Test Report

Date : 2017-05-27
No. : DM17050428

Applicant	:	Altis Technology (Hong Kong) Ltd. Suite 711, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Hong Kong
Supplier / Manufacturer	:	Altis Technology (Hong Kong) Ltd. Suite 711, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Hong Kong
Description of Sample(s)	:	Submitted sample(s) said to be Product: Bluetooth Speaker Brand Name: motorola Model No.: MS120 FCC ID: 2AHJMMS120
Date Samples Received	:	2017-05-18
Date Tested	:	2017-05-22 to 2017-05-26
Investigation Requested	:	Perform ElectroMagnetic Interference measurement in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2015 and ANSI C63.10:2013 for FCC Certification.
Conclusions	:	The submitted product COMPLIED with the requirements of Federal Communications Commission [FCC] Rules and Regulations Part 15. The tests were performed in accordance with the standards described above and on Section 2.2 in this Test Report.
Remarks	:	Bluetooth FHSS (GFSK/ π/4-DQPSK/ 8DPSK)

LONG Yun Tian, Along
Authorized Signatory
ElectroMagnetic Compatibility Department
For and on behalf of
STC (Dongguan) Company Limited

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Test Report

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1.0 General Details

1.1 Test Laboratory

STC (Dongguan) Company Limited
EMC Laboratory
68 Fumin Nan Road, Dalang, Dongguan, Guangdong, China
Telephone: (86 769) 81119888
Fax: (86 769) 81116222

1.2 Equipment Under Test [EUT]

Description of Sample(s)

Product:	Bluetooth Speaker
Manufacturer:	Altis Technology (Hong Kong) Ltd. Suite 711, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Hong Kong
Brand Name:	motorola
Model Number:	MS120
Rating:	5.0Vd.c. (Powered by USB port) / 3.7Vd.c Li-ion polymer rechargeable battery

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is a 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

2017-05-18

1.4 Submitted Sample(s):

1 Sample

1.5 Test Duration

2017-05-22 to 2017-05-26

1.6 Country of Origin

China

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1.7 RF Module Details

Module Model Number:	F-6188
Module FCC ID:	N/A
Module Transmission Type:	Bluetooth V2.1+EDR
Modulation:	FHSS (GFSK / π/4-DQPSK/ 8DPSK)
Data Rates:	1MBps: GFSK
	2 MBps: π/4-DQPSK
	3 MBps: 8DPSK
Frequency Range:	2400-2483.5MHz
Carrier Frequencies:	2402MHz – 2480MHz

Module Specification (specification provided by manufacturer)

1.8 Antenna Details

Antenna Type:	PCB antenna
Antenna Gain:	0dBi

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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: 2015 Regulations and ANSI C63.10:2013for FCC Certification.
According FCC KDB 558074 DTS Measurement Guidance, Duty cycle ≧98%.
The device was realized by test software.

2.2 Test Standards and Results Summary Tables

EMISSION Results Summary						
Test Condition	Test Requirement	Test Method	Class / Severity	Test Result		
				Pass	Failed	N/A
Maximum Peak Conducted Output Power	FCC 47CFR 15.247(b)(1)	ANSI C63.10: 2013	N/A	☒	☐	☐
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	☒	☐	☐

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 device was realized by test software.
The following table is a list of the test modes shown in this test report.

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

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3.0 Test Results

3.1 Emission

3.1.1 Maximum Peak Conducted Output Power

Test Requirement:	FCC 47CFR 15.247(b) (1)
Test Method:	ANSI C63.10: 2013
Test Date:	2017-05-23
Mode of Operation:	Tx mode

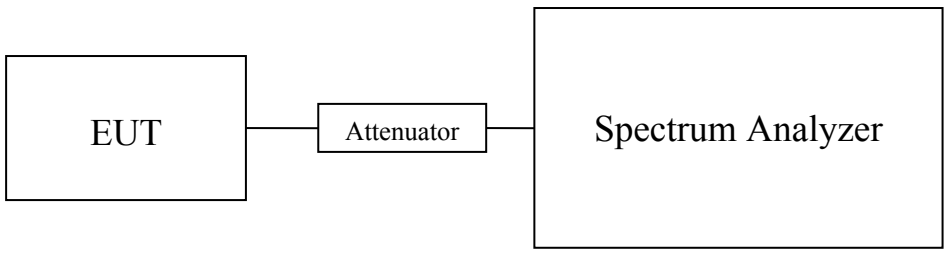
Test Method:

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

Spectrum Analyzer Setting:

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

Test Setup:



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

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

The maximum peak output power shall not exceeded the following limits: For Digital Transmission systems in 2400-2483.5 MHz Band: 125 Milliwatt Results of Bluetooth Communication mode (GFSK) (Fundamental Power): Pass

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

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.000640

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.000631

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.000562

The maximum peak output power shall not exceeded the following limits:
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 Watts
Results of Bluetooth Communication mode (π/4-DQPSK) (Fundamental Power): Pass

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.000615

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.000624

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.000561

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

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.000630

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.000622

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.000556

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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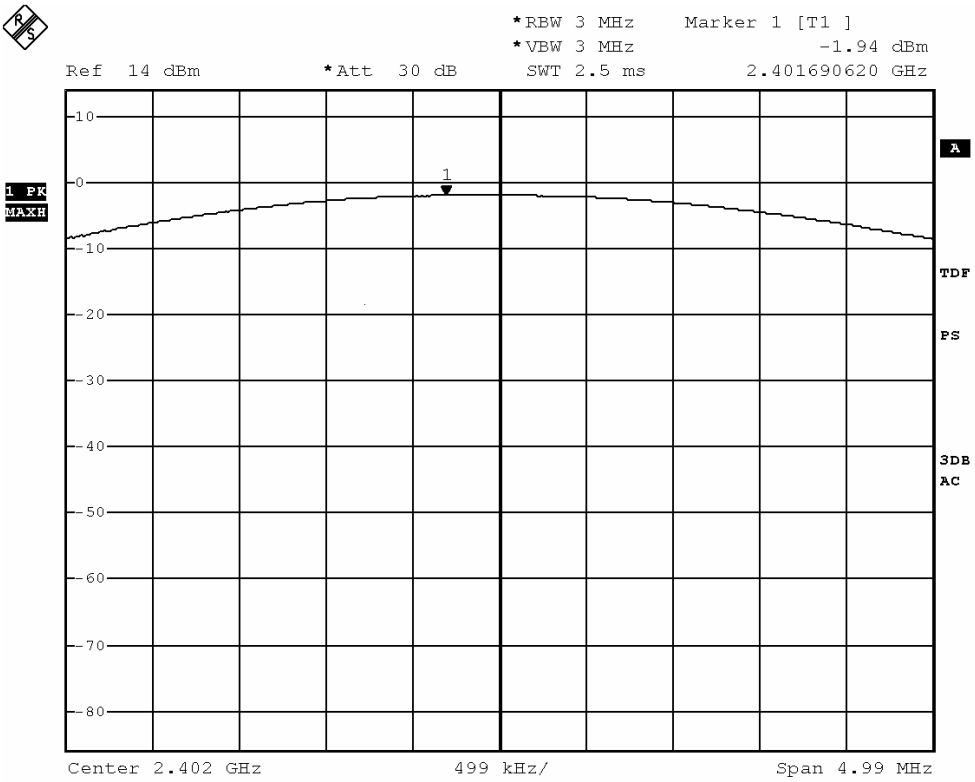
Test plot of Maximum Peak Conducted Output Power :

Bluetooth Communication mode (GFSK, 2402MHz)



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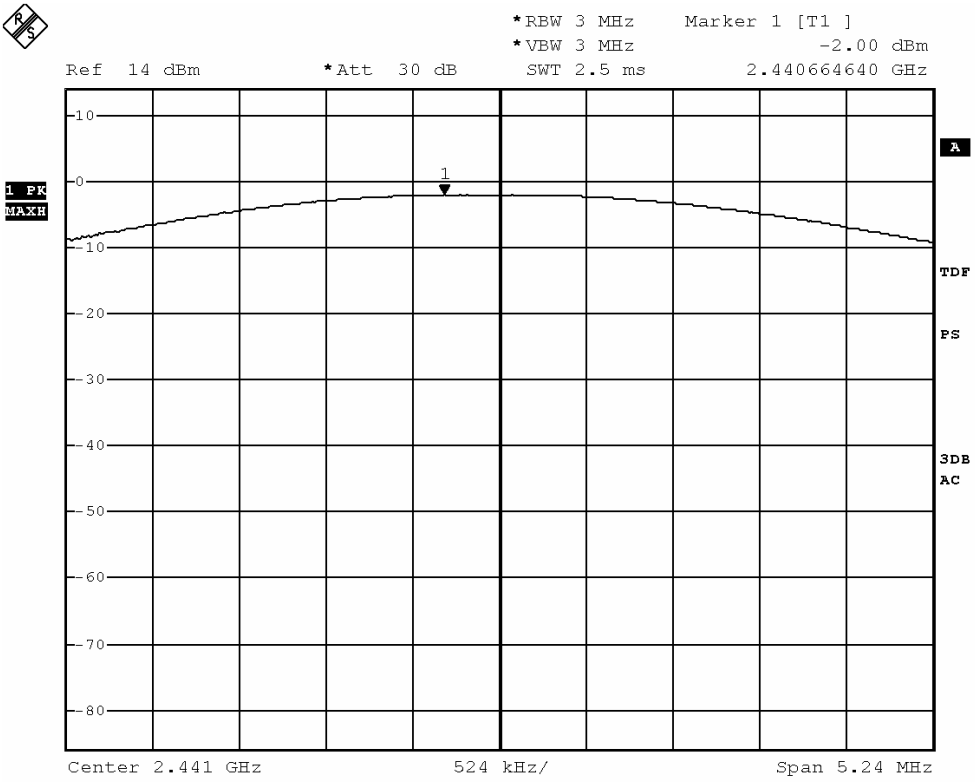
Bluetooth Communication mode (GFSK, 2441MHz)



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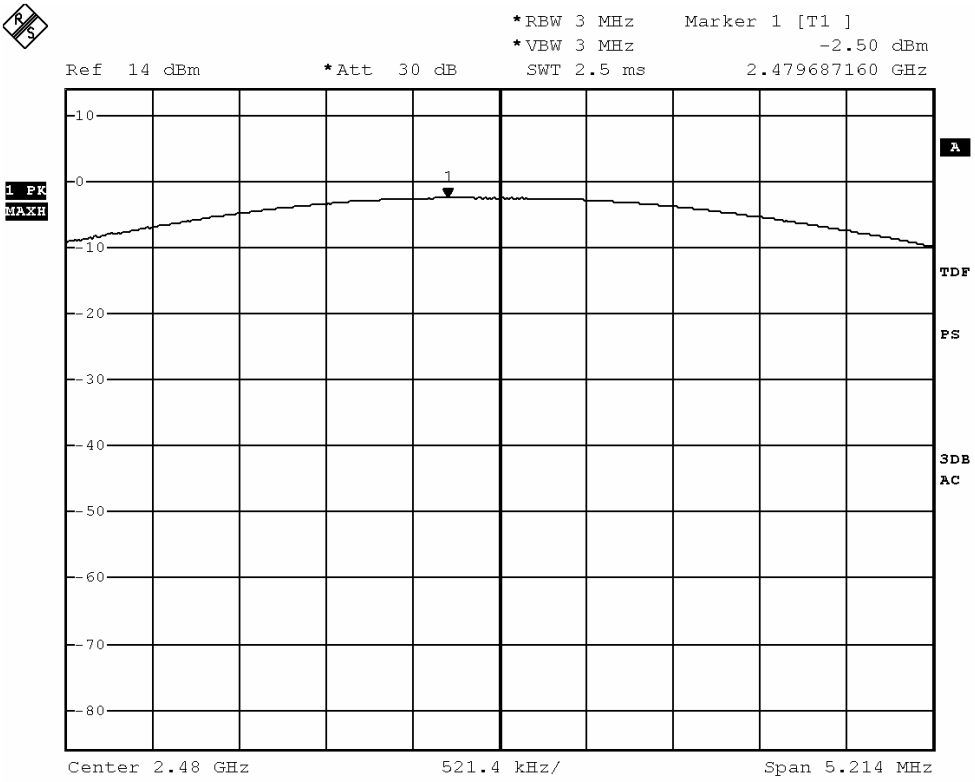
Bluetooth Communication mode (GFSK, 2480MHz)



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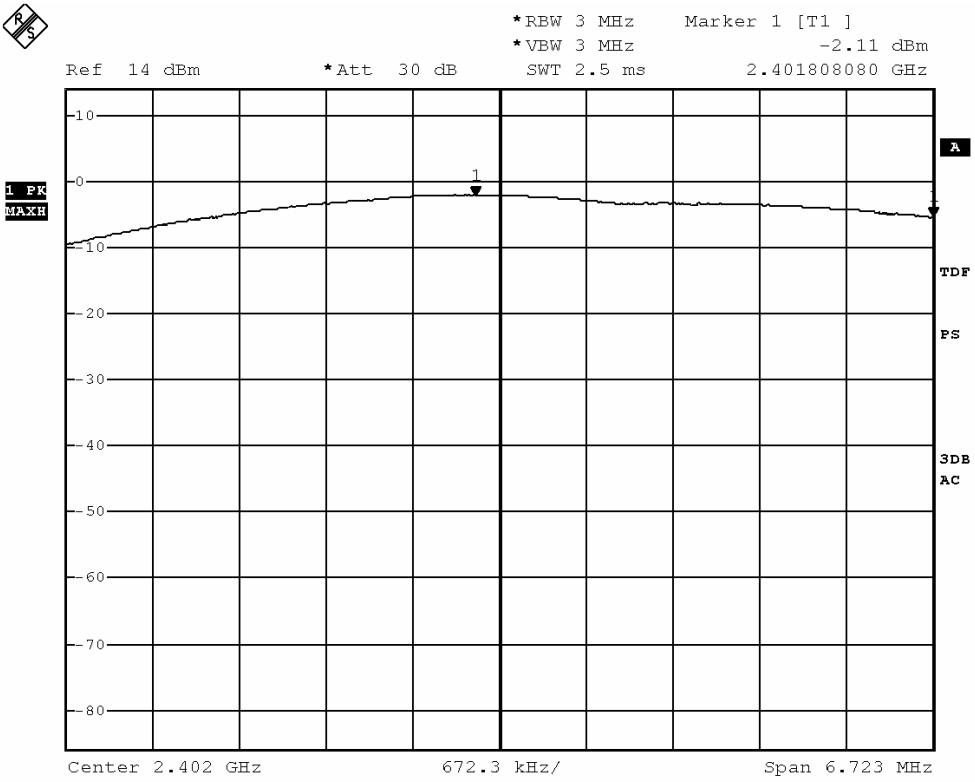
Bluetooth Communication mode (π/4 DQPSK, 2402MHz)



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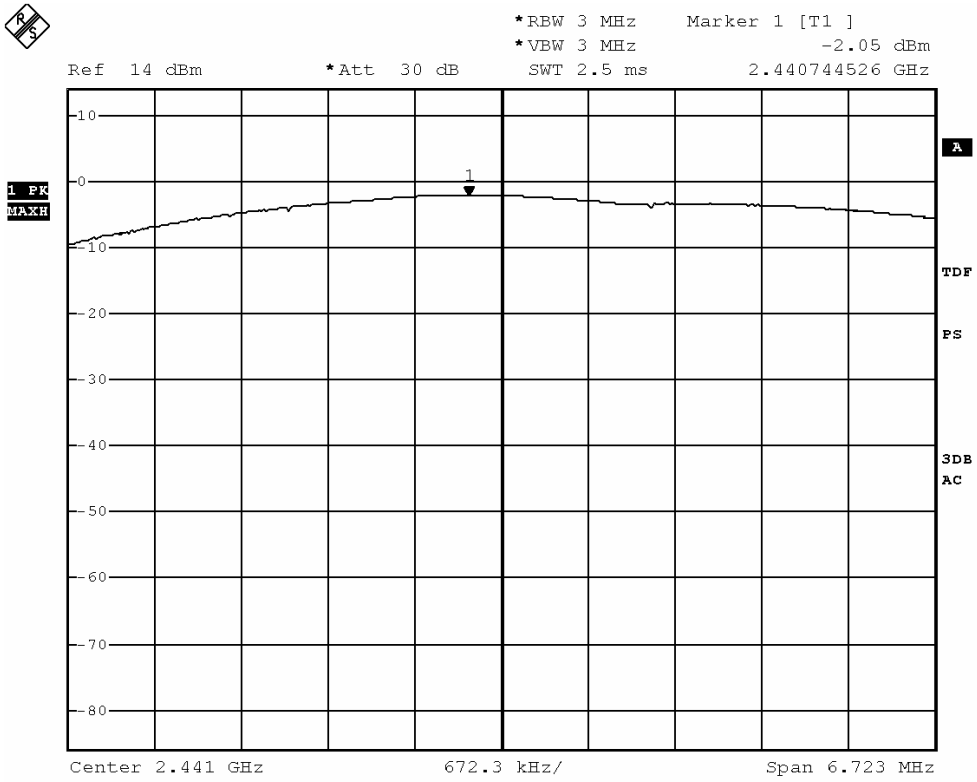
Bluetooth Communication mode (π/4 DQPSK, 2441MHz)



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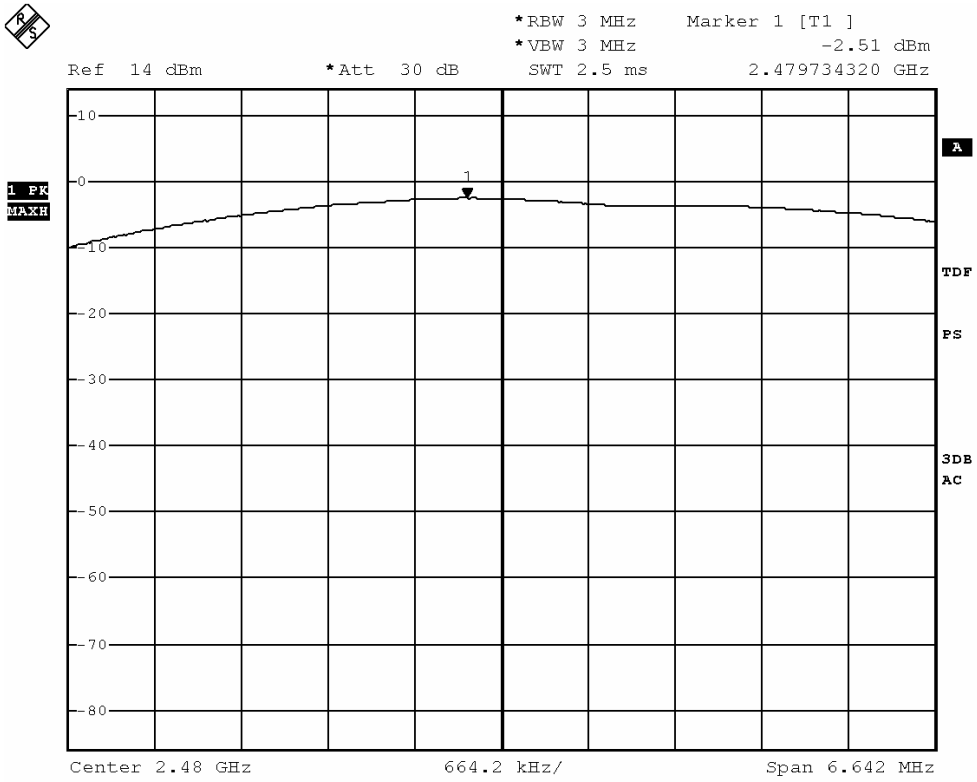
Bluetooth Communication mode (π/4 DQPSK, 2480MHz)



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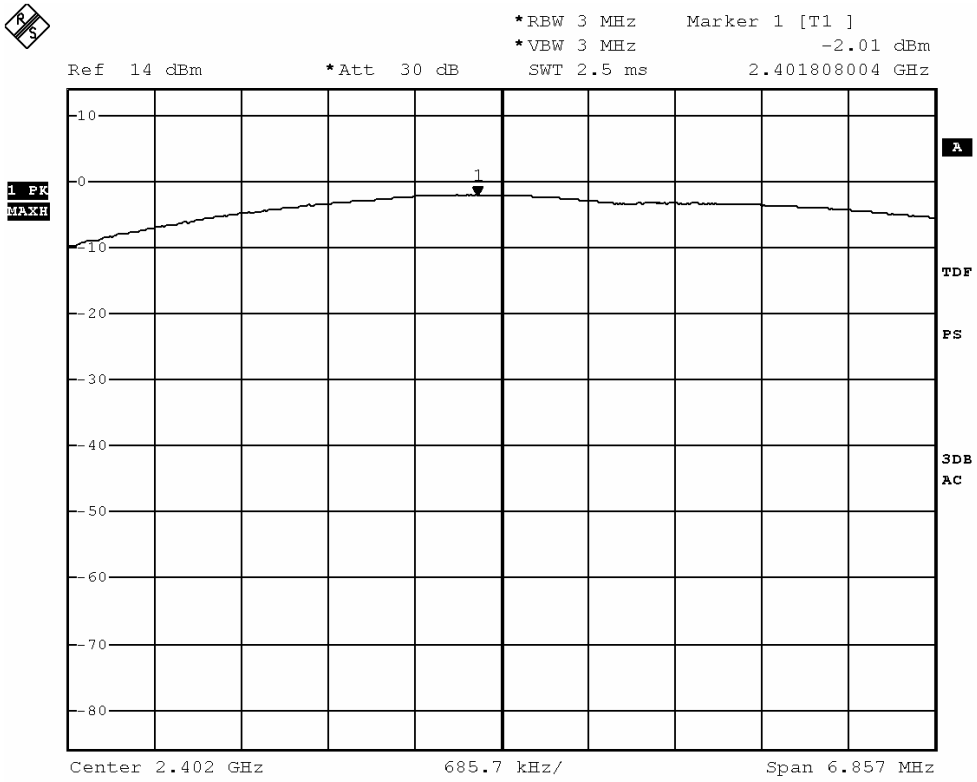
Bluetooth Communication mode (8DPSK, 2402MHz)



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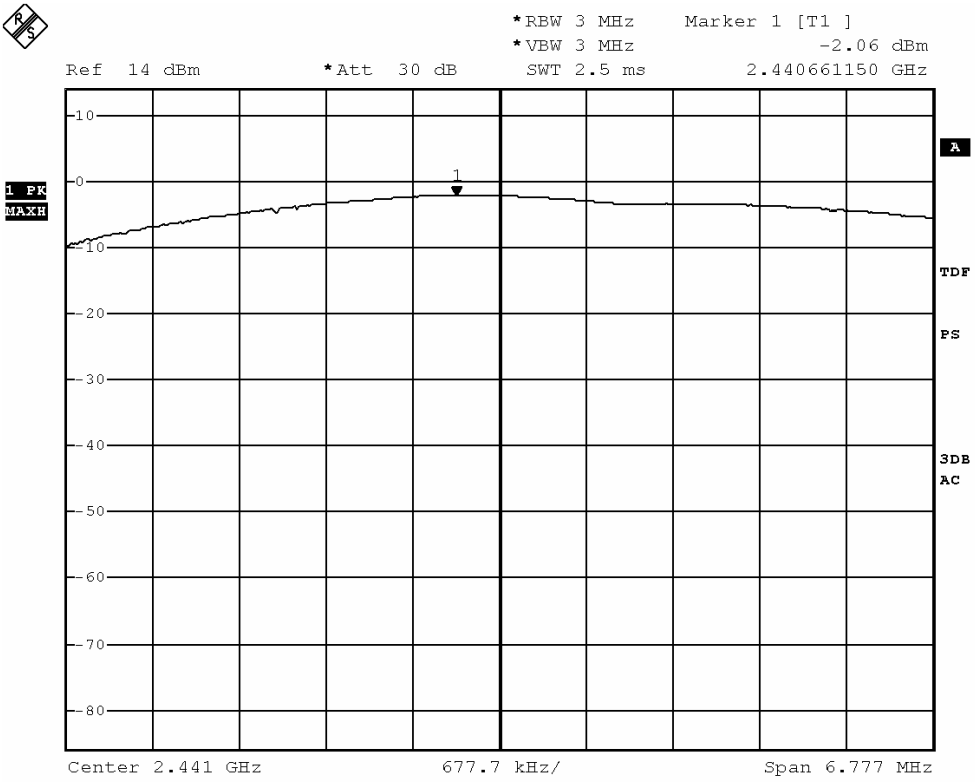
Bluetooth Communication mode (8DPSK, 2441MHz)



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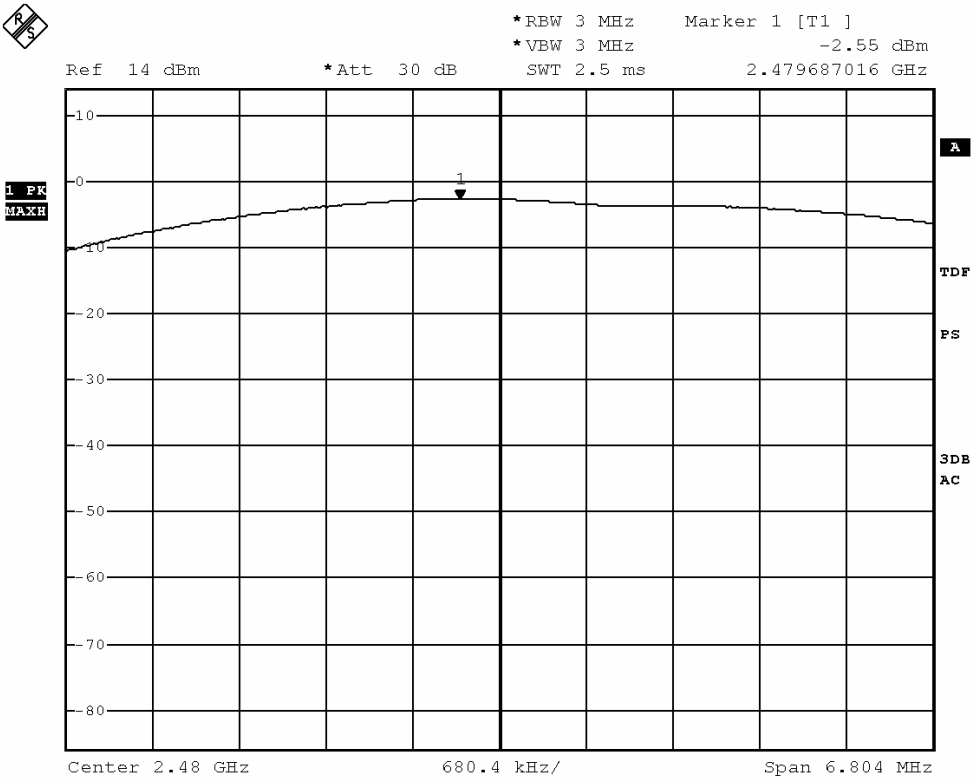
Bluetooth Communication mode (8DPSK, 2480MHz)



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3.1.2 Radiated Spurious Emissions

Test Requirement:	FCC 47CFR 15.209
Test Method:	ANSI C63.10:2013
Test Date:	2017-05-23
Mode of Operation:	Tx mode / Bluetooth Communication mode (GFSK)

Test Method:

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

* Semi-anechoic chamber located on the STC (Dongguan) Company Ltd. 68 Fumin Nan Road, Dalang, Dongguan, Guangdong, PRC with a metal ground plane filed with the FCC pursuant to section 2.948 of the FCC rules, with Registration Number: 629686.

