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TEST REPORT

Part 15C & IC RSS-210(Issue 8)

Equipment under test Bluetooth Adapter Card

Model name DMABTM8811

FCC ID MBBDMABTM8811

IC Cert. NO 11657A-DMABTM8811

Applicant Anam Electronics Co., Ltd.

Manufacturer Anam Electronics Co., Ltd.

Date of test(s) 2014.01.27 ~ 2014.02.11

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Revision history

Revision	Date of issue	Test report No.	Description
-	2014.02.12	KES-RF-14T0001	Initial

TABLE OF CONTENTS

1.0 General information description 4
1.1 Test frequency 4
1.2 Information about variant model 4
1.3 Device modifications 4
1.4 Information about the FHSS characteristics: 5
1.4.1 Pseudorandom frequency hopping sequence 5
1.4.2 Equal hopping frequency use 5
1.4.3 System receiver input bandwidth 5
1.4.4 Equipment description 5
1.5 Test facility 6
1.6 Laboratory accreditations and listings 6
2.0 Summary of tests 7
2.1 Test data 8
2.1.1 Pre-scanned output power 8
2.1.2 Peak power output power 8
2.1.3 Conducted spurious emission & band edge 13
2.1.4 20 dB bandwidth 23
2.1.5 Frequency separation 28
2.1.6 Number of hopping frequency 30
2.1.7 Time of occupancy (Dwell time) 33
2.1.8 Radiated spurious emission 38
2.1.9 AC conducted emissions 55
2.1.10 Occupied Bandwidth 57
Appendix A. Test equipment used for test 64
Appendix B. Test setup photo 64

1.0 General information description

Equipment under test	Bluetooth Adapter Card
Model name	DMABTM8811
Serial number	N/A
Frequency Range	2 402 ㎒ ~ 2 480 ㎒(Bluetooth BDR & EDR)
Modulation technique	FHSS(GFSK, π/4-DQPSK, 8DPSK)
Number of channels	79(Bluetooth BDR & EDR)
Antenna type & gain	Fixed type(PCB Pattern antenna) // 0 dBi
Power source	DC 3.3 V

1.1 Test frequency

	Low channel	**Middle channel**	**High channel**
Frequency (㎒)	2 402	2 441	2 480

1.2 Information about variant model

N/A

1.3 Device modifications

N/A

1.4 Information about the FHSS characteristics:

1.4.1 Pseudorandom frequency hopping sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

1.4.2 Equal hopping frequency use

All channels will be used equally to comply with the requirements stated in Part 15.247(a)(1) and DA 00-705.

All Bluetooth units participating in the piconet are time and hop-synchronized to the channel.
Example of a 79 hopping sequence in data mode:
40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67, 56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59, 72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75, 09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06, 01, 51, 03, 55, 05, 04

1.4.3 System receiver input bandwidth

Each channel bandwidth is 1 ㎒

1.4.4 Equipment description

15.247(a)(1) that the rx input bandwidths shift frequencies in synchronization with the transmitted

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.5 Test facility

C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea.
473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, 469-113, Korea.
The open area test site is constructed in conformance with the requirements ANSI C63.4-2003.

1.6 Laboratory accreditations and listings

Country	Agency	Scope of accreditation	Certificate No.
USA	FCC	3 & 10 meter Open Area Test Sites and one conducted site to perform FCC Part 15/18 measurements.	343818
KOREA	KC	EMI (10 meter Open Area Test Site and two conducted sites) Radio (3 & 10 meter Open Area Test Sites and one conducted site)	KR0100
CANADA	IC	3 & 10 meter Open Area Test Sites and one conducted site	4769B-1

2.0 Summary of tests

Section in FCC Part 15	Section in RSS-210 & Gen	Parameter	Status
15.247(b)(1)	RSS-210 A8.4(2)	Peak output power	C
15.247(d)	RSS-210 A8.5	Conducted spurious emission and band edge	C
15.247(a)(1)	RSS-210 A8.1(a)	20 dB bandwidth	C
15.247(a)(1)	RSS-210 A8.1(b)	Frequency separation	C
15.247(a)(1)(iii)	RSS-210 A8.1(d)	Number of hopping frequency	C
15.247(a)(1)(iii)	RSS-210 A8.1(d)	Time of occupancy(Dwell time)	C
15.205 15.209	RSS-210 A8.5	Radiated spurious emission	C
15.207	RSS-Gen 7.2.4	AC conducted emission	C
-	RSS-Gen 4.6.1	Occupied Bandwidth	C
Note 1: C=Complies NC=Not complies NT=Not tested NA=Not applicable			

Statement;

The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 ㎑ to 40 ㎓ (ANSI C63.4-2003) , the guidance provided in FCC OET Public notice DA 00-705, RSS-Gen (Issue 3) and RSS-210 (Issue 8) were used in the measurement of the DUT.

2.1 Test data

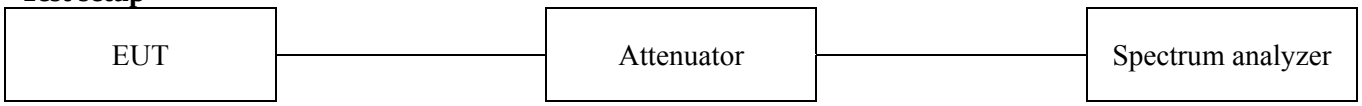
2.1.1 Pre-scanned output power

Preliminary tests were performed in different data rate as below table and the highest power data rates(1 Mbps, 2 Mbps, 3Mbps) were chosen for full test in the following section to demonstrate compliance to the FCC limit line.

Data rate	1 Mbps(GFSK)	2 Mbps(π/4-DQPSK)	3 Mbps(8DPSK)
Output power(dBm)	6.13	4.03	4.20

2.1.2 Peak power output power

Test setup



Test procedure

1. Use the following spectrum analyzer setting
   Center frequency: Lowest, middle and highest channels
   Span = 10 ㎒ (Approximately 5 times the 20 ㏈ bandwidth, centered on a hopping channel)
   RBW = 2 ㎒
   VBW = 5 ㎒ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the e mission. The indicated level is the peak output power.

Limit

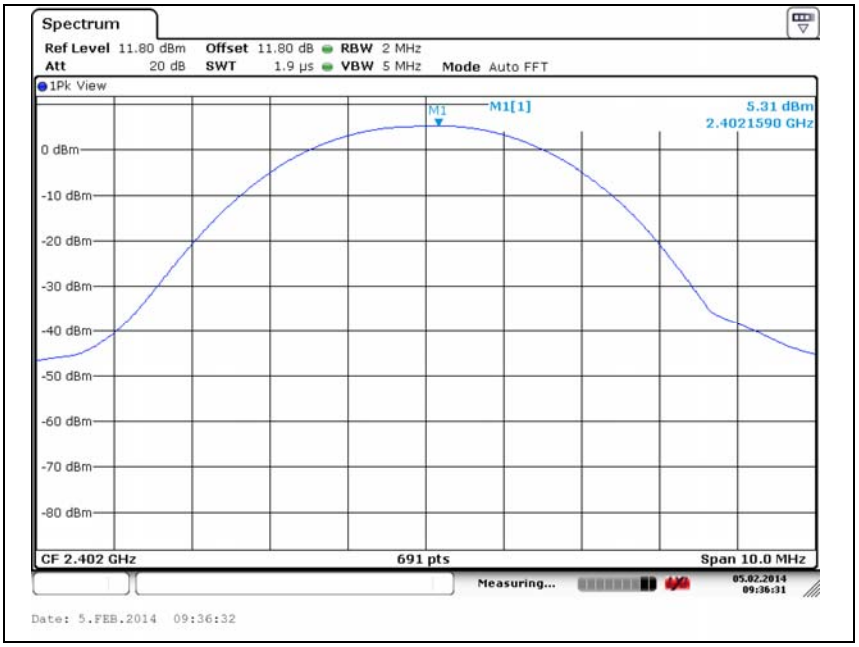
According to §15.247(b)(1), for frequency hopping systems operating in the 2 400 ~ 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 850 ㎒ band: 1 Watt.

According to RSS-210 A8.4(2), for frequency hopping systems operating in the band 2400-2483.5 Hz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. Except as provided in Section A8.4 (5), the e.i.r.p. shall not exceed 4 W.

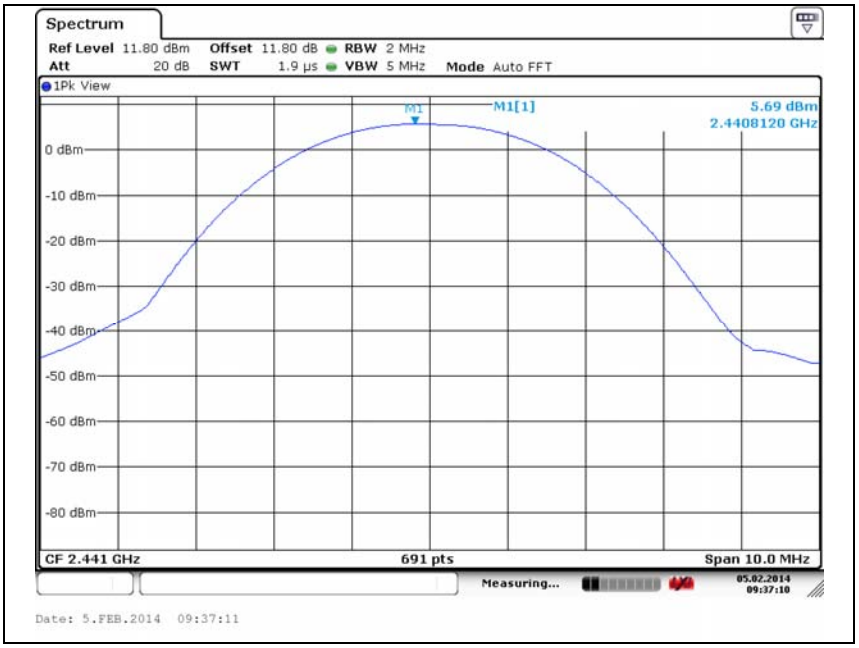
Test results

Operation mode	Frequency(㎒)	Output power (dBm)	Output power (W)	Limit (W)
GFSK	2 402	5.31	0.0034	1
	2 441	5.69	0.0037	1
	2 480	6.13	0.0041	1
8DPSK	2 402	3.21	0.0021	1
	2 441	3.75	0.0024	1
	2 480	4.20	0.0026	1

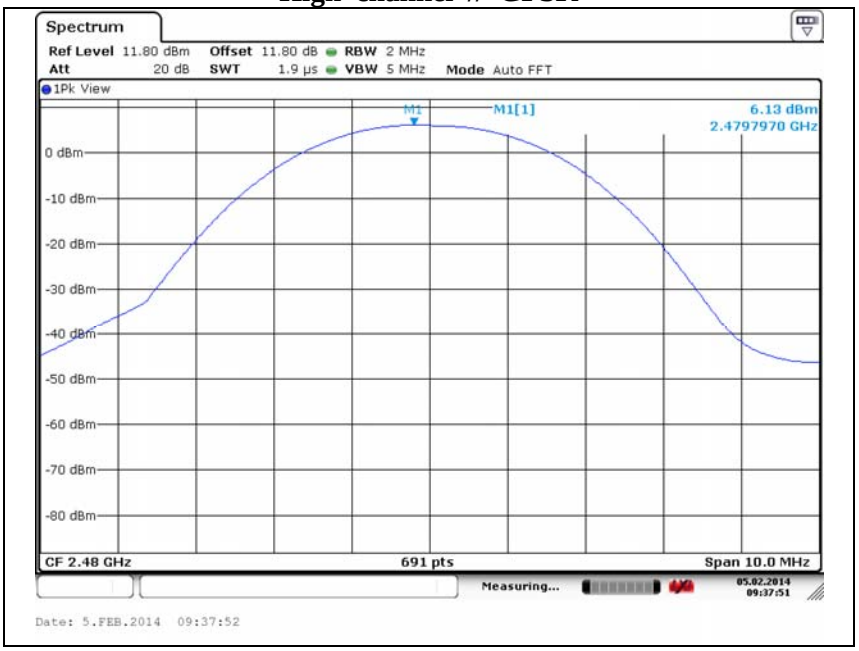
Low channel // GFSK



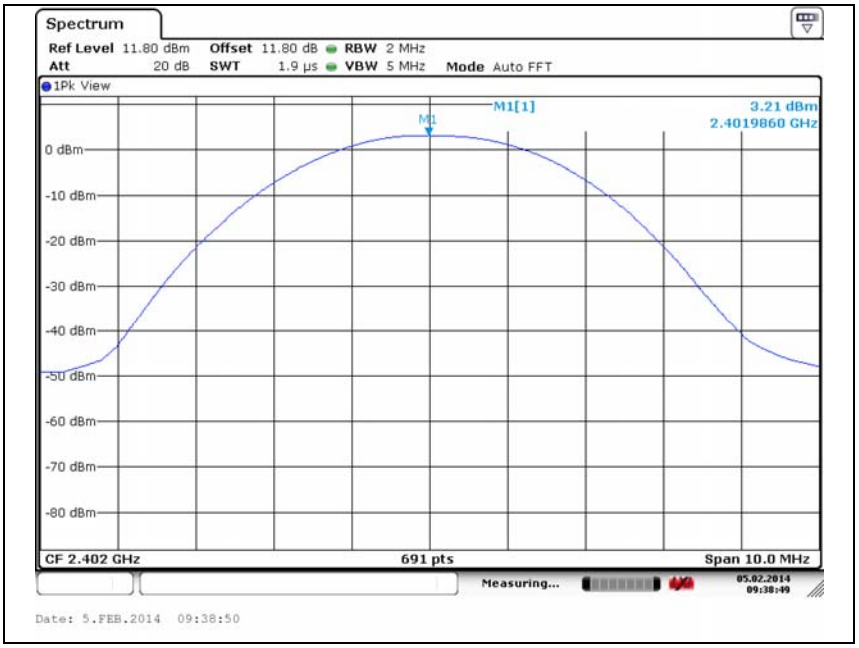
Middle channel // GFSK



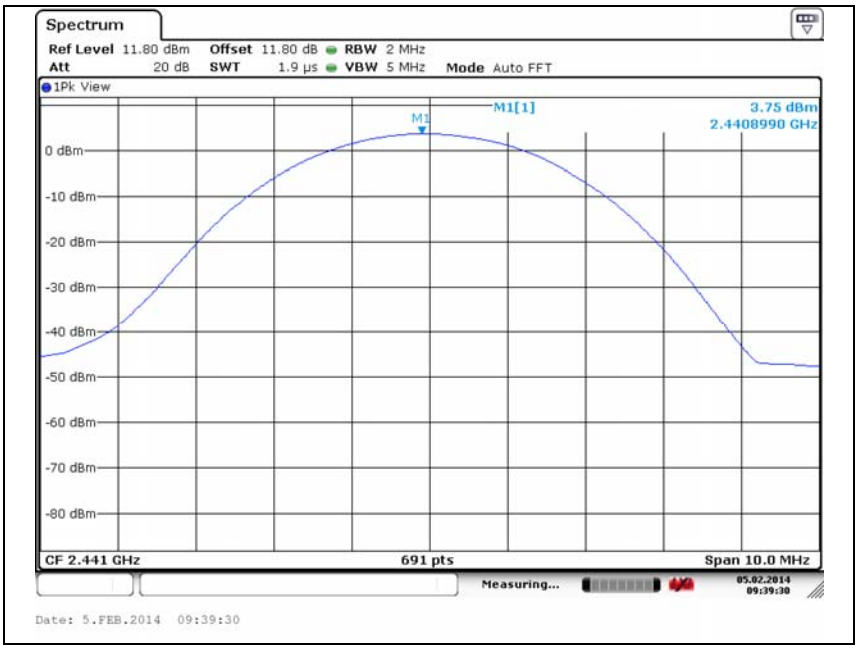
High channel // GFSK



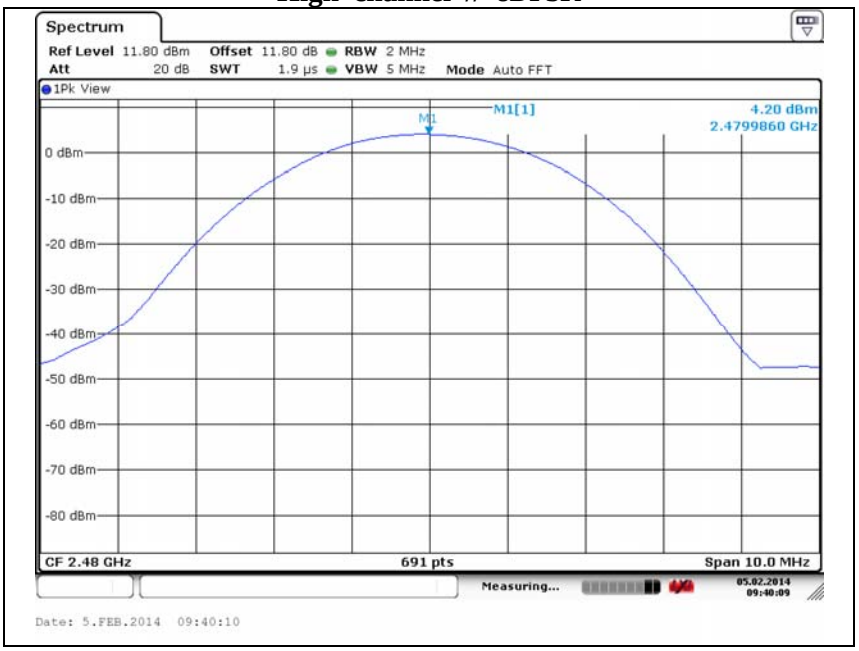
Low channel // 8DPSK



Middle channel // 8DPSK

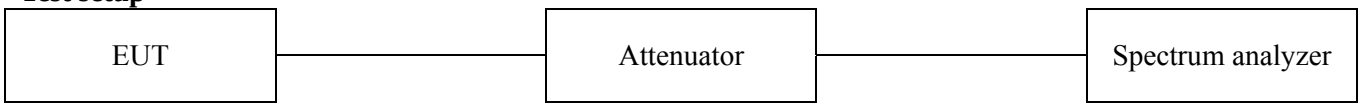


High channel // 8DPSK



2.1.3 Conducted spurious emission & band edge

Test setup



Test procedure for band edge

1. Use the following spectrum analyzer setting
   Center frequency: Low, middle and high channel.
   Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
   RBW = 100 ㎑ (1% of the span)
   VBW = 300 ㎑ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation on product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission

Test procedure for spurious emission

1. Use the following spectrum analyzer setting
   Center frequency: Low, middle and high channel.
   Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
   RBW = 100 ㎑
   VBW = 300 ㎑ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.

