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Project No.:	12CA42753
File No.:	TC9191
Report No.:	12CA42753-FCC-1
Date:	September 5, 2012
Model No.:	SPP-R400
FCC ID.:	U5MSPP-R400

FCC Test Report

in accordance with
FCC Part 15 Subpart C §15.247

for

Mobile Printer

BIXOLON CO.,LTD.
7th~8th FL, Miraeasset Venture Tower, 685, Sampyeong-dong,
Bundang-gu, Seongnam-si, 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

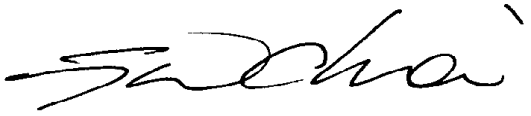
No	Reference Clause No.	FCC Part15 Subpart C Conformance Requirements	Verdict	Remark
1	15.205(a) 15.209 15.247(d)	Transmitter radiated spurious emissions and Conducted spurious emission	Complied	
2	15.247(a)(1)	20dB Bandwidth	-	Note 1
3	15.247(b)(1)	Maximum peak output power	Complied	
4	15.247(a)(1)	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	
7	15.207	Transmitter AC power line conducted emission	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.

Tested by
Kyung Duk Ko, WiSE Project Engineer
UL Verification Services- 3014ASEO
UL Korea Ltd.
September 5, 2012



Reviewed by
Jeawoon, Choi, WiSE Engineering Leader
UL Verification Services- 3014ASEO
UL Korea Ltd.
September 5, 2012

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Test Report Details

Tests Performed By:	UL Korea Ltd. 33rd FL. GFC Center, 737 Yeoksam-dong, Gangnam-gu, Seoul, 135-984, Korea
Test Site:	ONETECH Corp. 301-14 Daessangryeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do, 464-862 Korea
Applicant:	BIXOLON CO.,LTD. 7th~8th FL, Miraeasset Venture Tower, 685, Sampyeong-dong, Bundang-gu, Seongnam-si, Korea
Applicant Contact:	Son, Hyunsuk
Title:	QM Manager
Phone:	+82 31 218 5582
E-mail:	hs@bixolon.com
Product Type:	Mobile Printer
Model Number:	SPP-R400
Trademark	BIXOLON®
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:	August 13, 2012
Sample Receive Date:	August 13, 2012
Testing Date:	August 31, 2012
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.

Report Directory

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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 it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.2. Details of Test Equipment (EUT)

- Equipment Type : Mobile Printer
- Model No. : SPP-R400
- Trade name : BIXOLON
- Type of test Equipment : Portable type
- Operating characteristic : Short range wireless device operating in the 2400 – 2483.5 ISM frequency band
- Factory : EVERINT Co., Ltd.
  129, Chungjusandan 13(sipsam)-ro, Chungju-si,
  Chungcheongbuk-do, Korea

1.3. Equipment Configuration

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

Use*	Product Type	Factory	Model	Comments
EUT	Mobile Printer	EVERINT Co., Ltd.	SPP-R400	-
Note: Use = EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment. SIM - Simulator (Not Subjected to Test)				

1.4. Technical Data

Item	Type of Mobile Printer
Frequency Ranges	2400 – 2483.5 MHz
Output power	Max. 4.0 dBm e.i.r.p , Typical : 1.0 dBm
Kind of modulation (s)	1Mbps(GFSK) , 2Mbps(π/4-DQPSK) , 3Mbps(8DPSK)
Emission Designator	F1D, G1D
Hopping Channel	79 channel, 1600 hops/sec
Antenna Gain	-0.22 dBi
Antenna information	Integral antenna (Chip Antenna)
Working temperature	-20 ~ 70 ℃
Supply Voltage	DC 7.4 V

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

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1.5. Antenna Information

Antenna Model Name : KNC-1
Antenna Type : Chip Antenna
Manufacturer : Nice Korea Components Co., Ltd
Transmit Gain dBi : Max. -0.22 dBi
Azimuth Beam Pattern : Linear vertical

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
2	APPROVAL SHEET / NKC-1

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1.8. Description of additional model name

Model name	Model name Designation	Description of design
SPP-R400	Basic model	-

1.9. Maximum Output Power (Baseline Measurement)

Modulation Type	Rate		Peak Power(dBm)		
			2402 MHz	2441 MHz	2480 MHz
GFSK	1	Mbps	-8.57	-7.50	-7.19
π/4-DQPSK	2	Mbps	-9.29	-8.79	-8.83
8DPSK	3	Mbps	-8.10	-7.49	-7.58

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 C63.4:2009 : American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
3) ANSI C63.10:2009 : American National Standard for Testing Unlicensed Wireless Devices
4) FCC Public Notice DA 00-705-2003
   Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

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3. Test Conditions

3.1. Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	Mobile Printer	EVERINT Co., Ltd.	SPP-R400	-
AE	Note PC	LG	R510	-
Note: Use = EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment. SIM - Simulator (Not Subjected to Test)				

3.2. Input/Output Ports

No	Port Name	Type*	Cable Max. >3m (Y/N)	Cable Shielded (Y/N)	Comments
1	Power Input	DC	N	N	Connected to DC Power supply
2	Radio Antenna	I/O	N	Y	-
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**
Rated	7.40 V	-	-	DC	-	Normal operating voltage
1	6.66 V	-	-	DC	-	V_{MIN}
2	8.14 V	-	-	DC	-	V_{MAX}

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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 generated continuously for the representative channels (Low, Mid, High) by the test program incorporated
2	Carrier off (Idle) mode: RF carrier was not activated by the RF module

Note :
1. The measurements of the spurious emissions for transmitter on stand-by mode were performed as the receiver spurious emissions.
2. 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	Extreme condition
Temperature	+ 15℃ ~ +35℃	-20℃ / +55℃
Humidity	20% ~ 75%	No excessive condensation occur
Supply voltage	7.40 Vdc (Rated nominal voltage)	6.66 Vdc / 8.14 Vdc

Note ;
- The extreme condition is applied to the boundary limits of the declared operational environmental condition by the manufacturer.
- The operating condition for humidity requirement has not been declared in the manufacturer's specification.
- Test has been carried out for three frequencies specified above under the normal condition and for the extreme condition, minimum and maximum frequencies has been tested.

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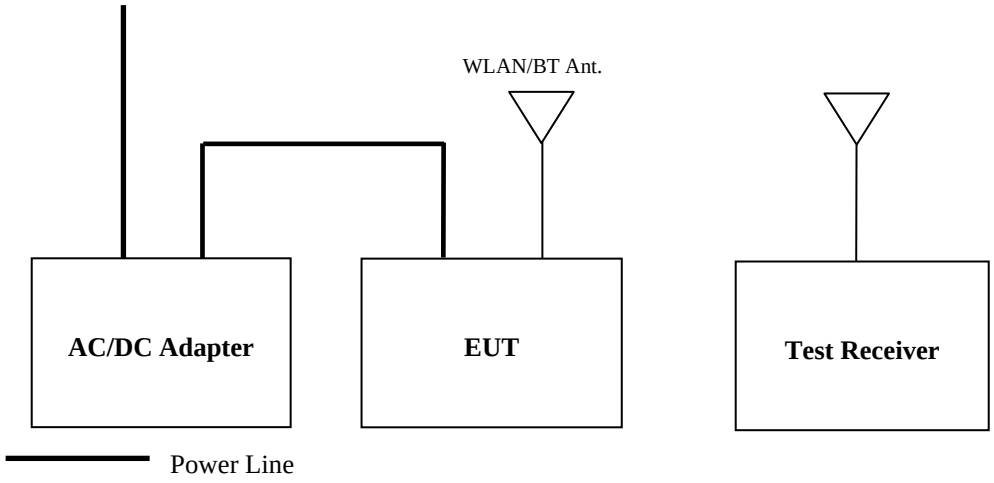
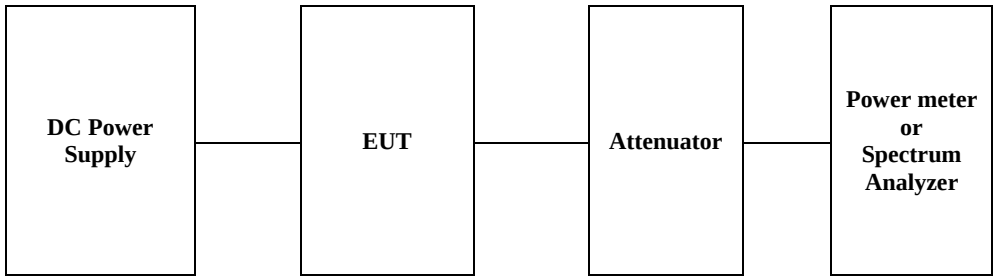
3.7. Test Configurations

Mode #	Description
1	
2	

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3.8. List of Test Equipment

No	Description	Manufacturer	Model	Identifier	Cal. Due
1	Signal Analyzer	Rohde & Schwarz	FSV30	101372	2013.05.31
8	Test Receiver	Rohde & Schwarz	ESCI	101012	2013.02.06
9	Test Receiver	Rohde & Schwarz	ESU	100261	2012.09.27
10	AMPLIFIER	Sonoma Instrument	310N	312544	2012.10.12
11	AMPLIFIER	Sonoma Instrument	310N	312545	2012.10.12
12	TRILOG Broadband Antenna	Schwarzbeck	VULB9163	9163-419	2014.05.27
13	TRILOG Broadband Antenna	Schwarzbeck	VULB9163	9163-420	2014.05.27
14	CONTROLLER	Innco Systems GmbH	CO2000	619/27030611/L	N/A
15	Turn Table	Innco Systems GmbH	DT3000	930611	N/A
16	Antenna Master	Innco Systems GmbH	MA4000-EP	MA4000/332	N/A
17	Antenna Master	Innco Systems GmbH	MA4000-EP	MA4000/335	N/A
18	Horn Antenna	Schwarzbeck	BBHA9120D	BBHA9120D295	2013.08.23
19	Horn Antenna	Schwarzbeck	BBHA9120D	BBHA9120D294	2013.08.23
20	Signal Conditioning Unit	Rohde & Schwarz	SCU 18	10041	2012.12.15
22	DC Power Supply	Digital Electronics	DRP-305DN	4030191	2013.09.13
	Test Receiver	Rohde & Schwarz	ESCI	101012	2013.02.06
	AMN	Schwarzbeck	NSLK 8128	8128-216	2013.06.11
	AMN	EMCO	3825/2	9109-1869	2013.05.30

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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 C63.4-2009 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]
15.207	Transmitter AC power line conducted emission	ANSI C63.4-2009 DA 00-705-2003	[X]

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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) ≥ 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	22 °C
	Relative Humidity	36 %
	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)
Rated	1	2
Supplementary information: None		

Limits

§15.247(a)(1) : No limit apply.

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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	933.40	N/A
		Middle	2441	933.40	
		High	2480	940.70	
8DPSK	2	Low	2402	1 273.50	
		Middle	2441	1 273.50	
		High	2480	1 259.00	

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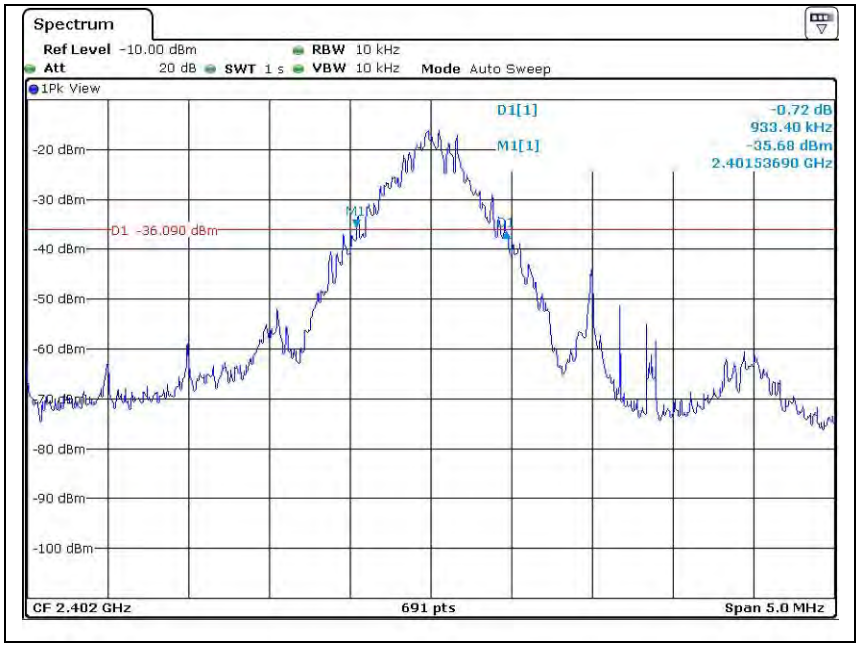
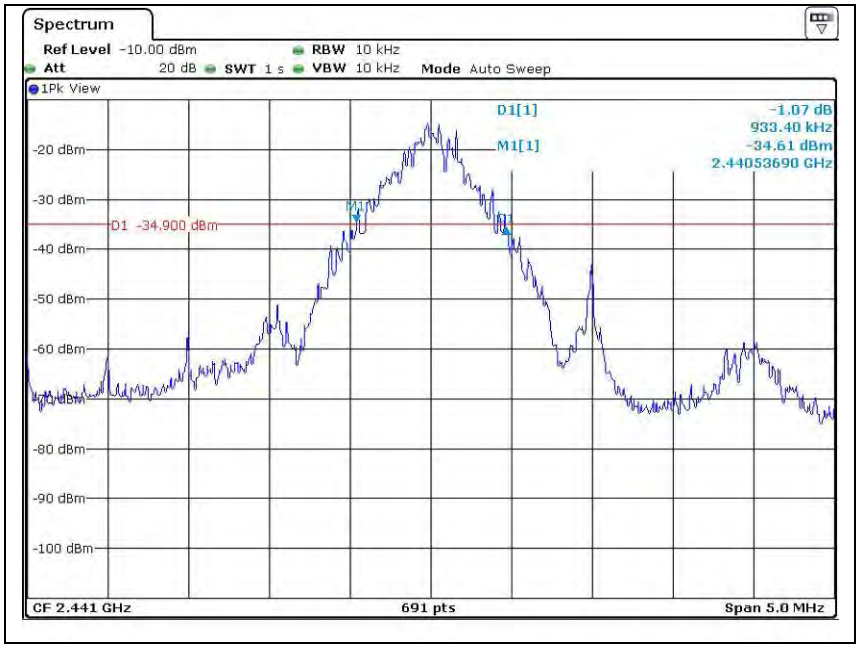
Figure 1. Plots of 20 dB Bandwidth

GFSK
Low



Middle



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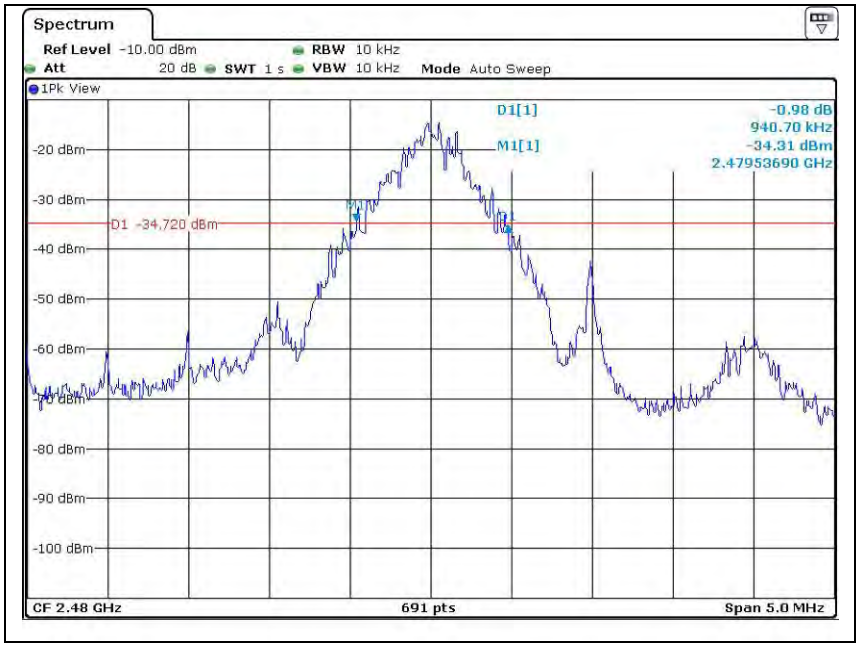
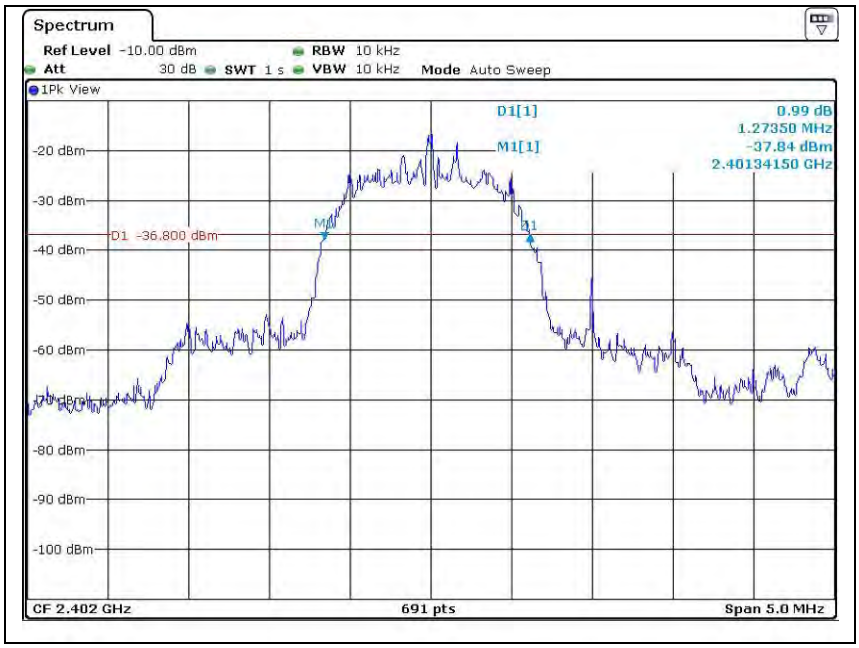
High



8DPSK
Low



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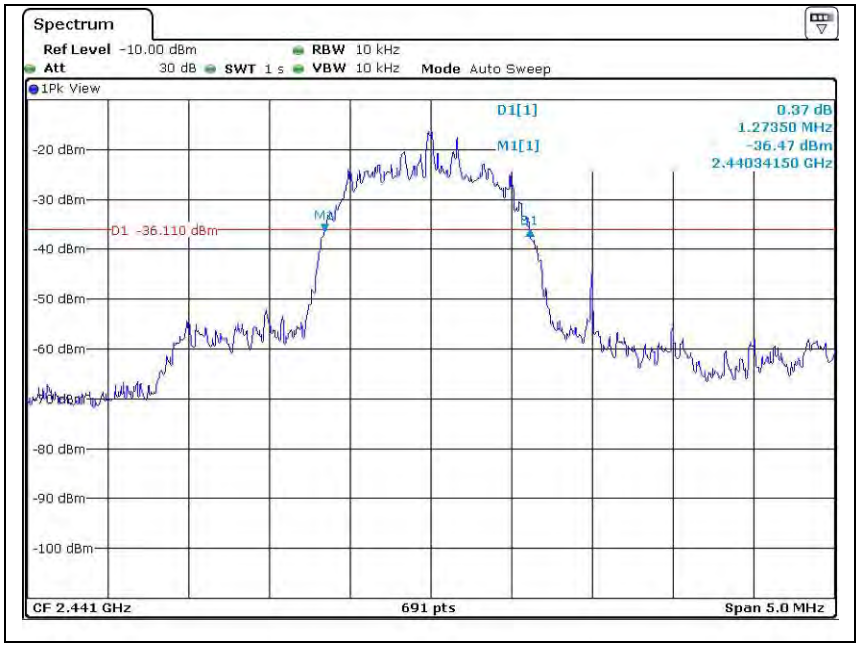
Middle



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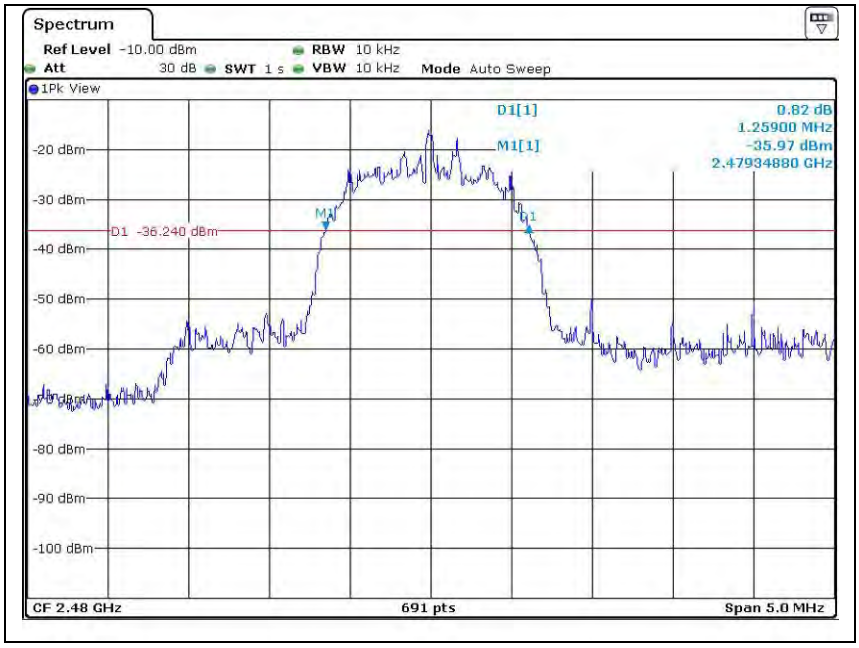

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5.2. Maximum Peak Output Power

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 ≥ 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	22 °C
		Relative Humidity	36 %
		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)
Rated	1	2
Supplementary information: None		

Limits

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

1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 ㎒ 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.

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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	-8.57	30.00
		Middle	2441	-7.50	
		High	2480	-7.19	
8DPSK	3	Low	2402	-8.10	20.97
		Middle	2441	-7.49	
		High	2480	-7.58	

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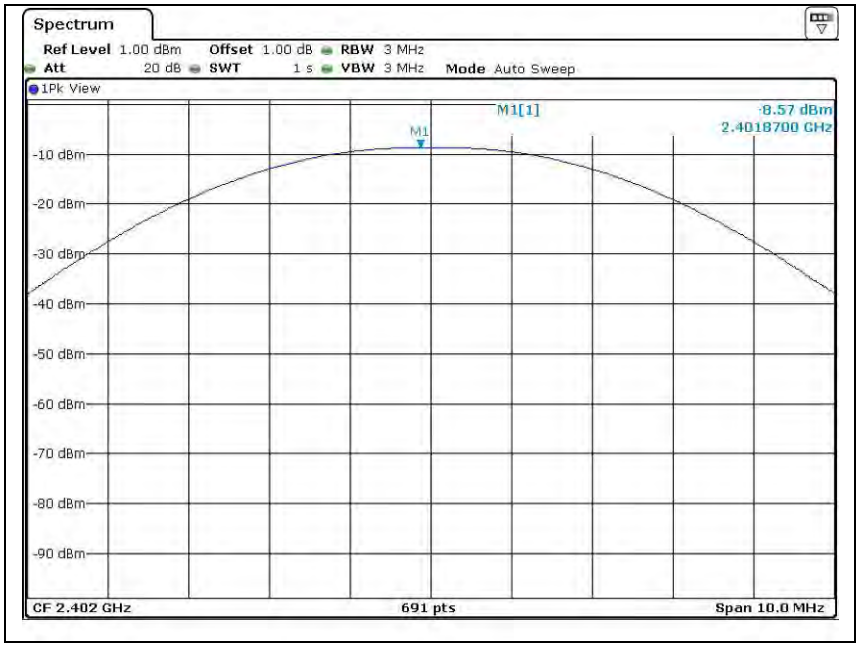
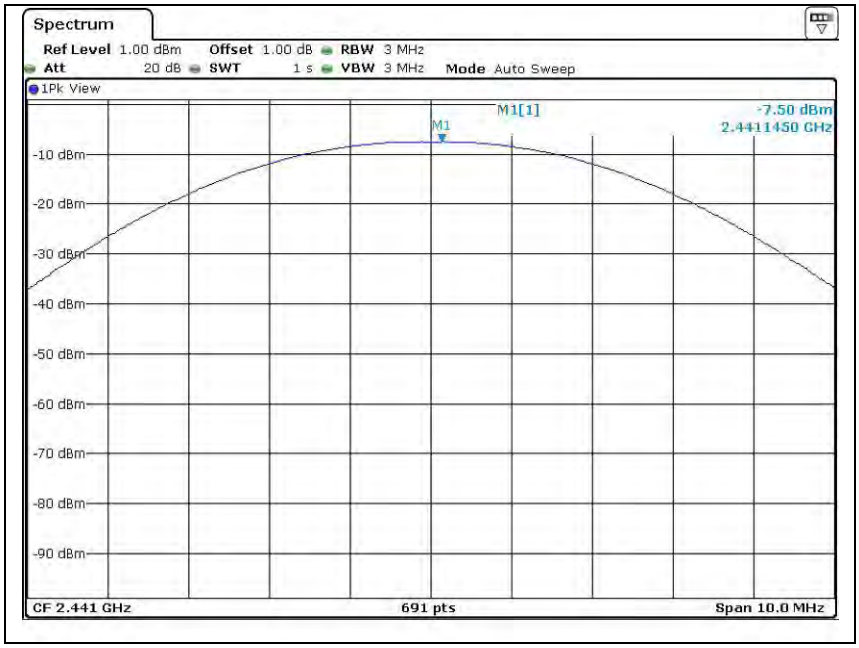
Figure 2. Plots of Maximum Peak Power

