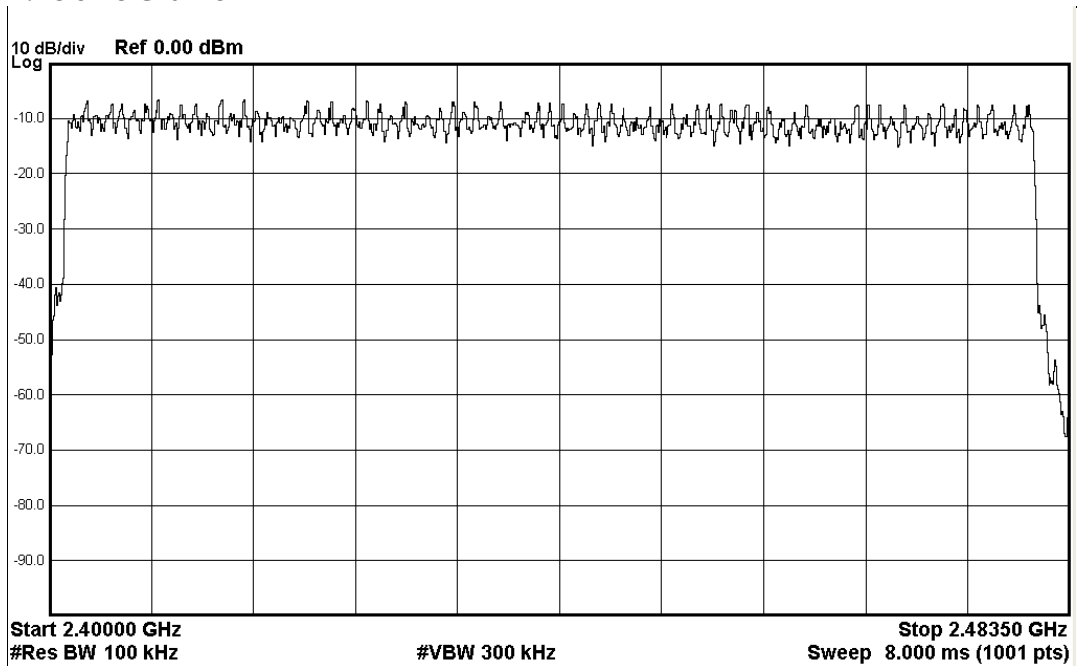
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$\pi/4$ -DQPSK: 79 of 79 Channel



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:	2017-08-11
Mode of Operation:	Tx mode

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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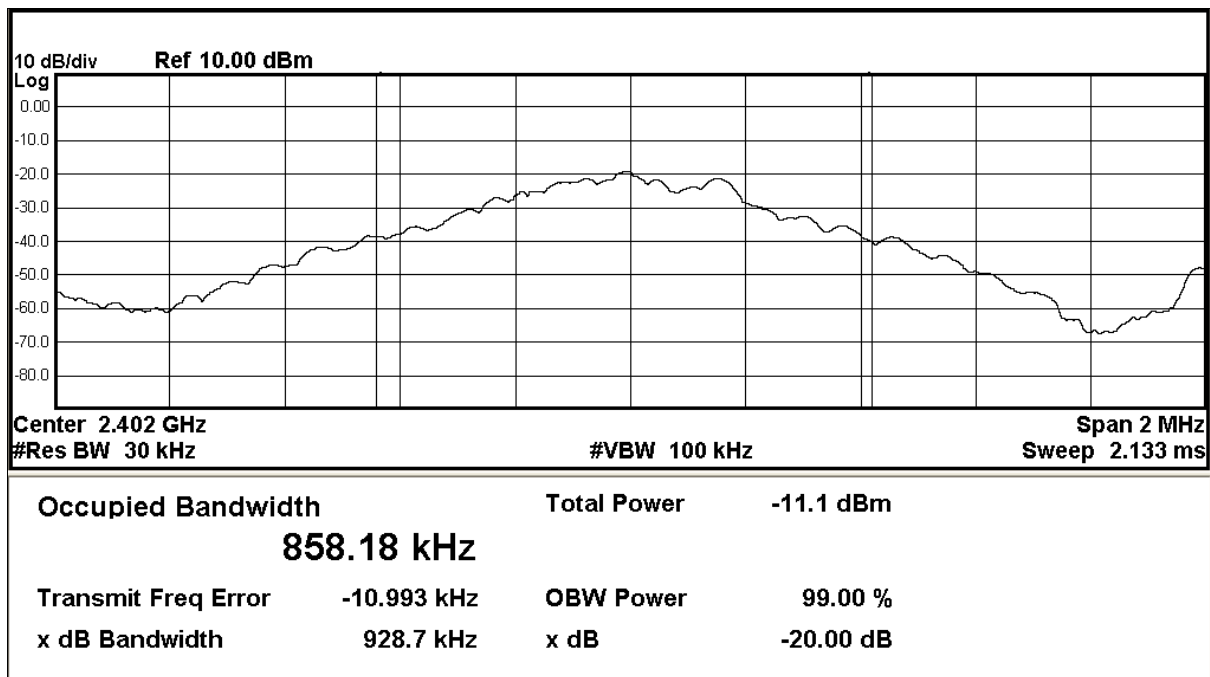
Date : 2017-10-19

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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [KHz]	FCC Limits [MHz]
2402	928.7	Within 2400-2483.5

(Lowest Operating Frequency) - (GFSK)



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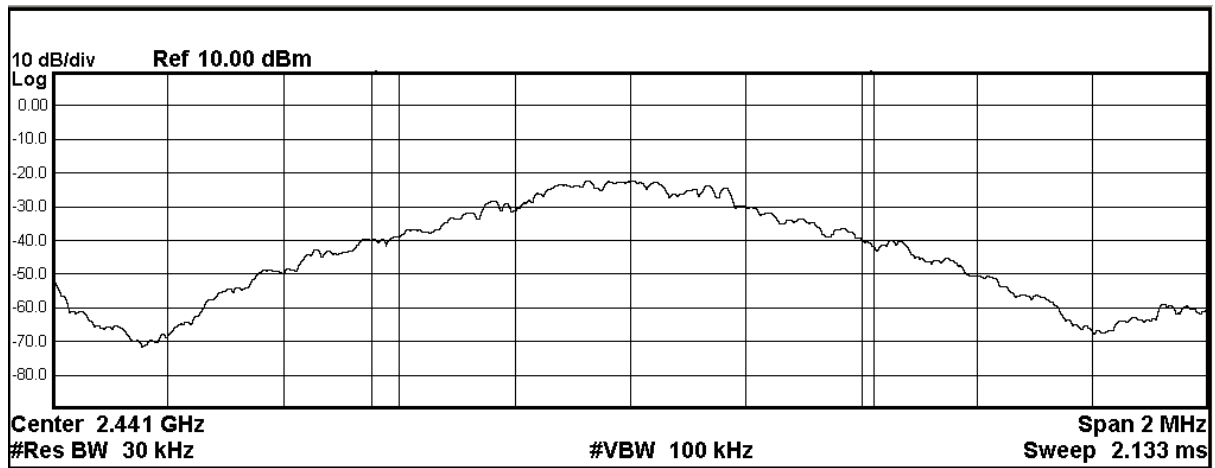
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [KHz]	FCC Limits [MHz]
2441	956.1	Within 2400-2483.5

(Middle Operating Frequency) - (GFSK)



Occupied Bandwidth	Total Power	-13.0 dBm
870.06 kHz		
Transmit Freq Error	OBW Power	99.00 %
-13.270 kHz		
x dB Bandwidth	x dB	-20.00 dB
956.1 kHz		

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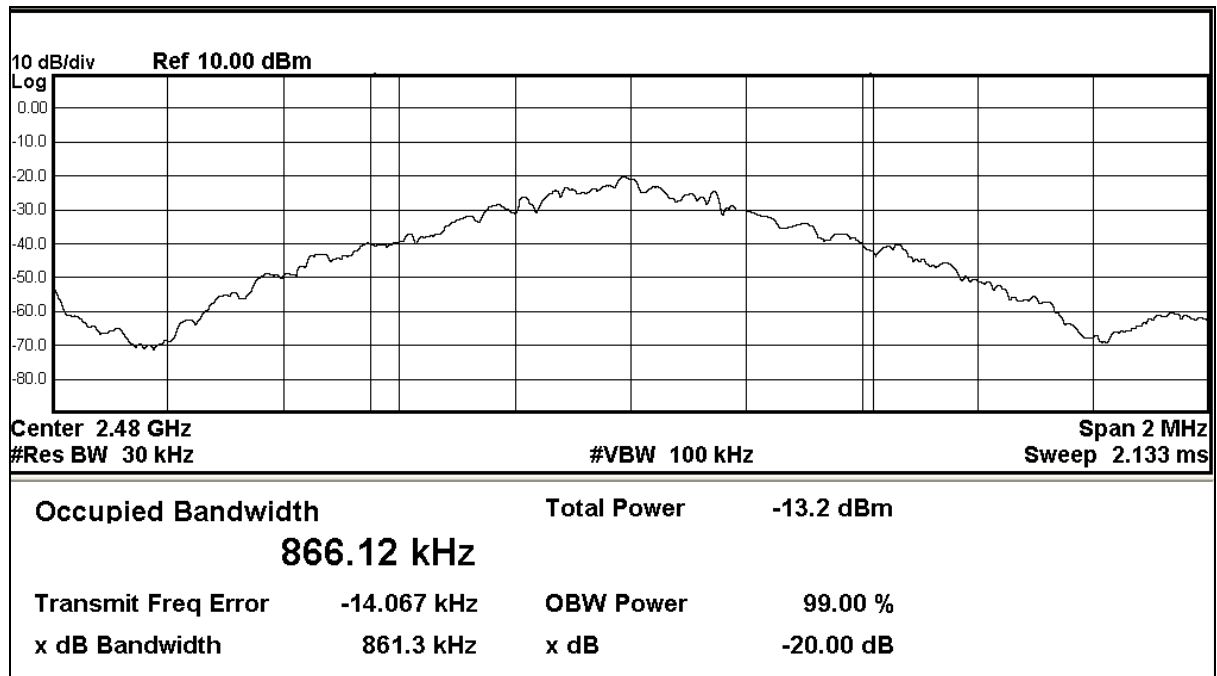
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [KHz]	FCC Limits [MHz]
2480	861.30	Within 2400-2483.5

(Highest Operating Frequency) - (GFSK)



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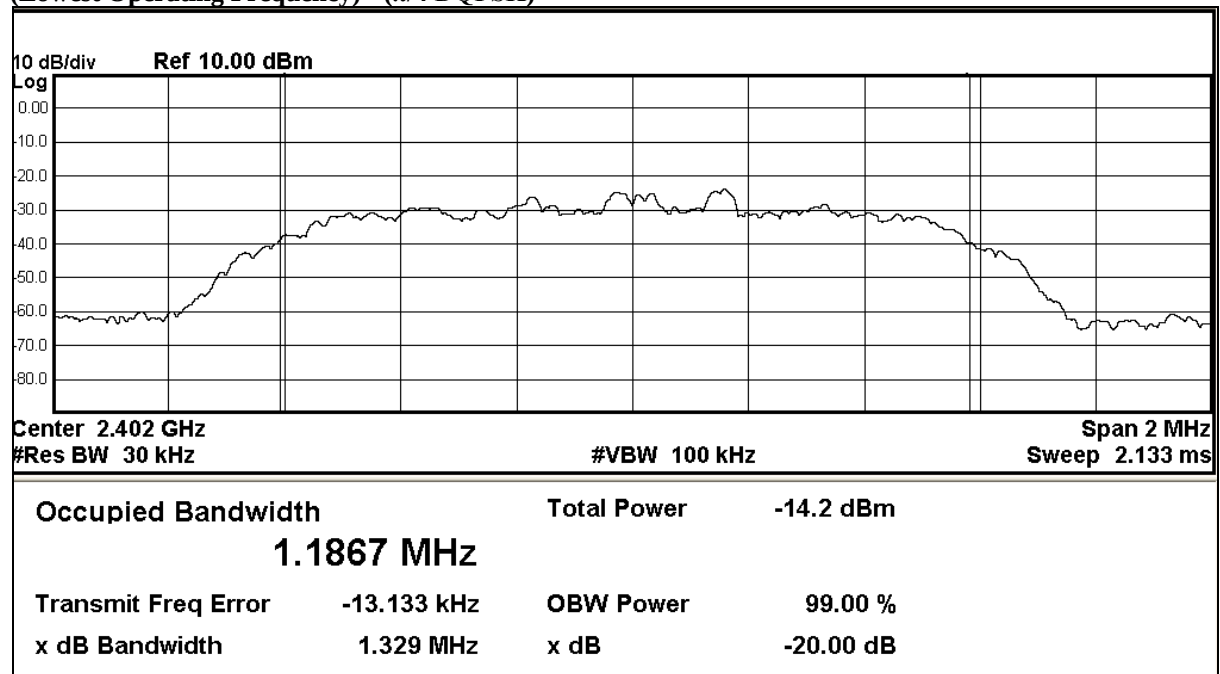
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.329	Within 2400-2483.5

