Appendix A: Test results. Bluetooth EDR (GFSK, Pi/4 DQPSK, 8DPSK)

INDEX

TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 12 Vdc.

Type of Power Supply: External power supply (Battery).

Type of Antenna: External antenna.

Declared Gain for antenna RF port 3 (maximum): 0.7 dBi (Antenna gain plus antenna cable loss).

TEST FREQUENCIES:

Low Channel: 2402 MHz

Middle Channel: 2441 MHz

High Channel: 2480 MHz

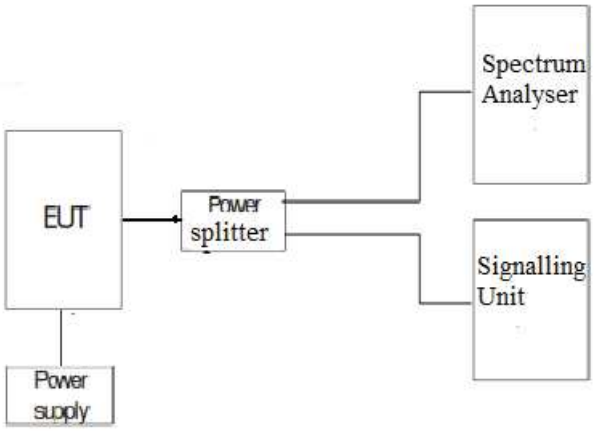
CONDUCTED MEASUREMENTS:

Hopping mode OFF:

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

Hopping mode ON:

The equipment under test was set up in a shielded room and it is connected to a Bluetooth signalling unit (Bluetooth test set) and to the spectrum analyzer using a 6 dB power splitter. The reading in the spectrum analyzer is corrected taking into account the power splitter loss.



The DC supply voltage is applied using an external calibrated power supply with a multimeter.

RADIATED MEASUREMENTS:

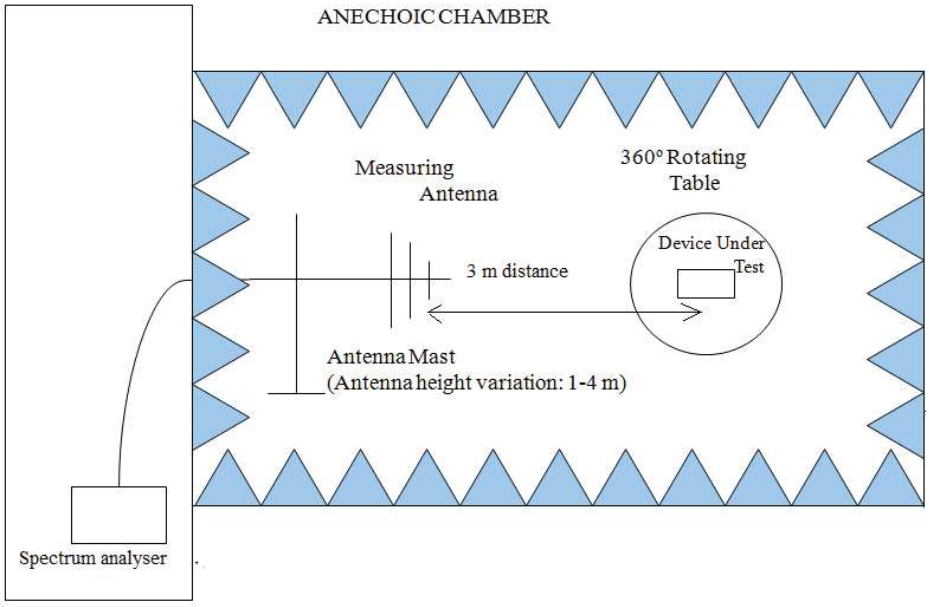
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

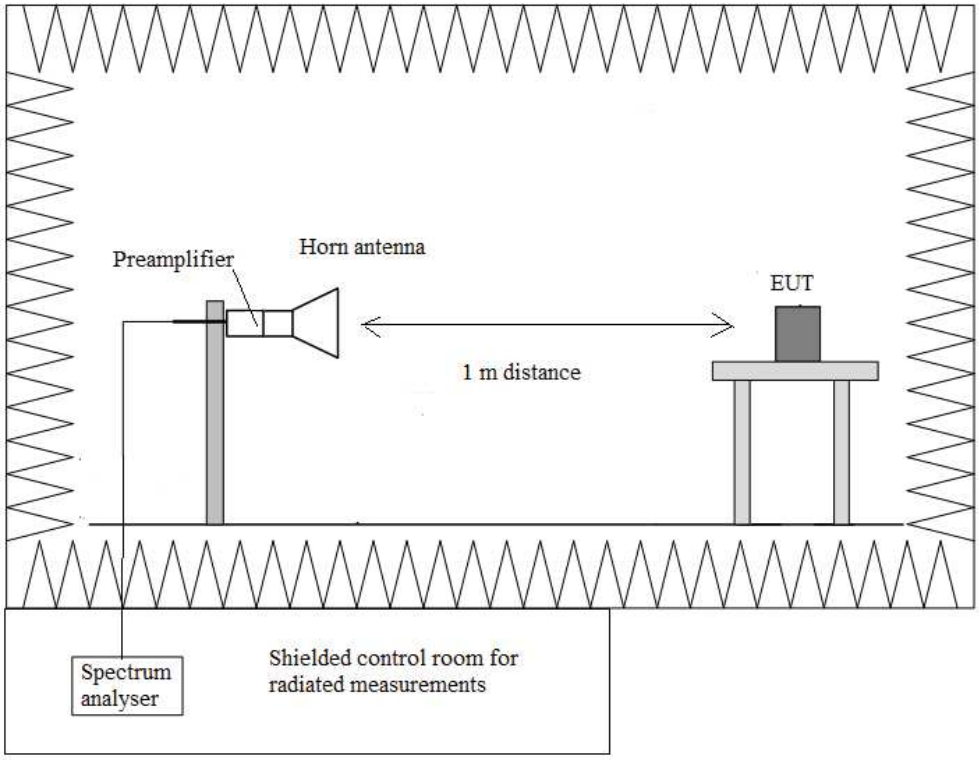
Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup from 30 MHz to 1 GHz:



Shielded Control Room For Radiated Measurements

Radiated measurements setup f > 1 GHz:



FCC Section 15.247 Subclause (a) (1) / RSS-247 Clause 5.1. (b) 20 dB Bandwidth and Carrier frequency separation.

SPECIFICATION:

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

RESULTS:

- **GFSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	945.703	943.360	943.342
99% Bandwidth (kHz)	880.2441	879.4046	878.6745
Measurement uncertainty (kHz)	<±5.0		

- **Pi/4 DQPSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	1361	1361	1359
99% Bandwidth (kHz)	1205.3	1205.2	1207.1
Measurement uncertainty (kHz)	<±5.0		

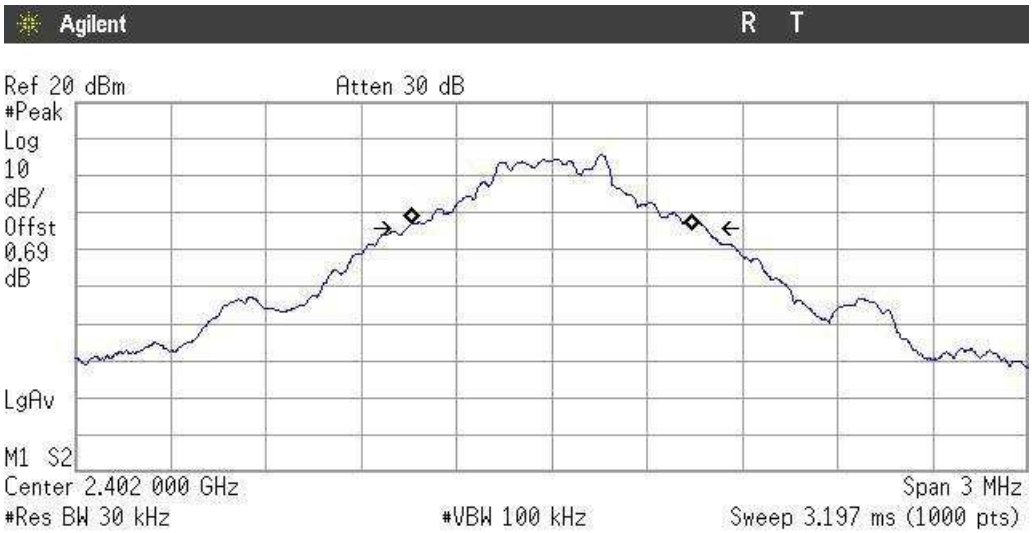
- **8DPSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	1317	1317	1318
99% Bandwidth (kHz)	1204.7	1205	1206.9
Measurement uncertainty (kHz)	<±5.0		

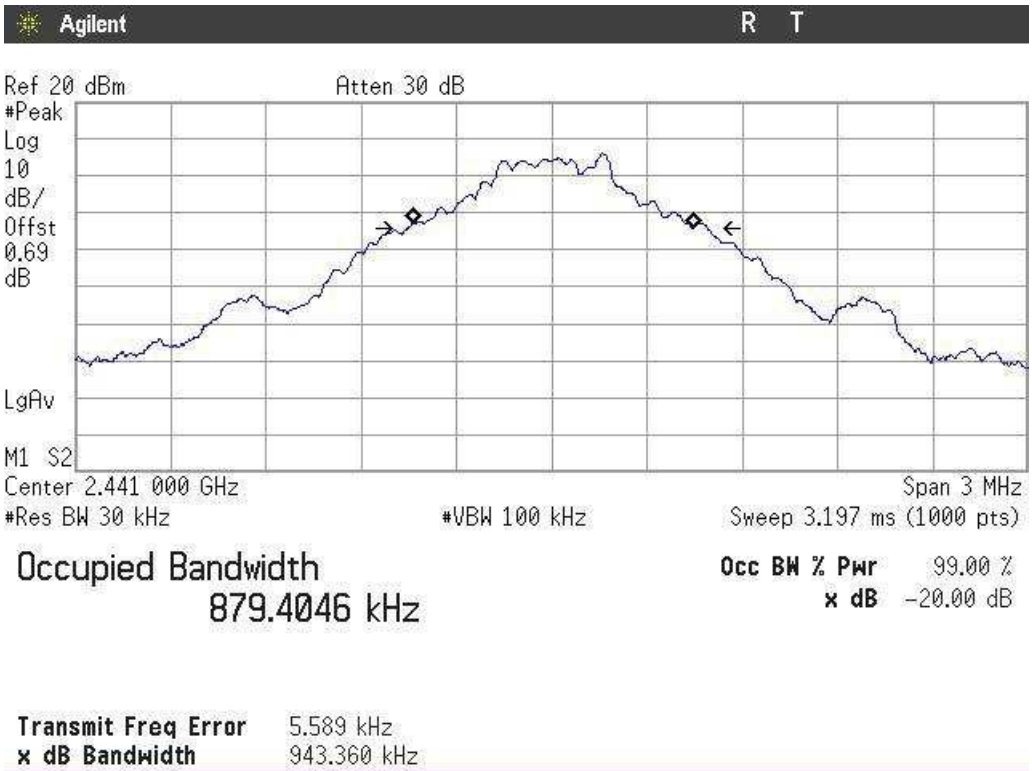
Verdict: PASS

- **GFSK – Bandwidths**

- Low Channel:



