Test Report

FCC ID.: 2AGCXQ5

Date of issue: Nov. 12, 2015

Sample Description:	Balance of electric car
Model(s):	Q5
Applicant:	Shenzhen Knight Electronics Co., Ltd.
Address:	4th Building, Hongxiang Industrial Park, Hezhou Village, Xixiang Town, Baoan District, Shenzhen, Guangdong, China
Date of Test:	Oct. 12, 2015 to Nov. 11, 2015

Shenzhen Microtest Co., Ltd.
http://www.mtitest.com

Tel:(86-755)88850135 Fax: (86-755) 88850136 http://www.mtitest.com E-mail: mti@51mti.com
Add: 1F & 3F, East Block, Hengfang Industrial Park, Xingye Road, Xixiang, Bao'an District, Shenzhen, Guangdong, P. R. China

TABALE OF CONTENTS

TEST RESULT CERTIFICATION	
Applicant's name:	Shenzhen Knight Electronics Co., Ltd.
Address:	4th Building, Hongxiang Industrial Park, Hezhou Village, Xixiang Town, Baoan District, Shenzhen, Guangdong, China
Manufacture's Name:	Shenzhen Knight Electronics Co., Ltd.
Address:	4th Building, Hongxiang Industrial Park, Hezhou Village, Xixiang Town, Baoan District, Shenzhen, Guangdong, China
Product description	
Product name:	Balance of electric car
Trademark:	/
Model name:	Q5
Serial Model:	/
Standards:	FCC Part 15.247
Test Procedure:	ANSI C63.4-2009; FCC public notice DA 00-705

This device described above has been tested by Shenzhen Microtest Co., Ltd. and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

Tested By : David Chen

David Chen Nov. 12, 2015

Reviewed By : Leon Chen

Leon Chen Nov. 12, 2015

Approved By : Ares Liu

Ares Liu Nov. 12, 2015

SUMMARY OF TEST RESULT

Item	FCC Part No.	Description of Test	Result
1	15.203	Antenna requirement	Pass
2	15.207	AC power line conducted emission	Pass
3	15.247(b)(1)	Peak output power	Pass
4	15.247(a)(1)	20dB emission bandwidth	Pass
5	15.247(a)(1)	Carrier frequency separation	Pass
6	15.247(a)1	Number of hopping channel	Pass
7	15.247(a)(1)	Time of occupancy (dwell time)	Pass
8	15.247(d)	Band edge spurious emission, conducted spurious emission	Pass
9	15.247(d), 15.209	Radiated emission	Pass

1. General description

1.1 Feature of equipment under test (EUT)

Product name:	Balance of electric car
Model name:	Q5
Serial Model:	/
Tx/Rx frequency range:	Tx/Rx: 2402MHz~2480MHz
Bluetooth version:	2.1+EDR
Modulation type:	GFSK, π/5-DQPSK, 8DPSK
Power source:	36VDC (rechargeable Li-on battery)
Adapter information:	Model: JZX-420200 Input: 100-240VAC 50/60Hz Output: DC 42V 2.0A
Antenna designation:	PCBA antenna (Antenna Gain: 1dBi)
Hardware version:	V1.0
Software version:	V1.0

1.2 operation channel list

Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	20	2422MHz	40	2442MHz
1	2403MHz	21	2423MHz	41	2443MHz
---	---	---	---	---	---
---	---	---	---	---	---
18	2420MHz	38	2440MHz	77	2479MHz
19	2421MHz	39	2441MHz	78	2480MHz

2. Test Configuration of EUT

2.1 Test Frequency Channel

Low	2402MHz
Middle	2441MHz
High	2480MHz

2.2 EUT operation mode

During testing, RF test program (RDA5851S Bluetooth Download & Debug Tool) provided by the manufacture to control the Tx/Rx operation followed the test requirement.

2.3 Test conditions

During the measurement the environmental conditions were within the listed ranges:

- Temperature: 20ºC~30ºC
- Humidity: 50%~70%
- Atmospheric pressure: 98kPa~101kPa

2.4 Testing site

Test Site	Shenzhen Toby Technology Co., Ltd.
Test Site Location	1 A/F., Bldg.6, Yusheng Industrial Zone The National Road No.107 Xixiang Section 467
FCC Registration No.:	811562

2.5 Ancillary equipment list

Equipment	Model	S/N	Manufacturer
/	/	/	/

2.6 Measurement uncertainty

Measurement Uncertainty for a Level of Confidence of 95 %, U=2xUc(y)

RF frequency	1 x 10-7
RF power, conducted	± 1 dB
Conducted emission of receivers	± 1 dB
Radiated emission of transmitter	± 6 dB
Radiated emission of receiver	± 6 dB
Temperature	±1 degree
Humidity	± 5 %

3. List of test equipment

For AC power line conducted emission:

Equipment	Manufacturer	Model	Serial No.	Calibration Due
LISN	R&S	ENV216	101313	2015.12.06
LISN	SCHWARZBECK	NNLK 8129	8129245	2015.12.25
Pulse Limiter	SCHWARZBECK	VTSD 9561F	9716	2015.12.25
Test Cable	N/A	N/A	C01	2015.12.06
EMI Test Receiver	R&S	ESCI	101160	2015.12.06

For Radiated emission:

Equipment	Manufacturer	Model	Serial No.	Calibration Due
Log-Bicon Antenna	MESS-ELEKTRONIK	VULB 9160	3058	2015.12.11
Horn Antenna	Schwarzbeck	BBHA 9120D	631	2015.12.05
Horn Antenna	Schwarzbeck	BBHA 9170	373	2015.12.05
Test Cable	United Microwave	57793	1m	2015.12.05
Test Cable	United Microwave	A30A30-5006	10M	2015.12.05
Microwave Pre_amplifier	Agilent	8449B	3008A01714	2015.12.05
Pre-Amplifier	Anritsu	MH648A	M09961	2015.12.05
EMI Test Receiver	R&S	ESCI-7	101318	2015.12.05
Spctrum analyzer	Agient	E4470B	MY41441082	2016.06.01

For RF conducted emission:

Equipment	Manufacturer	Model	Serial No.	Calibration Due
Spctrum analyzer	Agient	E4470B	MY41441082	2016.06.01

Note: the calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

4. Test Result

4.1 Conducted emission

4.1.1 Limit

Frequency (MHz)	Limit	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 50 46
0.5-5	56	46
5-30	60	50

Note: Decreases with the logarithm of the frequency from 0.15MHz to 0.5MHz.

4.1.2 Test method

1. The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipment powered from additional LISN(s). The LISN provide 50 Ohm/50uH of coupling impedance for the measuring instrument.

2. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

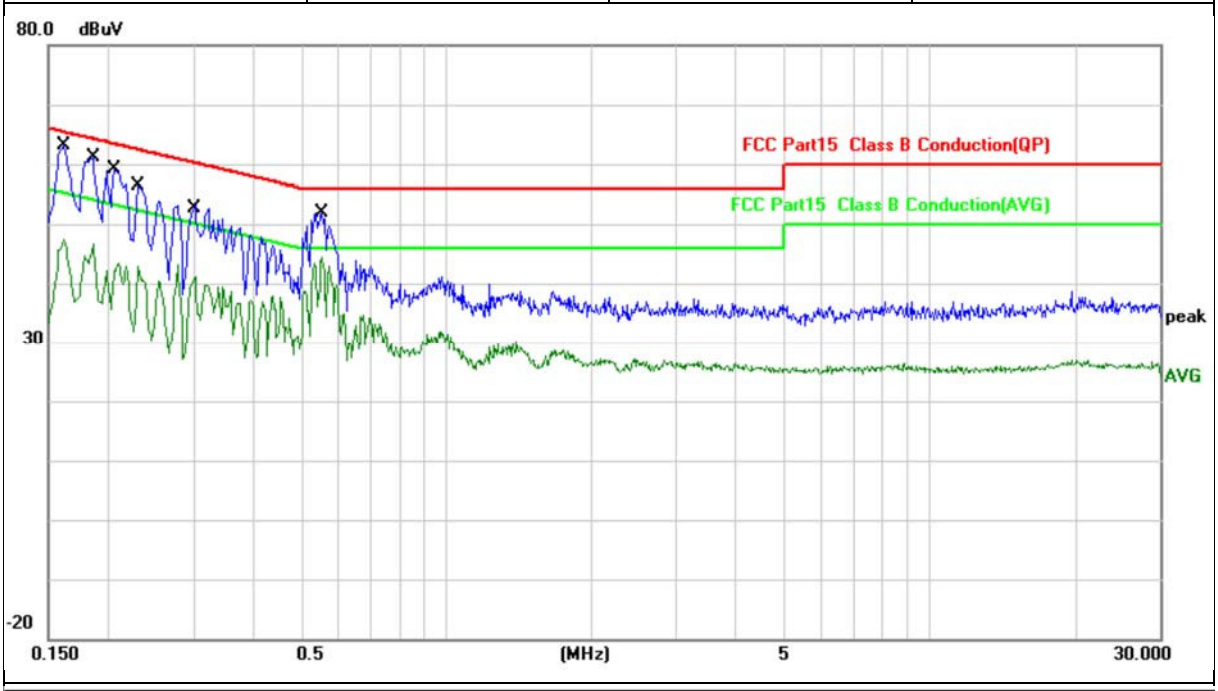
3. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