GFSK
Low



Middle



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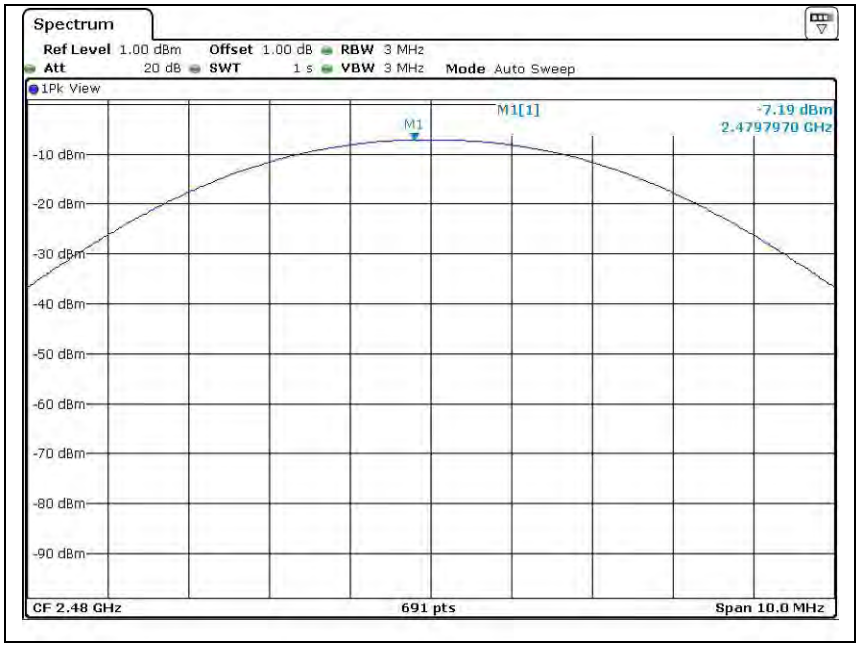
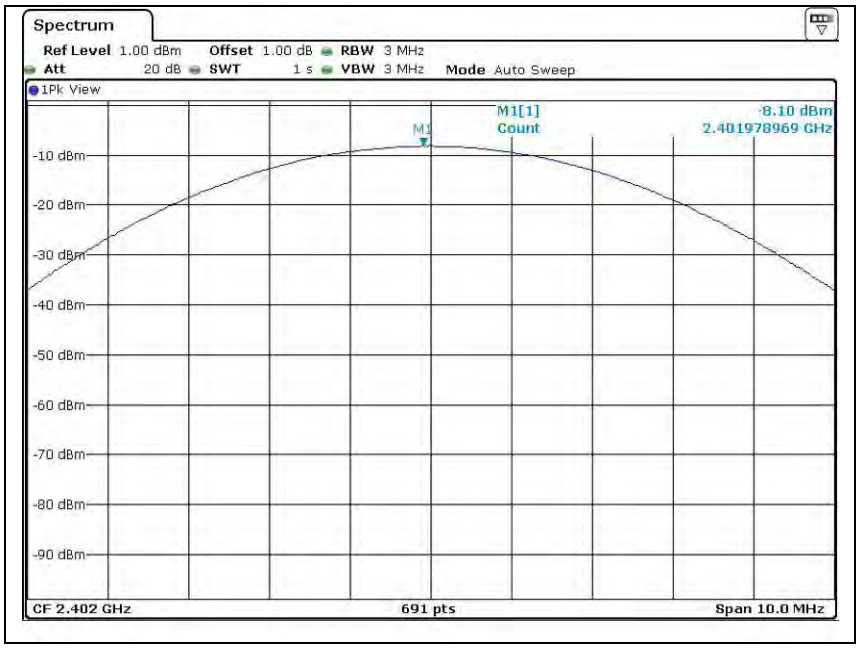
High



8DPSK
Low



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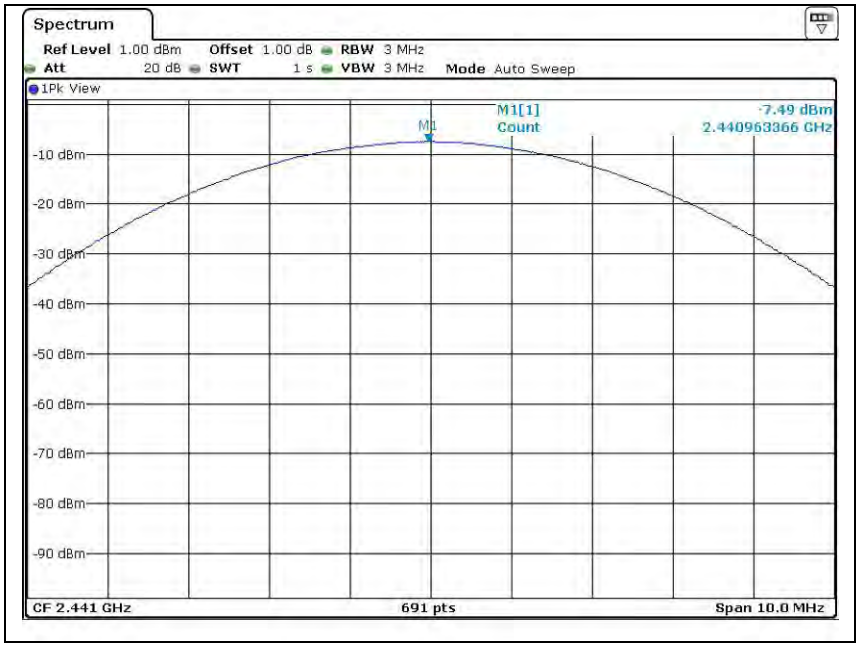
Middle



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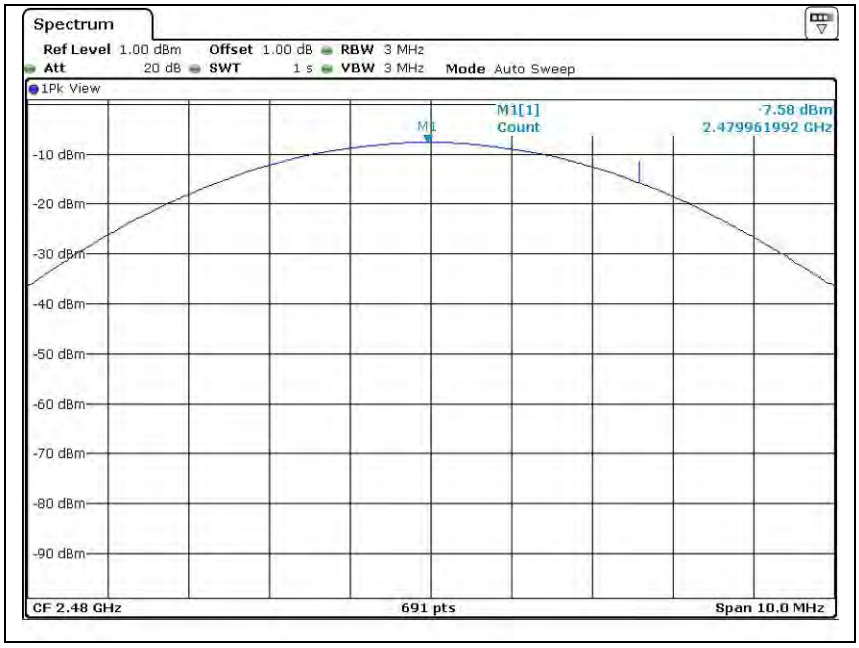

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5.3. Carrier Frequency Separation

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 ≥ 1 % of Span 4. VBW ≥ 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	22 °C
	Relative Humidity	36 %
	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)
Rated	1	2
Supplementary information: None		

Limits

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

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Measurement Results

Table 3. Data Table of Carrier Frequency Separation

Operating Mode	Data Rate (Mbps)	Mark #1 (MHz)	Adjacent Hopping Channel Separation (kHz)	Two-third of 20 dB Bandwidth (kHz)	Minimum Bandwidth (kHz)
GFSK	1	2439.806	998.6	622.3	25
8DPSK	3	2439.806	991.3	849.0	

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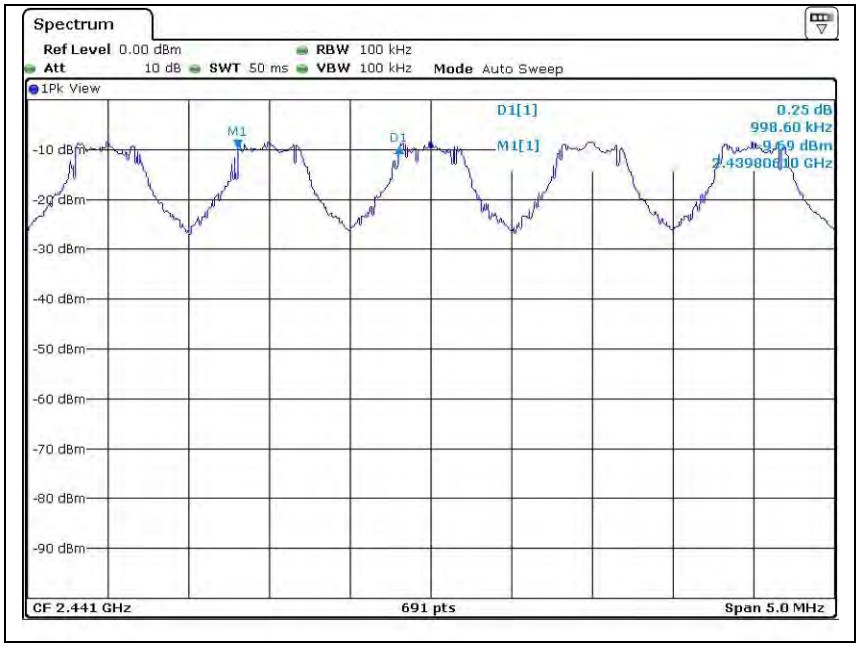
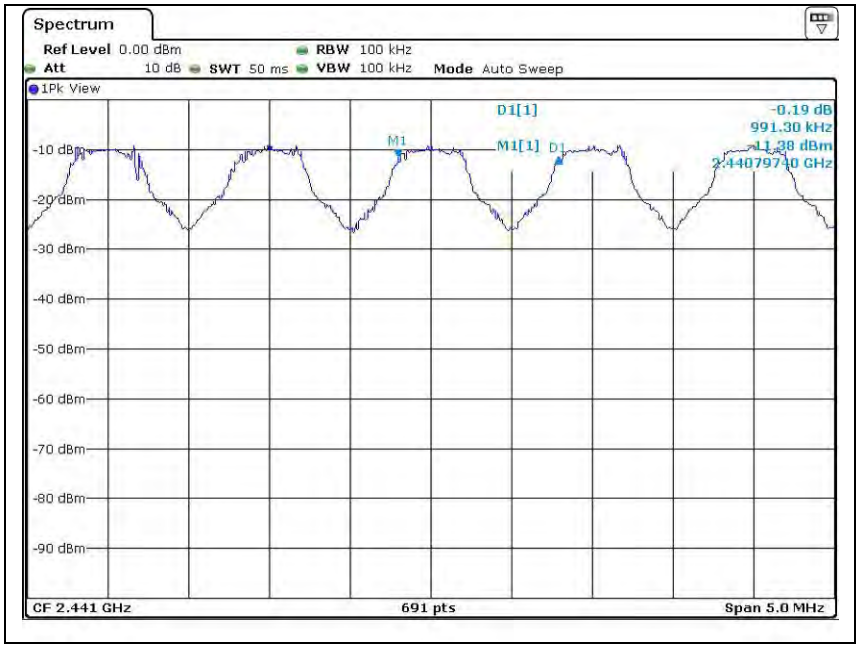
Figure 3. Plots of Carrier Frequency Separation

GFSK



8DPSK



Only those products bearing the UL Mark should be considered as being covered by UL.

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 ≥ 1 % of Span 4. VBW ≥ 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	22 °C
		Relative Humidity	36 %
		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)
Rated	1	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 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 ㎒ band: 1 Watt.

Only those products bearing the UL Mark should be considered as being covered by UL.

Measurement Results

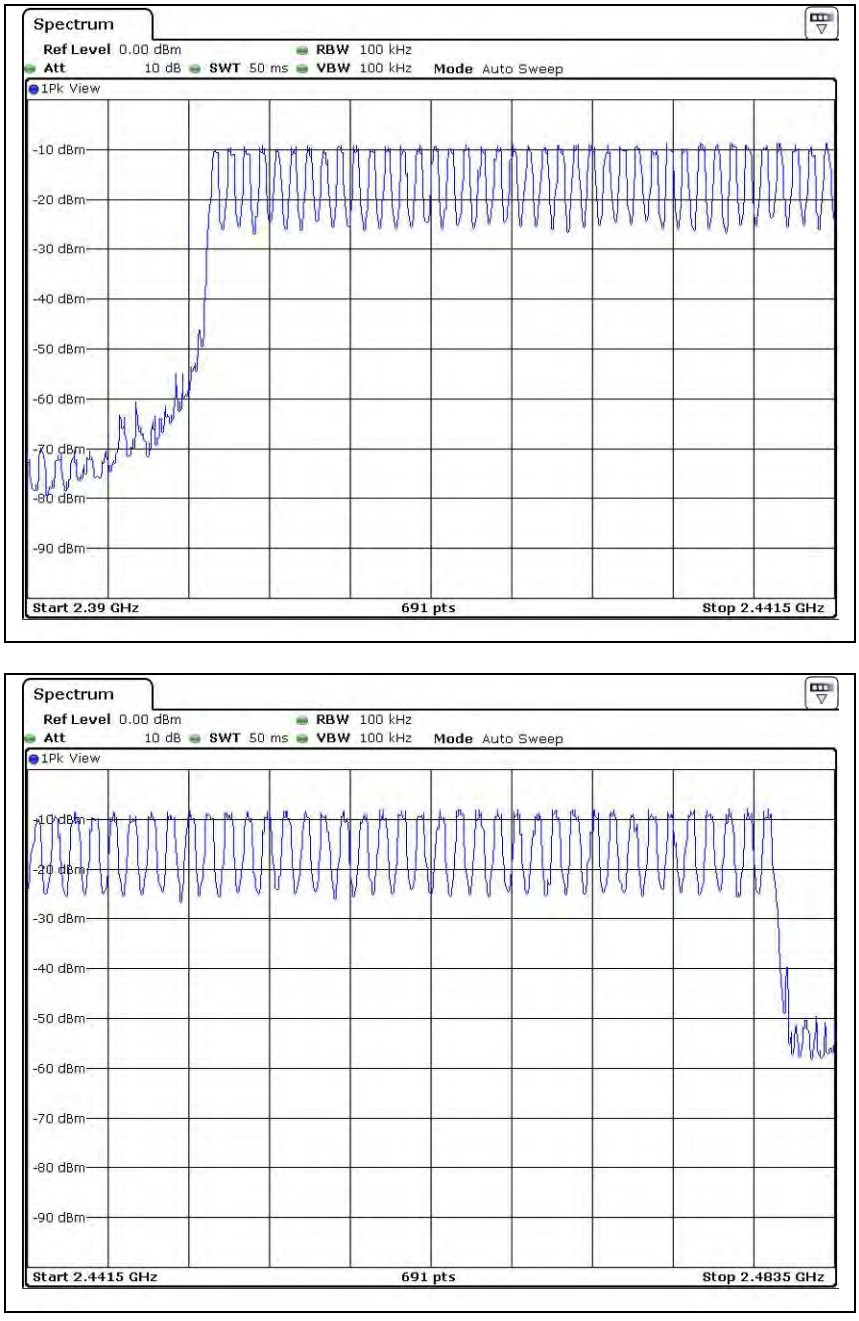
Table 4. Data Table of Number of Hopping Channels

Operating Mode	Data Rate (Mbps)	Measurement Result	Limit
GFSK	1	79	≥ 75
8DPSK	2	79	

Only those products bearing the UL Mark should be considered as being covered by UL.

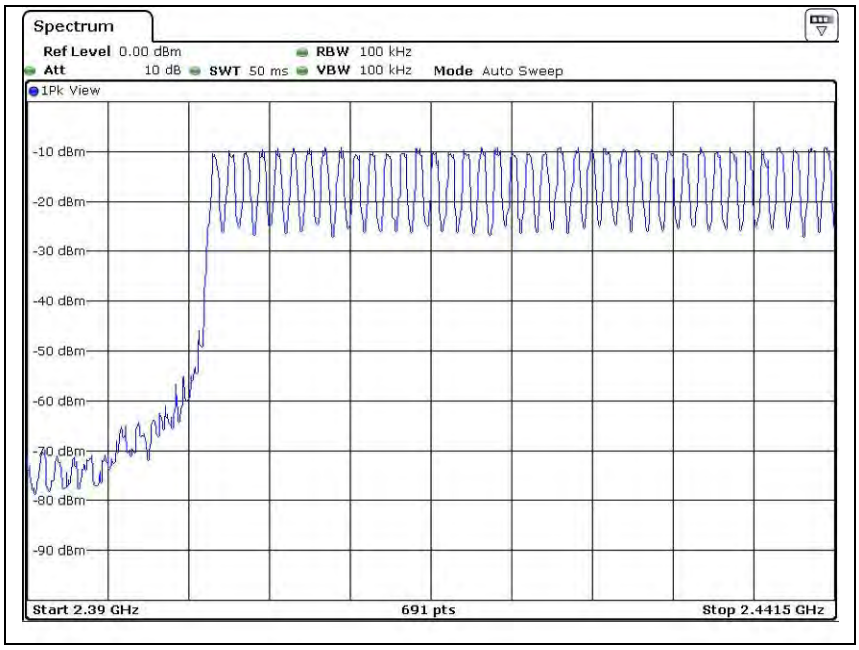
Figure 4. Plots of Number of Hopping Channels

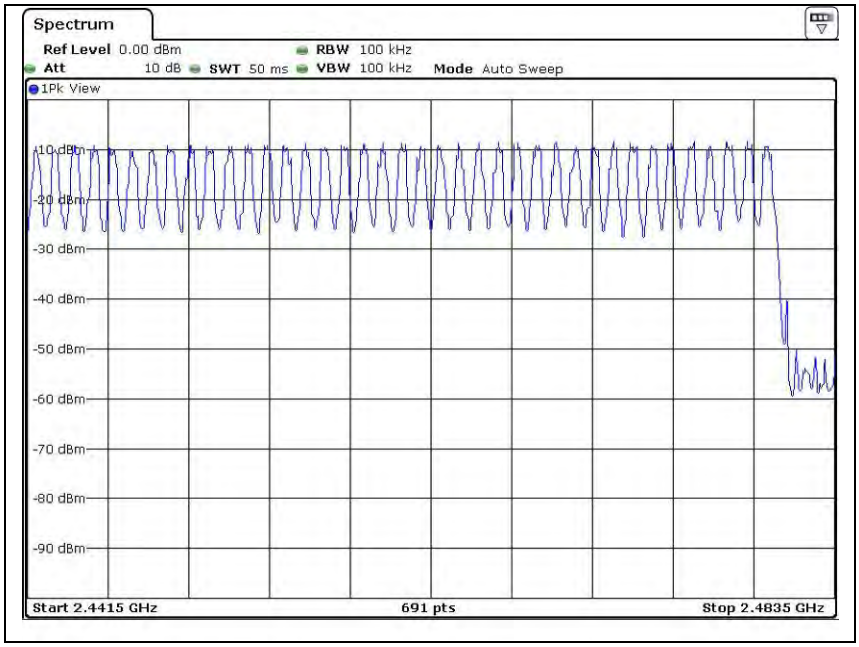
GFSK



Only those products bearing the UL Mark should be considered as being covered by UL.

8DPSK





Only those products bearing the UL Mark should be considered as being covered by UL.

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 ≥ 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	22 °C	
	Relative Humidity	36 %	
	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)
Rated	1	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.

Only those products bearing the UL Mark should be considered as being covered by UL.

Measurement Results

Table 5. Data Table of Time of Occupancy

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	0.413	10.13	31.6	132.20	400
		DH3	1.652	5.06	31.6	264.16	
		DH5	2.913	3.38	31.6	311.13	
8DPSK	3	DH1	0.428	10.13	31.6	137.01	
		DH3	1.674	5.06	31.6	267.67	
		DH5	2.928	3.38	31.6	312.73	

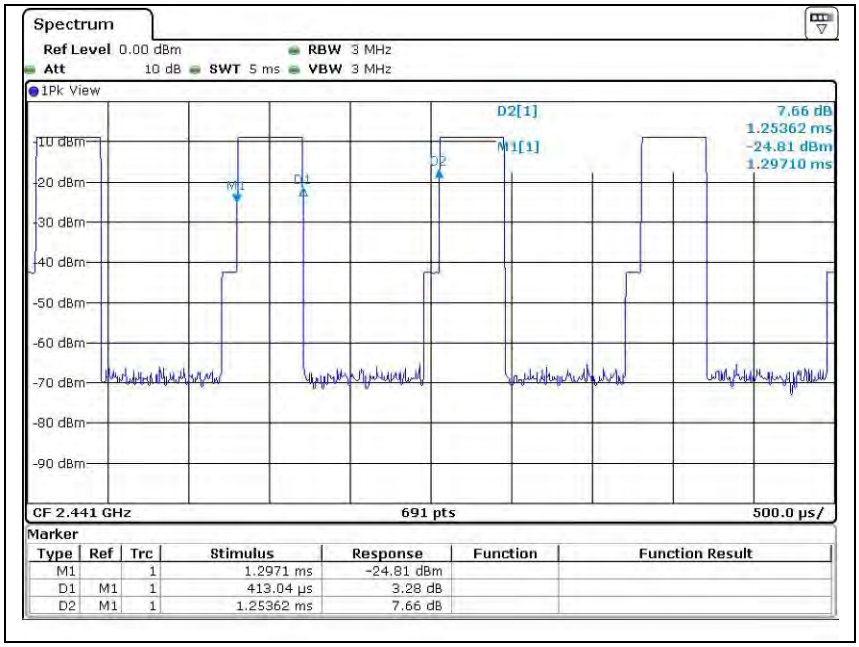
Dwell time calculation

- 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

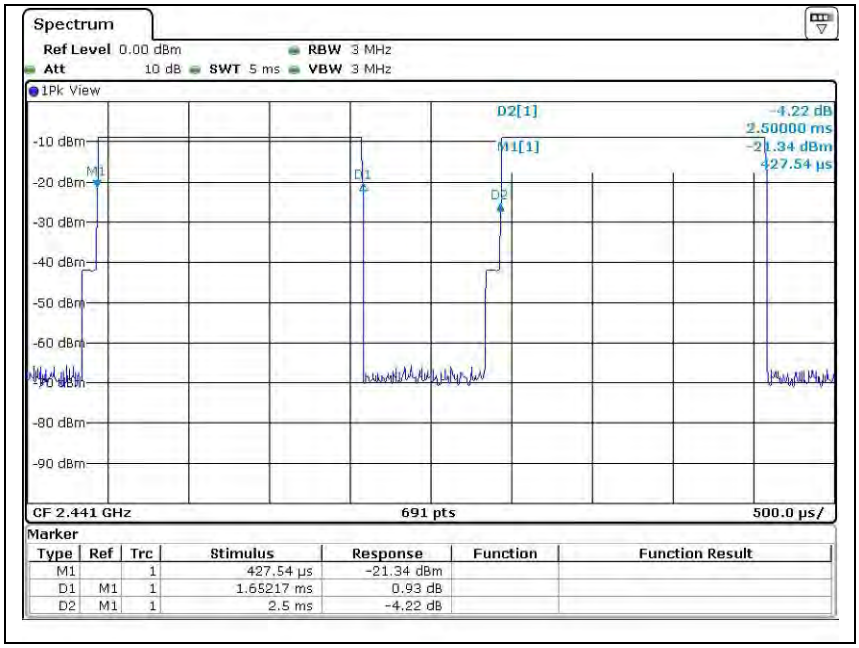
Only those products bearing the UL Mark should be considered as being covered by UL.

Figure 5. Plots of Average Time of Occupancy

GFSK
DH1

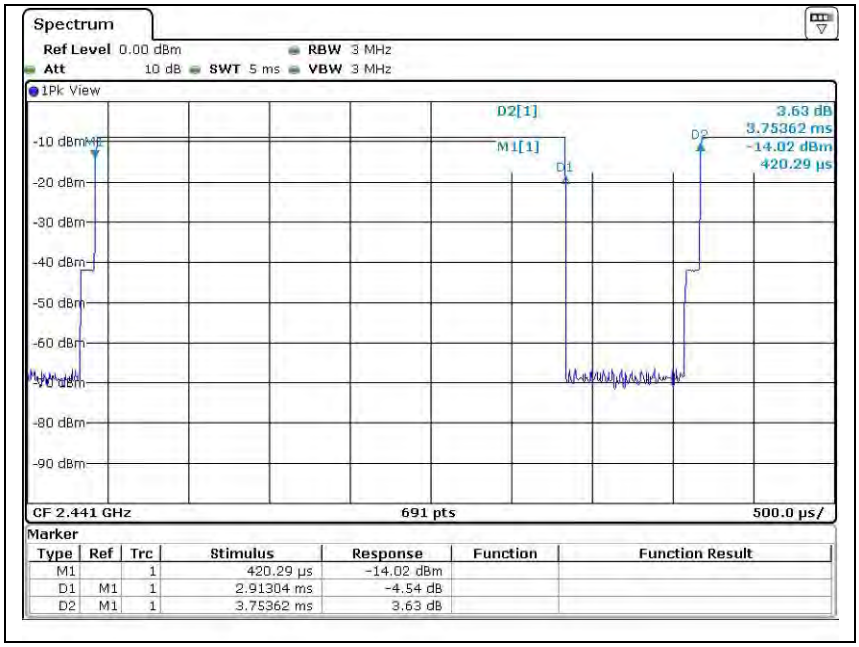


DH3



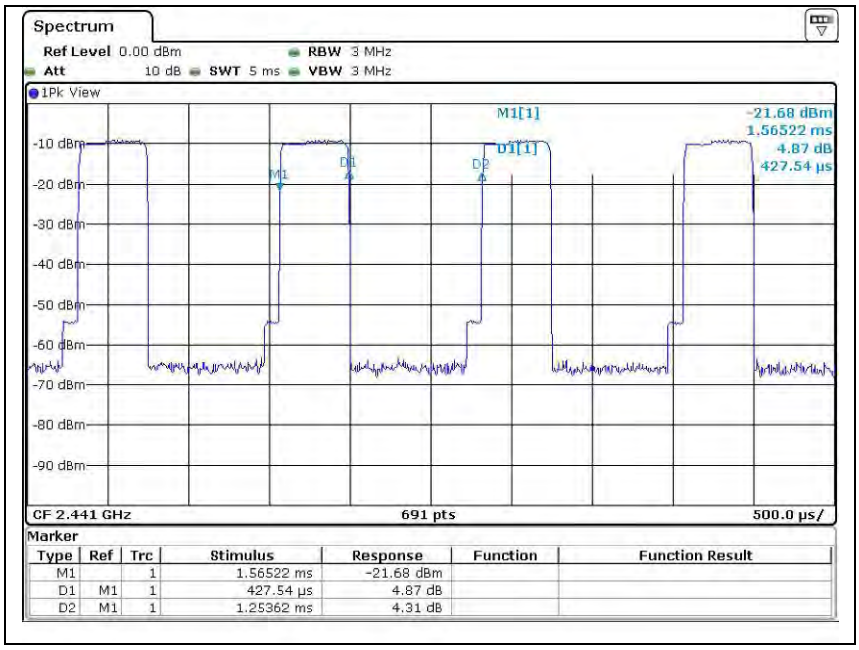
Only those products bearing the UL Mark should be considered as being covered by UL.

DH5

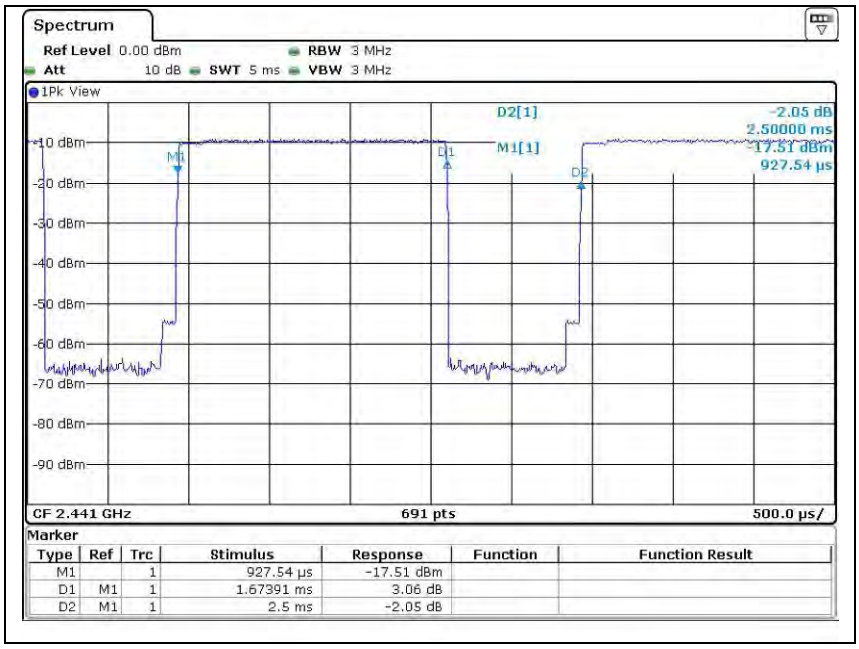


Only those products bearing the UL Mark should be considered as being covered by UL.

8DPSK
DH1

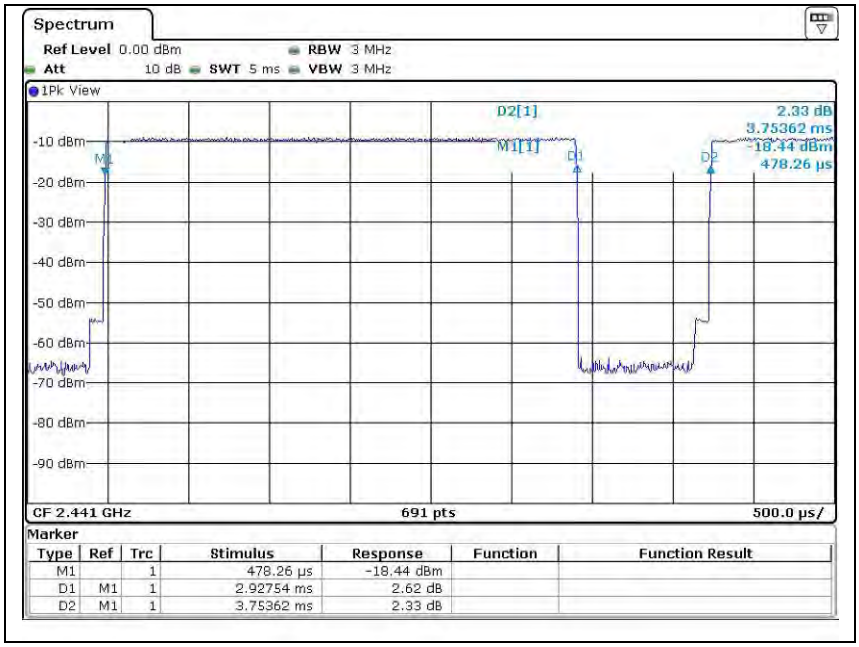


DH3



Only those products bearing the UL Mark should be considered as being covered by UL.

DH5



Only those products bearing the UL Mark should be considered as being covered by UL.

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 ≥ 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	22 °C	
	Relative Humidity	36 %	
	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	Rated	1	2
Supplementary information: None			

Limits

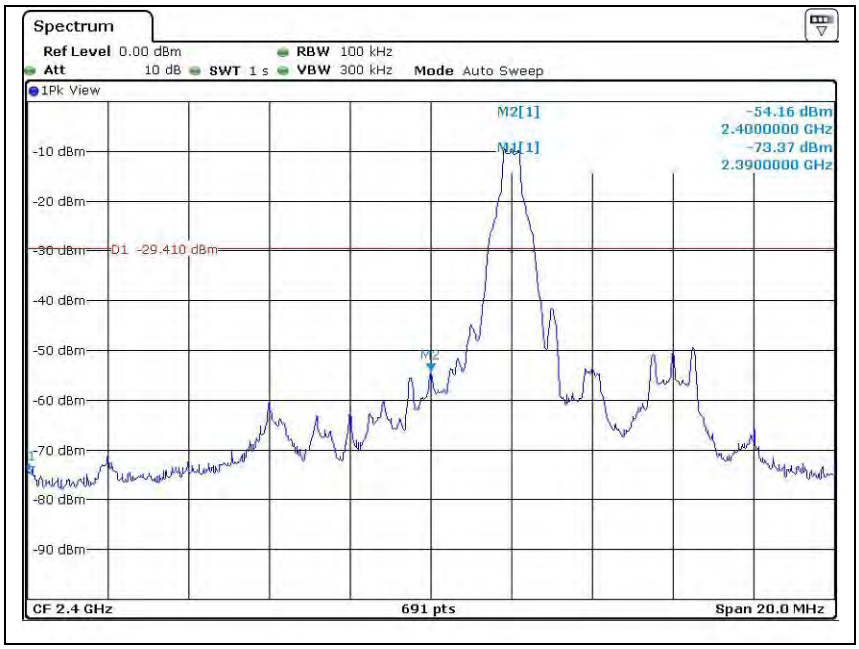
According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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))

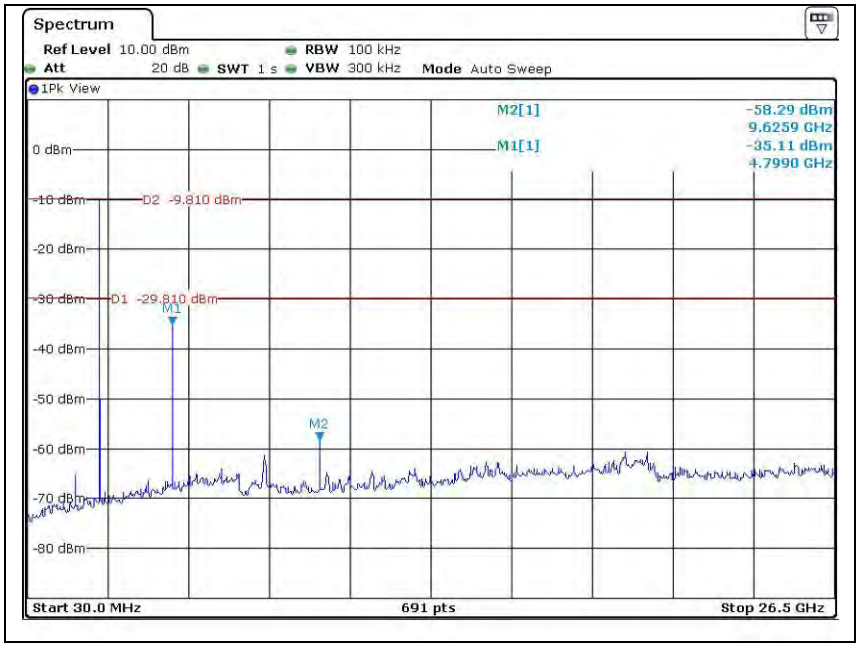
Only those products bearing the UL Mark should be considered as being covered by UL.

Measurement Results

Figure 6. Plots of Band-Edge and Restricted / Non-Restricted frequency bands

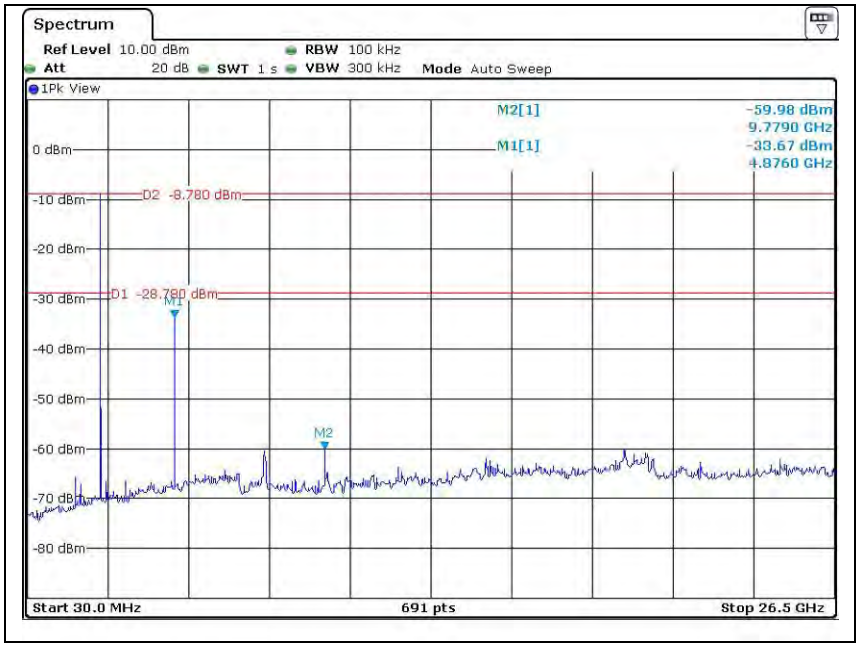
GFSK
Low





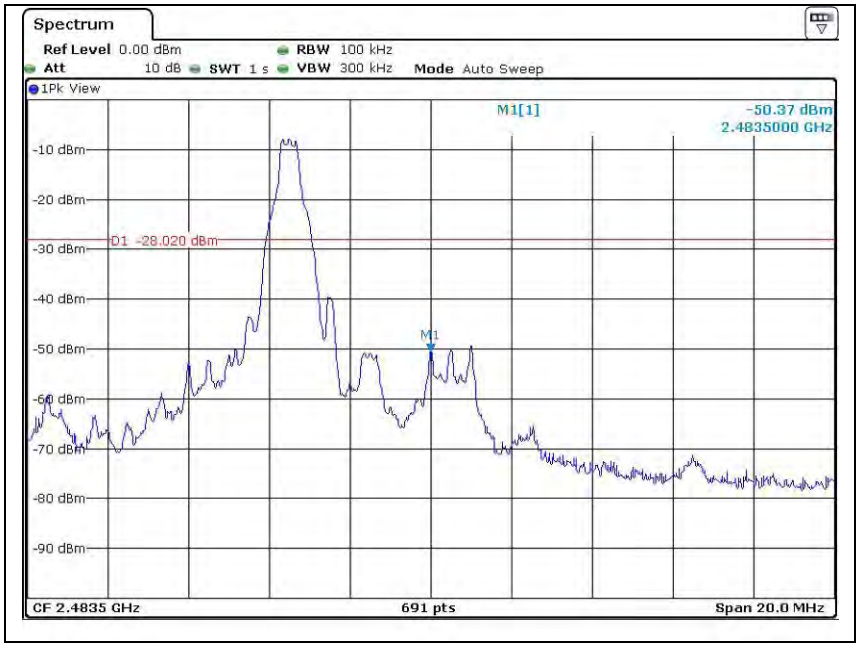
Only those products bearing the UL Mark should be considered as being covered by UL.

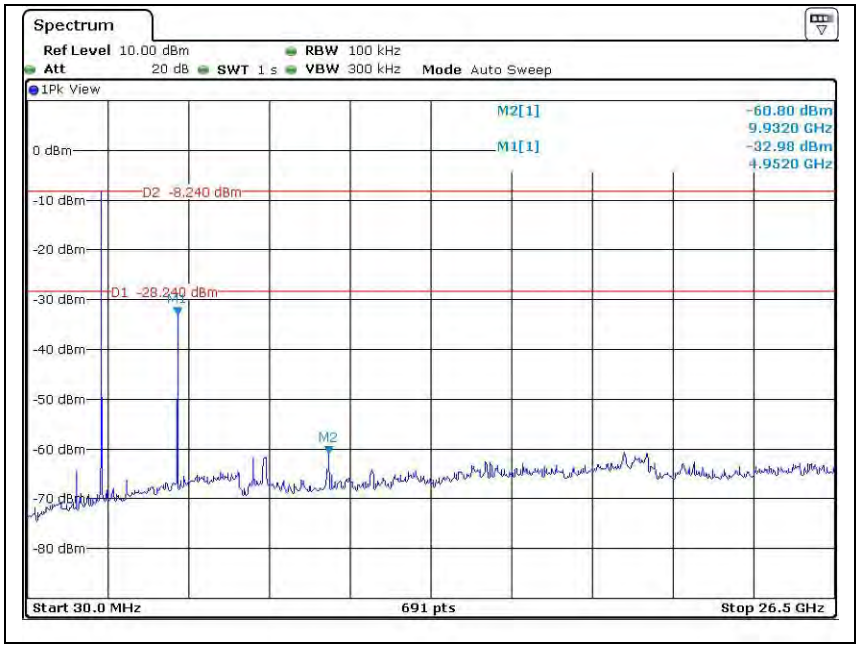
Middle



Only those products bearing the UL Mark should be considered as being covered by UL.

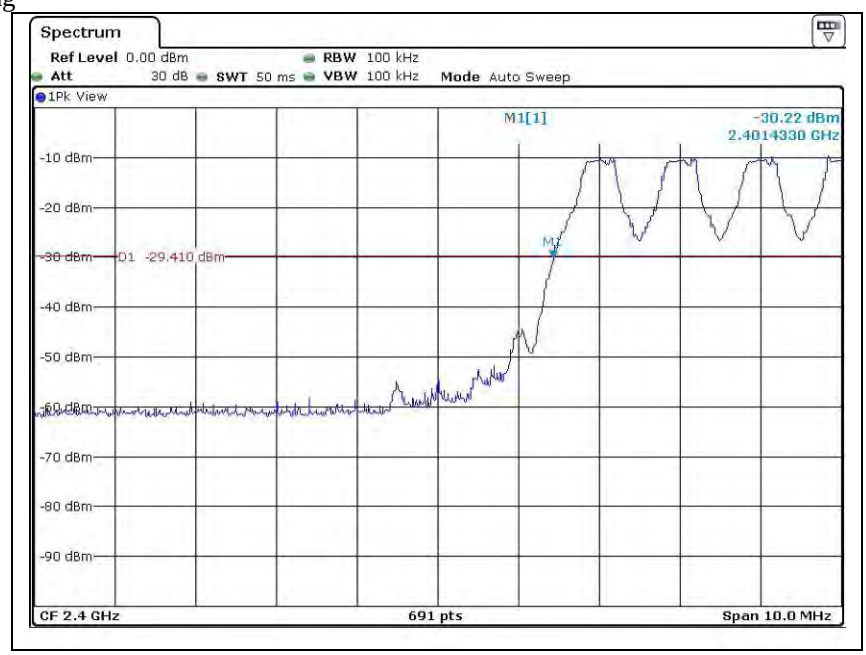
High

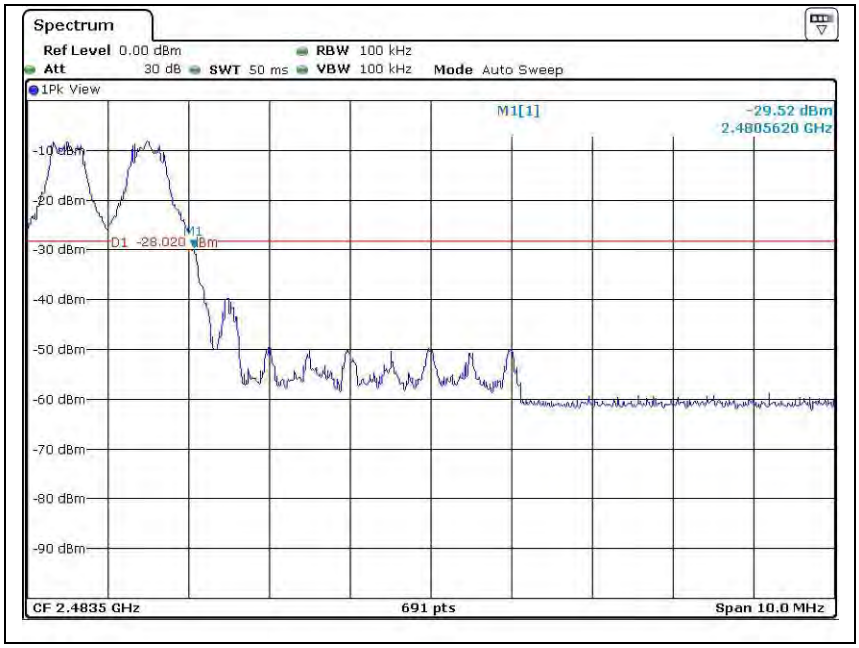




Only those products bearing the UL Mark should be considered as being covered by UL.

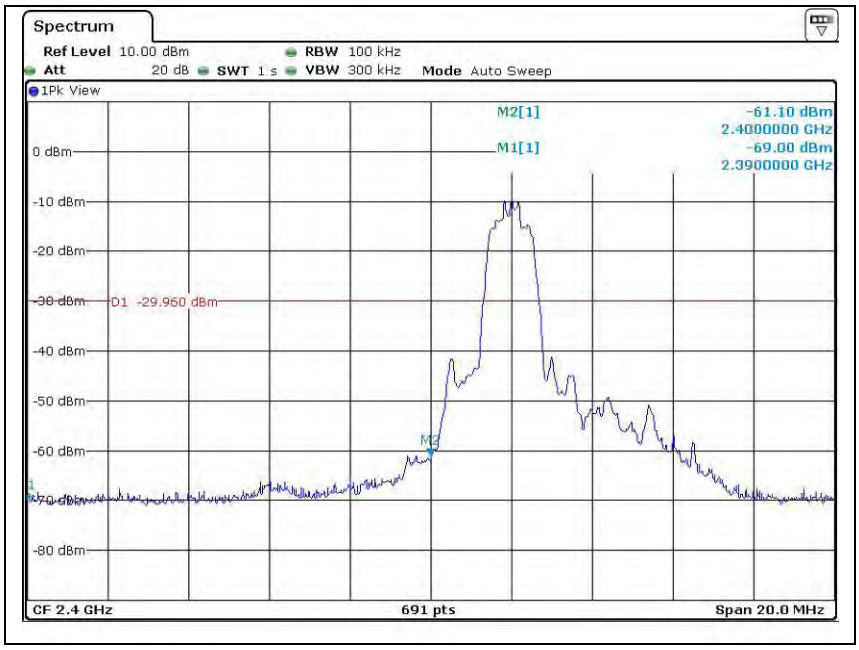
Bandedge at Hopping

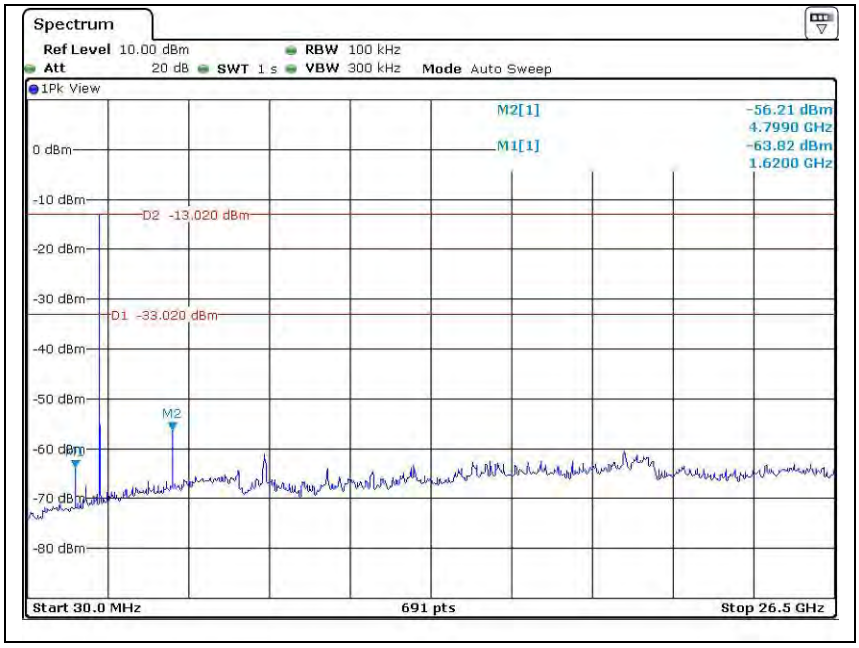




Only those products bearing the UL Mark should be considered as being covered by UL.

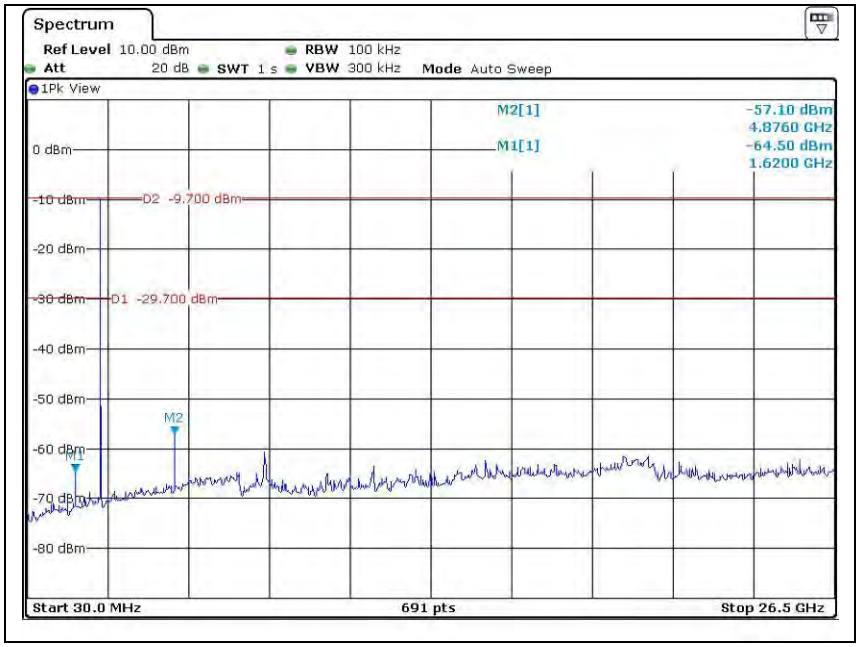
8DPSK
Low





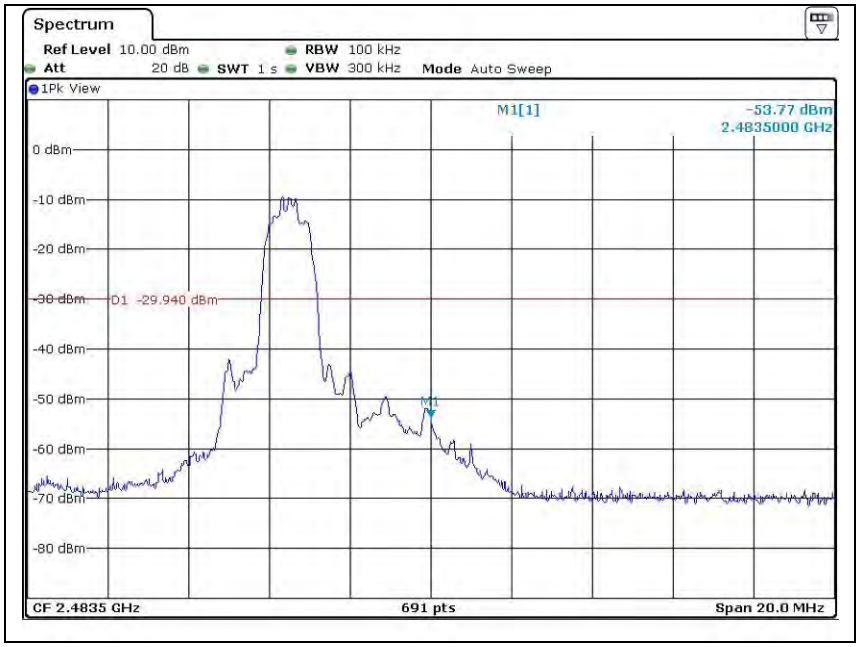
Only those products bearing the UL Mark should be considered as being covered by UL.

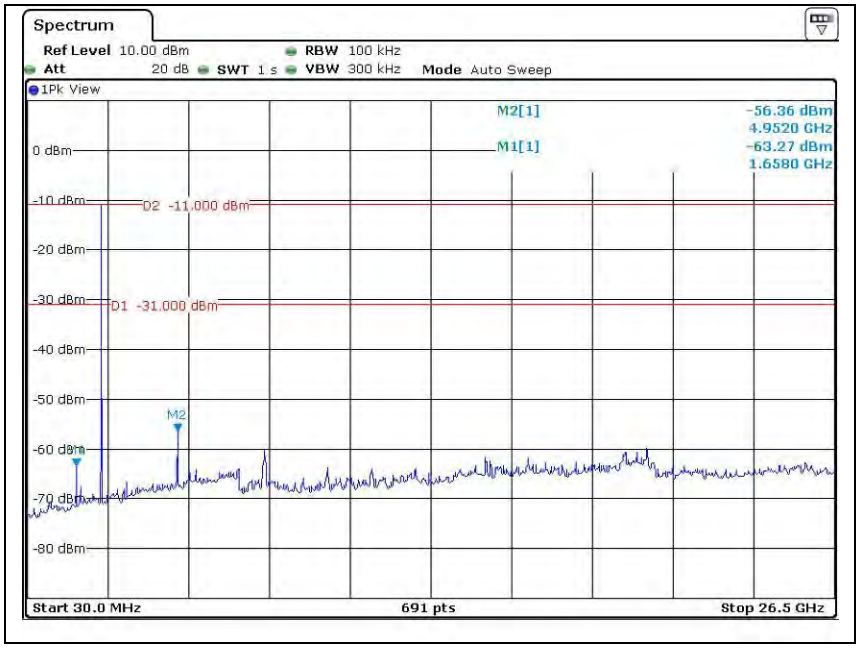
Middle



Only those products bearing the UL Mark should be considered as being covered by UL.

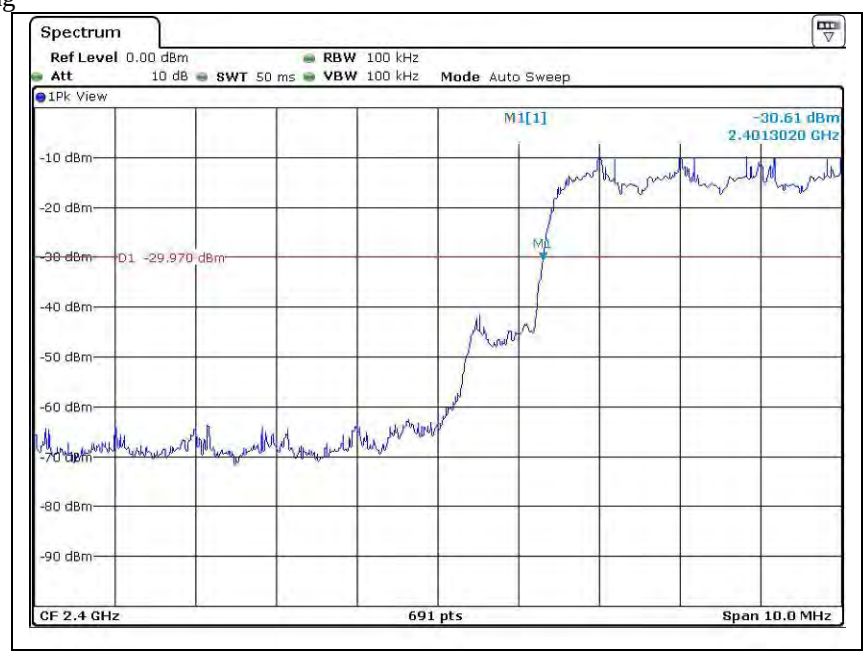
High

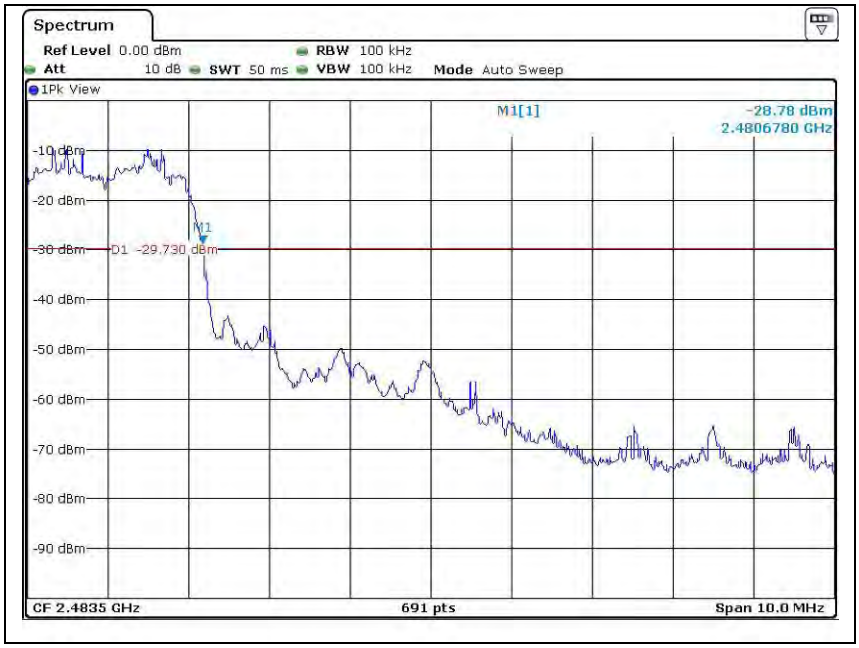




Only those products bearing the UL Mark should be considered as being covered by UL.

Bandedge at Hopping





Only those products bearing the UL Mark should be considered as being covered by UL.

5.7. Radiated Spurious Emissions Measurement

TEST: Radiated spurious emissions measurement		
Method	Radiated emissions from the EUT were measured according to ANSI C63.4 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 is set to 1 MHz and video bandwidth is set to 1 MHz for peak measurement and 10 Hz for average measurement. 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	22 °C
	Relative Humidity	36 %
	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	Rated	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:

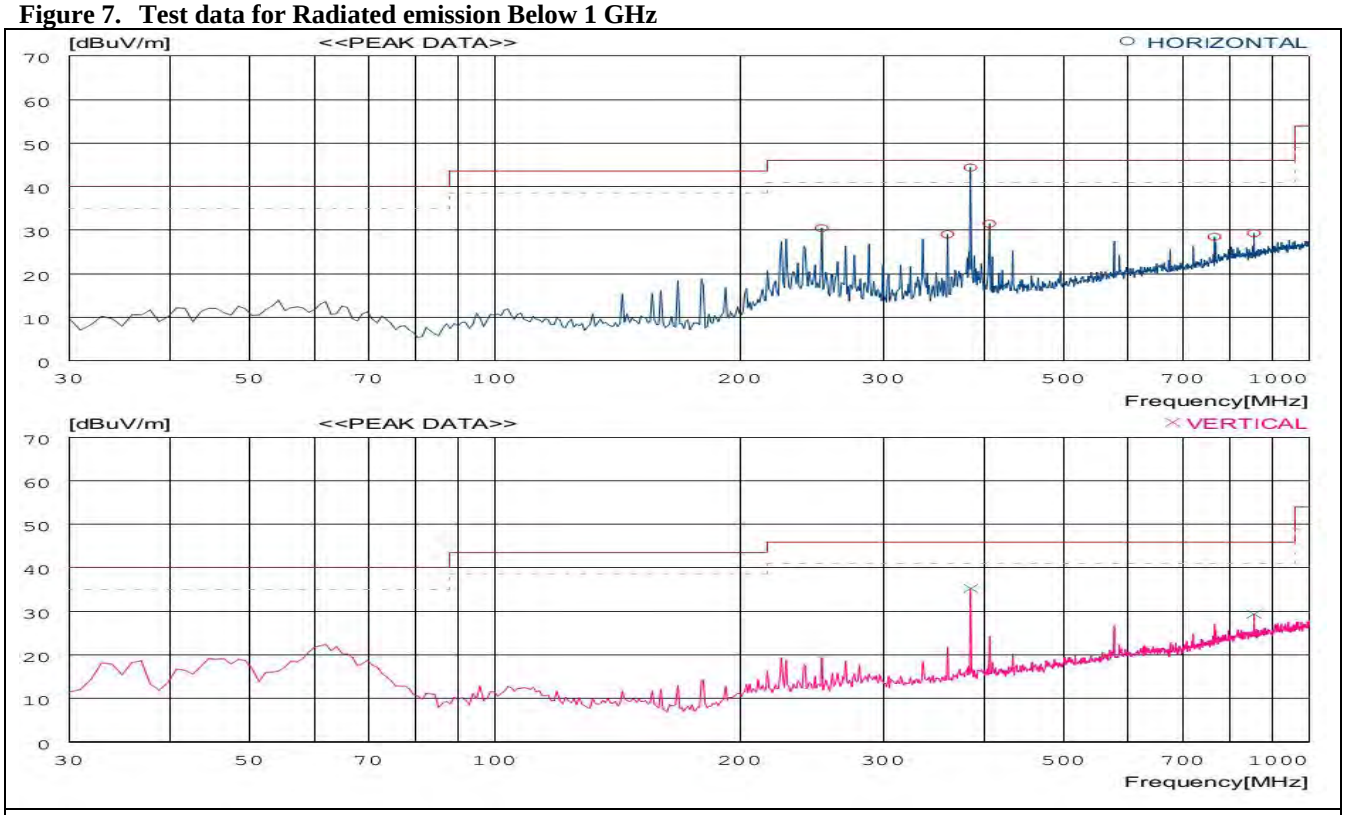
Frequency (MHz)	Distance (meters)	Field Strength (dBuV/m)	Field Strength (uV/m)
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

Only those products bearing the UL Mark should be considered as being covered by UL.

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 :

Figure 7. Test data for Radiated emission Below 1 GHz



No.	FREQ [MHz]	READING PEAK [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	252.130	46.9	13.6	2.9	32.9	30.5	46.0	15.5	100	358
2	359.800	42.5	16.0	3.6	33.0	29.1	46.0	16.9	100	348
3	384.050	57.1	16.6	3.7	33.0	44.4	46.0	1.6	100	358
4	405.390	43.7	17.0	3.8	33.0	31.5	46.0	14.5	100	358
5	765.253	33.9	21.7	5.5	32.6	28.5	46.0	17.5	100	0
6	855.460	32.9	22.9	5.8	32.3	29.3	46.0	16.7	200	32
----- Vertical ------										
7	384.050	48.0	16.6	3.7	33.0	35.3	46.0	10.7	200	322
8	855.460	33.0	22.9	5.8	32.3	29.4	46.0	16.6	100	0

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)

Only those products bearing the UL Mark should be considered as being covered by UL.

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)	AF (dB/m)	Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
*2390.00	43.44	Peak	H	N/A	27.05	46.23	74.00	30.52	43.48
*2390.00	44.83	Peak	V	N/A	27.05	46.23	74.00	31.91	42.09
4804.00	54.32	Peak	H	N/A	31.07	46.90	74.00	46.69	27.31
4804.00	56.59	Peak	V	N/A	31.07	46.90	74.00	48.96	25.04
*2390.00	34.21	Average	H	N/A	27.05	46.23	54.00	21.29	32.71
*2390.00	34.83	Average	V	N/A	27.05	46.23	54.00	21.91	32.09
4804.00	48.01	Average	H	N/A	31.07	46.90	54.00	40.38	13.62
4804.00	50.68	Average	V	N/A	31.07	46.90	54.00	43.05	10.95

Table 7. GFSK Mid Channel

Radiated emissions			Ant	Correction factors			Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	AF (dB/m)	Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
4882.00	53.46	Peak	H	N/A	31.19	46.92	74.00	45.97	28.03
4882.00	57.13	Peak	V	N/A	31.19	46.92	74.00	49.64	24.36
4882.00	47.65	Average	H	N/A	31.19	46.92	54.00	40.16	13.84
4882.00	51.54	Average	V	N/A	31.19	46.92	54.00	44.05	9.95

Table 8. GFSK High Channel

Radiated emissions			Ant	Correction factors			Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	AF (dB/m)	Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
*2483.50	52.64	Peak	H	N/A	27.31	46.27	74.00	40.02	33.98
*2483.50	44.72	Peak	V	N/A	27.31	46.27	74.00	32.10	27.98
4960.00	52.34	Peak	H	N/A	31.32	46.95	74.00	45.01	28.99
4960.00	55.95	Peak	V	N/A	31.32	46.95	74.00	48.62	25.38
*2483.50	47.14	Average	H	N/A	27.31	46.27	54.00	34.52	19.48
*2483.50	38.64	Average	V	N/A	27.31	46.27	54.00	26.02	41.90
4960.00	46.13	Average	H	N/A	31.32	46.95	54.00	38.80	15.20
4960.00	50.84	Average	V	N/A	31.32	46.95	54.00	43.51	10.49

Only those products bearing the UL Mark should be considered as being covered by UL.

Table 9. 8DPSK Low Channel

Radiated emissions			Ant	Correction factors			Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	AF (dB/m)	Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
*2390.00	43.77	Peak	H	N/A	27.05	46.23	74.00	30.85	43.15
*2390.00	45.31	Peak	V	N/A	27.05	46.23	74.00	32.39	41.61
4804.00	54.12	Peak	H	N/A	31.07	46.90	74.00	46.49	27.51
4804.00	55.46	Peak	V	N/A	31.07	46.90	74.00	47.83	26.17
*2390.00	34.07	Average	H	N/A	27.05	46.23	54.00	21.15	32.85
*2390.00	35.00	Average	V	N/A	27.05	46.23	54.00	22.08	31.92
4804.00	47.76	Average	H	N/A	31.07	46.90	54.00	40.13	13.87
4804.00	50.13	Average	V	N/A	31.07	46.90	54.00	42.50	11.50

Table 10. 8DPSK Middle Channel

Radiated emissions			Ant	Correction factors			Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	AF (dB/m)	Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
4882.00	53.37	Peak	H	N/A	31.19	46.92	74.00	45.88	28.12
4882.00	56.26	Peak	V	N/A	31.19	46.92	74.00	48.77	25.23
4882.00	46.68	Average	H	N/A	31.19	46.92	54.00	39.19	14.81
4882.00	50.86	Average	V	N/A	31.19	46.92	54.00	43.37	10.63

Table 11. 8DPSK High Channel

Radiated emissions			Ant	Correction factors			Limit (dBuV/m)	Total	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	Distance (dB)	AF (dB/m)	Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
*2483.50	52.07	Peak	H	N/A	27.31	46.27	74.00	39.45	34.55
*2483.50	45.47	Peak	V	N/A	27.31	46.27	74.00	32.85	41.15
4960.00	51.74	Peak	H	N/A	31.32	46.95	74.00	44.41	29.59
4960.00	55.23	Peak	V	N/A	31.32	46.95	74.00	47.90	26.10
*2483.50	47.62	Average	H	N/A	27.31	46.27	54.00	35.00	19.00
*2483.50	38.39	Average	V	N/A	27.31	46.27	54.00	25.77	28.23
4960.00	45.64	Average	H	N/A	31.32	46.95	54.00	38.31	15.69
4960.00	50.32	Average	V	N/A	31.32	46.95	54.00	42.99	11.01

Supplementary information:

- The frequency spectrum from 1 GHz to 26.5 GHz was investigated. Emission levels of 30 dB below than the limit is not reported.
- "*" means the restricted band.
- The worst case is x-axis and reported.
- Actual = Reading + AF + CL (AF : Antenna factor, CL : Cable loss)
- Distance factor = 20log(Measurement distance / The measured distance)
- Margin = Limit (dBuV/m) - Actual (dBuV/m)

Only those products bearing the UL Mark should be considered as being covered by UL.

5.8. Transmitter AC Power Line Conducted Emission

TEST: Transmitter AC Power Line Conducted Emission		
Method	AC line conducted emissions from the EUT were measured according to the dictates of ANSI C63.4-2003. 1. The test procedure is performed in a 5.05m × 4.0m× 3.0m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m(W)× 1.5 m(L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane. 2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. 3. The excess power cable between the EUT and the LISN was bundled. All connecting cables of EUT were moved to find the maximum emission.	
Basic Standard	FCC Part 15.207(a)	
Parameters recorded during the test	Laboratory Ambient Temperature	22°C
	Relative Humidity	46%
-	Frequency range on each side of line	Measurement Point
Fully configured sample scanned over the following frequency range	150 kHz to 30 MHz	A.C. Input port of A.C. to D.C. adapter.

Configuration Settings

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

Limits

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency of Emission (㎒)	Conducted limit (㏈ μV)	
	Quasi-peak	Average
0.15 – 0.5	66 - 56*	56 - 46*
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency.

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5.8.1. Transmitter AC Power Line Conducted Emission

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

Table 12. Test data for conducted emission

HOT LINE

NO	FREQ	READING(PK)	C.F	RESULT	LIMIT		MARGIN		PHASE
					QP	AV	QP	AV	
	[MHz]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]	
1	0.19900	42.9	10.0	52.9	63.7	53.7	10.8	0.8	N (PK)
2	0.29400	33.1	10.0	43.1	60.4	50.4	17.3	7.3	N (PK)
3	0.49300	28.7	10.1	38.8	56.1	46.1	17.3	7.3	N (PK)
4	2.06800	28.1	10.3	38.4	56.0	46.0	17.6	7.6	N (PK)
5	7.90500	24.1	10.5	34.6	60.0	50.0	25.4	15.4	N (PK)
6	22.53000	20.4	11.5	31.9	60.0	50.0	28.1	18.1	N (PK)
7	0.19900	29.4	10.0	39.4	63.7	53.7	24.3	14.3	N (AV)
8	0.29400	26.3	10.0	36.3	60.4	50.4	24.1	14.1	N (AV)
9	0.49300	25.1	10.1	35.2	56.1	46.1	20.9	10.9	N (AV)
10	2.06800	11.3	10.3	21.6	56.0	46.0	34.4	24.4	N (AV)
11	7.90500	15.0	10.5	25.5	60.0	50.0	34.5	24.5	N (AV)
12	22.53000	12.7	11.5	24.2	60.0	50.0	35.8	25.8	N (AV)

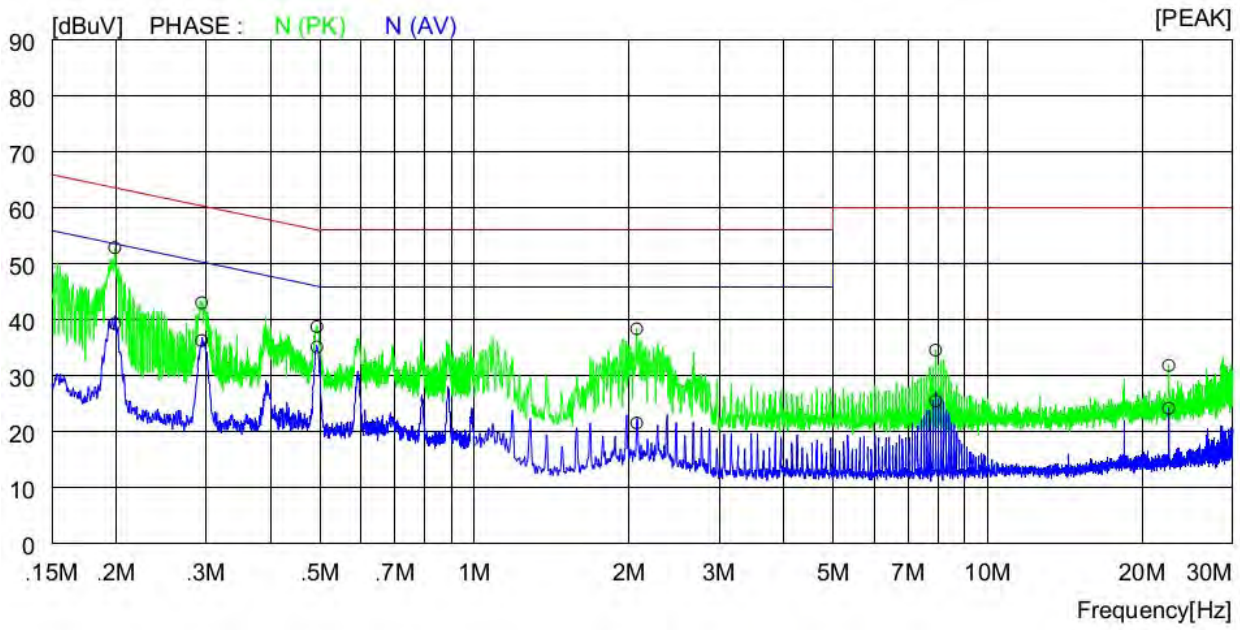
NETURAL LINE

NO	FREQ	READING(PK)	C.F	RESULT	LIMIT		MARGIN		PHASE
					QP	AV	QP	AV	
	[MHz]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]	
1	0.19700	40.8	10.0	50.8	63.7	53.7	12.9	2.9	N (PK)
2	0.39300	30.9	10.1	41.0	58.0	48.0	17.0	7.0	N (PK)
3	2.10000	24.4	10.3	34.7	56.0	46.0	21.3	11.3	N (PK)
4	8.04500	21.1	10.5	31.6	60.0	50.0	28.4	18.4	N (PK)
5	18.44000	16.9	11.1	28.0	60.0	50.0	32.0	22.0	N (PK)
6	22.52000	17.7	11.5	29.2	60.0	50.0	30.8	20.8	N (PK)
7	0.19700	31.0	10.0	41.0	63.7	53.7	22.7	12.7	N (AV)
8	0.39300	28.4	10.1	38.5	58.0	48.0	19.5	9.5	N (AV)
9	2.10000	6.8	10.3	17.1	56.0	46.0	38.9	28.9	N (AV)
10	8.04500	17.5	10.5	28.0	60.0	50.0	32.0	22.0	N (AV)
11	18.44000	9.9	11.1	21.0	60.0	50.0	39.0	29.0	N (AV)
12	22.52000	8.1	11.5	19.6	60.0	50.0	40.4	30.4	N (AV)

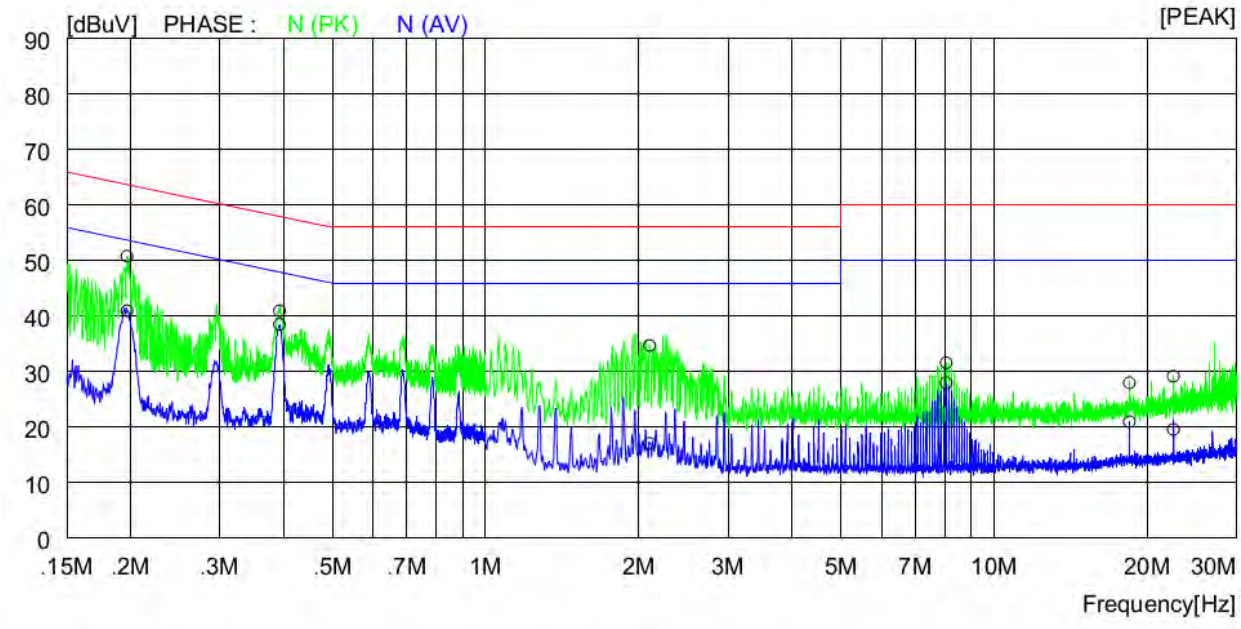
Only those products bearing the UL Mark should be considered as being covered by UL.

Figure 8. Graphical representation of Conducted Emission

HOT LINE



NEUTRAL LINE



Only those products bearing the UL Mark should be considered as being covered by UL.

5.9. Antenna Requirement

5.9.1. 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.

5.9.2. Antenna Connected Construction

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

Band	Antenna Gain (dBi)
2402 – 2480 MHz	-0.22

Only those products bearing the UL Mark should be considered as being covered by UL.

APPENDIX A. Accreditations and Authorizations

ONETECH Corp. has been accredited / filed / authorized by the agencies listed in the following table;

Certificate	Nation	Agency	Code	Mark
Accreditation	Korea	KOLAS	No. 85	ISO/IEC 17025
Site Filing	USA	FCC	KR0013	Test Facility list & NSA Data
	Japan	VCCI	C-940 R-906 T-1842	Test Facility list & NSA Data
Certification	Korea	KC	KR0013	Test Facility list & NSA Data

Quality control in the testing laboratory is implemented as per ISO/IEC 17025 which is the “General requirements for the competent of calibration and testing laboratory”.

Only those products bearing the UL Mark should be considered as being covered by UL.