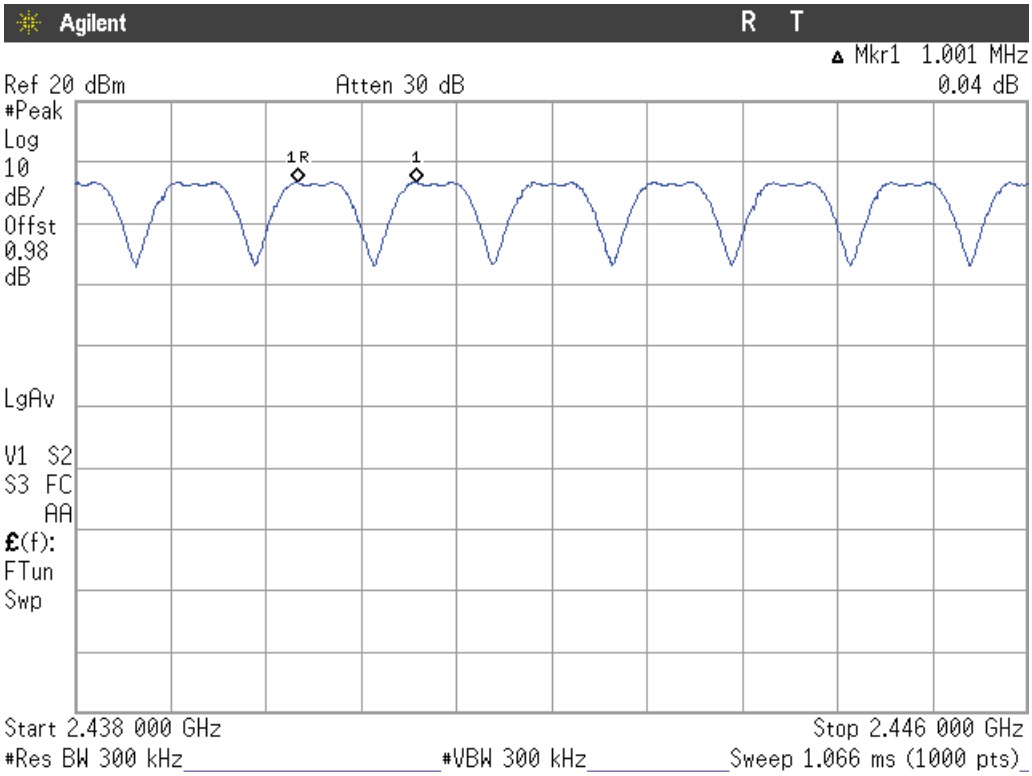
- Middle Channel:



- High Channel:

Carrier frequency separation - GFSK

Carrier frequency separation: 1001 kHz

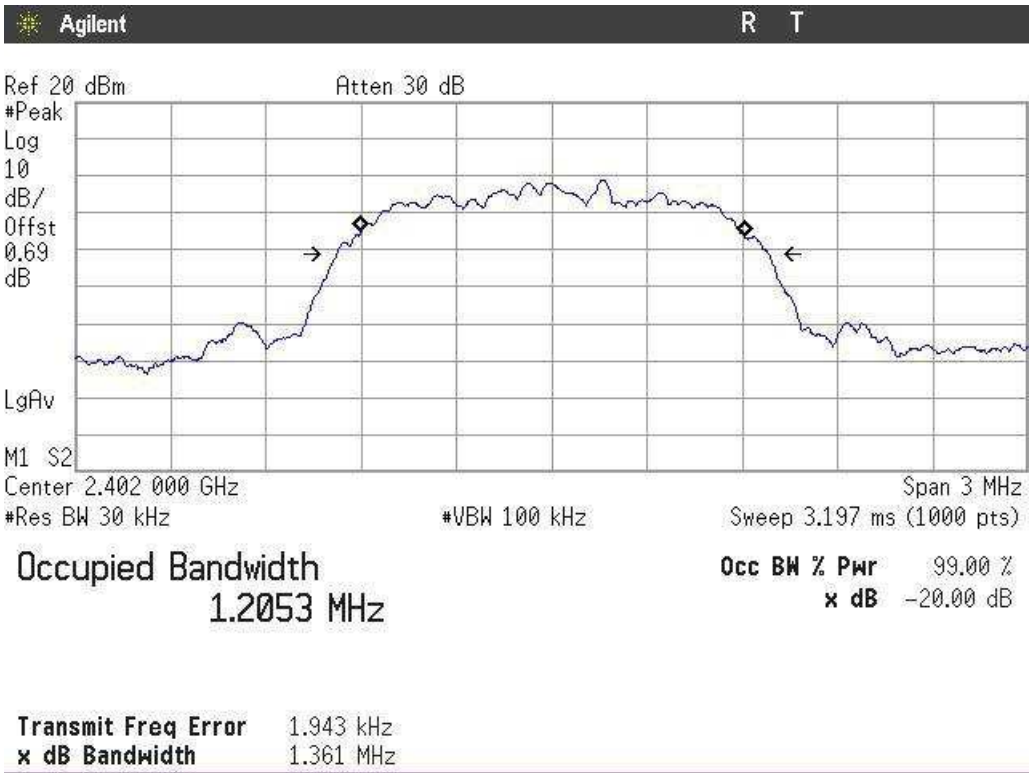


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

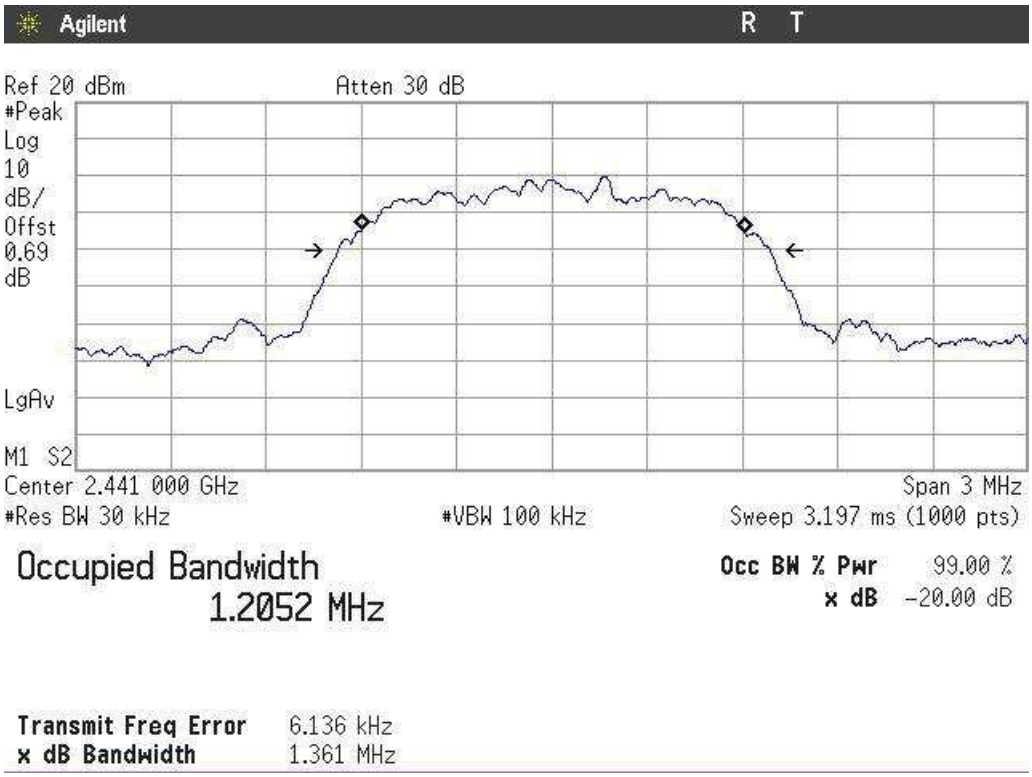
Verdict: PASS

- **Pi/4 DQPSK – Bandwidths**

- Low Channel:



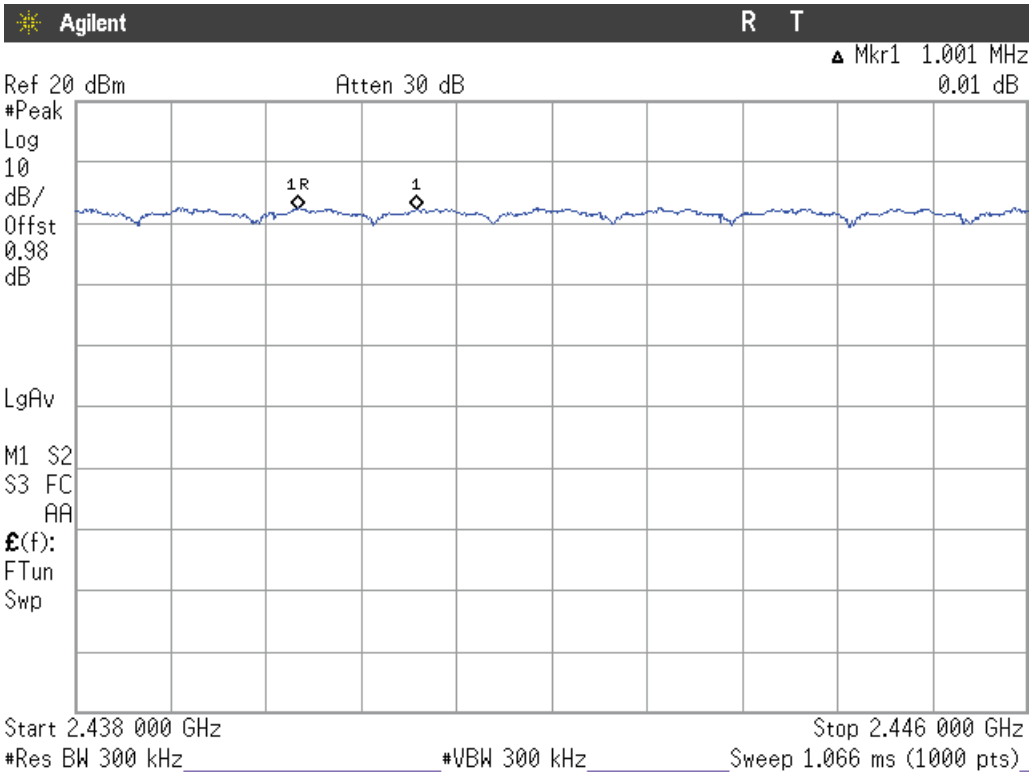
- Middle Channel:



- High Channel:

Carrier frequency separation - Pi/4 DQPSK

Carrier frequency separation: 1001 kHz

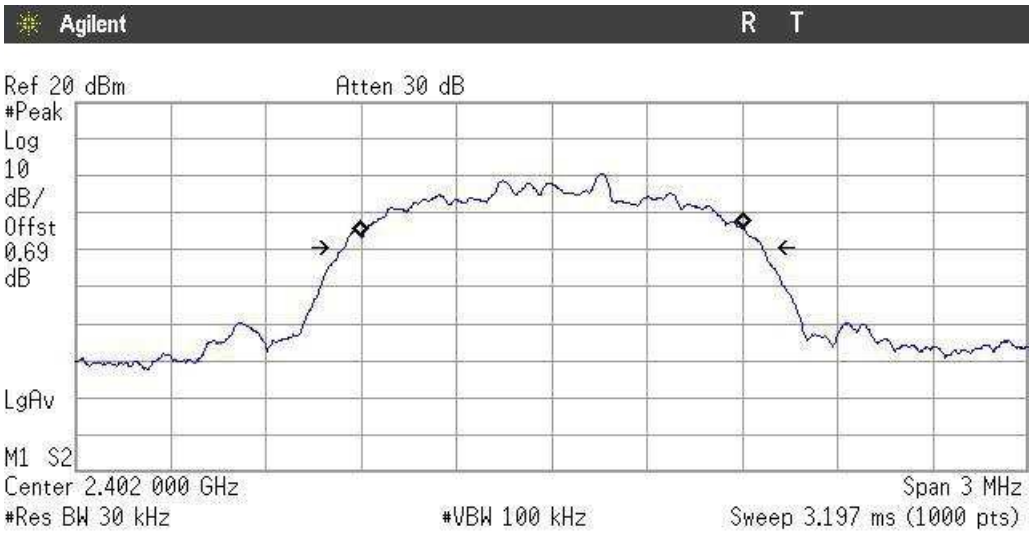


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

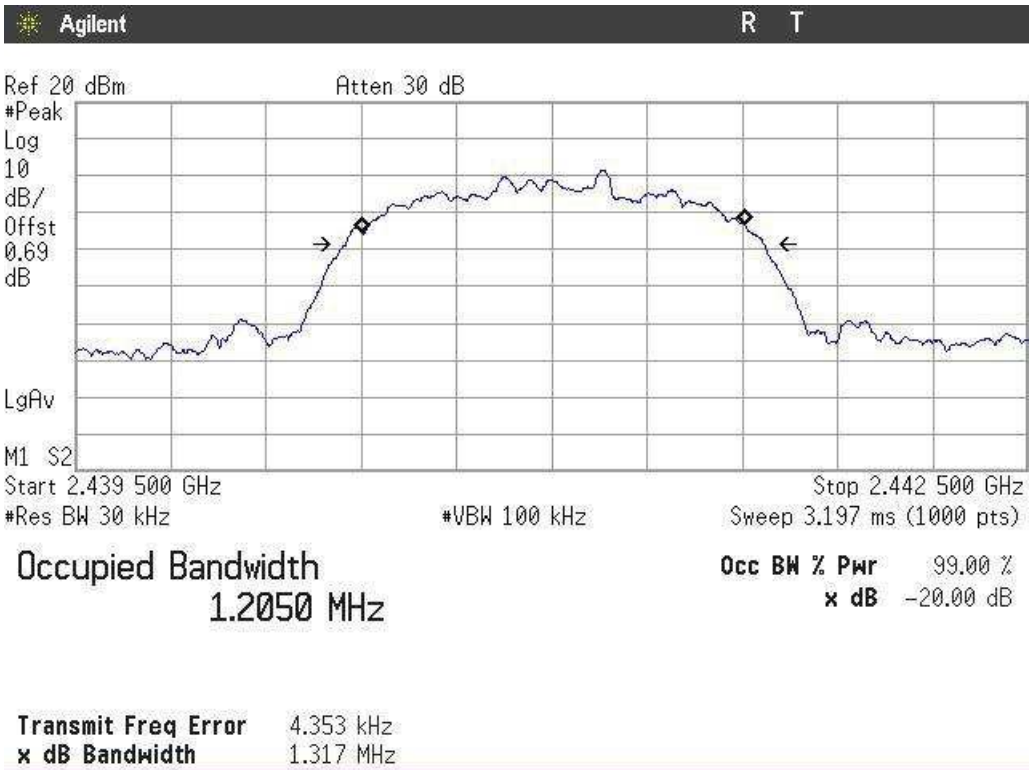
Verdict: PASS

- **8DPSK – Bandwidths**

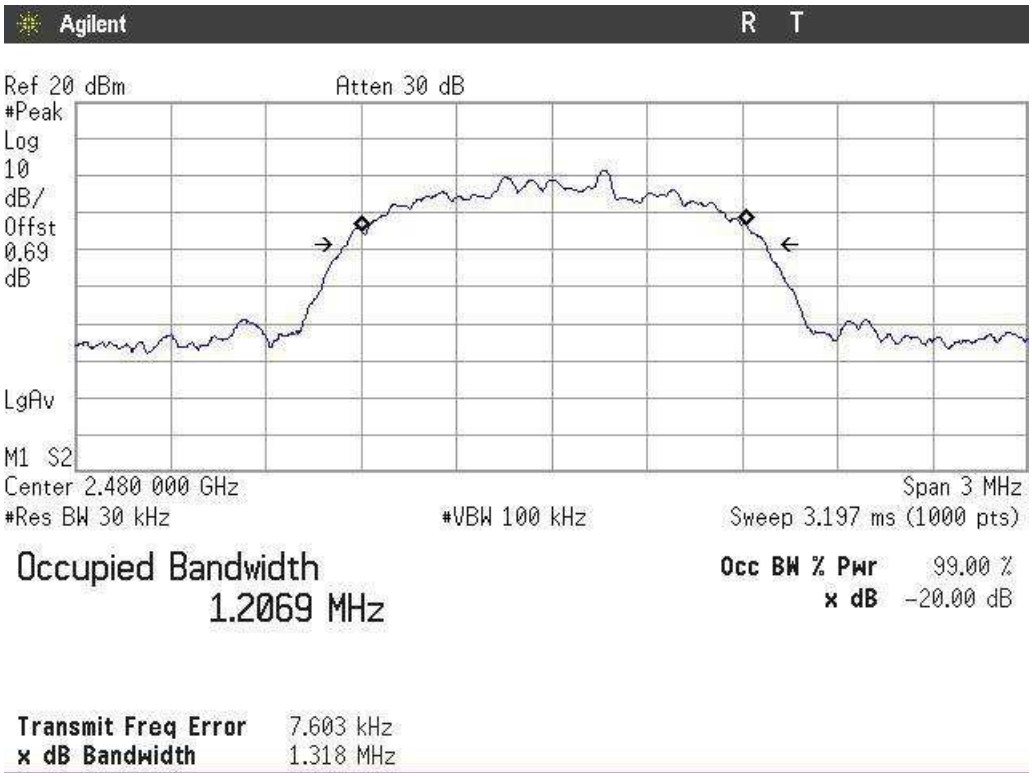
- Low Channel:



- Middle Channel:

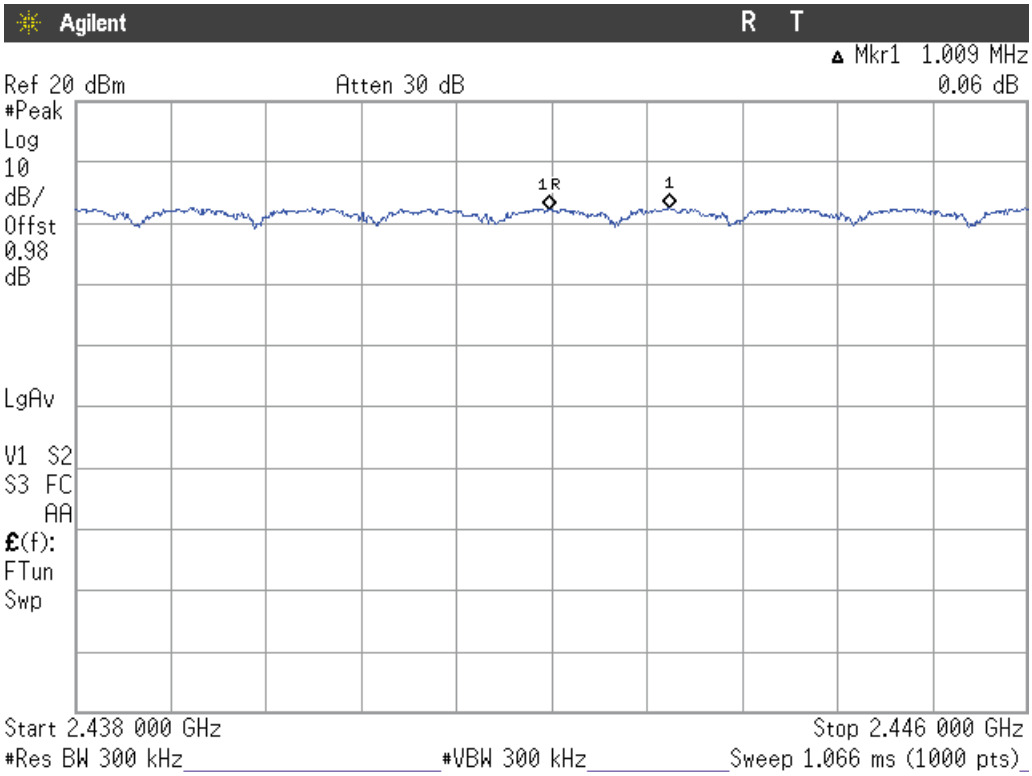


- High Channel:



Carrier frequency separation - 8DPSK

Carrier frequency separation: 1009 kHz



The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

Verdict: PASS

FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Number of hopping channels.

