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Competences and guarantees

DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample of NTG7 PREMIUM is an automotive head unit to be installed in cars with the following features: FM/AM/DAB/DVBT, USB, Bluetooth, WLAN and GNSS.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of result.

Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
60268/059	Automotive Infotainment System	NTG7 PREMIUM	HBM239KS000361	2019/09/23
60268/025	Cable RF Harness Short	--	--	2019/08/28
60268/245	Antennas	--	--	2019/08/26

Sample S/01 has undergone the following test(s): All RADIATED tests below 1 GHz indicated in Appendixes A and B.

- Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
60268/015	Automotive Infotainment System	NTG7 PREMIUM	HBM239GQ0KS000354	2019/08/26
60268/048	Radio Controller of Automotive Infotainment System	--	--	2019/08/28
60268/017	Harness	--	--	2019/08/26
60268/245	Antennas	--	--	2019/08/26

Sample S/02 has undergone the following test(s): All RADIATED tests above 1 GHz indicated in Appendixes A and B.

- Sample S/03 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
60268/059	Automotive Infotainment System	NTG7 PREMIUM	HBM239KS000361	2019/09/23
60268/143	Harness	--	--	2019/09/30

Sample S/03 has undergone the following test(s): All CONDUCTED tests indicated in Appendix A.

- Sample S/04 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
60268/015	Automotive Infotainment System	NTG7 PREMIUM	HBM239GQ0KS000354	2019/08/26
60268/048	Radio Controller of Automotive Infotainment System	--	--	2019/08/28
60268/026	Cable RF Harness Short	--	--	2019/08/28

Sample S/04 has undergone the following test(s): All CONDUCTED tests indicated in Appendix B.

Test sample description

Ports…… :	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)
	Car Connector A	>3m(x1)	☒	☐	☐
	Car Connector B	>3m(x1)	☒	☐	☐
	Display Connector CID/PIP / RVC	>3m(x1)	☒	☒	☐
	USB Connector	<3m(x2)	☒	☒	☐
	Eth Connector	>3m(x1)	☒	☐	☐
	BT/WLAN-Antenna	>3m(x1)	☒	☒	☐
	FM/AM, TV/SDARS Ant	>3m(x1)	☒	☒	☐
	GNSS Antenna	>3m(x1)	☒	☒	☐
Supplementary information to the ports…… :	-				
Rated power supply .....:	Voltage and Frequency	Reference poles			
		L1	L2	L3	N	PE
	☒ DC: 12V Car battery / attenuator (9,5-15,5V normal operation)					
Rated Power .....:	9,5-15,5V normal operation					
Clock frequencies .....:	see schematics					
Other parameters.....:	See Technical Description					
Software version .....:	E13.300					

Hardware version.....:	D4		
Dimensions in cm (W x H x D)....:	182 x 78 x 160 mm		
Mounting position.....:	☒ Other: automotive headunit		
Modules/parts .....:	Module/parts of test item	Type	Manufacturer
	n/a	-	
Accessories (not part of the test item) .....:	Description	Type	Manufacturer
	Display	-	LG.
	HARMANeco RasPi	-	HBAS
	Cable harness	-	HBAS
	BT/WLAN-Antenna	-	Hirschmann
Documents as provided by the applicant.....:	Description	File name	Issue date
	Technical Description		
	-		

Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH

BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2019-08-30
Date (finish)	2019-11-19

Document history

Report number	Date	Description
60268RRF.002	2019-12-04	First release

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 35 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: Francisco José Alcaide, José Manuel Jiménez, Miguel Ángel Torres, Verónica García, Ignacio Cabra, Jaime Barranquero, Nicolás Salguero, Ignacio Cabra, Cristina Calle, José Gabriel Pendón.

Used instrumentation:

Conducted Measurements:

		Last Calibration	Due Calibration
1.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
2.	Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV40	2019/09	2021/09
3.	DC Power Supply 40V/40A Rohde & Schwarz NGPE40	2018/02	2021/02
4.	Signal Analyzer 20 Hz to 8 GHz ROHDE AND SCHWARZ FSQ8	2018/08	2020/08
5.	Spectrum Analyzer PSA 3Hz-26.5 GHz AGILENT TECHNOLOGIES E4440A	2017/10	2019/10
6.	Power Sensor 50MHz-18GHz ROHDE AND SCHWARZ NRP-Z81	2019/06	2021/06

Radiated Measurements:

		Last Calibration	Due Calibration
1.	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
3.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2018/10	2020/10
4.	RF Pre-amplifier, 38 dB, 30 MHz-6 GHz BONN ELEKTRONIK BLNA 0360-01N	2019/02	2020/02
5.	Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2017/04	2020/04
6.	Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2018/02	2020/02
7.	RF Pre-amplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2019/04	2020/04
8.	RF Pre-amplifier, G>48dB, 18-40GHz NARDA JS44-18004000-33-8P	2018/02	2020/02
9.	Broadband Horn antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2016/11	2019/11
10.	Broadband Horn antenna 18 - 40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2018/07	2021/07
11.	Pre-Amplifier G>40dB 10MHz-6GHz, BONN ELEKTRONIK, BLNA 0160-01N	2019/02	2020/02
12.	DC Power Supply Keysight Technologies U8002A	---	---
13.	Digital multimeter FLUKE 179	2019/06	2020/06

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

1. Bluetooth EDR

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		**Verdict**	**Remark**
Section 15.247 Subclause (a) (1) / RSS-247 5.1. (b)	20 dB Bandwidth and Carrier frequency separation	P	
Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d)	Number of hopping channels	P	
Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d)	Time of occupancy (Dwell Time)	P	
Section 15.247 Subclause (b) / RSS-247 5.4. (b)	Maximum peak output power and antenna gain	P	
Section 15.247 Subclause (d) / RSS-247 5.5.	Band-edge emissions compliance (Transmitter)	P	
Section 15.247 Subclause (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
Supplementary information and remarks: None.			

2. WLAN 2.4 GHz (802.11 b/g/n20 2x2).

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		**Verdict**	**Remark**
Section 15.247 Subclause (a) (2) / RSS-247 5.2. (a)	6 dB Bandwidth	P	
Section 15.247 Subclause (b) / RSS-247 5.4. (d)	Maximum output power and antenna gain	P	
Section 15.247 Subclause (d) / RSS-247 5.5.	Band-edge emissions compliance (Transmitter)	P	
Section 15.247 Subclause (e) / RSS-247 5.2. (b)	Power spectral density	P	
Section 15.247 Subclause (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
Supplementary information and remarks: None.			

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

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TEST CONDITIONS

POWER SUPPLY (V):

V nonimal:	12 Vdc.
Type of Power Supply:	External power supply (Car Battery).
Type of Antenna:	External antenna.
Maximum Declared Antenna Gain:	+1.8 dBi (Antenna gain plus antenna cable loss).

TEST FREQUENCIES:

Low Channel:	2402 MHz
Middle Channel:	2441 MHz
High Channel:	2480 MHz

CONDUCTED MEASUREMENTS:

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.

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

RADIATED MEASUREMENTS:

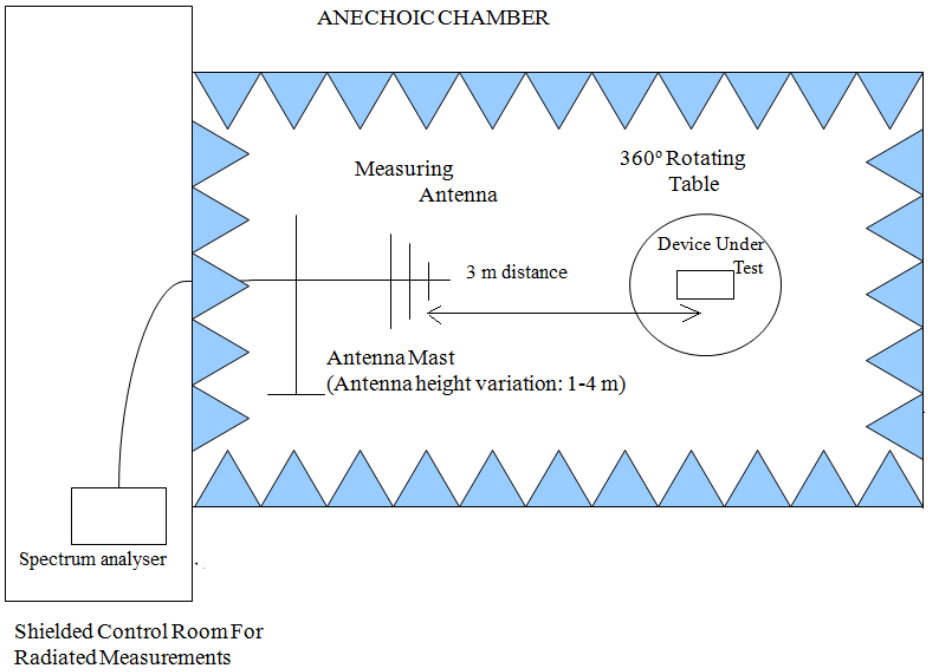
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

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.

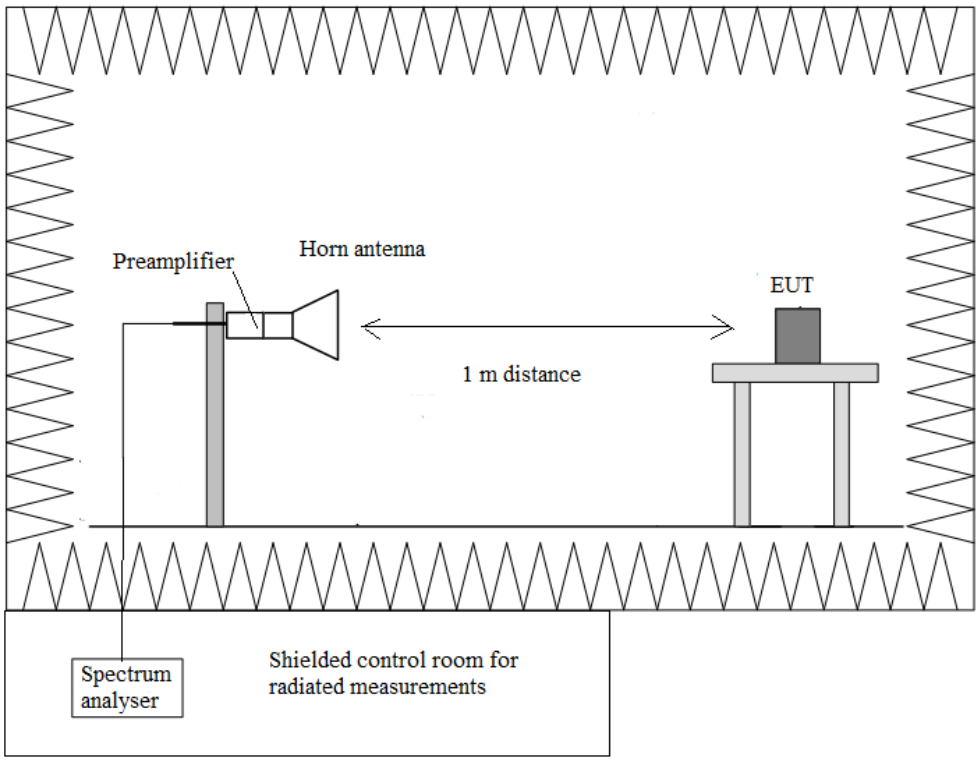
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

Radiated measurements setup from 30 MHz to 1 GHz:



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)	947.4	948.2	948.3
99% Bandwidth (kHz)	892	888	892
Measurement uncertainty (kHz)	<±0.07		

- **Pi/4 DQPSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	1365.3	1364.6	1362.6
99% Bandwidth (kHz)	1212	1212	1212
Measurement uncertainty (kHz)	<±0.07		

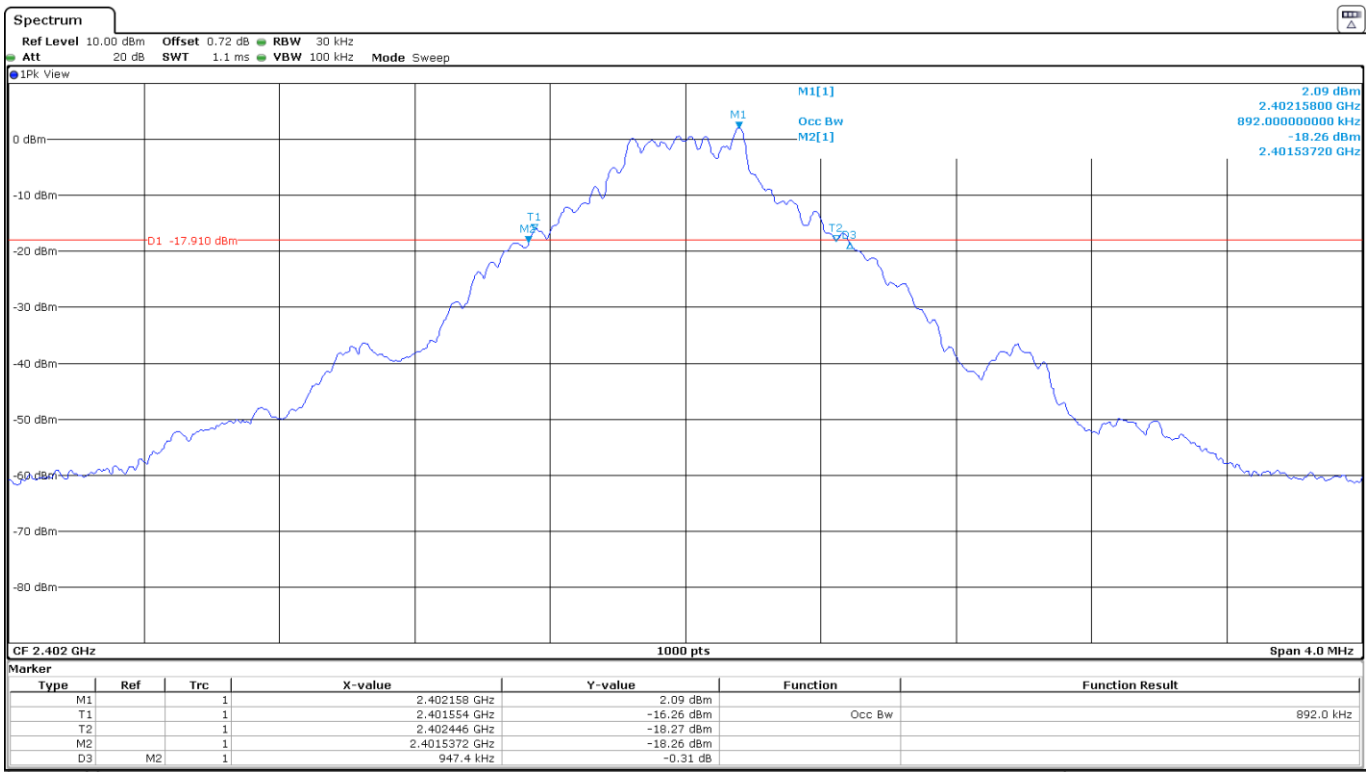
- **8DPSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	1333.3	1329.7	1332.8
99% Bandwidth (kHz)	1204	1204	1204
Measurement uncertainty (kHz)	<±0.07		

Verdict: PASS

- **GFSK – Bandwidths**

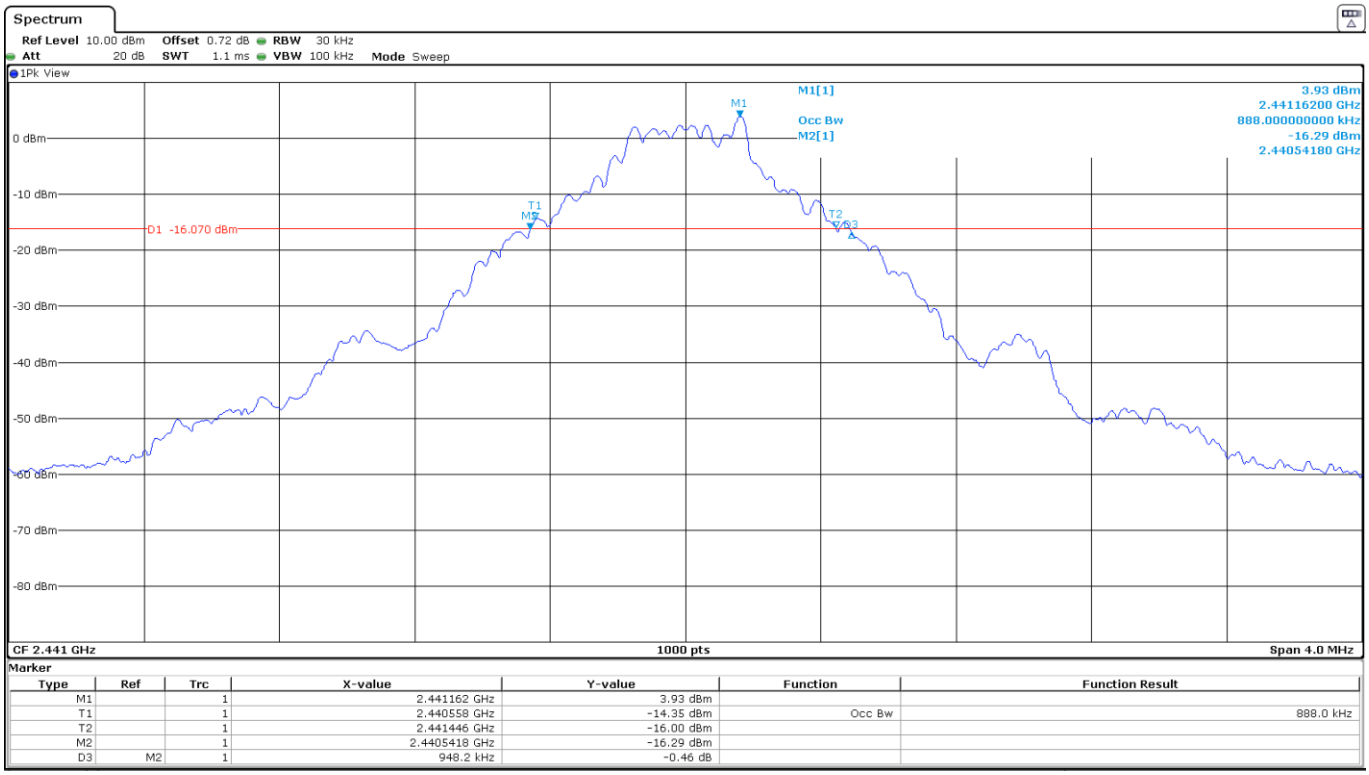
- Low Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402158 GHz	2.09 dBm		
T1		1	2.401554 GHz	-16.26 dBm	Occ Bw	892.0 kHz
T2		1	2.402446 GHz	-18.27 dBm		
M2		1	2.4015372 GHz	-18.26 dBm		
D3	M2	1	947.4 kHz	-0.31 dB		

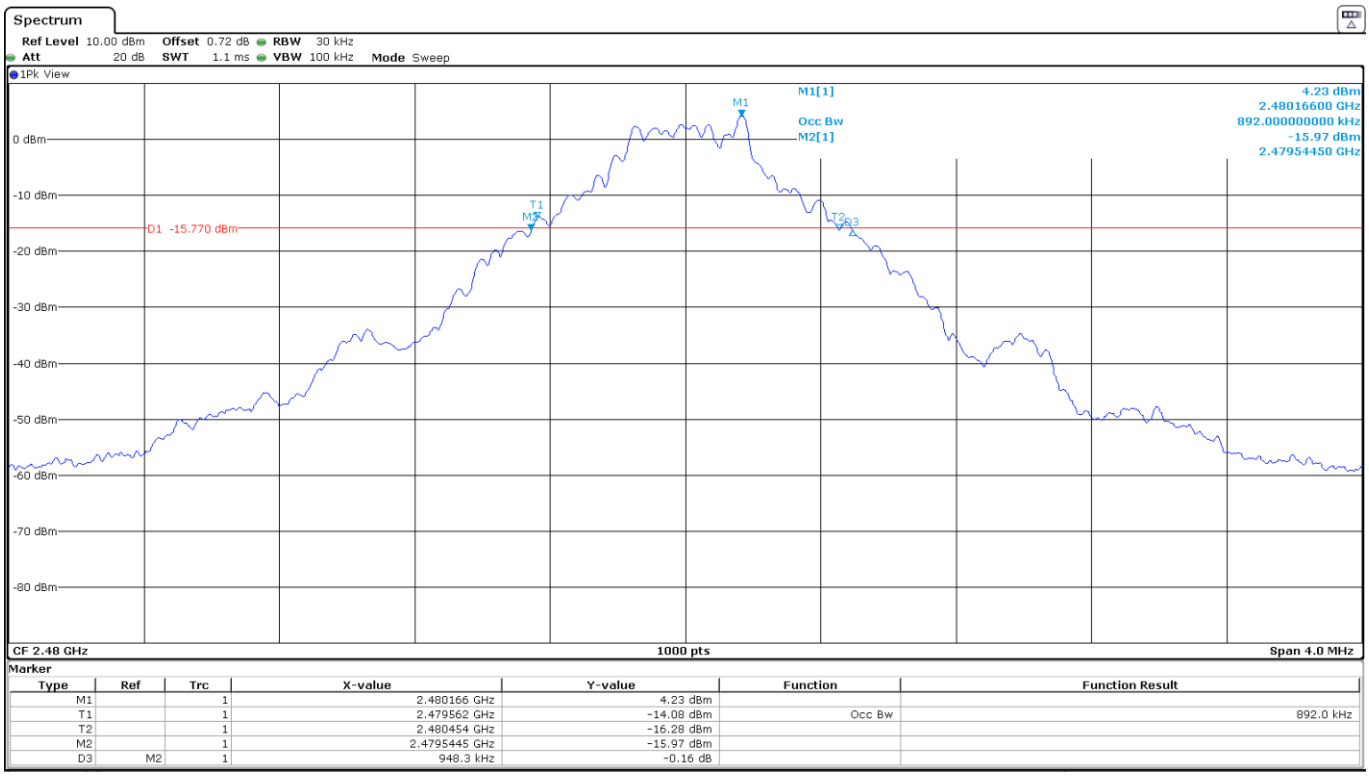
- Middle Channel:



Marker

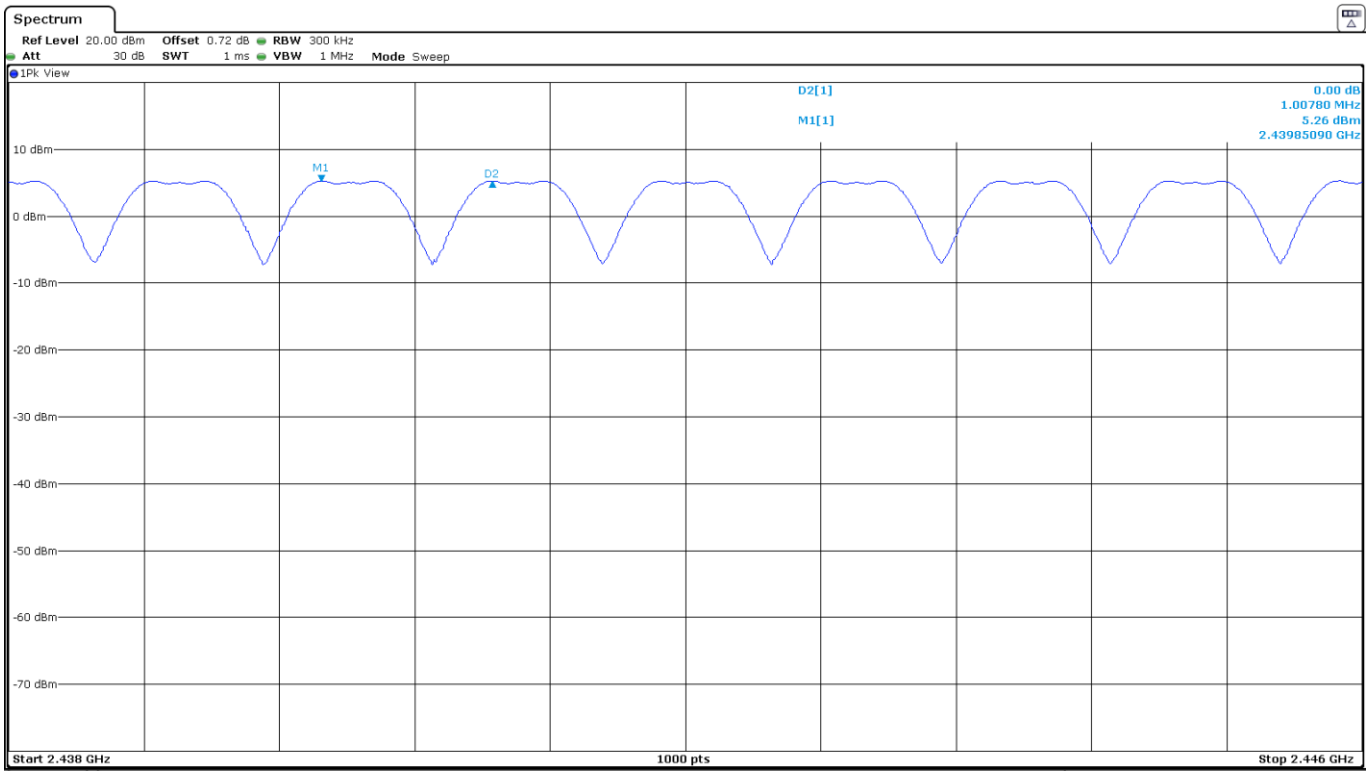
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.441162 GHz	3.93 dBm		
T1		1	2.440558 GHz	-14.35 dBm	Occ Bw	888.0 kHz
T2		1	2.441446 GHz	-16.00 dBm		
M2		1	2.4405418 GHz	-16.29 dBm		
D3	M2	1	948.2 kHz	-0.46 dB		

- High Channel:



Carrier frequency separation - GFSK

Carrier frequency separation: 1007.8 kHz

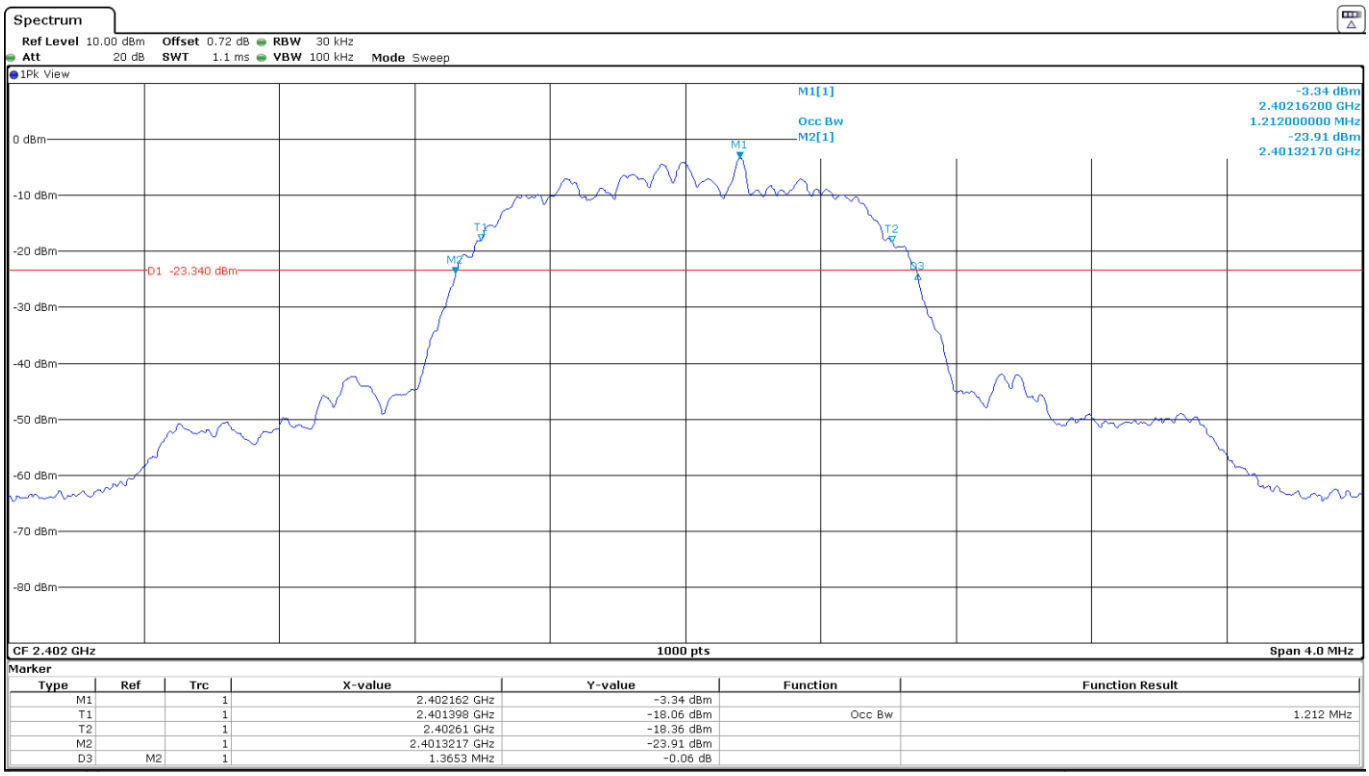


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

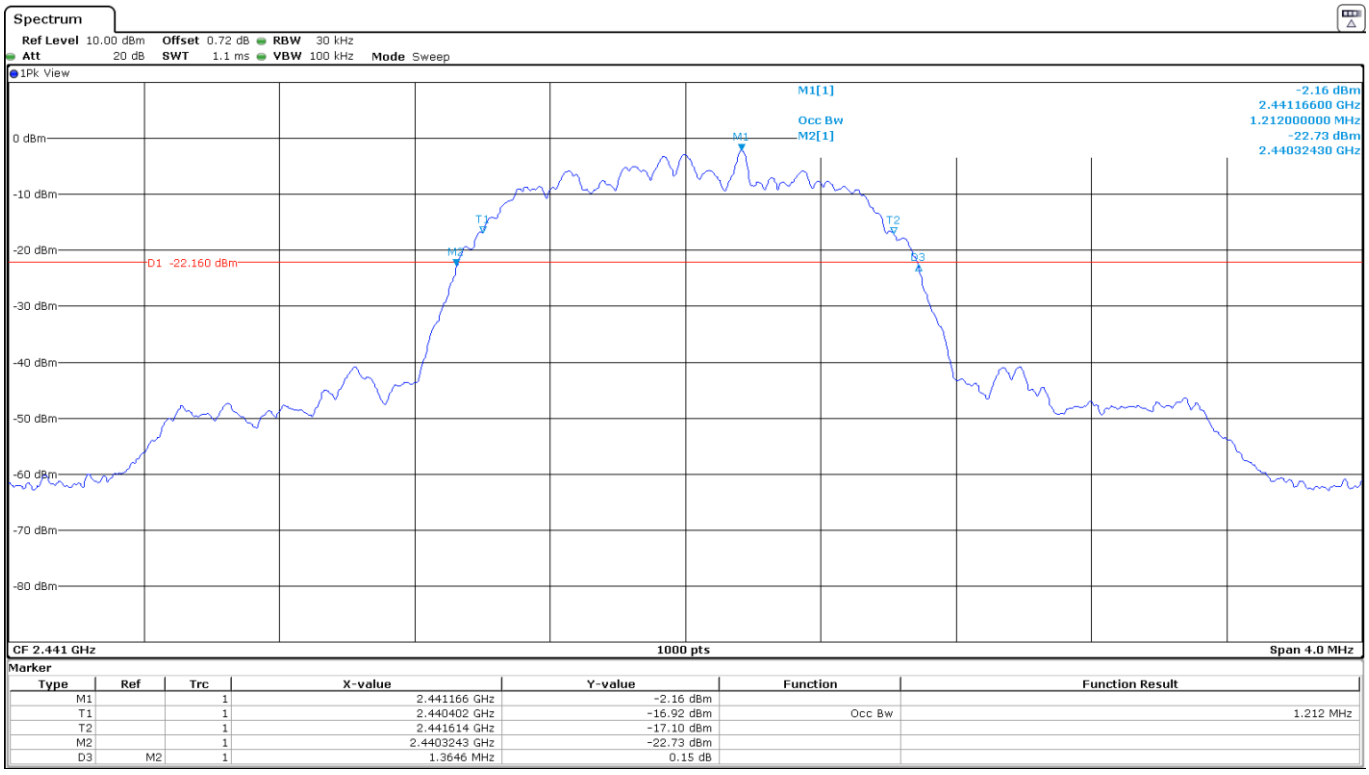
Verdict: PASS

- **Pi/4 DQPSK – Bandwidths**

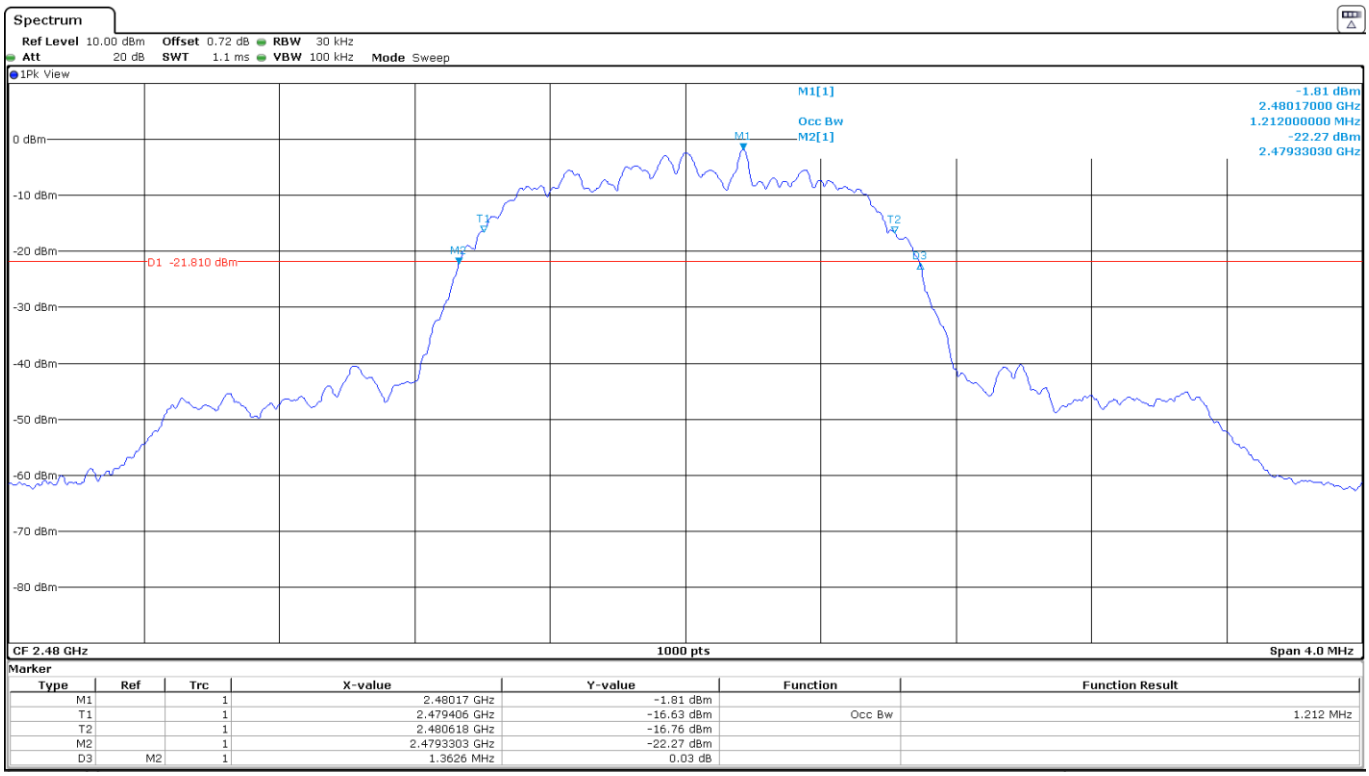
- Low Channel:



- Middle Channel:



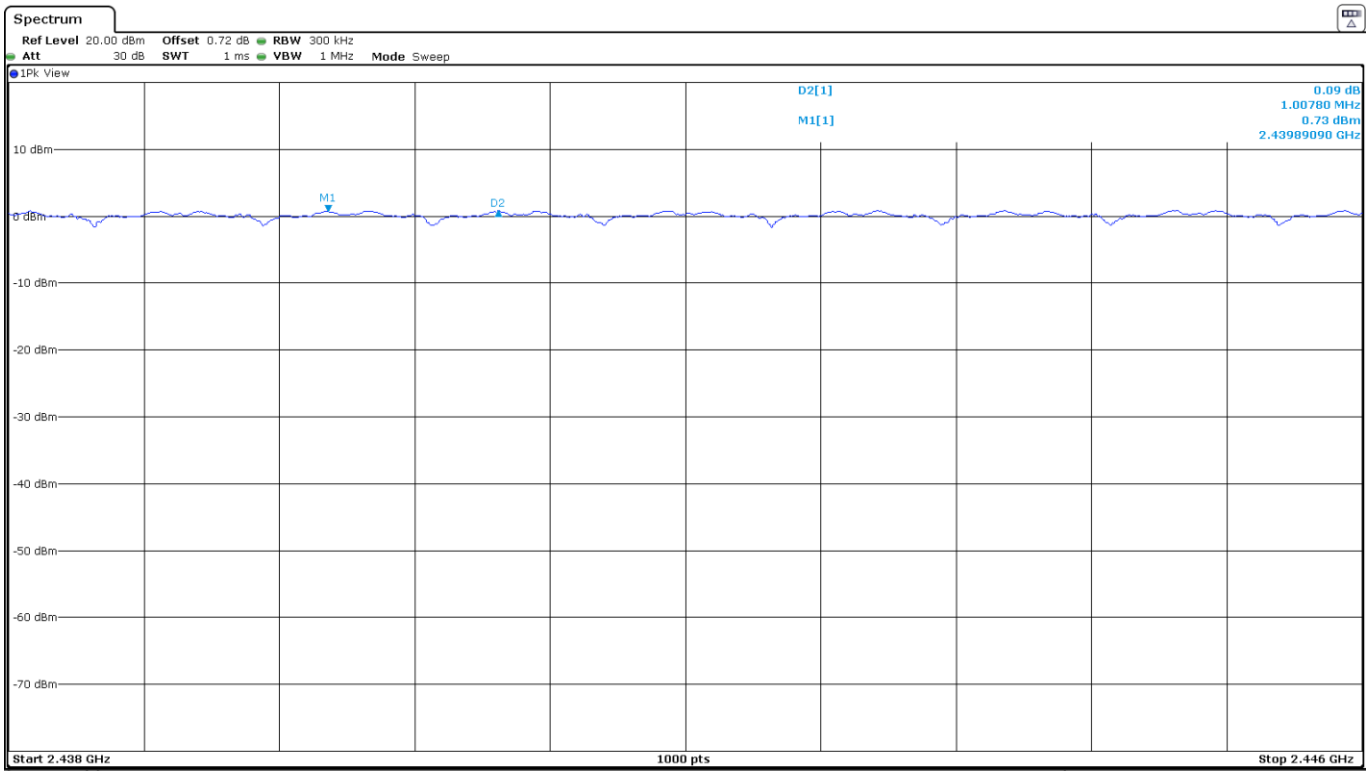
- High Channel:



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48017 GHz	-1.81 dBm		
T1		1	2.479406 GHz	-16.63 dBm	Occ Bw	1.212 MHz
T2		1	2.480618 GHz	-16.76 dBm		
M2		1	2.4793303 GHz	-22.27 dBm		
D3	M2	1	1.3626 MHz	0.03 dB		

Carrier frequency separation - Pi/4 DQPSK

Carrier frequency separation: 1007.8 kHz

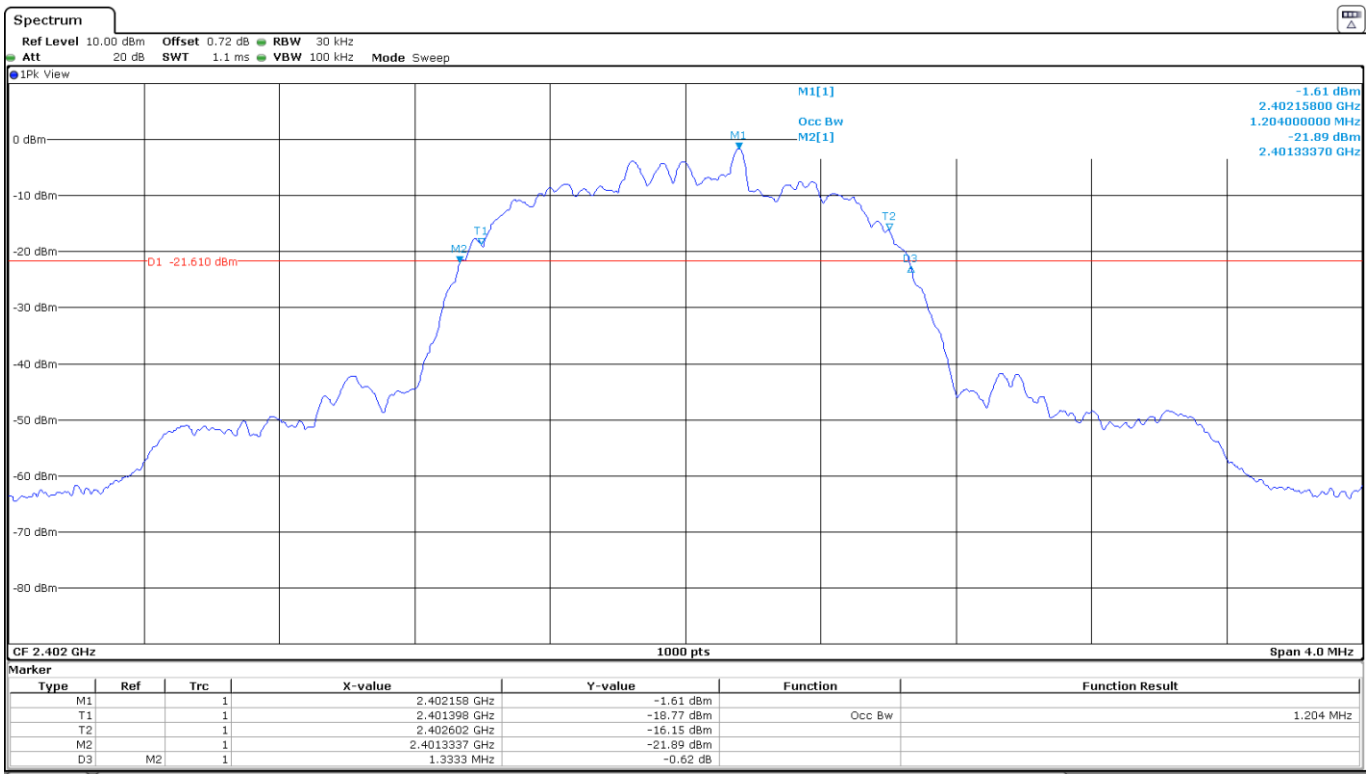


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

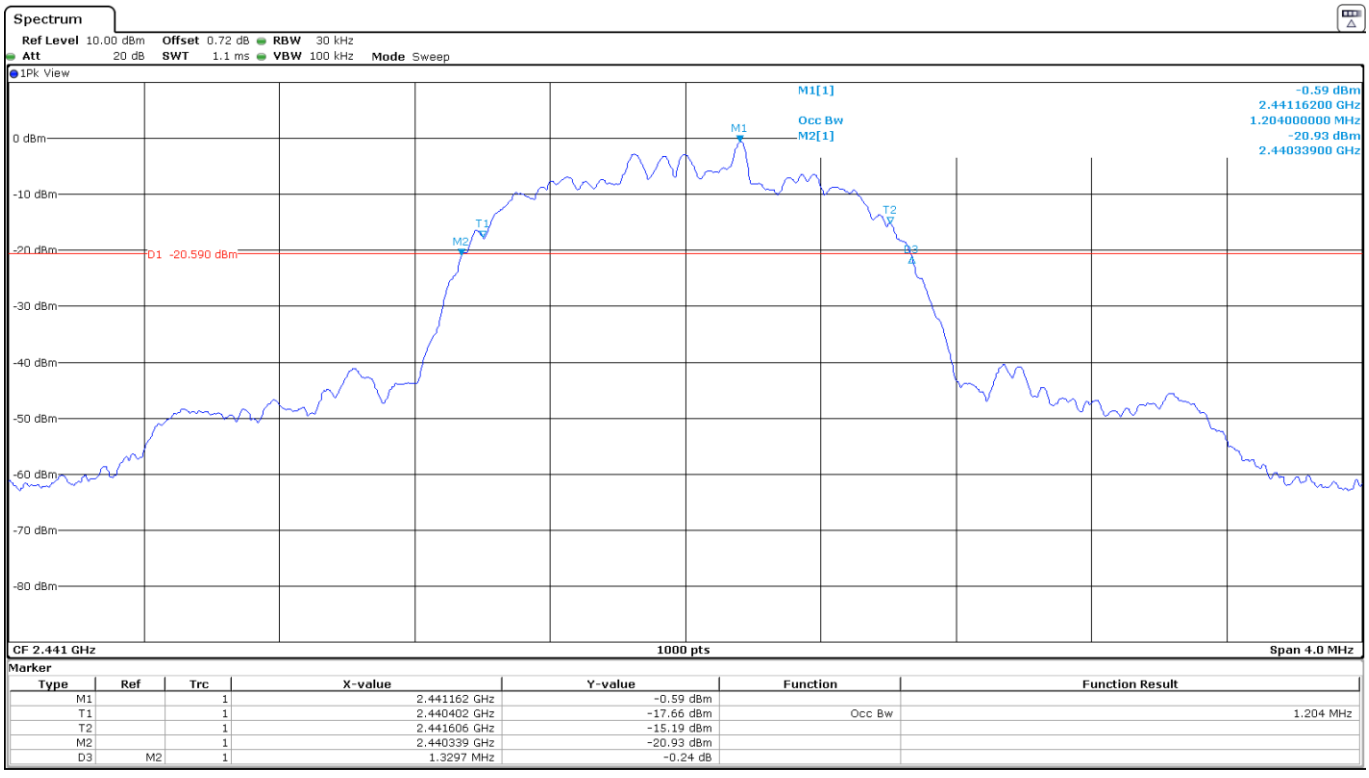
Verdict: PASS

- **8DPSK – Bandwidths**

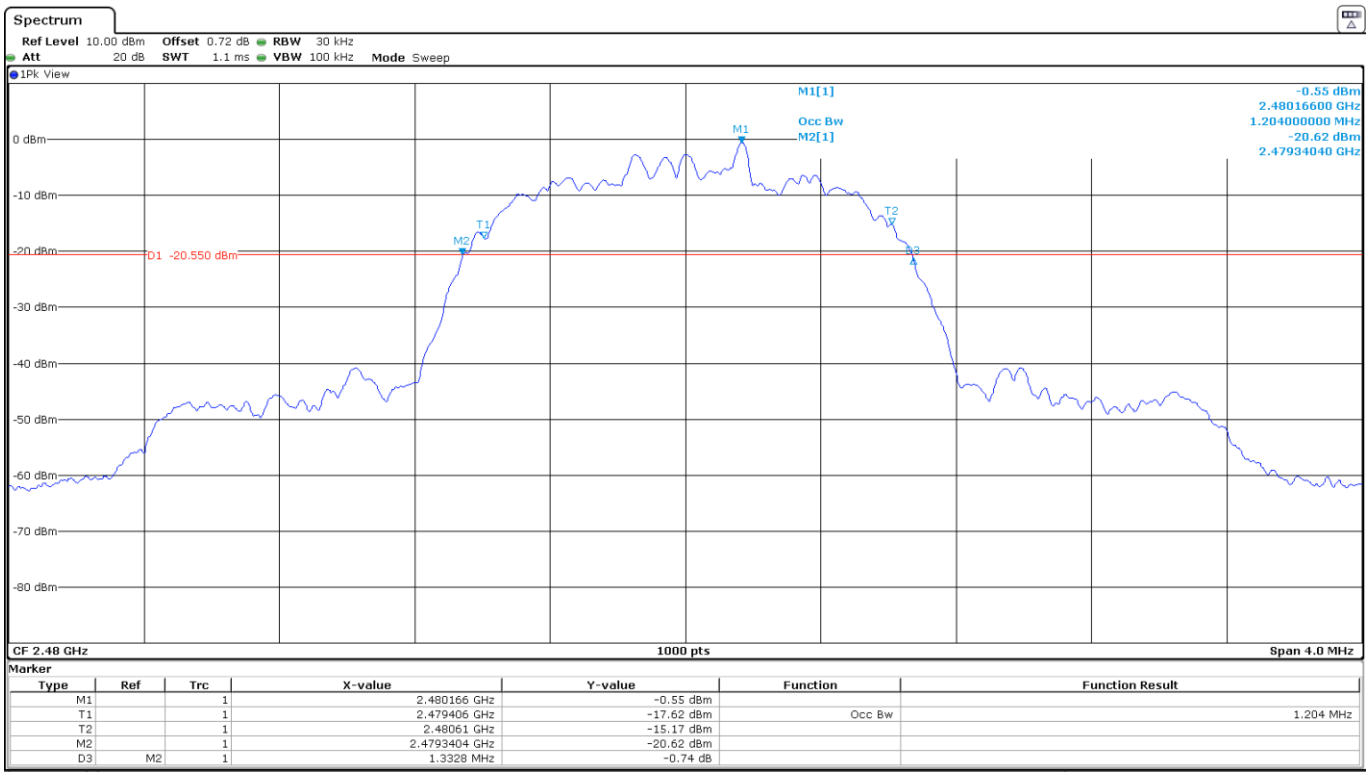
- Low Channel:



- Middle Channel:



- High Channel:

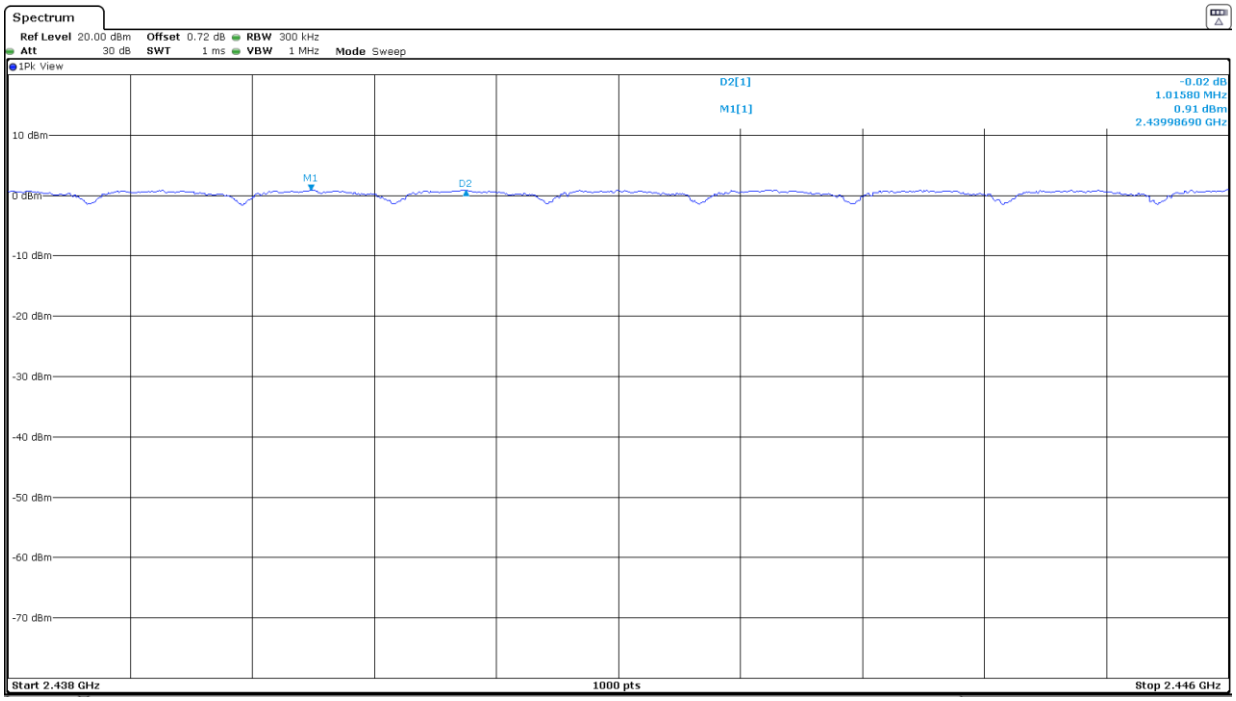


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.480166 GHz	-0.55 dBm		
T1		1	2.479406 GHz	-17.62 dBm	Occ Bw	1.204 MHz
T2		1	2.48061 GHz	-15.17 dBm		
M2		1	2.4793404 GHz	-20.62 dBm		
D3	M2	1	1.3328 MHz	-0.74 dB		

Carrier frequency separation - 8DPSK

Carrier frequency separation: 1015.8 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.

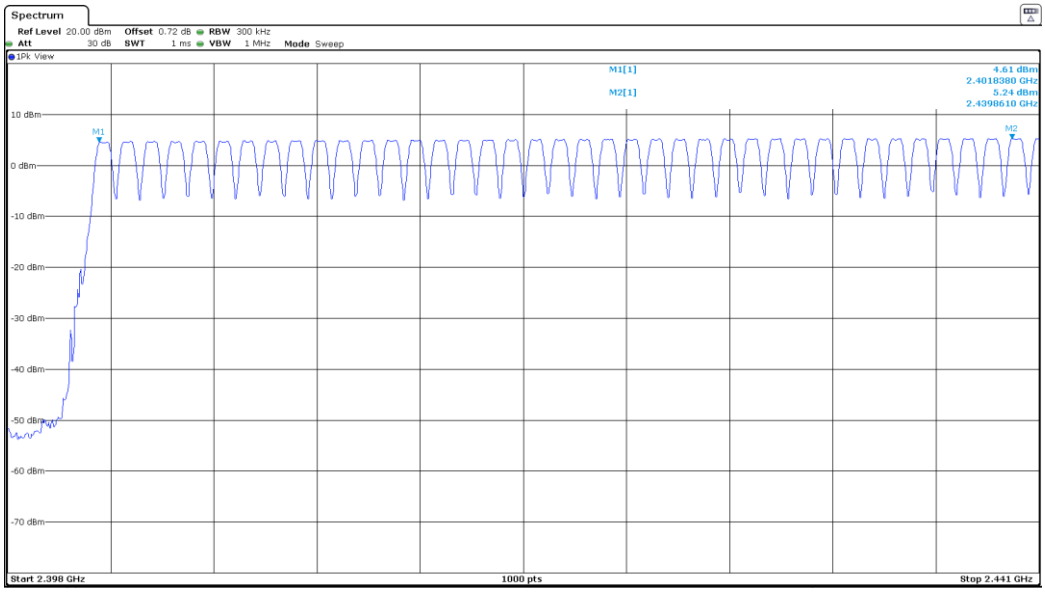
SPECIFICATION:

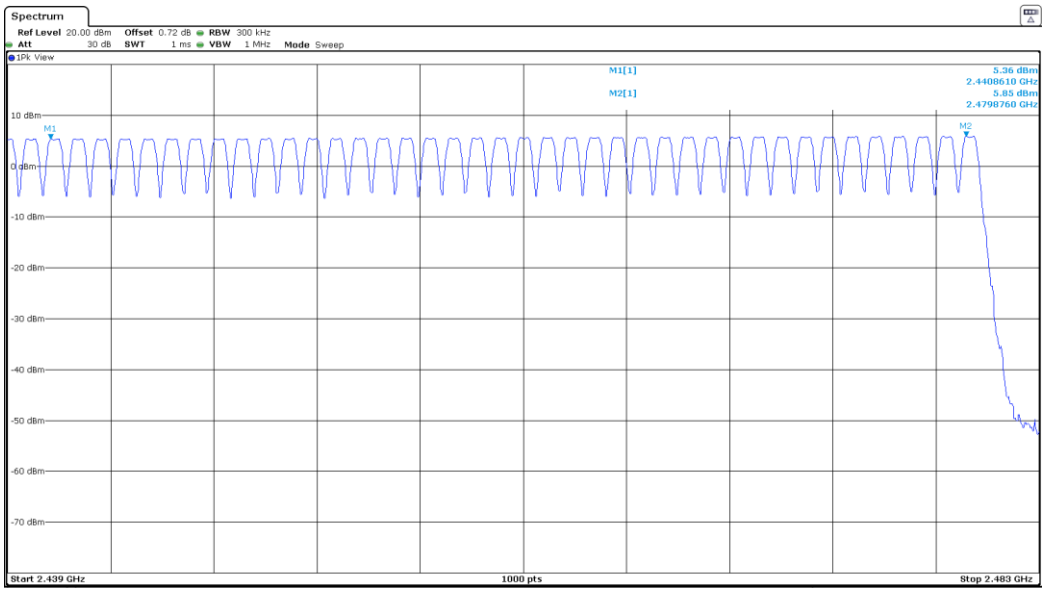
Frequency hopping system in the 2400-2483.5 MHz band shall use at least 15 channels.

RESULTS:

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

- **GFSK – Number of hopping channels**

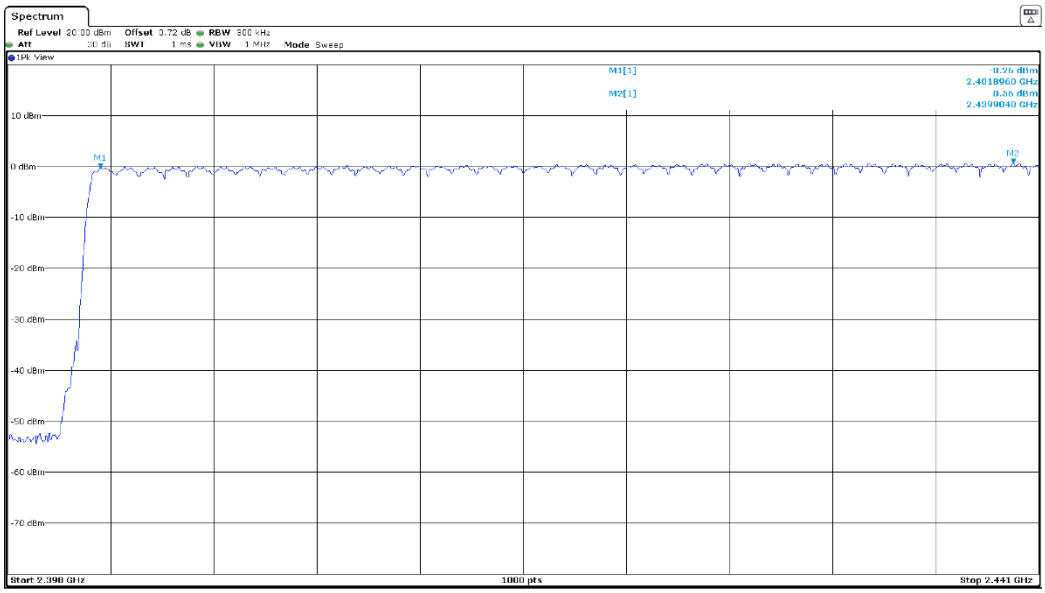


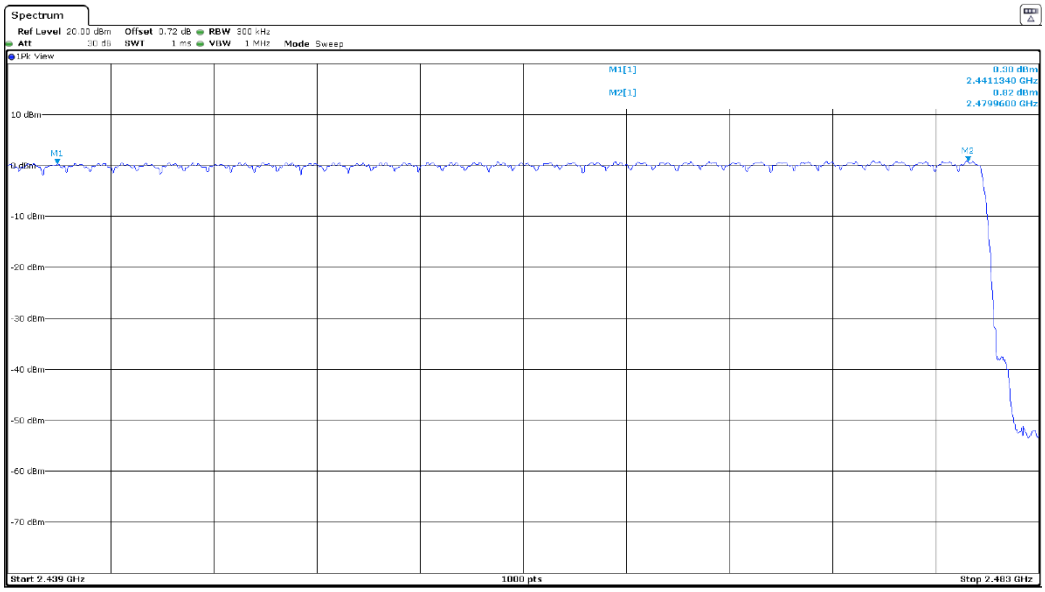


Total number of hopping channels 79

Verdict: PASS

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

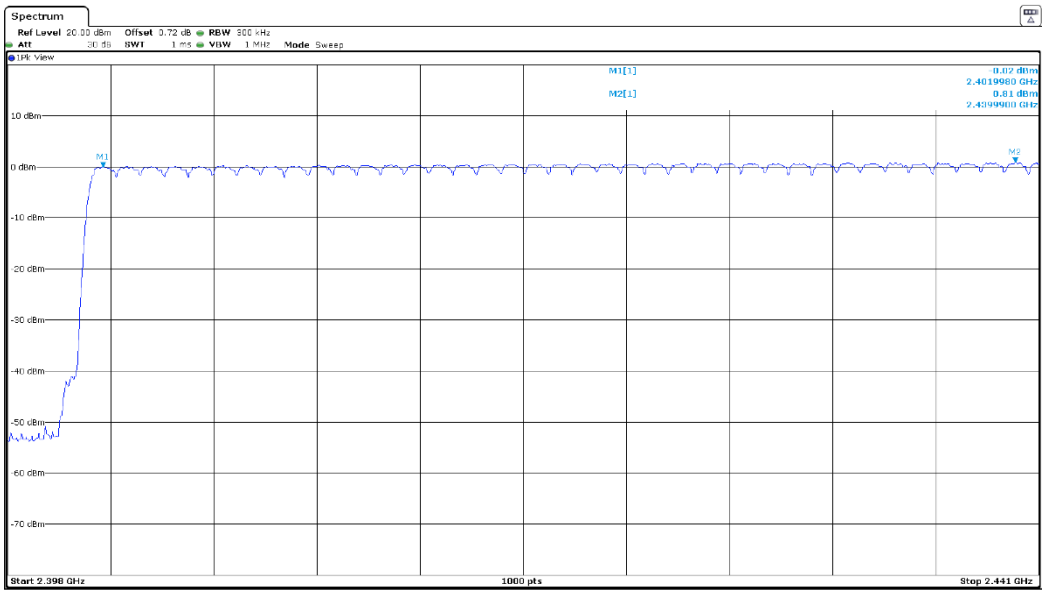


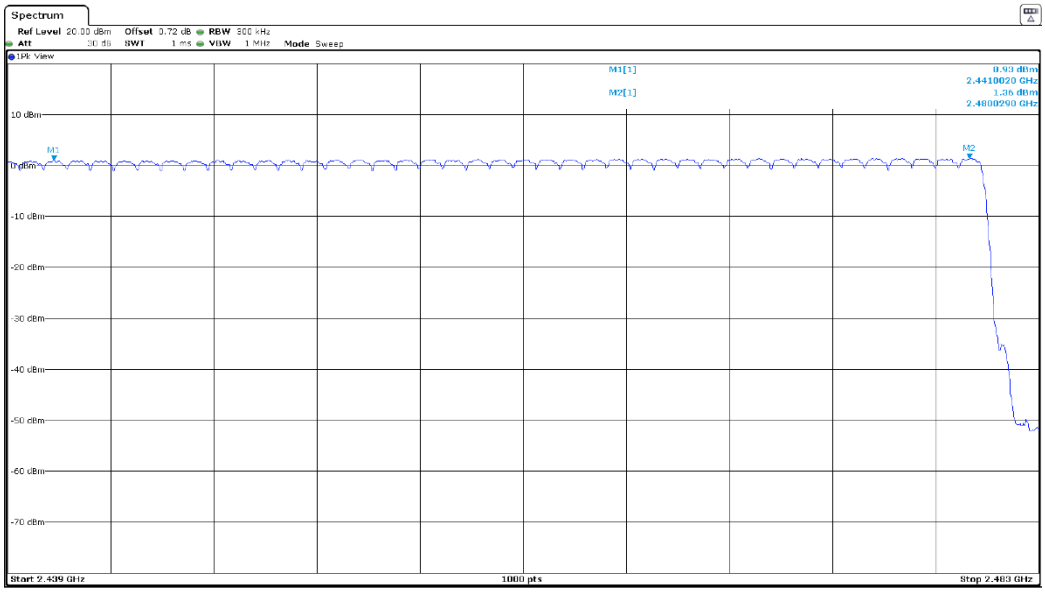


Total number of hopping channels 79

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:

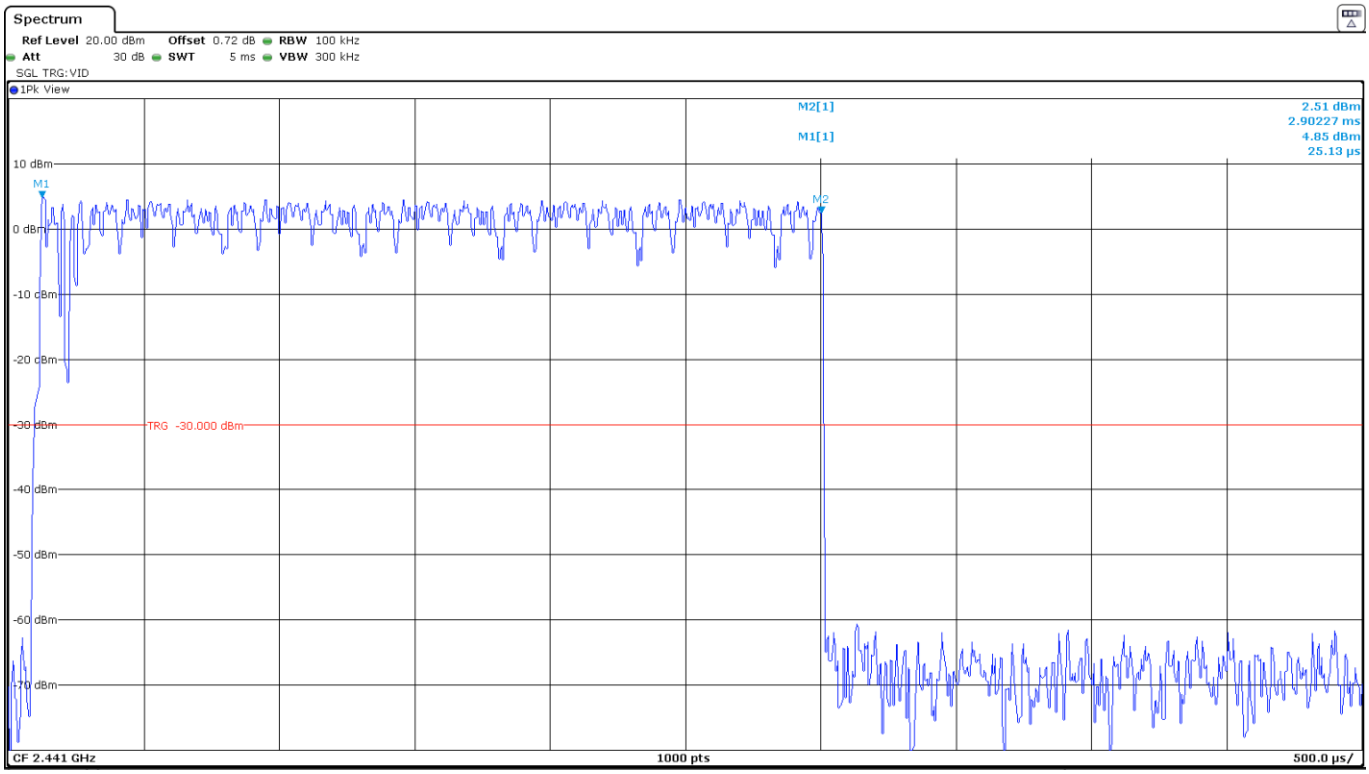
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = 0.4 x 79= 31.6 seconds.

RESULTS:

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

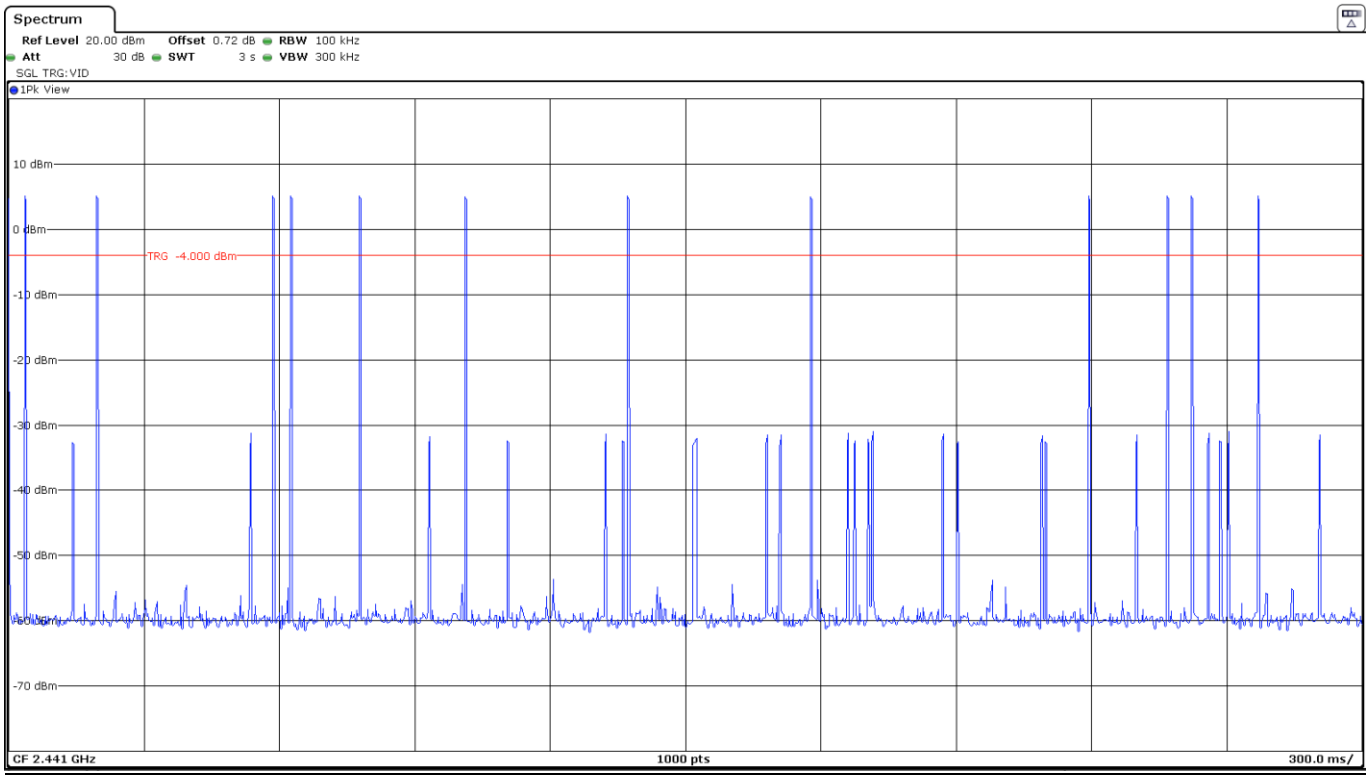
  - Transmit Time per Hop:

2.87714	ms



- Time of Occupancy:

Nº of hops on spectrum analyzer	12	
Nº of hops over the period	126.4	
Average Time of Occupancy	363.6705	ms



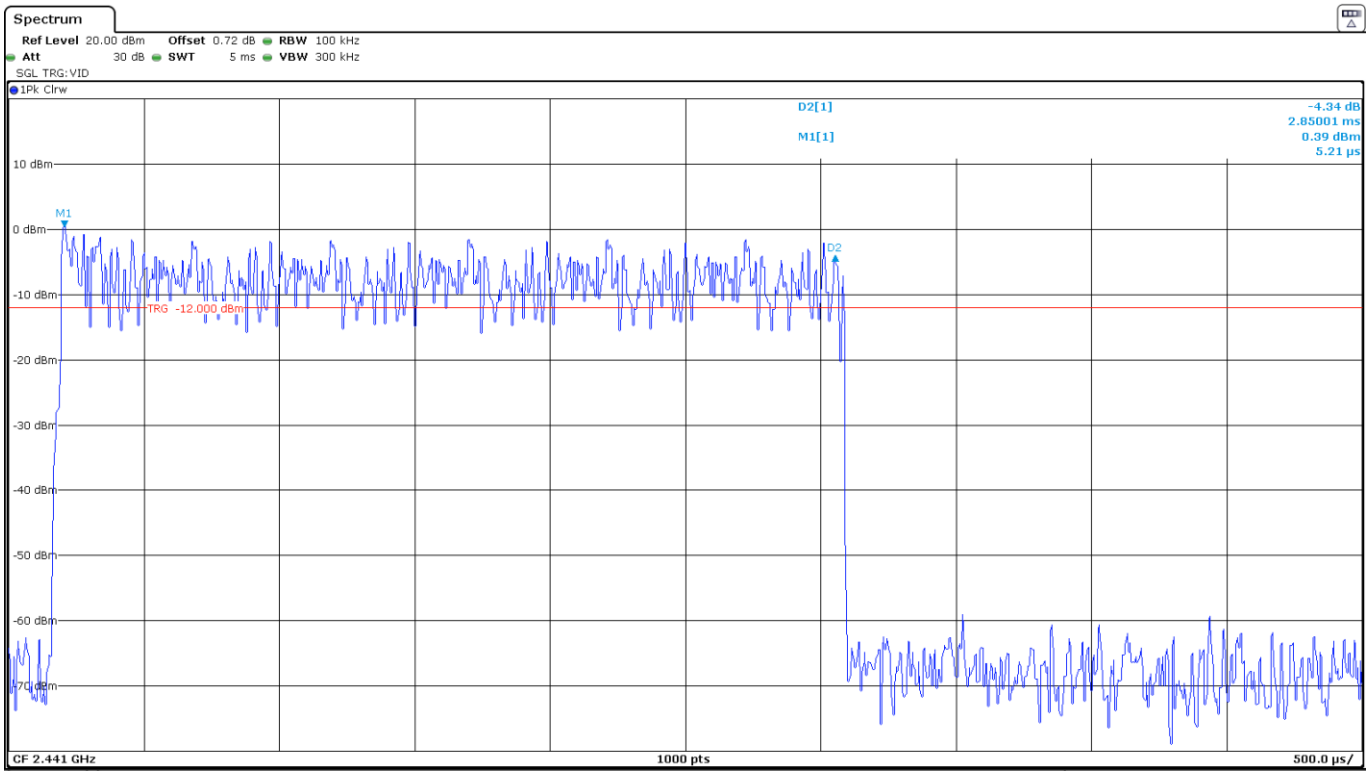
Measurement uncertainty (%)	<±0.12

Verdict: PASS

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

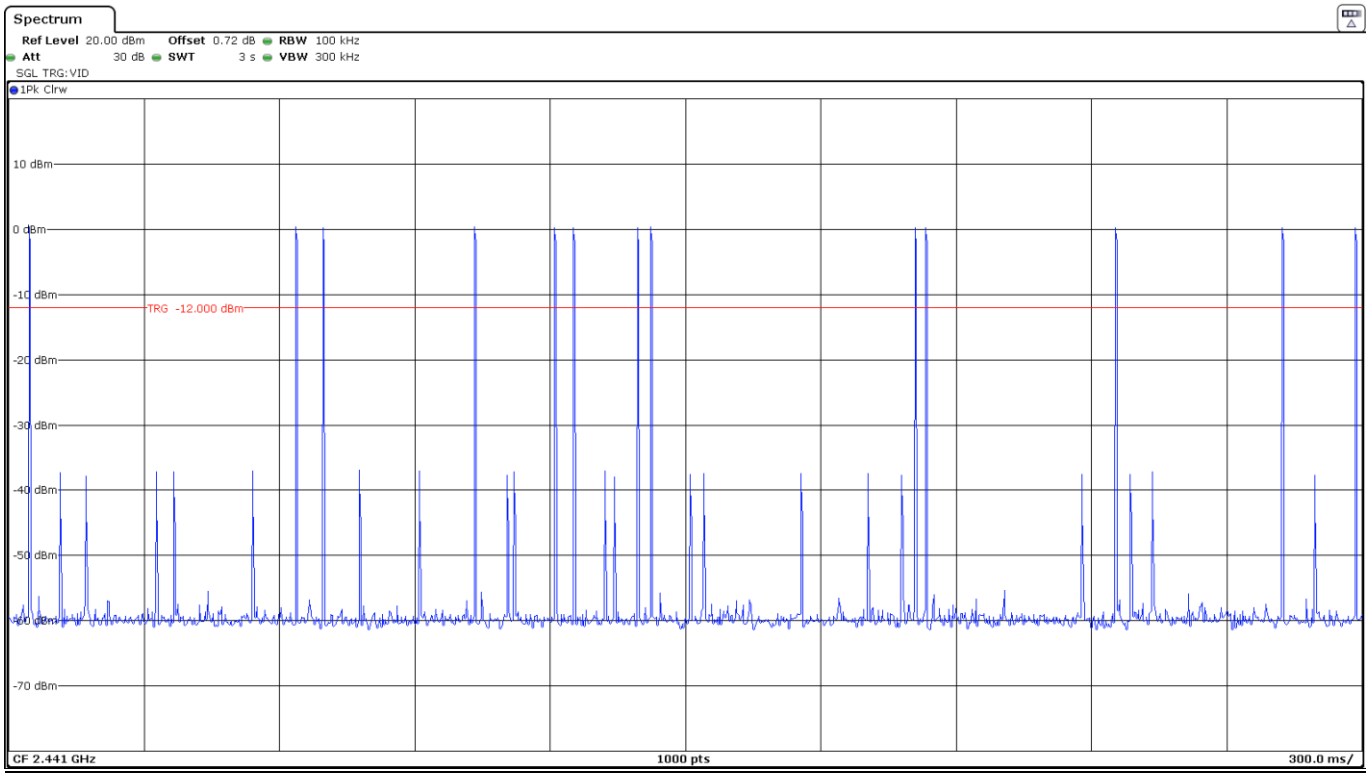
  - Transmit Time per Hop:

2.85001	ms



- Time of Occupancy:

Nº of hops on spectrum analyzer	13	
Nº of hops over the period	136.9333333	
Average Time of Occupancy	390.2614	ms



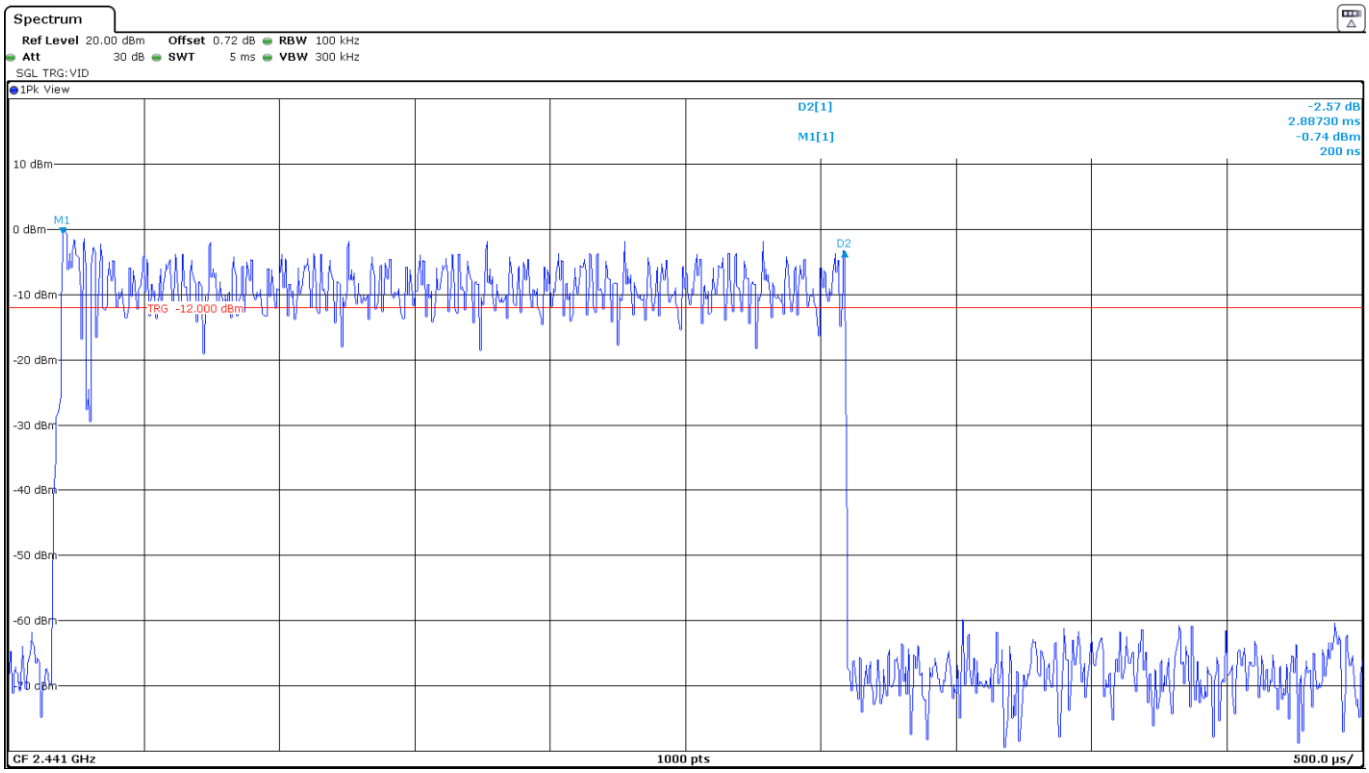
Measurement uncertainty (%)	<±0.12

Verdict: PASS

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

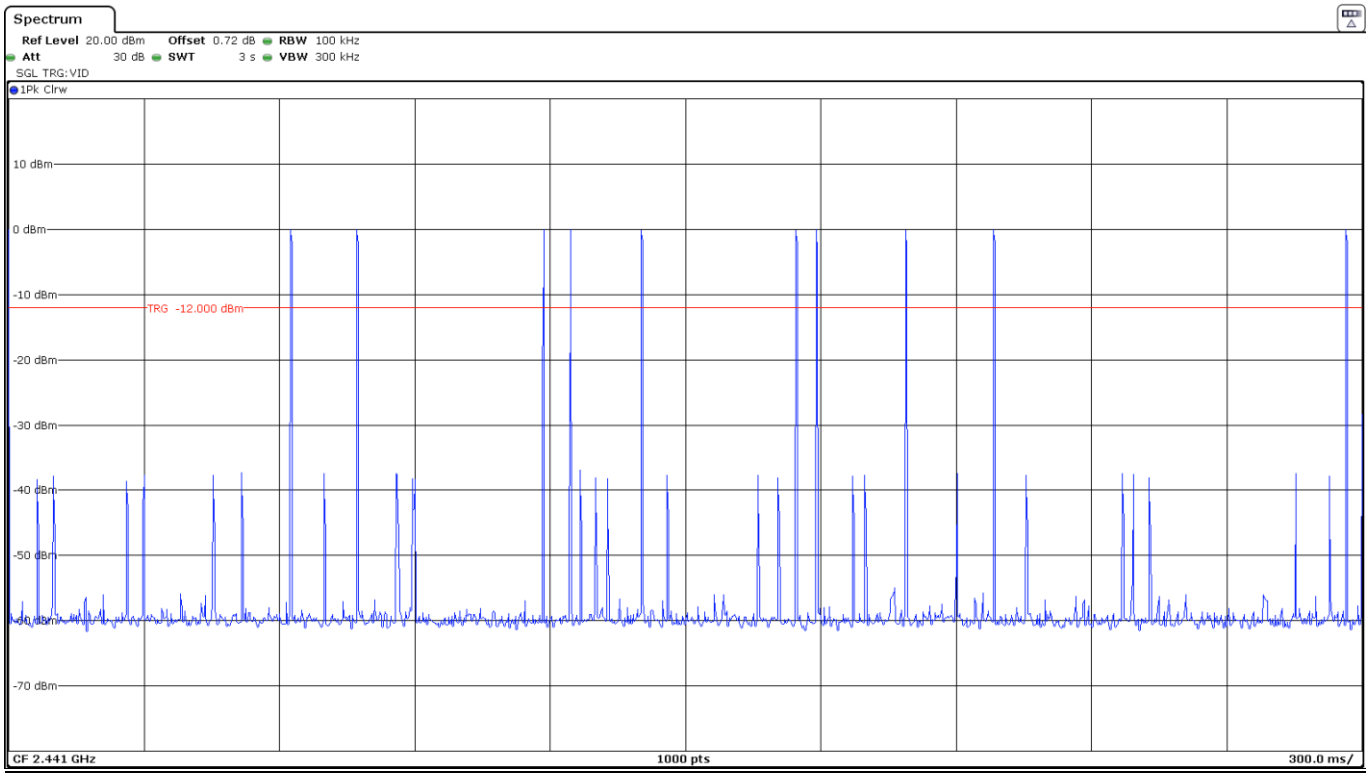
  - Transmit Time per Hop:

2.8873	ms



- Time of Occupancy:

Nº of hops on spectrum analyzer	10	
Nº of hops over the period	105.3333333	
Average Time of Occupancy	304.1289333	ms



Measurement uncertainty (%)	<±0.12

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: +1.8 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)	4.50	5.04	5.67
Maximum EIRP Power (dBm)	6.30	6.84	7.47
Measurement uncertainty (dB)	<±1.20		

- **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)	2.45	3.19	3.51
Maximum EIRP Power (dBm)	4.25	4.99	5.31
Measurement uncertainty (dB)	<±1.20		

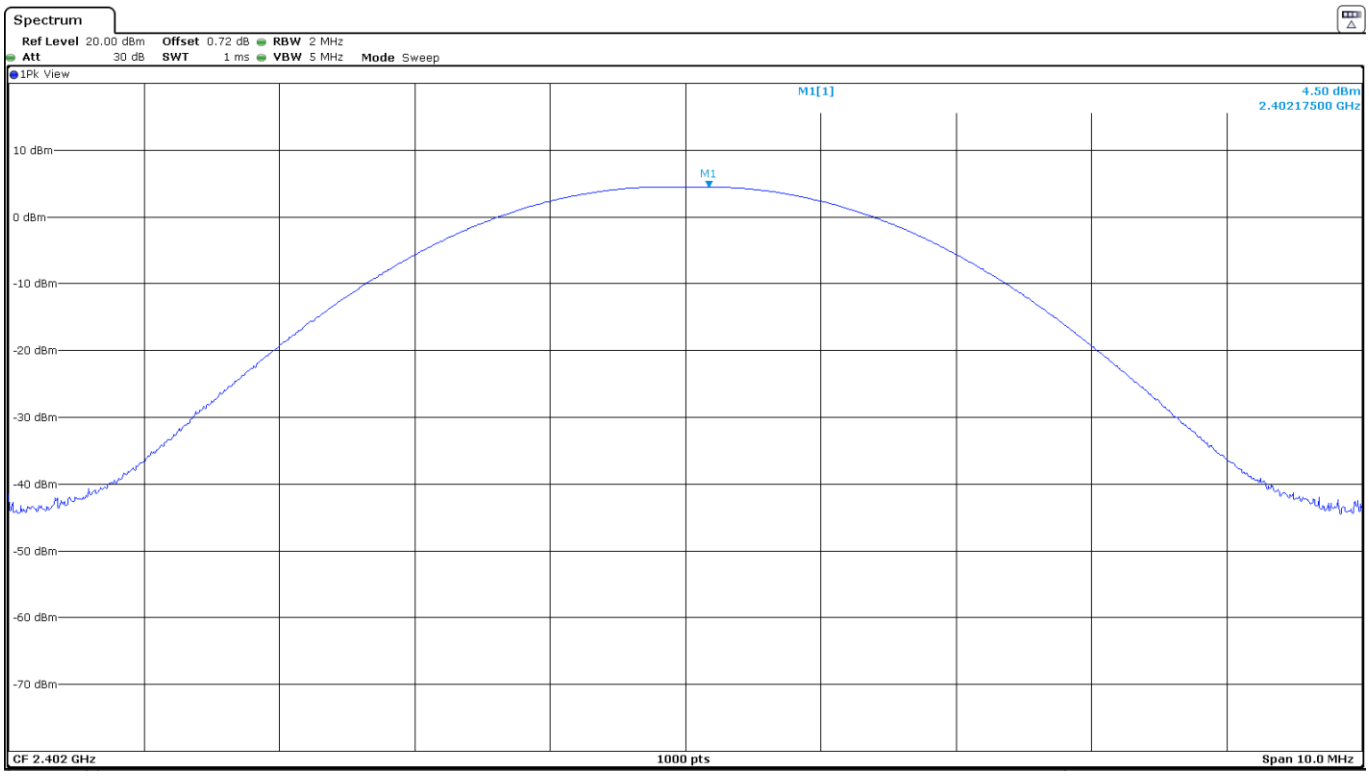
- **8DPSK** (3 Mbps)

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	2.72	3.35	3.71
Maximum EIRP Power (dBm)	4.52	5.15	5.51
Measurement uncertainty (dB)	<±1.20		

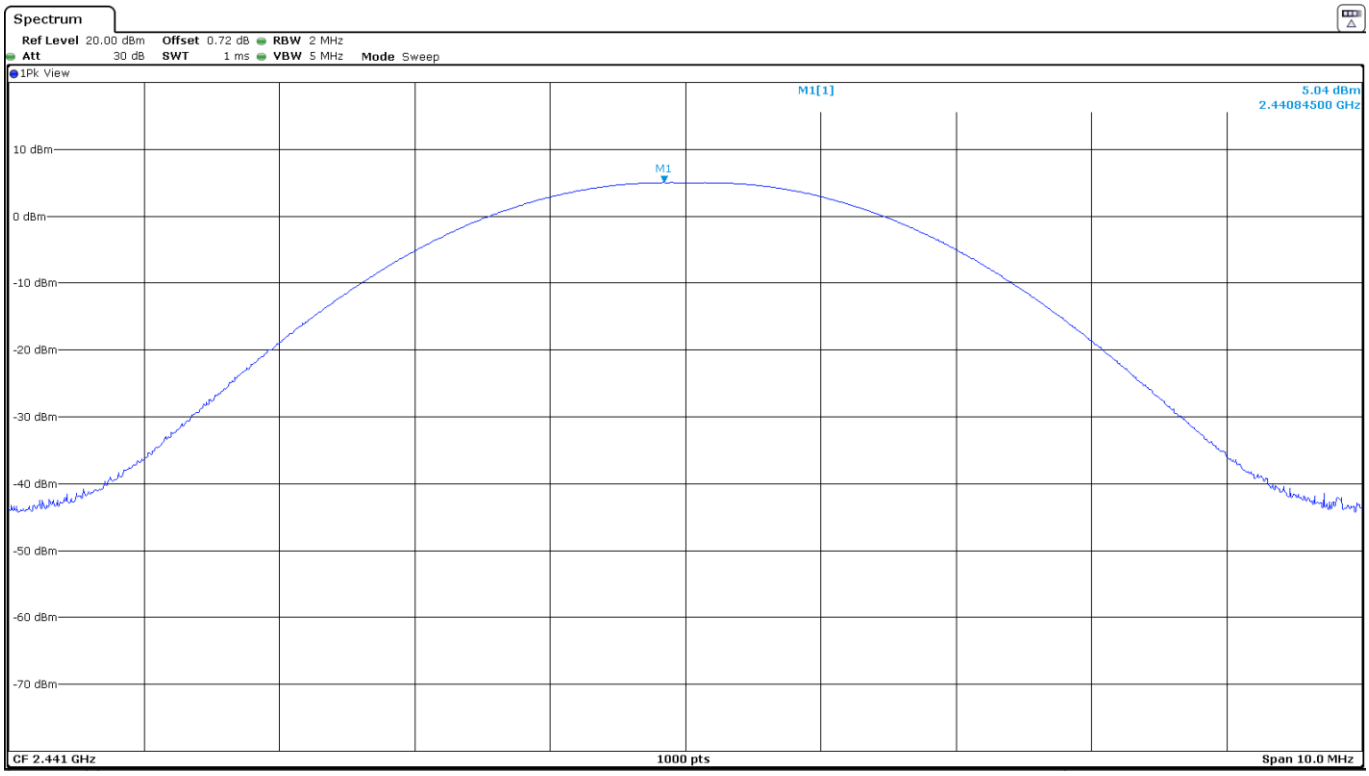
Verdict: PASS

- **GFSK – Peak Output Power**

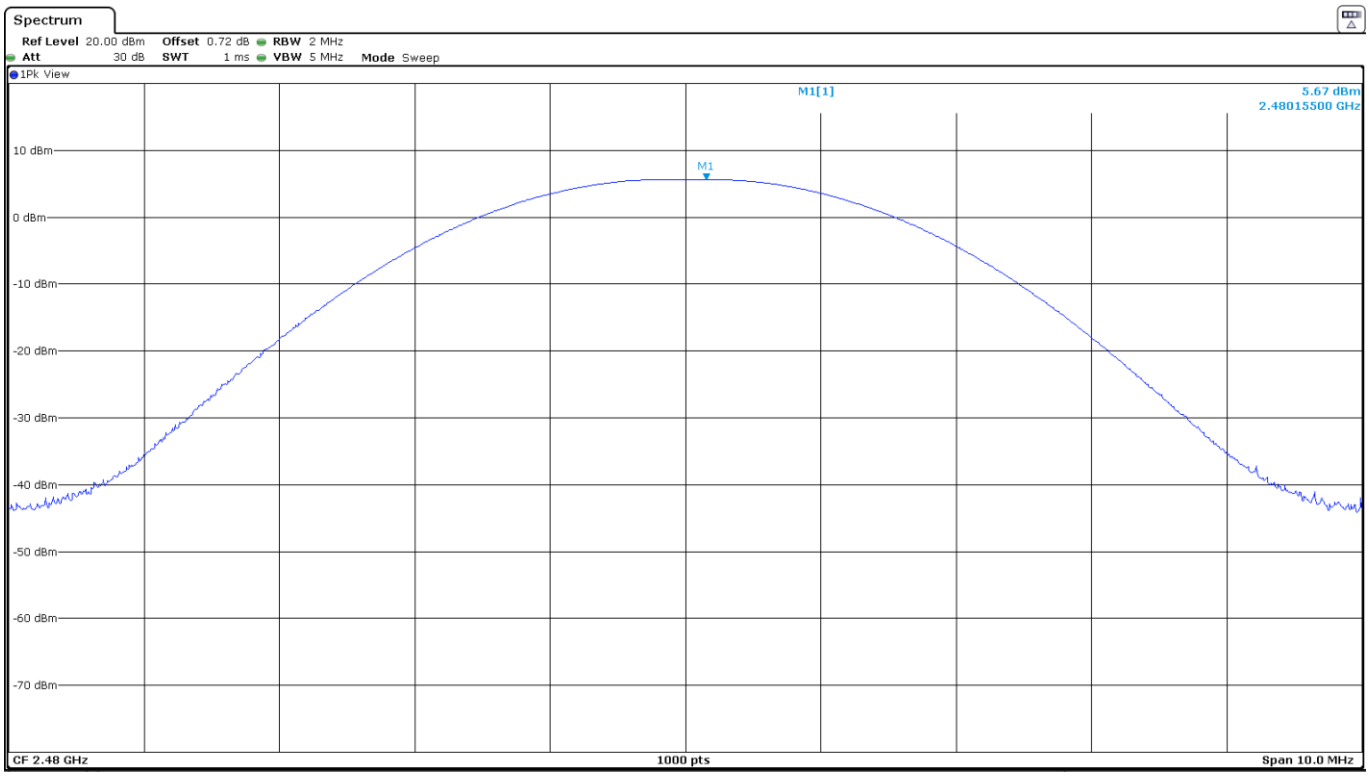
- Low Channel:



- Middle Channel:

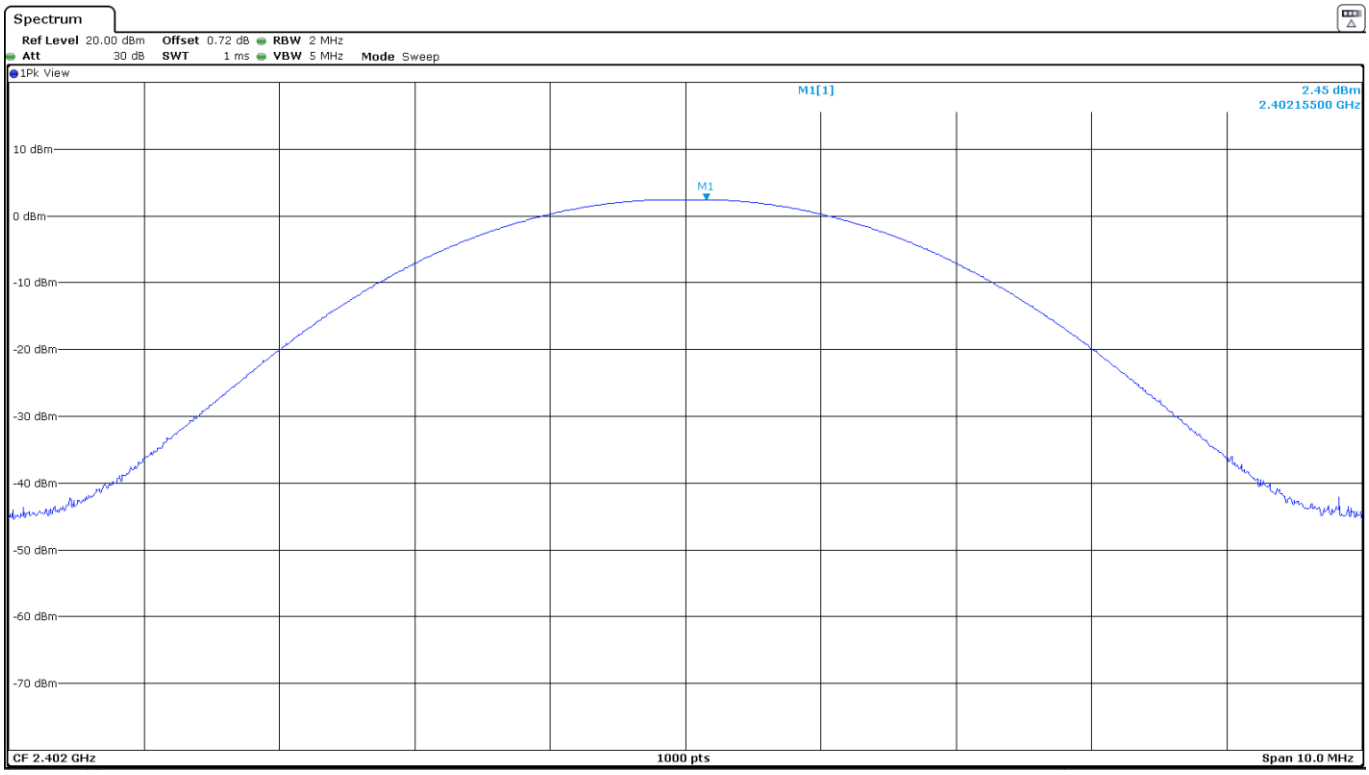


- High Channel:

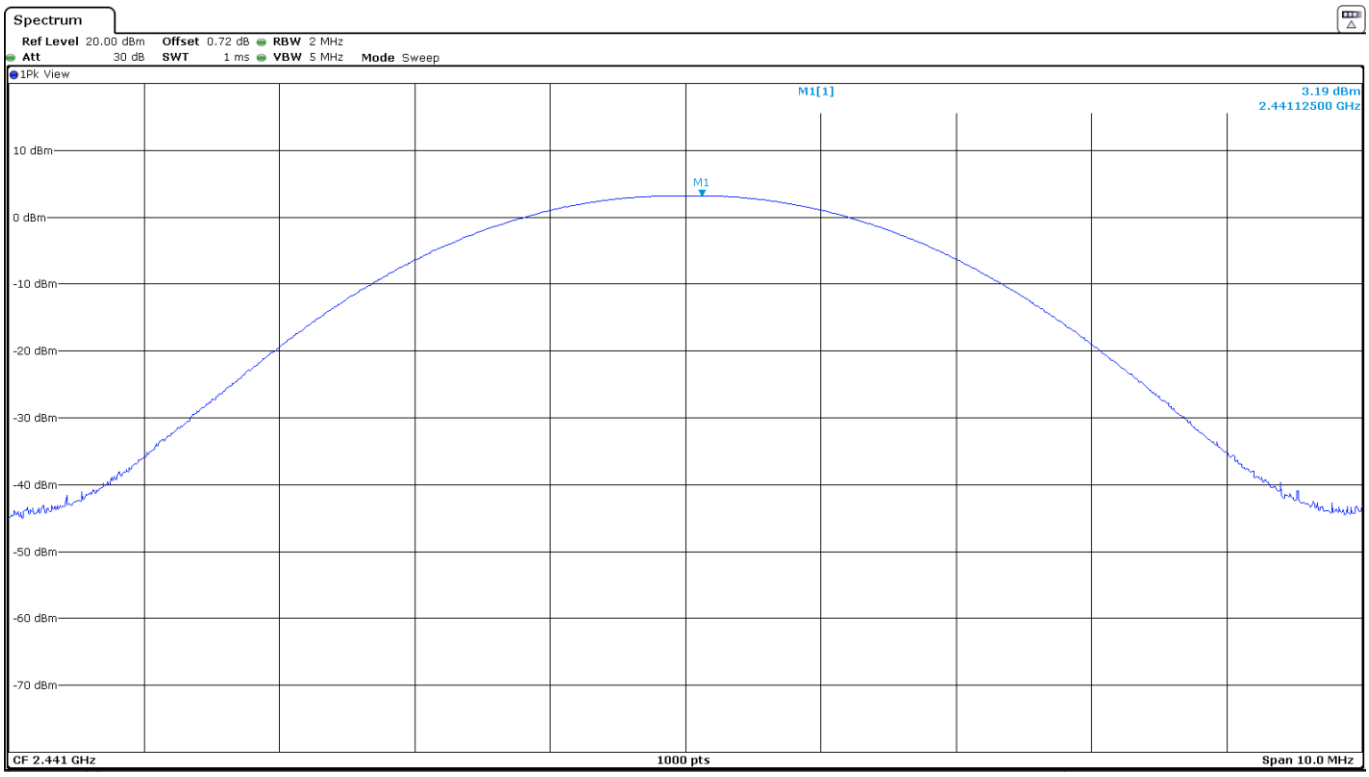


- **Pi/4 DQPSK – Peak Output Power**

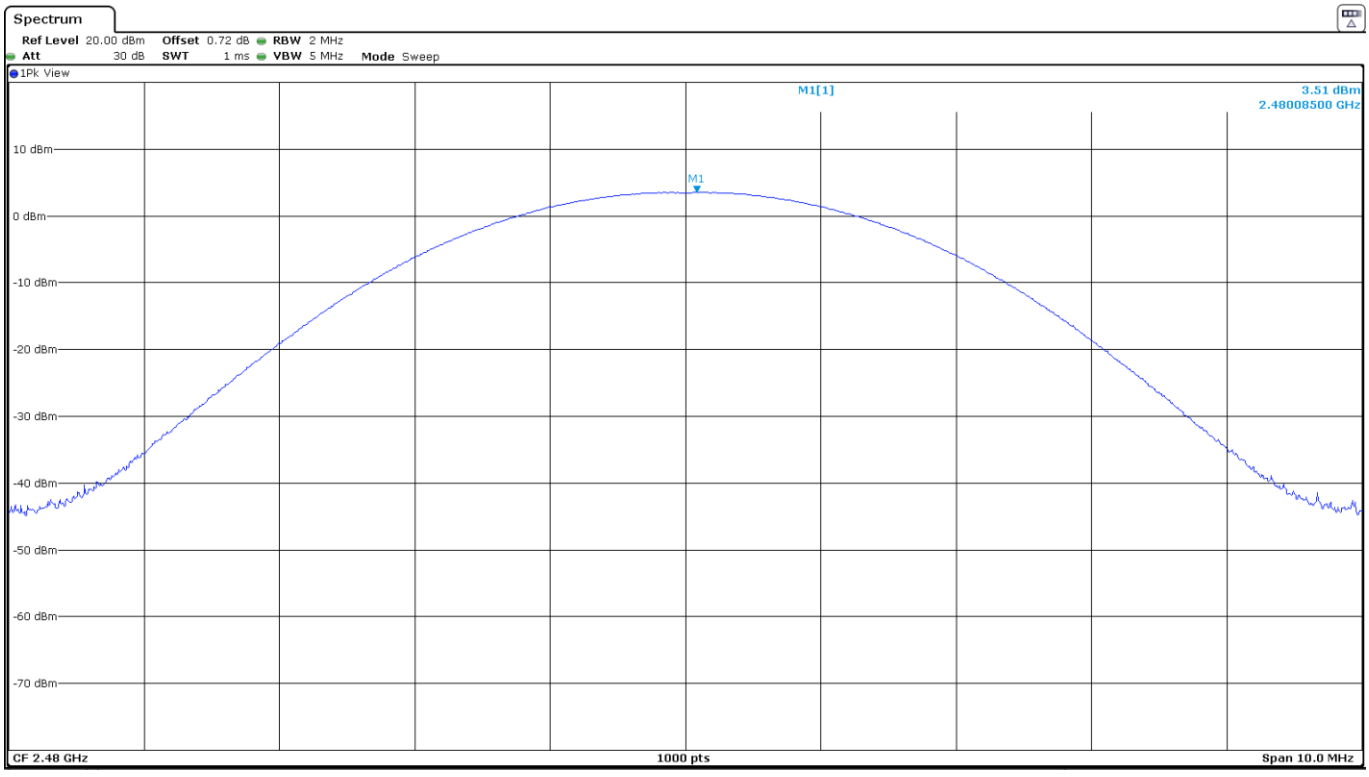
- Low Channel:



- Middle Channel:

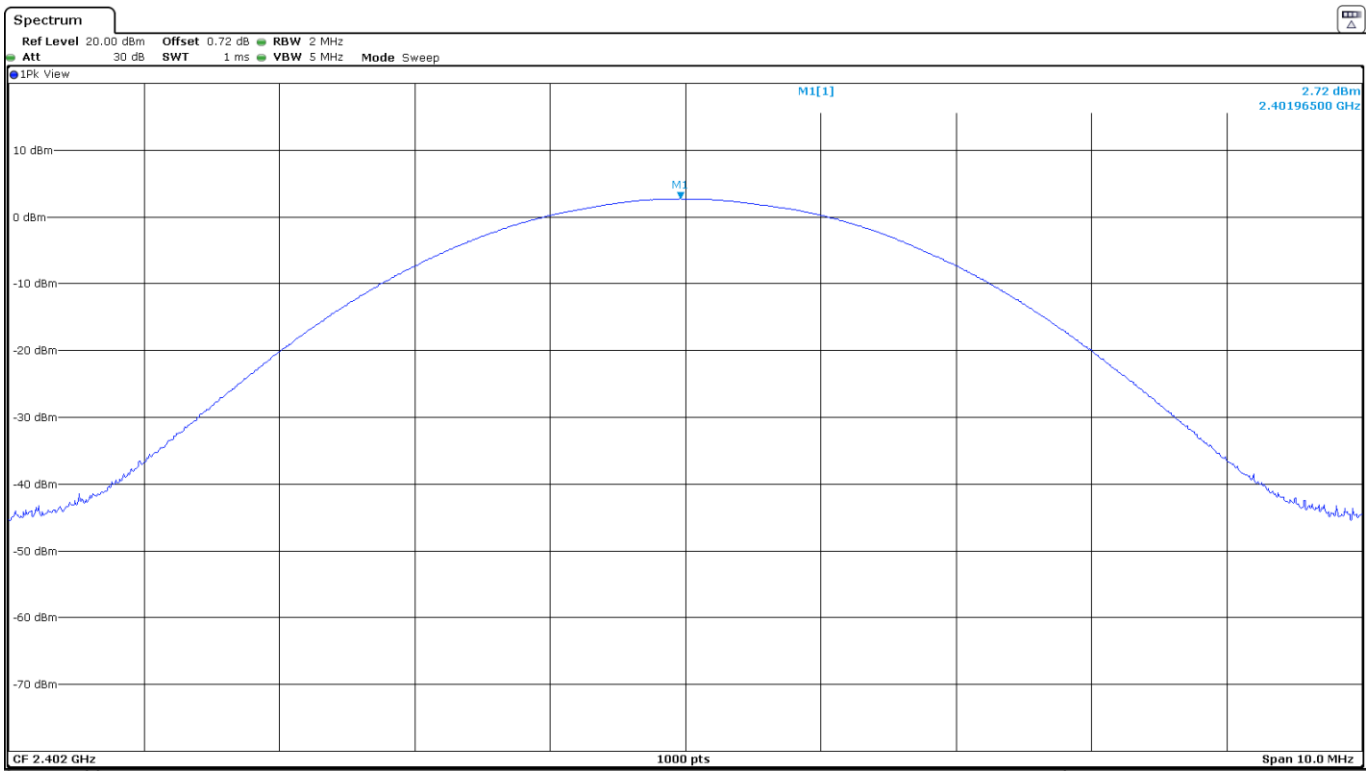


- High Channel:

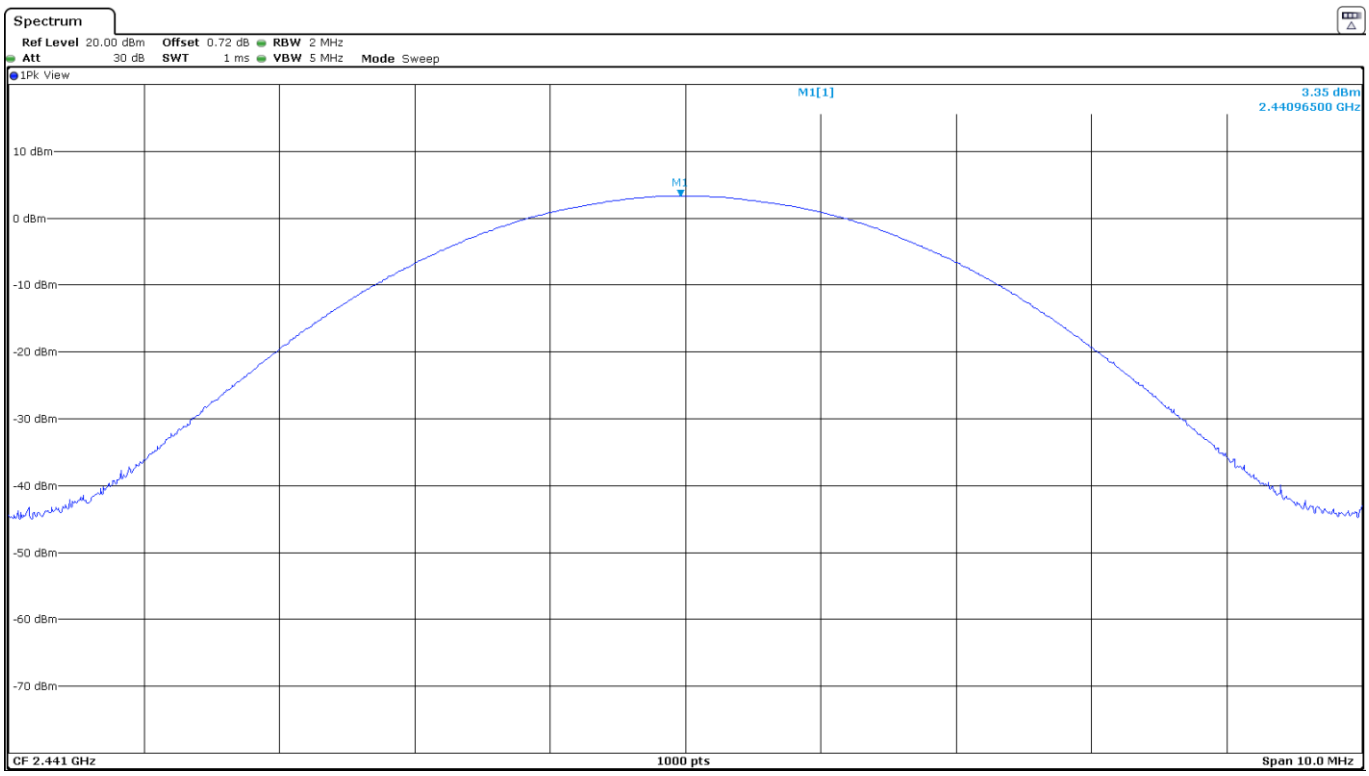


- **8DPSK – Peak Output Power**

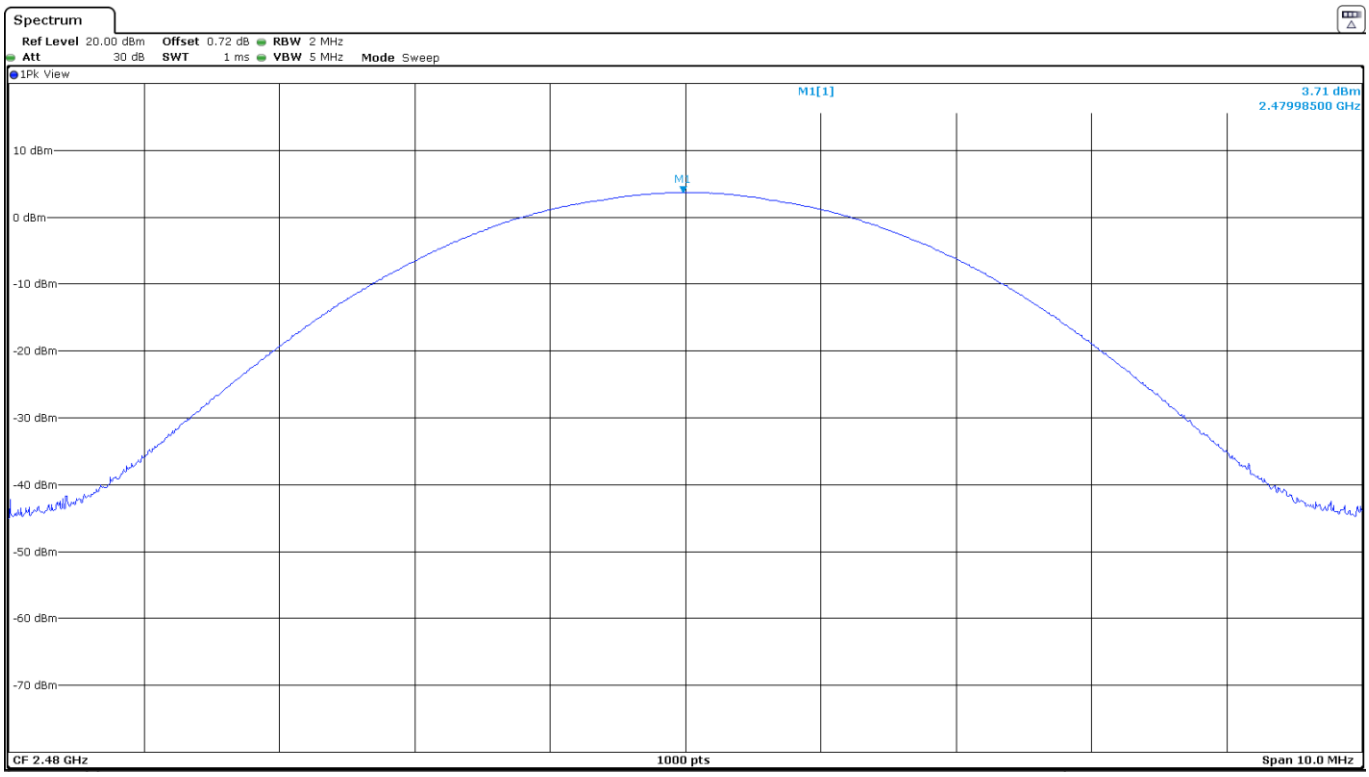
- Low Channel:



- Middle Channel:



- High Channel:



FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION:

Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20 dB below the highest level of the desired power.

RESULTS:

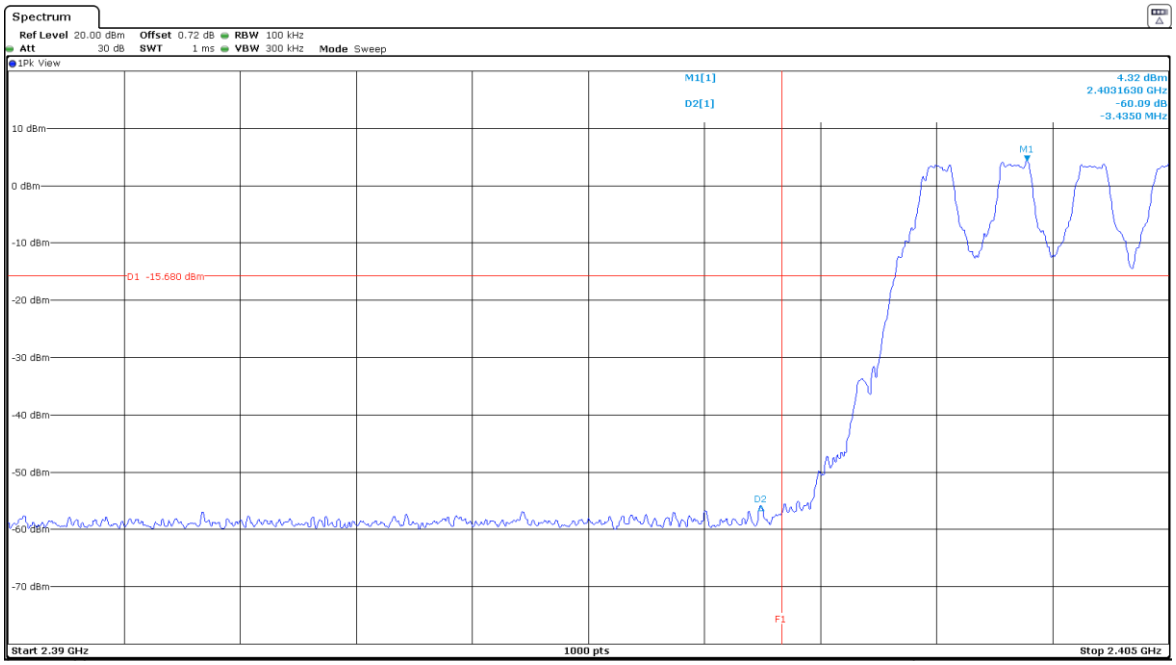
Radiated measurements were used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Measurement uncertainty (dB)	<±1.20

- **GFSK – Band-edge emissions compliance**

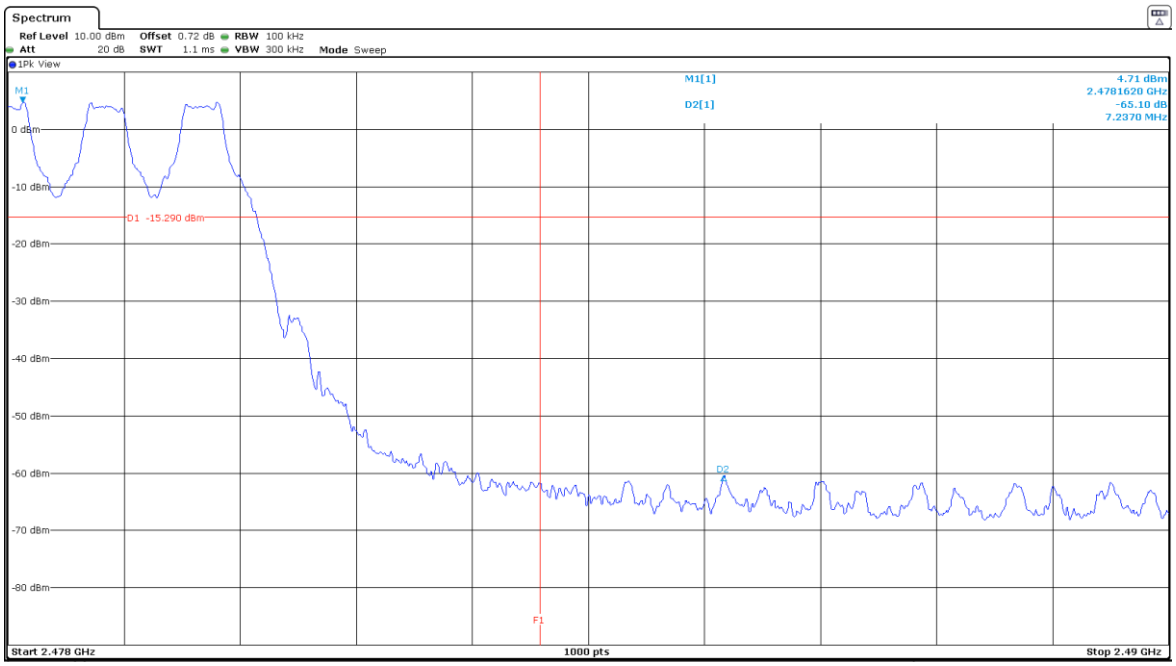
  ❖ HOPPING ON:

  - Low Frequency Section 2402 MHz:



Verdict: PASS

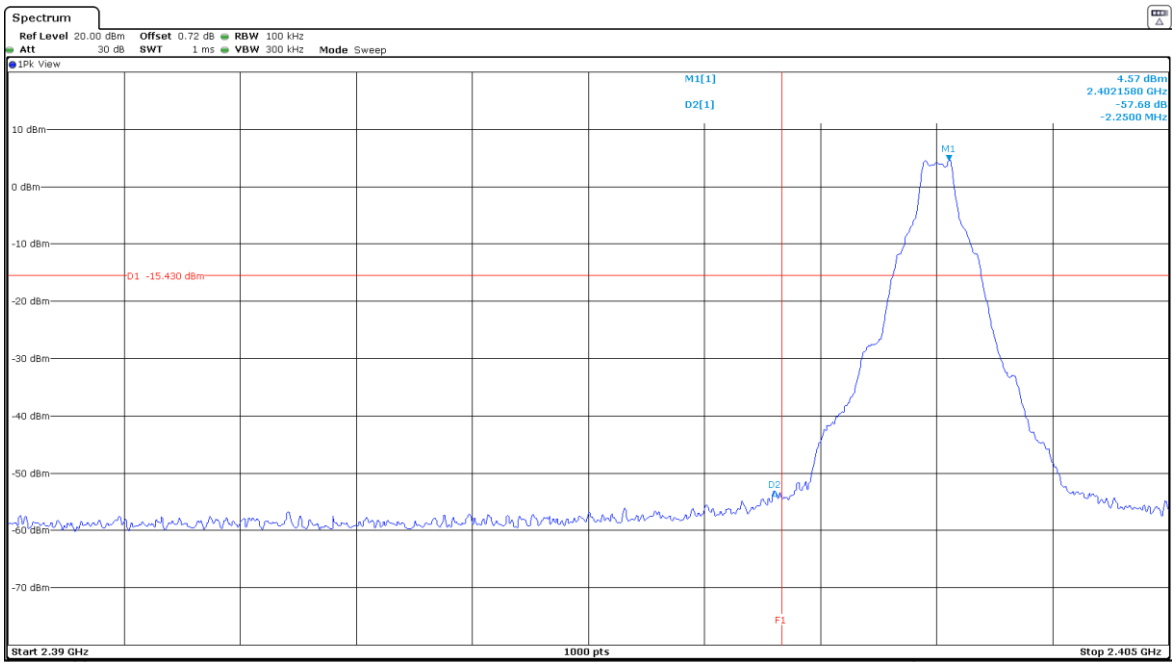
  - High Frequency Section 2480 MHz:



Verdict: PASS

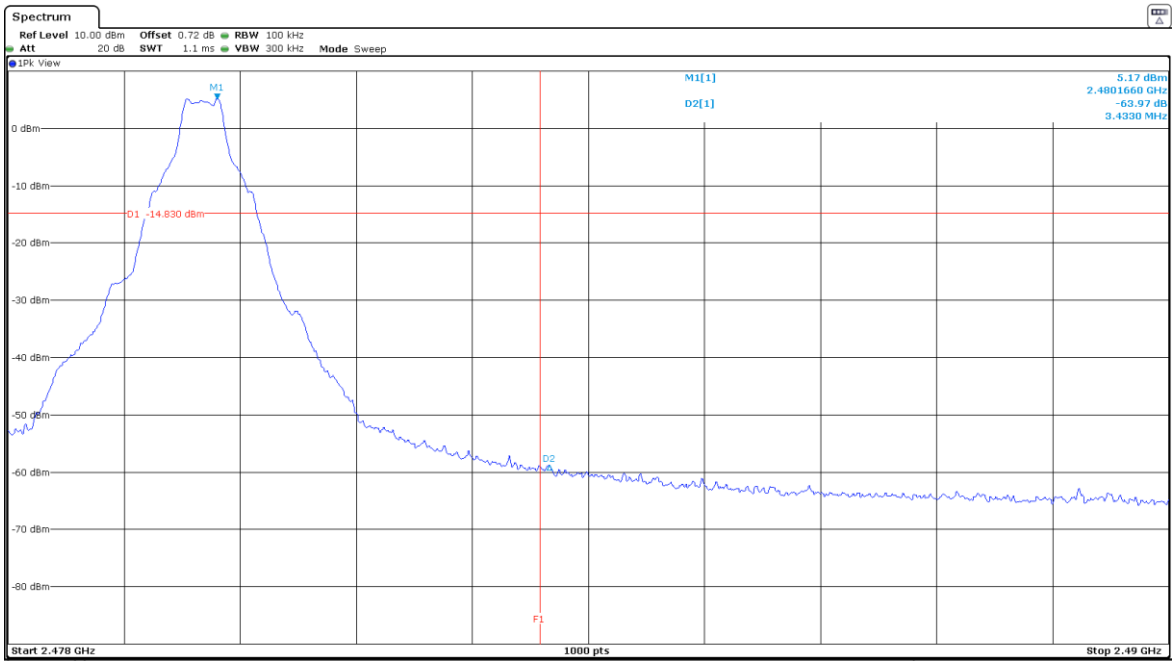
❖ HOPPING OFF:

- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:

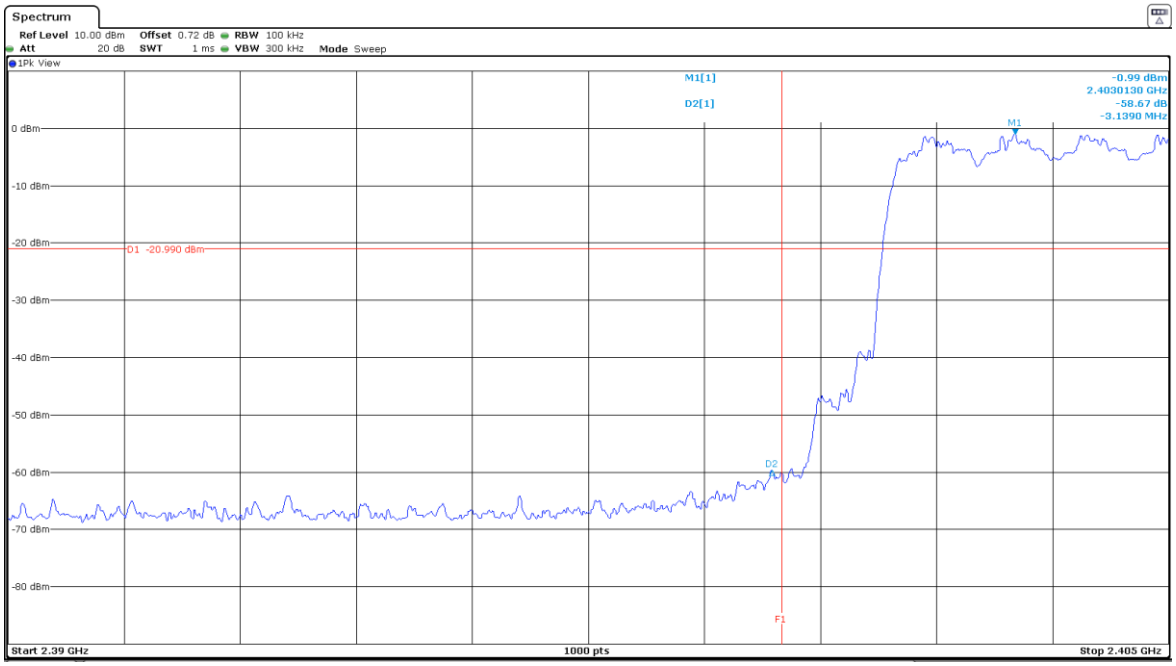


Verdict: PASS

- **Pi/4 DQPSK – Band-edge emissions compliance**

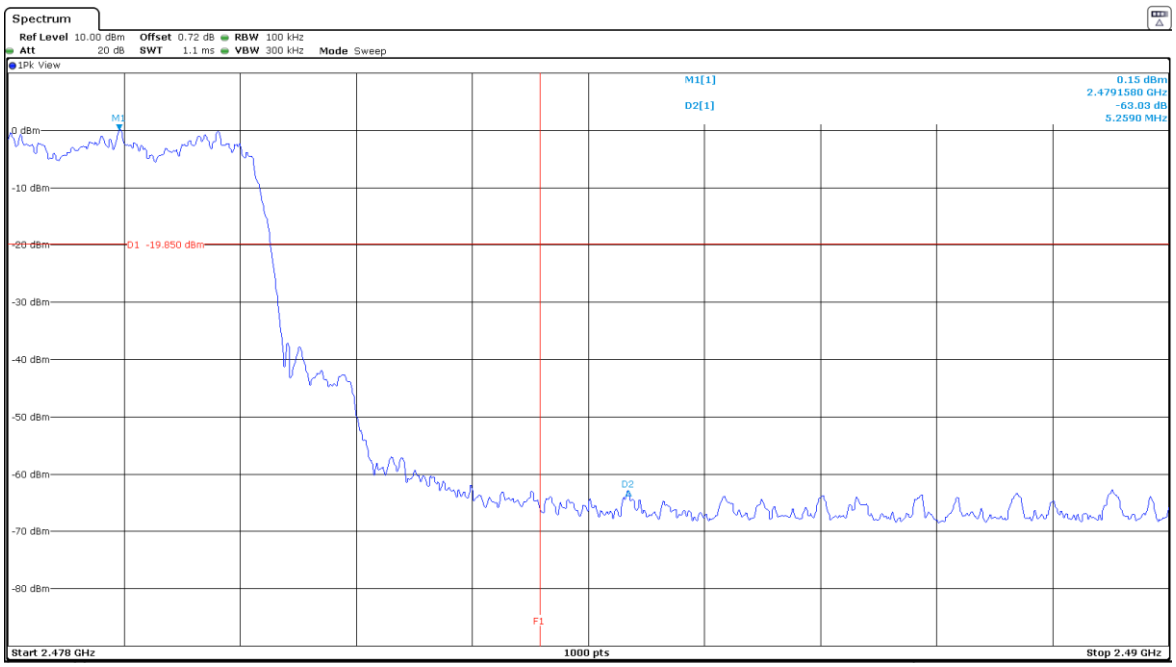
  - ❖ HOPPING ON:

    - Low Frequency Section 2402 MHz:



Verdict: PASS

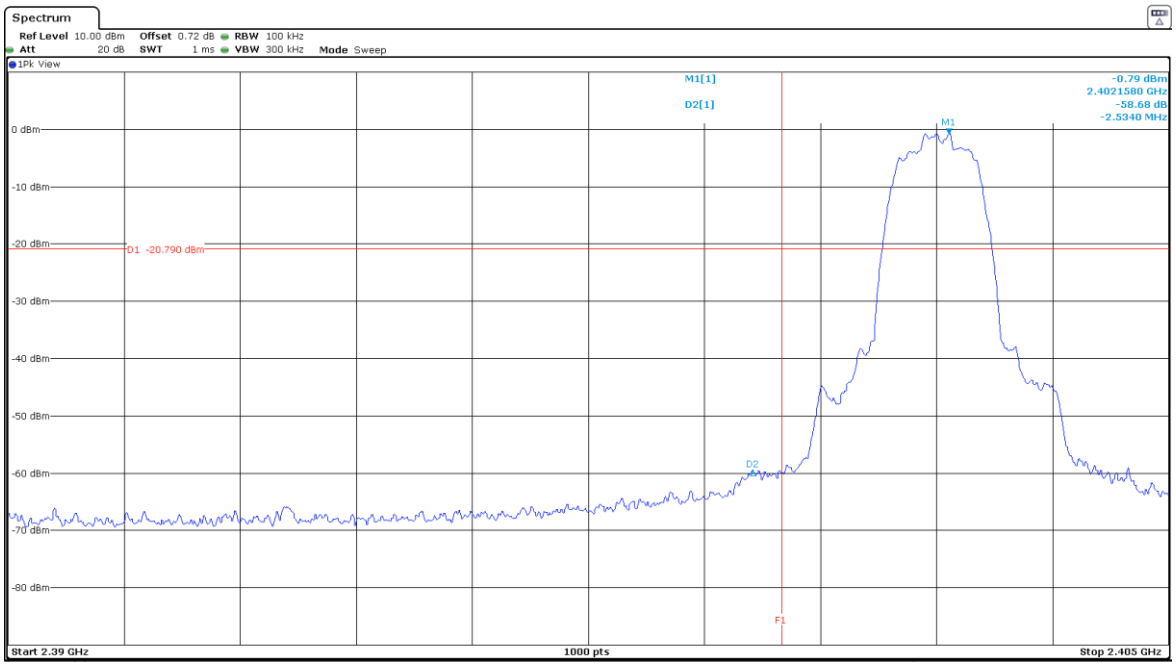
    - High Frequency Section 2480 MHz:



Verdict: PASS

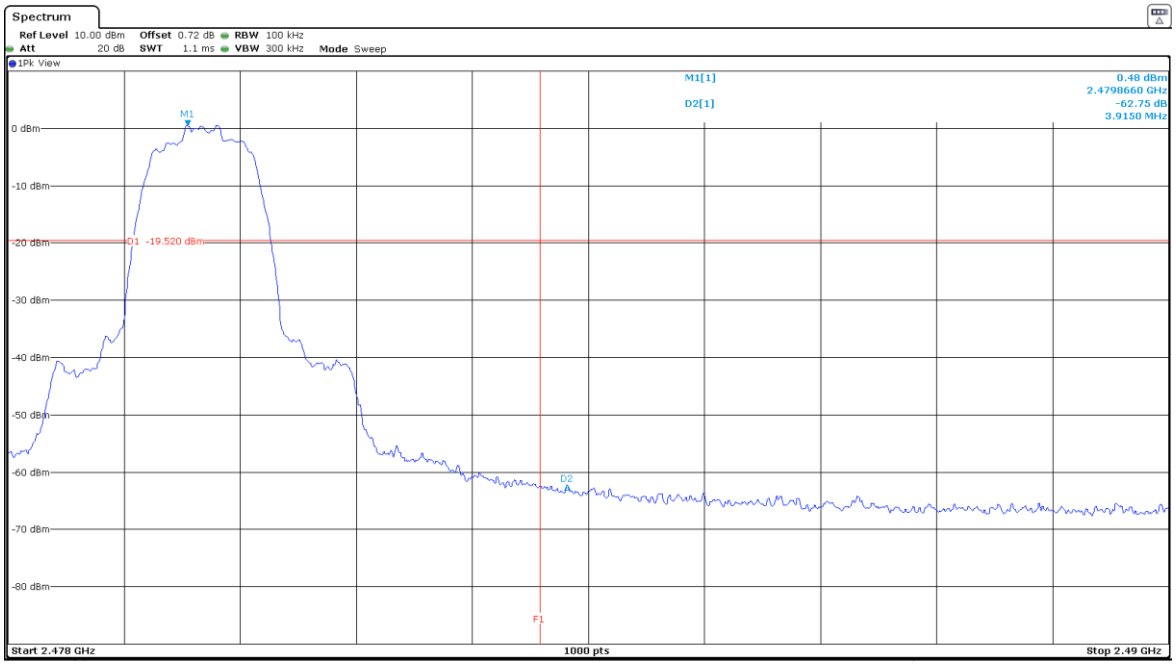
❖ HOPPING OFF:

- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:

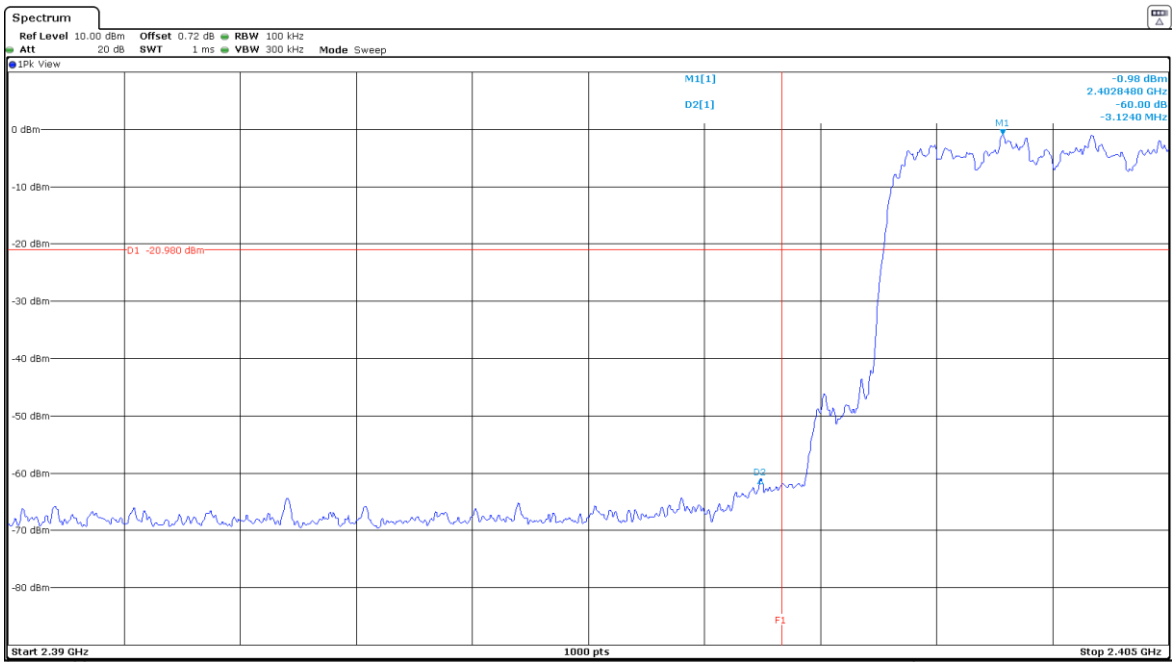


Verdict: PASS

- **8DPSK – Band-edge emissions compliance**

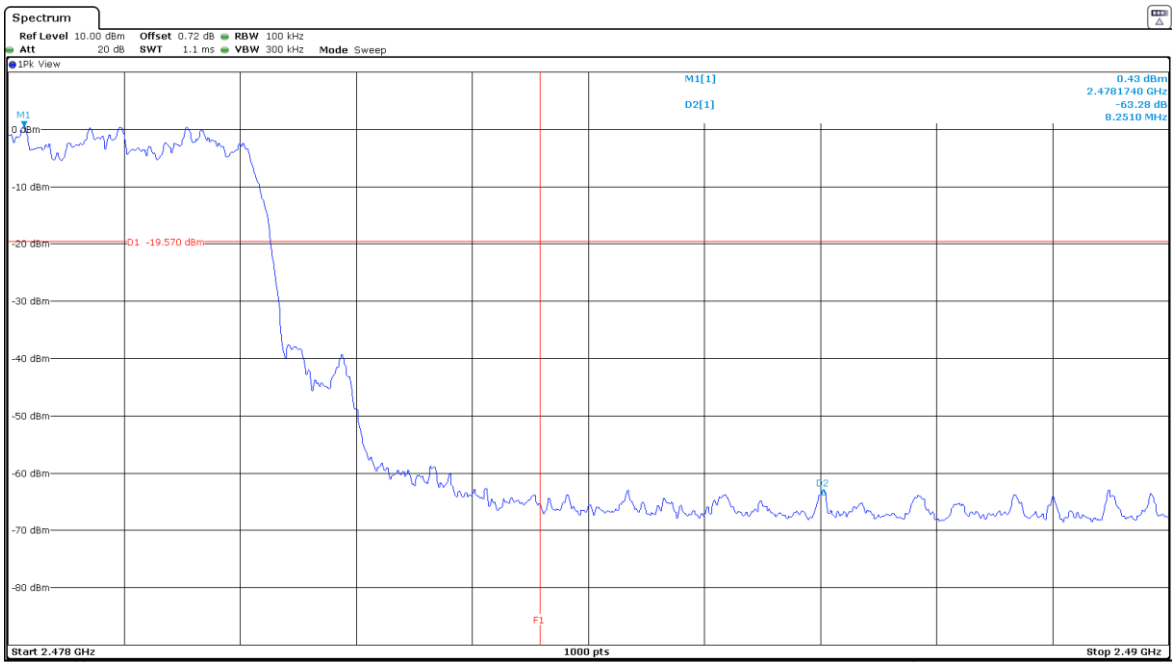
  - ❖ HOPPING ON:

    - Low Frequency Section 2402 MHz:



Verdict: PASS

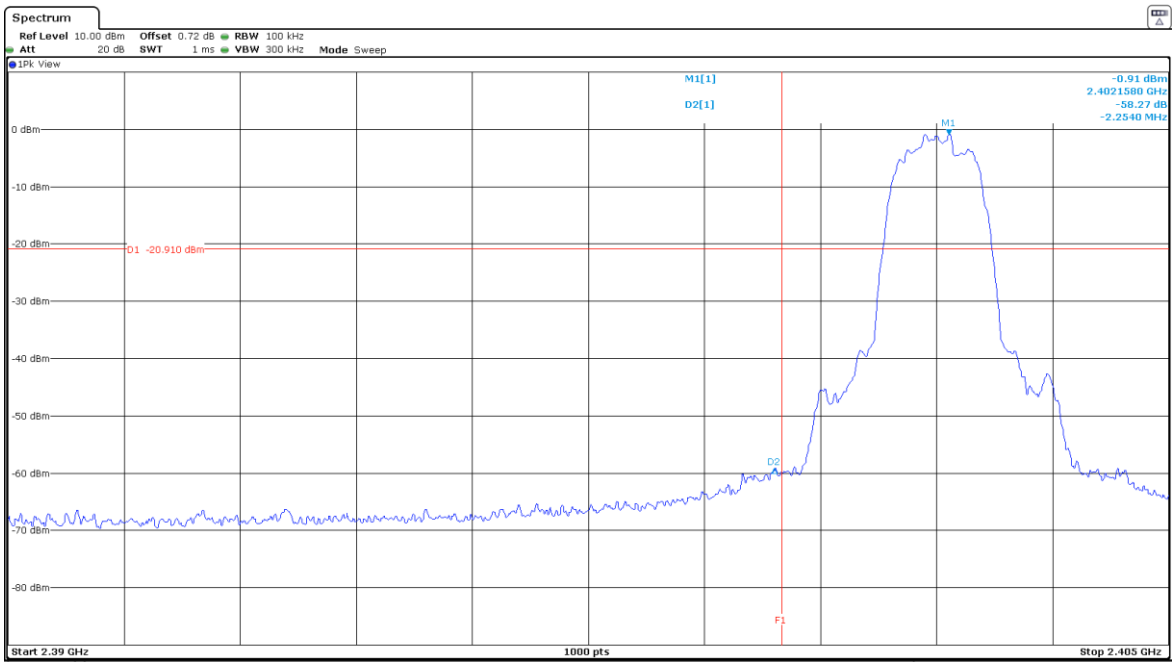
    - High Frequency Section 2480 MHz:



Verdict: PASS

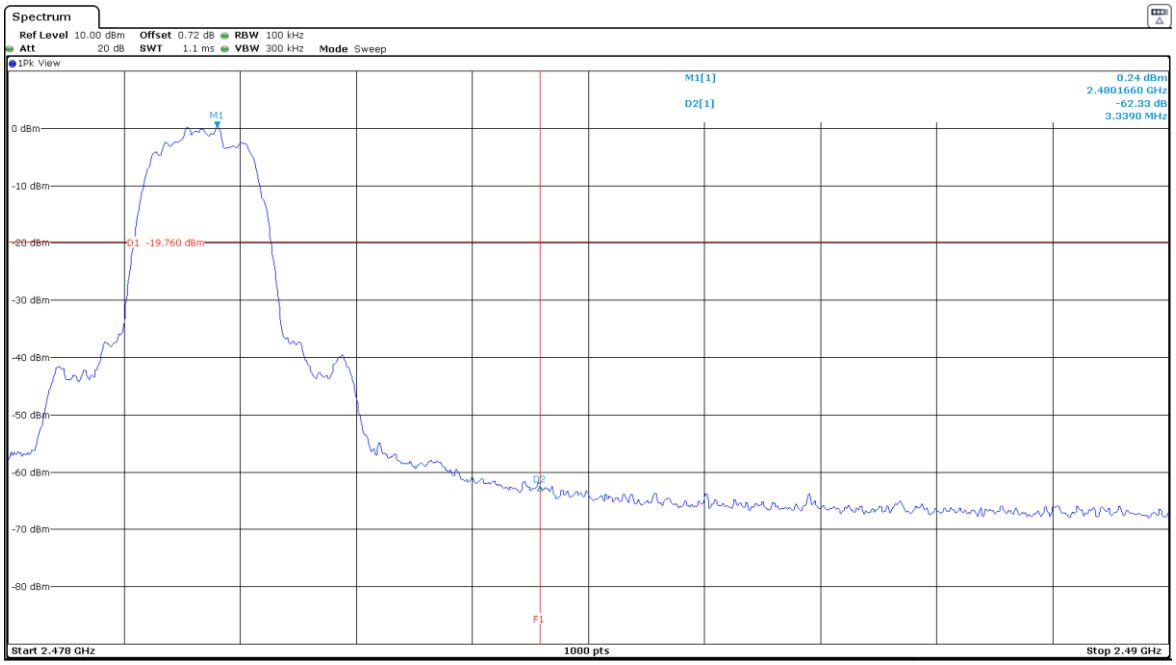
❖ HOPPING OFF:

- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:



Verdict: PASS

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations radiated. (Transmitter)

SPECIFICATION:

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) (see §15.205(c)/RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

Spurious frequencies operating detected at less than 20 dB below the limit:

Spurious frequency (MHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
58.631	Quasi peak	31.1	V	<± 3.81
98.466	Quasi peak	25.2	V	<± 3.81
250.012	Quasi peak	31.9	H	<± 3.81
375.013	Quasi peak	32.0	V	<± 3.81
875.016	Quasi peak	28.1	H	<± 3.81

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequencies with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- **GFSK modulation (DH5)**

  - LOW CHANNEL (2402 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.0627	Peak	47.44	H	<± 2.78
1.3333	Peak	47.22	V	<± 2.78
1.7559	Peak	49.09	H	<± 2.78
2.1332	Peak	49.67	H	<± 2.78
6.3724	Peak	47.22	V	<± 4.72

  - MIDDLE CHANNEL (2441 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.3335	Peak	45.98	V	<± 2.78
1.7487	Peak	46.41	V	<± 2.78
2.1310	Peak	51.76	H	<± 2.78
6.3985	Peak	49.13	V	<± 4.72

- HIGH CHANNEL (2480 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.0636	Peak	47.42	H	<± 2.78
1.1252	Peak	45.2	V	<± 2.78
1.3333	Peak	45.81	V	<± 2.78
2.1317	Peak	50.84	H	<± 2.78
6.3817	Peak	47.29	V	<± 4.72

Verdict: PASS

- **Pi/4-DQPSK modulation (2-DH5)**

- LOW CHANNEL (2402 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.064466	Peak	44.52	V	<± 2.78
1.125216	Peak	44.87	V	<± 2.78
2.128833	Peak	51.38	H	<± 2.78
6.39477	Peak	46.80	V	<± 4.72

- MIDDLE CHANNEL (2441 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.062233	Peak	50.35	V	<± 2.78
1.333164	Peak	48.21	V	<± 2.78
2.130624	Peak	49.68	H	<± 2.78
6.3877	Peak	49.79	V	<± 4.72
8.50503	Peak	49.06	V	<± 4.72

- HIGH CHANNEL (2480 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.0643	Peak	48.01	H	<± 2.78
2.131633	Peak	51.18	H	<± 2.78
6.3929	Peak	47.22	V	<± 4.72

Verdict: PASS

- **8-DPSK modulation (3DH5)**

  - LOW CHANNEL (2402 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.0643	Peak	47.77	V	<± 2.78
2.130424	Peak	49.48	H	<± 2.78
6.37423	Peak	45.71	H	<± 4.72

  - MIDDLE CHANNEL (2441 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.333297	Peak	47.00	V	<± 2.78
2.127191	Peak	48.88	V	<± 2.78
6.39757	Peak	47.93	V	<± 4.72

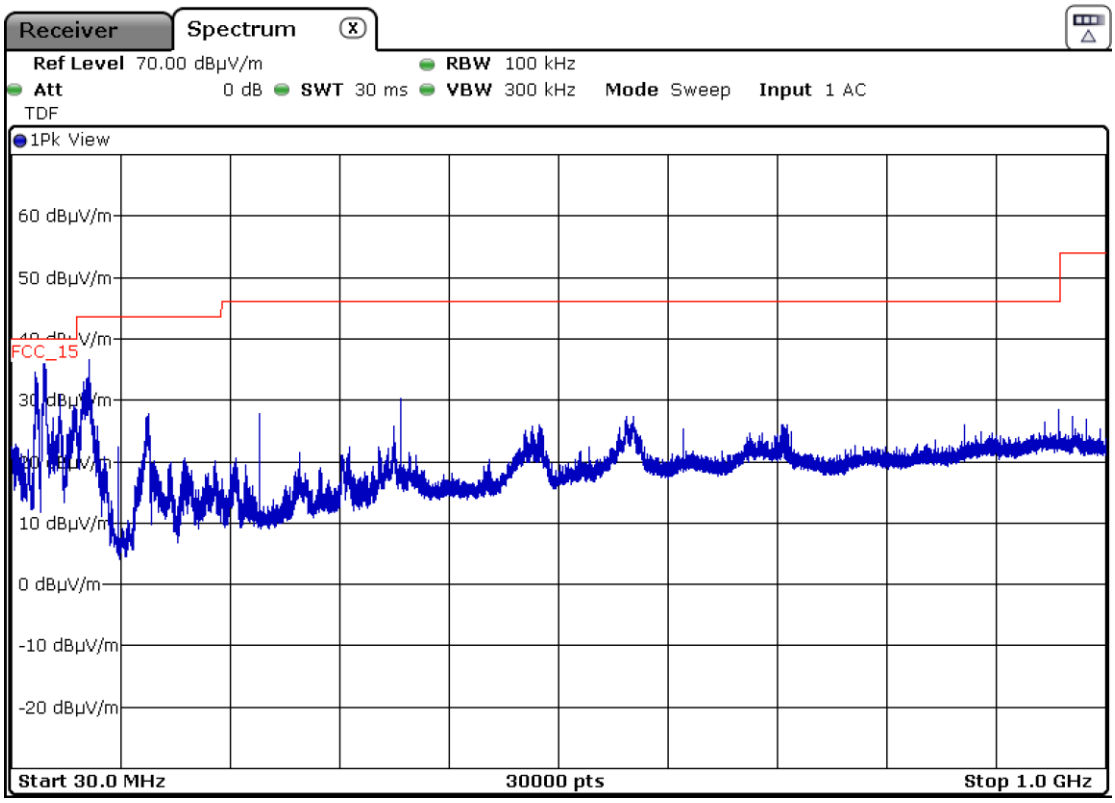
  - HIGH CHANNEL (2480 MHz). Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBµV/m)	Polarization	Measurement Uncertainty (dB)
1.0641	Peak	48.58	V	<± 2.78

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

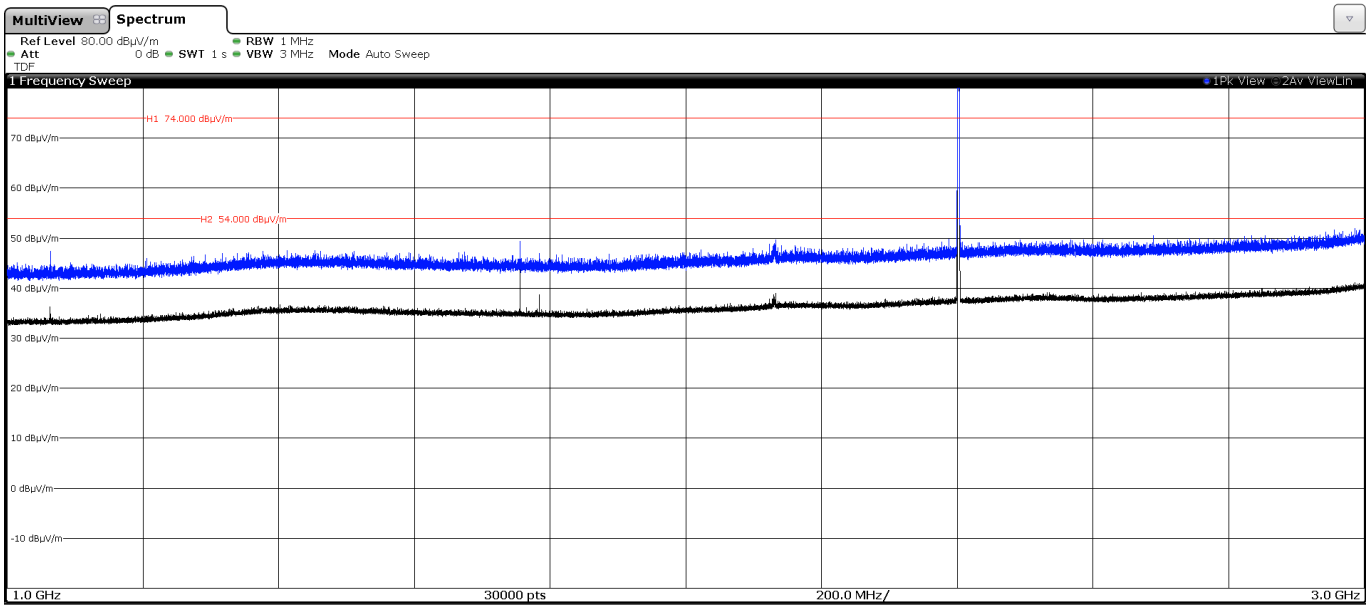
This plot is valid for the Low, Middle and High Channels and all the modulation modes.



FREQUENCY RANGE 1 - 3 GHz:

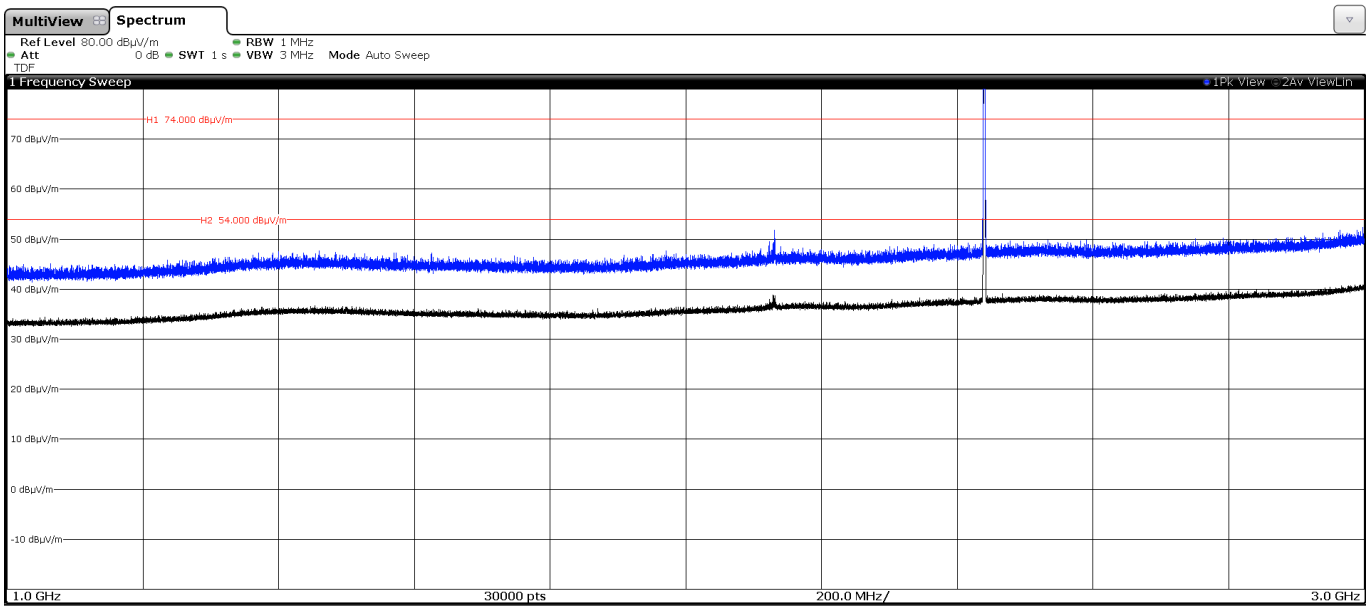
- **GFSK modulation (DH5)**

  - Low Channel (2402 MHz):



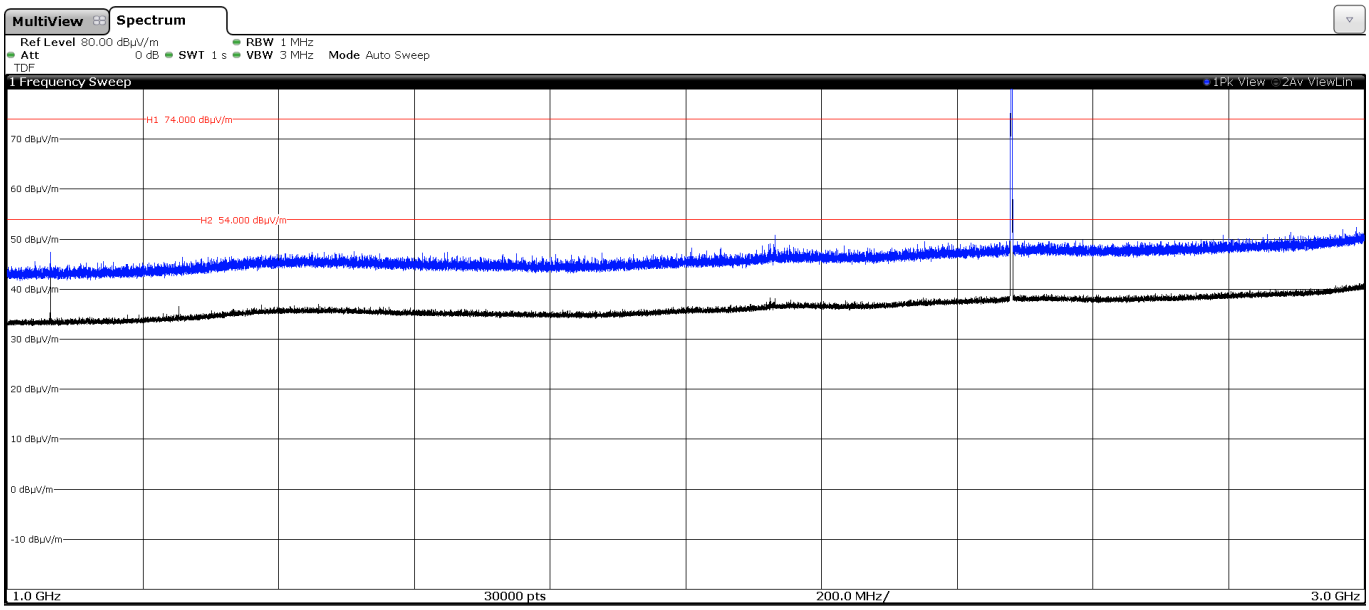
The peak above the limit is the carrier frequency.

  - Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

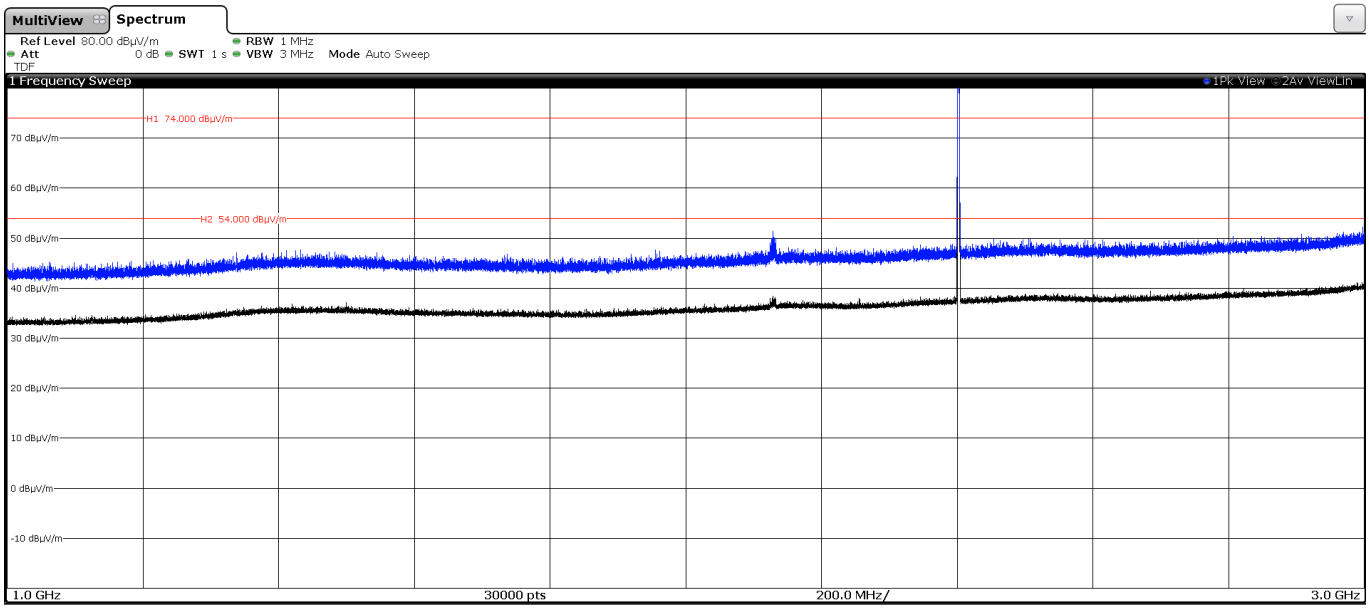
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

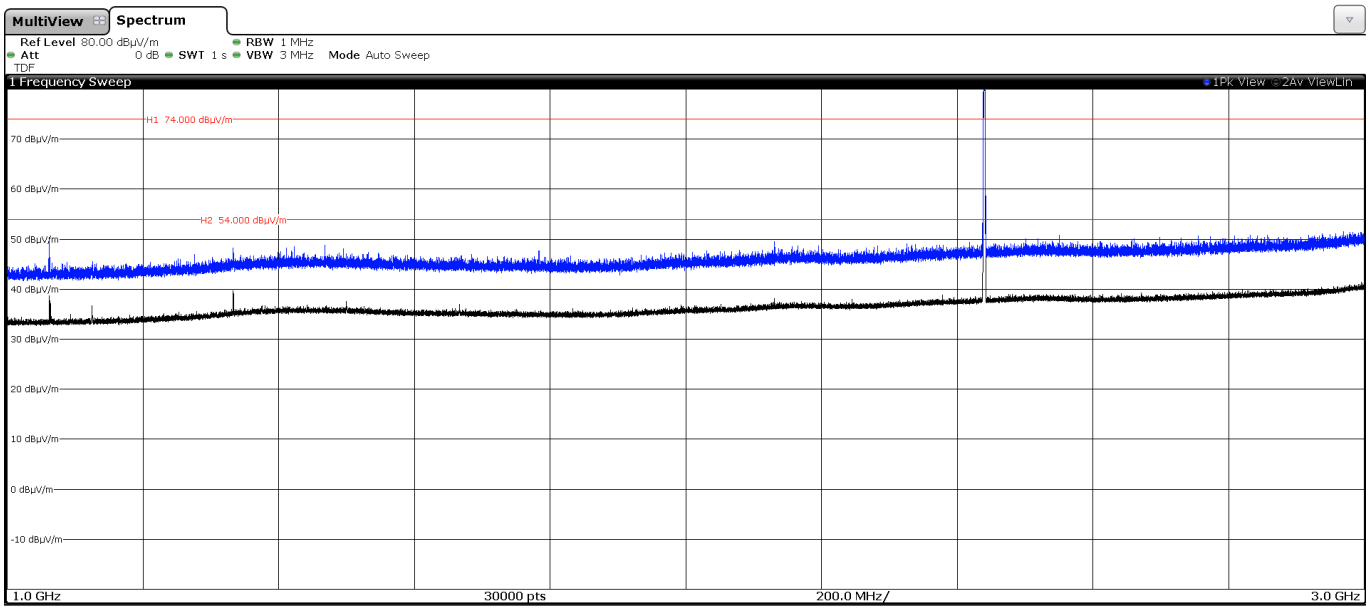
- **Pi/4-DQPSK modulation (2DH5)**

  - Low Channel (2402 MHz):



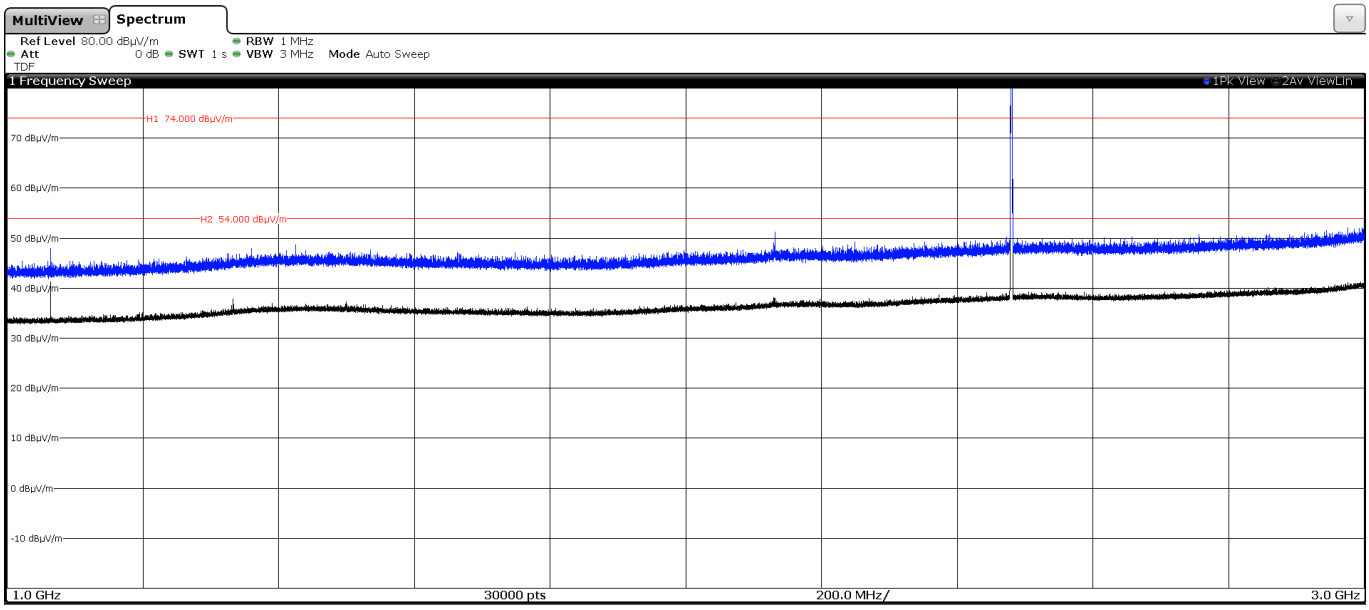
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

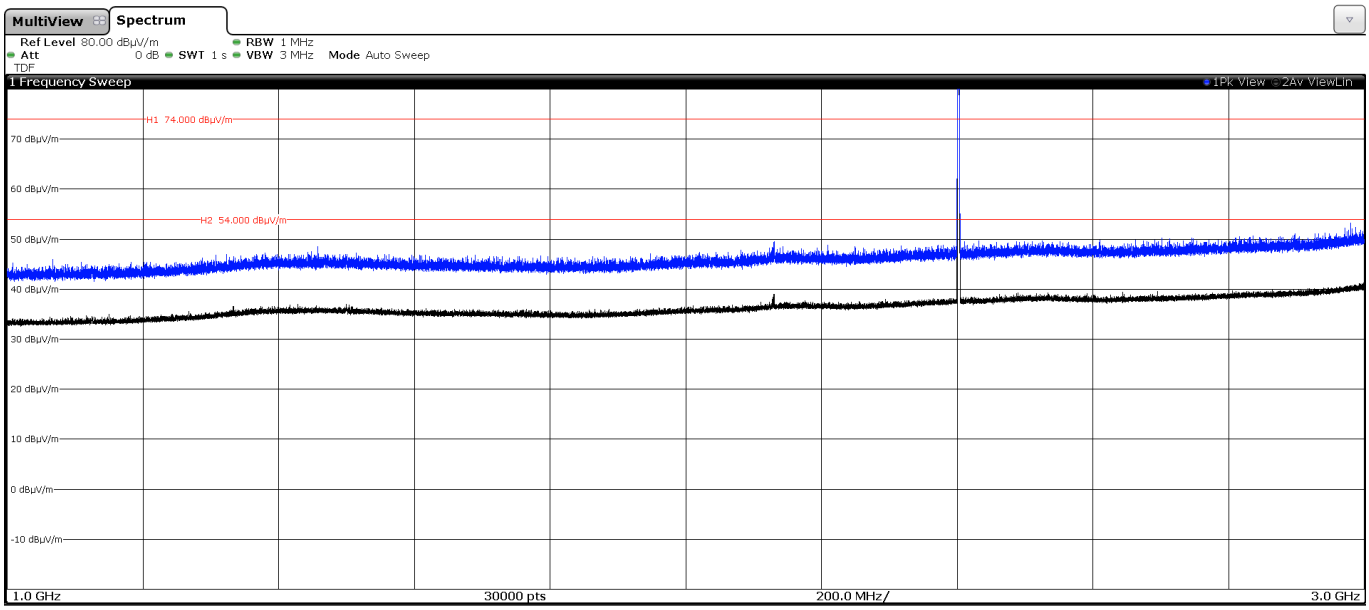
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

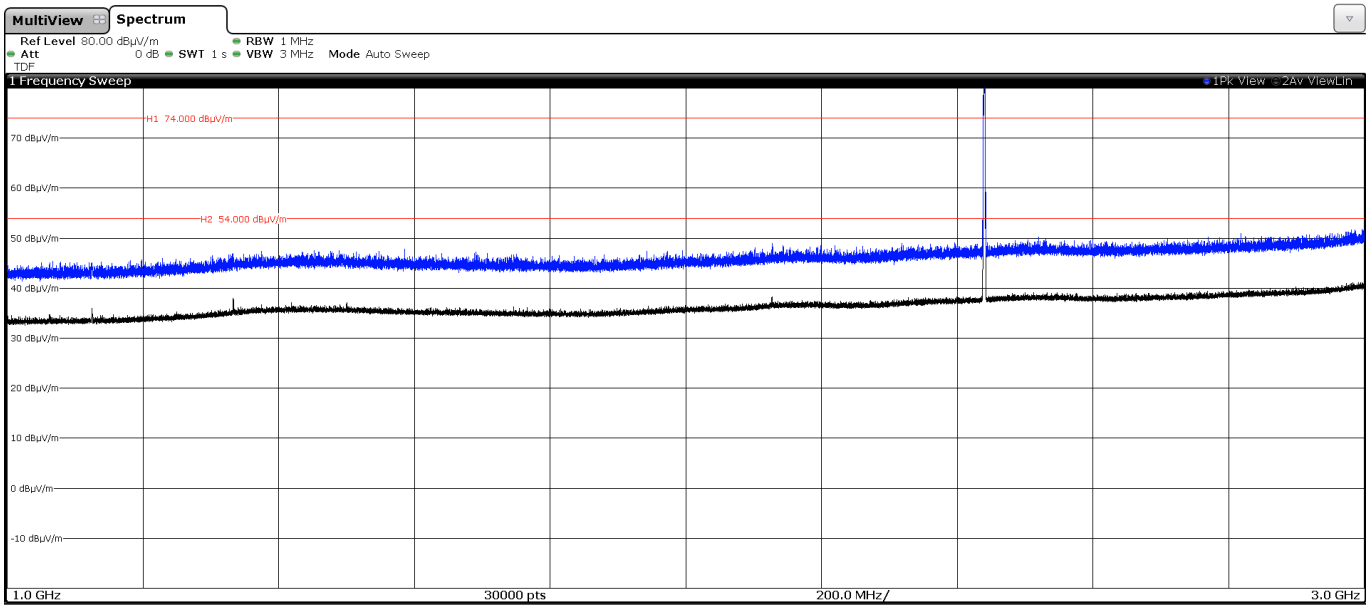
- **8-DPSK modulation (3DH5)**

- Low Channel (2402 MHz):



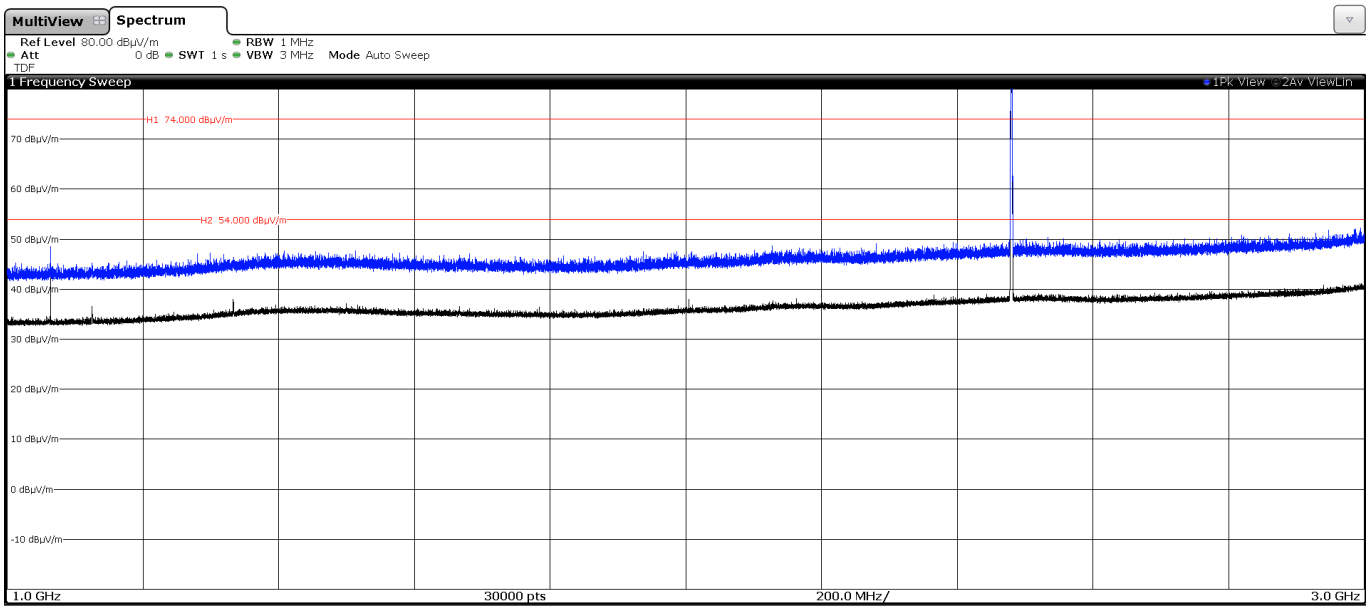
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

- High Channel (2480 MHz):

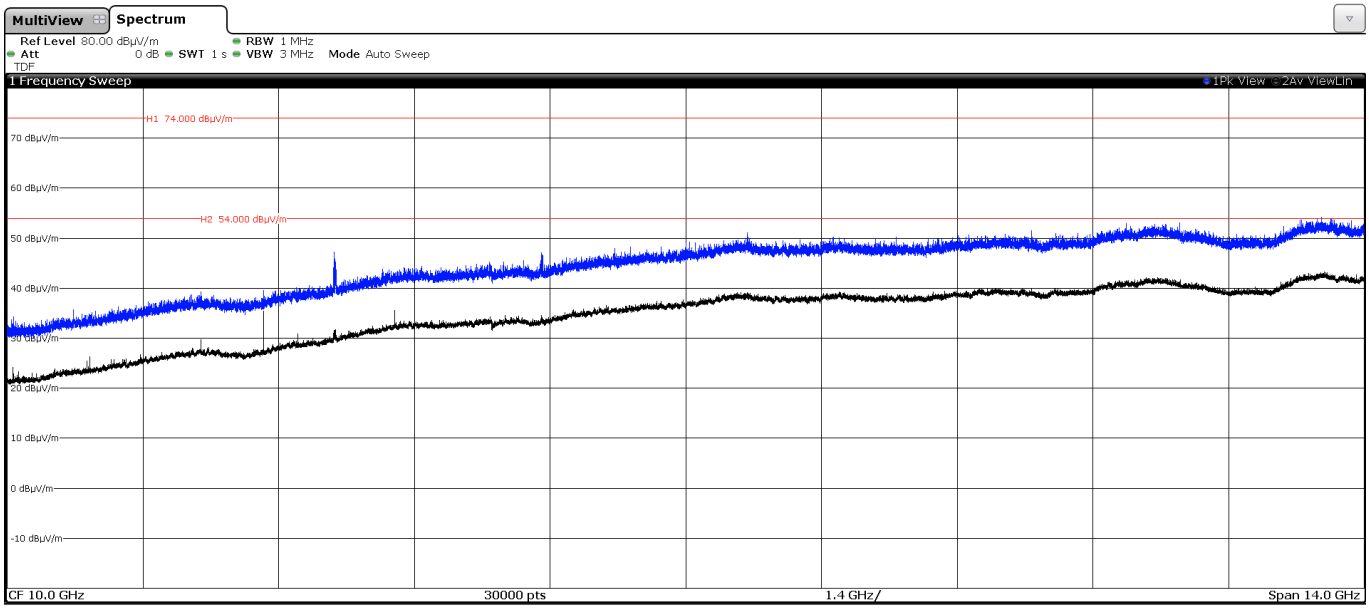


The peak above the limit is the carrier frequency.

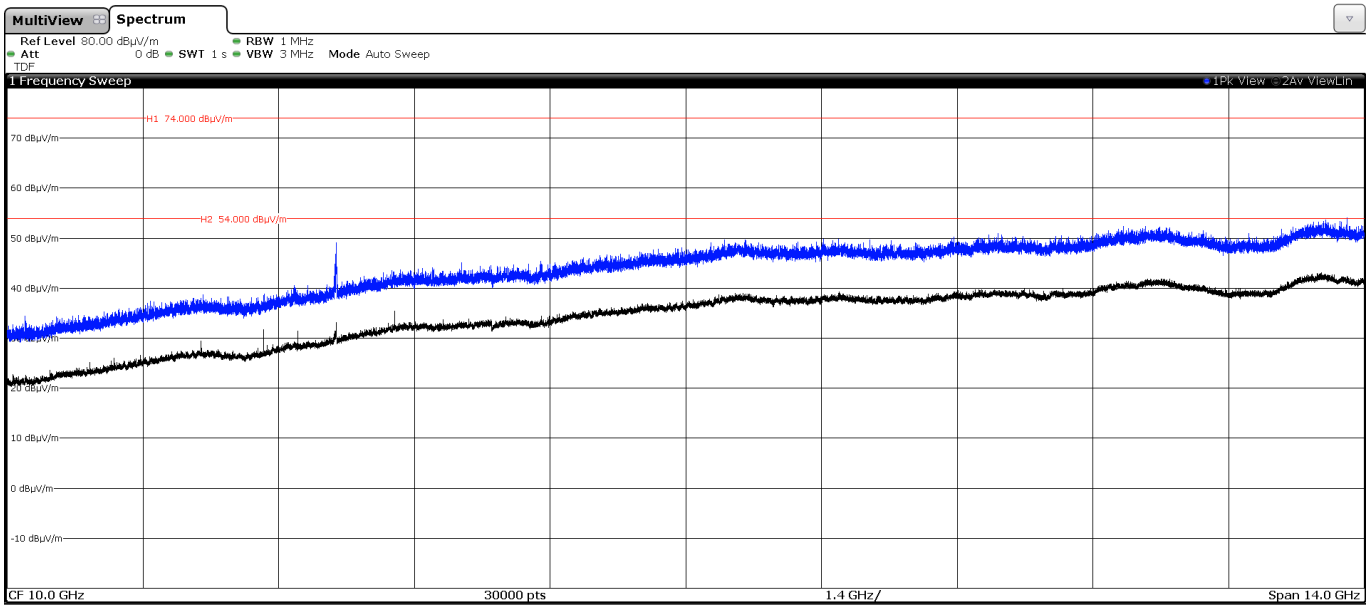
FREQUENCY RANGE 3 - 17 GHz:

- **GFSK modulation (DH5)**

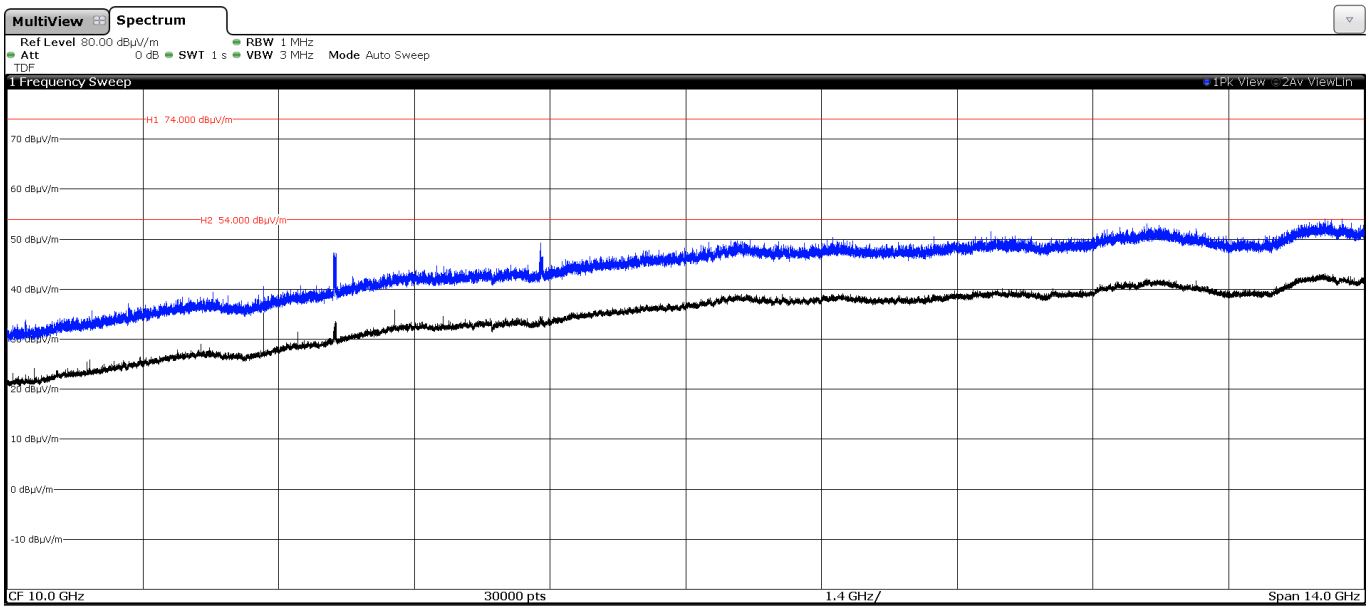
- Low Channel (2402 MHz):



- Middle Channel (2441 MHz):

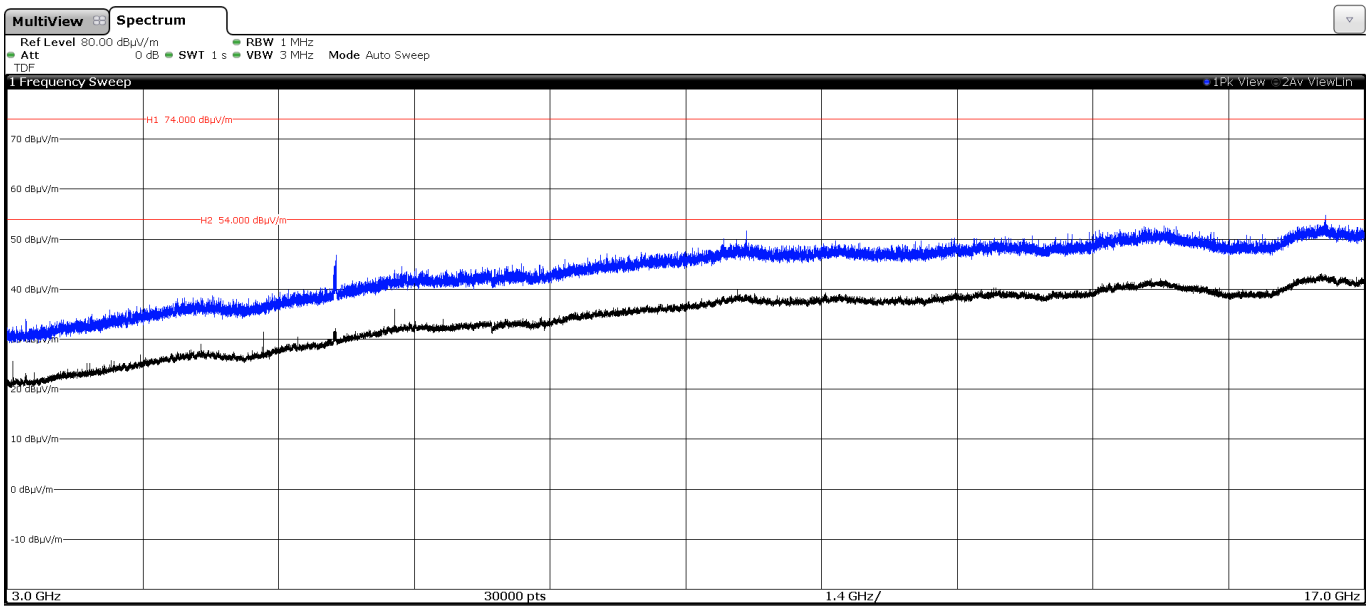


- High Channel (2480 MHz):

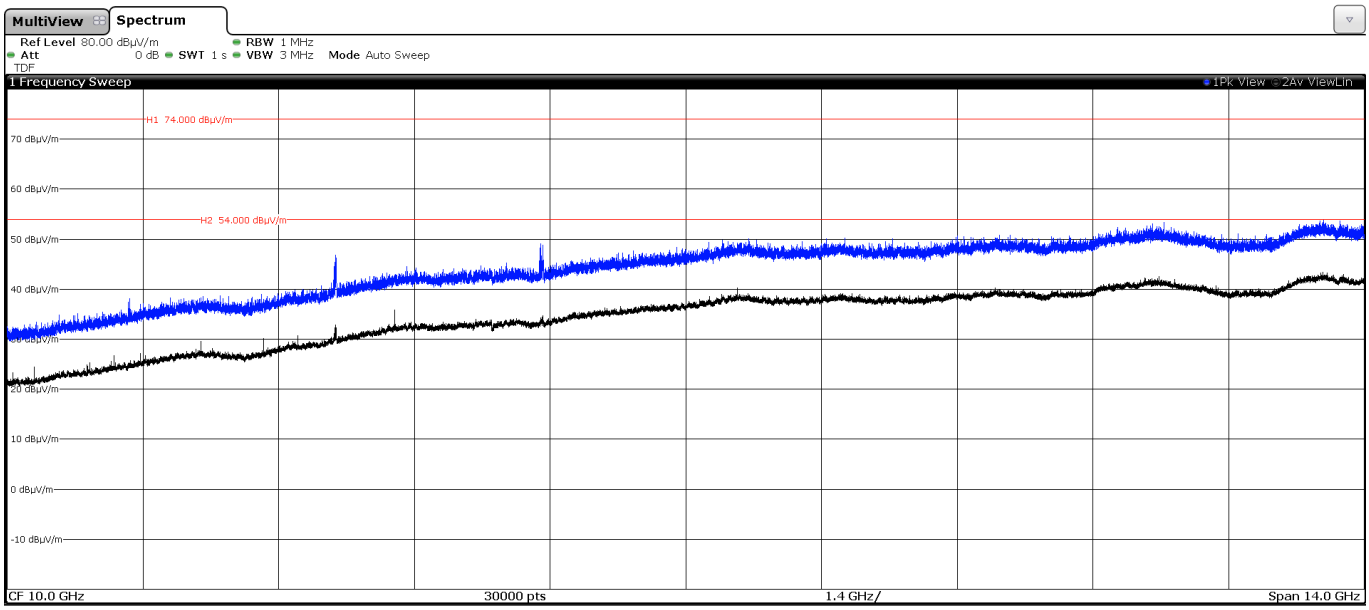


- **Pi/4-DQPSK modulation (2DH5)**

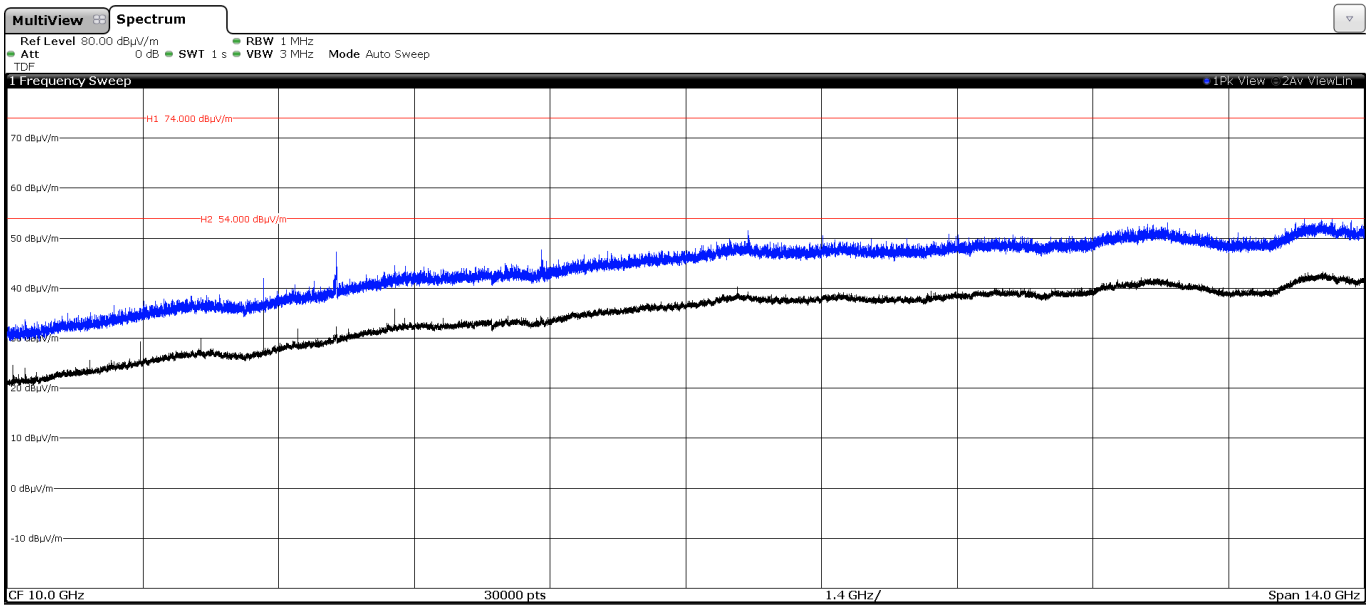
  - Low Channel (2402 MHz):



- Middle Channel (2441 MHz):

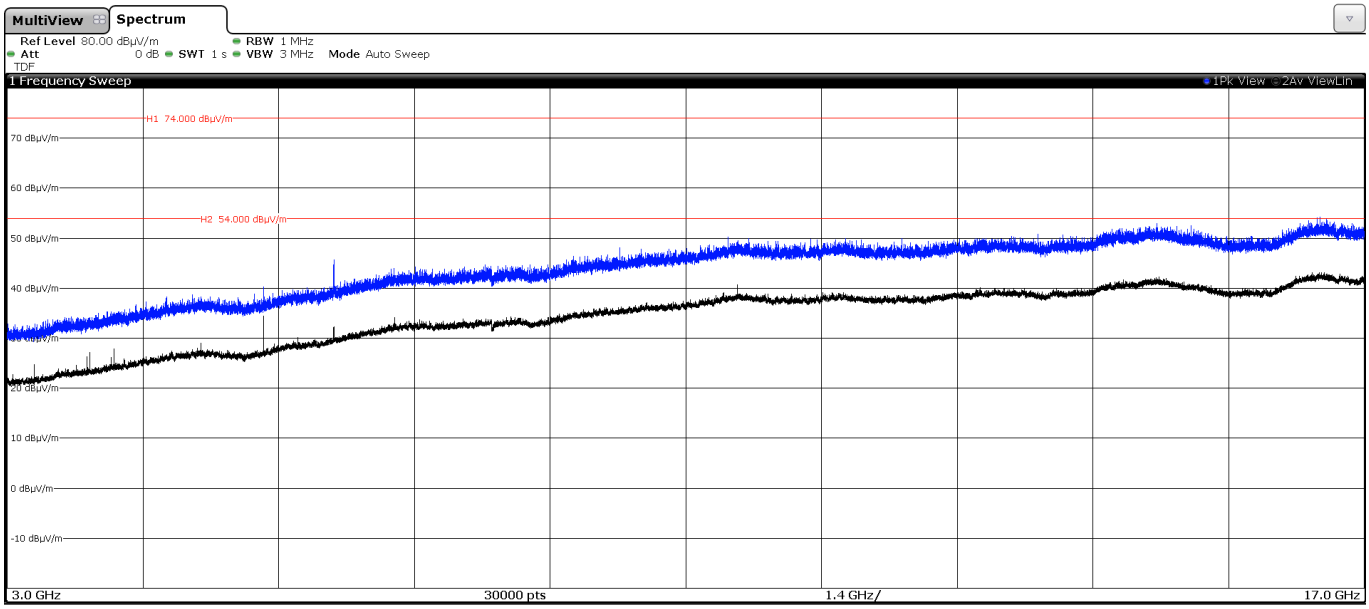


- High Channel (2480 MHz):