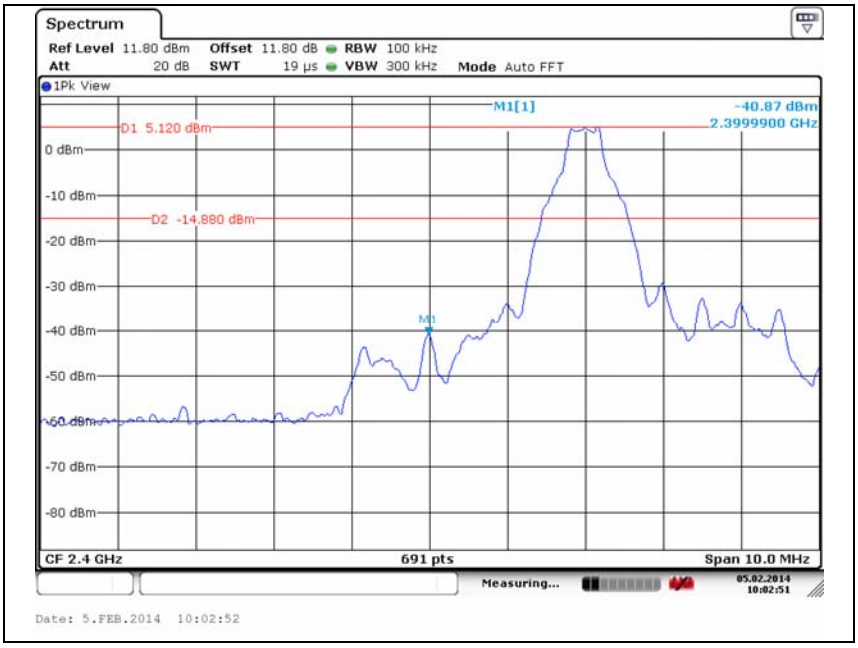
Limit

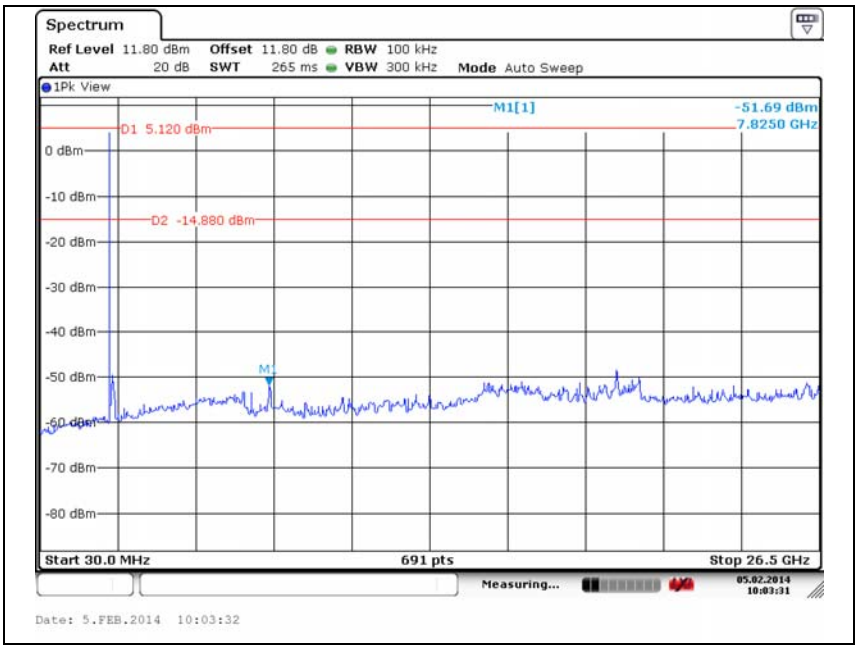
According to 15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section , the attenuation required under this paragraph shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section 15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section 15.205(a), must also comply the radiated emission limits specified in section 15.209(a) (see section 15.205(c))

