



Test report No:
NIE: 61249RRF.008

Test Report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.

General Requirements and Information for the Certification of Radio Apparatus.

(*) Identification of item tested	Multimedia System
(*) Trademark	Continental
(*) Model and /or type reference	NAC EUR 19W4
Other identification of the product	HW version: D4 SW version: 42.01.21.42 FCC ID: ZFW-HW19W4
(*) Features	See on page 4
Applicant	CONTINENTAL AUTOMOTIVE RAMBOUILLET FRANCE S.A.S. 1, rue de Clairefontaine, Rambouillet, 78120, France
Test method requested, standard	USA FCC Part 15.247 10-1-18 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-18 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 (April 2018). Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael López EMC Consumer & RF Lab. Manager
Date of issue	2019-10-23
Report template No	FDT08_22 (*) "Data provided by the client"

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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.

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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 NAC EUR 19W4 is a Multimedia System and OEM product for PSA.

This product is connected to the BSI (Boitier de Servitude Intelligent) via a CAN Low Speed BUS. Two displays can be connected.

3. Features:
 - BT 3.0
 - WiFi b,g,n, 2.4 GHz only
 - Radio (AM, FM, DAB band III & L)

- Navigation (GPS, GLONASS, GALILEO, SBAS)
- External GMSL colour display, CAN interface to car, Internal Audio Amplifier, USB plug

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 N°	Description	Model	Serial N°	Date of reception
61249D/011	Multimedia System	NAC EUR 19W4	W4_BS1921000013 8_TOP_RF_RE	2019/07/23
61249D/034	CAN Traffic Simulator (C6)	--	00010	2019/07/23
61249D/039	CSR Interface SDIO card	--	00015	2019/07/23
61249D/043	Ultra Light Harness – FAKRA Block Connector	--	00019	2019/07/23

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

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

Control N°	Description	Model	Serial N°	Date of reception
61249D/010	Multimedia System	NAC EUR 19W4	W4_BS1921000014 4_TOP_RF_CE	2019/07/23
61249D/034	CAN Traffic Simulator (C6)	--	00010	2019/07/23
61249D/039	CSR Interface SDIO card	--	00015	2019/07/23
61249D/043	Ultra Light Harness – FAKRA Block Connector	--	00019	2019/07/23

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

Test sample description

Ports..... :	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾
	Power Supply (EMC; Safety & RF cables)	2	☐	☐	☐
	CAN LS (EMC; Safety & RF cables)	2	☐	☐	☐
	Loudspeakers (EMC & Safety cables)	2	☐	☐	☐
	Video Input (EMC & Safety cables)	2	☐	☐	☐
	CD Power (EMC & Safety cables)	2	☐	☐	☐
	CD Audio In (EMC & Safety cables)	2	☐	☐	☐
	Line Out Subwoofer (EMC & Safety cables)	2	☐	☐	☐
	Line Out Central (EMC & Safety cables)	2	☐	☐	☐
	AUX In Stereo (EMC & Safety cables)	2	☐	☐	☐
	Microphone 1 (EMC & Safety cables)	2	☐	☐	☐

	Microphone 2 (EMC & Safety cables)	2	☐	☐	☐		
Supplementary information to the ports.....:	2 Harness configurations 1 st configuration is complete and used for the EMC & Safety tests 2 nd configuration is lighter and used for the RF tests (Power + CAN LS)						
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: 12 V					
☐	DC:						
Rated Power	12 V – 15 A => 180 W						
Clock frequencies	Max. Frequency = Bluetooth F _{max} 2.4835 GHz						
Other parameters.....:	FCC ID: ZFW-HW19W4						
Software version	42.01.21.42						
Hardware version.....:	D4						
Dimensions in cm (W x H x D)....:	22 x 5.2 x 16						
Mounting position.....:	☐	Table top equipment					
	☐	Wall/Ceiling mounted equipment					
	☐	Floor standing equipment					
	☐	Hand-held equipment					
	☒	Other: Car Dashboard Equipment					
Modules/parts	Module/parts of test item		Type	Manufacturer			
Accessories (not part of the test	Description		Type	Manufacturer			

item)	GPS Antenna	Antenna GPS7 M- Fakra Femelle	HIRSCHMAN N
	AM/FM/DAB antenna	RDA 015- 1450 RD/S	HIRSCHMAN N
	CAN SIM Box	C6	RIEDERER ELEKTRONIK
Documents as provided by the applicant.....:	Description	File name	Issue date
	Technical Specifications	HW2019_B T.pdf	
	Technical Specifications	HW2019_W iFi.pdf	

Identification of the client

CONTINENTAL AUTOMOTIVE RAMBOUILLET FRANCE S.A.S.
1, rue de Clairefontaine 78120 Rambouillet France

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2019-08-13
Date (finish)	2019-09-06

Document history

Report number	Date	Description
61249RRF.008	2019-10-23	First release

Environmental conditions

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

Temperature	Min. = 15 °C Max. = 35 °C
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 °C Max. = 35 °C
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 °C Max. = 35 °C
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: Miguel Ángel Torres, Ignacio Cabra, Jesús García Ramos, Cristina Calle Villarrazo.

Used instrumentation:

Conducted Measurements:

	Last Calibration	Due Calibration
1. Shielded Room ETS LINDGREN S101	N.A.	N.A.
2. Bluetooth Test Set ANRITSU MT8852B	N.A.	N.A.
3. Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV40	2018/02	2020/02
4. DC power supply R&S NGPE 40/40	2018/02	2021/02

Radiated Measurements:

	Last Calibration	Due Calibration
1. Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2. EMI Test Receiver ROHDE AND SCHWARZ ESR7	2018/10	2020/10
3. RF Pre-amplifier 40 dB, 10 MHz-6 GHz BONN ELEKTRONIK BLNA 0160-01N	2019/02	2020/08
4. Biconical/Log Antenna ETS LINDGREN 3142E	2017/09	2020/09
5. Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV40	2018/02	2020/02
6. RF Pre-amplifier 30 dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2019/04	2020/04
7. Broadband Horn antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2018/01	2021/01
8. RF Pre-amplifier 30 dB, 18 GHz-40 GHz BONN ELEKTRONIK BLMA 1840-1M	2019/02	2021/02
9. Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2018/07	2021/07

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 conducted (Transmitter)	P	
Section 15.247 Subclause (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
Supplementary information and remarks: None.			

2. Wi-Fi 2.4 GHz (802.11 b/g/n20 1x1).

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	Emission limitations conducted (Transmitter)	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)

TEST CONDITIONS	13
FCC Section 15.247 Subclause (a) (1) / RSS-247 Clause 5.1. (b) 20 dB Bandwidth and Carrier frequency separation.	16
FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Number of hopping channels.	26
FCC Section 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (d) Time of occupancy (Dwell Time).....	29
FCC Section 15.247 Subclause (b) / RSS-247 Clause 5.4 (b) Maximum peak output power and antenna gain	35
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations conducted (Transmitter).....	41
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge emissions compliance (Transmitter) (conducted)	50
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations radiated. (Transmitter)	57

TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 12 Vdc
Type of Power Supply: External power supply (car battery).
Type of Antenna: Internal (printed).
Maximum Declared Antenna Gain: -0.99 dBi

TEST FREQUENCIES:

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

CONDUCTED MEASUREMENTS:

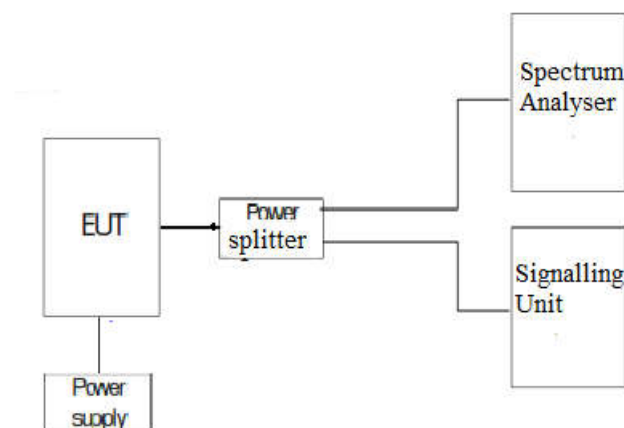
Hopping mode OFF:

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.

RADIATED MEASUREMENTS:

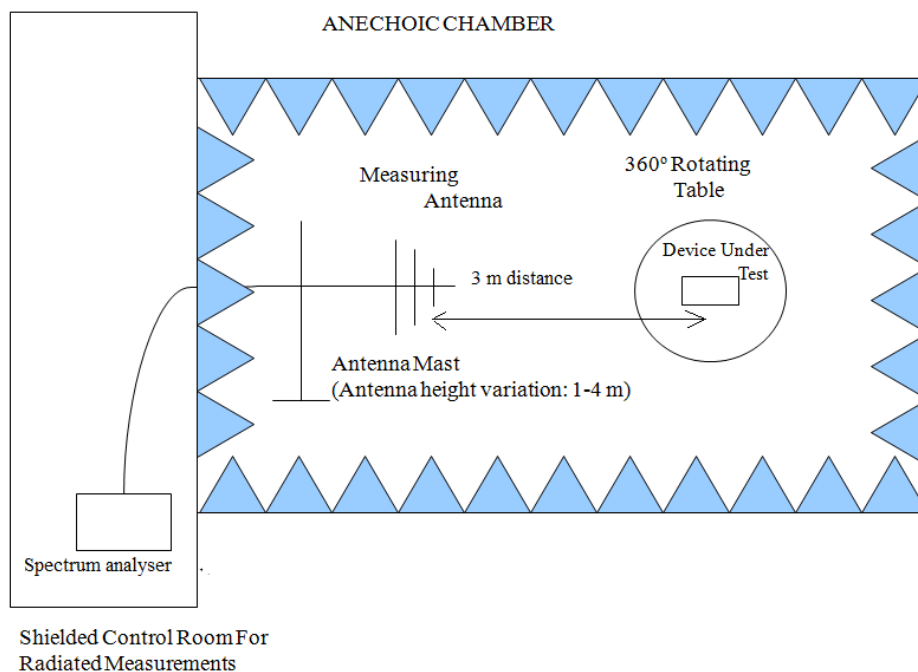
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

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.

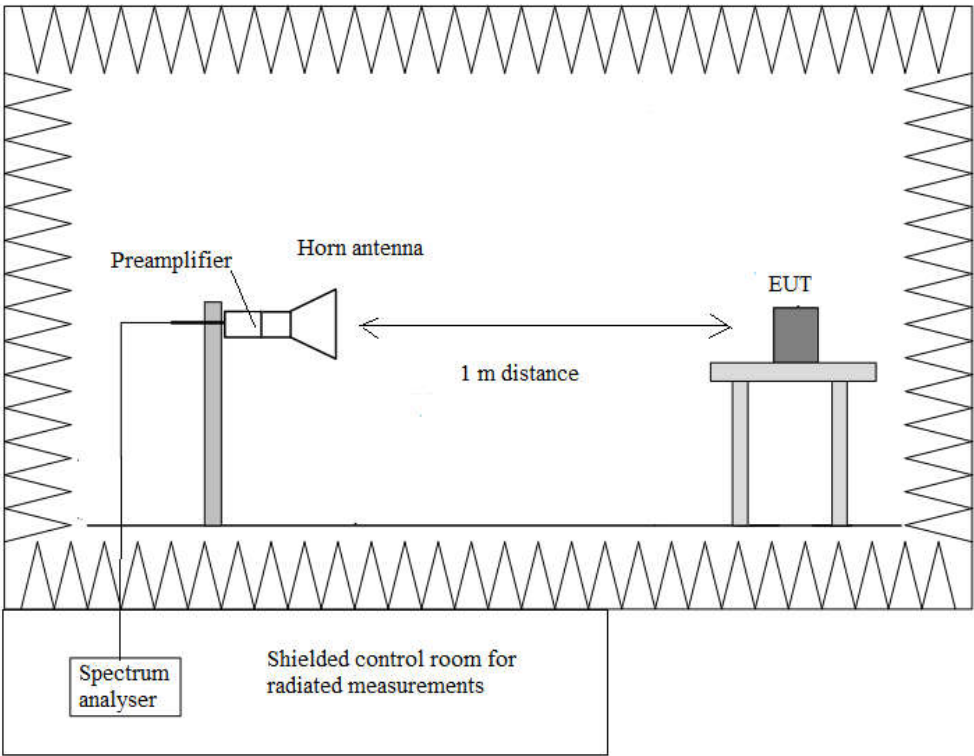
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find 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 $f > 1\text{ GHz}$:



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)	951.90	903.50	954.20
99% Bandwidth (kHz)	867	858	870
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)	1282.60	1283.80	1287.10
99% Bandwidth (kHz)	1167	1170	1182
Measurement uncertainty (kHz)	<±5.0		

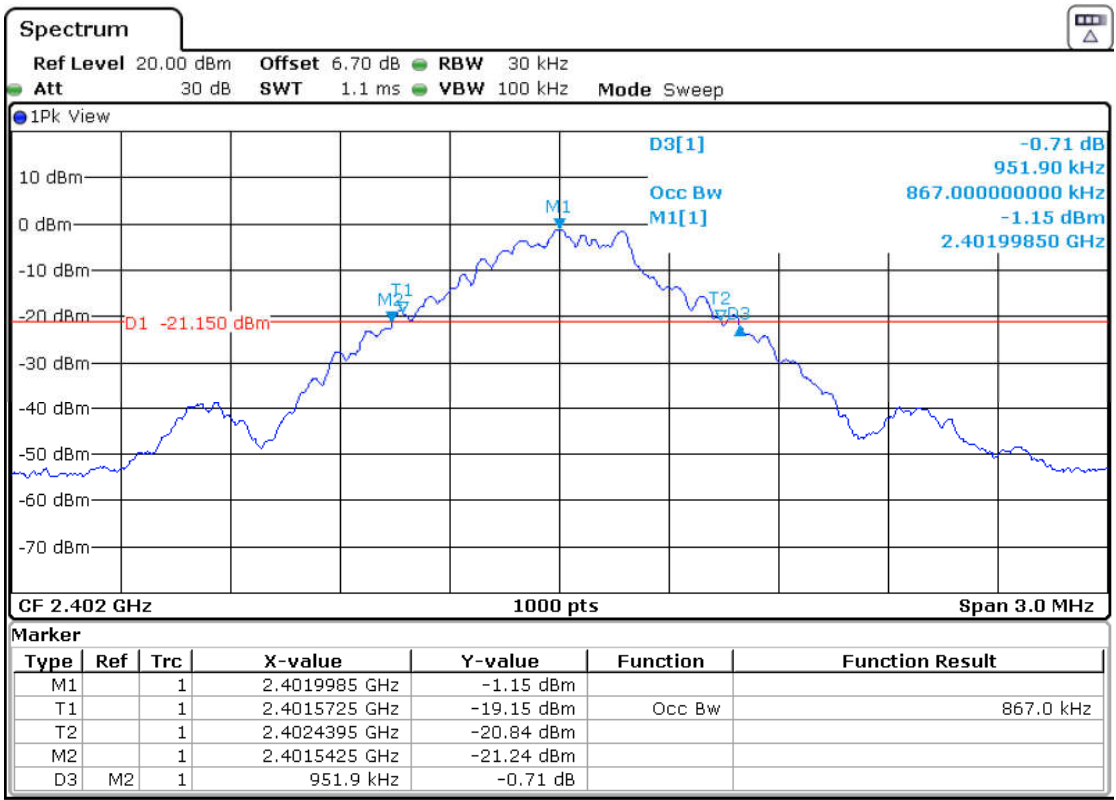
- 8DPSK**

	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
20 dB Spectrum Bandwidth (kHz)	1288.70	1289.70	1294.70
99% Bandwidth (kHz)	1167	1170	1182
Measurement uncertainty (kHz)	<±5.0		

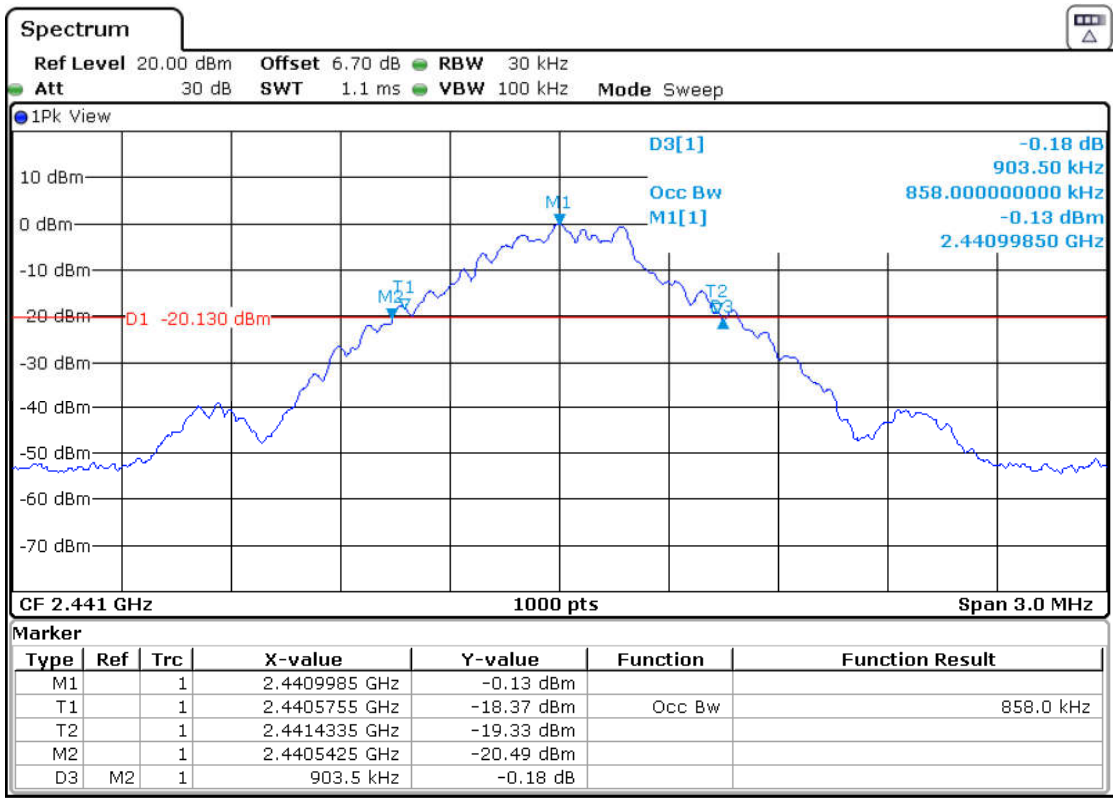
Verdict: PASS

GFSK – Bandwidths

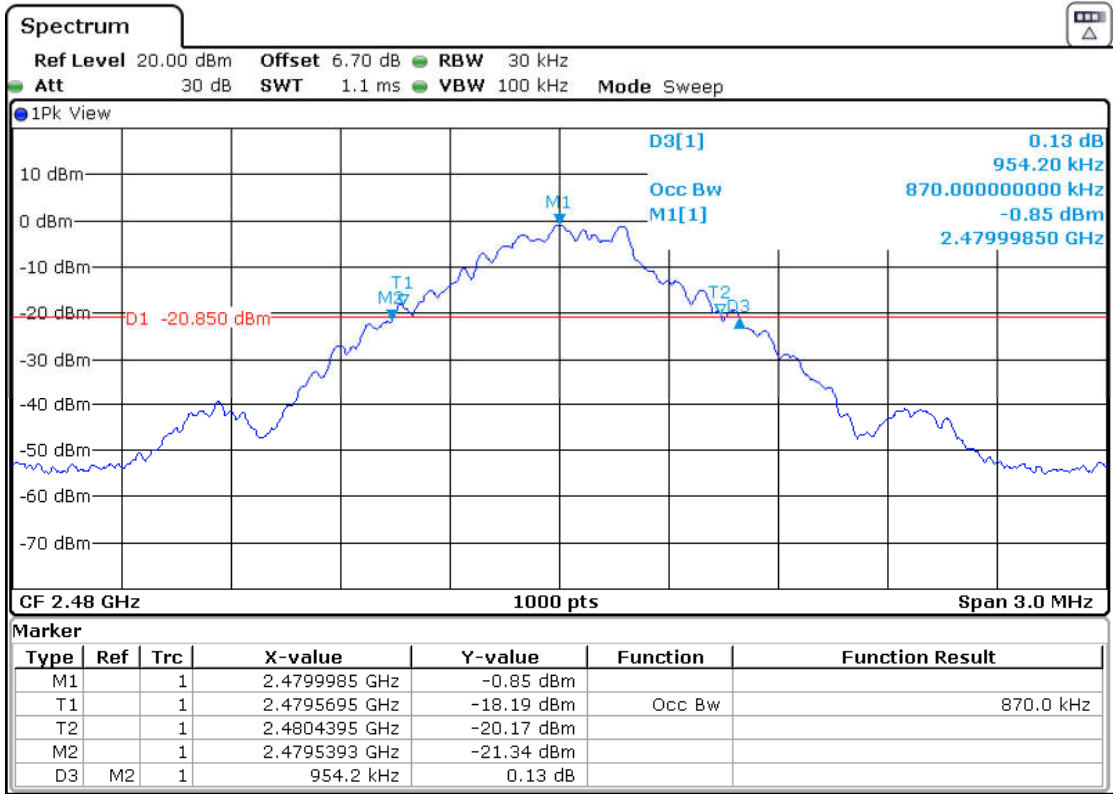
- Low Channel:



- Middle Channel:

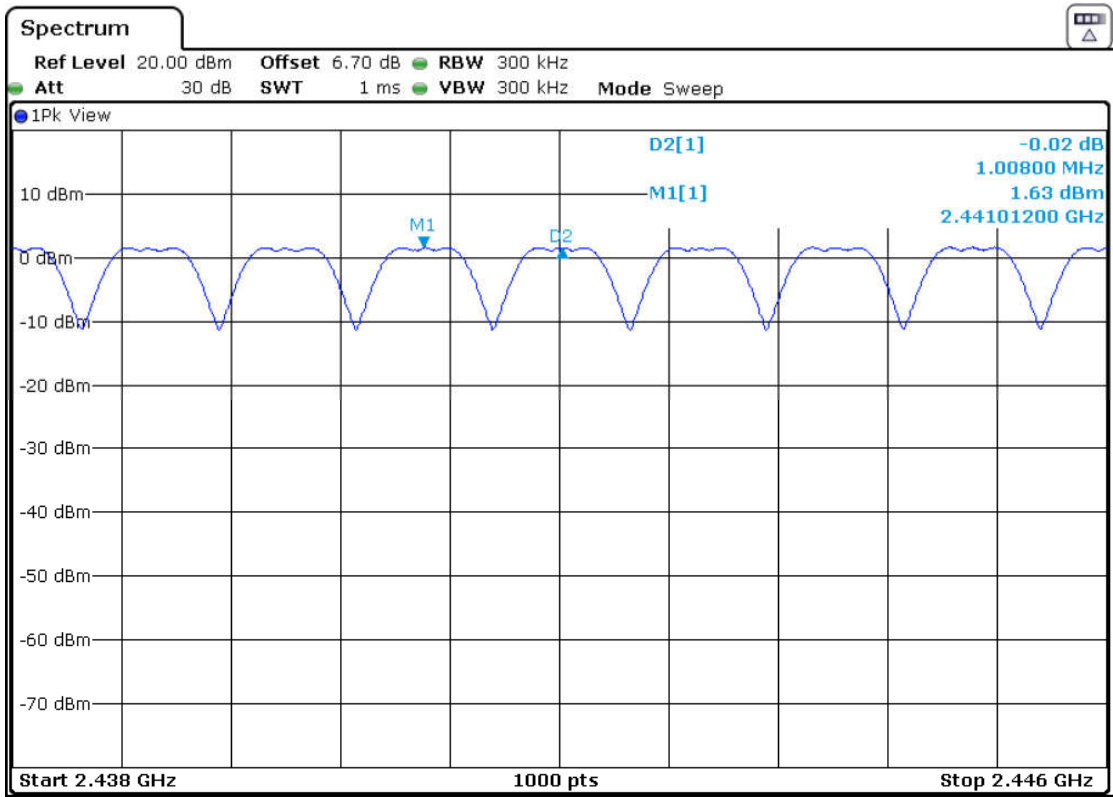


- High Channel:



Carrier frequency separation - GFSK

Carrier frequency separation: 1008 kHz

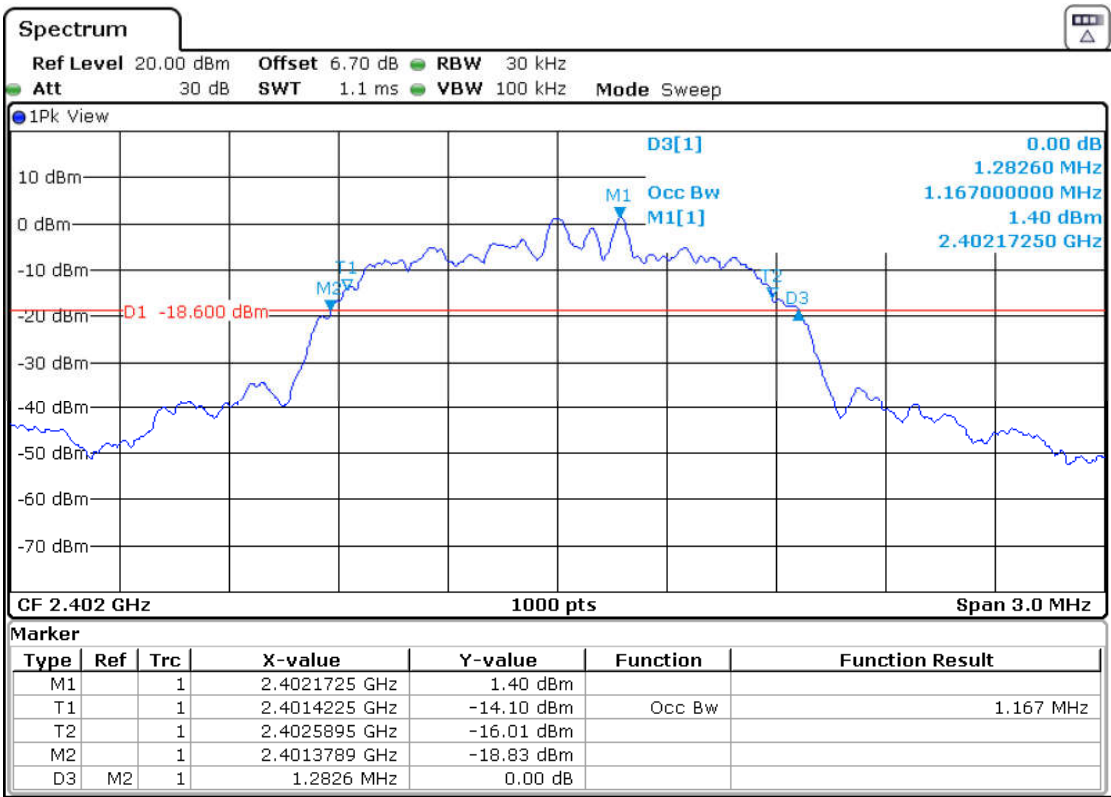


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

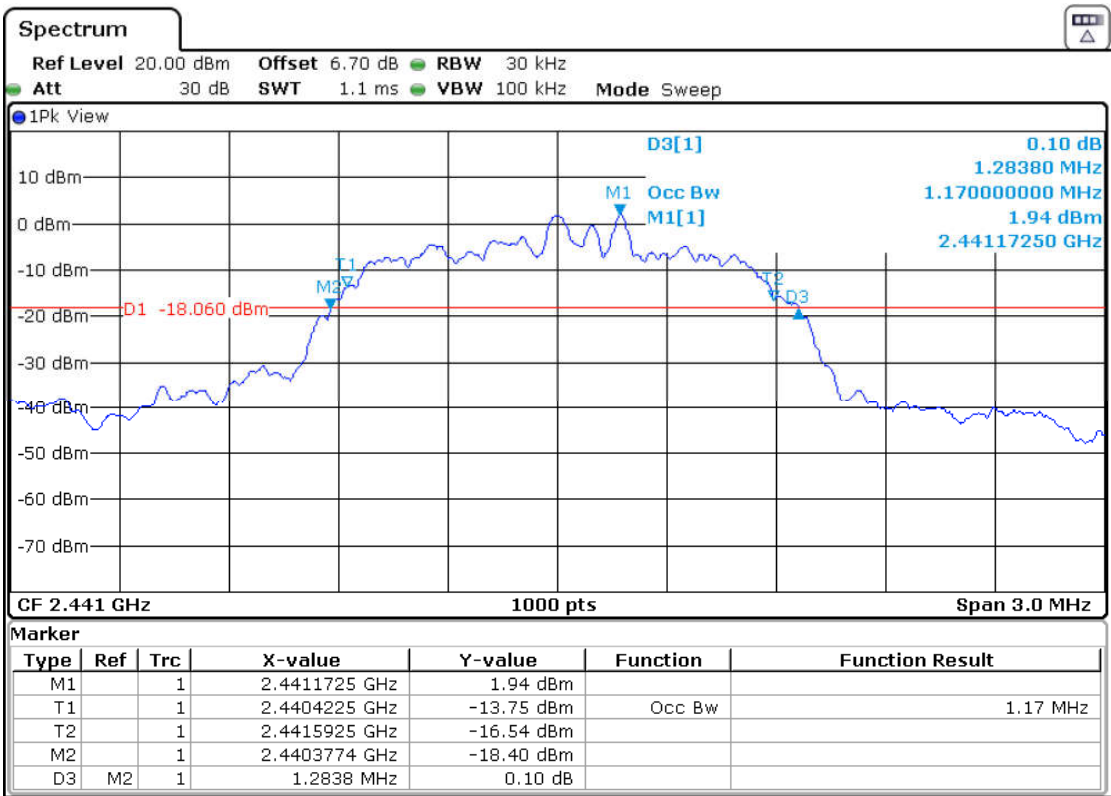
Verdict: PASS

• Pi/4 DQPSK – Bandwidths

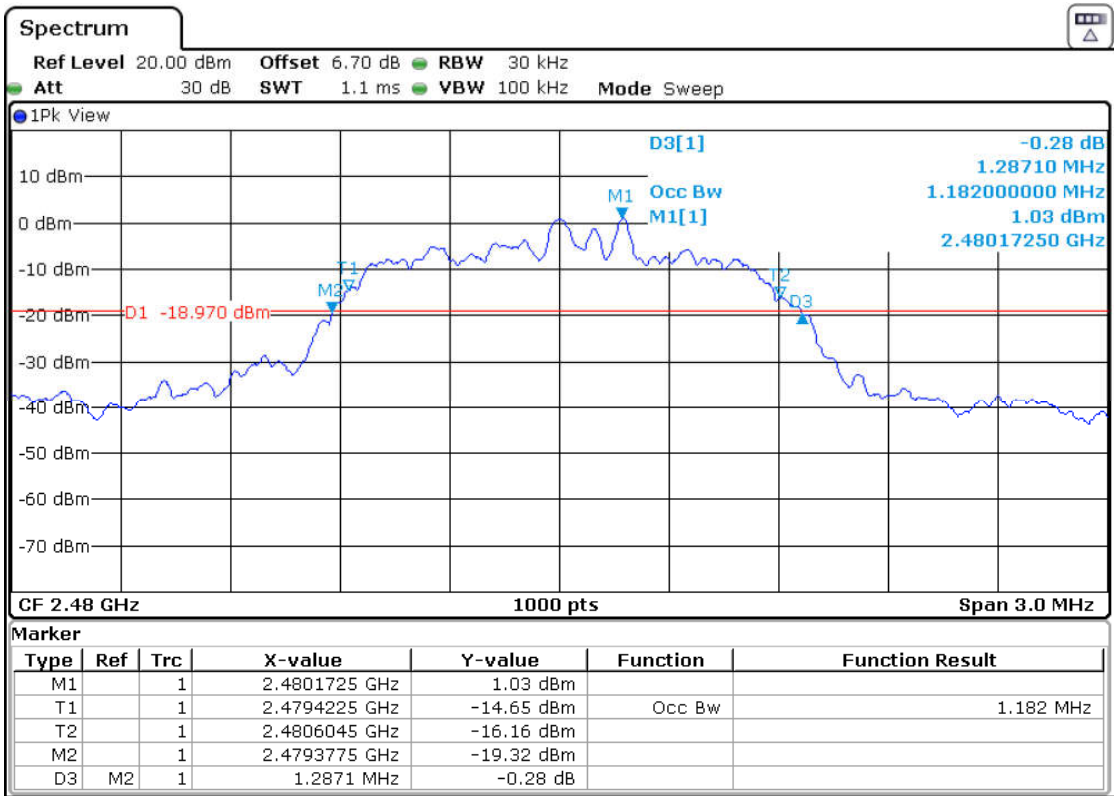
- Low Channel:



- Middle Channel:

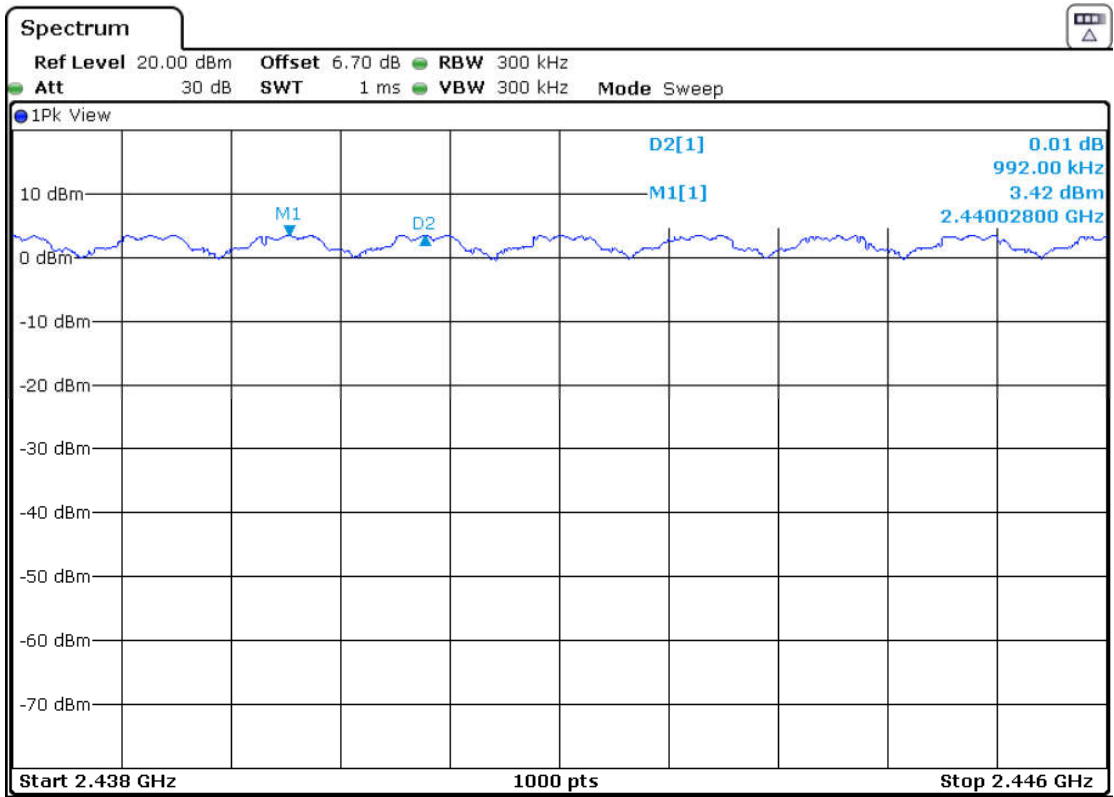


- High Channel:



Carrier frequency separation - Pi/4 DQPSK

Carrier frequency separation: 992 kHz

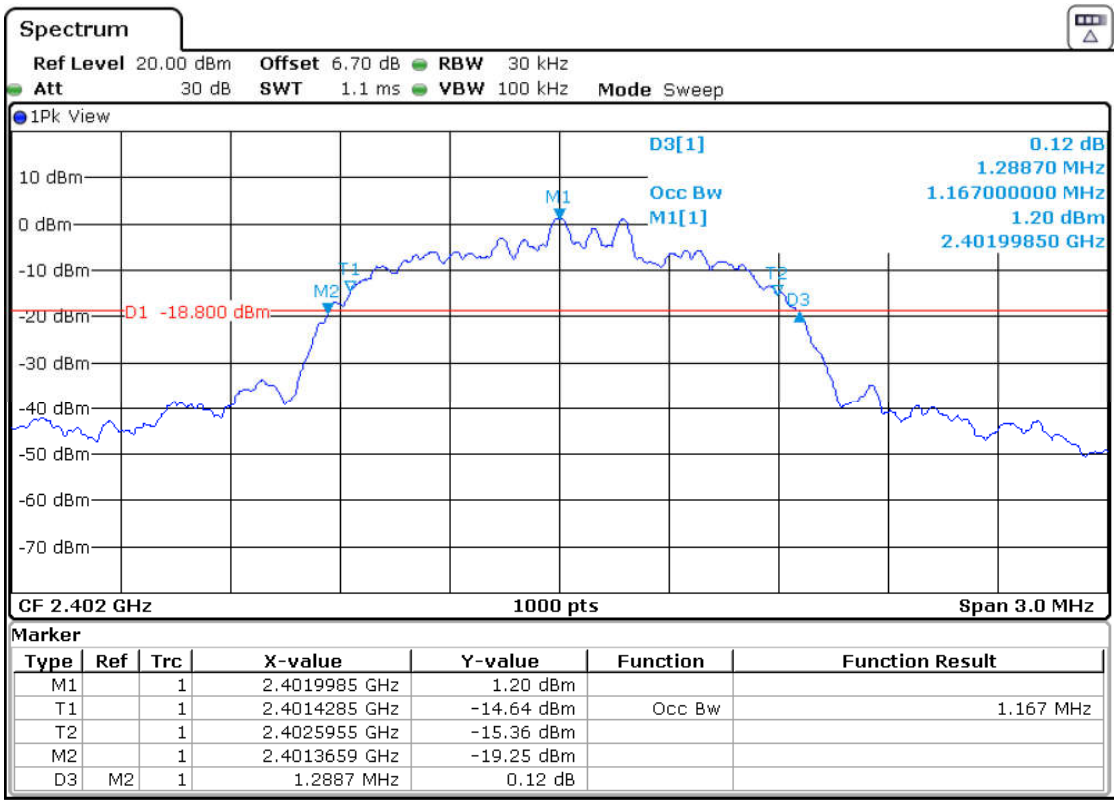


The hopping channel carrier frequencies are separated by a minimum two-thirds of the 20 dB bandwidth of the hopping channel.

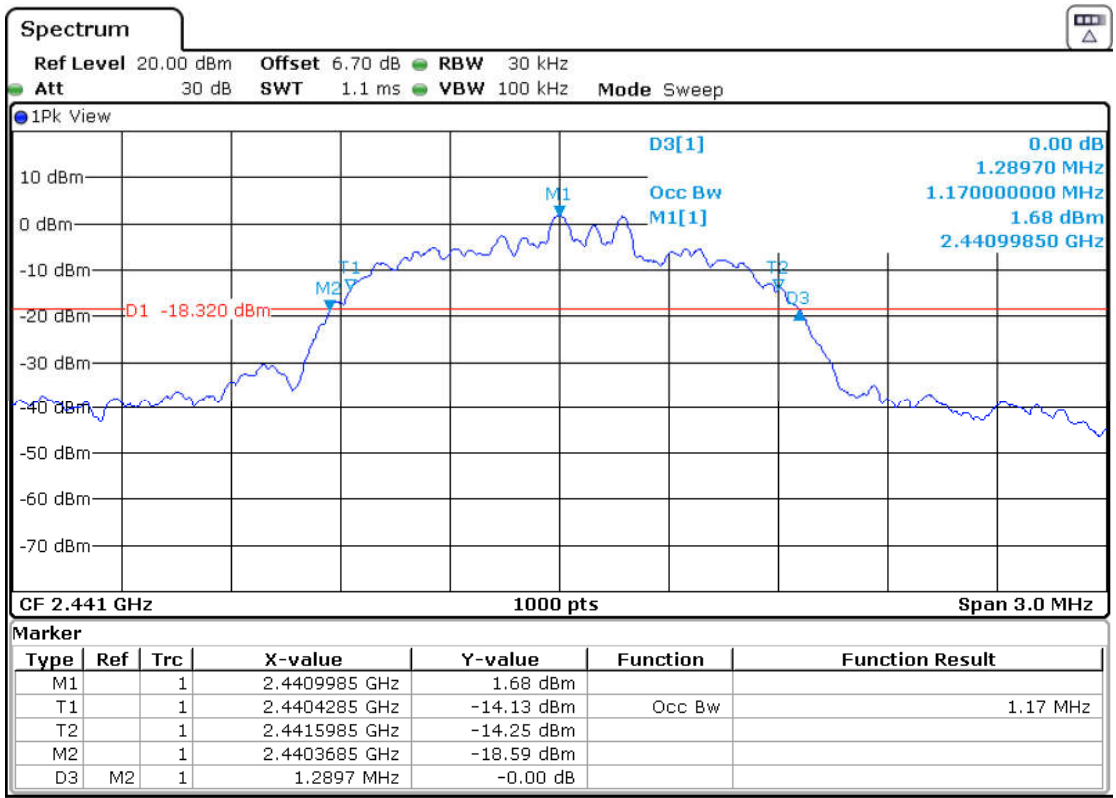
Verdict: PASS

• 8DPSK – Bandwidths

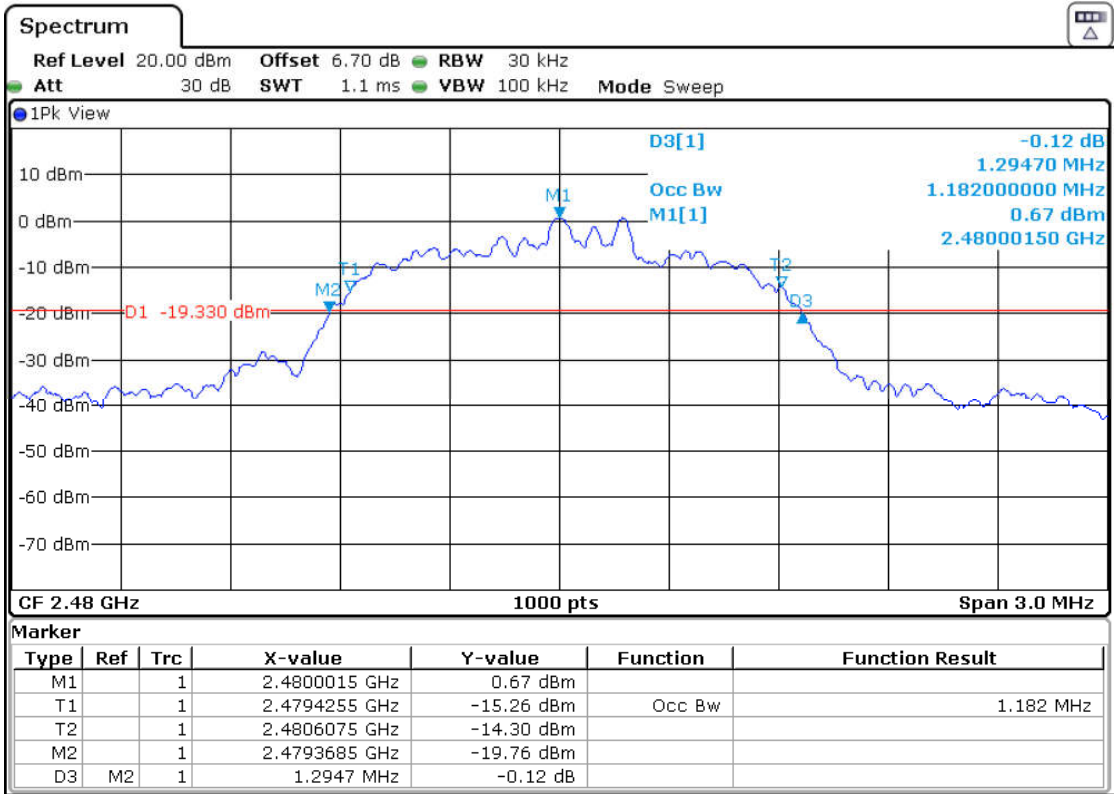
- Low Channel:



- Middle Channel:

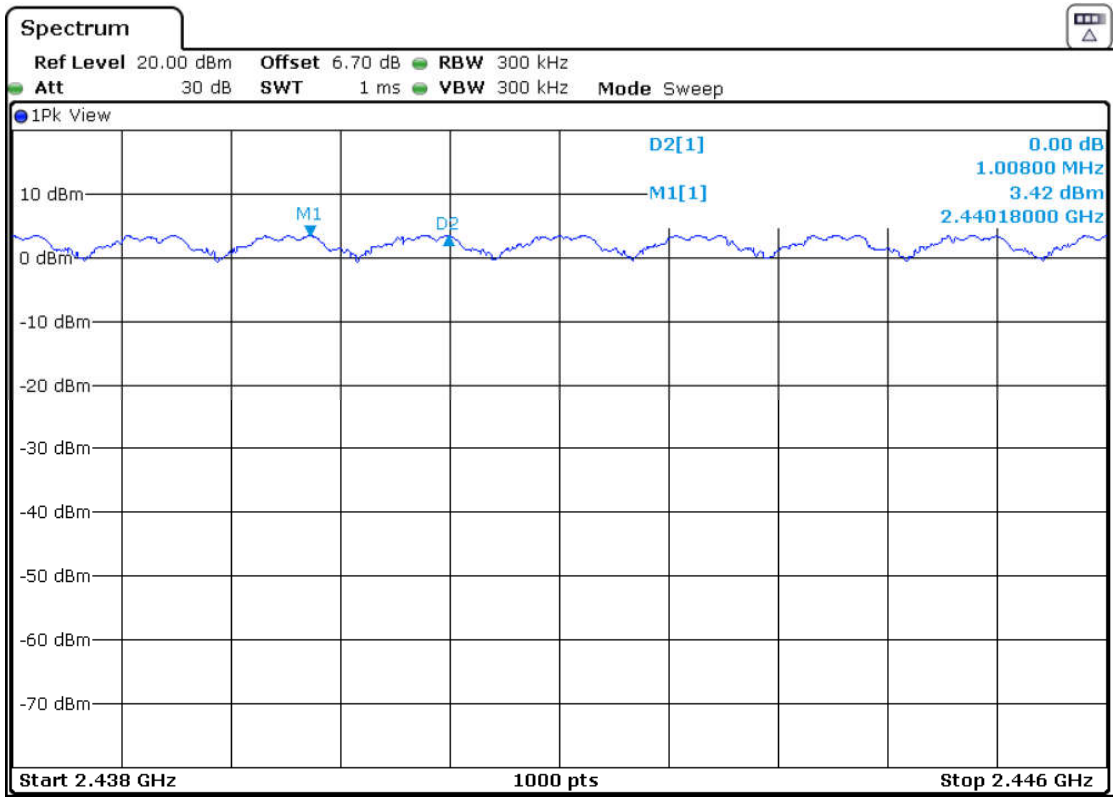


- High Channel:



Carrier frequency separation - 8DPSK

Carrier frequency separation: 1008 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.

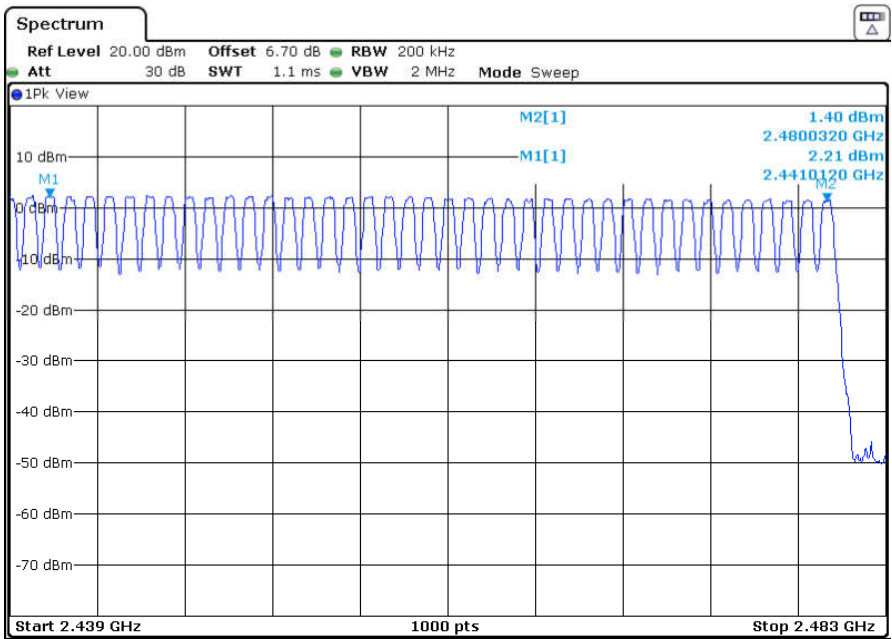
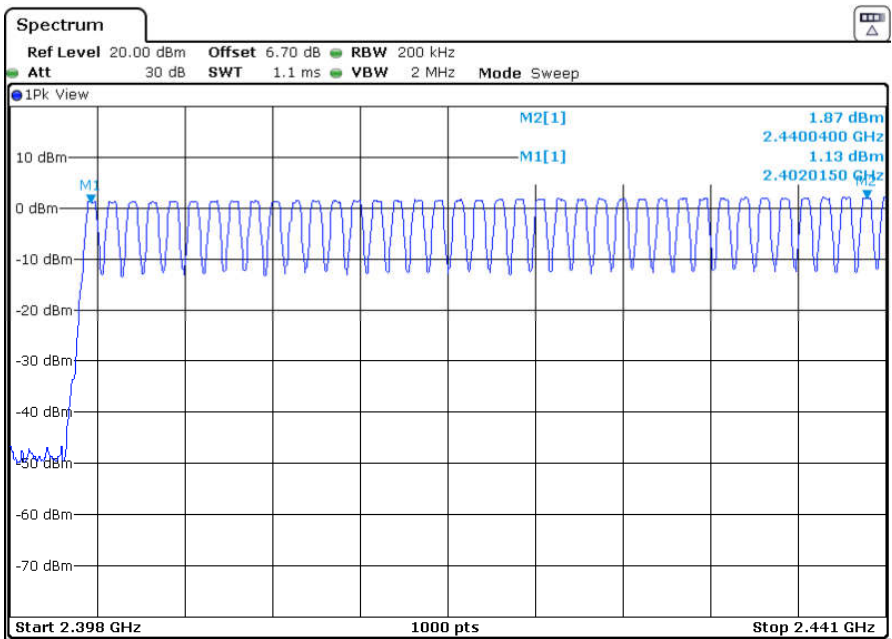
SPECIFICATION:

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.

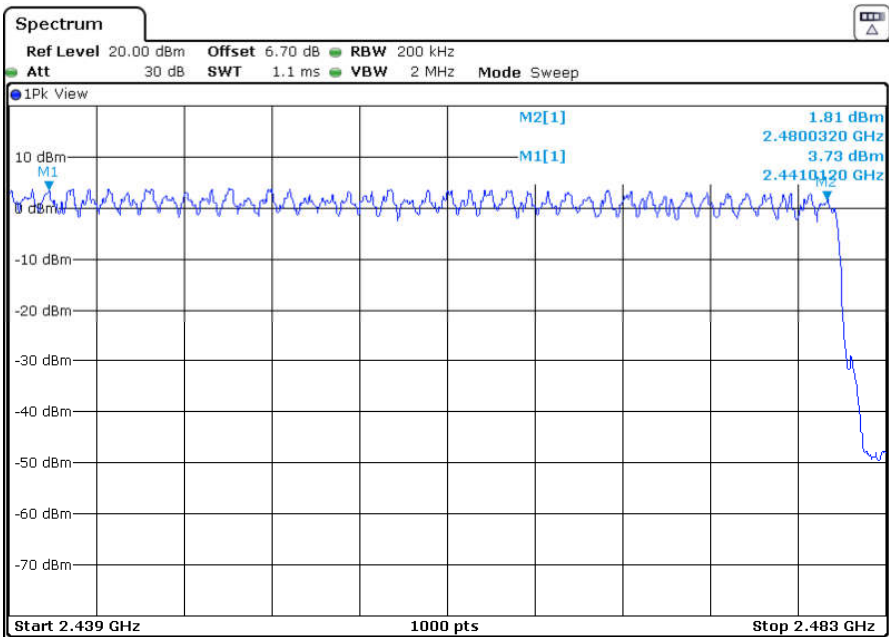
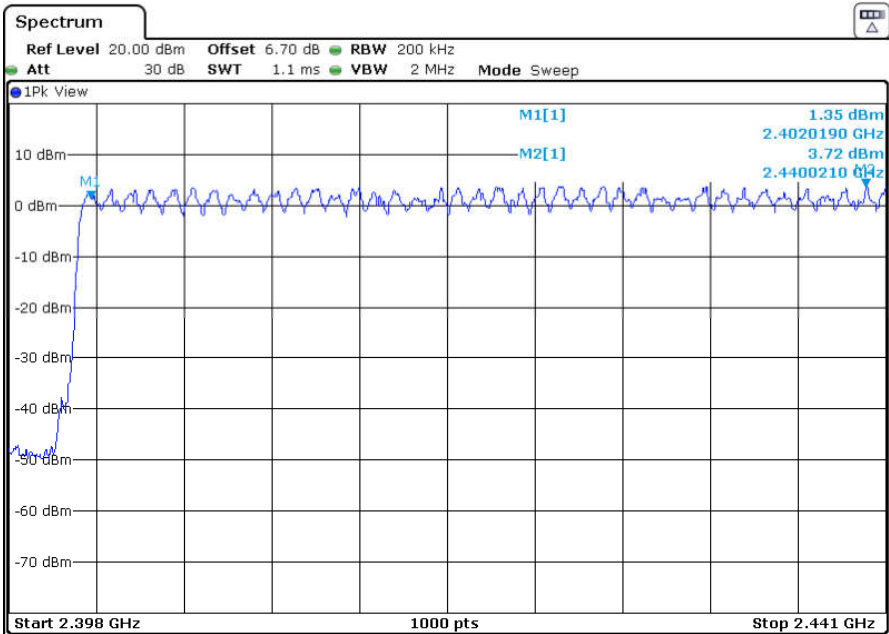
- GFSK – Number of hopping channels



Total number of hopping channels 79

Verdict: PASS

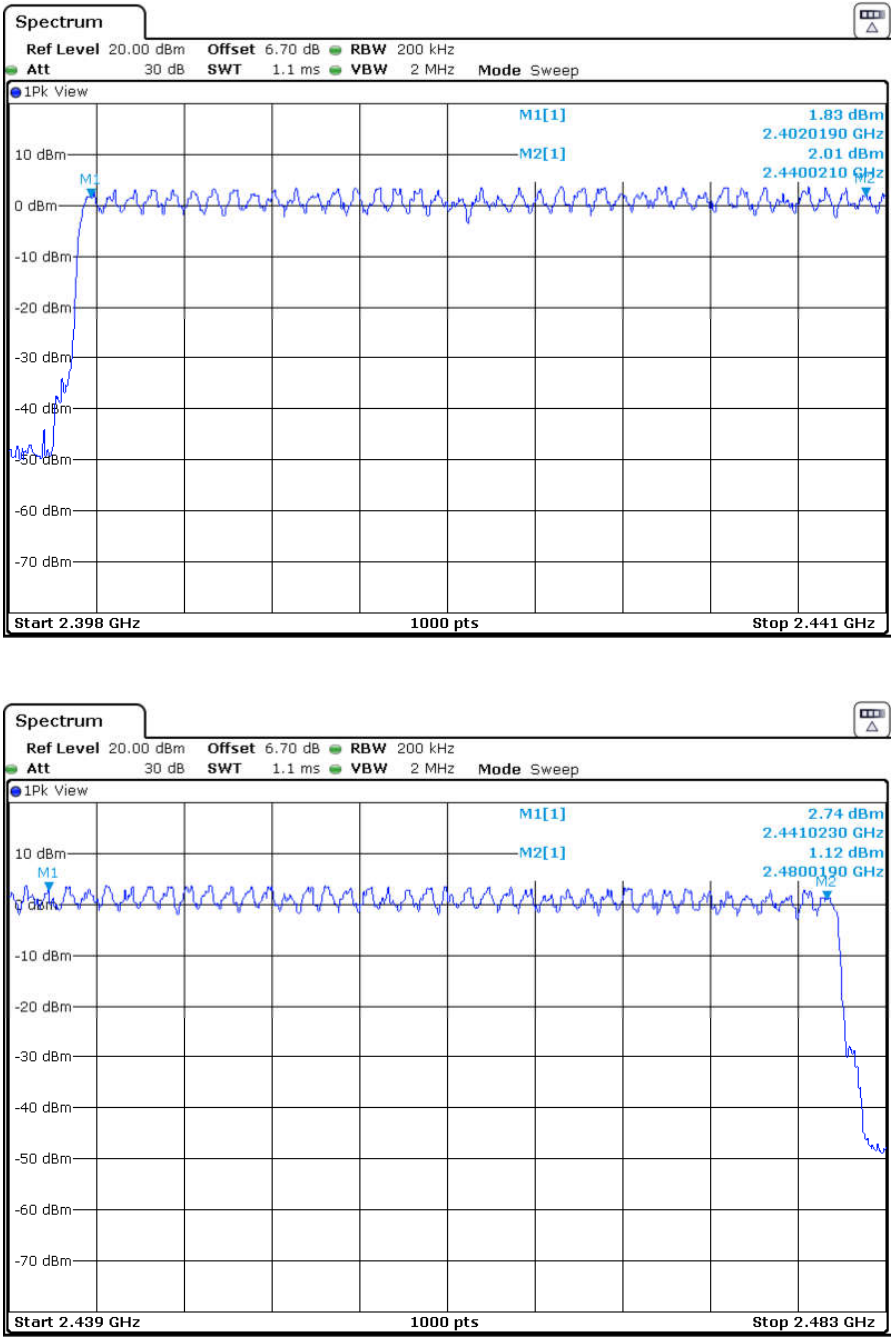
• Pi/4 DQPSK – Number of hopping channels



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:

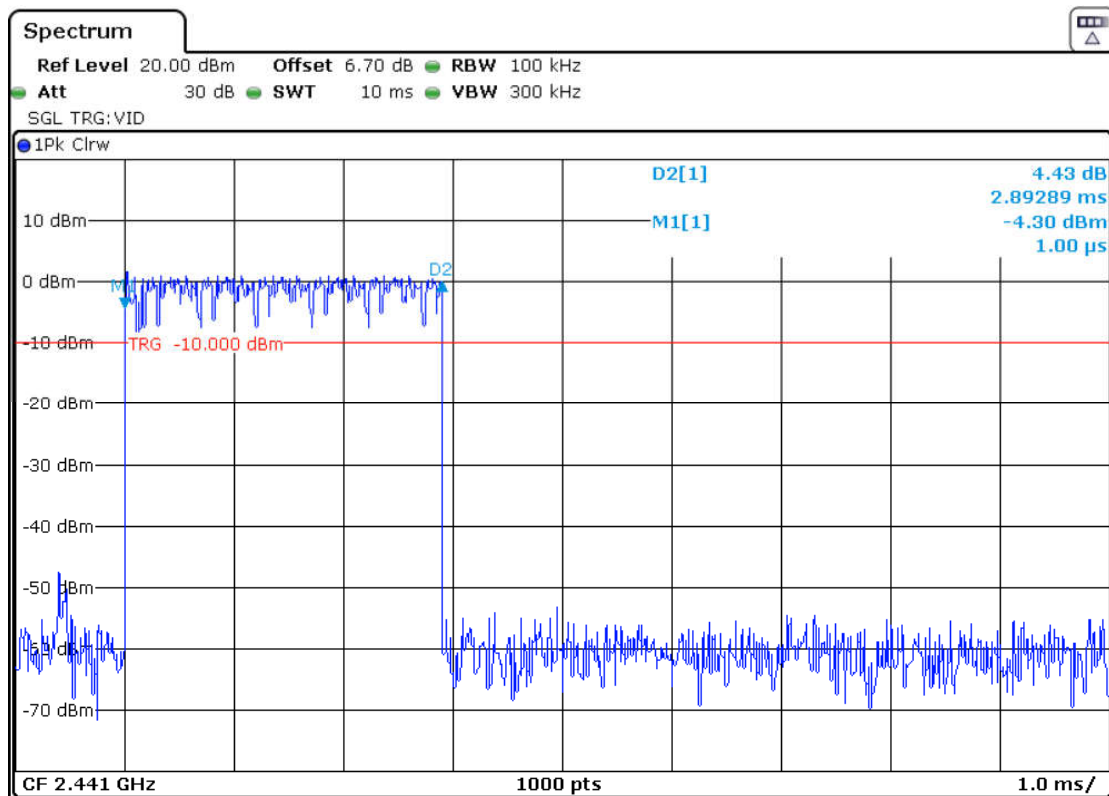
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = $0.4 \times 79 = 31.6$ seconds.

