FCC/IC TEST REPORT

Test report No.:	EMC- FCC- R0149
FCC ID:	MBBDSB200
IC:	11657A-DSB200
Type of equipment:	Bluetooth Speaker
Basic Model Name:	DSB-200
Applicant:	Anam Electronics Co., LTD
Max.RF Output Power:	3.84 dBm
FCC Rule Part(s):	FCC Part 15 Subpart C 15.247
IC Rule:	RSS-210, RSS-GEN
Frequency Range:	2 402 MHz ~ 2 480 MHz
Test result:	Complied

The above equipment was tested by EMC compliance Testing Laboratory for compliance with the requirements of FCC Rules and Regulations.
The results of testing in this report apply to the product/system which was tested only.
Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Date of test: 2014. 01. 17 ~ 21

Issued date: 2014. 02. 17

Tested by: SON, MIN GI

Approved by: YU, SANG HOON

[Contents]

1. Client information

Applicant:	Anam Electronics Co., LTD
Address:	(SUNGKOK-DONG) 213, MANHAE-RO, DANWON-GU, ANSAN-CITY, KYUNGKI-DO, KOREA
Telephone number:	(82) 31 490 2283
Contact person:	Byeong-Seob Lee/ bselee@aname.co.kr

Manufacturer:	D&M Holdings Inc.
Address:	2-1 Nisshin-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa-ken, 210-8569, JAPAN

2. Laboratory information

Address

EMC compliance Ltd.
65, Sinwon-ro, Yeongtong-gu, Suwon- si, Gyeonggi-do, 443-390, Korea
Telephone Number: 82-31-336-9919   Facsimile Number: 82-505-299-8311

Certificate

KOLAS No.: 231
FCC Site Registration No.: 687132
VCCI Site Registration No.: R-3327, G-198, C-3706, T-1849
IC Site Registration No.:8035A-2

SITE MAP

3. Description of E.U.T.

3.1 Basic description

Applicant	Anam Electronics Co., Ltd
Address of Applicant	(SUNGKOK-DONG) 213, MANHAE-RO, DANWON-GU, ANSAN-CITY, KYUNGKI-DO, KOREA
Manufacturer	D&M Holdings Inc.
Address of Manufacturer	2-1 Nisshin-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa-ken, 210-8569, JAPAN
Type of equipment	Bluetooth Speaker
Basic Model	DSB-200
Serial number	Proto Type

3.2 General description

Frequency Range	2 402 MHz ~ 2 480 MHz
Type of Modulation	Modulation technologies: FHSS Modulation : GFSK, 8DPSK
Number of Channels	79 channels
Type of Antenna	Integral type
Antenna Gain	-3.23 dBi
Transmit Power	3.84 dBm
Power supply	DC 7.4 V

3.3 Test frequency

	Frequency
Low frequency	2 402 MHz
Middle frequency	2 441 MHz
High frequency	2 480 MHz

3.4 Test Voltage

mode	Voltage
Norminal voltage	DC 7.4 V

※ 15.247 Requirements for Bluetooth transmitter

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
  1) This system is hopping pseudo-randomly.
  2) Each frequency is used equally on the average by each transmitter.
  3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
  4) The receiver shifts frequencies in synchronization with the transmitted signals.

- 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
- 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

4. Summary of test results

4.1 Standards & results

FCC Rule	IC Rule	Parameter	Report Section	Test Result
15.203, 15.247(b)(4)	RSS-GEN, 7.1.2	Antenna Requirement	5.1	C
15.247(b)(1), (4)	RSS-210, A8.4(2)	Maximum Peak Output Power	5.2	C
15.247(a)(1)	RSS-210, A8.1(b)	Carrier Frequency Separation	5.3	C
15.247(a)(1)	RSS-210, A8.1(a)	20dB Channel Bandwidth	5.4	C
-	RSS-210, A1.1	Occupied Bandwidth	5.4	C
15.247(a)(iii) 15.247(b)(1)	RSS-210, A8.1(d)	Nunber of Hopping Channel	5.5	C
15.247(a) (iii)	RSS-210, A8.1(d)	Time of Occupancy(Dwell Time)	5.6	C
15.247(d), 15.205(a), 15.209(a)	RSS-210, A8.5 RSS-210, A2.9 RSS-GEN, 7.2.3	Spurious Emission, BandEdge, Restricted Band	5.7	C
15.207(a)	RSS-GEN, 7.2.4	Conducted Emissions	5.8	C
15.247(i), 1.1307(b)(1)	-	RF Exposure	5.9	C
Note: C=complies NC= Not complies NT=Not tested NA=Not Applicable				

* The method of measurement used to test this DSS device is FCC Public Notice DA 00-705
* The general test methods used to test this device is ANSI C63.4 2003 (or 2009, or ANSI C63.10 2009)

4.2 Uncertainty

Measurement Item	Expanded Uncertainty U = KUc (K = 2)	
Conducted RF power	± 0.58 dB	
Conducted Emissions	9 ㎑ ~ 150 ㎑:	± 3.82 ㏈
	150 ㎑ ~ 30 ㎒:	± 3.43 ㏈
Radiated disturbance	30 ㎒ ~ 300 ㎒ :	+ 4.86 ㏈, - 4.88 ㏈
	300 ㎒ ~ 1 000 ㎒:	+ 4.98㏈, - 4.99 ㏈
	1 ㎓ ~ 6 ㎓ :	+ 6.19 ㏈, - 6.20 ㏈
	6 ㎓ ~ 18 ㎓ :	+ 6.41 ㏈, - 6.53 ㏈

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5. Test results

5.1 Antenna Requirement

5.1.1 Regulation

According to §15.203, 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.

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.2 Result

-Complied

The transmitter has an integral type of antenna. The directional gain of the antenna is -3.23 dBi.

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5.2 Maximum Peak Output Power

5.2.1 Regulation

According to §15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument (spectrum analyzer) using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel RBW > the 20 dB bandwidth of the emission being measured VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Measure the highest amplitude appearing on spectral display and record the level to calculate results.
6. Repeat above procedures until all frequencies measured were complete.

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5.2.3 Test Result

- Complied

* GFSK

Channel	Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
Low	2 402	3.05	20.00	16.95
Middle	2 441	2.55	20.00	17.45
High	2 480	1.62	20.00	18.38

* 8DPSK

Channel	Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
Low	2 402	3.84	20.00	16.16
Middle	2 441	2.99	20.00	17.01
High	2 480	1.93	20.00	18.07

NOTE:

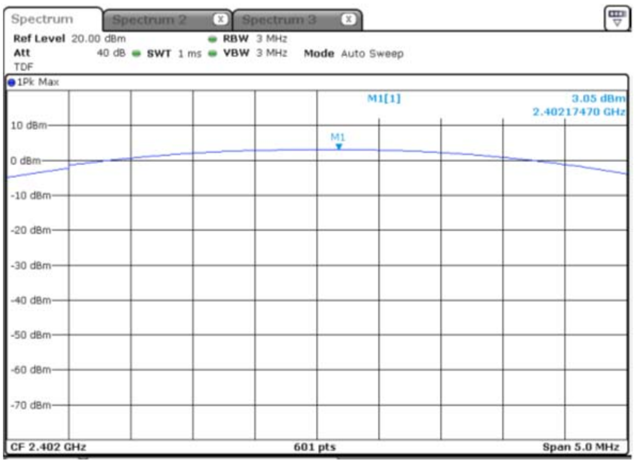
1. Since the directional gain of the integral antenna declared by the manufacturer (G_{ANT} = -3.23 dBi) does not exceed 6.0 dBi, there was no need to reduce the output power.
2. We took the insertion loss of the cable loss into consideration within the measuring instrument.

5.2.4 Test Plot

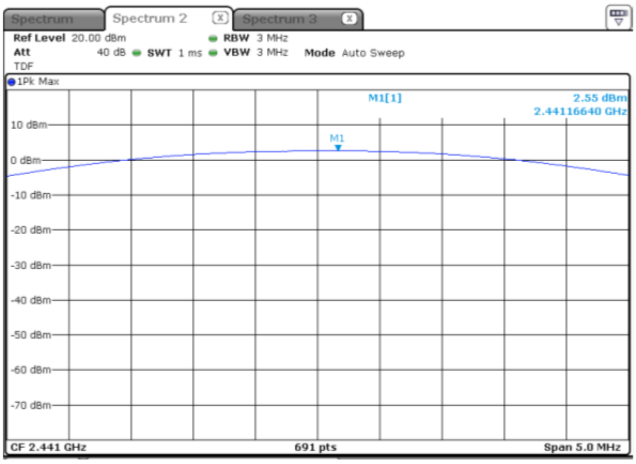
Figure 1. Plot of the Maximum Peak Output Power (Conducted)

*** GFSK**

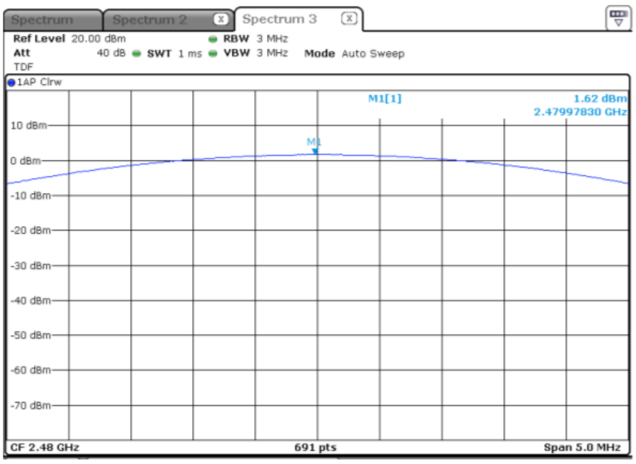
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)



Highest Channel
(2 480 MHz)



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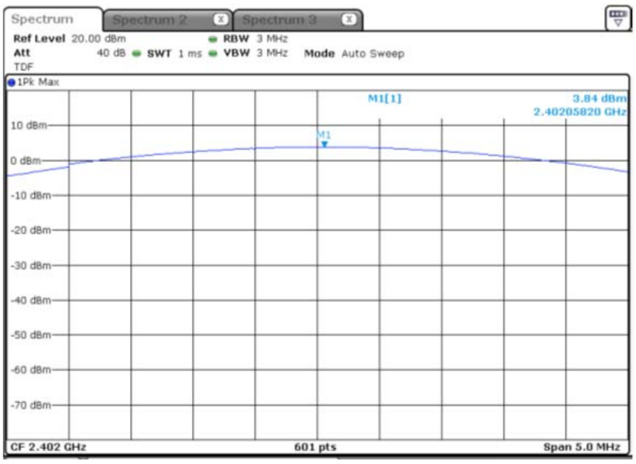
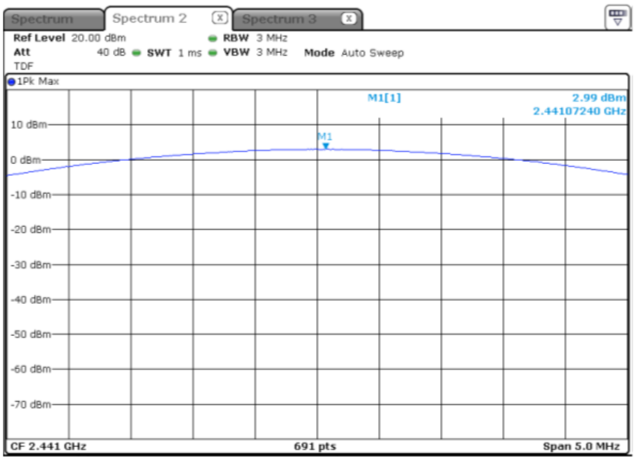
*** 8DPSK**

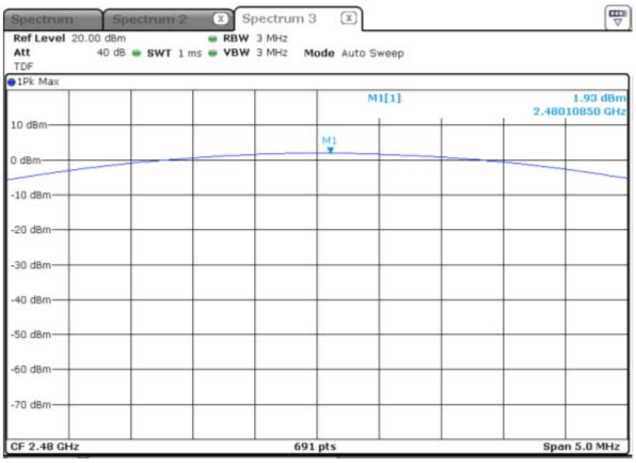
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)



Highest Channel
(2 480 MHz)



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5.3 Carrier Frequency Separation

5.3.1 Regulation

According to §15.247(a)(1), 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 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

5.3.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = wide enough to capture the peaks of two adjacent channels Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span Video (or Average) Bandwidth (VBW) ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Measure the separation between the peaks of the adjacent channels using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.