According to RSS-210 A8.5, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

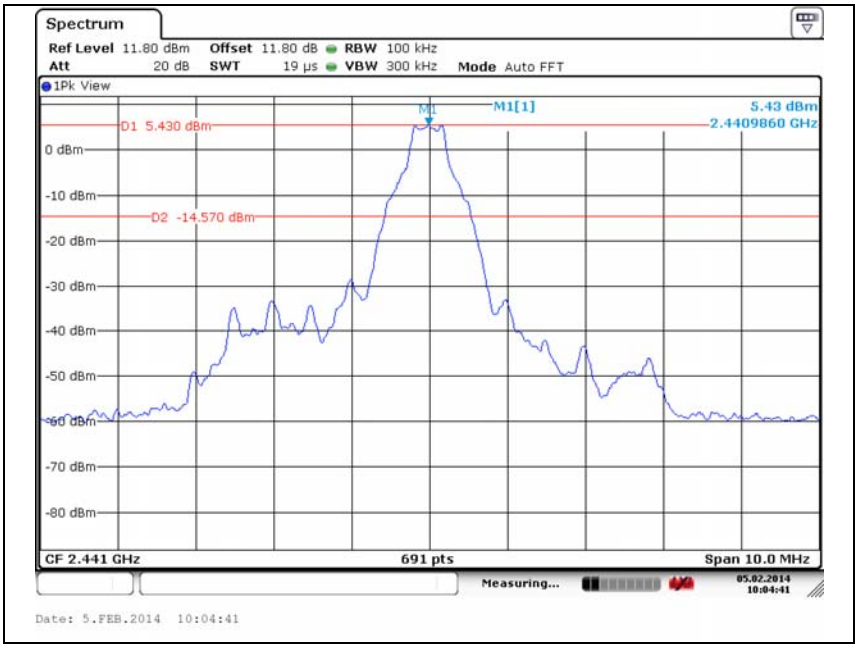
Test results

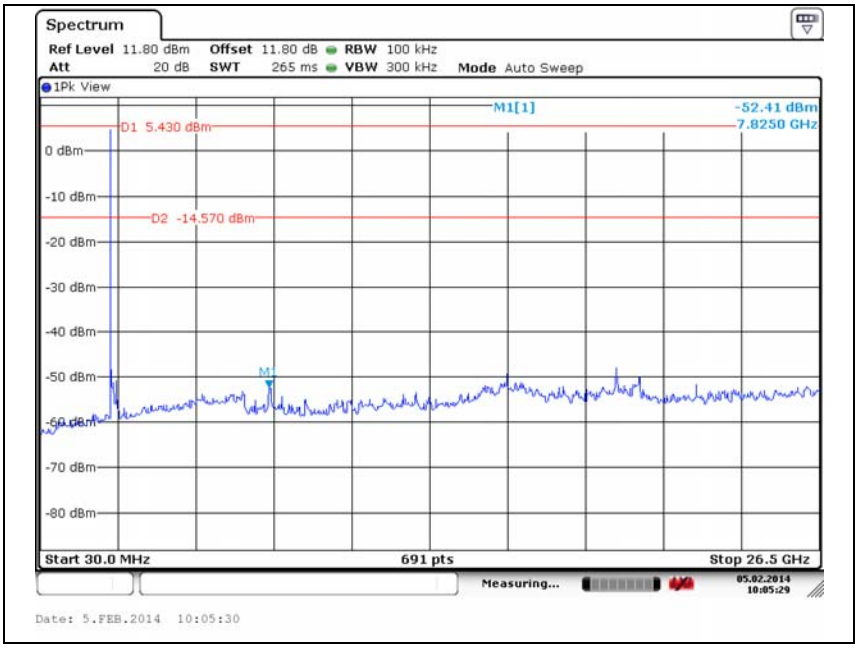
Low channel // GFSK



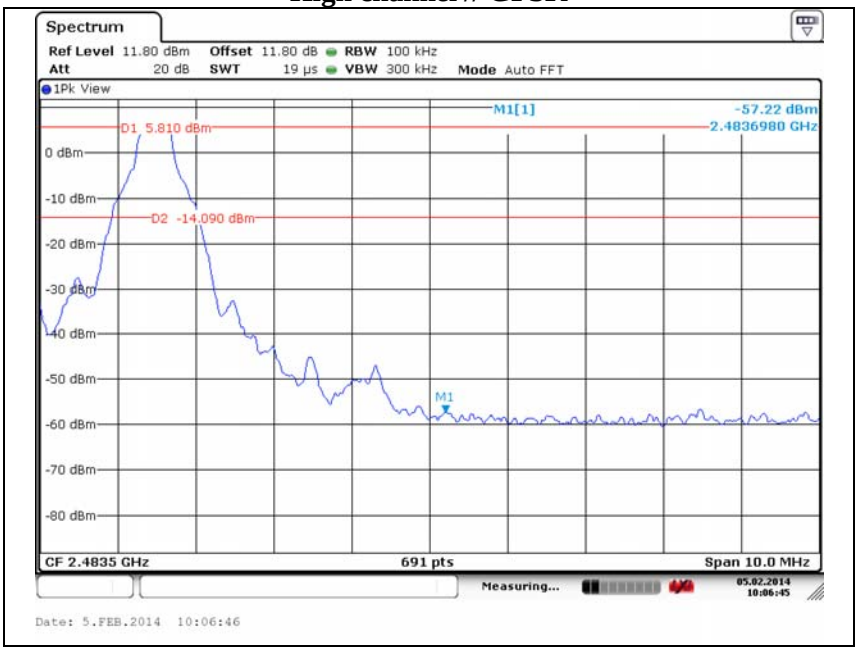


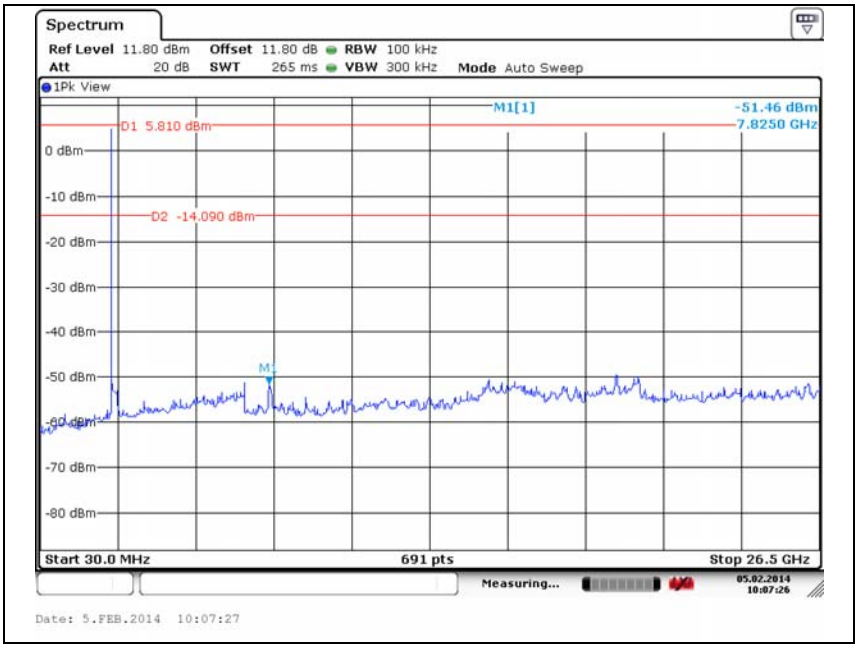
Middle channel // GFSK



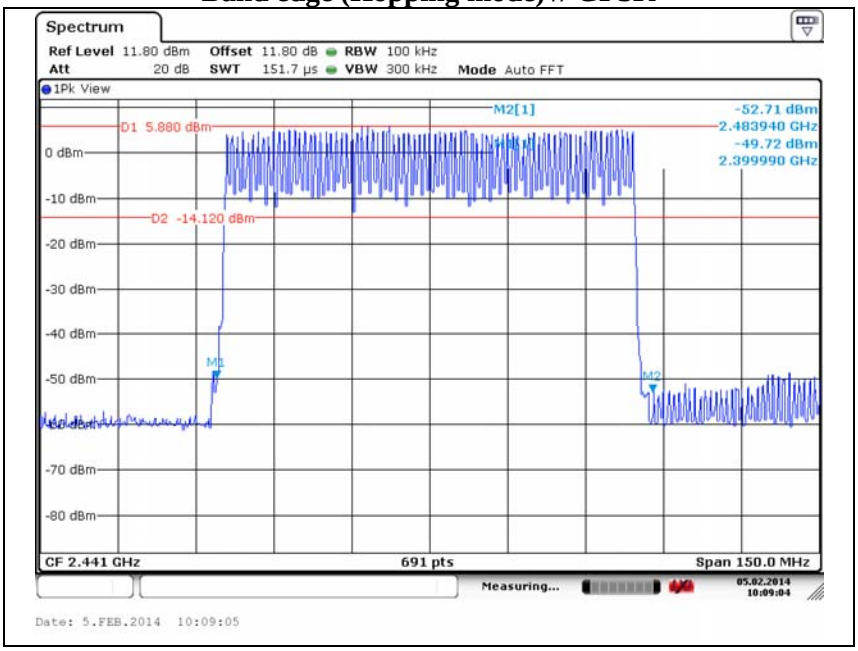


High channel // GFSK

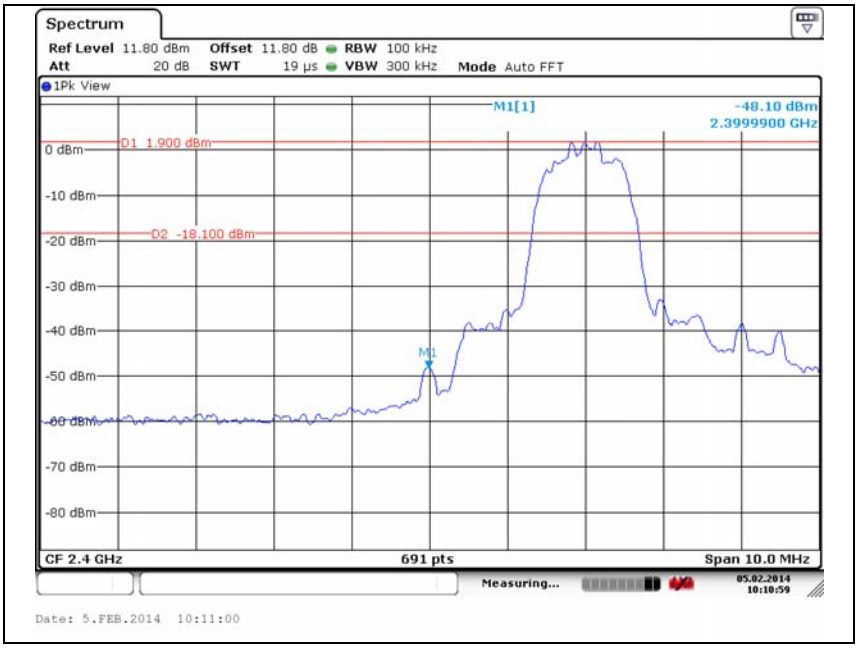


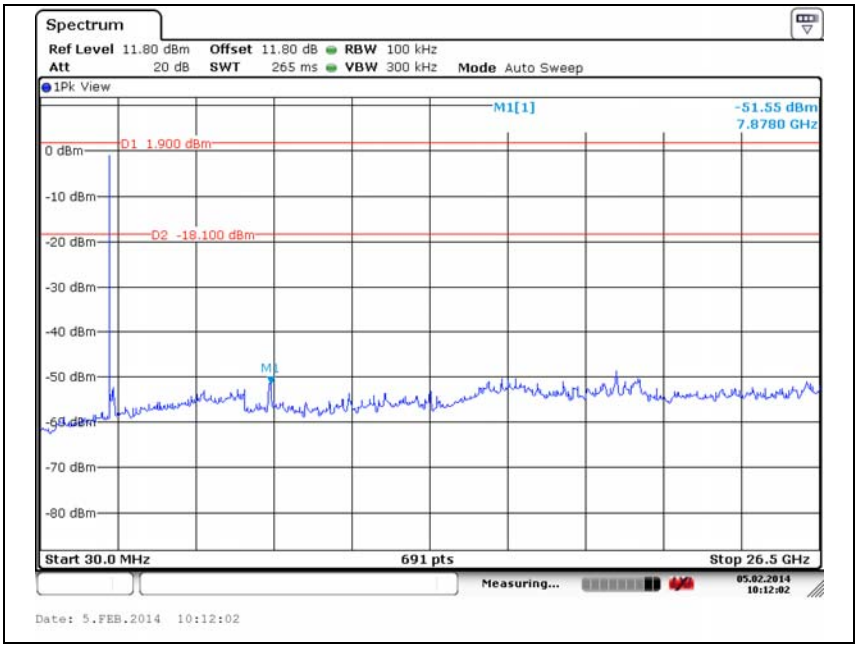


Band edge (Hopping mode) // GFSK

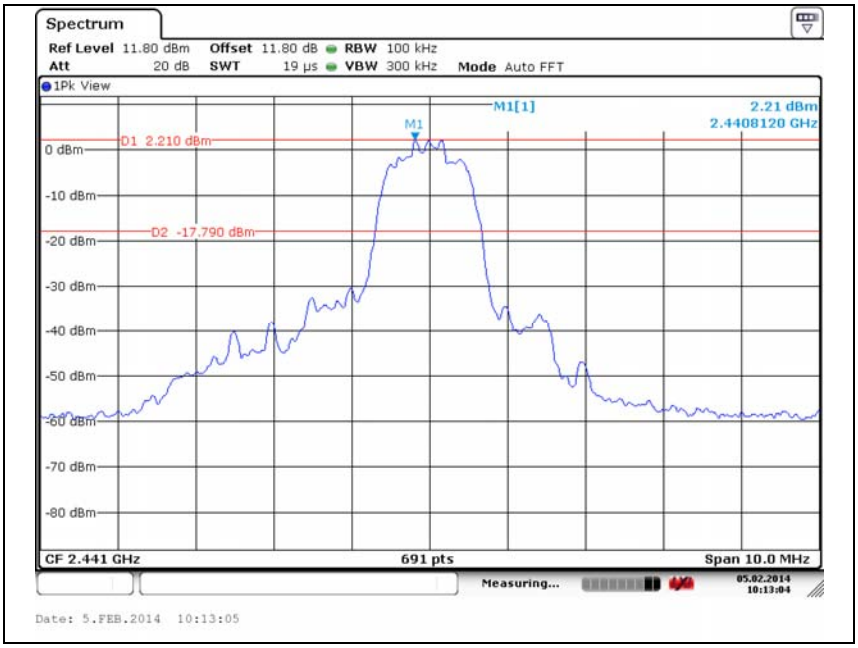


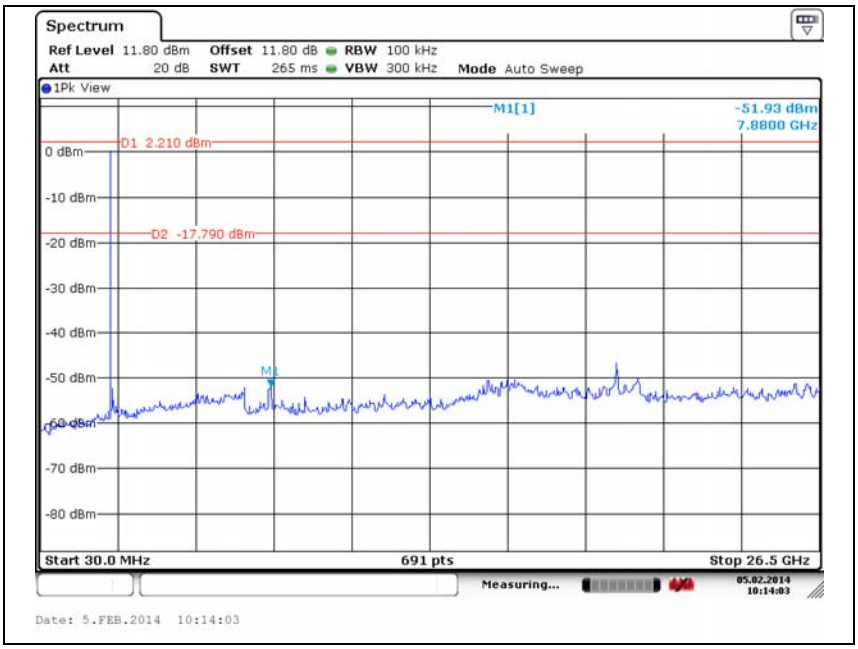
Low channel // 8DPSK



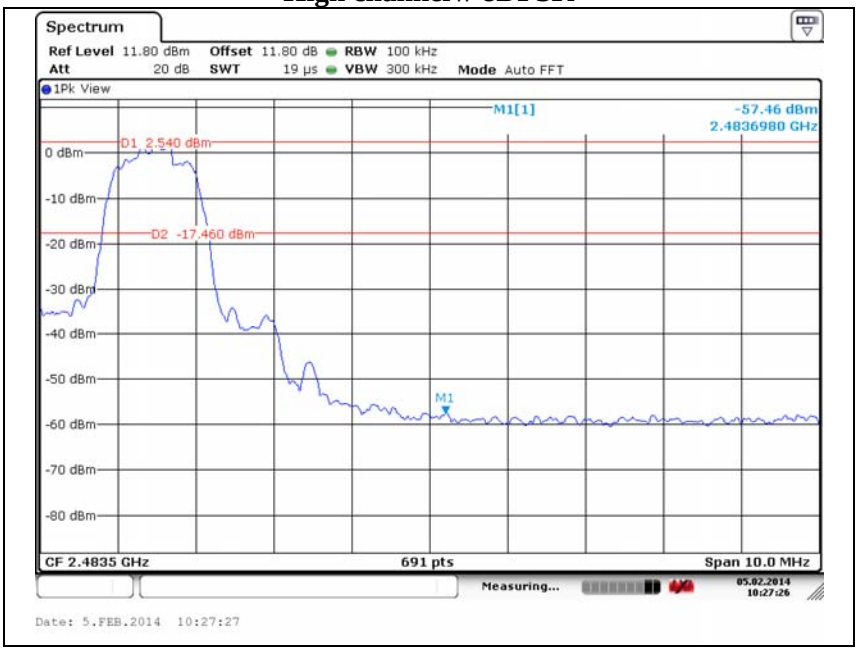


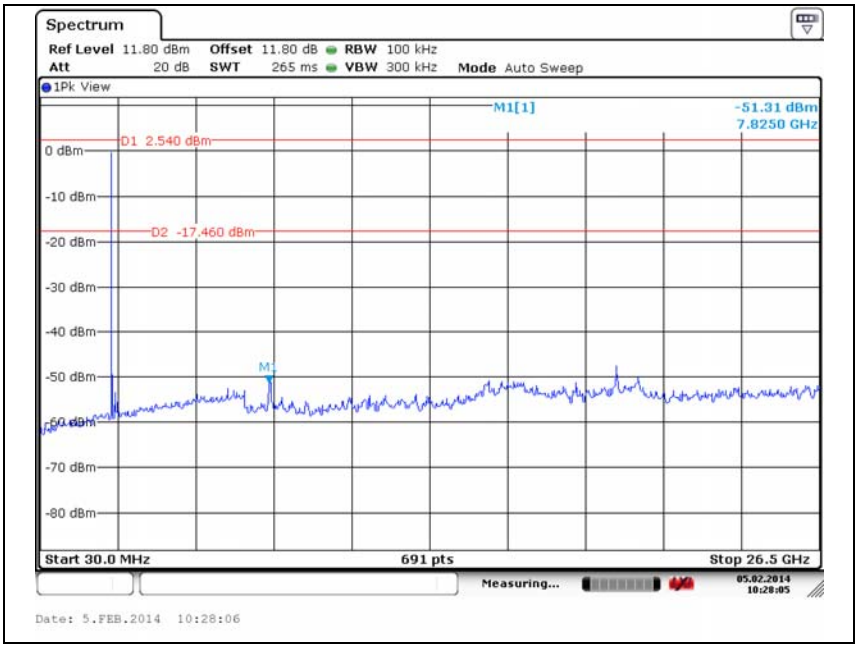
Middle channel // 8DPSK



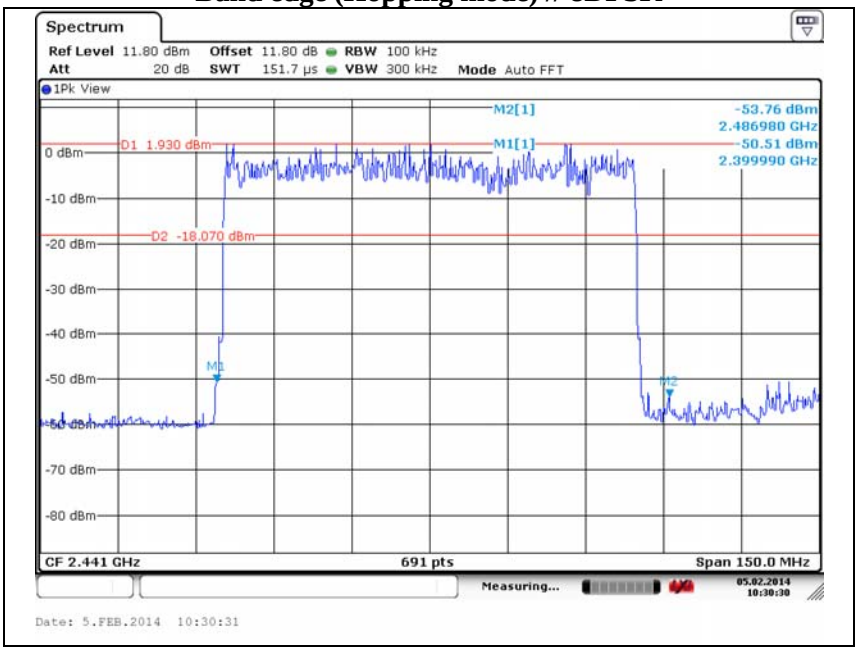


High channel // 8DPSK



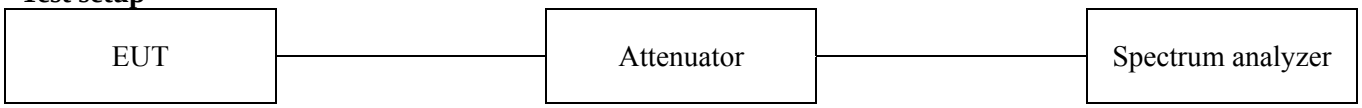


Band edge (Hopping mode) // 8DPSK



2.1.4 20 dB bandwidth

Test setup



Test procedure

1. Use the following spectrum analyzer setting
   Center frequency: Lowest, middle and highest channels
   Span = 3 ㎒ (Approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel)
   RBW = 20 ㎑ (≥ 1% of the 20 dB bandwidth)
   VBW = 50 ㎑ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. The EUT should be transmitting at its maximum data rate. Allow the trance to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down on side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level.

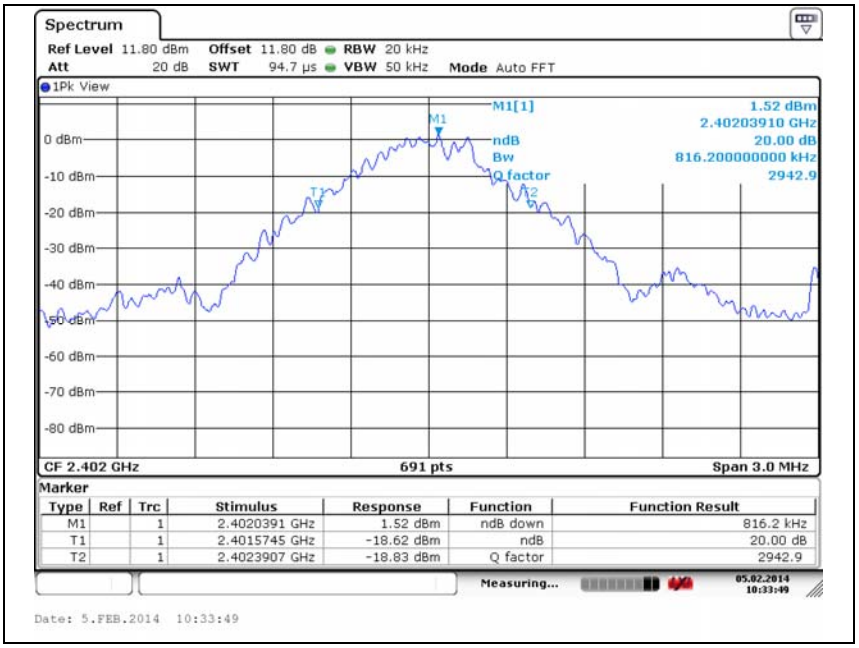
Limit

Not applicable

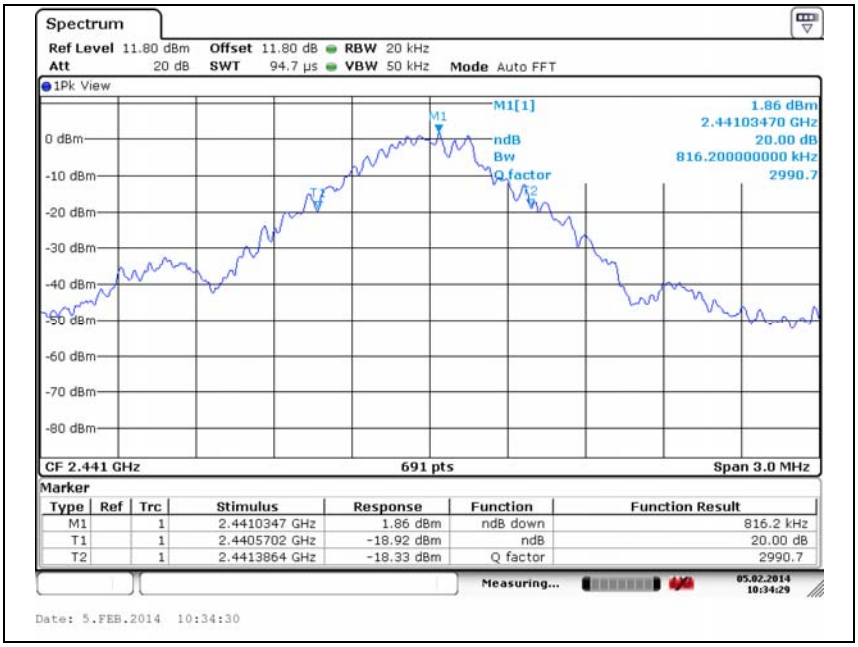
Test results

Operation mode	Frequency(㎒)	20 ㏈ bandwidth(㎒)
GFSK	2 402	0.82
	2 441	0.82
	2 480	0.82
8DPSK	2 402	1.28
	2 441	1.27
	2 480	1.28

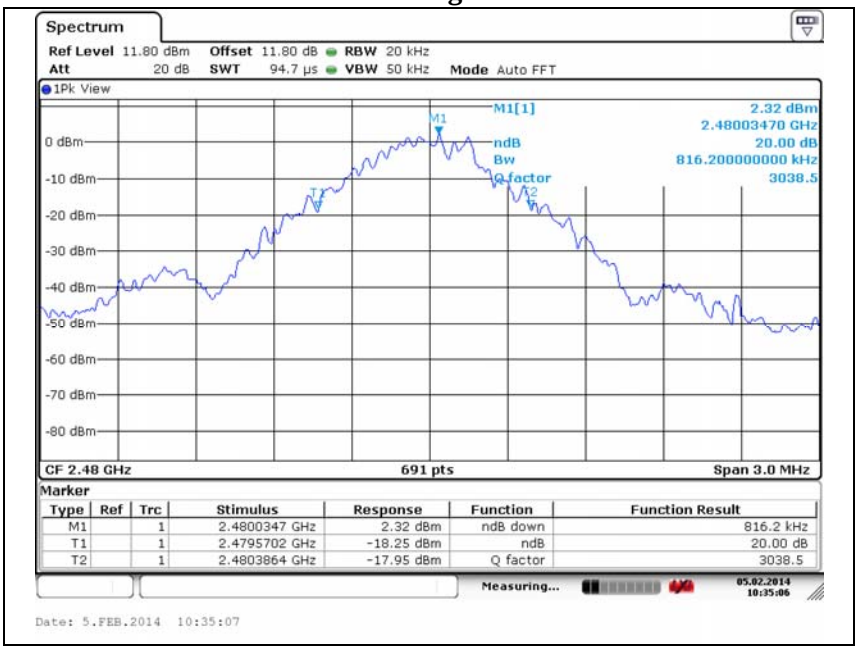
20 ㏈ bandwidth // Low channel // GFSK



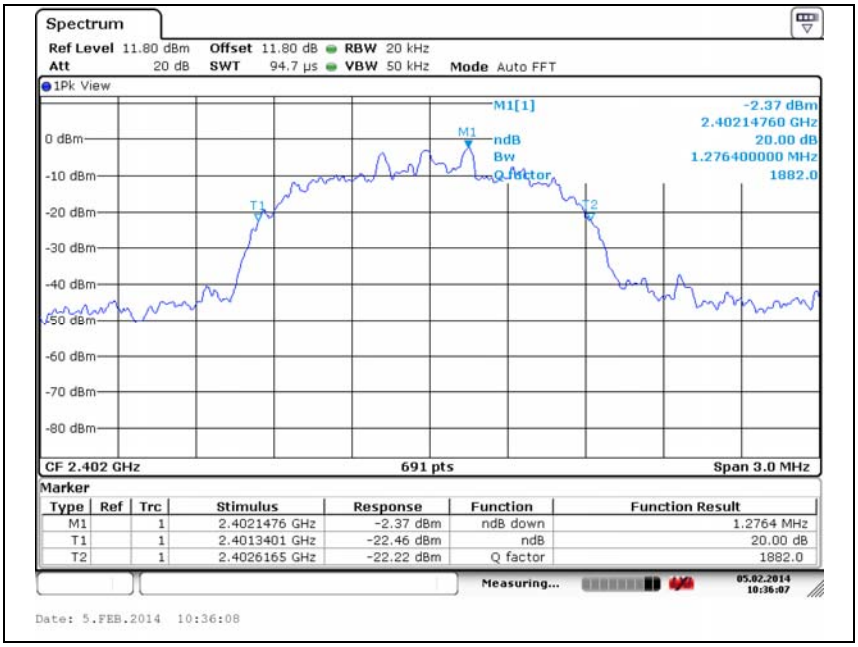
20 dB bandwidth // Middle channel // GFSK



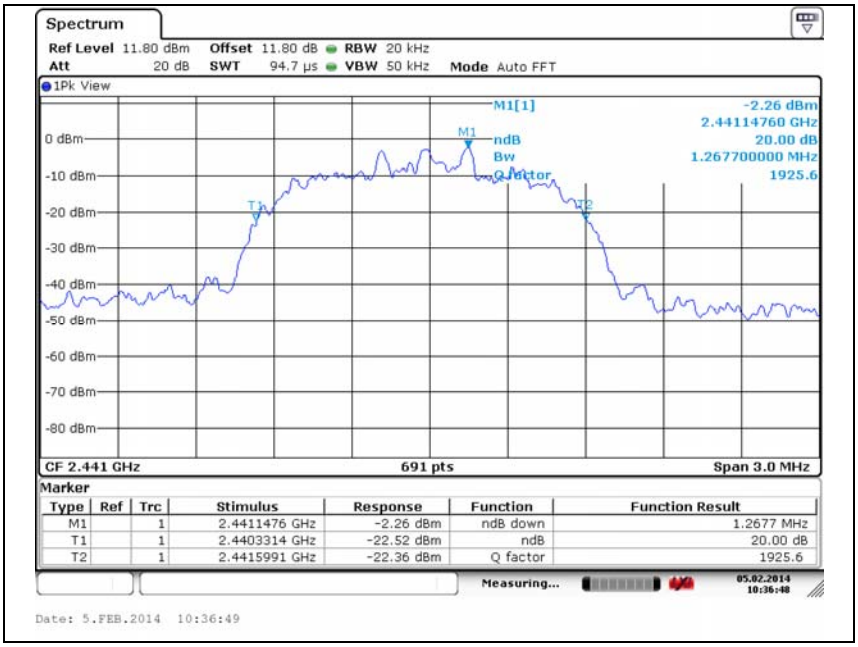
20 dB bandwidth // High channel // GFSK



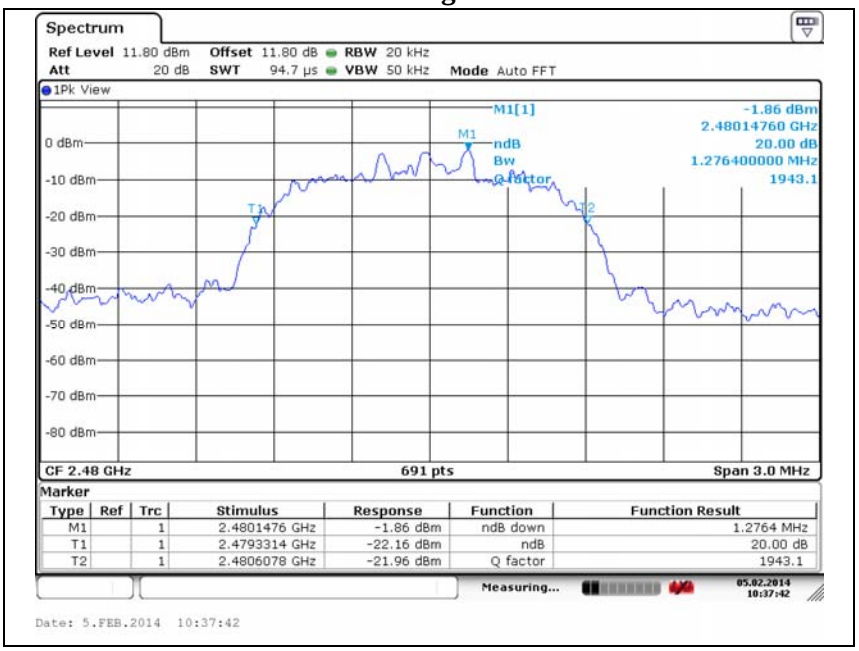
20 dB bandwidth // Low channel // 8DPSK



20 dB bandwidth // Middle channel // 8DPSK

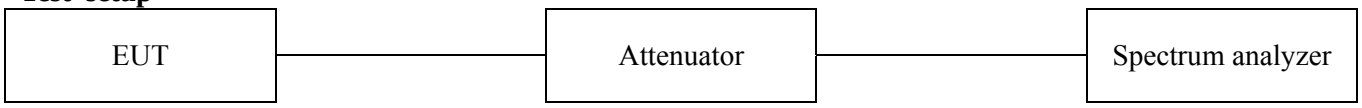


20 dB bandwidth // High channel // 8DPSK



2.1.5 Frequency separation

Test setup



Test procedure

1. The EUT must have its hopping function enabled.
2. Use the following spectrum analyzer setting
   Span = 3 ㎒ (wide enough to capture the peaks of two adjacent channels)
   RBW = 30 ㎑ (≥ 1% of the span)
   VBW = 100 ㎑ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
3. All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Limit