RESULTS:

• GFSK (packet type DH5) – Time of Occupancy (Dwell Time)

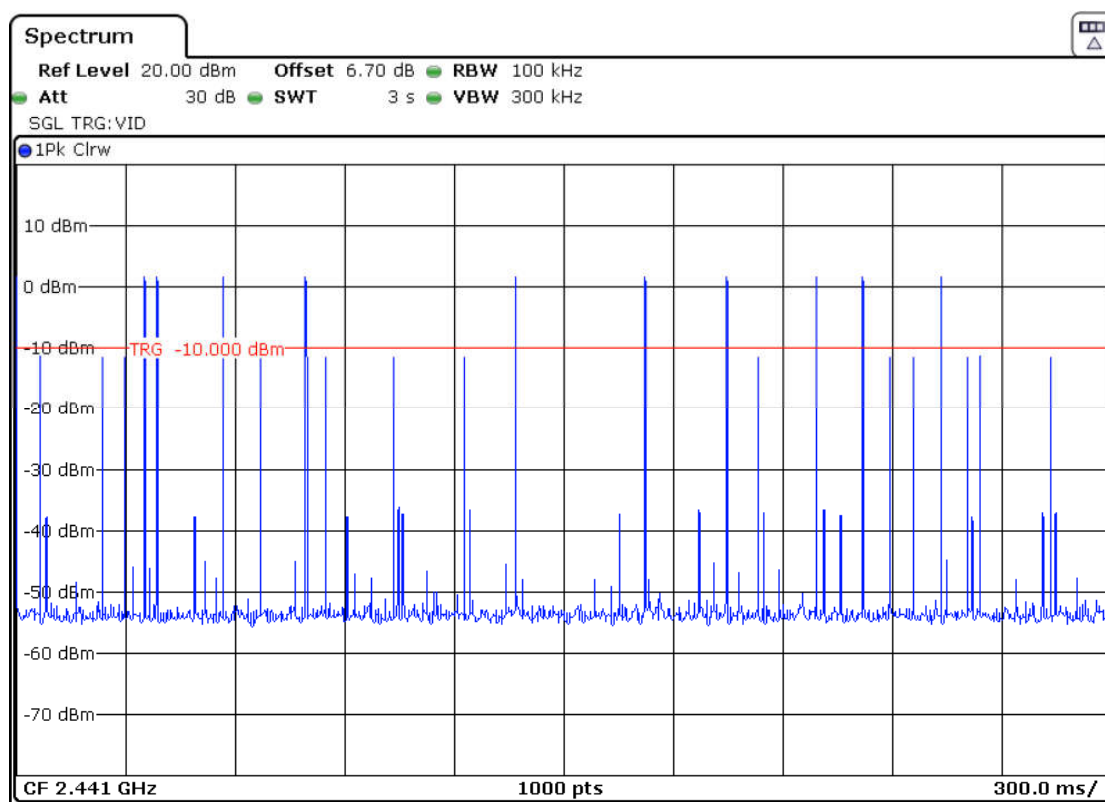
- Transmit Time per Hop:

2.893 ms



▪ Time of Occupancy:

Nº of hops on spectrum analyzer	10
Nº of hops over the period	105.3333
Average Time of Occupancy	304.7177 ms



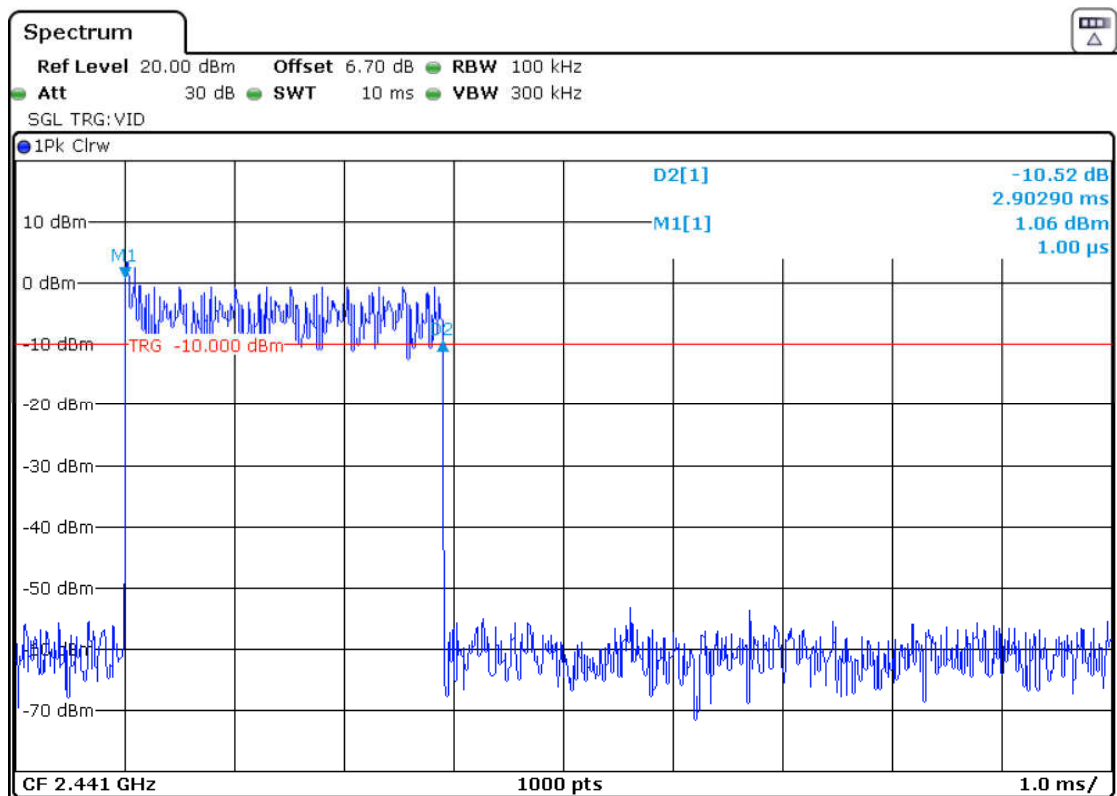
Measurement uncertainty (%)	<±0.01
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Verdict: PASS

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

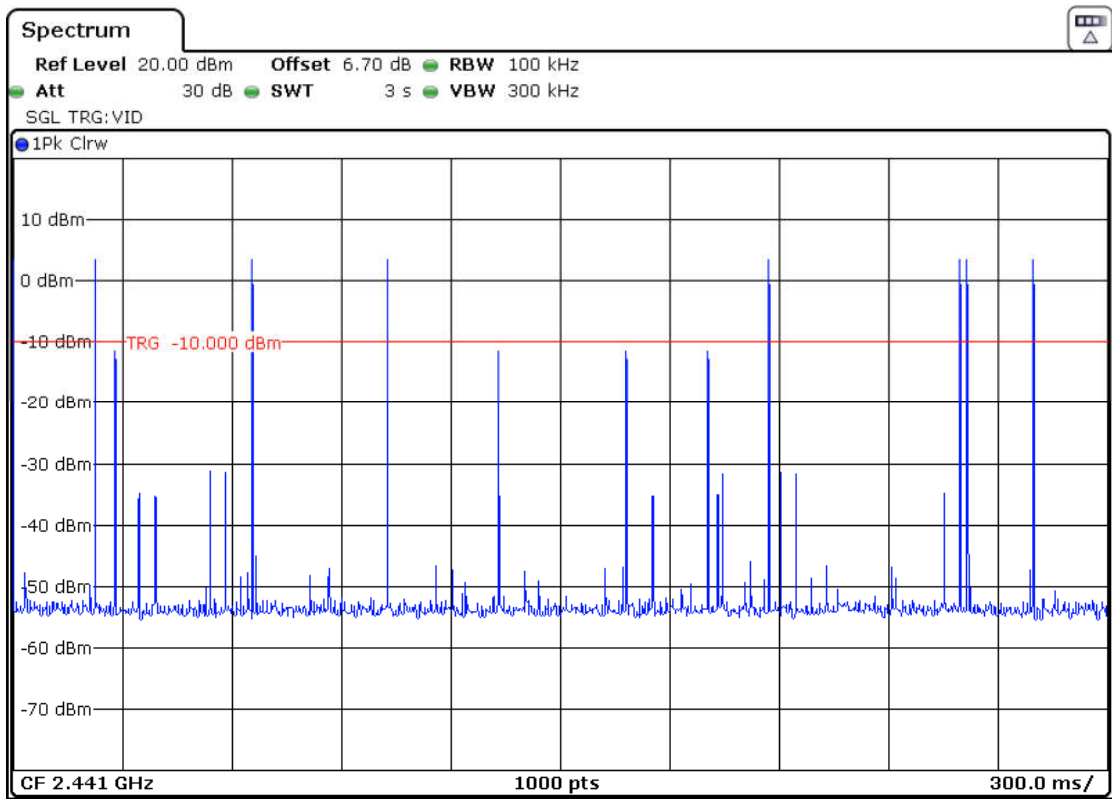
- Transmit Time per Hop:

2.903 ms



Time of Occupancy:

Nº of hops on spectrum analyzer	7
Nº of hops over the period	73.7333
Average Time of Occupancy	214.0404 ms



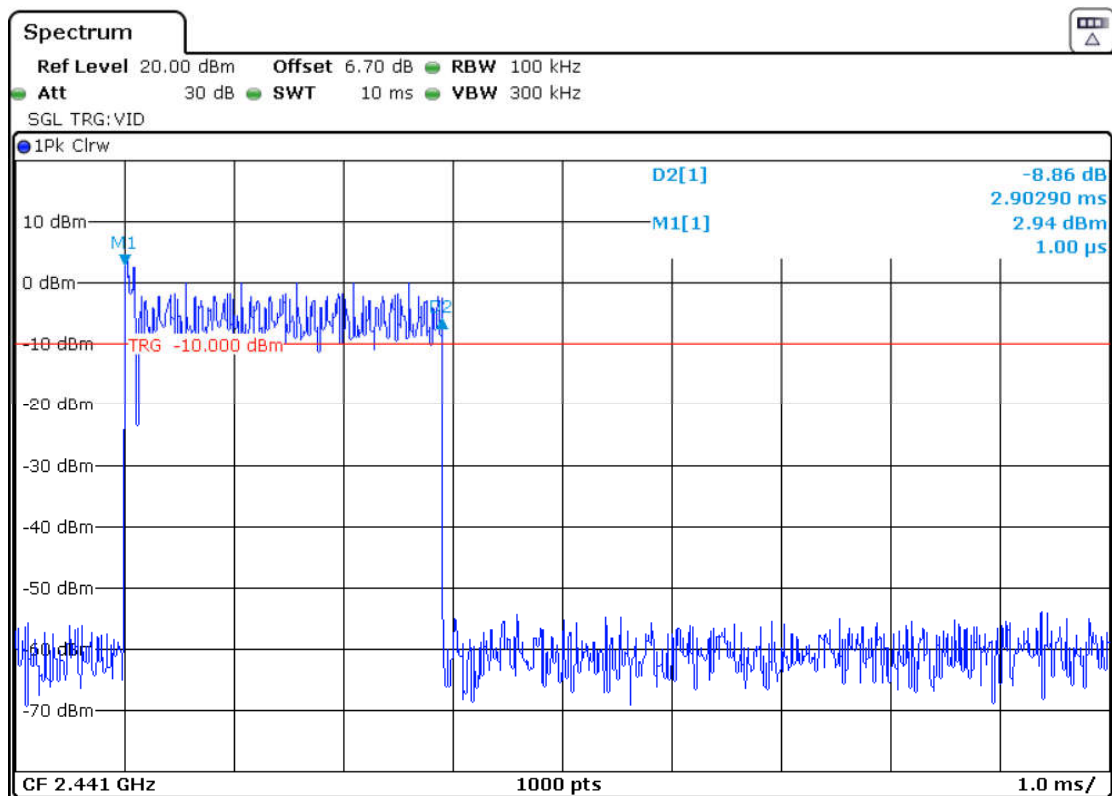
Measurement uncertainty (%)	<±0.01
-----------------------------	--------

Verdict: PASS

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

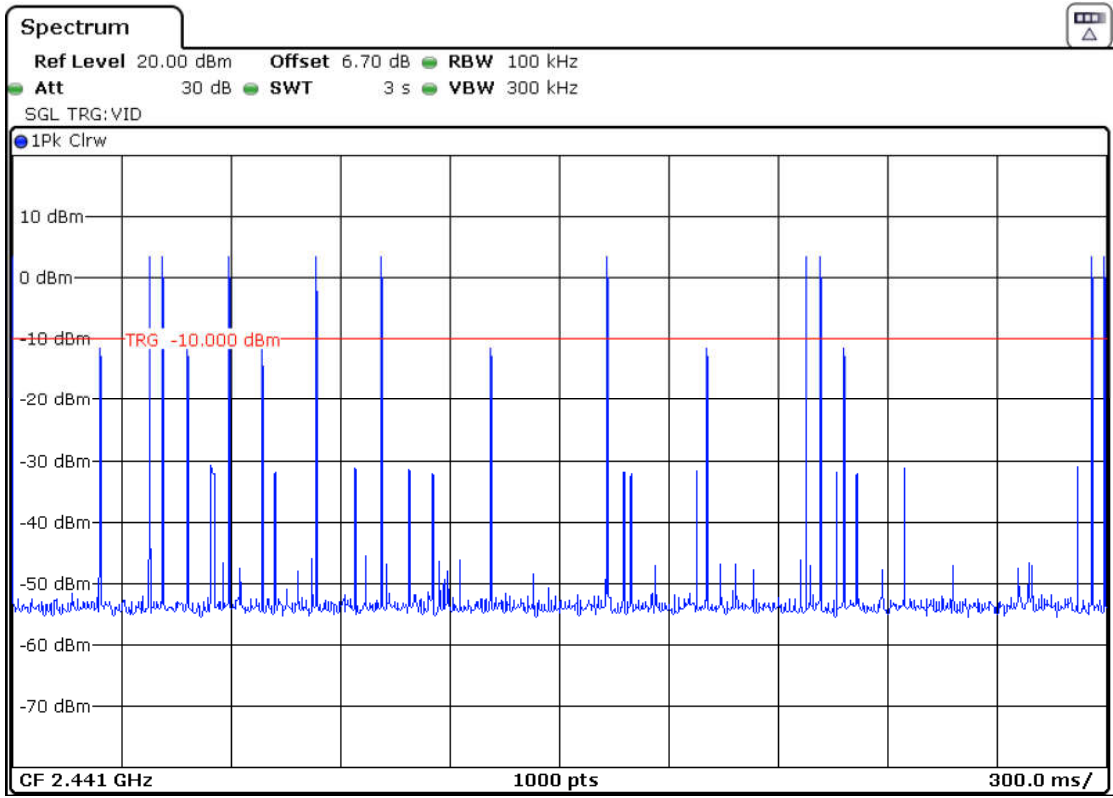
- Transmit Time per Hop:

2.903 ms



Time of Occupancy:

Nº of hops on spectrum analyzer	10
Nº of hops over the period	105.3333
Average Time of Occupancy	305.7721 ms



Measurement uncertainty (%)	<±0.01
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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: -0.99 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)	0.86	1.69	0.98
Maximum EIRP Power (dBm)	-0.13	0.70	-0.01
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)	4.21	4.75	3.85
Maximum EIRP Power (dBm)	3.22	3.76	2.86
Measurement uncertainty (dB)	<±0.78		

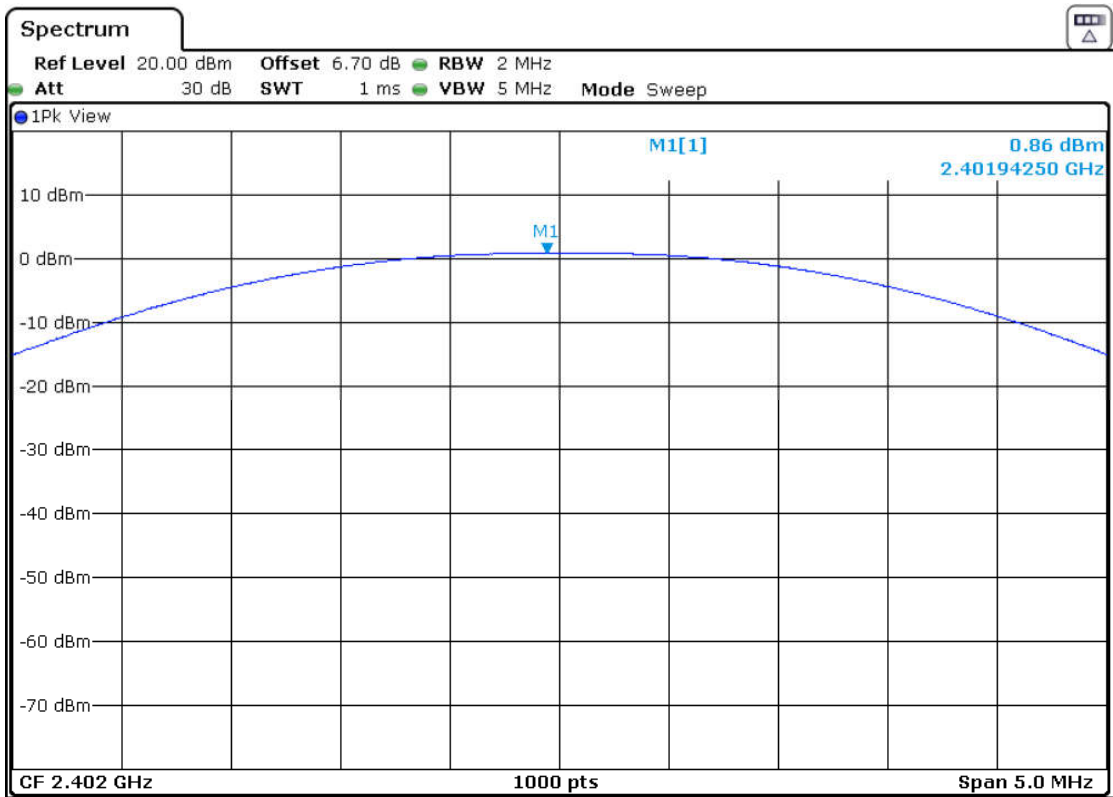
- 8DPSK (3 Mbps)**

Peak Conducted Output Power	Low Channel 2402 MHz	Middle Channel 2441 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	4.82	5.37	4.47
Maximum EIRP Power (dBm)	3.83	4.38	3.48
Measurement uncertainty (dB)	<±0.78		

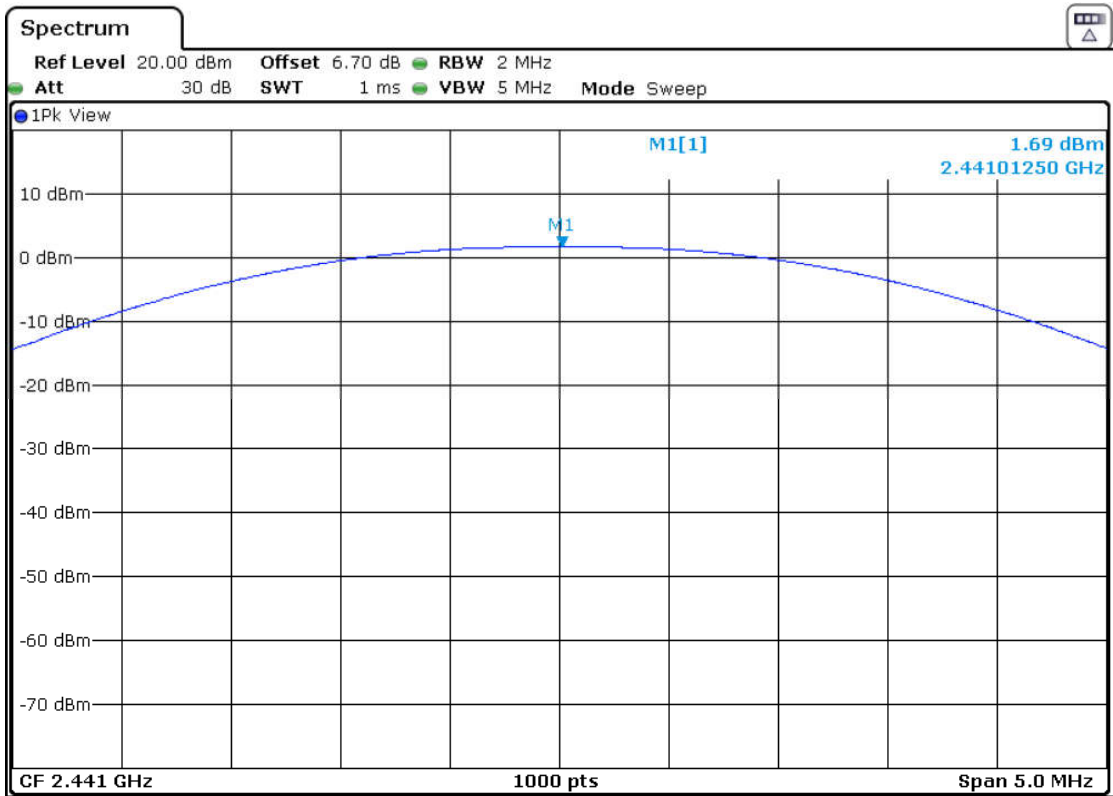
Verdict: PASS

GFSK – Peak Output Power

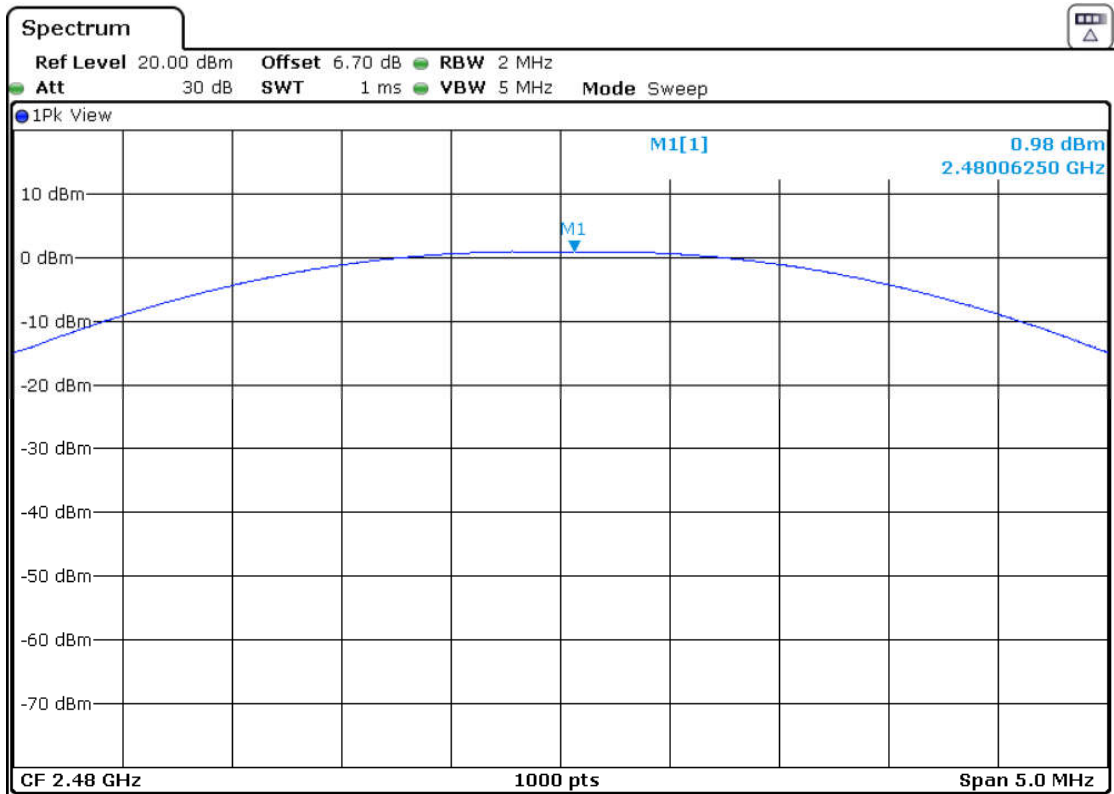
- Low Channel:



- Middle Channel:

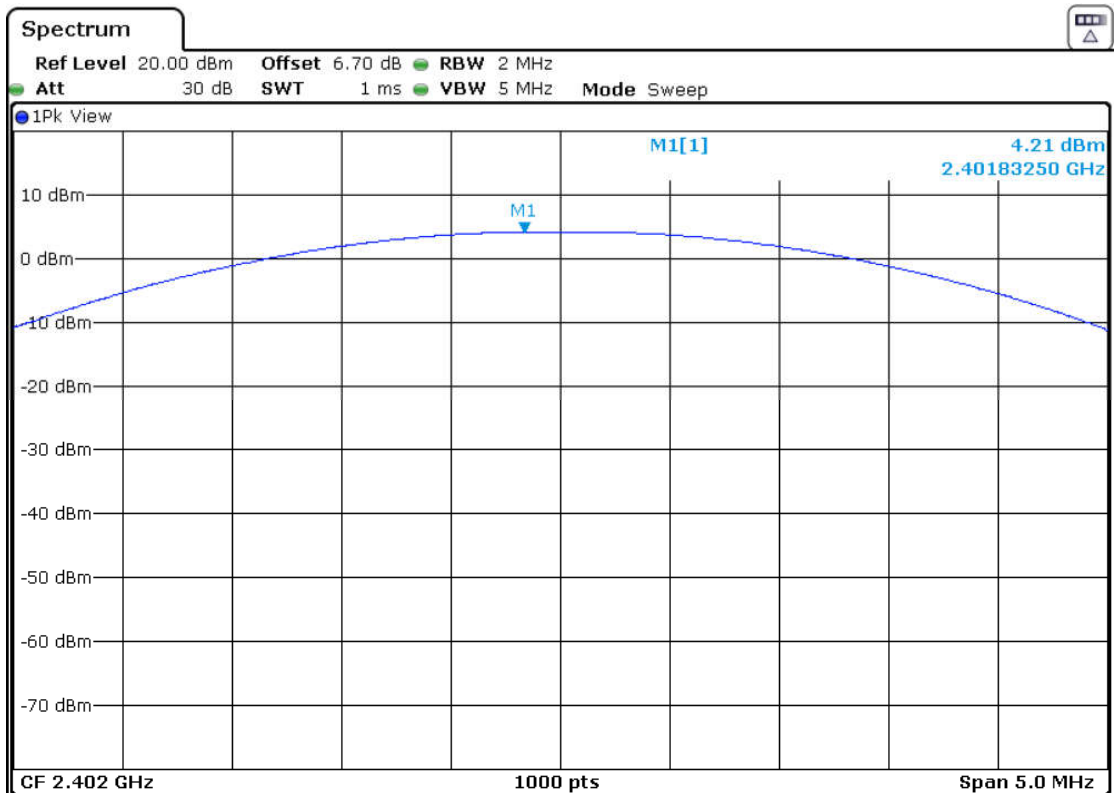


- High Channel:

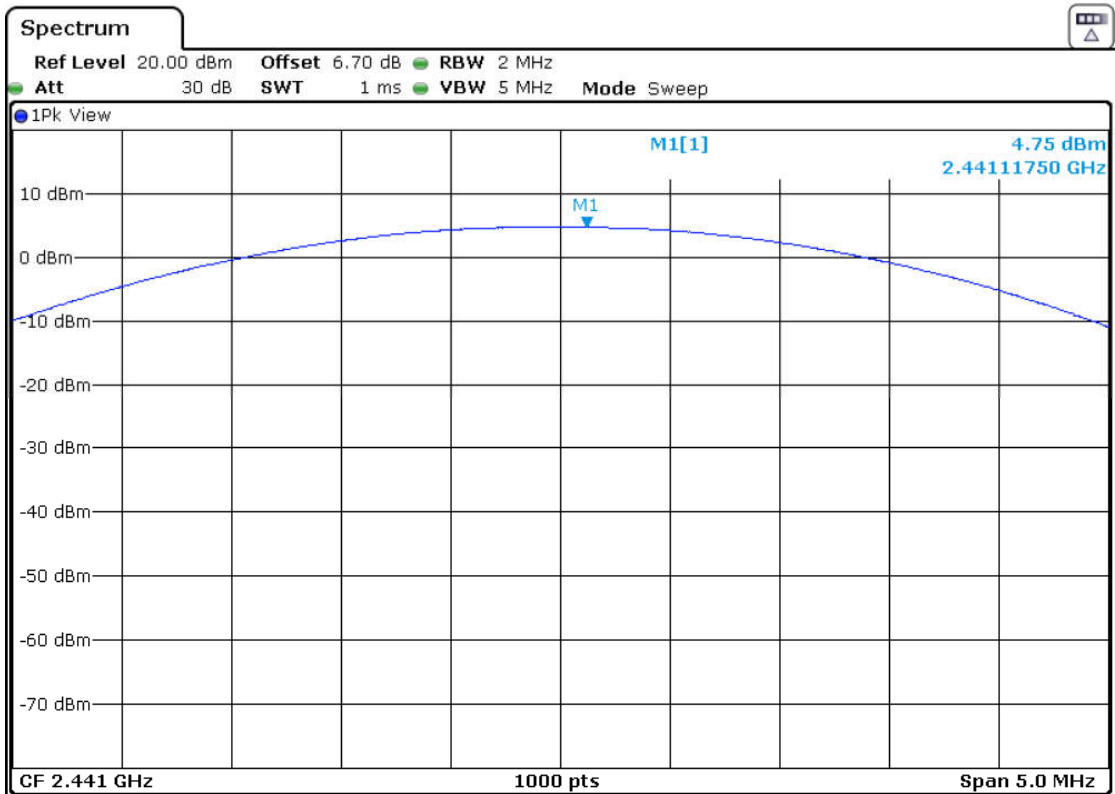


• Pi/4 DQPSK – Peak Output Power

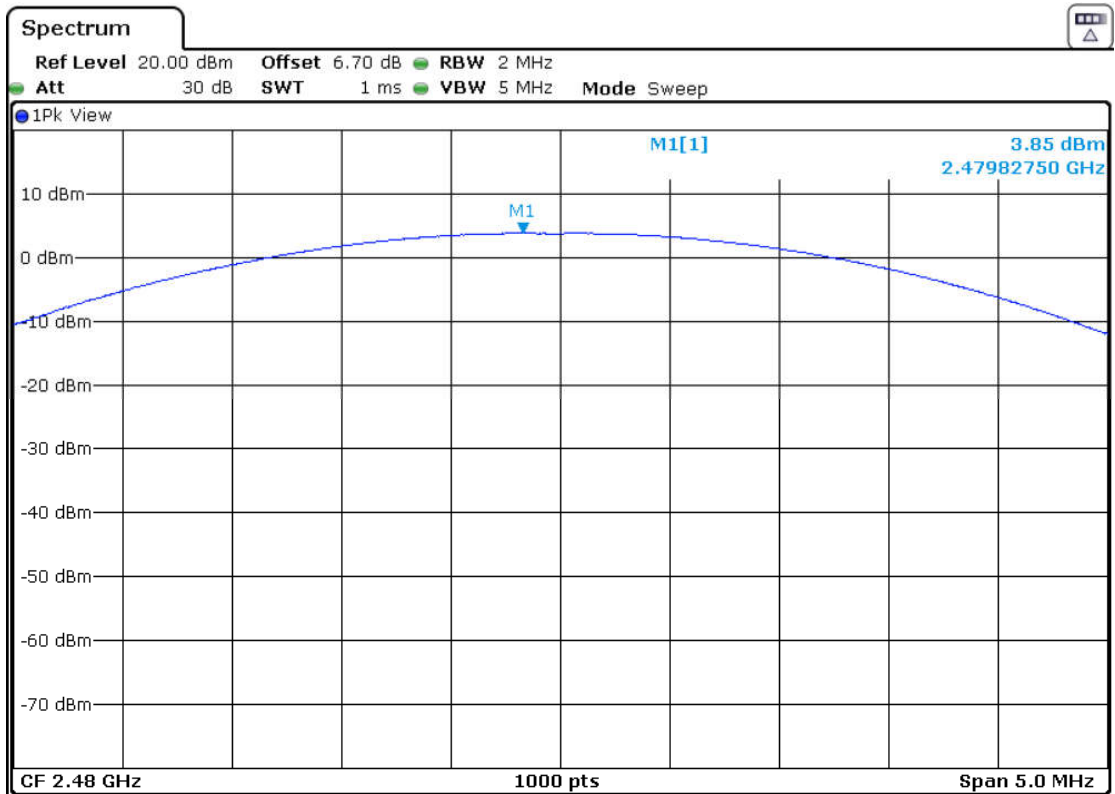
- Low Channel:



- Middle Channel:

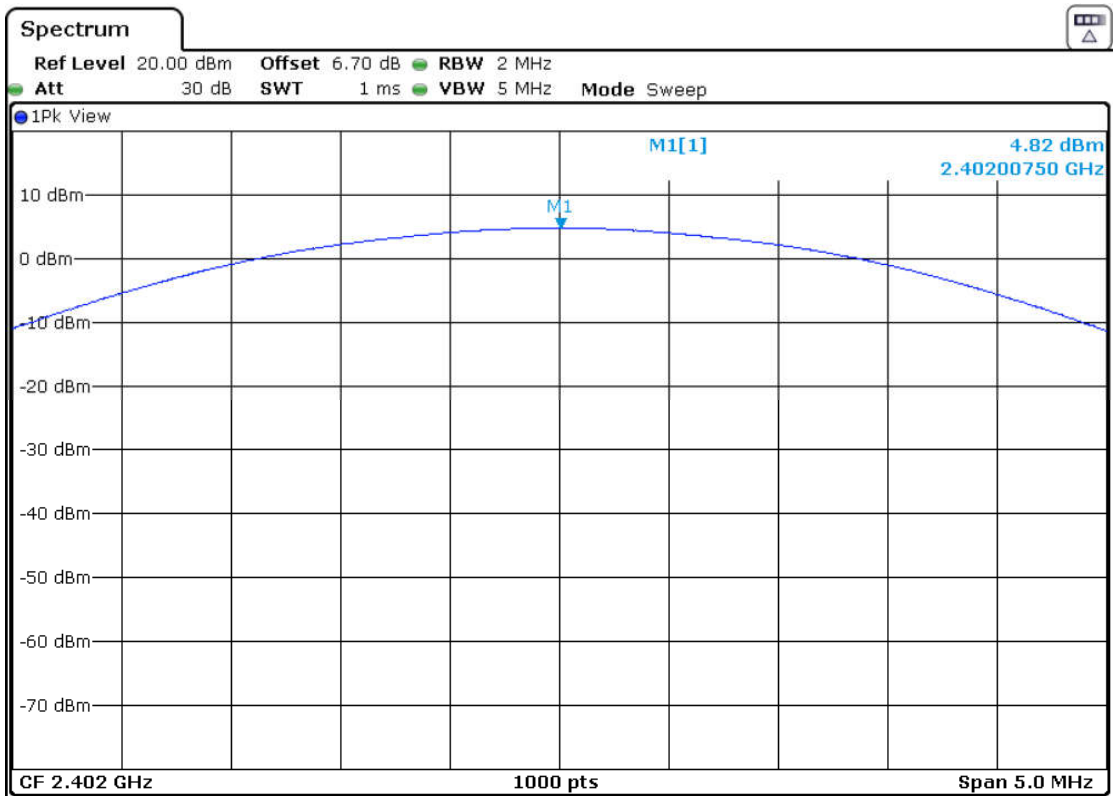


- High Channel:

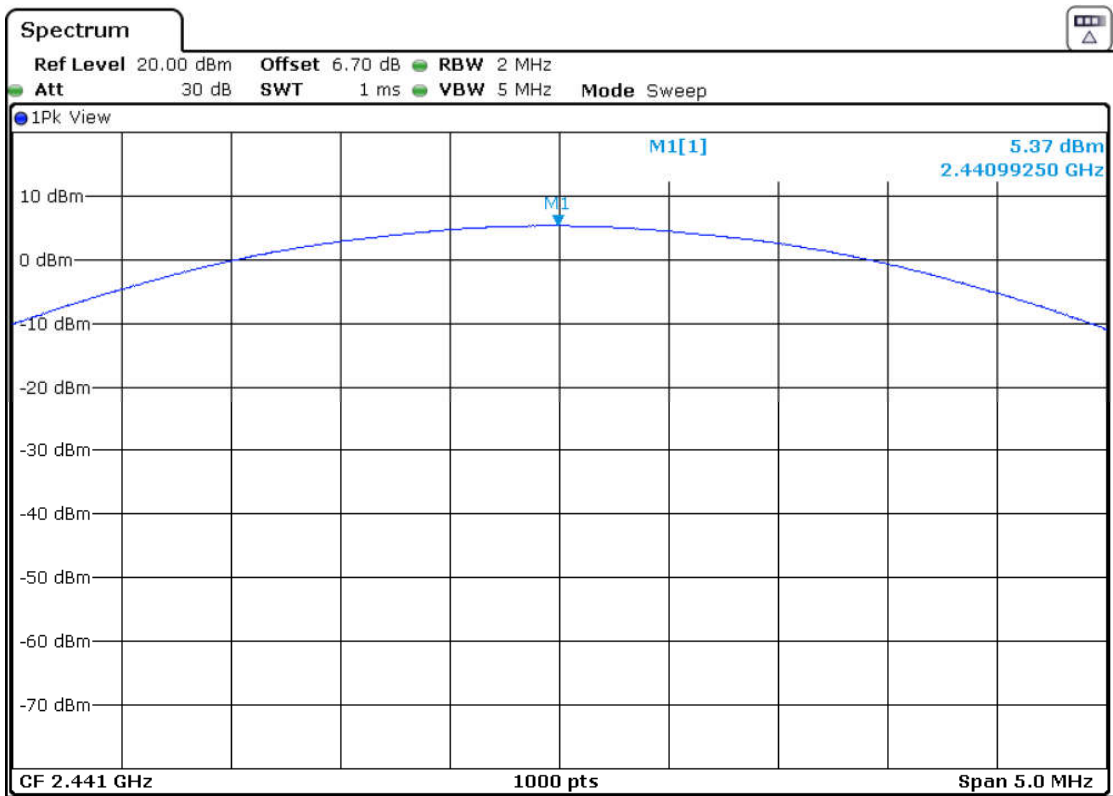


• 8DPSK – Peak Output Power

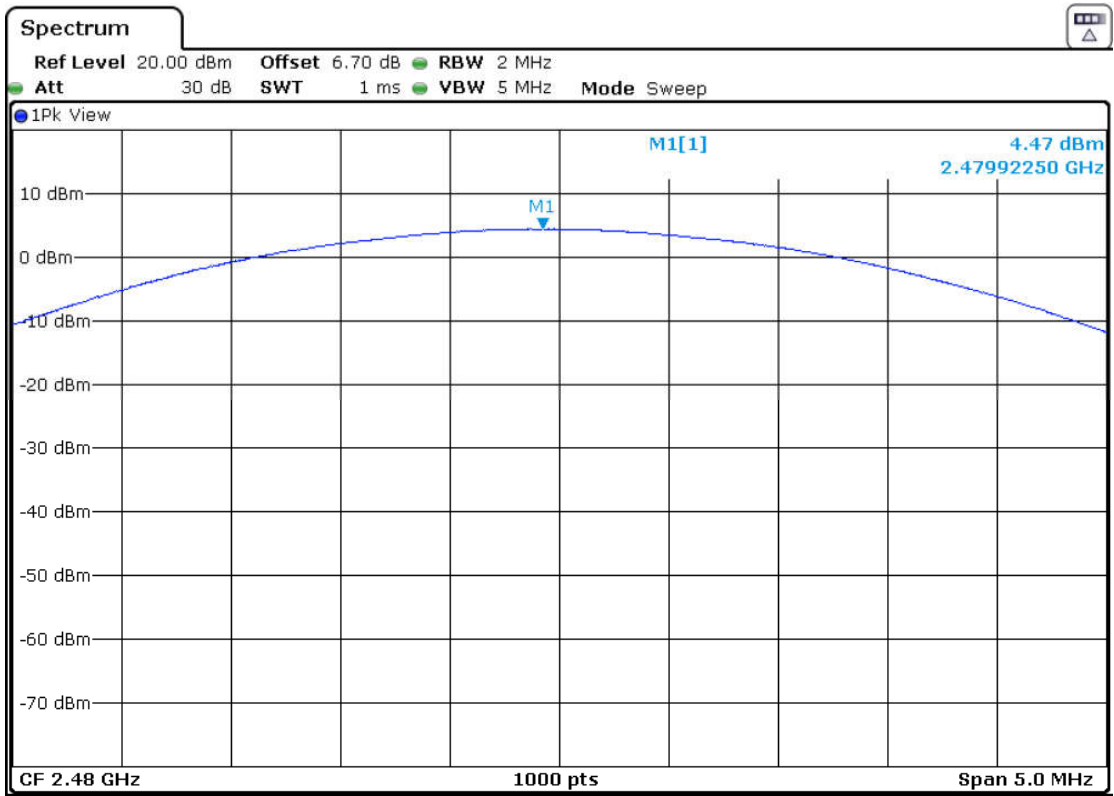
- Low Channel:



- Middle Channel:



- High Channel:



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

SPECIFICATION:

In any 100 kHz bandwidths outside the frequency band in which the 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

RESULTS:

- **GFSK:**

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Reference Level Measurement (dBm)	0.80	1.20	0.64
Measurement uncertainty (dB)	<±0.78		

- Low Channel:

No spurious peaks found at less than 20 dB below the limit.

- Middle Channel:

No spurious peaks found at less than 20 dB below the limit.

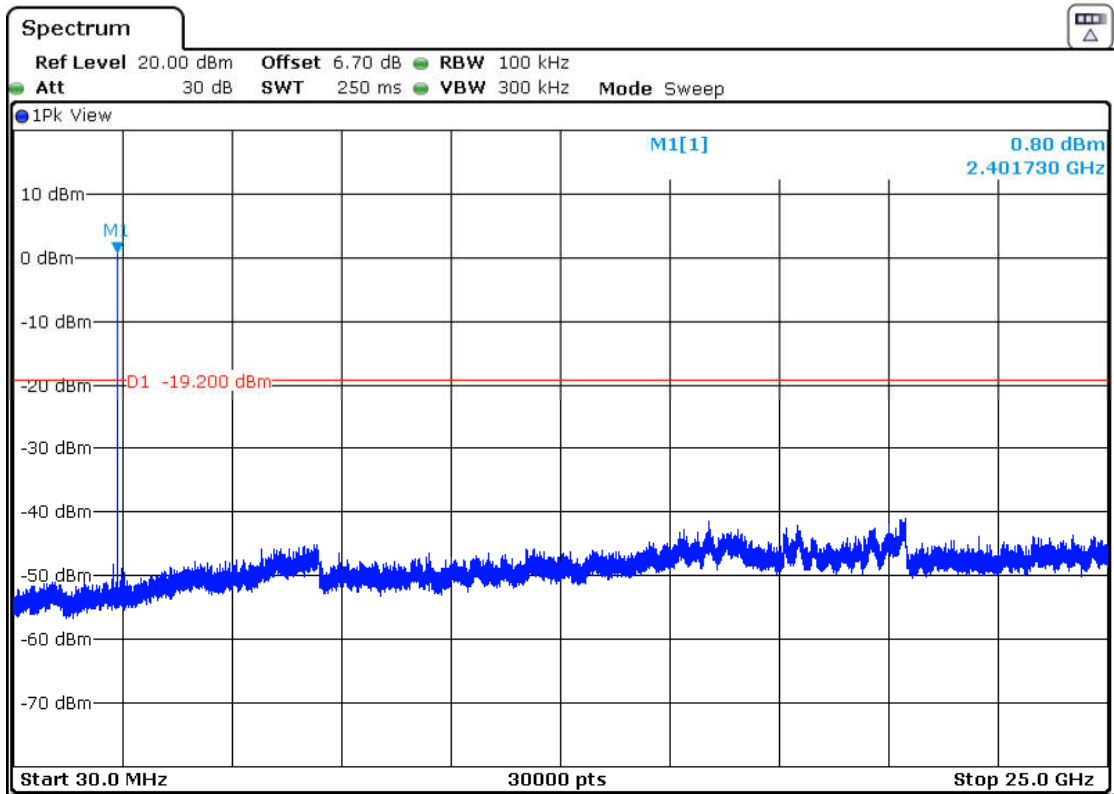
- High Channel:

No spurious peaks found at less than 20 dB below the limit.

Measurement uncertainty (dB)	<±2.03
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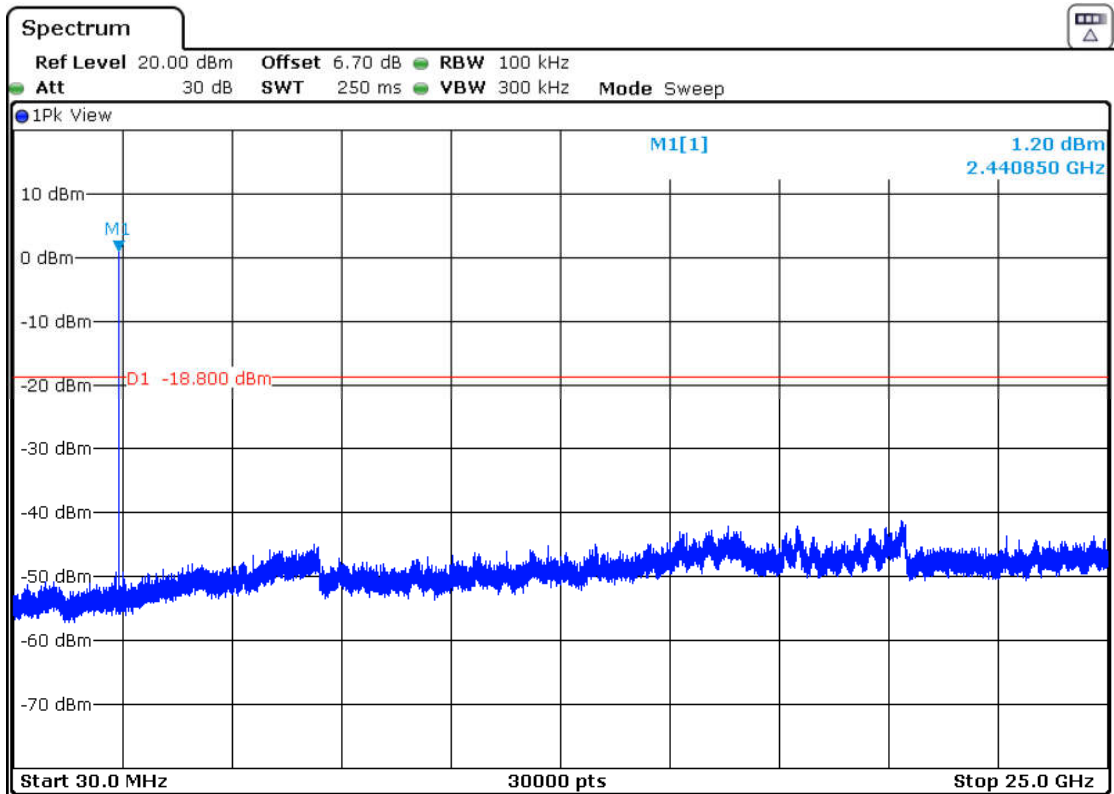
Verdict: PASS

- Low Channel:



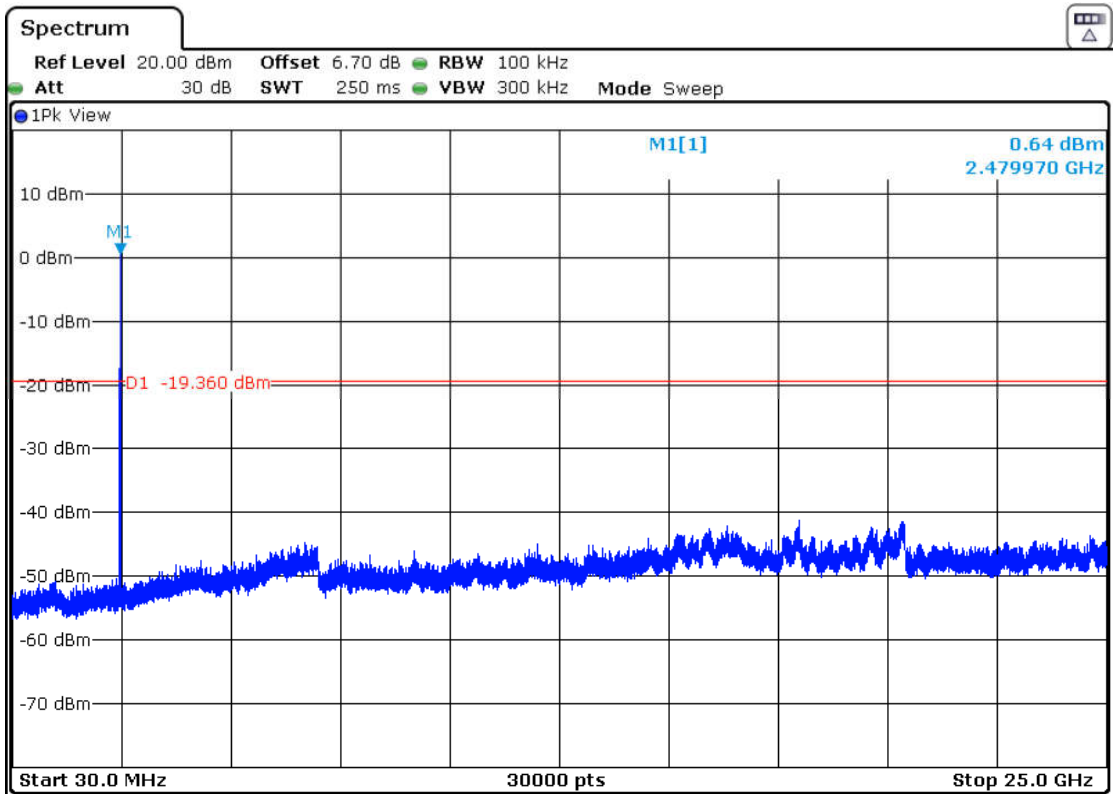
The peak shown in the plot above the limit is the carrier frequency.

- Middle Channel:



The peak shown in the plot above the limit is the carrier frequency.

- High Channel:



The peak shown in the plot above the limit is the carrier frequency.

• **PI/4 DQPSK:**

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Reference Level Measurement (dBm)	1.58	0.39	-0.86
Measurement uncertainty (dB)	<±0.78		

- Low Channel:

No spurious peaks found at less than 20 dB below the limit.

- Middle Channel:

No spurious peaks found at less than 20 dB below the limit.

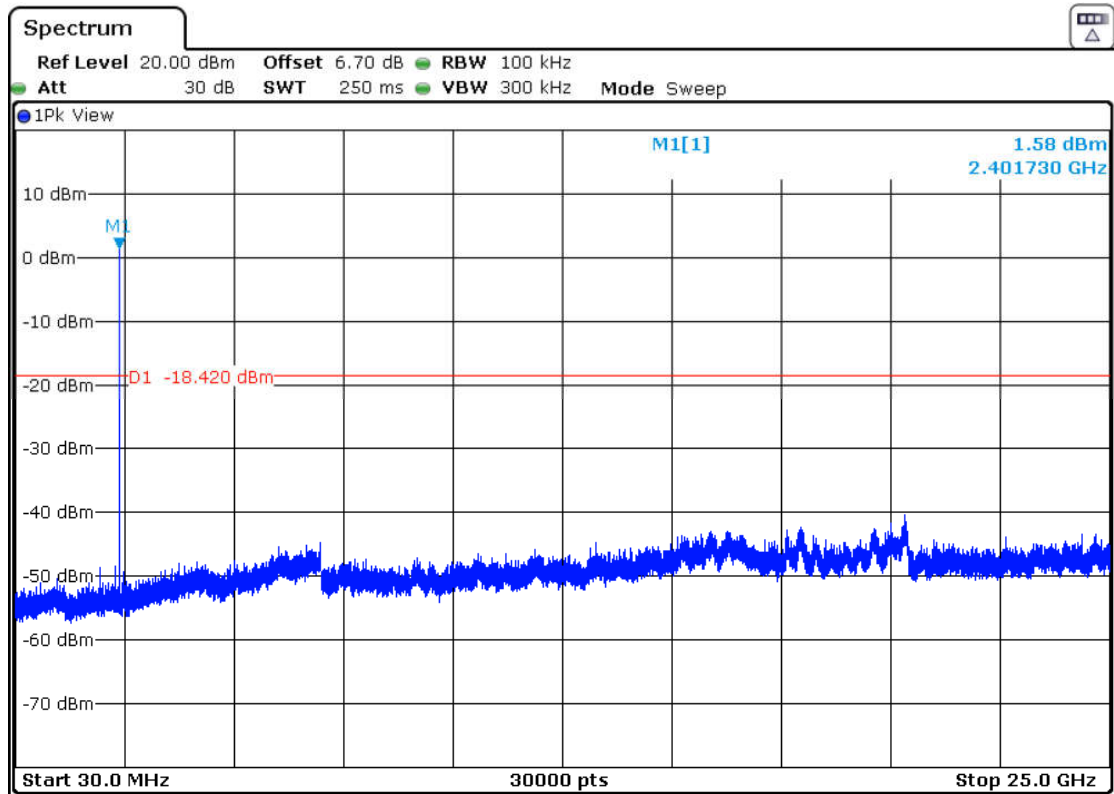
- High Channel:

No spurious peaks found at less than 20 dB below the limit.

Measurement uncertainty (dB)	<±2.03
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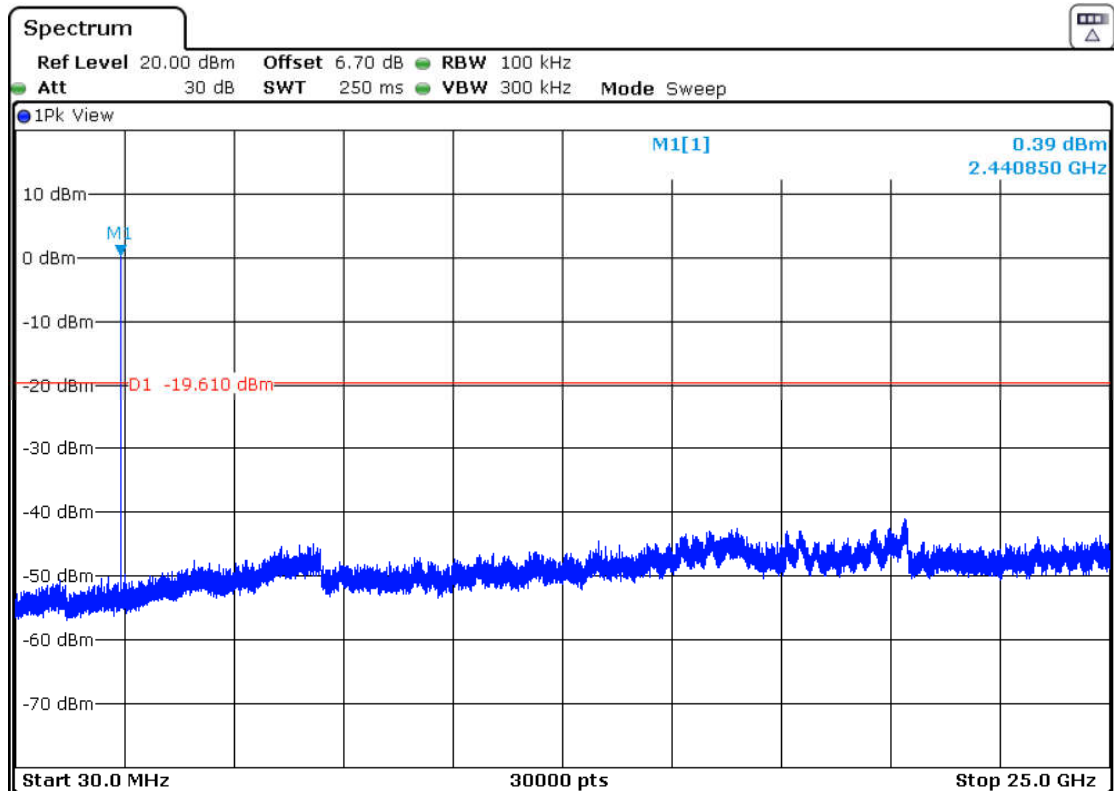
Verdict: PASS

- Low Channel:



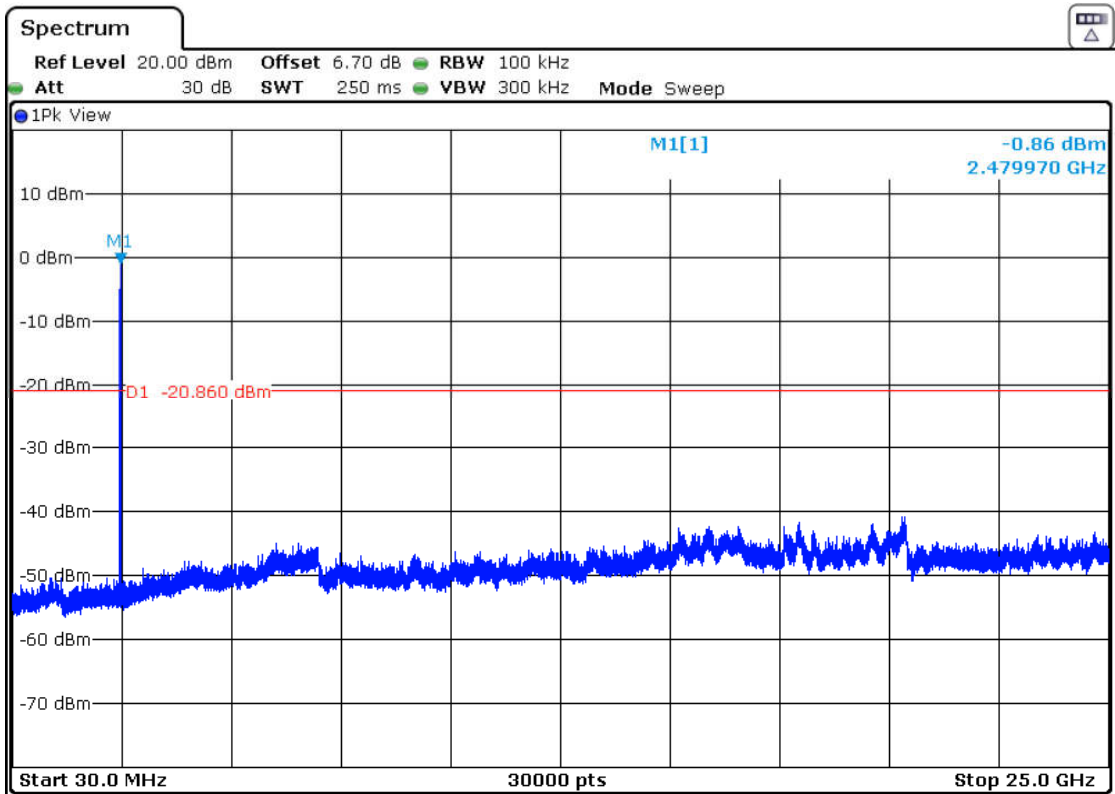
The peak shown in the plot above the limit is the carrier frequency.

- Middle Channel:



The peak shown in the plot above the limit is the carrier frequency.

- High Channel:



The peak shown in the plot above the limit is the carrier frequency.

• **8DPSK:**

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Reference Level Measurement (dBm)	0.46	3.41	2.63
Measurement uncertainty (dB)	<±0.78		

- Low Channel:

No spurious peaks found at less than 20 dB below the limit.

- Middle Channel:

No spurious peaks found at less than 20 dB below the limit.

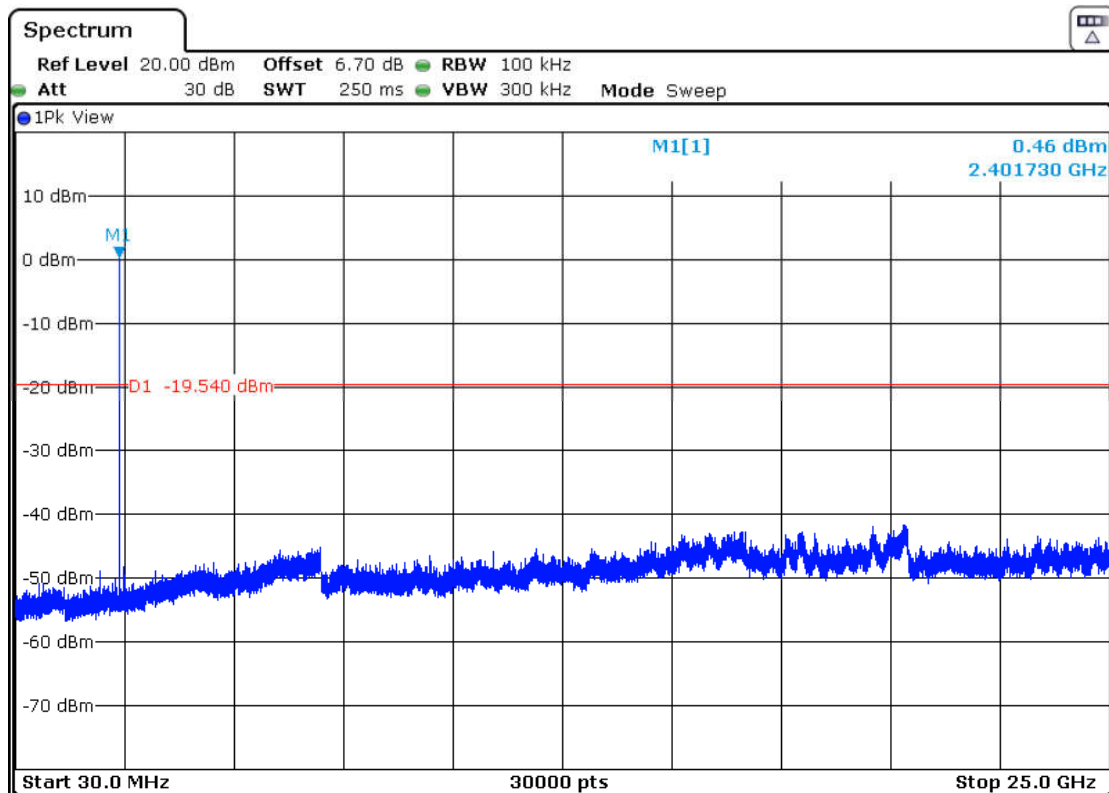
- High Channel:

No spurious peaks found at less than 20 dB below the limit.

Measurement uncertainty (dB)	<±2.03
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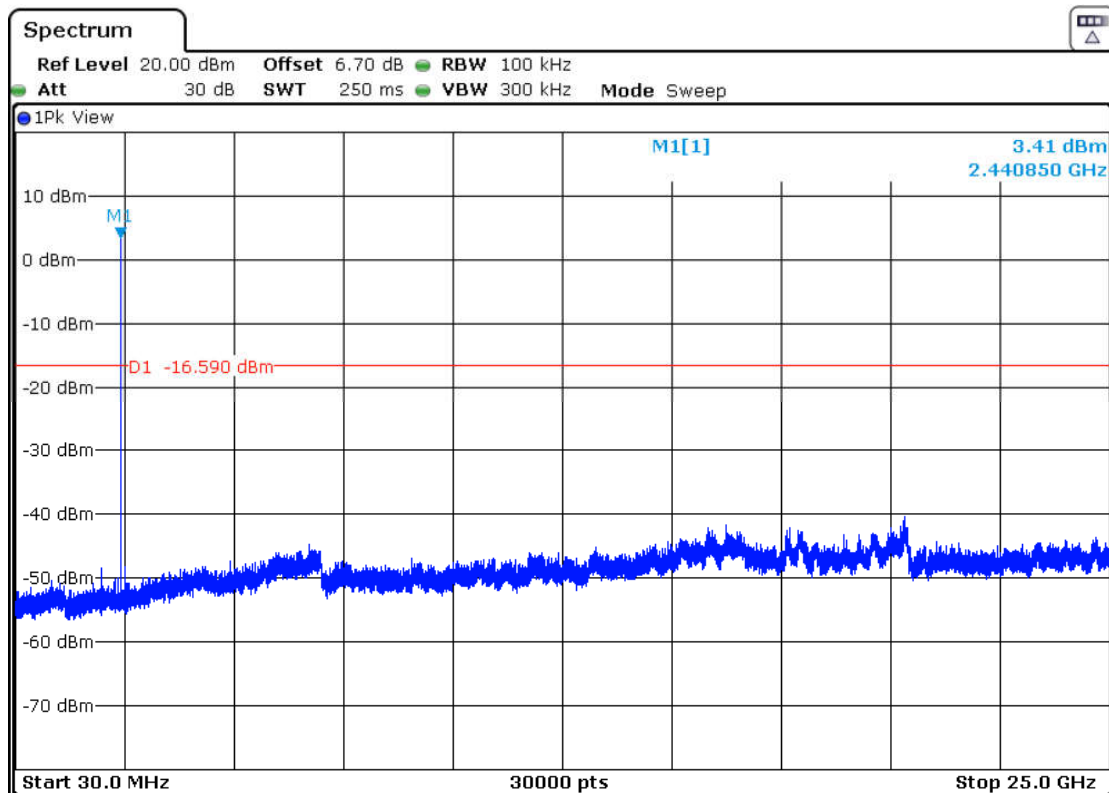
Verdict: PASS

- Low Channel:



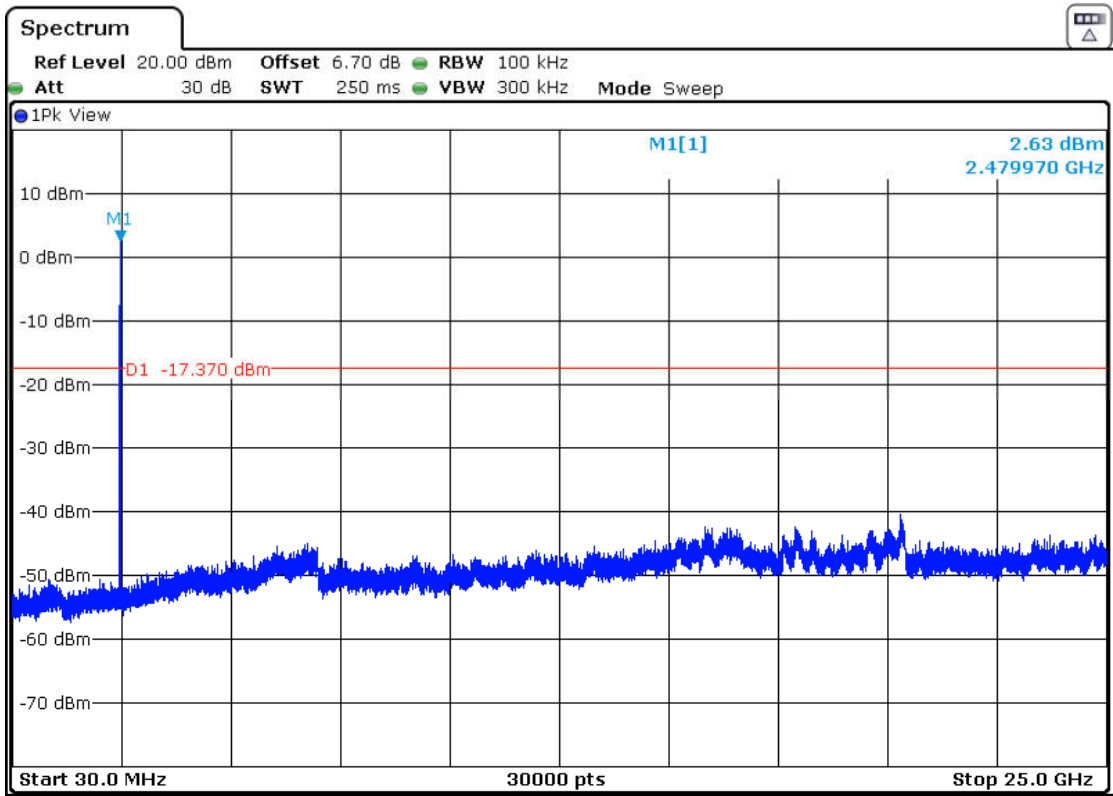
The peak shown in the plot above the limit is the carrier frequency.

- Middle Channel:



The peak shown in the plot above the limit is the carrier frequency.

- High Channel:



The peak shown in the plot above the limit is the carrier frequency.

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

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:

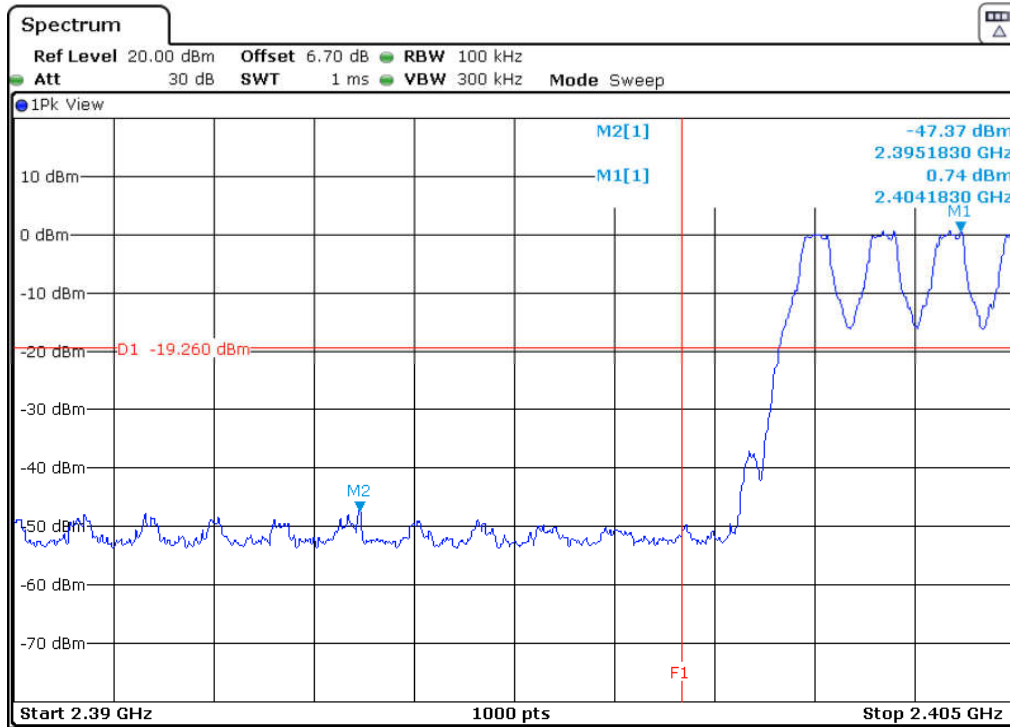
Radiated measurements were used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Measurement uncertainty (dB)	<±2.03
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- **GFSK – Band-edge emissions compliance**

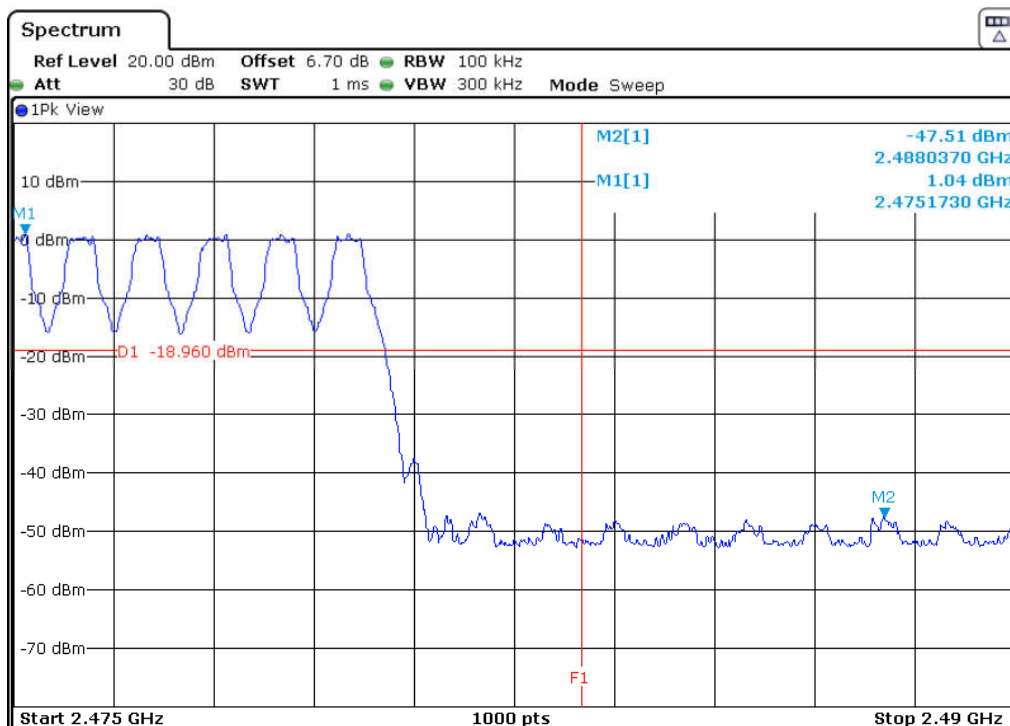
- ❖ **HOPPING ON:**

- **Low Frequency Section 2402 MHz:**



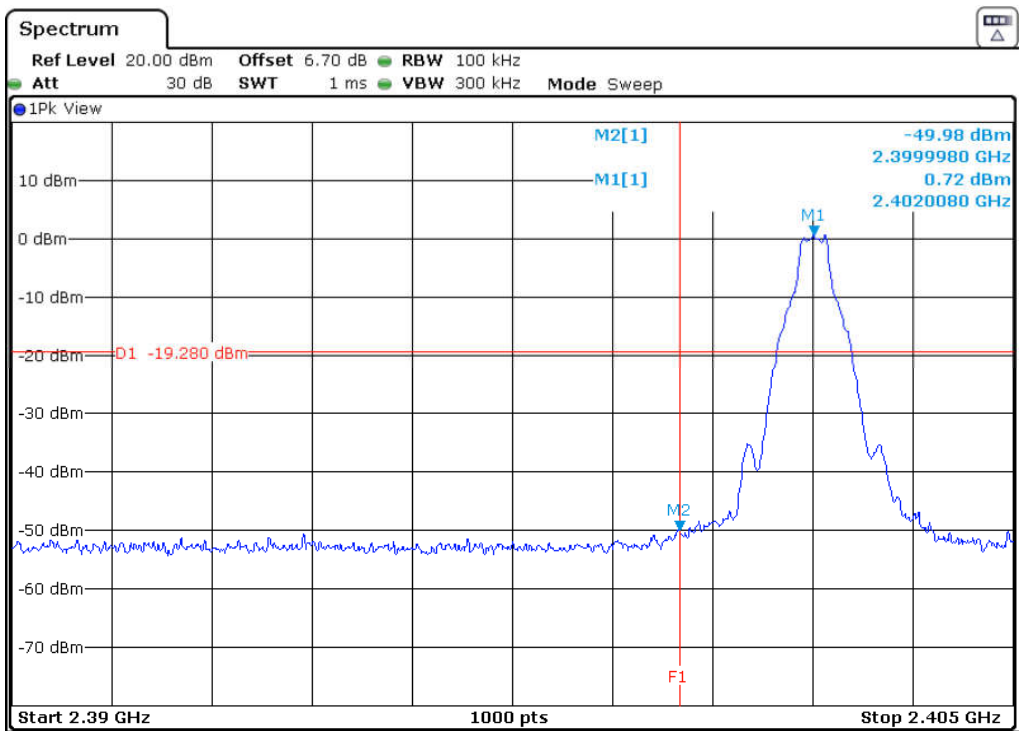
Verdict: PASS

- **High Frequency Section 2480 MHz:**



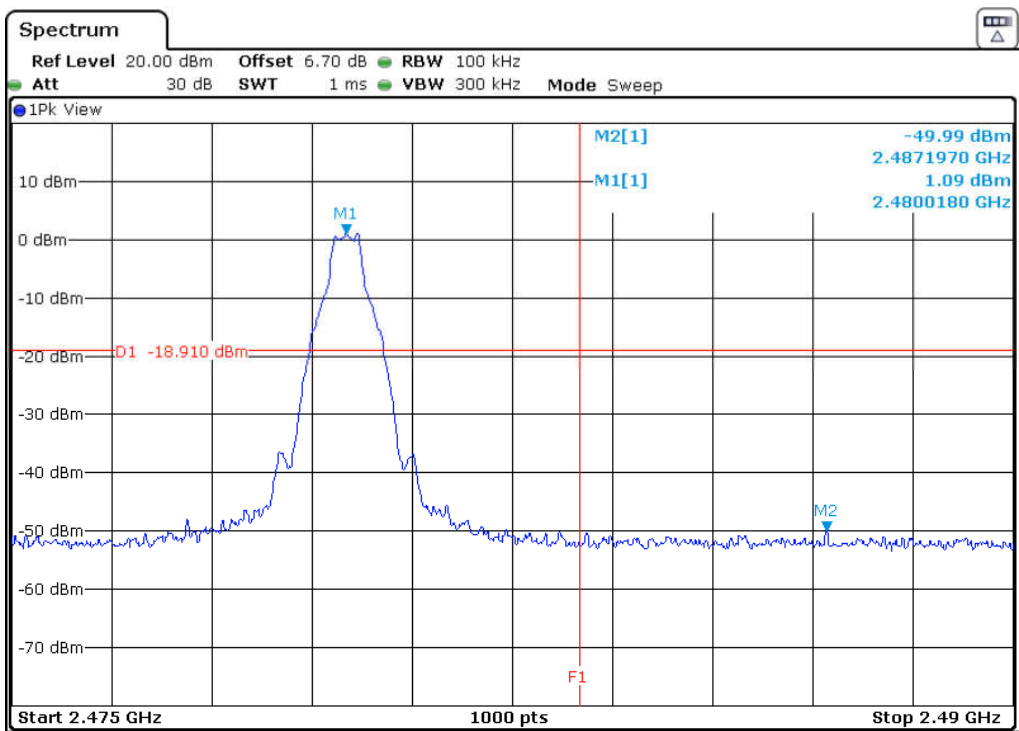
Verdict: PASS

- ❖ HOPPING OFF:
- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:

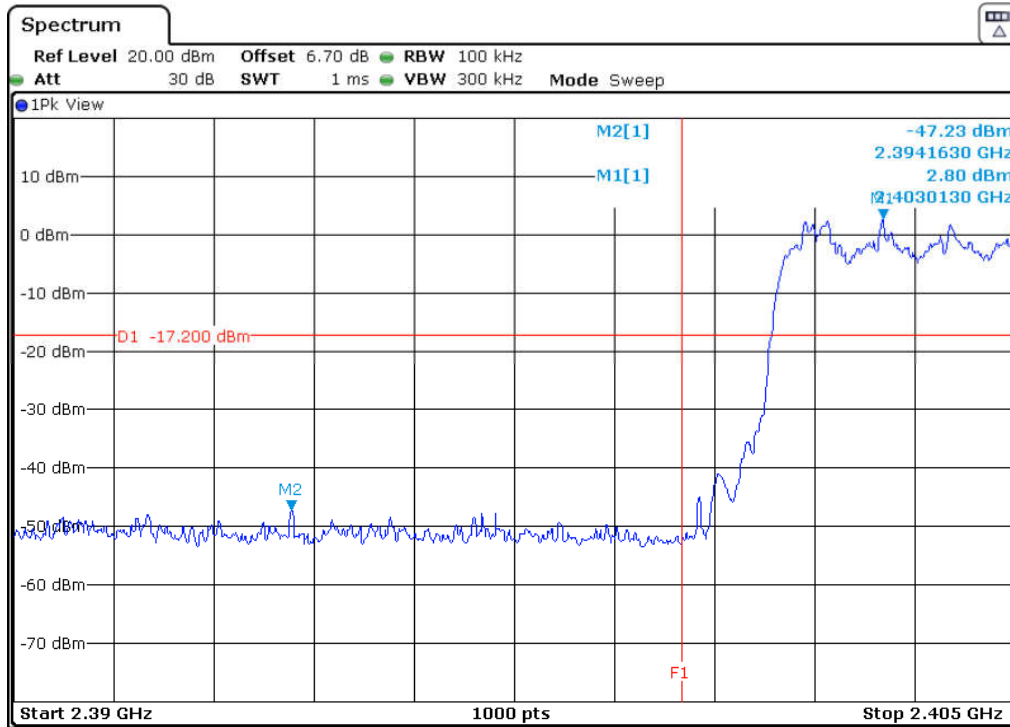


Verdict: PASS

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

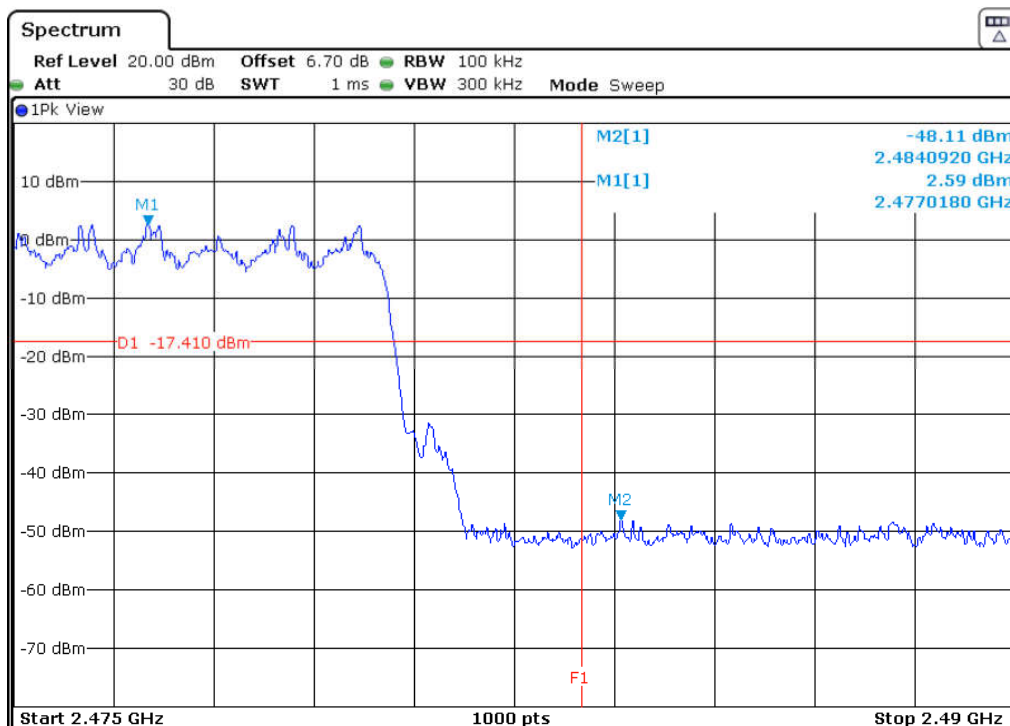
- ❖ HOPPING ON:

- Low Frequency Section 2402 MHz:



Verdict: PASS

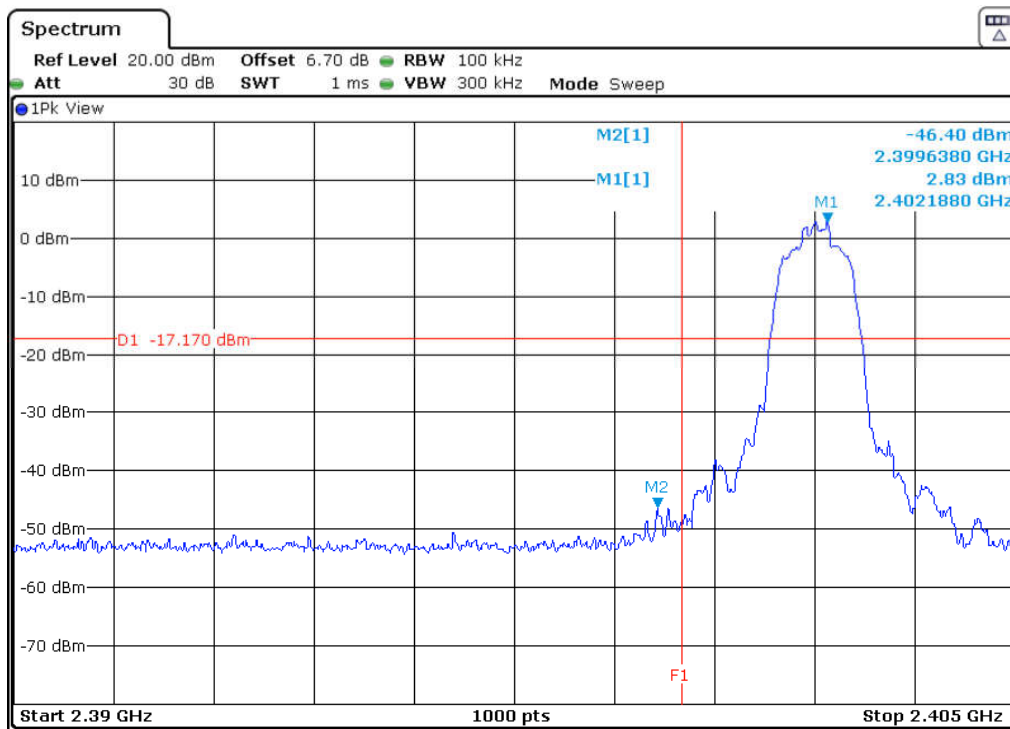
- High Frequency Section 2480 MHz:



Verdict: PASS

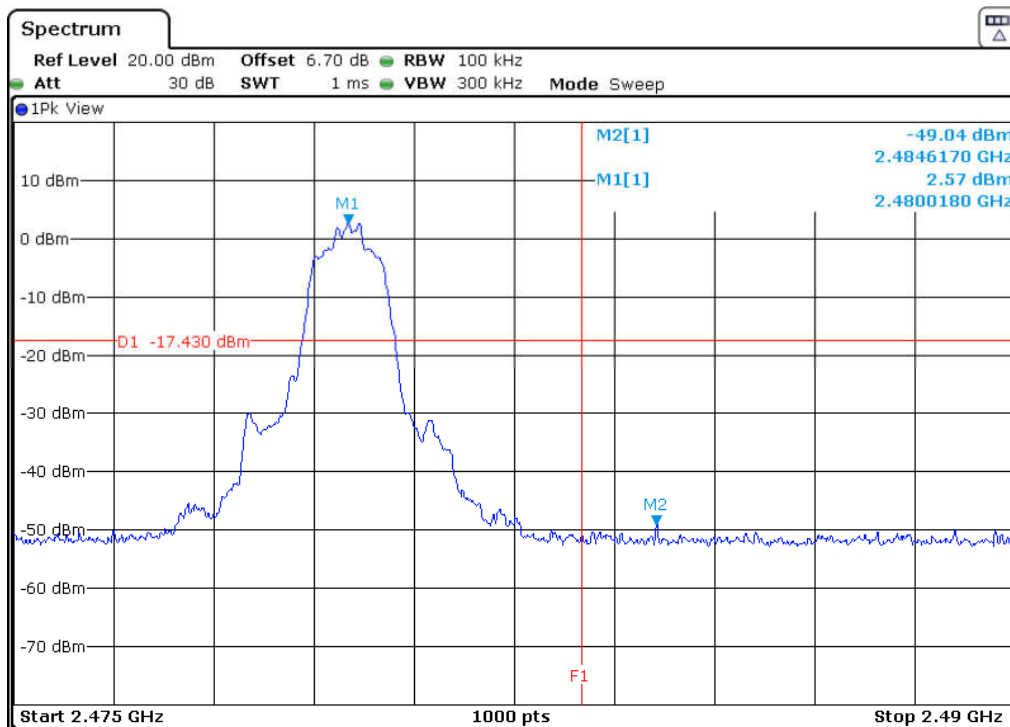
❖ HOPPING OFF:

- Low Frequency Section 2402 MHz:



Verdict: PASS

- High Frequency Section 2480 MHz:

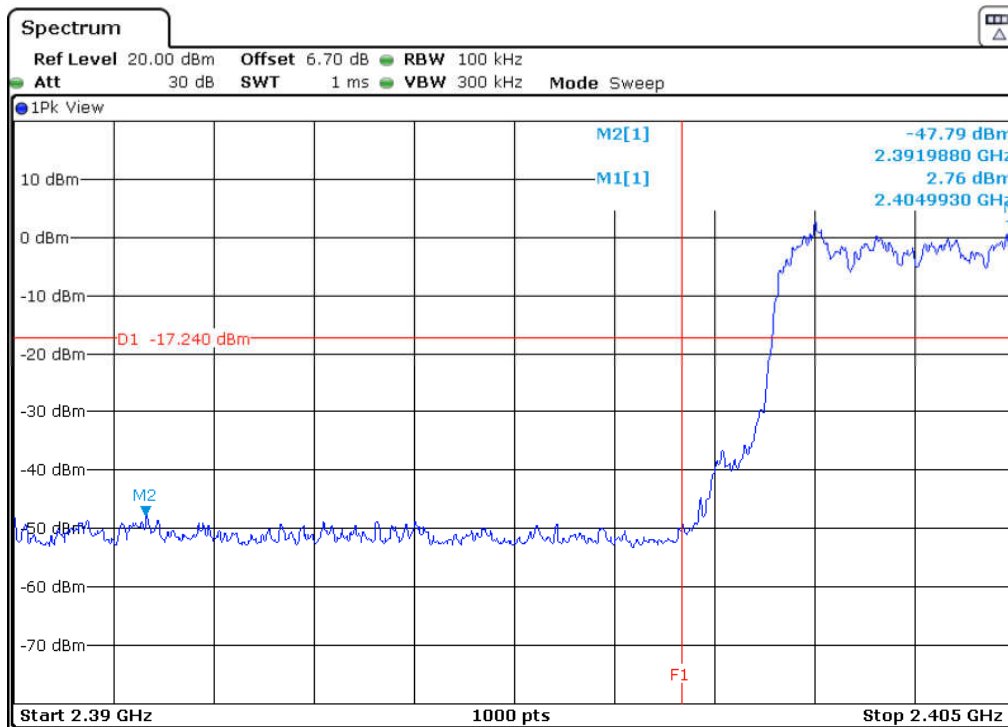


Verdict: PASS

- 8DPSK – Band-edge emissions compliance

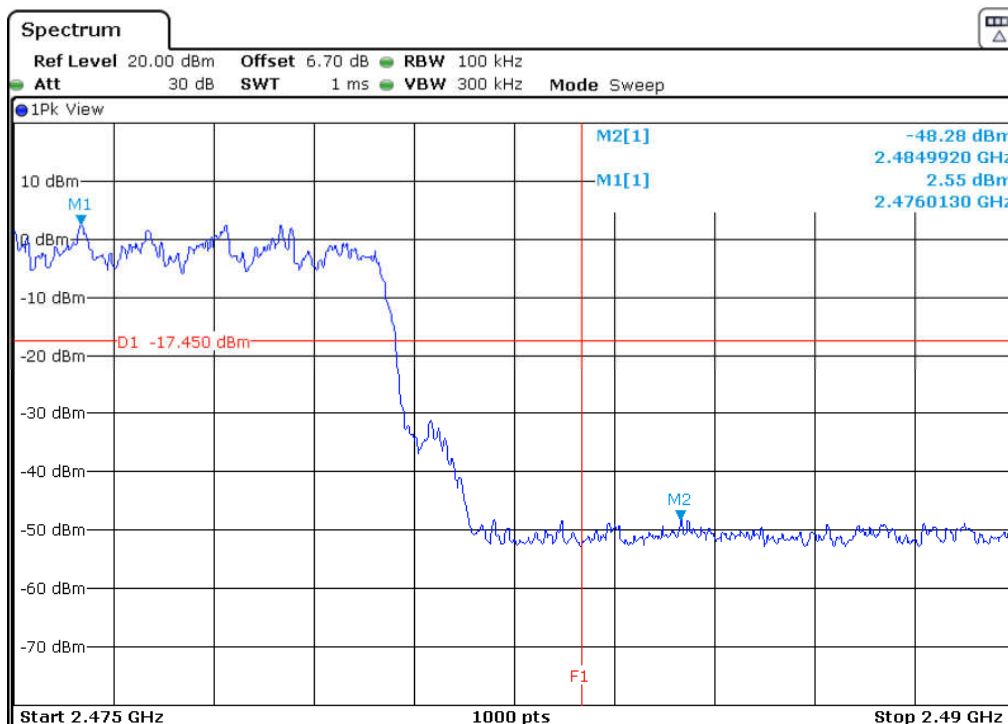
- ❖ HOPPING ON:

- Low Frequency Section 2402 MHz:



Verdict: PASS

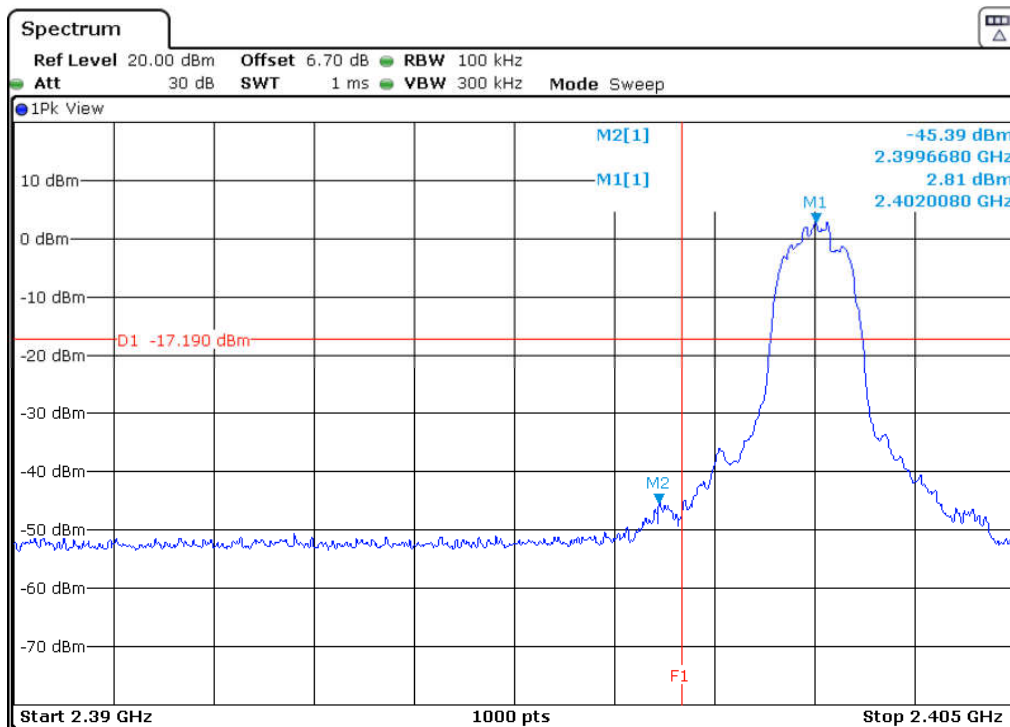
- High Frequency Section 2480 MHz:



Verdict: PASS

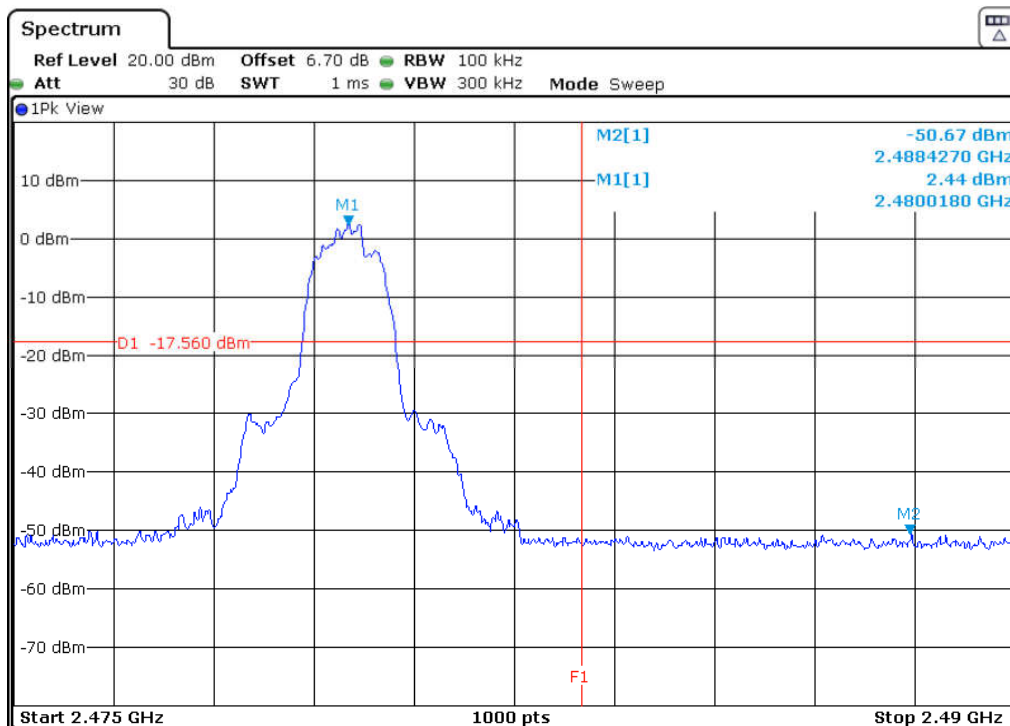
❖ HOPPING OFF:

▪ 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 ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	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 360° 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 emissions below 1 GHz do not depend neither on the operating channel nor the modulation mode selected in the EUT.

Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (MHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
37.259	Quasi peak	34.0	V	< $\pm$ 2.07
61.768	Quasi peak	35.6	V	< $\pm$ 2.07
192.006	Quasi peak	30.0	V	< $\pm$ 2.07
288.004	Quasi peak	32.3	H	< $\pm$ 2.07
320.014	Quasi peak	38.2	H	< $\pm$ 2.07
376.015	Quasi peak	34.1	H	< $\pm$ 2.07
448.022	Quasi peak	39.6	H	< $\pm$ 2.07
456.008	Quasi peak	31.7	V	< $\pm$ 2.07

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 signals with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with average detector for checking compliance with the average limit.

- Modulation: GFSK (DH5)**

- Low Channel (2402 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
2.32194	Peak	52.81	V	< $\pm$ 4.88
3.18550	Peak	45.94	V	< $\pm$ 4.88
3.29470	Peak	46.72	H	< $\pm$ 4.88
4.80343	Peak	49.91	V	< $\pm$ 4.88
7.20537(*)	Peak	58.76	V	< $\pm$ 4.88
	Average	56.05		< $\pm$ 4.88
9.60730	Peak	50.97	H	< $\pm$ 4.88
12.01063	Peak	50.78	H	< $\pm$ 4.88

(*): This spurious frequency is outside the restricted bands as defined in §15.205(a). The measured maximum carrier level at 3 m was 104.28 dB μ V/m (Peak) so the spurious level is more than 20 dB below the carrier level.

- Middle Channel (2441 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
2.32109	Peak	50.27	V	< $\pm$ 4.88
2.36118	Peak	52.69	V	< $\pm$ 4.88
2.52096	Peak	52.87	V	< $\pm$ 4.88
3.31337	Peak	47.86	H	< $\pm$ 4.88
4.88230	Peak	49.48	H	< $\pm$ 4.88
7.32297	Peak	56.91	V	< $\pm$ 4.88
	Average	53.98		< $\pm$ 4.88
9.76363	Peak	51.82	V	< $\pm$ 4.88
12.20570	Peak	48.47	V	< $\pm$ 4.88

- High Channel (2480 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
2.33475	Peak	51.09	H	< $\pm$ 4.88
2.39983	Peak	50.53	V	< $\pm$ 4.88
2.48357	Peak	56.52	V	< $\pm$ 4.88
	Average	41.61		< $\pm$ 4.88
3.28163	Peak	47.63	H	< $\pm$ 4.88
4.95977	Peak	52.56	H	< $\pm$ 4.88
7.44010	Peak	57.36	V	< $\pm$ 4.88
	Average	53.97		< $\pm$ 4.88
9.92043	Peak	50.53	V	< $\pm$ 4.88

Verdict: PASS

• **Modulation PI/4-DQPSK (2DH5)**

- Low Channel (2402 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.32219	Peak	51.88	V	<± 4.88
2.34412	Peak	51.01	H	<± 4.88
3.29423	Peak	46.11	H	<± 4.88
3.32317	Peak	43.10	V	<± 4.88
4.80390	Peak	45.88	V	<± 4.88
7.20630	Peak	56.57	V	<± 4.88
	Average	53.72		<± 4.88
9.60870	Peak	47.71	H	<± 4.88
12.01063	Peak	47.43	H	<± 4.88

- Middle Channel (2441 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.36130	Peak	52.48	V	<± 4.88
3.16963	Peak	46.21	V	<± 4.88
3.39690	Peak	46.70	H	<± 4.88
4.88230	Peak	46.72	H	<± 4.88
7.32343	Peak	54.57	V	<± 4.88
	Average	50.28		<± 4.88
9.76363	Peak	48.72	V	<± 4.88
12.20570	Peak	47.60	H	<± 4.88

- High Channel (2480 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.34029	Peak	51.18	H	<± 4.88
2.48352	Peak	54.99	V	<± 4.88
	Average	40.63		<± 4.88
3.15377	Peak	45.36	V	<± 4.88
3.31990	Peak	48.50	H	<± 4.88
4.96023	Peak	48.28	H	<± 4.88
7.44057	Peak	54.25	V	<± 4.88
	Average	51.36		<± 4.88
9.92043	Peak	47.25	V	<± 4.88

Verdict: PASS

• **Modulation: 8-DPSK (3DH5)**

- Low Channel (2402 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.32202	Peak	52.11	V	<± 4.88
3.30683	Peak	47.90	H	<± 4.88
3.33903	Peak	45.31	V	<± 4.88
4.80390	Peak	46.60	V	<± 4.88
7.20583	Peak	57.66	V	<± 4.88
	Average	52.42		<± 4.88
9.60777	Peak	48.48	H	<± 4.88
12.00877	Peak	49.08	V	<± 4.88

- Middle Channel (2441 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.36083	Peak	52.06	V	<± 4.88
2.36102	Peak	52.65	V	<± 4.88
3.29750	Peak	44.68	V	<± 4.88
3.41277	Peak	45.99	H	<± 4.88
4.88183	Peak	48.16	H	<± 4.88
7.32297	Peak	55.1	V	<± 4.88
	Average	50.4		<± 4.88
9.76363	Peak	49.77	V	<± 4.88

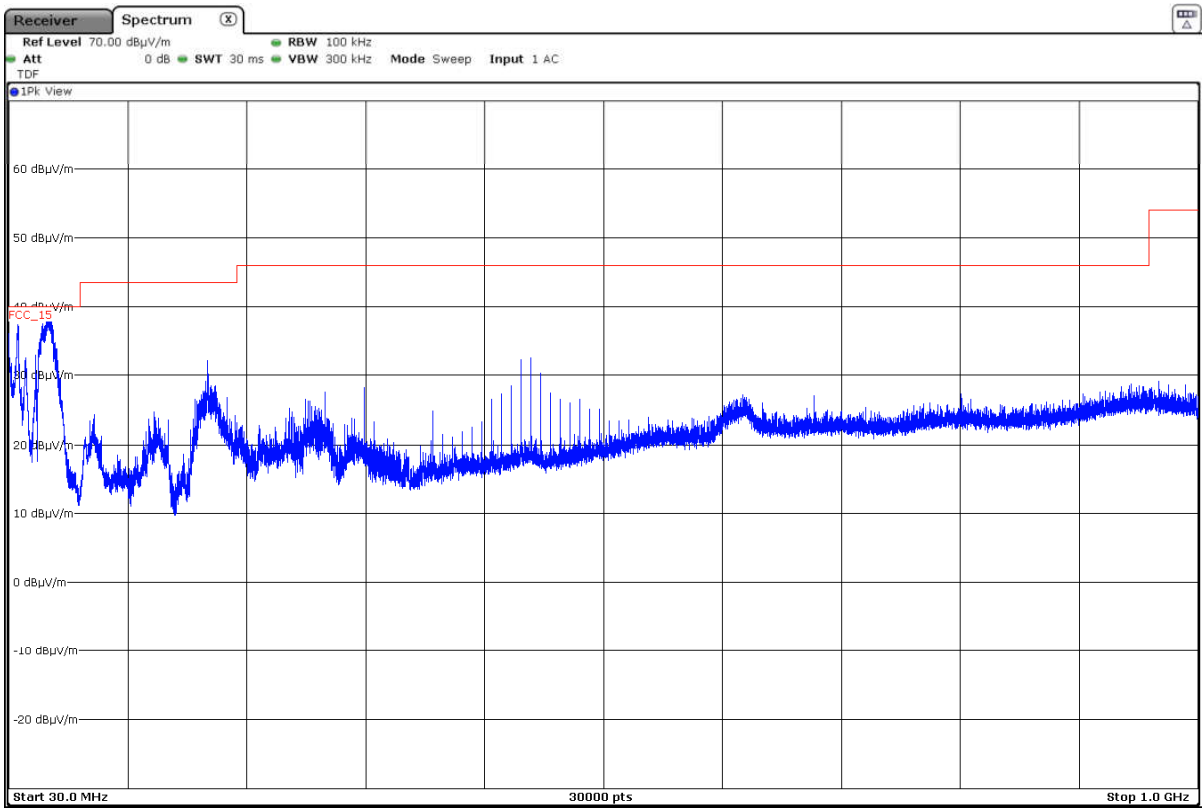
- High Channel (2480 MHz). Spurious frequencies operating (radiated) at less than 20 dB below limit:

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.31584	Peak	51.10	H	<± 4.88
2.36001	Peak	51.47	V	<± 4.88
2.48361	Peak	54.68	V	<± 4.88
	Average	40.71		<± 4.88
3.27510	Peak	47.20	H	<± 4.88
4.95977	Peak	49.88	V	<± 4.88
7.43963	Peak	55.43	V	<± 4.88
	Average	50.37		<± 4.88
9.92043	Peak	48.28	H	<± 4.88

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

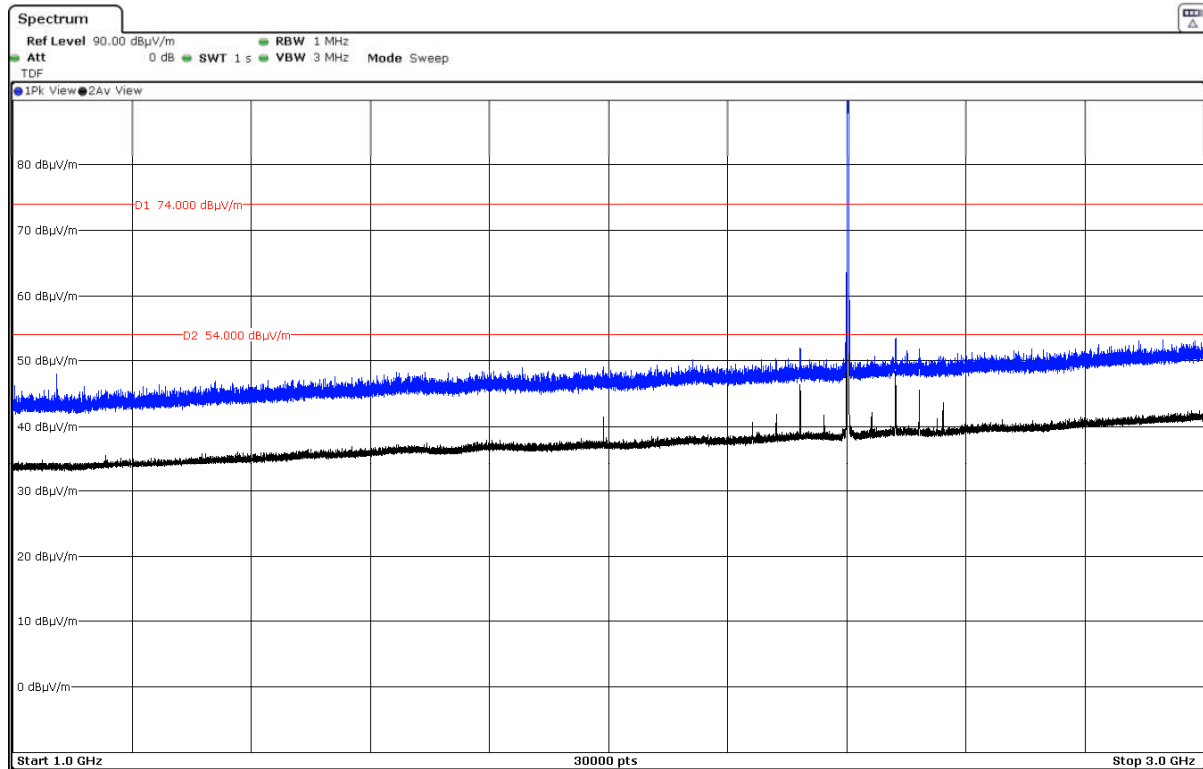
This plot is valid for the Low, Middle and High Channels and all modulation modes.



FREQUENCY RANGE 1 - 3 GHz:

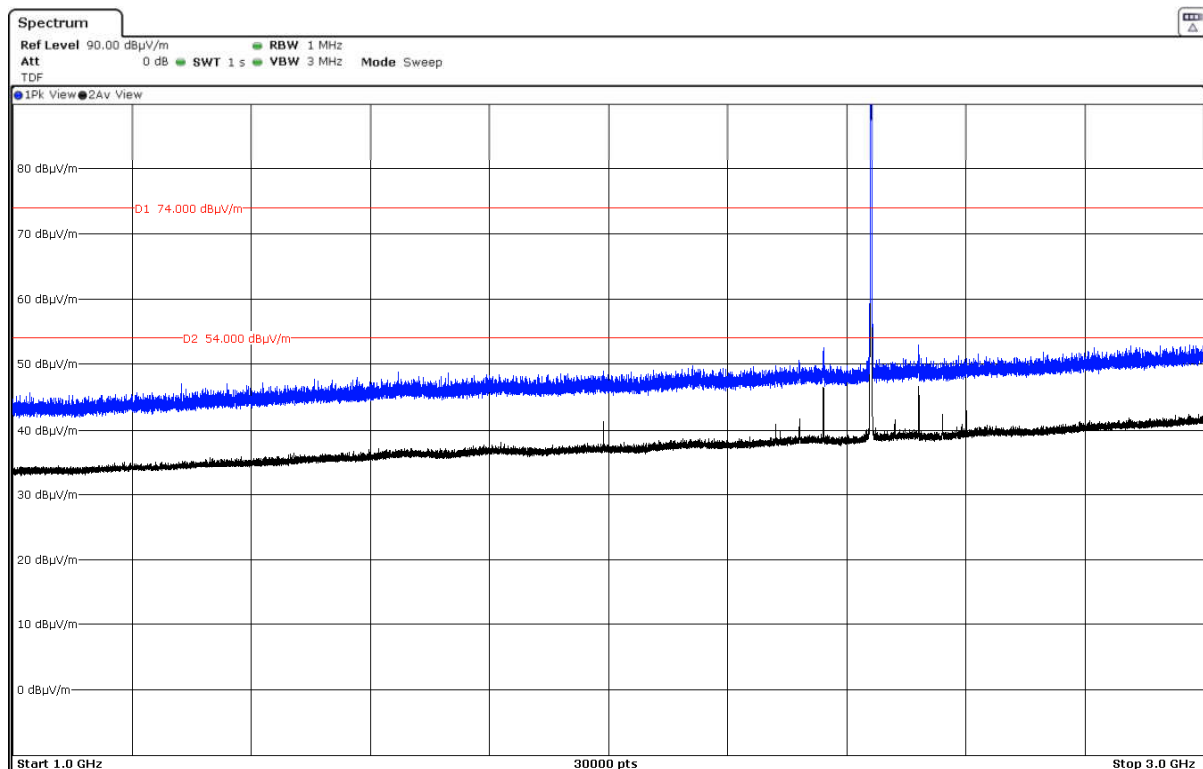
- Modulation: GFSK (DH5)**

- Low Channel (2402 MHz):



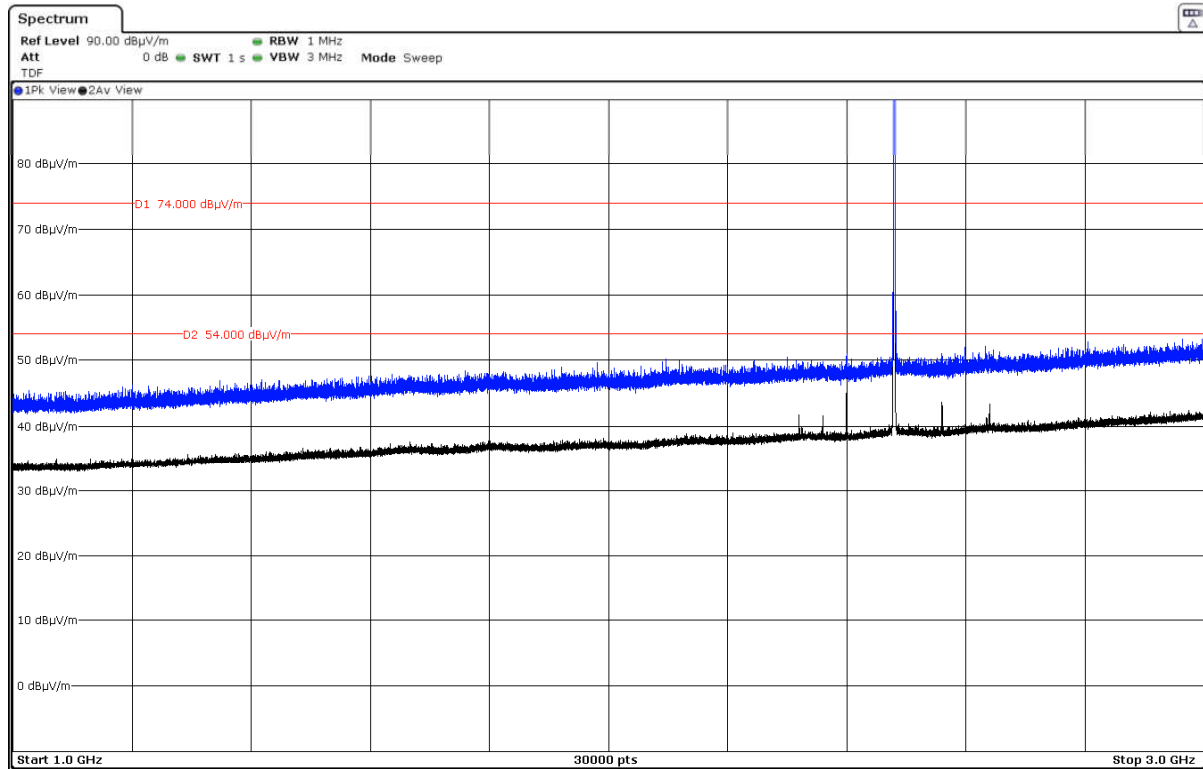
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

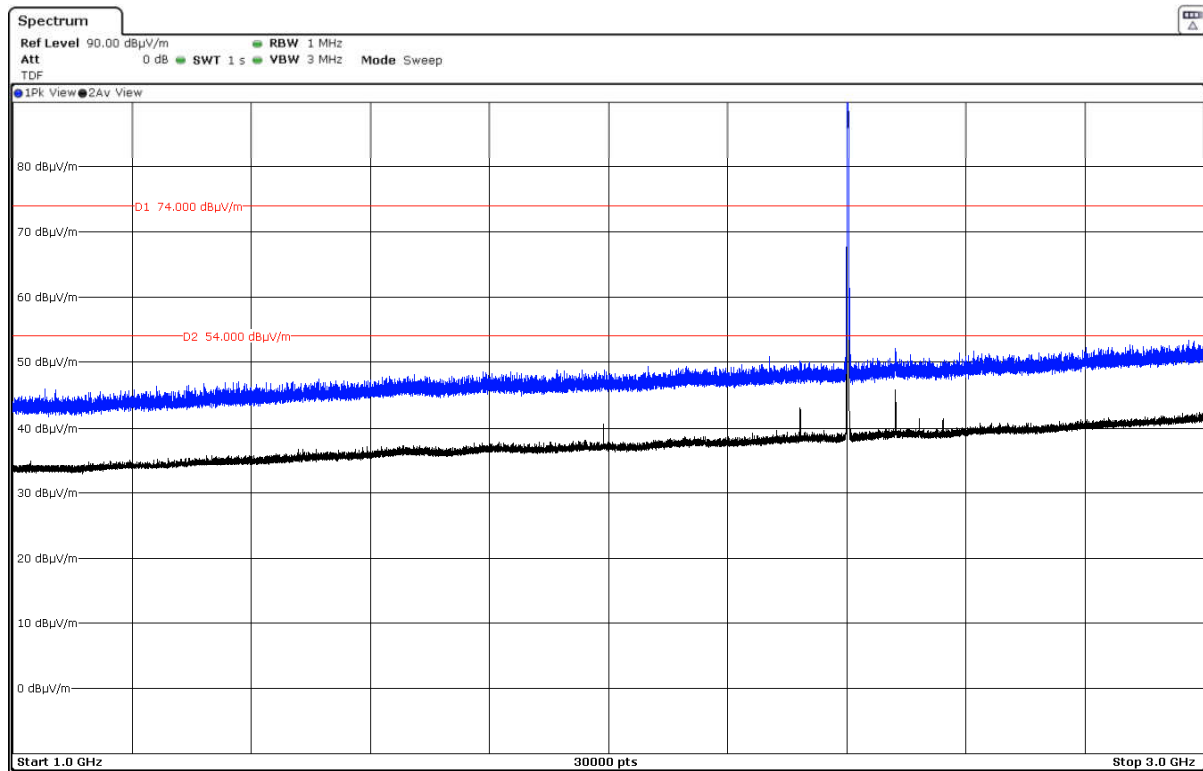
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

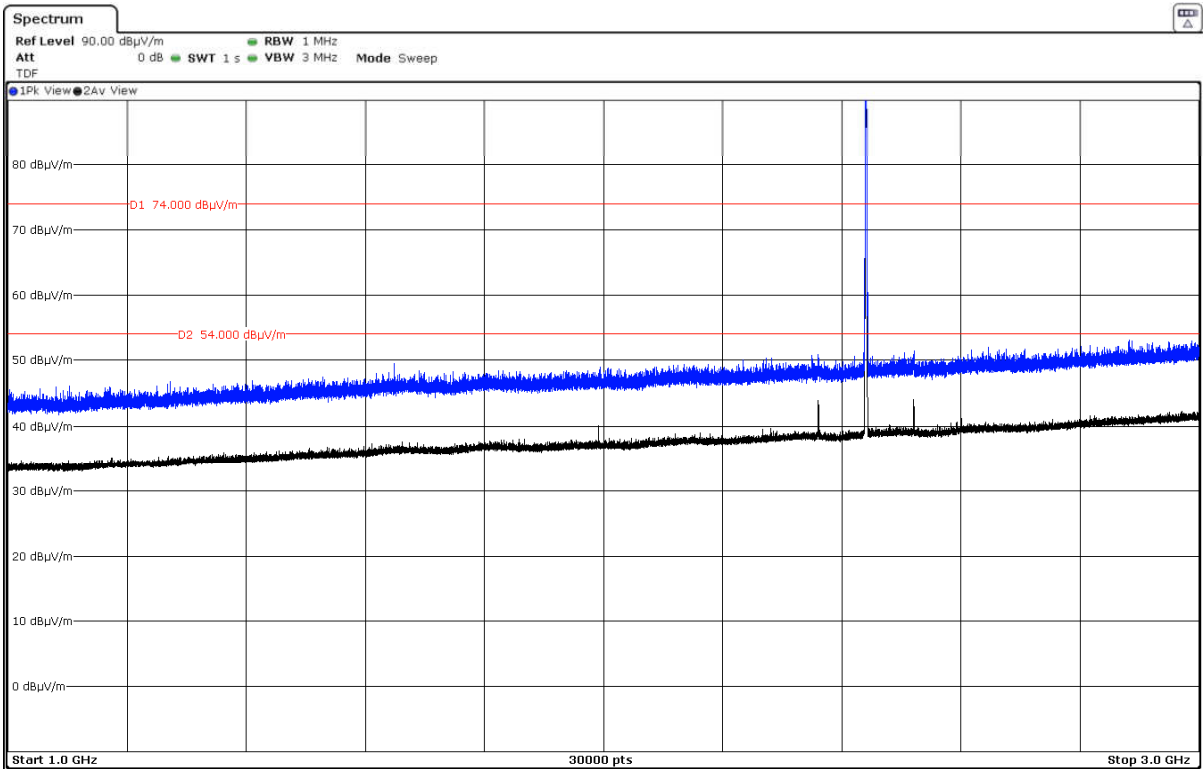
• Modulation: PI/4-DQPSK (2DH5)

- Low Channel (2402 MHz):