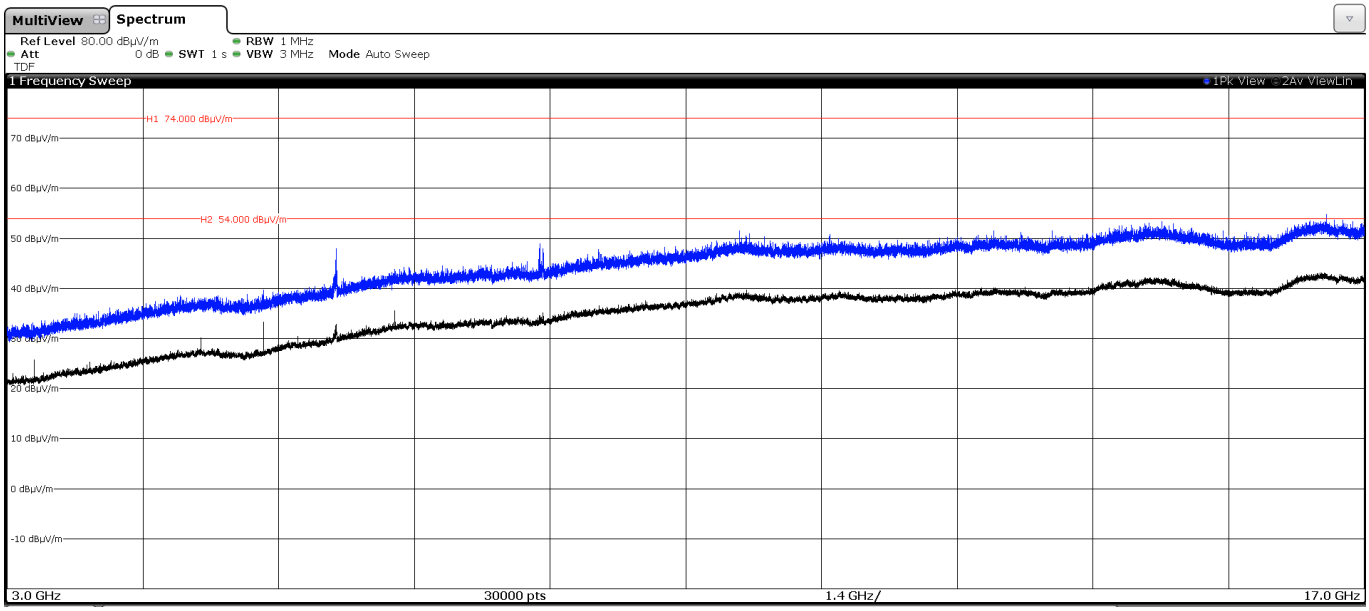


- **8-DPSK modulation (3DH5)**

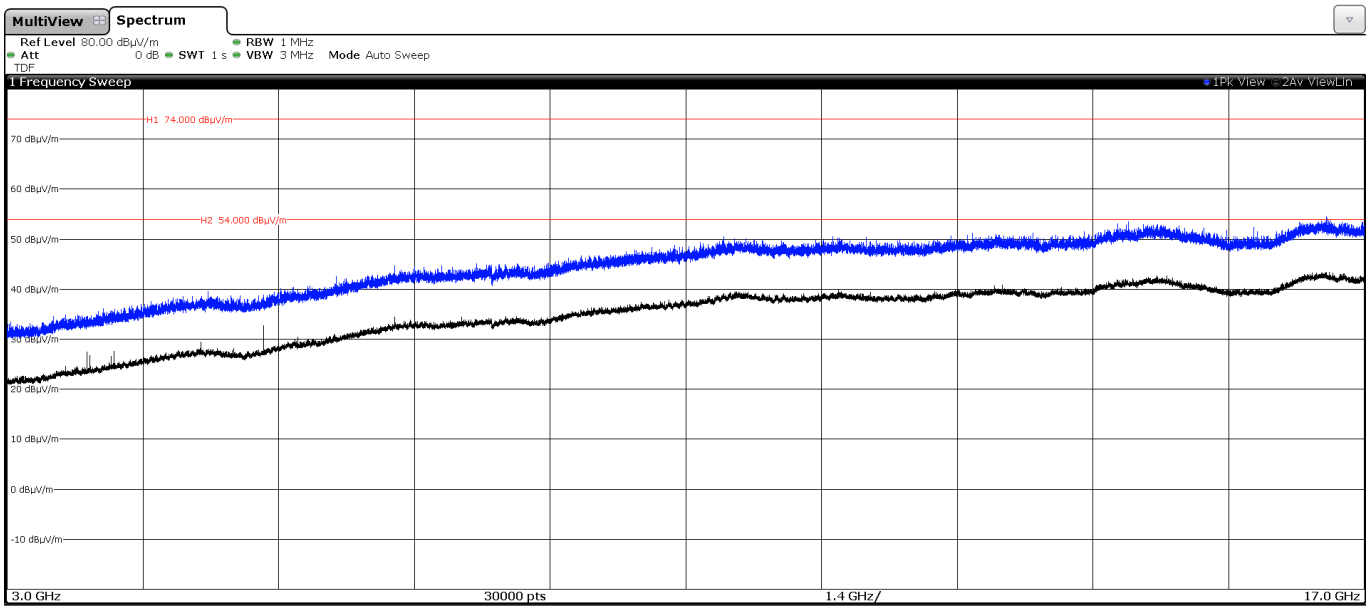
  - Low Channel (2402 MHz):



  - Middle Channel (2441 MHz):

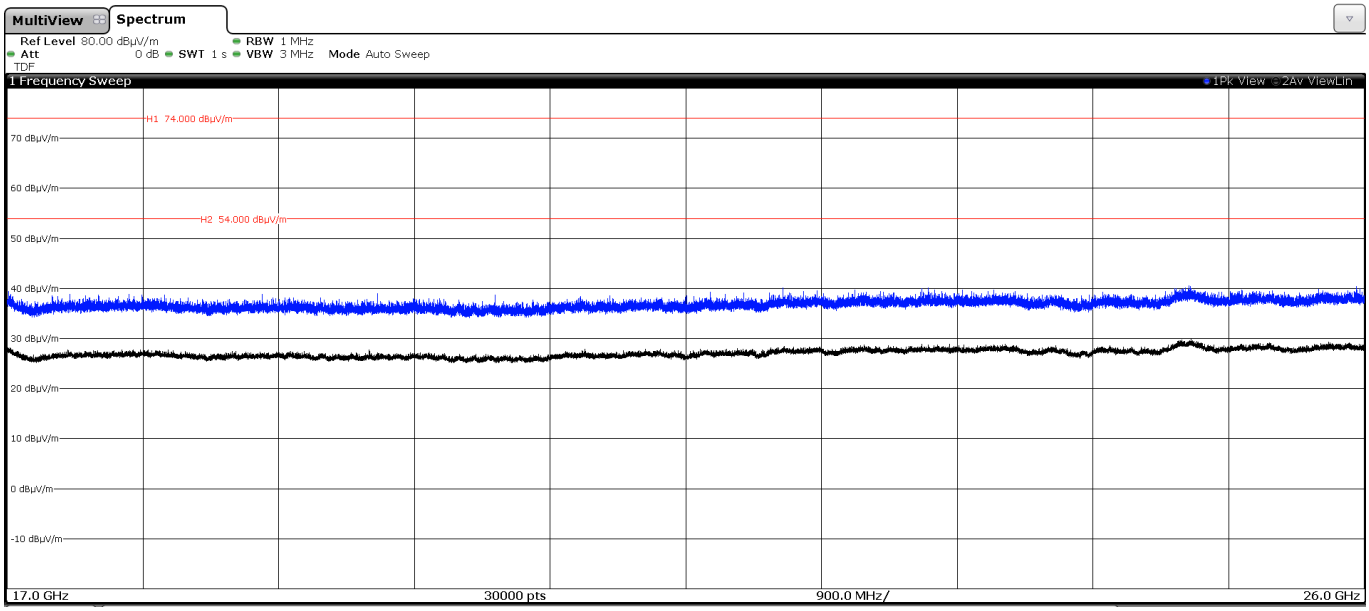


- High Channel (2480 MHz):



FREQUENCY RANGE 17 - 26 GHz:

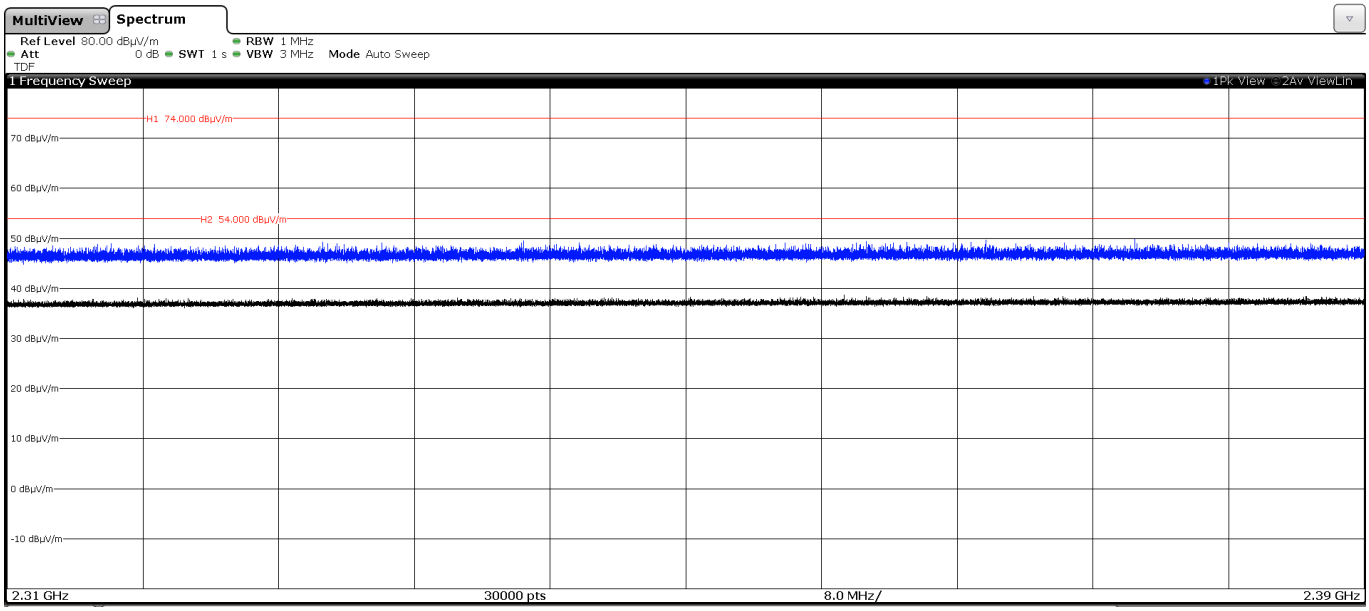
This plot is valid for the Low, Middle and High Channels and all the modulation modes.



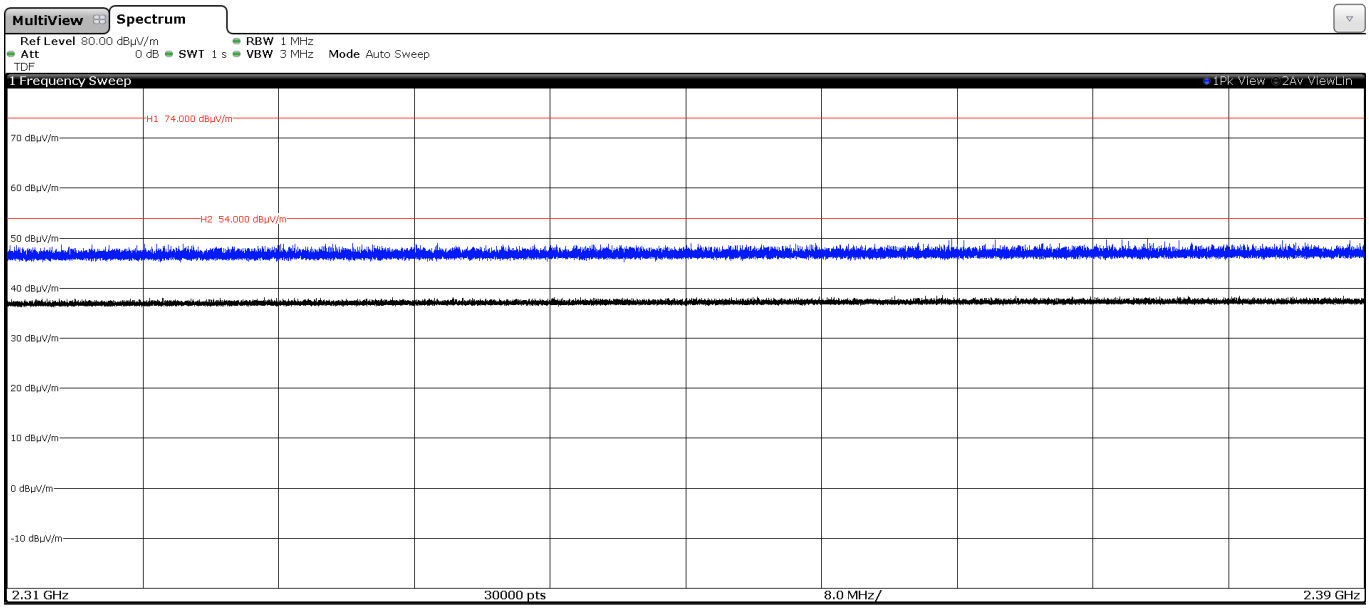
FREQUENCY RANGE 2.31-2.39 GHz:

- **GFSK modulation (DH5)**

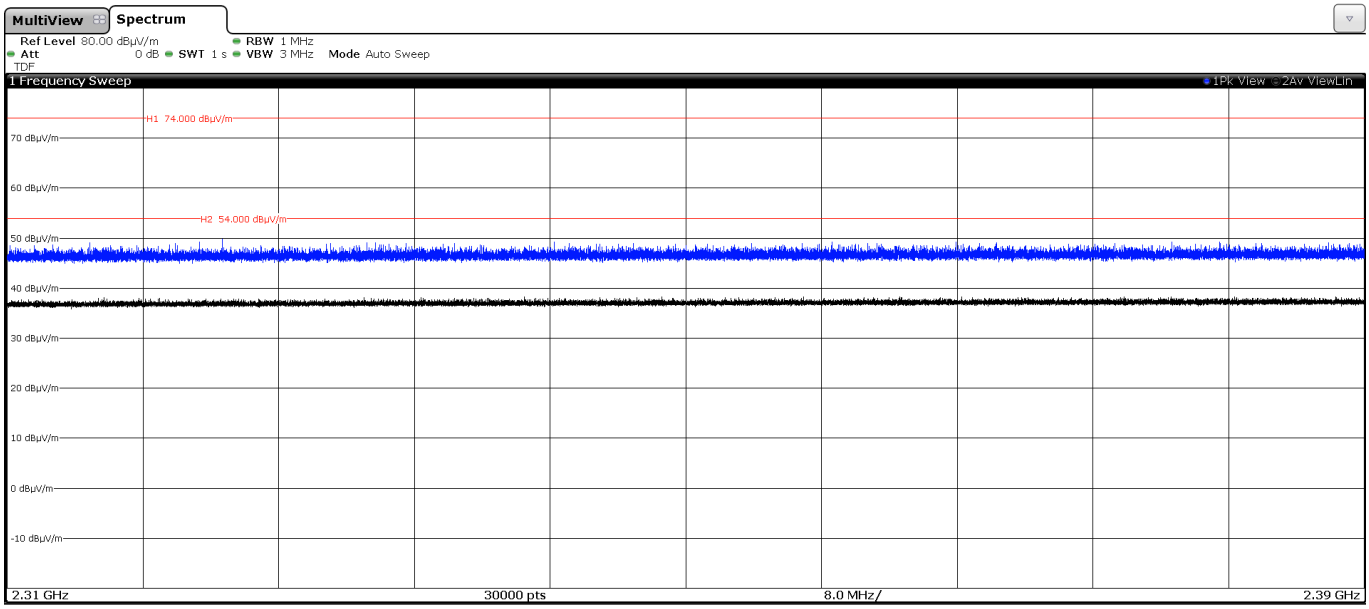
- Low Channel (2402 MHz):



- Middle Channel (2441 MHz):

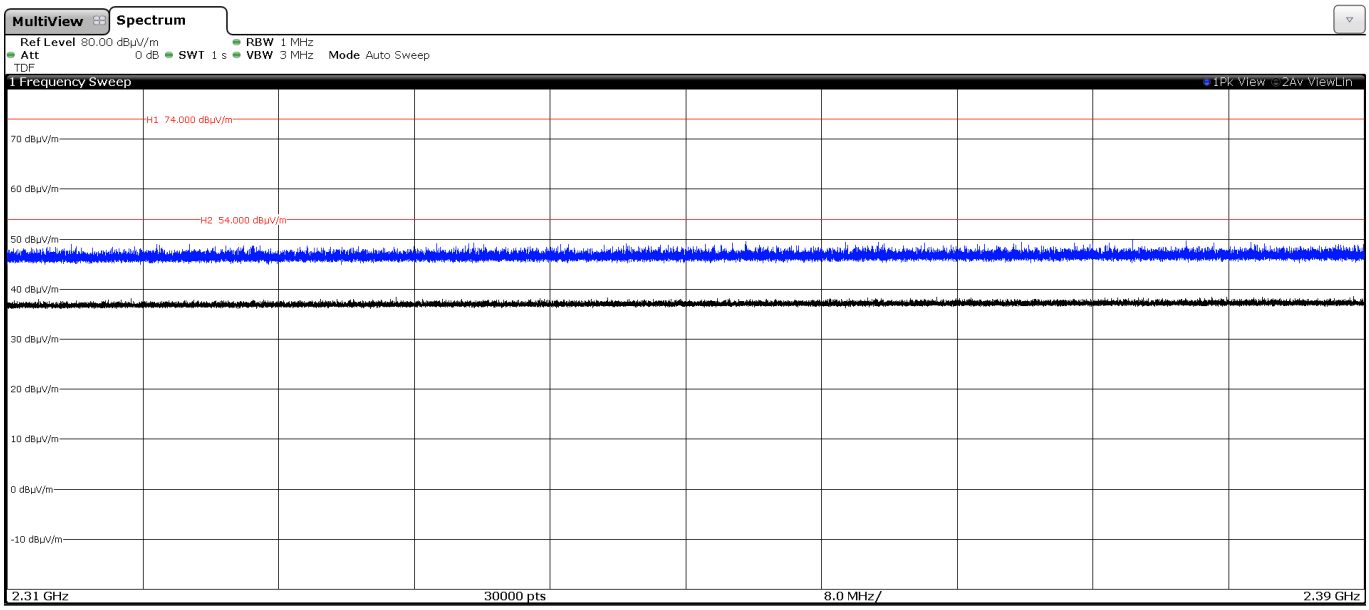


- High Channel (2480 MHz):

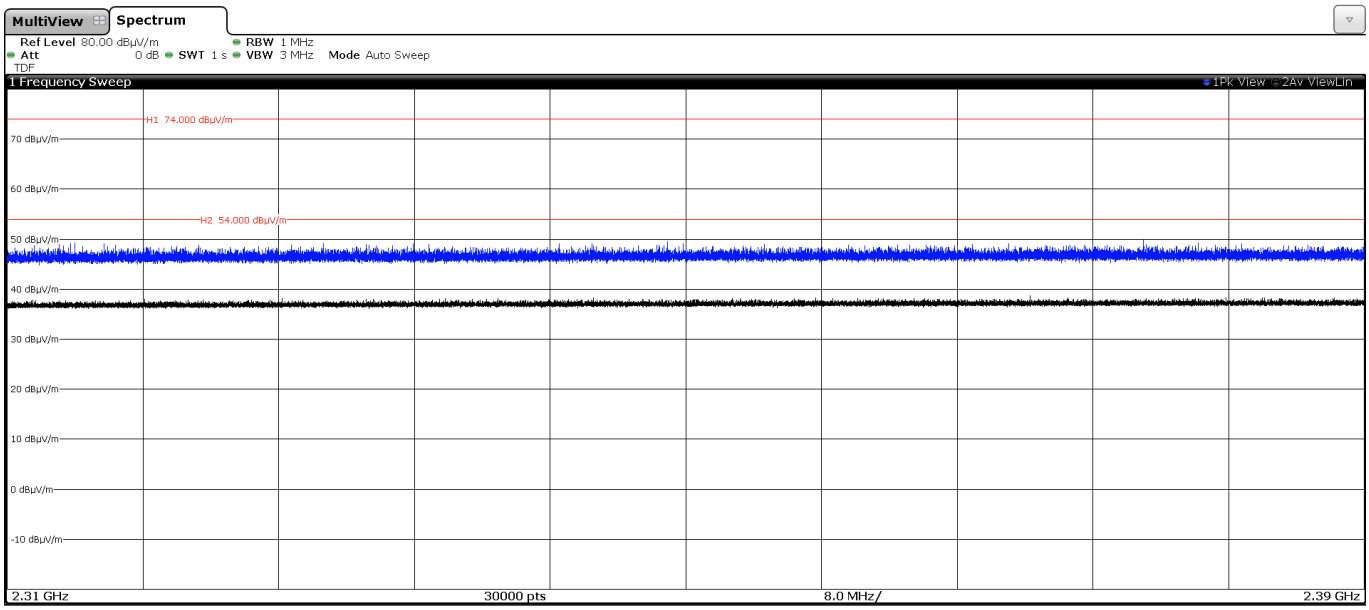


- **Pi/4-DQPSK modulation (2DH5)**

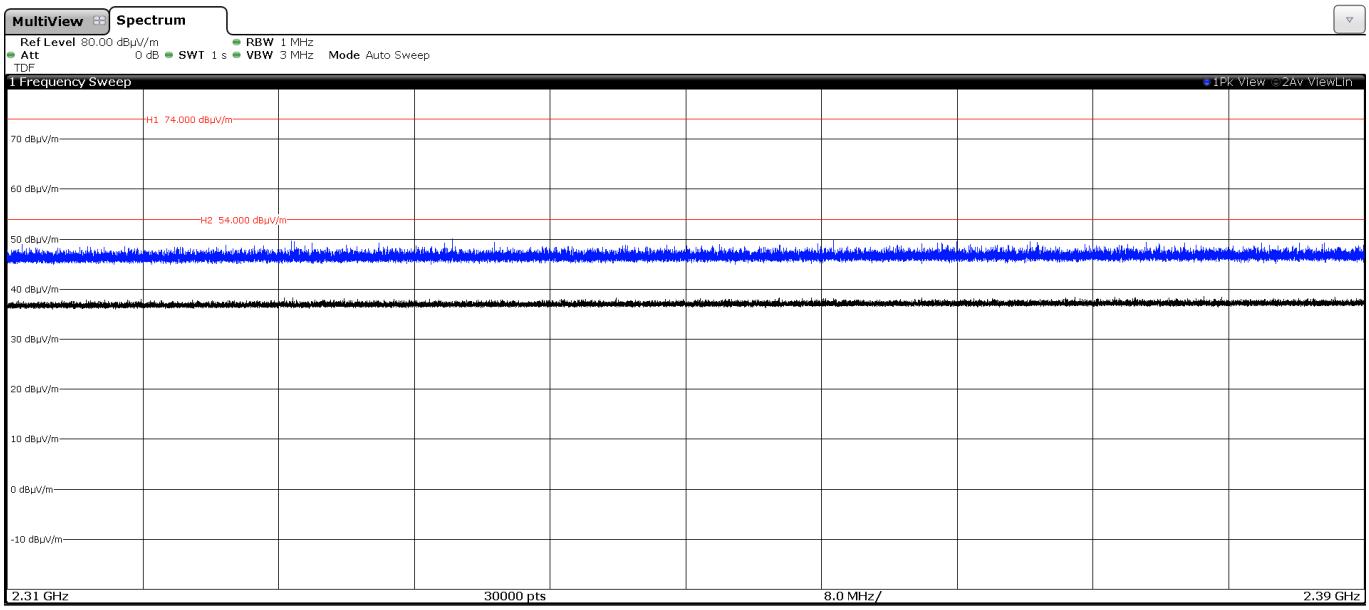
  - Low Channel (2402 MHz):



  - Middle Channel (2441 MHz):

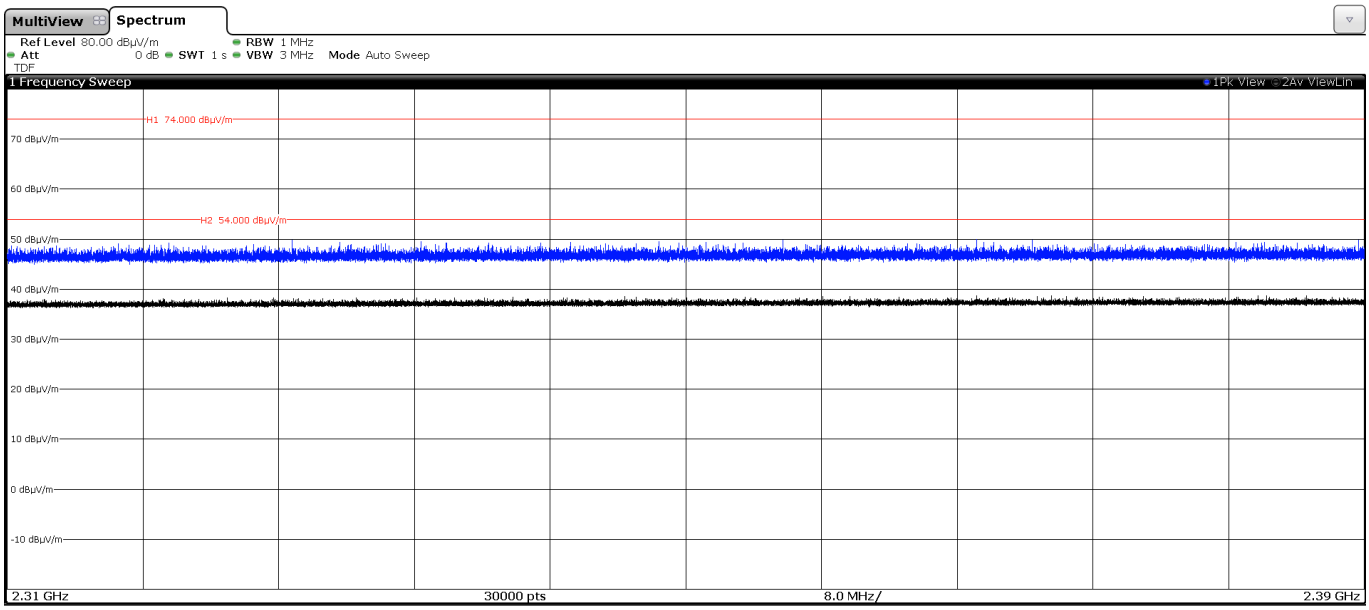


- High Channel (2480 MHz):

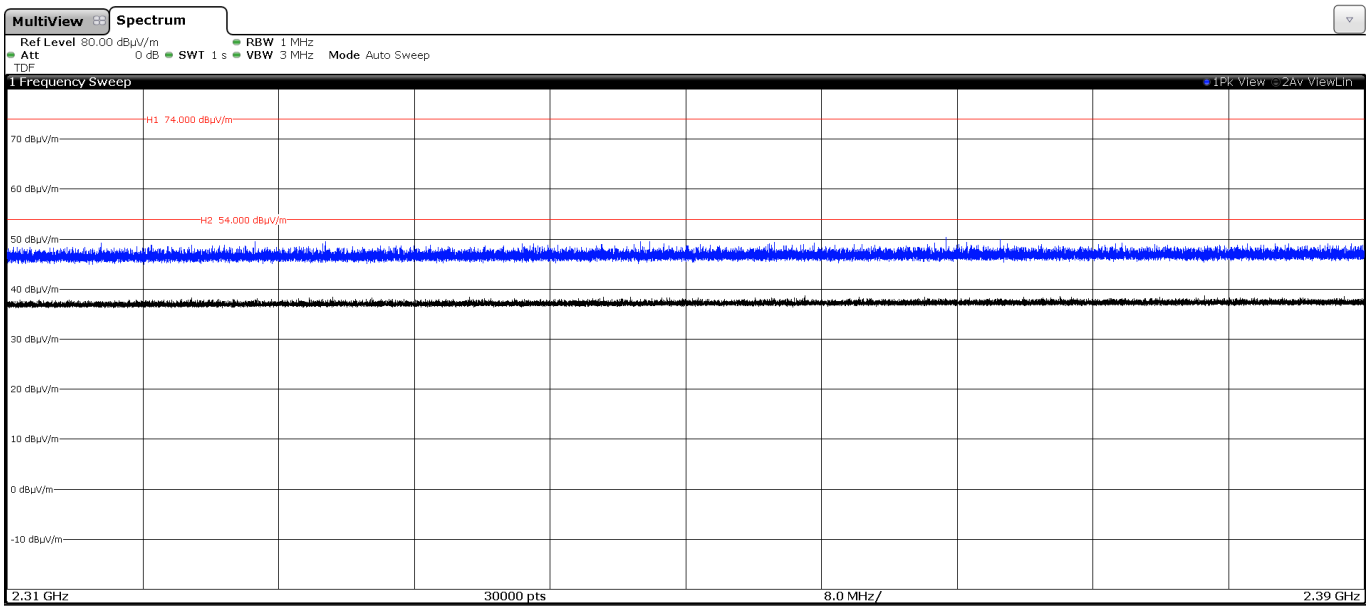


- **8-DPSK modulation (3DH5)**

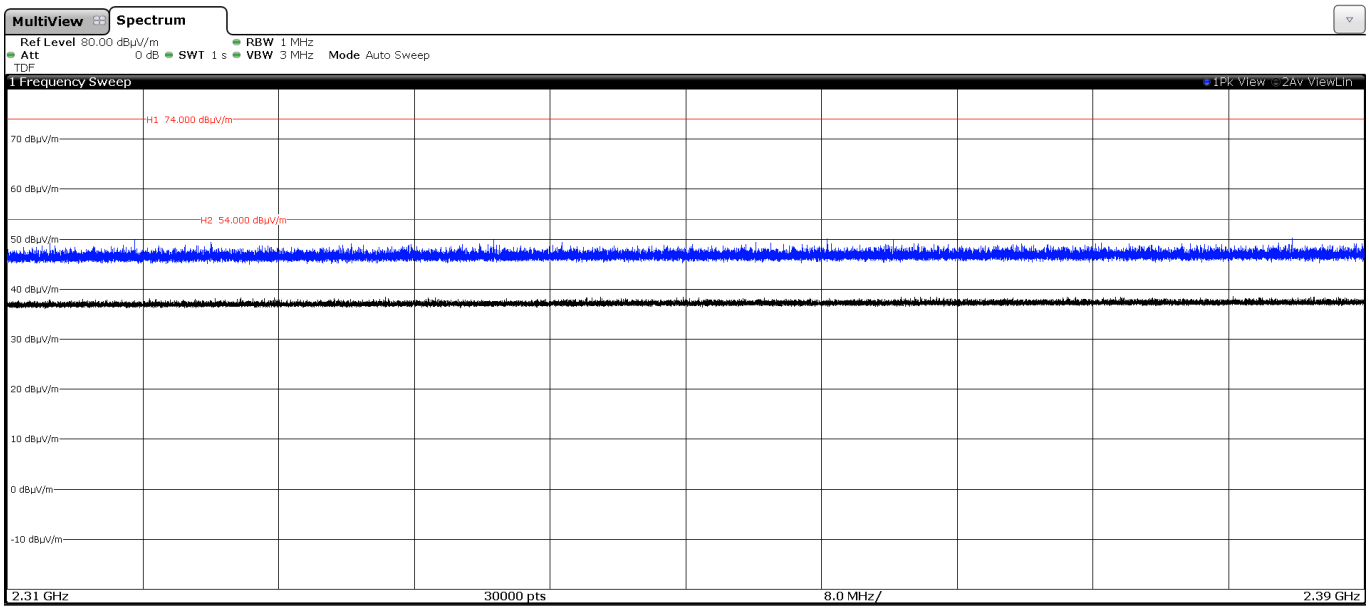
  - Low Channel (2402 MHz):



  - Middle Channel (2441 MHz):



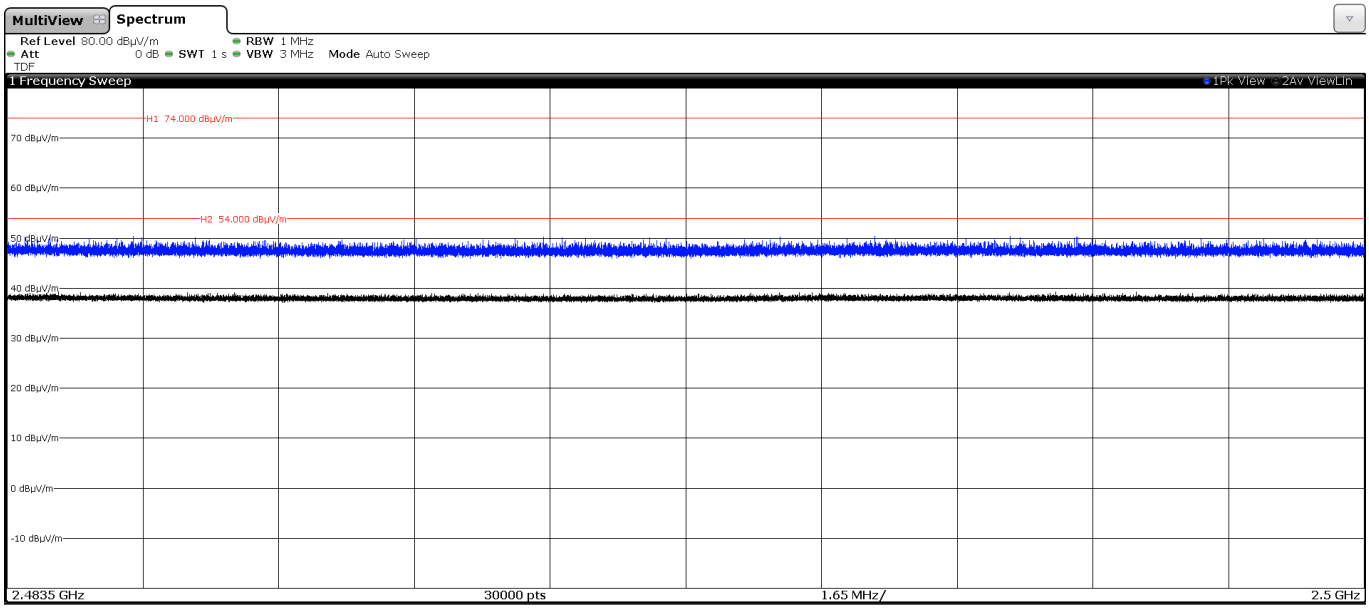
- High Channel (2480 MHz):