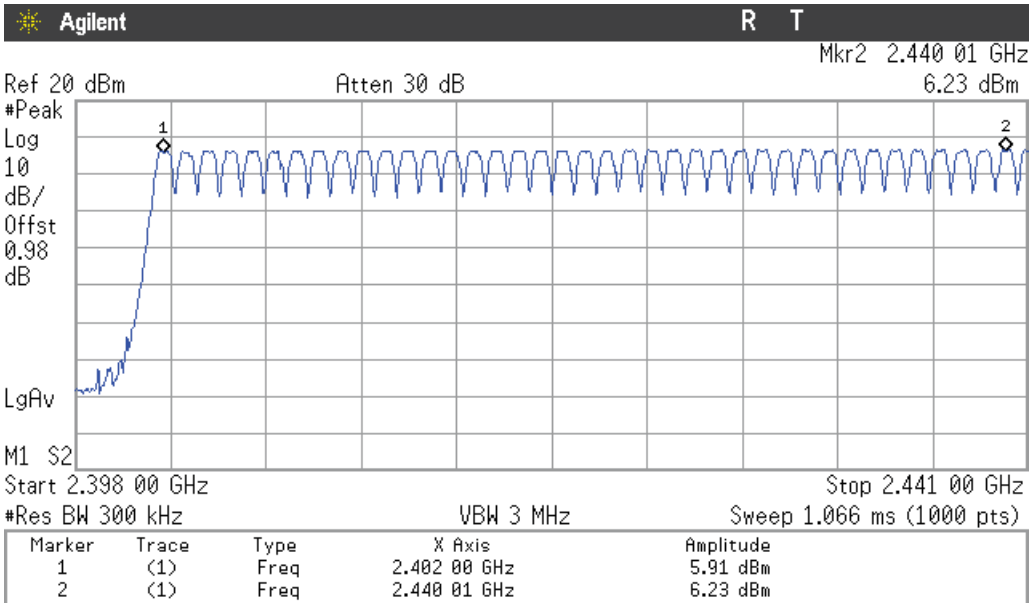
SPECIFICATION:

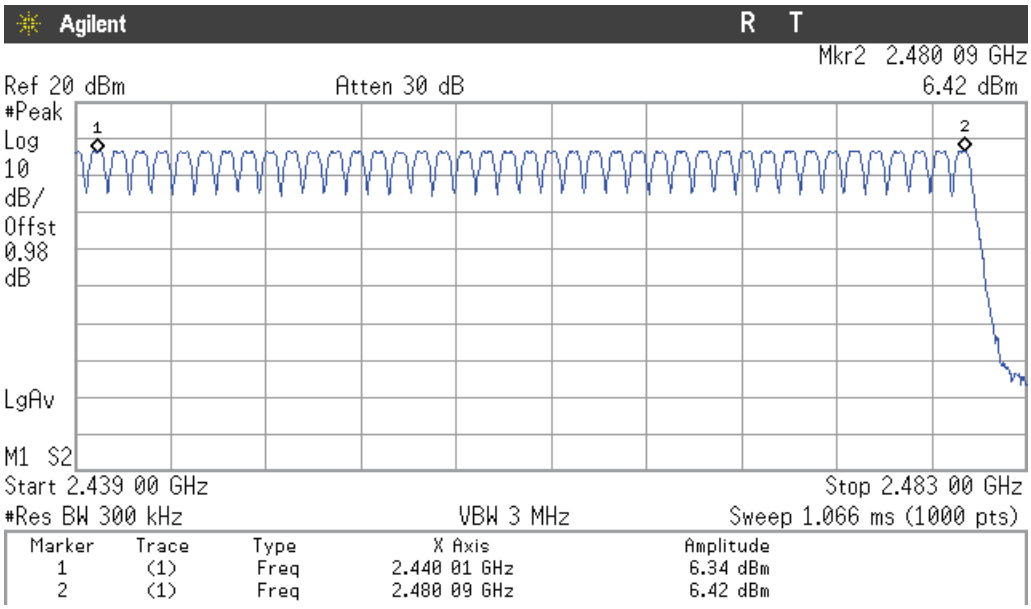
Frequency hopping system in the 2400-2483.5 MHz band shall use at least 15 channels.

RESULTS:

The number of hopping channels is 79 for all three modes.