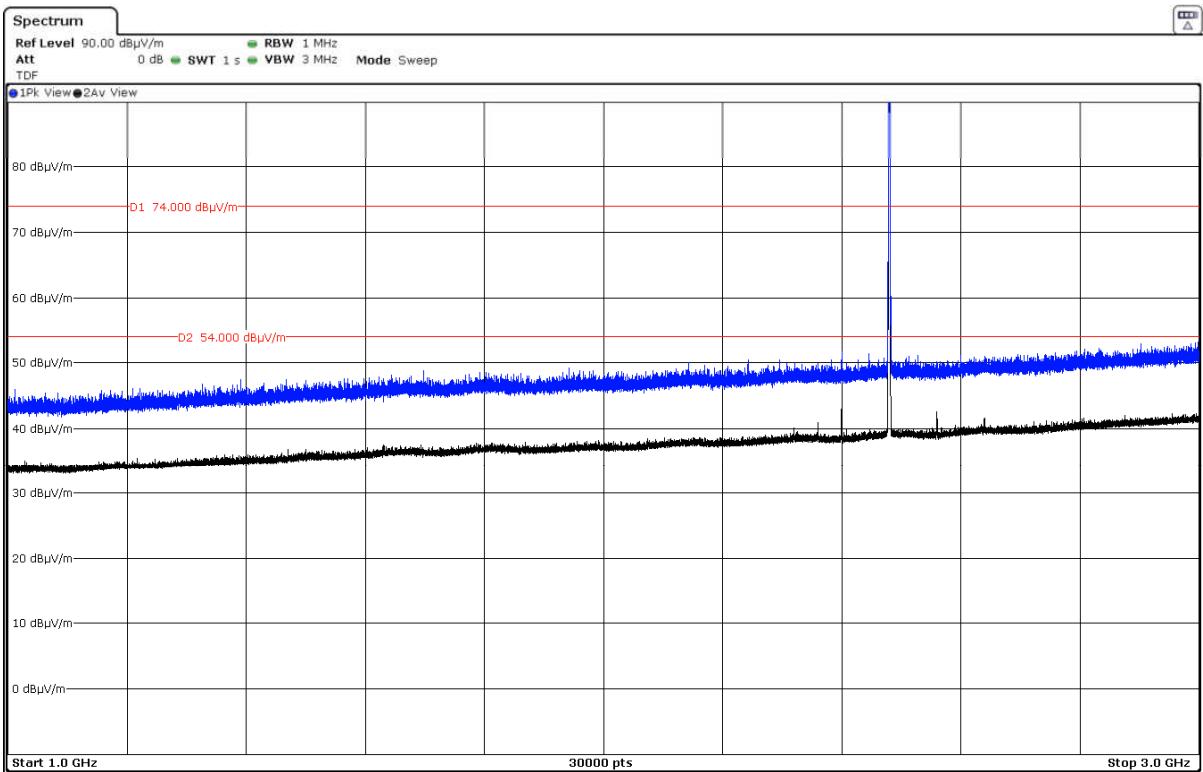
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

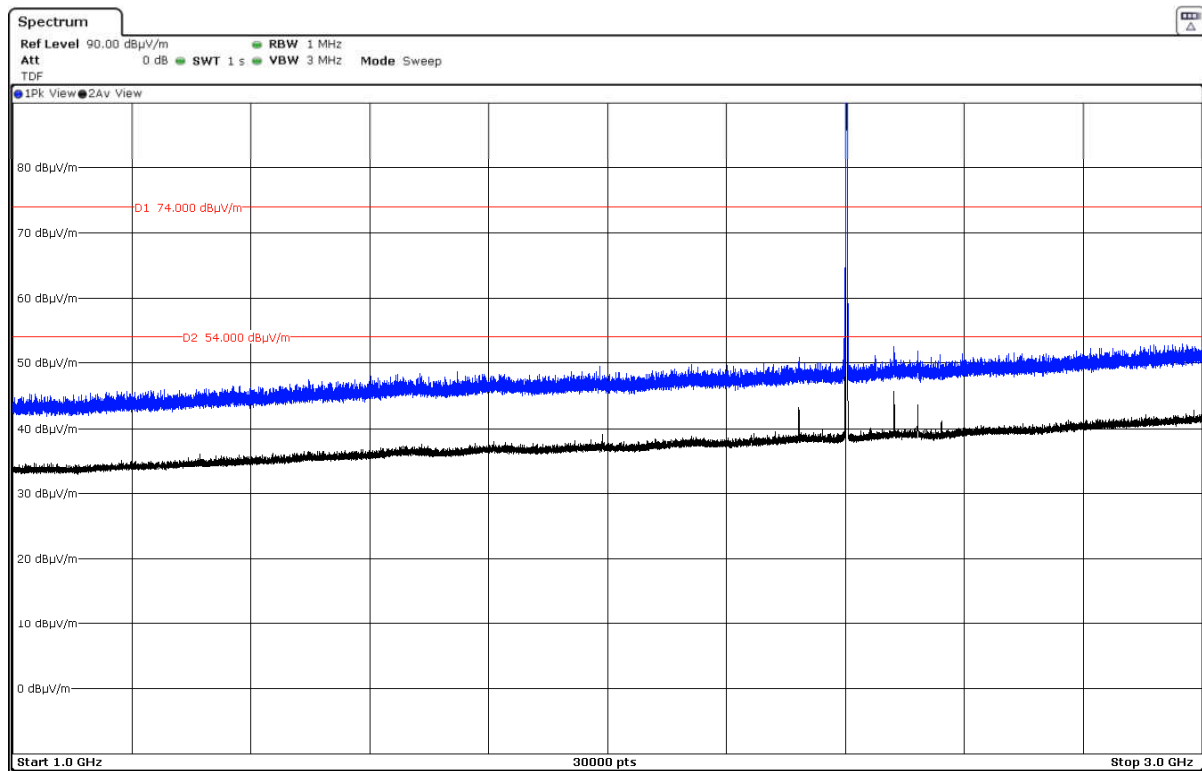
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

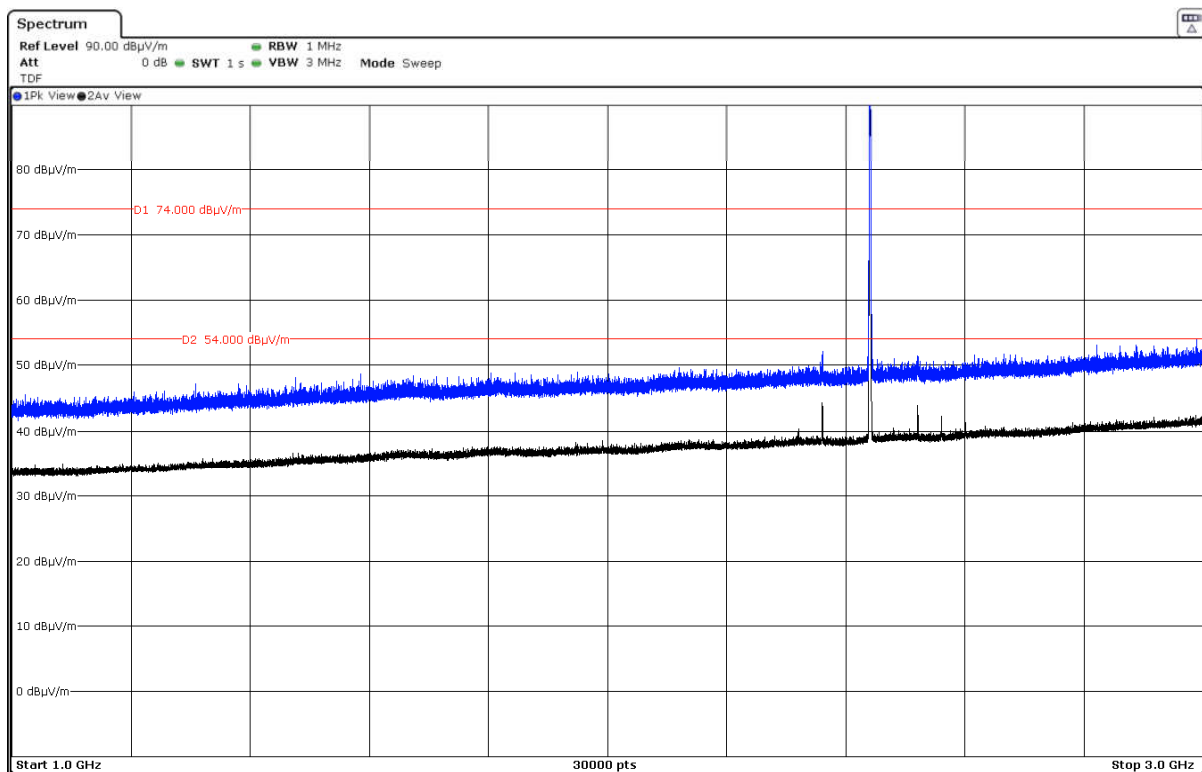
- **Modulation: 8-DPSK (3DH5)**

- Low Channel (2402 MHz):



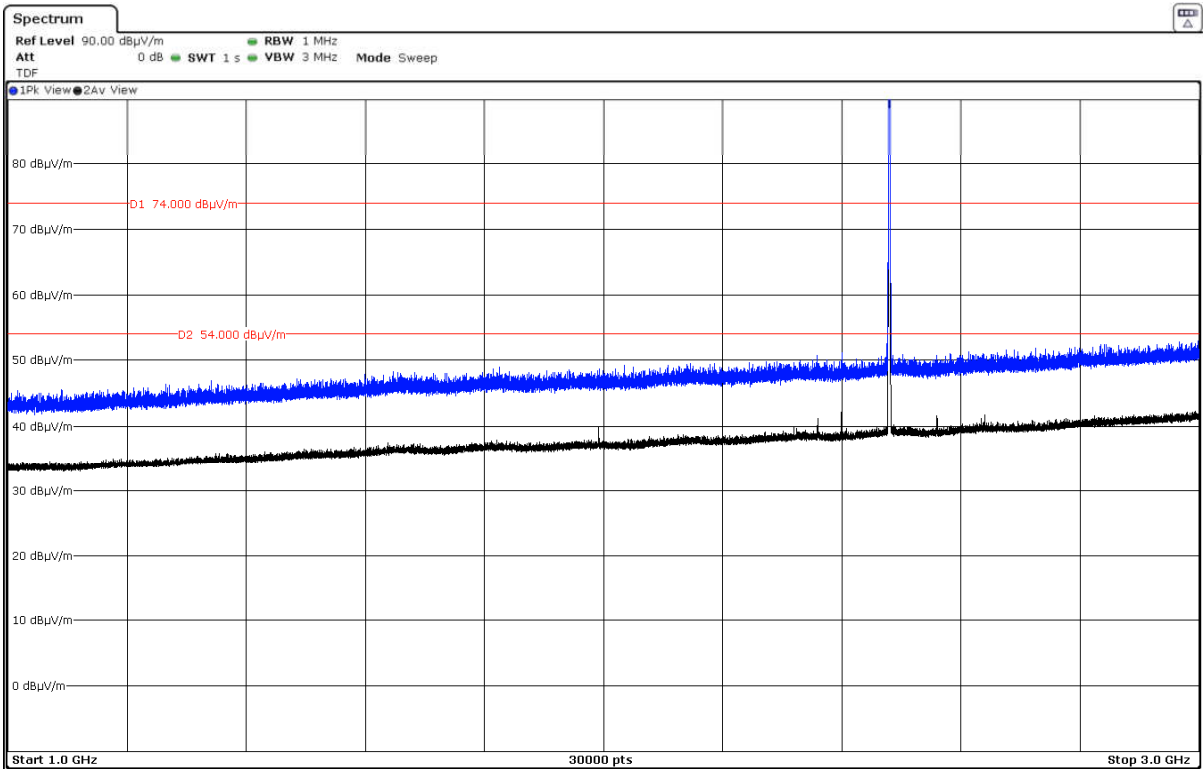
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

- High Channel (2480 MHz):

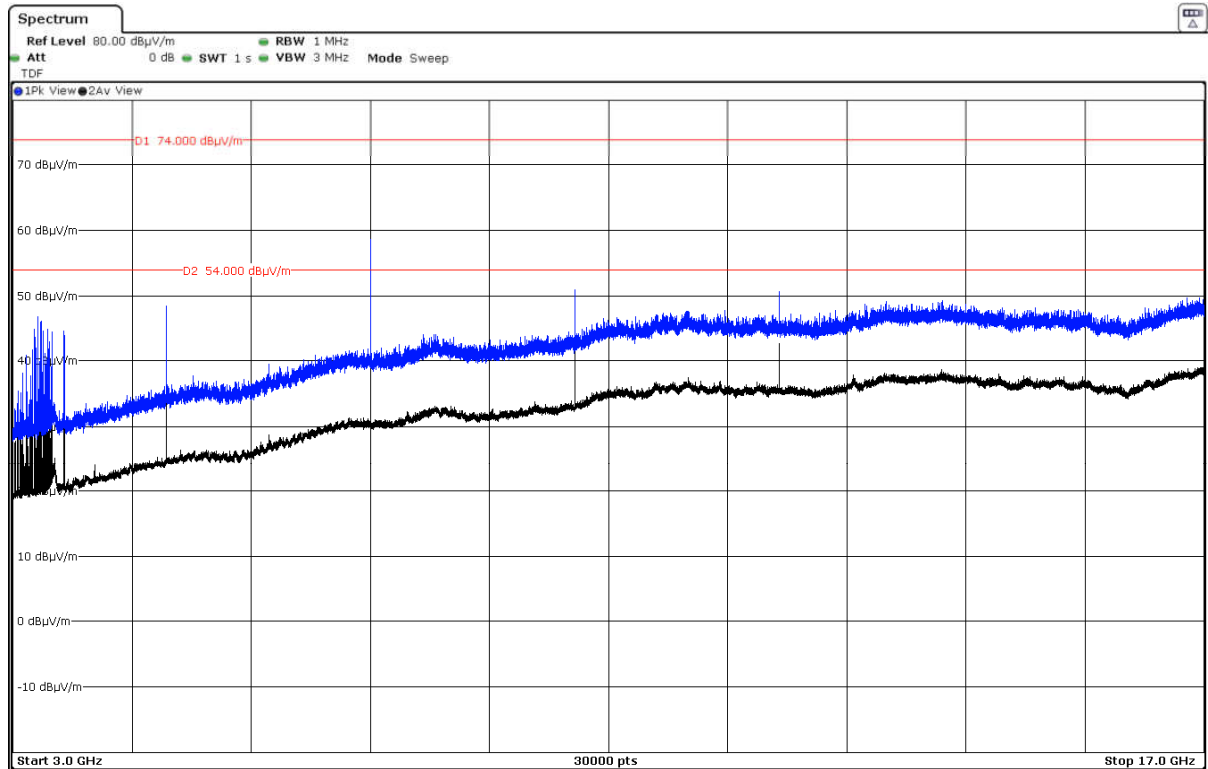


The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

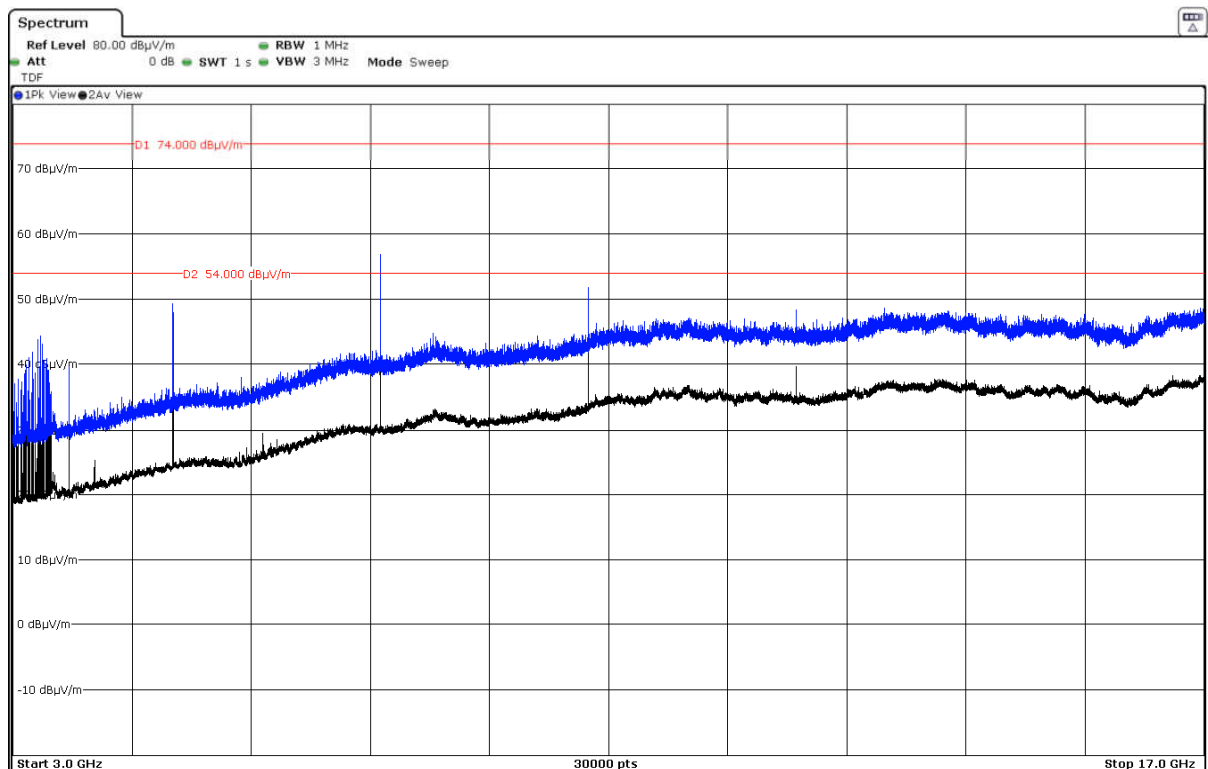
- **Modulation: GFSK (DH5)**

- Low Channel (2402 MHz):



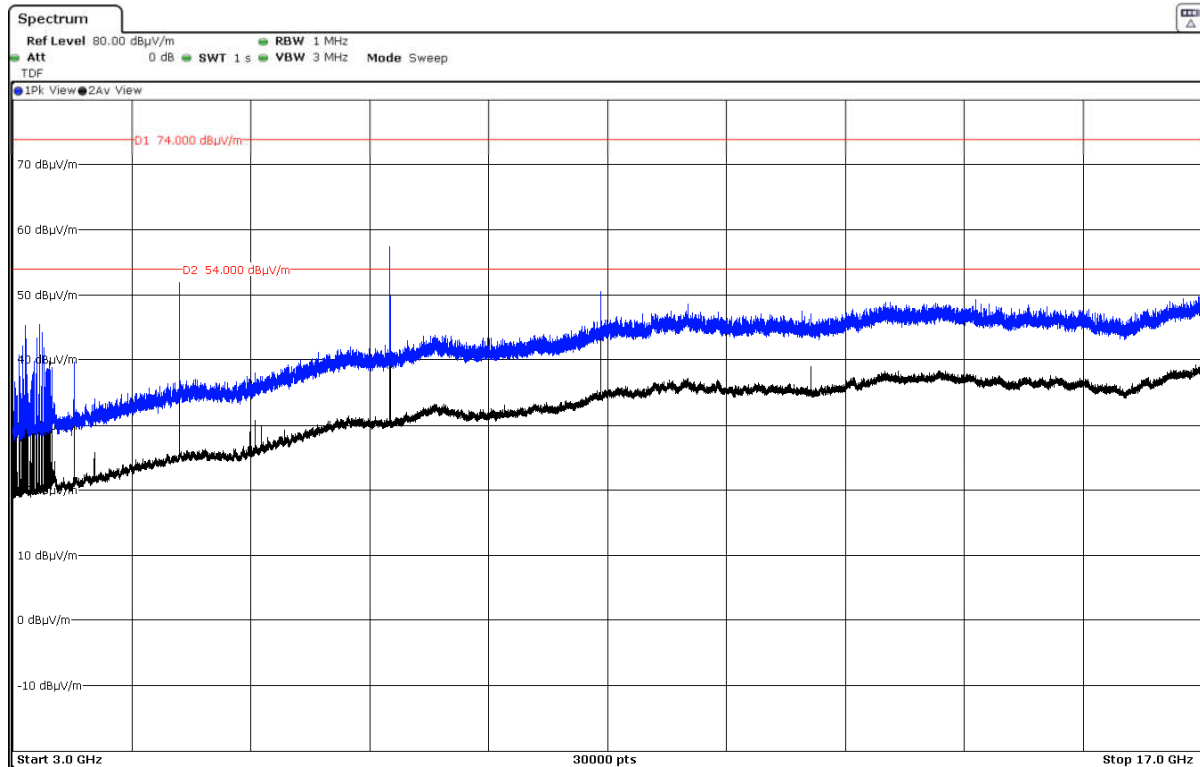
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

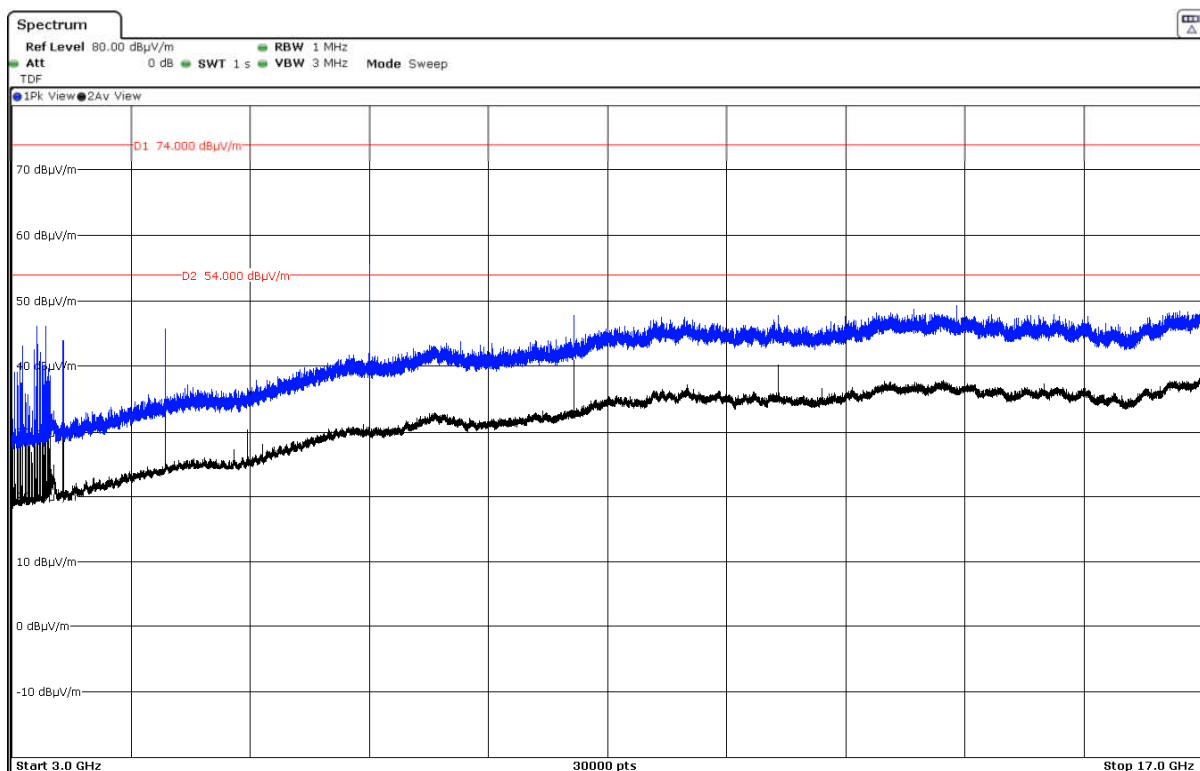
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

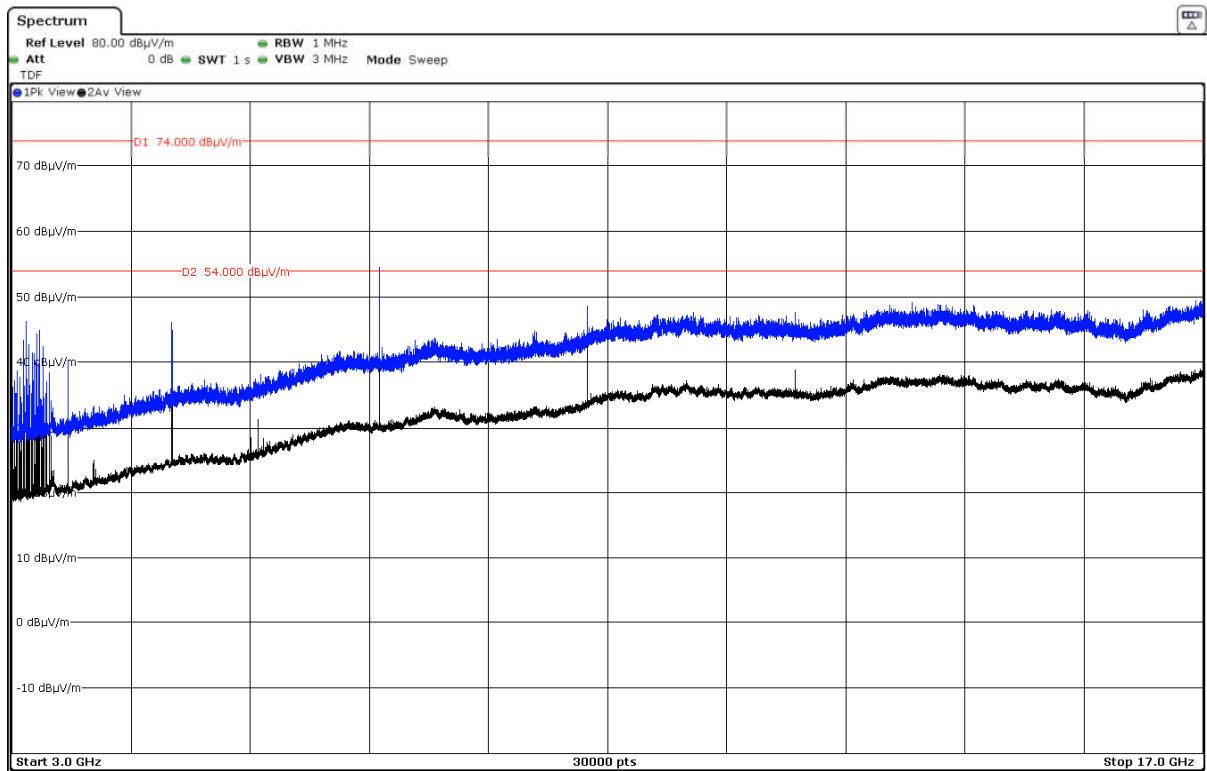
• **Modulation: PI/4-DQPSK (2DH5)**

- Low Channel (2402 MHz):



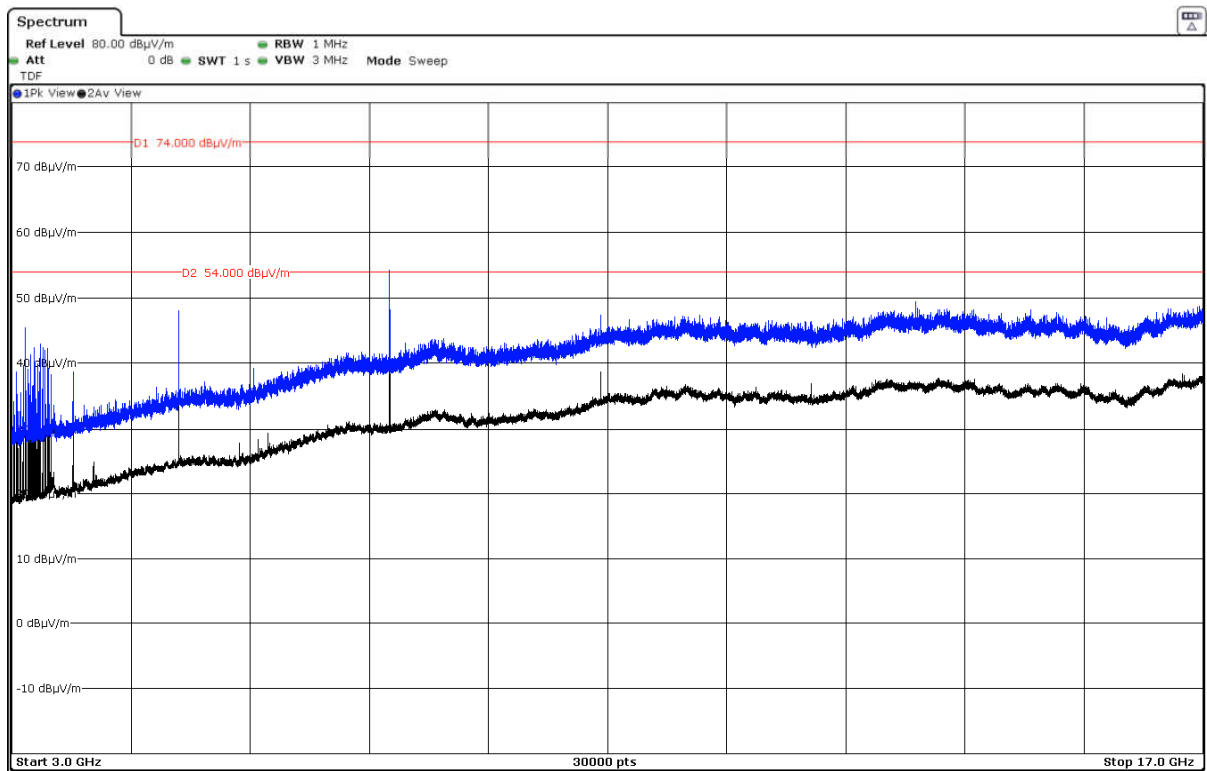
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

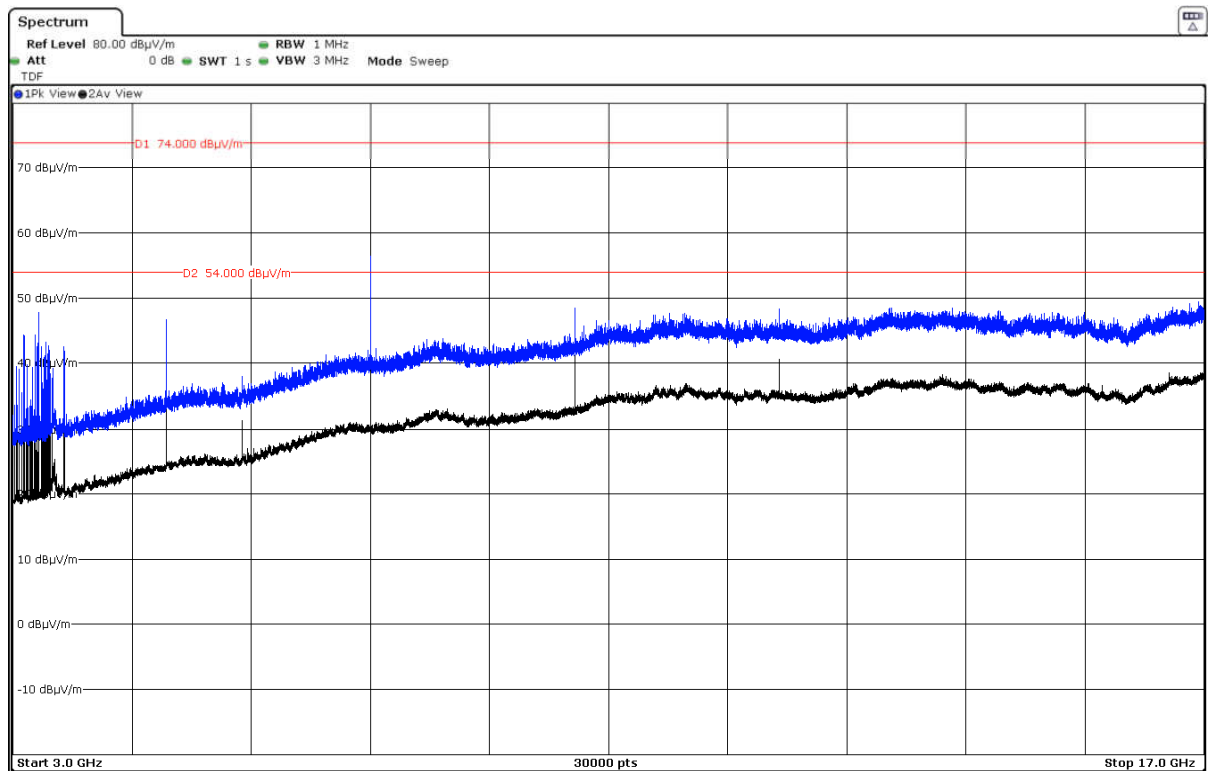
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

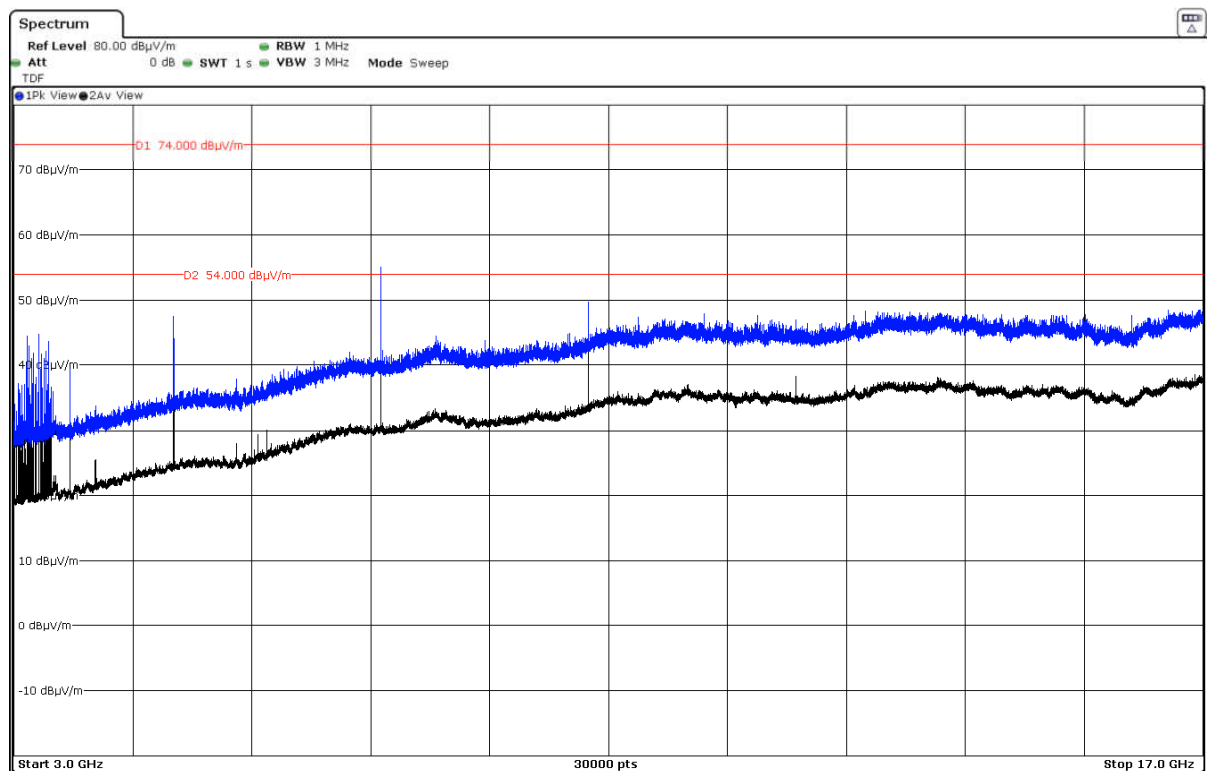
- **Modulation: 8-DPSK (3DH5)**

- Low Channel (2402 MHz):



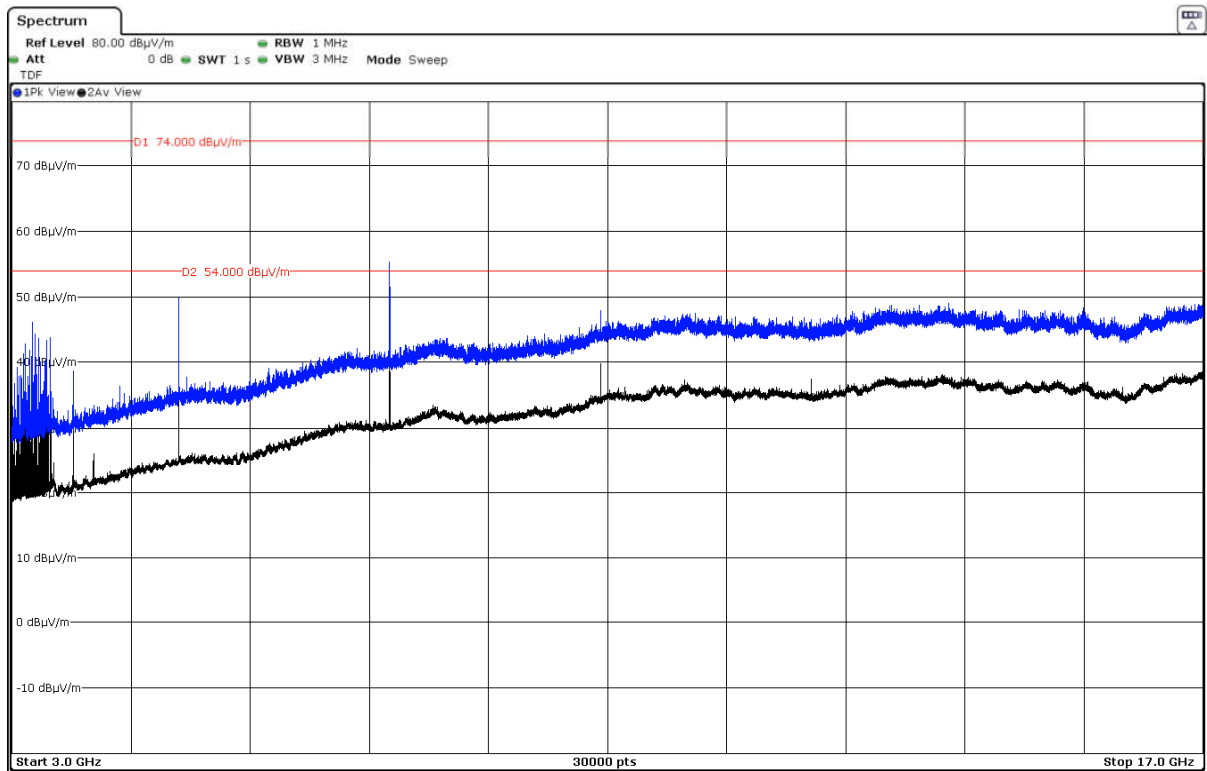
The peak above the limit is the carrier frequency.

- Middle Channel (2441 MHz):



The peak above the limit is the carrier frequency.

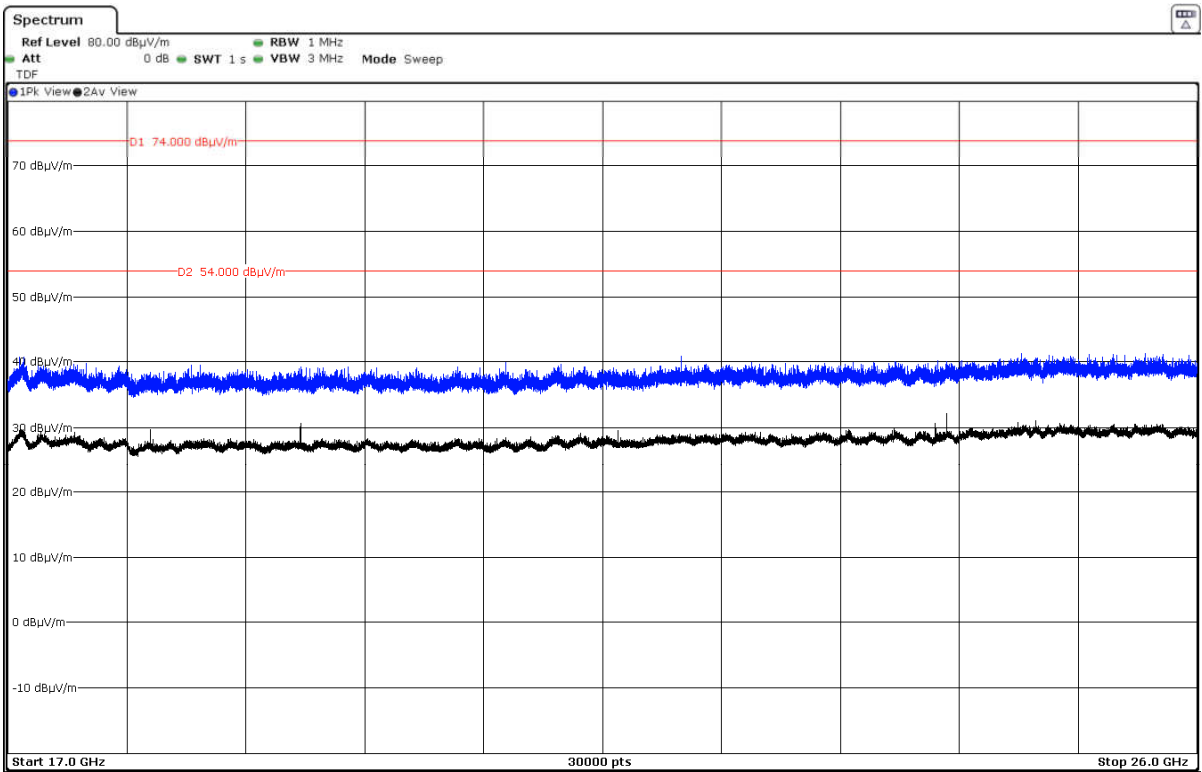
- High Channel (2480 MHz):



The peak above the limit is the carrier frequency.

FREQUENCY RANGE 17 - 26 GHz:

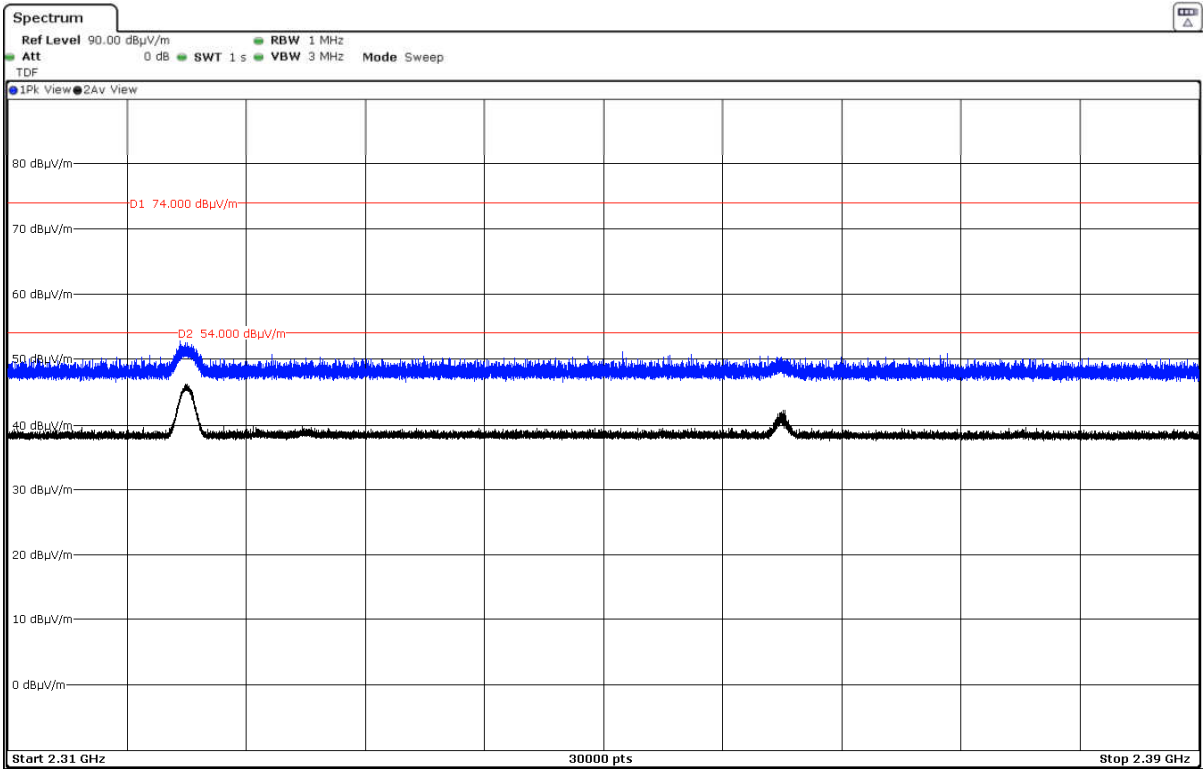
This plot is valid for the Low, Middle and High Channels and all modulation modes.



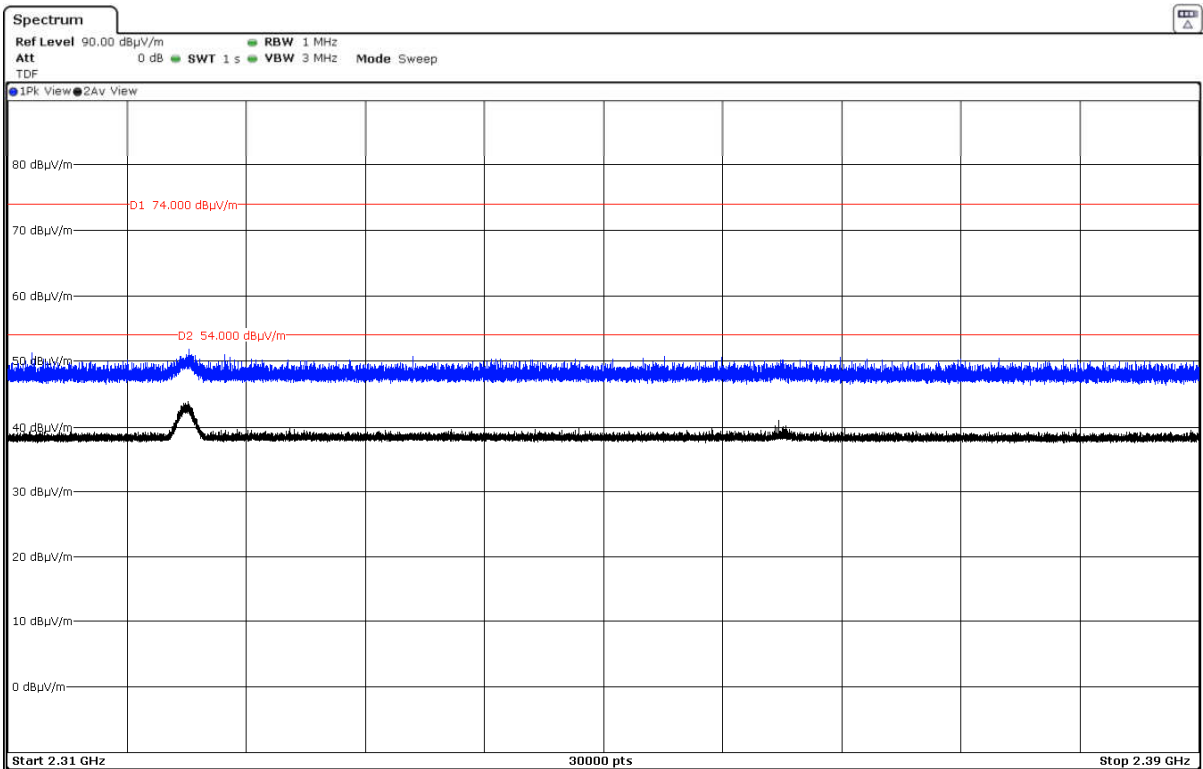
FREQUENCY RANGE 2.31-2.39 GHz (Restricted Band 1):

- Low Channel (2402 MHz):

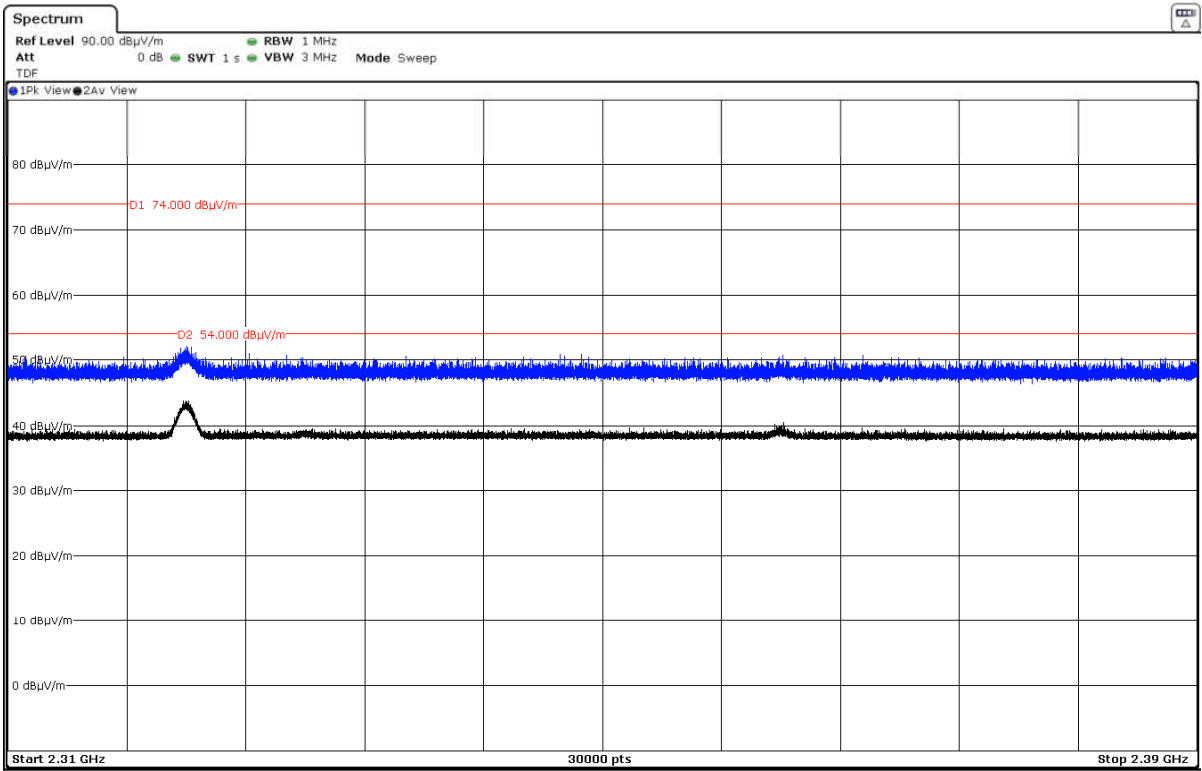
- Modulation: GFSK (DH5)



- Modulation: PI/4-DQPSK (2DH5)

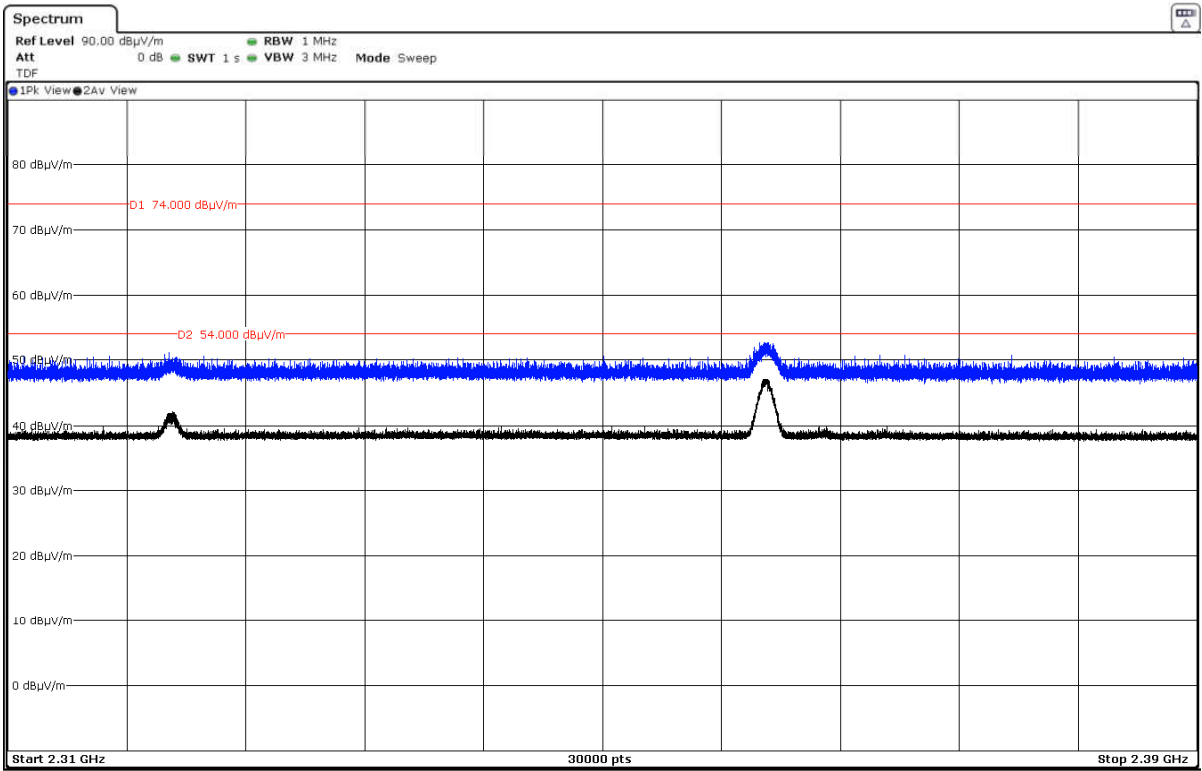


• Modulation: 8-DPSK (3DH5)

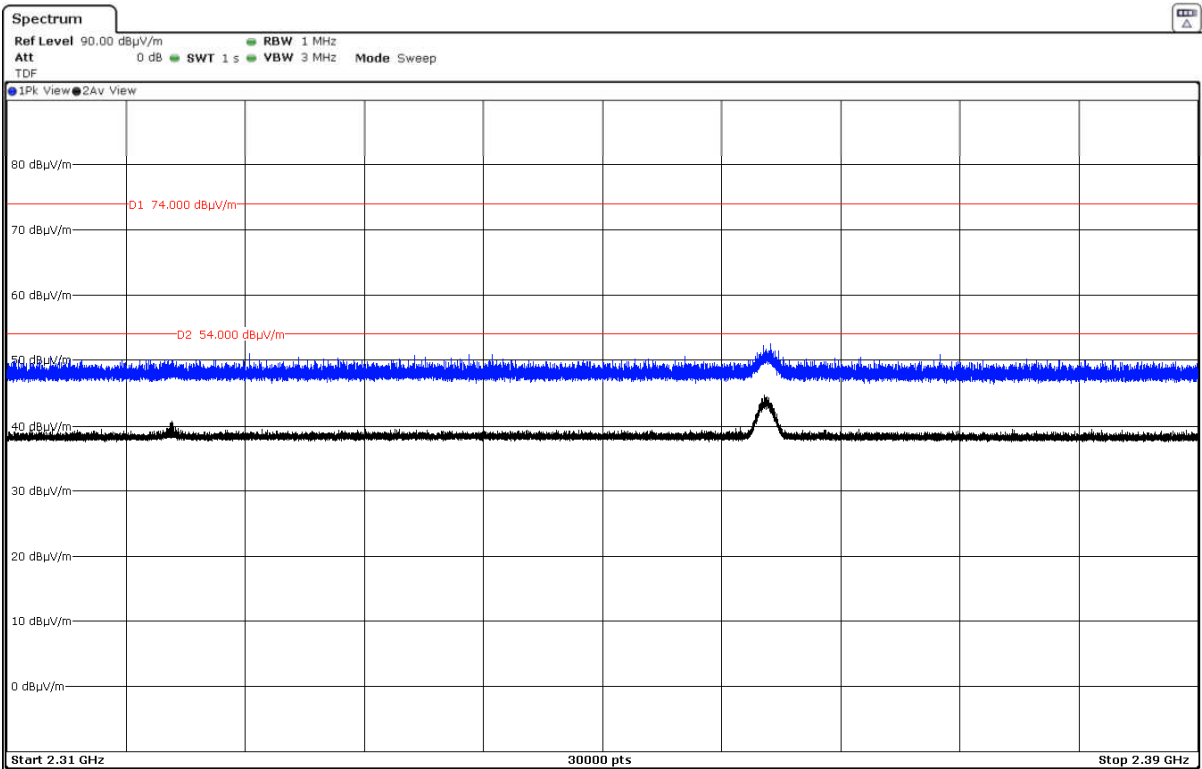


- Middle Channel (2441 MHz):

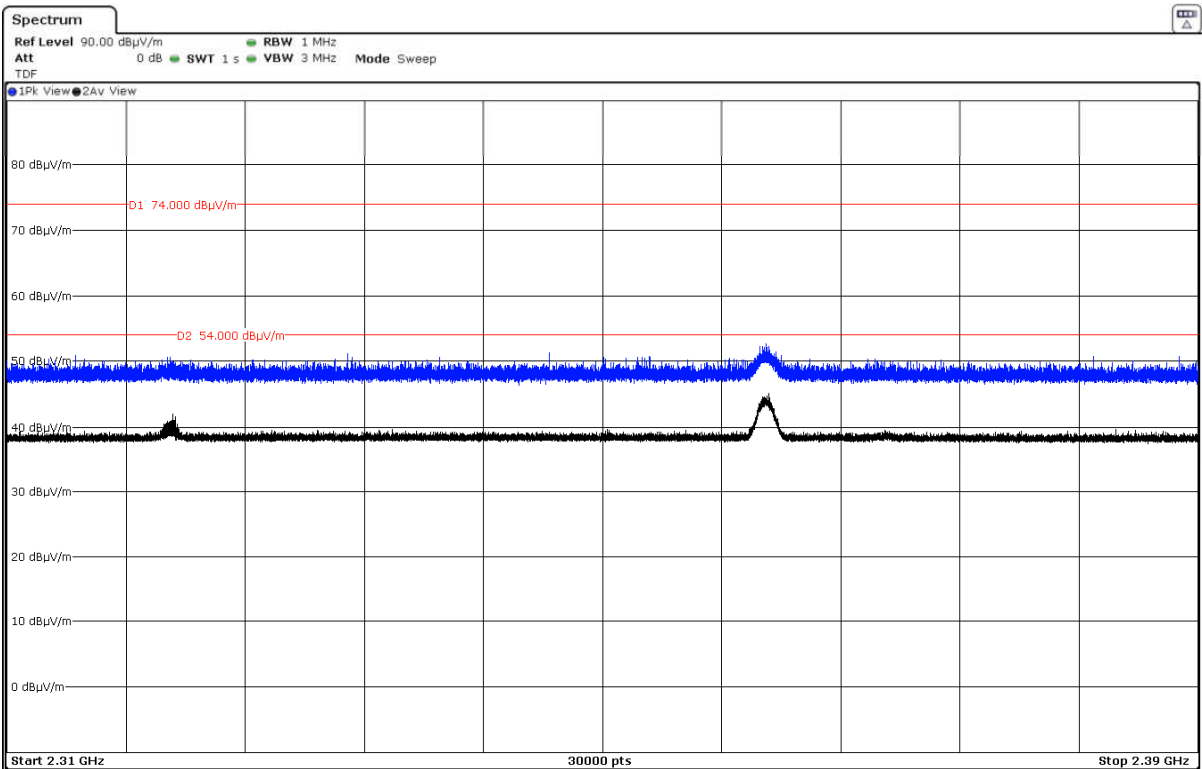
• Modulation: GFSK (DH5)



• Modulation: PI/4-DQPSK (2DH5)