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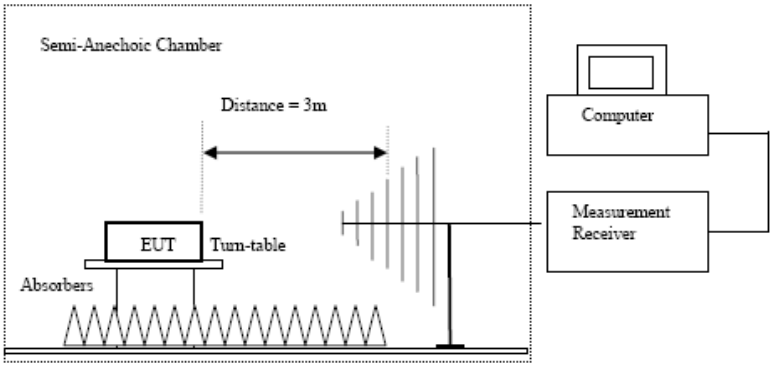
Spectrum Analyzer Setting:

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)	RBW:	1MHz
	VBW:	1MHz
	Sweep:	Auto
	Span:	Fully capture the emissions being measured
	Trace:	Max. hold
Above 1GHz (Av)	RBW:	1MHz
	VBW:	10Hz
	Sweep:	Auto
	Span:	Fully capture the emissions being measured
	Trace:	Max. hold

Test Setup:



Ground Plane

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

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

Frequency Range	Quasi-Peak Limits
[MHz]	[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 (2402.0 MHz) (GFSK) (9kHz – 30MHz): Pass

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
4804.0	21.8	41.5	63.3	74.0	10.7	Vertical
4804.0	17.0	42.4	59.4	74.0	14.6	Horizontal
7206.0	11.3	45.1	56.4	74.0	17.6	Vertical
7206.0	9.5	46.2	55.7	74.0	18.3	Horizontal
9608.0	7.7	48.0	55.7	74.0	18.3	Vertical
9608.0	6.5	48.8	55.3	74.0	18.7	Horizontal
12010.0	4.1	51.8	55.9	74.0	18.1	Vertical
12010.0	3.6	52.4	56.0	74.0	18.0	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4804.0	1.7	41.5	43.2	54.0	10.8	Vertical
4804.0	-1.3	42.4	41.1	54.0	12.9	Horizontal
7206.0	-6.5	45.1	38.6	54.0	15.4	Vertical
7206.0	-8.0	46.2	38.2	54.0	15.8	Horizontal
9608.0	-9.7	48.0	38.3	54.0	15.7	Vertical
9608.0	-10.5	48.8	38.3	54.0	15.7	Horizontal
12010.0	-12.9	51.8	38.9	54.0	15.1	Vertical
12010.0	-13.4	52.4	39.0	54.0	15.0	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4882.0	21.3	41.6	62.9	74.0	11.1	Vertical
4882.0	17.2	42.5	59.7	74.0	14.3	Horizontal
7323.0	3.7	53.2	56.9	74.0	17.1	Vertical
7323.0	11.6	46.3	57.9	74.0	16.1	Horizontal
9764.0	7.8	48.1	55.9	74.0	18.1	Vertical
9764.0	6.4	48.9	55.3	74.0	18.7	Horizontal
12205.0	4.5	51.6	56.1	74.0	17.9	Vertical
12205.0	3.4	52.5	55.9	74.0	18.1	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4882.0	0.9	41.6	42.5	54.0	11.5	Vertical
4882.0	-1.4	42.5	41.1	54.0	12.9	Horizontal
7323.0	-6.2	45.2	39.0	54.0	15.0	Vertical
7323.0	-6.5	46.3	39.8	54.0	14.2	Horizontal
9764.0	-8.8	48.1	39.3	54.0	14.7	Vertical
9764.0	-9.9	48.9	39.0	54.0	15.0	Horizontal
12205.0	-12.4	51.6	39.2	54.0	14.8	Vertical
12205.0	-13.5	52.5	39.0	54.0	15.0	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4960.0	21.7	41.4	63.1	74.0	10.9	Vertical
4960.0	18.9	42.7	61.6	74.0	12.4	Horizontal
7440.0	11.6	45.6	57.2	74.0	16.8	Vertical
7440.0	11.5	46.5	58.0	74.0	16.0	Horizontal
9920.0	7.2	48.6	55.8	74.0	18.2	Vertical
9920.0	5.8	49.7	55.5	74.0	18.5	Horizontal
12400.0	4.4	51.7	56.1	74.0	17.9	Vertical
12400.0	3.2	52.7	55.9	74.0	18.1	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4960.0	1.8	41.4	43.2	54.0	10.8	Vertical
4960.0	-1.4	42.7	41.3	54.0	12.7	Horizontal
7440.0	-5.4	45.6	40.2	54.0	13.8	Vertical
7440.0	-6.1	46.5	40.4	54.0	13.6	Horizontal
9920.0	-9.2	48.6	39.4	54.0	14.6	Vertical
9920.0	-10.4	49.7	39.3	54.0	14.7	Horizontal
12400.0	-12.5	51.7	39.2	54.0	14.8	Vertical
12400.0	-13.2	52.7	39.5	54.0	14.5	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBµV	Correction Factor dB/m	Field Strength dBµV/m	Limit @3m dBµV/m	Margin dBµV/m	E-Field Polarity
4804.0	21.3	41.5	62.8	74.0	11.2	Vertical
4804.0	19.2	42.4	61.6	74.0	12.4	Horizontal
7206.0	11.9	45.1	57.0	74.0	17.0	Vertical
7206.0	11.9	46.2	58.1	74.0	15.9	Horizontal
9608.0	7.7	48.0	55.7	74.0	18.3	Vertical
9608.0	6.8	48.8	55.6	74.0	18.4	Horizontal
12010.0	4.5	51.8	56.3	74.0	17.7	Vertical
12010.0	3.8	52.4	56.2	74.0	17.8	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4804.0	1.5	41.5	43.0	54.0	11.0	Vertical
4804.0	-0.4	42.4	42.0	54.0	12.0	Horizontal
7206.0	-4.1	45.1	41.0	54.0	13.0	Vertical
7206.0	-4.7	46.2	41.5	54.0	12.5	Horizontal
9608.0	-8.3	48.0	39.7	54.0	14.3	Vertical
9608.0	-9.6	48.8	39.2	54.0	14.8	Horizontal
12010.0	-11.7	51.8	40.1	54.0	13.9	Vertical
12010.0	-12.4	52.4	40.0	54.0	14.0	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4882.0	20.7	41.6	62.3	74.0	11.7	Vertical
4882.0	19.5	42.5	62.0	74.0	12.0	Horizontal
7323.0	4.0	53.2	57.2	74.0	16.8	Vertical
7323.0	10.8	46.3	57.1	74.0	16.9	Horizontal
9764.0	7.7	48.1	55.8	74.0	18.2	Vertical
9764.0	6.8	48.9	55.7	74.0	18.3	Horizontal
12205.0	4.6	51.6	56.2	74.0	17.8	Vertical
12205.0	3.7	52.5	56.2	74.0	17.8	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4882.0	1.1	41.6	42.7	54.0	11.3	Vertical
4882.0	0.0	42.5	42.5	54.0	11.5	Horizontal
7323.0	-4.8	45.2	40.4	54.0	13.6	Vertical
7323.0	-5.6	46.3	40.7	54.0	13.3	Horizontal
9764.0	-9.1	48.1	39.0	54.0	15.0	Vertical
9764.0	-9.7	48.9	39.2	54.0	14.8	Horizontal
12205.0	-11.0	51.6	40.6	54.0	13.4	Vertical
12205.0	-12.2	52.5	40.3	54.0	13.7	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4960.0	20.5	41.4	61.9	74.0	12.1	Vertical
4960.0	19.3	42.7	62.0	74.0	12.0	Horizontal
7440.0	12.0	45.6	57.6	74.0	16.4	Vertical
7440.0	10.5	46.5	57.0	74.0	17.0	Horizontal
9920.0	7	48.6	55.6	74.0	18.4	Vertical
9920.0	5.4	49.7	55.1	74.0	18.9	Horizontal
12400.0	4.5	51.7	56.2	74.0	17.8	Vertical
12400.0	3.4	52.7	56.1	74.0	17.9	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4960.0	-0.2	41.4	41.2	54.0	12.8	Vertical
4960.0	-0.6	42.7	42.1	54.0	11.9	Horizontal
7440.0	-5.3	45.6	40.3	54.0	13.7	Vertical
7440.0	-4.9	46.5	41.6	54.0	12.4	Horizontal
9920.0	-9.4	48.6	39.2	54.0	14.8	Vertical
9920.0	-10.6	49.7	39.1	54.0	14.9	Horizontal
12400.0	-11.7	51.7	40.0	54.0	14.0	Vertical
12400.0	-12.4	52.7	40.3	54.0	13.7	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBµV	Correction Factor dB/m	Field Strength dBµV/m	Limit @3m dBµV/m	Margin dBµV/m	E-Field Polarity
4804.0	20.5	41.5	62.0	74.0	12.0	Vertical
4804.0	19.6	42.4	62.0	74.0	12.0	Horizontal
7206.0	12.1	45.1	57.2	74.0	16.8	Vertical
7206.0	10.7	46.2	56.9	74.0	17.1	Horizontal
9608.0	7.7	48.0	55.7	74.0	18.3	Vertical
9608.0	6.3	48.8	55.1	74.0	18.9	Horizontal
12010.0	4.3	51.8	56.1	74.0	17.9	Vertical
12010.0	3.9	52.4	56.3	74.0	17.7	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4804.0	-0.2	41.5	41.3	54.0	12.7	Vertical
4804.0	-0.6	42.4	41.8	54.0	12.2	Horizontal
7206.0	-5.0	45.1	40.1	54.0	13.9	Vertical
7206.0	-7.0	46.2	39.2	54.0	14.8	Horizontal
9608.0	-8.4	48.0	39.6	54.0	14.4	Vertical
9608.0	-9.5	48.8	39.3	54.0	14.7	Horizontal
12010.0	-11.8	51.8	40.0	54.0	14.0	Vertical
12010.0	-12.2	52.4	40.2	54.0	13.8	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4882.0	20.4	41.6	62.0	74.0	12.0	Vertical
4882.0	18.9	42.5	61.4	74.0	12.6	Horizontal
7323.0	4.7	53.2	57.9	74.0	16.1	Vertical
7323.0	10.8	46.3	57.1	74.0	16.9	Horizontal
9764.0	7.5	48.1	55.6	74.0	18.4	Vertical
9764.0	6.3	48.9	55.2	74.0	18.8	Horizontal
12205.0	4.5	51.6	56.1	74.0	17.9	Vertical
12205.0	3.8	52.5	56.3	74.0	17.7	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4882.0	0.6	41.6	42.2	54.0	11.8	Vertical
4882.0	-1.1	42.5	41.4	54.0	12.6	Horizontal
7323.0	-4.5	45.2	40.7	54.0	13.3	Vertical
7323.0	-6.1	46.3	40.2	54.0	13.8	Horizontal
9764.0	-9.1	48.1	39.0	54.0	15.0	Vertical
9764.0	-10.0	48.9	38.9	54.0	15.1	Horizontal
12205.0	-11.5	51.6	40.1	54.0	13.9	Vertical
12205.0	-12.2	52.5	40.3	54.0	13.7	Horizontal

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

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

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

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4960.0	21.0	41.4	62.4	74.0	11.6	Vertical
4960.0	18.9	42.7	61.6	74.0	12.4	Horizontal
7440.0	12.4	45.6	58.0	74.0	16.0	Vertical
7440.0	10.7	46.5	57.2	74.0	16.8	Horizontal
9920.0	6.9	48.6	55.5	74.0	18.5	Vertical
9920.0	5.5	49.7	55.2	74.0	18.8	Horizontal
12400.0	4.6	51.7	56.3	74.0	17.7	Vertical
12400.0	3.4	52.7	56.1	74.0	17.9	Horizontal

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Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4960.0	0.7	41.4	42.1	54.0	11.9	Vertical
4960.0	-1.5	42.7	41.2	54.0	12.8	Horizontal
7440.0	-5.0	45.6	40.6	54.0	13.4	Vertical
7440.0	-6.5	46.5	40.0	54.0	14.0	Horizontal
9920.0	-10.0	48.6	38.6	54.0	15.4	Vertical
9920.0	-10.7	49.7	39.0	54.0	15.0	Horizontal
12400.0	-11.6	51.7	40.1	54.0	13.9	Vertical
12400.0	12.6	52.7	65.3	54.0	-11.3	Horizontal

Note: Above 13GHz Emissions detected are more than 20 dB below the FCC Limits .

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

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

Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty : 9kHz-30MHz 3.3dB
30MHz -1GHz 4.6dB
1GHz -26GHz 4.4dB

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

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Radiated Emissions Measurement:

Limit：

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).

Result： RF Radiated Emissions (Lowest)-GFSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	20.2	36.8	57.0	74.0	17.0	Vertical

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	1.9	36.8	38.7	54.0	15.3	Vertical

Result： RF Radiated Emissions (Highest) -GFSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	28.4	36.8	65.2	74.0	8.8	Vertical

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	5.6	36.8	42.4	54.0	11.6	Vertical

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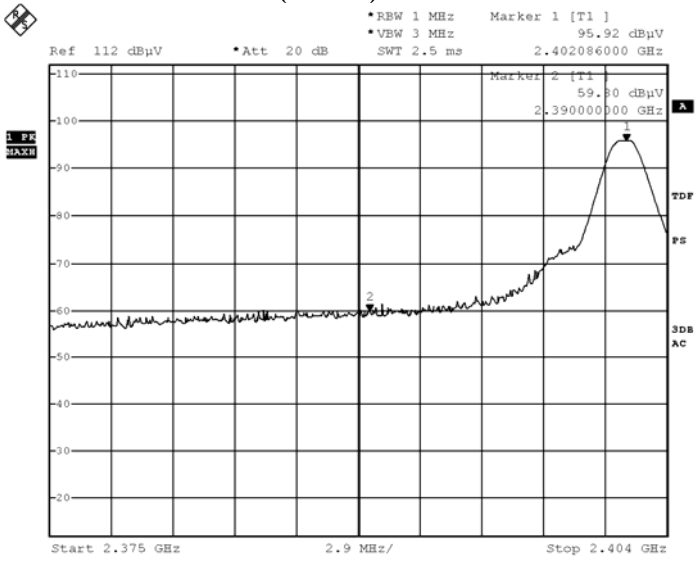
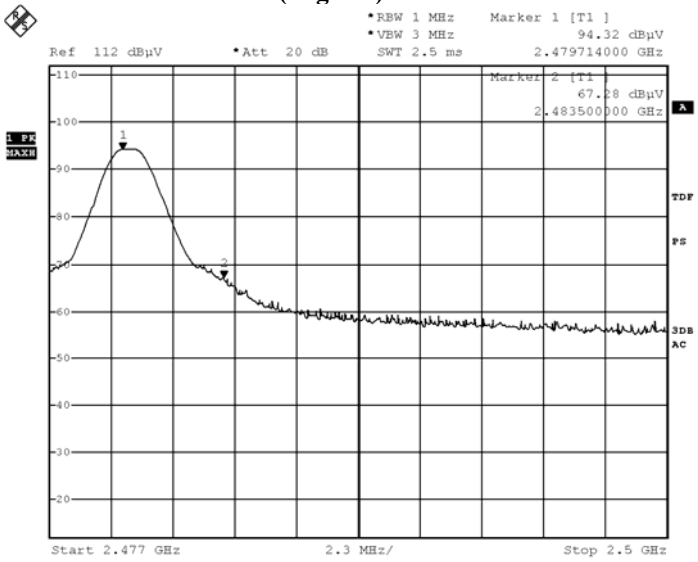
RF Radiated Emissions (Lowest)-GFSK



RF Radiated Emissions (Highest) -GFSK



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Radiated Emissions Measurement:

Limit：

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).

Result： RF Radiated Emissions (Lowest)- π/4-DQPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	20.2	36.8	57.0	74.0	17.0	Vertical

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	2.6	36.8	39.4	54.0	14.6	Vertical

Result： RF Radiated Emissions (Highest) -π/4-DQPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	28.6	36.8	65.4	74.0	8.6	Vertical

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	4.9	36.8	41.7	54.0	12.3	Vertical

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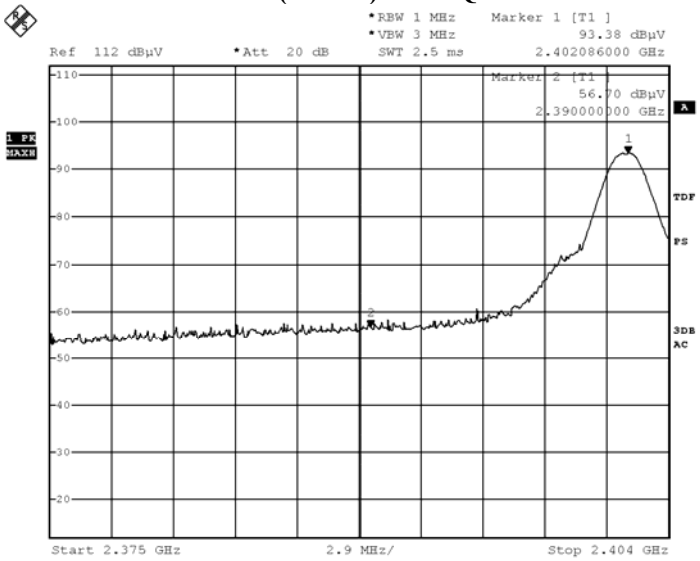
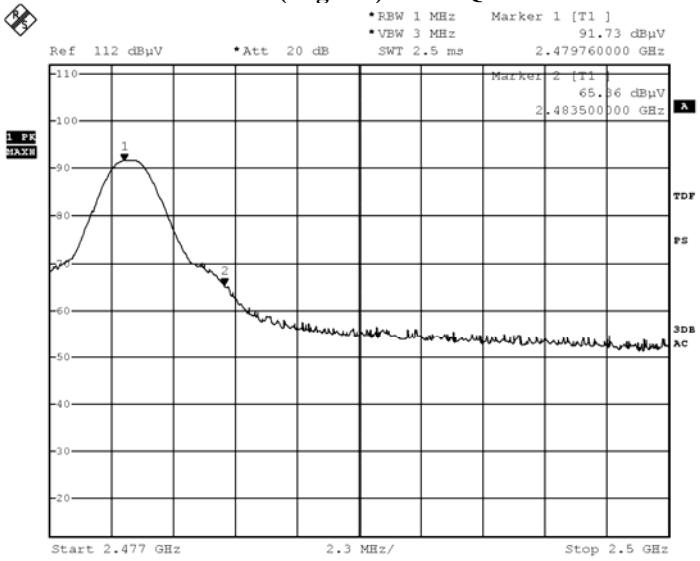
RF Radiated Emissions (Lowest)- π/4-DQPSK



RF Radiated Emissions (Highest) -π/4-DQPSK



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Radiated Emissions Measurement:

Limit：

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).