4. LISN at least 80 cm from nearest part of EUT chassis.

5. The resolution bandwidth of EMI test receiver is set at 9kHz.

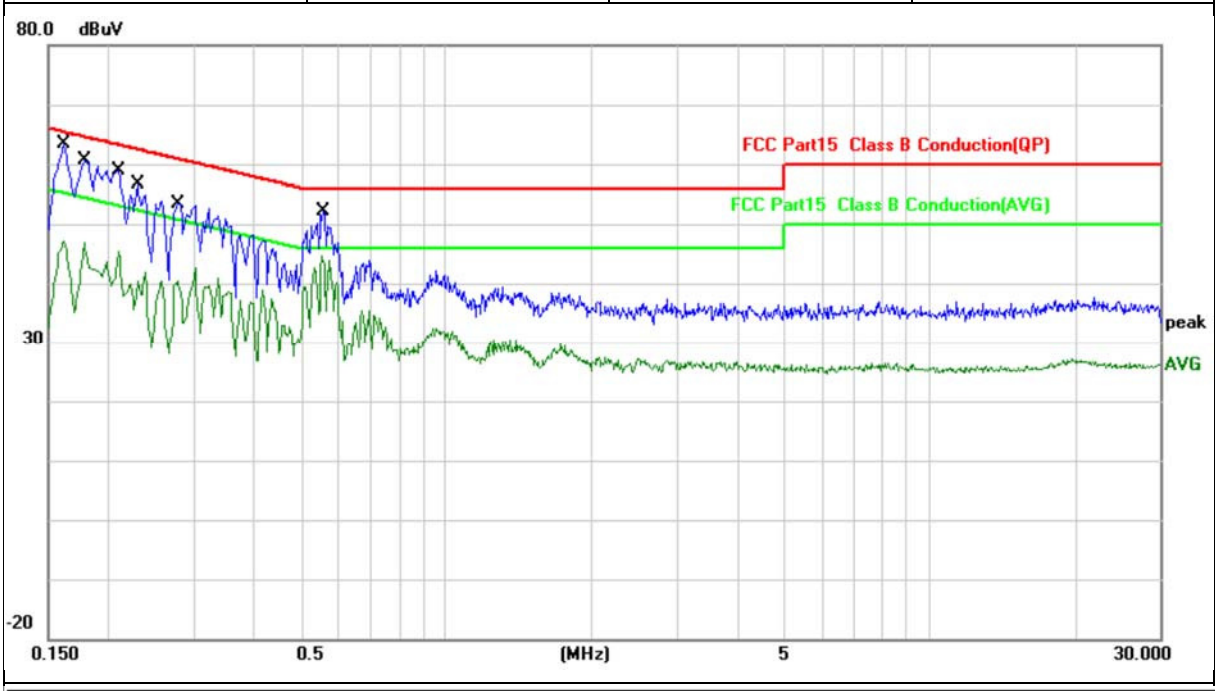
4.1.3 Test Result

Test mode:	Charging	Phase:	L



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1631	29.78	30.06	59.84	65.30	-5.46	QP	
2		0.1631	13.80	30.06	43.86	55.30	-11.44	AVG	
3		0.1848	27.65	30.06	57.71	64.26	-6.55	QP	
4		0.1848	11.41	30.06	41.47	54.26	-12.79	AVG	
5		0.2075	25.09	30.06	55.15	63.30	-8.15	QP	
6		0.2075	8.59	30.06	38.65	53.30	-14.65	AVG	
7		0.2289	21.56	30.06	51.62	62.49	-10.87	QP	
8		0.2289	5.29	30.06	35.35	52.49	-17.14	AVG	
9		0.2977	19.61	30.06	49.67	60.30	-10.63	QP	
10		0.2977	9.39	30.06	39.45	50.30	-10.85	AVG	
11		0.5505	18.79	30.06	48.85	56.00	-7.15	QP	
12	*	0.5505	12.13	30.06	42.19	46.00	-3.81	AVG	

Test mode:	Charging	Phase:	N



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1630	30.09	30.06	60.15	65.30	-5.15	QP	
2		0.1630	13.78	30.06	43.84	55.30	-11.46	AVG	
3		0.1763	26.35	30.06	56.41	64.65	-8.24	QP	
4		0.1763	9.59	30.06	39.65	54.65	-15.00	AVG	
5		0.2099	24.84	30.06	54.90	63.21	-8.31	QP	
6		0.2099	7.59	30.06	37.65	53.21	-15.56	AVG	
7		0.2298	22.24	30.06	52.30	62.45	-10.15	QP	
8		0.2298	6.57	30.06	36.63	52.45	-15.82	AVG	
9		0.2770	20.61	30.06	50.67	60.90	-10.23	QP	
10		0.2770	10.17	30.06	40.23	50.90	-10.67	AVG	
11		0.5552	18.89	30.06	48.95	56.00	-7.05	QP	
12	*	0.5552	13.81	30.06	43.87	46.00	-2.13	AVG	

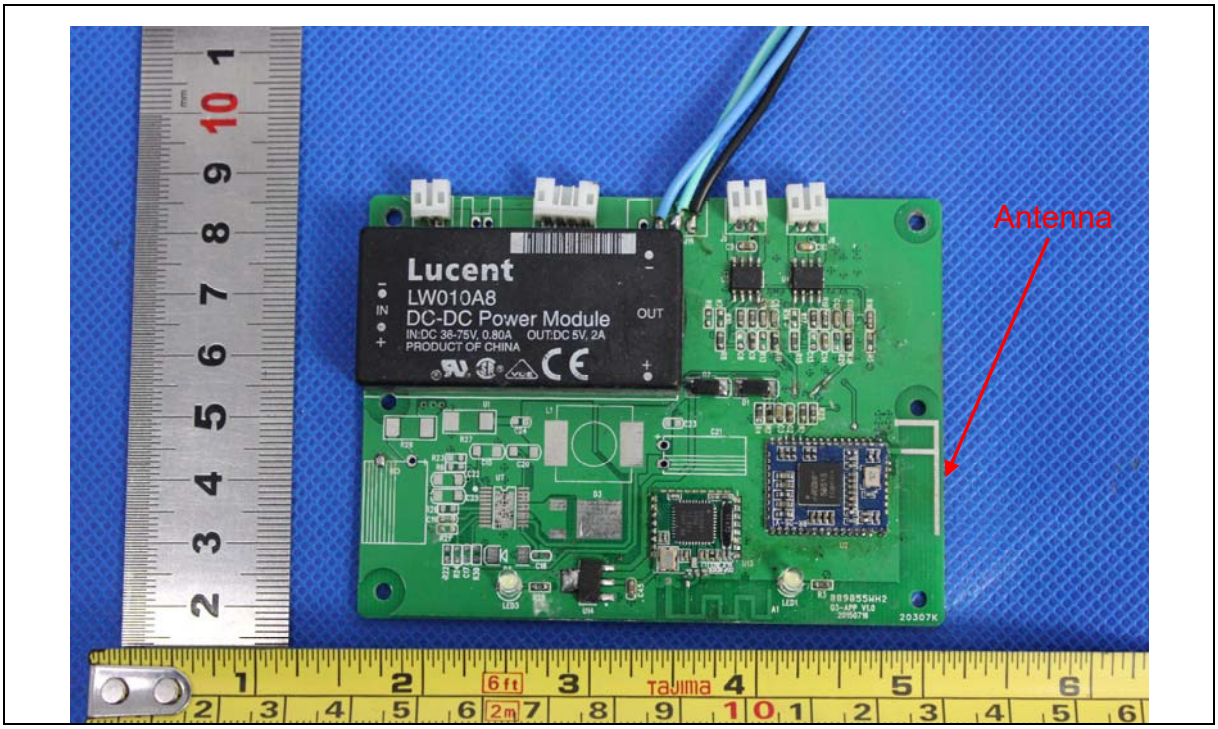
4.2 Antenna requirement

4.2.1 Requirement defined in FCC 15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

4.2.2 EUT antenna description

The Bluetooth antenna of EUT is an internal permanently attached antenna, the maximum gain is 1dBi. So the antenna meets the requirement of this part.



4.3 Peak output power

4.3.1 Limits

Conducted peak output power limit is 125mW (21dBm)

4.3.2 Test Method

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
RBW > the 20 dB bandwidth of the emission being measured
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission.

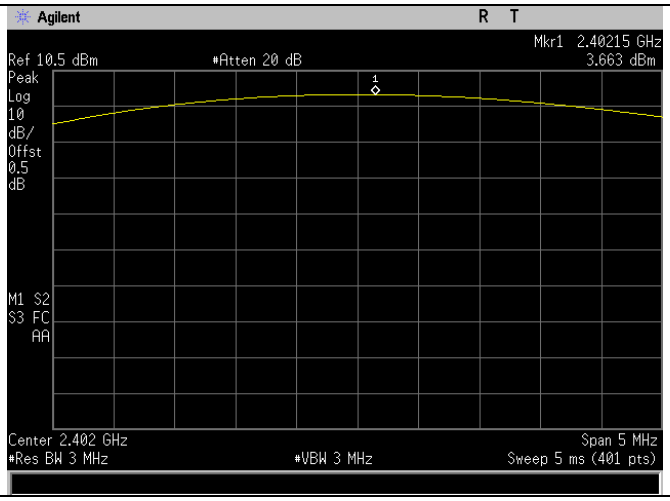
4.3.3 Test Result

Frequency (MHz)	Peak output power (dBm)	Limit (dBm)
GFSK mode		
2402	3.663	21
2441	3.639	21
2480	3.349	21
π/4-DQPSK mode		
2402	3.289	21
2441	3.387	21
2480	3.048	21
8DPSK mode		
2402	3.707	21
2441	3.717	21
2480	3.387	21

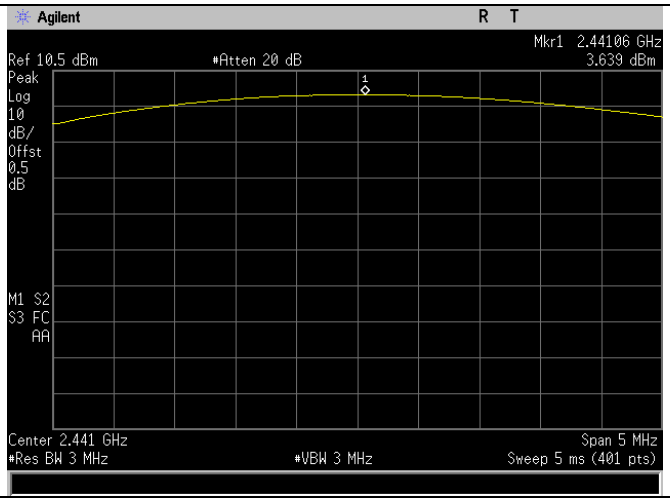
Test plots as below:

GFSK mode

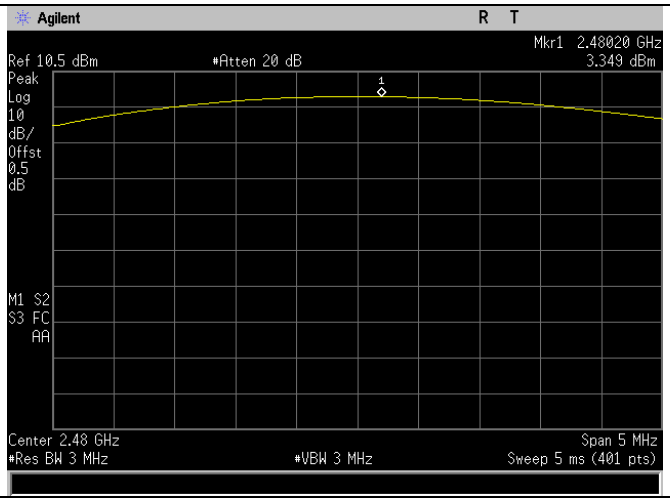
2402MHz



2441MHz

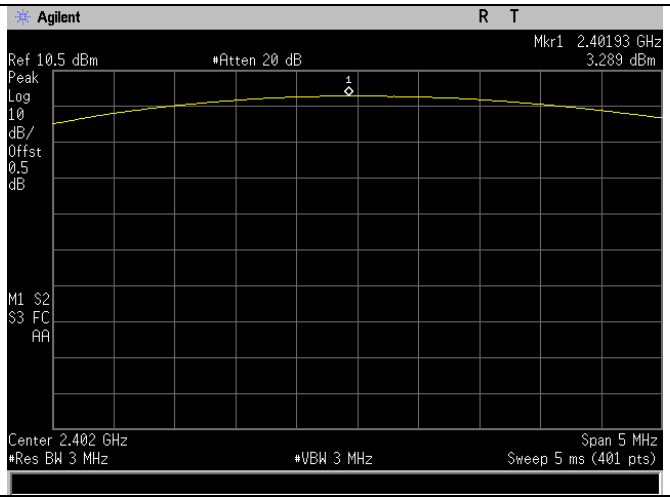


2480MHz

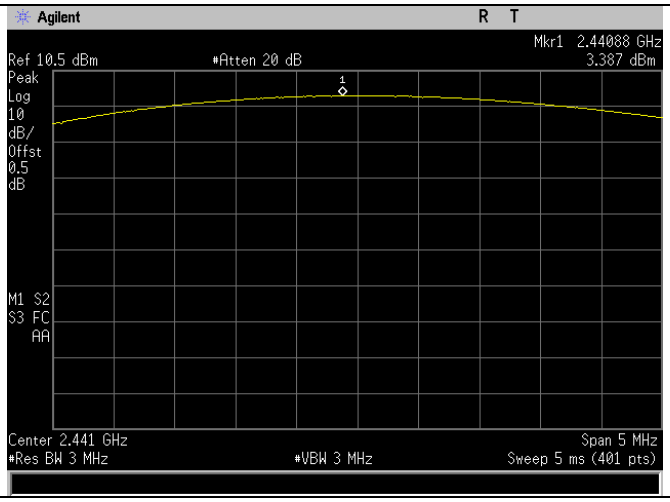


π/4-DQPSK mode

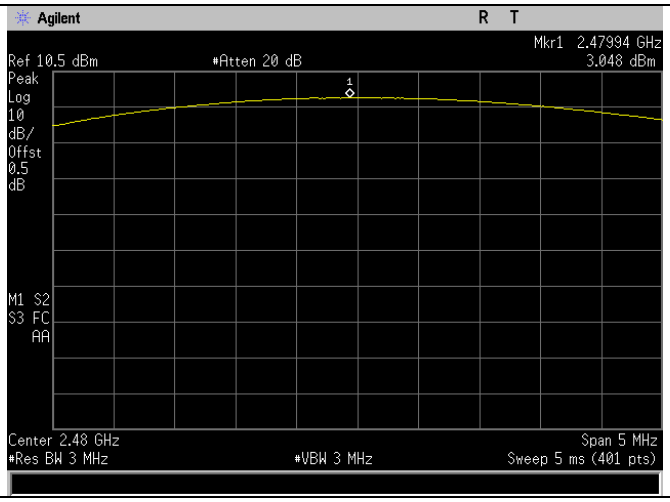
2402MHz



2441MHz

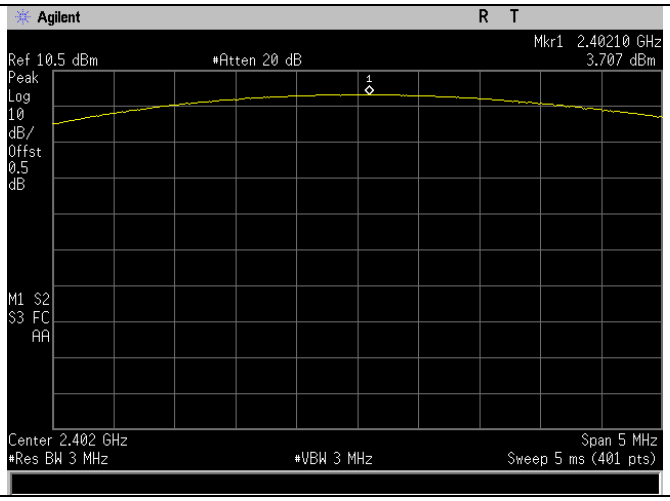


2480MHz

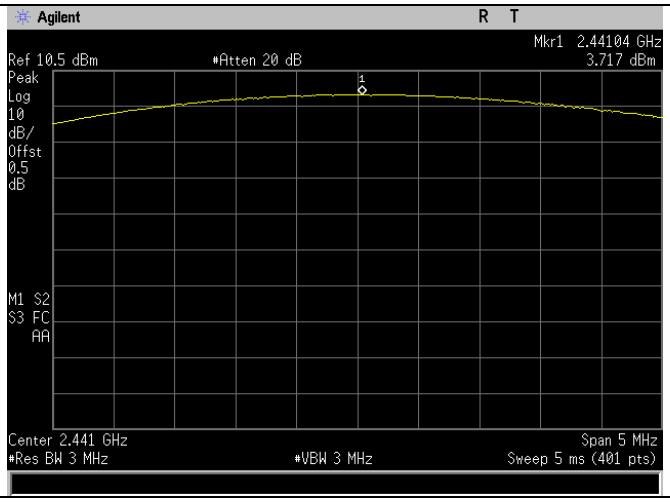


8DPSK mode

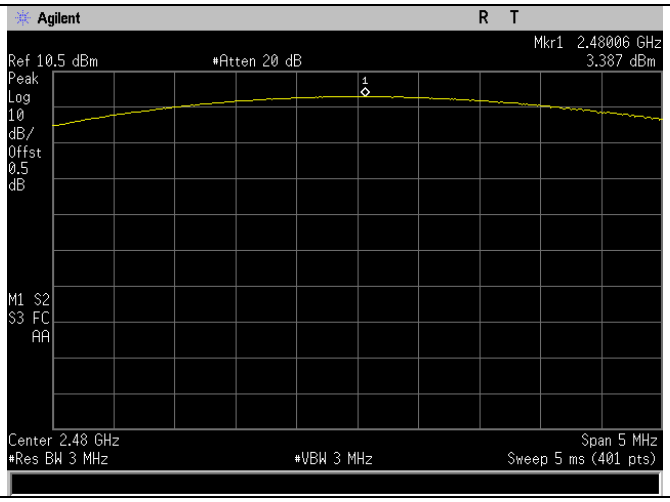
2402MHz



2441MHz



2480MHz



4.4 20dB emission bandwidth

4.4.1 Test method

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
RBW ≥ 1% of the 20 dB bandwidth
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.

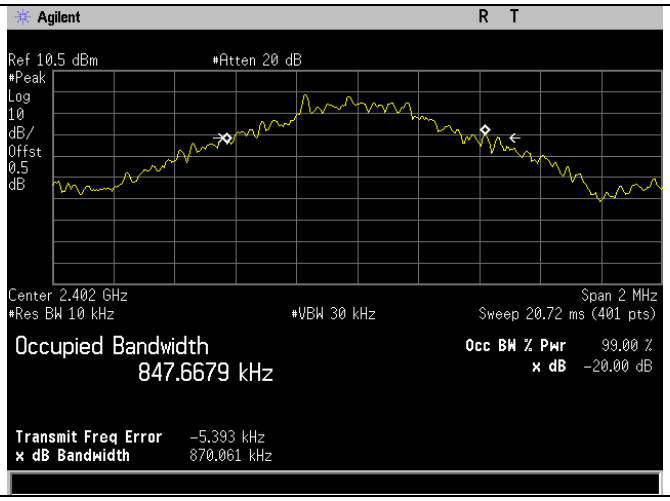
4.4.2 Test result

Frequency (MHz)	20dB emission bandwidth (MHz)
GFSK mode	
2402	0.87
2441	0.871
2480	0.868
π/4-DQPSK mode	
2402	1.273
2441	1.271
2480	1.273
8DPSK mode	
2402	1.261
2441	1.267
2480	1.26

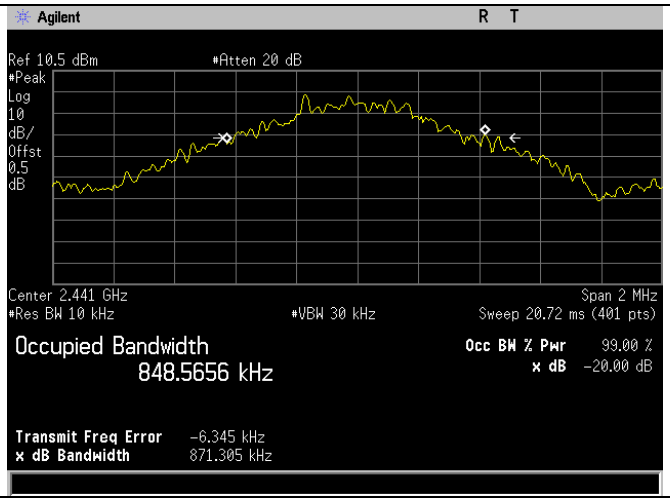
Test plots as below:

GFSK mode

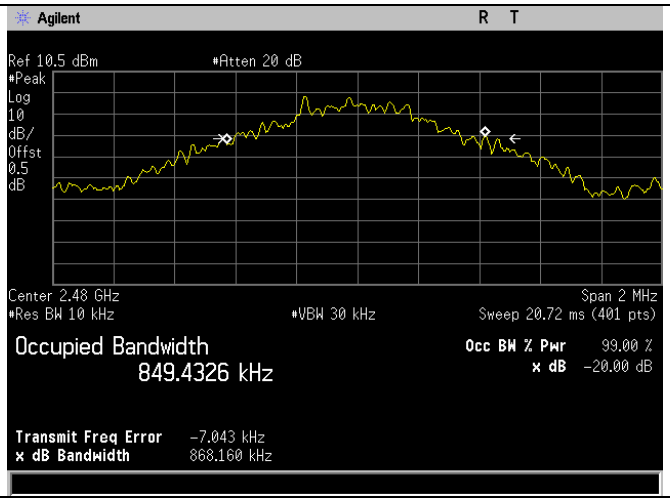
2402MHz



2441MHz

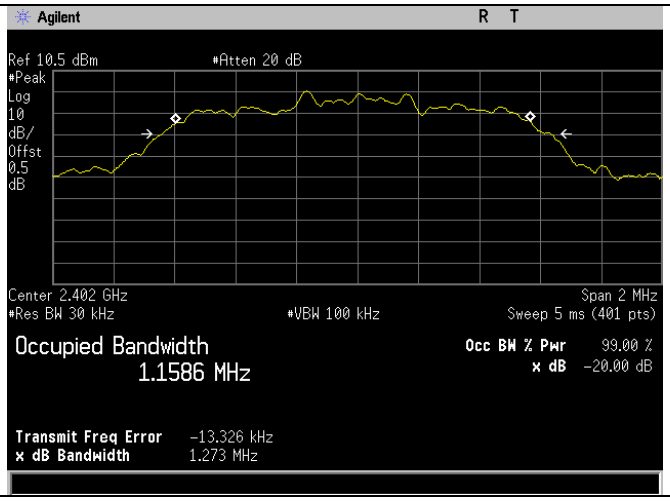


2480MHz

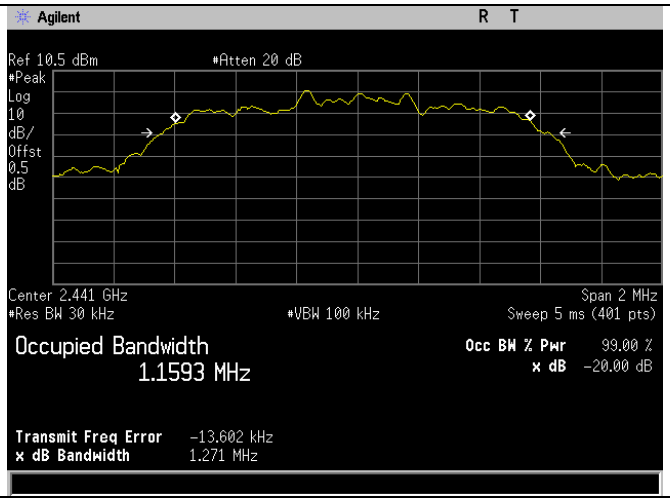


π/4-DQPSK mode

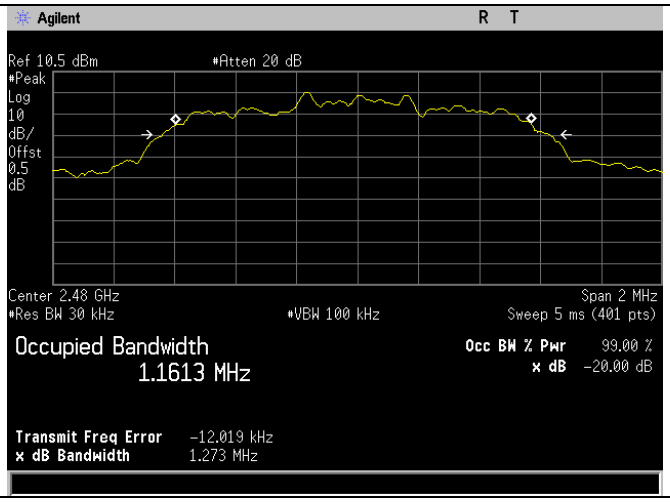
2402MHz



2441MHz

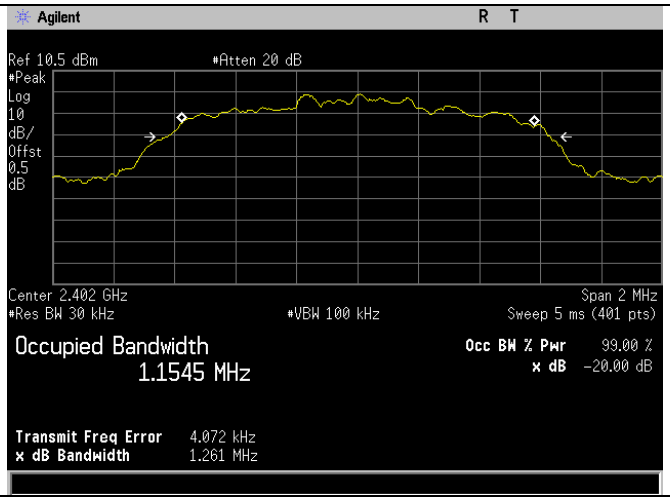


2480MHz

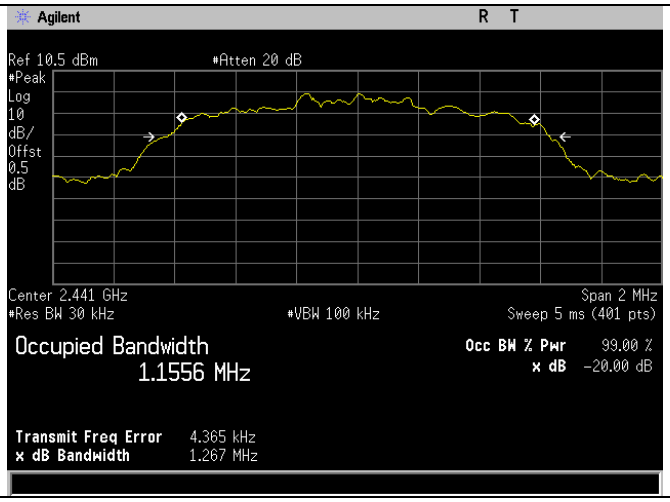


8DPSK mode

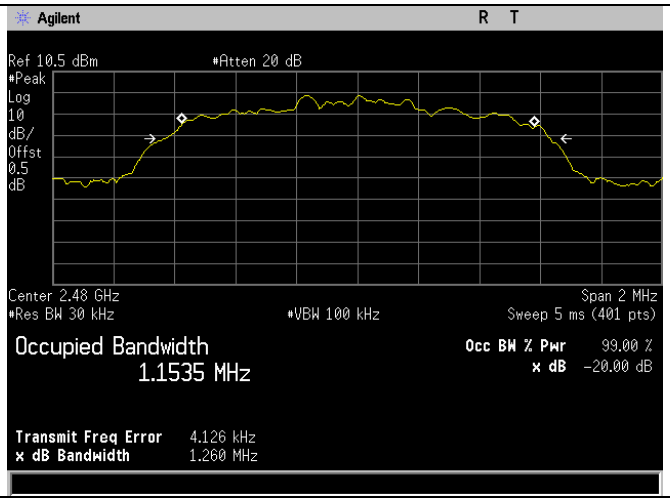
2402MHz



2441MHz



2480MHz



4.5 Carrier frequency separation

4.5.1 Limits

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.

4.5.2 Test method

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

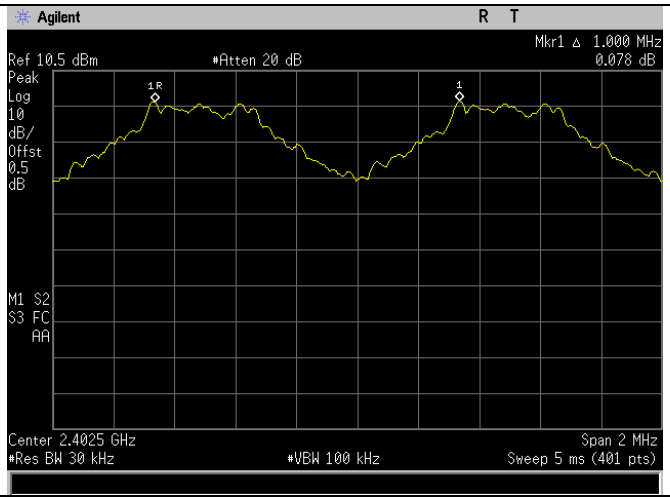
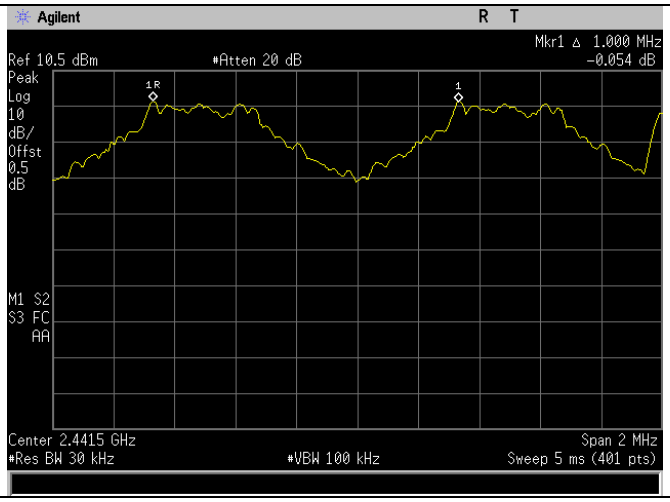
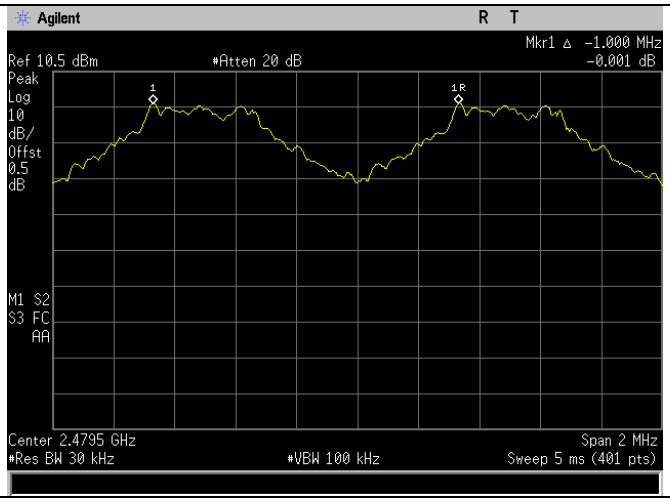
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

4.5.3 Test result

Frequency (MHz)	Separation (MHz)	Limit (MHz)
GFSK mode		
2402	1	0.581
2441	1	0.581
2480	1	0.581
π/4-DQPSK mode		
2402	1.005	0.849
2441	1	0.849
2480	1	0.849
8DPSK mode		
2402	1.005	0.845
2441	1	0.845
2480	1	0.845

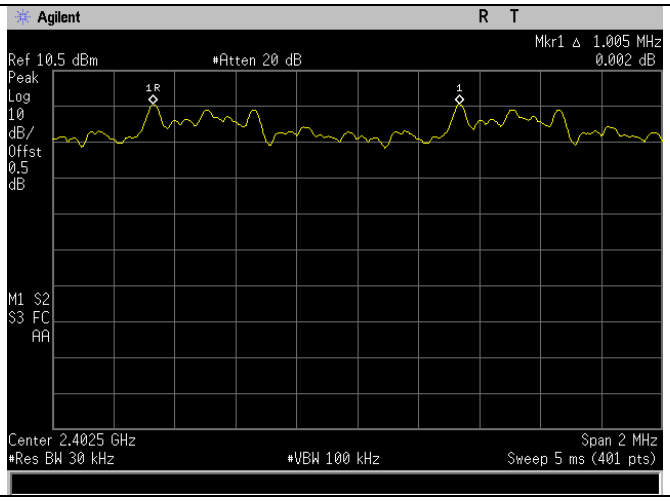
Test plots as below:

GFSK mode

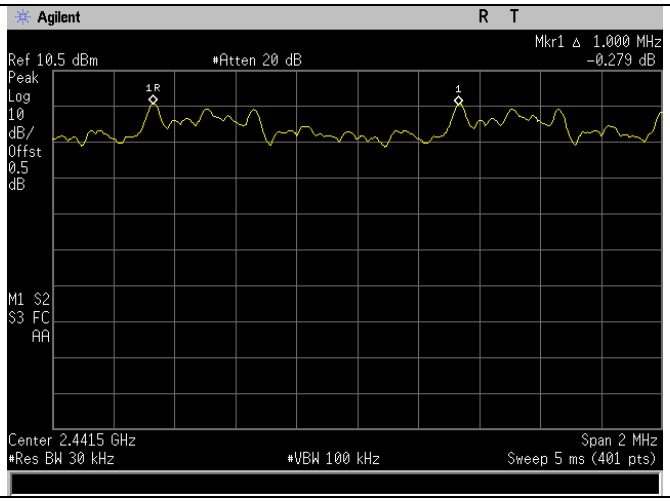
2402MHz

2441MHz

2480MHz


π/4-DQPSK mode

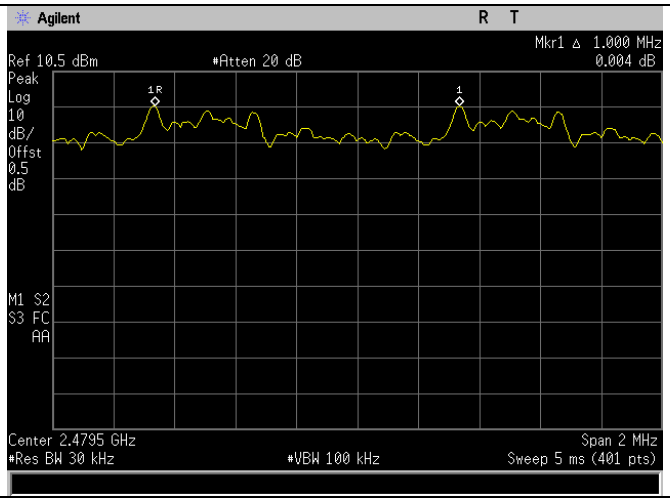
2402MHz



2441MHz

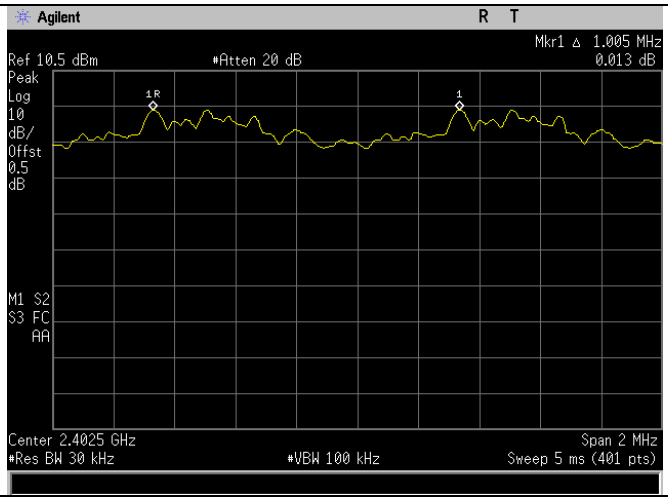


2480MHz

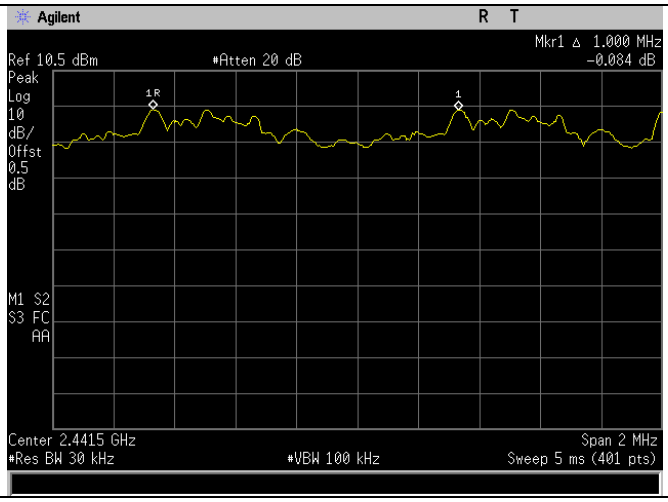


8DPSK mode

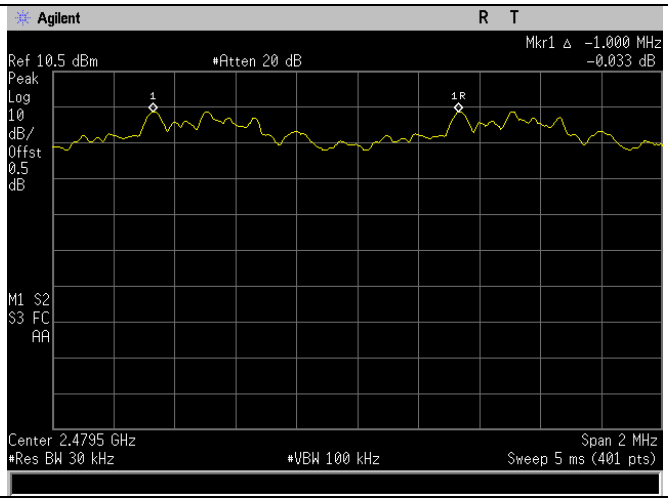
2402MHz



2441MHz



2480MHz



4.6 Number of hopping channel

4.6.1 Limits

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

4.6.2 Test method

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

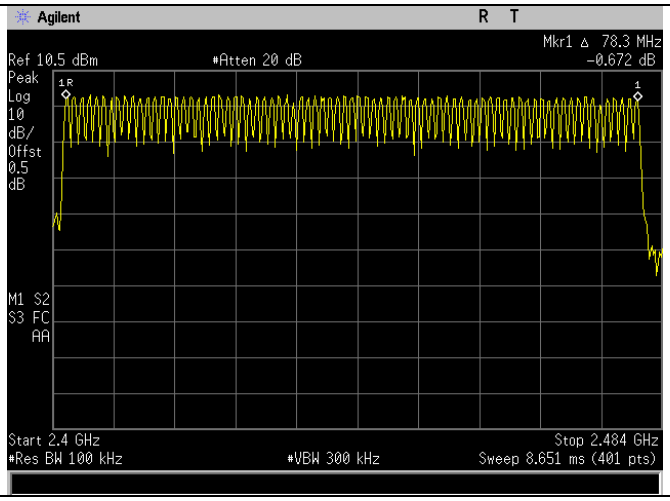
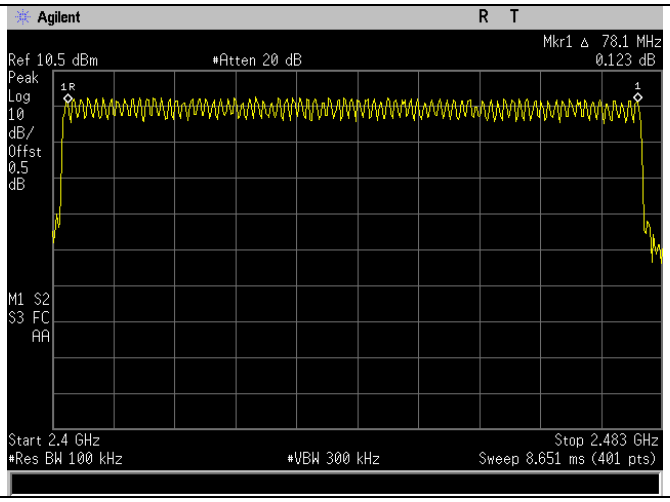
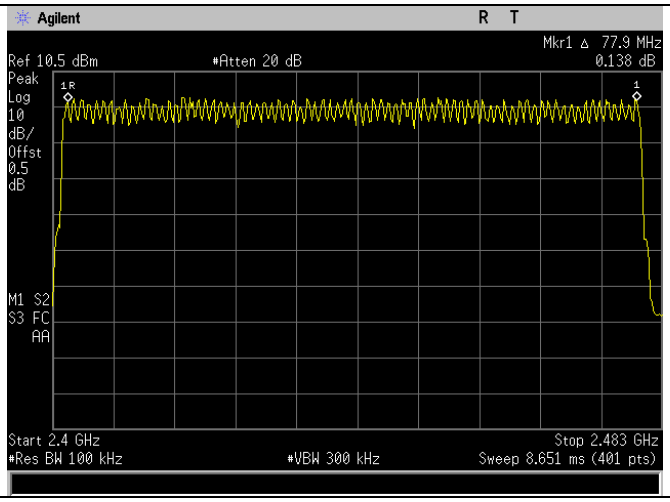
Span = the frequency band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. It

4.6.3 Test Result

Mode	Number of hopping channels	Limit
GFSK	79	≥15
π/4-DQPSK	79	≥15
8DPSK	79	≥15

Test plots as below:

GFSK mode

π /4-DQPSK mode

8DPSK mode


4.7 Time of occupancy (dwell time)

4.7.1 Limit

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.

4.7.3 Test method

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = zero span, centered on a hopping channel
RBW = 1 MHz
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector function = peak
Trace = max hold

Use the marker-delta function to determine the dwell time.

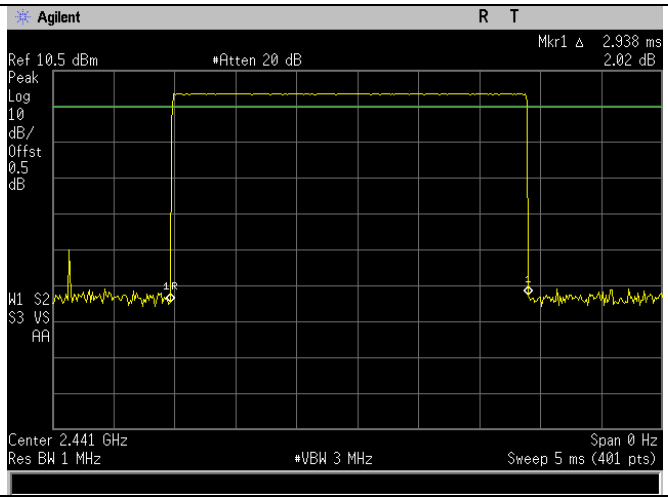
4.7.4 Test Result

Packet type	Pulse Duration (ms)	Dwell time (s)	Limit (s)
DH5(GFSK)	2.938	0.313	0.4
2DH5(π/4-DQPSK)	2.938	0.313	0.4
3DH5(8DPSK)	2.887	0.308	0.4

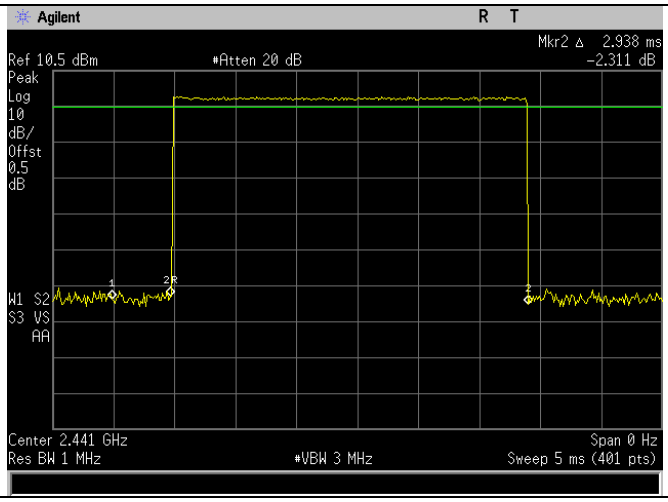
Note 1: for the worst mode of DH5, 2DH5, 3DH5 packet types, in normal hopping mode, hopping rate is 1600hops/s with 6 slots in 79 hopping channel.
Note 2: Dwell time = (Pulse Duration*1600/79/6)*0.4*79

Test plots as below:

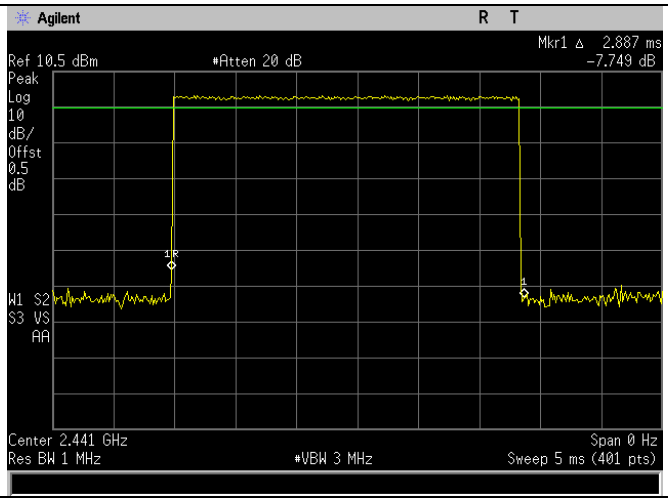
GFSK mode



π/4-DQPSK mode



8DPSK mode



4.8 Band edge spurious emission, conducted spurious emission

4.8.1 Limit

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.

4.8.2 Test method

Use the following spectrum analyzer settings:

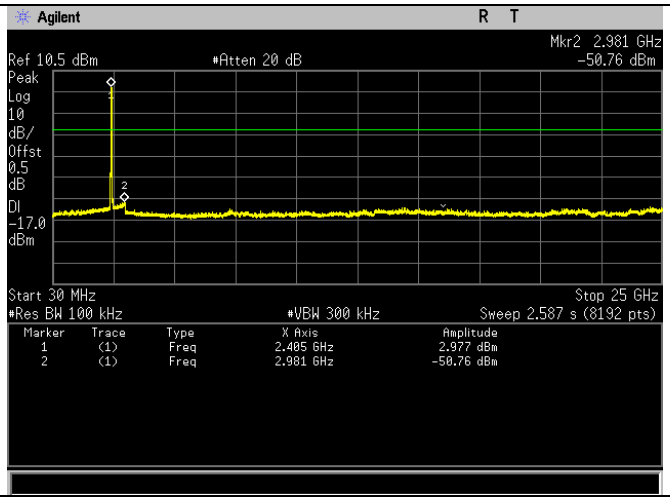
Set RBW=100 kHz. VBW≥3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.

4.8.3 Test Result

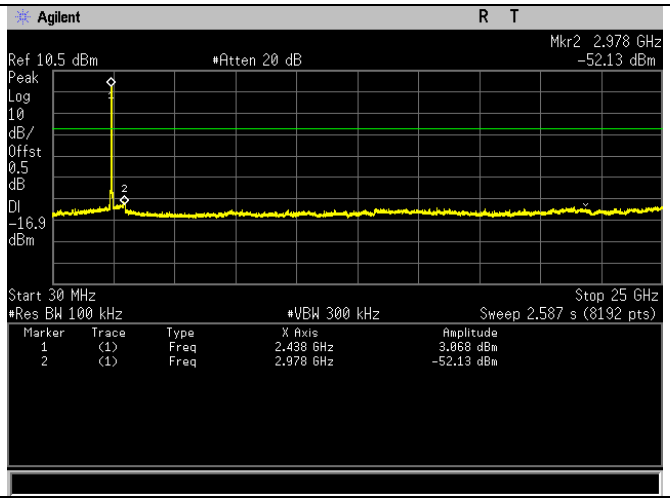
Test plots as below:

Conducted emission (GFSK mode)

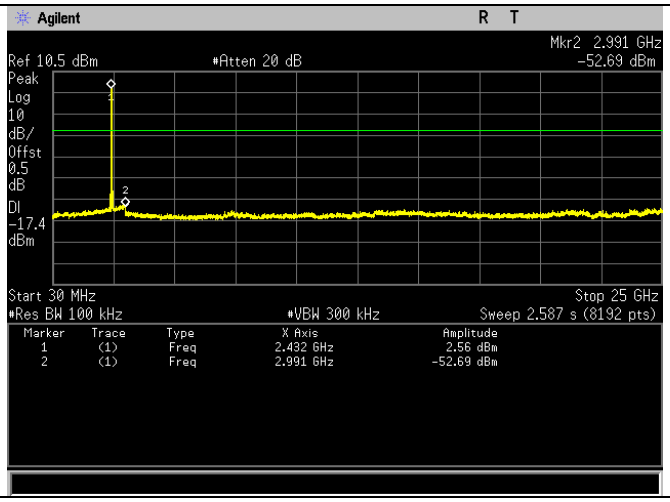
2402MHz



2441MHz

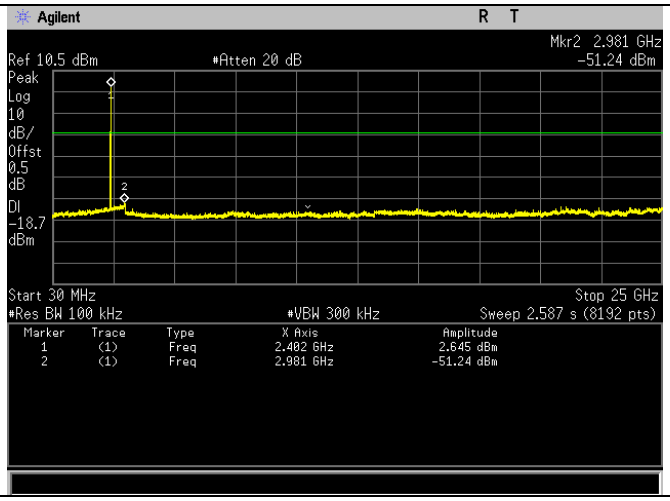


2480MHz

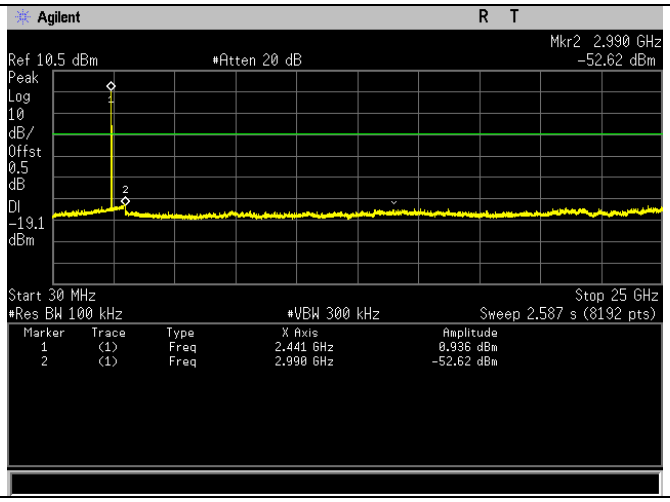


Conducted emission (π/4-DQPSK mode)

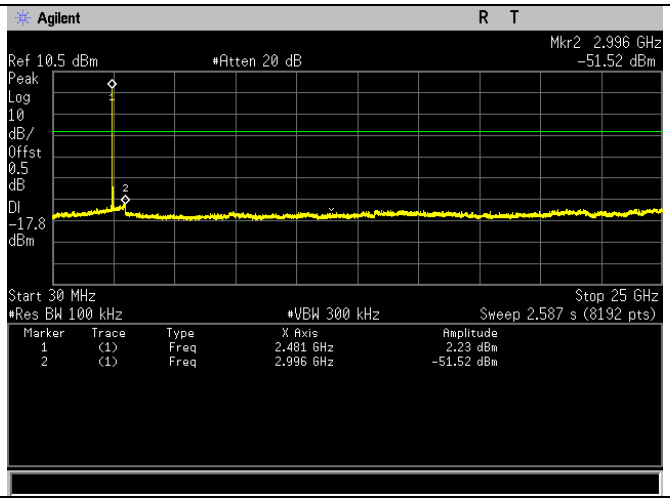
2402MHz



2441MHz

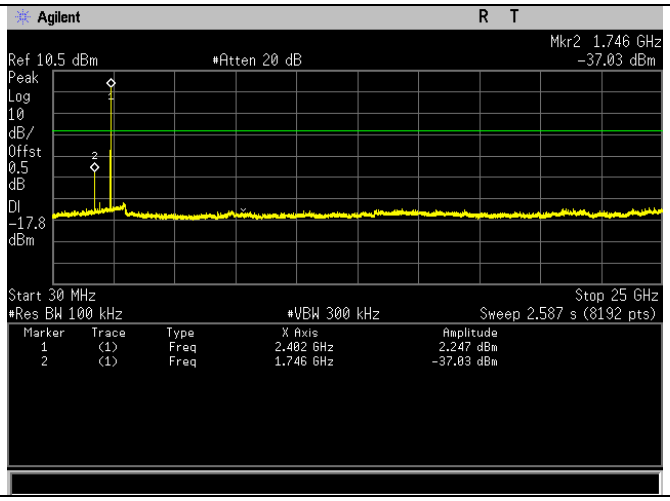


2480MHz

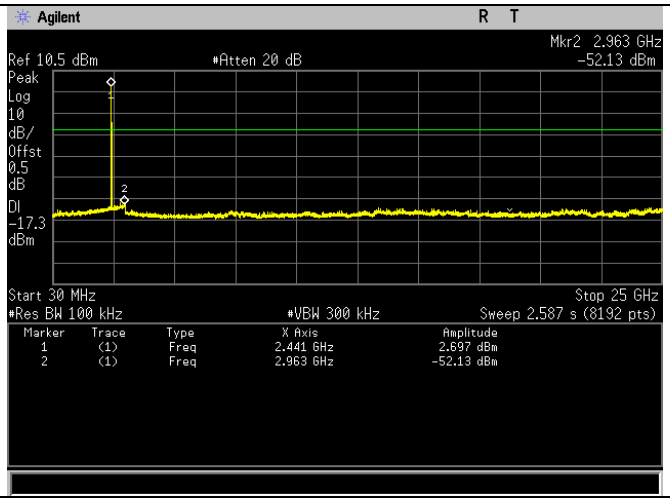


Conducted emission (8DPSK mode)

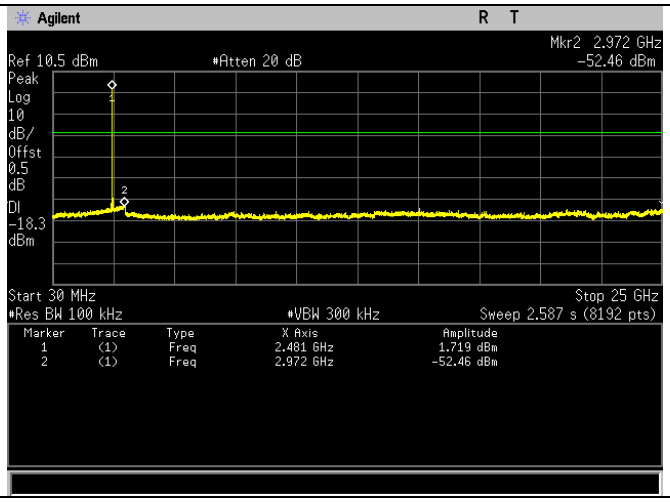
2402MHz



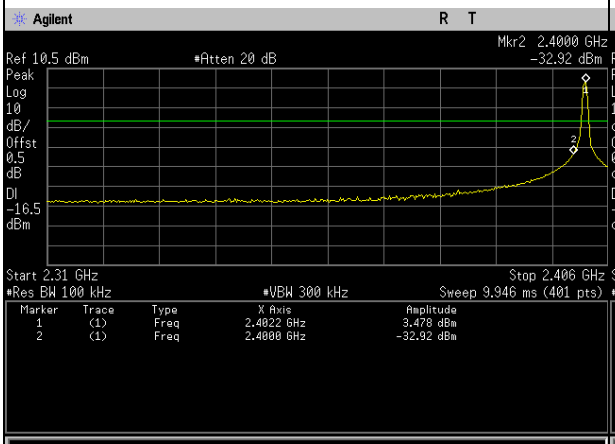
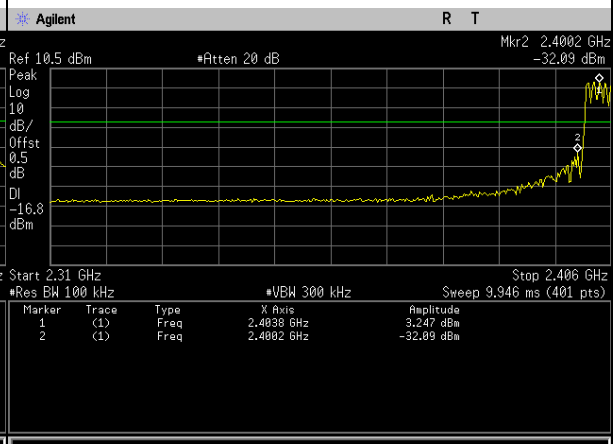
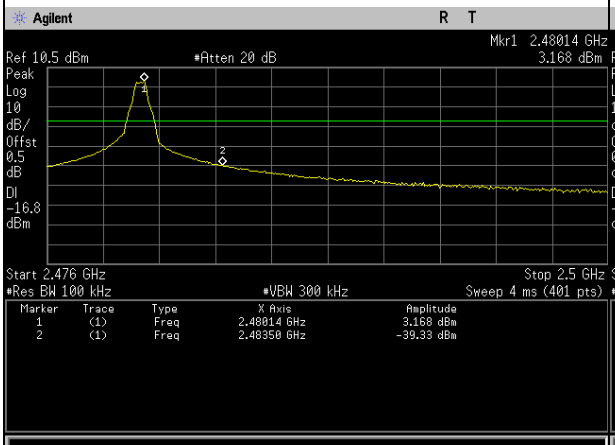
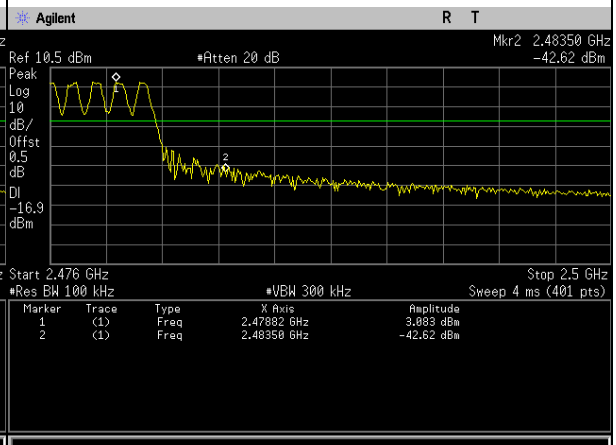
2441MHz



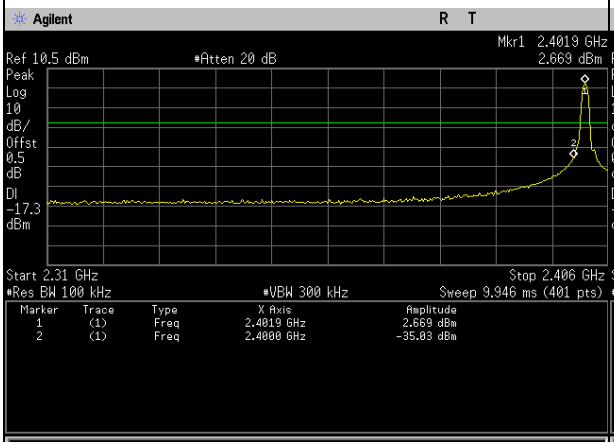
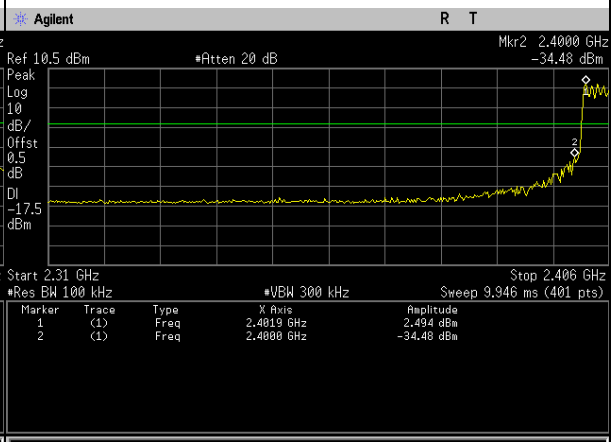
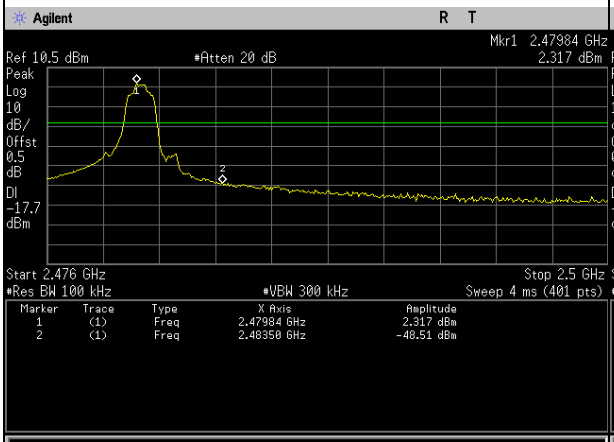
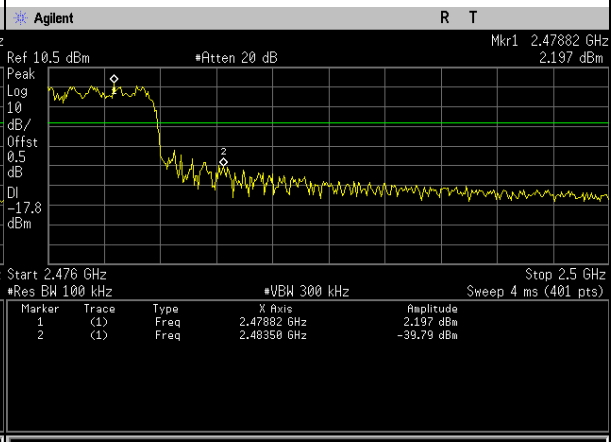
2480MHz



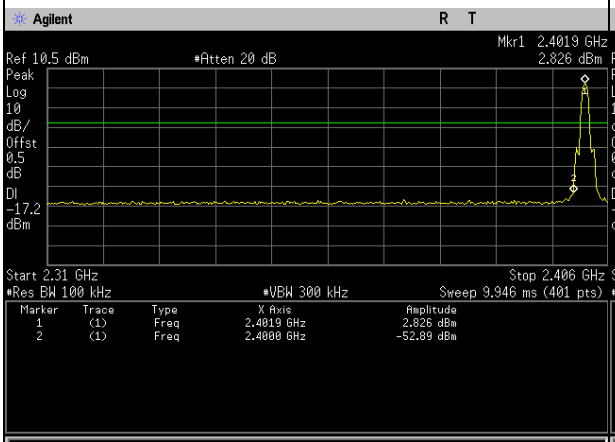
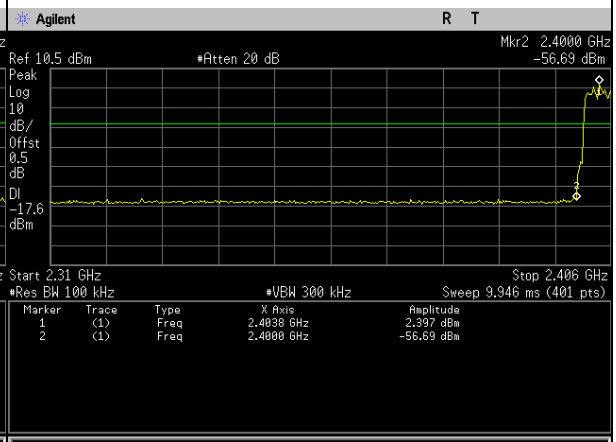
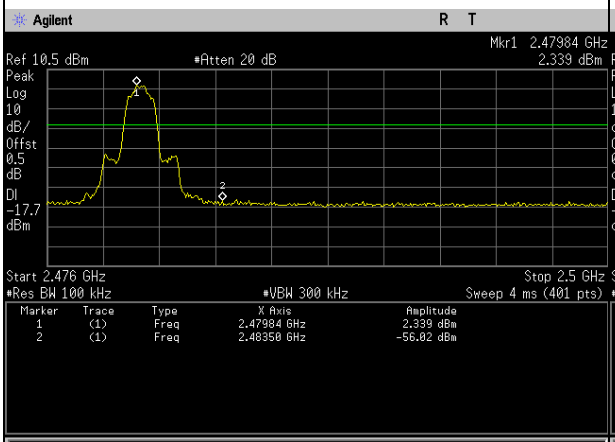
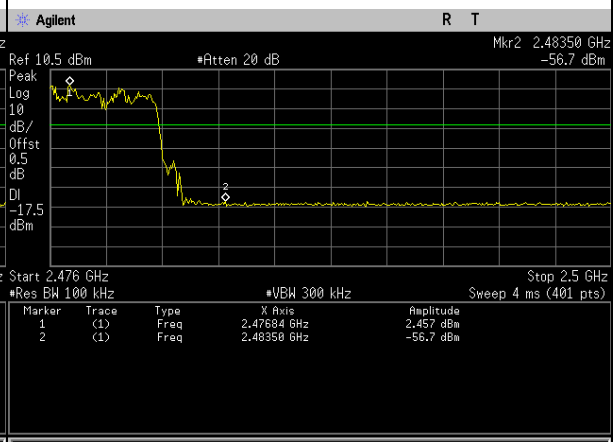
Band edge (GFSK mode)

2402MHz – no hop	2402MHz – hop
	
2480 – no hop	**2480 – hop**
	

Band edge (π/4-DQPSK mode)

2402MHz – no hop	2402MHz – hop
	
2480 – no hop	**2480 – hop**
	

Band edge (8DPSK mode)

2402MHz – no hop	2402MHz – hop
	
2480 – no hop	**2480 – hop**
	

4.9 Radiated emission

4.9.1 Limit

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 §15.209(a) is not required. In addition, 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).

Frequency (MHz)	Field strength μV/m	Field strength dBμV/m	Detector	Measurement distance
30-88	100	40	QP	3m
88-216	150	43.5	QP	
216-960	200	46	QP	
960-1000	500	46	QP	
Above 1000	500	54	AV	
Above 1000	5000	74	PK	

4.9.2 Test method

1. The EUT is placed on a turntable, which is 0.8m above ground plane.

2. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.

3. Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured, RBW = 1 MHz for f ≥ 1GHz, 100 kHz for f < 1 GHz, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold

4. Follow the guidelines in ANSI C63.4-2009 with respect to maximizing the emission by rotating the EUT, adjusting the measurement antenna height and polarization, etc. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, submit this data. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

5. Set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the duty cycle per channel of the hopping signal is less than 100ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a “duty cycle correction factor”, derived from 20log(duty cycle/100ms), in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

4.9.3 Test Result

Radiated emission (8DPSK mode)

2402MHz

Frequency	Ant. Polarization	Emission level	Limits	Detector	Result
(MHz)	H / V	dBμV/m	dBμV/m		
47.35	V	34.1	40	QP	Pass
160.91	H	30.2	43.5	QP	
2400	V	48.92	74	PK	
2400	H	46.33	74	PK	
4804	V	50.28	74	PK	
4804	H	51.36	74	PK	

2441MHz

Frequency	Ant. Polarization	Emission level	Limits	Detector	Result
(MHz)	H / V	dBμV/m	dBμV/m		
47.35	V	34.4	40	QP	Pass
160.91	H	30.3	43.5	QP	
4882	V	50.35	74	PK	
4882	H	50.84	74	PK	

2480MHz

Frequency	Ant. Polarization	Emission level	Limits	Detector	Result
(MHz)	H / V	dBμV/m	dBμV/m		
47.35	V	34.7	40	QP	Pass
160.91	H	29.5	43.5	QP	
2483.5	V	46.12	74	PK	
2483.5	H	46.91	74	PK	
4960	V	50.27	74	PK	
4960	H	49.62	74	PK	

Note:
Only the data of worst case (8DPSK modulation mode) is shown.
QP Emission Level= Antenna Factor +Cable Loss + Reading
PK Emission Level= Antenna Factor +Cable Loss - Amp. Factor + Reading
AV Emission Level= PK Emission Level+20log (duty cycle) or set the RBW/VBW to be 1MHz/10Hz to read the level.
If the PK measured values lower than average mode limit, the EUT shall be deemed to meet average limits and then no additional average mode measurement performed.

----END OF REPORT----