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



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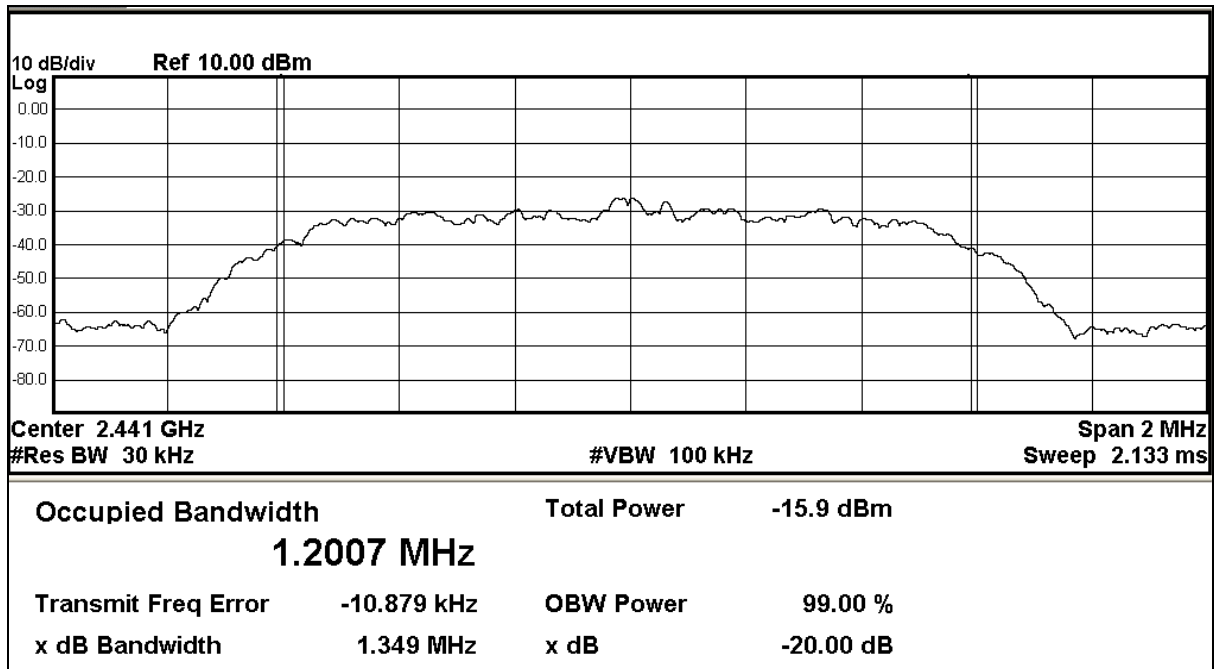
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.349	Within 2400-2483.5

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



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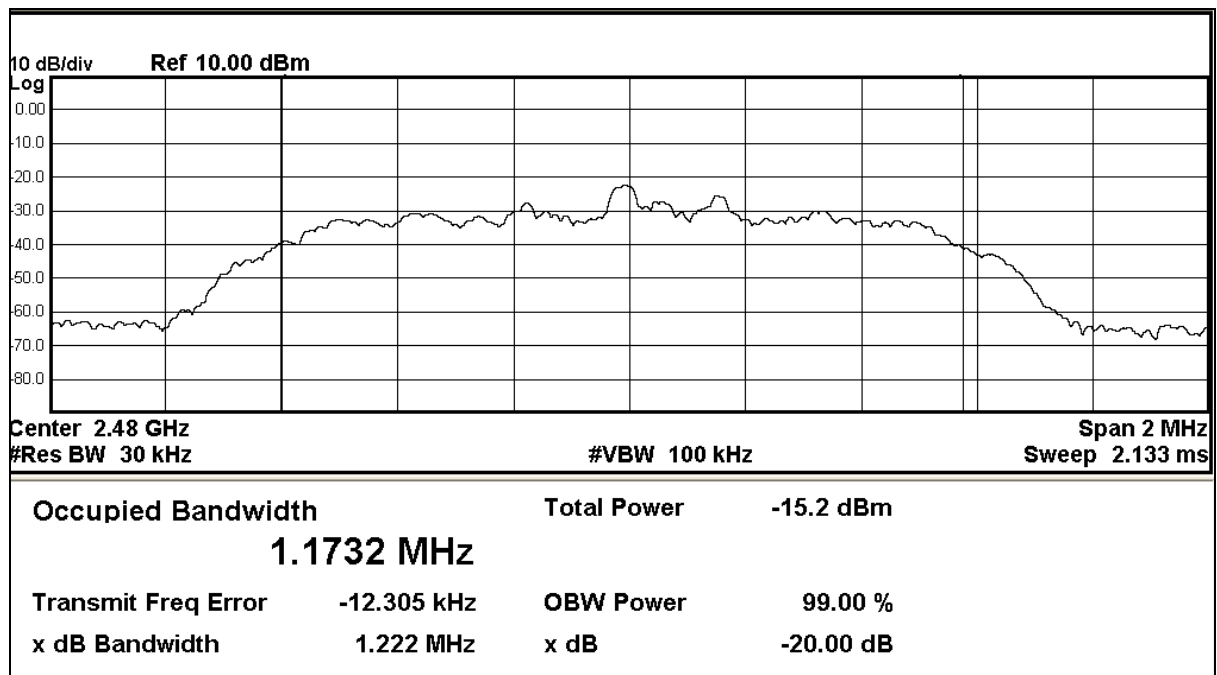
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.222	Within 2400-2483.5

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



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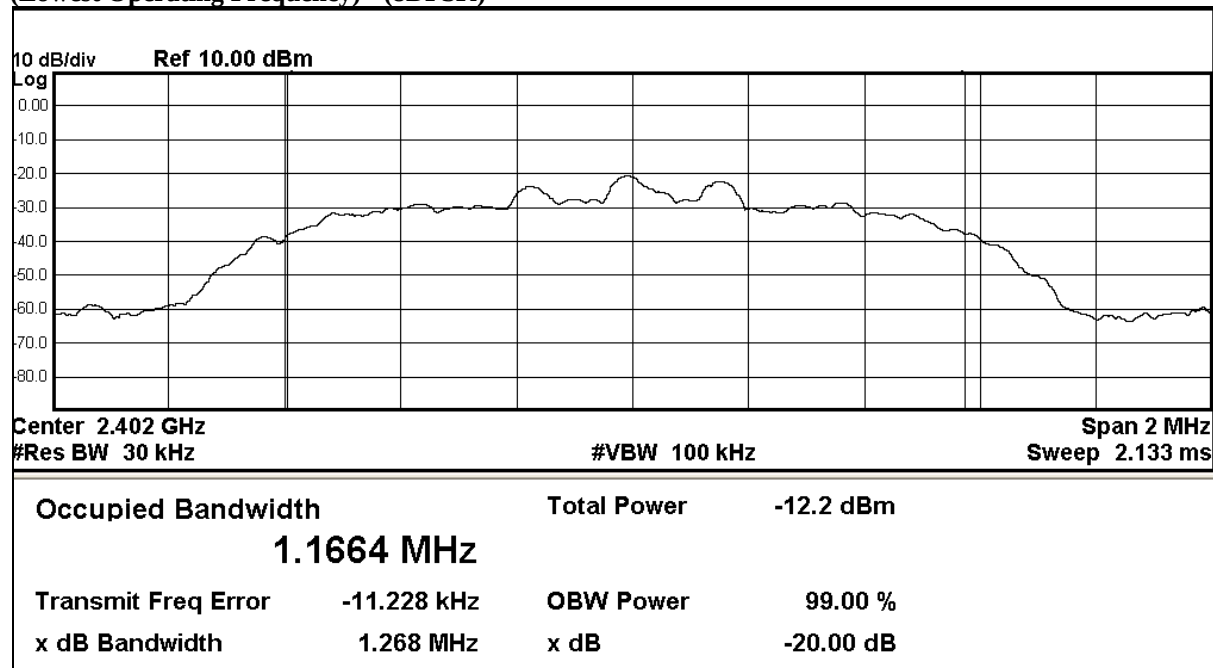
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.268	Within 2400-2483.5

(Lowest Operating Frequency) - (8DPSK)



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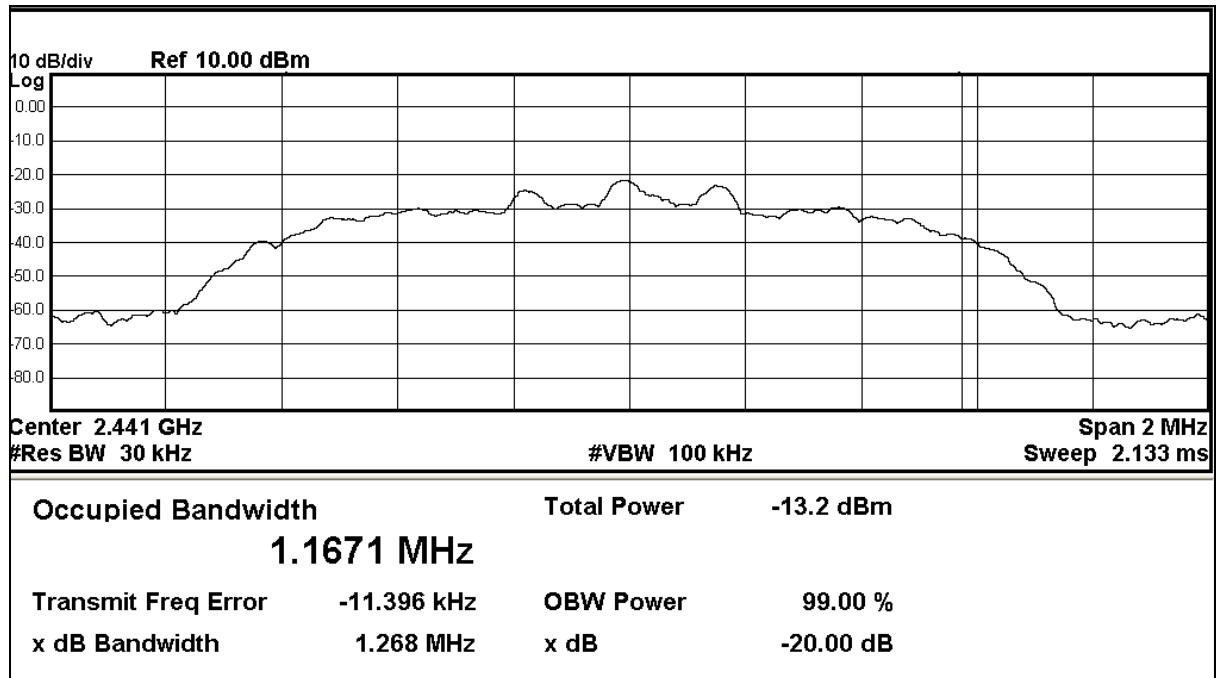
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.268	Within 2400-2483.5

(Middle Operating Frequency) - (8DPSK)