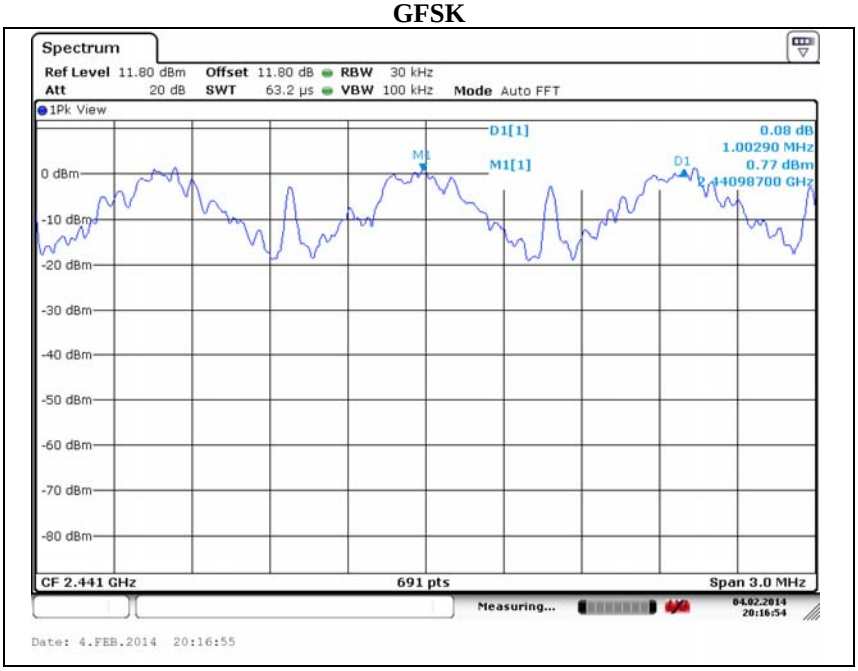
According to 15.247(a)(1), frequency hopping system operating in 2 400 ~ 2 483.5 ㎒. Band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-third of 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

According to RSS-210 A8.1(b), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

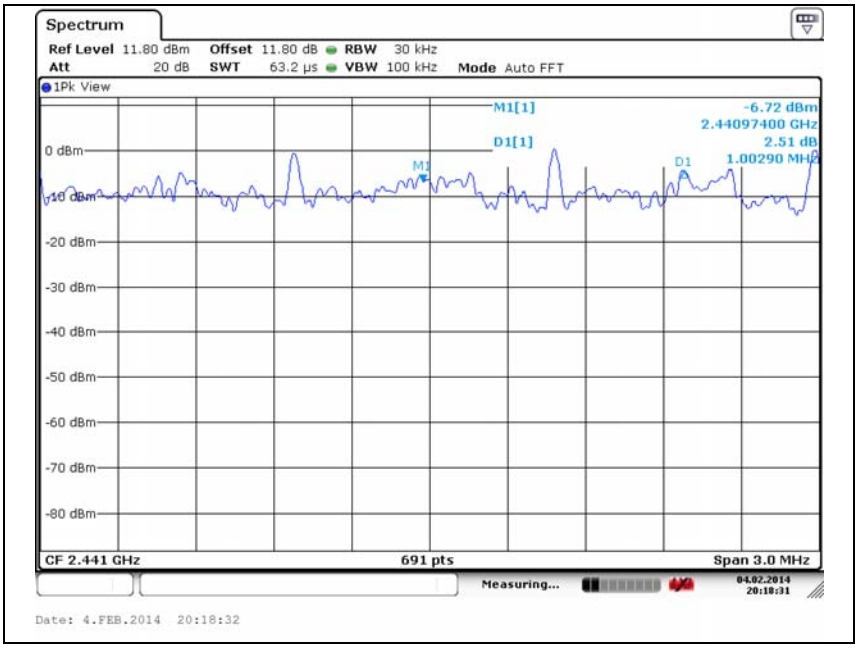
Test results

Operation mode	Frequency (㎒)	Adjacent hopping channel separation(㎒)	Two-third of 20 dB bandwidth (㎒)	Minimum bandwidth (㎑)
GFSK	2 441	1.0029	0.55	25
8DPSK	2 441	1.0029	0.85	25

GFSK

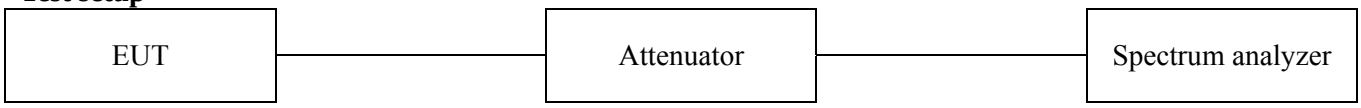


8DPSK



2.1.6 Number of hopping frequency

Test setup



Test procedure

1. The EUT must have its hopping function enabled.
2. Use the following spectrum analyzer setting
   Frequency range: 2 400 ㎒ ~ 2 441.5 ㎒, 2 441.5 ㎒ ~ 2 483.5 ㎒
   RBW = 500 ㎑ (≥ 1% of the span)
   VBW = 1 ㎒ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
3. All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Limit

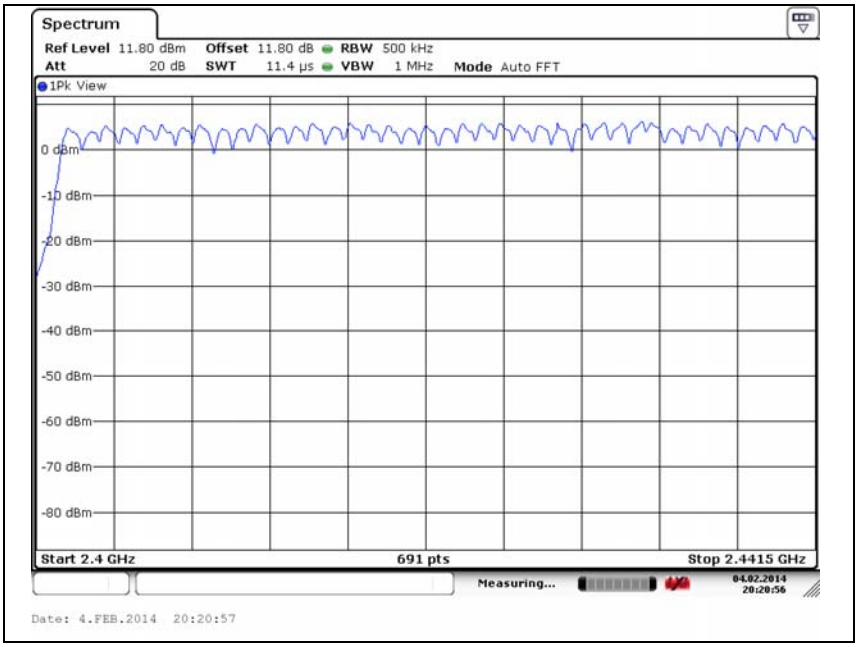
According to 15.247(a)(1)(iii), for frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

According to RSS-210 A8.1(d), frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

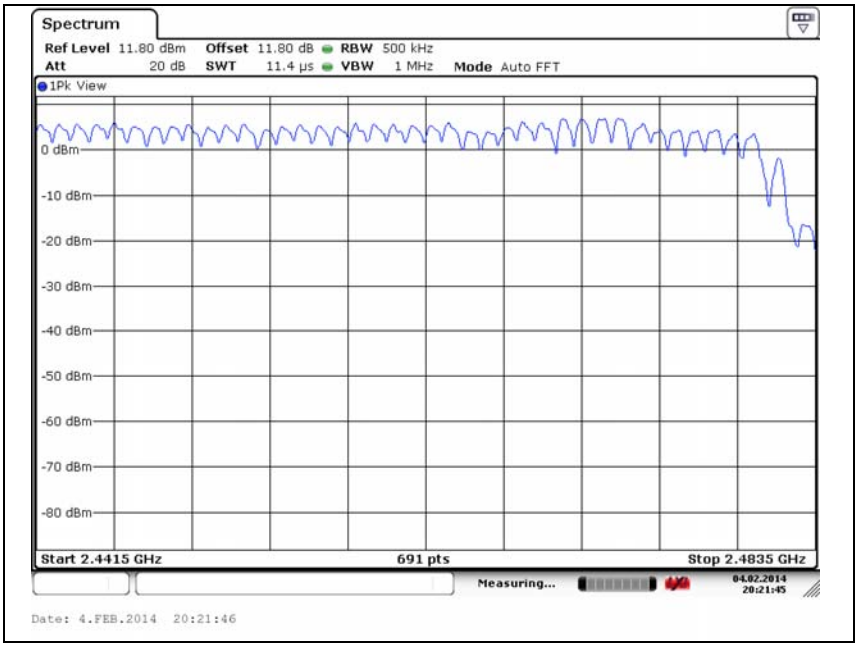
Test results

Operation mode	Number of hopping frequency	Limit
GFSK	79	≥ 15
8DPSK	79	≥ 15

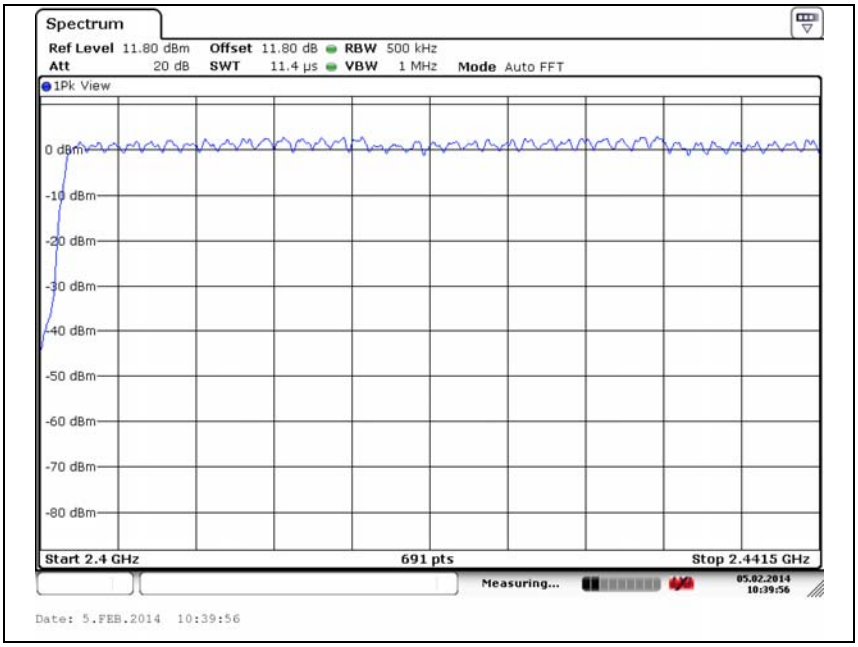
2 400 ㎒ ~ 2 441.5 ㎒ // GFSK



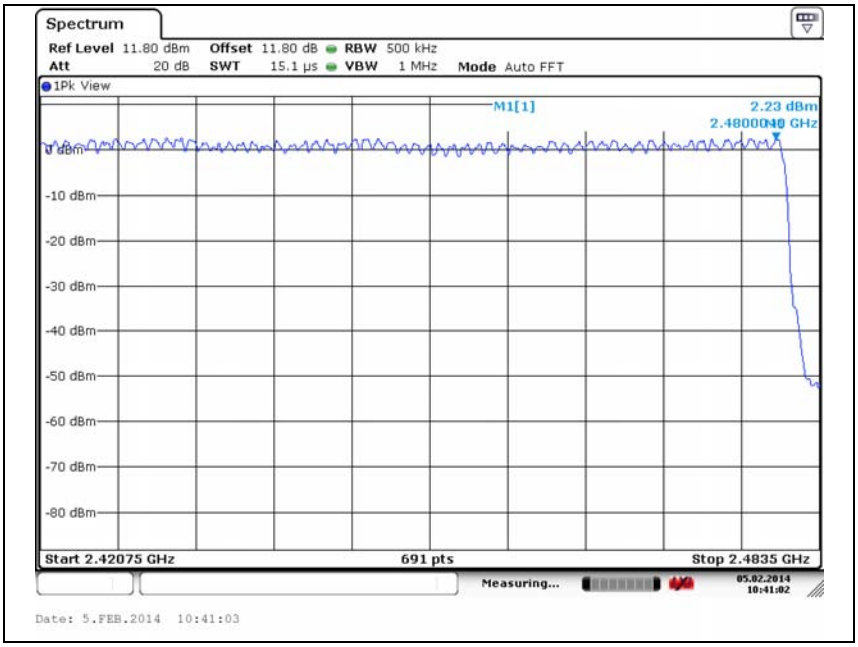
2 441.5 ㎒ ~ 2 483.5 ㎒ // GFSK



2 400 ㎒ ~ 2 441.5 ㎒ // 8DPSK

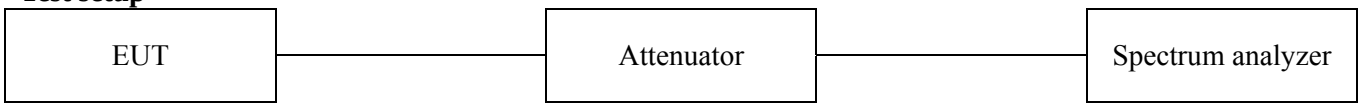


2 441.5 ㎒ ~ 2 483.5 ㎒ // 8DPSK



2.1.7 Time of occupancy (Dwell time)

Test setup



Test procedure

1. Use the following spectrum analyzer setting
   Center frequency: 2 441 ㎒
   Span = Zero span, centered on a hopping channel
   RBW = 1 ㎒
   VBW = 1 ㎒ (≥ RBW)
   Sweep = as necessary to capture the entire dwell time per hopping channel
   Detector function = peak
   Trace = max hold
2. If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., date rate, modulation format, etc.), repeat this test for each variation.
3. The Bluetooth has 3 type of payload DH1, DH3, DH5. The hopping rate is 1 600 per second.

Limit

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ band, the average time of occupancy on any frequency shall not be greater than 0.4 second, multiplied by the number of hopping channels employed.

According to RSS-210 A8.1(d), frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ band, 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 channels employed.