Result： RF Radiated Emissions (Lowest)- 8DPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	19.4	36.8	56.2	74.0	17.8	Vertical

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	3.8	36.8	40.6	54.0	13.4	Vertical

Result： RF Radiated Emissions (Highest) -8DPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	28.3	36.8	65.1	74.0	8.9	Vertical

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	4.5	36.8	41.3	54.0	12.7	Vertical

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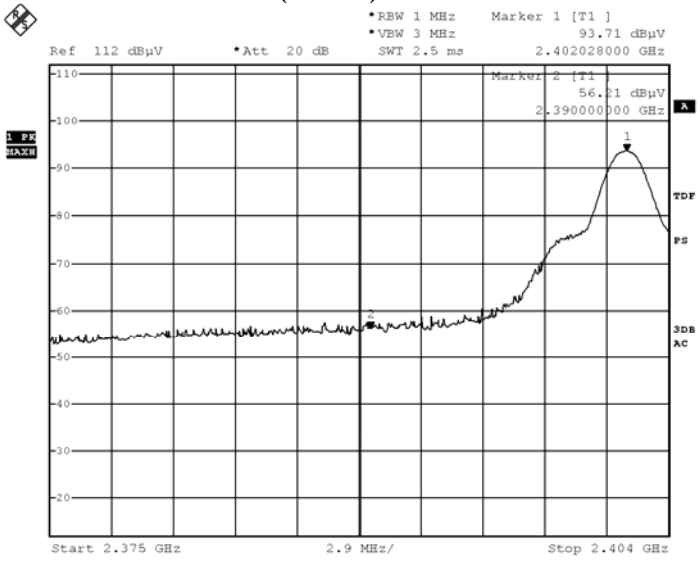
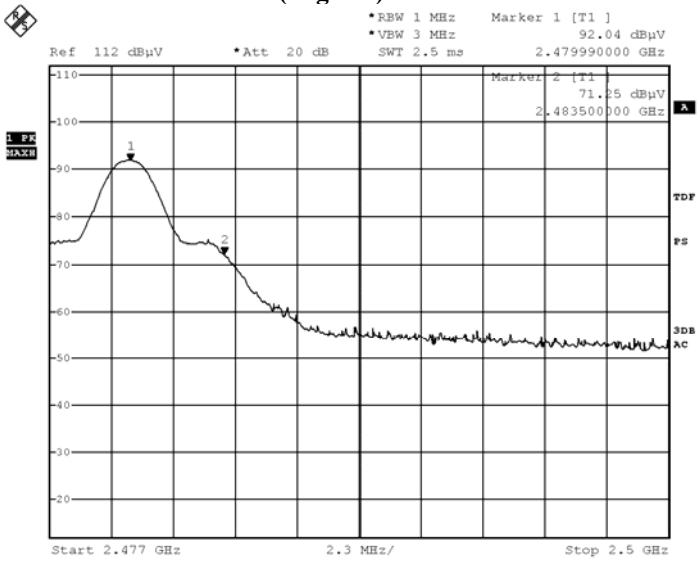
RF Radiated Emissions (Lowest)- 8DPSK



RF Radiated Emissions (Highest) -8DPSK



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

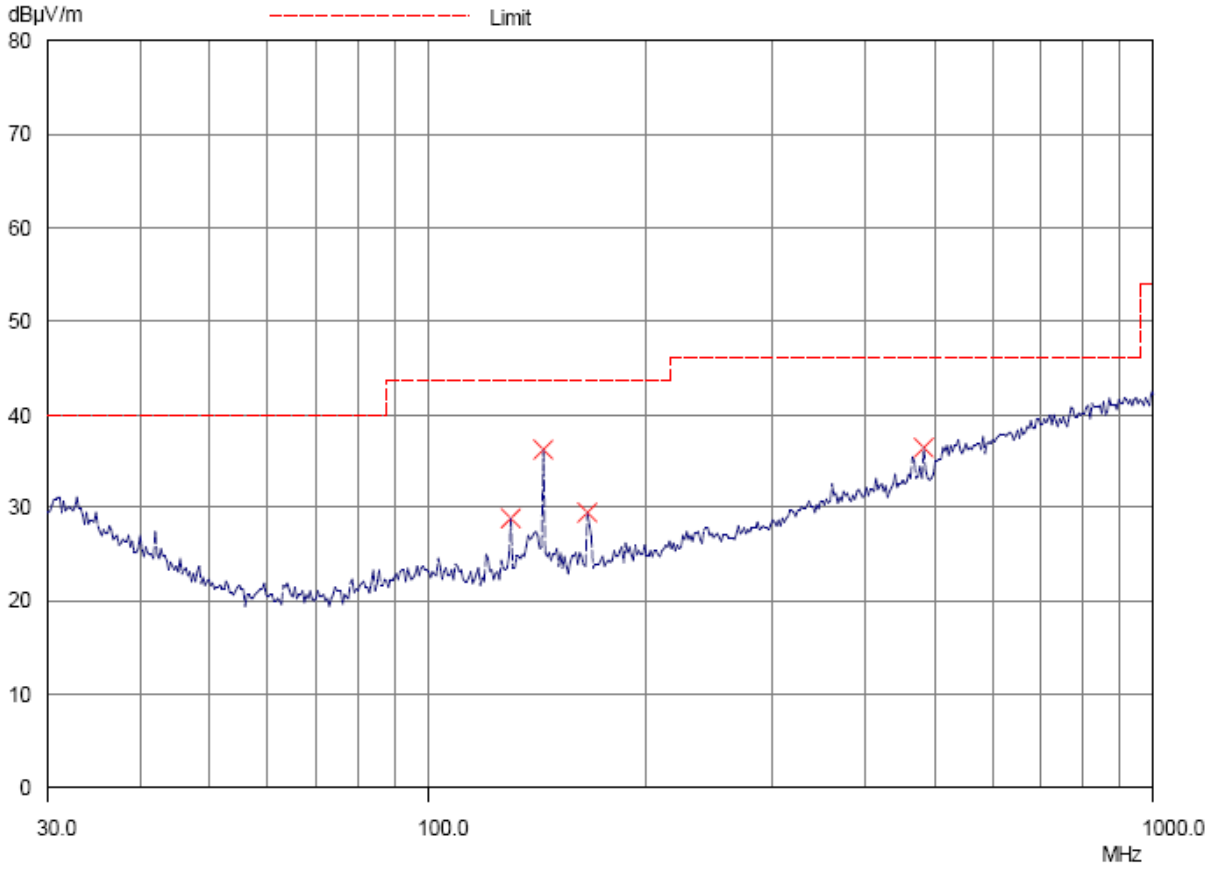
Frequency Range	Quasi-Peak Limits
[MHz]	[μV/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

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.

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

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

Horizontal



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

Radiated Emissions Quasi-Peak					
Emission Frequency MHz	E-Field Polarity	Level @3m dBμV/m	Limit @3m dBμV/m	Level @3m μV/m	Limit @3m μV/m
130.1	Horizontal	28.8	43.5	27.5	150
144.0	Horizontal	36.3	43.5	65.3	150
166.2	Horizontal	29.5	43.5	29.9	150
480.0	Horizontal	36.3	46.0	65.3	200

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

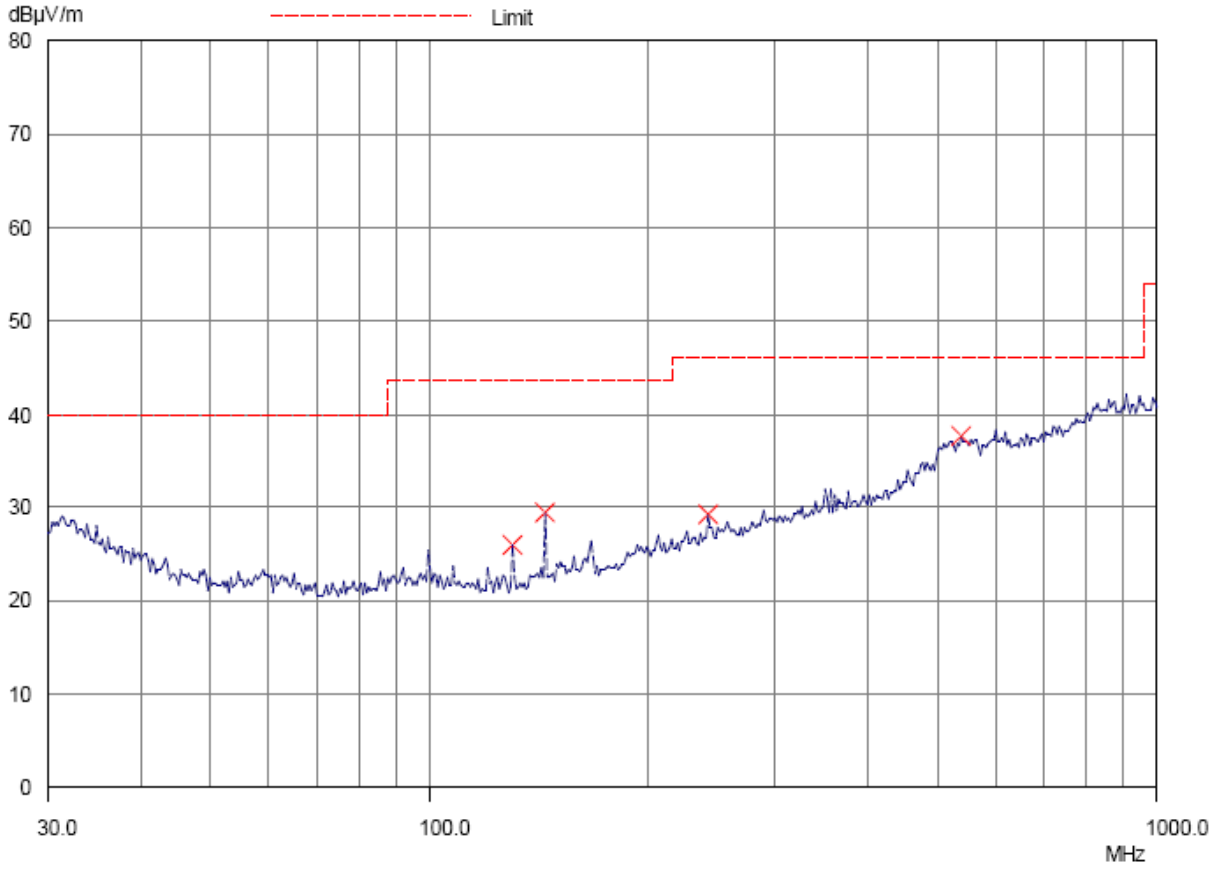
Frequency Range	Quasi-Peak Limits
[MHz]	[μV/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

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.

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

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

Vertical



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

Radiated Emissions Quasi-Peak					
Emission Frequency MHz	E-Field Polarity	Level @3m dBμV/m	Limit @3m dBμV/m	Level @3m μV/m	Limit @3m μV/m
129.9	Vertical	26.0	43.5	20.0	150
144.0	Vertical	29.5	43.5	29.9	150
239.9	Vertical	29.2	46.0	28.8	200
537.6	Vertical	37.7	46.0	76.7	200

Remarks:
Calculated measurement uncertainty (30MHz – 1GHz): 4.6dB
Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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

Test Requirement:	FCC 47CFR 15.207
Test Method:	ANSI C63.10:2013
Test Date:	2017-05-22
Mode of Operation:	Bluetooth Communication mode
Test Voltage:	120Va.c. 60Hz

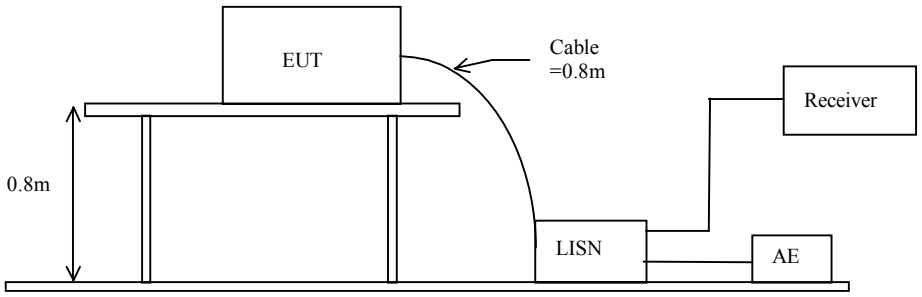
Test Method:

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

Receiver Setting:

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

Test Setup:



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Limits for Conducted Emissions (FCC 47 CFR 15.207):

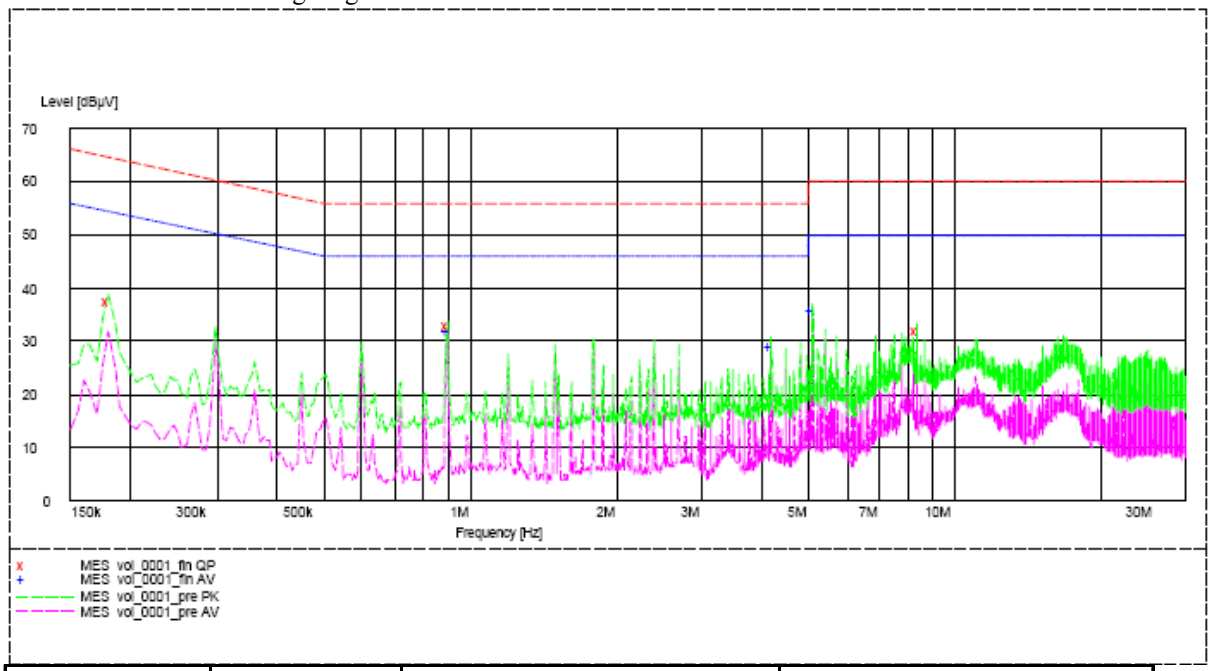
Frequency Range [MHz]	Quasi-Peak Limits [dBµV]	Average [dBµV]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

* Decreases with the logarithm of the frequency.

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

Results of Bluetooth Communication mode (L): PASS

Please refer to the following diagram for individual results.



Conductor Live or Neutral	Frequency MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Average Level dBµV	Average Limit dBµV
Live	0.180	37.3	65.0	-*-	-*-
Live	0.900	33.0	56.0	-*-	-*-
Live	8.395	32.2	60.0	-*-	-*-
Live	0.900	-*-	-*-	32.0	46.0
Live	4.195	-*-	-*-	28.8	46.0
Live	5.095	-*-	-*-	35.9	50.0

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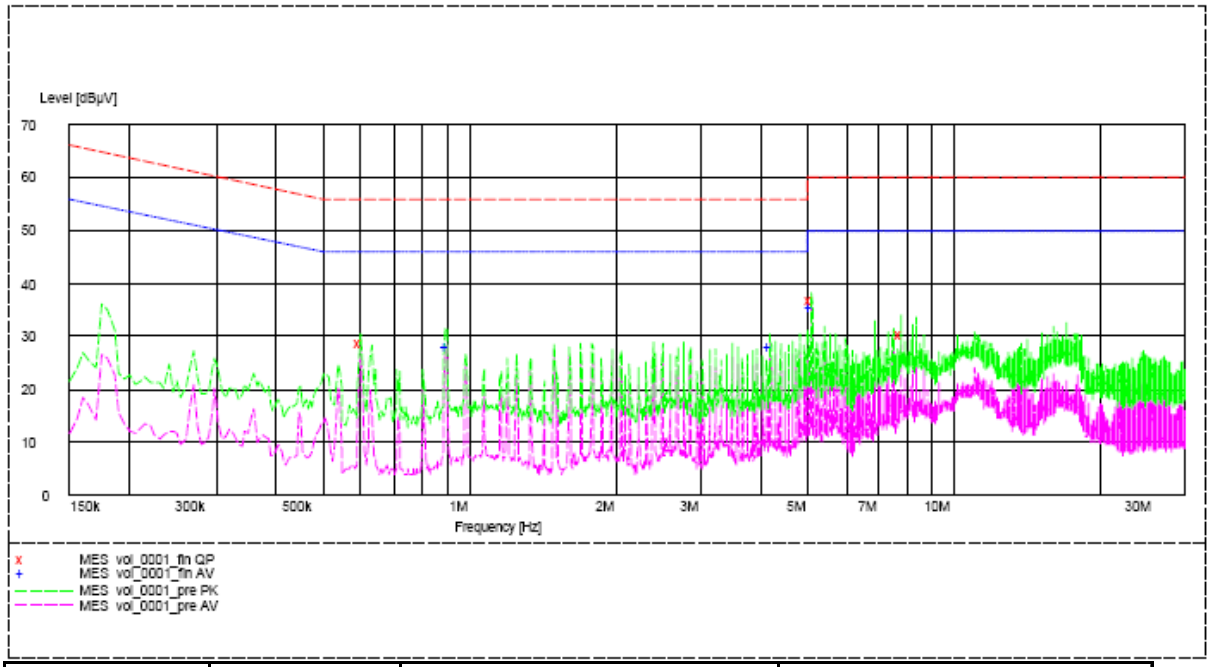
Frequency Range [MHz]	Quasi-Peak Limits [dBµV]	Average [dBµV]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

* 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 Bluetooth Communication mode (N): PASS
Please refer to the following diagram for individual results.



Conductor Live or Neutral	Frequency MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Average Level dBµV	Average Limit dBµV
Neutral	0.600	28.5	56.0	-*-	-*-
Neutral	5.095	36.8	60.0	-*-	-*-
Neutral	7.790	35.6	60.0	-*-	-*-
Neutral	0.900	-*-	-*-	28.3	46.0
Neutral	4.195	-*-	-*-	28.4	46.0
Neutral	5.095	-*-	-*-	35.6	50.0

Remarks:
Calculated measurement uncertainty (0.15MHz – 30MHz): 3.2dB
-*- Emission(s) that is far below the corresponding limit line.

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3.1.4 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:

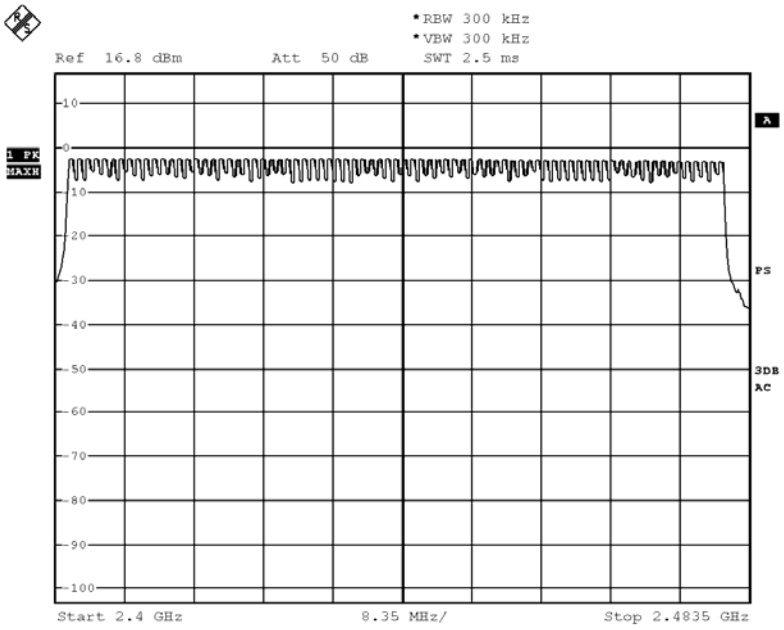
The RF output of the EUT was connected to the spectrum analyzer by a low loss cable.

Spectrum Analyzer Setting:

RBW = 300kHz, VBW ≥ 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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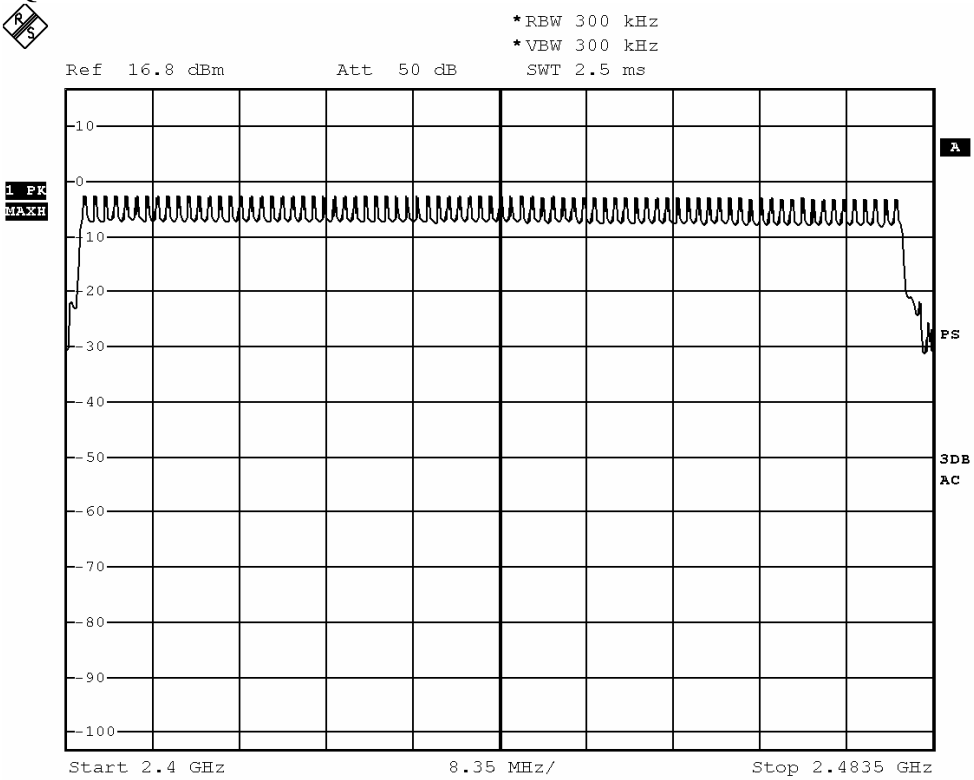
π/4-DQPSK: 79 of 79 Channel



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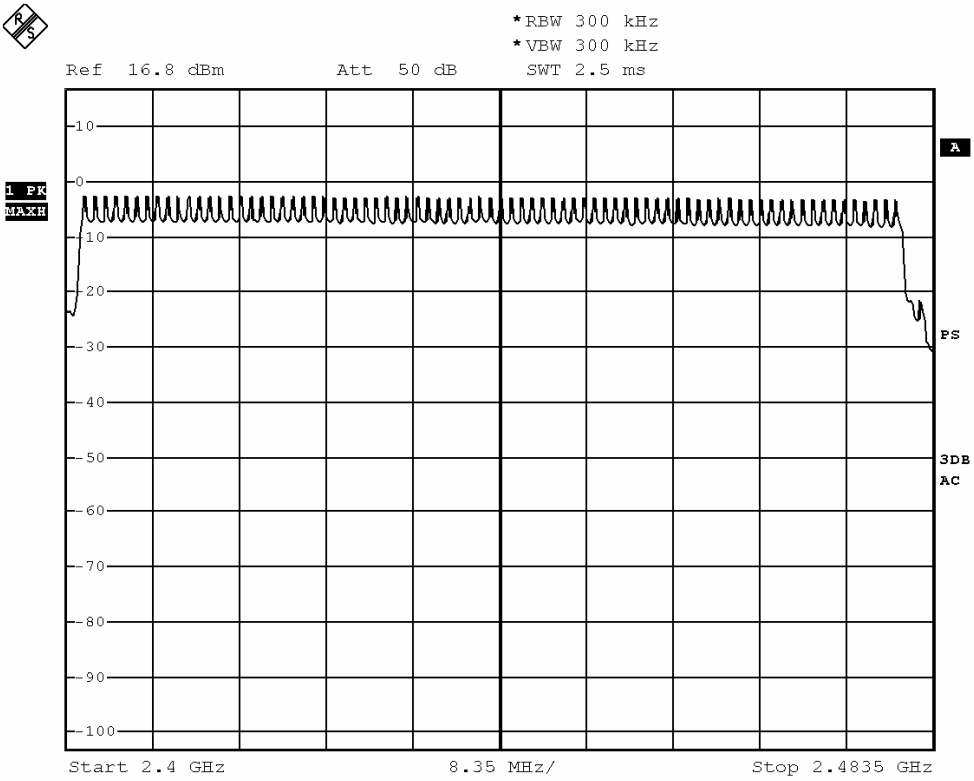
8DPSK: 79 of 79 Channel



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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:	2017-05-24
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 ≥ 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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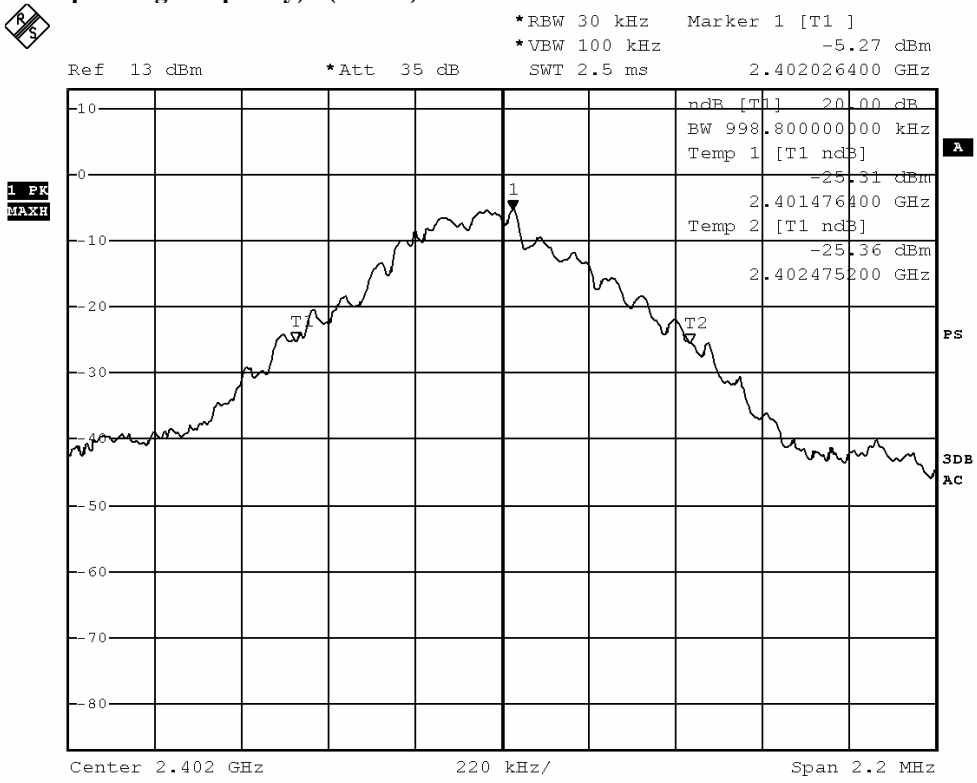
Fundamental Frequency [MHz]	20dB Bandwidth [KHz]	FCC Limits [MHz]
2402	998.8	Within 2400-2483.5

