AT4 wireless, S.A.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
www.at4wireless.com · C.I.F. A29 507 456

FCC LISTED, REGISTRATION NUMBER: 720267

IC LISTED REGISTRATION NUMBER IC 4621A-1

Informe de ensayo nº:
Test report No:

NIE: 45061RRF.001

Test report

USA FCC Part 15.247, 15.209
CANADA RSS-210, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz.
Licence-Exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
General Requirements and Information for the Certification of Radio Apparatus.

Identificación del objeto ensayado.....: Identification of item tested	AM/FM Car radio with Bluetooth and WLAN
Marca .....: Trade	Delphi
Modelo y/o referencia tipo .....: Model and /or type reference	DEA600
Other identification of the product .....:	Commercial name: Delphi Radio AM/FM/BT FCC ID: L2C0057TR IC: 3432A-0057TR
Final HW version .....:	REV A
Final SW version .....:	1.7
Serial number.....:	241261692842928614288004 5 241261692842928614288005 6 241261692842928614288005 8 241261692842928614288005 9 241261792844682314251007 3
Características .....: Features	Bluetooth EDR, WiFi 802.11b/g/n20, audio Jack input .
Fabricante .....: Manufacturer	DELTRONICOS DE MATAMOROS Parque ind del norte , Matamoros Tamaulipas Mexico
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.247 10-1-13 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-14 Edition: Radiated emission limits; general requirements. CANADA RSS-210 Issue 8 (December 2010). CANADA RSS-Gen Issue 4 (November 2014). Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r02 dated 05/06/2014. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Resultado.....: Summary	IN COMPLIANCE

Aprobado por (nombre / cargo y firma) .....: Approved by (name / position & signature)	A. Llamas RF Lab. Manager  Firmado digitalmente por Alejandro Llamas Rodríguez Fecha: 2015.04.13 15:53:33 +02'00'
Fecha de realización .....: Date of issue	2015-04-13
Formato de informe No. .....: Report template No	FDT08_16

Index

Competences and guarantees

AT4 wireless is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjuction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

AT4 wireless is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: IC 4621A-1.

In order to assure the traceability to other national and international laboratories, AT4 wireless has a calibration and maintenance program for its measurement equipment.

AT4 wireless 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 AT4 wireless at the time of performance of the test.

AT4 wireless 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 AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the AT4 wireless internal document PODT000.

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
45061/005	Radio with integral antenna	DEA600	241261692842928614288005 8	2014-07-11

1. Sample S/01 has undergone following test(s).

   All radiated tests indicated in appendix A.

Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
45061/001	Radio with antenna connector	DEA600	241261692842928614288005 9	2015-01-08

1. Sample S/02 has undergone the test(s) specified in subclause “Test method requested”.
   All conducted tests indicated in appendix A.

Sample S/03 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
45061/004	Radio with integral antenna	DEA600	241261692842928614288005 6	2015-01-08

1. Sample S/03 has undergone the test(s) specified in subclause “Test method requested”.
   All radiated tests indicated in appendix B.

Sample S/04 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
45061/045	Radio with antenna connector	DEA600	241261692842928614288004 5	2015-02-23

1. Sample S/04 has undergone the test(s) specified in subclause “Test method requested”.
   All conducted tests indicated in appendix B.

Auxiliary elements used with samples S/01, S/02, S/03 and S/04:

Control Nº	Description	Model	Serial Nº	Date of reception
45061/007	Auto radio	DEA610	241261792844682314251007 3	2015-01-08
45061/013	Connection box	---	---	2015-01-08
45061/021	USB cable	---	---	2015-01-08
45061/026	DB15 cable	---	---	2015-01-08
45061/031	Connection cable	---	---	2015-01-08
45061/038	Interface board	---	---	2015-01-08

Test sample description

The test sample consists of an AM/FM Car radio with Bluetooth and WLAN.

Identification of the client

DELPHI ELECTRONICS & SAFETY

2151 E. Lincoln RD. – Kokomo Indiana 46901 USA

Testing period

The performed test started on 2015-02-02 and finished on 2015-03-02.

The tests have been performed at AT4 wireless.

Environmental conditions

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

Temperature	Min. = 22.65 ºC Max. = 24.03 ºC
Relative humidity	Min. = 24.81 % Max. = 32.81 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

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

Temperature	Min. = 20.98 ºC Max. = 22.72 ºC
Relative humidity	Min. = 35.43 % Max. = 38.26 %
Air pressure	Min. = 1003 mbar Max. = 1018 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

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

Temperature	Min. = 21.42 ºC Max. = 27.65 ºC
Relative humidity	Min. = 33.21 % Max. = 34.96 %
Air pressure	Min. = 1003 mbar Max. = 1018 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

Remarks and comments

1: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Agilent PSA E4440A	2014/05	2016/05
2.	DC power supply R&S NGPE 40/40	2014/11	2017/11

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	BiconicalLog antenna ETS LINDGREN 3142E	2014/03	2017/03
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2013/11	2016/11
5.	Double-ridge Guide Horn antenna 15-40 GHz SCHWARZBECK BBHA 9170	2013/11	2016/11
6.	EMI Test Receiver R&S ESU 26	2013/08	2015/08
7.	Spectrum analyser Rohde & Schwarz FSW50	2013/10	2015/10
8.	RF pre-amplifier 9 kHz - 3 GHz SCHAFFNER CPA9231A	2013/06	2015/06
9.	RF pre-amplifier 1-18 GHz Schwarzbeck BBV 9718	2015/02	2016/02
10.	RF pre-amplifier Miteq AFS5-04001300-15-10P-6.	2014/05	2016/05
11.	RF pre-amplifier Miteq JS4-12002600-30-5A.	2014/05	2016/05
12.	RF pre-amplifier BONN BLMA 1840-1M 18-40 GHz.	2014/02	2016/02

Testing verdicts

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

1. Bluetooth EDR

FCC PART 15 PARAGRAPH / RSS-210		VERDICT			
		NA	P	F	NM
FCC 15.247 Subclause (a) (1) / RSS-210 Clause A8.1 (b)	20 dB Bandwidth and Carrier frequency separation		P		
FCC 15.247 Subclause (a)(1)(iii) / RSS-210 Clause A8.1 (d)	Number of hopping channels		P		
FCC 15.247 Subclause (a)(1)(iii) / RSS-210 Clause A8.1 (d)	Time of occupancy (Dwell Time)		P		
FCC 15.247 Subclause (b) / RSS-210, Clause A8.4 (2)	Maximum peak output power and antenna gain		P		
FCC 15.247 Subclause (d) / RSS-210 Clause A8.5	Emission limitations conducted (Transmitter)		P		
FCC 15.247 Subclause (d) / RSS-210 Clause A8.5	Emission limitations radiated (Transmitter)		P		

2. WiFi 2.4 GHz (802.11b/g/n20)

FCC PART 15 PARAGRAPH / RSS-210		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a)	6 dB Bandwidth		P		
Section 15.247 Subclause (b) / RSS-210 A8.4. (4)	Maximum output power and antenna gain		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations conducted (Transmitter)		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Band-edge emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e) / RSS-210 A8.2. (b)	Power spectral density		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations radiated (Transmitter)		P		

Appendix A – Test result "Bluetooth EDR"

INDEX

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 14 Vdc

Type of power supply = DC voltage from external power source.

Type of antenna = Integral antenna

Declared Gain for antenna (maximum) = -3.5 dBi

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyzer using a low loss RF cable. The reading in 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 is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 GHz-25 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 (wooden) platform one meter 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 was varied from 1 to 4 meters to find the maximum radiated emission.

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

FCC Section 15.247 Subclause (a) (1) / RSS-210 Clause A8.1 (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

(See next plots)

Modulation: GFSK

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	953.490	954.324	1010
Measurement uncertainty (kHz)	±11		

Modulation: Π/4-DQPSK (2Mbps)

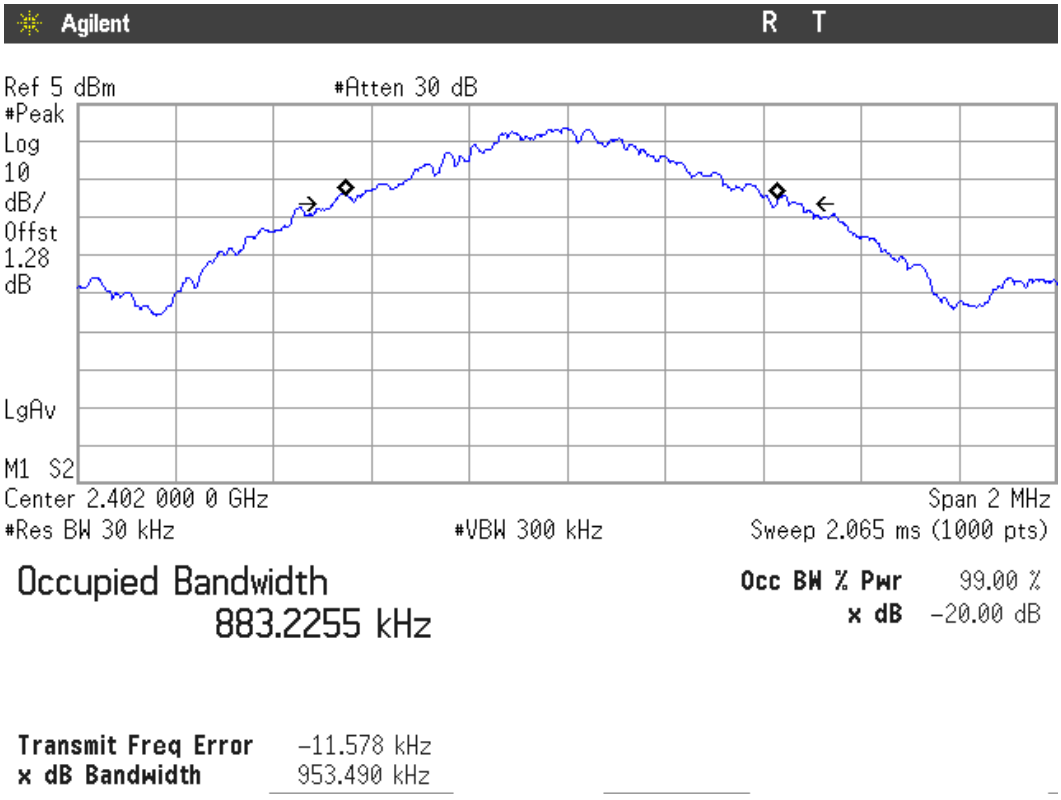
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1292	1315	1313
Measurement uncertainty (kHz)	±11		

Modulation: 8-DPSK (3Mbps)

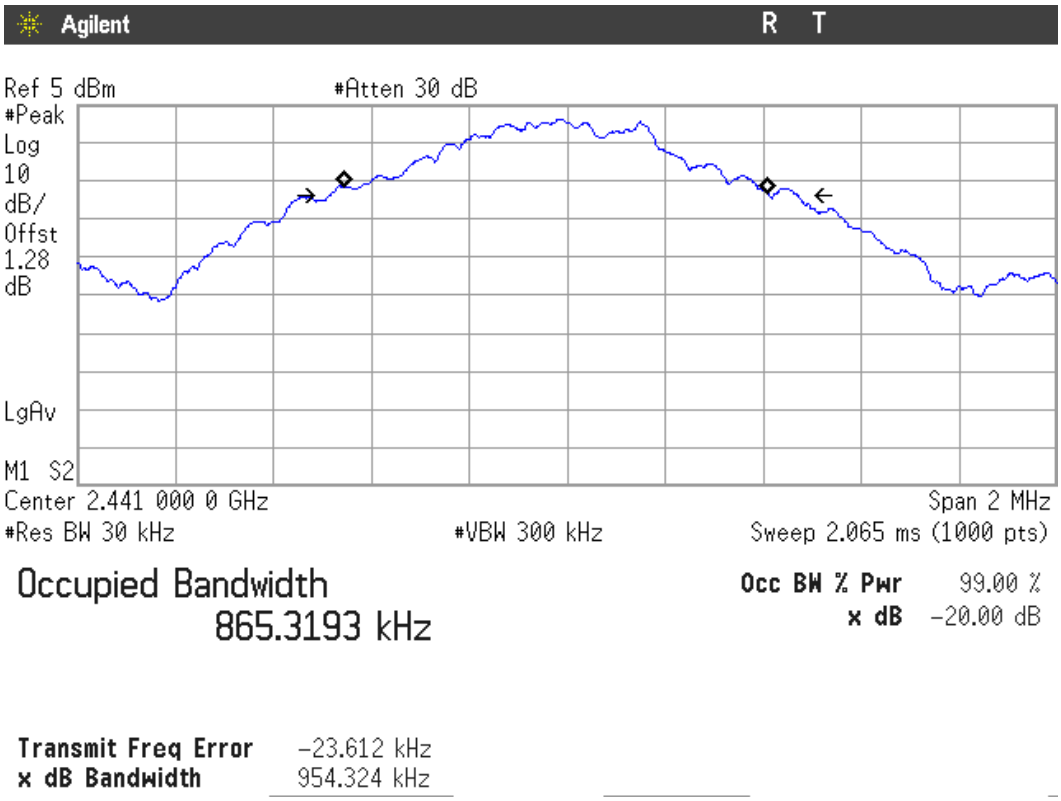
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	1307	1314	1310
Measurement uncertainty (kHz)	±11		

Modulation: GFSK

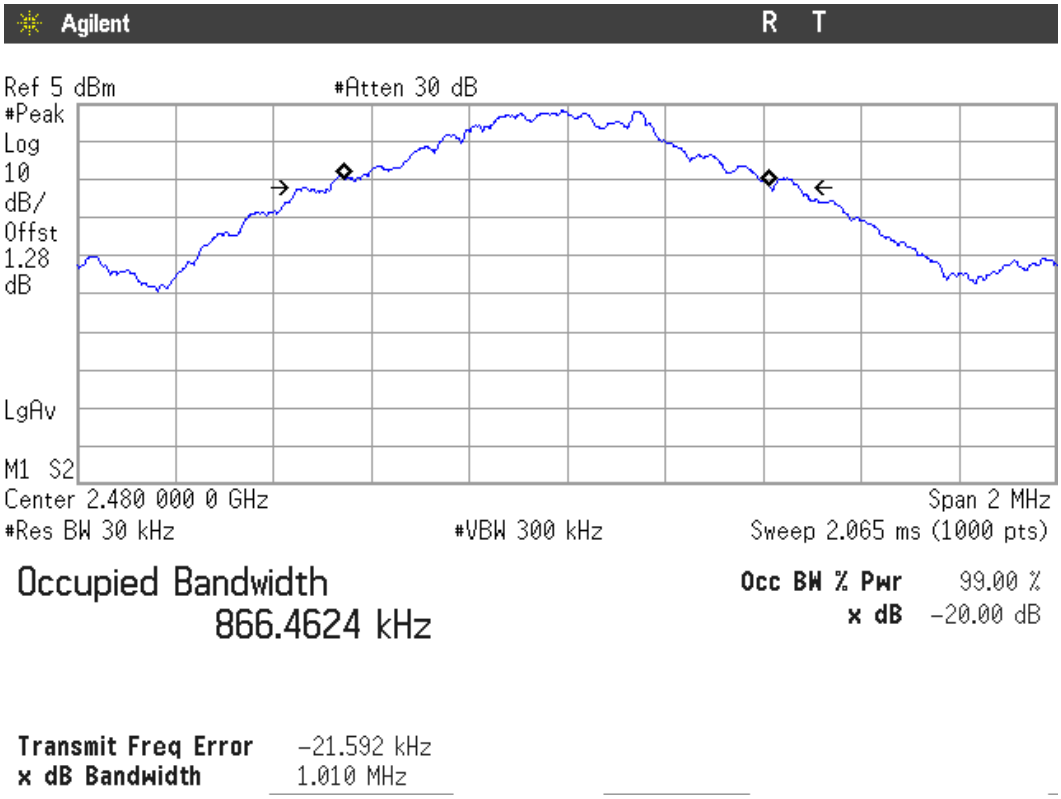
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



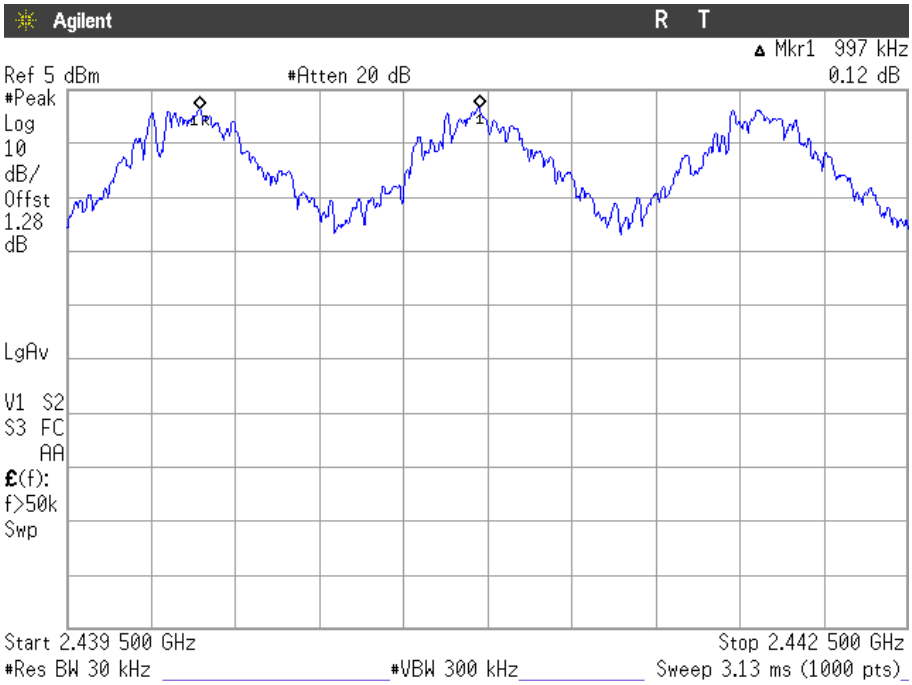
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

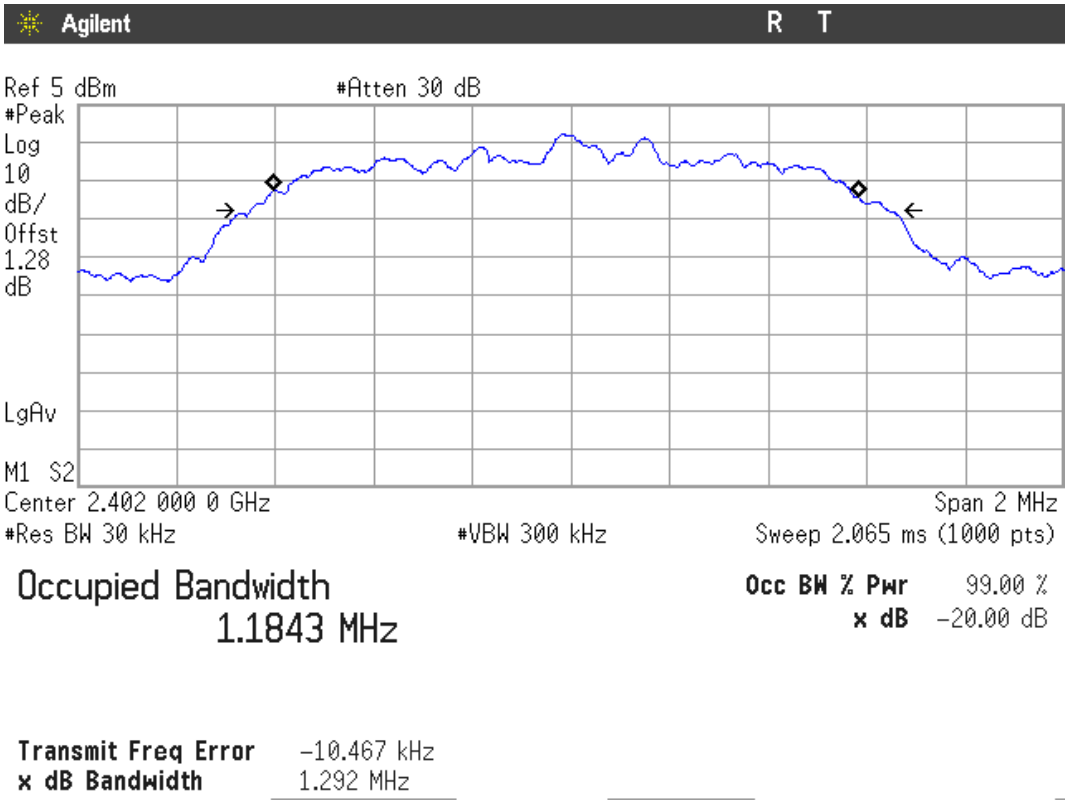


The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

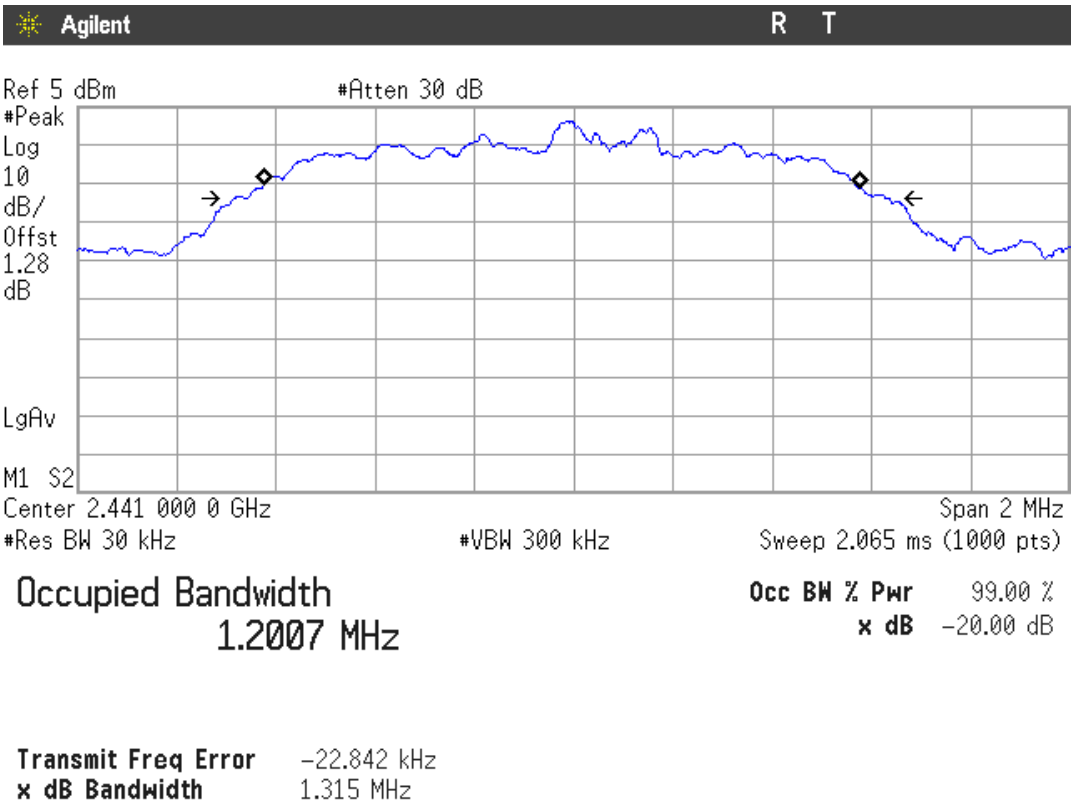
Verdict: PASS

Modulation: Π/4-DQPSK

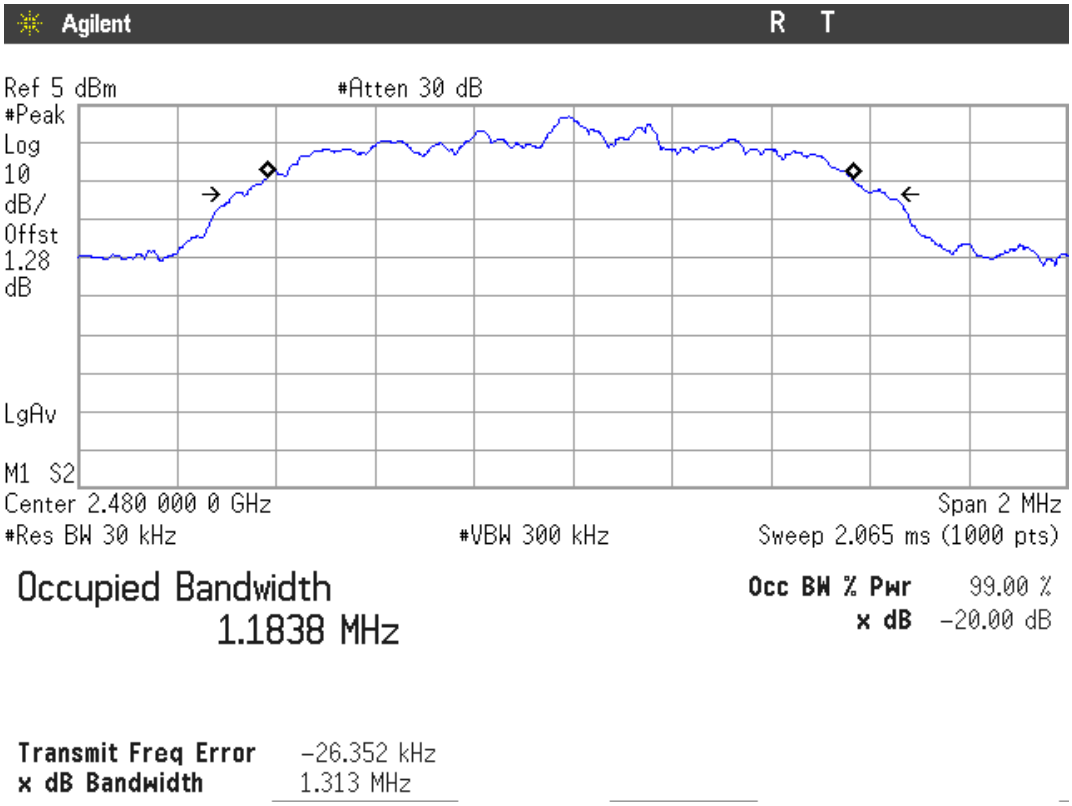
20 dB BANDWIDTH. Lowest Channel: 2402 MHz.



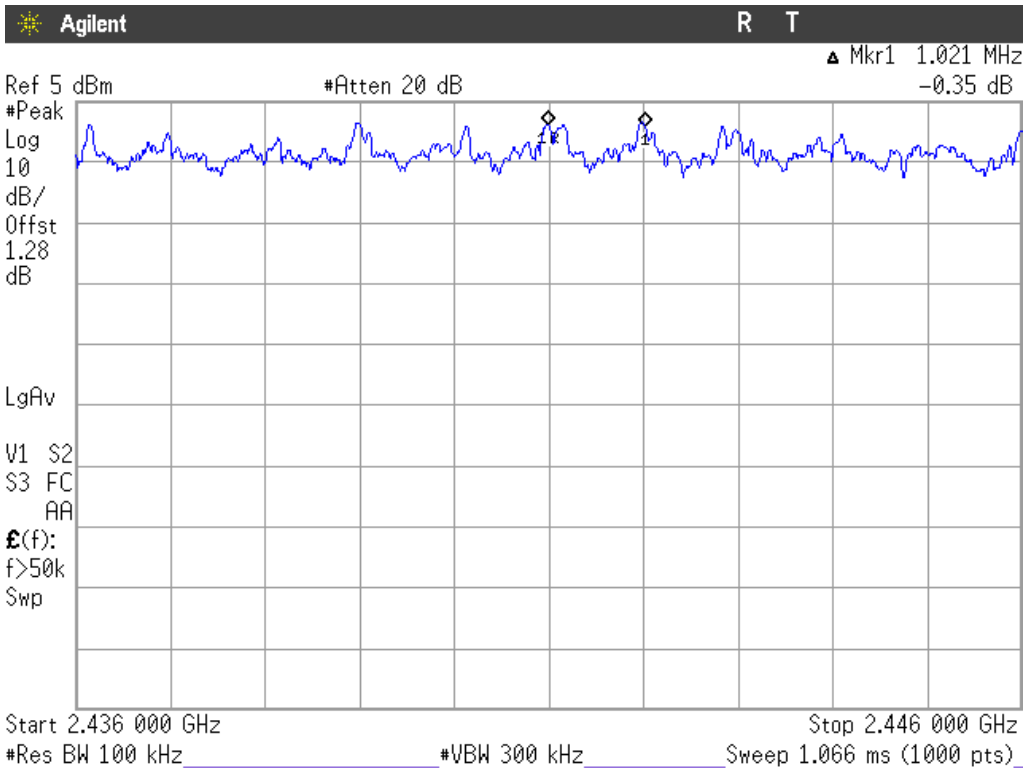
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation

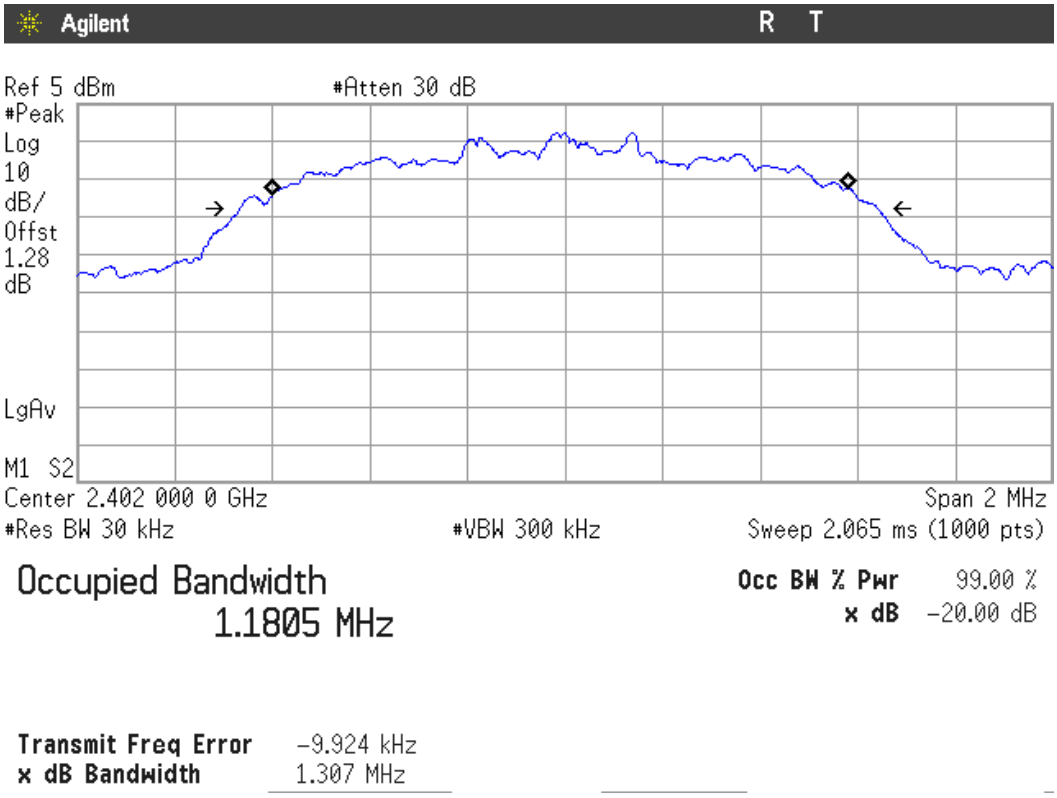


The hopping channel carrier frequencies are separated by a minimum of the two-thirds of the 20 dB bandwidth of the hopping channel

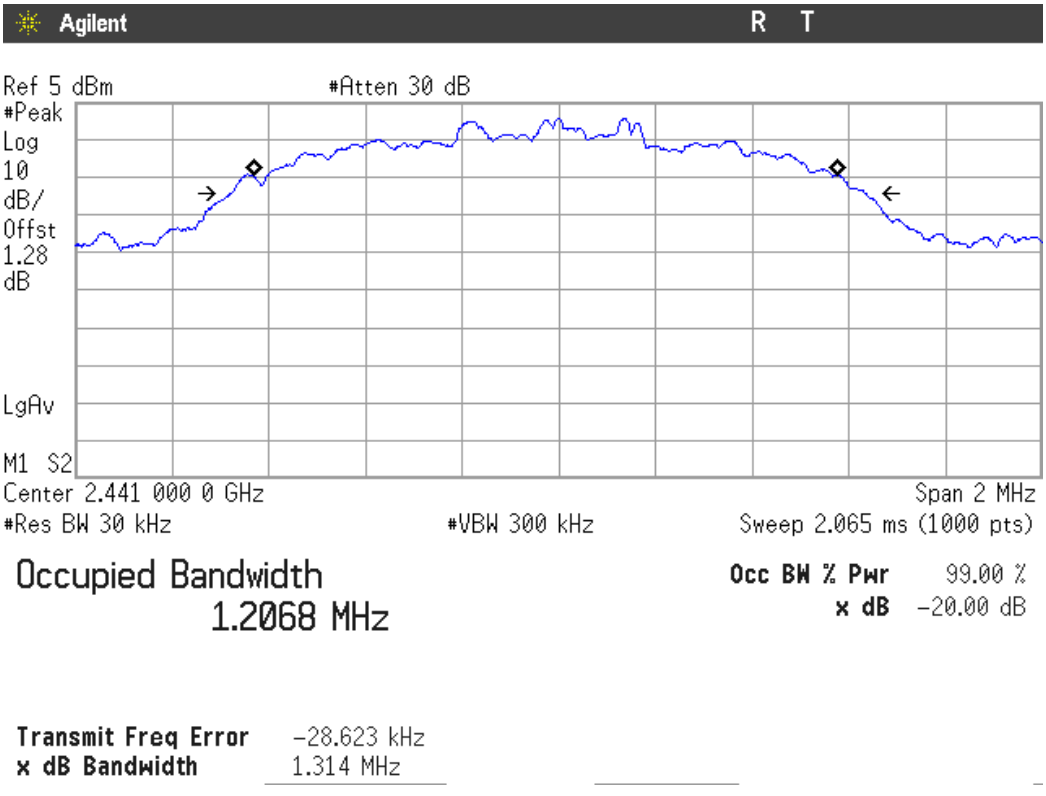
Verdict: PASS

Modulation: 8-DPSK

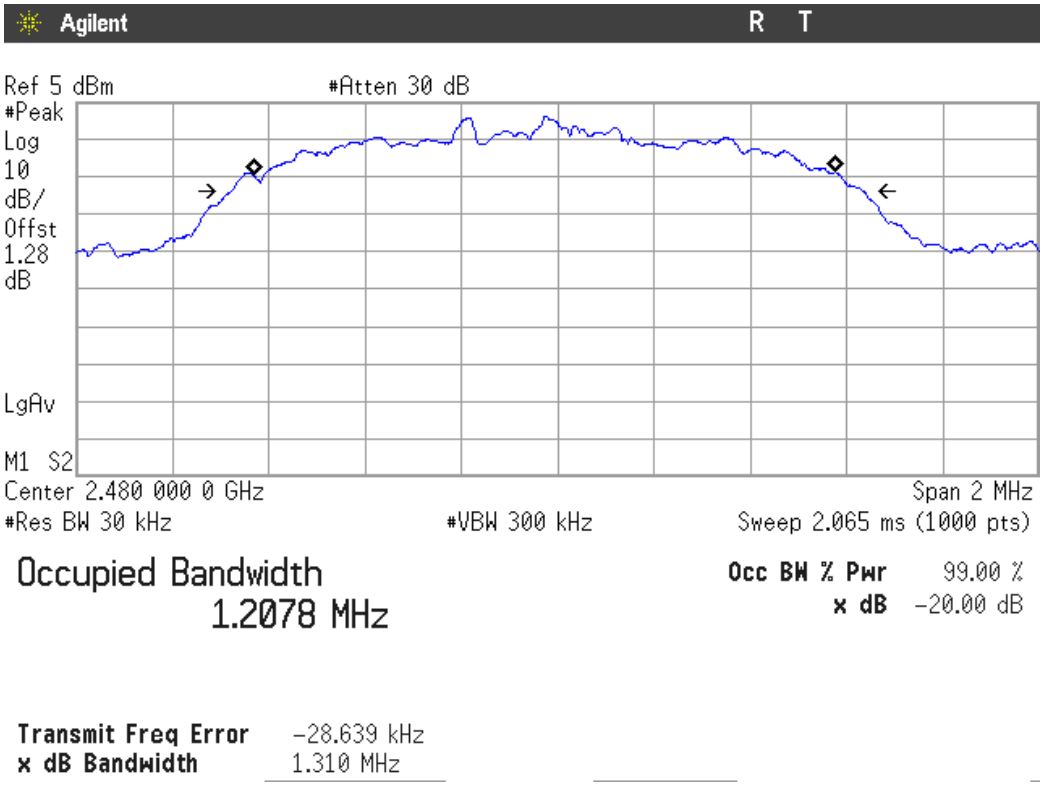
20 dB BANDWIDTH Lowest Channel: 2402 MHz.



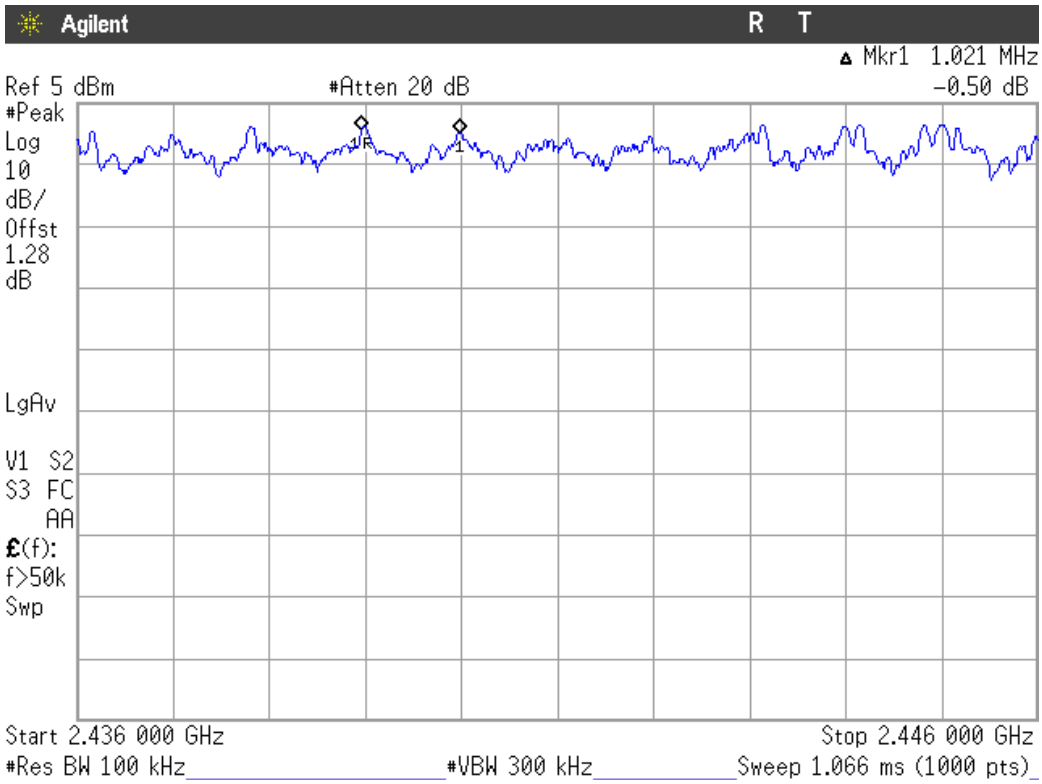
20 dB BANDWIDTH Middle Channel: 2441 MHz.



20 dB BANDWIDTH Highest Channel: 2480 MHz.



Carrier frequency separation



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

Verdict: PASS

FCC Section 15.247 Subclause (a) (1) (iii) / RSS-210 Clause A8.1 (d). Number of hopping channels

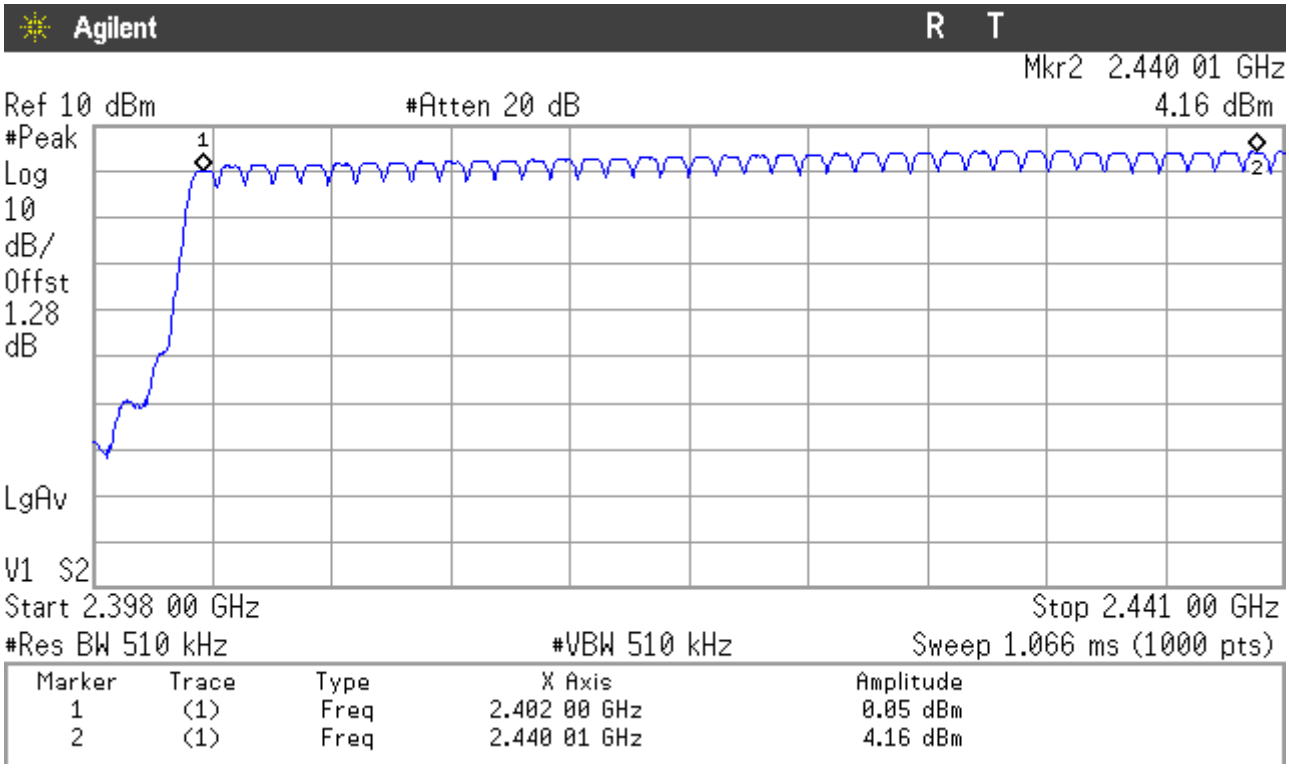
SPECIFICATION

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

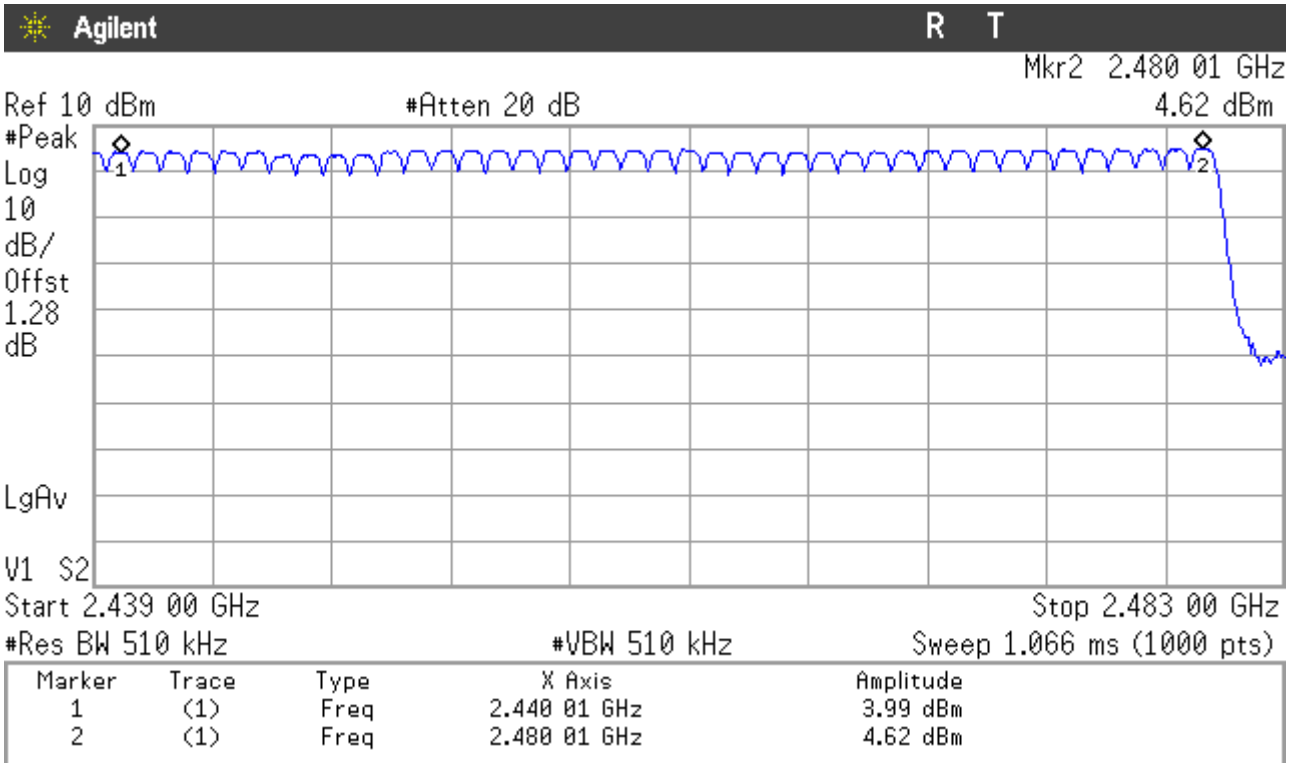
RESULTS

The number of hopping channels is 79 for all three modes (see next plots).

Modulation: GFSK



Number of hopping frequencies: 39

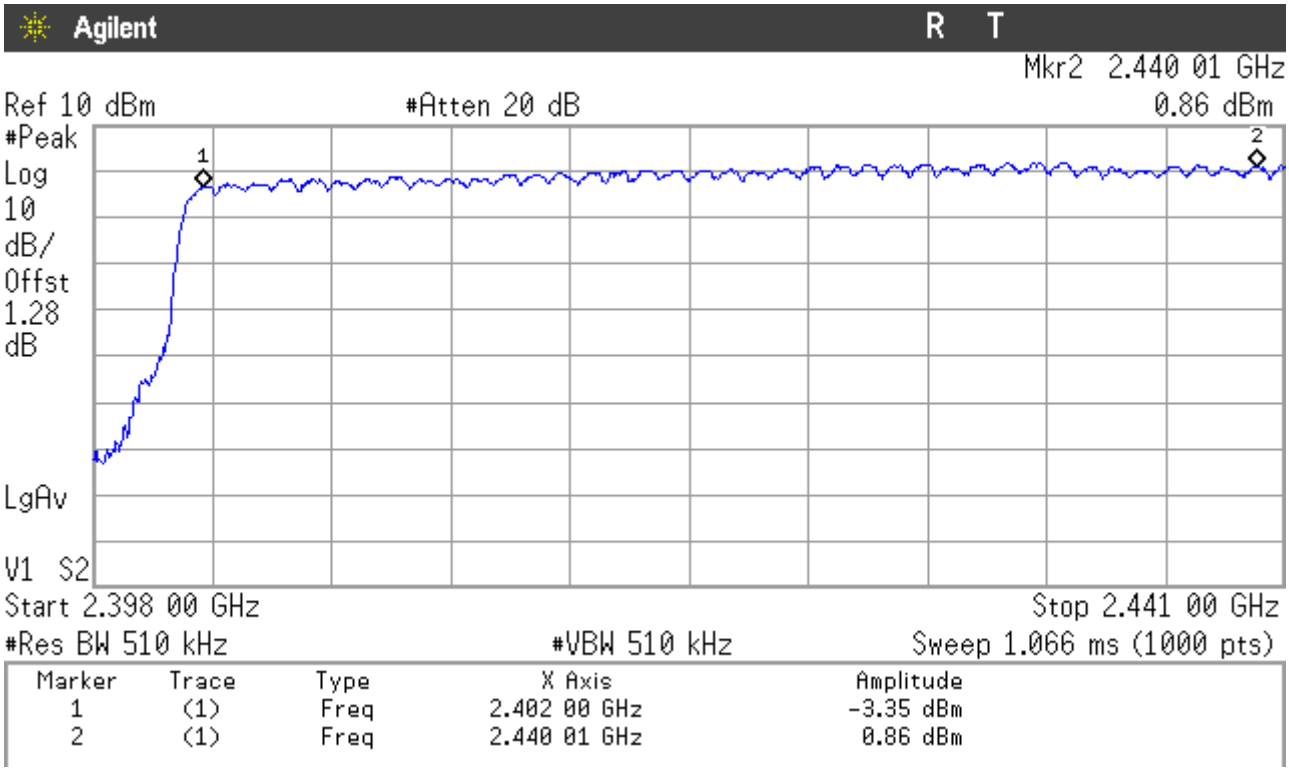


Number of hopping frequencies: 40

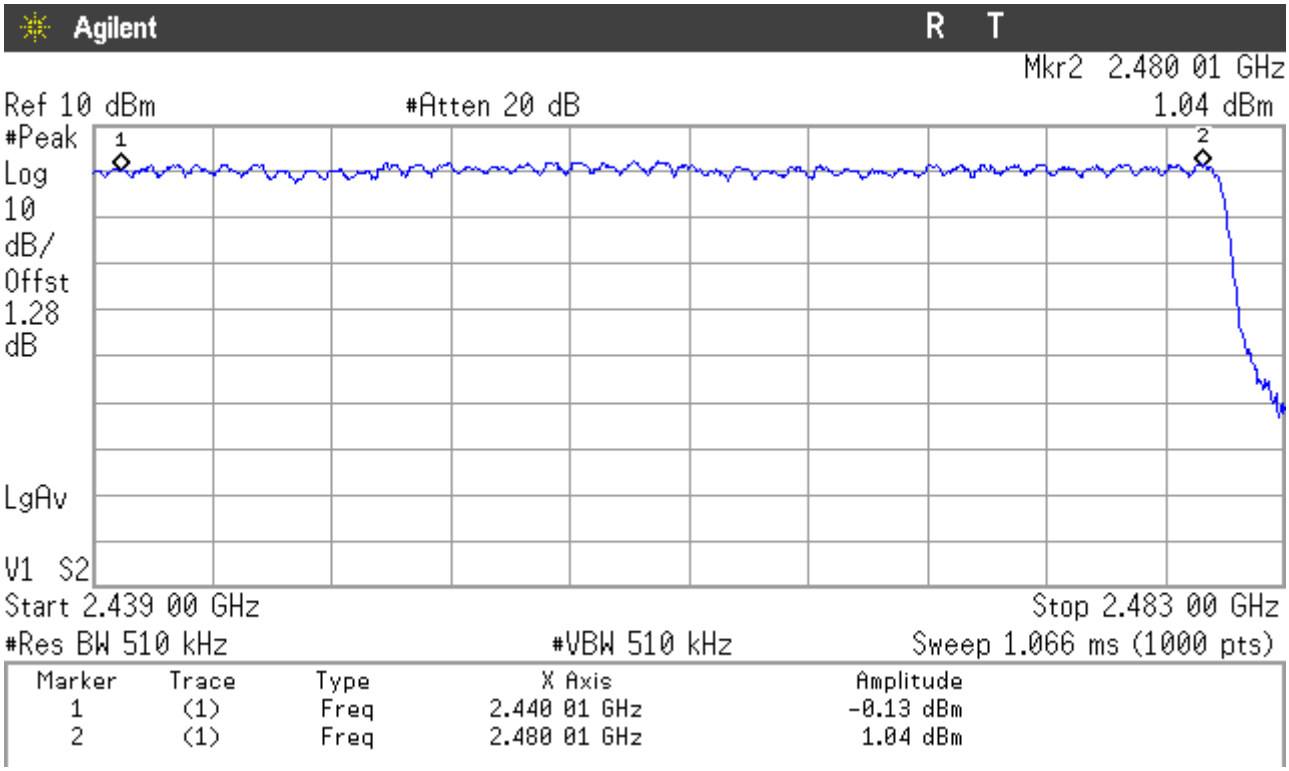
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: II/4-DQPSK



Number of hopping frequencies: 39

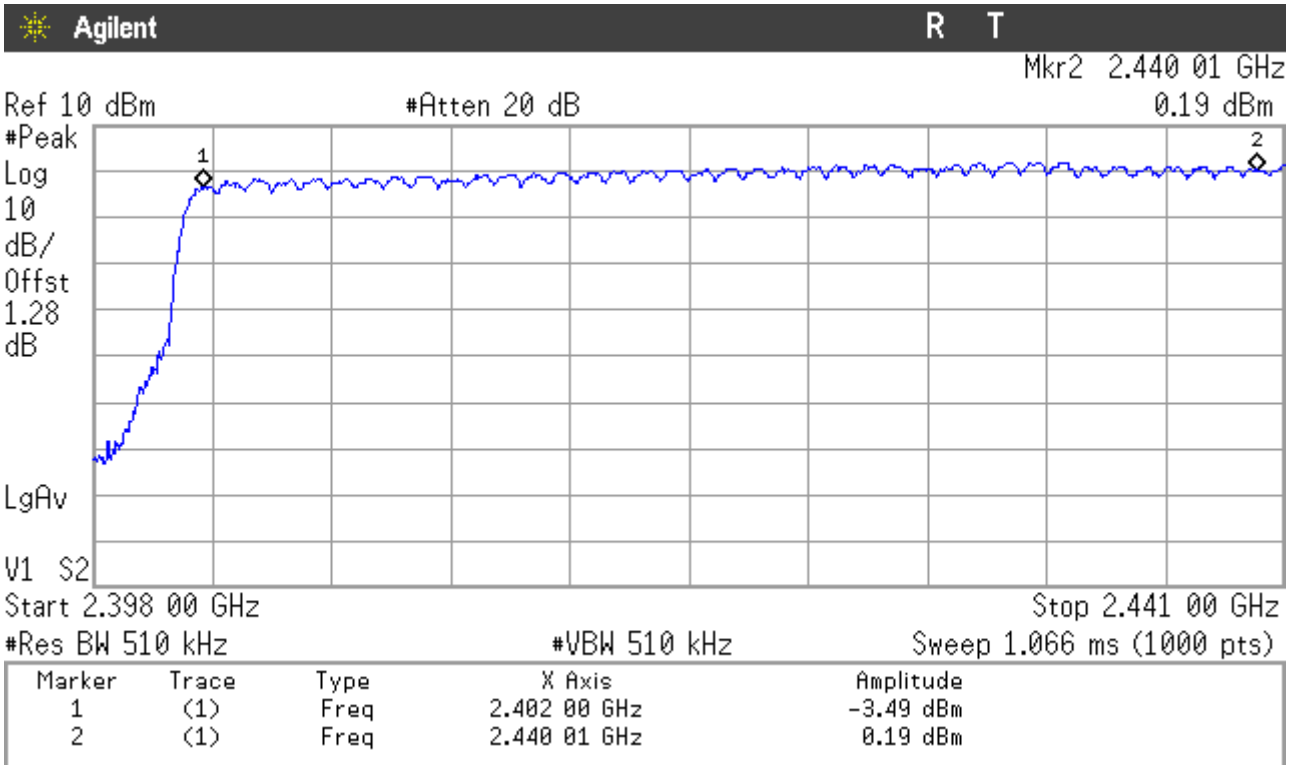


Number of hopping frequencies: 40

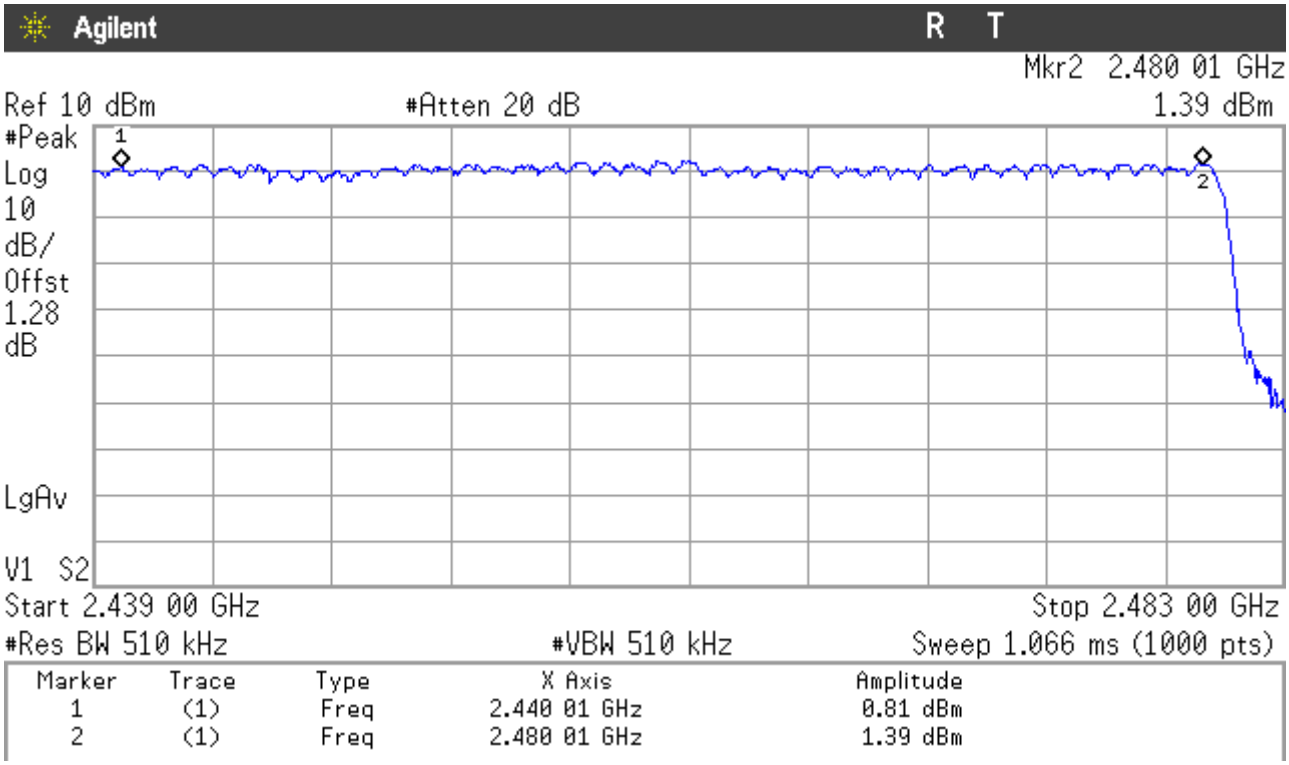
Total number of hopping frequencies: 79

Verdict: PASS

Modulation: 8-DPSK



Number of hopping frequencies: 39



Number of hopping frequencies: 40

Total number of hopping frequencies: 79

Verdict: PASS

FCC Section 15.247 Subclause (a) (1) (iii) / RSS-210 Clause A8.1 (d). Time of occupancy (Dwell Time)

SPECIFICATION

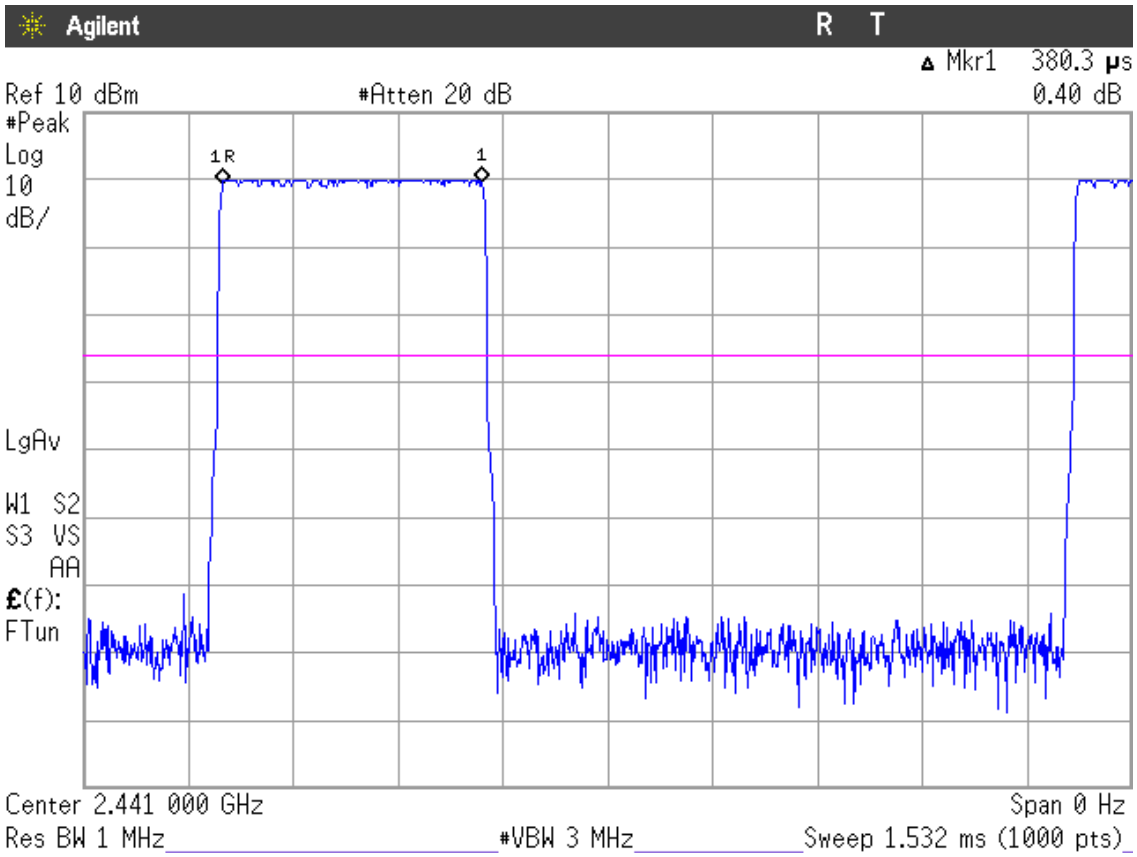
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = 0.4 x 79= 31.6 seconds.

RESULTS

Modulation: GFSK

1. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH1.

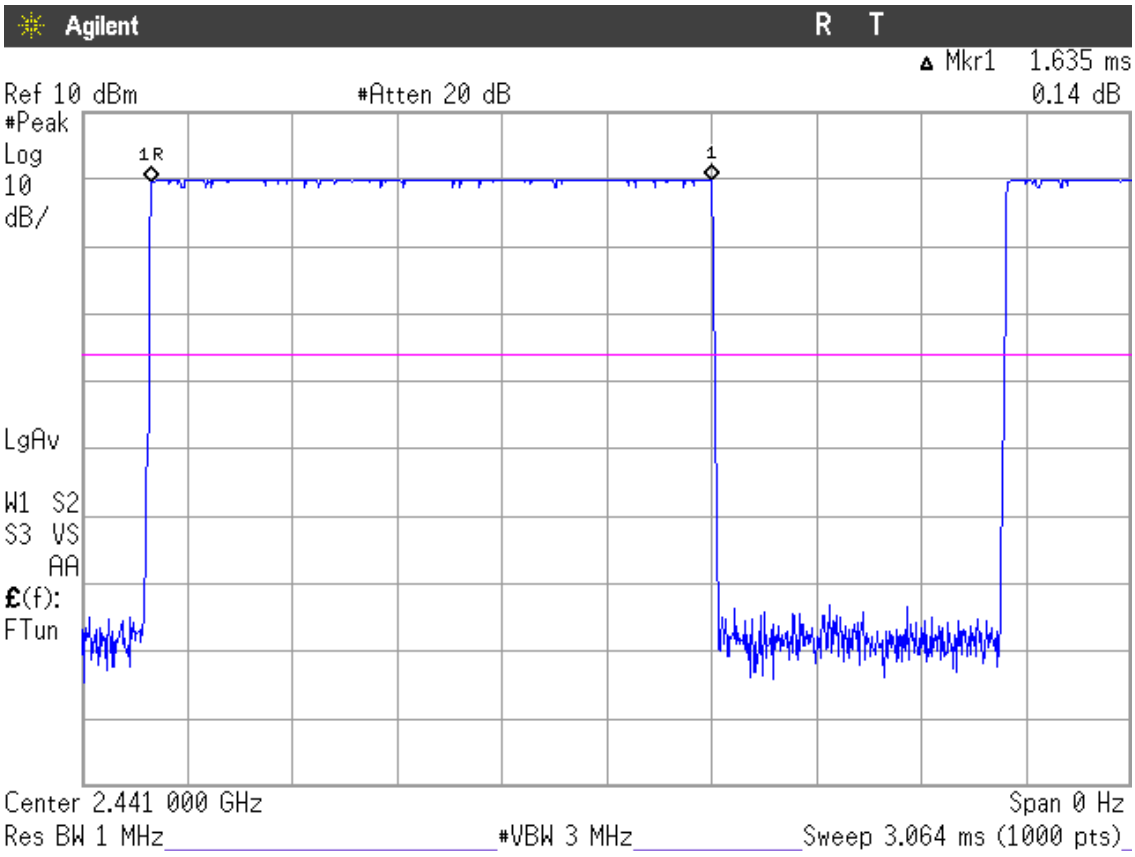
The system makes worst case 1600 hops per second or 1 time slot has a length of 625µs with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 79 channels. So you have each channel 800/79 = 10.13 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 10.13 x 31.6 = 320.11 times of appearance.
Each Tx-time per appearance is 380.3 µs (see next plot).
So we have 320.11 x 380.3 µs = 121.74 ms per 31.6 seconds.



Verdict: PASS

2. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH3.

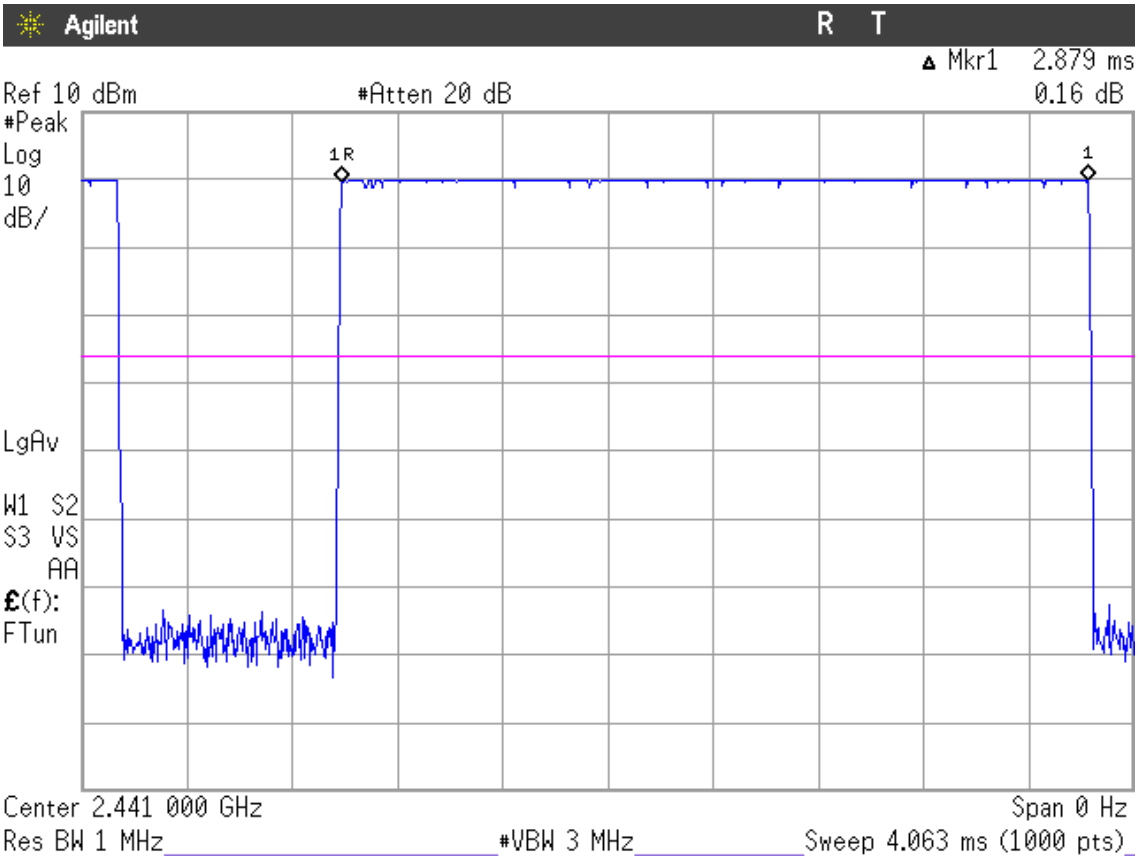
A DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/4 = 400 hops per second with 79 channels. So you have each channel 400/79 = 5.1 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 5.1 x 31.6 = 161.16 times of appearance.
Each Tx-time per appearance is 1.635 ms (see next plot).
So we have 161.16 x 1.635 ms = 263.49 ms per 31.6 seconds.



Verdict: PASS

3. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH5.

A DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/6 = 266.67 hops per second with 79 channels. So you have each channel 266.67/79 = 3.37 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 3.37 x 31.6 = 106.49 times of appearance.
Each Tx-time per appearance is 2.879 ms (see next plot).
So we have 106.49 x 2.879 ms = 306.58 ms per 31.6 seconds.

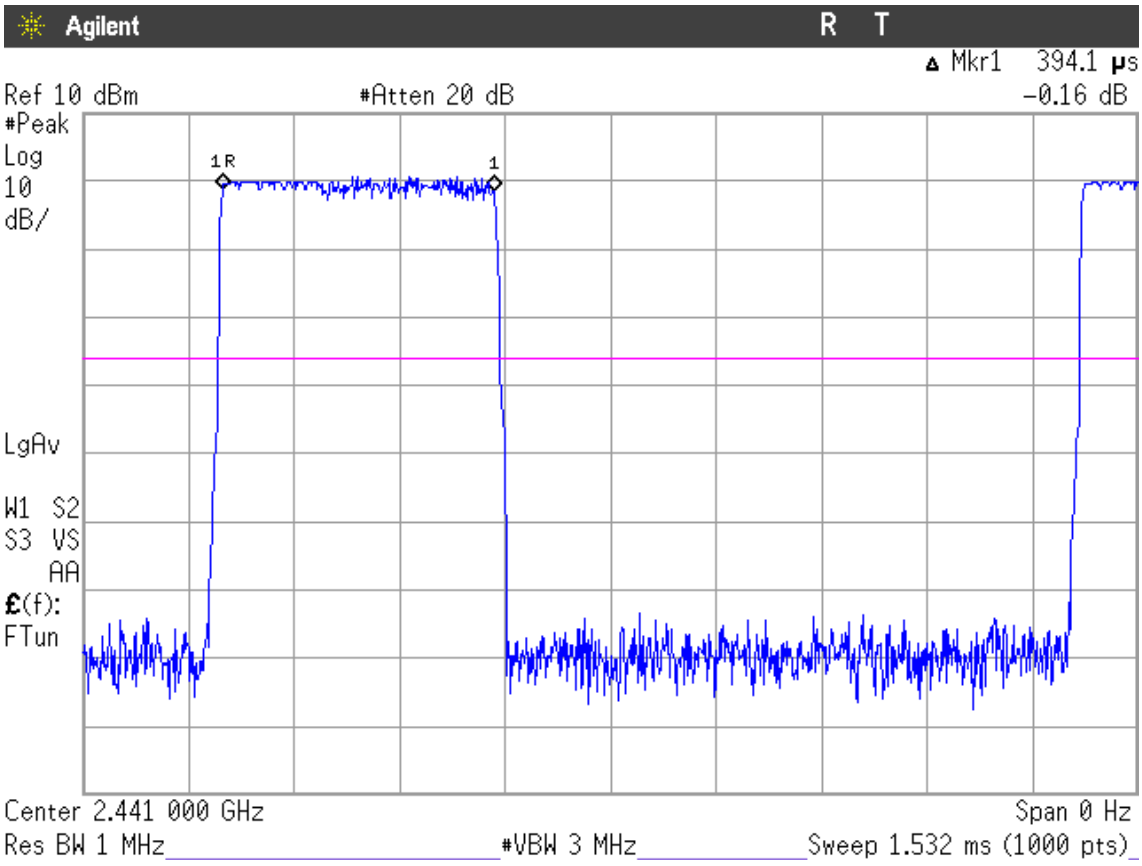


Verdict: PASS

Modulation: Π/4-DQPSK

1. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH1.

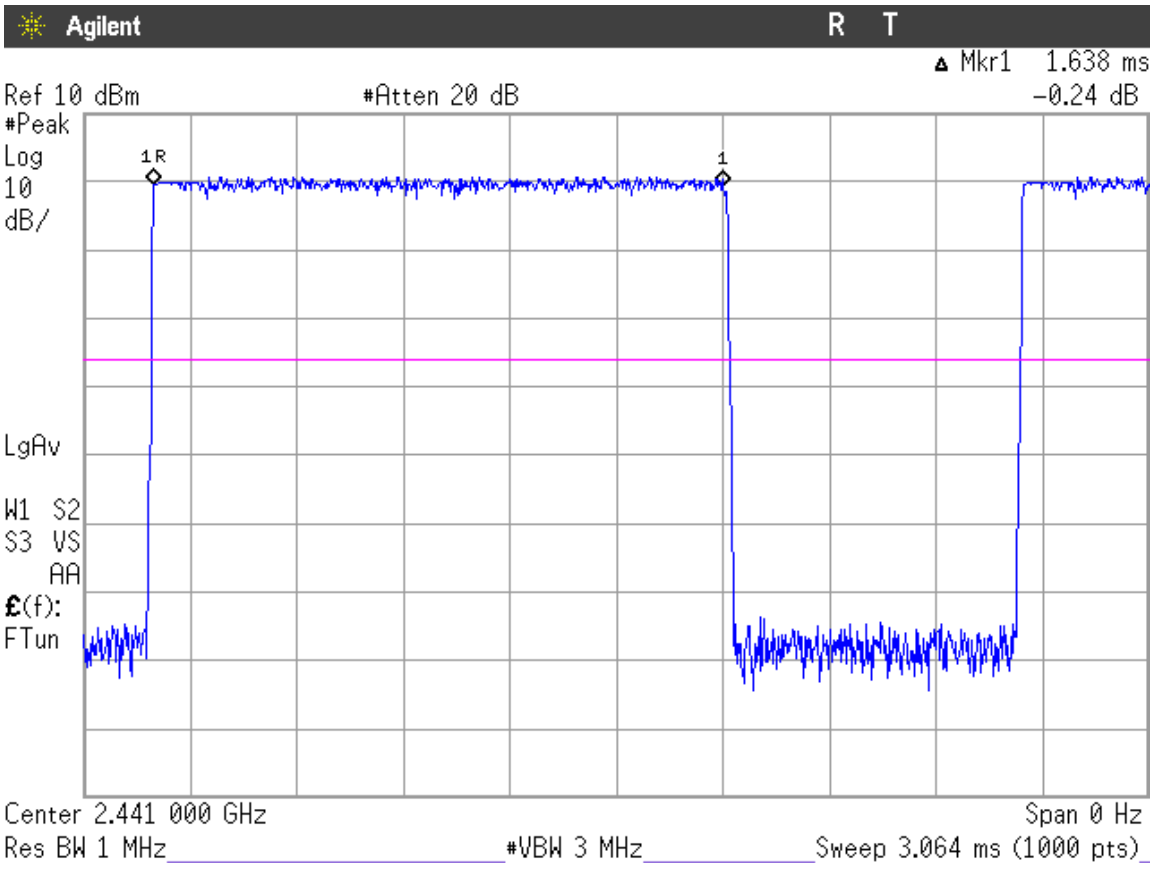
The system makes worst case 1600 hops per second or 1 time slot has a length of 625µs with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 79 channels. So you have each channel 800/79 = 10.13 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 10.13 x 31.6 = 320.11 times of appearance.
Each Tx-time per appearance is 394.1 µs (see next plot).
So we have 320.11 x 394.1 µs = 126.15 ms per 31.6 seconds.



Verdict: PASS

2. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH3.

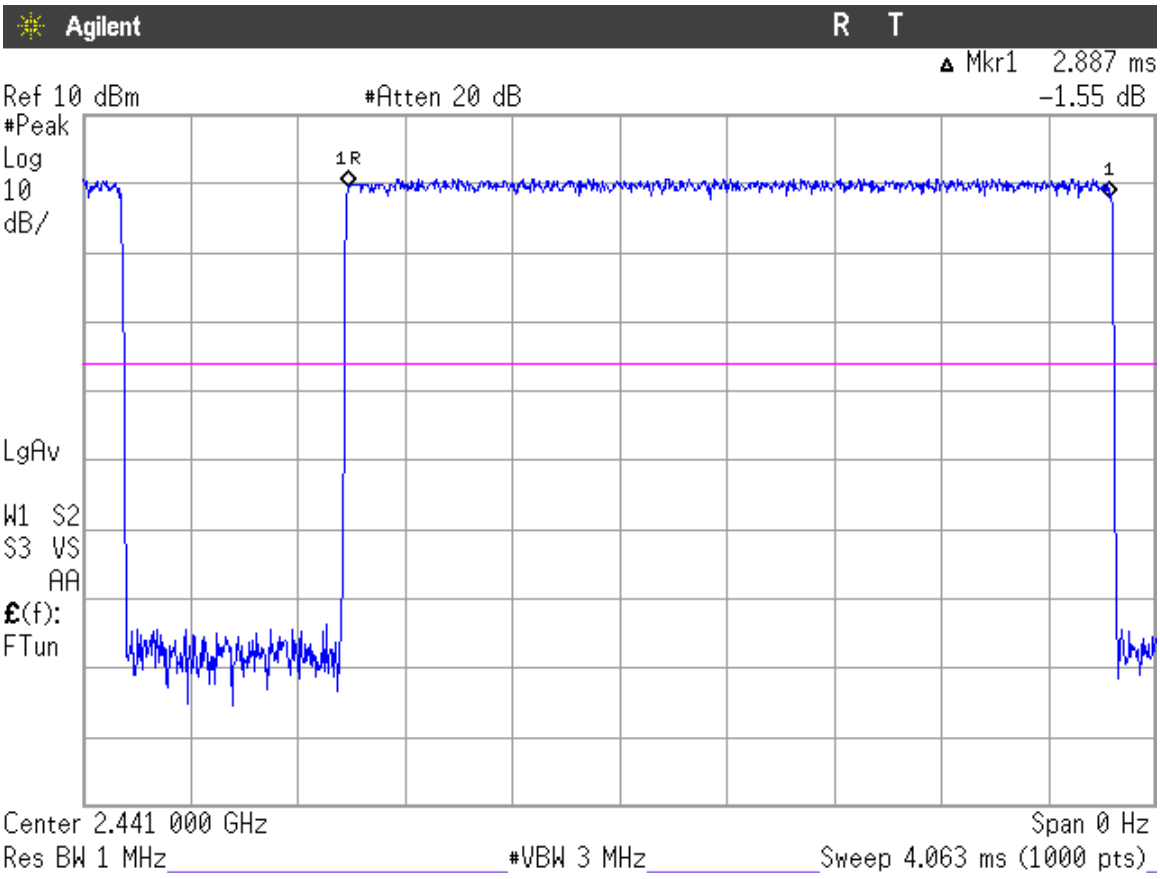
A DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/4 = 400 hops per second with 79 channels. So you have each channel 400/79 = 5.1 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 5.1 x 31.6 = 161.16 times of appearance.
Each Tx-time per appearance is 1.638 ms (see next plot).
So we have 161.16 x 1.638 ms = 263.98 ms per 31.6 seconds.



Verdict: PASS

3. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH5.

A DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/6 = 266.67 hops per second with 79 channels. So you have each channel 266.67/79 = 3.37 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 3.37 x 31.6 = 106.49 times of appearance.
Each Tx-time per appearance is 2.887 ms (see next plot).
So we have 106.49 x 2.887 ms = 307.44 ms per 31.6 seconds.

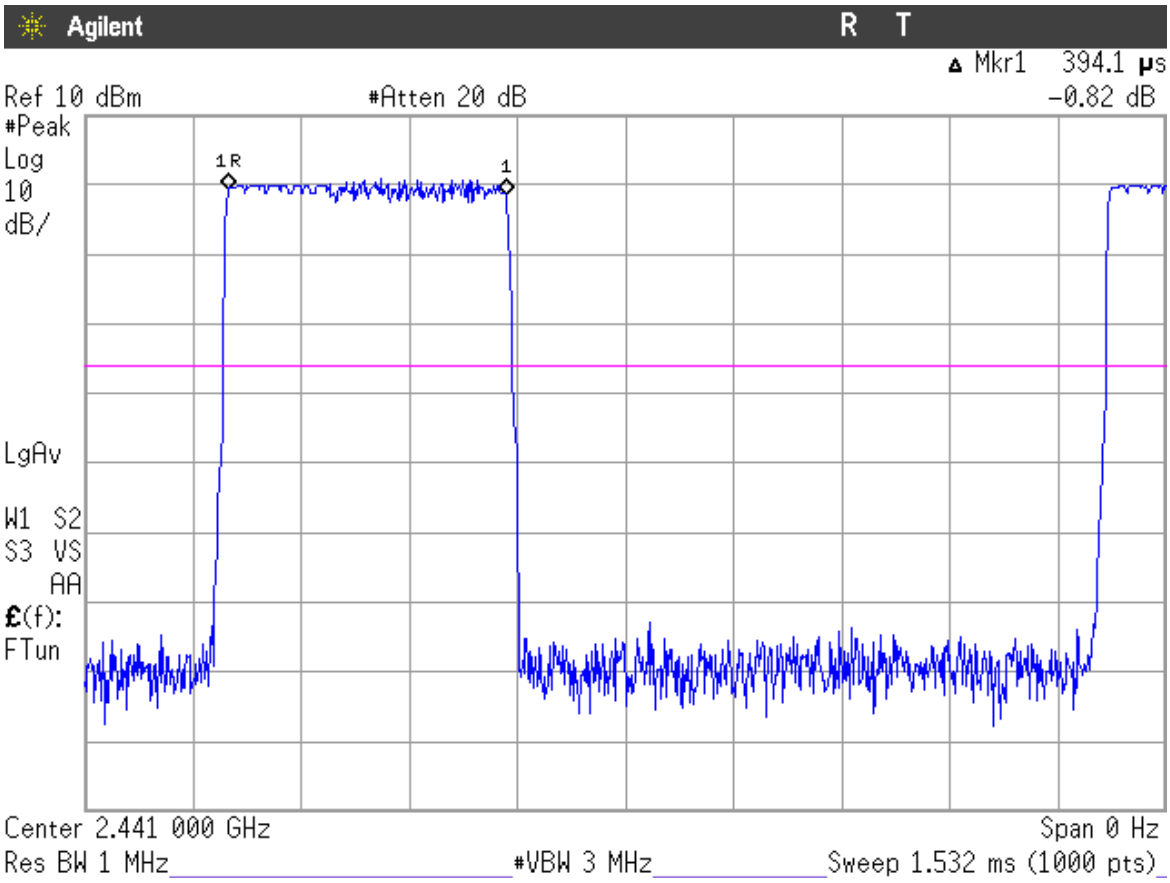


Verdict: PASS

Modulation: 8-DPSK

1. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH1.

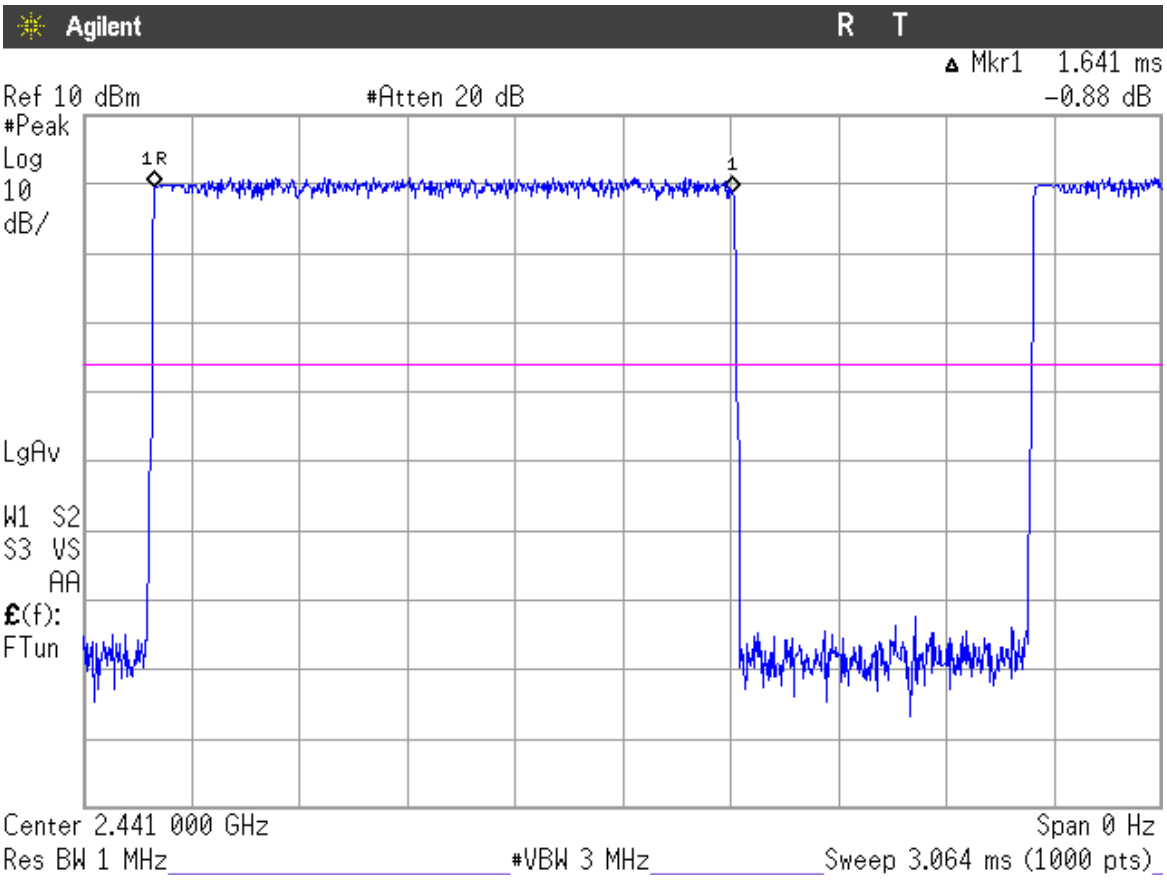
The system makes worst case 1600 hops per second or 1 time slot has a length of 625µs with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 79 channels. So you have each channel 800/79 = 10.13 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 10.13 x 31.6 = 320.11 times of appearance.
Each Tx-time per appearance is 394.1µs (see next plot).
So we have 320.11 x 394.1µs = 126.15 ms per 31.6 seconds.



Verdict: PASS

2. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH3.

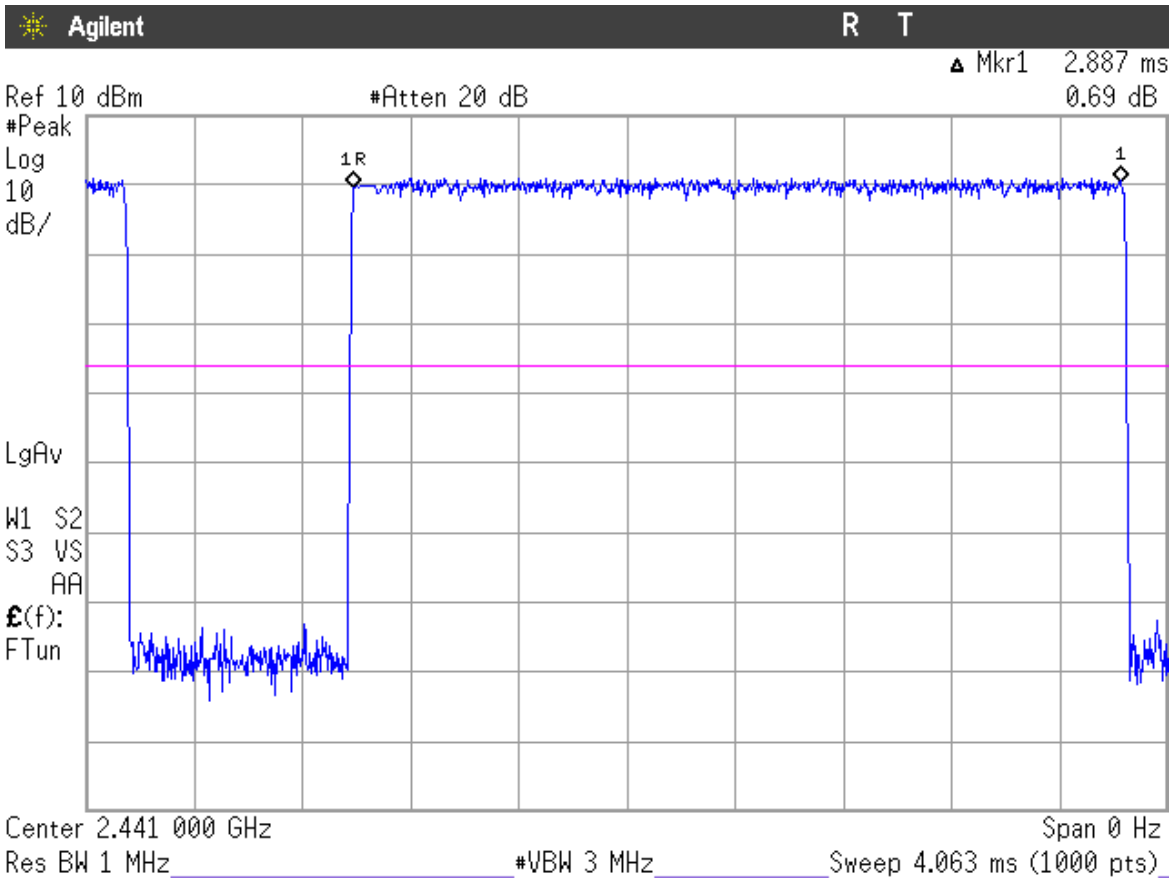
A DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/4 = 400 hops per second with 79 channels. So you have each channel 400/79 = 5.1 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 5.1 x 31.6 = 161.16 times of appearance.
Each Tx-time per appearance is 1.641 ms (see next plot).
So we have 161.16 x 1.641 ms = 264.46 ms per 31.6 seconds.



Verdict: PASS

3. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH5.

A DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/6 = 266.67 hops per second with 79 channels. So you have each channel 266.67/79 = 3.37 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 3.37 x 31.6 = 106.49 times of appearance.
Each Tx-time per appearance is 2.887 ms (see next plot).
So we have 106.49 x 2.887 ms = 307.44 ms per 31.6 seconds.



Verdict: PASS

FCC Section 15.247 Subclause (b) / RSS-210 Clause A8.4 (2). 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).

MAXIMUM OUTPUT POWER. See next plots.

Declared maximum antenna gain: -3.5 dBi

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

Modulation: GFSK

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	-0.32	3.34	3.98
Maximum EIRP power (dBm)	-3.82	-0.16	0.48
Measurement uncertainty (dB)	±1.5		

Modulation: Π/4-DQPSK (2Mbps)

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	-2.54	1.69	2.02
Maximum EIRP power (dBm)	-6.04	-1.81	-1.48
Measurement uncertainty (dB)	±1.5		

Modulation: 8-DPSK (3Mbps)

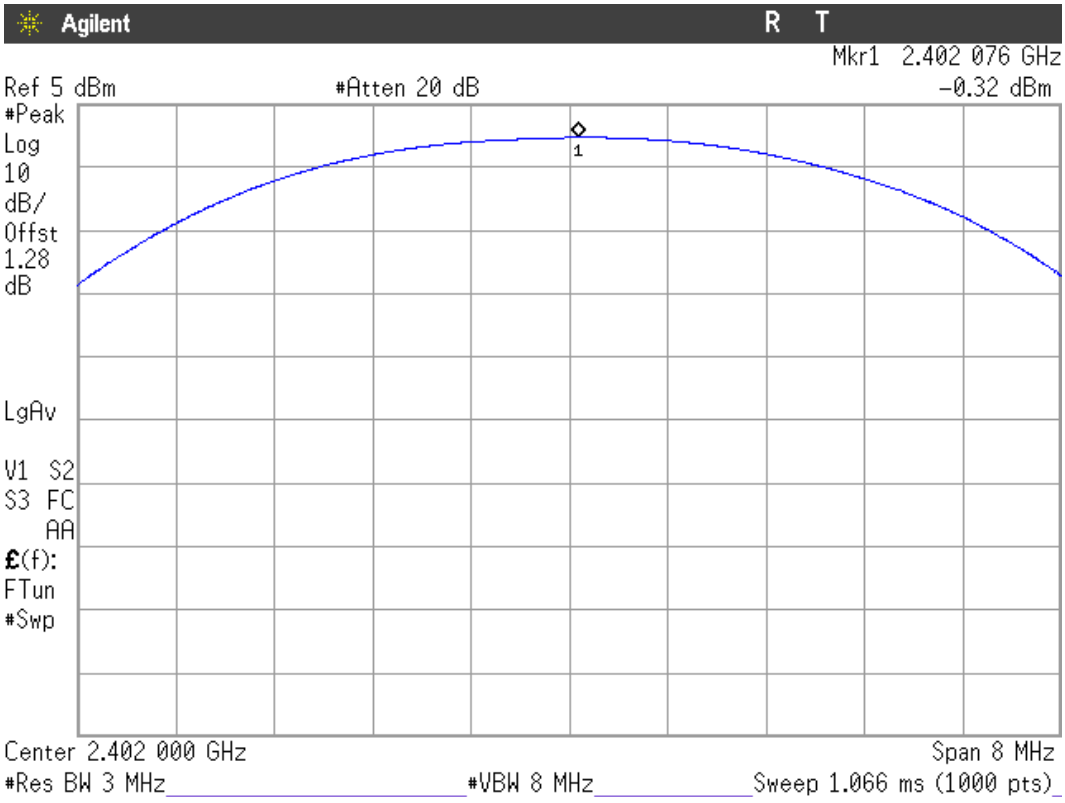
	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	-2.19	1.92	2.25
Maximum EIRP power (dBm)	-5.69	-1.58	-1.25
Measurement uncertainty (dB)	±1.5		

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.

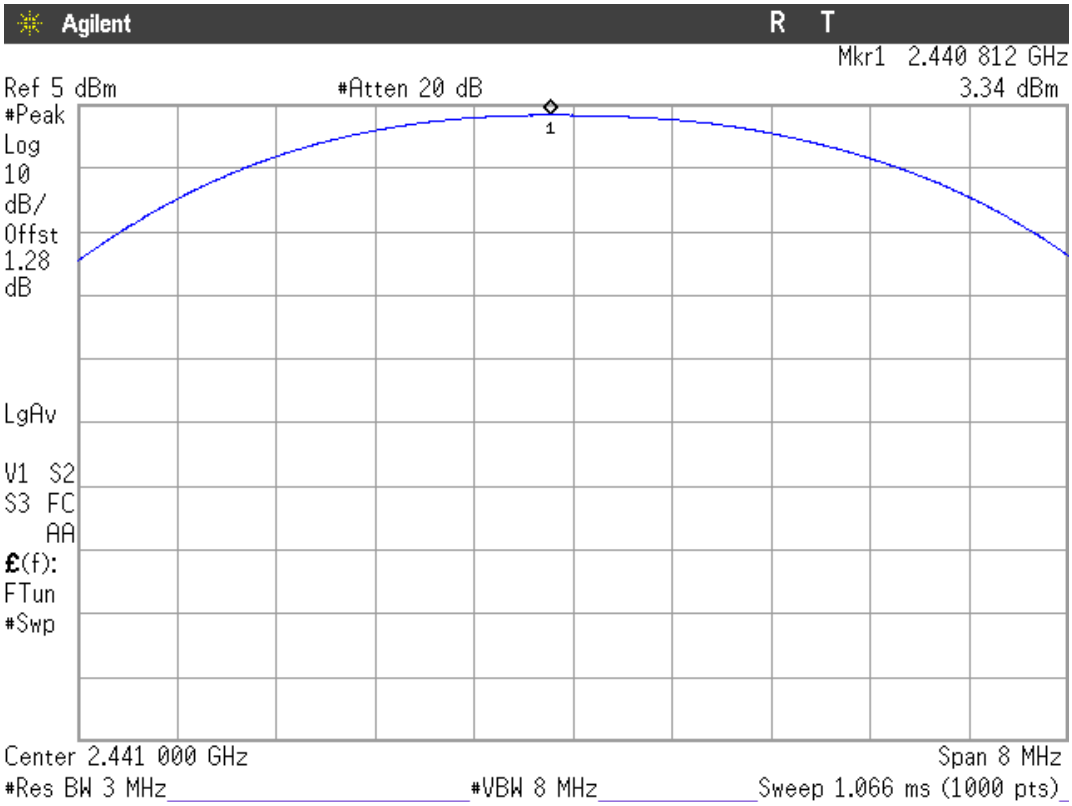
Verdict: PASS

PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Lowest Channel: 2402 MHz.

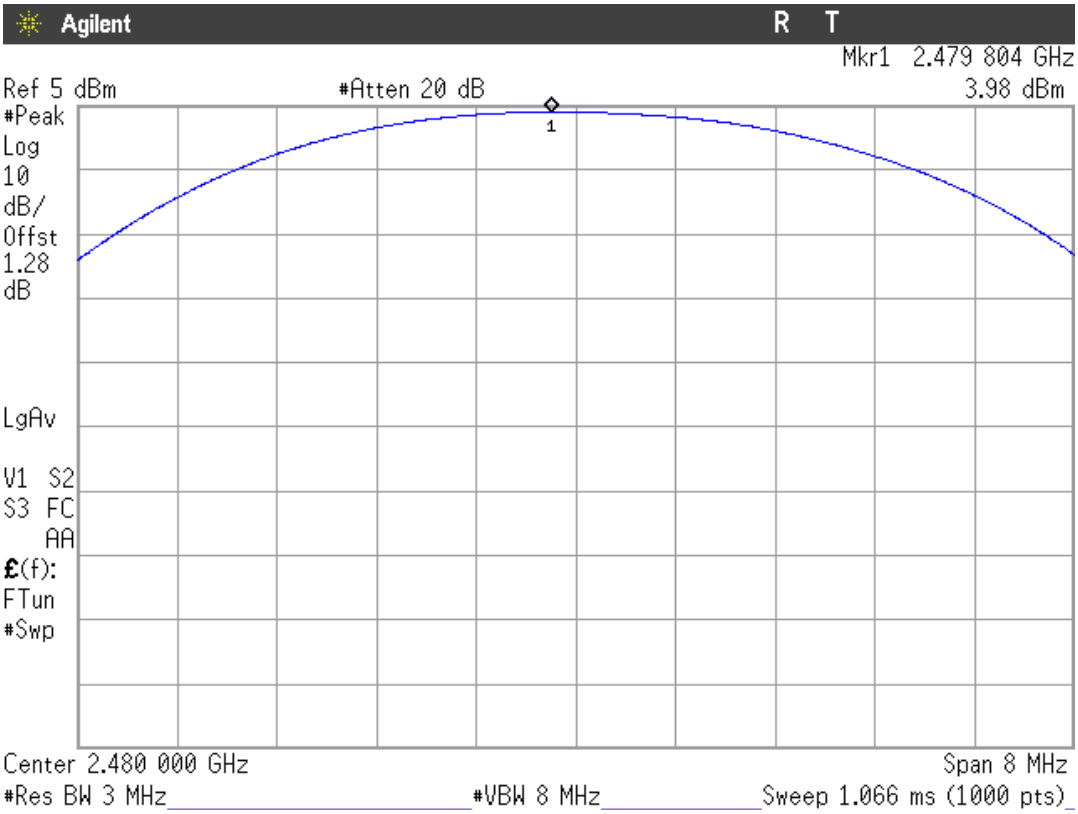


Modulation: GFSK Middle Channel: 2441 MHz.

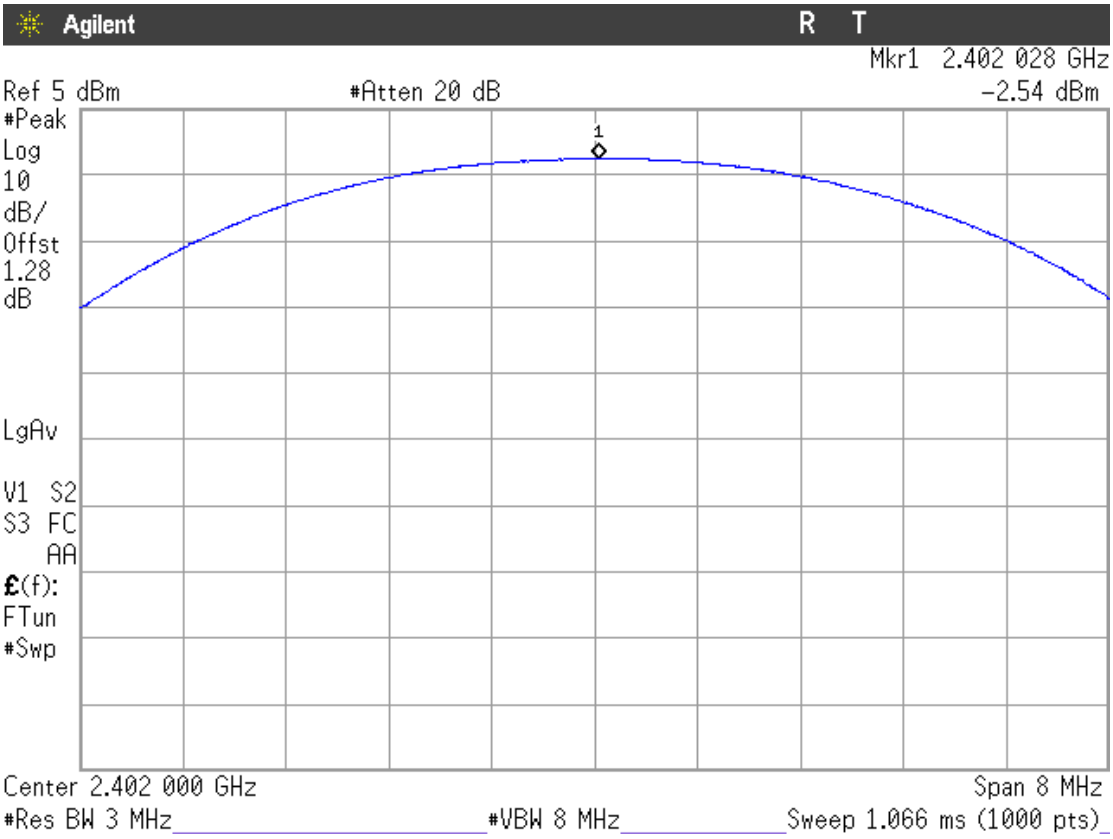


PEAK OUTPUT POWER (CONDUCTED).

Modulation: GFSK Highest Channel: 2480 MHz.

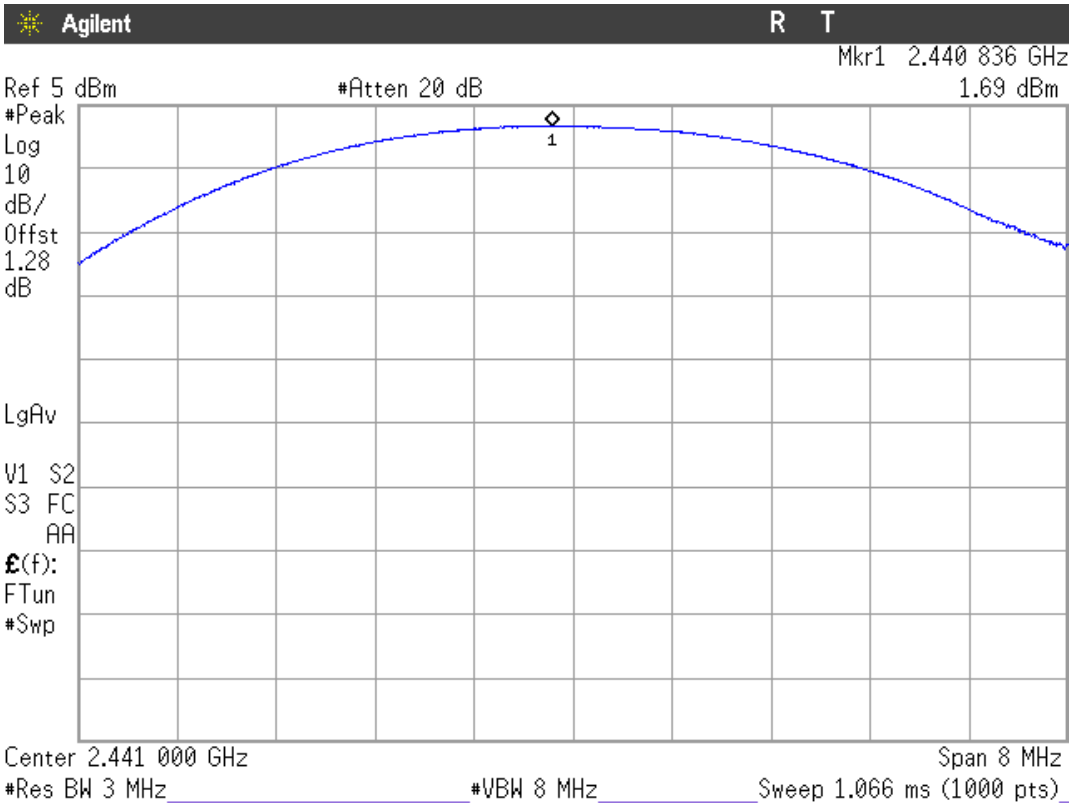


Modulation: Π/4-DQPSK Lowest Channel: 2402 MHz

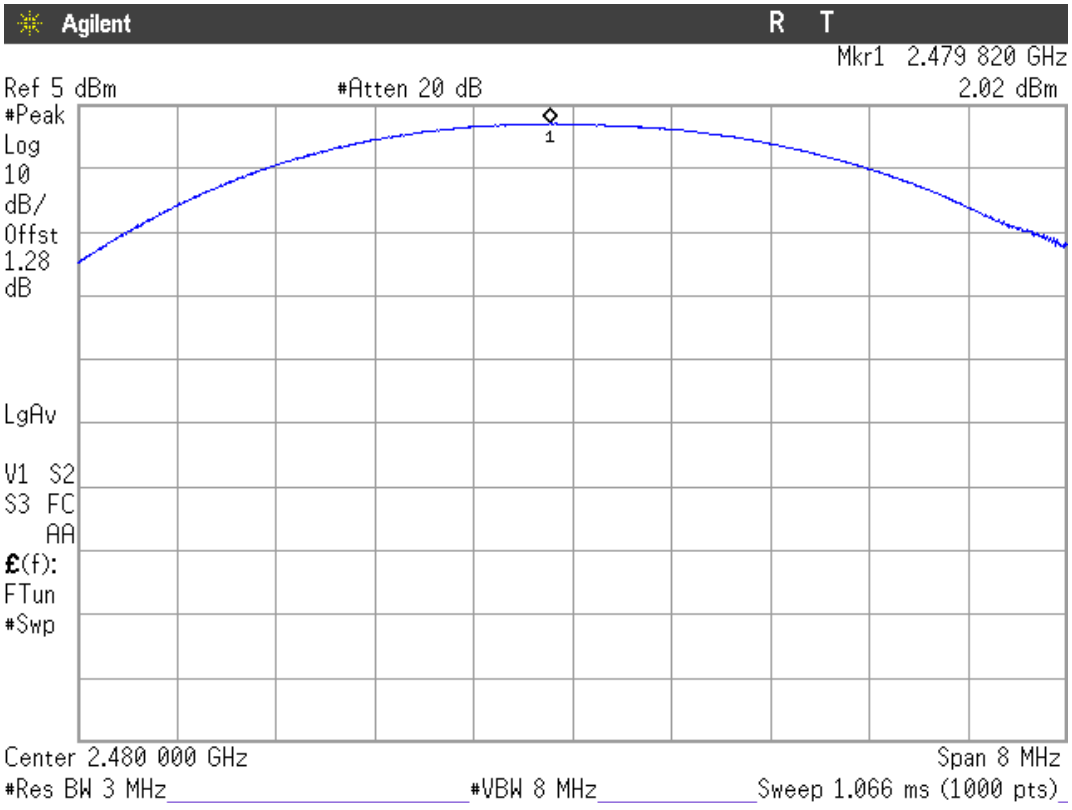


PEAK OUTPUT POWER (CONDUCTED)

Modulation: Π/4-DQPSK Middle Channel: 2441 MHz.

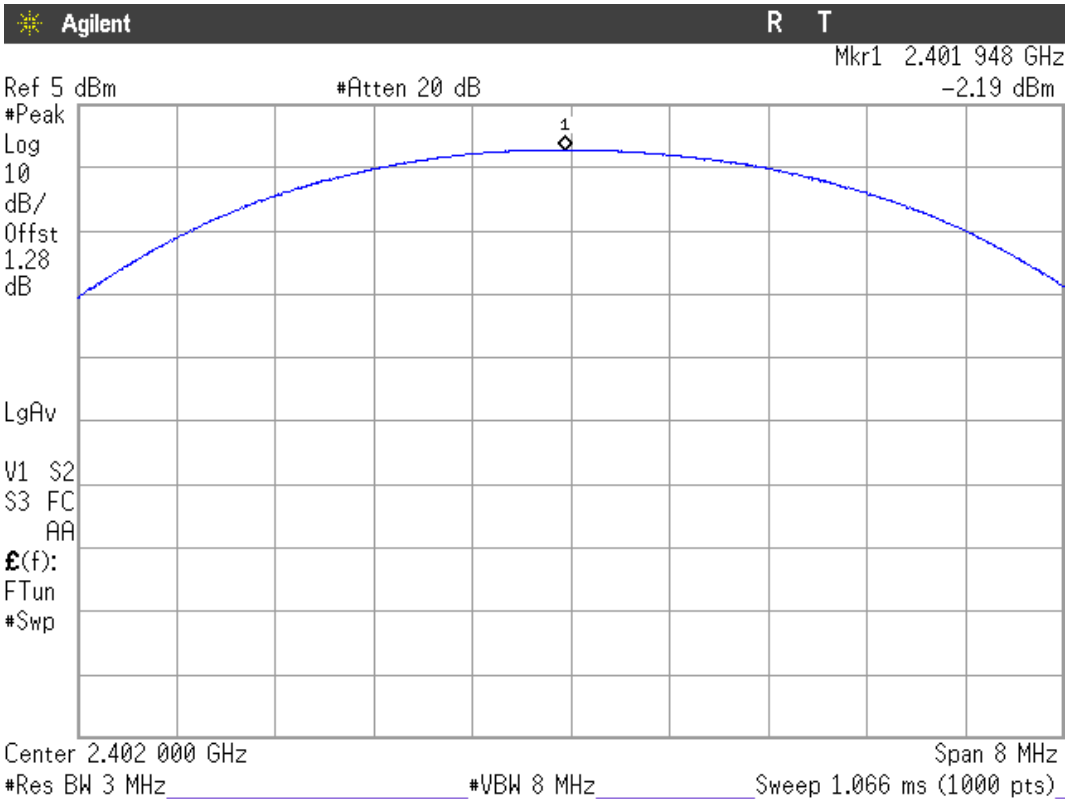


Modulation: Π/4-DQPSK Highest Channel: 2480 MHz.

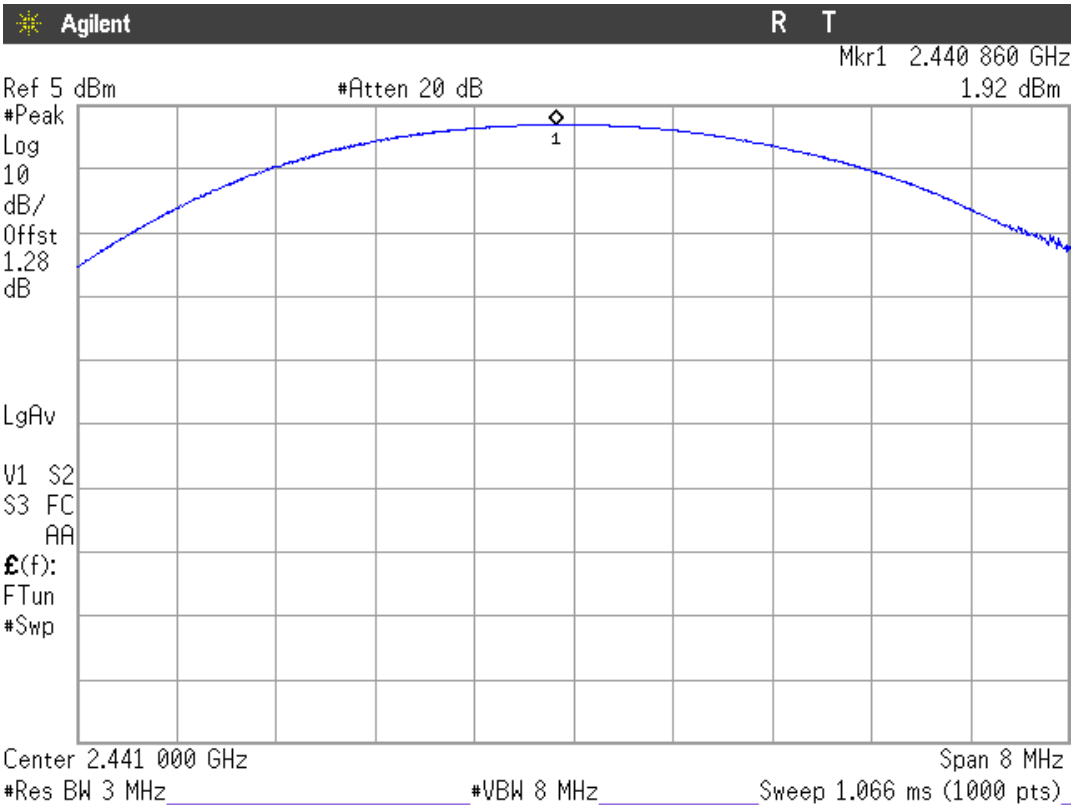


PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Lowest Channel: 2402 MHz

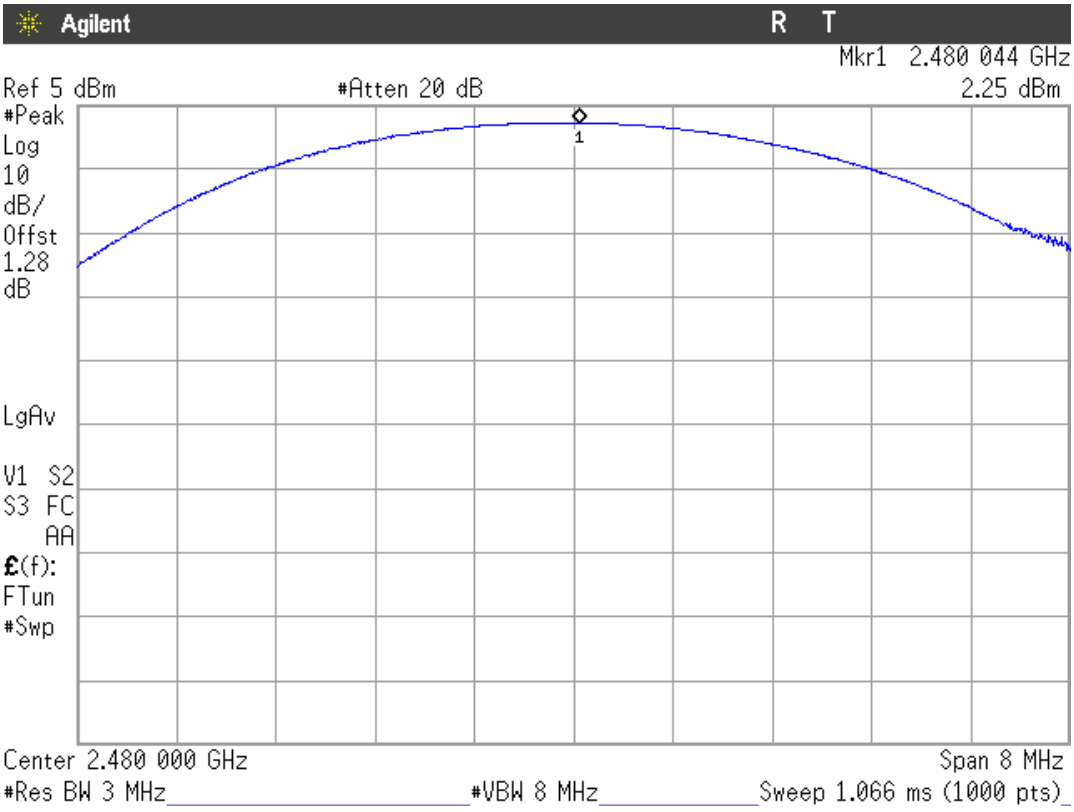


Modulation: 8-DPSK Middle Channel: 2441 MHz.



PEAK OUTPUT POWER (CONDUCTED).

Modulation: 8-DPSK Highest Channel: 2480 MHz.



FCC Section 15.247 Subclause (d) / RSS-210 Clause A8.5. Band-edge compliance of conducted emissions (Transmitter)

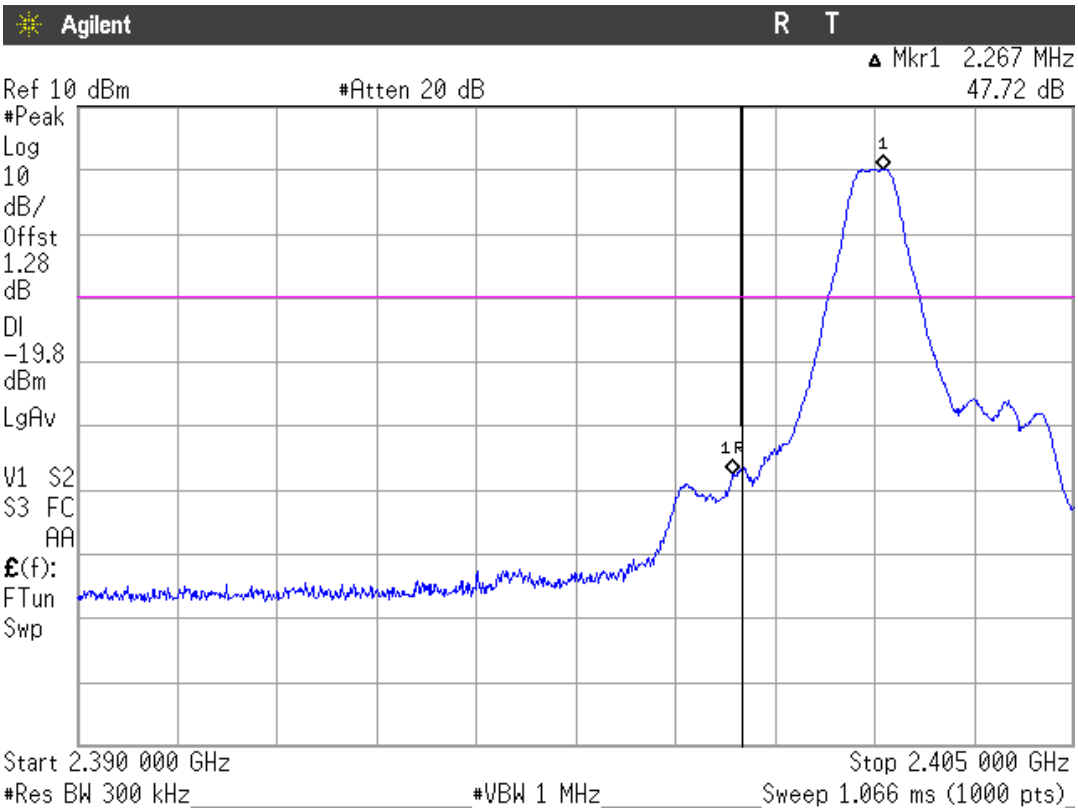
SPECIFICATION

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

RESULTS:

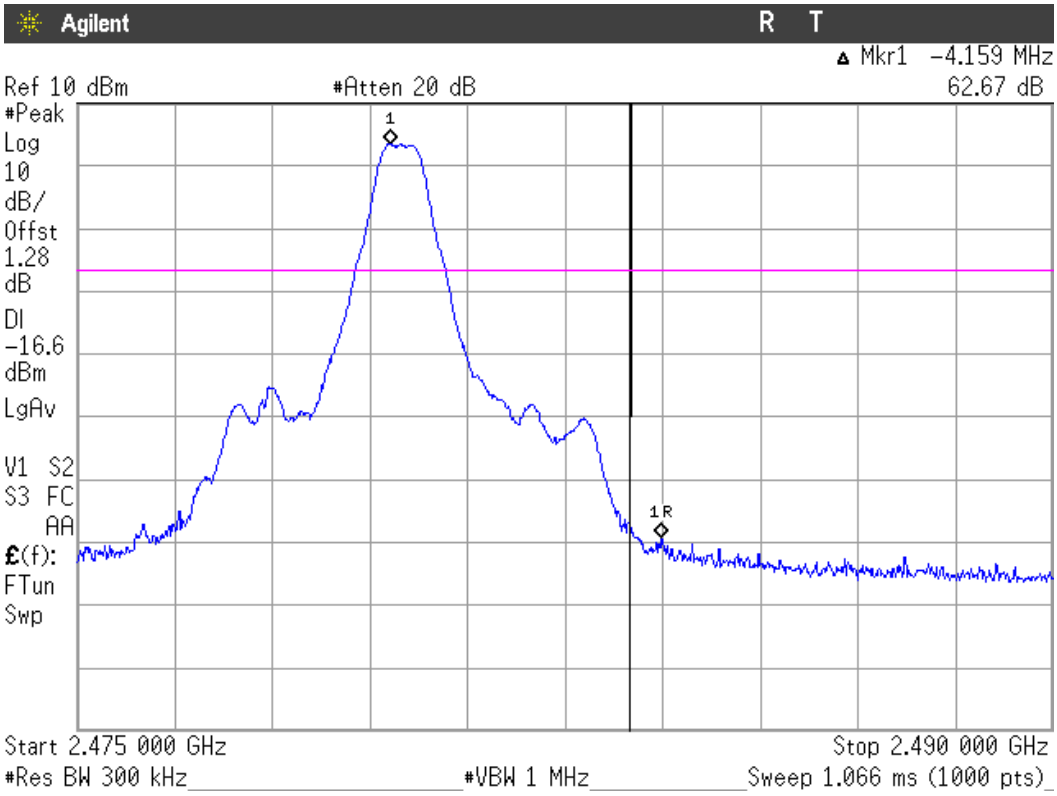
Modulation: GFSK

1. LOW FREQUENCY SECTION 2402 MHz (HOPPING OFF). See next plot.



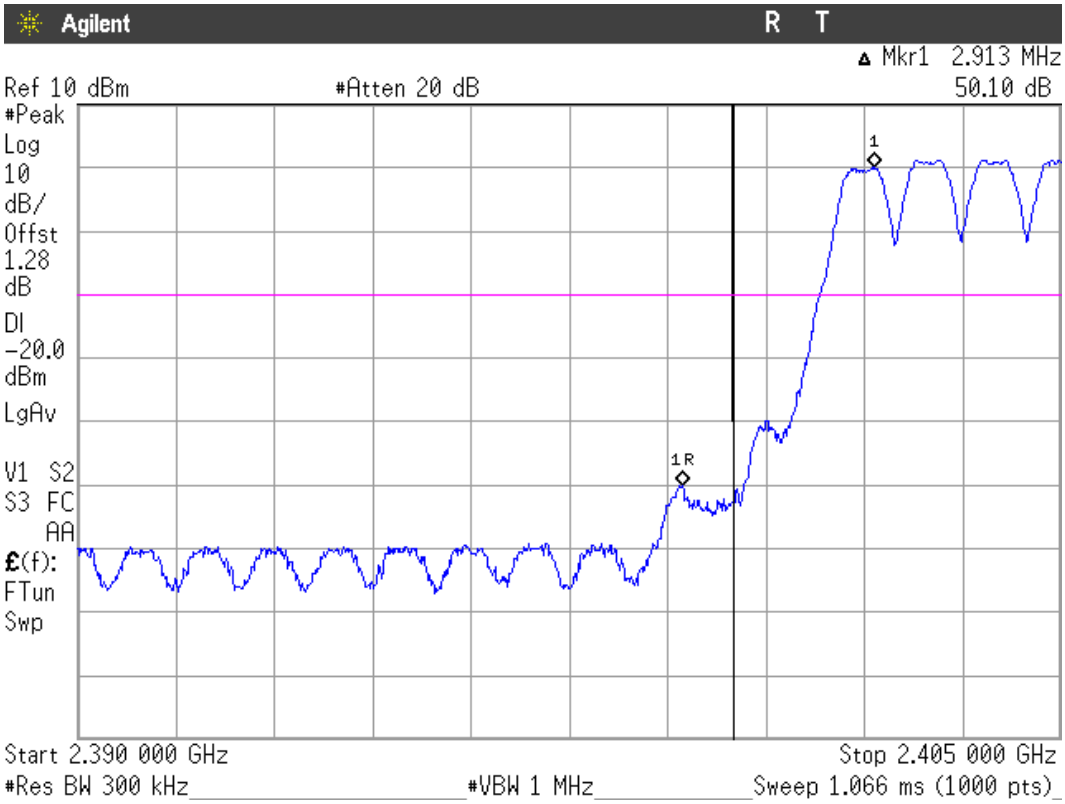
Verdict: PASS

2. HIGH FREQUENCY SECTION 2480 MHz (HOPPING OFF). See next plot.



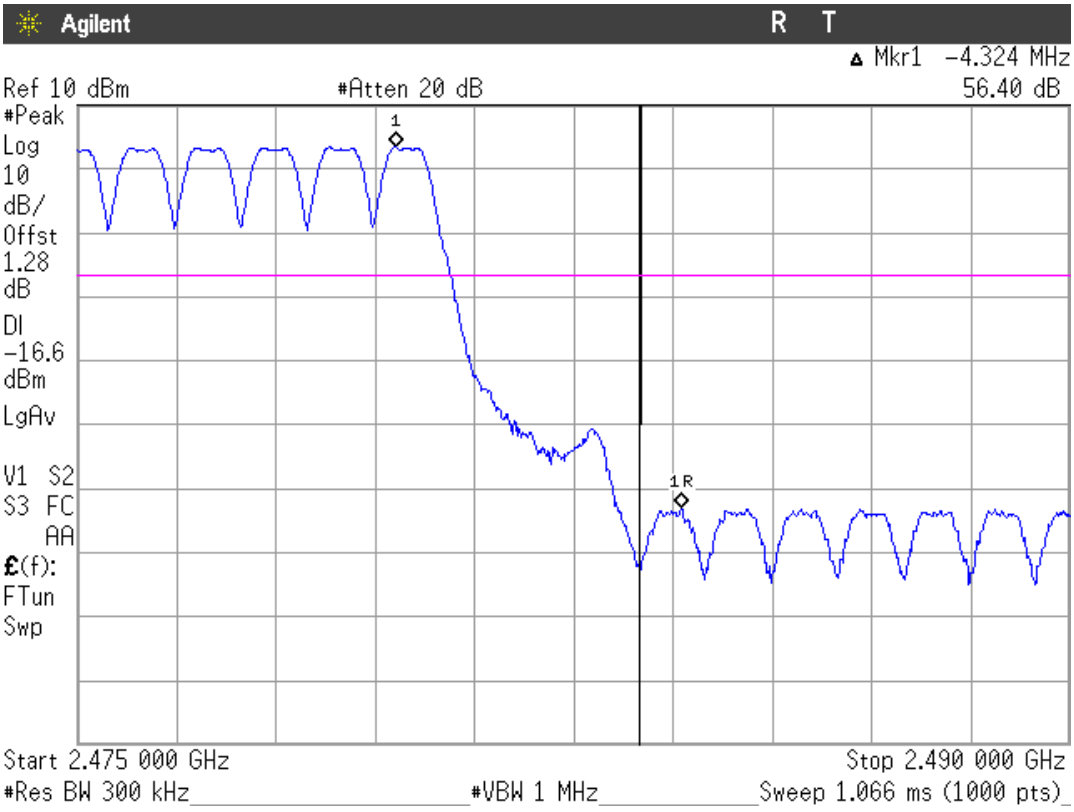
Verdict: PASS

3. LOW FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

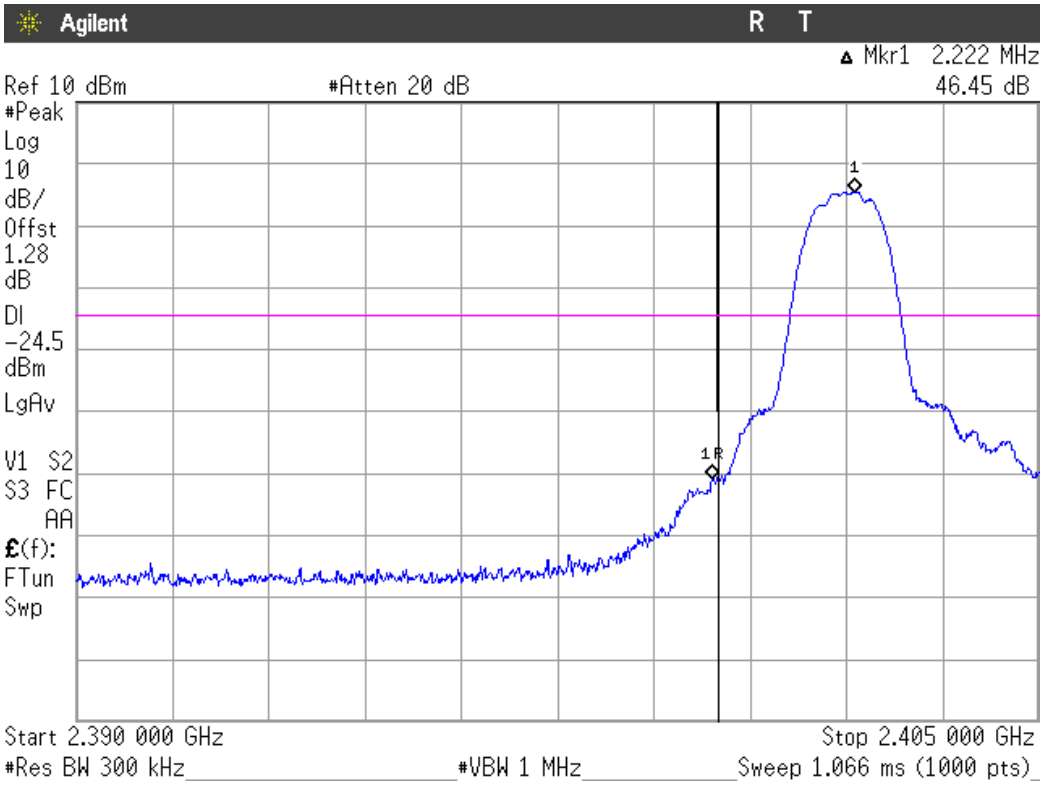
4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

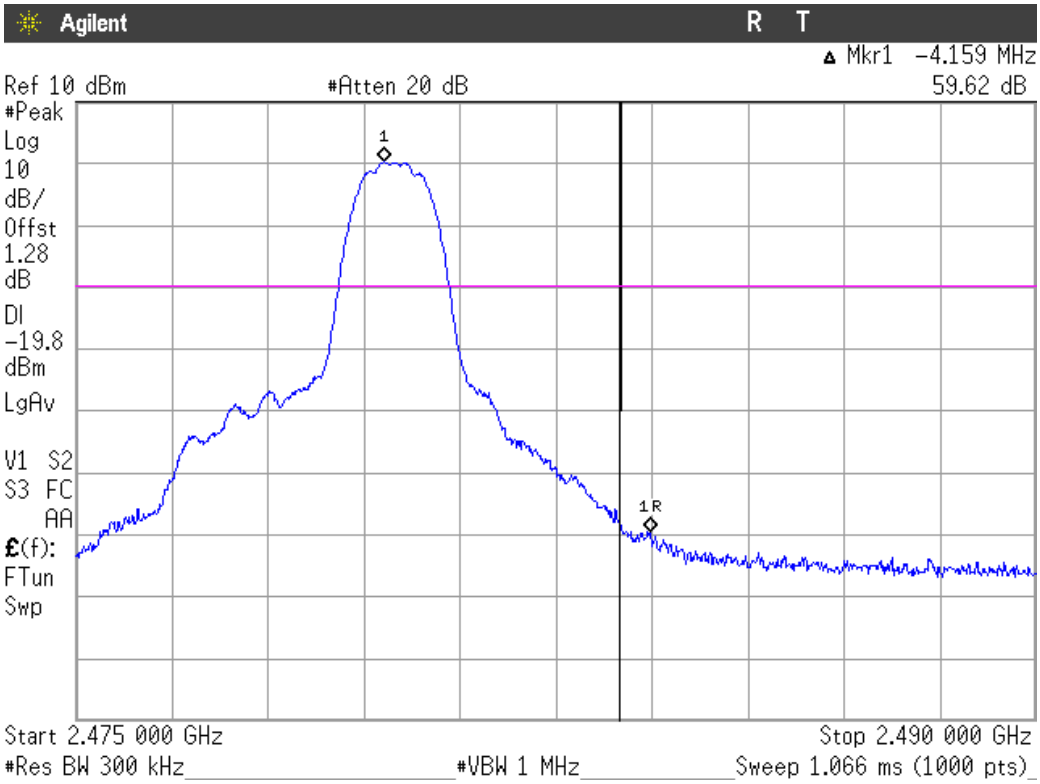
Modulation: Π/4-DQPSK

1. LOW FREQUENCY SECTION 2402 MHz (HOPPING OFF). See next plot.



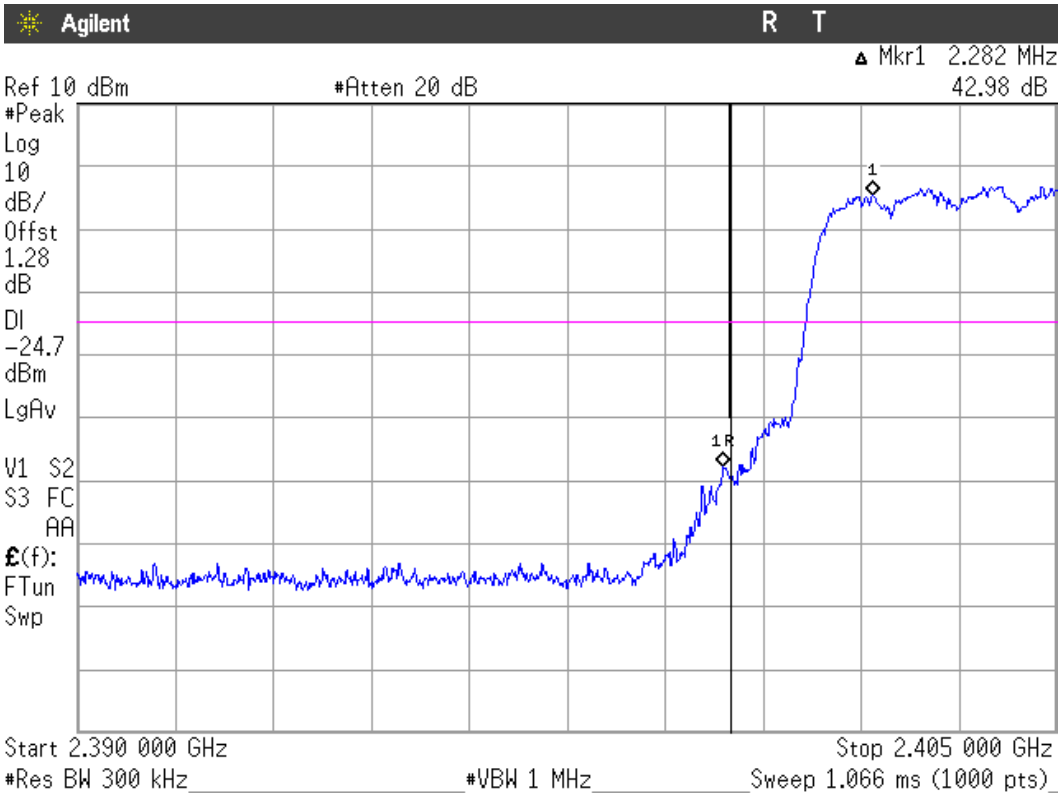
Verdict: PASS

2. HIGH FREQUENCY SECTION 2480 MHz (HOPPING OFF). See next plot.



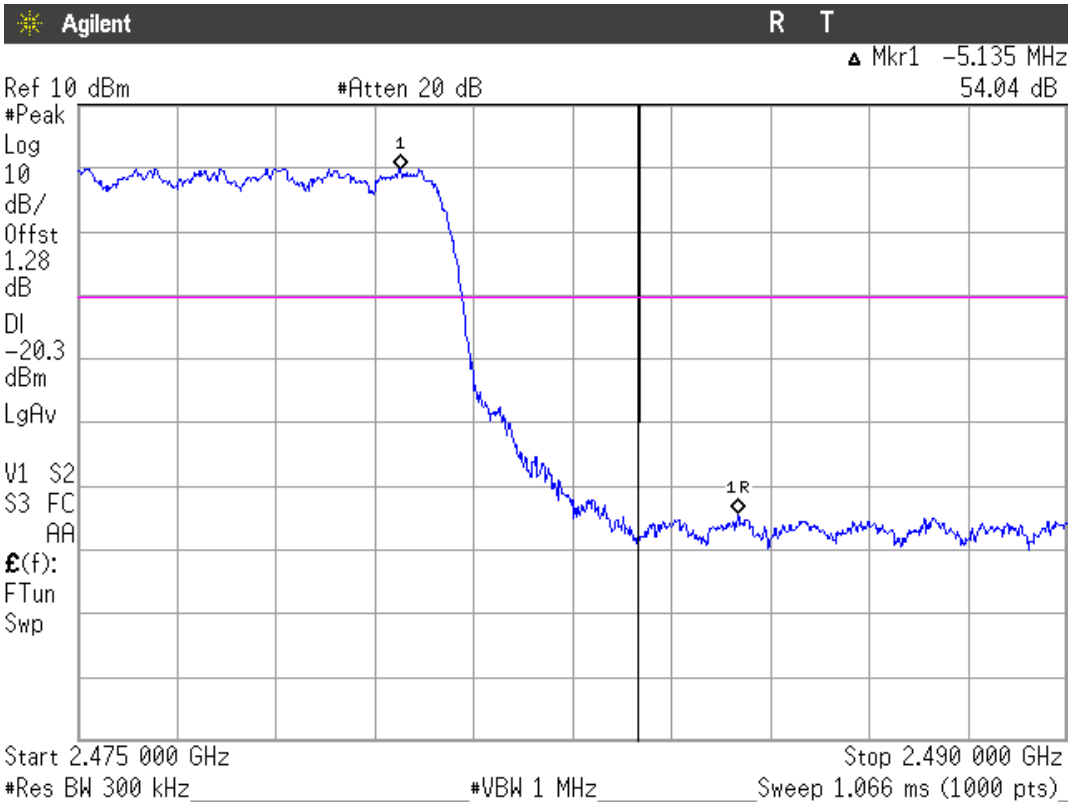
Verdict: PASS

3. LOW FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

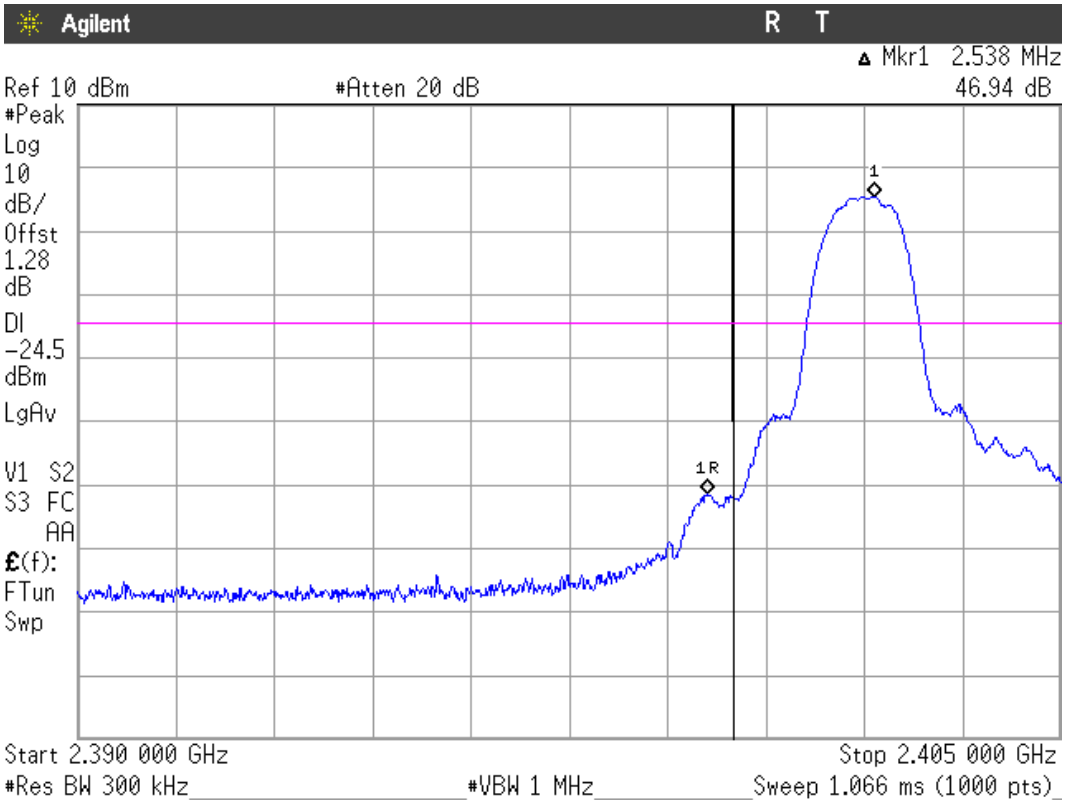
4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

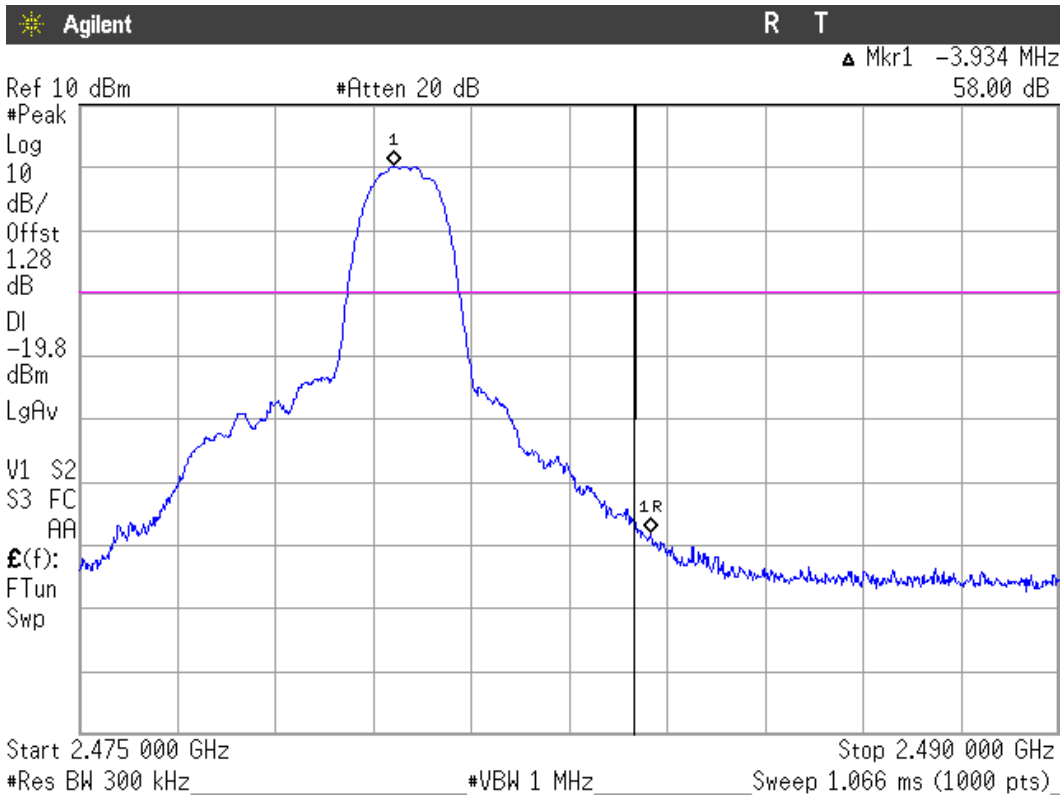
Modulation: 8-DPSK

1. LOW FREQUENCY SECTION 2402 MHz (HOPPING OFF). See next plot.



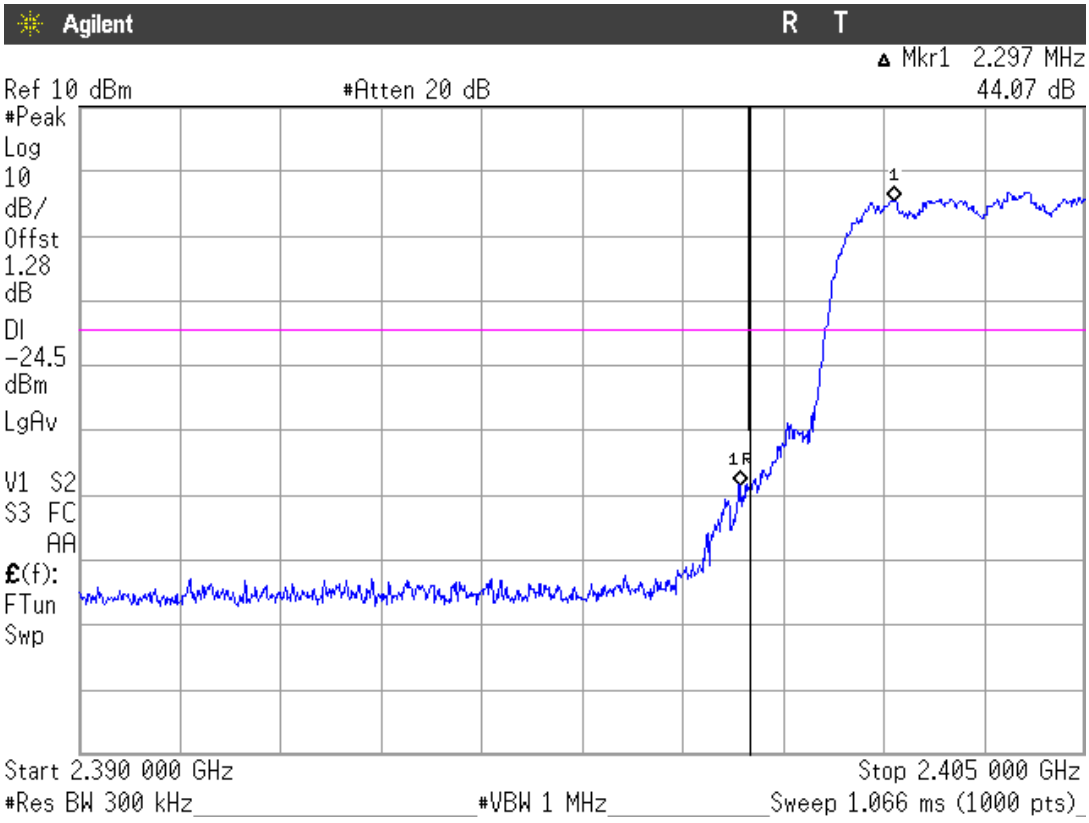
Verdict: PASS

2. HIGH FREQUENCY SECTION 2480 MHz (HOPPING OFF). See next plot.



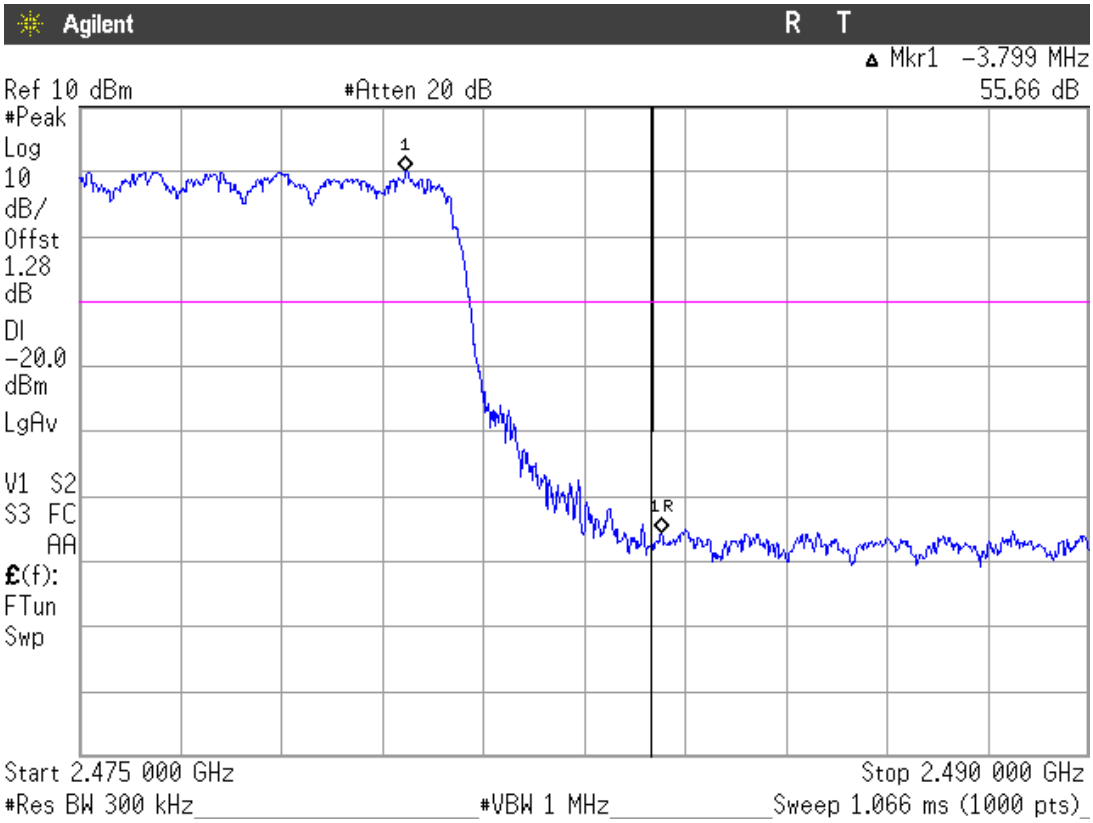
Verdict: PASS

3. LOW FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



Verdict: PASS

FCC Section 15.247 Subclause (d) / RSS-210 Clause A8.5. Emission limitations conducted (Transmitter)

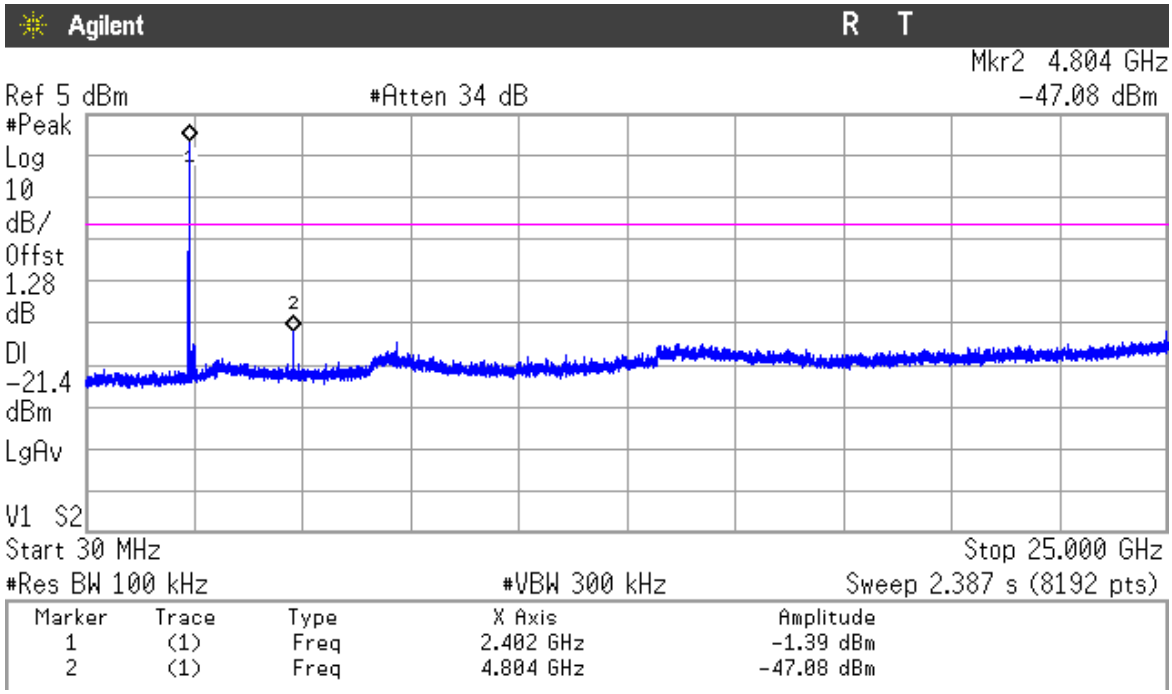
SPECIFICATION

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 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

RESULTS:

Modulation: GFSK

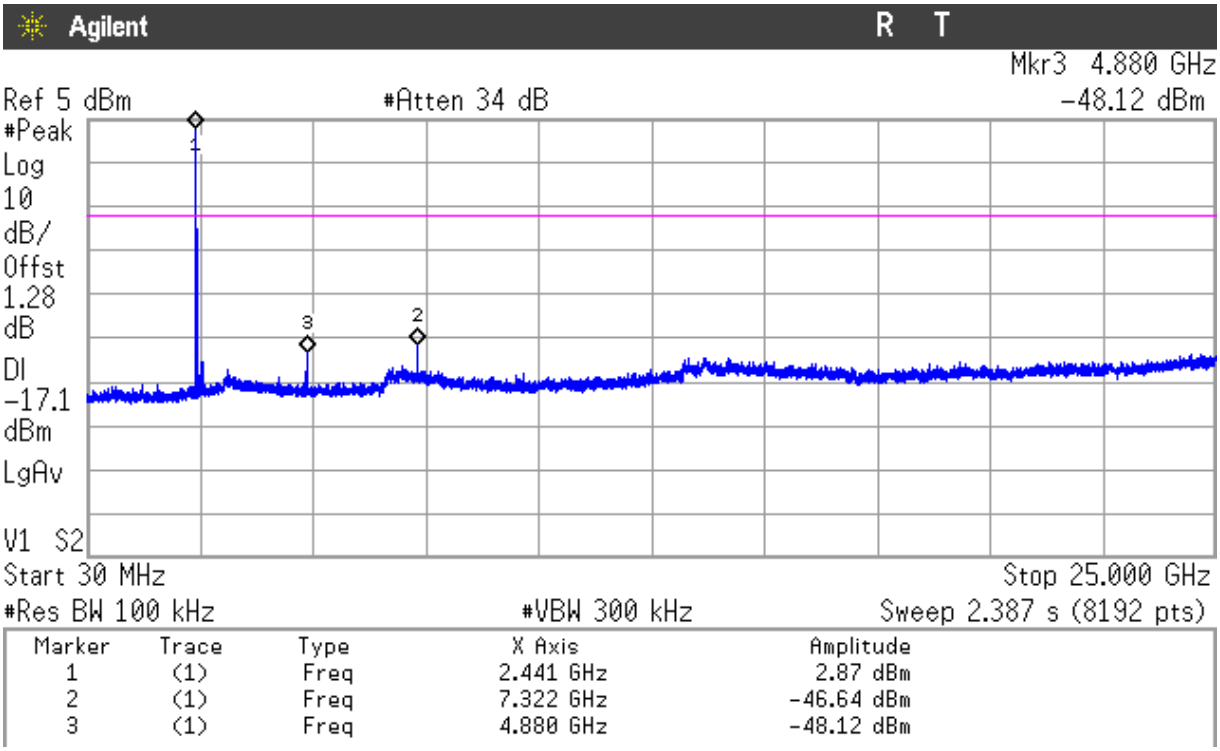
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

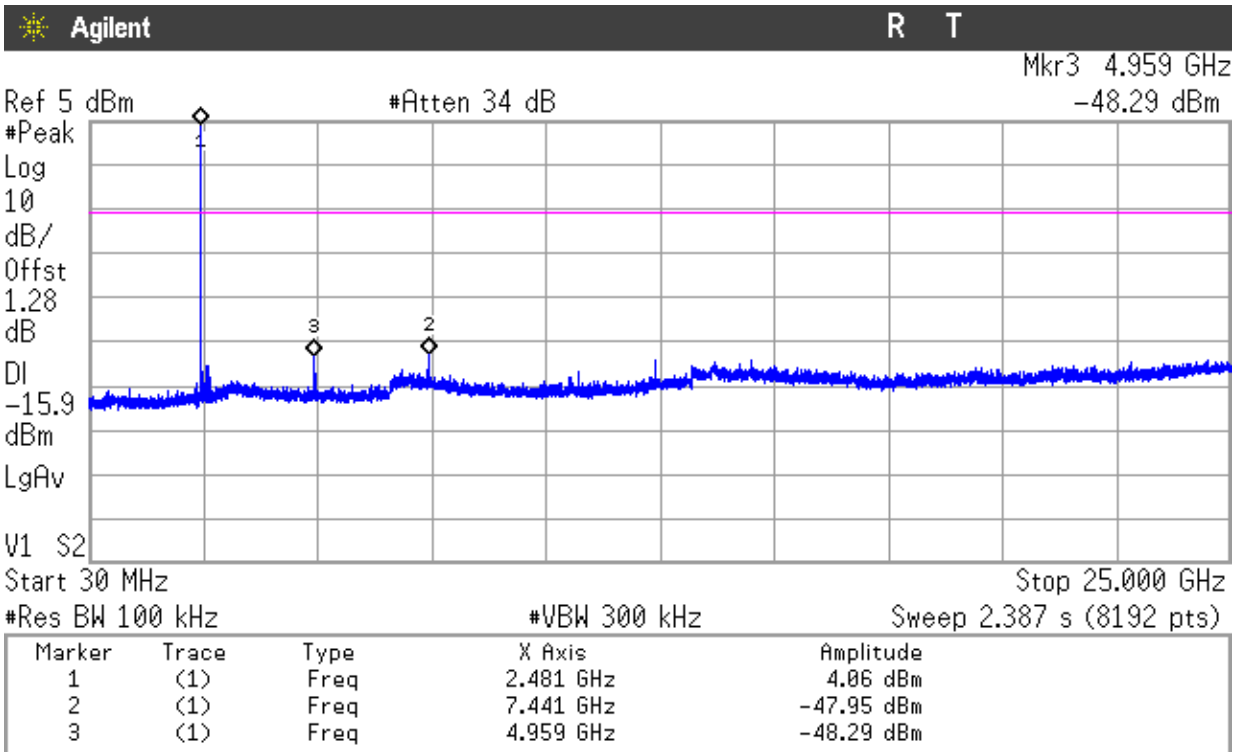
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).

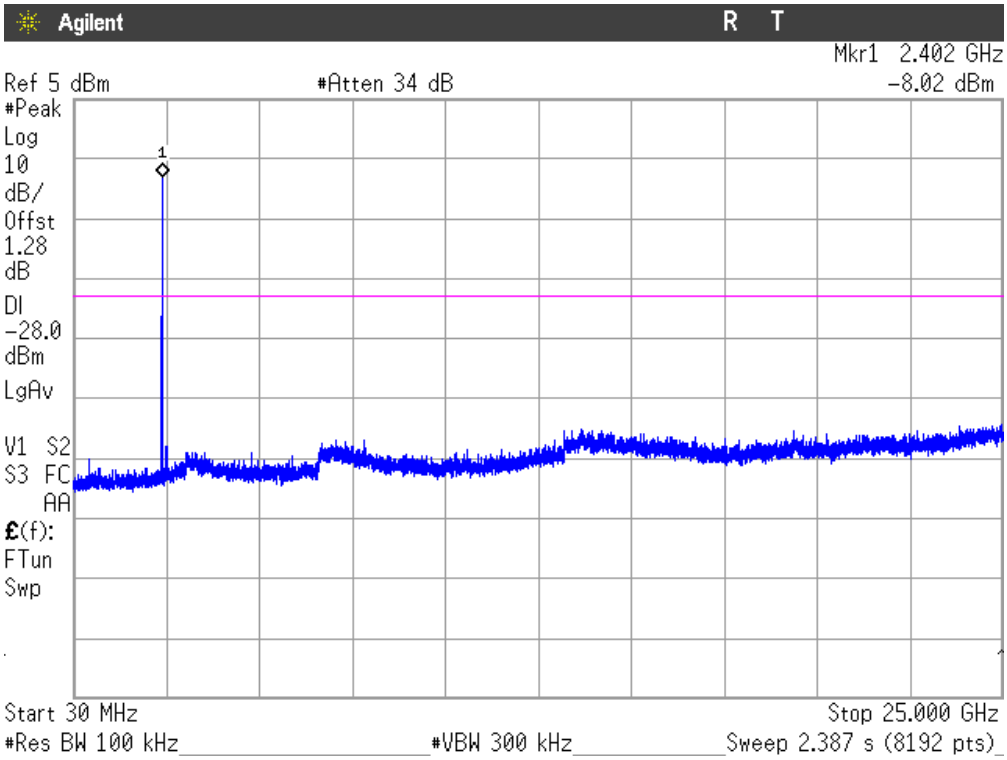


Note: The peak above the limits is the carrier frequency.

Verdict: PASS

Modulation: Π/4-DQPSK

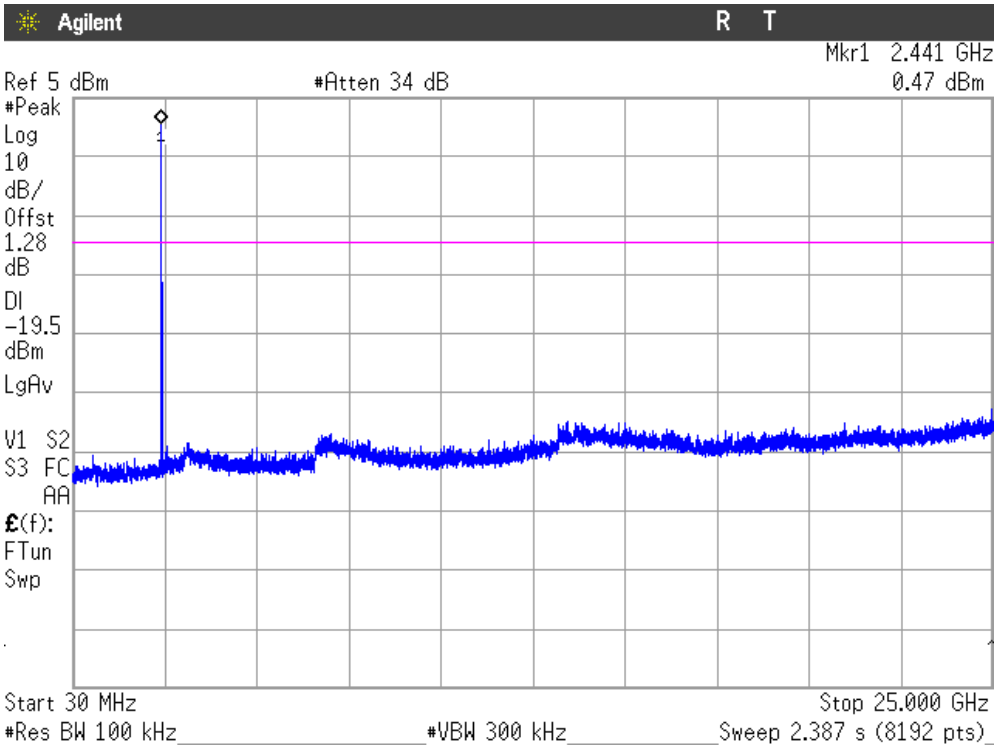
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

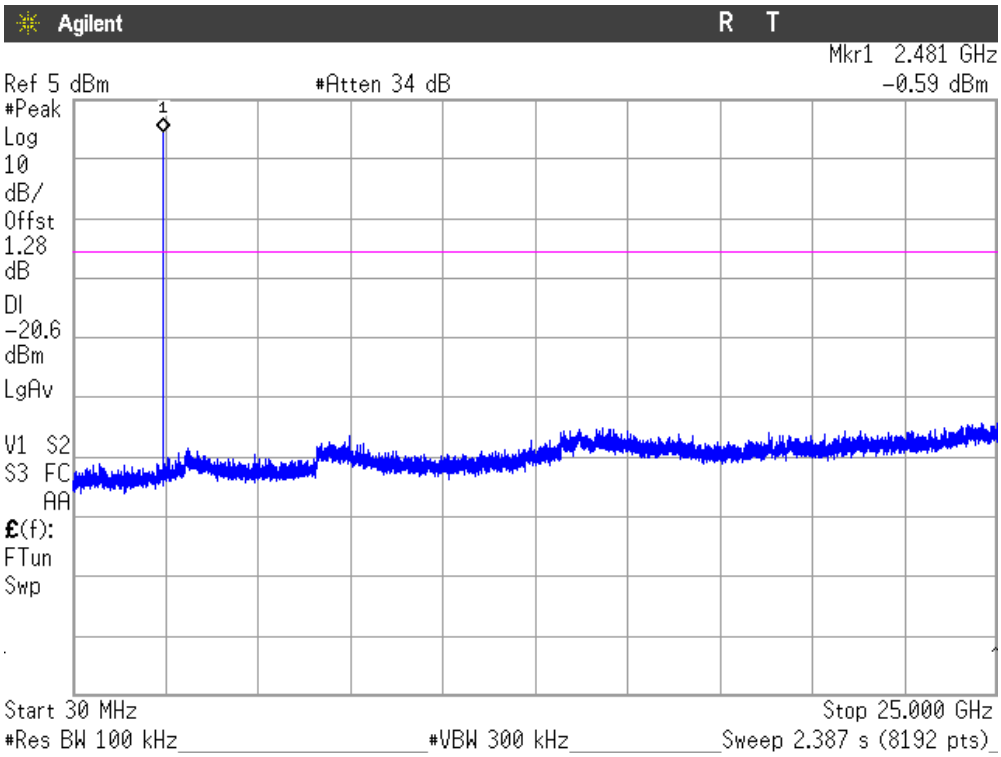
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peaks above the limits are the carrier frequencies.

Verdict:PASS

3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).

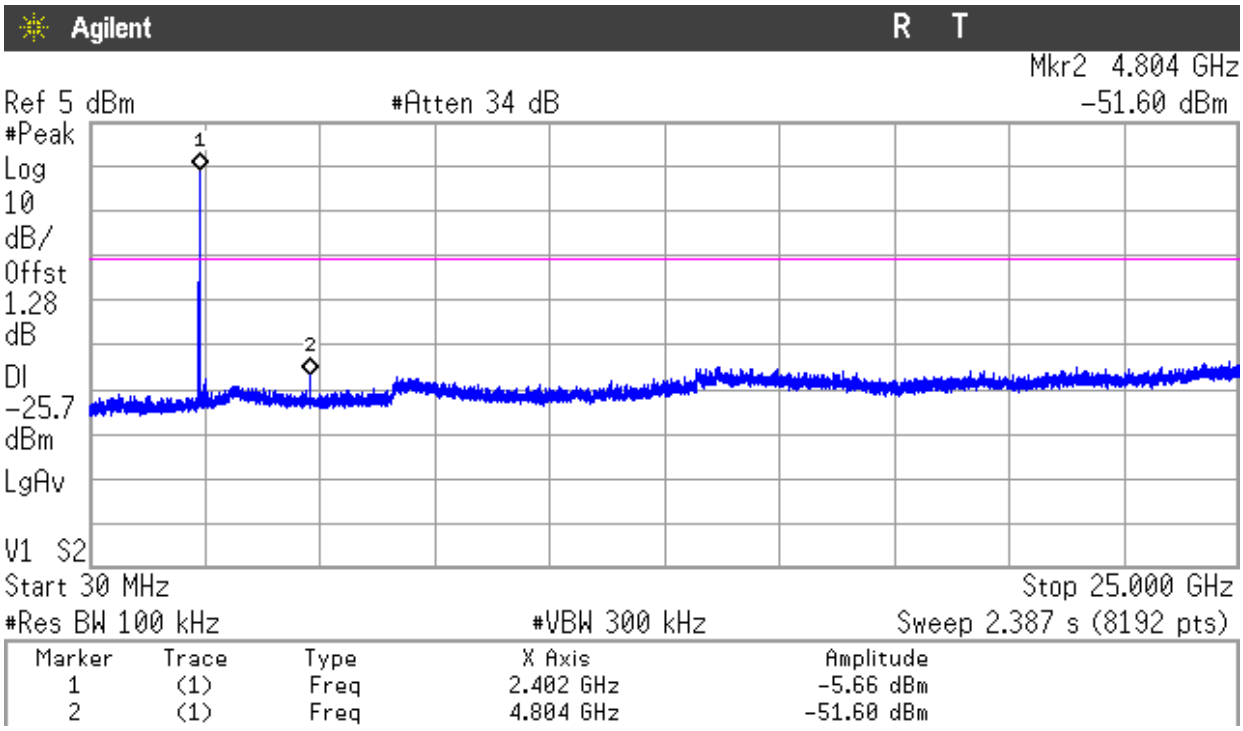


Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Modulation: 8-DPSK

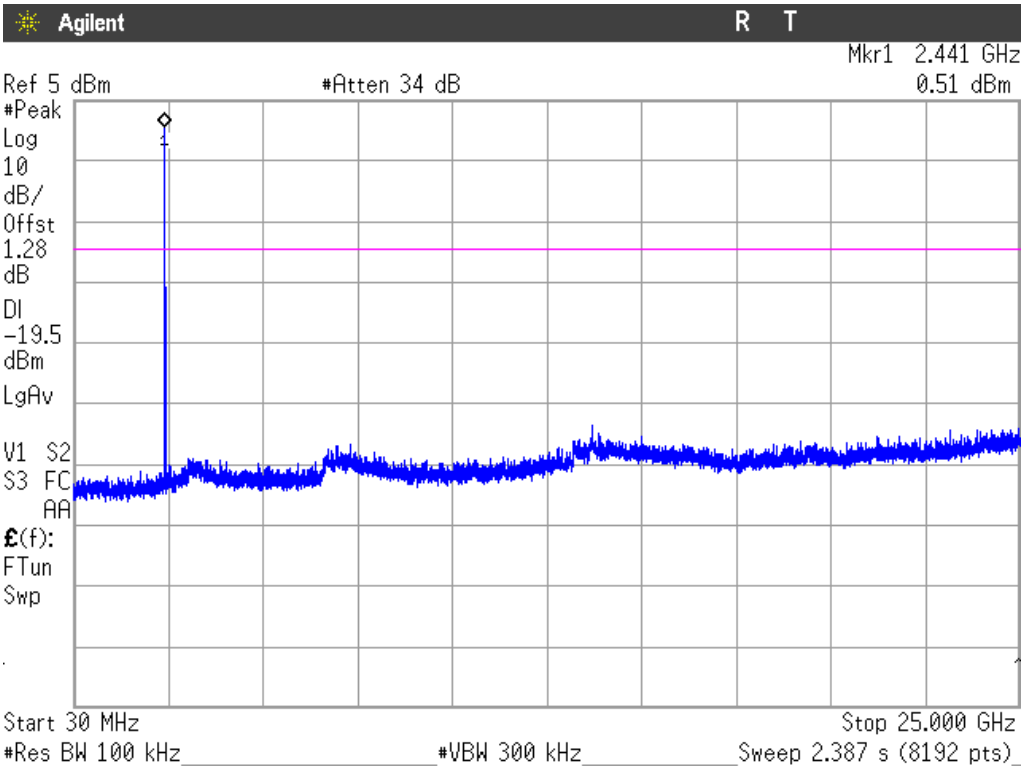
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

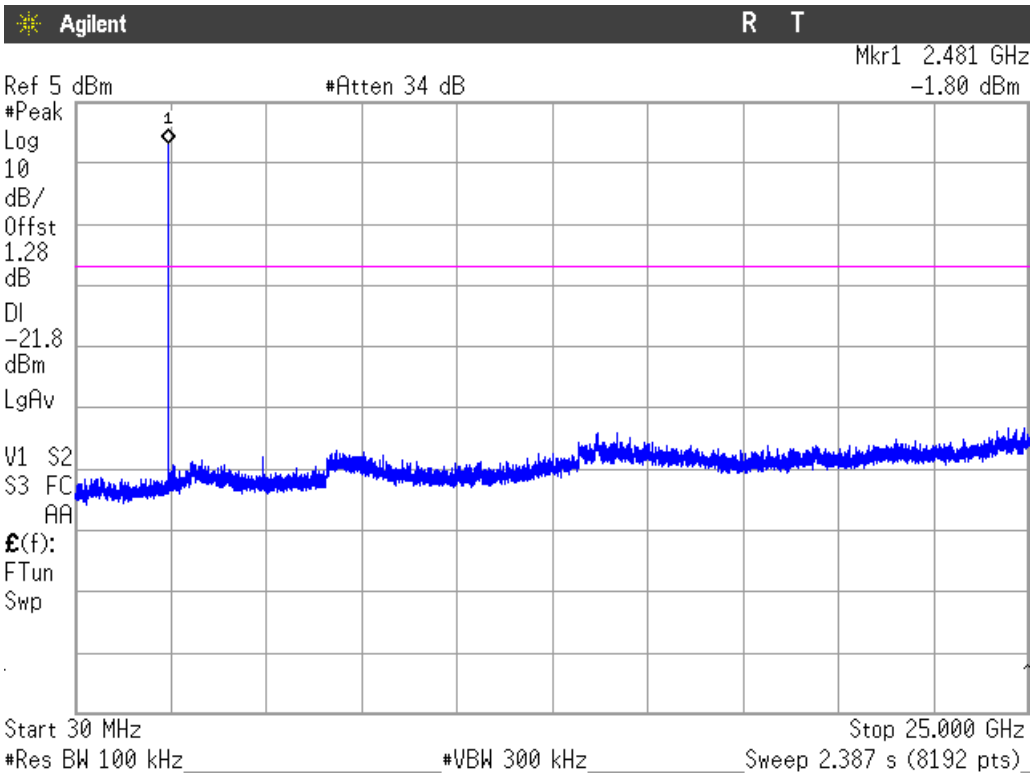
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peaks above the limit are the carrier frequencies.

Verdict: PASS

3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

FCC Section 15.247 Subclause (d) / RSS-210 Clause A8.5. 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)):

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)	-	300
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.

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-1000 MHz.

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

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
663.216	H	Quasi-peak	42.41	±4.12
875.064	H	Quasi-peak	40.64	±4.12

Frequency range 1 GHz-25 GHz

Modulation: GFSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.59110	H	Peak	45.65	± 4.0
	H	RMS	36.51	± 4.0
2.77197	H	Peak	48.85	± 4.0
	H	RMS	42.46	± 4.0
4.80424	V	Peak	51.92	± 4.0
	V	RMS	49.69	± 4.0
7.20599	V	Peak	48.15	± 4.0
	V	RMS	45.16	± 4.0

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.59730	V	Peak	50.83	± 4.0
	V	RMS	35.56	± 4.0
2.81597	V	Peak	48.93	± 4.0
	V	RMS	43.77	± 4.0
4.88191	H	Peak	51.27	± 4.0
	H	RMS	49.99	± 4.0
7.32266	H	Peak	53.05	± 4.0
	H	RMS	50.07	± 4.0

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.32697	H	Peak	46.04	± 4.0
	H	RMS	39.27	± 4.0
2.77190	H	Peak	49.26	± 4.0
	H	RMS	42.61	± 4.0
4.95959	V	Peak	56.04	± 4.0
	V	RMS	53.29	± 4.0
7.43999	V	Peak	50.00	± 4.0
	V	RMS	46.99	± 4.0

Verdict: PASS

Modulation: II/4-DQPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.37537	V	Peak	46.01	± 4.0
	V	RMS	36.58	± 4.0
1.59117	V	Peak	47.06	± 4.0
	V	RMS	39.27	± 4.0
3.56371	H	Peak	36.35	± 4.0
	H	RMS	32.96	± 4.0
4.80391	H	Peak	45.54	± 4.0
	H	RMS	40.34	± 4.0
7.20664	H	Peak	48.19	± 4.0
	H	RMS	41.86	± 4.0

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.32670	H	Peak	46.80	± 4.0
	H	RMS	40.81	± 4.0
2.816367	H	Peak	49.38	± 4.0
	H	RMS	41.09	± 4.0
4.88159	V	Peak	52.49	± 4.0
	V	RMS	47.39	± 4.0
7.32201	V	Peak	44.21	± 4.0
	V	RMS	35.59	± 4.0

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.59263	V	Peak	47.69	± 4.0
	V	RMS	37.51	± 4.0
2.81617	V	Peak	49.45	± 4.0
	V	RMS	42.85	± 4.0
3.56371	H	Peak	36.36	± 4.0
	H	RMS	32.45	± 4.0
4.96024	H	Peak	52.42	± 4.0
	H	RMS	46.98	± 4.0
7.43934	H	Peak	46.12	± 4.0
	H	RMS	38.81	± 4.0

Verdict: PASS

Modulation: 8-DPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.59150	V	Peak	47.33	± 4.0
	V	RMS	41.30	± 4.0
1.85717	V	Peak	43.86	± 4.0
	V	RMS	35.68	± 4.0
3.56371	H	Peak	36.23	± 4.0
	H	RMS	32.75	± 4.0
4.80424	H	Peak	45.25	± 4.0
	H	RMS	42.55	± 4.0
7.20631	H	Peak	49.14	± 4.0
	H	RMS	41.01	± 4.0

2. CHANNEL: MIDDLE (2441 MHz).

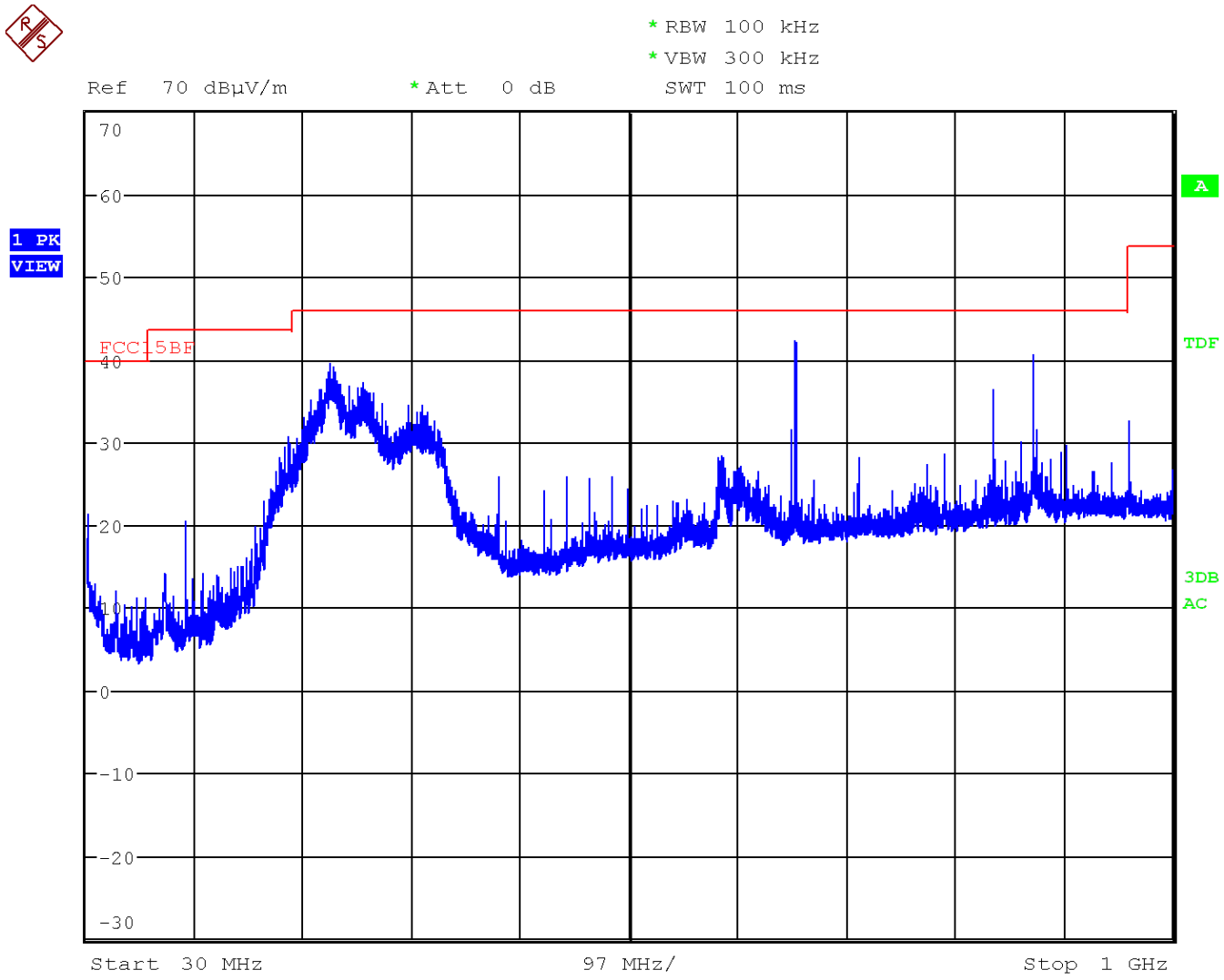
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.59257	H	Peak	46.59	± 4.0
	H	RMS	36.71	± 4.0
2.77197	H	Peak	49.01	± 4.0
	H	RMS	42.63	± 4.0
3.31671	V	Peak	33.31	± 4.0
	V	RMS	25.09	± 4.0
4.88191	V	Peak	53.08	± 4.0
	V	RMS	47.83	± 4.0
7.32299	V	Peak	44.01	± 4.0
	V	RMS	37.02	± 4.0

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.59223	V	Peak	47.02	± 4.0
	V	RMS	40.40	± 4.0
1.85717	V	Peak	46.19	± 4.0
	V	RMS	41.07	± 4.0
3.56404	H	Peak	36.11	± 4.0
	H	RMS	32.19	± 4.0
4.95991	H	Peak	52.70	± 4.0
	H	RMS	47.51	± 4.0
7.43966	H	Peak	47.49	± 4.0
	H	RMS	39.16	± 4.0

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

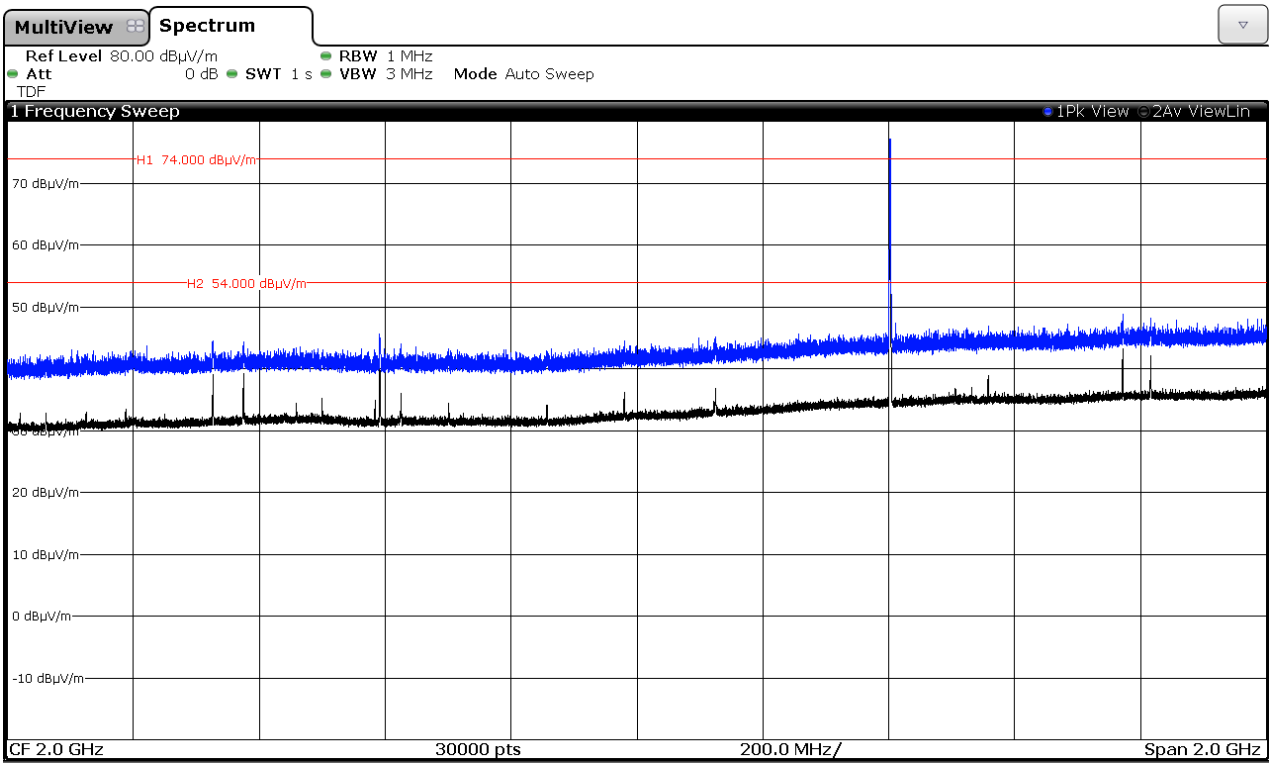


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

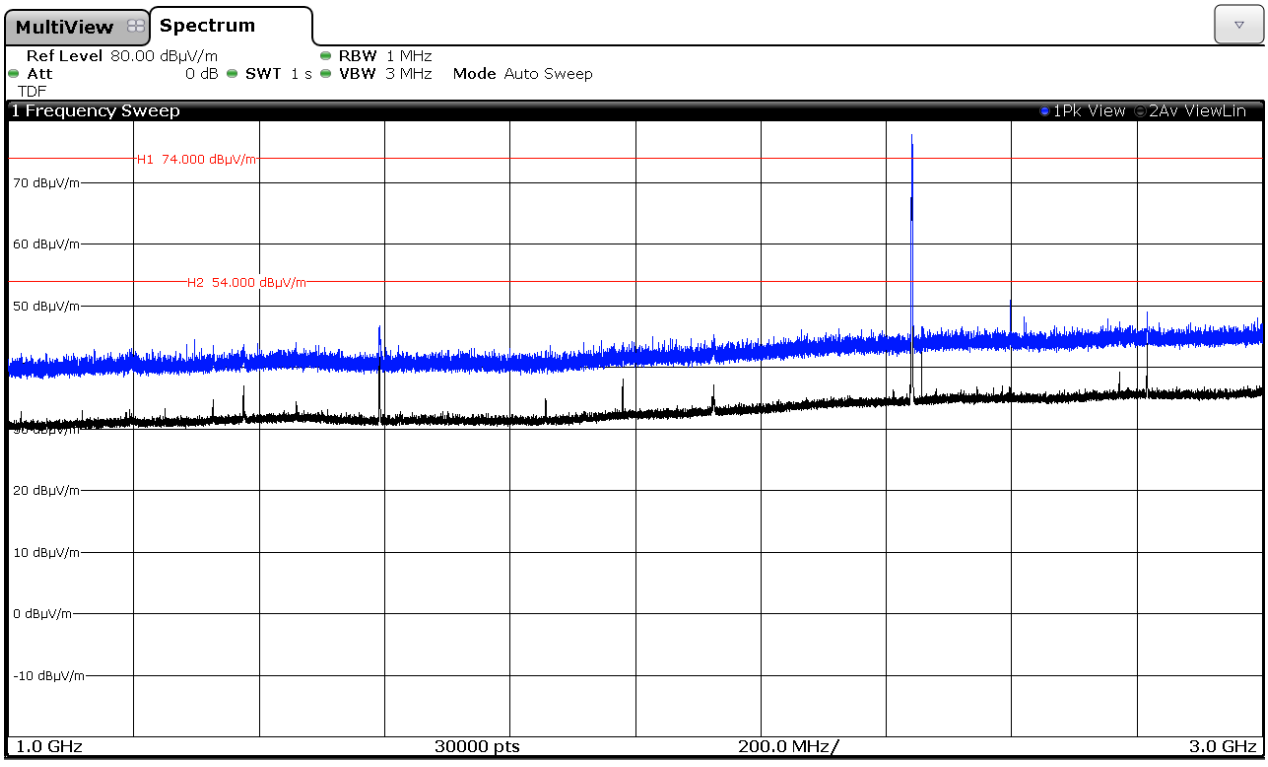
Modulation: GFSK

CHANNEL: Lowest (2402 MHz).



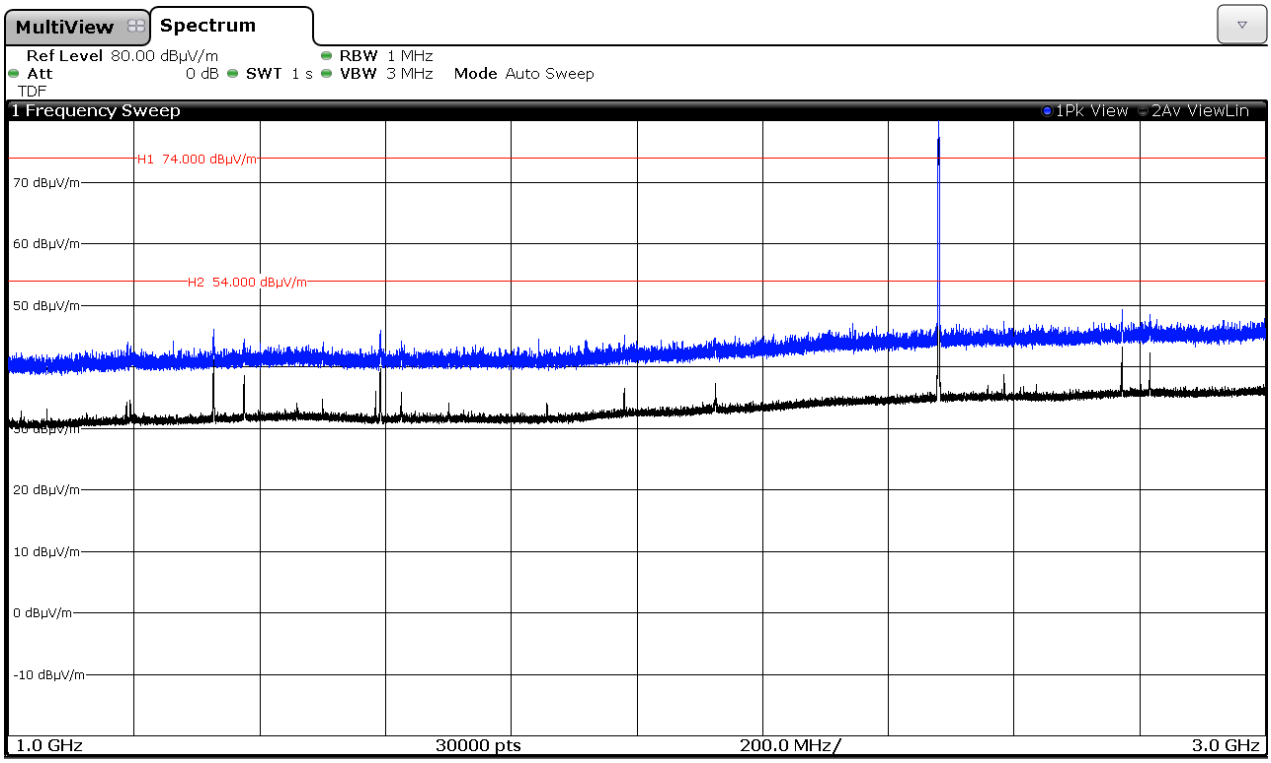
Note: The peak shown in the plot is the carrier frequency.

CHANNEL: Middle (2441 MHz).



Note: The peak shown in the plot is the carrier frequency.

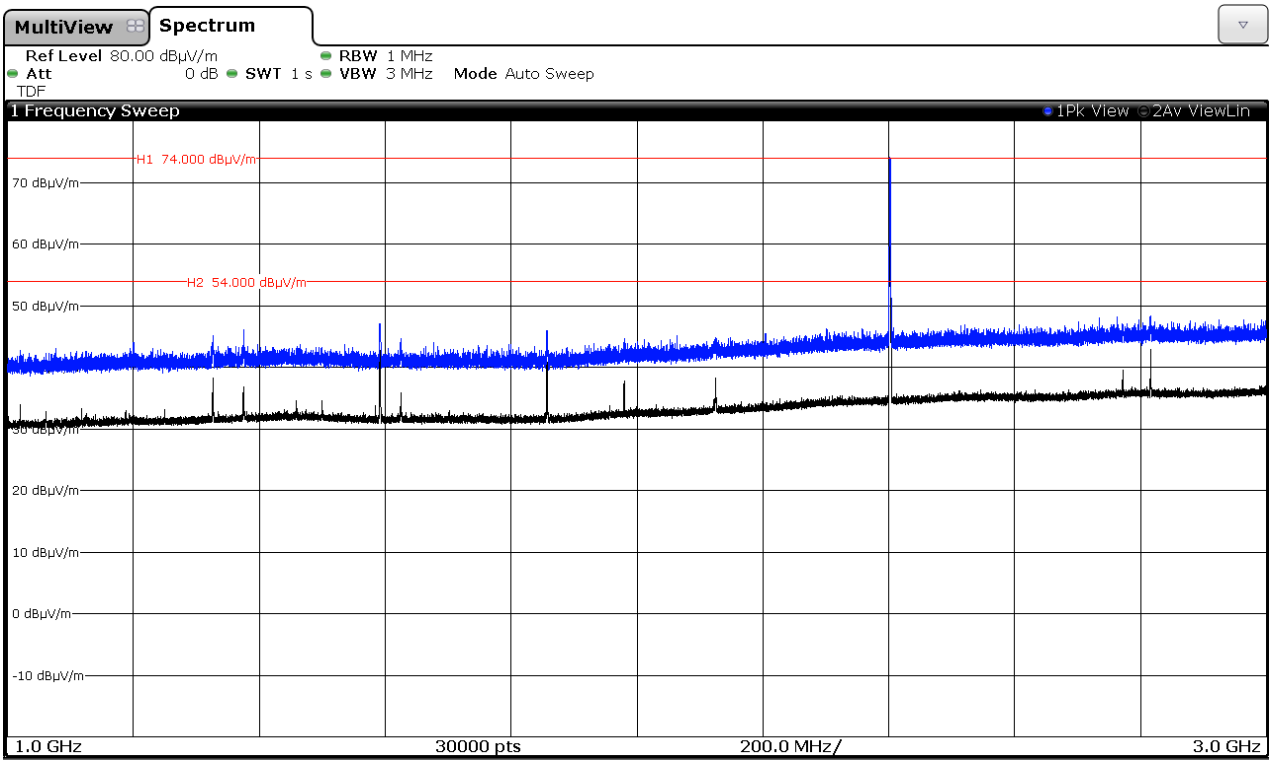
CHANNEL: Highest (2480 MHz).



Note: The peak shown in the plot is the carrier frequency.

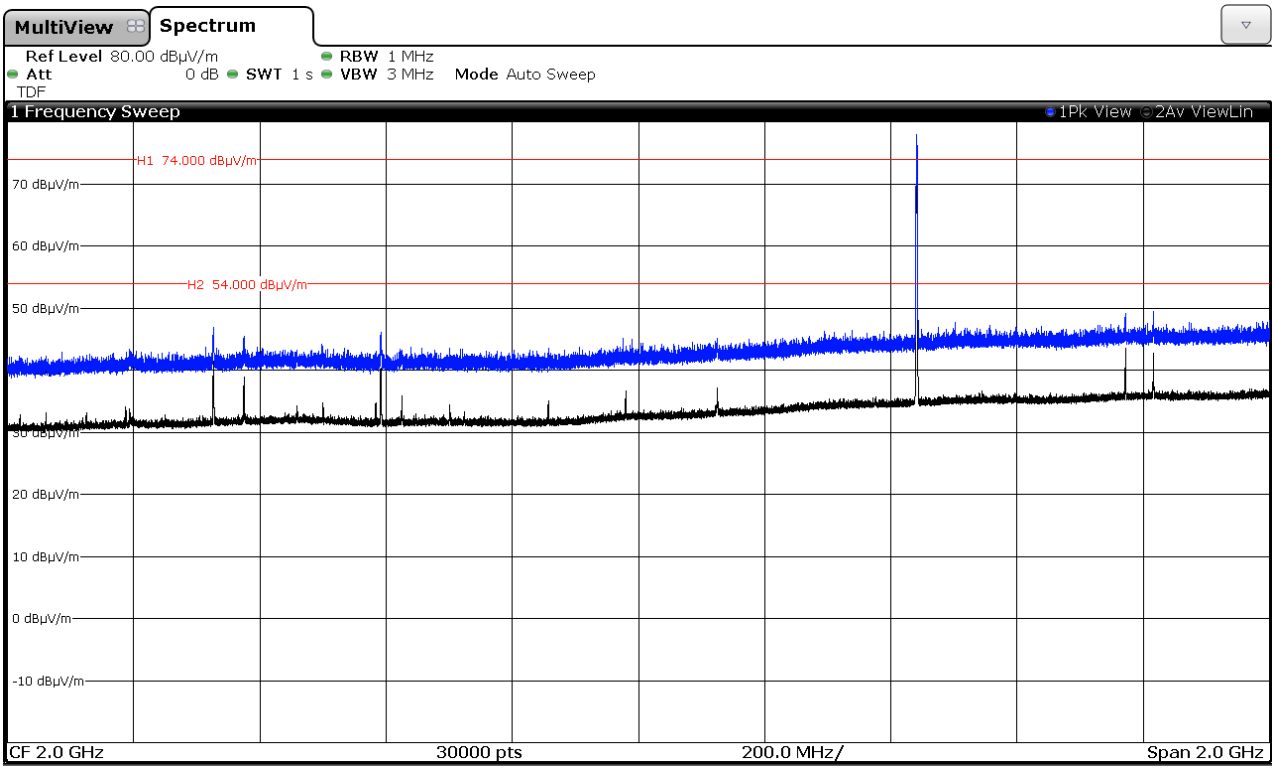
Modulation: Π/4-DQPSK

CHANNEL: Lowest (2402 MHz).



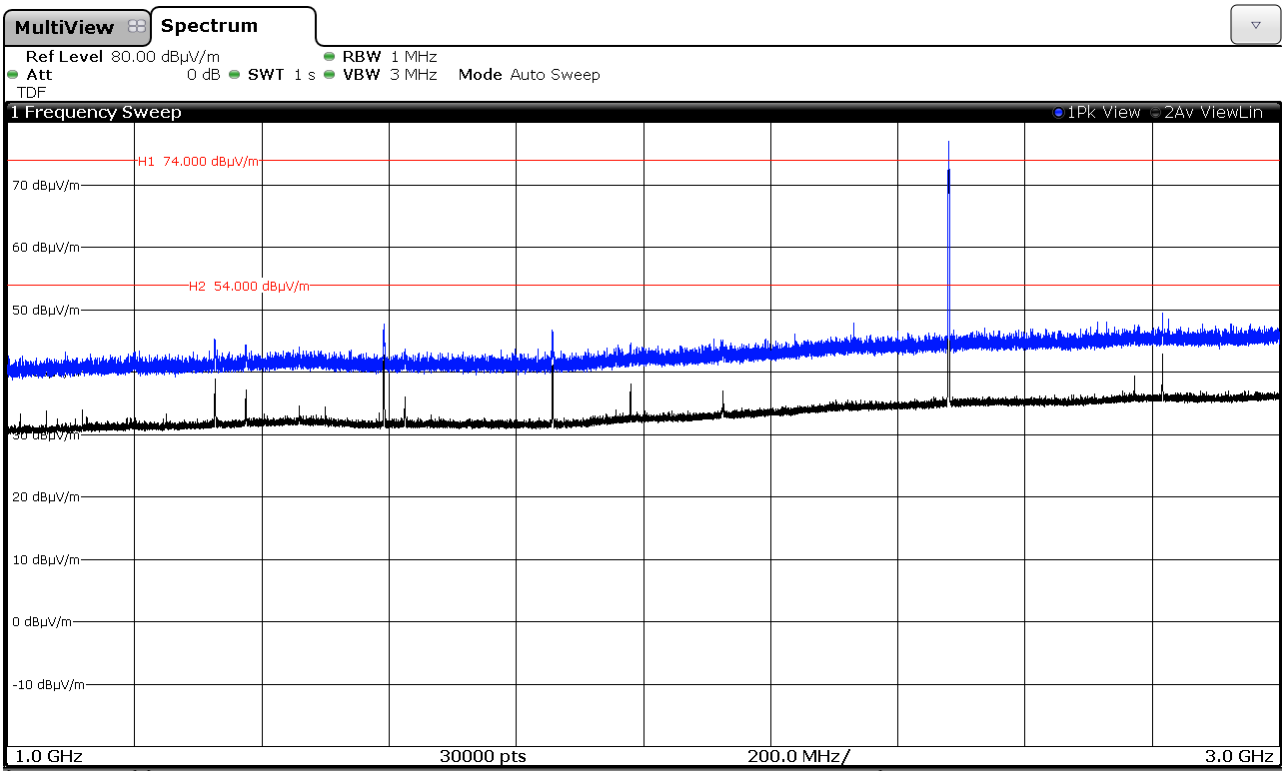
Note: The peak shown in the plot is the carrier frequency.

CHANNEL: Middle (2441 MHz).



Note: The peak shown in the plot is the carrier frequency.

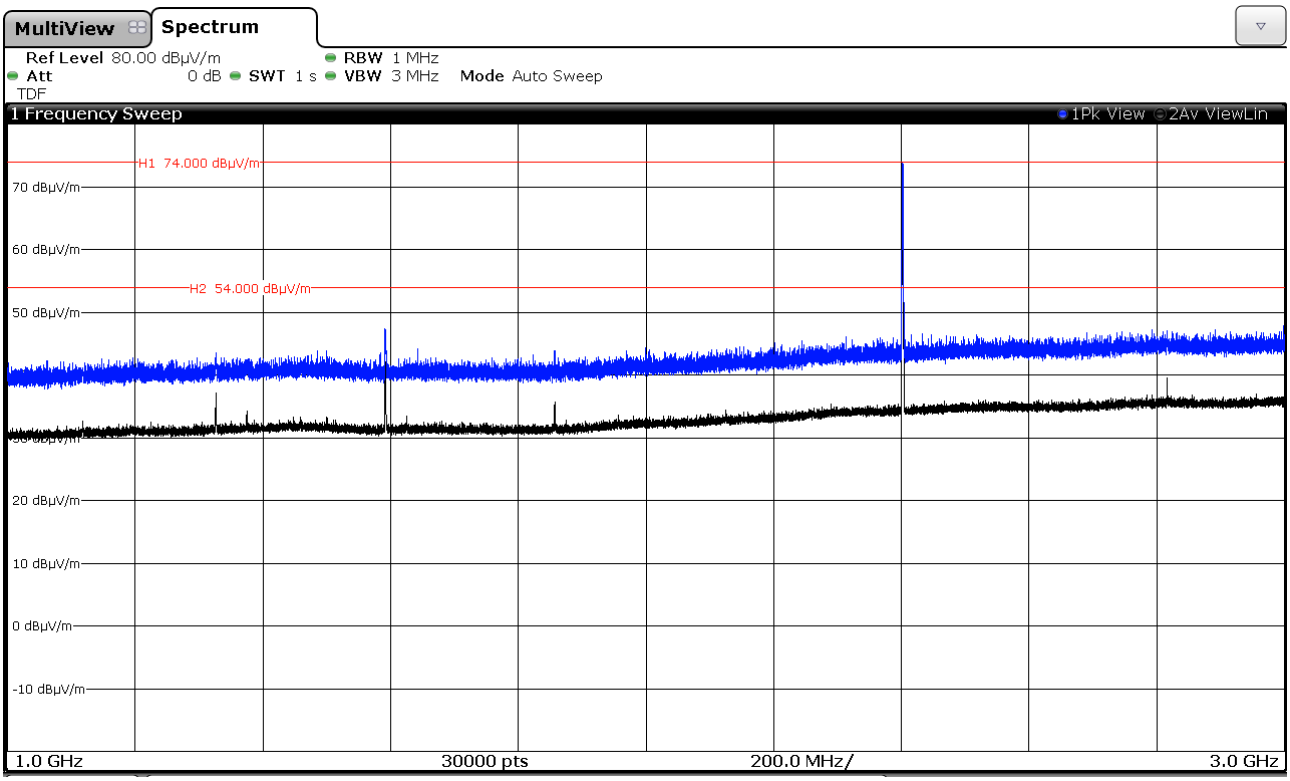
CHANNEL: Highest (2480 MHz).



Note: The peak shown in the plot is the carrier frequency.

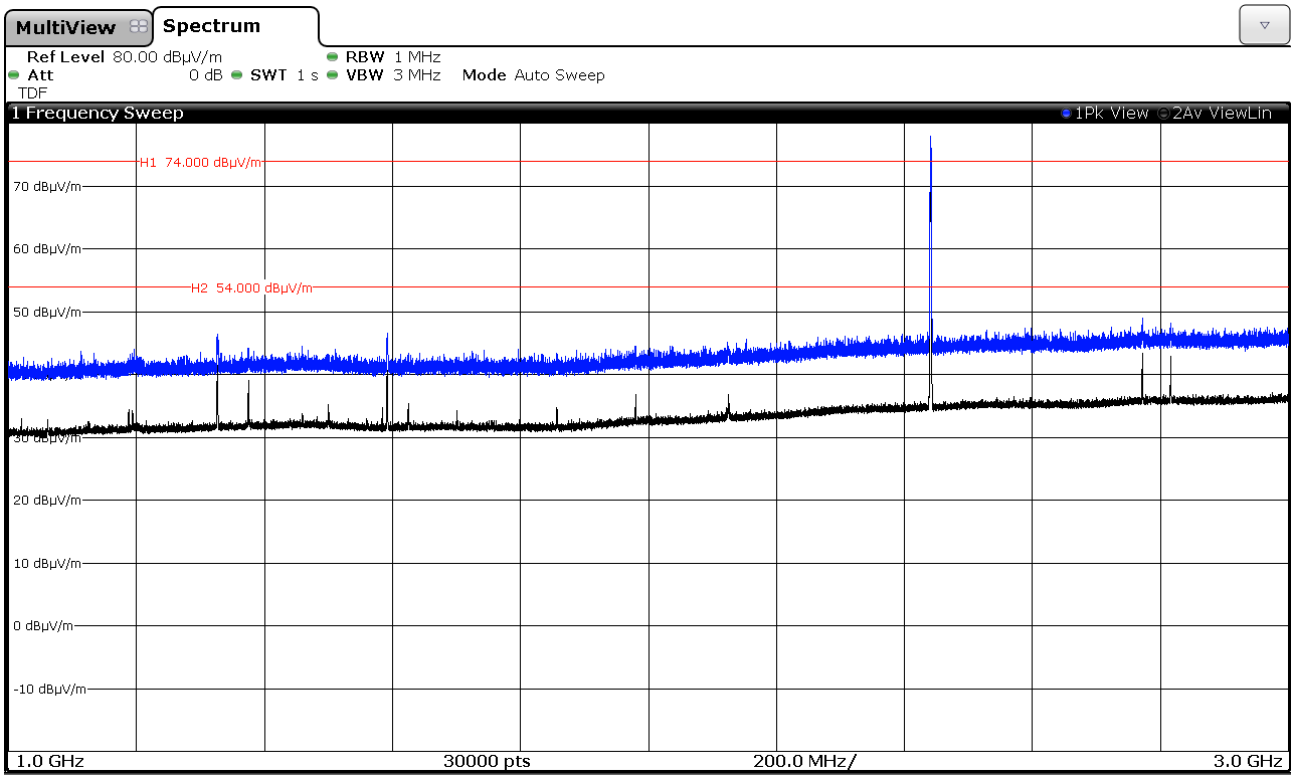
Modulation: 8-DPSK

CHANNEL: Lowest (2402 MHz).



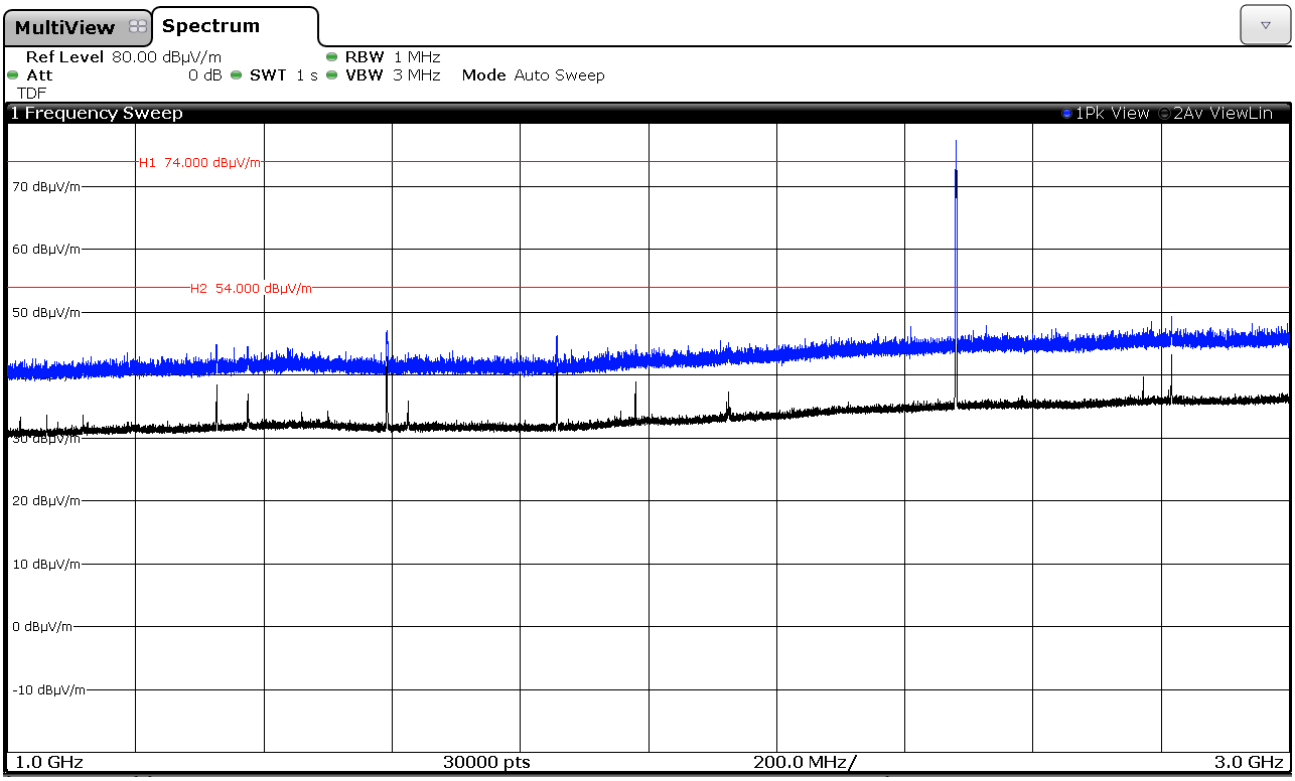
Note: The peak shown in the plot is the carrier frequency.

CHANNEL: Middle (2441 MHz).



Note: The peak shown in the plot is the carrier frequency.

CHANNEL: Highest (2480 MHz).

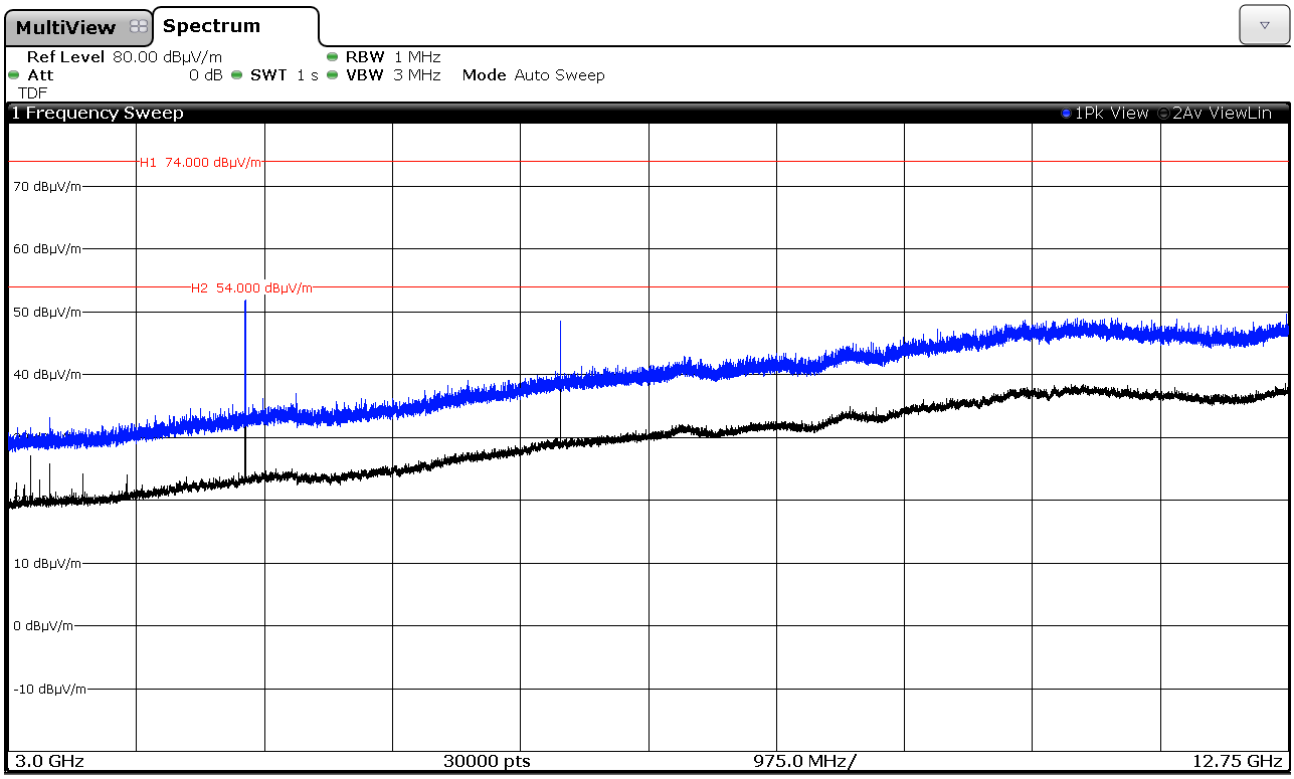


Note: The peak shown in the plot is the carrier frequency.

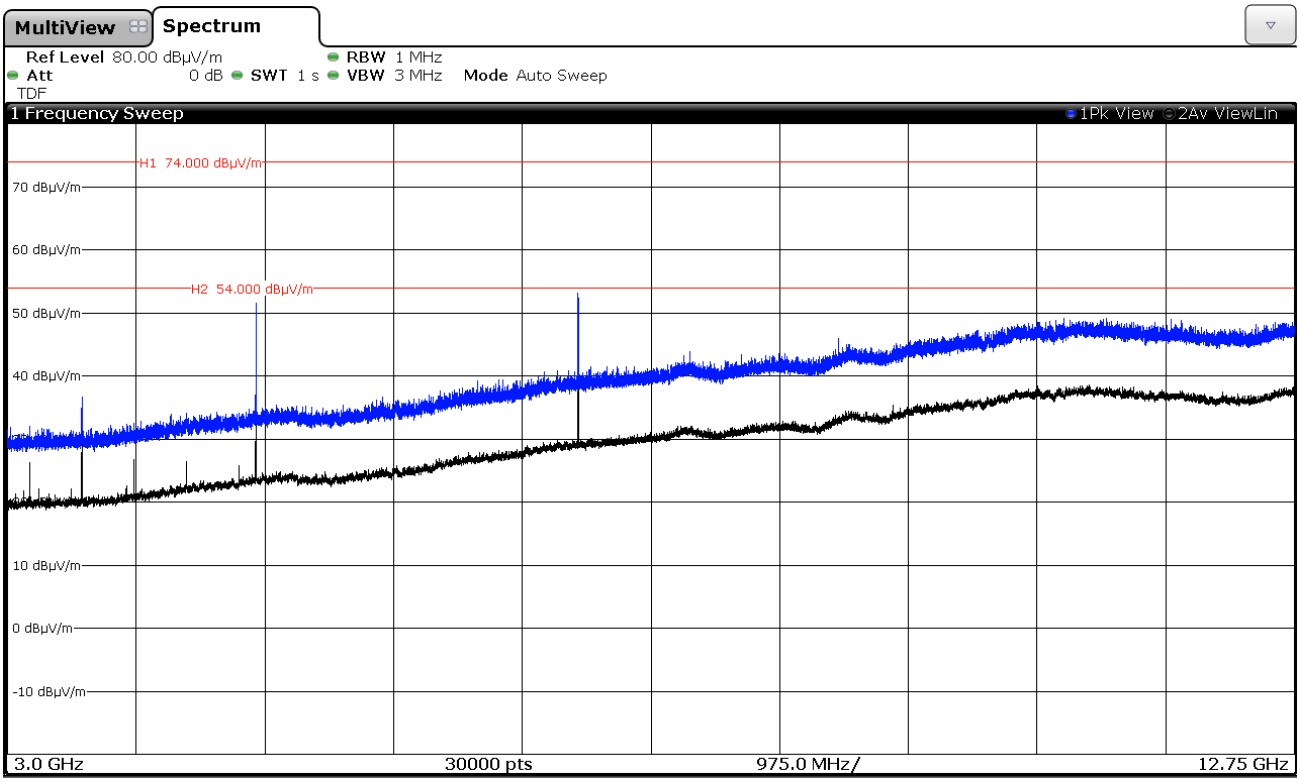
FREQUENCY RANGE 3 GHz to 12,75 GHz.

Modulation: GFSK

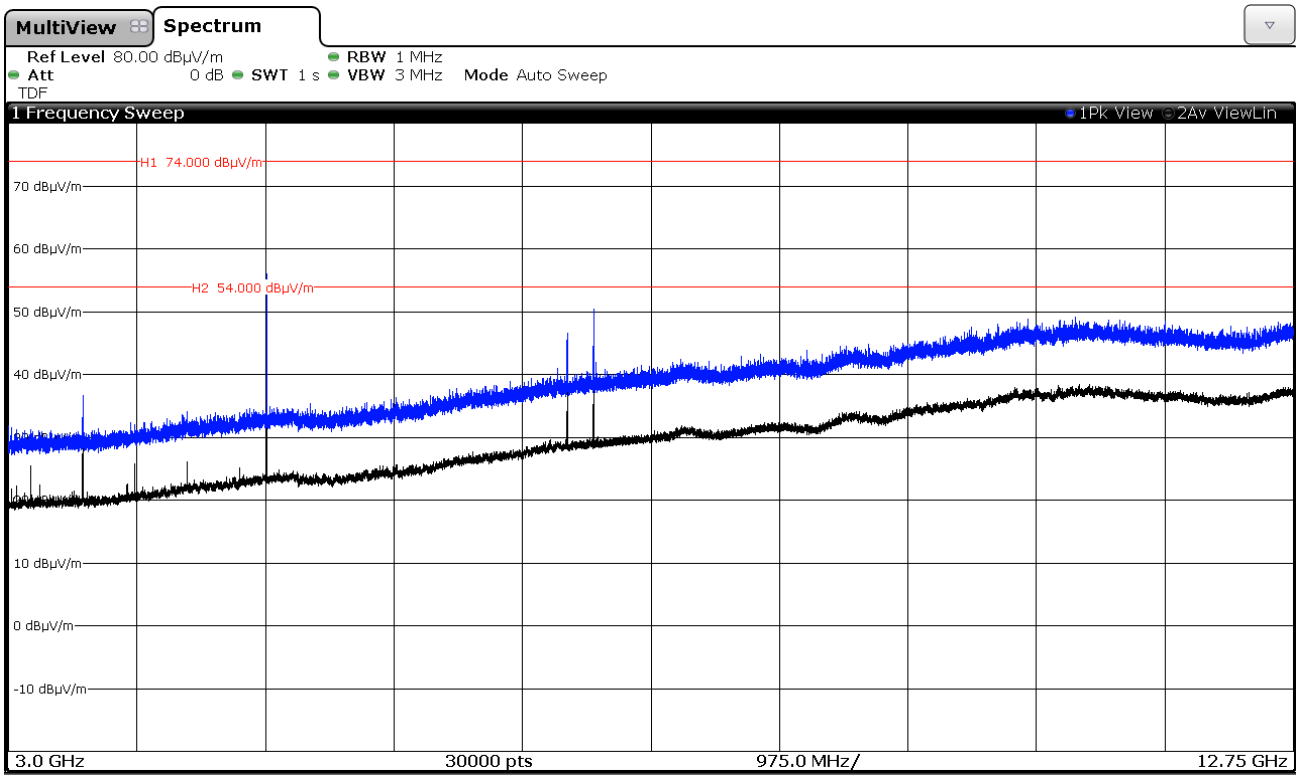
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

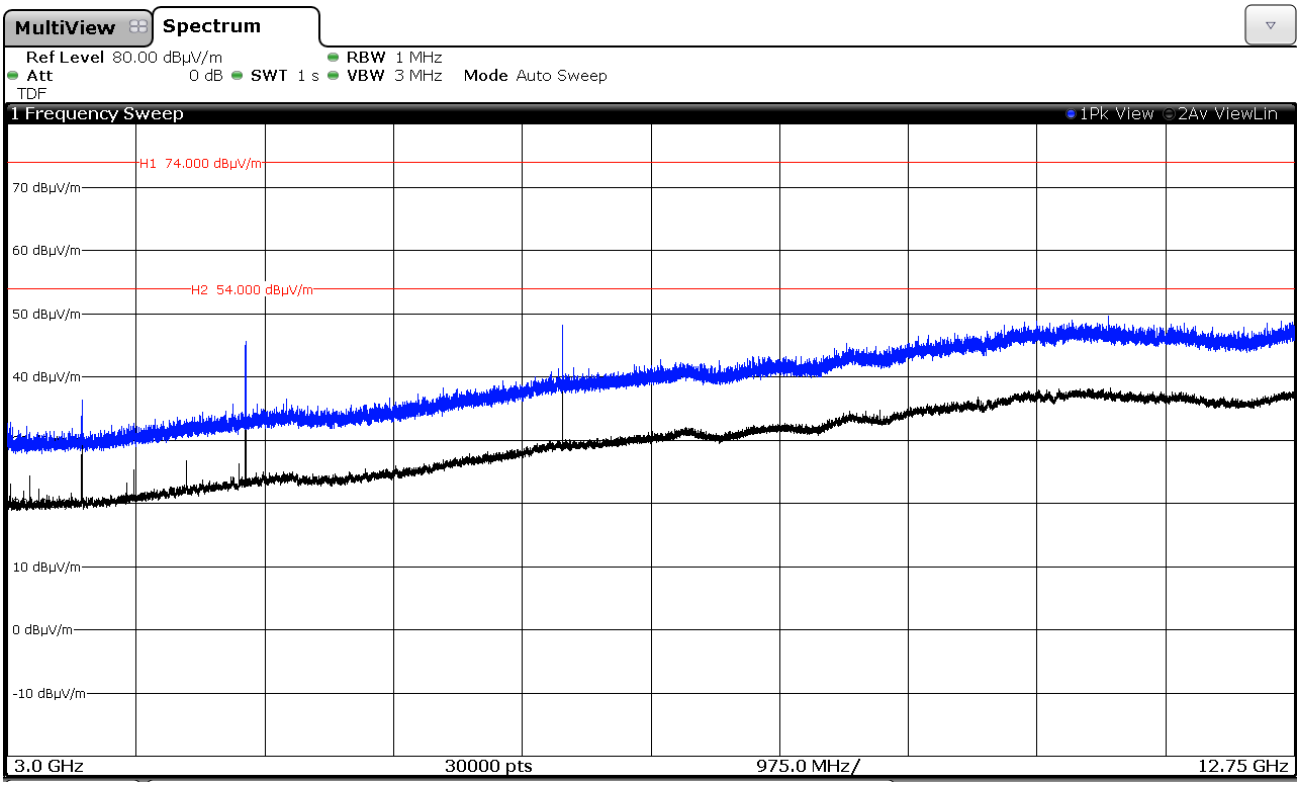


CHANNEL: Highest (2480 MHz).

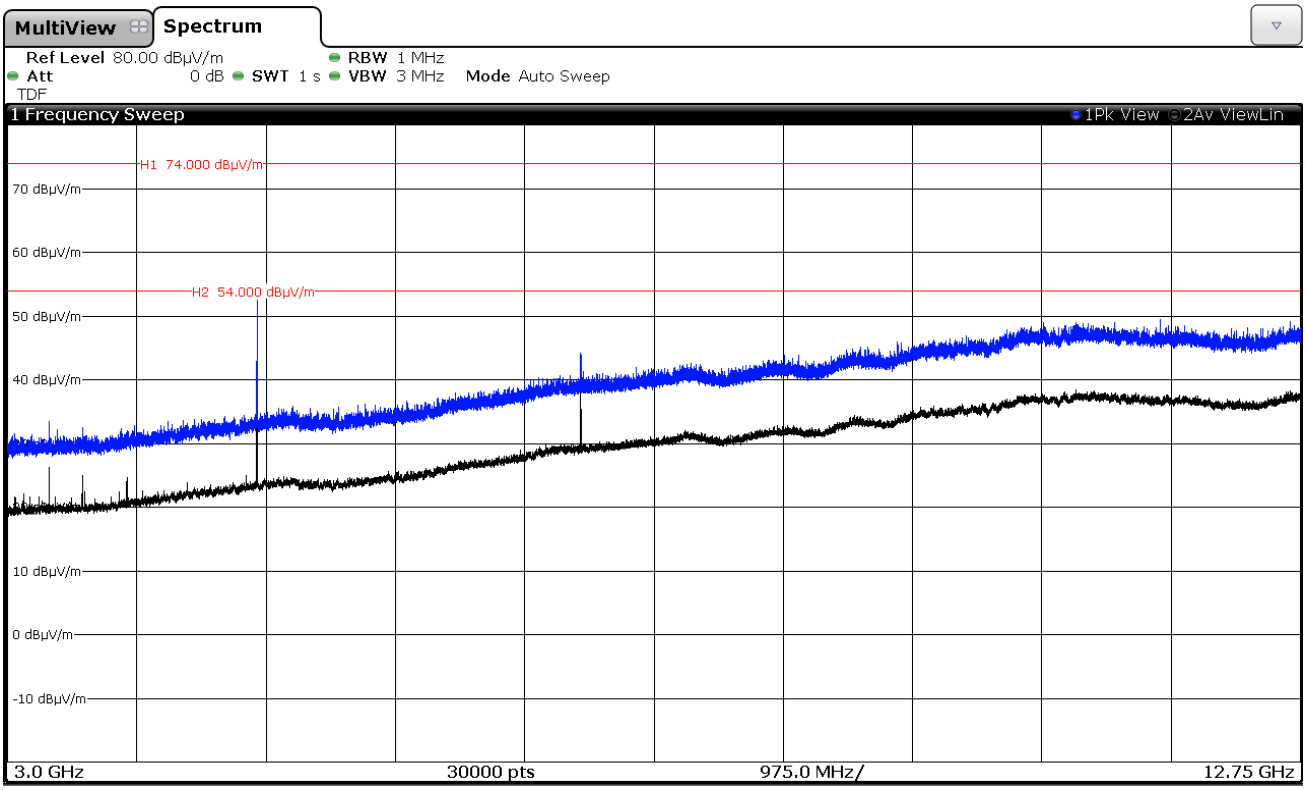


Modulation: Π/4-DQPSK

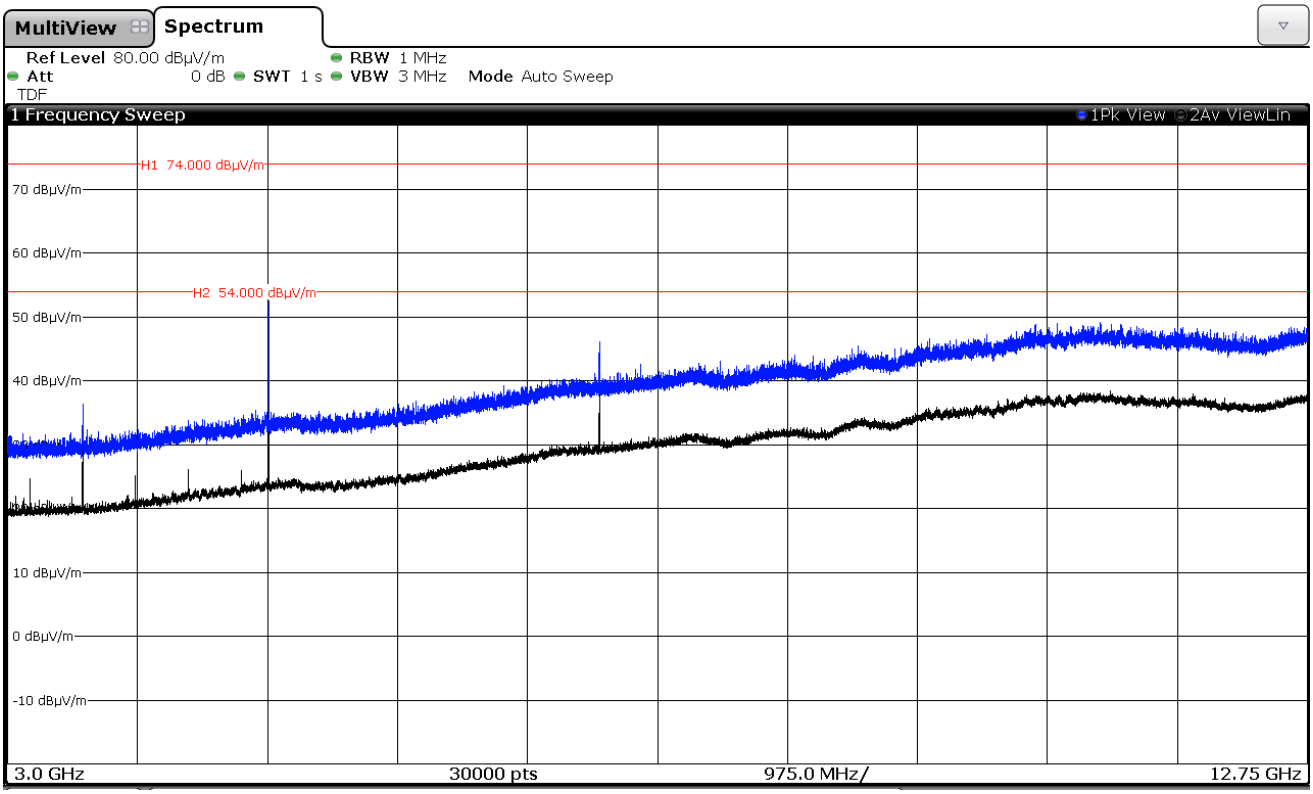
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

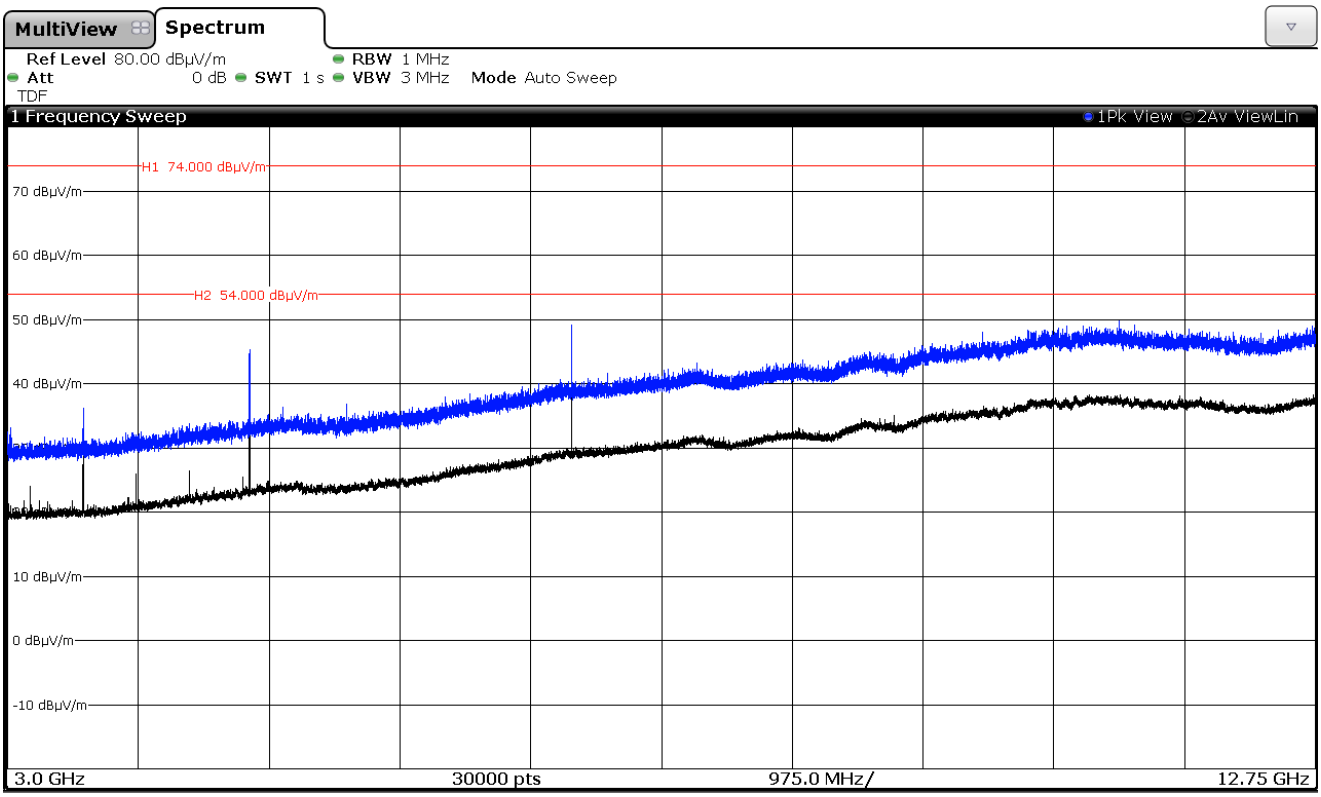


CHANNEL: Highest (2480 MHz).

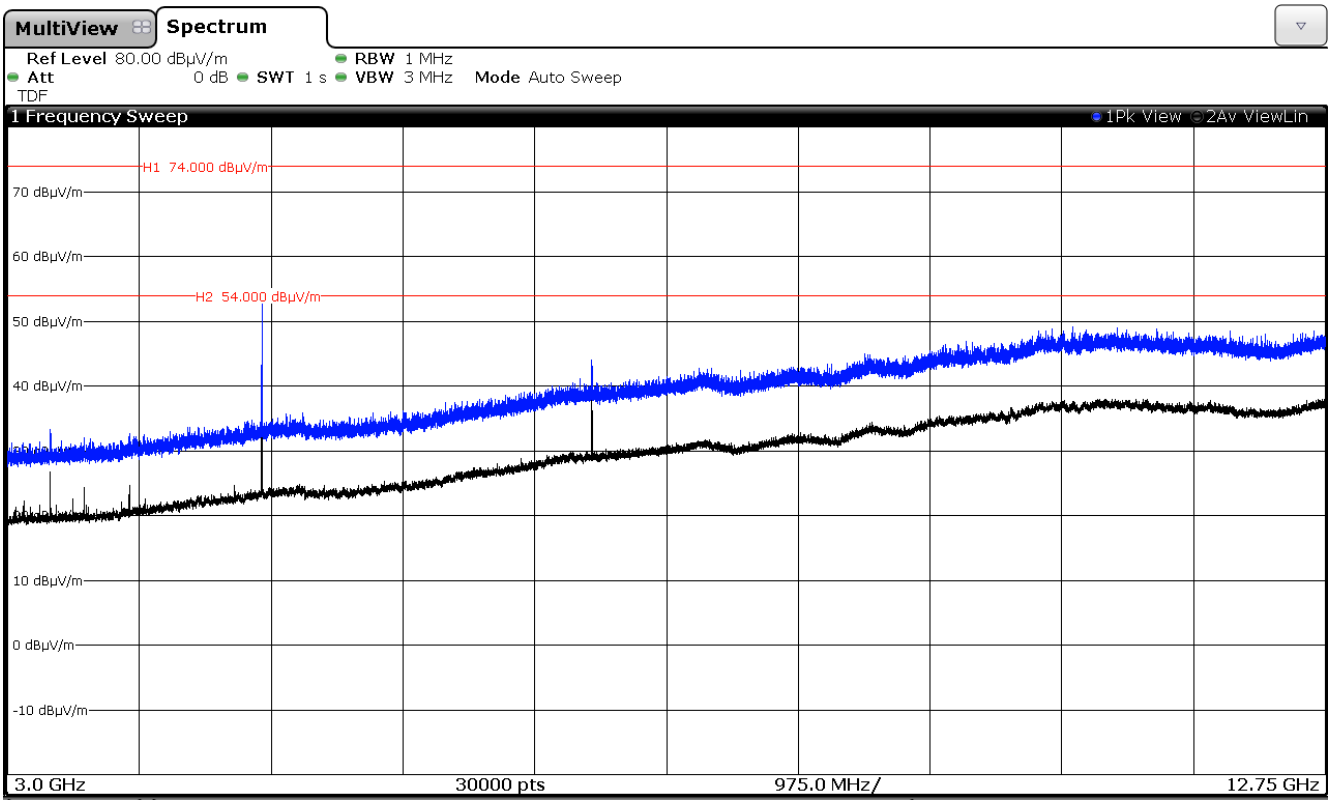


Modulation: 8-DPSK

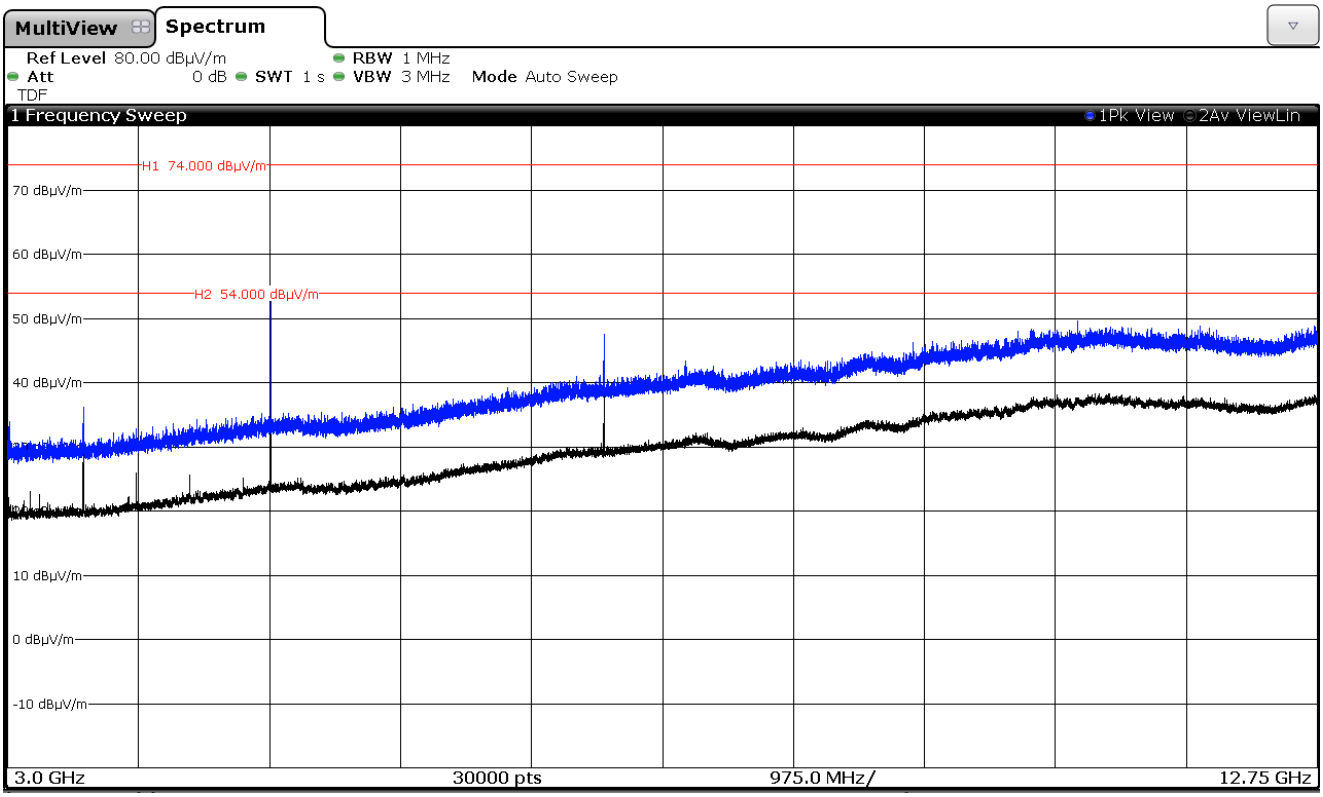
CHANNEL: Lowest (2402 MHz).



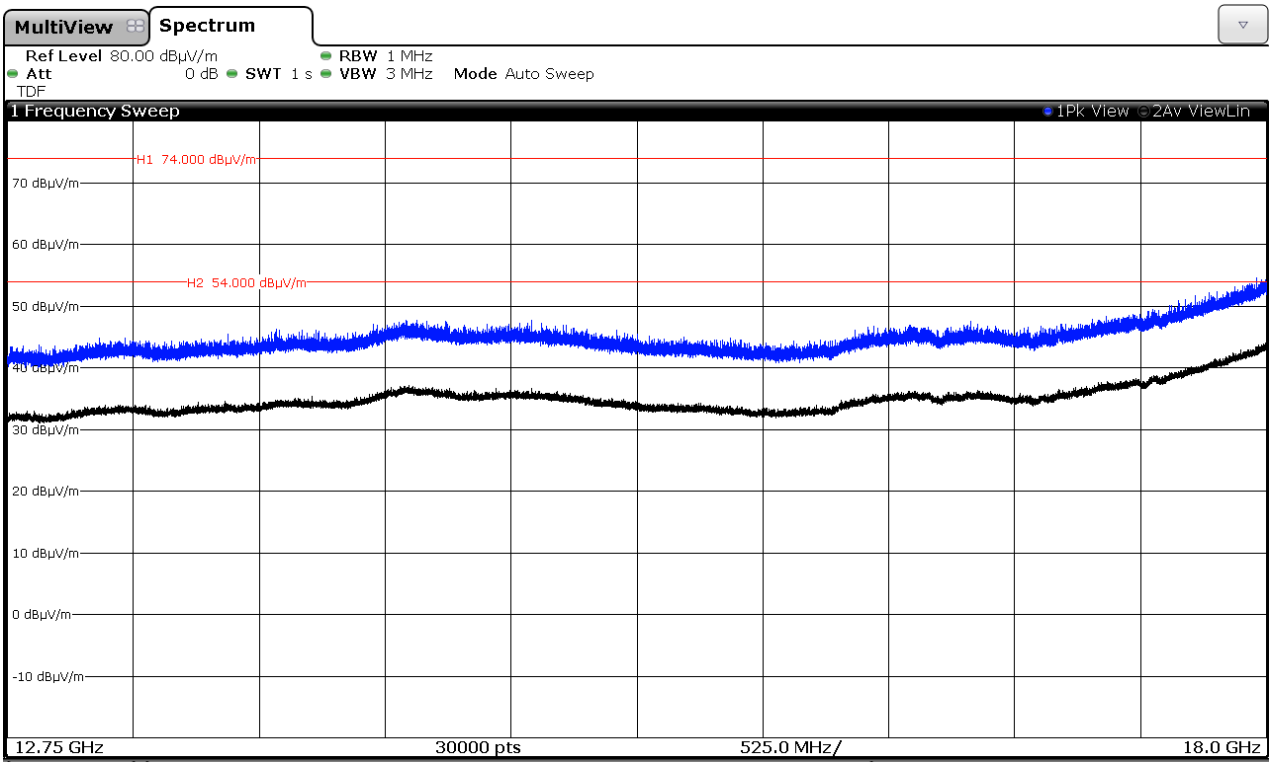
CHANNEL: Middle (2441 MHz).



CHANNEL: Highest (2480 MHz).

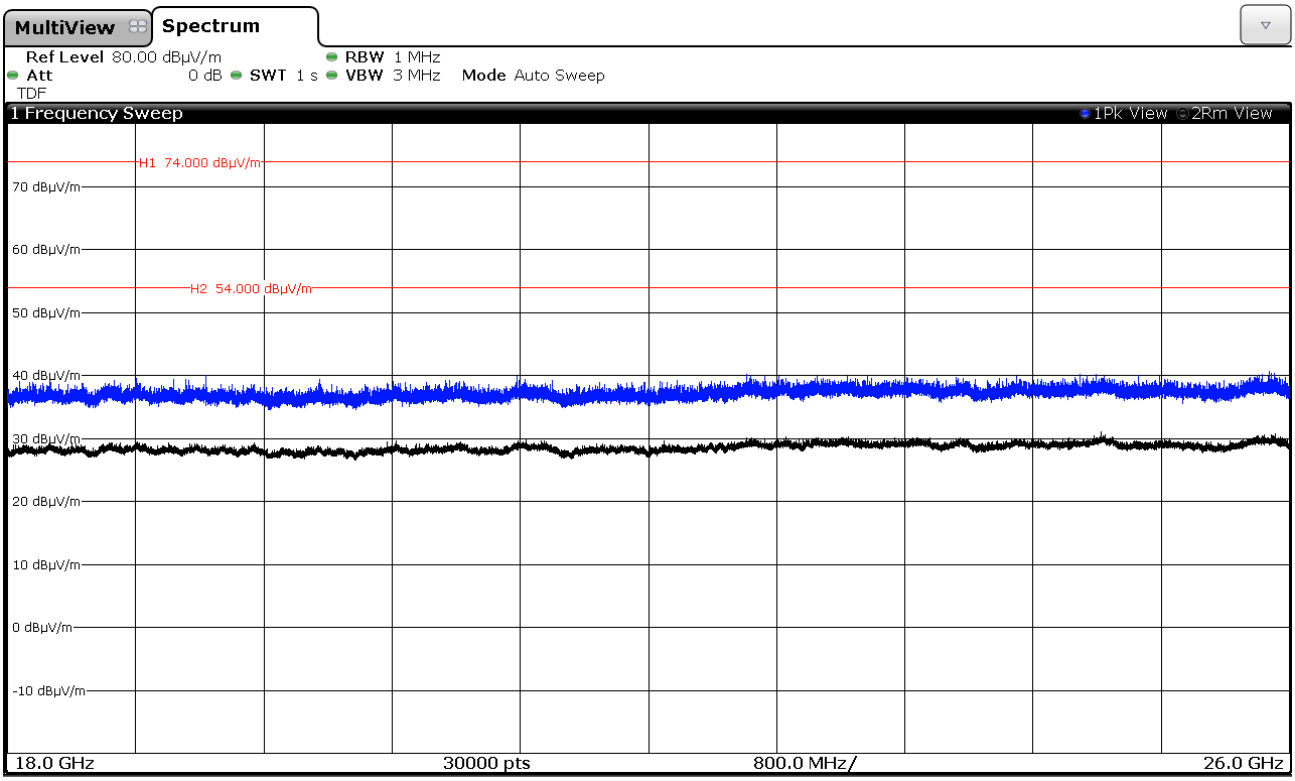


FREQUENCY RANGE 12 GHz to 18 GHz.



(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 18 GHz to 26 GHz.

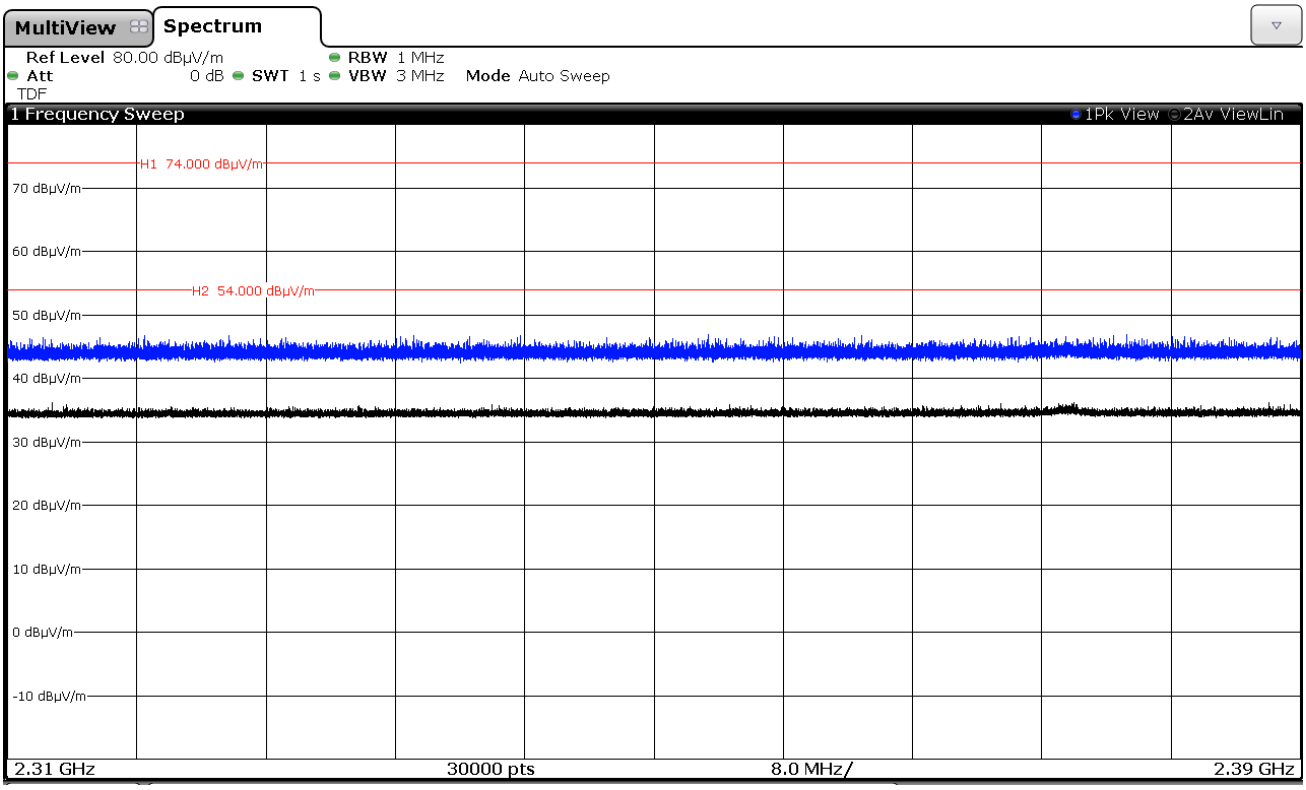


(This plot is valid for all three channels and all modulation modes).

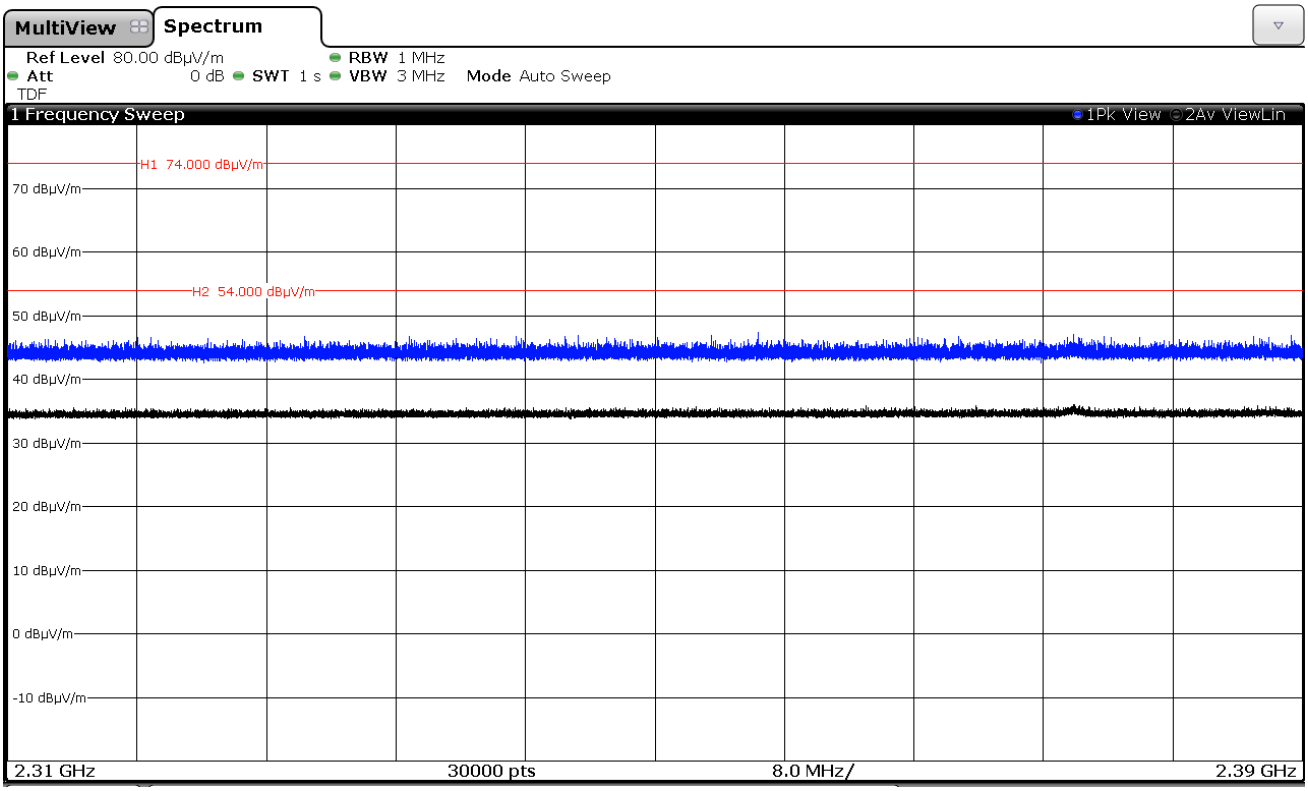
FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

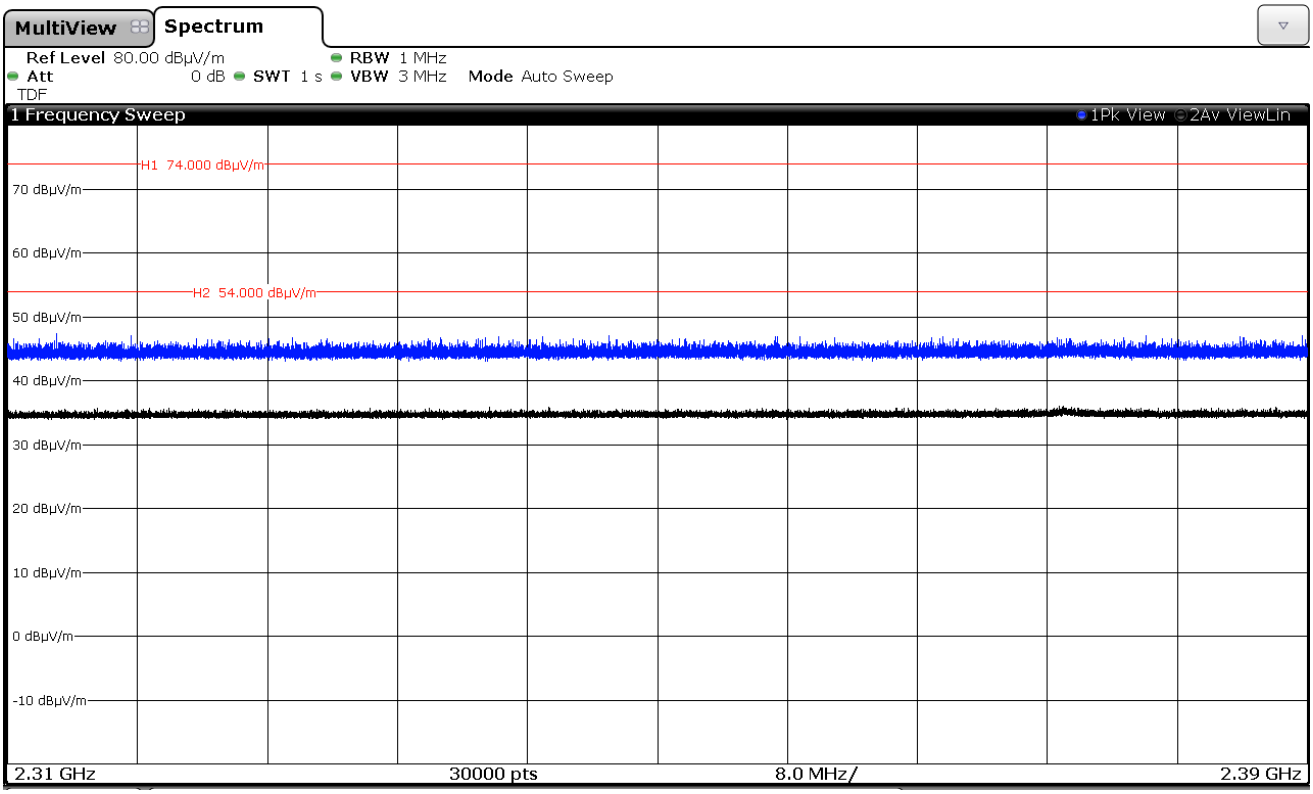
Modulation: GFSK



Modulation: Π/4-DQPSK

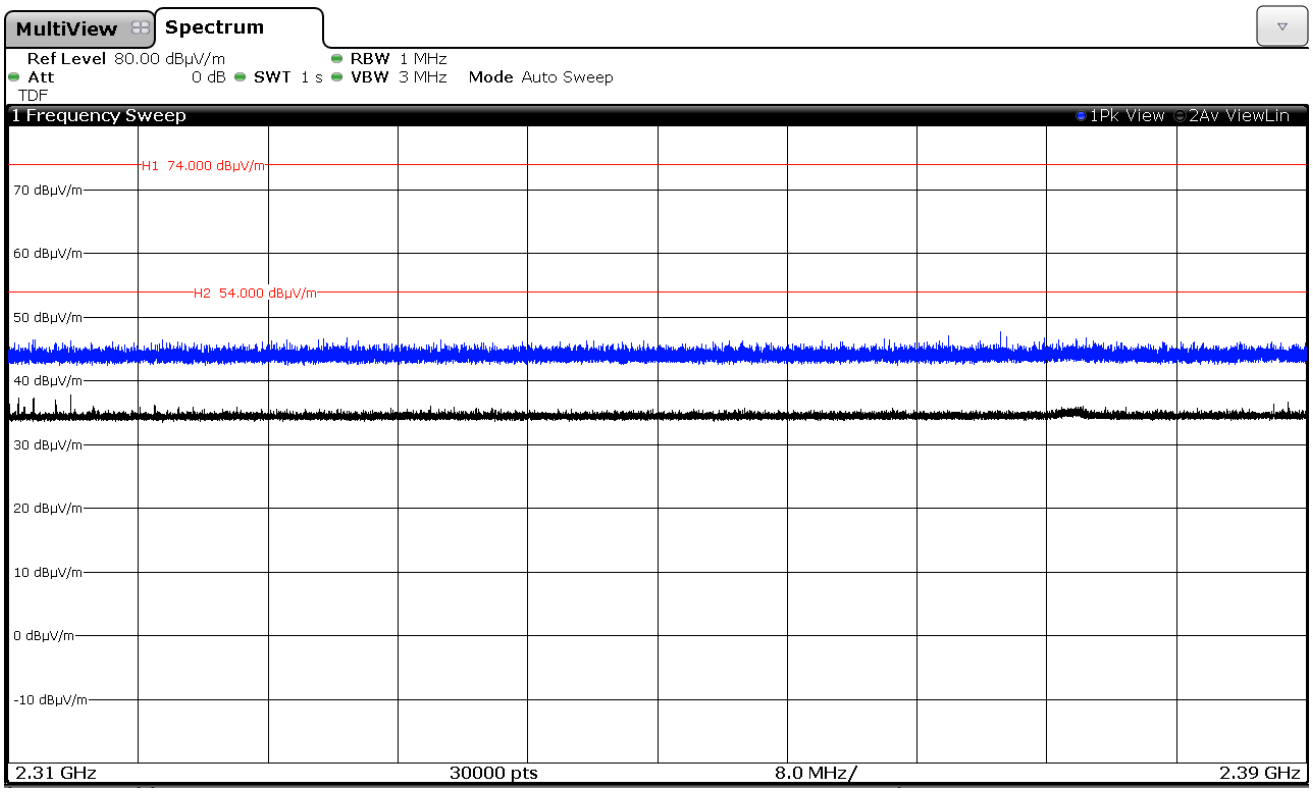


Modulation: 8-DPSK

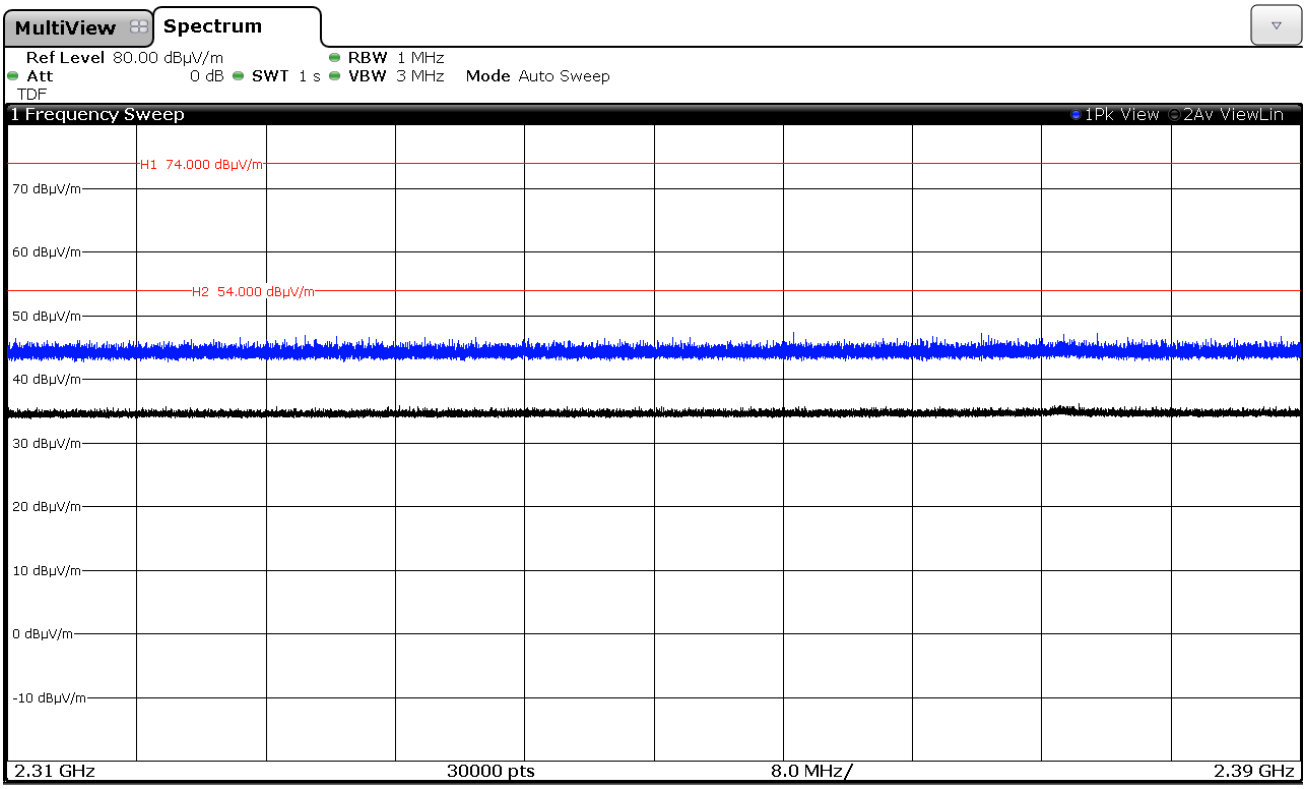


CHANNEL: Middle

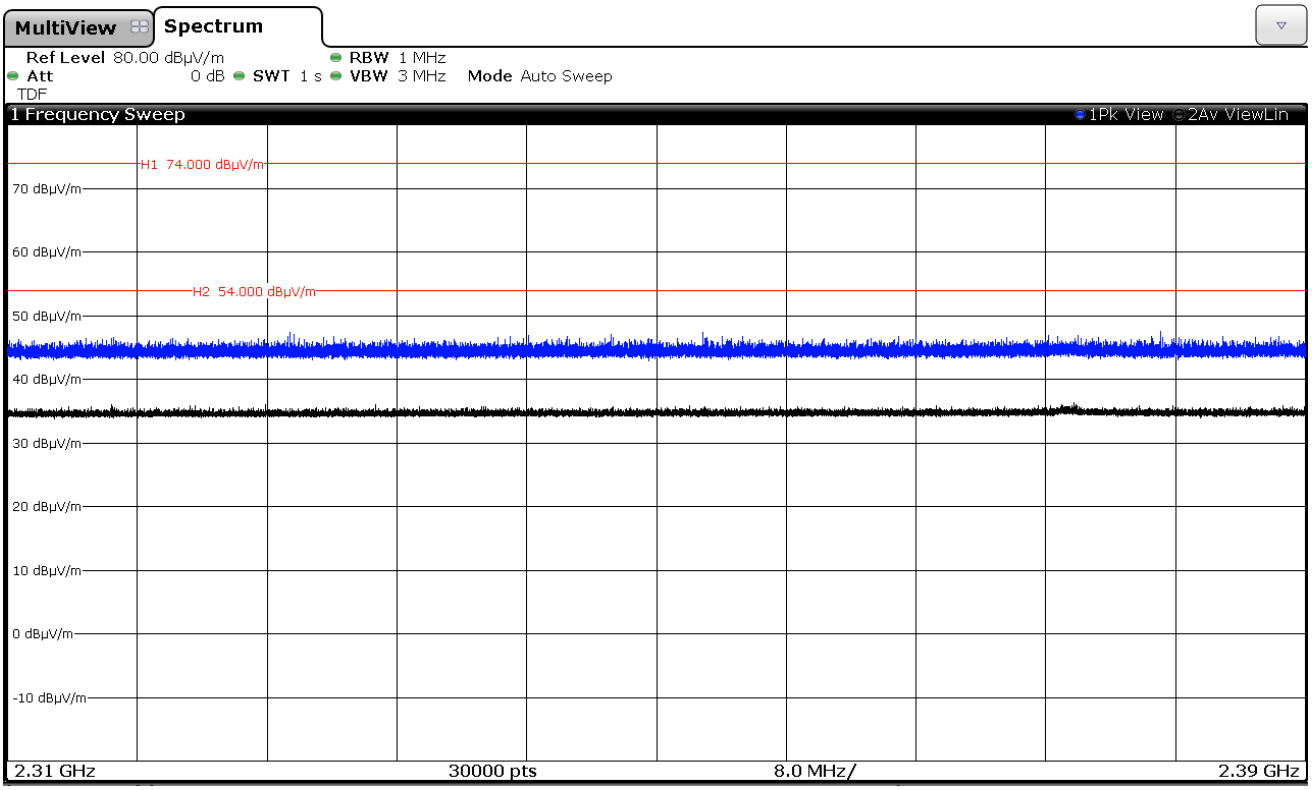
Modulation: GFSK



Modulation: Π/4-DQPSK

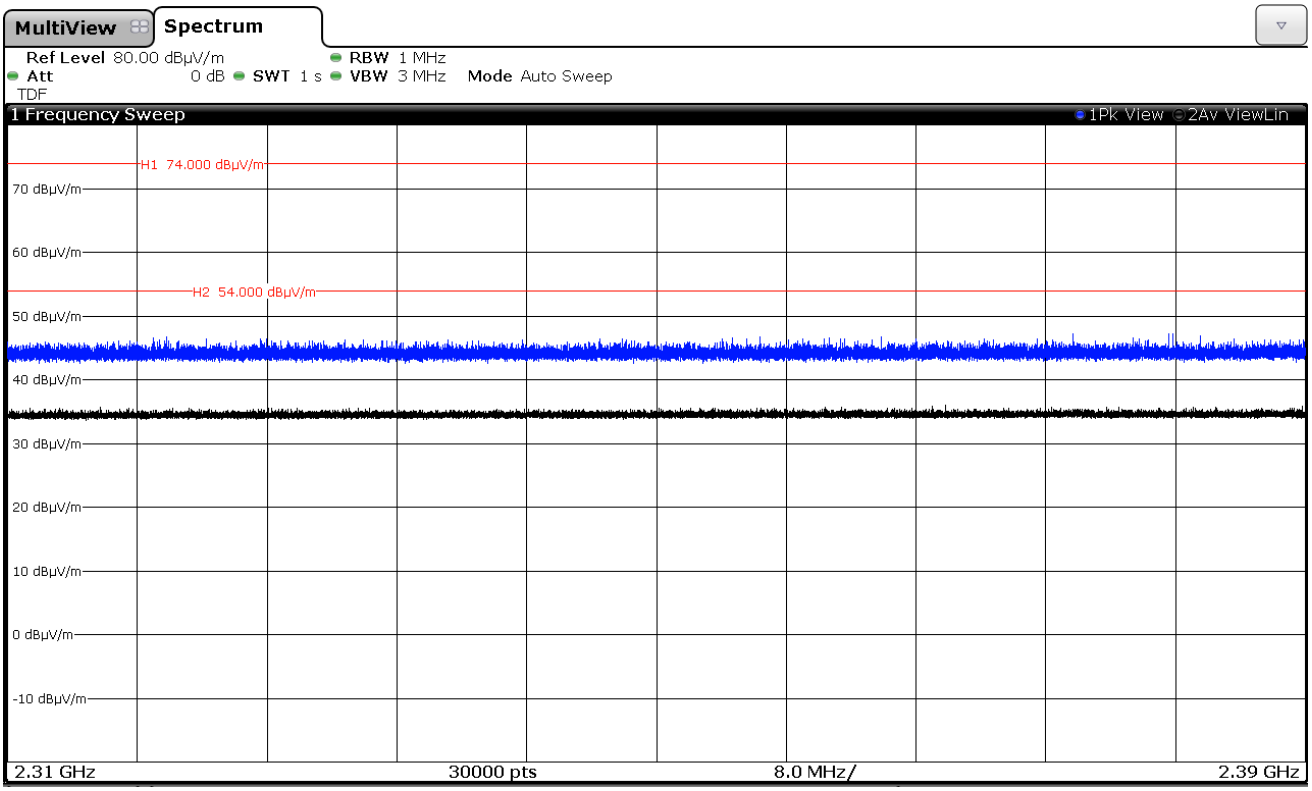


Modulation: 8-DPSK

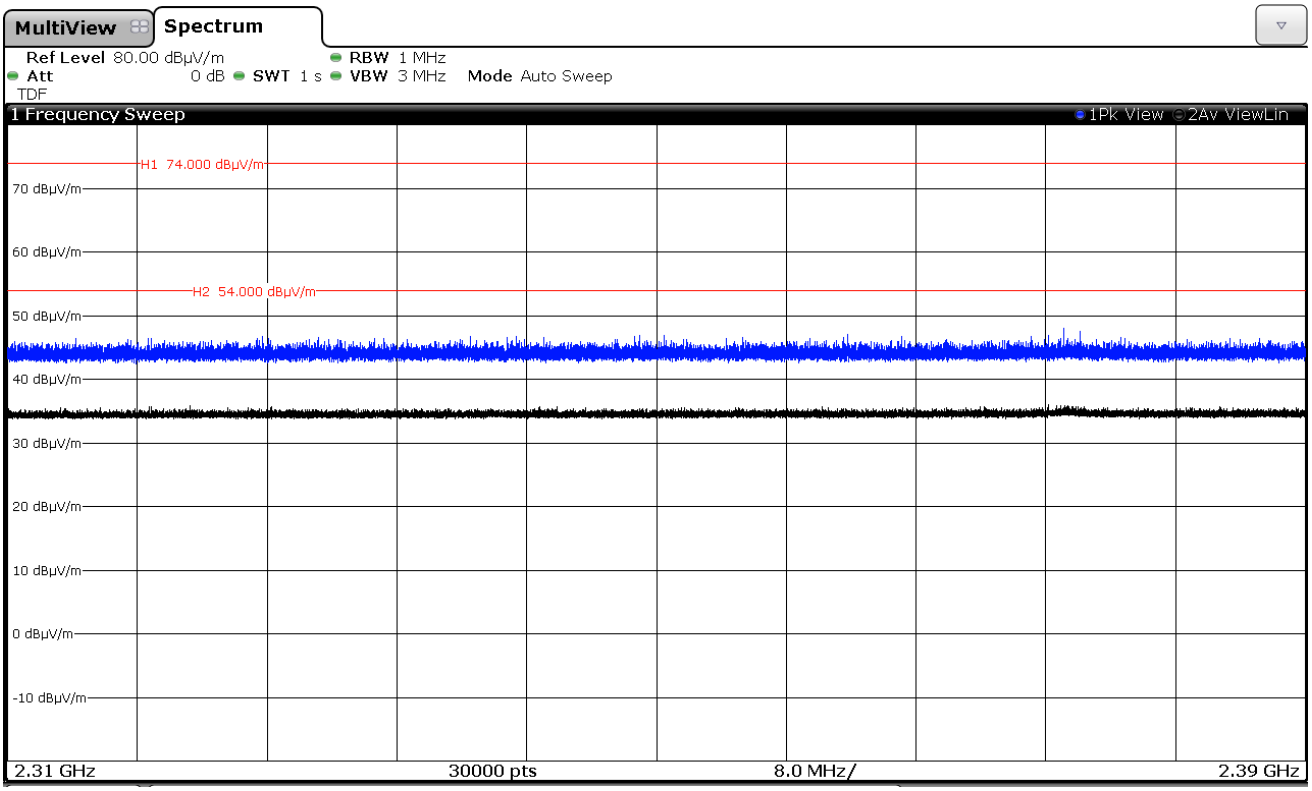


CHANNEL: Highest

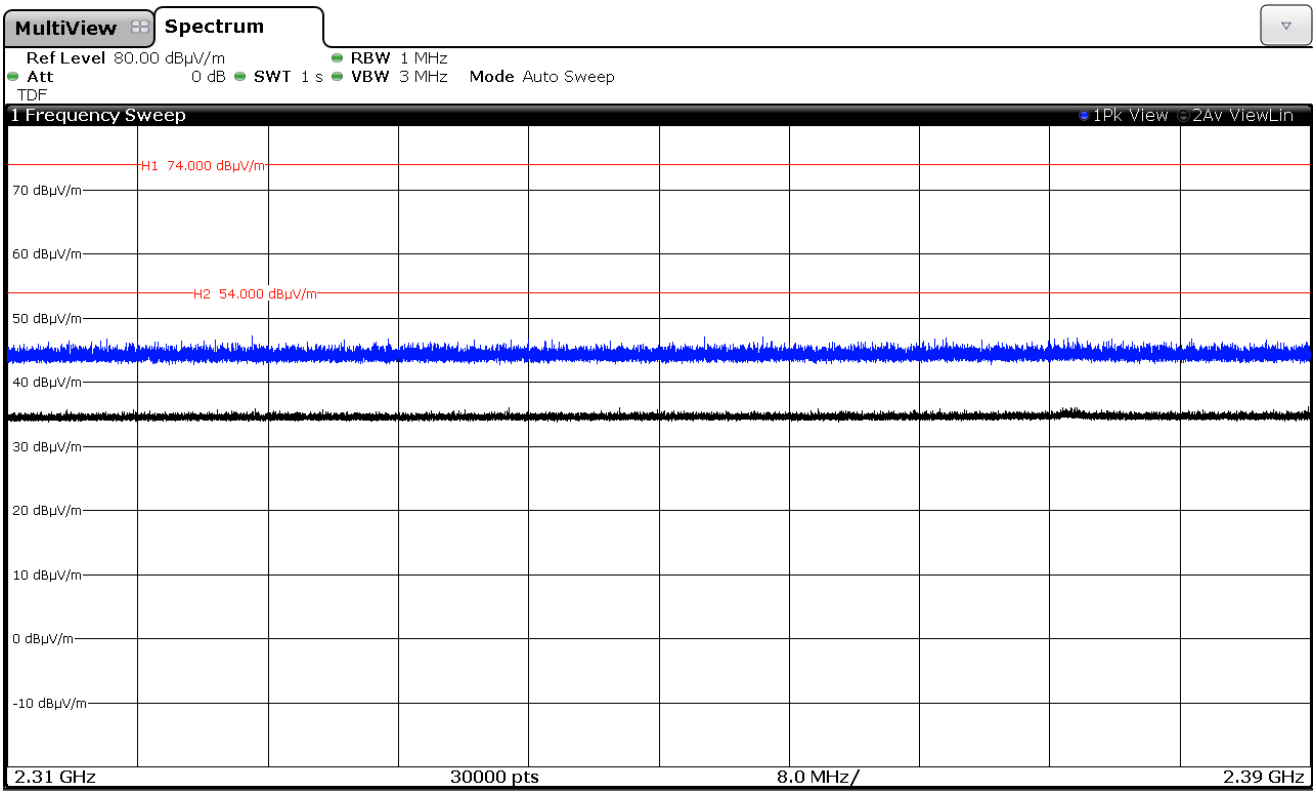
Modulation: GFSK



Modulation: Π/4-DQPSK



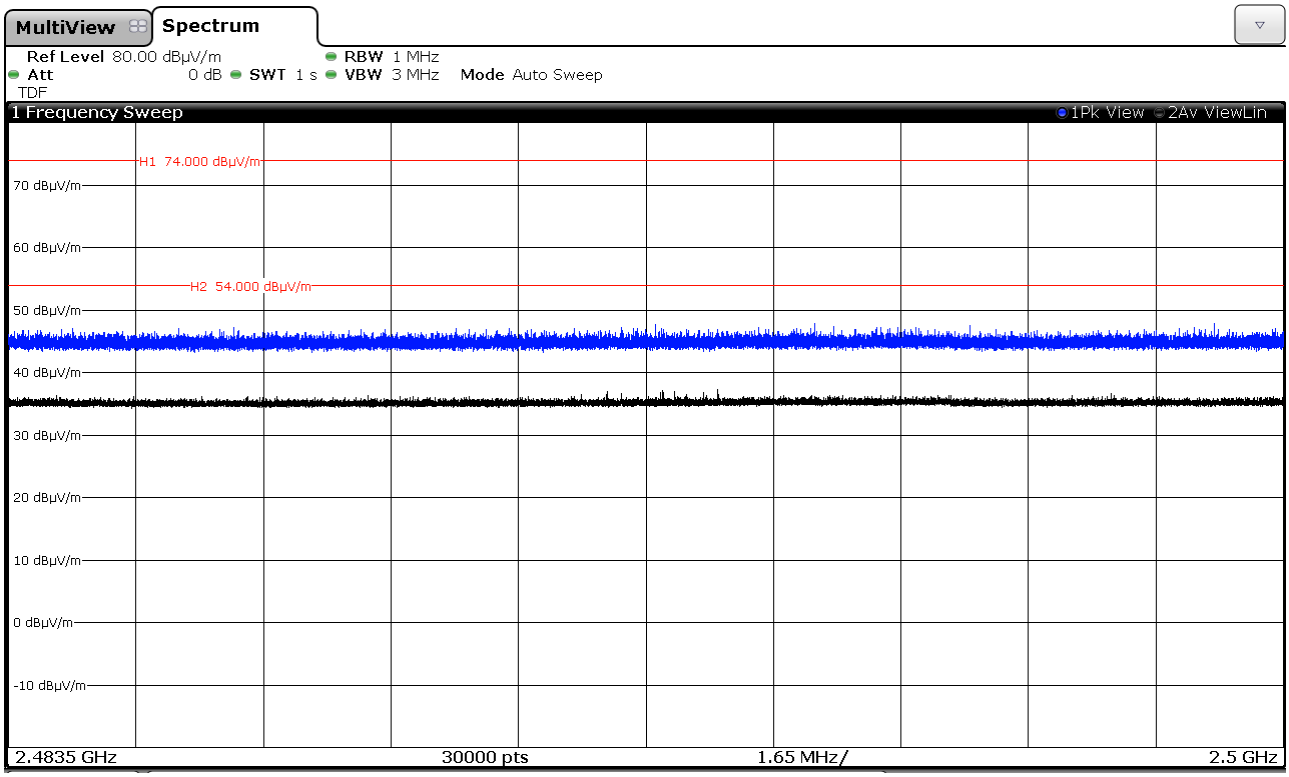
Modulation: 8-DPSK



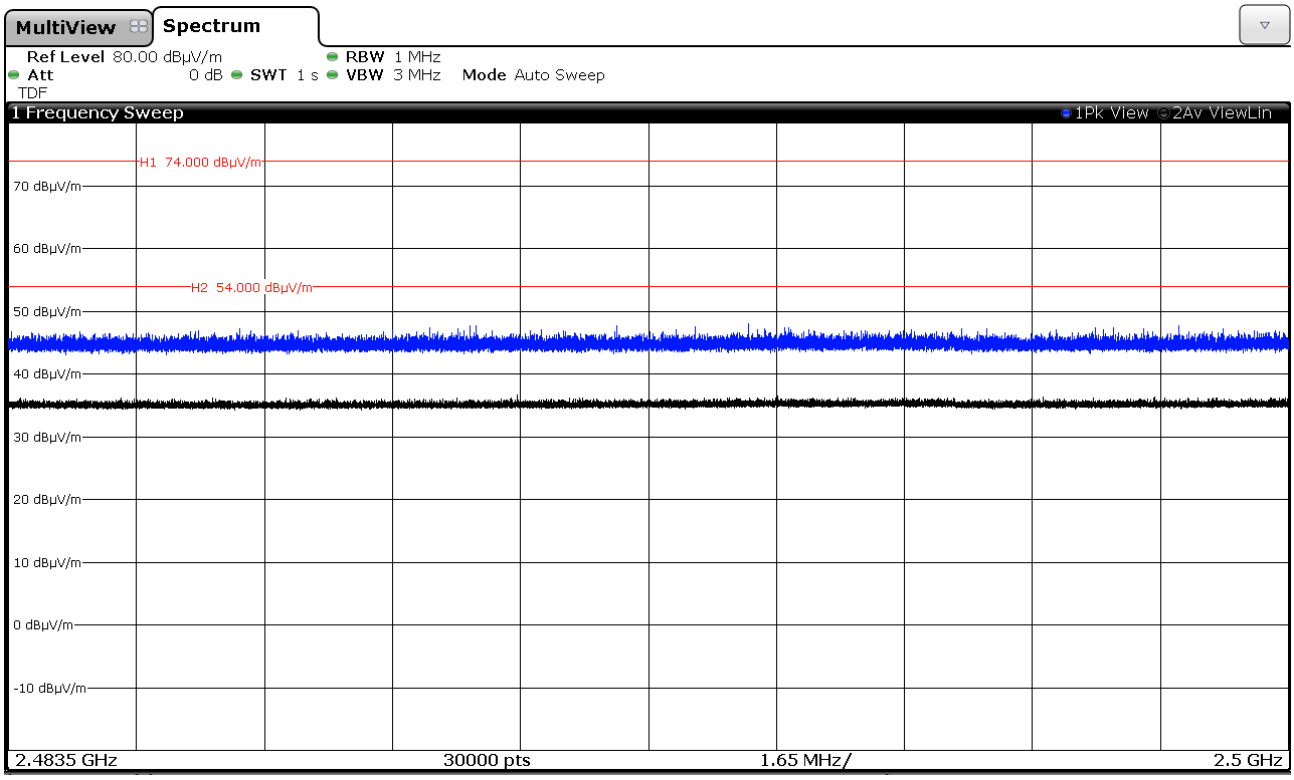
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

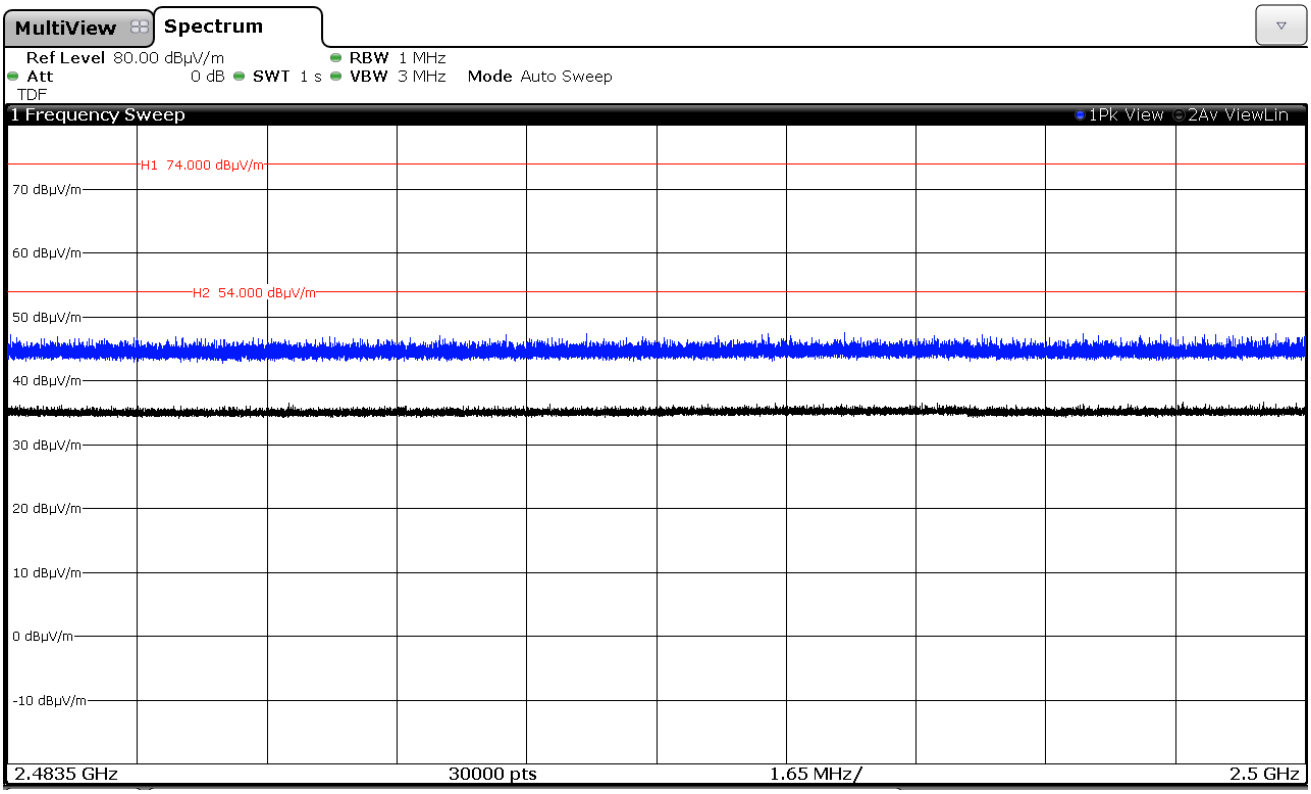
Modulation: GFSK



Modulation: Π/4-DQPSK

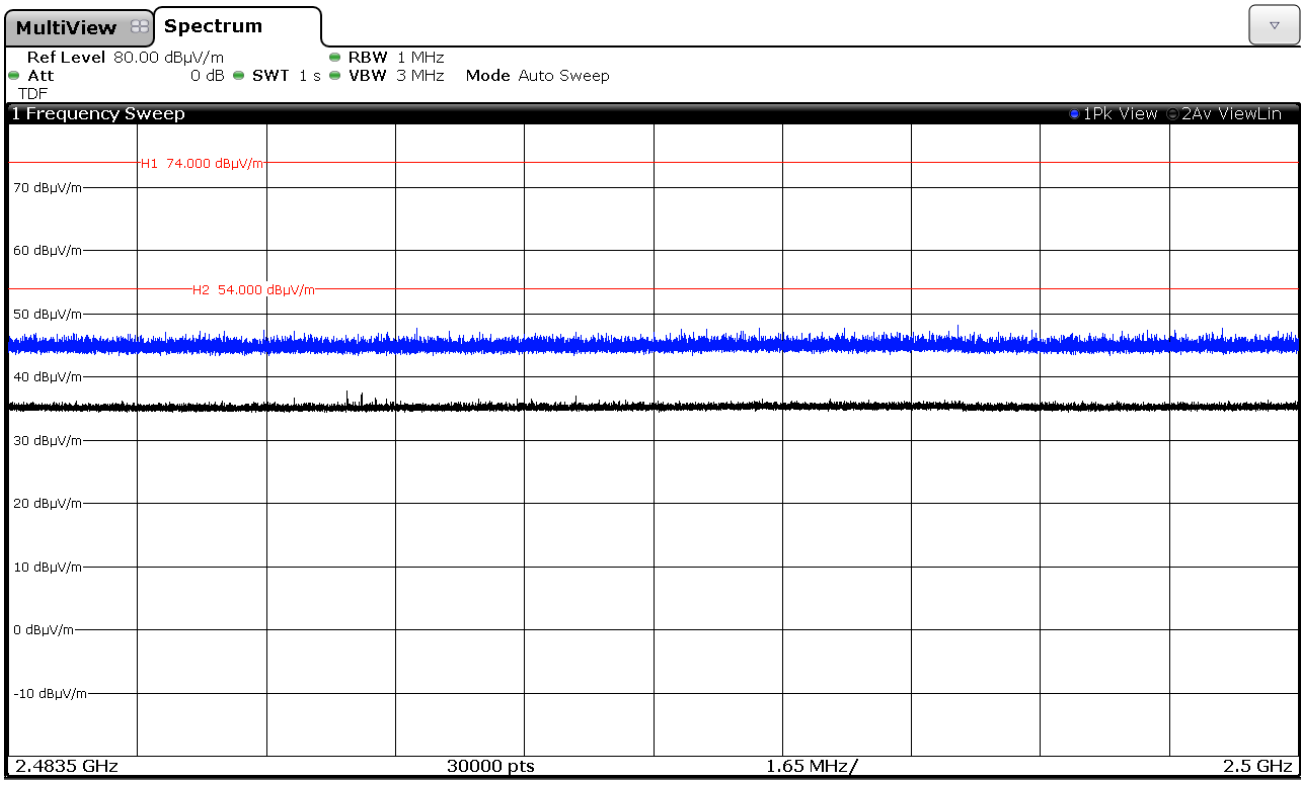


Modulation: 8-DPSK

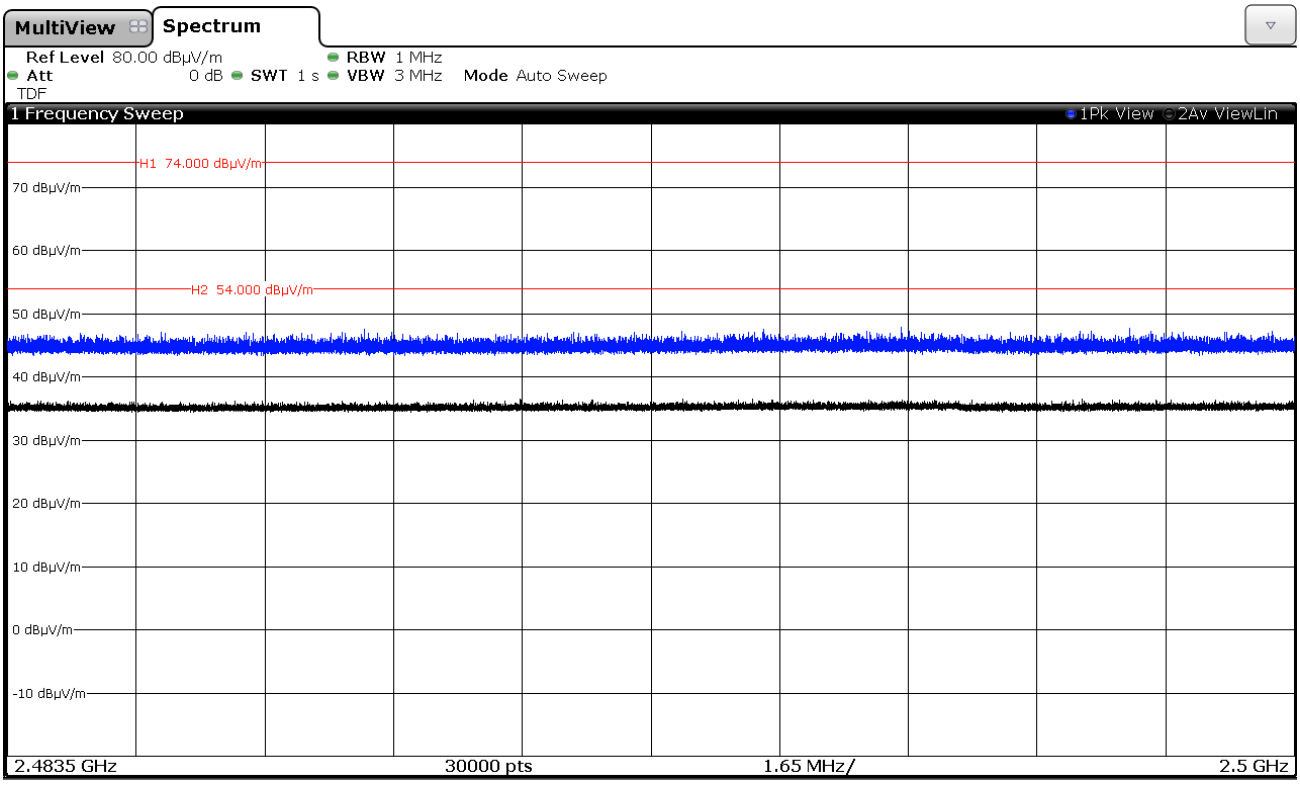


CHANNEL: Middle

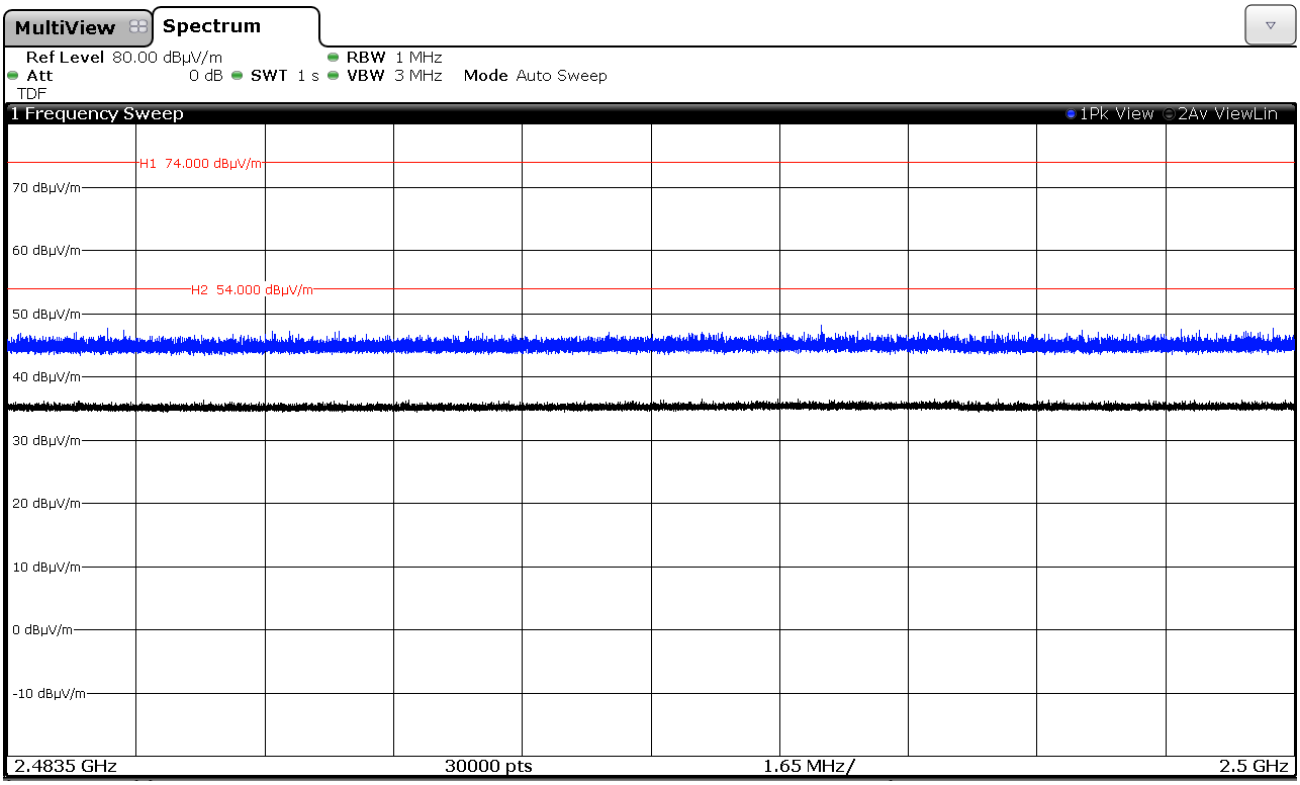
Modulation: GFSK



Modulation: Π/4-DQPSK

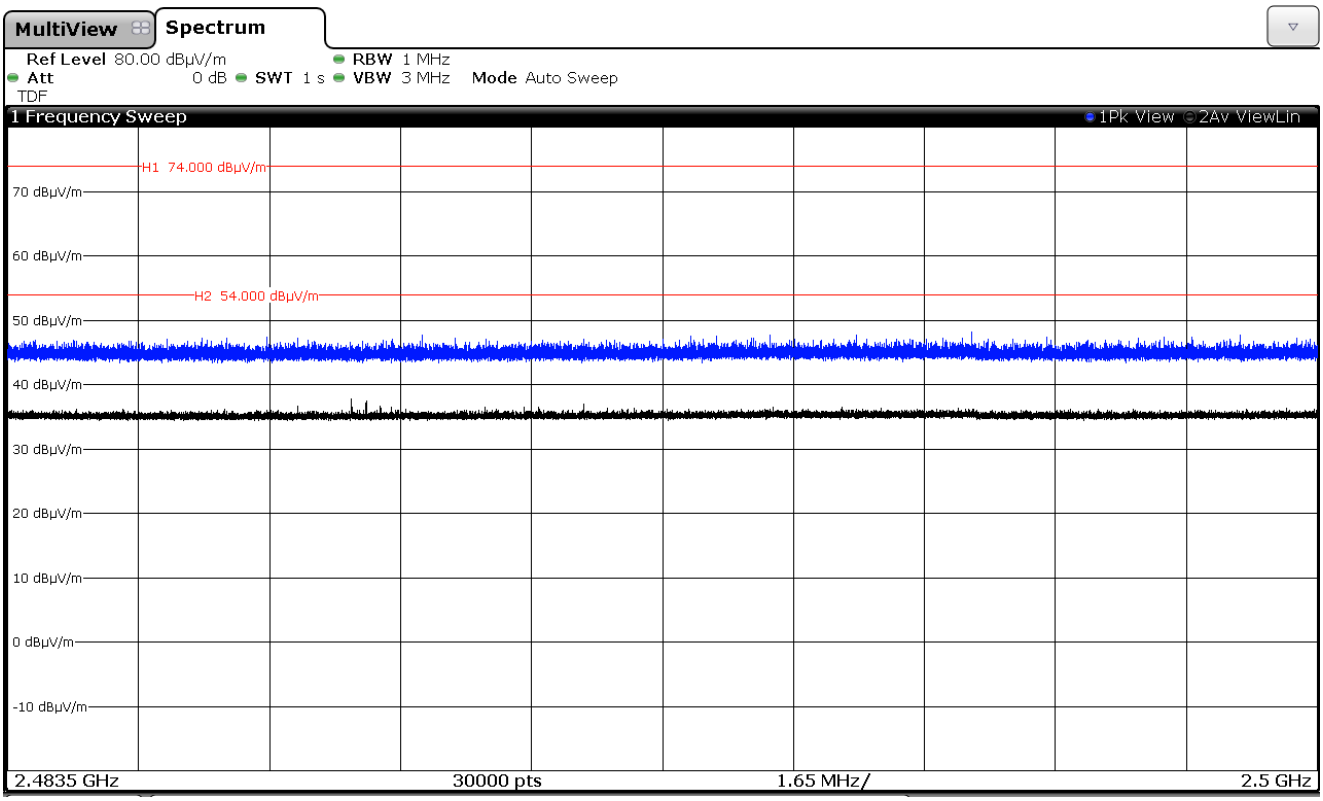


Modulation: 8-DPSK

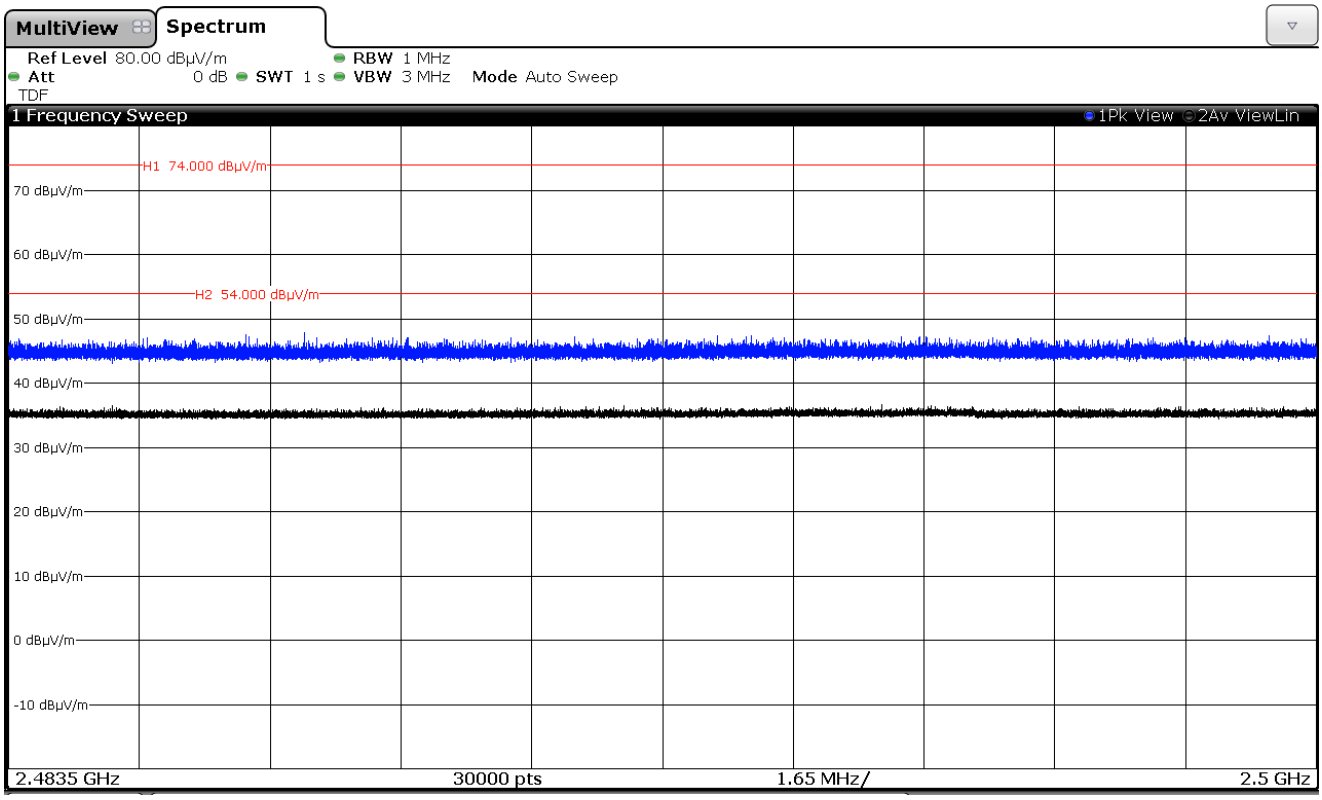


CHANNEL: Highest

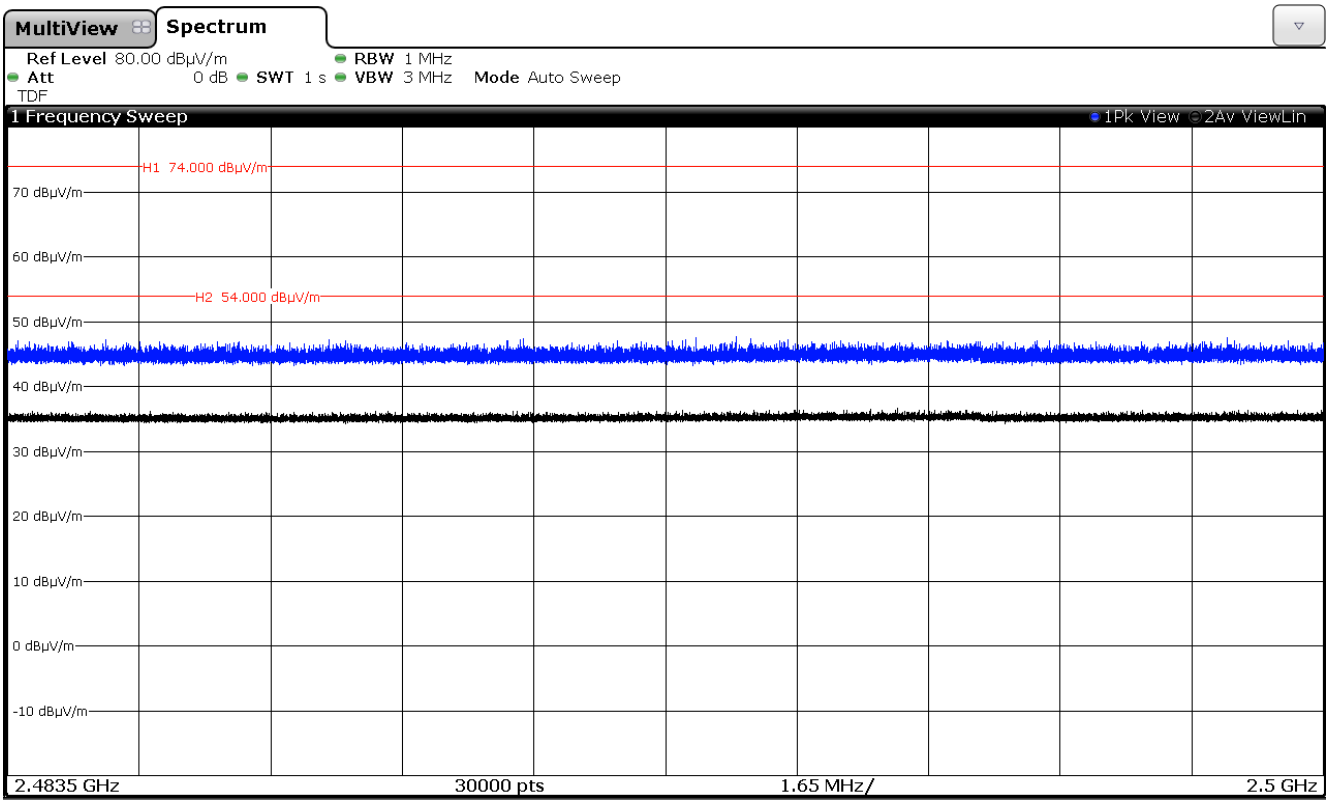
Modulation: GFSK



Modulation: Π/4-DQPSK



Modulation: 8-DPSK



Appendix B – Test result **"WiFi 2.4 GHz (802.11b/g/n20)"**

INDEX

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 14 Vdc

Type of power supply = DC voltage from external power source.

Type of antenna = Integral antenna

Declared Gain for antenna = -3.5 dBi

TEST FREQUENCIES:

For WiFi 802.11b/g/n20:

Lowest channel (1): 2412 MHz

Middle channel (6): 2437 MHz

Highest channel (11): 2462 MHz

The test set-up was made in accordance to the general provisions of FCC DTS Measurement KDB 558074 D01 DTS Meas Guidance v03r02.

The embedded test mode was used to configure the EUT to continuously transmit at a specified output power with different modes and modulation schemes.

WiFi 2.4 GHz: 802.11b, 802.11g, 802.11n20 (20 MHz channel bandwidth).

The field strength at the band edges was evaluated for each mode and on each chain individually on the lowest and highest channels at the rated power for the channel under test. Where the power at the edge channels was lower than the power at the center channels additional measurements were made at the adjacent channels.

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

The data rates of 1Mb/s for 802.11b, 6Mb/s for 802.11g and 6.5 Mb/s 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.

The conducted RF output power was adjusted according to the client's supplied adjustment values (see following table), which were selected in the test software:

Mode	BW (MHz)	Channel / Freq.	Data Rate	Power adjustment
802.11b	20	1 / 2412	1 Mbps	15
		2 / 2417		15
		6 / 2437		15
		10 / 2457		15
		11 / 2462		15
802.11g	20	1 / 2412	6 Mbps	16
		2 / 2417		16
		3 / 2422		16
		6 / 2437		16
		9 / 2452		16
		10 / 2457		16
		11 / 2462		16
802.11n	20	1 / 2412	6.5 Mbps	15
		2 / 2417		15
		3 / 2422		15
		6 / 2437		15
		9 / 2452		15
		10 / 2457		15
		11 / 2462		15

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a calibrated low loss RF cable. The reading in the spectrum analyser is compensated with the cable loss at each measurement frequency.

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 GHz-25 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 (wooden) platform one meter 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 was varied from 1 to 4 meters to find the maximum radiated emission.

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

Occupied Bandwidth

RESULTS

1. WiFi 2.4GHz 802.11 b mode

Occupied Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	15.4274	15.3727	15.4485
Measurement uncertainty (kHz)	±21.7		

2. WiFi 2.4GHz 802.11 g mode

Occupied Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	16.7624	16.7335	16.7431
Measurement uncertainty (kHz)	±21.7		

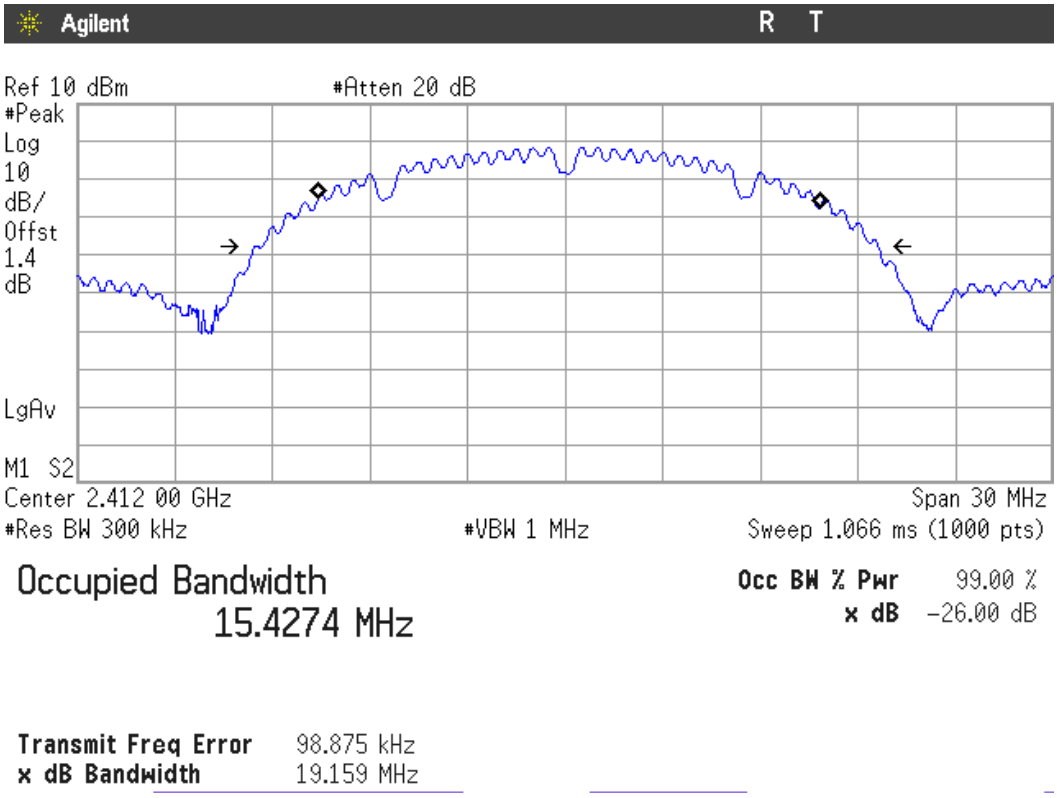
3. WiFi 2.4GHz 802.11 n20 mode

Occupied Bandwidth (see next plots).

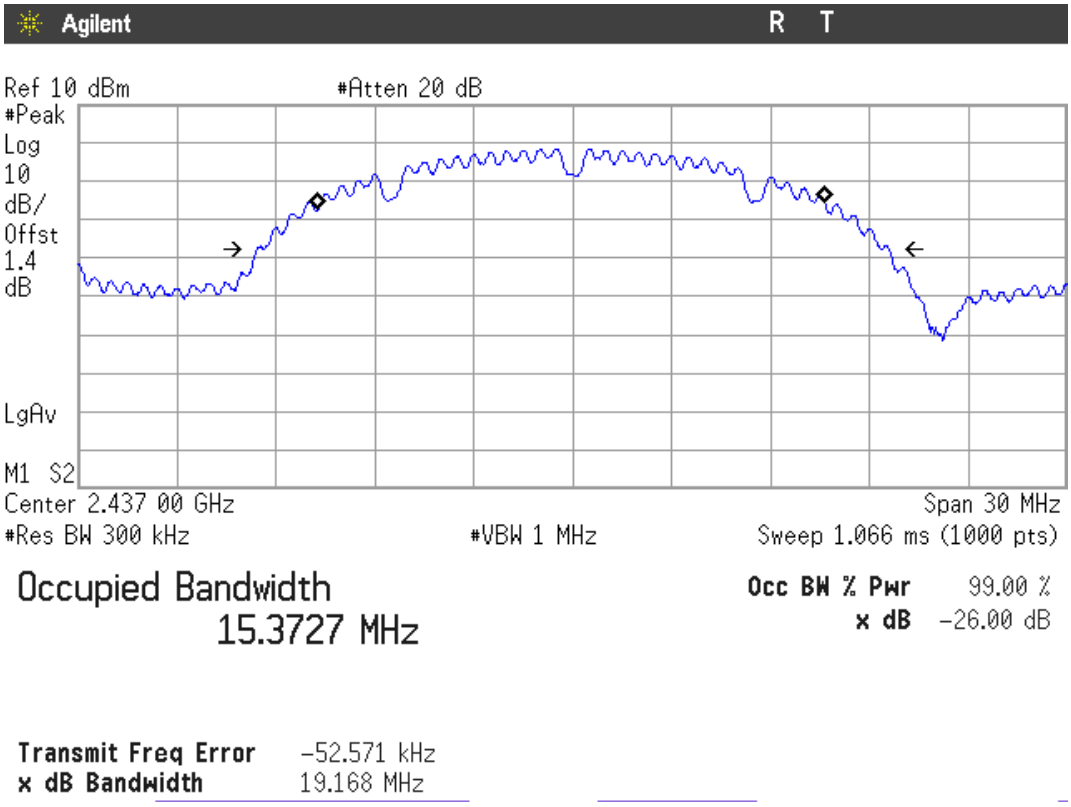
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	17.5809	17.6383	17.6328
Measurement uncertainty (kHz)	±21.7		

1. WiFi 2.4GHz 802.11 b mode

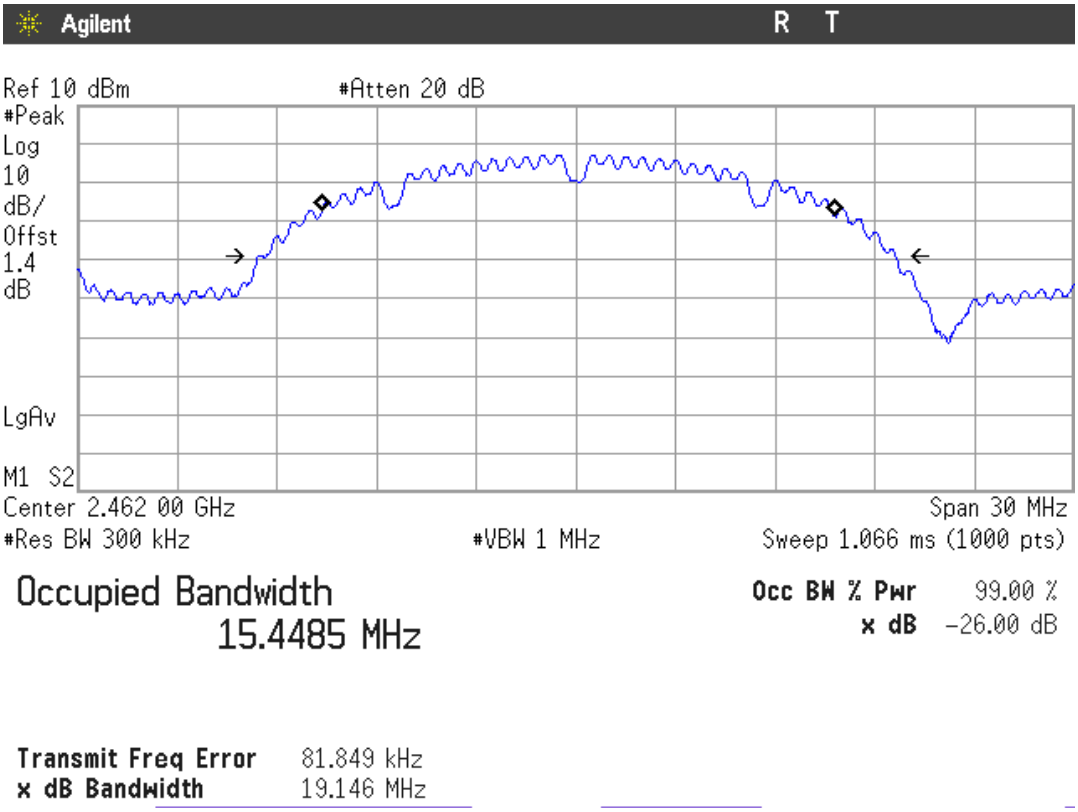
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.

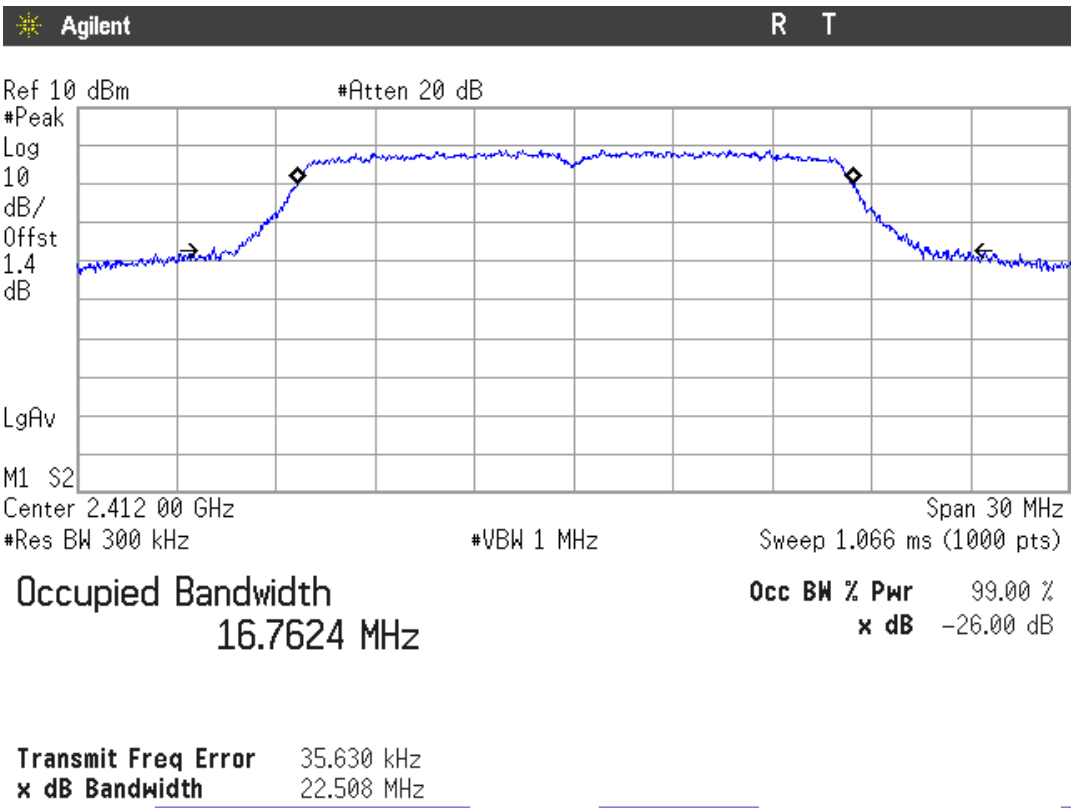


Highest Channel: 2462 MHz.

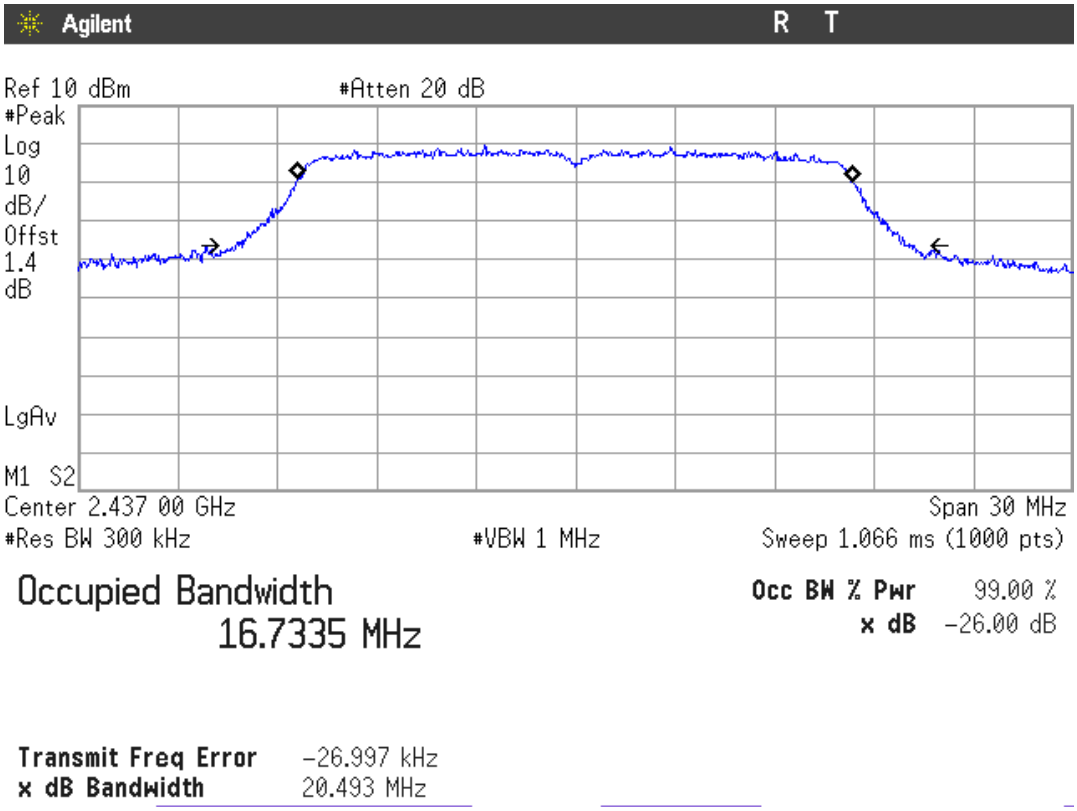


2. WiFi 2.4GHz 802.11 g mode

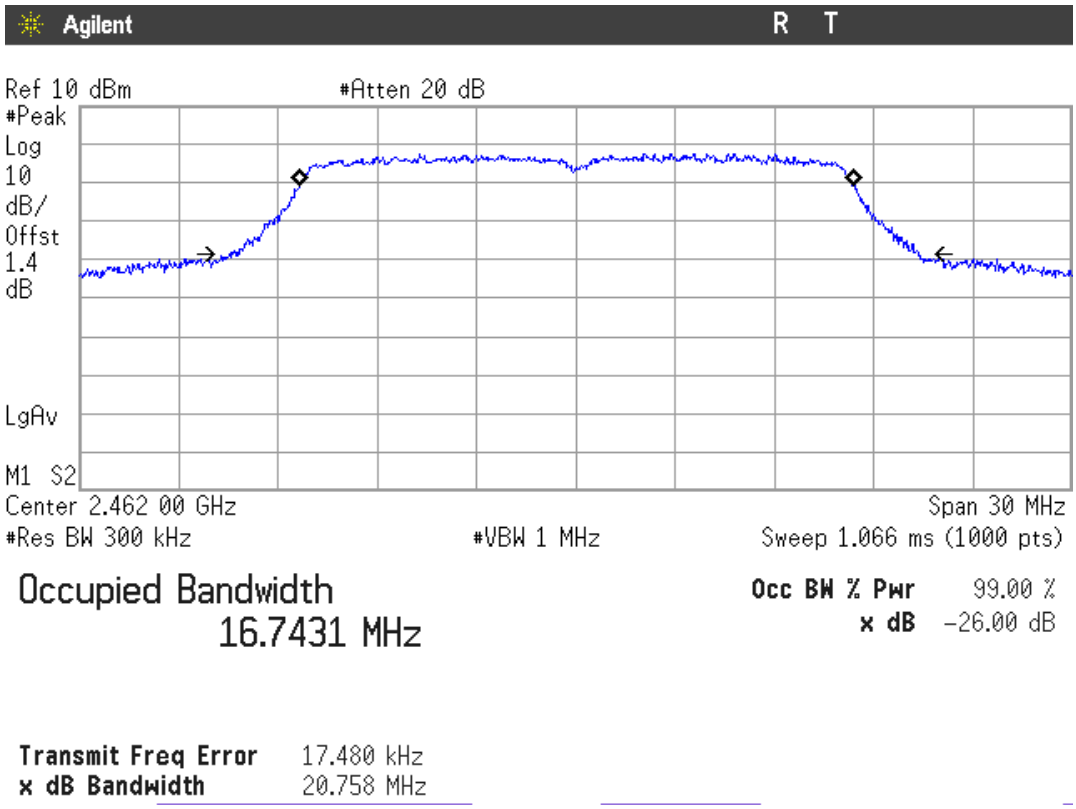
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.

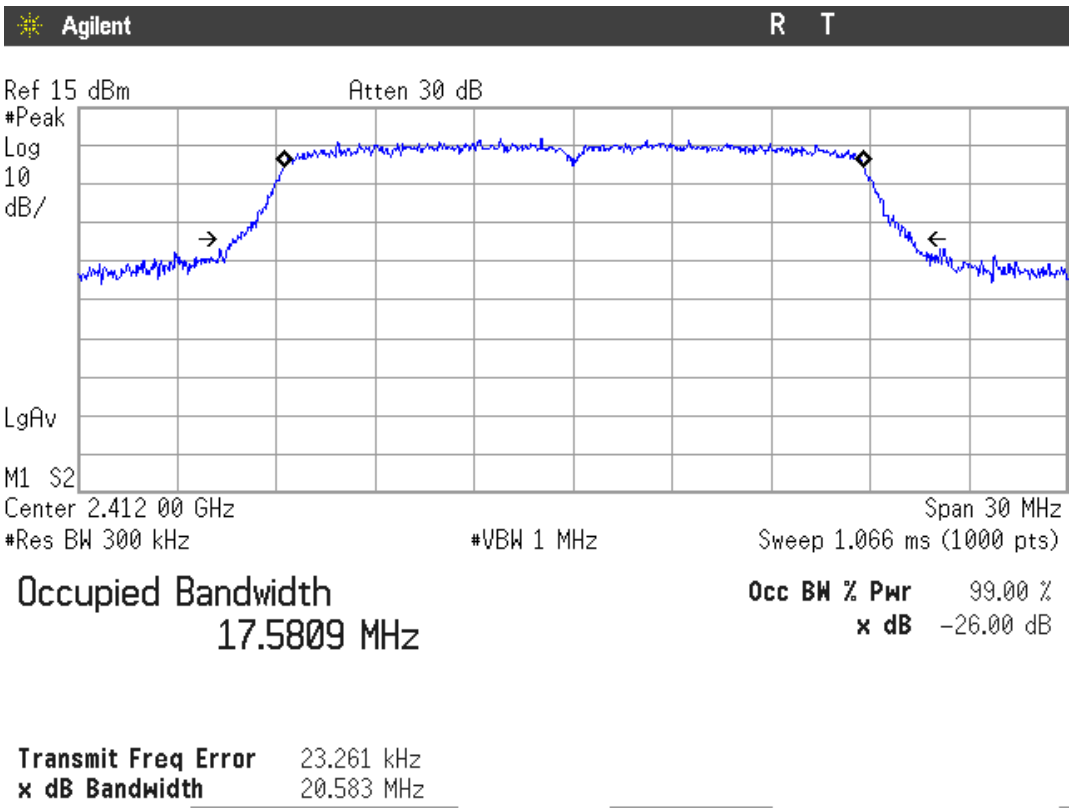


Highest Channel: 2462 MHz.

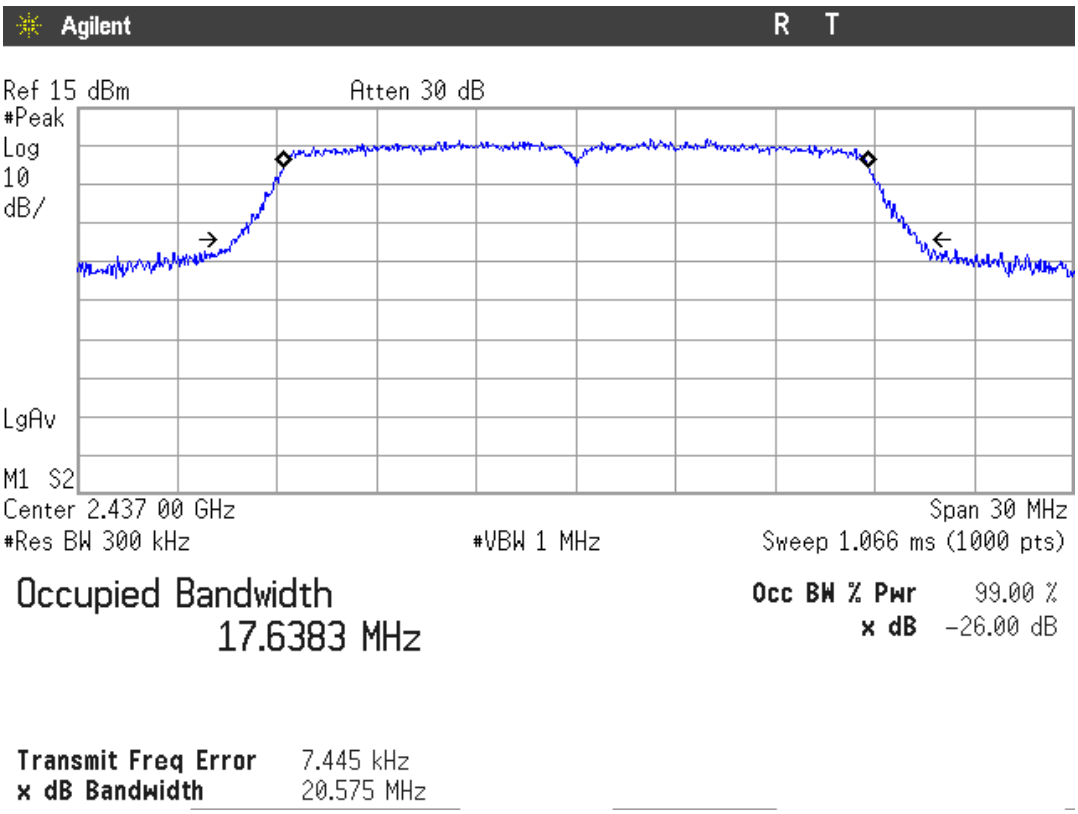


3. WiFi 2.4GHz 802.11 n20 mode

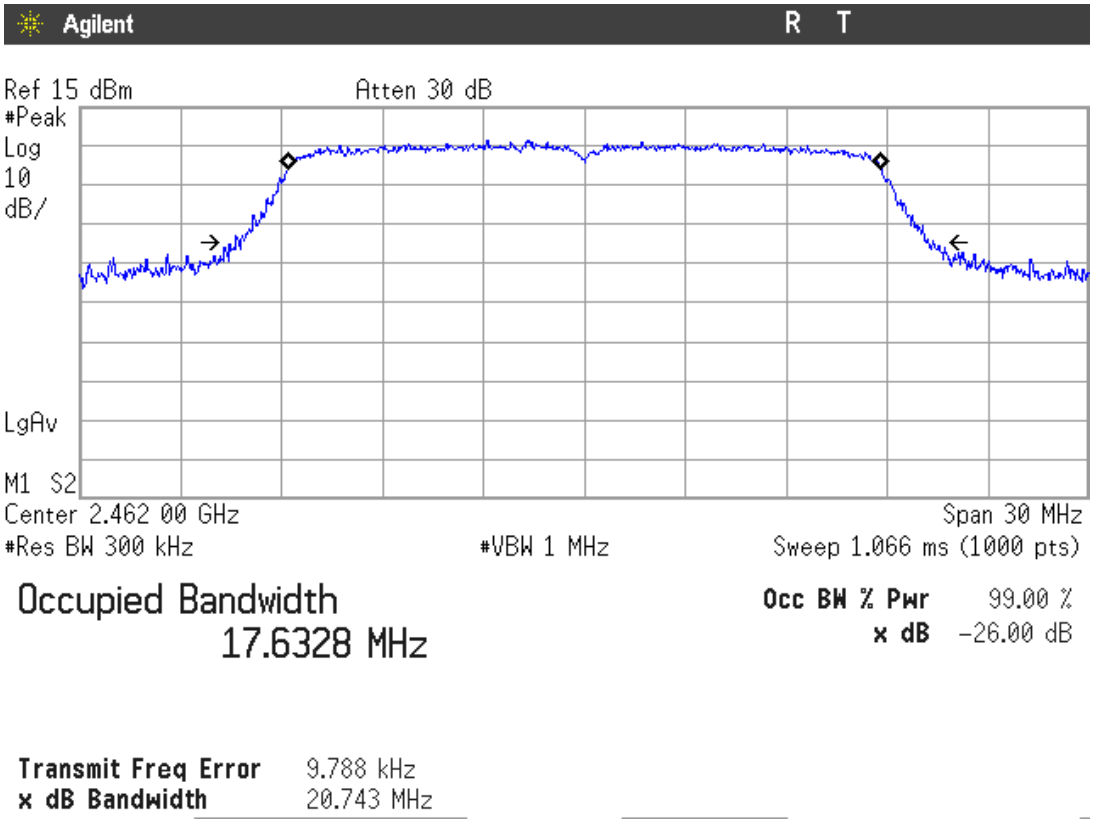
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.



Highest Channel: 2462 MHz.



Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a). 6 dB Bandwidth

SPECIFICATION

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

RESULTS

1. WiFi 2.4GHz 802.11 b mode

6 dB Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	10.130	10.130	10.130
Measurement uncertainty (kHz)	±89		

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

6 dB Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	16.376	16.356	16.376
Measurement uncertainty (kHz)	±89		

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

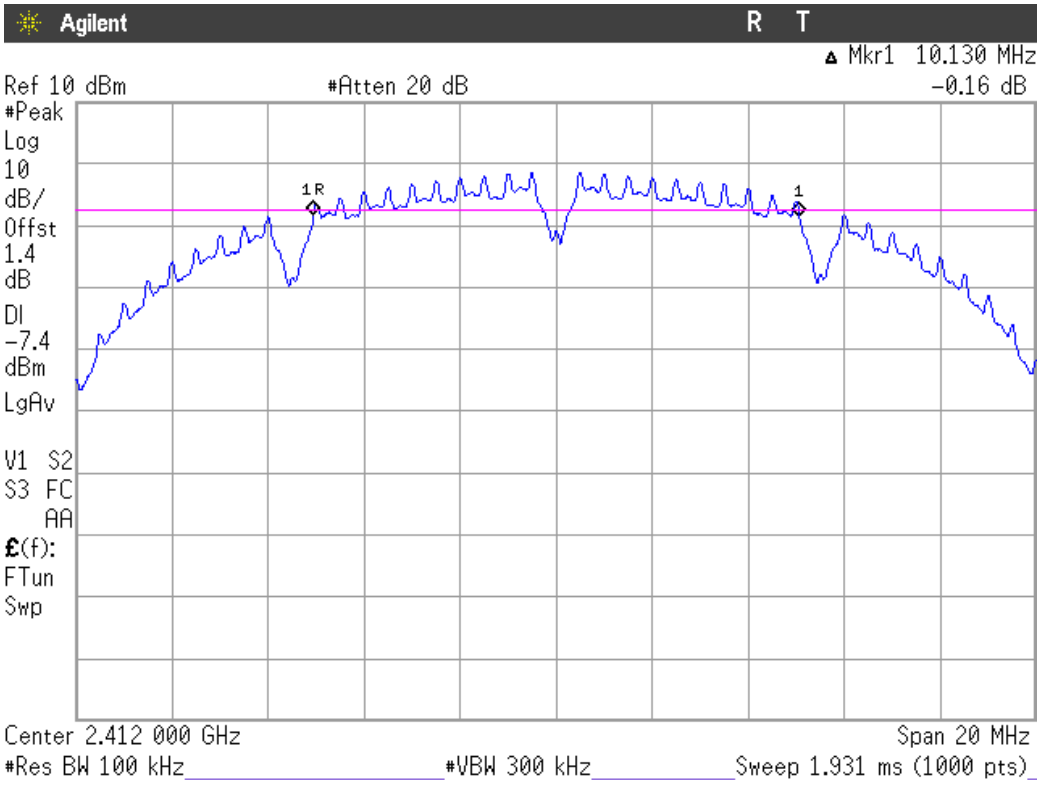
6 dB Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	17.097	17.117	17.337
Measurement uncertainty (kHz)	±89		

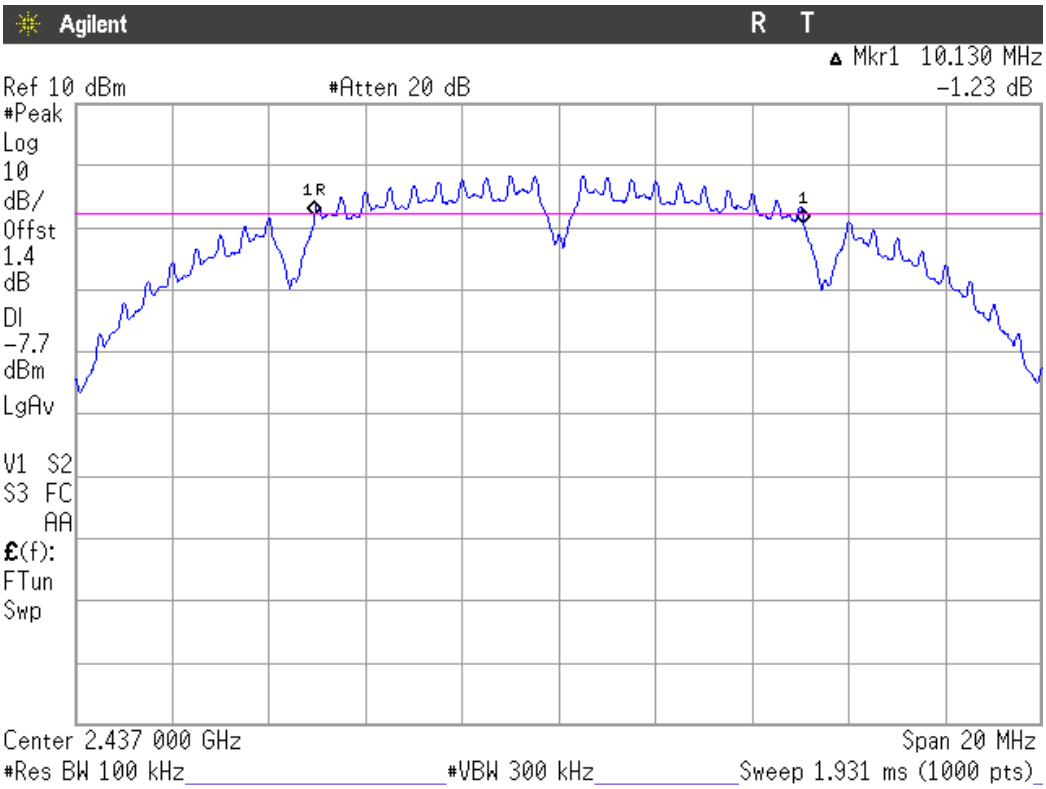
Verdict: PASS

1. WiFi 2.4GHz 802.11 b mode

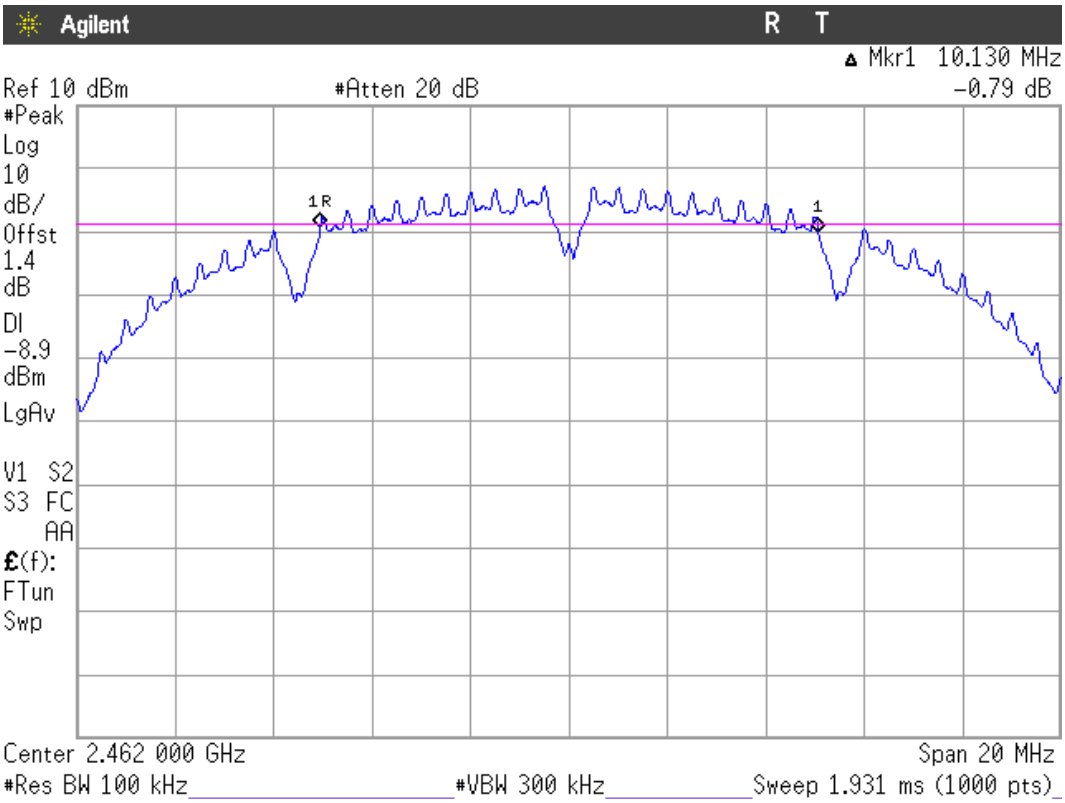
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.

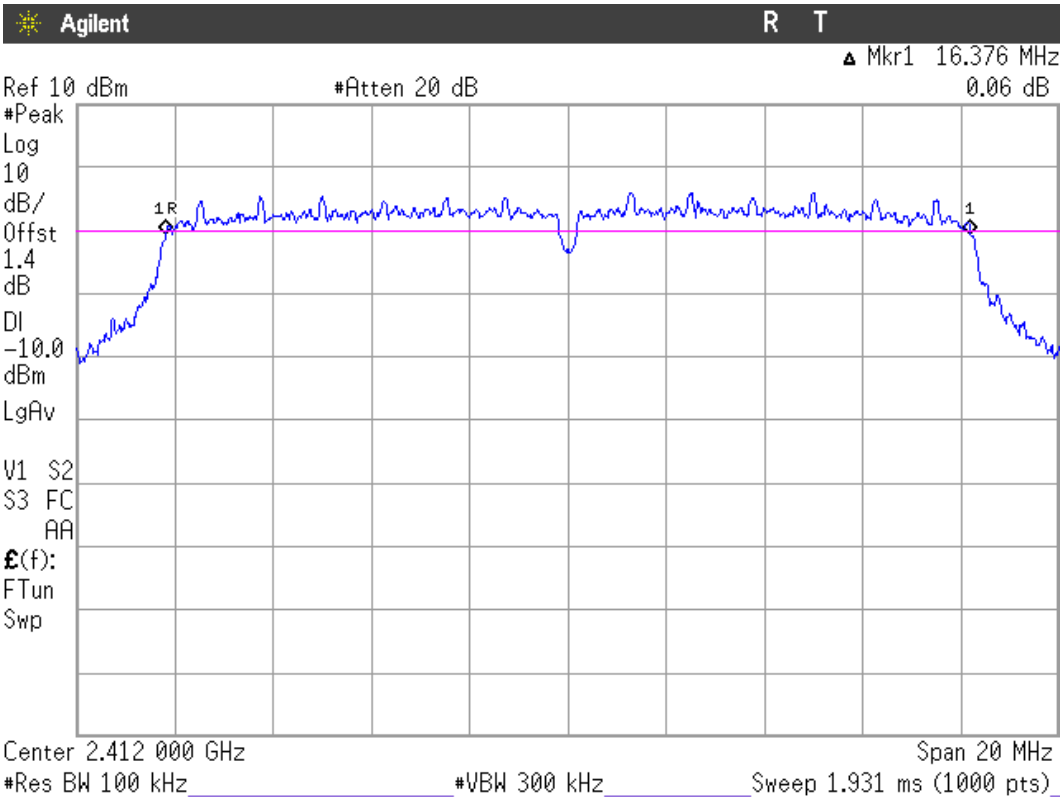


Highest Channel: 2462 MHz.

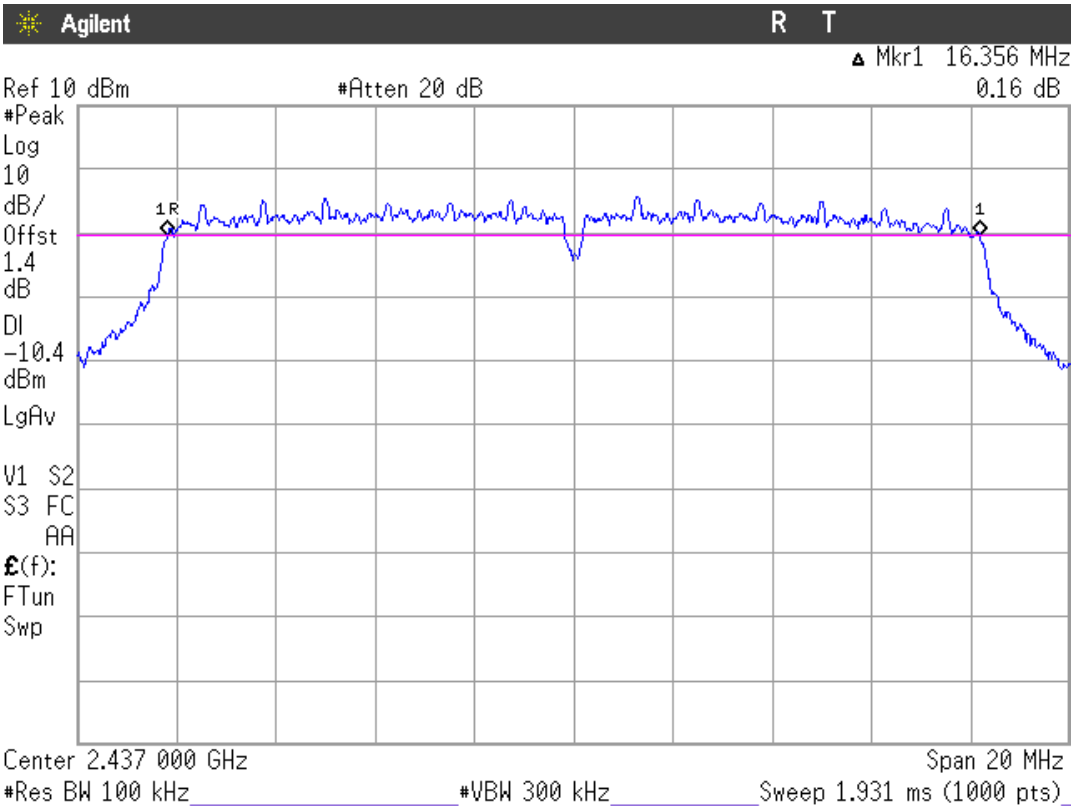


2. WiFi 2.4GHz 802.11 g mode

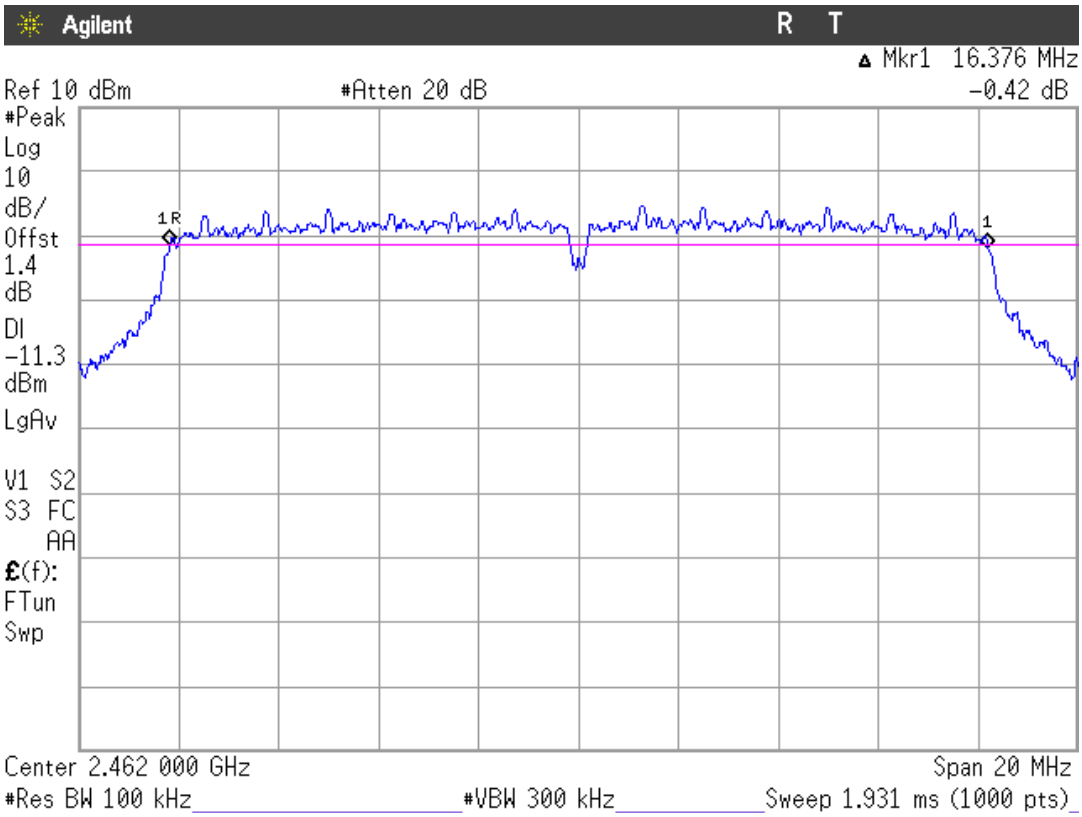
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.

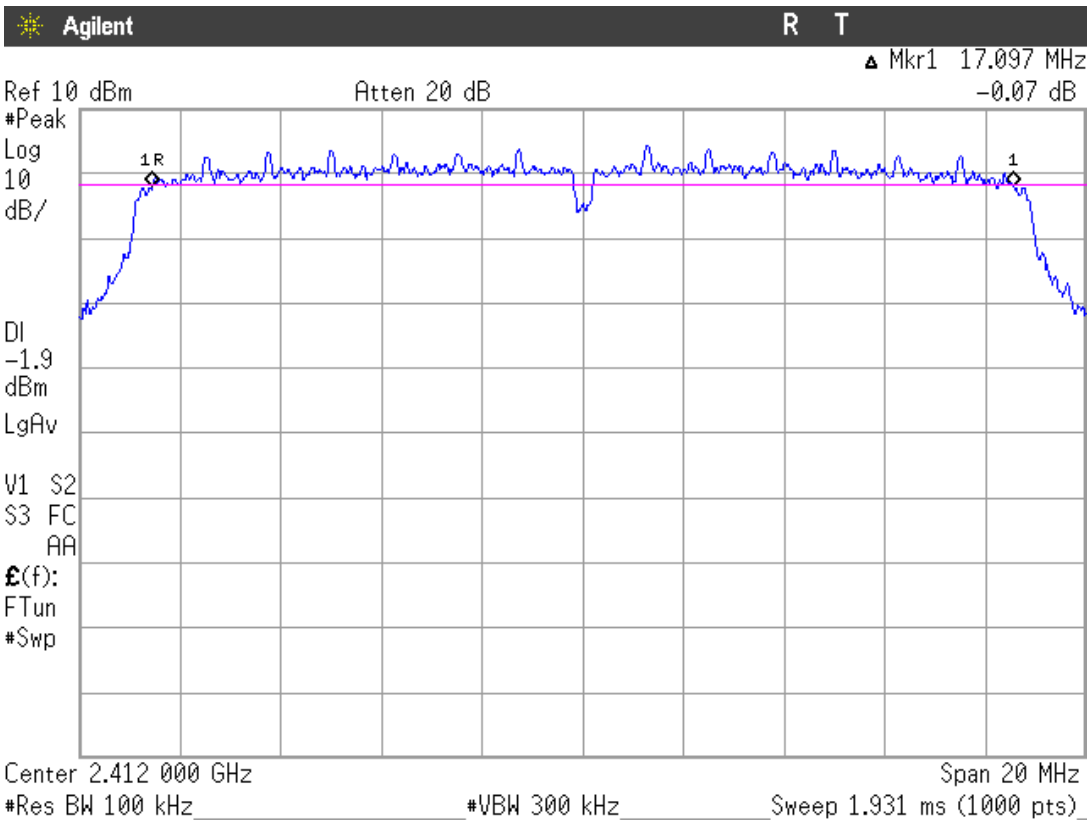


Highest Channel: 2462 MHz.

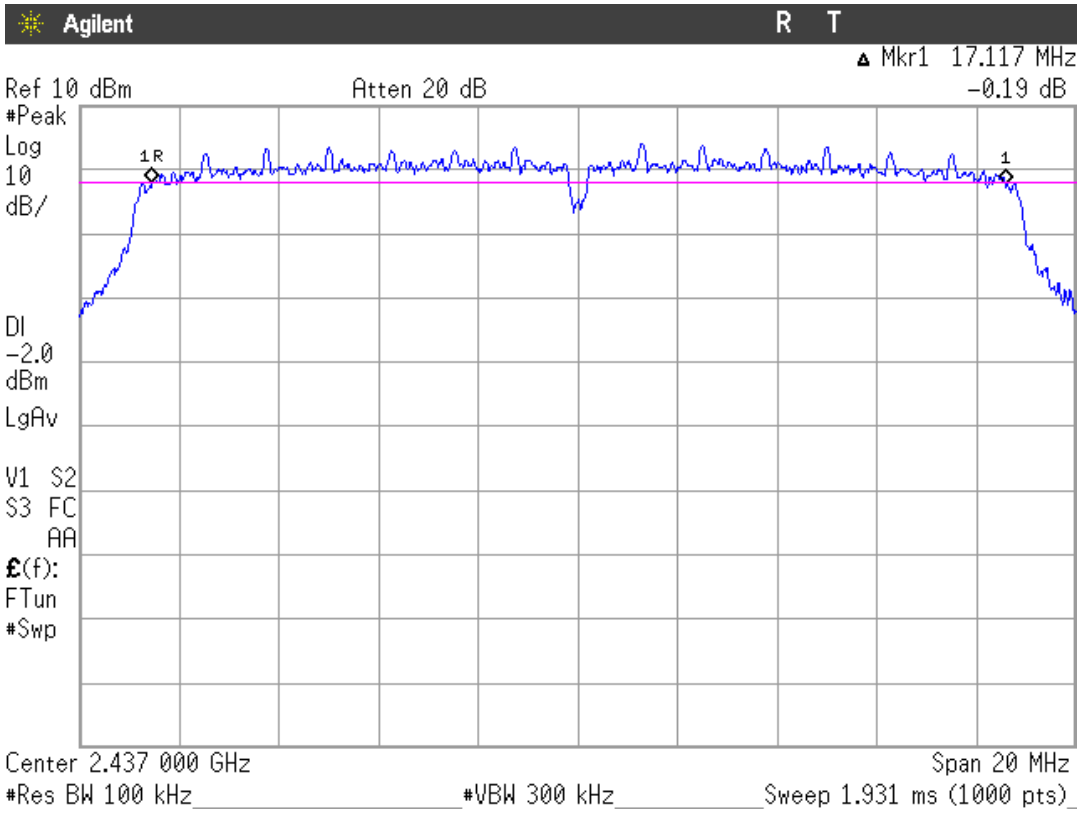


3. WiFi 2.4GHz 802.11 n20 mode

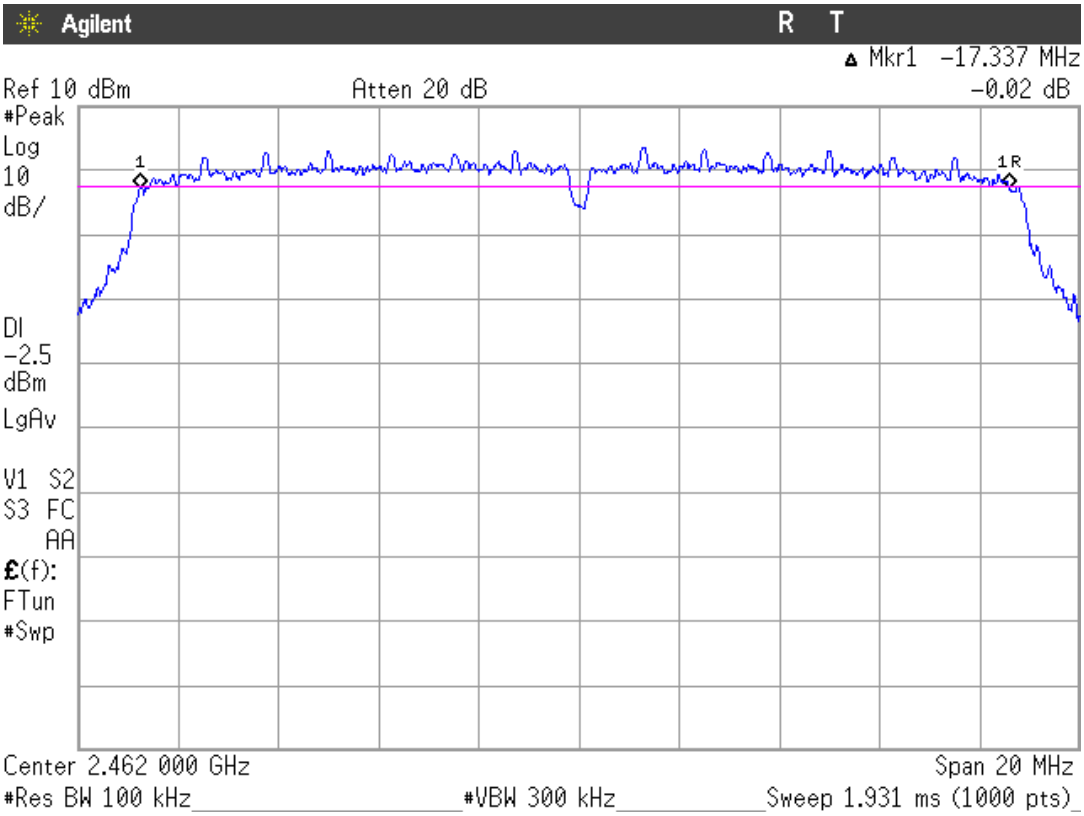
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.



Highest Channel: 2462 MHz.



Section 15.247 Subclause (b) / RSS-210 A8.4. (4). Maximum output power and antenna gain

SPECIFICATION

The maximum peak conducted output power of the intentional radiator shall not exceed 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power (average).

RESULTS

The maximum conducted (average) output power was measured using the method according to point 9.2.2.2. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r02 dated 06/05/2014.

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

1. WiFi 2.4GHz 802.11 b mode

MAXIMUM OUTPUT POWER. Conducted (average) output power (See next plots).

Maximum declared antenna gain: -3.5 dBi.

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	15.00	15.54	15.07
Maximum EIRP power (dBm)	11.5	12.04	11.57
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

MAXIMUM OUTPUT POWER. Conducted (average) output power (See next plots).

Maximum declared antenna gain: -3.5 dBi.

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	14.05	14.27	13.51
Maximum EIRP power (dBm)	10.55	10.77	10.01
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

MAXIMUM OUTPUT POWER. Conducted (average) output power (See next plots).

Maximum declared antenna gain: -3.5 dBi.

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	13.73	13.86	13.48
Maximum EIRP power (dBm)	10.23	10.36	9.98
Measurement uncertainty (dB)	±1.5		

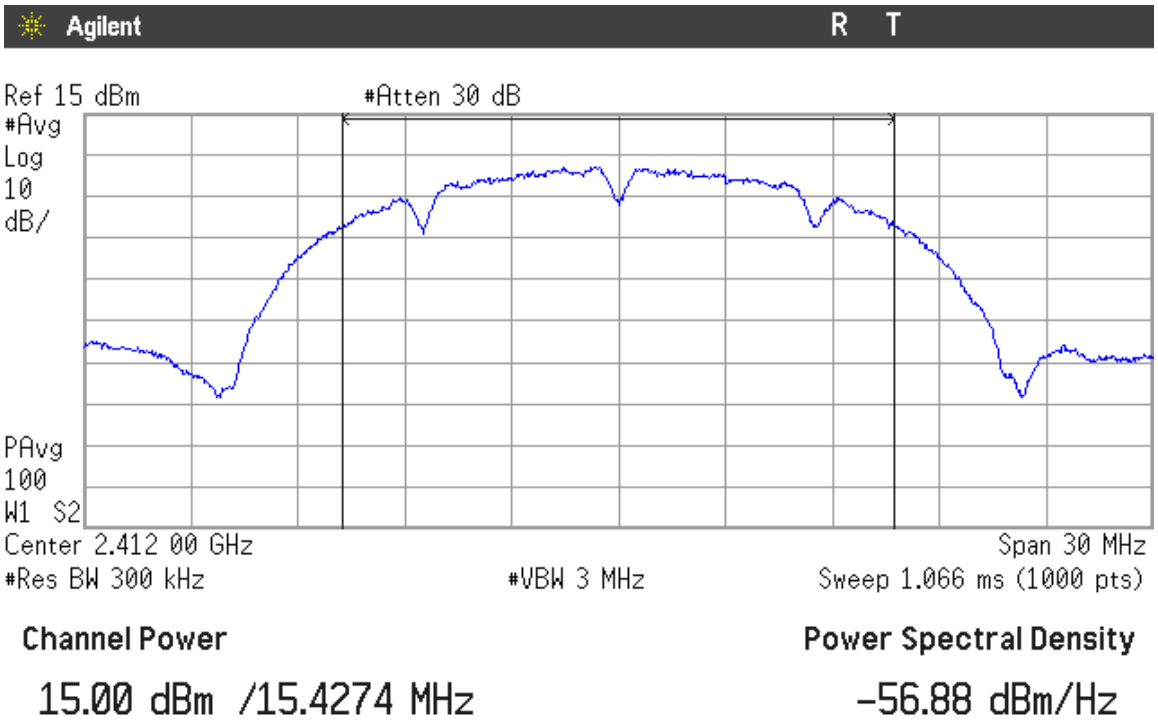
Verdict: PASS

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.

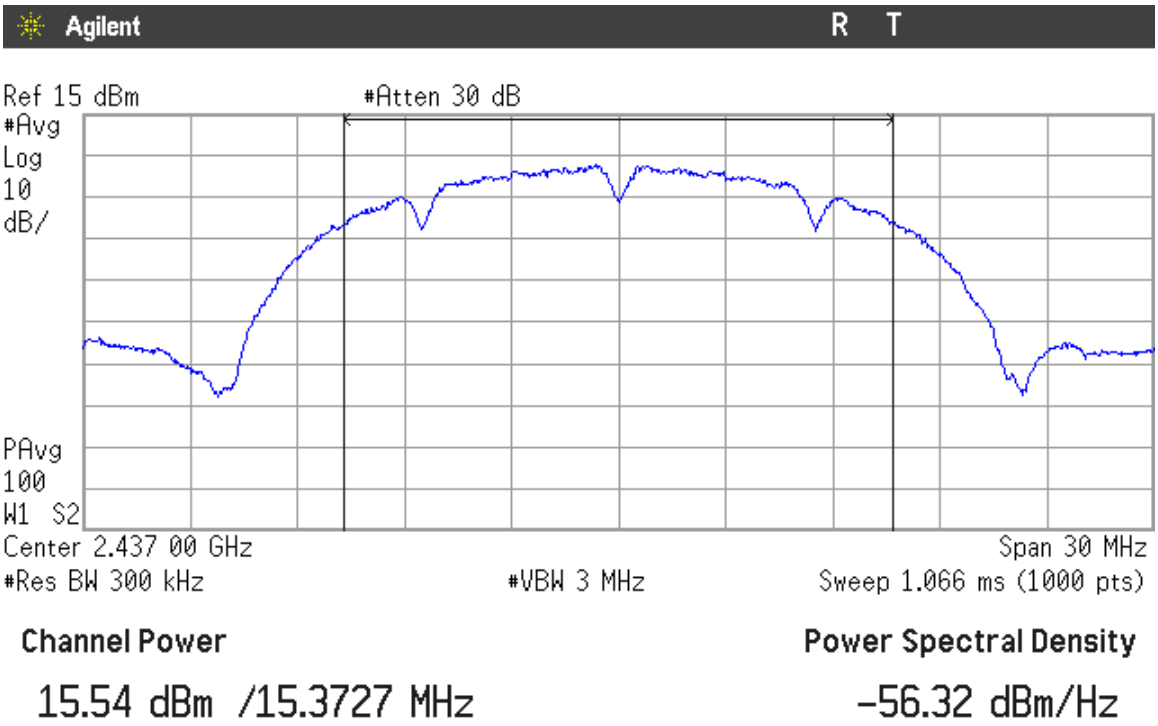
Peak conducted output power.

1. WiFi 2.4GHz 802.11 b mode

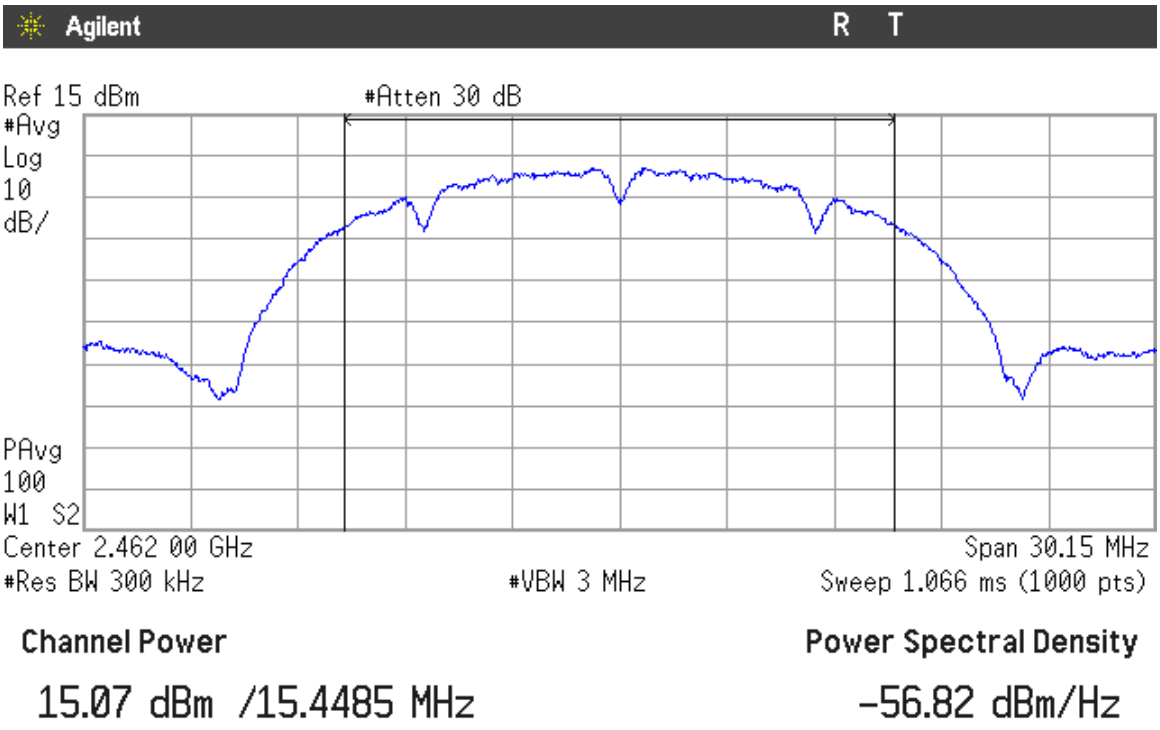
Lowest frequency 2412 MHz.



Middle frequency 2437 MHz.

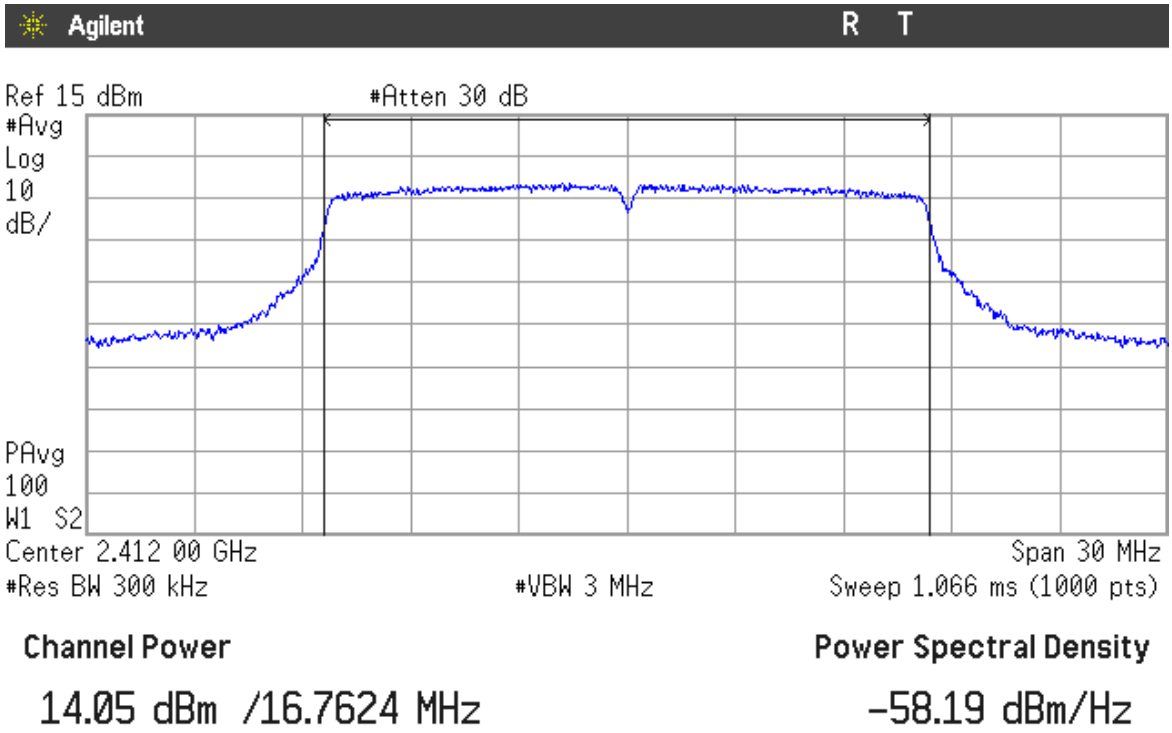


Highest frequency 2462 MHz.

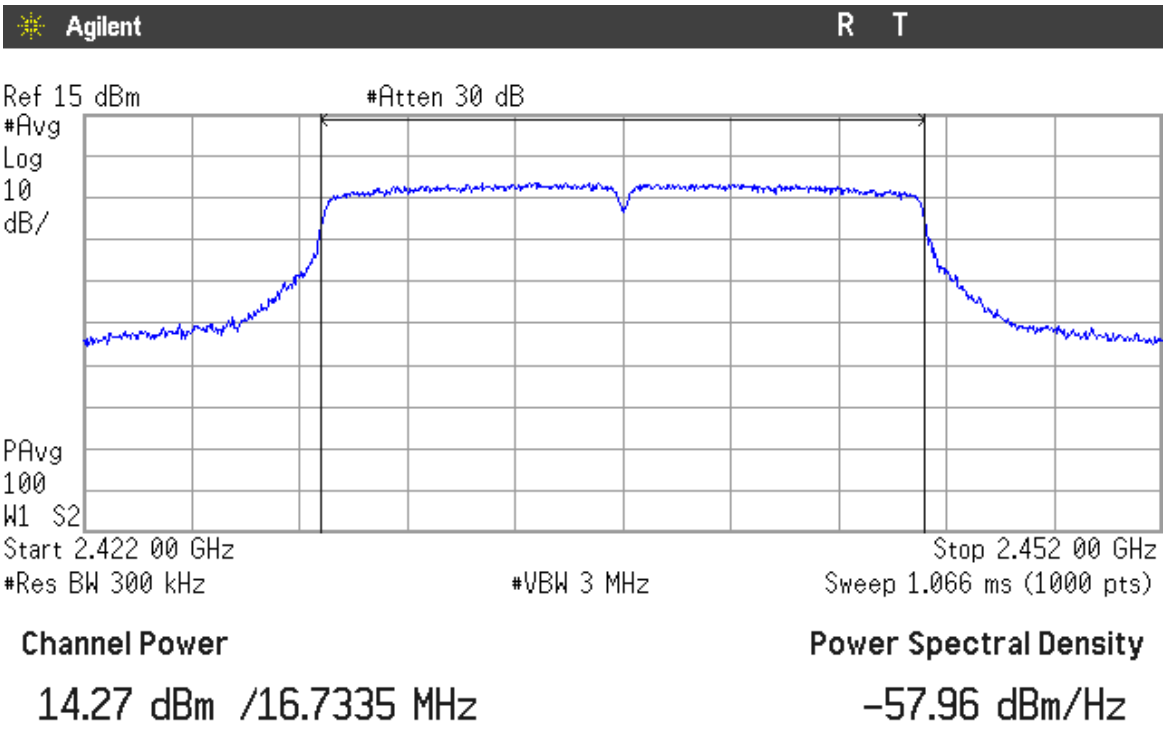


2. WiFi 2.4GHz 802.11 g mode

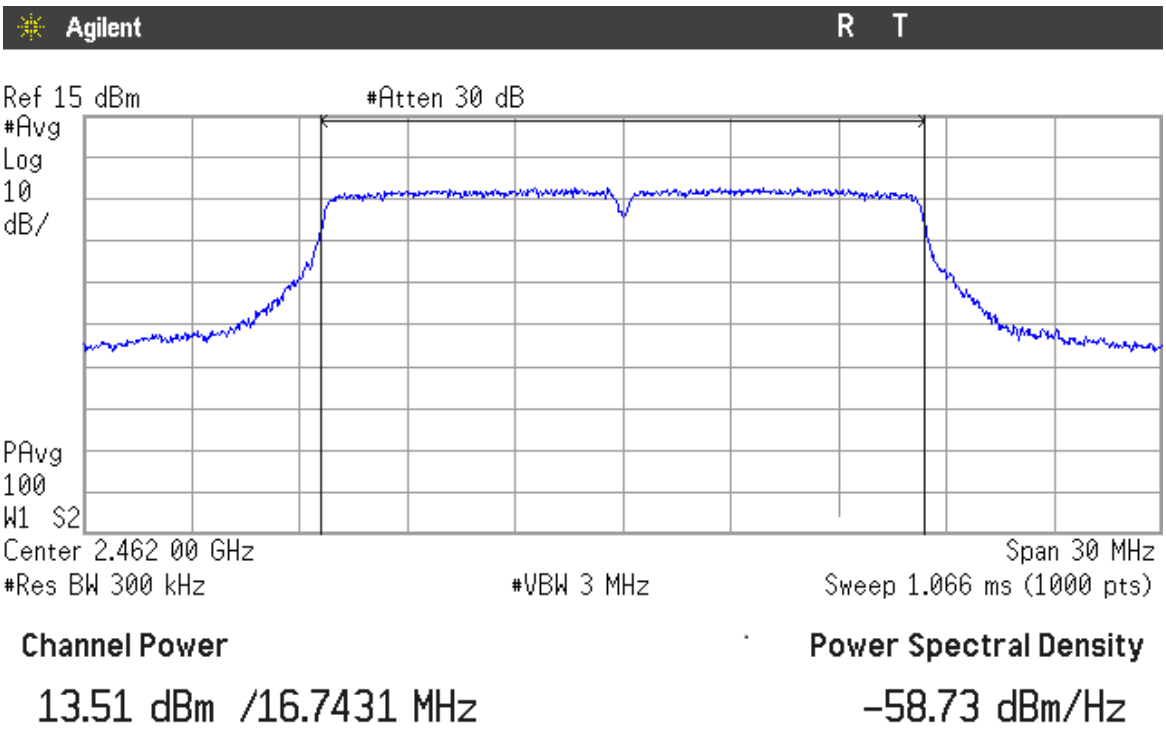
Lowest frequency 2412 MHz.



Middle frequency 2437 MHz.

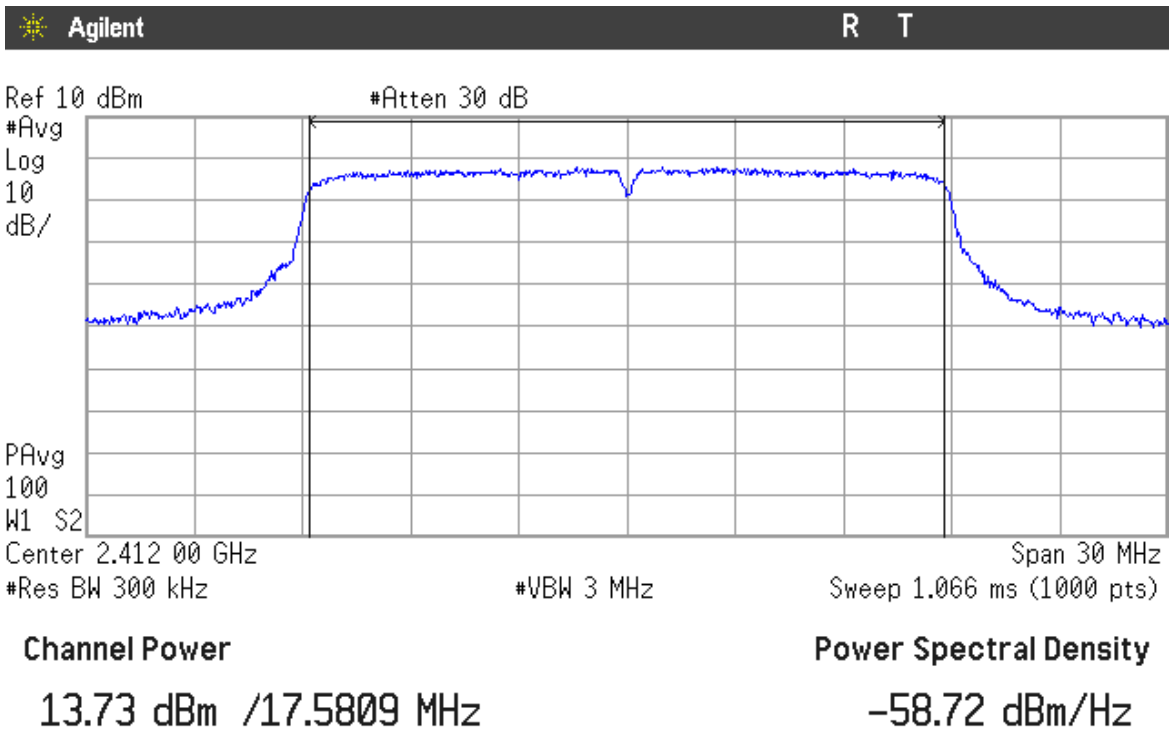


Highest frequency 2462 MHz.

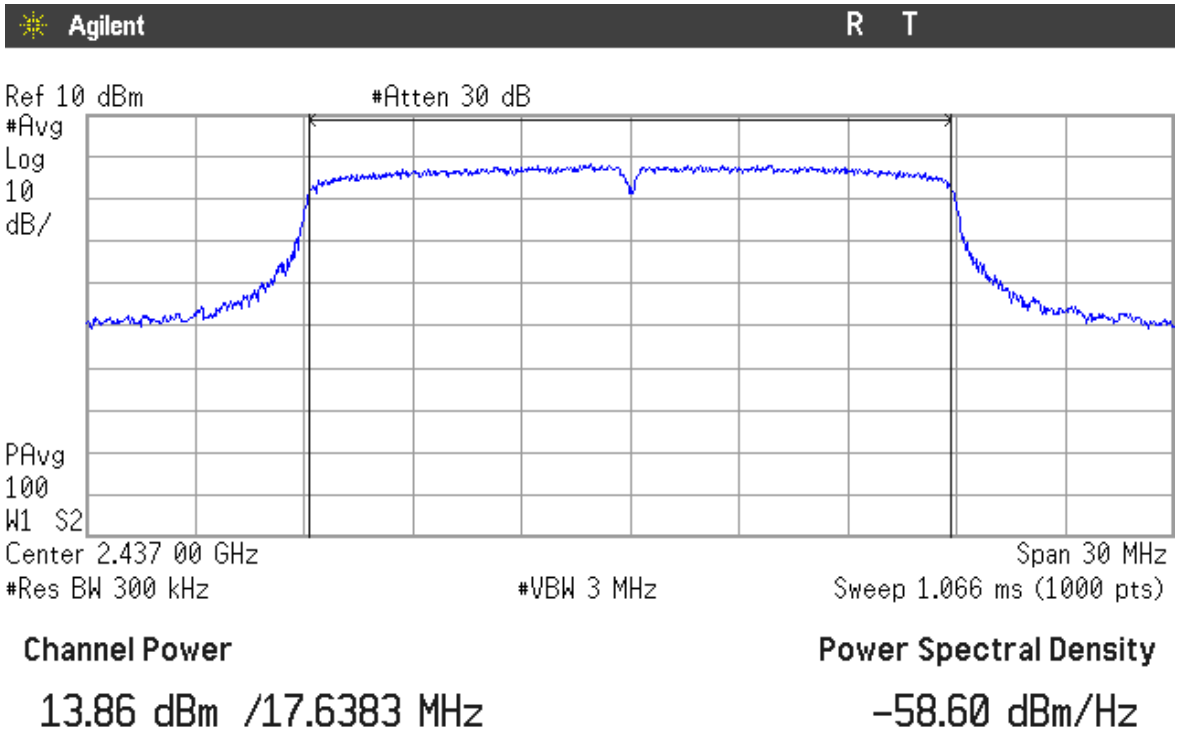


3. WiFi 2.4GHz 802.11 n20 mode

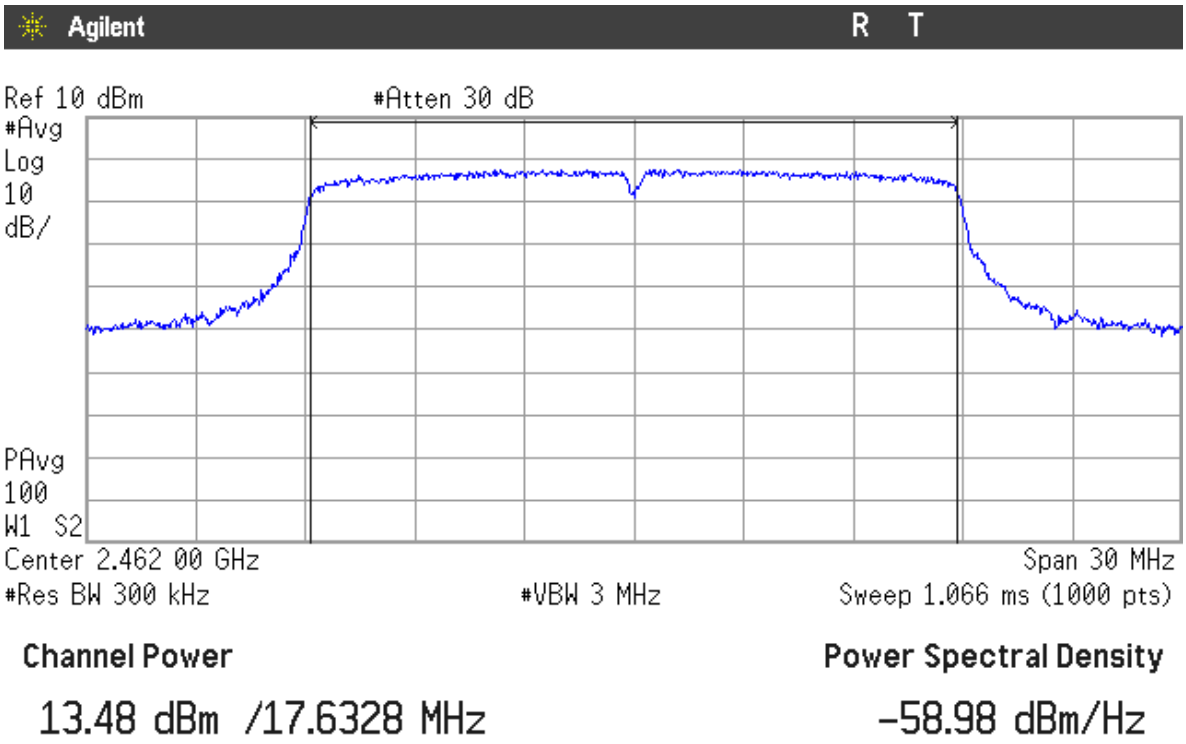
Lowest frequency 2412 MHz.



Middle frequency 2437 MHz.



Highest frequency 2462 MHz.



Section 15.247 Subclause (d) / RSS-210 A8.5. Emission limitations conducted (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:

1. WiFi 2.4GHz 802.11 b mode

Reference Level Measurement

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	7.38	7.31	6.78
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.62

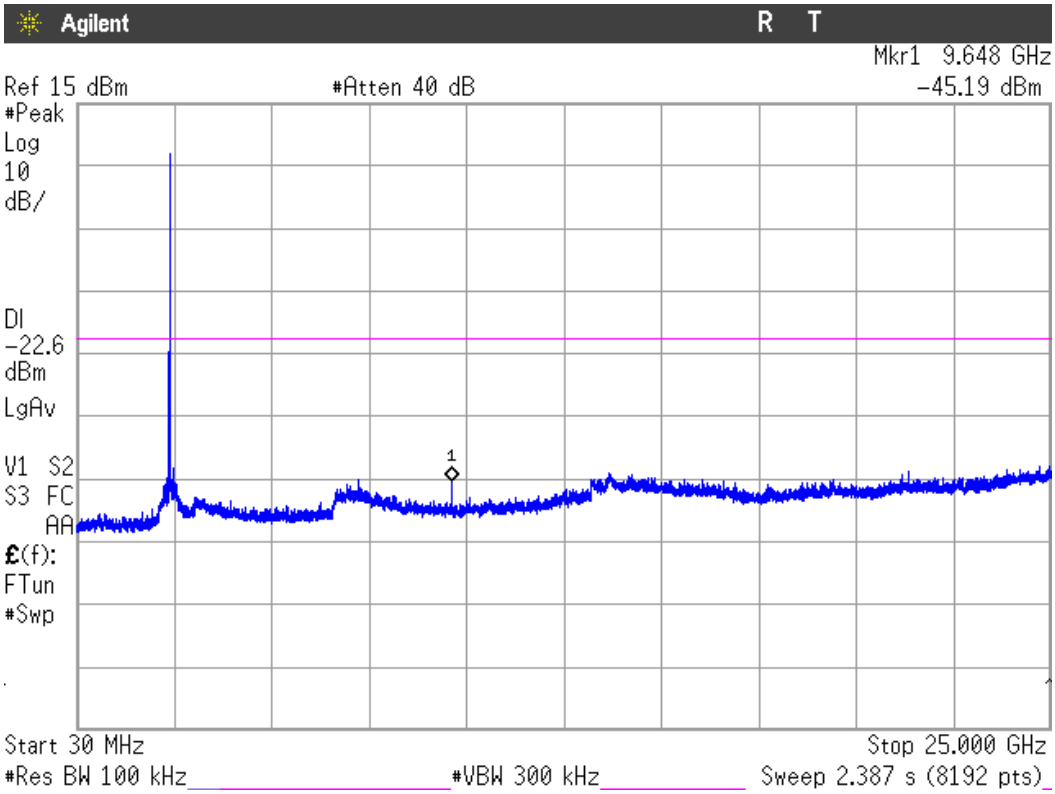
Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.69

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-23.22

Verdict: PASS

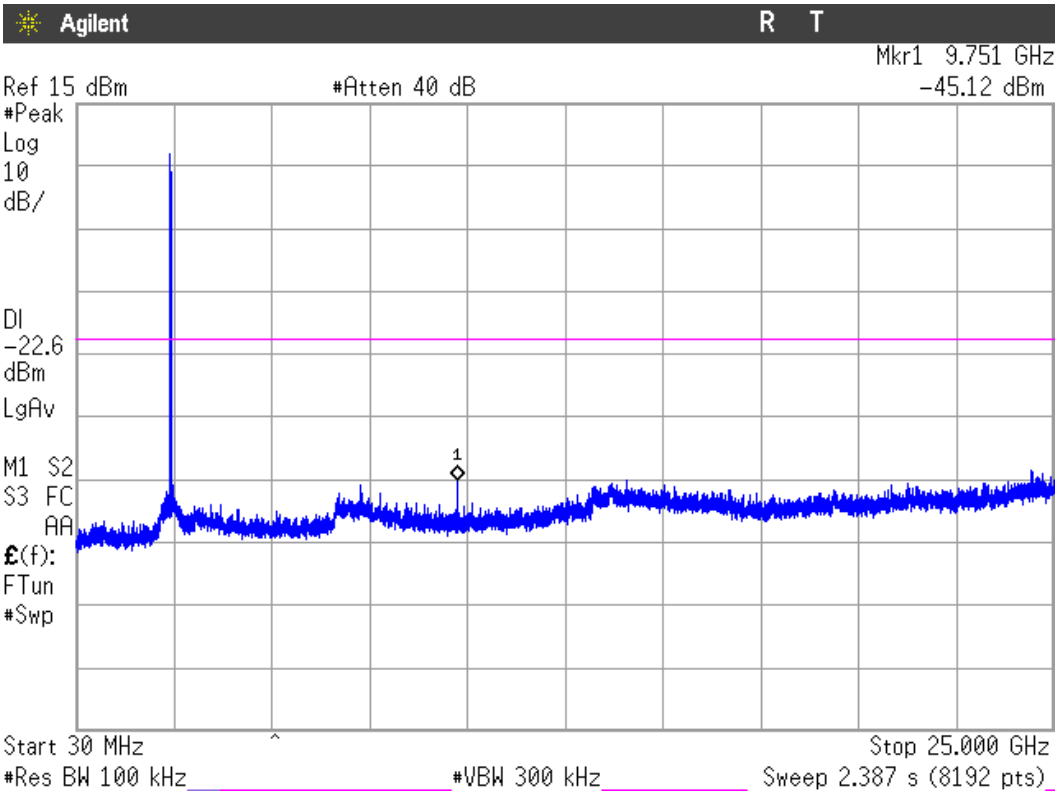
See next plots.

CH LOW:



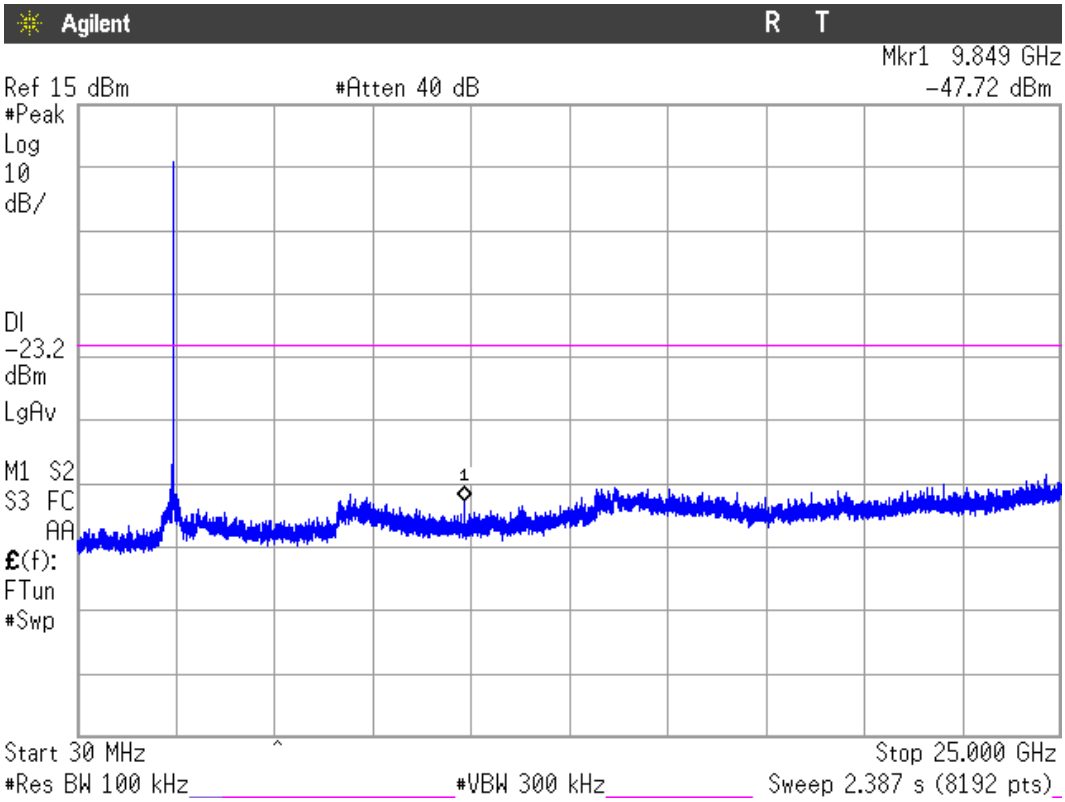
Note: The peak above the limit is the carrier frequency.

CH MIDDLE:



Note: The peak above the limit is the carrier frequency.

CH HIGH:



Note: The peak above the limit is the carrier frequency.

2. WiFi 2.4GHz 802.11 g mode

Reference Level Measurement

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	4.08	4.08	3.65
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.92

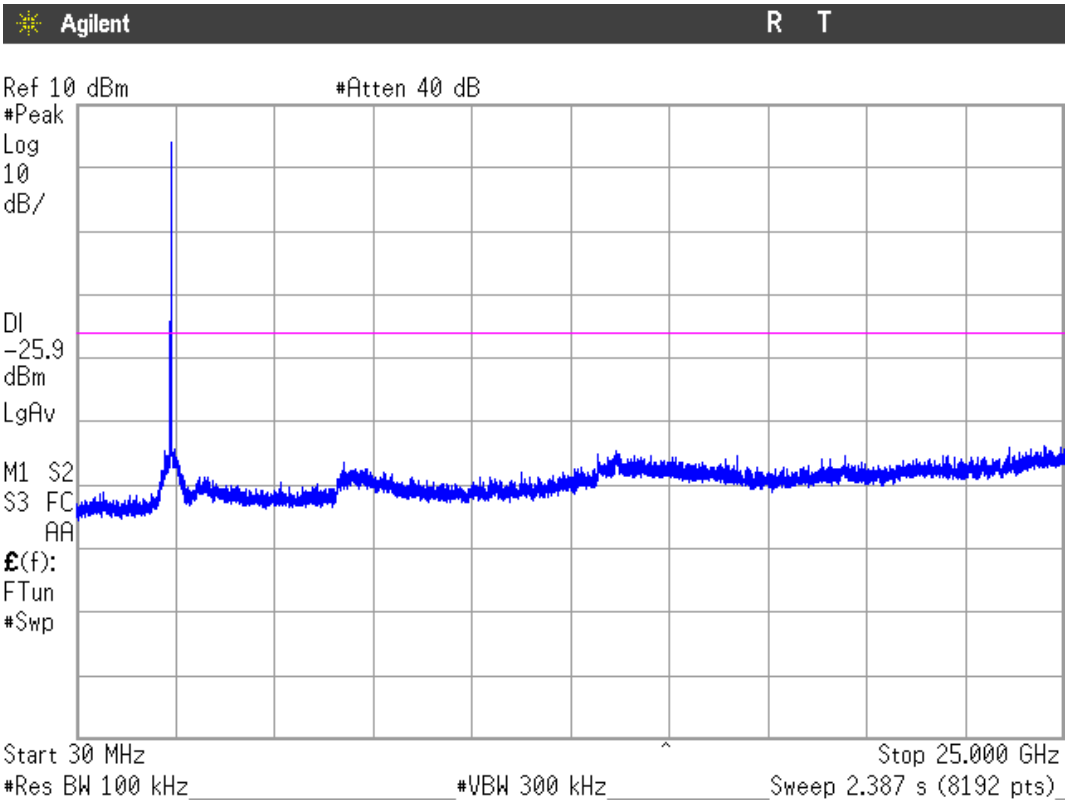
Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.92

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.35

Verdict: PASS

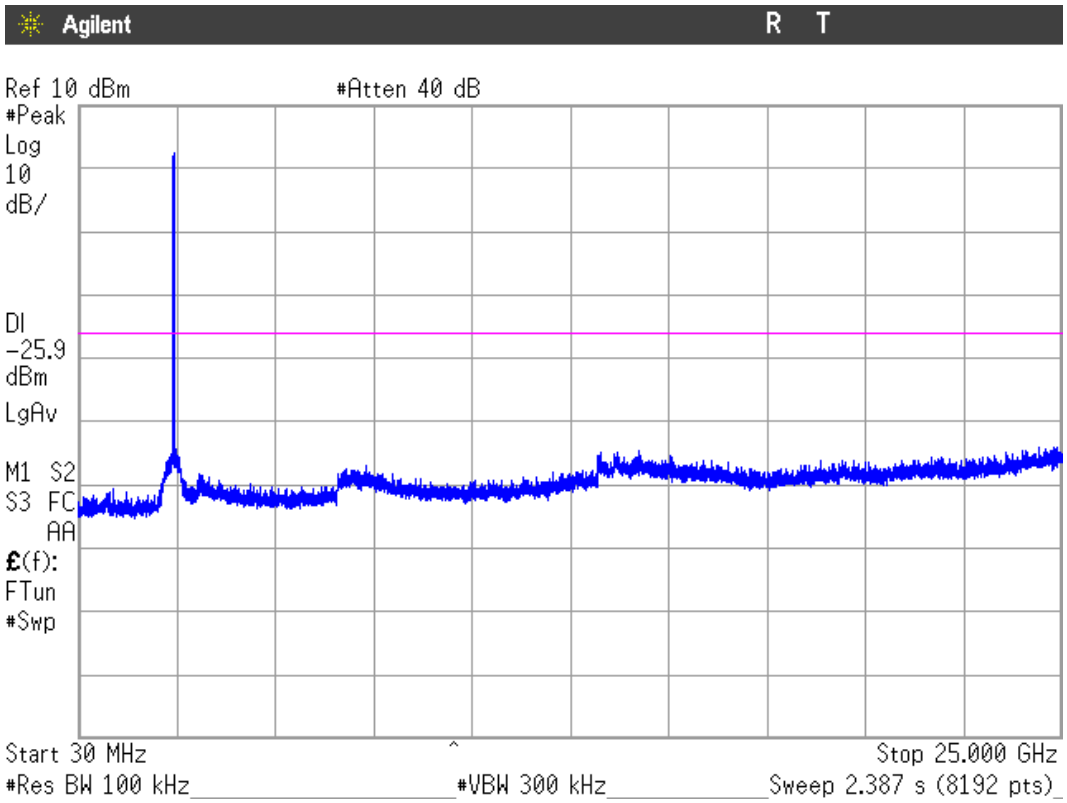
See next plots.

CH LOW:



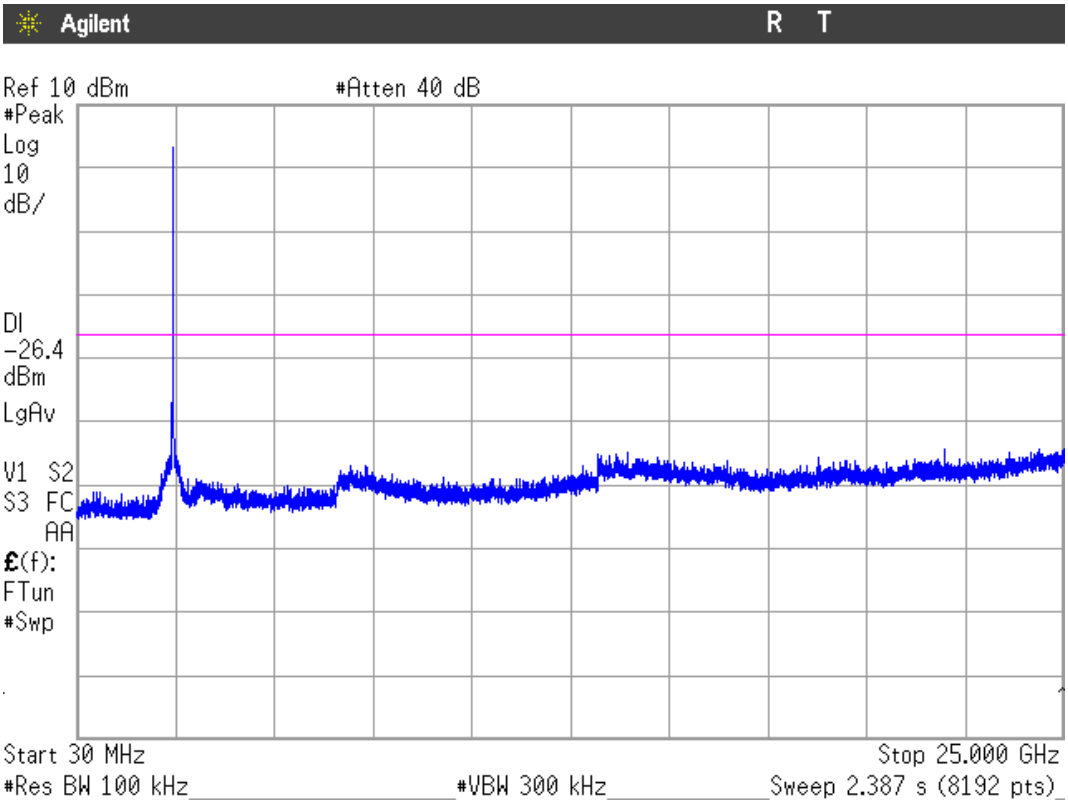
Note: The peak above the limit is the carrier frequency.

CH MIDDLE:



Note: The peak above the limit is the carrier frequency.

CH HIGH:



Note: The peak above the limit is the carrier frequency.

3. WiFi 2.4GHz 802.11 n20 mode

Reference Level Measurement

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	4.06	4.03	3.76
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.94

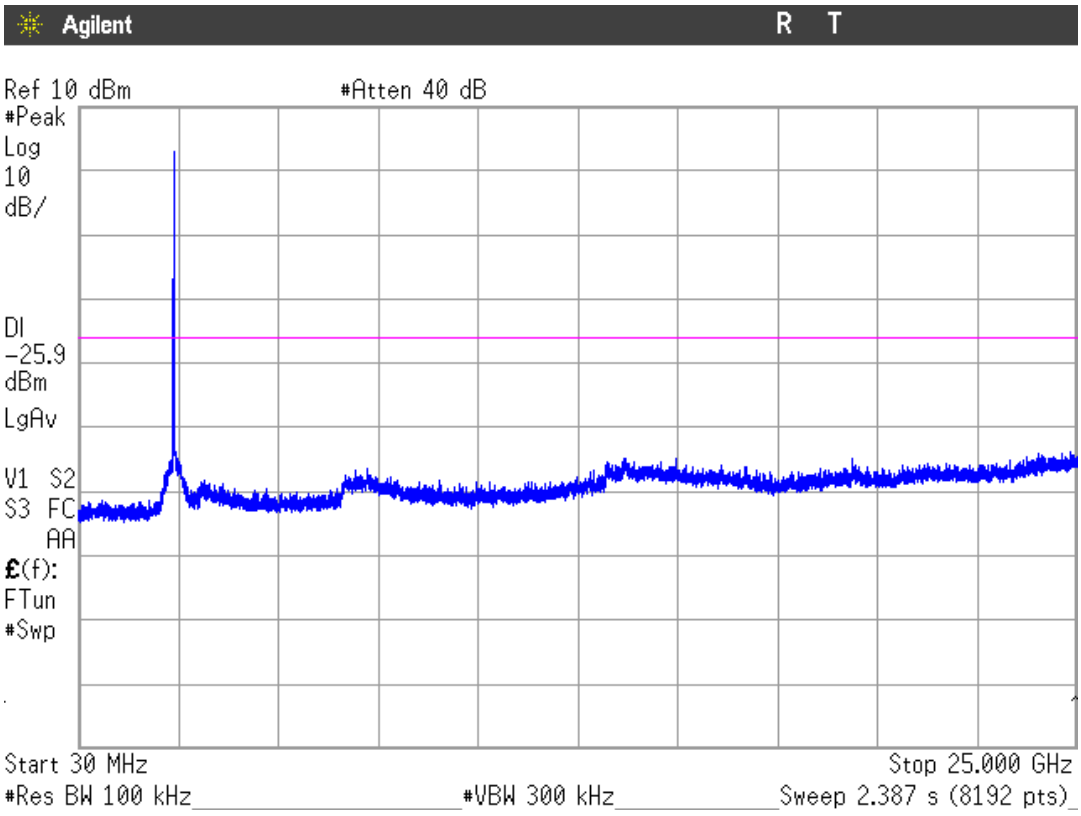
Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.97

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.24

Verdict: PASS

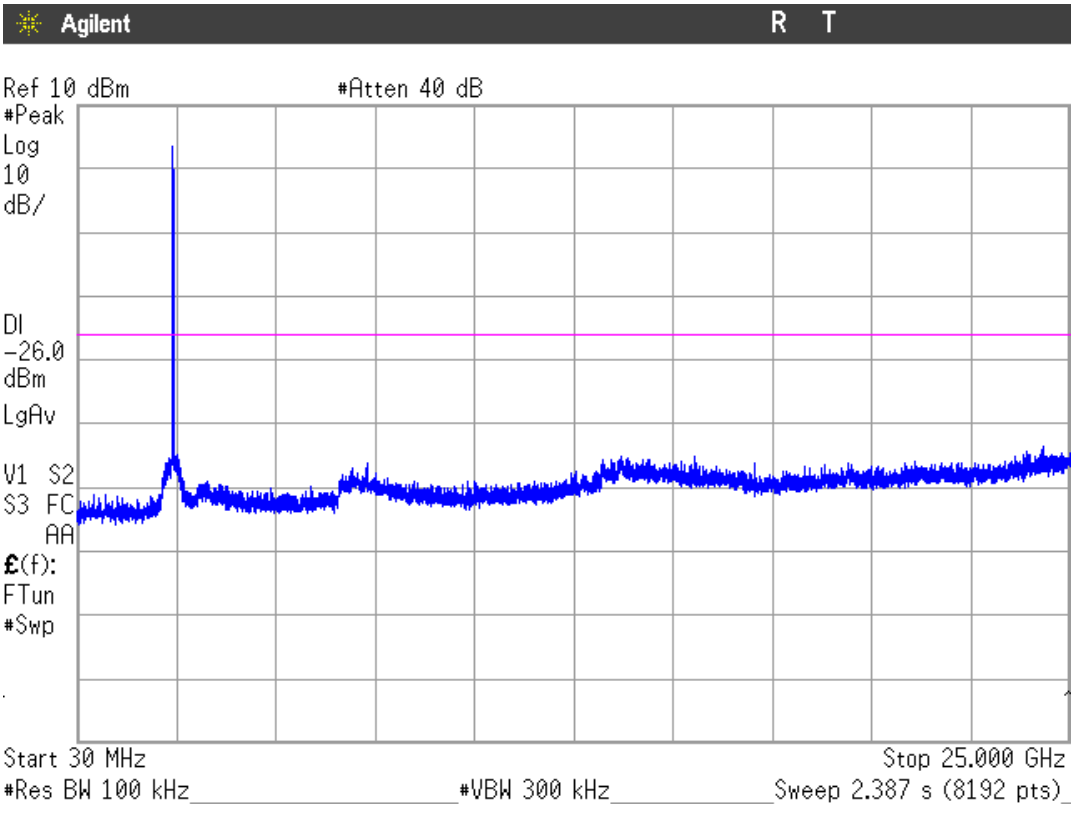
See next plots.

CH LOW:



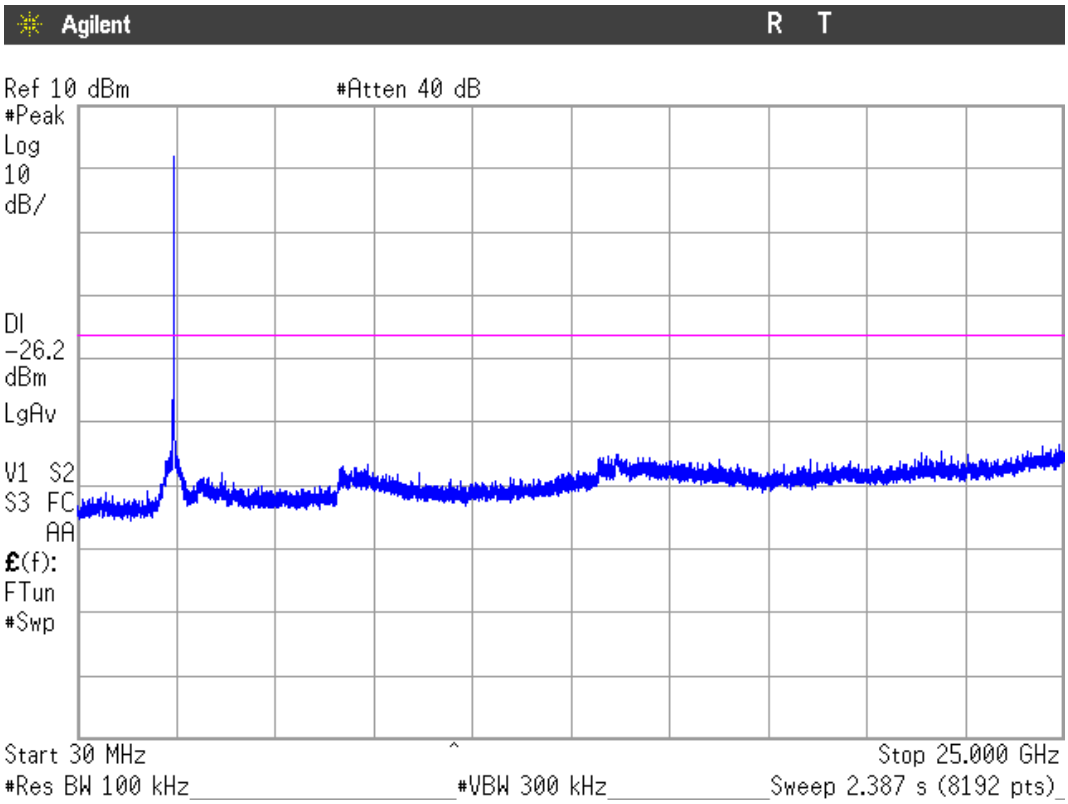
Note: The peak above the limit is the carrier frequency.

CH MIDDLE:



Note: The peak above the limit is the carrier frequency.

CH HIGH:



Note: The peak above the limit is the carrier frequency.

Section 15.247 Subclause (d) / RSS-210 A8.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION

Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below 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.

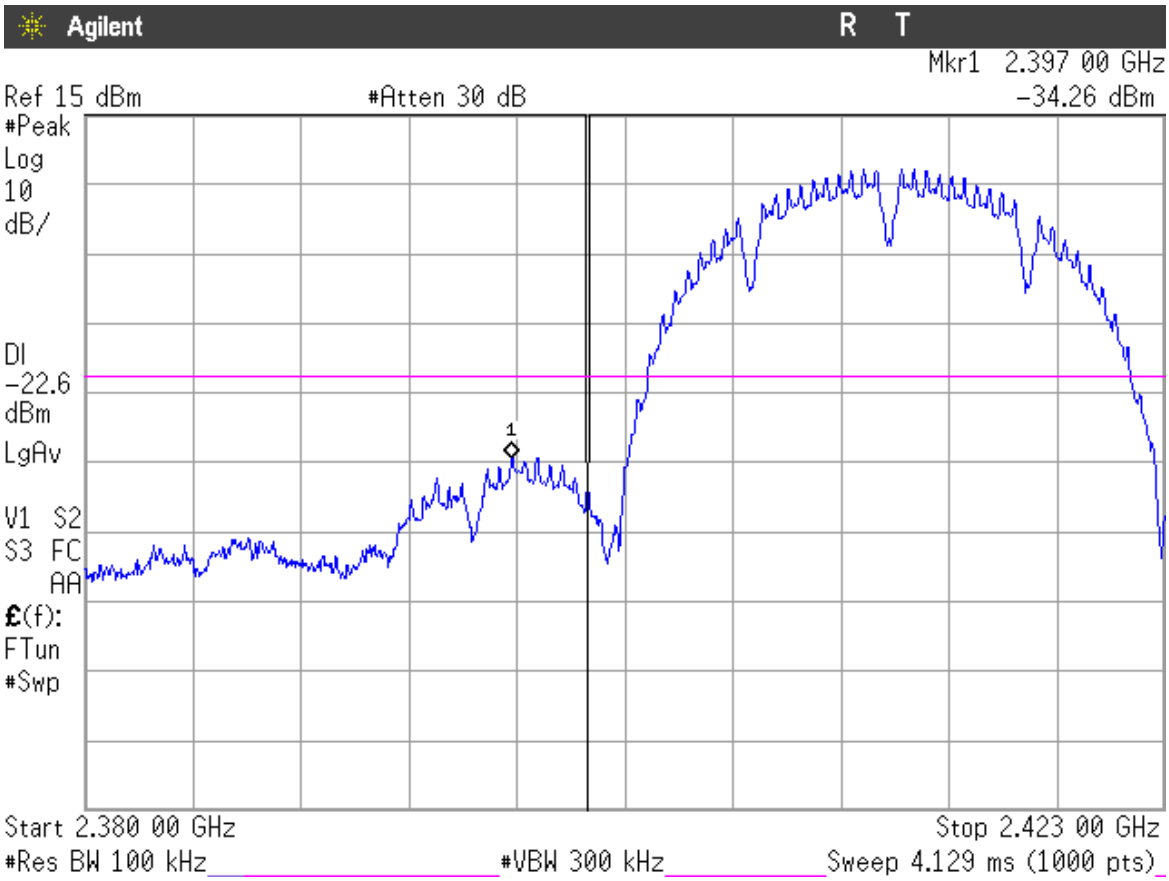
RESULTS:

Note: 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.

See next plots.

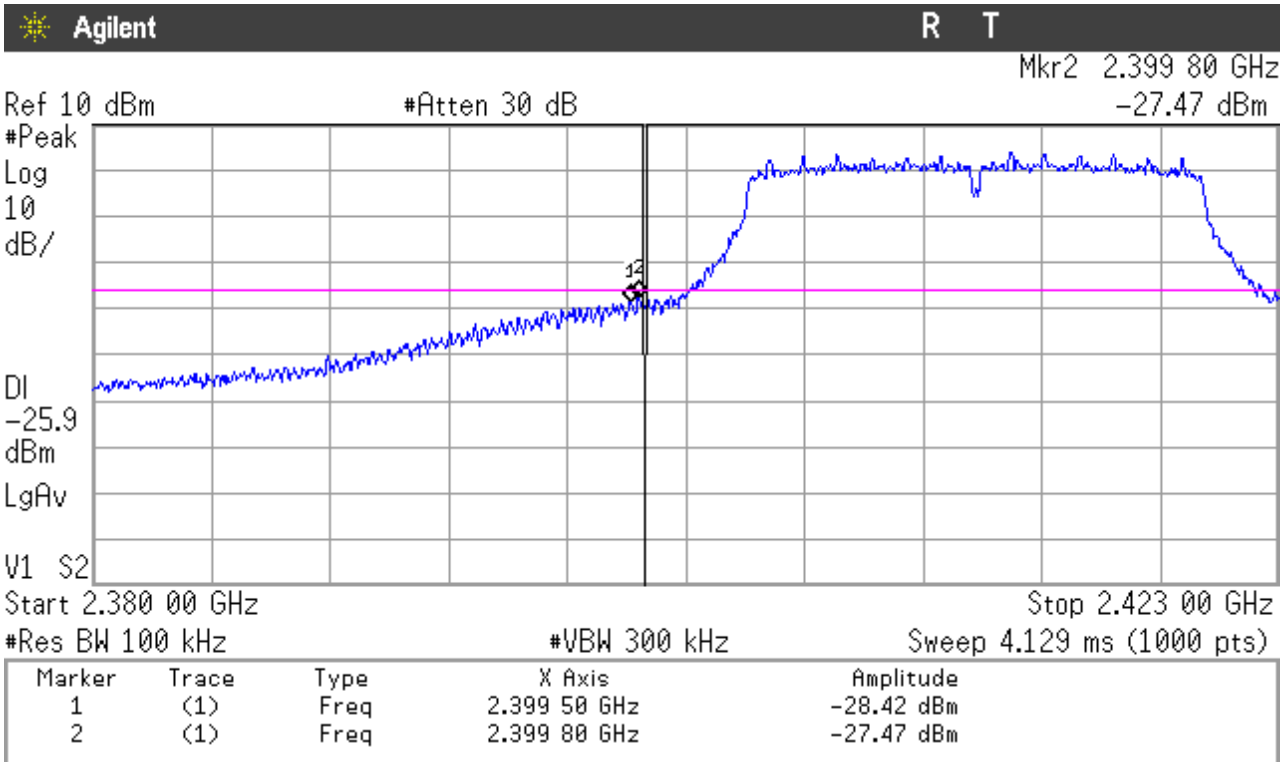
LOW FREQUENCY SECTION 2412 MHz. CONDUCTED.

1. WiFi 2.4GHz 802.11 b mode



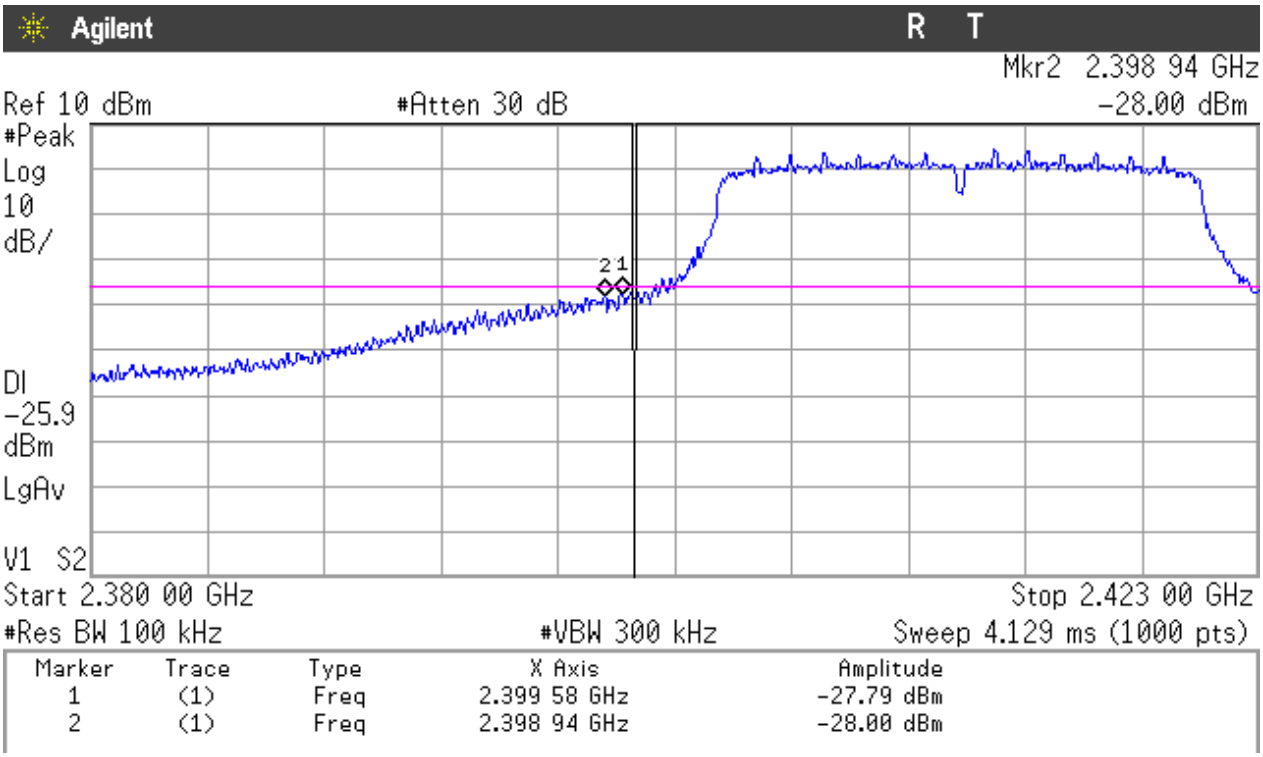
Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode



Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode



Verdict: PASS

Section 15.247 Subclause (e) / RSS-210 A8.5. 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

The maximum power spectral density level in the fundamental emission was measured using the method of trace averaging with EUT transmitting at full power throughout each sweep according to point 10.3. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r02 dated 06/05/2014.

1. WiFi 2.4GHz 802.11 b mode

Power spectral density (See next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-1.448	-1.766	-2.004
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

Power spectral density (See next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-4.978	-5.013	-5.853
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

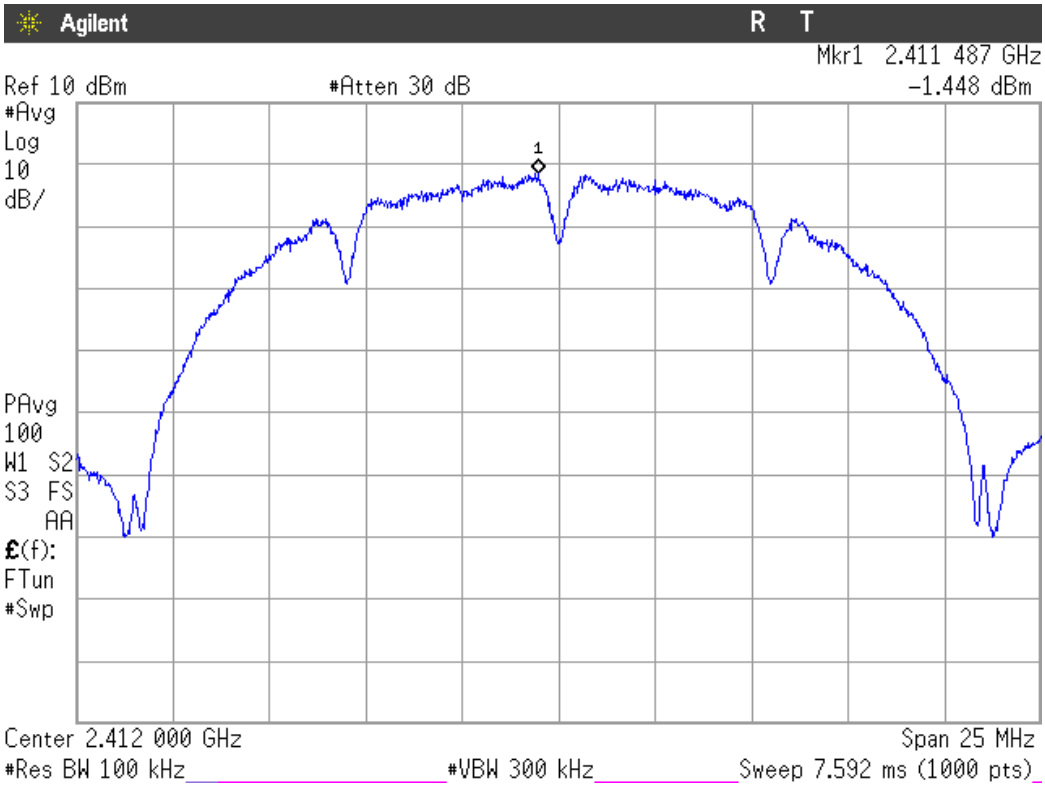
Power spectral density (See next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-5.586	-5.645	-6.136
Measurement uncertainty (dB)	±1.5		

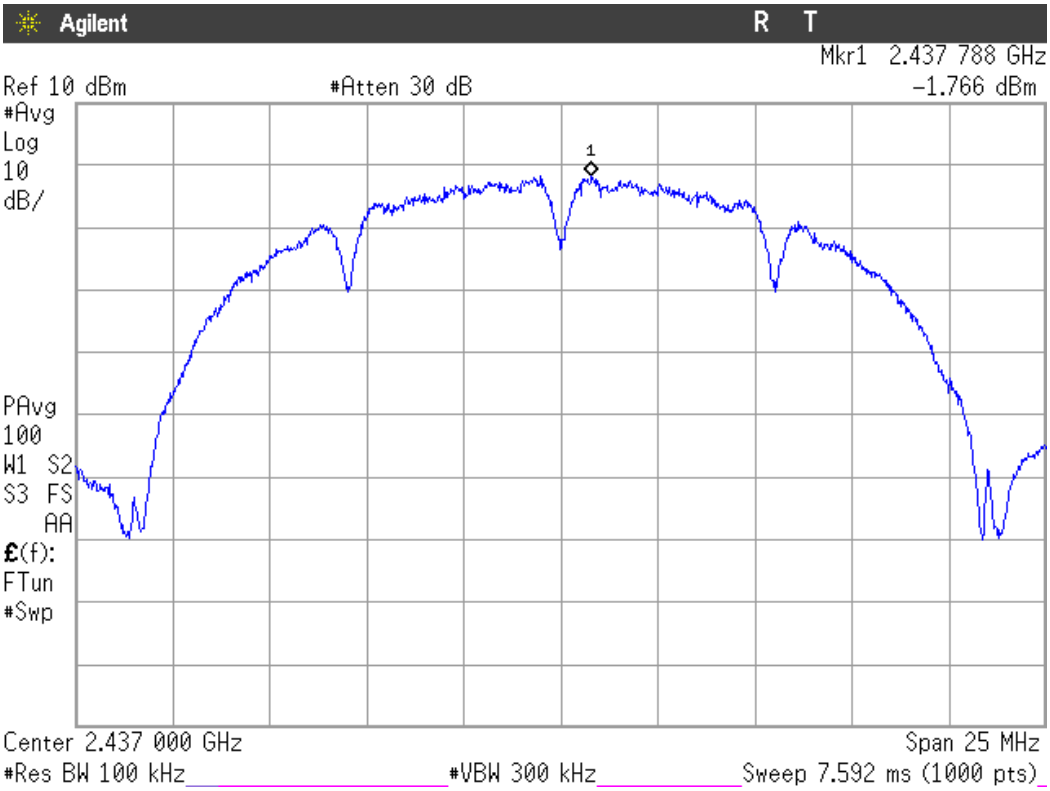
Verdict: PASS

1. WiFi 2.4GHz 802.11 b mode

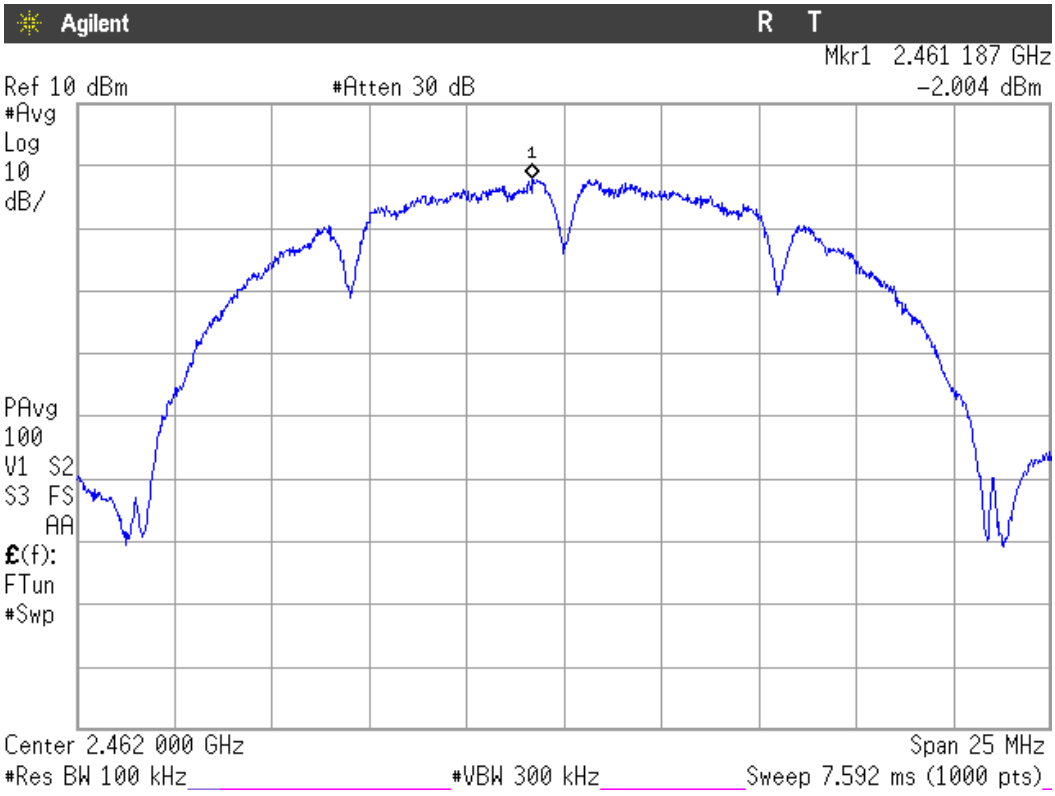
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.

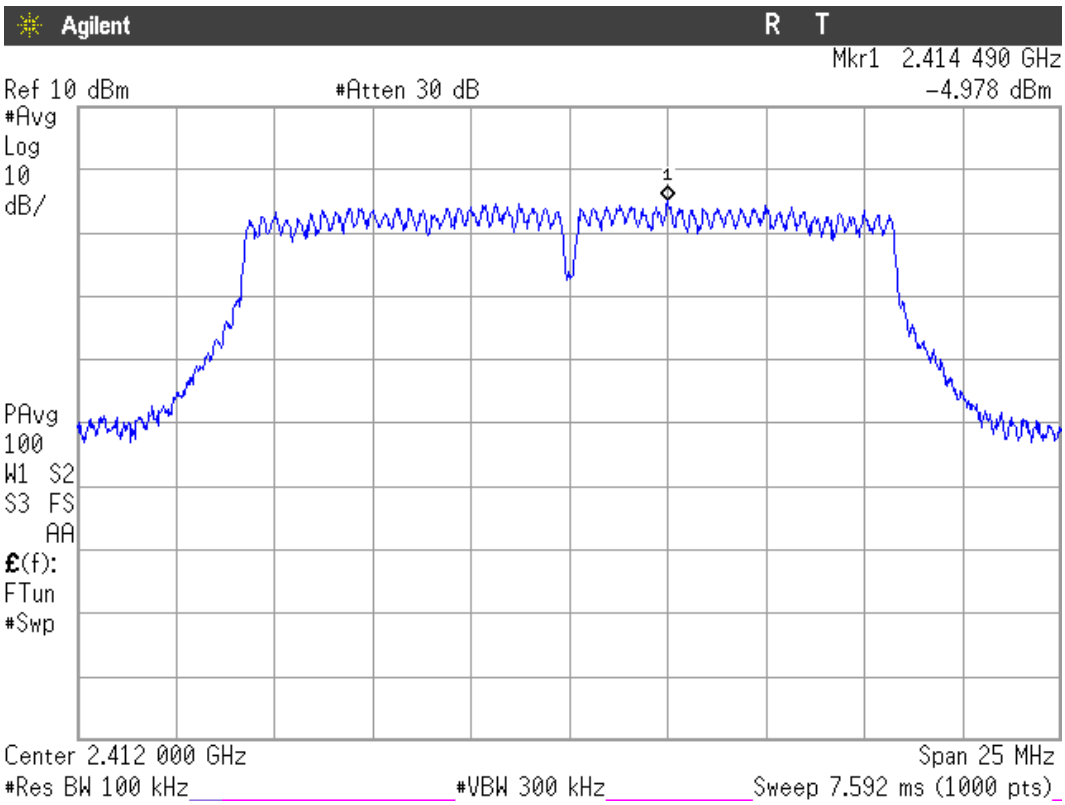


Highest Channel: 2462 MHz.

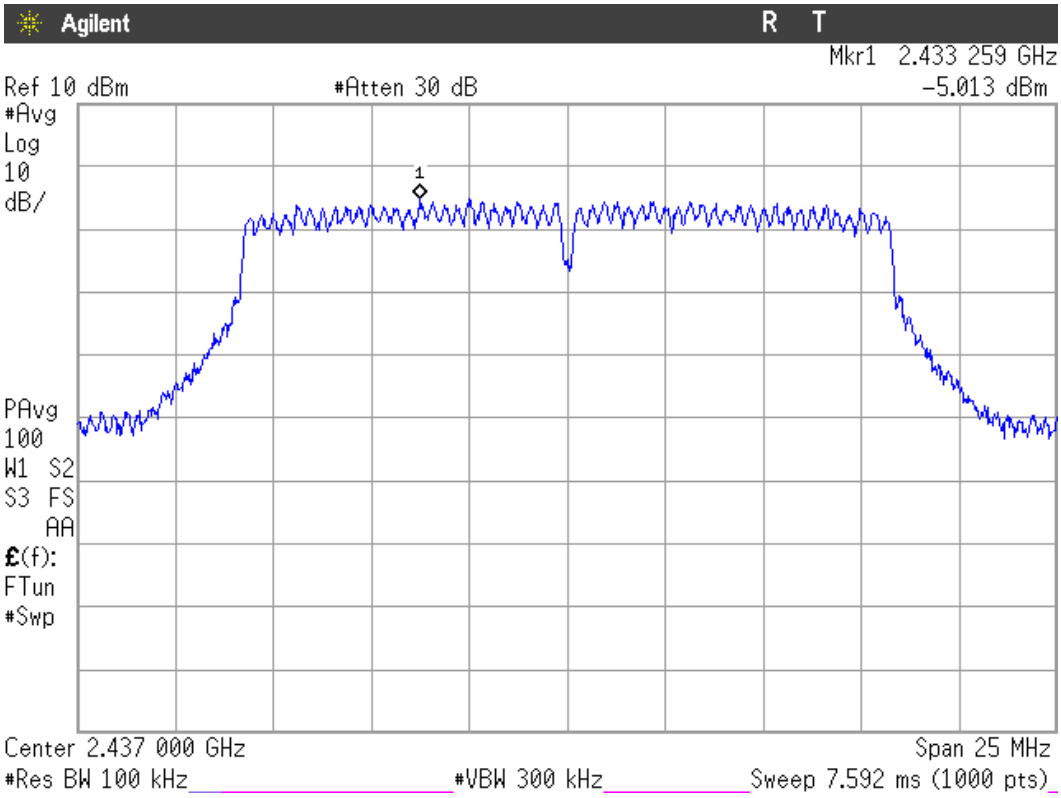


2. WiFi 2.4GHz 802.11 g mode

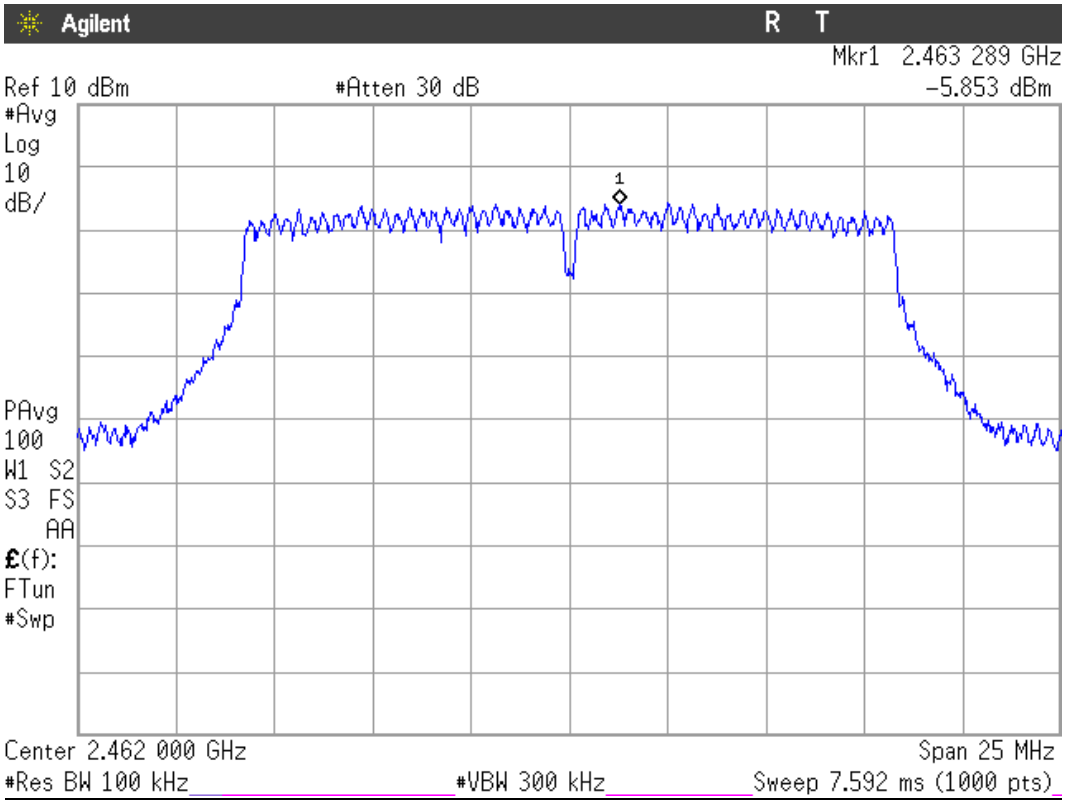
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.

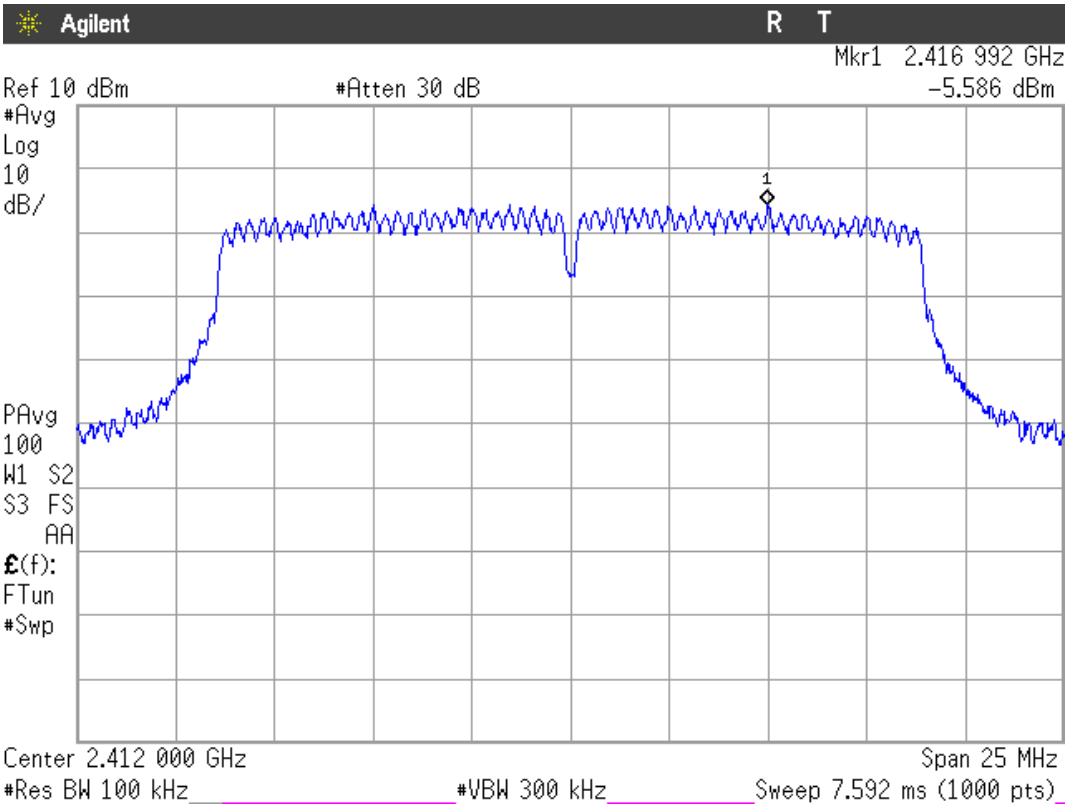


Highest Channel: 2462 MHz.

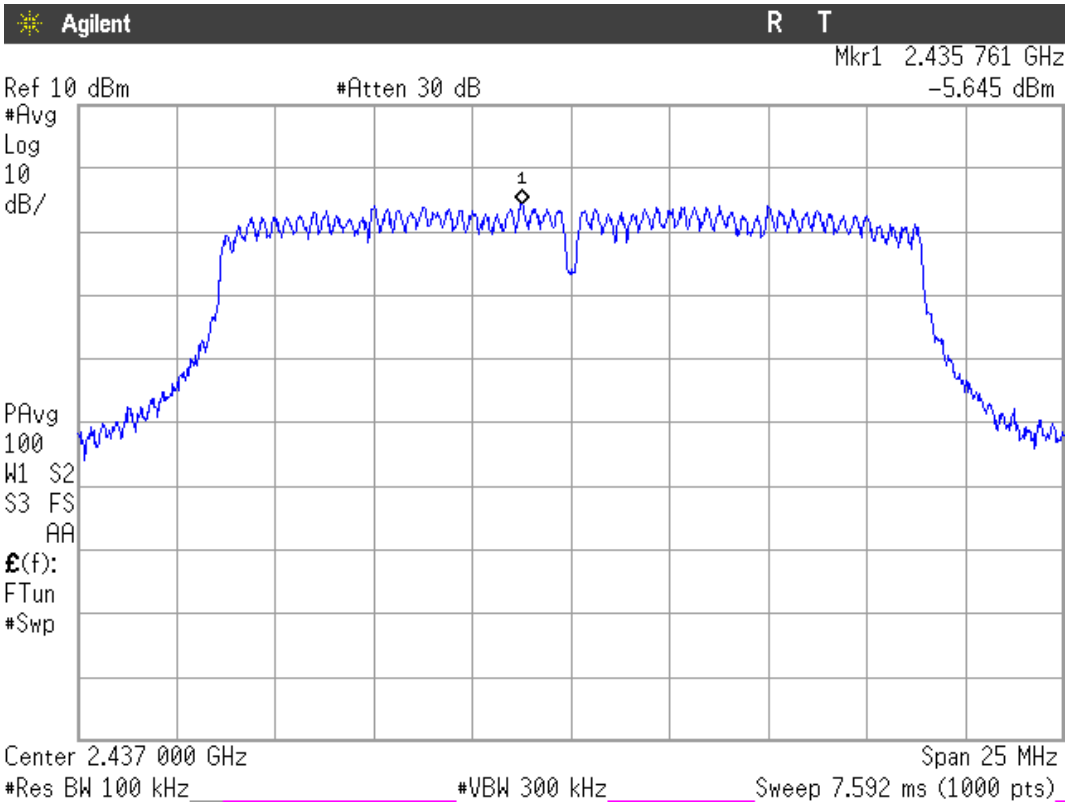


3. WiFi 2.4GHz 802.11 n20 mode

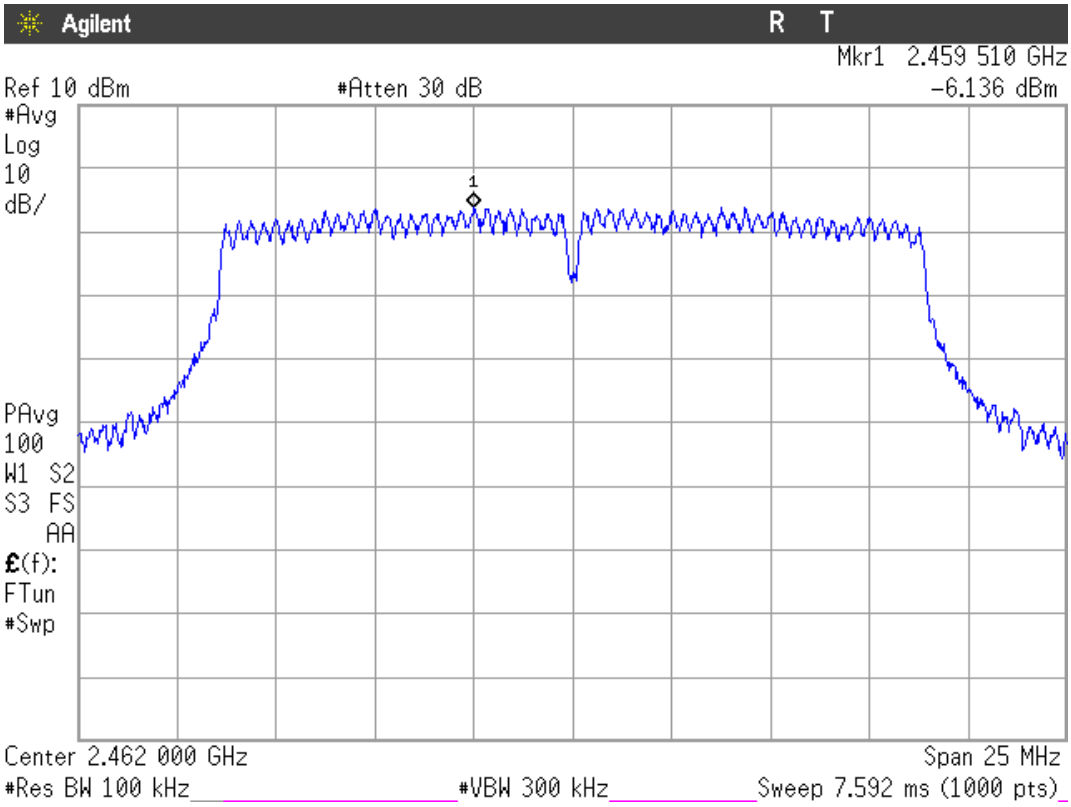
Lowest Channel: 2412 MHz.



Middle Channel: 2437 MHz.



Highest Channel: 2462 MHz.



Section 15.247 Subclause (d) / RSS-210 A8.5. 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)):

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)	-	300
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.

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.

The equipment transmits continuously in the selected channel so it is not necessary a duty cycle correction factor.

Frequency range 30 MHz-1000 MHz.

The spurious signals detected do not depend on either the operating channel or the modulation mode.

Spurious levels closest to the limit:

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
278.999	PH	Quasi-Peak	41.40	± 4.12
597.256	PH	Quasi-Peak	33.02	± 4.12
660.015	PH	Quasi-Peak	42.19	± 4.12
875.064	PH	Quasi-Peak	38.48	± 4.12

Frequency range 1 GHz-25 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 (see next plots).

The field strength at the band edges was evaluated for each mode on the lowest and highest channels at the rated power for the channel under test.

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

1. WiFi 2.4GHz 802.11 b mode.

1.1. CHANNEL 1: LOWEST (2412 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.326367	V	Peak	46.82	± 4.0
1.591900	V	Peak	48.38	± 4.0
2.334614	V	Peak	46.97	± 4.0
2.387924	V	Peak	49.51	± 4.0
2.815967	V	Peak	47.36	± 4.0
4.824250	V	Peak	51.35	± 4.0
7.237250	V	Peak	52.77	± 4.0
9.648250	V	Peak	45.63	± 4.0
19.29613	V	Peak	41.28	± 4.0

1.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.326433	V	Peak	45.60	± 4.0
1.592100	V	Peak	48.34	± 4.0
1.857900	V	Peak	44.71	± 4.0
4.873750	V	Peak	56.78	± 4.0
	V	RMS	48.71	± 4.0
7.311215	V	Peak	55.92	± 4.0
	V	RMS	50.74	± 4.0
9.748250	V	Peak	50.02	± 4.0
12.186750	V	Peak	47.33	± 4.0
19.496400	V	Peak	42.26	± 4.0

1.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.327033	V	Peak	44.90	± 4.0
1.592100	V	Peak	48.28	± 4.0
1.856967	V	Peak	45.02	± 4.0
2.488163	V	Peak	52.22	± 4.0
4.924250	V	Peak	53.42	± 4.0
7.387250	V	Peak	52.58	± 4.0
9.847750	V	Peak	53.57	± 4.0
12.31125	V	Peak	47.20	± 4.0
19.696130	V	Peak	40.49	± 4.0

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

2.1. CHANNEL 1: LOWEST (2412 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.326633	V	Peak	45.80	± 4.0
1.591767	V	Peak	48.70	± 4.0
2.381118	V	Peak	54.61	± 4.0
	V	RMS	40.37	± 4.0
2.389996	V	Peak	62.63	± 4.0
	V	RMS	48.59	± 4.0
2.815967	V	Peak	47.93	± 4.0
4.824750	V	Peak	47.47	± 4.0
7.228250	V	Peak	55.42	± 4.0
	V	RMS	42.99	± 4.0
19.296130	V	Peak	40.51	± 4.0

2.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.326700	V	Peak	45.86	± 4.0
1.856300	V	Peak	46.24	± 4.0
1.591100	V	Peak	48.63	± 4.0
2.295033	V	Peak	51.07	± 4.0
4.876750	V	Peak	46.71	± 4.0
7.312750	V	Peak	55.97	± 4.0
	V	RMS	48.66	± 4.0
9.745250	V	Peak	47.66	± 4.0
19.496130	V	Peak	40.89	± 4.0

2.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.326367	V	Peak	44.66	± 4.0
1.591767	V	Peak	48.88	± 4.0
1.857100	V	Peak	44.77	± 4.0
2.308100	V	Peak	51.00	± 4.0
2.483649	V	Peak	65.12	± 4.0
	V	RMS	50.20	± 4.0
2.816100	V	Peak	47.46	± 4.0
4.925250	V	Peak	49.47	± 4.0
7.392250	V	Peak	58.59	± 4.0
	V	RMS	47.30	± 4.0
9.850750	V	Peak	50.87	± 4.0
19.496130	V	Peak	40.89	± 4.0

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

3.1. CHANNEL 1: LOWEST (2412 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.592233	V	Peak	48.85	± 4.0
1.326367	V	Peak	45.80	± 4.0
2.286967	V	Peak	52.10	± 4.0
2.389817	V	Peak	66.85	± 4.0
	V	RMS	51.55	± 4.0
2.815900	V	Peak	48.91	± 4.0
4.825250	V	Peak	49.39	± 4.0
7.224750	V	Peak	58.07	± 4.0
	V	RMS	46.41	± 4.0
9.648250	V	Peak	45.92	± 4.0
19.296400	V	Peak	41.46	± 4.0

3.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range.

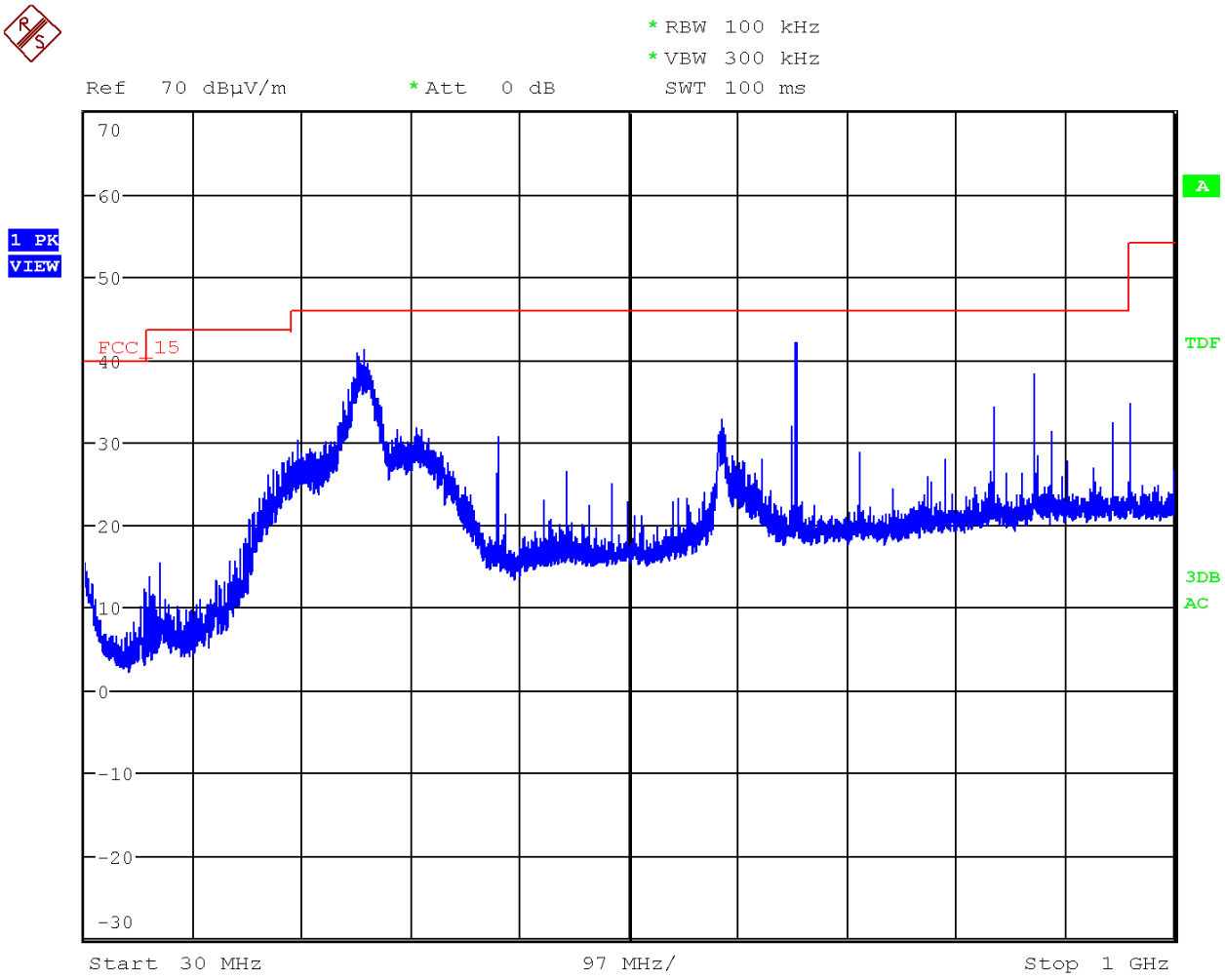
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.326900	V	Peak	46.14	± 4.0
1.591767	V	Peak	48.50	± 4.0
2.281367	V	Peak	51.91	± 4.0
2.815967	V	Peak	46.86	± 4.0
4.878750	V	Peak	48.29	± 4.0
7.317250	V	Peak	58.20	± 4.0
	V	RMS	47.61	± 4.0
9.748250	V	Peak	47.99	± 4.0
19.496130	V	Peak	40.90	± 4.0

3.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.326367	V	Peak	45.68	± 4.0
1.592100	V	Peak	48.97	± 4.0
2.483539	V	Peak	67.05	± 4.0
	V	RMS	51.56	± 4.0
2.816033	V	Peak	47.99	± 4.0
2.855670	V	Peak	50.65	± 4.0
4.923750	V	Peak	48.08	± 4.0
7.392750	V	Peak	59.59	± 4.0
	V	RMS	48.49	± 4.0
9.847750	V	Peak	50.47	± 4.0
19.696130	V	Peak	40.98	± 4.0

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

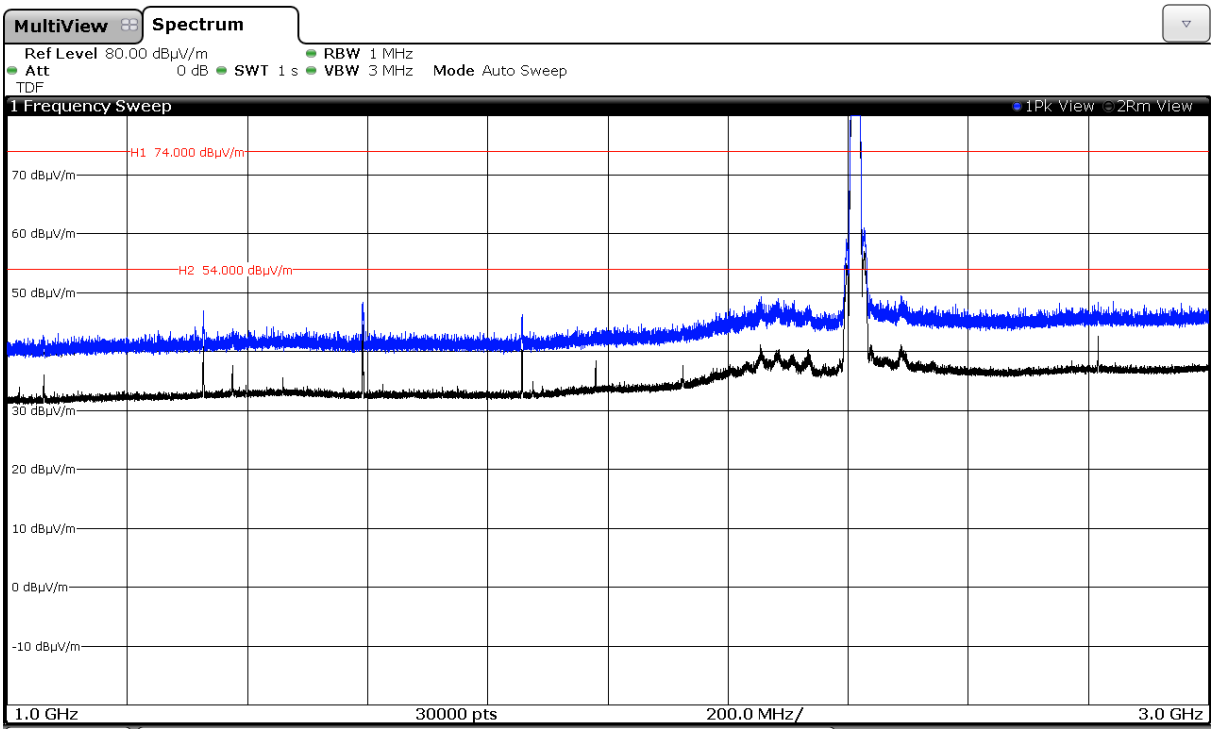


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

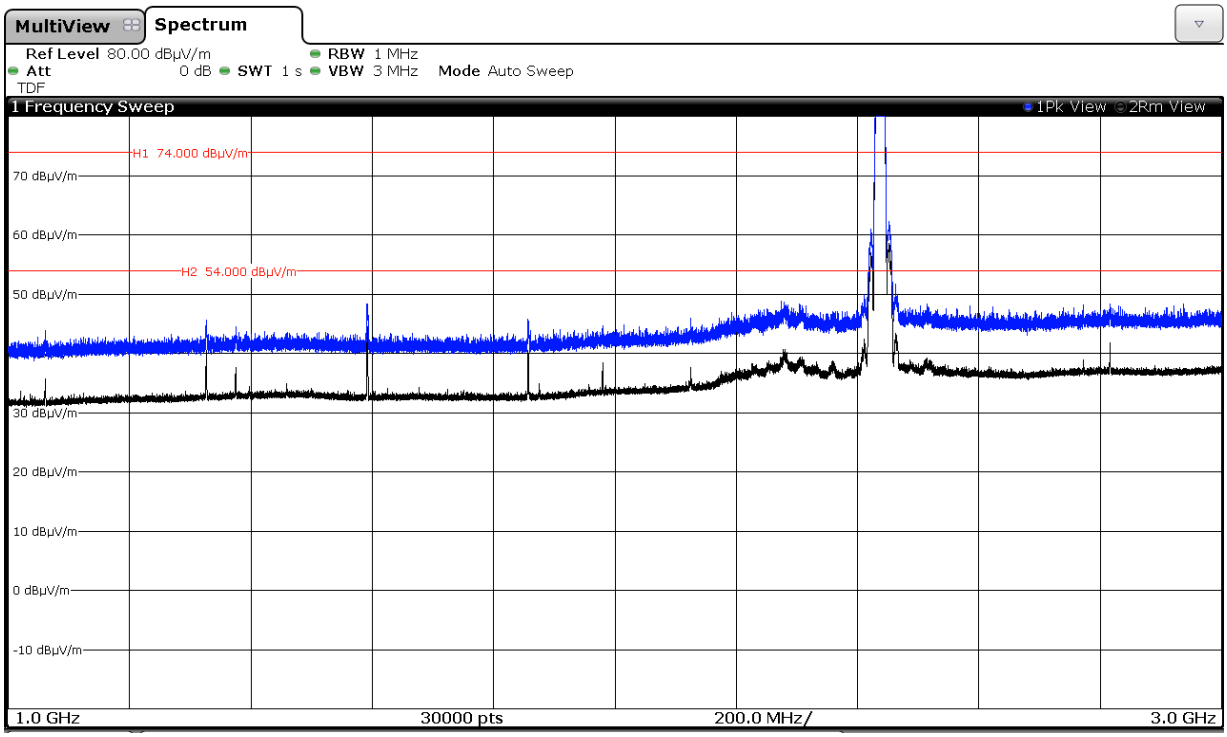
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



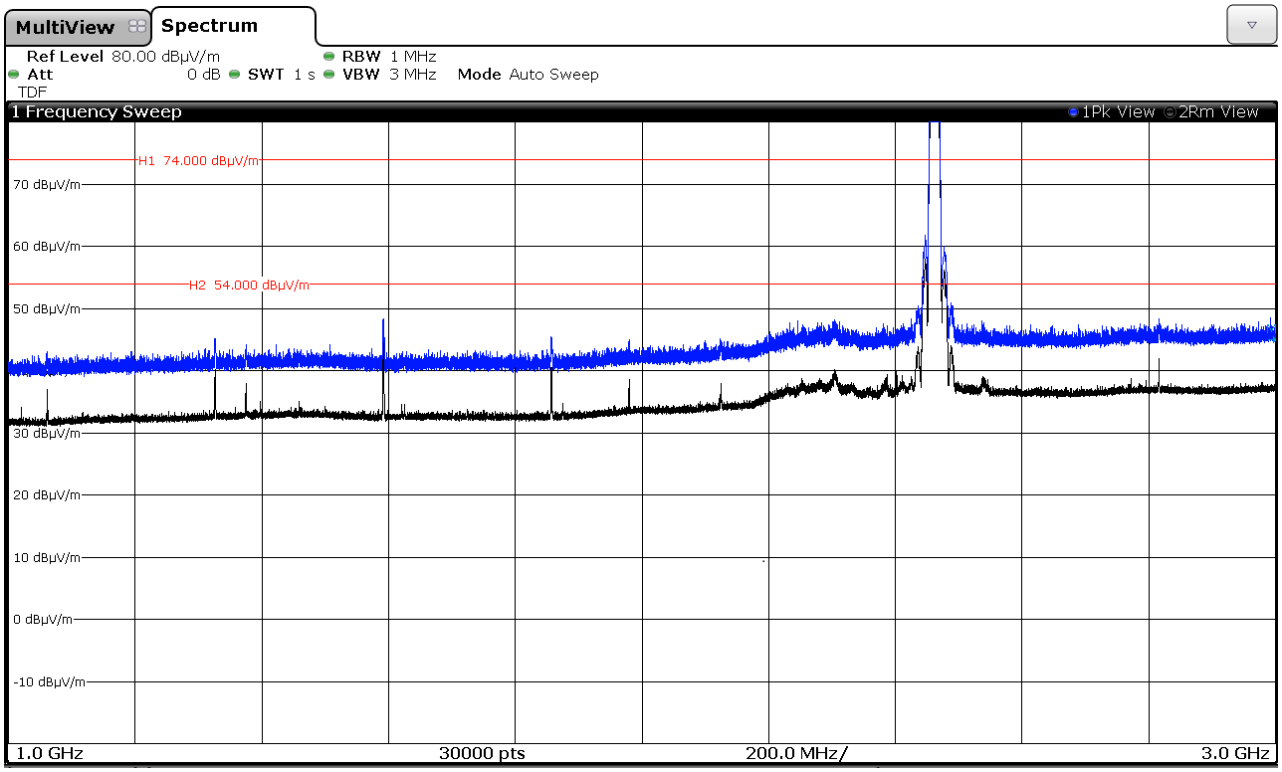
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



Note: The peak above the limit is the carrier frequency.

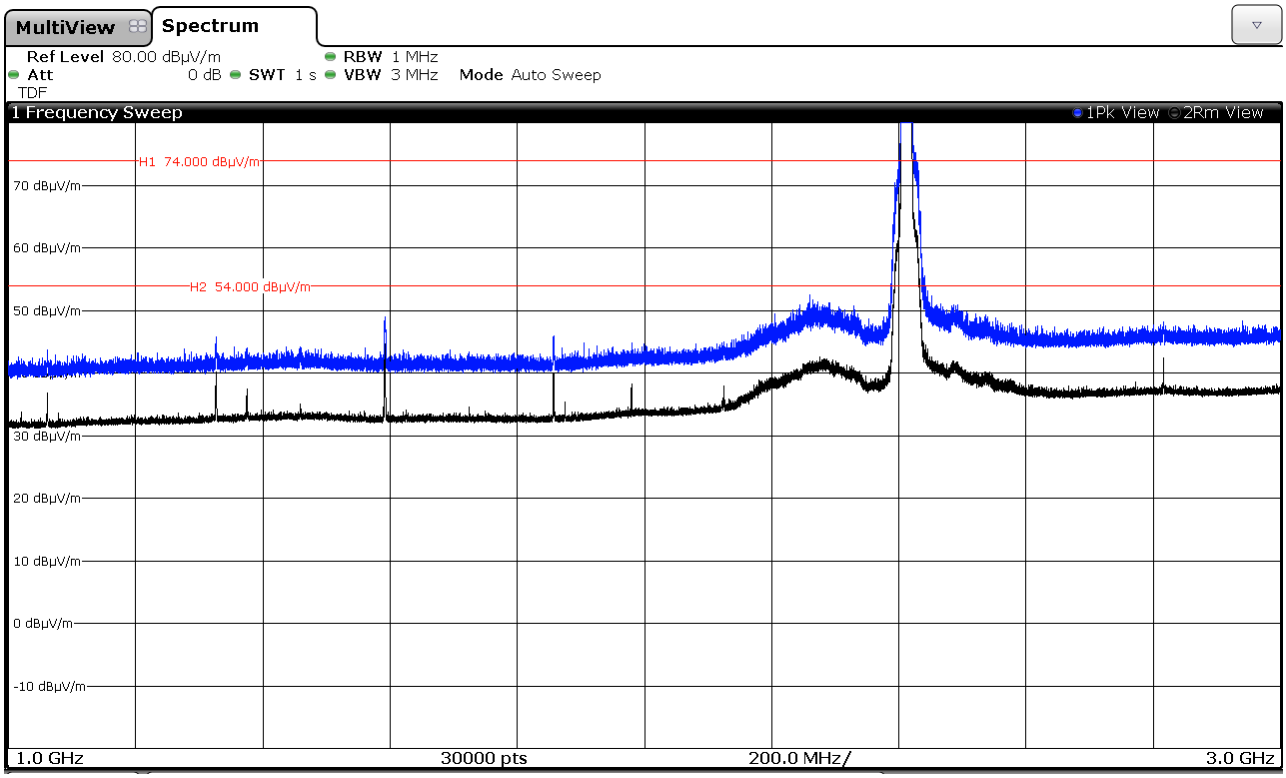
CHANNEL 11 (2462 MHz).



Note: The peak above the limit is the carrier frequency.

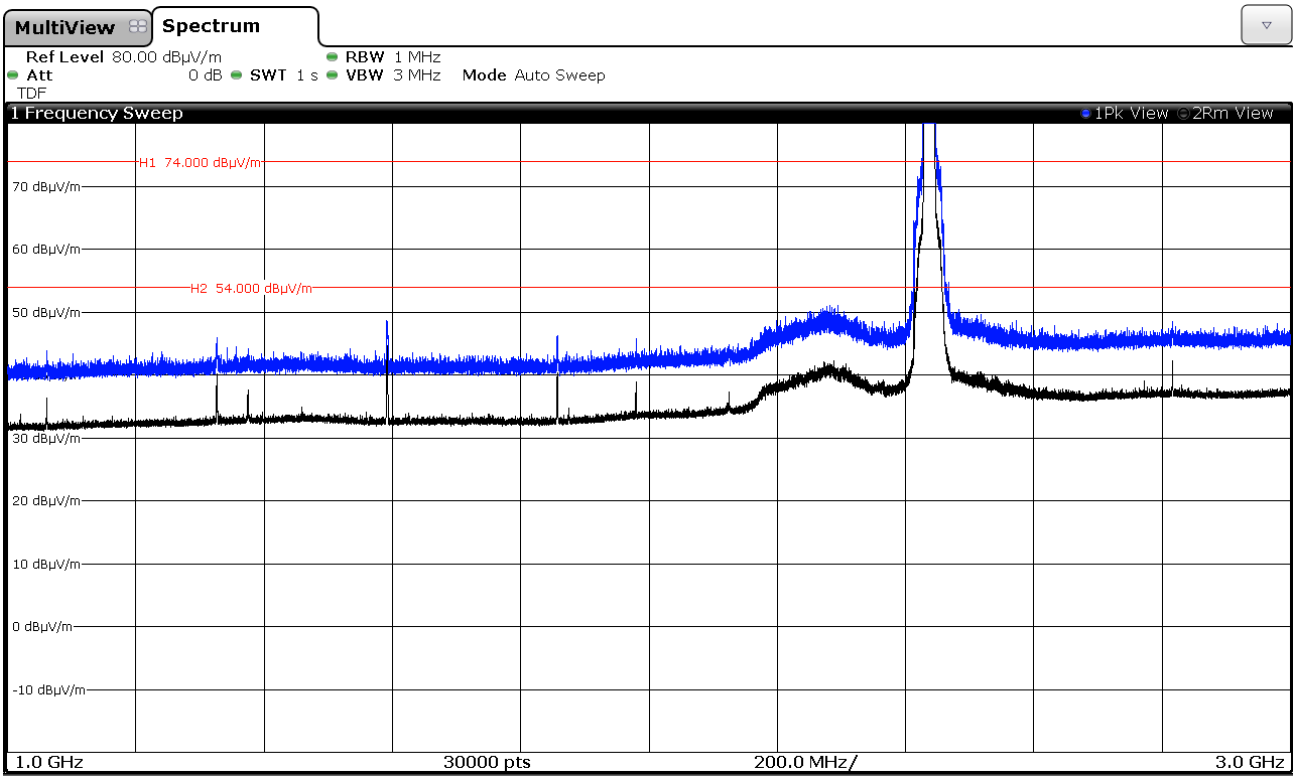
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



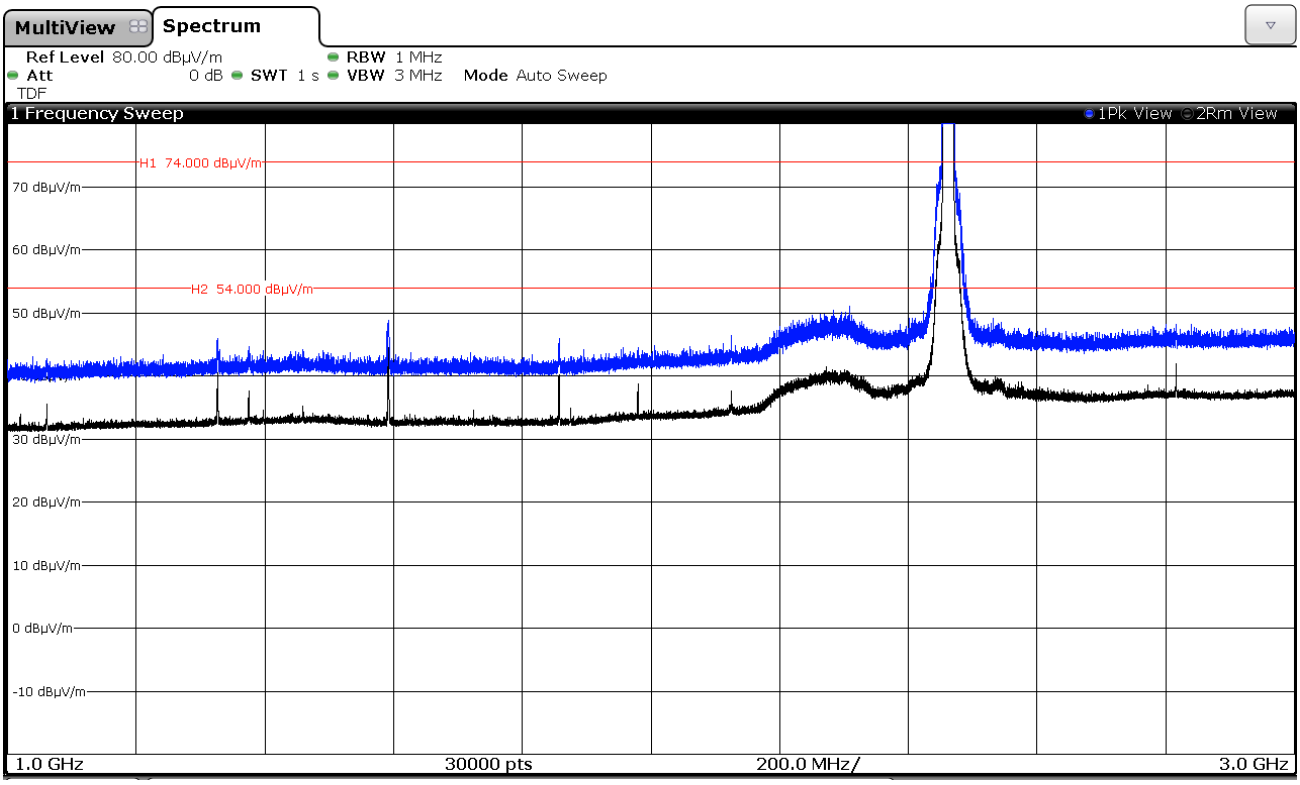
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



Note: The peak above the limit is the carrier frequency.

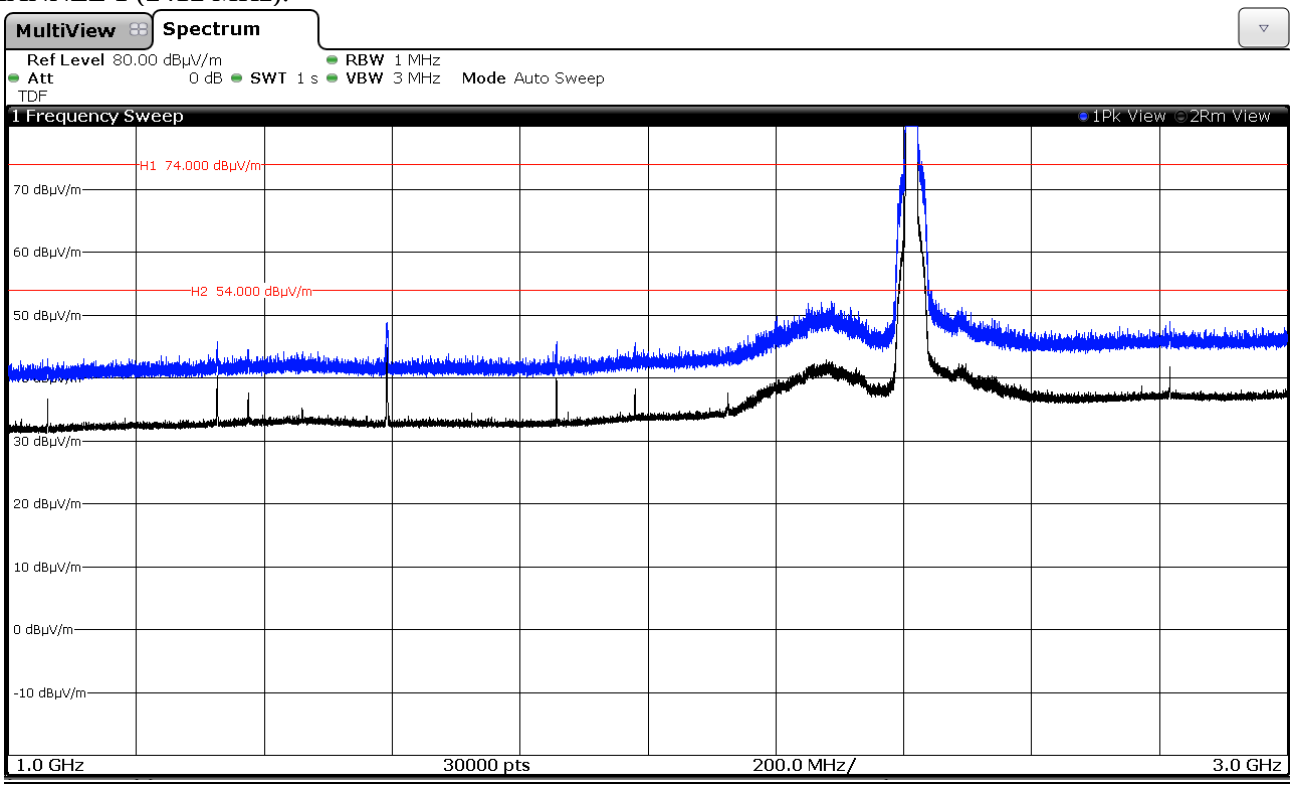
CHANNEL 11 (2462 MHz).



Note: The peak above the limit is the carrier frequency.

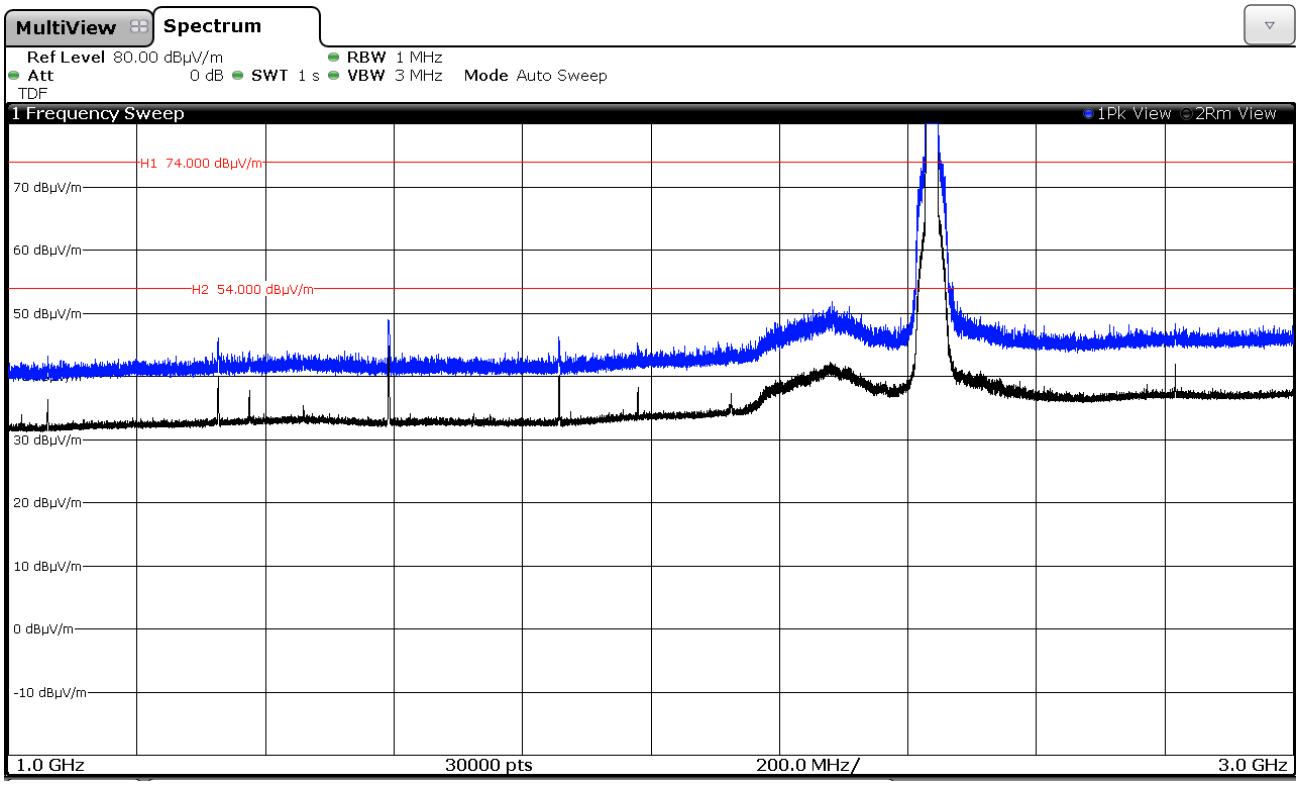
3.WiFi 2.4GHz 802.11 n20 mode

CHANNEL 1 (2412 MHz).



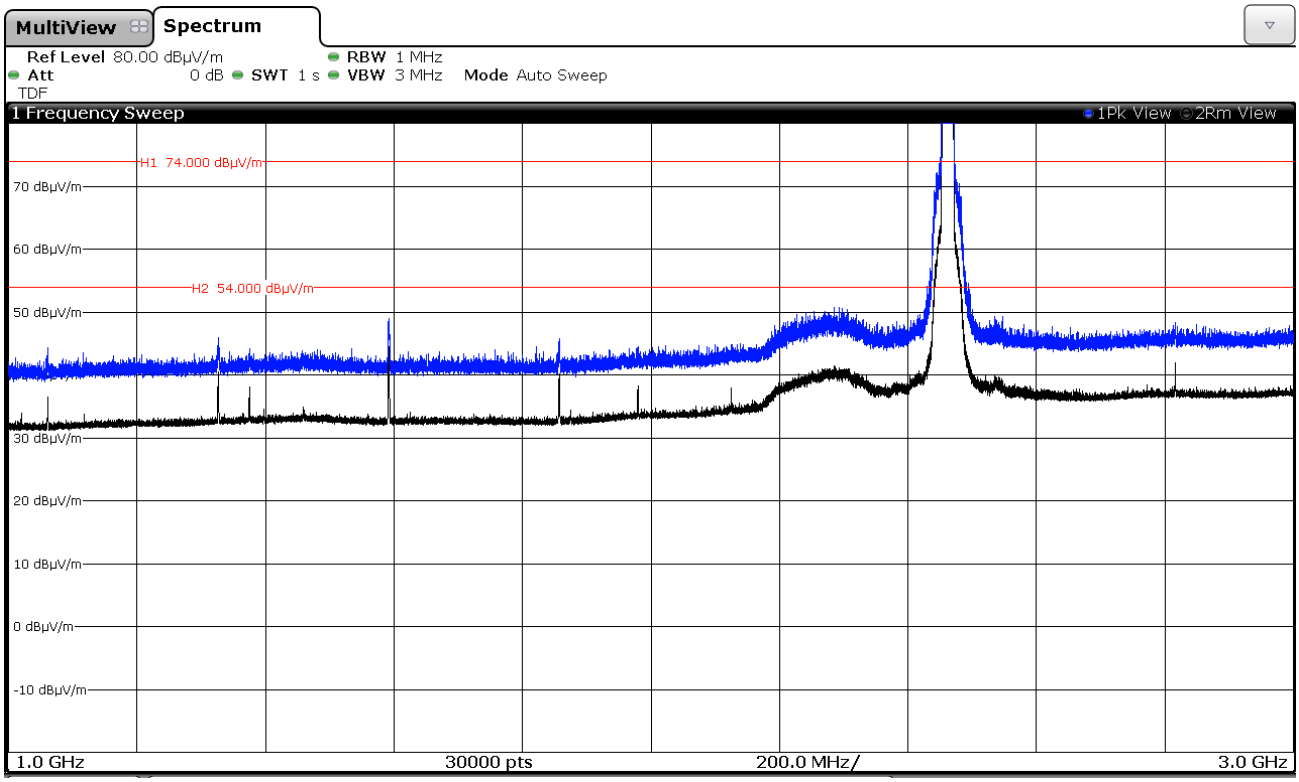
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



Note: The peak above the limit is the carrier frequency.

CHANNEL 11 (2462 MHz).

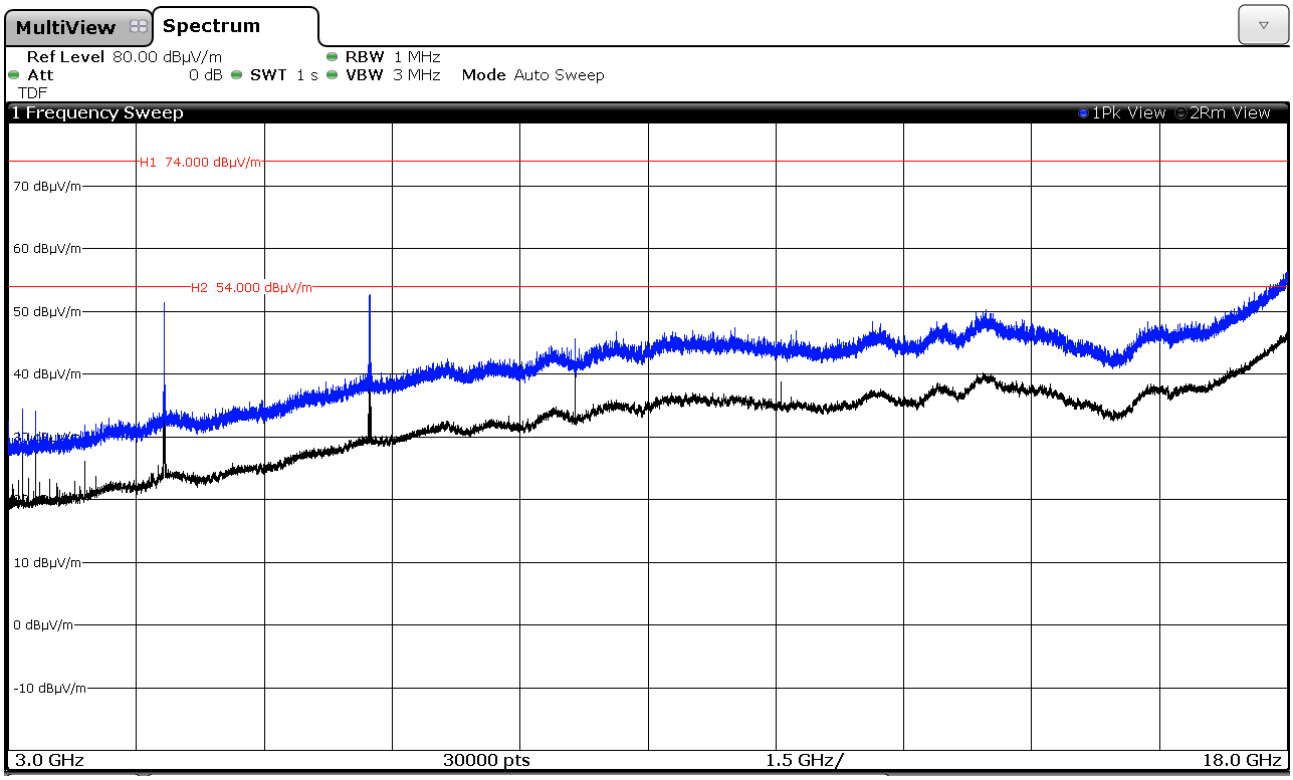


Note: The peak above the limit is the carrier frequency.

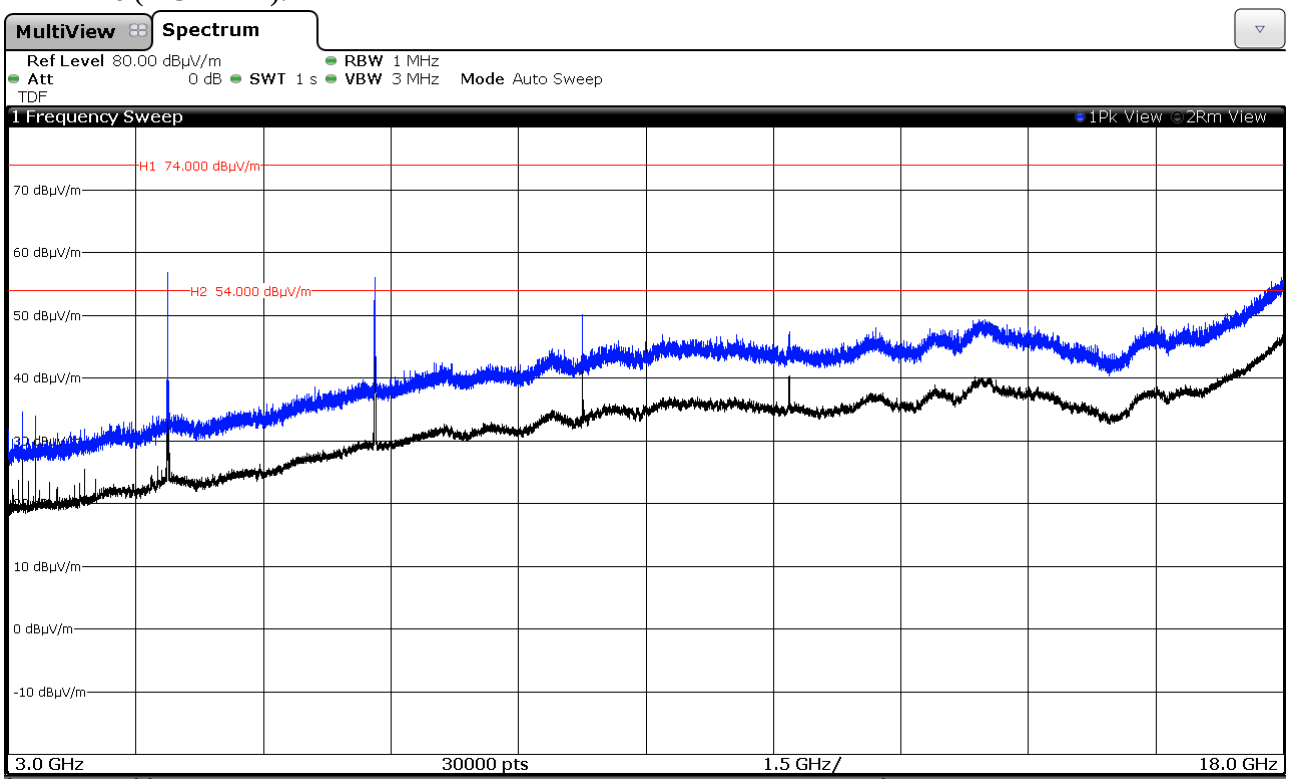
FREQUENCY RANGE 3 GHz to 18 GHz.

1. WiFi 2.4GHz 802.11 b mode

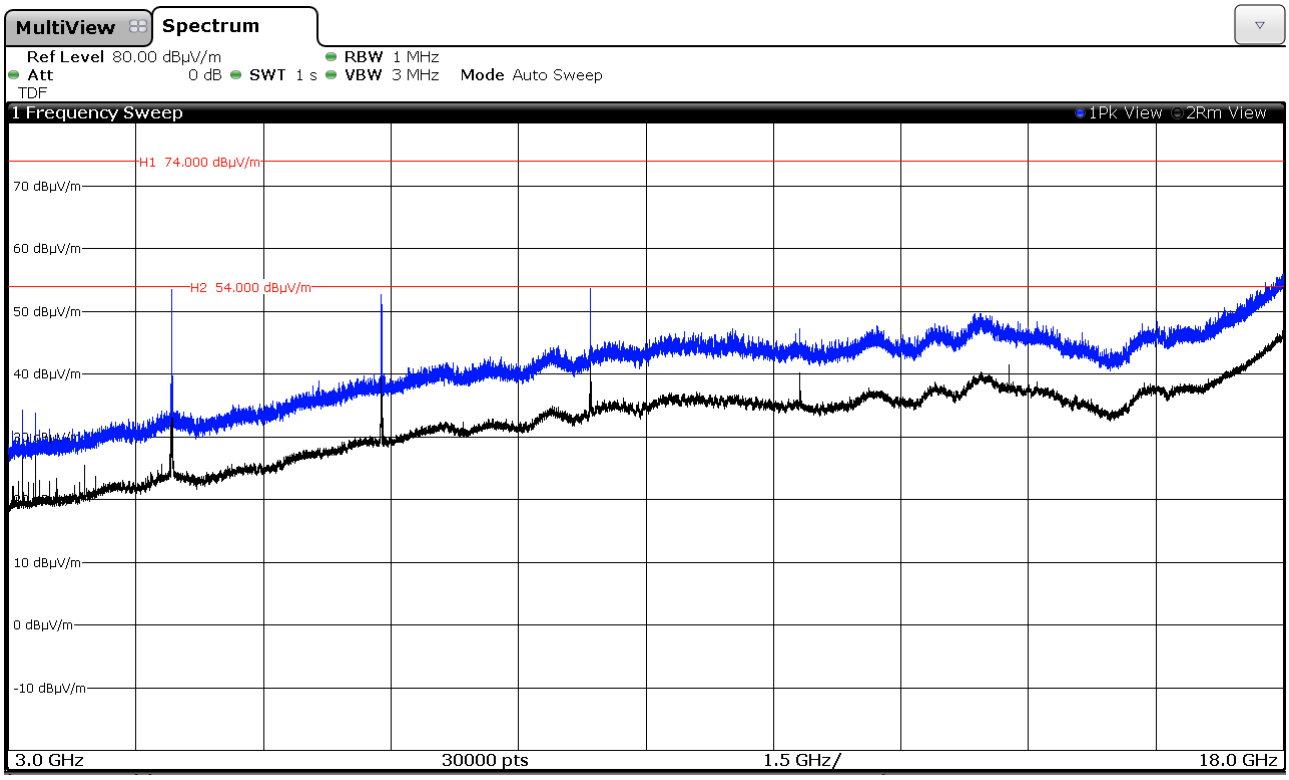
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

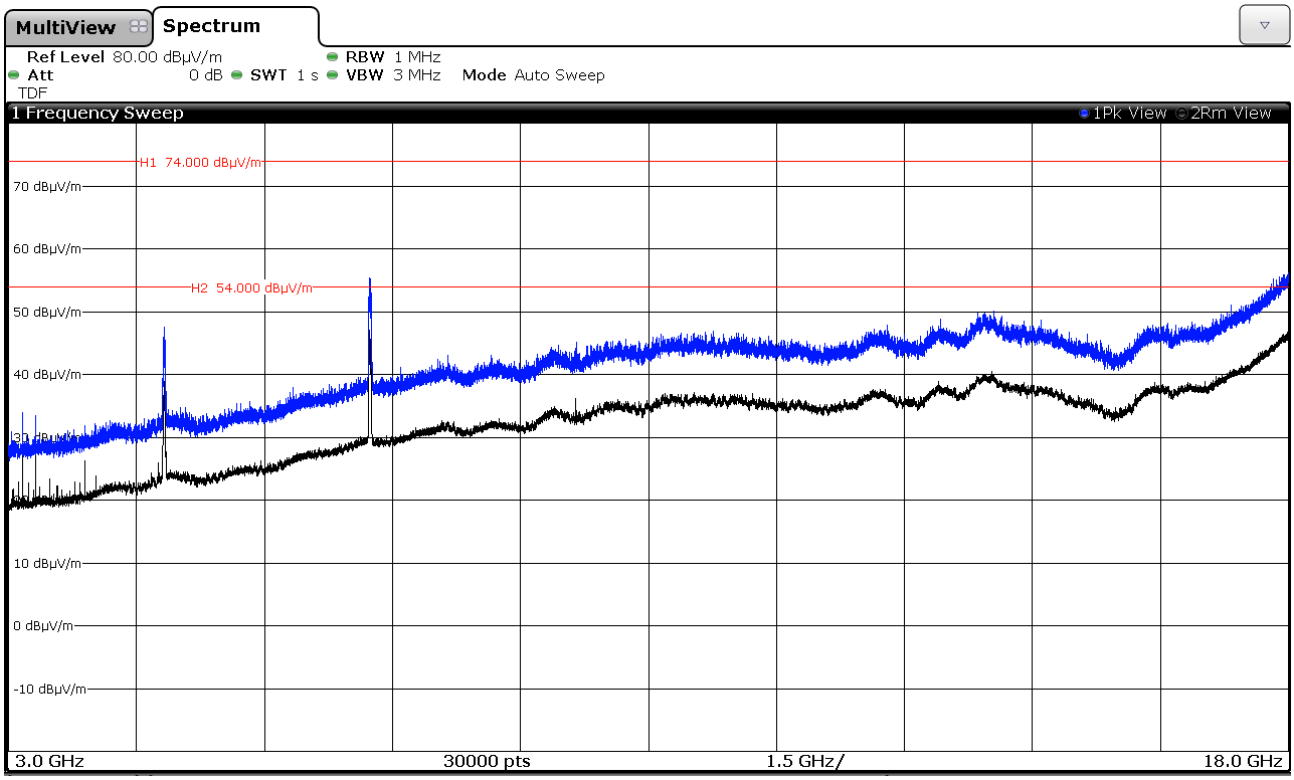


CHANNEL 11 (2462 MHz).

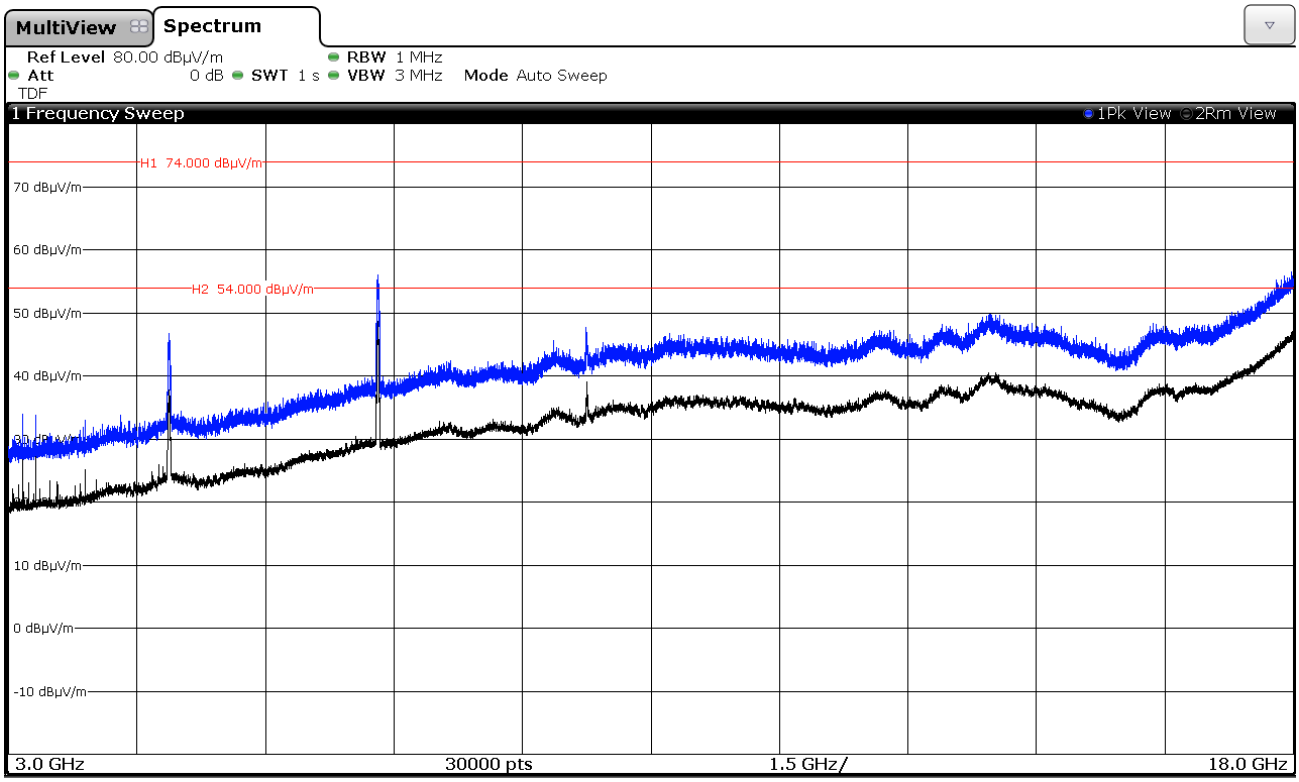


2. WiFi 2.4GHz 802.11 g mode

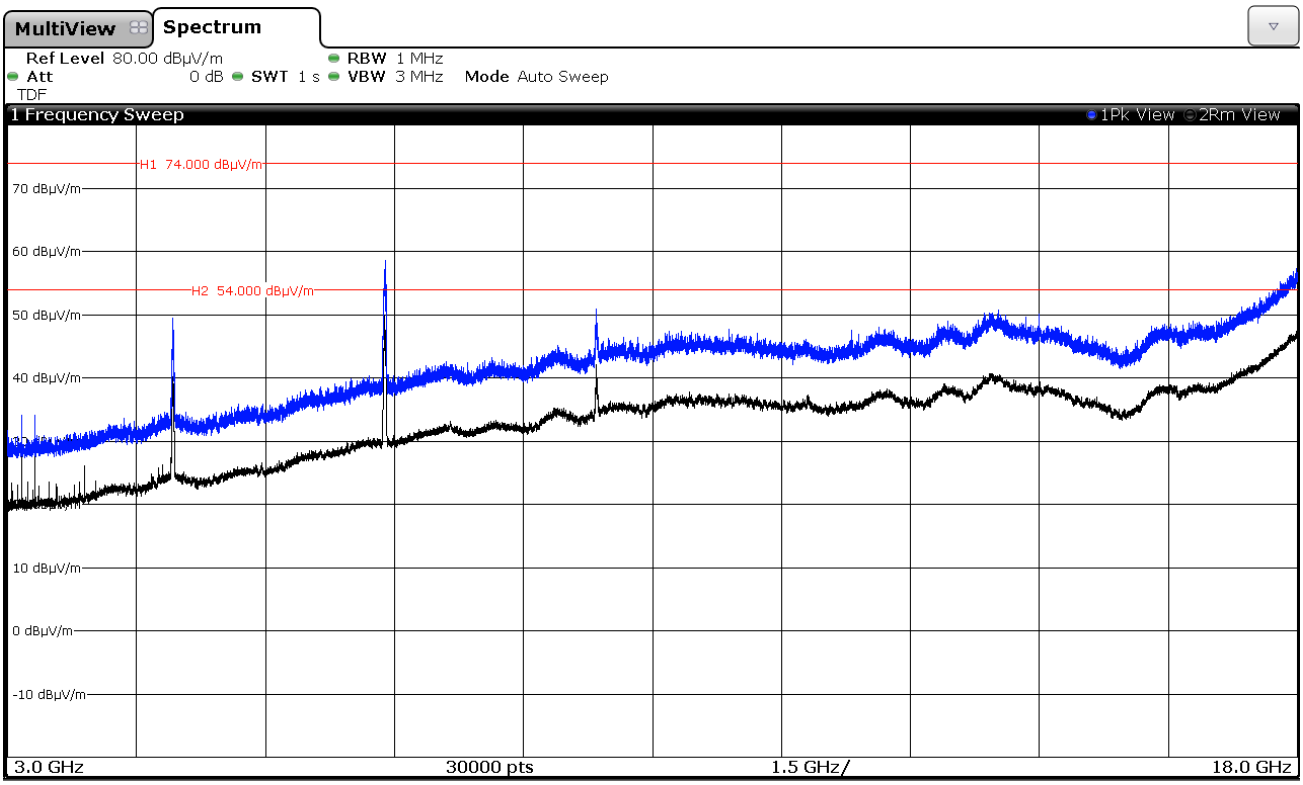
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

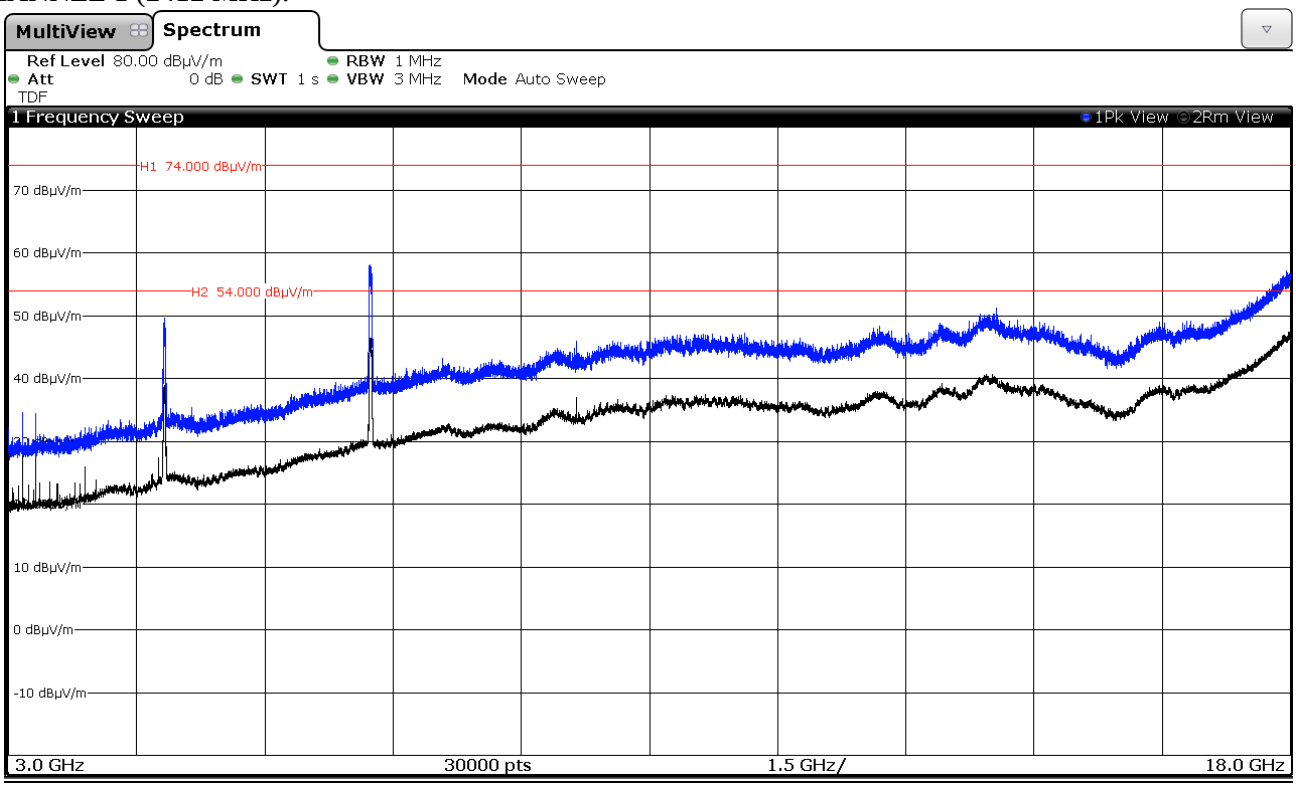


CHANNEL 11 (2462 MHz).

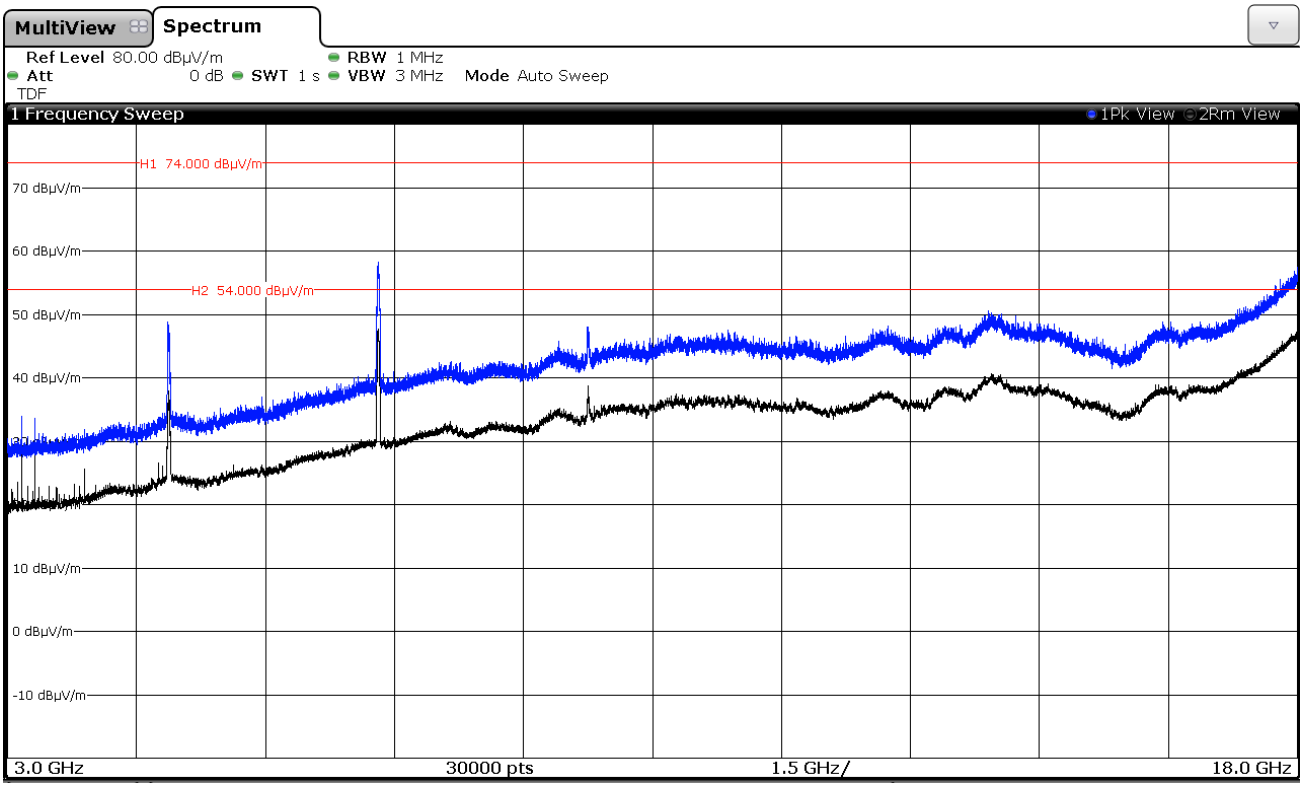


3.WiFi 2.4GHz 802.11 n20 mode

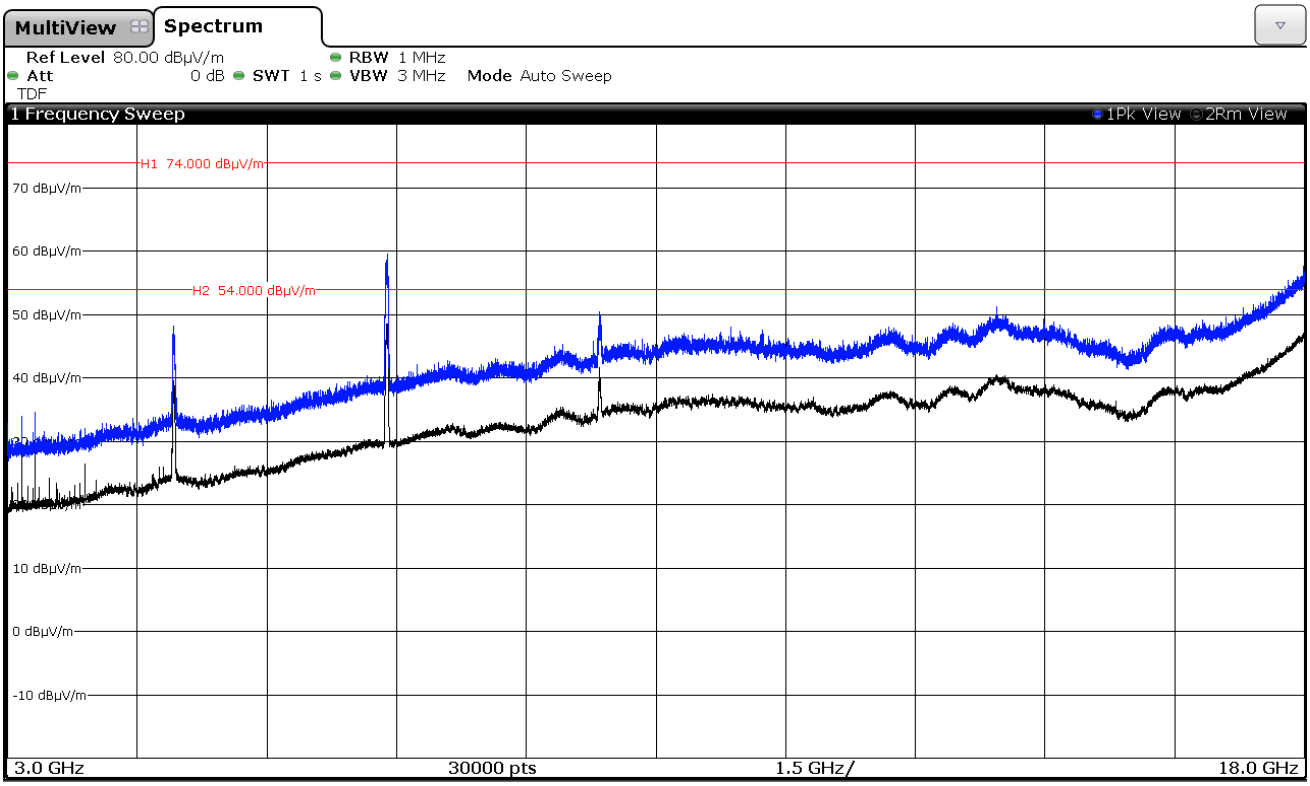
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).



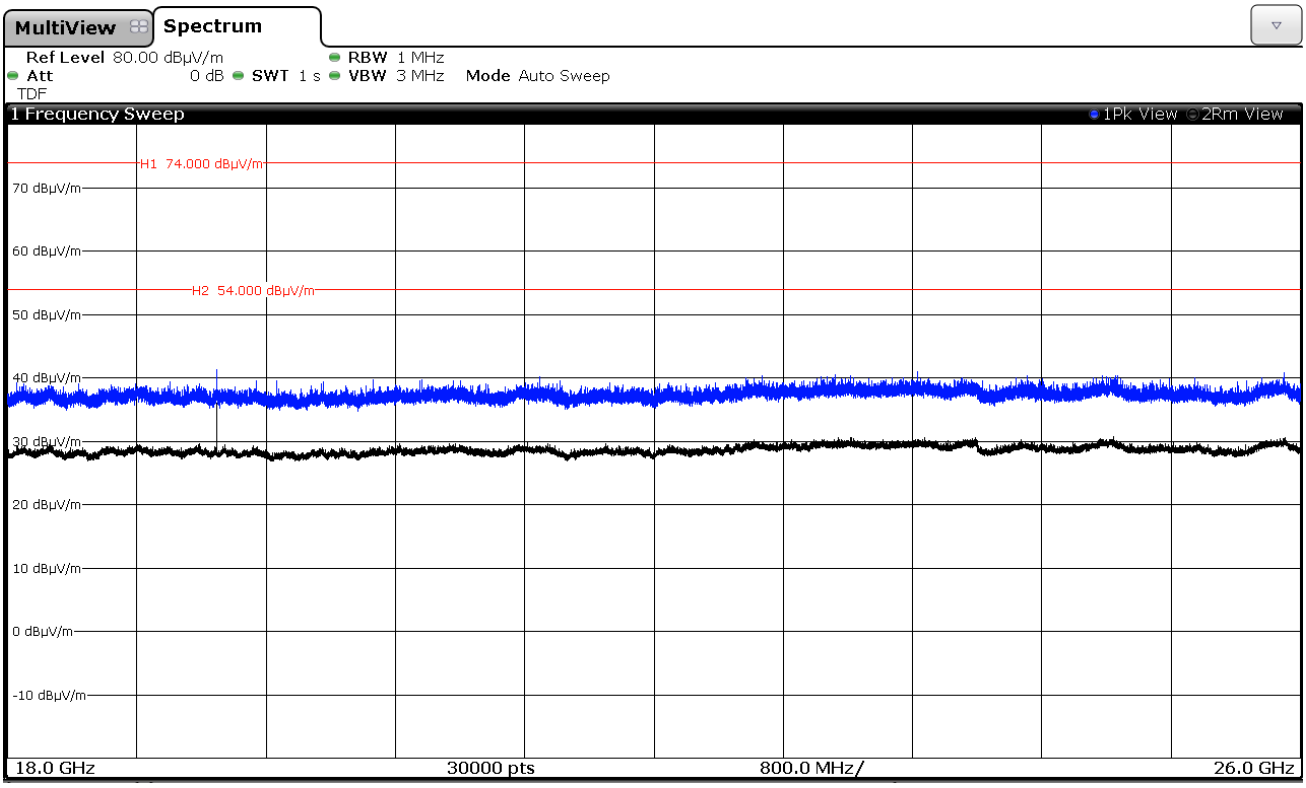
CHANNEL 11 (2462 MHz).



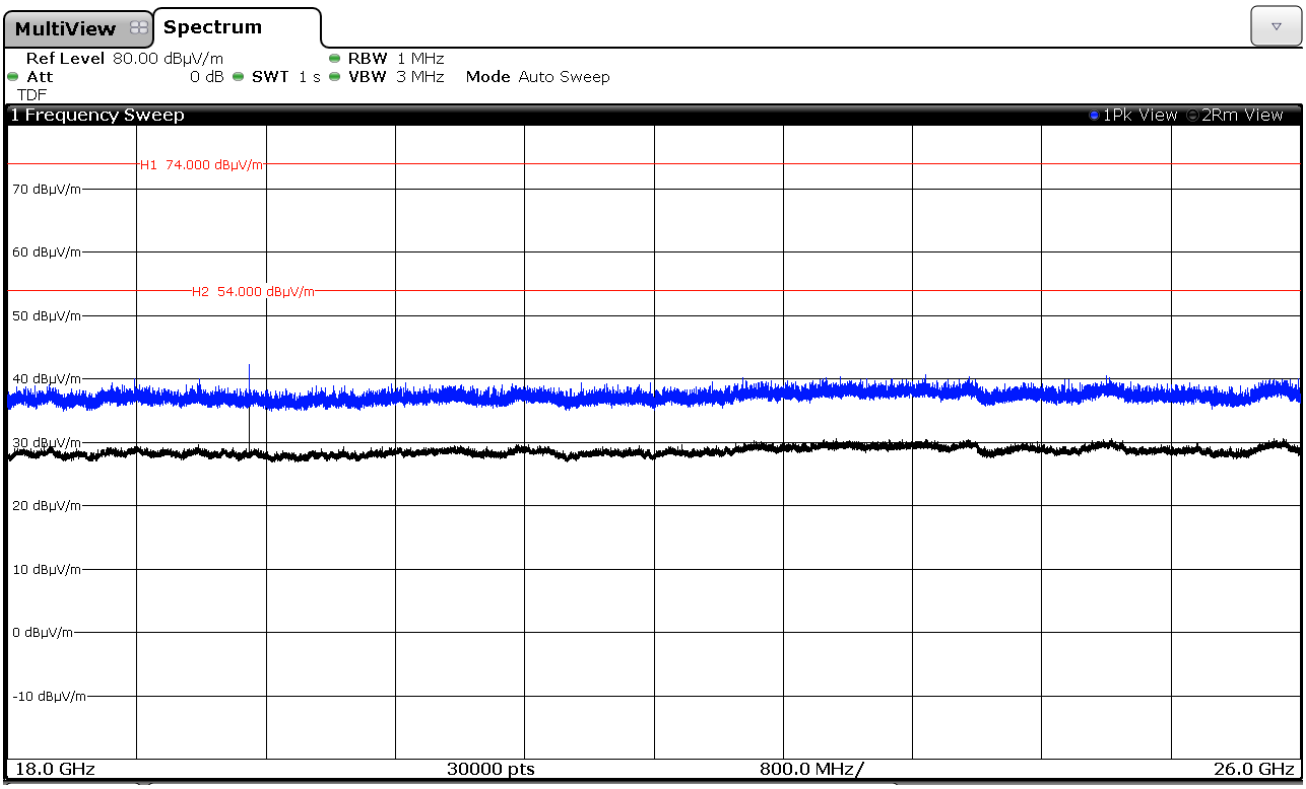
FREQUENCY RANGE 18 GHz to 26 GHz.

1. WiFi 2.4GHz 802.11 b mode

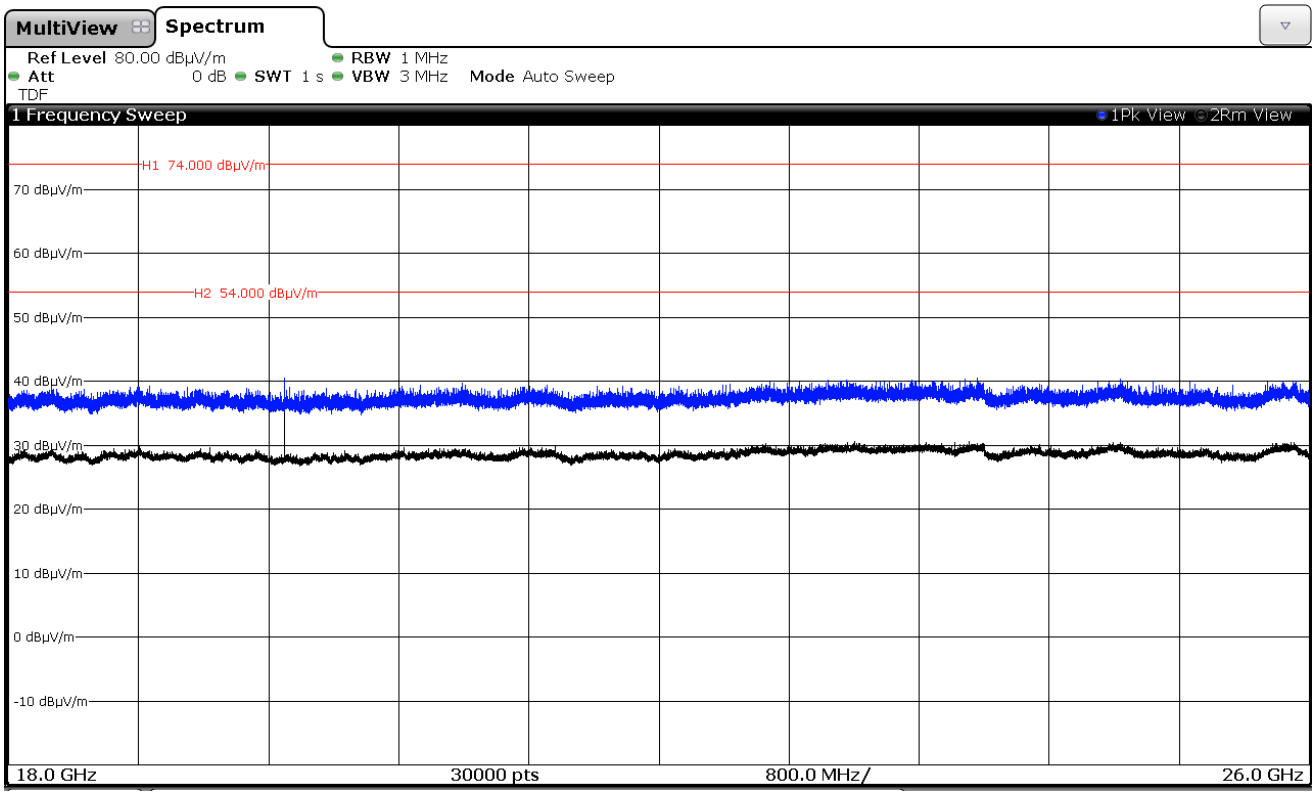
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

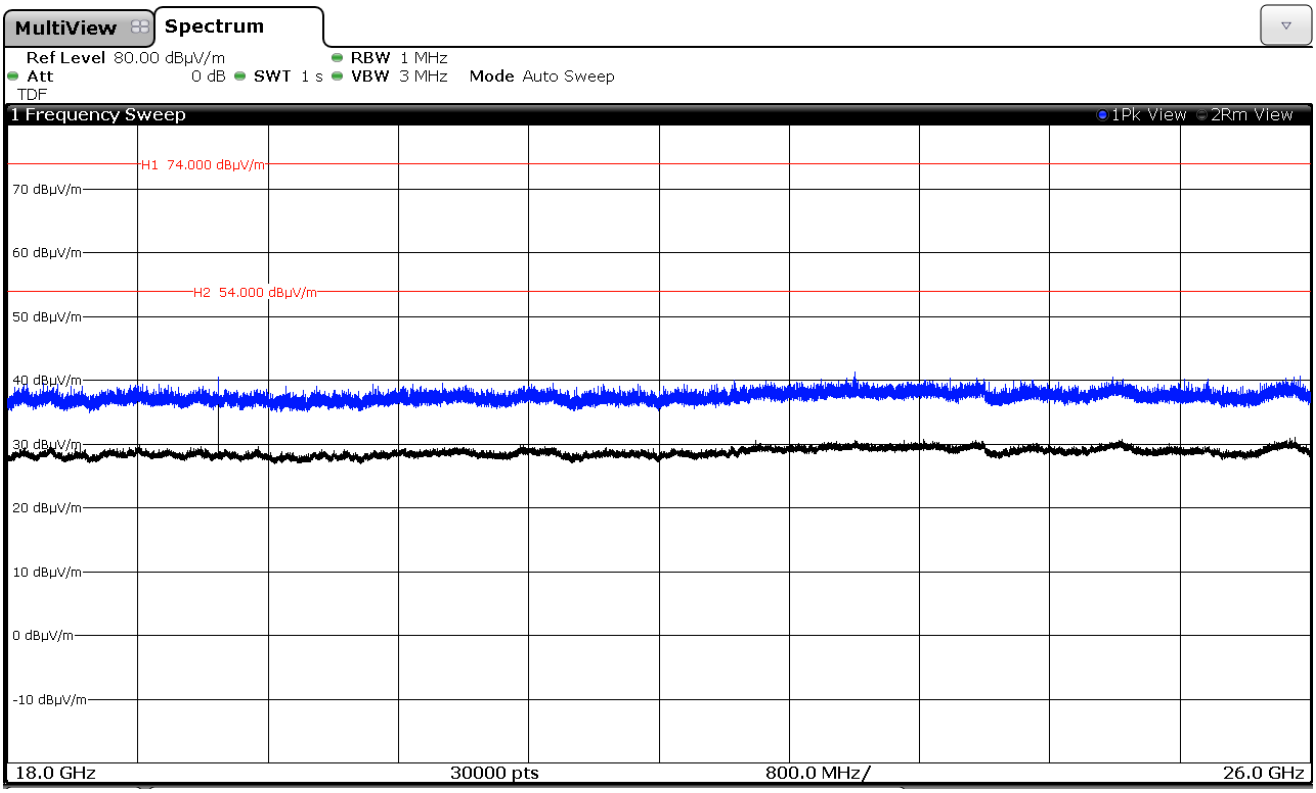


CHANNEL 11 (2462 MHz).

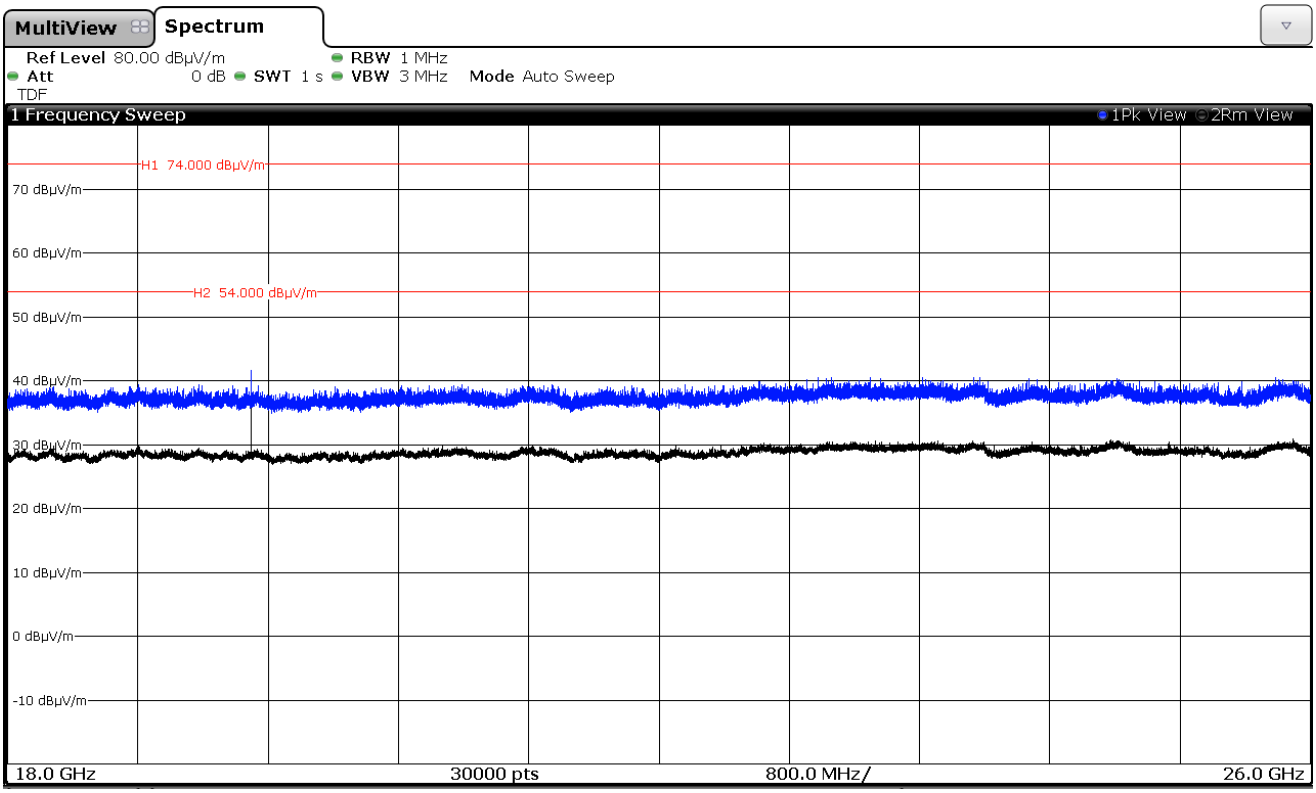


2. WiFi 2.4GHz 802.11 g mode

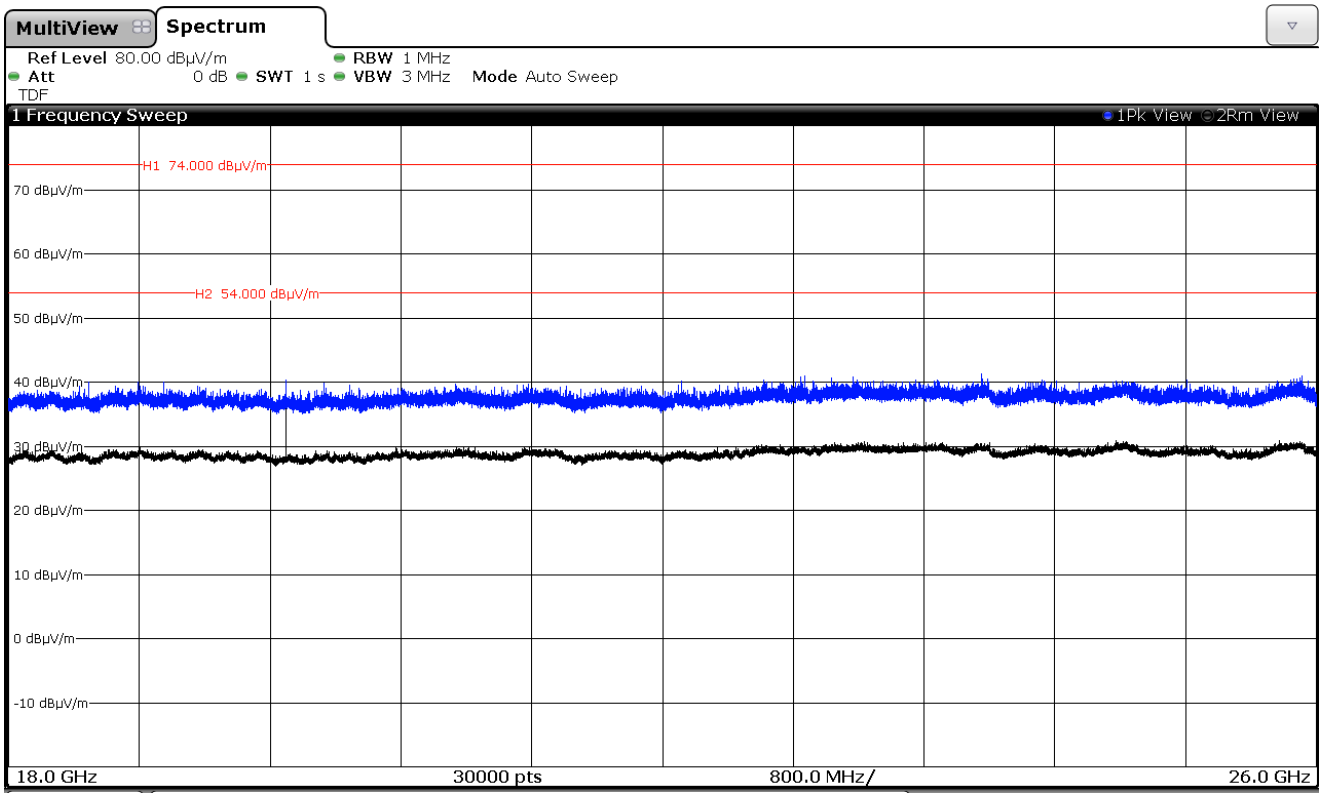
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

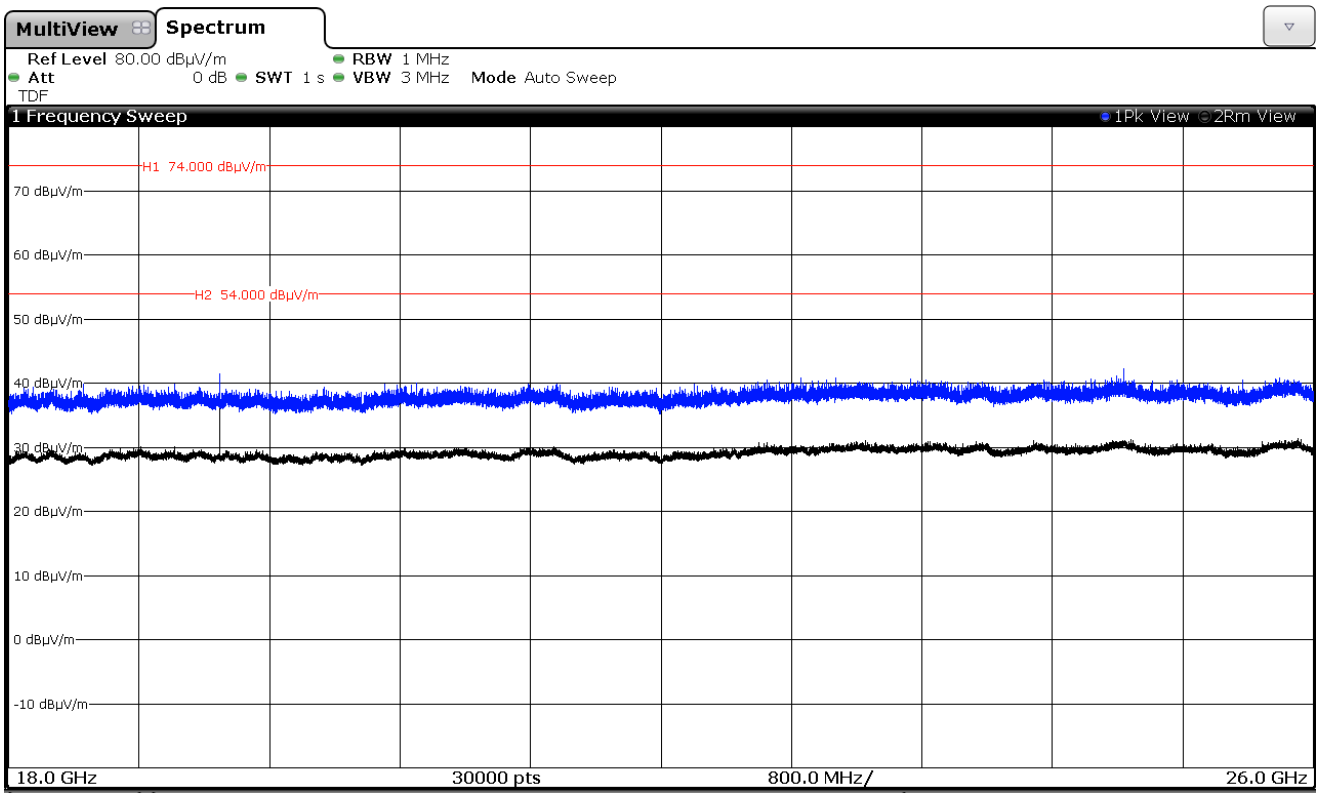


CHANNEL 11 (2462 MHz).

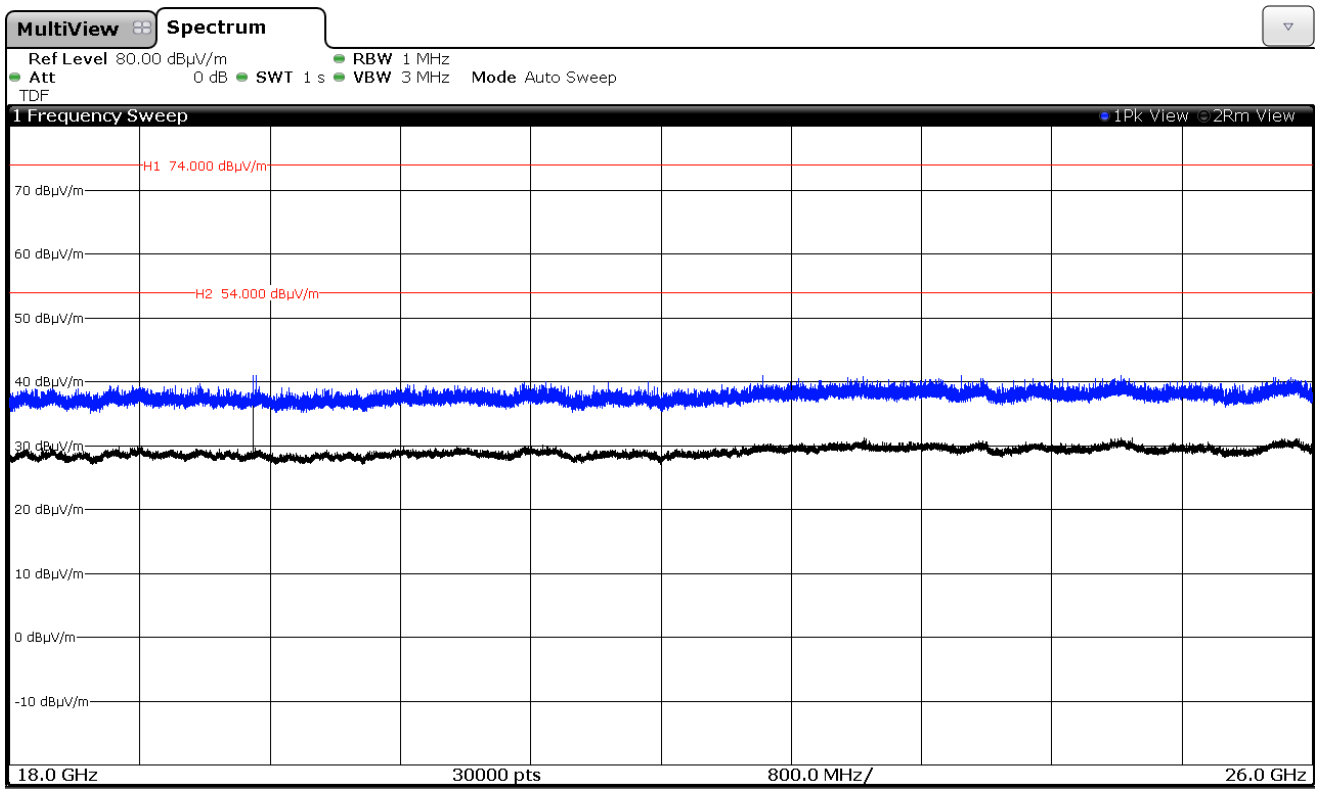


3.WiFi 2.4GHz 802.11 n20 mode

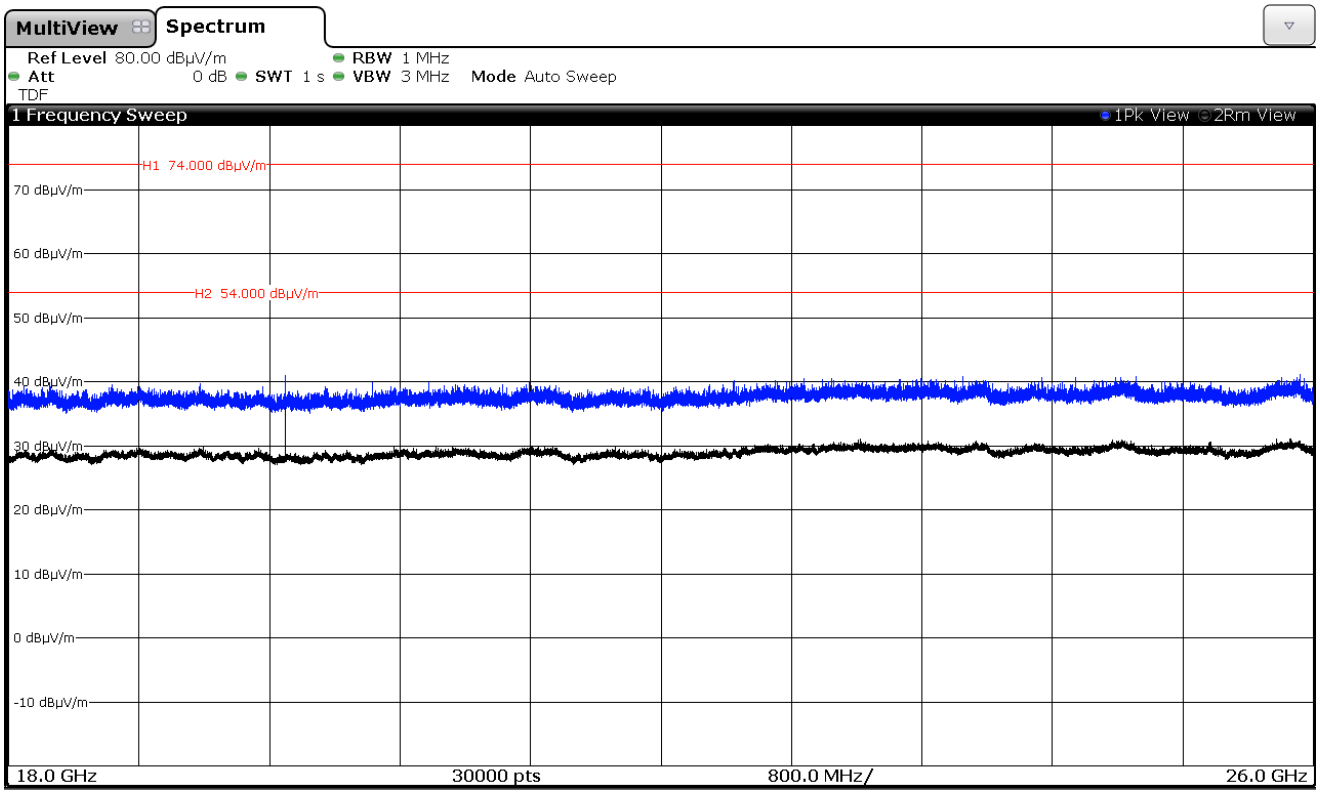
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).



CHANNEL 11 (2462 MHz).

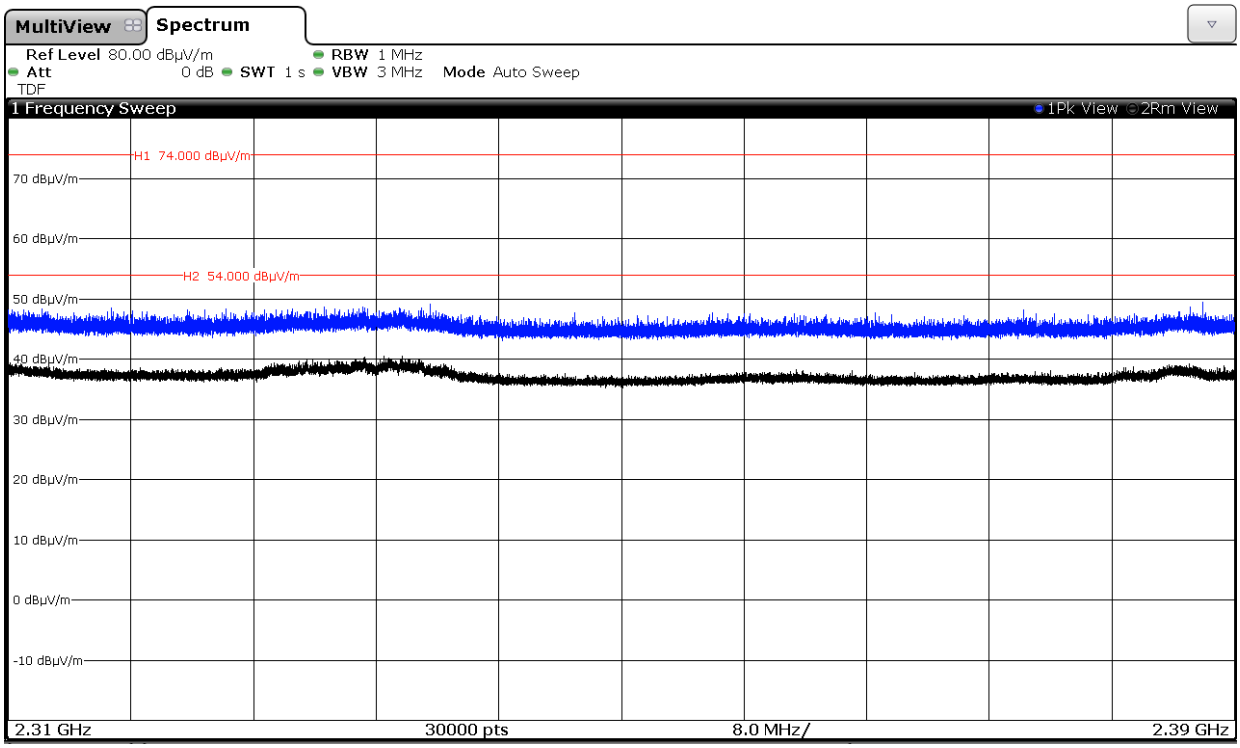


Radiated spurious emissions at band-edges and inside restricted bands 2.31-2.39 GHz and 2.4835 – 2.5 GHz.

FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

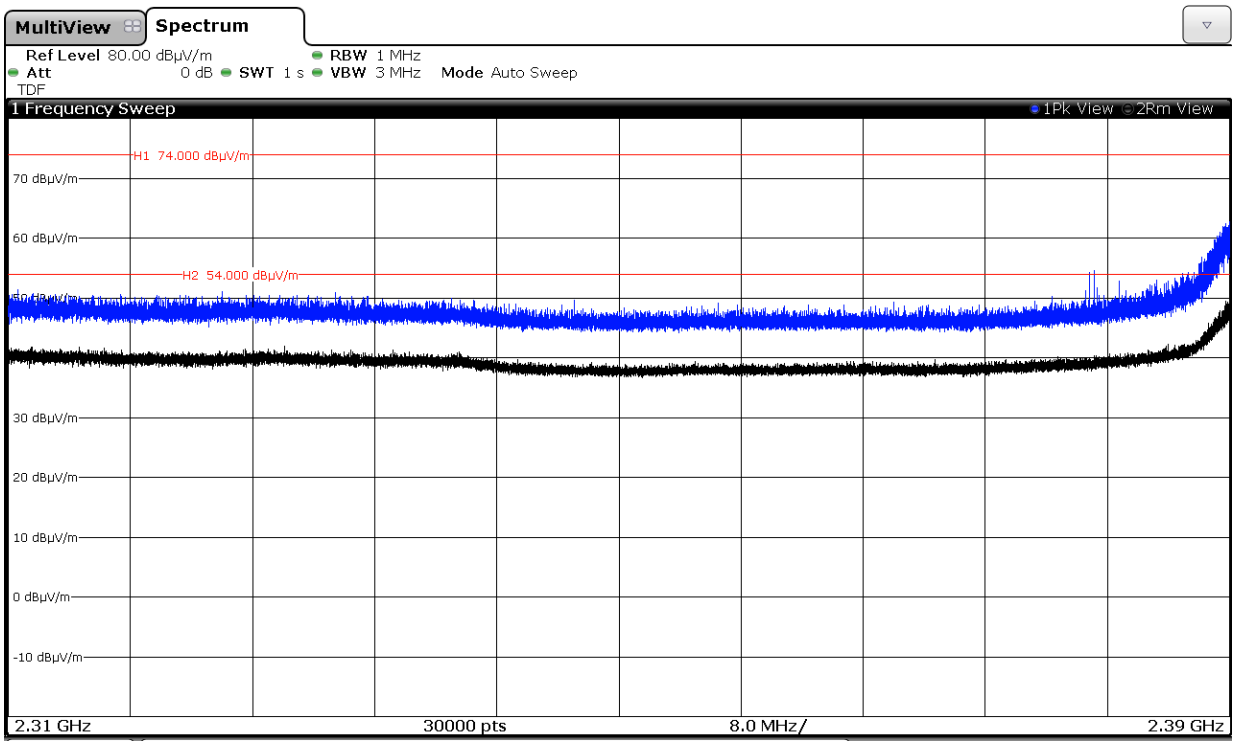
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



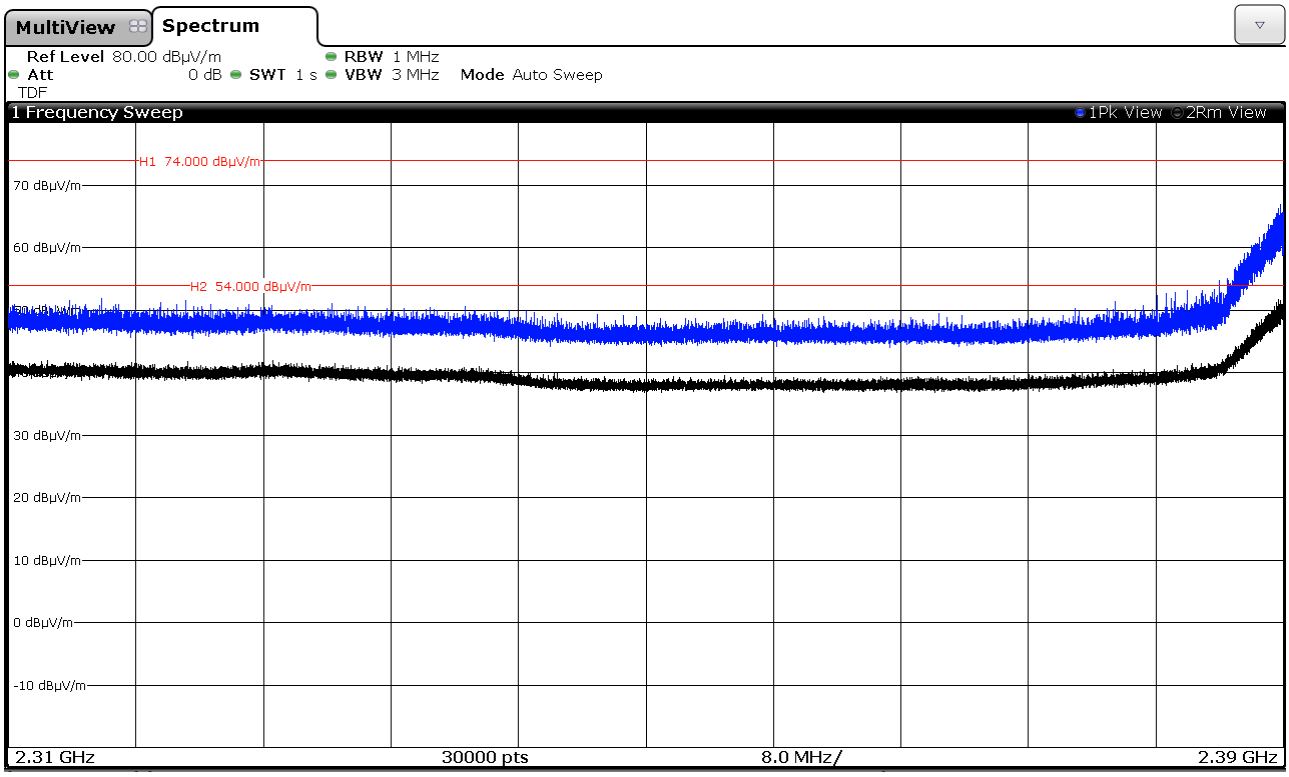
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



3. WiFi 2.4GHz 802.11 n20 mode

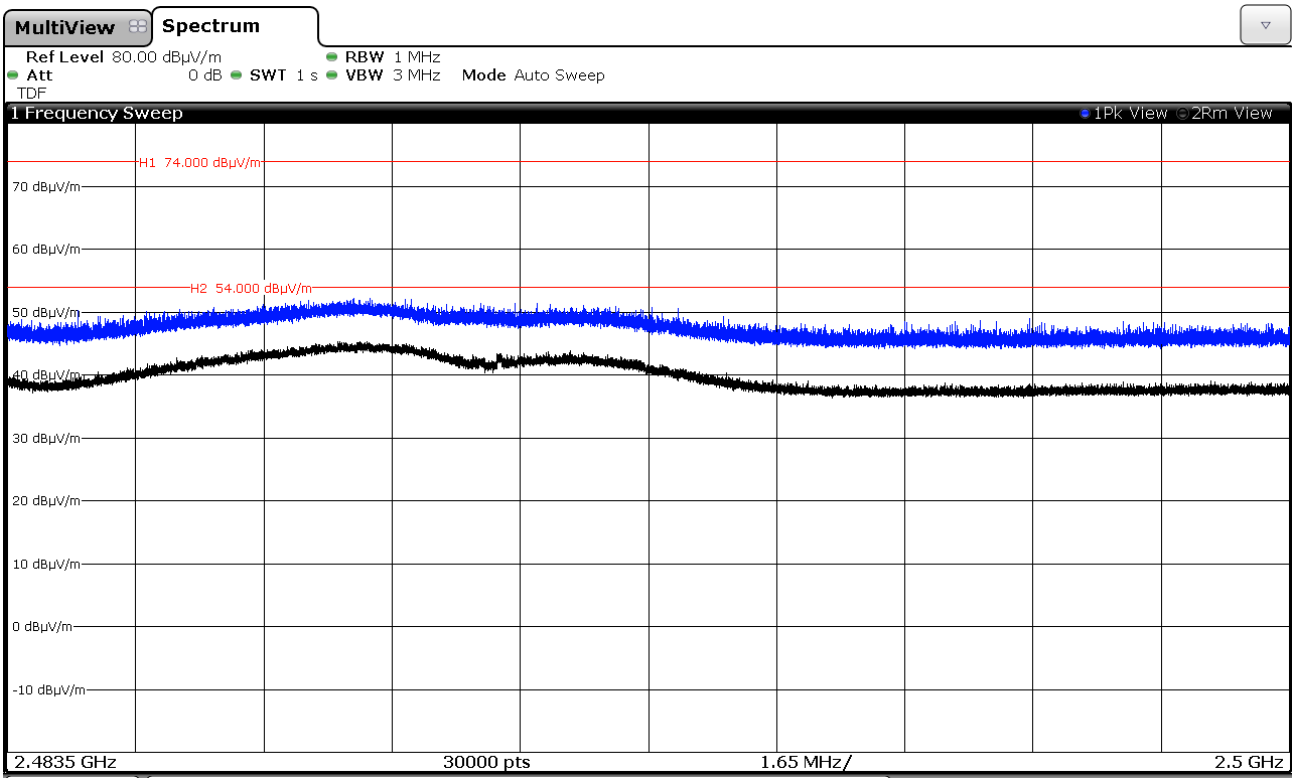
CHANNEL 1 (2412 MHz).



FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

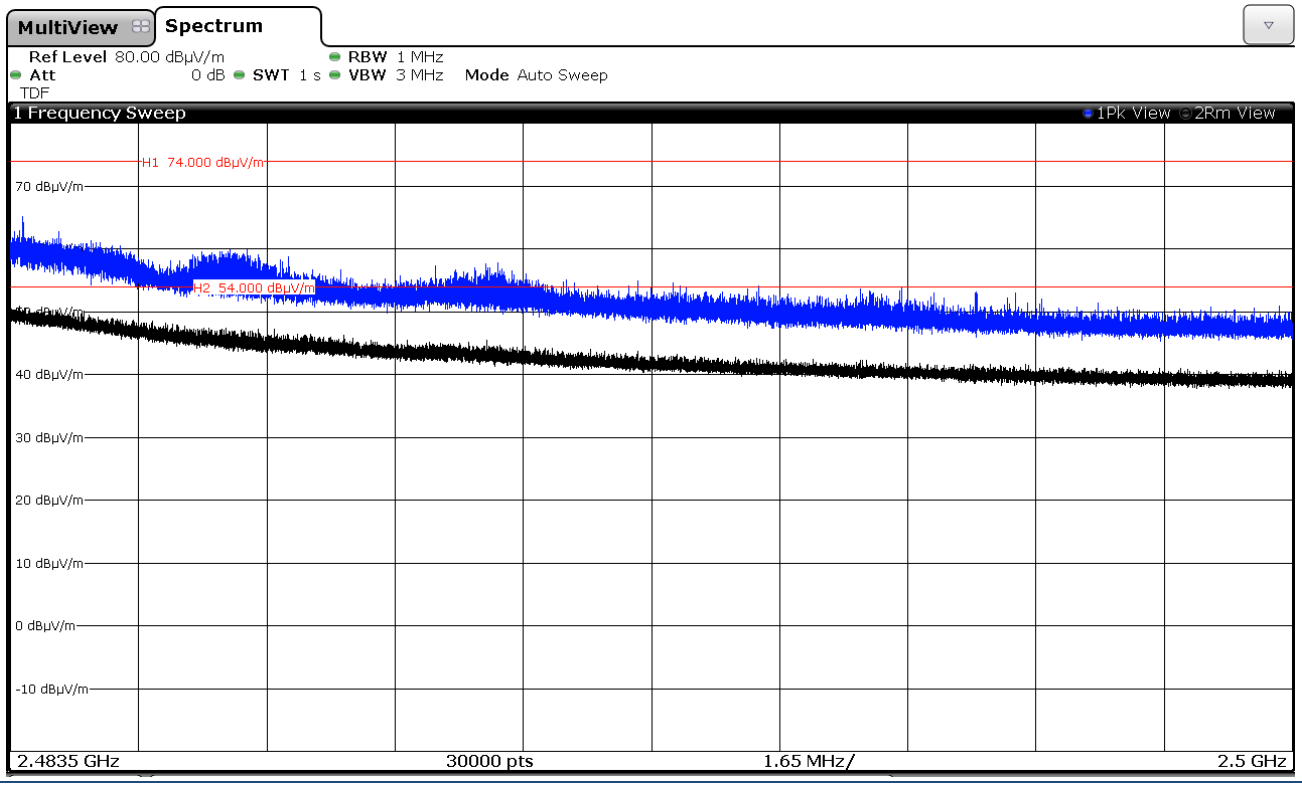
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 11 (2462 MHz).



2. WiFi 2.4GHz 802.11 g mode

CHANNEL 11 (2462 MHz).



3. WiFi 2.4GHz 802.11 n20 mode

CHANNEL 11 (2462 MHz).