- **GFSK – Number of hopping channels**

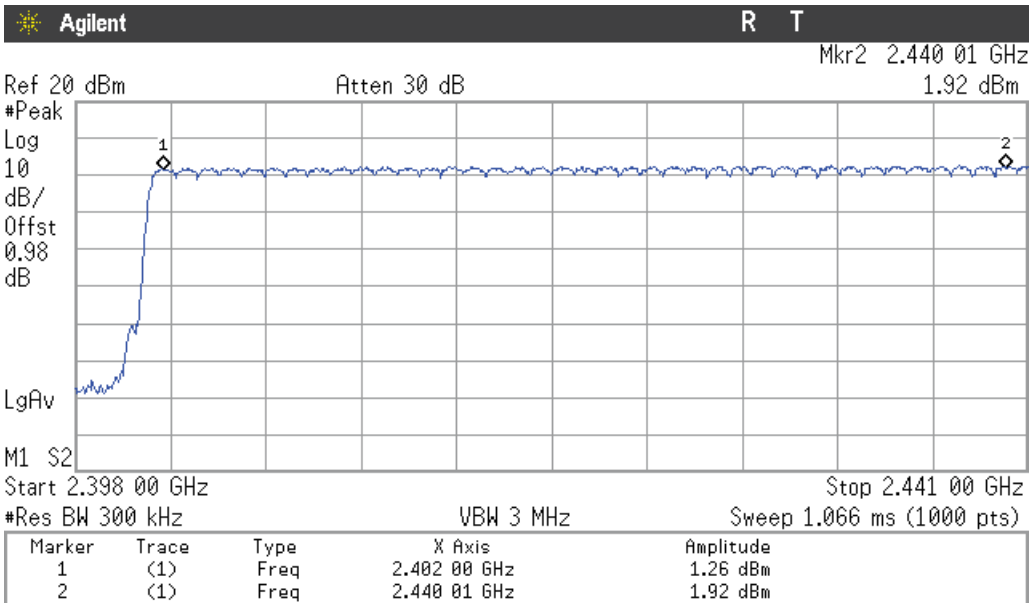


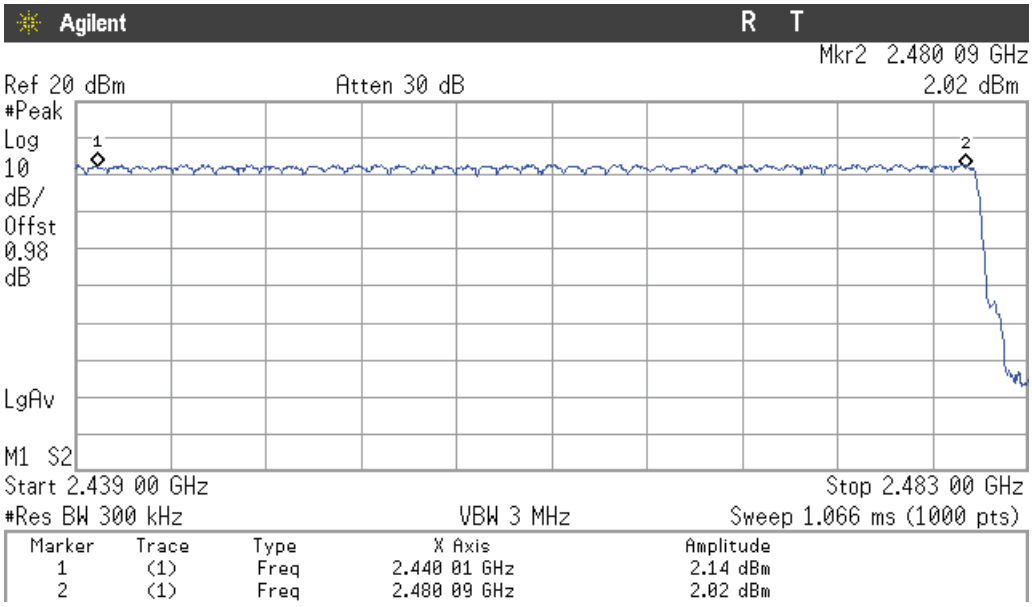


Total number of hopping channels 79

Verdict: PASS

- **Pi/4 DQPSK – Number of hopping channels**

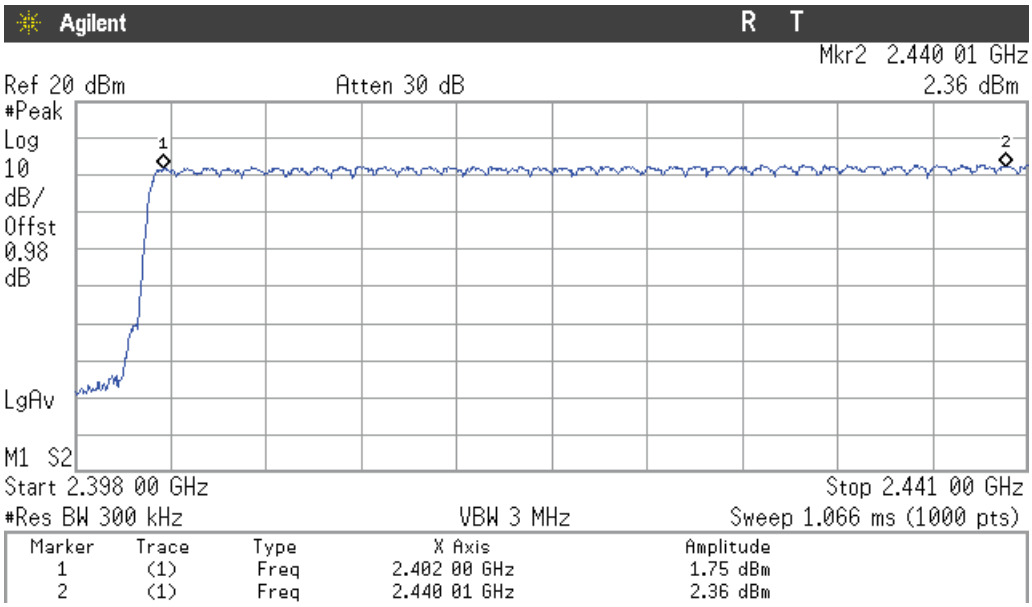


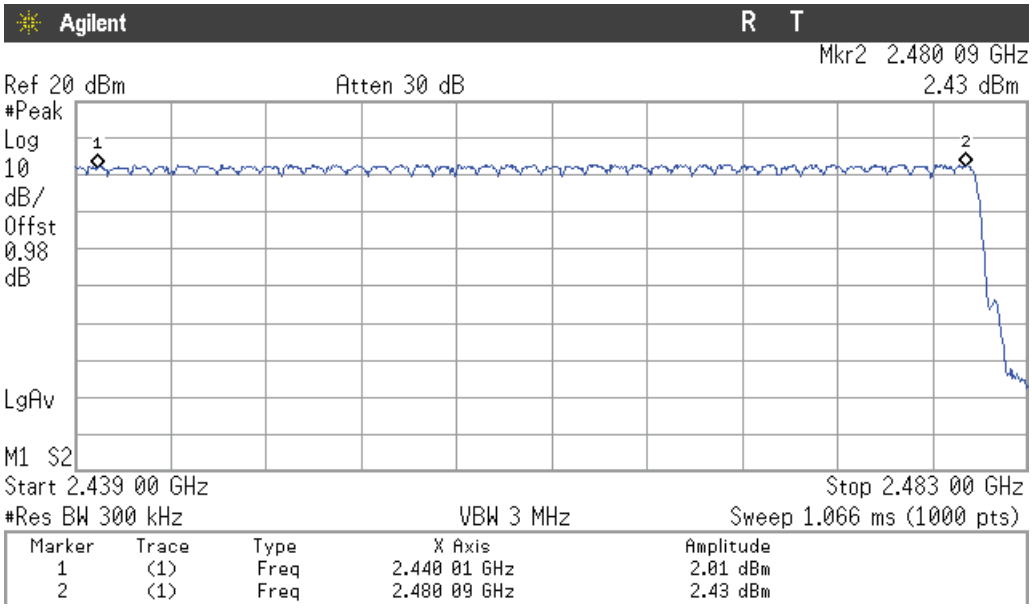


Total number of hopping channels 79

Verdict: PASS

- **8DPSK – Number of hopping channels**





Total number of hopping channels 79

Verdict: PASS

FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Time of occupancy (Dwell Time).

SPECIFICATION:

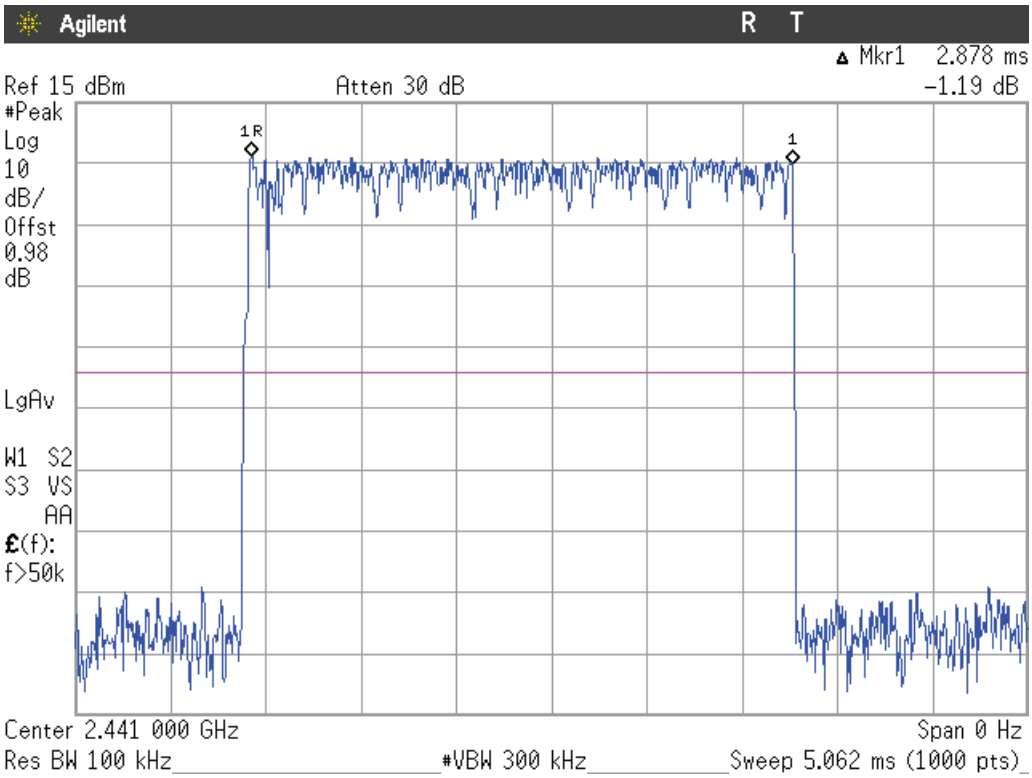
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = 0.4 x 79= 31.6 seconds.

RESULTS:

- **GFSK (packet type DH5) – Time of Occupancy (Dwell Time)**

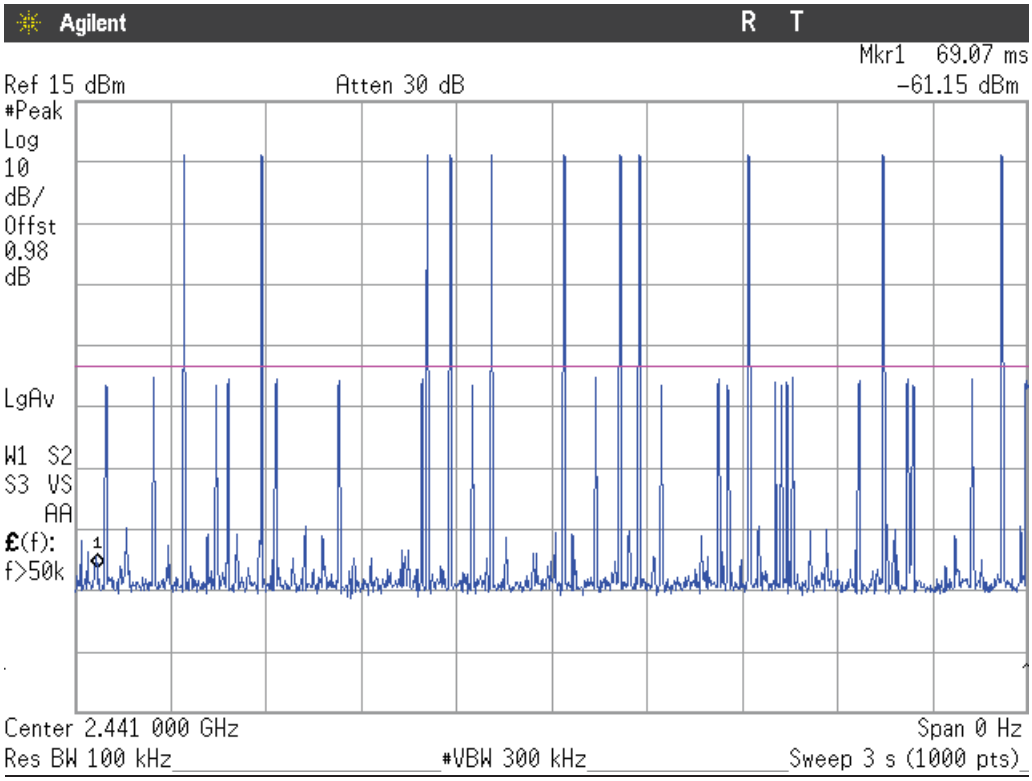
  - Transmit Time per Hop:

2.878	ms



- Time of Occupancy:

Nº of hops on spectrum analyzer	11	
Nº of hops over the period	115.8666667	
Average Time of Occupancy	333.4642667	ms



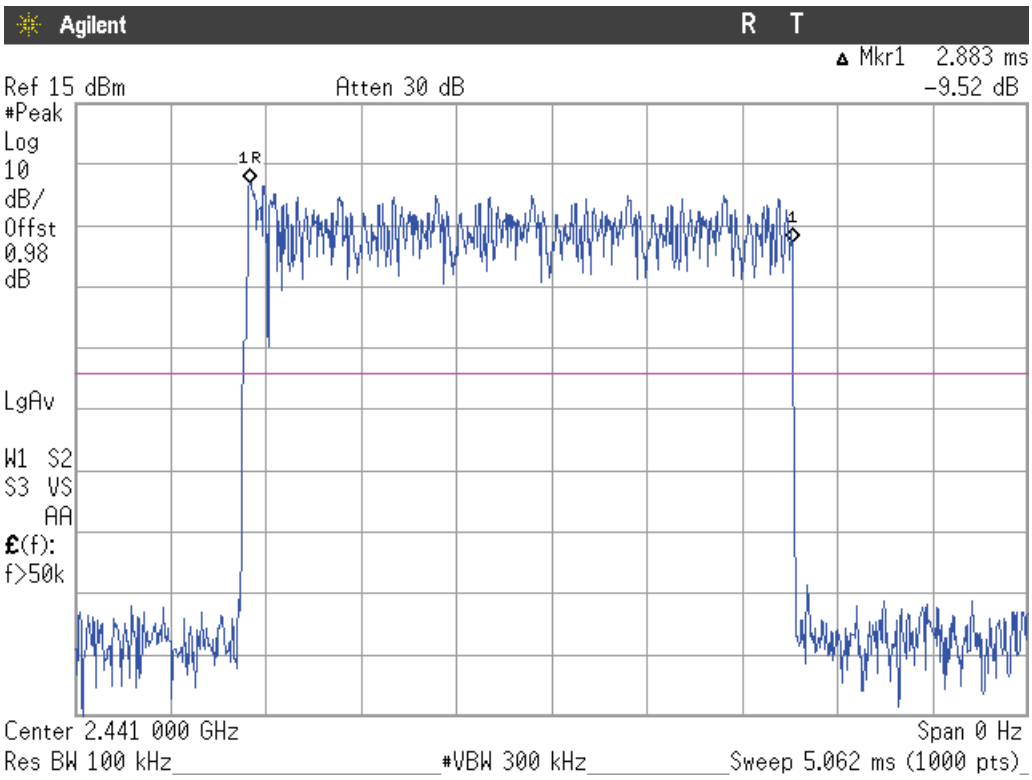
Measurement uncertainty (%)	<±0.01

Verdict: PASS

- **Pi/4 DQPSK (packet type 2DH5) – Time of Occupancy (Dwell Time)**

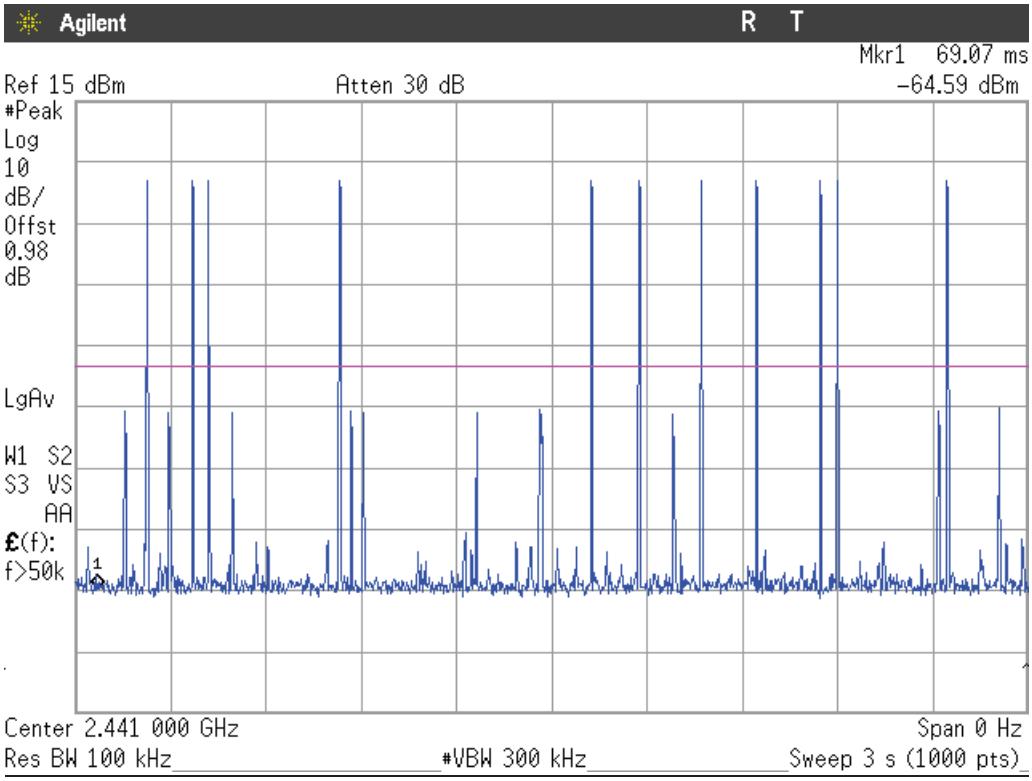
  - Transmit Time per Hop:

2.883	ms



- Time of Occupancy:

Nº of hops on spectrum analyzer	11	
Nº of hops over the period	115.8666667	
Average Time of Occupancy	334.0436	ms



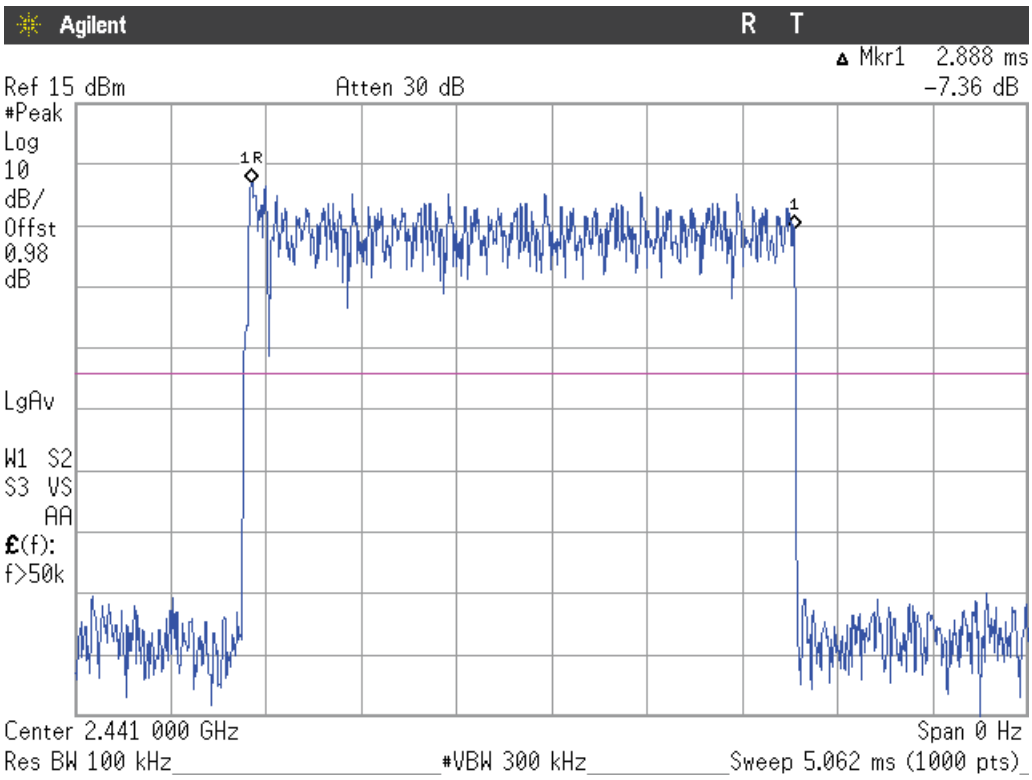
Measurement uncertainty (%)	<±0.01

Verdict: PASS

- **8DPSK (packet type 3DH5) – Time of Occupancy (Dwell Time)**

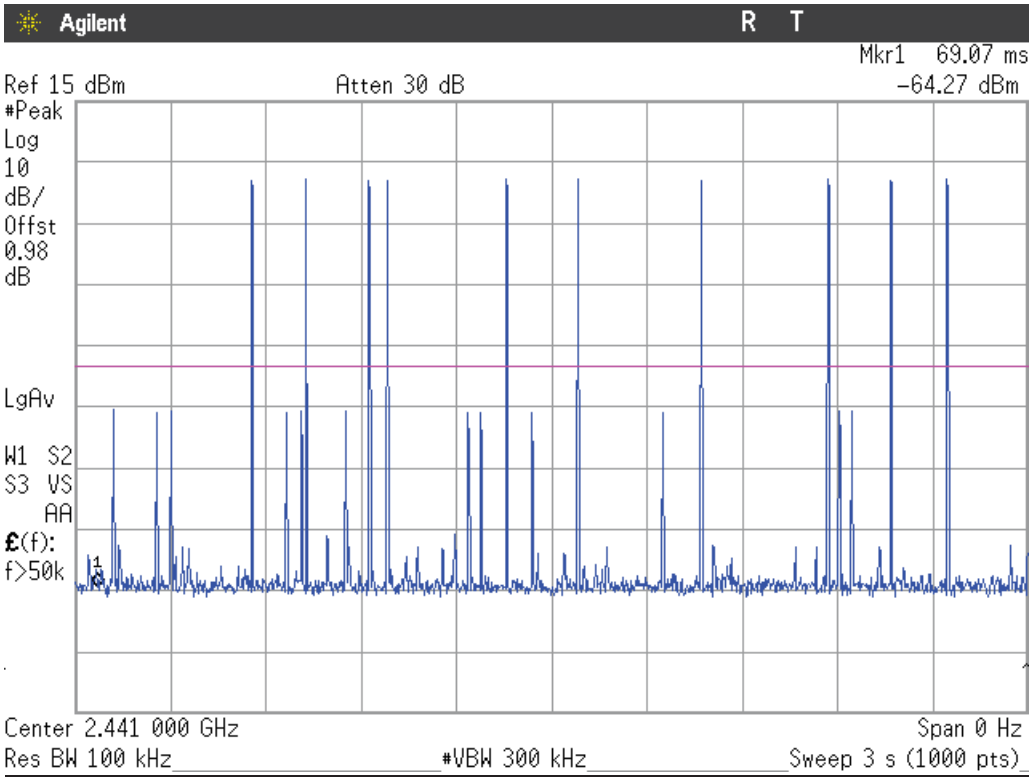
  - Transmit Time per Hop:

2.888	ms



- Time of Occupancy:

Nº of hops on spectrum analyzer	10	
Nº of hops over the period	105.3333333	
Average Time of Occupancy	304.2026667	ms



Measurement uncertainty (%)	<±0.01

Verdict: PASS

FCC Section 15.247 Subclause (b) / RSS-247 Clause 5.4 (b) Maximum peak output power and antenna gain

SPECIFICATION:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt (30 dBm). The e.i.r.p. shall not exceed 4 W (RSS-247).

RESULTS:

The EIRP power (dBm) is calculated by adding the maximum declared antenna gain to the measured conducted power.

Maximum Declared Antenna Gain: 0.7 dBi

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values

- **GFSK** (1 Mbps)

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	6.45	7.05	6.99
Maximum EIRP Power (dBm)	7.15	7.75	7.69
Measurement uncertainty (dB)	<±0.78		

- **Pi/4 DQPSK** (2 Mbps)

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	4.15	5	5.01
Maximum EIRP Power (dBm)	4.85	5.7	5.71
Measurement uncertainty (dB)	<±0.78		

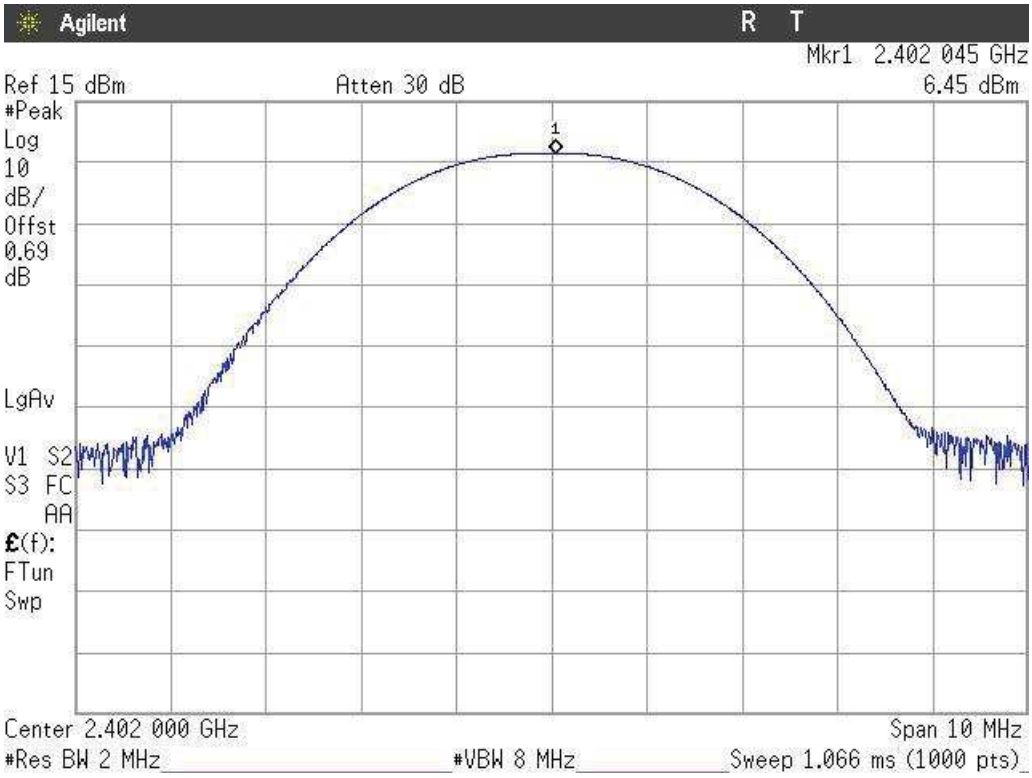
- **8DPSK** (3 Mbps)

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	4.63	5.41	5.45
Maximum EIRP Power (dBm)	5.33	6.11	6.15
Measurement uncertainty (dB)	<±0.78		

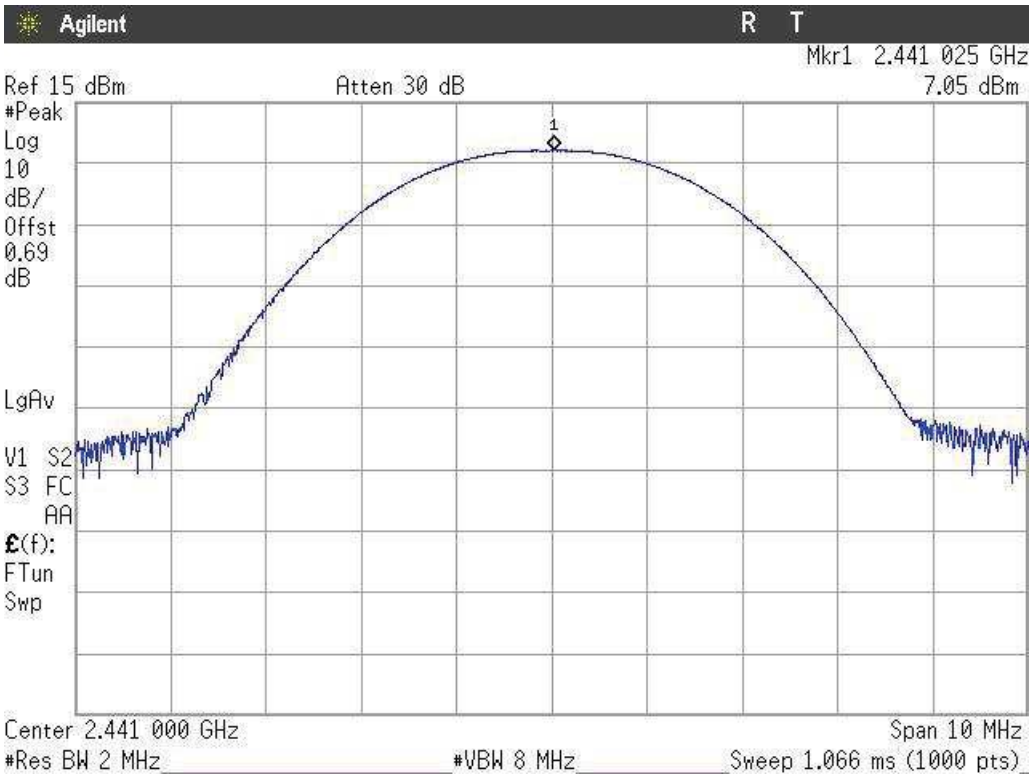
Verdict: PASS

- **GFSK – Peak Output Power**

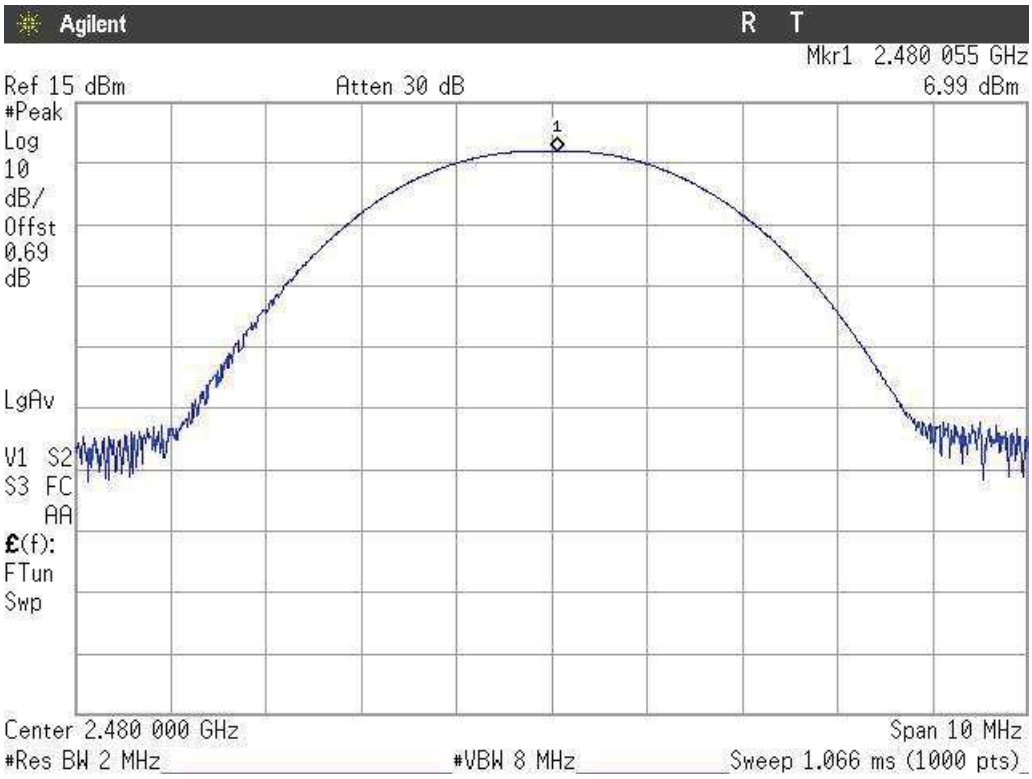
- Low Channel:



- Middle Channel:

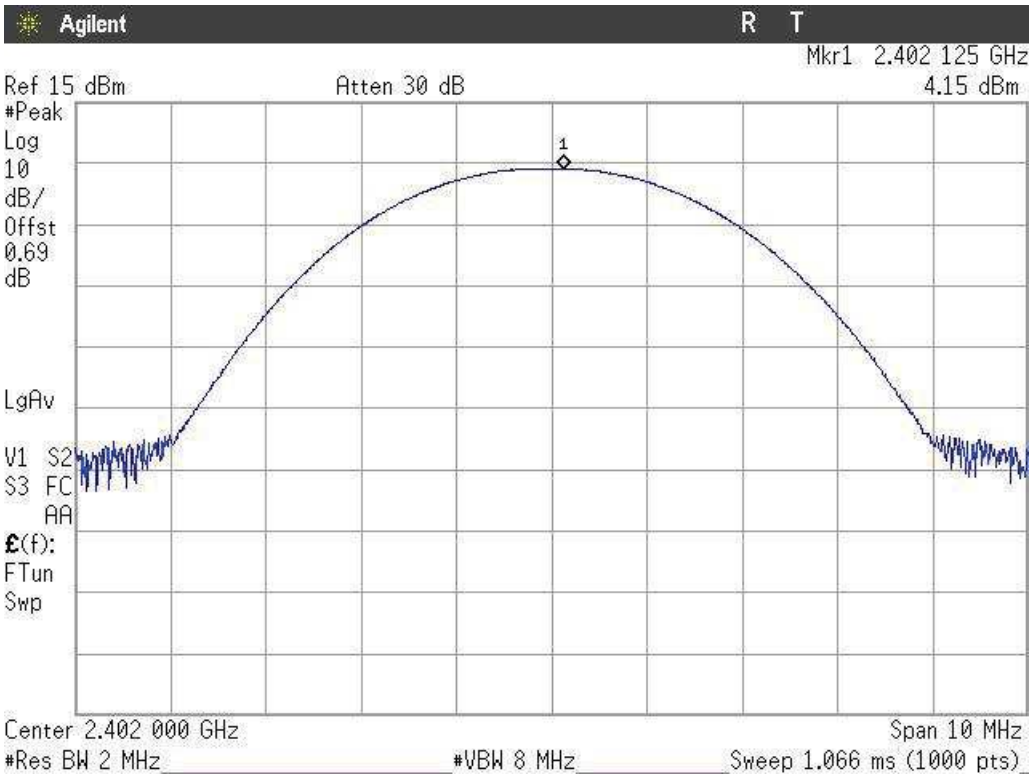


- High Channel:

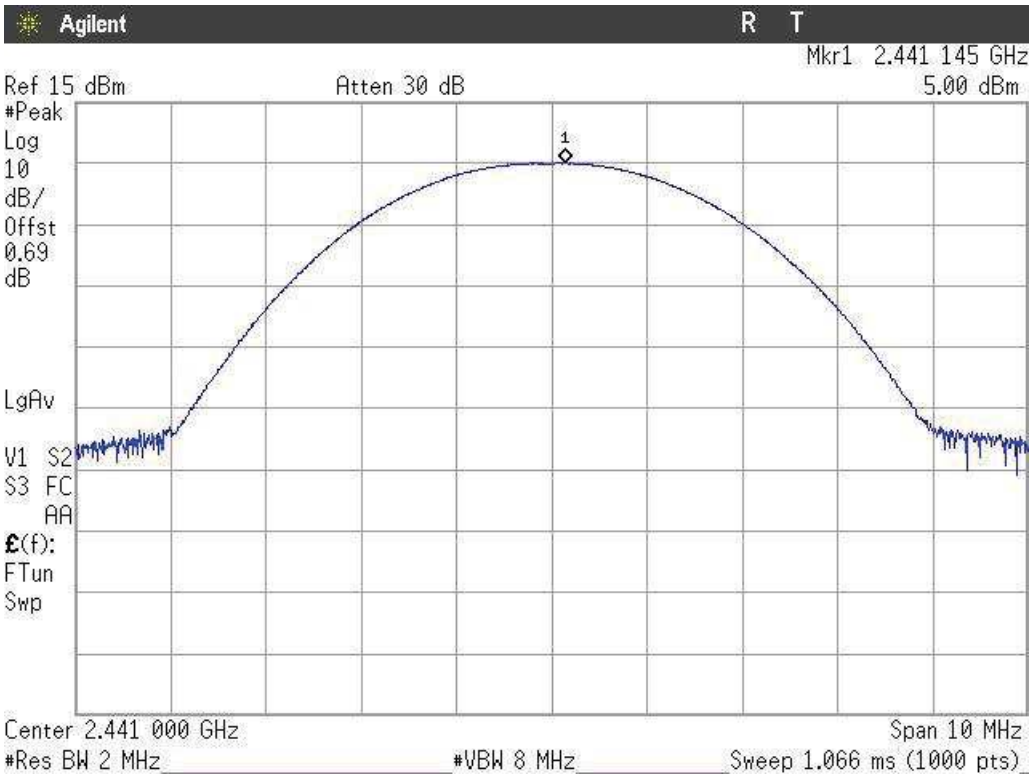


- **Pi/4 DQPSK – Peak Output Power**

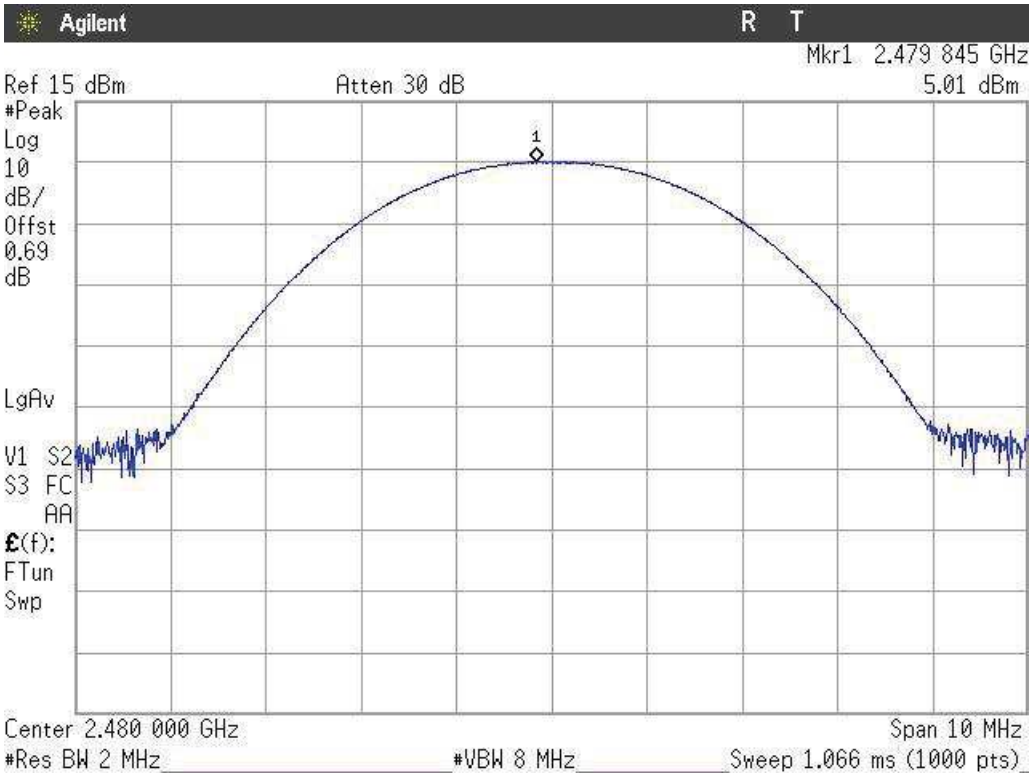
- Low Channel:



- Middle Channel:

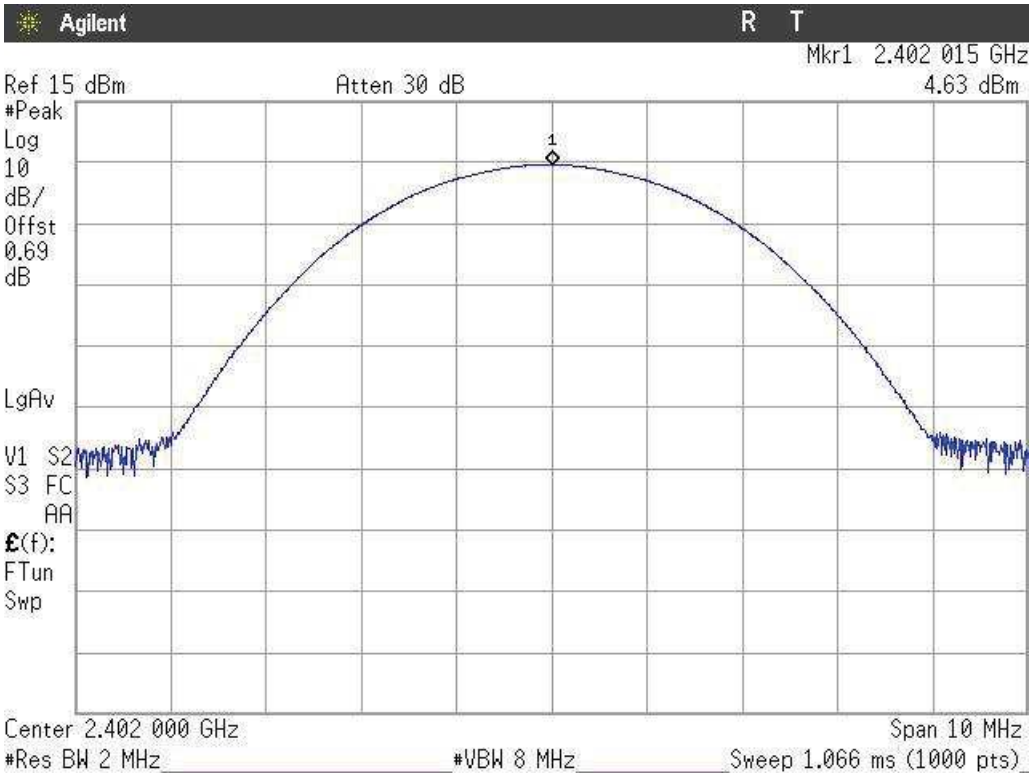


- High Channel:

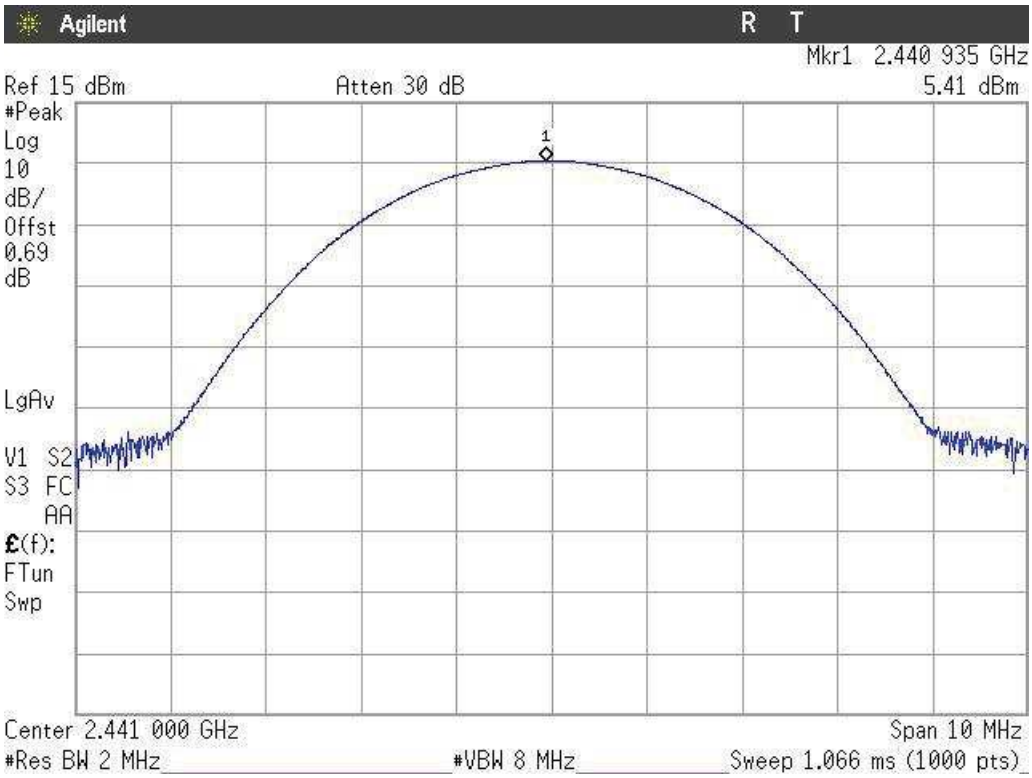


- **8DPSK – Peak Output Power**

- Low Channel:



- Middle Channel:



- High Channel: