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Order No.: 10468098
Report No.: 14-10468098-1-FCC
Date: August 21, 2014
Model No.: LND1420IWLM
FCC ID.: BEJ- LND1420IWLM

FCC Test Report

in accordance with
FCC Part 15 Subpart C §15.247

for

Car AVN with Bluetooth

LG Electronics Inc.

**222, LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, 451-713,
Republic of Korea**

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Summary of Test Results:

The following tests were performed on a sample submitted for evaluation of compliance with FCC Part 15 C Section 15.247

No	Reference Clause No.	FCC Part15 Subpart C Conformance Requirements	Verdict	Remark
1	15.205(a) 15.209 15.247(d)	Transmitter radiated spurious emissions and Conducted spurious emission	Complied	
2	15.247(a)(1)	20dB Bandwidth	-	Note 1
3	15.247(b)(1)	Maximum peak output power	Complied	
4	15.247(a)(1)	Frequency Separation	Complied	
5	15.247(a)(1)(iii)	Number of Hopping Channels	Complied	
6	15.247(a)(1)(iii)	Average Time of Occupancy	Complied	

Note 1 : No Compliance limit. Just Reporting purpose.

Conclusion:

The tests listed in the Summary of Testing section of this report have been performed and the results recorded by UL Korea Ltd. in accordance with the procedures stated in each test requirement and specification. The test list was determined by the Applicant as being applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.



Witnessed by
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UL Korea Ltd.
August 21, 2014



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August 21, 2014

Test Report Details

Tests Performed By: UL Korea Ltd.
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Test Site: EMC compliance Ltd.
65, Sinwon-ro, Yeongtong-gu, Suwon- si, Gyeonggi-do, 443-390, Korea

Applicant: LG Electronics Inc.
222, LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, 451-713, Republic of Korea

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Product Type: CAR AVN with Bluetooth

Model Number: LND1420IWLM

Trademark



Sample Serial Number: N/A

Test standards: FCC Part 15 C Section 15.247
Operation within the bands 902–928 MHz, 2400–2483.5 MHz,
and 5725–5850 MHz

Sample Serial Number: N/A

Sample Receive Date: July 21, 2014

Testing Start Date: July 21, 2014

Testing Complete Date: July 31, 2014

Overall Results: **Pass**

UL Korea Ltd. reports apply only to the specific test samples and test results submitted for UL's review. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. UL Korea Ltd. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from UL Korea Ltd. issued reports. This report shall not be used to claim, constitute or imply product certification, approval, or any agency of the National Authorities. This report may contain test results that are not covered by the NVLAP or KOLAS accreditation.

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1. General Product Information

1.1. Equipment Description

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 its 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.

1.2. Details of Test Equipment (EUT)

- Equipment Type : CAR AVN with Bluetooth
- Model No. : LND1420IWLM
- Trade name : LG
- Type of test Equipment : Portable type
- Operating characteristic : Short range wireless device operating in the 2400 – 2483.5 ISM frequency band
- Manufacturer : LG Electronics Inc.
222, LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, 451-713, Republic of Korea

1.3. Equipment Configuration

The EUT is consisted of the following component provided by the manufacturer.

Use*	Product Type	Manufacturer	Model	Comments
EUT	CAR AVN with Bluetooth		LND1420IWLM	-
Note: Use = EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment. SIM - Simulator (Not Subjected to Test)				

1.4. Technical Data

Transmitter frequency range(s)	2,402~2,480 MHz
Number of Channel	79 channels
Receiver frequency range(s)	2,402~2,480 MHz
Transmitter power	-3.16 dBm (Max 2.5 dBm)
Modulation	FHSS (GFSK, π /4DQPSK, 8DPSK)
Power supply	Typ. 12Vdc

Note ;

1. All the technical data described above were provided by the manufacturer.

1.5. Antenna Information

Antenna Model Name : ALA621C4
Antenna Type : Chip Antenna
Manufacturer : AMOTECH
Transmit Gain : Max. 0.7 dBi
Azimuth Beam Pattern : Linear

1.6. Equipment Type :

- ☐ Radio and ancillary equipment for fixed or semi-fixed use
☒ Radio and ancillary equipment for vehicular mounted use
☐ Radio and ancillary equipment for portable or handheld use
- ☒ Stand alone ☐ Host connected ☐ Host connected
- ☐ Self contained single unit ☒ Module with associated connection or interface

1.7. Technical descriptions and documents

The following documents was provided by the manufacturer.

No.	Document Title and Description
1	User Manual

1.8. Description of additional model name

Model name	Model name Designation	Description of design
LND1420IWLM	Basic model	-

1.9. Maximum Output Power (Baseline Measurement)

Modulation Type	Rate	Peak Power(dBm)		
		2402 MHz	2441 MHz	2480 MHz
GFSK	1 Mbps	-4.47	-6.46	-7.92
$\pi/4$ DQPSK	2 Mbps	-3.58	-5.15	-6.30
8DPSK	3 Mbps	-3.16	-4.78	-6.22

2. Test Specification

The following test specifications and standards have been applied and used for testing.

- 1) FCC Part 15 C Section 15.247 : Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz
- 2) ANSI C63.10:2009 : American National Standard for Testing Unlicensed Wireless Devices
- 3) FCC Public Notice DA 00-705-2003
Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

3. Test Conditions

3.1. Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	CAR AVN with Bluetooth		LND1420IWLM	-
SIM	Bluetooth Tester	Tescom	TC-3000A	-
Note: Use = EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment. SIM - Simulator (Not Subjected to Test)				

3.2. Input/Output Ports

Port #	Name	Type*	Cable Max. >3m	Cable Shielded	Comments
1	DC input port	DC	1.0	Unshielded	Car AVN with Bluetooth
2	ANT IN	I/O	20.0	Shielded	
3	GPS	I/O	1.5	Shielded	
4	Jack Accessory	I/O	1.0	Unshielded	
5	C Connector	I/O	0.4	Unshielded	
6	A Connector	I/O	0.4	Unshielded	
7	AUX IN	I/O	0.8	Unshielded	Jack Accessory
8	USB	I/O	-	-	
Note: * AC = AC Power Port DC = DC Power Port N/E = Non-Electrical I/O = Signal Input or Output Port (Not Involved in Process Control) TP = Telecommunication Ports					

3.3. Power Interface

Mode #	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
1	12 V DC	-	-	DC	-	Normal operating voltage

3.4. Operating Frequencies

Mode #	Frequency tested
1	- Low : 2402 MHz / CH = 1 - Mid : 2441 MHz / CH = 39 - Top : 2480 MHz / CH= 78

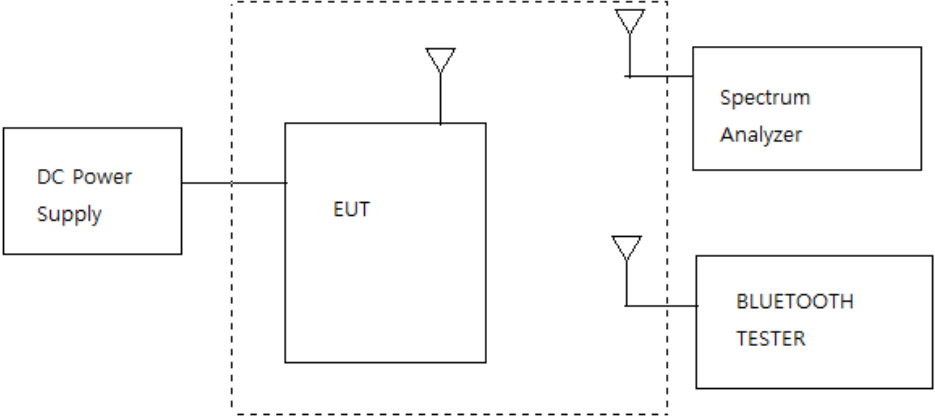
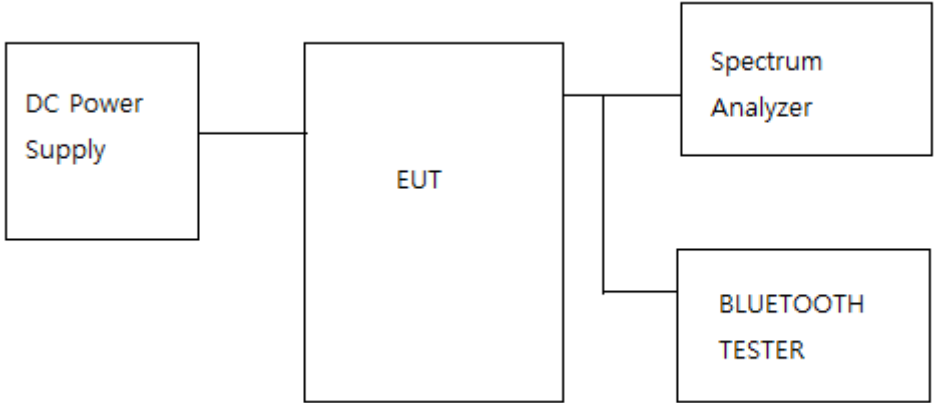
3.5. Operation Modes

Mode #	Description
1	Carrier on mode: Signal from the RF module was gene1 continuously for the representative channels (Low, Mid, High) by the test program incorpo1.
2	Carrier on Hopping mode: Signal from the RF module was gene1 continuously.
3	Carrier off (Idle) mode: RF carrier was not activated by the RF module.
Note : - The measurements of the spurious emissions for transmitter on stand-by mode were performed as the receiver spurious emissions. - The worst-case condition is determined by the baseline measurement of RF output power out of various modulations and data rates. Therefore all applicable requirements were tested to the two type of higher output power modulation (GFSK and 8DPSK)	

3.6. Environment Conditions

Parameters	Normal condition
Temperature	+ 15℃ ~ +35℃
Humidity	20% ~ 75%
Supply voltage	12 Vdc (Nominal voltage)
Note: - The operating condition for humidity requirement has not been declared in the manufacturer's specification.	

3.7. Test Configurations

Mode #	Description
1	
2	

3.8. List of Test Equipment

No	Description	Manufacturer	Model	Identifier	Cal. Due
1	Spectrum Analyzer	R&S	FSV30	100914	15.08.05
2	DC Power Supply	Agilent	E3632A	MY51220373	14.12.24
3	Signal generator	R & S	SMR40	100007	15.06.10
4	Bluetooth Tester	TESCOM	TC-3000A	3000A310047	15.04.10
5	POWER DIVIDER	Aeroflex/ Weinschel,Inc	1580-1	RM986	15.04.08
6	Spectrum Analyzer	R & S	FSP40	100209	14.10.21
7	Amplifier	Sonoma	310N	293004	14.10.31
8	Broadband Preamplifier	Schwarzbeck	BBV9718	9718-233	15.04.22
9	Broadband Preamplifier	Schwarzbeck	BBV9721	2	15.05.09
10	Loop Antenna	R&S	HFH2-Z2	100355	15.06.19
11	Bi-Log Antenna	Schwarzbeck	VULB9168	583	15.06.19
12	Horn Antenna	ETS - Lindgren	3115	62589	14.11.11
13	Horn Antenna	ETS - Lindgren	3116	86635	15.02.26
14	Attenuator	HP	8491A	16861	15.07.01
15	Highpass Filter	Wainwright Instruments GmbH	WHKX3.0/ 18G-12SS	44	15.02.05
16	Antenna Mast	Innco Systems	MA4000-EP	303	-
17	Turn Table	Innco Systems	DT2000S-1t	79	-

4. Overview of Technical requirements

The following essential requirements and test specifications are relevant to the presumption of conformity FCC Part 15 C Section 15.247			Reported
Reference Clause No.	Essential technical requirements	Test method	
15.205(a) 15.209 15.247(d)	Transmitter radiated spurious emissions and Conducted spurious emission	ANSI C63.10-2009 DA 00-705-2003	[X]
15.247(a)(1)	20dB Bandwidth	ANSI C63.10-2009 DA 00-705-2003	[X]
15.247(b)(1)	Maximum peak output power	ANSI C63.10-2009 DA 00-705-2003	[X]
15.247(a)(1)	Carrier Frequency Separation	ANSI C63.10-2009 DA 00-705-2003	[X]
15.247(a)(1)(iii)	Number of Hopping Channels	ANSI C63.10-2009 DA 00-705-2003	[X]
15.247(a)(1)(iii)	Average Time of Occupancy	ANSI C63.10-2009 DA 00-705-2003	[X]

5. Test Results

5.1. 20 dB Bandwidth

TEST: 20 dB Bandwidth		
Method	20 dB Bandwidth from the EUT were measured according to the procedure of DA 00-705-2003 The transmitter output is connected to the Spectrum analyzer. 20 dB Bandwidth from the EUT was measured under the below setting condition. 1. Set resolution bandwidth (RBW) ≥ 1 % of 20 dB Bandwidth. 2. Set the video bandwidth (VBW) $\geq$ RBW. 3. Detector = Peak. 4. Trace mode = max hold. 5. Sweep = auto couple. 7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.	
Reference Clause	Part15 C Section 15.247 (a)(1)	
Parameters recorded during the test	Laboratory Ambient Temperature	25.2 °C
	Relative Humidity	48.1 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	2402 MHz - 2480 MHz	Antenna port

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
1	1	2
Supplementary information: None		

Limits

§15.247(a)(1) : No limit apply.

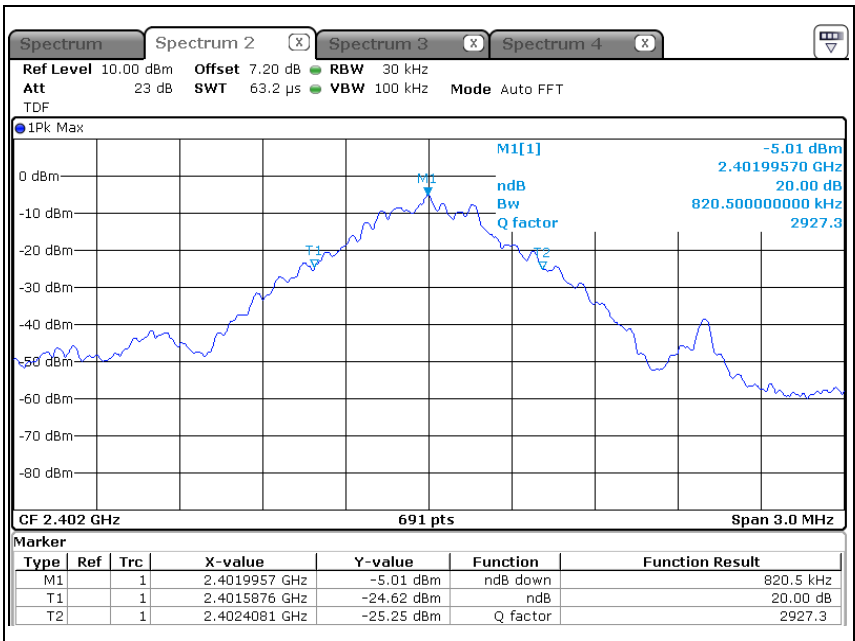
5.1.1. Measurement Results

Table 1. Data Table of 20 dB Bandwidth

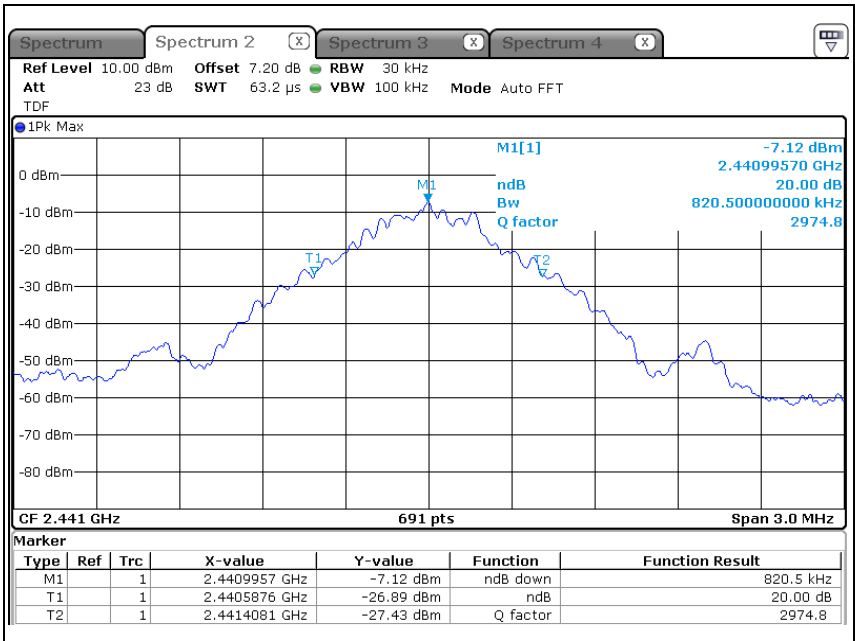
Operating Mode	Data Rate (Mbps)	Channel	Channel Frequency (MHz)	20 dB Bandwidth (kHz)	Minimum Limit (MHz)
GFSK	1	Low	2402	820.5	N/A
		Middle	2441	820.5	
		High	2480	820.5	
8DPSK	3	Low	2402	1.2634	
		Middle	2441	1.2547	
		High	2480	1.2590	

Figure 1. Plots of 20 dB Bandwidth

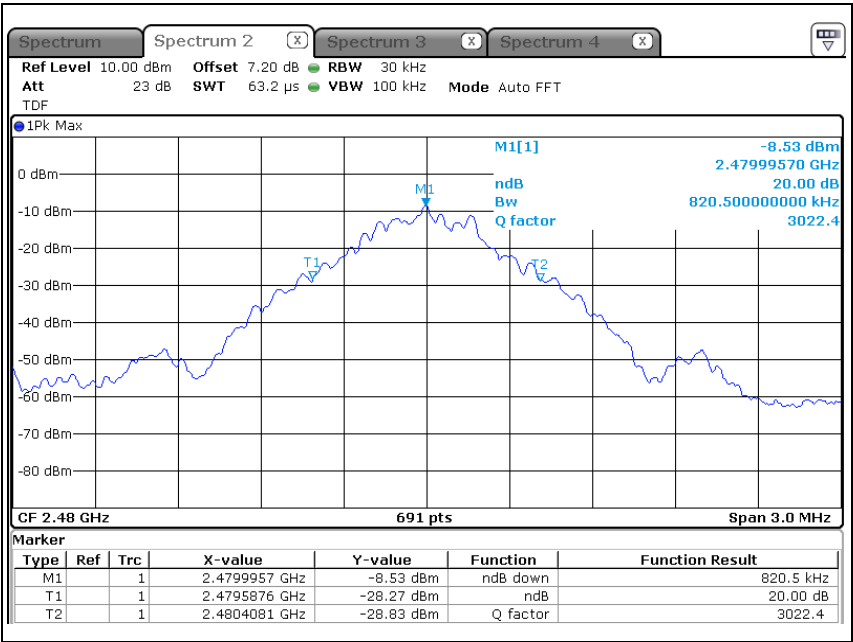
GFSK
Low



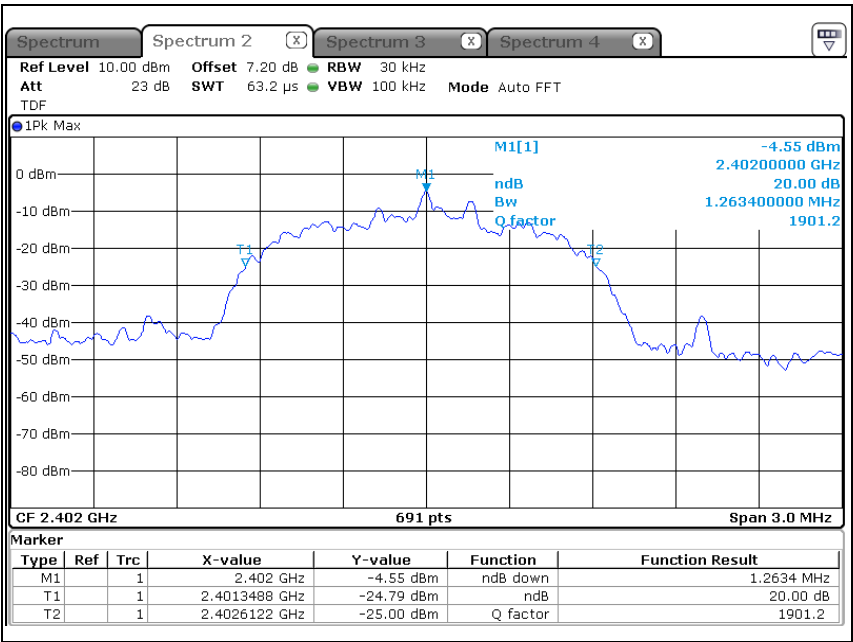
Middle



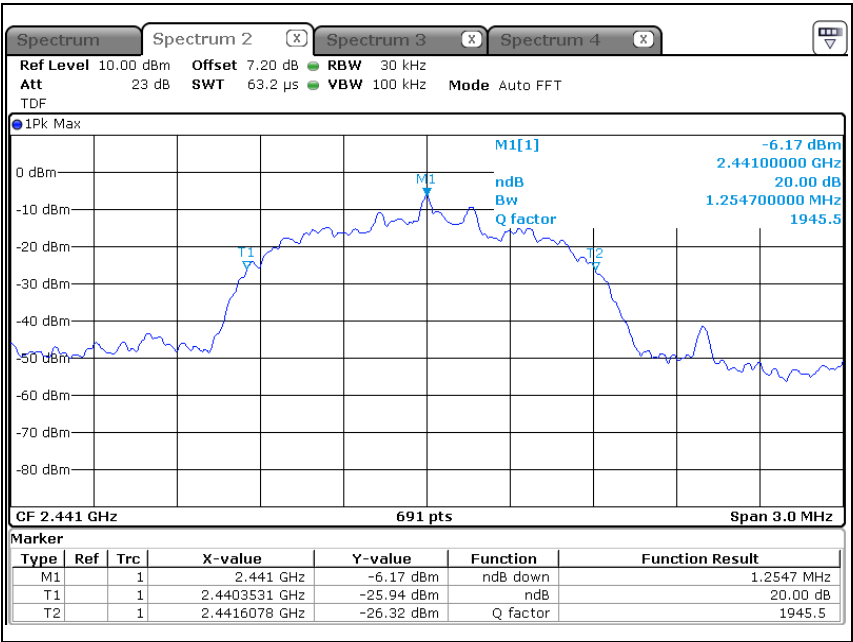
High



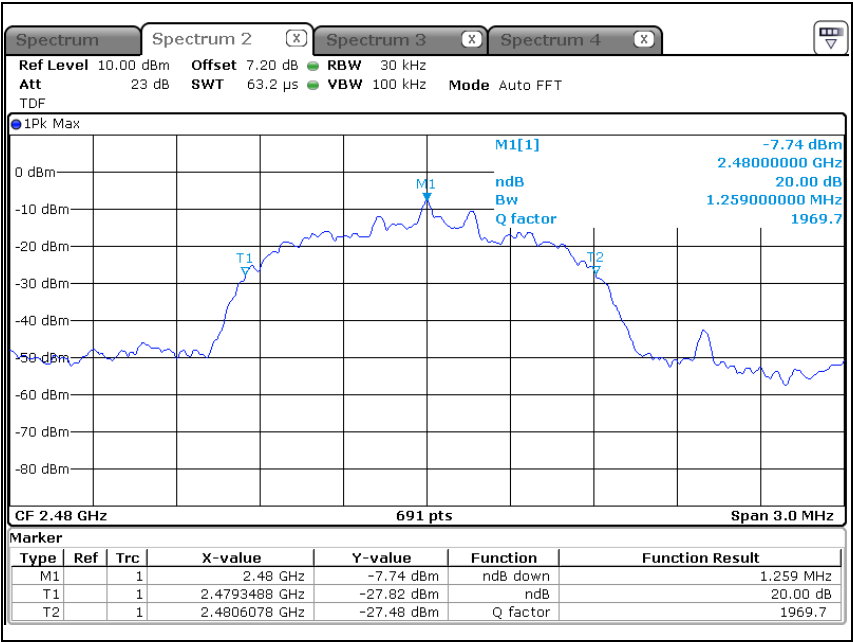
8DPSK
Low



Middle



High



5.2. Maximum Peak Output Power

TEST: Maximum Peak Output Power		
Method	Maximum Peak Output Power from the EUT were measured according to the procedure of DA 00-705-2003 1. Use the following spectrum analyzer settings: 2. Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel 3. RBW > the 20 dB bandwidth of the emission being measured 4. VBW $\geq$ RBW. 5. Detector = peak. 6. Sweep time = auto couple. 7. Trace mode = max hold. 8. Allow trace to fully stabilize. 9. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power. The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.	
Reference Clause	Part15 C Section 15.247 (b)(1)	
Parameters recorded during the test	Laboratory Ambient Temperature	25.2 °C
	Relative Humidity	48.1 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	2402 MHz - 2480 MHz	Antenna port

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
1	1	2
Supplementary information: None		

Limits

The maximum peak output power of the intentional radiator shall not exceed the following :

- §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, provided the systems operate with an output power no greater than 125 mW.
- §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 MHz band: 1 Watt.

According to §15.247(b)(4), the conducted output power limit specified in paragraph(b) of this section is based on the use of antenna with directional gains that do not exceed 6 dBi. Except as shown in paragraph(c) of this section, if transmitting antenna 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 paragraph (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.

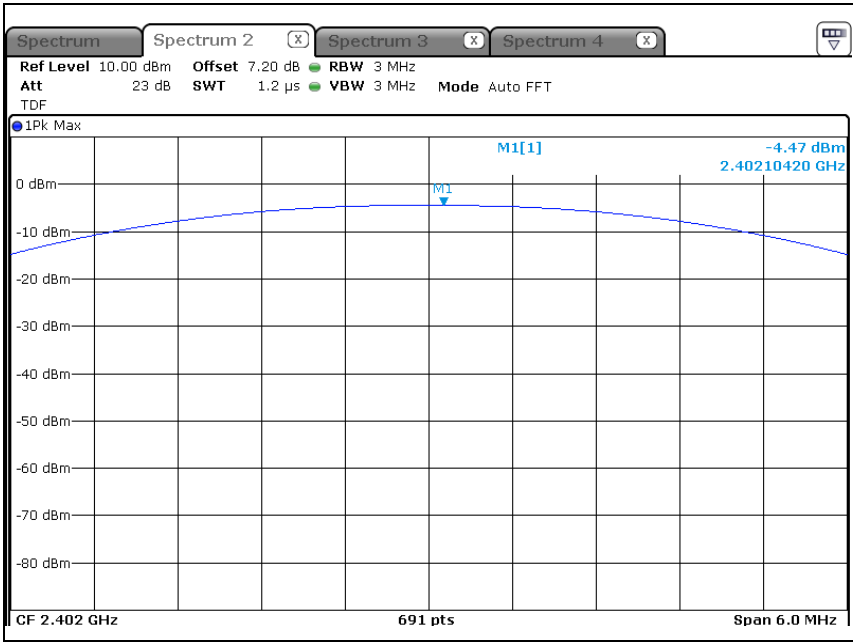
Measurement Results

Table 2. Data Table of Maximum Peak Output Power

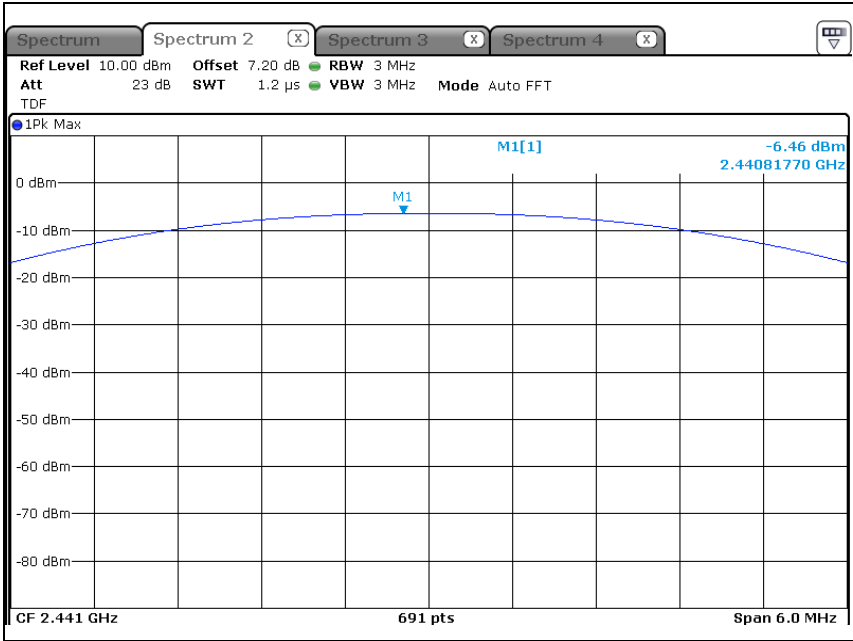
Operating Mode	Data Rate (Mbps)	Channel	Channel Frequency (MHz)	Peak Power Result (dBm)	Limit (dBm)
GFSK	1	Low	2402	-4.47	20.97
		Middle	2441	-6.46	
		High	2480	-7.92	
$\pi/4$ DQPSK	1	Low	2402	-3.58	20.97
		Middle	2441	-5.15	
		High	2480	-6.30	
8DPSK	3	Low	2402	-3.16	20.97
		Middle	2441	-4.78	
		High	2480	-6.22	

Figure 2. Plots of Maximum Peak Power

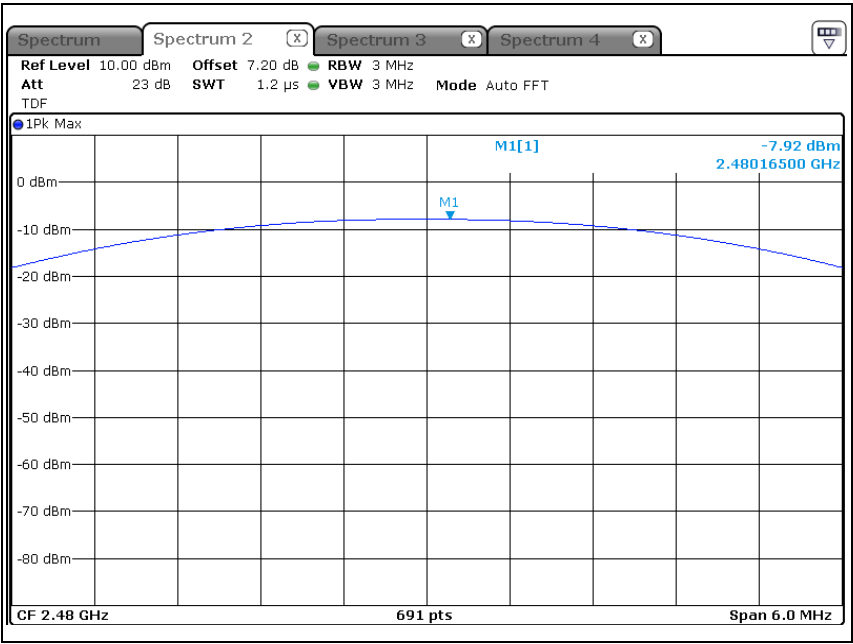
GFSK
Low



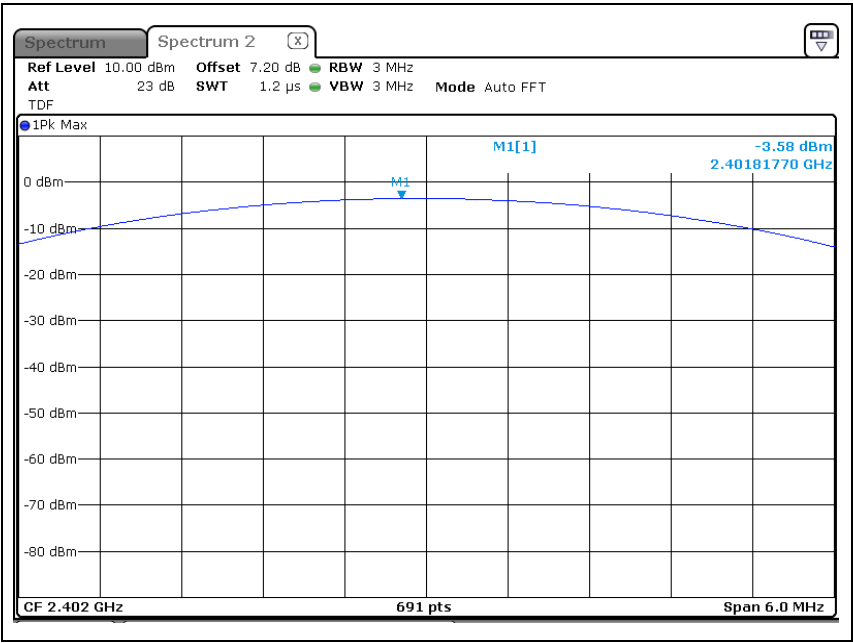
Middle



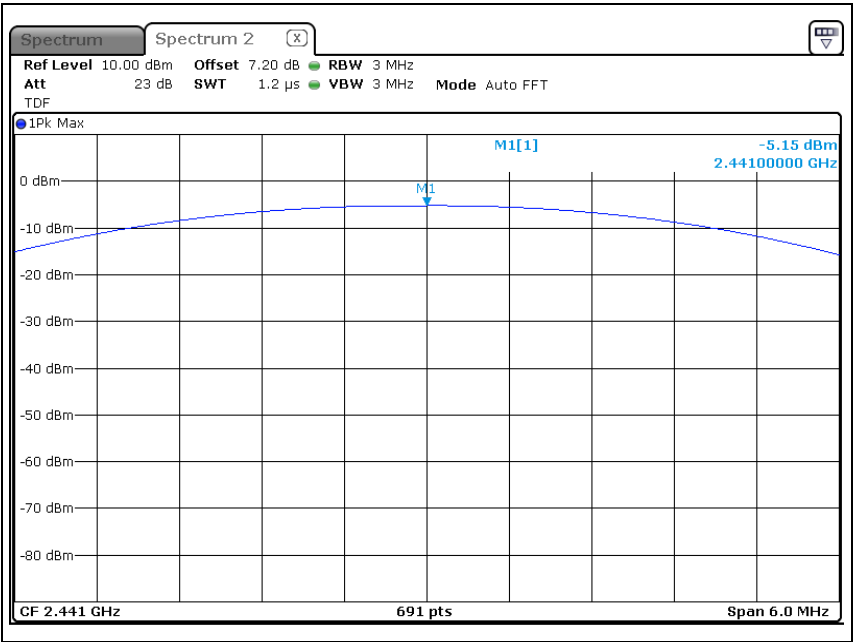
High



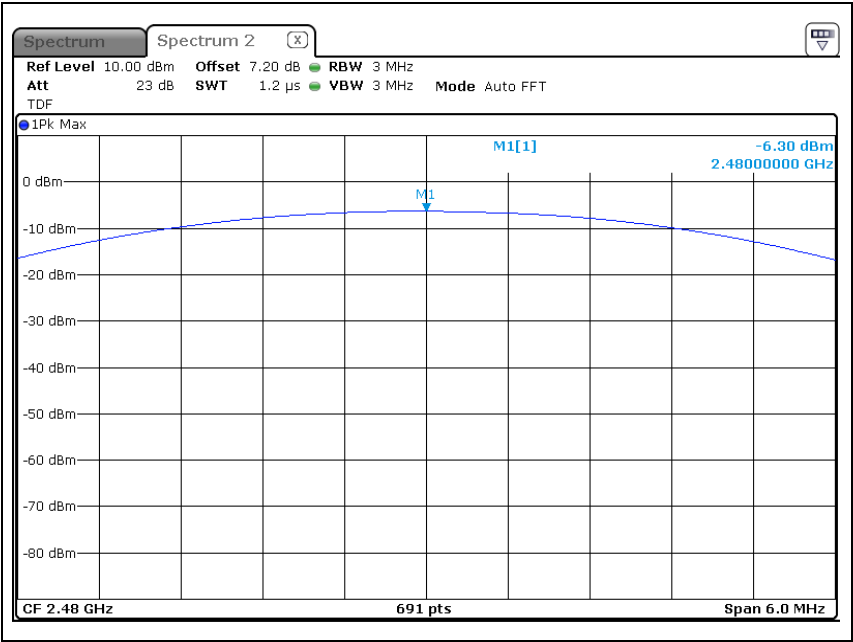
$\pi/4$ DQPSK
Low



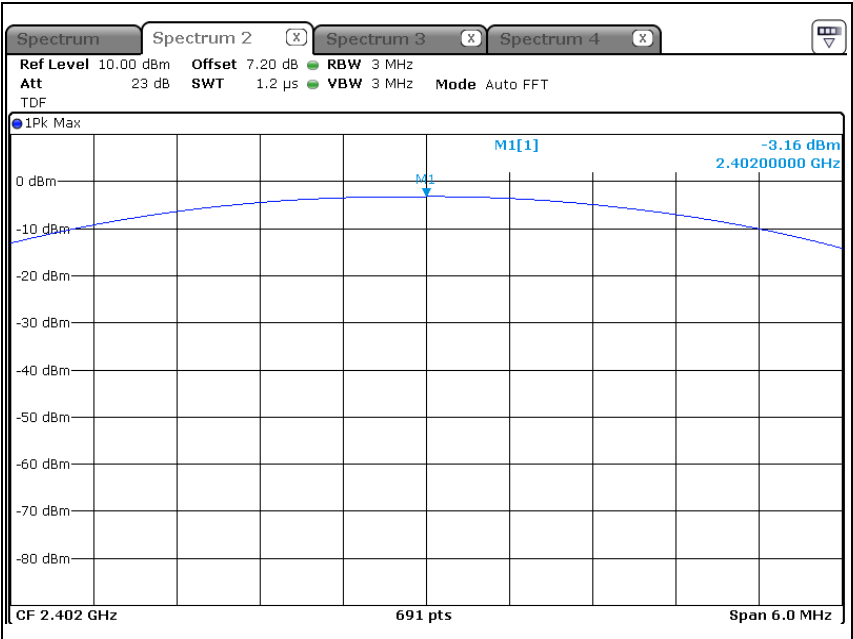
Middle



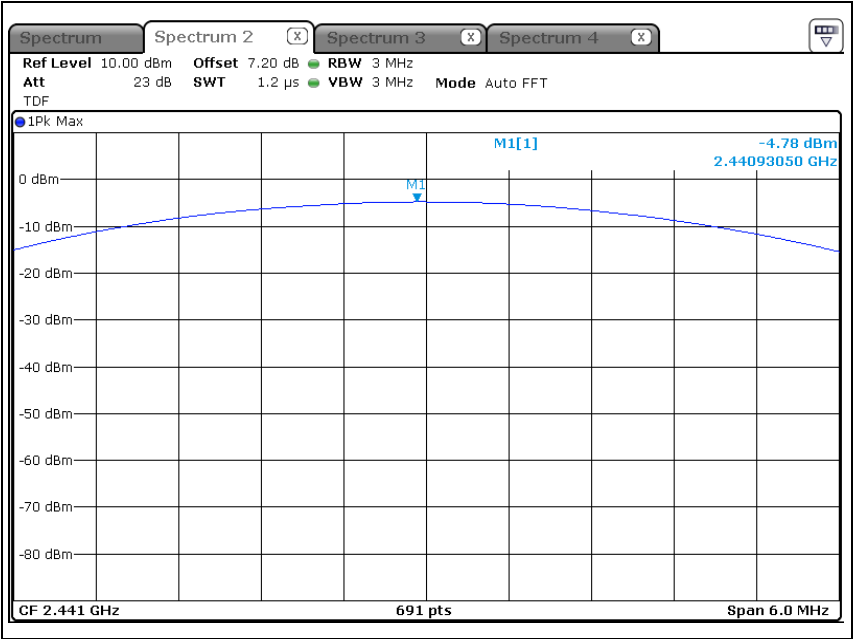
High



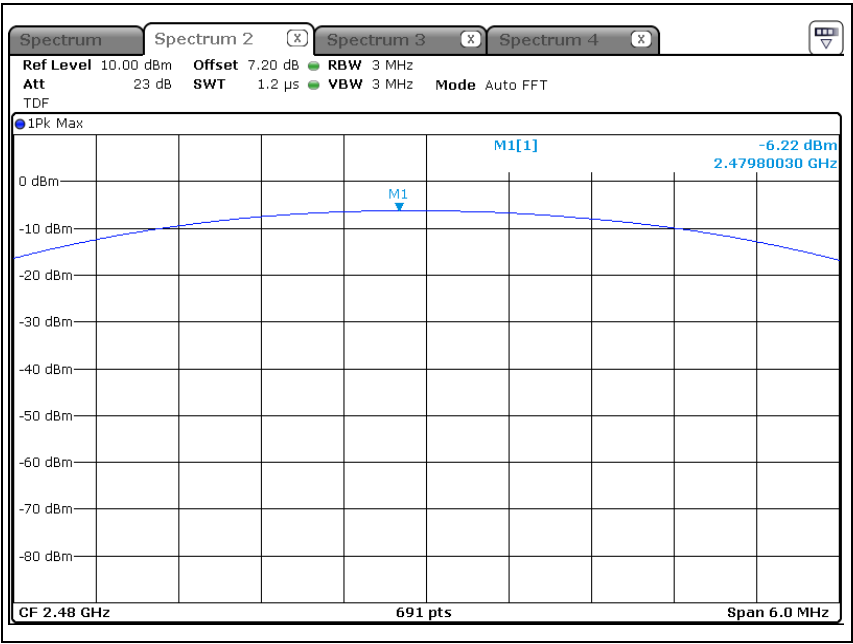
8DPSK
Low



Middle



High



5.3. Carrier Frequency Separation

TEST: Carrier Frequency Separation		
Method	Carrier Frequency Separation from the EUT were measured according to the procedure of DA 00-705-2003 The EUT must have its hopping function enabled. 1. Use the following spectrum analyzer settings: 2. Span = wide enough to capture the peaks of two adjacent channels 3. RBW $\geq$ 1 % of Span 4. VBW $\geq$ RBW. 5. Detector = peak. 6. Sweep time = auto couple. 7. Trace mode = max hold. 8. Allow trace to fully stabilize. 9. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.	
Reference Clause	Part15 C Section 15.247 (a)(1)	
Parameters recorded during the test	Laboratory Ambient Temperature	25.2 °C
	Relative Humidity	48.1 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	2402 MHz - 2480 MHz	Antenna port

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
1	2	2
Supplementary information: None		

Limits

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

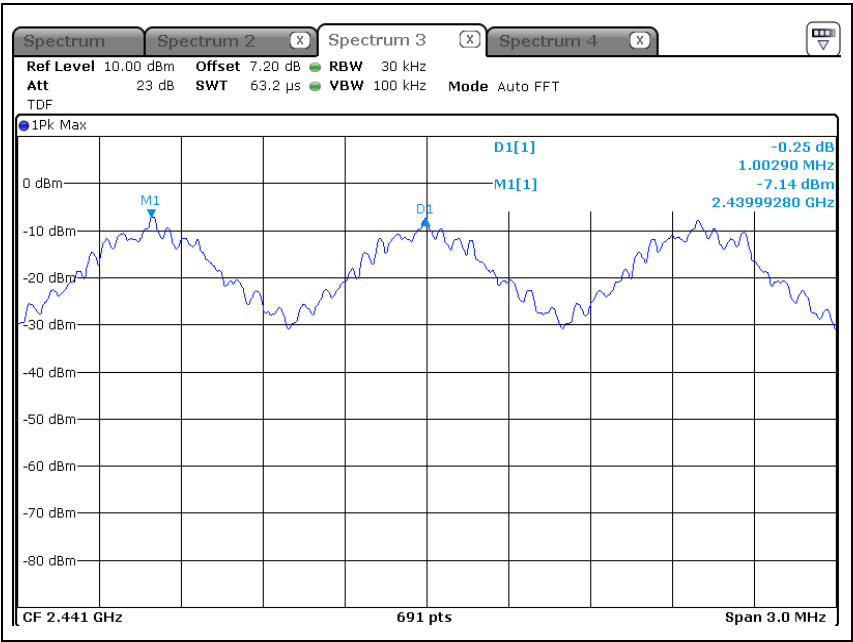
Measurement Results

Table 3. Data Table of Carrier Frequency Separation

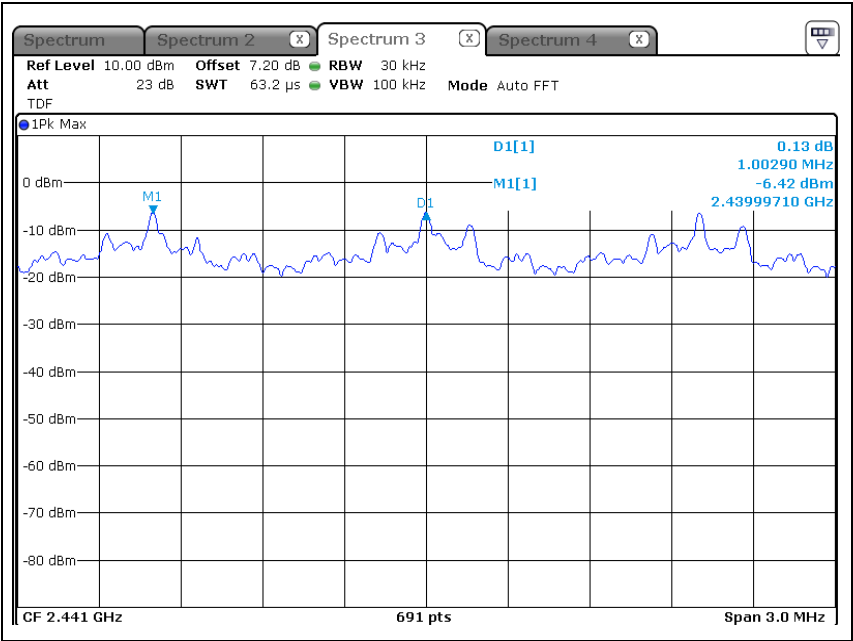
Operating Mode	Data Rate (Mbps)	Mark #1 (MHz)	Mark #2 (MHz)	Adjacent Hopping Channel Separation (kHz)	Two-third of 20 dB Bandwidth (kHz)	Minimum Bandwidth (kHz)
GFSK	1	2440	2441	1.003	547.0	25
8DPSK	3	2440	2441	1.003	836.5	

Figure 3. Plots of Carrier Frequency Separation

GFSK



8DPSK



5.4. Number of Hopping Channels

TEST: Number of Hopping Channels		
Method	Number of Hopping Channels from the EUT were measured according to the procedure of DA 00-705-2003 The EUT must have its hopping function enabled. 1. Use the following spectrum analyzer settings: 2. Span = the frequency band of operation 3. RBW $\geq$ 1 % of Span 4. VBW $\geq$ RBW. 5. Detector = peak. 6. Sweep time = auto couple. 7. Trace mode = max hold. 8. Allow trace to fully stabilize. 9. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s)	
Reference Clause	Part15 C Section 15.247 (a)(1)(iii)	
Parameters recorded during the test	Laboratory Ambient Temperature	25.2 °C
	Relative Humidity	48.1 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	2402 MHz - 2480 MHz	Antenna port

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
1	2	2
Supplementary information: None		

Limits

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

§15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 MHz band: 1 Watt.

Measurement Results

Table 4. Data Table of Number of Hopping Channels

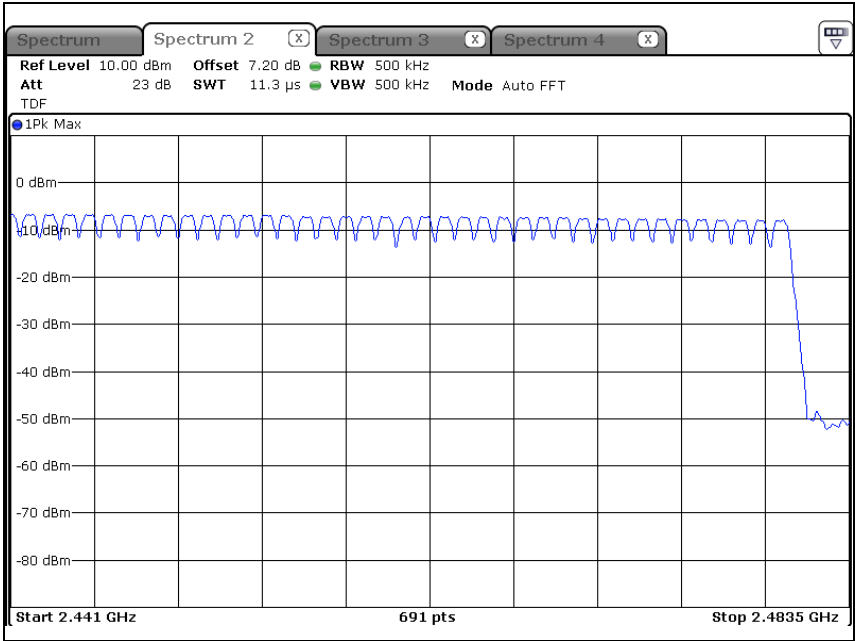
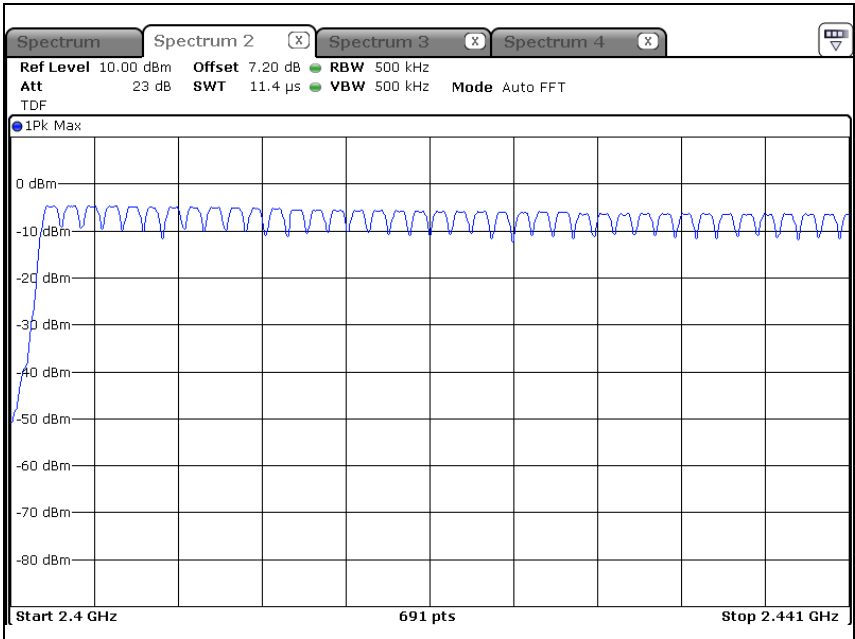
Operating Mode	Data Rate (Mbps)	Measurement Result	Limit
GFSK	1	79	≥ 75
8DPSK	3	79	

Remark:

Measurement is made with EUT operating in hopping mode between 79 channels providing a worst case scenario as compared to AFH mode hopping between 20 channels.

Plots of Number of Hopping Channels

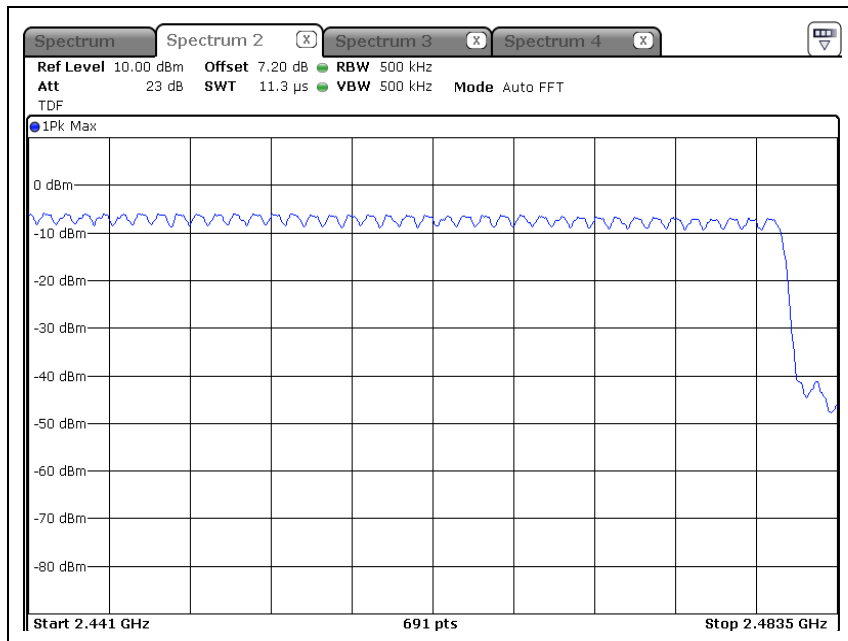
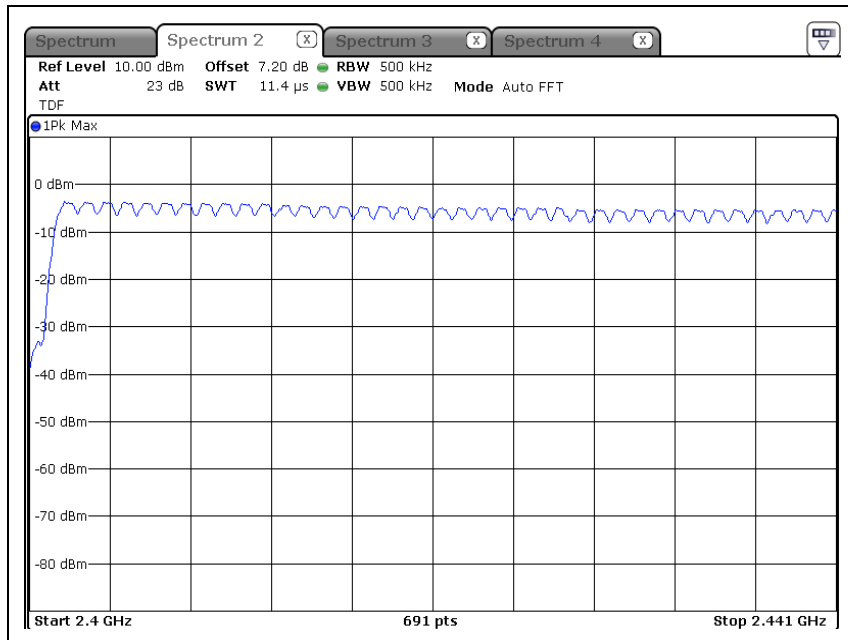
GFSK



Order Number: 10468098
Model Number: LND1420IWLM

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8DPSK



5.5. Average Time of Occupancy

TEST: Average Time of Occupancy		
Method	Average Time of Occupancy from the EUT were measured according to the procedure of DA 00-705-2003 The EUT must have its hopping function enabled. 1. Use the following spectrum analyzer settings: 2. Span = zero span, centered on a hopping channel 3. RBW = 1 MHz 4. VBW $\geq$ RBW. 5. Detector = peak. 6. Sweep time = as necessary to capture the entire dwell time per hopping channel. 7. Trace mode = max hold. 8. Allow trace to fully stabilize. 9. If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope may be used instead of a spectrum analyzer.	
Reference Clause	Part15 C Section 15.247 (a)(1)(iii)	
Parameters recorded during the test	Laboratory Ambient Temperature	24.5 °C
	Relative Humidity	31.5 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	2441 MHz	Antenna port

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
1	2	2
Supplementary information: None		

Limits

§15.247(a)(1) (iii) : For Frequency hopping systems in the 2400–2483.5 MHz 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.

Measurement Results

Table 5. Data Table of Time of Occupancy

● Non-AFH mode

Operating Mode	Data Rate (Mbps)	Packet Type	Burst on Time (ms/hop)	Hops per second (hop/s)	Period (s)	Dwell Time (ms)	Limit (ms)
GFSK	1	DH1	0.392	10.13	31.6	125.58	400
		DH3	1.653	5.06	31.6	264.33	
		DH5	2.900	3.38	31.6	309.69	
8DPSK	3	3DH1	0.400	10.13	31.6	127.90	
		3DH3	1.653	5.06	31.6	264.33	
		3DH5	2.907	3.38	31.6	310.47	

Dwell time calculation

- Dwell time = Pulse time * Hops per second within channel * Period time
- Hops per second within channel = 1600 hops/slot/no of channels
- DH1 = 1600/2/79(10.13), DH3 = 1600/4/79(5.06), DH5 = 1600/6/79(3.38)
- Period time = 0.4 sec * 79 channel = 31.6 sec

● AFH mode

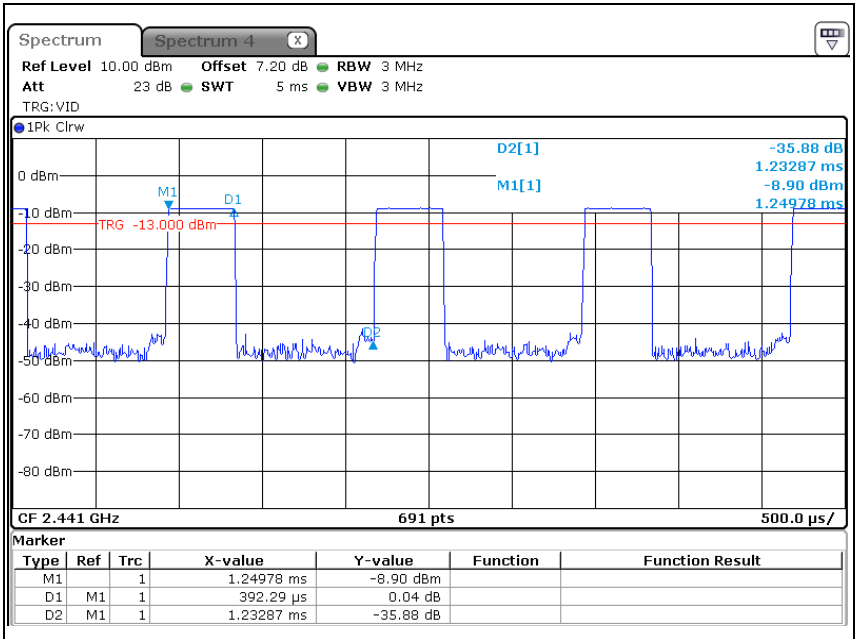
Operating Mode	Data Rate (Mbps)	Packet Type	Burst on Time (ms/hop)	Hops per second (hop/s)	Period (s)	Dwell Time (ms)	Limit (ms)
GFSK	1	DH1	0.392	20	8	62.72	400
		DH3	1.653	10	8	132.24	
		DH5	2.9	6.67	8	154.67	
8DPSK	3	3DH1	0.4	20	8	64.00	
		3DH3	1.653	10	8	132.24	
		3DH5	2.907	6.67	8	155.04	

Dwell time calculation

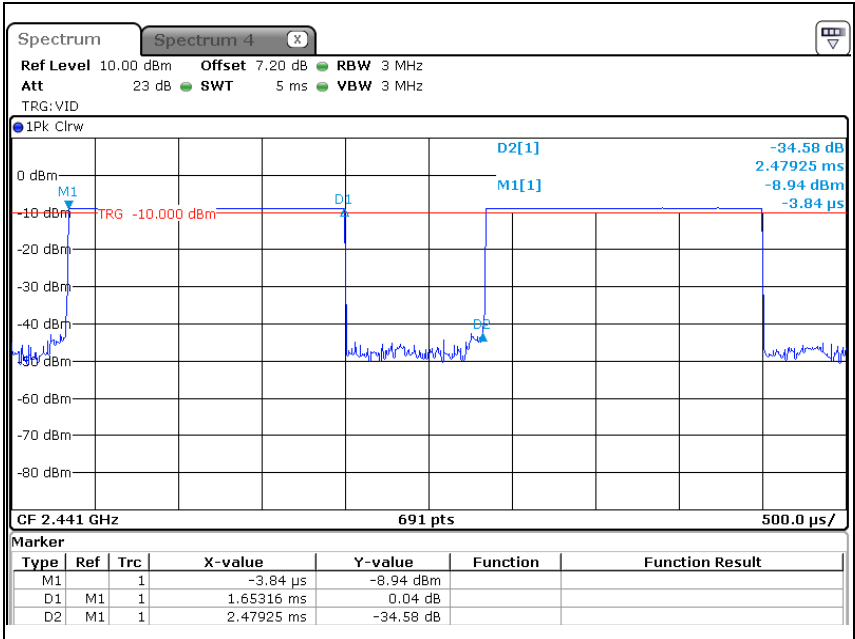
- Dwell time = Pulse time * Hops per second within channel * Period time
- Hops per second within channel = 1600 hops/slot/no of channels
- DH1 = 1600/2/20(20), DH3 = 1600/4/20(10), DH5 = 1600/6/20(6.67)
- Period time = 0.4 sec * 20 channel = 8 sec

Figure 4. Plots of Average Time of Occupancy

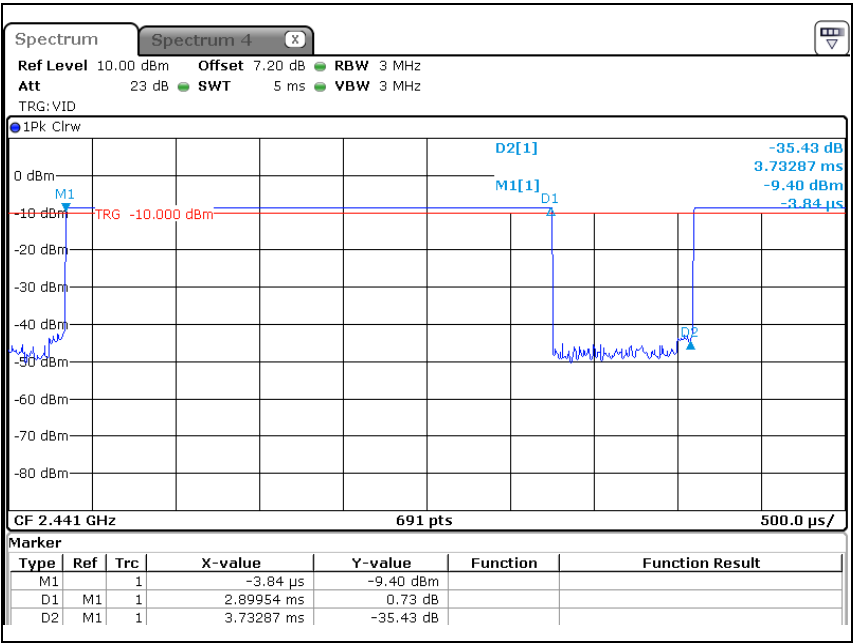
GFSK
DH1



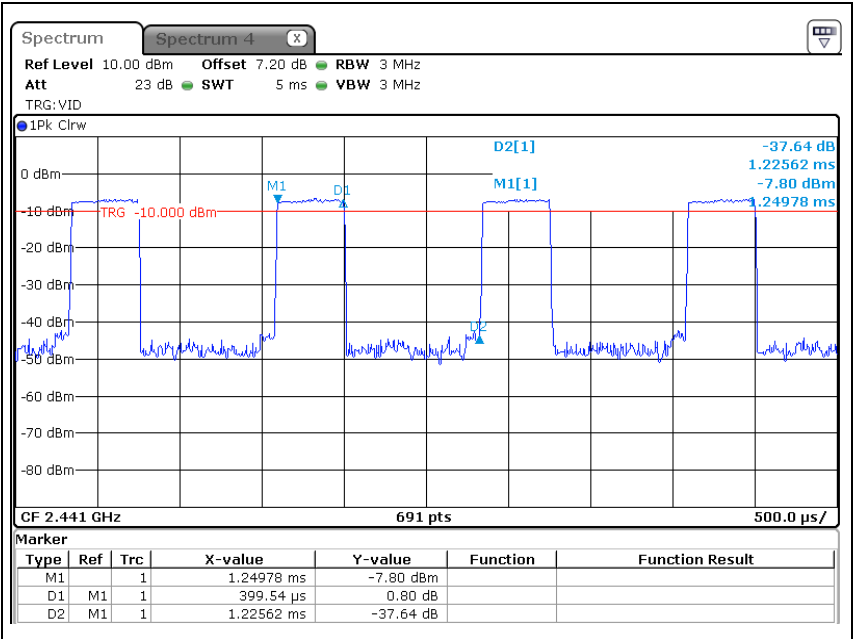
DH3



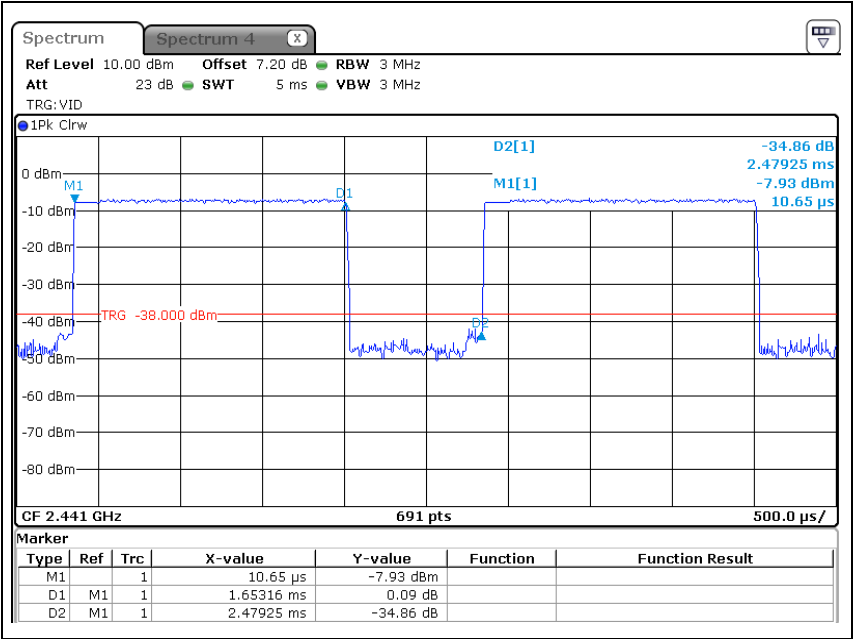
DH5



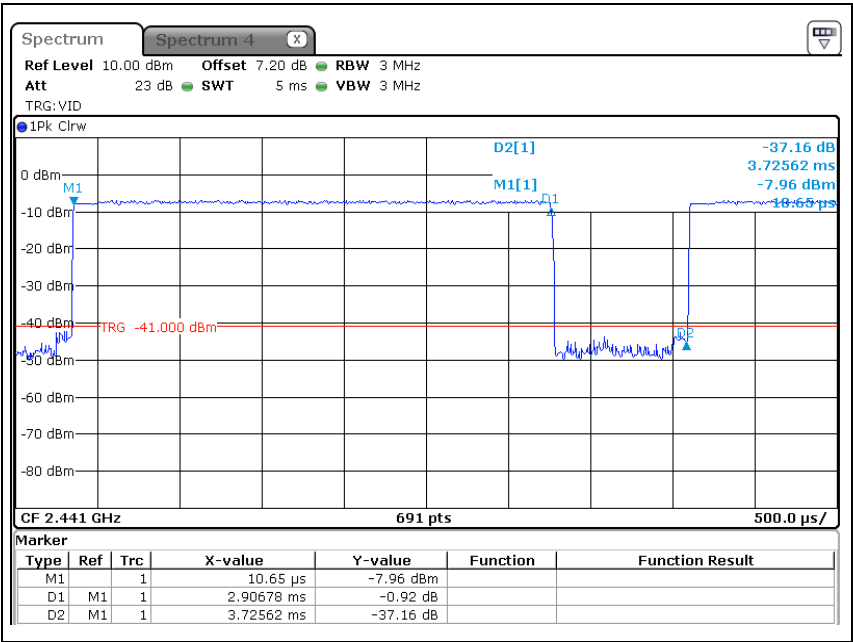
8DPSK
3DH1



3DH3



3DH5



5.6. Conducted spurious emission Measurement

TEST: Conducted spurious emission measurement		
Method	Conducted spurious emission from the EUT were measured according to the procedure of DA 00-705-2003 Measurement Procedure – Reference Level 1. Set the RBW = 100 kHz., VBW $\geq$ 300 kHz. 2. Set the span to 5-30 % greater than the EBW. 4. Detector = peak. 5. Sweep time = auto couple. 6. Trace mode = max hold. 8. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW. Measurement Procedure - Unwanted Emissions 1. Set RBW, VBW, detector as same with above 2. Set span to encompass the spectrum to be examined.	
Reference Clause	Part15 C Section 15.247 (d)	
Parameters recorded during the test	Laboratory Ambient Temperature	25.2 °C
	Relative Humidity	48.1 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30 MHz – 26.5 GHz	Antenna port

Configuration Settings

Test Item	Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
Conducted Spurious emission	1	1	2
Supplementary information: None			

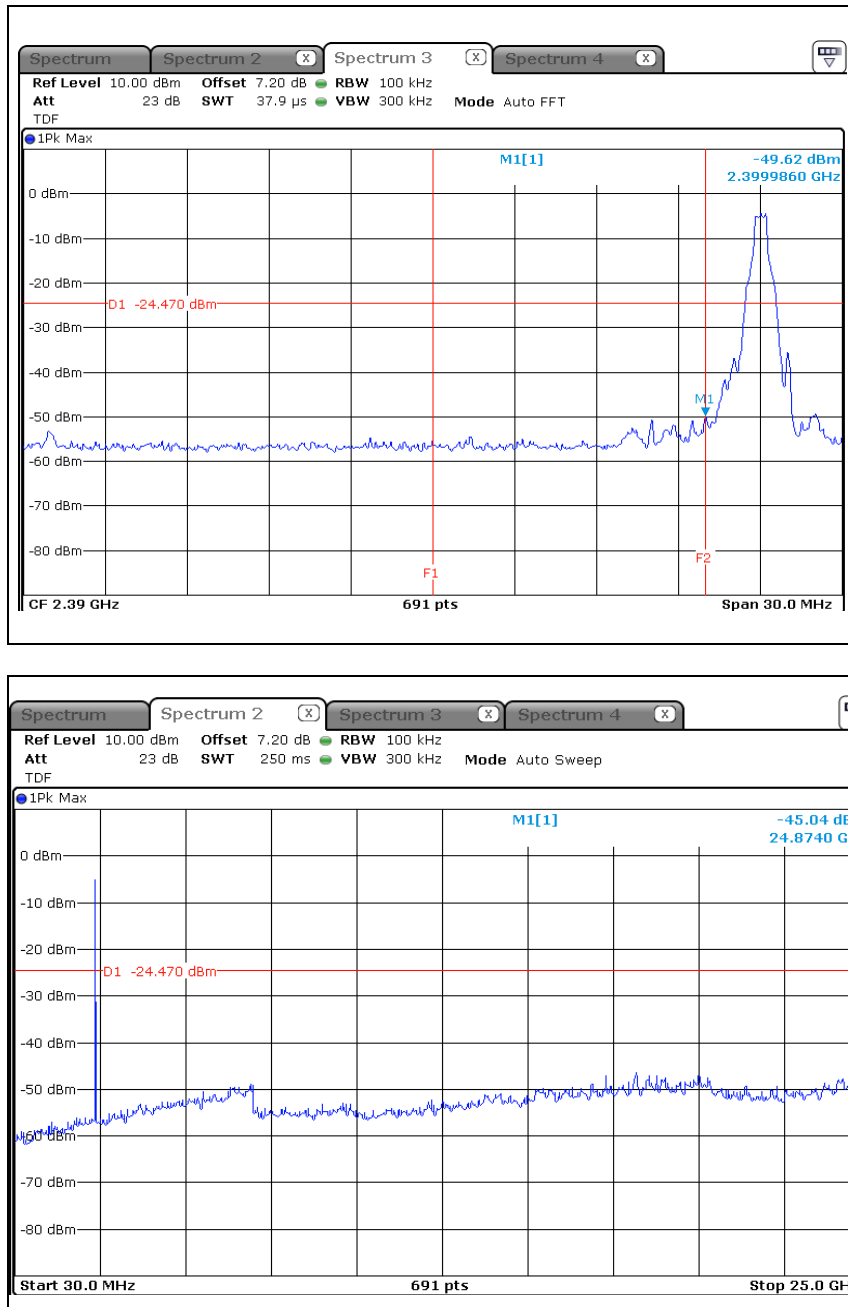
Limits

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. 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))

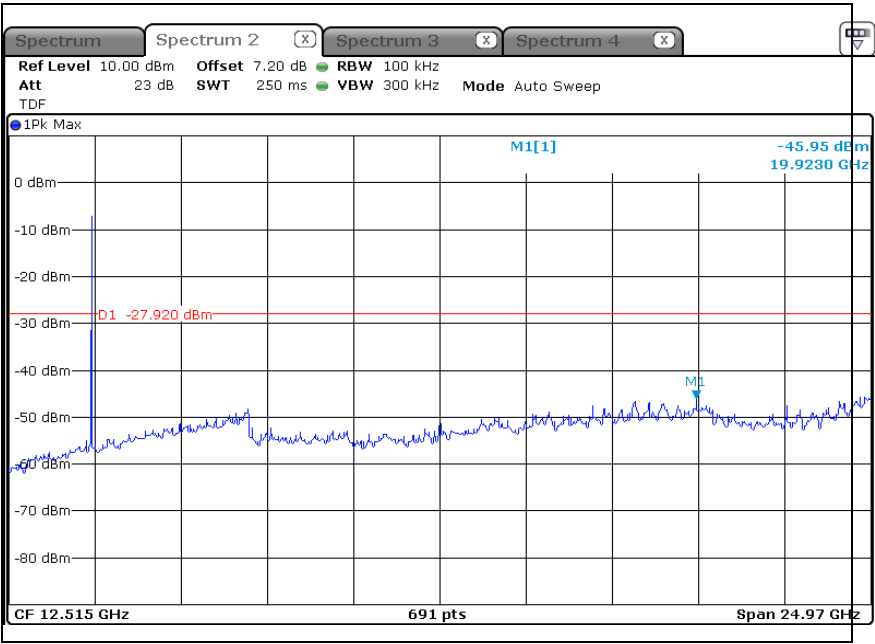
Measurement Results

Figure 5. Plots of Band-Edge and Restricted / Non-Restricted frequency bands

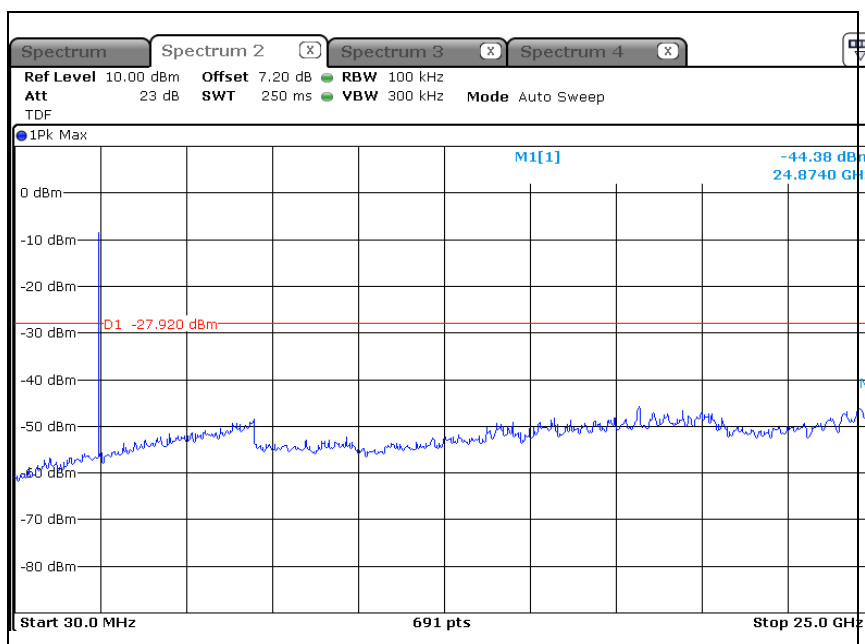
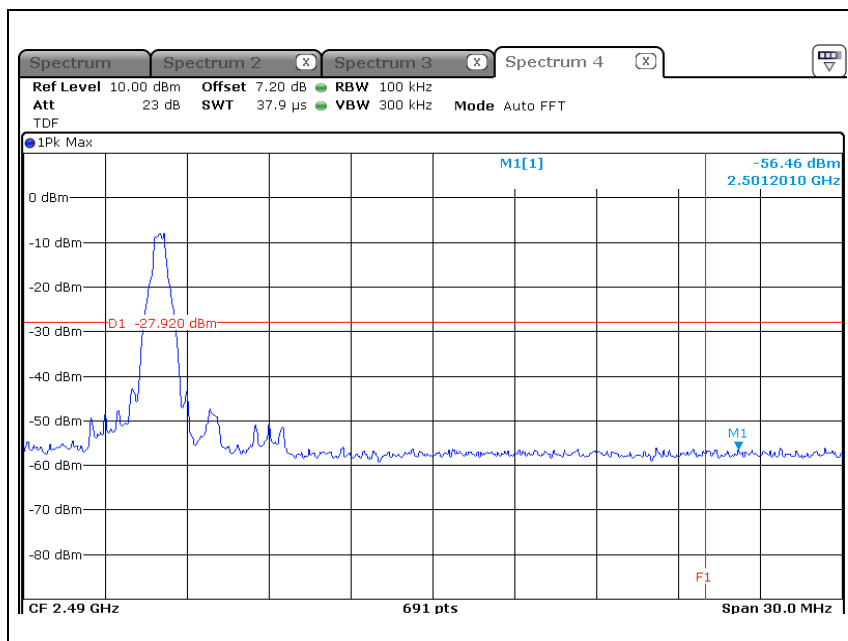
GFSK
Low



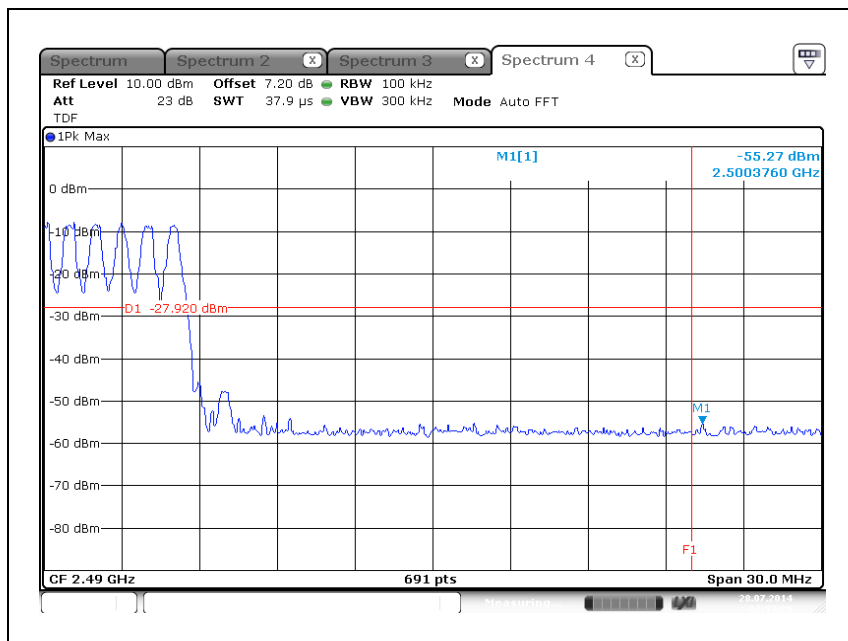
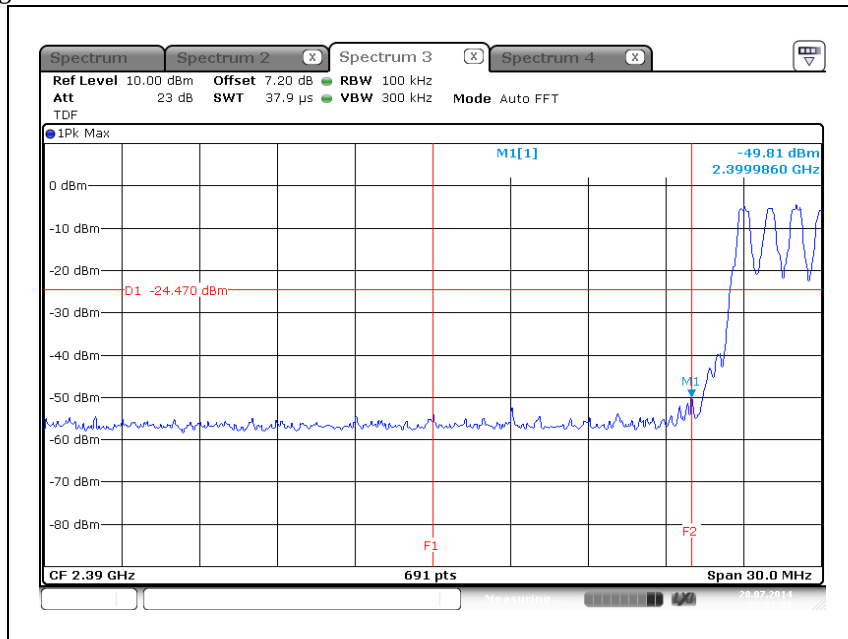
Middle



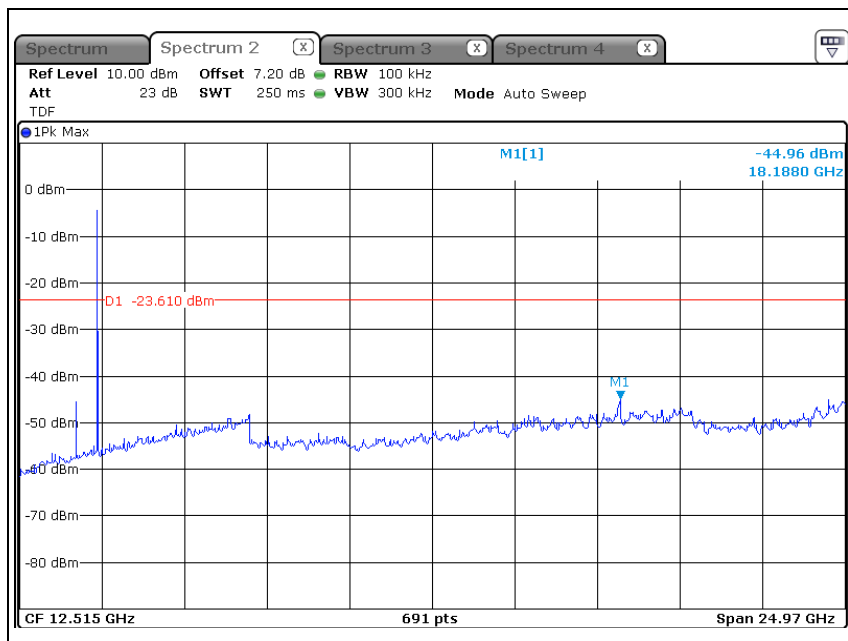
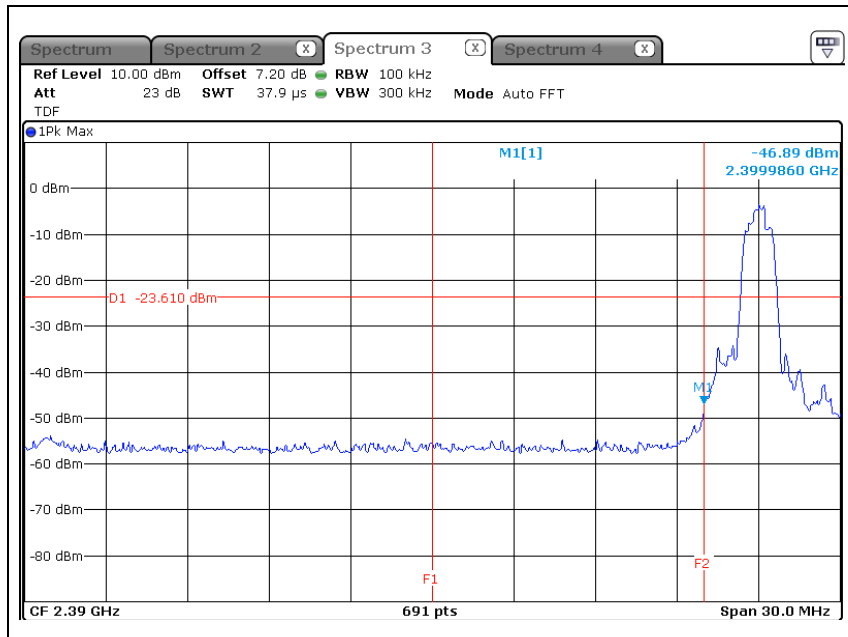
High



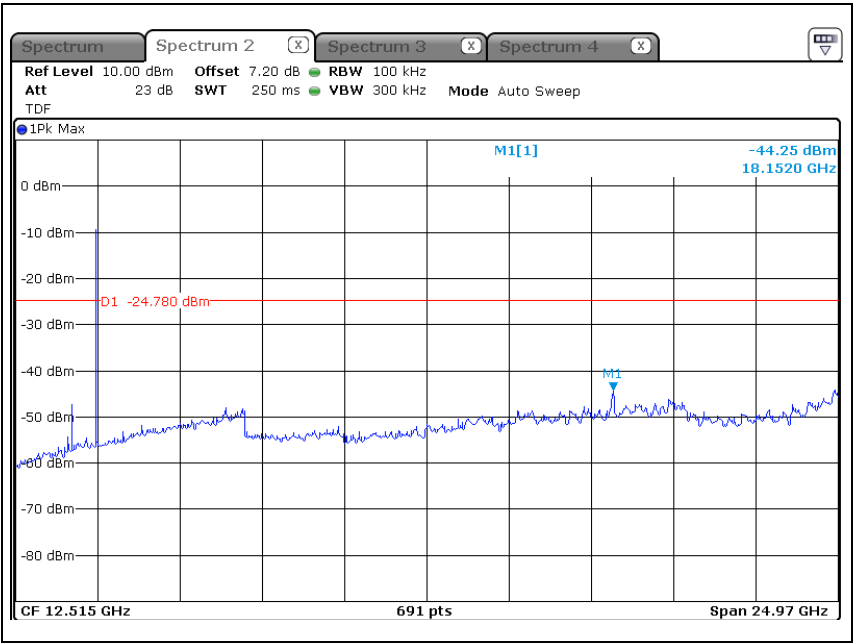
Bandedge at Hopping



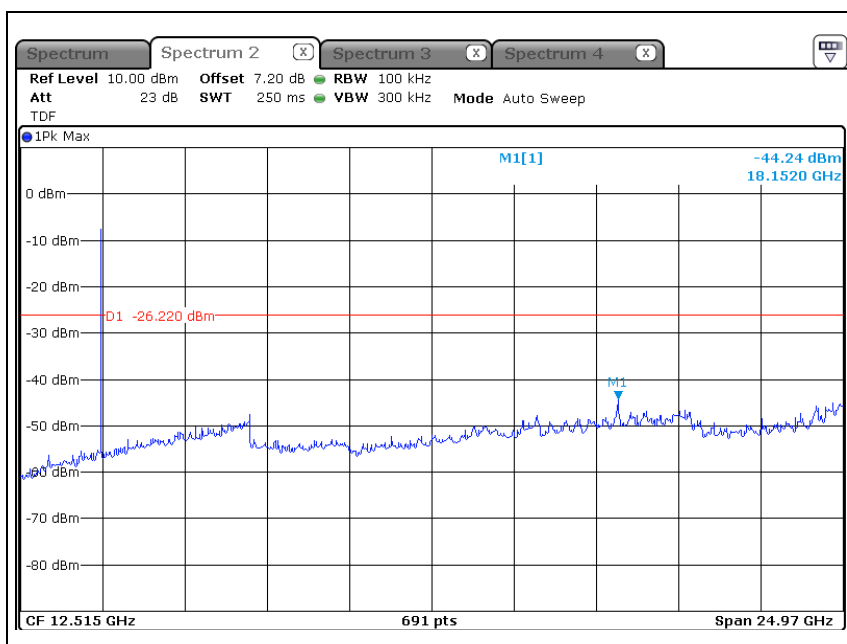
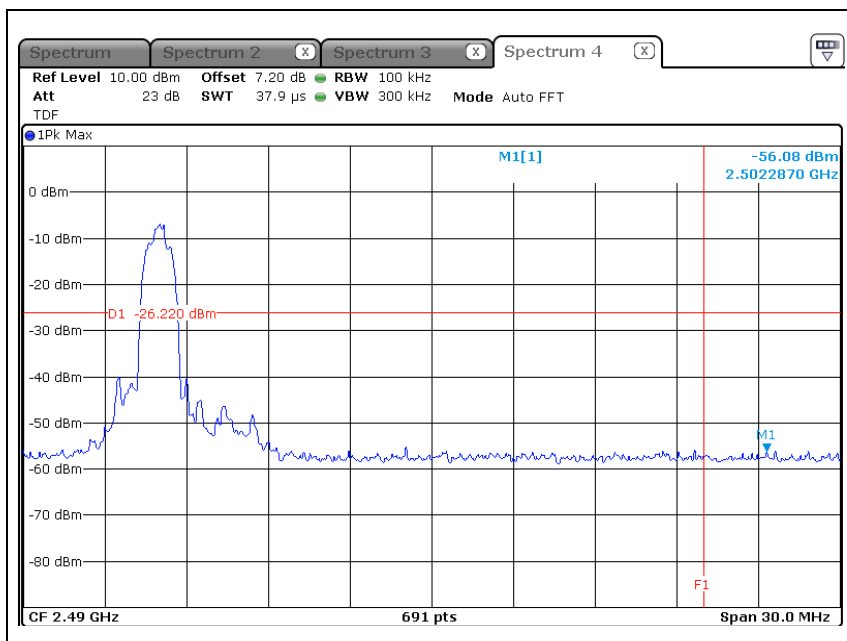
8DPSK
Low



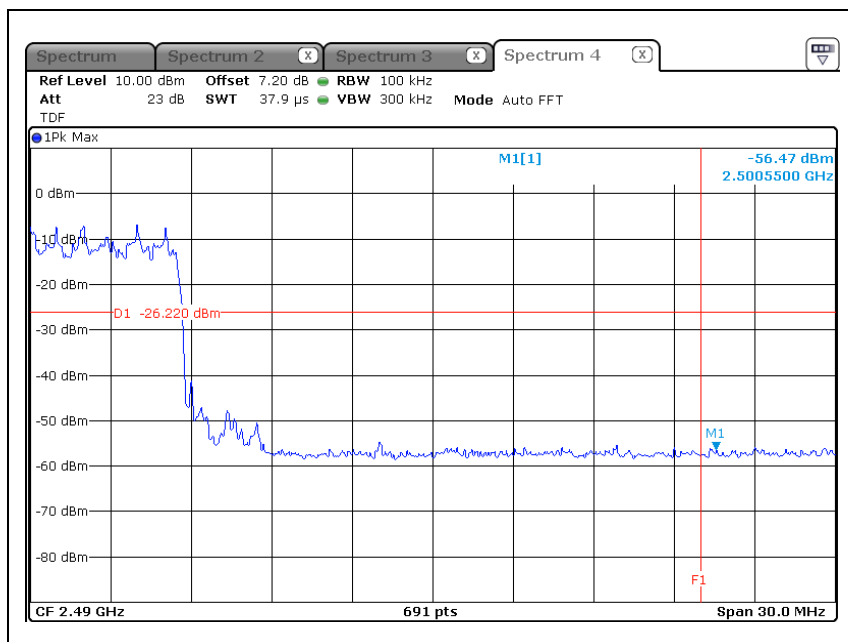
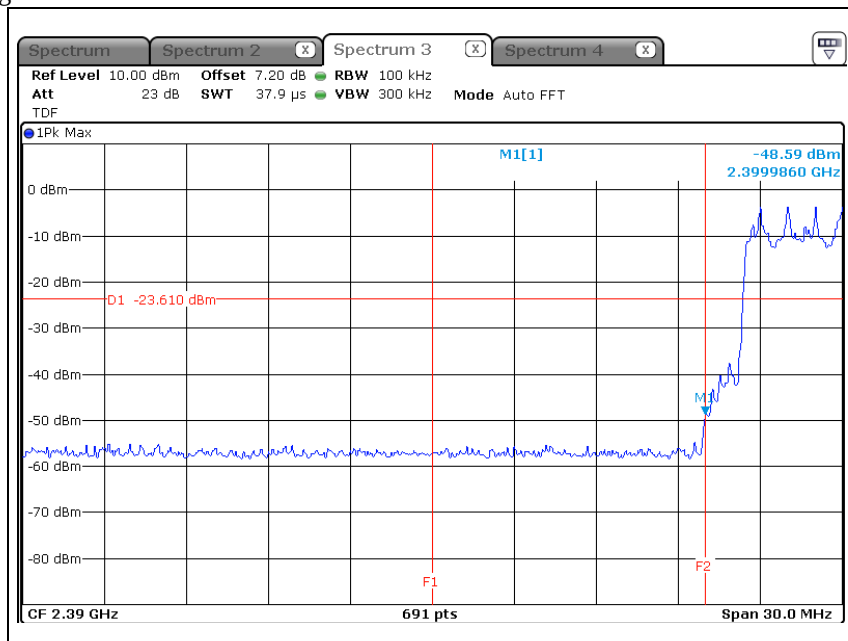
Middle



High



Bandedge at Hopping



5.7. Radiated Spurious Emissions Measurement

TEST: Radiated spurious emissions measurement		
Method	Radiated emissions from the EUT were measured according to ANSI C63.10 procedure. 1. The EUT was placed on the top of a rotating table 0.8 meters 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. The antenna is is varied from 1 to 4 meters above the ground to find the maximum field strength. Measurement are made with both horizontal and vertical polarizations For fundamental investigation, the EUT was positioned for 3 orthogonal orientations. 2. For measurement below 1GHz, the resolution bandwidth is set to 100 kHz for peak detection or 120kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak. 3. For measurement above 1GHz, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1/Ton Hz (Ton = On-time of the Pulsed emission) for Average detection (AV) at frequency above 1 GHz. VBW = 360 Hz $\geq$ 1/Ton Hz, pulse width in seconds (Ton = 2.90 ms). Refer to the DH5, 3DH5 of Time of Occupancy (Dwell Time) test item. 4. For 2.4GHz transmitter measurement, the spectrum from 30 MHz to 26GHz is investigated for Low, Mid and High channels. 5. For 5 GHz transmitter measurement, the spectrum from 30 MHz to 40GHz is investigated for Low, Mid and High channels.	
Reference Clause	Part15 C Section 15.247 (d)	
Parameters recorded during the test	Laboratory Ambient Temperature	23.1 °C
	Relative Humidity	33.2 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30 MHz – 40 GHz	3 meter chamber

Configuration Settings

Test Item	Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
Radiated Spurious emission	1	1	1
Supplementary information: None			

Limits

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. 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))

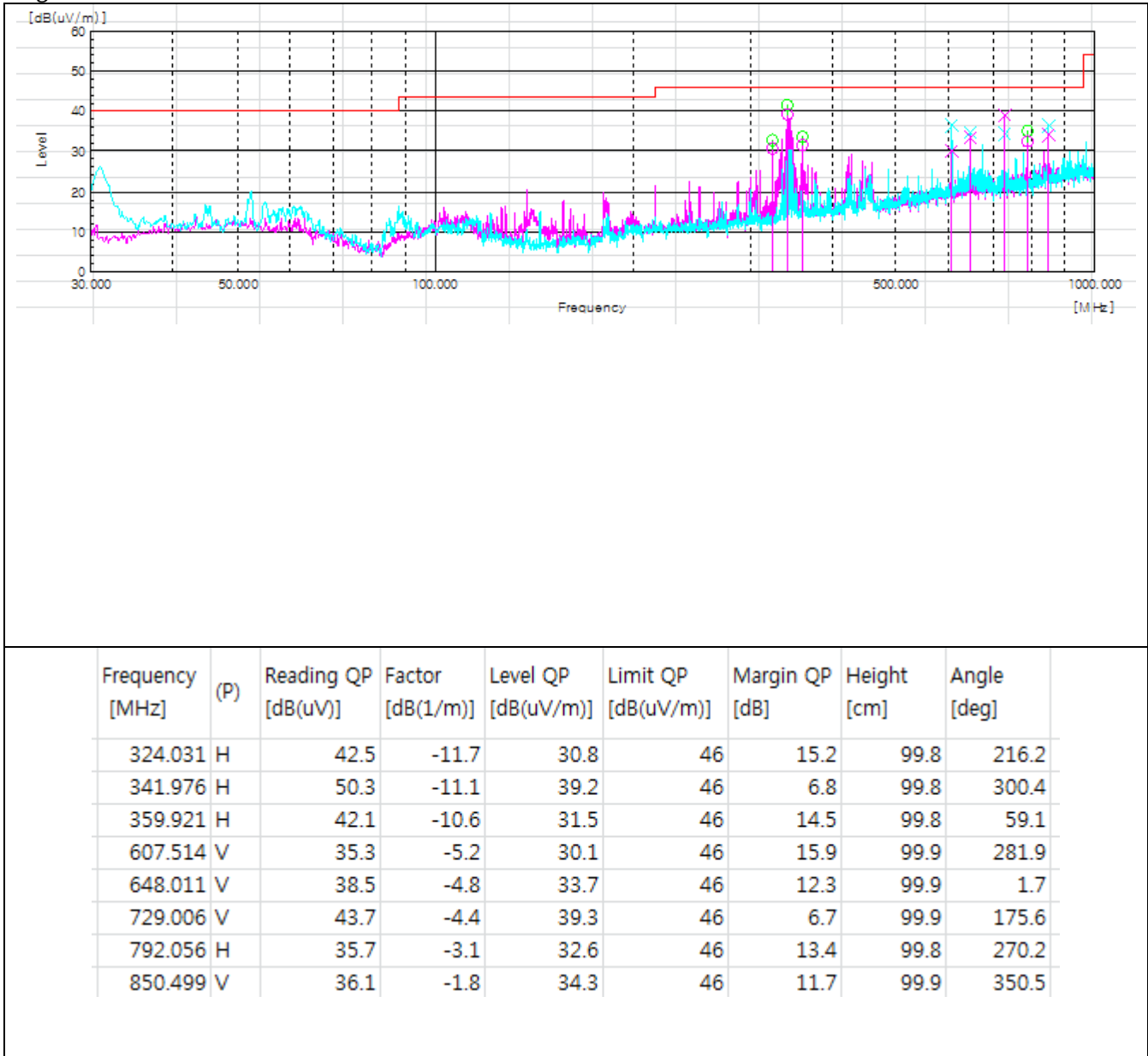
According to § 15.209(a), the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Distance (meters)	Field Strength (dBuV/m)	Field Strength (uV/m)
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

5.7.1. Radiated Spurious Emissions Below 1 GHz

Measurement method : ☒ Radiated ☐ Conducted
Mode of operation : Continuous Wave
Power setting : Max. Power condition declared by the manufacturer
Worst case configuration : 8DPSK Low channel

Figure 6. Test data for Radiated emission Below 1 GHz



Supplementary information:

- The frequency spectrum from 30 MHz to 1 000 MHz was investigated. Emission levels of 30 dB below than the limit is not reported.
- The worst case is x-axis and reported.
- Actual = Reading + AF + AMP + CL (AF : Antenna factor, AMP : Amp gain, CL : Cable loss)
- Margin = Limit (dBuV/m) - Actual (dBuV/m)

5.7.2. Radiated Spurious Emissions Above 1 GHz – 2.4 GHz band

Measurement method : ☒ Radiated ☐ Conducted
Mode of operation : 2.4 GHz band Continuous Wave
Power setting : Max. Power condition declared by the manufacturer

Table 6. GFSK Low Channel

Radiated emissions			Ant	Correction factors		Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	Amp gain+CL+AF (dB)		Actual (dBuV/m)	Margin (dB)
*2376.25	45.4	Peak	V	N/A	-0.6	74	44.8	29.2
*2376.25	39.7	Average	V	N/A	-0.6	54	39.1	14.9

Table 7. GFSK Mid Channel

Radiated emissions			Ant	Correction factors		Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	Amp gain+CL+AF (dB)		Actual (dBuV/m)	Margin (dB)
1628.00	38.2	Peak	V	N/A	-2.5	74	35.7	38.3
1628.00	22.6	Average	V	N/A	-2.5	54	20.1	33.9
2790.75	40.5	Peak	V	N/A	-1.4	74	39.1	34.9
2790.75	23.6	Average	V	N/A	-1.4	54	22.2	31.8
4881.75	43.1	Peak	V	N/A	6.7	74	49.8	24.2
4881.75	32.6	Average	V	N/A	6.7	54	39.3	14.7

Table 8. GFSK High Channel

Radiated emissions			Ant	Correction factors		Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	Amp gain+CL+AF (dB)		Actual (dBuV/m)	Margin (dB)
1654.00	42.1	Peak	V	N/A	-2.2	74	39.9	34.1
1654.00	25.3	Average	V	N/A	-2.2	54	23.1	30.9
*2483.50	64.2	Peak	V	N/A	-1.0	74	63.2	10.8
*2483.50	46.0	Average	V	N/A	-1.0	54	45.0	9.0
2790.50	40.5	Peak	V	N/A	-1.4	74	39.1	34.9
2790.50	22.9	Average	V	N/A	-1.4	54	21.5	32.5
4960.97	42.9	Peak	V	N/A	7.1	74	50.0	24.0
4960.97	28.6	Average	V	N/A	7.1	54	35.7	18.3

Supplementary information:

- The frequency spectrum from 1 GHz to 26.5 GHz was investigated. Emission levels of 40 dB below than the limit is not reported.
- “*” means the restricted band.
- The worst case is x-axis and reported.
- Actual = Reading+ Amp gain + AF + CL (AF : Antenna factor, CL : Cable loss)
- Distance factor = $20\log(\text{Measurement distance} / \text{The measured distance})$
- Margin = Limit (dBuV/m) - Actual (dBuV/m)
- The resolution bandwidth of receiver/spectrum analyzer is 1MHz and the video bandwidth is 1/T Hz for Average detecting (AV) at frequency above 1GHz.
(T=2.90ms, 1/T=344Hz, so set the VBW = 500Hz)

Table 9. 8DPSK Low Channel

Radiated emissions			Ant	Correction factors		Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	Amp gain+CL+AF (dB)		Actual (dBuV/m)	Margin (dB)
1600.50	42.2	Peak	V	N/A	-3.0	74	39.2	34.8
1600.50	24.7	Average	V	N/A	-3.0	54	21.7	32.3
*2376.25	45.3	Peak	V	N/A	0.4	74	45.7	28.3
*2376.25	40.8	Average	V	N/A	0.4	54	41.2	12.8
2790.50	40.5	Peak	V	N/A	0.6	74	41.1	32.9
2790.50	23.0	Average	V	N/A	0.6	54	23.6	30.4

Table 10. 8DPSK Middle Channel

Radiated emissions			Ant	Correction factors		Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	Amp gain+CL+AF (dB)		Actual (dBuV/m)	Margin (dB)
1627.75	42.1	Peak	V	N/A	-2.8	74	39.3	34.7
1627.75	28.2	Average	V	N/A	-2.8	54	25.4	28.6
*4881.75	35.1	Peak	H	N/A	6.7	74	41.8	32.2
*4881.75	22.6	Average	H	N/A	6.7	54	29.3	24.7

Table 11. 8DPSK High Channel

Radiated emissions			Ant	Correction factors		Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	Amp gain+CL+AF (dB)		Actual (dBuV/m)	Margin (dB)
1654.00	43.3	Peak	V	N/A	-2.2	74	41.1	32.9
1654.00	25.8	Average	V	N/A	-2.2	54	23.6	30.4
*2483.50	64.2	Peak	V	N/A	-1.0	74	63.2	10.8
*2483.50	45.2	Average	V	N/A	-1.0	54	44.2	9.8
2790.75	42.1	Peak	V	N/A	-1.4	74	40.7	33.3
2790.75	23.6	Average	V	N/A	-1.4	54	22.2	31.8

Supplementary information:

- The frequency spectrum from 1 GHz to 26.5 GHz was investigated. Emission levels of 40 dB below than the limit is not reported.
- “*” means the restricted band.
- The worst case is x-axis and reported.
- Actual = Reading+ Amp gain + AF + CL (AF : Antenna factor, CL : Cable loss)
- Distance factor = $20\log(\text{Measurement distance} / \text{The measured distance})$
- Margin = Limit (dBuV/m) - Actual (dBuV/m)
- The resolution bandwidth of receiver/spectrum analyzer is 1MHz and the video bandwidth is 1/T Hz for Average detecting (AV) at frequency above 1GHz.
(T=2.90ms, 1/T=344Hz, so set the VBW = 500Hz)

5.8. Antenna Requirement

5.8.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §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. And according to FCC 47 CFR Section § 15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in Db that the gain of the antenna exceeds 6 dBi.

5.8.2. Antenna Connected Construction

The antenna used of this product is Metal Stamping Antenna Assembly and peak max gain of each antennas as below . :

Band	2402 – 2480 MHz
Antenna Gain (dBi)	0.7

APPENDIX A. Accreditations and Authorizations



KOLAS: Accredited by Korea Laboratory Accreditation Scheme (KOLAS) as Testing Laboratory in accordance with the provisions of Article 23 of the National Standards Act. These criteria encompass the requirements of ISO/IEC 17025:2000.
KOLAS No.: 231



FCC: Details of the measurement facilities used for these tests have been filed with the Federal Communications Commission's Laboratory in Columbia, Maryland and accepted in a letter dated April 01, 2005 (FCC CAB: KR0040).



Industry Canada Industrie Canada

Industry of Canada: Accredited by Industry Canada for performance of radiated measurements.
Industry Canada Registration No.: 8035A



VCCI: Accepted as an Associate Member to the VCCI. The measurement facilities detailed in this test
VCCI Registration No.: R-3327, G-198, C-3706, T-1849

Appendix B _ Measurement Uncertainties

Test	Uncertainty	
Conducted Emissions	9 kHz ~ 150 kHz = ± 3.82 dB 150 kHz ~ 30 MHz = ± 3.43 dB (* Note see)	
Radiated emission	30 MHz ~ 300 MHz	3 m: + 4.86 [dB], - 4.88 [dB] 10 m: + 4.86 [dB], - 4.86 [dB]
	300 MHz ~ 1 000 MHz	3 m: + 4.98 [dB], - 4.99 [dB] 10 m: + 4.85 [dB], - 4.87 [dB]
	1 GHz ~ 6 GHz	3 m: + 6.19 [dB], - 6.20 [dB]