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5.3.3 Test Result

- Complied

*** GFSK**

Channel	Carrier frequency separation (MHz)	Limit
Low	1.003	≥25 kHz or two-thirds of the 20 dB bandwidth
Middle	1.003	≥25 kHz or two-thirds of the 20 dB bandwidth
High	1.003	≥25 kHz or two-thirds of the 20 dB bandwidth

*** 8DPSK**

Channel	Carrier frequency separation (MHz)	Limit
Low	1.003	≥25 kHz or two-thirds of the 20 dB bandwidth
Middle	1.003	≥25 kHz or two-thirds of the 20 dB bandwidth
High	1.003	≥25 kHz or two-thirds of the 20 dB bandwidth

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

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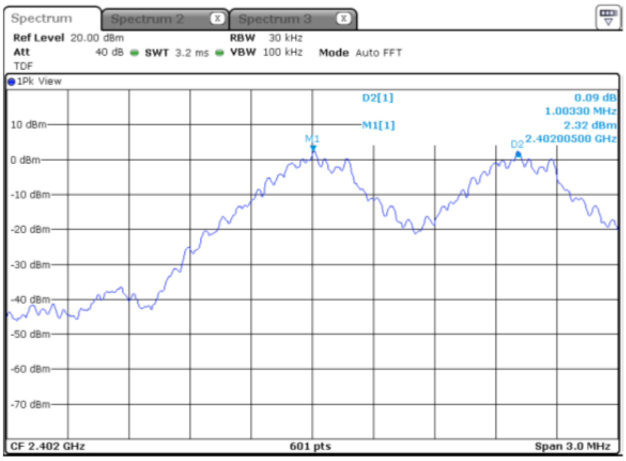
5.3.4 Test Plot

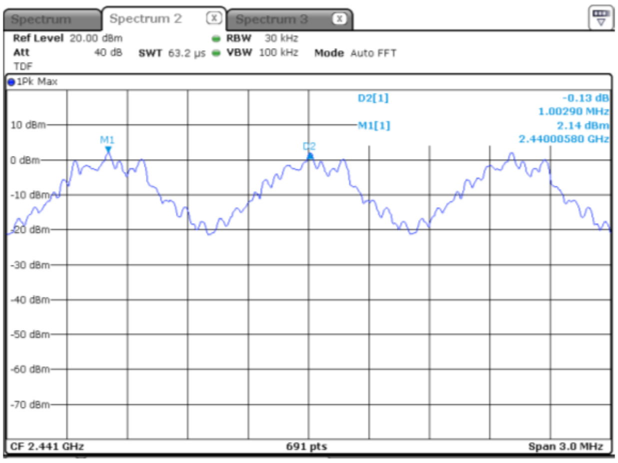
Figure 2.Plot of the Carrier Frequency Separation (Conducted)

*** GFSK**

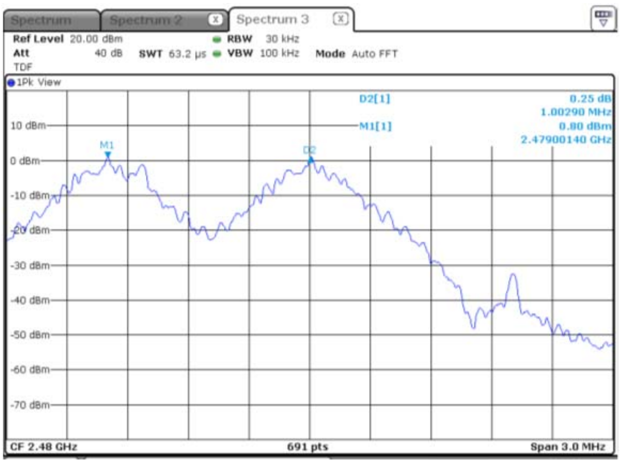
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)

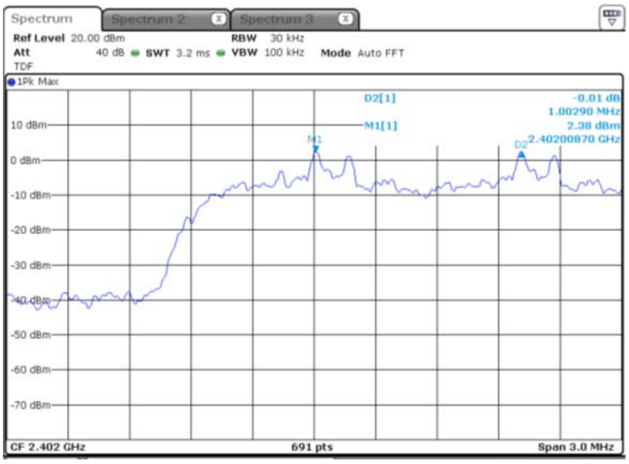


Highest Channel
(2 480 MHz)

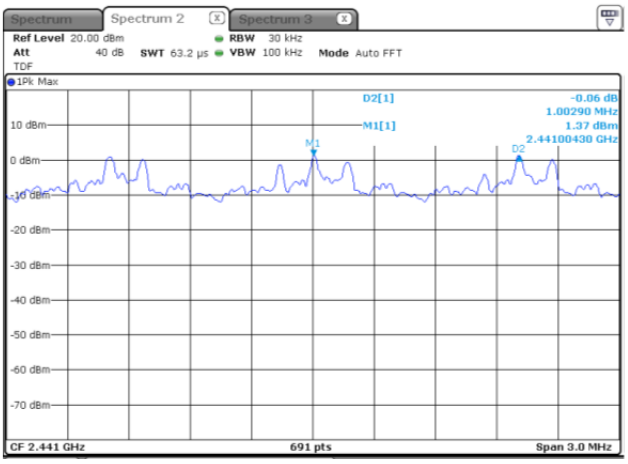


*** 8DPSK**

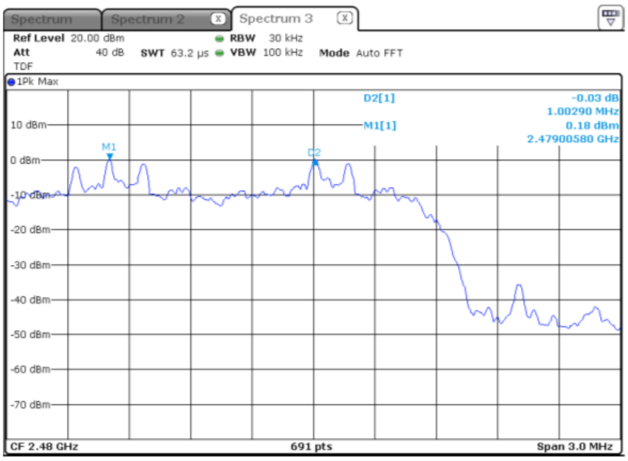
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)



Highest Channel
(2 480 MHz)



5.4 20 dB Channel Bandwidth

5.4.1 Regulation

According to §15.247(a)(1), 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 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

5.4.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel RBW ≥ 1% of the 20 dB bandwidth VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Set a reference level on it equal to the highest peak value.
6. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
7. Repeat above procedures until all frequencies measured were complete..

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5.4.3 Test Result

- Complied

* GFSK

Channel	20dB Channel Bandwidth(MHz)	Carrier frequency Separation(MHz)	Occupied Bandwidth (99% BW)(MHz)
Low	0.816	1.003	0.864
Middle	0.816	1.003	0.864
High	0.816	1.003	0.864

* 8DPSK

Channel	20dB Channel Bandwidth(MHz)	Carrier frequency Separation(MHz)	Occupied Bandwidth (99% BW)(MHz)
Low	1.216	1.003	1.164
Middle	1.216	1.003	1.159
High	1.216	1.003	1.155

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

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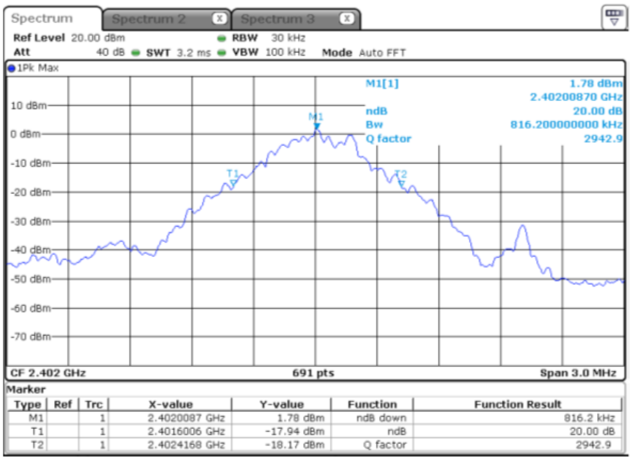
5.4.4 Test Plot

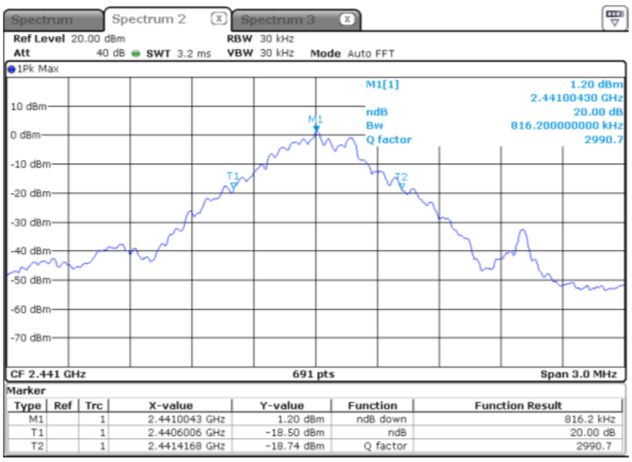
Figure 3.Plot of the 20dB Channel Bandwidth/ Occupied Bandwidth (Conducted)