(Lowest Operating Frequency) - (GFSK)



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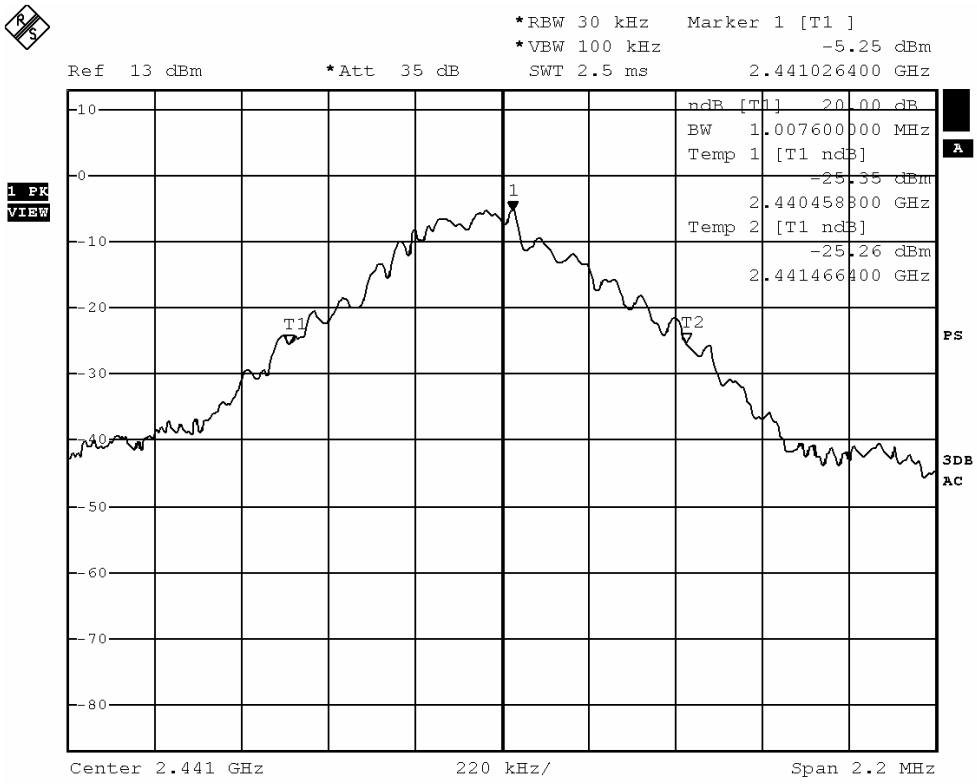
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.0076	Within 2400-2483.5

(Middle Operating Frequency) - (GFSK)



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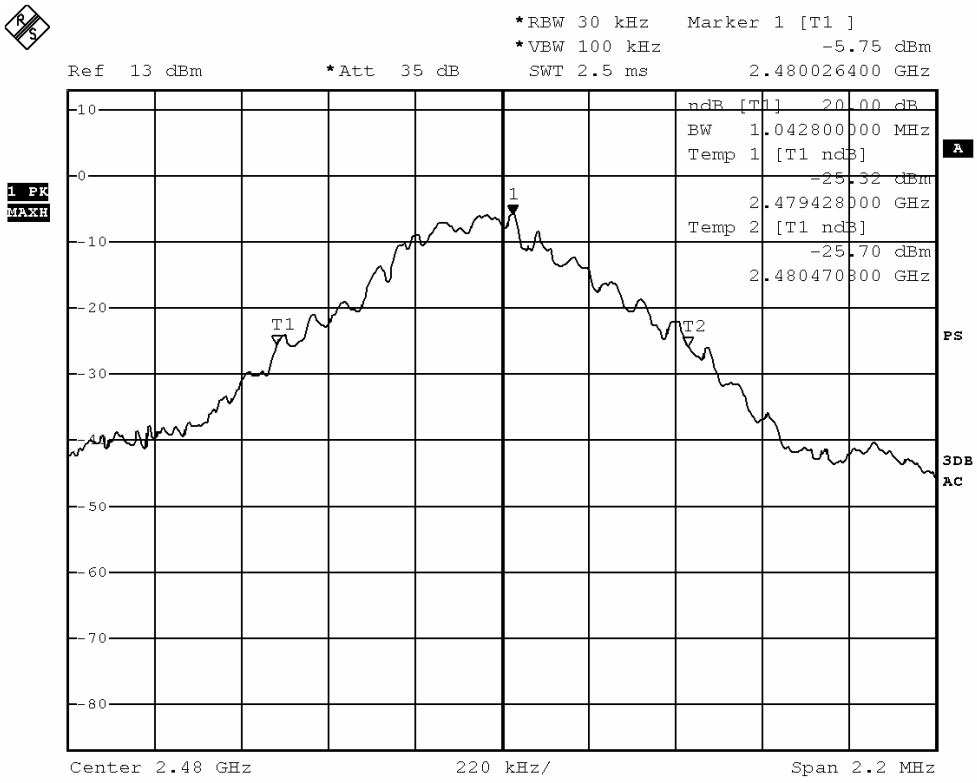
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.0428	Within 2400-2483.5

(Highest Operating Frequency) - (GFSK)



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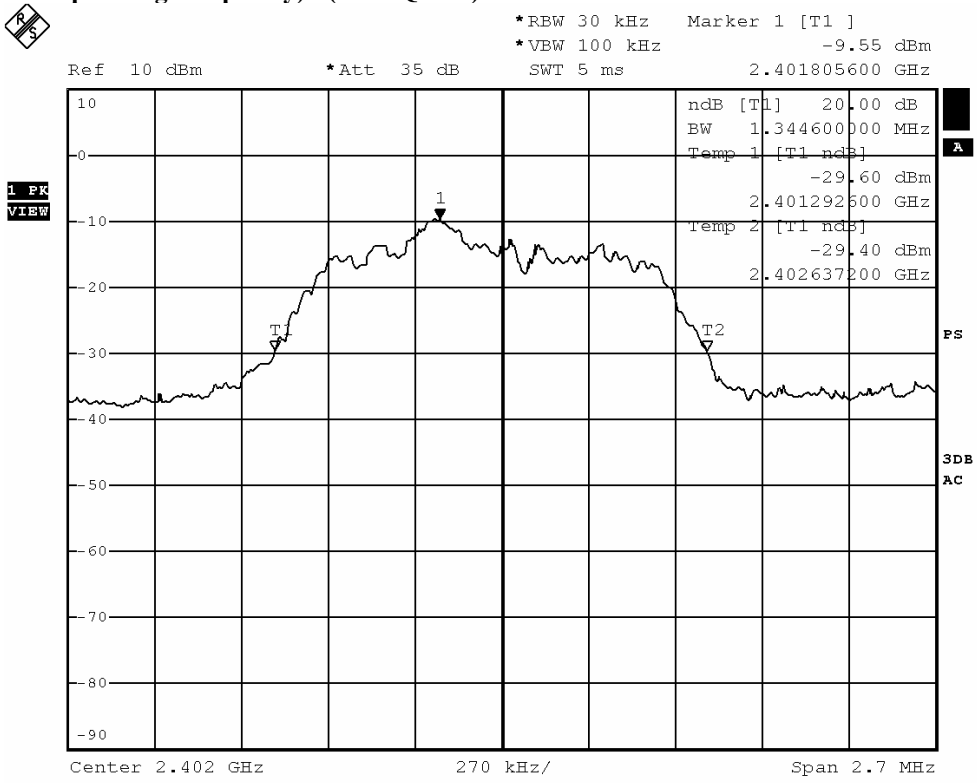
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.3446	Within 2400-2483.5

(Lowest Operating Frequency) - (π/4 DQPSK)



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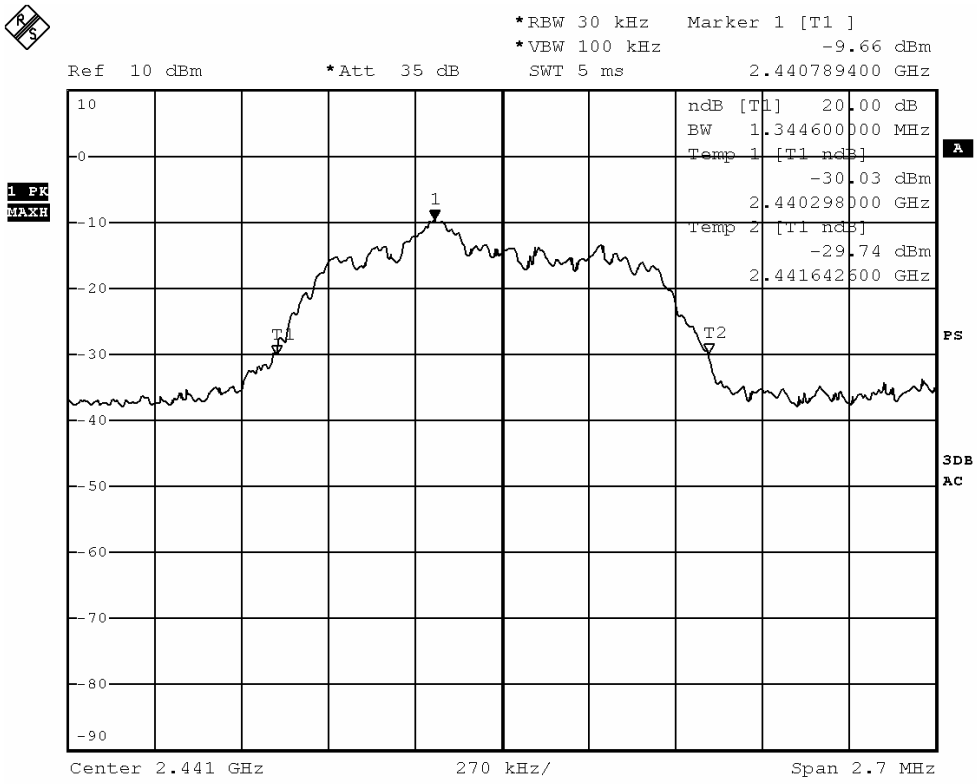
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.3446	Within 2400-2483.5

(Middle Operating Frequency) - (π/4 DQPSK)



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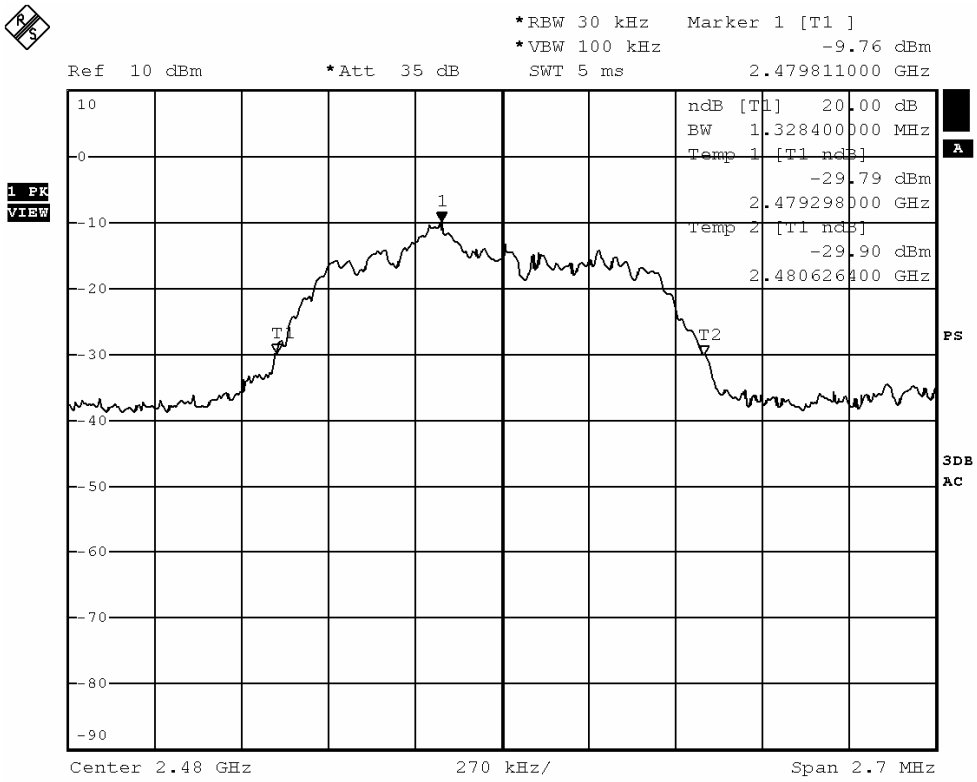
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.3284	Within 2400-2483.5

(Highest Operating Frequency) - (π/4 DQPSK)



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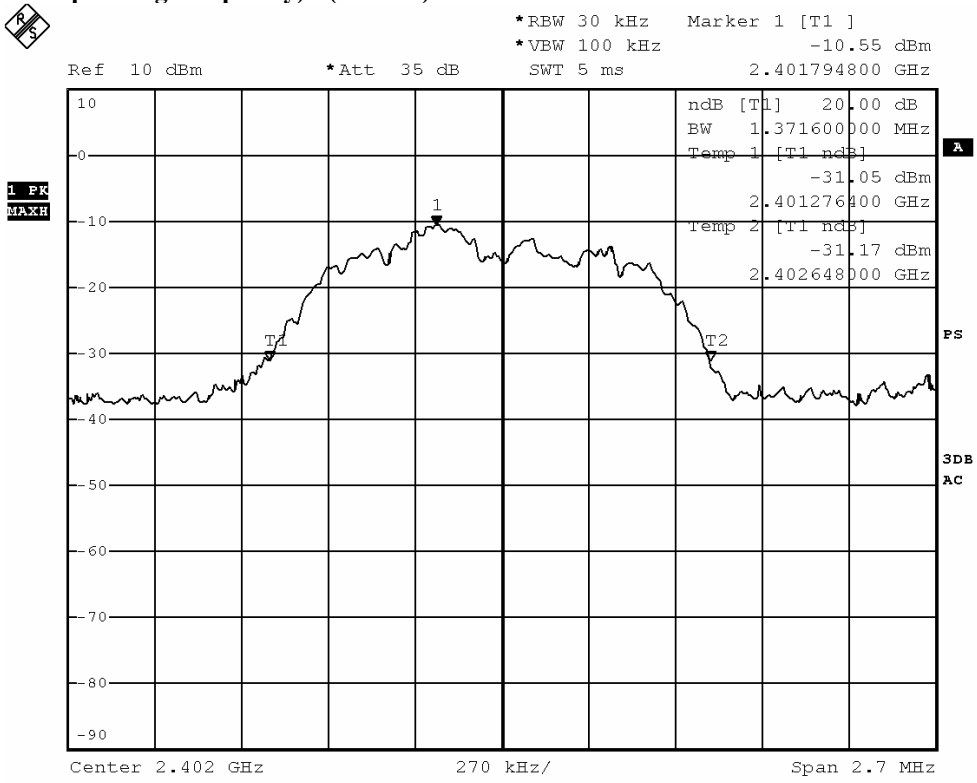
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.3716	Within 2400-2483.5

(Lowest Operating Frequency) - (8DPSK)



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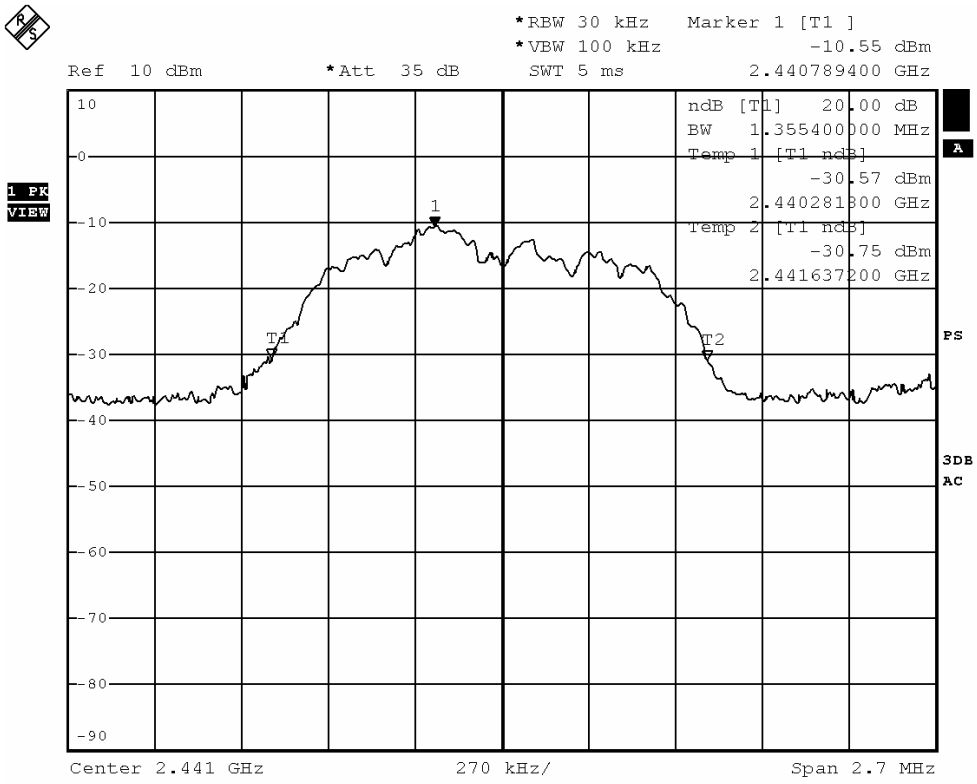
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.3554	Within 2400-2483.5

(Middle Operating Frequency) - (8DPSK)



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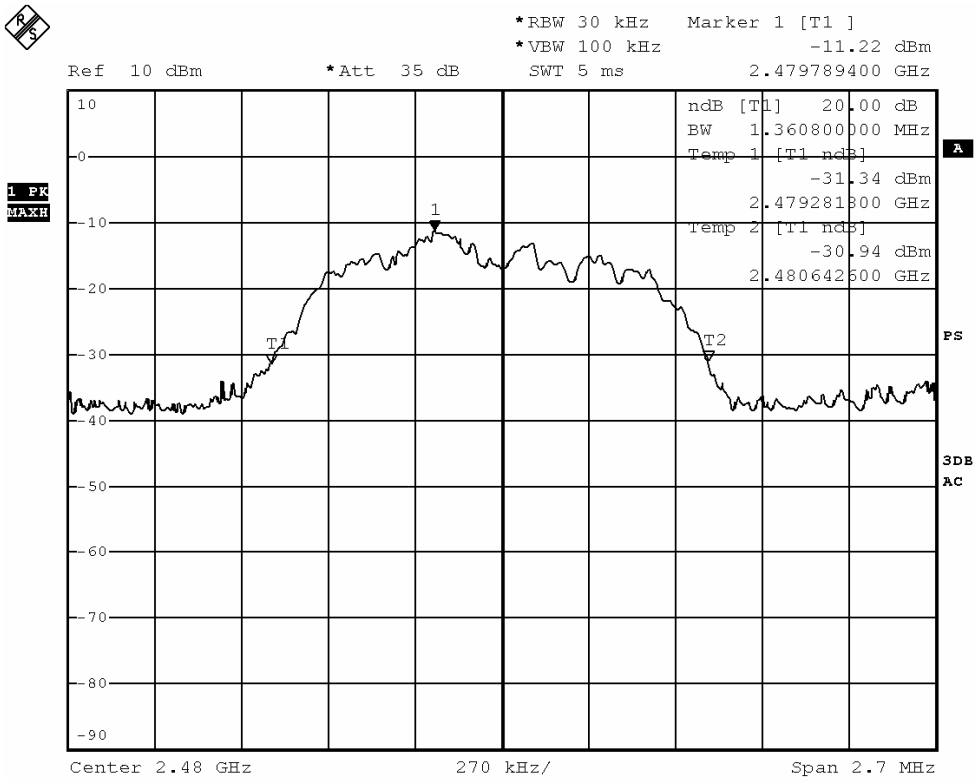
Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.3608	Within 2400-2483.5

(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 ≥ RBW, Sweep = Auto,
Span = Wide enough to captur the peaks of two adjacent channels
Detector = Peak, Trace = Max. hold

Limit:

The measured maximum bandwidth* 2/3 = 1.0428MHz * 2/3 = 695.2kHz (GFSK)

The measured maximum bandwidth * 2/3 = 1.3716MHz * 2/3 = 914.4kHz(π/4 DQPSK, 8DPSK)

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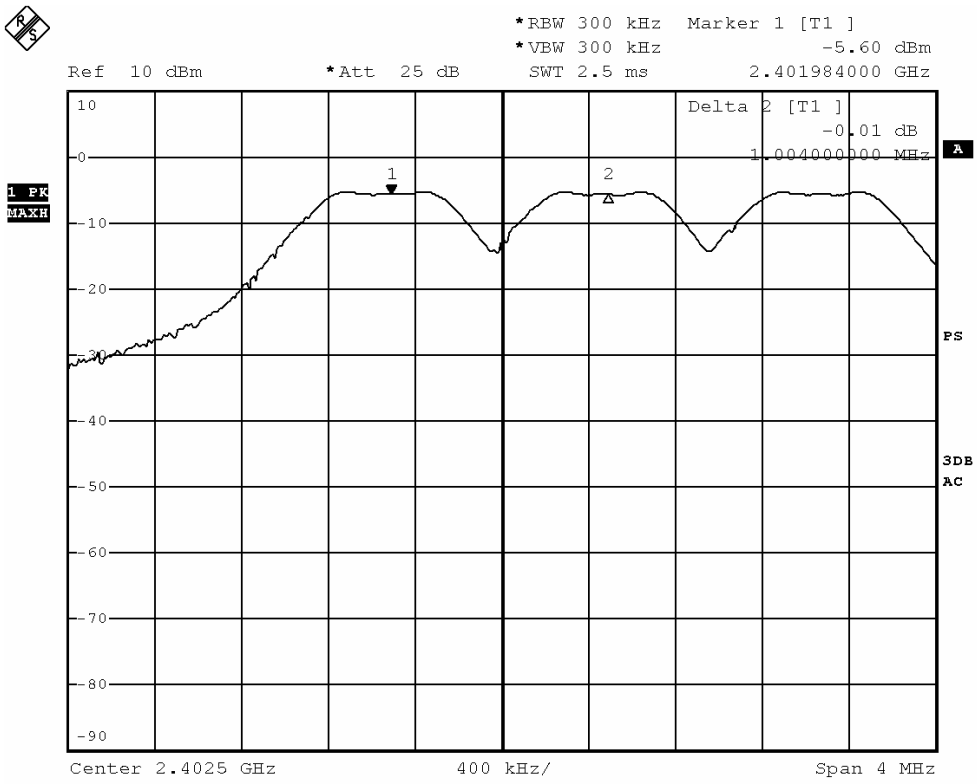
Channel separation = 1MHz (>695.2kHz) （Lowest） (GFSK)



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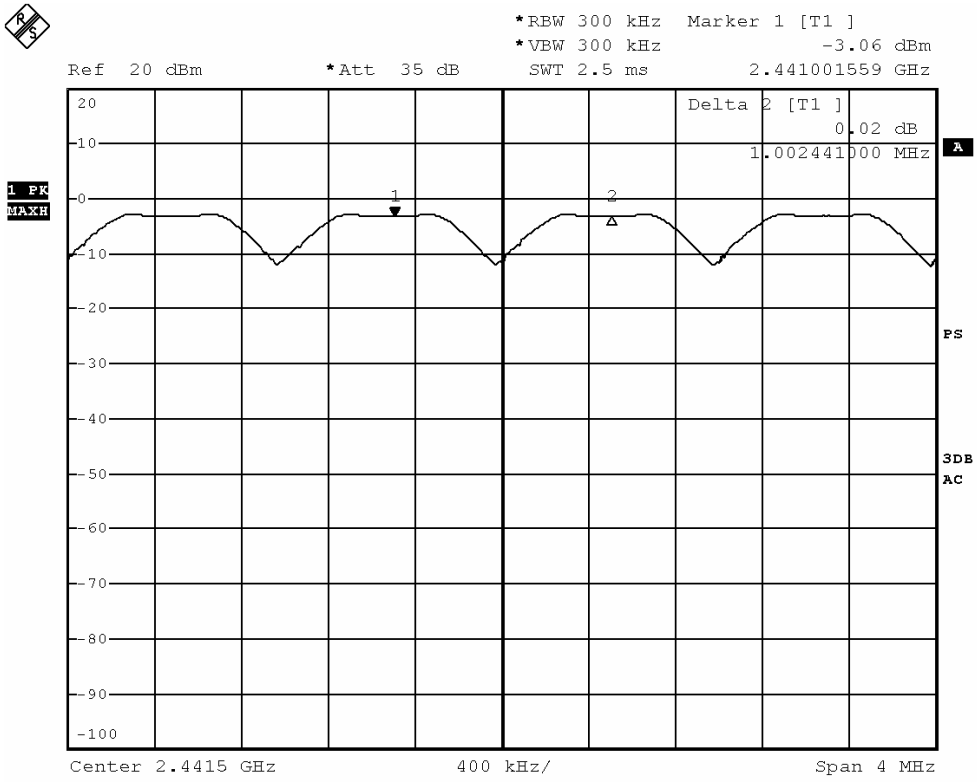
Channel separation = 1MHz (>695.2kHz) （Mid） (GFSK)



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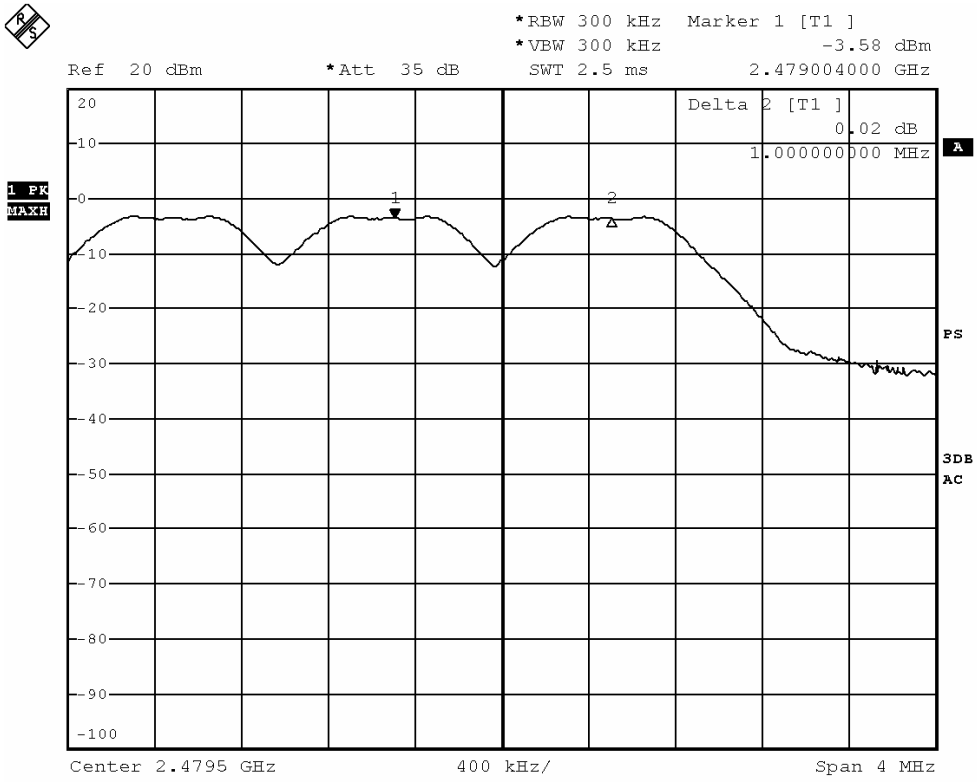
Channel separation = 1MHz (>695.2kHz) （Highest） (GFSK)



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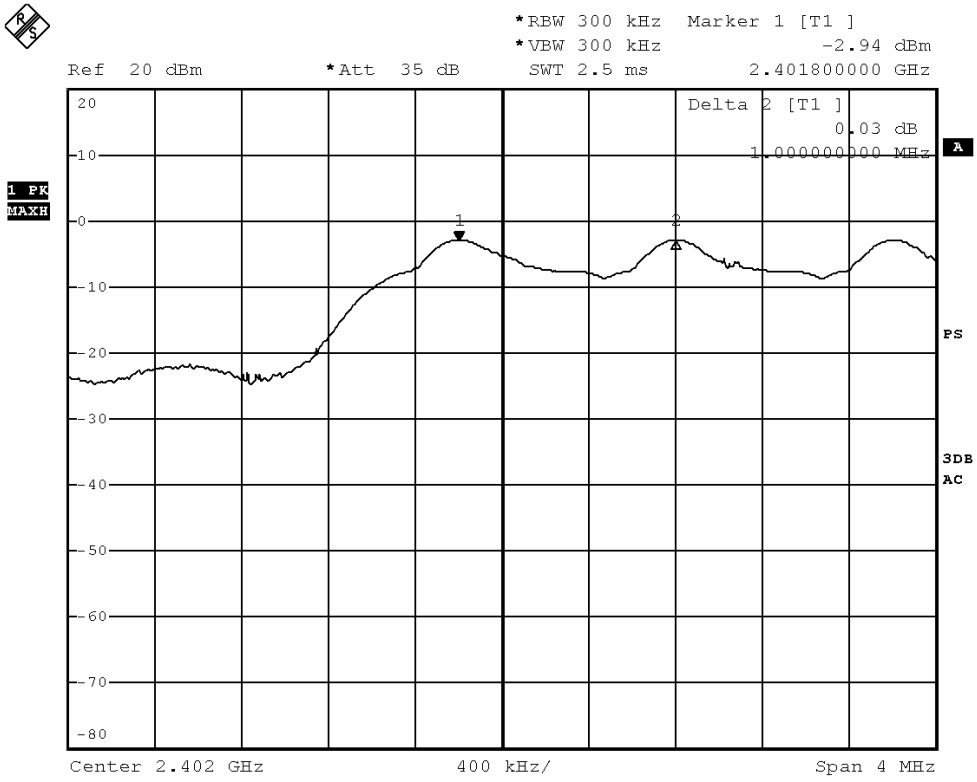
Channel separation = 1MHz (>914.4kHz) （Lowest） (π/4 DQPSK)



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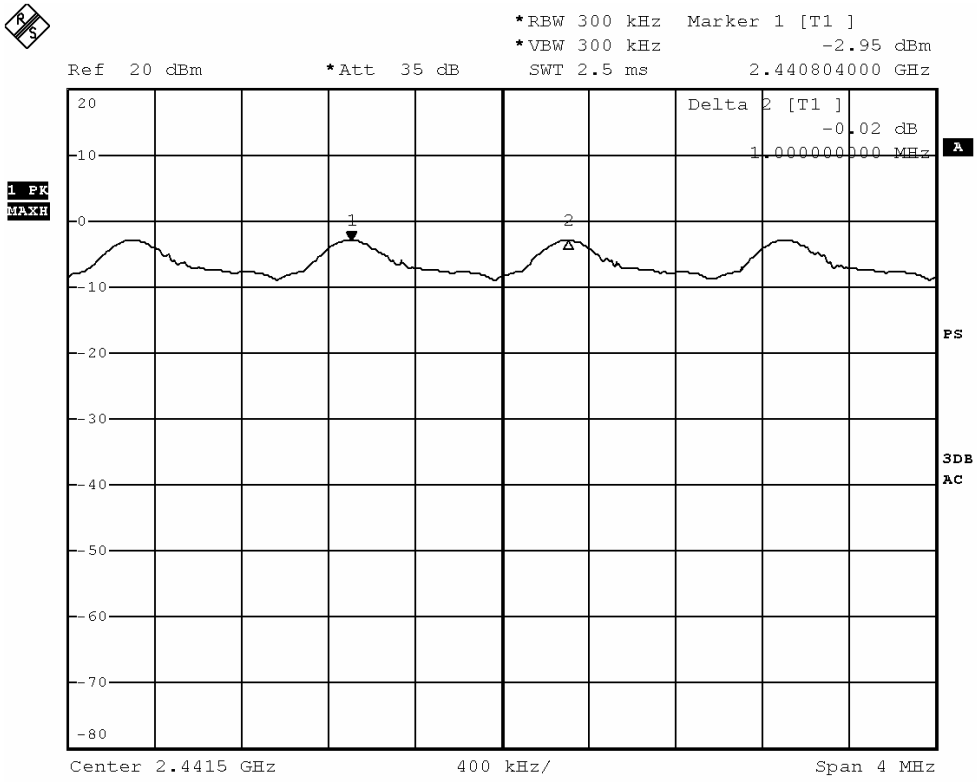
Channel separation = 1MHz (>914.4kHz) （Mid） (π/4 DQPSK)



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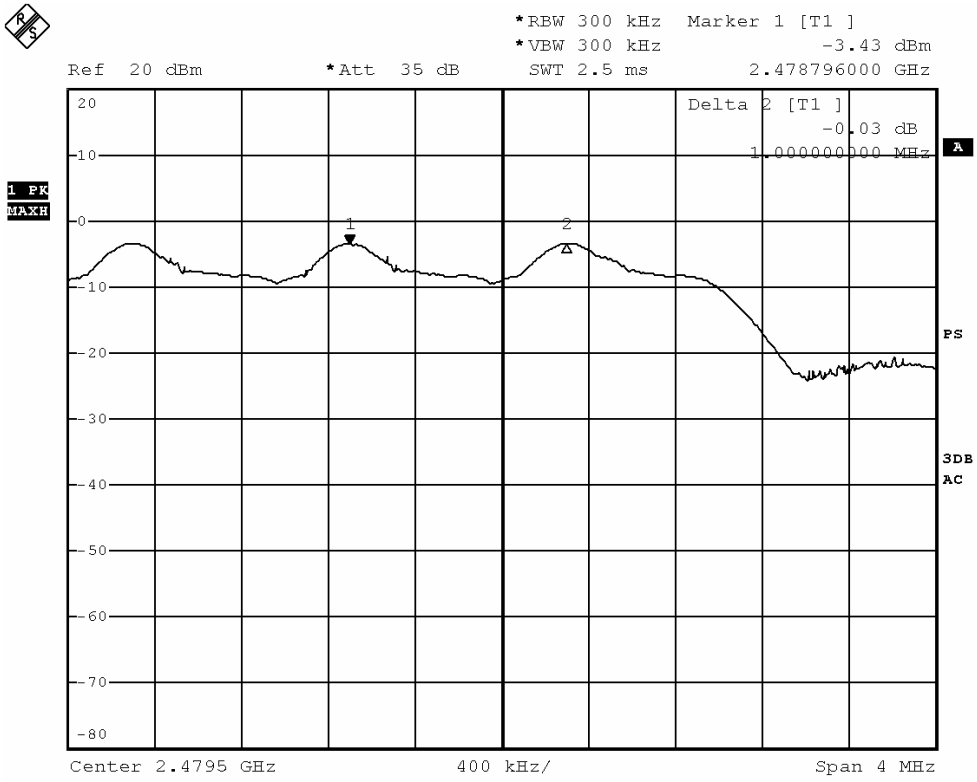
Channel separation = 1MHz (>914.4kHz) （Highest） (π/4 DQPSK)



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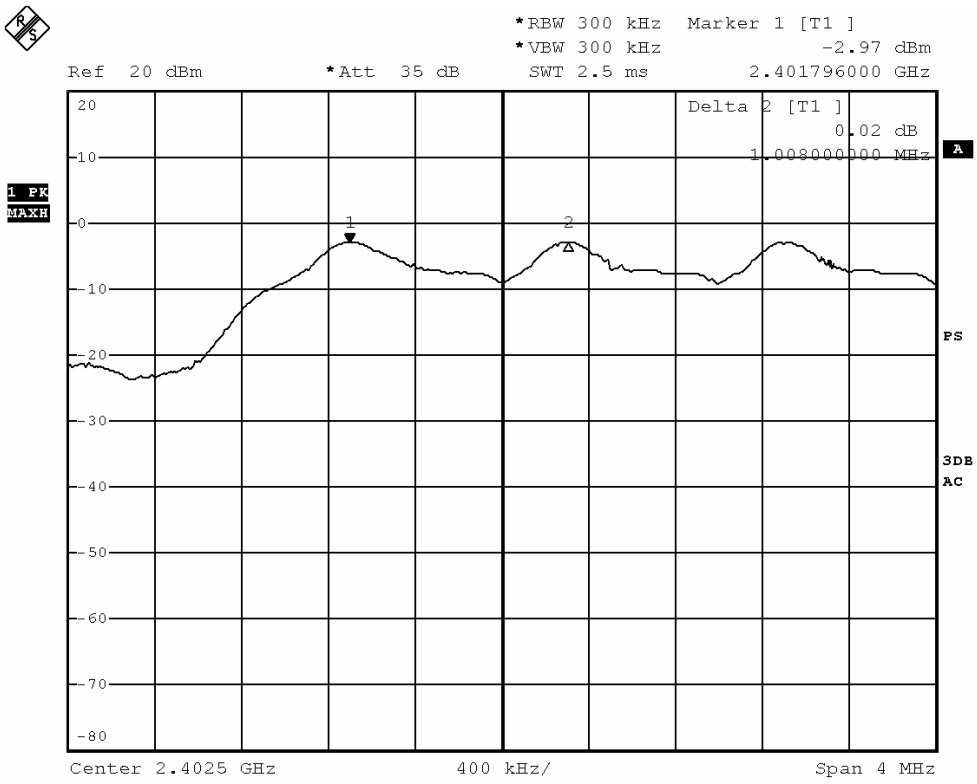
Channel separation = 1MHz (>914.4kHz) （Lowest） (8DPSK)



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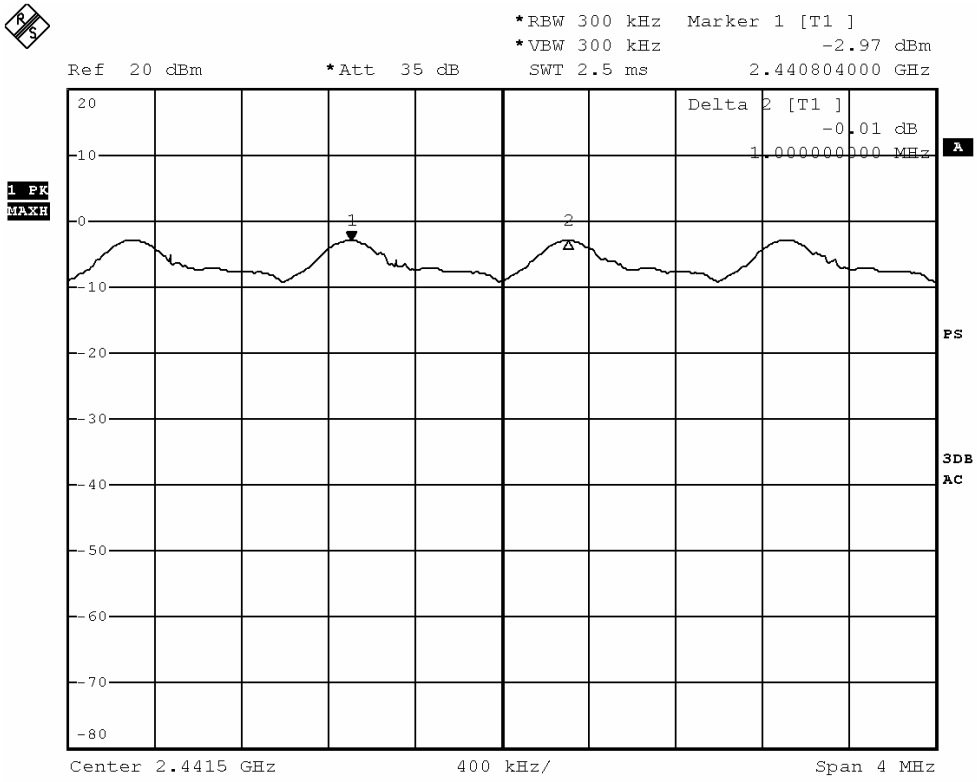
Channel separation = 1MHz (>914.4kHz) （Mid） (8DPSK)



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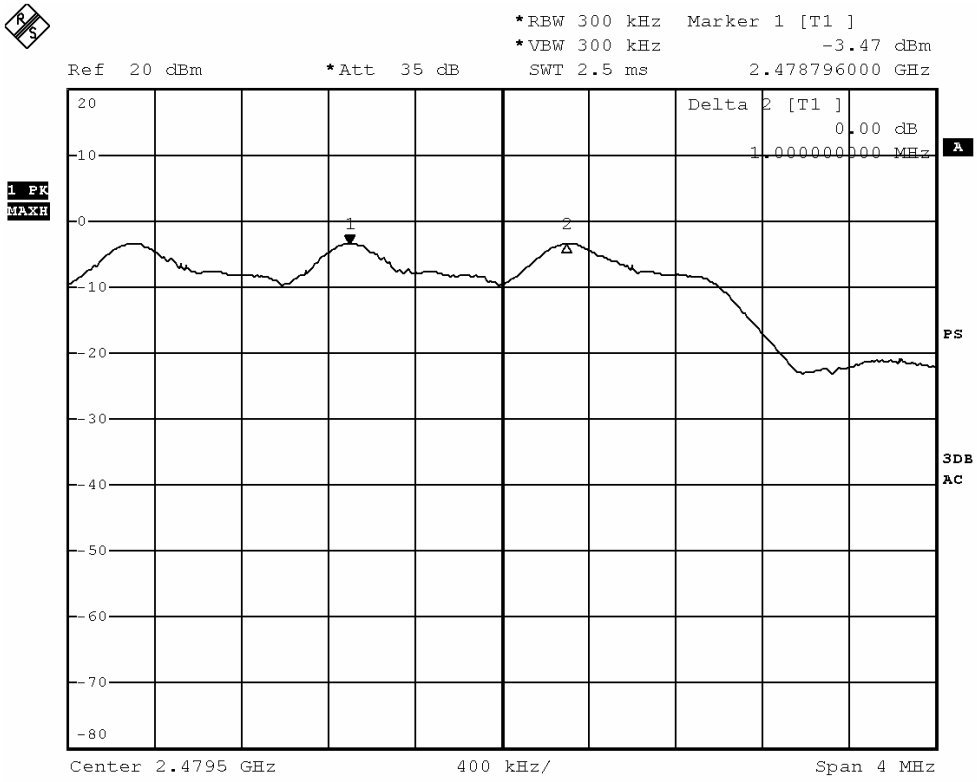
Channel separation = 1MHz (>914.4kHz) （Highest） (8DPSK)



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3.1.7 Band-edge Compliance of RF Conducted Emissions Measurement:

Limit：

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.
According to the test method DA 00-705.

Spectrum Analyzer Setting:
RBW = 100kHz, VBW= 300kHz, Sweep = Coupled,
Span = Wide enough to captur the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
Detector = Peak, Trace = Max. hold

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

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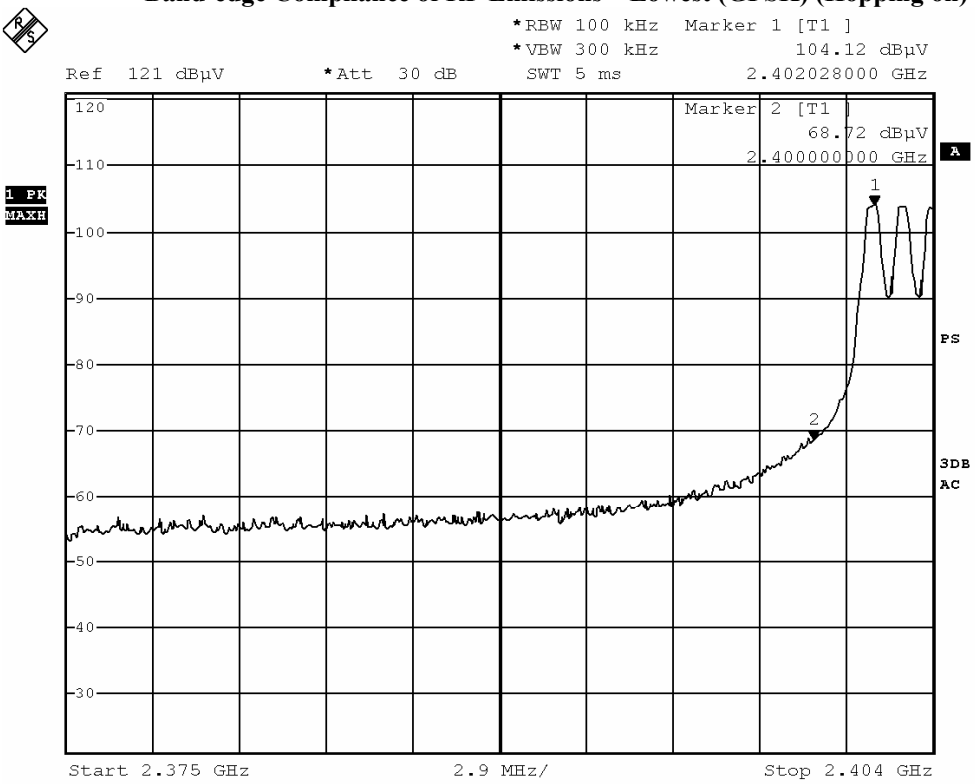
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	36.67

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



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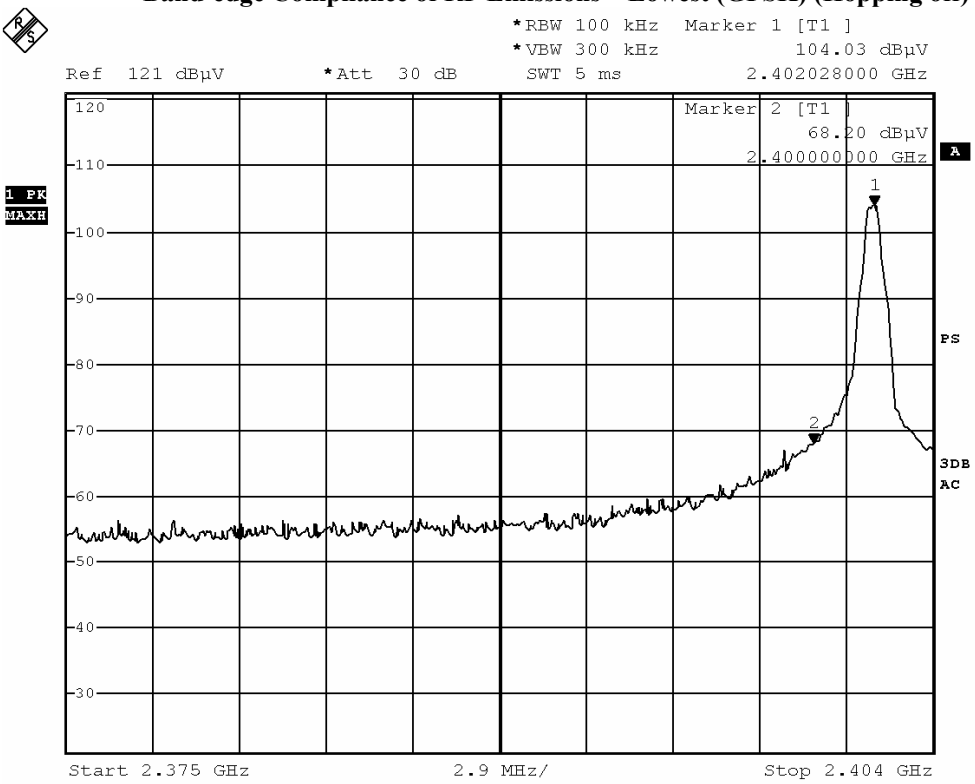
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	36.16

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



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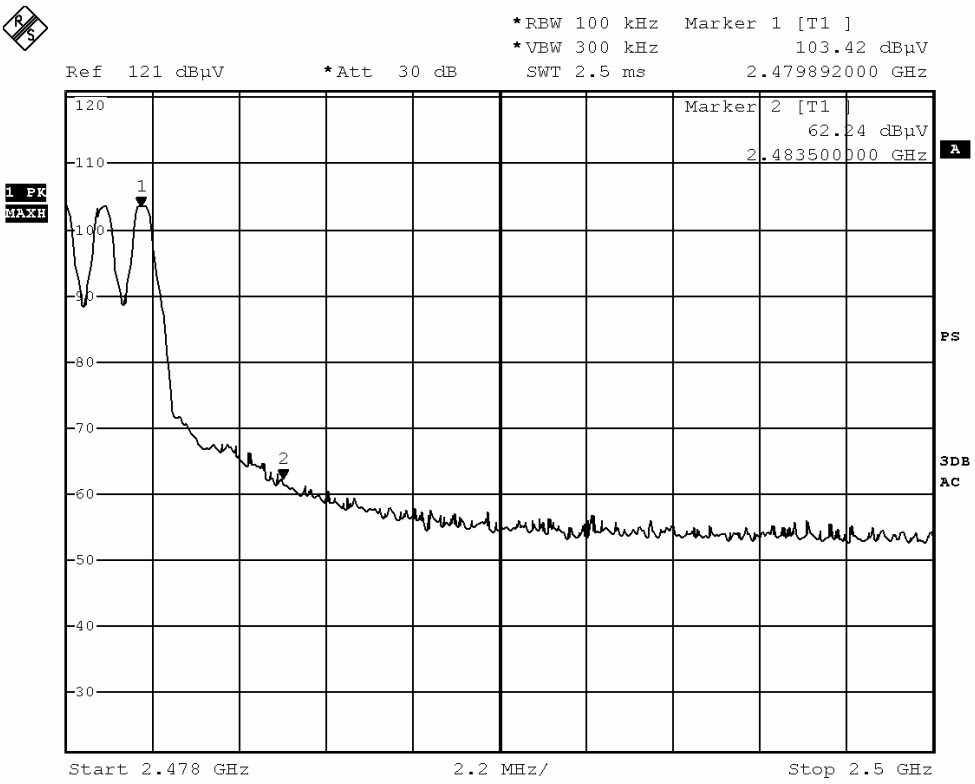
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	42.01

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



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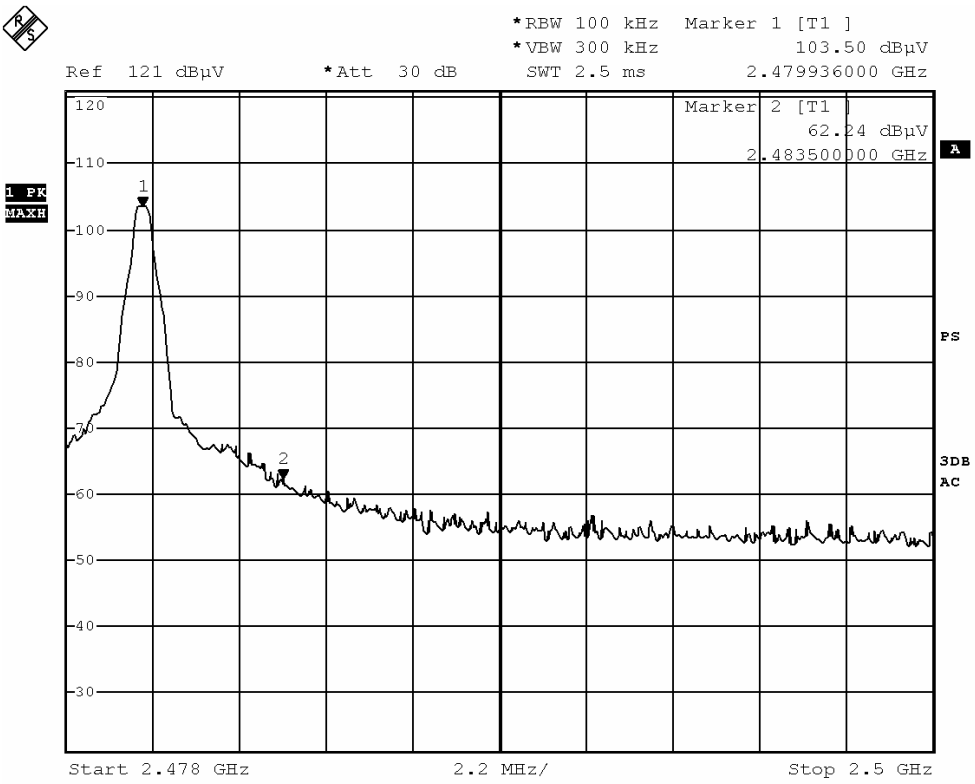
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	41.75

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



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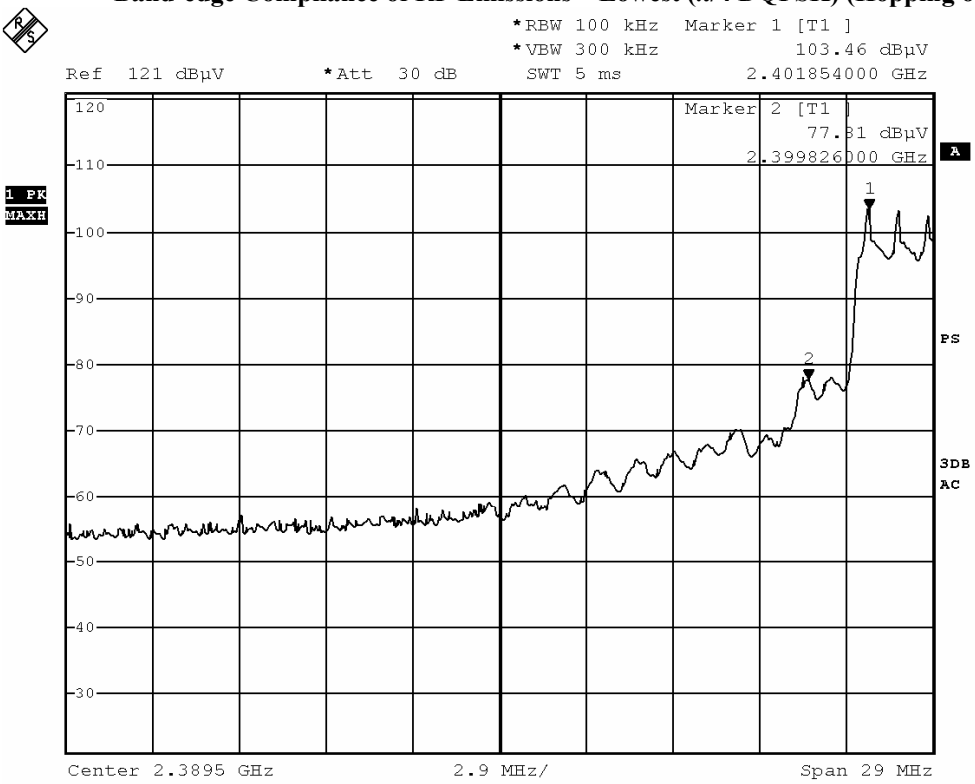
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	27.09

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



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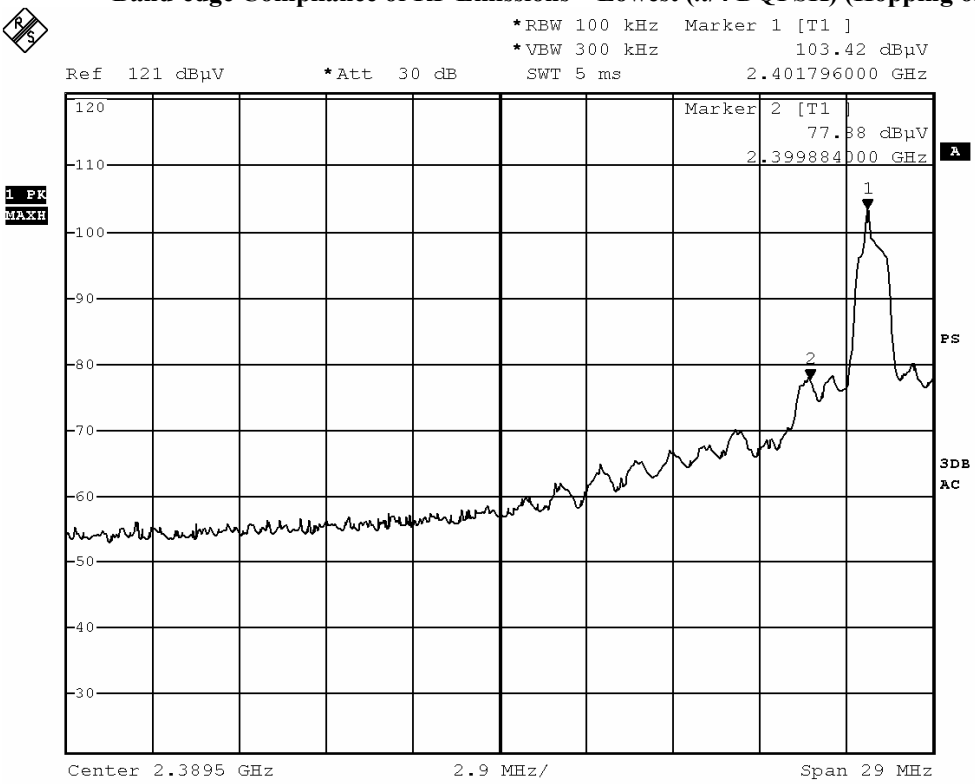
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	27.09

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



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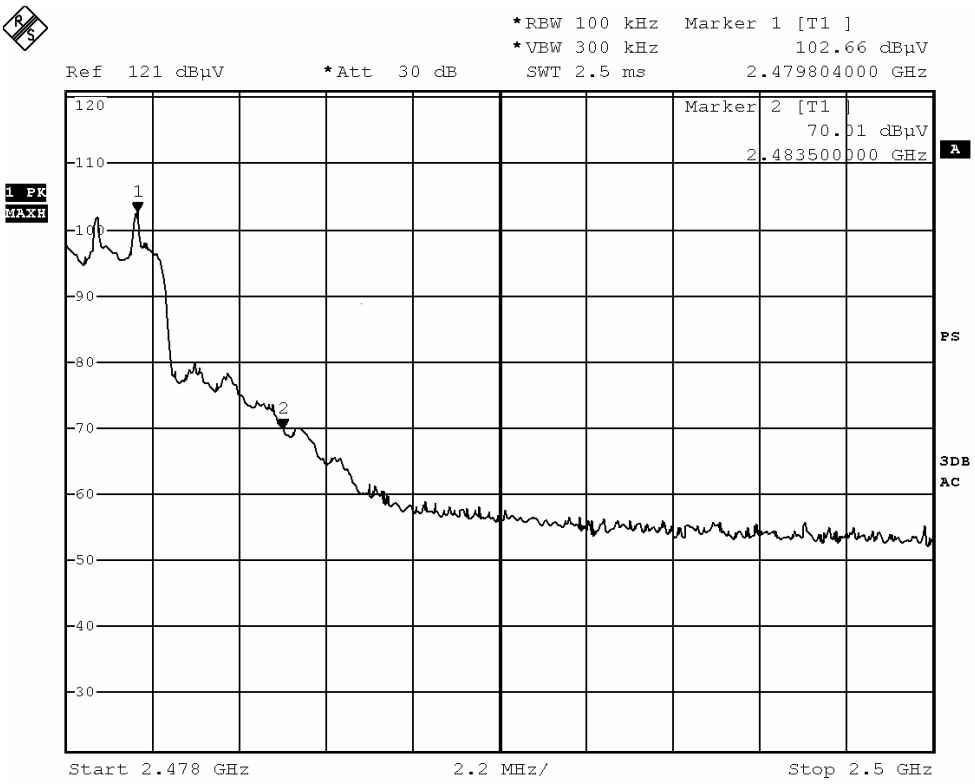
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	32.32

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



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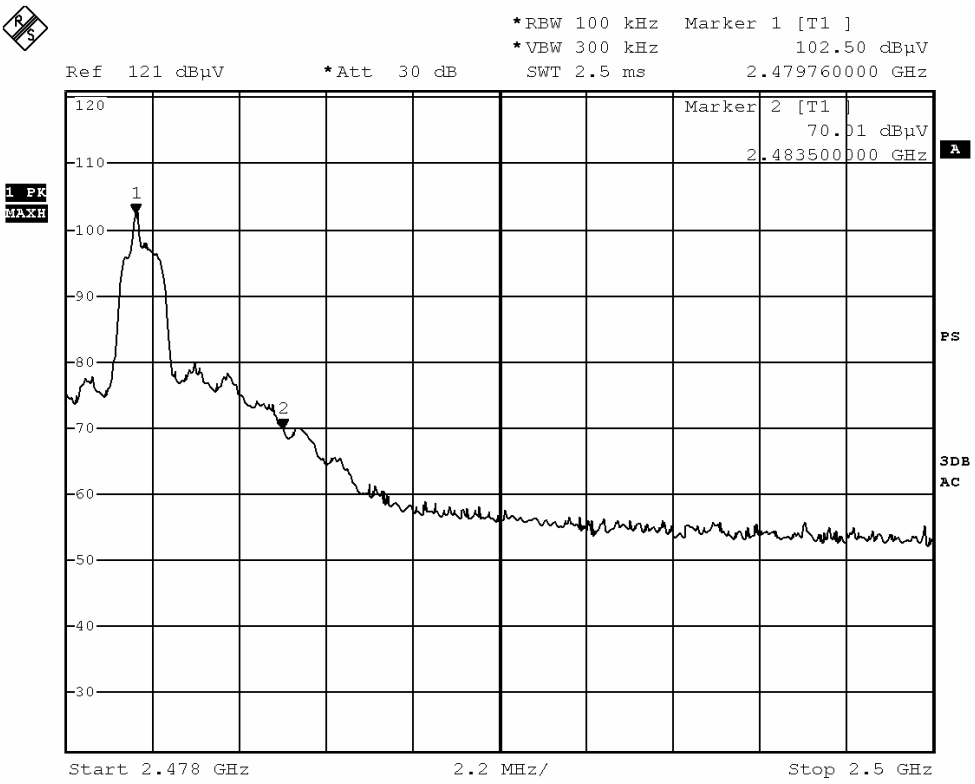
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	32.36

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



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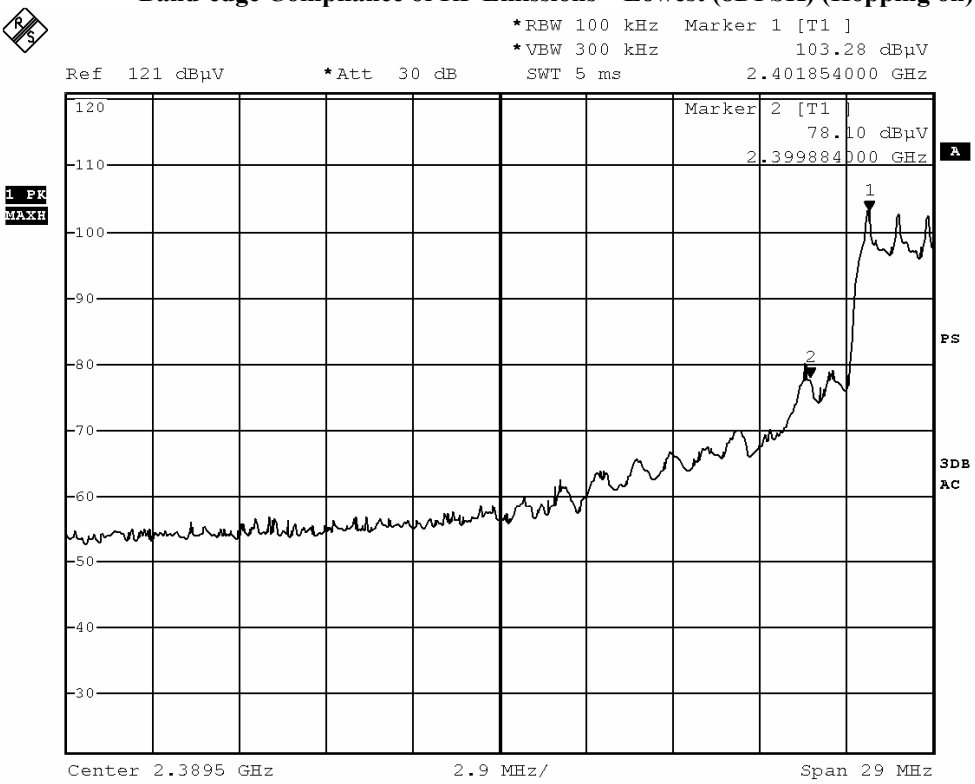
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	27.57

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



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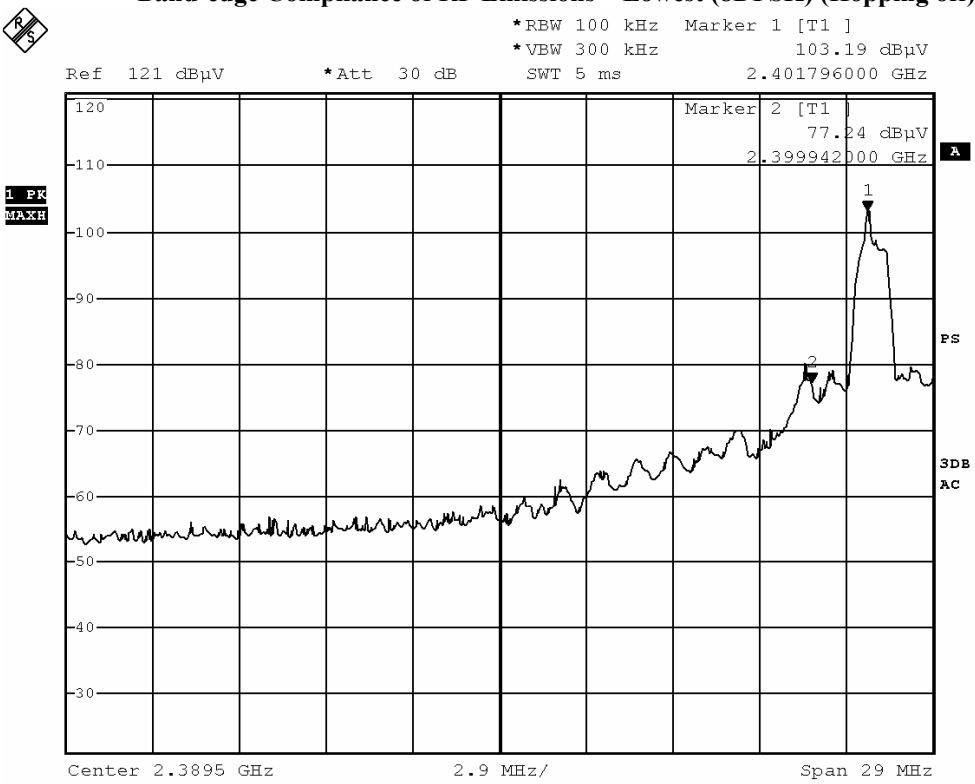
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	25.28

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



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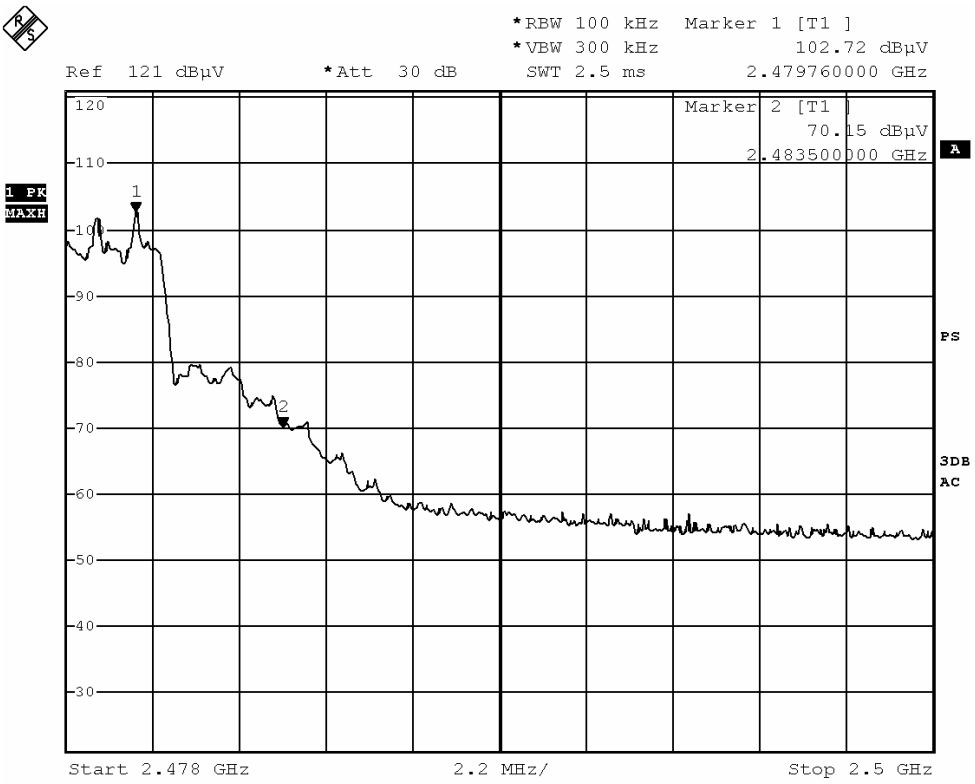
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	32.35

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



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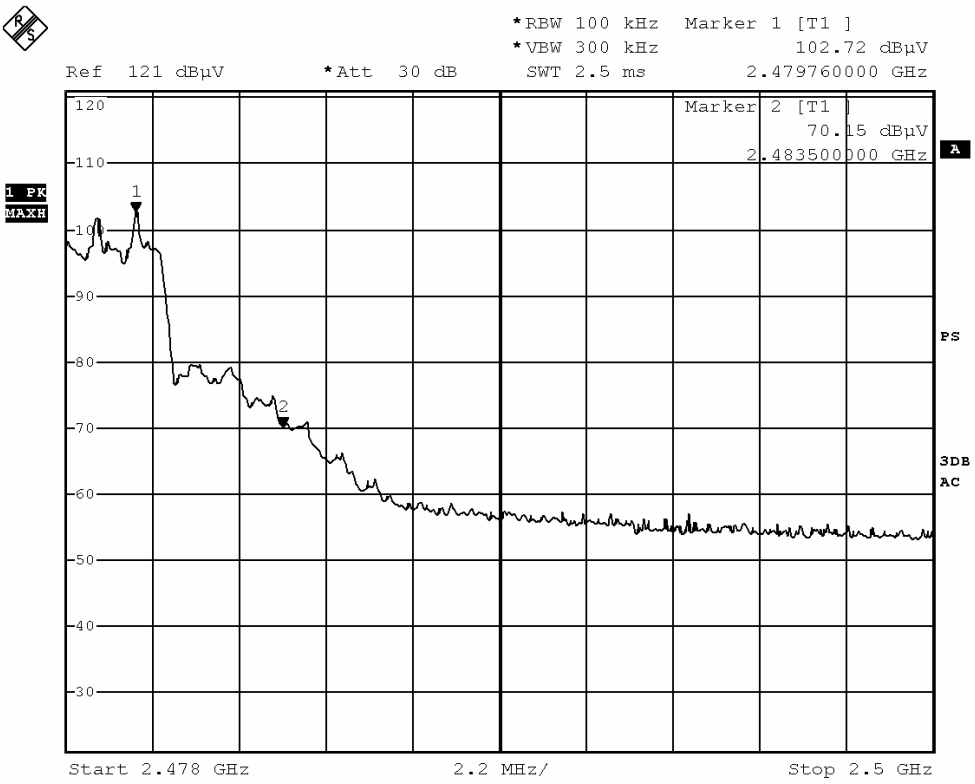
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2480)	32.46

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



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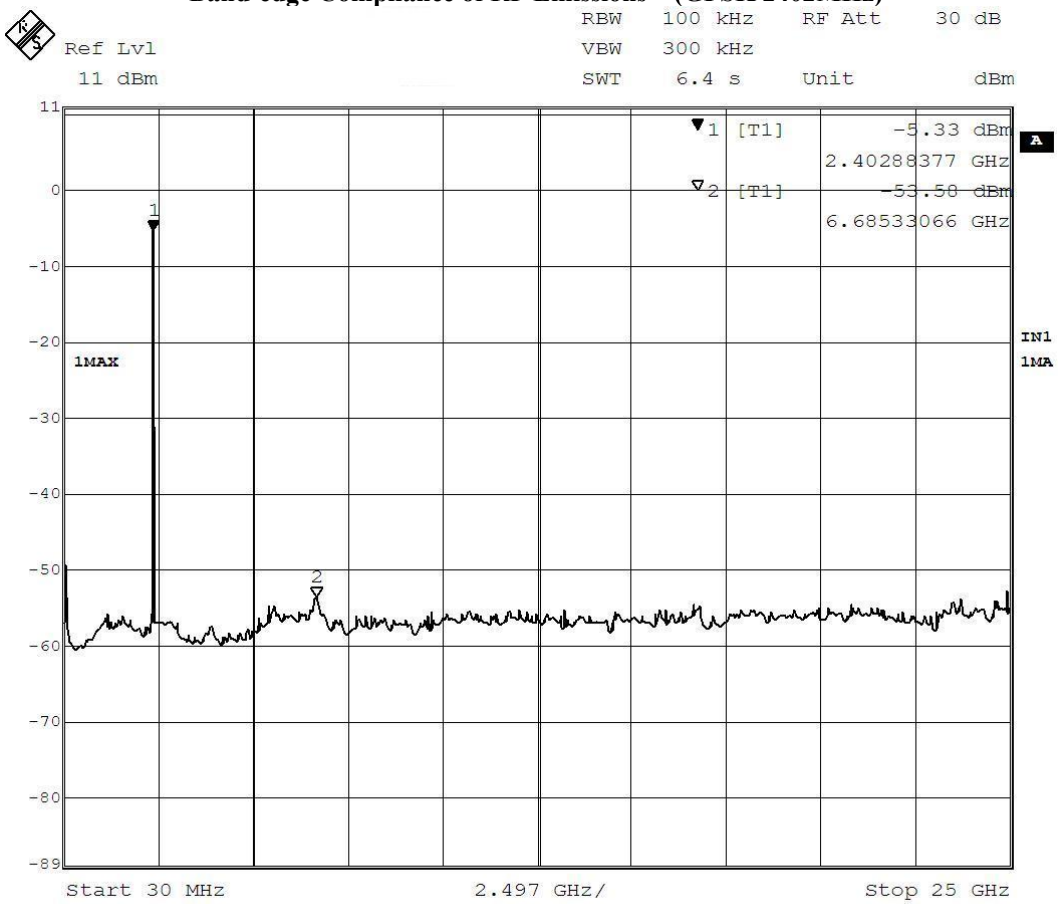
Band-edge Compliance of RF Conducted Emissions Measurement:

Limit：

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

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

Band-edge Compliance of RF Emissions – (GFSK 2402MHz)



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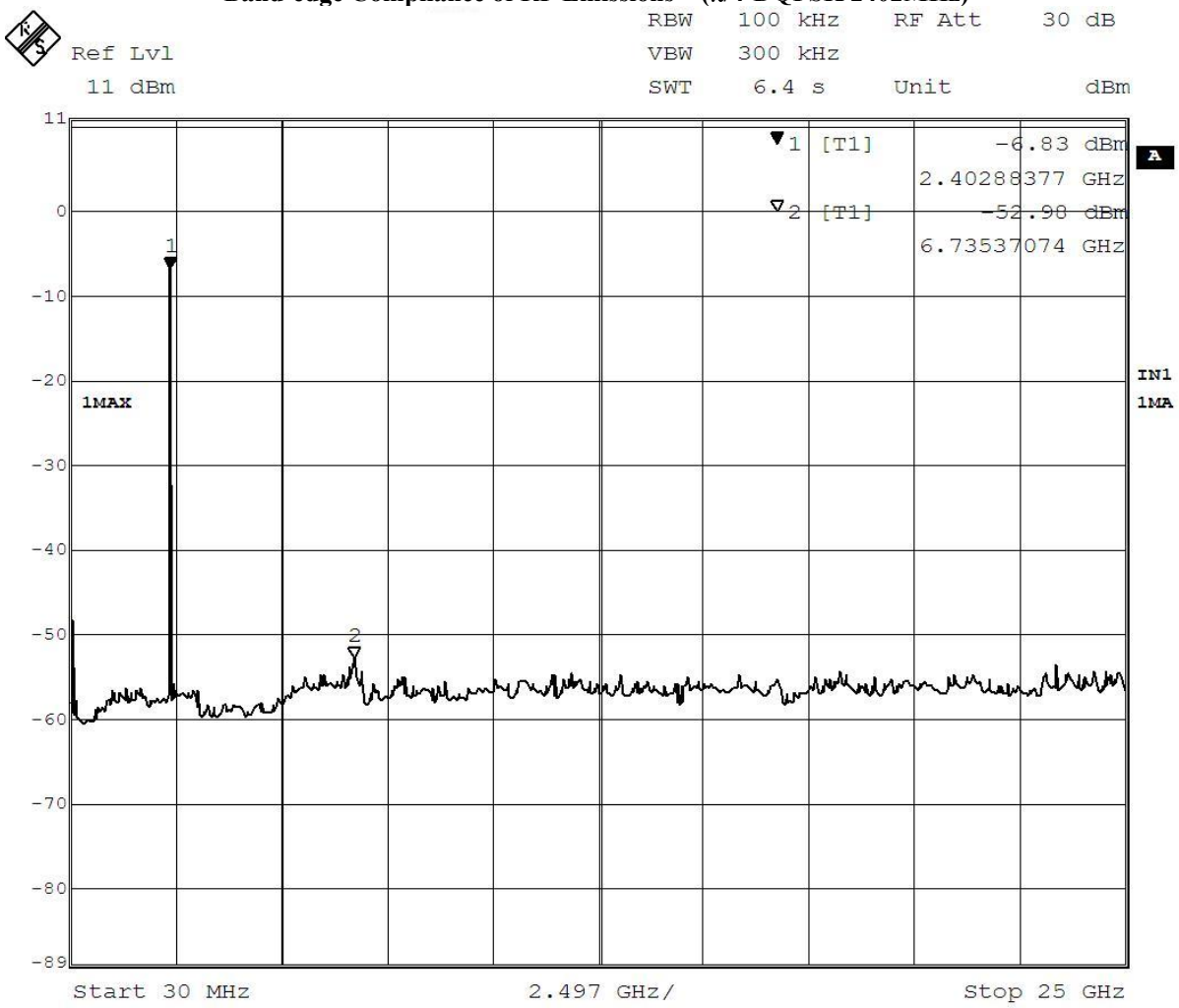
Band-edge Compliance of RF Emissions – (π/4-DQPSK 2402MHz)



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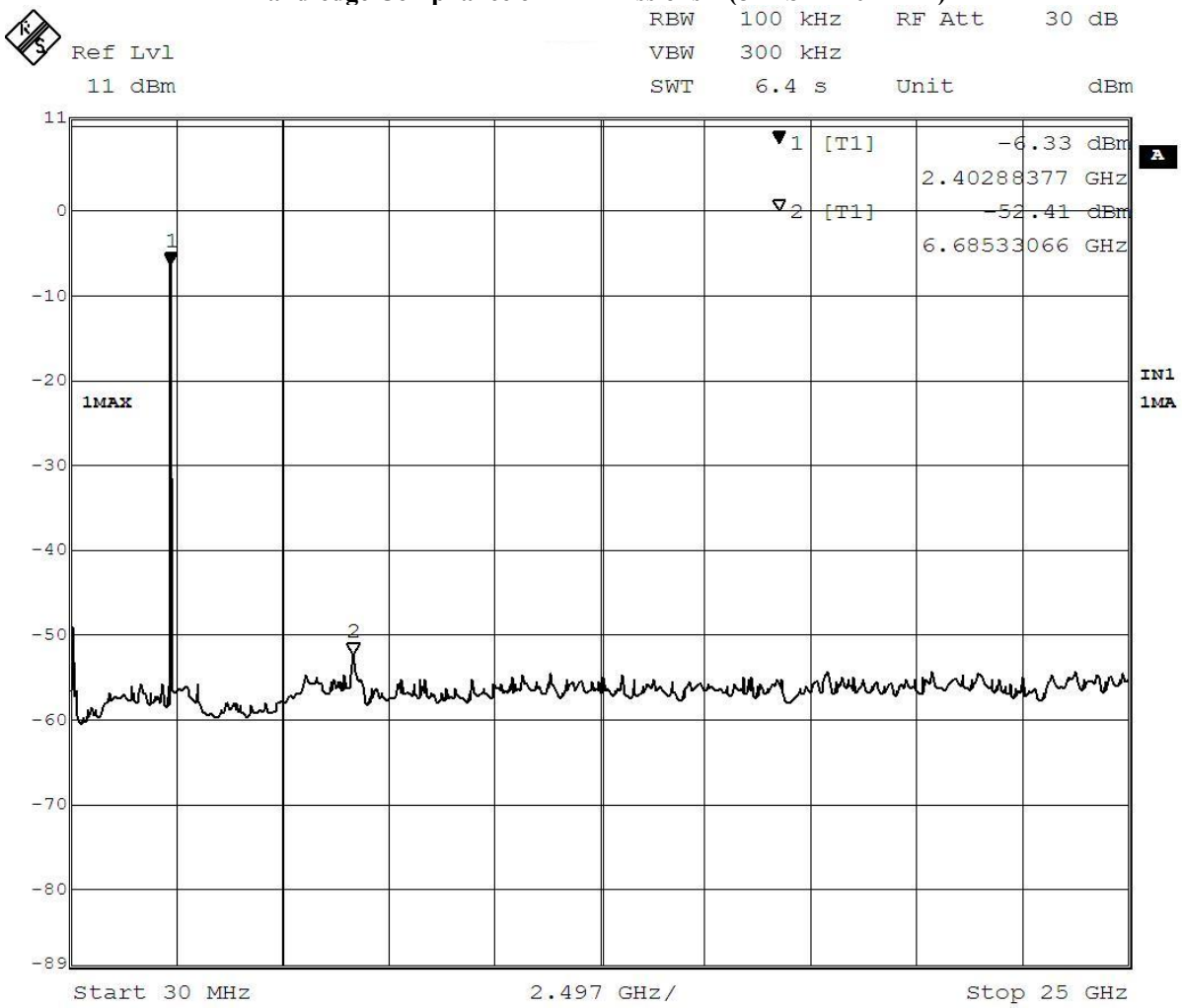
Band-edge Compliance of RF Emissions – (8DPSK 2402MHz)



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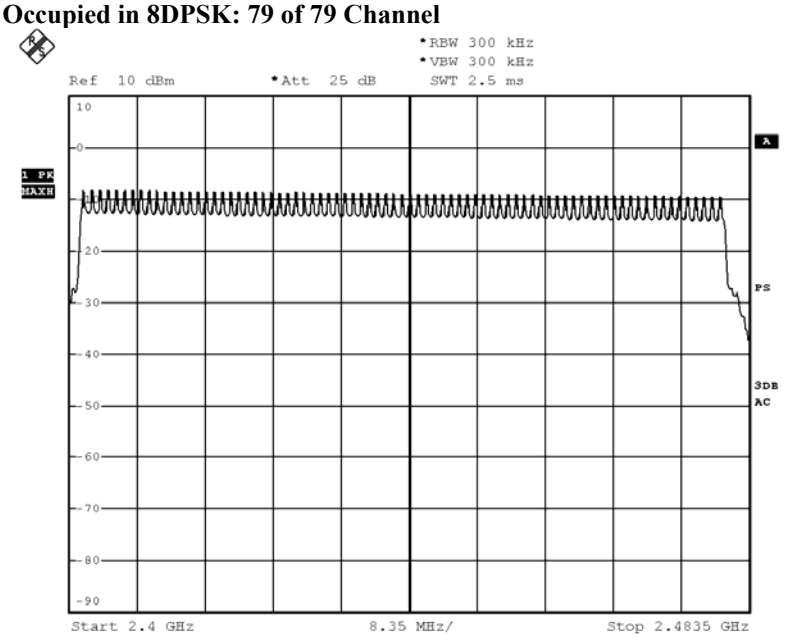
3.1.8 Time of Occupancy (Dwell Time)

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≥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:

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 x 31.6 = 106.6 within 31.6 seconds

Fig. A
[Pulse duration of Lowest Channel]

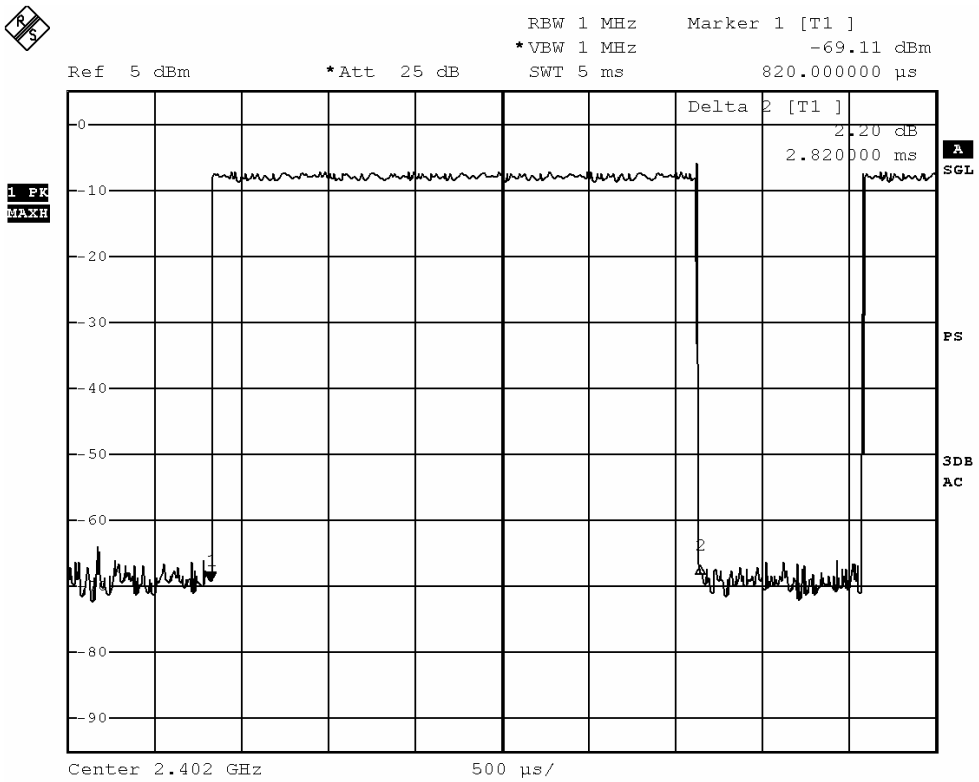

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Fig. B
[Pulse duration of Middle Channel]

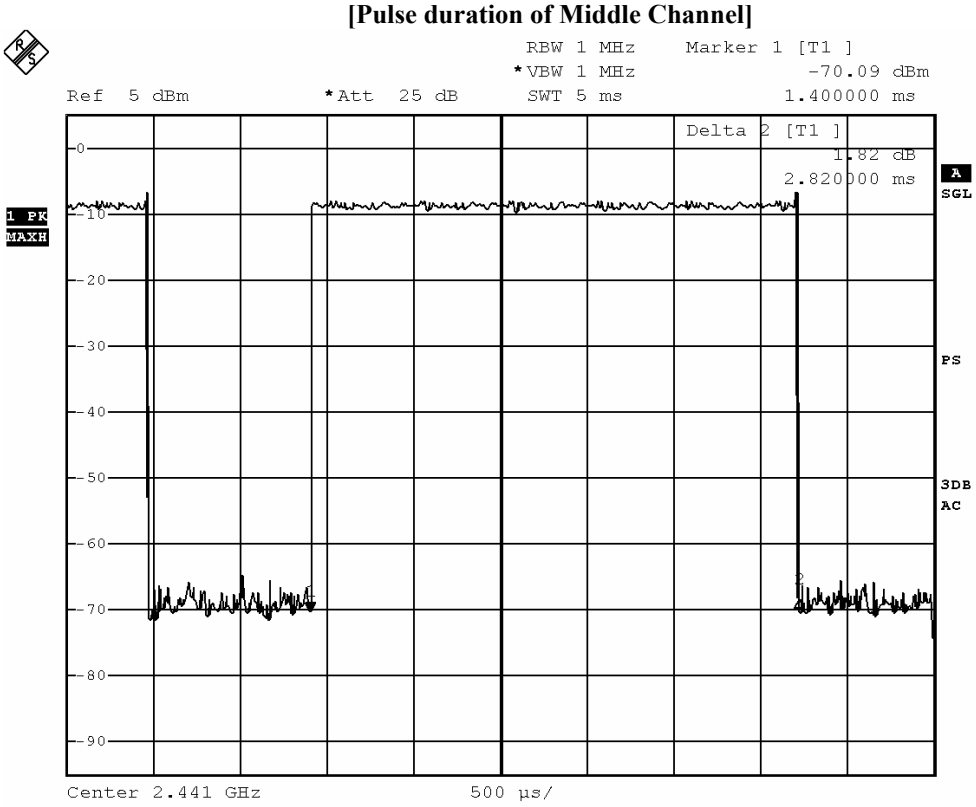

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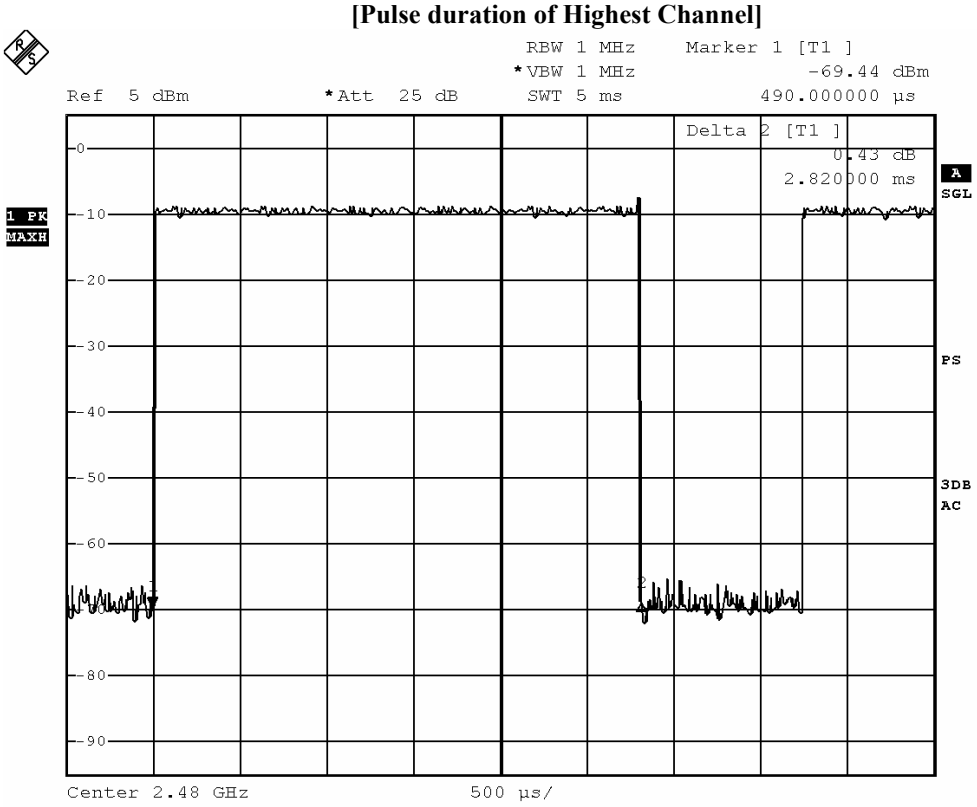
Fig. C
[Pulse duration of Highest Channel]



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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 x 31.6 = 160 within 31.6 seconds

Fig. D
[Pulse duration of Lowest Channel]

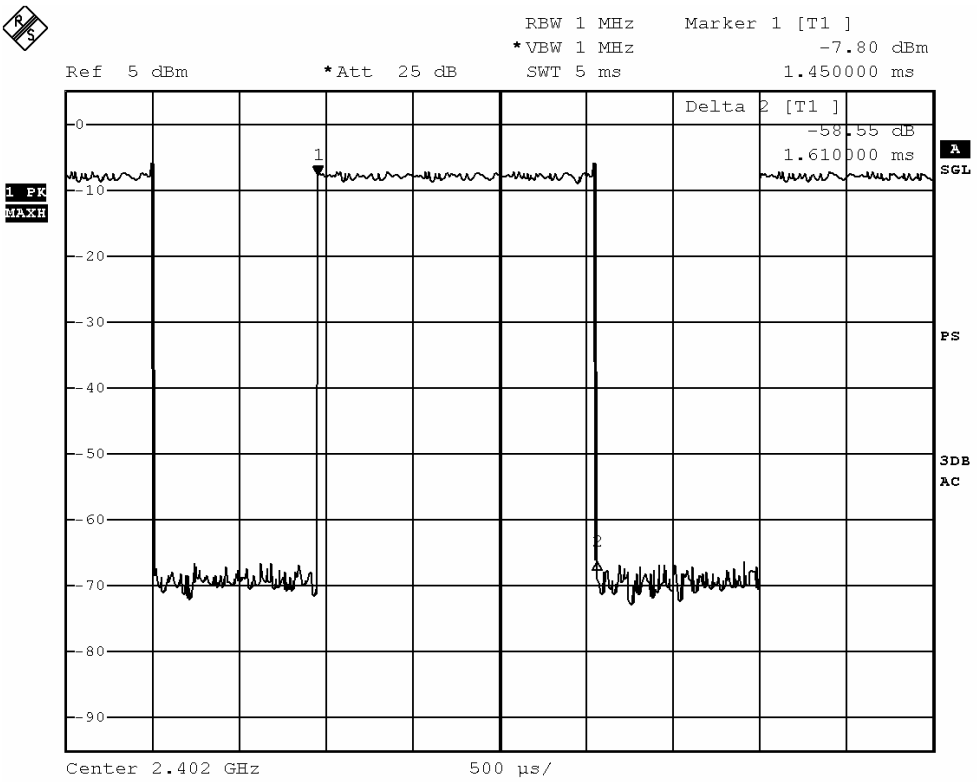

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Fig. E
[Pulse duration of Middle Channel]

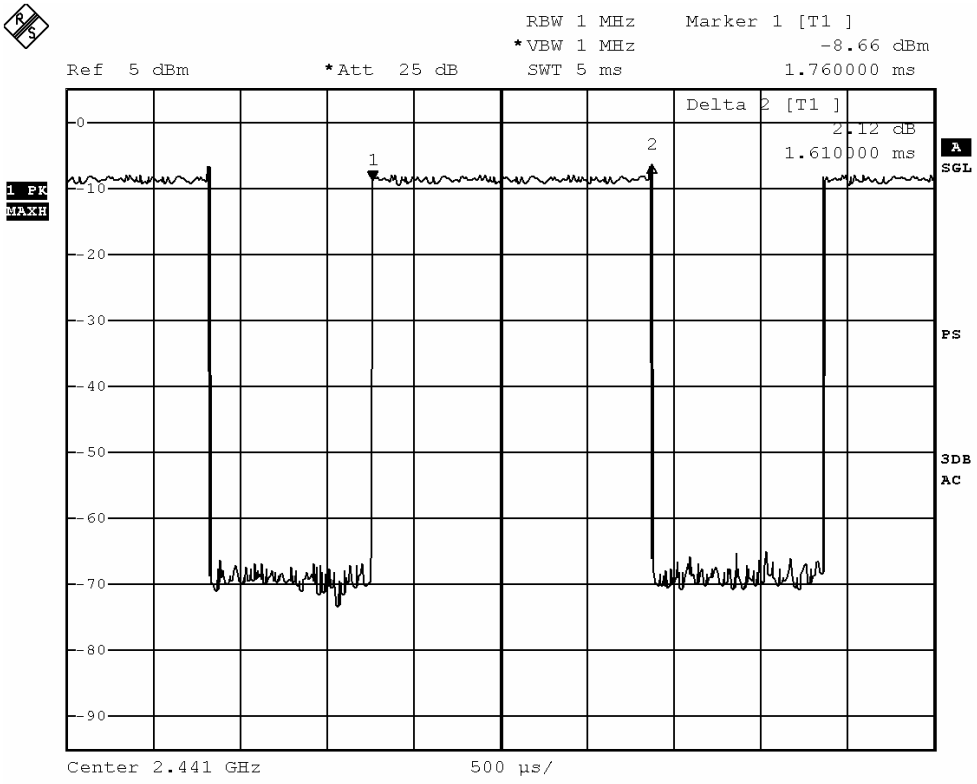

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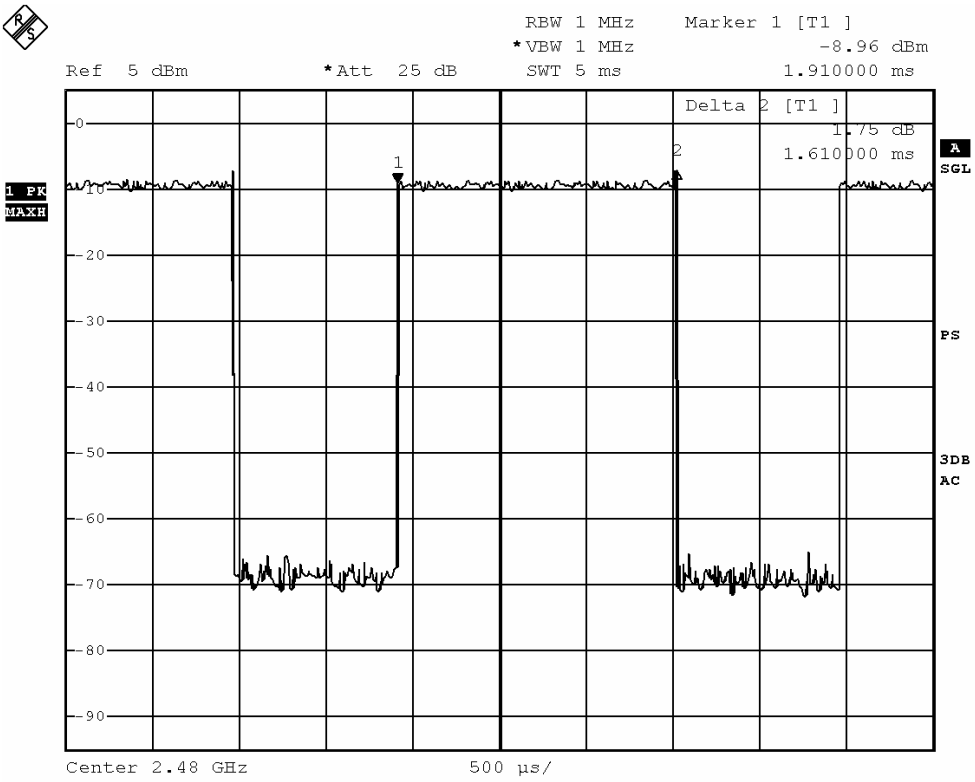
Fig. F
[Pulse duration of Highest Channel]