A period time = 0.4(s) × 79 = 31.6(s)

Test results

Time of occupancy on the TX channel in 31.6 sec
= Burst On Time × (hop rate ÷ number of hop per channel) × 31.6

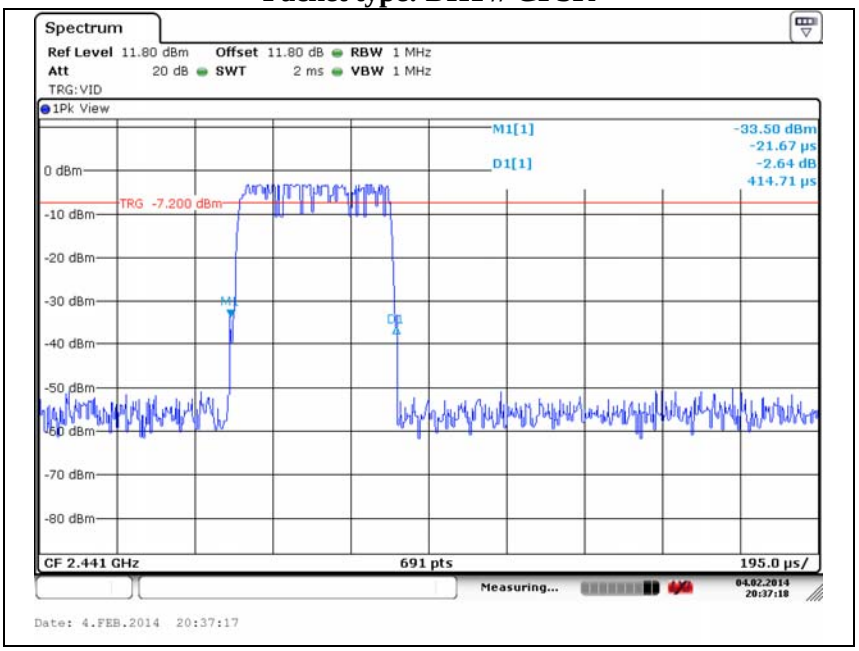
Operation mode: GFSK , 8DPSK

Packet type	Frequency (㎒)	Burst On Time (ms)	Time of occupancy(Dwell time) on the Tx channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx channel in 31.6 sec (ms)
DH1	2 441	0.41	131	400
DH3	2 441	1.68	269	400
DH5	2 441	2.92	311	400
3-DH1	2 441	0.43	138	400
3-DH3	2 441	1.68	269	400
3-DH5	2 441	2.93	312	400

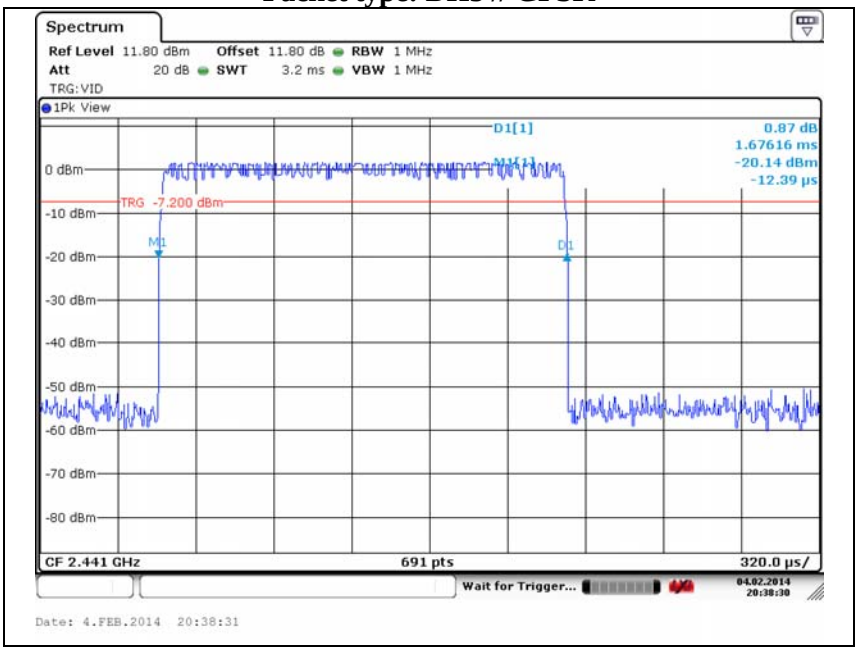
※ Remark:

DH1: Burst on time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 131 (ms)
DH3: Burst on time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 269 (ms)
DH5: Burst on time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 311 (ms)
3-DH1: Burst on time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 138 (ms)
3-DH3: Burst on time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 269 (ms)
3-DH5: Burst on time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 312 (ms)

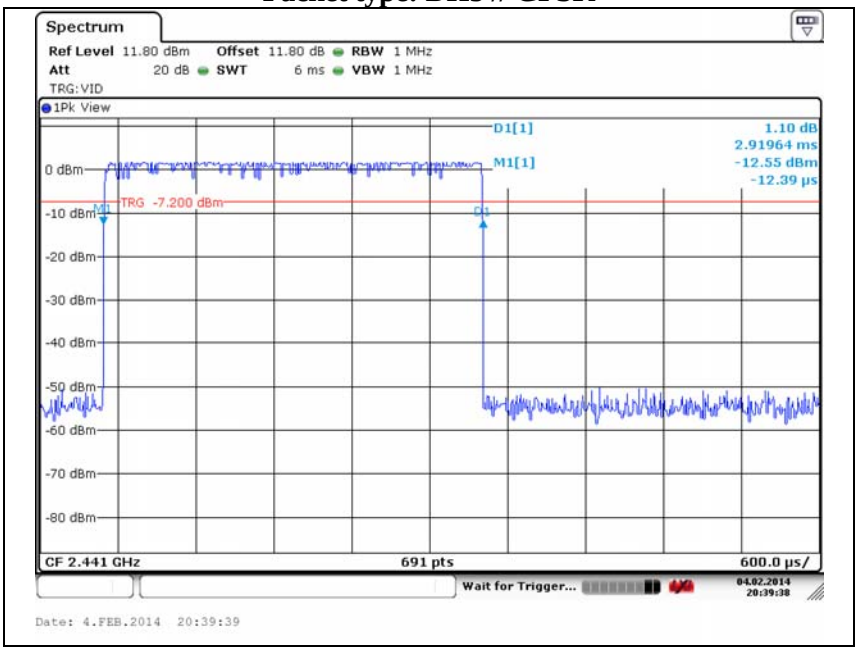
Packet type: DH1 // GFSK



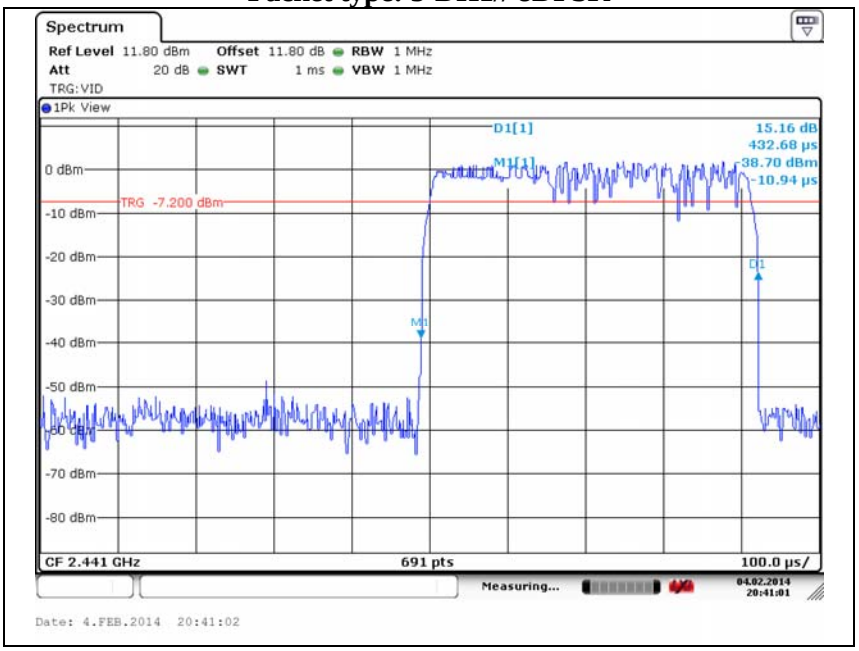
Packet type: DH3 // GFSK



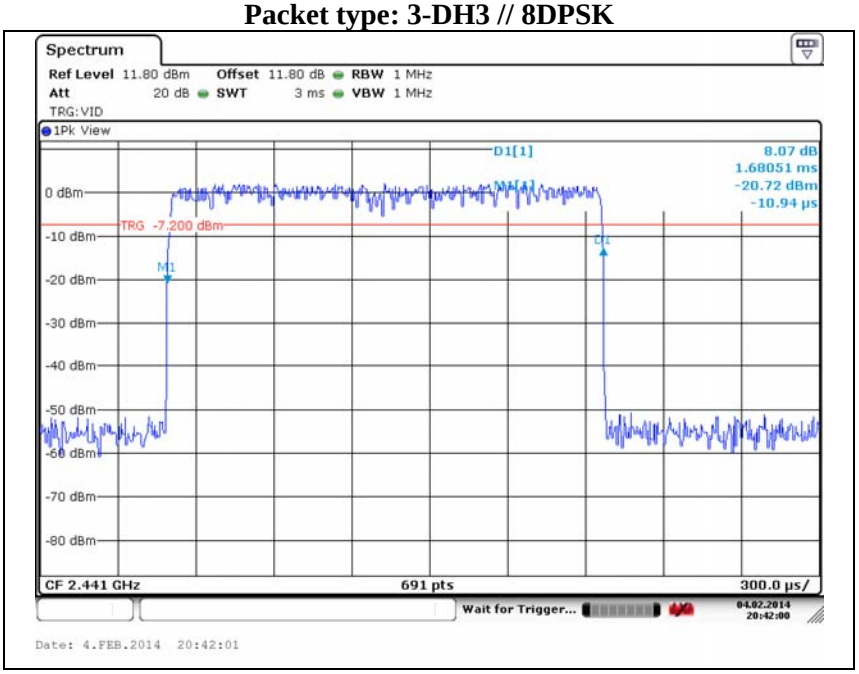
Packet type: DH5 // GFSK



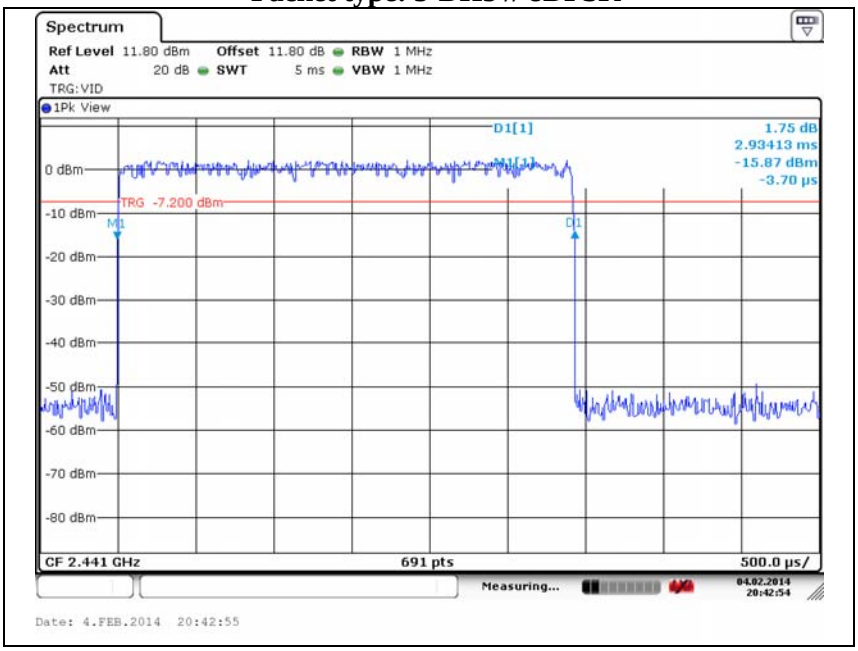
Packet type: 3-DH1// 8DPSK



Packet type: 3-DH3 // 8DPSK



Packet type: 3-DH5 // 8DPSK



2.1.8 Radiated spurious emission

Test location
Testing was performed at a test distance of 3 meter Open Area Test Site

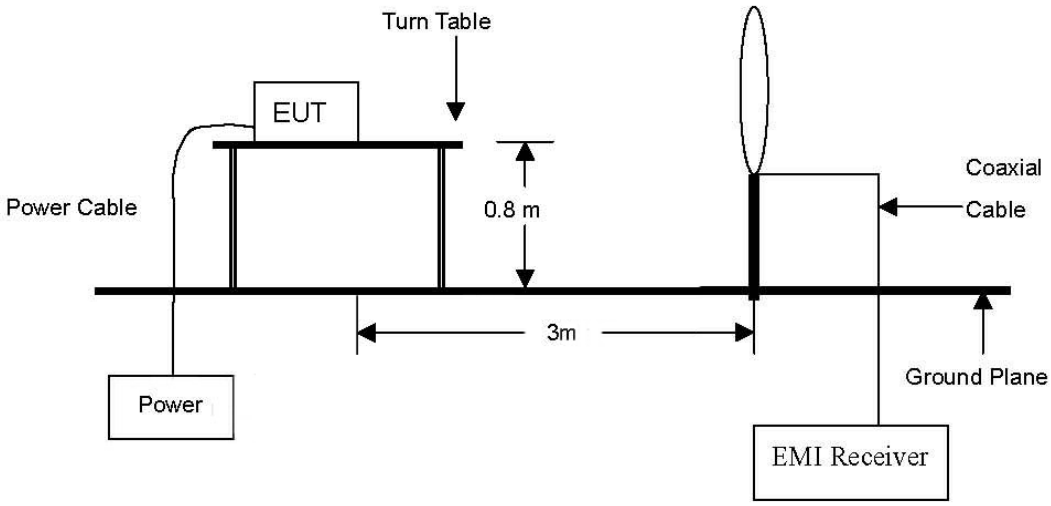
Test procedures
[9 ㎑ to 30 ㎒]
The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to Quasi-peak function and specified bandwidth with maximum hold mode.

The spectrum analyzer is set to:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 200 ㎐ for Quasi-peak detection (QP) at frequency below 9 ㎑~ 150 ㎑.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 9 ㎑ for Quasi-peak detection (QP) at frequency below 150 ㎑~ 30 ㎒.

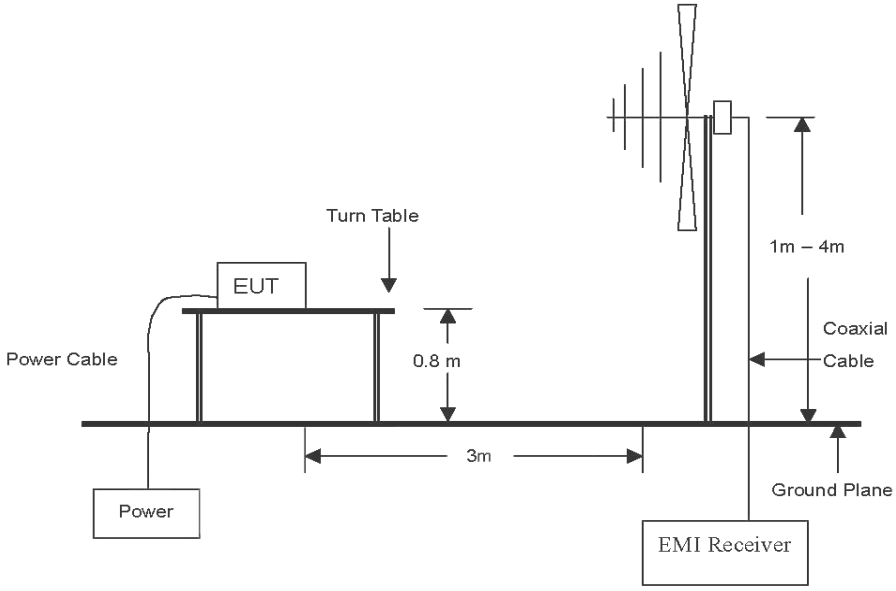
[30 ㎒ to 1 ㎓ and 1 ㎓ to 24 ㎓]
The height of the measuring antenna was varied between 1 to 4 m and the table was rotated a full revolution in order to obtain maximum values of the electric field intensity.
The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

The spectrum analyzer is set to:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection at frequency above 1 ㎓.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1 ㎓.

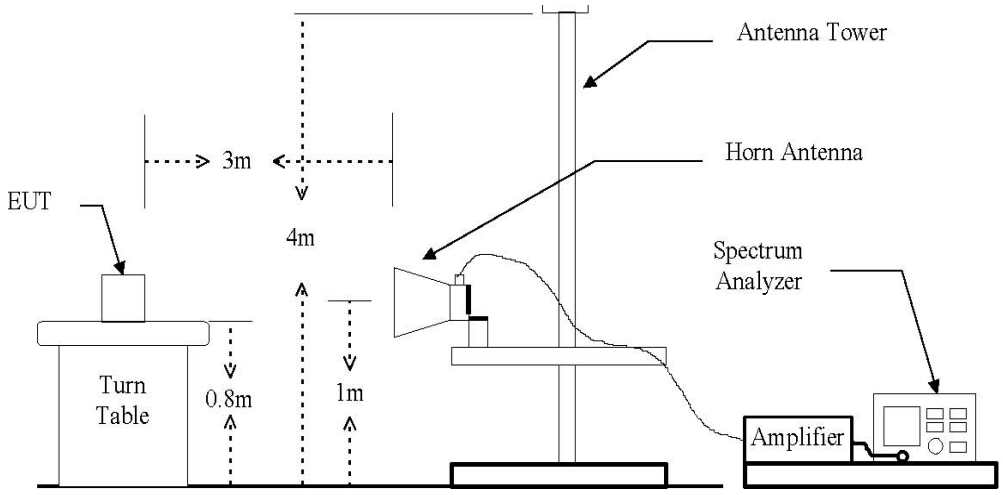
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 24 ㎓ emissions.



Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2400 / F(㎑)
0.490 ~ 1.705	30	24000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 ㎒, 76 ~ 88 ㎒, 174 ~ 216 ㎒ or 470 ~ 806 ㎒. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

Test results (Below 30 ㎒) – Worst case configuration: GFSK

The frequency spectrum from 9 ㎑ to 30 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈.

Radiated emissions		Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Pol.	Ant. factor (㏈/m)	Cable loss (㏈)	F_d (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
Below 30	Not detected							

※ Remark

1. All spurious emission at channels are almost the same below 30 ㎒, so that middle channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss + F_d
3. $F_d = 40\log(D_m / D_s)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters

Test results (Below 1 000 ㎒) – Worst case configuration: GFSK

The frequency spectrum from 30 ㎒ to 1 000 ㎒ was investigated.

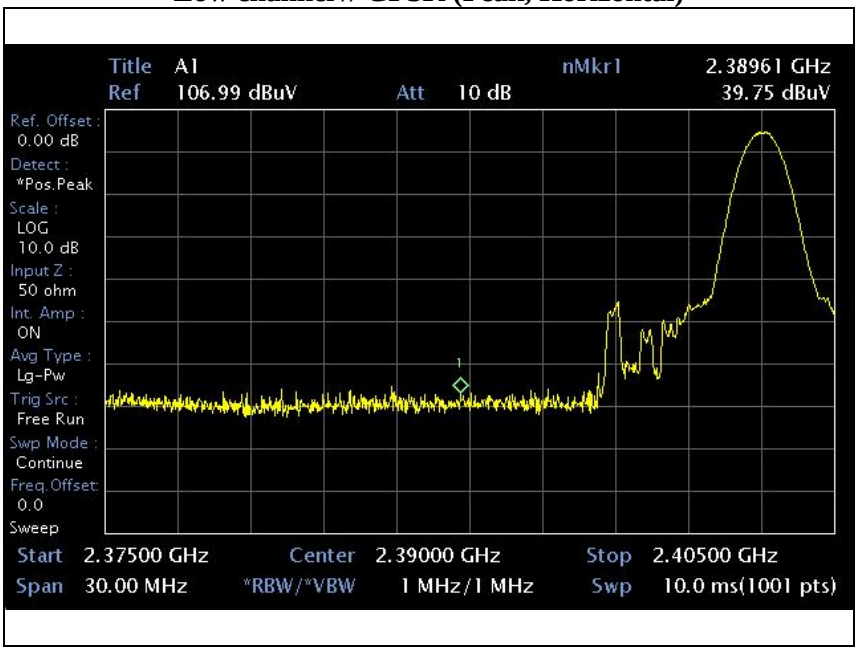
Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
34.85	19.96	V	12.63	1.30	33.89	40.0	6.11
75.59	23.16	V	9.21	2.03	34.40	40.0	5.60
95.96	26.82	H	9.11	2.40	38.33	43.5	5.17
288.02	22.45	H	12.32	4.37	39.14	46.0	6.86
353.01	17.97	V	13.90	4.90	36.77	46.0	9.23
564.47	15.96	V	18.01	5.78	39.75	46.0	6.25

※ Remark

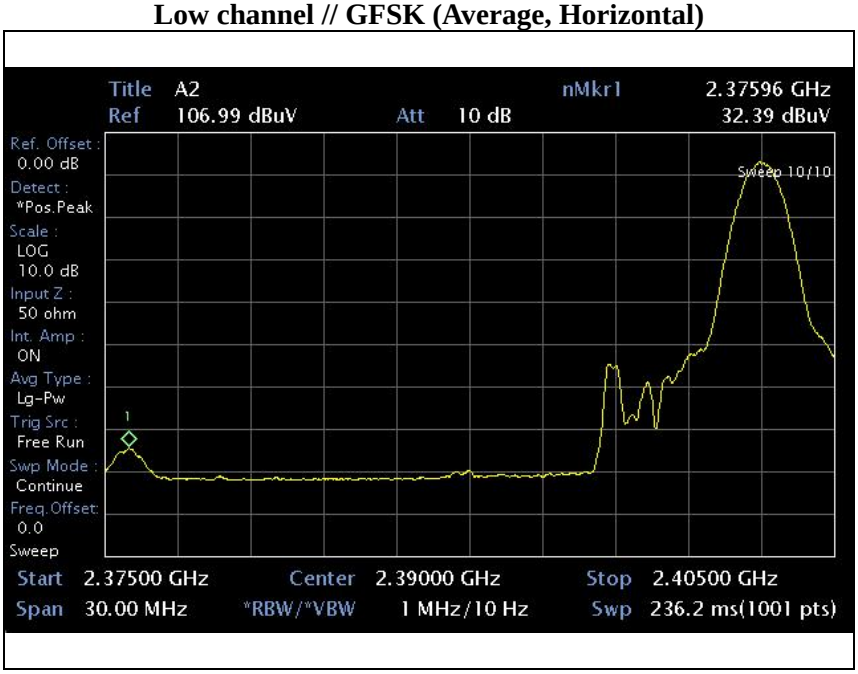
1. All spurious emission at channels are almost the same below 1 ㎓, so that middle channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss
3. Detector mode: Quasi peak
4. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Above 1 000 ㎒)

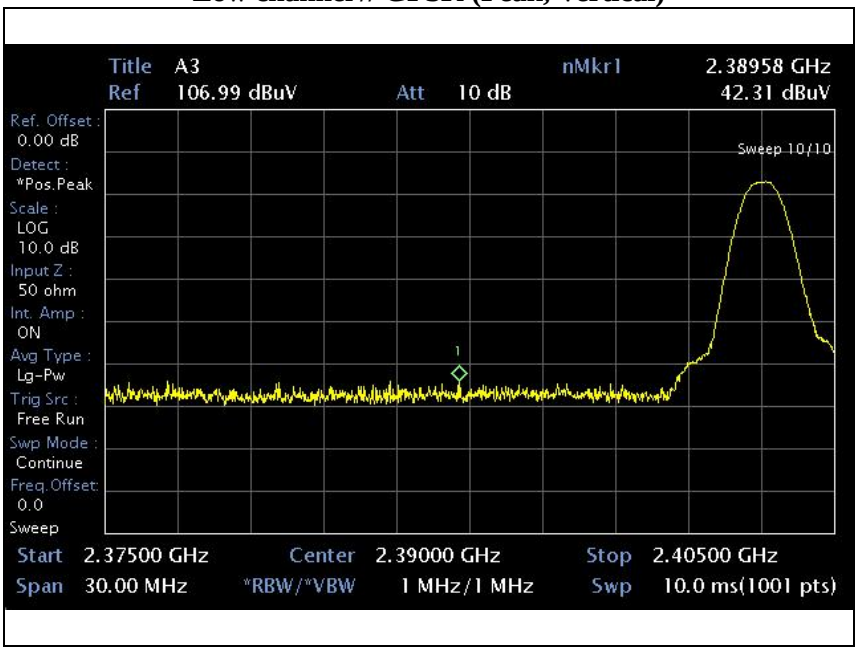
Low channel // GFSK (Peak, Horizontal)



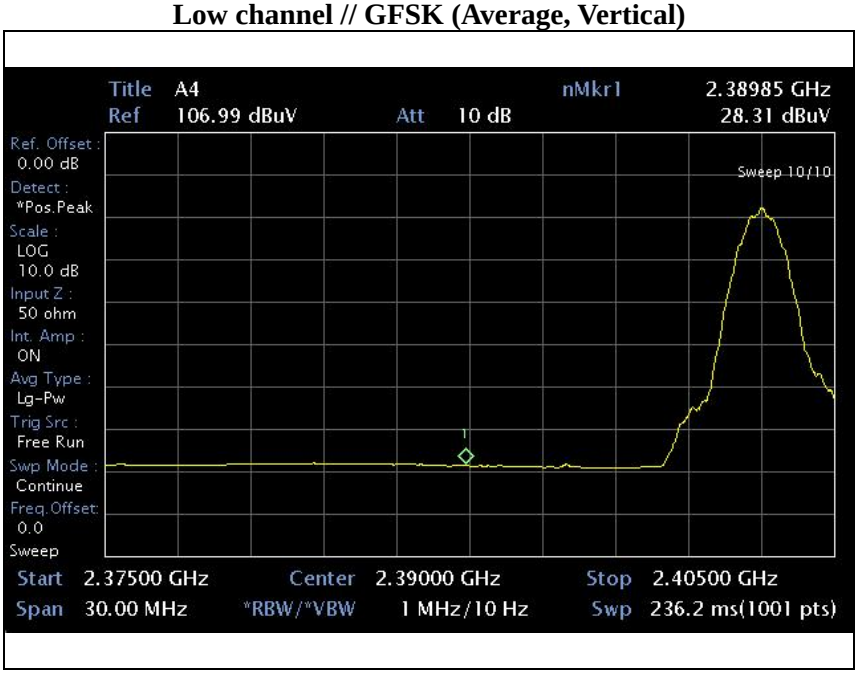
Low channel // GFSK (Average, Horizontal)



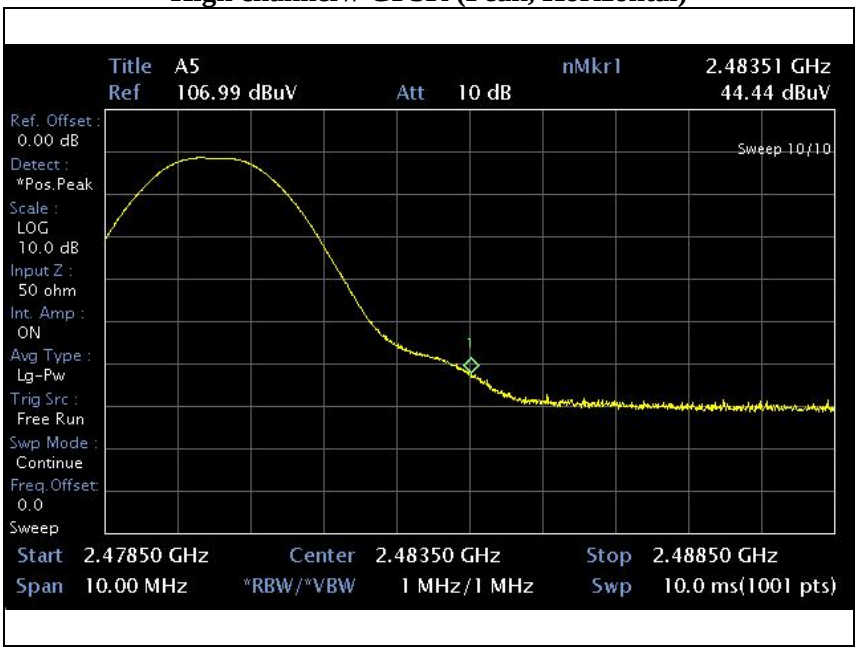
Low channel // GFSK (Peak, Vertical)



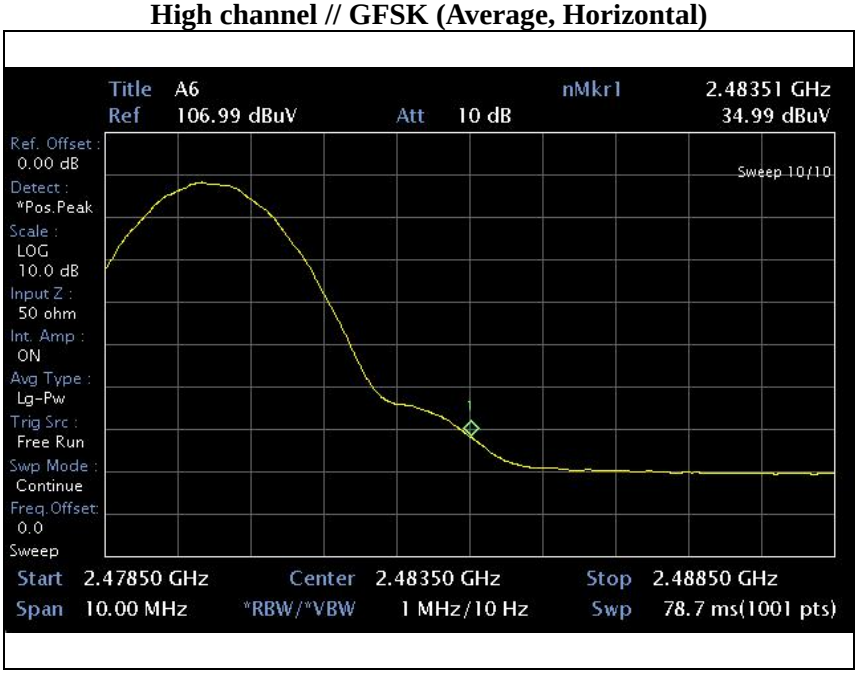
Low channel // GFSK (Average, Vertical)



High channel // GFSK (Peak, Horizontal)

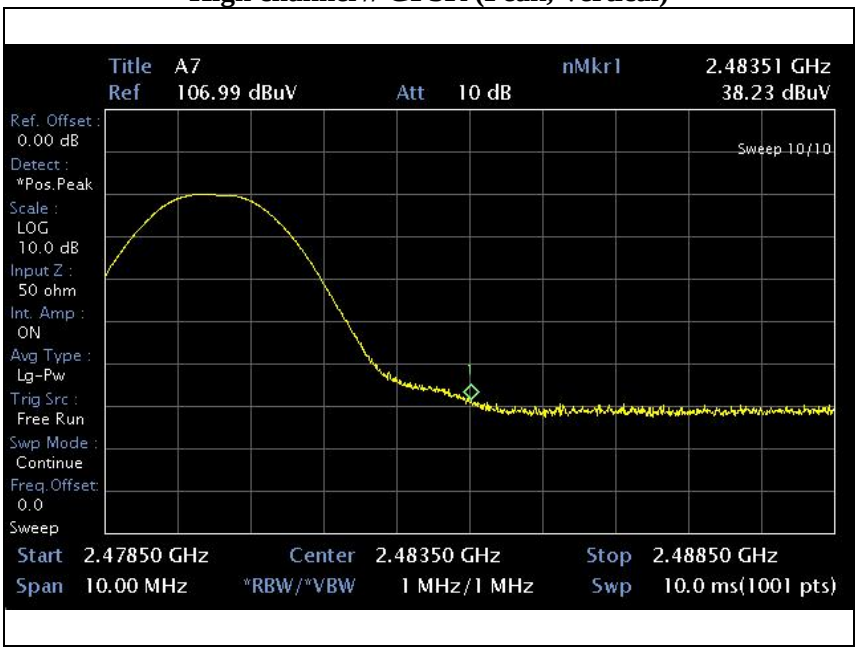


High channel // GFSK (Average, Horizontal)

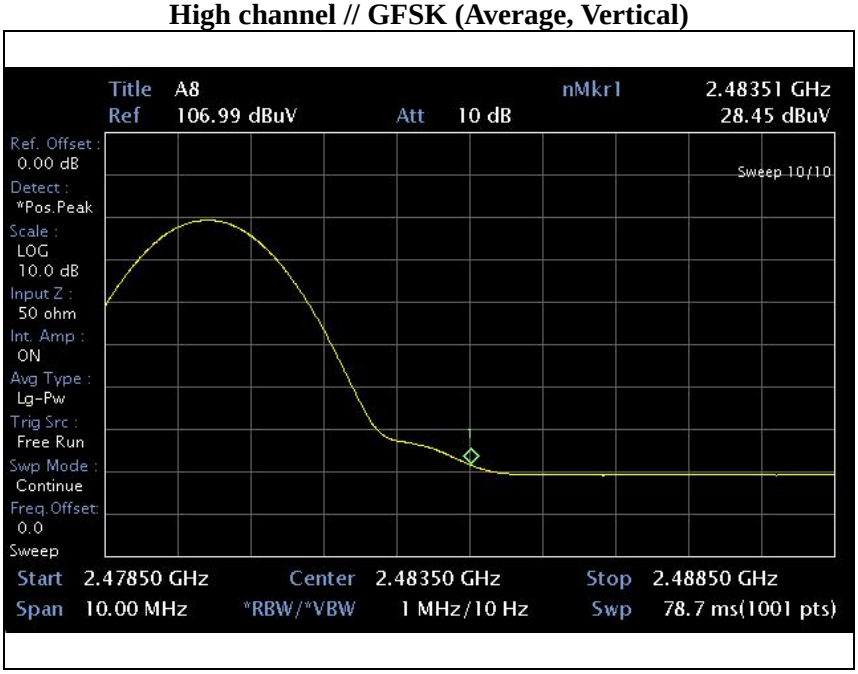


2483.

High channel // GFSK (Peak, Vertical)



High channel // GFSK (Average, Vertical)



The frequency spectrum from 1 ㎓ to 25 ㎓ was investigated.

Low channel // GFSK

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	AFCL (dB)	DCF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2389.61	39.75	PK	H	9.46	-	49.21	74.00	24.79
2375.96	32.39	Avg	H	9.23	-	41.62	54.00	12.38
2389.58	42.31	PK	V	9.46	-	51.77	74.00	22.23
2389.85	28.31	Avg	V	9.47	-	37.78	54.00	16.22
4804.25	52.08	PK	H	14.27	-	66.35	74.00	7.65
4804.25	50.52	Avg	H	14.27	-30.69	34.10	54.00	19.90
4804.05	43.28	PK	V	14.27	-	57.55	74.00	16.45
4803.87	40.54	Avg	V	14.26	-30.69	24.11	54.00	29.89

Middle channel // GFSK

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	AFCL (dB)	DCF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4881.77	53.15	PK	H	14.92	-	68.07	74.00	5.93
4881.83	51.50	Avg	H	14.92	-30.69	35.73	54.00	18.27
4882.27	44.93	PK	V	14.93	-	59.86	74.00	14.14
4882.05	41.28	Avg	V	14.92	-30.69	25.51	54.00	28.49

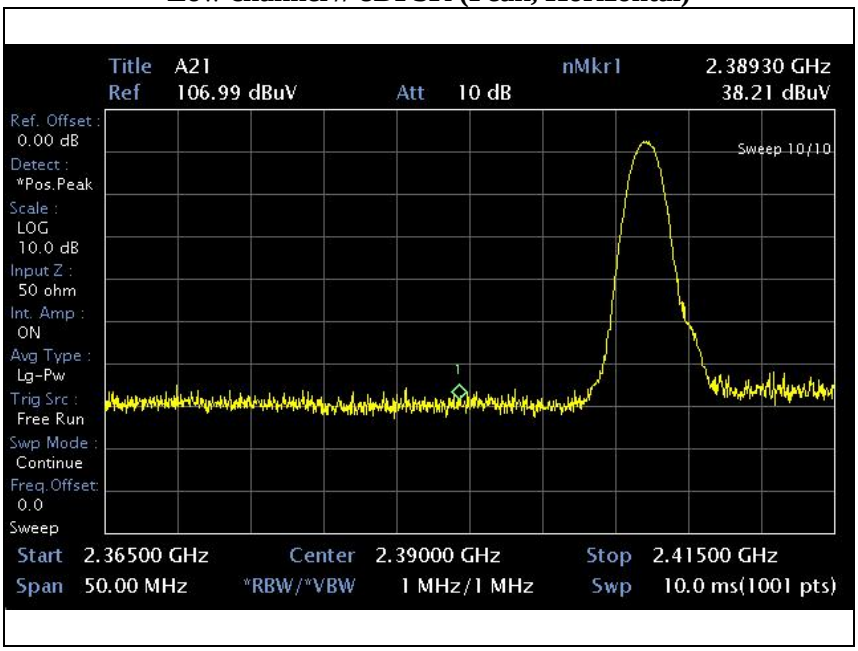
High channel // GFSK

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	AFCL (dB)	DCF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2483.51	44.44	PK	H	11.08	-	55.52	74.00	18.48
2783.51	34.99	Avg	H	11.08	-	46.07	54.00	7.93
2483.51	38.23	PK	V	11.08	-	49.31	74.00	24.69
2483.51	28.45	Avg	V	11.08	-	39.53	54.00	14.47
4959.66	53.80	PK	H	15.58	-	69.38	74.00	4.62
4959.98	52.23	Avg	H	15.58	-30.69	37.12	54.00	16.88
4959.73	48.17	PK	V	15.58	-	63.75	74.00	10.25
4959.71	45.61	Avg	V	15.58	-30.69	30.50	54.00	23.50

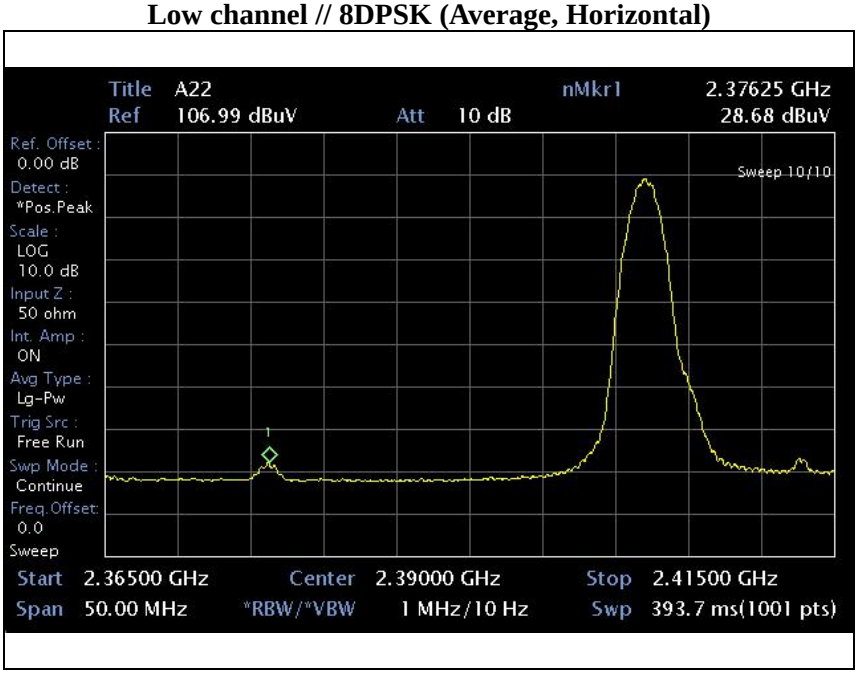
※ Remark

1. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + AFCL(Ant. factor – Amp. gain + Cable loss) + DCF(Duty cycle correction factor)
5. Duty cycle correction factor = 20log(dwell time/100 ms)
6. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

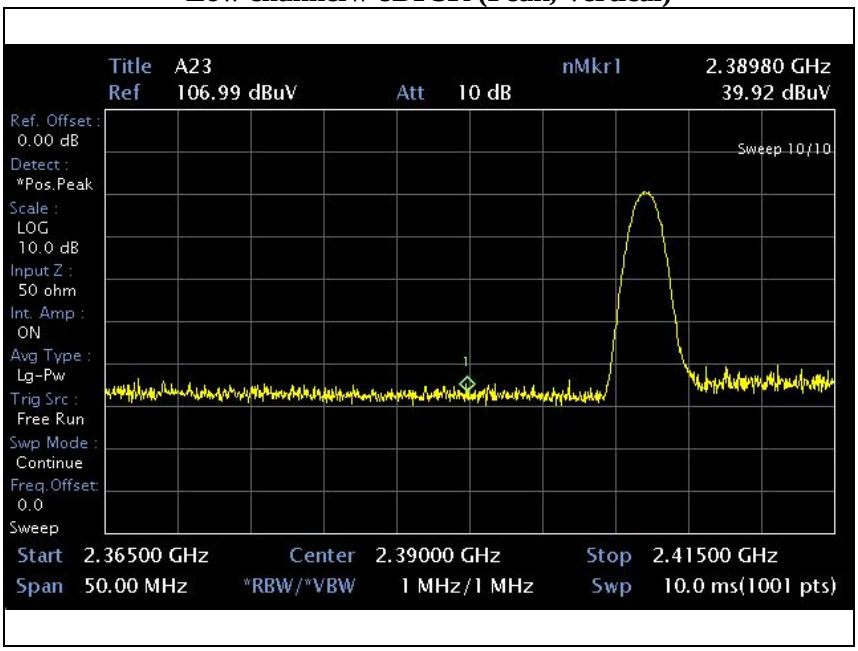
Low channel // 8DPSK (Peak, Horizontal)



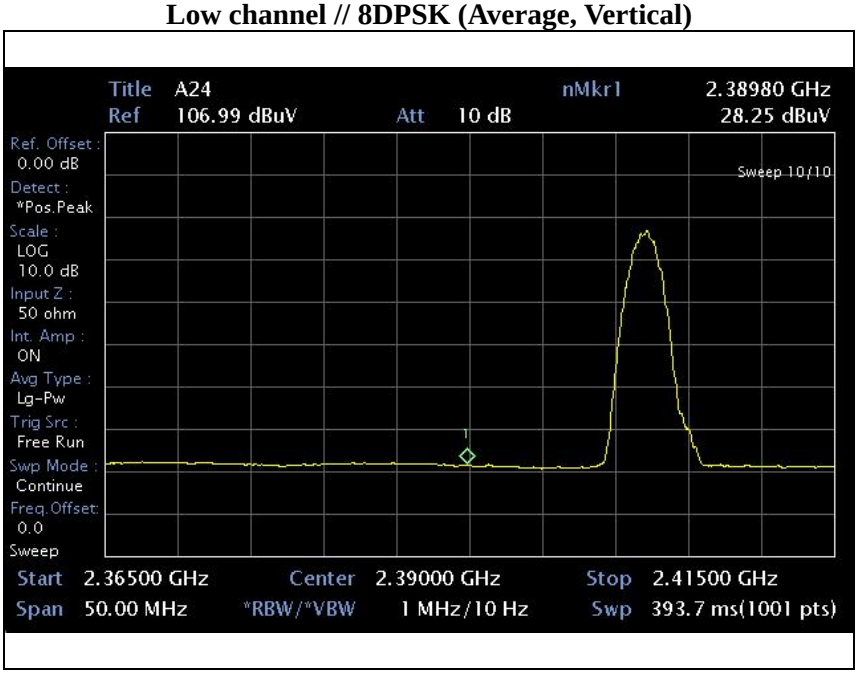
Low channel // 8DPSK (Average, Horizontal)



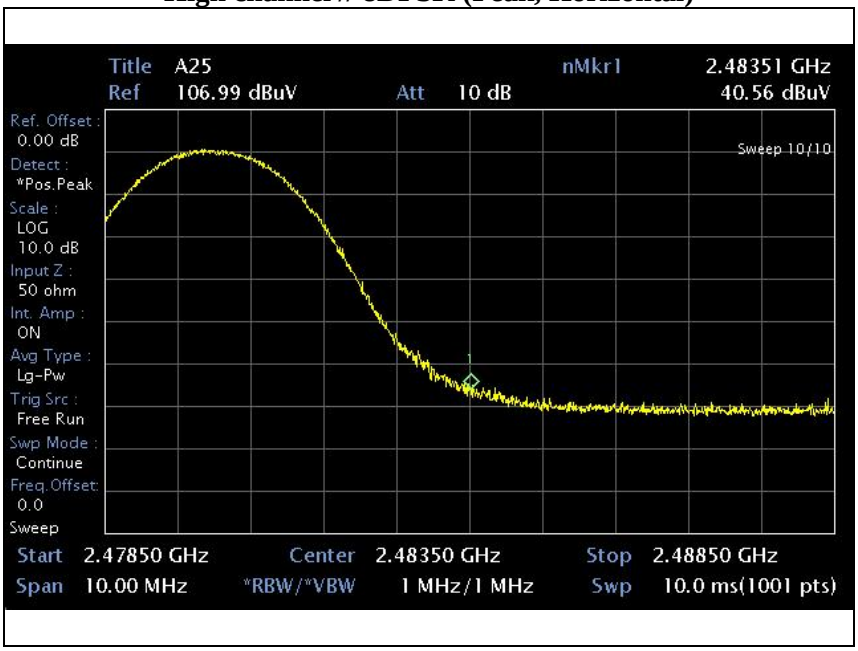
Low channel // 8DPSK (Peak, Vertical)



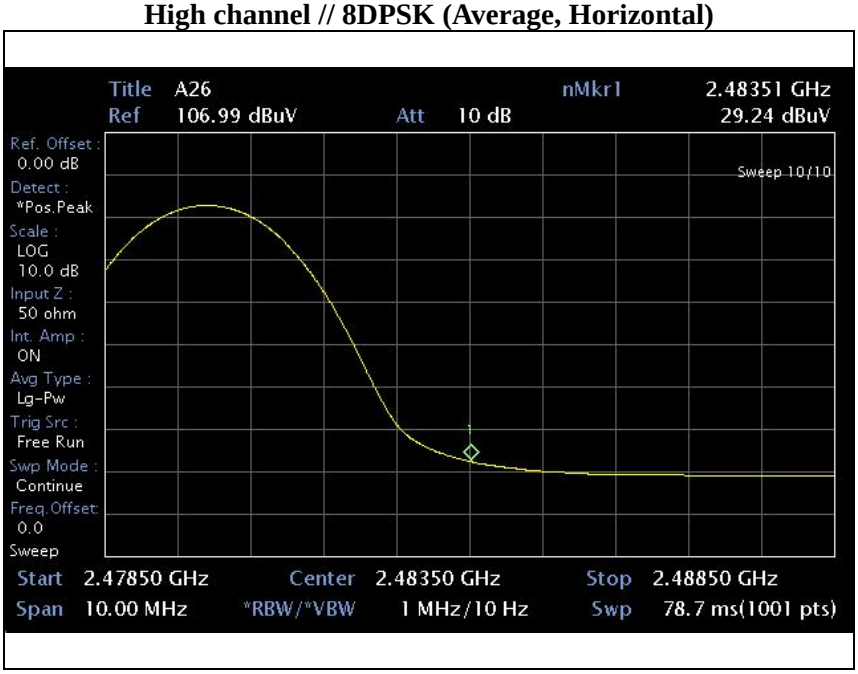
Low channel // 8DPSK (Average, Vertical)



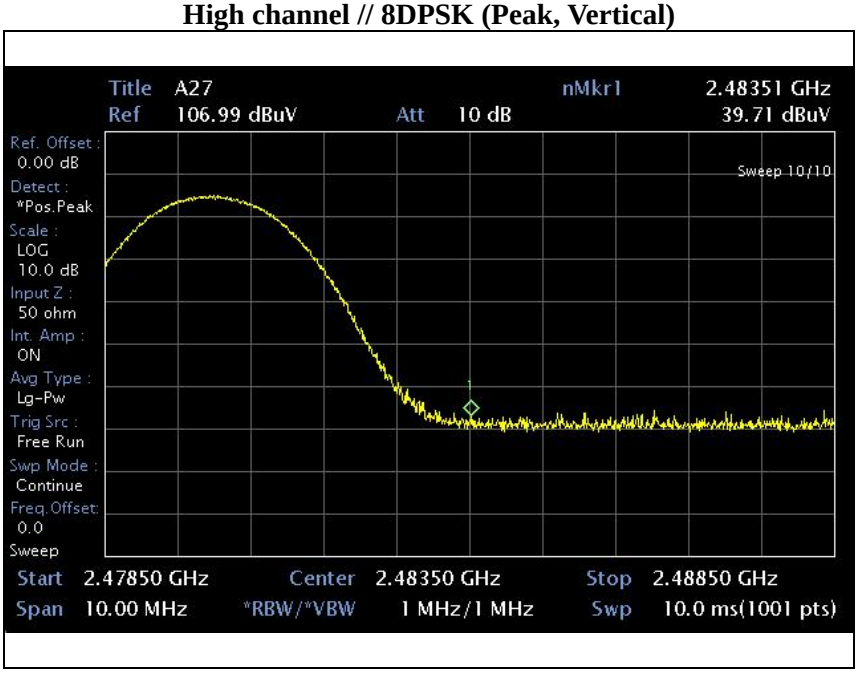
High channel // 8DPSK (Peak, Horizontal)



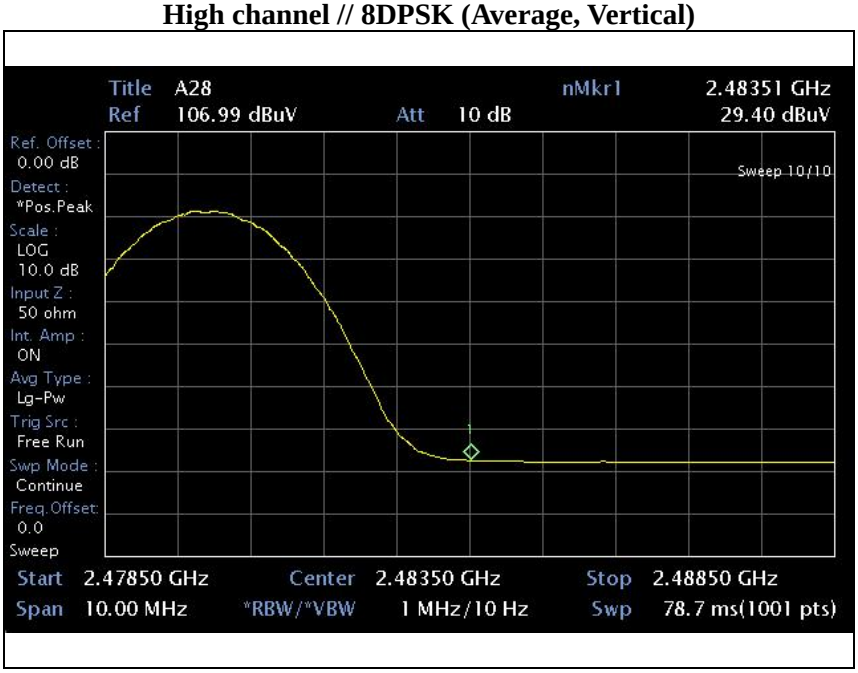
High channel // 8DPSK (Average, Horizontal)



High channel // 8DPSK (Peak, Vertical)



High channel // 8DPSK (Average, Vertical)



The frequency spectrum from 1 ㎓ to 25 ㎓ was investigated.

Low channel // 8DPSK

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	AFCL (dB)	DCF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2389.30	38.21	PK	H	9.46	-	47.67	74.00	26.33
2376.25	28.68	Avg	H	9.23	-	37.91	54.00	16.09
2389.80	39.92	PK	V	9.47	-	49.39	74.00	24.61
2389.80	28.25	Avg	V	9.47	-	37.72	54.00	16.28
4804.20	49.27	PK	H	14.27	-	63.54	74.00	10.46
4803.78	43.41	Avg	H	14.26	-30.66	27.01	54.00	26.99
4804.00	39.38	PK	V	14.27	-	53.65	74.00	20.35
4803.90	32.29	Avg	V	14.26	-30.66	15.89	54.00	38.11

Middle channel // 8DPSK

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	AFCL (dB)	DCF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4882.24	48.34	PK	H	14.93	-	63.27	74.00	10.73
4882.18	42.29	Avg	H	14.93	-30.66	26.56	54.00	27.44
4882.20	37.57	PK	V	14.93	-	52.50	74.00	21.50
4882.31	31.18	Avg	V	14.93	-30.66	15.45	54.00	38.55

High channel // 8DPSK

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	AFCL (dB)	DCF (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2483.51	40.56	PK	H	11.08	-	51.64	74.00	22.36
2483.51	29.24	Avg	H	11.08	-	40.32	54.00	13.68
2483.51	39.71	PK	V	11.08	-	50.79	74.00	23.21
2483.51	29.40	Avg	V	11.08	-	40.48	54.00	13.52
4959.45	48.79	PK	H	15.58	-	64.37	74.00	9.63
4959.41	42.41	Avg	H	15.58	-30.66	27.33	54.00	26.67
4959.38	36.34	PK	V	15.58	-	51.92	74.00	22.08
4959.34	31.67	Avg	V	15.58	-30.66	16.59	54.00	37.41

※ Remark

1. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + AFCL(Ant. factor – Amp. gain + Cable loss) + DCF(Duty cycle correction factor)
5. Duty cycle correction factor = 20log(dwell time/100 ms)
6. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

2.1.9 AC conducted emissions

Frequency range of measurement
150 ㎑ to 30 ㎒

Instrument settings
IF Band Width: 9 ㎑

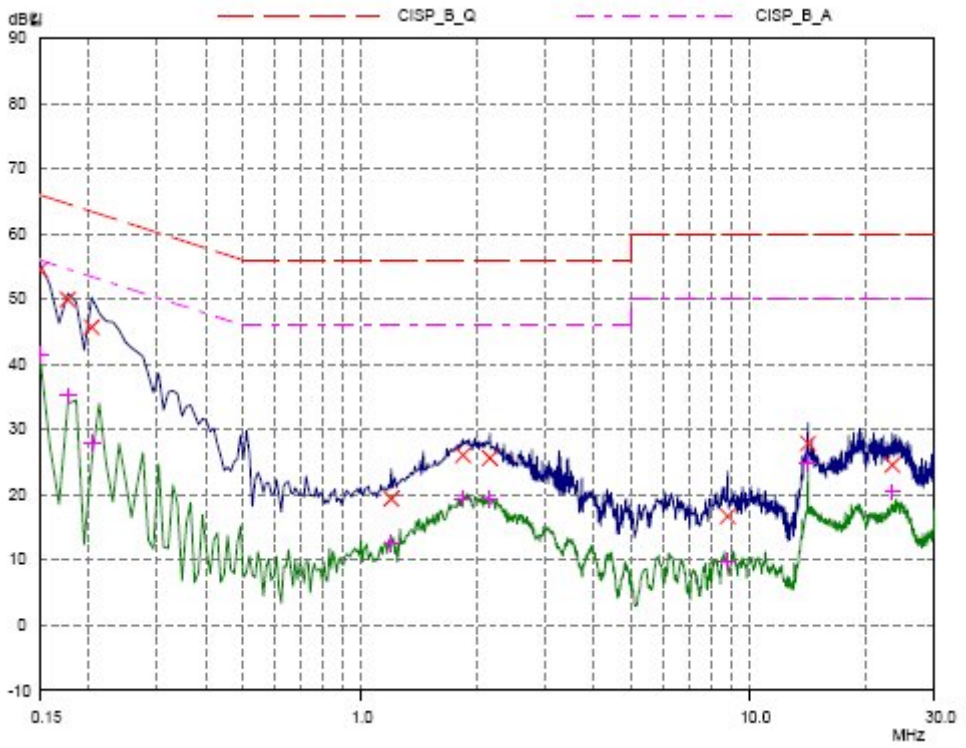
Test procedures
The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m. Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit
According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

※ Remark
1. Decreases with the logarithm of the frequency.
2. Worst case configuration: GFSK
3. All AC Conducted emission at channels are almost the same, so that middle channel was chosen at representative in final test.

Test results

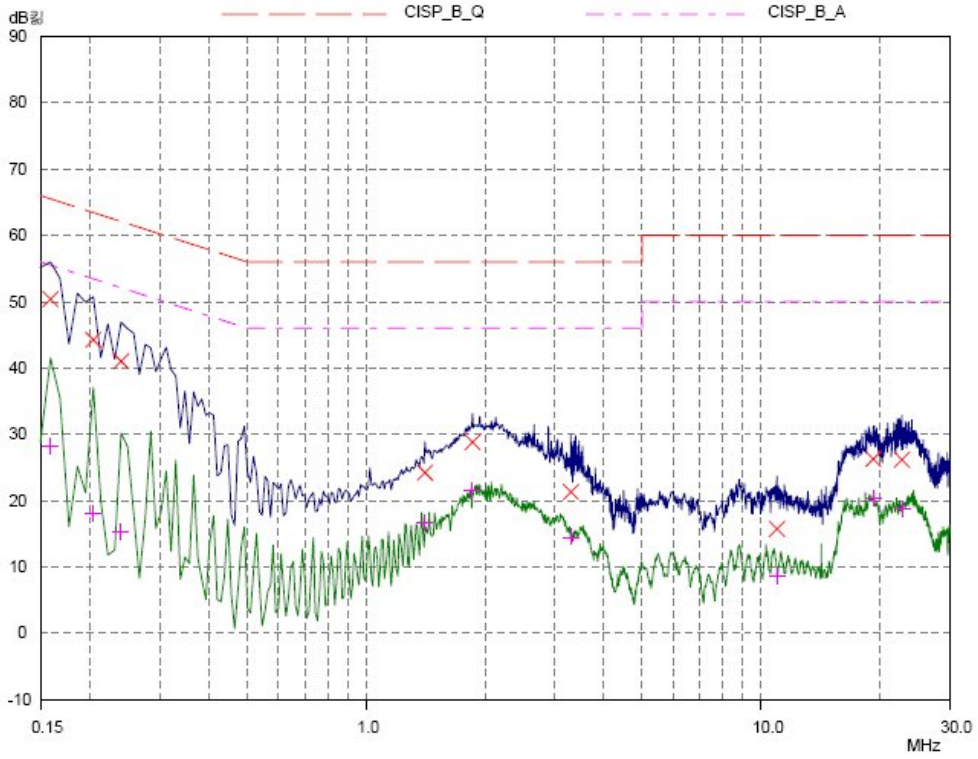


Final Measurement Results

Frequency MHz	QP Level dBµV	QP Limit dBµV	QP Delta dB
0.15	54.52	66.00	11.48
0.177	49.97	64.63	14.66
0.204	45.71	63.45	17.74
1.203	19.40	56.00	36.60
1.842	26.09	56.00	29.91
2.157	25.64	56.00	30.36
8.834	16.70	60.00	43.30
14.207	27.89	60.00	32.11
23.414	24.57	60.00	35.43

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
0.15	41.47	56.00	14.53
0.177	35.23	54.63	19.40
0.204	28.00	53.45	25.45
1.203	12.55	46.00	33.45
1.842	19.44	46.00	26.56
2.157	19.36	46.00	26.64
8.834	9.81	50.00	40.19
14.207	24.84	50.00	25.16
23.414	20.48	50.00	29.52

Note; **Hot Line**
Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).



Final Measurement Results

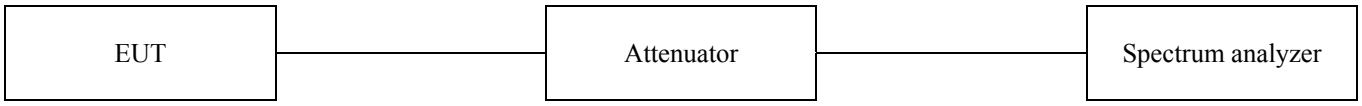
Frequency MHz	QP Level dBµV	QP Limit dBµV	QP Delta dB
0.159	50.37	65.52	15.15
0.204	44.24	63.45	19.21
0.24	41.02	62.10	21.08
1.41	24.22	56.00	31.78
1.86	28.81	56.00	27.19
3.3	21.30	56.00	34.70
10.967	15.73	60.00	44.27
19.229	26.26	60.00	33.74
22.712	26.17	60.00	33.83

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
0.159	28.11	55.52	27.41
0.204	18.00	53.45	35.45
0.24	15.22	52.10	36.88
1.41	16.71	46.00	29.29
1.86	21.49	46.00	24.51
3.3	14.48	46.00	31.52
10.967	8.66	50.00	41.34
19.229	20.35	50.00	29.65
22.712	18.69	50.00	31.31

Note; **Neutral Line**
Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

2.1.10 Occupied bandwidth

Test setup



Test procedure

1. Use the following spectrum analyzer setting
   Center frequency: Lowest, middle and highest channels
   Span = 3 ㎒ (shall be set to capture all products of the modulation process)
   RBW = 30 ㎑(shall be set to as close to 1% of the selected span)
   VBW = 100 ㎑ (RBW x 3)
   Sweep = auto
   Detector function = sample

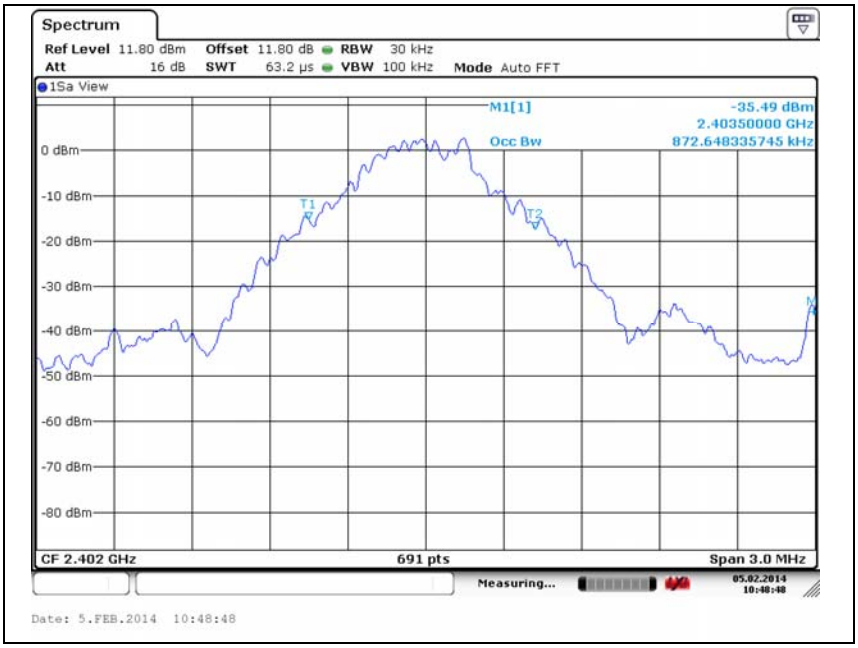
Limit

Not applicable

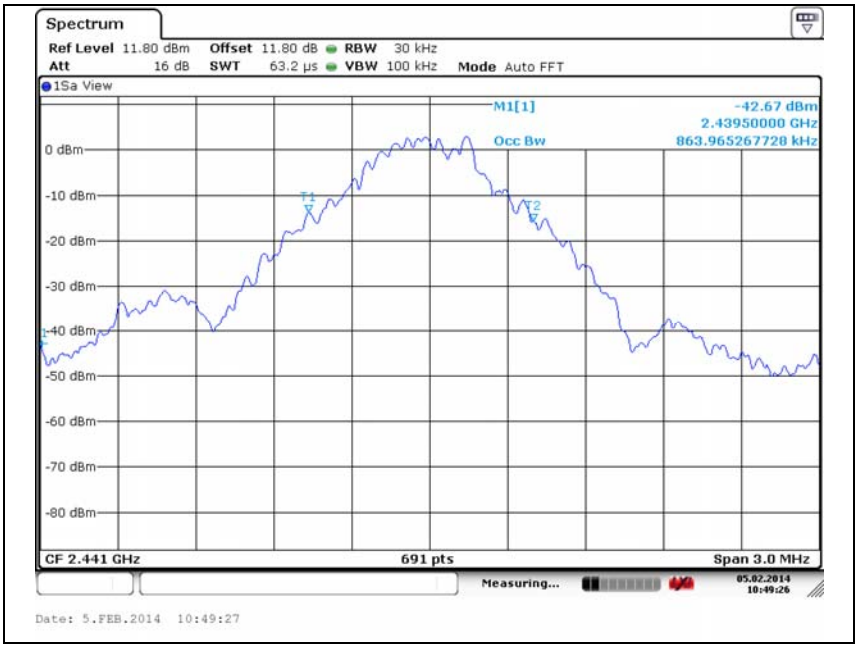
Test results

Operation mode	Frequency(㎒)	OBW (㎒)
GFSK	2 402	0.87
	2 441	0.86
	2 480	0.86
8DPSK	2 402	1.15
	2 441	1.16
	2 480	1.16

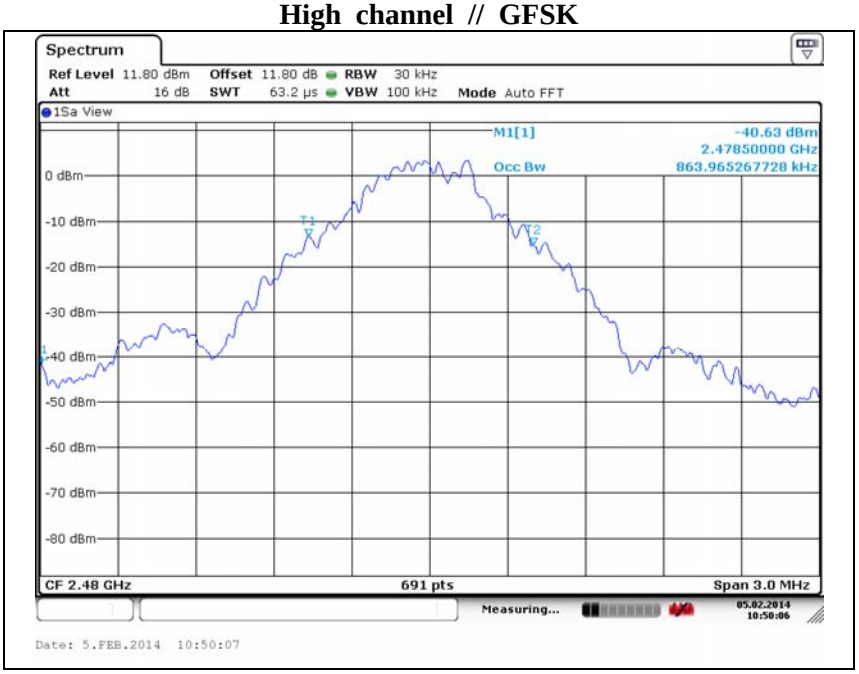
Low channel // GFSK



Middle channel // GFSK

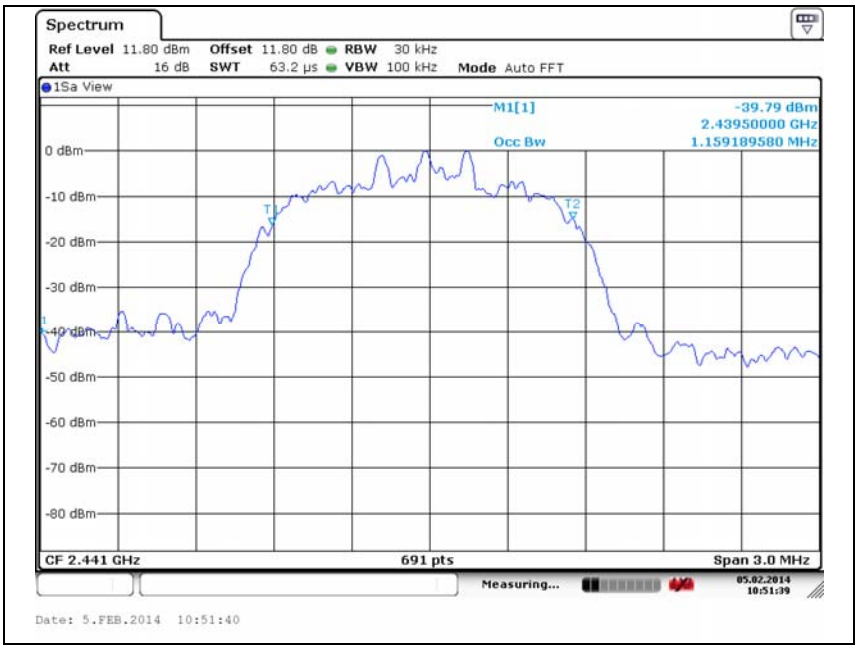


High channel // GFSK

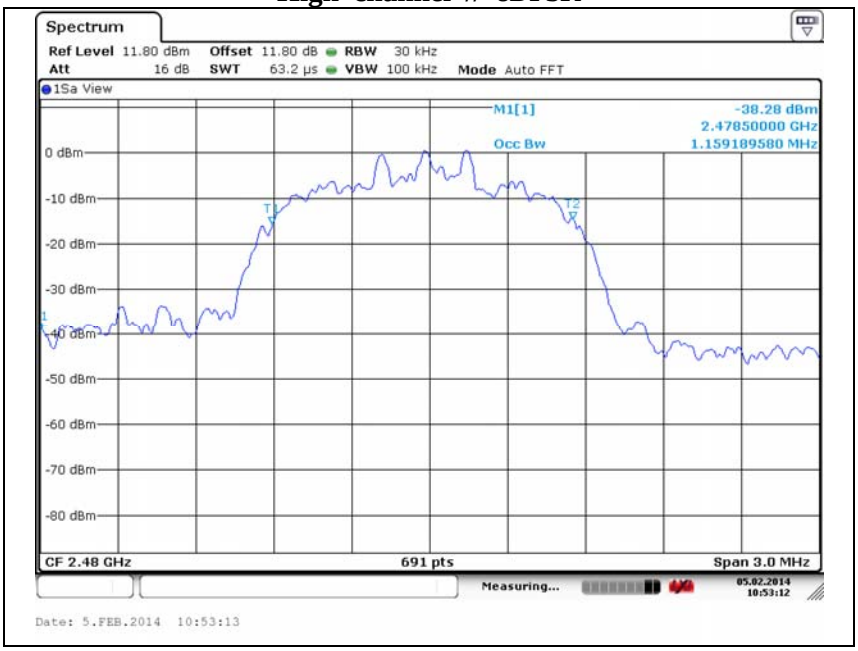


Low channel // 8DPSK

Middle channel // 8DPSK



High channel // 8DPSK



Appendix A. Test equipment used for test

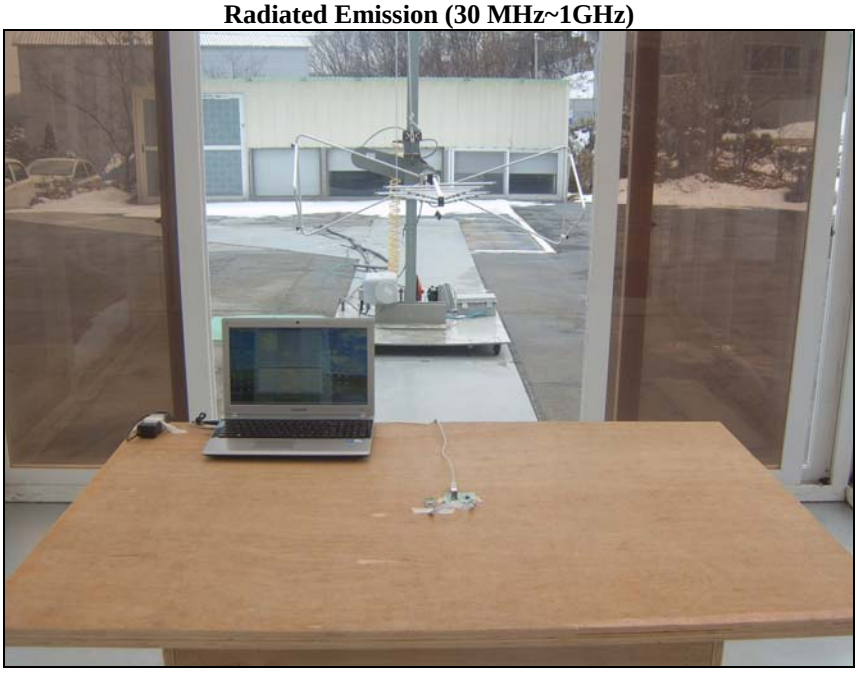
Equipment	Manufacturer	Model	Serial number	Cal Interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	100736	1Y	2014.05.06
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1Y	2014.05.06
Attenuator	HP	8494B	2630A12857	1Y	2014.05.06
Loop Antenna	R&S	HFH2-Z2.335.4711.52	826532	2Y	2015.04.25
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	9168-385	2Y	2015.05.09
Horn Antenna	A.H. System	SAS-571	414	2Y	2015.02.28
Horn Antenna	A.H. System	SAS-572	269	2Y	2015.09.07
High Pass Filter	Wainwright Instrument	WHJS3000-10TT	1	1Y	2014.11.11
Preamplifier	Schwarzbeck Mess-Elektronik	BBV-571	781	1Y	2014.09.23
Preamplifier	MITEQ	AFS43-01002600	1374382	1Y	2014.10.04
EMI Test Receiver	LIG NEX1	ISA-80	L0912K014	1Y	2014.11.15
EMI Test Receiver	R & S	ESVS10	826008/014	1Y	2014.04.09
EMI Test Receiver	R & S	ESHS10	862970/018	1Y	2014.05.06
LISN	SCHWARZBECK	2823-568-1	8126157	1Y	2015.01.29

Peripheral device

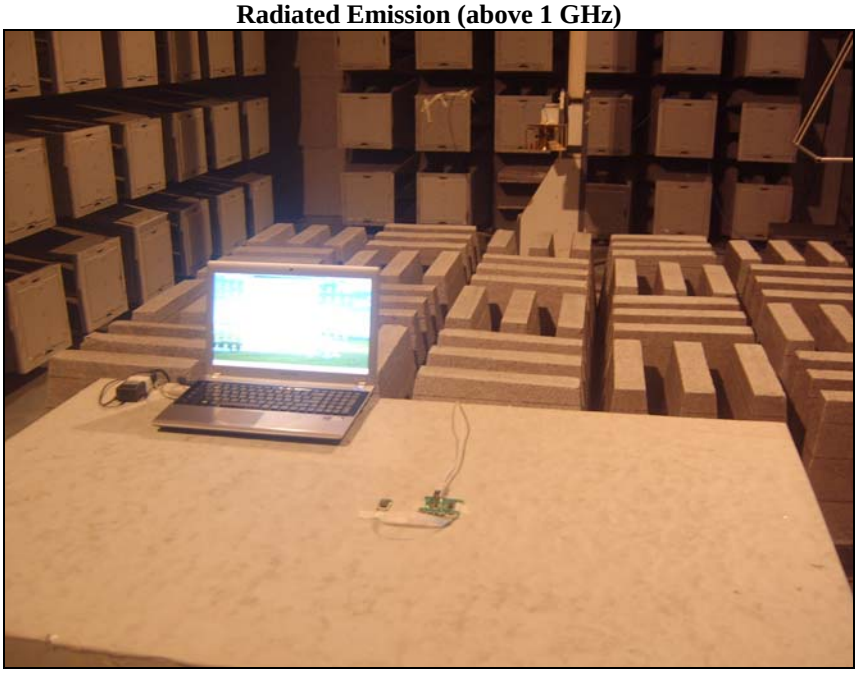
Device	Manufacturer	Model No.	Serial No.
Notebook(Laptop)	Samsung Electronics	RV518	HTK991NC600207R

Appendix B. Test setup photo

Radiated Emission (30 MHz~1GHz)



Radiated Emission (above 1 GHz)



AC conducted Emission