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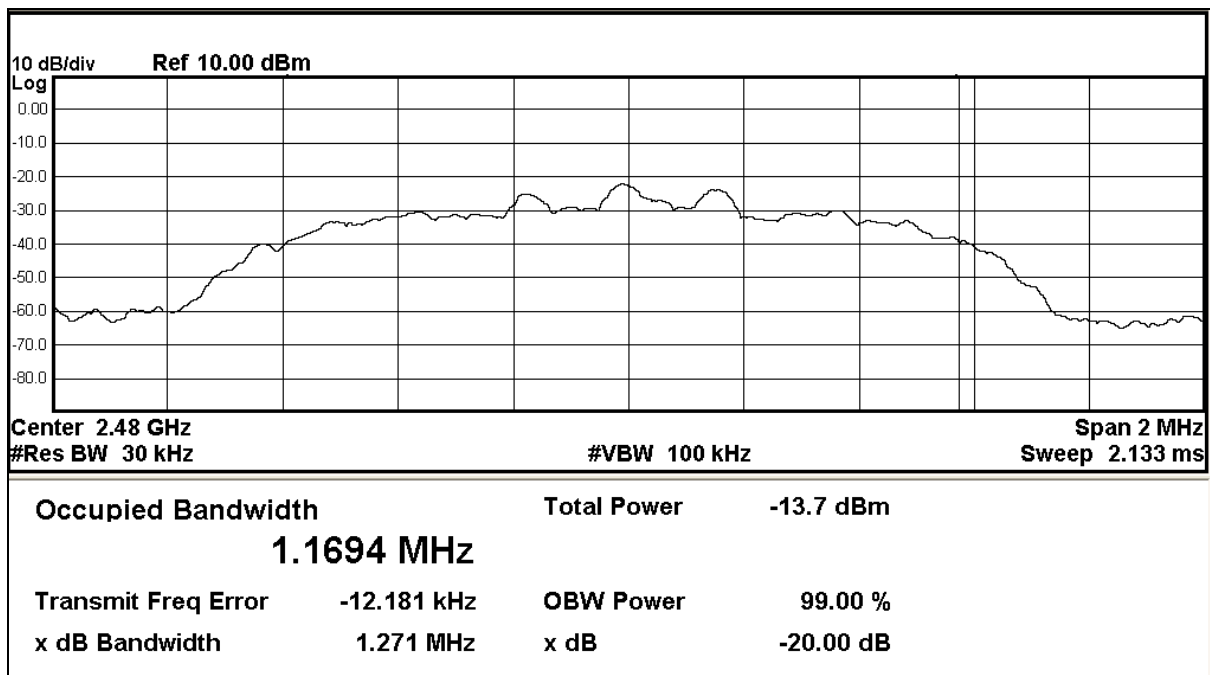
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No. : HM170844

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.271	Within 2400-2483.5

(Highest Operating Frequency) - (8DPSK)



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3.1.6 Hopping Channel Separation

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:

GFSK: The measured maximum bandwidth * 2/3 = 956.1 kHz * 2/3 = 637.4kHz

$\pi/4$ DQPSK: The measured maximum bandwidth * 2/3 = 1.349MHz * 2/3 = 899.3kHz

8DPSK: The measured maximum bandwidth * 2/3 = 1.271MHz * 2/3 = 847.3kHz

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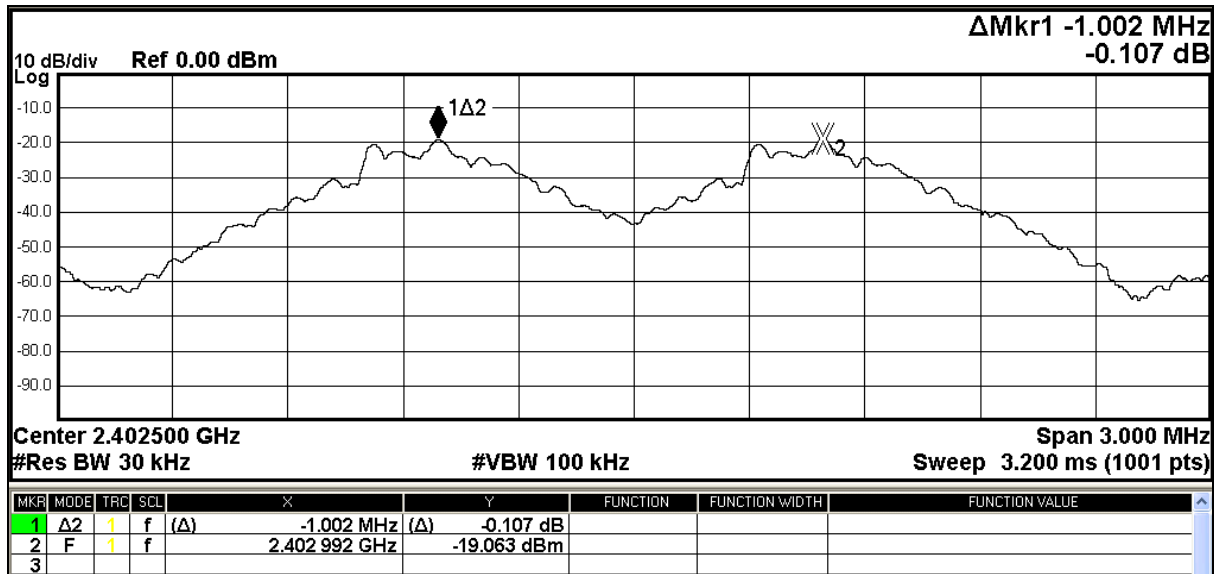
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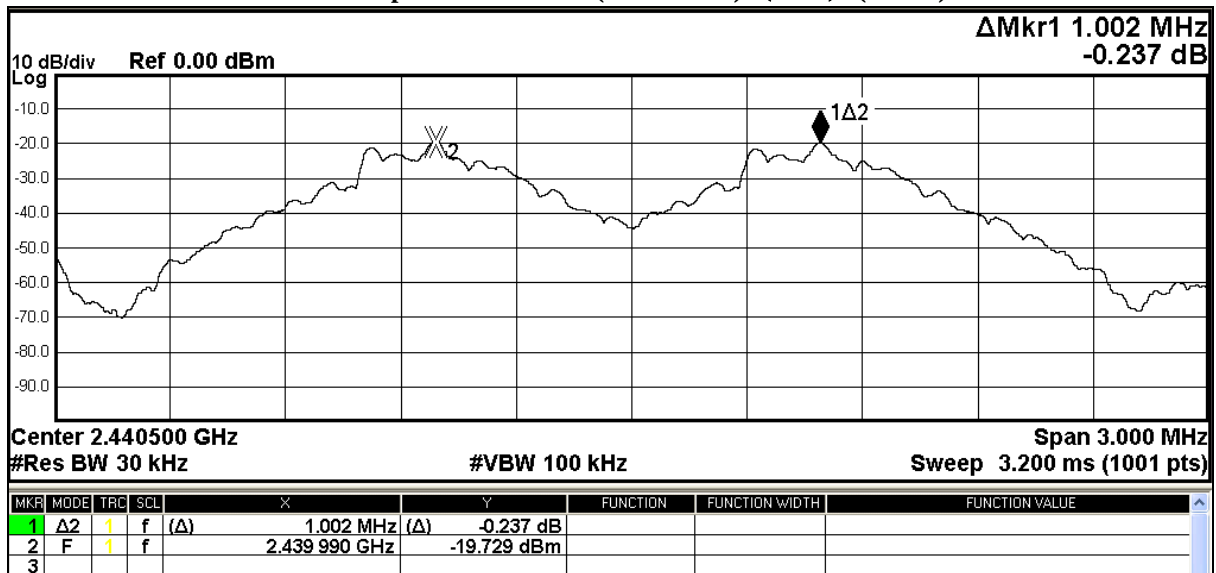
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Channel separation = 1MHz (>2/3 of BW) (Lowest) (GFSK)



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



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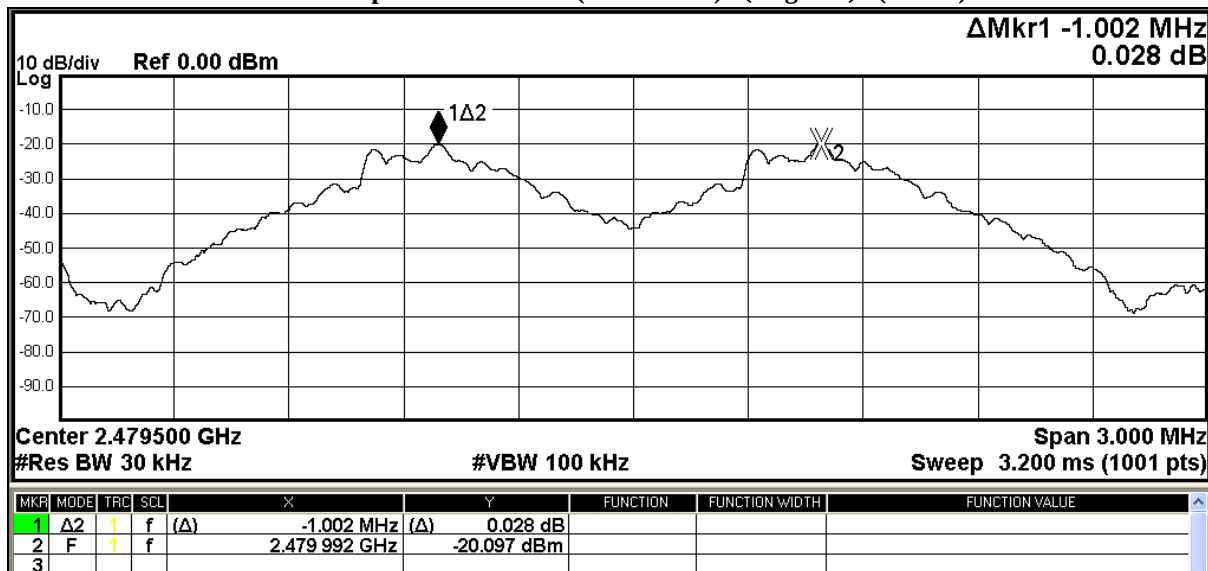
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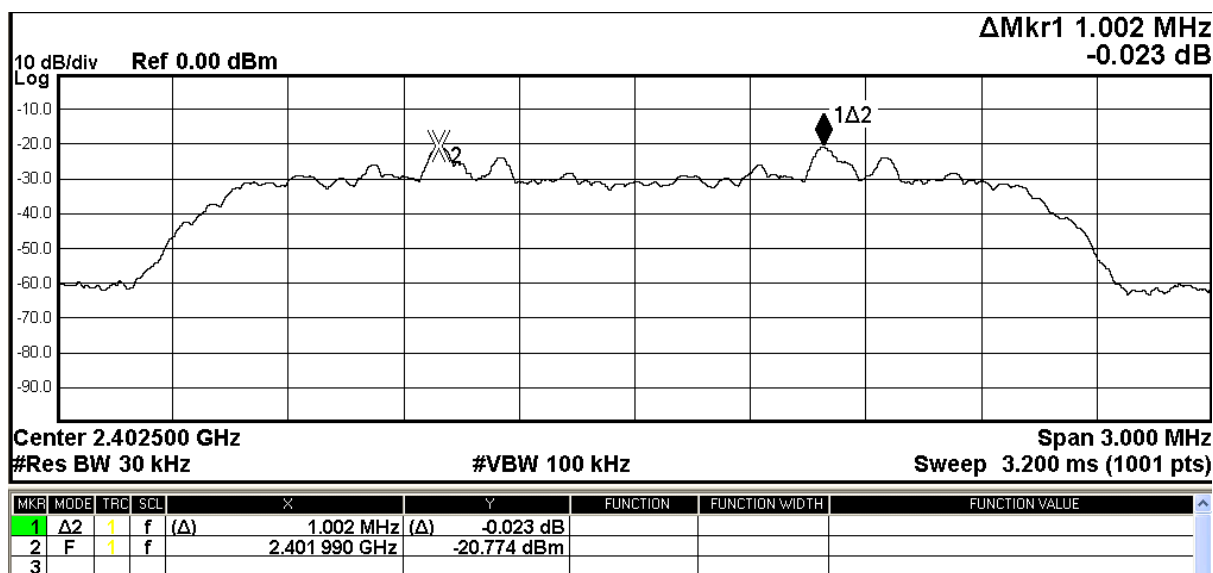
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No. : HM170844