*** GFSK (20dB Channel Bandwidth)**

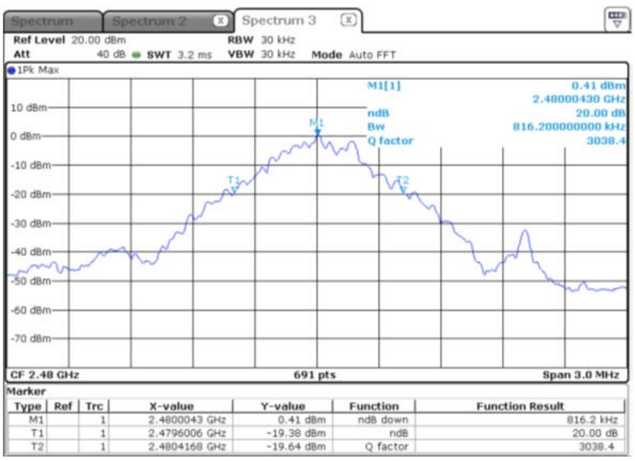
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)

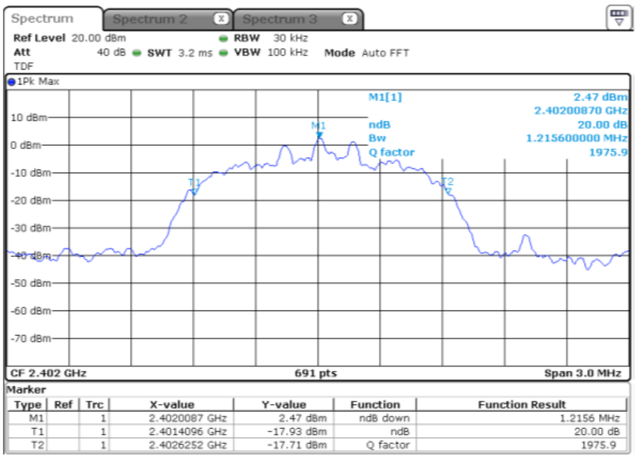


Highest Channel
(2 480 MHz)

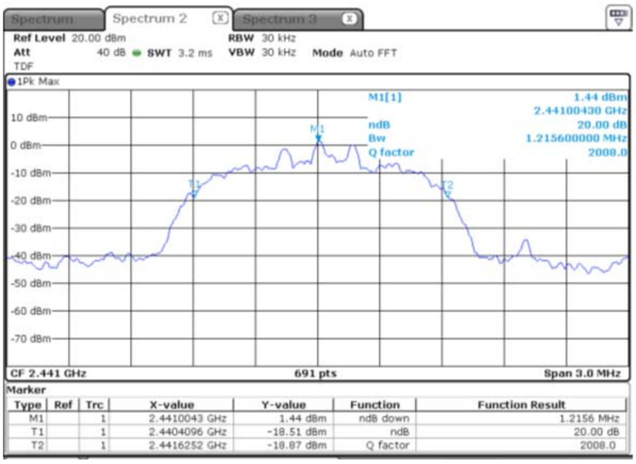


*** 8DPSK (20dB Channel Bandwidth)**

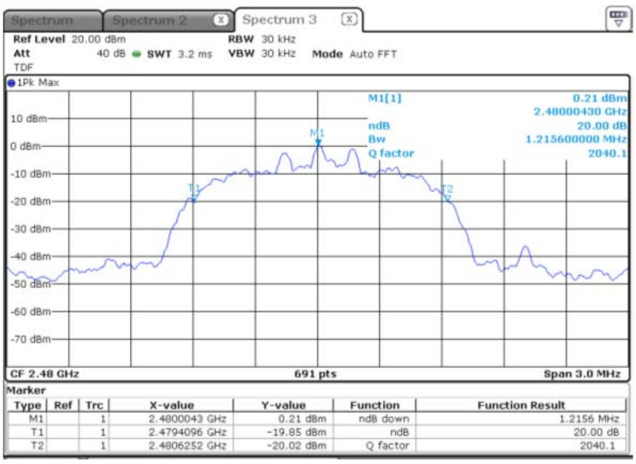
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)

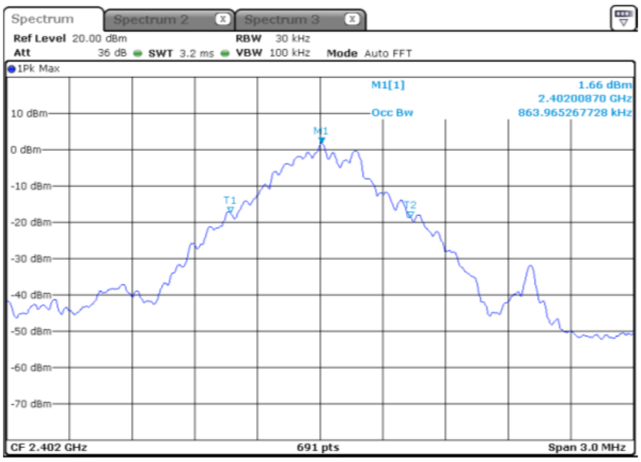


Highest Channel
(2 480 MHz)

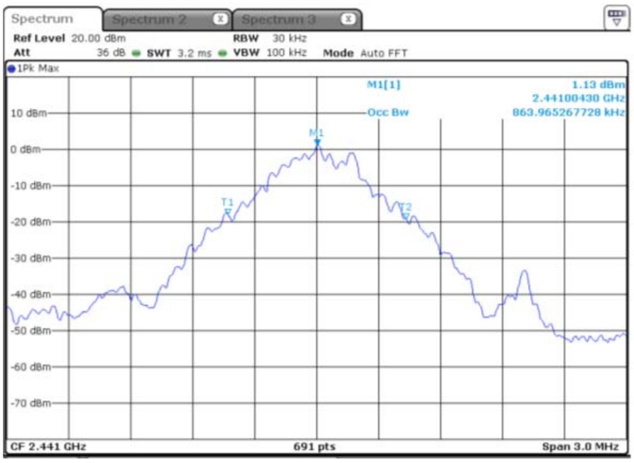


*** GFSK (Occupied Bandwidth)**

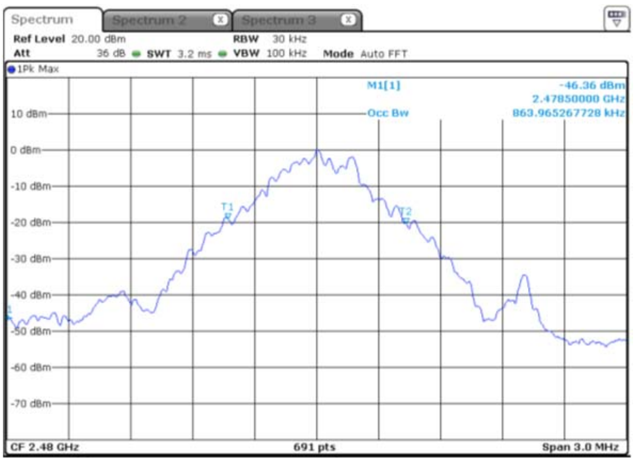
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)



Highest Channel
(2 480 MHz)



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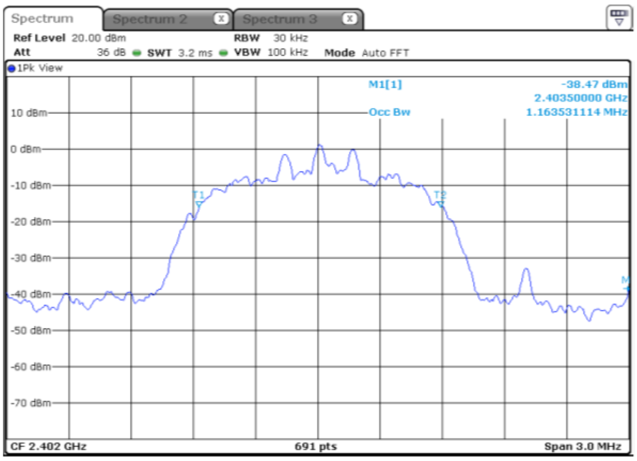
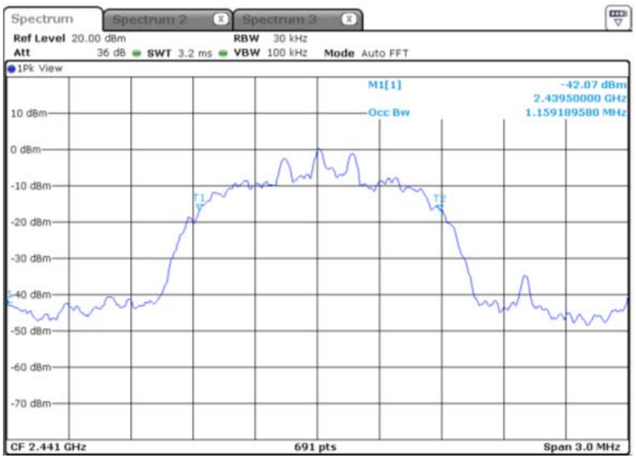
*** 8DPSK (Occupied Bandwidth)**

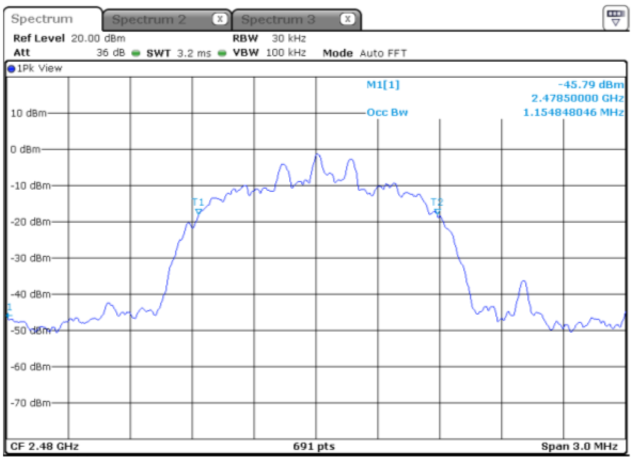
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)



Highest Channel
(2 480 MHz)



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5.5 Number of Hopping Channels

5.5.1 Regulation

According to §15.247(a)(1)(iii), Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used. According to §15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.5.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set the hopping function enabled by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = the frequency band of operation RBW ≥ 1% of the span VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Record the number of hopping channels.

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5.5.3 Test Result

- Complied

* GFSK

Frequency	Number of hopping channel	Limit
2 402 – 2 480 MHz	79	≥15

* 8DPSK

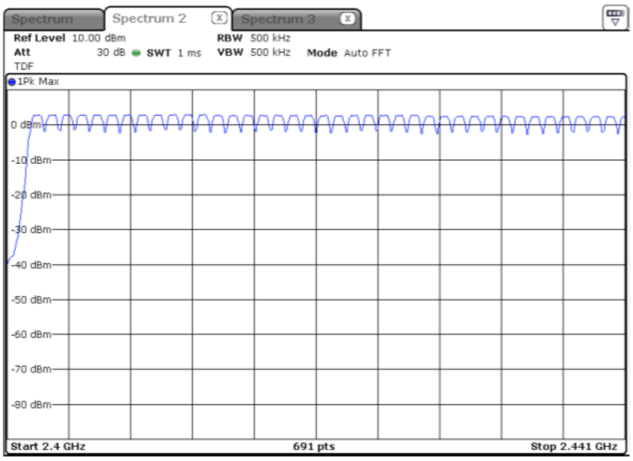
Frequency	Number of hopping channel	Limit
2 402 – 2 480 MHz	79	≥15

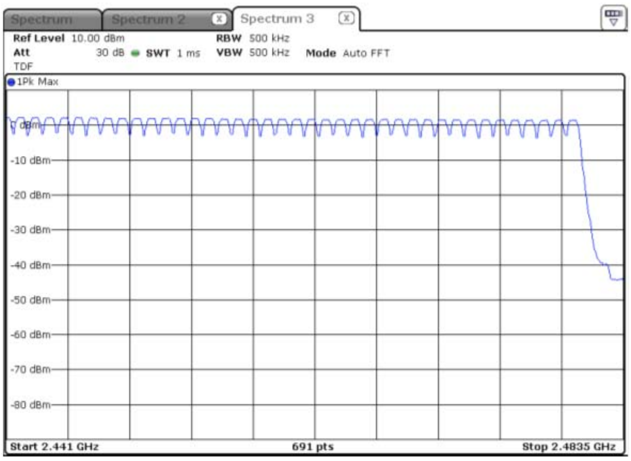
NOTE: 1. We took the insertion loss of the cable loss into consideration within the measuring instrument.
2. Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.

5.5.4 Test Plot

Figure 4. Plot of the Number of Hopping Channels (Conducted)

*** GFSK**





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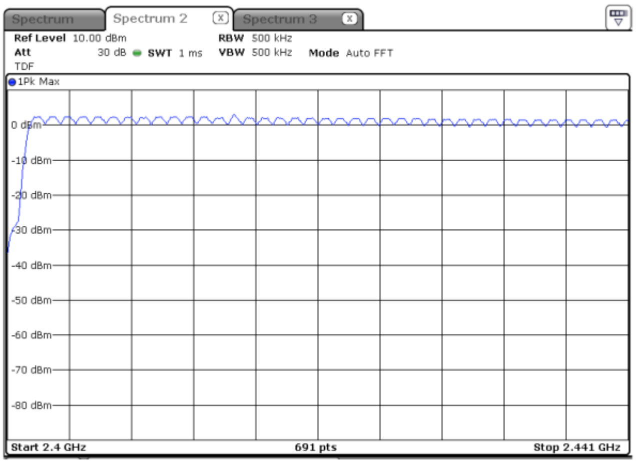
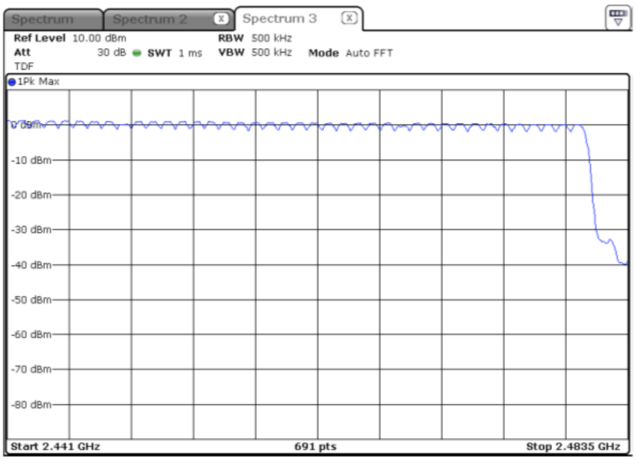
*** 8DPSK**





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5.6 Time of Occupancy(Dwell Time)

5.6.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.6.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = zero span, centered on a hopping channel RBW = 1 MHz VBW ≥ RBW Sweep = as necessary to capture the entire dwell time per hopping channel Detector function = peak Trace = max hold
5. Measure the dwell time using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.
7. Repeat this test for different modes of operation (e.g., data rate, modulation format, etc.), if applicable.

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5.6.3 Test Result

- Complied

* GFSK (Non-AFH mode)

Channel	Reading[ms]	Hopping rate[hop/s]	Number of Channels	Actual[s]	Limit[s]
Low	2.904	266.667	79	0.310	0.40
Middle	2.904	266.667	79	0.310	0.40
High	2.904	266.667	79	0.310	0.40

* 8DPSK (Non-AFH mode)

Channel	Reading[ms]	Hopping rate[hop/s]	Number of Channels	Actual[s]	Limit[s]
Low	2.904	266.667	79	0.310	0.40
Middle	2.904	266.667	79	0.310	0.40
High	2.904	266.667	79	0.310	0.40

Actual = Reading × (Hopping rate / Number of channels) × Test period
Test period = 0.4 [seconds / channel] × 79 [channel] = 31.6 [seconds]
NOTE:
1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

* GFSK (AFH mode)

Channel	Reading[ms]	Hopping rate[hop/s]	Number of Channels	Actual[s]	Limit[s]
Low	2.904	133.333	20	0.155	0.40
Middle	2.904	133.333	20	0.155	0.40
High	2.904	133.333	20	0.155	0.40

* 8DPSK (AFH mode)

Channel	Reading[ms]	Hopping rate[hop/s]	Number of Channels	Actual[s]	Limit[s]
Low	2.904	133.333	20	0.155	0.40
Middle	2.904	133.333	20	0.155	0.40
High	2.904	133.333	20	0.155	0.40

Actual = Reading × (Hopping rate / Number of channels) × Test period
Test period = 0.4 [seconds / channel] × 20 [channel] = 8 [seconds]
NOTE:
1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

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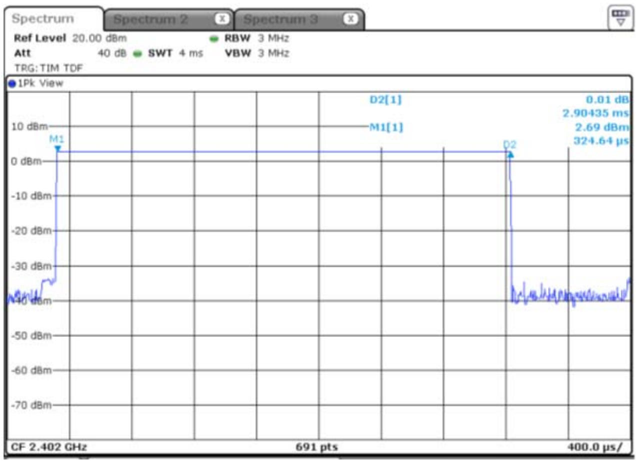
5.6.4 Test Plot

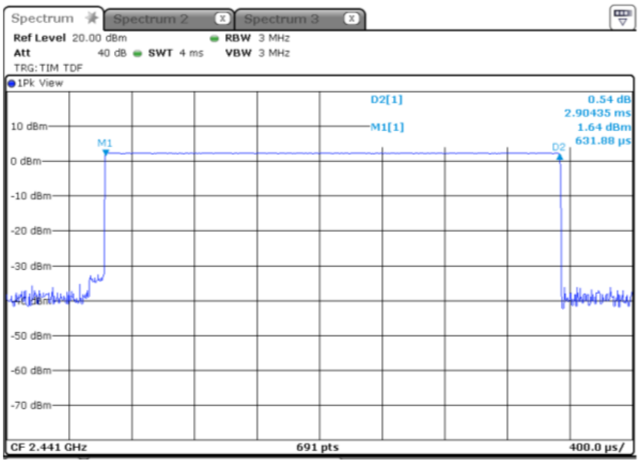
Figure 5. Plot of the Time of Occupancy (Conducted)

*** GFSK**

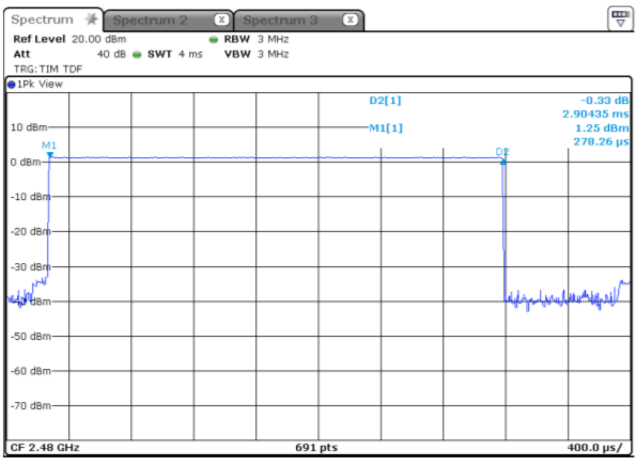
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)



Highest Channel
(2 480 MHz)



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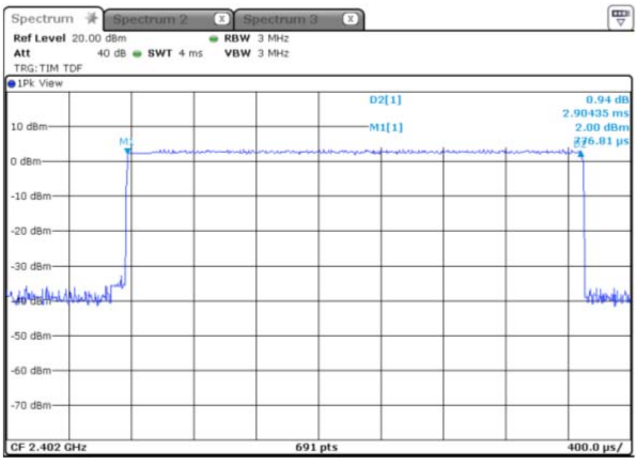
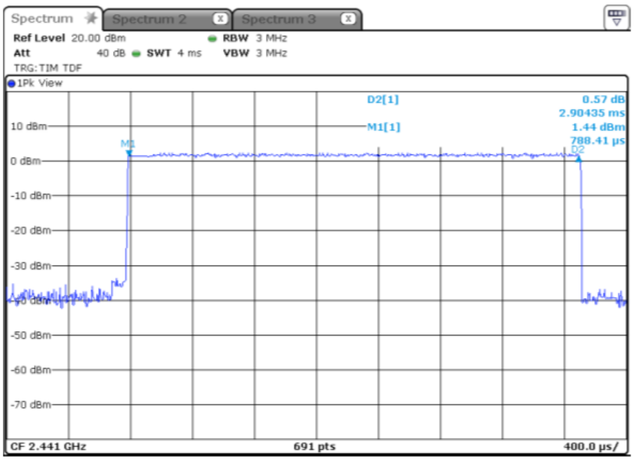
*** 8DPSK**

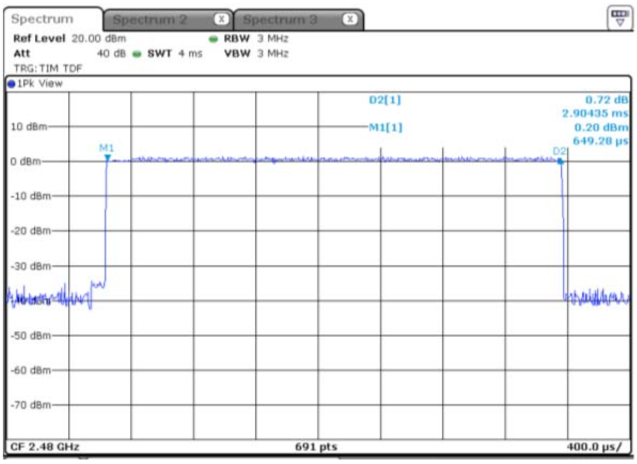
Lowest Channel
(2 402 MHz)



Middle Channel
(2 441 MHz)



Highest Channel
(2 480 MHz)



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5.7 Spurious Emission, Band edge, and Restricted bands

5.7.1 Regulation

According to §15.247(d), 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, 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 dB instead of 20 dB. 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 15.205(c)).

According to §15.209(a), Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall notexceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (µV/m)	Measurement distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

**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 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permItted under other sections of this part, e.g., §§15.231 and 15.241.

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According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	Above 38.6
13.36 - 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

5.7.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1) Band-edge Compliance of RF Conducted Emissions

1. Set the spectrum analyzer as follows:
   Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
   RBW ≥ 1% of the span
   VBW ≥ 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 product outside of the band, if this level is greater than that at the band-edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
3. Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

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2) Spurious RF Conducted Emissions:

1. Set the spectrum analyzer as follows:
   Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
   RBW = 100 kHz
   VBW ≥ 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.
   a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
3. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

3) Spurious Radiated Emissions:

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360˚.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1000 MHz using the TRILOG broadband antenna, and from 1000 MHz to 26500 MHz using the horn antenna.
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

Note
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1MHz for Peak detection and frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1/T for Average detection (AV) at frequency above 1 GHz. (where T = pulse width)
4. The radiated restricted band edge and Spurious radiated emissions average measurements use a duty cycle correction factor (DCCF).

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5.7.3 Test Result

- Complied

1. Band edge compliance of RF Conducted Emissions was shown in figure 6.
2. Band edge compliance of RF Radiated Emissions was shown in figure 7.
3. Spurious RF conducted Emissions were shown in the Figure 8.
   Note: We took the insertion loss of the cable into consideration within the measuring instrument.
4. Measured value of the Field strength of spurious Emissions (Radiated)

*** Below 1 GHz data (worst-case: 8DPSK)**

8DPSK _ Middle channel (2 441 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz							
Below 30.00	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1GHz							
133.31	120	V	41.3	-14.9	26.4	43.5	17.1
Above 200.00	Not Detected	-	-	-	-	-	-

*** Above 1 GHz data**

GFSK _Low channel (2 402 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	DCCF [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1GHz								
1 602.19	1 000	H	50.7	-5.8	0.0	44.9	74.0	29.1
4 804.06	1 000	H	53.6	5.4	0.0	59.0	74.0	15.0
Above 5 000.00	Not Detected	-	-	-	-	-	-	-
Average DATA. Emissions above 1GHz								
1 600.72	1 000	H	49.1	-2.8	-24.7	21.6	54.0	32.4
4 804.06	1 000	V	48.7	5.7	-24.7	29.7	54.0	24.3
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

GFSK _Middle channel (2 441 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	DCCF [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1GHz								
1 627.16	1 000	V	51.6	-2.5	0.0	49.1	74.0	24.9
4 881.91	1 000	V	52.9	5.9	0.0	58.8	74.0	15.2
Above 5 000.00	Not Detected	-	-	-	-	-	-	-
Average DATA. Emissions above 1GHz								
1 627.16	1 000	V	46.7	-2.5	-24.7	19.5	54.0	34.5
4 881.91	1 000	V	51.3	5.9	-24.7	32.5	54.0	21.5
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

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GFSK _High channel (2 480 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	DCCF [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1GHz								
1 653.59	1 000	V	53.4	-2.2	0.0	51.2	74.0	22.8
4 959.75	1 000	V	53.4	6.1	0.0	59.5	74.0	14.5
Above 5 000.00	Not Detected	-	-	-	-	-	-	-
Average DATA. Emissions above 1GHz								
1 653.59	1 000	v	48.1	-2.2	-24.7	21.2	54.0	32.8
4 959.75	1 000	v	48.8	6.1	-24.7	30.2	54.0	23.8
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

8DPSK_Low channel (2 402 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	DCCF [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1GHz								
1 602.19	1 000	H	50.9	-2.8	0.0	48.1	74.0	25.9
1 732.91	1 000	H	50.7	-1.3	0.0	49.4	74.0	24.6
Above 2 000.00	Not Detected	-	-	-	-	-	-	-
Average DATA. Emissions above 1GHz								
1 602.19	1 000	V	51.6	-2.5	-24.7	24.4	54.0	29.6
3 256.00	1 000	V	39.5	-0.2	-24.7	14.6	54.0	39.4
4 881.91	1 000	H	39.7	5.9	-24.7	20.9	54.0	33.1
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

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8DPSK_Middle channel (2 441 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	DCCF [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1GHz								
1 627.16	1 000	V	52.0	-2.5	0.0	49.5	74.0	24.5
1 732.91	1 000	H	53.4	-1.3	0.0	52.1	74.0	21.9
4 881.91	1 000	H	47.1	5.9	0.0	53.0	74.0	21.0
Above 5 000.00	Not Detected	-	-	-	-	-	-	-
Average DATA. Emissions above 1GHz								
1 627.16	1 000	V	51.6	-2.5	-24.7	24.4	54.0	29.6
3 256.00	1 000	V	39.5	-0.2	-24.7	14.6	540	39.4
4 881.91	1 000	H	39.7	5.9	-24.7	20.9	54.0	33.1
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

8DPSK_High channel (2 480 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	DCCF [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Peak DATA. Emissions above 1GHz								
1 653.59	1 000	V	51.9	-2.2	0.0	49.7	74.0	24.3
1 715.28	1 000	V	45.4	-1.5	0.0	43.9	74.0	30.1
4 959.75	1 000	H	47.7	6.1	0.0	53.8	74.0	20.2
Above 5 000.00	Not Detected	-	-	-	-	-	-	-
Average DATA. Emissions above 1GHz								
1 653.59	1 000	V	47.0	-2.2	-24.7	20.1	54.0	33.9
1 715.28	1 000	V	37.9	-1.5	-24.7	11.7	54.0	42.3
4 959.75	1 000	H	41.5	6.1	-24.7	22.9	54.0	31.1
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

Note.

1. Margin (dB) = Limit - Result
2. Result = Reading + Factor + DCCF
3. Factor(dB) = ANT Factor - Amp Gain + Cable Loss
4. DCCF(Duty Cycle Correction Factor)

   Time to cycle through all channels = T x 20 minimum hopping channels(AFH mode) = 2.904 x 20 = 58.08 ms (where T = pulse width)

   Number of times transmitter hits on one channel = 100 ms / 58.08 ms = 1.72 =>2 hop

   The Worst Case Dwell Time = T x 2 hop = 5.81 ms

   DCCF = 20 Log(Dwell Time / 100 ms) dB = 20 Log(5.81 ms / 100 ms) = -24.72 dB

* All emissions not reported were more than 20 dB below the specified limit or in the noise floor.

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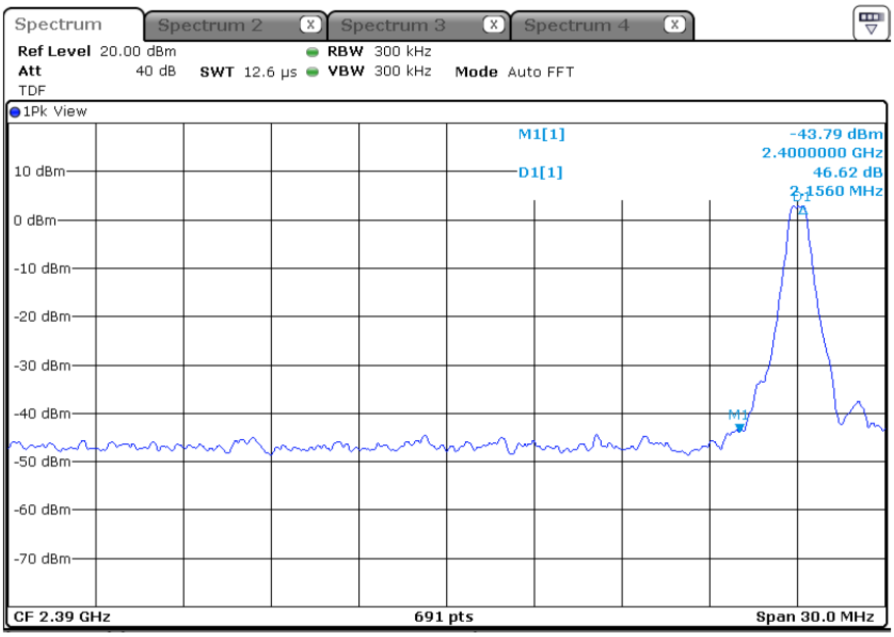
5.7.4 Test Plot

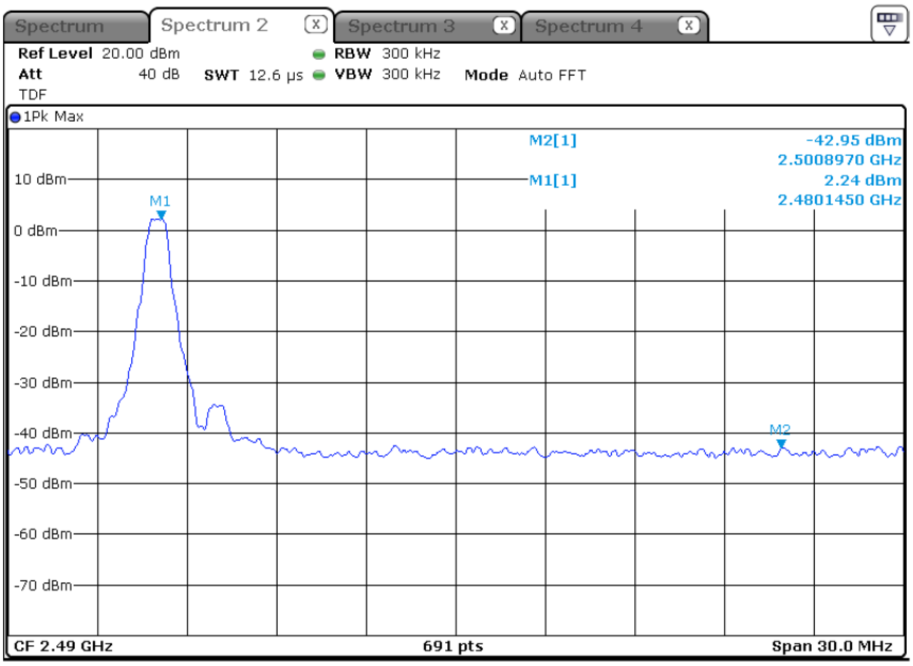
Figure 6. Plot of the Band Edge (Conducted)

*** GFSK (Without hopping)**

Lowest Channel
(2 402 MHz)



Highest Channel
(2 480 MHz)



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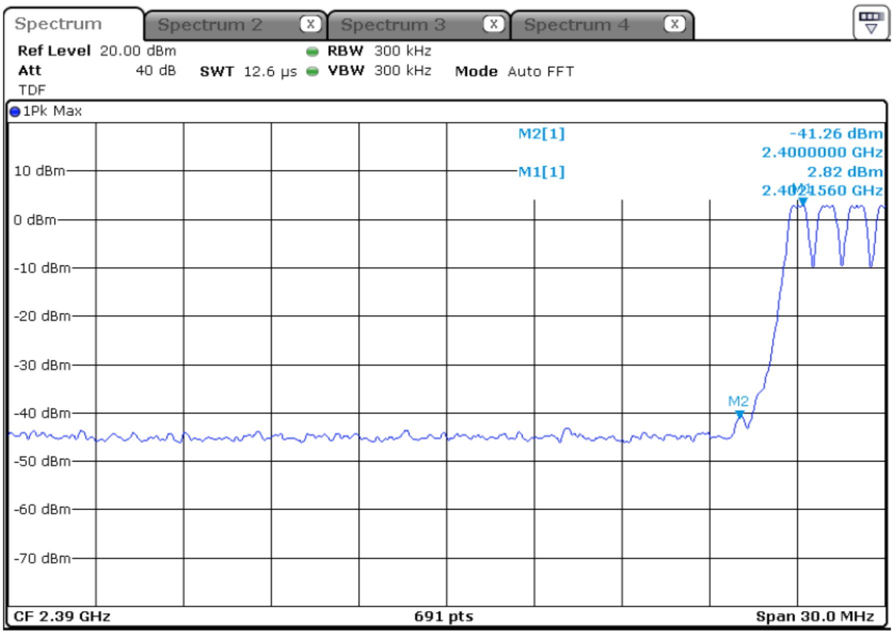
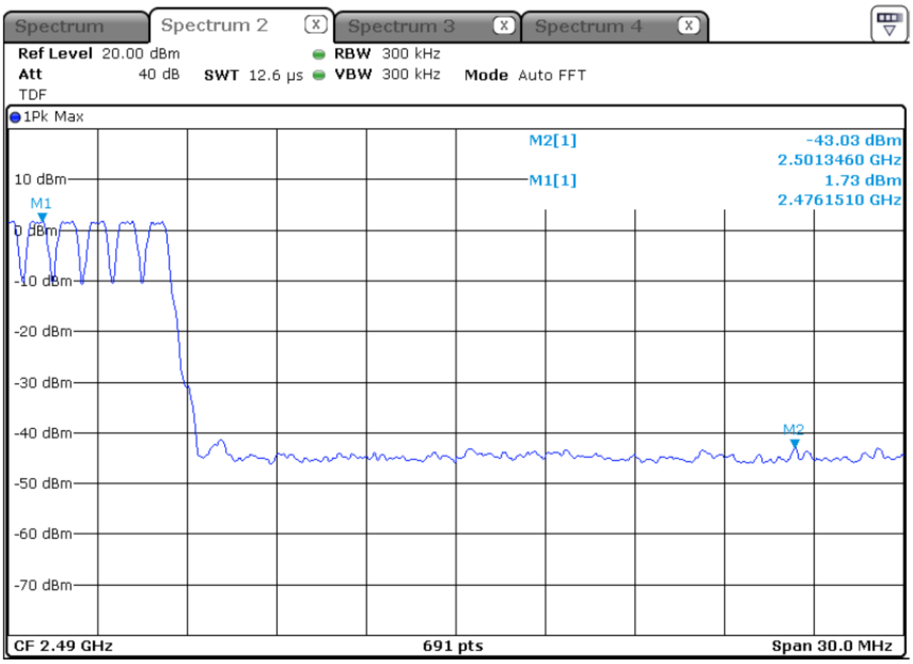
*** GFSK (With hopping)**

Lowest Channel
(2 402 MHz)



Highest Channel
(2 480 MHz)



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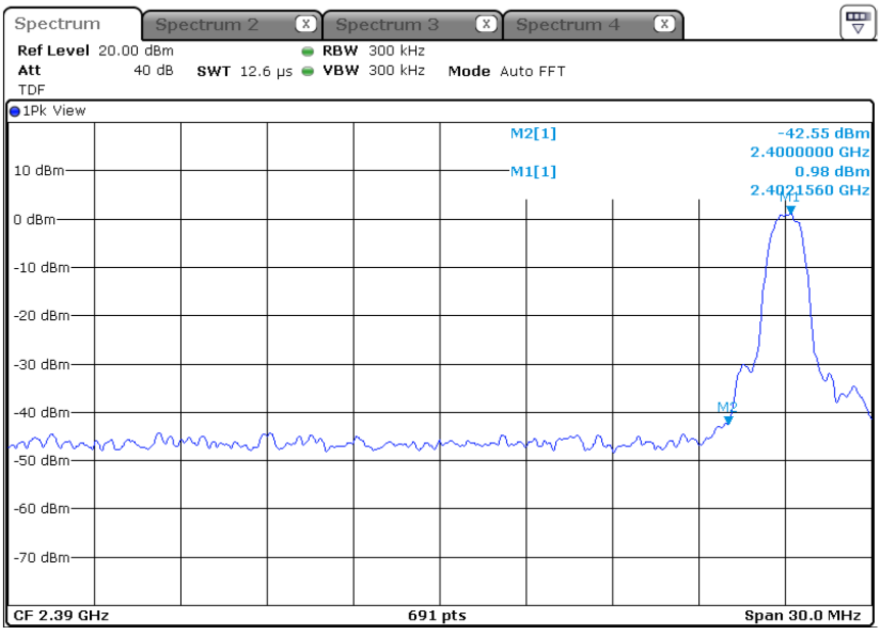
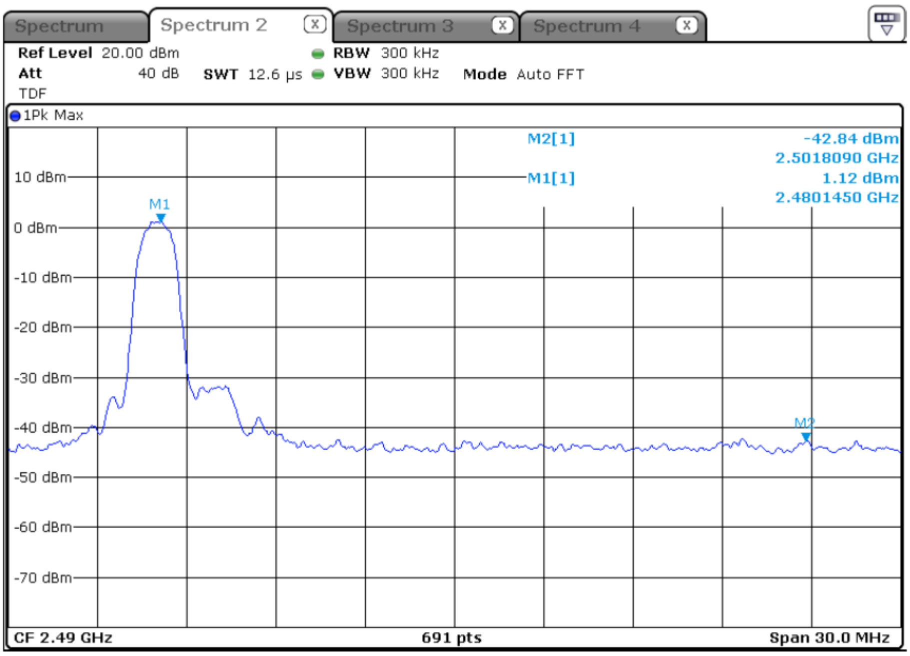
*** 8DPSK (Without hopping)**

Lowest Channel
(2 402 MHz)



Highest Channel
(2 480 MHz)



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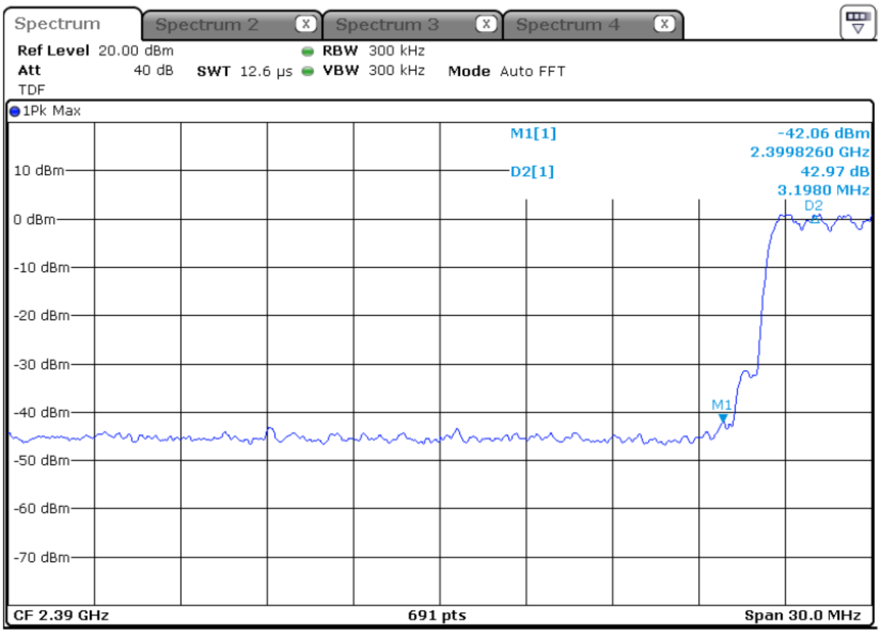
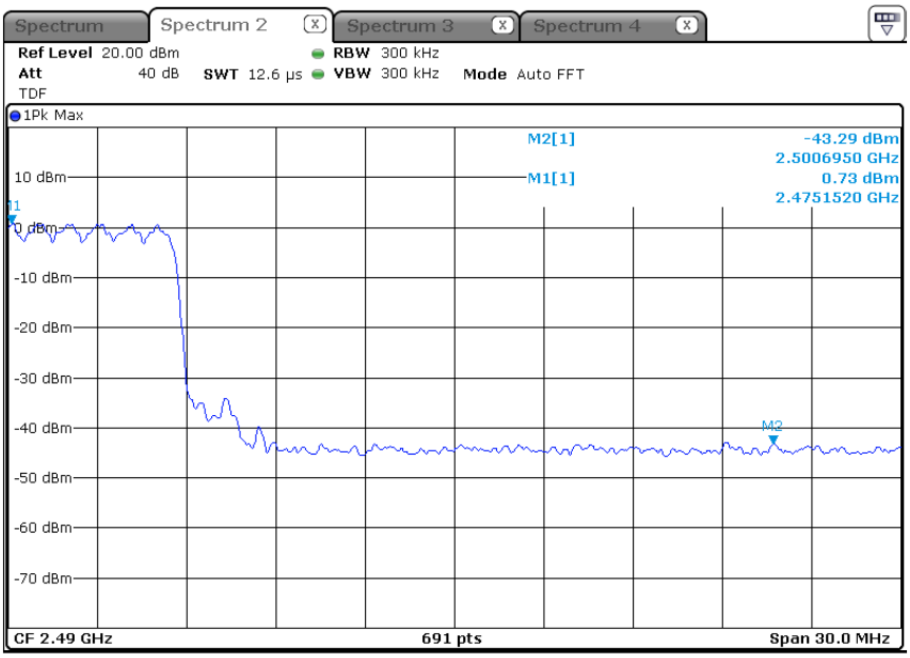
*** 8DPSK (With hopping)**

Lowest Channel
(2 402 MHz)



Highest Channel
(2 480 MHz)



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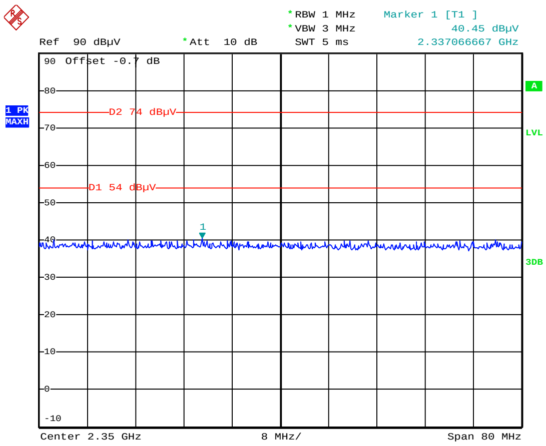
5.7.4 Test Plot (Continue)

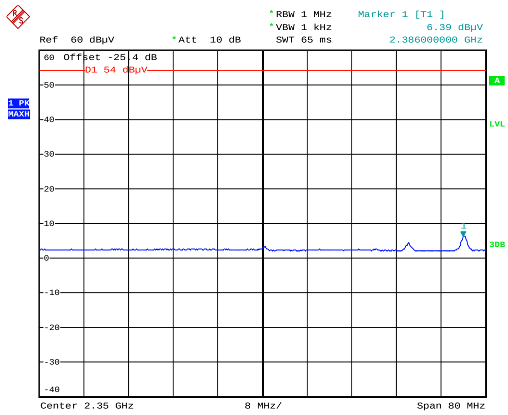
Figure 7. Plot of the Band Edge (Radiated)

*** GFSK**

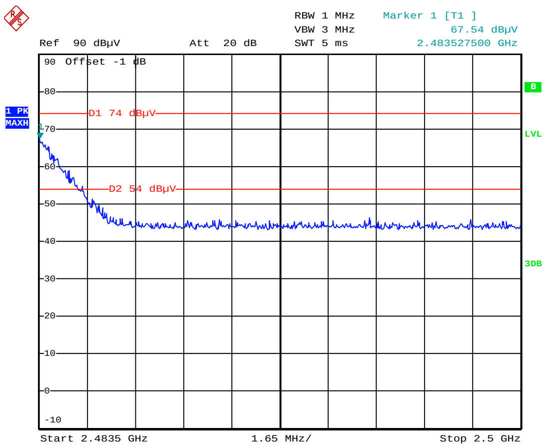
Lowest Channel(2 402 MHz): PEAK



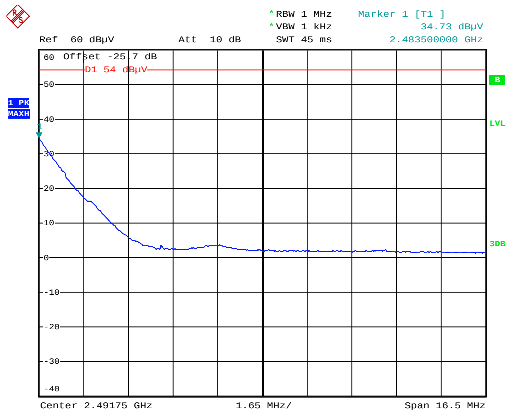
Lowest Channel(2 402 MHz): AVERAGE



Highest Channel(2 480 MHz): PEAK



Highest Channel(2 480 MHz): AVERAGE



Note.
Peak offset(dB) = ANT Factor- Amp Gain + Cable Loss
Average offset (dB) = (ANT Factor- Amp Gain + Cable Loss) + DCCF

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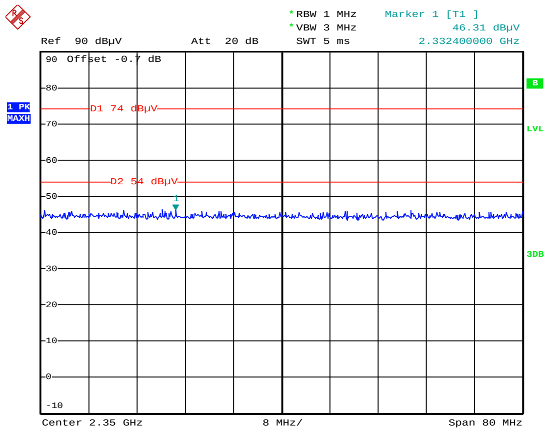
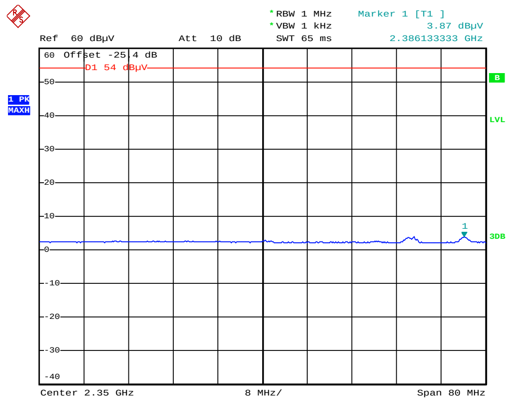
*** 8DPSK**

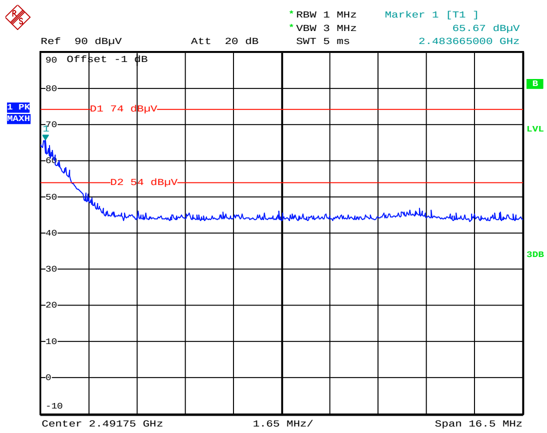
Lowest Channel(2 402 MHz): PEAK



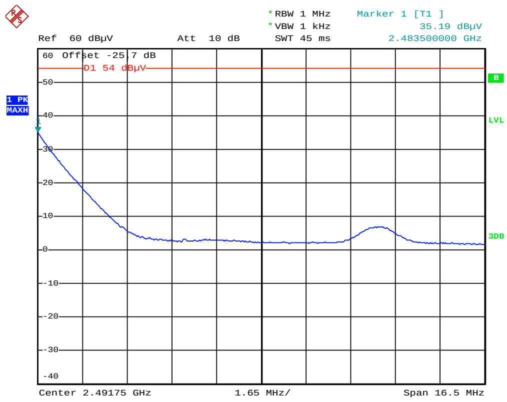
Lowest Channel(2 402 MHz): AVERAGE



Highest Channel(2 480 MHz): PEAK



Highest Channel(2 480 MHz): AVERAGE



Note.
Peak offset(dB) = ANT Factor- Amp Gain + Cable Loss
Average offset (dB) = (ANT Factor- Amp Gain + Cable Loss) + DCCF

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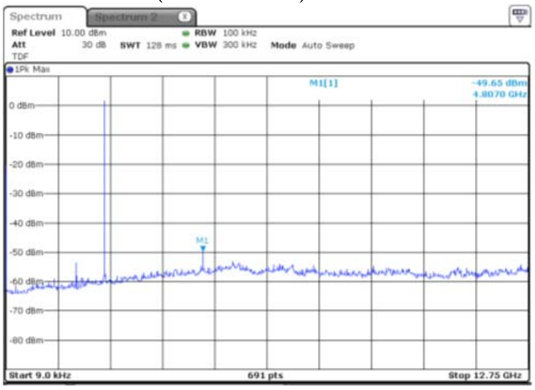
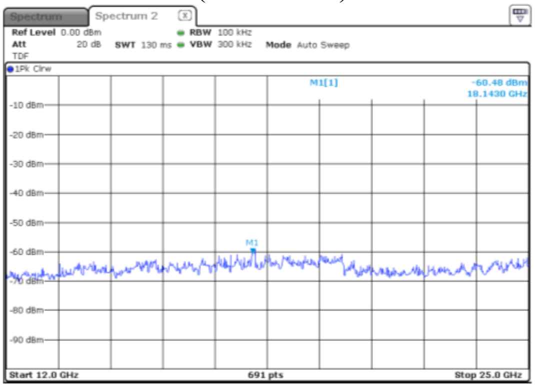
Figure 8. Plot of the Spurious RF conducted emissions

*** GFSK**

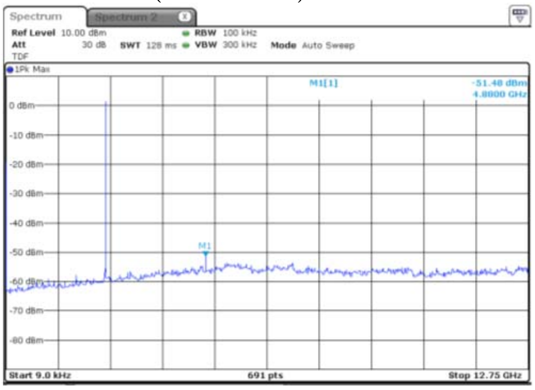
Lowest Channel(2 402 MHz):30 MHz ~ 12 GHz



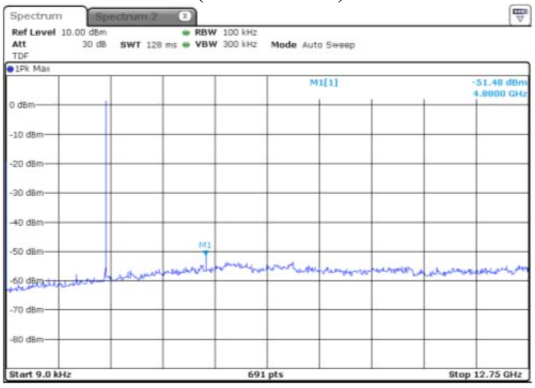
Lowest Channel(2 402 MHz):12 GHz ~ 25 GHz



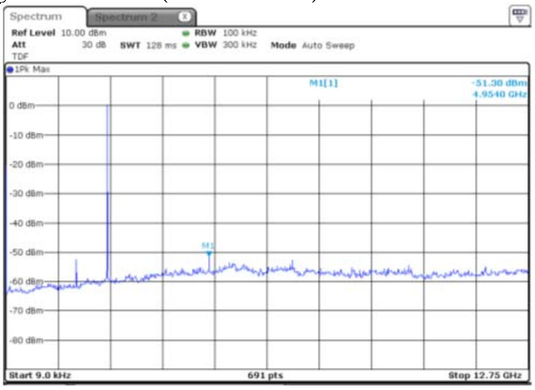
Middle Channel(2 441 MHz): 30 MHz ~ 12 GHz



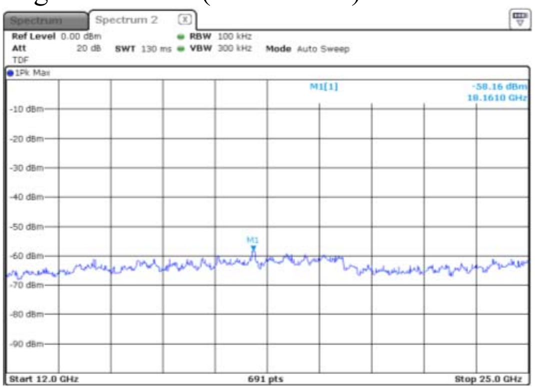
Middle Channel(2 441 MHz): 12 GHz ~ 25 GHz



Highest Channel(2 480 MHz): 30 MHz ~ 12 GHz



Highest Channel(2 480 MHz): 12 GHz ~ 25 GHz



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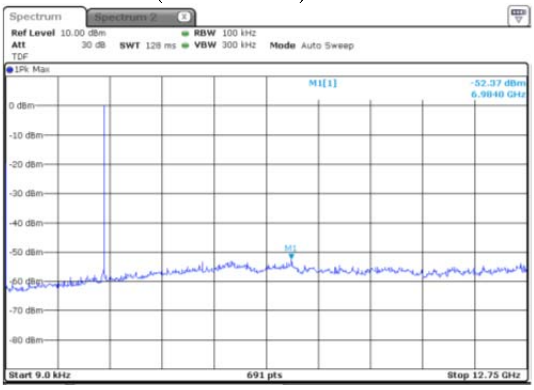
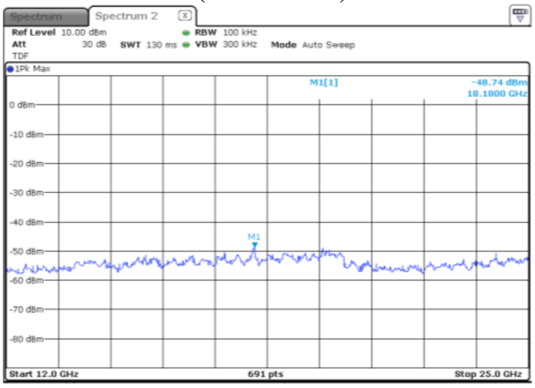
*** 8DPSK**

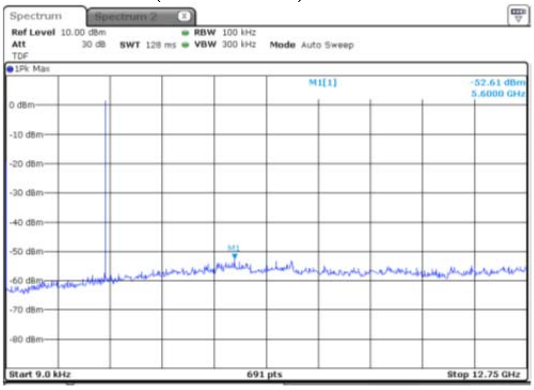
Lowest Channel(2 402 MHz):30 MHz ~ 12 GHz



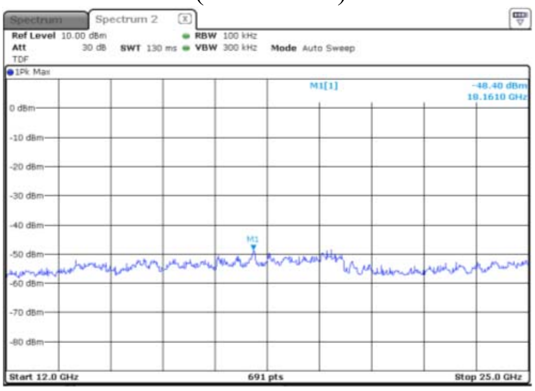
Lowest Channel(2 402 MHz):12 GHz ~ 25 GHz



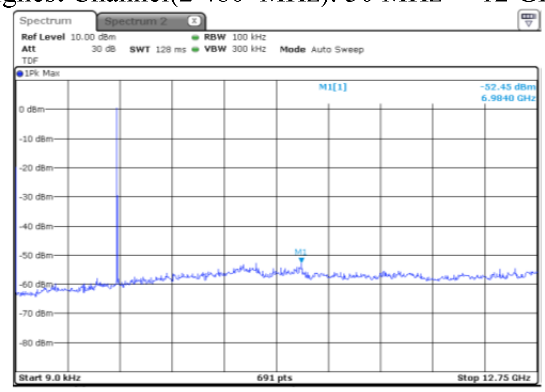
Middle Channel(2 441 MHz): 30 MHz ~ 12 GHz



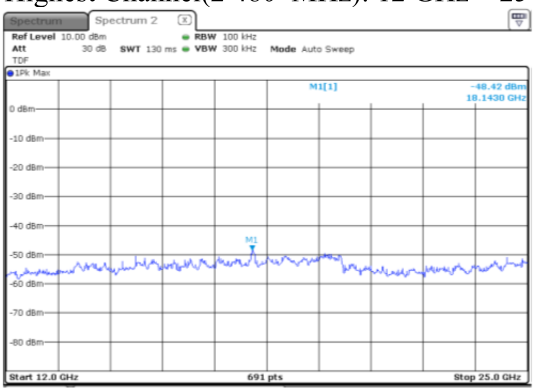
Middle Channel(2 441 MHz): 12 GHz ~ 25 GHz



Highest Channel(2 480 MHz): 30 MHz ~ 12 GHz



Highest Channel(2 480 MHz): 12 GHz ~ 25 GHz



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5.8 Conducted Emission

5.8.1 Regulation

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 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Qausi-peak	Average
0.15 – 0.5	66 to 56 *	56 to 46 *
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

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5.8.2 Measurement Procedure

1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.

2) Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50µH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.

3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.

4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.

5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

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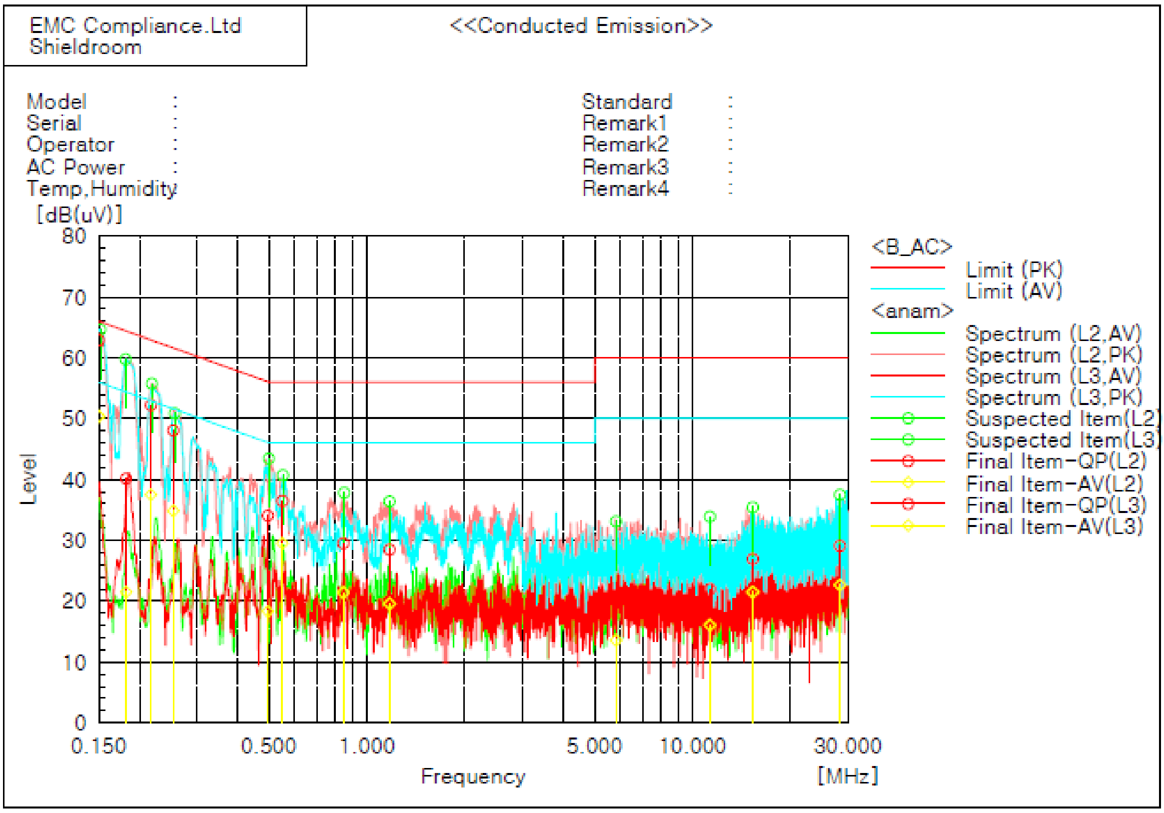
5.8.3 Test Result

- Complied

***Conducted worst-case data : 8DPSK mode (2 402 MHz)**



Final Result

--- L2 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.21676	41.8	27.1	10.4	52.2	37.5	62.9	52.9	10.7	15.4
2	0.84549	19.1	11.1	10.4	29.5	21.5	56.0	46.0	26.5	24.5
3	1.17151	18.2	9.3	10.3	28.5	19.6	56.0	46.0	27.5	26.4
4	15.35031	13.8	8.4	13.1	26.9	21.5	60.0	50.0	33.1	28.5

--- L3 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.15015	52.6	40.1	10.3	62.9	50.4	66.0	56.0	3.1	5.6
2	0.18194	29.7	11.1	10.4	40.1	21.5	64.4	54.4	24.3	32.9
3	0.25416	37.9	24.6	10.2	48.1	34.8	61.6	51.6	13.5	16.8
4	0.49609	23.6	7.9	10.4	34.0	18.3	56.1	46.1	22.1	27.8
5	0.54943	26.1	19.2	10.4	36.5	29.6	56.0	46.0	19.5	16.4
6	5.81841	10.0	3.0	10.6	20.6	13.6	60.0	50.0	39.4	36.4
7	11.29908	10.3	4.4	11.7	22.0	16.1	60.0	50.0	38.0	33.9
8	28.41168	13.0	6.6	16.1	29.1	22.7	60.0	50.0	30.9	27.3

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5.9 RF Exposure

5.9.1 Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissive Exposure: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm²]	Averaging Time [minute]
Limits for General Population / Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*(100)	30
1.34 ~ 30	824 /f	2.19/f	*(180/f²)	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1500	/	/	f/1500	30
1500 ~ 15000	/	/	1.0	30

*f=frequency in MHz, *= plane-wave equivalent power density*

MPE (Maximum Permissive Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad \left(\Rightarrow R = \sqrt{PG/4\pi S}\right)$$

S=power density [mW/cm^2]
P=Power input to antenna [mW]
G=Power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna [cm]

EUT: Maximum peak output power = 2.42 [mW](= 3.84 dBm) Antenna gain= 0.48(= -3.23 [dBi])	
100 mW, at 20 cm from an antenna 6[dBi]	$S = PG/4\pi R^2 = 100 \times 3.98 / (4 \times \pi \times 400)$ $= 0.079\ 18$ [mW/cm^2] < 1.0 [mW/cm^2]
2.42 mW, at 20 cm from an antenna -3.23 [dBi]	$S = PG/4\pi R^2 = 0.000\ 23$ [mW/cm^2] < 1.0 [mW/cm^2]
2.42 mW, at 2.5 cm from an antenna -3.23 [dBi]	$S = PG/4\pi R^2 = 0.014\ 65$ [mW/cm^2] < 1.0 [mW/cm^2]

5.9.2 RF Exposure Compliance Issue

The information should be included in the user's manual:
This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter. A minimum separation distance of 20 cm must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

6. Test equipment used for test

	Description	Manufacture	Model No.	Serial No.	Next Cal Date.
■	DC Power Supply	Agilent	E3632A	MY40004399	15.01.09
■	Signal Generator	R&S	SMR40	100007	14.06.11
■	Spectrum Analyzer	R&S	FSV30	100914	14.08.19
■	Test Receiver	R&S	ESCI7	100732	14.02.18
■	Spectrum Analyzer	R&S	FSP40	100209	14.10.21
■	Loop Antenna	R&S	HFH2-Z2	100355	15.06.19
■	Bi-Log Antenna	Schwarzbeck	VULB9163	552	14.07.18
■	Horn Antenna	ETS-Lindgren	3115	86706	14.08.20
■	Horn Antenna	ETS-Lindgren	3116	00086632	15.11.15
■	Amplifier	Sonoma	310N	186280	14.02.15
■	Amplifier	Schwarzbeck	BBV9718	233	14.05.03
■	Amplifier	Schwarzbeck	BBV9721	2	14.05.09
■	Attenuator	HP	8491A	16861	14.07.08
■	Antenna Mast	Innco Systems	MA4000-EP	303	-
■	Turn Table	Innco Systems	DT2000S-1t	79	-

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