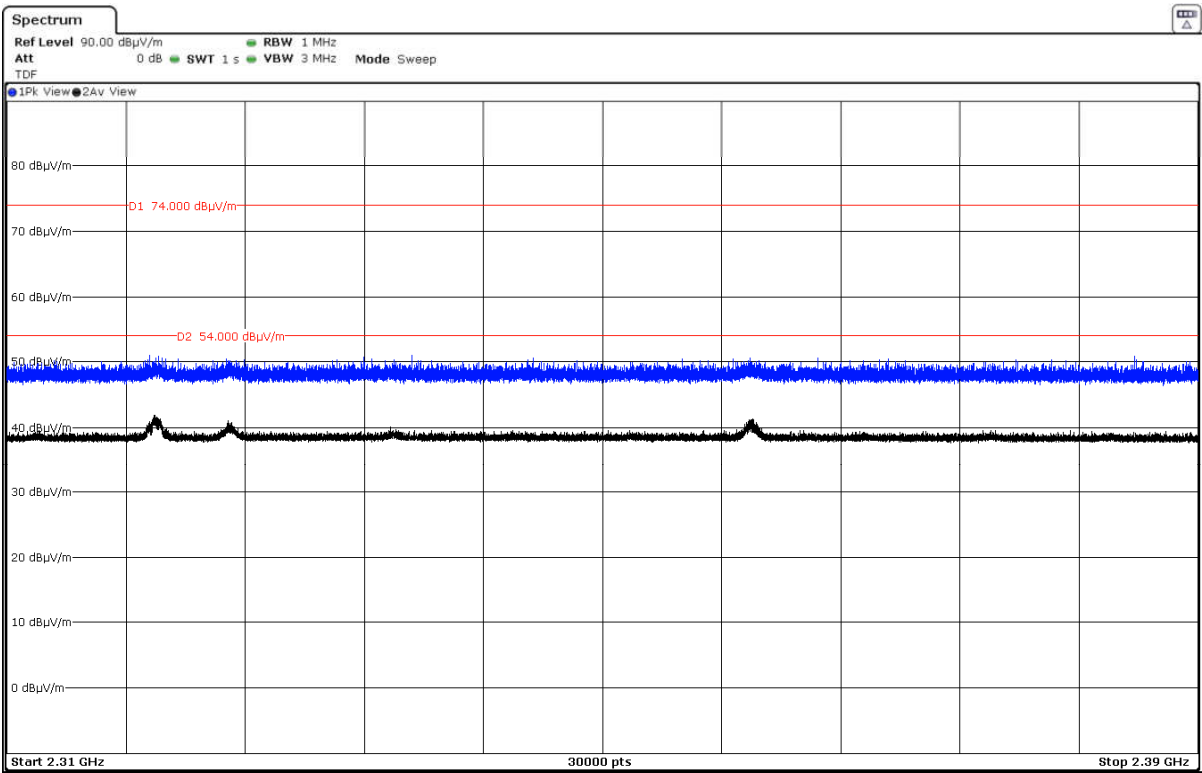


• Modulation: 8-DPSK (3DH5)

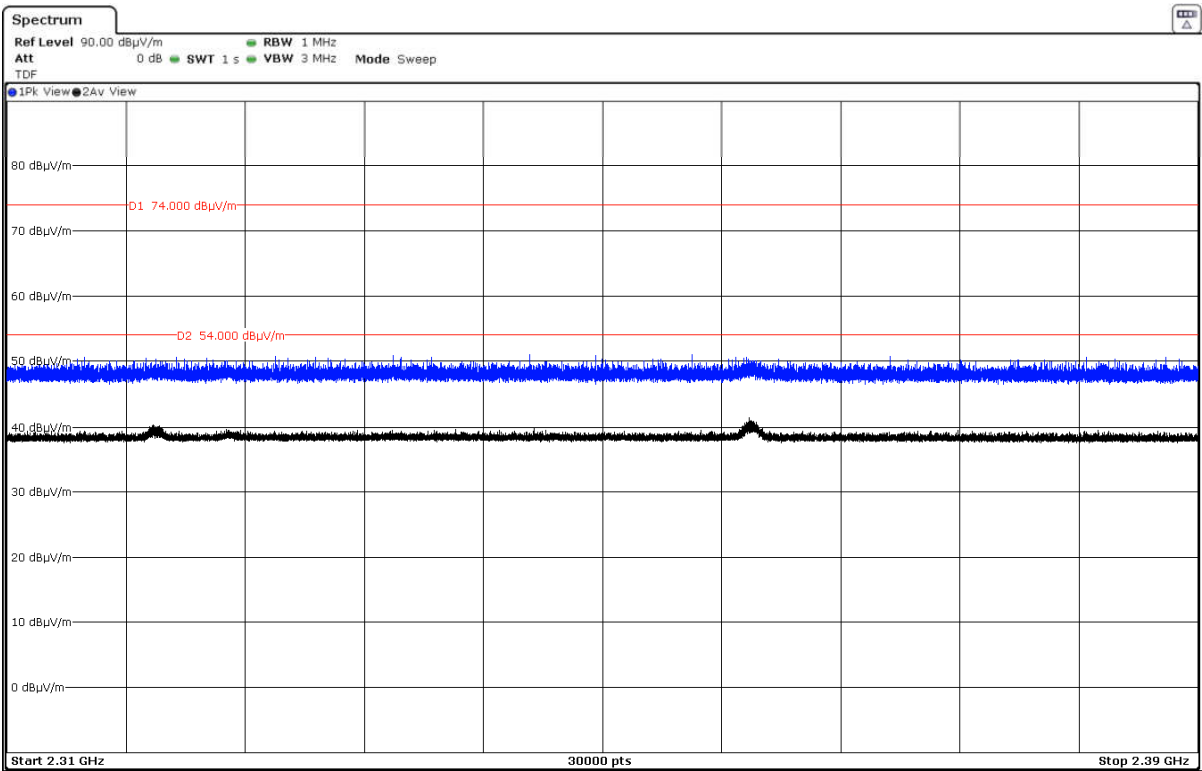


- High Channel (2480 MHz):

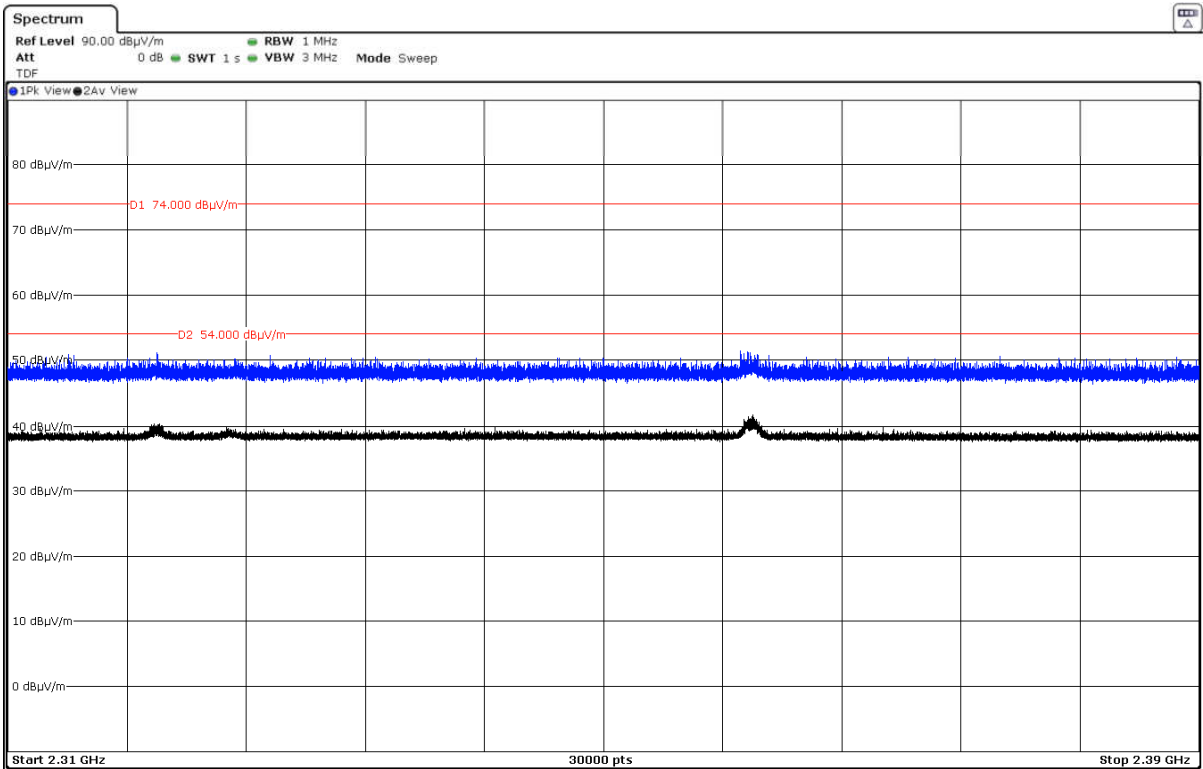
- Modulation: GFSK (DH5)



- Modulation: PI/4-DQPSK (2DH5)



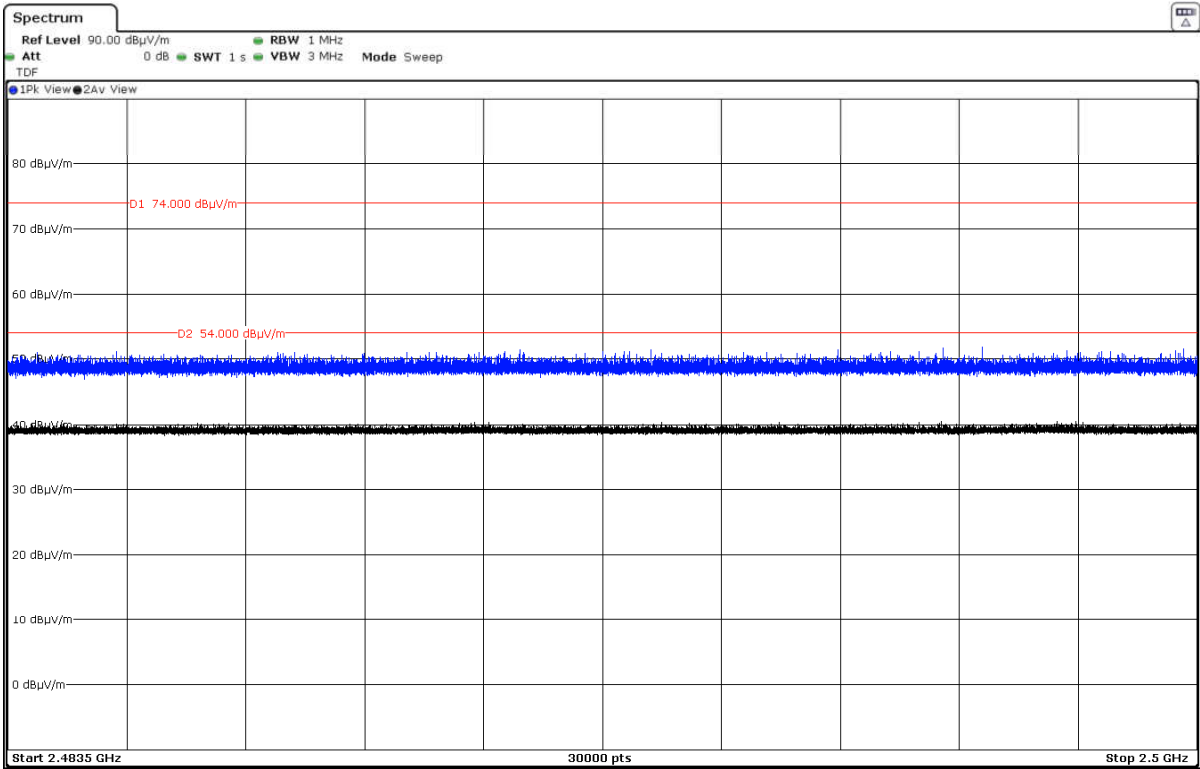
Modulation: 8-DPSK (3DH5)



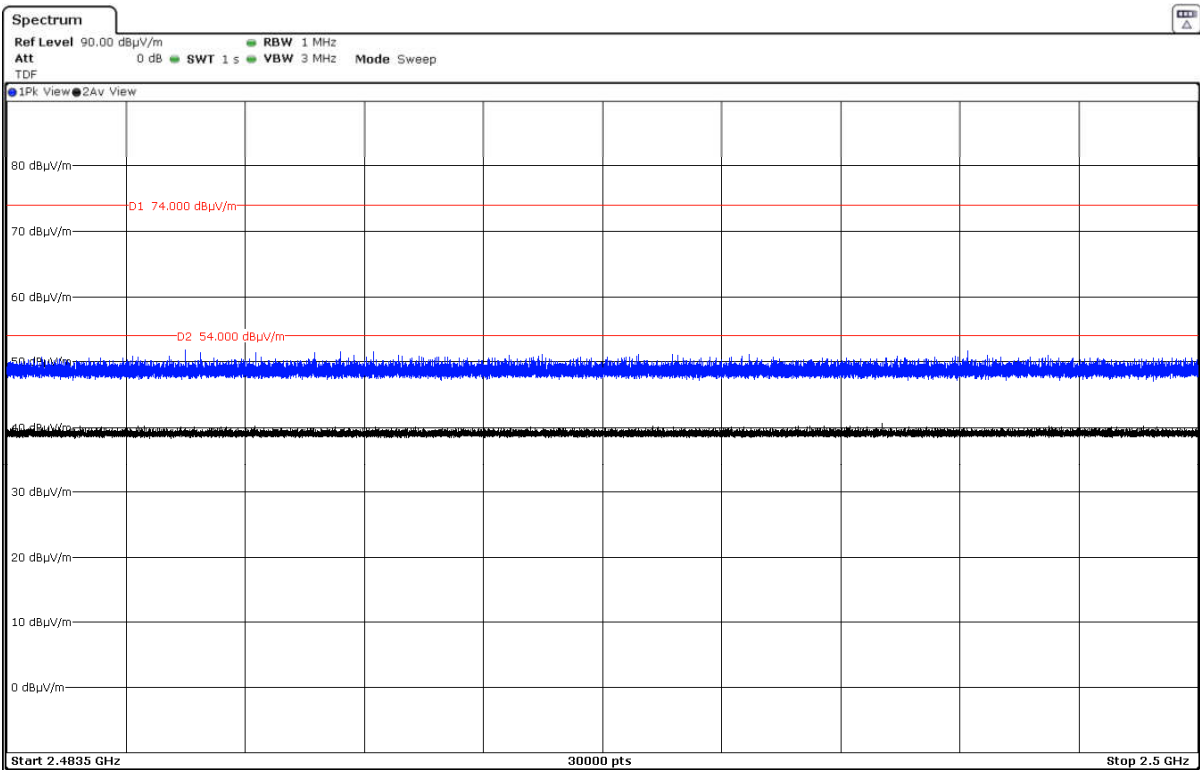
FREQUENCY RANGE 2.4835-2.5 GHz (Restricted Band 2):

- Low Channel (2402 MHz):

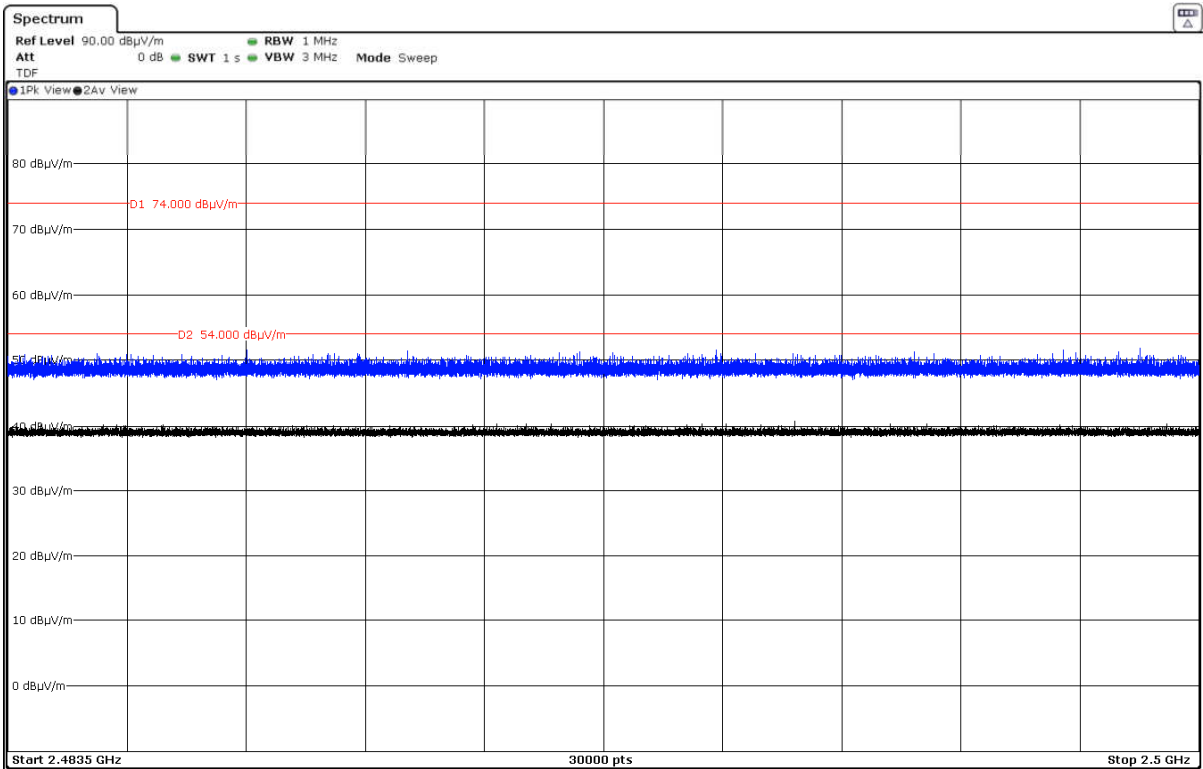
- Modulation: GFSK (DH5)



- Modulation: PI/4-DQPSK (2DH5)

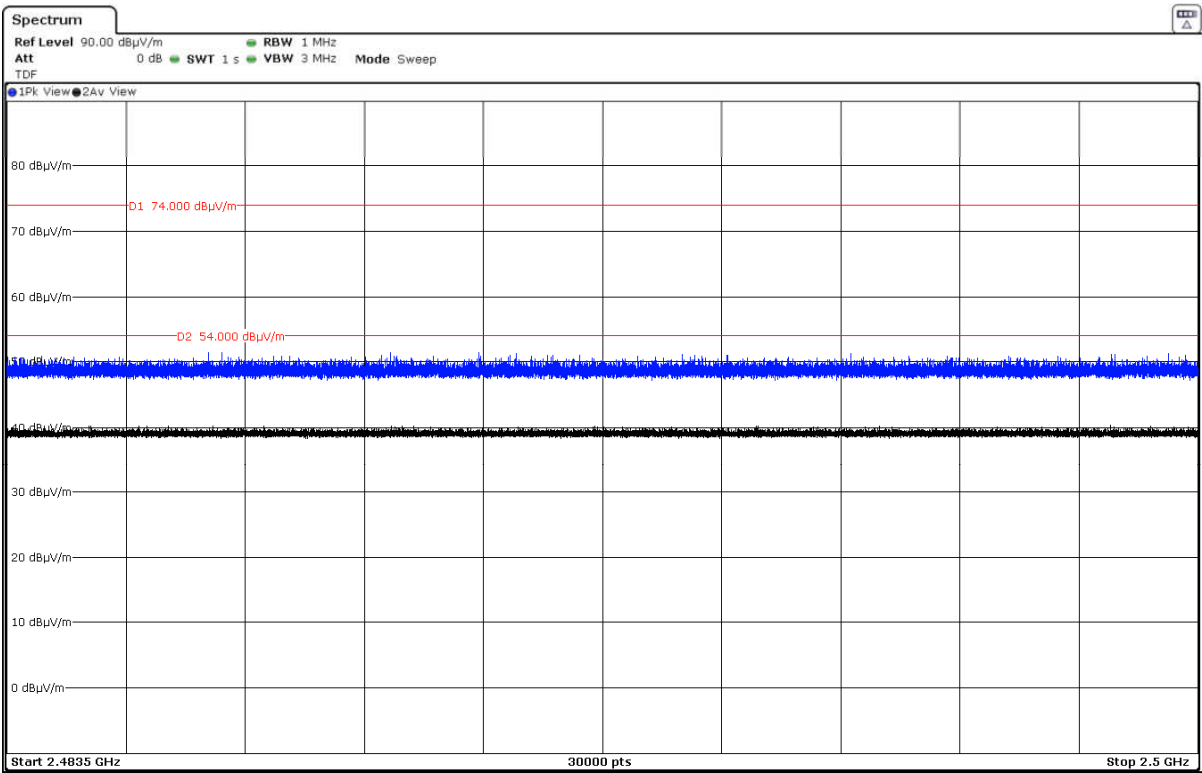


• Modulation: 8-DPSK (3DH5)

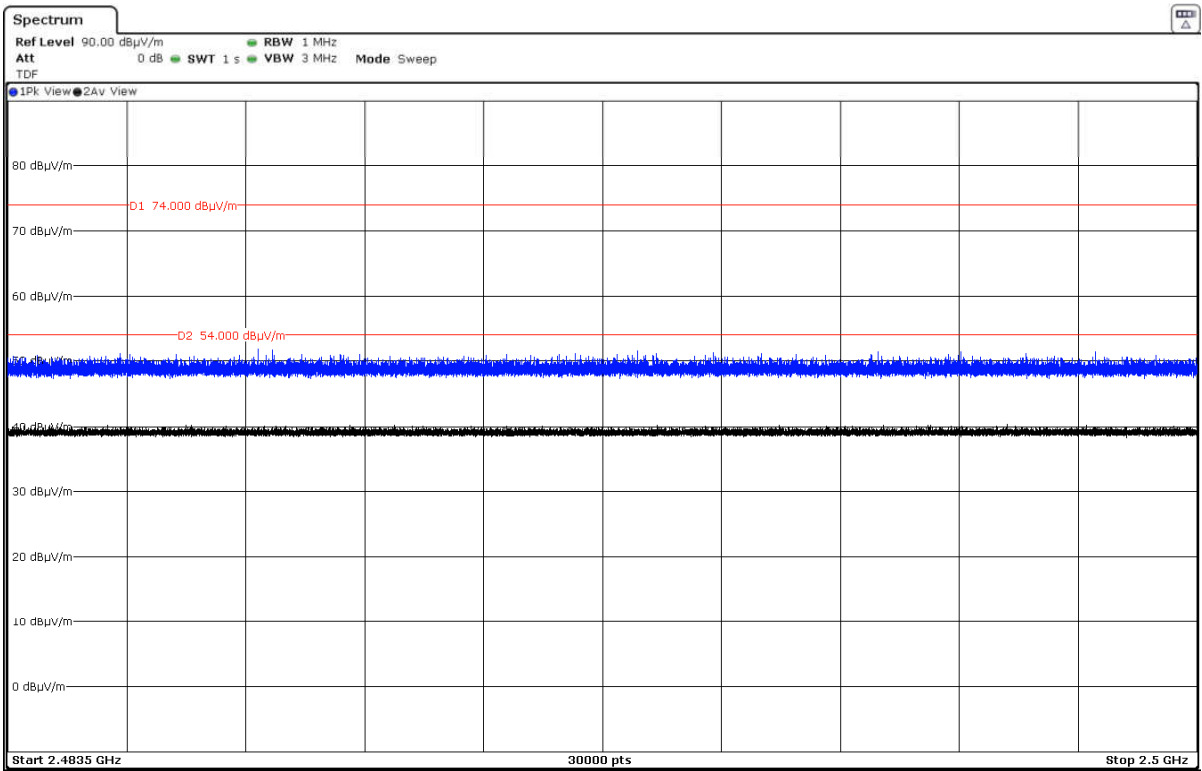


- Middle Channel (2441 MHz):

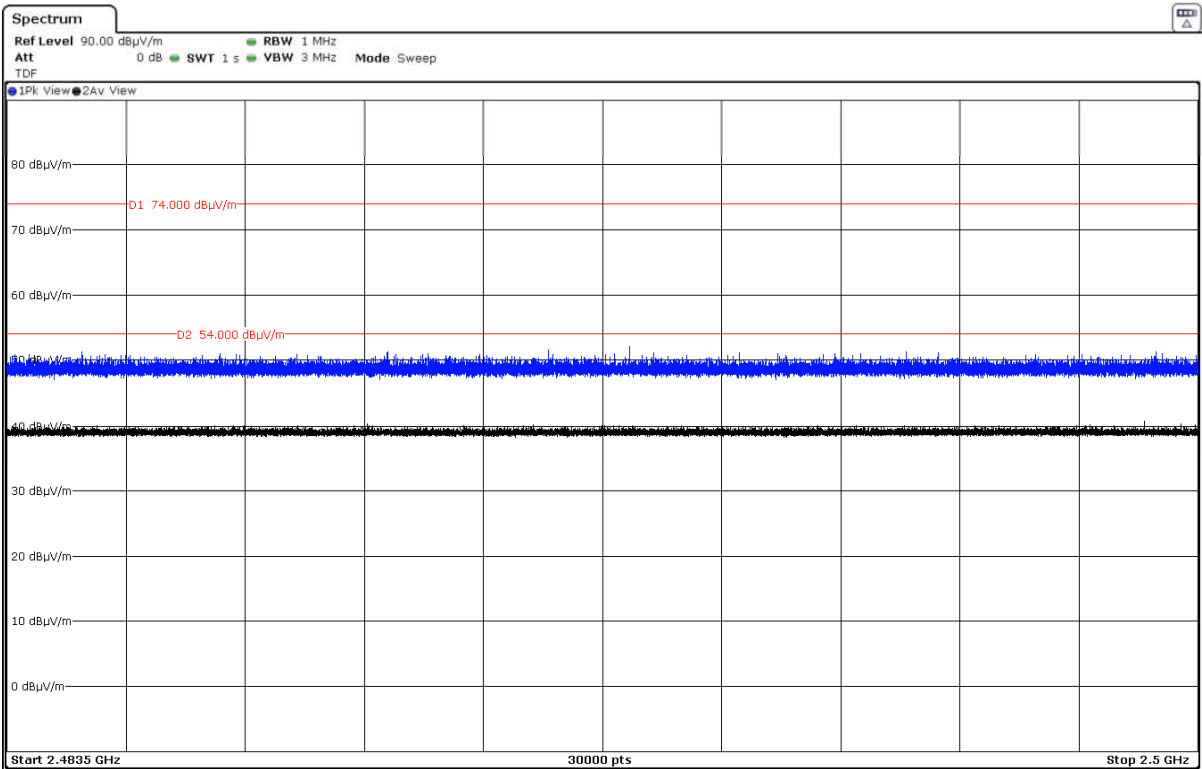
- Modulation: GFSK (DH5)



- Modulation: PI/4-DQPSK (2DH5)

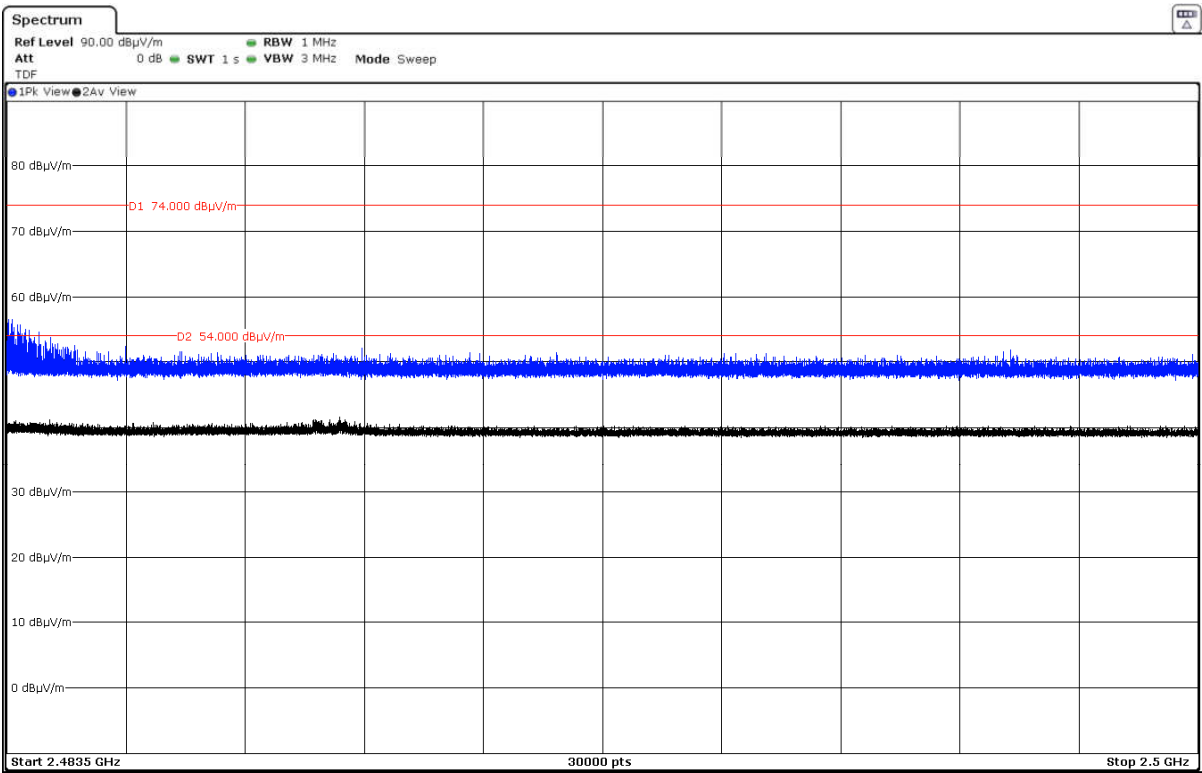


Modulation: 8-DPSK (3DH5)

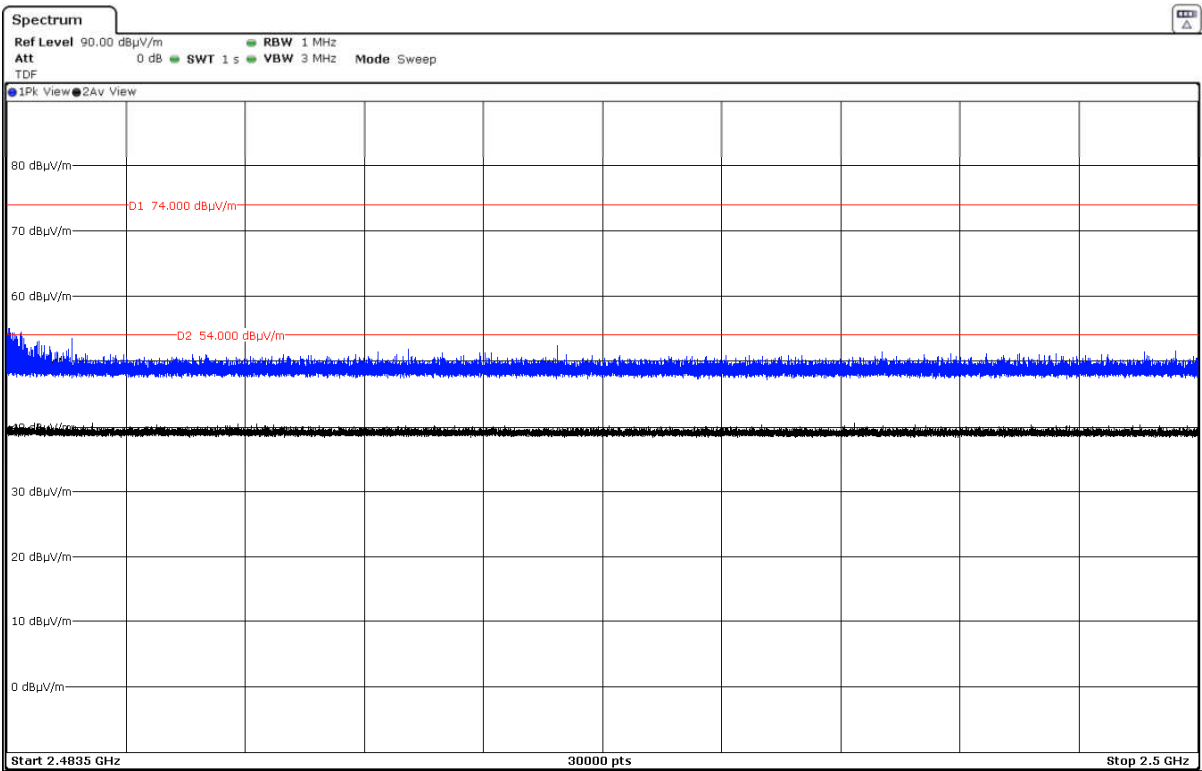


- High Channel (2480 MHz):

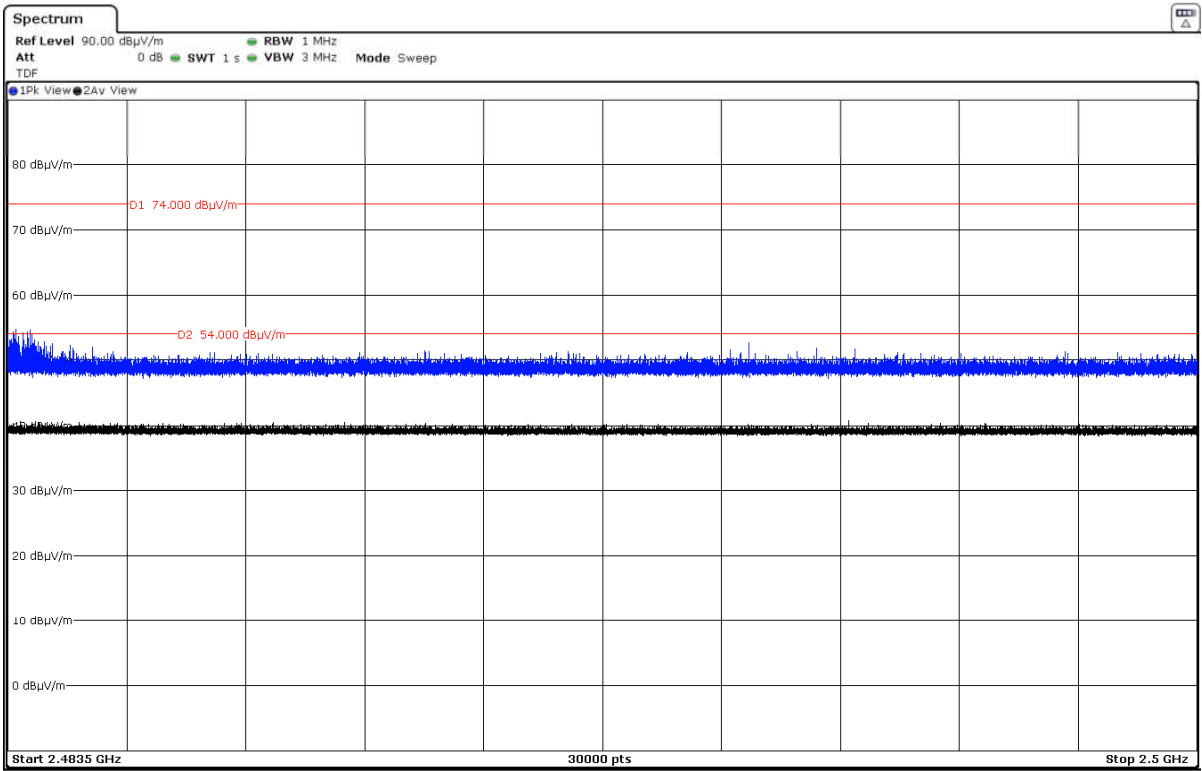
- Modulation: GFSK (DH5)



- Modulation: PI/4-DQPSK (2DH5)



Modulation: 8-DPSK (3DH5)



Appendix B: Test results. 802.11 bgn20 1x1.

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TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 12 Vdc
Type of Power Supply: External power supply (car battery).
Type of Antenna: Internal (printed).
Maximum Declared Antenna Gain: -0.99 dBi.

TEST FREQUENCIES:

Low Channel: 2412 MHz
Middle Channel: 2437 MHz
High Channel: 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.

WiFi 2.4 GHz	Channels CH0-CH10	CH11
	SiSo	SiSo
802.11b	31.75	31.75
802.11g	31.75	15.50
802.11n20	31.75	15.50

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

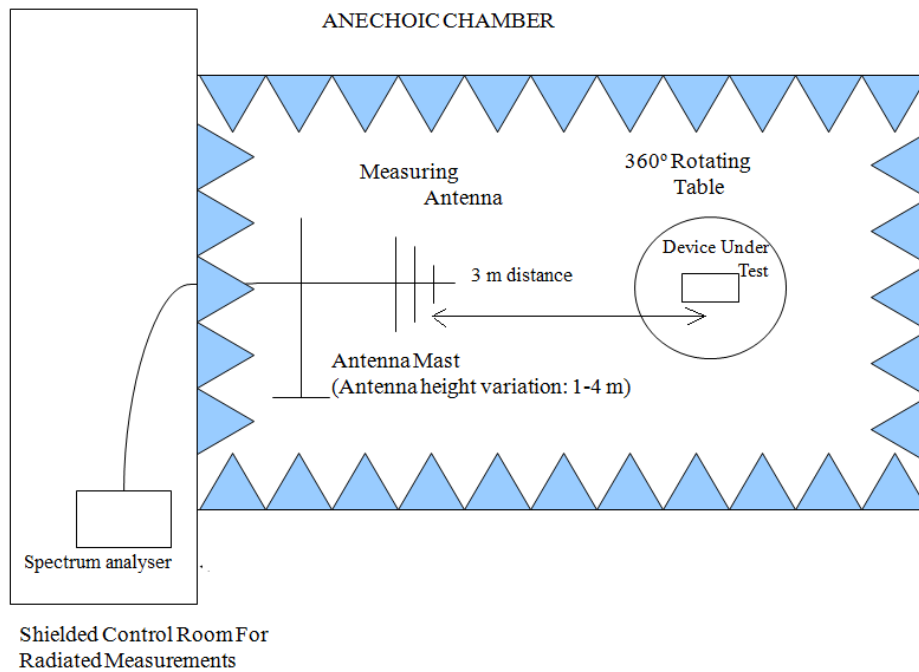
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) is situated at a distance of 3 m and at a distance of 1m for the frequency range 1 GHz-26 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

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.

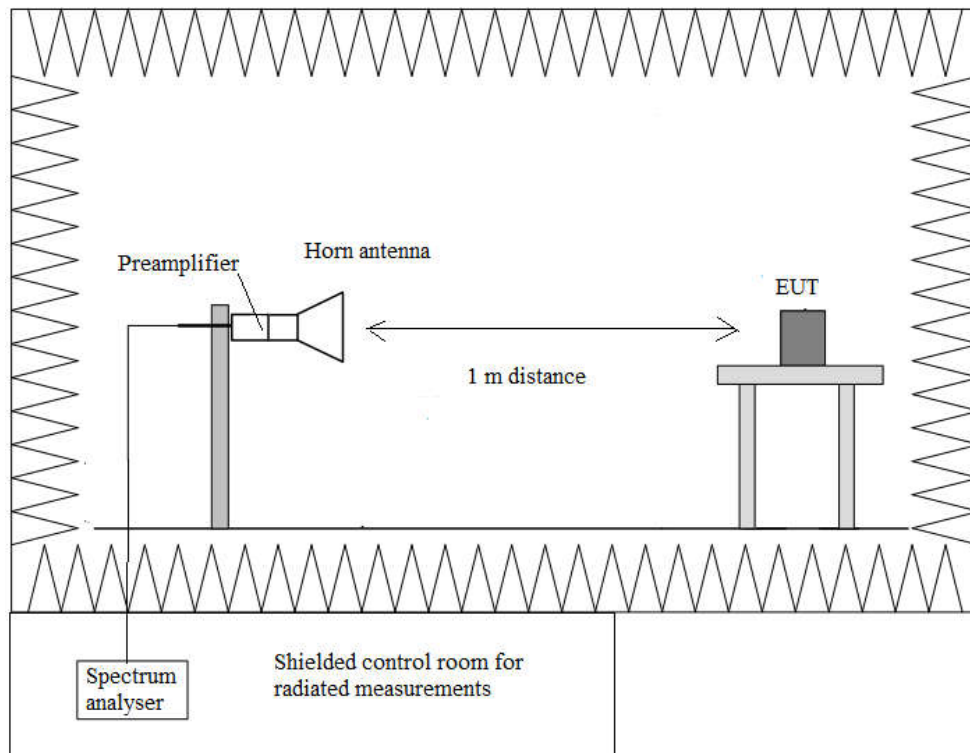
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

- **Mode 802.11 b**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	13.380	13.377	13.434
-26 dBc bandwith (MHz)	17.208	17.215	17.228
Measurement uncertainty (kHz)	<± 4.50		

- **Mode 802.11 g**

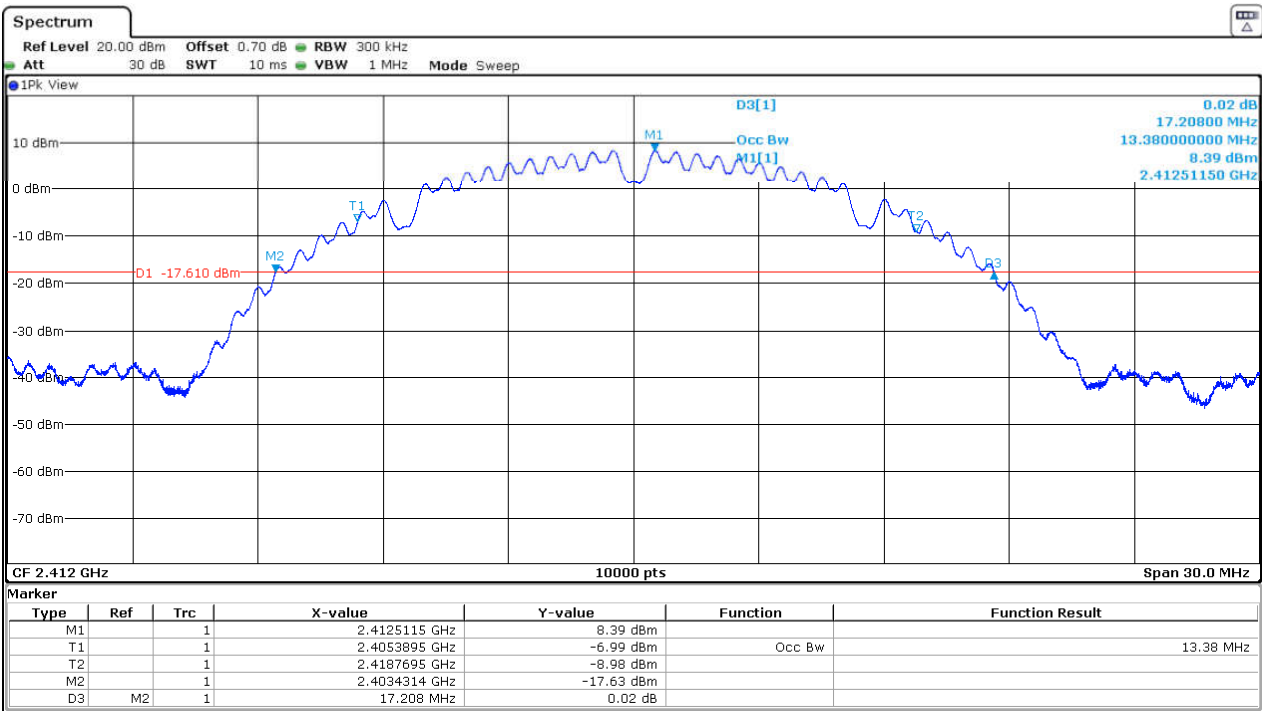
	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	19.000	18.845	18.935
-26 dBc bandwith (MHz)	29.231	24.863	31.164
Measurement uncertainty (kHz)	<± 5.50		

- **Mode 802.11 n20**

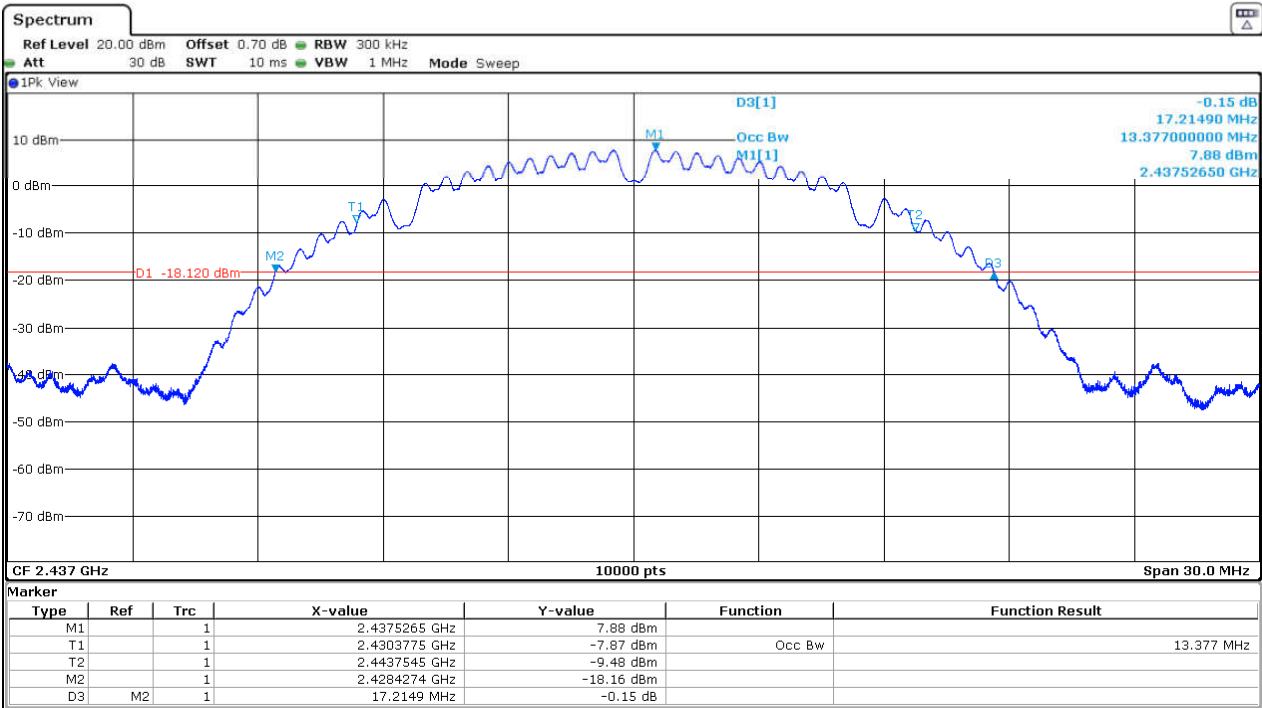
	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	19.645	19.370	19.500
-26 dBc bandwith (MHz)	26.117	24.994	24.801
Measurement uncertainty (kHz)	<± 5.50		

• Mode 802.11 b – Occupied Bandwidth

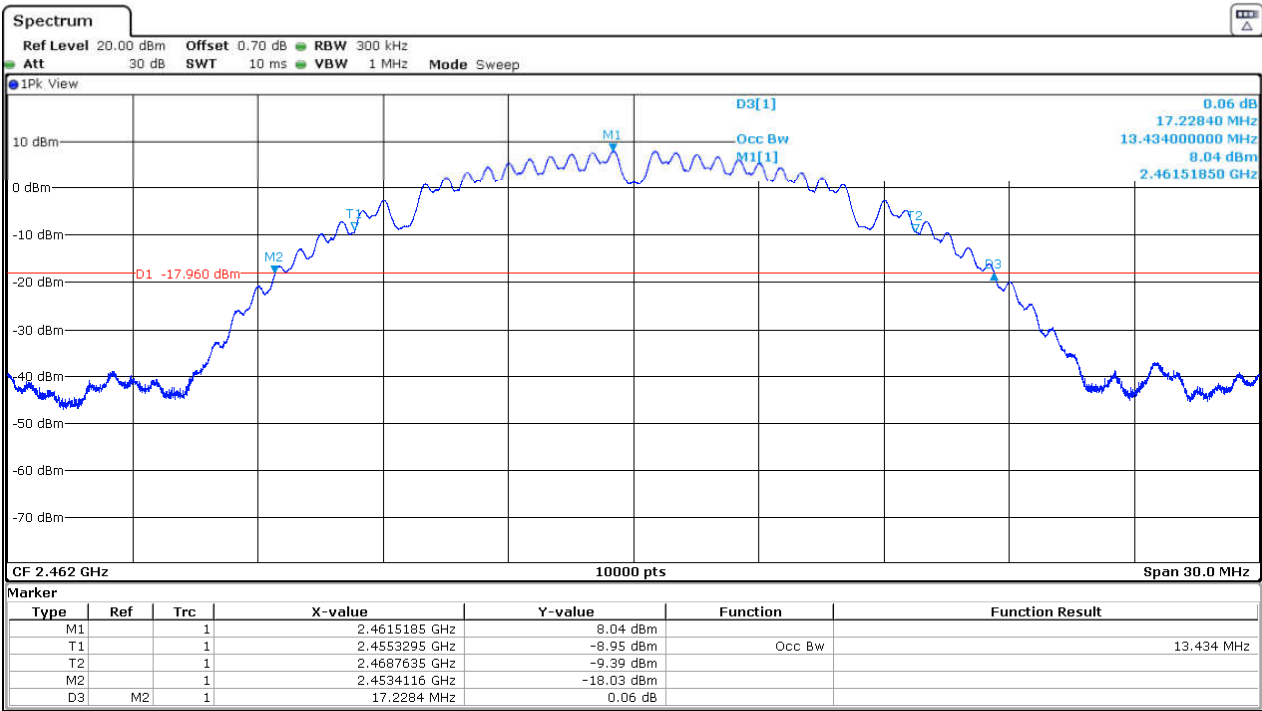
- Low Channel:



- Middle Channel:

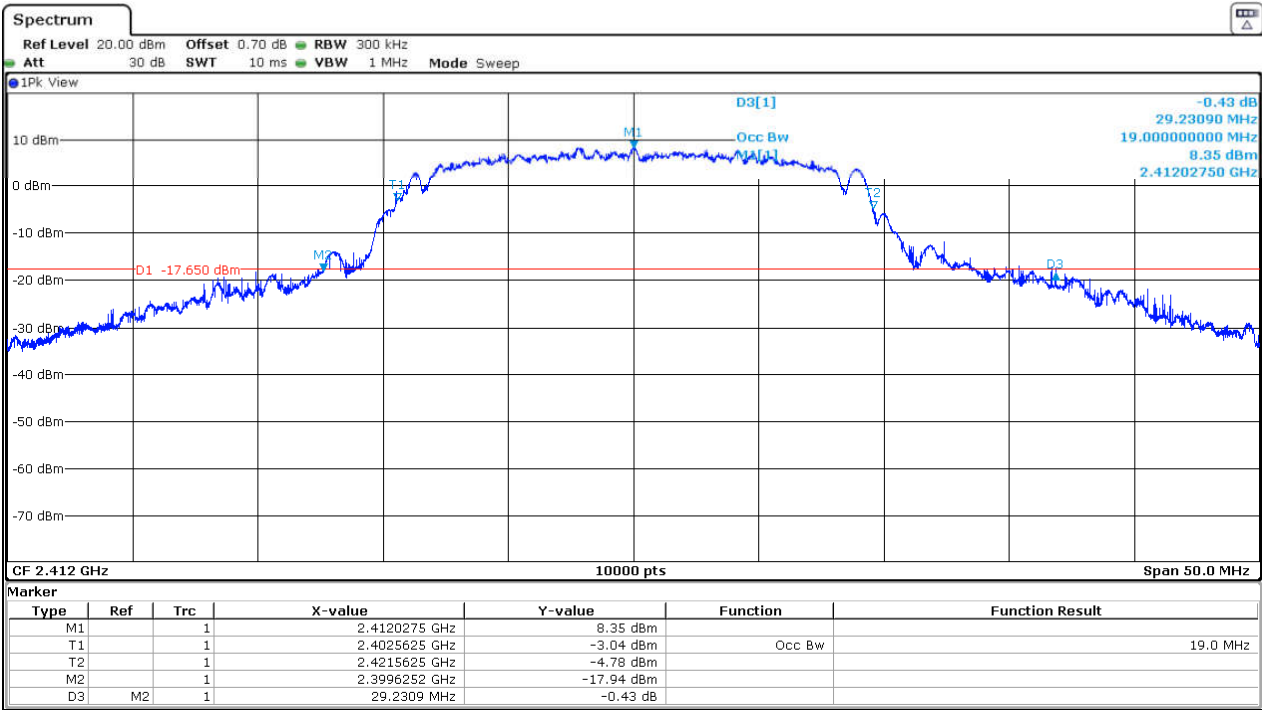


- High Channel:

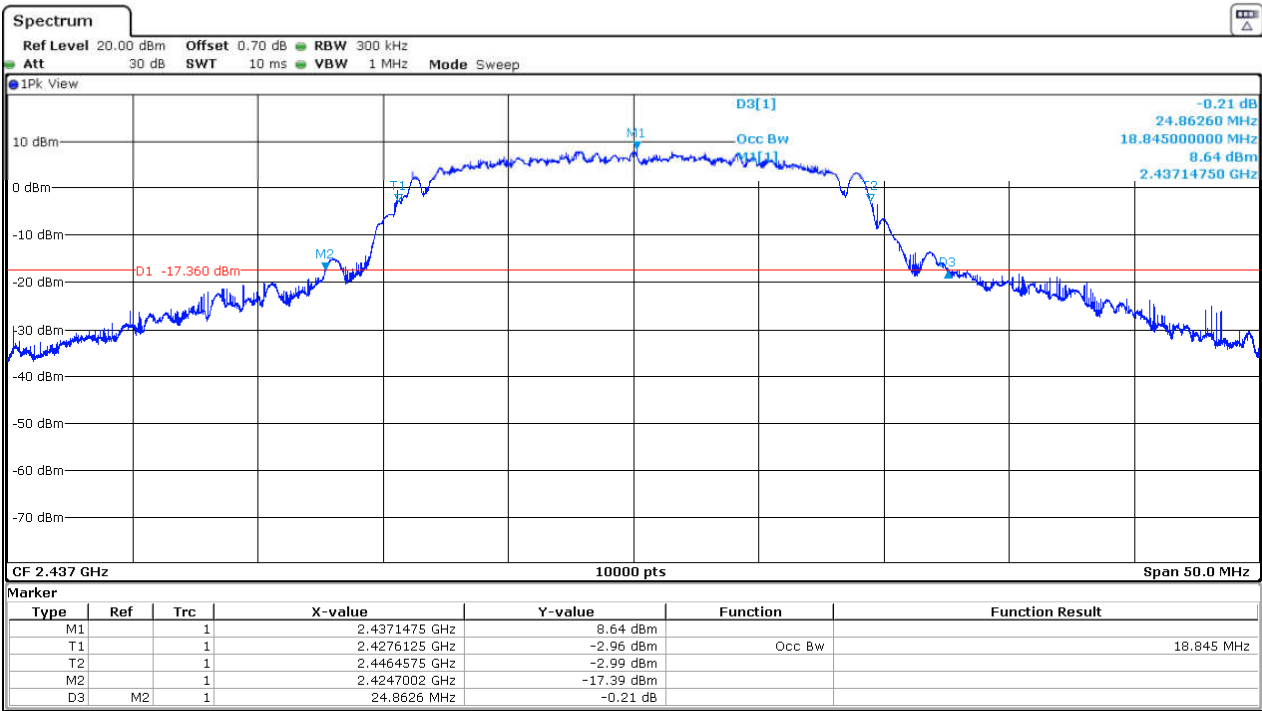


- Mode 802.11 g – Occupied Bandwidth

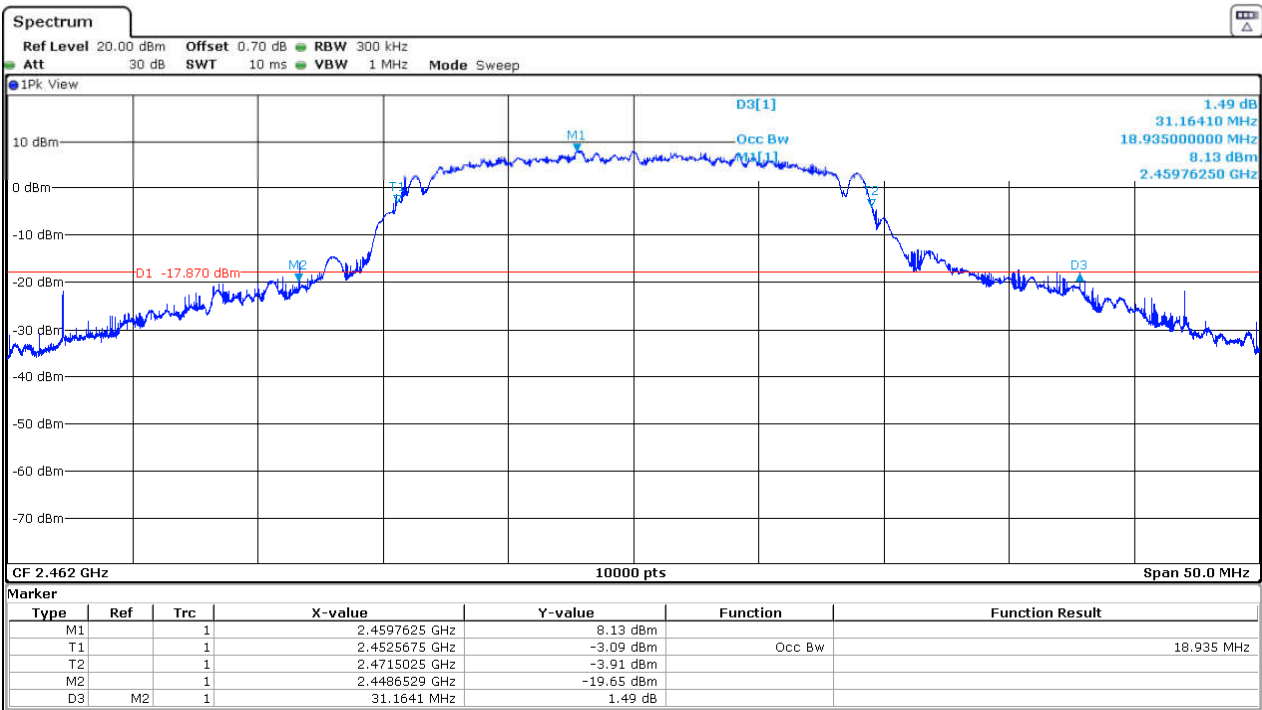
- Low Channel:



- Middle Channel:

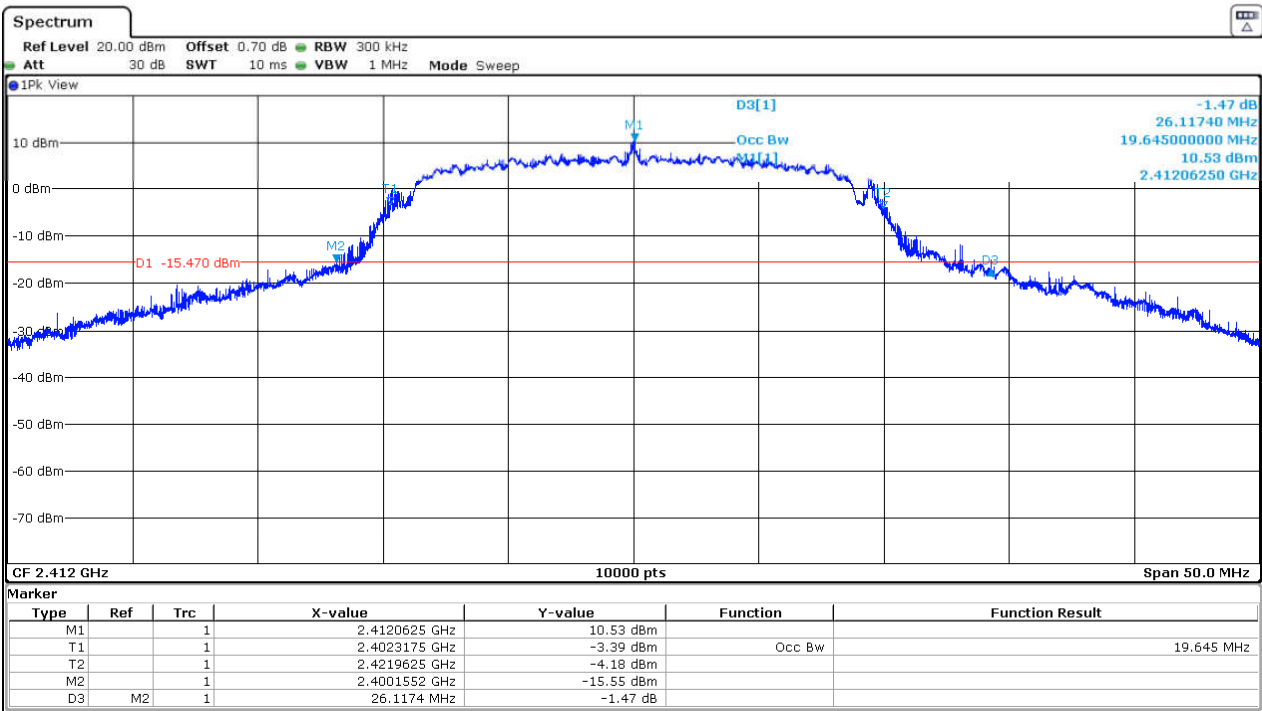


- High Channel:

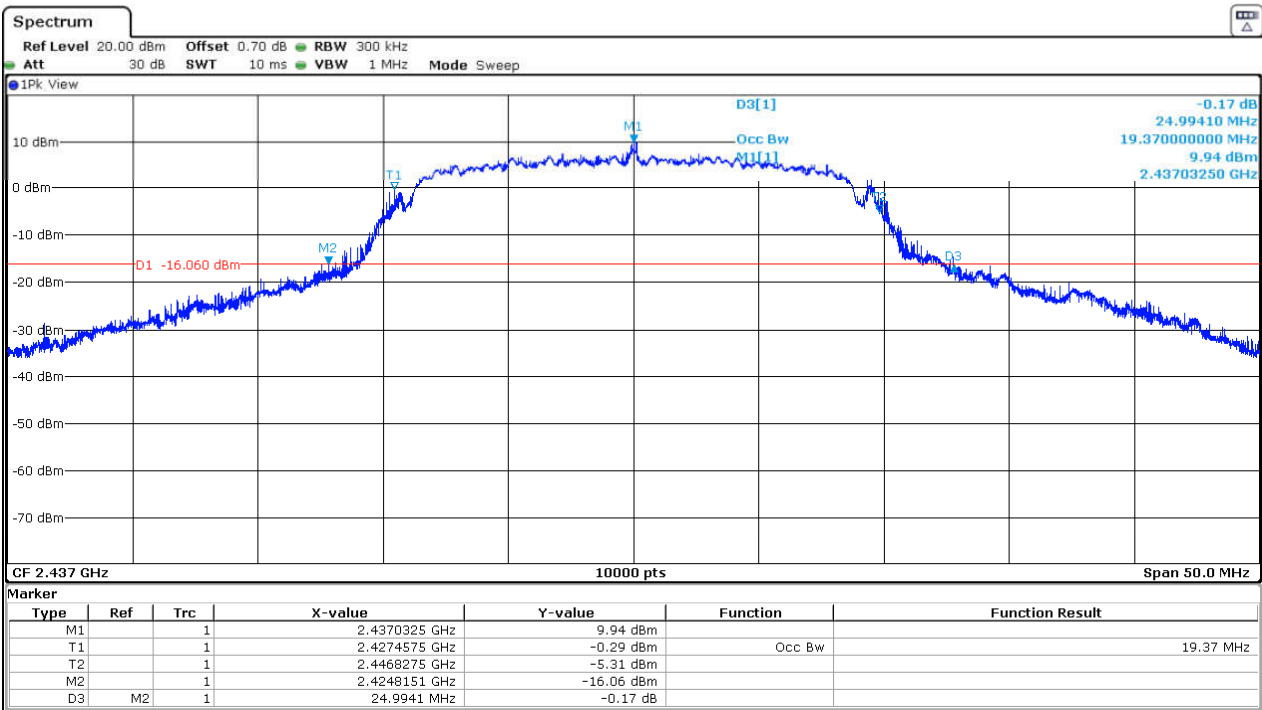


• Mode 802.11 n20 – Occupied Bandwidth

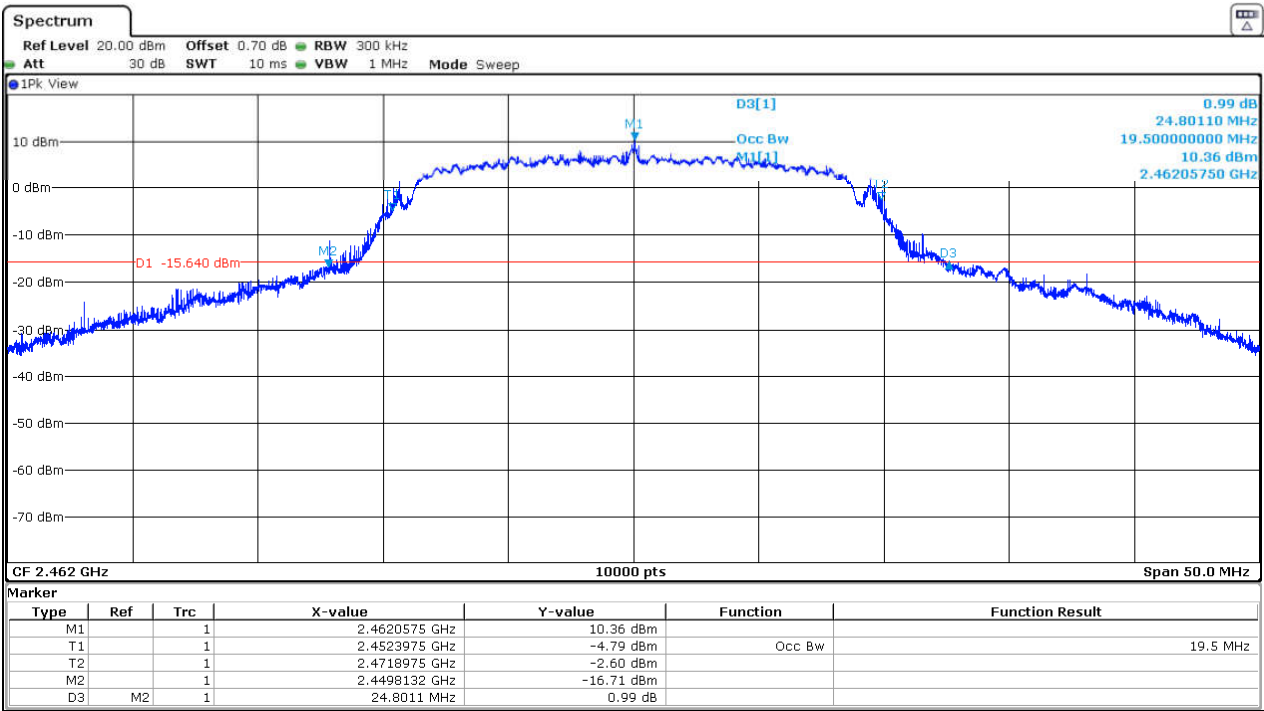
- Low Channel:



- Middle Channel:



- High Channel:



FCC Section 15.247 Subclause (a) (2) / RSS-247 Clause 5.2 (a) 6 dB Bandwidth.

SPECIFICATION:

The minimum 6 dB bandwidth shall be at less 500 kHz.

RESULTS:

- **Mode 802.11 b**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
6 dB Spectrum Bandwidth (MHz)	8.086	8.081	8.083
Measurement uncertainty (kHz)	<±3.50		

- **Mode 802.11 g**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
6 dB Spectrum Bandwidth (MHz)	15.136	15.132	15.131
Measurement uncertainty (kHz)	<±3.50		

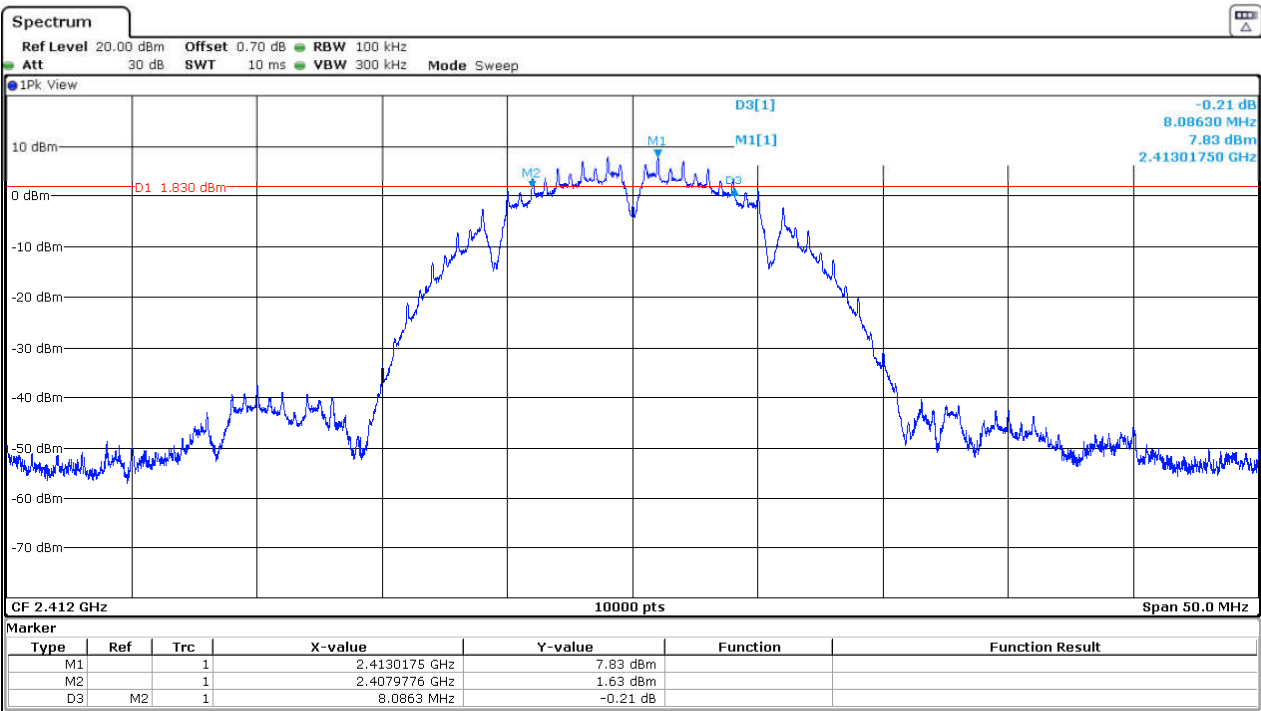
- **Mode 802.11 n20**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
6 dB Spectrum Bandwidth (MHz)	15.134	15.127	15.131
Measurement uncertainty (kHz)	<±3.50		

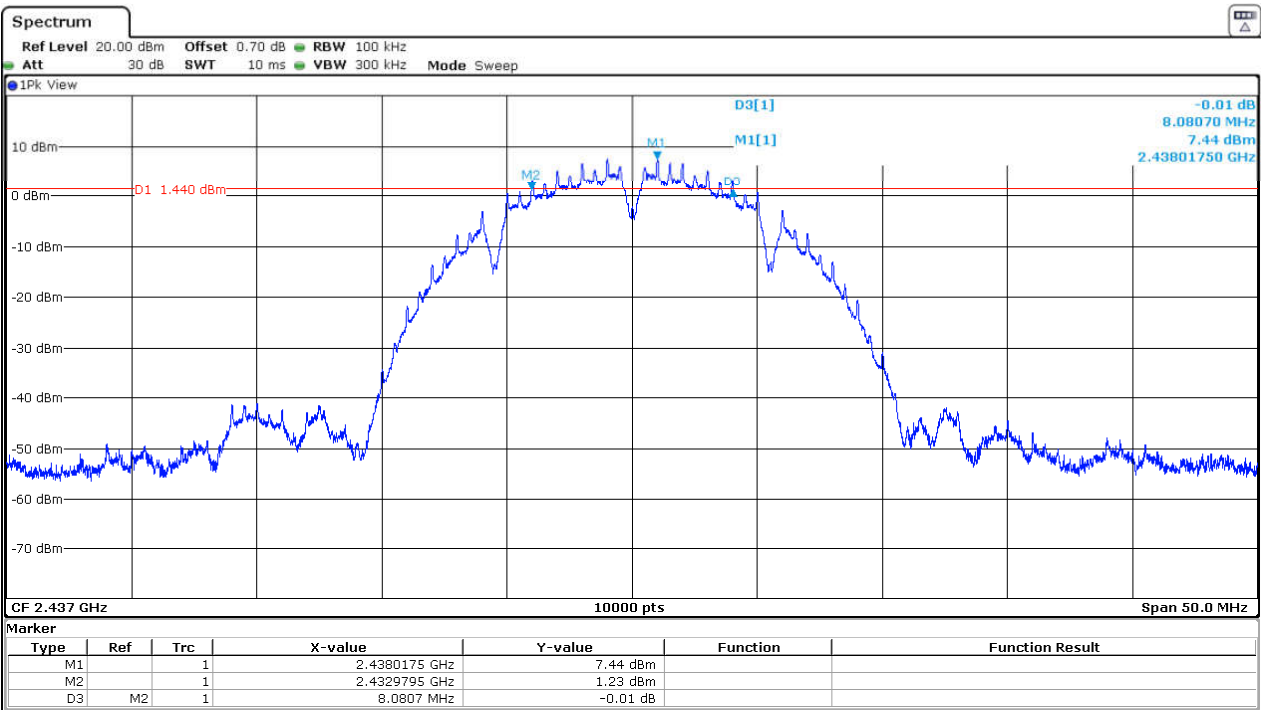
Verdict: PASS

• Mode 802.11 b – 6 dB Bandwidth

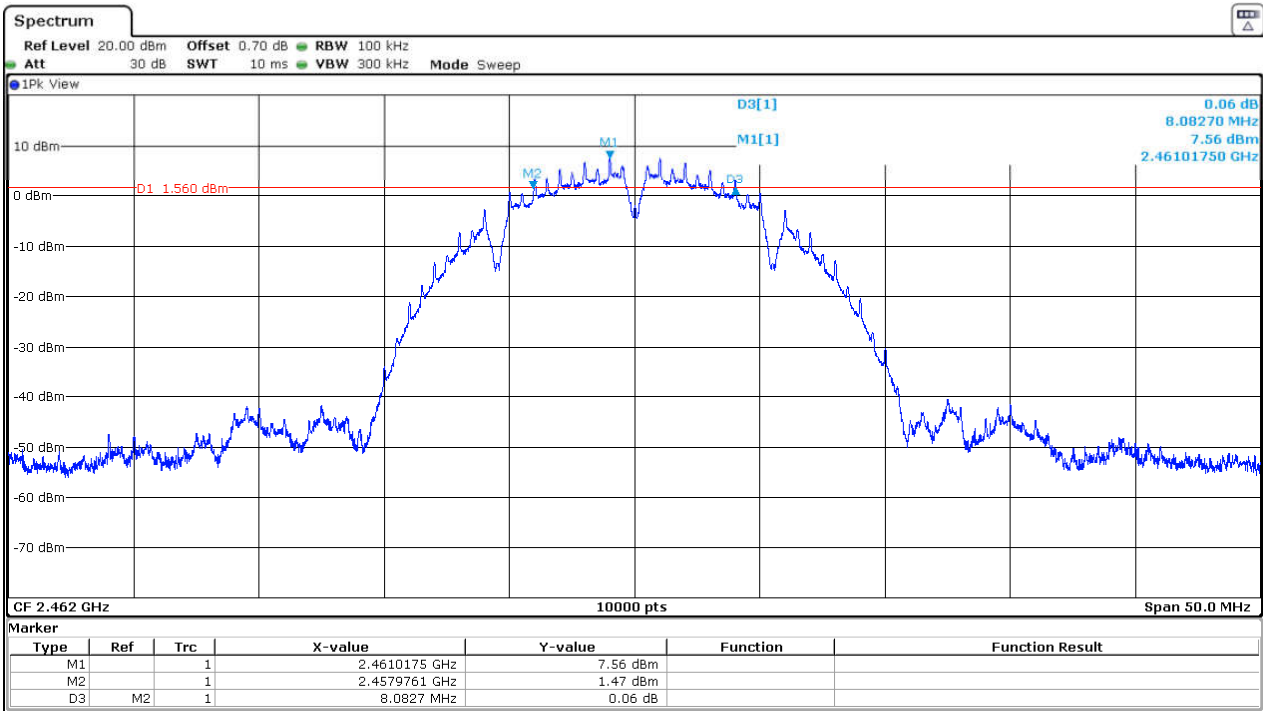
- Low Channel:



- Middle Channel:

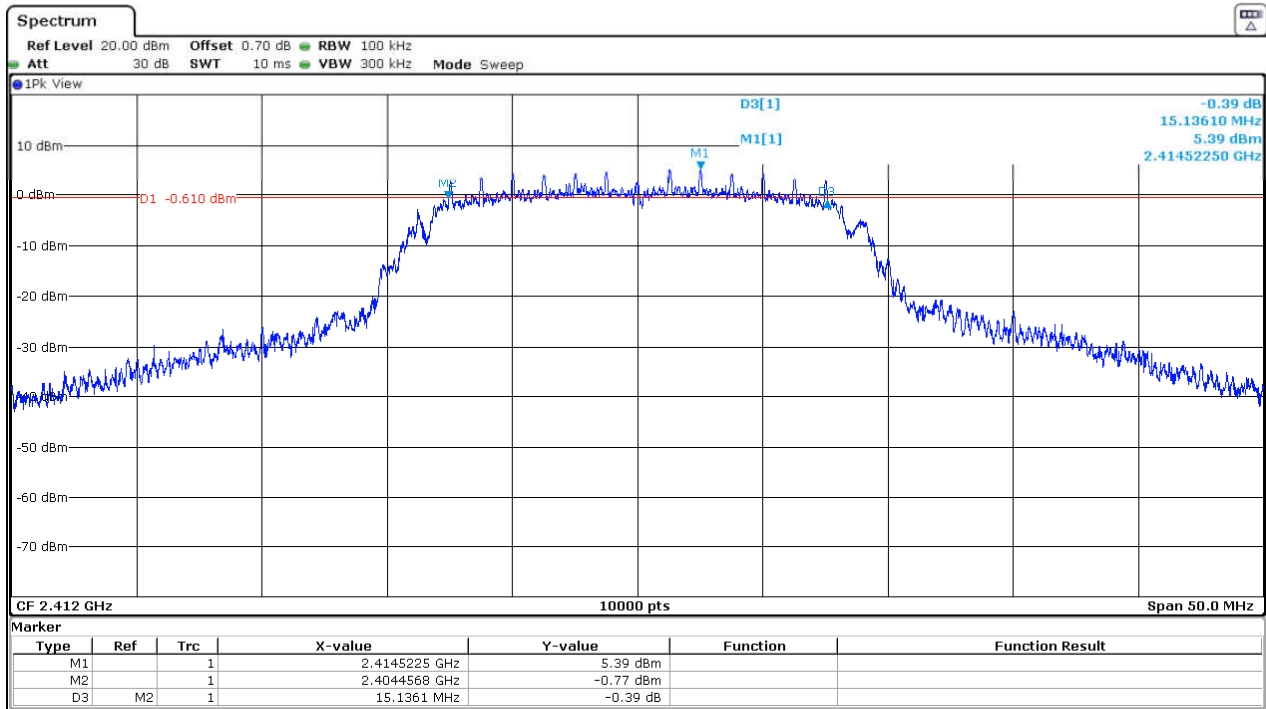


- High Channel:

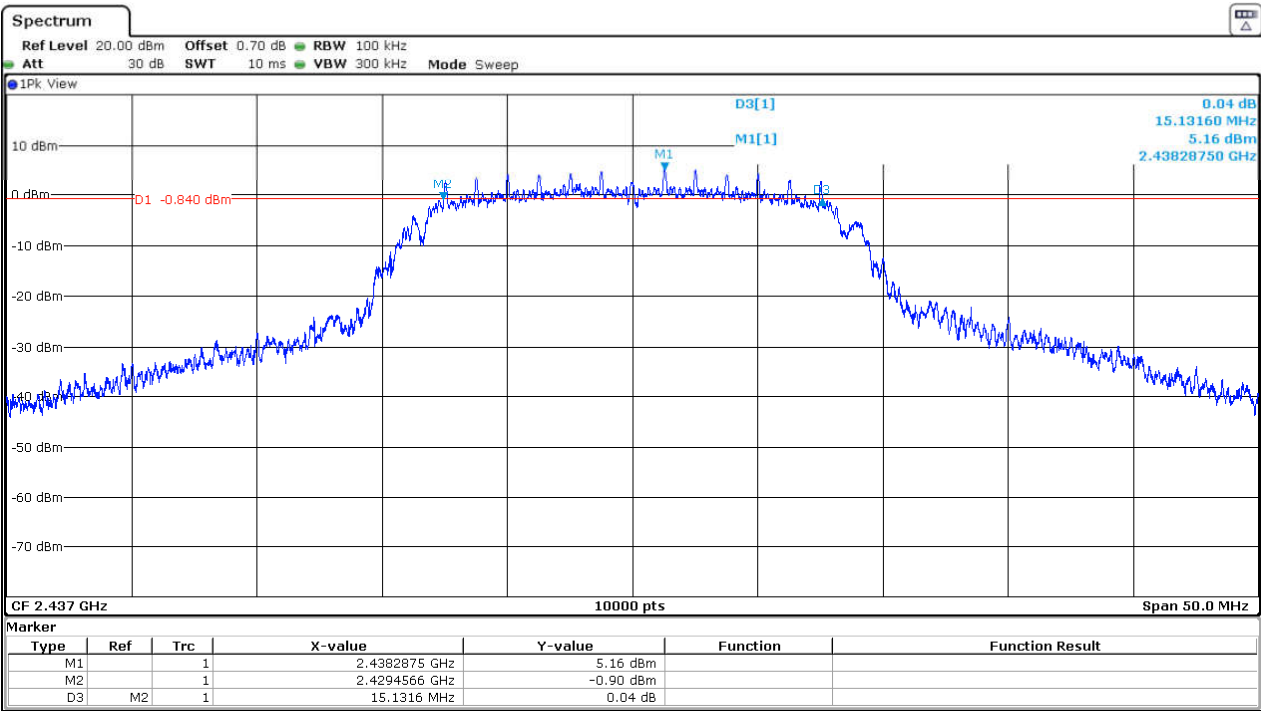


- Mode 802.11 g – 6 dB Bandwidth

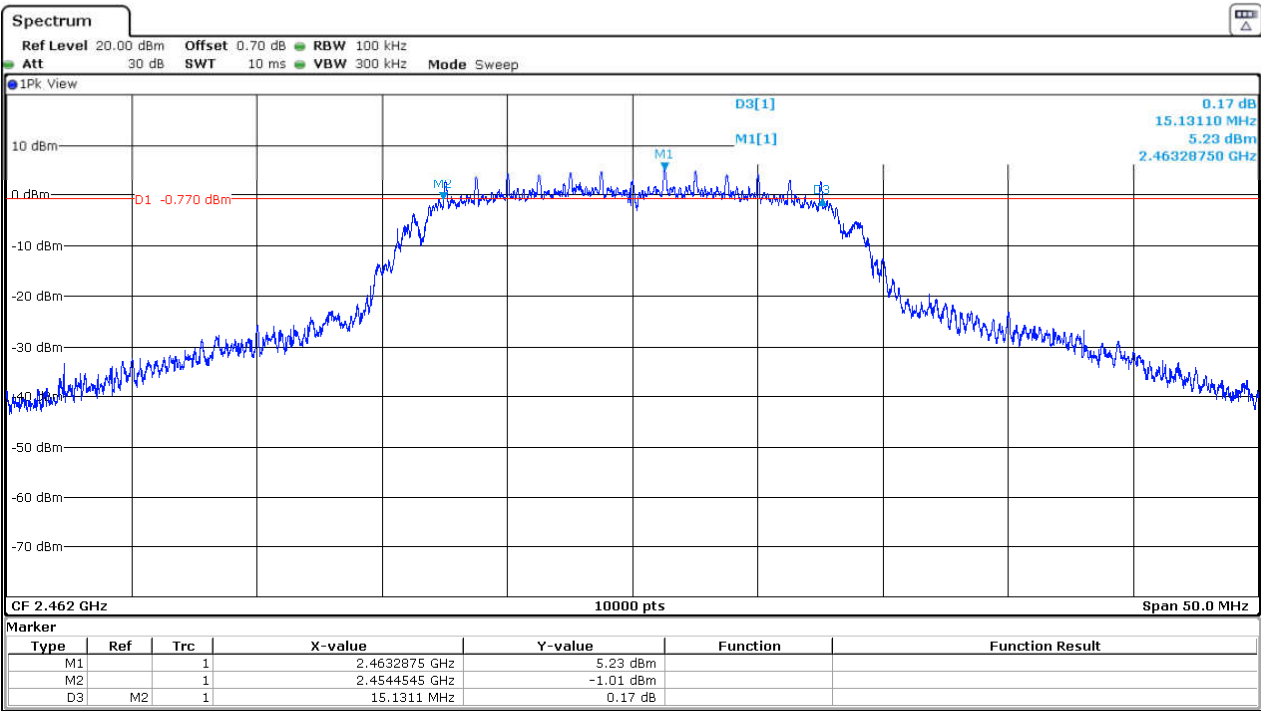
- Low Channel:



- Middle Channel:

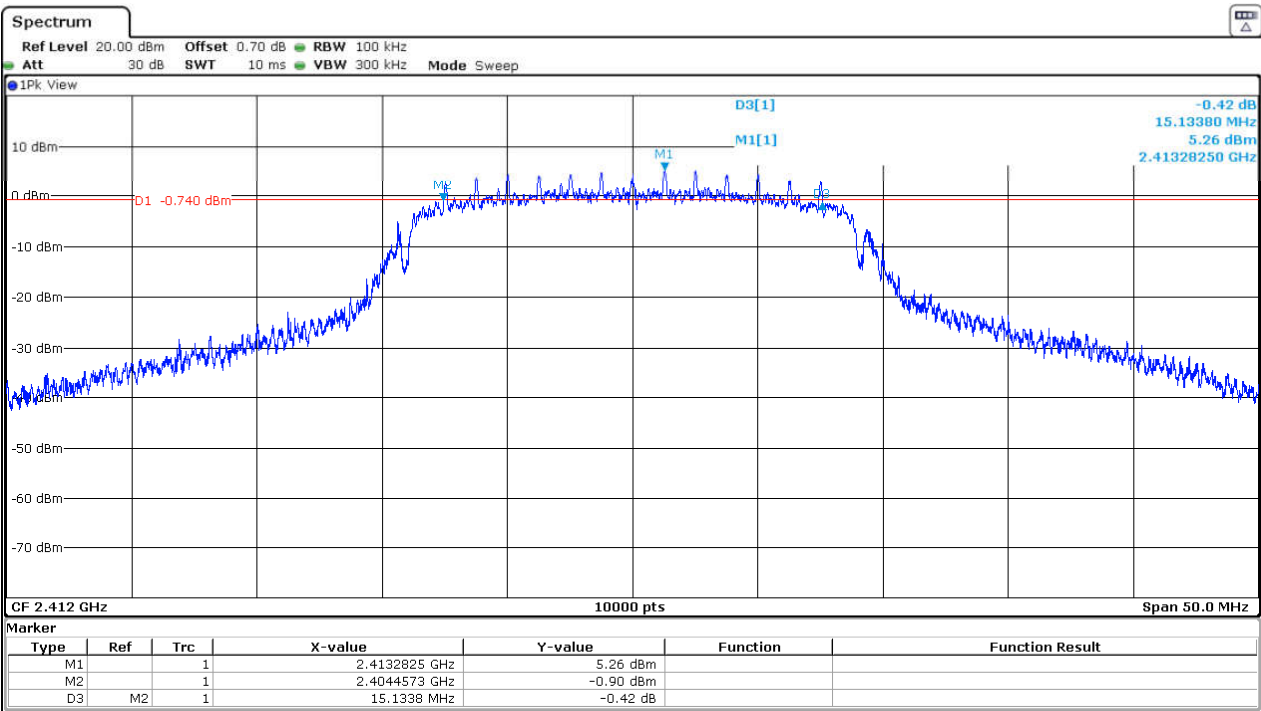


- High Channel:

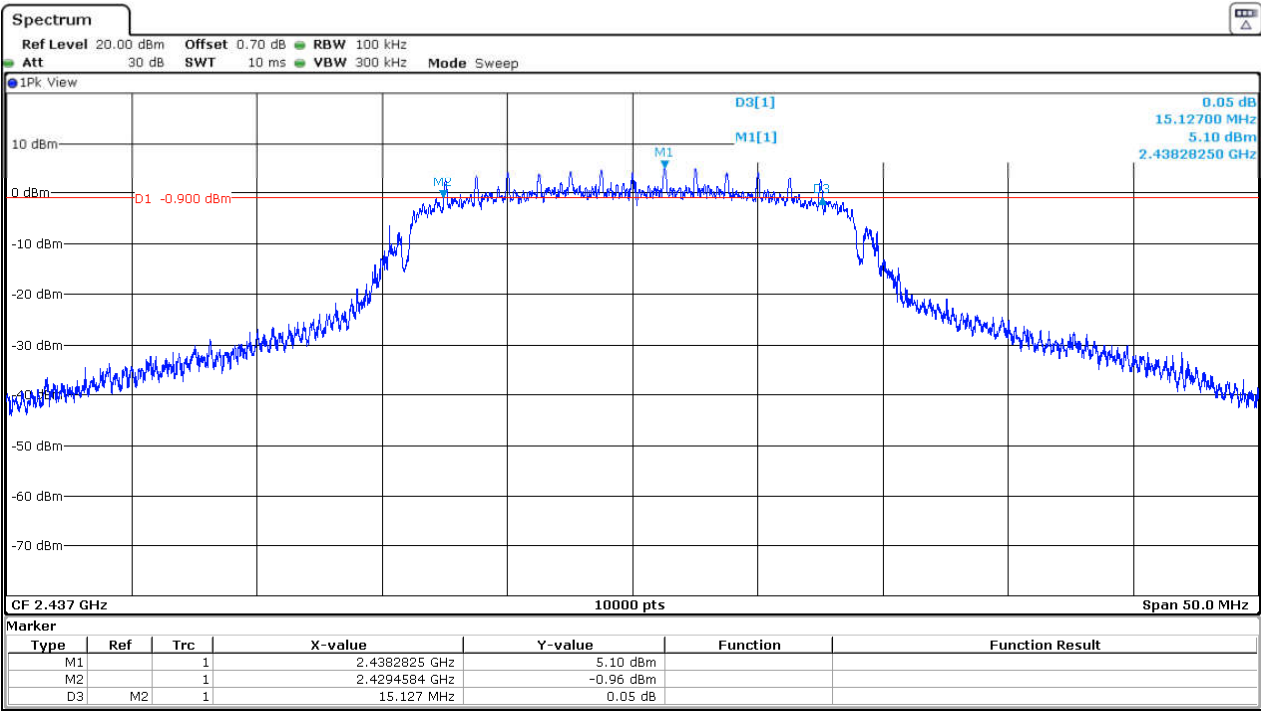


• Mode 802.11 n20 – 6 dB Bandwidth

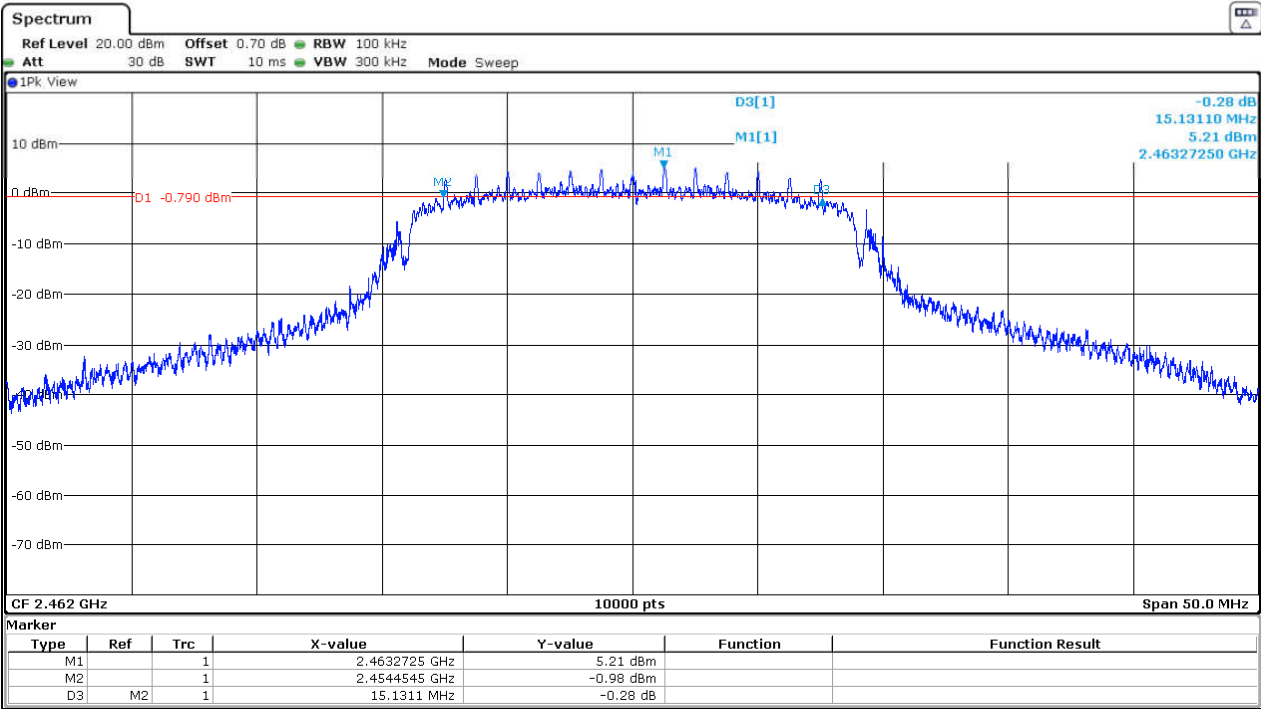
- Low Channel:



- Middle Channel:



- High Channel:



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

SPECIFICATION:

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS:

For all modes, the maximum conducted output power was measured using the method according to point 11.9.1.3 "Method PKPM1" of ANSI C.63.10-2013

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

Maximum Declared Antenna Gain: -0.99 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.

Mode 802.11 b

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Maximum Peak Conducted Power (dBm)	18.31	18.30	18.44
Maximum EIRP Power (dBm)	17.32	17.31	17.45
Measurement uncertainty (dB)	<±0.33		

Mode 802.11 g

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Maximum Peak Conducted Power (dBm)	21.97	22.04	18.95
Maximum EIRP Power (dBm)	20.98	21.05	17.96
Measurement uncertainty (dB)	<±0.33		

Mode 802.11 n20

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Maximum Peak Conducted Power (dBm)	21.80	21.82	18.46
Maximum EIRP Power (dBm)	20.81	20.83	17.47
Measurement uncertainty (dB)	<±0.33		

Verdict: PASS

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

SPECIFICATION:

In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at less 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

RESULTS:

- Mode 802.11 b**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Reference Level Measurement (dBm)	7.93	7.52	7.60
Measurement uncertainty (dB)	<±1.56		

No spurious peaks detected at less than 20 dB below the limit.

- Mode 802.11 g**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Reference Level Measurement (dBm)	5.36	5.38	-1.21
Measurement uncertainty (dB)	<±1.56		

No spurious peaks detected at less than 20 dB below the limit.

- Mode 802.11 n20**

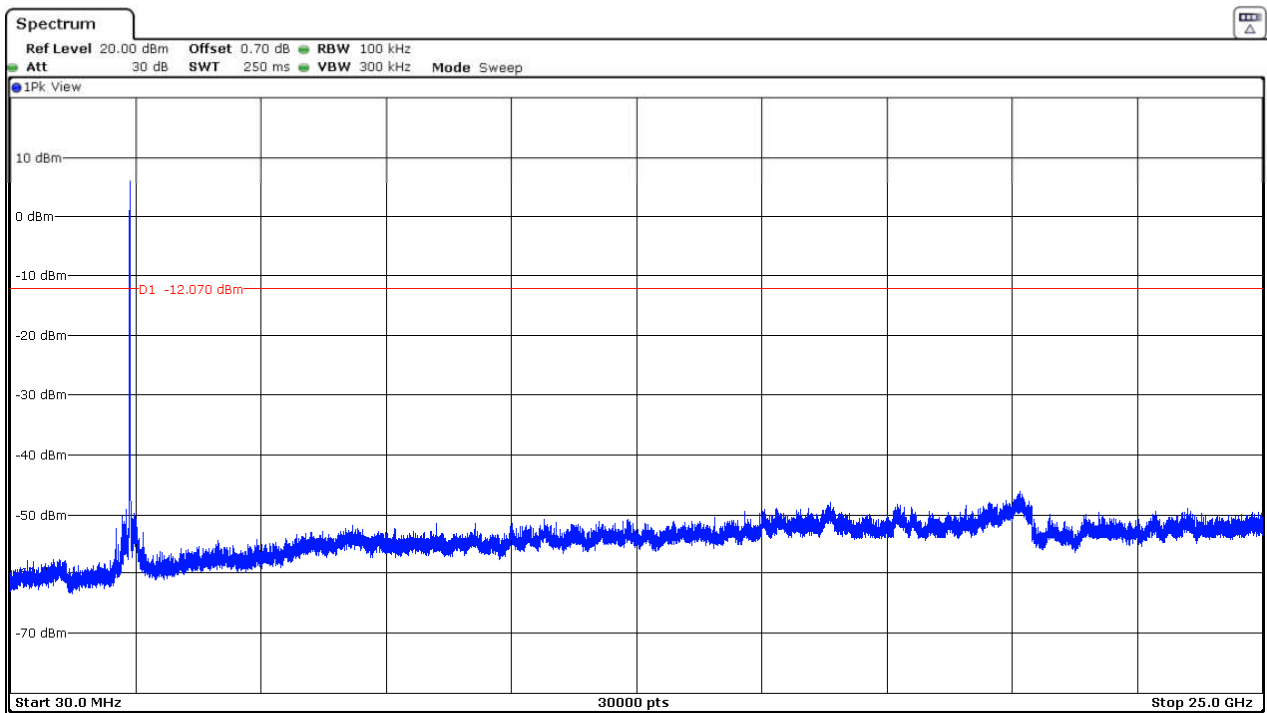
	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Reference Level Measurement (dBm)	5.23	5.37	-0.79
Measurement uncertainty (dB)	<±1.56		

No spurious peaks detected at less than 20 dB below the limit.

Verdict: PASS

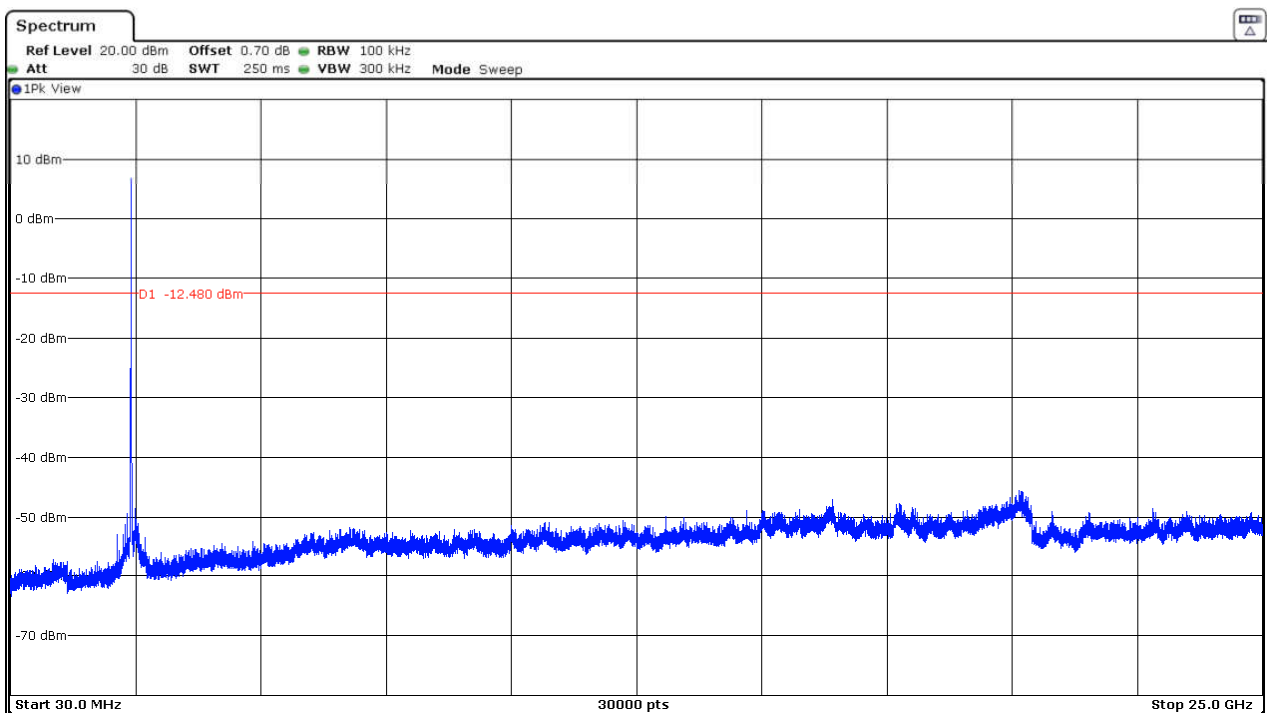
- **Mode 802.11 b – Emission limitations conducted**

- Low Channel:



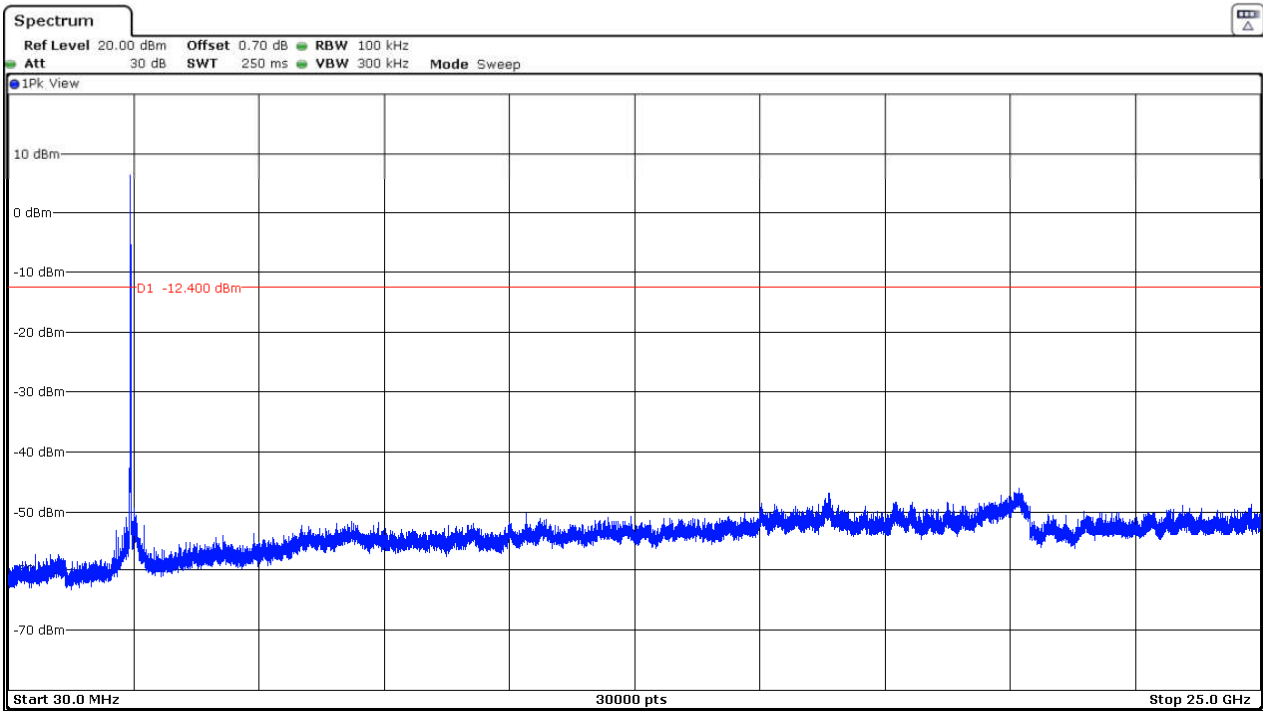
The peak shown in the plot above the limit is the carrier frequency.

- Middle Channel:



The peak shown in the plot above the limit is the carrier frequency.

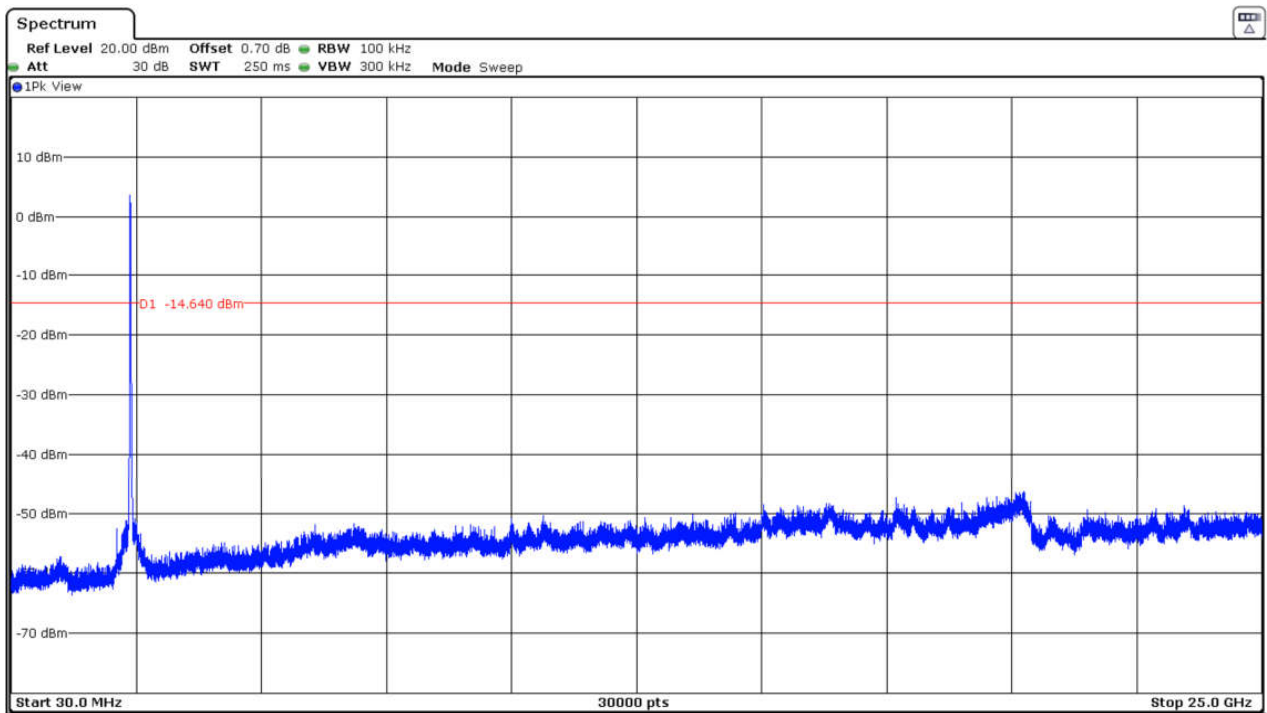
- High Channel:



The peak shown in the plot above the limit is the carrier frequency.

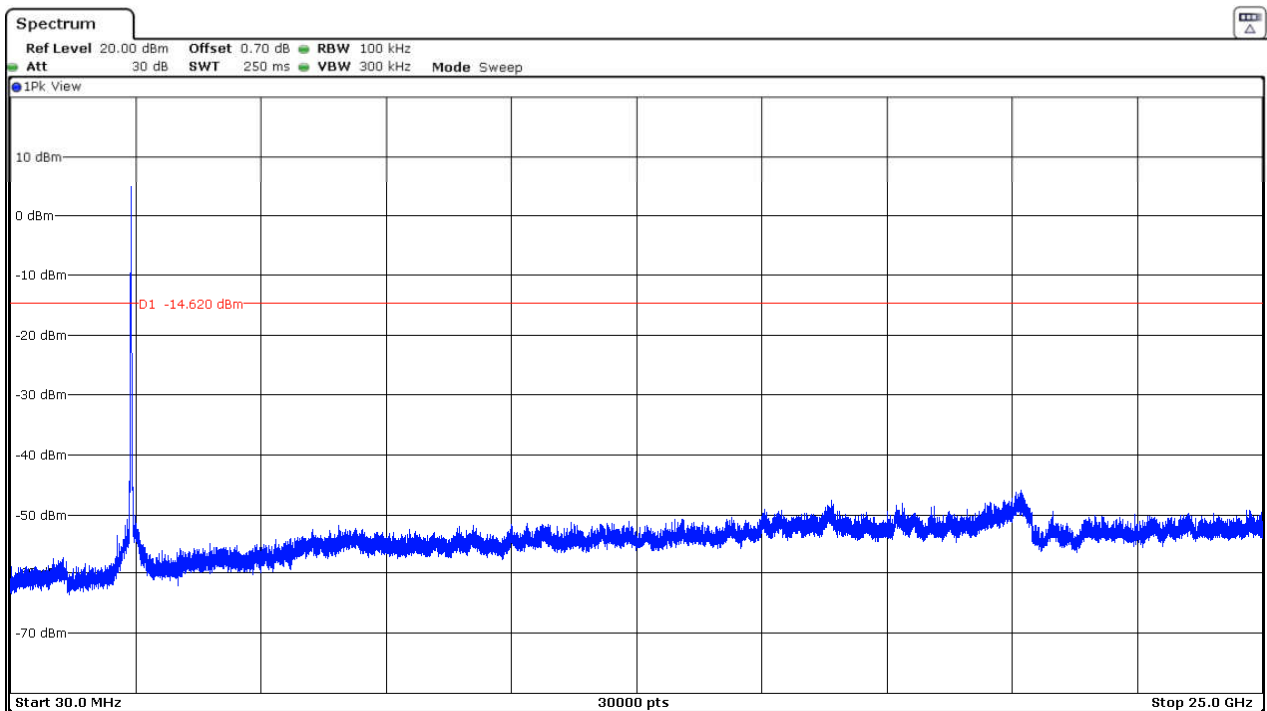
- **Mode 802.11 g – Emission limitations conducted**

- Low Channel:



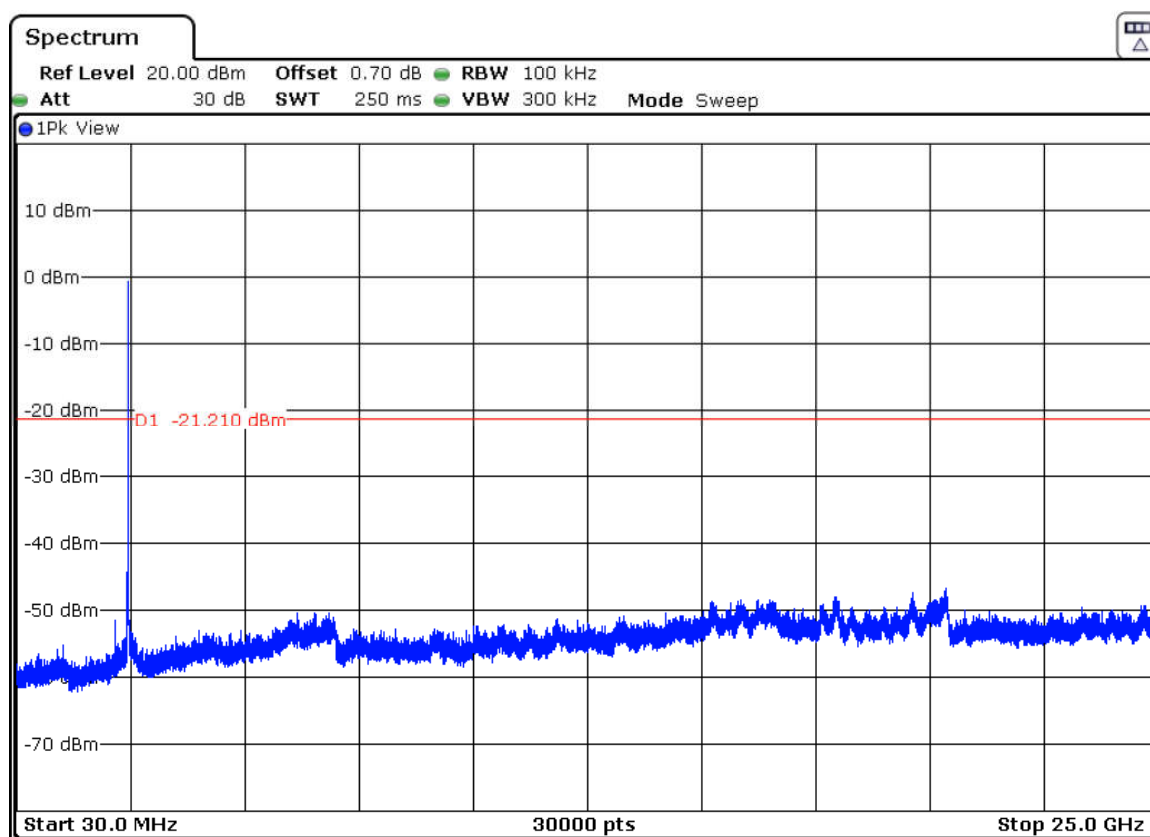
The peak shown in the plot above the limit is the carrier frequency.

- Middle Channel:



The peak shown in the plot above the limit is the carrier frequency.

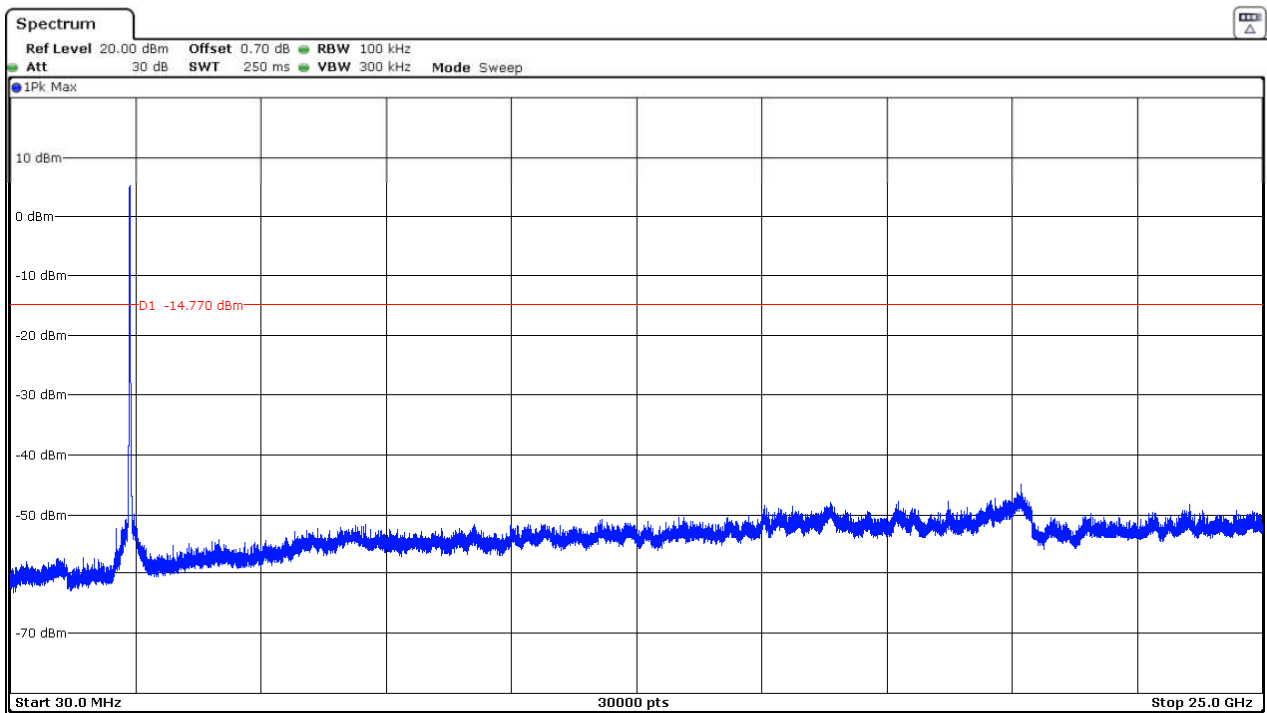
- High Channel:



The peak shown in the plot above the limit is the carrier frequency.

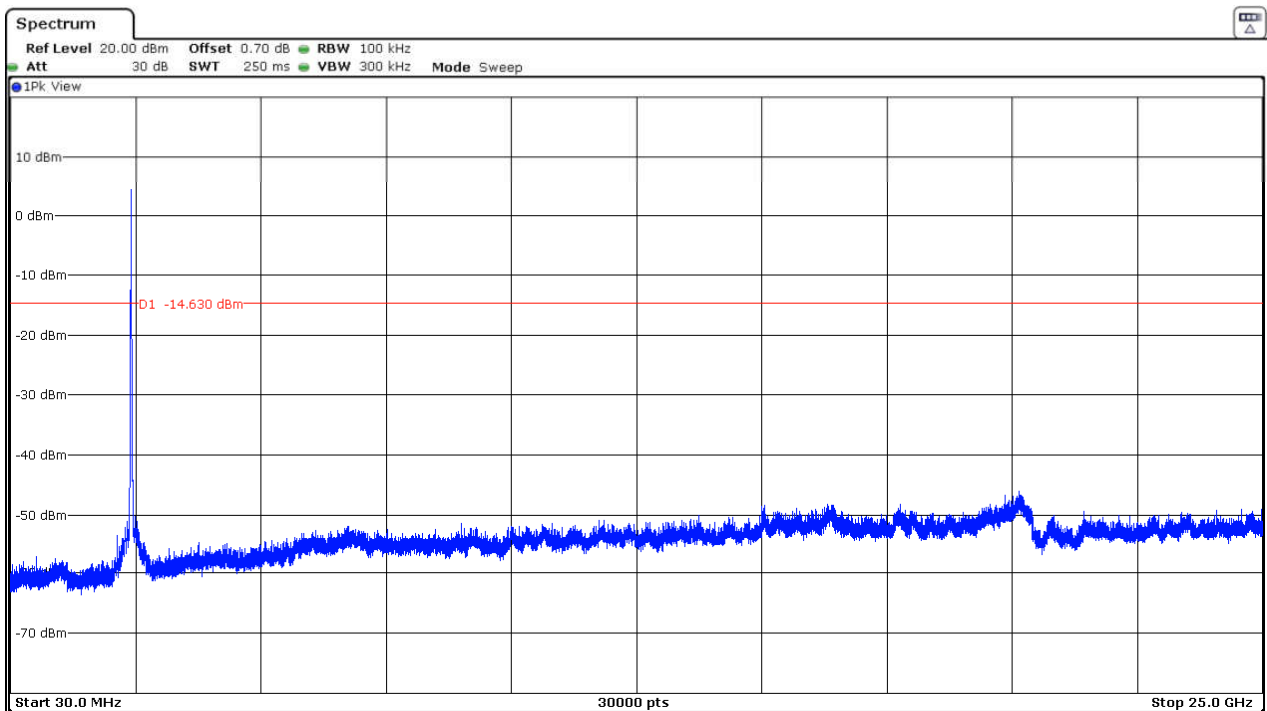
- **Mode 802.11 n20 – Emission limitations conducted**

- Low Channel:



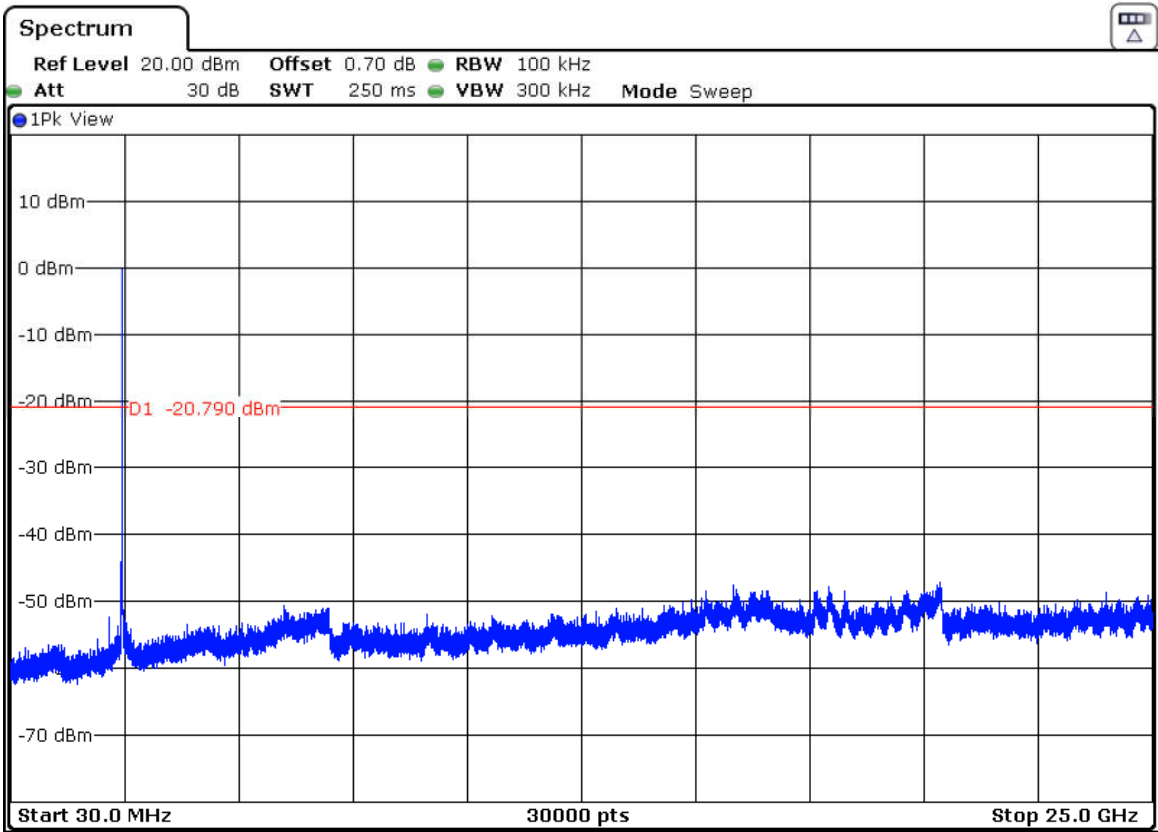
The peak shown in the plot above the limit is the carrier frequency.

- Middle Channel:



The peak shown in the plot above the limit is the carrier frequency.

- High Channel:



The peak shown in the plot above the limit is the carrier frequency.

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

SPECIFICATION:

In any 100 kHz bandwidth outside the frequency band in which the 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

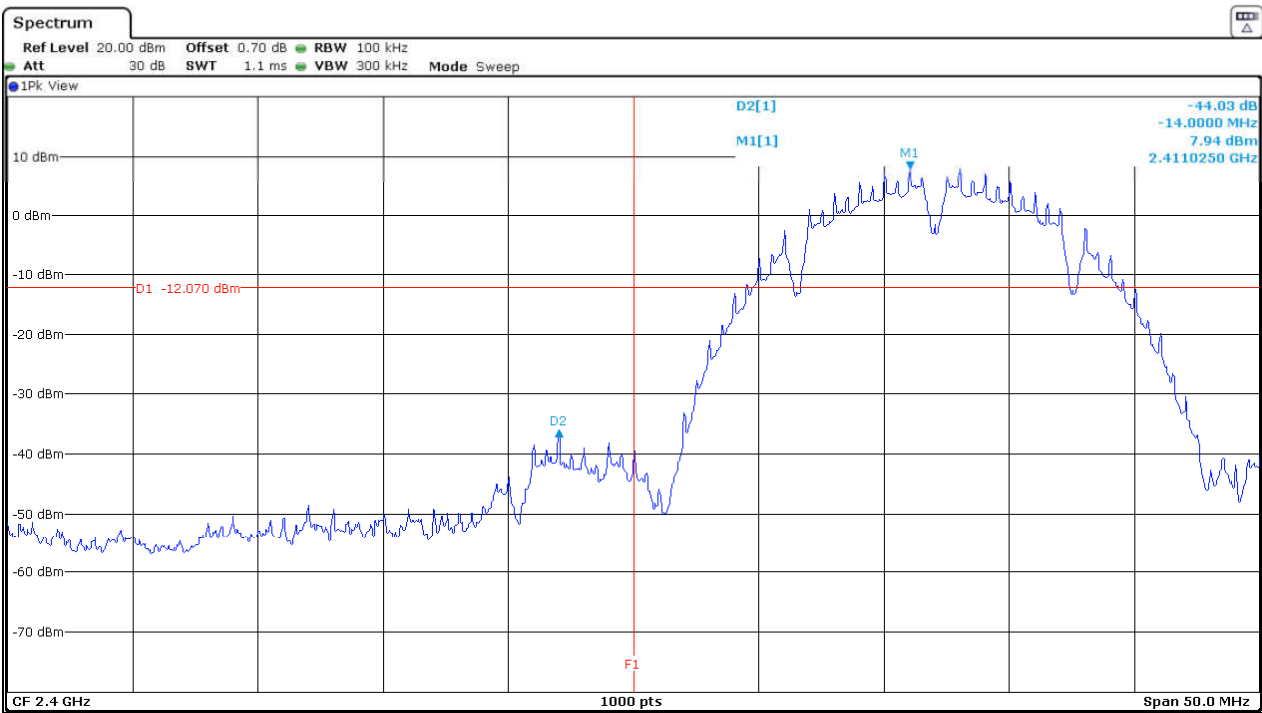
RESULTS:

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)	<±1.56
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- Mode 802.11 b – Band-edge emissions compliance

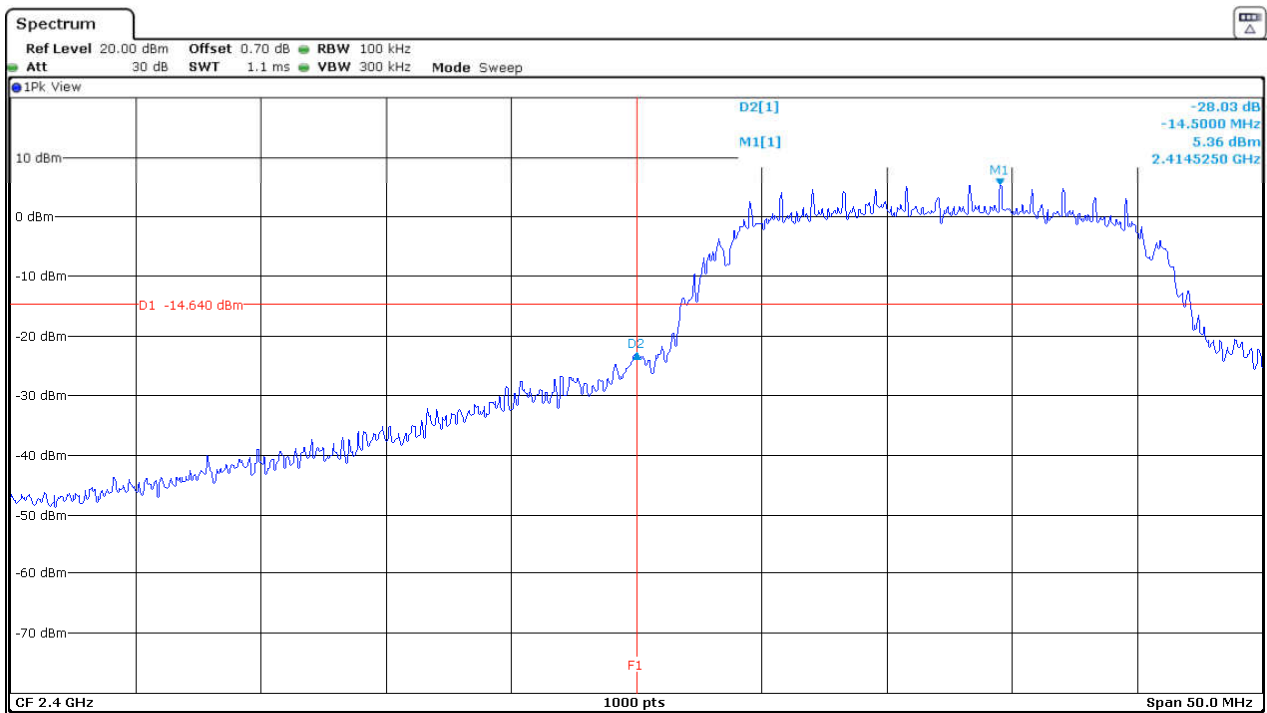
- Low Channel:



Verdict: PASS

- **Mode 802.11 g – Band-edge emissions compliance**

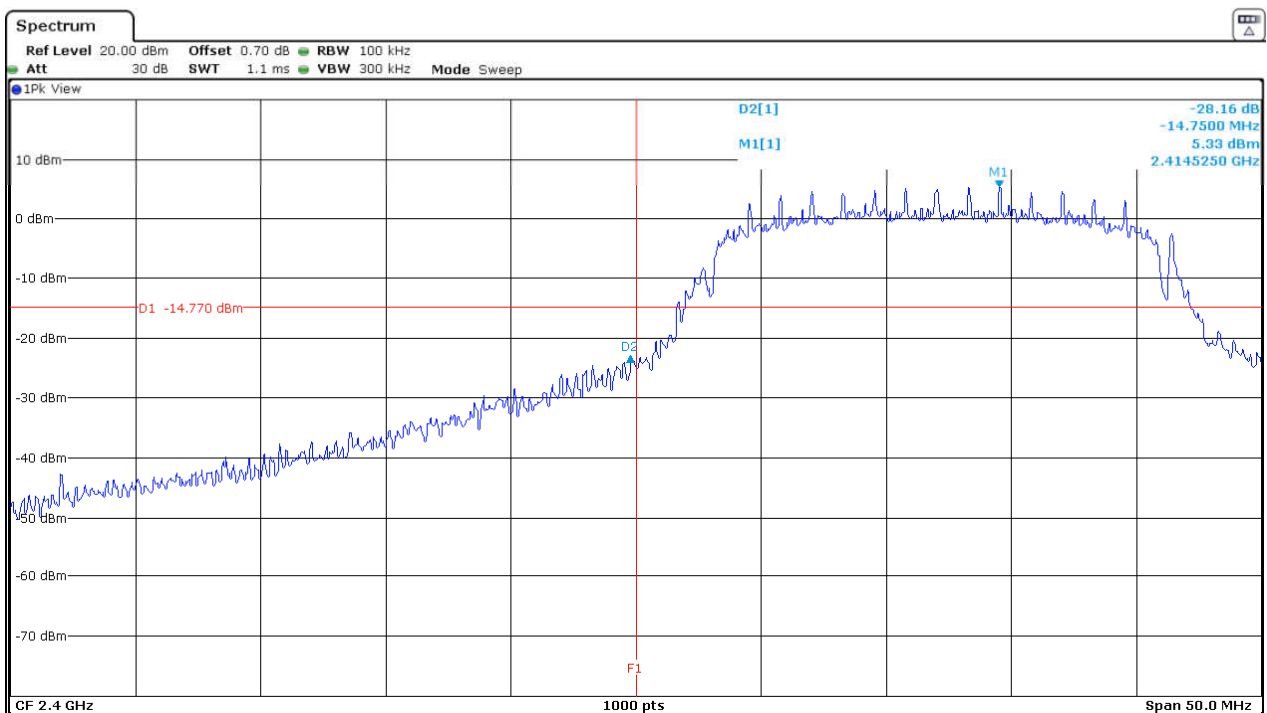
- Low Channel:



Verdict: PASS

- **Mode 802.11 n20 – Band-edge emissions compliance**

- Low Channel:



Verdict: PASS

FCC Section 15.247 Subclause (e) / RSS-247 5.2. (b) Power spectral density

SPECIFICATION:

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS:

For all modes, the maximum power spectral density level in the fundamental emission was measured using the method according to point 11.10.2 "Method PKPSD" of ANSI C.63.10-2013.

- **Mode 802.11 b**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Peak Power Spectral Density (dBm/100KHz)	7.93	7.52	7.6
Measurement uncertainty (dB)	<±0.78		

- **Mode 802.11 g**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Peak Power Spectral Density (dBm/100KHz)	5.36	5.38	-1.21
Measurement uncertainty (dB)	<±0.78		

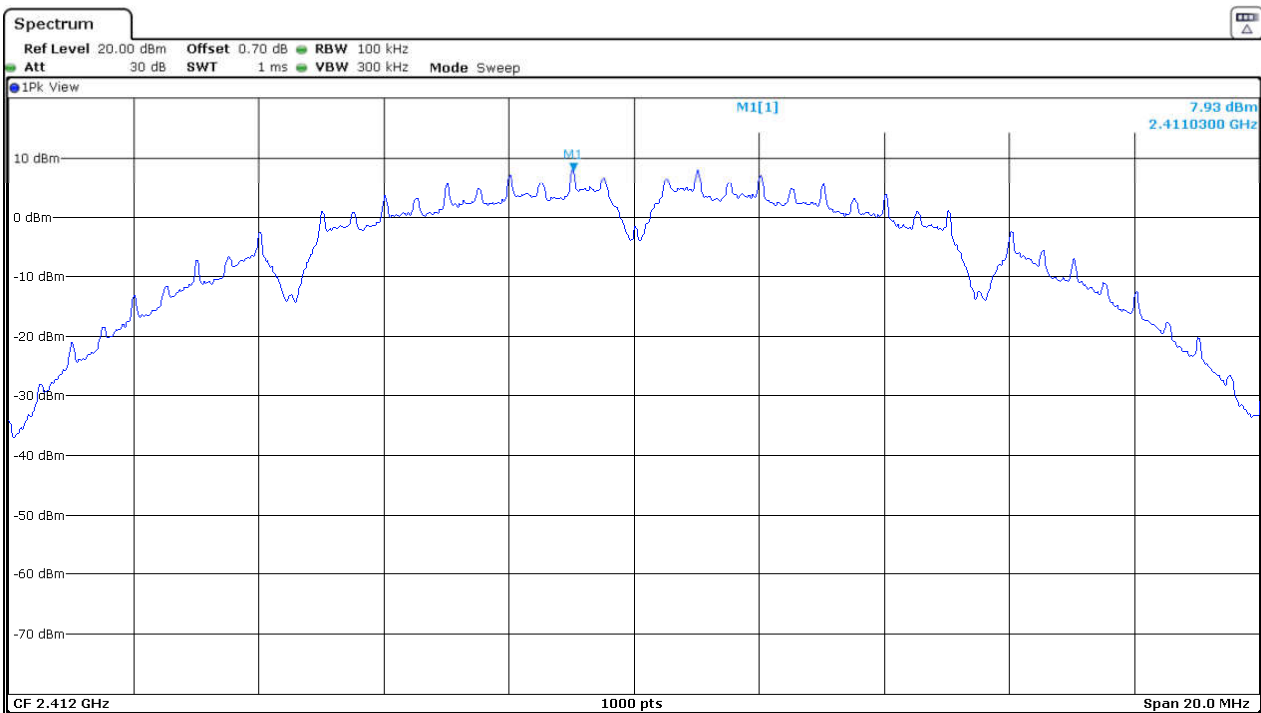
- **Mode 802.11 n20**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
Peak Power Spectral Density (dBm/100KHz)	5.23	5.37	-0.79
Measurement uncertainty (dB)	<±0.78		

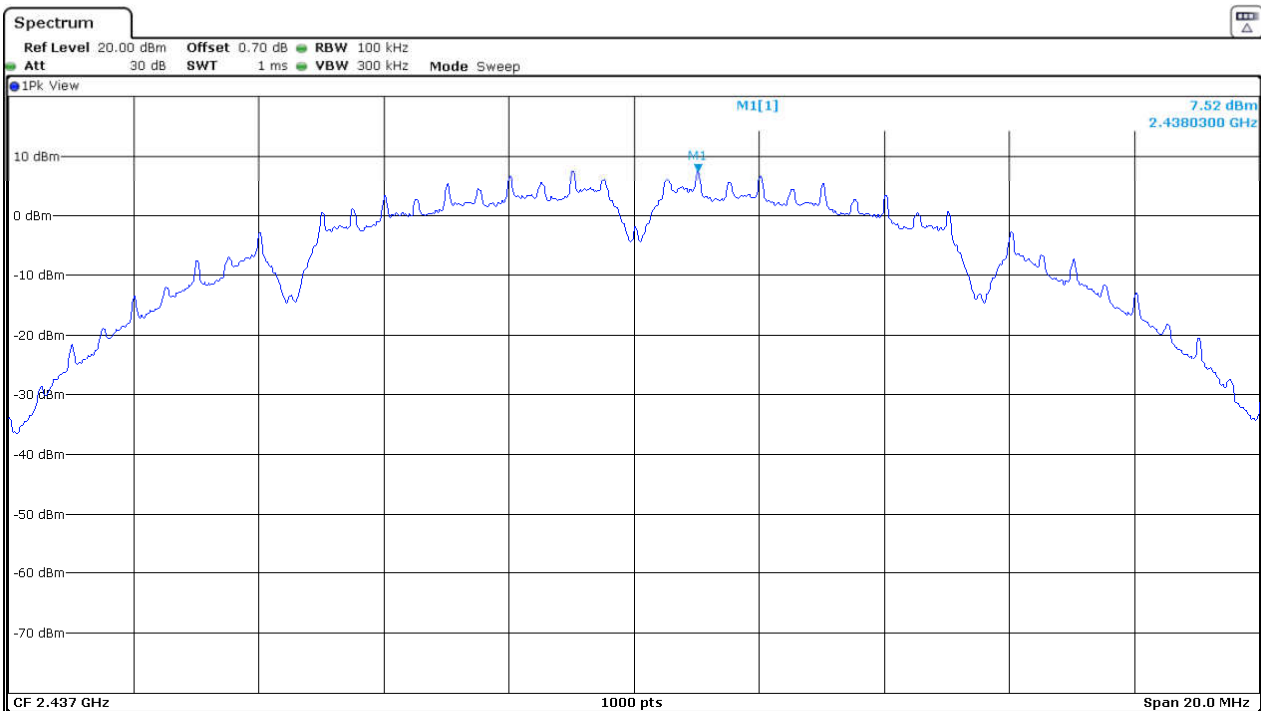
Verdict: PASS

• Mode 802.11 b – Power Spectral Density

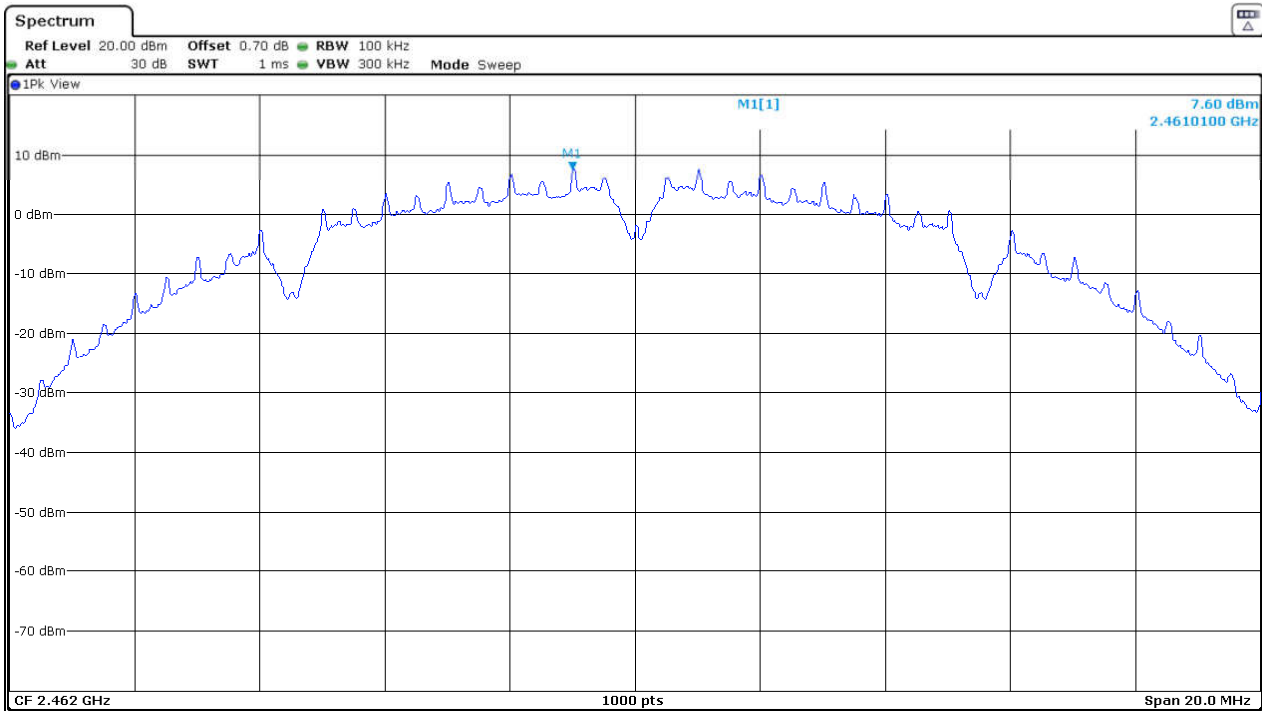
- Low Channel:



- Middle Channel:

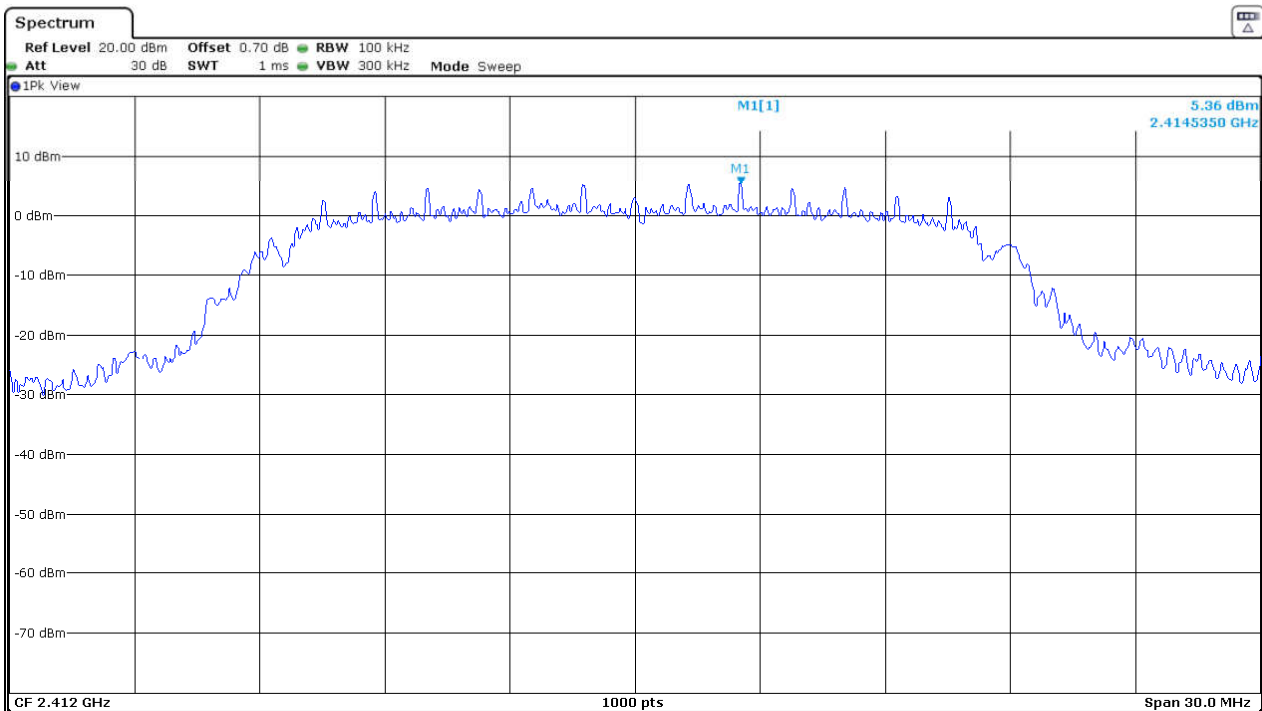


- High Channel:

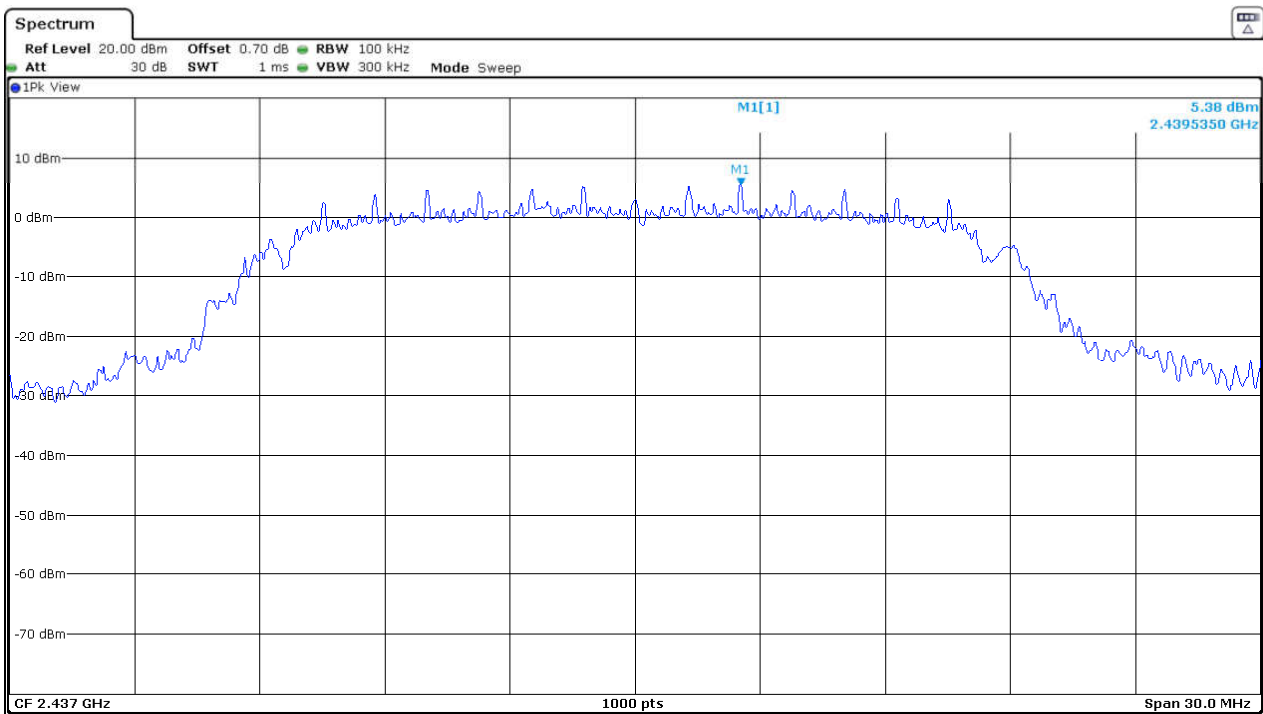


- Mode 802.11 g – Power Spectral Density

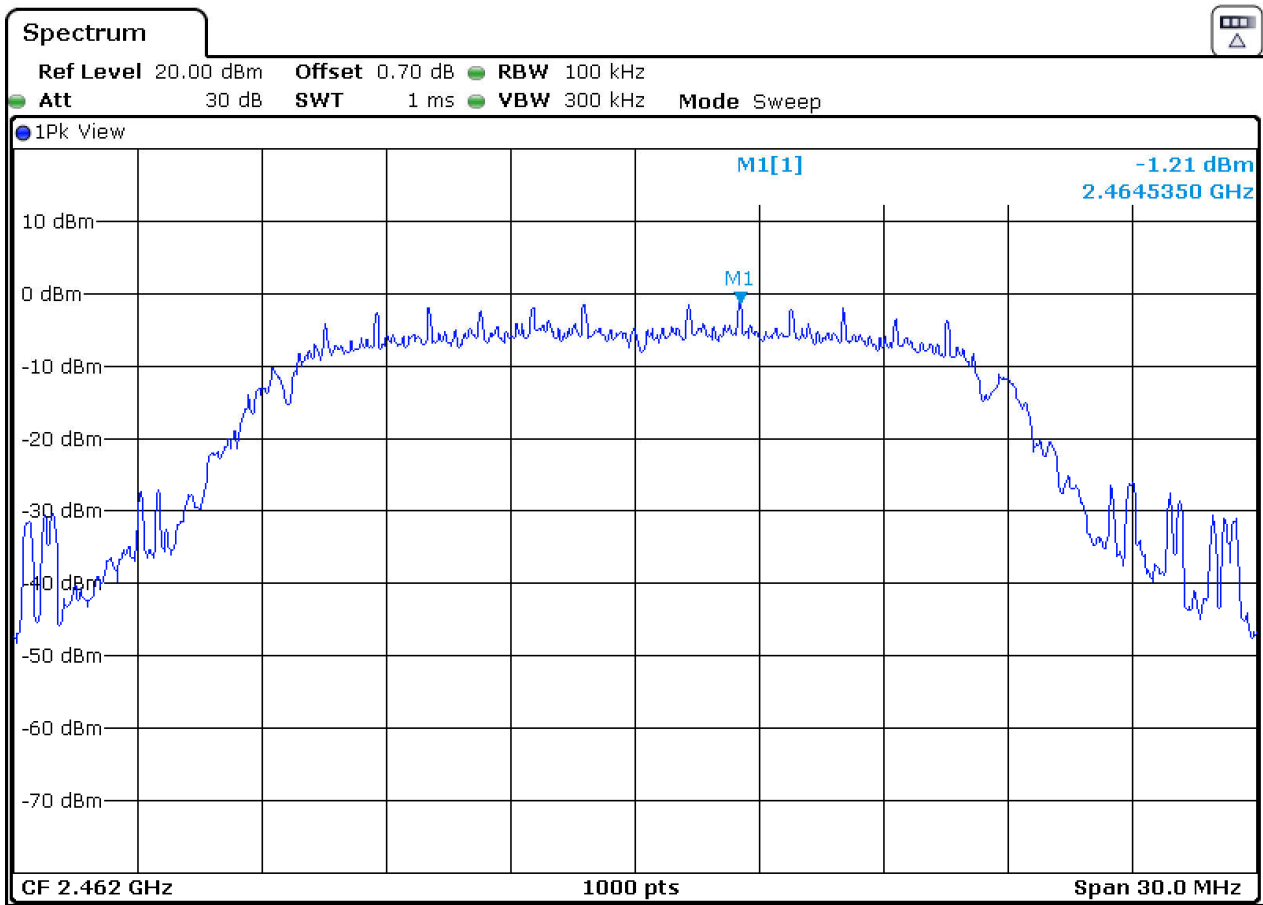
- Low Channel:



- Middle Channel:

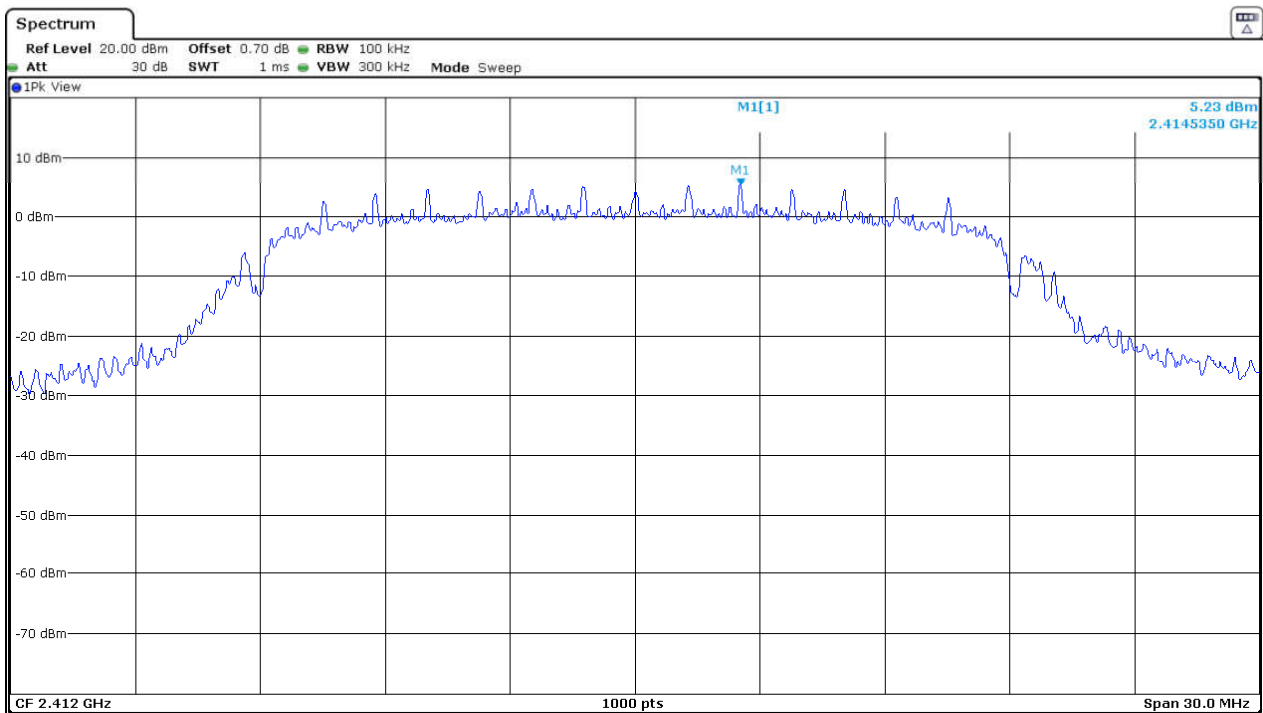


- High Channel:

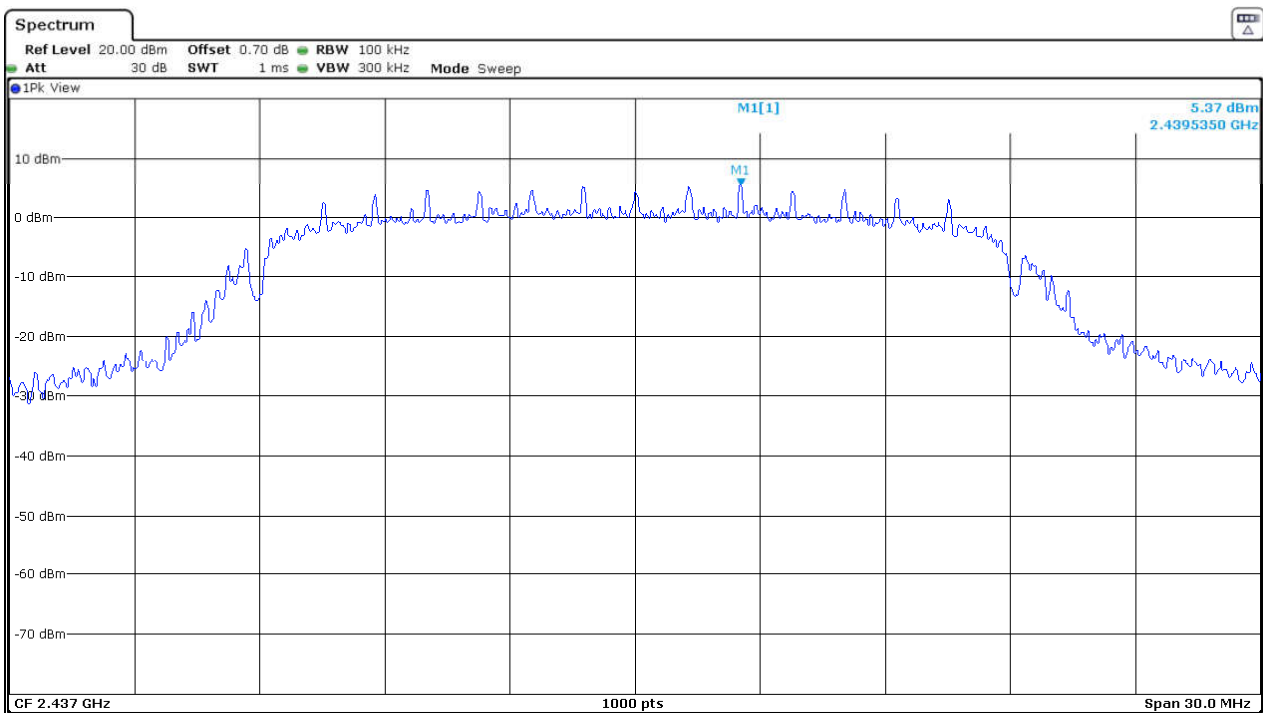


- Mode 802.11 n20 – Power Spectral Density

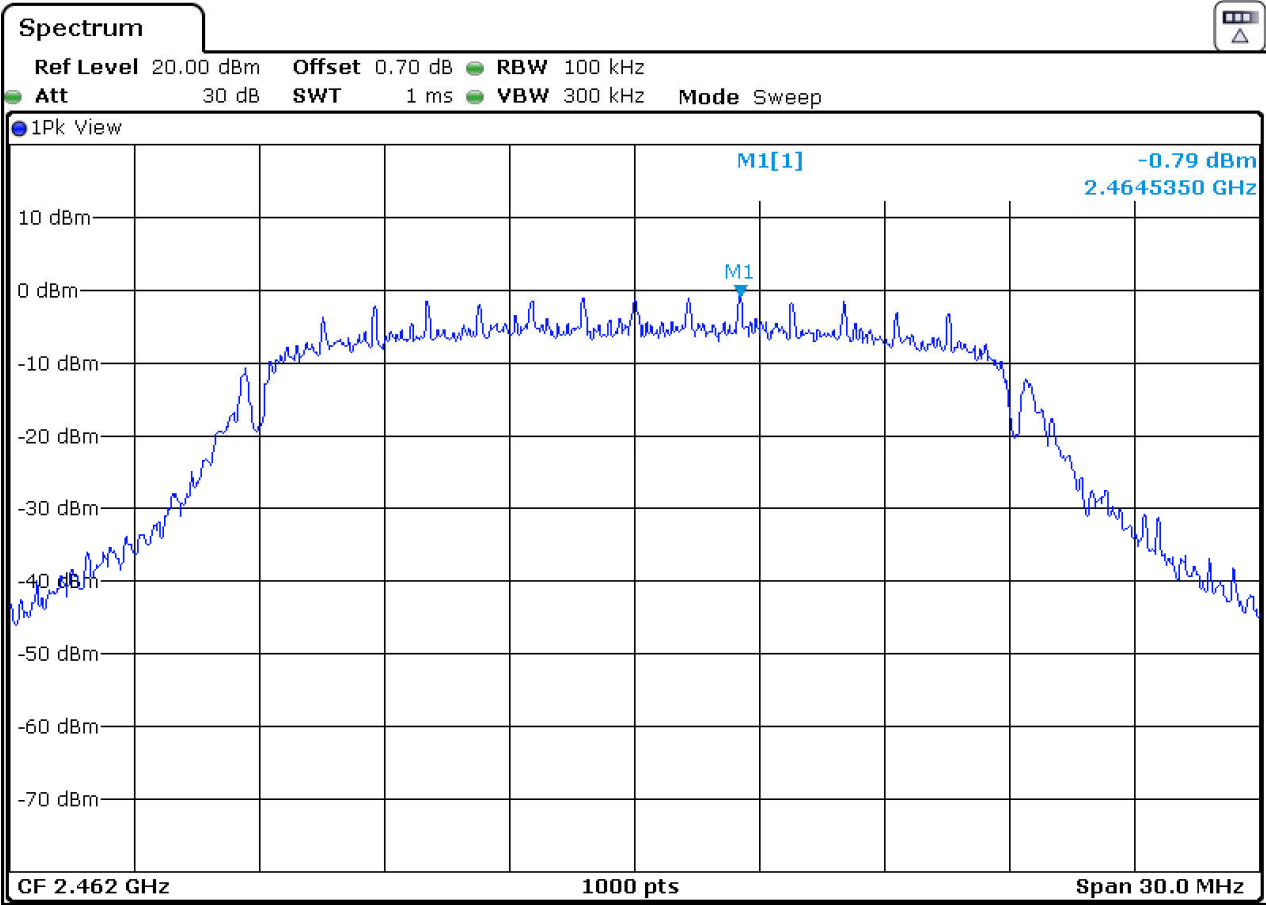
- Low Channel:



- Middle Channel:



- High Channel:



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 Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)/RSS-Gen):

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	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 - 10000	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.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° 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-26 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.

RADIATED:

Frequency range 30 MHz - 1 GHz:

The spurious frequencies do not depend neither on the operating channel nor the modulation mode.

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

Spurious frequency (MHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
40.234	Quasi peak	36.1	V	<± 2.07
63.546	Quasi peak	32.9	V	<± 2.07
296.572	Quasi peak	26.7	H	<± 2.07
376.015	Quasi peak	29.8	H	<± 2.07
448.020	Quasi peak	37.0	H	<± 2.07
456.008	Quasi peak	37.5	H	<± 2.07

• Mode 802.11 b

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-25 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious signals 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.

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

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.38709	Peak	53.51	V	<± 4.88
3.40343	Peak	45.34	V	<± 4.88
4.82397	Peak	48.29	H	<± 4.88
7.23617	Peak	47.36	H	<± 4.88
19.29575	Peak	47.37	V	<± 4.88
24.10355	Peak	39.40	V	<± 4.88

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

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
3.24943	Peak	45.29	H	<± 4.88
4.87390	Peak	47.71	V	<± 4.88
7.31177	Peak	45.37	H	<± 4.88
19.49585	Peak	50.19	V	<± 4.88

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

Spurious frequency (MHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
2.48516	Peak	54.11	V	< $\pm$ 4.88
	Average	45.04		< $\pm$ 4.88
3.18877	Peak	45.46	V	< $\pm$ 4.88
3.29423	Peak	48.07	H	< $\pm$ 4.88
4.92383	Peak	47.07	V	< $\pm$ 4.88
7.38690	Peak	46.07	V	< $\pm$ 4.88
19.69595	Peak	50.5	V	< $\pm$ 4.88

Verdict: PASS

OFDM modes:

For spurious emissions in the range 30 MHz - 26 GHz (except field strength at the band edges that was performed for all modes) a preliminary scan was performed to determine the worst case mode. Herein the results for the worst case mode: 802.11n20.

Spurious emissions in the Restricted Band 1 and Restricted Band 2 are measured for all modes.

• **Mode 802.11 n20 (OFDM worst case for spurious emissions)**

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-25 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious signals with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with average detector for checking compliance with the average limit.

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

Spurious frequency (GHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
2.38976	Peak	68.91	V	< $\pm$ 4.88
	Average	53.91		< $\pm$ 4.88
3.27830	Peak	45.34	V	< $\pm$ 4.88
3.40623	Peak	46.26	H	< $\pm$ 4.88
4.81930	Peak	46.87	H	< $\pm$ 4.88
7.23430	Peak	53.54	V	< $\pm$ 4.88
19.29575	Peak	47.70	V	< $\pm$ 4.88

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

Spurious frequency (GHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
3.28490	Peak	47.65	V	< $\pm$ 4.88
3.41277	Peak	46.01	H	< $\pm$ 4.88
4.86730	Peak	47.69	V	< $\pm$ 4.88
7.30897	Peak	49.34	H	< $\pm$ 4.88
9.74770	Peak	47.42	H	< $\pm$ 4.88
19.49585	Peak	48.75	V	< $\pm$ 4.88

- CHANNEL 10. Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
2.48483	Peak	68.11	V	< $\pm$ 4.88
	Average	52.63		< $\pm$ 4.88

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

Spurious frequency (GHz)	Detector	Emission Level (dB μ V/m)	Polarization	Measurement Uncertainty (dB)
2.48418	Peak	71.76	V	< $\pm$ 4.88
	Average	52.06		< $\pm$ 4.88
3.29423	Peak	46.90	H	< $\pm$ 4.88
3.40950	Peak	44.08	V	< $\pm$ 4.88
4.92430	Peak	46.92	V	< $\pm$ 4.88
7.38410	Peak	49.39	V	< $\pm$ 4.88
9.84810	Peak	49.09	V	< $\pm$ 4.88
19.69595	Peak	49.94	V	< $\pm$ 4.88

Verdict: PASS

• **Mode 802.11 g**

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

Spurious signals 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.

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

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.38974	Peak	68.14	V	<± 4.88
	Average	53.63		<± 4.88

- CHANNEL 10. Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.48420	Peak	70.58	V	<± 4.88
	Average	53.97		<± 4.88

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

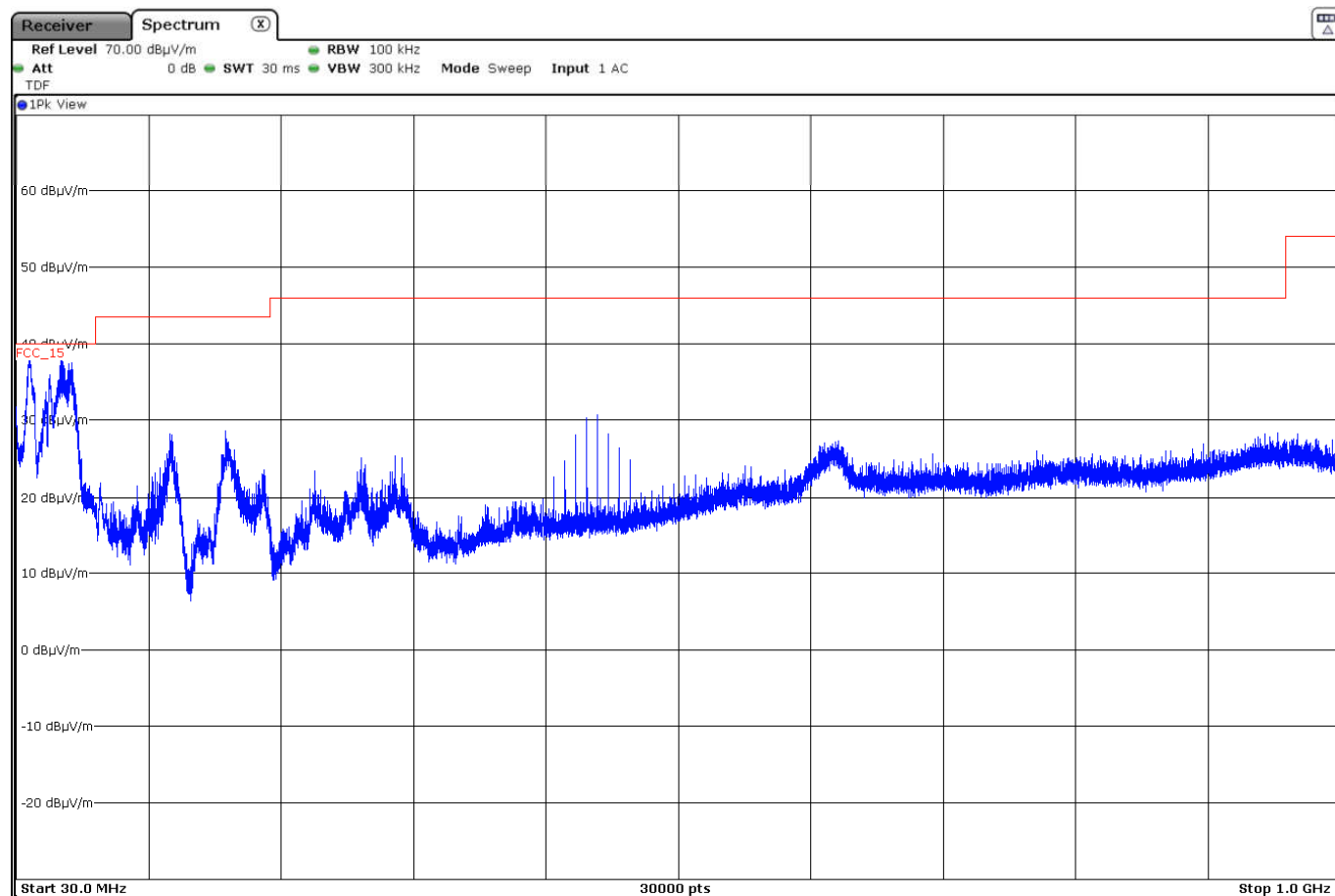
Spurious frequency (GHz)	Detector	Emission Level (dBμV/m)	Polarization	Measurement Uncertainty (dB)
2.48359	Peak	71.80	V	<± 4.88
	Average	53.14		<± 4.88

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

The spurious frequencies detected do not depend neither on the operating channel nor the modulation mode.

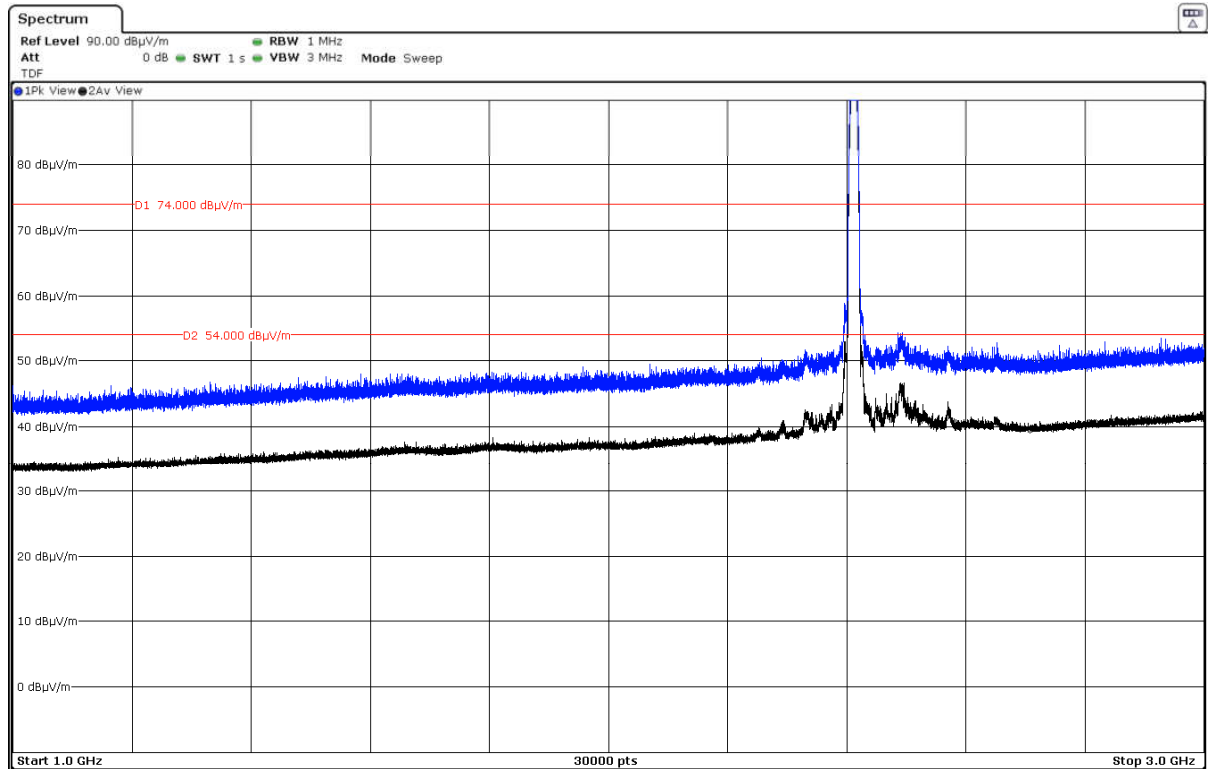
This plot is valid for the Low, Middle and High Channels.



- **Mode 802.11 b**

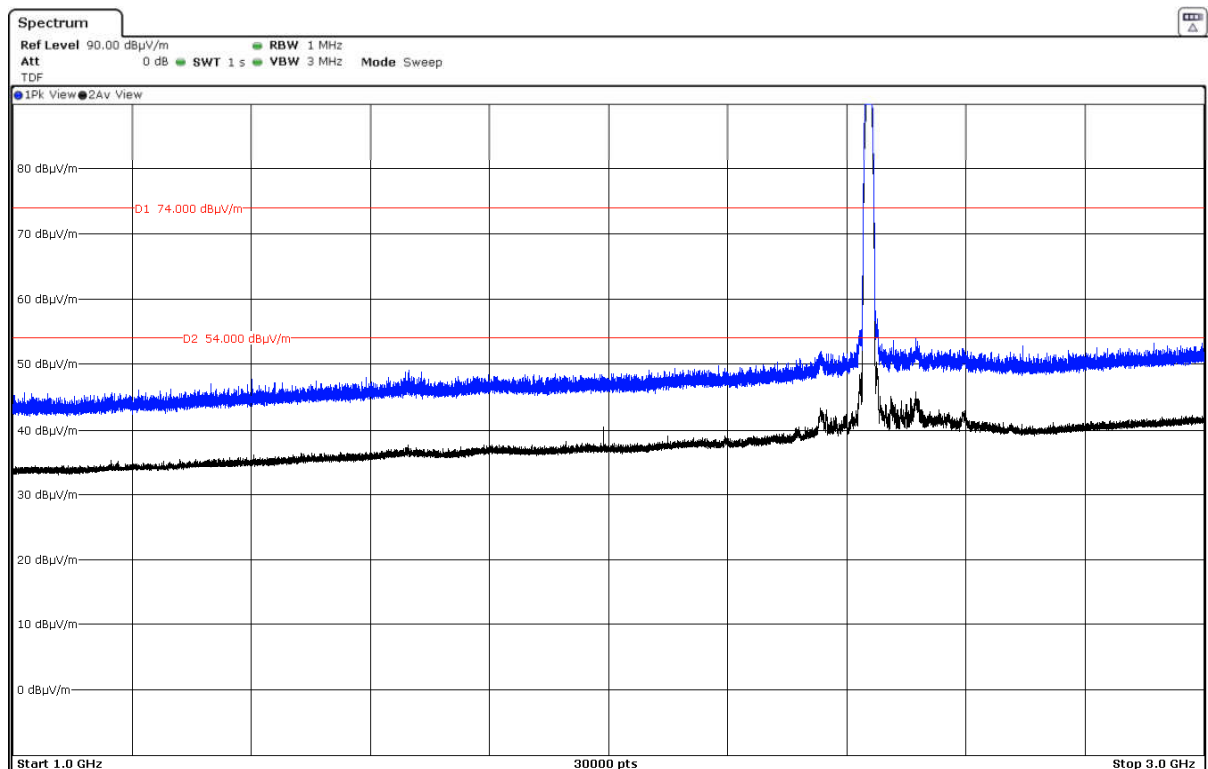
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



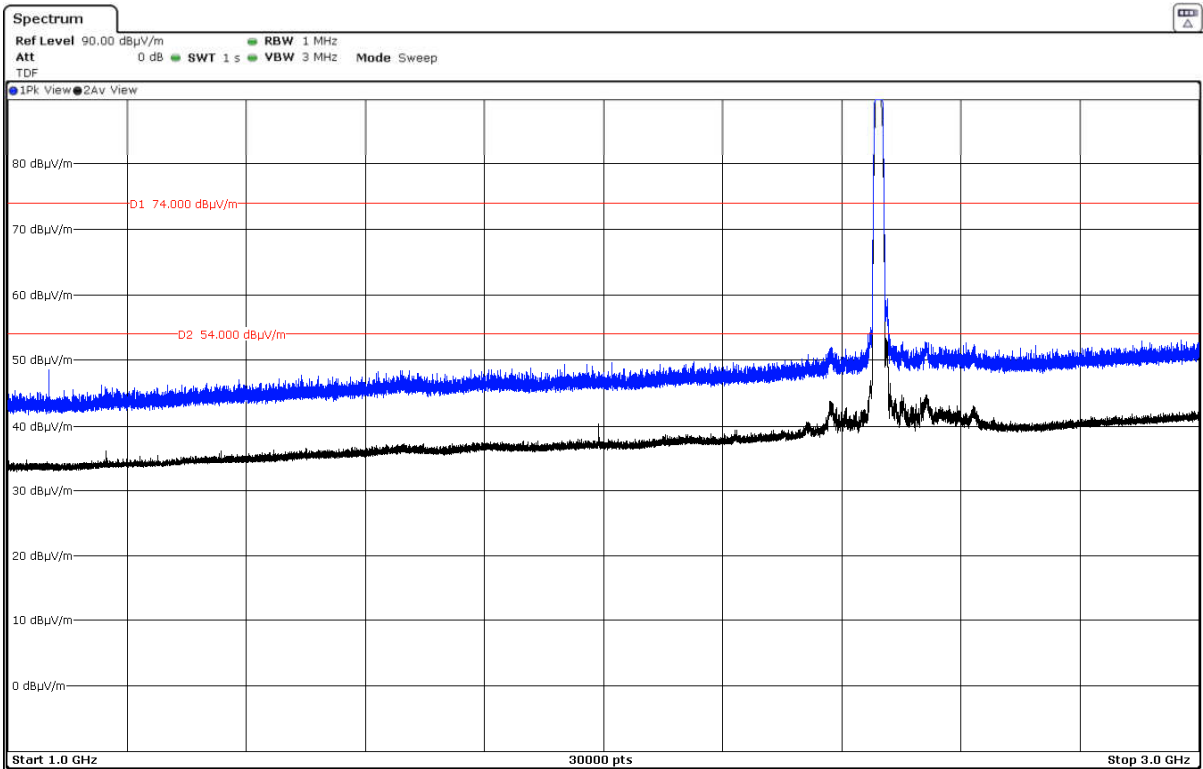
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

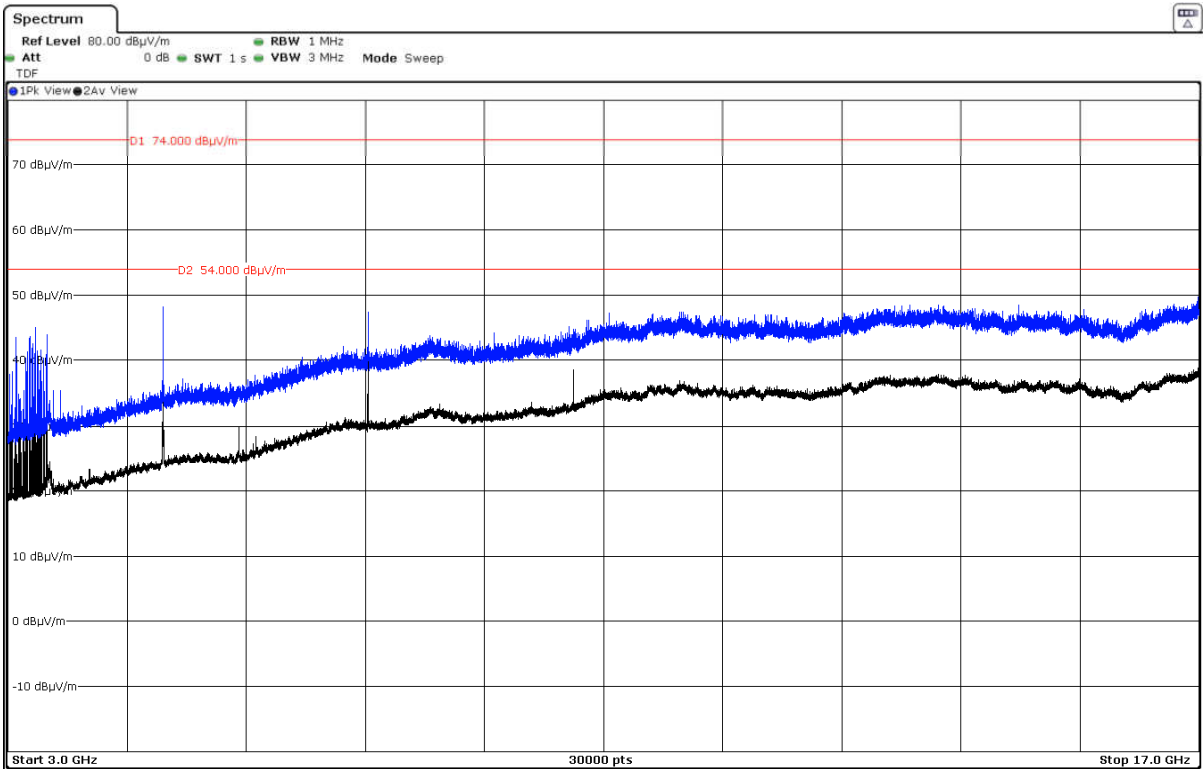
- High Channel:



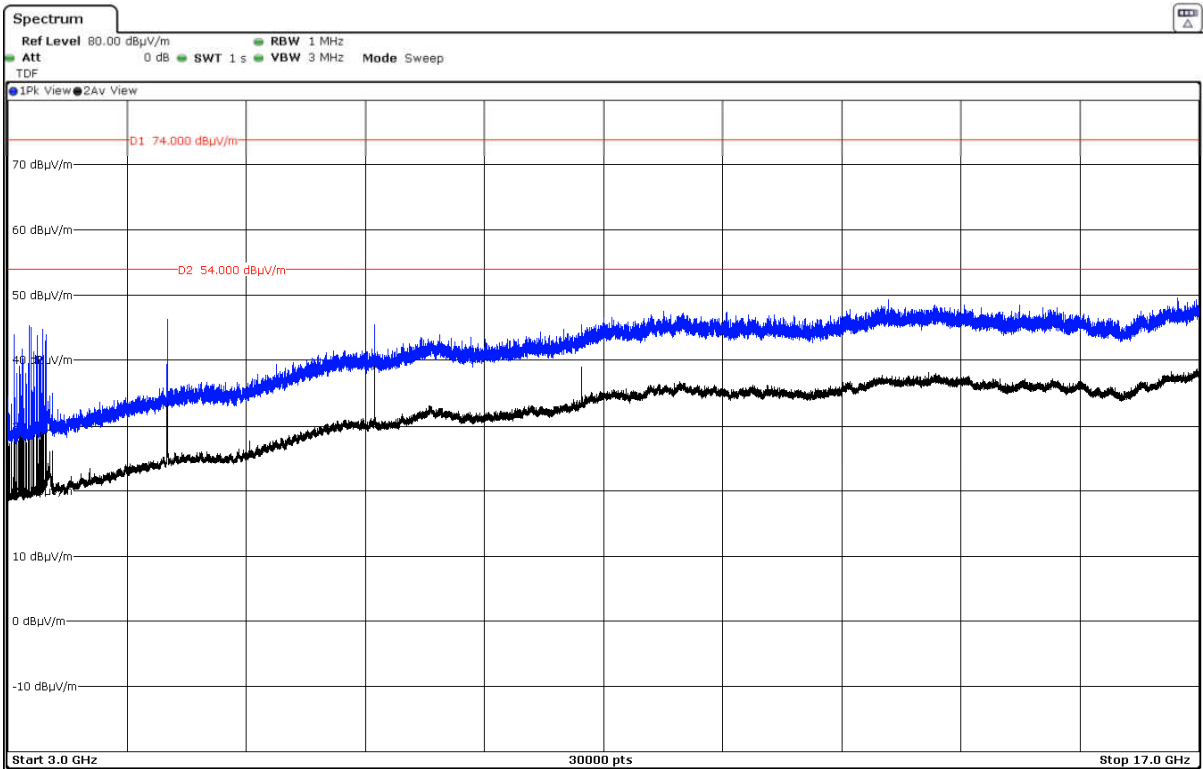
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

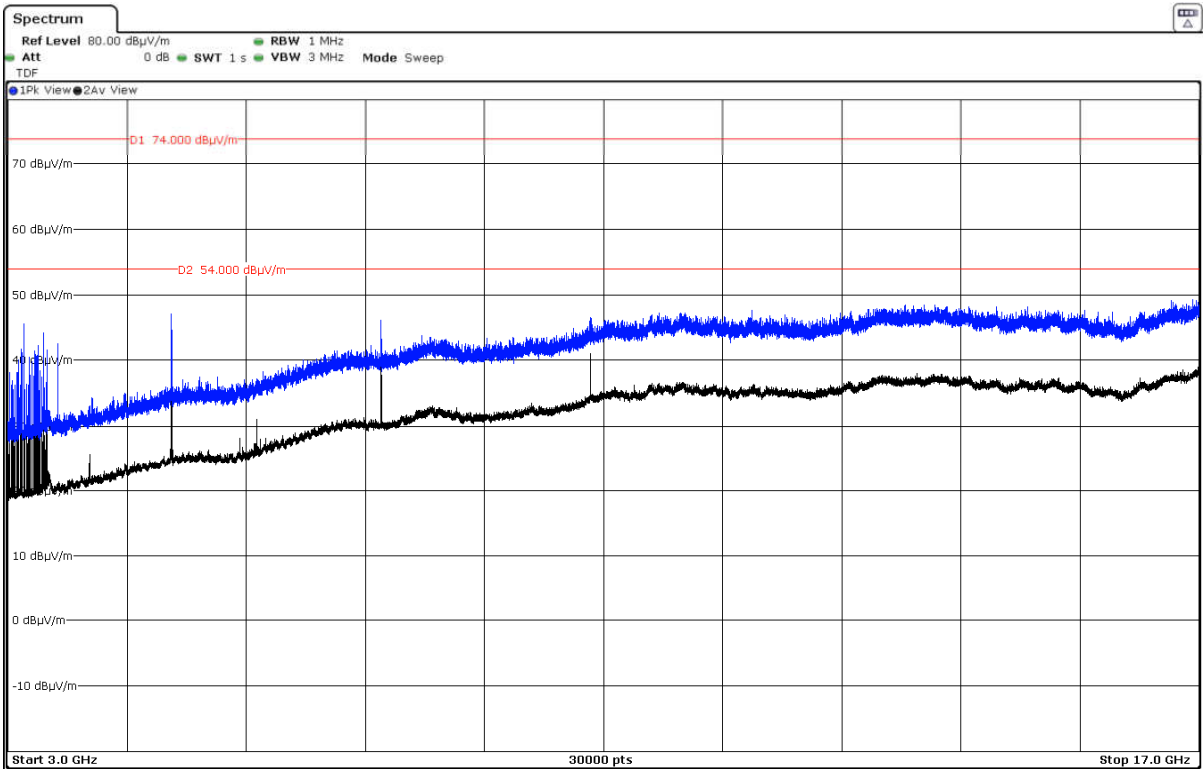
- Low Channel:



- Middle Channel:

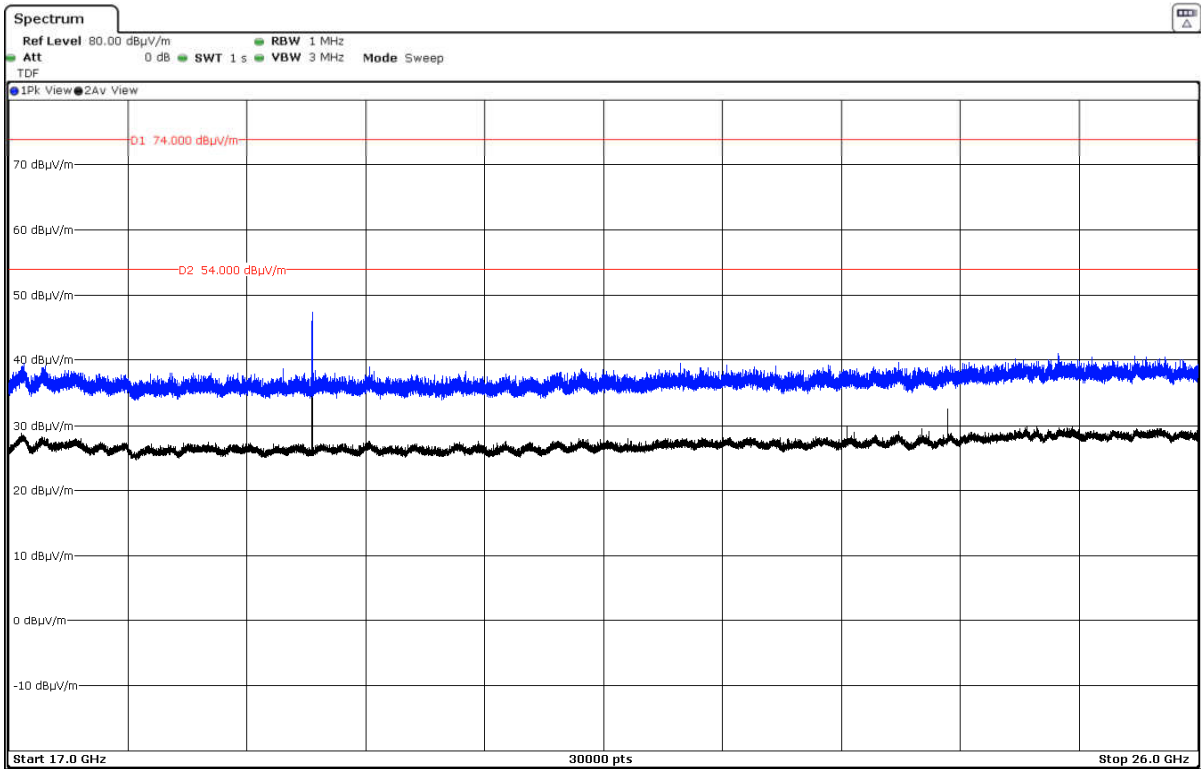


- High Channel:

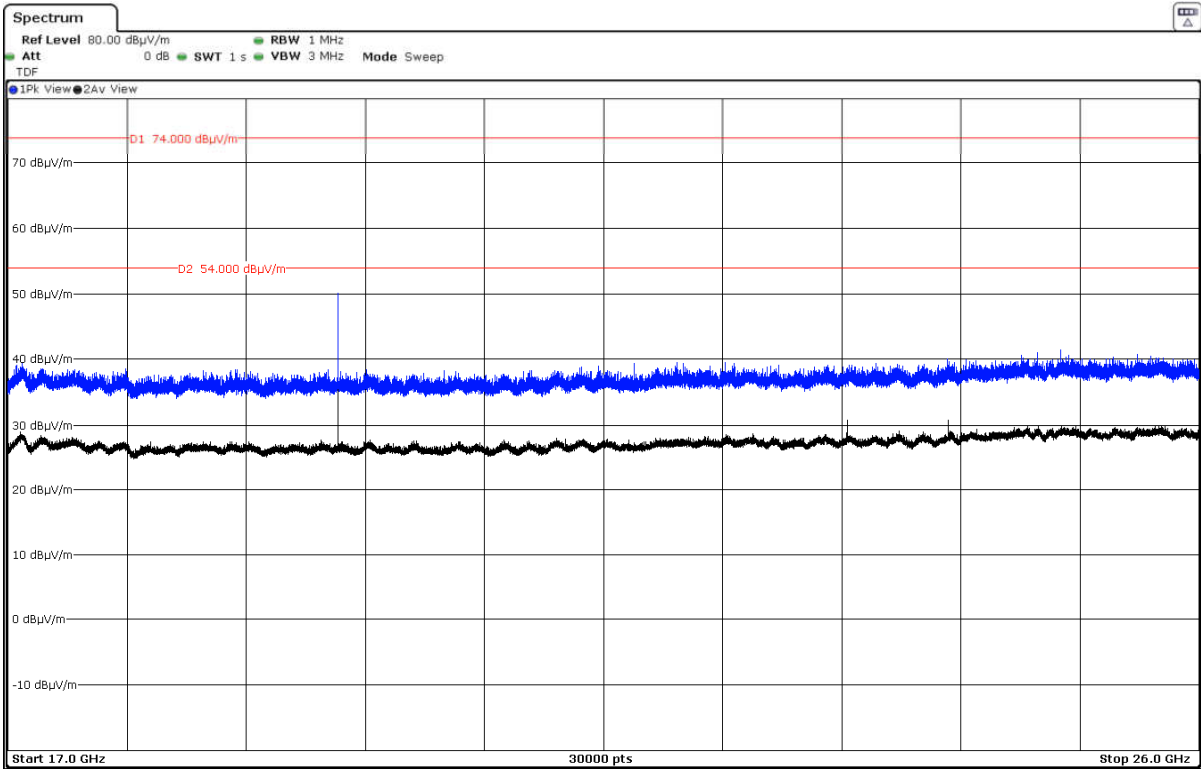


FREQUENCY RANGE 17 - 26 GHz:

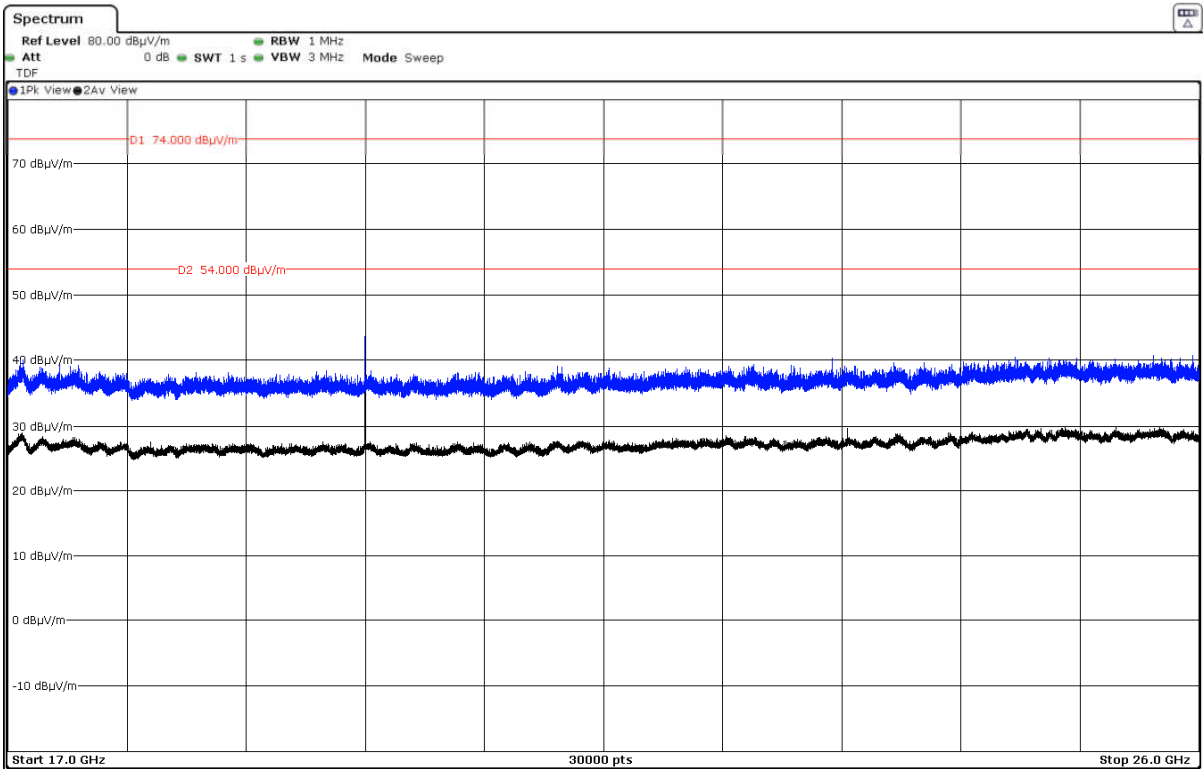
- Low Channel:



- Middle Channel:

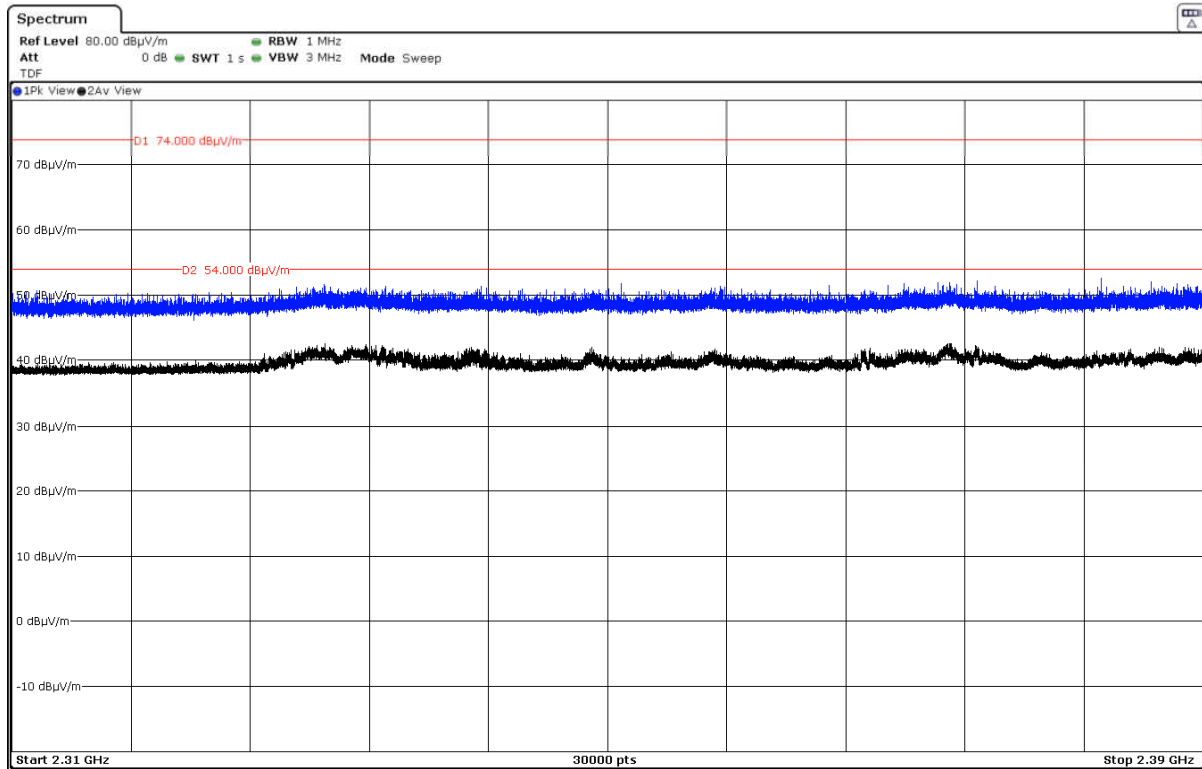


- High Channel:



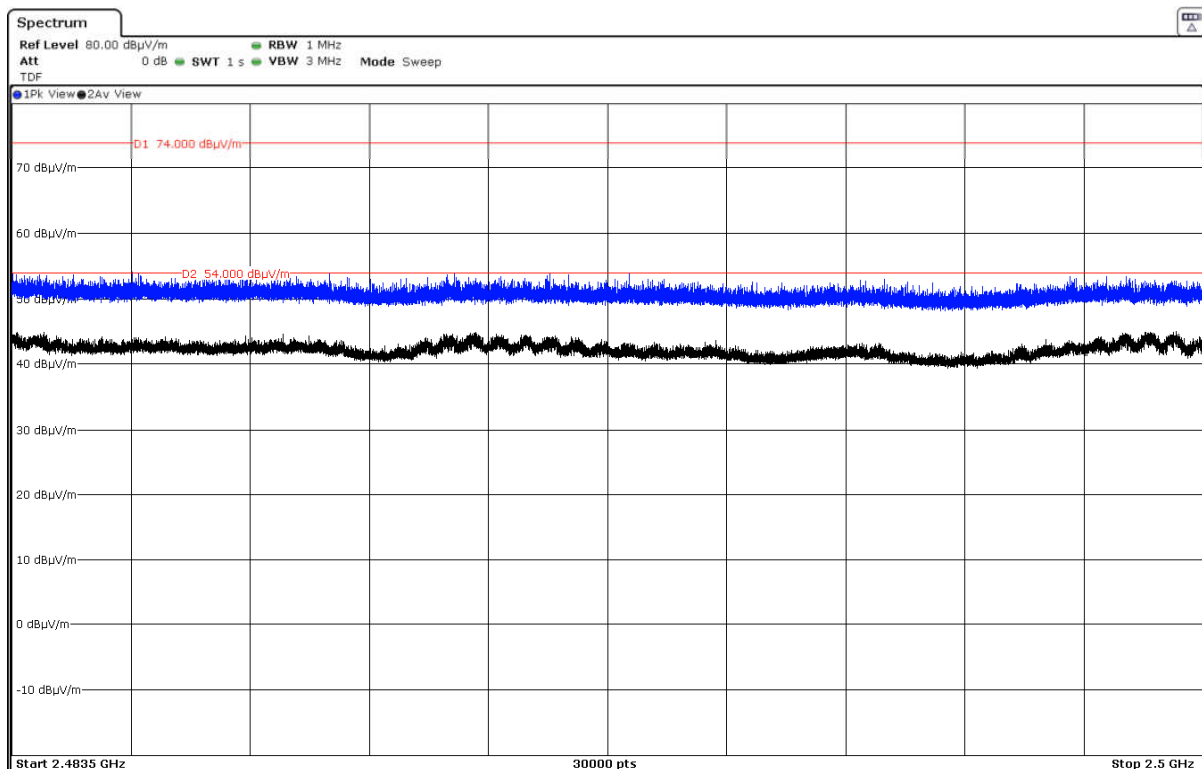
FREQUENCY RANGE 2.31-2.39 GHz (Restricted Band 1):

- Low Channel. CH 1:



FREQUENCY RANGE 2.4835-2.5 GHz (Restricted Band 2):

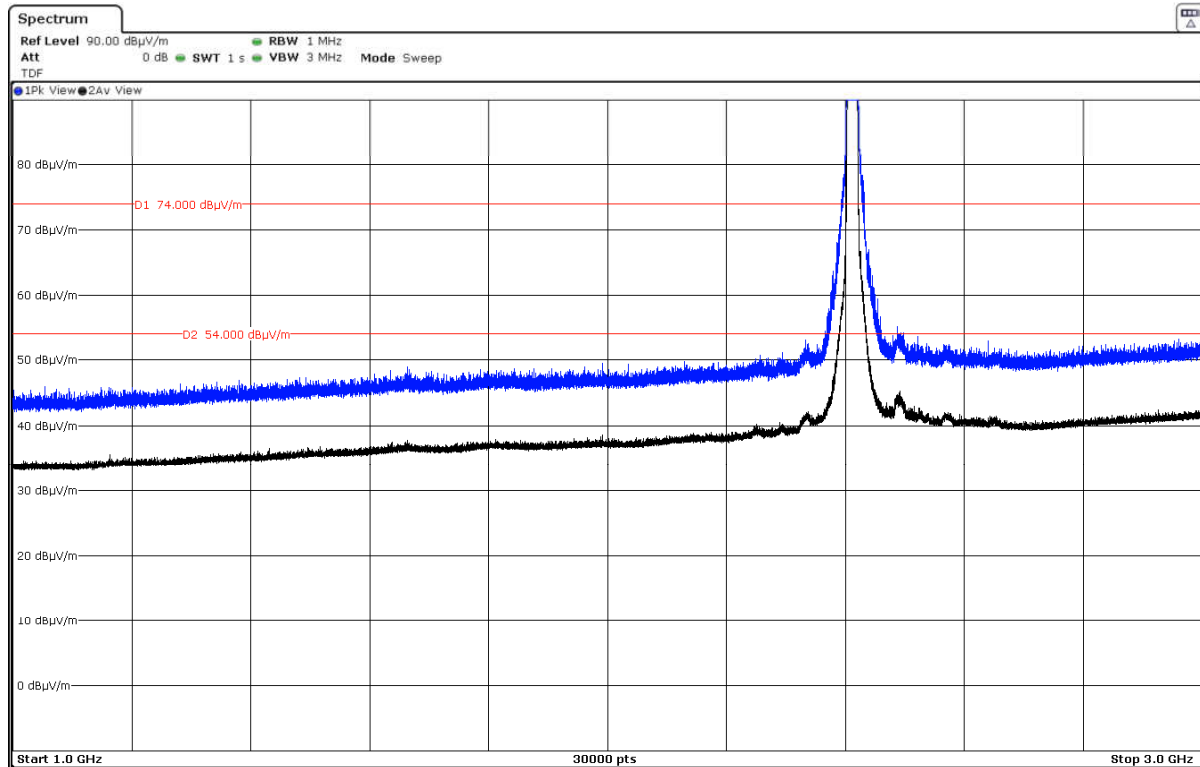
- High Channel. CH 11:



- **Mode 802.11 n20 (OFDM worst case for spurious emissions)**

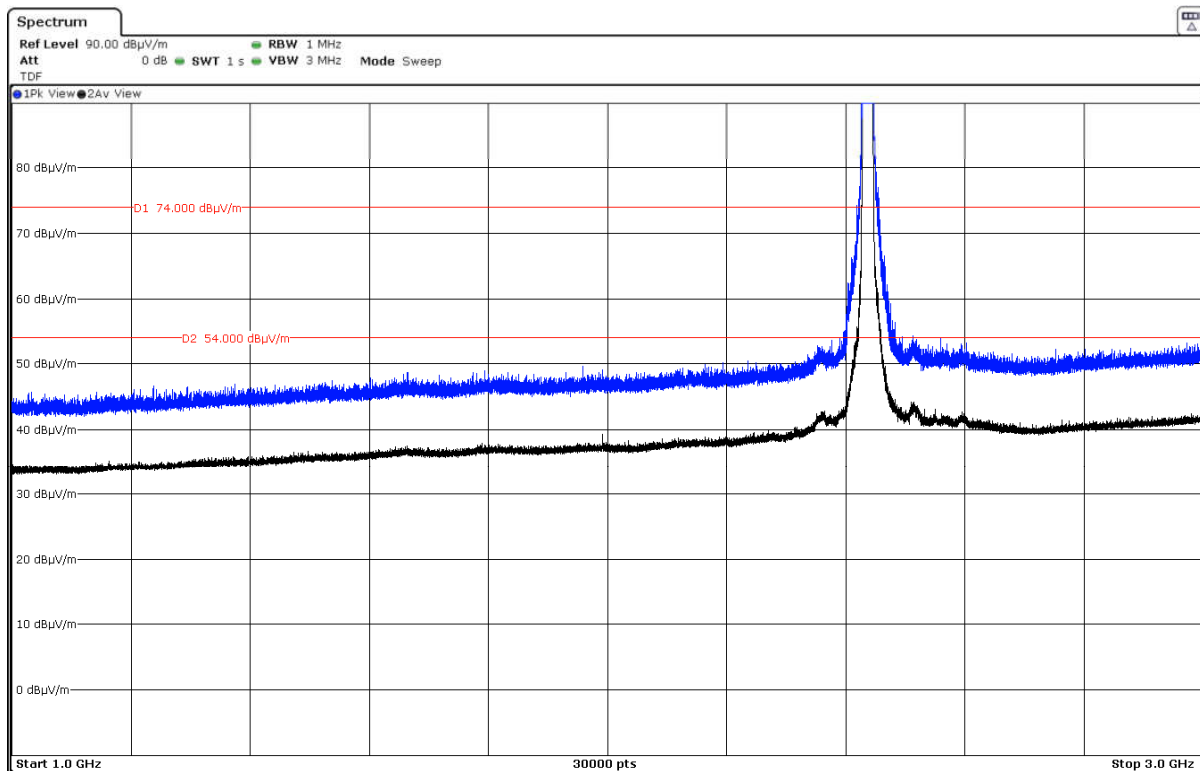
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



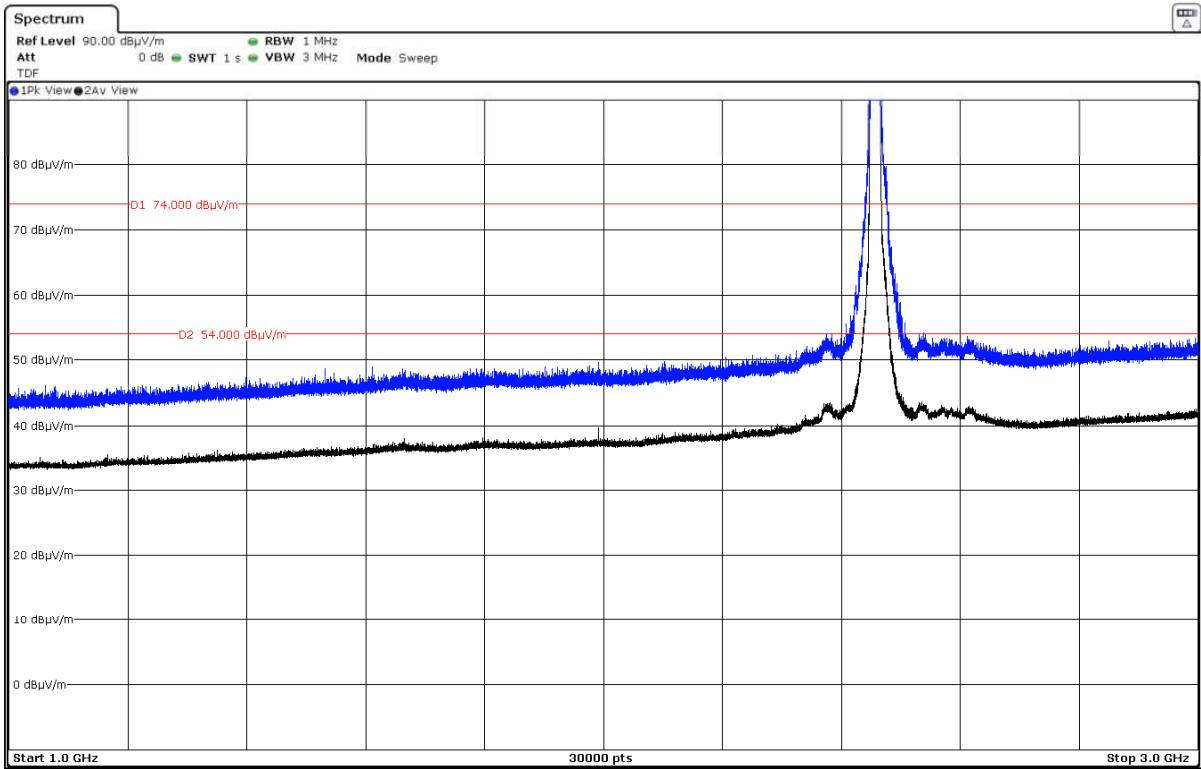
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

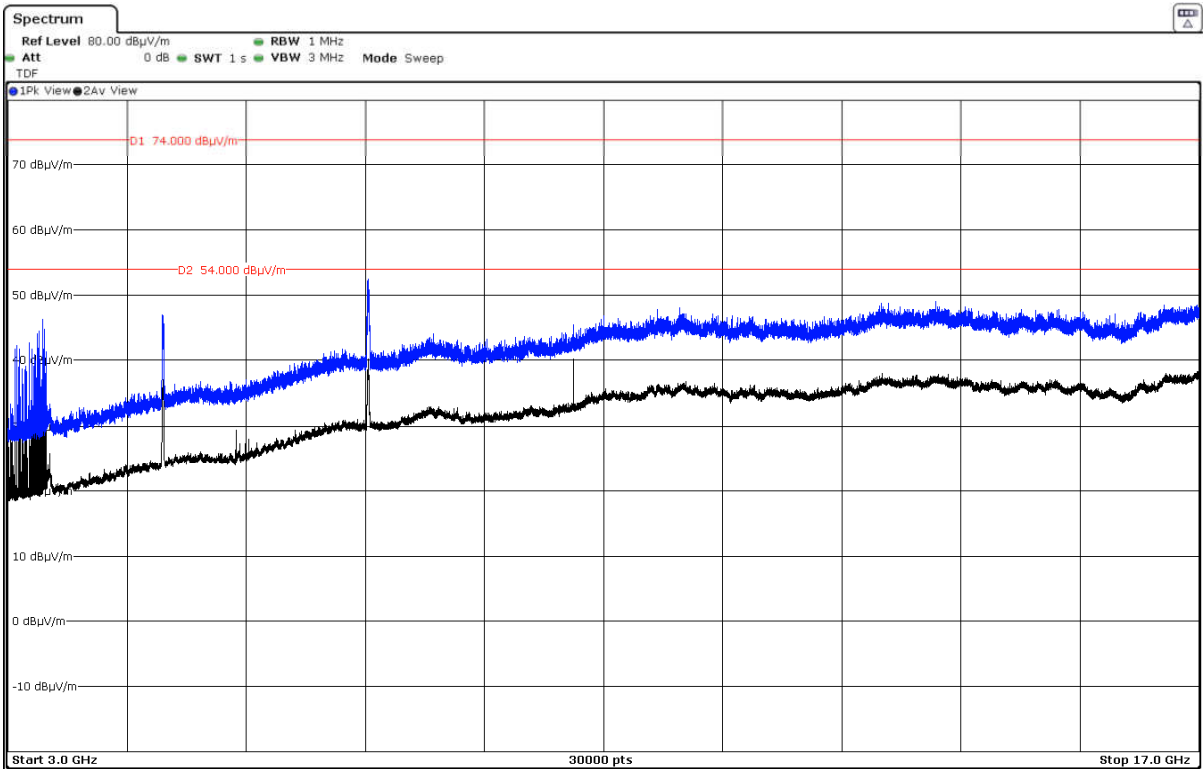
- High Channel:



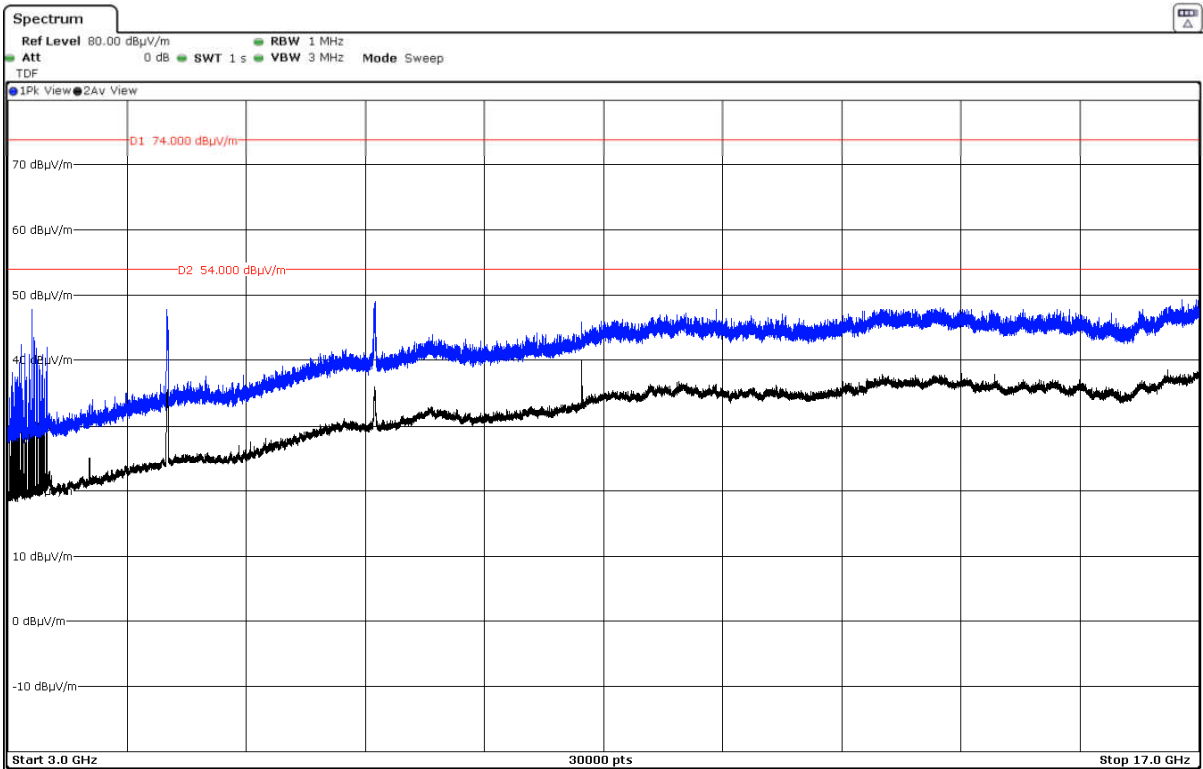
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

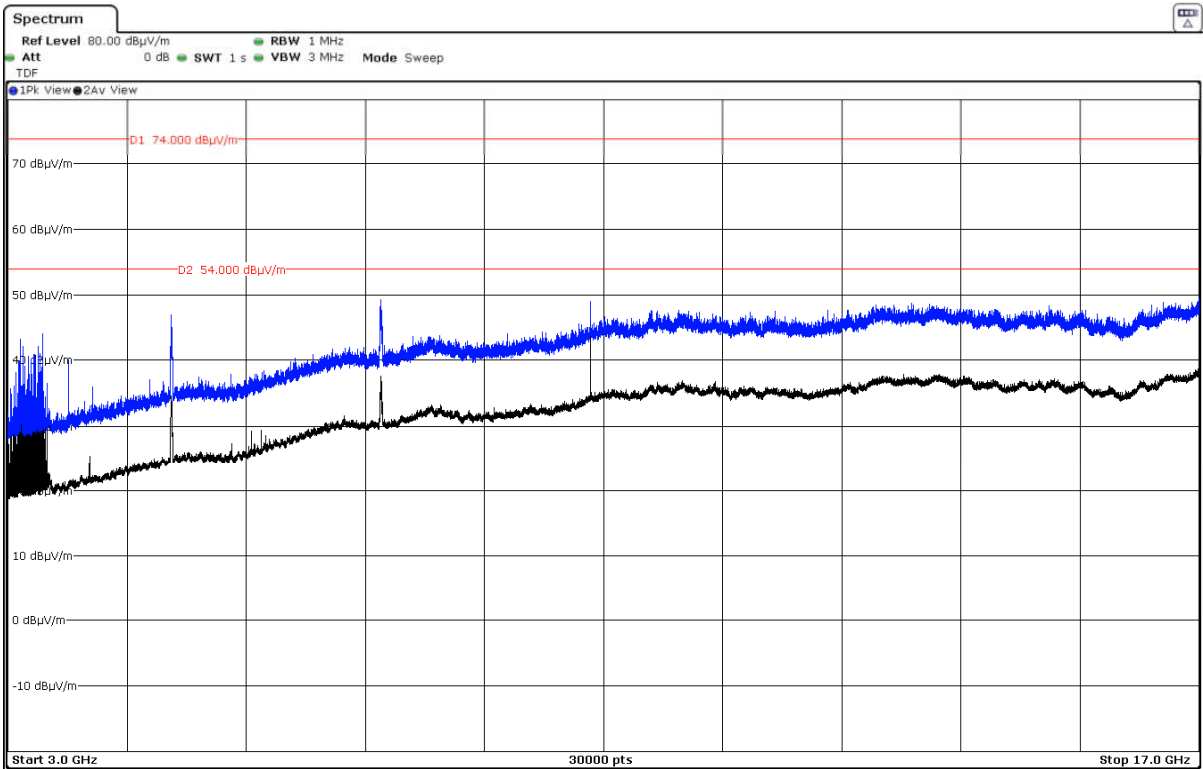
- Low Channel:



- Middle Channel:



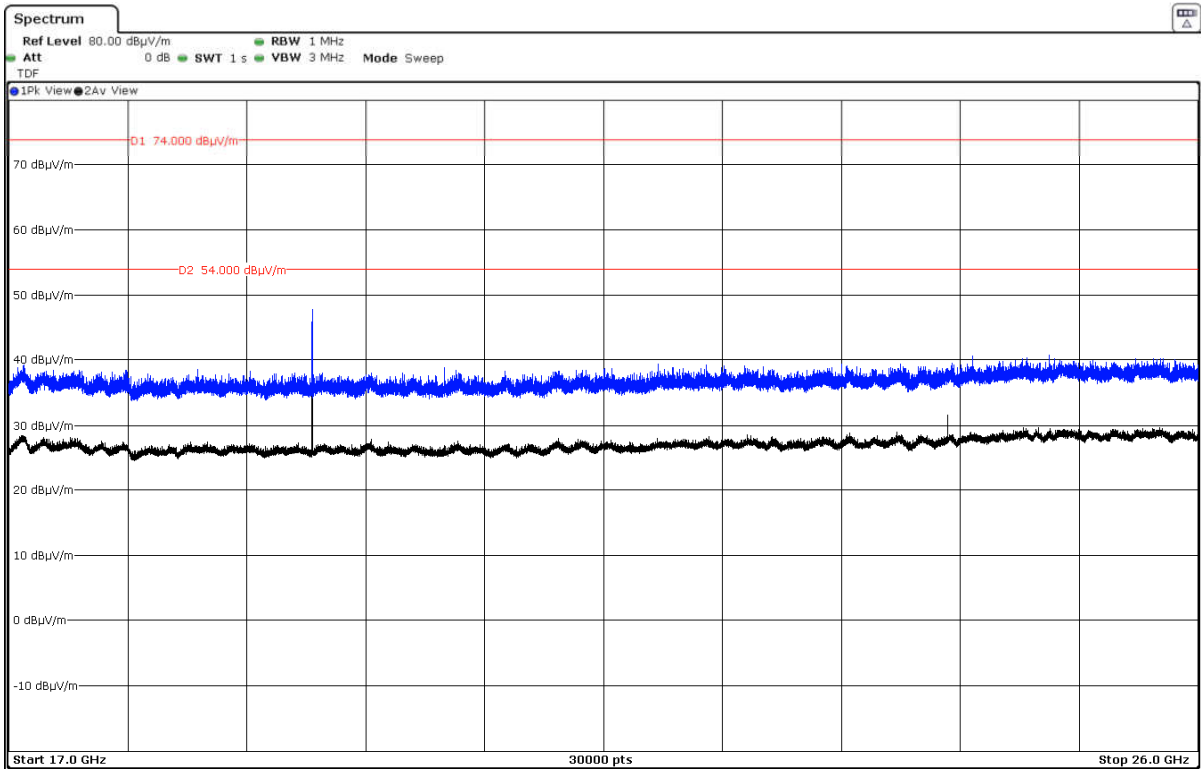
- High Channel:



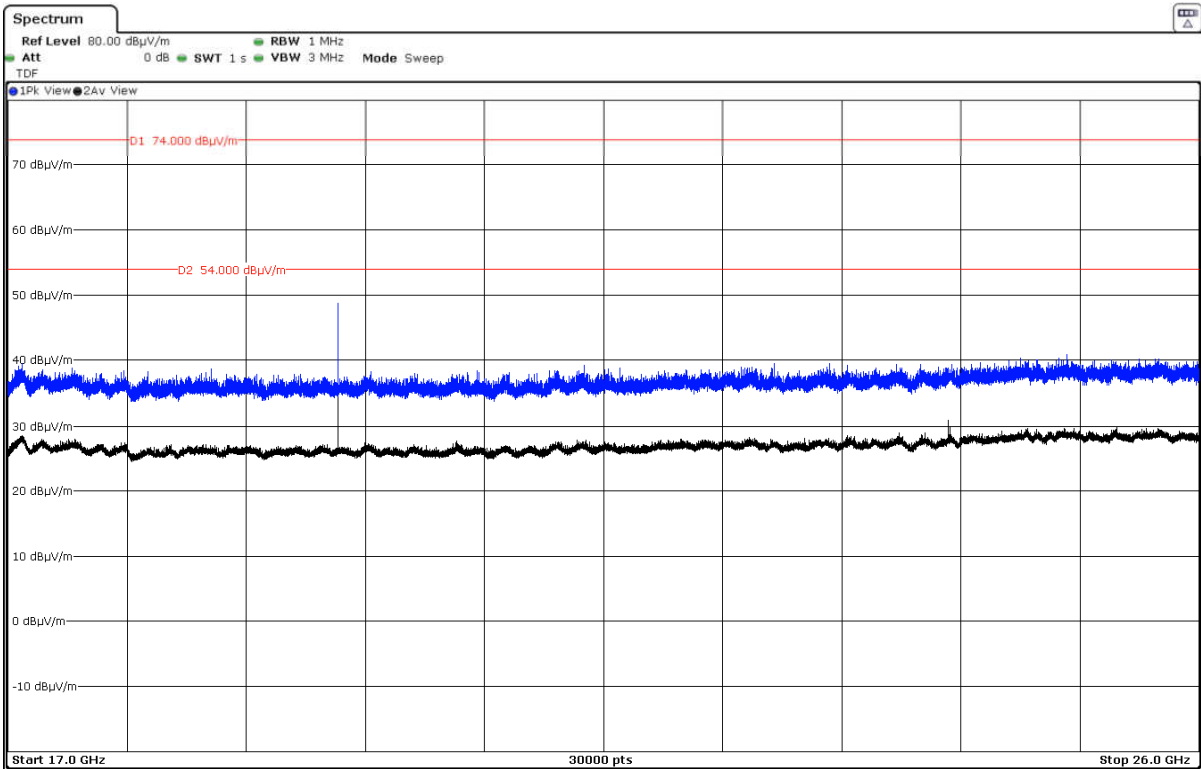
FREQUENCY RANGE 17 - 26 GHz:

The spurious frequencies detected do not depend neither on the operating channel nor the modulation mode.

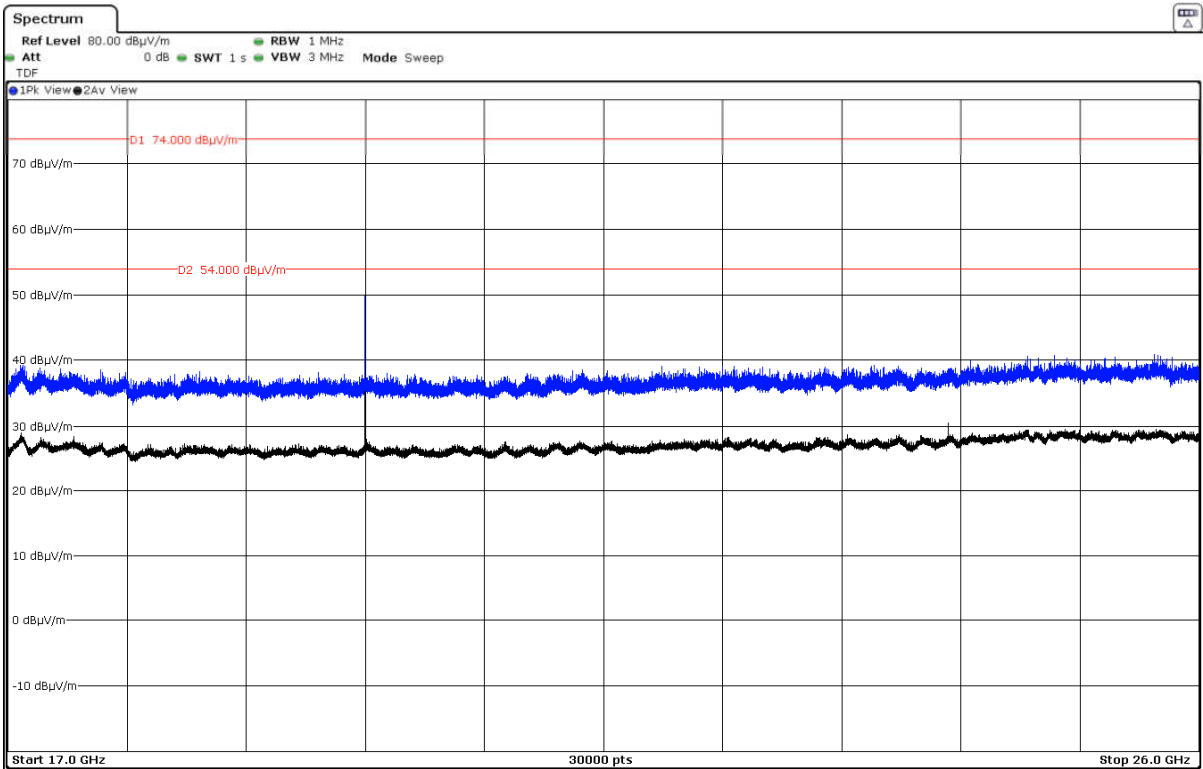
- Low Channel:



- Middle Channel:

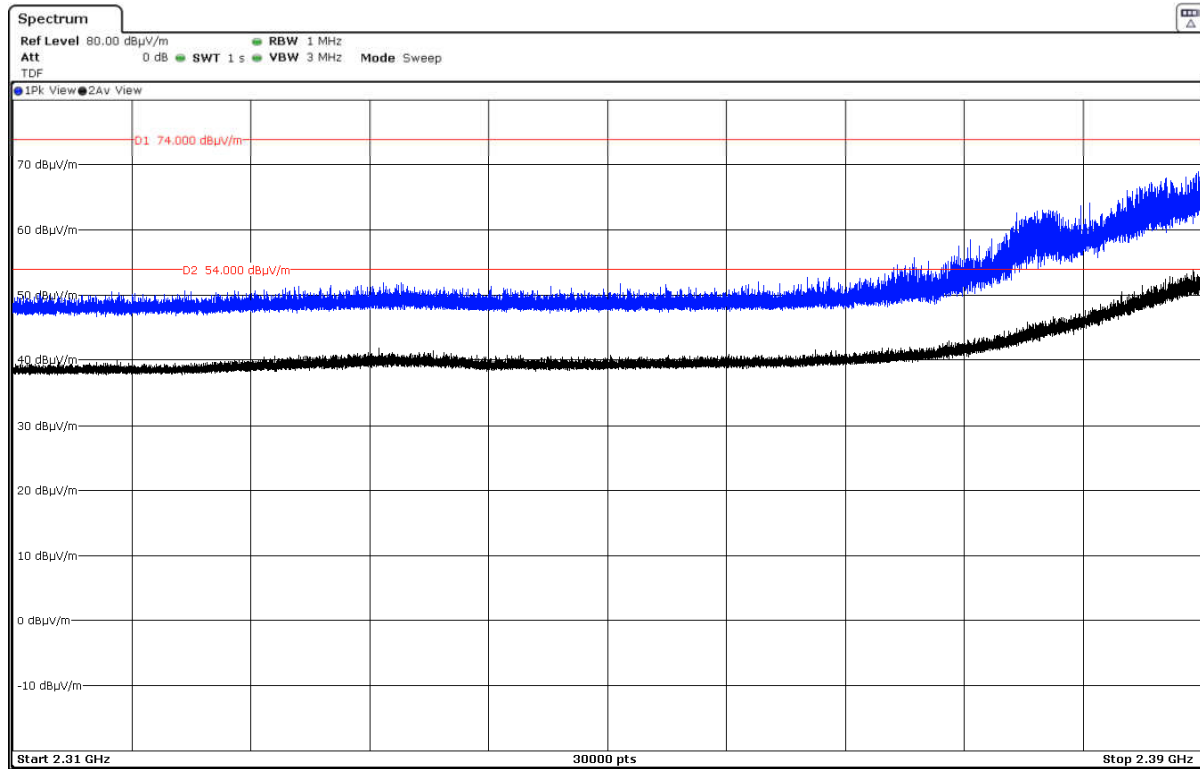


- High Channel:



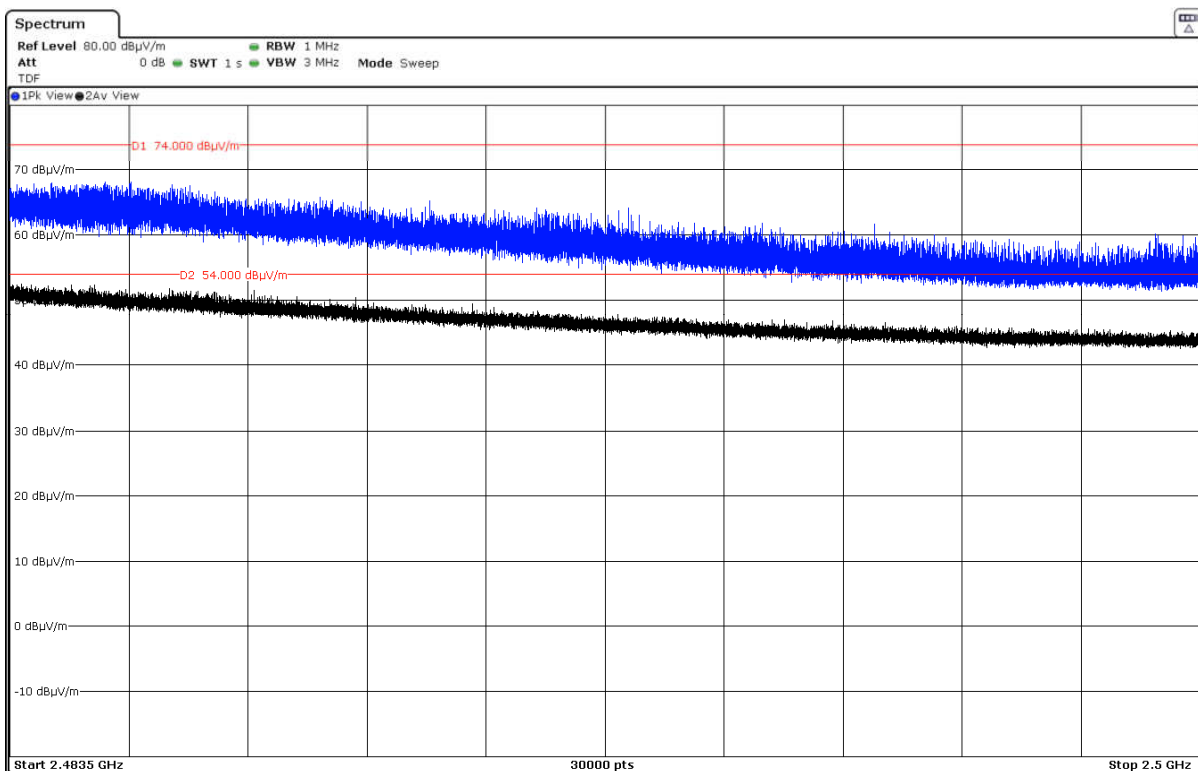
FREQUENCY RANGE 2.31-2.39 GHz (Restricted Band 1):

- Low Channel. CH 1:

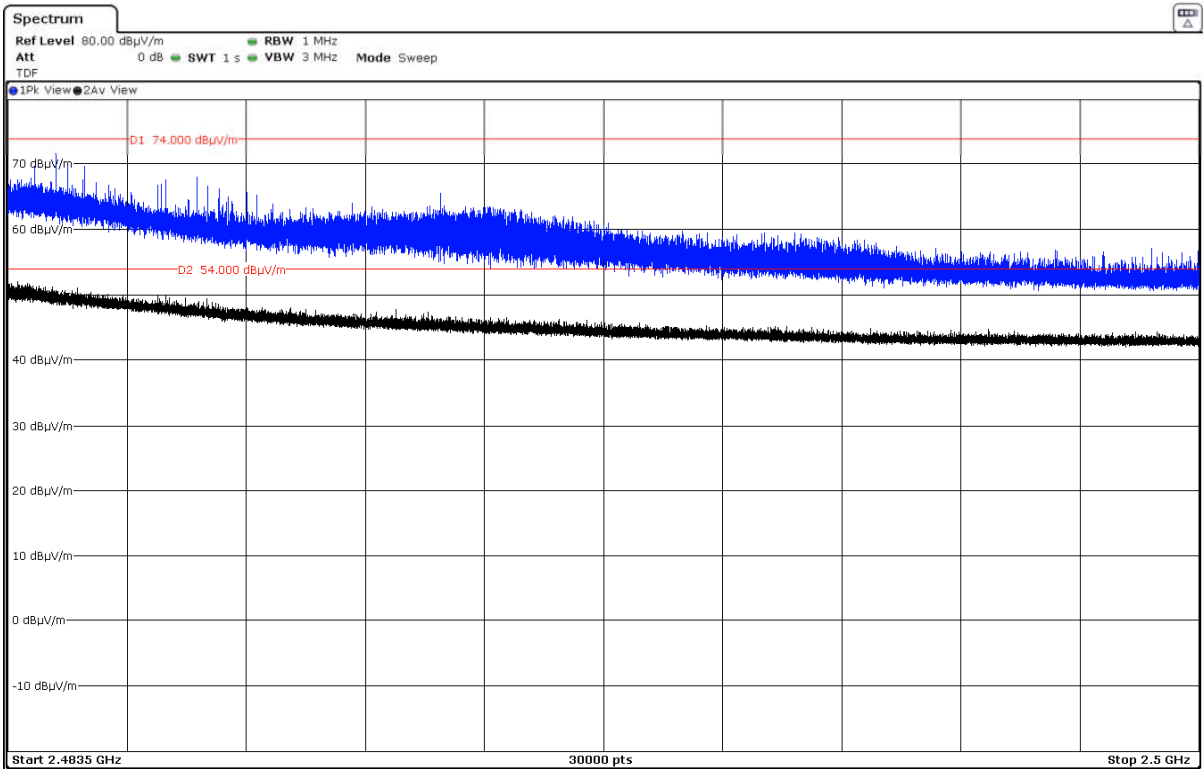


FREQUENCY RANGE 2.4835-2.5 GHz (Restricted Band 2):

- CH 10:



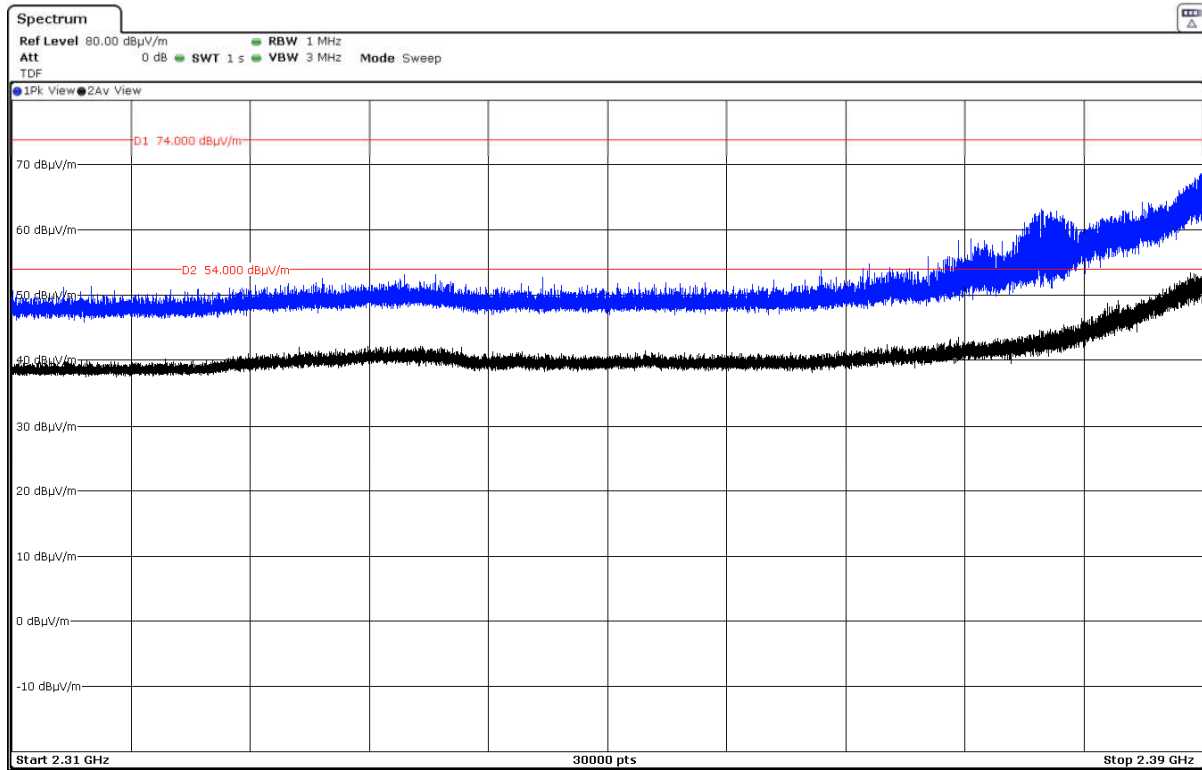
- High Channel. CH 11:



- **Mode 802.11 g**

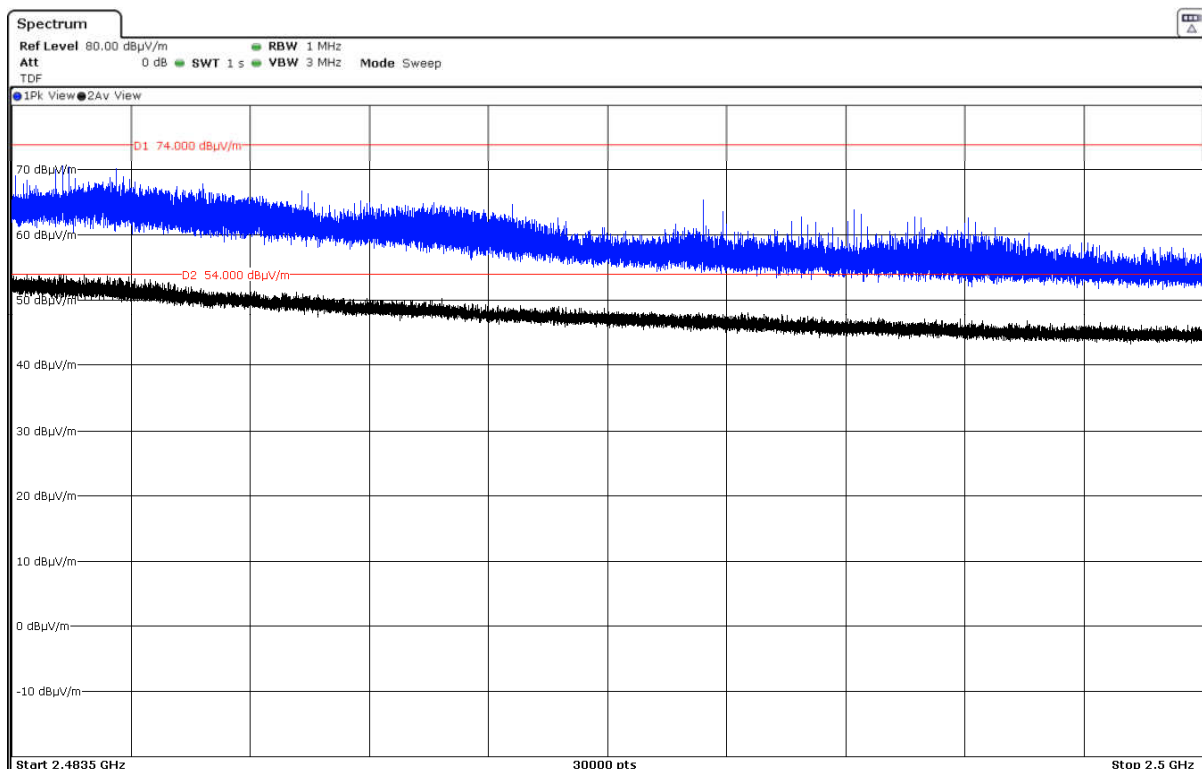
FREQUENCY RANGE 2.31-2.39 GHz (Restricted Band 1):

- Low Channel. CH 1:



FREQUENCY RANGE 2.4835-2.5 GHz (Restricted Band 2):

- CH 10:



- High Channel. CH 11:

