FCC&ISED RF TEST REPORT

No. 170400689SHA-001

Applicant	:	Shanghai New Terminal Industrial Co., Ltd. Rm812, Wujiaofengda Building, No.48 Zhengyi Road, Shanghai 200433 China
Manufacturing Site	:	Dongguan Speedtek Electronic Co.,Ltd. 3F, 6 Building, Yingshuo Industrial Park, 177 Wenming Rd., Qiaotou Town, Dongguan, Guangdong, 523520 China
Product Name	:	LED Bluetooth Work Lamp
Type/Model	:	WL22FM, WL22BT
TEST RESULT	**:**	**PASS**

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 (2016): Radio Frequency Devices

ANSI C63.10 (2013): American National Standard for Testing Unlicensed Wireless Devices

RSS-247 Issue 2 (February 2017): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen Issue 4 (November 2014): General Requirements for Compliance of Radio Apparatus

Date of issue: August 11, 2017

Prepared by:

Wade Zhang

Wade Zhang (Project engineer)

Reviewed by:

Daniel Zhao (Reviewer)

FCC ID: 2AF3F-WL22FM
IC: 20697-WL22FM

Description of Test Facility

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Content

1. General Information

1.1 Applicant Information

Applicant	:	Shanghai New Terminal Industrial Co., Ltd. Rm812, Wujiaofengda Building, No.48 Zhengyi Road, Shanghai 200433 China
Name of contact	:	QIU HONG DONG
Tel	:	0086 21 55227001
Fax	:	/
Manufacturing Site	:	Dongguan Speedtek Electronic Co.,Ltd. 3F, 6 Building, Yingshuo Industrial Park, 177 Wenming Rd., Qiaotou Town, Dongguan, Guangdong, 523520 China

1.2 Identification of the EUT

Equipment	:	LED Bluetooth Work Lamp
Type/model	:	WL22FM, WL22BT
FCC ID	:	2AF3F-WL22FM
IC	:	20697-WL22FM
Description of EUT	:	The EUT is a LED Bluetooth Work Lamp, which contains a Bluetooth function, there have two models and all models are electric identical, and used the same RF part module, except WL22FM have FM radio function and WL22BT without FM function, We tested WL22FM and listed the BT results in this report.
Rating	:	100-240VAC 50/60Hz 24W IP44
Port identification	:	AC output*1
Category of EUT	:	Class B
EUT type	:	☒ Table top ☐ Floor standing
Sample received date	:	May 13, 2017
Sample Identification No	:	/
Date of test	:	May 13, 2017 ~ June 15, 2017

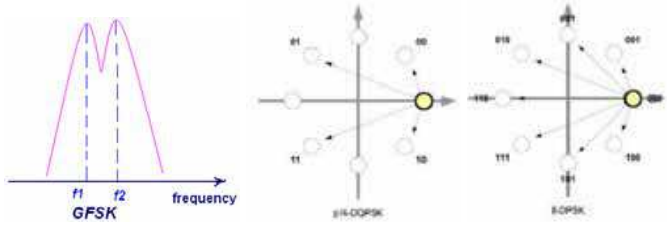
1.3 Technical specification

Operation Frequency Band: 2402 - 2480 MHz

Protocol: BT 2.1+EDR

Modulation: GFSK, π/4 DQPSK, 8DPSK

Technology:



GFSK is different from π/4DQPSK and 8DPSK. 8DPSK is similar with π/4DQPSK but more complex, and with a bigger data rate. So all the tests except output power, occupied bandwidth, dwell time and number of hopping frequencies were performed with GFSK modulation and 8DPSK modulation for representative.

Antenna Designation: Internal PCB antenna

Gain of Antenna: 0dBi

Channel Description: There are 79 channels in all. The designed channel spacing is 1MHz.

Channel Identifier	Frequency (MHz)
low	2402
middle	2441
high	2480

Antenna Requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The manufacturer used a permanently attached PCB antenna, so fulfill these requirements.

1.4 Mode of operation during the test / Test peripherals used

While testing the transmitter mode of the EUT, the internal modulation is applied.
All the functions of the host device except the BT module were set on stand-by mode.

As the EUT can install at Horizontal and Vertical orientation to the floor, two axes were observed while the test receiver worked as “max hold” continuously and the highest reading among the whole test procedure was recorded. Compare with the test results that Horizontal install axis is the worst case.

The test setting software is offered by the manufactory. The pre-scan for the conducted power with all rates in each modulation and bands was used, and the worst case was found and used in all test cases.

Radiated test mode:
Mode 1: EUT transmitted signal with BT antenna;

Conducted test mode:
Mode 2: EUT transmitted signal from BT RF port connected to SPA directly;

The worst case modulation configuration:

Worst Modulation Used for Conformance Testing			
Bluetooth Mode	**Data Rate**	**Packet Type**	**Worst Mode**
GFSK	BR-1Mbps	DH1,DH3,DH5	**BR-1Mbps DH5**
π/4 DQPSK	EDR-2Mbps	2DH1,2DH3,2DH5	EDR-2Mbps 2DH5
8DPSK	EDR-3Mbps	3DH1,3DH3,3DH5	EDR-3Mbps 3DH5
Note: The BR-1Mbps DH5 mode was chosen for radiation emission bellow 1GHz and Conducted emission testing as representative in this report.			

The power setting parameter:

The worst case power setting parameter			
Test software Version	BK3256 RF Test_V1.3		
Modulation Mode	2402MHz	2441MHz	2480MHz
BR-1Mbps	0	0	0
EDR-2Mbps	0	0	0
EDR-3Mbps	0	0	0

Test Peripherals:

Equipment	Brand Name	Model	Note
Notebook	HP	6470b	
Mobile Phone	Apple	IPhone 5	
Note: The accessories are used for configuration only and not used during test.			

2. Test Specification

2.1 Instrument list

Selected	Equipment	Type	Manu.	Internal no.	Cal. Date	Due date
☒	PXA Analyzer	N9030A	Agilent	EC5338	2017/3/3	2018/3/2
☒	Vector SG	N5182B	Agilent	EC5175	2017/3/3	2018/3/2
☒	Power sensor	U2021XA	Agilent	EC5338-1	2017/3/3	2018/3/2
☒	MXG Analog SG	N5181A	Agilent	EC5338-2	2017/3/3	2018/3/2
☒	Power meter	N1911A/N1921A	Agilent	EC4318	2017/5/17	2018/5/16
☒	EMI Receiver	ESCS 30	R&S	EC 2107	2016/10/19	2017/10/18
☒	A.M.N.	ESH2-Z5	R&S	EC 3119	2015/12/16	2017/12/15
☒	I.S.N.	FCC-TLISN-T8-02	FCC	EC3756	2017/2/15	2018/2/14
☒	EMI chamber	3m	Albatross	EC 3048	2016/9/10	2017/9/9
☒	Test Receiver	ESIB 26	R&S	EC 3045	2016/10/19	2017/10/18
☒	Test Receiver	ESCI 7	R&S	EC4501	2017/2/23	2018/2/22
☒	Bilog Antenna	CBL 6112D	TESEQ	EC 4206	2017/6/1	2018/5/31
☒	Horn antenna	HF 906	R&S	EC 3049	2016/9/24	2017/9/23
☒	Horn antenna	HAP18-26W	TOYO	EC 4792-3	2017/6/11	2018/6/10
☒	Pre-amplifier	Pre-amp 18	R&S	EC 5262	2016/6/30	2017/6/29
☒	Pre-amplifier	Tpa0118-40	R&S	EC 4792-2	2017/4/10	2018/4/9
☒	Shielded room	-	Zhongyu	EC 2838	2017/1/8	2018/1/7

2.2 Test Standard

47CFR Part 15 (2016)
ANSI C63.10 (2013)
DA 00-705
RSS-247 Issue 2 (February 2017)
RSS-Gen Issue 4 (November 2014)

2.3 Test Summary

This report applies to tested sample only. This report shall not be reproduced in part without written approval of Intertek Testing Service Shanghai Limited.

TEST ITEM	FCC REFERANCE	IC REFERANCE	RESULT
20 dB Bandwidth	15.247(a)(1)	RSS-247 Issue 2 Clause 5	Tested
Carrier Frequency Separation	15.247(a)(1)	RSS-247 Issue 2 Clause 5	Pass
Output power	15.247(b)(1)	RSS-247 Issue 2 Clause 5	Pass
Radiated Spurious Emissions	15.205 & 15.209	RSS-247 Issue 2 Clause 5	Pass
Conducted Spurious Emissions & Band Edge	15.247(d)	RSS-247 Issue 2 Clause 5	Pass
Power line conducted emission	15.207	RSS-Gen Issue 4 Clause 8.8	Pass
Number of Hopping Frequencies	15.247(a)(1)(iii)	RSS-247 Issue 2 Clause 5	Pass
Dwell time	15.247(a)(1)(iii)	RSS-247 Issue 2 Clause 5	Pass
Occupied bandwidth	-	RSS-Gen Issue 4 Clause 6.6	Tested
Spurious emission for receiver	15B	RSS-310 Issue 3 Clause 3.1	NA

Notes: 1: NA =Not Applicable

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2.4 Frequency Hopping System Requirement

Test Requirement: Section 15.247 (a)(1), (g), (h) requirement:

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

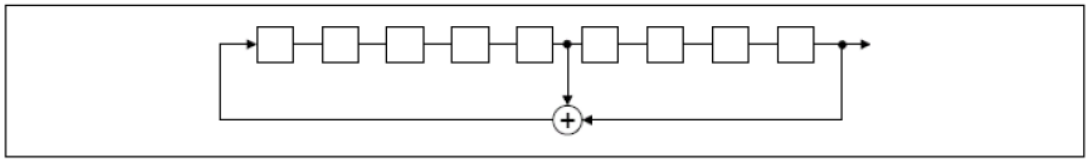
Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Compliance for section 15.247(a)(1)

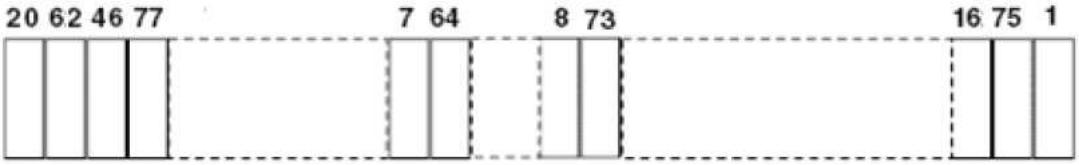
According to Bluetooth Core Specification, the pseudorandom sequence may be generated in a nine stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs;
i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: 2^9 -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.
According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.

Compliance for section 15.247(g)

According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

Compliance for section 15.247(h)

According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.
According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinate with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

2.5 Measurement uncertainty

The measurement uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Test item	Measurement uncertainty
Maximum peak output power	± 0.74dB
Radiated Emissions in restricted frequency bands below 1GHz	± 4.90dB
Radiated Emissions in restricted frequency bands above 1GHz	± 5.02dB
Emission outside the frequency band	± 2.89dB
Power line conducted emission	± 3.19dB

3. 20 dB Bandwidth

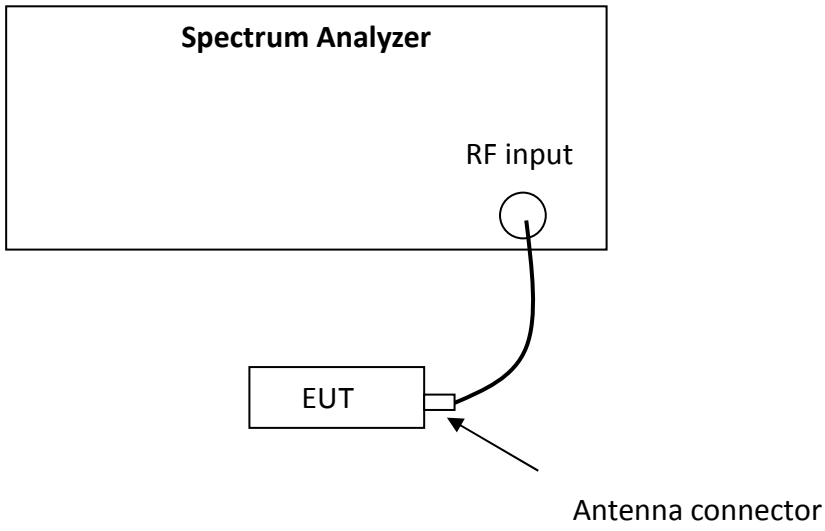
Test result: Tested

3.1 Limit

☐ 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.

☒ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

3.2 Test Configuration



3.3 Test Procedure and test setup

The 20 bandwidth per FCC §15.247(a)(1) is measured using the Spectrum Analyzer with Span = 2 to 3 times the 20 dB bandwidth, RBW≥1% of the 20 dB bandwidth, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

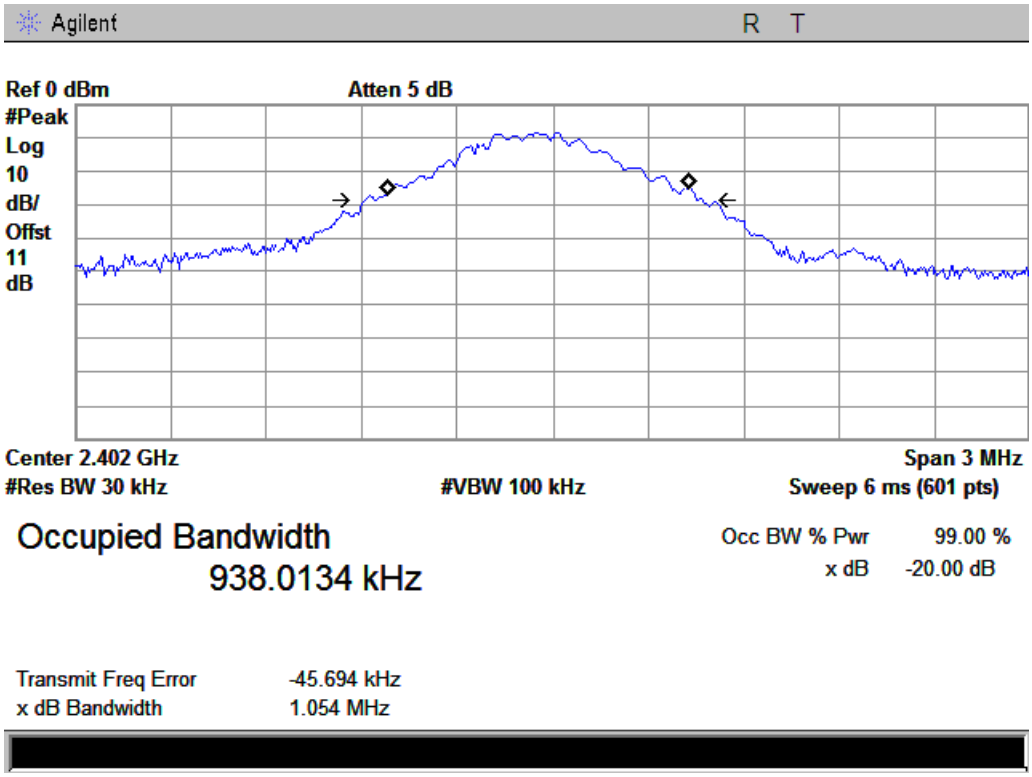
3.4 Test Protocol

Temperature : 25°C

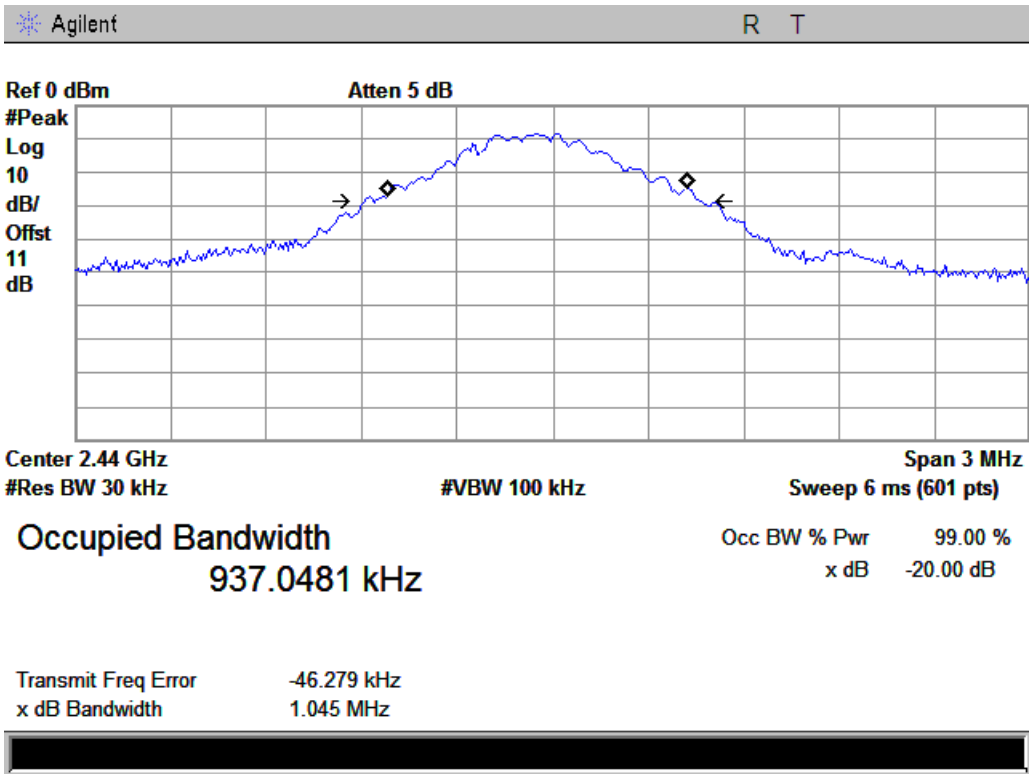
Relative Humidity : 55 %

Modulation	CH	Bandwidth (kHz)	Two-thirds of Bandwidth (kHz)
GFSK	L	1054	702.67
	M	1045	696.67
	H	1036	690.67

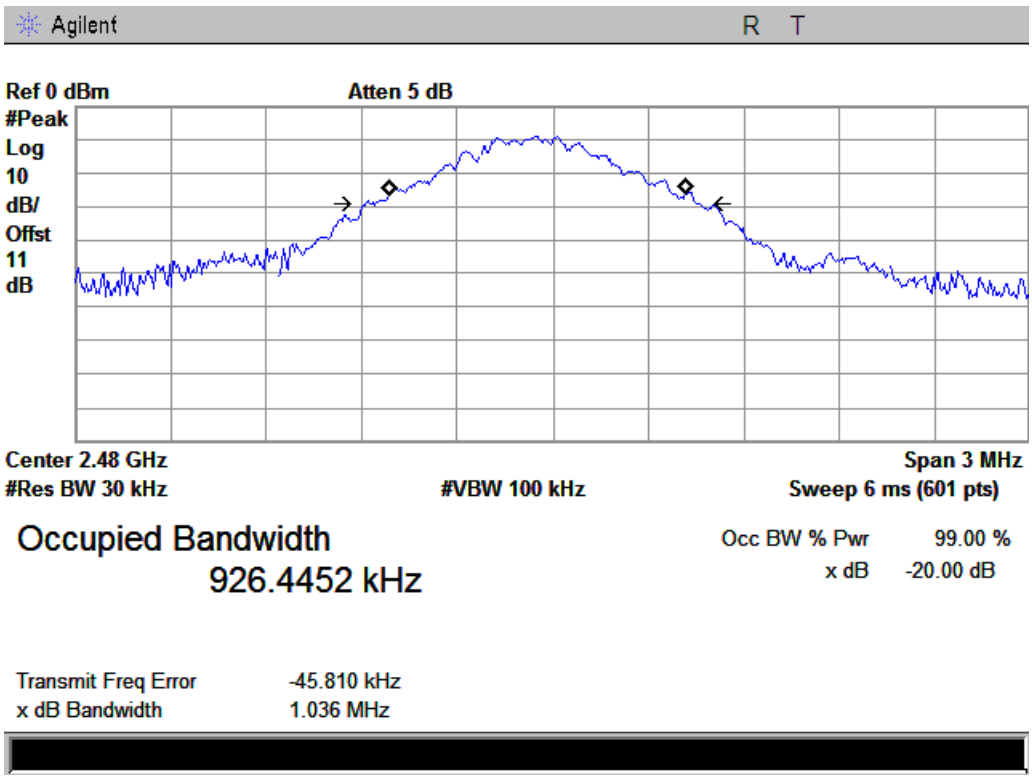
Channel L



Channel M

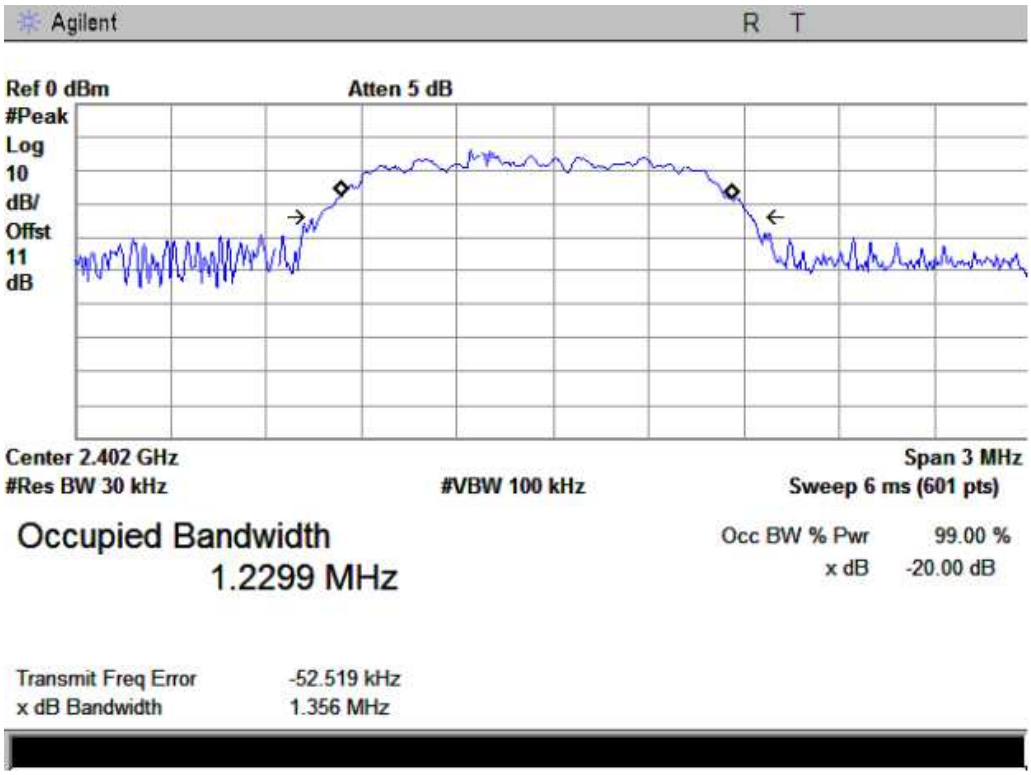


Channel H

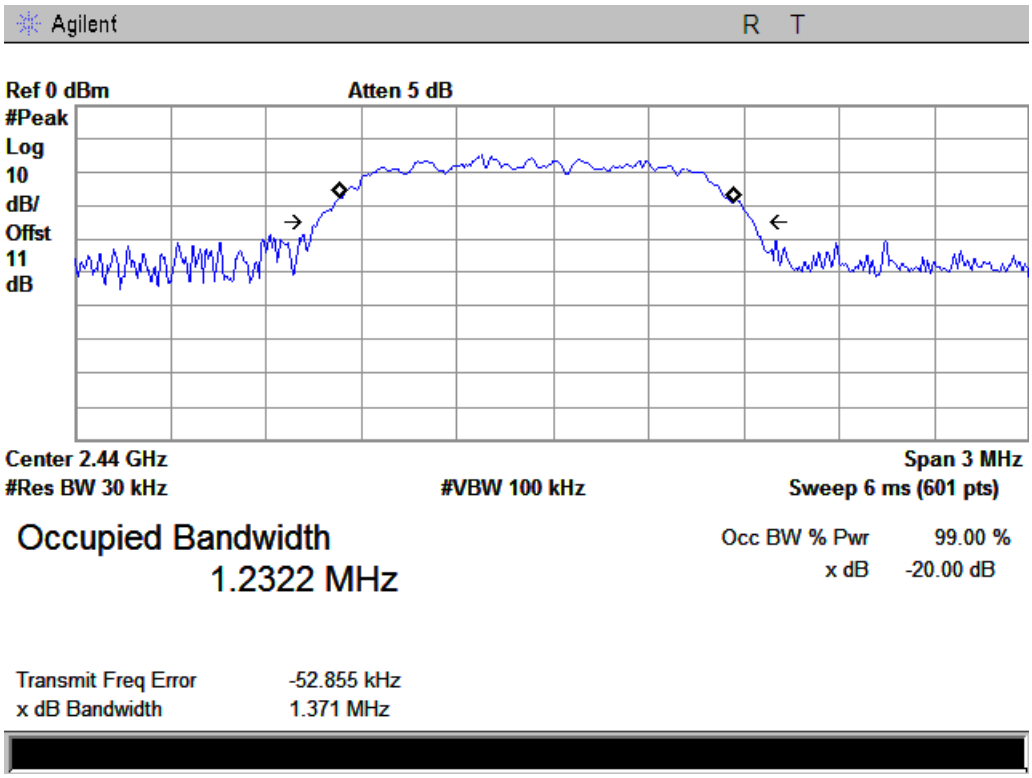


Modulation	CH	Bandwidth (kHz)	Two-thirds of Bandwidth (kHz)
π/4 DQPSK	L	1356	904.00
	M	1371	914.00
	H	1366	910.67

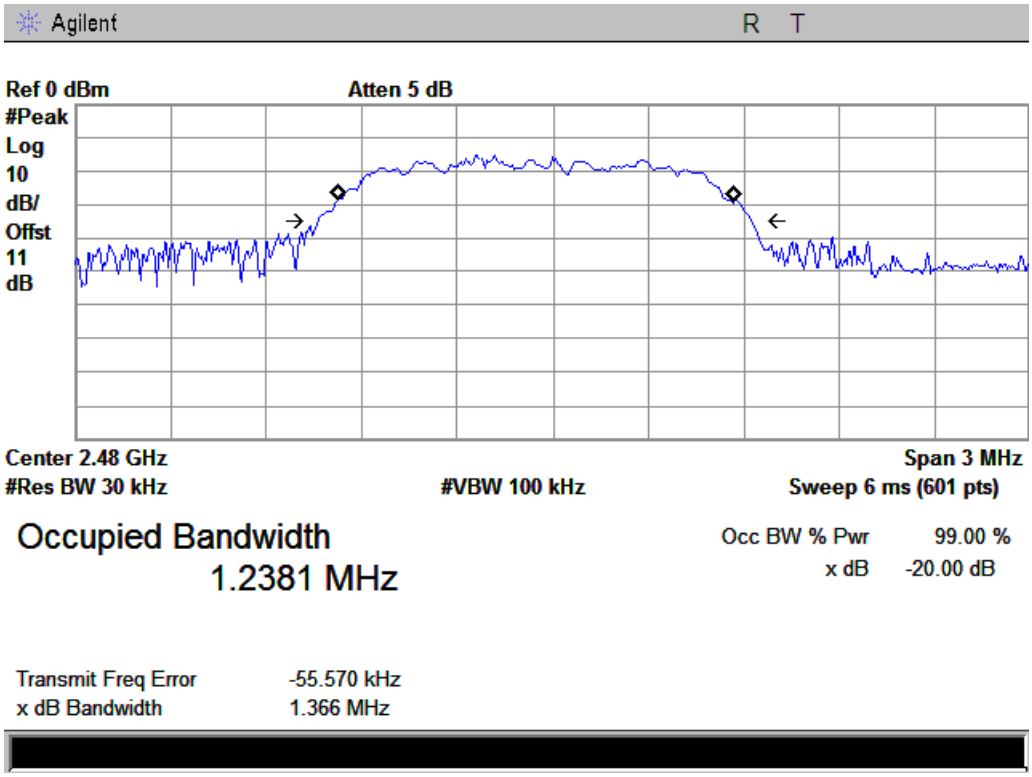
Channel L



Channel M

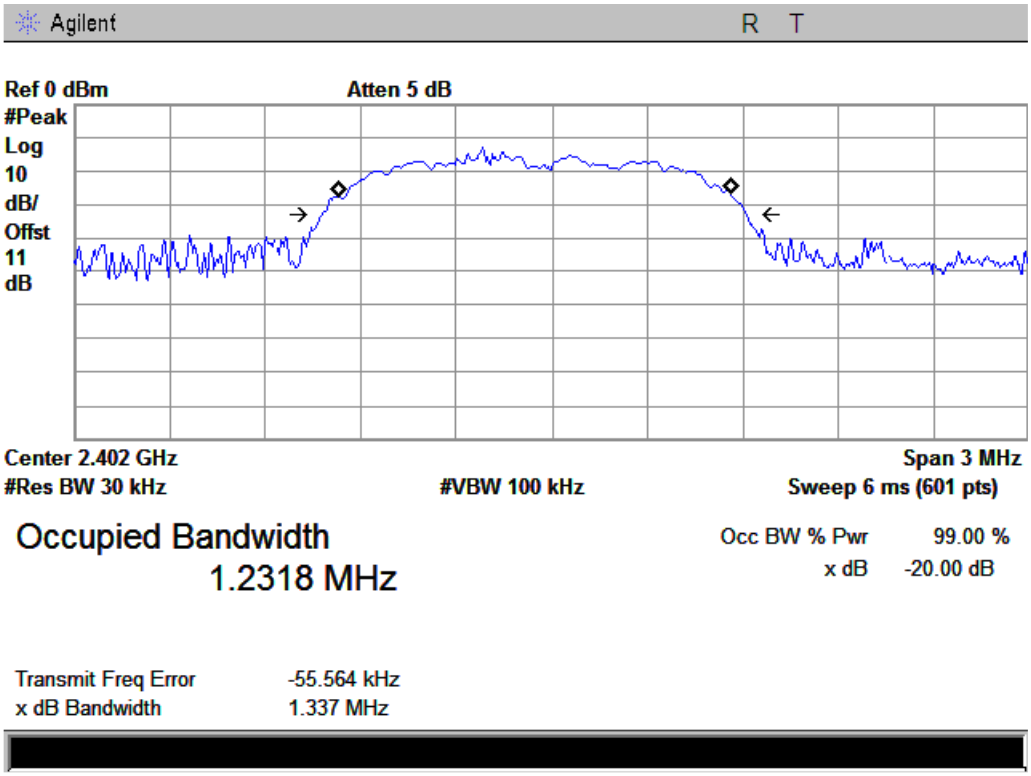


Channel H

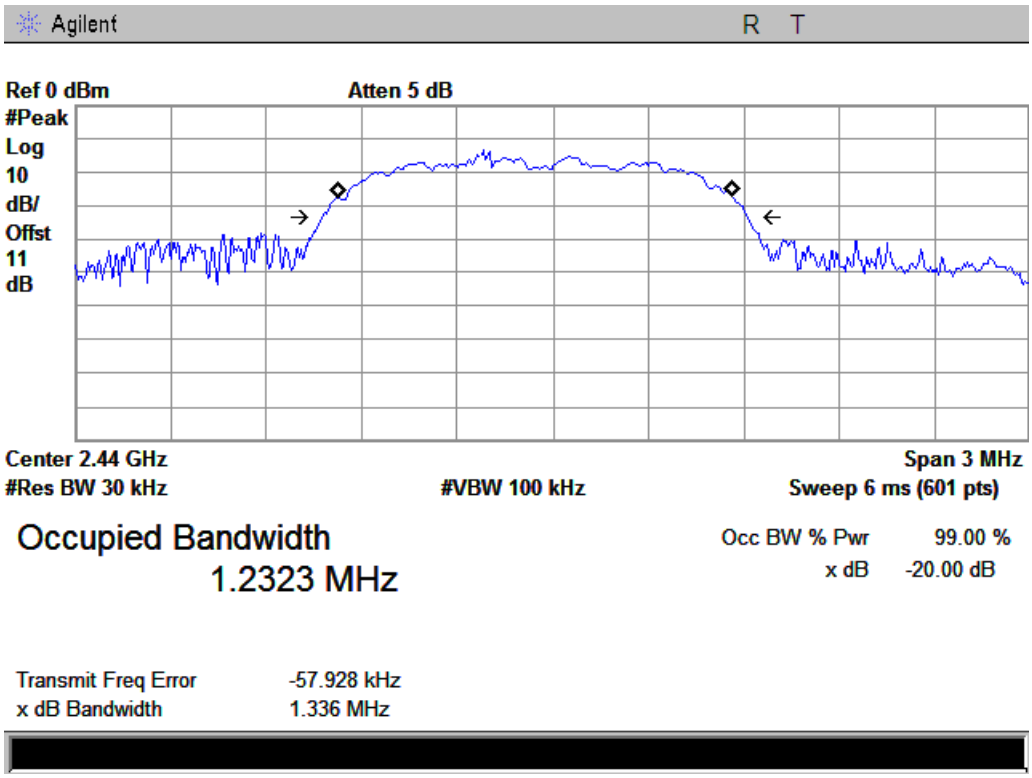


Modulation	CH	Bandwidth (kHz)	Two-thirds of Bandwidth (kHz)
8DPSK	L	1337	891.33
	M	1336	890.67
	H	1355	903.33

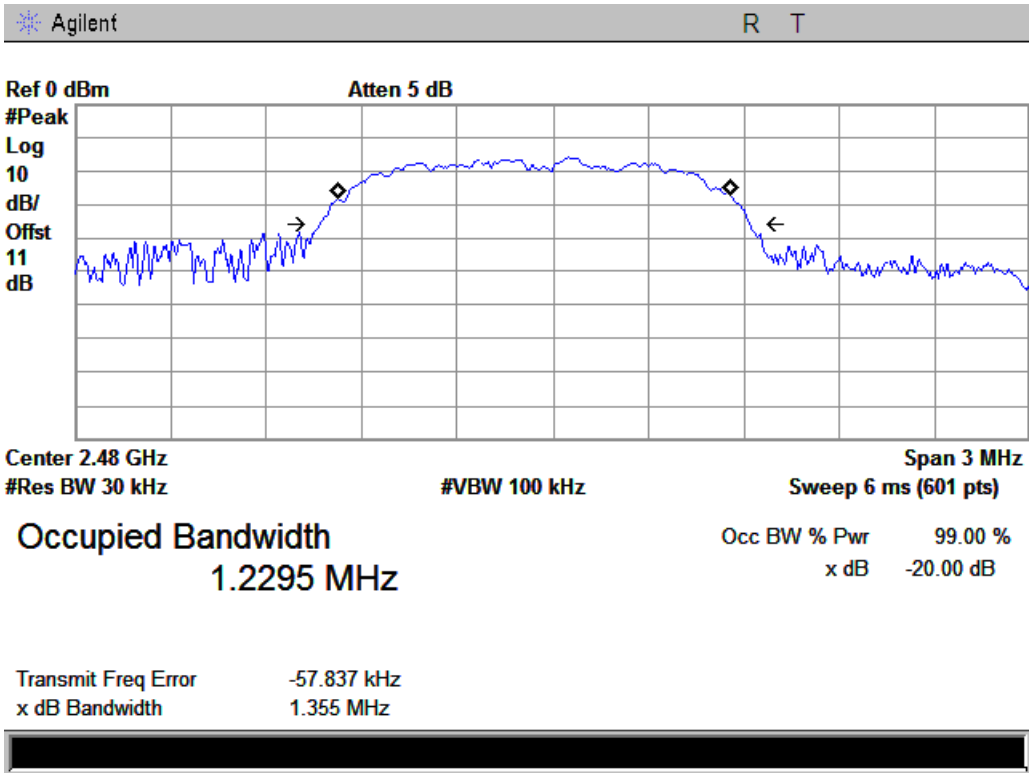
Channel L



Channel M



Channel H



4. Carrier Frequency Separation

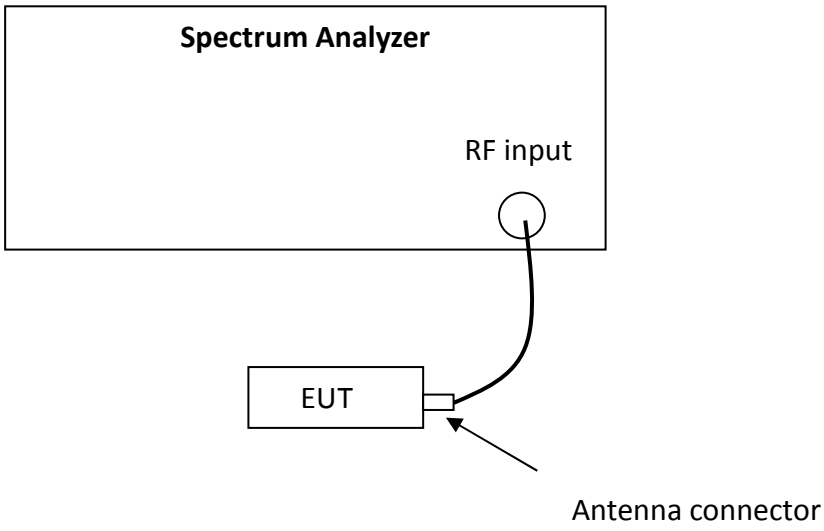
Test result: Pass

4.1 Limit

☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

☒ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

4.2 Test Configuration



4.3 Test Procedure and test setup

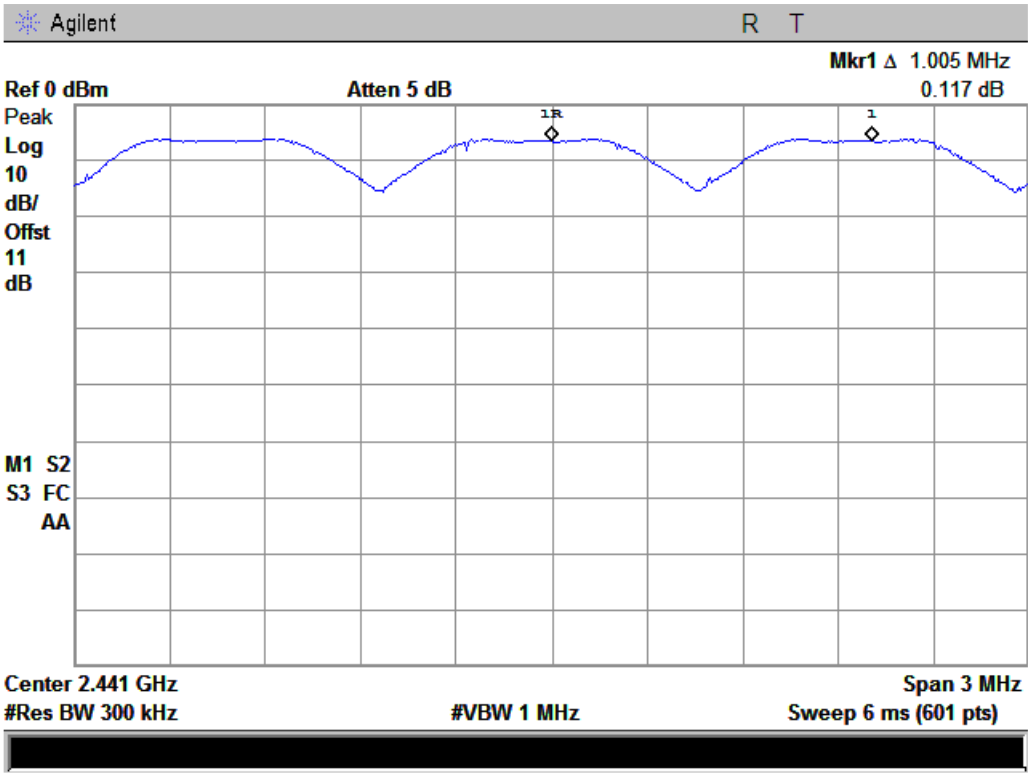
The Carrier Frequency Separation per FCC §15.247(a)(1) is measured using the Spectrum Analyzer with Span can capture two adjacent channels, RBW≥1% of the span, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

4.4 Test Protocol

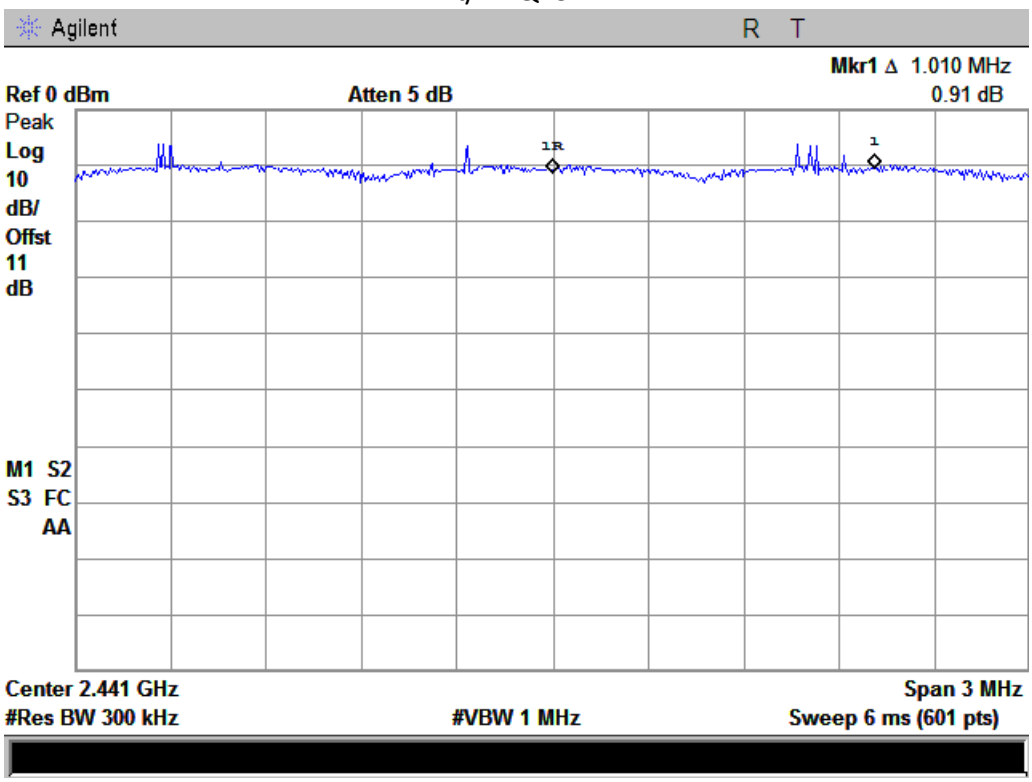
Temperature	:	25°C
Relative Humidity	:	55 %

The Bluetooth Module operates at hopping-on test mode.
For any adjacent channels (e.g. the channel 38 and 40 as showed below), the EUT does have hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater. So, the verdict is PASSING

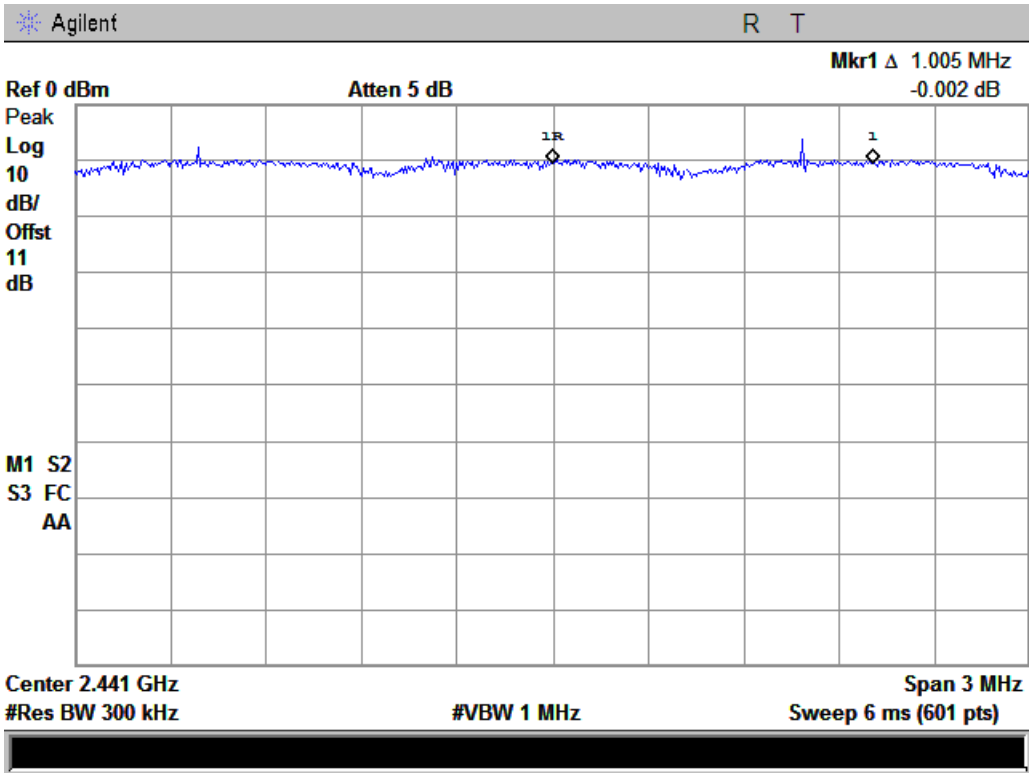
GFSK



π/4 DQPSK



8DPSK



5. Maximum peak output power

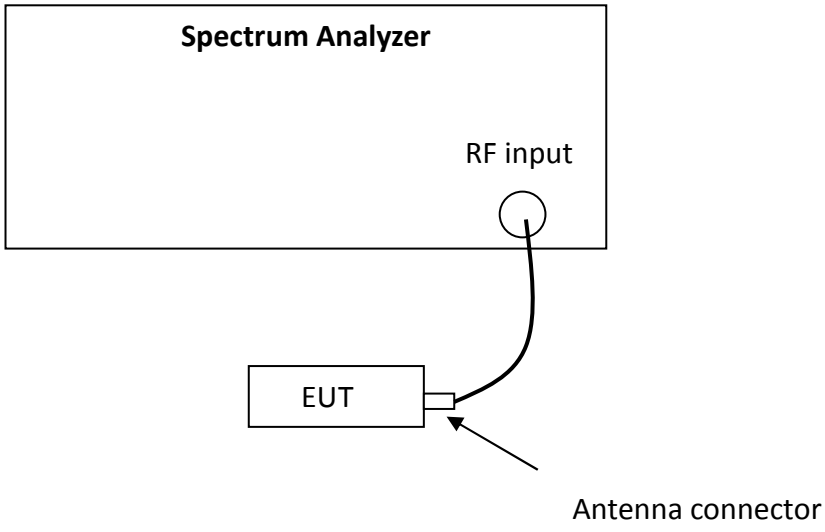
Test result: Pass

5.1 Test limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt

For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts
If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

5.2 Test Configuration



5.3 Test procedure and test setup

The power output per FCC §15.247(b) is measured using the Spectrum Analyzer with Span = 5 times the 20 dB bandwidth, RBW≥ the 20 dB bandwidth, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

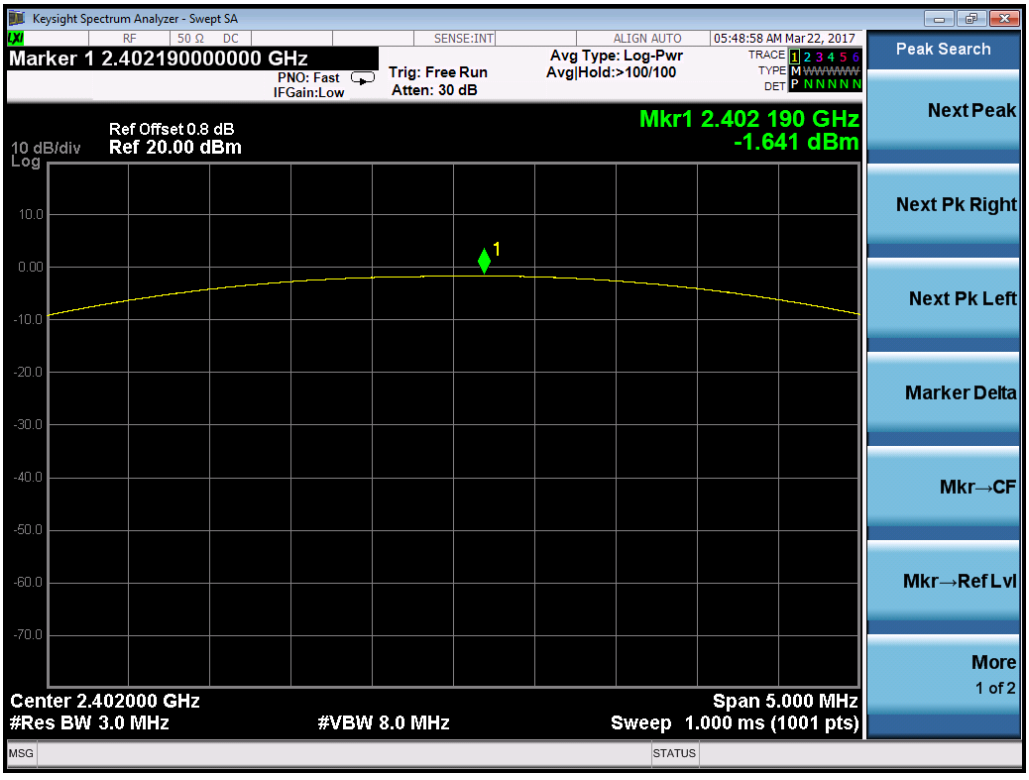
5.4 Test protocol

Temperature : 25 °C

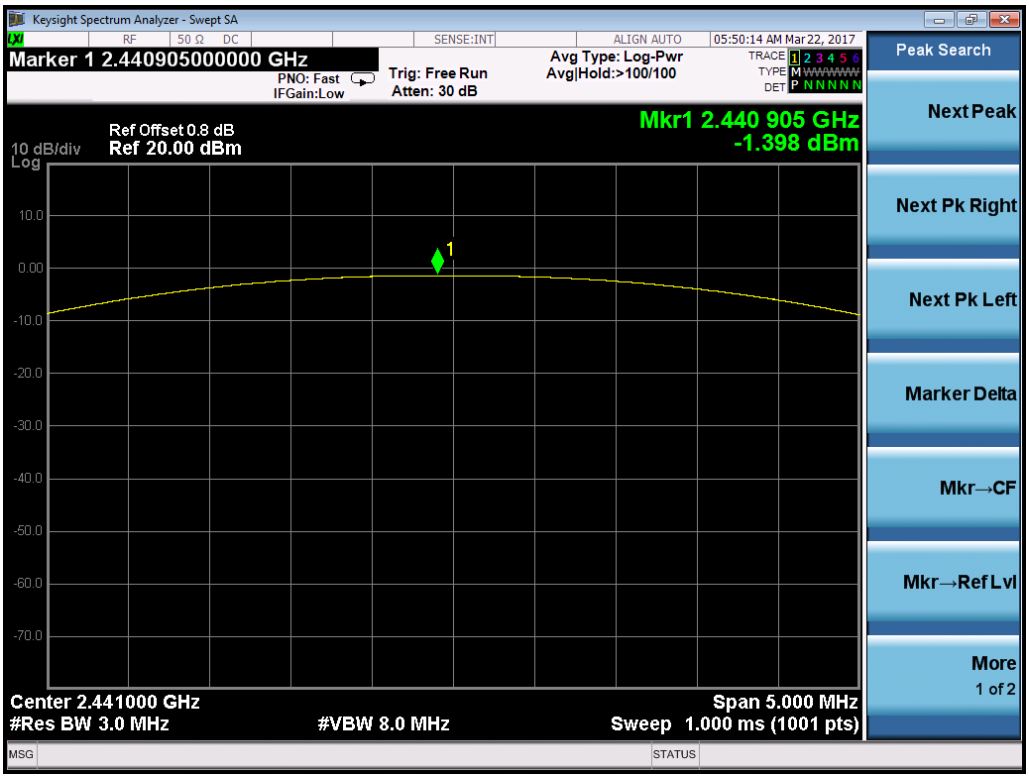
Relative Humidity : 55 %

Mode	CH	Cable loss (dB)	Corrected reading (dBm)	Limit (dBm)
GFSK (DH5)	L	0.8	-1.641	≤21.00
	M	0.8	-1.398	
	H	0.8	2.323	

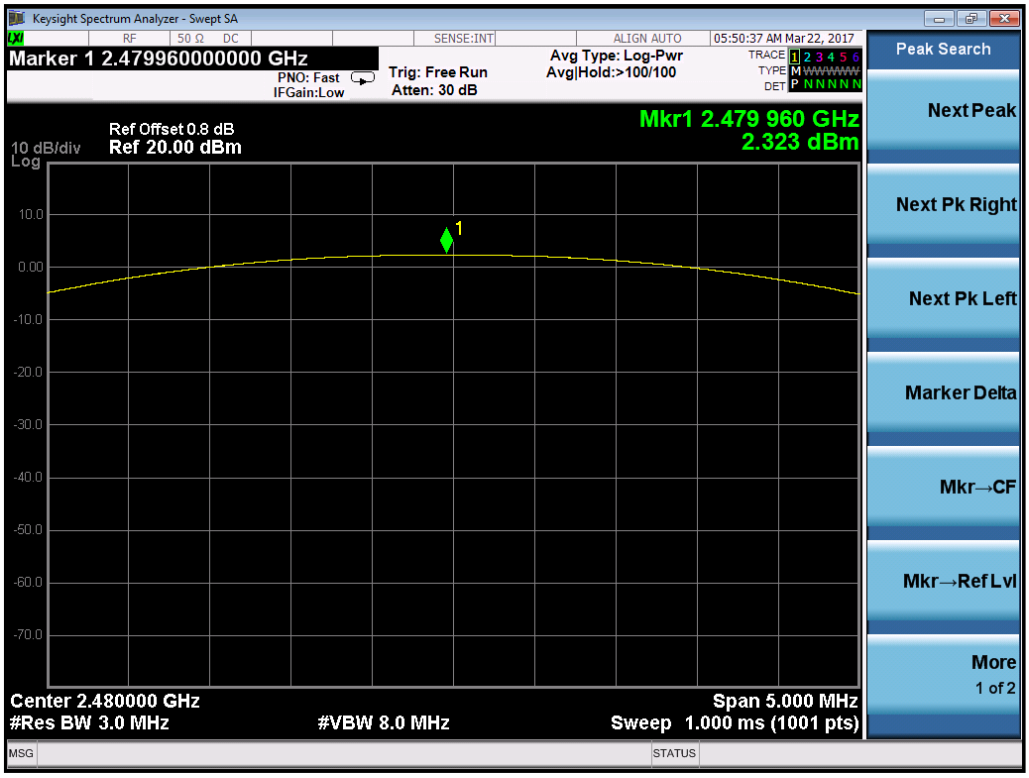
Channel L



Channel M

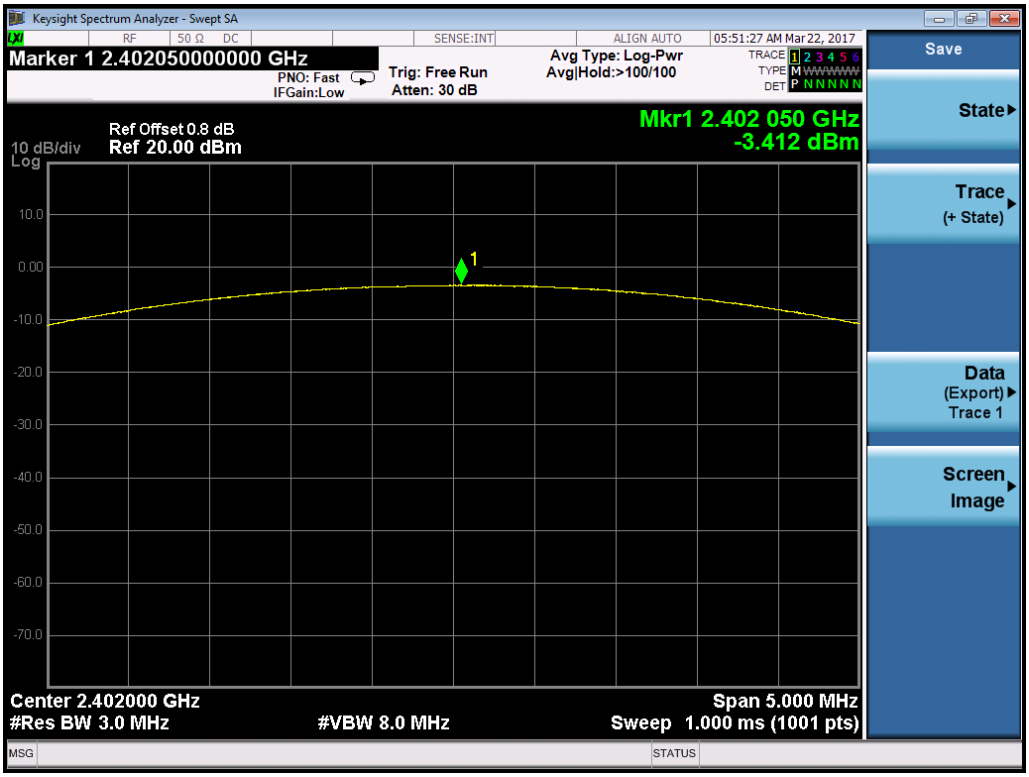


Channel H

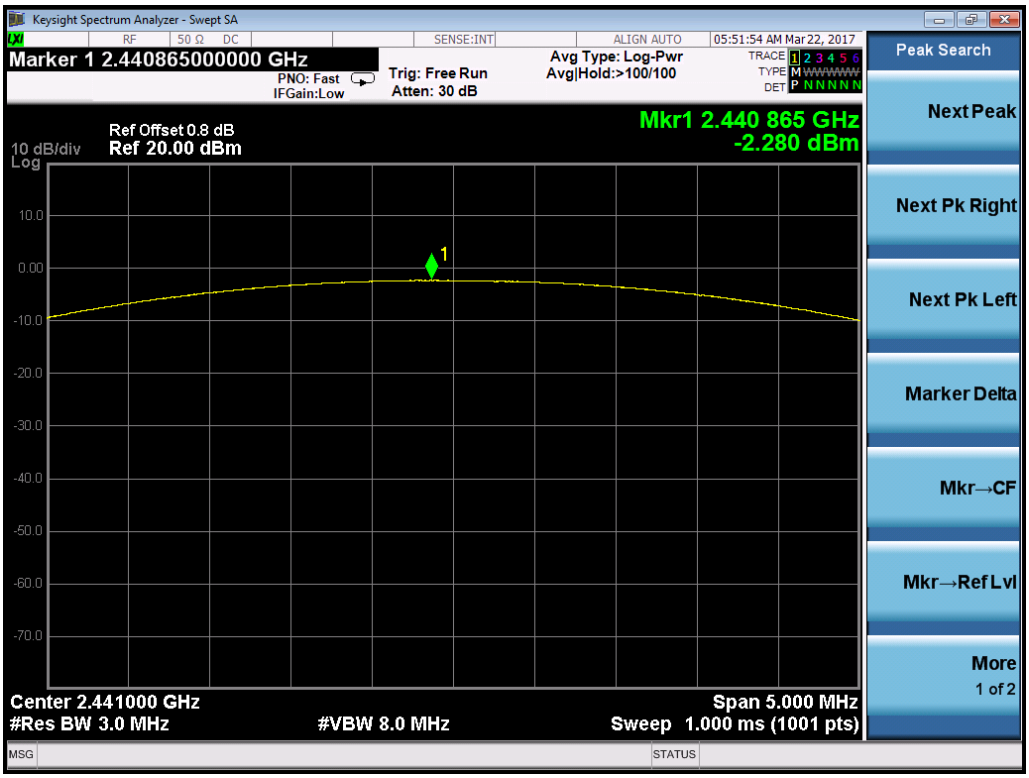


Mode	CH	Cable loss (dB)	Corrected reading (dBm)	Limit (dBm)
π/4 DQPSK (2DH5)	L	0.8	-3.412	≤21.00
	M	0.8	-2.280	
	H	0.8	1.677	

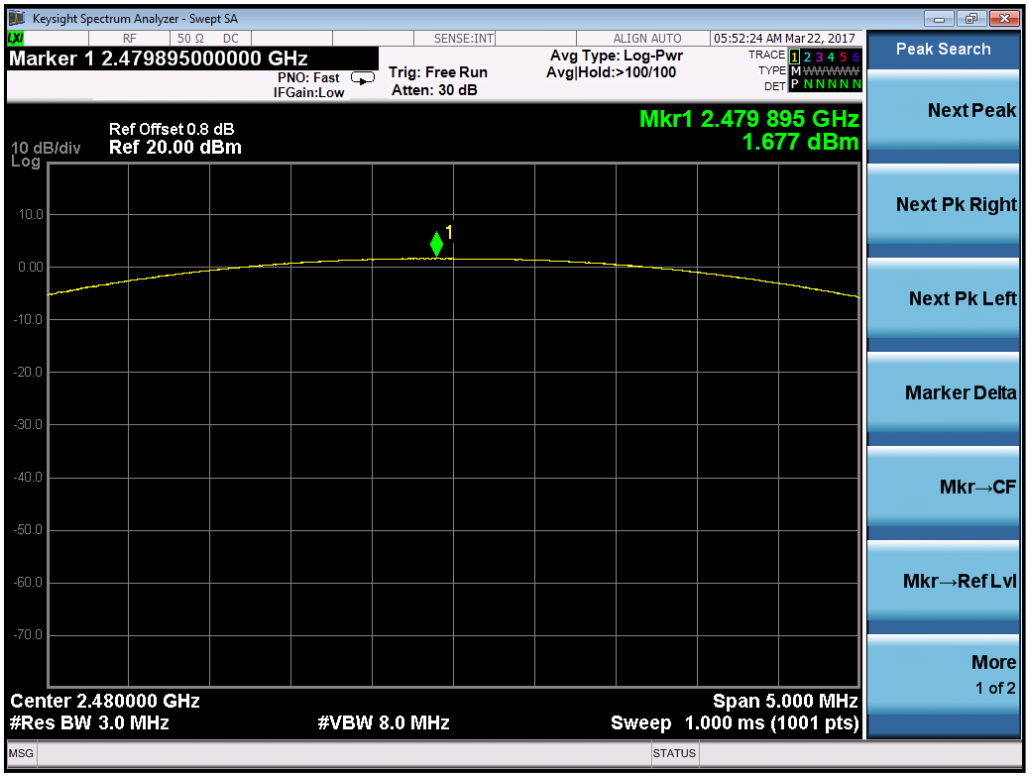
Channel L



Channel M

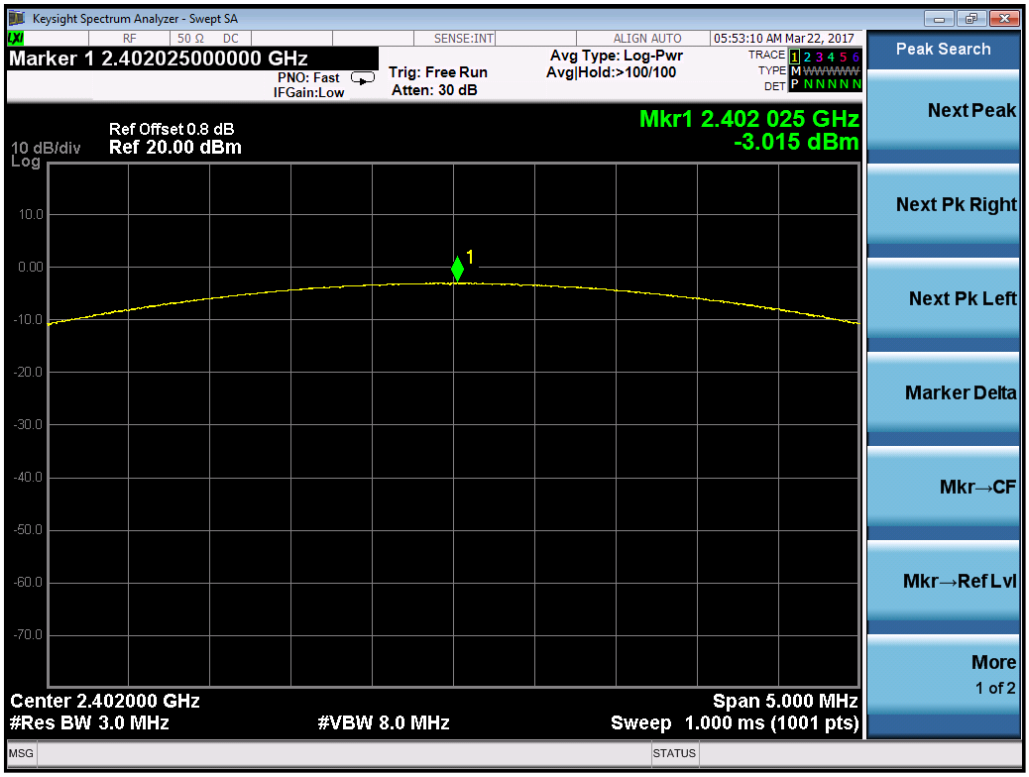


Channel H

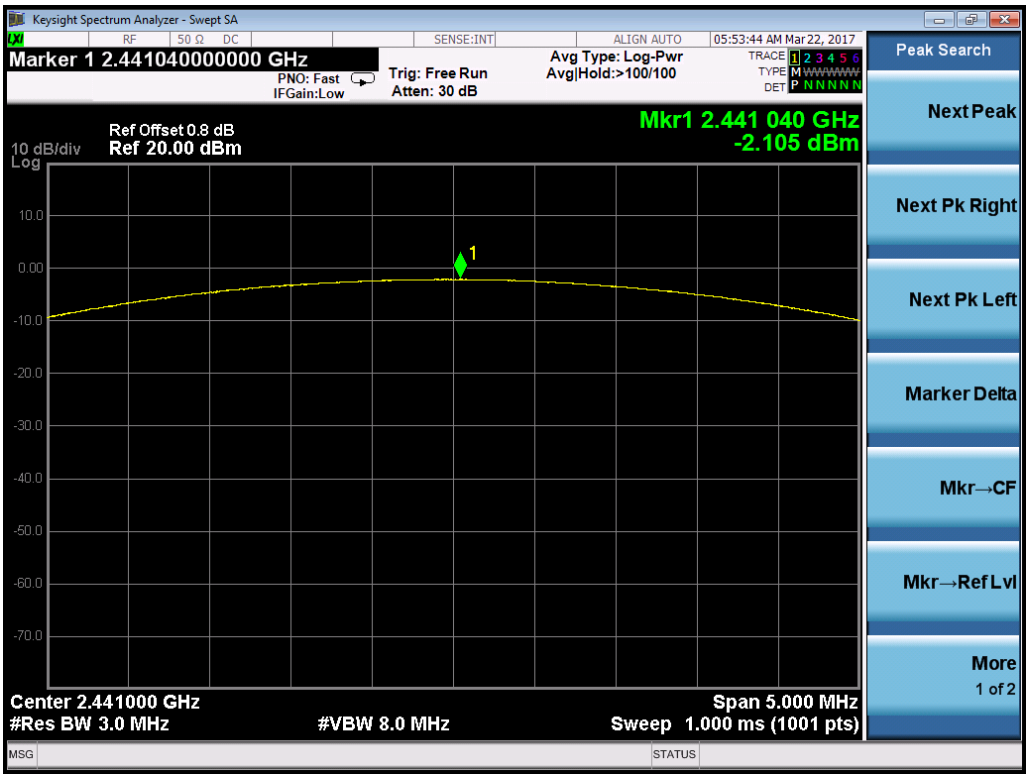


Mode	CH	Cable loss (dB)	Corrected reading (dBm)	Limit (dBm)
8DPSK (3DH5)	L	0.8	-3.015	≤21.00
	M	0.8	-2.105	
	H	0.8	1.688	

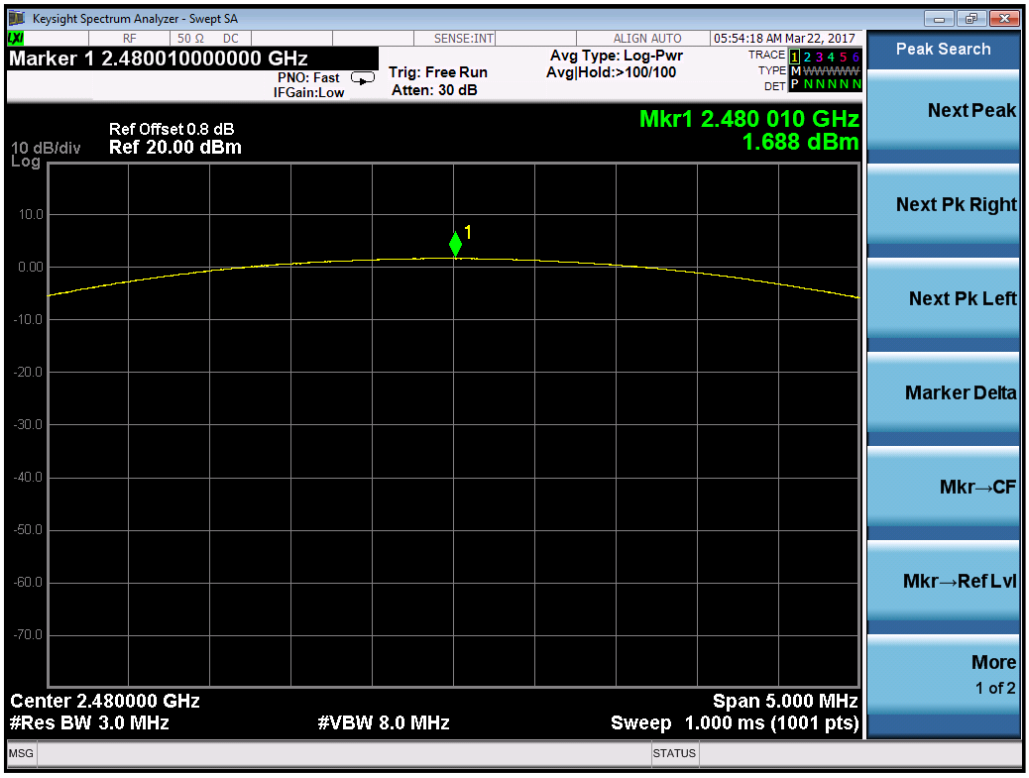
Channel L



Channel M



Channel H



6. Radiated Spurious Emissions

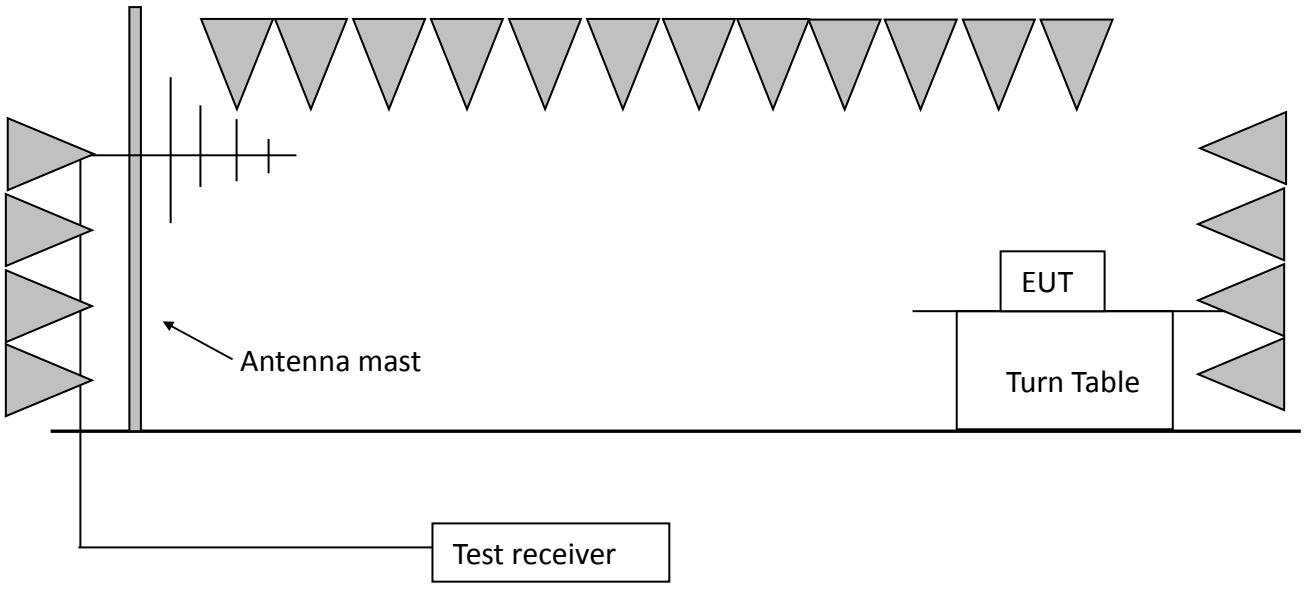
Test result: Pass

6.1 Test limit

The radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) showed as below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

6.2 Test Configuration



6.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, if applied, the pre-amplifier would be equipped just at the output terminal of the antenna.

Tabletop devices shall be placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m.

The turn table rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.

The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

The radiated emission was measured using the Spectrum Analyzer with the resolutions bandwidth set as:

RBW = 100 kHz, VBW = 300 kHz (30MHz~1GHz)
RBW = 1MHz, VBW = 3MHz (>1GHz for PK);

Remark: 1. For fundamental emission, no amplifier is employed.
2. Correct Factor = Antenna Factor + Cable Loss (-Amplifier, is employed)
3. Corrected Reading = Original Receiver Reading + Correct Factor
4. Margin = limit – Corrected Reading
5. If the PK reading is lower than AV limit, the AV test can be elided.
6. The emission was conducted from 30MHz to 25GHz.

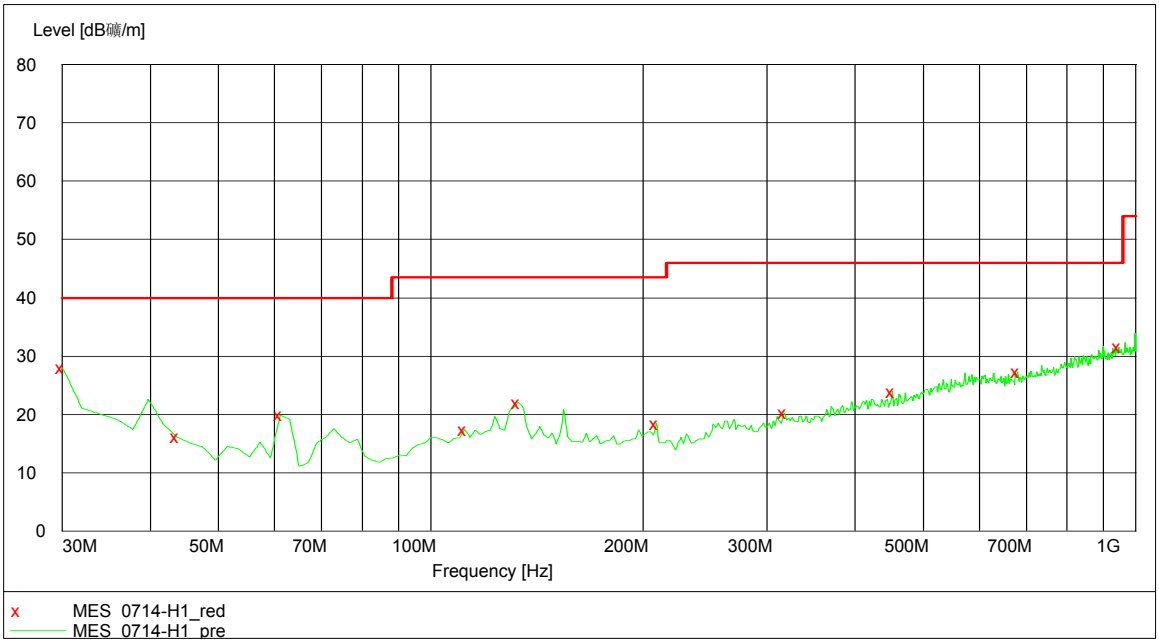
Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Correct Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m; Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 54 - 10.20 = 43.80dBuV/m

6.4 Test protocol

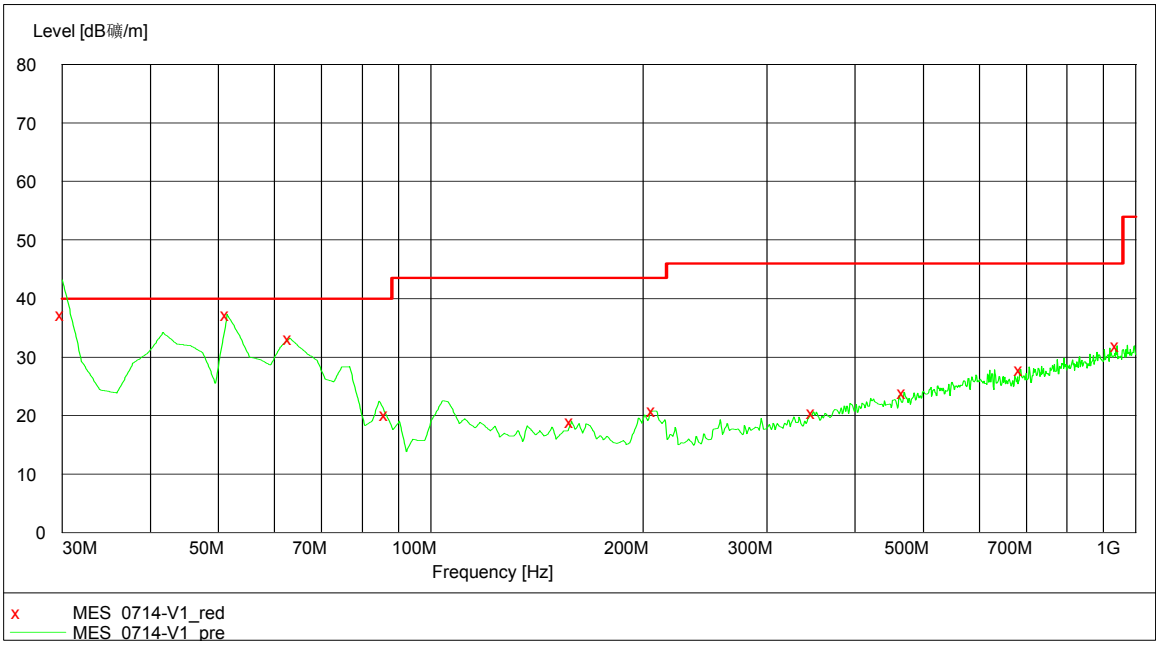
Temperature	:	25 °C
Relative Humidity	:	55 %

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

Horizontal



Vertical



Test data (30MHz~1GHz, GFSK (DH5) Mode):

Polarization	Frequency (MHz)	Measured level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
H	30.00	28.0	40.0	12.0	PK
	43.61	16.1	40.0	23.9	PK
	61.10	19.9	40.0	20.1	PK
	111.64	17.4	43.5	26.1	PK
	133.03	22.0	43.5	21.5	PK
	208.84	18.4	43.5	25.1	PK
	317.70	20.2	46.0	25.8	PK
	451.82	23.9	46.0	22.1	PK
	679.26	27.3	46.0	18.7	PK
	947.52	31.6	46.0	14.4	PK
V	30.00	37.2	40.0	2.8	PK
	51.38	37.3	40.0	2.7	PK
	63.05	33.2	40.0	6.8	PK
	86.37	20.2	40.0	19.8	PK
	158.30	19.0	43.5	24.5	PK
	206.89	20.8	43.5	22.7	PK
	348.80	20.6	46.0	25.4	PK
	469.32	24.0	46.0	22.0	PK
	687.03	27.9	46.0	18.1	PK
	941.68	31.9	46.0	14.1	PK

Test Data (>1GHz):

GFSK (DH5) Modulation:

H	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2402.00	30.70	95.60	Fundamental	/	PK
	H	2389.90	30.20	57.40	74.00	16.60	PK
	H	2389.90	30.20	46.40	54.00	7.60	AV
	H	4804.00	-1.50	52.50	74.00	21.50	PK
M	V	2441.00	30.70	95.30	Fundamental	/	PK
	V	4882.00	-1.10	52.20	74.00	21.80	PK
H	H	2480.00	30.70	97.70	Fundamental	/	PK
	V	2483.50	31.52	55.20	74.00	18.80	PK
	V	2483.50	31.52	45.50	54.00	8.50	AV
	V	4960.00	-0.80	51.20	74.00	22.80	AV

π/4DQPSK (2DH5) Modulation:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2402.00	30.70	94.40	Fundamental	/	PK
	H	2389.98	30.20	54.60	74.00	19.40	PK
	H	2389.98	30.20	45.70	54.00	8.30	AV
	H	4804.00	-1.50	50.50	74.00	23.50	PK
M	V	2441.00	30.70	94.90	Fundamental	/	PK
	V	4882.00	-1.10	52.60	74.00	21.40	PK
H	H	2480.00	30.70	95.10	Fundamental	/	PK
	V	2483.50	31.52	54.50	74.00	19.50	PK
	V	2483.50	31.52	45.20	54.00	8.80	AV
	V	4960.00	-0.80	48.70	74.00	25.30	PK

8DPSK (3DH5) Modulation:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2402.00	30.70	94.90	Fundamental	/	PK
	H	2389.93	30.20	52.60	74.00	21.40	PK
	H	2389.93	30.20	43.20	54.00	10.80	AV
	H	4804.00	-1.50	50.30	74.00	23.70	PK

M	V	2441.00	30.70	95.20	Fundamental	/	PK
	V	4882.00	-1.10	52.30	74.00	21.70	PK
H	H	2480.00	30.70	96.30	Fundamental	/	PK
	V	2483.50	31.52	53.30	74.00	20.70	PK
	V	2483.50	31.52	42.70	54.00	11.30	AV
	V	4960.00	-0.80	48.60	74.00	25.40	AV

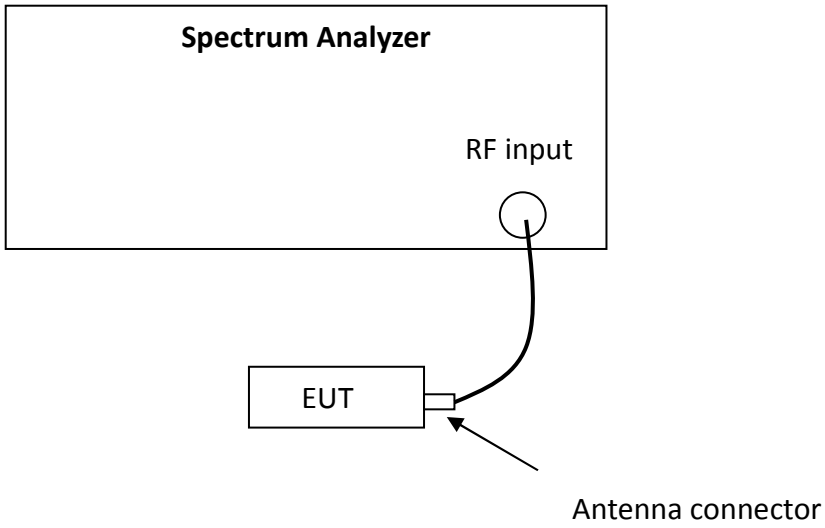
7. Conducted Spurious Emissions & Band Edge

Test result: Pass

7.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

7.2 Test Configuration



7.3 Test procedure and test setup

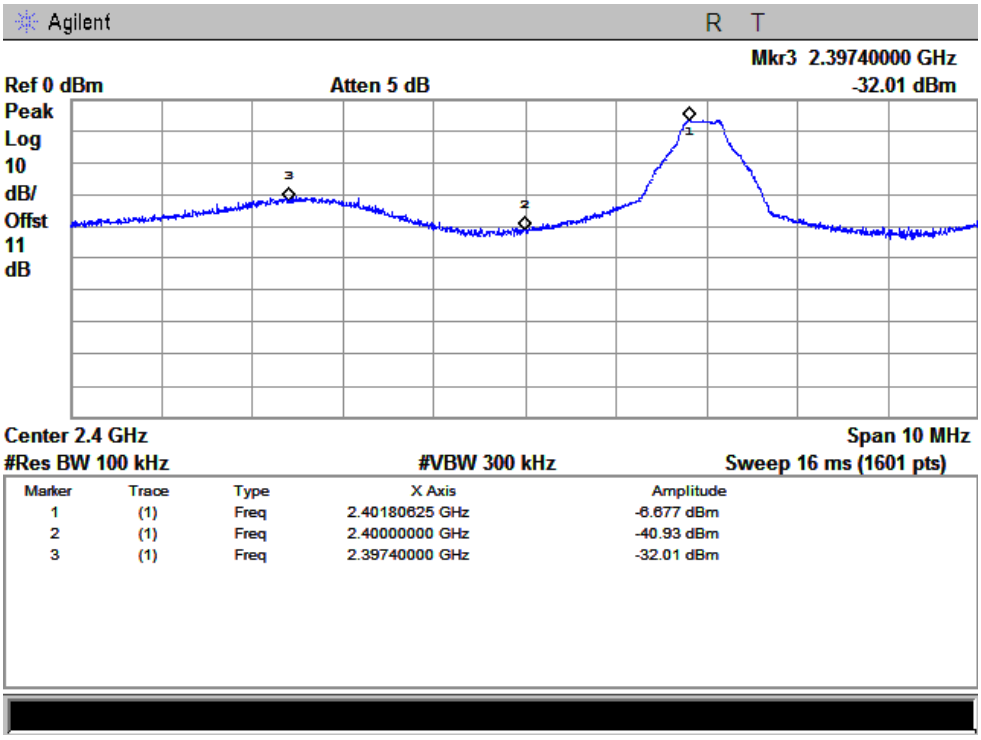
The Conducted Spurious Emissions per FCC §15.247(d) is measured using the Spectrum Analyzer with Span wide enough capturing all spurious from the lowest emission frequency of the EUT up to 10th harmonics, RBW = 100kHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

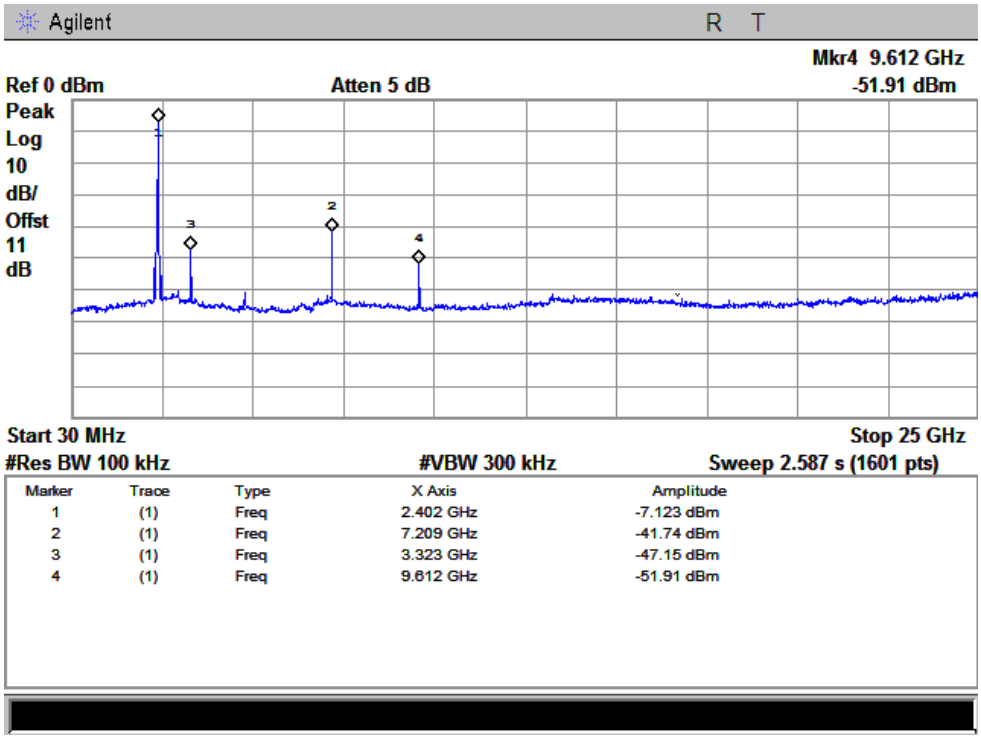
7.4 Test protocol

Temperature : 25 °C

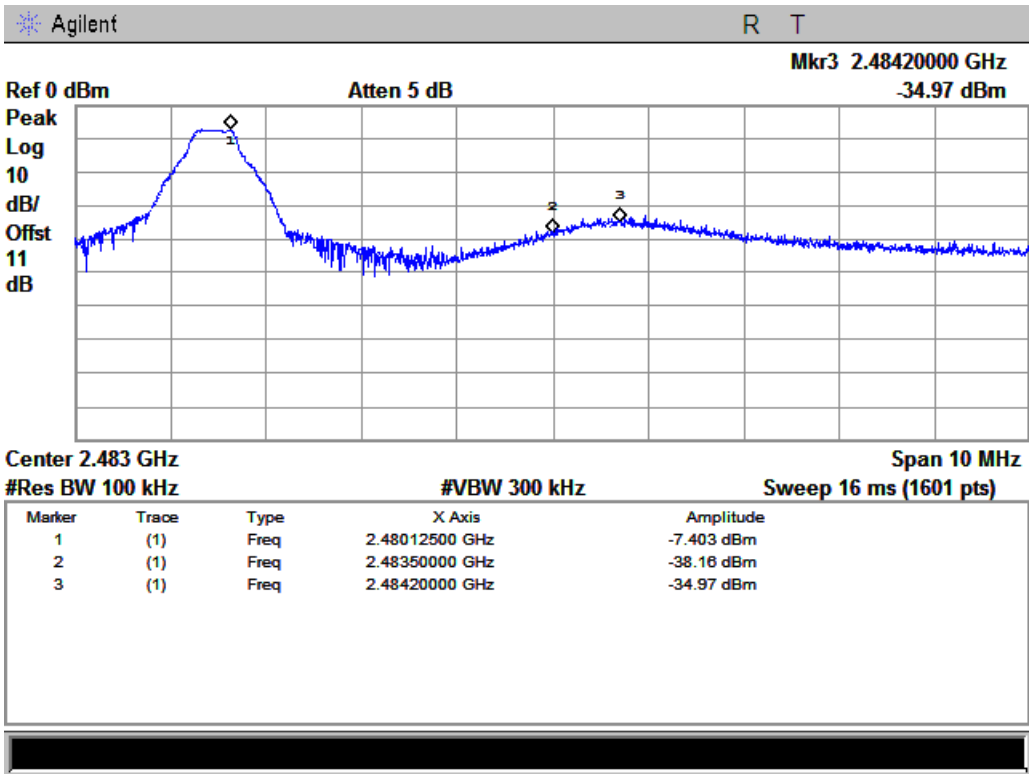
Relative Humidity : 55 %

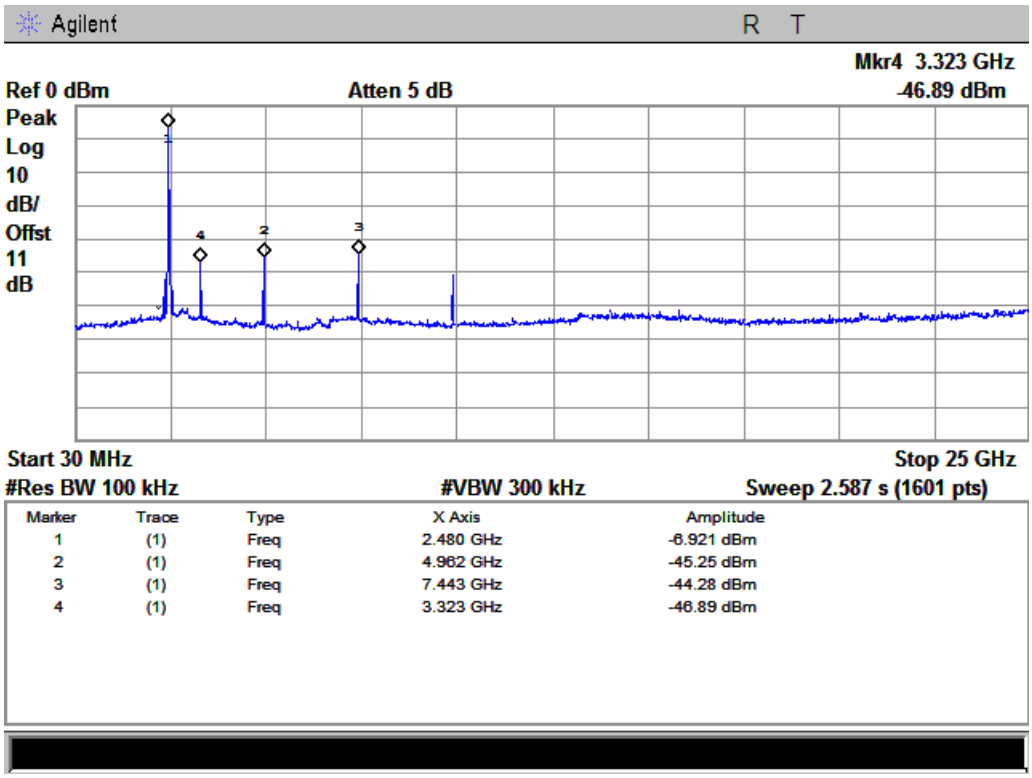
GFSK Channel- L



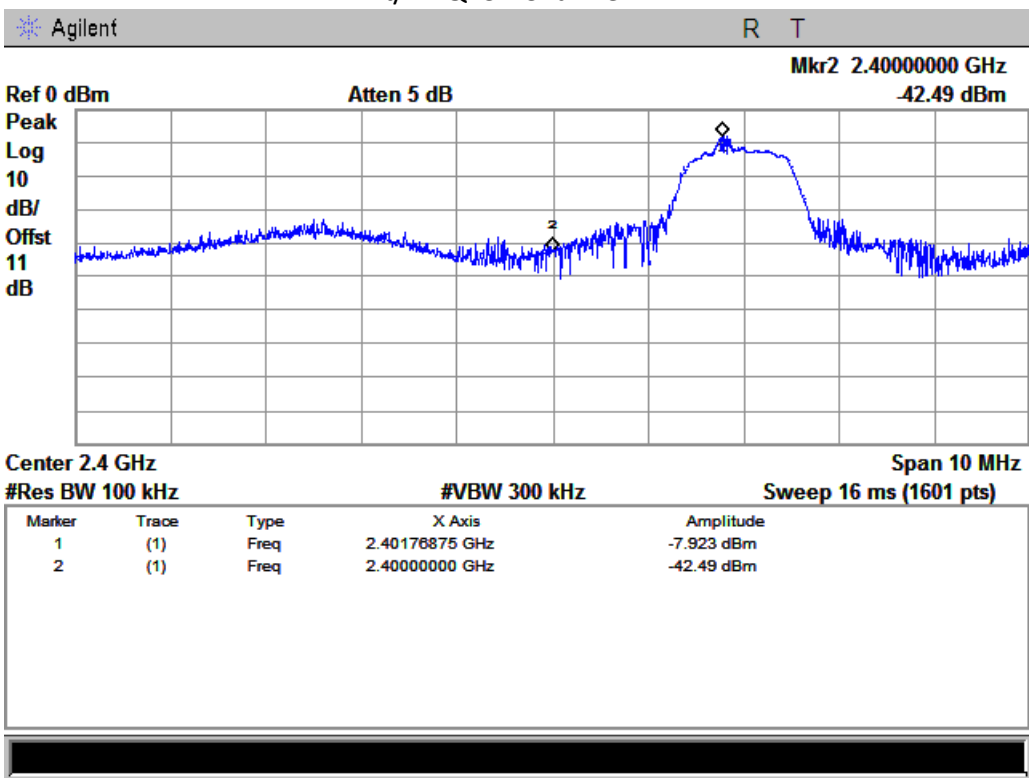


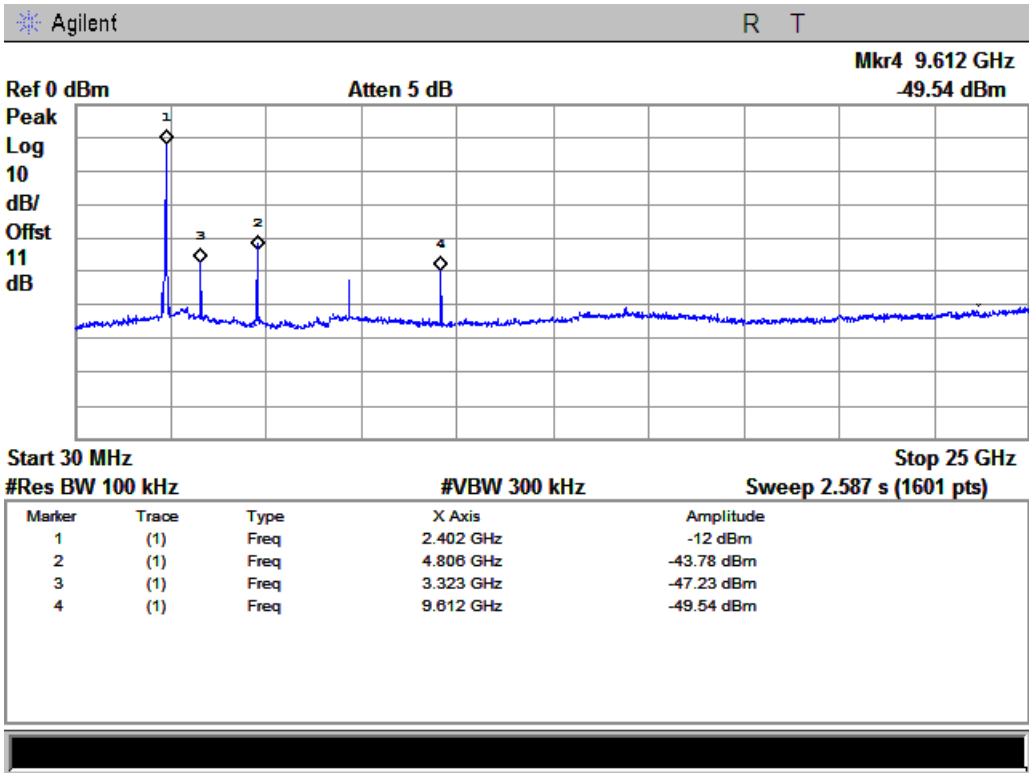
GFSK Channel- H



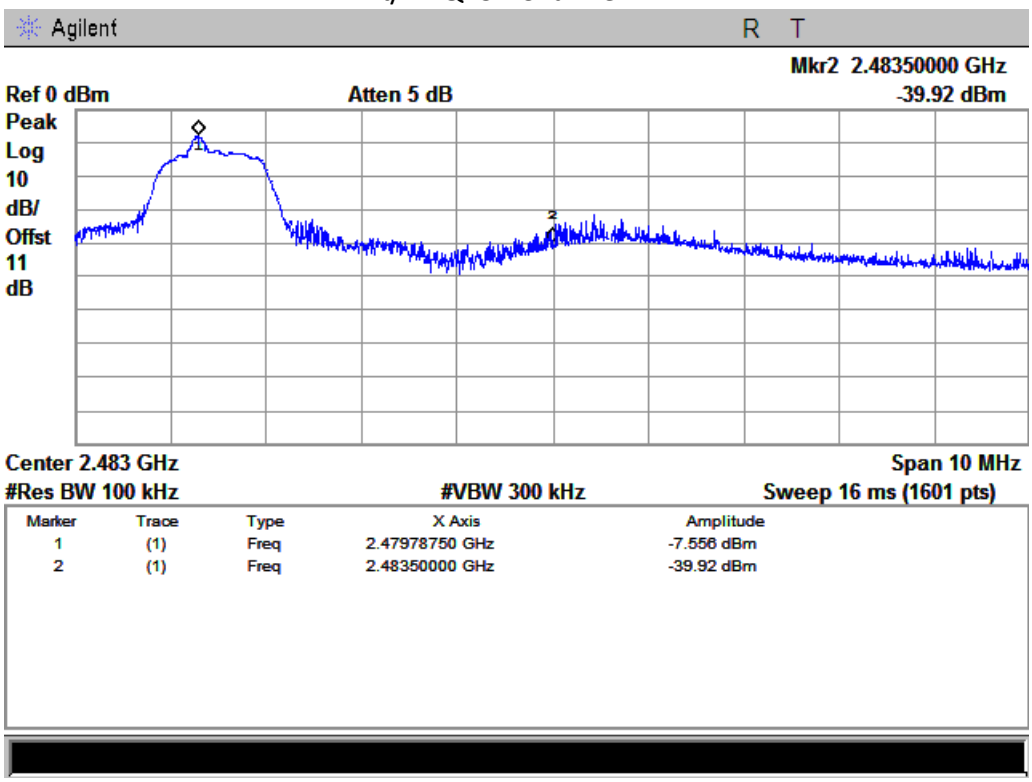


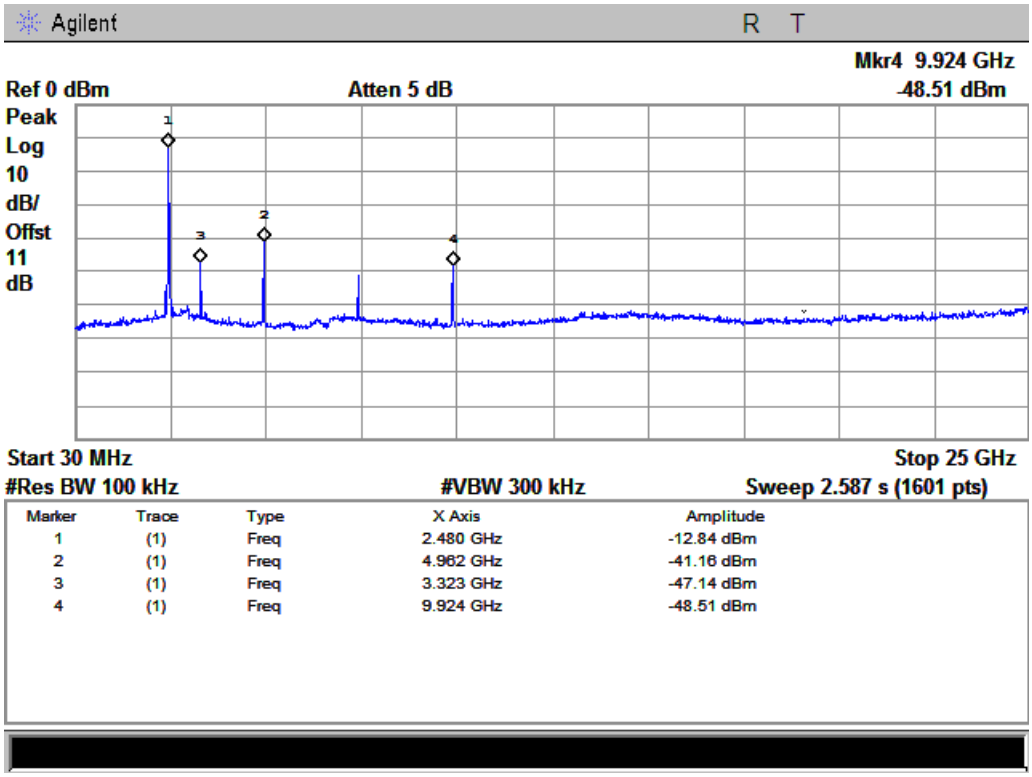
π/4 DQPSK Channel- L



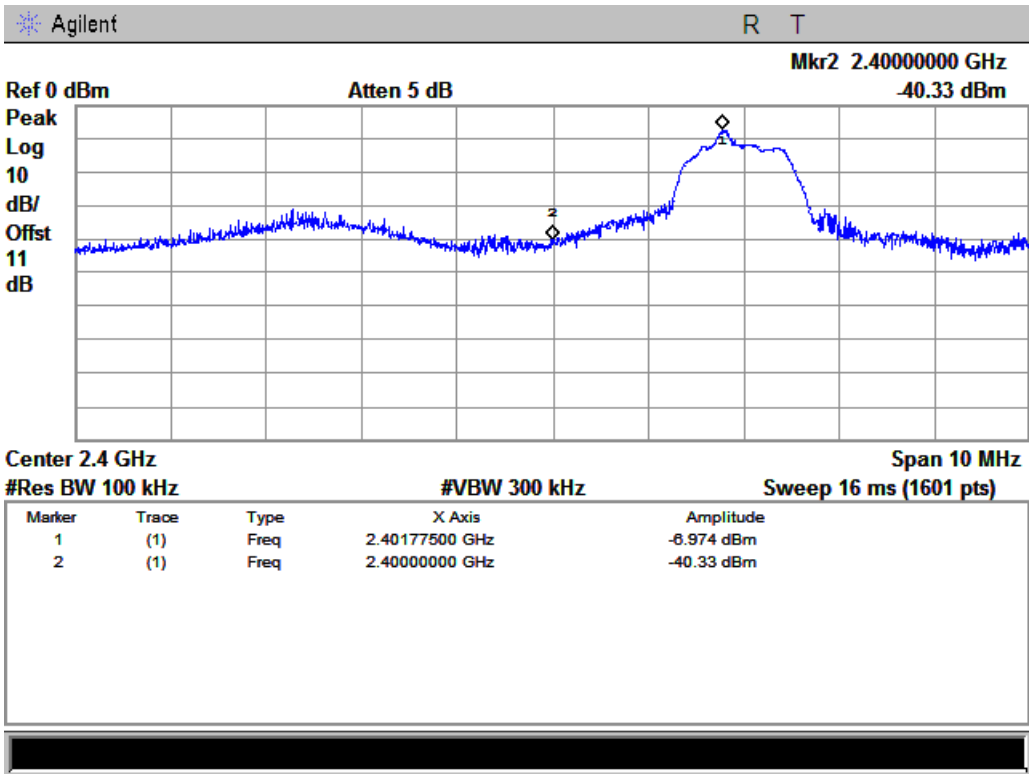


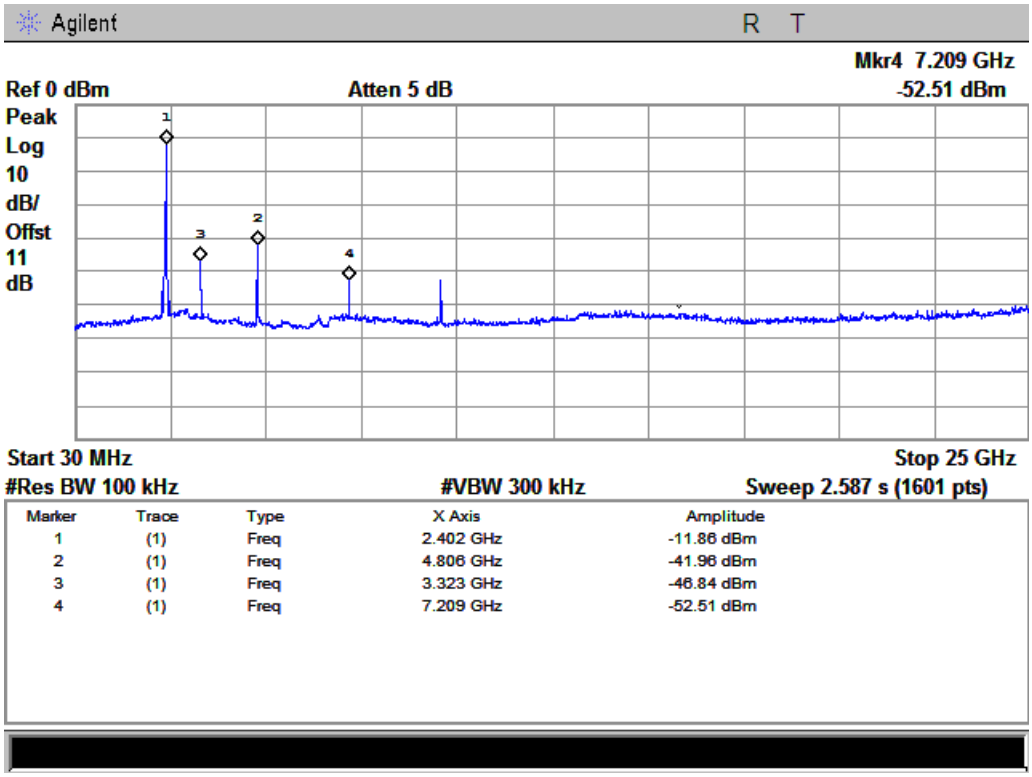
π/4 DQPSK Channel- H



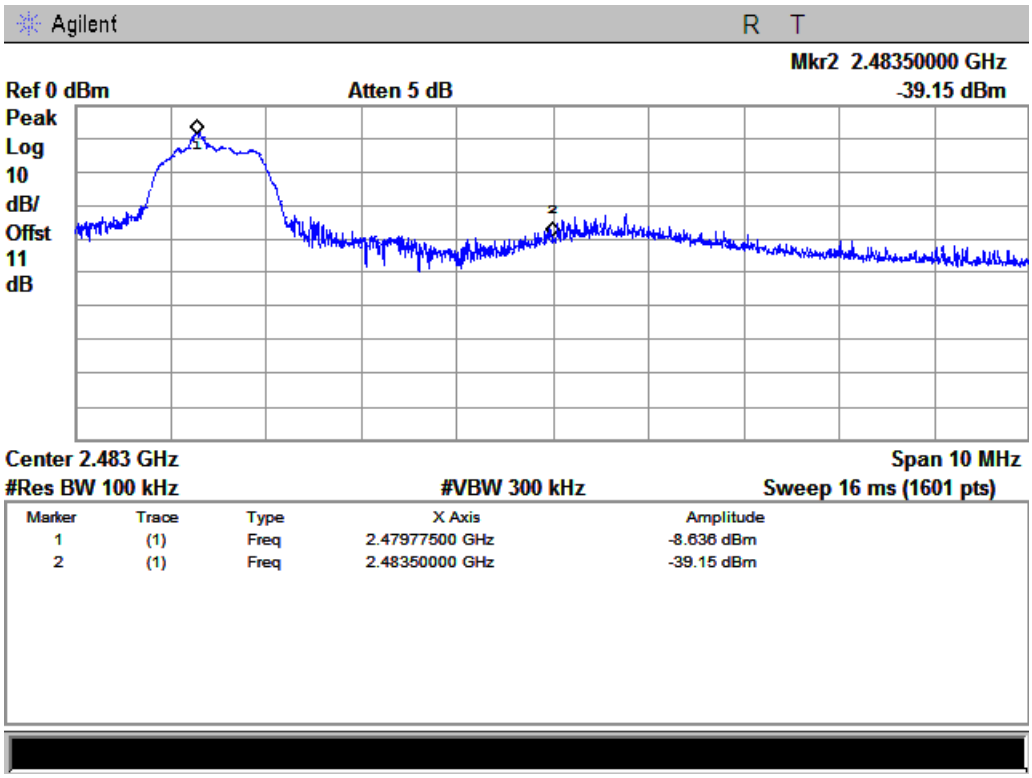


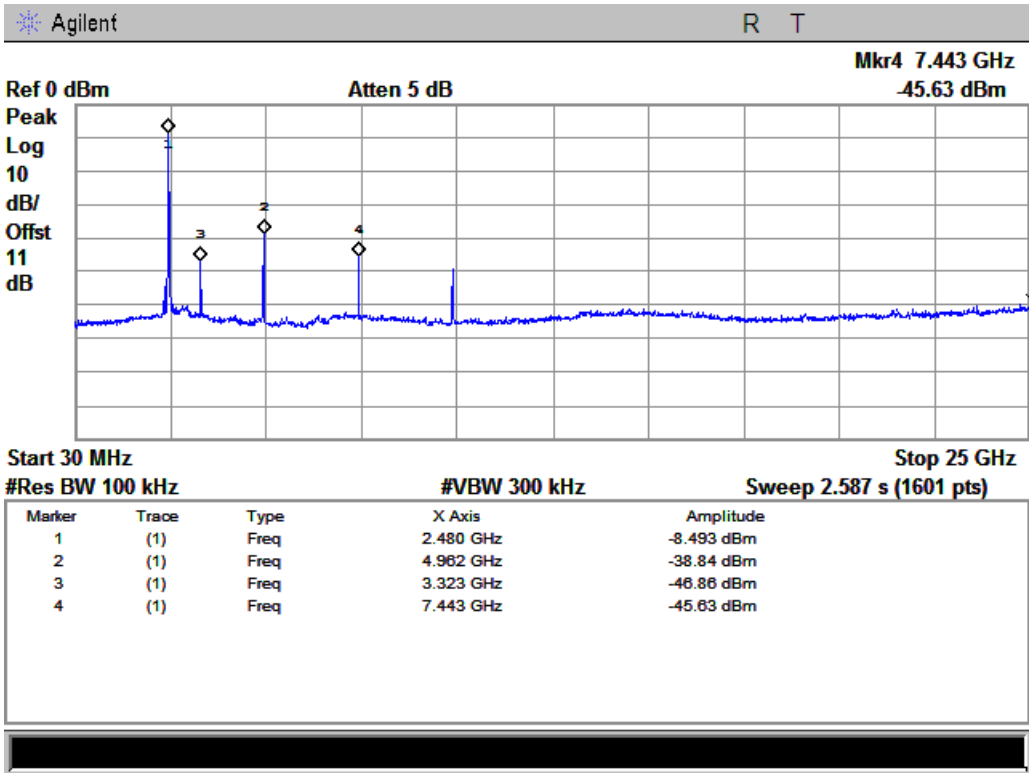
8DPSK Channel- L



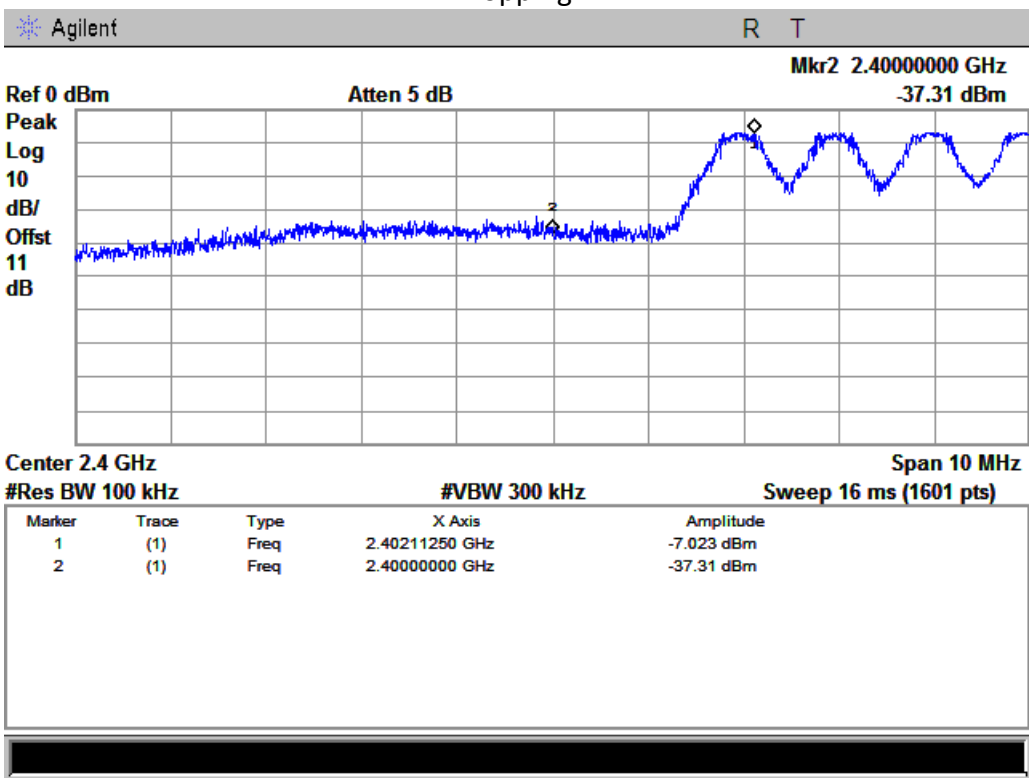


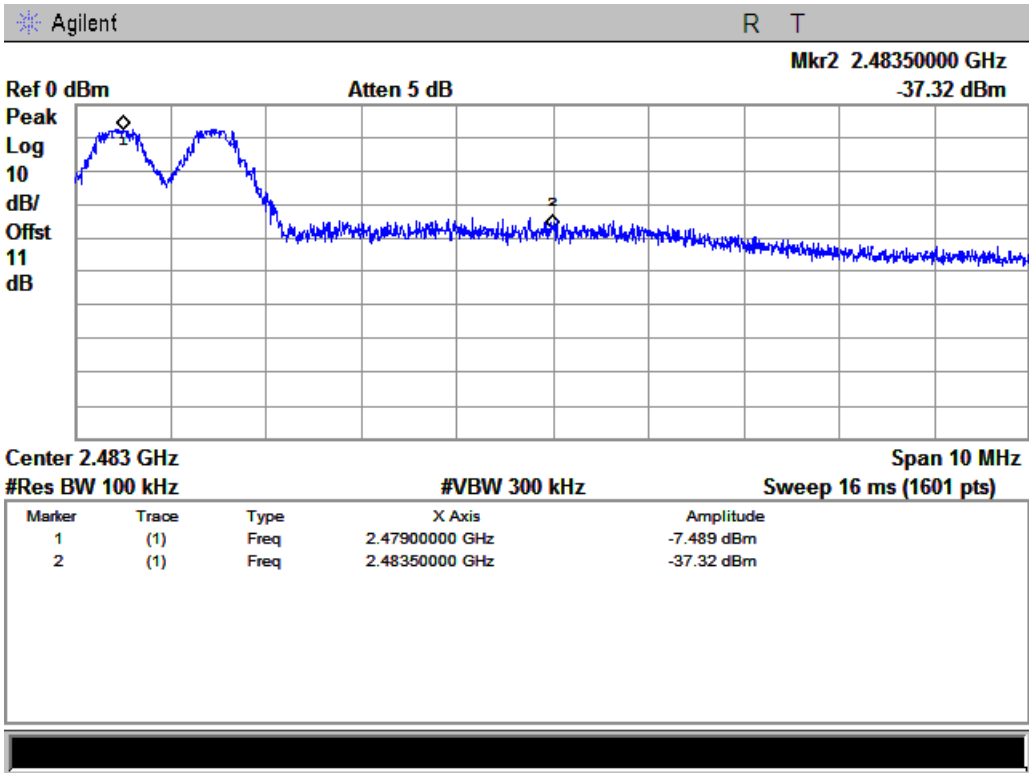
8DPSK Channel- H





Hopping





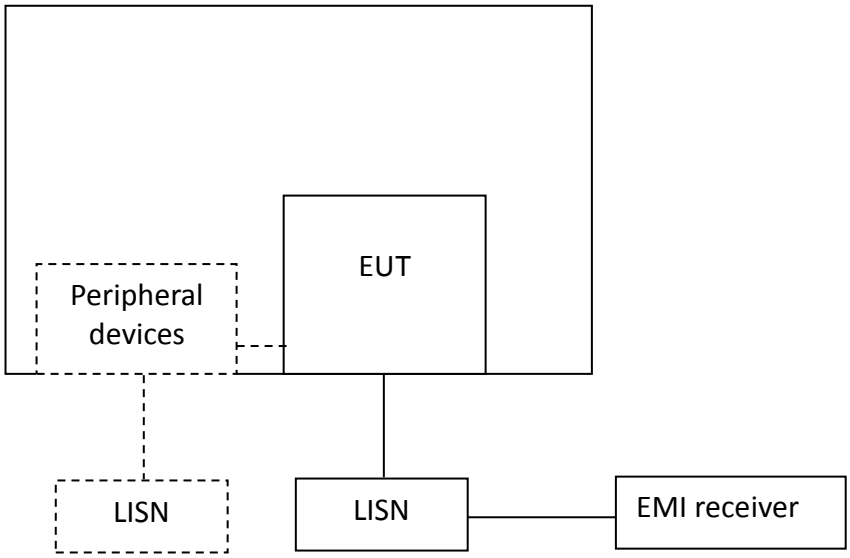
8. Power line conducted emission

Test result:Pass

8.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
0.15-0.5	66 to 56*	56 to 46 *
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

8.2 Test configuration



☒ For table top equipment, wooden support is 0.8m height table

☐ For floor standing equipment, wooden support is 0.12m height rack.

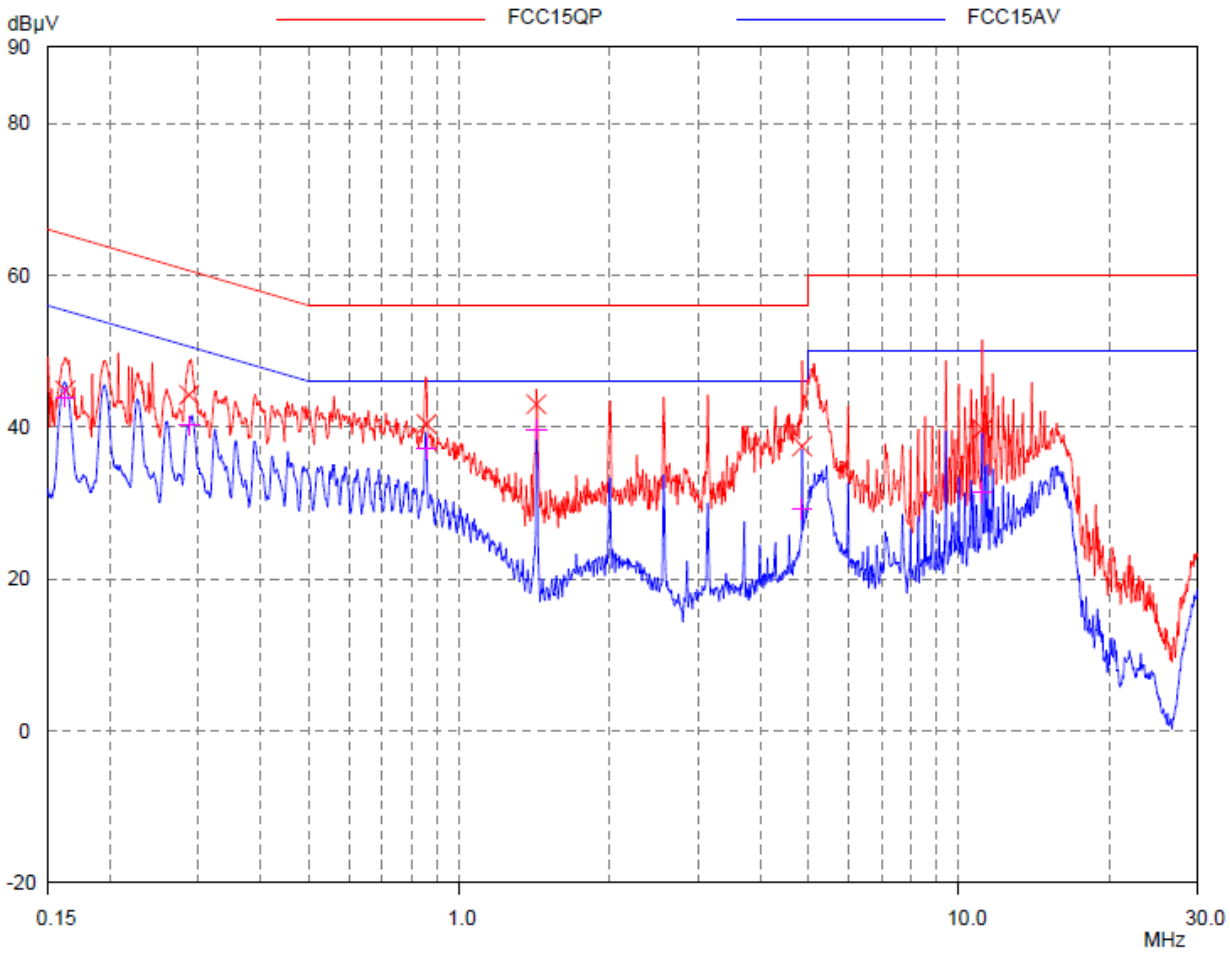
8.3 Test procedure and test set up

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50Ω/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50Ω/50uH coupling impedance with 50Ω termination.
Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4 on conducted measurement.
The bandwidth of the test receiver is set at 9 kHz.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

8.4 Test protocol

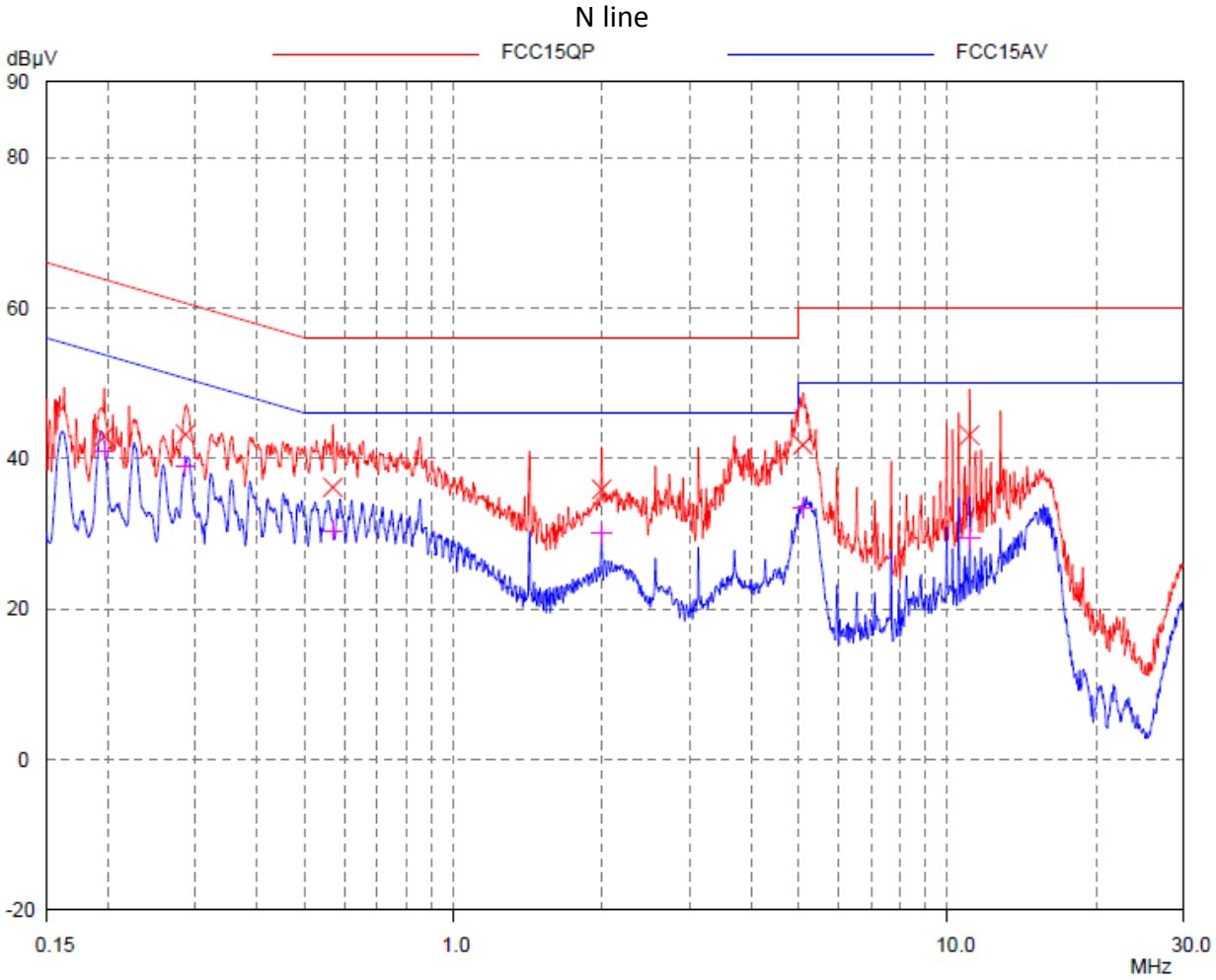
Temperature : 25 °C
Relative Humidity : 55 %

L line



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(µV)	Limit dB(µV)	Margin (dB)	level dB(µV)	limit dB(µV)	Margin (dB)
0.162	44.83	65.34	20.51	43.92	55.34	11.42
0.288	44.25	60.60	16.35	40.26	50.60	10.34
0.858	40.43	56.00	15.57	37.22	46.00	8.78
1.425	43.02	56.00	12.98	39.72	46.00	6.28
4.855	37.46	56.00	18.54	29.24	46.00	16.76
11.137	39.73	60.00	20.27	31.46	50.00	18.54



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(µV)	Limit dB(µV)	Margin (dB)	level dB(µV)	limit dB(µV)	Margin (dB)
0.196	42.92	63.78	20.86	41.08	53.78	12.70
0.286	43.20	60.63	17.43	38.95	50.63	11.68
0.569	36.15	56.00	19.85	30.45	46.00	15.55
1.993	35.89	56.00	20.11	30.05	46.00	15.95
5.093	41.80	60.00	18.20	33.48	50.00	16.52
11.093	43.09	60.00	16.91	29.40	50.00	20.60

Note: The worst test results of channel H (2480MHz, 1Mbps DH5) was chosen to list in the report as representative.

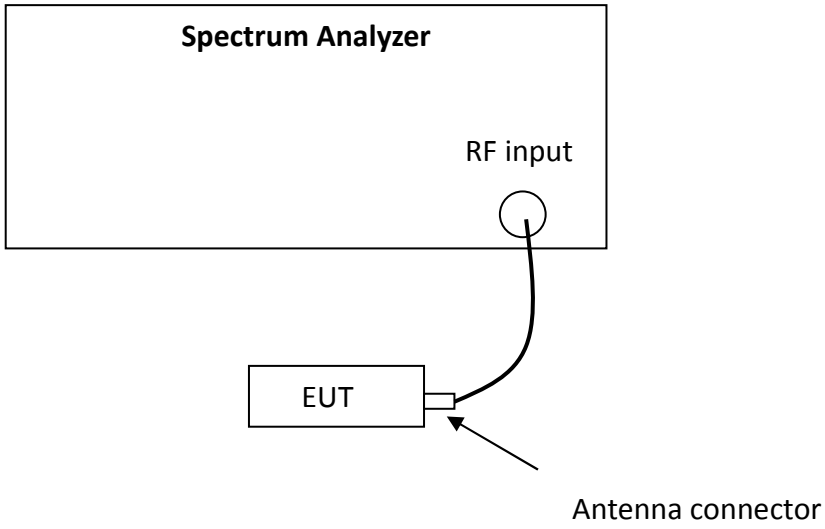
9. Number of Hopping Frequencies

Test result: Pass

9.1 Limit

Number of Hopping Frequencies in the 2400-2483.5 MHz band shall use at least 15 channels.

9.2 Test Configuration



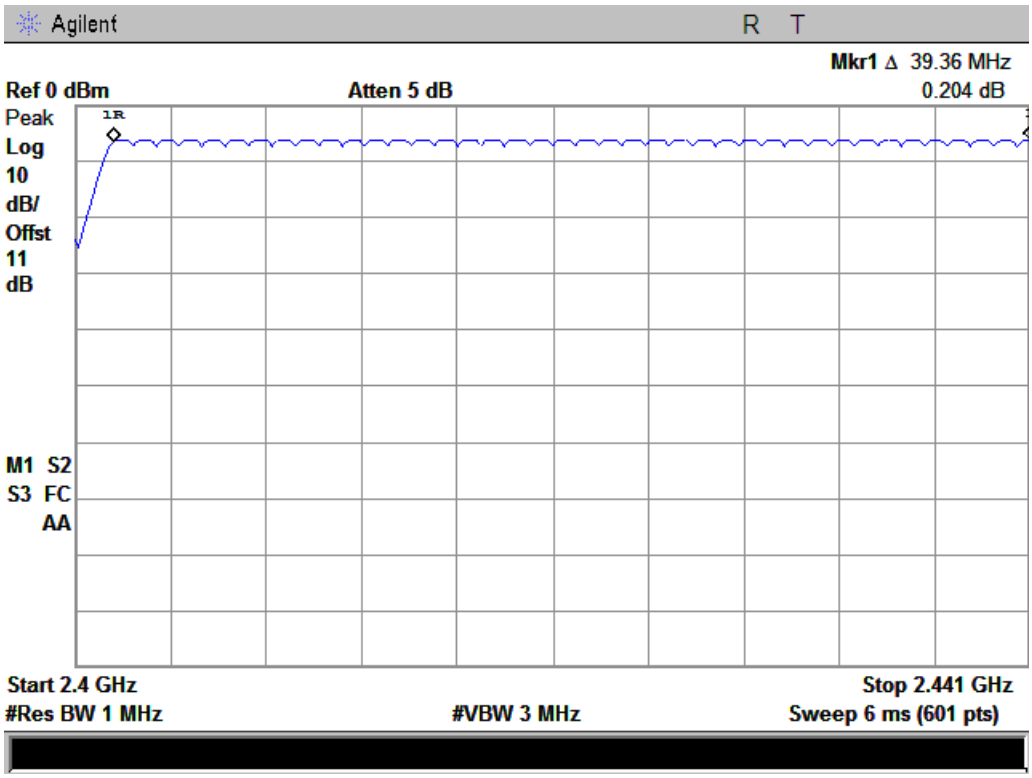
9.3 Test procedure and test setup

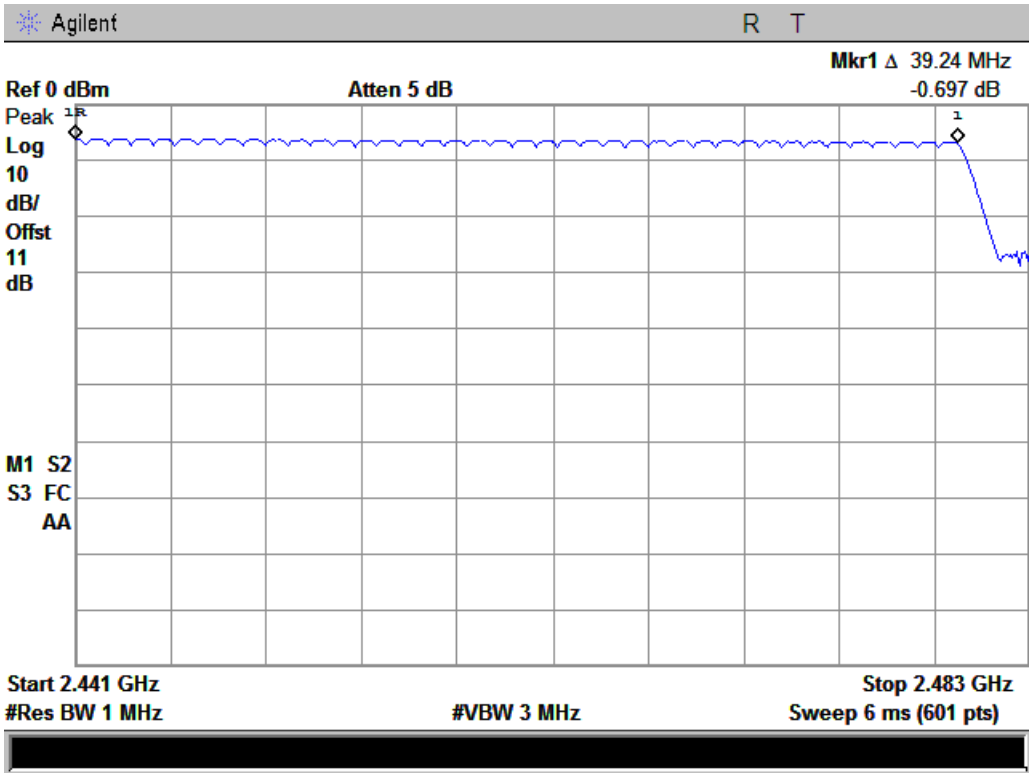
The channel number per FCC §15.247(a)(1)(iii) is measured using the Spectrum Analyzer with RBW=100kHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

9.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

Channel Number	Limit
79	≥15





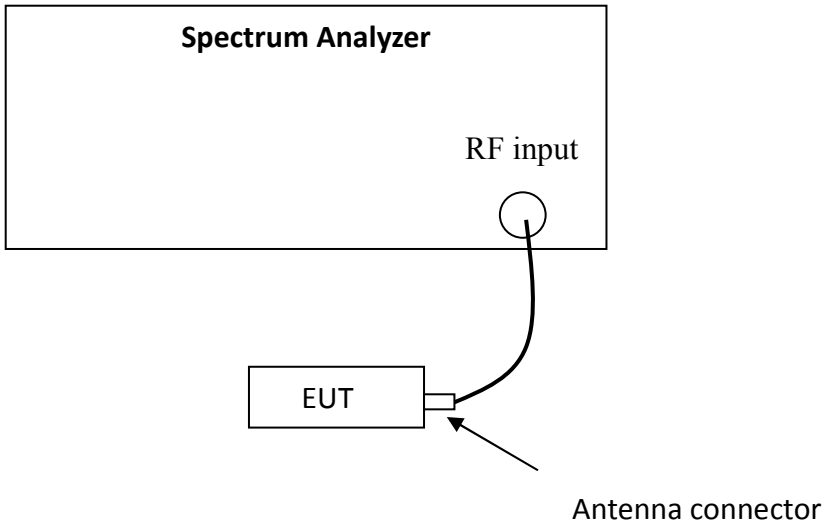
10. Dwell Time

Test result: **Pass**

10.1 Limit

The dwell time on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

10.2 Test Configuration



10.3 Test procedure and test setup

Dwell time per FCC §15.247(a)(1)(iii) is measured using the Spectrum Analyzer with Span = 0, RBW=1MHz, VBW≥RBW, Sweep can capture the entire dwell time, Detector = peak, Trace = max hold.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

10.4 Test protocol

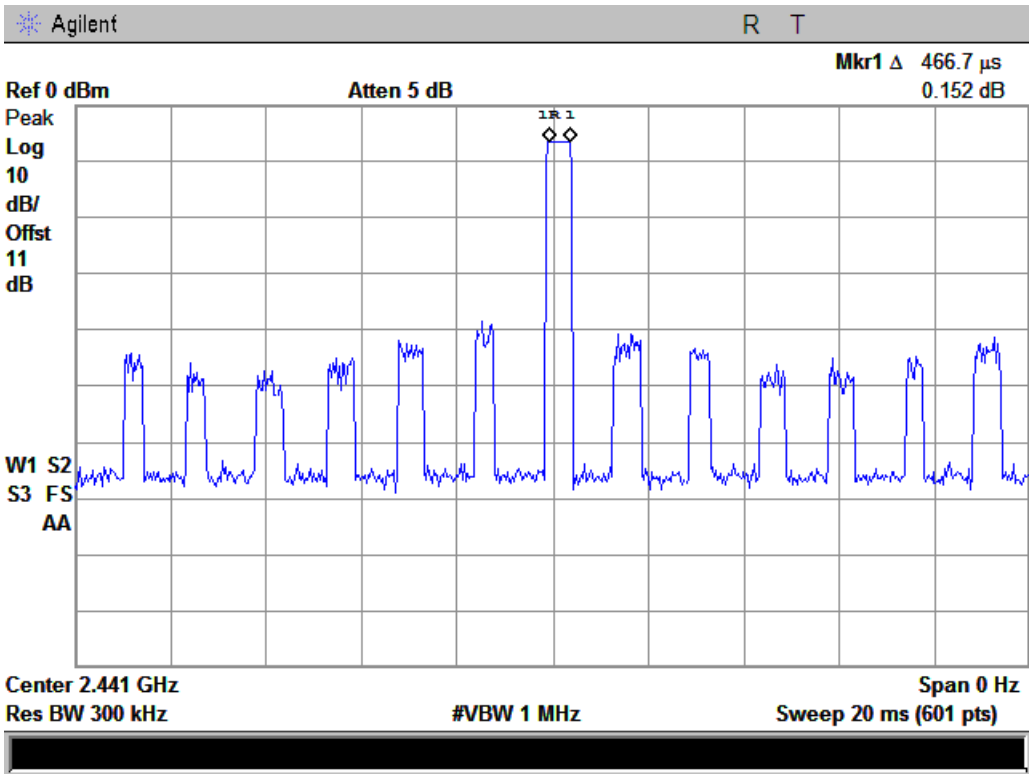
Temperature : 25 °C
Relative Humidity : 55 %

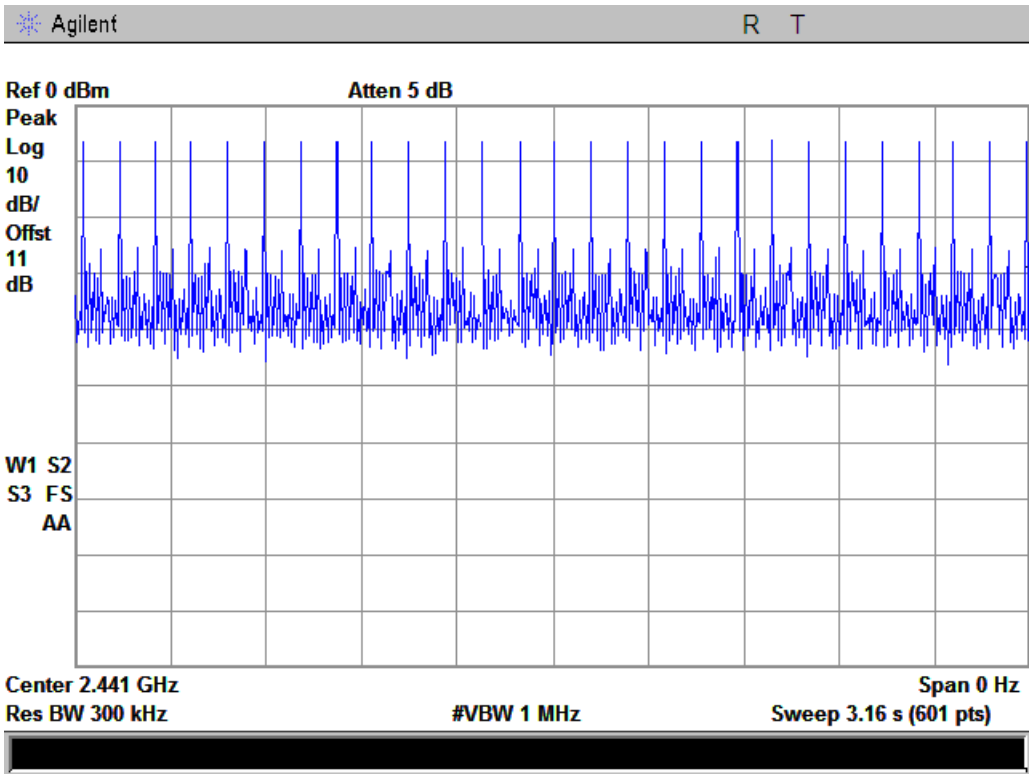
8DPSK Modulation:

Packet	Occupancy time for single hop (ms) **O**	CH	Real observed period (s) **P**	Hops among Observed period **I**	Dwell time (ms) **T**	Limit (s)
DH1	0.466	L	3.16	27	121.92	≤0.4
		M	3.16	32	121.92	
		H	3.16	32	121.92	
DH3	1.640	L	3.16	16	262.40	
		M	3.16	16	262.40	
		H	3.16	16	262.40	
DH5	2.885	L	3.16	11	317.35	
		M	3.16	11	317.35	
		H	3.16	11	317.35	

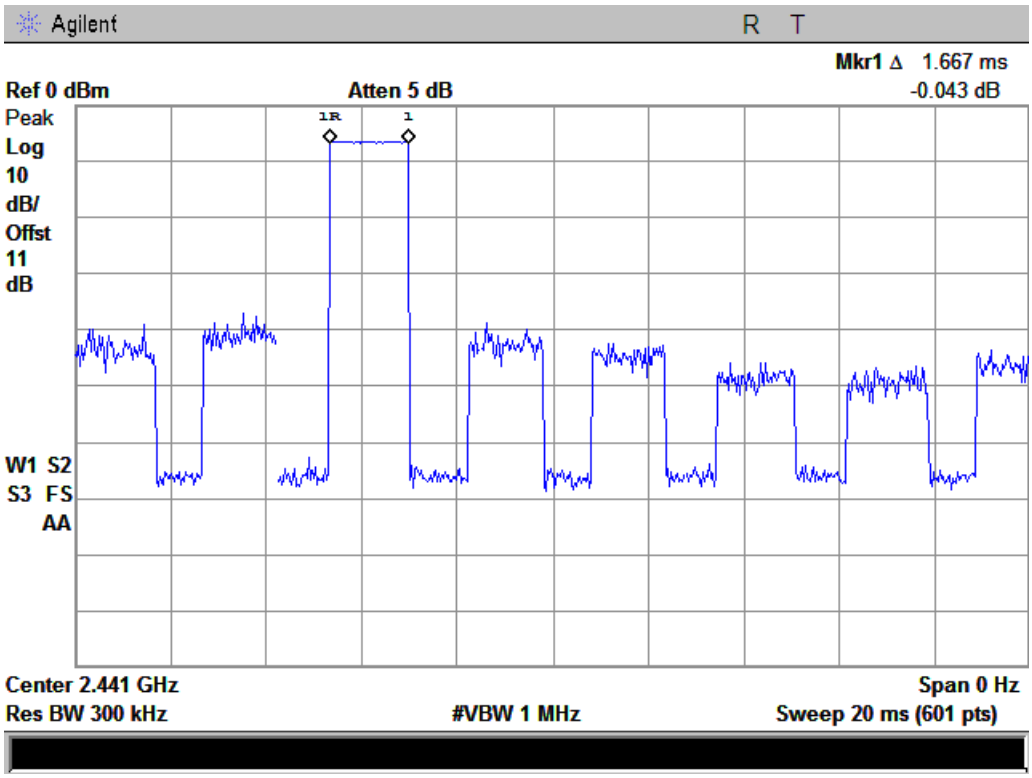
Remark: 1. There are 79 channels in all. So the complete observed period P = 0.4 * 79 = 31.6 s.
2. Average time of occupancy **T = O *I * 31.6 / P**

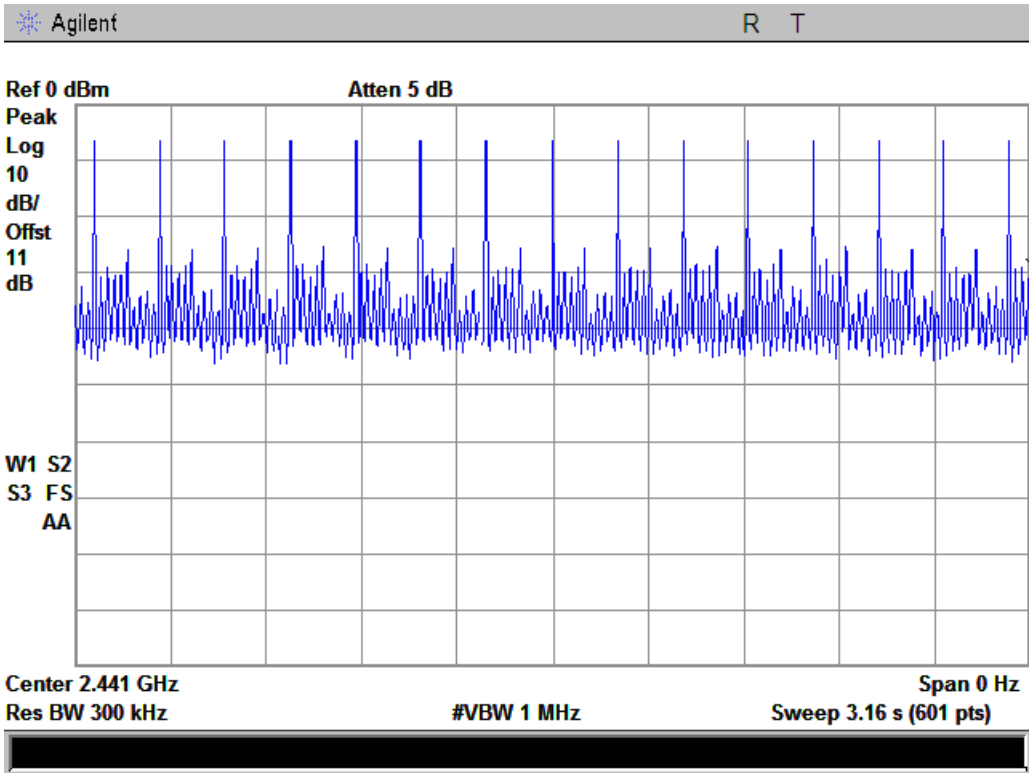
DH1



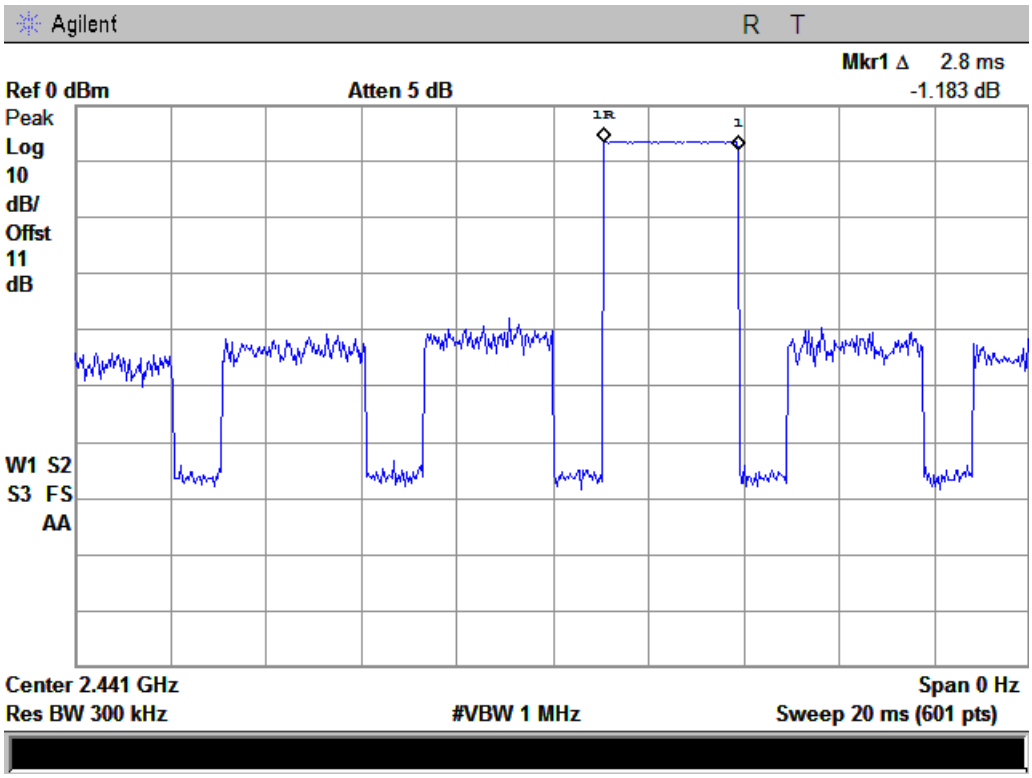


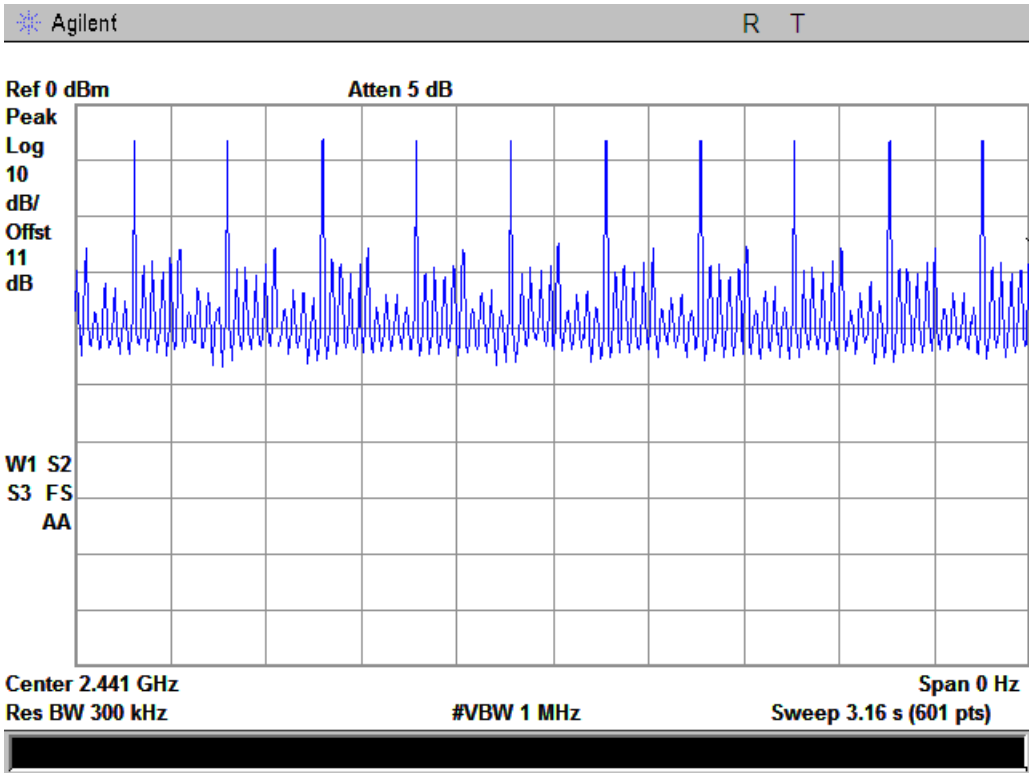
DH3





DH5





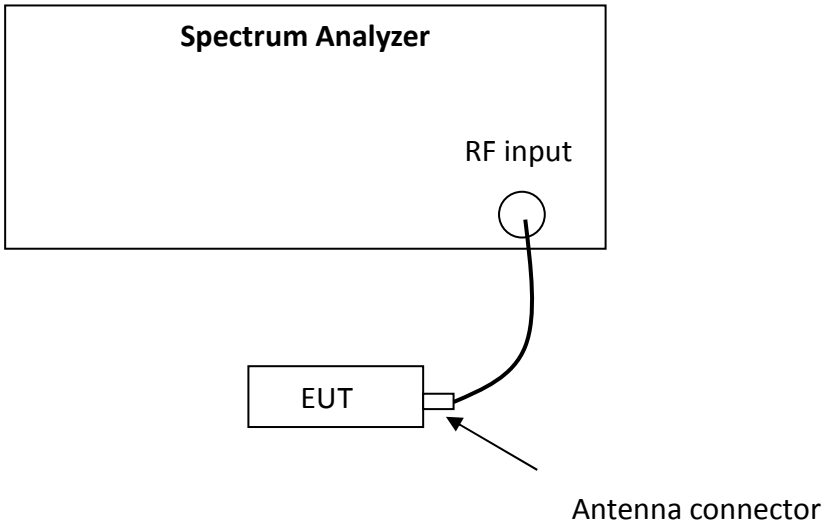
11. Occupied Bandwidth

Test result: **Tested**

11.1 Test limit

None

11.2 Test Configuration



11.3 Test procedure and test setup

The occupied bandwidth per RSS-Gen Issue 4 Clause 6.6 was measured using the Spectrum Analyzer with the RBW close to 1% of the selected span, VBW = 3 * RBW
Detector = Sample, Sweep = Auto.

11.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

Modulation	Channel	99% Occupied Bandwidth (kHz)
GFSK	L	938.0134
	M	937.0481
	H	926.4452

Modulation	Channel	99% Occupied Bandwidth (kHz)
π/4 DQPSK	L	1229.9
	M	1232.2
	H	1238.1

Modulation	Channel	99% Occupied Bandwidth (kHz)
8DPSK	L	1231.8
	M	1232.3
	H	1229.5

Note: The test plots please see Section 3 in this report.

12. Spurious emission for receiver

Test result:NA

12.1 Test limit

The spurious emission shall test through 3 times tuneable or local oscillator frequency whichever is the higher, without exceeding 40 GHz.

☐ If a conducted measurement is made, no spurious output signals appearing at the antenna terminals shall exceed 2nW per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5nW above 1 GHz.

☐ If a radiated measurement is made, all spurious emissions shall comply with the limits of Table below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

12.2 Test Configuration

Please refer to clause 6.2

12.3 Test procedure and test setup

Please refer to clause 6.3.

12.4 Test protocol

Polarization	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Remark: 1. Correct Factor = Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Corrected Reading = Original Receiver Reading + Correct Factor
3. Margin = limit – Corrected Reading

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Original Receiver Reading = 10dBuV.
Then Correct Factor = 30.20 + 2.00 = 32.20dB/m; Corrected Reading = 10dBuV + 32.20dB/m = 42.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 42.20dBuV/m, then Margin = 54 - 42.20 = 11.80dBuV/m