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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 x 31.6 = 320 within 31.6 seconds

Fig. G
[Pulse duration of Lowest Channel]

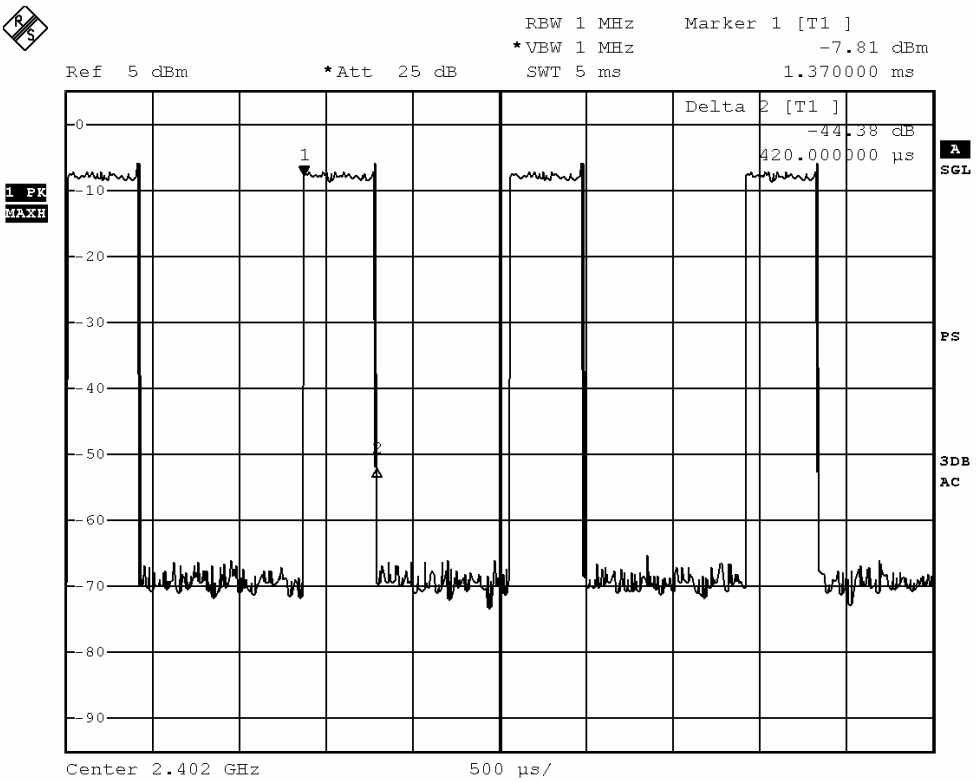

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Fig. H
[Pulse duration of Middle Channel]

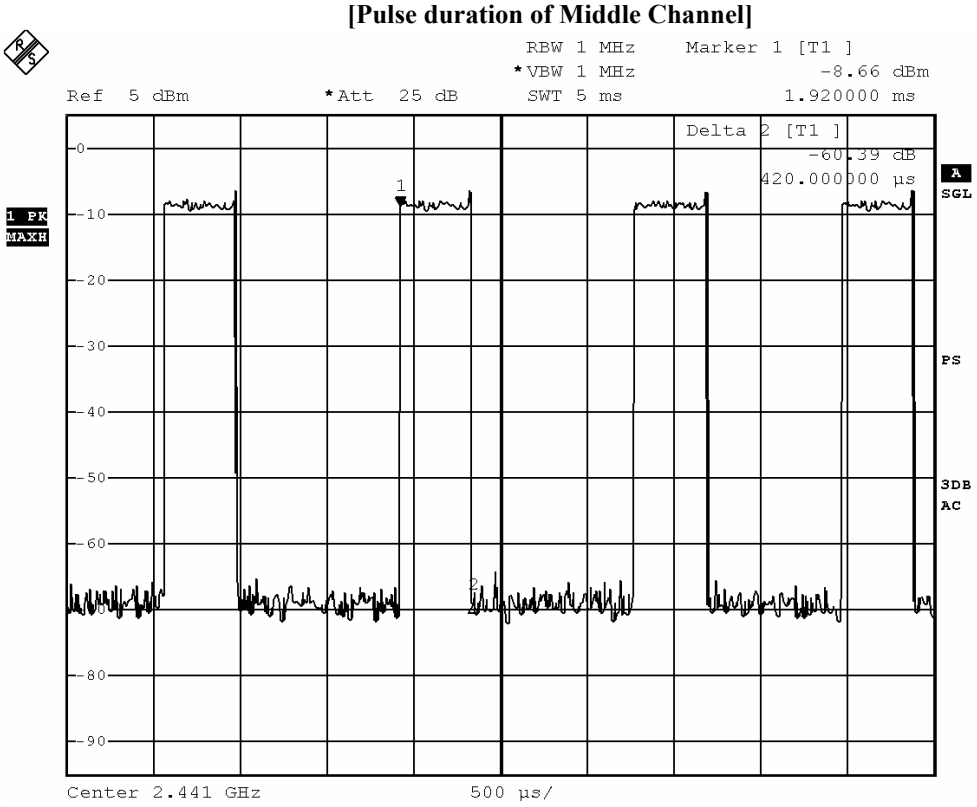

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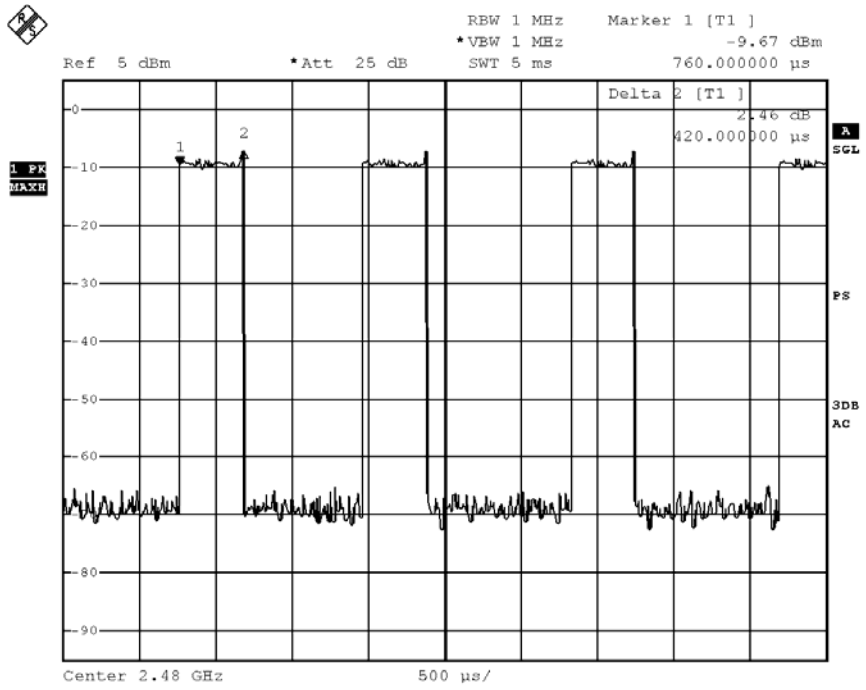
Fig. I
[Pulse duration of Highest Channel]



Time of occupancy (Dwell Time):

Data Packet	Frequency (MHz)	Pulse Duration (ms)	Dwell Time (s)	Limits (s)	Test Results
DH5	2402	2.820	0.3003	0.400	Complies
DH5	2441	2.820	0.3003	0.400	Complies
DH5	2480	2.820	0.3003	0.400	Complies
DH3	2402	1.610	0.2574	0.400	Complies
DH3	2441	1.610	0.2574	0.400	Complies
DH3	2480	1.610	0.2574	0.400	Complies
DH1	2402	0.420	0.1343	0.400	Complies
DH1	2441	0.420	0.1343	0.400	Complies
DH1	2480	0.420	0.1343	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 PCB antenna. There is no external antenna, the antenna gain =0dBi. User is unable to remove or changed the Antenna.

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Appendix A

List of Measurement Equipment

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EMD004	LISN	ROHDE & SCHWARZ	ESH3-Z5	100102	2016.3.29	2018.3.29
EMD022	EMI Test Receiver	ROHDE & SCHWARZ	ESCS30	100314	2016.3.29	2018.3.29
EMD035	EMI Test Receiver	ROHDE & SCHWARZ	ESCI	100441	2016.3.29	2018.3.29
EMD036	EMI Test Receiver	ROHDE & SCHWARZ	ESIB 26	100388	2016.3.29	2018.3.29
EMD041	TWO-LINE V-NETWORK	ROHDE & SCHWARZ	ENV216	100261	2016.3.29	2018.3.29
EMD061	Biconilog Antenna	ETS.LINDGREN	3142C	00060439	2016.12.30	2018.12.30
EMD062	Double-Ridged Waveguide (1GHz – 18GHz)	ETS.LINDGREN	3117	00075933	2014.11.15	2017.11.15
EMD084	MULTI-DVICE CONTROLLER	ETS.LINDGREN	2090	00060107	N/A	N/A
EMD088	Video Contol Unit	ETS.LINDGREN	Y21953A	2601073	N/A	N/A
EMD093	Monitor	ViewSonic	VA9036	Q8X064201876	N/A	N/A
EMD102	Intelligent Frequency	Ainuo lnstrument Co., Ltd	AN97005SS	79707454	N/A	N/A
EMD103	Intelligent Frequency	Ainuo lnstrument Co., Ltd	AN97005SS	79707455	N/A	N/A
EMD105	FACT-3 EMC Chamber	ETS.LINDGREN	FACT-3	3803	N/A	N/A
EMD106	Shielding Room #1	ETS.LINDGREN	RFD-100	3802	N/A	N/A
EMD111	Power meter	ROHDE & SCHWARZ	NRVD	102051	2016.3.29	2018.3.29
	100V Insertion Unit	ROHDE & SCHWARZ	URV5-Z4	100464	2016.3.29	2018.3.29
EMD113	Pre-Amplifier	ROHDE & SCHWARZ	N/A	1129588	2016.3.29	2018.3.29
EMD124	Loop Antenna	ETS-Lindgren	6502	00104905	2016.05.23	2018.05.23
EMD131	Standard Gain Horn Antenna (18GHz – 26.5GHz)	Chengdu AINFO lnc.	JXTXLB-42-15-C-KF	J2021100721001	2015.04.09	2017.04.09
RE01	RF cable	N/A	N/A	N/A	2016-9-28	2018-9-27
RE02	RF cable	N/A	N/A	N/A	2016-9-28	2018-9-27

Remarks:-

N/A Not Applicable or Not Available

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Appendix B

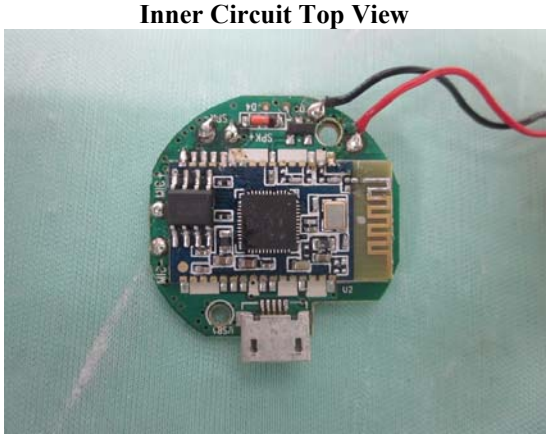
Photographs of EUT

Front View of the product

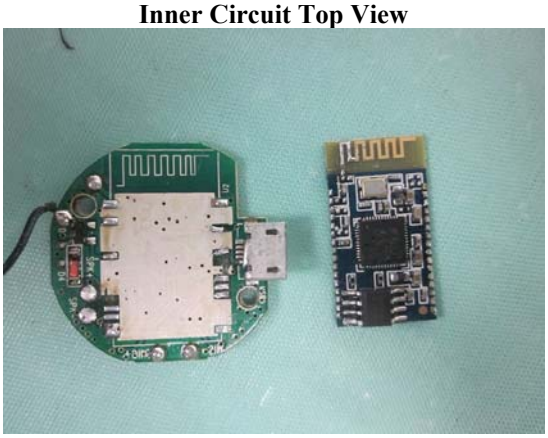
Rear View of the product

Inside View of the product

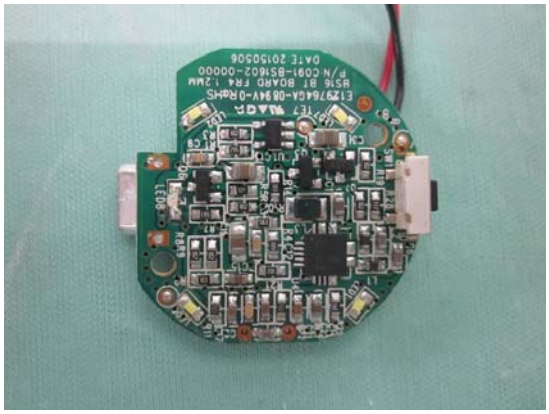
Inner Circuit Top View



Inner Circuit Top View



Inner Circuit Bottom View



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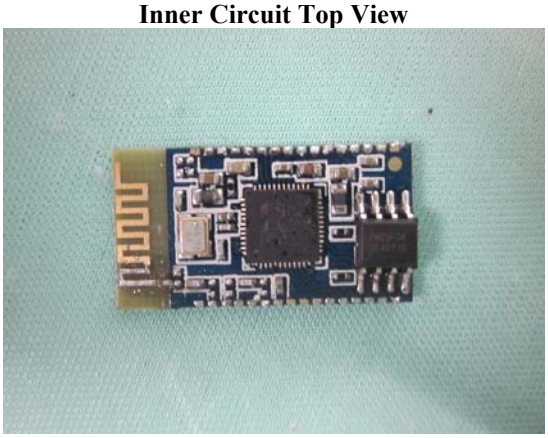
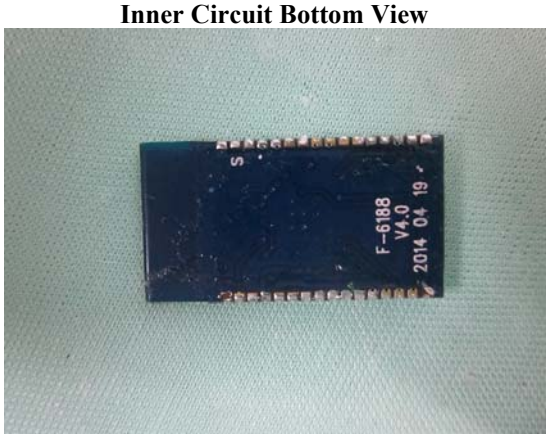
Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



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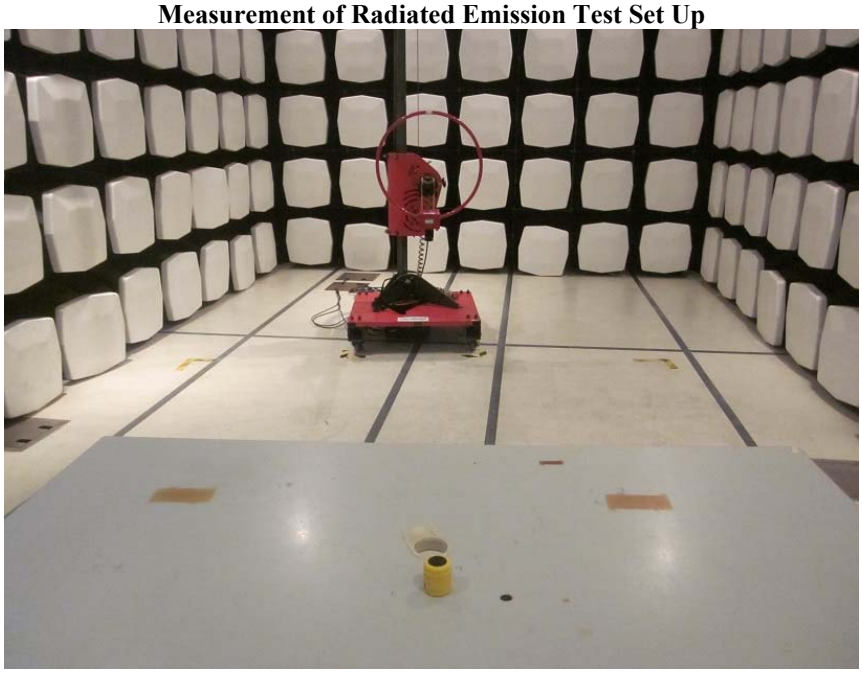
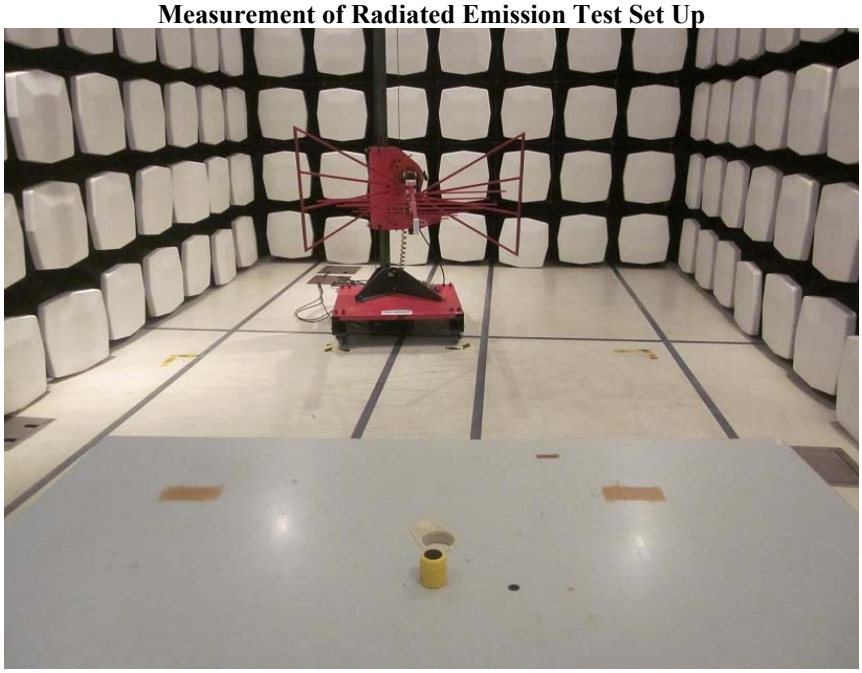
Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Radiated Emission Test Set Up



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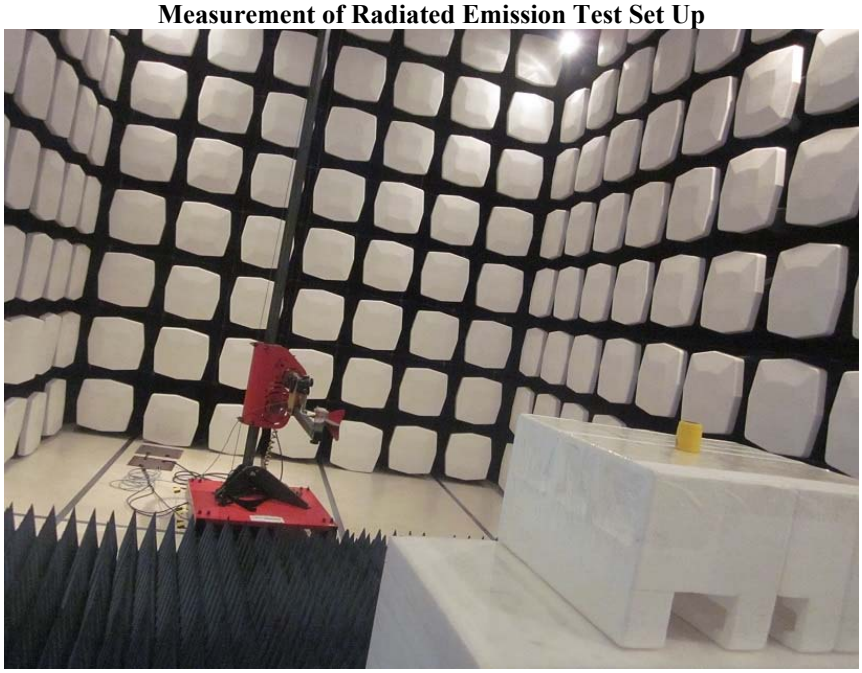
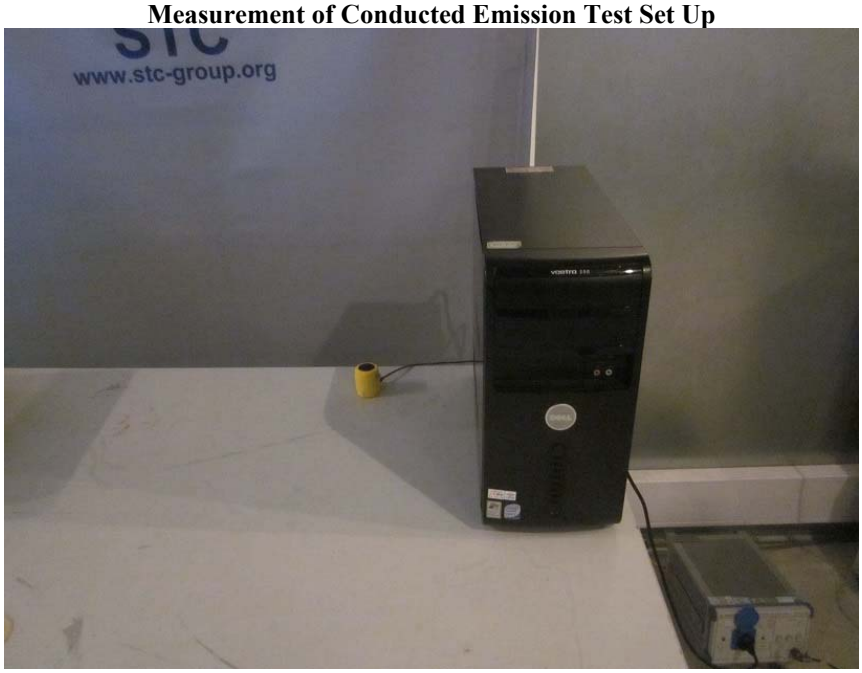
Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Conducted Emission Test Set Up



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

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2. Any report issued by the Company as a result of this application for testing service (the "Report") shall be issued in confidence to the Clients and the Report will be strictly treated as such by the Company. It may not be reproduced either in its entirety or in part and it may not be used for advertising or other unauthorized purposes without the written consent of the Company. The Clients to whom the Report is issued may, however, show or send it, or a certified copy thereof prepared by the Company to his customer, supplier or other persons directly concerned. The Company will not, without the consent of the Clients, enter into any discussion or correspondence with any third party concerning the contents of the Report, unless required by the relevant governmental authorities, laws or court orders.

3. The Company shall not be called or be liable to be called to give evidence or testimony on the Report in a court of law without its prior written consent, unless required by the relevant governmental authorities, laws or court orders.

4. The Report refers only to the sample tested and does not apply to the bulk, unless the sampling has been carried out by the Company and is stated as such in the Report.

5. In the event of the improper use the report as determined by the Company, the Company reserves the right to withdraw it, and to adopt any other additional remedies which may be appropriate.

6. Sample submitted for testing are accepted on the understanding that the Report issued cannot form the basis of, or be the instrument for, any legal action against the Company.

7. The Company will not be liable for or accept responsibility for any loss or damage howsoever arising from the use of information contained in any of its Reports or in any communication whatsoever about its said tests or investigations.

8. Clients wishing to use the Report in court proceedings or arbitration shall inform the Company to that effect prior to submitting the sample for testing.

9. Subject to the variable length of retention time for test data and report stored hereinto as to otherwise specifically required by individual accreditation authorities, the Company will only keep the supporting test data and information of this test report for a period of three years. The data and information will be disposed of after the aforementioned retention period has elapsed. Under no circumstances shall we provide any data and information which has been disposed of after the retention period. Under no circumstances shall we be liable for damages of any kind, including (but not limited to) compensatory damages, lost profits, lost data, or any form of special, incidental, indirect, consequential or punitive damages of any kind, whether based on breach of contract of warranty, tort (including negligence), product liability or otherwise, even if we are informed in advance of the possibility of such damages.

10. Issuance records of the Report are available on the internet at dgstc@dgstc.org. Further enquiry of validity or verification of the Reports should be addressed to the Company.