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



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



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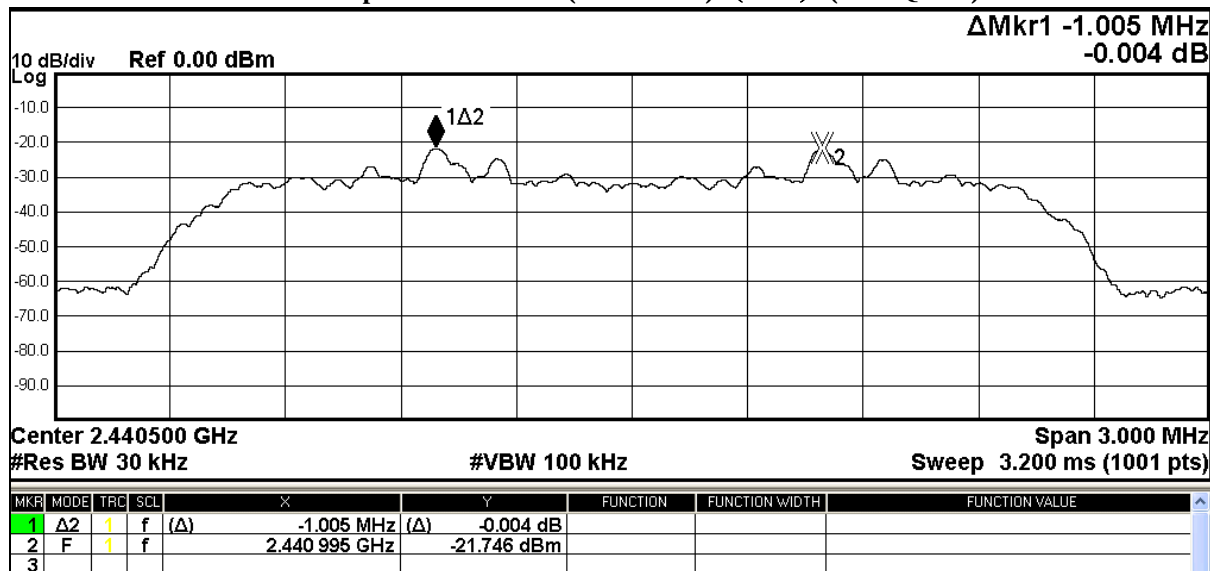
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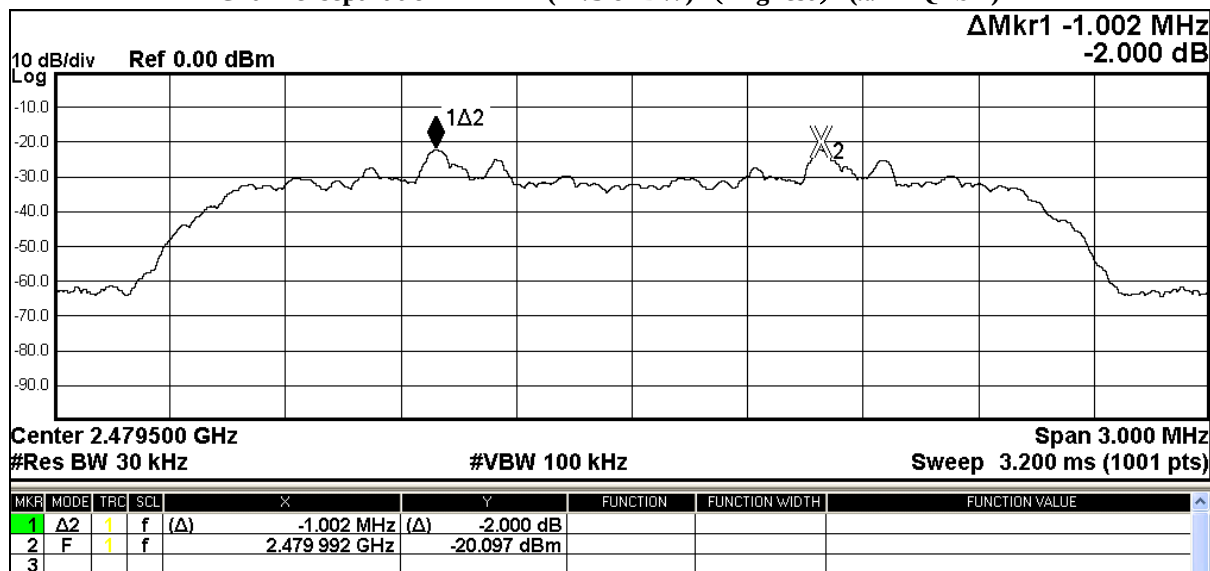
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Channel separation = 1MHz (>2/3 of BW) (Mid) ($\pi/4$ DQPSK)



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



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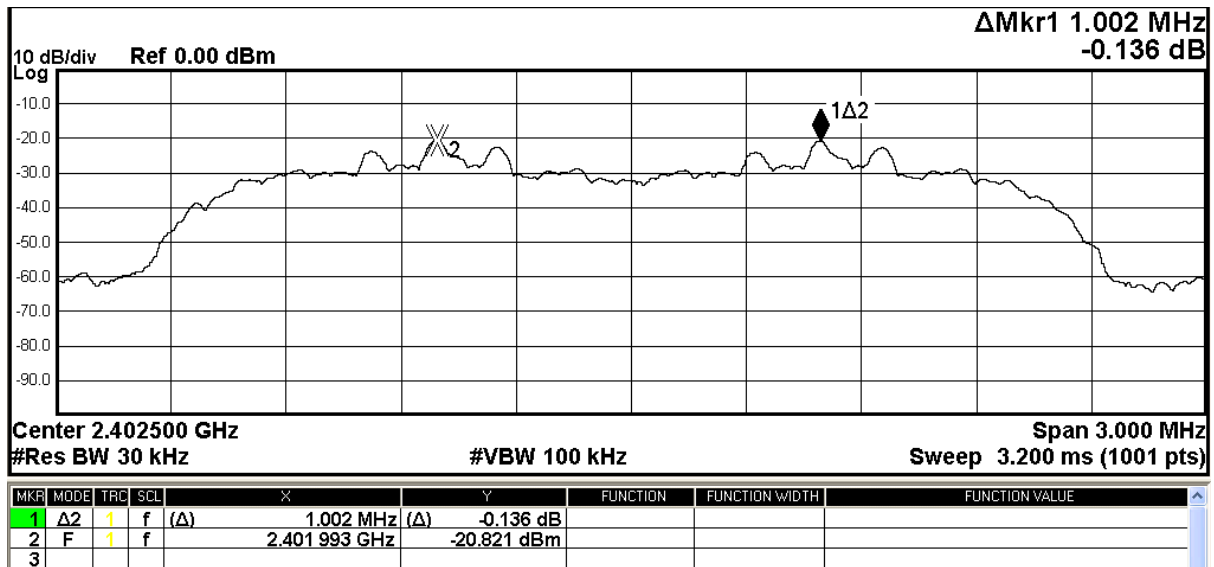
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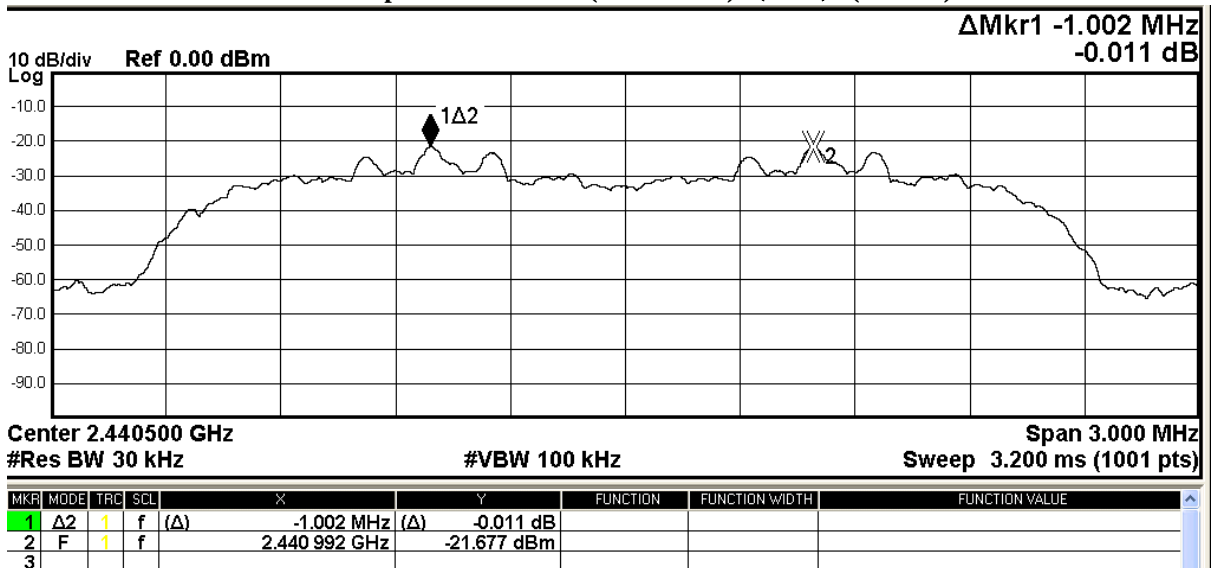
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Channel separation = 1MHz (>2/3 of BW) (Lowest) (8DPSK)



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



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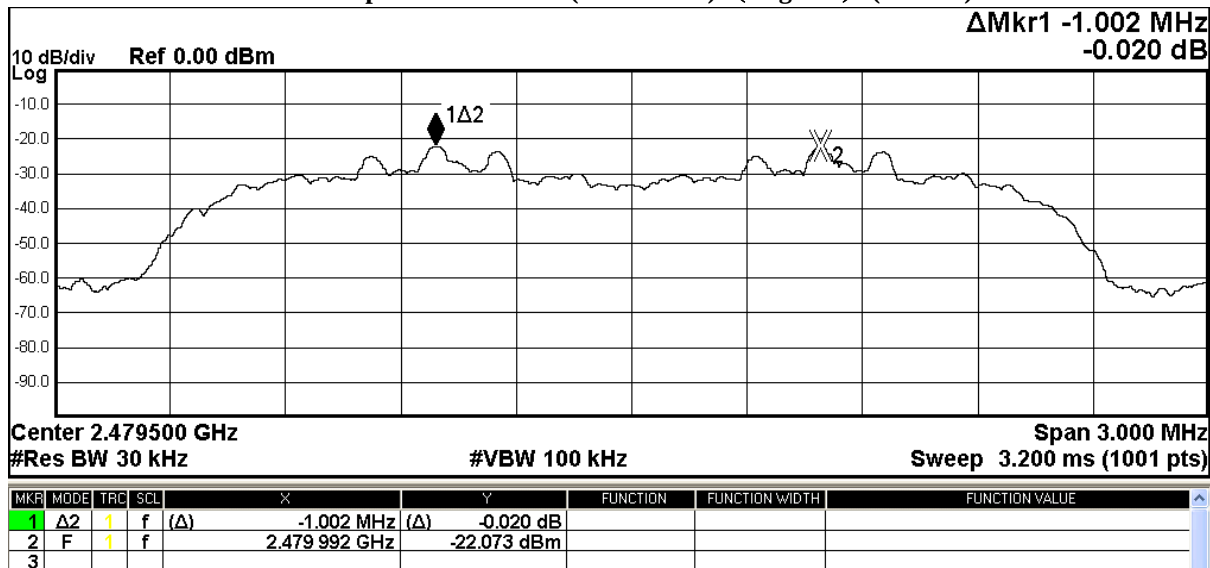
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Channel separation = 1MHz (>2/3 of BW) (Highest) (8DPSK)



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3.1.7 Band-edge Emissions Measurement:

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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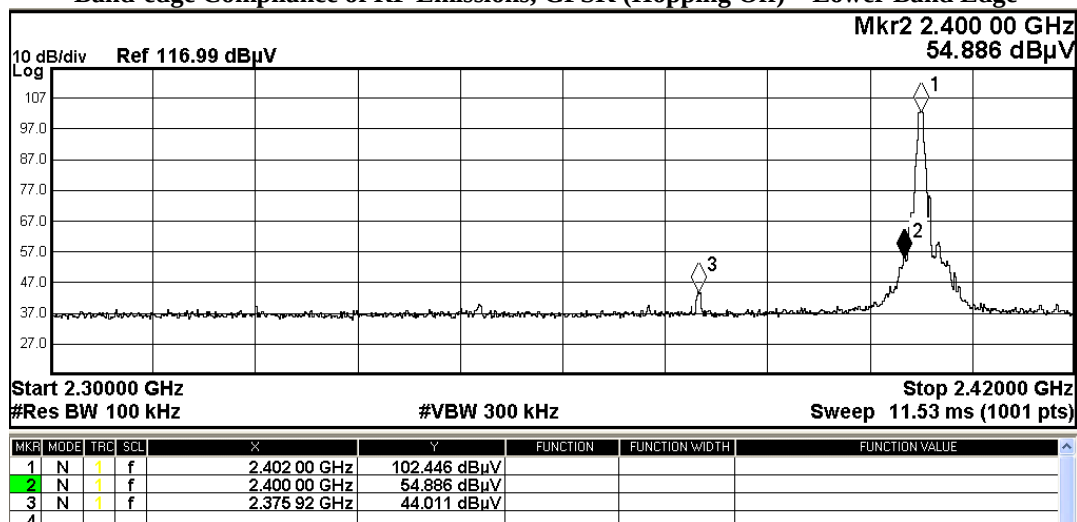
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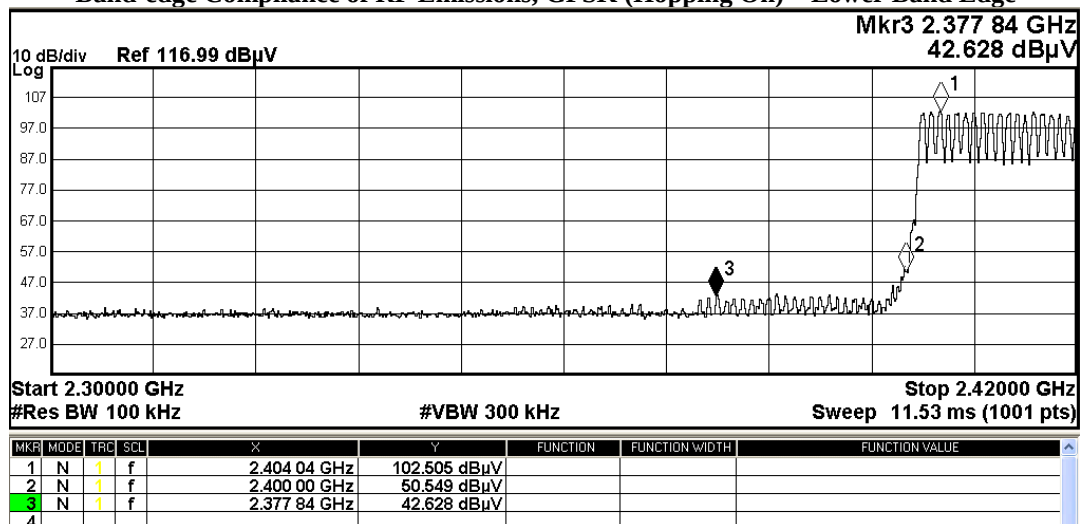
Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	47.6

Band-edge Compliance of RF Emissions, GFSK (Hopping Off) – Lower Band Edge



Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	55.0

Band-edge Compliance of RF Emissions, GFSK (Hopping On) – Lower Band Edge



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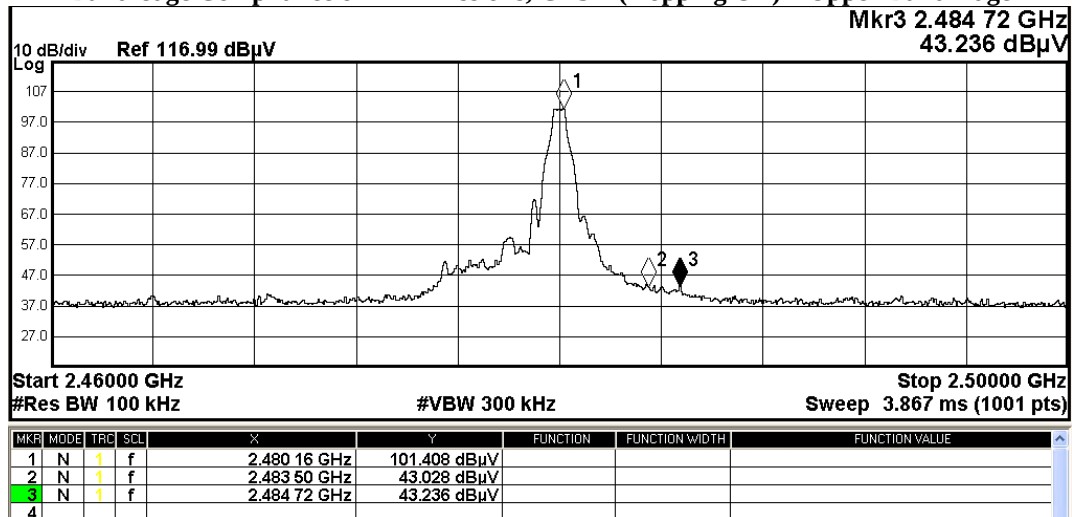
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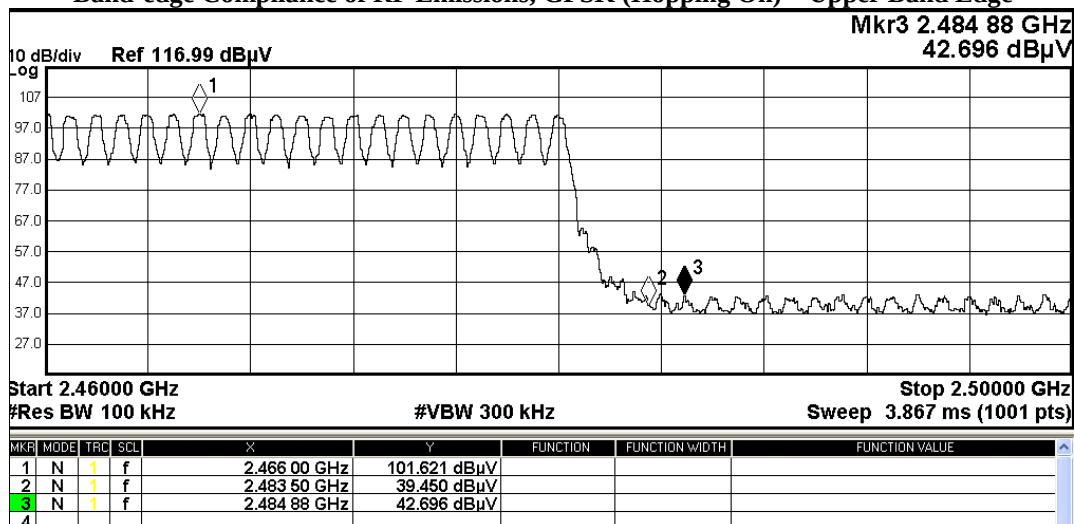
Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	58.4

Band-edge Compliance of RF Emissions, GFSK (Hopping Off) – Upper Band Edge



Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	62.2

Band-edge Compliance of RF Emissions, GFSK (Hopping On) – Upper Band Edge



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Band-edge Emissions Measurement:

Result: RF Radiated Emissions - 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 dBuV/m	E-Field Polarity
2375.9	7.2	36.8	44.0	74.0	30.0	Vertical
2377.8	5.8	36.8	42.6	74.0	31.4	Vertical
2484.7	6.3	36.9	43.2	74.0	30.8	Vertical
2484.9	5.8	36.9	42.7	74.0	31.3	Vertical

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 dBuV/m	E-Field Polarity
2375.9	-3.8	36.8	33.0	54.0	21.0	Vertical
2377.8	-4.1	36.8	32.7	54.0	21.3	Vertical
2484.7	-4.3	36.9	32.6	54.0	21.4	Vertical
2484.9	-4.3	36.9	32.6	54.0	21.4	Vertical

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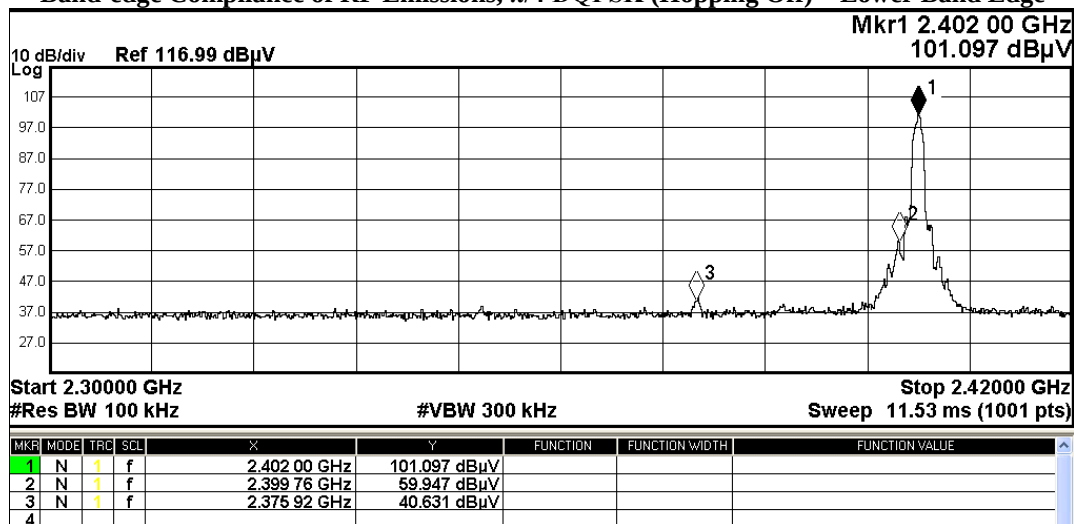
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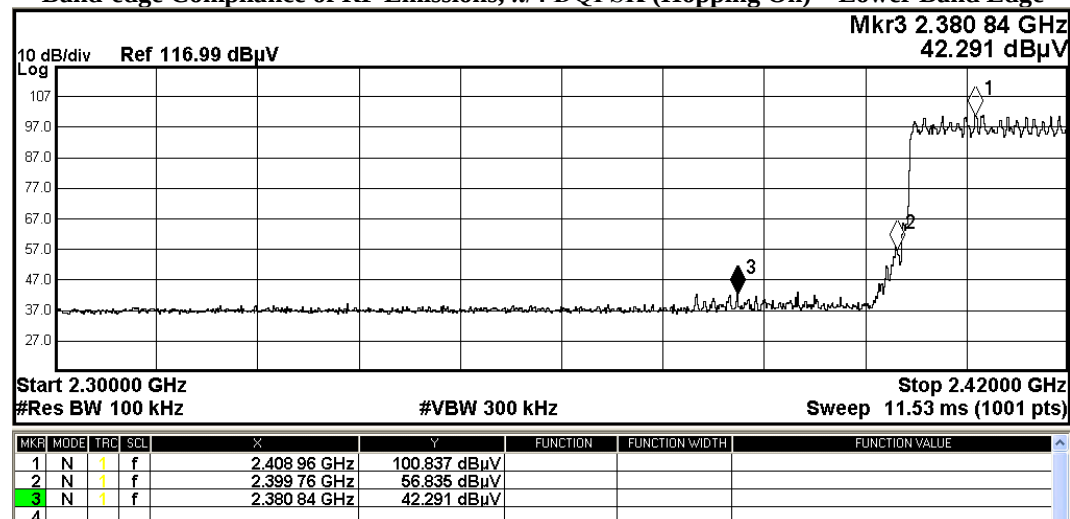
Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	41.2

Band-edge Compliance of RF Emissions, $\pi/4$ DQPSK (Hopping Off) – Lower Band Edge



Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	44.0

Band-edge Compliance of RF Emissions, $\pi/4$ DQPSK (Hopping On) – Lower Band Edge



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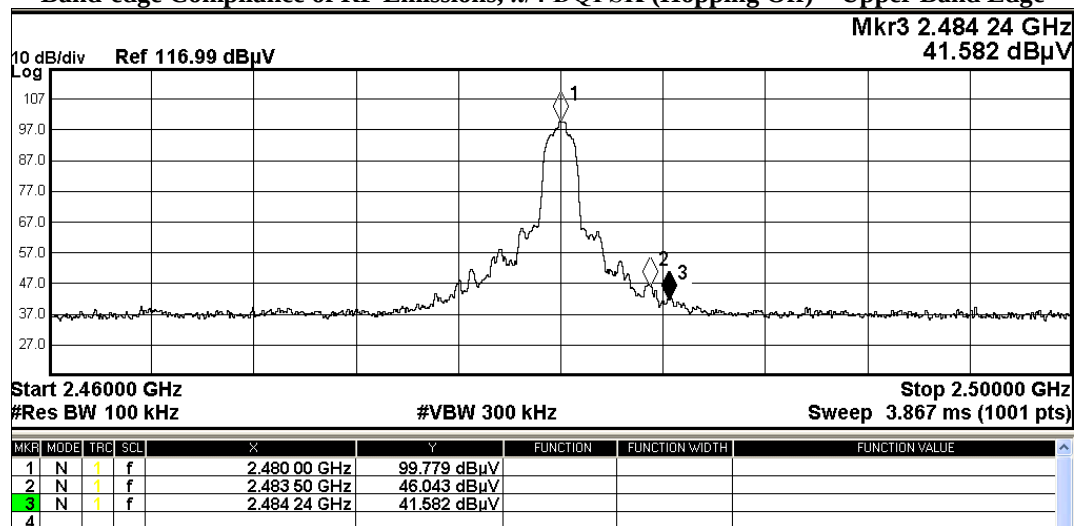
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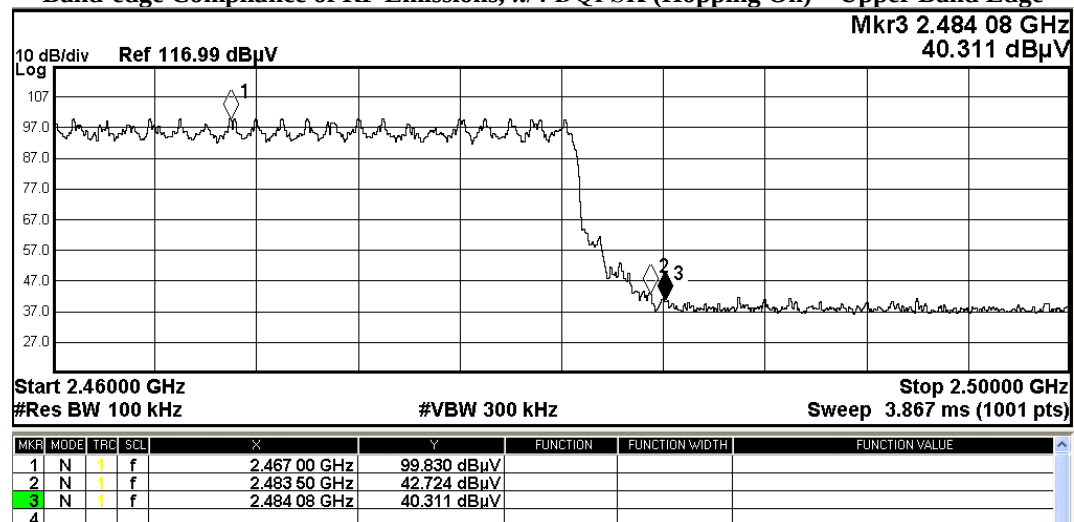
Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	53.7

Band-edge Compliance of RF Emissions, $\pi/4$ DQPSK (Hopping Off) – Upper Band Edge



Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	57.1

Band-edge Compliance of RF Emissions, $\pi/4$ DQPSK (Hopping On) – Upper Band Edge



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Band-edge Emissions Measurement:

Result: RF Radiated Emissions $-\pi/4$ 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 dBuV/m	E-Field Polarity
2375.9	3.8	36.8	40.6	74.0	33.4	Vertical
2380.8	5.5	36.8	42.3	74.0	31.7	Vertical
2484.2	4.7	36.9	41.6	74.0	32.4	Vertical
2484.1	3.4	36.9	40.3	74.0	33.7	Vertical

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 dBuV/m	E-Field Polarity
2375.9	-3.9	36.8	32.9	54.0	21.1	Vertical
2380.8	-4.3	36.8	32.5	54.0	21.5	Vertical
2484.2	-4.1	36.9	32.8	54.0	21.2	Vertical
2484.1	-4.5	36.9	32.4	54.0	21.6	Vertical

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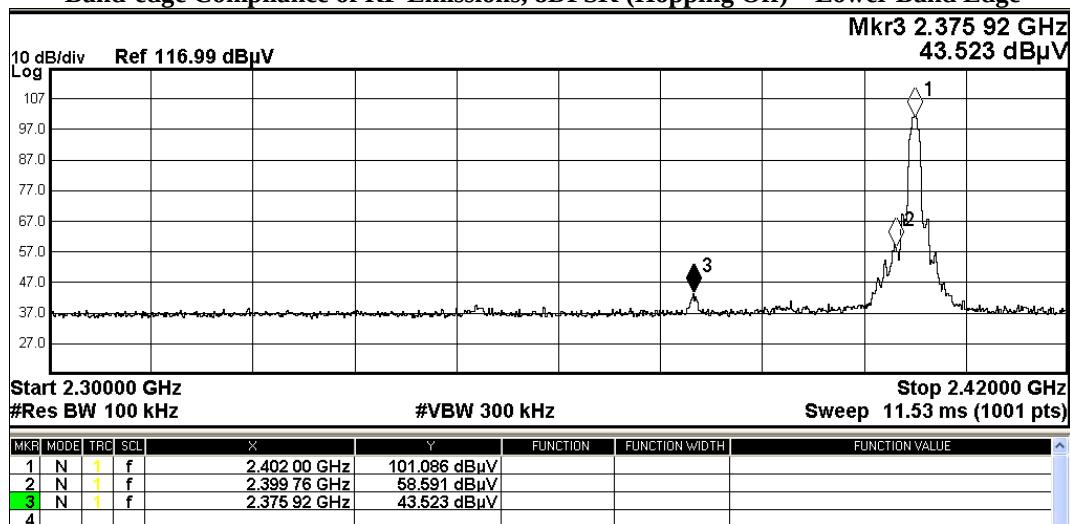
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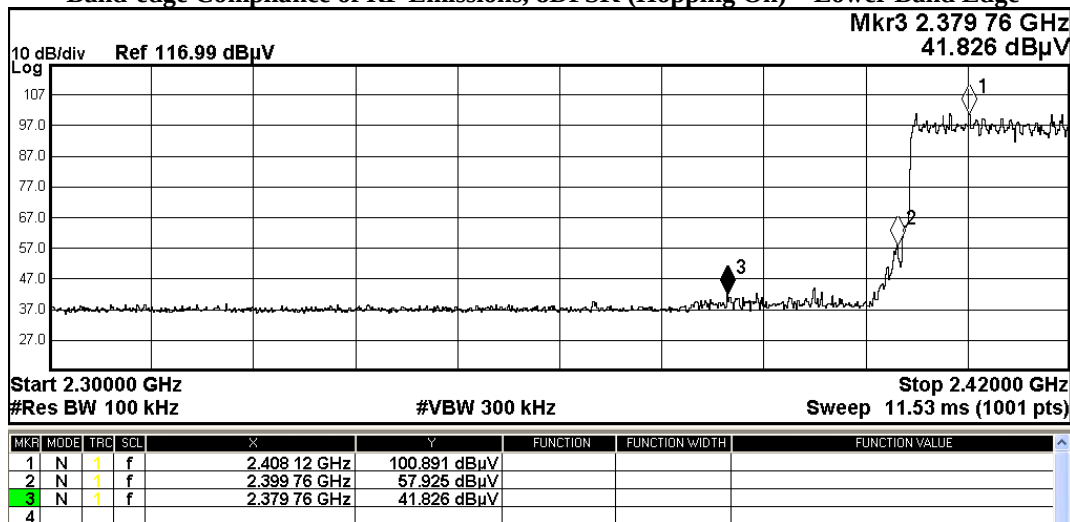
Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	42.5

Band-edge Compliance of RF Emissions, 8DPSK (Hopping Off) – Lower Band Edge



Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	43.0

Band-edge Compliance of RF Emissions, 8DPSK (Hopping On) – Lower Band Edge



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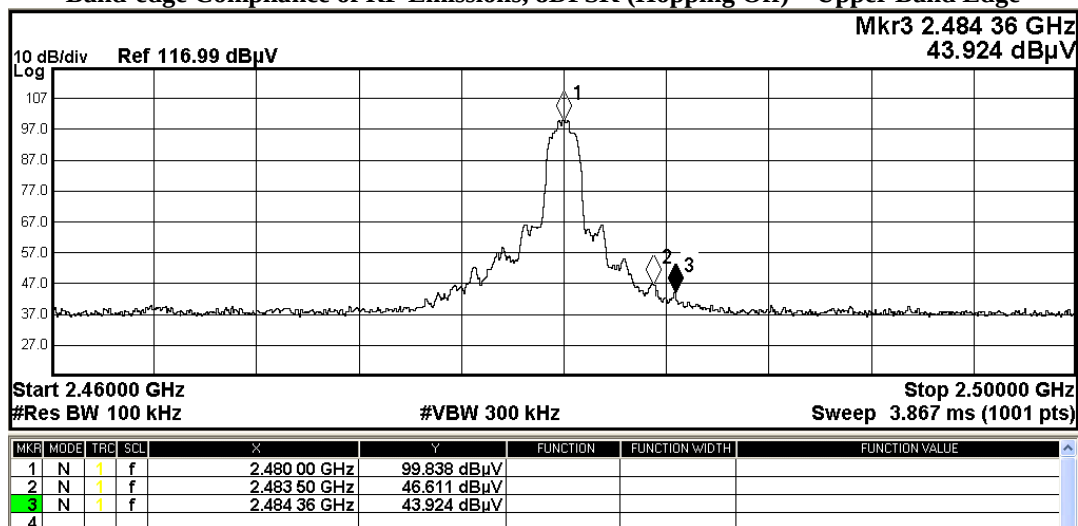
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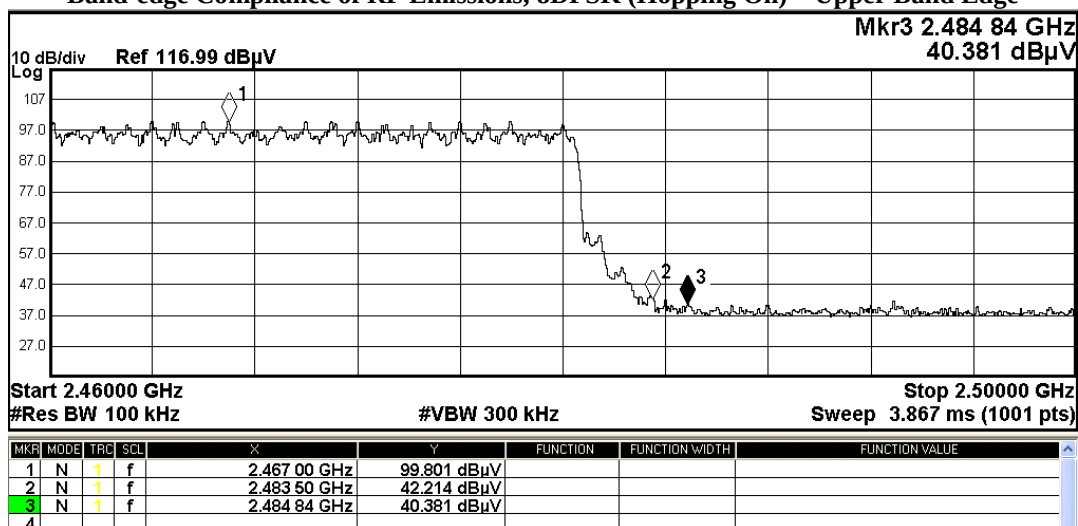
Frequency Range [MHz]	Radiated Emission Attenuate below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	53.2

Band-edge Compliance of RF Emissions, 8DPSK (Hopping Off) – Upper Band Edge



Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	57.6

Band-edge Compliance of RF Emissions, 8DPSK (Hopping On) – Upper Band Edge



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Band-edge Emissions Measurement:

Result: RF Radiated Emissions – 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 dBuV/m	E-Field Polarity
2375.9	6.7	36.8	43.5	74.0	30.5	Vertical
2379.8	5.0	36.8	41.8	74.0	32.2	Vertical
2484.4	7.0	36.9	43.9	74.0	30.1	Vertical
2484.8	3.5	36.9	40.4	74.0	33.6	Vertical

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 dBuV/m	E-Field Polarity
2375.9	-3.7	36.8	33.1	54.0	20.9	Vertical
2379.8	-4.0	36.8	32.8	54.0	21.2	Vertical
2484.4	-3.9	36.9	33.0	54.0	21.0	Vertical
2484.8	-4.1	36.9	32.8	54.0	21.2	Vertical

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3.1.8 Time of Occupancy (Dwell Time)

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,

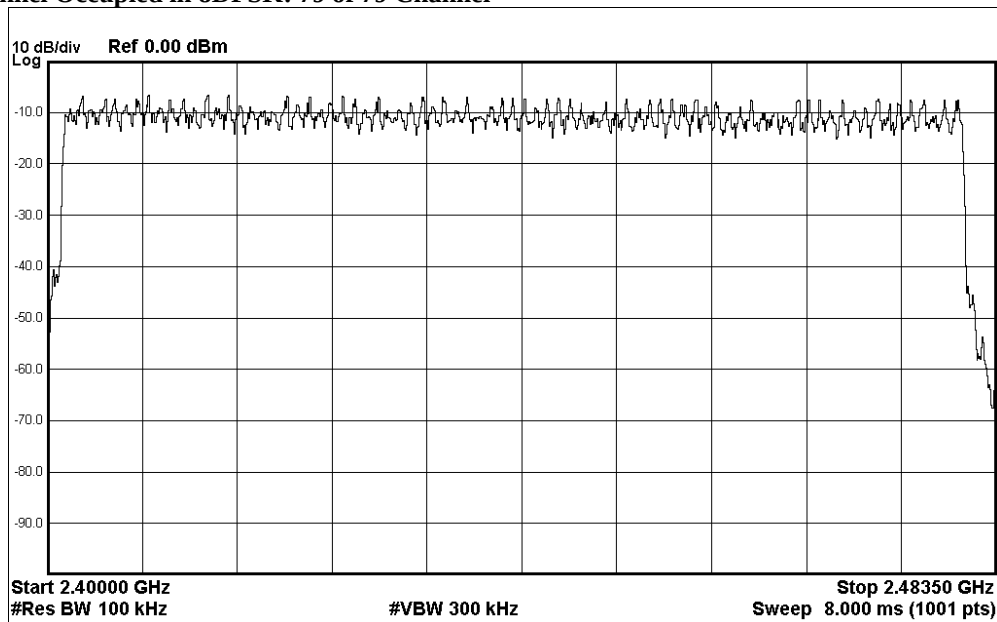
Span = Zero, Detector = Peak, Trace = Max. hold

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]

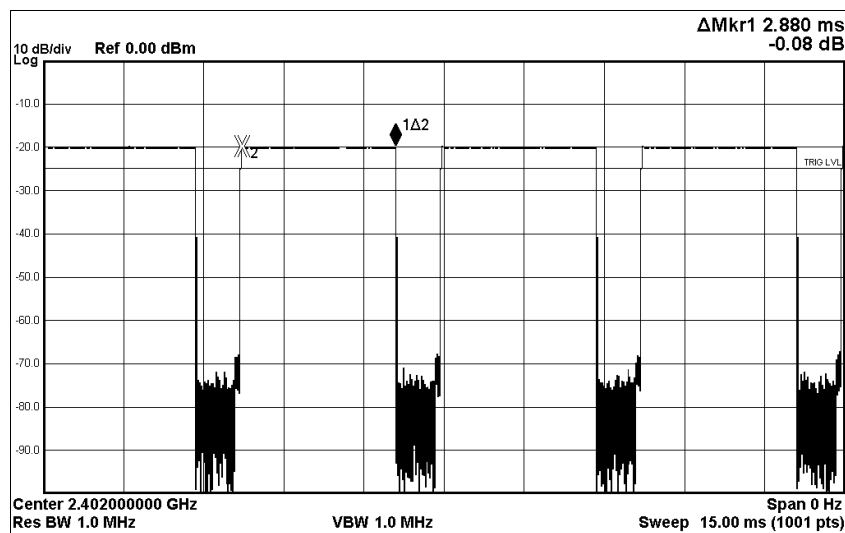
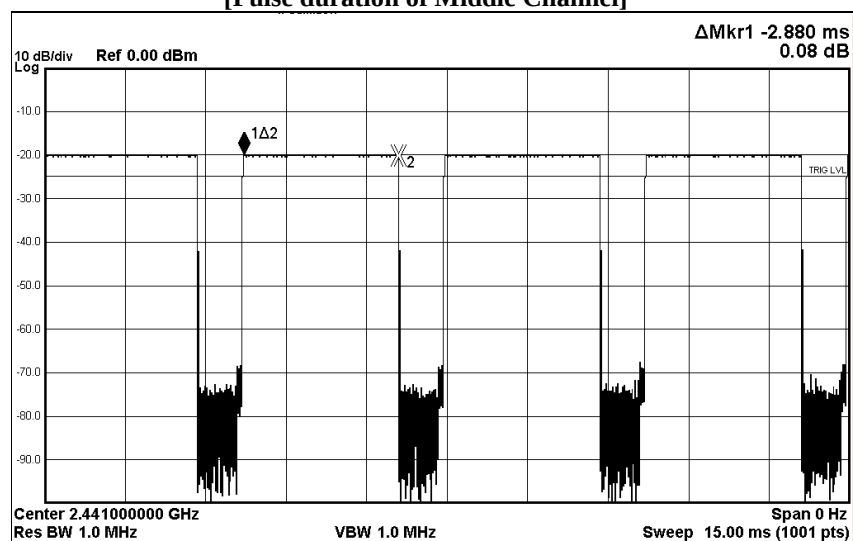


Fig. B
[Pulse duration of Middle Channel]



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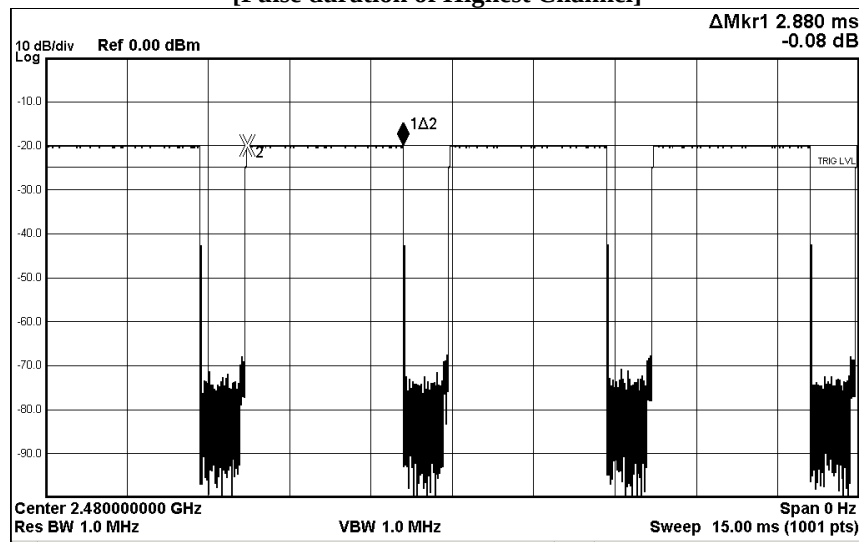
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Fig. C
[Pulse duration of Highest Channel]



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DH3 Packet:

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]

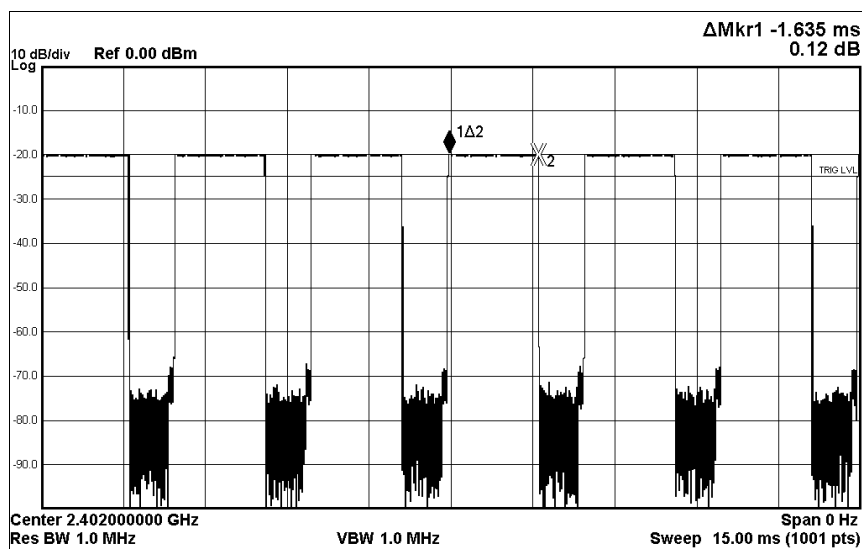
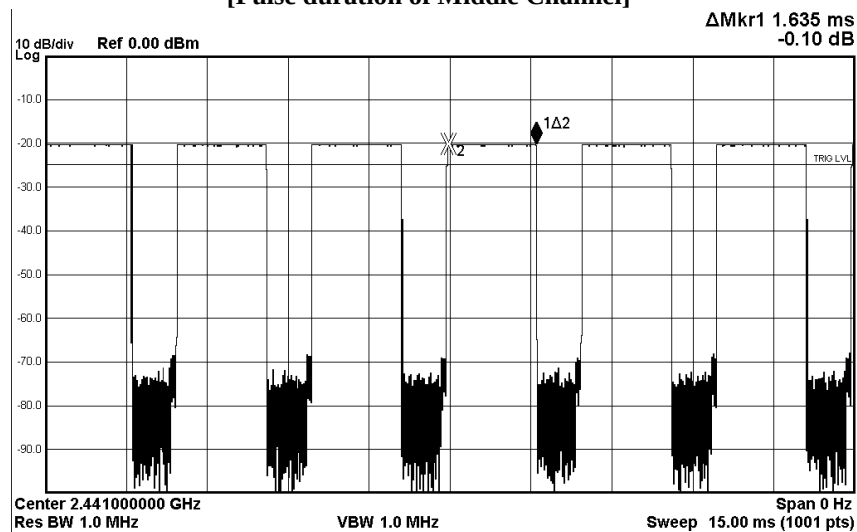


Fig. E
[Pulse duration of Middle Channel]



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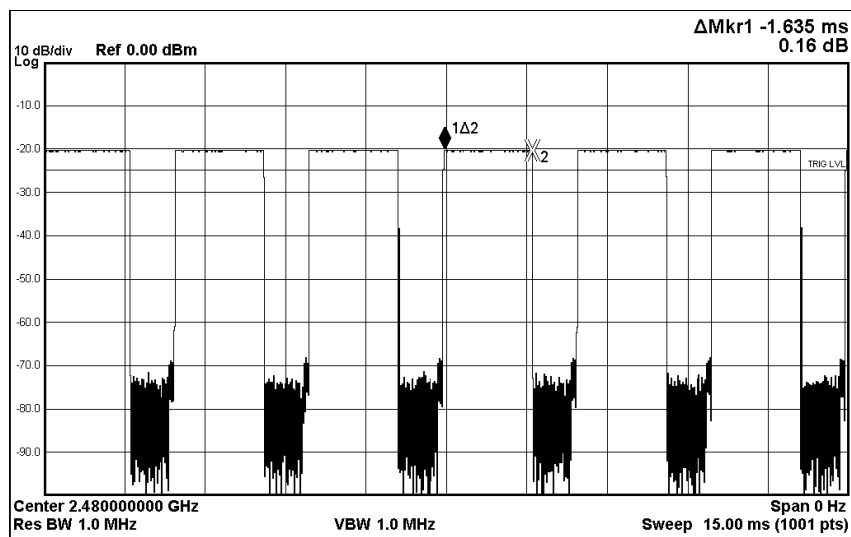
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Fig. F
[Pulse duration of Highest Channel]



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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]

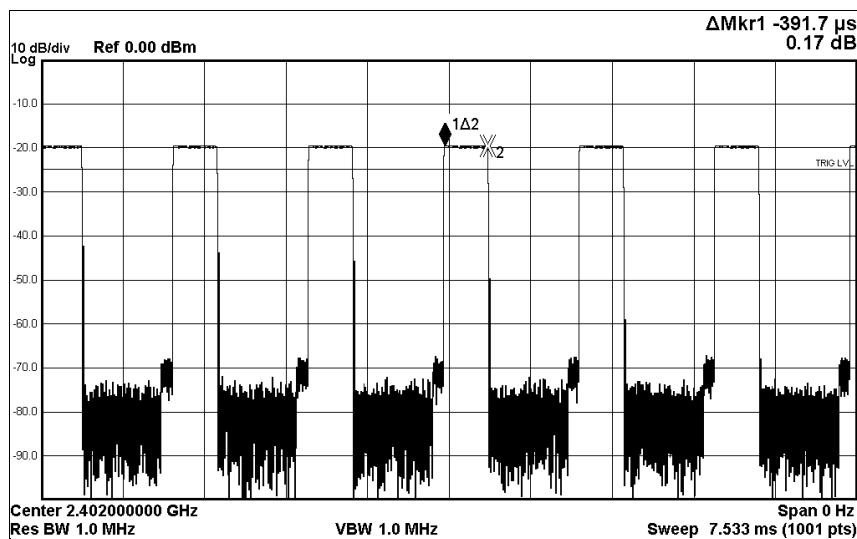
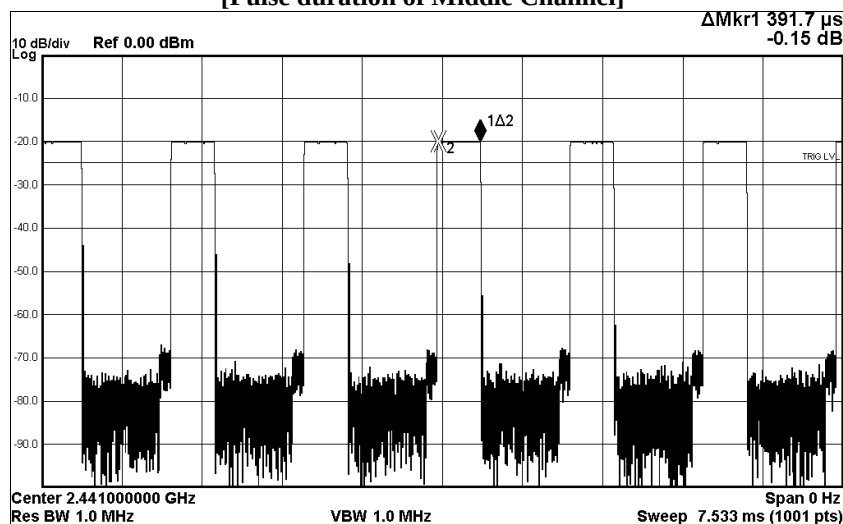


Fig. H
[Pulse duration of Middle Channel]



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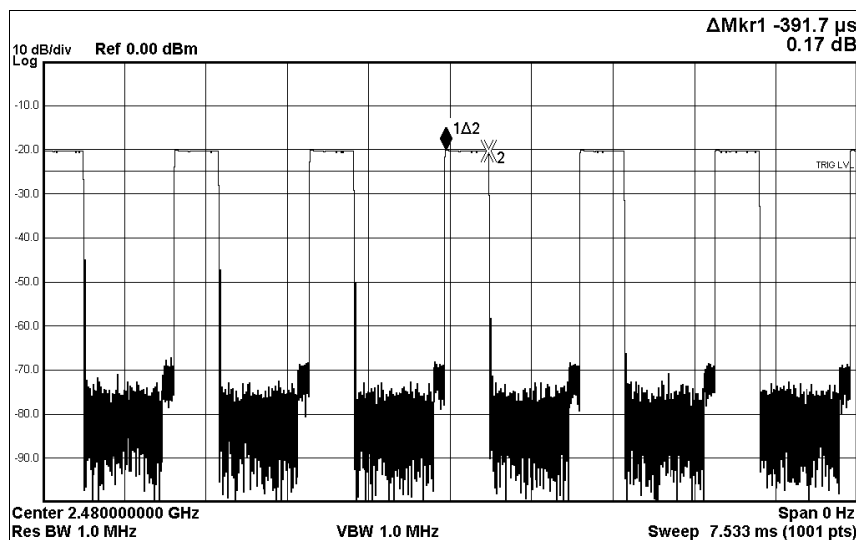
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Fig. I
[Pulse duration of Highest Channel]



Time of occupancy (Dwell Time):

Data Packet	Frequency (MHz)	Pulse Duration (ms)	Dwell Time (s)	Limits (s)	Test Results
DH5	2402	2.880	0.307	0.400	Complies
DH5	2441	2.880	0.307	0.400	Complies
DH5	2480	2.880	0.307	0.400	Complies
DH3	2402	1.635	0.262	0.400	Complies
DH3	2441	1.635	0.262	0.400	Complies
DH3	2480	1.635	0.262	0.400	Complies
DH1	2402	0.392	0.125	0.400	Complies
DH1	2441	0.392	0.125	0.400	Complies
DH1	2480	0.392	0.125	0.400	Complies

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3.1.9 Channel Centre Frequency

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

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

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 a PIFA. There is no external antenna, the antenna gain = 0dBi. User is unable to remove or changed the Antenna.

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3.1.12 RF Exposure

Test Requirement: FCC 47CFR 15.247(i)
Test Date: 2017-08-11
Mode of Operation: Tx mode (GFSK)

Test Method:

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

Test Results:

The EUT complied with the requirement(s) of this section.
EUT meets the requirements of these sections as proven through MPE calculation
The MPE calculation for EUT @ 20cm

GFSK

Based on the highest P = 1.36mW (2480MHz)

$$\begin{aligned} P_d &= PG / 4\pi R^2 = (1.36 \times 1) / 12.566 \times (20)^2 \\ &= (1.36) / 12.566 \times 400 = 1.36 / 5026.4 \\ &= 0.00027 \text{ mW/cm}^2 \end{aligned}$$

where:

- *Pd = power density in mW/cm²
- * G = Antenna numeric gain (1); Log G = g/10 (g = 0dBi).
- * P = Conducted RF power to antenna (1.36mW).
- * R = Minimum allowable distance.(20 cm)

**The SAR evaluation is not needed (this is a desk top device, R> 20 cm)

**The EUT(antenna) must be 0.2 meters away from the General Population.

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Appendix A

List of Measurement Equipment

LIST OF MEASUREMENT EQUIPMENT

Radiated Emission

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM215	MULTI-DEVICE 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	--	2017/04/24	2018/04/24
EM356	ANTENNA POSITIONING TOWER	ETS-LINDGREN	2171B	00150346	N/A	N/A
EM354	BICONILOG ANTENNA	ETS-LINDGREN	3143B	00142073	2016/02/29	2018/02/29
EM229	EMI TEST RECEIVER	R&S	ESIB40	100248	2017/06/01	2018/06/01
EM299	DOUBLE-RIDGED WAVEGUIDE HORN ANTENNA	ETS-LINDGREN	3115	00114120	2016/04/27	2018/04/27
EM300	PYRAMIDAL STANDARD GAIN HORN ANTENNA	ETS-LINDGREN	3160-09	00130130	2016/05/13	2018/05/13
EM301	PYRAMIDAL STANDARD GAIN HORN ANTENNA	ETS-LINDGREN	3160-10	00130988	2016/05/13	2018/05/13
EM302	PRECISION OMNIDIRECTIONAL DIPOLE (1 – 6GHZ)	SEIBERSDORF LABORATORIES	POD 16	161806/L	2016/05/11	2018/05/11
EM303	PRECISION OMNIDIRECTIONAL DIPOLE (6 – 18GHZ)	SEIBERSDORF LABORATORIES	POD 618	6181908/L	2016/05/11	2018/05/11
EM353	LOOP ANTENNA	ETS_LINDGREN	6502	00206533	2016/03/16	2018/03/16

Line Conducted

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM119	LISN	R & S	ESH3-Z5	0831.5518.52	2016/11/29	2017/11/29
EM181	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB7	100072	2017/06/01	2018/06/01
EM179	IMPULSE LIMITER	ROHDE & SCHWARZ	ESH3-Z2	357-8810.52/54	2017/01/11	2018/01/11
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	ESIB-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



Inside View of the product



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Photographs of EUT

Inner Circuit Bottom View



Inner Circuit Top View



WiFi module Top View (with Shield)



WiFi module Top View



WiFi module Bottom View



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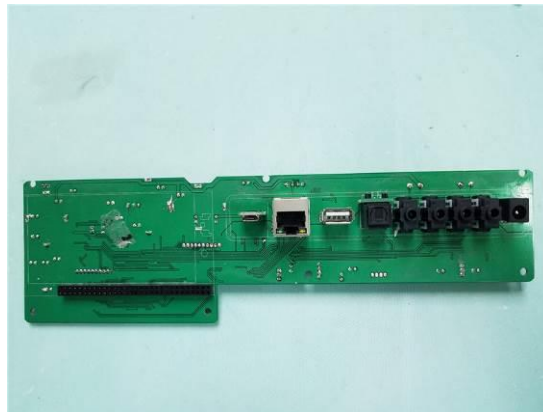
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Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



Inner Circuit Top View (NFC)



Inner Circuit Top View (NFC)



Inner Circuit Bottom View (NFC)



Test Report

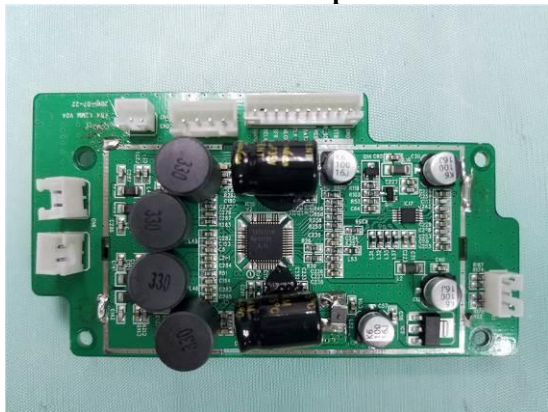
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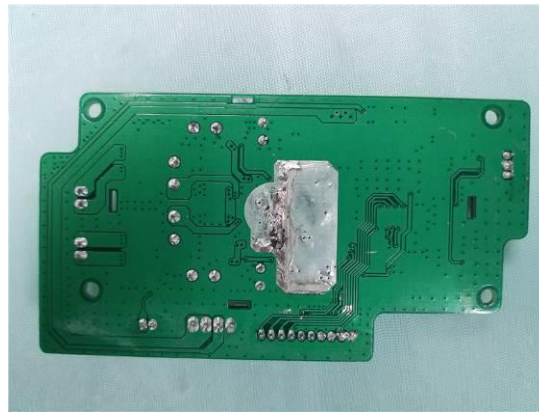
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Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



Inner Circuit Top View



Inner Circuit Bottom View



Inner Circuit Top View



Inner Circuit Bottom View



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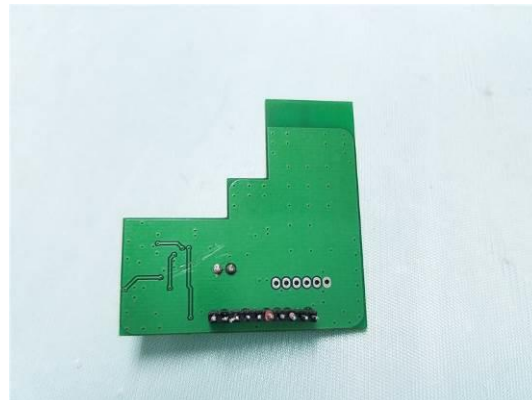
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Photographs of EUT

Inner Circuit Top View



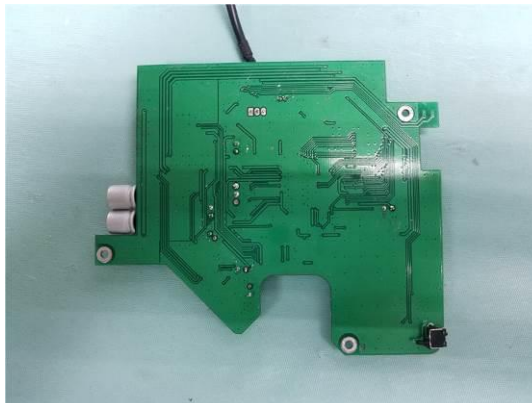
Inner Circuit Bottom View



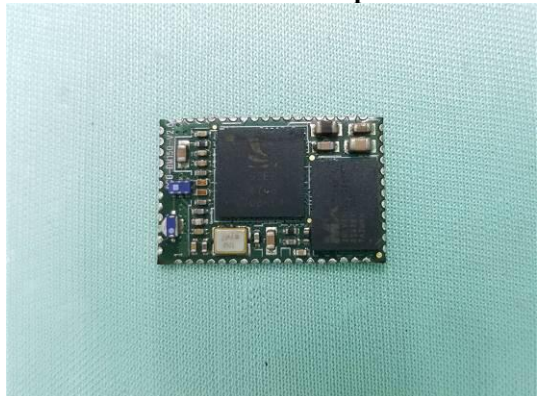
Inner Circuit Top View



Inner Circuit Bottom View



Bluetooth Module Top View



Bluetooth Module Bottom View



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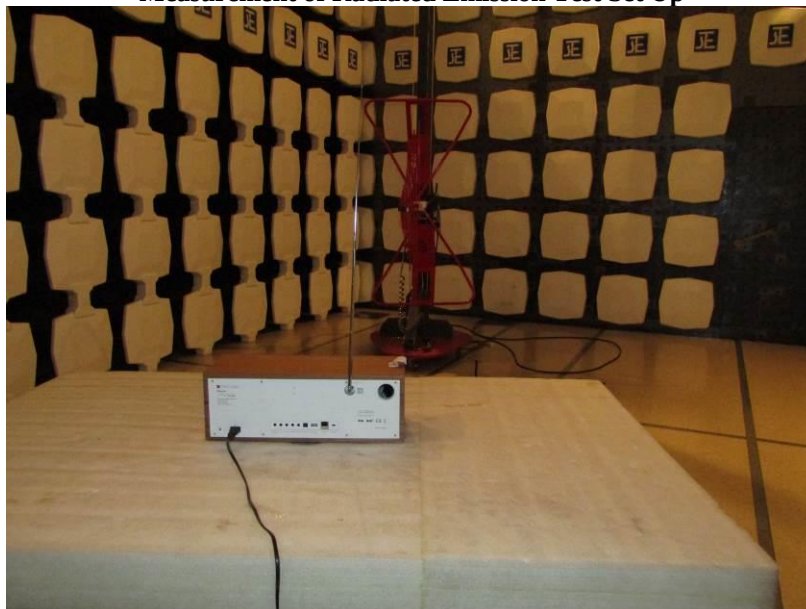
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Photographs of EUT

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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