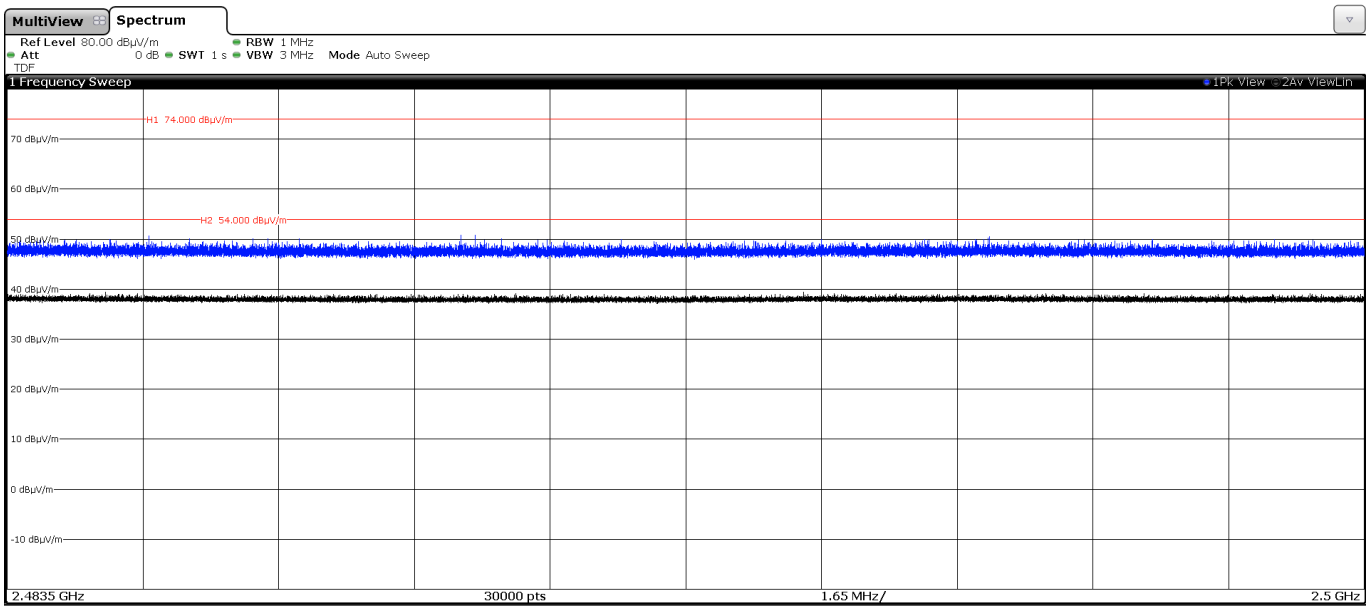
FREQUENCY RANGE 2.4835-2.5 GHz:

- **GFSK modulation (DH5)**

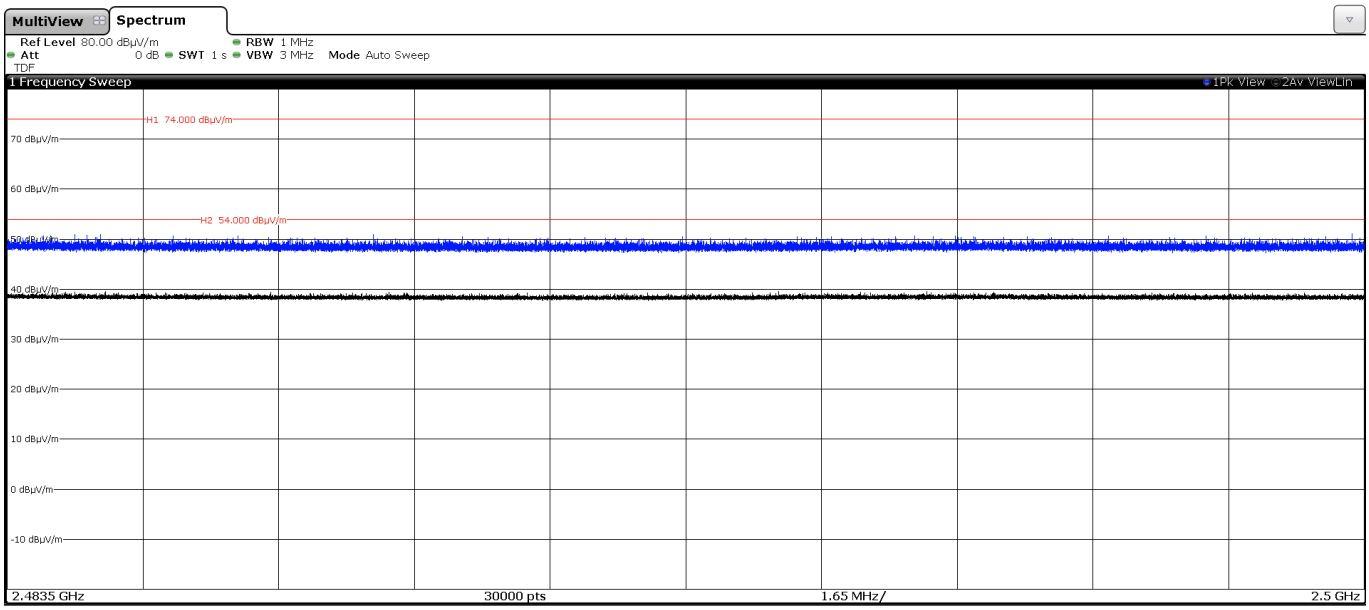
- Low Channel (2402 MHz):



- Middle Channel (2441 MHz):

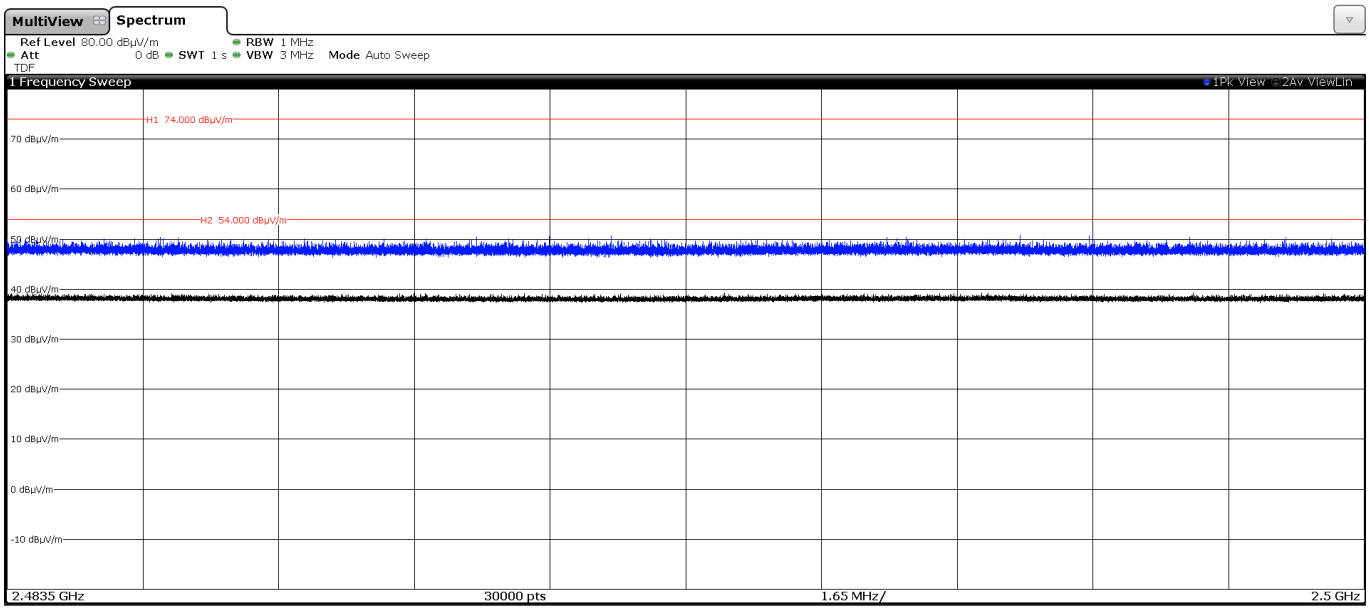


- High Channel (2480 MHz):

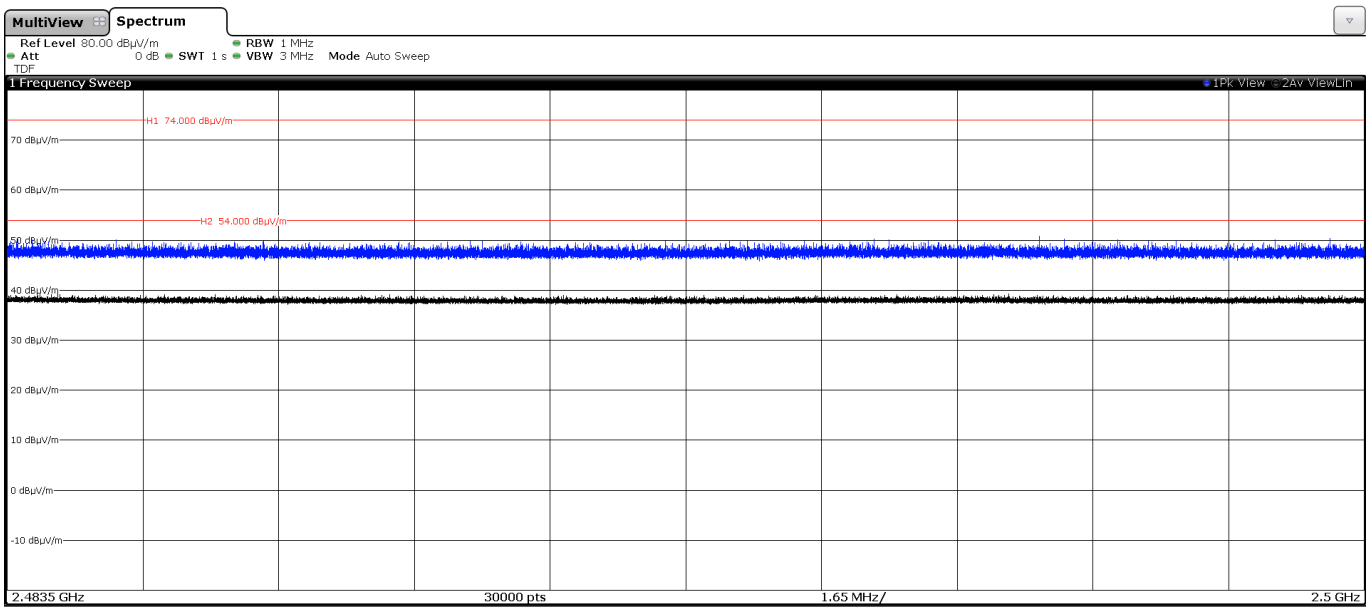


- **Pi/4-DQPSK modulation (2DH5)**

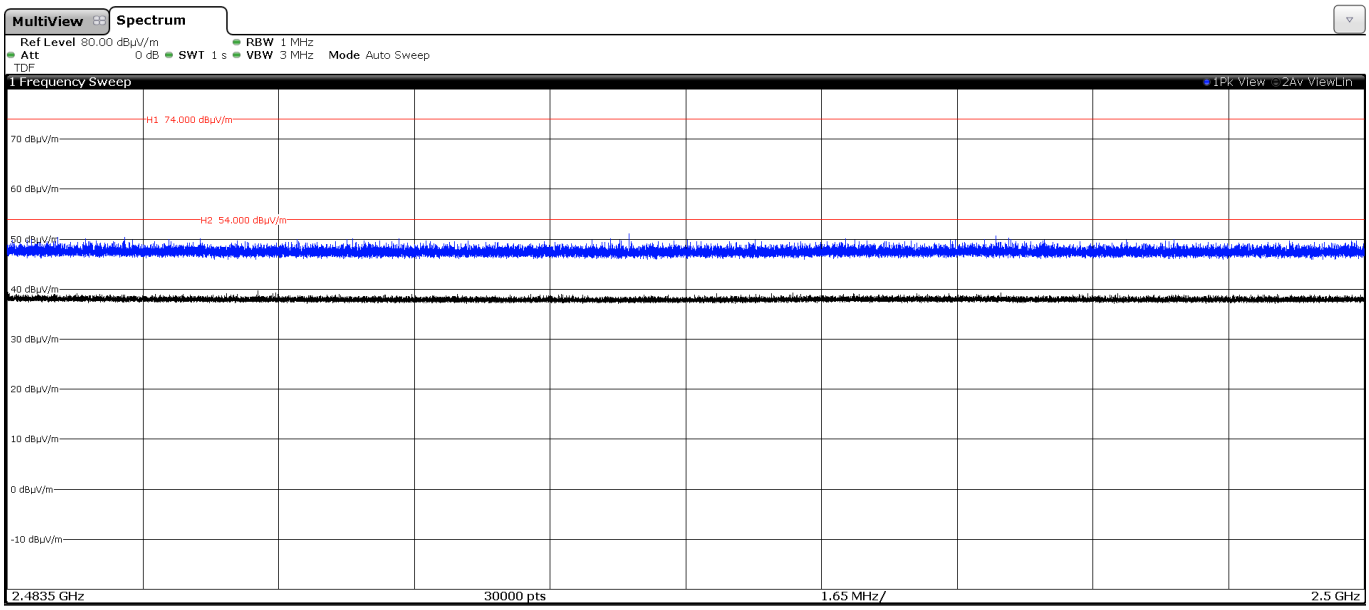
  - Low Channel (2402 MHz):



  - Middle Channel (2441 MHz):

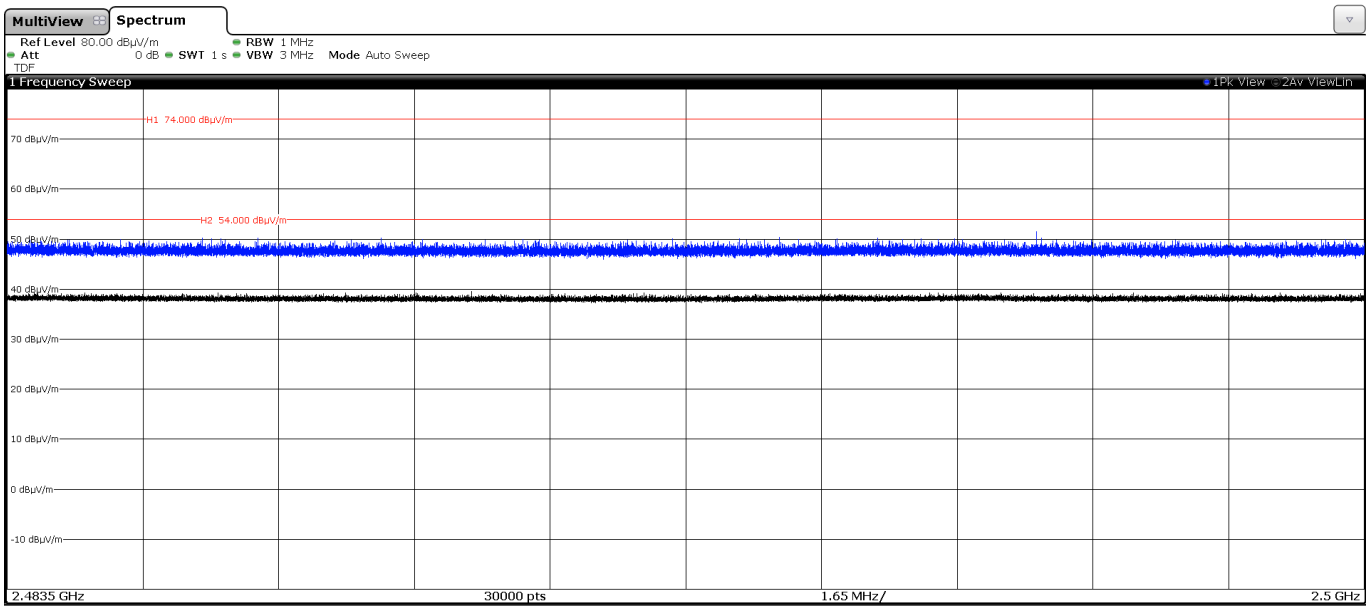


- High Channel (2480 MHz):

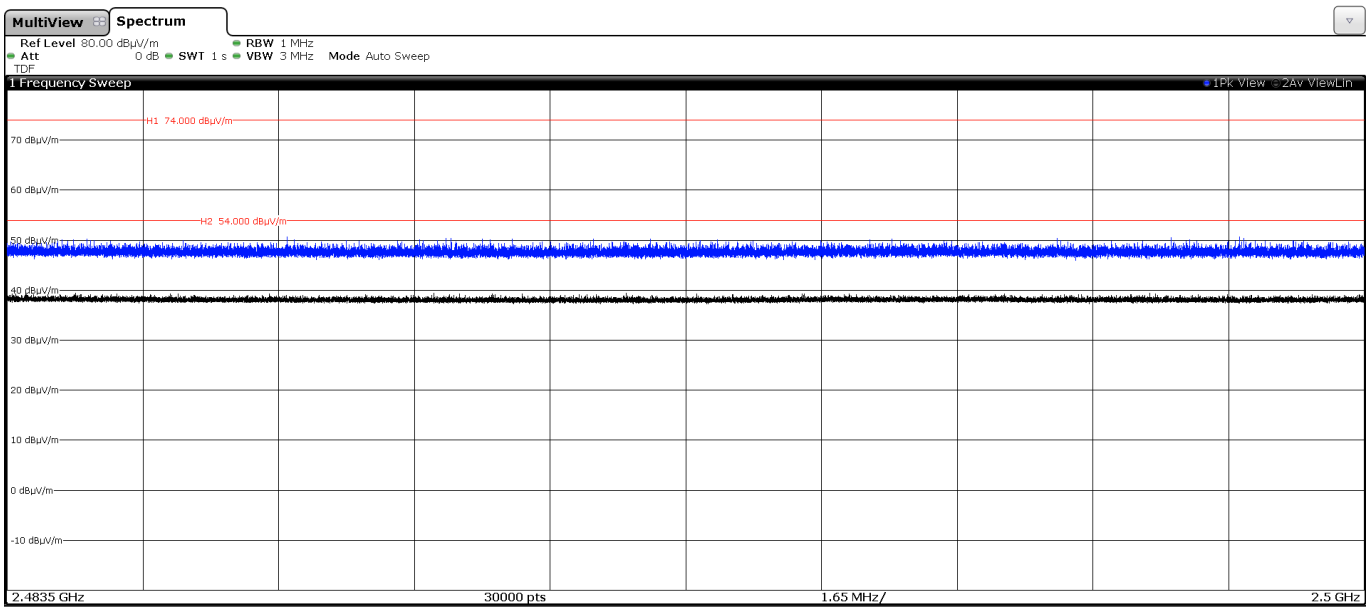


- **8-DPSK modulation (3DH5)**

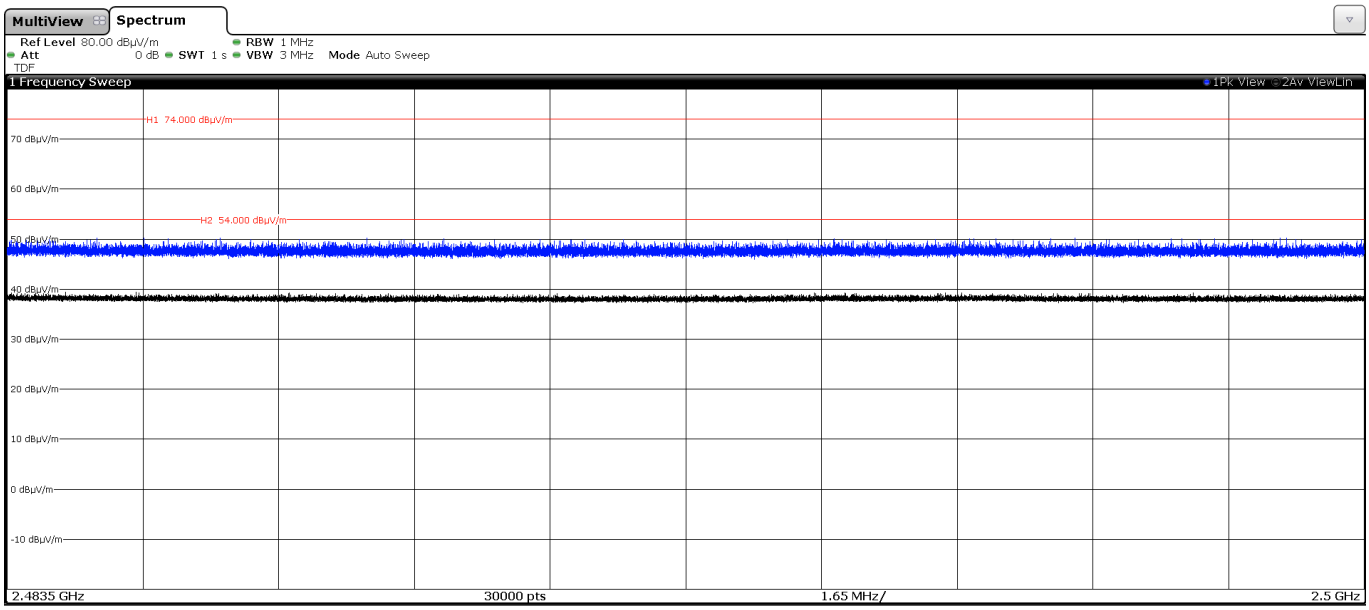
- Low Channel (2402 MHz):



- Middle Channel (2441 MHz):



- High Channel (2480 MHz):



Appendix B: Test results. 802.11 bgn20 2x2

INDEX

TEST CONDITIONS

POWER SUPPLY (V):

V nonimal:	12 Vdc
Type of Power Supply:	DC voltage from external power supply (car battery).

ANTENNAS:

Type of Antenna: External.

Antennas Gain:

- SISO – CORE1_Port4 Antenna – Declared Maximum Antenna Gain: +2.4 dBi
- MIMO – CORE1_Port4 & Port1 Antennas – Declared Maximum Antenna Gain: +3 dBi

TEST FREQUENCIES:

For Wi-Fi 802.11b/g/n20:

Low Channel (1):	2412 MHz
Middle Channel (6):	2437 MHz
High Channel (11):	2462 MHz

The sample was used to configure the EUT to continuously transmit at a specified output power in all channels with different modes and modulation schemes.

The field strength at the band edges was evaluated for each mode for the channel under test.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The EUT has four separate antennas which correspond to one port of the equipment.

For the Transmitter Minimum 6 dB Bandwidth test, only SISO modes were tested since the bandwidth does not change depending on chains used.

The data rates of 1Mb/s for 802.11b, 6.5Mb/s for 802.11g, MSC0 for 802.11n20 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and band edge levels at restricted bands.

CONDUCTED MEASUREMENTS

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.

RADIATED MEASUREMENTS

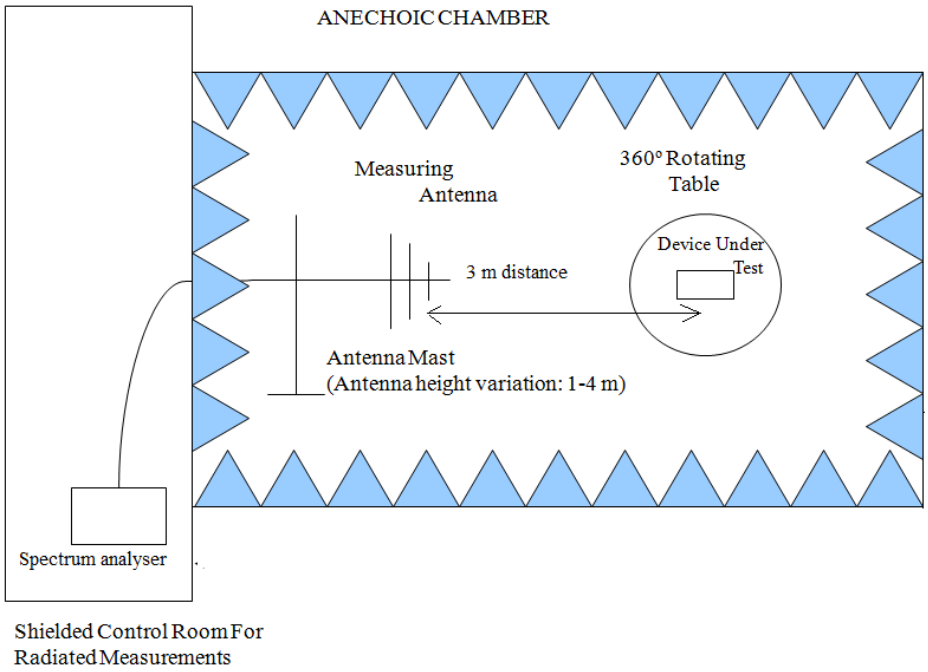
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

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.

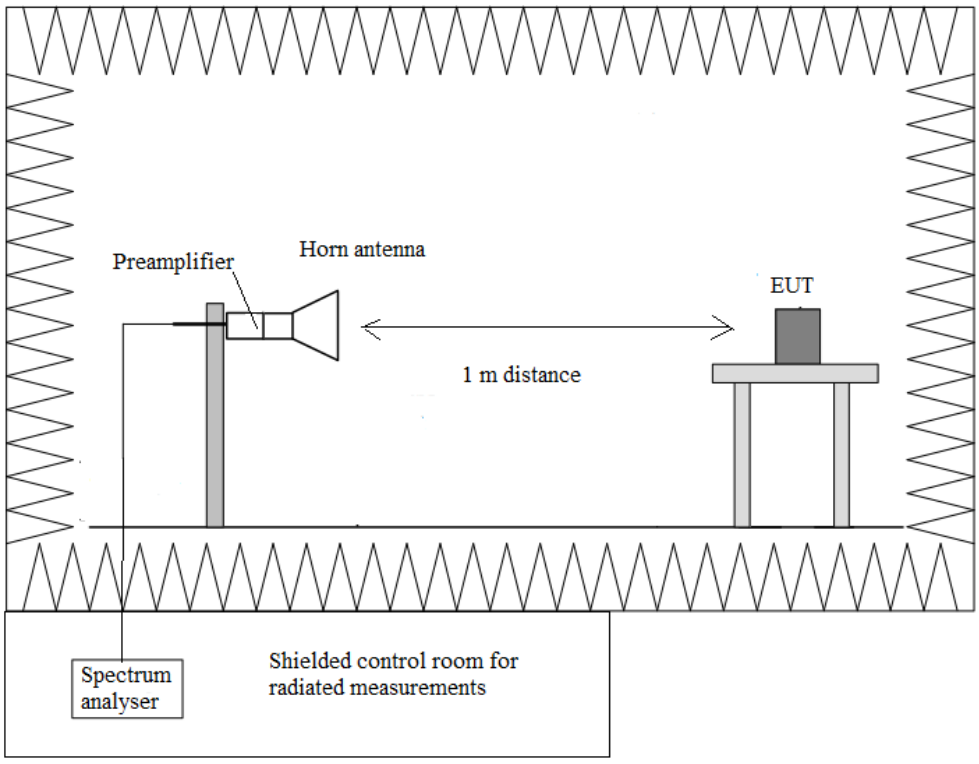
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup f > 1 GHz:



Occupied Bandwidth

RESULTS:

Preliminary tests determined the SISO worst case is CORE1_Port4 Antenna.
Preliminary tests determined the MIMO worst case is CORE1_Port4 Antenna & CORE1_Port1 Antenna.

SISO CORE1_Port4 Antenna:

- **Mode 802.11 b**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	11.20	11.20	11.05
-26 dBc bandwidth (MHz)	14.515	14.436	14.434
Measurement uncertainty (kHz)	<± 28.03		

- **Mode 802.11 g**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	16.90	16.85	16.85
-26 dBc bandwidth (MHz)	21.315	21.319	21.412
Measurement uncertainty (kHz)	<± 23.08		

- **Mode 802.11 n20**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	18.15	18.10	18.10
-26 dBc bandwidth (MHz)	21.915	21.869	21.862
Measurement uncertainty (kHz)	<± 23.08		

Verdict: PASS

MIMO – CORE1_Port4 Antenna & CORE1_Port1 Antenna:

- **Mode 802.11 b**

	Low Channel 2412 MHz		Middle Channel 2437 MHz		High Channel 2462 MHz	
	CORE1_ Port4	CORE1_ Port1	CORE1_ Port4	CORE1_ Port1	CORE1_ Port4	CORE1_ Port1
99% bandwidth (MHz)	11.30	11.00	10.70	10.64	11.15	10.85
-26 dBc bandwidth (MHz)	14.459	14.409	14.280	14.280	14.457	14.407
Measurement uncertainty (kHz)	<± 18.02					

- **Mode 802.11 g**

	Low Channel 2412 MHz		Middle Channel 2437 MHz		High Channel 2462 MHz	
	CORE1_ Port4	CORE1_ Port1	CORE1_ Port4	CORE1_ Port1	CORE1_ Port4	CORE1_ Port1
99% bandwidth (MHz)	16.80	16.90	16.83	16.86	16.85	16.85
-26 dBc bandwidth (MHz)	21.531	21.431	21.360	21.330	21.465	21.515
Measurement uncertainty (kHz)	<± 18.02					

- **Mode 802.11 n20**

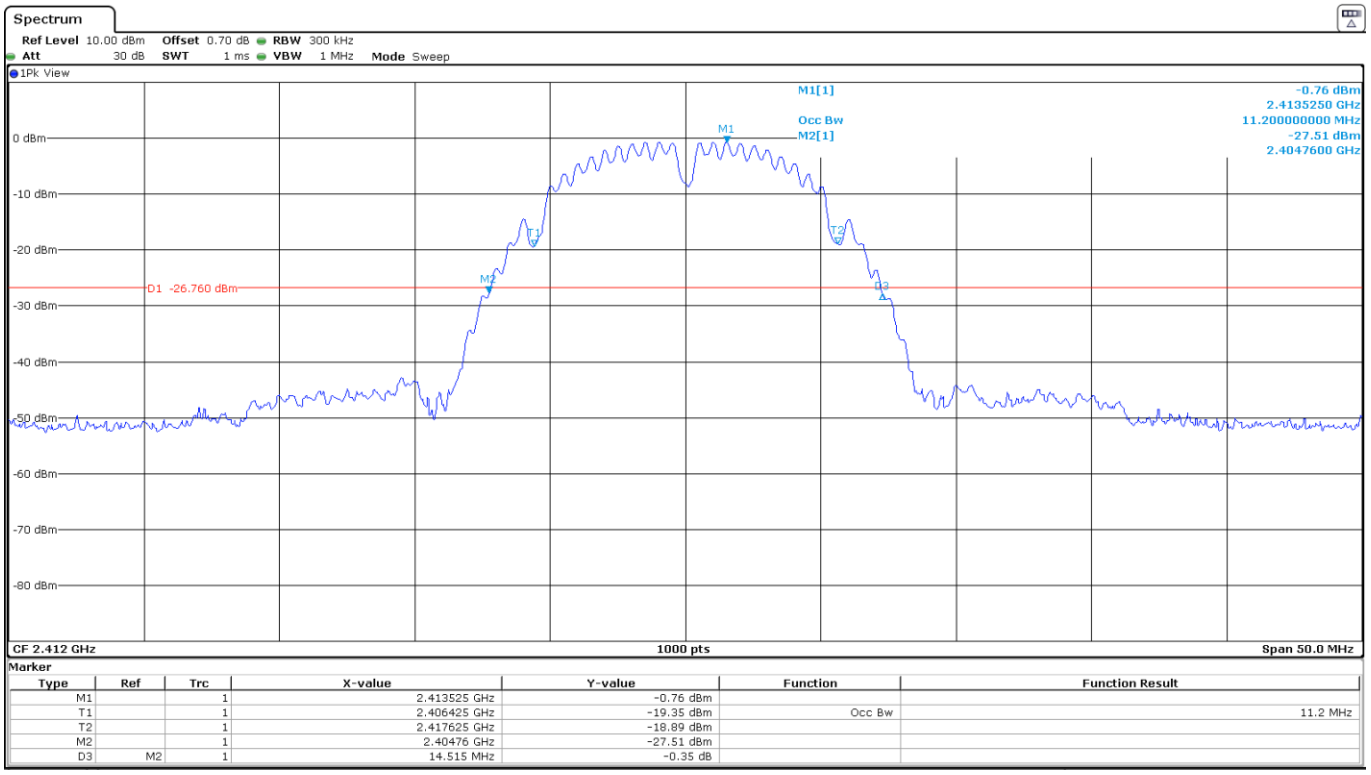
	Low Channel 2412 MHz		Middle Channel 2437 MHz		High Channel 2462 MHz	
	CORE1_ Port4	CORE1_ Port1	CORE1_ Port4	CORE1_ Port1	CORE1_ Port4	CORE1_ Port1
99% bandwidth (MHz)	17.75	18.10	17.76	18.06	17.80	18.10
-26 dBc bandwidth (MHz)	21.531	21.881	21.450	21.720	21.665	21.815
Measurement uncertainty (kHz)	<± 23.02					

Verdict: PASS

SISO CORE1_Port4 Antenna:

- **Mode 802.11 b – Occupied Bandwidth**

- Low Channel:



- Middle Channel: