



Test Report

Date : 2018-03-02
No. : HM18010011

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Applicant: Huizhou Qing Teng Electron Technology Co., Ltd
He-Bei Village, Lilin Town, Zhongkai Hi-tech Development Zone,
Huizhou City, Guangdong, China

Manufacturer: Huizhou Qing Teng Electron Technology Co., Ltd
He-Bei Village, Lilin Town, Zhongkai Hi-tech Development Zone,
Huizhou City, Guangdong, China

Description of Sample(s):

Product:	Bluetooth Speaker
Brand Name:	Sakar
Model Number:	SP2-17716
FCC ID:	2AAWNSP217716BTS

Date Sample(s) Received: 2018-01-03

Date Tested: 2018-02-07 to 2018-02-22

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/ $\pi/4$ -DQPSK)

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: Bluetooth Speaker
Manufacturer: Huizhou Qing Teng Electron Technology Co., Ltd
He-Bei Village, Lilin Town, Zhongkai Hi-tech Development
Zone, Huizhou City, Guangdong, China
Brand Name: Sakar
Model Number: SP2-17716
Rating: Input: Li-ion Rechargeable battery x1: 3.7Vd.c / 110Va.c,
5Vd.c (USB Micro B), (Adaptor was not provided by
manufacturer, universal adaptor was used for tests. Adaptor
info: Model no., SP-12-UK, Input: 100-240Va.c, Output:
5V, 14.4VA)

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is Bluetooth Speaker. 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

2018-01-03

1.4 Submitted Sample(s):

2 Samples

1.5 Test Duration

2018-02-07 to 2018-02-22

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1.6 Country of Origin

China

1.7 Antenna Details

Antenna Type (Bluetooth): Circuit board printed meander line antenna
Antenna Gain (Bluetooth): -0.58dBi

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	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
Hopping Channel Separation	GFSK / $\pi/4$ -DQPSK
Number of Hopping Frequency	GFSK / $\pi/4$ -DQPSK
Time of Occupancy(Dwell Time)	$\pi/4$ -DQPSK (DH1 / DH3 / DH5)
Radiated Spurious Emissions	GFSK / $\pi/4$ -DQPSK

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3.0 Test Results

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3.1 Emission

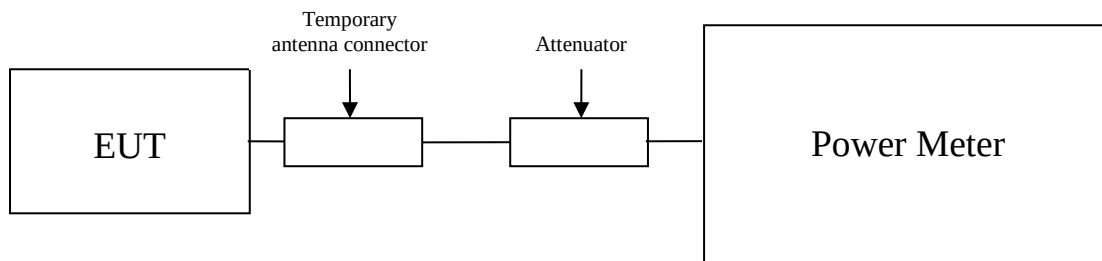
3.1.1 Maximum Peak Conducted Output Power

Test Requirement: FCC 47CFR 15.247(b)(2)
Test Method: ANSI C63.10:2013
Test Date: 2018-02-22
Mode of Operation: Tx mode :GFSK/ π /4-DQPSK

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	0.000178
39	2441	0.000186
78	2480	0.000231

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

Channel	Frequency(MHz)	Output Power(Watt)
0	2402	0.000134
39	2441	0.000156
78	2480	0.000201

:

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)

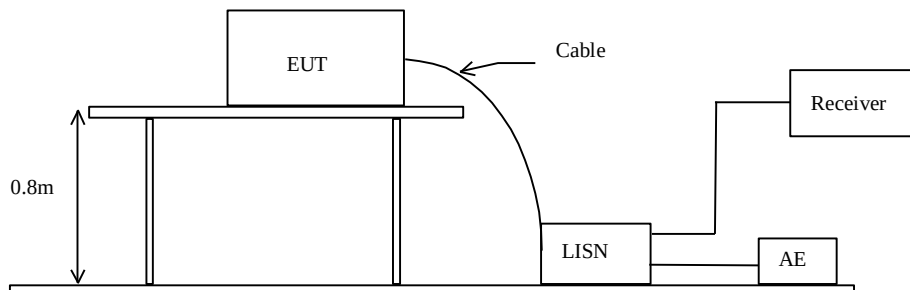
Test Requirement: FCC 47CFR 15.207
Test Method: ANSI C63.10:2013
Test Date: 2018-02-07

Mode of Operation: Tx mode

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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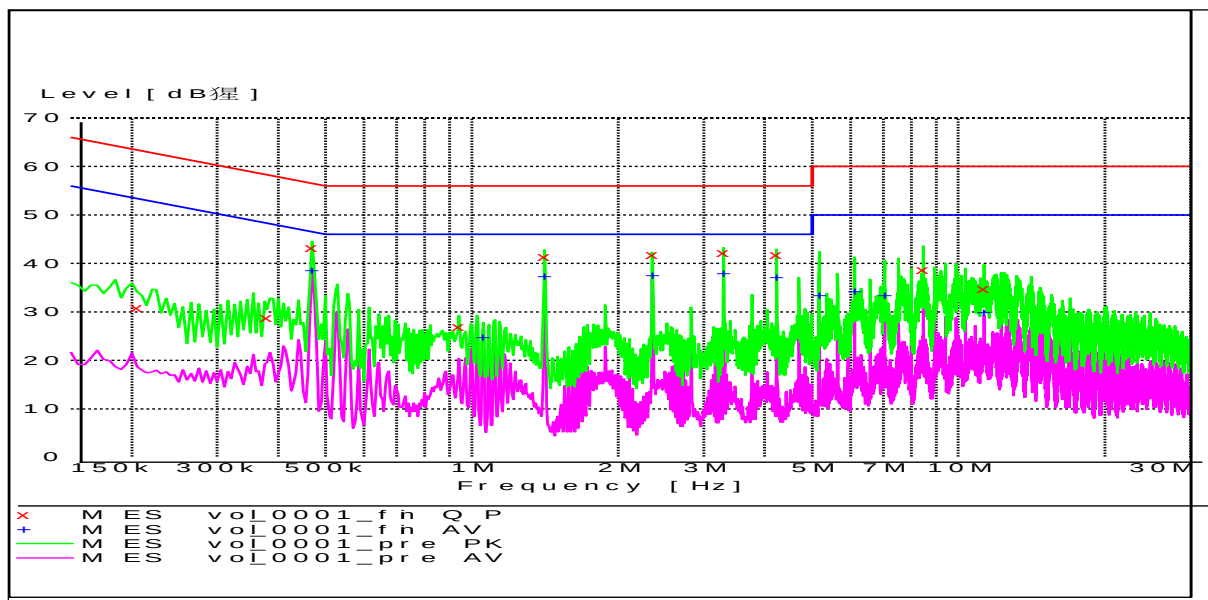
Limit for Conducted Emissions (FCC 47CFR 15.207):

Frequency Range [MHz]	Quasi-Peak Limits [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: PASS



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MEASUREMENT RESULT: "vol_0001_fin QP"

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Line	PE
0.205000	30.80	9.9	63	32.6	L1	GND
0.380000	28.80	10.0	58	29.5	L1	GND
0.470000	43.10	10.0	57	13.4	L1	GND
0.940000	26.90	9.8	56	29.1	L1	GND
1.410000	41.40	9.9	56	14.6	L1	GND
2.355000	41.70	10.2	56	14.3	L1	GND
3.295000	42.30	10.4	56	13.7	L1	GND
4.235000	41.80	10.5	56	14.2	L1	GND
8.470000	38.70	10.5	60	21.3	L1	GND
11.300000	34.80	10.5	60	25.2	L1	GND

MEASUREMENT RESULT: "vol_0001_fin AV"

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Line	PE
0.470000	38.50	10.0	47	8.0	L1	GND
1.055000	24.60	9.8	46	21.4	L1	GND
1.410000	37.30	9.9	46	8.7	L1	GND
2.355000	37.50	10.2	46	8.5	L1	GND
3.295000	37.80	10.4	46	8.2	L1	GND
4.235000	37.00	10.5	46	9.0	L1	GND
5.175000	33.30	10.5	50	16.7	L1	GND
6.120000	34.20	10.6	50	15.8	L1	GND
7.060000	33.40	10.5	50	16.6	L1	GND
11.295000	29.80	10.5	50	20.2	L1	GND

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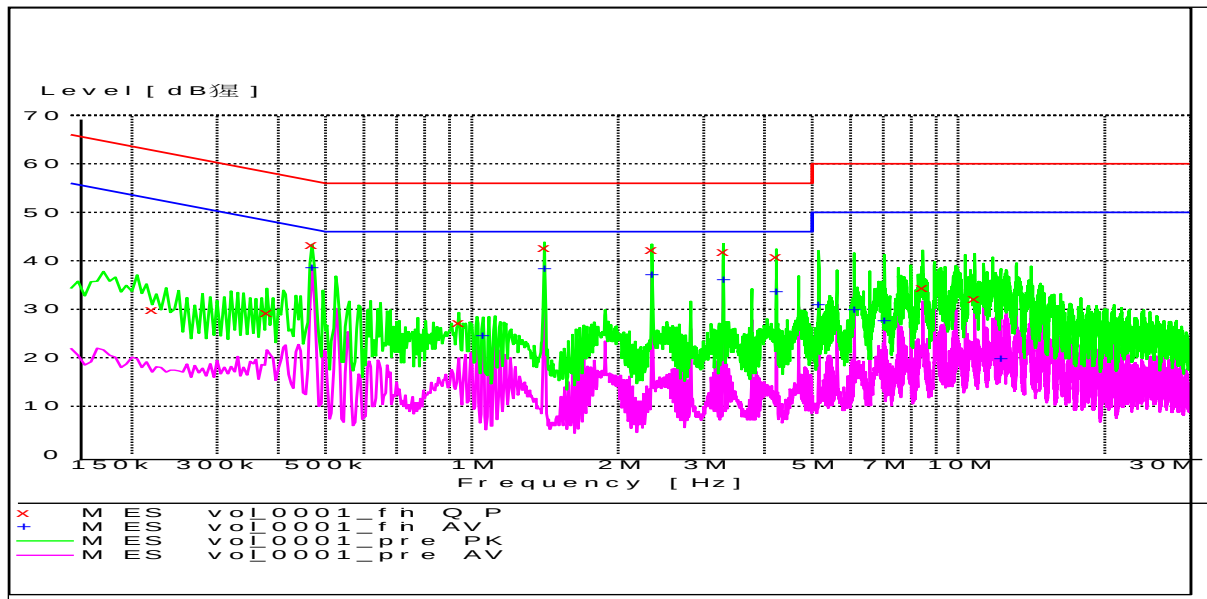
Limit for Conducted Emissions (FCC 47CFR 15.207):

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 –Neutral: PASS



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MEASUREMENT RESULT: "vol_0001_fin QP"

Frequency MHz	Level dB μ V	Transd dB	Limit dB μ V	Margin dB	Line	PE
0.220000	29.90	9.9	63	32.9	N	GND
0.380000	29.30	10.0	58	29.0	N	GND
0.470000	43.20	10.0	57	13.3	N	GND
0.940000	27.20	9.8	56	28.8	N	GND
1.410000	42.60	9.9	56	13.4	N	GND
2.350000	42.30	10.2	56	13.7	N	GND
3.290000	41.90	10.4	56	14.1	N	GND
4.230000	40.80	10.5	56	15.2	N	GND
8.460000	34.50	10.5	60	25.5	N	GND
10.810000	32.10	10.4	60	27.9	N	GND

MEASUREMENT RESULT: "vol_0001_fin AV"

Frequency MHz	Level dB μ V	Transd dB	Limit dB μ V	Margin dB	Line	PE
0.470000	38.60	10.0	47	7.9	N	GND
1.055000	24.60	9.8	46	21.4	N	GND
1.410000	38.30	9.9	46	7.7	N	GND
2.350000	37.20	10.2	46	8.8	N	GND
3.290000	36.10	10.4	46	9.9	N	GND
4.230000	33.70	10.5	46	12.3	N	GND
5.170000	30.90	10.5	50	19.1	N	GND
6.110000	29.80	10.6	50	20.2	N	GND
7.050000	27.50	10.5	50	22.5	N	GND
12.220000	19.80	10.6	50	30.2	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:	2018-02-07 and 2018-02-22
Mode of Operation:	Tx mode :GFSK/ π /4-DQPSK

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 Designation Number: HK0001.

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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

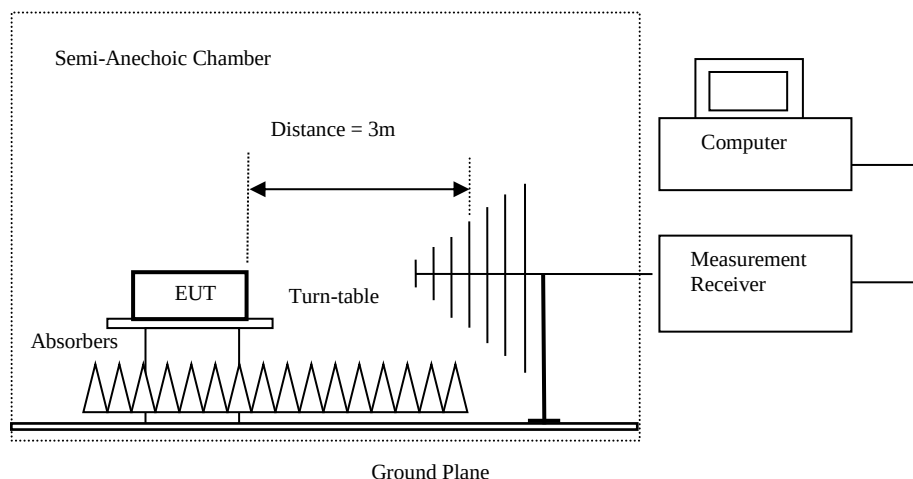
30MHz – 1GHz (QP)

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 Class B]:

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

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

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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) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
2402.0	57.6	27.8	85.4	N/A	N/A	Vertical
4804.0	2.3	42.4	44.7	74.0	29.3	Vertical
7206.0	2.1	46.7	48.8	74.0	25.2	Vertical
9608.0	1.3	48.4	49.7	74.0	24.3	Vertical
12010.0	0.6	53.1	53.7	74.0	20.3	Vertical

Result of Tx mode (GFSK: 2402.0 MHz) (Above 1GHz): 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 dB	E-Field Polarity
2402.0	45.7	27.8	73.5	N/A	N/A	Vertical
4804.0	-8.6	42.4	33.8	54.0	20.2	Vertical
7206.0	-10.3	46.7	36.4	54.0	17.6	Vertical
9608.0	-11.8	48.4	36.6	54.0	17.4	Vertical
12010.0	-12.3	53.1	40.8	54.0	13.2	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) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
2441.0	56.7	27.8	84.5	N/A	N/A	Vertical
4882.0	2.4	42.5	44.9	74.0	29.1	Vertical
7323.0	1.8	47.1	48.9	74.0	25.1	Vertical
9764.0	1.6	49.3	50.9	74.0	23.1	Vertical
12205.0	0.7	53.1	53.8	74.0	20.2	Vertical

Result of Tx mode (GFSK: 2441.0 MHz) (Above 1GHz): 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 dB	E-Field Polarity
2441.0	45.7	27.8	73.5	N/A	N/A	Vertical
4882.0	-8.6	42.5	33.9	54.0	20.1	Vertical
7323.0	-9.3	47.1	37.8	54.0	16.2	Vertical
9764.0	-10.9	49.3	38.4	54.0	15.6	Vertical
12205.0	-12.0	53.1	41.1	54.0	12.9	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) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
2480.0	58.9	27.8	86.7	N/A	N/A	Vertical
4960.0	2.6	43.2	45.8	74.0	28.2	Vertical
7440.0	1.5	46.2	47.7	74.0	26.3	Vertical
9920.0	1.3	50.9	52.2	74.0	21.8	Vertical
12400.0	0.7	54.3	55.0	74.0	19.0	Vertical

Result of Tx mode (GFSK: 2480.0 MHz) (Above 1GHz): 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 dB	E-Field Polarity
2480.0	45.9	27.8	73.7	N/A	N/A	Vertical
4960.0	-9.1	43.2	34.1	54.0	19.9	Vertical
7440.0	-10.8	46.2	35.4	54.0	18.6	Vertical
9920.0	-11.7	50.9	39.2	54.0	14.8	Vertical
12400.0	-11.9	54.3	42.4	54.0	11.6	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) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
2402.0	56.4	27.8	84.2	N/A	N/A	Vertical
4804.0	2.5	42.4	44.9	74.0	29.1	Vertical
7206.0	1.7	46.7	48.4	74.0	25.6	Vertical
9608.0	1.8	48.4	50.2	74.0	23.8	Vertical
12010.0	0.9	53.1	54.0	74.0	20.0	Vertical

Result of Tx mode ($\pi/4$ -DQPSK: 2402.0 MHz) (Above 1GHz): 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 dB	E-Field Polarity
2402.0	44.6	27.8	72.4	N/A	N/A	Vertical
4804.0	-9.3	42.4	33.1	54.0	20.9	Vertical
7206.0	-10.8	46.7	35.9	54.0	18.1	Vertical
9608.0	-11.5	48.4	36.9	54.0	17.1	Vertical
12010.0	-12.4	53.1	40.7	54.0	13.3	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) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
2441.0	56.2	27.8	84.0	N/A	N/A	Vertical
4882.0	2.1	42.5	44.6	74.0	29.4	Vertical
7323.0	1.5	47.1	48.6	74.0	25.4	Vertical
9764.0	1.3	49.3	50.6	74.0	23.4	Vertical
12205.0	0.9	53.1	54.0	74.0	20.0	Vertical

Result of Tx mode ($\pi/4$ -DQPSK: 2441.0 MHz) (Above 1GHz): 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 dB	E-Field Polarity
2441.0	43.4	27.8	71.2	N/A	N/A	Vertical
4882.0	-8.9	42.5	33.6	54.0	20.4	Vertical
7323.0	-10.4	47.1	36.7	54.0	17.3	Vertical
9764.0	-11.5	49.3	37.8	54.0	16.2	Vertical
12205.0	-12.2	53.1	40.9	54.0	13.1	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) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
2480.0	56.3	27.8	84.1	N/A	N/A	Vertical
4960.0	2.7	43.2	45.9	74.0	28.1	Vertical
7440.0	1.8	46.2	48.0	74.0	26.0	Vertical
9920.0	1.6	50.9	52.5	74.0	21.5	Vertical
12400.0	0.9	54.3	55.2	74.0	18.8	Vertical

Result of Tx mode ($\pi/4$ -DQPSK: 2480.0 MHz) (Above 1GHz): 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 dB	E-Field Polarity
2480.0	44.3	27.8	72.1	N/A	N/A	Vertical
4960.0	-8.9	43.2	34.3	54.0	19.7	Vertical
7440.0	-10.4	46.2	35.8	54.0	18.2	Vertical
9920.0	-11.8	50.9	39.1	54.0	14.9	Vertical
12400.0	-12.3	54.3	42.0	54.0	12.0	Vertical

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Limits for Radiated Emissions [FCC 47 CFR 15.209 Class B]:

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 Bluetooth communication 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
60.0	24.5	6.8	31.3	36.7	100	Vertical
120.0	22.1	7.8	29.9	31.3	150	Vertical
240.0	15.6	12.4	28.0	25.1	150	Horizontal
360.0	10.4	16.1	26.5	21.1	200	Horizontal
420.0	8.5	17.3	25.8	19.5	200	Horizontal
540.0	12.4	20.0	32.4	41.7	200	Horizontal

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

Emissions detected are more than 20 dB below the FCC Limits

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

Emissions detected are more than 20 dB below the FCC Limits

Remarks:

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

Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty:
(9kHz - 30MHz): 2.4dB
(30MHz - 18GHz): 5.0dB
(18GHz - 26GHz): 5.24dB

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:

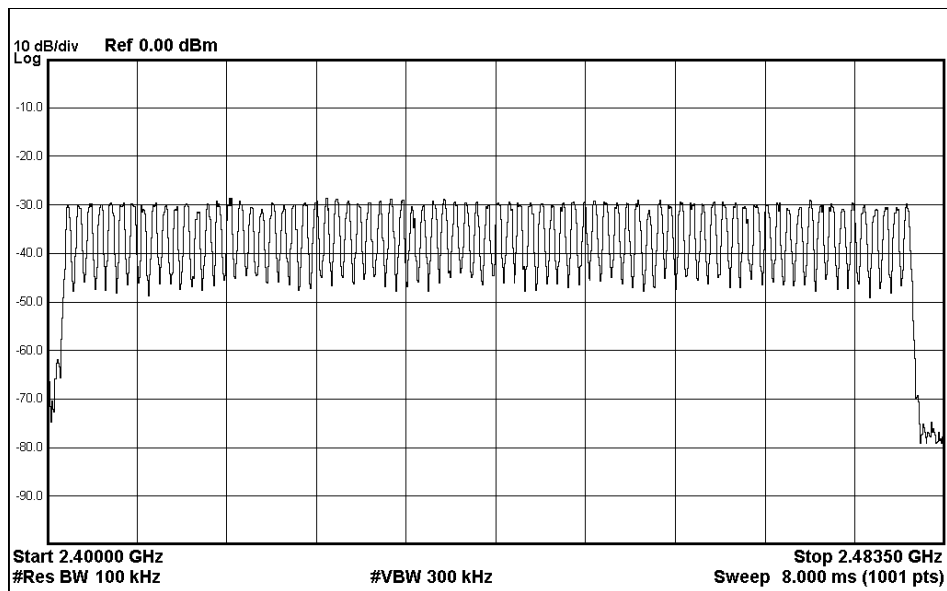
RBW = 100kHz, VBW $\geq$ RBW, Sweep = Auto, Span = the frequency band of operation
Detector = Peak, Trace = Max. hold

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

Measurement Data:

GFSK: 79 of 79 Channel



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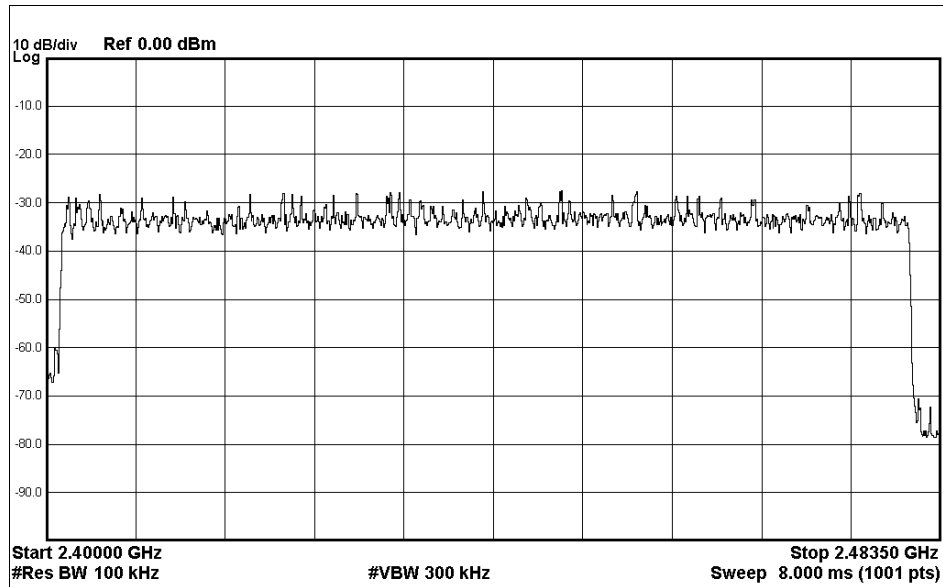


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$\pi/4$ -DQPSK: 79 of 79 Channel



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3.1.5 20dB Bandwidth

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Test Requirement:	FCC 47CFR 15.247(a)(1)
Test Method:	ANSI C63.10:2013
Test Date:	2018-02-22
Mode of Operation:	Tx mode :GFSK/ π /4-DQPSK

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.

Uncertainty: $\pm 1.0 \times 10^{-8}$

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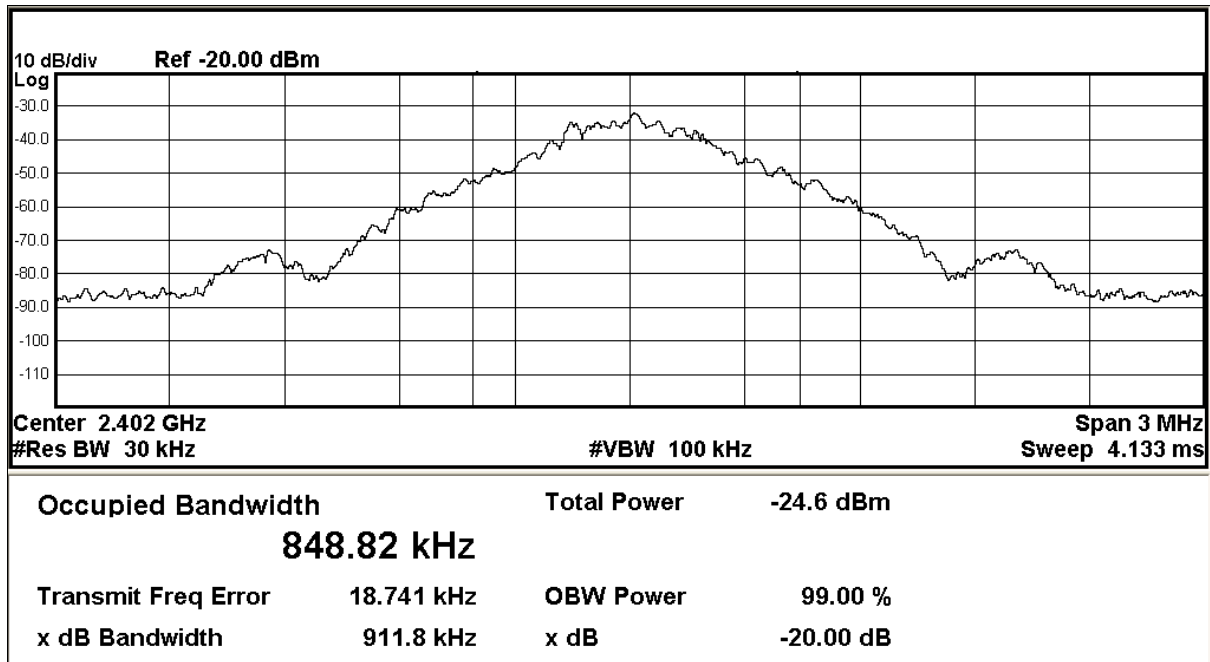
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	0.91	Within 2400-2483.5

(Lowest Operating Frequency) - (GFSK)



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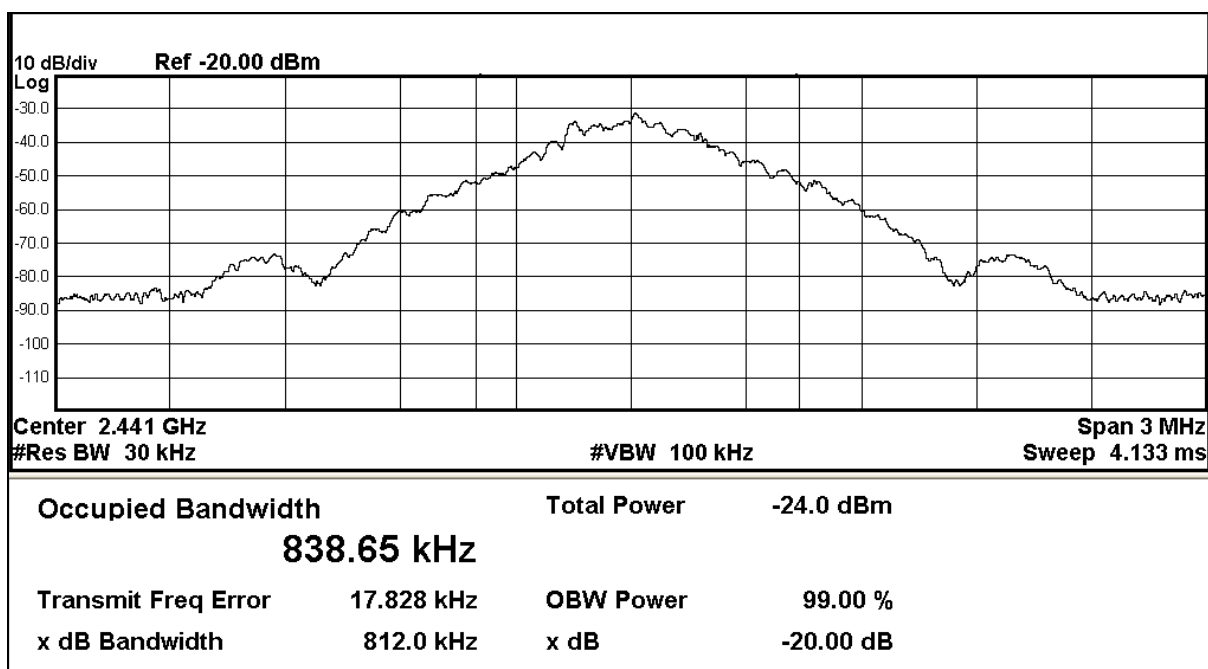
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	0.81	Within 2400-2483.5

(Middle Operating Frequency) - (GFSK)



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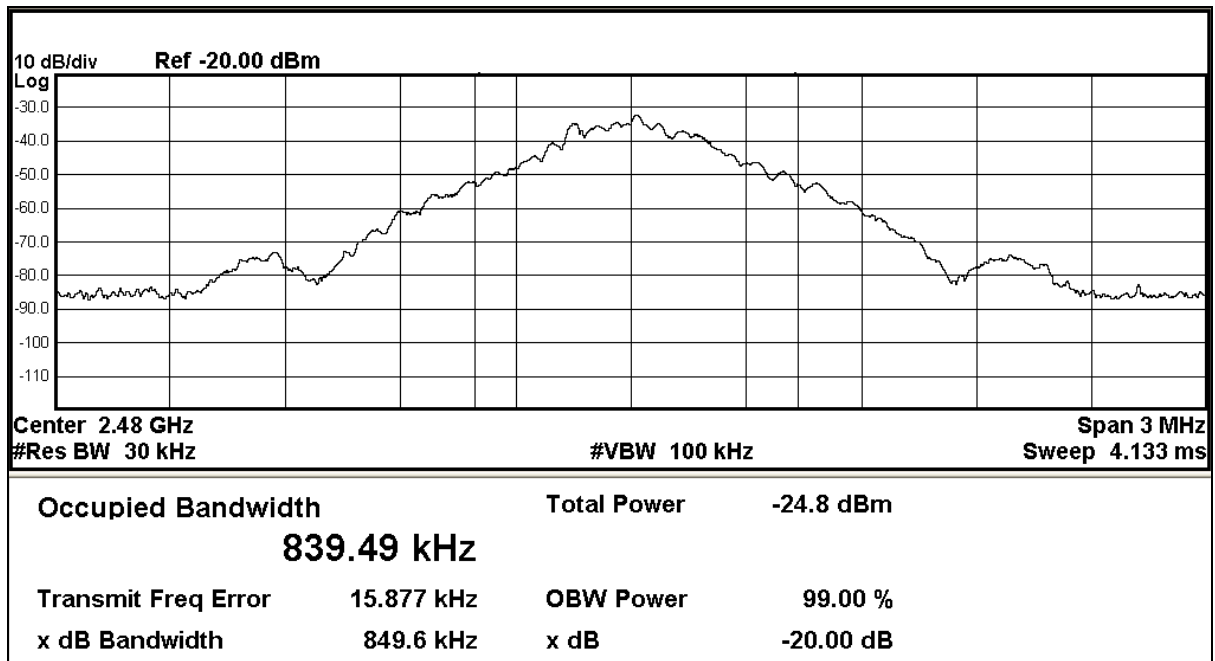
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	0.85	Within 2400-2483.5

(Highest Operating Frequency) - (GFSK)



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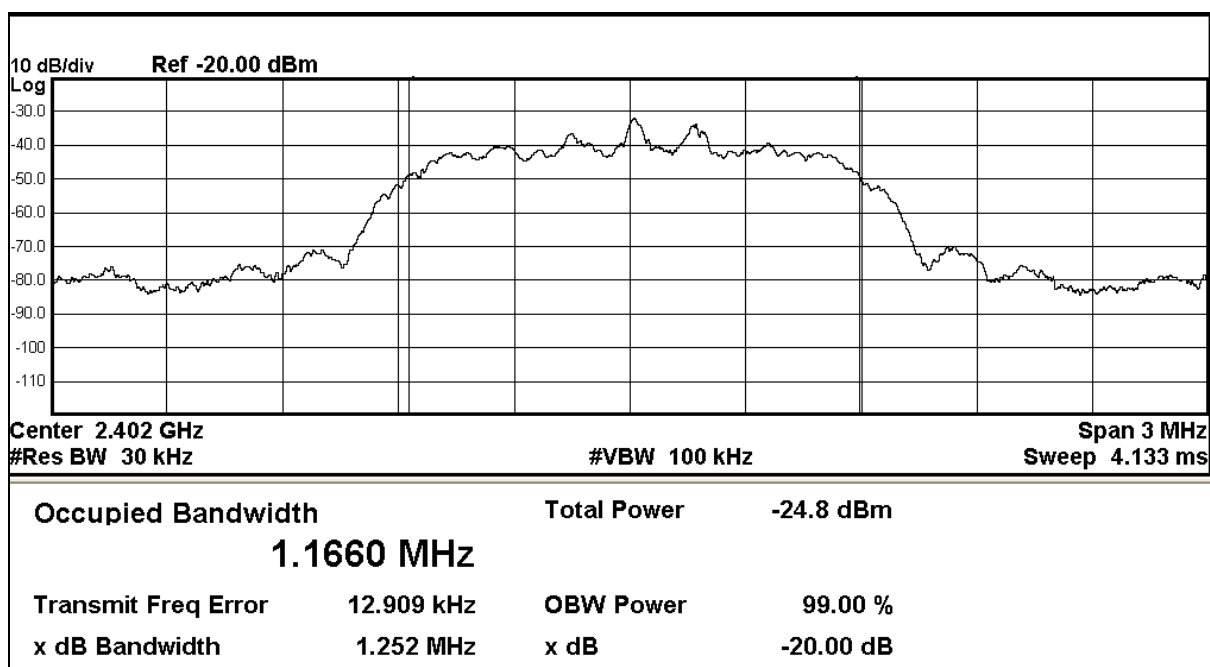
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.25	Within 2400-2483.5

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



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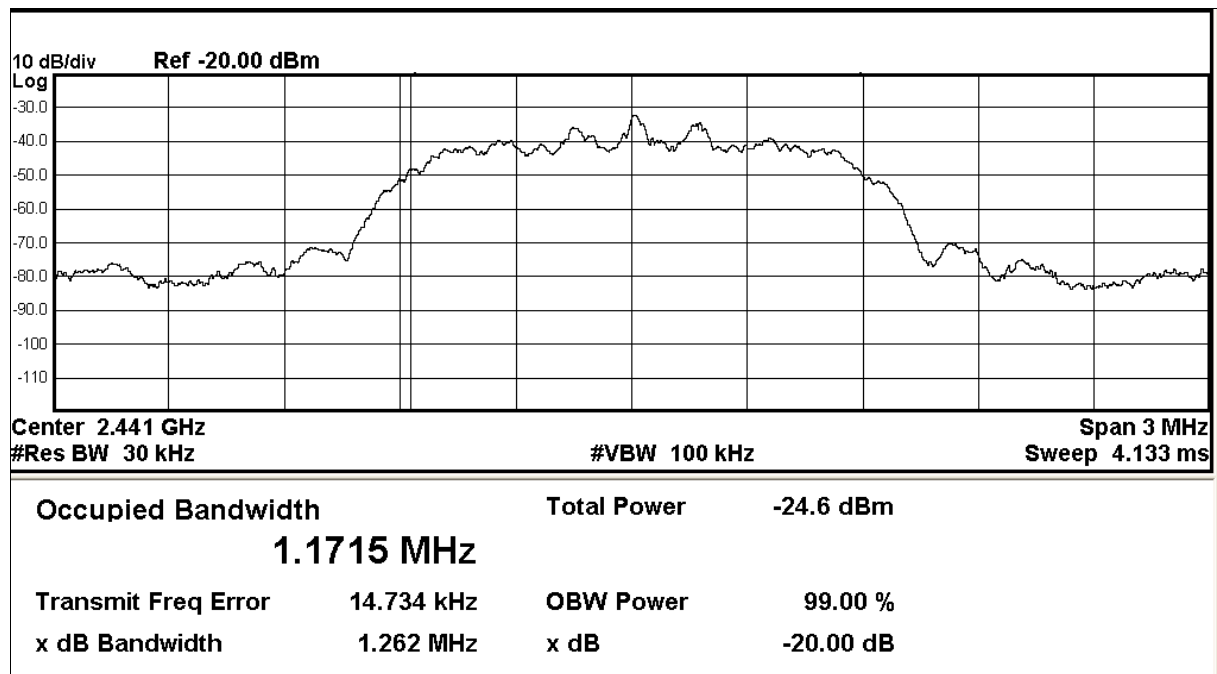
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.26	Within 2400-2483.5

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



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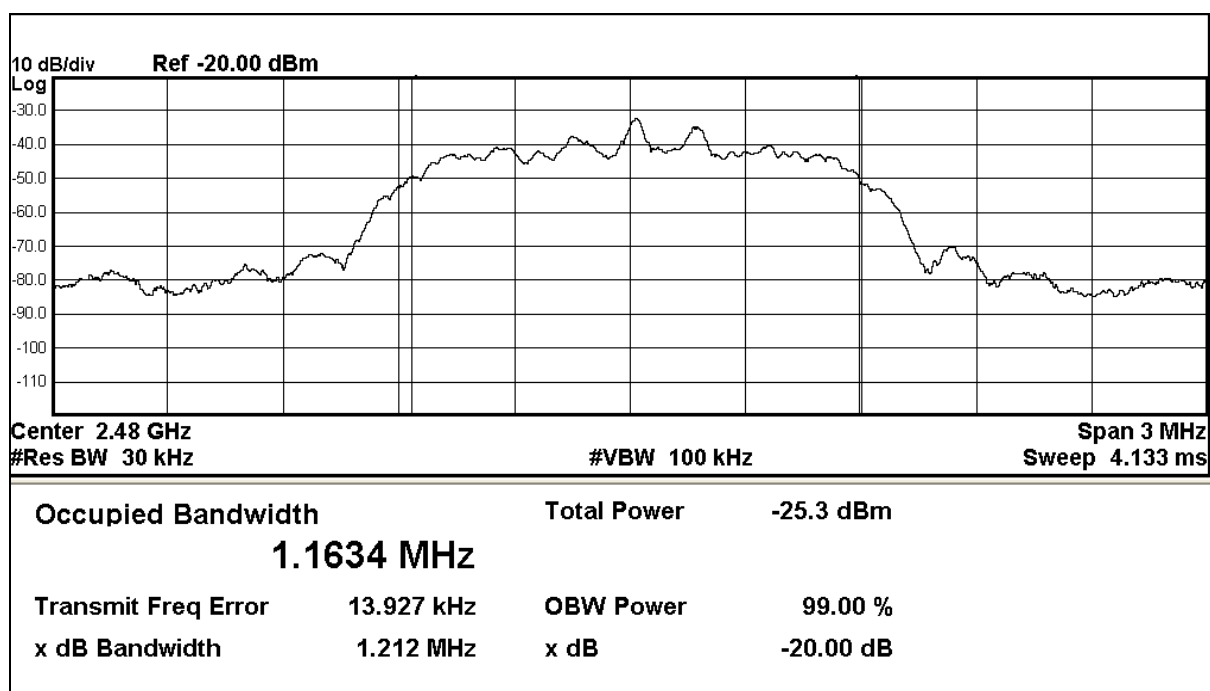
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.21	Within 2400-2483.5

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



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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 = 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 = 0.91MHz * 2/3 = 606.7kHz

$\pi/4$ DQPSK: The measured maximum bandwidth * 2/3 = 1.26MHz * 2/3 = 840.0kHz

Uncertainty: $\pm 1.0 \times 10^{-8}$

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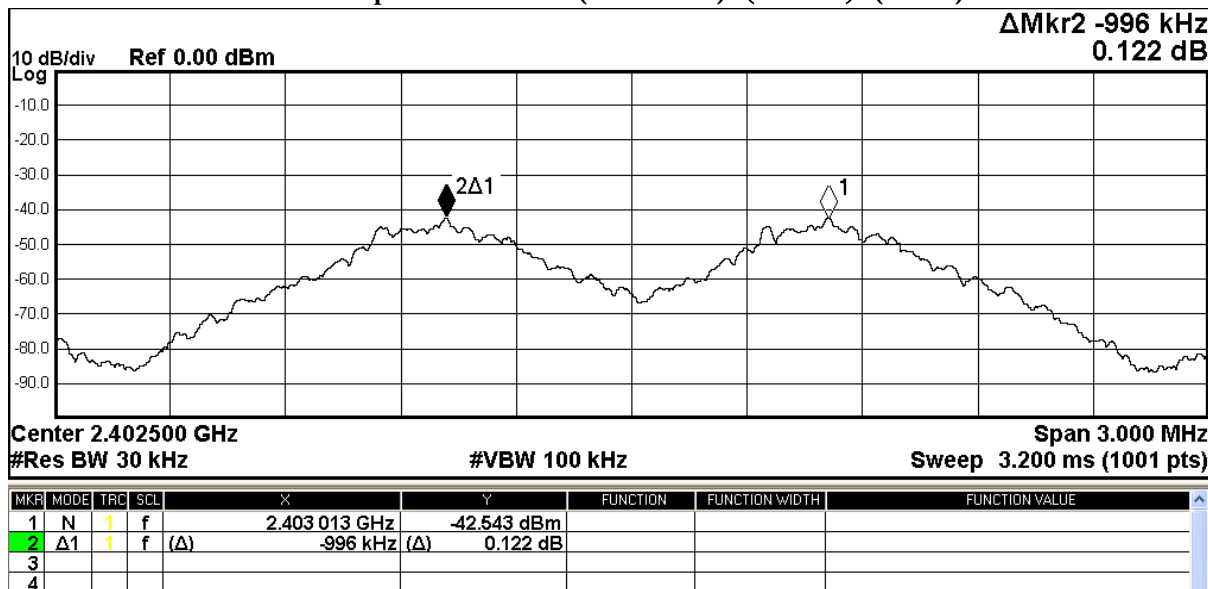
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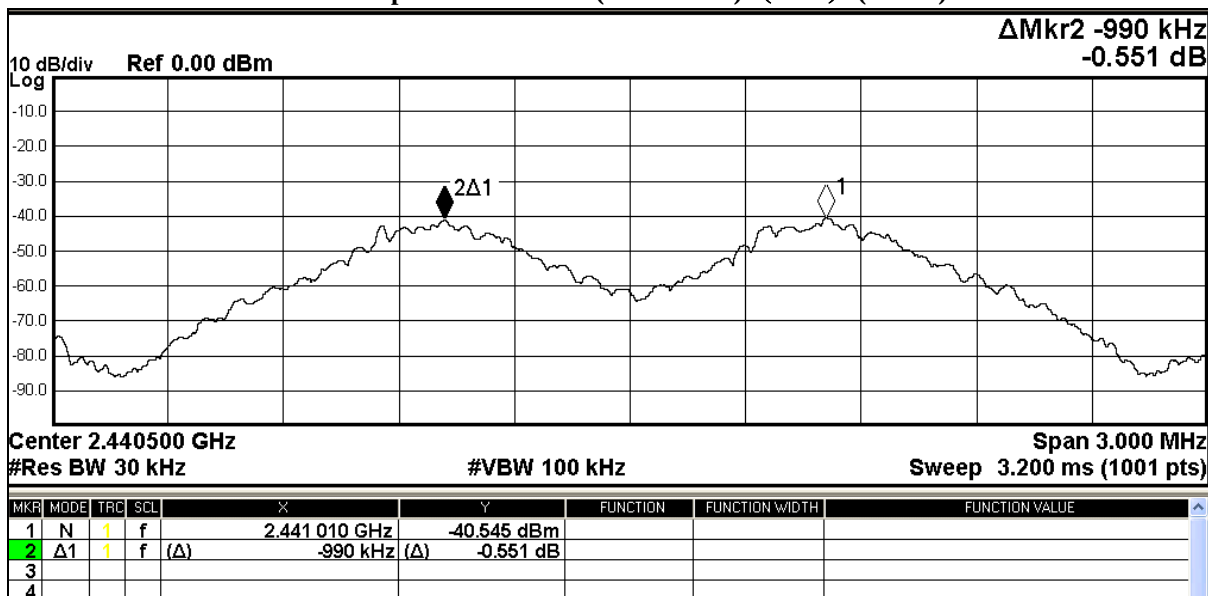
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Channel separation = 1MHz (>2/3 of BW) (Lowest) (GFSK)



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



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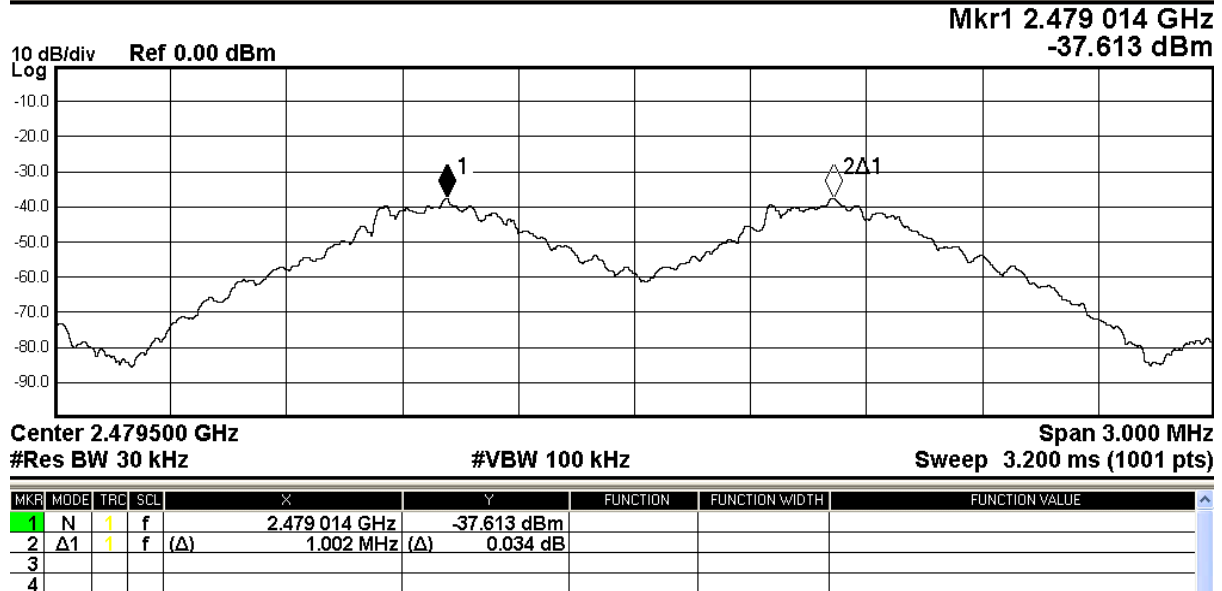


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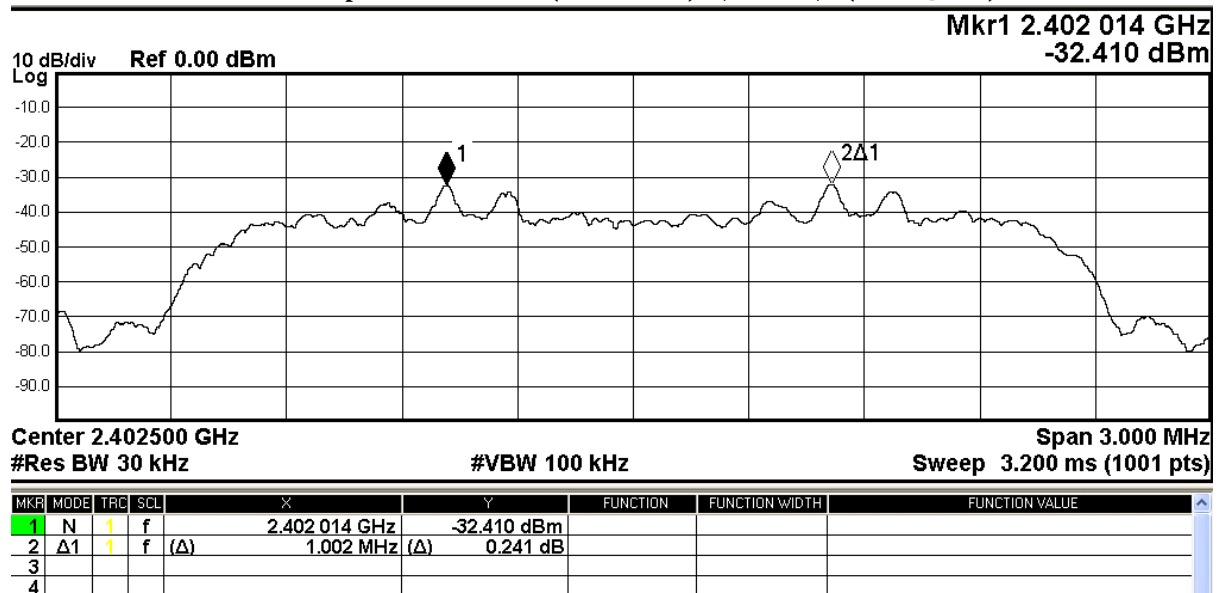
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Channel separation = 1MHz (>2/3 of BW) (Highest) (GFSK)



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



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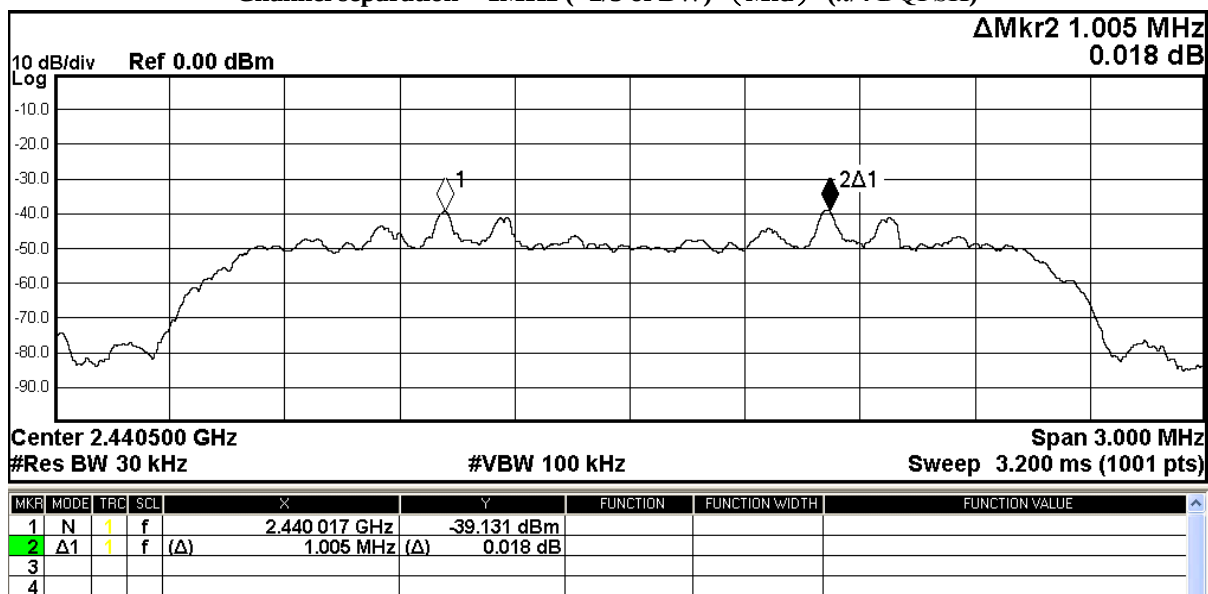
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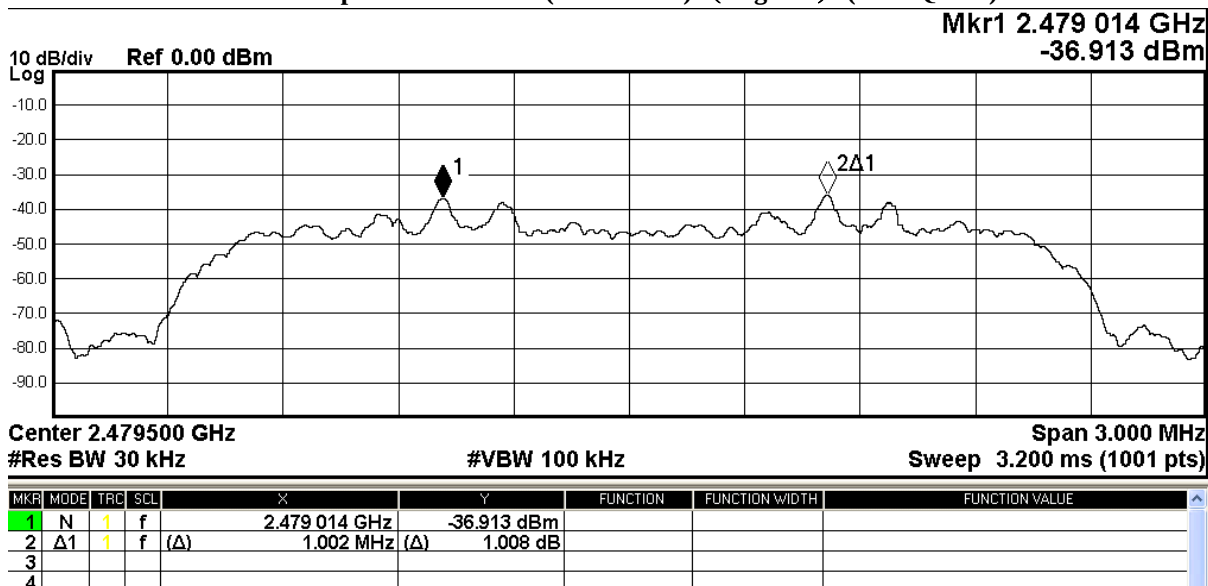
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Channel separation = 1MHz (>2/3 of BW) (Mid) ($\pi/4$ DQPSK)



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



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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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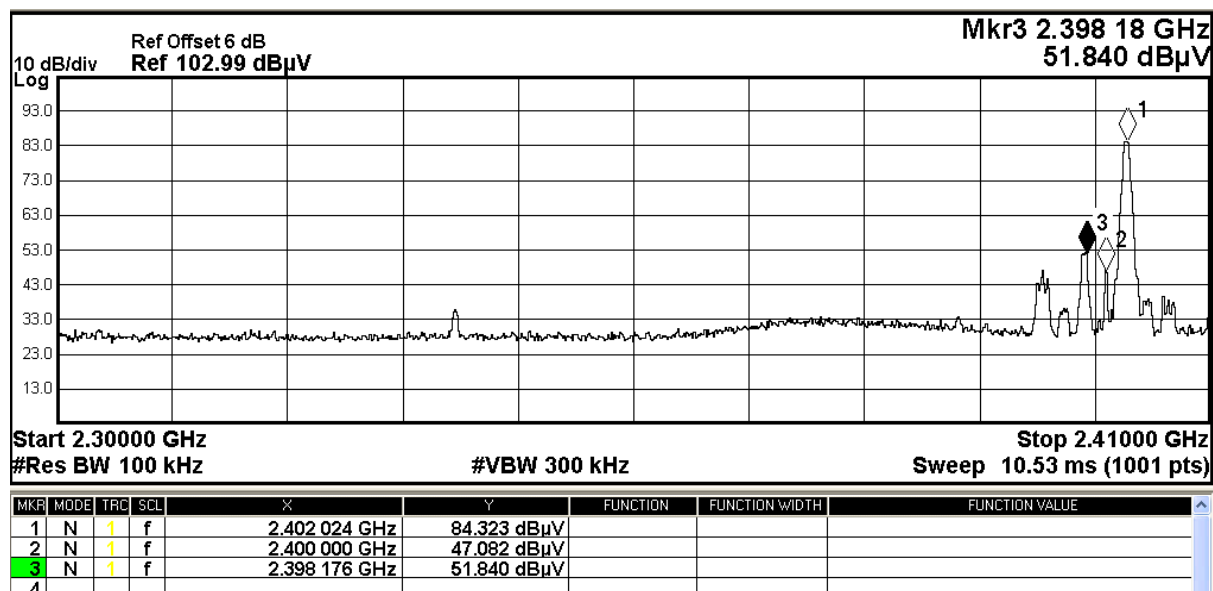
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	37.2

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



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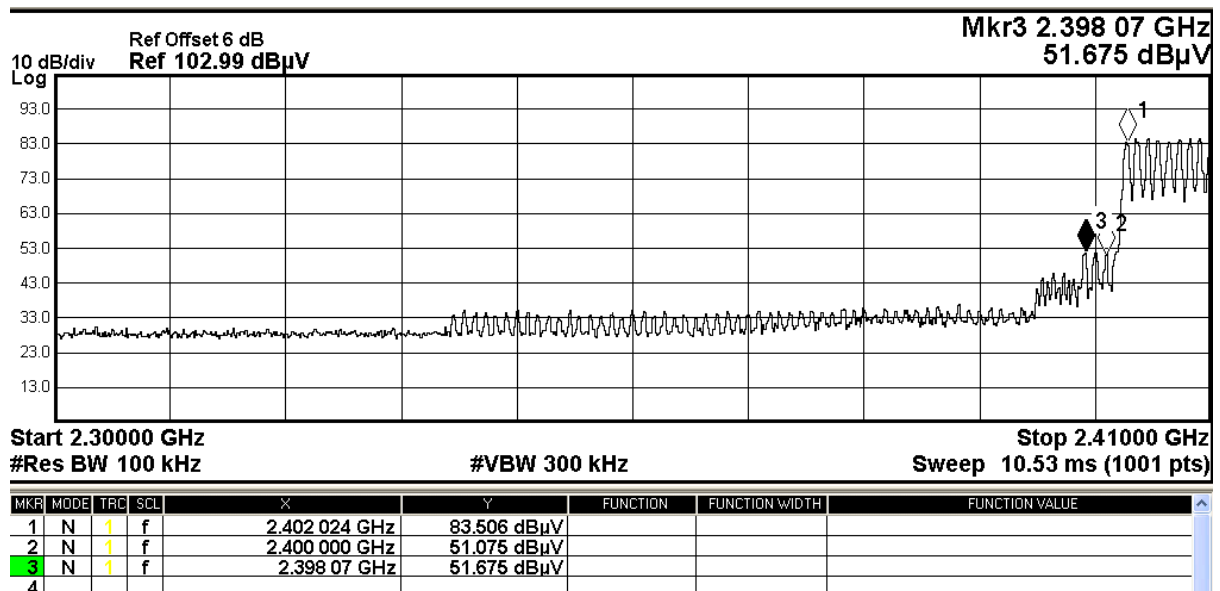
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	32.4

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



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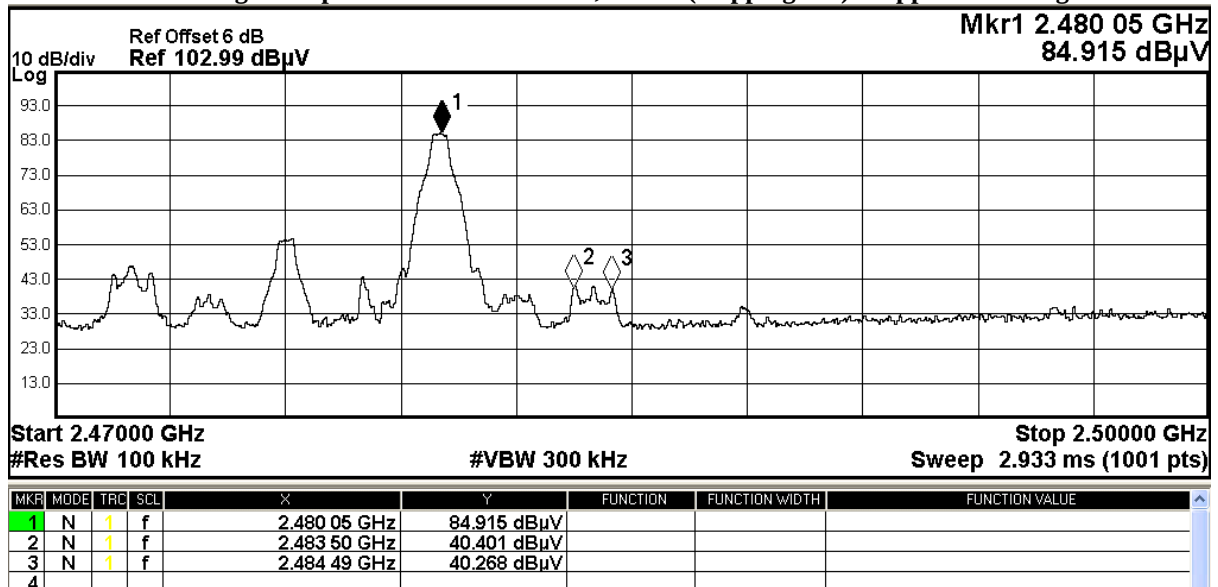
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	44.5

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



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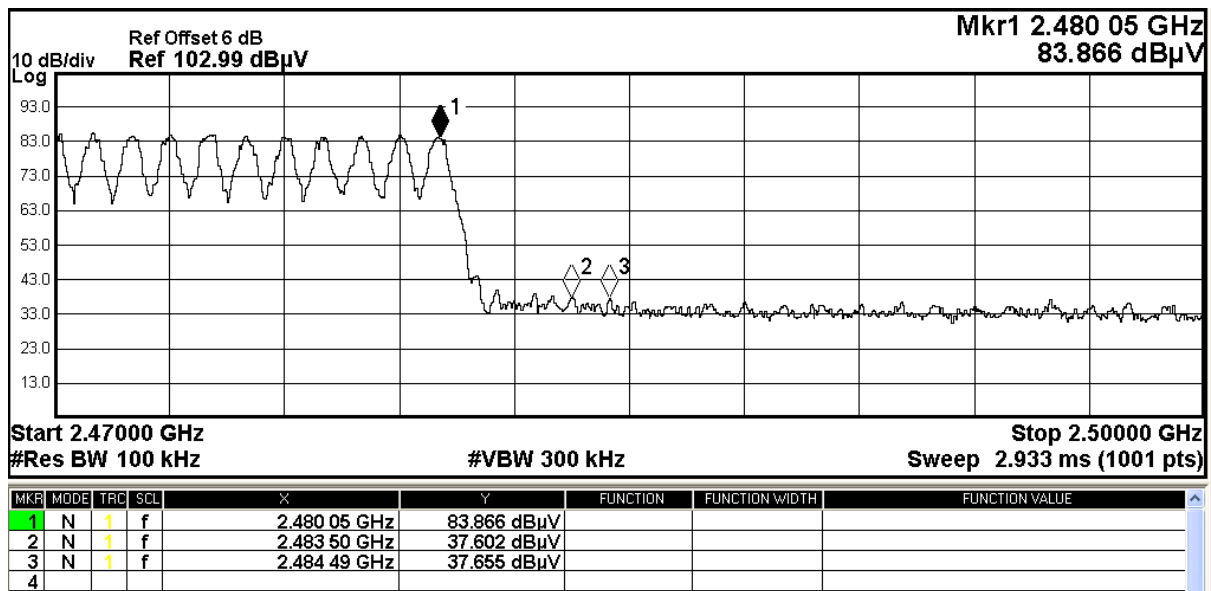
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	46.6

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 dB	E-Field Polarity
2398.2	25.3	27.8	53.1	74.0	20.9	Vertical
2398.1	25.8	27.8	53.6	74.0	20.4	Vertical
2484.5	13.1	27.9	41.0	74.0	33.0	Vertical
2484.5	10.4	27.9	38.3	74.0	35.7	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 dB	E-Field Polarity
2398.2	6.7	27.8	34.5	54.0	19.5	Vertical
2398.1	6.9	27.8	34.7	54.0	19.3	Vertical
2484.5	-2.1	27.9	25.8	54.0	28.2	Vertical
2484.5	-1.9	27.9	26.0	54.0	28.0	Vertical

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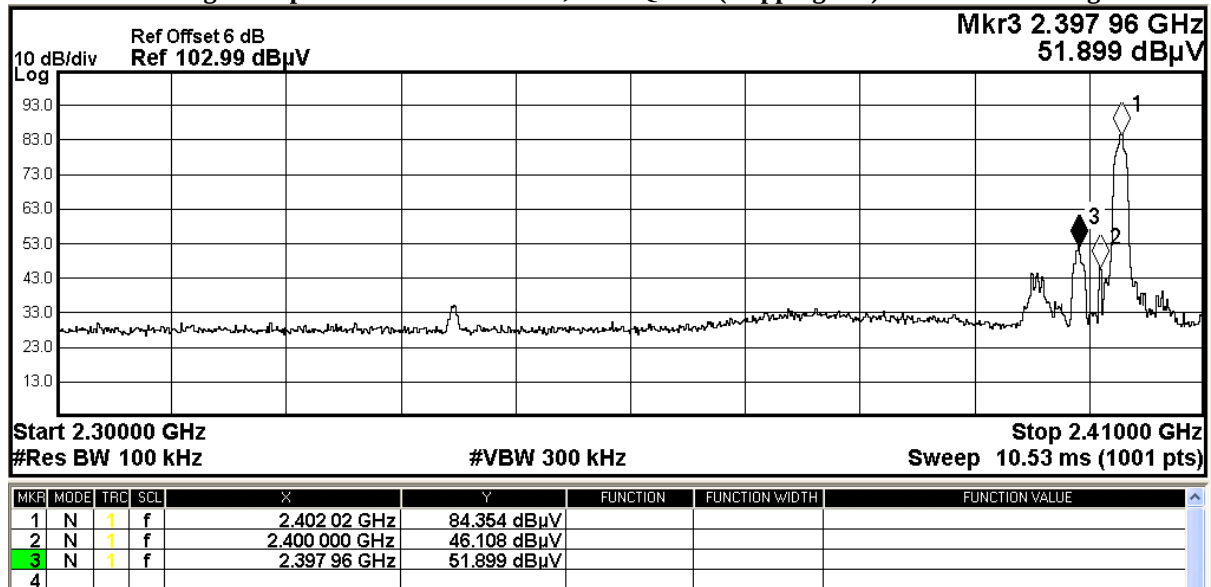
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	50.9

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



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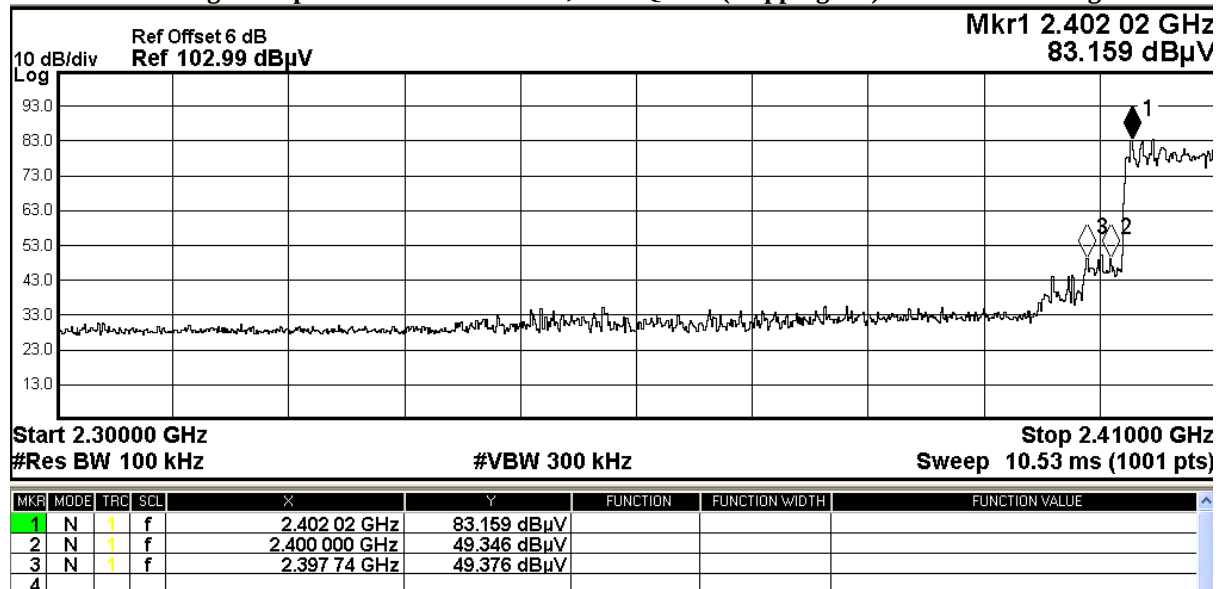
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	48.1

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



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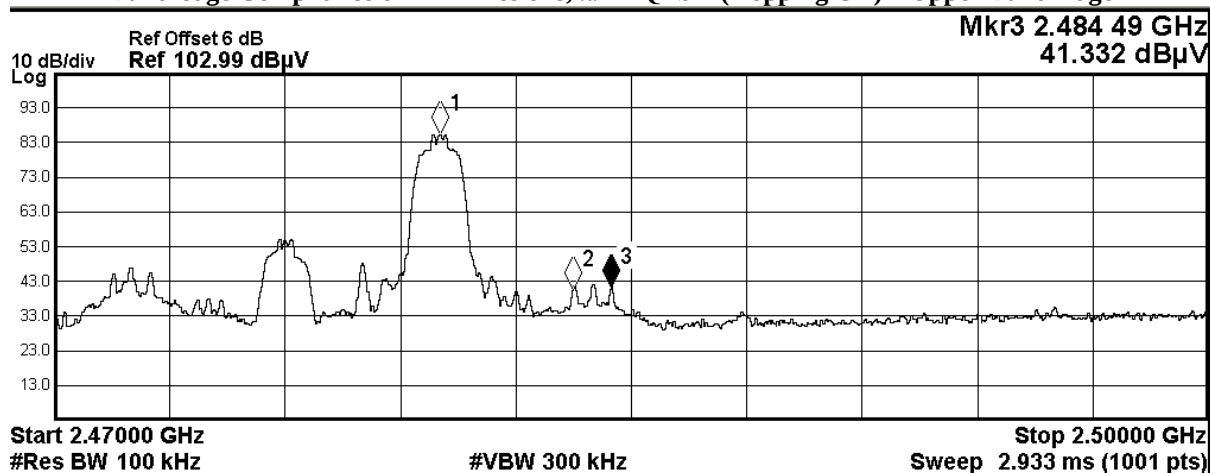
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	58.2

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



MKR	MODE	TAC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.480 02 GHz	85.294 dB μ V			
2	N	1	f	2.483 50 GHz	40.424 dB μ V			
3	N	1	f	2.484 49 GHz	41.332 dB μ V			
4								

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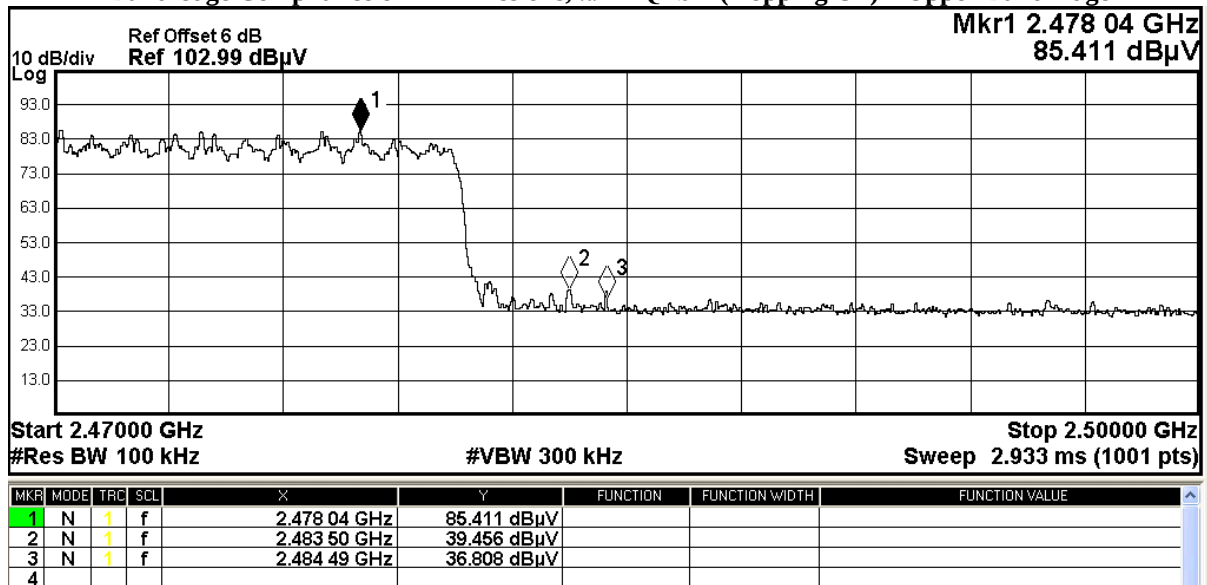
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Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	50.3

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 dB	E-Field Polarity
2398.0	25.8	27.8	53.6	74.0	20.4	Vertical
2397.7	23.7	27.8	51.5	74.0	22.5	Vertical
2484.5	14.9	27.9	42.8	74.0	31.2	Vertical
2484.5	11.4	27.9	39.3	74.0	34.7	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 dB	E-Field Polarity
2398.0	6.5	27.8	34.3	54.0	19.7	Vertical
2397.7	6.7	27.8	34.5	54.0	19.5	Vertical
2484.5	-2.3	27.9	25.6	54.0	28.4	Vertical
2484.5	-2.1	27.9	25.8	54.0	28.2	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,

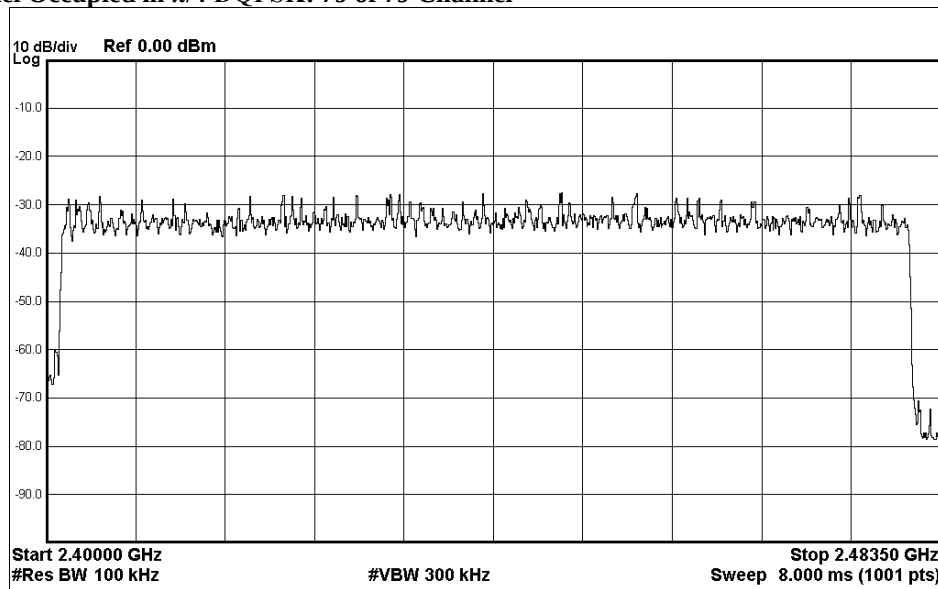
Span = Zero, Detector = Peak, Trace = Max. hold

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

Observed duration: 0.4s x 79 = 31.6s

Measurement Data:

Channel Occupied in $\pi/4$ DQPSK: 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]

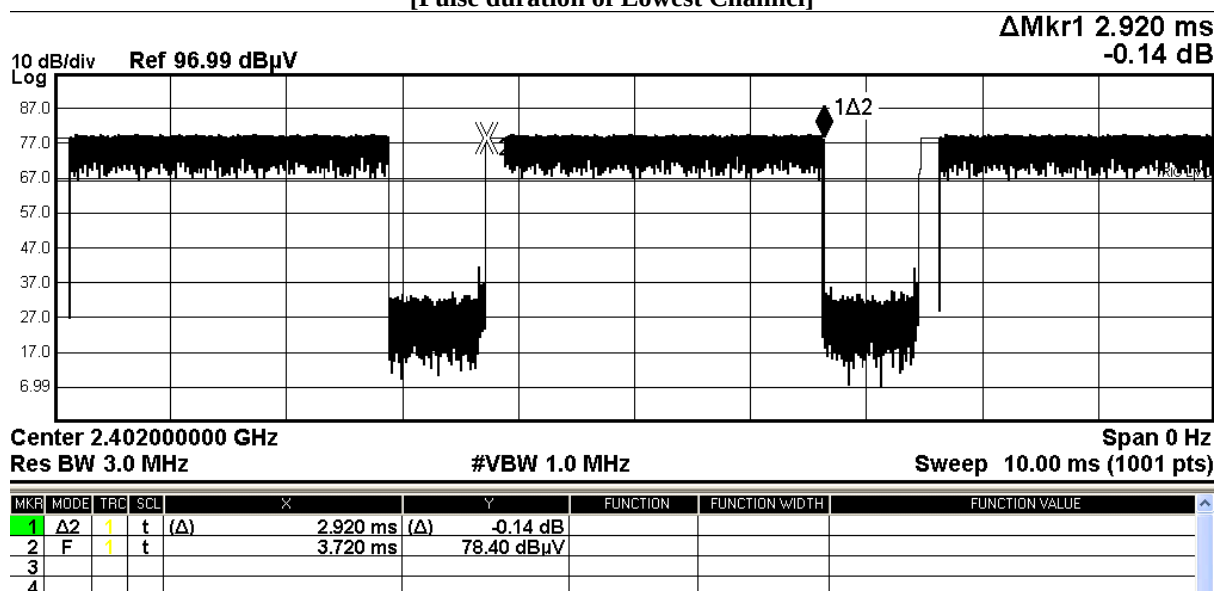
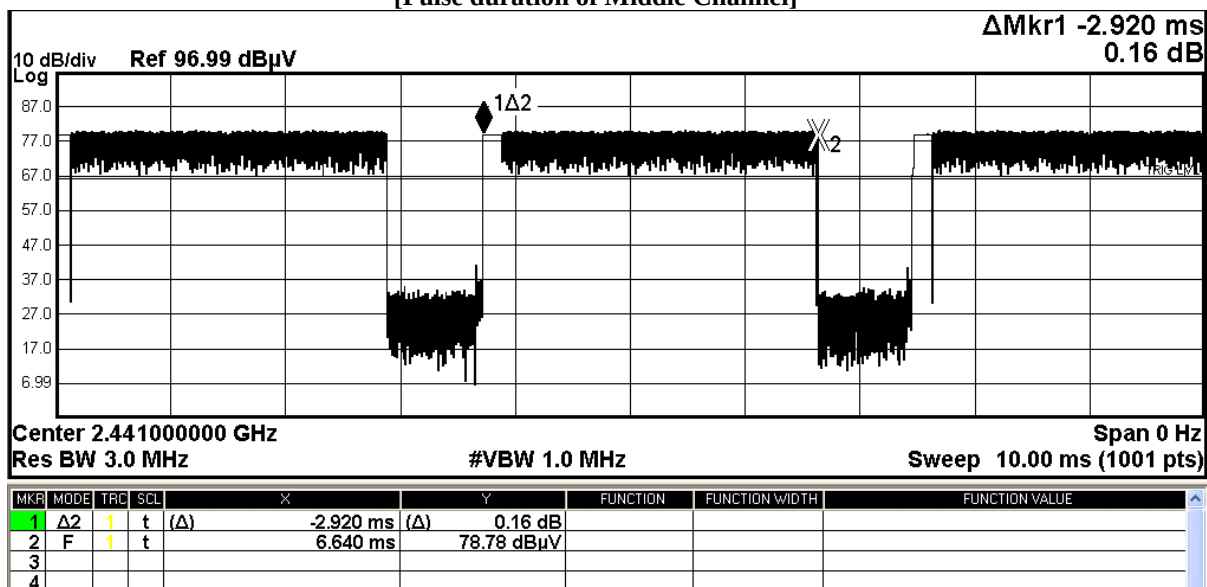


Fig. B
[Pulse duration of Middle Channel]



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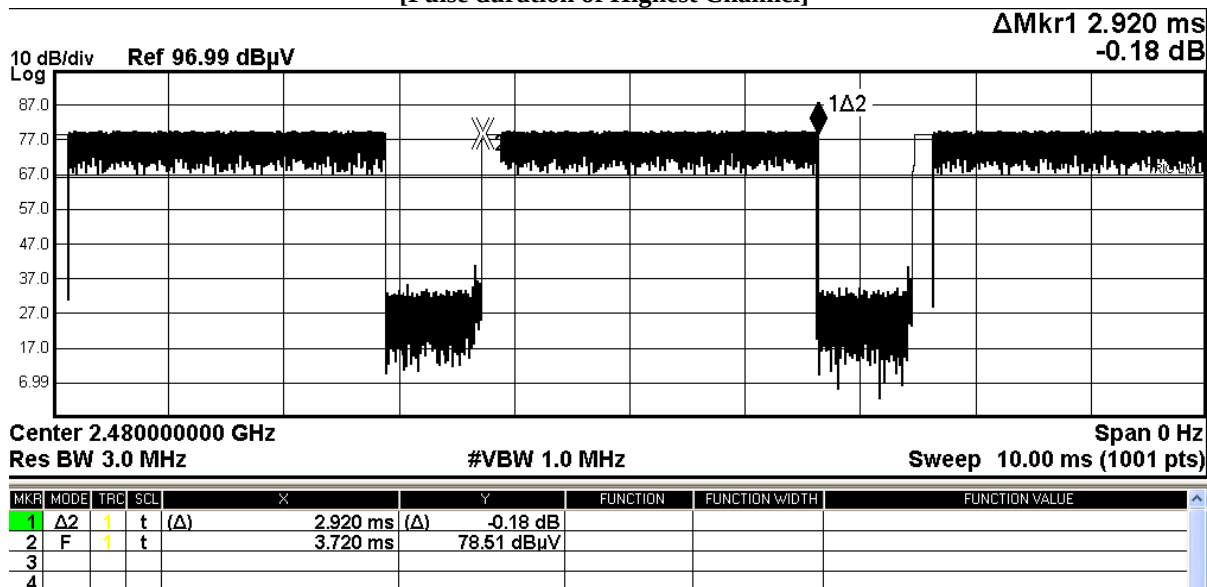


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Fig. C
[Pulse duration of Highest Channel]



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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]

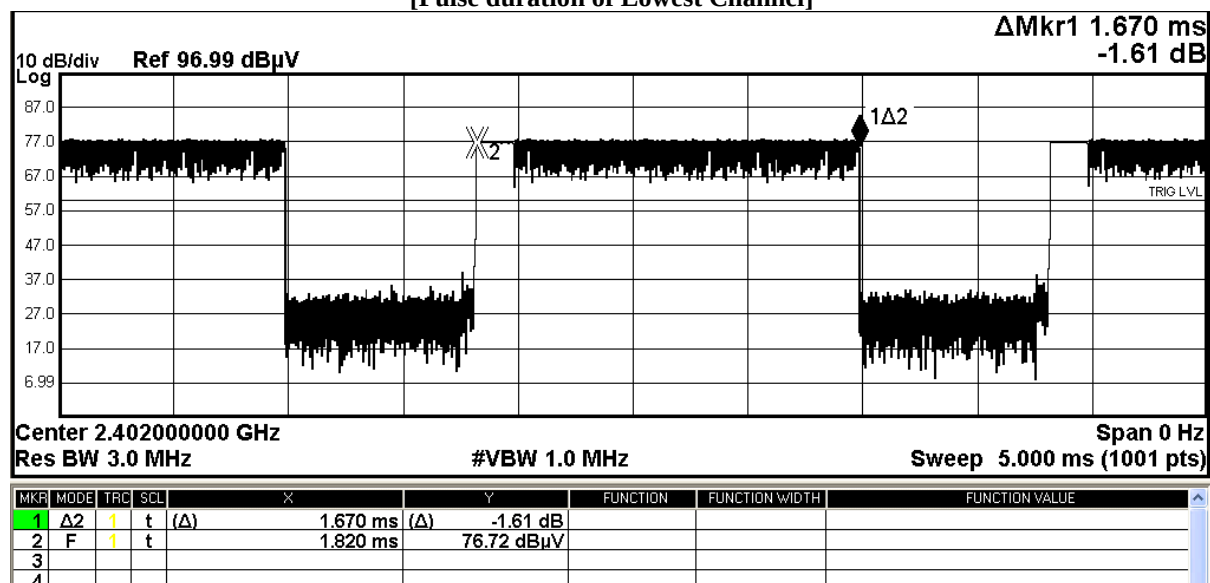
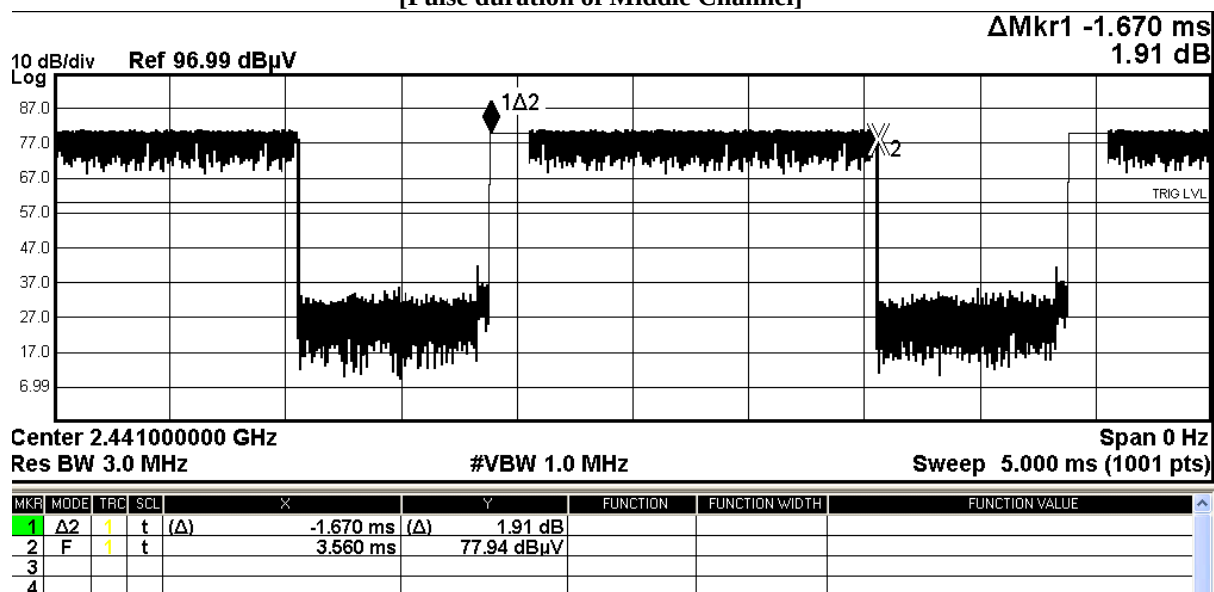


Fig. E
[Pulse duration of Middle Channel]



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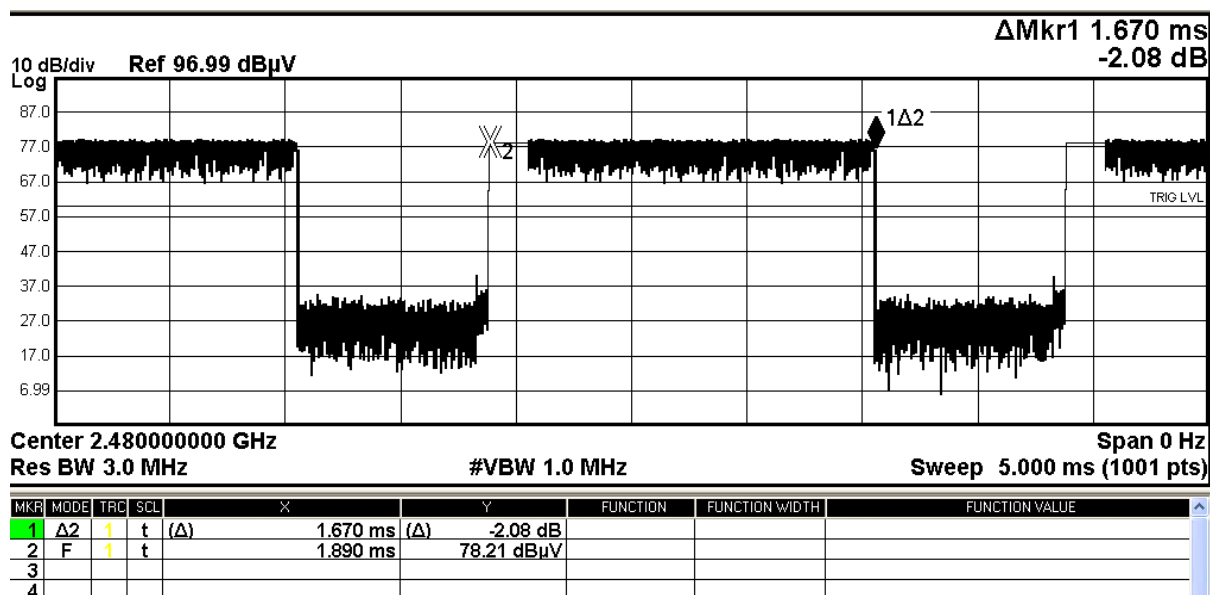


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Fig. F
[Pulse duration of Highest Channel]



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DH1 Packet:

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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]

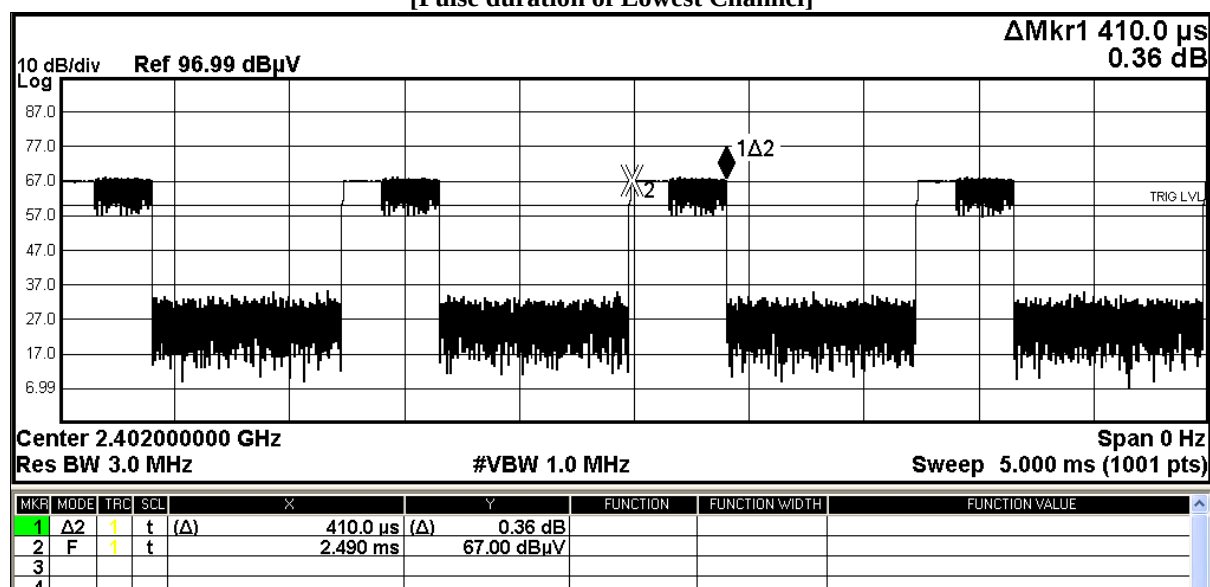
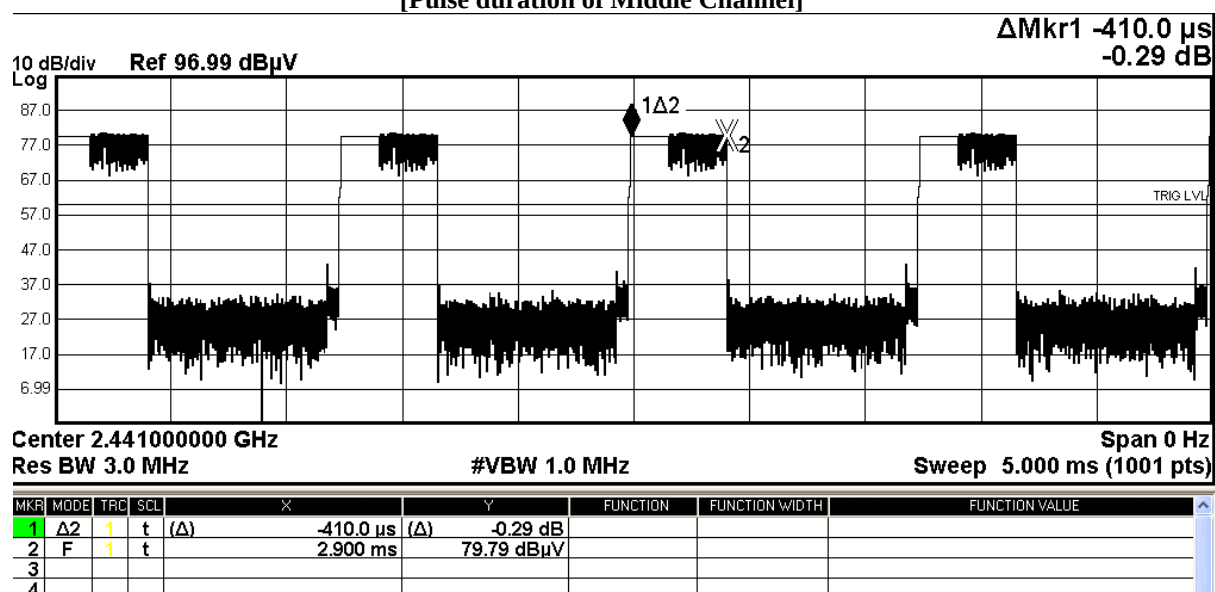


Fig. H
[Pulse duration of Middle Channel]



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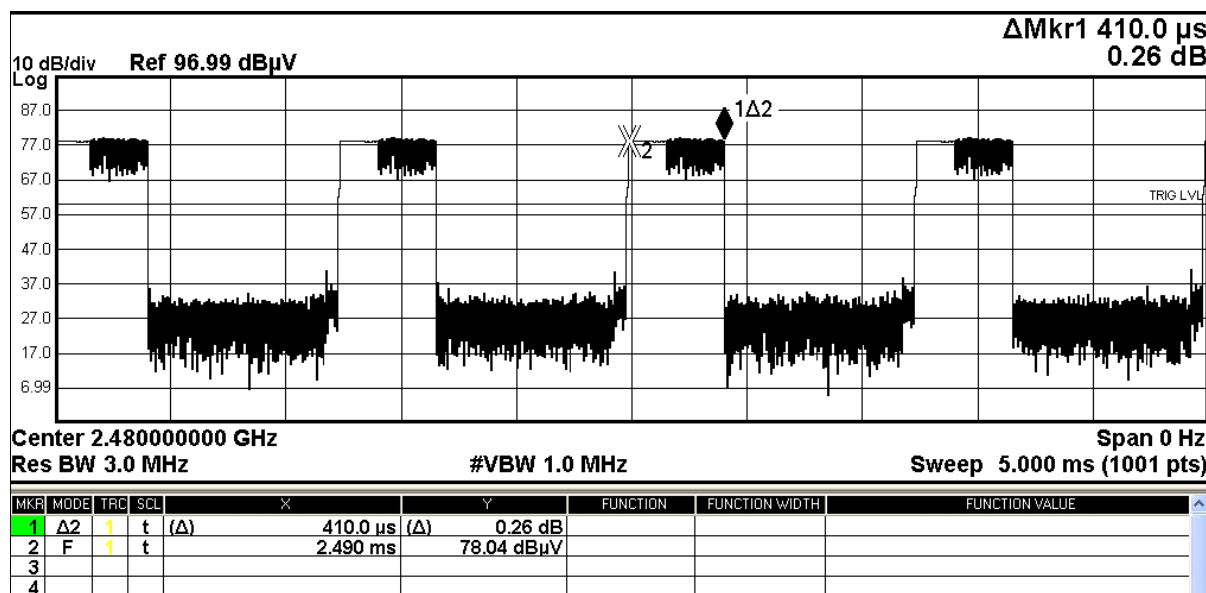


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Fig. I[Pulse duration of Highest Channel]



Time of occupancy (Dwell Time):

Data Packet	Frequency (MHz)	Pulse Duration (ms)	Dwell Time (s)	Limits (s)	Test Results
DH5	2402	2.920	0.312	0.400	Complies
DH5	2441	2.920	0.312	0.400	Complies
DH5	2480	2.920	0.312	0.400	Complies
DH3	2402	1.670	0.267	0.400	Complies
DH3	2441	1.670	0.267	0.400	Complies
DH3	2480	1.670	0.267	0.400	Complies
DH1	2402	0.410	0.131	0.400	Complies
DH1	2441	0.410	0.131	0.400	Complies
DH1	2480	0.410	0.131	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 Circuit printed meander line antenna. There is no external antenna, the antenna gain = -0.58dBi. User is unable to remove or changed the Antenna.

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3.1.12 RF Exposure

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Test Requirement: FCC 47CFR 15.247(i)
Test Date: 2018-02-22
Mode of Operation: On mode

Requirements:

In 15.247(i), an equipment shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the limits in §§ 1.1310 and 2.1093 of this chapter.

Applications to the Commission for construction permits, licenses to transmit or renewals thereof, equipment authorizations or modifications in existing facilities must contain a statement confirming compliance with the limits unless the facility, operation, or transmitter is categorically excluded, as discussed below. Technical information showing the basis for this statement must be submitted to the Commission upon request.

According to KDB447498 D01 General RF Exposure Guidance v06, unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Exclusion Threshold condition.

RF Exposure Evaluation

The Maximum tune-up power = -4.66dBm (0.342mW)

SAR Test Exclusion Thresholds=0.1≤3.0 for 1-g SAR,

The test separation distances is ≤5 mm

The power tune up tolerance is -6.36±1.70dBm

Max. duty factor is 100%

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Appendix A

List of Measurement Equipment

Radiated Emission

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM299	DOUBLE-RIDGED WAVEGUIDE HORN ANTENNA	ETS-LINDGREN	3115	00114120	2016/04/27	2018/04/27
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	--	2017/04/20	2018/04/20
EM356	ANTENNA POSITIONING TOWER	ETS-LINDGREN	2171B	00150346	N/A	N/A
EM355	BICONILOG ANTENNA	ETS-LINDGREN	3143B	00094856	2016/03/03	2018/03/03
EM229	EMI TEST RECEIVER	R&S	ESIB40	100248	2017/06/01	2018/06/01
EM353	LOOP ANTENNA	ETS_LINDGREN	6502	00206533	2016/03/16	2018/03/16
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

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
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	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	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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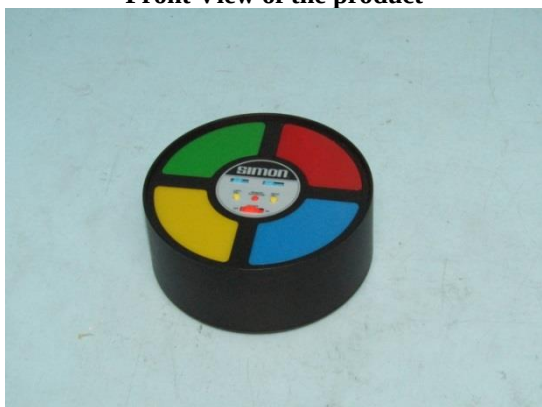
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Appendix B

Photographs of EUT

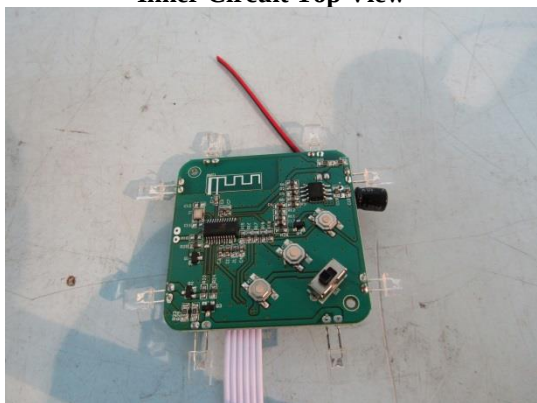
Front View of the product



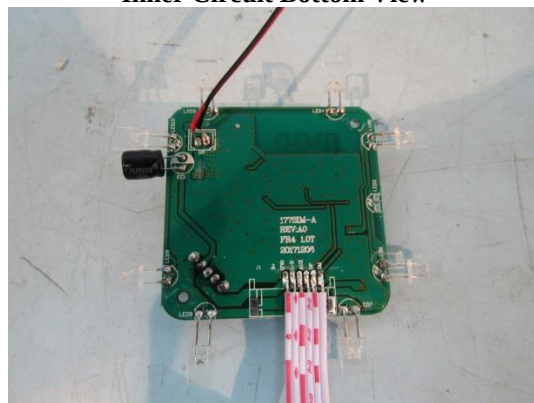
Rear View of the product



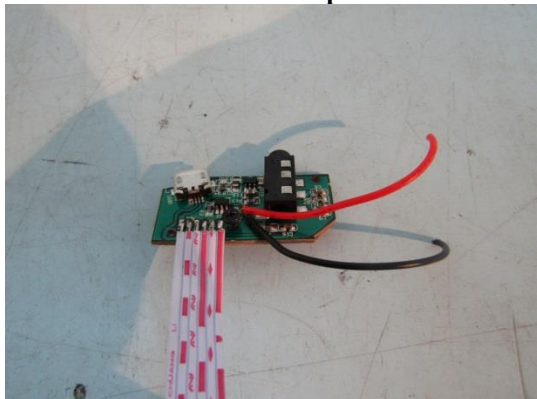
Inner Circuit Top View



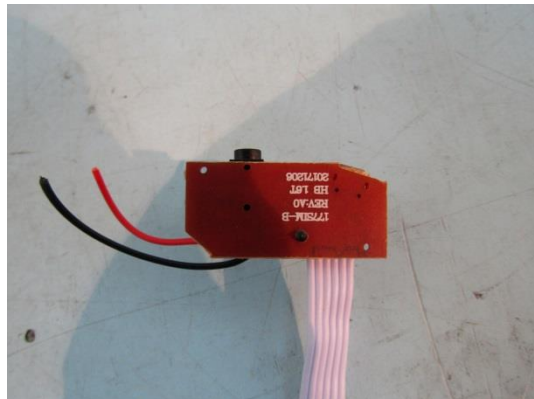
Inner Circuit Bottom View



Inner Circuit Top View



Inner Circuit Bottom View



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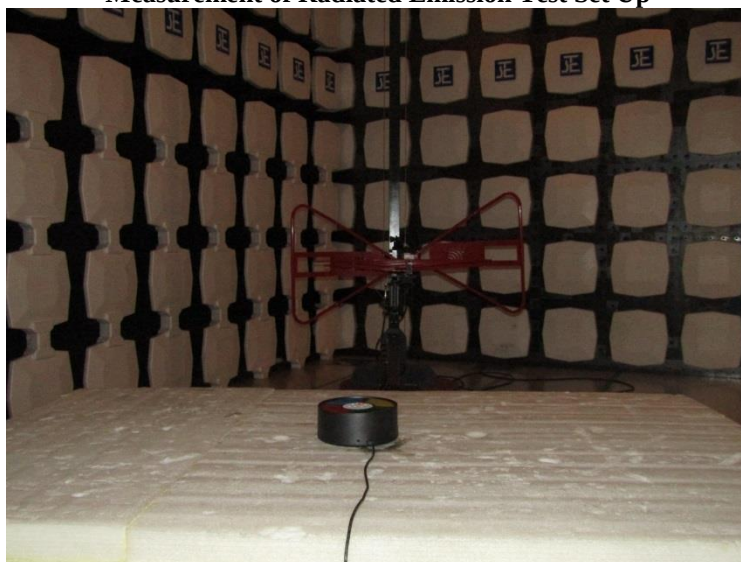
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Photographs of EUT

Measurement of Conducted Emission Test Set Up



Measurement of Radiated Emission Test Set Up



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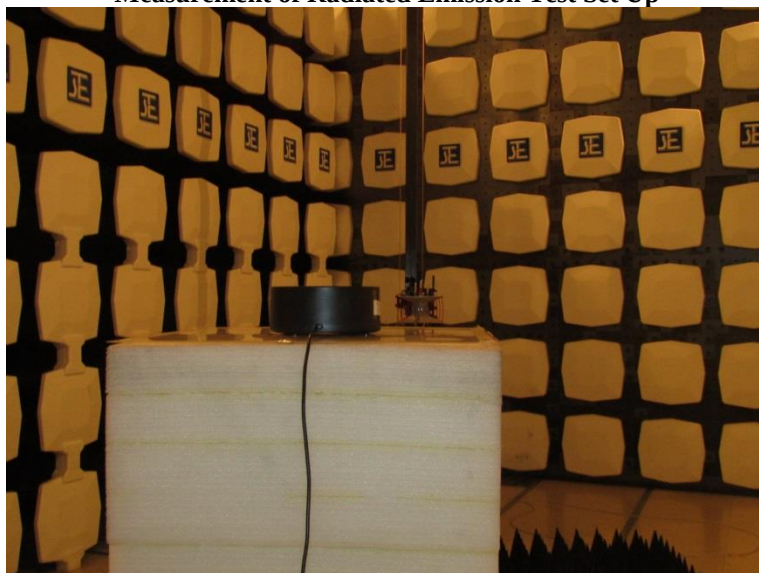
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Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Radiated Emission Test Set Up



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